SS4
Environmental Evidence

SS4.1 Introduction

Gill Campbell and Mark Robinson

Like work on the finds, analysis of the environmental material from the Raunds Prehistoric sites was undertaken over a considerable period of time, some twelve years, and has involved a number of different specialists. Sometimes more than one specialist has worked on a particular class of material. Human bone is a case in point, where Janet Henderson, Simon Mays and Angela Boyle have all worked on material from different monuments within the study area. Rather than try to rework the results of these various investigations, the individual reports produced by each specialist have been included their entirety, in the appropriate section, followed, where appropriate, by an overview. The exception to this is the pollen work undertaken on deposits in palaeochannels by Tony Brown (2006). This is published as part of the Raunds Area Survey within a detailed discussion of the geology and geomorphology of the study area (Parry 2006).

In the early 1990s it was decided that nomenclature would follow Clapham *et al* (1989) for both the palynological investigations and work on macroscopic plant remains. This was in order to achieve comparability between the work completed in the late 1980s and that completed in the 1990s.

SS4.1.1 Sampling strategy

All the excavations from which environmental material was recovered were undertaken as part of the Raunds Area Project, with the exception of the excavation of the Long Barrow (see below). Sites excavated as part of the project were sampled in accordance with a general sampling strategy devised by Mark Robinson, with advice from members of the Ancient Monuments Laboratory of English Heritage.

The aim of this strategy was to sample as wide a range of contexts as possible both spatially and temporally. In general bone did not preserve well in dry prehistoric contexts, the exception being the cattle cairn overlying Barrow 1 where the large volume of bone present produced its own high level of calcium. Molluscs were similarly rare in prehistoric features. Pollen was sampled from waterlogged palaeochannels and from the waterlogged deposits in the south ditch of the Long Barrow (Wiltshire SS4.2).

All the monuments were sampled. Particular attention was paid to those contexts that produced significant quantities of charcoal. There was not, however, a policy of sampling all prehistoric contexts. Samples for soil micromorphology, recovery of insect and waterlogged plant remains, molluscs etc, were taken either by the specialists themselves or their assistants. Details of these samples and their contexts are given in sections below.

At West Cotton nearly 250 samples for flotation and wet sieving were taken from prehistoric contexts and, in a few cases, from the overlying soil horizon. Samples were typically *c* 10 litres, although some of *c* 20 litres were taken from mound or ditch contexts, and 100% samples of between 1 and 5 litres were taken from some small features such as cremations or stakeholes.

Around 430 samples were taken from prehistoric features during the main excavations at Irthlingborough between 1985 and 1987. Samples were typically 20 litres, although some features such as the central pits of some of the barrows were sampled in their entirety.

During the 1991 and 1992 seasons at Stanwick, where one of the main aims was to date the field systems, 100-litre samples were taken from each excavated length of ditch, 80 litres of each sample being wet-sieved and 20 litres reserved for flotation. Both processes were carried out on site. At least two 50-litre samples were taken from each pit of the Segmented Ditch Circle and at least one 50-litre sample from other features. Cremations were bagged whole.

Each of the units involved in the excavations used different systems to float their samples although the same mesh sizes, 500 microns for the flot, and 1mm for the residue, were used throughout. All residues were sorted for bone, artefacts, and material that had failed to float, down to 4mm, and a minimum of 25% down to 2mm. The remaining portions of the residues were retained for further processing, dependent on the results of this sorting. In the event no further work on these residues was required.

SS4.1.2 The Long Barrow

Fieldwork at the Long Barrow took place outside the aegis of the Raunds Area Project under a PPG 16 brief from Northamptonshire County Council as part of the conditions for consent to gravel extraction on the site. The environmental archaeology of the Long Barrow was therefore not initially regarded as part of the Project. The sampling policy adopted, however, followed the same strategy as that for the Raunds Area Project sites. Waterlogged organic sediments were found in the bottom of the barrow ditches and it was realised that they had the potential to give important information on the Neolithic environment. A monolith was therefore taken through the deepest organic sediments of the southern ditch for pollen analysis and a sequence of bulk samples was taken through these deposits for macroscopic plant and invertebrate remains. The excavators took additional bulk samples from the ditch and sampled various deposits, including some middle Bronze Age cremations in front of the monument, for charred plant remains. A block was taken of the soil sealed beneath the barrow mound for micromorphological analysis. Bones and pieces of waterlogged wood were collected during the excavation.

Stratigraphic correlation between the pollen and main waterlogged macroscopic biological sequence

The pollen sample comprised a monolith 0.50m in height taken from the western face of section 62 through the organic sediments in the southern barrow ditch. The bottom of the monolith extended about 10mm into the terrace gravels through which the ditch was cut; the top of the monolith was at a height of 32.72m OD, at the transition between the organic sediment of context 226 and the overlying heavily iron-panned inorganic sediments of context 225 (Fig SS1.43).

The sequence for macroscopic remains comprised four bulk samples taken from the extreme eastern face of the same section through the southern ditch. The size of sample required necessitated a coarse sampling interval which followed lines of sedimentation. The bottom bulk sample, sample 131 (context 229), corresponded to a depth of 390–490mm on the pollen monolith. Sample 130 (context 228) corresponded to 230–390mm of the monolith, sample 129 (context 227) to 110–230mm of the monolith and sample 128 (context 226) to 0–110mm of the monolith.

SS4.2 Palynological analysis of organic sediments in the Long Barrow ditch

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SS4.2.1 Introduction

A monolith sample was obtained of basal sediments from the southern Long Barrow ditch (Fig SS1.43). These gleyed, organic deposits were underlain by thin primary silts and overlain by inorganic fill and alluvium. The organic deposits are dated to the second quarter of the fourth millennium cal BC by radiocarbon measurements on waterlogged seeds from their base and their top, and on oak chips and an oak plank preserved within them, which relate to the construction of the monument (OxA-3001, -3002, -3003, -6405, -6406; Bayliss *et al* SS6). Analyses of plant macrofossils and insects have been carried out on these sediments (Robinson, SS4.3.1) and it was considered that a palynological study might provide additional information on both the local vegetation and the wider landscape during this early phase of the Neolithic period.

Elegant models of the relationships between pollen catchment and basin size have been constructed to aid palaeoecological interpretation of pollen data (Tauber 1965; Jacobson and Bradshaw 1981). In broad terms it is considered that a large basin will collect palynomorphs from a wider area than a small one. However, such models are not directly applicable to ditches and pits (personal observation), and the relative inputs of palynomorphs into features on archaeological sites from local, extra-local, and regional sources need resolving.

There is little doubt that much of the pollen entering a ditch will be derived from plants within and in the near vicinity of the feature, but a proportion will also be received from extra-local and regional pollen rain. Superimposed on the ‘natural’ input might be palynomorphs contained within material being placed or discarded into the feature during and after functional use, and this material can be very mixed, containing plant remains from a variety of habitats and domestic sources. Interpretation of palynological sequences from archaeological features can, therefore, be problematical.

SS4.2.2 Methods

Sampling

For analysis, subsamples from the 0.50m monolith were taken at the interface of the basal organic sediment and overlying inorganic deposit, and then at 40mm and 20mm intervals. At each sampling point sediment was taken over a depth of 10mm.

Radiographic analysis

The monolith was examined radiographically to determine the size of clastic material, degree of porosity of the sediments, and the extent and distribution of plant roots throughout the profile. A standard X-ray was taken with a Faxitron X-ray machine on industrial grade Kodak film.

Processing

Standard preparation procedures were used (Dimbleby 1985). Wet sediment was measured for 20 cu mm volume displacement (Bonny 1972). Tablets of *Lycopodium* spores (Stockmarr 1972) were added to allow estimates of palynomorph concentration (Benninghof 1962). Samples were lightly stained with 0.5% safranine and mounted in glycerol jelly.

Counting

Pollen counting was carried out with a Zeiss phase contrast microscope at ×400 and ×1000 magnification. Palynomorphs were relatively poorly preserved and present in low concentration throughout the profile; only samples to a depth of 240mm were polleniferous enough to allow counting. In samples to 220mm, counts varied from 212 to 464 palynomorphs, with an average count being 310. In each sample, grains which were too badly corroded for identification, were also counted, being classified as 'unidentified'. This category included a small number of grains which eluded identification and remained as unknowns. Percentage data for unknowns are shown in Table SS4.1.

Too few palynomorphs were counted at 240mm to allow reliable statistical representation, and raw counts for this sample are shown in Table SS4.2. Samples from 260mm to 480mm contained only occasional palynomorphs and counting was considered impracticable.

Table SS4.2. Long Barrow. Pollen raw counts for sample at 240 mm

Pollen taxa	*Raw Counts*	*% Value*
Trees and Shrubs		
Alnus	2	3.5
Betula	1	1.7
Corylus avellana type	1	1.7
Tilia	1	1.7
TOTAL	5	8.6
Herbs		
Plantago lanceolata	3	5.2
Gramineae	11	19
Artemisia	1	1.7
Cyperaceae	25	43.1
Compositae – Liguliforae	3	5.2
TOTAL	43	74.1
Unidentified	10	17.2

Table SS4.1. Long Barrow. Frequency and percentages of *Glomus* type, acritarchs, algal spores and unidentified grains in waterlogged deposits (phase 2.2.i)

() = Raw counts

Depth (mm)	*0*	*40*	*80*	*100*	*120*	*140*	*160*	*180*	*200*	*220*	*240*
Glomus type sporangia			+		+			+			(2)
Acritarch	+										
Algal spores Indet	7.4	15.8	25.8	28.4	12.4	31.6	20.7	33.4	6.8	2.3	(5)
Mougeotia		0.2	0.4				0.5	0.2			
Pediastrum		0.2									
Spirogyra	5	4.3	4.4	8.3	18.7	3.9	1.8	9	7	1.8	
Zygnema	2.4	2.1	1.6	1.2	1.1	1.2	0.8	1.1	0.5		
Unidentified	11.3	15	17.9	14.1	8.2	5.1	1.3	7.2	5.8	11.3	(10)

Microscopic charcoal
Errors are inherent in all quantitative methods of estimating the abundance of microscopic charcoal in pollen preparations. Chemical and physical processing of polleniferous sediments inevitably result in comminution of large fragments of charcoal into variable numbers of smaller particles. Another possible source of error is variation in the volume of sub-samples. Here, subsample volume was the same throughout, and processing error was treated as a constant. All particles >5.0µm diameter in a total of 10 traverses were counted.

Iron pyrite framboids
There were counted in the same way as microscopic charcoal particles.

Fungal and algal palynomorphs
Percentage data for these groups are shown in Table SS4.1.

Identification and nomenclature

Identification was aided by examination of modern reference material wherever necessary. Nomenclature follows that of Clapham *et al* (1989) in order to achieve consistency with the work on macroscopic plant remains, which took place prior to the publication of Stace (1991). Cereal type/*Glyceria* pollen refers to all grains of >40.0µm; the level of pollen preservation did not allow critical examination of annuli and pores. In view of the fact that *Glyceria* had been recorded from the ditch sediments (Robinson SS4.3.1), and that this grass produces pollen in the size range of certain cereals, it was considered prudent not to claim cereal status for large grass pollen grains. No attempt was made to differentiate *Corylus avellana* (hazel) from *Myrica gale* (sweet gale), and both are included in *Corylus avellana* type. Given the nature of the site, it was considered that this pollen taxon represented hazel and this taxon will be referred to as '*Corylus*' rather than '*Corylus avellana* type' throughout.

Expression of palynomorph data
Concentrations of pollen and pteridophyte spores were expressed as numbers cm^{-3}. Percentage data were expressed on the basis of total pollen and spores (TLP/S), excluding obligate aquatics. Aquatics and algae were expressed as percentage of self plus TLP/S. Microscopic charcoal was expressed as numbers of particles cm^{-3} and iron pyrite framboids were also expressed as numbers cm^{-3}.

Diagrams

Figure SS4.1 shows concentrations of palynomorphs, microscopic charcoal, iron pyrite framboids, and percentage data for selected taxa. Figure SS4.2 is a diagram showing percentages of all pollen and pteridophyte spore taxa. Single grains or values of less than 1% are shown as '+'. Local pollen assemblage zones were determined subjectively, based on characteristics of pollen and plant spore spectra. These were designated RF1a, RF1, RF2 and RF3 for convenience of description.

SS4.2.3 Results

Results are shown in Figures SS4.1–2 and Tables SS4.1–SS4.2. Figure SS4.1 is a summary diagram showing pollen and pteridophyte spores, microscopic charcoal, and iron pyrites framboid concentrations. Also shown are curves for dominant algae, arboreal taxa, Cyperaceae (sedges), Gramineae (grasses) and other herbs. Figure SS4.2 is a detailed diagram of pollen and pteridophyte spores. Table SS4.1 shows frequency and percentages of *Glomus* type, acritarchs, algal spores, and unidentified grains. The values given for the sample at 240mm (shown in brackets) are raw counts. Table SS4.2 shows the raw counts and percentage values of all the pollen taxa observed in the sample at 240mm. These values must be treated with caution in view of the very low count.

Description of lithology from X-radiography

The basal 270mm of sediment consisted of compacted, inorganic sediment containing abundant closely packed clasts of variable size, but not exceeding 20mm in diameter. At about 230mm this gave way to a finer-grained, less radio-opaque, less compacted sediment. Clast size was variable but mostly of <3mm; but larger mineral fragments ranging from 12mm to 25mm were distributed throughout. The uppermost 110mm of sediment appeared to be the least radio-opaque and clasts did not exceed 5mm in diameter. Traces of plant roots were present throughout the profile but were least abundant in the top 110mm of sediment.

Description of local pollen assemblage zones

Palynomorphs were present throughout the profile but reached concentrations that allowed reliable counting only down to 220mm. A count was produced for 240mm

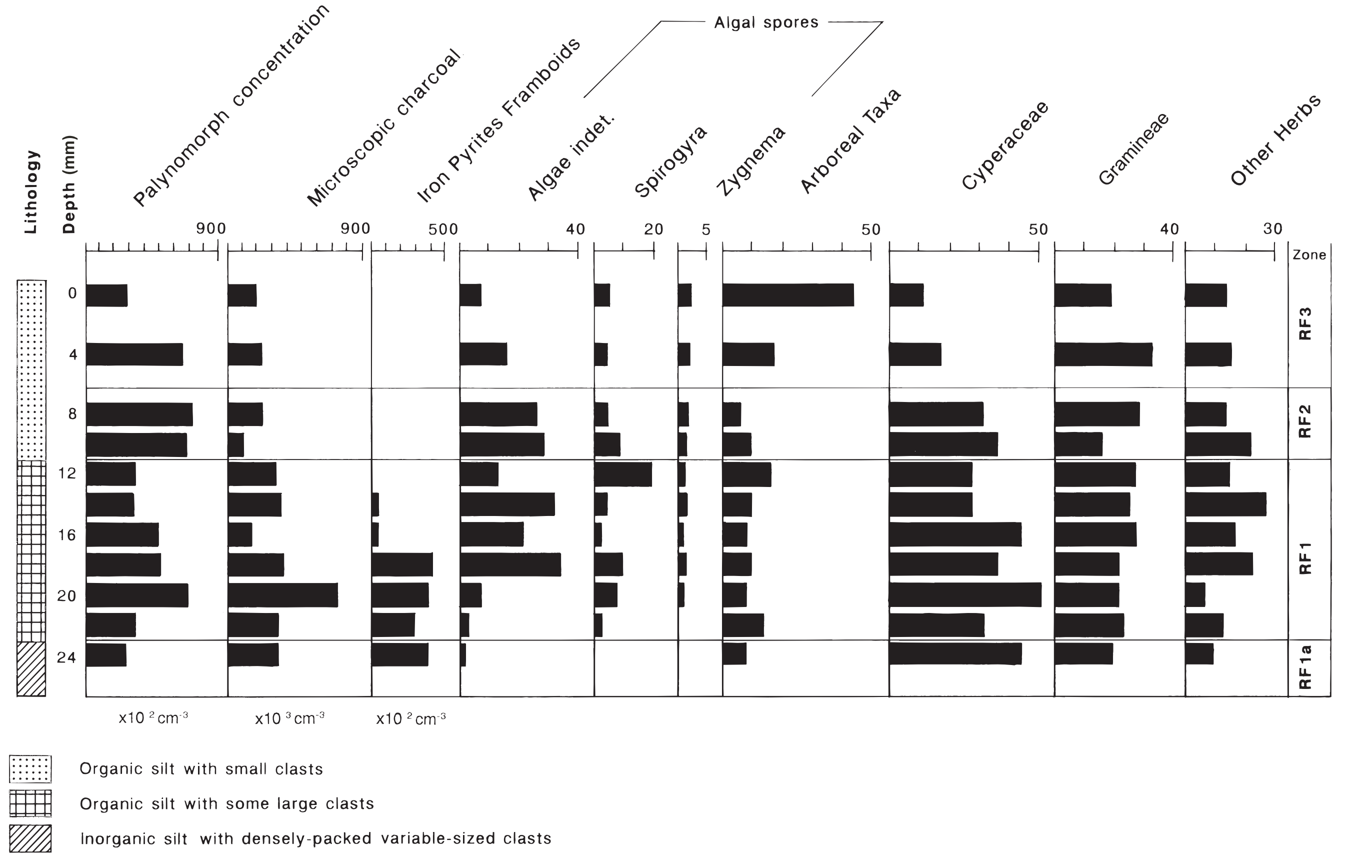


Figure SS4.1 Long Barrow. Summary diagram showing concentrations of palynomorphs, microscopic charcoal, iron pyrite framboids, and percentage data for selected taxa in organic ditch deposits.

but pollen and spores were exceedingly sparse and the data may only be taken to indicate presence of taxa and a crude picture of relative abundance (Table SS4.2). Percentage data from this count are included in the summary diagram (Fig SS4.1 – zone RF1a) but not in the detailed diagram (Fig SS4.2).

Below 240mm only occasional grains were seen and the majority were so badly corroded and distorted that, in most cases, identification was impossible. Nevertheless, results from the scanning of pollen slides suggested that open habitat taxa, particularly Gramineae and Cyperaceae were the most abundant.

Zone RF1a

The single sample in this zone (at 240mm) was taken from the top of the densely packed inorganic silt. The pollen spectra must be viewed with caution in view of the low palynomorph concentration and low counts. Microscopic charcoal was moderately frequent and iron pyrite framboids were abundant, reaching levels of 339 x 102 cm^{-3}. Algal spores were present at low level. The dominant plant taxa were those of open habitat such as Cyperaceae and Gramineae with *Plantago lanceolata* (ribwort plantain), Compositae-Liguliflorae (eg hawkbits, cat's ears, nipplewort, sow thistles, dandelions etc), and *Artemisia* (mugwort). *Alnus* (alder), *Betula* (birch), *Corylus avellana* type (hazel), and *Tilia* (lime) were recorded, but at very low level, and accounted for 8.6% of TLP/S *Glomus* type sporangia were present.

Zone RF1

The boundaries of this zone coincide with the layer of organic silt which contained some large clasts. Pollen concentration reached its highest level at 200mm and then declined in a step-wise fashion to the end of the zone towards the boundary between RF1 and RF2. Iron pyrite framboids persisted at relatively high concentration but declined markedly at 160mm and 140mm. None were found above 140mm. *Glomus* type sporangia were found at 180mm and 120mm.

Indeterminate algal spores increased to a maximum level at 180mm; high levels were maintained at 160mm and 140mm but they declined at 120mm. Spores of the green, filamentous algae *Spirogyra* and *Zygnema* were well represented in this zone. *Spirogyra* fluctuated throughout the zone, reaching its highest representation at 120mm while

Zygnema was present at consistently low level. *Mougeotia*, another green, filamentous alga, was recorded at 180mm and 160mm. Although palynomorphs were relatively sparse, the percentage of unidentified was relatively low, ranging from 1.3 to 8.2%.

Throughout the zone, arboreal taxa were at low level, the highest representation being 16% TLP/S at 120mm. The most frequent and abundant tree taxon was *Quercus* (oak) with percentages ranging between 3.4 to 4.4%. *Alnus*, *Corylus* and *Tilia* were represented at every level while *Betula*, *Fraxinus* (ash), and *Pinus* (pine) were relatively frequent although at very low level. Also recorded were *Crataegus* type (eg hawthorn), *Salix* (willow), and *Taxus* (yew).

The herbaceous pollen assemblage was relatively rich with a large number of taxa being represented, and fern spores were also frequent (Fig SS4.2). Herb spectra were dominated by Cyperaceae, Gramineae, Compositae-Liguliflorae (eg hawkbits etc) and *Plantago lanceolata*. Ruderals and plants frequently found in weedy grassland/pasture were present as were those characteristic of standing water or wet soils, such as *Equisetum* (horsetails), *Mentha* type (eg water mint), *Polygonum amphibium* (amphibious bistort), and *Typha angustifolia* type (eg bur-reed or lesser bulrush).

Zone RF2

The boundary between RF1 and RF2 coincided with the change from an organic silt with some large clasts to one which had predominantly small inorganic particles. Palynomorph concentration was relatively high but microscopic charcoal declined. The percentage of unidentified pollen increased from 8.2% in the previous zone to a value of 18% at 80mm Algae indet and *Zygnema* both increased but *Spirogyra* declined. *Mougeotia* was recorded at 80mm as well as *Glomus* type sporangia. Aquatics/emergents such as *Potamogeton* (pondweed), *Batrachium* type *Ranunculus* (eg water crowfoots), and *Mentha* type were recorded. Trees and shrubs declined and a value of only 5.7% was recorded at 80mm. *Alnus*, *Corylus*, *Pinus*, *Quercus* and *Tilia* were present and *Ulmus* (elm) was recorded at 80mm. The number of herbaceous taxa was lower than in RF1, with 13 taxa (including pteridophytes) being recorded as opposed to 29. Cyperaceae increased and Gramineae declined, although they recovered at the end of the zone. Compositae-Liguliflorae were maintained at previous levels and ruderals such as *Rumex* (docks) and *Cirsium*

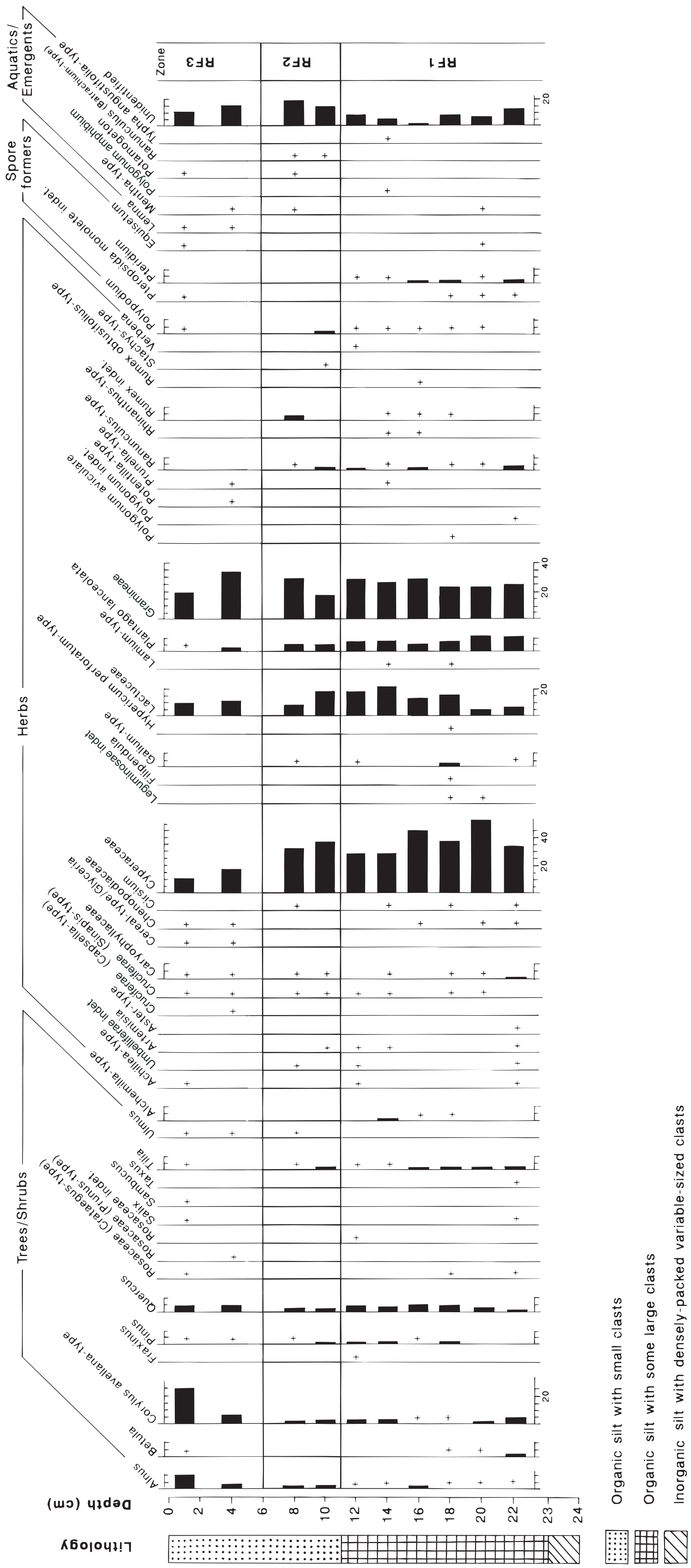


Figure SS4.2 Long Barrow. Percentages of all pollen and pteridophyte spore taxa in organic ditch deposits. Single grains or values of less than 1% shown as '+'.

(thistle) were recorded. Although *Polypodium* (polypody fern) reached a value of 1.2% at 100mm, other ferns were not recorded.

Zone RF3

There was no obvious change in lithology in this upper zone and pollen and charcoal concentrations remained unchanged initially. However, both showed a fall in the top sample. Unidentified grains reached values of 15% and 11.3%. There was a steady decline in algae indet although *Spirogyra* and *Zygnema* increased slightly. *Mougeotia* was recorded as well as the green colonial, planktonic alga, *Pediastrum*. Acritarchs were found in the top sample. Aquatics such as *Lemna* (duckweed), *Potamogeton* and *Mentha* type were recorded.

Arboreal taxa increased markedly, with *Alnus*, *Corylus*, and *Quercus* being the most significant contributors to the pollen rain. In the top sample *Corylus* reached a value of 25% while *Alnus* and *Quercus* reached 10% and 5.4% respectively. Other trees and shrubs included *Betula*, *Pinus*, *Tilia*, *Ulmus*, *Crataegus* type, *Prunus* type (eg sloe or bullace), *Salix* and *Sambucus* (elder). The number of woody taxa also increased with 11 being recorded as opposed to 6 in the previous zone.

Gramineae and other herbaceous taxa showed a slight initial increase. However, Cyperaceae declined quite markedly and all herbaceous taxa, including Gramineae, had reduced percentages in the top sample. *Polypodium*, *Equisetum* and Pteropsida monolete indet (undifferentiated ferns) were present.

SS4.2.4 Interpretation

The sediments within the barrow ditch have provided information on *in situ* physico-chemical changes as well as temporal variation in the local and more regional vegetation.

Conditions within the ditch

When considered in conjunction with palynomorph concentration and state of preservation, the general characteristics of the sediments themselves (degree of compaction, clast size, and organic content) suggest that the base of the ditch filled very rapidly. Observations in the Experimental Earthworks Projects (Crabtree 1990; Bell 1990) are providing valuable information on the infilling of ditches, but data on sedimentation rates are difficult to obtain (Pitt-Rivers 1898; Cornwall 1958). Thus no time scale can be applied to the initial infilling of the feature.

Although results are not presented here, examination of the sediments below 240mm showed a relative abundance of iron pyrites framboids. This indicates that (a) the ditch probably contained standing water, (b) it contained fermenting organic matter, (c) the sediments had very low redox potential (Eh = -100 to -150 mV), (d) there was a supply of detrital ferric iron, probably from inwashed soil (Wiltshire *et al* 1995) and (e) the pH of the waterlogged sediment was between 6.0 and 8.0 (Andrews *et al* 1996). With such low redox, good preservation of organic material might be expected, but palynomorphs were too sparse to be counted, and plant macrofossil material was at low level (Robinson pers comm). This paucity of ecofacts might be due to a dilution effect of rapidly accumulating sediment.

The sample at 240mm (zone RF1a) represents a period when sedimentation was slowing down. X-rays showed that plant root remains were most abundant in zones RF1a and RF1. Few plants are able to tolerate waterlogged, anoxic soils although some are adapted for these conditions. It is likely, therefore, that Cyperaceae and possibly *Equisetum*, *Mentha* type, and *Filipendula* (meadowsweet) colonised the waterlogged ditch. Plants have the effect of binding soils, and this might account for the apparent relative stability in RF1, and more so in RF2.

The presence of *Glomus* type (sporangia of arbuscular mycorrhizal fungi (sensu Bagyaraj and Varma 1995)) indicates that bioactive soil was a component of the early ditch fill. The lack of stability and probable high turbidity (hence low light levels) within the water of the ditch might also be reflected in the very low numbers of algal spores in this sample. The moderately high microscopic charcoal levels in such rapidly accumulating sediment might indicate that charcoal input was much greater than is indicated. There is certainly evidence of burning in the vicinity of the feature.

Palynomorph concentrations varied throughout zone RF1 and this might indicate changes in stability of local soils and relative degrees of disturbance. *Glomus* type sporangia were found sporadically throughout zones RF1 and RF2 so there must have been some degree of soil instability locally, even when sedimentation rates were low. Palynomorph concentration was highest in zone RF2 and at 40mm in RF3. This suggests a slowing down of sedimentation, and it certainly coincides with a change in lithology. The uppermost sediments represented by

RF2 and RF3 were more organic and clast size was small, and it is possible that plants growing in the ditch and adjacent soils were preventing clastic material from entering the sequence.

The presence of iron pyrites framboids suggests that the ditch contained persistent standing water for some period. The occasional record of aquatic plants such as *Potamogeton*, *Lemna*, *Polygonum amphibium* and *Batrachium* type *Ranunculus* all point to the availability of standing water while *Equisetum* and *Mentha* type also indicate a high water table. The presence of *Typha angustfolia* type is interesting; this taxon includes *Sparganium* (bur-reed) which could have been growing in the waterlogged ditch, although its pollen could also have been derived from a wet area further away.

Framboids declined in numbers and then disappeared towards the top of RF1. However, the presence of abundant algal spores, and the sporadic presence of pollen of aquatic plants throughout the sequence, suggests that shallow water was present (at least seasonally) throughout the period of sediment accumulation. The absence of framboids in the upper levels might be related to the rise in algal populations; once algae had become established, photosynthesis might have effectively oxygenated the ditch water. Redox would thus be raised above the low levels required for framboid formation, and framboids at the sediment/water interface would be oxidised to extinction. Algae such as *Spirogyra* and *Mougeotia* have also been shown to produce bactericidal tannins (Pankow 1961 – quoted in Round 1981), and since framboid formation depends on the activity of iron and sulphate-reducing bacteria, algal growth might have had a direct, negative impact. Another possibility is that with a slowing down of sedimentation, the limiting factor to framboid formation was the amount of available detrital ferric iron (Wiltshire *et al* 1994).

The abundance of algal spores throughout RF1 and RF2 suggests that not only was the water well illuminated (shallow and unshaded) but also it was probably nutrient-enriched. Filamentous algae such as *Spirogyra*, *Zygnema*, and *Mougeotia* respond very readily to nitrogen and phosphate eutrophication, and are generally considered to be 'algal weeds' (Round 1981). Inwashed soil would contribute to nutrient-enrichment, especially if grazing animals had access to the site; urine and faeces are very rich sources of both nitrogen and phosphate.

The fluctuations in algal spores throughout zones RF1 and RF2 could be due to individual algal responses to a multiplicity of ecological parameters, including both specific ambient physico-chemical conditions and interspecific competition. However, the low levels in the basal deposits probably reflect a period in which populations were becoming established while the decline in *Spirogyra* and algae indet in zone RF3 might indicate a response to lower illumination, possibly through shading (see below).

The curve of unidentified palynomorphs (Fig SS4.2) shows an increase in RF2 and RF3. In most cases, identification was not possible because of the state of preservation, although the curve does include a small number of elusive pollen types. The increase in poor preservation in the two upper zones coincides with the change in lithology. This is tentative evidence for periodic water fluctuation so that oxidation and/or decomposition occurred.

Vegetation characteristics and change

Table SS4.1 shows the relative proportions of tree/shrub pollen to those of herbaceous taxa at the base of the sequence (240mm). Although data for this sample must be treated with caution, it would appear that the area around the barrow had been cleared of woodland; woody plants account for only 8.6% of the total palynomorph sum, and Cyperaceae, Gramineae and ruderals dominated the vegetation. Trees and shrubs were also represented at low level throughout RF1 and RF2 (Figs SS4.1–2) and it would seem that the environs of the barrow continued to be very open, although mixed woodland, or mature individual trees and shrubs, were present in the catchment. However, to be recorded at all, some must have been growing fairly close to the feature. Certain trees and shrubs, including *Crataegus* type, *Salix* and *Tilia*, are insect-pollinated and have such poor pollen dispersal that even a low representation can indicate a relative abundance of the plant locally.

With such poor preservation, much of the floral record has been lost, but throughout the period represented by RF1 and RF2 there are strong indications that Cyperaceae, and possibly other plants, had colonised the ditch itself while its environs supported weedy grassland and areas of open disturbed soil. Zone RF2 had lower numbers of herbaceous taxa, although, as suggested by the higher levels of unidentified palynomorphs, this could be a function of differential decomposition rather than meaningful changes in plant communities. The lack of resolution in pollen taxonomy makes specific habitat reconstruction rather difficult but the range of taxa does seem to reflect considerable heterogeneity in both soil hydrology and reaction (pH). Some plants such as *Hypericum perforatum* type (eg perforate St John's wort), *Rhinanthus* type (eg yellow rattle), *Prunella* type (eg self-heal) and *Verbena* (vervain) are often found on mesic, drier soils. Moister soils might be suggested by *Sinapis* type (eg lady's smock), *Rumex obtusifolius* type (eg broad-leaved dock), and *Filipendula*. Dry, acidic soils are indicated by the consistent representation of *Pteridium* (bracken) throughout RF1 although the spores of this plant can travel considerably distances and might have been derived from podzolised soils further away.

Considerable changes were recorded in RF3. *Pinus*, *Tilia* and *Ulmus* were represented only as occasional single pollen grains, and there is little doubt that these trees had been heavily exploited and/or virtually removed from the landscape during the later period of sediment accumulation. However, the decline and reduced number of herbaceous taxa, and the marked increase of *Corylus*, *Alnus*, and *Quercus*, might indicate that shade-tolerant taxa were out-competing plants with a higher light requirement or that they were being managed less intensively than previously. Shrubs such as *Crataegus* type, *Salix*, *Prunus* type and *Sambucus* were all represented in this zone and, in view of their low representation in the pollen rain, they were probably growing close to the ditch. These plants are certainly rapid colonisers of open ground, especially where there has been some degree of soil eutrophication (Grime *et al* 1988).

Although the pollen spectra suggest that woodland had been cleared, it is difficult from palynological data, and in the absence of chronological information, to differentiate between clearing and the effects of exploitation (coppicing and pollarding). It is also difficult to determine whether regeneration of woodland is occurring or whether trees are recovering from being cut. Even when coppicing ceases, many woody plants take a considerable time to flower. *Acer campestre* (field maple), *Corylus*, and *Crataegus* can take up to 10 years to recover from severe cutting; *Ulmus* takes 34–40 years, *Fraxinus* 25–30 years, *Quercus* 40–50 years, and *Tilia* 20–30 years. *Fagus* (beech) has been known to flower within 28 years, but 50–60 years is more usual (Gordon and Rowe, 1982; Forestry Commission, pers. comm.). *Corylus* is a rather poor coloniser and its large increase in zone RF3 might suggest a relaxation of coppicing rather than spread of the plant itself.

Robinson's findings (SS4.3.1) are in agreement with the results presented here. He suggests that the barrow had been constructed in an area cleared of woodland, and that there was a subsequent succession through open-habitat, herb-dominated communities to scrub vegetation. On most soil types in Britain, the maintenance of open turf relies on continued suppression of encroaching woodland by repeated cutting and/or persistent grazing; if these are relaxed, colonisation by woodland type shrubs is usually rapid (Packham and Harding 1982; Rackham 1990; Ward 1990). The presence of shrub taxa in zone RF3 supports Robinson's observation that the site had become neglected and there was scrub invasion. Shrubs might even have colonised the barrow itself and caused shading of the ditch water which resulted in the smaller algal populations in zone RF3. The barrow could have been abandoned or stocking densities of domestic animals might have been much reduced. Certainly, the small increase in grass pollen at the beginning of RF3 could have been due to enhanced flowering of grasses on relaxation of grazing pressure.

Pollen which resembled cereal type or the grass *Glyceria* (sweet grass) was found in RF3. It is rather unfortunate that it was impossible to differentiate between cereal pollen and that produced by the aquatic grass. However, it is more likely to have been sweet grass pollen since the plant is recorded in the macrofossil analysis. Furthermore, the evidence for scrub invasion suggests abandonment rather than the development of local arable agriculture.

Palynological, macrofossil, and insect analyses of sediments from a palaeochannel of the River Nene at West Cotton (Brown and Keough 1992c; Robinson and Campbell SS4.3.2; Robinson SS4.3) have indicated that, although there were open areas of weedy grassland and scrub, the landscape was extensively wooded during the late Neolithic period. The palaeochannel deposits were younger than those of the Long Barrow ditch, and it is possible that they reflect a widespread reduction of grazing pressure, leading to later encroachment and establishment of woodland within the catchment. Palynological analysis of the barrow ditch sediments seem to record just the beginnings of this woodland regeneration.

The poor representation of trees, and the fact that elm was recorded at <1% (and in only two samples), suggests that the barrow was constructed some time after the mid-Holocene decline in elm trees. This event had been thought to have been a more-or-less synchronous event over Britain, occurring at about 5000 BP (Smith and Pilcher 1973). However, more recent work has indicated that the decline took place over a much longer period of time and was not synchronous (Peglar *et al* 1989). An early date for the decline (about 6000 BP) and a late one (about 4500 BP) have been recorded at different sites in East Anglia (Bennet 1983; Bennett 1986).

SS4.2.5 Conclusion

Initial sedimentation within the barrow ditch was very rapid but it eventually stabilised, aided by colonisation of Cyperaceae and other plants. Throughout the period of sediment accumulation, nutrient-enriched, stagnant, shallow water was present in the feature. Eutrophication might have been due to the influx of bioactive soil into the water, possibly caused by animal trampling. The soil itself was probably enriched with phosphate and nitrogen from animal excreta, and this encouraged the growth of filamentous, green algae in the ditch water.

The immediate locality appears to have been dominated by herb-rich grassland, although some mature trees and shrubs were growing in the catchment. In spite of the impact of clearance, there was no convincing evidence for cereal-growing in the vicinity of the ditch.

The nature of the tree pollen spectra, and the paucity of elm records in the sequence, suggests that the barrow post-dates the mid-Holocene elm decline. An estimated construction date of *3800–3640 cal BC at 95% probability* for the monument (Bayliss *et al* SS6) may thus provide a *terminus ante quem* for the elm decline in the region. The impression of a cleared landscape in the early life of the barrow might be due, in part, to extensive coppicing and pollarding of woody plants rather than their complete removal. The later marked recovery of *Corylus*, a poor coloniser, might confirm that this shrub had been coppiced rather than removed. However, no absolute chronology is available for sediment accumulation, and it is impossible to assess the length of time represented by the sediments in zone RF3. It is not therefore possible to determine whether zone RF3 represents a period long enough for hazel colonisation and flowering. In any event, there certainly seems to have been development of scrub in the vicinity of the barrow. This might have been due to abandonment of the area, or to reduced stocking densities of grazing animals.

This palynological analysis covers only the beginning of woodland recovery, but studies of late Neolithic palaeochannel sediments of the River Nene suggest that the area was extensively forested by the late Neolithic (Campbell and Robinson 2007).

SS4.3 Waterlogged plant and insect remains

SS4.3.1 Environmental remains from waterlogged deposits in the Long Barrow ditches

Mark Robinson

Introduction

The Long Barrow occupied almost all of a slight elongate gravel eminence rising above the general level of the surface of the floodplain gravels. This served to enhance the prominence of the monument. The palaeosol which survived beneath the barrow mound, was a reddish brown silt loam, but the original soil which developed over the lower areas of the floodplain probably had a higher clay content. This soil only survived as reddish brown silty clay ploughsoil containing some gravel beneath alluvial clay loam.

The palaeosols were not sufficiently calcareous for the survival of mollusc shells. Shells were also absent from the barrow ditch sediments, where the incorporation of limestone from the underlying gravels resulted in conditions being conducive to bone preservation. The deeper parts of both ditches, however, extended below the permanent water table. These depths contained well preserved macroscopic plant and insect remains, although their concentrations were low, probably as a result of rapid sedimentation.

Bulk samples were accordingly taken from the waterlogged ditch sediments and analyzed by the Environmental Archaeology Unit at the University Museum, Oxford. Wood recovered during the excavation was also identified.

Table SS4.3. Long Barrow. Details of samples from waterlogged deposits (phase 2.2.i)

Sample	*Context*	*Barrow ditch*	*Radiocarbon Date*	*Description*	*Total sample for macroscopic plant remains (kg)*	*Total sample for insect remains (kg)*
128	226	south	3760–3370 cal BC (4810±80 BP; OxA-3001). Seeds	Black very organic silt loam to sandy silt. Top organic sample from Section 62, above Sample 129	2.0	20.0
129	227	south	-	Dark grey organic silt loam to sandy silt with a little gravel. Section 62, above Sample 130	2.0	20.0
130	228	south	-	Dark grey organic silt loam to sandy silt with much gravel. Section 62, above Sample 131	2.0	20.0
131	229	south	3650–2890 cal BC (4560±140 BP; OxA-3002). Seeds 3760–3360 cal BC (4790±90 BP; OxA-3003). *Quercus* wood	Dark grey organic silt loam with gravel. Bottom sample from Section 62, below Sample 130	2.0	20.0
132		north	-	Dark grey organic silt loam with gravel	0.5	-
170		south	-	Black organic sandy silt	0.5	-
179	212	south	-	Dark grey organic sandy silt with gravel	0.5	-
181	226c	south	-	Black very organic silt	0.5	-
182		north	-	Grey organic silt loam with some gravel	0.5	-
183	278	north	-	Grey slightly organic sandy silt with some gravel	0.5	-
187	226/8	south	-	Black organic sandy silt	0.5	-

Sampling strategy and the samples

It was decided that the main effort would be concentrated on the analysis of a series of large samples for macroscopic plant and insect remains from section 62 through the southern barrow ditch, where the organic sediments were deepest. (The pollen monolith was also taken from this section; Fig SS1.43). These samples would be used to establish the detailed environmental sequence for the site. Smaller samples would then be analysed from other waterlogged macroscopic remains in order to attempt to detect local differences in the vegetation. Insect remains tend to be derived from larger catchments than waterlogged macroscopic plant remains (unless human or water transport is involved), so it was decided that only those insect remains which appeared to be of additional interest would be recovered from these subsidiary samples.

Sample details are given in Table SS4.3. In addition, a continuous sequence of 28 samples each of 1 kg were taken through the full depth of sediments in the southern ditch from section 62 (sample series 171) in order to check for the presence of mollusc shells and for sediment description purposes (Fig SS1.43).

Methods and results

The part of each sample which was to be analysed for macroscopic plant remains was weighed out and washed over onto a 0.2mm aperture sieve in order to extract the organic fraction. This was graded through a stack of sieves and sorted in water with the aid of a binocular microscope at x12 magnification. Seeds and other potentially identifiable plant remains were picked out from all these subsamples. Those subsamples which were from the main sample sequence (samples 128, 129, 130, 131) were also fully sorted for insect fragments, the remainder were just scanned for insects. In addition, a substantial subsample from each of the samples from the main sequence was processed for insect remains alone. It was weighed out, washed over onto a 0.2mm sieve, drained and subjected to paraffin flotation. The flot was washed in detergent, then sorted as before. Both plant and insect remains were stored in alcohol prior to identification.

Specimens were identified with reference to the collections in the University Museum, Oxford at magnifications of up to x100 and the results have been given in Tables SS4.4–SS4.7. The tables either record the minimum number of individuals represented

Table SS4.4. Long Barrow. Waterlogged plant remains (phase 2.2.i; seeds unless otherwise stated)

Sample			*131*	*130*	*129*	*128*	*179*	*181*	*170*	*187*	*183*	*132*	*182*
RANUNCULACEAE													
Ranunculus cf *acris* L		Buttercup	-	-	1	-	-	-	-	-	-	-	-
R cf *bulbosus* L		Buttercup	2	1	-	-	1	-	-	-	-	1	-
R cf *repens* L		Buttercup	4	9	8	29	1	-	-	-	-	-	-
R *sceleratus* L		Celery-leaved Crowfoot	-	1	8	49	-	-	-	1	-	-	1
R S Batrachium sp		Water Crowfoot	30	85	90	1	19	-	1	-	-	-	-
PAPAVERACEAE													
Papaver somniferum L		Opium Poppy	-	-	-	-	-	-	8	-	-	-	-
Chelidonium majus L		Greater Celandine	3	-	-	-	-	-	-	-	-	-	-
CRUCIFERAE													
Brassicaceae indet	siliqua fragment	Wild Turnip etc	-	1	-	-	-	-	-	-	-	-	-
Cruciferae indet			-	-	-	-	10	-	-	-	-	-	-
VIOLACEAE													
Viola S Viola sp		Violet	-	-	1	37	-	1	-	-	-	-	2
V S Melanium sp		Pansy	-	-	-	1	-	-	-	-	-	-	-
HYPERICACEAE													
Hypericum sp		St John's Wort	1	1	3	57	-	-	-	-	-	-	-
CARYOPHYLLACEAE													
Silene cf *dioica x latifolia*		Pink Campion	1	-	-	-	-	-	-	-	-	-	-
Cerastium cf *fontanum Beug*		Mouse-ear Chickweed	64	11	-	-	3	-	-	10	-	-	-
Myosoton aquaticum (L) Moen		Water Chickweed	-	2	-	-	-	-	-	-	-	-	-
Stellaria cf *media* (L) Vill		Chickweed	2	2	2	-	1	-	1	-	-	-	-
S cf *neglecta* Weihe		Chickweed	1	-	1	-	-	-	-	-	-	-	-
S cf *palustris* Retz		Marsh Stitchwort	-	-	1	-	-	-	-	-	-	-	-
S graminea L		Stitchwort	-	4	2	2	2	-	-	-	-	-	-
Moehringia trinervia (L) Clairv		Wood Sandwort	3	2	-	3	-	-	-	-	-	-	-
Arenaria serpyllifolia L		Sandwort	113	7	42	1	21	-	10	30	10	20	-
Sagina sp		Pearlwort	-	-	-	-	10	-	10	-	10	90	-
Caryophyllaceae indet			1	-	-	-	-	-	-	-	-	-	-
PORTULACAEAE													
Montia fontana L ssp *chondrosperma* (Fenzl) Walt		Blinks	-	-	-	1	-	-	-	-	-	-	-
CHENOPODIACEAE													
Chenopodium album L		Fat Hen	51	8	5	1	4	-	1	4	-	-	-
Atriplex sp		Orache	1	-	-	-	1	-	-	-	-	-	-
LEGUMINOSAE													
Trifolium sp	flower	Clover	-	1	-	-	-	-	-	-	-	-	-
ROSACEAE													
Rubus fruticosus agg		Blackberry	1	-	-	13	-	3	-	1	-	-	-
Rubus sp		Blackberry or Raspberry	-	-	-	3	-	-	-	-	-	-	-
Potentilla reptans L		Creeping Cinquefoil	3	29	93	105	8	7	7	2	2	-	31
Aphanes arvensis L		Parsley Piert	223	45	20	-	64	-	12	26	7	14	-
A microcarpa (Bois & Reut) Roth		Parsley Piert	124	16	10	-	37	-	3	14	2	25	-
Prunus spinosa L		Sloe	-	-	1	5	-	-	-	-	-	-	-
Prunus/Crataegus tp	thorny twigs	Hawthorn or Sloe	-	4	2	2	-	-	-	1	-	-	-
Pomoideae	wood	Hawthorn, Apple etc	-	-	-	1	-	-	-	-	-	-	-
ONAGRACEAE													
Epilobium sp		Willow-herb	3	-	-	-	-	-	-	1	-	-	-

Table SS4.4. Continued

Sample			*131*	*130*	*129*	*128*	*179*	*181*	*170*	*187*	*183*	*132*	*182*
CORNACEAE													
Cornus sanguinea L		Dogwood	-	-	1	11	-	-	-	-	-	-	-
POLYGONACEAE													
Polygonum aviculare agg		Knotgrass	20	3	1	1	-	-	1	1	-	-	-
P persicaria L		Red Shank	-	11	13	42	2	-	4	-	-	-	-
Fallopia convolvulus (L) Löve		Black Bindweed	8	6	3	-	1	-	-	1	-	2	-
Rumex conglomeratus Mur		Sharp Dock	15	28	15	1	2	-	2	-	-	-	-
Rumex sp		Dock	9	47	17	1	17	1	6	-	-	-	-
Rumex sp	stem fragments with pedicels	Dock	-	3	5	-	-	-	-	-	-	-	-
URTICACEAE													
Urtica dioica L		Stinging Nettle	9	14	28	21	11	3	4	-	-	-	3
BETULACEAE													
Alnus glutinosa (L) Gaert		Alder	-	-	-	-	-	-	1	-	-	-	-
A glutinosa (L) Gaert	female catkin	Alder	1	-	-	-	-	-	-	-	-	-	-
FAGACEAE													
Quercus sp	leaf fragments	Oak	+	-	-	-	+	-	-	-	+	+	-
Quercus sp	wood fragments	Oak	4	-	-	-	-	-	1	1	-	1	-
SCROPHULARIACEAE													
Scrophularia sp		Figwort	-	1	-	-	-	-	-	-	-	-	-
Veronica S Beccabunga sp		Water Speedwell	33	-	-	-	-	-	-	10	-	-	-
cf *Veronica* sp		Speedwell	-	-	1	1	-	-	1	-	-	-	-
VERBENACEAE													
Verbena officinalis L		Vervain	-	1	2	44	-	-	-	-	-	-	-
LABIATAE													
Mentha cf aquatica L		Water Mint	-	-	6	68	-	7	-	-	-	-	-
Lycopus europaeus L		Gipsywort	-	-	3	3	-	-	-	-	-	-	-
Prunella vulgaris L		Self-heal	30	17	18	1	6	-	-	-	-	3	-
Stachys sylvatica L		Woundwort	2	-	1	1	-	1	2	-	-	-	-
Glechoma hederacea L		Ground Ivy	-	-	-	14	-	1	-	-	-	-	-
PLANTAGINACEAE													
Plantago major L		Plantain	2	2	-	-	1	-	1	-	-	-	-
CAPRIFOLIACEAE													
Sambucus niger L		Elder	-	1	5	35	-	6	-	-	-	-	1
VALERIANACEAE													
Valerianella carinata Lois		Lamb's Lettuce	2	1	2	4	-	1	-	-	-	-	-
COMPOSITAE													
Carduus sp		Thistle	-	-	-	2	-	-	-	-	-	-	-
cf *Cirsium* sp		Thistle	4	2	5	-	1	-	1	-	-	-	-
Lapsana communis L		Nipplewort	-	-	2	-	-	-	-	-	-	-	-
Crepis capillaris (L) Walr		Hawk's-beard	2	-	-	-	-	-	-	-	-	-	-
Taraxacum sp		Dandelion	2	1	1	-	-	-	-	-	-	-	-
POTAMOGETONACEAE													
Potamogeton sp		Pondweed	-	3	2	-	-	-	1	-	-	-	-
JUNCACEAE													
Juncus effusus gp		Tussock Rush	614	775	615	630	130	40	30	30	10	20	70
J articulatus gp		Rush	70	131	100	20	10	20	10	10	-	-	10
Juncus spp		Rush	60	50	110	70	10	70	20	-	10	-	220
Luzula sp		Woodrush	-	-	2	-	-	-	-	-	-	-	-

Table SS4.4. Continued

Sample			*131*	*130*	*129*	*128*	*179*	*181*	*170*	*187*	*183*	*132*	*182*
CYPERACEAE													
Eleocharis S Palustres sp		Spike Rush	34	162	65	6	31	1	6	-	-	-	1
Carex spp		Sedge	3	3	4	21	-	-	1	-	-	-	-
Cyperaceae indet			-	-	11	-	-	-	-	-	-	-	-
GRAMINEAE													
Glyceria sp		Flote- or Reed-grass	-	8	9	-	-	-	6	-	-	-	-
Bromus S Eubromus sp		Brome	1	-	-	-	-	-	-	-	-	-	-
Gramineae indet		Grass	5	3	-	5	1	-	11	-	-	-	-
Ignota			2	1	-	-	1	-	1	-	-	-	-
Bryophyta	stem with leaves	Moss	+	+	+	-	-	-	-	-	-	-	-
Bud Scales			-	-	-	1	-	-	-	-	-	-	-
Deciduous Tree Leaf Fragments		+	+	+	+	+	-	-	-	+	+	-	
Leaf Abscission Pads			-	1	1	-	-	-	-	-	-	-	-
TOTAL SEEDS			1,558	1,494	1,330	1,310	406	162	162	141	51	175	339

Table SS4.5. Long Barrow. Charred plant remains from waterlogged contexts (phase 2.2.i; seeds unless otherwise stated)

			131	*130*	*129*	*128*	*179*	*181*	*170*	*187*	*183*	*132*	*182*
Vicia or *Lathyrus* sp		Vetch, Tare etc	-	1	-	-	-	-	-	-	-	-	-
Crataegus cf *monogyna* Jacq		Hawthorn	1	-	-	-	-	-	-	-	-	-	-
Corylus avellana L		Hazel	-	-	-	-	1	-	-	-	-	-	-
Quercus sp	— charcoal	Oak	+	+	-	-	+	-	+	-	-	-	-
Galium sp		Goosegrass or Bedstraw	-	-	1	-	-	-	-	-	-	-	-

by the fragments identified from a sample or show presence/absence. Nomenclature follows Clapham *et al.* (1989) for the higher plants. The Royal Entomological Society's revised checklists of British insects (Kloet and Hincks 1964; 1977; 1978) have been used for the nomenclature of the entomological results, with the addition of Lucht (1987) for three species of *Coleoptera* no longer extant in Britain.

Waterlogged macroscopic plant remains
Results are given in Table SS4.4. A one-tenth subsample was examined for seeds from the sieved fraction of sample between 0.5mm and 0.2mm. The number of seeds recovered (mostly *Juncus* spp) has been multiplied by ten for inclusion in the table.

Charred macroscopic plant remains
The results given in Table SS4.5 are only for those charred remains in the waterlogged plant samples and a separate report was prepared on those samples specifically examined for charred remains (Campbell, SS4.6).

Coleoptera
Results are given in Table SS4.6 for the main sample column. In addition, the remains of two individuals of *Onthophagus taurus* (Schr) were recovered from sample 187 and another individual of *Abax parallelepipedus* (P & M) from sample 179.

Other insects
Results are given in Table SS4.7. Insect-induced plant galls have been included in this table rather than Table SS4.4.

Mollusca
Mollusc shells were entirely absent from the samples listed in Table SS4.3 and also the samples of sample series 171.

Hand-excavated waterlogged wood identifications

In addition to the fragments of wood from the samples for macroscopic plant remains (detailed in Table SS4.4), a total of 28 pieces of wood that had been recovered by hand excavation were submitted for identification. They were initially examined in tangential section at x25 magnification under a binocular microscope to identify any *Quercus* sp (oak). The remaining pieces were thin-sectioned in the transverse, radial and longitudinal planes for examination in transmitted light at magnifications of up to x400. The results are

Table SS4.6. Long Barrow. Coleoptera from waterlogged deposits (phase 2.2.i)

Sample	*131*	*130*	*129*	*128*	*Species Group*
CARABIDAE					
Carabus nemoralis Müll	-	1	-	-	
Nebria brevicollis (F)	1	6	3	1	
Notiophilus cf *palustris* (Duft)	-	1	-	-	
Notiophilus sp	-	-	1	-	
Blethisa multipunctata (L)	-	1	-	-	
Dyschirius globosus (Hbst)	1	6	1	1	
Trechus obtusus Er or *quadristriatus* (Schr)	-	2	-	1	
Bembidion properans Step	-	1	-	-	
B lampros (Hbst) or *properans* Step	-	1	2	-	
B varium (Ol)	-	1	1	-	
B tetracolum Say	-	2	-	-	
B quadrimaculatum (L)	-	4	1	-	
B articulatum (Pz)	-	4	-	-	
B guttula (F)	1	-	2	1	
B guttula (F) or *unicolor* Chaud	-	3	-	-	
Tachys sp	-	2	-	-	
Pterostichus anthracinus (Pz)	-	1	-	-	
P gracilis (Dej)	-	1	-	-	
P lepidus (Leske)	1	-	1	-	
P melanarius (Ill)	-	1	-	-	
P niger (Schal)	-	1	1	-	
P nigrita (Pk)	-	-	1	-	
P versicolor (Sturm)	1	1	-	-	
P cupreus (L) or *versicolor* (Sturm)	-	1	-	-	
Abax parallelepipedus (P& M)	1	4	4	1	
Calathus fuscipes(Gz)	1	5	3	-	
C melanocephalus (L)	-	3	2	1	
C cf *melanocephalus* (L)	-	-	1	-	
Synuchus nivalis (Pz)	-	1	1	-	
Olisthopus rotundatus (Pk)	-	1	2	-	
Agonum muelleri (Hbst)	1	-	1	-	
Amara cf *aenea* (Deg)	-	1	1	-	
A consularis (Duft)	-	2	-	-	
A tibialis (Pk)	1	2	-	-	6a
Amara sp	1	3	1	1	
Harpalus rufipes (Deg)	-	1	2	-	6b
Harpalus S *Ophonus* sp	-	1	-	-	
Acupalpus dorsalis (F)	-	2	-	-	
A exiguus Dej	1	2	-	-	
Chlaenius vestitus (Pk)	-	-	2	-	
Metabletus foveatus (Fouc)	-	1	-	-	
HALIPLIDAE					
Haliplus sp	-	2	-	-	1
DYTISCIDAE					
Hygrotus inaequalis (F)	-	1	1	-	1
Hydroporus sp	1	2	2	-	1
Agabus bipustulatus (L)	-	5	9	2	1
Agabus sp (not bipustulatus)	1	5	2	-	1
Rhantus sp	-	1	-	-	1
Colymbetes fuscus (L)	1	1	1	-	1
GYRINIDAE					
Gyrinus sp	-	2	1	-	1
SPHAERIIDAE					
Sphaerius acaroides Wal	1	1	-	-	
HYDROPHILIDAE					
Helophorus aquaticus (L) or *grandis* Ill	-	1	1	-	1
Helophorus spp (*brevipalpis* size)	44	191	118	13	1

Sample	*131*	*130*	*129*	*128*	*Species Group*
Coelostoma orbiculare (F)	-	1	-	-	1
C haemorrhoidalis (F)	-	-	1	-	7
C sternalis Sharp	1	-	1	-	7
C ustulatus (Pres)	-	1	-	-	7
Cercyon sp	-	1	1	1	7
Megasternum obscurum (Marsh)	2	20	9	5	7
Cryptopleurum minutum (F)	-	1	1	-	7
Hydrobius fuscipes (L)	6	19	5	1	1
Anacaena sp	1	-	-	-	1
Laccobius sp	3	1	1	-	1
HISTERIDAE					
Paralister purpurascens (Hbst)	-	-	1	-	
HYDRAENIDAE					
Ochthebius bicolon Germ	1	3	-	-	1
O cf *bicolon* Germ	-	-	1	-	1
O minimus (F)	40	159	98	11	1
O cf *minimus* (F)	22	102	43	5	1
Hydraena riparia Kug	3	5	5	-	1
H testacea Curt	1	-	-	-	1
Limnebius papposus Muls	2	9	4	-	1
L truncatellus (Thun)	3	2	-	-	1
LEIODIDAE					
Anisotoma sp	-	1	-	-	
Agathidium marginatum Sturm	-	1	-	-	
SILPHIDAE					
Thanatophilus rugosus (L)	-	-	1	-	
Silpha atrata L	-	2	1	-	
S obscura L	-	1	1	-	
STAPHYLINIDAE					
Metopsia retusa (Step)	-	-	2	-	
Acidota cruentata Man	-	-	-	1	
Bledius sp	-	1	1	-	
Carpelimus rivularis (Mots)	-	2	-	-	
*Platystethus arenar*ius (Fouc)	-	1	-	-	7
P cornutus gp	1	5	4	2	
P nodifrons (Man)	-	2	4	-	
Anotylus nitidulus (Grav)	1	5	2	1	
A sculpturatus gp	1	4	3	1	7
Stenus biguttatus (L)	-	1	-	-	
Stenus spp (not *biguttatus*)	2	9	8	2	
Paederus littoralis Grav	-	1	-	-	
Lathrobium spp	3	3	1	-	
Rugilus cf *geniculatus* (Er)	-	1	1	-	
R orbiculatus (Pk)	-	-	1	1	
Xantholinus linearis (Ol)	1	2	-	1	
X longiventris Heer	1	1	-	-	
X linearis (Ol) or *longiventris* Heer	-	5	4	-	
Neobisnius sp	1	3	1	-	
Erichsonius cf *cinerascens* (Grav)	-	4	3	-	
Philonthus sp	-	1	1	-	
Gabrius sp	-	4	1	-	
Staphylinus caesareus Ced or *dimidiaticornis* Gem	-	-	-	1	
S aeneocephalus Deg or *fortunatarum* (Woll)	2	1	1	-	
S olens Müll	-	1	-	-	
Tachyporus sp	2	4	1	-	
Aleocharinae indet	8	7	7	3	

Table SS4.6. Continued

Sample	*131*	*130*	*129*	*128*	*Species Group*
LUCANIDAE					
Dorcus parallelipipedus (L)	-	1	1	-	4
GEOTRUPIDAE					
Geotrupes sp	-	1	1	-	2
SCARABAEIDAE					
Colobopterus erraticus (L)	-	1	1	1	2
C haemorrhoidalis (L)	-	-	1	-	2
Aphodius distinctus (Müll)	1	1	-	-	2
A foetens (F)	-	-	1	-	2
A cf *foetidus* (Hbst)	-	-	1	-	2
A granarius (L)	-	1	-	-	2
A luridus (F)	-	1	-	-	2
A porcus (F)	-	-	1	-	2
A pusillus (Hbst)	-	3	1	-	2
A cf *sphacelatus* (Pz)	2	2	2	-	2
Aphodius sp	1	1	-	1	2
Copris lunaris (L)	-	1	-	-	2
Caccobius schreberi (L)	1	-	-	-	2
Onthophagus ovatus (L)	1	4	4	3	2
Onthophagus sp (not *nutans*, *ovatus* or *taurus*)	-	-	1	-	2
Hoplia philanthus (Fues)	-	-	1	-	11
Phyllopertha horticola (L)	1	4	5	1	11
Valgus hemipterus (L)	-	2	-	-	4
DASCILLIDAE					
Dascillus cervinus (L)	-	1	-	-	
BYRRHIDAE					
Simplocaria cf *semistriata* (F)	1	1	-	-	
HETEROCERIDAE					
Heterocerus sp	5	5	3	-	
LIMNICHIDAE					
Limnichius pygmaeus (Sturm)	1	7	7	-	
DRYOPIDAE					
Dryops sp	-	7	4	1	1
ELMIDAE					
Oulimnius sp	1	1	-	-	1
ELATERIDAE					
Agrypnus murinus (L)	-	3	2	2	11
Melanotus erythropus (Gml)	1	1	-	-	4
Athous cf *haemorrhoidalis* (F)	1	-	-	-	11
A hirtus (Hbst)	1	2	-	-	11
Agriotes acuminatus (Step)	1	-	-	-	11
A obscurus (L)	-	-	1	-	11
Agriotes sp	2	2	1	1	11
CANTHARIDAE					
Cantharis sp	1	-	-	-	
ANOBIIDAE					
Anobium punctatum (Deg)	1	1	1	-	10
NITIDULIDAE					
Brachypterus urticae (F)	3	5	3	2	
CRYPTOPHAGIDAE					
Atomaria sp	1	2	1	3	
CORYLOPHIDAE					
Corylophus cassidoides (Marsh)	-	-	1	-	

Sample	*131*	*130*	*129*	*128*	*Species Group*
COCCINELLIDAE					
Adalia bipunctata (L)	-	-	1	-	
LATHRIDIIDAE					
Enicmus transversus (Ol)	1	2	-	-	8
Corticariinae indet	-	2	-	1	8
TENEBRIONIDAE					
Opatrum sabulosum (L)	-	1	-	-	
MORDELLIDAE					
Mordellistena sp	-	1	-	-	
MELOIDAE					
Meloe violaceus Marsh	1	-	-	-	
CHRYSOMELIDAE					
Donacia or *Plateumaris* sp	-	-	-	1	5
Chrysolina cf *hyperici* (Forst)	-	-	1	1	
C polita (L)	1	-	-	-	
Gastrophysa viridula (Deg)	-	1	-	-	
Phaedon sp (not *tumidulus*)	-	1	-	-	
Phyllotreta vittula Redt	-	-	1	-	
Longitarsus spp	2	4	2	2	
Crepidodera ferruginea (Scop)	4	4	2	1	
Chaetocnema concinna (Marsh)	2	8	7	-	
Chaetocnema sp (not concinna)	1	3	2	-	
Psylliodes sp	-	-	1	-	
ATTELABIDAE					
Rhynchites cf t*omentosus* Gyl-	1	-	-	4	API
ONIDAE					
Apion spp	4	12	1	2	3
CURCULIONIDAE					
Trachyphloeus aristatus (Gyl)	1	1	-	-	
Phyllobius roboretanus Gred or *viridiaeris* (Laich)	-	2	-	1	
Phyllobius sp	-	-	2	-	
Sitona hispidulus (F)	3	6	1	-	3
S puncticollis Step	1	3	2	-	3
Sitona sp	-	1	-	1	3
Hypera punctata (F)	2	1	2	-	
Acalles turbatus Boh	1	-	-	-	4
Notaris acridulus (L)	-	-	-	2	5
Thryogenes nereis (Pk)	-	-	-	1	5
Ceuthorhynchidius troglodytes (F)	1	2	2	-	
Ceuthorhynchinae indet	2	5	2	1	
Anthonomus cf *rubi* (Hbst)	-	-	-	2	
Curculio pyrrhoceras Marsh	-	-	1	-	4
Tychius sp	2	1	2	-	
Mecinus pyraster (Hbst)	1	-	2	-	
Gymnetron pascuorum (Gyl)	1	1	-	1	
G rostellum (Hbst)	-	2	-	-	
G veronicae (Germ)	-	1	-	-	5
G villosulum Gyl	-	2	2	-	5
Rhynchaenus quercus (L)	-	-	2	1	4
R testaceus (Müll)	-	1	1	-	4
SCOLYTIDAE					
Scolytus intricatus (Ratz)	-	-	-	1	4
TOTALS	226	812	473	92	

Table SS4.7. Long Barrow. Other insects from waterlogged deposits (phase 2.2.i)

Sample		*131*	*130*	*129*	*128*
DERMAPTERA					
Forficula auricularia L		2	7	1	-
HEMIPTERA	— Heteroptera				
Stygnocoris sp		1	-	1	-
Drymus sylvaticus (F)		-	1	-	-
Lygaeidae indet		-	1	-	-
Saldula S *Saldula* sp		-	1	1	-
Gerris sp		1	7	1	-
	— Homoptera				
Megophthalmus scabripennis Ed or *scanicus* (Fal)		-	1	-	-
Aphrodes bicinctus (Schr)		-	2	1	-
A cf *flavostriatus* (Don)		-	1	1	-
Aphrodes sp		-	-	1	1
Aphidoidea indet		1	4	1	-
Homoptera indet		2	1	1	-
TRICHOPTERA					
Trichoptera indet	— larva	12	28	15	1
Trichoptera indet	— case	9	19	16	5
HYMENOPTERA					
Neuroterus quercus-baccarum (L)	— ag leaf gall	1	-	-	-
Tetramorium caespitum (L)	— female	2	-	-	-
T caespitum (L)	— worker	1	2	-	-
Formica eg *fusca* L	— worker	1	-	-	-
Lasius niger gp	— worker	3	1	-	-
Hymenoptera indet	— adult heads	12	25	14	2
DIPTERA					
Chironomidae indet	— larva	+	+	+	-
		-	1	-	-
Diptera indet	— puparium	1	-	-	-
Diptera indet	— adult	4	4	1	1

Table SS4.8. Long Barrow. Waterlogged wood (excavated, phase 2.2.i)

			Sample	
			Southern Ditch	*Northern Ditch*
Tilia sp	— bark	Lime	137	-
Pomoideae		Hawthorn, Apple etc	140/15	-
Alnus glutinosa (L) Gaert	— rootwood	Alder	168/3 ident, 185/7 ident	-
Corylus avellana L		Hazel	140/37, 189	-
Quercus sp		Oak	140/19, 140/21, 140/25, 140/26, 140/29, 140/30, 140/31, 140/32, 140/35, 140/44, 166, 188, 190	162

given in Table SS4.8 The *Alnus glutinosa* (alder) wood from the two apparent root clusters were confirmed as rootwood on the basis of the thin walled open structure to the fibres seen in transverse section (Cutler *et al* 1987, 16–17) and the high concentration of scalariform perforation plates in the vessels.

Noteworthy species records

***Papaver somniferum* L Opium Poppy**. Eight seeds of P *somniferum* were found in sample 170. They were easily separated from other species of *Papaver* by their size and their coarse reticulate surface cell pattern (Fig SS4.3). This annual weed is generally regarded as an introduced species. The Redlands Farm examples are at present the earliest British records. Other sites with early records include the middle Bronze Age Wilsford Shaft, Wilts (Robinson 1989) and a middle Bronze Age pit at Godmanchester, Cambridgeshire (McAvoy 2000, 56; P Murphy pers comm).

***Tilia* sp Lime**. Neolithic records of *Tilia* pollen are far from unusual and *Tilia* fruit have been identified from several sites of this date: indeed *Tilia cordata* (small-leaved lime) is regarded as a major component of Neolithic woodland over much of southern England and the Midlands (Greig 1982). Finds of Neolithic *Tilia* wood (and for that matter, charcoal, see Campbell, SS4.6) in contrast have proved very elusive, although it was identified from the Sweet Track in the Somerset Levels (Coles and Orme 1979, 47). A large fragment of bark excavated from the southern barrow ditch (sample 137) proved to be *Tilia* sp. It was identified on the basis of the wavy bands of small thick-walled fibres alternating with larger thin-walled cells (Jane 1970, 56–7).

Caccobius schreberi (L). A head of *C schreberi* was identified from sample 131 from the southern barrow ditch (Fig SS4.5). This scarabaeoid dung beetle occurs throughout most of mainland Europe and is regarded as common in northern France (Paulian 1959, 82). However, it has not previously been recorded from Britain and was not even amongst the various Scarabaeoidae suspected as formerly native (Allen 1967). A second archaeological example has subsequently been found from an Iron Age ditch at Abingdon, Oxon (Robinson, unpublished).

Onthophagus taurus (Schreb). A pronotum, left elytron and two right elytra of *O taurus* were recovered from sample 187 from the southern barrow ditch (Fig SS4.6). It is another scarabaeoid dung beetle that is now extinct in Britain. However, it has been identified from several Neolithic and Bronze Age insect assemblages including the Neolithic deposits at Runnymede Bridge, and reported early captures suggest that it was a very rare member of the British insect fauna in the early 19th century (Allen 1967, 205–6, 220–21; Jessop 1986, 26; Robinson 1991, 320). *O taurus* is now common in southern and central Europe but is rare and of sporadic occurrence further north, although it does still occur in Belgium and northern France (Harde 1984, 232; Paulian 1959, 88–9).

Valgus hemipterus (L). Fragments of two left elytra of *V hemipterus* showing their very characteristic sculpturation were found in sample 130 from the southern barrow ditch (Fig SS4.4). It is another scarabaeoid beetle that is now extinct in Britain but its larvae feed on rotten wood in old tree stumps etc rather than dung. It is widespread in Europe but the only records of its capture in Britain are all highly dubious (Allen 1967, 285; Paulian 1959, 252).

Analysis of the Data

Waterlogged seeds

Some of the more abundant waterlogged seeds from the main sample sequence from the southern barrow ditch (samples 131–128) have been plotted as percentages of the total seeds excluding *Juncus* spp (rushes). *Juncus* spp have been excluded because their seeds are very small and often extremely abundant, outnumbering all the other seeds in a sample. The data are displayed in Figure SS4.7, the histograms being grouped under ecological headings that relate to the interpretation of the site.

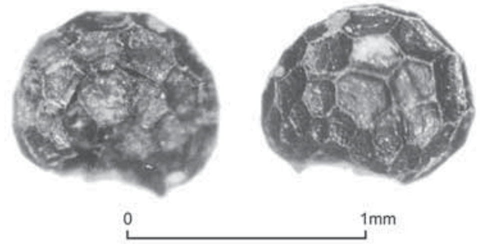


*Figure SS4.3 (left) Long Barrow. Seeds of Opium Poppy (*Papaver somniferum *(L)) from sample 170. (Photo Mark Robinson)*

*Figure SS4.4 (above) Long Barrow. Left elytron of Scarabaeoid dung beetle (*Valgus hemipterus *(L)) from sample 130. (Photo Mark Robinson)*

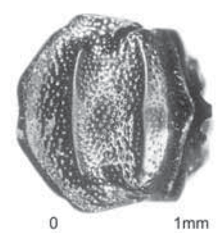


*Figure SS4.5 (above) Long Barrow. Head of Scarabaeoid dung beetle (*Caccobius schreberi *(L)) from sample 131. (Photo Mark Robinson)*

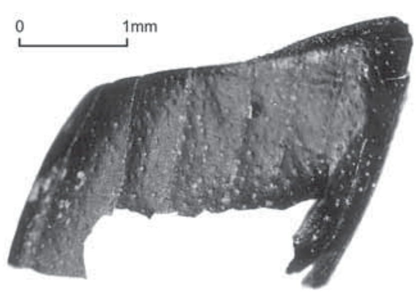
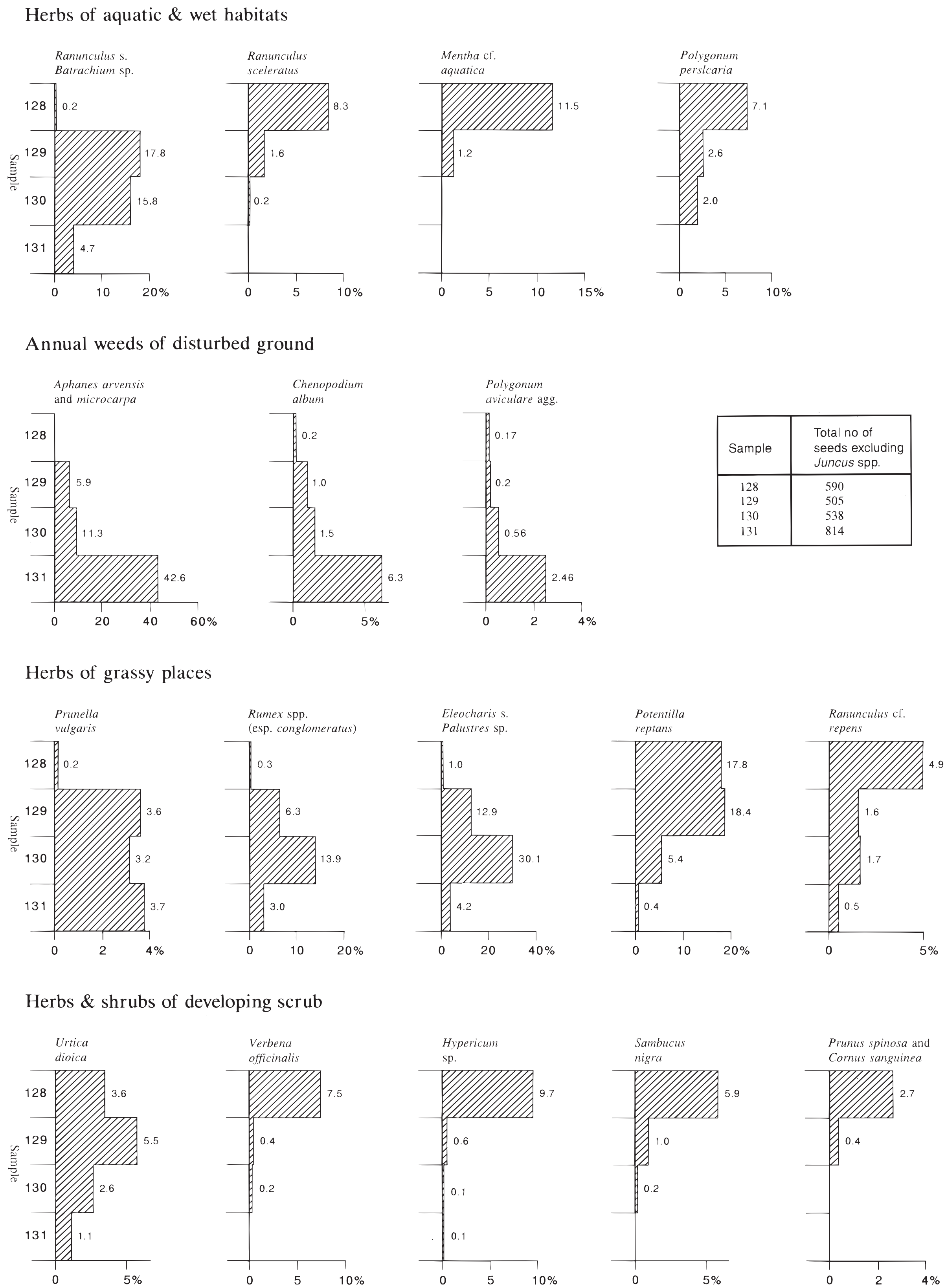


*Figure SS4.6 (left) Long Barrow. Right elytron of Scarabaeoid dung beetle (*Onthophagus taurus*) (Schreb)) from sample 187. (Photo Mark Robinson)*



Sample	Total no of seeds excluding *Juncus* spp.
128	590
129	505
130	538
131	814

Figure SS4.7 Long Barrow. Composition of waterlogged seeds.

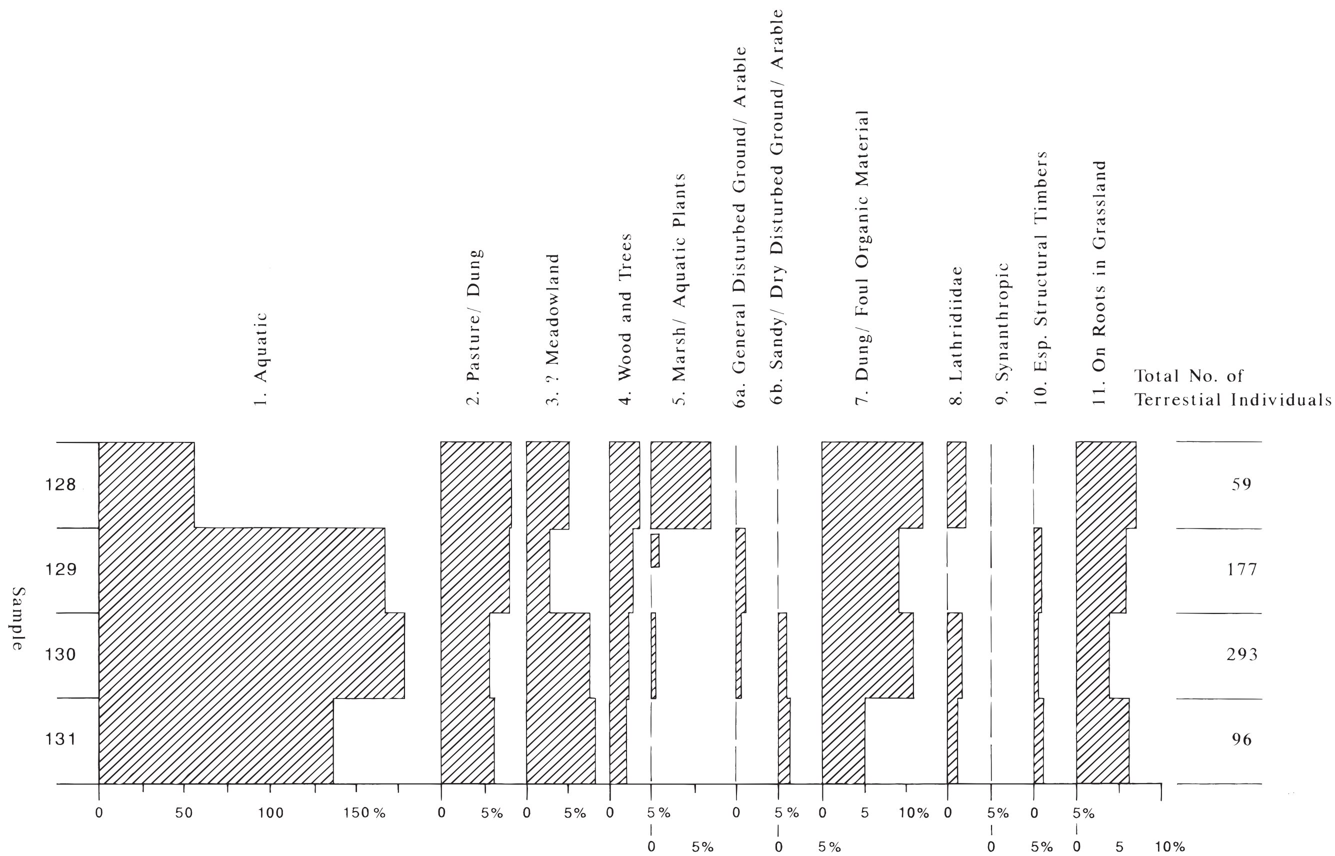


Figure SS4.8
Long Barrow.
Composition of Coleoptera from organic fills of ditches.

Coleoptera

The results for the Coleoptera from the sequence from the southern barrow ditch (samples 131–128) have been displayed in Figure SS4.8 as Species Groups expressed as percentages of the minimum number of individuals of terrestrial Coleoptera in each assemblage. Aquatic Coleoptera have been excluded from the total because the assemblages accumulated under water and it enables some of the difference due to the environment of the deposit itself to be eliminated. The Species Groups used follow Robinson (1991, 278–81) and the members of each Species Group are indicated in Table SS4.6. Not all the Coleoptera have been classified into categories.

Interpretation of the Neolithic environmental sequence

Taphonomy of the waterlogged macroscopic plant and insect remains from the Long Barrow ditches

With the exception of some of the wood, the waterlogged macroscopic plant and insect remains all appeared to have accumulated in the organic sediments at the bottom of the barrow ditches as a result of natural agencies. These ditches held stagnant water. The seeds were from three main sources: plants that grew in the ditches, plants that grew on the barrow mound and plants from the surrounding landscape. The majority of seeds in the last group were probably from plants growing in the immediate vicinity of the ditches, although some small seeds, for example *Juncus* spp (rushes) could have been brought from much further afield by wind. Oak leaves in some of the samples could also have been blown from a more distant source. The insects can be divided into those that lived in the ditch and those from the surrounding landscape. It is only possible to differentiate a very few insects that perhaps lived on the mound from the remainder of the fauna of the surrounding landscape. The composition of the terrestrial insect fauna suggested that they had been derived from a much larger catchment than the majority of the seeds and that a general landscape picture could be derived from them.

Much of the wood in the ditches had been brought to the site and some of it represented woodworking debris. Roots of alder trees grew into waterlogged layers of the ditches following sedimentation, and two preserved root clusters were found.

The preservation of organic remains was good in samples 131, 130 and 129, the bottom three samples of the main sample sequence. The usual biases were shown due to the differential preservation between taxa, but only in two of the subsidiary samples, samples 181 and 183, did there seem to have been additional loss through poor preservation.

The concentration of organic remains in the deposits was low, necessitating large samples. This was probably the result of rapid sedimentation.

The Environment of the Barrow and the Surrounding Landscape

General considerations

The waterlogged seeds can be divided into four main groups, some of the main members being shown in Figure SS4.7:

1 herbs of aquatic and wet habitats
2 annual weeds of disturbed ground
3 herbs of grassy places
4 herbs and shrubs of developing scrub.

The first, it will be argued, represents the flora of stagnant water and mud in the barrow ditches, and showed a transition from aquatic species to plants of mud as the ditches silted.

The second group is annual weeds that colonised the newly constructed mound, although some could have grown on the floodplain if there was disturbance pre-dating the monument. This group declined up the profile, probably as a result of ecological succession on the mound.

The seeds of herbs of grassland are believed mostly to have been derived from the general vegetation of the floodplain although some probably represent a stage in the vegetational succession of the mound.

The final group is regarded as being primarily from scrub succession on the mound, although some regeneration could also have occurred on the floodplain.

The insects can be divided into two main groups:

1 species of stagnant water and bankside habitats
2 species of lightly grazed grassland.

The first group lived in the barrow ditches and includes the aquatic Coleoptera of Species Group 1 and the beetles which feed on mud and aquatic plants of Species Group 5 in Figure SS4.8

The second group was probably derived from a general expanse of grassland around the monuments. They include the dung beetles of Species Group 2, the meadowland weevils of Species Group 3, the chafers and elaterid beetles of Species Group 11 and most of the beetles of foul organic material of Species Group 7 in Figure SS4.8.

In addition, the Coleoptera suggest that there was a background presence of woodland and a few beetles of dry sandy ground can probably be attributed to the mound itself.

Conditions in the ditches

Once the ditch sides stabilised, the stagnant water of the ditches became well vegetated with aquatic plants. The ditches were also colonised by small water beetles, which made up the majority of the Coleoptera in the first three samples of the sample column. The predominant aquatic plant in both ditches appears from the seeds to have been *Ranunculus* S *Batrachium* sp (water crowfoot). Its seeds increased in abundance up the sample column until they reached 18% of the seed sum. Seeds of other floating-leafed and emergent aquatic plants including *Veronica* S *Beccabunga* sp (water speedwell or brooklime), *Potamogeton* sp (pondweed) and *Glyceria* sp (flote-grass or reed grass) were also present in the lower three samples of the column.

By far the most common of the water beetles from the ditches were *Helophorus* cf *brevipalpis* and *Ochthebius minimus*. They fly readily and can rapidly reach high population levels in small bodies of stagnant water. They had been joined by larvae of *Trichoptera* (caddis flies) and *Hydrobius fuscipes*, a medium-sized water beetle that tends to occur in stagnant water above a bed of organic detritus. *Gerris* sp (pondskaters) evidently skimmed over the surface of the water. Coleoptera that feed on marsh or aquatic plants were very sparse. They mostly seem to have been associated with the vegetation of the ditches rather than the channel of the Nene, which lies to the NW of the site. For example, two of the more host-specific species, *Gymnetron veronicae* and *G villosulum* both feed on the aquatic species of *Veronica*. Seed numbers of *Ranunculus* sceleratus (celery-leaved crowfoot), *Mentha* cf *aquatica* (water mint) and *Polygonum persicaria* (redshank) increased up the sample column, to reach their highest in sample 128 (Fig SS4.7). *R sceleratus* is an annual of nutrient-rich soil, *M aquatica* is a perennial of marsh and waterside habitats, and P *persicaria* is an annual of damp disturbed ground and waterside mud. Their rise can be interpreted as the result of the water of the ditches becoming shallower as it silted and much of the bottom of the ditches eventually becoming seasonally exposed mud. The reason that *P persicaria* is regarded as belonging to this community rather than growing with the other annual weeds of disturbed ground is that the latter group declined up the sample column until it was almost absent from sample 128 whereas numbers of *P persicaria* seeds peaked in sample 128. The other annual weeds also included species of dry ground. Water beetles declined to about a third of the total Coleoptera from sample 128 (Fig SS4.8, Species Group 1) and there was only a single seed of *Ranunculus* S *Batrachium* sp.

One of the above-mentioned water beetles, *Ochthebius minimus* has somewhat amphibious tendencies and can also be found amongst wet dead vegetation or on wet mud at the edge of water. In addition to this species, there was a small but distinctive element in the insect assemblage from the sample column which occurs on bankside mud including:

Sphaerius acaroides
Platystethus cornutus gp
Heterocerus sp
Limnichus pygmaeus

S *acaroides* is now regarded as a very rare species in Britain (although its very small size and habit of burrowing under muddy leaves and stones probably means that it is often overlooked by collectors). *Dyschirius globosus* and some of the species of *Bembidion* eg *Bembidion varium* and B *articulatum* were also likely to have lived in moist habitats on the ditch sides.

Two other plants which were well represented by their seeds, *Juncus effusus* gp (the tussock rushes) and *Eleocharis* S *Palustres* sp (spike rush) could potentially have grown either in the barrow ditches or in the surrounding landscape. It is thought unlikely that the main source of the *J effusus* gp seeds was the ditches because numbers of their seeds were very high from the start of the sample column sequence and a dense growth of *Juncus* in the ditches would not be compatible with marginal mud on which light-demanding annual species, such as *Ranunculus sceleratus*, apparently grew at the top of the sequence. The abundance of seeds of *E* S *Palustres* sp might have been expected to increase towards the top of the sample column had it been growing in the ditches, as the water became shallower. Instead, it showed a substantial decline. The abundance of *E* S *Palustres* sp closely matched that of *Rumex conglomeratus* (sharp dock), one of the plants included in the grassland group. It is therefore argued that *J effusus* gp and *E* S *Palustres* were part of a wet grassland or marsh element to the flora of the floodplain rather than growing in the ditches.

Ecological succession on the Long Barrow mound and disturbed ground

The majority of seeds from sample 131, from the bottom of the southern barrow ditch, were from annual weeds of disturbed ground. Their origins would have included the immediate environs of the ditch. The main species were:

Arenaria serpyllifolia (sandwort)
Chenopodium album (fat hen)
Aphanes arvensis (parsley piert)
Aphanes microcarpa (slender parsley piert)
Polygonum aviculare agg (knotgrass)

A rather weedy perennial that was represented by many seeds in sample 131, *Cerastium* cf *fontanum* (mouse-ear chickweed) ought to also be considered along with them. The most numerous of the seeds were from two closely related species, *A arvensis* and *A microcarp*a, which together comprise the *Aphanes arvensis* agg. They are low-growing plants of arable land and bare places in grassland, mainly occurring on dry soils (Clapham *et al*. 1989). With the exception of *C album*, the other plants are also low-growing plants of arable, which readily colonise bare places in grassland. Phytophagous Coleoptera that could have been associated with annual weeds included *Chaetocnema concinna*, which feed on Polygonaceae including *P aviculare* agg and Ceuthorhynchinae indet, many of which feed on Cruciferae, but they also feed on plants of grassland.

If a phytosociological approach is adopted, these plant species can be seen as representing an element of the *Aphanion arvensis* within the order Centauretalia cyani of the class Stellarietea (Silverside 1977, table 80). The Stellarietea is the major class that includes annual weeds of disturbed ground in Britain. The absence from Redlands Farm of various biennial weeds enables the elimination of the ruderal orders such as the Sisymbrietalia and the Onopordietalia. The thermophilous weeds of the order Eragrostietalia and the nitrophilous weeds of the order Polygono-Chenopodietalia are also absent. The only Polygono-Chenopodietalia character species to be present on the site in any numbers was *Polygonum persicaria* (redshank), but it was absent from sample 131 and argument has been given above that it grew on mud in the ditch rather than with the remaining annual weeds of disturbed ground. The order Centauretalia cyani, to which it is believed the Redlands Farm weed community showed some similarities, comprises three alliances: the *Arnoseridion minimae*, the *Aphanion arvensis* and the *Caucalidion lappulae* (Silverside 1977, 322–46). The Arnoseridion is a community of very base poor soils, the Aphanion is an alliance of well drained, slightly acidic soils and the Caucalidion is strictly confined to calcareous soils. The occurrence of *Aphanes microcarpa*, a plant of acid sandy soils and the absence of calcicolous species serve to eliminate the Caucalidion. However, the full acidophilous range of plants characteristic of the Arnoseridion, such as *Spergula arvensis* and *Rumex acetosella*, was absent. *Aphanes arvensis* and *A. microcarpa* occur together, along with the other species that were found, in Aphanion communities on the circum-neutral brown earth soils which develop over the terrace gravels of the Upper Thames, Ouse and Nene valleys. These communities are probably most familiar amongst autumn-sown cereals but also occur on other disturbed ground, especially if soil nutrient levels are low.

There did not seem to be a full arable-type weed assemblage from sample 131 and it is possible that the disturbed ground took the form of areas of exposed soil supporting low growing elements of Aphanion vegetation amongst grassland. Such conditions would probably be expected on the barrow mound if some turf had been placed on the top and also around the mound where disturbance had been caused by construction activities. The insect evidence suggested that the local landscape of the floodplain was mostly grassland although this does not preclude the possibility that there were small arable plots or even that the monument had been constructed on former arable.

Aphanion communities are transitory unless disturbance to the soil continues on an annual basis. Above sample 131, the seed evidence suggested that conditions had stabilised and numbers of annual weed seeds declined substantially (Fig SS4.7). There was no evidence that they were succeeded by biennial ruderals. Instead, the rise of *Potentilla reptans* (creeping cinquefoil) in samples 130 and 129 from a very low level might suggest that the mound largely became grassed over. *Arrhenatherum elatius* grassland, in which *P reptans* readily grows, would seem a likely candidate for this stage, of the succession, although seeds of the tall umbellifers which also characterise the *Arrhenatheretum* (Rodwell 1992, 32) were absent. There was a rise in numbers of seeds of *Urtica dioica* (stinging nettle) in samples 130 and 129 which presumably reflected an increase in the presence of this plant, although the nettle seed numbers were very low indeed in comparison with what might be expected from a settlement. The nettle-feeding beetle *Brachypterus urticae* was present throughout the sequence.

Sample 128, the top waterlogged sample from the column showed the next stage in succession, with herbs such as *Verbena officinalis* (vervain) and *Hypericum* sp (St John's wort) spreading and scrub becoming established. The woody taxa identified from their seeds/stones in this sample were:

Rubus fruticosus agg (blackberry)
Prunus spinosa (sloe)
Cornus sanguinea (dogwood)
Sambucus nigra (elder)

Prunus/*Crataegus* (sloe/hawthorn) type thorns were also present. The occurrence of *C. sanguinea* serves as a reminder that although the soil of the site was sufficiently non-calcareous to support *Aphanes arvensis*; the limestone in the gravel also enabled deep-rooted calcicoles to survive. It is possible that scrub succession was not just restricted to the barrow and there was a decline in seeds of some of the grassland species. However, the insects only hinted at the changes that were occurring and did not show any large scale-spread of scrub on the floodplain. The Coleoptera possibly reflected the rise of *Hypericum* sp and *Rubus fruticosus* agg with the eponymous phytophagous species of these plants, *Chrysolina* cf *hyperici* (Koch 1992, 79) and *Anthonomus* cf *rubi* (Hoffmann 1954, 110). The shading effect of the shrubs seems to have enabled some other woodland edge plants to become established, for example seed numbers of *Viola* S *Viola* sp (violet) and *Glechoma hederacea* (ground ivy).

The other waterlogged samples from both the northern and southern ditches all fall into the same basic vegetational sequence. For example, sample 179 and 187 from the southern ditch and sample 132 from the northern ditch all had high numbers of *Aphanes arvensis* agg seeds and can be placed early in the sequence. *A arvensis* agg seeds were absent from sample 182 from the northern ditch, but seeds of *Potentilla reptans* were well represented, suggesting it fell later in the sequence.

It is difficult to separate the beetle community of the barrow mound from the remainder of the Coleoptera. For example, many of the Carabidae of drier ground considered below could have lived on the mound. However, the following species, which tend to favour sandy soils with a sunny aspect and in some cases broken ground, were present in samples 131 and 130:

Amara consularis
Opatrum sabulosum
Meloe violaceus

They would have found conditions on the mound during the earlier stages of vegetational succession very suitable. *A consularis* lives in open habitats on sand and gravel, often occurring in gravel pits (Lindroth 1974, 92). *O sabulosum* is found in sand dunes and sandy areas principally on the coast (Brendell 1975, 10). It no longer occurs in the Nene Valley. *M violaceus* is a beetle of banks, commons and heaths with a most curious life cycle (Rye and Fowler 1890, 237–40). Eggs are laid in the soil, the larvae emerge and when conditions are warm, climb into low flowers, especially *Ranunculus* spp (buttercups). They attach themselves to passing bees and are taken back to the bees' nests. Once in a nest, a larva devours the bee's eggs, eats the food supply in the cells and then pupates.

The ecological succession on the barrow and perhaps also its immediate surrounds can be summarised as follows: low-growing annual weeds on areas of sandy well-drained broken ground were succeeded by rough grassy vegetation which in turn began to give way to mixed, somewhat thorny scrub. The last stage suggests some neglect of the monument but there does not seem to have been a major decline of grassland on the floodplain.

Floodplain grassland

The evidence of the insect remains suggested grassland to have been the main biotope within the catchment from which they had been derived. The chafers and elaterid beetles of Species Group 11, which feed on the roots of grassland herbs, averaged 5.0% of the terrestrial Coleoptera from Species Group 11 (Fig SS4.8). Such a value is entirely appropriate to a landscape of well-drained permanent grassland (Robinson 1991, 280). The most numerous of these beetles was the chafer *Phyllopertha horticola*, followed by the elaterid *Agrypnus murinus*. Unlike some grassland elaterids, *A murinus* does not seem to be able to tolerate flooding very well and is more characteristic of well-aerated soils. Weevils of the genera *Apion* and *Sitona*, which comprise Species Group 3, made up 5.9% of the terrestrial Coleoptera from samples 131–128. This group mostly feeds on grassland trefoils and is favoured by hay meadow conditions. While their relative abundance was not high enough to indicate managed hay meadow, neither does the grassland appear to have been so heavily grazed as to prevent the flowering of *Lotus corniculatus* (bird's foot trefoil) and *Trifolium* spp (clover). The scarabaeoid dung beetles of Species Group 2 comprised 6.6% of the terrestrial Coleoptera, sufficient to indicate a significant presence of the larger herbivorous mammals but not so high as to suggest heavy grazing.

Although the elaterid beetles suggested grassland growing on a well-drained soil, the waterlogged seeds included a strong element of wet grassland species, implying a range of conditions. Starting with the drier grassland, sample 131 contained many seeds of *Prunella vulgaris* (self-heal). These were joined in the higher samples of the sequence by *Ranunculus* cf *repens* (creeping buttercup) and *Potentilla reptans* (creeping cinquefoil), potential members of this grassland community, although it has been argued that the rise of *P reptans* was due to vegetational succession on the mound itself. The more host-specific of the phytophagous Coleoptera provide good evidence for two more species whose seeds do not commonly survive under waterlogged conditions (Koch 1992, 235–341):

Sitona hispidulus	*Trifolium* spp, esp *T pratense* (red clover)
S puncticollis	esp *Trifolium* spp (clovers)
Hypera punctata	esp *Trifolium* spp (clovers)
Ceuthorhynchidius troglodytes	*Plantago lanceolata* (ribwort plantain)
Mecinus pyraster	*P lanceolata* and *P media* (plantains)
Gymnetron pascuorum	*P lanceolata* (ribwort plantain)

Such vegetation would probably be closest to MG6 *Lolium perenne-Cynosurus cristatus* grassland (Rodwell 1992, 67–73). This is a grassland of mesotrophic brown earth soil that is grazed throughout the year. However, in its modern form, it is an improved grassland and the vegetation has been influenced by the use of fertilisers. The absence of *Centaurea nigra*, *Leucanthemum vulgare* and *Ranunculus acris* serves to differentiate it from MG5 *Cynosurus cristatus-Centaurea nigra* grassland, seasonally grazed unimproved hay meadow on similar soils. The absence of tall umbellifers shows that it was not fully developed MG1 *Arrhenatherum elatius* grassland, ungrazed unmanaged grassland of circumneutral soils. (All the above-mentioned seeds survive well under waterlogged conditions). However, it is possible that light grazing, sufficient to eliminate the umbellifers, which are particularly palatable to stock, had resulted in a grassland on the site that was transitional between MG1 and MG6.

The almost complete absence of *Ranunculus acris* (meadow buttercup) seeds and seeds of various Compositae is slightly surprising. It is possible that this was because the grassland of the floodplain was immature but it can only be speculated whether this was because the site had only recently been cleared of woodland (but see below) or whether the grassland had followed cultivation.

The very high number of seeds of the *Juncus effusus* group (tussock rushes) in all the samples and the high proportion of seeds of *Rumex conglomeratus* (sharp dock) and *Eleocharis S Palustres* sp (spike rush) from samples 130 and 129 suggests a wet ground element to the floodplain vegetation. The insect evidence showed that there was not a major presence of marsh on the floodplain, but would be consistent with areas of poorly grazed grassland in addition to the grassland on better drained soil. The most likely community would be MG10 *Holcus lanatus-Juncus effusus* rush pasture, (Rodwell 1992, 88–93). It is a grassland with prominent tussocks of *J effusus* that occurs on gleyed, permanently moist, mesotrophic soils and is usually grazed. It can be regarded as the equivalent of MG5 *Lolium perenne-Cynosurus cristatus* grassland for soils where the drainage is impeded, and they often grade into each other.

The floodplain of the River Nene at Redlands Farm was not generally waterlogged during the Neolithic. The height to which waterlogged preservation occurred in the barrow ditches was 0.74m below the surface of the floodplain gravels. The evidence for vegetational change in the ditches suggested that this was indeed the top of the permanent water table. There was no evidence that the site experienced flooding during the Neolithic or even for several millennia subsequently. Single examples of the flowing water elmid beetle, *Oulimnius* sp, from samples 131 and 130, although unable to flourish in the stagnant water of the ditches, could have flown from the site to the river. The soil that survived over the gravel and beneath the medieval alluvium around the barrow was a non-gleyed sandy loam. However, gravel extraction showed that, although higher areas of the floodplain at Redlands Farm had a free-draining soil beneath the alluvial clay, the lower areas, which tended to be alongside the channels of the Nene, had a deeper covering of gleyed clay. The barrow was situated on a very high area of gravel and the grassland of its immediate environs probably showed similarities to MG5 whereas to the north of the barrow was a low-lying area related to a palaeochannel which would have been a plausible locality for the rush pasture.

The majority of the terrestrial insects from samples 131–128 comprised a balanced fauna of grassland. The fauna was very diverse and from personal collecting experience seemed more appropriate to unimproved grassland, for example MG5 *Cynosurus cristatus-Centaurea nigra* grassland, rather than modern intensively managed MG6 *Lolium perenne-Cynosurus cristatus* grassland. However, this is likely to be very much a factor of grassland improvement such as the use of fertilisers and does not imply that the Neolithic grassland was being cut for hay. The Elateridae with larvae that feed on roots in grassland included, in addition to *Agrypnus murinus*, two species each of *Athous* and *Agriotes*. The more host-specific phytophagous grassland Coleoptera have already been mentioned but there was also a significant presence of beetles of grassland plants that could not be linked so closely with their hosts, for example *Longitarsus* spp Some of the insects feed on the leaves of the grasses themselves, including the homopteran bug *Aphrodes bicinctus* and the chrysomelid beetle *Crepidodera ferruginea* (Koch 1992, 119).

The Carabidae and Staphylinidae included many species that commonly occur in grassland although they are not restricted to it. Some occur in a wide range of types of grassland, especially when it is not very short:

Nebria brevicollis
Bembidion tetracolum

Calathus fuscipes
C melanocephalus
Stenus spp
Xantholinus linearis
X longiventris
Staphylinus aeneocephalus or fortunatarum
S olens

There was a distinctive element of Carabidae that are associated with dry or sandy soils that would be appropriate to the vegetation of the higher areas of the floodplain:

Bembidion quadrimaculatum
Pterostichus lepidus
Synuchus nivalis
Olisthopus rotundatus
Amara consularis

Some of these species tend to favour sparse vegetation cover and were perhaps living in the area around the barrow. One of the ants, *Tetramorium caespitum*, which was represented by both fertile females and workers, is associated with sandy habitats. In Britain it is predominantly a coastal species, although it is locally abundant on a few inland heaths in southern England and East Anglia (Bolton and Collingwood 1975, 20). It has not been recorded living in Northamptonshire (Collingwood and Barrett 1964, 115). However, it has been identified from four archaeological sites on the gravels of the Upper Thames ranging in date from Neolithic to Roman (Robinson 1986, fiche 9:C14). It is possible that this species was formerly more widespread on inland habitats with sandy soils and was not restricted to heathland.

There were also Carabidae of damp soils which could have found a suitable habitat in the low-lying areas of rush pasture, although it is difficult to separate this faunal element from species which were living on the ditch sides:

Bembidion guttula
Pterostichus anthracinus
P nigrita
Chlaenius vestitus

C vestitus, for example, tends to occur in close proximity to water. Some of these species also occur in marshes although a full marsh fauna was absent. One carabid, *Blethisa multipunctata*, does usually live in marshes. Perhaps it had come from an area of marsh alongside the river some distance away.

Two of the Carabidae, *Pterostichus niger* and *Abax parallelepipedus* would usually be regarded as woodland beetles in this region, although they do occasionally venture into arable fields (Lindroth 1974, 73, 76; personal collecting experience). In northern England, however, they frequently occur in grassland provided conditions are humid. Twelve individuals were found from the main Redlands Farm sample column, mostly from samples 130 and 129, more than might be expected given the proportion of other woodland insects. They have been recorded from Neolithic and Bronze Age sites in southern England where they were apparently living under grassland conditions, including Silbury Hill (Robinson 1997) and Runnymede Bridge (Robinson 1991, 322). It was speculated that at Runnymede they were managing to survive in areas that had been cleared of woodland but had not been subjected to intensive agriculture. Recent pitfall trapping at Whiteknights, Reading University, by the author showed *P niger* to be living in ungrazed grassland, with a vegetation height of about 0.35m, as part of an otherwise typical grassland fauna of Coleoptera. The presence of these two species at Redlands Farm was therefore perhaps as much a reflection of light grazing as of recent clearance, although both are possible.

The scarabaeoid dung beetles provided sufficient evidence for the droppings of the larger herbivorous mammals to imply that the grassland was being grazed by domestic animals. As appears to be typical for Neolithic and Bronze Age and, to a lesser extent, Iron Age insect assemblages with a significant proportion of Scarabaeoidae, the fauna included some species which are either extinct or very rare in Britain:

Copris lunaris
Caccobius schreberi
Onthophagus taurus

C lunaris was identified from sample 130 and *C schreberi* was identified from sample 131 in the main waterlogged sample column, *O taurus* was recovered from sample 187, one of the subsidiary samples. *C lunaris* is perhaps on the verge of extinction in Britain (Jessop 1986, 26), the other two species are already extinct in Britain (see noteworthy species records above). All have been recorded from prehistoric sites in southern England (see noteworthy species records above and Robinson 1991, 320). They seem most usually to be associated with cattle dung, but some readily feed on sheep droppings (Jessop 1986, 26; Koch 1989, 353–4, Paulian 1959, 73, 82, 88–9).

All tend to be associated, at least in the northern part of their present ranges, with warm, sandy and chalky soils. The decline of these three species and some other dung-feeding scarabaeoids has been attributed both to climatic deterioration (Osborne 1982, 68–74, Osborne 1988, 724–5) and to the destruction of their larval chambers by the ploughing of their favoured habitat of well-drained permanent pasture in recent times (Allen and Robinson 1993, 137; Robinson 1991, 326).

The remainder of the dung-feeding Scarabaeoidea comprise species of *Geotrupes*, *Colobopterus*, *Aphodius* and *Onthophagus* that still occur in the region. Various of the Hydrophilidae, especially *Megasternum obscurum* and Staphylinidae, especially *Anotylus sculpturatus* gp, which make up Species Group 7 and are associated with foul organic material, were probably living in the animal droppings on the pasture in company with them. The dung fauna was completed by further Staphylinidae, such as some of the Aleocharinae and a few members of the smaller families such as *Paralister purpurascens* from the Histeridae.

It has already been suggested that the vegetational succession towards scrub on the barrow mound could also have included an area around the monument. There was certainly a substantial decline in the numbers of seeds of some of the grassland species in absolute as well as percentage terms, including *Prunella vulgaris* (self heal), *Rumex conglomeratus* (sharp dock) and *Eleocharis* S *Palustres* sp (spike rush) in sample 128 (Fig SS4.7). However, seed numbers of *Juncus effusus* gp (tussock rush) held up. There were no significant changes in the various groups of grassland insects from samples 131 to 128.

Background woodland

Wood and tree-dependent beetles comprised 2.4% of the terrestrial Coleoptera from samples 131 to 128 (Fig SS4.8, Species Group 4). Such a value would be consistent with a landscape that was largely open but with a presence of woodland or scrub in the catchment that was more than just tree-lined hedgerows. The more host-specific amongst these beetles are dependent on the following trees (Koch 1992, 150, 171, 282, 349–50).

Rhynchites cf *tomentosus*	mostly *Salix* spp (willow) – leaves
Curculio pyrrhoceras	*Quercus* spp (oak) – leaf galls
Rhynchaenus quercus	*Quercus* spp (oak) – leaves
R testaceus	*Alnus glutinosa* (alder) – leaves
Scolytus intricatus	mostly *Quercus* spp (oak) – under bark of large dead branches

The oak-feeding beetles were in the majority and there was only a single individual of *R* cf *tomentosus. C pyrrhoceras* feeds on the galls of *Cynips quercus-folii* (cherry gall), a cynipid wasp gall of oak leaves (Koch 1992, 282).

The macroscopic plant remains also suggested a background presence of trees or woodland. The finds included leaves of *Quercus* sp (oak), a gall of the agamic generation of the cynipid gall wasp, *Neuroterus quercus-baccarum* (spangle gall) which is a leaf gall of oak (Darlington 1968, 157–9), a female catkin of *Alnus glutinosa* (alder) and an alder seed. The wood recovered from the barrow ditches was mostly oak, although *Corylus avellana* (hazel), Pomoideae (hawthorn, apple etc) and bark of *Tilia* sp (lime) were also identified. Some of the wood showed evidence of working and most had probably been imported to the site for construction purposes but it serves to show the taxa available.

The occurrence of the tree-dependent insects and the macroscopic plant remains such as tree leaves was unrelated to the rise in scrub on the site shown by the top of the waterlogged sample sequence. They were woodland rather than scrub species and they were not just restricted to sample 128. Neolithic clearance in the floodplain need not have been extensive. The remains could have been derived from surviving oak/alder woodland on the edge of the catchment for the insects and beyond the catchment of most of the macroscopic plant remains, except wind-blown leaves. This would have been at a distance of perhaps several hundred metres from the barrow. The well-drained nature of the higher areas of the floodplain gravels would have made them suitable for oak and possibly lime while the proximity of the water table to the surface, especially on the lower areas, would have favoured alder.

The wood from the ditches showed

limited evidence for woodland management practices with one of the pieces of oak (sample 161) perhaps being from a coppice stool and a length of hazel roundwood (sample 140/15) possibly being a coppice rod. It is uncertain whether the large piece of lime bark (sample 137) had been removed from a tree to extract the bast (fibres) or whether it was all that was left from a decayed log.

In addition to the members of Species Group 4, various of the other Coleoptera can occur in woodland habitats and doubtless some were derived from it. However, few of them are restricted to woodland. *Silpha atrata*, for example, is most usually found under loose bark but will also hunt its molluscan prey in grassland. The status of *Pterostichus niger* and *Abax parallelipipedus* has already been considered above and they do appear to have been living in grassland on the site. Even if this was as a relict of the pre-clearance woodland cover, they were not concentrated in sample 131, from the bottom of the column. Sample 131 did, however, contain the highest concentration of seeds of the following woodland or woodland edge plants:

Chelidonium majus (greater celandine)
Silene cf *dioica* x *latifolia* (pink campion)
Moehringia trinervia (wood sandwort)
Stachys sylvatica (hedge woundwort)

This could be a reflection of the barrow having been constructed not long after clearance and before an open-country flora had become fully established on the site. It is also possible that clearance had occurred earlier, but the seed bank of the soil still contained live seeds of these species and they were prompted to germinate by the disturbance of the barrow building.

There was also some evidence from the Coleoptera that clearance could have been a recent event when the barrow was constructed. The wood and tree-dependent Coleoptera only included three species of rotten wood. Two of them, *Valgus hemipterus*, which is now extinct in Britain, and *Dorcus parallelipipedus*, are large, strong flying Scarabaeoidea that are particularly associated with large rotten hardwood stumps (Koch 1989, 380–1). Each species was represented by two individuals. It is possible that these beetles were living in tree stumps left to decay after clearance.

Other habitats and activities

Most of the remaining habitats for which the plant and insect remains provide evidence are additional components of the biotopes that have already been described. The proportion of beetles that occur in dung/foul organic material and belong to Species Group 7 was not so high as to suggest dumps of such material on the site. The few carrion beetles, for example *Thanatophilus rugosus*, could have been living on the occasional corpse of a small wild animal in the grassland. The Lathridiidae (Species Group 7), beetles of somewhat mouldy plant material, which tend to be favoured by human settlement, were poorly represented. Naturally occurring litter in grassland often results in higher values. The synanthropic beetles, which tend to live inside buildings (Species Group 9) were entirely absent. Although the woodworm beetle *Anobium punctatum* (Species Group 10) was present, numbers were insufficient to suggest the presence of timber buildings on the site and it is possible that they had been derived from the woodland. They could have lived in the timber revetment to the barrow, although none of the wood recovered from the ditches showed signs of insect damage.

It is possible that limited cultivation took place in the vicinity of the barrow. The occurrence in Sample 131 of many seeds of annual plants that can grow as arable weeds has been noted, although this presence was thought likely to have resulted from soil disturbance when the monument was constructed (Macphail SS4.8.1). The insects provided slight evidence for disturbed ground but this need not imply cultivation. There were no plough or other cultivation marks in the soil sealed beneath the mound, despite earlier claims to the contrary, although the micromorphological studies of this soil did yield evidence of disturbance (Macphail SS4.8.1).

The only potential crop remains found were eight waterlogged seeds of *Papaver somniferum* (opium poppy) from sample 170 from the southern barrow ditch. It was a well-established crop in central Europe during the Neolithic, where it was grown for its edible oily seeds (Zohary and Hopf 1994, 130). In Britain it now commonly occurs as a weed of gardens and refuse tips, but in central Europe it is also a member of arable communities. *P somniferum* is sufficiently common in charred crop processing assemblages from the Danebury Environs sites to show that it was an arable weed on the Hampshire Chalk during the Iron Age (Campbell, 2000, 48). Its exact status at Redlands Farm remains uncertain but in the absence of other evidence for cultivation or crops it is perhaps best regarded as a member of the weed community growing on the disturbed ground of the monument. However, this would still hint at introduction to the region as a crop or an arable weed at an earlier date.

The sparse charred plant material from the ditches did not necessarily include any crop processing remains. While *Vicia* or *Lathyrus* sp (vetch or tare) and *Galium* sp (goosegrass) seeds often occur in charred crop processing assemblages, the single seed of each could also have been derived from the burning of coarse herbaceous vegetation. The charred fragment of *Corylus avellana* (hazel) nut shell in sample 179 does, however, suggest the consumption of collected food plants at the site. The few small fragments of oak charcoal from the ditches were just as likely to have been reworked from charcoal spreads related to tree clearance as from settlement on the site.

The later environmental sequence

The two root clusters of *Alnus glutinosa* (alder) growing through the organic sediments (wood samples 168 and 185) suggested that the scrub succession on the site progressed to the establishment of trees. However, in the absence of any contemporaneous organic sediments, it was not possible to trace other aspects of the vegetational development.

The inorganic sediments in the southern barrow ditch above sample 128 were mostly colluvial in origin and they contained gravel which was probably derived from the barrow mound. From sample 171/19 up to sample 171/12, the ditch sediments comprised gravelly spills from the barrow mound interdigitated with sediments with a lower gravel content entering from the southern side of the ditch. Whether any of these deposits resulted from cultivation remains uncertain, as does their date of formation. From sample 171/11 up to sample 171/ 2, the fill of the ditch comprised a ploughsoil of clay loam with some gravel. This ploughsoil extended southwards over the gravel of the floodplain and northwards up onto the barrow mound. Whereas the soil sealed beneath surviving areas of the mound showed no macroscopic evidence for cultivation, Romano-British cross-ploughing cut into the mound at the base of the ploughsoil (Fig SS1.58).

By the end of the episode or episodes of cultivation, which by analogy with West Cotton could have continued until the early medieval period, sedimentation from the barrow mound had raised the level of the ditch fill at the position of the 171 series of samples to above that of the surrounding floodplain. Consequently, when alluvial clay loam was deposited over the floodplain during the medieval period (dated from other Raunds Project sites on the Nene floodplain), only the far side of the ditch received much sediment. The ploughsoil on the floodplain, however, was sealed by up to 0.65m of alluvium through which the remains of the barrow mound projected. In very recent years, the site was ploughed and the top of the sample sequence, sample 171/1, was a ploughsoil derived from the alluvium.

SS4.3.2 Waterlogged plant remains and wood from prehistoric palaeochannel deposits

Mark Robinson and Gill Campbell

Eleven samples from four sections through palaeochannels were examined for macroscopic plant remains, molluscs and insects. Descriptions of the deposits sampled, sample sizes etc, and associated radiocarbon dates are given in Table SS4.9. Subsamples taken for the recovery of plant macroscopic remains were wet sieved down 0.212mm. They were separated into fractions by re-sieving through a stack of sieves of the following mesh sizes: 6.7mm, 4mm, 2mm, 1mm, 0.5mm, and 0.212mm. Sorting was carried out using a binocular dissecting microscope of up to ×20 magnification. Only 10% of the 0.5–0.212mm fraction was sorted for waterlogged plant remains, although insects were recovered from the whole of this fraction.

Remains were identified using the reference collection at the Oxford University Museum of Natural History. The results from sections in trenches B139 and B141 are presented in Table SS4.10 and those from the section through the palaeochannel adjacent to West Cotton in Tables SS4.11 and SS4.12. The results from another section, sample C, through this channel located to the north of West Cotton are also given in Tables SS4.11 and SS4.12. Nomenclature follows Clapham *et al* (1989). Items identified from the fine fraction (0.55–0.212mm) were multiplied up accordingly. Some items were not fully quantified, but a four point scale was used to estimate their abundance: + 1–3 items, ++ 4–25, +++ 26–100, ++++ >100. * is used to indicate

Table SS4.9. Samples analysed from waterlogged deposits in palaeochannels

Trench	*sample*	*context*	*deposit description*	*plant remains*	*molluscs*	*insects*
West Cotton	1	7131 (between timbers). Timber ^{14}C 3990±54 BP (UB-3319)	Compact grey-brown to black silty clay	1kg	1kg	3kg
	2	7130	very compact mid-grey silt oxidisng to orange-brown	500g	absent	836g
	8	?7136 — section 776 — grey black 'peaty' silt, NW side of channel	Orange-brown silty-sand	1kg	1kg	1kg
	9	?7382 — section 776 —banded fine gravels & silts, NW side of channel	Mottled orange-brown to dark-grey-black silt.	1kg	1kg	1kg
	16	7131 — under timber	Fibrous, compact grey silt	1kg	1kg	3kg
	19	7135 — ^{14}C 4268±32 BP (UB-3419)	Grey brown silty sand, 5% gravel inclusion	1kg	1kg	3kg
Channel C, north of West Cotton		bottom of channel — ^{14}C 4300±150 BP (HAR-9241)	Orange-brown silty clay	1kg	1kg	4.5kg
B139	33473 (Oxford 6)	62099	Grey organic silt and sand	1kg	-	1kg
	33474 (Oxford 7)	62093	Grey organic silt	1kg	-	1kg
B141 (Oxford 8)	33073	62304 — ^{14}C date 9370±170 BP (HAR-9243)		+	-	+
	? (Oxford 9)	Treehole in edge of channel, ? around 62306		+	-	+

presence where no attempt was made at quantification.

Discussion of results

Channel section B139

Sample 6 produced only a few remains. The presence of *Salix* sp (willow) buds and a seed of *Betula* cf *nana* (dwarf birch) is consistent with an early post-glacial date for this deposit suggested by the presence of the beetle *Helophorus glacialis* (Robinson SS4.3.3).

Sample 7 was stratigraphically later than sample 6, though undated. It produced a small assemblage which included aquatic or wetland plants such as *Ranunculus* Subgenus *Batrachium* (water crowfoot), *Zannichellia palustris* (horned pondweed), *Sagittaria sagittifolia* (arrowhead), and *Schoenoplectus lacustris* (bulrush). Plants of disturbed habitats such as *Stellaria media* gp (chickweed), *Polygonum aviculare* agg (knotgrass), *Urtica dioica* (stinging nettle), and *Sonchus asper* (spiny milk-thistle), were also recorded. A small grassland element was suggested by the presence of *Ranunculus acris/repens/bulbosus* (buttercups), and *Trifolium* sp (clover, trefoil). The results are in keeping with the insect results which suggested an open country fauna (Robinson SS4.3.3).

Channel section B141

The assemblage from sample 8 produced mainly buds of *Salix* sp (willow) and seeds of *Filipendula ulmaria* (meadowsweet). These taxa and the other plants recorded appear to reflect the vegetation growing on the river bank or within the channel and give few clues as to the surrounding environment. However the absence of species characteristic of disturbed habitats might be taken to suggest no clearance was taking place at this date.

Sample 9, from a treehole in the edge of this channel, produced evidence for woodland, as well as plants of wet places. Fragments of *Corylus avellana* (hazel) nutshell, a fruit of *Tilia cordata* (small-leaved lime), and a fruiting catkin of *Alnus glutinosa* (alder) give an indication of the types of tree that grew on the floodplain. The presence of *Stellaria media* gp and *Rumex* sp (dock) suggests some disturbance.

Palaeochannel at West Cotton and Channel C

The single sample from Channel C, and the samples from the channel at West Cotton, with the exception of sample 2, are of Neolithic date. Sample 2 represents a small area of sedimentation that was observed sealing the Neolithic deposits on the edge of the channel. It is dated to the early or middle Bronze Age by an OSL measurement of 1680±210 BC (IRSL-792d), calculated as 2100–1260 BC (Rees-Jones 1995, 81–5). Unfortunately it was only exposed briefly when the section through the channel was

Table SS4.10. Waterlogged plant remains from prehistoric palaeochannel deposits in Trenches B139 and B141

Where items are not fully quantified a four-point scale is used to estimate their abundance: + 1–3 items, ++ 4–25, +++ 26–100, ++++ >100

* is used to indicate presence where no attempt was made at quantification

	trench	*B139*		*B141*	
	EAU sample no	*6*	*7*	*8*	*9*
	CAS sample no	*33473*	*33474*	*33073*	*-*
Taxon (element if not a seed)	*context*	*62099*	*62093*	*62304*	*-*
Ranunculus acris/repens/bulbosus		-	2	-	-
R Section *Ranunculus* sp		-	1	2	-
R Subgen *Batrachium* sp		-	2	1	-
Stellaria media gp		-	2	-	1
Chenopodium polyspermum L		-	1	-	-
Tilia cordata Miller		-	-	-	1
Trifolium sp (petal)		-	1	-	-
Filipendula ulmaria (L) Maxim		-	-	42	-
Potentilla cf *sterilis* (L) Garcke		-	-	-	1
Potentilla sp		-	-	-	1
Aphanes microcarpa (Boiss & Reuter) Rotm		-	1	-	-
Callitriche sp		-	1	-	-
Polygonum aviculare agg		-	2	-	-
Polygonum sp		-	1	-	-
Rumex sp		-	-	-	1
Urtica dioica L		1	3	-	-
Betula cf *nana* L		1	-	-	-
Alnus glutinosa (L) Gaertner (catkin)		-	-	-	1
Corylus avellana L		-	-	-	2
Salix sp (capsule)		-	-	1	6
Salix sp (bud)		2	2	23	25
Lycopus europaeus L		-	-	1	-
Valeriana cf *dioica* L		-	-	1	-
Cirsium sp		-	2	4	-
Carduus/Cirsium sp		-	-	1	-
Sonchus arvensis L		-	1	-	-
S asper (L) Hill		-	1	-	-
Alisma plantago-aquatica L		-	-	1	-
Sagittaria sagittifolia L		-	3	-	-
Zannichellia palustris L		-	1	-	-
Potamogeton sp		-	-	-	14
Schoenoplectus lacustris (L) Palla		1	2	-	2
S cf *lacustris* (L) Palla		1	-	-	-
Carex spp		-	2	1	-
IGNOTA		2	-	1	4
Characeae indet		-	18	-	-
Characeae indet (stem fragment)		-	16	-	-
Byrophyta		-	-	-	+
Buds		-	-	1	+
Deciduous Leaf Fragments (including *Salix* sp) -		-	++	++	
TOTAL SEEDS		4	28	54	23

first cut and was not located with any certainty in the subsequent larger excavation of this area.

The results from the Neolithic samples and from the single possible Bronze Age sample are discussed separately below with reference to the insect report (Robinson SS4.3.3).

Neolithic Plant Assemblages

The aquatic and waterside environment

The channel supported a rich wetland vegetation. In the channel itself grew *Nymphea alba* (white water-lily) and *Nuphar lutea* (yellow water-lily), *Myriophyllum* sp (water-milfoil), *Callitriche* sp (starwort), *Veronica* Subgen *Beccabunga* (brooklime), *Damasonium alisma* (starfruit), and *Potamogeton* sp(p). (pondweed). The yellow water-lily, which requires at least one metre of water in which to grow, is tolerant of some shade and turbulence. The white water lily will grow in shallower water but is less tolerant of flow (Haslam, Sinker, and Wolseley1975, 299–300). The former may have dominated the deeper shadier parts of the channel, and the latter, the more open parts.

At the margins of the channel were plants such as *Caltha palustris* (marsh marigold), *Polygonum hydropiper* (water pepper), and *Iris pseudacorus* (yellow flag), with stands of *Typha* sp (reedmace), and *Schoenoplectus lacustris* (true bulrush). Along the banks grew plants such as *Brassica nigra* (black mustard), *Barbarea vulgaris* (common marsh yellow cress), *Polygonum persicaria* (red shank), *Polygonum lapathifolium* (pale periscaria), *Lycopus europeaus* (gypsywort), and *Bidens* sp (bur-marigold).

Patches of bare mud supported *Arenaria* sp (sandwort), *Montia fontana* (blinks), *Chenopodium rubrum* type, *Valerianella carinata* (keel-fruited cornsalad), and *Alisma plantago-aquatica* (water plaintain. These species are well-represented in sample 1 but decline in sample 8. Possibly, as a result of the construction of the brushwood platform, the immediate catchment became wetter with less exposed mud. This may explain the increase in seeds of *Potamogeton* (pondweed) and the decline in *Damsonium alisma* (starfruit) which prefers a gravelly substrate (Clapham *et al* 1989, 517).

Woodland and scrub

The remains of wood found in context 7131, associated with the platform, included alder, hazel, oak, ash, and Pomoideae type, a group which includes hawthorn, crab apple and *Sorbus* species. The large timbers themselves were of alder. Catkins of hazel and alder,

Table SS4.11. Waterlogged plant remains from prehistoric palaeochannel deposits near West Cotton

Where items are not fully quantified a four-point scale is used to estimate their abundance:
+ 1–3 items, ++ 4–25, +++ 26–100, ++++ >100

* is used to indicate presence where no attempt was made at quantification

Taxon (element if not a seed)	*sample* / *context*	*19* / *7135*	*16* / *7131*	*1* / *7131*	*8* / *?7136*	*9* / *?7382*	*C* / *-*	*2* / *7130*
Caltha palustris L		-	2	-	-	-	2	-
Ranunculus cf *acris* L		-	-	-	-	-	-	6
R acris/repens/bulbosus		6	9	7	9	7	21	14
R sceleratus L		-	-	1	-	-	-	1
R Subgen *Ranunculus* sp		-	9	-	-	-	-	-
R Subgen *Batrachium* sp		15	20	22	-	4	39	2
Ranunculus sp		2	-	1	-	-	1	2
Nymphaea alba L		1	7	12	-	3	1	-
Nuphar lutea (L) Sm		3	-	1	2	-	5	-
Papaver sp		-	-	-	-	-	-	1
Chelidonium majus L		-	1	3	-	-	-	-
Fumaria sp		1	-	-	-	-	-	-
Brassica cf *nigra* (L) Koch		1	-	-	-	-	-	-
Barbaris vulgaris R Br		-	-	2	10	-	1	-
Rorripa cf *palustris* (L) Besser		-	-	-	-	-	1	-
Rorripa/Nasturtium sp		-	-	-	6	-	-	-
Cruciferae indet		-	-	-	-	-	-	1
Viola odorata/hirta		-	-	1	-	-	-	-
Hypericum sp		10	-	10	-	10	11	-
Silene cf *dioica* (L) Clairv		-	2	-	-	-	-	-
Lychnis flos-cuculi L		5	3	6	1	2	1	-
Cerastium cf *fontanum* Baumg		-	1	-	-	-	1	-
Cerastium sp		-	-	-	1	-	-	-
Stellaria cf neglecta Weihe		13	8	11	-	5	16	-
S media gp		5	4	19	16	4	12	-
S cf *palustris* Retz		-	1	-	-	-	-	-
S graminea L		-	-	2	1	1	2	-
Sagina sp		-	-	40	1	-	-	-
Moehringia trinervia (L) Clairv		4	-	1	1	-	2	-
Arenaria sp		-	-	11	1	-	-	-
Caryophyllaceae indet		1	-	-	1	1	-	-
Montia fontana spp *chondrosperma* (Fenzl) S M Walters		-	-	3	-	-	-	1
Chenopodium polyspermum L		1	3	2	-	-	-	-
C cf *album* L		-	-	12	3	1	-	1
C rubrum type		-	-	5	-	1	-	4
Atriplex sp		*	3	-	1	-	-	-
Chenopodiaceae indet		-	2	-	-	-	-	-
Tilia cordata Miller		-	-	2	1	-	3	-
Linum catharticticum L		-	-	-	-	-	-	1
Rhamnus catharticus L		2	5	2	-	-	1	-
Filipendula ulmaria (L) Maxim		-	2	-	-	-	1	1
Rubus fruticosus agg		3	1	4	3	2	-	-
Rubus sp		1	1	2	1	1	1	-
Potentilla anserina L		-	-	1	-	-	-	2
P cf *reptans* L		1	2	4	13	-	-	1
Potentilla sp		-	-	2	7	-	1	1
Fragaria vesca L		-	1	-	-	-	-	-

Table SS4.11. Continued

Taxon (element if not a seed)	*sample* / *context*	*19* / *7135*	*16* / *7131*	*1* / *7131*	*8* / *?7136*	*9* / *?7382*	*C* / *-*	*2* / *7130*
Potentilla/Fragaria sp		-	-	2	-	-	-	-
Rosa sp		-	-	-	3	-	-	-
Rubus/Rosa type (thorn)		-	1	-	-	-	-	-
Aphanes arvensis L		1	-	2	15	-	1	1
Aphanes microcarpa (Boiss & Reuter) Rothm		-	-	-	8	-	-	-
Prunus spinosa L		5	1	4	-	9	2	-
Crataegus sp		1	-	1	3	14	2	-
Malus sp		-	1f	-	-	-	2	-
Rosaceae indet		-	-	-	-	1	-	-
Epilobium sp		10	11	-	1	2	-	-
Myriophyllum sp		3	-	3	2	2	1	1
Callitriche sp		-	-	1	-	-	-	-
Cornus sanguina L		1	-	-	2	-	1	-
Chaerophyllum temulentum L		-	-	-	-	-	2	-
Torilis cf *japonica* (Houtt) DC		-	-	-	-	-	5	-
Torilis sp		1	-	-	-	-	-	-
Oenanthe aquatica type		-	1	-	-	-	1	-
Aethusa cynapium L		-	-	-	-	-	2	-
Apium sp		-	-	-	-	-	-	1
Angelica sylvestris L		-	-	1	-	-	-	-
Umbelliferae indet		-	2	1	1	-	1	-
Mercuralis perennis L		1	2	1	-	-	-	-
Polygonum aviculare agg		-	-	2	3	-	1	-
P persicaria L		2	-	4	2	6	-	-
P cf *persicaria* L		-	3	1	-	-	-	-
P lapathifolium L		-	1	-	8	-	1	-
P hydropiper L		-	1	3	5	2	-	-
Polygonum sp		2	-	1	2	1	2	-
Fallopia convolvulus (L) A Löve		-	-	-	-	-	-	1
Rumex cf *acetosella* agg		-	-	1	-	-	1	-
R cf *acetosa* L		-	-	-	-	-	1	-
R cf *conglomeratus* Murray		1	2	-	2	1	1	-
Rumex spp		12	30	33	48	5	38	5
Urtica urens L		-	-	1	-	-	-	-
U dioica L		92	82	122	35	78	27	2
Humulus lupulus L		-	-	2	-	-	-	-
Alnus glutinosa (L) Gaertner		191	473	333	43	17	240	-
A glutinosa (L) Gaertner (female catkin: flowering)		-	5	1	8	4	-	-
A glutinosa (L) Gaertner(female catkin: fruiting) 42		54	46	56	3	53	4	
A glutinosa (L) Gaertner (male catkin)		4	14	7	3	7	8	-
Corylus avellana L		1	3f	2	1	5	18	-
C avellana L (male catkin)		2	4	2	-	-	3	-
Quercus robur/petrea (cupule + seed)		-	1	3	4	3	2	-
Salix sp (capsule frag)		-	-	-	1	1	-	-
S not *viminalis* sp (leaves)		-	1f	-	-	2	-	-
cf *Salix* sp (capsule frag)		2	-	-	-	-	-	-
Myosotis sp		-	-	2	-	-	-	-
Cuscuta cf *europea* L		-	-	-	-	3	-	-
Solanum dulcamara L		-	-	1	1	-	-	-
Solanum sp		-	1	-	-	2	-	-
Scrophularia sp		2	4	-	-	-	-	-
Veronica Subgen *Beccabunga* sp(p)		10	-	40	-	-	30	-
Mentha cf *aquatica* L		2	5	5	-	1	-	-

Table SS4.11. Continued

Taxon (element if not a seed)	sample / context	19 / 7135	16 / 7131	1 / 7131	8 / ?7136	9 / ?7382	C / -	2 / 7130
Mentha sp		5	4	12	1	-	1	1
cf *Mentha* sp		-	-	1	1	-	-	-
Lycopus europaeus L		5	7	4	-	3	-	-
Prunella vulgaris L		-	-	2	18	-	-	2
Stachys cf *sylvatica* L		-	2	1	-	-	-	-
Stachys sp		-	-	-	1	-	2	-
Lamium cf *album* L		-	-	-	-	-	1	-
Lamium sp		-	-	-	-	1	1	-
Galeopsis sp		1	-	1	-	1	1	-
Glechoma hederacea L		-	-	2	1	1	-	-
Ajuga reptans L		-	1	4	1	-	-	-
Ajuga sp		-	-	-	1	-	-	-
Labiatae indet		-	-	-	3	2	-	-
Plantago major L		2	9	3	54	1	1	8
Galium sp		-	1	-	-	-	-	-
Sambucus nigra L		6	1	2	2	10	6	2
Valerianella carinata Loisel		-	-	4	1	-	-	1
Valeriana cf *officinalis* L		-	1	-	-	-	-	-
Bidens sp		-	1	-	-	1	-	-
Senecio sp		2	2	2	14	-	-	-
Carduus sp		1	2	1	-	2	-	-
Cirsium sp		-	-	1	1	2	1	1
Carduus/*Cirsium* sp		1	-	-	-	-	1	-
Lapsana communis L		*	2	2	-	-	1	-
Leontodon sp		-	1	-	-	1	-	-
Sonchus cf *oleraceus* L		-	-	-	-	-	1	-
S asper (L) Hill		2	1	1	-	-	-	-
Taraxacum sp		1	-	1	2	-	-	-
Compositae indet		-	-	1	-	1	-	1
Alisma plantago-aquatica L		11	21	15	4	6	8	1
Alisma sp (case)		-	-	-	-	4	1	1
Damsonia sp		15	22	21	1	3	8	-
Sagittaria sagittifolia L		-	-	-	-	1	-	-
Potamogeton sp(p)		2	2	3	68	7	7	-
Juncus bufonius gp		-	-	-	-	-	-	80
J effusus type		30	1	250	50	60	40	70
J Sugen *Septati*		20	-	20	-	30	10	90
Juncus sp		-	-	30	-	10	-	20
Iris pseudacorus		-	-	-	-	-	1	-
Sparganium cf *erectum* L		-	-	-	3	2	1	-
Typha sp		10	*	-	-	-	-	-
Eleocharis palustris/uniglumis		-	-	-	3	2	1	-
Schoenoplectus lacustris (L) Palla		2	8	1	41	21	1	14
Carex sp (nutlet case)		1	1	-	-	-	2	-
Carex spp		3	13	6	4	7	1	7
Cyperaceae indet		-	1	-	2	3	-	1
Bromus secalinus type		-	-	-	-	-	1	-
Gramineae indet		22	6	9	2	-	2	63
Gramineae indet (rachis frag)		-	-	3	-	-	-	-
cf Gramineae indet		-	-	-	1	-	-	-
IGNOTA		3	8	9	7	5	12	3
Characeae indet		+++	+	++	+++	+++	+++	++

Table SS4.11. Continued

Taxon (element if not a seed)	*sample* *context*	*19* *7135*	*16* *7131*	*1* *7131*	*8* *?7136*	*9* *?7382*	*C* *-*	*2* *7130*
Bryophyta		++	++	+++	+++	+++	+++	+++
Buds		++	+++	+++	+++	++	++	-
Bud scales		+++	+++	+++	++	+++	+++	++
Catkin indet		+	+	+	+	+++	-	
Flower fragments		-	-	-	++	+	-	+
Deciduous Leaf Fragments		*	*	-	*	*	*	-
Wood		++++	++++	++++	++++	++++	++++	+
Charcoal		+	+	+++	+++	+++	++	++
TOTAL SEEDS		554	819	1161	547	372	603	416

acorn cupules, hazelnuts, lime fruits, numerous alder seeds, and some seed capsules and leaves of willow were also recorded.

Underwood or scrubby species were represented by fragments of *Prunus* cf *spinosa* (sloe) wood and fruit stones, seeds of *Cornus sanguinea* (dogwood), *Rhamnus catharticus* (buckthorn), *Rubus fruticosus* agg (blackberry) and *Rosa* sp (rose). Woodland herbs were also present, plants such as *Viola hirta/odorata* (violet), *Mercuralis perennis* (dog's mercury), and *Ajuga reptans* (bugle).

Overall there is the impression of a mixed woodland with ash and alder dominating the wetter areas and oak and lime becoming more dominant in the dryer parts. At the edge of the woodland, along the riverbank or at the edge of clearings, grew plants such as *Chelidonium majus* (greater celandine), *Lychnis flos-cuculi* (ragged-robin), *Stellaria* cf *neglecta* (chickweed), *Stellaria graminea* (stitchwort), *Angelica sylvestris* (wild angelica), *Torilis japonica* (upright hedge-parsley), *Solanum dulcamara* (woody nightshade) and *Stachys sylvatica* (hedge woundwort). *Humulus lupulus* (hop) may have flourished under such conditions. *Cuscuta* cf *europea* (greater dodder) may have been parasitic on this plant or on stinging nettle (Clapham *et al* 1989, 365)

Grassland and open environments

Ranunculus acris/repens/bulbosus (buttercup), *Potentilla anserina* (silverweed), *Potentilla* cf *repens* (creeping cinquefoil), *Prunella vulgaris* (self-heal), and *Leontodon* sp (hawkbit) are all characteristic of grassland. Some of the umbellifers, such as *Chaerophyllum temulentum* (rough chervil) and *Torilis* cf *japonica* (upright hedge-parsley), may have grown on the edge of this grassland, while *Filipendula ulmaria* (meadowsweet), *Rumex* cf *conglomeratus* (sharp dock), and *Valeriana* cf *officinalis* (common valerian) probably grew in the wetter areas.

Plants of disturbed ground may have grown on bars of gravel and sand in the river, or on areas of bare ground at the edge, expanding their territory as human clearance took place. Such plants include *Fumaria* sp (fumitory), *Aphanes arvensis* (parsley piert), *Aphanes microcarpa* (slender parsley piert), *Aethusa cynapium* (fool's parsley), *Rumex acetosella* agg (sheep's sorrel), *Plantago major* (great plantain), and *Sonchus asper* (spiny milk-thistle). They generally appear to increase with time and are noticeably more abundant in sample 8. Some, such as *Aphanes microcarpa* and *Rumex acetosella* agg are associated with circumneutral to acidic soils. This contrasts with the woodland species, many of which require more calcareous conditions, and suggests that the soils that developed under natural, undisturbed woodland were much less acidic.

In addition to these indicators of disturbance, the samples also contained fragments of charcoal. These were more plentiful in the later samples.

The Bronze Age Plant Assemblage

Sample 2 produced little or no evidence of woodland or scrub. Only a few remains of fruiting alder catkins were present. However, there was good evidence for the presence of grazed grassland including seeds of buttercups and grasses, *Potentilla anserina* (silverweed), *Linum catharticum* (purging flax), and *Juncus bufonius* gp (toad rush). The latter suggests trampling. Seeds of disturbed ground included *Papaver* sp (poppy), and *Fallopia convovulus* (black bindweed).

The list of aquatic and wetland species was smaller than for the Neolithic samples. This may be due to the depositional nature of the deposit. Very few large items were recovered which would suggest that only lighter material was being deposited at this point in the channel. This in turn may mean

Table SS4.12. Waterlogged wood from prehistoric palaeochannel deposits near West Cotton

* is used to indicate presence where no attempt was made at quantification

	West Cotton channel contexts																					*Channel*
Taxon	*6763*	*6764*	*6765*	*7115*	*7116*	*7117*	*7118*	*7119*	*7122*	*7125*	*7126*	*7129*	*7131*	*7135*	*7137*	*7138*	*7139*	*7140*	*7141*	*7142*	*7354*	*7380*	*C*
Prunus cf *spinosa* L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5
Pomoideae	-	8	-	-	1	-	-	-	-	-	-		3	-	-	-	-	-	3	-	-	-	-
Alnus sp	1	1	1	1	-	1	1	1	1	1	1	-	5	1	-	1	1	1	-	1	-	1	1
Corylus sp	3	-	-	-	-	-	-	-	-	-	-	-	5	-	-	-	-	-	-	-	-	-	2
Alnus/Corylus sp	-	-	-	-	-	-	-	-	-	-	-	-	1	1	-	-	-	-	-	-	-	-	1
Quercus sp	-	-	-	-	-	-	-	-	-	-	-	-	4	-	-	-	-	-	-	-	-	-	1
Fraxinus sp	1	-	-	-	-	-	-	-	-	-	-	-	2	-	1	-	-	-	3	-	*	-	-
Indet	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	1

that indicators of scrub and woodland were under-represented. However overall the impression is of a very open environment.

Conclusion

The plant remains from the palaeochannels give a detailed picture of the environment of the channel itself and the surrounding vegetation. They show a succession from open, early post-glacial conditions, through to mature woodland, followed by clearance, culminating in a largely open landscape, although it is uncertain as to when this final stage was reached. Apart from numerous charcoal fragments, little or no evidence for economic activity was recovered from these deposits. However, the plants recovered, do give a good indication of the types of wild plant resources which would have been available for exploitation. Fruits such as wild strawberry, blackberry and sloe, and hazelnuts could have been eaten. Small-leaved lime, stinging nettle, and bramble could all have been used for fibre. Many other plants could also have been eaten or used medicinally.

SS4.3.3 Prehistoric insect remains from the palaeochannels

Mark Robinson

Introduction

Insect remains were analysed from the same samples of the prehistoric sediments from the palaeochannels at Irthlingborough and West Cotton as the macroscopic plant remains. Full details of the contexts, their dates and sample sizes are given in Table SS4.9. The work was funded by the Ancient Monuments Laboratory of English Heritage.

Methods and results

Insect remains were picked out from the samples being examined for macroscopic plant remains. Additional subsamples from some of these samples were processed for insect remains alone. These subsamples were weighed out, washed onto 0.2mm sieve, drained and subjected to paraffin flotation. The flots were washed in detergent, then sorted. The insect remains were stored in alcohol prior to identification.

Specimens were identified with reference to the collections of the University Museum, Oxford, at magnifications of up to x100, and the results are given in Tables SS4.13–SS4.16. The tables either record the minimum number of individuals represented by the fragments identified from a sample

Table SS4.13. Early prehistoric Coleoptera from palaeochannel deposits in Trenches B139 and B141

	Min no of individuals			
Sample	*6*	*7*	*8*	*9*
CARABIDAE				
Notiophilus cf germinyi Fauv	-	-	1	-
Bembidion assimile Gyl	-	-	-	1
B guttula (F)	-	1	-	-
Pterostichus anthracinus (Pz) or *nigrita* (Pk)	-	-	-	1
P cupreus (L) or *versicolor* (Sturm)	-	1	-	-
Agonum muelleri (Hbst)	-	1	-	-
Amara sp	-	-	-	1
DYTISCIDAE				
Agabus bipustulatus (L)	-	-	-	1
Agabus sp (not *bipustulatus*)	-	-	1	-
HYDROPHILIDAE				
Helophorus glacialis Vil	1	-	-	-
H aquaticus (L) or *grandis* Ill	-	-	-	1
Helophorus sp (*brevipalpis* size)	-	2	1	-
STAPHYLINIDAE				
Lesteva sp	-	-	-	1
Platystethus sp	-	1	-	-
Stenus sp	-	-	1	-
Philonthus spp	-	-	3	1
Tachinus sp	-	-	-	1
SCARABAEIDAE				
Aphodius cf *sphacelatus* (Pz)	-	2	-	-
Aphodius sp	-	1	1	-
DRYOPIDAE				
Dryops sp	-	1	-	-
ELATERIDAE				
Hypnoidus riparius (F)	-	-	-	1
CHRYSOMELIDAE				
Donacia sp	-	1	-	-
Longitarsus spp	-	3	-	-
Chaetocnema concinna (Marsh)	-	1	-	-
CURCULIONIDAE				
Sitona sp	-	1	-	-
TOTALS	1	16	8	9

or show presence/absence. Nomenclature follows the Royal Entomological Society's revised check list of British insects (Kloet and Hincks 1964; 1977) with the addition of Lucht (1987) for a species no longer extant in Britain.

Tables SS4.13 and SS4.14 give the results for the late Devensian to early Flandrian deposits and some undated sediments. Their analyses were undertaken very much on an exploratory basis and as an aid to

Table SS4.14. Other early prehistoric insects from palaeochannel deposits in Trenches B139 and B141 (minimum numbers of individuals)

Sample		*6*	*7*	*8*	*9*
Odonata indet		-	1	-	-
Aphrodes sp		-	1	-	-
Homoptera indet		-	-	11	-
Trichoptera indet	— larva	-	1	-	-
Trichoptera indet	— case	-	2	1	1
Formica sp	— worker	-	-	-	1
Lasius niger gp	— worker	-	1	-	

establishing channel development. Only very small assemblages of insects were examined. The results for the Neolithic and Bronze Age deposits are given in Tables SS4.15 and SS4.16. Where possible larger assemblages were examined so that the results could be used for more detailed palaeoecological reconstructions. The results for the Coleoptera from some of the samples have been displayed in Fig SS4.9 as species groups expressed as percentages of the minimum number of individuals of terrestrial Coleoptera in each assemblage. Aquatic Coleoptera have been excluded from the total because the assemblages accumulated under water and it enables some of the differences due to the environment of the deposit itself to be eliminated. The species groups used follow Robinson (1991, 278–81) and the members of each group are indicated in Table SS4.15. Not all the Coleoptera have been classified into categories.

Interpretation of the earlier and undated insects

Channel section B139

Only a single beetle, *Helophorus glacialis*, was identified from Sample 6, an organic deposit interstratified with coarser mineral sediment on the north edge of the channel. It is a small water beetle of snow meltwater pools which now has an arctic-alpine distribution (Freude *et al* 1971, 119). It is a common member of late Devensian Zone III insect assemblages but is now extinct in Britain. The significance of this discovery is that it helps to confirm that the channel was of early origin.

Sample 7, which was stratigraphically later than Sample 6, contained a small open country fauna without any obvious cold elements. It is likely to have been either early Postglacial or later prehistoric/Romano-British in date. An open country fauna was

Table SS4.15. Neolithic and Bronze Age Coleoptera from prehistoric palaeochannel deposits near West Cotton (minimum numbers of individuals)

Sample	19	16	1	8	9	C	2	*Species Group*
CARABIDAE								
Carabus nemoralis Müll	-	-	-	-	-	1	-	
Calosoma inquisitor (L)	-	-	1	-	-	-	-	
Nebria brevicollis (F)	-	1	1	-	-	-	-	
Notiophilus aquaticus (L)	1	-	-	-	-	-	-	
Notiophilus sp	-	1	-	-	-	-	-	
Elaphrus cupreus Duft	-	1	1	-	-	-	-	
Loricera pilicornis (F)	1	1	1	-	-	-	-	
Dyschirius globosus (Hbst)	2	-	1	-	3	-	-	
Clivina collaris (Hbst) or *fossor* (L)	-	1	1	-	-	1	1	
Patrobus atrorufus (Ström)	-	1	-	-	-	-	-	
Trechus obtusus Er or *quadristriatus* (Schr)	2	1	-	-	-	-	-	
T secalis (Pk)	-	1	1	-	-	-	2	
Bembidion properans Step	-	-	1	-	-	-	-	
B dentellum (Thun)	1	-	-	-	-	-	-	
B gilvipes Sturm	-	2	2	-	-	-	-	
B assimile Gyl	-	-	-	-	-	-	1	
B biguttatum (F)	-	2	-	-	-	-	-	
B guttula (F)	1	2	1	-	1	1	-	
Pterostichus cupreus (L)	1	-	-	-	-	-	1	
P diligens (Sturm)	-	1	2	-	-	-	-	
P melanarius (Ill)	1	1	1	-	-	-	1	
P minor (Gyl)	-	-	-	-	-	1	-	
P niger (Schal)	-	1	-	-	-	-	-	
P anthracinus (Pz) or *nigrita* (Pk)	-	-	-	1	-	-	1	
P strenuus (Pz)	3	1	-	1	1	-	-	
P cupreus (L) or *versicolor* (Sturm)	-	-	1	-	-	-	-	
P vernalis (Pz)	1	-	-	-	-	-	-	
Abax parallelepipedus (P & M)	2	1	1	-	-	-	-	
Agonum albipes (F)	1	1	-	-	-	1	-	
A cf *fuliginosum* (Pz)	-	1	-	-	-	-	-	
A muelleri (Hbst)	1	-	-	-	-	-	1	
A obscurum (Hbst)	-	-	1	-	-	-	-	
A viduum (Pz)	1	-	-	-	-	1	-	
Amara sp	1	-	1	-	-	-	1	
Harpalus S *Ophonus* sp	-	1	1	-	-	-	-	
Chlaenius nigricornis (F) or *nitidulus* (Schr)	-	1	-	-	-	-	-	
C vestitus (Pk)	-	1	-	1	-	-	-	
HALIPLIDAE								
Haliplus sp	-	1	1	-	-	-	-	1
DYTISCIDAE								
Hydroporus sp	-	1	-	-	1	-	-	1
Potamonectes depressus (F)	1	1	-	-	1	1	-	1
Agabus bipustulatus (L)	1	-	1	-	-	-	-	1
Agabus sp (not *bipustulatus*)	-	1	1	-	-	-	-	1
Colymbetes fuscus (L)	-	1	1	-	-	-	1	1
Dytiscus sp	1	-	-	-	-	-	1	1
GYRINIDAE								
Gyrinus sp	1	1	-	-	-	1	-	1
Orectochilus villosus (Müll)	-	1	-	-	-	-	-	1

Table SS4.15. Continued

Sample	19	16	1	8	9	C	2	*Species Group*
HYDROPHILIDAE								
Helophorus arvernicus Muls	-	1	-	-	1	-	-	1
H grandis Ill	-	1	-	-	-	-	-	1
H aquaticus (L) or *grandis* Ill	-	-	1	-	-	-	1	1
Helophorus spp (*brevipalpis* size)	2	4	23	1	1	3	5	1
Cercyon haemorrhoidalis (F)	-	-	1	-	-	-	1	7
C sternalis Sharp	1	-	-	-	1	-	-	7
C cf *tristis* (Ill)	-	2	-	-	-	-	1	7
Cercyon sp	1	1	1	-	-	1	-	7
Megasternum obscurum (Marsh)	3	5	2	1	1	6	2	7
Hydrobius fuscipes (L)	1	-	1	-	-	-	1	1
Laccobius sp	1	1	1	-	-	-	-	1
HYDRAENIDAE								
Ochthebius bicolon Germ	-	1	-	-	-	-	-	1
O cf *bicolon* Germ	-	7	-	-	-	-	-	1
O minimus (F)	1	7	3	1	1	2	1	1
O cf *minimus* (F)	3	-	8	-	2	3	4	1
Hydraena pulchella Germ	1	2	1	-	-	1	-	1
H riparia Kug	6	6	13	1	1	4	2	1
H testacea Curt	-	-	1	-	1	-	-	1
Hydraena sp	-	-	2	-	-	-	-	1
Limnebius papposus Muls	1	-	1	-	-	-	1	1
L truncatellus (Thun)	-	1	-	-	-	-	-	1
PTILIIDAE								
Ptenidium sp	-	3	2	-	-	-	-	
Ptiliidae gen et sp indet (not *Ptenidium* sp)	1	2	-	-	1	1	2	
LEIODIDAE								
Nargus velox (Spence)	-	1	-	-	-	-	-	
Sciodrepoides fumata (Spence) or *watsoni* (Spence)	1	-	-	-	-	-	-	
SILPHIDAE								
Dendroxena quadrimaculata (Scop)	1	-	-	-	-	-	-	
Silpha atrata L	1	1	-	-	-	-	-	
SCYDMAENIDAE								
Scydmaenidae gen et sp indet	2	-	-	1	-	-	-	
STAPHYLINIDAE								
Micropeplus fulvus Er	-	1	-	-	-	-	-	
Anthobium atrocephalum (Gyl)	1	-	-	-	-	-	-	
Olophrum cf *consimile* (Gyl)	1	-	-	-	-	-	-	
O fuscum (Grav) or *piceum* (Gyl)	-	1	-	-	-	-	-	
Acidota cruentata Man	1	-	1	-	-	-	-	
Lesteva longoelytrata (Gz)	-	1	-	-	-	-	-	
Dropephylla ioptera (Step)	-	1	1	-	-	-	-	
Carpelimus cf *corticinus* (Grav)	1	5	-	-	1	-	2	
C cf *rivularis* (Mots)	-	1	-	-	-	-	-	
Platystethus arenarius (Fouc)	-	1	-	1	-	-	-	7
P nodifrons Man	-	-	-	-	1	-	1	
Anotylus nitidulus (Grav)	-	-	1	-	-	-	1	
A rugosus (F)	-	2	-	-	-	-	1	7
A sculpturatus gp	2	1	2	-	-	-	2	7
A cf *tetracarinatus* (Block)	-	-	1	-	-	-	-	
Stenus bimaculatus Gyl	1	-	-	-	-	-	-	

Table SS4.15. Continued

Sample	19	16	1	8	9	C	2	*Species Group*
Stenus spp (not *bimaculatus*)	3	1	3	-	-	1	2	
Lathrobium longulum Grav	-	1	1	-	-	-	-	
Lathrobium sp (not *longulum*)	-	1	1	-	-	1	-	
Rugilus orbiculatus (Pk)	1	-	-	-	-	-	-	
Othius punctulatus Gz	-	-	1	-	-	-	-	
Gyrohypnus sp	1	-	-	-	-	-	-	
Xantholinus linearis (Ol)	-	1	-	-	-	-	1	
X linearis (Ol) or *longiventris* Heer	-	-	-	-	-	-	2	
Philonthus spp	1	2	1	1	-	-	1	
Gabrius sp	1	1	-	1	-	-	1	
Staphylinus aeneocephalus Deg or *fortunatarum* (Woll)	2	-	-	-	-	-	1	
S olens Müll	-	1	-	-	-	-	-	
Mycetoporus sp	-	-	1	-	-	-	-	
Sepedophilus sp	-	1	-	-	-	-	-	
Tachyporus sp	1	1	-	-	-	-	1	
Tachinus sp	-	4	1	-	-	-	1	
Aleocharinae gen et sp indet	10	7	4	1	1	1	3	
PSELAPHIDAE								
Pselaphidae gen et sp indet	-	1	1	-	-	-	-	
GEOTRUPIDAE								
Geotrupes sp	-	1	1	-	1	1	-	2
SCARABAEIDAE								
Colobopterus erraticus (L)	-	-	-	1	-	-	-	2
Aphodius cf *fimetarius* (L)	-	-	1	-	-	-	-	2
A luridus (F)	-	-	-	-	-	1	-	2
A rufipes (L)	1	-	-	-	-	-	1	2
A cf *sphacelatus* (Pz)	1	1	1	-	-	-	1	2
Aphodius sp	-	-	1	-	-	-	1	2
Onthophagus ovatus (L)	-	-	-	-	-	-	2	2
Phyllopertha horticola (L)	1	1	1	1	-	1	2	11
DASCILLIDAE								
Dascillus cervinus (L)	1	-	1	-	-	-	1	
SCIRTIDAE								
cf *Cyphon* sp	2	1	-	-	-	-	-	
BYRRHIDAE								
Byrrhus sp	-	-	-	-	-	1	-	
DRYOPIDAE								
Helichus substriatus (Müll)	5	3	1	1	-	3	-	1
Dryops sp	2	2	1	-	1	1	1	1
ELMIDAE								
Elmis aenea (Müll)	1	1	1	-	-	-	-	1
Esolus parallelepipedus (Müll)	1	1	-	-	-	-	-	1
Macronychus quadrituberculatus Müll	1	1	1	-	-	-	-	1
Normandia nitens (Müll)	9	3	1	-	2	-	-	1
Oulimnius sp	23	24	10	2	6	10	3	1
Stenelmis canaliculata (Gyl)	1	2	-	-	-	-	-	1
ELATERIDAE								
Agrypnus murinus (L)	1	1	1	-	-	1	1	11
Melanotus erythropus (Gml)	1	-	1	-	-	1	-	4
Athous hirtus (Hbst)	1	-	-	-	-	-	-	11

Table SS4.15. Continued

Sample	19	16	1	8	9	C	2	*Species Group*
Agriotes obscurus (L)	-	1	1	-	-	-	-	11
A sputator (L)	-	-	1	-	-	-	-	11
Agriotes sp	1	-	-	1	1	-	1	11
Dalopius marginatus (L)	1	-	-	-	-	-	-	
Adrastus pallens (F)	-	1	-	-	-	-	-	
THROSCIDAE								
Trixagus caranifrons (de Bon)	2	-	-	-	-	-	-	
T dermestoides (L)	-	-	1	-	-	-	-	
EUCNEMIDAE								
Melasis buprestoides (L)	-	1	-	-	-	-	-	4
CANTHARIDAE								
Cantharis sp	1	1	-	-	-	-	1	
ANOBIIDAE								
Grynobius planus (F)	2	1	1	-	-	1	-	4
Gastrallus immarginatus (Müll)	-	-	1	-	-	-	-	4
Anobium punctatum (Deg)	1	1	-	-	-	-	-	10
PELTIDAE								
Thymalus limbatus (F)	1	-	-	-	-	-	-	4
MELYRIDAE								
Malachius bipustulatus (L)	1	-	-	-	-	-	-	
Malachius sp	-	1	-	-	-	-	-	
NITIDULIDAE								
Brachypterus urticae (F)	1	-	1	-	-	-	-	
CRYPTOPHAGIDAE								
Cryptophagidae indet (not *Atomaria*)	1	-	-	-	-	1	-	
Atomaria sp	-	1	-	-	-	-	1	
CORYLOPHIDAE								
Orthoperus sp	1	-	-	-	-	-	-	
COCCINELLIDAE								
Coccidula rufa (Hbst)	-	-	-	-	-	-	1	
LATHRIDIIDAE								
Enicmus transversus (Ol)	-	-	1	-	-	-	-	8
Corticariinae gen et sp indet	1	1	1	-	-	-	1	8
MELANDRYIDAE								
Osphya bipunctata (F)	-	1	-	-	-	-	-	4
SCRAPTIIDAE								
Anaspis sp	-	-	1	-	-	-	-	
MORDELLIDAE								
Mordellistena sp	-	1	-	-	-	-	-	
CERAMBYCIDAE								
Rhagium mordax (Deg)	1	-	-	-	-	-	-	4
Grammoptera variegata (Germ)	-	1	-	-	-	-	-	4
CHRYSOMELIDAE								
Macroplea appendiculata (Pz)	-	-	1	-	1	-	-	5
Donacia aquatica (L)	-	-	1	-	-	-	-	5
D clavipes F	1	2	2	-	-	-	-	5
D crassipes F	1	1	1	-	-	-	-	5

Table SS4.15. Continued

Sample	19	16	1	8	9	C	2	*Species Group*
D impressa Pk	1	-	-	-	1	-	-	5
D simplex F	1	2	1	-	-	-	-	5
Donacia sp	1	1	-	1	-	1	1	5
Chrysolina polita (L)	1	-	1	-	-	-	-	
C varians (Schal)	-	1	-	-	-	-	-	
Gastrophysa viridula (Deg)	1	-	-	-	-	-	-	
Phaedon sp (not *tumidulus*)	-	-	-	-	1	-	-	
Hydrothassa glabra (Hbst)	1	2	-	-	-	-	-	
H marginella (L)	-	-	-	-	1	-	1	
Agelastica alni (L)	1	1	1	-	1	-	-	4
Phyllotreta tetrastigma (Com)	1	-	-	-	-	-	-	
P vittula Redt	-	1	1	-	-	-	-	
Aphthona nonstriata (Gz)	1	1	-	-	-	-	-	5
Longitarsus spp	-	3	3	-	1	-	3	
Crepidodera ferruginea (Scop)	-	-	1	1	-	-	1	
Epitrix pubescens (Koch)	1	-	2	-	-	-	-	
Chaetocnema concinna (Marsh)	-	1	-	-	-	-	1	
Chaetocnema sp (not *concinna*)	-	1	-	-	-	-	1	
Apteropeda orbiculata (Marsh)	-	1	-	-	-	-	-	
Psylliodes sp	1	2	1	-	-	-	-	
APIONIDAE								
Apion spp	3	1	1	1	1	-	3	3
CURCULIONIDAE								
Phyllobius calcaratus (F)	-	-	1	-	-	-	-	4
Phyllobius sp	-	-	-	-	1	-	1	
Polydrusus undatus (F)	-	1	-	-	-	-	-	4
Barypeithes araneiformis (Schr)	1	-	-	-	-	-	-	
Sciaphilus asperatus (Bons)	-	-	1	-	-	-	-	
Strophosomus melanogrammus (Forst)	-	2	-	-	-	-	-	
Barynotus obscurus (F)	-	-	-	1	-	1	-	
Sitona cf *lineatus* (L)	-	-	-	-	-	-	1	3
S cf *puncticollis* Step	-	-	1	-	-	-	-	3
Sitona sp	-	1	1	-	-	-	1	3
Alophus triguttatus (F)	1	-	-	-	-	-	1	
Bagous sp	1	-	3	2	-	1	1	5
Notaris acridulus (L)	1	-	1	-	-	3	1	5
Coeliodes erythroleucos (Gml)	-	1	-	-	-	-	-	4
Cidnorhinus quadrimaculatus (L)	-	1	1	-	-	-	-	
Ceuthorhynchidius troglodytes (F)	-	-	1	-	-	-	-	
Eubrychius velutus (beck)	-	1	-	-	-	-	-	5
Ceuthorhynchinae gen et sp indet	1	1	1	-	-	1	1	
Curculio cf *nucum* L	-	1	1	-	-	-	-	4
C pyrrhoceras Marsh	-	-	1	-	-	-	-	4
Tychius cf *quinquepunctatus* (L)	-	-	1	-	-	-	-	
Tychius sp (not *quinquepunctatus*)	-	-	-	1	-	-	-	
Mecinus pyraster (Hbst)	-	1	-	-	-	-	1	
Rhynchaenus quercus (L)	1	-	-	-	-	-	-	4
R salicis (L)	-	-	1	-	-	-	-	4
SCOLYTIDAE								
Scolytus scolytus (F)	1	-	-	-	-	-	-	4
Kissophagus hederae (Sch)	-	1	-	-	-	-	-	4
TOTALS	168	199	168	25	39	61	89	

Table SS4.16. Other Neolithic and Bronze Age insects from prehistoric palaeochannel deposits near West Cotton (minimum number of individuals)

Sample		*19*	*16*	*1*	*8*	*9*	*C*	*2*
ODONATA								
Agrion sp		-	1	-	-	-	-	-
Odonata indet		1	-	-	-	-	-	-
DERMAPTERA								
Forficula auricularia L		1	1	-	-	-	-	-
HEMIPTERA								
Pentatoma rufipes (L)		-	1	1	-	-	-	1
Pentatomidae indet		-	1	-	-	-	-	-
Stygnocoris sp		-	-	1	-	-	-	-
Drymus sylvaticus (F)		-	1	-	-	-	-	-
Eremocoris sp		-	1	-	-	-	-	-
Lygaeidae indet		-	-	-	1	-	-	-
Anthocorinae indet		1	-	-	-	-	-	-
Gerris sp		-	-	-	-	-	1	1
Aphrodes cf *albifrons* (L)		-	-	1	-	-	-	1
A bicinctus (Schr)		-	-	-	-	-	-	1
A flavostriatus (Don)		-	-	1	-	-	-	-
Aphrodes sp		-	-	-	-	-	-	1
Homoptera indet		3	-	-	1	-	-	-
TRICHOPTERA								
Ithytrichia lamellaris Eat or *clavata* Mort	— case	79	121	15	63	14	38	-
Orthotrichia sp	— case	2	4	8	2	5	3	-
Trichoptera indet	— larva	176	136	23	3	16	10	3
Trichoptera indet	— case	4	15	10	23	21	-	4
HYMENOPTERA								
Myrmica rubra (L) or *ruginodis* Nyl	— worker	-	1	-	-	-	-	-
Lasius flavus gp	— worker	-	-	1	-	-	-	-
Hymenoptera indet	— adult head	15	6	6	-	4	2	3
DIPTERA								
Chironomidae	— larva	+	+	-	-	-	-	+
Diptera indet	— puparium	1	4	6	2	4	2	2
Diptera indet	— adult	6	8	4	-	4	2	2

also identified from Sample 3, which post-dated Sample 6 and was believed to be Saxon in date. This is described in the West Cotton report (Robinson 2010).

Channel section B141

Very small undiagnostic insect assemblages were recovered from Sample 8, the early Post-glacial organic sediment and Sample 9, from a treethrow hole which cut through this deposit.

Interpretation of the Neolithic insect assemblages

Introduction

All the Neolithic samples were from further downstream of the palaeochannel that was investigated by Section B139. Samples 1, 8, 9, 16 and 19 were from the West Cotton palaeochannel section. Sample C was from an exposure in the quarry even further downstream. Samples 19, 16 and 1 comprised a stratigraphic sequence, the remainder of the samples were spot samples.

The sediments which were sampled all accumulated on the bed of a flowing channel. The aquatic insects could all have lived in the channel at the point of deposition but many of them would have been carried from some considerable distance upstream before incorporation into the sediments. There was no evidence that any of the insect remains experienced human transport to the deposits.

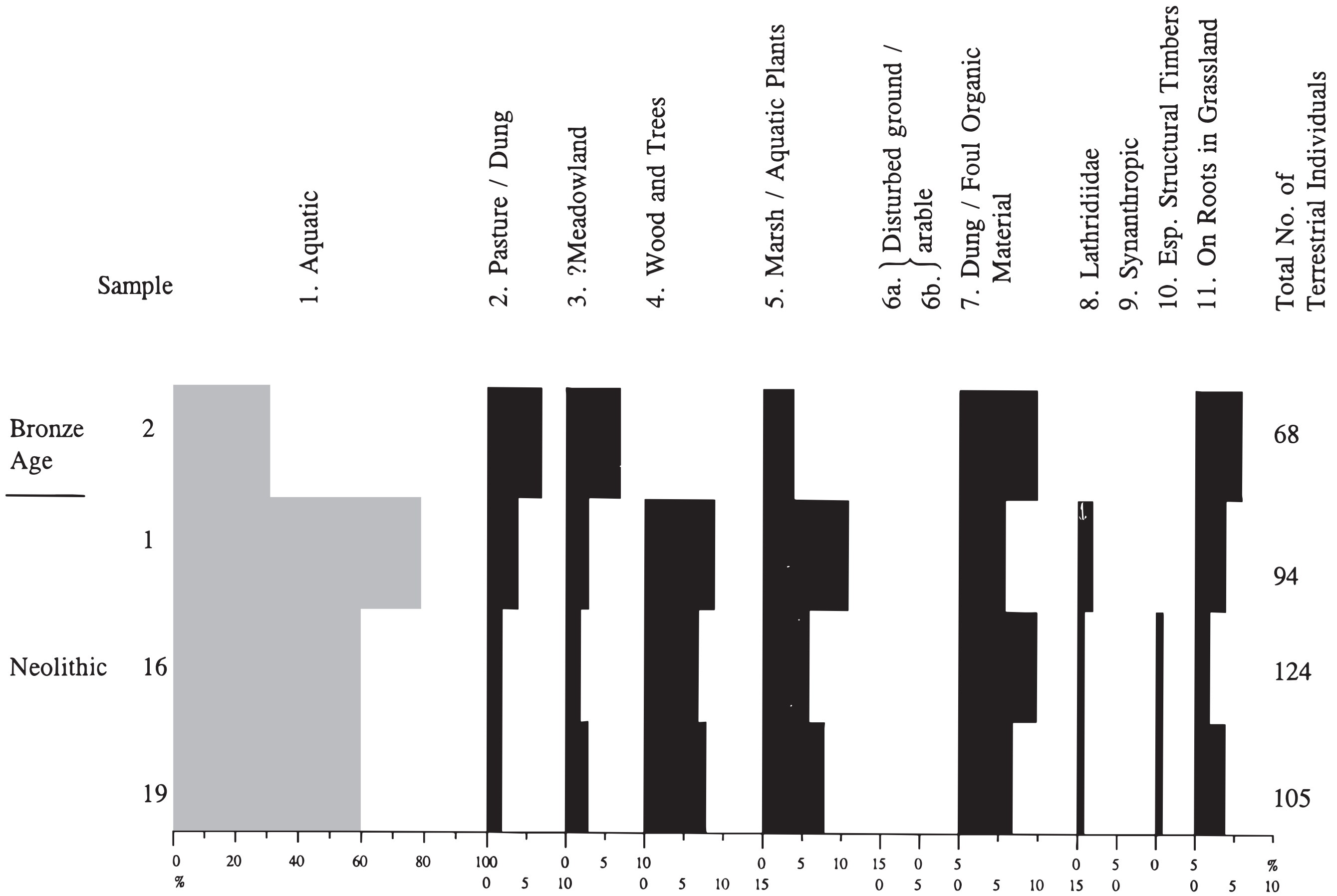


Figure SS4.9 Palaeochannels. Species groups of Coleoptera from Neolithic and Bronze Age sediments in the West Cotton palaeochannel

Most of the terrestrial individuals probably fell or inadvertently flew into the river from the surrounding landscape, although some could have been derived from a substantial strip of landscape extending upstream on either side of the river and thus be giving a regional picture for the environment of the floodplain of the Nene rather than one just restricted to a limited area around the point of deposition.

The aquatic and waterside environment
The majority of the total insects from the samples were aquatic. Around 40% of the Coleoptera were water beetles (ie they were at a level of 67% of the total terrestrial Coleoptera; Fig SS4.9). The aquatic insects comprised a fauna of clean, well oxygenated flowing water with well-vegetated margins where the water in summer was almost still. Larval cases of the caddis *Ithytrichia* sp, which develops in flowing water, occurred in all the samples. Beetles of the family Elmidae, which are even more fastidious in their requirement for clean, well-oxygenated water, were well represented in the samples. They cling to stones and aquatic plants. *Oulimnius* sp was the most numerous but *Macronychus quadrituberculatus* and *Stenelmis canaliculata*, two species which no longer occur in the drainage system of the River Nene, were identified from some of the samples. Two other water beetles which now have a very restricted distribution, *Helophorus arvernicus* and *Helichus substriatus*, were identified from the Neolithic samples. All these beetles were formerly more widespread but they have declined as a result of river management slowing the rates of water flow, a change from a stone to a silt bed in many rivers and water pollution (Osborne 1988, 722–4; Robinson 1991, 316–17). There was also an element of beetles that more usually occur in slowly moving or stagnant water, including *Helophorus* cf *brevipalpis* and *Ochthebius minimus*. They were probably living amongst emergent vegetation at the margin of the channel.

A few of the phytophagous Coleoptera fed on submerged aquatic plants. They included *Eubrychius velutus* and the now very rare *Macroplea appendiculata*, both of which feed on *Myriophyllum* (water-milfoil) and *Potamogeton* (pondweed) species. The samples also contained various host-specific species of *Donacia* which feed on floating-leaved and emergent vegetation. *D crassipe*s feeds on the water lilies *Nymphaea alba* and *Nuphar lutea*, while *D clavipes* and *D impressa* suggested a marginal reedswamp respectively of *Phragmites australis* (common reed) and *Schoenoplectus lacustris* (true bulrush) (Koch 1992, 51–2, 307).

There was not a full marsh or fenland fauna amongst the insects but there were species of wet bankside habitats. The carabid beetles *Elaphrus cupreus* and *Chlaenius vestitus* occur at the edge of water especially where the ground is vegetated (Lindroth 1974, 33, 121). One staphylinid beetle of decaying organic material in swampy places, *Micropeplus caelatus*, no longer occurs on the British mainland, although there are other archaeological records of it (Allen and Robinson 1993, 138). The vegetation of this transitional zone probably included *Iris pseudacorus* (yellow flag), the food of *Aphthona nonstriata* possibly *Solanum dulcamara* (woody nightshade), the main host of *Epitrix pubescens* (Koch 1992, 102, 122).

Woodland and scrub

Over 7% of the terrestrial Coleoptera from the Neolithic samples belong to the Species Group 4, wood and tree-dependent species. Many more of the insects were from woodland communities. These results would suggest that a substantial part of the catchment was wooded. The more host-specific amongst these beetles are dependent on the following trees (Koch 1992, 97, 151, 281–2, 315, 349–51):

Agelastica alni *Alnus glutinosa*
(alder) – leaves

Coeliodes erythroleucos *Quercus* spp
(oak) – leaves

Curculio cf nucum *Corylus avellana*
(hazel) – nuts

C. pyrrhoceras *Quercus spp*
(oak) – leaf galls

Rhynchaenus quercus *Quercus spp*
(oak) – leaves

R. salicis *Salix spp*
(willow) – leaves

Scolytus scolytus mostly *Ulmus* spp
(elm) – under bark of dead branches

Kissophagus hederae *Hedera helix*
(ivy) – under bark of dead wood

There were also beetles that occur in different categories of dead and decaying wood, ranging from hard and dry through to soft and very rotten. These included:

Melanotus erythropus
Gastrallus immarginatus
Melasis buprestoides
Thymalus limbatus
Grynobius planus
Rhagium mordax

The relative abundance of the various host-specific individuals and the occurrence of the Coleoptera of dead and decaying wood imply that much of the tree cover was from established alder and oak woodland rather than thorn or willow scrub.

The remainder of the woodland fauna included *Calosoma inquisitor* and *Dendroxena quadrimaculata* which hunt caterpillars in the tree canopy (Koch 1989, 166; Lindroth 1974, 24), Carabidae and Staphylinidae which occur in woodland floor habitats, such as amongst leaf litter, and phytophagous species of woodland herbs. These included *Apteropeda orbiculata*, which mostly feeds on *Ajuga reptans* (bugle) and *Sciaphilus asperatus*, which favours *Primula vulgaris* (primrose) (Hoffmann 1950, 326; Koch 1992, 128). One large carabid which is usually regarded as a woodland species, Abax parallelepipedus could indeed have been occurring in woodland here but at the Long Barrow it seems to have been living in grassland during the Neolithic (Robinson SS4.3.1).

As is typical for Neolithic woodland insect assemblages, the West Cotton samples included Coleoptera that are now very rare or extinct in Britain. *Gastrallus immarginatus* is now restricted to Windsor Great Park and *Agelastica alni* is apparently extinct, although both have been recorded from other Neolithic sites (Robinson 1991, 319). However, the site did not produce the great range of 'old woodland' species associated with decaying wood that have been identified from some sites.

Grassland and the open environment

Although a major part of the landscape was wooded, tree cover was by no means complete. The Scarabaeoidea and Elateridae, with larvae that feed on the roots of grassland plants (Species Group 11), comprised 4% of the terrestrial Coleoptera. They included *Agrypnus murinus*, which is characteristic of well-aerated soils. This would be consistent with the other evidence (Robinson 2006) that much of the floodplain had well drained soils and did not experience seasonal inundation during the prehistoric period. The weevils of Species Group 3 from the genera *Apion* and *Sitona*, which feed on grassland clovers and vetches made up 2.5% of the terrestrial Coleoptera from the Neolithic samples. Other phyto- phagous Coleoptera of grassland plants included *Hydrothassa glabra*, which feeds on *Ranunculus* spp (buttercups), *Crepidodera ferruginea*, which feeds on grasses, and *Mecinus pyraster*, which feeds on *Plantago lanceolata* (ribwort plantain; Koch 1992, 86, 119, 340).

The occurrence of scarabaeoid dung beetles of Species Group 2, such as *Geotrupes* sp and *Aphodius* spp, at 3% of the terrestrial Coleoptera would suggest the presence of some grazing animals over and above that of any wild medium- to large-sized herbivores that might have lived in the region. However, this was still a relatively low value for Species Group 2 and it does not imply that domestic animals were concentrated at West Cotton itself. It was probably a reflection of some domestic animals being herded within the catchment.

The open areas seem to have been predominantly grassland, but the possibility that there were arable plots or other types of disturbed ground within the catchment cannot be excluded. Some of the Carabidae and Staphylinidae just as readily occur in arable fields as in grassland. Likewise, some of the phytophagous Coleoptera can feed on weeds of disturbed ground as well as grassland or woodland herbs, for example *Chaetocnema concinna* on *Polygonaceae* (knotgrass, docks etc). There were also a few phytophagous beetles that feed on herbs likely to have been growing along the edge of the river and at the edge of wooded areas, for example *Chrysolina varians* on *Hypericum* spp (St John's wort) and Cidnorhinus quadrimaculatus on *Urtica dioica* (Koch 1992, 75, 337).

Other habitats

The insects gave no evidence for human habitation on the site. The few members of Species Group 8 and 10 could have been living in natural habitats and the synanthropic beetles of Species Group 9 were entirely absent. The percentage of beetles of dung/foul organic matter which belong to Species Group 7 was about what might be expected for a rural site, and indeed there would probably have been suitable habitats for these species in accumulated rotting plant debris along the river bank.

Environmental change during the period of sedimentation

Samples 19, 16 and 1 comprised a sequence that accumulated over perhaps 100 years. The only evidence from the insects for change during this period came from the aquatic species. In Samples 19 and 16, the lower two samples, cases from the flowing water caddis *Ithytrichia* sp outnumbered cases of *Orthotrichia* sp, a genus of stagnant or slowly moving water, by a factor of over 30. In Sample 1, the concentration of *Ithytrichia* sp had declined and that of *Orthotrichia* sp increased such that *Ithytrichia* sp only outnumbered *Orthotrichia* sp by a factor of less than 2.

A decline was also shown by the flowing water beetles from the family Elmidae between the lower two samples and Sample 1. A corresponding increase was shown in Sample 1 by the beetles *Helophorus* cf *brevipalpis* and *Ochthebius minimus*, which favour stagnant or slowly moving water. This sequence would suggest that the flow of water along the channel declined over this period, although this did not result in the abandonment of the channel.

Interpretation of the Bronze Age insect assemblages

Introduction

The single Bronze Age sample, Sample 2, continued the stratigraphic sequence above Sample 1, although it followed a hiatus in sedimentation. Similar considerations apply to the accumulation of this deposit and the origin of the insect remains in it as were discussed above for the Neolithic sediments. Unfortunately, only a small sample was available from the Bronze Age deposit, so the palaeoecological information that could be derived from the insects was somewhat limited.

The aquatic and waterside environment

Aquatic insects still comprised a major component of the Bronze Age assemblage, although not as large as in the Neolithic assemblages. Water beetles comprised around 25% of the Coleoptera (ie there were at a level of 30% of the total terrestrial Coleoptera; Fig SS4.9). Although a few elmid beetles from the genus *Oulimnius* sp were present, no other remains from flowing water insects were identified. The most numerous water beetles were *Helophorus* cf *brevipalpis* and *Ochthebius minimus*, suggesting that these sediments had been laid down during a period when water flow in the channel was relatively slow. Beetles of aquatic and marginal plants were not as abundant as previously but included *Donacia* sp and *Bagous* sp.

The terrestrial environment

The wood- and tree-dependent beetles of Species Group 4 were entirely absent from the Bronze Age sample. The only insect suggestive of woody vegetation was a single example of the bug *Pentatoma rufipes*, which commonly occurs in woodlands and orchards (Southwood and Leston 1959, 45–6).

With the clearance of woodland, there was a corresponding rise in grassland insects. Scarabaeidae and Elateridae with larvae that feed on to roots of grassland herbs such as *Phyllopertha horticola* and *Agrypnus murinus* (Species Group 11) comprised 6% of the terrestrial Coleoptera. The clover- and vetch-feeding weevils of the genera *Apion* and *Sitona* (Species Group 3) were also well represented at 7% of the terrestrial Coleoptera. The assemblage was not sufficiently large to contain a wide range of host-specific grassland Coleoptera, but *Crepidodera ferruginea*, which feeds on grasses, and *Mecinus pyraster*, which feeds on *Plantago lanceolata* (ribwort plantain), were again present. There were also grass-feeding bugs from the genus Aphrodes.

Scarabaeoid dung beetles of Species Group 2, including *Aphodius rufipes* and *Onthophagus ovatus* comprised 7% of the terrestrial Coleoptera. Such a value for these beetles, which feed on the droppings of larger herbivores on pasture, would be appropriate to a largely pastoral landscape away from any concentrations of domestic animals such as occur around settlements (Robinson 1991, 278–80).

The overall impression from the insect evidence is that the late Neolithic floodplain landscape, which was perhaps a mosaic of wooded and open areas with of the order 30 to 60% tree cover had largely been cleared of trees by this time in the Bronze Age: Woodland could still have been extensive on the valley sides and the insect assemblage was sufficiently small that hedgerows and small areas of scrub or woodland on the floodplain would probably have remained undetected. However, substantial changes must have occurred in the catchment since the Neolithic.

Other habitats

As for the Neolithic insect assemblages, the Bronze Age insects gave no evidence for the proximity of human settlement. The other insects could all have lived in the habitats already mentioned.

SS4.4 Molluscs

Gill Campbell

SS4.4.1 Introduction

The majority of the deposits encountered during the Raunds Area Project excavations were de-calcified, and there was little opportunity for the recovery of samples suitable for molluscan studies. However, some Neolithic deposits in palaeochannels, which had remained permanently waterlogged, contained high numbers of molluscs. Details of these deposits, including the size of subsample processed, are given in Table SS4.9.

In addition, a snail-rich layer was encountered in the Causewayed Ring Ditch. Accordingly a series of samples were taken through ditch section 38105 of this feature as follows (Fig SS1.67):

1.34–1.27m – context 38112:
probable contamination by surrounding gravely infill

800–00mm – context 38112:
gravelly fill below snaily fill

550–450mm – context 38110:
bottom of snaily layer

450–350mm – context 38110:
middle of snaily layer

350–250mm – context 38110:
top of snaily layer

150–50mm – context 38106:
top fill

Only the samples from the ‘snaily layer’ were found to contain molluscs.

In the same area the flot obtained from treehole fill 38951 was also found to contain large numbers of molluscs. Molluscs from this flot were identified but not fully quantified as the assemblage is likely to be biased.

Soil samples for molluscs were wet-sieved down to 0.5mm in the laboratory and sorted using a binocular dissecting microscope. They were identified using the Grinstead collection housed in the Geological Collections of the Oxford University Museum of Natural History. The results from the Causewayed Ring Ditch and nearby treehole are given in Table SS4.17. The results from palaeochannel deposits are given in Table SS4.18. Nomenclature follows Kerney 1976 and Waldén 1976.

Table SS4.17. Molluscs from the Causewayed Ring Ditch and undated treehole fill 38951

Taxon	Sample/level Context	550–450 mm 38110	450–350 mm 38110	350–250 mm 38110	33436 38951
Carychium minimum Müller		-	2	9	*
C tridentum Risso		-	2	11	*
Carychium sp		-	2	39	+++
*Lymnea truncula*ta L		-	1	4	
Catinella arenaria Buchard/*Succinea oblonga* Draparnaud		-	-	1	-
Succinea/Oxyloma sp		-	-	2	-
Cochlicopa sp		-	3	15	++
Columella edentula Draparnaud		-	-	1	-
V pygmaea Draparnaud		-	1	-	++
Vertigo pusilla Müller		-	-	1	+++
V substriata Jeffreys		-	-	1	-
Vertigo sp		1	1	-	-
Lauria cylindracea Da Costa		-	-	-	+
Pupilla muscorum L		1	-	-	++++
Vallonia costata Müller		-	-	11	++++
V pulchella Müller		-	1	3	++
V excentrica Sterki		6	1	-	++
Vallonia sp		-	-	4	+
Acanthinula aculeata Müller		-	-	7	+++
Punctum pygmaeum Draparnaud		-	-	8	++
Discus rotundatus Müller		-	2	17	++++
Vitrea sp		-	1	2	++
Nesovitrea hammonis Ström		-	-	9	++
Aegopinella pura Alder		-	2	3	++
A nitidula Draparnaud		-	-	6	-
O cellarius Müller		-	1	11	++
O allarius Miller		-	-	1	++
Zonitoides nitidus Müller		-	1	-	-
Limacidae indet		-	-	1	-
Euconulus alderi Gray		-	-	1	-
Cecilioides acicula Müller		-	-	9	++
Cochlodina laminata Montagu		-	-	-	+
Clausilia bidentia Ström		-	3	6	++
Hellicella itala L		-	-	-	+
Ashfordia granulata Alder		-	-	1	-
Trichia hispida gp		2	4	7	+++
Arianta arbustorum L		-	1	5	+
cf *Hellicogona lapicida* L		-	-	-	+
Cepea hortensis Müller		1	-	-	-
Cepea sp		-	3	4	+
Indeterminate		2	-	-	-

SS4.4.2 Discussion of the results

Causewayed Ring Ditch and treehole fill 38951

The fact that a treehole and the fill of the Causewayed Ring Ditch both produced molluscan remains suggests that conditions for preservation were better with respect to molluscs in this area than the other areas of the floodplain. This may be because larger amounts of limestone are present in the gravels in this part of the site. This may not only have affected the survival of the molluscan remains, but may also have produced conditions more favourable to molluscan life

Table SS4.18. Molluscs from prehistoric palaeochannel deposits near West Cotton

Taxon	*Sample* / *Sample size*	*1* / *1kg*	*8* / *1kg*	*9* / *1kg*	*C* / *1kg*
Operculi		23	108	85	11
Theodoxus fluviatilis L		-	31	33	2
Valvata cristata Müller		-	14	14	1
Valvata piscinalis Müller		-	166	68	6
Bithynia tentaculata L		-	35	58	16
Bithynia leachii Sheppard		-	43	36	12
Bithynia sp		1	65	24	6
Carychium cf *minimum* Müller		-	-	1	1
C cf *tridentum* Risso		-	-	-	2
Carychium sp		-	-	6	-
Lymnea truncatula Müller		-	6	8	-
L cf *truncatula* Müller		-	-	1	-
L auricularia L		-	4	4	2
L peregra Müller		-	3	3	4
Lymnea sp		-	2	11	1
Anisus vortex L		-	-	2	1
Bathyomphalus contortus L		-	1	4	4
Gyraulis albus Müller		-	80	61	11
Armiger crista L		-	34	10	6
Planorbarius corneus L		-	-	-	1
Ancylus fluviatilis Müller		-	58	11	1
Succineidae indet		-	3	14	6
Cochlicopa cf *lubrica* Müller		-	-	3	-
Cochlicopa sp		-	-	4	-
Vertigo pygmaea Draparnaud		-	1	-	-
Vallonia costata Müller		-	-	-	3
Vallonia pulchella Müller		-	-	4	1
Vallonia sp		-	3	5	-
Ena obscura Müller		-	-	-	1
Discus rotundatus Müller		-	1	1	1
Vitrea contracta Westerlund		-	-	-	1
Vitrea sp		-	-	1	-
Nesovitrea hammonis Ström		-	-	3	1
Aegopinella nitidula Draparnaud		-	-	-	1
Zonitoides nitidus Müller		-	-	1	-
Trichia cf *hispida* gp		-	-	1	1
Gastropod indet		-	2	4	-
Pseudanodanta complanata Rossmässler		-	2	1	-
Sphaerium cf *corneum* L		-	-	2	1
Sphaerium sp		-	11	12	-
Pisidum amnicum Müller		1	2	5	-
Pisidium cf *supinum* A Schmidt		-	-	8	-
Pisidum henslowanum Sheppard		-	8	20	-
Pisidium moitessierianum Paladilhe		-	72	15	1
Pisidium sp		-	70	53	9
Sphaerium/Pisidium sp		++	++	+	+
TOTAL SHELLS		2	717	512	104

at the time of burial. The episodic nature of the preservation of molluscs is now generally recognised (Bell and Johnson 1996). This provides an explanation for the presence of molluscs within the recut of the ditch, and their absence from the fill of the primary cut.

The sample from the treehole fill contained large numbers of *Discus rotundatus*, along with other shade-loving species such as *Carychium tridentum*, *Vertigo pusilla*, *Lauria cylindracea* and *Punctum pygmaeum*. However, all five common open-country species: *Vertigo pygmaea*, *Pupilla muscorum*, *Vallonia costata*, *V excentrica* and *Hellicella itala*, were also recorded in large numbers (Evans 1972 198). The results would suggest that some clearance of woodland had already taken place by the time the treehole became infilled, but that substantial areas of woodland still remained.

The bottommost sample from the snail-rich layer in the Causewayed Ring Ditch produced a very small assemblage. This is probably as a result of the rapid accumulation of sediment at this point in the sequence, combined with a fairly harsh environment, supporting only a small land snail population. However, the presence of *Pupilla muscorum* and *Vallonia excentrica* and the absence of shade-loving species indicate that the area in the vicinity of the monument was open when the ditch began to infill. Despite the small numbers of molluscs present, the numbers of *Vallania excentrica* recovered would suggest that differential preservation of molluscs was not occurring.

The next sample in the sequence produced more snails. The assemblage contained some open country species such as *Vallonia pygmaea* and *Vallonia excentrica*, as well as shade-loving species such as *Carychium tridentum* and *Aegopinella pura*. The assemblage may indicate the existence of ungrazed grassland in the vicinity of the monument at this time. Some species present, such as *Lymnea truncatula*, *Oxychilus cellarius* and *Zontioides nitidus* prefer damp, shaded conditions and were probably living in the ditch itself.

The final sample in the sequence produced nearly ten times the number of snails as the other two samples. Most of the species recorded prefer damp, shady conditions and are characteristic of woodland. *Ashfordia granulata* is rarely recovered from archaeological contexts due to its poorly calcified shell (Evans 1972, 71). However the identification was confirmed by Professor Evans. Overall the assemblage indicates that regeneration of woodland had taken place by this stage in the sequence.

Palaeochannels

Not surprisingly the most of the molluscs recovered from palaeochannel deposits were freshwater species. The presence of *Theodoxus fluviatilis* and *Ancylus fluviatilis* suggests that the flow of water was rapid, at least in places, while *Anisus vorte*x would have lived on the abundant vegetation. *Acroloxus lacustris*, which is also found attached to vegetation (Macan 1960, 41), was absent from these deposits but was present in those of middle Saxon date (Campbell and Robinson 2010). This may be because the water contained more calcium carbonate by this period.

In addition to the freshwater species, molluscs characteristic of woodland were also recovered, eg *Ena obscur*a and *Discus rotundatus*, while *Vertigo pygmaea* and *Vallonia pulchella* are characteristic of open conditions. These results complement the evidence from macroscopic plant remains and insects, which suggested that some clearance had taken place, but that much of the woodland remained extant.

SS4.4.3 Appendix. Notes on identifications

Species of *Pisidum* sp were identified with reference to Ellis 1962. *Pisidum amnicum* is distinguished by its distinct ridges. In *Pisidum moitessieranum* the umbonal appendicula or 'crest' follows the lines of growth and this serves to distinguish it from *P supinum* and *P henslowanum* where the crest does not follow the lines of growth. *P henslowanum* is more delicate than either *P supnium* or *P moitessieranum* and is less triangular than *P moitessieranum*.

SS4.5 Charred plant remains and charcoal

Gill Campbell

SS.4.5.1 Introduction

The work on the charred plant remains and charcoal from the Raunds Area Prehistoric Project comprises excavations undertaken by three different archaeological units, Central Archaeological Services, Northamptonshire County Council, and Oxford Archaeological Unit. Overall, *c* 900 samples were taken from prehistoric features, although not all these were intended principally for the recovery of charred plant remains. The standard sample size chosen at the beginning of the project in 1985 was 10 litres; this was later revised to 20 litres. However, in many cases much larger samples were taken. Samples were processed either using a simple wash-over technique, or by flotation machine. The flot was retained on a mesh of 0.5mm and the residue on a 0.5mm or 1mm mesh (SS4.1).

All the samples floated were scanned under a dissecting microscope and assessed as to the quantity and quality of the charred remains present. The abundance of charcoal in each sample was recorded in order to assess its suitability for radiocarbon dating. The presence of cereal grain, cereal chaff, and weeds was noted along with the other items of interest. The results were entered onto a series of databases written in dBase IV, and are retained in the archive.

Most of the samples contained very little in the way of charred plant remains and charcoal. In addition, the majority of the samples from the monuments underneath the deserted hamlet of West Cotton contained intrusive material of late Saxon to medieval date. This was evident from the presence of large amounts of free-threshing wheat-type grain and free-threshing wheat chaff along with weeds such as *Anthemis cotula* (stinking mayweed), all of which were plentiful in late Saxon to medieval contexts (Campbell forthcoming). Contamination by material of Iron Age or Romano-British date in features underlying the Stanwick settlement was less of a problem. However, the possibility that small amounts of charcoal recovered from prehistoric features might be of later date had to be considered when selecting material for analysis or for dating purposes.

All samples of prehistoric date that contained material other than charcoal were analysed if there was no evidence for later contamination. Other samples, such as those from the Long Mound, were analysed even if there was evidence for contamination by later material, if they were believed to contain material of a prehistoric character, ie remains of tubers and hazelnut shell fragments. Both tubers and hazelnut shell fragments were uncommon in Roman and late Saxon to medieval deposits.

In general charcoal was analysed only where the number of fragments recovered was over 25. Some single large pieces were identified prior to radiocarbon dating, while occasionally smaller assemblages of charcoal were identified from key contexts where dating was to be carried out on the material, and where there was no evidence of contamination.

The results from the analyses have been grouped according to feature type and period. They are discussed below. Nomenclature follows Clapham *et al* (1989) for wild plants, Miller (1987) for wheat and Zohary and Hopf (1994) for barley.

SS4.5.2 Evidence from treeholes

Unlike some other sites such as the Drayton cursus in Oxfordshire (Barclay *et al* 2003), very few of the treehole features excavated contained much charcoal, and it was difficult to find sufficient material for dating. In all, the charcoal from five treeholes was analysed, the charcoal from three of them being subject to radiocarbon dating. The results are given in Table SS4.19.

Four of the five treeholes contained hazel, though the evidence from treehole fill 62140 is based on a single, poorly preserved fragment, where the other pieces examined were all from rootwood. The single sample from a treehole beneath the Long Barrow contained a few fragments of ash. In addition, a partially waterlogged oak stump was noted *in situ* close to the river (sample 33080, treehole F60522), but this was not dated.

Overall the impression given by these results is that the floodplain woodland was dominated by hazel, with some ash and oak. However results from a waterlogged treehole fill located at the edge of one of the palaeochannels (sample 9, channel section B141, Campbell SS4.3.2) gave a somewhat different picture. Waterlogged plant macrofossils included hazelnut shell fragments, an alder catkin, and an immature fruit of small-leaved lime (*Tilia cordata*), suggesting that these trees also grew on the floodplain.

The presence of lime may provide an explanation for the absence of charcoal in many of the treehole features. Lime charcoal is rarely recovered from archaeological sites, and this is believed to be due to differential preservation of this genus (Robinson pers comm). Thus, if many of the treeholes features resulted from the destruction of lime trees the absence of charcoal would be expected.

Fluctuating water levels throughout the period of burial may also be responsible for the generally poor preservation of the charcoal, or its absence. While charcoal is not subject to chemical or microbial attack, mechanical damage does occur. Continual wetting and drying, and/or freezing and thawing of the burial environment may have caused the charcoal to break up to such an extent that it became unrecognisable. This may also have occurred at Reading Business Park, Berkshire, which is situated on the floodplain of the river Kennet (Campbell 1992, 103).

Alternatively it is also possible that the trees were not burnt. Some treeholes could have been the result of natural tree fall while others, if deliberately felled, may have been dragged to the edge of the cleared area and left to rot, or cut up and used for fuel.

Some of the treehole fills produced remains other than charcoal. This was particularly the case in an area close to Barrow 1. While one of these features is believed to be Roman in date (treehole F30028) the other features are believed to date to the prehistoric period. The results from these features are presented in Table SS4.20. While some of the remains, such as the *Triticum dicoccum/spelta* glume bases could be Iron Age or Roman in date, the number of tubers recovered from these features suggested that they could be

Table SS4.19. Charcoal from treeholes

Contexts 61240, 62127 and 62114 from Trench B140; context 60534 form Trench B275; context 289 from beneath the Long Barrow

Sample	*33047*		*33037*		*33044*		*33084*		*196*	
Context	*62140*		*62127*		*62114*		*60534*		*289*	
Feature	*F62123*		*F62126*		*F62113*		*F60533*		*F289*	
	5370±80 BP		*6130±80 BP*		*4700±80 BP*					
	(OxA-3057)		*(OxA-3059)*		*(OxA-3058)*					
Taxon	*Fragments*	*Weight (g)*	*Fragments*	*Weight (g)*	*Fragments*	*Weight (g)*	*Fragments*	*Weight (g)*	*Fragments*	*Weight (g)*
Corylus sp.	-	-	2	0.21	10	2.09	10	4.69	-	-
cf. *Corylus* sp	1	0.03	-	-	1	0.16	-	-	-	-
Fraxinus sp.	-	-	-	-	-	-	-	-	3	0.06
Indeterminate root	8	0.38	8	0.57	-	-	-	-	-	-
Indeterminate					1	0.12	-	-	-	-
TOTALS	9	0.41	10	0.78	12	2.37	10	4.69	3	0.06

early prehistoric. Taken as a whole, the assemblage might be seen as the scattered remains of crop processing debris that entered the tops of the treehole fills, although it is uncertain when this occurred or whether the assemblage represents a single phase of activity.

SS4.5.3 Evidence for Neolithic activity

Evidence from Neolithic monuments

Small assemblages of charred plant remains were recovered from samples taken from contexts associated with monuments of Neolithic date. The results are presented in Table SS4.21. In addition, samples from pits related to the Long Mound produced large charcoal assemblages. Charcoal from three of these samples was examined. The results are given in Table SS4.22. Some of the samples from the Avenue also produced large charcoal assemblages. One of these, sample 99228, was analysed. It produced a mixture of fast-growing and slow-growing oak. The results from this sample are not tabulated.

The samples from the Long Mound contained frequent hazelnut shell fragments, the occasional *Arrhenatherum elatius* ssp *bulbosum* (onion-couch) tuber and some *Ranunculus ficaria* (lesser celandine) tubers. The presence of *Anthemis* cf *cotula* and a *Secale cereale* (rye) rachis in context 5261 indicates medieval intrusion, and the free-threshing wheat-type grain recorded in many of the samples is also probably medieval. Similarly, some of the hulled wheat grain recovered from the Avenue may be of Roman date. However the possible sloe stone, hazelnut shell fragments and tubers suggest that most of this material dates to the early prehistoric period.

The samples from the Turf Mound contained a few hazelnut shell fragments with no obvious signs of contamination. Two samples, 95 and 97, from the Long Enclosure produced two hazelnut shell fragments and an onion-couch tuber respectively. Sample 95 showed considerable evidence of medieval contamination.

The results from these monuments are not very useful because of the problems of contamination by later material. However the presence of hazelnut shell fragments and onion couch tubers does appear to coincide with the location of the monuments and to correspond to early prehistoric activity. There is, however, no real evidence of any agricultural activity relating to this period.

The charcoal associated with the Long Mound shows an interesting succession (Table SS4.22). Oak charcoal was identified

Table SS4.20. Charred plant remains from treehole contexts

Contexts 61224 and 62312 from Trench B140, the remainder from undated treeholes outside Barrow 1

	Sample	*33033*	*33067*							
	Context	*62114*	*62312*	*30029*	*30039*	*30100*	*30104*	*30113*	*30115*	*30122*
Taxon (element if not a seed)	*Feature*	*F62113*	*F62311*	*F30028*	*F30028*	*F30101*	*F30105*	*F30114*	*F30116*	*F30123*
Fallopia convovulus Á Löve	black bindweed	-	-	-	-	1	-	-	-	-
Lamium sp	dead-nettle	-	-	-	-	1	-	-	-	-
Valerianella carinata Loisel	keel-fruited cornsalad	-	-	-	1	-	-	-	-	-
Bromus sp	brome grass	-	-	-	1	-	-	-	-	-
Arrhenatherum elatius ssp *bulbosum* (tuber)	onion-couch	-	1	2	-	-	-	-	-	2
cf *A elatius* ssp *bulbosum* (tuber)	onion-couch	-	-	-	1	-	-	1	-	1
Triticum dicoccum/spelta (glume base)	emmer or spelt wheat	-	-	-	-	-	-	-	1	-
cf *Triticum* sp (grain)	wheat	-	-	-	-	-	1	-	1	-
Avena type (twisted awn)	oat	-	-	1	-	-	-	-	-	-
Cereales indet (grain)	cereal grain	1	-	2	-	-	-	-	2	-
tuber type B		-	-	-	1	-	-	1	-	-
root tuber 1		-	1	1	-	-	-	-	-	-
IGNOTA		-	-	3	1	-	1	-	-	2
Items per litre		0.5	0.1	0.45	0.25	0.05	0.1	0.1	0.2	0.13

Table SS4.21. Charred plant remains from early Neolithic Monuments (1)

							Long Mound				
		Sample	*303*	*386*	*359*	*392*	*377*	*378*	*397*	*401*	*405*
Taxon (element if not a seed)	*Common name*	*Context*	*2023*	*2056*	*2061*	*2066*	*2068*	*2068*	*2072*	*2073*	*2074*
Ranunculus ficaria L (tuber)	lesser celandine		-	1	1	-	-	-	-	-	-
Silene noctiflora/vulgaris	campion		-	-	-	-	1	-	-	-	-
Stellaria media gp	chickweed		1	-	-	-	-	-	-	-	-
Chenopodium cf *album*	fat hen		5	-	-	-	-	-	-	-	-
Atriplex sp	orache		1	-	-	-	-	-	-	-	-
Vicia/Lathyrus sp	vetch or tare		-	-	-	1	-	-	-	-	-
cf *Vicia/Lathyrus* sp	vetch or tare		-	-	-	-	-	-	-	-	-
Leguminosae indet			-	-	-	-	-	-	-	-	-
cf *Euphorbia peplus* L	petty spurge		1	-	-	-	-	-	-	-	-
cf *Prunus spinosa* L	sloe		-	-	-	-	-	-	-	-	-
Fallopia convovulus Á Löve	black bindweed		2	-	-	-	-	-	-	-	-
Rumex sp	dock		-	1	-	-	1	-	-	-	-
Corylus avellana (nut shell frag)	hazel		-	-	-	1	1	1	1	1	1
Labiatae (small) indet			-	-	-	-	-	-	-	-	-
Galium cf *aparine* L	cleavers		-	-	-	-	-	-	-	-	-
Galium sp	bedstraw		-	-	-	-	-	-	-	-	-
Sambucus nigra L	elder		-	-	-	-	-	-	-	-	-
Anthemis cotula L	stinking mayweed		-	-	-	3	-	-	-	-	-
A cf *cotula* L	stinking mayweed		-	-	-	-	-	-	-	-	-
cf *Bromus* sp	brome grass		-	-	-	1	-	-	-	-	-
Arrhenatherum elatius ssp *bulbosum* (tuber)	onion-couch		-	-	-	1	1	-	-	-	-
cf *A elatius* ssp *bulbosum* (tuber)	onion-couch		1	-	-	-	-	-	1	-	-
Gramineae (small) indet	small grass		-	-	-	-	-	-	-	-	2
cf Gramineae (large) indet	large grass		-	-	-	4	-	-	-	-	-
Gramineae indet	grass		1	-	-	3	-	-	-	-	-
Triticum sp, *tetraploid* (rachis)	tetraploid wheat		1	-	-	-	-	-	-	-	-
Triticum sp, cf *tetraploid* (rachis)	tetraploid wheat		-	-	-	-	-	-	-	-	-
Triticum sp, *hexalploid* (rachis)	hexaploid wheat		-	-	-	-	-	-	-	-	-
Triticum sp, free-threshing type (grain)	wheat		-	2	2	-	1	-	2	-	-
T dicoccum/spelta (glume base)	emmer or spelt wheat		-	-	-	3	1	-	-	-	-
T dicoccum/spelta (spikelet fork)	emmer or spelt wheat		-	-	-	-	-	-	-	-	-
Triticum sp (grain)	wheat		-	2	-	13	1	-	-	-	-
Triticum sp (glume base)	wheat		-	-	-	-	-	-	-	-	-
cf *Triticum* sp (grain)	wheat		-	-	1	1	-	-	-	-	-
Secale cereale L (rachis)	rye		-	-	-	-	-	-	-	-	-
Avena cf *sativa* L (grain in floret)	oat		-	-	-	-	-	-	-	-	-
Avena sp (grain)	oat		-	-	-	-	-	-	-	-	-
cf *Avena* sp (grain)	oat		-	-	-	-	-	-	-	-	-
Hordeum sp, hulled, straight (sprouted grain)	hulled barley		-	-	-	-	-	-	-	-	-
Hordeum sp (grain)	barley		-	-	-	1	-	-	-	-	-
Hordeum sp (sprouted grain)	barley		-	-	-		-	-	-	-	-
Cereales indet (grain)	cereal		-	1	2	6	1	1	1	2	1
Cereales indet (glume base/rachis)	cereal		-	-	-	-			-	-	-
indeterminate tuber			-	-	-	-	-	-	-	-	-
indeterminate nut shell fragment			-	-	-	-	-	-	-	-	-
root fragments			-	-	-	-	-	-	-	+	-
IGNOTA			-	1	-	-	4	1	-	-	1
Items per litre			1.4	0.8	0.6	3.6	1.2	0.3	0.5	0.3	0.5

Table SS4.21. Charred plant remains from early Neolithic Monuments (2)

			Long Mound (ctd)					*Avenue*	
		Sample	*874*	*850*	*875*	*865*	*877*	*99156*	*99158*
Taxon (element if not a seed)	*Common name*	*Context*	*5261*	*5261*	*5266*	*5338*	*5529*	*87502*	*87507*
Ranunculus ficaria L (tuber)	lesser celandine		2	5	-	-	-	-	-
Silene noctiflora/vulgaris	campion		-	-	-	-	-	-	-
Stellaria media gp	chickweed		-	-	-	-	-	-	-
Chenopodium cf *album*	fat hen		-	-	-	-	-	-	-
Atriplex sp	orache		-	-	-	-	-	-	-
Vicia/Lathyrus sp	vetch or tare		1	-	-	-	-	3	5
cf *Vicia/Lathyrus* sp	vetch or tare		-	-	-	-	-	2	-
Leguminosae indet			1	-	-	-	-	-	-
cf *Euphorbia peplus* L	petty spurge		-	-	-	-	-	-	-
cf *Prunus spinosa* L	sloe		-	-	-	-	-	1	-
Fallopia convovulus Á Löve	black bindweed		-	-	-	-	-	2	1
Rumex sp	dock		2	-	-	-	-	2	1
Corylus avellana (nut shell frag)	hazel		11	32	-	9	3	2	-
Labiatae (small) indet			-	-	-	-	-	1	-
Galium cf *aparine* L	cleavers		-	1	-	-	-	-	-
Galium sp	bedstraw		-	-	-	-	1	-	-
Sambucus nigra L	elder		-	-	-	-	-	1	-
Anthemis cotula L	stinking mayweed		-	-	-	-	-	-	-
A cf *cotula* L	stinking mayweed		1	-	-	-	-	-	-
cf *Bromus* sp	brome grass		-	-	-	-	-		-
Arrhenatherum elatius ssp *bulbosum* (tuber)	onion-couch		-	-	1	-	-	7	4
cf *A elatius* ssp *bulbosum* (tuber)	onion-couch		-	-	-	-	-	-	-
Gramineae (small) indet	small grass		-	-	-	-	-	2	-
cf Gramineae (large) indet	large grass		-	-	-	-	-	1	-
Gramineae indet	grass		-	-	-	-	-	-	-
Triticum sp, tetraploid (rachis)	tetraploid wheat		-	-	-	-	-	-	-
Triticum sp, cf tetraploid (rachis)	tetraploid wheat		-	-	-	-	-	-	-
Triticum sp, hexalploid (rachis)	hexaploid wheat		-	-	-	-	-	-	-
Triticum sp, free-threshing type (grain)	wheat		-	-	-	1	-	-	-
T dicoccum/spelta (glume base)	emmer or spelt wheat		-	-	-	-	-	2	1
T dicoccum/spelta (spikelet fork)	emmer or spelt wheat		-	-	-	-	-	1	-
Triticum sp (grain)	wheat		-	-	-	2	-	-	-
Triticum sp (glume base)	wheat		-	-	-	-	-	2	2
cf *Triticum* sp (grain)	wheat		-	-	-	-	-	1	-
Secale cereale L (rachis)	rye		1	-	-	-	-	-	-
Avena cf *sativa* L (grain in floret)	oat		-	-	-	-	-	-	-
Avena sp (grain)	oat		-	-	-	-	-	-	-
cf *Avena* sp (grain)	oat		-	-	-	-	-	-	-
Hordeum sp, hulled, straight (sprouted grain)	hulled barley		-	-	-	-	-	-	-
Hordeum sp (grain)	barley		-	-	-	-	-	-	-
Hordeum sp (sprouted grain)	barley		-	-	-	-	-	-	-
Cereales indet (grain)	cereal		-	-	-	1	1	5	-
Cereales indet (glume base/rachis)	cereal		-	-	-	-	-	2	-
indeterminate tuber			-	-	-	-	-	1	-
indeterminate nut shell fragment			-	-	-	-	1	-	-
root fragments			-	-	-	-	-	+	+
IGNOTA			-	2	-	-	1	29	2
Items per litre			1.9	2.0	0.1	1.3	0.7	0.67	0.26

Table SS4.21. Charred plant remains from early Neolithic Monuments (3)

		Long Barrow		*Turf Mound*		*Long Enclosure*	
	Common	*Sample*	*134*	*1009*	*428*	*95*	*97*
Taxon (element if not a seed)	*name*	*Context*	*233*	*6302*	*3121*	*208*	*221*
Ranunculus ficaria L (tuber)	lesser celandine		-	-	-	-	-
Silene noctiflora/vulgaris	campion		-	-	-	-	-
Stellaria media gp	chickweed		-	-	-	-	-
Chenopodium cf *album*	fat hen		-	-	-	-	-
Atriplex sp	orache		-	-	-	-	-
Vicia/Lathyrus sp	vetch or tare		-	-	-	-	-
cf *Vicia/Lathyrus* sp	vetch or tare		-	-	-	2	-
Leguminosae indet			-	-	-	-	-
cf *Euphorbia peplus* L	petty spurge		-	-	-	-	-
cf *Prunus spinosa* L	sloe			-	-	-	--
Fallopia convovulus Á Löve	black bindweed		-	-	-	-	-
Rumex sp	dock		-	-	-	-	-
Corylus avellana (nut shell frag)	hazel		-	1	1	2	-
Labiatae (small) indet			-	-	-	-	-
Galium cf *aparine* L	cleavers		-	2	-	-	-
Galium sp	bedstraw		-	-	-	-	-
Sambucus nigra L	elder		-	-	-	-	-
Anthemis cotula L	stinking mayweed		-	-	-	2	-
A cf *cotula* L	stinking mayweed		-	-	-	-	-
cf *Bromus* sp	brome grass		-	-	-	-	-
Arrhenatherum elatius ssp *bulbosum* (tuber)	onion-couch		-	-	-	-	1
cf *A elatius* ssp *bulbosum* (tuber)	onion-couch		-	-	-	-	-
Gramineae (small) indet	small grass		-	-	-	-	-
cf Gramineae (large) indet	large grass		-	-	-	1	-
Gramineae indet	grass		-	-	-	-	-
Triticum sp, tetraploid (rachis)	tetraploid wheat		-	-	-	-	-
Triticum sp, cf tetraploid (rachis)	tetraploid wheat		-	-	-	1	-
Triticum sp, hexalploid (rachis)	hexaploid wheat		-	-	-	1	-
Triticum sp, free-threshing type (grain)	wheat		-	-	-	9	1
T dicoccum/spelta (glume base)	emmer or spelt wheat		-	-	-	-	-
T dicoccum/spelta (spikelet fork)	emmer or spelt wheat		-	-	-	-	-
Triticum sp (grain)	wheat		-	-	2	5	1
Triticum sp (glume base)	wheat		-	-	-	-	-
cf *Triticum* sp (grain)	wheat		-	-	-	-	-
Secale cereale L (rachis)	rye		-	-	-	-	-
Avena cf *sativa* L (grain in floret)	oat		-	-	-	1	-
Avena sp (grain)	oat		-	-	-	3	-
cf *Avena* sp (grain)	oat		-	-	-	1	-
Hordeum sp, hulled, straight (sprouted grain)	hulled barley		-	-	-	3	-
Hordeum sp (grain)	barley		-	-	-	-	-
Hordeum sp (sprouted grain)	barley		-	-	-	1	-
Cereales indet (grain)	cereal		1	1	-	9	-
Cereales indet (glume base/rachis)	cereal		-	-	-	-	-
indeterminate tuber				-	-	-	--
indeterminate nut shell fragment			-	-	-	-	-
root fragments			-	-	-	-	-
IGNOTA			-	1	-	-	-
Items per litre			-	?0.4	0.3	4.1	0.3

Table SS4.22. Long Mound. Charcoal from F5488 beneath the mound (contexts 5461, 5489), and F5263 at the base of the north 'quarry pit' (context 5261)

	Sample	850		870		871	
	Context	5261		5461		5489	
Taxon		*Fragments*	*Weight (g)*	*Fragments*	*Weight (g)*	*Fragments*	*Weight (g)*
Rhamnus catharticus L	buckthorn	1	0.02	-	-	-	-
Prunus sp	sloe/bullace/plum etc	9	0.34	-	-	-	-
Pomoideae type	crab apple/hawthorn etc	1	0.02	-	-	-	-
Quercus sp	oak	-	-	8	2.17	7	0.71
cf *Quercus* sp	oak	-	-	1	0.27	-	-
Indeterminate		3	0.03	1	0.19	3	0.29
TOTALS		14	0.41	10	2.63	10	1

in the two samples from F5488, beneath the mound, and a fragment of oak from the same feature was dated to 5300–4800 cal BC (5767±58 BP; UB-3329). Sample 850 from context 5261 in F5263 in the base of the north 'quarry pit' adjacent to the mound, produced only thorny species. The assemblage included *Rhamnus catharticus* (buckthorn), *Prunus* sp, which on the basis of the width of the medullary rays is likely to be *P spinosa* (sloe), and Pomoideae-type charcoal which includes such species as *Malus sylvestris* (crab apple) and *Crataegus* sp (hawthorn). A hazelnut shell fragment and an *Arrhenatherum elatius* ssp *bulbosum* (onion couch) tuber from the same context were dated to 3650–3370 cal BC (4770±45 BP; OxA-7943) and 3650–3370 cal BC (4750±45 BP; OxA-7944). Another group of wood fragments found in the top of a feature in a disturbed area in the western part of the mound were identified as oak and were dated to 2620–2340 cal BC (3970±45 BP; OxA-7942), 2830–2460 cal BC (4015±45 BP; OxA-7941) and 2660–2350 cal BC (3995±BP; OxA-7952).

These results might suggest that changes in local woodland took place over the period of monument use. However the contexts are very different. Both sets of oak wood appeared to have been burnt *in situ* while the sample that produced the thorny scrub species appeared to be dumped (SS1.1). It is, however, possible to suggest that before the monument was built oak was readily available. There then came a period when tree cover was reduced and thorny species such as buckthorn were more dominant. This may have been followed by the re-establishment of oak woodland, resulting in this wood again being more readily available.

Table SS4.23. Charred plant remains from the Grooved Ware pit (F31820)

Taxon (element if not a seed)		*context 31821*
Prunus spinosa L (fruit frag)	sloe	22
P spinosa L	sloe	3
Prunus sp (skin)	sloe/bullace/plum etc	38
Malus cf *sylvestris* Miller (core frag)	crab apple	17
Pyrus/Malus sp	apple/pear	2
Corylus avellana (nut shell frag)	hazel	297
cf *C avellana* L (nut shell frag)	hazel	2
Sambucus nigra L		1
Triticum sp (grain)	wheat	1
cf Cereales indet	cereal	1
IGNOTA FRAG		++++
Items per litre		11.3

Evidence from the Grooved Ware pit

A single pit containing Grooved Ware pottery was excavated and this produced the largest assemblage of charred plant remains of Neolithic date from the entire project. The results from two samples (33382 and 33383) taken from the same context were combined and are given in Table SS4.23. Charcoal from one of these samples (33383) was also analysed. The results are given in Table SS4.24.

The charred plant remains from this pit are typical of such features (Moffett *et al* 1989; Robinson 2000b). Numerous hazelnut shell fragments were recovered along with fruit remains of crab apple and sloe. A single seed of elder was recorded and two cereal grains, one of which was identified as wheat. The charcoal from the feature was mainly hazel with some Pomoideae-type, probably

Table SS4.24. Charcoal from the Grooved Ware pit (F31820)

		Sample	*33383*
		Context	*31821*
Taxon (element if not a seed)	*Common name*	*Fragments*	*Weight (g)*
Pomoideae type	sloe/bullace/plum etc	4	0.34
Corylus sp	hazel	3	0.3
cf *Corylus* sp	hazel	2	0.18
Quercus sp	oak	1	0.1
Indeterminate		1	0.09
TOTALS		11	1.01

Malus sylvestris, given the presence of core fragments from the fruit of this tree. A single fragment of oak was also identified.

While these remains could be interpreted as food debris, the presence of sloe fruit and *Prunus* sp skin in the assemblage, in addition to sloe fruit stones, would argue against this, since these would normally have been eaten. In addition the presence of charcoal of both crab apple and hazel shows that more than just the fruit was being collected, although this may be because this wood was closest to hand.

The possibility that these pits were associated with some ceremonial purpose has already been suggested (Thomas 1991, 183). Charred plant remains from such contexts are certainly very distinctive and it seems likely that they are the result of a specific activity or set of activities.

SS4.5.4 Evidence for Bronze Age activity

The evidence from Bronze Age monuments

The evidence from charred plant remains recovered from the Bronze Age monuments (Table SS4.25) is of a similar nature to that obtained from samples associated with the Neolithic monuments, although, in these

Table SS4.25. Charred plant remains associated with Bronze Age activity

			Barrow 6		*Barrow 1*		*Segmented Ditch Circle*	
		Sample	*540*	*502*	*11277*	*11097*	*99178*	*99191*
Taxon (element if not a seed)	*Common name*	*Context*	*3620*	*3201*	*30428*	*30257*	*87542*	*87560*
Ranunculus ficaria L (tuber)	lesser celandine		-	-	-	1	-	-
Montia fontana ssp *chondrosperma* (Fenzl) S M Walters	blinks		-	-	-	2	-	-
Vicia/Lathyrus sp	vetch or tare		-	3	-	-	1	-
Bupleurum rotundifolium L	thorowax		-	1	-	-	-	-
Rumex sp	dock		-	1	-	-	-	-
Corylus avellana (nut shell frag)	hazel		-	-	1	-	-	-
cf *Bromus* sp	brome grass		-	1	-	-	-	-
Arrhenatherum elatius ssp *bulbosum* (tuber)	onion-couch		-	-	-	1	3	1
Gramineae (large) indet	large grass		1	-	-	-	-	-
Triticum sp, free-threshing type (grain)	wheat		2	5	-	-	-	-
T dicoccum/spelta (glume base)	emmer or spelt wheat		-	1	-	-	-	-
T cf *dicoccum/spelta* (grain)	emmer or spelt wheat		-	1	-	-	-	-
Triticum sp (grain)	wheat		-	4	-	-	-	-
Avena sp (grain)	oat		-	1	-	-	-	-
cf *Avena* sp (grain)	oat		-	2	-	-	-	-
Hordeum sp hulled, straight (grain)	hulled barley		1	-	-	-	-	-
Hordeum sp (grain)	barley		1	-	-	-	-	-
cf *Hordeum* sp (grain)	barley		-	2	-	-	-	-
Cereales indet (grain)	cereal		2	24	-	-	-	-
cf Cereales indet (grain)	cereal		-	-	-	-	2	-
tuber type B			-	-	1	-	-	-
root tuber 1			-	-	-	1	-	-
root fragments			-	-	-	-	+	-
IGNOTA			-	1	-	1	-	-
Items per litre			0.7	7.3	1	0.3	0.25	?

Table SS4.26. Charcoal from the ditch fills of Barrow 3

	Sample	33008		33016		33018	
	Context	30738		30862		30862	
Taxon	*Common name*	*Fragments*	*Weight (g)*	*Fragments*	*Weight (g)*	*Fragments*	*Weight (g)*
Rhamnus catharticus L	buckthorn	4	0.34	-	-	-	-
Prunus sp	sloe/ bullace/ plume etc	9	1.09	10	1.13	-	0.31
Pomoideae type	crab apple/ hawthorn etc	-	-	-	-	-	0.02
cf *Corylus* sp	hazel	1	0.17	-	-	-	-
TOTALS		14	1.6	10	1.13	10	0.33

samples only a single hazelnut shell fragment was found, in the outer ditch of Barrow 1 (sample 11277, context 30428). As well as a *Ranunculus ficaria* tuber and several onion couch tubers, the samples also contained some remains which were plentiful in the samples from cremations (described below), including tuber type B and root fragment type A. These are described in more detail below.

The occurrence of tubers in samples appears to coincide with the monuments. It would seem to indicate prehistoric activity. It is, however, very ephemeral compared with the evidence from cremations.

The hulled wheat remains found in sample 502 from context 3201 in the outer ditch of Barrow 6 may be of prehistoric date since very few hulled wheat remains were present in the medieval contexts overlying this barrow. However since this sample also produced a record of *Bupleurum rotundifolium* (thorowax), which is likely to be of Saxon or medieval date, the evidence remains inconclusive.

The dates obtained from the tubers recovered from the Segmented Ditch Circle pre-date those obtained from both antlers recovered from this monument. They almost certainly derive from the Neolithic activity centred on the Avenue which was cut by this monument (SS1.2; SS1.11). Similarly a hazelnut shell fragment associated with a cremation within this feature was dated to the Mesolithic (Bayliss *et al* SS6), showing that the fills of this monument contained material of varying date.

In addition to these charred plant remains, samples from the Segmented Ditch Circle also contained numerous fragments of charcoal, all of which appeared to be oak. Charcoal from sample 99191 was analysed. It contained largely fast-growing oak, with some slow-growing fragments also present. No other taxa were present and the results have not been tabulated.

Possible re-use of Barrow 3

Three samples from charcoal spreads in the ditch fills of Barrow 3 produced large charcoal assemblages. These were analysed and the results are presented in Table SS4.26. The species identified are those associated with scrub. The assemblages probably represent the burning of thorny scrub that had grown up on or near the barrow. This may have part of a deliberate clearance carried out either to maintain or refurbish the monument.

The evidence from cremations

Eight samples from cremations were analysed for charcoal. The results are presented in Table SS4.27. In addition, charcoal from four further cremations was examined prior to radiocarbon dating (sample 47, context 3206, and sample 53 from 3224, both from cremations associated with Barrow 6; sample 33308, context 47088 from a cremation between the inner and outer ditches of Barrow 5; and sample ST126, context 206 from a cremation associated with the Long Barrow). Sample 47 contained oak charcoal, while sample 53 contained Pomoideae-type charcoal. The charcoal from the sample from the cremation associated with the Long Barrow was also oak. The fragments from sample 33308, context 47088, associated with Barrow 5, appeared to have been charred at a very high temperature and could not be identified. Given the late fourth to early third millennium cal BC date obtained from this charcoal (Bayliss *et al* SS6), one possible explanation might be that curated wood from an earlier burial was used in this cremation.

Of the eleven cremations examined five produced only oak, while another produced only Pomoideae-type charcoal. However, two of the cremations from Barrow 1, samples 11254 and 11256 (contexts 30308 and 30309, F30307) and 11076 (context 30031, F30030) produced quite a large range of taxa. These results contrast with those

Table SS4.27. Charcoal from Neolithic and Bronze Age cremations

Contexts 30308–9 from F30307 outside Barrow 1, context 30031 from F30030 cut into the silted middle ditch of Barrow 1; context 5550 from F5549 in the base of the south 'quarry pit' of the Long Mound; the remainder from the cremation cemetery outside the Long Barrow

Frags = Fragments W = Weight

Sample		11254		11256		11076		882		112		115		116		117	
Context		30308		30309		30031		5550		198/B		106/B		110		201B	
Taxon	*Common name*	*Frags*	*W (g)*	*Frags*	*W(g)*	*Frags*	*We (g)*	*Frags*	*W (g)*	*Frags*	*W (g)*	*Frags*	*W (g)*	*Frags*	*W (g)*	*Frags*	*W (g)*
Rosa sp.	rose	-	-	-	-	2	0.15	-	-	-	-	-	-	-	-	-	-
cf *Rosa*	rose	-	-	-	-	1	0.09	-	-	-	-	-	-	-	-	-	-
Acer sp	maple	-	-	-	-	1	0.02	-	-	-	-	-	-	-	-	-	-
Pomoideae type	crab apple/hawthorn etc	-	-	-	-	1	0.02	-	-	1	0.07	3	0.13	-	-	-	-
cf Pomoideae type	crab apple/hawthorn etc	-	-	-	-	-	-	-	-	-	-	2	0.13	-	-	1	0.05
Corylus sp	hazel	1	0.03	3	0.11	-	-	-	-	-	-	-	-	-	-	-	-
Alnus/Corylus sp	alder/hazel	1	0.05	1	0.07	-	-	-	-	-	-	-	-	-	-	-	-
Quercus sp	oak	10	0.93	4	0.11	-	-	10	0.56	22	1.38	21	1.6	87	16.34	39	4.58
cf *Quercus* sp	oak	1	0.04	-	-	-	-	-	-	-	-	15	0.65	6	0.16	5	0.29
Fraxinus sp	ash	-	-	1	0.12	9	0.45	-	-	-	-	-	-	-	-	-	-
cf *Fraxinus* sp	ash	-	-	-	-	1	0.05	-	-	-	-	-	-	-	-	-	-
Indeterminate		-	-	4	0.2	4	0.08	-	-	2	0.24	31	3.29	8	0.04	2	0.17
TOTALS		13	1.05	13	0.61	19	0.86	10	0.56	25	1.69	72	5.8	101	16.54	47	5.09

obtained from cremations at Radley Barrow Hills (Thompson 1999) where only one or two taxa were identified from a single cremation. The significance of these results is discussed by Campbell and Robinson (2007).

Twenty-two contexts associated with cremations produced charred plant remains other than charcoal. Samples from all these contexts were analysed. Results from samples taken from the same context were amalgamated. Charred plant remains from deposits in the centre of Barrow 5 are included in this section. One of these features (F47171) contained an inverted collared urn, which was filled with the cremated remains of at least three individuals. While no samples were taken from this feature, the mouth of the urn lay within the top fill (47180) the central feature F47179, and this fill, along with fills of feature F47168, which is believed to cut F47171, all contained charred plant material very similar to that recovered from other cremation deposits. One explanation of the presence of charred remains in these contexts is that they represent all that remains of pyre debris cleared out, or redeposited, in these features. It is possible that feature F47168 may have originally been dug as a bustum or draft pit, although the stratigraphy remains unclear. The results from all deposits apparently associated with cremation ritual are present in Table SS4.28.

Arrhenatherum elatius ssp *bulbosum* (onion-couch) tubers were commonly found in the assemblages from cremation deposits, as were the remains of roots and stems of grasses and other herbaceous plants. In addition, other types of parenchyma tissue were present, most of which could not be identified, with the exception of *Ranunculus ficaria* (lesser celandine) tubers. They were classified as types wherever possible and these types are described and illustrated in SS4.5.6. In addition a number of weeds were identified from these deposits, including *Montia fontana* ssp *chondrosperma* (blinks), small legumes, *Fallopia convovlvulus* (black bindweed), and other members of the Polygonaceae. The occasional cereal grain was also recorded.

In context 47181, the central pit of Barrow 5, a free-threshing type wheat grain and a free-threshing wheat rachis were present. These remains could be of Bronze Age date, and represent food offerings added to the cremation pyre. However, as this barrow was later the site of a Roman *temenos*, it is also possible that this material represents Roman contamination rather than evidence for the use of free-threshing wheat in the Bronze Age.

Table SS4.28. Charred plant remains from cremations and related contexts

Context 5548 from F5549 in the base of the south 'quarry pit' of the Long Mound; context 3224 from F3219, cut in to the outer ditch of Barrow 6, context 4848 from isolated cremation F4948 at West Cotton; context 30031 from F30030 cut into the silted middle ditch of Barrow 1; contexts 30308–9 from F30307 outside Barrow 1; context 60312 from Barrow 4; contexts 47169, 47170 and 47181 from F47168 in Barrow 5; context 47180 from F47179 in Barrow 5, context 87595 from F87594 within the Segmented Ditch Circle; the remainder from the cremation cemetery outside the Long Barrow

* = estimated

	Sample	*881*	*490*	*783*										*99206*	*107*	*108*	*111*	*113*	*115*	*116*	*117*	*125*
	Context	*5548*	*3224*	*4948*	*30031*	*30037*	*30308*	*30309*	*60312*	*47181*	*47169*	*47170*	*47180*	*87595*	*192*	*193*	*197*	*196*	*106*	*110*	*201*	*208*
Taxon (element if not a seed)	*Common name*																					
Ranunculus ficaria L (tuber)	lesser celandine	-	-	-	-	-	-	-	1	9	-	-	-	-	-	-	-	-	-	-	-	-
Brassica/Sinapis sp	cabbage/mustard/ charlock etc	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
Chenopodium cf *album*	fat hen	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Montia fontana ssp *chondrosperma* (Fenzl) S M Walters	blinks	-	-	1	-	-	13	1	-	-	-	-	-	-	-	1	-	-	-	-	-	1
Vicia/Lathyrus sp	vetch or tare	1	-	-	-	-	-	-	-	2	-	1	-	-	-	-	-	-	-	-	-	-
Medicago type	medick/trefoil etc	-	1	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Leguminosae indet		-	-	-	-	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-
Polygonum aviculare agg	knotgrass	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Polygonum sp	persicaria or bistort	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Fallopia convolvulus A Löve	black bindweed	-	2	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-
Rumex sp	dock	-	-	-	-	-	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
cf *Rumex* sp	dock	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Polygonaceae indet		-	-	-	-	-	1	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-
Corylus avellana (nut shell frag)	hazel	-	-	-	-	-	-	-	-	1	-	-	2	1	-	-	-	-	-	-	-	-
Plantago media/lanceolata	plantain	-	-	2	3	2	10	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Galium sp	bedstraw	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-
Anthemis sp	mayweed	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-
Carex sp	sedge	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-
cf *Bromus* sp	bromegrass	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Arrhenatherum elatius ssp *bulbosum* (tuber)	onion-couch	1	-	1	27	25	-	-	-	4	1	2	1	-	3	1	1	1	1	-	-	5
cf *A elatius* ssp *bulbosum* (tuber)	onion-couch	-	-	-	1	1	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Gramineae indet	grass	-	-	-	-	-	-	1	-	-	-	1	-	-	-	-	-	-	-	-	-	-
Gramineae indet (roots/ culm node/straw)	grass	-	-	-	-	20	233	270	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Table SS4.28. Continued

Taxon (element if not a seed)	*Common name*	*Sample* 881 *Context* 5548	490 3224	783 4948	30031	30037	30308	30309	60312	47181	47169	47170	47180	99206 87595	107 192	108 193	111 197	113 196	115 106	116 110	117 201	125 208
cf Gramineae (small) indet	smallgrass	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-
cf Gramineae indet	grass	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Triticum sp, free-threshing (rachis)	free-threshing wheat	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	--	
Triticum sp, free-threshing type (grain)	wheat	2	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	1	-
Triticum sp (grain)	wheat	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cereales indet (grain)	cereal	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-
cf Cereales indet (grain)	cereal	-	-	-	-	1	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-
tuber type B		-	-	-	-	19	46	14	-	-	-	-	-	-	-	-	-	-	-	-	-	-
cf tuber type B		-	-	-	-	-	-	2	-	2	-	-	-	-	-	-	-	-	-	-	-	-
bulb-like tuber C		-	-	-	-	3	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-
round flat tuber		-	-	7	21	16	19	6	1	-		-	-	-	-	-	-	1	-	-	-	-
root tuber 1		-	-	3	27	47	73	18	-	-	-	-	-	-	-	-	1	-	-	1	-	
root tuber 2		-	-	-	-	1	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
root frag.		-	+	++	-	+	++	-	-	-	-	++	-	-	-	-	-	-	-	-	-	-
indet tuber frags		-	-	-	3	6	27	24	-	-	-	-	-	-	-	-	-	-	1	-	-	3
Indeterminate herbage		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
IGNOTA		4	-	-	-	-	4	2	-	2	-	-	-	-	1	-	1	-	1	-	1	1
Items per litre		3	1.6	2.8	4.18	11.15	17	0.13*	0.07	0.36*	0.2	0.87	0.02									

The charred plant remains from the cremations are remarkably similar to assemblages from cremations throughout Britain (Robinson 1988, 102). The presence of tubers in cremations has been interpreted in a number of ways. Robinson (1988, 102) suggested that *Arrthenatherum elatius* grass was gathered for use as tinder, and that following burning only the tough tubers were preserved. Godwin (1975, 480) suggested that these tubers may have been used for food. An assemblage recovered from a cremation at Barrow Hills, Radley, Oxfordshire (Moffett 1988, Moffett 1991, 188) which contained moss fragments, seed of small legumes, and grass culm nodes, was also interpreted as the remains of possible tinder. However two tubers identified as either *Conopodium majus* (pignut) or *Bunium bulbocastanum* (greater pignut) were thought to represent the remains of food.

Some hazelnut shell fragments were also found associated with cremations. The hazelnut shell fragment found associated with the segmented-ditch circle was dated to 8160–7590 cal BC (8715±60 BP; OxA-7906), making it Mesolithic in date. It is possible that the hazelnut shell fragments in the central pit of Barrow 5 may also be earlier than the rest of the material recovered from this feature.

The charred plant remains from contexts associated with structure 157209

Three samples were analysed from postholes outside post-built roundhouse 157209, samples 80515, 80519 and 80522. The results are presented in Table SS4.29.

Sample 80522, from the top of F85106, contained numerous cereal grains, nearly all of which were identified as wheat, with a little hulled barley also present. Only a single wheat glume base was recovered, and this could not be identified to species.

The identification of wheat grain to species on the basis of the grain alone is not reliable, and in the absence of chaff cannot be confirmed (Hillman *et al* 1996). However, most of the wheat grains recovered from the sample were of the hulled type and many of them showed morphological characteristics which are associated with *Triticum dicoccum* (emmer wheat). These grains had a pronounced dorsal ridge with the highest point just above the embryo. The apex of the grains were attenuated rather than rounded and the ventral surface was flattened. These grains were designated *Triticum dicoccum* type. In addition to these grains, many others had split longitudinally along the ventral furrow. This could be an artefact of the conditions under which this grain was charred but may also relate to the depth of the ventral furrow, which may be greater in tetraploid than in hexaploid wheats (Hillman pers comm; Hillman *et al* 1996, 205). This would support the identification of this wheat as emmer.

Overall then the assemblage from sample 80522 appears to represent clean emmer wheat grain, with barley present as a contaminant, possibly with some spelt and/or bread wheat. It may have been charred during parching prior to grinding. Very few weeds are recorded but the presence of *Brassica* cf *rapa* ssp *sylvestris* (navew) and a *Brassica*/*Sinapis* sp seed is worth noting. Brassica species may have been important oil crops in the Bronze Age, although the seeds here were almost certainly derived from weeds growing in the wheat crop. The possibility that the seeds were being cultivated or

Table SS4.29. Charred plant remains from postholes outside post-built roundhouse 157209

Taxon (element if not a seed)	Common name	*Sample* *Context* *Feature*	*80522* *85107* *F85106*	*80515* *85052* *F85051*	*80519* *85060* *F85059*
Brassica cf *rapa* ssp *sylvestris*	navew		1	-	-
Brassica/*Sinapis* sp	cabbage/mustard/charlock etc		1	-	-
Stellaria media gp,	chickweed		1	-	-
Chenopodium cf *album* L	fat hen		1	-	-
Atriplex sp	orache		1	2	-
Chenopodiaceae indet			1	-	-
Vicia/*Lathyrus* sp	vetch or tare		1	-	-
cf *Vicia*/*Lathyrus* sp	vetch or tare		-	1	-
Medicago type	medick or trefoil		-	1	-
cf *Fallopia convolvulus* (L) Á Löve	black bindweed		1	1	-
Rumex sp(p)	dock		1	1	-
Euphrasia/*Odontites* sp	eyebright or bartsia		1	-	-
Galium cf *aparine* L	cleavers		1	-	-
Galium sp	bedstraw		1	1	-
Gramineae (large) indet	large grass		4	-	-
Gramineae (small) indet	small grass		6	1	-
Triticum dicoccum type (grain)	wheat		40	1	-
T cf *dicoccum* type (grain)	wheat		7	-	1
T spelta L (glume base)	spelt wheat		-	1	-
T spelta type (grain)	wheat		6	-	-
T cf *spelta* type (grain)	wheat		3	-	-
Triticum, free-threshing type (grain)	wheat		3	-	-
T dicoccum/*spelta* (glume base)	emmer or spelt wheat		-	1	1
T dicoccum/*spelta* type (grain)	wheat		95	-	-
T cf dicoccum/*spelta* type (grain)	wheat		32	-	-
Triticum sp (grain)	wheat		121	-	-
Triticum sp (glume base)	wheat		1	1	1
cf *Triticum* sp (grain)	wheat		2	-	-
Hordeum sp hulled (grain)	hulled barley		4	-	-
Hordeum sp (grain)	barley		1	-	-
Cereales indet(grain)	cereal		272	2	-
straw			+	-	-
herbage			++	+	-
concretion			+++	++	-
IGNOTA			9	1	2
Items per litre			61.8	0.5	0.3

collected needs to be kept in mind.

Two samples of emmer-type grain from this assemblage were dated to 1110–830 cal BC (2815±40 BP; OxA-7905) and 1050–830 cal BC (2795±40 BP; OxA-7946). This dates this assemblage to the late Bronze Age, later than the fence line of which F85059 (the source of sample 80519) formed a part (Bayliss *et al* SS6). It suggests that emmer was been grown as a cereal crop in the area by this period. It is the earliest cereal assemblage of reasonable size from the study area.

The samples from the other two contexts produced only very small charred plant assemblages. A single *Triticum spelta* (spelt wheat) glume base was recovered from sample 80515. This may be of Bronze Age date but could be later.

SS4.5.5 Conclusion

It has proved difficult to interpret some of the assemblages of charred plant remains because of problems of contamination by later material, but prehistoric activity tends to be characterised by the presence of hazelnut shell fragments and onion-couch tubers. Overall the evidence provided both by the charred plant remains and the charcoal is patchy, but some insight has been gained into particular activities undertaken on and around the monuments, including possible evidence for the upkeep of the monuments themselves and information about cremation practices. The later material provides evidence for the conversion of the 'ritual' landscape into an agricultural one, in the form of a large assemblage of wheat grain from a late Bronze Age posthole.

SS4.5.6 Appendix. Descriptions and illustrations of unidentified material from prehistoric contexts

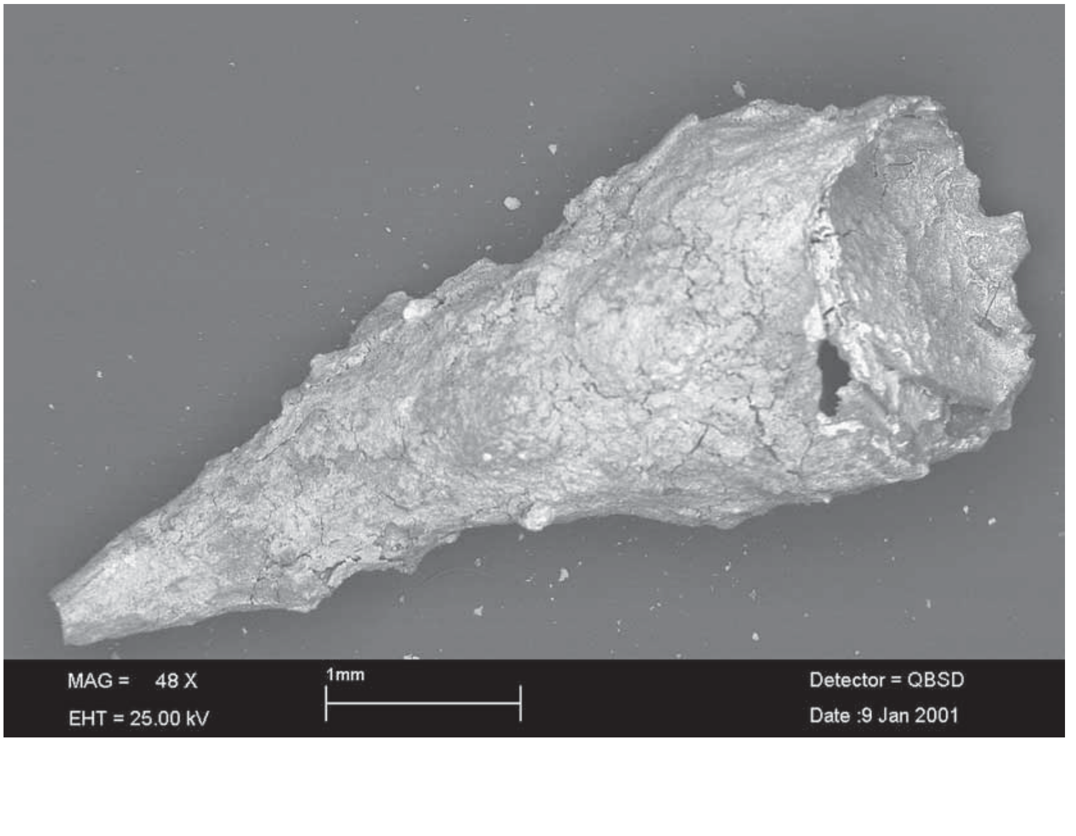
Tuberous root 1

Large numbers of tuberous roots of this type were found in the samples. They had a distinctive internal structure, most of which is void of any tissue apart from transverse plates at intervals along the length of the 'root'. Two examples, from one of the cremations outside Barrow 1 (sample 11254, context 30308), are illustrated in Figures SS4.10–11.

Tuberous root 2

These were very similar to the items published by Murphy (1989, 29, fig 5c). Murphy interprets these items as consisting of the central xylem and fibre core of a root. They resemble 'small twigs' with numerous small side 'shoots' (Murphy 1989, 29).

Figure SS4.10 Barrow 1. Tuberous root 1 from sample 11254, context 30308 in peripheral cremation F30307.



Round tubers type A

Large numbers of round tubers were recovered from cremation deposits. Some were rather poorly preserved, rather flat with little or no surface detail. Others were better preserved, showing a distinct point of attachment and some surface detail. The tubers could represent more than one species but this could not be ascertained with any certainty. Some of the tubers are comparable

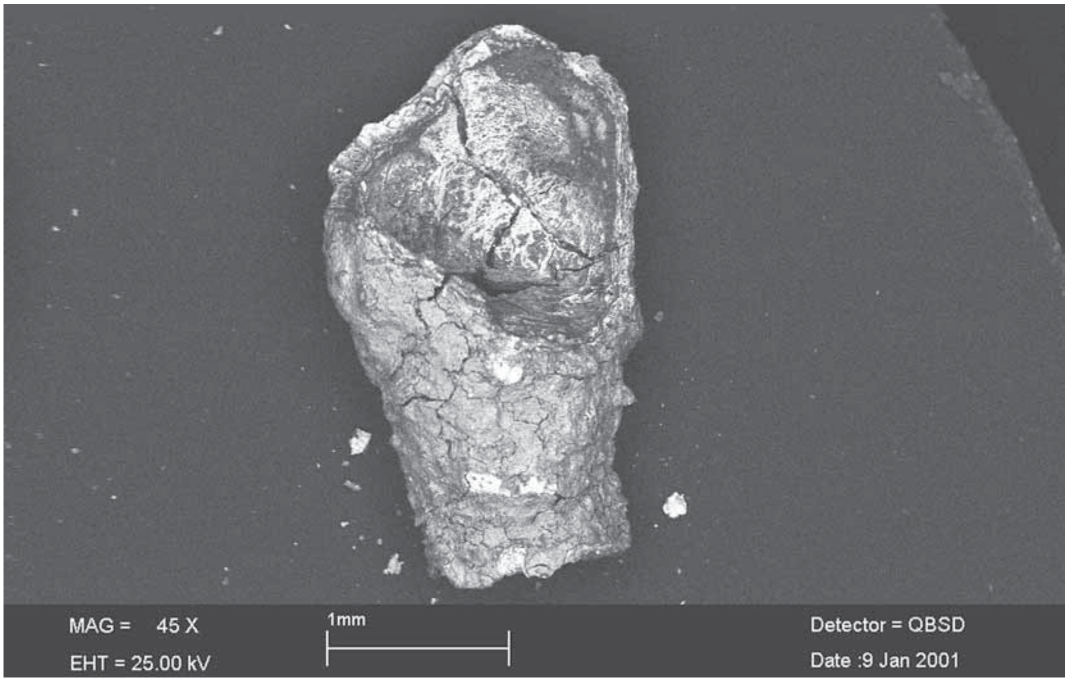


Figure SS4.11 Barrow 1. Tuberous root 1 from sample 11254, context 30308 in peripheral cremation F30307, second view.

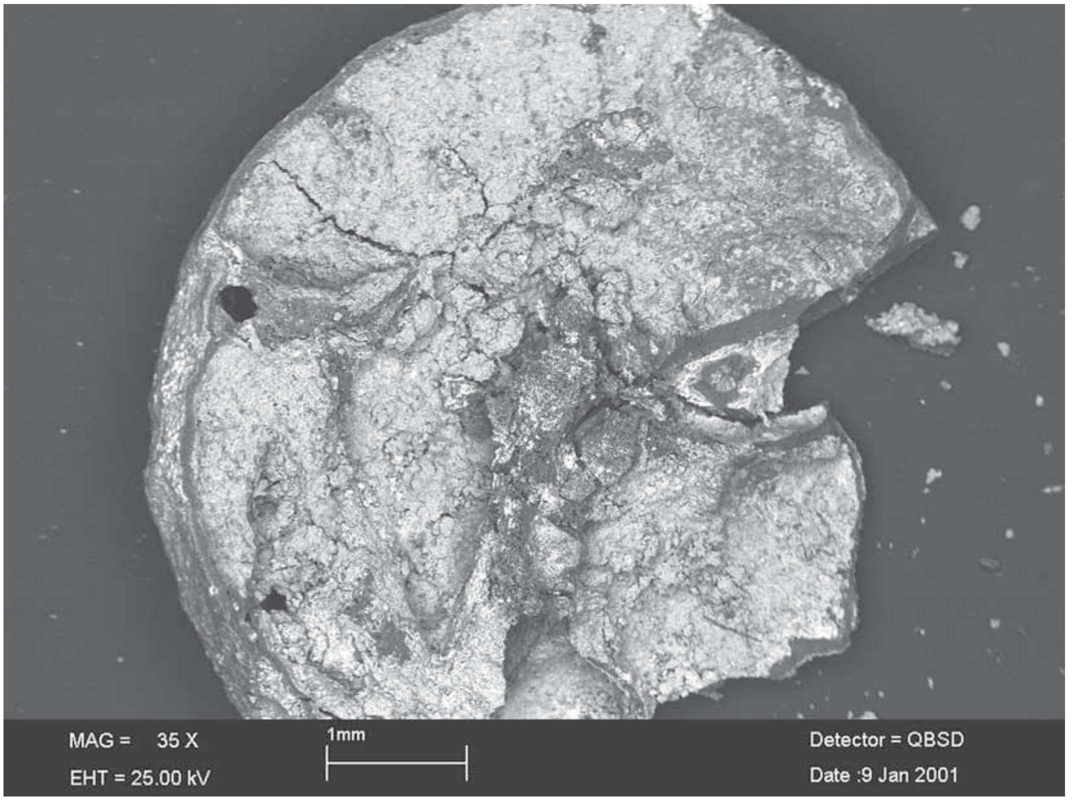


Figure SS4.12 Barrow 1. Round tuber type A from sample 11076, context 33037 in cremation F30030.

to tubers of *Ranunculus bulbosus* L. However, they also resembled a number of other types of tuber and no definite identification was made. An internal cross-section of one of these tubers is illustrated in Figure SS4.12 and part of a large specimen showing the point of attachment is shown in Figure SS4.13. Both are from another of the Barrow 1 cremations (F30030, sample 11076, context 33037).

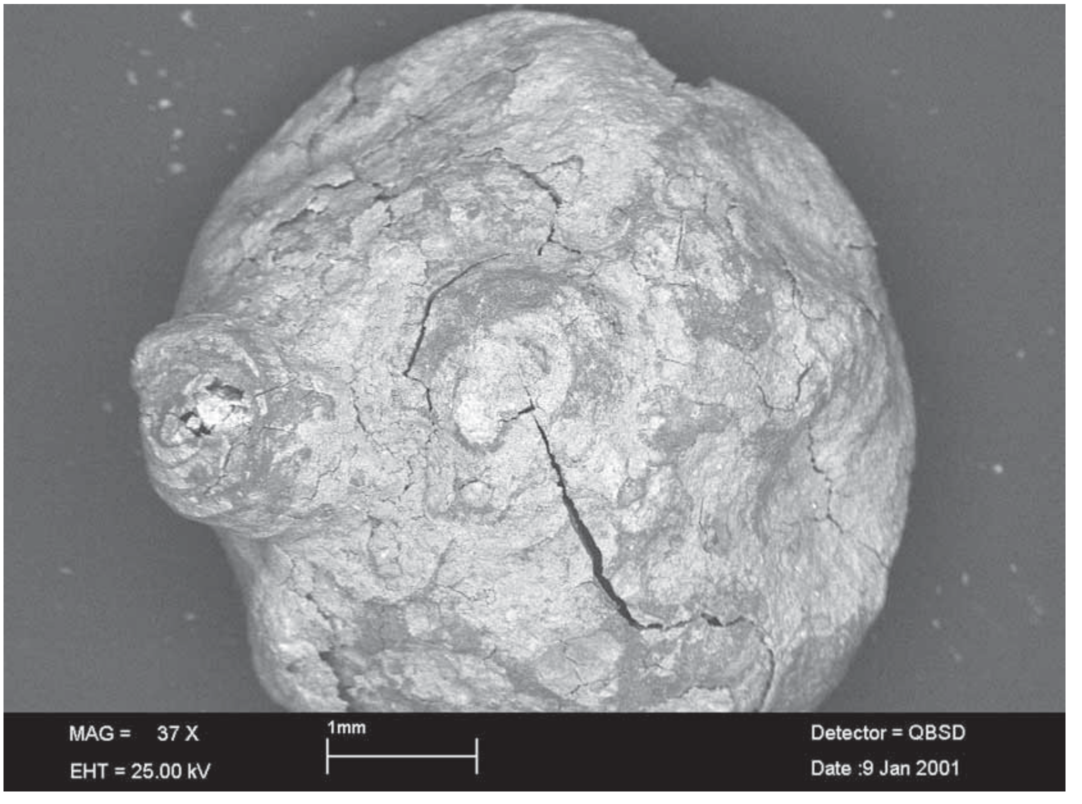


Figure SS4.13 Barrow 1. Round tuber type A from sample 11076, context 33037 in cremation F30030.

Figure SS4.14 Barrow 1. Item B from sample 11254, context 30308 in peripheral cremation F30307.

Item B

These items are often recovered from cremation deposits. They vary in shape and are somewhat reminiscent of large *Veronica spicata* L seeds. However, they have no discernible embryo and at a high magnifications of over x100 no surface pattern is apparent. This suggests that these items are vegetative in origin. Their distinctive appearance is probably due to changes that occur as a result of the charring process. A typical example from cremation F30307 (sample 11254, context 30308) is illustrated in Figure SS4.14.

SS4.6 Animal bone

SS4.6.1 The animal remains from Barrow 1

Simon J M Davis

Adapted from Ancient Monuments Laboratory Report 119/89

Note

AML report 119/89 and a paper based on it (Davis and Payne 1993) both described the animal remains from the barrow on the understanding that they had all been heaped over the limestone cairn surmounting the primary burial. It has since become apparent that, while the overwhelming majority of the collection indeed came from this deposit (phase 2.2), small numbers of specimens came from other contexts, which are distinguished by phase in the accompanying tables. The contexts themselves are described in the landscape unit description (SS1.12). They fall into two groups.

The first consists of those stratigraphically earlier than the cairn, namely the gravel upcast from the primary grave, which underlay the cairn and extended beyond it (stippled in Fig SS4.15); fills packed between the walls of the grave and the oak chamber which enclosed the burial; and the fill of the burial itself. These are all attributed to phase 2.1. The animal bone from them almost certainly derived from the cairn. Finds from the gravel upcast were confined to the area underlying the cairn; finds from the fills around the chamber were all at or close to their surface, where they directly underlay the cairn; and finds from the burial seem to have fallen into the grave when the chamber roof gave way, so that the central part of the cairn collapsed into the grave.

The second consists of those stratigraphically later than the cairn. Material from the first mound (phase 3.2), directly overlying the cairn, is likely to have been removed from the top of the cairn as it was being exposed; and two cattle teeth from the inner ditch (phase 4) may have weathered off the cairn into it. The larger collection of bone from the more superficial contexts of phases 8, 9 and 11 comes from deposits severely disturbed by cultivation and animal burrowing, in which there was much Roman pottery, some medieval pottery and some iron objects alongside prehistoric material. Much of the bone may still derive from the cairn, and such a provenance is particularly likely for material from the centre of the barrow, although it cannot be demonstrated. All the equid bone and all the sheep or goat bone listed in the original reports comes from these mixed contexts and may never have formed part of the early Bronze Age funerary deposit.

The original dating of the deposit and its components has been reviewed in the context of the barrow and the area as a whole (Bayliss *et al* SS6) and the revised conclusions are incorporated here.

Introduction

The excavation of Barrow 1 revealed a limestone cairn below which was the skeleton of an adult man buried with a Beaker and exceptionally fine and abundant grave goods, which indicates that this man was probably of very high rank (SS1.12). The cairn was covered by a deposit extending over an area of approximately 9 sq m containing abundant cattle teeth and bone fragments (Fig SS4.15).

A preliminary examination of the faunal remains from this deposit indicated that they included the remains of approximately 185 cattle skulls, a much smaller number of mandibles, scapulae and pelves, and an aurochs skull. Very few limb bones or bones of any other animal are present. Teeth are generally well preserved but bones are in very poor condition. The extraordinary nature of this assemblage, presumably evidence of some kind of ritual associated with the death of the man, called for special methods.

Objectives

This study has several aims: to identify the status – domestic or wild – of the cattle; to determine their age at slaughter; to ascertain how many different parts of the skeleton from how many animals were originally deposited; to try to understand the manner in which parts of the animal were placed over the cairn in antiquity; to ascertain the length of time during which the remains were assembled and finally, to speculate upon the meaning of this unusual assemblage of cattle remains.

Methods (see also Davis 1987c)

Retrieval of bone in the field

When exposed during excavation, each bone or group of teeth was assigned an AOR (Archaeological Object Record) number. Its position was recorded three-dimensionally using a Nikon DR1 Electronic Distance-meter. It was then lifted from the soil and bagged – an operation supervised by Mr Roger Jones of the Ancient Monuments Laboratory. The concentration of finds was so dense that little residual soil remained after specimens had been lifted (Jones *pers comm*); the residual soil was not sieved. Initial examination, washing and re-packing of the faunal remains was undertaken by Mrs Alison Locker.

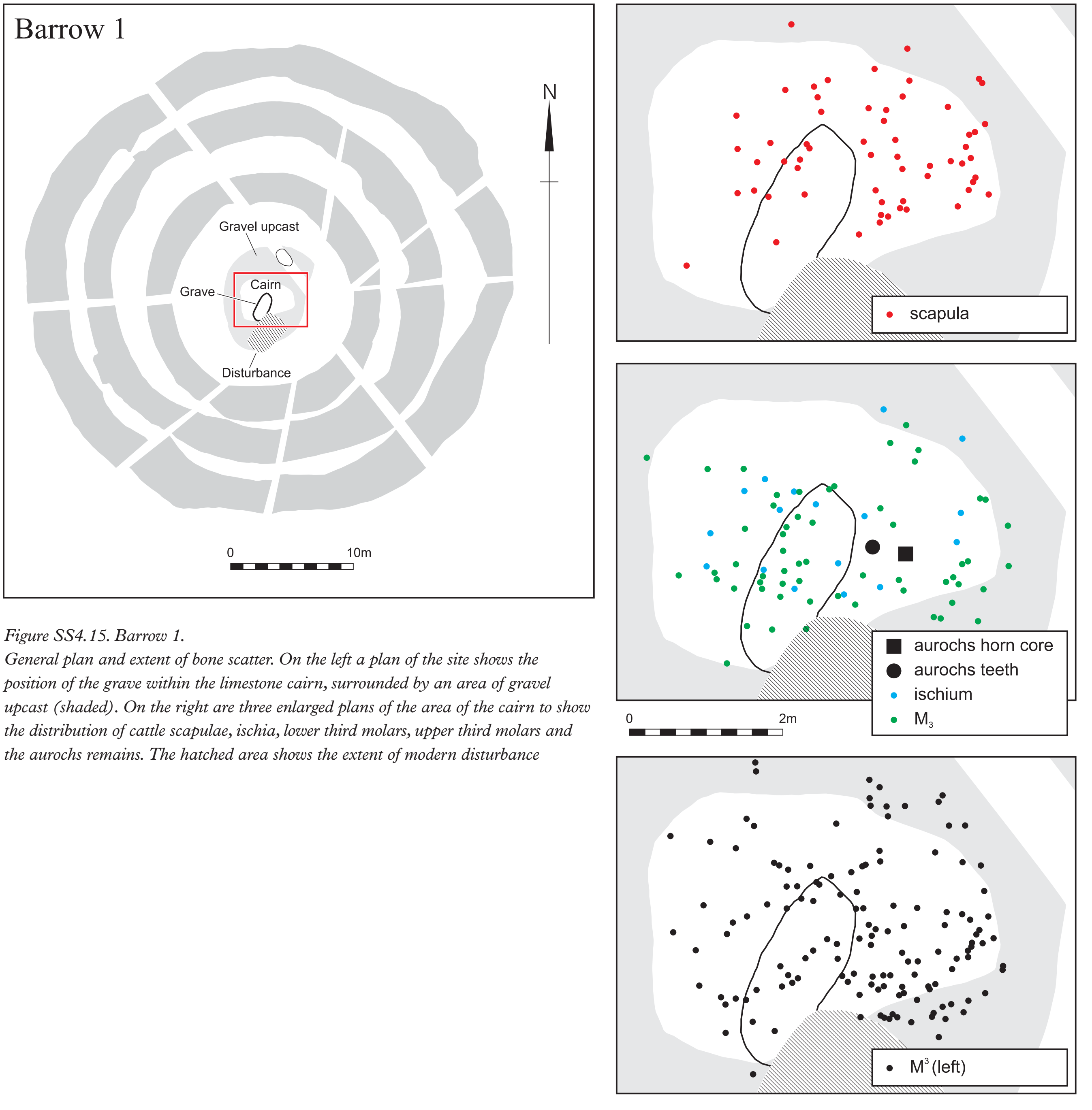


Figure SS4.15. Barrow 1.
General plan and extent of bone scatter. On the left a plan of the site shows the position of the grave within the limestone cairn, surrounded by an area of gravel upcast (shaded). On the right are three enlarged plans of the area of the cairn to show the distribution of cattle scapulae, ischia, lower third molars, upper third molars and the aurochs remains. The hatched area shows the extent of modern disturbance

State of preservation

Since much of the bone was poorly-preserved, many of the teeth had broken out of their jaws and are hence isolated. However, most teeth have fared quite well – especially their enamel. But some teeth have lost part or all of their dentine, making the remaining enamel structure very fragile. Some of these dentine-less teeth have collapsed, probably during or after excavation, leaving numerous strips of enamel. None of the bones is charred.

Identification and counting

Many of the teeth are isolated. Isolated upper molars are not always easy to distinguish from one another. M^3s are usually, though not always, differentiated from M^1s and M^2s (a) by the presence of a keel up the posterior-external corner of the tooth, (b) by the absence of an interdental wear facet on the posterior face of the crown and (c) by the very wide posterior root (Fig SS4. 16). M^1s and M^2s are more difficult to separate from one another, but usually the width of the posterior root, wider in M^2 than M^1 (Fig SS4.16), is helpful. Many isolated molars, especially the damaged ones, could not be assigned their position in the jaw and had to be recorded as '$M^{1/2}$' or just 'upper molar'. Some of the isolated teeth had completely collapsed as a result of dentine loss: their numbers were estimated by counting the bovine pillars (fewer than 5% of the teeth were affected in this way). All identifiable bones and teeth are recorded in Table SS4.30.

Double counting of an element was avoided by only recording cases in which 50% or more of the element in question was present. For a tooth this requires the presence of 50% or more of the crown, for the scapula 50% or more of the glenoid (See also Davis 1987c).

Measurements

Bones were measured in the manner suggested by von den Driesch (1976). Both the antero-posterior length of the lower third molar and the external-internal (ie bucco-lingual) width of its anterior pillar were measured. Measurements of cattle upper teeth are not described by von den Driesch and these teeth are rarely measured by zooarchaeologists. Upper teeth from this assemblage have been measured since they are much more common than lower ones. Upper teeth presented a problem, since they vary considerably in width (more so than lower teeth) from occlusal surface to root. Measurements taken across the occlusal

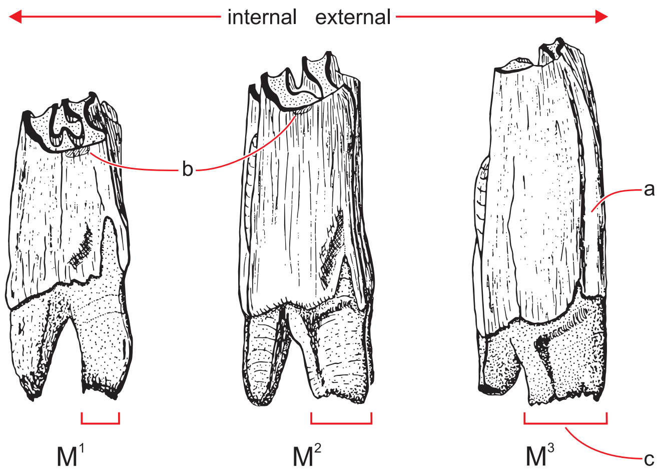


Figure SS4.16. Barrow 1.
Posterior views of cattle M^1, M^2 and M^3 to show the distinction between them. a = posterior keel on M^3, b = wear facets on posterior surfaces of M^1 and M^2 (absent from the posterior surface of M^3), c = the increasing internal-external width of the posterior root from M^1 to M^3.

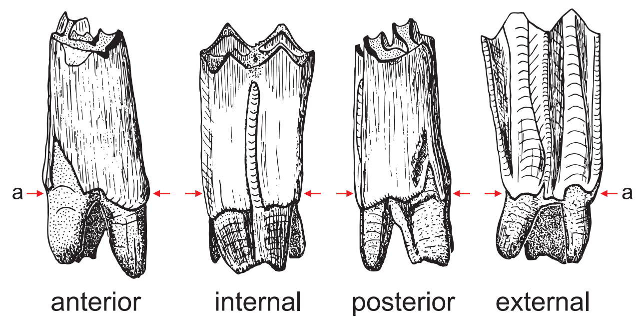


Figure SS4.17. Barrow 1.
Measurement of the circumference of a cattle upper molar. A sketch of the four sides of an isolated M^2 showing the region (arrowed) around which cotton thread was wound in order to measure the circumference of the base of the crown

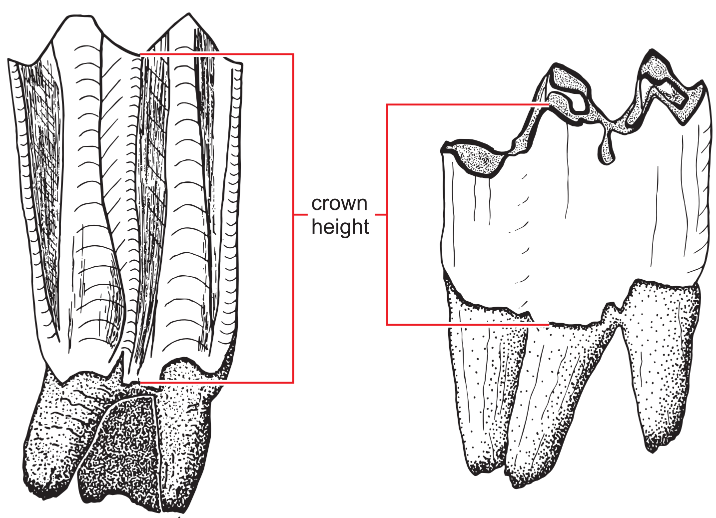


Figure SS4.18. Barrow 1.
Measurement of crown height. Sketch of the external sides of a cattle upper molar (in this case an M^2) and lower third molar to show how 'crown height' was measured from the crown–root junction to the occlusal surface: up the central trough of the upper molars and up the middle of the central lobe of the M_3; P^4s were measured up the centre of the external side.

Table SS4.30. Barrow 1. Numbers of bones and teeth

Teeth in parentheses are those observed below the jaw ramus, ie unerupted. These are only minimum counts, since an unknown proportion of teeth in the main count were probably also unerupted

UM and LM refer to counts of upper and lower molars whose precise identification within the tooth row could not be ascertained

L/R = left/right

F/U = fused or unfused

Approximate values are in parentheses

Those parts of the skeleton not listed were either absent from the assemblage or could not be identified.
Note that more parts of the skeleton have been recorded than are recommended in Davis (1992) such as ilia, pubes, proximal metapodials, etc. A tooth, premaxilla, horn core base, petrosal, occipital condyle, vertebra, scapula (glenoid joint surface), limb bone (proximal or distal end) or pelvic girdle element (acetabulum part) was recorded only if 50% or more of that bone/tooth was present. The rib fragments and the aurochs horn core fragment, however, represent less than 50% of the original bone

		Cattle		*Aurochs*		*Horse*		*Sheep/goat*		*Pig*		*Other*
Bone/tooth	*L*		*R*	*L*	*R*	*L*	*R*	*L*	*R*	*L*	*R*	
Phase 2.2 (cairn) and related contexts												
Skull and mandible												
Maxillary teeth												
Premaxilla	17		27									
dP^2			1									
P^2	6 (+6)		4 (+11)									
dP^3	11		13									
P^3	42 (+21)		47 (+25)							1	1	
dP^4	27		24									
P^4	92 (+26)		86 (+25)							2		
M^1	126		137	1						2	1	
M^2	146		159	1	1					2	1	
M^3	159		164	1	1							
$M^{1/2}$	33		39									
UM	22	43	19									
Horn core		49			1							
Petrosal bone		261										
Occcipital condyle		144										
												?Dog parietal ?Dog palate
Mandibular teeth												
Incisors		1										
dP_2												
P_2	1		4									
$P_{2/3}$	1		1									
dP_3												
P_3	9 (+3)		8 (+2)									
$dP_{3/4}$												
$P_{3/4}$	2		3 (+1)									
dP_4	1		5									
P_4	11 (+4)		15 (+2)									
M_1	25		29									
M_2	27		35									
M_3	28		31									

Table SS4.30. Continued.

Bone/tooth	Cattle L	Cattle R	Aurochs L	Aurochs R	Horse L	Horse R	Sheep/goat L	Sheep/goat R	Pig L	Pig R	Other
$M_{1/2}$	4	9									
LM	1	(1)									
Mandible condyle	10	12									
Vertebral column											
Atlas	7										
Axis	1										
Cervical vertebrae	14										
Throacic vertebrae	6										
Lumbar vertebrae	10										
Sacra	3										
Forelimb girdle											
Scapula U											
Scapula F	16	20									
Scapula ?	16	13									
Forelimb											
Humerus proximal											
Humerus shaft	1										
Humerus distal F	1	1									
Radius proximal F	1										
Radius distal											
Ulna											
Carpals											
Metacarpal proximal											
Metacarpal shaft											
Metacarpal distal											
Rib cage											
Rib fragments	13										
Hindlimb girdle											
Pubis	14	10									
Ischium	13	8									
Ilium	14	10									
Hind limb											
Femur proximal											
Femur distal F	1										
Femur distal epiphysis U									1		
Tibia proximal F	1										
Tibia shaft	1										
Tibia distal											
Fibula											
Astragalus											
Calcaneum											
Naviculo-cuboid											
Metatarsus proximal	1										
Metatarsus shaft	1										
Metatarsus distal											
Phalanges											
1											
2											
3	1										

Table SS4.30. Continued.

Bone/tooth	*Cattle* *L*		*R*	*Aurochs* *L*	*R*	*Horse* *L*		*R*	*Sheep/goat* *L*	*R*	*Pig* *L*	*R*	*Other*
Phase 3.2 (first mound)													
Skull and mandible													
Maxillary teeth													
P^2			1										
dP^3			1										
P^3	1		2										
dP^4			1										
P^4	3		1										
M^1	1												
M^2	1		1										
M^3	2		3								1		
$M^{1/2}$	8		5										
UM		8											
Horncore		1											
Petrosal bone		13											
Mandibular teeth													
$P_{3/4}$			1										
dP_4	1												
M_1			1										
M_2	1		1										
M_3	1		1										
$M_{1/2}$	1												
Phase 4 (fill of inner ditch)													
Skull and mandible													
Maxillary tooth													
$M^{1/2}$			2										
Forelimb													
Metacarpal proximal			1										
Phase 8 (outer ditch fill and flint scatter)													
Skull and mandible													
Maxillary tooth													
$M^{1/2}$	2												
Phase 9 (disturbed and eroded mound)													
Skull and mandible													
Maxillary teeth													
dP^4			2										
P^4	1		1										
M^1	1												
M^2	1												
M^3	2		2										
$M^{1/2}$	2		1										
UM			1			1							
Petrosal bone		1											
Incisors							1						
Mandibular teeth													
$P_{3/4}$			1										
M_3	1									1			
$M_{1/2}$	2	1	1			1			1	1			

Table SS4.30. Continued.

	Cattle			Aurochs		Horse			Sheep/goat		Pig		Other
Bone/tooth	*L*		*R*	*L*	*R*	*L*		*R*	*L*	*R*	*L*	*R*	
Forelimb													
Humerus shaft									1				
Metacarpal shaft							1						
Hindlimb girdle													
Ilium	1		1										
Hind limb													
Tibia shaft		1											
Phase 11 (later activity)													
Skull and mandible													
Maxillary teeth													
M^1			1										
M^2			2			1							
M^3			2					1					
$M^{1/2}$	1		3					1					
UM		1											
Mandibular teeth													
dP_4	1												
M_3			1							1			
$M_{1/2}$										1			
Forelimb													
Humerus distal F	1												
Radius proximal F										1			
Hindlimb girdle													
Ilium			1										
Hind limb													
Astragalus										1			

surface therefore vary with the animal's age at death. In order to obtain an age-independent estimate of size the crown-base circumference[1] (Fig SS4.17) was measured. Using this procedure it was possible to measure approximately 20% of the dP^4s and upper molars. Many teeth had no roots or were badly damaged. Their circumferences could not therefore be measured.

Ageing

Relative age estimates were obtained by measuring crown height and noting wear stage:

a) Crown height. Bovids, like most grass-eating mammals, have high-crowned teeth. The crown gradually wears away in the course of the animal's life: the older the animal, the shorter the crown. In this assemblage, the crown heights of dP^4, P^4, M^1, M^2 and M^3 and M_3 were measured to the nearest 0.1mm up the external (buccal) surface from the occlusal edge to the crown-root junction, as shown in Figure SS4.18.

b) Wear stage. The pattern on the occlusal surface of a bovid tooth changes as wear proceeds. Each dP^4, P^4, M^1, M^2 and M^3 was assigned to a wear stage similar in principle to the wear stages described by Payne (1987) for sheep and goat mandibular cheek teeth (Fig SS4.19). Mandibular teeth were assigned to the wear stages suggested by Grant (1982).

Description

Observations during excavation

Jones (pers comm) noted that some complete skulls had been present during the excavation but that these subsequently broke up due to poor preservation. He also noted that maxillary teeth were generally pointing into the ground (ie with their occlusal surfaces facing down) indicating that skulls had been incorporated into the assemblage 'the right way up'. Skulls and tooth rows were not facing in any particular direction.

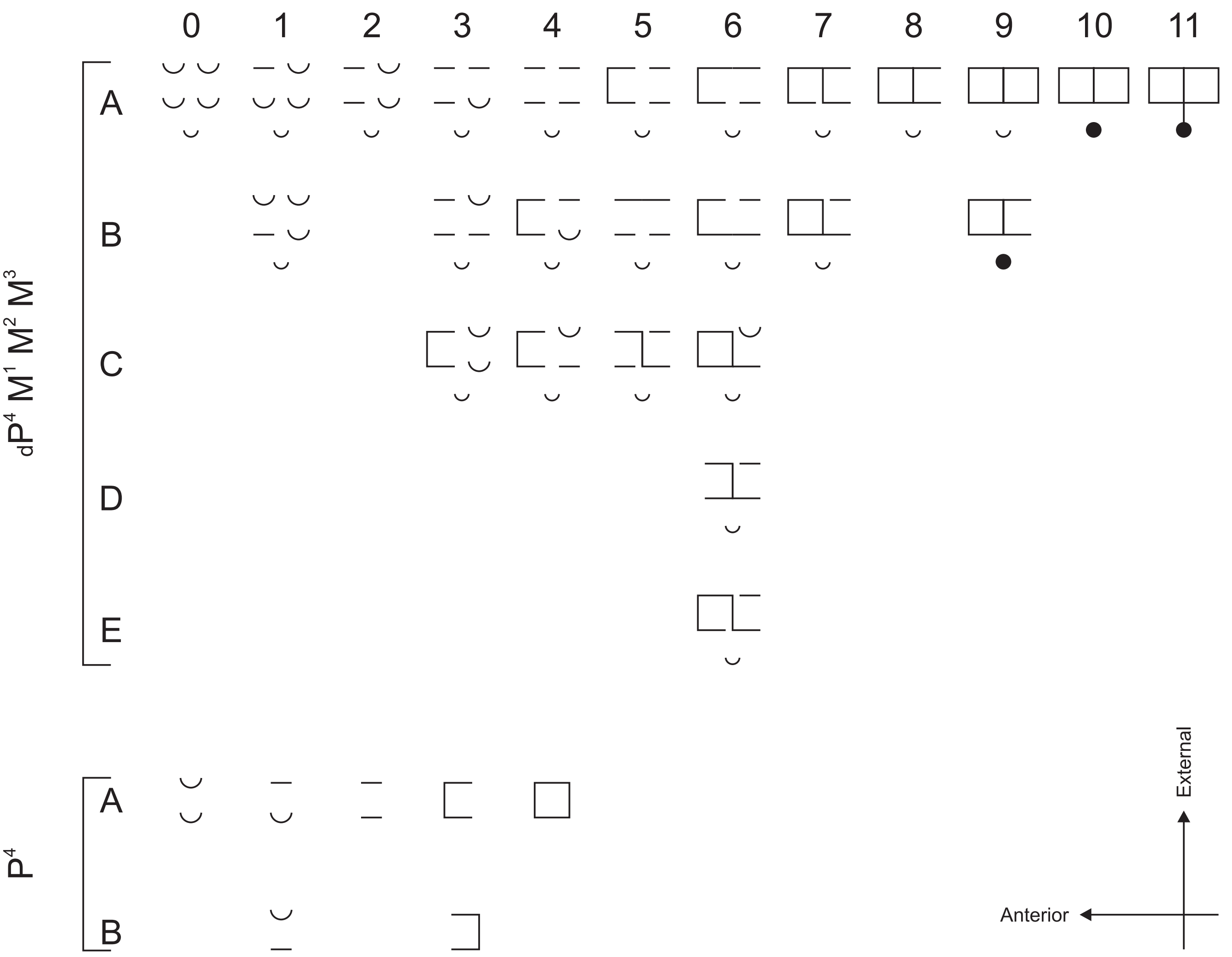


Figure SS4.19. Barrow 1. Wear stages (numbered) and variants (lettered) of cattle upper teeth (after S Payne 1987): the pattern of cusps and enamel folds on the occlusal surface of a tooth changes as wear proceeds. U = an unworn cusp, – = a cusp with exposed dentine. Adjacent cusps with continuous dentine are joined.

Species and numbers present (Table SS4.30)[2]

Most of the bones and teeth belonged to cattle which, on the basis of their small size, were undoubtedly domestic (Figs SS4.20–21). As with many domesticated animals, bones and teeth of domestic cattle are smaller than those of their wild ancestor, the aurochs. At least 185 domestic cattle are represented. A few bones and teeth of other animals are also included.

Five very large cattle teeth, a left M^1, one left and one right M^2, and one left and one right M^3, all came from within one metre of each other (Figs SS4.15, SS4.22). Their circumferences (Table SS4.31) are much greater than those of the rest of the cattle teeth from the barrow: note the wide separation shown in Figure SS4.20. There can be little doubt that these larger teeth belonged to the aurochs or wild cattle, *Bos primigenius*. Near these five teeth, a fragment of a large horn core was found. It is too large to belong to domestic cattle and is very similar to the horn core of a fossilised but undated male aurochs skull from Lincolnshire in the AM laboratory collection (AML no 756). The five aurochs teeth and the horn core fragment could derive from the same skull, as their proximity suggests (Fig SS4.15). One of the two dated teeth, however, is significantly older than the other (see Date below).

Measurements of the scapulae (Table SS4.34, Fig SS4.25) also reveal two specimens, AORs 34258 and 34977 (left and right sides respectively), which on account of their large size may have belonged to an aurochs. The aurochs survived in Britain at least until the later Bronze Age: Clutton-Brock and Burleigh (1983) dated aurochs remains from Somerset to *c* 1500 cal BC. Caesar made no mention of this beast in

Table SS4.31. Barrow 1. Wear stages, crown height and circumference (Figs SS4.17–SS4.19) of domestic cattle and aurochs upper (maxillary) teeth

Data for all five aurochs teeth are given, but for the cattle only instances where two or more adjacent teeth (left side only) are present are given.

L/R = left or right side, - = tooth present but too damaged to measure.

Values in parentheses are approximate. In order to save space data for the left side only are given. The illustrations are based on both sides.

			Wear stage					*Crown height (mm)*					*Circumference (mm)*		
AOR	*Box*	*L/R*	*dP^4*	*P^4*	*M^1*	*M^2*	*M^3*	*dP^4*	*P^4*	*M^1*	*M^2*	*M^3*	*M^1*	*M^2*	*M^3*
Phase 2.2 (cairn) and related contexts															
34181	1	L	11A		10A	8A		11.1		27.4	36.8				
34148	1	L		0	11A	9A	3C		29.9	28.4	39.9	45.9			
34186	1	L			9A	3B	0			32.8	43.8				
34669	1	L		4A	11A	9A	9A		26.8	21.9	38.4	40.3	80	86	93
34599	1	L		4A	11A	11A	11A		29.1	13.1	24.7	28.0			
35047	2	L		1A	9A	9A	2A		32.2	31.1	39.6	43.3	76	84	89
34614	2	L		4A	10A	9A			26.8	25.8	35.8				
34614	2	L		3A	11A	11A	8A		27.5	21.6	30.7	34.7	75	81	90
34409	2	L				11A	10A				28.2	36.3			
34413	2	L			11A	9A	?			17.8	25.3	29.6			
34400	2	L	11A		9A	5A	0	7.9		31.0	39.8				
34391	2	L		1B	11A	9A	4A		29.7	23.6	34.4	41.6			
34415	2	L		4A	11A	9A	9A		27.6	16.6	28.1	36.8	72	79	85
34984	3	L	11A		9A	6C		8.0		31.9	38.6				
35141	3	L	11A		7B	0		11.2		33.0					
34523	3	L		4A	11A				24.0	16.7					
34571	3	L	11A		7B	4A	0	6.3		36.0	44.9				
34551	3	L		4A	11A				18.2	12.7					
34925	3	L			10A	5A	0			30.1	42.1				
34953	3	L		4A	11A				17.9	12.0					
34295	4	L			10A	5A	0			28.6	36.9				
34301	4	L		4A	11A	11A	9A		28.1	19.6	29.1	-			
34293	4	L		4A	11A	9A	9A		-	29.0	36.9	42.7			
34265	4	L			11A	11A				20.4	31.9				
34313	4	L		2A	11A				-	21.5					
34171	4	L		0	10A	9A	5A		30.9	24.5	33.4	39.1			
34170	4	L			?11A	9A	9A				30.3	30.6			
34174	4	L			11A	10A					26.2				
34144	4	L	11A		7B	0		10.2		35.4					
34317	5	L			10A	9A	8A			29.0	36.0	37.9			
34326	5	L		4A	11A	9A	6A		29.9	25.4	34.2	38.3			
34205	5	L			?	10A				27.2	28.7				
34330	5	L		4A	11A				23.7	25.6					
34198	5	L			11A	9A	9A			18.0	31.0	37.2			
34197	5	L			?11A	9A	8A			25.5	33.5	36.6			
34195	5	L		4A	?				23.0	13.6					
34178	5	L		4A	?	?	?		27.6	23.1	35.6	39.6			
34827	6	L	11A		10A	8A	0	8.6		30.0	40.3				
34897	6	L		U	9A	6D	0			21.8	39.2				
34218	7	L		?3B	11A	9A			26.1	24.5	33.4				
34217	7	L			11A	10A	9A			(17.5)	(30.3)	34.4			
34225	7	L				8A	0				36.1				

Table SS4.31. Continued.

			Wear stage					*Crown height (mm)*					*Circumference (mm)*		
AOR	*Box*	*L/R*	*dP^4*	*P^4*	*M^1*	*M^2*	*M^3*	*dP^4*	*P^4*	*M^1*	*M^2*	*M^3*	*M^1*	*M^2*	*M^3*
34210	7	L				10A	8A				29.0	36.4		87	90
34474	10	L				10A	9A				32.0	36.2			
34486	10	L		4A	11A	10A	8A		24.4	23.1	33.2	36.1	77	84	9
34483	10	L		4A	11A	11A	8A		22.7	18.1	27.4	32.0	78	81	87
34628	10	L		3B	11A	9A	8A		28.7	26.8	36.4	40.2			
35075	11	L				10A	9A				34.1	37.6			
35071	11	L			7B	0				32.8					
35067	11	L			11A	9A	8A			27.1	38.4	39.8	78	84	88
35078	11	L	11A		8A	0		11.8		35.1			75		
34698	11	L			9A	6C	0			31.8	41.0				
34708	11	L				9A	7B				38.4	37.5			
34684	11	L				8A	0				40.8				
34692	11	L				11A	9A				33.2	39.2		84	94
35018	12	L			11A	10A	9A			20.2	29.7	34.1	76	83	83
34278	13	L		U	10A	7B	0			31.7	41.2		82	88	
34280	13	L			11A	9A	6E			28.4	40.2	42.7			
34284	13	L		4A	11A	11A	9A		18.6	15.7	21.7	25.9	75	79	83
34274	13	L				9A	6C				34.6	43.6			
34913	14	L		2A	11A	9A	8A		27.7	26.7	37.3	40.0			
34996	14	L			11A	9A	3B			24.5	34.2	37.8	74	80	86
34847	14	L		4A	11A	11A	10A		24.7	20.1	31.1	35.0	81	87	98
34385	15	L				9A	8A				33.6	36.2			
34384	15	L				9A	5B				-	40.3			
34896	15	L	11A		9A	5A	0	6.1		33.3	40.9				
34730	16	L		4A	11A	10A	9A		31.0	22.5	32.6	36.9	78	82	86
34727	16	L		4A	11A				18.2	16.3					
34732	16	L	11A		8A	1A		10.7		32.2	44.1				
34608	16	L		4A	11A				18.7	16.9			80		
34608	16	L				11A	11A				22.0	23.9		87	94
34991	17	L	11A		11A	8A	0	9.0		13.1	31.3		76	80	
34969	17	L		4A	11A	11A			27.7	19.1	26.9		83	87	
35083	19	L		2A	10A	9A	4C		30.4	27.5	38.4	42.8	77	88	94
34539	20	L			11A	11A	?			16.7	23.7	25.5			
34705	20	L			9A	?	0			28.7	36.6				
34392	21	L			11A	2A	0			31.5	41.2				
34502	21	L		4A	11A	11A	10A		18.9	14.3	22.5	27.2	81	85	88
34507	21	L			11A	8A	?			29.6	43.1				
34508	21	L			?	9A	8A			26.5	36.2	39.8			
34503	21	L				9A	8A				36.4	39.7		82	88
34350	24	L				?	4A				41.5	45.0			
34345	24	L				7B	0				41.0				
34810	24	L		U	9A	9A			28.3	29.5	37.0		82	85	
34777	24	L				10A	5C				35.4	39.4		88	93
34883	24	L		3B	10A	9A	5B		27.5	26.3	37.0	41.4	81	85	94
3476?2	24	L	11A		9A	8A	0	5.5		30.7	40.3				
34873	24	L			11A	9A	3B			26.1	35.9	38.7	78	83	85
35109	25	L		3B	11A	9A			28.4	21.5	33.7		80	83	
34462	26	L		U	9A	7B	0			30.5	40.0				
34453	26	L		4A	11A	10A	9A		23.2	18.4	27.1	35.8	79	82	89
34469	26	L				11A	9A				24.3	30.5		83	93
34447	26	L			9A	8A	0			33.0	43.9				

Table SS4.31. Continued.

			Wear stage					*Crown height (mm)*					*Circumference (mm)*		
AOR	*Box*	*L/R*	*dP^4*	*P^4*	*M^1*	*M^2*	*M^3*	*dP^4*	*P^4*	*M^1*	*M^2*	*M^3*	*M^1*	*M^2*	*M^3*
34466	26	L		4A	11A	11A	10A		19.6	14.8	24.1	30.8	80	85	94
34461	26	L	11A		9A	5A	0	8.2		33.9	41.8				
34363	26	L			10A	8A				31.7	40.4				
34112	26	L		U	9A	8A	0			(25.9)	37.0				
34356	26	L			11A	10A				16.9	22.6				
34359	26	L				8A	0				37.4				
34229	27	L		4A	11A	10A	9A		21.7	17.5	28.5	32.8			
34237	27	L			10A	9A				26.9	35.0				
34237	27	L			10A	8A				28.2	35.2				
context 30417	27	L	11A		9A	5A	1A	-		34.0	41.6	42.2	82	85	95
34622	29	L		4A	11A				28.4	23.8					
34190	29	L	11A		9A	6B	0	10.0		33.5	44.1				
34542	30	L		4A	11A	10A	8A		29.1	21.2	31.3	38.7	77	82	90
34587	30	L			11A	9A	5A			26.6	38.4	40.3			
34549	30	L				9A	3B				38.4	43.0			
34553	30	L		4A	11A	10A	9A		22.4	19.5	27.5	31.9		83	91
34591	30	L		2A	11A	10A	8A		26.8	22.7	35.0	40.3	75	80	88
34643	31	L			11A	10A	8A			23.0	33.6	38.4	77	86	91
34261	31	L				8A	0				41.7				
34361	31	L			11A	9A	8A			35.9	42.6	46.0			
34370	31	L				10A	9A				37.0	36.2			
34246	31	L		U	9A	8A	0			(31.2)	41.4				
34254	31	L		4A	11A	10A			29.7	22.7	35.1				
34262	31	L			8A	1B				33.8	42.4				
34682	32	L				10A	9A				23.8	28.3			
34682	32	L		4A	11A	10A	8A		22.8	22.1	27.5	31.4	76	80	85
34521	33	L			?	11A				17.9	27.0				
34368	33	L		4A	11A	11A	11A		-	17.1	21.8	24.5			
34440	33	L				11A	9A				26.0	33.4			
34738	33	L				10A	9A				30.9	37.5			
34531	33	L	11A		7B	0		9.4		34.4					
34923	34	L			?11A	10A	10A				(28.8)	33.8			
34695	34	L				8A	0				39.3				
34308		L		4A	11A				28.6	24.2					
34228	34	L			11A	11A	9A			22.1	31.3	36.6			
34974	34	L		4A	11A	11A	10A		24.1	21.2	29.8	30.1	84	89	93
35030	34	L				11A	10A				22.8	30.7		90	95
34962	35	L			11A	9A	4A			24.0	33.0	38.5			
34680	36	L		0	9A	8A	0		28.6	30.4	38.7				
35096	36	L	12A	U	9A	8A	0	-	30.6	31.7	38.9				
35085	36	L	11A		10A	7B	0	8.2		34.8	42.7				
34433	36	L				9A	3A				36.8	42.4		89	
Aurochs															
34872	24	L			11A					18.4			99		
34873	24	R				11A					29.2			109	
34873	24	L				11A					29.6			109	
34814	28	R					11A					31.5			115
34814	28	L					11A					31.3			115
Phase 3.2 (first mound)															
context 30414	18	L			11A	10A				24.7	-				

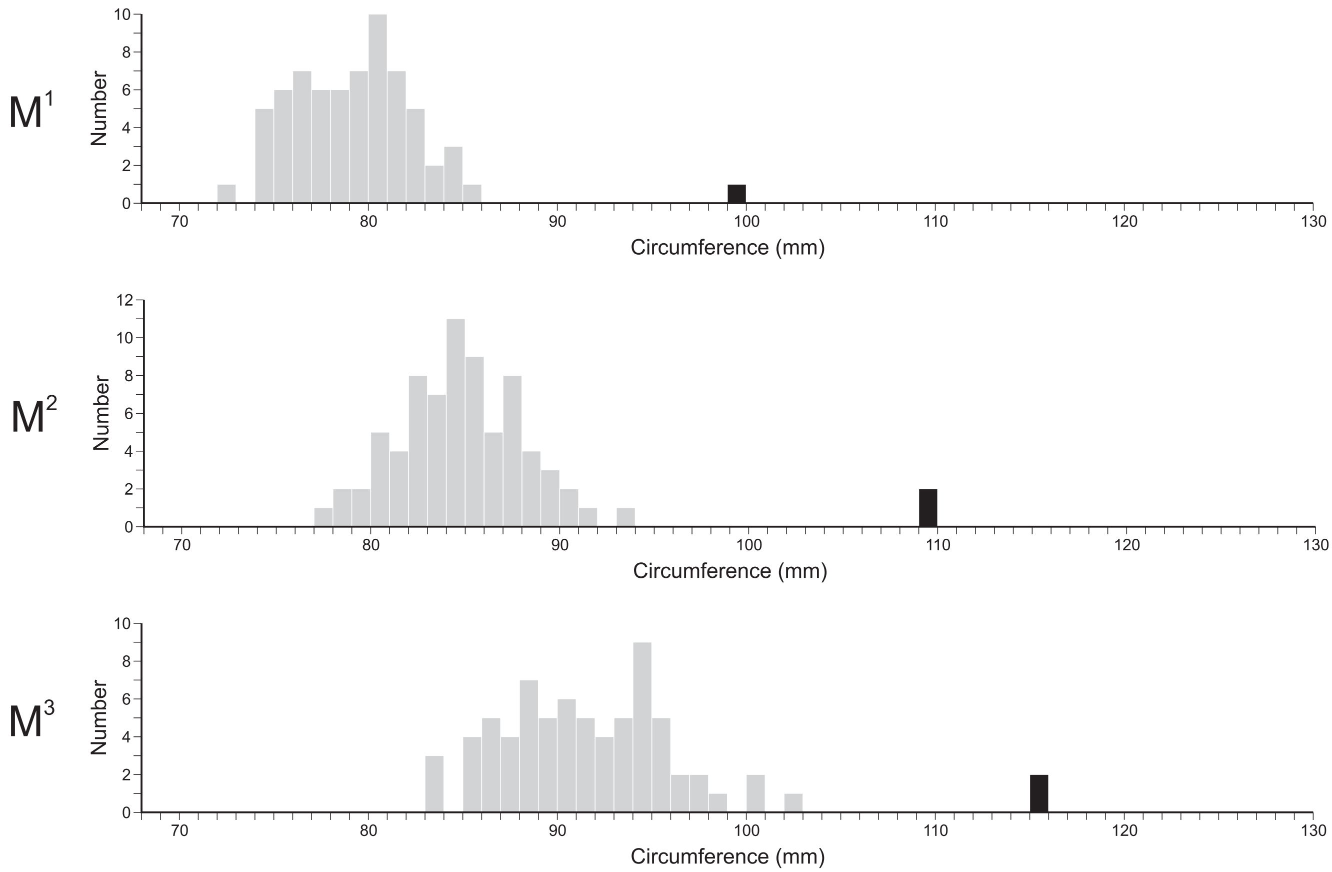


Figure SS4.20. Barrow 1. Circumferences of upper first, second and third molars of cattle from Irthlingborough. Teeth identified as domestic cattle are illustrated in grey and the five large teeth identified as aurochs are illustrated in black.

Figure SS4.21. (opposite) Barrow 1. Size change in north European cattle lower third molars and the identification of the Barrow 1 cattle (measurements of both left and right sides are included). Data come from the following sources: Grigson 1983 (Danish aurochsen and English Neolithic cattle), S Davis 1988 (Dodder Hill cattle), and S Davis 1987a (Prudhoe Castle cattle).

England and blame for its demise must lie with the native Britons (Owen 1846, 503)

A few teeth and a bone of a pig, and a single palate and parietal fragment of a canid (probably dog), are also present. Thus, apart from the domestic cattle, at least three pigs, one or two aurochsen and a single canid are represented in the deposit.

From disturbed and later contexts there were six teeth and two limb bones which belonged to a small equid. The protocone of an $M^{1/2}$ is elongated (the other upper teeth are damaged), and on an $M_{1/2}$ the internal (lingual) fold is U-shaped and the external (buccal) fold partially penetrates between ento- and meta-flexids. These are caballine (ie horse/pony) characters. There are also a few teeth and bones from at least two caprines (sheep or goat). Both equid and caprine bones were scattered well beyond the area of the cairn.

Distribution of elements across the barrow (Fig SS4.15)

Distributions of cattle left upper M^3s, right and left lower M_3s, right and left ischia (the ischium is part of the pelvis) and right and left scapulae across the site indicate that these formed a single cluster around the grave within which the bones are scattered at random.

Parts of the anatomy[3] (Table SS4.30, Fig SS4.23)

It is clear that cattle skulls, mandibles, scapulae and pelves are most common almost to the exclusion of the rest of the skeleton. A few vertebrae are also present but limb bones are conspicuously rare. The cattle limb bones and 13 rib fragments may have originated from other sources and are presumably not part of the ritual assemblage (ie the skull and girdle complex) at Irthlingborough. An approximate estimate (rounded to the nearest five) of the smallest number of individual cattle from which the bones are derived is as follows:

skulls from 185[4] individuals
mandibles from 40 individuals
scapulae from 35 individuals
pelves from 15 individuals

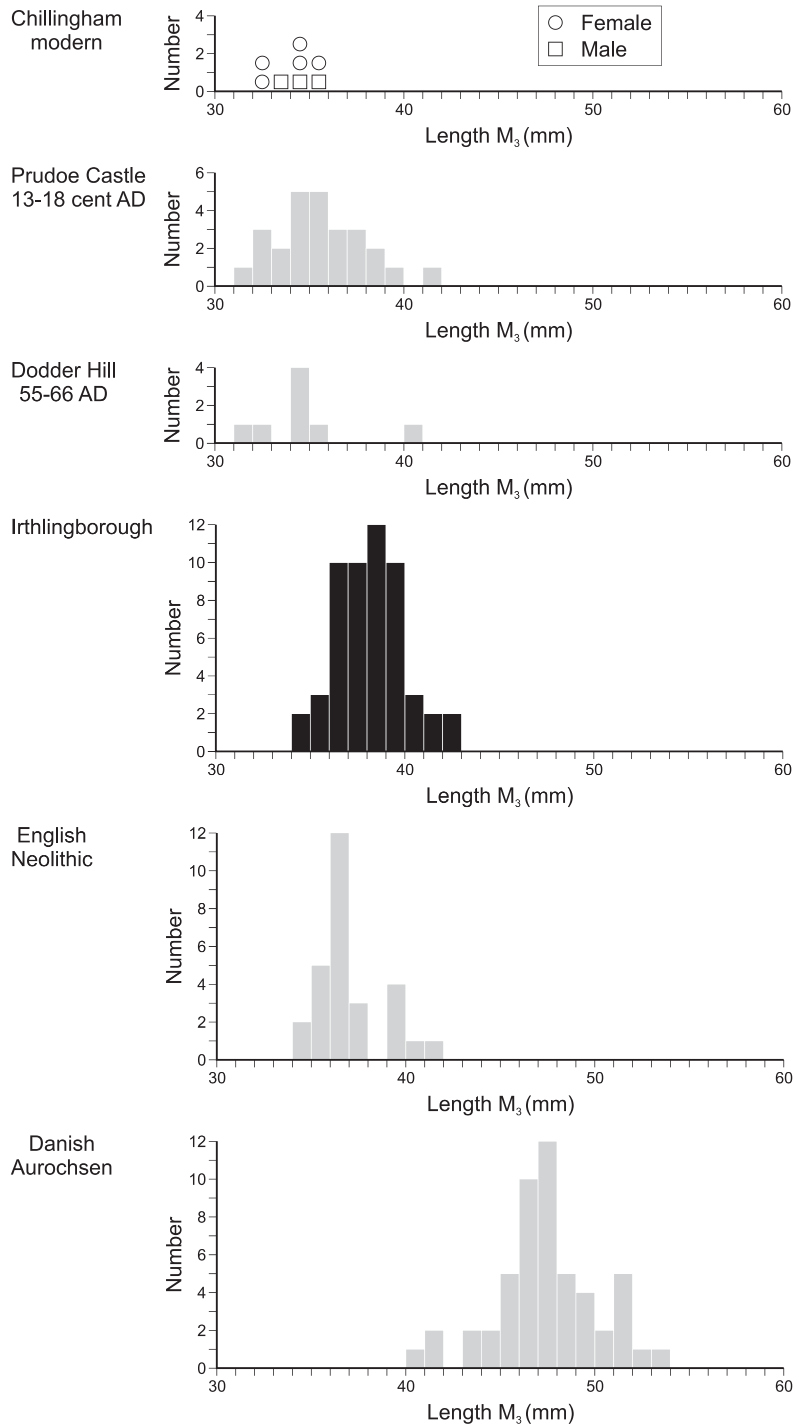
Table SS4.30 also shows that incisors are rare (only one was found, there should have been approximately 320; ie 8 × 40) and premolars are less common than expected (for example there are 1100 upper molars but only 480 deciduous and permanent upper premolars when there should have been at least 1100).

The pig remains comprise upper premolars and molars and one femur and, like the few cattle limb bones and rib fragments, they are probably not part of the ritual assemblage. The same is true of the sheep/goat and equid remains from disturbed contexts.

Age at death of the cattle

Table SS4.32 gives the numbers of cattle maxillary teeth in each successive wear stage. Figure SS4.24 shows the plots of the crown heights of these same teeth. Table SS4.33 provides the wear stages of the mandibular teeth and M^3 measurements. The plots of crown height show a progressive decline in numbers with crown height (ie age) and suggest that most of the teeth belonged to young adults. Calves are rare: for example only one of the dP^4s is in wear stages 0–9. None of the M^1s is in wear stages 0–6. These are approximately equivalent to Andrews' (1982)[5] eruption stages 0–7 which, for the M^1, he suggests include individuals aged between birth and *c* 373 days old, ie calves. Similarly for M^2, Andrews' stages 0–6 are roughly equivalent to stages 0–7 in this study. Andrews gives a mean age of *c* 636 days (or 1.75 years) for the beginning of his stage 7. This would mean that most of the 34 Irthlingborough M^2s in stages 0–6 came from cattle which were probably slaughtered during their second year of life. The remaining 228 M^2s came from cattle aged 1.5 years or more. Teeth from very old individuals are absent from the sample: none of the permanent teeth are very worn.

Despite careful measuring of crown heights and the unusually large sample size, there is no clear evidence for grouping of teeth (neither upper teeth nor M_3s) into a series of discrete 'cohorts' (or peaks in the crown height plots), each with a progressively smaller crown height due to slaughtering at one time of the year. The reason may simply be that the individual crowns of cattle teeth vary too much – observe the amount of variation of crown height of unworn P^4s (shown cross-hatched) in Figure SS4.24. Any 'peak and trough' effect due to seasonal slaughter would be masked by the large amount of random variation. The recognition of discrete age cohorts would also require that Bronze Age cows gave birth during a short season (for example in spring) – something which does not happen today and probably did not happen in the early nineteenth century AD[6]. The detection of seasonal culling practices by



measuring tooth crown heights is probably only possible for deciduous teeth, and even then reliability has yet to be tested using modern specimens of known age. The dP^4 measurements at Irthlingborough unfortunately do not (in the absence of modern known-age comparative data) provide an interpretable picture. A single dP^4 with a crown height of 16–17mm probably belonged to a calf.

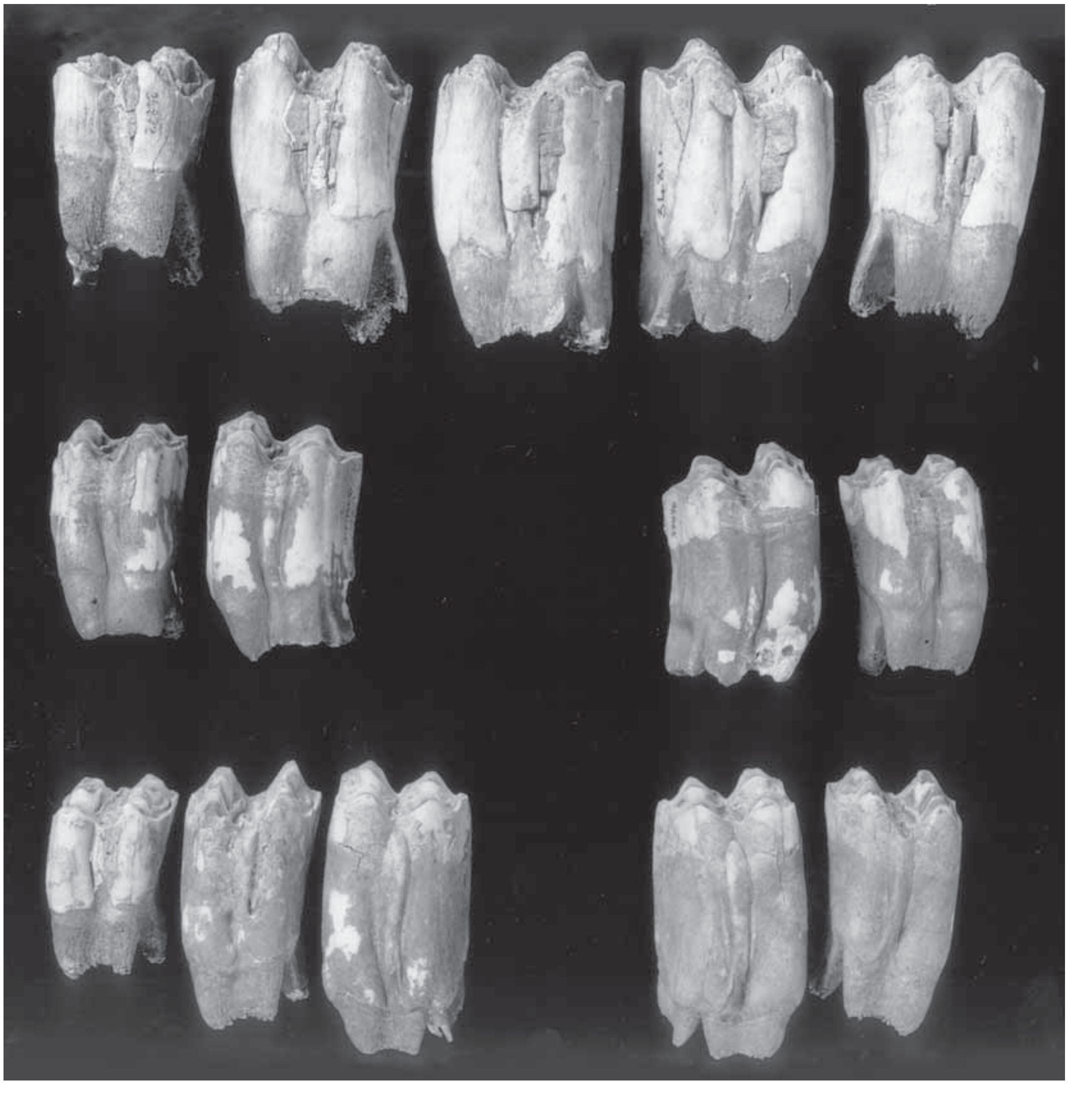


Figure SS4.22. Barrow 1. The aurochs molars. Above: the five aurochs upper molars, from left to right: left M^1, left M^2, left M^3, right M^2 and right M^3. Centre and bottom: Cattle upper molars to show the size difference between aurochs and domestic cattle. (Photo Ancient Monuments Laboratory)

Cut and burn marks

Several scapulae and basi-occipitals have fine cut marks, probably made by a sharp instrument during the removal of flesh. Unfortunately most of the bone was so poorly preserved that it is not possible to determine how widespread these marks were on other bones. None of the teeth show any signs of intentional damage post mortem. None of the bones or teeth show any signs of burning.

Date

Ten radiocarbon measurements from Barrow 1 (Table SS6.1, Fig SS6.11) make it possible to estimate the date of the burial covered by the bone deposit as *2140–1800 cal BC at 95 % probability* (Bayliss *et al* SS6). Those relating directly to the burial and cairn are listed in Table SS4.35.

The cairn must have been piled up after the burial was complete, yet one aurochs tooth, dated by OxA-2085, was between *960–330 years old at 95% probability* (Difference Last Barrow_1 and OxA-2085). The difference in age between this and the second dated aurochs tooth (OxA-2086) makes them unlikely to have belonged to the same animal, although they were found together. Neither formed part of a longer tooth row, unlike both dated domestic cattle molars, suggesting that they were already loose when deposited. The incorporation of an already old tooth is echoed by the presence in the burial of a boar tusk dated by OxA-4067, which was piled up with the other grave goods at the feet of the skeleton dated by UB-3148, and must have been placed there at the same time, yet it was *between 990 and 420 years old at 95% probability* when buried.

Table SS4.32. Barrow 1. Numbers of maxillary teeth in successive wear stages (Fig SS4.19)

Tooth		*Wear stages*												
		0	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*Late 11*
dP^4	A	-	-	-	-	-	-	-	-	-	1	-	48	1
	B	-	-	-	-	-	-	-	-	-	-	-	-	-
	C	-	-	-	-	-	-	-	-	-	-	-	-	-
	D	-	-	-	-	-	-	-	-	-	-	-	-	-
	E	-	-	-	-	-	-	-	-	-	-	-	-	-
M^1	A	-	-	-	-	-	-	-	-	10	45	28	133	-
	B	-	-	-	-	-	-	-	6	-	-	-	-	-
	C	-	-	-	-	-	-	-	-	-	-	-	-	-
	D	-	-	-	-	-	-	-	-	-	-	-	-	-
	E	-	-	-	-	-	-	-	-	-	-	-	-	-
M^2	A	7	1	1	-	3	10	-	1	35	90	51	45	-
	B	-	2	-	2	-	-	3	6	-	-	-	-	-
	C	-	-	-	-	-	-	4	-	-	-	-	-	-
	D	-	-	-	-	-	-	1	-	-	-	-	-	-
	E	-	-	-	-	-	-	-	-	-	-	-	-	-
M^3	A	73	3	7	2	12	4	5	1	53	70	27	8	-
	B	-	1	-	5	-	2	-	3	-	1	-	-	-
	C	-	-	-	3	2	1	1	-	-	-	-	-	-
	D	-	-	-	-	-	-	2	-	-	-	-	-	-
	E	-	-	-	-	-	-	1	-	-	-	-	-	-
P^4	A	79	2	16	6	102								
	B	-	5	-	11	-								

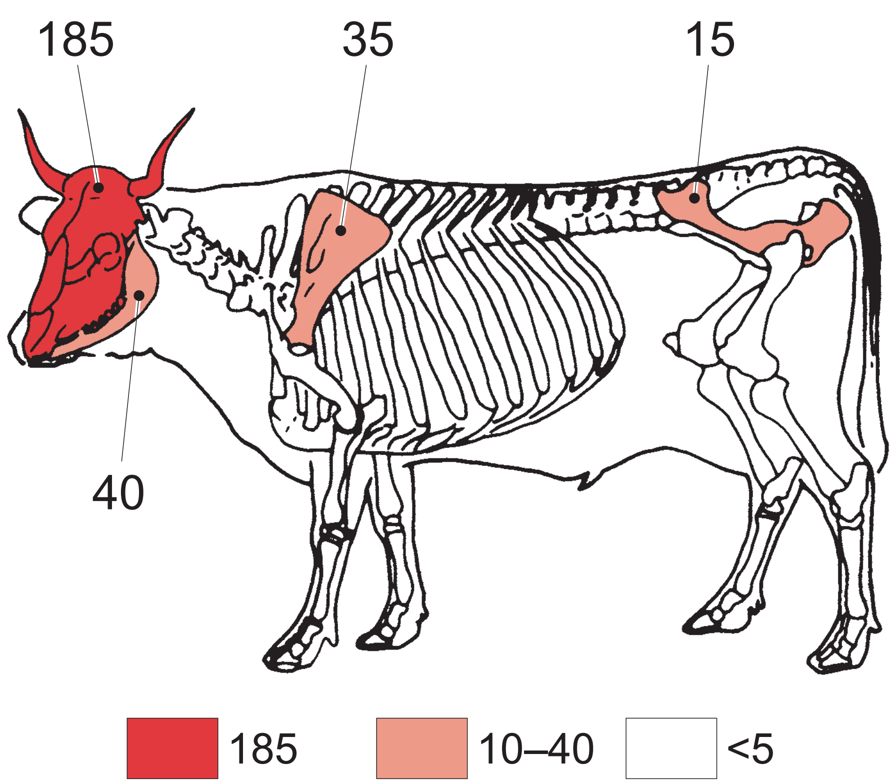


Figure SS4.23. Barrow 1. Sketch to show which body parts are represented (shown in red and pink). The numbers represent the approximate number of cattle that must have been slaughtered to contribute each part of the skeleton.

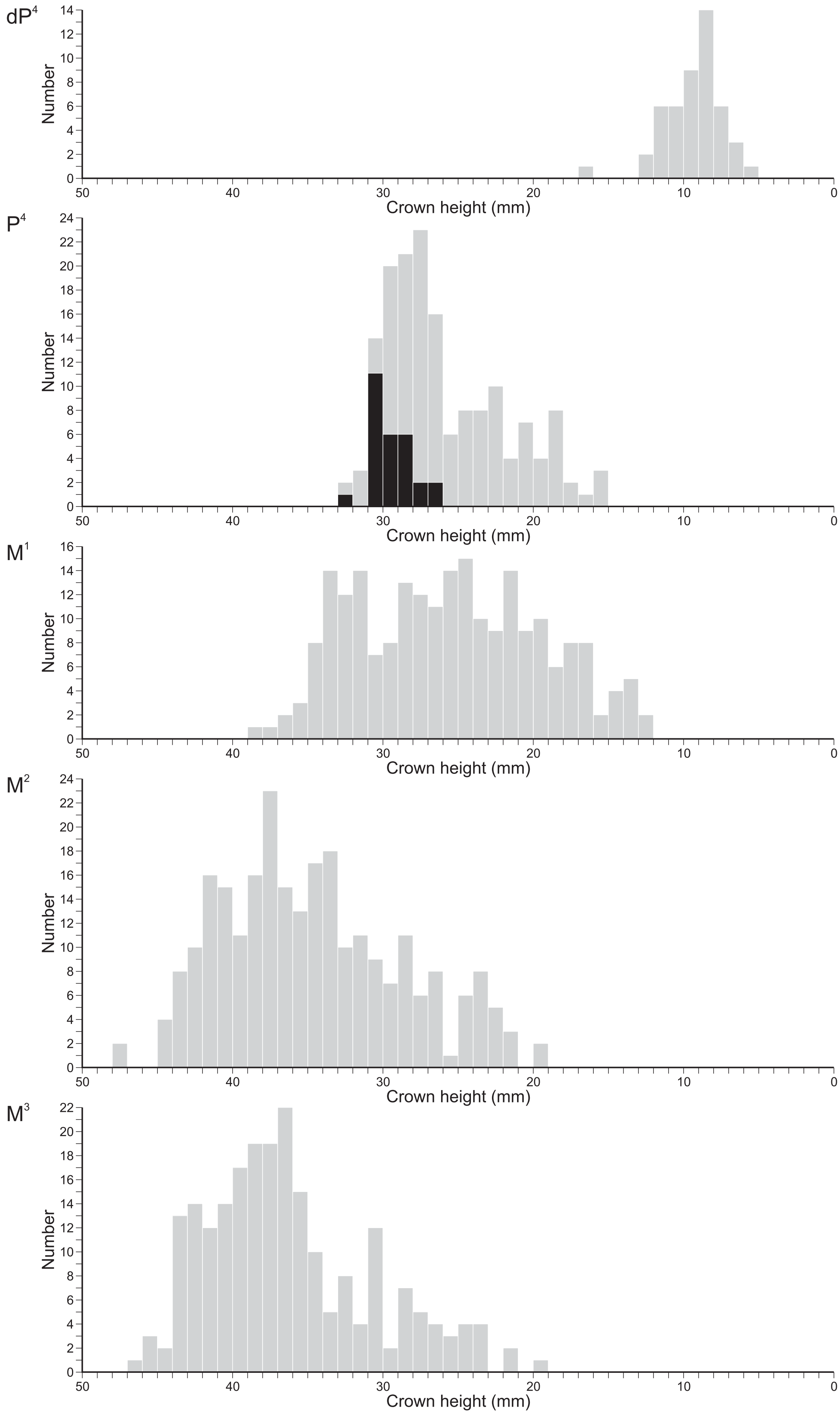


Figure SS4.24. Barrow 1. Distributions of crown heights of cattle upper teeth and crown height variation (measurements of both left and right sides are given). These show that the majority of the cattle were young adults, fewer older animals are represented and none can be described as 'senile'. Crown heights of 28 cattle P⁴s in wear stages 0 and 1B (ie with no wear on the external cusp) are depicted in black to show the amount of variation in crown height not due to attrition.

Discussion

An archaeological site containing skulls of some 185 cattle, and mandibles, scapulae and pelvic girdles from some 15–40 cattle and few other parts of the skeleton is a rare if not unique occurrence. It poses a number of questions. What was the sequence of events which led to the deposit of this unusual assemblage? Are there other known examples in ancient Britain? Did cattle and cattle skulls have some religious significance? Can parallels be found today? Answers to some of these questions call for some speculation.

What do the bones represent? In general animal bones found on an archaeological site and presumed to be butchery or kitchen waste are derived from most parts of the skeleton – including the limb bones, ribs and girdle elements. Skull fragments are represented but are no commoner than other parts of the skeleton. An interesting ceremonial use of cattle is the so-called 'hide and hooves' burials, reported at several Neolithic and Beaker barrows such as Tilshead Lodge, Fussell's Lodge and Hemp Knoll, where the dead person and the feet and sometimes the head of a cow were found associated (Grigson 1984). Barrow 1, however, is quite different. With the kind of frequencies of bones, and their provenance over the cairn, there can be little doubt that they were put there as part of a ritual associated with the dead man. It is possible that the cattle skulls represent tribute brought by members of the dead man's tribe (and perhaps even by members of neighbouring tribes) on the occasion of his death. Can we interpret the assemblage any further than this?

Most of the cattle were prime adults when slaughtered, few (perhaps only one) calves and no very old individuals are represented. They were not retired dairy cows or stud bulls. Did the skulls derive from animals slaughtered primarily for meat – the prime beef cattle? Were they slaughtered in the usual

Figure SS4.25. Barrow 1. Cattle scapula SLC (smallest length of the collum). Scapulae from sexed Danish aurochsen are shown in the lower graph (data from Degerbøl and Fredskild 1970). Barrow 1 cattle scapulae (both left and right sides) are shown in black and above are cattle scapulae from the General Accident site, 24–36 Tanner Row, York (c AD 170–250; unpublished data kindly supplied by T O'Connor) and Greyhound Yard, Dorchester (Romano-British; unpublished data kindly supplied by M Maltby).

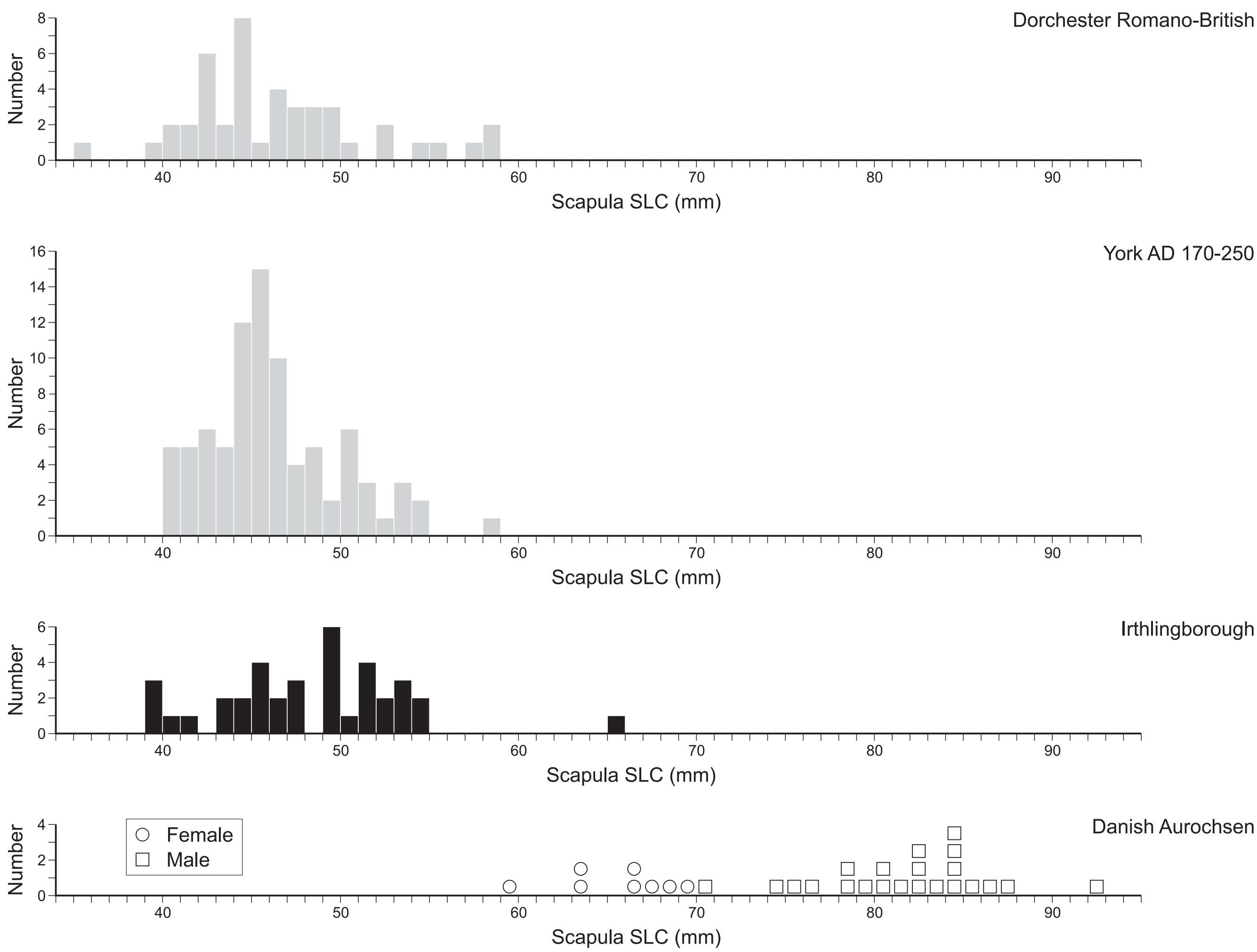


Table SS4.33. Barrow 1. Cattle mandibles and mandibular teeth – wear stages (following Grant 1982), crown heights (measured from crown/root junction to the occlusal surface up the external side of the central pillar; see Fig SS4.18) and third molar dimensions (external-internal width of the base of the crown and antero-posterior crown length)

U = unerupted tooth

Teeth whose exact location within the tooth row is uncertain are noted with a '?' in the comments column.

Measurements are in millimetres and approximate values are in parentheses

					Grant wear stage					M_3		
AOR	*Box*	*L/R*	dP_4	P_4	M_1	$M_{1/2}$	M_2	M_3	*Crown height*	*Width*	*Length*	*Comments*
Phase 2.2 (cairn) and related contexts												
34142	1	L						h	34.9	16.5	38.3	
34673	1	L			k		g	g		14.2	37.0	
34610	2	L		f	k		k	g	34.7	16.3	36.6	
34163	4	L						?a			38.9	
34143	4	L		f	k		j	g	42.0	17.2	37.0	
34320	5	L		f	k		g	g	39.7	16.4	39.7	
34321	5	L					k	k	29.9	17.4	37.8	
34310	5	L					k	g	37.1	15.9	36.5	
34177	5	L						g			(38)	
34218	7	L		?e	k		j	g	47.9	18.2	(41)	
34212	7	L			j		f	d	48.9	16.6	39.7	
34213	7	L						g	33.9	16.1	38.3	
34208	7	L		a	h		g					
34234	7	L			?k		g	?b	-	-	-	
34235	7	L		U	l		k	k	33.5	17.6	40.3	
30209	8	L				f						Tooth in $M_{1/2}$
30382	8	L			j		g					
35061	16	L					f					?M_2
35058	16	L	k		g		e	a	-	-	-	
34690	20	L						j	32.2	17.0	41.2	
34690	20	L				k						
34242	20	L			f		a					
34687	20	L			f		a					
34494	21	L		f	l		k	j	29.7	17.8	38.6	
34522	22	L				?d-e						
34748	22	L		h	m		l	k	18.1	16.9	37.4	
34487	22	L		f	k		k	j	30.6	(17.6)	38.6	
34762	24	L				U						
34458	26	L						j	23.7	16.6	37.7	
34116	26	L						g	44.7	16.0	37.5	
34104	26	L			f		b	a				
34216	27	L					k	j	31.4	15.7	36.1	
context 30417	27	L	?j		g		b					
34793	27	L				f/g						
34649	29	L						?d-g	45.7	15.4	35.3	
34592	30	L			g		f	b	51.1	17.5	38.1	
34772	33	L		f	k		k	j	31.1	18.8	39.5	
34695	34	L		?								
34677	34	L		?d	k		g	f	45.3	16.0	38.5	
34699	35	L			m		l	?g	21.9	16.4	36.4	
34961	35	L			k		f	a				
34595	1	R						b				?

Table SS4.33. Continued.

			Grant wear stage							*M_3*		
AOR	*Box*	*L/R*	*dP_4*	*P_4*	*M_1*	*$M_{1/2}$*	*M_2*	*M_3*	*Crown height*	*Width*	*Length*	*Comments*
34595	1	R					e					
34604	1	R		e	k		g	g		15.9	38.4	
34654	1	R			l		k	k	(17.0)	17.1	39.4	
34596	1	R		a								
34648	1	R			l		k					
34648	1	R						h	28.8	16.6	(38)	
34927	2	R						k	24.1	16.0	37.1	
34395	2	R			f/g		b					?Belong to same mandible
34563	3	R			g		b					
34953	3	R						j	(36.7)	17.1	37.4	
34264	4	R		h	l		k	j	35.2	17.2	39.7	
34303	4	R			k		j	g	44.5	16.4	39.7	
34293	4	R			g		g	f	45.6	16.1	37.5	
34145	4	R			j		f	b	55.3	18.7	42.8	
34129	4	R					j	j	(33)	-	(39.7)	
34129	4	R					g	f/g	(45.2)	-	-	
34318	5	R			l		k	g	38.2	-	(42.3)	
34329	5	R		e	k		j	g	-	-	40.2	M_3 in ramus
34330	5	R					j	?j			(39.5)	
30094	8	R						g	36.0	16.6	37.5	
34929	9	R				l						
34472	10	R					g	b	44.6	-	36.5	
35081	11	R					b	U				
34697	11	R				c						
35017	12	R		a	k		g	d	46.0	17.2	38.1	
34285	13	R		h	l		k	k	-	17.1	38.6	
34279	13	R		f	k		g	g	36.1	15.6	34.6	
34271	13	R				l						
34841	14	R		g	l		k	k	26.4	15.7	35.7	
34390	15	R			k		k					
34398	15	R		a	j		f/g					
34745	16	R		e								
34653	16	R			l		f	g	39.0	16.8	39.0	
35040	16	R		e	k		j	g	-	16.7	39.6	
34943	17	R				a						
34943	17	R			k		j	g	41.3	16.7	38.5	
34999	18	R						b	52.3	16.7	40.8	
35014	19	R	?k									
34845	20	R		c	k		j	f	40.6	16.3	36.0	
34507	21	R	j		g		d					
35002	22	R	l		g		f	b	-	16.0	36.8	
34711	22	R		a	k		g	g	42.7	15.9	-	Reduced third pillar
34458	26	R				a						
34103	26	R			g		a					
34190	29	R	j		g		b					M_1 and M_2 may not fit together
34249	31	R					?					
34726	34	R			j		g	d	45.7	15.6	36.3	
34695	34	R						?				Broken
34230	34	R	?j		g		a					
34715	34	R			j		e	b	47.3	15.0	35.2	

Table SS4.33. Continued.

			Grant wear stage						M_3			
AOR	*Box*	*L/R*	dP_4	P_4	M_1	$M_{1/2}$	M_2	M_3	*Crown height*	*Width*	*Length*	*Comments*
34981	36	R				g						
35107	36	R		?j	l		k	k	22.0	16.9	37.6	
Phase 3.2 (1st mound)												
context 30414	18	L				k						probably M_1
context 30414	18	R		g								?P_4
context 30414	18	R					j	g	38.8	15.6	36.6	
context 30414	18	R						U				
context 30415	18	R				?e						
Phase 9 (disturbed and eroded mound)												
14262	37	L				k						
15538	8	L						?e	(46.9)	16.4	36.1	
15537	8	L					?					
18337	8	R					f					

course of events, their skulls being set aside prior to the death of the buried man, or were they especially slaughtered for this occasion?

The suggestion that skulls were brought to the funeral as tokens may be over-simplified. The presence of a significant number of limb-girdles (scapulae and pelves) but no limb bones is most puzzling. Even more strange is the similarity between the numbers of mandibles and scapulae. One explanation might be that the assemblage includes the remains of tributes from peoples who had slightly different customs. For example most of those attending the ceremony might have done so with skulls only, but some 35 or so might have brought girdle bones too. Another possibility is that 150 (ie 185–35) skulls were token tributes from people living far away, and that 35 skulls plus girdles derive from 35 animals slaughtered and consumed at Irthlingborough during construction of the cairn and/or at the funeral of the dead man – but what became of the rest of the skeletons and why put only the girdle bones on the cairn?

What of the original state of the skulls? Do the unequal numbers of teeth (there are far fewer premolars and only one incisor was found) reveal anything about the state of the skulls when laid upon the cairn? Loss during excavation could have contributed to this disparity. However it is so great that other factors were probably responsible and may be relevant to the question of how the assemblage was formed in antiquity. Following death and as putrefaction sets in, bovid incisors and premolars with their tapering roots tend to fall out easily compared to the molars which remain 'locked' in their sockets. Could this loss of incisors and premolars have occurred during a delay between slaughter and final incorporation of the skulls/mandibles into the barrow? Such a delay might have had to be of the order of a month or more to allow time for the flesh to rot and teeth to drop. A mechanical factor might also have helped. A long journey may have provided the time for these skulls to rot and jolting may have promoted loss of teeth. In sum then, I speculate that many or all of the cattle skulls were placed on the cairn a) as skulls without flesh and b) some time after slaughter (perhaps, in some cases from far away) to allow time for incisors and premolars to fall. The possibility that defleshed and dry skulls were placed over the cairn may be of some significance as I shall discuss later.

The cut marks were presumably made while flesh was removed from the bone and imply that beef was consumed before cattle skulls were placed on the cairn. In other words we are not dealing with the sacrifice of joints of meat 'on the bone' as was often practised in the classical world to provide the soul with nourishment on its journey into the next world or as a gift to the gods. I suggest that the skulls and limb girdles were devoid of flesh when laid upon the cairn.

The resulting quantity of beef conjures up images of orgiastic feasting on the banks of the Nene. 185 cattle could have provided at least 40,000 kg (= approximately 40 tons) of meat, which on a ration of 1 kg per person per day equals 40,000 man days. Put another way, 500 people could have been sustained for 2.5 months. Darvill (1987, 94) quotes some estimates of the labour requirements

Table SS4.34. Barrow 1. Measurements, in millimetres, of cattle scapulae

L/R = left/right, F/U = fused or unfused coracoid. Approximate values are in parentheses

AOR	*Box*	*L/R*	*F/U*	*SLC*	*GLP*	*LG*	*BG*	*Comment*
34617	1	L	F	51.2	-	-	-	
34795	2	L	?	-	-	(54.5)	-	
34479	3	L	?	43.2	-	-	-	
34289	4	L	?	40.9	-	-	-	
34298	4	L	F	(54)	-	-	-	
34376	4	L	?	47.1	-	-	-	
34333	5	L	?	(44)	-	-	-	
34158	5	L	F	-	-	64.1	-	
34750	6	L	?	45.5	-	-	-	
35074	11	L	F	39.4	-	-	-	
34679	11	L	?	46.2	-	-	-	
34931	17	L	F	49.5	(62.6)	55.0	-	
34975	18	L	?	43.3	-	-	-	
34874	24	L	F	44.9	(62.3)	50.3	42.5	
34465	26	L	?	41.5	-	-	-	
34421	28	L	F	-	-	57.9	-	
34585	29	L	F	(49.4)	-	-	-	
34258	31	L	F		-	68.8	-	?aurochs
34760	32	L	F	39.3	-	52.0	-	
34538	34	L	F	51.0	-	55.6	-	
34193	34	L	F	47.5	-	-	-	
34721	34	L	?	45.2	-	-	-	
34784	34	L	F	54.5	-	(56.2)	-	
35088	36	L	F	49.0	67.4	53.4	-	
34425	36	L	F	52.4	-	60.6	-	
34631	1	R	F	45.0	58.9	51.5	41.8	
34792	2	R	F	46.6	67.2	53.5	44.7	
34414	2	R	F	51.6	-	-	-	
34412	2	R	F	(52.3)	64.5	50.9	-	
34544	3	R	F	53.4	-	-	-	
34557	3	R	F	39.5	-	-	-	
34215	7	R	F	(51.7)	-	-	-	
34997	14	R	F	45.1	(64.7)	52.9	43.4	
34956	17	R	F	-	-	61.8	56.3	
34977	17	R	F	65.9	83.2	67.6	-	?aurochs
34528	22	R	F	(53.0)	66.3	50.6	-	
34947	23	R	F	50.4	-	-	-	
34774	24	R	F	49.9	-	61.8	-	
34355	26	R	F	(49.2)	-	-	-	
34428	29	R	F	53.8	-	-	-	
34363	31	R	F	47.9	-	-	-	
34709	35	R	F	(49.5)	-	50.8	-	

for several well known English prehistoric earthworks. For example the Devil's Quoits henge in Oxfordshire is over 110 metres in diameter and may have required over 1,000 man days to construct. Durrington Walls in Wiltshire covers 30 acres and may have required some 37,000 man days. These two sites are certainly much larger than the modest first mound of Barrow 1, which incorporated the bone cairn, suggesting that 185 cattle were more than would have been required during its construction, which may have taken as little as nine or ten man days (SS1.12). Was the beef cut up in Irthlingborough and distributed to the thousands who attended the funeral? Did some of the beef

Table SS4.35. Barrow 1. Radiocarbon measurements relating to the primary burial and bone cairn

Laboratory number	*Sample reference*	*Description*	*δ¹³C (‰)*	*Radiocarbon age (BP)*	*Calibrated date range (95% confidence)*
UB-3148	291-6410	Human bone from adult male from primary Beaker burial in grave F30426	-21.0±0.2	3681±47	2200–1920 cal BC
OxA-7902	291-11439	*Quercus* sp sapwood chamber or coffin enclosing primary Beaker burial in grave F30426	-25.1	3775±45	2400–2030 cal BC
OxA-4067	291-35126	Boar's tusk, one of grave goods accompanying primary Beaker burial in grave F30426	-22.4	4100±80	2890–2460 cal BC
OxA-2085	291-34873R	R aurochs M^2 from bone cairn, forming part of same find as sample for OxA-2086, with other teeth and a horncore all from domestic cattle	-21.0 assumed	4040±80	2880–2340 cal BC
OxA-2086	291-34873L	L aurochs M^2 from bone cairn, forming part of same find as sample for OxA-2087, with other teeth and a horncore all from domestic cattle	-21.0 assumed	3810±80	2470–1980 cal BC
OxA-2084	291-34628R	R cattle M^2 from badly preserved skull in bone cairn	-21	3610±110	2290–1680 cal BC
OxA-2087	291-35082R	R cattle M^2 from badly preserved skull in bone cairn	-21.0 assumed	3810±80	2470–1980 cal BC

supply a small work party during construction of the cairn and the first mound over a period of days? Or were many of the cattle slaughtered in different places and only the skulls brought as tribute? Some kind of large-scale feasting at the barrow does seem to be a strong possibility.

For how long could the defleshed skulls have lain exposed to weathering in antiquity before becoming covered? While the bone is poorly preserved, most of the teeth are in good condition and show little sign of the kinds of shattering damage that can result from exposure to frost and temperature change for a few years. The enamel is generally complete. Instances in which a tooth is poorly preserved are the result of dentine loss, probably through leaching within the soil. In many of these cases enamel probably collapsed during and after excavation. Thus it would seem that both dentine and bone from the skulls have been leached in the same manner within the soil (ie following their burial). According to Balaam (*pers comm*) Barrow 1 was probably waterlogged intermittently and for much of its existence by rising and falling of the water table in the Nene valley. Animal bone from other Neolithic and Bronze Age monument in the area is even worse-preserved, suggesting that the limestone cairn and the exceptional quantity of bone may have created an exceptionally calcareous micro-environment. The unweathered nature of the teeth (many are in pristine condition) suggests that in antiquity these skulls were not exposed to the elements for more than a few years at most. They were presumably covered with earth fairly rapidly. If this hypothesis is correct then the accumulation of skulls may have been formed within a year or two rather than several decades or centuries. The funeral of the important person and laying of skulls over his cairn may well have been a ceremony of relatively short duration, consistent with the similarity of dates for the skeleton and chamber and three of the teeth form the overlying deposit (Table SS4.35, Fig SS6.11).

The ^{14}C dates indicate that one aurochs tooth was derived from an individual which was probably a contemporary of the other cattle and may, therefore, have been hunted by the people who attended the funeral. The presence of an aurochs may be of some significance. Perhaps this animal, the largest terrestrial quadruped known to ancient Britons, signified great strength and hence the great power of the buried person.

Jones' observation that the occlusal surfaces of the cattle maxillary teeth faced downwards indicates that the skulls had been placed the right-way-up and on the ground in antiquity (rather than, say, on the ends of poles). Since the area of the cairn was 9 sq m, and given the size of a cattle skull (*c* 0.30 x 0.50m), these 185 skulls must originally have been stacked on top of one another in three or four tiers.

Have assemblages like the one here at Irthlingborough been reported elsewhere in Britain? It is unfortunate that many prehistoric barrows were 'opened' in the 18th and 19th centuries when little or no attention was paid to animal bones and teeth. We shall probably never know how common the practise of cattle skull tribute was in ancient Britain. There is only one similar occurrence of this kind referred to in the literature[7] and it comes from Harrow Hill, an Iron Age hillfort in west Sussex excavated in 1936 by

Holleyman. On page 250 of his report Holleyman (1937) wrote

'Although there was a paucity of occupation material, animal bone was abundant and, with few exceptions, represented only the heads of what Dr Wilfrid Jackson has identified as a species of early Iron Age ox. Hardly a limb-bone was found, yet the skulls, represented principally by mandibles and teeth, must number between fifty and one hundred from our small cuttings alone. This would mean, at a very conservative estimate, that the whole earthwork must contain remains of well over a thousand heads. Dr. Jackson knows of no analogous example, and at present we can do no more than record the strange fact.'

Here in Sussex is another example of a cattle head/skull accumulation perhaps similar to Barrow 1. (The fact that Holleyman only dug several test pits lends some doubt as to the precise cultural assignation of the cattle skulls at Harrow Hill.) Jackson never published a report on these 'ox skulls' (Holleyman *pers comm.*). Further hints that cattle skulls may have had some significance in ancient English mortuary practices comes from Bateman's (1861, 128–30) account of barrows 'opened by Mr. Carrington in 1849'. Bateman reported the careful interment of part of the head of an ox, an occurrence which he had discovered on several earlier occasions. He also mentions the presence of the upper jaw of an ox which was ' … the fifth instance, of the intentional burial of the whole or part of the head of the ox', and which according to Bateman 'goes far to prove the existence of some peculiar superstition or rite, of which no notice has reached modern times.' 'Hide and hooves' burials cited above (Grigson 1984) are further evidence for special treatment of the skull. These finds suggest then that cattle heads/skulls were especially revered in ancient Britain.

If indeed the suggestion that skulls rather than heads with their flesh intact were placed over the cairn is correct, then Barrow 1 differs from Hellenistic sacrificial deposits such as the one at Halikarnassos in south-western Turkey (Hojlund 1981). Here whole joints of meat and/or quarters of animals (several species) were sacrificed. My own understanding of the classical sources does not provide any examples of a parallel between Barrow 1 on the one hand and the classical world on the other. Barrow 1 cannot have been a Hekatomb in which joints (ie meat) from large numbers of animals were placed over the grave of the dead person. The ancient Greek emphasis was upon the flesh and blood of the animals being sacrificed and I could find no described instance in which only skulls of a single species were placed over a tomb.

What of other cultures? The ancient Sanskrit texts indicate that in Indo-Iranian times cattle sacrifice was fairly common, but Zarathustra's condemnation of it and the development of the doctrine of 'ahimsa' in India led to a decline of this practice (Lincoln 1981). The Biblical 'Golden Calf' (Exodus 32) may also reflect an earlier reverence paid to cattle in the Near East. One may wonder, too, whether the public slaughter of bulls in modern Spain has something to do with prehistoric practices in Britain.

Whereas a search of the archaeological and classical literature did not reveal much that could shed light upon the meaning of Barrow 1, modern ethnographic accounts of death and mortuary rites provide a little that is of possible relevance and might help us to understand the Barrow 1 assemblage. Where are large numbers of a single species of animal sacrificed at a funeral or second burial? Where are skulls deposited over a grave? What is the meaning of animal bones associated with a tomb? Some useful clues are to be found in the works of Hertz (1907), Bloch (1971), Huntington and Metcalf (1979) and Mack (1986).

People who perform elaborate funeral rites involving large numbers of cattle are to be found in Madagascar[8]. Among many Malagash peoples great reverence is paid to their ancestors – dead and living form a single society in constant contact. The body of the deceased is first placed in a temporary burial place. A period of waiting ensues before a second burial can take place. An important distinction is made between, on the one hand, a putrefying corpse in which the bones are still 'wet' and, on the other hand, the end product of putrefaction, ie the dry bones. This period may vary from several months to as much as ten years – on average two years. During reburial, known as 'Famadihana', bones of the deceased are examined and re-wrapped in a special shroud. This is accompanied by a feast. Reburial cannot take place until the corpse has completely decomposed and only the dry bones remain. An evil power, linked with the smells of putrefaction, is thought to reside in the corpse. Hence as desiccation of the bones progresses, so the deceased is freed from this evil. Its soul is then deemed worthy of admittance to the company of its ancestors. But in the intermediate period it wanders incessantly waiting for the feast which will put an end to its restlessness (Hertz 1907).

While not necessarily the main source of sustenance, cattle reflect status and wealth. Cattle play an important role in the burial and reburial of the dead (see for example Mack 1986). A second burial may last several days or even a whole month and may be accompanied by elaborate preparations and very great expense, often reducing the family of the deceased to poverty. Many cattle are sacrificed and eaten in banquets that often develop into huge orgies. In parts of southern Madagascar (for example among the Antandroy) Famadihana is not practised: the dried human bones cannot be seen. Instead cattle skulls – symbolising the desiccation of the human skeleton – are placed over the tomb or on some high place nearby such as up a tree or on a cenotaph. These are the skulls of cattle sacrificed during the funeral and of course their numbers reflect the status of the deceased. The skull serves as an emblem of the virility and power whose increase is implied in the act of sacrifice. For these reasons skulls are often displayed at funerals (Mack *pers comm*).

While drawing parallels between the culture of modern Madagascar and Bronze Age England is extremely speculative, there may be a lesson in the contrast between the composition of the Barrow 1 faunal assemblage and the usual English Bronze Age faunal assemblages with their predominance of sheep and pigs as well as cattle. Perhaps, as they are today in Madagascar, cattle in Bronze Age England were valued as status symbols and were kept mainly to serve in funerary rites. The great accumulation of cattle skulls and the aurochs above the cairn of the dead man at Barrow 1 may be a reflection of the power he was able to wield during his life.

Conclusions and summary

The faunal remains at Irthlingborough Barrow 1 derive from approximately 185 domestic cattle skulls and one aurochs skull. Cattle mandibles derive from *c* 40 individuals and scapulae and pelves derive from *c* 35 and 15 individuals respectively. Scapulae from a single aurochs may also be present. Bones belonging to other parts of the cattle skeleton and bones of other species are conspicuously rare. It is obvious that this faunal assemblage was deposited as part of a ritual associated with the man buried in the cairn.

The low variability of measurements of the lower third molar teeth suggests that the domestic cattle belonged to a single sex – perhaps male in view of the robustness of the few pubes that were found. Examination of tooth eruption and wear indicates that most of the cattle were young adults when slaughtered with few calves (probably only one) and few old animals. The relative paucity of premolars may reflect their loss before incorporation into the archaeological site. If

Endnotes

1 Starting at point ‘a’, the corner between the anterior and external sides of the tooth where the enamel of the crown meets the root (Fig SS4.17) a thread was wrapped around the base of the crown approximately perpendicular to the tooth’s root-occlusal axis (as indicated by the points arrowed in Fig SS4.17) and marked where it overlapped, allowing the circumference to be measured to the nearest millimetre.

2 Since most of the soil from the bone deposit was not sieved it is possible that some smaller bones and teeth were not recovered. A small sample from the grave infill (context 30467) was sieved; it included an unerupted cattle P^4 (not included in the tables and figure).

3 Estimates of the numbers of different parts of the anatomy, particularly the more fragile and smaller ones, may be somewhat biased due to a) the poor preservation of faunal remains and b) the fact that most of the residual soil was not sieved during excavation.

4 Computed from the total of 1100 upper molars (Table SS4.30) divided by 6.

5 Andrews’ data refer to modern breeds of cattle and may therefore not be entirely appropriate when comparing them with Bronze Age cattle but nonetheless are, in the light of Payne’s (1984) findings, preferred to the data for nineteenth century cattle published by Silver (1969).

6 Burke (1834:II, 441) recommends that when meant for stock, cows should be managed ‘as to calve down by the middle of the month of May at the farthest; as late calves will not be sufficiently grown to hardily stand the winter, and the earlier they are dropped in the spring the better will they be able to meet the inclemency of the season.’

7 I am grateful to Caroline Grigson for drawing my attention to this reference.

8 I have not found references to this kind of practice in other parts of the world, except passing mention of 200 buffaloes slaughtered in the case of a chief of the Batak of Pertibi (Von Rosenberg, 1878). This is in Indonesia, a region whence the Malagash originated.

this interpretation is correct, then skulls (rather than heads) were stacked on the cairn some time following removal of flesh (or simply following rotting). Skulls were found within a restricted area of 9 sq m and their maxillary teeth were facing downwards. Skulls must therefore have been stacked 'the right way up' in several tiers above the cairn. The good preservation of many of the teeth and absence of frost-induced shattering on the enamel suggests that the skulls were not exposed to weathering for very long. It is therefore possible that this accumulation of skulls was made during a relatively short period (perhaps less than one year?) while the cairn was being built and the man buried. Some of the skulls may have derived from cattle slaughtered in order to sustain the workers during construction of the barrow or to feed the people attending the funeral, while the majority of skulls were possibly brought to the funeral as tokens. This reconstruction of events (my own preferred one) is, however, one of several likely ones.

Only one other possibly similar instance of an accumulation of cattle skulls has been reported in England, although cattle skulls appear to have had an important ritual significance in ancient English mortuary practices. The closest analogy today is to be found in parts of southern Madagascar where cattle skulls are placed over or near the tomb and their desiccation symbolises that of the bones of the deceased person. Cattle in Madagascar as in many other societies are a symbol of wealth and the skull symbolises virility and power. The large number of cattle skulls at Barrow 1 probably reflects the great power which the buried man – perhaps chief of an important tribe – was able to wield in life, an interpretation certainly borne out by the quality of the grave goods.

SS4.6.2 A horse mandible from Barrow 3

Simon Davis
(Introductory paragraph updated by Frances Healy)

Barrow 3 was excavated in 1987 under the direction of Claire Halpin of the Central Excavation Unit (SS1.14). Its construction date is estimated at *2180–1930 cal BC at 95% probability* (SS6). The poorly preserved equid mandible reported here has Archaeological Object Record Numbers 37455 and 37387 and was stratified in context 30790, a layer of iron-panned sandy loam which formed part of the original mound. Although 30790 would have been built into the barrow in the early Bronze Age, it was very mixed and disturbed by burrows, so that the mandible may post-date the mound. On the other hand, only two crumbs/3g of Iron Age or Roman pottery were present (identified by Ed Mc Sloy), in contrast to the abundant collection from later levels, from which the crumbs could well have been intrusive. The mandible was submitted for radiocarbon dating but contained too little collagen. Horse remains from Bronze Age England are rare. This report was written in 1990 in advance of the intended destruction of the mandible for radiocarbon analysis and provides a description with illustrations and measurements of the teeth.

Methods

Equid teeth are usually identified by the patterns which the enamel folds form on the occlusal surface of the worn cheek teeth. The reader is referred to figures 24 and 25 in Davis (1987b) for the terms used here and for how the measurements were taken. Figure SS4.26 was drawn by laying each tooth, occlusal surface face down, on a magnifying xerox machine, and tracing off from the resulting prints. Measurements (Table SS4.36) are in millimetres.

Description (Figure SS4.26)

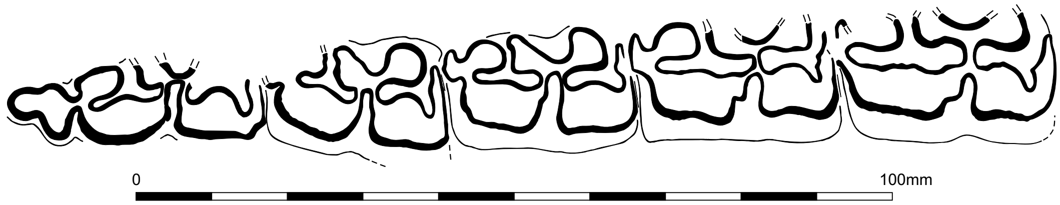
The find comprises three incisors with badly abraded occlusal surfaces, and part of a badly fragmented right mandibular ramus, five cheek teeth: third and fourth premolars (P_3 and P_4), and all three molars (M_1–M_3). All the cheek teeth except M_1 are damaged on their internal corners. They all fit together and there can be no doubt that they derive from the same mandible. P_2 is missing.

Table SS4.36. Barrow 3. Measurements of the horse cheek teeth from Barrow 3 taken as shown in Davis (1987), in millimetres

ACH is the approximate crown height measured up the external side from root 'saddle' to occlusal surface, as shown in Levine (1982). Measurements in parentheses are approximate values

Tooth	L_1	L_2	L_3	W_a	W_b	W_c	W_d	*ACH*
P_3	29.4	15.8	15.8	(15.8)	(16.4)		6.5	38
P_4	27.2	14.5	13.6	(16.0)	(16.3)	14.1	5.5	47
M_1	25.0	13.2	9.4	14.2	13.3	12.0	2.2	40
M_2	24.5	12.1	8.7	14.0	12.7		2.4	44
M_3	34.0	(12.8)	10.7	(12.8)	(11.4)	10.4	1.5	42

Figure SS4.26. Barrow 3. Horse cheek teeth P_3–M_3 in occlusal view to show the enamel folds. The scale is 100mm.



The internal (lingual) folds, especially of P_3 and P_4, are 'U'-shaped. This is characteristic of the caballine equids (horses). The external (buccal) folds exhibit partial penetration between ento- and metaflexids in M_1 and M_2, but no penetration in the premolars – a situation which is also characteristic of horses. In the M_3, a tooth which often displays greater variability than the other molars, it is interesting to note the complete penetration of the external fold which almost touches the internal one.

Measurements given in Table SS4.36 indicate a small horse, slightly larger than the Iron Age one described from Hook in Hampshire (Davis 1987b). Due to severe abrasion of the occlusal surfaces of the incisors, it is impossible to determine whether infundibula were still present. The crown heights of the cheek teeth (Table SS4.36) are equivalent to those of modern New Forest ponies aged between 9 and 11 years (data from Levine 1982).

A wild horse was present in England in early postglacial times, but was absent from Ireland (Grigson 1981), so the presence of horse in Beaker sites in Ireland (Wijngaarden- Bakker 1974), *c* 2600–1800 cal BC (Kinnes *et al* 1991) no doubt reflects its domestic status at that time in the British Isles. Wijngaarden-Bakker suggests that the domestic horse was a Beaker introduction into western Europe. Whether the Barrow 3 equid belonged to a wild or domestic individual cannot be determined.

SS4.6.3 Animal bone from the Long Barrow

Simon Davis

A small assemblage of animal bone was recovered from a total of 19 different contexts (Table SS4.37). Fragments of *Bos* (cattle/aurochs) and *Cervus elaphus* (red deer) were recovered from pre-barrow contexts. The majority of the bone derived from the ditch fills and included *Bos*, *Cervus elaphus*, *Sus* (pig/boar) and equid (horse). Two fragments of *Bos* were recovered from the mound material. A humerus identified as ?*Cervus elaphus* from the central pit (239) has been dated to the first millennium cal BC, probably corresponding to disturbance noted during excavation (910–760 cal BC; 2655±55 BP; OxA-5551).

SS4.6.4 A note on the animal bones from the Riverside structure and small assemblages from the Long Mound, the Southern Enclosure and Barrow 3

Polydora Baker, June 2001

Animal bone assemblages were recovered from various prehistoric contexts. The more important of these was a large deposit of cattle bones, which were used in the construction of a cairn over the primary Beaker burial in Barrow 1 (Davis SS4.6.1; Davis 1989; Davis and Payne 1993). This report focuses on the much smaller assemblage from the Riverside Structure. Additional small assemblages from the Long Mound, the Southern Enclosure and Barrow 3 include few identifiable bones and are summarised briefly below. The objectives of the analysis were to discuss aspects which might provide information on the formation and use of the Riverside Structure, and to provide a bone archive. The total results are documented in Table SS4.44.

The Riverside structure or platform consisted of deposits of brushwood and alder trunks, located at the edge of a major palaeochannel of the Nene. The structure dates from the early to mid third millennium cal BC (SS6). Animal bones were found in an alder rootball (context 7380) underlying the structure, in a silt layer (context 7379) also underlying the structure, in the lower (context 7377) of two brushwood layers forming part of the structure and in the upper part of the second brushwood layer (context 7367) which overlay the main timbers. This layer was sealed by a clay layer placed in the early to mid second millennium by an OSL date of 2100–1260 BC (1680±210 BC; Rees-Jones 1995, 82–85). The clay contained plant and insect remains

Table SS4.37. Long Barrow. Identifiable animal bone by phase and context

Measurements in tenths of a millimetre.

Cervus elaphus = red deer, *Bos* = cattle/aurochs, *Sus* = pig/boar. U = epiphysis unfused, UM = unfused metaphysis, F = epiphysis fused.

Context	*Ditch*	*Phase*	*Bone*	*Fusion*	*Identification*	*GL*	*Bd*	*BT*	*HTC*	*SLC*	*Bp medio-Lat width*	*Antero-Post depth*	*Other measurements*	*Comments*
152		0	Metatarsal shaft		?*Cervus elaphus*									
237		0	Ilium		?*Bos*									
237		0	Radius prox		*Bos*								Bp=*c* 1050–1100	Very large
245		0	Humerus frag		?*Bos*									
239		1 (disturbed)	Humerus		?*Cervus elaphus*									2655±55 BP (OxA-5551)
266	F302	2.2.i	Ischium		*Sus*									
287	F302	2.2.i	Antler		*Cervus elaphus*									Shed, cut marks
205	F303	2.2.i	Horncore		*Bos*						446	620		
205	F303	2.2.i	Horncore		*Bos*									
226	F303	2.2.i	Scapula	?	?*Bos*									
226	F303	2.2.i	Scapula	F	*Bos*					520				
226	F303	2.2.i	Rib head		?*Bos*									
227	F303	2.2.i	Horncore		*Bos*									Fragmentary
227	F303	2.2.i	Horncore		*Bos*						564	705		
227	F303	2.2.i	Tibia	UM	*Sus*									
187	F302	2.2.ii	Metatarsal	F	*Cervus elaphus*									
190	F302	2.2.ii	Lower molar		*Bos*									
190	F302	2.2.ii	$M^{1/2}$ (tooth)		*Bos*									No wear, in fragments
234	F302	2.2.ii	Astragalus		*Bos*	728	452							
234	F302	2.2.ii	Calcaneum	?	*Bos*									
129	F303	2.2.ii	Upper molar		*Bos*									
129	F303	2.2.ii	$M^{1/2}$ (tooth)		*Bos*									
129	F303	2.2.ii	M^3 (tooth)		*Bos*	378	Wa=161							
129	F303	2.2.ii	Metacarpal	F	*Bos*		727							In very bad condition
129	F303	2.2.ii	Femur distal fragment		?*Bos*									
129	F303	2.2.ii	Naviculo-cuboid		*Bos*									Very large
129	F303	2.2.ii	Humerus	F	*Cervus elaphus*				302					
129	F303	2.2.ii	Humerus	F	*Cervus elaphus*			536	311					
183	F303	2.2.ii	P^2 (tooth)		*Equid*	L1=324	L2=128	L3=160	Wa=107	Wb=136	Wc=136 Wd=68			
185	F303	2.2.ii	Scapula	?	*Bos*									
204	F303	2.2.ii	Scapula	F	*Bos*									
225	F303	2.2.ii	Petrosal		?*Bos*									
225	F303	2.2.ii	Calcaneum	U	*Bos*									
138	F302	2.3	Phalanx 1	F	*Bos*									
146		2.3	Molar		*Bos*									Badly abraded

Table SS4.38. Riverside Structure, Long Mound, Avenue, Southern Enclosure and Barrow 3. Taxonomic distribution by landscape unit (identified and unidentified bone counts)

All remains are hand-collected except for the Avenue and Southern Enclosure assemblages which are from samples (>2mm and >4mm fractions).
Faunal remains from the Long Mound, Avenue, Southern Enclosure and Barrow 3 are listed by context in Table SS.44.
Bos taurus – domestic cattle, *Bos primigenius* – aurochs, *Cervus elaphus* – red deer, *Ovis aries/Capra hircus* – sheep/goat, *Sus scrofa* – pig, *Aythia* sp – Pochard species

Landscape Unit			*Riverside Structure*				*Long Mound*	*Avenue*	*Southern Enclosure*	*Barrow 3*
Context	*7367*	*7368*	*7377*	*7379*	*7380*	*Totals*				
Identified										
Equus sp	1					1				1
Bos taurus	53.5	5	1			59.5			1	
cf *Bos taurus*	1	1				2	1			
cf *Bos primigenius*				1						
Bos taurus/Cervus elaphus	1	2				3				
cf *Cervus elaphus*		1			2	3				
Ovis aries/Capra hircus		1				1	2		1	
Sus scrofa	2					2				
Aythya sp	2					2				
Total identified	60.5	10	1	1	2	74.5	3	0	2	1
Unidentified										
Large mammal	6					6	7		5	
Large/medium mammal	27		1	1		29	18	15		
Medium mammal	1					1			1	
Mammal								2		7
Bird — medium size							1			
Small mammal								1		
Indeterminate		8				8	79	23		
Total unidentified	34	8	1	1	0	44	105	41	6	7
TOTALS	94.5	18	2	2	2	118.5	108	41	8	8

reflecting slow-flowing water and a landscape consisting mainly of grazed grassland with some disturbed ground (Robinson SS4.4), which is compatible with what is known of the Bronze Age ecology of the area. There was a smaller quantity of bone in a pit (F7202) cut into the upper slope of the river edge. It has been suggested that the platform and animal bones may have had a ritual function, given their close association with other ritual monuments (SS1.8). Unfortunately, given the small size of the assemblage and the mixed nature of the deposits, the data provide limited information about diet, husbandry, or other activities relating to the use of the site.

Methods

The identified and unidentified remains were quantified by bone count. Where diagnostic features and/or the shape of the remains allowed identification to species or genus, the specimens were recorded in detail, including element, element part, side, age data and measurements. The use of a restricted suite of elements or zones was not followed, as this would have excluded most of the material. Half distal metapodials of cattle were counted as 0.5 (Davis 1992). The remains were identified with the aid of the faunal reference collection at English Heritage (Environmental Studies), Fort Cumberland, Portsmouth. Tooth wear in cattle was recorded following Grant (1982) and epiphysial fusion after Silver (1969). Measurements were recorded following von den Driesch (1976) and Davis (1992).

The Riverside Structure

Provenance and preservation

The material selected for analysis includes *c* 120 bones/teeth, hand-collected from five contexts (7367, 7368, 7377, 7379, 7380; Table SS4.38). Most of the material is from layer 7367, described as a very mixed and disturbed layer, which forms part of the upper brushwood, and would either have

Table SS4.39. Riverside Structure. Preservation of identified specimens

? = possible

Preservation category *Context*	*N*	*Spiky*	*Battered*	*Rounded*	*Weathered*	*Exfoliated*	*Carnivore-gnawed*	*Scratched*	*Residual*
7367	60.5	2	43	39	19	8	3+5?	28	2+5?
7368	10		9	9	7		1	3	
7377	1		1						
7379	1		1	1	1				
7380	2		1	1	2	1		1	1

been contemporaneous with the platform or have been deposited after its construction at some time before or during the early Bronze Age. The animal bones were located between the inner trunk and river-edge, and may have been deposited during 'the last stages of dumping or subsequently whilst the layer was subject to water action disturbance' (SS1.8). The other contexts yielded few remains.

Most of the remains are poorly preserved and show heavy attrition (battering and rounding of edges), and many are weathered (Table SS4.39). In addition, a high proportion of the fragments shows fine scratches over the entire bone surfaces. Originally, these marks were thought to be butchery marks (Windell *et al.* 1990, 13), as many consist of fine incisions resembling fine knife/blade marks. However, the location, form and ubiquity of the marks suggest that they result instead from rubbing against grit, sharp stones and/or branches. This may have come about during deposition in the channel and disturbance by water action. Some bone waste was exposed for a while before deposition in the channel, as indicated by the presence of carnivore gnawing marks. A few fragments show extreme erosion and may be residual.

The data

A total of 74.5 remains were identified. These consist almost exclusively of cattle bones and teeth. Other taxa include pig, caprine, equid, red deer and a species of pochard (*Aythya* sp; Table SS4.38). The cattle remains include elements from all bodyparts (Table SS4.40). Many of the bones include longbone shafts, in which both articular ends are absent. The heavy attrition evident on the bones no doubt contributed to their destruction (Lyman 1994; Brain 1981). Only a few isolated teeth and no small foot bones were recovered, which is probably due to the method of excavation and possibly excavation conditions; small bones may have been washed away by water action also.

An unusual feature of the cattle assemblage is the young age of many of the remains. All but one of the mandibular tooth rows are from immature animals (after O'Connor 1988; Table SS4.41). The epiphysial fusion data also show the predominance of unfused early, middle and late fusing articular ends, indicating that they are from juvenile and subadult animals (Table SS4.42). The size and stage of development of many bones for which epiphysial fusion data are not available also suggest that they are from juvenile animals (see table SS4.44). For example, a metacarpal and metatarsal are very small and show incomplete fusion of the third and fourth metapodials together.

Few measurements could be taken, due

Table SS4.40. Riverside Structure. Skeletal element representation in cattle and/or aurochs

(Number of identified specimens, NISP)

Context *Element/Element part*	*7367*	*7368*	*7377*	*7379*
Cranium	8	1		
Upper molar	2			
Mandible	7			
Scapula (including collum)	4	1		
Humerus proximal and distal shaft	4	1		
Humerus distal-mid shaft	5			
Humerus distal epiphysis	1			
Radius proximal epiphysis-mid shaft	1			
Ulna proximal-mid shaft	2			
Ulna shaft	1			
Innominate	1	1		
Femur proximal epiphysis-mid shaft				1
Femur proximal and distal shaft	4	1		
Tibia proximal and distal shaft	10			
Metacarpal proximal shaft	1			
Metacarpal distal shaft	1			
Metatarsal proximal and distal shaft	2	1	1	
Metatarsal distal epiphysis and shaft	0.5			
TOTALS	54.5	6	1	1

to the fragmentary nature of the specimens and the young age of the animals (Table SS4.43). A few cattle bones are unusually large compared with most of the specimens, and one may be from aurochs. The following measurements were taken:

femur (context 7379): BC: >66.9mm; SD: >59.0mm.
tibia (context 7367): SD: 50.5mm.

Unfortunately, few comparative metric data for British aurochsen are available. The size of the femur compares to data for male aurochsen from Neolithic Denmark, while the tibia compares to data for female aurochsen and male domestic cattle (Degerbol 1970). Two very weathered and possibly residual ulna fragments from context 7367 are large also, but measurements could not be taken. The remaining cattle specimens are probably from domestic animals.

Table SS4.41. Riverside Structure (context 7367). Tooth wear in cattle (after Ewbank *et al* 1964, Grant 1982 and O'Connor 1988)

Cr = visible in crypt/unerupted (perforation in bone present); ½ = half-erupted

Mandible #	*dP_4*	*P_4*	*M_1*	*M_2*	*M_3*	*Age group*
5	k					
56	j		e	Cr		Immature
57	j		d	Cr		Immature
58	h?		b	Cr		Immature
60				½		Immature
61			g	d		Subadult+

Bones and teeth of other animals are rare. The equid metacarpal from context 7367 is from a small animal (see Vitt 1952 in Driesch and Boessneck 1974). The withers height calculated from the lateral length is 1282mm (after Kieswalter 1888 in Driesch and Boessneck 1974). The slenderness index of *c* 13.6 (GL estimate 206.4 mm; calculation after Payne 1988, data in Eisenmann 1986) does not allow distinction between species, although it falls within the range calculated for ponies; it is not possible to tell if the bone is from a domestic or wild animal. 'Celtic' equids known from Neolithic and Bronze Age sites in Britain were probably similar in size and shape to Exmoor ponies (Clutton-Brock 1981).

The red deer tibia from context 7380 is considerably larger and more robust than bones of a modern 20+ year-old male red deer specimen in the English Heritage faunal reference collection (accession #8). The shaft diameter (SD) measures approximately 33mm. Measurements of a metacarpal from the same context are approximate, due to poor preservation (Bp *c* 38.2mm and SD *c* 23.3mm); these compare to measurements of the modern skeleton mentioned above and to a metacarpal from Neolithic Hambledon (Bp 39.3mm; A. Legge *pers comm* 2001).

Other assemblages (Long Mound, Southern Enclosure, Barrow 3)

The assemblages from other areas are very small and yielded few identifiable remains. The assemblage from the body of the Long Mound includes a probable sheep metatarsal

Table SS4.42. Riverside Structure. Epiphysial fusion in cattle (after Silver 1969)

p = proximal; d = distal; j = juvenile; j? = probable juvenile; j/i = juvenile/immature; i/s? = probable immature/subadult; s = subadult; numbers in brackets included in total; U = unfused; F = fused; Indet = indeterminate

Element	*Age (months)*	*7367*			*7368*		*7377*	*7379*
		U	*F*	*Indet*	*U*	*Indet*	*Indet*	*F*
Scapula d	7–10 m			4(2j?)	1(j)	1(i/s?)		
Innominate	7–10 m							
Humerus d	12–18 m	4(1j, 2j?)		5(1j, 1j?)		1(j?)		
Radius p	12–18 m		1					
Metacarpal d	24–30 m			1(j?)				
Tibia d	24–30 m	1(j?)		9(2j?)				
Metatarsal d	30–36 m	1(j)	0.5	1(j?)		1(j)	1	
Humerus p	36–42 m	1(j)		4(2j?)				
Femur p	42 m	4(1j, 1j/i, 1s)				1(j)		1
Ulna p	42–48 m			3(1j?)				
Ulna d	42–48 m			1				
Femur d	42–48 m	2(1j)		2(1j?, 1s)		1(j?)		

Table SS4.43. Riverside Structure. Measurements of teeth and postcranial bones in tenths of a mm (after Driesch 1976, Davis 1992)

f = fused; indet = indeterminate; j? = probable juvenile; e = estimate

Context	*Taxon*	*Element*	*Fusion*	*Age*	*Measurement*		
					SLC		
7367	*Bos taurus*	scapula	indet	j?	265		
					W. Condyle	W. trochlea	
7367	*Bos taurus*	metatarsal	f		273	246	
					L	Wa	Wp
7367	*Bos taurus*	dP_4			277	104	
7367	*Bos taurus*	dP_4			e 273	107	
7367	*Bos taurus*	dP_4			e 265	104	
7367	*Bos taurus*	M_1			206	135	149
					SD		
7367	*Bos primigenius*	tibia	indet		505		
					Ll	Sc	Bd (at fusion)
7367	*Equus* sp.	metacarpal	f		2001	281	417
					SLC		
7368	*Ovis aries/Capra hircus*	scapula	indet		211		

(from context 5271), and a caprine upper molar (from context 5408). From F5263 at the base of the north 'quarry pit' there is a cattle upper molar (context 5262). At the Southern Enclosure, context 87691 (in pit F87690) yielded one cattle lower first or second molar, and there was a caprine scapula from context 87759 in pit F877760. Both pits were probably Neolithic.

The Barrow 3 assemblage includes a lower right deciduous second premolar (dP_2) of an equid from context 30779, near the centre of the enlarged mound (phase 4.3). The relative simplicity of the enamel folds suggests it is a deciduous tooth, but it is not possible to determine the species, given its young age. There is no penetration of the external fold between the meta- and entoflexids, and the internal fold is poorly developed, small and V-shaped (Davis 1987b; Payne 1991). The mandible of an adult equid of possible Bronze Age date, was recovered from context 30790, in the first mound, only *c* 1m away in horizontal distance (Davis SS4.6.2). The contexts of both finds indicate an early Bronze Age date, unless they are the result of disturbance.

Summary

Unfortunately, few of the contexts from the various excavations yielded identifiable bones/teeth. The Riverside Structure yielded the more interesting assemblage. This consists mainly of cattle bones, many of which are from juvenile or subadult animals. Given the very poor preservation of many of these, and clear evidence for battering, rounding and weathering of the bone, it is possible that many more remains of young animals were originally deposited, but did not survive postdepositional destruction. Other domestic animals include pig and caprines, while some animals were probably hunted, including red deer and possibly aurochs. Given the small sample size, and the provenance of the material (from only five mixed or disturbed contexts), it is not possible to say if the bones are representative of wider site diet or economy, nor if they indicate ritual activity in the Neolithic period. The relatively high proportion of juveniles is interesting, and indicates that at least some animals were raised locally. The pattern may be interpreted in various ways; for example, in herds raised for dairy products, young animals may be culled so as to free up milk for human consumption. Excess young animals may also be killed if there is insufficient fodder for overwintering of stock. It is not possible to say in the case of this small sample, if either of these strategies might have applied.

Table SS4.44. The Animal bone analysed from the Riverside Structure, the Long Mound, the Avenue, the Southern Enclosure and Barrow 3

Cat# = catalogue number; proportion scale 1–10, 10 being complete; N = number of specimens (where a tooth is present in a counted mandible, N=0); y = present

	Square	*Sample or find no*	*Cat#*	*Taxon*	*Element*	*Part*	*Propotion*	*Side*	*N*	*Proximal fusion*	*Distal fusion*	*Wear*	*Relative age*	*Spiky*	*Battered*	*Rounded*	*Weathered*	*Exfoliation*	*Carnivore gnawing*	*Scratches*	*Modern breakage*	*Residual*
Riverside Structure																						
7367	170/640		24	*Aythya* sp	cpm	complete	10	r	1	fused	fused		adult	y								
7367	170/640		25	*Aythya* sp	ulna	complete	10	r	1	fused	fused		adult	y								
7367	165/640		5.1	*Bos taurus*	dP$_3$				0													
7367	165/640		5.2	*Bos taurus*	dP$_4$				0													
7367	170/640		56.1	*Bos taurus*	dP$_4$			r	0			j										
7367	170/640		57.1	*Bos taurus*	dP$_4$			r	0			j										
7367	170/640		58.1	*Bos taurus*	dP$_4$			r	0			h?										
7367	165/640		1	*Bos taurus*	femur	shaft	8	r	1	unfused	indeterminate		subadult			y				y		possible
7367	165/640		7	*Bos taurus*	femur	shaft	8	l	1	unfused	unfused		juvenile			y				y		possible
7367	170/640		36	*Bos taurus*	femur	shaft	8	l	1	unfused	unfused				y	y				y		
7367	170/640		47	*Bos taurus*	femur	shaft	8	r	1	unfused	indeterminate		juvenile/ immature		y	y	y			y		
7367	170/640		14	*Bos taurus*	frontal			l	1						y	y						
7367	170/640		15	*Bos taurus*	frontal			r	1						y	y				y		
7367	170/640		19	*Bos taurus*	frontal			r	1				juvenile?		y	y						
7367	170/640		20	*Bos taurus*	frontal			l	1				juvenile?			y	y					
7367	165/640		8	*Bos taurus*	humerus	shaft	7	r	1	indeterminate	unfused		juvenile?		y	y						
7367	165/640		9	*Bos taurus*	humerus	shaft	7	l	1	indeterminate	indeterminate				y	y				y		
7367	165/640		10	*Bos taurus*	humerus	shaft	7	r	1	indeterminate	unfused				y	y		y				
7367	170/640		26	*Bos taurus*	humerus	distal-proximal shaft	7	l	1	indeterminate	unfused		juvenile?			y	y	y	possible			
7367	170/640		27	*Bos taurus*	humerus	shaft	8	r	1	unfused	unfused		juvenile			y	y			y		
7367	170/640		28	*Bos taurus*	humerus	distal-proximal shaft	4	r	1		indeterminate		juvenile		y					y		
7367	170/640		34	*Bos taurus*	humerus	distal shaft	7	r	1		indeterminate		juvenile?		y	y	y			y		
7367	170/640		35	*Bos taurus*	humerus	distal-mid shaft	4	l	1		indeterminate									y		
7367	170/640		41	*Bos taurus*	humerus	distal shaft	6	l	1		indeterminate											
7367	170/640		30	*Bos taurus*	inn	ilium neck	2	l	1						y	y						
7367	170/640		56.2	*Bos taurus*	M$_1$			r	0			e										
7367	170/640		57.2	*Bos taurus*	M$_1$			r	0			d										
7367	170/640		58.2	*Bos taurus*	M$_1$			r	0			b										
7367	170/640		61.1	*Bos taurus*	M$_1$			r	0			g										
7367	170/640		56.3	*Bos taurus*	M$_2$			r	0			Vis-E										
7367	170/640		57.3	*Bos taurus*	M$_2$			r	0			Cr										
7367	170/640		60.1	*Bos taurus*	M$_2$			l	0			1/2										
7367	170/640		61.2	*Bos taurus*	M$_2$			r	0			d										
7367	165/640		5	*Bos taurus*	mandible	diastema-alveolus M$_1$		r	1									y				
7367	170/640		56	*Bos taurus*	mandible	diastema-ramus		r	1				subadult		y		y	y				
7367	170/640		57	*Bos taurus*	mandible	diastema-ramus		r	1						y	y	y					
7367	170/640		58	*Bos taurus*	mandible	diastema-M$_2$		r	1						y		y					
7367	170/640		59	*Bos taurus*	mandible	diastema-alveolus M$_1$?		l	1						y							y
7367	170/640		60	*Bos taurus*	mandible	M$_1$ -condyle		l	1						y						y	y

Table SS4.44. Continued.

	Square	Sample or find no	Cat#	Taxon	Element	Part	Propotion	Side	N	Proximal fusion	Distal fusion	Wear	Relative age	Spiky	Battered	Rounded	Weathered	Exfoliation	Carnivore gnawing	Scratches	Modern breakage	Residual
7367	170/640		61	*Bos taurus*	mandible	M_1-cond		r	1						y	y				y		
7367	170/640		37	*Bos taurus*	metacarpal	proximal epiphysis-mid shaft	4	l	1						y	y				y		
7367	170/640		48	*Bos taurus*	metacarpal	distal-mid shaft	6	ind	1		indeterminate		juvenile?		y	y	y	y	possible	y		
7367	165/640		4	*Bos taurus*	metatarsal	distal epiphysis+shaft	3	ind	0.5		fused				y	y					y	possible
7367	170/640		32	*Bos taurus*	metatarsal	shaft	7	l	1	indeterminate	indeterminate		juvenile?		y	y						
7367	170/640		40	*Bos taurus*	metatarsal	shaft	8	l	1		unfused		juvenile?		y	y						
7367	170/640		54	*Bos taurus*	$M^{1/2/3}$	crown		l	1													
7367	170/640		55	*Bos taurus*	$M^{1/2/3}$	crown		l	1													
7367	170/640		16	*Bos taurus*	occipital			a	1						y	y						
7367	170/640		17	*Bos taurus*	pre-sphenoid		a	1						y	y							
7367	170/640		29	*Bos taurus*	radius	proximal epiphysis-mid shaft	4	l	1	fused					y	y		y	possible	y		
7367	165/640		2	*Bos taurus*	scapula	distal-mid shaft+neck	4	l	1		indeterminate		juvenile?							y	y	
7367	165/640		3	*Bos taurus*	scapula	distal-proximal shaft	8	r	1		indeterminate		juvenile?		y					y	y	
7367	170/640		44	*Bos taurus*	scapula	glenoid-proximal blade	8	l	1		indeterminate				y	y	y			y		
7367	170/640		45	*Bos taurus*	scapula	neck-proximal blade	7	l	1		indeterminate				y					y		
7367	165/640		11	*Bos taurus*	tibia	shaft	7	r	1	indeterminate	unfused		juvenile?		y	y				y		
7367	165/640		12	*Bos taurus*	tibia	shaft	6	r	1	indeterminate	indeterminate				y	y	y		possible		y	
7367	165/640		13	*Bos taurus*	tibia	shaft	6	l	1	indeterminate	indeterminate				y	y				y		
7367	170/640		31	*Bos taurus*	tibia	shaft	6	l	1	indeterminate	indeterminate				y	y		y	possible	y		
7367	170/640		38	*Bos taurus*	tibia	shaft	6	l	1	indeterminate	indeterminate				y							
7367	170/640		39	*Bos taurus*	tibia	shaft	6	r	1	indeterminate	indeterminate						y			y		
7367	170/640		49	*Bos taurus*	tibia	shaft	7	r	1	indeterminate	indeterminate		juvenile?		y	y			y	y		
7367	170/640		50	*Bos taurus*	tibia	shaft	7	r	1	indeterminate	indeterminate		juvenile?		y	y			y	y		
7367	170/640		51	*Bos taurus*	tibia	shaft	6	r	1	indeterminate	indeterminate								y	y		
7367	170/640		52	*Bos taurus*	tibia	shaft	8	r	1	indeterminate	indeterminate				y	y	y					
7367	170/640		18	*Bos taurus*	ulna	proximal-mid shaft	5	l	1	indeterminate			juvenile?		y	y				y		
7367	170/640		33	*Bos taurus*	ulna	proximal shaft	1	l	1	indeterminate					y		y					possible
7367	170/640		53	*Bos taurus*	ulna	shaft	7	l	1	indeterminate	indeterminate				y	y	y	y				possible
7367	170/640		21	*Bos taurus*	vomer			a	1						y							
7367	170/640		22	*Bos taurus*	zygomatic			l	1								y					
7367	170/640		46	*Bos taurus*/ *Cervus elaphus*	scapula	neck+anterior blade	3	r	1		indeterminate				y	y	y					
7367	170/640		43	cf *Bos taurus*	humerus	distal epiphysis	1	l?	1		unfused					y	y					
7367	165/640		6	*Equus*	metacarpal	complete	10	r	1		fused									y		
7367	170/640		23	*Sus scrofa*	innominate	acetabulum+neck of ilium	3	l	1						y	y						
7367	170/640		42	*Sus scrofa*	tibia	shaft	8	l	1	indeterminate	unfused				y	y	y			y		
7367 total identified									58.5													
7367	165/640			large or medium mammal	rib	complete +/-	9		1						y							
7367	170/640			large or medium mammal	rib				5													
7367	170/640			large mammal	cranium				2						y		y					
7367	170/640			large mammal	cranium				4													
7367	170/640			large mammal	indeterminate				1													
7367	170/640			large mammal	indeterminate				5													
7367	170/640			large mammal	longbone				4													

Table SS4.44. Continued.

	Square	*Sample or find no*	*Cat#*	*Taxon*	*Element*	*Part*	*Propotion*	*Side*	*N*	*Proximal fusion*	*Distal fusion*	*Wear*	*Relative age*	*Spiky*	*Battered*	*Rounded*	*Weathered*	*Exfoliation*	*Carnivore gnawing*	*Scratches*	*Modern breakage*	*Residual*
7367	170/640			large mammal	longbone				1													
7367	170/640			large mammal	rib				2													
7367	170/640			large mammal	unid				1							y						
7367	165/640			large mammal	cervical vertebra	complete +/-	9	a	1							y						
7367	170/640			large mammal	cervical vertebra				1						y	y						
7367	170/640			large mammal	thoracic vertebra				1						y	y						
7367	170/640			large mammal	thoracic vertebra				1						y	y						
7367	170/640			large mammal	thoracic vertebra				1						y	y						
7367	170/640			large mammal	thoracic vertebra				1						y	y						
7367	170/640			large mammal	thoracic vertebra	spine			1													
7367	170/640			medium mammal	rib	articulation			1													
7367 total unidentified								34														
7367 total								92.5														
7368	170/640		2	*Bos taurus*	humerus	shaft	7	l	1		indeterminate		juvenile?		y	y	y			y		
7368	170/640		5	*Bos taurus*	innominate	ilium		r	1		unfused		juvenile		y	y	y					
7368	170/640		3	*Bos taurus*	metatarsal	proximal-distal shaft	9	r	1		indeterminate		juvenile?		y	y	y					
7368	170/640		1	cf *Bos primigenius*	scapula	neck-proximal	6	l	1		indeterminate		immature/ subadult?	y	y				y			
7368	170/640		4	*Bos taurus*	temporal	+tympanic bulla +petrous		l	1													
7368	170/640		6	cf *Bos taurus*	femur	shaft	6	l	1	indeterminate	indeterminate		juvenile?		y	y	y		y	y		
7368	170/640		9	cf *Cervus elaphus*	innominate	acetabulum-proximal	1	l	1						y	y	y					
7368	170/640		7	cf *Cervus elaphus*/ *Bos taurus*	innominate	acetabulum-distal-lat	1	l	1						y	y	y					
7368	170/640		8	cf *Cervus elaphus*/ *Bos taurus*	innominate	acetabulum-distal-med	1	l	1						y	y	y					
7368	170/640		10	*Ovis aries*/ *Capra hircus*	scapula	glenoid-proximal shaft	8	l	1		indeterminate				y	y						
7368 total identified									10													
7368	170/640			large mammal	longbone				1						y	y	y					
7368	170/640			large mammal	mandible fragment	diastema			1						y	y	y			y		
7368	170/640			large mammal	mandible fragment	ramus, condyle			1							y	y					
7368	170/640			large mammal	rib				3						y	y	y					
7368	170/640			large mammal	rib articulation				1						y	y	y					
7368	170/640			large mammal	thoracic vertebra				1						y	y	y					
7368 total unidentified								8														
7368 total								18														
7377	170/640		1	*Bos taurus*	metatarsal	proximal-distal shaft	9	r	1		indeterminate				y						y	
7377	170/640		2	large mammal	indeterminate				3													
7379	170/640		1	*Bos taurus*	femur	proximal epiphysis-mid shaft	6		1	fused					y	y	y					
7379	170/640			large mammal	indeterminate				3													
7380	170/640		1	cf *Cervus elaphus*	metacarpal	proximal-distal shaft	9	l	1		indeterminate				y	y	y	y				possible
7380	170/640		2	cf *Cervus elaphus*	tibia	shaft	7	l	1		fused						y			y		
Riverside Structure grand total									121													

Table SS4.44. Continued.

Square	Sample or find no	Cat#	Taxon	Element	Part	Propotion	Side	N	Proximal fusion	Distal fusion	Wear	Relative age	Spiky	Battered	Rounded	Weathered	Exfoliation	Carnivore gnawing	Scratches	Modern breakage	Residual
Long Mound																					
5262	9227		indeterminate	indeterminate				56													
5262	9237		cf *Bos taurus*	$M^{1/2}$	buccal side			1								y					
5262	9237		large or medium mammal	tooth				17												y	
5262	9237		large mammal	tooth				7												y	
5271	8545		*Ovis aries/ Capra hircus*	metatarsal	mid-distal shaft		l	1		indeterminate								possible			
5272	8546		Aves-medium	tibiotarsus	proximal shaft		r	1													
5273	8547		indeterminate	indeterminate				1													
5278	8668		indeterminate	indeterminate				4													
5279	8746		indeterminate	indeterminate				6													
5408	8786		*Ovis aries/ Capra hircus*	$M^{1/2}$	crown+part roots		r	1			moderate										
5671	9516		indeterminate	indeterminate				3													
5671	9517		indeterminate	indeterminate				4													
5679	10841		indeterminate	indeterminate				4													
5697	10840		indeterminate	indeterminate				1						y	y						possible
5697	10841		large or medium mammal	vertebra				1						y	y	y					possible
Long Mound total								108													
Avenue																					
87502	99156		indeterminate	indeterminate				6													
87502	99156		indeterminate	indeterminate				1													
87502	99156		small mammal	caudal vertebra				1													
87505	99157		indeterminate	indeterminate				1													
87572	99157		indeterminate	indeterminate				11													
87572	99197		large or medium mammal	longbone				15													
87572	99197		mammal	indeterminate				2													
87572	99197		indeterminate	indeterminate				2													
87655	99229		indeterminate	indeterminate				1													
87572	99197		indeterminate	indeterminate				1													
Avenue total								41													
Southern Enclosure																					
87689			large mammal	longbone				1								y					
87759			*Ovis aries/ Capra hircus*	scapula	glenoid-mid shaft	5	l	1								y					
87759			medium mammal	indeterminate				1													
87691			large mammal	longbone				4													
87691			*Bos taurus*	$M^{1/2/3}$	crown		l	1			b-d					y				y	
Southern Enclosure total							8														
Barrow 3																					
30791	37327		mammal	indeterminate				6								y				y	
30779	36892		*Equus*	dP_2	part crown		r	1								y				y	
30787	37314		mammal	indeterminate				1								y					
Barrow 3 total								8													

SS4.7 Human Remains

SS4.7.1 The inhumations from Barrow 1

Janet D Henderson
Adapted from Ancient Monuments Laboratory Report 64/88

Two fairly complete skeletons of early Bronze Age date were examined. In the primary grave, F30426, was skeleton 6410, associated with a Beaker and a rich assemblage of grave goods, and dated to 2200–1920 cal BC (3681±47 BP; UB-3148). This skeleton was slightly displaced from full articulation, probably because the wooden coffin or chamber in which it had been buried and the limestone cairn surmounting it had collapsed into the grave. In a secondary grave, F30449, was skeleton 6409, associated with a bone pin and dated to 1940–1690 cal BC (3504±38 BP; UB-3147). Both were of adult males and the most notable finds were pathological (an injury to an ankle joint in one case and joint disease in the other). Although the skeletons were nearly complete (approximately 90%), bone preservation was only fair at best. Observations were made for age, sex, stature, metrics, morphology and any abnormalities. A complete catalogue of the results is attached and a full archive inventory of the bones and teeth present is kept in the Ancient Monuments Laboratory.

Both skeletons were of adults with a sex attribution of 'probably male'. 6410, from the primary burial, was too poorly preserved for a precise age estimate; 6409 was assessed as *c* 20–30 years. Stature was estimated at 1.77m (c 5ft 9½in) and 1.72m (c 5ft 7in) respectively. With the exception of the presence of two wormian bones in the lambdoid suture of the skull of 6409 no metrical or morphological anomalies of any particular note were found. Evidence for pathological change was noted on both the teeth and the bones of these individuals. Orally, on 6409 this was confined to slight polishing of the occlusal surfaces of the teeth. On 6410 the wear pattern was similar although it was more marked on the anterior teeth. There had been ante mortem loss of two teeth (mandibular right canine and third molar) and there was evidence for abscesses adjacent to the mandibular left first molar and right third molar. Additionally there was marked bony recession of the alveolar margins. This is generally taken to indicate some form of gingivitis (gum disease) during life.

Skeletal evidence for trauma was seen on 6409 and for joint disease on 6470. On 6409 there were severe degenerative changes involving bones of the right ankle joint and foot (tibia, fibula, talus, calcaneum and navicular). Despite the absence of any evidence for a fracture, it is suggested that this was the result of trauma, the arthropathy being secondary, and that the most likely cause might have been an abduction or an adduction injury. The absence of fracture and of evidence for displacement or loss of length or height of any of the bones seems to indicate that the original injury had not been of great severity although its consequences were definitely marked.

In 6410 there were changes to joint surfaces in the chest, the shoulders, the spine and the hands. These were unremarkable except for marked grooving and eburnation of the right inferior posterior facet of the atlas (the axis was unfortunately missing) and slight marginal osteophytes, joint surface destruction, and eburnation on the left first metacarpal and two proximal phalanges.

Catalogue

Note: Teeth are listed according to the F D I system (eg Downer 1975)

F30426 (skeleton 6410, context 30476)

Partial skeleton in poor condition with many of the bones showing additional surface damage. All parts represented (the skeleton was approximately 90% complete).
Sex: Male, based on skull and mandible morphology, humeral head size, and the overall robustness of the bones (see Henderson 1984 for references).
Age: Adult, there was too little evidence available for a more precise estimate.
Stature: 1.77 m±0.0405, *c* 5ft 9½in. Estimate based on Trotter's method (1970), using the right humerus.
Dental Pathology: Ante mortem tooth loss: 4, 3 and 4, 8
Wear: Slight polishing of the occlusal surfaces of the molars, wear was more marked on the anterior teeth (incisors and canines).
Abscesses: 3, 6, visible from the buccal side, of medium size. 4, 8, a large abscess, probably the cause of the loss of the tooth.

A small deposit of sub-periosteal new bone was noted on the lingual surface of the mandible.
Periodontal Disease: Marked recession of the alveolar margins.
Skeletal Pathology: There was very little evidence available for this individual but

some changes attributable to joint disease were noted. Slight marginal osteophytes were noted at the clavicular notches of the sternum, the glenoid fossa of the right scapula and both humeral heads (ie affecting the gleno-humeral joints). Additionally there was slight surface destruction of the medial left clavicle. There was evidence for costal cartilage ossification on the sternum at the level of the first rib on both sides. On the spine there was some development of marginal osteophytes and, more particularly, the right inferior posterior facet of the atlas was markedly eburnated and grooved. Unfortunately the axis was not present for comparison. Finally the first left metacarpal and two proximal phalanges had slight marginal osteophytes, damage to the joint surface of one of the phalanges and small eburnated patches.

Comment: The only other joints that could be assessed were the elbows and wrists, none of which had any changes. In view of the paucity of the data the overall significance of the joint disease that was seen could not be determined.

F30449 (skeleton 6209, context 30470)

Nearly complete skeleton in fair condition, all parts represented (the skeleton was approximately 90% complete). There was minimal damage to the bone surfaces.

Sex: male, based on skull and pelvic morphology, the dimensions of the humerus, scapula and femur and the overall robustness of the bones (see Henderson 1984 for references).

Age: 20–30 years, based on dental wear and epiphysial union.

Stature: 1.72m ±0.0327, *c* 5ft 7½in. Estimate based on Trotter's method (1970), using the left femur.

Dental Pathology: None

Wear: Slight polishing of the occlusal surfaces only.

Skeletal Pathology: The only evidence for pathological change was found on the right ankle and foot.

Trauma: bones involved: R tibia, fibula, talus, calcaneum and navicular.

Other bones present: R cuboid, lateral cuneiform, metatarsals l–5, 5 proximal phalanges. Bones of the left side all normal.

Ankle joint: the joint surfaces of the tibia, fibula and talus were all enlarged and had a 'roughened' appearance. There were areas of trabecular exposure anteriorly on the tibia and talus (where they articulate) and marked marginal osteophytes around the facets, particularly anteriorly and posteriorly on the tibia and talus. The general impression was one of the addition of bone over the original joint surfaces and a consequential narrowing of the joint space, rather than destruction. Reapproximation and radiographic examination seemed to confirm this. Morphologically and radiographically there was no evidence for fracture or loss of length (tibia and fibula) or height (talus).

Foot: there was osseous ankylosis of the talus, calcaneum and navicular bones. Radiographic examination demonstrated continuity across the joints in all cases. No other changes, such as subperiosteal new bone, were observed. The anterior facets of the calcaneum (for cuboid) and the navicular (for the cuneiform bones) were apparently normal.

Comment: Given this individual's estimated age and the absence of changes to the remaining bones it is suggested that the underlying cause was a traumatic event rather than an arthopathy (the degeneration being secondary to the original injury). The bony evidence would seem to indicate the absence of fracture, although it should be noted that the medial malleolus of the tibia was broken and a fracture of this could not be ruled out. External rotation, abduction, adduction and vertical compression injuries may all affect the ankle joint (Watson-Jones 1946). It was thought unlikely that the cause was external rotation (there was no fracture of the lateral malleolus) or vertical compression (changes insufficiently extensive) but either an abduction or an adduction injury would be possible as in both there may be fracture of the medial malleolus without displacement (ibid). Whatever the particular event that had caused the injury, the appearance of the bones indicated that, whilst the original trauma had not been that extensive, it had led to a considerable degree of secondary degeneration of the joint.

SS4.7.2 Inhumations and disarticulated human bone from the Riverside Structure, Barrow 3 and Barrow 6

Simon Mays

Adapted from Ancient Monuments Laboratory Report 56/90, with the addition of more recent identifications of disarticulated bones from the Riverside Structure and Barrow 3

Methods used are noted, with appropriate references, for each individual case. In the sections on ageing, the term 'infant' refers to a child of less than two years of age.

The Riverside Structure

Two adult femur shaft fragments, one left and one right, were found at separate locations in context 7367, a layer between the river bank and the structure which also contained most of the animal bone from the site. The right femur shaft showed carnivore gnawing at the proximal and distal ends, in the form of irregular edges and pitting of the bone surface. A second right adult femur shaft came from context 7203, a layer post-dating the structure and sealing a pit on the river bank. The predominance of robust bones among the animal remains from the site may reflect the degradation of less durable ones (Baker SS4.6.4). The presence of human femurs to the exclusion of other bones may perhaps be similarly interpreted.

Barrow 3

A right adult tibia shaft (AOR 37312) and a right adult calcaneum (AOR 37311) came from the same part of a scatter of limestone fragments over the mound of the barrow.

Barrow 6 (Tables SS4.45–46)

Disarticulated human remains dated to 3360–3030 cal BC (4500±33 BP; UB-3310) were recovered from F3390, a pit underlying the central grave, F3259, which contained a richly furnished Beaker burial, dated to 2130–1820 cal BC (3608±41 BP; UB-3311). An infant femur was found in the final fill of the outermost of the three ditches surrounding the barrow, a deposit interpreted as a plough-turned soil horizon predating the late Saxon occupation of the site.

Table SS4.45. Barrow 6. Metric variation for the articulated central burial (F3259)

Cranial and postcranial measurements were taken according to the definitions of Howells (1973) (skull measurements), and Brothwell (1981) (mandibular and post-cranial measurements).
All measurements in millimetres

Bregma-lambda chord	110.0
Mastoid height (right)	31.8
Simotic chord	8.3
Foramen mentalia breadth	46.0
Minimum ramus breadth (right)	37.8
Coronoid height (right)	61.8
Humerus length right	335.0
Radius length right	266.0
Humerus epicondylar width right	65.0
Femoral head diameter left	45.8
Meric index right	75.1
Cnemic index left	71.8
Cnemic index right	67.7

F3390 (sf 4654)

Material: Skull fragments, axis and atlas vertebral fragments, parts of longbones and a little other material (much of which consists of unidentified fragments), representing the remains of a minimum of two adults (duplication of skull fragments, axis and atlas vertebrae, right femora and left tibiae). Bones poorly preserved (see Notes).

Sex: 1 male (pelvis), 1 ?male (there are two sets of male-looking skull fragments).

Age: 1 adult aged about 25 (dental attrition – Brothwell 1981, fig 3.9), 1 indeterminate adult.

Dental formula:

															E
			X	.	.	.	X			.	.	T	.	.	.
8	7	6	5	4	3	2	1	1	2	3	4	5	6	7	8
8	7	6	5	4	3	2	1	1	2	3	4	5	6	7	8
					T										
L															R

Key: . = tooth present in socket, X = tooth lost post mortem, T = socket missing or damaged but loose tooth present, E = erupting, blank = socket and tooth missing post mortem

Notes: Many of the bones were moderately well preserved on one side but very eroded on the obverse face. The medial surface of a right tibia, for example, is largely intact but its lateral surface is heavily eroded. Observations in the field indicated that these heavily eroded surfaces are those which faced uppermost in the soil. Initially it was thought possible that this pattern of preservation suggested that the bones were left exposed to the elements or covered only by a very thin layer of soil, having been deposited in the pit in a disarticulated state. However close examination of the remains suggests that this scenario is perhaps unlikely. The teeth are in good condition. Teeth, particularly the enamel parts, tend to fragment if exposed to the elements for any length of time. Large pieces of cancellous bone are present; these would be rapidly destroyed if left exposed on the surface. It has been the writer's experience that, when a grave is cut by a later feature (be it another grave or not), the bones lying nearest the later cut are frequently rather worse preserved than those lying further away. The reasons for this are obscure, but it may be related to differences in permeability

Table SS4.46. Barrow 6. Non-metric traits for the disarticulated bones in F3390 and for the articulated central burial in F3259

Non-metric traits are minor skeletal variants which are scored here mainly on a presence/absence basis. Definitions of cranial traits are those of Berry and Berry (1967); post-cranial traits are defined after Finnegan 1978)

1 = trait present, 0 = trait absent, - = no observation possible. Scores for bilateral traits are presented as score for left side/score for right side

F3390	Mastoid foramen extra-sutural	1/-
	Mastoid foramen absent	0/-
	Divided hypoglossal canal	1/0 (probably not a pair)
	Posterior condylar canal patent	0/-
	Precondylar tubercle	0/0
	Supra-condyloid process	-/0
	Septal aperture	-/0
	Acetabular crease	1/1
	Atlas facet double	0/-
	Atlas facet double	0/- (other individual)
F3259	Metopic suture	0
	Ossicle at lambda	0
	Lambdoid ossicle	1
	Inca bone	0
	Ossicle at bregma	0
	Coronal ossicle	0
	Squamo-parietal ossicle	-/0
	Parietal notch bone	-/0
	Auditory torus	0/0
	Foramen of Hushke	0/0
	Ossicle at asterion	-/0
	Palatine torus	0
	Maxillary torus	0
	Mastoid foramen extra-sutural	0/1
	Mastoid foramen absent	0/0
	Double condylar facet on occipital	-/0
	Parietal foramen	0/0

F3259 continued		
	Zygomatic-facial foramen	-/0
	Divided hypoglossal canal	1/-
	Posterior condylar canal patent	0/-
	Precondylar tubercle	0/-
	Foramen ovale incomplete	1/-
	Supra-orbital foramen complete	0/0
	Maxillary M3 agenesis	0/0
	Mandibular M3 agensis	0/0
	Mandibular torus	0
	Mylohyoid bridging	1/1
	Fossa of Allen	-/0
	Plaque formation	-/0
	Extosis in trochanteric fossa	0/0
	Supra-condyloid process	0/0
	Septal aperture	1/0
	Acetabular crease	0/0
	Accessory sacral facets on ilium	0/-
	Spina bifida occulta	Partial – S1 and S2 arches incomplete
	Acromial articular facet	0/-
	Os acromiale	0/-
	Supra-scapular foramen	0/-
	Vastus notch	1/-
	Vastus fossa	1/-
	Emarginate patella	0/-
	Anterior calcaneal facet double	1/0
	Anterior calcaneal facet absent	0/1

between natural, undisturbed soil and the more loosely packed soil of a man-made feature. The bones in F3390 lay only a few centimetres beneath grave cut F3259; the erosion on the upward-facing parts of the bones from F3390 is probably due to proximity of these surfaces to the later feature.

There is no evidence for mixing of bones between F3390 and F3259. The bones in F3390 were clearly interred when the soft tissues had decayed. No signs of animal gnawing were found on the bones. No cut marks were found, as might be expected if the flesh had been cut from the bones as part of funerary ritual. It thus seems that the corpses must have been left to decay naturally, in a place where animals could not gnaw the bones, most probably by earth burial. The skeletons were then exhumed and some bones taken and buried in F3390.

A maxilla from this context shows an impacted third molar. The tooth has erupted so that the top of the crown is level with the base of the crown of the fully erupted M^2 and impacted against its distal surface. The orientation of the M^3 is not abnormal, there is simply insufficient space for it to erupt fully. There is resorbtion of the alveolar bone on the lateral side of the tooth, so that the whole of the crown is visible.

F3259 (sf 4647)

Material: Skeleton about three-quarters complete; bones somewhat fragmentary but moderately well preserved.
Sex: Male (Workshop of European Anthropologists 1980).
Age: Probably 25–35 (see Notes).

Dental formula:

.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
8	7	6	5	4	3	2	1	1	2	3	4	5	6	7	8
8	7	6	5	4	3	2	1	1	2	3	4	5	6	7	8
.	.	.	.	.	.	.	*	.	.	.	.	.	.	.	.
L															R

Key: . = tooth present in socket, * = tooth lost ante mortem

Stature: 1.774m (5 ft 10 in) – using humerus and radius length in the formula of Trotter and Gleser (1952; 1958; reproduced by Brothwell 1981, table 5).

Notes: Aging: the attrition on the molar teeth suggests an age at death of about 25 (using the chart of Brothwell (1981, fig 3.9), although the wear on the anterior dentition is rather marked. The pattern of cranial suture closure is rather irregular but seems to suggest a rather older age than the teeth (using Perizonius 1984). The skeleton has the general appearance of a young adult, showing a lack of ossification at the enstheses and very little degenerative joint disease. The pubic symphyses are missing. Hence the age of this individual was estimated at about 25–35.

The molar teeth show dental calculus to Dobney's and Brothwell's (1987) grade 2.

An area on the right calcaneum just anterior to the anterior facet for the talus has a rough, porotic appearance, as does the inferior border of the right navicular. The appearance of these two bones suggests that they were united in life by a bridge of fibrous or cartilaginous tissue. Coalition of calcaneum and navicular may in many cases be symptomless, but it may cause a painful flat foot known as peroneal spastic flat foot (Leonard 1974). This is the most common tarsal coalition (Renton and Stripp 1982), and the most common type of union between the bones is via fibrous tissue (as seems to have been the case here) with complete bony bridges being rather less common (Chambers 1950). Leonard (1974) found that when calcaneo-navicular coalition was present it was generally bilateral; in the present case the condition is unilateral. Peroneal spastic flat foot is a fairly uncommon condition in modern populations – a survey by Harris and Beath (1948) of Canadian army recruits found a prevalence of 2%, although this represents an underestimate of the prevalence of tarsal coalitions as many are symptomless. Several studies (eg Wray and Herndon 1963; Leonard 1974) show that calcaneo-navicular coalition is an inherited congenital anomaly.

Three thoracic vertebrae show irregular depressions on the inferior surfaces of their centre. These probably represent Schmorl's nodes. An intervertebral disc consists of a tough outer layer (the annular fibrosus) surrounding an inner core (the nucleus pulposus) which, until early adulthood, is composed of semi-gelatinous material. In younger individuals excessive compression of the spine (as might occur on heavy lifting) may result in extrusion of material from the nucleus pulposus into the adjacent vertebral body. The bony manifestation of this is a pit or cleft, the Schmorl's node. In some individuals congenital weakness of the cartilage plate of the vertebral body may increase the likelihood of the formation of Schmorl's nodes, but there is no doubt that a single trauma may cause extrusion of disc material in a healthy spine (Schmorl and Junghanns 1971, 158–68).

Two of the centra with Schmorl's nodes are adjacent lower thoracic vertebrae. One thoracic vertebra shows osteoarthritis of its facet joints to Sager's (1969 – cited by Brothwell 1981) grade 1, and four show osteoarthritis to Sager's grade 3. The remainder of the skeleton is free from osteoarthritic changes. Mechanical stress plays a major role in the aetiology of osteoarthritis, and it may occur as a consequence of a single traumatic injury (Kellgren and Lawrence 1958; Radin *et al* 1980). Three adjacent lower thoracic vertebrae show grade 3 osteoarthritis and two of these also show Schmorl's nodes. Bearing in mind the general lack of osteoarthritis in this skeleton, it seems likely that the osteoarthritis and Schmorl's nodes were caused by traumatic injury to the lower thoracic spine.

The plantar parts of both faces of the articulation between the left third metatarsal and the lateral cuneiform show irregular, porotic bone depressed below the normal joint surface. Lesions of this type have been noted sporadically by the writer in British skeletal material ranging in date from the early Bronze Age to the mediaeval period. They have also been noted in skeletons from the US (Tenney 1989). The cause is uncertain, but it may well be that they simply represent a skeletal variant rather than being the result of any disease process. It is not possible to ascertain whether the changes are unilateral or bilateral as the relevant parts of the right foot are missing.

The mandibular canines show many ripples of depressed enamel and the crowns of the maxillary premolars show a depressed line about 2mm from the cemento-enamel junction. These lesions are dental enamel hypoplasias – disturbances of enamel formation during childhood associated with a wide variety of stressors, including infectious diseases and nutritional deficiencies. Using the methodology of Goodman *et al* (1980), the location of the defects on the premolars suggests that the stress episode giving rise to them occurred when the individual was about four years old.

Context 3196 (sf 4068)

A single human infant femur found in the topmost fill of the outer ditch.
Sex: Unknown.
Age: The diaphysial length is 73mm, suggesting neonatal age, perhaps slightly premature – the formula of Scheuer *et al* (1980) gives an age of about 37–38 weeks in utero – a full term foetus is about 38–41 weeks.

SS4.7.3 Cremations from the Long Mound, Barrow 6, and minor features in West Cotton

Simon Mays
Adapted from Ancient Monuments Laboratory Report 56/90.

Recovery

At West Cotton, bone from some cremations was recovered by hand-picking on site – such cases are denoted by the entry 'unsieved' in the recovery section. Bone from others was recovered by wet-sieving down to 2mm mesh – these cases are denoted by the entry 'sieved' in the recovery section.

Methods by which age and sex were estimated in individual cases are given in the text. When age in immature individuals was estimated using epiphysial fusion, use was made of the chart in Workshop of European Anthropologists (1980, fig 6), and when cranial suture closure was used to give a very approximate indication of age in adults reference was made to the study of Perizonius (1984).

Several cremations were truncated, disturbed, or both, and are unlikely to have been complete.

The Long Mound

F5549, context 5548/5550 (sf 9293)
Context: Pit cut into natural sand and gravel from the base of the southern complex of 'quarry pits', sealed by their upper fills. Cremated bone, charcoal, an indeterminate crumb of pottery, a core, a core fragment, a non-bulbar fragment, two slightly burnt flakes and a blade were scattered through a soil fill.
Recovery: Sieved
Material:

Total weight:	1.51g
Fragment count:	100
Mean fragment size:	4mm

Colours: White/bluish white
Sex: Unknown
Age: Infant (indicated by size of bones)

Barrow 6

F3206/context 3226
Context: Pit cut into largely silted outer ditch. Cremated bone was confined to the bottom fill, within and under a grey-black loam with flecks and fragments of charcoal and some blackened pebbles, mixed with dark brown sandy loam. 3226 was a lens of grey ashy loam, also containing cremated bone, which extended into the upper ditch fills for a short distance from the pit and was probably derived from it by animal disturbance. Study of the bone supported this conclusion. *Terminus post quem* provided by date on charcoal (mainly oak) form F3206 of 1750–1510 cal BC (3347±54 BP; UB-3315).
Recovery: F3206 sieved, context 3226 unsieved
Material:

Skull	
Weight:	0.14g
Fragment count:	9
Mean fragment size:	4mm
Post-cranial and unidentified	
Weight:	4.80g
Fragment count:	200
Mean fragment size:	5mm
Total	
Weight:	4.94g
Fragment count:	209

Colour: Neutral white.
Identified elements include fragments of skull and longbones.
Sex: Unknown
Age: The small size of the longbone and the paper-thin skull fragments indicate infant.

F3219, contexts 3224 (sample 490), 3225 (sample 491)
Context: Pit cut into largely silted outer ditch, possibly slightly truncated in early stages of excavation. Lower fill of brown loam mixed with a dark grey charcoal-flecked loam containing a few pebbles

with blackened and heat-reddened surfaces. Stakehole extending to base of pit, itself filled with grey-black charcoal-flecked loam. Cremated bone in both lower fill and stakehole. Fragments from small Collared Urn above cremation in upper fill. Pomoideae type charcoal from stake dated to 2130–1820 cal BC (3610±40 BP; OxA-7866).
Recovery: Part sieved, part: unsieved
Material:

Total weight:	5.51g
Fragment count:	150
Mean fragment size:	4mm

Colour: Neutral white
Identified elements include fragments of: skull vault
Sex: Unknown
Age: Paper-thin skull fragments and size of bones indicate infant.
Notes: Fragments of burnt animal tooth/ teeth found with the remains.

F3178, context 3179 (sf 3677)
Context: Truncated pit, immediately under post-barrow ploughsoil, on berm between inner and outer ditches. Cremation lay on part of a Collared Urn, which was on its side, the upper part having been ploughed away. Ceramic stud or button among bones, cattle teeth and a flint flake in red-brown sand fill of pit. No stratigraphic relation to barrow sequence, but proximity to F3206 and F3219 my suggest contemporaneity.
Recovery: Part sieved, part unsieved.
Material:

Skull	
Weight:	58.29g
Fragment count:	65
Mean fragment size:	16mm
Post-cranial and unidentified	
Weight:	464.92g
Fragment count:	4800
Mean fragment size:	5mm
Total	
Weight:	523.21g
Fragment count:	4865

Colours: Mainly neutral white, a few grey or bluish fragments.
Identified elements include fragments of: root of maxillary permanent tooth, root of permanent molar, thoracic vertebral facet joints, ribs, proximal joint surface of radius, shaft of left fifth metacarpal, intermediate and proximal hand phalanges, vertebral bodies, left and right radial tuberosities, cranial vault (with ununited sutures), sacral vertebral bodies (not fused to one another), cervical vertebral body (with unfused epiphyses), first metacarpal, metatarsal fragments, distal joint surface of tibia, vertebral neural arches, a distal hand phalanx (epiphysis just fused), scapula, lumbar vertebral body, metacarpal shaft, fibula and unidentifiable longbone fragments.
Sex: Unknown, but where enough of individual bones are present to give an impression of their size (mainly the hand and foot bones) they seem to be rather small, even in cases where the epiphyses have fused; perhaps this might be suggestive of female sex.
Age: About 16–21 (epiphysial fusion – Workshop of European Anthropologists 1980). This is also consistent with the state of fusion of the skull sutures and with dental development.
Note: Fragments of a cow/horse tooth and oyster shell found with the remains.

Minor Features

F1741, context 1738 (sf 4556)
Context: Truncated pit, *c* 8m south-east of the eastern end of the Long Mound, filled with grey-brown sandy clay containing a compact mass of cremated bone, the upper part of which had been lost. No other finds apart from a single small piece of charcoal.
Recovery: Part sieved, part unsieved.
Material:

Total weight:	149.9g
Fragment count:	600
Mean fragment size:	9mm

Colours: Mainly neutral white, a few blue fragments.
Identified elements include fragments of: distal joint surface of R femur.
Sex: Unknown
Age: Size of femur fragment suggests older adolescent or adult

F4948
Context: Truncated pit, *c* 6m north of the Double Ring Ditch, with calcined bone and charcoal flecks scattered through the fill.
Recovery: Sieved
Material:

Skull	
Weight:	27.83g
Fragment count:	31
Mean fragment size:	19mm
Post-cranial and unidentified	
Weight:	95.20g
Fragment count:	125
Mean fragment size:	17mm
Total	
Weight:	123.03g
Fragment count:	156

Colours: Mainly neutral white, some blue.

Identified elements include fragments of: skull (including right temporal bone in region of external auditory meatus), ulna, and vertebrae.

Sex: Unknown

Age: Adult. Skull sutures are ununited but have lost the serrated appearance characteristic of children and young adults, having rather rounded edges.

Discussion

Six cremations from West Cotton were studied, of which three were probably adults, and three were infants. The quantity of material ranged up to 523g for the adult remains and up to about 5g for the infants. In no case did a burial contain the remains of more than one individual. Studies (discussed by Wahl 1982) show that complete cremation of an adult corpse yields about 2 kg of bone; thus the adult cremations from West Cotton each represent less than about one quarter of the remains expected from a human body. The infant cremations, too, must be substantially incomplete. All but F5549 may have been depleted by truncation and/or disturbance between burial and recovery. Since burning in all cases was not *in situ*, but must have occurred on a pyre, with subsequent collection of remains for burial, it is probable that much loss of material occurred during funerary ritual, although inevitable losses in recovery, and destruction of bone during its sojourn in the soil, must not be forgotten. The bone fragments from all six burials are quite uniform in colour, mainly neutral white, with some light blue or grey fragments. Colour may be used as a very approximate guide to firing temperature (Shipman *et al* 1984). The appearance of the West Cotton remains suggests thorough, even firing: most fragments have probably been exposed to temperatures in excess of about 940° C.

SS4.7.4 Cremations from Barrows 1, 3, 4 and 5

Simon Mays

Adapted from Ancient Monuments Laboratory Report 101/90

Recovery

The cremated bone examined from Barrows 1, 3, 4 and 5 comprises material wet-sieved through 2mm and 4mm meshes. The 4mm fraction was hand-sorted in its entirety, as was one-quarter of the 2–4mm fraction. In all cases the tables detailing weights, fragment sizes and fragment counts refer to the >4mm fraction unless otherwise stated. The material retained by the 2mm mesh was scanned for diagnostic fragments; no attempt was made to assess numbers of fragments, although they were weighed, since for same contexts they formed an appreciable proportion of the total bone. An estimate of the total weight of the bone retained by the 2mm mesh was obtained by multiplying the weight of the sorted part by four.

Barrow 1

One cremation with early Bronze Age associations (F30017) was inserted into the mound within the inner ditch. In the centre of the mound a second cremation may perhaps have been contained in an inverted Collared Urn, truncated down to the base of the collar, from which no bone was recovered. A peripheral cremation in the southwest quadrant (F30030) was cut into the upcast from the outer ditch overlying the silted middle ditch. A further three (F30305, F30307, F30440) lay beyond the outer ditch to the south-east, and may have formed part of a larger group extending beyond the excavated area.

F30017, cremation 6400, context 30018 (sample 11070)

Context: Cut into the mound within the inner ditch, in a truncated Collared Urn or Food Vessel, probably originally upright, damaged by ploughing and animal burrowing, accompanied by an unburnt bronze dagger, a burnt antler pommel fragment and a burnt bone or antler pin. A sample of cremated bone is dated to 1950–1730 cal BC (3520±40 BP; GrA-22378).

Material:

Skull	
Weight:	213.4g
Mean fragment size:	15mm
Max fragment size:	45mm
Fragment count:	300
Post-cranial and unidentified	
Weight:	2210.9g
Mean fragment size:	14mm
Max fragment size:	50
Fragment count:	8200
Total	
Weight:	2424.3g
Fragment count:	8500

Estimated total weight of 2–4mm fraction = 70.8g; thus estimated total weight of bone is 2495.1g.

Colours: Neutral white, some bluish and blue-grey fragments.

Identified elements include fragments of: mandibular canine with root tip still incomplete, roots of other teeth, including mandibular incisors, premolars and molars and maxillary canines and premolars; crown of a mandibular M3 (dark grey in colour, probably unerupted at death, crown formation complete or almost complete), crown of R mandibular PM1, 2 L and 1 R mandibular condyle, R mental foramen area of mandible (probably child), R temporal bone with zygomatic process (probably child), L zygomatic, skull vault and base fragments (adult and child, adult sutures ununited, L supercillary arch (probably child), R petrous temporal, R temporal (area for articulation with occipital and parietal bones), R zygomatic, sphenoid, alveolar fragments, L temporal bone (external auditory meatus area), L petrous temporal, R petrous temporal (probably child), zygomatic process of R temporal bone, root of zygomatic process of L temporal bone, mastoid processes of L and R temporal bones (probably a pair, large robust mastoid processes), R side of mandible (including sockets of R canine, PM1, PM2, and mesial root of M1, R tibia, R ulna, R clavicle, odontoid process of axis, 7 distal hand phalanges (child – unfused epiphyses), 15 intermediate/proximal hand phalanges (10 child, 5 adult), atlas vertebra, tibia, 5 proximal foot phalanges (1 child, 4 adult), vertebral facet joints (large adult-sized), unfused distal epiphysis of a metacarpal, 1st (?) metatarsal, many fragments of unfused longbone epiphyses, proximal unfused epiphysis of radius, longbone shaft fragments (many of rather robust appearance with thick cortices), fibula (large adult-sized), centrum of thoracic vertebra (child), posterior arch of atlas, 1st metacarpal, R calcaneum (child), 1st metatarsal, L scapula (including base of spine and acromium – child), R scapula (unfused epiphysis at medial border), ribs, tuberosity area of R radius (child), body of hyoid, fibula (child), anterior facet of L calcaneum, L hamate, hallucial sesamoid, lumbar vertebral facet joint, ischium (probably child), unfused basal epiphysis of 1st metatarsal.

Sex: Two individuals – 1 adult, probably male (robusticity of cranial and post-cranial bones), and 1 child of unknown sex.

Age: Young adult – probably about 20–40 (cranial sutures); the child is probably about 13–14 (dental development, consistent with state of epiphysial fusion).

Remarks: The adult shows a unilateral extra-sutural mastoid foramen on the L side. This is probably an inherited anomaly (Sjøvold 1984). A small amount of 'clinker' was found in this context (see Discussion).

F30030, cremation 6401, contexts 30031(samples 11071, 11076), 30037 (sample 11077)

Context: Pit cut into the upcast from the outer ditch overlaying the silted middle ditch, disturbed by animal burrowing and truncated by ploughing. Lower fill (30037) of sandy loam, pebbles, a little charcoal and cremated bone. Upper fill (30031) with much charcoal and burnt bone, both visible on surface, disturbance evidenced by iron hobnail. Some burnt flint. Charred *Arrhenatherum* tubers from upper fill dated to 1370–1000 cal BC (2950±50 BP; OxA-3089).

Material:

Skull	
Weight:	1.4g
Mean fragment size:	10mm
Max fragment size:	12mm
Fragment count:	8
Post-cranial and unidentified	
Weight:	24.9g
Mean fragment size:	8mm
Max fragment size:	34
Fragment count:	193
Total	
Weight:	26.0g
Fragment count:	201

Colours: Mainly neutral white, a few fragments light grey.

Sex: Unknown.

Age: The general size of the bone fragments and the thinness of the skull vault are suggestive of a younger child – possibly aged about 2–6 years.

F30305, cremation 6402, context 30306 (sample 11251)

Context: In one of three cremation pits clustered outside barrow 1 to south-east, possibly truncated. Charcoal and cremated bone scattered throughout fill, but more frequent in lower part.

Material:

Skull	
Weight:	5.2g
Mean fragment size:	8mm
Max fragment size:	21mm
Fragment count:	22
Post-cranial and unidentified	
Weight:	18.8g
Mean fragment size:	7mm
Max fragment size:	23
Fragment count:	151
Total	
Weight:	24.0g
Fragment count:	173

Estimated total weight of 2–4mm fraction = 5.6g, thus estimated total weight of bone = 29.6g.
Colours: mainly neutral white, some fragments and many endosteal surfaces grey or blue-grey.

Identified elements include fragments of: skull vault, a vertebral facet joint, distal hand (?thumb) phalanx – unfused epiphysis.
Sex: Unknown.
Age: The general size of the bone fragments and the thinness of the skull vault fragments suggest a younger child – probably about 2–10 years.

F30307, cremation 6403, contexts 30308 (samples 11254, 11255), 30309 (sample 11256)
Context: In one of three cremation pits clustered outside barrow 1 to south-east, possibly truncated. Upper fill (30308) mottled with much charcoal and some cremated bone, lower fill less mottled, with more cremated bone and less charcoal. Charred tubers (indeterminate) from lower fill dated to 1390–1120 cal BC (3005±35 BP; OxA-7948).
Material:

Skull	
Weight:	2.3g
Mean fragment size:	8mm
Max fragment size:	14mm
Fragment count:	26
Post-cranial and unidentified	
Weight:	16.5g
Mean fragment size:	5mm
Max fragment size:	19
Fragment count:	431
Total	
Weight:	18.8g
Fragment count:	457

Colours: Mainly neutral white, a few fragments light grey.

Identified elements include fragments of: skull vault, distal hand phalanx.
Sex: Unknown.
Age: The general size of the bone fragments and the thinness of the skull vault suggest a younger child – probably about 2–5 years of age.

F30440, cremation 6404, context 30441 (sample 11433)
Context: In one of three cremation pits clustered outside barrow to south-east, possibly truncated. Clayey loam fill with small amounts of cremated bone, charcoal and burnt stone.
Material: Lost soon after excavation.

Barrow 3

Two secondary cremations were examined, from F30663, in the ESE quadrant, and F30847 near the centre of barrow.

F30663, cremation 6411, context 30665 (samples 33001–33007).
Context: Poorly-defined pit in barrow mound, filled with sandy loam with a small amount of gravel, in centre of which was a large, concentrated mass of cremated bone. There were only a few flecks of charcoal.
Material:

Skull	
Weight:	83.7g
Mean fragment size:	17mm
Max fragment size:	34mm
Fragment count:	90
Post-cranial and unidentified	
Weight:	1138.5g
Mean fragment size:	17mm
Max fragment size:	96
Fragment count:	3000
Total	
Weight:	1222.2g
Fragment count:	3090

Estimated total weight of 2–4mm fractions = 575.2g, thus the total weight of bone received =1797.4g.
Colours: Mainly neutral white, a few fragments white-grey and blue-white.

Identified elements include fragments of: skull vault, alveoli, L zygomatic, L mandibular condyle, maxilla fragment with sockets for some molar teeth and fragment with sockets for R incisors, R temporal bone, R petrous temporal, lateral margin of L superciliary arch, tooth root (possibly maxillary PM1), distal end of R humerus, R scapula (glenoid cavity), fragment of unfused epiphysial surface – probably proximal humerus, thoracic vertebral facet joints, lower thoracic/lumbar vertebrae, sacral face of R sacro-iliac joint, ribs, fibula, hook of L hamate, pelvis, distal end of femur, rim of acetabulum, inferior border of L scapula, distal joint surface of ulna, tibia, R distal hallucial phalanx, an indeterminate and a distal foot phalanx (fused together), 2 distal hand phalanges, 5 proximal/slash intermediate hand phalanges, proximal ends of L and R ulnae, ulna shaft, greater trochanter of L femur, distal joint surface of femur, R ilium (pre-auricular area), proximal joint surface of radius, radial shaft, distal joint surface of R humerus (duplicates R humerus fragment above), L pisiform, proximal foot phalanx.
Sex: Probably female (morphology of pre-

auricular area of pelvis). The duplication of the distal R humerus indicates a minimum of two individuals (but see Discussion); the other is unsexable.
Age: About 16–25 (epiphysial fusion, consistent with state of fusion of skull sutures). The second individual is an adult or at least an older juvenile – over 14 years of age.
Remarks: The distal and intermediate phalanges of a toe are fused together. In modern Europeans this type of anomaly may be present in about 35–45% of individuals, generally in the fifth toe (Venning 1960, cited in Renton and Stripp 1982).

F30847, cremation 6412, context 30848/30850 (sample 33024)
Context: Pit near centre of mound filled with mottled red/brown sandy loam with iron pan, containing a small amount of loosely-packed cremated bone. Root- and rabbit-disturbance, with some cremated bone in rabbit burrow 30849, which ran through the feature.
Material:

Skull	
Weight:	10.9g
Mean fragment size:	18mm
Max fragment size:	33mm
Fragment count:	15
Post-cranial and unidentified	
Weight:	101.4g
Mean fragment size:	9mm
Max fragment size:	35
Fragment count:	405
Total	
Weight:	112.3g
Fragment count:	420

Estimated total weight of 2–4mm fraction = 43.6g, thus estimated total weight of bone = 155.9g.
Colours: White, a few endosteal surfaces grey.
Identified elements include fragments of: skull vault, roots of permanent teeth, tibia, facet joint of a thoracic vertebra, L scapula (coracoid), 2 proximal/intermediate hand phalanges.
Sex: Unknown.
Age: Adult.

Barrow 4

F60312, cremation 6460 (sample 33467)
Context: Badly-preserved cremation set into west quadrant of mound, first observed during hoeing after the machining off of a clearance layer. Charcoal flecks present. ?Pottery under burnt bone (AOR 55522), not subsequently identified as such. Charred tubers from cremation dated to 1940–1530 cal BC (3450±70 BP; OxA-3052).
Material:

Skull	
Weight:	1.6g
Mean fragment size:	11mm
Max fragment size:	19mm
Fragment count:	7
Post-cranial and unidentified	
Weight:	97.8g
Mean fragment size:	9mm
Max fragment size:	35
Fragment count:	400
Total	
Weight:	99.4g
Fragment count:	407

Estimated total weight of 2–4mm fraction = 53.2g, thus estimated total weight of bone = 152.6g.
Colours: Mainly neutral white; some fragments and many endosteal surfaces grey
Identified elements include fragments of skull vault, tooth root, navicular, unfused proximal radius epiphysis.
Sex: Unknown.
Age: About 12–16 (epiphysial fusion, bone size).

Barrow 5

Three secondary cremations from Barrow 5 were examined.

Context 47111, cremation 6451 (samples 33301 from cremation, 33298 from surrounding soil)
Context: Small pile of burnt and fragmented bone with some charcoal in the south-east quadrant of the mound, observed just below the interface of the mound material with the overlying alluvium. Truncated to south by mediaeval plough furrow, almost certainly also truncated during machining of topsoil and alluvium
.

Skull	
Weight:	45.1g
Mean fragment size:	20mm
Max fragment size:	43mm
Fragment count:	36
Post-cranial and unidentified	
Weight:	167.7g
Mean fragment size:	14mm
Max fragment size:	45
Fragment count:	1100
Total	
Weight:	212.8g
Fragment count:	1136

Estimated total weight of 2–4mm fraction = 22.0g; thus estimated total weight of bone is 234.8g.

Colours: Neutral white, grey-white and grey.

Identifiable elements include fragments of: roots and dentine parts of the crowns of maxillary PM2s, PM1s, a maxillary molar, and other, unidentified teeth; mandible (internal surface with genial tubercle), maxillary alveolus, occipital, L temporal bone (area just above mastoid process), skull vault, L and R trapezia, L triquetral, L hamate, distal end of a metacarpal, 2 distal hand phalanges, 3 proximal foot phalanges, proximal hallucial phalanx, distal joint surface of R humerus, anterior facet of L calcaneum, L and R fibulae, 3 cervical vertebrae, thoracic and lumbar vertebral facet joints, inferior parts of L pubic symphysis (older-looking – surface rather bumpy but no trace of ridge and furrow system; sharp edge to dorsal border), patella, pelvis, rib; also midshaft part of a femur of an infant.

Sex: Unsexable adult, but bones fairly robust. The presence of the infant femur indicates a second individual (but see Discussion).

Age: Adult probably middle-aged – ie about 30–50 (pubic symphysis and cranial suture closure). The infant bone probably comes from a neonatal or slightly older individual.

F47143, cremation 6452, context 47144 (samples 33299, 33300, and 33304)

Context: Pit in north-west quadrant of mound, containing badly-damaged cremation.

Material:

Skull	
Weight:	20.2g
Mean fragment size:	16mm
Max fragment size:	31mm
Fragment count:	28
Post-cranial and unidentified	
Weight:	227.0g
Mean fragment size:	11mm
Max fragment size:	56
Fragment count:	1300
Total	
Weight:	247.2g
Fragment count:	1328

Estimated total weight of 2–4mm fractions = 248.4 g; thus, total weight of bone received = 495.6g.

Colour: Mainly white, a few grey fragments; some endosteal surfaces dark grey or black.

Identifiable elements include fragments of skull vault, dentine parts of maxillary L M3 (no wear detectable on dentine of crown), maxillary alveolus with sockets for the L M3 and M2, L? mandibular ramus, mandibular alveolar fragment, palate, mandibular molar, tibia, humeral head, femur (with linea aspera), L radius (with area for attachment of pronator teres), ?scapula, 5 proximal/intermediate hand phalanges, 2 cervical vertebrae.

Sex: Unknown, but of fairly light build.

Age: Middle aged adult – probably about 30–50 (cranial suture closure).

Remarks: Fragment of burnt animal bone also present.

F47087, cremation 6453, context 47085 (samples 33305 and 33308 from cremation, sample 33309 from just below it)

Context: Pit cut into natural gravel between inner and outer ditches at south side of mound. Quite densely-packed, apparently complete, cremation deposit. Twiggy charcoal from the cremation was so degraded as to be unidentifiable, suggesting that it may have been burnt twice (Campbell, SS4.6). This makes it uncertain whether the cremation is as old as the Neolithic date of the charcoal, 3370–2910 cal BC (4460±70 BP; OxA-3054).

Material:

Skull	
Weight:	102.1g
Mean fragment size:	19mm
Max fragment size:	38mm
Fragment count:	140
Post-cranial and unidentified	
Weight:	708.5g
Mean fragment size:	13mm
Max fragment size:	51
Fragment count:	3000
Total	
Weight:	810.6g
Fragment count:	3140

Estimated total weight of 2–4mm fractions = 234.0g; thus, total weight of bone received = 1044.6g.

Colours: Mainly neutral white, a few fragments grey-white or grey-blue.

Identified elements include fragments of: 2 R mandibular condyles, tip of zygomatic process of R temporal bone, robust-looking lateral part of R superciliary arch, L petrous temporal bone, tooth root fragments, atlas vertebra, lumbar vertebral body, navicular, tibia, metacarpal, fibula, thoracic vertebral facet joint, 2 proximal/intermediate hand phalanges, calcaneum.

Sex: The replication of the R mandibular condyles indicates a minimum of 2 individuals (but see Discussion); both are unsexable.

Age: Both adult.

F47171, cremation 6461, context 47172 (samples 33089 and 33090)

Context: Pit cut into centre of mound, truncating primary feature, filled with dark brown sandy clay loam with charcoal flecks, which surrounded an inverted Collared Urn, its base lost to ploughing or machining, in which was the cremation deposit and an unburnt bifacially-flaked foliate flint knife. The relation of F47171 to F47168, a larger pit also cut into the centre of the mound, is uncertain. If F47168 cut F47171, as seems likely, then the date of a large mammal tibia from F47168 may provide a *terminus ante quem* for the cremation of 2140–1880 cal BC (3625±40 and 3680±100 BP; OxA-7950, -3120).

Recovery: The urn was lifted as a block and emptied in the Ancient Monuments Laboratory. Sample 33089 was sieved with a 5mm mesh and sample 33090 with 4mm, 2mm and 1mm meshes.

Material:

Skull	
Weight:	263.0g
Mean fragment size:	25mm
Max fragment size:	47mm
Fragment count:	223
Post-cranial and unidentified	
Weight:	2583.5g
Mean fragment size:	17mm
Max fragment size:	75
Fragment count:	10200
Total	
Weight:	2846.5g
Fragment count:	10423

Estimated total weight of 2–4mm fraction = 1112.8g, thus total weight of bone received = 3959.3g.

Colours: mainly white, occasional grey or bluish-grey fragments.

Identified elements include fragments of: 2 R superciliary arches, L superciliary arch, occipital bone with large nuchal crest, skull vault (some sutures ununited or in the early stages of fusion, some are fused with lines beginning to be obliterated), 2 R zygomatics, L petrous temporal, R styloid of temporal bone, L temporal bone including root of zygomatic process, 3 L mandibular condyles, L coronoid process, mandibular alveolar fragment, tooth roots, L and R maxillae (a pair) with sockets for L I1–PM2 and R I1–PM1, occipital fragment including rim of foramen magnum, R petrous temporal bone, tooth roots (including maxillary molar and maxillary canine), glabella area, mandible fragment with sockets for some permanent teeth, L mastoid process (small), nasal processes of L and R maxillae (a pair), 2 L zygomatics, L temporal bone (area just above mastoid process), mandible (area with socket for L M3, R mandibular condyle, frontal bone, styloid process of L temporal bone, tibia, 2 cervical vertebra bodies, pelvis, fibula, thoracic vertebral facet joints, thoracic vertebral centrum, atlas vertebra (articular facet for odontoid), ribs, distal articular surface of tibia, R ulna, lumbar vertebral body, femur, wing of scapula, R lunate, metacarpal, hallucial sesamoid, sacral vertebral body, R intermediate cuneiform, 8 proximal/intermediate hand phalanges, 5 distal hand phalanges, L tibia, L patella, neural arches of 3 thoracic vertebrae, proximal and distal thumb phalanges (which articulate with one another), proximal and distal hallucial phalanges, trochlear surface of R talus, R scapula, (base of spine), odontoid (large) process of axis, iliac crest, proximal joint surface of radius, distal joint surface of R 1st metatarsal, proximal hand phalanx, proximal foot phalanx.

Sex: A minimum of 3 individuals. 1 possibly male, 1 possibly female (both based on size and robusticity of bones) and 1 unknown.

Age: Most of the remains seem to be from fairly young adults – ie probably under about 40 years – (cranial suture closure, lack of any osteoarthritis or ossification at the enstheses).

Remarks: There are abscess cavities at the sockets of the L PM2 and the R PM1 in the pair of maxillae from cremation 6461. A left patella shows a vastus notch, a minor variant of uncertain significance.

Discussion

Eleven contexts yielded cremated human bone: six seemed to contain the remains of only one individual, four contained the remains of a minimum of two, and one the remains of a minimum of three individuals. Of the contexts containing the remains of more than one individual, three (cremation 6411 in Barrow 3 and cremations 6451 and 6453 in Barrow 5) showed replication of only one skeletal element: in 6411 there was a fairly complete distal joint surface of a right humerus and also a small fragment which clearly came from the distal joint surface of another right humerus. In 6451 there were two right mandibular condyles and in 6453 there was a midshaft part of an infant femur among the adult remains. The impression gained in all three cases was that the remains were predominantly of a single individual. The question thus arises as to whether these contexts should be considered as 'true' double cremation burials, or whether the duplicated fragment should be regarded as a 'stray' element in a single cremation burial. A major hindrance in answering this question is the substantial quantity of bone in a cremation burial which remains unidentifiable: clearly one might make the argument that had more fragments been identifiable more remains of a second individual would have emerged. Against this, however, was the fact that, in addition to the material which could be identified to skeletal element, there was a substantial portion which could be identified to the level of 'longbone', 'flatbone', etc. In the two cases where only adult bones were present (6411 and 6453) there were no differences in the robusticity of the remains, stage of closure of the skull sutures, etc, which might have suggested the presence of two individuals even in the absence of further duplication of skeletal elements. In 6451 there was no evidence for further infant remains (such as deciduous tooth fragments, unfused epiphysial surfaces or thin skull fragments). Cremation 6452 had been disturbed by a mediaeval plough furrow – thus the infant femur may well be a stray bone. If the same pyre (or pyre area) was used for several separate cremations, then, when the remains of a cremated individual were collected together for burial, bone fragment(s) from a previous cremation may have been inadvertently (or even intentionally) included with them. At some sites where artefacts were burnt with the body adjoining fragments of the same artefact were found in different burials, suggesting that this type of scenario may have occurred. Unfortunately no such adjoining fragments were found in the Irthlingborough cremations. However this is an explanation which would be consistent with the findings in cremations 6421 and 6453.

The remains of 6400 and 6461 indicated that they were multiple cremations (double and triple) in the proper sense. From inurned cremation 6461, sample 33089 was from inside the urn and sample 33090 was from the soil surrounding it; there was no evidence for segregation of the remains of different individuals inside and outside the urn (although it must be remembered that the burial was somewhat disturbed).

Cremation of an adult corpse yields about 2kg of bone (studies cited by Wahl 1982). Using this as a guide, it is clear that all the cremations from Irthlingborough are substantially incomplete. The lowest weight of a single adult cremation at the site was 155.9g (cremation 6412), with burial 6400 (2495.1g for an adult and a 13–14-year-old child), or perhaps 6411 (1797.4g, discussed above) being the most complete. In almost every case, disturbance of the cremation, by animal burrowing, cultivation, machining or all three, contributed to loss of material. It is probable that much other loss of bone occurred in funerary ritual during the transfer of remains from the pyre to their burial place. Inevitable losses during recovery, and destruction of bone during its long sojourn in the soil should also not be forgotten.

In all cremations at Irthlingborough the fragments were predominantly neutral white in colour, with some greys and blues. Shipman *et al* demonstrate that colour can be used as a very approximate guide to firing temperature (1984). The appearance of the Irthlingborough fragments suggests temperatures in excess of 645° C, and probably in excess of 940° C.

In many cases endosteal surfaces were less well fired than periosteal surfaces. Since the heat of the pyre causes the bones to shatter, exposing their endosteal surfaces, lesser firing of these surfaces suggests that either the heat of the pyre was already past its peak when this occurred or, perhaps more likely, that when the bones shattered the fragments fell down towards lower, cooler parts of the pyre.

Cremation 6400 contained a small quantity of 'clinker', a pale yellow/greenish-coloured material. It has an irregular, glistening surface which shows many small cavities and vesicles. It has unfused soil particles adhering to its surface. The material weighs 0.57g (including adhering soil) and measures 20 x 13 x 11mm. This seems to be the same material as the 'clinker' first described in archaeological cremations by Wells (1960). He suggested that it was derived from burnt hair, but later work (Henderson *et al* 1987) showed that this explanation was unlikely and that the 'clinker' was probably a result of fusion of soil with material from the pyre. The intimate association between the soil and the clinker in the present case might be viewed as consistent with this suggestion.

SS.4.7.5 Cremations from the Segmented Ditch Circle

Simon Mays

Recovery

In all cases, bone was recovered by wet-sieving through 4mm and 2mm meshes. All bone retained by 4mm mesh was separated out from extraneous material; all weights and fragment counts refer solely to this bone.

Results

F87594, cremation 6184, context 87595 (sample 99206 = cremation, sample 99231= remainder of fill)
Context: Small, steep-sided pit inside the Segmented Ditch Circle, perhaps just cutting its inner edge, filled with dark brown sandy loam with very small stones. Well-preserved cremation in centre of pit, not discovered until half-sectioning had begun, and hence unlikely to have been truncated from surface. The only charred or burnt material with the cremation consisted of two hazelnut shell fragments, one of which was dated to 8160–7590 cal BC (8715±60 BP; OxA-7906). They were almost certainly redeposited.
Material:

Skull	
Weight:	170.1g
Mean fragment size:	25mm
Approximate fragment count:	100
Post-cranial and unidentified	
Weight:	1458.5g
Mean fragment size:	15mm
Approximate Fragment count:	3400
Total	
Weight:	1628.6g
Approximate fragment count:	3500

Colours: Mainly neutral white; some light grey.
Sex: Probably male (cranial morphology; post-cranial robusticity – Brothwell 1981).
Age: Probably 20–40 years (cranial suture closure – Perizonius 1984).

F87541, cremation 6185, context 87542 (sample 99177 = cremation, samples 99178, 99192 = surrounding soil)
Context: Near top of fill of north-west part of circuit, close to cremation 6184, in pocket of very dark greyish brown sandy loam with small charcoal flecks and a few pebbles, possibly truncated. Antler implements at lower horizons elsewhere in circuit are dated to 2140–1690 cal BC (3560±70 and 3570±70 BP; GU-5317, -5316).
Material:

Skull	
Weight:	110.2g
Mean fragment size:	25mm
Approximate fragment count:	75
Post-cranial and unidentified	
Weight:	439.6g
Mean fragment size:	10mm
Approximate Fragment count:	2500
Total	
Weight:	549.8g
Approximate fragment count:	2575

Colours: Neutral white; a little light grey.
Sex: Female (cranial morphology; post-cranial robusticity – Brothwell 1981).
Age: 50+ years (cranial suture closure – Perizonius 1984; thinness of cortical bone and presence of degenerative joint changes).
Remarks: Osteophytosis, representative of degeneration of the intervertebral discs, is present on several vertebral bodies to Sager's grade II (Brothwell 1981, fig 6.9). Osteoarthritis of Sager's grade II severity (Brothwell 1981, fig 6.9) is present on several vertebral facet joints and on a metacarpal. A facet joint from a cervical vertebra shows changes to Sager's grade III, with eburnation.

F87577, cremation 6186, context 87576 (sample 99235)
Context: In upper fill of south part of circuit, surrounded by dark brown silty clay loam with areas of black and dark reddish-brown. These deposits sealed the cremation, so that it is unlikely to have been truncated from the surface. Dating as for F87541.
Material:

Skull	
Weight:	93.8g
Mean fragment size:	20mm
Approximate fragment count:	70
Post-cranial and unidentified	
Weight:	490g
Mean fragment size:	15mm
Approximate Fragment count:	2350
Total	
Weight:	584.0g
Approximate fragment count:	2420

Colour: Neutral white.
Sex: Unknown.
Age: 10–15 years (epiphysial fusion – Mays 1998, fig 3.11; dental development – Mays 1998, fig 3.9; general bone size). It is likely that the true age of the individual lies toward the lower end of the stated age range.

Discussion

The ash weight of an adult human skeleton is approximately 2kg (Trotter and Hixon 1974). This indicates that burial 6184 represents nearly the complete remains of this individual, and, consistently with this, fragments from most areas of the skeleton are present. At less than 500g, burial 6185 is clearly much less complete than 6184, even taking into account that this was a female probably aged well over 50 years (elderly women may lose about 30% of their skeletal mass due to age-related loss of bone mineral – Trotter and Hixon 1974). The ash weight of the skeleton of a 10-year-old child is about 800g (Trotter and Hixon 1974), so 6186 appears to comprise most of the skeletal remains which could be expected from this individual, an inference corroborated by the observation that, as with 6184, fragments of most parts of the skeleton were present.

Bone colour may be used as an approximate guide to firing temperature. The colours displayed by the Segmented Ditch Circle cremations are indicative of pyre temperatures in excess of about 650° C (Mays 1998, table 11.1). The uniformity of coloration of the remains in each case denotes even firing, with no evidence for variation in firing temperature or duration across different parts of the body.

SS.4.7.6 The human remains from Redlands Farm

Angela Boyle

Introduction

A total of nine inhumations, a small quantity of disarticulated bone and fifteen cremation burials (plus a further five deposits which were not regarded as cremations *per se*) were recovered (Tables SS4.47–50). The assemblage came from a variety of contexts of different date which will be considered in the following groups: the Long Barrow (three inhumations, a small quantity of disarticulated bones, fifteen cremations and five 'deposits' of cremated bone), Barrow 7 (one inhumation) and Barrow 9 (five inhumations).

Methodology

Inhumations

The age of adult individuals was assessed according to the degree of attrition on the molar dentition (Brothwell 1981, 72). Sexing of adult individuals was based on both metric and morphological data (Workshop of European Anthropologists 1980). It is not feasible to determine the sex of infants and children by their skeletal remains. The term infant refers to a child of less than two years of age. Age estimates for subadults and infants were based on dental development (Van Beek 1983) and diaphyseal length (Scheuer *et al* 1980; Workshop of European Anthropologists 1980). Adult stature could not be calculated as complete or recon-

Table SS4.47. Redlands Farm. Details of inhumation practice

Landscape unit/phase	*Skeleton*	*Degree of completeness*	*Burial position*	*Associated structures*	*Associated objects*	*Comments*
Long Barrow						
1	233	numerous long bone fragments		within fill of stone cist		
2.3	144	1 fragment		incorporated in mound		weathered
2.3	159	1 fragment		incorporated in mound		
3.2	130	preservation poor, less than 50% survival	crouched on left side	grave		
3.2	131	preservation fair, 70% survival	crouched on right side	grave	shale armlet, copper-alloy earring, Beaker, 2 flint flakes	
3.2	163	preservation very poor, less than 50% survival		no visible grave		
Barrow 7						
2.1	2000	preservation very poor, less than 25% survival	on back with legs drawn tightly into body, hands on chest	sub-rectangular grave	LNEBA sherd	bones survived largely as powder
Barrow 9						
1.1	747	preservation fair, 70% survival	on back with legs drawn tightly into body	wooden structure within grave		
1.4	732	preservation poor, 50% survival	crouched on left side	grave		
1.4	737	preservation poor, less than 50% survival	crouched on left side	grave		
1.4	738	preservation very poor, less than 50% survival		grave		
1.4	751	preservation poor, 50% survival	crouched on left side	grave	Beaker	

Table SS4.48. Redlands Farm. Details of inhumations

Landscape unit/phase	*Skeleton*	*Age*	*Sex*	*Skeletal pathology*	*Dental pathology*	*Non-metric traits*
Long Barrow						
1	233	?	?			
2.3	144	?	?			
2.3	159	?adult	?			
3.2	130	25–35 y	male			
3.2	131[1]	33–45 y	female	osteoarthritis of right sacro-iliac joint	caries	metopic suture, right septal aperture
3.2	163	?adult	?			
Barrow 7						
2.1	2000	25–35 y	?			
Barrow 9						
1.1	747	33–45 y	male	alveolar resorption	crowding and rotation	
1.4	732	10–12 y	-		enamel hypoplasia	
1.4	737	5–7 y	-	cribra orbitalia		
1.4	738	neonate	-			
1.4	751	4–6 y	-			

[1] The remains of a further two individuals were associated with sk 131. A second adult was represented by anterior teeth and a fragment of ilium. A subadult was represented by a humeral diaphysis

structable bones did not survive. Standard metric measurements (eg Berry and Berry 1967) and incidence of non-metric traits (Finnegan 1978) could also not be recorded due to the poor preservation of material.

The dental notation employed is as follows:
c = caries
x = pm loss
/ = am loss
T = socket missing or damaged but loose tooth present
e = erupting
- = tooth and socket absent
k = calculus
u = unerupted, in crypt

Cremation burials

The approach to recording the cremated deposits was based on the system devised by McKinley (1994) and used with some success on the large sample from the Anglo-Saxon cemetery at Spong Hill, Norfolk. The recording system can be defined as follows: each deposit was passed through a series of three Endicott laboratory test sieves with mesh sizes of 10, 5 and 2mm, beginning with the largest and ending with the smallest mesh size. The weight of bone present in each sieve size was calculated as a percentage of the total weight of the cremation. At each of the three stages the bone sample recovered was examined in detail and sorted into identifiable bone types which were defined as skull (including mandible and dentition), axial (clavicle, scapula, ribs and vertebrae), upper limbs and lower limbs. Where a distinction could not be made between upper and lower limbs, fragments were grouped under the heading ‘longbones’. Metapodials were recorded with the appropriate upper or lower limbs. Each of these samples was then weighed on digital scales and details of colour and largest fragments were recorded. Also, where possible, the presence of individual bones within the categories was noted.

The Long Barrow

The Long Barrow lay on a low gravel island in the floodplain. Excavations in August–November 1989 uncovered evidence of a timber revetment, stone mortuary structure and central pit. The inhumations and cremation burials reported on here were largely from later phases of use. Exceptions are the fragments of bone from turf layers forming part of the mound (144, 159) and the fill of a stone cist (233). The mound had suffered extensive Roman and later plough damage. The preservation of both inhumations and cremation burials is therefore on the whole poor. Cremation burial 106 was partially machined and truncated by an assessment trench prior to the full excavation. Additionally, some of the pits containing cremation burials intercut (192–197) and this has implications for both quality of preservation

Table SS4.49. Redlands Farm. Details of cremations

Landscape unit/phase	*Cremation*	*Age*	*Sex*	*MNI1*	*Degree of burning and distortion*	*Comments*
Long Barrow						
3.3	106	adult	?	1	white and well calcined	in Deverel-Rimbury vessel, probably a Bucket Urn; 1 sherd of Peterborough Ware (4g); cut posthole 203=206
3.3	109	?	?	1	white and well calcined	context number assigned prior to discovery that this was 4 intercutting cremations (192–195)
3.3	110	adult	?	1	predominantly white with two blue-black long bone fragments	
3.3	111	adult	?	1	predominantly white with a small number of blue-grey fragments	small stones, 1 flint fragment
3.3	134	adult	?	1	predominantly white, two blue-black long bone fragments in 5mm sample	spread outside NE edge of Long Barrow, small stones in 2mm sample; Deverel-Rimbury pottery (11g)
3.3	162	?	?	-	white and well calcined	upper fill of barrow ditch
3.3	173	?	?	-	2 fragments only, white with blue-grey cortex	upper fill of barrow ditch
3.3	192	adult and subadult	?	2	white and well calcined	one of 4 intercutting cremation pits (192–195)
3.3	193	adult, subadult, infant	?	3	white and well calcined ??*in situ* burning	indeterminate prehistoric pottery (2g); one of 4 intercutting cremation pits (192–195)
3.3	194	adult	?	1	white excepting one blue-grey fragment	one of 4 intercutting cremation pits (192–195)
3.3	195	adult	?	1	predominantly white, some bone ends are a little grey	one of 4 intercutting cremation pits (192–195)
3.3	196	?	?	-	predominantly white, one fragment of skull vault is blue-grey	Deverel-Rimbury base, probably from Bucket Urn (31g); cut by cremation pit 197
3.3	197	?adult	?	1	white and well calcined	Deverel-Rimbury (6g); cuts cremation pit 196
3.3	198	adult and subadult		2	predominantly white, a few long bone fragments have cortices which are merely blackened	small stones and flint fragments; Deverel-Rimbury base, probably from Bucket Urn (746g)
3.3	201	adult and possible subadult	?	?2	white and well calcined	
3.3	202	?subadult	-	1	white and well calcined	Deverel-Rimbury? (< 1g); possible token deposit (or very badly disturbed)
3.3?	203	?	?	1	white and well calcined	203=206; cut by cremation pit 106
3.3?	206	?	?	1	grey-white	Late Neolithic/early Bronze Age stab-decorated pottery (2g); 203=206; cut by cremation pit 106
3.3	207	adult	?	1	white, one fragment with merely blackened cortex	small stones, one fragment of burnt flint
3.3	208 B	adult and ?subadult	?male	2	predominantly white, a small number of long bone fragments are blue-black	indeterminate prehistoric (1g)
3.3	1013/A/1 (trench 92)	?	?	?	1 fragment only, blue-black	

1 MNI = minimum number of individuals

Table SS4.50. Long Barrow. Breakdown of cremated bone weights by body parts

Sk = skull, A = axial, Ul = upper limb, Ll = lower limb

	10 mm						5 mm						2 mm						Total
Context	*Sk*	*A*	*Ul*	*Ll*	*unid*	*Total*	*Sk*	*A*	*Ul*	*Ll*	*Unid*	*Total*	*Sk*	*A*	*Ul*	*Ll*	*Unid*	*Total*	*weight*
106						22g						10g						3g	35g
109	2g			2g*		4g	<1g				5g	6g					2g	2g	12g
110	10g			45g*		55g	2g				91g	93g					11g	11g	159g
111	60g	6g	12g	50g	138g	266g	19g	1g	1g	5g	362g	388g					68g	68g	722g
134	19g	8g	26g	14g	49g	116g	10g	2g	3g	5g	136g	156g					37g	37g	309g
192	37g	2g	7g	59g		264g	5g	2g	<3	g>		232g						84g	580g
193	55g	14g	9g	27g	65g	170g						186g					52g	52g	408g
194	28g		4g	50g	54g	136g	5g		1g	2g*	76g	84g					20g	20g	240g
195	27g	9g		35g	73g	144g	4g	2g			66g	72g	1g				15g	16g	232g
196																			16g
197																			3g
198	80g	55g	43g	148g	614g	940g						302g					134g	134g	1376g
201	37g		<7g	2g>	120g	229g	2g			2g*	283g	287g	2g				85g	87g	603g
202																			2g
207	10g		4g	10g	23g	47g	3g			1g*	29g	33g					4g	4g	84g
208 B	94g	70g	76g	114g	544g	898g	14g	1g	<4	g>	521g	540g					64g	64g	1502g

and in particular the quantity of material recovered from individual contexts. In the case of the inhumations, quality of preservation has particular implications for the calculation of stature and the level of metric analysis which can be undertaken.

Phases 1 and 2

A stone cist, disturbed by later ploughing, was located at the south-west end of the Long Barrow. Several fragments of bone were recovered from the fill (233). The bone is almost certainly human and probably represents the much-degraded remains of a single long bone. All fragments have a well-weathered appearance. It is dated to 3710–3510 cal BC (4825±65 BP (OxA-5632); 4820±80 BP (OxA-5633)).

A single fragment of probable human long bone derived from a turf layer within the barrow mound (144). This bone had a well-weathered appearance.

A single incomplete adult ?second metatarsal was also recovered from the barrow mound (159). The distal end was missing and the proximal end had suffered some post-mortem damage that largely obscured the articular facets.

Phase 3.2 The inhumations

Three inhumations (130, 131 and 163) were inserted into the north-east end of the Long Barrow along the central axis (north-east/south-west). They were securely stratified, and one of the three (131) was associated with a Beaker and other diagnostic artefacts. In addition skeletons 130 and 131 have been radiocarbon dated.

Inhumation 130 was located 2m from the north-east end of the Long Barrow. The skeleton was crouched on its left side facing east. There were no associated grave goods and no grave cut was identified. Less than half of the skeleton was present and those bones which did survive were extremely fragmented and poorly preserved. The burial was that of an adult ?male. Assessment of sex was based on the morphology of the supra-orbital ridges which were hyper-masculine (Workshop of European Anthropologists 1980). Age was assessed entirely on the degree of molar attrition (Brothwell 1981, 72). Surviving canines and incisors had a marked degree of attrition with exposure of dentine throughout. A sample from this skeleton was dated to 2200–1890 cal BC (3665±45 BP (OxA-5549); Bayliss *et al* SS6).

Inhumation 131 was located slightly out of alignment in the centre of the row, approximately 3m from both 130 and 163. The skeleton was crouched on its right side with legs tightly flexed and the left arm crossed over the right. It lay in an oval grave which measured 1.2m x 0.9m x 0.08m. Associated grave goods comprised a shale armlet, a copper alloy earring, a fragmentary Beaker and two unretouched flint flakes. Approximately two-thirds of the skeleton had survived and preservation was fair although there were no complete long bones. The burial was identified as an adult female (Workshop of European Anthropologists 1980) of approximately 33–45 years (Brothwell 1981, 72). A carious cavity was present on the second left mandibular molar. An area of circular green staining was noted on the endocranial surface of the parietal measuring approximately 26 x 30mm. Surface degeneration of the right sacro-iliac joint was also noted. Porosity and eburnation were both present. Localised osteoarthritis can therefore be diagnosed. A sample from the skeleton was dated to 1890–1630 cal BC (3450±45 BP, BM-2833).

Of particular interest here is the presence of two other individuals within this grave cut. A second adult is represented by two mandibular incisors, a fragment of frontal bone and possibly by a fragment of ilium. A subadult is represented by an immature humeral diaphysis, dated to 2290–1980 cal BC (3730±45 BP, OxA-5550).

Inhumation 163 was located 3m south-west of burial 131. It was badly disturbed by ploughing and no grave cut was visible. Nor was body position discernible. Less than half of the skeleton had survived and preservation was extremely poor. The remains represent those of a probable adult individual whose gender could not be determined.

Phase 3.3 The cremation cemetery

A small cremation cemetery dating to the middle Bronze Age was located approximately 7m from the north-east end of the Long Barrow. Plough damage meant that in many cases only the bases of the cremation survived. Additionally some deposits were dispersed. Even taking in to account the level of disturbance and intercutting, it is clear that none of them are likely to have ever represented the complete remains of a single individual. Since burning in all cases was not *in situ* but must have occurred on a pyre with subsequent collection of material, it is probable that material was lost during the funeral ritual. Additionally losses in recovery and destruction of the bones whilst in the soil would have been inevitable. The quantity of bone recoverable from a modern adult cremation is between 1600–3600g, with an average of *c* 3000g (ie roughly the same weight as a dry-bone specimen (Wahl 1982; McKinley 1994). Only two of the cremation deposits from this cemetery weigh over 1000g (198 at 1376g and 208B at 1502g). All but one of the cremation burials were clustered together, some of them originally in Deverel-Rimbury urns. Cremation burial 105 was found close to the north-east barrow terminal.

Colour can be used as an approximate guide to firing temperature (Shipman *et al* 1984). Where bone is a neutral white colour this is indicative of a thorough even firing with temperatures in excess of 940°C.

Cremation burial 106 cut a Neolithic postpit (203/206) from which a Peterborough Ware sherd was derived. Both features lay on the same alignment as the Beaker inhumations. The cremation was damaged in antiquity by ploughing and by machining during the excavation. It weighed 35g and identifiable bone included skull vault, femur and scapula.

Context number 109 was assigned to a cremation deposit subsequently identified as four separate features (192, 193, 194 and 195). Approximately 12g of cremated bone were assigned to context 109. Identifiable fragments included skull vault, tooth root (?adult) and long bone fragments. It is not possible to identify which of the four subsequently identified deposits this material might have come from.

Cremation burial 110 lay in an oval pit north-west of 106 and east of 111. The deposit incorporated some large fragments of charcoal. There were 159g of predominantly white bone representing a possible adult. Identifiable bone included skull vault, three tooth roots, mandibular condyle, long bone fragments and one phalange.

Cremation burial 111 was in a round pit with a flattish bottom west of 110. This was a substantial deposit which weighed approximately 722g. The remains represented an adult individual. Identifiable fragments were frontal, petrous, dentition, atlas, axis, vertebrae, rib shafts, humerus, radius, ulna, lunate, femur, tibia, fibula, metapodials and phalanges. Thus it would appear that all parts of the skeleton were represented. Small stones and one flint fragment were also noted. The quantity of pottery associated with this deposit was small.

Cremation burial 134 was described as a spread of burnt bone. It weighed 309g and represented the remains of an adult individual. Identifiable bones included skull vault, 5 tooth roots, 1 molar crown, rib shaft, vertebrae including axis, humerus, radius, ulna, femur, tibia, fibula and phalanges. Only a small quantity of pottery was present.

Cremation burial 162 comprised a single fragment of long bone which weighed 3g. It derived from an upper ditch fill.

Cremation burial 173 was described as a dark lens within ditch fill 129. There were two unidentifiable fragments weighing less than 1g.

Cremation burial 192 lay in an oval pit with near-vertical sides and a bowl-shaped bottom. It weighed 580g and comprised the selective remains of one adult and one subadult. Identifiable fragments included skull vault, 1 petrous bone, mandible, dentition, ribs, vertebrae, pelvis, proximal epiphysis and proximal diaphysis of immature humerus, immature femur, adult femur and tibia, adult fibula, adult and subadult patella, calcaneum and phalanges.

Cremation burial 193 lay in a circular pit with sloping sides and a flattish bottom. There were 408g of well calcined bone including the selected remains of three individuals. Identifiable bones included skull vault, at least three, possibly four petrous bones, tooth roots including one molar crown, rib shafts (both adult and subadult), pelvis, one vertebral body (possibly thoracic), humerus, radius, ulna, lunate, hamate, femur, tibia, left and right talus, diaphysis of proximal femur (subadult), distal epiphysis of tibia (subadult), fibula, phalanges and metapodials. A further two bones are clearly those of an infant and have been identified as ?humerus and clavicle.

Cremation burial 194 was located in a subcircular pit with sloping sides and a bowl-shaped bottom. It contained 240g of mainly well calcined bone. One fragment was blue-grey. Bones identified were skull vault including frontal, malar, mandible, 4 tooth roots, distal ulna and humerus, metacarpal, femur, tibia and two phalanges. One adult individual was represented.

Cremation burial 195 lay in a circular pit with vertical sides and a flattish bottom. The deposit comprised 232g of predominantly well calcined bone although some bone ends are a little grey. Identifiable bones were skull vault, a premolar crown, tooth roots, scapula, ilium, rib shaft, femur, distal tibia, distal femur, distal fibula and fibula shaft. One adult is represented.

Cremation burial 196 lay in a small circular pit which was very shallow and bowl-shaped. It had almost certainly suffered considerable plough damage. It comprised 16g which were white excepting 1 blue-grey fragment of skull vault. Identifiable bones were skull vault and long bone shaft.

Cremation burial 197 lay in an oval pit with sloping sides and a rounded bottom. It was cut by 196 and consequently weighed only 3g. Identifiable bone included 1 fragment of skull vault, 1 fragmentary tooth root and 1 phalange.

Cremation burial 198 lay in a round pit with irregular sloping sides and a rounded bottom. It was contained within a pottery vessel, the top of which had been destroyed by ploughing. This deposit was one of the most substantial and weighed 1376g. The pieces were predominantly white although a few long bone fragments had merely blackened cortices. Identifiable bones included skull vault (adult and subadult), 1 petrous bone, 2 tooth roots, humerus, radial head, ulna, femur (adult and immature femoral diaphysis), tibia, proximal fibula, talus, navicular, patella, 1st metatarsal. The remains represent one adult and one subadult. The most substantially preserved urn (Fig. SS3.72: P16) was associated with this deposit.

Cremation burial 201 lay in a round pit with irregular sloping sides and a flattish bottom. It comprised 603g of white and well calcined bone. Identifiable fragments included skull vault (frontal), maxilla, 9 tooth roots, 1 articular facet (probably cervical), 1 metacarpal, long bone fragments, 1st meta-tarsal and 2 phalanges. The remains represent one adult ?male and one child? represented by a deciduous tooth root.

Cremation burial 202 was located in an oval pit with sloping sides and a rounded bottom. Only 2g of burnt bone were recovered. A few fragments of thin skull vault were tentatively identified as subadult.

Feature 203=206 was a single posthole, although cremated bone is labelled separately as deriving from both 203 and 206. It was cut by cremation deposit 106, and the bone ascribed to it is likely to derive from cremation 106. Cremation deposit 203 comprises 2g including a fragment of skull vault. Cremation deposit 206 weighs 10g. There are no identifiable fragments.

Cremation burial 207 was located in a circular pit with sloping sides and a rounded bottom, the top of which was damaged by ploughing. It weighed 84g and was well calcined with the exception of one fragment with a blackened cortex. Identifiable bone included skull vault, humerus, radius, ulna, femur and tibia. One adult individual was represented.

Cremation burial 208 **B** lay in a circular pit north of the main group. Charcoal was present in the top fill, and a fragment of oak charcoal from it has been dated to 1860–1420 cal BC (3320±80 BP, OxA-2989). This was the largest deposit and comprised 1502g. The fragments were predominantly white excepting a small number of blue-black long bone fragments. Identifiable bones were skull vault, 2 petrous bones, 2 mandibular condyles, tooth roots, pelvis, vertebrae, sacrum, scapula, 2 humeral heads, humerus shaft, radius, ulna, femur, tibia, fibula, distal tibia, distal fibula and phalanges. The remains represent one adult ?male and one possible subadult.

At Briar Hill a small cremation cemetery comprising at least 27 small pits was excavated (Bamford 1985, 47–49, fig 25). These were tightly grouped and overlapping. In two of the pits (240 and 243) it would appear that the bone was originally contained in a perishable container, since pottery was absent and the cremated bone was found to be very compacted within the fill. The excavators suggested that the cemetery had been in use for some time 'judging by the way the pits were intercut' (Bamford 1985, 49). A comparable cremation cemetery was found at Brampton Hall Farm, Chapel Brampton, north of Northampton (Moore 1971; 1973).

Barrows 7 and 8

Barrows 7 and 8 lay approximately 280m north-east of the Long Barrow on a low gravel island. Minimal excavation was carried out due to an agreement that they be preserved within the gravel extraction area.

One grave and two probable graves were identified in Barrow 7 (2000, 2004 and 2005), although only 2000 was excavated. It was a subrectangular feature 2.30m long, 1.60m wide and up to 0.30m deep. The skeleton was orientated south-west/north-east, facing north-west, and had been placed on its back with legs drawn tightly into the body and arms were by the sides. The majority of bones survived largely in powdered form and therefore the proportion present could not be calculated. Preservation was extremely poor. Sex could not be determined and an age estimate of 25–35 years was based entirely on dental attrition (Brothwell 1981, 72). A sample from this skeleton was submitted for radiocarbon dating but there was insufficient collagen present.

A cremation burial (2009) was located at the centre of Barrow 8 but it was not excavated

Barrow 9

The barrow had suffered extreme plough damage and the preservation of the skeletons in the shallower graves reflects this. Five inhumations were recovered. Age estimates were based entirely on dental development (732, 737, 738, 751) and attrition (747). It was not possible to use diaphyseal length to estimate the ages of the four subadults as none had survived in a complete state. The sex of the adult was based on skull and pelvic morphology.

Inhumation 732 was a subadult aged approximately 10–12 years. Approximately half of the skeleton had survived and preservation was poor. The skeleton is dated to 1920–1690 cal BC (3500±70 BP (OxA-5548); 3495±40 BP (OxA-5547)).

Inhumation 737 was a subadult of approximately 5–7 years. Less than half of the skeleton was present and preservation was poor. Very mild cribra orbitalia affected the left orbit. The skeleton is dated to 2140–1920 cal BC (3690±40 BP (OxA-5545); 3615±45 BP (OxA-5546)).

Inhumation 738 was a neonate burial which was located in the upper fill of grave 741. Less than half of the skeleton had survived and preservation was very poor. The location of this skeleton suggests that the precise location of the earlier grave was known.

Central inhumation 747 lay in a subrectangular grave (727) which measured approximately 3m x 1.6m x 1.15 m. A natural feature at the south end made it difficult to determine the exact length of the grave. The skeleton was orientated south-west/north-east and lay in a crouched position apparently within a wooden mortuary structure. Preservation was fair and approximately two-thirds of the skeleton had survived. The remains were those of a male aged approximately 33–45 years (Brothwell 1981, 72). Calculus was present on all surviving teeth. Slight rotation and crowding of incisors was noted. The skeleton is dated to 2200–1950 cal BC (3750±55 BP (OxA-5544); 3645±45 BP (OxA-5543)).

Inhumation 751 was a subadult of approximately 4–6 years who was associated with a complete Beaker. Preservation was poor and the remains comprised mandible, humerus, femur and tibia. These are dated to 2140–1780 cal BC (3610±50 BP (BM-2866))

Catalogue of human remains from Redlands Farm

1. Long Barrow: inhumations and disarticulated bone

Skeleton 130
Context: crouched inhumation cut into top of barrow, skeleton lay on its left side, facing east, considerable plough damage no visible grave cut.
Material: less than half complete; bones extremely fragmented and poorly preserved.
Sex: male (Workshop of European Anthropologists 1980). Assessment based on presence of hyper-masculine supra-orbital ridges.
Age: adult (25–35 years)
Dental formula:

-	-	-	5	-	-	-	-	1	2	3	-	5	6	-	-
-	-	-	-	-	3	2	1	-	2	3	-	-	-	-	-

Stature: no complete long bones
Comments: Age estimate is uncertain, as it is based on the level of attrition affecting the only surviving molar; the dentine of all surviving teeth is exposed.

Skeleton 131
Context: crouched inhumation cut into top of Long Barrow, skeleton lay on its right side facing east.
Material: two-thirds complete; preservation fair
Sex: female (Workshop of European Anthropologists 1980)
Age: 33–45 years
Dental formula:

8	-	-	-	-	-	2	1	1	2	3	4	5	6	7	8
8	7	6	5	4	3	2	-	-	2	3	4	5	6	7	-
	c														
x	k	k	k	k											

Dentine of all surviving dentition is exposed.
Stature: no complete long bones
Non-metric traits: retention of metopic suture, right septal aperture
Comments: Fragment of right auricular surfaces shows marked surface degeneration, porosity and eburnation. An additional fragment which may be sacrum has a similar appearance. A circular area of green staining measuring approximately 26 x 30mm was noted on the endocranial surface of the right parietal. Staining almost certainly caused by associated copper alloy earring. The remains of a further two individuals are present. One is an adult with marked attrition of surviving dentition. Identifiable bones are 1–2 mandibular incisors, fragmented frontal bone and possibly a fragment of ilium. A subadult is represented by the presence of an immature humerus shaft. All of the above appears to have suffered animal disturbance in the form of gnawing of surfaces.

Skeleton 163
Context: inhumation cut into top of round barrow, body position uncertain, no visible grave cut.
Material: incomplete femora, fibula, calcaneum, talus; preservation very poor
Material: indeterminate
Age: adult?

Context 144
Context: derived from turf layer within mound.
Material: one fragment of long bone, possibly femur or tibia, almost certainly human.
Comments: Bone is unburnt and has a well weathered appearance.

Context 159
Context: barrow mound.
Material: a single incomplete adult ?second metatarsal, distal end missing, proximal end had suffered some post-mortem damage which largely obscured the articular facets.
Long Barrow: cremations.

Cremation burial 106
Context: within pottery vessel, upper part damaged by machine.
Material: 57 fragments, weight 35g, fragment size 4–43mm.
Colour: white
Identifiable bones: skull vault fragments, long bone fragments including femur and scapula.
Comments: This cremation cuts posthole or pit 203=206. A small quantity of bone said to derive from this context is probably associated with cremation 106. Some of the bone may derive from cremations 110 and 111.

Cremation burial 109
Context: original number assigned to single cremation which upon investigation was seen to be four separate deposits (192–195).
Material: 5 fragments in 10mm sample, weight 12g, maximum fragment size 27mm
Colour: white
Identifiable bones: skull vault, tooth root and long bone fragments

Cremation burial 110
Context: oval pit with a rounded bottom located north-west of 106 and east of 111, large pieces of charcoal in fill.
Material: 42 fragments in 10mm sample, 159g, maximum fragment size 54mm.
Colour: predominantly white with two blue-black long bone fragments.
Identifiable bones: skull vault, 3 tooth roots, mandibular condyle, long bone fragments, 1 phalange.
Comments: Possible adult.

Cremation burial 111
Context: subcircular pit with sloping sides and flattish bottom located south-west of 110.
Material: 219 fragments in 10mm sample, 722g, maximum fragment size 55mm.
Colour: predominantly white with a small number of blue-grey fragments.
Identifiable bones: skull vault including frontal, 1 petrous bone, dentition represented by 7 tooth roots, atlas, axis (represented by odontoid process only), one vertebral body, 1 vertebral articular facet, rib shaft fragments, humerus, radius, ulna, lunate, femur, tibia, fibula, metapodials, phalanges.
Comments: One adult individual. Small stones and one flint fragment also present.

Cremation burial 192
Cremation pits 192–195 are intercutting, so some mixing of bone deposits is likely.
Context: oval pit with near-vertical sides and bowl-shaped bottom, partly machined.
Material: 190 fragments in 10mm sample, weight 580g, maximum fragment size 50mm.
Colour: white.
Identifiable bone: skull vault (adult and subadult), one petrous bone, mandible, dentition, ribs, vertebrae, pelvis, proximal epiphysis and proximal diaphysis of immature humerus, immature femur, adult femur and tibia, adult fibula, adult and subadult patella, calcaneum, phalanges.
Comments: One adult and one subadult are present.

Cremation burial 193
Context: circular pit with sloping sides and flattish bottom mottles of scorched earth within fill.
Material: 142 fragments in 10mm sample, weight 408g, maximum fragment size 49mm.
Colour: white.
Identifiable bones: skull vault (predominantly thin), at least 3 possibly 4 petrous bones, tooth roots including molar crown, rib shafts (adult and subadult), pelvis, one vertebral body possibly thoracic, humerus, radius, ulna, lunate, hamate, femur, tibia, left and right talus, Diaphysis of proximal femur (subadult), distal epiphysis of tibia (subadult), fibula, phalanges, metapodials
Comments: Three individuals are represented in this deposit. Two bones in the 5mm sample clearly belong to an infant: ?humerus and clavicle. The 5mm sample additionally contains the skull vault and possibly the dentition of two individuals.

One adult, one subadult, one infant.

Cremation burial 194
Context: subcircular pit, one of four intercutting cremations.
Material: 85 fragments in 10mm sample, weight 240g, maximum fragment size 67mm.
Colour: White with the exception of one blue-grey fragment
Identifiable bones: skull vault including frontal, malar, mandible, 4 tooth roots, distal ulna and humerus, metacarpal, femur, tibia and two phalanges.
Comments: One adult

Cremation burial 195
Context: subcircular pit, one of four intercutting cremations.
Material: 91 fragments in 10mm sample, weight 232g, maximum fragment size 65mm, considerable fissuring, splitting of skull table.
Colour: predominantly white, some bone ends are a little grey.
Identifiable bones: skull vault, premolar crown, tooth roots, scapula, ilium, rib shaft, femur, distal end of tibia, distal femur, distal fibula. fibula shaft.
Comments: One adult individual.

Cremation burial 196
Context: small circular pit, cut to the west by cremation 197.
Material: 36 fragments, weight 16g, fragment size 2–59mm.
Colour: white, excepting one blue-grey fragment of skull vault.
Identifiable bones: skull vault and long bone fragments.

Cremation burial 197
Context: oval pit, cut cremation 196.
Material: 20 fragments. weight 3g, fragment size 4–21 mm.
Colour: white.
Identifiable bones: 1 fragment of skull vault, 1 fragmentary tooth root and one phalange. Possible adult.

Cremation burial 198
Context: cremation in pottery vessel, upper part of pot destroyed by ploughing.
Material: 693 fragments, weight 1376g, maximum fragment size 2–56mm.
Colour: predominantly white, a few long bone fragments have blackened cortices.
Identifiable bones: skull vault (adult and subadult), 1 petrous bone, 2 tooth roots, humerus, radial head, ulna, femur (adult and immature femoral diaphysis), tibia, proximal fibula, talus, navicular, patella, 1st metatarsal.
Comments: One adult and one subadult. Small stones and flint fragments are present.

Cremation burial 201
Context: subcircular pit with irregular sloping sides and flattish bottom.
Material: 182 fragments, weight 603g, maximum fragment size 52mm.
Colour: white.
Identifiable bones: skull vault including frontal, maxilla, 9 tooth roots, 1 articular facet (possibly cervical), 1 metacarpal, long bone fragments, 1st metatarsal, 2 phalanges.
Comments: One adult ?male and one possible child represented by a probable deciduous tooth root.

Cremation burial 202
Context: oval pit with sloping sides and rounded bottom.
Material: 14 fragments, weight 2g, fragment size 4–14mm.
Colour: white.
Identifiable bones: skull vault, this is quite thin.
Comment: Possible subadult.

Cremation burial 207
Context: circular pit with sloping sides and rounded bottom, plough damage.
Material: 168 fragments, weight 84g, maximum fragment size 44mm.
Colour: white excepting 1 fragment with blackened cortex.
Identifiable bones: skull vault, humerus, radius, ulna, femur, tibia.
Comments: One adult individual. Small stones and one fragment of burnt flint present.

Cremation burial 208
Context: irregular oval pit, charcoal in upper fill.
Material: 589 fragments in 10mm sample, weight 1502g, maximum fragment size 74mm, quite marked distortion of larger long bone fragments, skull has split in parts
Colour: predominantly white, a small number of long bone fragments are blue-black.
Identifiable bones: skull vault, 2 petrous bones, 2 mandibular condyles, tooth roots, pelvis, vertebrae, sacrum, scapula, 2 humeral heads, humerus shaft, radius, ulna, femur, tibia, fibula, distal tibia, distal femur, phalanges.
Comments: One adult ?male (based on the presence of a very large odontoid process) and one possible subadult (based on the presence of fragments of thinner skull vault and incompletely closed root tips).

Deposit 134
Context: a spread located outside the north-east end of the Long Barrow. It almost certainly represents ploughed out material deriving from certain of the cremations.
Material: 69 fragments in 10mm sample, weight 309g, maximum fragment size 40mm.
Colour: predominantly white, 2 blue-black long bone fragments in 5mm sample.
Identifiable bones: skull vault, 5 tooth roots, 1 molar crown, rib shaft, vertebrae including axis, humerus, radius, ulna, femur, tibia, fibula, phalanges.
Comments: One adult individual. Small stones present in 2mm sample.

Deposit 162
Context: upper fill of Long Barrow ditch.
Material: 1 fragment, weight 3g, fragment size 25mm.
Colour: white.
Identifiable bones: long bone fragment, possibly femur or tibia.

Deposit 173
Context: dark lens located within upper fill of Long Barrow ditch 129.
Material: 2 unidentifiable fragments, weight less than 1g, fragment size 7mm.
Colour: white with blue-grey cortex.

Deposit 203=206
Context: these numbers have been assigned to a single posthole. It was cut by cremation 106 and it is probable that the cremated bone attributed to this context is actually derived from that cremation.
Material: 61 fragments, weight 13g, fragment size 3–17mm.
Colour: white, grey-white.

One fragment of skull vault.

Barrow 7

Skeleton 2000
Context: supine with legs flexed, arms flexed tightly at elbows, hands placed on chest.
Material: The majority of bones survived largely in powdered form and therefore the proportion present could not be calculated; preservation was extremely poor.
Sex: indeterminate.
Age: 25–35 years (based on dental attrition (Brothwell 1981, 72).
Dental formula:

8	-	6	5	-	-	2	-	1	-	3	-	5	6	7	8
8	7	6	5	4	-	-	-	-	-	-	4	5	6	7	8

Stature: no complete long bones

Barrow 9

Skeleton 732
Context: crouched on left side, secondary burial.
Material: Fragmentary long bones, mandible and skull vault, about fifty percent of skeleton is present; preservation poor.
Age: 10–12 years (based on dental development).
Dental formula:

u	k	k	e	e							/	k	u
T	T	T	T	T	T	T	T	T	T	T	T	T	T
7	6	E	4	3	2	1	1	2	C	4	5	6	7
7	6	E	4	3	2	1	1	2	3	4	E	6	7
e	k	k	e	e					e		k	k	u

Very slight exposure of deciduous dentine, hypoplasia of 3s and mandibular 4s.

Skeleton 737
Context: supine with legs flexed, secondary burial.
Material: Less than half of skeleton present, very fragmented long bones, vertebral arches and rib shafts; preservation poor.
Age: 5–7 years (based on dental development).
Dental formula:

u				3					3	4	u		
7	-	-	D	C	-	-	-	2	C	D	5	6	
7	6	E	4	3	2	1	1	2	3	4	E	-	
u			u	u					u	u			

Very slight exposure of deciduous dentine.
Comments: Very mild cribra orbitalia affecting left orbit.

Skeleton 738
Context: body position unclear, secondary burial.
Material: less than fifty percent survival, very fragmented long bones, skull, rib and vertebrae; preservation very poor.
Age: neonate (Basi-occipital width is equal to length. This is indicative of a pre-term baby (28–37 weeks). Therefore the baby was born prematurely and died during or immediately after birth).

Skeleton 747
Context: supine with legs tightly flexed, primary burial within wooden mortuary structure.
Material: approximately two thirds of skeleton survives, only one vertebrae; preservation fair.
Sex: Male
Age: 33–45 years.
Dental formula:

k	k	k	k	k	k	k	k	k	k	k	k	k	k	k	k
8	7	6	5	4	3	2	1	1	2	3	4	5	6	7	8
8	7	6	5	4	3	2	1	1	-	3	4	5	6	-	8
k	k	k	k	k	k	k	k	k		k	k	k	k		k

Slight alveolar absorption/continuing eruption in response to wear. Dentine exposure affects all teeth particularly incisors. Slight crowding of maxillary incisors with very slight rotation of second maxillary incisor away from mid-line.
Comments: Skeleton is platymeric.

Skeleton 751
Context: crouched on right side, secondary burial.
Material: approximately two thirds of skeleton survived; preservation poor, no epiphyses, all long bones incomplete.
Sex: –.
Age: 4–6 years.
Dental formula:

-	e	d	-		-						
				2							
6					1	1					6
	e	d	c	-			-	-	d	e	

SS4.7.7 Overview

Angela Boyle

Introduction

This report is an attempt to provide a synthetic overview which encompasses the human remains from all the monuments variously excavated as part of the Raunds Area Project. Material was analysed by Simon Mays, Janet Henderson and the writer, all of whose reports are reproduced above. Methodology is detailed in the individual reports and is not repeated here.

The assemblage comprises thirteen inhumations, ten deposits of disarticulated material and forty-three deposits of cremated bone. A single deposit of cremated bone was lost soon after excavation (Barrow 1, F30440) and another was exposed though not excavated (Barrow 8, F2009).

The assemblage as a whole is not well preserved and in osteological terms there is not a great deal of information to be gleaned. Perhaps of more interest is a consideration of a limited range of more general questions related to burial ritual. These include the treatment of the corpse prior to burial or burning and the evidence for ritual or ceremonial use of human remains.

Inhumation burials (Table SS4.51)

A total of twelve inhumations were associated with five funerary monuments: two from Barrow 1 (F6209 and F6410), one from Barrow 6 (F4647), three from the Long Barrow (F130, F131 and F163), one from Barrow 7 (F2000) and five from Barrow 9 (F732, F737, F738, F747 and F751).

Preservation was generally poor, or at best fair. A sample from F2000, Barrow 7 was submitted for radiocarbon dating but there was insufficient collagen surviving. Grave F725 in Barrow 9 was very shallow and the skeleton had been plough damaged. All three burials from the Long Barrow (F130, F131, F163) had suffered plough damage.

Age and sex

A detailed breakdown of the age of all inhumations appears in Table SS4.51. There were eight articulated adult inhumations. Five were males or probable males (from the central grave of Barrow 6, the primary burial and a secondary grave in Barrow 1, F130 cut into the Long Barrow, and the central grave of Barrow 9), one was a female (from F131 cut into the Long Barrow) and two were unsexed (from F163 cut into the Long Barrow and F2000 in Barrow 7). The remaining four were subadults (from peripheral graves in Barrow 9). No attempt has been made to sex the subadults. Ages ranged from perinatal infant to 45 years.

The biggest group of inhumations in the entire project derived from Barrow 9 and comprises one adult male and four children. One of these (738) was a perinatal infant (28–37 weeks) whose grave was cut directly through a secondary burial (751). This suggests that the latter grave was clearly marked and that superimposition was deliberate. 751 was the only burial in Barrow 9 to be accompanied, by a complete Beaker vessel. A femur from a slightly older neonate infant (37–38 weeks) was found in the uppermost fill of the outer ditch of Barrow 6. It may well have been all that was left of a complete burial which had weathered out of the mound.

Stature

Preservation was generally poor and there were few complete long bones. Therefore it was only possible to calculate the stature of three individuals. Skeleton 6209 from the secondary grave in Barrow 1 was 1.72m (5ft 6.4ins) and skeletons 4647 from the central grave of Barrow 6 and 6410 from the primary burial in Barrow 1 were both 1.77m (5ft 8ins).

Skeletal pathology

Few pathological manifestations were observed. There were two incidences of degenerative joint disease (skeleton 6410 and the skeleton from F131). In the case of 6410 the torso, spine, shoulders and hands were affected. One of the subadults from Barrow 9 (737) had cribra orbitalia which has traditionally been interpreted as an indicator of iron deficiency anaemia, although its aetiology is not fully understood (Stuart-MacAdam 1991). Skeletal evidence for trauma was seen on 6209. There was degenerative change involving the bones of the right ankle joint and foot (tibia, fibula, talus, calcaneum and navicular). Despite the absence of any evidence for a fracture, it is suggested that this was the result of trauma, the arthropathy being secondary.

Dental health

A single individual had caries (from F131), one had an abscess and periodontal disease (6410). Enamel hypoplasia was noted on the dentition of two (4647 and 732), while skeleton 747 had crowding and rotation of the incisors.

Disarticulated unburnt bone

Small quantities of disarticulated bone were associated with a number of monuments: 3 fragments of femur representing at least two adult individuals from the Riverside Structure (contexts 7367, 7203); a right adult tibia shaft and right adult calcaneum from Barrow 3 (contexts 37312, 37311); the disarticulated remains of two adult males from Barrow 6 (Skelton 4654); an infant femur from the uppermost fill of the outer ditch in Barrow 6 (skeleton 4068); long bone from the stone cist of the Long Barrow (context 233); long

Table SS4.51. Summary of inhumations

Monument	*Context*	*Date*	*Associated structure*	*Associated objects*	*Skeleton No*	*Age*	*Sex*	*Stature*	*Skeletal pathology*	*Dental pathology*	*Preservation*	*Completeness*
Long barrow	233 stone cist fill	3710–3510 cal BC				?					very poor, weathered	probable human long bone
	144 turf layer within barrow mound					?					very poor, weathered	probable human long bone
	159 mound					adult?					poor	?2nd metatarsal
	F130	2200–1890 cal BC				adult	M?			marked attrition	poor	>50%
	F131	1890–1630 cal BC		Beaker, 2 flint flakes, copper alloy basket earring, shale armlet		33–45 y	F		oa of right sacro-illiac joint	caries	fair	66%
	F131					adult	?				poor	2 incisors, frontal, illium
	F131	2290–1980 cal BC				subadult	-				poor	humeral shaft
	F163			flint knife		adult?	?				very poor, plough damaged	>50%
Riverside structure	7367 layer between riverbank and structure	clay layer sealing bone has OSL date of 2100–1260 cal BC			-	adult			carnivore gnawing			right femur shaft
	7203 silt layer post-dating structure, sealing a pit on river bank	post-dates 7367			-	adult						right femur shaft
Barrow 6	F3390 pit underlying central grave	3360–3030 cal BC		indeterminate pottery	4654	adult (25 y)	M M?				poor	
	F3259 central grave	2130–1820 cal BC		Beaker, flint tools, chalk limp, jet button	4647	adult 25–35 y	M	1.77m	?flat foot, schmorl's nodes, spinal djd (possible traumatic cause)	calculus, enamel hypoplasia	fair	75%
	3196 uppermost fill of outer ditch				4068	infant 37–38 weeks	-					femur only
Barrow 3	F30787 cluster of limestone fragments in upper part of barrow mound				37312	adult					shaft	right tibia
	Ditto				37311	adult						right calcaneum

Table SS4.51. Continued.

Monument	*Context*	*Date*	*Associated structure*	*Associated objects*	*Skeleton No*	*Age*	*Sex*	*Stature*	*Skeletal pathology*	*Dental pathology*	*Preservation*	*Completeness*
Barrow 1	F30426 primary grave	2200–1920 cal BC	within partly charred oak plank chamber	Beaker, worked flint, wrist-guard, amberring, jet buttons, worked animal bone	6410	adult	M?	1.77m	djd	abscess, periodontal disease	poor	90%
	F30449 secondary grave	1940–1690 cal BC		bone pin	6209	20–30 y	M?	1.72m	trauma to right ankle		fair	90%
	Ditto				-	adult						left femur shaft
Barrow 7	F2000			LN/EBA sherd		25–35 y	?				very poor	>50%
Barrow 9	F725 secondary burial	1920–1690 cal BC			732	10–12 y	-			enamel hypoplasia	poor	50%
	F729 secondary burial	2140–1920 cal BC			737	5–7 y	-		cribra orbitalia		poor	>50%
	F739 cut into F741				738	28–37 weeks	-				very poor	>50%
	F727 central burial	2220–1950 cal BC	wooden coffin		747	33–45 y	M			incisor crowding and rotation	fair	75%
	F741 secondary burial	2140–1780 cal BC		Beaker	751	4–6 y					poor	66%

bone and a probable metatarsal from the Long Barrow mound (contexts 144, 159). In addition, the partial remains of an adult and a subadult were mixed with the inhumation in F131 cut into the Long Barrow. It is conceivable that these last represent disturbed burials. The subadult humerus shaft was radiocarbon dated (2290–1980 cal BC at 2 sigma) and it is at least 100 years older than the articulated inhumation in the same grave (1890–1630 cal BC), although it is broadly contemporary with the inhumation F130 (2200–1890 cal BC).

The disarticulated bone from the stone cist (233) within the Long Barrow mound and from the mound itself (context 144) had a very weathered appearance and there were traces of animal gnawing on one of the fragments from the Riverside Structure (context 7367). The disarticulated fragments found in the grave F131 were not weathered. This latter fact adds weight to the argument that these fragments do indeed represent the partial remains of disturbed burials, as opposed to bone which has been 'curated' elsewhere, for example, in the stone cist associated with the Long Barrow or a pit possibly associated with Barrow 6.

Simon Mays' comments on deposit 4654 in Barrow 6 are of particular interest (SS4.7.2) and therefore appear in full below.

> 'Many of the bones were moderately well preserved on one side but very eroded on the obverse face. The medial surface of a right tibia, for example, is largely intact but its lateral surface is heavily eroded. Observations in the field indicated that these heavily eroded surfaces are those which faced uppermost in the soil. Initially it was thought possible that this pattern of preservation suggested that the bones were left exposed to the elements or covered only by a very thin layer of soil, having been deposited in the pit in a disarticulated state. However, close examination of the remains suggests that this scenario is perhaps unlikely. The teeth are in good condition. Teeth, particularly the enamel parts, tend to fragment if exposed to the elements for any length of time. Large pieces of cancellous bone are present; these would be rapidly destroyed if left exposed on the surface. It has been the writer's (S Mays) experience that, when a grave is cut by a later feature (be it another grave or not), the bones lying nearest the later cut are frequently rather worse preserved than those lying further away. The reasons for this are obscure, but it may be related to differences in permeability between natural, undisturbed soil and the

more loosely packed soil of a man-made feature. The bones lay only a few centimetres beneath central grave cut F3259; the erosion on the upward-facing parts of the bones from F3390 is probably due to proximity of these surfaces to the later feature.

There is no evidence for mixing of bones between F3390 and F3259. The bones in F3390 were clearly interred when the soft tissues had decayed. No signs of animal gnawing were found on the bones. No cut marks were found, as might be expected if the flesh had been cut from the bones as part of the funerary ritual. It thus seems that the corpses must have been left to decay naturally, in a place where animals could not gnaw the bones, most probably by earth burial. The skeletons were then exhumed and some bones taken and buried in F3390. This indicates that the location of the pit was marked in some way.'

Cremation burials (Table SS4.52)

Quantification

A total of forty-three deposits of cremated bone were recovered from eight monuments and two discrete features; Barrow 1 (skeletons 6400, 6401, 6402, 6403, 6404 – lost), Barrow 3 (skeletons 6411, 6412), Barrow 4 (skeleton 6460), Barrow 5 (skeletons 6451, 6452, 6453, 6461), Barrow 6 (from F3206/3226, F3219, F3178), the Long Barrow (from F106, F109, F110, F111, F192=109, F193=109, F194=109, F195=109, F196=108, F197=108, F198, F201, F202, F203=206, F207, F208B, F162, F173, F179, F134, F1013/A/1), Barrow 8 (F2009 – not excavated), the Long Mound (skeleton 9213), the Segmented Ditch Circle (skeletons 6184, 6185, 6186) and two pits at West Cotton (F1741, F4948).

Age and sex

There were five possible males (6400, 6461, F201, F208B, 6184) and four possible females (6411, 6461, 3677, 6185), 18 unsexed adults (6412, 6451, 6452, 6453–2, 6461, F106, F109, F110, F111, F192=109, F193=109, F194, F195=109, F197=108, F198, F207, F134, F4948), one adolescent/adult (F1741) and 19 subadults (6400, 6401, 6402, 6403, 6411, 6460, 6451, F3206/3226, F3219, 9293, F192, F193=109 – 2, F198, F201, F202, F208B, 6186, 9293). A further five deposits were unidentifiable (F196=108, F203=206, F162, F173, 1013/A/1).

A number of the deposits comprised more than one individual and these are discussed in detail below.

Weight (Table SS4.53)

The weight of deposits was extremely variable, ranging from >1g–2846.5g. It is important to identify those whose weight has been directly affected by disturbance rather than deliberate selection. The majority of the cremation burials had suffered some damage and this is indicated in Table SS4.52.

Barrows 1, 2, 3 and 4 had undergone considerable erosion before alluviation began some 3000 years after monument construction; the buried soil beneath the alluvium had been ploughed at least until the Roman period.

Many of the cremation burials were therefore truncated, for example F3206, F3219, F3178, F1741 and F4948. Burning in all cases was not *in situ*, but must have occurred on a pyre, with subsequent collection of remains for burial. It is probable that much loss of material occurred during the funerary ritual, although inevitable losses in recovery, and destruction of bone whilst in the soil would also have played a part.

Exceptions include cremation 6184 from the Segmented Ditch Circle which weighed 1628.6g. This indicates that nearly the complete remains of this individual are present and consistently with this, fragments from most areas of the skeleton are present.

The expected weight of a cremation is derived from known weights of adult cremated remains from modern crematoria (using the >2mm fraction to render them comparable with most archaeological cremated material), which have been found to range between 1001.5g and 2422.5g, with an average of 1625.9g (McKinley 1993). Only six of the deposits from this monument complex fall within this range (6400, 6411, 6461, F198, F208B, 6184). It is surely significant that all these deposits, with the exception of F6184, contain the remains of more than one individual. Indeed, 6461 which is the heaviest at 2846.5g, contains the remains of three adults.

From a sample of *c* 4000 multi-period burials, a range of 57–2200g was obtained from undisturbed adult burials (McKinley 1994). The reason for this variation is uncertain. However it is clear that widely different quantities of bone were included in burials at the time of deposition.

McKinley noted (1997, 142) that primary Bronze Age barrow burials consistently produced high weights of bone (902.3g to 2747g with an average of 1525.7g), while the average weights of bone from contemporary cremation cemeteries were much lower (327g to 466g). At Barrow Hills, Radley,

Table SS4.52. Summary of cremations

Monument	*Context*	*Date*	*Skeleton no or find no*	*Age*	*Sex*	*MNI*	*Weight*	*Colour*	*Pathology*	*Associated objects*	*Comments*
Barrow 1	F30017 secondary burial within innermost barrow ditch	1950–1730 cal BC	6400	20–40 y 13–14 y	M? -	2	2424.3g (2495.1g)	neutral white, some bluish and blue-grey fragments		?Collared Urn, horn-hilted dagger, antler pommel, bone pin; pommel and pin are burnt	clinker present, truncated, damaged by ploughing and animal burrowing
	F30012 at top of cattle skull and limestone cairn					1				pottery, 2 flint flakes	
	F30030	1370–1000 cal BC	6401	2–6 y	-	1	26g	neutral white, a few fragments light grey		4 flint flakes, 4 irregular debitage all burnt	truncated, damaged by ploughing and animal burrowing, charcoal
	F30305 pit to SE of barrow		6402	2–10 y	-	1	24g (29.6g)	mainly neutral white, some fragments and many endosteal surfaces blue-grey			possibly truncated, charcoal and bone throughout fill
	F30307 pit to SE of barrow	1390–1120 cal BC	6403	2–5 y	-	1	18.8g	mainly neutral white, a few fragments light grey			possibly truncated, charcoal and bone throughout fill
	F30440		6404								possibly truncated, bone, charcoal and burnt stone, lost
Barrow 3	F30665 poorly defined pit in ESE quadrant of barrow		6411	16–25 y 14+ y	F? -	2	1222.2g (1797.4g)	mainly neutral white, a few fragments white-grey and blue-white			concentrated mass of bone, a few flecks of charcoal
	F30847 - pit near centre of barrow		6412	adult	?	1	112.3g (155.9g)	white, a few endosteal surfaces grey			loosely packed cremated bone, root and rabbit disturbance, with some cremated bone in adjacent burrow
Barrow 4	F60312 in western quadrant of barrow	1940–1530 cal BC	6460	12–16 y	-	1	99.4g (152.6g)	mainly neutral white, some fragments and many endosteal surfaces grey			badly preserved, charcoal flecks present
Barrow 5	F47111 secondary insertion into NE quadrant of barrow		6451	adult infant	? -	2	212.8g (234.8g)	neutral white, grey-white and grey		pottery	plough truncated, machine damage, some charcoal, infant femur only
	F47143 secondary insertion into NW quadrant of barrow		6452	30–50 y	?	1	247.2g (495.6g)	mainly white, a few grey fragments, some endosteal surfaces dark grey or black			badly damaged, burnt animal bone

Table SS4.52. Continued.

Monument	*Context*	*Date*	*Skeleton no or find no*	*Age*	*Sex*	*MNI*	*Weight*	*Colour*	*Pathology*	*Associated objects*	*Comments*
	F47087	3350–2920 cal BC (?old charcoal reburnt on pyre)	6453	adult adult	?	2	810.6g (1044.6g)	mainly neutral white, a few fragments grey-white or grey-blue		1 blade, 1 flake, 1 fabricator, all burnt	quite densely packed, apparently complete, charcoal
	F47171 centre of barrow, truncating primary feature		6461	20–40 y 20–40 y 20–40 y	M? F? ?	3	2846.5g (3959.3g)	mainly white, occasional grey or bluish-grey fragments	dental abscesses	Collared Urn, flint knife	plough damaged, multiple cremation in the true sense
Barrow 6	F3206/3226 cut into outer ditch of barrow	1750–1510 cal BC		infant	-	1	4.94g	infant			
	F3219 cut into outer ditch of barrow, marked by stake	2030–1870 cal BC			-	1	5.51g	neutral white		miniature Collared Urn	burnt animal teeth
	F3178 on berm between middle and outer ditches		3677	16–21 y	F??	1	523.21g	mainly neutral white, a few grey or bluish fragments		Collared urn, ceramic button, flint flake	cow/horse tooth, oyster shell, plough truncated
Long Barrow. MBA cemetery 7m NE of front end of mound	F106			adult	?	1	35g	neutral white		Deverel-Rimbury	plough and machine damage, partially truncated during machining of evaluation trench, possibly mixed with 110 and 111
	F109			?adult	?	1	12g	neutral white			number assigned to a cremation deposit which was subsequently identified as four separate features
	F110			adult	?	1	159g	neutral white, 2 blue-black fragments			large fragments of charcoal
	F111			adult	?	1	722g	neutral white, a few blue-grey fragments			
	F192=109			adult subadult	? -	2 2	580g	neutral white			partly machined, features 192–195 are intercutting so some mixing of deposits is likely, possible double cremation
	F193=109			adult subadult infant	? - -	3	408g	neutral white		1 pottery sherd (indeterminate)	features 192–195 are intercutting so some mixing of deposits is likely
	F194=109			adult	?	1	240g	neutral white, 1 blue-grey fragment			features 192–195 are intercutting so some mixing of deposits is likely
	F195=109			adult	?	1	232g	neutral white, some grey			features 192–195 are intercutting so some mixing of deposits is likely

Table SS4.52. Continued.

Monument	*Context*	*Date*	*Skeleton no or find no*	*Age*	*Sex*	*MNI*	*Weight*	*Colour*	*Pathology*	*Associated objects*	*Comments*
	F196=108			?	?	1	16g	neutral white, 1 blue-grey skull vault fragment		pottery	
	F197=108			adult?	?	1	3g	neutral white			
	F198			adult subadult	? -	2	1376g	mainly neutral white, a few black fragments		Deverel-Rimbury	plough damage, double cremation
	F201			adult subadult	M? -	2	603g	neutral white		Deverel-Rimbury	
	F202			subadult?	-	1	2g	neutral white			
	F203=206			?	?	1				LN/EBA pottery	
	F207			adult	?	1	84g	mainly neutral white, 1 blackened fragment		small stones, burnt flint	plough damage
	F208B	1860–1420 cal BC		adult subadult?	M? -	2	1502g	neutral white, a few blue-black fragments		1 sherd indeterminate	charcoal
	F162			?	?	-	3g	neutral white			1 fragment of cremated bone
	173, dark lens within ditch fill 129			?	?	-	< 1g	white and blue-grey			2 fragments of cremated bone
	134, spread outside NE edge of long barrow			adult	?	1	309g	white, 2 blue-grey fragments			
	1013/A/1 evaluation trench 92		?	?	?	>1g	neutral white				1 fragment of cremated bone
Barrow 8	F2009 cremation inserted into top of mound at its centre									Collared Urn or Food Vessel	left in situ, scorched clay fragments within pit, possible pyre debris
Long mound	F5549 small circular pit cut into natural at base of southern 'quarry pit'		9293	infant	-	1	1.51g				charcoal, pottery, worked flint (burnt and unburnt)
Segmented ditch circle	at W end of P87577	after 2020-1680 cal BC	6186	10-15 y	-	1	584g	neutral white			compacted deposit, possibly originally in organic container
	near top of backfill	after 2020-1680 of F87541	6185 cal BC	50+ y	F	1	549.8g little lightgrey	neutral white, a	osteophytosis on several vertebral bodies and facets		small charcoal flecks, probably truncated
	pit F87594 just inside circle	?post-dates 6185 and 6186	6184	20-40 y	M?	1	1628.6g	mainly neutral white, some light grey			compacted deposit, possibly originally in organic container
West Cotton discrete features	F1741 8m SE of long mound		4556	older adolescent/ adult	?	1	150g	mainly neutral white			compacted deposit, possibly originally in organic container, 1 fragment charcoal, plough truncated
	F4948 6m N of double ring ditch			adult	?	1	123.03	mainly neutral white, some blue fragments			charcoal flecks, charred plant remains, all material distributed throughout fill

Oxfordshire, deposits other than the central ones were on the whole very much smaller. This may suggest deliberate selection and burial of a token deposit (Boyle 1999, 176). Other possible causes of loss need to be considered and these include incomplete recovery, disintegration in the soil and truncation due to ploughing.

Multiple cremation burials (Table SS4.53)

The number of individuals within a deposit is demonstrated either by obvious age-related differences in bone size and development as one would see between an immature and adult individual, or by the duplication of identifiable bone fragments (McKinley 1997, 130). Multiple burials most commonly include a subadult or adult, of either sex, with an immature individual (McKinley 1997, 142).

A number of the deposits appeared to contain the remains of more than one individual (6400, 6411, 6451, 6453, 6461, F192, F193=109, F198, F201, F208B), however, the majority are not multiple burials in the true sense. A number of deposits had replication of only one skeletal element. For example, there was a distal right humerus in 6411 in Barrow 3; there were two mandibular condyles in 6451 in Barrow 5; and there was a midshaft part of an infant femur among the adult remains in 6453 at the edge of Barrow 5. The impression gained was therefore that each of these cremation burials predominantly contained the remains of only one individual. The question thus arises as to whether these contexts should be considered as 'true' double cremation burials, or whether the duplicated fragment should be regarded as a 'stray' element in a single cremation burial. A major hindrance in answering this question is the substantial quantity of bone in a cremation burial which remains unidentifiable: clearly one might make the argument that had more fragments been identifiable more remains of a second individual would have emerged. Against this, however, was the fact that, in addition to the material which could be identified to skeletal element, there was a substantial portion which could be identified to the level of 'longbone', 'flatbone', etc.

In the two cases where only adult bones were present (6411 and 6453) there were no differences in the robusticity of the remains, stage of closure of the skull sutures, etc, which might have suggested the presence of two individuals even in the absence of further duplication of skeletal elements. In 6451 there was no evidence for further infant remains (such as deciduous tooth fragments, unfused epiphysial surfaces or thin skull fragments).

Cremation 6452 had been disturbed by a medieval plough furrow – thus the infant femur may well be a stray bone. If the same pyre (or pyre area) was used for several separate cremations, then, when the remains of a cremated individual were collected together for burial, bone fragment(s) from a previous cremation may have been inadvertently (or even intentionally) included with them. At some sites where artefacts were burnt with the body adjoining fragments of the same artefact were found in different burials, suggesting that this type of scenario may have occurred. Unfortunately no such adjoining fragments were found in the Irthlingborough cremations. However this is an explanation which would be consistent with the findings in cremations 6421 and 6453.

The remains of 6400 and 6461 indicated that they were multiple cremations (double and triple) in the proper sense. From inurned cremation 6461, sample 33089 was from inside the urn and sample 33090 was from the soil surrounding it; there was no evidence for segregation of the remains of different individuals inside and outside the urn (although it must be remembered that the burial was somewhat disturbed).

F192 near the Long Barrow contained the partial remains of one adult and one subadult both represented by multiple skeletal elements. The identification of the deposit from F193, also near the Long Barrow, as a true multiple cremation is less certain: the majority of the bones are adult, the subadult is represented by rib, femur and tibia, while the infant is represented by clavicle and probable humerus.

The deposit from F198 is though to be a genuine double cremation burial (adult and subadult) while the subadult in the deposit from F201 is only represented by a single deciduous tooth root.

Deposit 6461 from the centre of Barrow 5 is interesting – the feature containing a

Table SS4.53. Weight categories of all cremation deposits

Weight range	*Cremation nos*	*Total*
>100g	6401, 6402, 6403, 6460, F3206/3226, F3219, 9293, F106, 109, F196=108, F197=108, F202, F207, 162, 173, 134, 1013/A/1, 9293	17
100–499g	6412, 6451, 6452, 4556, F4948, F110, F193=109, F194=109, F195=109	11
500–999g	6453, 3677, F111, F192=109, F201, 6186, 6185	7
1000–1999g	6411, F198, F208B, 6184	4
2000–3000g	6400, 6461	2

multiple cremation cut into an empty grave which contained the standard range of Beaker grave goods but no bone – Is it conceivable that after disturbance the inhumation was removed and cremated with the other adults identified in this cremation?

Burnt and unburnt animal bone
From a total of *c* 130 British Bronze Age burials, about 16% contained fragments of cremated animal bone (McKinley 1997, 132). The quantities recovered were generally small, including parts of one or two species, most commonly immature sheep/goat or pig and bird. With both artefacts and animal bone it should be remembered that since not all of the human bone was collected for burial it is probable that neither were all of the pyre goods, hence those noted should be viewed as a minimum.

Pyre sites (in situ burning)
No evidence for *in situ* burning was identified in association with any of the cremation features. This is not necessarily surprising: at Barrow Hills, evidence of *in situ* burning within monuments had only been found during earlier excavations in the first half of the twentieth century (Boyle 1999, 171), the more recently excavated monuments had suffered considerable plough damage.

Pyre debris dumps
Redeposited pyre debris comprises a mix of fuel ash (most frequently charcoal), with (depending on the soil over which the pyre was constructed) burnt flint, burnt stone, burnt clay and fuel ash slag, often incorporating cremated bone and fragments of pyre goods (McKinley 1997, 137). The upper fills of the Long Barrow ditches contained dumps of burnt material; scorched clay was associated with the cremation burial at the centre of Barrow 8.

Selection of body parts
Experimental cremation has indicated that throughout the process the corpse (sheep and neonatal lamb) remained in position above the wood; in the final stages the cremated bone and charred soft tissues were in correct anatomical position on the bed of wood ash. At the end of cremation the entire skeletal remains were present, clearly visible above the wood ash and easily collectable by hand, although this took about four hours (McKinley 1997, 134). Given the disturbed nature of the majority of the cremation burials this issue cannot be pursued.

Temperature (Table SS4.54)
Bone colour may be used as an approximate guide to firing temperature. Uniformity of colouration denotes even firing, with no evidence for variation in firing temperature or duration across different parts of the body. In all cremation burials the fragments were predominantly neutral white in colour, with some greys and blues. Shipman *et al* demonstrate that colour can be used as a very approximate guide to firing temperature (1984). The appearance of the fragments suggests temperatures in excess of 645° C, and probably in excess of 940° C.

In many cases endosteal surfaces were less well fired than periosteal surfaces. Since the heat of the pyre causes the bones to shatter, exposing their endosteal surfaces, lesser firing of these surfaces suggests that either the heat of the pyre was already past its peak when this occurred or, perhaps more likely, that when the bones shattered the fragments fell down towards lower, cooler parts of the pyre.

Cremation 6400 contained a small quantity of 'clinker', a pale yellow/greenish-coloured material. It has an irregular, glistening surfaces which shows many small cavities and vesicles. It has unfused soil particles adhering to its surface. The material weighs 0.57g (including adhering soil) and measures 20 x 13 x 11mm. This seems to be the same material as the 'clinker' first described in archaeological cremations by Wells (1960). He suggested that it was derived from burnt hair, but later work (Henderson *et al* 1987) showed that this explanation was unlikely and that the 'clinker' was probably a result of fusion of soil with material from the pyre. The intimate association between the soil and the clinker in the present case might be viewed as consistent with this suggestion.

Table SS4.54. Colours observed after heating of fresh goat bone (Mays 1998, table 11.1)

Mays' results		*Shipman et al's 1984 results*	
Temperature (°C)	*Colour*	*Temperature (°C)*	*Colour*
185	red/orange	under 285	white or yellow
285	dark brown/black	285–525	red/brown, red/yellow, dark grey/brown or dark grey
360	black		
440	grey/brown	525–645	black, blue or red/yellow
525	grey/brown (lighter than that observed at 440°C)	645–940	white, light grey or light blue/grey
645–1200	white, some pale yellow	940	white, some grey or red/yellow

SS4.8 Soils and sediments

Richard I Macphail

SS4.8.1. The Long Barrow, soil microstratigraphy and chemistry

Introduction

In 1989 the long barrow at Redlands Farm was excavated by the Oxford Archaeological Unit. The site is located on a low gravel island in the floodplain of the river Nene, and comprises part of the prehistoric monument complex around Raunds (Windell *et al* 1990; Keevill 1992b). The monument, which is Neolithic in origin, was later re-used by the insertion of three Beaker inhumations into the mound and badly disturbed by probably Romano-British ploughing. The latter badly damaged the south western end of the barrow. Post-Roman alluviation partly sealed the monument. Preliminary phasing suggests that the site was cleared, as indicated by treethrow holes in the old ground surface, and a central pit and cist were constructed prior to being sealed by the barrow. The Long Barrow was set between two flanking ditches. Radiocarbon determinations on bone from the cist and waterlogged samples from the ditches place the construction of the barrow in 3710–3430 cal BC at 95% confidence (Bayliss *et al* D6, OxA-3001, -3002, -3003, -5632, -5633, -6405, -6406).

Soil sampling was carried out to investigate a possible ploughsoil present between the mound and the OLS/natural subsoils, and buried soils associated with a treethrow hole and local to the cist. Fieldwork was carried out during a heavy rainstorm at the end of the excavation and samples were not located on the field sections during the author's visit. There is now some confusion over the contexts which were sampled, the author thinking that he had mainly sampled the buried soils, whereas the layers sampled are described in the context records as forming the lower part of the mound (context 138; Phillippa Bradley, pers comm). The field data recorded by Macphail is, however, assumed to be correct and is followed in this report, as sample 155 was marked in the author's field notebook as being taken from the same level as the disturbed soil in the treethrow hole (context 219) and as there are also discrepancies between the author's recorded location of the samples and the context record. There is also a secondary confusion over the terming of the OLS as the layer below context 219 when layer 219 was described as ploughsoil below the mound. Some of the discrepancies concerning the actual level of the buried OLS *sensu stricto* may arise from soil mixing by earthworms which can quite easily mask junctions of OLS and monuments (cf the Overton Down experimental earthwork; Bell *et al* 1996). The results of the analytical studies throw a little more light on the probable sample locations, and the taphonomy and origins of the site's buried soils and mound deposits.

This soil investigation was carried out within the context of the Raunds Area Prehistoric Project (English Heritage). As part of this, the soils of seven prehistoric (Neolithic to Bronze Age) barrows and five treethrow holes at Irthlingborough and West Cotton have also been under investigation by the author. The same techniques as those used at Redlands Farm were employed. This wider investigation has therefore been able to supply reference and archaeological soil data across the local area of the Nene floodplain for the Redlands Farm long barrow project.

Samples and methods

During fieldwork, soils were briefly described and six 150mm long undisturbed Kubiena samples were collected from the site (Table SS4.55; Fig SS1.45). These are:

Sample 151 from the mound (context 138),

Sample 152 from the mound (?) (context 138),

Sample 153 from the supposed buried ploughsoil (context 219),

Sample 154 from the supposed buried ploughsoil (context 219),

Sample 155 from the mound soil associated with a treethrow hole (context 138/139?), and

Sample 156 from a soil local to the cist (context 138?).

Each Kubiena sample was complemented by a bulk sample (listed as x151–x156; Table SS4.55). Samples 151–153 form a continuously sampled vertical sequence through the mound into the buried soil towards the north-eastern end of the long mound. Sample 154 was taken through the supposed ploughsoil 5m to the north-west. Sample 155 was located some 9m to the south-west of samples 151–153, with sample 156 being taken some 15m further to the south-west. Thus four widely dispersed areas of the site were sampled. A similar soil sampling strategy at the Neolithic long barrow at Hazleton,

Table SS4.55. Long Barrow. Soil micromorphology: soil samples and chemistry

Data supplied by Roger Engelmark and Johan Linderholm of the Laboratory for Environmental Archaeology, Department of Archaeology, Umeå University, Sweden

	F2 *Depth (m)*	F3 *Chemistry number (thin section)*	F4 *LOI*	F5 *P°*	F6 *Ptot*	F7 *Pt/P°*	F8 *MS*	F9 *MS550*	F10 *Context/deposit/feature*
Thin section sample									
151	c 0.40	x151	6.4	100	560	5.6	248	464	138: Dark brown (7.5YR3/4) mound becoming a mottled dark reddish brown (5YR3/3) with depth.
152	*c* 0.55	x152	6.3	90	470	5.1	289	443	138: Dark reddish brown (5YR3/3) mound/buried soil (?).
153	*c* 0.70	x153	6.0	90	430	4.9	275	356	219: Brown (7.5YR4/4) buried soil, over loose sands and gravels.
154	*c* 0.70	x154	4.4	90	370	4.3	250	288	219: Adjacent dark reddish brown (5YR3/3) buried soil (undulating surface area).
155	*c* 0.20 ?	x155	5.0	110	440	3.9	283	333	138/139: Dark reddish brown (5YR3/3) mound/buried soil (?) (by tree-throw hole).
156	*c* 0.20 ?	x156	4.8	90	370	4.2	103	146	138: Mottled brown (7.5YR4/2) mound/buried soil (?) (by cist).
Reference samples									
		Reference x1	2.1	90	230	2.6	33	60	bB2 horizon, Turf Mound
		Reference x2	3.3	130	350	2.6	48	133	bBt horizon, Turf Mound
		Reference x3	2.1	100	250	2.4	24	52	bB2 horizon, Barrow 5
		Reference x4	4.4	150	380	2.6	24	210	bBt horizon, Barrow 5

Gloucestershire, had proved successful (Macphail 1990a).

Undisturbed samples were air-dried, impregnated with a crystic resin mixture at the Institute of Archaeology, UCL and manufactured into large (135 x 55mm) thin sections at the Institut National Agronomique, Paris-Grignon (Guilloré 1985; Murphy 1986). Thin sections were viewed at a number of magnifications from x1, up to x400 under the polarising microscope and employed plane polarised light (PPL), crossed polarised light (XPL), oblique incident light (OIL) and blue light (BL). The combined use of these different forms of illumination permit a large number of optical tests to be made, enabling more precise identifications of the materials under study. For instance, the non-calcareous soil microfabrics at the Long Barrow are poorly birefringent under XPL, whereas calcareous root pseudomorphs and calcium carbonate impregnated soils that are frequently found here, are highly birefringent. OIL is useful in identifying red and black soil that has been impregnated by iron and manganese, a phenomenon which can occur because of poor drainage. No soil was found to be autofluorescent under BL.

Semi-quantitative data

In order to identify variations in the microstratigraphy of poorly stratified deposits, such as the mound and buried soils at the Long Barrow, it is very useful to obtain soil micromorphological data that can be presented graphically. Point counting is one approach, but is extremely time consuming and therefore expensive in terms of time and money. A semi-quantitative method has been adopted therefore, which can provide a guide to variations in the microstratigraphy but is not nearly so time-consuming. This approach is based upon exhaustive testing at the experimental earthwork at Overton Down, which is similarly composed of a buried soil and turf-cored bank (Crowther *et al* 1996; Macphail and Cruise 1996). Here, a pilot study that semi-quantitatively estimated microstratigraphic variations at a vertical scale of 10mm proved robust (Macphail and Cruise 1996). Moreover, initial results from a comparison of semi-quantitative data 'counted' from Overton Down and that measured by image analysis has been shown to be highly consistent (Acott *et al* 1997).

At the Long Barrow, microfabric types, inclusions and pedofeatures, the last *sensu* Bullock *et al* (1985), were semi-quantitatively counted (Table SS4.56). Each thin

Table SS4.56. Long Barrow. Soil micromorphology: semi-quantitative microstratigraphy

Notations are keyed in the final rows

		Soil microfabric types			*Inclusions*			*Textural features*		*Calcite*	*Biological features*						
Approx depth (m)	*Sample*	*SM1*	*SM2*	*SM3*	*I1*	*I2*	*I3*	*TF1*	*TF2*	*CF1*	*BF1*	*BF2*	*BF3*	*BF4*	*BF5*	*BF6*	*Stratigraphy*
0.40	151	##	*	*	*	*				*	**	*	*	*			Earthworm-worked mound
0.41	151	##	*	**		*	*				***			**	*		
0.42	151	##		*		*				*	***			**			
0.43	151	##	*			*				*	***			**			
0.40	151	##		*		*		*		*	**			**			
0.45	151	##		*		***		*		*	***			*			
0.46	151	##		***	*		*			*	***			**	*		
0.47	151	#	*			**	*				***			**			
0.48	151	##		*					*	*	***			*			
0.49	151	##		***		***		*		*	***	*		**			
0.50	151	##		*		*		*		**	***			*			
0.51	151	##		**		*	*	*			***			*			
0.52	151	##		*				*	*	*	**	*		*		*	Mixed junction of mound
0.54	152	##		**	*	*	*	***		**	***		*			*	and OLS?
0.55	152	##		**	**	*		**	**	**	***	*		*		*	
0.56	152	##		***	*			**	*	**	***		*				
0.57	152	##		**	*			**	*	**	***	*	*	*			
0.58	152	##		**		*		**	**	**	***		*	**			Buried soil
0.59	152	##		**		*	*	**		***	***			**			
0.60	152	##		*	*	*		***	*	**	***			*			
0.61	152	##		*		**		**	*	**	**						
0.62	152	##		**	*	***	*	**		*	**			*			
0.63	152	##		*	*	**		**	**	**	**			*			
0.64	152	##	*	**		*	*	**	**	**	***						
0.65	152	##	*	**		*	*	**	**	**	***			*	*		
0.66	152	##	*	**	*	*		**	*		***			**	*		
0.68	153	##		*		**		**	**	*	*			*			
0.69	153	##	*	*		**		**	***	*	*			*			
0.70	153	**	**	*		*		*	*	*	*			**			
0.71	153	##		*		*	*	**	***		**			**			
0.72	153	##	*	**		***		*	**	*	**			*			
0.73	153	##	*	**				**	*	*	**			**			
0.74	153	**	*	*	*			***	***	**	**			*			
0.75	153	##	*	*	*			***	***	*	**			*			
0.76	153	##	*	**	*			**	**	*	***		*	*			

Table SS4.56. Continued.

Approx depth (m)	*Sample*	*SM1*	*SM2*	*SM3*	*I1*	*I2*	*I3*	*TF1*	*TF2*	*CF1*	*BF1*	*BF2*	*BF3*	*BF4*	*BF5*	*BF6*	*Stratigraphy*
0.77	153	##		*			*	***	***	*	***		*				
0.78	153	##		**	*			**	**		**			*			
0.79	153	##		**	*		*	**	*	*	**			*			
0.80	153	**	*	*			*	**	***	*	*			*			
0.68	154	##				*		***			***			*			Buried soil
0.69	154	##		*		*		***			***			***			
0.70	154	##			*	*		***	*		**			**			
0.71	154	##			*			**			**			*	*		
0.72	154	##			*	*		**	**		**			**			
0.73	154	##	*			***		**	*		*			**			
0.74	154	##				*		*	***		**			**			
0.75	154	##			*	*		**	*		**			**			
0.76	154	***	*			***		**	**		**			*			
0.77	154	##				*		**	***		*						
0.78	154	##				*		**	*		**			*	*		
0.79	154	##				***		***	**		**			*			
0.80	154	***	*			***		**	***		**			*			
0.20 ?	155	##		*		*		*	*	*	**			*	*		Buried soil?
0.21	155	##			*	*		*		*	***						
0.22	155	##			*	*		*			**			*	*		
0.23	155	##		*				*	*	*	**			**			
0.24	155	##		*		*		*		***	**			*			
0.25	155	***	*	***				**	*	***	**			***			
0.26	155	***	*	***		*		**	*		**			*			
0.27	155	##	*		*	*		**	**	***	***			*			
0.28	155	##	*			*		**		***	**			*			
0.29	155	##		*		*		*			***						
0.30	155	##		*		*		**	**	*	***			*			
0.31	155	##	*	*		*		*	*		***			**			
0.32	155	##		*	*	**		**	*		**						
0.20 ?	156	***	**			***		**	*		*			*			Buried soil?
0.21	156	***	*			**		**	*		**			**			
0.22	156	***	**			*		***			**			***			
0.23	156	***	*					**	**		***			***			
0.24	156	**	***			*		**	***		**			**			
0.25	156	**	***		*	***		*	***		**			**			
0.26	156	***	**			*		**	***		**			**			
0.27	156	***	**			**		**	***		**			**			
0.28	156	***	**			*		**	***		*			**			
0.29	156	***	*			**		*	***		**			**			
0.30	156	***	*		*	*		**	**		**			**			
0.31	156	**	***		*			***			**			*			

Table SS4.56. Continued.

Soil microfabric types
SM1: heavily speckled, dark yellowish brown (PPL), very low interference colour (XPL), bright orange (OIL)
SM2: very dark blackish yellow brown to black (PPL), very low interference colour to isotic (XPL), dominantly blackish with some red areas (OIL)
SM3: heavily speckled, dark yellowish brown (PPL), low to high interference colour (XPL), bright orange with blackish areas (OIL)

Inclusions
I1: charcoal
I2: coarse sand to gravel-size ferruginous materials (including oolite, nodules etc), flint, quartzite etc
I3: coarse sand to gravel-size calcareous materials (oolitic limestone, chalk, shell)

Textural (pedo)features
TF1: very dusty, dark, poorly birefringent clay coatings and infills, up to 100 µm in thickness
TF2: very dusty, dark, poorly birefringent clay coatings and infills, sometimes up to 250-300 µm in thickness; associated closed vughs, pan-like features

Crystallitic (pedo)features
CF1: semi-pseudomorphic calcium carbonate-replaced roots (rhyzoliths) and immediately juxtaposed calcium carbonate impregnated soil

Biological (pedo)features
BF1: probable earthworm burrow fills (bow-like infills, sand separations etc)
BF2: enchytraeid-like organo-mineral excrements
BF3: biogenic calcite granules (earthworm/slugs)
BF4: coarse (>2mm) channels and chambers
BF5: relic in situ root tissue
BF6: *c* 160 µm size probable spore cases of vesicular-arbuscular mycorrhizae

Frequency and Abundance (after Bullock *et al* 1985, 23 & 112)

Microfabric types and Inclusions	Pedofeatures
## – very dominant	*** – abundant to very abundant
# – dominant	** – many
*** – common	* – rare to occasional
** – frequent	
* – very few to few	

section is some 55mm wide, which permits 5 x 10mm squares to be examined per 10mm of vertical stratigraphy. Microfabric types, coarse (coarse sand to gravel-size) inclusions and pedofeatures (here also including coarse channels and organic materials indicative of biological activity) were noted and recorded on a count sheet, for each five squares (see Table SS4.56 and text). Other soil phenomena were also noted for each vertical 10mm of stratigraphy. The dominant microfabric type (SM), frequency of major coarse inclusions (I), and abundance of pedofeatures (TF – textural features, CF – calcite features and BF – biological features) were then estimated for each vertical 10mm of stratigraphy in Table SS4.56 (see below and Bullock *et al* 1985, 23 and 112, for terminology of frequency and abundance). As each thin section is 135mm in length, this permitted the examination of some 65 squares to contribute to the semi-quantitative micro-stratigraphic analysis of each thin section. In all 390 squares were examined to study a total of 740mm of vertical stratigraphy.

These estimations were carried out primarily to characterise the continuously sampled vertical stratigraphy of the mound and buried soil (samples 151–153). This then permitted a more accurate comparison of the soils across the rest of the sampled areas of the site. Soil microfabric types represent the dominant soils present, whereas pedofeatures reflect pedological (weathering, biological activity, disturbance, etc) processes, so that contemporary conditions and post-depositional transformations of the soils can also be 'measured' for each context. For example, these are represented graphically as very dominant (>70%) – ## – and dominant (50–70%) – # – microfabric types, with lesser amounts being represented by a star system. The less dominant microfabrics can be common – *** – (30–50 %), frequent – ** – (15–30%) or few – * – (5–15%) in amount. Also, according to Bullock *et al* (1985, 112), rare pedofeatures and inclusions are given a different scheme of abundance and here can be rare to occasional – * – (<5%), many – ** – (5–10%) and abundant to very abundant – *** – (10–20%).

Fifteen aspects of the microstratigraphy have been reported in Table SS4.56. More were actually recorded during counting, so as to provide additional detail for interpretational purposes. For convenience, data on flint gravel and all types of ferruginous gravel are, for example, grouped as non-calcareous coarse inclusions. Similarly, all shell, oolitic limestone and chalk are grouped as calcareous coarse inclusions.

The semi-quantitative estimations were made only after considerable time had been spent studying the thin sections so that no important soil microfabric types, inclusions and pedofeatures (*sensu lato*) would be missed during 'counting'. As a warning to other workers, it should be noted that 'counting', for its own sake and before the basic soil micromorphology is mastered, is a complete waste of time (Courty, Fedoroff, Goldberg and Romans, pers comms 1982–1996).

Chemical and magnetic susceptibility signature analysis

Phosphate methods. Phosphate analysis has been used for many years to identify and map general areas of human occupation (eg Proudfoot 1976; Bethell and Máté 1989). More recently, a Swedish team based at Umeå University have adapted the well-established principles of phosphate analysis to the surveying and landuse separation of, for example, dwelling areas from manured fields (Engelmark and Linderholm 1996). These have distinctive chemical (and also magnetic susceptibility) signatures which can be distinguished from one another.

There appear to be as many methods of extracting P from the soil as there have been workers in this field (see review by Bethell and Máté 1989). The Swedish team employ citric acid as their extractant, a method used by surveyors in both Sweden and the UK (eg Arrhenius 1955; Avery 1964), because large numbers of samples can be easily processed for their survey work. The method of measuring P from non-ignited (inorganic P) and ignited soil samples (total P) to differentiate broadly between inorganic and organic P, is a totally standard method (cf Conesa *et al* 1982; Liversage *et al* 1987; Bethell and Máté 1989, 21–22).

Phosphate analysis of archaeological sites. It is worth noting that total phosphate measurements on their own, as habitually carried out on archaeological sites, do not allow the important differentiation between, for example, phosphate from bone and phosphate from organic manure. Thus important archaeological characteristics of a site may not be revealed. Locations rich in bone, ashes and mineral-replaced faecal matter (coprolites and cess) can be considered as essentially 'dwelling areas', whereas those dominated by manure can be manured fields, animal paddocks etc (see Engelmark and Linderholm 1996; Macphail *et al* 1997). High absolute amounts of phosphate also indicate more intensive dwelling areas, with high MS values also contributing to this interpretation. Using this signature method, Roman urban dark earth, for instance, can be readily differentiated from Roman dark soils of a rural character that owe their origin to inputs of dung.

Analyses of the Long Barrow soils. Calcareous soils may neutralize weak acids, like citric acid, so that less phosphate is released. At the Long Barrow the Neolithic soils appear to have been essentially decalcified, but a number of secondary calcitic features had formed within the barrow (see below). A number of pilot studies have been carried out which have combined soil micromorphology and this suite of chemical methods. These have consistently produced reliable findings, and the possibility of a less than 100% phosphate extraction at the Long Barrow is not thought to be significant as it does not affect the overall signature.

To provide chemical and magnetic susceptibility signature analysis data comparable to other Raunds sites, exactly the same chemical methods were employed. This was carried out at Umeå University, Sweden. The methodological approach of Engelmark and Linderholm (1996) is described in full below.

Chemical signature method. All samples were homogenised so as to pass through a 0.5mm sieve. Soil organic matter, pH, magnetic susceptibility, total ('available') and inorganic P (P corresponds to PO4–3) were included among the parameters analysed. Inorganic P (P inorg) is usually determined by weak acid extraction (or by salt solutions). Citric acid extraction followed by molybdenum blue reagent (Arrhenius 1934), is a gentle and sufficiently selective method for extracting and quantifying inorganic-P (as mg P2O5*100 g-1 soil, P°; 1 P° equaling 4.36 ppm P). All of the Long Barrow data have been converted to parts per million (ppm).

A direct quantification of the organic fraction is more laborious, so the common procedure has been to determine the total P-content and obtain the organic fraction by means of subtraction. Determinations of the true total elemental content in soils require rather complicated and expensive analytical techniques, but are not always necessary. By combustion at temperatures at which the soil organic matter (SOM) is oxidised (in this case 550°C), the organically bound P is released and can subsequently be extracted with acid (cf Bethell and Máté 1989, 21–22; Liversage *et al* 1987). Obtained values of P are hereafter referred to as Ptot. As a bonus the soil organic matter is determined by loss on ignition.

It may be worth noting that in Sweden, where all the original work has been carried out, P° values generally range from 0–100 P° (0–436 ppm) for natural soils, 75–250 P° (327–1090 ppm) in soils affected by cultural activity and >250 P° (>1090 ppm) for heavily disturbed soils. On the other hand, experimental pastures and some Roman manured arable soils have been found to contain far lower amounts of P° (eg 13–30 units (57–131 ppm); Macphail *et al* 1997). The higher Swedish results may well relate to their intensive manuring regime during the Iron Age when podzols were occupied (Engelmark and Linderholm 1996). Ptot/ P° values around 1.0 have been found to be associated with 'dwelling sites' with high phosphate inputs, whereas locations of animal stabling and manured fields have values around 1.5 up to 10 depending on soil type and landuse. Again, these results have been found to be consistent with pilot studies in the UK.

Magnetic susceptibility has been measured on 10g of soil before and after 550° C ignition, with a Bartington MS2 system with a MS2B probe. Data are reported as SI-units per ten grams of soil (10^{-8} SI kg^{-1}).

Results

Local soils

Presently, the valley of the Nene has a fine pelo-alluvial gley soil (Fladbury 1 soil association; Hodge *et al* 1983) cover. This results from a period of a fine alluviation, most of it medieval (Windell *et al* 1990; Robinson 1992, fig 19.3). The prehistoric soils, as found across the Raunds Project area, were fine and coarse loamy typical argillic brown earths, approximating to the Waterstock soil association mapped some 5 km downstream on probably late Devensian Nene river terrace drift (Hodge *et al* 1983; see Macphail and Goldberg 1990; Macphail in preparation). At the Long Barrow, the gravel island is under this recent alluvium, with the partly sealed barrow occurring as a low mound.

Neolithic soils

Field data. In the field (Table SS4.55) it was noted that the junction between contexts 219 (buried soil) and 138 (mound) was undulating or ridged. The buried soil (219) also appeared to be some 150mm thinner at the location of sample 154 compared to 5m away where the mound and buried soil had been continuously sampled (151–153).

Soil micromorphology. Soil micromorphological analysis of the six thin sections identified three microfabric types (SM1–3), coarse inclusions (I1–3), textural features (TF1–2), calcite features (CF1) and biological features (BF1–6; Bullock *et al* 1985; Courty *et al* 1989). The biological features incorporate fabric pedofeatures (probable earthworm burrow fills – BF1), excremental pedofeatures (enchytraeid-like excrements – BF2), biogenic calcite (probable earthworm and slug granules – BF3), porosity features (coarse channels – BF5) and plant remains (root traces and 'bright rings' – BF4 and BF5). It should also be noted that calcite features are mainly associated with the pseudomorphic calcite replacement of root cells (rhizoliths). Thus CF1 features are an additional indicator of biological activity.

The three microfabric types represent decalcified soil (SM1), mottled iron and manganese stained decalcified soil (SM2) and soil impregnated with calcium carbonate (SM3). The last can be associated with CF1 features. The soils contain abundant textural features that relate to the mobilisation of fine soil (clay and fine silt) and its translocation to, and deposition in, soil pores, as void coatings for example. As these textural features all have a similar very dusty, poorly birefringent appearance, the author has attempted to differentiate this soil translocation phenomenon on the basis of intensity, so that thin void coatings of <100 μm in thickness (TF1) were separated from thicker void coatings of >100 μm in thickness (TF2). In practice, TF1 features were often <80 μm in thickness. To respect this higher intensity of soil translocation and deposition within the TF2 category, 'closed vughs' were included where soil movement had been sufficiently intense to strongly infill soil pores so that they no longer appeared to interconnect in the two-dimensional plane under observation. Lastly, where silt dominated the textural features and where translocated fine soil formed pan-like features (broad horizontally oriented void fills; cf Bullock *et al* 1985) these were included as probable indicators of higher intensity deposition, because more coarse material (ie silt) was involved or where translocated material was concentrated into horizontal layers (pans).

Semi-quantitative soil micromorphological data are schematically presented in Table SS4.56. Little clear stratigraphy is present, although some trends can be isolated.

Generally, all soils show major channelling (BF1) and earthworm burrowing (BF4) indicative of a history of marked biological activity. Interestingly at the same time, with the exception of sample 151, there is common evidence of fine soil translocation (TF1–2). The latter phenomenon is normally best recorded where biological activity is low, and therefore where soil features are generally little worked, ie in subsoil Bt horizons (eg McKeague 1983). Coarse charcoal (I1) is present in low amounts, but ubiquitous in the samples. Coarse clasts of ironstone, flint, etc (I2), are also ubiquitous, but clasts of oolitic limestone and shell (I3) appear to be present only in samples 151–153. In sample 151 abundant channelling and burrowing is possibly correlated with possibly lower amounts of preserved charcoal and fewer textural features than found deeper in the soil in this area, including sample 154. Generally, decalcified soil (SM1) is dominant, except for sample 156. Calcareous soil microfabric type SM3 is common in samples 151, 152, 153 and 155. In contrast, in sample 154, only a little is present at the top of the sample, and at sample 156 it appears to be absent. Secondary calcite features (CF1) mirror this distribution. Soil microfabric SM2 is only important in sample 156, and here calcareous soil (SM3) appears to be absent.

All soils include coarse sand-size and small stone-size (gravel) clasts of flint, 'ironstone' and quartzite (I2), whereas chalk, calcareous oolitic limestone and shell (I3) are absent from samples 154, 155 and 156. This pattern does not necessarily correlate with the presence or absence of calcite impregnated soils (SM3 and CF1), as SM3 soil and CF1 features are only mainly absent from samples 154 and 156. In fact, both calcitic SM3 soil and CF1 features can be common/abundant in sample 155. Rare phenomena included in Table SS4.56 are enchytraeid-like excrements (BF2), biogenic calcite (BF3) and *c* 160 µm size probable spore cases of vesicular-arbuscular mycorrhizae (BF6). These were recorded around the junction of samples 152 and 153. These spore cases have been termed 'bright rings' because they are birefringent under XPL, a characteristic that is believed to take some 900 years of aging (Romans and Robertson 1983a). When examining the distribution of textural features, the most marked characteristic is their paucity in sample 151 compared with samples 152, 153 and 154. TF2 features also seem more common in sample 156 in comparison to sample 155.

Interpretation; hierarchy of the features. During the soil micromorphogical study of the thin sections and the 'counting' of textural, calcite and biological features, their hierarchy was noted and produced the following results. Earthworm activity and rooting was ubiquitous and probably postdates some textural feature formation, some of which had become fragmented. Biological mixing has partially homogenised soil material SM2 (mottled soil) into SM1, and SM1 soil cannot often be recognised as discrete peds. Less effective biological mixing of SM3 (calcitic soil) was noted, and little calcareous soil has been mixed with SM1. Rooting (CF1 and BF5) appears to mainly postdate many of the soil processes forming the present day soil, ie these rhizoliths are little disturbed by earthworm mixing except for sample 151 in the mound. Also some textural features postdate this rhizolith formation and coat this material.

Chemistry. Chemical data are presented in Table SS4.56, where results from two reference subsoils from the Raunds area (the Turf Mound and Barrow 5) are included. Samples 151–153 have a higher LOI compared with samples 154–156 and the apparently poorly humic subsoils at Raunds generally. These subsoils also have very poorly enhanced MS values (24–33) compared to the Long Barrow soils (MS 103–289). The relationships between LOI and MS for the reference subsoils and the Long Barrow soils is illustrated in Figure SS4.27. On heating (MS550), the translocated clay enriched bBt horizons (MS550 133–210) show much higher values compared to non-clay enriched subsoils (MS550 52–60). Phosphate measurements mirror this trend, with consistently higher Ptot and P° in the bBt horizons. At the Long Barrow, the P° is in the same order of magnitude as in the reference subsoil samples, although Ptot is generally higher. All have high Ptot/P° ratios although there is apparent clustering of the reference subsoils (bottom), samples 154–156 (middle) and 151–153 (top; Fig SS4.27). At the Long Barrow it is worth noting that the two samples (151 and 152), which are at the highest elevations at the site, also have the highest Ptot.

Discussion

Contexts

It is crucial to discuss the analytical data in the light of the supposed sample locations and their contexts. Any discussion of the Neolithic buried soils and their environment has to follow the establishment of the correct

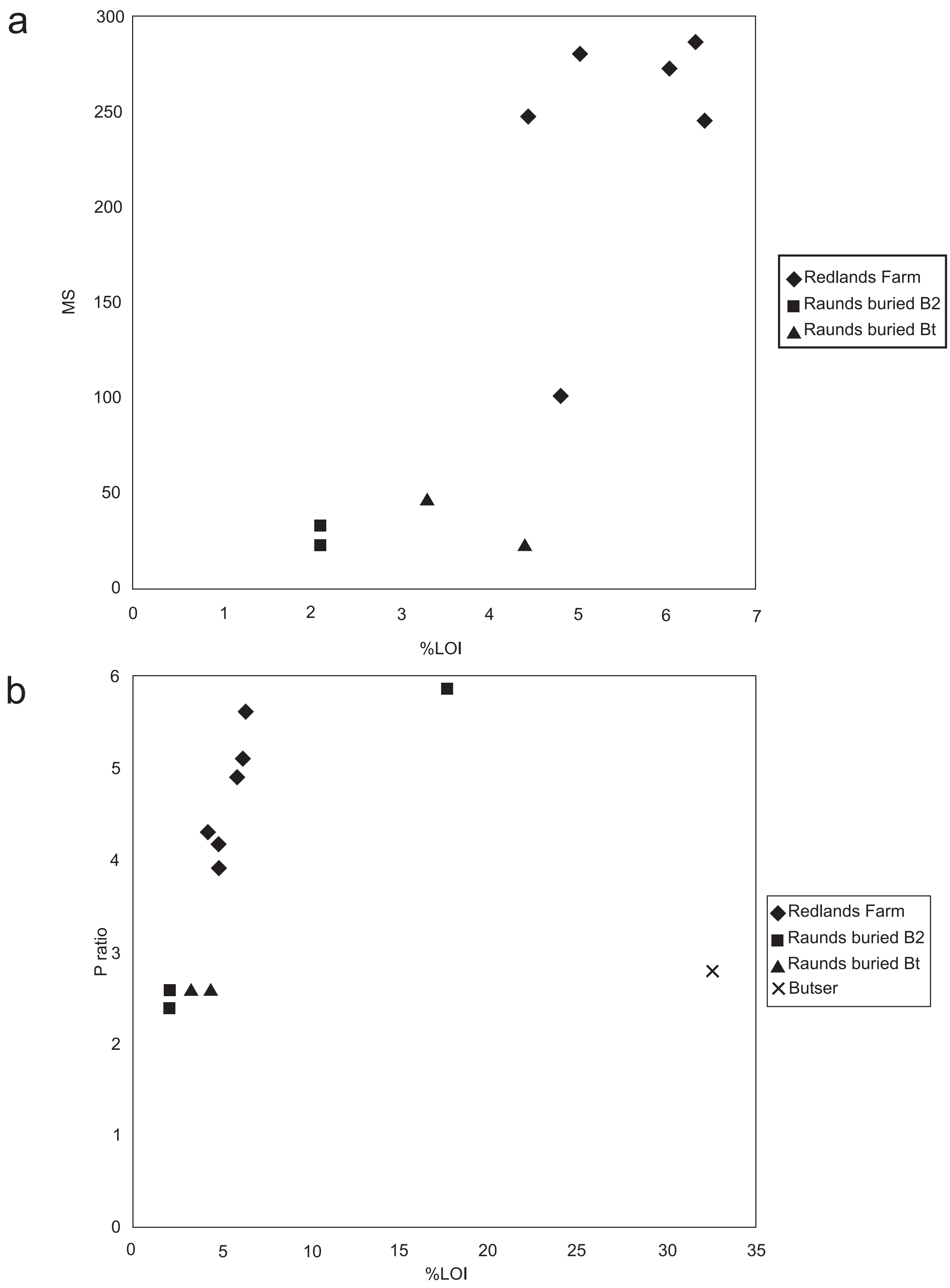


Figure SS4.27 Long Barrow.
(a) MS values in the Long Barrow soils compared with those in subsoils beneath the Turf Mound and Barrow 5;
(b) Ptot and P values in the long barrow soils compared with those in subsoils beneath the Turf Mound and Barrow 5

contexts of the samples. Firstly, samples from the soils by the treethrow hole (155) and the cist (156), although recorded as 'mound' material have lower LOI than the mound samples 151 and 152 (Table SS4.56). Secondly, the microfabric of sample 156 is again quite different from the mound material of samples 151 and 153, by containing common mottled soil (SM2), as noted in the field. Lastly, sample 155 is clearly marked in the author's field notebook as coming from the buried soil adjacent to, and at the same level as, a treethrow disturbance, although not from the treethrow hole itself. Samples 155 and 156 will therefore be considered as Neolithic buried soils. Equally, it will be argued that sample 152 is probably also mainly from the buried soil, like samples 154 and 153 (see below, Table SS4.56). Complications relating to the site's taphonomic phenomena, such as rooting and earthworm burrowing, which have successfully masked both the field- and micro-stratigraphy, are discussed below. Other data supporting these contentions are also presented below.

Soil micromorphology

Neolithic soils. The dominant Neolithic soils at the Long Barrow are decalcified loams (SM1). Occasional mottled soil microfabrics (SM2) also occur. In sample 156, near the cist, this iron and manganese stained soil is common. It has been well-integrated into the soil, probably by earthworm activity. All calcitic soil microfabrics (SM3) and related pseudomorphic calcite root replacement features (CF1) appear to be secondary. It can therefore be stated that, as elsewhere at Raunds, soils were probably decalcified brown earths by the Neolithic period. These appear to have been generally freely-draining, although at depth, soils on the gravel island may have been affected by groundwater. The preservation of wood and the formation of peat in the barrow ditches testifies to this high groundwater table during the Neolithic. The common occurrence of mottled soil (156) by the cist could therefore represent the mixing of gleyed subsoil into this Neolithic 'topsoil'. One possible mechanism for this would have been the mixing of spoil from excavation of the nearby cist during pre-barrow activity. It is less likely that this sample contains so much iron and manganese stained soil material (SM2) just because the site got wetter in its history, as in that case the other buried soils would contain similarly common amounts of SM2. Also in sample 156, SM2 material is in the form of mixed-in soil material. It is not impregnative mottling as such, which occurs through general waterlogging. In fact, as the site became increasingly affected by groundwater, a process which probably increased during the alluviation of the area during the Medieval period (Robinson 1992), another soil process appears to have begun. This is the formation of calcite impregnated soil (SM3) and the pseudomorphic replacement of roots by calcite (rhizoliths, CF1). Although the Neolithic soils were decalcified, they were formed originally on alluvial sands and gravels containing calcareous material (oolitic limestone, chalk and shell). Inclusions of the last (I3) are present in the mound and in fact occur throughout samples 151–153. It may be suggested that deep rooting through the mound pulled calcareous groundwater up into it from the little weathered gravel substrate, forming the rhizoliths. It is also noteworthy that dusty clay coatings (TF) continued to develop after the formation of the rhyzoliths.

The old ground surface. The possibility that the old ground surface may be located in the upper half of sample 152, as was believed during field sampling, may be coincident with the rare presence of probable enchytraeid excrements, biogenic calcite (earthworm/slug granules) and probable spore cases of vesicular-arbuscular mycorrhizae (BF2, BF3 and BF6). These are generally absent from the soils elsewhere. A mixed junction of mound and OLS has been tentatively identified on this basis (Table SS4.56). It is also important to note that the textural features (TF) that are scarce in the overlying mound, can become frequent in this zone. Many, however, may possibly relate to Romano-British ploughing at the site (see below).

It has been shown at the experimental earthwork at Overton Down 1992 that the junction of the buried soil and the overlying bank was biologically mixed over a 32 year period, pollen moving a maximum of 90mm both up into the bank and down into the buried soil (Crabtree 1996). Under the chalk bank, earthworms mixed chalk of the bank with decalcified soil of the buried soil. On the other hand, beneath the turf core earthworm-formed soil structures became aggregated and the presence of abundant enchytraeid-like excrements indicated a change in the dominant soil animals (Macphail and Cruise 1996). Chemistry showed an increase in acidity at the junction of the turf core and buried soil, and there was both microbiological and soil micromorphological indicators (enchytraeid-like excrements) of this (Wallwork 1976; Crowther *et al*, 1996; Kelley and Wiltshire 1996). At the Long Barrow, it is conceivable that despite the generally oxidising conditions of the site, burial led to some short-lived acidic conditions as represented by enchytraeid excrements. Such an environment may also have been conducive to the formation and preservation of spore cases of vesicular-arbuscular mycorrhizae. It is also interesting to note the isolated presence of biogenic (earthworm/slug) granules here. At Overton Down such granules were absent from the local decalcified soil but were present at the mixed junction of the buried soil and chalk bank (Macphail and Cruise 1996). At the Long Barrow there is evidence of calcareous parent materials (Table SS4.56, I3) being present in the mound and buried soil.

Textural features. The interpretation of the textural features at the Long Barrow is not simple. Textural features appear to be coeval with earthworm mixing in some places, but major channelling and earthworm burrowing, especially in sample 151, appear to postdate the formation of these. In interglacial (Holocene) soils textural features can form in two main ways. Firstly they can develop naturally as limpid, highly birefringent clay coatings under a woodland vegetation, and form typical argillic Bt horizons (Duchaufour 1982; McKeague 1983; Bullock *et al* 1985; Avery 1990; Fedoroff *et al* 1990). Some of the textural features present in the Bt horizons used here as reference material (Table SS4.56) from the Turf Mound and Barrow 5 probably mainly formed in this way (SS4.8.2). On the other hand, poorly birefringent, dusty clay coatings, as found at the Long Barrow, are much more likely to be the result of mechanical disturbance affecting the whole soil, rather than just mobilising the fine clay as under woodland. The effect on soils of disturbance caused by ancient clearance and cultivation, and the formation of a variety of dusty clay textural features, has been reviewed (Macphail *et al* 1990; Macphail 1992). Cultivation would be one mechanism that could produce these features at the Long Barrow. Romano-British cultivation of the barrow has been reported and ploughmarks were mapped on the barrow, above and close to the sampling point of samples 151–154 (Figs SS1.45, SS1.58). On the other hand, if all the textural features at the Long Barrow originated from this Romano-British ploughing, there is some difficulty in explaining the lack of sorting that should occur with depth, and which should have produced a concentration of less dusty and more highly birefringent textural features down profile. This is a factor of ancient and modern cultivated soils that has been discussed in detail with Dr Nicholas Fedoroff (Institut National Agronomique, Paris-Grignon, University of Paris) and John C C Romans (late of Macaulay Institute, Aberdeen; see also Macphail *et al* 1987). Also it is difficult to see how Romano-British ploughing of the upper mound alone can have produced the concentrations of translocated soil, which are sometimes silty, and which have formed closed vughs and pans in the buried soils, some 0.60–0.80m below. Such features are much more likely to form very close to the origin of the mechanical disturbance (eg in the ploughzone). Other phenomena need to be considered. It is quite clear from the number of textural features present that the Long Barrow soils were unstable. The very process of topsoil stripping and dumping of soil to form a barrow mound can cause tremendous disturbance of the soil. Romans and Robertson (1983b) interpreted much of the abundance of dusty textural features within the Neolithic long mound at Strathallan, Perthshire, as resulting from the dumping of poorly stable topsoil that had lost its structure through cultivation. They also found that in the buried soil here and at other supposed Neolithic cultivated sites, textural features were concentrated at a depth of some 60mm along the 'ploughsoil'/ subsoil interface (Romans and Robertson 1983b, 1983c). No such concentrations were noted at the Long Barrow in the buried soils. Lastly, there would have been trampling by the people constructing the monument, but any soil disturbance and the formation of TF2 features would have been confined to within 100mm or less of the surface, as found for example at Carn Brea, Cornwall (Macphail 1990b). In contrast, at the Long Barrow, TF2 features are found deep within buried topsoils (Table SS4.56) and constructional activity is also hardly likely to have produced the enhanced levels of phosphates which are present (Table SS4.56).

These are therefore some of the mechanisms that can produce textural features of the kind found at the Long Barrow. A further mechanism is animal trampling, and the possible impact of animal activity at the Long Barrow site will be considered after the chemistry is discussed.

Chemistry. LOI and MS data (Figure SS4.27; Table SS4.56) clearly indicate that the Long Barrow soils had a more strongly enhanced magnetic signature and higher organic matter content than the reference subsoils from the Turf Mound and Barrow 5. The MS 550 data shows that the Turf Mound and Barrow 5 soils have a generally lower potential for magnetic enhancement, but even so, the Long Barrow soils have overall, a probable occupation/topsoil signature (Tite and Mullins 1971; Clarke 1990; Crowther and Barker 1995). The Long Barrow soils also appear to have enhanced quantities of phosphate. It is also likely that the Turf Mound and Barrow 5 subsoils have been enriched in phosphate (with a lower Ptot/ P° value, see below) because of human occupation of these sites (SS4.8.2), and their respective buried 'topsoils' and mound make-up have similar amounts of phosphate.

The high Ptot/ P° ratios at the Long Barrow are indicative of high amounts of organic phosphate being present (Figure SS4.27). Low Ptot/ P° values (around 1.0), on the other hand, are indicative of a dominance of inorganic P being present, as found for example where bone is present and where P has become mineralised (Engelmark and Linderholm 1996; Macphail *et al* 1997). There appear to be two ways in which the Long Barrow soils can have been enriched in P, through manuring or through the concentration of animal activity (See Butser pasture soil in Figure SS4.27).

Manured cultivation and/or animal stocking at the Long Barrow? There are no clear examples of deliberate manuring of cultivated soils in the Neolithic of England (Macphail *et al* 1990; Macphail 1992). Bakels (1997) in her recent review notes some possible evidence of dung being used for manuring in Switzerland. Clear evidence of early manuring comes from the Bronze Age (Macphail 1992; Macphail *et al* 1997; Bakels 1997). The soil micromorphological evidence for Neolithic cultivation at the Long Barrow as the major landuse before ritual activity and mound construction, is equivocal, even when post-burial earthworm working and dusty clay translocation are included in the equation. For example, there appears to be no clear distribution of textural features to indicate an uppermost 60mm-thick ard-ploughed zone in the three buried soil locations that were studied (cf Romans and Robertson 1983c; Gebhardt 1992). Moreover, it also seems unlikely from the literature and current soil evidence in western Europe that the phosphate levels here could relate, on their own, to deliberate manuring; as may also be indicated by microscopic inclusions of anthropogenic materials (Macphail *et al* 1990; 1997; Macphail 1992). On the other hand, the manuring of the ploughed Romano-British soils formed in parts of the upper mound is quite likely. This is suggested by the generally higher amounts of LOI and P, and the highest P ratios that occur towards the surface of the mound (Table SS4.56, samples 151–153). In addition, there is clear field evidence of the mound being ploughed, and disturbed soil in the form of dusty clay, presumably from this cultivation, coats the rhizoliths (CF1) that developed after the mound was constructed. As noted earlier, chemical data from the reference Bt horizons at Raunds (Table SS4.56, reference samples 2 and 4) indicates how translocated clay can accumulate P. Lastly, Romans manured their ploughsoils (eg Barker 1985; cf phosphate at Roman Oakley; Macphail *et al* 1996; 1997).

Animal activity has been tentatively recognised as affecting the prehistoric buried soils at Raunds from the phosphate chemistry and the textural microfeatures (SS4.8.2; Courty *et al* 1994). As stated above, cultivation can also produce various forms of textural features, but animal trampling produces poorly structured, 'poached' soils that have textural features associated with pans and closed vughs (Beckman and Smith 1974; Valentin 1983). Two other features may possibly also indicate animal activity at the Long Barrow. Firstly, the marked differences in thickness of the buried soil between the sampling areas of 151–153 and 154, and its ridged nature could indicate terraceting as exacerbated by animal stocking. Secondly, the presence of spore cases of vesicular-arbuscular mycorrhizae is of interest because elsewhere a possible relationship was noted between this size (*c*. 160 μm) of spore case and sheep grazing (Romans and Robertson 1983a). Other independent indicators of animal stocking at the Long Barrow are dung beetles and nitrogenous conditions in the water-filled ditch (Robinson, SS4.3.2; Wiltshire, SS4.4).

Suggested site history. It may be suggested that a number of impacts can be recorded at the site, as follows:

1. After clearance, possible animal stocking produced unstable, trampled soils, which contributed to the number of textural features, including pans and associated closed vughs (an earlier history of cultivation

cannot be elucidated). Amounts of organic P were also enhanced. Occupation also raised the MS of the soils. It can also be noted that Mark Robinson (SS4.3.2) found dung beetles and Patricia Wiltshire (SS4.4) found microfossil evidence of nitrogenous enrichment of the ditch fills.

2. Unstable topsoils were used to construct the mound. The very act of collection and dumping also contributed to the overall amounts of textural features present in the mound soil, some disturbed soil also possibly washing down-profile into the buried soils (*cf* Strathallan Mound; Romans and Robertson 1983b).

3. Earthworm activity masked the junction of the mound and OLS (cf Overton Down; Crowther *et al* 1996), and worked some of the earlier-formed textural features.

4. The creation of the mound and the rising water table of the area altered the drainage conditions. Rooting by plants into the mound drew up water containing calcium carbonate and rhyzoliths were formed.

5. Romano-British cultivation on top of the mound produced a new phase of textural feature formation that contributed to the overall amount of these. It is likely that cultivation was accompanied by manuring (eg Barker 1985; cf phosphate at Roman Oakley; Macphail *et al* 1996; 1997), and this activity contributed to the higher amounts of Ptot in the mound soils (see Table SS4.56). The last phenomenon can be recognised in the reference Bt horizon subsoils at Raunds.

6. Post-Roman earthworm activity continued to destroy many of the textural features in the mound.

Conclusions

The soils at the Long Barrow have been difficult to interpret, because of the combined effects of fine soil translocation (textural features) and biological activity (earthworm burrowing and rooting). The soil micromorphological data suggest that these activities can probably be identified in both the original soils and in the mound itself. Counting of microfabric features and soil inclusions, however, has helped to locate the earthworm-mixed junction of the buried soil and the mound. The use of soil micromorphology, augmented by chemistry, allowed the tentative identification of a probably grazed Neolithic environment at the Long Barrow, with later Romano-British cultivation of the site probably being accompanied by manuring.

SS4.8.2 Irthlingborough and West Cotton soils: results from the prehistoric period

Richard Macphail

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Summary

Fieldwork at fourteen soil sites of pre-Iron Age date within the Raunds Area Project and laboratory analyses of the samples from them were carried out from 1985 to 1999. Research objectives comprised the study of (1) late Mesolithic and early Neolithic soils, by the investigation of treethrow holes and early monuments and (2) the Neolithic and early Bronze Age landscape by the examination of soils buried beneath and incorporated in subsequent monuments.

This soil investigation is probably the most detailed study of fossil treethrow holes and a prehistoric barrow landscape yet undertaken in the United Kingdom. Fifty-two thin sections and seventy associated bulk samples were analysed. Soil micromorphological thin section studies included description, semi-quantitative counting of four key sites and microprobe studies of selected microfeatures. Analysis of bulk soil samples included grain size, magnetic susceptibility, organic matter, calcium carbonate, pH and phosphate estimations. The last involved the measurement of a), total P by nitric acid extraction and b), phosphate (P_2O_5) extraction by citric acid, before and after soil ignition. The latter permitted attempts to infer an organic phosphate to inorganic phosphate ratio (P ratio). Bulk data underwent statistical testing. Thin sections and bulk data were analysed and interpreted within a large experimental and analogue database.

The prehistoric soils comprised fine to medium loamy Argillic Brown Earths over river terrace gravel. Treethrow holes provided soil time capsules from the mid-Holocene woodland environment, and were preserved below topsoils formed during later prehistory and the Saxon period which were in turn overlain by early medieval alluvium. Burnt soil from treethrow holes attained distinctively high values of magnetic susceptibility. Burning was recorded in all treethrow holes, but deliberate clearance of individual trees by fire cannot be demonstrated. Textural features (eg clay coatings) counted in thin sections are far more numerous in treethrow holes than outside them, and mainly originate from soil disruption

induced by treethrow, rather than from simple forest soil illuviation/lessivage. Statistically significant (95% confidence level) correlation was found between magnetic susceptibility and measures of organic matter, which probably reflects both the natural topsoil formation of strongly magnetic maghaemite and the presence of burnt soil in the ancient topsoils. Fire would have been an important mechanism for creating and maintaining open conditions for the pastoral Neolithic and early Bronze Age landscape inferred from the soil data. For example, there are both strongly significant correlations (99.9%) between both P_{nitric} and P_{citric}, and measurements of organic matter, to support the identification of animal management.

In addition, the counting of textural pedofeatures at selected sites and analysis of some of these through microprobe suggested a link between animal activity and topsoil slaking/poaching and the concomitant anomalous deposition of dark red coloured clay coatings. The last are enriched in organic matter and phosphate; occur only in monument-buried topsoils/mound material; and are absent from the treethrow features. The possible effects of human trampling, as monitored from experiments, are unlikely to be the key process in the formation of these poaching features at Raunds. Instead, arguments for a grazed landscape and occasional animal concentrations at some pre-monument locations, were supported by strongly significant correlations between clay and Org C, and clay and P_{nitric} for Raunds as a whole. In contrast, there was no evidence for arable cultivation until the early Bronze Age, when evidence of possible cultivation was found only at Barrow 6. These suggestions are consistent with interpretations of the environment based on studies of plant and insect macrofossils, faunal remains and pollen.

A number of experiments and archaeological analogues also support the above interpretations of Raunds soils, one example of a Bronze Age trackway in Sweden recording concentrations of organic matter, phosphate and clay coatings as an assumed major consequence of animal passage, whilst the modern Shabbington soil series (found at Raunds) has a recognised poaching risk. Any effects of human trampling were unrecognised due to the dominance of animal impact on the soil. Data from Raunds, when viewed in the light of other sites, further showed that the buried soils had not formed through human occupation or middening. The exercise succeeded in characterising the early-mid Holocene woodland soils, showing how the landscape was slowly opened up and identifying the long-term local dominance of pastoral activity over arable.

4.8.2.1 Introduction

Research objectives

The main objectives of the soil investigations at Raunds were to contribute to the understanding of

1. the late Mesolithic and early Neolithic landscape – with particular focus on the study of tree holes, and
2. the Neolithic and early Bronze Age landscape – with attempts to recover information from buried soils and mound material from the Avenue, the Long Mound, six round barrows and the Southern Enclosure.

Objective 1 includes the pedological investigation of a landscape that dates to the early Holocene, and one that, as at the Drayton Cursus, may well have been deliberately cleared of large trees (A Barclay *et al* 2003; Lambrick 1992). Objective 2 deals with how this soil landscape developed during the Neolithic and early Bronze Ages, and tackles, from the soil science point of view, major issues of prehistory such as

2a. estimating the possible relative importance of arable and herding activities on this floodplain, as compared with other Neolithic sites and landscapes with which the author is familiar, and

2b. exploring any soil landuse history and landscape relationship to barrow locations, that can be utilised by archaeologists in their study of the ritual monument complex.

The soil investigations

The project entailed the study of numerous monuments and archaeological features such as treethrow holes along a 3.5 km length of the Nene valley in Northamptonshire (Fig 1.4). Palaeosols from fourteen sites were studied (Table SS4.57) both on Irthlingborough island (treethrow holes and Barrows 1–4) and on the terrace to the east (the Avenue, the Long Mound, the Turf Mound, Barrows 5–6 and the Southern Enclosure). The Long Barrow, excavated by the Oxford Archaeological Unit at Redlands Farm, is reported on above (SS4.8.1), and only chemical data and discussion are presented here. Roman to medieval sites were also studied (Windell *et al* 1990), and the results will be published with the relevant archaeological reports (Chapman forthcoming;

Crosby in prep). The prehistoric sites were subsequently affected to varying extents by Iron Age and Roman settlement and agriculture and the landscape was influenced by late Saxon to early medieval alluviation, and more recent cultivation and pasture.

The modern soils of the site are Pelo-alluvial Gley Soils (Thames series, Fladbury 1 soil association; Avery 1990; Soil Survey of England and Wales 1983; Hodge *et al* 1984, 158). These are moderately humic, weakly calcareous (2.1% $CaCO_3$) alluvial clay soils (Tables SS4.58–60, samples 3, 22, 29, 33–34). They are of post-prehistoric date (Ch2; Robinson 1992a) and vary in thickness from 0.50m at Barrow 5 to 0.90m at treethrow hole F62338. Prehistoric archaeology is present in the underlying Gleyic Argillic Brown Earth soils (Waterstock soil association), which are still exposed to the east of Northampton (Soil Survey of England and Wales 1983, Hodge *et al* 1984, 290). These are non-calcareous, deeply permeable soils formed in river terrace drift since the Pleistocene. They vary in texture from clay loams to sandy clay loams and sandy silt loams (Waterstock series) on Irthlingborough island to fine and medium loamy soils (Shabbington series) on the terrace.

This burial of the palaeosol made it impossible to identify local control soils sensu stricto, as the alluvially buried landscape was not sealed until the early medieval period. Nevertheless, to mitigate this constraint, samples were collected from outside archaeological features up into the modern profiles to provide as wide a soil coverage as possible, including samples from known medieval contexts. A soil profile between treethrow holes was also sampled.

Table SS4.57. List of features and monuments from which soils have been studied

Feature or monument	*Brief description*	*Further information*
Treethrow holes	F62338 in trench B145. Treehole 1. Undated	Harding and Healy 2007, Panel 3.2
	F62123 in trench B140. Treehole 2. *4360–3980 cal BC*	Harding and Healy 2007, Panel 3.2 SS3.7.4, SS3.7.7, SS6
	F62119 in trench B140. Treehole 3. Undated	Harding and Healy 2007, Panel 3.2
	F62113 in trench B140. Treehole 4. *3660–3330 cal BC*	Harding and Healy 2007, Panel 3.2 SS3.7.7, SS4.5.2, SS6
The Avenue	Two parallel alignments of discontinuous ditch segments and small, irregular hollows, in which bushes or shrubs may have grown, perhaps constructed *3860–3620 cal BC*	Harding and Healy 2007, 64–67 SS1.2, SS3.7.7, SS4.5.3,SS6
The Long Mound	A turf or turf and topsoil mound estimated to have been built *3940–3780 cal BC*	Harding and Healy 2007, 54–64 SS1.1, SS3.7.7, SS3.8.4, SS4.5.3, SS6
The Long Barrow (soils described separately in SS4.8.1)	A ditched long barrow, built *3800–3640 cal BC*	Harding and Healy 2007, 23–28, 73–84 SS3.7.6, SS3.8.3, SS4.2, SS4.3.1, SS4.6.3, SS6
Turf Mound (south)	A turf or turf and topsoil mound built onto the tail of an earlier monument after *2470–2300 cal BC*	Harding and Healy 2007, 128–30 SS1.3, SS4.5.3, SS6
Barrow 1	A round barrow built *2140–1800 cal BC*	Harding and Healy 2007, 153–64 SS1.12, SS3.7.7, SS3.8.4, SS4.6.1, SS4.7, SS4.8, SS6
Barrow 3	A round barrow built *2180–1930 cal BC*	Harding and Healy 2007, 148–53 SS1.14, SS3.7.7, SS3.8.4, SS4.5.4, SS4.6.2, SS6
Barrow 4	A round barrow built *2020–1600 cal BC* or *1880–1520 cal BC*	Harding and Healy 2007, 15–67 SS1.15, SS3.7.7, SS6
Barrow 5	A round barrow perhaps built before *2140–2070 cal BC* or *2050–1880 cal BC*	Harding and Healy 2007, 141–47 SS1.16, SS3.7.7, SS3.8.4, SS4.5.4, SS6
Barrow 6	A round barrow built *2140–2080 cal BC* or *2050–1890 cal BC*	Harding and Healy 2007, 130–36 SS1.17, SS3.7.7, SS3.8.4, SS4.5.4, SS4.7, SS6
Southern Enclosure	An undated, although almost certainly Neolithic or early Bronze age, cursus-like monument	Harding and Healy 2007, 104–108 SS1.7, SS3.7.7, SS3.8.4, SS4.6.4

This work was carried out in the context of other preliminary investigations at Raunds and investigations of similar landscapes (Davis and Payne 1993; Pryor 1998a; Windell *et al* 1990). In addition, a number of complementary studies have been undertaken by the author on buried soils, treethrow holes and barrows at the Neolithic sites of the Drayton cursus, Oxfordshire, and Hazleton long cairn, Gloucestershire, and at the late Bronze Age/early Iron Age site of Hengistbury Head, Dorset. Soil studies from the Experimental Earthworks Project and treethrow holes have also contributed to this investigation (Bell *et al* 1996; Langohr 1993; Macphail and Goldberg 1990).

The fieldwork and first phase of laboratory analyses of the soils took place during the mid to late 1980s (exceptions were the Long Barrow, excavated in 1989, and the Avenue and Southern Enclosure, excavated in 1991–2, which were studied during the early 1990s). Since then, techniques employed in archaeological soil science have become increasingly more sophisticated, and databases have become much larger. The approach adopted has therefore been to attempt to build upon the earlier studies of the site with the application of new methods to key soil sequences and to address new archaeological questions. As part of British research in geoarchaeology a number of methods were tested at Raunds. Thus, thin sections have been re-examined under the microscope and through microprobe analysis, and soil micromorphological data have been recorded semi-quantitatively from selected sequences in order in increase microstratigraphic resolution. In the same way, bulk samples have undergone a whole series of analyses, varying from basic particle size and organic carbon studies in the 1980s to various forms of phosphate analyses in the 1990s. The number of magnetic susceptibility studies was also expanded. This reflects the key areas of archaeopedological interest, namely the investigation of the Mesolithic/early Neolithic landscape from treethrow holes that contain burnt soil and the reconstruction of soil landuse history from soils buried beneath Neolithic and early Bronze Age monuments (Macphail and Goldberg 1990; Courty *et al* 1994). In addition to the employment of soil micromorphology, complementary techniques such as magnetic susceptibility and phosphate analysis augmented standard bulk soil studies in order to test identifications of burnt soil and the inferred presence of domestic animals. Bulk sample data also underwent statistical analysis.

SS4.8.2.2 Samples and methods

Soils from fourteen archaeological features were studied (Table SS4.57–8). Most were described and sampled in the field by the author. A major exception is the Long Mound, which was sampled by the environmental team. Fifty-two thin sections and seventy bulk samples have been studied, including those from the Long Barrow. The samples and their associated buried soils and alluvial overburdens are listed in Table SS4.60.

A variety of soil data have been collected to address the research objectives at Raunds. Soil micromorphological analysis, grain size and chemical studies have been carried out across the site, but for practical reasons the most detailed analyses (semi-quantitative counts and microprobe) could only be carried out on a limited number of samples. Four thin section sequences (i–iv) have been counted at Raunds, from undated treethrow hole F62119, the early Neolithic Long Barrow (described in detail in SS4.8.1) the early Bronze Age south end of the Turf Mound and early Bronze Age Barrow 5. When these sites were selected, treehole F62119 was believed to be Mesolithic since all the treeholes in trench B140 appeared contemporary (cf Brown 1997, 141) and some of them contained Mesolithic artefacts. They were only subsequently found to be of varying ages (Harding and Healy 2007, panel 3.2), so that F61119 could date from any time in the Holocene up to alluviation, although the soil data recovered from it make a date in the historical period very unlikely. At this time too, the south end of the Turf Mound appeared to be part of the early Neolithic monument, rather a later addition to it. The altered date of the Turf Mound samples (which including two from overlying post-prehistoric alluvial/ploughsoil horizons) has made it possible to compare them to those from early Bronze Age Barrow 5, which was also buried by post-prehistoric alluvium. Two key soil horizons from Barrow 5 were analysed by microprobe.

Soil Micromorphology

Undisturbed samples were air-dried, impregnated with a crystic resin mixture at the Institute of Archaeology, UCL and manufactured into large (60–70 x 55mm) thin sections either at the Institut National Agronomique, Paris-Grignon or Stirling University (Guilloré 1985; Murphy 1986).

Thin sections (Table SS4.60) were viewed at a number of magnifications from x1, up to x400 under the polarising microscope and employed plane polarised light (PPL), crossed polarised light (XPL), oblique incident light (OIL) and fluorescence microscopy using blue incident light (BL). The combined use of these different forms of illumination permit a large number of optical tests to be made, enabling more precise identifications of the materials under study (Bullock *et al* 1985; Stoops 1996). For instance, the non-calcareous soil microfabrics at Raunds generally have low interference colours under XPL. On the other hand, some textural features (eg well orientated void clay coatings) derived from recent alluvial clay deposition display high interference colours and can be compared to darker textural features dating to the prehistoric period. OIL is useful in identifying red and black soil that has been impregnated by iron and manganese, a phenomenon that can occur because of poor drainage. Rubefication of soils, due to burning is also recognizable when observing under OIL. Apart from well-preserved root material little soil material of importance was found to be autofluorescent under BL.

Investigations of archaeological soils are based on a clear understanding of natural pedogenesis and the soil micromorphology (and chemistry) of natural soils, and both of these have a long history of study (Avery 1990; Duchaufour 1982; Kubiena 1938; Kubiena 1953). In the context of Raunds, familiarity with the different soil micromorphological characteristics of, for example, forest soils and grassland soils is therefore fundamental (eg Soil Survey of England and Wales, and UCL reference collections; Babel 1975; Murphy and Kemp 1984; Parfenova *et al* 1964). In addition, intensive studies of analogue sites and experiments both in soil science (eg animal and human trampling, soil crusts and pans) and archaeology (eg drowned landscapes, earthworks, animal husbandry) provide useful databases for investigations of ancient soils (Beckman and Smith 1974; Chartres 1997; Courty *et al* 1989; Courty *et al* 1994; Crowther *et al* 1996; French 1998; Macphail 1987; Macphail *et al* 2003; Rentzel and Narten 2001).

Semi-quantitative data

In order to quantify variations in the microstratigraphy of the most important and key sequences at Raunds, semi-quantitative soil micromorphological data were gathered from treethrow hole F62119, the Turf Mound (south) and Barrow 5 (Tables SS4.62–64). The features counted in the fourteen thin sections from these sites were selected after the soil micromorphological study of the whole site. This was necessary so as to identify more clearly and contrast the characteristics of the prehistoric subsoils, topsoils, barrow mound material and overlying post-prehistoric overburden of plough soils and alluvium. It was also a way to provide data that could be useful in understanding the palimpsest nature of the sequences. For example, what was the pedological effect of occupation on the natural soil cover? and how did barrow construction and post-prehistoric flooding influence the underlying and older soils?

Point counting is another approach, but if rare components are not to be missed it is extremely time consuming and therefore expensive in terms of time and money. A semi-quantitative method has therefore been adopted, which provides an accurate guide to variations in the microstratigraphy but is not nearly so time-consuming (Macphail and Cruise, 2001).

At Raunds, microfabric types, inclusions and pedofeatures, the last sensu Bullock *et al* (1985), were counted semi-quantitatively (Tables SS4.62–64) after all 51 thin sections had been studied. In the three selected sequences each thin section is some 55 to 60mm wide, which permits 5(6) x 10mm squares to be examined per 10mm of vertical stratigraphy. Microfabric types (Table SS4.61), void space and type, coarse inclusions (charcoal and gravel) and pedofeatures (here mainly textural features) were noted and recorded on a count sheet, for each 5(6) horizontal squares (Table SS4.62–64 and text). During counting other soil phenomena were also noted for each vertical 10mm of stratigraphy. The dominant soil microfabric type (SMF), frequency of void types and gravel, and abundance of pedofeatures (textural features, biogenic calcite and amorphous features – Fe/Mn) were then estimated for each vertical 10mm of stratigraphy (Table SS4.62–64; see below and Bullock *et al* 1985, 23 and 112, for terminology of frequency and abundance). As each thin section is 60 or 70mm in length, this permitted the examination of some 30 or 35 squares to contribute to the semi-quantitative microstratigraphic analysis of each thin section. Counting of 10mm squares at Raunds took between 2–4 hours per slide, while at the Overton Down and Wareham Experimental Earthworks counting of 5mm squares required an 8-hour counting time

Table SS4.58. Samples and field descriptions

Sample number and relative depths	*Thin section number, relative depths and stratigraphy*	*Brief field description*
Turf Mound (south end)		
3 (medieval Ap/alluvium, 0.15–0.73m)	37 (Ap/alluvium, 0.48–0.56m)	0–0.15m: grassland topsoil/A1h: Dark brown (7.5YR4/2) firm clay, with crumb and fine to medium subangular blocky structures; abundant fine roots; gradual smooth boundary 0.15–0.73m: alluvial B(g)/bAp: light olive brown (2.5Y5/4) moderately firm clay (Table SS4.59), with coarse prisms; few pores; few fine roots; gradual, irregular boundary
4 (Ap ridge and furrow, 0.73–1.32m)	38 (Ap ridge and furrow, 0.99–1.06m)	0.73–1.32m: ridge and furrow 2bAp: reddish brown (5YR4/4) firm sandy loam with channel infills of light olive brown (2.5Y5/4) clay; massive with poorly formed coarse prisms; few fines pores; no observable roots; clear, smooth boundary.
5 (mound, 1.32–1.64m)	39 (mound, 1.45–1.53m)	1.32–1.64m: mound: very dark grey to dark reddish brown (5YR3/1–3/2) very firm sandy loam, with few fine pores and channels infilled with light olive brown (2.5Y5/4) clay; charcoal present; massive; gradual, irregular boundary.
6 (bB, 16.4–1.72m)	40 (bB, 1.56–1.65m)	1.64–1.72(89)m: bB: dark reddish brown to very dark grey (5YR3/2–7.5YR3/1) weak sandy loam, with few pores; gradual, irregular boundary.
7 (bB2, 1.72–2.04m)	-	1.72(89)–2.04m: bB2: strong brown to yellowish brown (7.5YR5/6–10YR5/8) weak, structureless loamy sand; gradual, horizontal boundary.
8 (bBt, 2.04–2.25m)	41 (bB't, 1.73–1.81m)	2.04–2.25(8)m: bBt: yellowish red (5YR5/8) moderately firm, massive loamy sand and gravel, clear, irregular boundary.
9 (bC, 2.25+m)	-	2.25(8)+m: yellow (10YR7/8) weak, massive, sands and gravels.
Long Mound (east end)		
1 (mound)	35 (mound/OLS/buried soil)	No data
2 (bA & B)	36 (buried soil)	No data
Barrow 6		Area protected by medieval building. Long recent grassland history with perhaps a couple of ploughing episodes; Windell, pers comm 1986) Excavated/machined surface
10 (mound, 0.06–0.16m)	31 (mound, 0.06–0.15m)	0–0.28m: mound: very dark brown (10YR3/2) moderately weak sandy loam (Table SS4.59), becoming very dark greyish brown (10YR3/4) with depth; weak coarse subangular blocky; rare stones; frequent earthworm burrows, moderately humic without roots; clear horizontal boundary.
11 (lower mound, 0.16–0.28m)	32 (lower mound, 0.17–0.26m)	ditto
12 (bA & B, 0.28–0.37m)	33 (bA & B, 0.28–0.36m)	0.28–0.46m: bA & B and bB2: strong brown (7.5YR4/6) moderately weak sandy loam becoming a loamy sand with depth; weak coarse subangular blocky; common gravel and small stones; gradual, horizontal boundary.
13 (bB2, 0.37–0.49m)	34 (bB2, 0.38–0.47m)	ditto 0.46+m: bC: dark yellowish brown (10YR4/6) loose, structureless sands and gravels.
Barrow 1		
14 (modern Ap/top of mound, 0–0.30m)		No data
15 (B1 mound, 0.30–0.63m)	1 (mound and buried soil, 0.58– 0.70 m; OLS at 0.63m)	No data
16 (bA & B, 0.63–0.76m)	1 and 2 (buried soil 0.72–0.80m)('stoneline' at 0.76m)	No data
17 (bB2, 0.76–0.91m)		No data

Table SS4.58. Continued.

Sample number and relative depths	*Thin section number, relative depths and stratigraphy*	*Brief field description*
Barrow 3		
18 (bAg[Bf], 1.41–1.44m)	4 (bAg, 1.40–1.48m)	0–1.41m: mound: dark brown (7.5YR3/2) weak sandy loam; poorly developed coarse subangular blocky becoming strongly mottled (strong brown 7.5YR4/6 and yellowish red (5YR4/6) towards the base; moderately stony; thin (2–5 mm) dark reddish brown (2.5YR3/4) ironpans at *c* 138 and 1.40m (turf lines?) with brown (7.5YR4/2) structureless sandy loam between
		1.41–1.48m: bAg[Bf]: yellowish red (5YR4/6) weak, massive loamy sand with thin ironpans (see above); gradual, horizontal boundary.
19 (bAg[Eg], 1.44–1.48m)	4	Ditto (leached zone)
20 (bAg & Bg1, 1.48–1.63m)	5 (bAg & Bg, 1.51–1.59m)	1.48–1.63m: bAg & Bg1: dark reddish brown (5YR3/4) loamy sand, with dominant dark reddish brown (2.5YR3/4) mottles; few fine pores; gradual, horizontal boundary.
21a (bBg1, 1.63–1.72m)		1.63–1.72m: Bg1: ditto
21b (bBg2, 1.72–1.93m)		1.72–1.93m: bBg2: dark reddish brown (5YR3/4) loamy sand, with fine, diffuse 'grey' and 'reddish' mottles; gradual, horizontal boundary.
21c (bC, 1.93+m)		1.93+m: Cg: strong brown (7.5YR5/8) mottled sands and gravels.
Barrow 4		No chemical data
		0–0.14m: Ah: very dark brown to greyish brown (10YR3/1–3/3) clay with abundant roots; gradual, horizontal boundary
		0.14–0.42m: B: dark brown (7.5YR4/2) clay; gradual, horizontal boundary
		0.42–0.55m: Bg: dark brown (7.5YR4/2) loamy sand with abundant coarse, diffuse mottles; gradual, horizontal boundary
		0.55–0.73m: C (alluvium/barrow?): strong brown (7.5YR5/6) and greyish brown (10YR5/2) clay; earthworm burrowing at base forming a gradual, horizontal boundary
	6 (bA, 0.87–0.95m)	0.73–1.01m: bA: black (2.5Y5/4) massive, sandy loam, with frequent faint ochreous mottles; gradual, horizontal boundary
	7 (bB, 0.97–1.05m)	1.01–1.07m: bB: light olive brown (2.5Y5/4) massive loamy sand, with frequent strong red mottles; gradual horizontal boundary
Barrow 5		
22 (medieval Ap/alluvium, 0.20–0.52m)		0–0.20m: Ap: dark brown (10YR3/3) moderately weak clay, with coarse clods; rare pores; clear, smooth boundary
		0.20–0.52m: medieval Ap/alluvium: dark yellowish brown (10YR4/4) moderately weak sandy loam; weakly developed coarse prisms; earthworm burrows; gradual, horizontal boundary.
23 (mound, 0.80–0.86m)	8 (mound/bA, 0.83–0.90m)	0.52–0.86m: mixed B and mound: dark brown (7.5YR3/2) moderately weak sandy loam, with common fine diffuse mottles; massive; few pores; clay coatings, manganese staining and earthworm burrows present; gradual, horizontal boundary.
24 (bA, 0.86–0.99m)	8	0.86–0.99m: bA: dark reddish brown to yellowish red (5YR3/4–5/6) moderately weak sandy loam, with common medium diffuse mottles; few pores; poorly formed medium prisms; clay coatings; earthworm burrows; gradual, horizontal boundary.
25 (bB, 0.90–1.06m)	9 (bB, 0.92–1.00m)	0.99–1.06m: bB: dark brown to strong brown (7.5YR4/4–5/6) weak loamy sand, with very diffuse coarse mottles; earthworm burrows, clay coatings and fine channels present; clear, irregular boundary.
26 (bB2, 1.06–1.25m)	10 (bB2, 1.02–1.10m) and 11	1.06–1.20m: bB2: as above.
27 (bBt, 1.25–1.32m)	11 (bB2/bBt, 1.20–1.27m)	1.25–1.32m: bBt: strong brown (7.5YR5/8) moderately firm clay loam/sandy loam, with common clay coatings on stones, and brown (7.5YR4/4) moderately weak loamy sand; gradual, horizontal boundary.
28 (bC, 1.32+m)		1.32+m: bC: yellowish brown (10YR5/6) loose sands and gravels.

Table SS4.58. Continued.

Sample number and relative depths	*Thin section number, relative depths and stratigraphy*	*Brief field description*
Avenue (F87566)		
41a (bB [brown soil fill], 0.43–0.58m)	52 (bB [basal fill], 0.39–0.46m)	
42 (bC [sands and gravels], 0.58+m)		
43 (bB [red burnt fill], 0–0.27m)	53 (bB [red burnt soil], 0.13–0.21m)	
44 (bB [dark brown fill], 0.27–0.43m)	53	
45 (bB [black burnt fill and charcoal], 0–0.19m)	54 (bB [black burnt soil], 0.11–0.19m)	
F62338 (treethrow hole 1, B145)		
29 (alluvium, 0–0.86m)	12 (alluvium/bAg & Btg, 0.80–0.88m)	
30 (bAg & Btg/burnt soil, 0.89–0.96m)	13 (bAg & Bg/burnt soil, 0.89–0.97m)	
31 (bBtg, 0.98–1.06m)	14 (bBtg, 0.98–1.06m)	
32 (bAg & Btg/burnt soil fragments, 0.86–0.94m)		15 (bAg & Btg and burnt soil fragments, 0.86–0.94m)
F62123 (treethrow hole 2, B140)		
33 (Ah, 0–0.25m)		
34 (Bg, 0.25–0.43m)	-	Clay
35 (Bg2, 0.43–0.80m)	-	Clay loam
36 (bBtg [upper dark infill, north], 0.80–0.86m)		16 (Btg2/bBtg [dark fill], 0.78–0.86m) Clay loam
37 (bBtg [lower dark infill, north], 0.89–0.95m)		17 (bBtg [dark fill], 0.89–0.95m) Clay loam
38 (bBtg [upper infill centre], 0.74–0.82m)	18 (bBtg [dark fill], 1.12–1.18m)	Sandy silt loam
39 (bBtg [lower infill, centre], 0.96–1.04m)	19 (Btg2/bBtg [centre], 0.74–0.82m)	
40 (bBtg [upper infill, south], 0.80–0.88m)	20 (bBtg [centre], 0.96–1.04m)	
F62119 (treethrow hole 3, B140)		
41b (bBg [main dark fill], 0.035–0.115m)	21 (bBg [main dark fill], 0.035–0.115m)	Clay loam
42 (bBg [centre fill], 0.04–0.12m)	22 (bBg [centre fill], 0.04–0.12m)	
No data	23 (bBg [thin dark fill at edge of hole], 0.065–0.145m)	
43 (bBg [lower main dark fill], 0.35–0.43m)	24 (bBg [lower main dark fill], 0.35–0.43m)	Sandy clay loam
No data	25 (bBg [outside hole], 0.06–0.14m)	
44 (bBg [outside hole], 0.20–0.28m)	26 (bBg [outside hole], 0.20–0.28m)	Loamy sand
45 (base of fill)		Sands
46 (below treethrow hole)		Calcareous (pH 8.6) sands and gravels
F62113 (treethrow hole 4, B140)		No chemical data
	27 (bBg [burnt soil], 0–0.07m)	
	28 (bBg [burnt soil], 0.07–0.14m)	
	29 (bBg [burnt soil], 0.19–0.26m)	
	30 (bBg, 0.33–0.44m)	
Long Barrow		
	46 (mound/OLS/buried soil, *c* 0.45–0.60m; OLS at 0.52m – NE end)	138: Dark brown (7.5YR3/4) mound becoming a mottled dark reddish brown (5YR3/3) with depth
		138: Dark reddish brown (5YR3/3) mound/buried soil (?).
	47 (buried soil, *c* 0.60–0.75m)	138: Dark reddish brown (5YR3/3) mound/buried soil

Table SS4.58. Continued.

Sample number and relative depths	*Thin section number, relative depths and stratigraphy*	*Brief field description*
	48 (buried soil, *c* 0.75–0.80m)	219: Brown (7.5YR4/4) buried soil, over loose sands and gravels
	49 (buried soil, *c* 0.52–0.67 m; 5 metres lateral to 46–48)	219: Adjacent dark reddish brown (5YR3/3) buried soil (undulating surface area)
	50 (buried soil, *c* 0.52–0.67 m; centre of monument by tree hole)	138/139: Dark reddish brown (5YR3/3) mound/buried soil (?)(by tree hollow)
	51 (buried soil, *c* 0.52–0.67 m; by cist – SW end)	138: Mottled brown (7.5YR4/2) mound/buried soil (?) (by cist)

per thin section (Crowther *et al* 1996; Macphail *et al* 2003). In all 320 squares were counted from the Turf Mound and Barrow 5. Five thin sections were counted from treethrow hole F62119, but only on a contextual basis, because iron-staining obscures much of the detail of the microfabric (cf French 1998). In samples M21–M25 the slides were counted as single contexts while sample M26 is composed of three contexts/layers (Table SS4.64).

The specific aim of these estimations was to identify broadly the intensity of various forms of biological activity by fauna (burrows and chambers), roots (channels), hydromorphism (Fe, Fe/Mn), soil translocation (textural features), and possibly associated porosity types (vughs). Such counting methods were established during the 1960s in Holland (Jongerius and Jager 1964). The study of the Redlands Farm Long Barrow involved the counting of 390 squares.

This approach is based upon exhaustive testing at the Experimental Earthwork at Overton Down, which is similarly composed of a buried soil and a turf-cored monument (Crowther *et al* 1996; Macphail and Cruise 1996). Moreover, results from a comparison of semi-quantitative data 'counted' from the Experimental Earthworks of Overton Down and Wareham, and that measured by image analysis have been shown to be highly consistent (error range equals ≤5%; Acott *et al* 1997; Macphail *et al* 2002). This method has been used on late Bronze Age/early Iron Age occupation sequences such as those at Potterne, Wiltshire, and Salford, Bedfordshire, colluvial sites, like the Roman and medieval Haynes Park, Bedfordshire, dark earth, as in London, and experimental floors and arable soils at Butser Ancient Farm and Umeå Ancient Farm, in order to draw out changes in microstratigraphy (Lawson 2000; Macphail 1997; Macphail and Cruise, 2001). It was also employed to examine Saxon feature fills and the sediments at West Heslerton, north Yorkshire (Macphail in prep). Carter employed the same approach during combined pollen and soil micromorphological research in Scotland (Davidson *et al* 1999). A buried acid forest soil employed as an analogue for Raunds (see below) was studied in this detailed way (Macphail *et al* forthcoming).

As can be noted from Tables SS4.62–4, textural features (Bullock *et al* 1985) came under special scrutiny. This was done, in order to attempt to differentiate types of soil translocation typical of

a. forest soils (ferriargillans)
b. disturbed (dusty clay) soils
c. strongly disturbed (pan-like features) soils
d. inwash from alluvial flooding (yellowish brown clay), and
e. inferred animal activity (dark red clay; Chartres 1997; Fedoroff 1974; Fedoroff *et al* 1990; French 1998; Jongerius 1970; Macphail and Cruise, 2001; Murphy and Kemp 1984; Nørnberg and Courty 1985)

Caveats concerning semi-quantitative estimations, like those made at Raunds, have already been presented (Macphail 1998; Macphail and Cruise 2001).

Microchemistry

A Jeol JXA8600 EPMA was used at the Institute of Archaeology, UCL, to carry out microprobe analyses. Areas of interest were photographed from uncovered thin sections from two horizons of the counted Barrow 5 sequence (Table SS4.63: M9 and M11). These were then examined under the SEM, and a number of textural features and an example of an iron pan fragment were chosen for line analysis and elemental mapping. Line analyses across textural features ran from identifiable mineral grains (dominant Si) to void spaces (resin filled with 'low element counts'). The elemental composition of the textural features under study was carried out using line lengths that varied between 47 and 168 µm but only the average, maximum and minimum amounts (%) of P, Ca, Na, S, Fe, Mn, Mg, Si, Al and K are presented here (Table SS4.65). For this exercise, only 'clay' (colloidal soil) with a marked Al/Si content was included in the counted material, with counts from resin and mineral grains being excluded. It should therefore be especially noted that this policy allowed only a few (n=6) counts to be accepted from the coarse capping/pan feature in sample M9, and the resulting data cannot therefore be used to represent the chemistry of the feature as a whole. Elemental maps of Si, Fe, P and Ca were photographed from the VDU.

Bulk Soil Analyses

As noted earlier, analyses were carried out over a large number of years and a number of different methods were employed as further research questions were formulated. Bulk soil analyses were carried out at the Institute of Archaeology, UCL and the Centre for Environmental Archaeology, Department of Archaeology, Umeå University, Sweden because of a collaborative project. In

Table SS4.59. Soil grain size data

NB Clay: <2µm; FZ (fine silt): 2–6 µm; MZ (medium silt): 6–20 µm; CZ (coarse silt): 20–50 µm; VFS (very fine sand): 50–100 µm; FS (fine sand): 100–200 µm; MS (medium sand): 200–500 µm; CS (coarse sand): 500–1000 µm; VCS (very coarse sand): 1000–2000 µm

Sample number	*% Clay*	*% FZ*	*% MZ*	*% CZ*	*% Silt*	*% VFS*	*% FS*	*% MS*	*% CS*	*% VCS*	*% Sand*	*Texture*	*Thin section no*
Turf Mound (south end)													
3 (Ap/alluvium)	47	19	14	9	42	2	4	4	<1	<1	11	Clay	37
4 (Ap ridge and furrow)	15	4	10	14	28	5	15	30	6	1	57	Sandy loam	38
5 (mound)	13	7	10	14	31	6	18	29	2	1	56	Sandy loam	39
6 (bB)	11	6	6	16	28	6	16	36	3	<1	61	Sandy loam	40
7 (bB2	6	2	4	16	22	8	21	38	4	1	72	Loamy sand	-
8 (bBt)	14	-	1	12	13	4	15	41	11	2	73	Loamy sand	41
9 (bC)	-	-	-	-	4	4	16	60	14	2	96	Sand	-
Barrow 6													
10 (mound)	16	6	8	14	28	9	9	34	3	1	56	Sandy loam	31
11 (lower mound)	15	5	7	13	25	13	9	34	3	1	60	Sandy loam	32
12 (bA&B)	9	5	4	13	22	11	9	42	6	2	69	Sandy loam	33
13 (bB2)	9	1	2	7	10	10	10	52	6	3	81	Loamy sand	34
Barrow 1													
14 (Ap/mound)	20	8	12	10	30	7	12	24	5	2	50	Clay loam	-
15 (lower mound)	21	11	6	10	27	12	12	21	5	2	52	Clay loam	1
16 (bA&B)	20	9	6	12	27	13	12	21	5	2	53	Clay loam	1 and 2
17 (bB2)	17	8	5	10	23	16	15	24	3	2	60	Sandy silt loam	2 and 3
Barrow 3													
20	9	4	4	7	15	6	18	42	7	3	76	Loamy sand	4
21	7	6	2	5	13	6	19	45	8	2	80	Loamy sand	5
Barrow 5													
22 (Ap/alluvium)	36	12	10	11	33	4	10	14	2	1	31	Clay	-
24 (bA)	9	6	5	15	26	6	17	37	4	1	65	Sandy loam	8
26 (bB2)	12	3	2	13	18	9	25	32	3	1	70	Loamy sand	10 and 11
27 (bBt)	24	2	3	9	14	8	17	27	7	3	62	Silty clay loam	11
28 (bC)	3	5	2	10	17	7	20	33	10	10	80	Loamy sand	-
F62123 (treethrow hole 2)													
34 (Bg)	56	19	13	9	41	1	1	1	<1	<1	3	Clay	-
35 (Bg2)	31	16	13	15	44	5	11	7	1	1	25	Clay loam	-
36 (bBg [upper dark infill])	26	15	15	15	45	7	12	8	1	1	29	Clay loam	16
37 (bBg [lower dark infill]	31	14	13	15	42	7	10	8	1	1	27	Clay loam	18
38 (bBg [upper infill centre])	17	13	9	16	38	11	18	12	3	1	45	Sandy silt loam	19
F62119 (treethrow hole 3)													
42 (bBtg [centre fill])	30	10	13	14	37	13	13	3	4	<1	33	Clay loam	22
43 (bBtg [lower main dark fill])	29	4	0	0	4	26	28	10	3	<1	77	Sandy clay loam	24
44 (bB(t)g [outside hole])	9	2	3	3	8	4	39	36	4	<1	83	Loamy sand	26

the 1980s organic carbon, $CaCO_3$, pH (H_20 and $CaCl_2$) and grain size (dry sieving and hydrometer) analyses were carried out at UCL employing standard techniques on <2mm size samples (Avery and Bascomb 1974). In the 1990s loss on ignition (LOI), magnetic susceptibility (χ) and phosphate analyses were mainly carried out on <0.5mm size soil, because this size range records a better signal (Crowther 1997; Crowther and Barker 1995).

Magnetic Susceptibility

Magnetic susceptibility (χ) analysis was carried out in two ways.

UCL: During the 1980s the treethrow hole soils and some barrow soils were analysed using <2mm size soil (Table SS4.60).

Umeå University: In the 1990s a number of soils were measured for low frequency magnetic susceptibility using 10g of <0.5mm size soil with a Bartington MS2 system with a MS2B probe. Data are reported as internationally accepted SI-units per ten grams of soil (χx 10^{-8} SI kg^{-1}).

Phosphate Methods

Soils were analysed for phosphorus (P) and phosphate (P_2O_5) content by employing two different extractants, nitric acid at UCL (by Cyril Bloomfield) and citric acid at Umeå University (by Johan Linderholm), respectively. Citric acid is a weaker extractant than HCl/nitric acid, but is employed because in non-calcareous soils it is very efficient in differentiating inorganic from organic phosphate, an important research topic at Raunds (Arrhenius 1934; Arrhenius 1955; Engelmark and Linderholm 1996; see below). Only non-calcareous soils at Raunds, as identified through analysis with a calcimeter, were analysed for P_2O_5 using 2% citric acid.

UCL. Thirteen samples were analysed for total phosphorus (P) employing ignition, HCl pretreatment and 2N nitric acid extraction by Cyril Bloomfield (Table SS4.60).

Where both citric acid and nitric acid were employed on the same samples there was an acceptable 79% relationship (eg R^2= 0.79) between measurements of P (Fig SS4.28). As this relationship is so robust it was possible to calculate the amounts of P that could be expected from phosphate extraction employing nitric acid (Crowther pers comm 2002). This permitted easier comparisons between phosphate data collected using the two different methods. Although citric acid was found to be a reliable method for measuring phosphate compared to nitric acid (R^2 0.7972), because it extracts only *c* 25% of the phosphate taken up by nitric acid (P_{nitric}), the $P_2O_{5citric}$ data needs to be treated with caution. Nevertheless, testing for Spearman's Rank Correlation Coefficient showed efficient fractionation of inorganic and organic phosphate by citric acid (to produce the P ratio) with a strongly significant correlation (99.9% level) between P_{citric} and LOI and a significant correlation (95% level) between P ratio and Org C (Tables SS4.67–8). Although more nitric acid analyses of P would have been desirable at Raunds, the employment of citric acid as an extractant to discriminate between inorganic and organic phosphate was a successful experiment as shown through statistical testing, and key at the time to developing this research into pastoral activity.

Umeå University: Thirty-six samples were subjected to 2% citric acid phosphate (P_2O_5) extraction using methods, which had been successfully developed at Umeå University, Sweden (Arrhenius 1934; Arrhenius 1955; Engelmark and Linderholm 1996). Only a brief outline is provided here.

Together with analyses for LOI and MS, measurements were made of 2% citric acid soluble phosphate (termed P_2O_5) and 2% citric acid soluble phosphate after ignition at 550°C (termed $P_2O_{5\text{-ignited}}$, phosphate on ignition). Inorganic P is usually determined by weak acid extraction (or by salt solutions). Citric acid extraction followed by molybdenum blue reagent, is a gentle and sufficiently selective method for extracting and quantifying inorganic P (P_2O_5; Arrhenius 1934). As citric acid is a weak acid, it can be less effective on highly calcareous soils, because of the buffering effect of $CaCO_3$. Soils analysed at Raunds usually contain less than 0.1% $CaCO_3$ (the exception is sample 3 with 2.1% $CaCO_3$). Parent materials with, for example, 9.6% $CaCO_3$ and a pH above 8.0, were not analysed. Phosphate data are reported in ppm.

Phosphate analysis has been used for many years to identify and map general areas of human occupation (Bethell and Máté 1989; Proudfoot 1976). At Umeå University citric acid is used as an extractant, a method used by surveyors in both Sweden and the United Kingdom (Arrhenius 1955; Avery 1964), because large numbers of samples can be easily processed. The method of measuring P from non-ignited (inorganic P) and ignited soil samples (total P) to differentiate

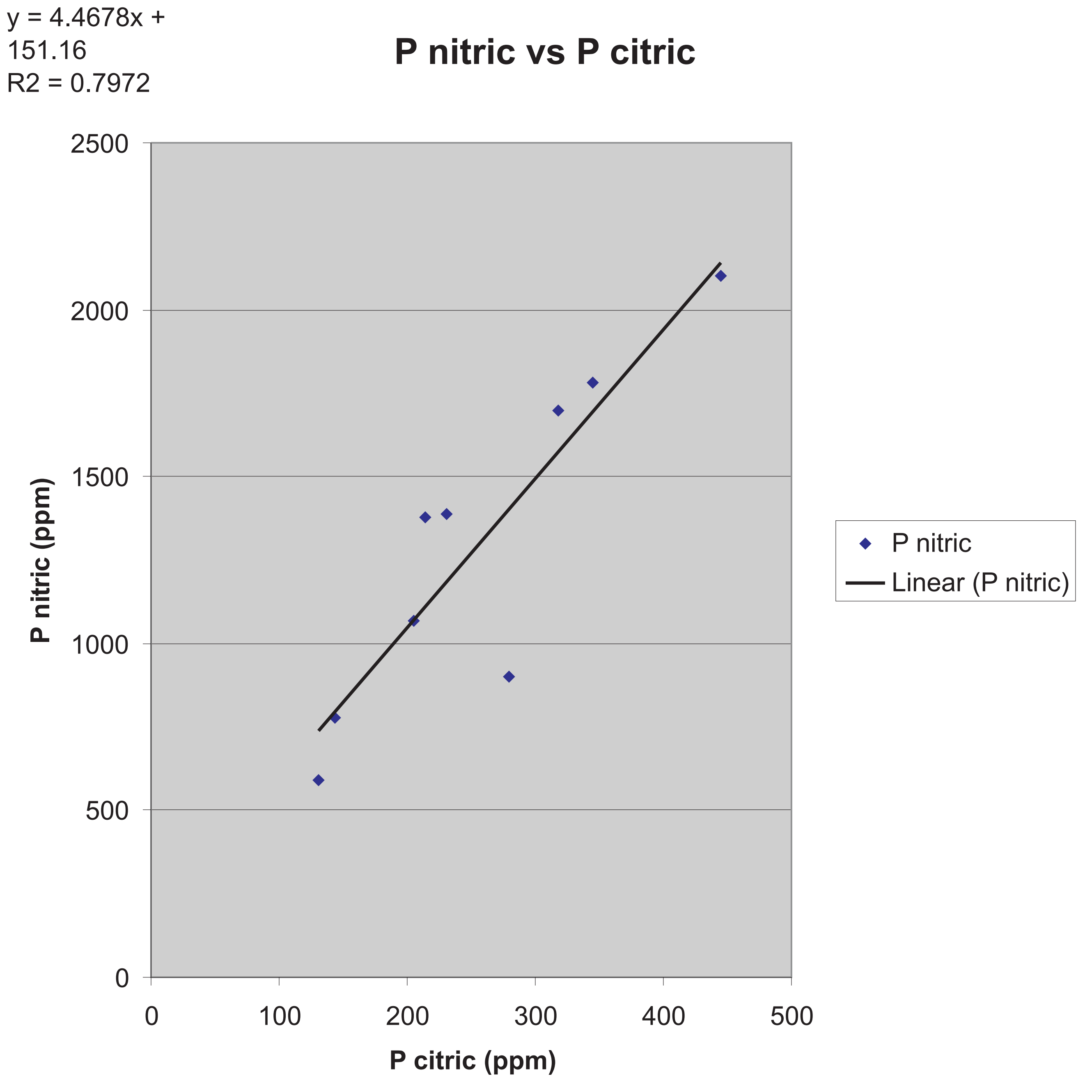


Figure SS4.28 Regression figure of Pnitric against Pcitric.

broadly between inorganic and organic P, is a standard one (Bethell and Máté 1989; Conesa *et al* 1982; Liversage *et al* 1987, 21–22). The resulting P ratio can thus be regarded as an inferred ratio between inorganic and organic phosphate. This topic was discussed at a round table by chemists working in archaeology at the 1997 meeting of the International Archaeological Soil Micromorphology Working Group at UCL (http://www.gre.ac. United Kingdom/~at05/ micro/soilmain/intro1.htm). Soils with very high amounts of organic matter may inhibit the extraction of phosphate (P_2O_5) and show exaggerated P ratios (see Hengistbury Head and Wormley Wood, Table SS4.66; Linderholm, pers comm).

Phosphate and magnetic signature analysis of archaeological sites

It is worth noting that total phosphate measurements on their own, as habitually carried out on archaeological sites, do not allow the important differentiation between, for example, phosphate from bone and phosphate from organic manure. Thus important archaeological characteristics of a site may not be revealed. Intensively occupied locations where the natural soil chemistry is modified (anthrosols) because of inputs of bone, ashes and mineral-replaced faecal matter (coprolites and cess) can be considered as essentially 'dwelling areas' (cf the late Bronze Age/early Iron Age 'midden' sites of Potterne and Chisenbury in Wiltshire), whereas those dominated by manure can be manured fields, animal paddocks etc, (Engelmark and Linderholm 1996; Lawson 2000). High absolute amounts of phosphate also indicate more intensive dwelling areas. In order to see Raunds in the context of its chemical and magnetic signature, a number of sites are included for comparison (Table SS4.66, Figs SS4.29–31):

a. 'dwelling areas' – late Bronze Age/ early Iron Age Chisenbury and Potterne, Wiltshire (Lawson 2000; Macphail in prep)

b. occupation – late Bronze Age/early Iron Age Salford, Bedfordshire (Macphail 1997)

c. enclosures – Neolithic–Beaker Belle Tout, East Sussex (Macphail *et al* 1998a),

d. enclosures – late Bronze Age/early Iron Age Balksbury, Hampshire (Macphail *et al* 1998a)

e. pre-barrow occupation 'midden' – Neolithic Hazleton, Gloucestershire (Macphail 1990a; unpublished data)

f. occupation 'midden' – Neolithic Eton Rowing Lake, Buckinghamshire (Macphail 1999b), and

g. undisturbed broad-leaved forest soil – late Bronze Age/early Iron Age Hengistbury Head and prehistoric Wormley Wood (Macphail 1992a; unpublished reports and data).

These sites, however, have to be considered as providing very broad general data on phosphate content because of their different geologies and environmental histories. Within-site differences between subsoils and topsoils, on the other hand, are worth comparing with within-site variation at Raunds. Measurements of total phosphorus (P) using HCl/nitric acid at Raunds were also compared to measurements of total P at the Neolithic occupation sites of Easton Down, Wiltshire and Tofts Ness, Orkney. Descriptive statistics, regression and correlation analysis were carried out on bulk data. The author was advised on statistical testing by John Crowther (University of Wales, Lampeter) and Robert Shiel (Newcastle University).

Statistical tests

Bulk data were analysed in terms of descriptive statistics (mean, standard deviation, skewness etc) and both Pearson's correlation coefficients and Spearman's rank correlation were applied to the data matrix. As some data (eg carbonate) are skewed, Spearman's rank correlation was used to discuss bulk data results as this avoids problems of skewness when levels of significance are calculated (Crowther pers comm 2002).

SS4.8.2.3 Results

Data from the individual site at Raunds (Table SS4.57) are presented in tables, graphs and digital images. The tables are as follows:

Table SS4.58 – Samples and field descriptions

Table SS4.59 – Soil grain size data

Table SS4.60 – Soil samples, thin sections, magnetic susceptibility and chemistry,

Table SS4.61 – Soil micromorphology; soil microfabrics and pedofeatures

Table SS4.62 – Turf Mound. Soil microfabrics and counted microstratigraphy

Table SS4.63 – Barrow 5. Soil microfabrics and counted microstratigraphy

Table SS4.64 – Treethrow hole F62119. Soil microfabrics and counted microstratigraphy

Table SS4.65 – Microprobe line analyses; Barrow 5, samples M9 and M11 (%), and

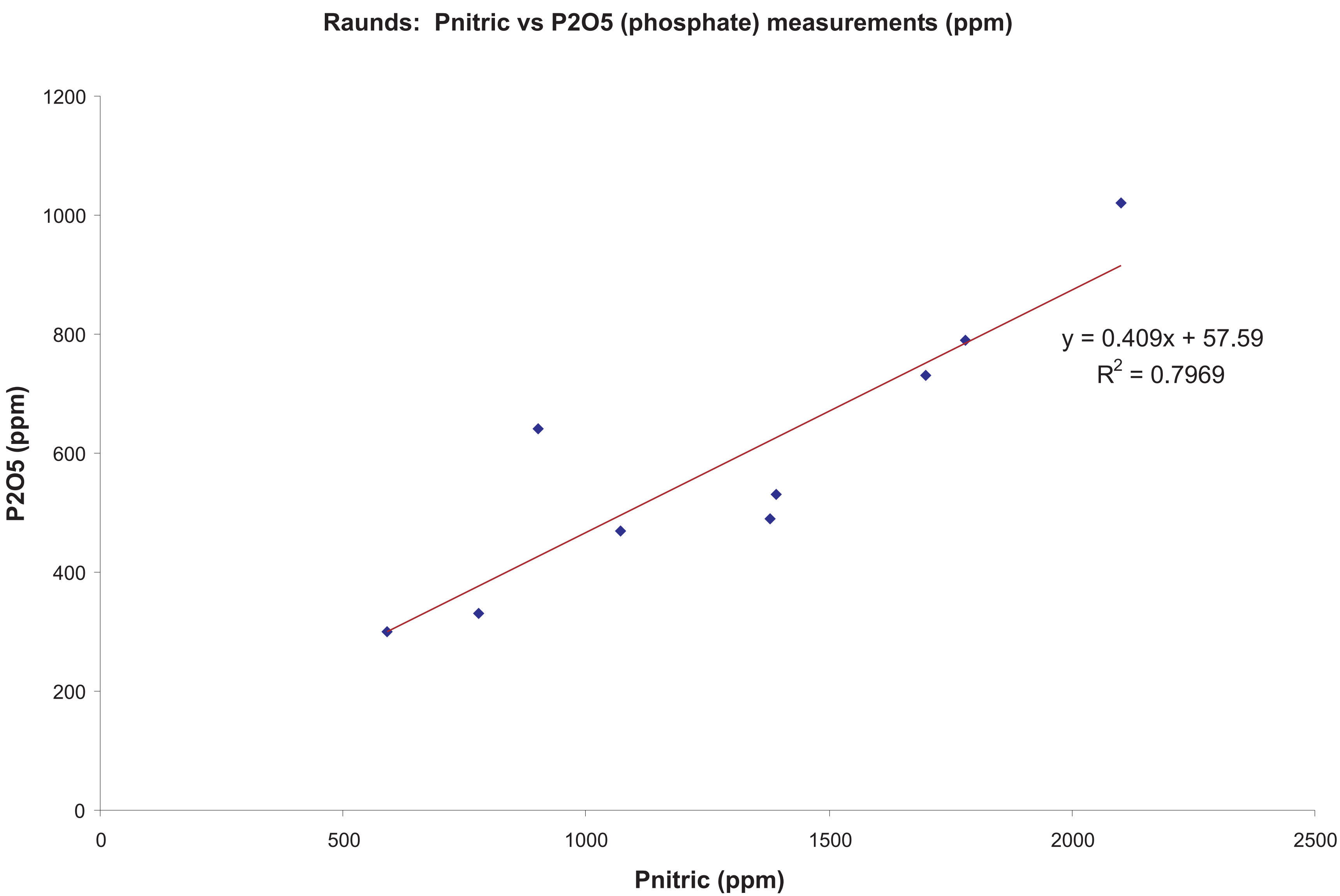
Table SS4.66 – Mean soil chemical and magnetic signatures at Raunds in comparison to other prehistoric sites.

Some chemical data are also expressed in scattergrams (Figs SS4.30–31). Statistical analysis of the bulk data is given in Tables SS4.67–68. The general characteristics of the bulk data are described first, then sites are dealt with one-by-one. Each site description is augmented by some site-specific interpretations. Further interpretations are discussed in section SS4.8.2.4.

Statistical analysis of bulk data

Some expected correlations were found, using Spearman's Rank Correlation Coefficient, namely a strongly significant correlation (r_s value 0.8674 at 99.9% level) between LOI and Organic C, and significant negative correlations between Organic C and pH (H_2O and $CaCl_2$, with r_s values of -.6208 and -.8463 at 95% level, respectively; Tables SS4.67–68). There are also significant (95% level) correlations between and measures of organic matter (Org C, r_s value 0.5584; LOI, r_s value 0.4667). Phosphate and organic matter are also correlated. The most significant

Figure SS4.29
Regression figure of P_2O_5 against Pnitric



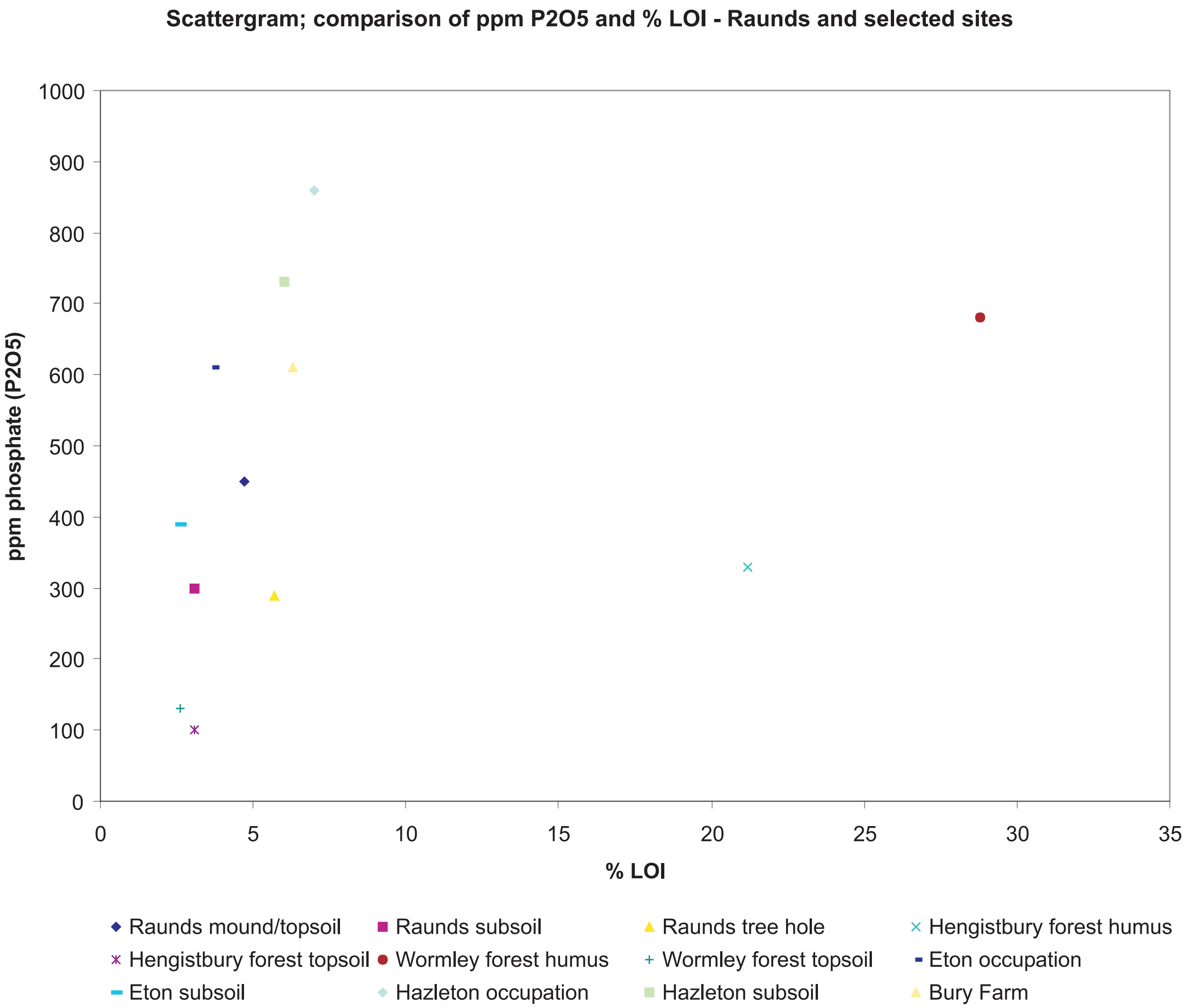


Figure SS4.30 Scattergram; comparison of ppm P2O5 and % LOI – Raunds and selected archaeological sites.

(99.9% level) correlations occur between P_{nitric} and Org C (r_s value 0.8583), and P_{citric} and LOI (r_s value 0.7761). P ratio is also correlated with Org C (r_s value 0.6395 at 95% level). Another series of interesting strongly significant correlations (99.9% level) concern clay and Org C (r_s value 0.6779) and clay and P_{nitric} (r_s value 0.9364), with clay and LOI being less correlated (r_s value 0.7572) at the 95% level.

Treethrow holes

During the 1987 Irthlingborough excavations (by Claire Halpin of the then Central Excavation Unit), a large number of trenches were cut through the Saxon and medieval alluvium to examine prehistoric features, including treethrow holes, with approximate old land surfaces at around 0.80–1.30m deep. A detailed study was carried out on four treethrow holes: F62338 (no 1) in trench B145 and F62123 (no 2), F62119 (no 3), and F62113 (no 4), all in nearby trench B140. Trench B140 had been especially widened, and around 35 tree holes were counted in this 30 x 22m trench alone (Figs SS4.32–33). The amount of treethrow disturbance here is thus near the upper limit (<1–50%) quoted in the reviews by Langohr (Langohr 1993) and Peterken (1996, 195).

The prehistoric treethrow features occur beneath moderately humic, weakly calcareous alluvial clay soils (Tables SS4.58–60: samples 29, 33–34). These Pelo-alluvial Gley Soils (Fladbury 1 Association; Avery 1990; Hodge *et al* 1984, 307) are typical, with dark greyish brown (10YR4/2) Ah horizon topsoils and strongly mottled (eg light grey 5YR6/1) yellowish brown (10YR5/8) subsoil Bg horizons. In plan, as noted in trench

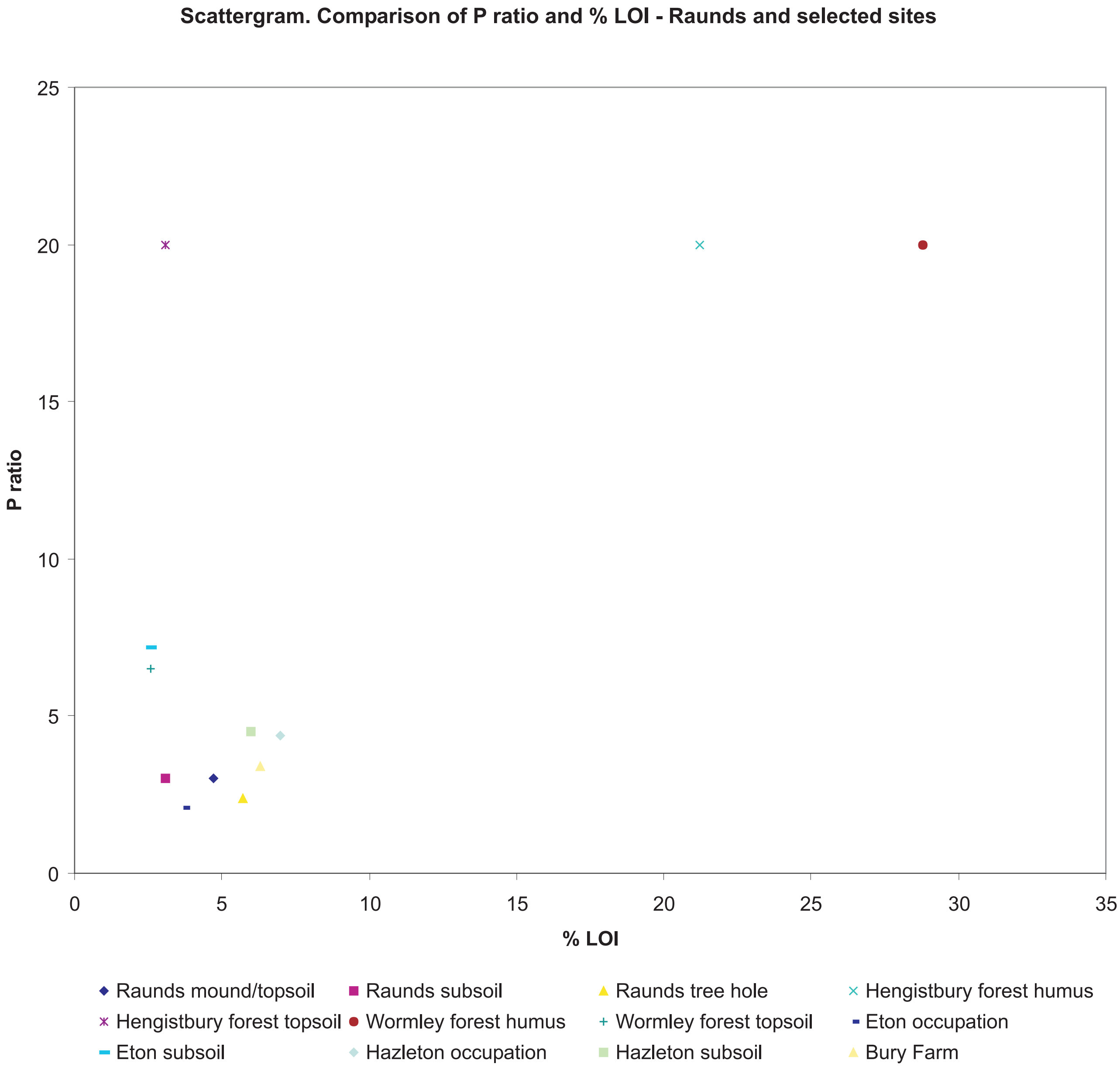


Figure SS4.31 Scattergram; comparison of P ratio and %LOI – Raunds and selected archaeological sites.

B140, the tree hollows have a circular outline some 1.5–3 metres across, with often a curved or 'banana shaped' dark infill on one side (Fig SS4.33). In section, the dark infill can be seen to be very thick on one side, with sometimes only a trace of it on the other side of the circular feature.

The excavated treethrow holes were exposed at depths of 0.90–1.30m below the present ground surface. The overburden of some 0.40m of present day soil formed in early medieval alluvial clay (Tables SS4.58–60) occurs over another 0.40m of sandy loam soil, which can be interpreted as representing pedogenic homogenization of the upper treethrow holes and associated prehistoric land surface (see sample M55, Southern Enclosure). This homogenization took place from late prehistory to the early medieval period (Robinson 1992a), and resulted from an arable/pastoral landuse. This 0.80–0.90m of late prehistoric-early medieval and early medieval-recent soil was removed through excavation to reveal the base of treethrow holes, as seen at baulk sections (eg treethrow holes F62123 and F62338; Figs SS4.34–5). Soil studies of the treethrow holes were thus carried out below this 0.90–1.30m level in little-disturbed soil, as recognized by the excavators (cf the Drayton Cursus; A Barclay *et al* 2003). In order to investigate 'control soils' from the prehis-

Table SS4.60. Soil samples, thin sections, magnetic susceptibility (χ) and chemistry

n d – no data; <2 mm size samples – Org. C, $CaCO_3$, pH and some magnetic susceptibility χ *; <0.5 mm size samples – P (nitric), P_2O_5 (citric acid) and most magnetic susceptibility [χ])

Sample number and relative depths	*% Org C*	*% $CaCO_3$*	*pH (1:2.5 H_2O)*	*pH ($CaCl_2$)*	*%LOI*	*χx 10^{-8} $SIkg^{-1}$*	*P (ppm Nitric acid) Italics = calculated*	*P_2O_5 (ppm Citric acid)*	*$P_2O_{5\text{-ignited}}$ (ppm Citric acid)*	*P ratio*	*Thin section number, relative depths and stratigraphy*
Turf Mound (S end)											
3 (medieval Ap/alluvium, 0.15–0.73m)	1.0	2.1	7.6	-	9.3	40	*1050*	170	460	2.7	37 (Ap/alluvium, 0.48–0.56m)
4 (Ap ridge and furrow, 0.73–1.32m)	0.4	<0.1	7.4	-	4.0	77	*1070*	130	470	3.6	38 (Ap ridge and furrow, 0.99–1.06m)
5 (mound, 1.32–1.64m)	0.5	0.1	7.3	-	4.2	134	*1010*	130	440	3.4	39 (mound, 1.45–1.53m)
6 (bB, 1.64–1.72m)	0.3	-	7.6	-	3.0	81	*790*	110	330	3.0	40 (bB, 1.56–1.65m)
7 (bB2, 1.72–2.04m)	0.1	-	7.5	-	2.1	33	*600*	90	230	2.5	-
8 (bBt, 2.04–2.25m)	0.2	-	7.5	-	3.3	48	*830*	130	350	2.7	41 (bBt, 1.73–1.81m)
9 (bC, 2.25+m)	<0.1	-	8.6	-	-	-	-	-	-	-	-
Long Mound (E end)											
1 (mound)	1.0	-	7.4	6.9	10.2	218	1380	340	490	1.4	35 (mound/OLS/buried soil)
2 (bA&B)			0.3	-	7.2	6.8	2.3	64	780	290	330 1.1 36 (buried soil)
Barrow 6											
10 (mound, 0.06–0.16m)	0.9	-	7.6	7.1	4.1	70*	1410				31 (mound, 0.06–0.15m)
11 (lower mound, 0.16–0.27m)	0.6	-	7.5	7.1	3.8	150*	1290				32 (lower mound, 0.17–0.26m)
12 (bA&B, 0.27–0.37m)	0.3	-	7.5	7.1	2.9	70*	1020				33 (bA&B, 0.28–0.36m)
13 (bB2, 0.37–0.49m)	0.2	-	7.5	7.1	2.8	50*	1200				34 (bB2, 0.38–0.47m)
Barrow 1											
14 (modern Ap/top of mound, 0–0.30m)	3.2	-	4.8	4.3	10.4	140	2100	180	1020	5.7	
15 (B1 mound, 0.30–0.63m)	1.7	-	6.0	5.7	7.8	163	1780	140	790	5.6	1 (mound and buried soil, 0.58– 0.70m; OLS at 0.63m)
16 (bA&B, 0.63–0.76m)	1.3	-	6.5	6.2	7.1	213	1700	170	730	4.3	1 and 2 (buried soil 0.72–0.80m) ('stoneline' at 0.76m)
17 (bB2, 0.76–0.91m)	1.1	-	6.5	6.2	6.2	249	1390	130	530	4.1	2 and 3 (buried soil 0.83–0.91m) 0.91+ m sands and gravels)
Barrow 3											
18 (bAg[Bf], 1.41–1.44m)	0.7	-	-	-	6.8	64	1070	100	470	4.7	4 (bAg, 1.40–1.48m)
19 (bAg[Eg], 1.44–1.48 m)	0.5	-	-	-	4.0	8	900	190	640	3.4	4
20 (bAg&Bg1, 1.48–1.63m)	0.4	-	-	-	3.3	9	590	60	300	5.0	5 (bAg&Bg, 1.51–1.59m)
21a (bBg1, 1.63–1.72m)	0.4	-	-	-	7.0	226	*1110*	90	490	5.4	
21b (bBg2, 1.72–1.93m)					2.8	86	*680*	50	270	5.4	
21c (bC, 1.93+m)					1.9	59	*460*	30	160	5.3	

Table SS4.60. Continued.

Sample number and relative depths	*% Org C*	*% $CaCO_3$*	*pH (1:2.5 H_2O)*	*pH ($CaCl_2$)*	*%LOI*	*χ x 10^{-8} SI kg^{-1}*	*P (ppm Nitric acid) Italics = calculated*	*P_2O_5 (ppm Citric acid)*	*$P_2O_{5\text{-ignited}}$ (ppm Citric acid)*	*P ratio*	*Thin section number, relative depths and stratigraphy*
Barrow 4 – no chemical data											
											6 (bA, 0.87–0.95m)
											7 (bB, 0.97–1.05m)
Barrow 5											
22 (medieval Ap/alluvium, 0.20–0.52m)	1.2	<0.1	6.7	-	8.0	32	*1160*	130	520	3.5	
23 (mound, 0.80–0.86m)	0.6	<0.1	6.8	-	4.6	78	*1010*	130	440	3.4	8 (mound/bA, 0.83–0.90m)
24 (bA, 0.86–0.99m)	0.2	<0.1	-	-	2.0	34	*600*	90	230	2.5	8
25 (bB, 0.90–1.06m)	0.2	<0.1	6.8	-	2.1	30	*620*	100	240	2.4	9 (bB, 0.92–1.00 m
26 (bB2, 1.06–1.25m)	0.1	<0.1	7.3	-	2.1	24	*640*	100	250	2.5	10 (bB2, 1.02–1.10m) and 11
27 (bBt, 1.25–1.32m)	0.2	0.2	7.5	-	4.4	24	*900*	150	380	2.5	11 (bB2/bBt, 1.20–1.27m)
28 (bC, 1.32+m)	<0.1	9.6	8.1	-			-				
Avenue (F87566)											
41a (bB [brown soil fill], 0.43–0.58m)	-	-	-	-		46*	-				52 (bB [basal fill], 0.39–0.46 m
42 (bC [sands and gravels], 0.58+m)	-	-	-	-		13*	-				
43 (bB [red burned fill], 0–0.27m) -	-	-	-		753*	-				53 (bB [red burned soil], 0.13–0.21m)	
44 (bB [dark brown fill], 0.27–0.43m)	-	-	-	-		75*	-				53
45 (bB [black burned fill and charcoal], 0–0.19m)						572*					54 (bB [black burned soil], 0.11–0.19 m)
F62338 (treethrow hole 1, B145)											
29 (alluvium, 0–0.86m)	0.5	-	-	-		46*	-				12 (alluvium/bAg&Bg, 0.80–0.88m)
30 (bAg&Btg/burned soil, 0.89–0.96m)	0.6	-	-	-		894*	-				13 (bAg&Btg/burned soil, 0.89–0.97m)
31 (bBtg, 0.98–1.06m)	0.3	-	-	-		19*	-				14 (bBtg, 0.98–1.06m)
32 (bAg&Btg/burned soil fragments, 0.86–0.94m)	0.3	-	-	-		96*	-				15 (bAg&Bt(bBg [lower main dark fill], 0.35–0.43m) g and burned soil fragments, 0.86–0.94m)
F62123 (treethrow hole 2, B140)											
33 (Ah, 0–0.25m)	2.6	0.3	-	-		26*	-				
34 (Bg, 0.25–0.43m)	1.0	0.4	-	-		15*	-				
35 (Bg2, 0.43–0.80m)	0.5	0.2	-	-		11*	-				
36 (bBtg [upper dark infill, north], 0. 80–0.86m)	0.4	0.2	-	-		44*	-				16 (Btg2/bBtg [dark fill], 0.78–0.86m)
37 (bBtg [lower dark infill, north], 0.89–95m)	0.5	<0.1	-	-		22*	-				17 (bBtg [dark fill], 0.89–0.95m)
38 (bBtg [upper infill centre], 0.74–0.82m)	0.1	<0.1	-	-		10*	-				18 (bBtg [dark fill], 1.12–1.18m)
39 (bBtg [lower infill, centre], 0.96–1.04m)	0.2	<0.1	-	-		10*	-				20 (bBtg [centre], 0.96–1.04m)
40 (bBtg [upper infill, south], 0.80–0.88m)	0.2	<0.1	-	-		8*	-				19 (Btg2/bBtg [centre], 0.74–0.82m)

Table SS4.60. Continued.

Sample number and relative depths	*% Org C*	*% $CaCO_3$*	*pH (1:2.5 H_2O)*	*pH ($CaCl_2$)*	*%LOI*	*χx 10^{-8} $SIkg^{-1}$*	*P (ppm Nitric acid) Italics = calculated*	*P_2O_5 (ppm Citric acid)*	*$P_2O_{5\text{-ignited}}$ (ppm Citric acid)*	*P ratio*	*Thin section number, relative depths and stratigraphy*
F62119 (treethrow hole 3, B140)											
41b (bBtg [main dark fill], 0.035–0.115m)			7.1		6.5	80	*810*	130	340	2.6	21 (bBtg [main dark fill], 0.3.5–1.1.5m)
42 (bBtg [centre fill], 0.04–0.12m)			7.0		5.5	14	*550*	140	260	1.9	22 (bBtg [centre fill], 0.04–0.12m)
	n d	n d	n d		n d	n d	n d	n d	n d	n d	23 (bBtg [thin dark fill at edge of hole], 0.65–0.145m
43 (bBtg [lower main dark fill], 0.35–0.43m)			7.0		6.2	53	*780*	120	320	2.7	24 (bBtg [lower main dark fill], 0.35–0.43m)
	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d	25 (bB(t)g [outside hole], 0.06–0.14m)
44 (bB(t)g [outside hole], 0.20–0.28m)			7.2		2.1	5	*460*	50	160	3.2	26 (bB(t)g [outside hole], 0.20–0.28m)
45			6.9		4.5	9	*660*	110	260	2.4	(base of central fill *c* 0.40m)
46			8.6		-	-					(sands and gravels below hole)
F621113 (treethrow hole 4, B140) – no chemical data											
											27 (bBg [burned soil], 0–0.07m)
											28 (bBg [burned soil], 0.07–0.14m)
											30 (bBg, 0.33–0.44m)
Long Barrow											
					6.4	248		100	560	6.5	151 (mound/OLS/buried soil, c 0.45–0.60m; OLS at 0.52m) (NE end)
					6.3	289		90	470	5.5	152 (buried soil, *c* 0.60–0.75m)
					6.0	275		90	430	5.0	153 (buried soil, *c* 0.75–0.80m)
					4.4	250		90	370	4.5	154 (buried soil, *c* 0.52–0.67m; 5m lateral to 151–153)
					5.0	283		110	440	3.3	155 (buried soil, *c* 0.52–0.67m; centre of monument by treehole)
					4.8	103		90	370	4.0	156 (buried soil, *c* 0.52–0.67m; by cist, SW end)
Southern Enclosure											
47						906*					99182a reddish surface
48						239*					99182b Fe/Mn pan
49						42*					99182c pale zone
50						23*					99182d ditch fill
51						129*					99183 reddish surface
Saxon 'old land surface' sample 99180											55 ('buried soil' at 0.63–0.79m)

Figure SS4.32 Irthlingborough 1987; Trench B140; 30m x 22m trench, with approximately 35 tree hollows; topsoil and Saxon/medieval alluvium removed.

Figure SS4.33 Irthlingborough 1987; Trench B140, detail.

toric palaeo-landscape, an example of the soil profile was taken outside treethrow hole F62119. This was collected from below the 'reworked' zone at around 0.80m below the present ground surface. Sample M26, some 0.20–0.28m below the excavated surface (ie *c* 1.00–1.08m depth) is characterised by undisturbed alluvial sedimentary layering (0.24–0.28m) and thus can be regarded as absolutely intact, and unaffected by physical disturbance of prehistoric or modern origin. It thus can be compared to the juxtaposed treethrow fill that was sampled down to 0.43m (ie *c* 1.23m depth) and shows the preserved remains of ancient treethrow (see below).

Treethrow hole F62338 (treethrow hole 1). Undated

This feature is approximately two metres long, and has a clear irregular boundary with the overlying alluvium (Fig SS4.34). Firm patches of red (2.5YR5/8) soil occur within a generally mottled (dark reddish brown 2.5YR3/4) brownish yellow soil layer some 170–250mm thick. This layer and its junction with the alluvium were sampled (thin sections M12, M13 and M14) in detail. A lateral control sample within the hole was also taken (thin section M15). Disturbed upthrow features could be traced down to the brownish yellow sands and gravels at 1.20m deep, some 1.60m below the approximate relict surface of the treethrow feature.

Magnetic susceptibility analyses show convincing differences between presumed burnt soil (χ: 894 x 10^{-8} SI kg^{-1}), scattered burnt soil (χ: 96 x 10^{-8} SI kg^{-1}), gley soil (χ: 19 x 10^{-8} SI kg^{-1}) and alluvium in general (χ: 46 x 10^{-8} SI kg^{-1}; Table SS4.60: samples 29–32). Soil micromorphology identified a number of features (Macphail and Goldberg 1990). Firstly, flooding of the site and burial by alluvium has induced hydromorphic conditions resulting in dominant gleying. Very abundant ferruginous and iron and manganese impregnative features are superimposed upon the buried soil microfabric, obscuring and transforming it into a gley soil microfabric (Figs SS4.51–61). In addition, plants growing on the accreting alluvium have rooted deeply into the buried soil, in places producing a marked channel microfabric within the generally dense and prismatic structured soil. These root channels, which are often vertically oriented, are generally surrounded by very pale, iron-depleted soil, because anaerobic/leaching conditions have been concentrated along these channels. This process of biological turbation and iron-depletion has further obscured earlier soil features.

Micromorphological details of the prehistoric soil were initially investigated in the large fragments of red soil (thin section M13), which are characterised by strongly enhanced magnetic susceptibility readings (see above). These red fragments are here associated with wood charcoal, and the red soil has a dense microfabric and is bright red under oblique incident light (Table SS4.61, SMF 6). All these factors indicate that this red soil has been highly burnt (Courty *et al* 1989). Because this red soil has been burnt it has resisted later biological mixing. The main post-depositional effects appear only to have been impregnation by iron and manganese along cracks and other voids (Figs SS4.55–56). In this way, the burnt soil has preserved its prehistoric character (cf Drayton Cursus, Oxfordshire; A Barclay *et al* 2003).

Careful examination shows this preserved prehistoric soil to contain a number of soil elements. There are clay-rich fragments (pieces of Bt horizon) with vughs (a type of void) coated by finely dusty clay. These argillic features are not right-way-up, as in undisturbed argillic soils. There are also fragments of less clay-rich material (Eb horizon?) and pieces of darker soil containing relict organic matter (Ah horizon). Between these fragments very dusty clay soil is present, sometimes the infillings being well oriented to right-way-up. These characteristics indicate that the original prehistoric soil was an Argillic Brown Earth ('Atlantic forest soil'), and that treethrow disrupted the soil profile, mixing it up and allowing loose soil to wash down into fissures (Macphail 1992b; Macphail and Goldberg 1990). Charcoal and (iron-replaced) lignified woody material also occurred within burnt soil fragments.

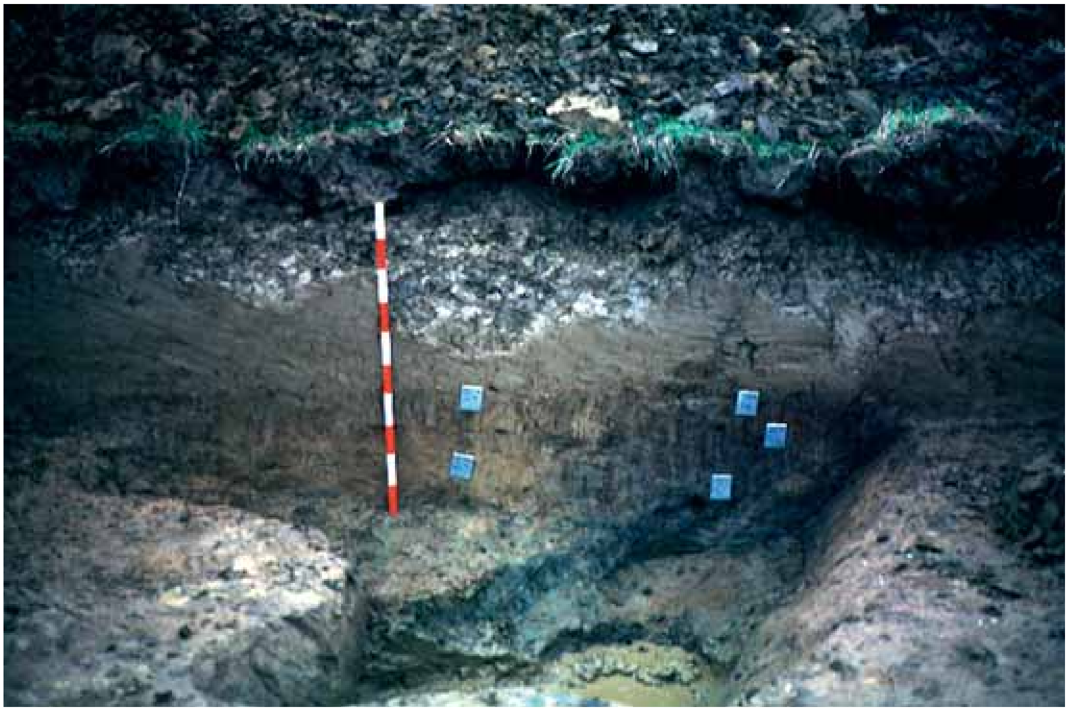
Many other patches of this disrupted soil fabric, but unburnt, can be identified in all the other thin sections. These have sometimes the optical advantage of not being rubified (reddened) by burning. Again, soil fragments from the various original 'stratified' soil horizons (Ah, Eb, Bt) of the original forest soil are identifiable, and these too are mixed up through the hollow infilling. As these parts of the tree hollow soil were not burnt, they have developed over a longer period. Large fissures within the treethrow pit have infilled with coarse layered infills; sand grains, etc have well-oriented (right-way-up) soil around them ('embedded' grains; Bullock and Murphy 1979), and some intercalatory features are present (Figs SS4.51–53). All these show that the soil was a focus of soil water drainage (Veneman *et al* 1984), permitting slaking of the loose infill material. Some of these infill clays are perforated by roots, or a series of root holes which are preserved by ferruginisation. This reveals that biological activity was contemporary with the infilling of the treethrow hole.

Treethrow hole F62123 (treethrow hole 2). 4360–3980 cal BC (5370 ±80 BP; OxA-3057)

This treethrow feature, which is associated with late Mesolithic/early Neolithic flint artefacts (of which some are burnt and some

Figure SS4.34
Treethrow hollow 1 (B145, F62338; undated); as sampled (M12–M15).

Figure SS4.35
Treethrow hollow 2 (B140, F62123) (5370±80 BP, OxA-3057); as sampled (M16–M20).



refit) is some 2.5 metres across (Fig SS4.35). Clay loam soils (Tables SS4.59–60: sample 35/Bg2) are buried by 0.43m of alluvial clay (sample 34/Bg). The excavated treethrow hole occurs at around 0.80m deep and, like treethrow hole F62338, is thus not directly overlain by alluvial clay, but by some 0.40m (Bg2, 0.43–0.80m) of intervening soil that probably relates to topsoil formation up to early medieval alluviation. Of particular interest is the strongly manganese-stained infill at least some 0.40–0.50m deep, with dominant reddish brown (2.5YR5/4) mottling in the dark grey (10YR4/1) strong brown (7.5YR5/8) soil. This is also a clay loam (Table SS4.59; samples 37–36), but seems to contain slightly more organic matter than other parts of the treethrow hole sampled laterally (Table SS4.60; compare samples 36–37 with samples 38–40). A brown soil infill on the other side of the hollow is much sandier, having a silty clay loam texture (Table SS4.59: sample 38).

Three soil micromorphological samples (M16, M17 and M18) were taken from the dark infill area, and two samples were taken of the sandier brown infill (M19, M20; Table SS4.59; Fig SS4.35). Burnt soil fragments, often including small wood charcoal fragments, were identified both in the brown soil infill and dark soil infills (Table SS4.61, SMF7 and SMF8), despite much of the latter's microfabric being strongly obscured by dominant iron and manganese impregnation. The burnt soil is only orange-red under oblique incident light, and thus apparently less rubified compared with burnt soil from treethrow hole F62338.

Gley features, in the form of ferruginous and iron and manganese impregnations, including nodular formations representing episodic hydromorphism, and iron-depleted rooting features, are abundant. Disrupted soil fabrics of original argillic soils, and their mixing within the hollow are also well represented, and no differences could be identified between these features and those in treethrow hole F62338. Of interest, is the microfabric of the dark infill. Close scrutiny of this shows iron-replaced root pseudomorphs and possible amorphous organic matter, replaced mainly by iron and manganese, a feature typical of tree hollow soils at Drayton Cursus, Oxfordshire (A Barclay *et al* 2003). These features and the higher (residual) organic content (Table SS4.60: samples 36–37) of this dark fill, may indicate preferential iron and manganese replacement of an infill of humic Ah horizon (topsoil) material. This is consistent with forest soil data demonstrating much higher moisture and organic matter content for treethrow holes (pits) compared to 'mound' soil, that fell in subsequently (Peterken 1996, table 8.6; see also Langohr 1993, fig 2).

The presence of burnt soil within the dark fill has only weakly enhanced the soil's magnetic susceptibility (χ: 44 x 10^{-8} SI kg^{-1}, Table SS4.60: sample 36), again indicating diffusion of this material into the soil by biological mixing. This relatively low figure for magnetic susceptibility may also possibly reflect the lower degree of rubification of the soil. Thin section M19 is different from the others, in that it comprises a sandy soil (Table SS4.59: sample 38). Lenses of sandy soil are mixed up with clay loam soil, whereas probable earthworm burrows clearly mix sandy soil with clay loam. These sandier, silty clay loam soils probably indicate disturbance of the deep sandy soils overlying gravels of the upward–fining Pleistocene alluvial sequence.

At treethrow hole F62123 there is a clear association with human activity (flint working, fires) and treethrow in the fifth to fourth millennium cal BC. As the treethrow feature is poorly observable in the 0.40m of clay loam soil beneath the presumed early medieval alluvial clay, it seems possible that weathering and biological processes over some 6,000 years have obscured the upper part of the treethrow pit, which may have been some 0.80–0.90m deep originally (Fig SS4.35).

Treethrow hole F62119 (treethrow hole 3). Undated

This treethrow hole is of the same large size (2.5 – 3.0m) and depth (1.20–1.30m below present ground surface) as treethrow hole F62123. It was extensively sampled for soil micromorphology (Fig SS4.36). The samples comprise two (M21 and M22) from the top and bottom of the mottled dusky red (2.5YR3/2) and dark greyish brown (2.5YR4/2) dark fill of the banana shape, one (M22) from the top of the central fill, one (M23) from dark periphery of the tree hole fill and two control samples (M25 and M26) from the upper brownish yellow (10YR6/8) soil and lower subsoil of the soil profile just outside the treethrow hole. The upper dark fill (M21) contains small fragments of burnt soil (only moderately reddened) and charcoal, with biological mixing being strongly in evidence (χ: 80 x 10^{-8} SI kg^{-1}). The lower part of the fill (M24) has a much disturbed and slaked soil preserved, and includes a coarse (3mm) earthworm burrow that contains high amounts of inwashed impure soil and charcoal. This dark infill is also highly impregnated with iron and iron and manganese nodules. At the edge of the hollow (M23) the thin dark infill contains high amounts of fine to medium size charcoal of both woody and perhaps herbaceous material, and amorphous iron and manganese cementation have preserved patches of probable humic topsoil material. This organic and burnt soil content is probably reflected in the relatively high LOI (5.5–6.5%) for these dark fills and other subsoil (LOI 4.5%) compared to ('control') soil outside the hole

Figure SS4.36 Treethrow hollow 3 (B140, F62119) (undated); as sampled (M21–M26).

(LOI 2.1%; Table SS4.60). These latter subsoils also feature much lower χ (5–9 x 10^{-8} SI kg^{-1}) values.

Phosphate is concentrated in the main dark fill (320–340 ppm $P_2O_{5\text{-ignited}}$) and has a higher P ratio (2.5–2.7) compared to the centre and lowermost fills (260 ppm $P_2O_{5\text{-ignited}}$, P ratio 1.9–2.4). The subsoil outside the treethrow hole has the least phosphate ($P_2O_{5\text{-ignited}}$ 160 ppm) and highest P ratio (3.2).

Outside the treethrow hole, the control soil is gleyed in the same way as in the centre of the feature, but the soil is much less heterogeneous, and much poorer in textural features (no intercalations or impure soil infills; Table SS4.63). Clay coatings are finely dusty, but occur only infrequently compared with the soils in the hollow. Sometimes clay coatings occur in compound coatings, which include iron laminae, suggesting episodic clay illuviation and gleying (high

Figure SS4.37 Treethrow hollow 4 (B140, F62113) (4700±80 BP, OxA-3058); as sampled (M27–M30).

water tables). The lowermost thin section (M26) samples 15mm of ferruginous gravels, 20mm of medium to coarse sands and 35mm of sandy argillic loam, where patches of occasional dusty clay coated voids are present. The lowermost sand and gravels are also calcareous (pH 8.6, Table SS4.60). These features are relict of calcareous parent material sedimentary layering.

The soil infill of treethrow F62119 contains, on average less phosphate (mean 290 ppm $P_2O_{5\text{-ignited}}$, n=4) than is found in the Neolithic and Bronze Age barrow mounds and buried topsoils (mean 420 ppm $P_2O_{5\text{-ignited}}$, n=15). But this is more than is present in the local subsoil (160 ppm $P_2O_{5\text{-ignited}}$). It is difficult to know what the expected amount of phosphate is for prehistoric acid woodland topsoils formed on highly weathered substrates, as at Raunds, because there are no local analogues. It can be noted, however, that the well-studied (by archaeology, radiocarbon dating, palynology and soil micromorphology) prehistoric woodland topsoils at Hengistbury Head (100–330 ppm $P_2O_{5\text{-ignited}}$) and Wormley Wood (130 ppm $P_2O_{5\text{-ignited}}$; Table SS4.66) cover a similar range to that found in treethrow hole F62119. P ratios, on the other hand are much lower at Raunds, probably due to much stronger organic matter mineralisation than at Hengistbury Head, which has continued as a wet site. It is therefore possible that the organic matter and phosphate present in treethrow hole F62119 mainly relate to infilling by forest humus, although Langohr (1993) noted trampling by forest animals in tree holes. It is remarkable how little affected by Holocene weathering and biological mixing the soil is outside the treethrow hole (sample M26, Table SS4.64). Burrowing has had little effect on soils below 240mm (1.04m below present ground surface) where original sedimentary stratification is preserved. This may be evidence of little pedological activity affecting this 'buried' soil at this depth despite the area having a long history of agricultural landuse prior to alluviation. It seems likely that machine and hand excavation have exposed soils at a depth below major biological and agricultural working that affected the site in late prehistory through to the early medieval period. Importantly, the control soil (M25 and M26) shows little evidence of argillic brown earth maturity compared to the fill of the treethrow hole soil (Table SS4.64).

Unfortunately, F62119 is undated, although small amounts of charcoal and dispersed amounts of burnt soil (χ: 50 and

Key to Tables SS4.61–65

Microfabric type

Voids

Burrows and chambers

Channels

Vughs

Gravel (ironstone and flint)

Charcoal (>10µm)

Soil clast (sand-size loam, occasionally humic in character)

Organic matter – plant material (eg roots) in M37 and amorphous organic matter in M39

Ferriargillan/argillan textural features (yellowish brown to reddish brown to brown, well-oriented, microlaminated, limpid to finely dusty void and grain coatings and void infills; OIL – yellowish to brown; most commonly present in Bt horizon microfabrics, eg coating coarse mineral grains)

Dusty clay textural features (brown, moderately well-oriented, microlaminated, fine to coarse dusty void and grain coatings and void infills; OIL – yellowish brown; eg present as last 'sorted' layer in otherwise coarse pans)

Dark red clay textural features (dark red to blackish, probably humic, moderately well-oriented, limpid to dusty void and grain coatings and void infills; OIL – dark orange brown; eg most common in mound and uppermost buried soil layers)

Pan-like textural features (speckled, dark blackish brown, very poorly oriented, sometimes poorly sorted, microlayered, very dusty to impure (fine silt to very coarse silty) clay pans; OIL – yellowish orange to orange brown; eg most common in upper buried soil, in association with dusty clay and dark red clay coatings and in humic burrow fills in upper buried soil)

(In samples 37 and 38, Ap1 – fine alluvium and Ap2 – coarse aluvium/ridge and furrow, crusts and intercalatory textural features are very dominant)

Yellowish brown textural features (bright yellowish brown, well- to moderately well-oriented finely dusty clay void and grain coatings and infills; may contain fine charcoal; OIL – pale yellow; eg most commonly present in alluvium and medieval plough soils, and most obvious lower down in mound and buried soils in secondary root channels and burrows)

Compound textural features (commonly ferriargillans with secondary dusty clay or dark red clay coatings; dusty clay/impure clay over dark red coatings)

Calcite (secondary calcite, including biogenic calcite – earthworm granules)

Fe/Mn (blackish iron and manganese nodular impregnations)

Fe (very dark yellowish brown to black in PPL, bright yellow in OIL, iron hypocoatings, single ring amiboidal nodules, impregnative nodules and mottles)

NB Coarse:Fine (C:F) limit is at 10µm

Table SS4.61. Soil microfabric types and associated data

Counts of soil micromorphology are based on 30 or 35 x 10 mm size squares; detailed results are in Tables SS4.62–64; microprobe data are reported in Table SS4.65; microfabric types and microprobe elemental maps are illustrated in Figures SS4.51–110

A key to pedofeatures is in the final rows of this table

Material	*Sample numbers of examples*	*Fig(s)*	*Summarised soil micromorphology and counted data (M), bulk data (BD), microprobe (probe) and elemental map (EM)*	*Interpretation and comments*
Soil Microfabric Type 1	M37, BD3 and 22	SS4.57–60	SM: prismatic structures, frequent to dominant planar voids (mean 33%, range 20–50%; *n*=6 x 5(6) x 10^2 mm) with fine and medium channels (burrows, chambers, vesicles and vughs also present); Coarse mineral: C:F 30:70, moderately poorly sorted, few to frequent subangular silt-size and subrounded to rounded fine to medium sand-size quartz; very few opaques and silt-size mica; Fine mineral: (clay dominated) very dusty, with few brown speckles, dark yellowish brown (PPL), moderately low interference colours (XPL)(open porphyric; speckled, granostriate and weakly parallel striate b-fabric), very pale yellowish orange with frequent sand-size black and ochreous inclusions (OIL); heterogeneous with patches of darker soil; rare very fine calcareous inclusions; occasional to many fine plant fragments; many relic amorphous organic matter; occasional fine charcoal and rubified material; Pedofeatures (see key in final rows of this table) include occasional to many pan-like and rare to occasional yellowish brown textural features rare to occasional blackish iron and manganese nodular impregnations (Fe/Mn), and rare biogenic calcite (earthworm granule). BD: clay, with 36–47% clay, 33–42% silt and 11–31% sand; poorly humic (1–1.2% Organic C; 8–9.3% LOI) and very weakly calcareous (<0.1–2.1% $CaCO_3$); 460–520 ppm $P_2O_{5ignited}$, 2.6–4.0 P ratio (*n*=2); MS 32–40 x 10^{-8} SI kg^{-1}.	Fine alluvium/ephemeral Ap (Ap1)
Soil Microfabric Type 2	M38, BD4	SS4.61–66	SM: massive structured, with frequent to dominant coarse (>10 mm) burrows, with channels, planes and vughs (Voids, mean 21%, range 15–30%; *n*=6 – as above); Coarse mineral: C:F 70:30, very dominant, moderately poorly sorted subangular silt and subrounded to rounded very fine to medium sand-size quartz; very few opaques and silt-size mica; Fine mineral: dotted, very dark yellowish brown (PPL), very low interference colours (XPL)(single spaced porphyric, speckled b-fabric), pale orange with very few very fine black specks (OIL);rare plant fragments; occasional relic amorphous organic matter; rare charcoal and rubified material; Pedofeatures include rare to many pan-like and rare to occasional yellowish brown textural features rare to occasional blackish iron and manganese nodular impregnations (Fe/Mn), and rare biogenic calcite (earthworm granule).	Sandy alluvium/ephemeral Ap (Ap2)
	(M55)		(SM: as above but with textural pedofeatures of rare intercalations and dusty/impure clay void coatings. BD: sandy loam, with 15% clay, 28% silt, 57% sand; poorly humic (0.4% Organic C; 4% LOI) and non-calcareous (<0.1% $CaCO_3$); 470 ppm $P_2O_{5ignited}$, 3.5 P ratio (x1); MS 32–40 x 10^{-8} SI kg^{-1}.	
Soil Microfabric Type 3	M8, M35, M36, M39, M40, BD5, 6, 10, 11, 24	SS4.67–72	SM: massive structured, compact; mainly frequent to dominant burrows and chambers, with very few to common channels and vughs (Total voids: mean 24% voids, range 10–30% voids; *n*=18– as above); C:F 65:35; Coarse mineral: very poorly sorted; very few gravel-size flint and quartzite; very dominant subangular silt-size to subrounded and rounded medium sand-size quartz ; very few opaques and silt-size mica; rare soil clasts; Fine mineral: heavily dotted, blackish, dark reddish brown (PPL), isotic to extremely low birefringence (XPL) (single spaced porphyric, speckled b-fabric); brownish orange with few black inclusions (OIL);	Humic and 'compacted' turf (mound and buried topsoil)

			many to abundant relic amorphous organic matter; occasional to many fine charcoal and occasional rubified material; Pedofeatures: rare to occasional dusty clay, rare to many dark red clay, rare to many pan-like, occasional to many yellowish brown clay and rare to many compound textural features (see Key); rare biogenic calcite; rare to occasional blackish iron and manganese nodular impregnations (Fe/Mn). BD: sandy loam, with 9–16% clay, 25–31% silt, 56–65% sand; poorly humic 0.2–0.6% Organic C, 2.0–4.6% LOI; mean 330 ppm $P_2O_{5ignited}$, range 230–440 ppm $P_2O_{5ignited}$, 3.4–3.5 P ratio (*n*=3); mean 1350 ppm P_{nitric}, range 1290–1410 ppm P_{nitric} (*n*=2)	
Soil Microfabric Type 4	M9 (39, 40) BD7, 25, 26	SS4.71–75, SS4.92–93	SM: massive structured, with common to dominant burrows and chambers, few to frequent channels and vughs (eg total voids: mean 37% voids, range 20–40% voids); C:F 85:15; Coarse mineral as SMF 3; Fine mineral: heavily speckled, greyish yellow brown (PPL), very low interference colours (XPL)(single spaced porphyric, speckled b-fabric); pale yellow orange (OIL); occasional to many relic amorphous organic matter; occasional charcoal and rubified material; Pedofeatures: rare to many dusty clay, occasional to abundant dark red clay, occasional to abundant pan-like, rare yellowish brown clay and rare to occasional compound textural features (see Key); rare to occasional blackish iron and manganese nodular impregnations (Fe/Mn). BD: sandy loam to loamy sand, with 6–11% clay, 22–28% silt and 61–72% sand; poorly humic (0.1–0.3% Organic C, 2–3% LOI), non-calcareous (<0.1% $CaCO_3$); 270 ppm $P_2O_{5ignited}$, range 240–330 ppm $P_2O_{5ignited}$, 2.3–2.9 P ratio (*n*=3).	bEb (B1)
		SS4.94–99	Probe/EM: Textural features Clay void infill: mean 0.11% P, 1.05% Ca, 0.06% Na, 0.06% S, 7.19% Fe, 0.37% Mn, 0.65% Mg, 16.6% Si, 8.3% Al and 1.56% K (*n*=19); Coarse capping/pan-like textural feature (excluding large sand grains): mean 0.07% P, 0.48% Ca, 0.19% Na, 0.13% S, 3.29% Fe, 0.03% Mn, 0.21% Mg, 20.6% Si, 3.0% Al and 0.88% K (*n*=6);dark red clay void coating: mean 0.25% P, 1.03% Ca, 0.38% Na, 0.04% S, 20.6% Fe, 0.12% Mn, 1.09% Mg, 12.2% Si, 7.8% Al and 0.97% K (*n*=9).	
Soil Microfabric Type 5	M11, M41, BD8, BD27	SS4.76–77	SM: Massive structured; few to dominant channels, with very few to frequent burrows and chambers and very few to common vughs (Total voids, mean 36% voids, range 20–40%, *n*=12, as above); C:F 80:20–70–30; Coarse mineral: poorly sorted with rare to very dominant gravel-size flint and ironstone, and frequent to dominant silt to coarse sand-size quartz (as above); Fine mineral: lightly speckled, pale yellowish brown (PPL), very low interference (XPL)(enaulic, speckled b-fabric), yellow (OIL); rare relic amorphous organic matter; rare charcoal and rubified material; Pedofeatures: abundant to very abundant ferriargillans, occasional to abundant dusty clay, occasional to many dark red clay, occasional to abundant yellowish brown clay and occasional to many compound textural features (see Key); occasional to many blackish iron and manganese nodular impregnations (Fe/Mn). BD: silty clay loam to loamy sand, with 14–24% clay, 13–14% silt, 62–73% sand (stony with few gravel); poorly humic (0.2% Organic C, 3.3–4.4% LOI), very weakly calcareous (up to 0.2% $CaCO_3$); 360 ppm $P_2O_{5ignited}$, 2.4–2.6 P ratio (*n*=2) Probe/EM: clay coating textural features (*n*=5): mean 0.06% P, range 0.04–0.07% P; mean 1.57% Ca, range 0.83–4.28% Ca; 0.24% Na, range 0.07–0.53% Na; mean 0.10% S, range 0.04–0.23% S; mean 6.98% Fe, range 5.99–7.48% Fe; mean 0.06% Mn, range 0.04–0.07% Mn; mean 0.56% Mg, range 0.35–0.80% Mg; mean 18.24% Si, range 14.2–20.5% Si, mean 6.48% Al, range 5.00–8.30% Al; mean 1.33% K, range 0.86–1.47% K (*n*=38).	bBt

Table SS4.61. Continued.

Material	*Sample numbers of examples*	*Fig(s)*	*Summarised soil micromorphology and counted data (M), bulk data (BD), microprobe (probe) and elemental map (EM)*	*Interpretation and comments*
Soil Microfabric Type 6	M13, BD30	SS4.51–56	SM: Massive structured (large – 20–30 mm – clasts)(channels, vughs and closed vughs); C:F 40:60; Coarse mineral: common angular silt-size and common fine to medium subrounded to rounded sand-size quartz; very few opaques and silt-size mica; Fine mineral: heavily speckled red (PPL), very low interference colours (XPL), porphyric, speckled and grano-striate b-fabric), bright red (OIL); occasional fine and small charcoal; Pedofeatures (see Key): include rare to occasional reddish ferriargillans and occasional to abundant reddish dusty clay void coatings and infills, and associated rare to occasional intercalations – all unoriented to present way up, sometimes void coatings themselves are coated by rare iron/manganese hypocoatings; many to abundant nodular iron and manganese impregnations. BD: weakly humic (0.6% Organic C), with very high MS (894 x 10^{-8} SI kg^{-1}).	F62338 (treethrow hole 1); burned argillic brown earth Btg
Soil Microfabric Type 7	M19, M20, BD39, BD40		SM: Massive (channels, vughs and closed vughs); C:F 45:55; Coarse mineral: as SMT 6; Fine mineral: heavily speckled yellowish brown to dark yellowish brown (PPL), low interference colours (XPL), porphyric, speckled and grano-striate b-fabric), pale yellowish brown (OIL); Pedofeatures (see Key): include rare to occasional ferriargillans and occasional to abundant dusty clay void coatings, infills and associated intercalations (and compound textural features); abundant iron depletion features, including around soil pores. BD: very poorly humic (0.2% Organic C) and calcareous (<0.1% $CaCO_3$) with very low MS (8–10 x 10^{-8} SI kg^{-1})(n=2).	F62123 (treethrow hole 2); gleyic argillic brown earth Btg – brown fill
Soil Microfabric Type 8	M16, M17, M18,BD36, BD37, BD38		SM: Massive (burrows, channels and vughs); C:F 45:55; Coarse mineral: as SMF 6; Fine mineral: areas of a) – Fe/Mn stained – very dark brown and black (PPL), isotic (XPL)(porphyric), yellowish brown, brown and black (OIL); rare relic amorphous organic matter and b) – depleted and unstained soil – speckled, grey and dark yellowish brown (PPL), low interference colours (XPL)(porphyric, speckled and grano-striate b-fabric); Pedofeatures: as SMF6. BD: sandy silt loam to clay loam, with 17–31% clay, 38–45% silt and 27–45% sand; very poorly moderately poorly humic (0.1–0.5% Organic C) and calcareous (<0.1% $CaCO_3$), with very low MS (10–22 x 10^{-8} SI kg^{-1})(n=3).	F62123 (treethrow hole 2); gleyic argillic brown earth Btg – dark fill
Soil Microfabric Type 9	M21, M22, M23, M24, BD41b, BD42, BD43		SM: Massive, with frequent to common burrows and chambers, common to abundant channels and frequent vughs (Total voids, mean 22%, range 20–25%, n=3, as SMT1); C:F 45:55; Coarse mineral: as SMF6, with very few gravel; Fine mineral: areas of a) – Fe stained – very dark brown and black (PPL), isotic (XPL)(porphyric), yellowish brown and bright orange (OIL); rare relic amorphous organic matter and b) –unstained soil – speckled, dark yellowish brown (PPL), low interference colours (XPL)(porphyric, speckled and grano-striate b-fabric); occasional coarse wood charcoal in M22; Pedofeatures (see key and Table SS4.64) include rare to occasional ferriargillans, occasional to abundant dusty clay void coatings and infills and rare to occasional compound textural features; abundant to very abundant very dark yellowish brown to black iron (Fe) hypocoatings, single ring amiboidal nodules and impregnative nodules and mottles, and rare iron and manganese (Fe/Mn) nodular impregnations BD: sandy loam to sandy clay loam with 29–30% clay, 4–30% silt and 33–77% sand; moderately humic (mean 6.1% LOI, range 5.2–6.5% LOI), neutral (pH 7.0–7.1), mean 310 ppm $P_2O_{5ignited}$, range 260–340 ppm $P_2O_{5ignited}$, 1.9–2.7 P ratio, with very low to moderate MS (14–80 x 10^{-8} SI kg^{-1})(n=3)	F62119 (treethrow hole 3), gleyic argillic brown earth Btg – dark fill
Soil Microfabric Type 10	M25		SM: Massive, with common burrows and chambers, common channels and very few vughs (total voids, 10%, n=1, as SMT1) ; C:F 45:55 ('loam') and 65:35 ('sands'); Coarse mineral: as SMT6; Fine mineral: dark yellowish brown to very	F62119 (treethrow hole 3), gleyic argillic brown earth B(t)g – control profile, 0.06–0.14m

		dark yellowish brown (PPL), low (to isotic) to very low interference colours (XPL) (porphyric, speckled b-fabric); bright yellow (OIL); rare amorphous organic matter and fine charcoal; Pedofeatures (see key and Table SS4.64): rare ferriargillans and occasional compound textural features; very abundant very dark yellowish brown to black iron (Fe) hypocoatings, single ring amiboidal nodules and impregnative nodules and mottles, and rare iron and manganese (Fe/Mn) nodular impregnations..	
Soil Microfabric Type 11	M26a	SM: Massive, with common burrows and chambers and channels, and few vughs (total voids, 15%); C:F 50:50, Coarse mineral: poorly sorted frequent angular silt-size and subrounded to rounded fine to coarse sand-size quartz, and very few gravel; Fine mineral: heavily speckled, dark yellowish brown (PPL), very low (to isotic) to moderately low interference colours (XPL)(porphyric, speckled, with grano- and parallel-striate b-fabric); rare relic amorphous organic matter; rare fine charcoal; rare root traces and coarse wood charcoal; Pedofeatures: include occasional ferriargillans and rare dusty clay void coatings and infills; very abundant very dark yellowish brown to black iron (Fe) hypocoatings, single ring amiboidal nodules and impregnative nodules and mottles, and rare iron and manganese (Fe/Mn) nodular impregnations.	F62119 (treethrow hole 3), gleyic argillic brown earth B(t)g – control profile, 0.20–0.24m
Soil Microfabric Type 12	M26b	SM: Massive, with dominant complex packing voids and few burrows and chambers, channels and vughs (total voids, 25%); C:F 70:30, Coarse mineral: moderately sorted very dominant subrounded to rounded fine to coarse sand-size quartz, and very few gravel; Fine mineral: speckled dark yellow brown (PPL), low to moderately low interference colours (XPL)(porphyric, speckled b-fabric), yellow to bright yellow (OIL); rare relic root traces; Pedofeatures: include occasional ferriargillans and dusty clay coatings and infillings, and rare compound textural features; abundant ferruginous features (see above).	F62119 (treethrow hole 3), gleyic argillic brown earth B(t)g – control profile, 0.24–0.26m
Soil Microfabric Type 13	M26c, BD44	SM: Massive with dominant simple packing voids and few vughs (total voids, 35%); C:F 95:5, Coarse mineral: as above with very dominant contains poorly sorted gravel and very coarse sand; Fine mineral: speckled dark yellow brown (PPL), moderately low interference colours (XPL)(chitonic, speckled b-fabric), yellow (OIL); Pedofeatures: include occasional dusty clay coatings and rare ferriargillans and compound textural features. BD: loamy sand, with 9% clay, 8% silt and 83% sand; neutral (pH 7.2), very poorly humic (2.1% LOI), 160 ppm $P_2O_{5ignited}$, 3.2 P ratio, with very low MS (5 x 10^{-8} SI kg^{-1}).	F62119 (treethrow hole 3), gleyic argillic brown earth B(t)g – control profile, 0.26–0.28m
Soil Microfabric Type 14	M53, BD43	SM: (generally strongly bioturbated with 5 mm wide burrows and 2 mm wide yellowish clay infilled channels) undisturbed soil – massive with agglomerated pellety microfabric; few burrows and chambers; C:F 60:40, Coarse mineral: as SMT6; Fine mineral: finely speckled dark reddish brown (PPL), very low interference colours ((XPL)(close porphyric, speckled b-fabric); red (OIL); traces of abundant fine amorphous organic matter; Pedofeatures: include very abundant thin to moderately thin (100–200 μm) organic and organo-mineral excrements. BD: very high MS (753 x 10^{-8} SI kg^{-1}).	Avenue (F875666); central red fill 87568
Soil Microfabric Type 15	M54, BD45	SM: as above, with very dominant subrounded sand-size coarse wood charcoal; Fine mineral: black (PPL), isotic (XPL)(porphyric), black with reddish orange patches (OIL); abundant charred organ and tissue fragments; abundant thin to broad (1mm) organo-mineral excrements. BD: very high MS (572 x 10^{-8} SI kg^{-1}).	Avenue (F875666); outer charcoal-rich fill 87569
Soil Microfabric Type 16	M52, BD42	SM: structure and mineral as SMT 11–13; with horizontal clay, silt and sand bedding at base of sample, and fragmented bedding higher up; Pedofeatures: include abundant dusty clay infills and coatings BD: very low MS (13 x 10^{-8} SI kg^{-1})	Avenue (F875666); lowermost feature fill/natural 87569/87570

80 x 10^{-8} SI kg^{-1}) are evidence of possible *in situ* burning. Equally, undated treethrow hole F62338 and fifth to fourth millennium BC treethrow holes F62113 and F62123, contain various amounts of wood charcoal and burnt soil with enhanced magnetic susceptibility values, indicative of a wooded landscape managed/affected by fire. At the Avenue, fires produced burnt soil with similar magnetic characteristics to those found in the treethrow holes, but because the site was much less well-sealed the soils provide less clear information on the fourth millennium BC soils. Nevertheless, the above findings permit the reconstruction of the mid-Holocene wooded soil landscape.

Treethrow hole F62113 (treethrow hole 4). 3660–3330 cal BC (4700±80 BP; OxA-3058)
This treethrow hole is only 1.5 metres across, but as deep as the other hollows described (Fig SS4.37). Three samples focused upon an upper fill area that appeared to be heavily burnt (thin sections M27, M28, M29). A sample at the base of the unburnt fill (M30) was also taken. Iron and manganese staining and ferruginisation are juxtaposed to iron-depleted soil which is often associated with rooting. At the base of the fill the soil is quite strongly cemented by iron, whereas in the upper burnt fill iron and manganese staining again seemed concentrated in soils that may once have been humic. Both the burnt and unburnt soils show large amounts of textural features (embedded grains, dusty clay coatings and intercalations), probably relict of disturbance and later slaking. The burnt soils are very strongly reddened.

Neolithic Monuments

The Avenue. 3860–3620 cal BC
F87566, dated to 4040–3530 cal BC (4990±110 BP; GU-5319), is one of a number of small (*c* 1.50m by *c* 0.60m deep) burnt and disturbed features which made up two parallel alignments later cut by the early Bronze Age Segmented Ditch Circle (Fig SS4.38). The Avenue lay on the gravel terrace, at approximately 1m higher than the treeholes, so that F87566 was covered by only some 0.30–0.40mm of ploughsoil. Magnetic susceptibility assays show marked enhancement of the burnt and charcoal-rich areas (753 and 572 x 10^{-8} SI kg^{-1}; Table SS4.58: samples 43–45). Soil micromorphological investigations of the red and very dusky red (2.5YR4/2 and 2.5YR2.5/2) burnt soil (M53) and charcoal-rich soil (M54), and the dark brown subsoil (M52), found that, unlike the treethrow holes described above, F87566 has been very strongly biologically transformed and influenced by 'modern' agriculture. This biological working is a consequence of not being deeply buried by the Saxon and medieval alluvium that affected the treethrow holes. Also in contrast to the treethrow holes, F87566 was only weakly affected by gleying (minor ferruginisation and iron and manganese mottling). The major post-depositional processes that have been active are, in the first instance, almost

Figure SS4.38 Avenue (F 87566) (4990±100 BP (GU-5319); as sampled (M52–M54).

total biological working of the prehistoric soil fabrics, including the strongly rubified burnt soil. Along with wood charcoal, burnt soil has been broken up into fine fragments by biological activity (faunal excrements) and weathering processes, such as wetting and drying. Superimposed upon this biological fabric are very thick impure clay infills and coatings, some infilling coarse worm burrows. These textural features probably all stem from agricultural activity, fine ploughsoil washing into the prehistoric soil, forming a plough pan-like horizon.

The original soils on the site were predominantly sands with patches of silt and clay. Despite post-depositional disturbance elements of the Neolithic soil have been teased out. For example, the subsoil/natural alluvial bedding and its Neolithic disruption is still recognisable (Table SS4.61: SMT 16). Equally, parts of the rubified soil have resisted biological working and show evidence of being worked by small, probable acidophyle, mesofauna relict of the pre-burnt organo-mineral soil (SMT 14), while the charcoal-rich layer, because of its increased nutrient content (ash) appears to have been worked by larger mesofauna (SMT 15). Other microstructural evidence of the prehistoric soil, have been unfortunately lost, probably because the feature has been exposed for such a long time to surface biological and weathering processes.

The Long Mound. 3940–3780 cal BC

During the excavation of 1985, the basal part of the mound (context 2061) and the top of the buried soil (context 2072/4) at the east end were sampled by Joy Ede (thin sections M35 and M36, respectively; Fig SS4.42). The mound material is humic compared with the subsoil, which also has a very low magnetic susceptibility (Table SS4.60: samples 1–2). The present day pHs are weakly alkaline, and probably bear no relationship to the pH of the Neolithic soil (see below). Saxon buildings composed of calcareous constructional materials buried the site. Early medieval alluvium also washed down coarse voids into the Neolithic soil (Figs SS4.78–80)

Soil micromorphology shows that the Neolithic soils are sandy loams, like the early Bronze Age soils under the south end of the Turf Mound (see Table SS4.59, samples 5–6). The Long Mound was made up of two types of soil material. These are (i) a dark brown humic soil, with a very fine pellety and humic excremental fabric – Ah horizon material (cf Table SS4.61: SMF3), and (ii) pale greyish soil, poor in organic matter and iron (cf SMF4). The last is likely to be strongly leached Eb horizon material. Both soil types are mixed, although the Ah horizon material dominates. The mound was thus constructed of turf and topsoil of mainly humic Ah horizon material and small amounts of included Eb horizon soil (Fisher and Macphail 1985; Macphail 1996; Macphail *et al* 2003; Scaife and Macphail 1983). The Ah material is unusual in that much of its void space is coated by abundant very dark-reddish humic clay, which is generally not oriented right-way-up. The last, relates to the turf being not an *in situ* soil, but a mound. These dark coatings are poorly birefringent, very finely dusty and sometimes microlaminated (cf Table SS4.61; Figs SS4.83–85). This type of textural material is also very common in the upper buried soil. The turf material is also anomalous because, although it comprises a total biological fabric, it appears to be very compacted in places, producing a weakly birefringent fabric within a generally non-birefringent soil. These coatings and compacted fabrics are not generally found in natural Ah horizons. Very fine charcoal is present in the turves, but has been very well integrated into the soil fabric. The buried soil surface is humic and generally compacted, with again abundant dark reddish brown humic clay void coatings, some up to 600 μm thick. Patches of leached Eb horizon material also occur, and earthworm burrows are occasionally present beneath this compacted surface soil, and are common a short distance down-profile in the 'subsoil' where they occur in coarse voids with loose soil infillings. These loose soil infills are mainly excremental, and both fine and coarse excrements of earthworm and smaller fauna, such as Enchytraeids (pH <4.8) or Collembola (pH >5.4) are represented according to the pH extant during the Neolithic (Mücher 1997). This infill has also been strongly affected by the inwash of reddish brown coatings, noted above. Soil in these loose infills includes broken fragments of these clay coatings ('papules').

This lower part of the buried soil, although made up primarily of mixed Ah and Eb horizon material, includes pale sandy soil with finely laminated, very finely dusty birefringent void clay coatings, which indicate that these are pieces of an original argillic brown soil subsoil (Eb/Bt horizon material). Void spaces on the outer margins of these, and juxtaposed against them, are dusty clay coatings that sometimes contain fine charcoal. These coatings post-date the fragmentation of the Eb/Bt horizon soil, but occur before the reddish clay coatings. Some voids and channels contain silty soil infills that have occurred through the inwash of soil, and these may also form cappings on gravel clasts. Again the fine clay component of these coatings is a humic reddish clay material.

Evidence from treethrow holes studied at Raunds and elsewhere (Macphail 1992b; Macphail and Goldberg 1990) clearly indicates that the mixing of subsoil Eb/Bt horizon material into the near surface soil, may well have arisen from clearance disturbance. This is supported by the presence of dusty clay coatings and included charcoal that are associated with these fragments. On the other hand the acid fauna nature of the excrements in the mound and buried topsoil, and the presence of strongly leached Eb horizon material, show that soils were strongly acid, with pHs probably as low as pH 4. This is becoming too acid for argillic soils (and non-enchytraeid worms), and may suggest that acid topsoils formed sometime after clearance.

Long Mound discussion. It seems quite reasonable to suggest that argillic brown earth formation here under woodland had led to the general leaching of the sandy loam parent material. The effect of clearance and probable Neolithic landuse practices, such as the burning indicated by the fine charcoal in the topsoil and turves, triggered increased acidity and possibly even shallow podzolisation, but this has not been preserved. At Carn Brea, Cornwall, clearance assumed to be of Neolithic date produced a shallow podzol with a weakly formed Bh horizon in a matter of a couple of centuries, but this was on an upland, granitic moorland in the wetter western part of the United Kingdom (Macphail 1990a). At the Long Mound, this kind of strong acidification could have developed over some decades, during which the vegetation was probably kept open by burning. Combined soil micromorphological and soil pollen analyses from buried Neolithic soils in Brittany, France, have shown these kinds of edaphic changes relating to clearance and secondary clearance activities (Gebhardt 1993).

The acid topsoils themselves were also affected by the deep mixing of Ah and Eb horizon material, the formation of fissures, faunal activity, compaction and the deposition of reddish clay coatings and silty soil crusts and infillings, all before burial. These features can also be recognised in the south end of the nearby but early Bronze Age Turf Mound, indicating that a reasonably wide expanse of soil was similarly affected across the site.

The compaction features are quite clearly defined and associated with textural feature formation, and thus have not been induced by burial (SS4.8.2.4). In fact, as will be argued, the compaction features, the deep mixing and formation of silty soil infills and pan-like textural features and compacted topsoil layer, all indicate trampling by herbivores. Trampling experiments (Beckman and Smith 1974), investigation of soils affected by trampling (*sensu lato*) along modern transhumance routes (Valentin 1983) show that soils can become compacted and form crusts. As discussed above, textural features are only found in the Bt horizons of Argillic Brown Earth soils, and here abundant textural features occur in Ah horizon material (M35) and in the buried upper profile (M36). In fact, it is difficult to explain the very abundant reddish clay coatings on this site without some reference to animal activity. Relatively high amounts of soil P (1380 ppm) and phosphate (490 ppm $P_2O_{5\text{-ignited}}$; Table SS4.60, sample 1) in the mound turf and the anomalous presence of textural features are, as argued in SS4.8.2.4, indicative of animal activity.

The Long Barrow 3800–3640 cal BC

This is described separately in SS4.8.1.

Early Bronze Age monuments

The Turf Mound (south end), after 2470–2300 cal BC

The Turf Mound was excavated by Dave Windell of the Northamptonshire Archaeological Unit) in June 1987 (Windell *et al* 1990). It was sealed beneath a thick headland of ridge and furrow, and more recent alluvium (Fig SS4.39). The sequence comprises 150mm of dark brown (7.5YR4/2) topsoil (Ap horizon) over 600mm of light olive brown (2.5YR5/4) alluvial clay (Table SS4.58, sample 3). These bury, at a depth of 730mm, a reddish brown (5YR4/4) medieval ridge and furrow soil, within which many coarse channels are infilled with light olive brown clay from above. At a depth of 1.32 metres this sandy loam buries the remains of a very dark grey (5YR3/1) humic turf mound of similar texture (Tables SS4.58–60, samples 4 and 5). The 300mm-thick mound rests on a dark reddish brown (5YR3/2) to very dark grey (7.5YR3/1) buried sandy loam soil (sample 6). The subsoil layers beneath are strong brown (7.5YR5/6) to

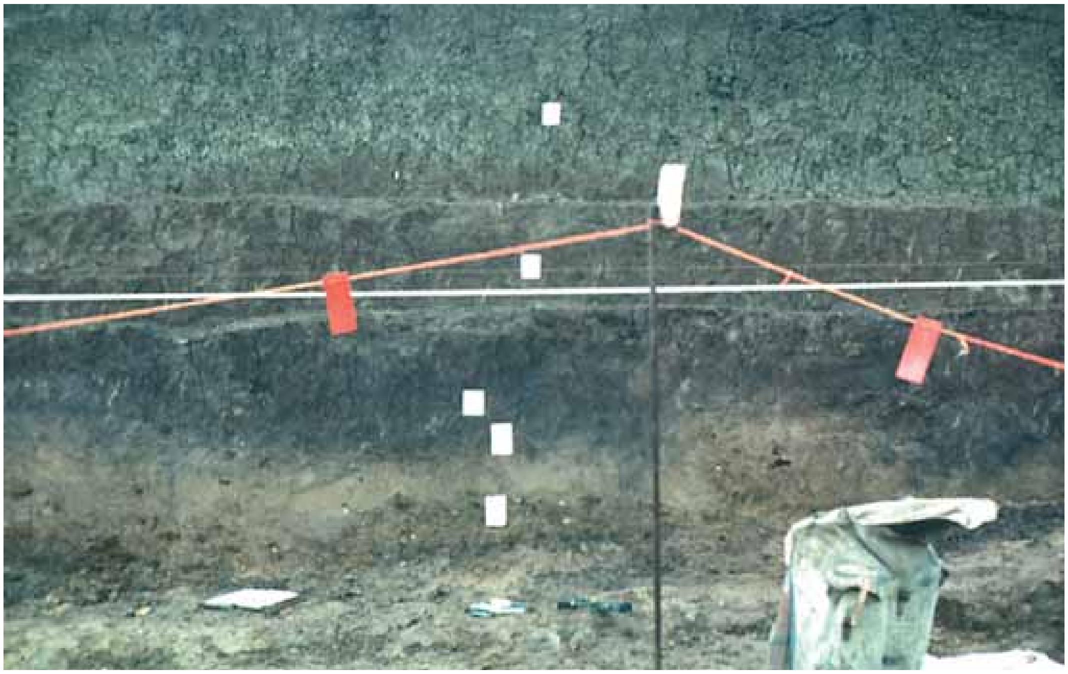


Figure SS4.39
Turf Mound, south end; as sampled:(M37–Ap1/ alluvium, M38–Ap2/a ridge and furrow, M39–mound.

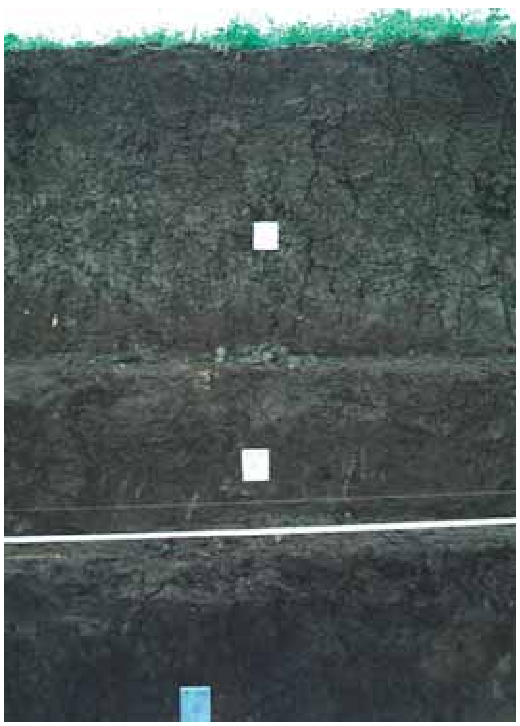


Figure SS4.40 (far left)
Turf Mound, south end; as sampled (M38–Ap2 ?ridge and furrow, M39–mound, M40–bB, M41–stony bB't).

Figure SS4.41 (left)
Turf Mound, south end; as sampled (M37–M41).

yellowish brown (10YR5/8) poorly humic loamy sands, although at a depth of 2.04 metres a 200mm thick yellowish red (5YR5/8) Bt horizon with an enhanced clay content is present (Table SS4.59, samples 7 and 8). A yellow (10YR7/8) sandy and alkaline (pH 8.6) parent material rich in gravels occurs below (sample 9). The overlying soils are non-calcareous except for the most recent alluvial clay (Table SS4.60, sample 3). The magnetic susceptibility (χ) of the mound is high (169 x 10^{-8} SI kg^{-1}; cf samples 1 and 5). Thin sections were made of the alluvial clay (M39), the ridge and furrow soil (M40), the mound (M41), the upper buried soil (M42) and the bBt subsoil (M43). These

Table SS4.62. Turf Mound, south end; soil microfabrics and counted microstratigraphy, M37 (Ap1), M38 (Ap2), M39 (mound), M40 (bEb & B) and M41 (bBt)

* – very few 0–5%, f – few 5–15%, ff – frequent 15–30%, fff – common 30–50%, ffff - dominant 50–70%, fffff – very dominant >70%
a – rare <2%, aa – occasional 2–5%, aaa – many 5–10%, aaaa – abundant 10–20%, aaaaa – very abundant >20%

Sample/layer	*Relative depth (m)*	*Soil microfabric (SMF)*	*% Voids*	*Burrows and chambers*	*Channels*	*Planes*	*Vesicles*	*Vughs*	*Gravel (ironstone and flint)*	*Charcoal*	*Soil clast*	*Organic matter*	*Ferriargillan textural features*	*Dusty clay textural features*	*Dark red clay textural features*	*Pan-like textural features*	*Yellowish brown textural features*	*Compound textural features*	*Calcite, e.g., earthworm granules*	*Fe/Mn*
M37/1 (Ap1)	0.48	1	30	*	f	ff	*					aa				aaa	aa		a	aa
M37/2 (Ap1)		1	30	*	f	ff	*	*				aa				aaa	aa			aa
M37/3 (Ap1)		1	20	*	*	ff		*				aaa				aaa	a			aa
M37/4 (Ap1)		1	35	*	f	fff	*	*	*	a						aa	a			aa
M37/5 (Ap1)		1	35	fff	f	fff	*	*		a	a	aa				aa	a			a
M37/6 (Ap1)	0.56	1	50	*	f	ffff	*					aa				aa	a			a
M38/1 (Ap2)	0.99	2(2,1)	15	ff	f	f		ff		aa						a				a
M38/2 (Ap2)		2(2,1)	30	ff	*	ff		f	f							a	aa			a
M38/3 (Ap2)		2(2,1)	20	ffff	f	*		f		a		a				aa	aa			aa
M38/4 (Ap2)		2(2,1)	20	ffff	f			ff	*	aa						aa	aaa		a	a
M38/5 (Ap2)		2(2,1)	20	fff	f			ff	*	a		a				aaa	aaa		a	a
M38/6 (Ap2)	1.06	2(2,1)	20	ffff	ff			ff	*	aa						aaa	aaa			a
M39/1 (mound)	1.45	3(3,2,1)	15	ff	*			ff	*	aa	a	aa		aa	aa	a	aa			a
M39/2 (mound)		3(3,2,1)	15	ff	f			fff	*	aa	a	a		aa	aaa	aaa	aaa			a
39/3 (mound)		3(3,2,1)	15	ffff	*			ff	*	aa	a	a			a	aaa	aaa			aa
M39/4 (mound)		3(1)	10	ff	ff			ff	*	aa	a	a		a	aa	aa	aaa	a	a	aa
M39/5 (mound)		3(3,4)	20	fff	f			*	*	aa	a	aa		a	a	a	aaa			aa
M39/6 (mound)	1.53	3,4	20	ff	f			*	*	aa	a	a			aa	a	aa			aa
M40/1 (bEb&B)	1.56	3,4	20	f	*			*						aaa	aaa	aa	aa			aaa
M40/2 (bEb&B)		4(3,4)	25	ff	*			f						aa	aaa	aaa	a			aa
M40/3 (bEb&B)		4(3,4)	15	f	*			ff	*					aaa	aaaa	aaaa	a			aa
M40/4 (bEb&B)		4(3,4)	30	fff	*			*	*					aaa	aaaa	aa	aa			aa
M40/5 (bEb&B)		4(3,4)	30	ff	*			*	*					aa	aaa	aa	aa			aa
M40/6 (bEb&B)	1.65	4(3,4)	30					*						aa	aaa	aaa	aa			aa
M41/1 (bBt)	1.73	4(5)	30	ff	f			*	f	a			aa	aaaa	aaa	aaaa	aaaa	aaa	aa	
M41/2 (bBt)		5(4)	30	ff	f			*	ff				aaa	aaaa	aa		aaaa	aa		aa
M41/3 (bBt)		5(4)	30	*	ff			*	fffff				aaa	aaaa	aa		aaa	aa		aa
M41/4 (bBt)		5(4)	30	f	fff	f		f	fffff				aaaa	aaa	aaa		aaa	aaa	aaa	
M41/5 (bBt)		5,4	30	ff	f	*		fff	ffff				aaa	aaa	aaa		aa	aaa	aa	
M41/6 (bBt)	1.81	4,5	40	ff	fff			ff	ff	a			aaa	aaa	aaa		aaa	aa		aa

Figure SS4.42
Long Mound, east end; as sampled:M35–36).

have been described and counted (Tables SS4.61, SS4.62; Figs SS4.57–77) as discussed in SS4.8.2.4.

Flooding deposited alluvial clay (M39), as testified by its basic microfabric of intercalations and associated vughs, and overall highly speckled birefringent fabric (Table SS4.61: SMT1; Figs SS4.57–60; Table SS4.62). This brown clay subsequently developed a prismatic structure and a channel microfabric containing ghosts of roots. It is possible that this alluvium was ploughed, or that its slurry-like character permitted much of the underlying soil to be affected by the downward percolation of this muddy sediment. In fact, this mud, as yellowish brown clay, can be traced some 2 metres down-profile (Table SS4.62).

The ridge and furrow ploughsoil (M38) was formed before major alluvial clay deposition, out of prehistoric sandy loam soil, including probable mound material. Some coarse fissures are infilled with a mixture of strongly humic and moderately humic clay soil, which has sometimes formed thick birefringent infills at the bottom of voids. Many burnt soil fragments and iron-replaced amorphous organic matter (manure?) occur within the dark brown dusty sandy loam soil, which is poorly birefringent, although having weakly formed intercalations (SMT2, Table SS4.61; Figs SS4.61–66). Dusty textural features also occur throughout, which are also indicative of its ploughsoil origin (Figs SS4.57–58; Table SS4.62). It seems likely that early medieval agriculture persisted for a short time before being engulfed by alluviation.

Perhaps 40% of the mound (thin section M39) material has been affected by biological mixing and inwash of fine soil material from the overlying ploughsoil and alluvial clay (Figs SS4.69–71; Table SS4.62). The original Ah material is a non-birefringent highly humic blackish brown sandy loam (SMT3, Table SS4.61). It contains much fine charcoal, and the organic matter is predominantly amorphous and weakly fine pellety. This acid Ah horizon turf material features abundant very blackish red, clay coatings and infills with low interference colours. Leached sandy patches of Eb horizon material occur too.

Even in the buried soil (thin section M40) large voids can be affected by impure clay inwash from the overlying alluvium. It is brown and poorly-ferruginous and little stained by humic matter, and thus easily distinguishable from textural features dating to the buried soil. These last comprise two main types: very abundant dark red clay void coatings and infills with very low interference colours and often dark stained impure clay and silty coatings, which occur often in voids associated with compacted lamina fabrics and as cappings on coarse clasts. The origins of this type of textural feature, in relationship to organic phosphate and inferred animal activity, are discussed below.

The buried upper soil in general is a pale greyish brown silty sand, that is poor in iron (a transitional Ah and EbB horizon; SMT4,

Table SS4.61; Figs SS4.71–72). Laminar and compacted fabrics occur throughout the thin section, some with dark textural features showing pan-like graded bedding characteristics (Table SS4.62, Figs SS4.73–75; cf Figs SS4.64, SS4.92–97). Occasionally within this soil, coarse sand size areas of brown, dusty silty loam soil are present. This soil contains fine charcoal, fine channel porosity and dusty clay coatings and infills that are not oriented right-way-up.

Deep in the subsoil, some 0.6m below the mound, the bBt horizon (thin section M41) contains numerous gravel and stones, and a complex suite of textural features (SMF5, Tables SS4.58, SS4.61 and SS4.62; Figs SS4.76–77). The hierarchy of these (Courty *et al* 1989; Fedoroff *et al* 1990) is as follows. The primary textural features have high interference colours, well oriented finely laminated limpid clay coatings and infills (ferriargillan textural features). These are succeeded, sometimes within the same pore, by poorly birefringent, blackish and ferruginous clay coatings. Much of the packing porosity, which characterises this once sandy horizon (Table SS4.59: sample 8), is now infilled by slightly ferruginous dusty clay. Later coatings of dusty clay may coexist with the blackish red, coatings with very low interference colours, noted in the mound and buried Eb and B-horizon above. Lastly, some coarse voids contain the very mobile, non-ferruginous yellowish brown clay of alluvial origin (cf Figs SS4.77–80). The primary ferriargillan textural features are in all ways similar to those present in treethrow hole F62119, and relate to clay translocation under woodland (see above, Table SS4.66). The large amount of dusty clay being deposited at this depth may relate to treethrow, clearance and other human disturbance of the site, leading to an accumulation of translocated clay at this depth (Macphail 1992b; Macphail *et al* 1990; Macphail *et al* 1987; Romans and Robertson 1983c).

Turf mound discussion. As discussed in SS4.8.2.4, although the effects of arable agriculture cannot be ruled out, the accumulation of organic matter and phosphate in the upper soil and the combined presence of dark red clay coatings and pan-like textural features, are more indicative of animal herding than of subsistence tillage (Courty *et al* 1994; Romans and Robertson 1983c). A number of factors indicate that the argillic sandy soil underwent soil degradation. Even under an undisturbed woodland cover argillic brown earth soils may become acid argillic brown earths (Duchaufour 1982; Mackney 1961 282; Macphail 1992a). Human use of the site probably accelerated acidification with woodland giving way to grassland, and perhaps any arable land was abandoned to pasture (Ch 2). This led to the formation of the acid Moder and/or Moder-like Mull of Babel (1975), acid humus topsoils that are characterised by amorphous pellety (excremental) organic matter. This material was used to construct the mound. The presence of dark red humic clay coatings suggests that the soil had developed a low pH (pH 4, Courty pers comm). Soils at the Turf Mound testify to an acid pastureland with an inferred herding landuse.

Barrow 1. 2140–1800 cal BC

Barrow 1 was excavated in September 1986, by Claire Halpin of the Central Excavation Unit (Figs SS4.43–44). The monument is noteworthy for the very large number of cattle skulls piled over the cairn covering the primary burial (Davis and Payne 1993; Davis SS4.6.1). The mound comprises some 630mm of clay loam (Table SS4.58, samples 14–15) soil, with a humic (Table SS4.59, sample 14) dark brown (7.5YR3/4) modern Ap horizon (0–240mm) overlying the generally moderately humic (sample 15) reddish brown mound. The modern Ap horizon is acid, whereas the rest of the soil is weakly acid. The upper part of the buried soil is a moderately humic dark reddish brown clay loam (sample 16), but becomes more sandy with depth, sands and gravels being present at some 300mm below the old ground surface. A discontinuous stone line seen in the baulk section and sampled for soil micromorphology represents a patchy spread of small gravel *c* 5–15mm in size with a scattering of larger 20–25mm angular stones (context 30429). This was noted by Claire Halpin some 130mm below the old ground surface. Soil thin section M2 (90–170mm) sampled the buried soil across this zone, and thin section M3 (200–280mm) was taken from the soil just above the sands and gravels.

The soil demonstrates moderately high values of χ throughout, with higher values (213–249 x10^{-8} SI kg^{-1}; site mean 105 x 10^{-8} SI kg^{-1}) in the subsoil than in the mound (MS 140–163 x 10^{-8} SI kg^{-1}). The modern Ap/uppermost mound soil is also the most phosphate-rich studied at Raunds (2100 ppm P; site mean 970 ppm P; 1020 ppm $P_2O_{5ignited}$). High amounts of phosphate occur throughout the soil sequence (1390–1780 ppm P; 530–790 ppm $P_2O_{5ignited}$).

Figure SS4.43
Barrow 1:
excavated cairn, sampled baulk; Claire Halpin and Joy Ede.

Figure SS4.44
Barrow 1;
as sampled (MM1–M3).

The soil has a generally compacted prismatic fabric, although 20–30% of the buried soil has been disturbed by deeply burrowing earthworms since the construction of the monument. Other burrowing fauna have produced channels some 20–25mm across with large infills. Within the buried soil, some dark humic subangular blocky structures, up to 10mm in size, occur both at the base of thin section M2 and in sample M3, at depths of 150mm, 230mm and 270mm. These may be humic topsoil fragments from the mound that have been biologically mixed down-profile (cf Overton Down; Crowther *et al* 1996).

The uppermost part of the mound has been strongly transformed by modern agriculture, as reflected in the very high amounts of phosphate that result from modern manuring practices. As a result, recent earthworm burrowing has doubtless contaminated the upper mound.

In the early Bronze Age soils of the lower mound and buried soil, however, recent earthworm burrowing is easily distinguished from the ancient soil microfabrics (Table SS4.61, SMT3 and 4). The early Bronze Age soil is a very dark, speckled clay loam and contains much fine charcoal. Fragments of argillic and burnt (reddened; cf Table SS4.61, SMT 6) argillic soil may testify to an earlier clearance event or occupation. This burning is reflected in the high MS values attained by the buried soil (213–249 x 10^{-8} SI kg^{-1}). It is strongly marked by abundant textural features, and these are very abundant throughout the buried soil. Two types of associated features are present. These are finely laminated to dusty clay coatings, dark reddish black to dark orange in colour, and very dusty to silty infills (Table SS4.61;

Figs SS4.86–90). Many complex infills and coatings occur, including lamina fabrics at around 270mm below the old ground surface. **Barrow 1 discussion.** Microprobe studies at Barrow 5 showed that dark red clay coatings and pan-like textural features are rich in phosphorus. Here at Barrow 1, these probably contribute to the accumulation of phosphate in the early Bronze Age soils even whilst total amounts could reflect some modern contamination as noted earlier (cf Figs SS4.29, SS4.94, SS4.110–111). As at the Turf Mound and Barrow 6, these features are interpreted as mainly resulting from herbivore trampling and herding. The occurrence of coarse fragments of soil which show layering may be significant. They have a humic character, with many void coatings, and have an edge (once the top), which comprises a layer of very dusty poorly sorted soil, beneath which are layered fine, dusty and silty infills. These typical near-surface crust features (Boiffin and Bresson 1987; Macphail 1992b) have been rotated. In addition, many straight edge pores, probably pseudomorphic of *in situ* roots, have fine and impure clay coatings.

What is intriguing at Barrow 1 is that many of the compaction features occur at the bottom of the stone-free soil, nearly 300mm below the old ground surface. The very abundance of the textural features throughout this buried soil, the coating of root pores and the presence of a discontinuous stone (max 100mm) line halfway down the buried soil, may suggest a sequence of occurrences. Firstly, there is no evidence that the stone line was naturally formed by earthworm working, as this would have destroyed the textural features. Also the stone line is unlikely to be relict of periglacial activity because it is well within the 'homogenised' Holocene soil profile. In fact it seems more likely that animals were herded on the thin soils on the site for some time, causing compaction and puddling (Beckman and Smith 1974; Kemp *et al* 1994; Schofield and Hall 1985). Perhaps the site was left for a short time and a herbaceous vegetation developed, rooting into the soil. As the area was again needed for animal herding, a stone layer was laid down as some form of hard standing or kicked in by animals. Animals then trampled in more soil to bury the stone layer. Such occupation would help account for the high values for χ here. Again the upper buried soil developed puddled crust features from animal trampling. This development of some 130mm of highly puddled soil, possibly brought in on the hooves of animals, suggests very intensive herding at this site. It should not be forgotten that a cairn was constructed on this site where more than 145 cattle skulls, and skulls and bones from a further 40 cattle, were buried, and where some 40 cattle could have been concentrated (Davis and Payne 1993).

Barrow 3. 2180–1930 cal BC

During the excavation of 1987, sampling was carried out with Nick Balaam (CEU). Barrow 3 is located in low ground, with gentle slopes of 2–4° in all directions (Figs SS4.45–46). More steeply sloping ground also occurs along the ridge to the north. Two thin section samples were taken. Sample M4 was collected from the apparent base of the barrow, marked by a series of iron pans, and the top of the buried gleyed soil (Ag horizon). Sample M5, included the base of the Ag horizon and the top of the assumed subsoil Bg horizon, as identified in the field. Bulk samples were collected down to a depth of 1.93m. In the excavated section it was

Figure SS4.45
Barrow 3; low ground.

observed that three 3–5mm thick red (2.5YR3/4) iron pans at the base of the barrow were separated by some 20mm of brown (7.5YR4/2) soil (Table SS4.58). Some 40mm beneath these, another 5–10mm thick iron pan was present.

The soils are clay-poor (7–9% clay) loamy sands (Table SS4.59: samples 20–21). The uppermost sampled soils are moderately humic (Table SS4.60: samples 18–20, 0.4–0.7% organic carbon; 3.3–7.0% LOI) compared to the lowermost sampled soils down-profile (samples 21b and 21c; 1.9–2.8% LOI). Sample 21a is anomalous with 7.0% LOI. Values for χ vary greatly from very low (8–9 x 10^{-8} SI kg^{-1}) to moderate (59–86 x 10^{-8} SI kg^{-1}), with a high (226 x 10^{-8} SI kg^{-1}) recorded for sample 21a. The soils are phosphate-rich (590–1070 ppm P, 300–640 ppm $P_2O_{5ignited}$) compared to the subsoils (160–270 ppm $P_2O_{5ignited}$). Again, sample 21a seems anomalous in the sequence with 490 ppm $P_2O_{5ignited}$. All show high P ratios (4.7–5.7).

In thin section, the Ag/Bg1 horizon soil is rather massive with coarse channel features. Sand and gravel occur with a ferruginised fine matrix, penetrated by a few roots that are poorly preserved by iron. Some non-ferruginised plant roots also occur. The fine soil, although obscured by iron, is of a dusty, biological (pellety) and amorphous (organic matter) nature (cf Table SS4.61, SMT3 and 8). Postdating the biological fabric are occasional finely dusty clay void coatings. Some large soil fragments contain these textural features, but are not oriented to right-way-up. There are also inclusions of silty loam soil, some up to 60mm in size. Textural features increase from occasional to many upwards. A possible amorphous (iron-replaced organic matter?) feature, some 5mm long, with a marked outer rim, could possibly be a herbivore coprolite as identified

Figure SS4.46 Barrow 3; as sampled (M4–M5).

Figure SS4.47 Barrow 3.

from Butser Ancient Farm reference material (Macphail *et al* 1998b; Macphail and Goldberg 1995, fig 9).

The uppermost soil layer is similarly sandy, and contains a non-ferruginised plant root almost 10mm in diameter (Fig SS4.91). At the base of thin section M4 there is a 2–8mm thick sub-horizontal and curved iron and manganese pan. Where it is not totally obscured by iron, it can be seen to comprise very abundant dusty clay coatings, infilling voids between sand grains and amorphous soil. Iron-depletion of the soil above this Fe-Mn pan allows the clear identification of the components making up the fine matrix here. It is very dominantly composed of phytoliths, speckled amorphous organic matter and clay, the last often in the form of very abundant textural features. Studies of reference phytoliths and reference sites suggest that the phytoliths are of a grass origin, rather than cereals (Institute of Archaeology reference collection; cf Potterne, Macphail 2000). This phytolith-dominated soil can be traced upwards into the series of iron pans marking the base of the barrow. The pans are again associated with textural features, although dominated by amorphous iron that obscures the fine fabric. In the basal pan sub-horizontal organic fragments can be recognised, whereas in the uppermost pan, articulated phytoliths and associated multi-layered plant remains (7+ layers of primary organic material) can be traced across the slide. The pans also contain loamy soil fragments of sand to gravel size, and ancient (birefringent) possible spore cases of vesicular arbuscular mycorrhizae, with some being 200 μm in diameter. Many unidentifiable, poorly preserved organic fragments are present throughout.

Microfabric evidence indicates that this surface soil was always humic and intermittently biologically active, although it was poorly drained at times. This is evidenced by biological fabrics being ferruginised, although not all later features are similarly affected. Ferruginisation or iron pan formation and gleying is reflected in the magnetic susceptibility data (Table SS4.60).

Barrow 3 discussion. Sample M5 shows this once humic and biologically active loamy sand soil to have been disturbed and mixed, at least to a depth of *c* 190mm below the old ground surface. Fragments of 'foreign' silty loam soil have also been introduced. Such transported soil could be little related to clearance and cultivation, as this receiving site would more likely be characterised by overall colluvial accretion (Macphail 1992).

The exact location of the old ground surface is difficult to determine at Barrow 3, and the pan at the base of thin section M4 can best be interpreted as either a trample pan or a trample pan preserved in a turf (Macphail *et al* 1998b). The phytolith and textural feature-dominated fine soil also probably results from the trampling of herbivore excrement (Courty *et al* 1994;). The upper iron pans (turf lines?) of pseudomorphically preserved herbaceous plants may reflect periods of trampling of locally growing plants, as evidenced by coarse rooting. 'Foreign soil' was probably imported on the hooves of large animals. Plant tissue analysis by Jon Hather (Institute of Archaeology) of plant fragments in the upper pans suggest that they present oblique sections cut through 'stems', indicating that they were bent over before being flattened. A large plant fragment in an iron depleted soil contain two types of cells, including radial cells, within a protective sheath, possibly indicating that these could be *in situ* growing rhizomes (Hather, pers comm). As three distinctly layered deposits (iron pans) are identifiable, it seems likely that several layers of *in situ* plant remains and dung-rich puddled sediment/soil seemed to have accumulated. This is reflected in the phosphate data. In addition, the large size (200 μm) of the vesicular arbuscular mycorrhyzae present could imply the possible past presence of cattle (Romans and Robertson 1983a), although their work has never been tested. Moreover, and with the eye of faith, the morphology of the basal iron and manganese pan may be seen to represent a cattle hoof print (cf Goldcliff, Gwent; Bell *et al* 1999). The anomalously humic (7.0% LOI) and phosphatic (490 ppm $P_2O_{5ignited}$; P ratio 5.7) bBg1 horizon beneath is also indicative of perhaps an earlier dung-rich accumulation at this site. Again, because the morphology of Barrow 3 is so unclear, this organic and phosphate-rich horizon may well represent the buried old land surface. Post-burial alteration of the soil has typically formed an iron pan either along the assumed buried surface or picks out turf lines, with an iron and manganese pan formed some 40mm further down-profile (Allen and Macphail 1987; Crowther *et al* 1996).

The soil microstratigraphical and chemical data all suggest that Barrow 3 occupied a wetter site than any other monument at Raunds, and this reflects its low and 'receiving' site position (Fig SS4.45). It is unclear how wet this site was in the early Bronze Age.

Barrow 4. 2020–1600 or 1880–1520 cal BC
Barrow 4 was examined early in 1988 by Claire Halpin of the CEU. The site lies on low ground, the buried soil showing dark mottling, indicating gleying on this site. Two thin section samples were taken from the buried topsoil (M6) and the top of the buried subsoil (M7).

The subsoil is moderately massive with coarse cracking, becoming poorly subangular blocky upwards. The buried topsoil is better structured with coarse subangular blocks and a coarse channel, vugh and fissure microstructure. During excavation, a diffuse earthworm-worked junction was noted between the buried soil and overlying the browner base of the barrow – a possible silty clay 'alluvial dump' (Halpin pers comm).

Microfabric evidence confirms that earthworms were active after burial, as found at Overton Down, mixing the basal layer of the barrow and buried topsoil into the subsoil (Macphail and Cruise 1996). Gleying has also had the post-burial, post-earthworm-working effect, of coating some voids with manganese, whereas much of the topsoil fine fabric is heavily stained with iron and manganese. Hence the dark mottling of these horizons. Thus, fragments of earthworm-worked dark topsoil have formed dark mottles within the brown upper subsoil.

Barrow 4 discussion. The microfabric of the upper subsoil shows it to be a moderately humic loam containing abundant textural features, embedded grains, coarse matrix coatings and infills and many intercalations. Some of these textural features are dark red and probably humus stained. These features are evidence of muddy disturbed conditions, during which time organic (and phosphatic?) liquids were deposited (SS4.8.2.2). The topsoil and the fragments of topsoil included within the subsoil are almost opaque because of heavy iron and manganese staining and replacement. The fine fabric appears to be composed of amorphous organic matter (now Fe- and Mn-replaced). The dark humic soil is abundantly associated with dark-stained microlaminated clay coatings, some of which have penetrated into the subsoil (M7), creating small dark soil patches. In the topsoil, and post-dating the dark stained clay coatings, are dark stained silty clay coatings and pan-like textural features (Table SS4.61). In laminar voids for example, the micro-sedimentary sequence implies the following mechanisms:

a) disturbance and slaking of a probably truncated/devegetated surface;
b) formation of a highly humic topsoil;
c) translocation of very abundant dark red clay into the topsoil and subsoil (cf Figs SS4.74–6; Table SS4.61);
d) deposition of organic stained silty soil;
e) burrowing and minor mixing by earthworms;
It is likely that some soil burial occurred between phases (c) and (d), and after (d);

A possible interpretation of the sequence is as follows;

a) herbivore herding, poaching of vegetation cover, trampling effects on wet, bare ground;
b) development of humic mud in puddled area;
c) liquid waste, from domestic stock, forms dark organic and phosphate-rich clay coatings (SS4.8.2.4);
d) further herding activity, including localised soil colluviation, lead to thin burial of organic soil and silty soil translocation and crust formation, and
e) a phase of earthworm working after construction of barrow.

Barrow 5. Perhaps built before 2140–1880 cal BC or 2050–1880 cal BC
Barrow 5, excavated by Claire Halpin of the CEU, comprises an early Bronze Age barrow with associated Roman ritual activity, alluviation and medieval ridge and furrow cultivation (Figs SS4.48–49). This later history of alluvial burial and medieval cultivation, make it a useful comparison to the south end of the Turf Mound, hence, the focus of analytical techniques on this site.

Barrow 5 buries a soil over 0.5m thick that is classed as an acidic argillic brown loamy sand (Tables SS4.58–60). It is developed in an upward fining sequence typical of alluvial sediments, with upwards, diminishing amounts of sand (80%, 70%, 65%, respectively) and generally increasing amounts of silt (17%, 18%, 26%, respectively) and clay (3%, 12% and 9%, respectively). Clay translocation affecting the subsoil bBt horizon has produced a more clay-rich silty clay loam horizon (24% clay, 14% silt, 62% sand). The medieval alluvium overlying the barrow is a humic (1.2% organic carbon) clay (36% clay), as at the Turf Mound (Table SS4.59). The 0.50m thick mound and buried soils are decalcified above a still calcareous (9.6% $CaCO_3$) and alkaline (pH 8.1) loamy sand alluvium found at 1.32m (Table SS4.60). The medieval alluvium and the early Bronze Age soils show similar quantities (230–440 ppm $P_2O_{5ignited}$) and type (P ratio 2.3–3.4) of phosphate to the Turf Mound, and these are grouped in Figures SS4.30–31. MS analyses show similar trends compared with the Turf Mound, even if somewhat lower values are attained.

Figure SS4.48 Barrow 5; as sampled (Alluvium over mound/bA (M8), bB (M9), bB2 (M10), bB2/bB't (M11).

Four thin sections sampled the bBt/bB2 interface (M11), the bB2 (M10), the bB1 (M9) and the mound/bA (M8) horizons (Figs SS4.48–49). Microfabrics, voids, components and pedofeatures have been defined and counted (Tables SS4.61 and 62; SS4.8.2.2). Microprobe line analysis (Fig SS4.29) and elemental mapping have been carried out on uncovered slides M9 (bB) and M11 (bB2/Bt).

These analyses allowed yellowish-brown textural features that probably derive from the overlying alluvium (Table SS4.63; Figs SS4.60–62, SS4.69–40) to be traced through the buried soil sequence. In the uppermost 20mm of slide M8, the mound soil is a dark and humic Mull-like Moder humus (Table SS4.61: SMT 3; Babel 1975; Duchaufour 1982). It also contains charcoal. The most abundant textural features are dark red clay coatings and infillings (Figs SS4.87–89), which are present alongside dusty, compound and pan-like textural features. These textural features are also common throughout the slightly less humic bA horizon. Rare 'foreign' soil clasts occur here and in the bA and Eb horizon below.

The buried A and Eb horizon (M9) contains more (iron and clay depleted) pale soil (SMT4), although earthworms have mixed areas of mound material (SMT3) into this horizon. Textural features continue to be

Figure SS4.49 Barrow 5; as sampled (mound/bA (M8), bB (M9), bB2 (M10), bB2/bB't (M11).

Table SS4.63. Barrow 5. soil microfabrics and counted microstratigraphy, M8 (mound/bA), M9 (bA&Eb), M10 (bEb & B) and M11 (bBt)

* – very few 0–5%, f – few 5–15%, ff – frequent 15–30%, fff – common 30–50%, ffff - dominant 50–70%, fffff – very dominant >70%
a – rare <2%, aa – occasional 2–5%, aaa – many 5–10%, aaaa – abundant 10–20%, aaaaa – very abundant >20%

Sample/layer	*Relative depth (m)*	*Soil microfabric (SMF)*	*% Voids*	*Burrows and chambers*	*Channels*	*Vughs*	*Gravel (ironstone and flint)*	*Charcoal*	*Soil clast*	*Ferriargillan textural features*	*Dusty clay textural features*	*Dark red clay textural features*	*Pan-like textural features*	*Yellowish brown textural features*	*Compound textural features*	*Calcite, e.g., earthworm granules*	*Fe/Mn*
M8/1 (mound)	0.83	3	30	ffff	*	f	*	aa			aa	aaa	aa	a	aa		aa
M8/2 (mound)		3	30	fff	*				a		aa	aaa	aa	a	a		a
M8/3 (bA)		3	25	*	f	f		a	a		aaa	aaaa	aaa	a	aa		aa
M8/4 (bA)		3	25	ff	f	f			a		aa	aaa	aa	a	aa		a
M8/5 (bA)		3	30	ff	ff	ff	*				a	aaaa	aa		aa		a
M8/6 (bA)		3	30	fff	fff	f	*				aaa	aaaaa	aaa		aaa		a
M8/7 (bA)	0.90	3	30	fff	ff	ff	*				aa	aaaaa	aa		aaa		aa
M9/1 (bA&Eb)	0.92	4(3)	25	ffff	*	ff			a		a	aa	aaa		a		
M9/2 (bA&Eb)		4	30	fff	f	f	*		a		a	aa	aa		a		a
M9/3 (bA&Eb)		4	20	fff	f	ff	*				a	aaa	aa		a		a
M9/4 (bA&Eb)		4(3)	35	fff	f	f	*				aaa	aaaa	aaaa	a	a		a
M9/5 (bA&Eb)		4(3)	35	fff	f	f	*				aaa	aaaa	aaa		aa		aa
M9/6 (bA&Eb)		4(3)	35	fff	ff	f			a		aaa	aaaa	aaa		a		aa
M9/7 (bA&Eb)	1	4	40	fff	ff	f	*				aa	aaa	aaa	a	a		aa
M10/1 (bEb&B)	1.02	4(4,5)	20	ff	ff	ff	*			aa	aaa	aaa		a	aa		aaa
M10/2 (bEb&B)		4(4,5)	25	fff	ff	ff	*				aa	aaa		aa	aa		aa
M10/3 (bEb&B)		4(5,1)	30	ffff	ff	ff					a	aa		aaaa	aa		aa
M10/4 (bEb&B)		4(4,5)(1)	30	fff	ff	ff	*				aa	aa		aaa	a		aa
M10/5 (bEb&B)		4(4,5)(1)	30	f	*	*					aa	aa		aa			aa
M10/6 (bEb&B)		4(4,5)(1)	30	f	*	*	*				a	aa		aa	a		aa
M+A4810/7 (bEb&B)	1.10	4(4,5)	30	f	*	*				a	a	aa		aaa	a		aa
M11/1 (bBt)	1.20	5	20	*	ff	f	*			aaaaa	aa	aaa		aa	aa		aaa
M11/1 (bBt)		5	40	ff	*	*	f			aaaa	aa	aa			aaa		aaa
M11/1 (bBt)		5	30	f	ff	f	fff			aaaaa	aaa	aa			aaa		aa
M11/1 (bBt)		5	35	ff	ff	f	ff			aaaa	aa	aa			aaa		aaa
M11/1 (bBt)		5	40	f	ff	ff	f			aaaa	aa	aa			aa	a	aa
M11/1 (bBt)		5	40		ffff	f	f			aaaa	aa	aa			aa		aaa
M11/1 (bBt)	1.27	5	40		ffff	ff	f			aaaaa	aa	aa			aa		aaa

Table SS4.64. F62119 (treethrow hole 3). Soil microfabrics and microstratigraphy, M21 (main dark fill), M22 (centre fill), M24 (lower main dark fill), M25 (outside hole – upper) and M26 (outside hole – lower)

Sample/layer	*Relative depth (m)*	*Soil microfabric (SMF)*	*% Voids*	*Burrows and chambers*	*Channels*	*Vughs*	*Packing voids*	*Gravel (ironstone and flint)*	*Charcoal*	*Soil clast*	*Ferriargillan textural features*	*Dusty clay textural features*	*Dark red clay textural features*	*Pan-like textural features*	*Yellowish brown textural features*	*Compound textural features*	*Fe*	*Fe/Mn*
M21	0.035–0.115	8 & 9	25	ff	fff	ff		*			a	aaaa					aaaa	a
M22	0.04–0.12	8 & 9	25	ff	ffff	ff			aa		aa	aaa				aa	aaaaa	a
M24	0.35–0.43	9 & 8	20	fff	fff	ff					aa	aa				a	aaaaa	a
M25	0.06–0.14	10	10	fff	fff	f		*			a					aa	aaaaa	a
M26a	0.20–0.24	11	15	fff	fff	f		*	a		aa	a					aaaaa	a
M26b	0.24–0.26	12	25	f	f	f	ffff	*			aa	aa				a	aaaa	
M26c	0.26–0.28	13	35			f	ffff	fffff			a	aa				a		

* – very few 0–5%, f – few 5–15%, ff – frequent 15–30%, fff – common 30–50%, ffff - dominant 50–70%, fffff – very dominant >70%
a – rare <2%, aa – occasional 2–5%, aaa – many 5–10%, aaaa – abundant 10–20%, aaaaa – very abundant >20%

common, with dark red clay and pan-like features being occasional to abundant (Figs SS4.92–93, SS4.98–99). Microprobe line analyses of these, found dark red clay coatings and infills to contain high amounts of Si (mean 16.6%) and Al (mean 8.3%) that make up the clay, and associated cations (1.56% K, 1.05% Ca, 0.65% and 0.06% Na, mean values; Fig SS4.30; Table SS4.65; n=19). Fe (7.19%) and Mn (0.37%) are also present alongside P (0.11%). Another example of a dark red clay coating contains 0.25% P, while a spot sample of iron pan found a concentration of 0.69% P had accumulated. Fine soil within a pan-like feature contains 0.07% P (mean value; Figs SS4.92–97). Line analyses and elemental mapping suggest that there is a possible association between P and Ca.

Down-profile (M10) a mixed soil is present that features deep earthworm burrowing, inwash of yellowish brown (alluvial) clay and patches of Bt horizon material (Table SS4.63). Pan-like textural features do not occur, but occasional to many dark red clay textural features are present.

Burrowing is less frequent in the subsoil argillic bBt horizon, although void space has increased and channel porosity is dominant (M11; SMT5). Here, ferriargillans and iron and manganese (Fe/Mn) also become much more frequent, although occasional to many dark red clay coatings continue to occur (Figs SS4.100–111). Microprobe line analysis of 6 dark reddish clay coatings showed them to contain similar quantities of Si, Al and associated cations, but rather less P (mean 0.06%, range 0.01–0.13%; 38 readings) compared to dark red clay coatings in the bA and Eb horizon (mean 0.18%, range 0.1–0.83%; 28 readings).

A sequence of soil formation, human landuse, barrow construction and medieval agriculture/alluviation can be identified. The sequence is almost a mirror image of the pedological sequence examined at the Turf Mound, just some 150m to the north. Unfortunately, no impact on the mound by Roman activities has been recognized, in contrast to the situation at the Long Barrow.

Barrow 5 discussion. An examination of the hierarchy of the pedofeatures in the subsoil bBt horizon suggests that the majority of the ferriargillans were deposited first, with dusty clay and dark red clay textural features being mainly deposited second, sometimes forming compound textural features. The infrequent yellowish brown clay textural features came last. Ferriargillans and some

Table SS4.65. Microprobe line analyses – % – (5 micron wide beam). Barrow 5 samples M9 (bA & Eb, 92–100 cm) and M11 (bB't, 120–127 cm)

Sample/ Horizon	*Feature readings*	*Number of (microns)*	*Line length*		*P*	*Ca*	*Na*	*S*	*Fe*	*Mn*	*Mg*	*Si*	*Al*	*K*
M9b1/ bA & Eb	Clay infill	19	168 µm	Average	0.11	1.05	0.06	0.06	7.19	0.37	0.65	16.62	8.31	1.56
				Max	0.83	1.46	0.16	0.07	8.61	0.84	0.87	20.29	9.86	2.13
				Min	0.01	0.45	0.00	0.04	4.55	0.07	0.26	11.56	4.99	1.16
M9(167a4)/ bA & Eb	Coarse capping/pan	6	168 µm	Average	0.07	0.48	0.19	0.13	3.29	0.03	0.21	20.62	3.02	0.88
				Max	0.15	1.36	0.67	0.33	7.26	0.07	0.5	28.3	5.94	1.71
				Min	0.02	0.15	0.01	0.05	1.01	<0.01	0.1	7.19	1.18	0.24
M9(167a2)/ bA & Eb	Iron pan fragment	Selected			0.69	0.15	0.00	0.04	10.98	0.06	0.00	4.04	4.17	0.00
M9(167b2)/ bA & Eb	Clay coating	9	114 µm	Average	0.25	1.03	0.38	0.04	20.6	0.12	1.09	12.20	7.78	0.97
				Max	0.34	1.45	1.7	0.09	25.8	0.54	3.03	17.69	11.00	1.69
				Min	0.05	0.20	0.00	0.00	2.63	0.01	0.27	3.36	2.27	0.22
M11(169B-b1)/ bB't	Clay coating	9	83 µm	Average	0.07	1.17	0.15	0.04	7.50	0.07	0.59	20.5	5.91	1.21
				Max	0.13	2.51	0.41	0.05	10.80	0.10	1.12	37.9	10.92	2.06
				Min	0.02	0.06	0.00	<0.01	0.13	0.01	0.00	6.64	0.00	0.02
M11(169B-b2)/ bB't	Clay coating	8	122 µm	Average	0.06	4.28	0.18	0.05	5.99	0.06	0.51	20.51	4.95	0.86
				Max	0.10	10.5	1.20	0.07	9.53	0.13	1.01	35.24	10.50	1.91
				Min	0.03	0.19	0.00	0.03	0.15	<0.01	0.00	10.72	0.00	0.05
M11(169B-b3)/ bB't	Clay coating	4	47 µm	Average	0.06	1.31	0.07	0.06	7.48	0.07	0.80	19.15	8.26	1.50
				Max	0.08	1.58	0.26	0.08	8.86	0.08	1.05	23.57	10.72	1.77
				Min	0.05	0.84	0.00	0.03	4.57	0.04	0.47	12.72	5.23	1.02
M11(169B-A3L)/ bB't	Clay coating	11	90 µm	Average	0.04	1.25	0.25	0.19	7.13	0.04	0.53	14.20	7.24	1.47
				Max	0.08	1.96	0.85	0.31	9.50	0.06	0.99	20.24	10.23	2.20
				Min	0.00	0.13	0.00	0.04	1.23	0.01	0.00	1.24	0.62	0.13
M11(169B-A4L)/ B't	Clay coating	6	53 µm	Average	0.06	0.83	0.53	0.23	6.78	0.08	0.35	16.8	6.03	1.60
				Max	0.12	1.15	1.17	0.31	8.54	0.15	0.58	23.9	8.10	3.58
				Min	0.01	0.37	0.00	0.17	2.73	0.02	0.20	8.97	3.59	0.91

Table SS4.66. Raunds soil data (excluding the Long Barrow) summarised and compared with selected Neolithic, prehistoric and /modern analogues

Raunds soils are non-calcitic (in thin section) (<0.1–0.1% $CaCO_3$) with mean pH 6.6 (range pH 4.8–7.6, *n*=17), although deep subsoils (not included) are calcareous (eg 9.6% $CaCO_3$, pH 8.1)
Hengistbury Head – pH 4.7 (*n*=2); Wormley Wood – pH 3.6–3.8 (*n*=3); Eton – occupation soils are non-calcitic, with patches of calcitic soil in subsoil; Hazleton – all soils are generally non-calcitic with mean pH 7.7 (range pH 6.9–8.1, *n*=10); Bury Farm – non-calcitic

Site	*%LOI*	*MS x 10^{-8} SI Kg^{-1}*	*P_{nitric} ppm*	*P_2O_5 ppm*	*$P_2O_{5ignited}$ ppm*	*P ratio*
Raunds						
Neo/BA Mound/topsoil						
Mean	4.7	101	1190	150	450	3.0
Range	2.1–10.2	8–218	590–1780	90–340	230–790	1.1–5.7
Number	13	16	10	13	13	
Neo/BA Subsoil						
Mean	3.1	69	1290	100	300	3.0
Range	1.9–7.0	24–249	1200–1390	90–150	160–530	2.4–6.2
Number	8	8	2	8	8	8
Undated treethrow hole 3 fill						
Mean	5.7	39		120	290	2.4
Range	4.5–6.5	9–80		110–140	260–340	1.9–2.7
Number	4	4		4	4	4
Undated treethrow hole 3 subsoil outside hole	2.1	5		50	160	3.2
Hengistbury Head						
LBA/EIA forest humus	21.2	0		20	330	>20
LBA/EIA forest topsoil	3.1	1		<10	100	>20
Wormley Wood						
Modern forest humus	28.8	28		30	680	>20
Prehistoric forest topsoil						
Mean	2.6	4		20	130	6.5
Range	2.3–2.9	4		10–20	110–140	7–11
Number	2	2		2	2	2
Eton						
Neo occupation soil						
Mean	3.7	32		260	610	2.1
Range	3.1–4.4	17–51		180–350	450–690	1.8–2.5
Number	8	8		8	8	8
Neo forest subsoil						
Mean	2.6	12		60	390	7.2
Range	2.5–3.2	9–24		40–70	380–410	5.6–9.5
Number	3	3		3	3	3
Hazleton						
Neo occupation soil						
Mean	7.0	63		200	860	4.4
Range	5.9–7.6	39–84		140–270	600–1190	3.3–5.9
Number	4	4		4	4	4
Neo forest subsoil	6.0	85		160	730	4.5
Bury Farm						
Neo topsoil	6.3	146		180	610	3.4

dusty textural features probably date mainly to the Holocene woodland and its disturbed Mesolithic and Neolithic history (Table SS4.63). This gravel-rich horizon also features a marked channel structure, as evidence of early Holocene weathering of the alluvium, and as found in gravelly soils outside treethrow hole F62119 (Table SS4.64). Bulk analyses show accumulations of clay, organic matter and organic phosphate, but as shown by microprobe studies the later dark red (humic) clay coatings are also a strong source for these accumulations. Upwards in the buried soil profile, these dark red clay textural features become more numerous, whereas ferriargillans become infrequent to absent. In the bA and Eb horizon these dark red clay textural features are in fact more rich in P than clay translocated deeper into the profile (bBt). These upper horizons show greater amounts of burrowing by earthworms and in addition, pan-like textural features become more numerous and these coarse pedofeatures are again more rich in P compared to the surrounding soil. The mound/bA horizon also contains more P (440 ppm $P_2O_{5ignited}$) than is naturally present in the example of forest humus accumulated in the treethrow hole at Raunds (290 ppm $P_2O_{5ignited}$; range 260–340 ppm $P_2O_{5ignited}$, *n*=4). Although not directly comparable, it can be noted that the amounts of phosphate in topsoils at the two ancient acid woodland sites of Hengistbury Head (100–330 ppm $P_2O_{5ignited}$) and Wormley Wood (140 ppm $P_2O_{5ignited}$), are also less (Table SS4.66). The anomalous presence of a) textural features in the upper soil, b) greater amounts of P in textural features in the upper soil compared to the subsoil, c) apparently more P in topsoils compared to amounts of P accumulated in natural forest humus, d) the presence of 'foreign' soil clasts in upper soils and e) pan-like features in the upper soils, all point towards surface and subsurface soil disturbance by a mechanism that also adds organic matter and organic phosphate. The mechanism also encouraged burrowing activity by earthworms in a soil that was probably rather acidic by the early Bronze Age. The best explanation we have at the moment to account for these soil features is probably dung and liquid animal waste deposition, combined with animal trampling. The soil data could indicate either long-term low concentrations of stock at this site, or a few episodes of high-intensity activity. The identification of charred tubers of onion couch grass in early Bronze Age contexts argues for low intensity grazing in the valley (Campbell and Robinson 2007), whereas this on-site evidence of soil poaching is more likely to have recorded animal concentrations.

Another major process that disturbs soil and leads to concentrations of P is human occupation. Human activity, however, is more likely to lead to the accumulation of large amounts of inorganic phosphate (not organic P; Engelmark and Linderholm 1996) through the deposition of bone and ash. This is because, where humans are strongly concentrated as at the late Bronze Age/early Iron Age sites of Chisenbury (on Chalk) and Potterne (on Upper Greensand), both in Wiltshire, and Salford (on decalcified terrace drift), in Bedfordshire, soil conditions become altered by large inputs of $CaCO_3$ (eg ash) and phosphate, and here under conditions of localised and ephemeral anaerobic conditions, calcium phosphate cemented materials, including mineralised coprolites, can be preserved (Table SS4.66, Figs SS4.30–31; Macphail *et al* 2000; SS4.8.2.4). The effects of human trampling can also be considered. In the construction of the Experimental Earthworks at Overton Down (rendzinas) and Wareham (podzols) turf was cut from a juxtaposed area (ditch) and used to construct a bank. No effects of human trampling were observed; only the single fragment of 'foreign' soil found at the top of the old land surface of the 1980 excavation at Wareham implied human trampling (Crowther *et al* 1996; Macphail 1996; Macphail *et al* 2003). This was because a vegetated turf resists the impact of human and animal trampling. At Carn Brea, Cornwall, devegetation and burning prior to construction of the rampart produced a surface soil that was unstable, and here human trampling, relating to construction, appears to have been recorded (Macphail 1990). Trampling experiments have been carried out, but again it seems that disturbed soil and/or non-vegetated surfaces need to be involved if humans are going to produce major textural feature and/or compacted feature effects (Macphail and Cruise 2001; Rentzel and Narten 2000). Human trampling generally produces near-surface (eg 0–30mm) features in sandy loams although 6 weeks of modern trampling accumulated 50–80mm of soil (Rentzel and Narten 2000). Of greater import at Raunds, however, is the presence of dark-coloured organic and phosphate-enriched clay coatings in trampling features, because these have never been directly related to experimental or ancient domestic floors/surfaces (Courty *et al* 1994; Rentzel and Narten 2000). Human trampling is more likely to lead to thin compacted surfaces, not upper subsoil disturbance, poaching and the deposition of organic matter and phosphate enriched clay (Courty *et al* 1994; Macphail and Cruise 2001).

It is not inconceivable that some of the dusty clay textural features that occur in the profile, may also be possibly indicative of an earlier (pre-herding) history of cultivation at the site, but this evidence has been heavily overprinted by the effects of animal stocking (Macphail *et al* 1990).

Some post-depositional features need to be considered at Barrow 5. It is likely that burrowing and some dusty clay movement resulted from the medieval agriculture that was studied in detail at the Turf Mound. These features, along with the downwash of yellowish brown clay (from medieval agricultural activity and clay alluviation, which through deep burrowing and channelling is found in up to abundant amounts as deep as the bEb and bB horizon), are still distinguishable from (woodland) ferri-argillans and dark red clay coatings (inferred animal activity; Table SS4.64).

Barrow 6. 2140–2080 cal BC or 2050–1890 cal BC

Barrow 6 was excavated by Dave Windell of the Northamptonshire Archaeological Unit in October 1986 (Windell *et al* 1990). There was approximately 280mm of very dark brown (10YR2/2) mound material, that became less dark with depth (10YR3/2; Table SS4.60). The mound buried 180mm of strong brown (7.5YR4/6) soil, that became increasingly more sandy and gravely, and dark yellowish brown (10YR4/6) in colour. Four samples were taken of the mound (M31, M32) and buried soil (M33, M34; Table SS4.60). The soils are poorly humic sandy loams, developed on loamy sand subsoils (Tables SS4.58–60, samples 10–13), and presently display weakly alkaline pHs. The mound is more organic (3.8–4.1% LOI) and shows higher values of χ (150–170 x 10^{-8} SI kg^{-1}) and contains more P (1290–1410 ppm) than the buried soils (2.8–2.9% LOI, 50–70 x 10^{-8} SI kg^{-1}, 1020–1200 ppm P, respectively). The soils are less humic, but similarly phosphatic compared to the Turf Mound.

The upper part (M31) of the relict turf stack has been partially reworked by biological activity and coarse channels (350 µm across) are frequently infilled by impure clay (cf Figs SS4.69–71). These coatings and infills do not occur in the lower part of the mound (M32). Soil peds coated by these impure clay coatings and infills, are a compacted humic sandy loam soil in places, and contain fine charcoal (Table SS4.61, SMT4). The very few voids are often closed vughs coated with thin (10–20 µm) very dusty coatings. These peds can be massive in character, with weak intercalations and weakly embedded grains, and occasional pan-like textural features. Elsewhere the soil has a spongy microfabric because of biological activity (earthworms and Enchytraeids). This porous fabric present in the lower mound may also display thin dusty clay coatings.

Figure SS4.50 Barrow 6.

Within the generally humic soil, there seems to have been very abundant loose infilling of voids by humus stained and clay coated Enchytraeid (and/or Collembola)-like faecal material. Overall, the mound soil has a generally non-calcareous appearance, but small fragments of calcareous material are present.

The buried soil is thin, only some 180mm thick. Thin section M33 sampled the fine soil, and again a generally biologically open soil, of a humic character is present (SMT3 and 4). Compacted soil peds also occur. One, at 30mm depth, has a semi-laminar fabric, where a series of medium size (200 µm) horizontal voids have become infilled by textural features forming closed vughs. There is a sequence of two types of coatings. The first is a very dark reddish brown dusty clay with low interference colours (cf Figs SS4.74–76). Dusty clay or silty soil coating with higher interference colours succeeds it. Occasionally the biological porosity has these reddish coatings, whereas much of the fine soil also has a dusty appearance, due to its humic and fine charcoal content. Some peds are composed of humic and non-humic slightly ferruginous soil (Eb/B horizon material), and again these are all coated with dusty clay. A sand-sized fragment of iron-depleted 'foreign' soil from a probable gleyed (Bg) soil was also mixed into the soil.

The gravely subsoil (M34) contains fragments of sandy soil with laminated finely dusty clay coatings (Bt horizon), whereas this material is commonly partially homogenised into the microfabric (cf SMT5 and 12). Thin dusty clay coatings occur throughout, affecting the biological fabric. Rare calcitic infills and calcareous clasts are present.

Barrow 6 discussion. The thick impure clay infillings seem to be the last features to affect the mound soil, and probably date to historic ploughing of the alluvial clay soil that buried the West Cotton earthworks (cf the Turf Mound and Barrow 5 sequences). The mound is mainly made up of humic Ah horizon turf material, some of which has a biologically mixed character, whereas many peds are compacted. The buried upper soil has a similar character, and likewise includes many to abundant textural features. The deeper subsoil is a Bt horizon formed in the loamy sand alluvial parent material, and reflects pedogenesis under a long history of woodland. The soil was a well–drained argillic brown earth. At present the soil is very shallow compared to the soils described from prehistoric treethrow hollows and at the Turf Mound where some 0.5m of buried soil is present (see below). In addition, the argillic coatings are very strongly worked into the soil fabric by biological activity, indicating that original subsoil horizons have come under the influence of upper soil processes. In fact, there appears to be something of an hiatus between the uppermost buried soil, and the more sandy and gravel-rich lower subsoil, although they are included within a thin buried soil profile. A period of substantial soil erosion or truncation may thus have to be suggested to account for this. This soil loss possibly occurred before the major Beaker/Bronze Age landuse. The lower part of the topsoil has a slightly heterogeneous character, including both Ah and possible Eb horizon material. It is also affected by many dusty clay coatings and related dusty intercalatory features. These give the impression of a rather unstable soil that has been physically disturbed, and may possibly have had a history of cultivation (Macphail 1992b; Macphail *et al* 1990). The topsoil also contains compacted soil fragments with closed vughs and associated features that appear to be unrelated to processes relating to tillage. In addition, there are these late (present in many of the biological pores) dark reddish clay coatings that are common, and also present in turves in the mound, and which themselves can be post-dated by very dusty and silty soil coatings. As at the Turf Mound and Barrow 5, these later features may be interpreted as evidence of herbivore herding – high amounts of liquid waste and trampling effects. In addition, animal trampling here would explain the presence of 'foreign' gley soil fragments.

The history of the site may be summarised thus. Argillic soil formation under woodland was followed by human activities leading to soil truncation or erosion, and these activities may have included cultivation, possible traces of which are apparent in the lower part of the topsoil. The land was then left to pasture and a biologically worked and humic topsoil developed. Animals were herded here up and until the construction of the barrow, but on the basis of the fewer dark red and pan-like textural features present, probably less intensively than at the Turf Mound and Barrow 5.

Southern Enclosure

A section through the Southern Enclosure showed rubified soil surfaces with magnetic susceptibility enhancement (eg 906 x10^{-8}

SI kg^{-1}), decreasing down-profile (42 x 10^{-8} SI kg^{-1}; Table SS4.60). The juxtaposed ditch fill also has a much lower χ (23 x 10^{-8} SI kg^{-1}).

Early medieval 'old land surface'
A single 130 mm-long thin section was collected from the supposed junction of the prehistoric land surface and early medieval alluvium at the Southern Enclosure. The slide essentially displays SMT 2 (Table SS4.61), and reflects post-prehistoric pedogenic activity such as probable ploughing and biological working.

SS4.8.2.4 Discussion

Chemical and magnetic characteristics

Statistical analyses
Although citric acid was found to be reliable as an extractant of phosphate compared to nitric acid (r^2 0.7972; Fig SS4.28), because it extracts only *c* 25% of the phosphate taken up by nitric acid, the P_2O_5 (P_{citric}) data needs to be treated with caution. This was brought out by the poor correlation between P_{citric} and clay, compared to clay and P_{nitric} (Results and Tables SS4.67–68), reflecting some problems of extraction of phosphate by citric acid in clay soils (Linderholm, pers comm 2002). On the other hand, P_{citric} appears efficient in separating organic from inorganic phosphate, as brought out by the significant correlation (95%) between P ratio and Org C (r_s value 0.6395).

A number of important correlations were found, using Spearman's Rank Correlation Coefficient (Tables SS4.67–68). There are significant (95% level) correlations between χ and measures of organic matter (Org C, r_s value 0.5584; LOI, r_s value 0.4667), which probably reflect both the natural topsoil formation of strongly magnetic maghaemite and the presence of burnt soil in topsoils, seemingly including humic treethrow hole fills. Of especial importance for inferences concerning animal management in the Neolithic and early Bronze Age is the correlation between phosphate and organic matter. The most significant (99.9% level) correlations occur between P_{nitric} and Org C (r_s value 0.8583), and P_{citric} and LOI (rs value 0.7761). P ratio is also correlated with Org C (r_s value 0.6395 at 95% level). These show that there is a relationship between organic matter and the different organic and inorganic phosphate fractions. Another series of interesting strongly significant correlations (99.9% level) concern clay and Org C (r_s value 0.6779) and clay and P_{nitric} (r_s value 0.9364), with clay and LOI being correlated (r_s value 0.7572) at the 95% level of significance. As discussed below the movement of phosphate and organic matter enriched clay, is an already recognised phenomenon in woodland soils (Parfenova *et al* 1964). These correlations support this identification at Raunds (micromorphology, microprobe, bulk chemical analysis of horizons/contexts).

Chemistry
It is possible to point out some general chemical trends in the prehistoric soils (Tables SS4.60 and SS4.66). The mounds and buried topsoils of the Neolithic and early Bronze Age barrows continue to be more

Table SS4.67. Chemical and magnetic properties: statistical analysis

Variable	*Mean*	*Std. Dev.*	*Skewness*	*Minimum*	*Maximum*	*Valid Number*
Org C	0.62	0.66	2.40	0.00	3.20	40
Carbonate	0.73	2.27	3.95	0.00	9.60	18
pH (H_2O)	7.21	0.73	-1.03	4.80	8.60	29
pH ($CaCL_2$)	6.45	0.90	-1.73	4.30	7.10	10
LOI	4.88	2.31	0.70	1.90	10.40	39
χ	104.69	90.00	0.86	5.00	289.00	39
P (nitric)	1277.69	420.95	0.31	590.00	2100.00	13
P (citric)	178.21	86.22	1.32	70.00	445.00	29
$P_2O_{5ignited}$	410.34	195.84	1.35	160.00	1020.00	29
P ratio	3.41	1.29	0.39	1.10	5.70	29
Sand	56.43	22.54	-0.66	3.00	96.00	30
Silt	25.17	11.90	-0.04	4.00	45.00	30
Clay	18.73	12.71	1.19	0.00	56.00	30

Table SS4.68. Chemical and magnetic properties, statistical analysis: Spearman's Rank Correlation Coefficients (r_s values)

	Org C	*Carbonate*	*pH (H_2O)*	*pH ($CaCL_2$)*	*LOI*	*χ*	*P (nitric)*	*P (citric)*	*P ratio*	*Sand*	*Silt*
Carbonate	.2598 N(18) Sig .298										
pH (H_2O)	-.6208 N(23) Sig .002*	.8377 N(9) Sig .005*									
pH ($CaCL_2$)	-.8463 N(10) Sig .002*	. N(0) .Sig .	.9811 N(10) Sig .000**								
LOI	.8674 N(26) Sig .000**	.5270 N(9) Sig .145	-.4218 N(26) Sig .032*	-.650 N(10) Sig .036*							
χ	.5584 N(26) Sig .003*	.0746 N(9) Sig .849	-.1732 N(26) Sig .398	-.4719 N(10) Sig .168	.4667 N(39) Sig .003*						
P (nitric)	.8583 N(13) Sig .000**	. N( ) Sig.	-.5970 N(10) Sig .068	-.6838 N(00010) Sig .029*	.7692 N(13) Sig .002*	.7135 N(13) Sig .006*					
P (citric)	.8832 N(22) Sig.000*	.1641 N(9) Sig .673	-.3752 N(22) Sig .085	-.9276 N(6) Sig .008*	.7761 N(29) Sig .000**	.5738 N(29) Sig .003*	.9000 N(9) Sig .001*				
P ratio	.6395 N(22) Sig .001*	-.0759 N(9) Sig .846	-.4445 N(22) Sig .038	-.9276 N(6) Sig .008*	.2638 N(29) Sig .167	.4265 N(29) Sig .022*	.5167 N(9) Sig .154	.4708 N(29) Sig .010*			
Sand	-.6668 N(27) Sig .000**	-.2529 N(13) Sig .404	.4280 N(22) Sig .047	.8222 N(8) Sig .012*	-.6552 N(23) Sig .001*	-.2355 N(23) Sig .279	-.9456 N(9) Sig .000**	-.5125 N(19) Sig .025*	-.1094 N(19) Sig .656		
Silt	.5233 N(27) Sig .005*	.1237 N(13) Sig .687	-.2325 N(22) Sig .298	-.5717 N(8) Sig .139	.1662 N(23) Sig .449	.8787 N(9) Sig .002*	.8787 N(9) Sig 002*	.3225 N(19) Sig .178	.0539 N(19) Sig .826	-.9489 N(30) Sig .000**	
Clay	.6779 N(27) Sig .000**	.2285 N(13) Sig .453	-.5118 N(22) Sig .015*	-.8854 N(8) Sig .003*	.7572 N(23) Sig .000*	.0545 N(23) Sig .804	.9364 N(9) Sig .000**	.4002 N(19) Sig .090	-.0416 N(19) Sig .866	-.8461 N(30) Sig .000**	.6781 N(30) Sig .000**

humic (organic C, mean range 0.5–1.7%; LOI, mean range 3.8–7.8%) than the buried upper subsoil B2 horizons (organic C, range 0.1–1.1%; LOI, range 2.1–6.2%). This can be compared to the mean amounts of organic matter for the site as a whole (0.62% organic C; 4.88% LOI, Table SS4.67). The Bt horizons exhibit small subsoil accumulations of organic matter (organic C, 0.2%; LOI, range 3.3–4.4%). Mounds and buried topsoils are thus broadly more organic (LOI, mean 4.7%, range 2.1–10.2%, *n*=13) than subsoils (LOI mean 3.1%, range 1.9–7.0%, *n*=13; Table SS4.66).

Measurements of organic carbon in the treethrow hole soil sequences show diminishing amounts of organic matter down-profile from the modern topsoil (Table SS4.60, sample 33, 2.6% organic C), through the post-prehistoric alluvium (samples 29, 34 and 35; range 0.5–1% organic C; cf samples 3 and 22), into the buried treethrow hole features. Soils containing rubified burnt soil (and sometimes charcoal) contain 0.3–0.6% organic C (samples 30–32). In treethrow hole F62123, upper dark (iron- and manganese-stained) fills contain more organic carbon (0.4 and 0.5%) compared to lower dark fills (0.2%, *n*=2) and fills not mottled with iron and manganese (0.1%). Soils within the dark fill of treethrow hole F62119 are more humic (LOI, mean 5.7, range 4.5–6.5%, *n*=4) than the soil outside (LOI, 2.1%). It must be remembered, however, that organic matter is another potentially labile material in buried soils, and much reduced by post-burial oxidation and microbiological activity, except when preserved by wetness as at Hengistbury Head (Table SS4.66; eg Crowther *et al*, 1996). P ratios are likely to be affected in the same way.

Medieval alluvium and Ap horizons (samples 3, 4 and 22) contain on average 480 ppm phosphate ($P_2O_{5ignited}$, range 460–520, *n*=3). The mixed modern Ap and mound at Barrow 1 (sample 14) displays the highest concentrations of P (P_{nitric} 2100 ppm) and phosphate ($P_2O_{5ignited}$, 1020 ppm). The site as whole displays means of 1277.69 ppm P and 410.34 ppm $P_2O_{5ignited}$.

Neolithic and early Bronze Age mound and topsoil samples contain more phosphate ($P_2O_{5ignited}$, mean 450 ppm, range 230–790 ppm, *n*=13) than the buried subsoils ($P_2O_{5ignited}$, mean 300 ppm, range 160–530 ppm, *n*=13), with little difference in P ratio (cf mean 3.0, range 1.1–5.7 with mean 3.0, range 6.2; Tables SS4.60 and SS4.67–68). The mean P ratio for the site is 3.41. This is despite noticeable subsoil concentrations of organic matter and phosphate in bBt horizons (Table SS4.60, samples 8 and 27). These mound and topsoil samples are also moderately phosphorus-rich (P mean 1190 ppm, *n*=10) but show a broad range (590–1780). Unfortunately, there are not enough subsoil samples for comparison (P mean 1290 ppm, range 1200–1390 ppm, *n*=2). At the Long Barrow the mound and buried topsoils contained similar amounts of phosphate ($P_2O_{5ignited}$, mean 440 ppm, range 370–560 ppm), but higher P ratios (mean 4.8, range 3.3–6.5), compared with other Neolithic and early Bronze Age sites (Macphail SS4.8.1).

It is also not an easy matter to compare levels of phosphorus (P) and phosphate (P_2O_5) although levels of P_{nitric} have been calculated based upon a regression figure (Fig SS4.28). There are few data for the Long Mound (mound – 1380 ppm P, 490 ppm $P_2O_{5ignited}$, P ratio 1.5; bA and B – 780 ppm P, 330 ppm P_2O_5OI, P ratio1.1). Amounts of phosphate are naturally low at Raunds. For example, the subsoil sample collected from outside treethrow hole F62119 contains 160 ppm $P_2O_{5ignited}$. Still, if only the earlier Neolithic Long Mound soils (see above) are compared with the early Bronze Age barrow mound and buried topsoils (P, mean 1220, range 590–1780, n=8; $P_2O_{5ignited}$ mean 460 ppm, range 230–790 ppm, *n*=10), absolute amounts do not appear dissimilar, although the range has a higher limit in the early Bronze Age soils. On the other hand, P ratios are higher in the early Bronze Age (mean P ratio 3.8) compared to the Long Mound soil (P ratio, range 1.1–1.5). The fill of treethrow hole F62119 contains generally lower amounts of phosphate ($P_2O_{5ignited}$ mean 290 ppm, range 260–340 ppm, *n*=4) than found in the Neolithic Long Mound and early Bronze Age soils. Soil outside the treethrow hole is less phosphate-rich ($P_2O_{5ignited}$ 160 ppm) and has a higher P ratio (cf mean P ratio 2.4 with 3.2).

It is important to view the phosphate chemistry at Raunds in the context of Neolithic to late Bronze Age/early Iron Age and modern analogue forest soils from the United Kingdom (see above). This is necessary because of the dearth of 'control' soils from Raunds, despite the fact that other sites are located on other parent materials with different natural background amounts of phosphate, so that all comparisons must be treated with caution. On the other hand, it is expected that soils formed on poorly fertile parent materials, such as Tertiary Sands (Hengistbury Head), sandy Pleistocene drift (Wormley Wood), and Pleistocene river terrace drift (Eton Rowing Lake and Bury Farm) as at Raunds, are likely to be similar to the Raunds soils in their phosphate chemistry. It is also important to look at within-site variation and trends, and makes the study of decalcified soils at Hazleton relevant here, despite their location on Oolitic Limestone/Marls. Moreover, as the chemical database for British ancient soils is extremely limited, such comparisons may help put Raunds into a wider context. Phosphate data from soils from five sites were plotted against data from the Raunds barrow sites and the undated treethrow hole, namely:

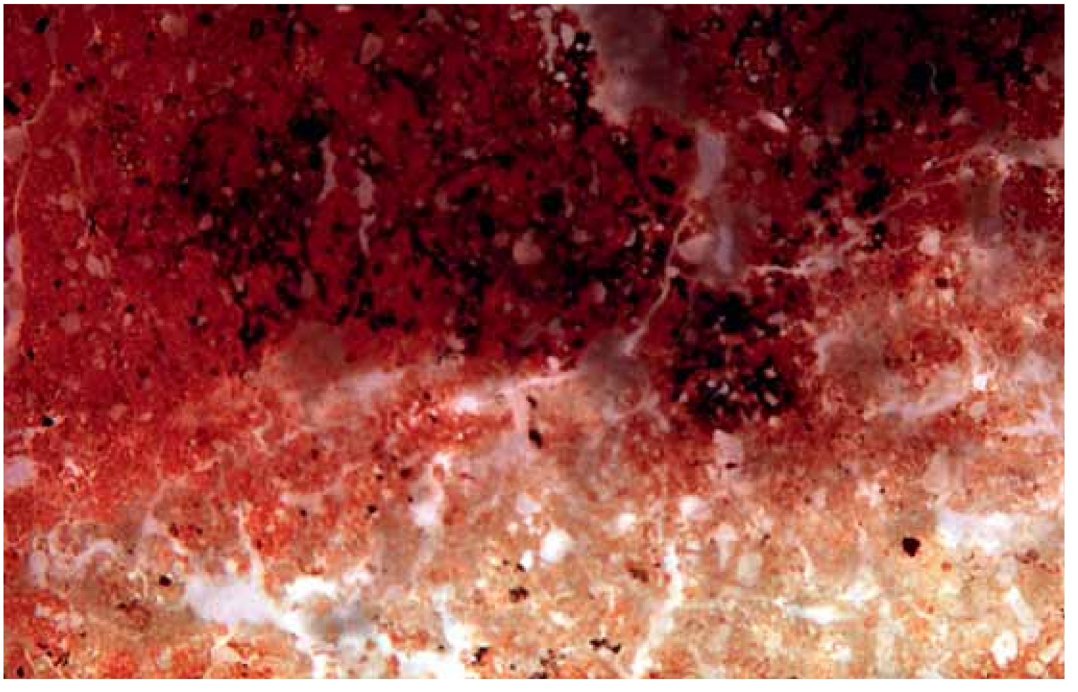


Figure SS4.51 Treethrow hole F62338: M13, burned soil mixed with unburned soil and alluvium; projected microfiche reader image; frame 11mm.

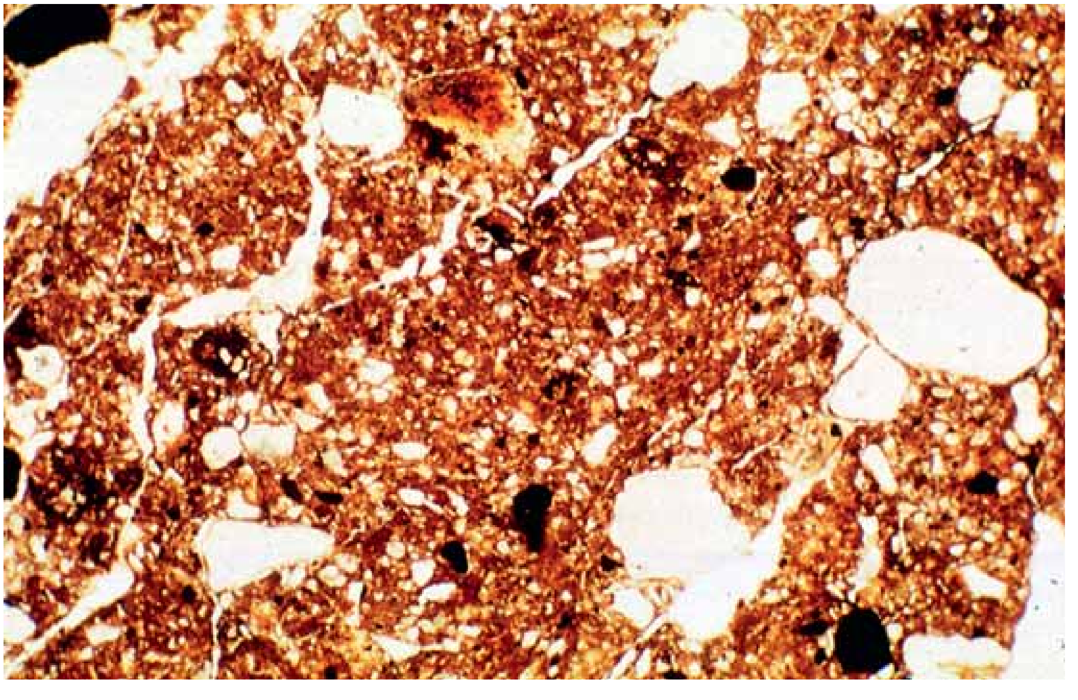


Figure SS4.52 Treethrow hole F62338: M13; burned soil; textural features (intercalations and void clay coatings) reddened with matrix; PPL, frame 5.34mm.

barrow mound and topsoil samples
barrow subsoil samples, and
treethrow fill samples (treethrow hole F62119)

In all, twenty-five Raunds samples were variously grouped against twenty-one samples from analogue sites (Figs SS4.30–31). An example from a modern forest topsoil that has been shown to have formed over many centuries (Wormley Wood) was also added. These studies show clearly the expected difference between modern high levels of organic matter, phosphate and P ratio and those in an ancient soil on the same parent material (Wormley Wood; Table SS4.66).

For example, Fig SS4.31 ($P_2O_{5ignited}$ ppm/%LOI) gives a clear indication of how high levels of organic matter in forest topsoils

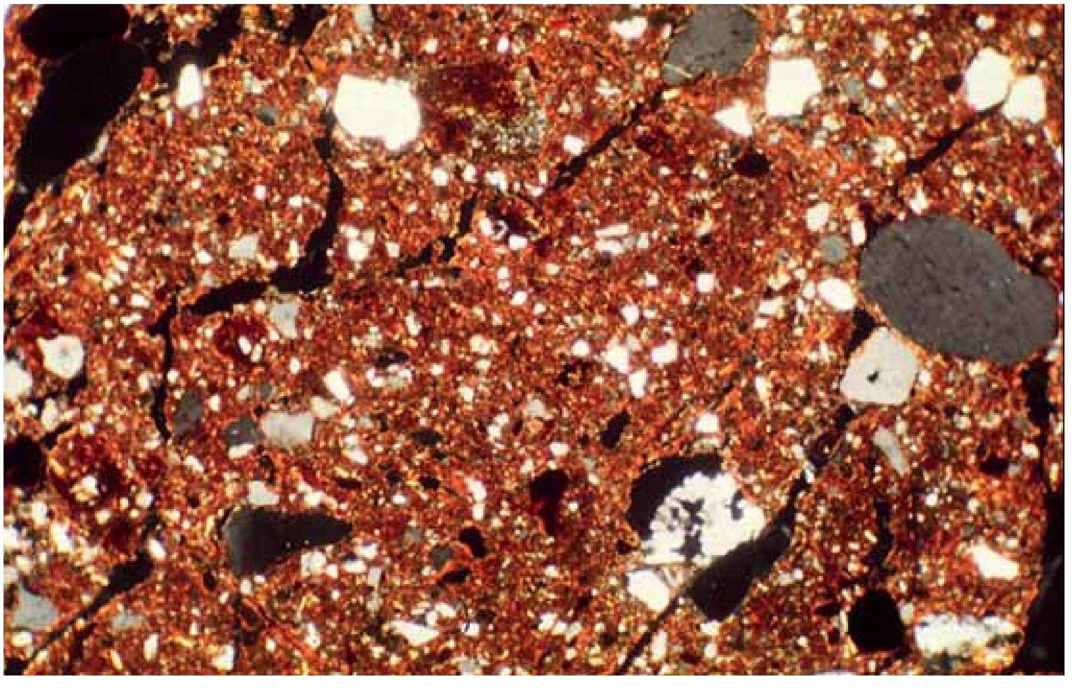


Figure SS4.53 Treethrow hole F62338: M13; burned soil; textural features (intercalations and void clay coatings) reddened with matrix; XPL, frame 5.34mm.

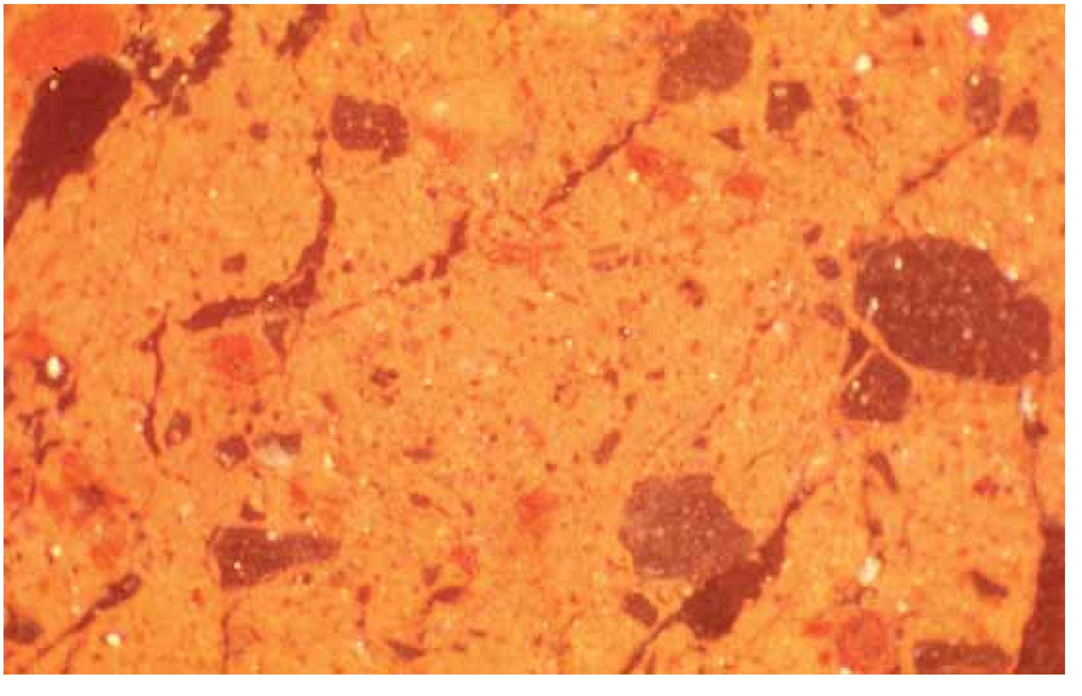


Figure SS4.54 Treethrow hole F62338: M13; burned soil; textural features (intercalations and void clay coatings) reddened with matrix; OIL, frame 5.34mm.

can be (Wormley Wood), and of how this can be preserved in wet acid buried soils (Hengistbury Head). There are also evident chemical differences between ancient topsoils and their subsoils, as recorded at both Eton and Hazleton. Raunds mounds and topsoils are much less phosphate-rich compared with the Eton and Hazleton (midden) occupation soils, and a soil sample from a Neolithic context at Bury Farm in the Great Ouse valley near Bedford. In the case of Eton and Hazleton, bone is present from middening to help account for this, apart from any differences induced by parent material variations. Unfortunately, Bury Farm has not yet been fully studied. The effect of bone on reducing P ratios is only clear from Eton.

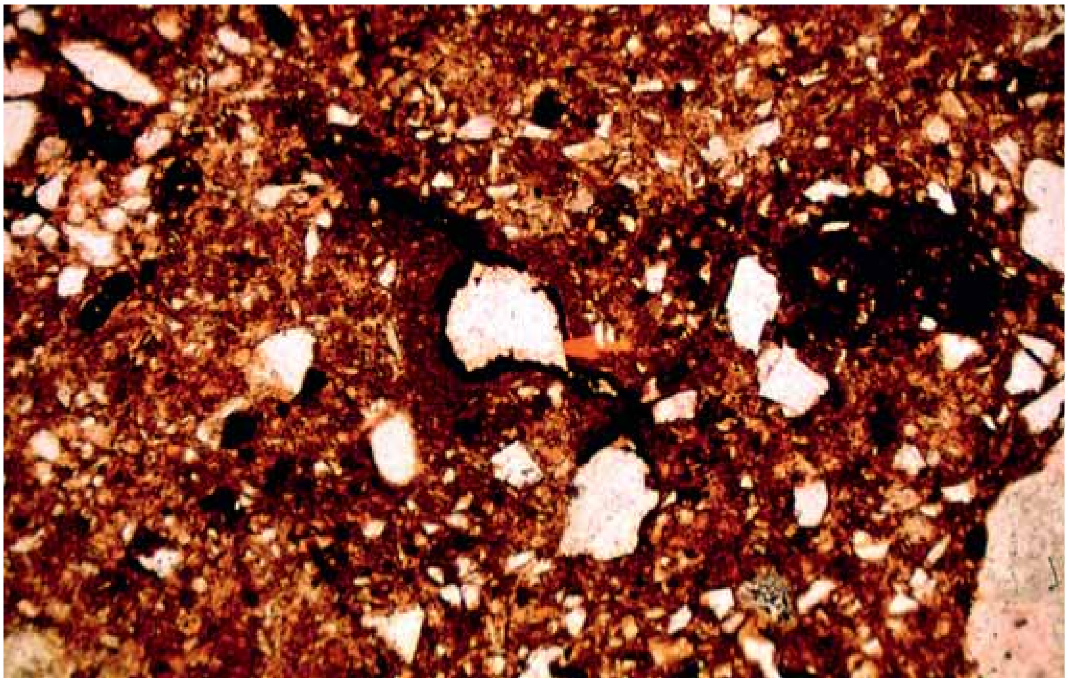


Figure SS4.55
Treethrow hole F62338: microphotograph, M13; dark red burned soil, with reddened clay coating and later Mn hypocoating; PPL, frame 1.2mm.

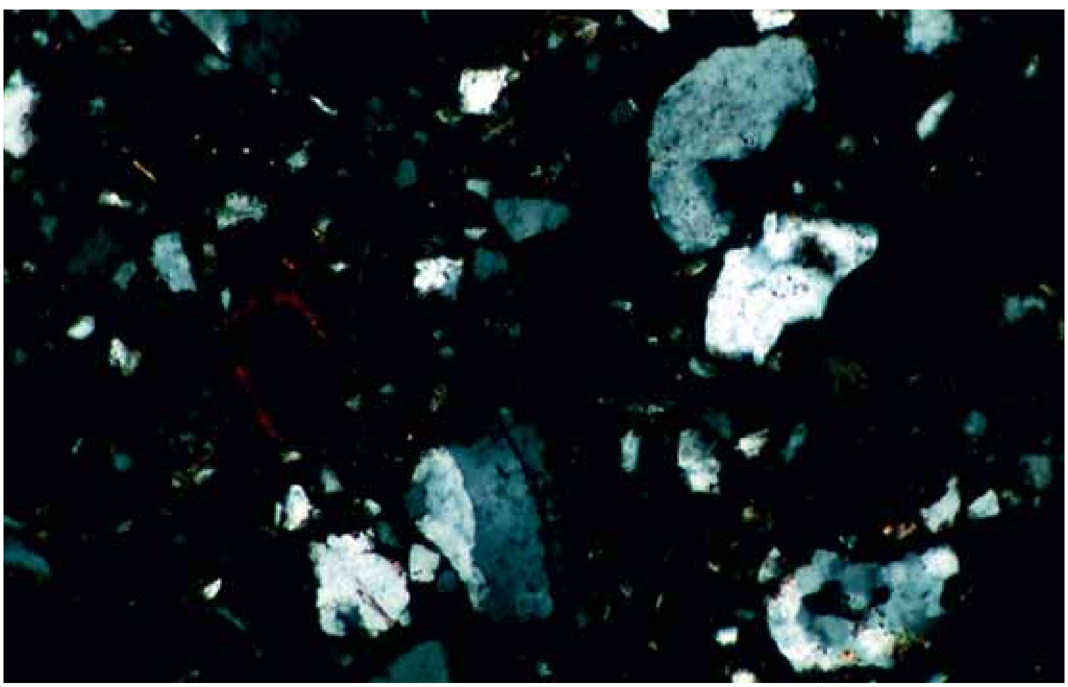


Figure SS4.56
Treethrow hole F62338: microphotograph, M13; dark red burned soil, with reddened clay coating and later Mn hypocoating; XPL, frame 1.2mm.

In terms of phosphate it can also be noted that late Bronze Age/early Iron Age occupation deposits at Chisenbury and Potterne, Wiltshire are even more phosphate-rich (Chisenbury – 3750 ppm P_2O_5; Potterne – 3560 ppm P_2O_5; Macphail in prep). When considering total P, mean amounts of 1190 ppm P present in the Raunds mounds and topsoils is lower than found in the pre-Long Barrow Neolithic occupation at Easton Down (P mean 4420 ppm P, range 4250–4550 ppm, *n*=3; Crowther 1996) and a Neolithic midden at Tofts Ness, Orkney (P range ~1410–3070 ppm; Simpson 1994). Clearly, sites of human occupation concentrate higher levels of P than found in any of the Raunds soils.

Magnetic susceptibility (χ)

Burnt soil from treethrow hole F62338 has a strongly enhanced χ (894 x 10^{-8} SI kg^{-1}), similar in value to a prehistoric burnt sandy soil (901 x 10^{-8} SI kg^{-1}) in a tree hole at Biddenham, Bedfordshire (Macphail 1999a). F87566 in the Avenue contains burnt soil with values of 572–753 x 10^{-8} SI kg^{-1}. Soil (M21) in treethrow hole F62119, which contains mixed burnt soil and charcoal, has an MS of 80 x 10^{-8} SI kg^{-1}. In a Neolithic burnt treethrow hole at West Heslerton both rubified (383 x 10^{-8} SI kg^{-1}) and charcoal-rich (333 x 10^{-8} SI kg^{-1}) soils also demonstrated enhanced magnetic susceptibilities. No absolutely pure rubified/burnt soil was tested at Raunds, because post-burial biological activity had mixed burnt soil with surrounding unburnt soil. The measured values in F62338 and F87566 are still far higher than those in F62123 and F62119, where no coarse burnt soil fragments were found in the thin sections (mean 23, range 8–80 x 10^{-8} SI kg^{-1}, *n*=10). A section through the Southern Enclosure showed a rubified surface soil with magnetic susceptibility enhancement, decreasing down-profile from context 87545 to context 87548.

At Raunds, overlying alluvial soils have values ranging between 11–46 x 10^{-8} SI kg^{-1} (mean 24 x 10^{-8} SI kg^{-1}, *n*=4), the same range as attained by alluvium at the Turf Mound and Barrow 5 (samples 3 and 22; 40 and 32 x 10^{-8} SI kg^{-1}, respectively). In treethrow hole F62338 a gleyed, dark coloured, strongly iron- and manganese-mottled sample gave a value of 19 x 10^{-8} SI kg^{-1}, while a mixed burnt and unburnt soil produced a value of 96 x 10^{-8} SI kg^{-1}. The lowest MS values were attained by iron depleted gleyed horizons below Barrow 3, namely 8–9 x 10^{-8} SI kg^{-1}. χ also varies naturally because some soil horizons are iron-poor because of pedogenesis, whereas others are relatively iron-rich because ferruginous oolitic ironstone is exposed, as at the Long Barrow. Nevertheless, mounds can show higher values than their buried subsoils (eg, Turf Mound – cf 134 x 10^{-8} SI kg^{-1} with mean 54 x 10^{-8} SI kg^{-1}, *n*=3; Long Mound – cf 218 x 10^{-8} SI kg^{-1} with 64 x 10^{-8} SI kg^{-1}; Barrow 6 – cf 150 x 10^{-8} SI kg^{-1} with mean 60 x 10^{-8} SI kg^{-1}, *n*=2; Barrow 5 – cf 78 x 10^{-8} SI kg^{-1} with 28 x 10^{-8} SI kg^{-1}, *n*=4), and these all essentially occur on a similar parent material (river terrace drift). This is an expected result as topsoils naturally develop enhanced magnetic susceptibility through surface microbial activity, but the differences also hint at anthropogenic affects such as burning (see Statistical Testing).

Soil micromorphology

The semi-quantitative counts recorded in Tables SS4.62–64 reveal the following patterns:

Alluvium

At the Turf Mound the uppermost alluvium (sample M37) is a dusty, dark yellowish brown (PPL) clay (C:F 30:70), with moderately low interference colours and a grano- and parallel-striate b-fabric (Table SS4.61: SMF 1; Figs SS4.57–60). The following distinguish it from the underlying soils:

1. frequency of planar voids and paucity of burrows and chambers (mean, voids 30%),
2. many plant fragments, and
3. occasional to many pan-like features and rare to occasional yellowish brown void clay coatings.

The underlying ridge and furrow ploughsoil (M38) is a dotted, very dark yellowish brown (PPL) sandy loam (C:F, 70:30), with low interference colours and a speckled b-fabric (SMF2, Figs SS4.61–66). It is characterised by, in comparison to the overlying fine alluvium;

1. many more burrows, chambers and vughs (mean voids 20%), with planar voids only affecting the uppermost soil
2. more gravel and charcoal, and
3. increased amounts of bright yellowish brown textural features (Table SS4.61).

Mound material and buried topsoils

At both the Turf Mound and Barrow 5, the mounds and buried soils show a number of similarities. The mound and buried topsoils (bA) have:

1. a heavily dotted, blackish to dark reddish brown (PPL) sandy loam (C:F, 65:35)

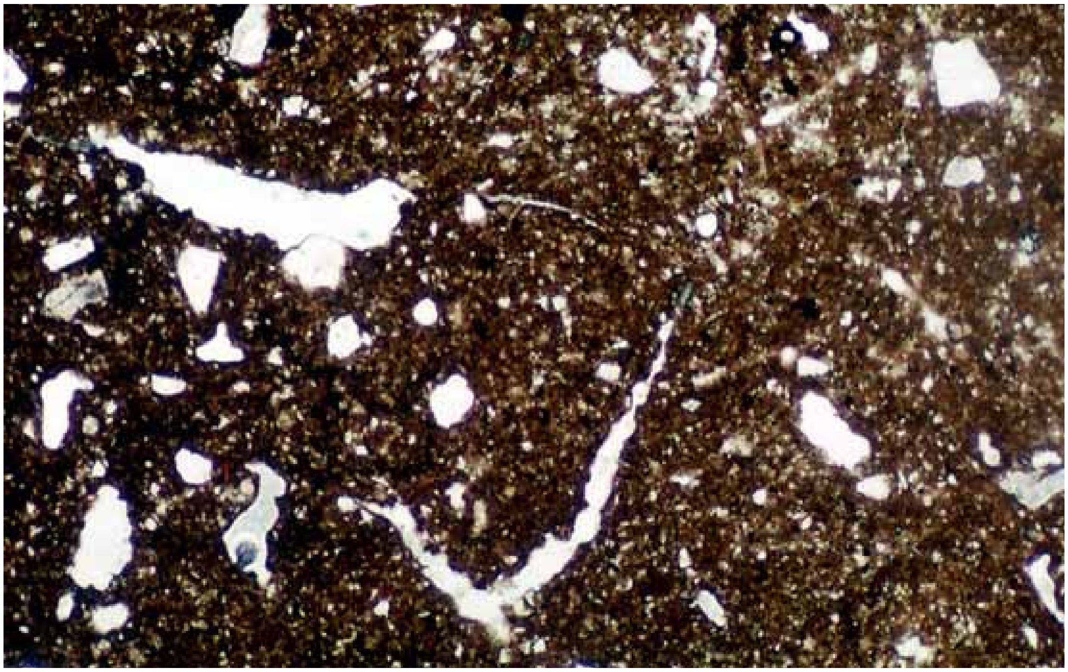


Figure SS4.57 Turf Mound: M37; Ap1/alluvium; SMF1; PPL, frame 5.5mm.

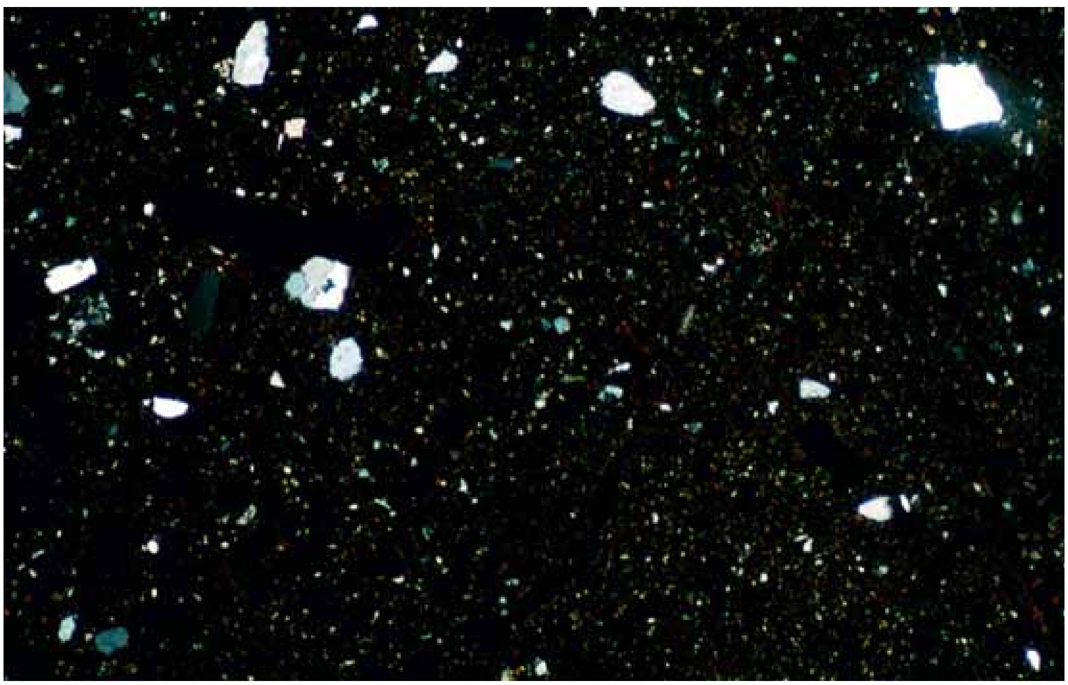


Figure SS4.58 Turf Mound: M37; Ap1/alluvium; SMF1; XPL, frame 5.5mm.

microfabric, with extremely low interference colours and a speckled b–fabric (Table SS4.61: SMF 3, as at the Long Mound; Figs SS4.78–80)

2. much relict fine amorphous and charred organic matter

3. included soil clasts

4. a comparatively lower void space (*c* 15% in the Turf Mound) compared to overlying medieval and alluvial soils (20–35% voids), with slightly more vughs (frequent to common) present (including closed vughs) compared to very few to frequent, and

5. a first appearance of many to abundant dark red to blackish, poorly birefringent clay void coatings and dusty clay textural features (Figs SS4.76–77)

and

6. a small increase in the amount of iron and manganese mottling.

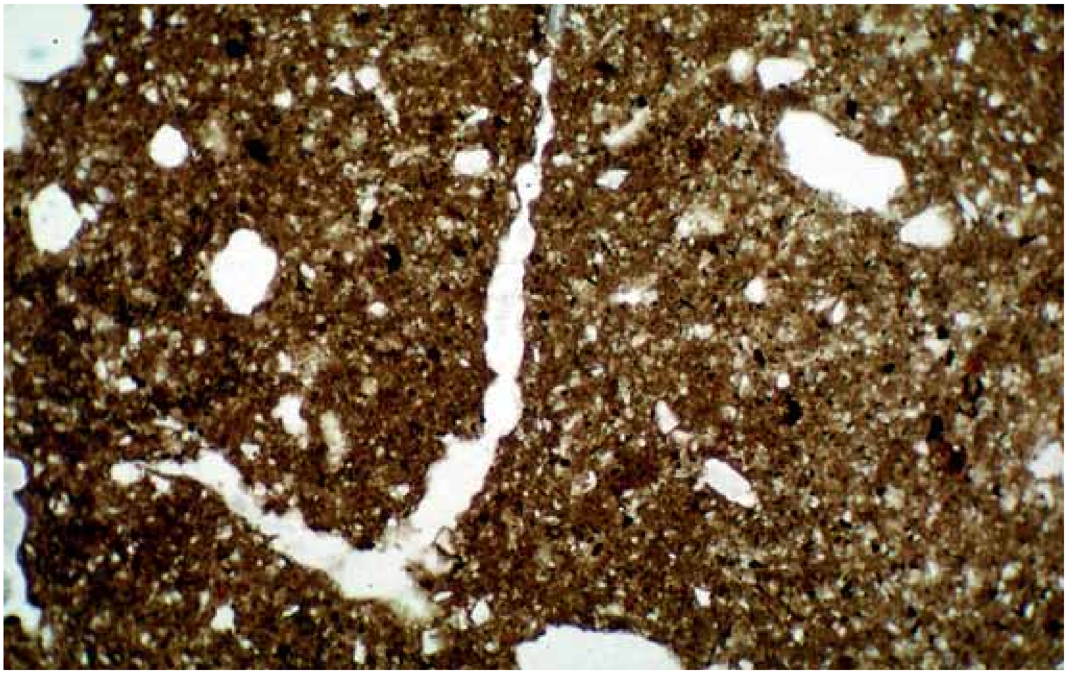


Figure SS4.59 Turf Mound: M37; Ap1/alluvium; SMF1; PPL, frame 3.5mm.

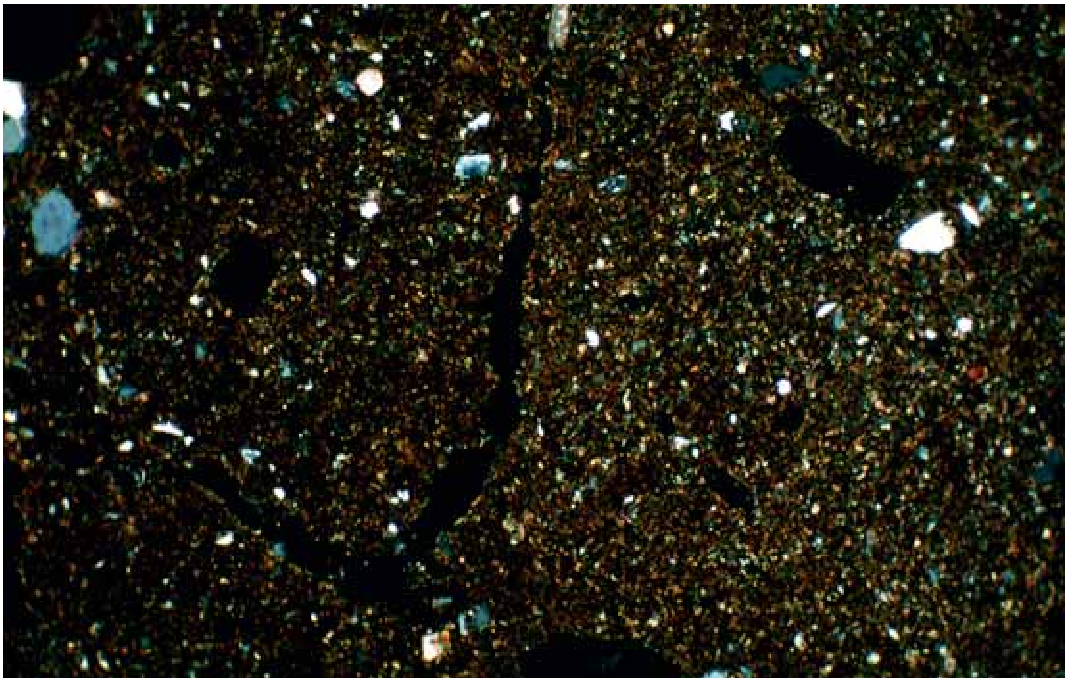


Figure SS4.60 Turf Mound: M37; Ap1/alluvium; SMF1; XPL, frame 3.5mm.

Buried topsoils and upper subsoil Eb horizons

These soils (A and Eb) are heterogeneous with

1 a mixture of SMF3 and much more pale, grey yellow (PPL), loamy sand with very low interference colours (Table SS4.61: SMF 4, as at the Long Mound, Figs SS4.81–82)

2 very little included organic matter in the SMF4 soil

3. concentrations of frequent vughs (including closed vughs), and

4. abundant dark red textural features and the highest amounts (abundant) of speckled, dark blackish brown, very poorly oriented, sometimes poorly sorted, microlayered, very dusty to impure (fine silt to very coarse silty) clay pans (pan-like textural features; Figs SS4.83–85) compared to the other soil horizons examined.

Buried lower subsoil
This horizon is characterised by

1. a yellowish brown (PPL) silty clay loam, with low interference colours (SMF5, Table SS4.61)
2. relatively high void space (c 30%) with an increased number of channels (few to dominant) compared to the horizons above
3. the new appearance of many to very abundant reddish brown to brown PPL), well–oriented, microlaminated, limpid to finely dusty void and grain clay coatings and void infills (ferriargillans; Figs SS4.76–77)
4. an increase in compound textural features (commonly ferriargillans with secondary dusty clay or dark red clay coatings), and
5. a marked increase of few to dominant gravel (flint and ironstone).

It can be noted from Tables SS4.62–64 that the bright yellowish-brown textural features are ubiquitous from the fine alluvium down into the buried subsoils, but pan-like textural features are generally absent from the lowermost subsoils. At the Long Barrow, major concentrations of dark-coloured and very dusty clay coatings, and associated pan-like features and closed vughs were found in all four buried topsoil locations (details in SS4.8.1).

Soil micromorphology counts at treethrow hole F62119 showed the fill to be dominated by dark brown and black soil, iron, iron and manganese stained, with mainly occasional to abundant dusty clay coatings (SMFs 8 and 9; Tables SS4.61 and SS4.64). Outside the treethrow hole, the soil showed less porosity with depth, fewer textural features and very dominant gravel in the still partially sedimentary stratified basal subsoil (SMF 10–12).

Descriptions of other treehole fills are also found in Table SS4.61, including burnt red soil from treehole F62338 (SMF 6), brown (SMF 7) and very dark brown and black (SMF 8) fills from treehole F62123. The red (SMF 14) and charcoal-rich (SMF 15) soil layers, and underlying subsoil (SMF 16) at the Avenue are also described in Table SS4.61.

Microprobe Analysis

Phosphorus (P) is present in varying quantities in the buried soil. In an example of an iron pan fragment, Fe (11%) is dominant in an aluminium silicate (clay – 4.1% Al, 4.04% Si), that contains concentrated amounts of P (0.69%; Table SS4.65).

Buried A and Eb horizon
As noted above, this horizon is rich in textural features. Elemental mapping of Si, Fe, Ca and P found that, apart from fragments of phosphorus and iron-rich iron pan/ironstone fragments (see above), P is most commonly present in textural features (eg Figs SS4.42, SS4.111).

Two examples of dark red clay coatings and infills were studied through microprobe line analysis, and showed them to be dominated by clay (Si and Al), with much associated Fe (7.19 and 20.60% mean values) and other cations (Ca, K, Mg, Mn and Na) present in smaller amounts. They also contain 0.11% to 0.25% P (= 1100 to 2500 ppm P – mean values). The relative distribution of these elements through an example of a clay infill (M9b1; Figs SS4.98–99) is diagrammatically represented in Figure SS4.29. Analysis of 'fine soil' (excluding large sand grains) forming an example of a dark coloured, coarse pan or grain capping textural feature, found it to be largely Si-dominated (quartz inclusions), with clay (Al), Fe and other cations (eg Figs SS4.94–97). A mean value of 0.07% P (700 ppm) is present. The three line analyses indicates average values of 0.14% P (1400 ppm P; n=31) in the fine soil of the textural features.

Buried lower subsoil Bt horizons
Elemental mapping again showed that P is most common in textural features, with little P in the matrix (eg Figs SS4.104–5 and SS4.110–111). Line analysis of six clay coatings found them to be clay (Si and Al) dominated, with high amounts of Fe, with a regular presence of other cations (Table SS4.65). Amounts of P vary from 0.04–0.07% (400–700 ppm P, mean values; average 0.06% P, n=47). These ferriargillans are no more ferruginous than the clay coatings in the bA and Eb horizon, and amounts of Ca, K, Mg and Na in textural features are similar between the two horizons. On the other hand, more Fe and Mn appears to be present in the coatings sampled from the bA and Eb (mean values 10.36% and 0.17%, cf 6.9% and 0.06%, respectively). Lastly, the buried topsoil and Eb horizon appears to contain generally more P (0.14%) in its textural features compared with amounts of P in the textural features in the Bt horizon (0.06%). The significance of this is discussed later.

Prehistoric soils of the Nene floodplain

The Gleyic Argillic Brown Earth soils underlying the alluvium are non-calcareous, deeply permeable soils formed in river terrace drift since the Pleistocene. They vary in texture from clay loams to sandy clay loams and sandy silt loams of the Waterstock series in places on Irthlingborough island (eg Barrow 1, treethrow holes F62123 and F62119), to fine and medium loamy soils of the Shabbington series on the terrace and at Redlands Farm (eg the Turf Mound, Long Barrow; Tables SS4.58–60). During the Neolithic and early Bronze Ages these soils were shallow to moderately thick (0.30–0.60m) sandy loam/loamy sand soils, over gravel.

Argillic brown earths

It should be noted that the natural pedogenic trends exhibited by argillic brown earths, relate to the following (Avery 1990; Duchaufour 1982):

1. Development under a woodland vegetation with a mull/mull-moder humus (here

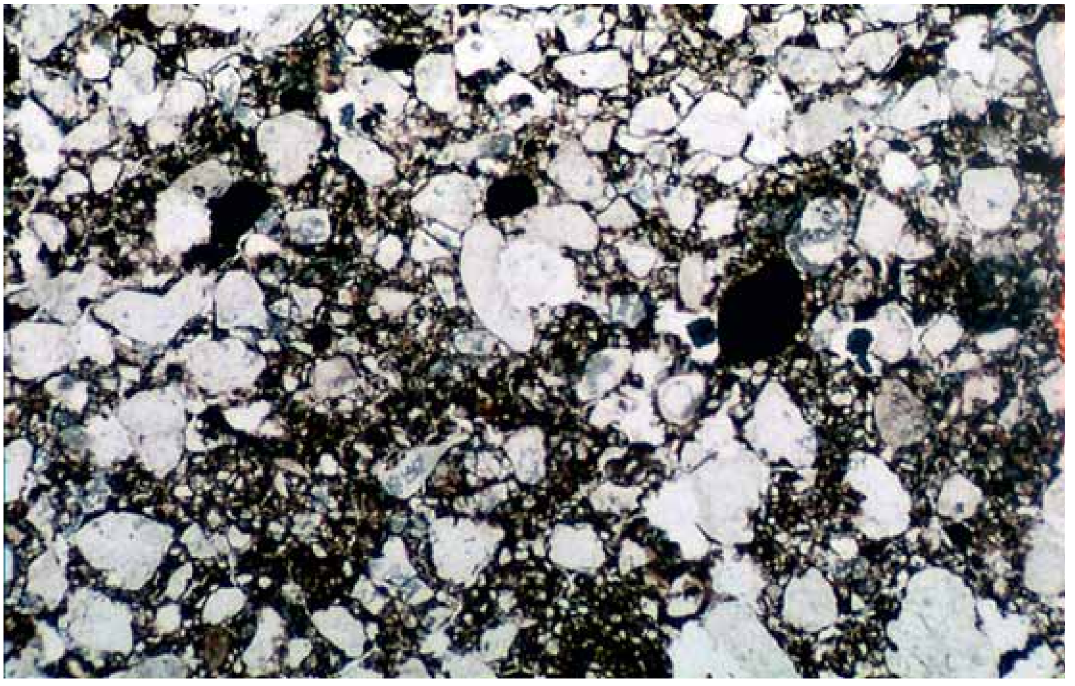


Figure SS4.61 Turf Mound: M38; Ap2/ridge and furrow; SMF2; PPL, frame 5.5mm.

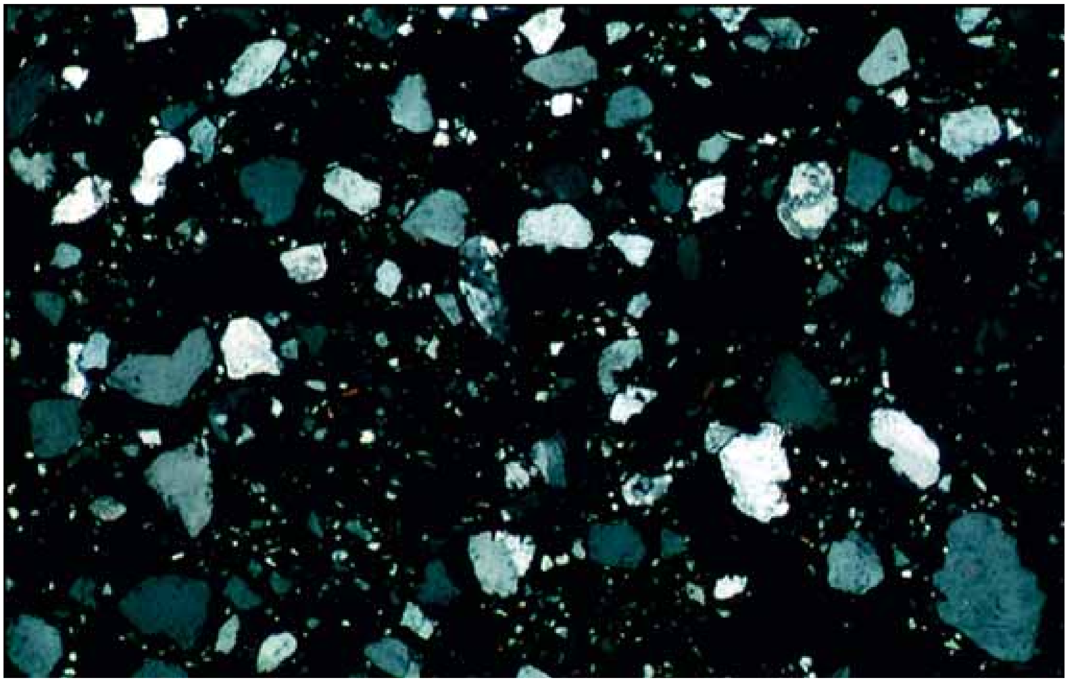


Figure SS4.62 Turf Mound: M38; Ap2/ridge and furrow; SMF2; XPL, frame 5.5mm.

oak and lime on drier ground, Robinson, this volume SS4.4)

2. Leaching and development of an acidic soil, with three prominent horizons, the Ah topsoil/turf, the Eb upper subsoil and the lower subsoil Bt horizon (eg Ah – pH 4.6, Eb – pH 4.5, Bt pH 4.7–5.4; Avery 1990, 214)

3. Clay translocation, forming a clay (and iron) depleted Eb upper subsoil horizon, over a clay (and iron) enriched lower subsoil Bt horizon (Duchaufour 1982, 287)

4. Continued leaching can lead to the formation of an acid degraded argillic brown earth, as at Hengistbury Head, Dorset, where an acid oak woodland (pH 4.7; Table SS4.66) developed a moder humus, and the Eb and Bt horizons were converted to the Ea and B(t)sg horizons of a podzol, respectively

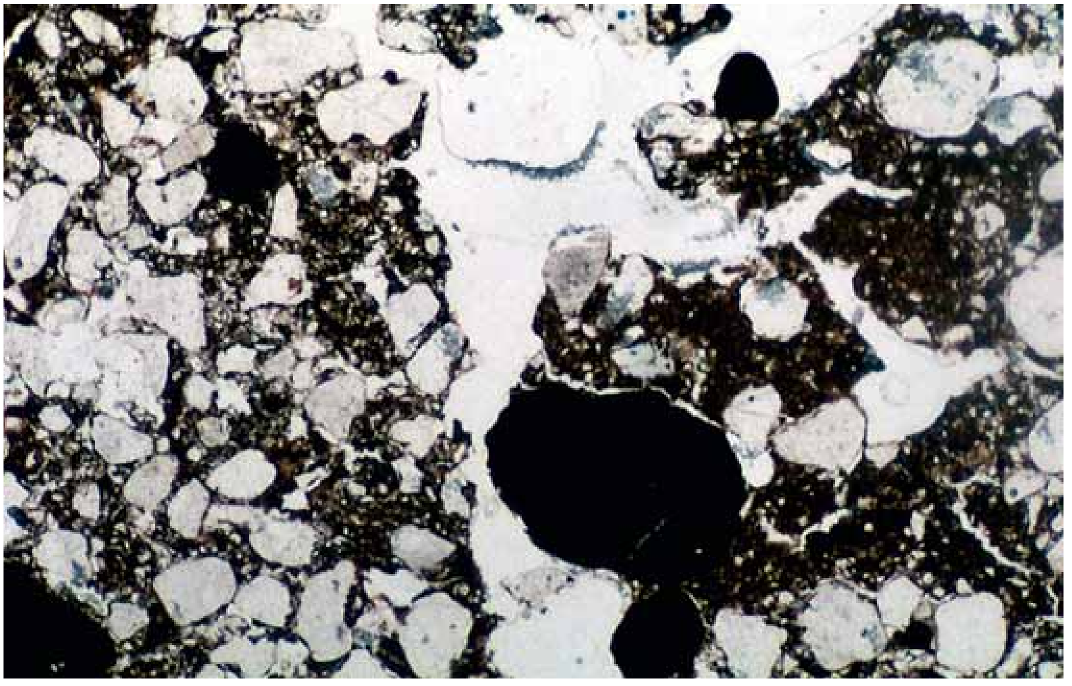


Figure SS4.63 Turf Mound: M38; Ap2/ridge and furrow; SMF2/1; PPL, frame 5.5mm.

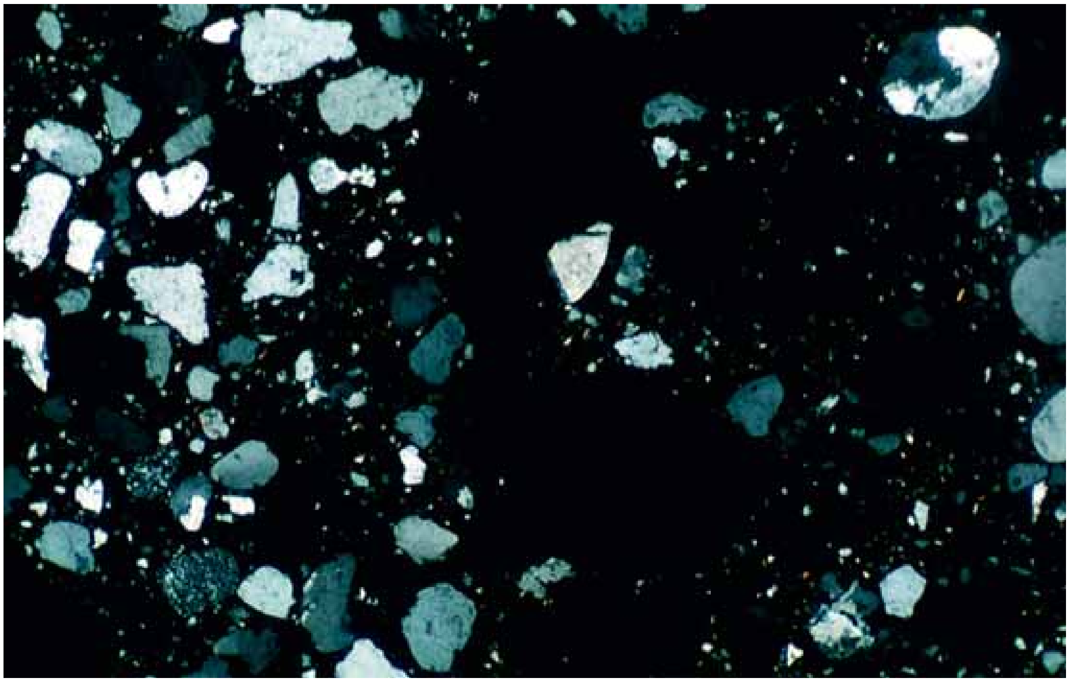


Figure SS4.64 Turf Mound: M38; Ap2/ridge and furrow; SMF2/1; XPL, frame 5.5mm.

(Macphail 1992a). At Wormley Wood, Hertfordshire an acid woodland cover on coarse loamy drift over London Clay led to strong acidification from prehistory to the present day (pH 3.6–3.8; Table SS4.66; see also Duchaufour 1982; Mackney 1961, 287).

All these pedogenic trends can be recognised at Raunds, despite later alluviation/changes in base level, and recent agriculture superimposing anomalously high pHs (range pH 6.0–7.4, pH being unfortunately a labile feature of buried soils). For example, buried Bt horizons at the Turf Mound and Barrow 5 show relatively high amounts of clay (14–24%) in their Bt horizons compared to other buried topsoil (9–13% clay) and Eb/B (6–12% clay) horizons (Tables SS4.59–60: samples 5–8 and 24–27). On the other hand,

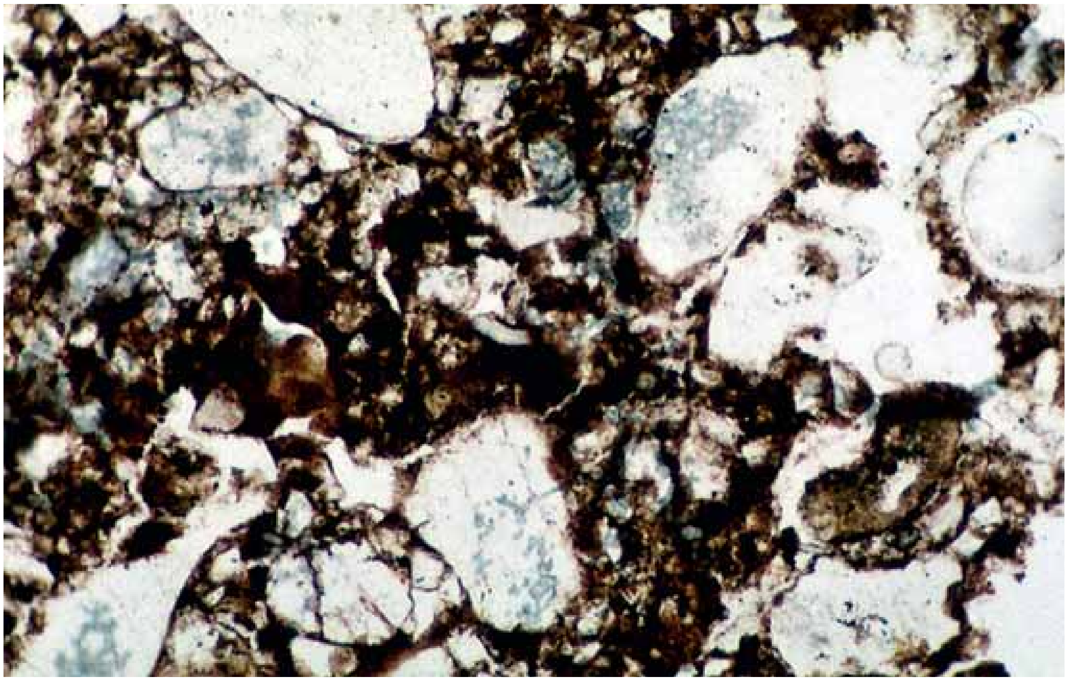


Figure SS4.65 Turf Mound: M38; Ap2/ridge and furrow; SMF2/1 – textural features; PPL, frame 1.5mm.

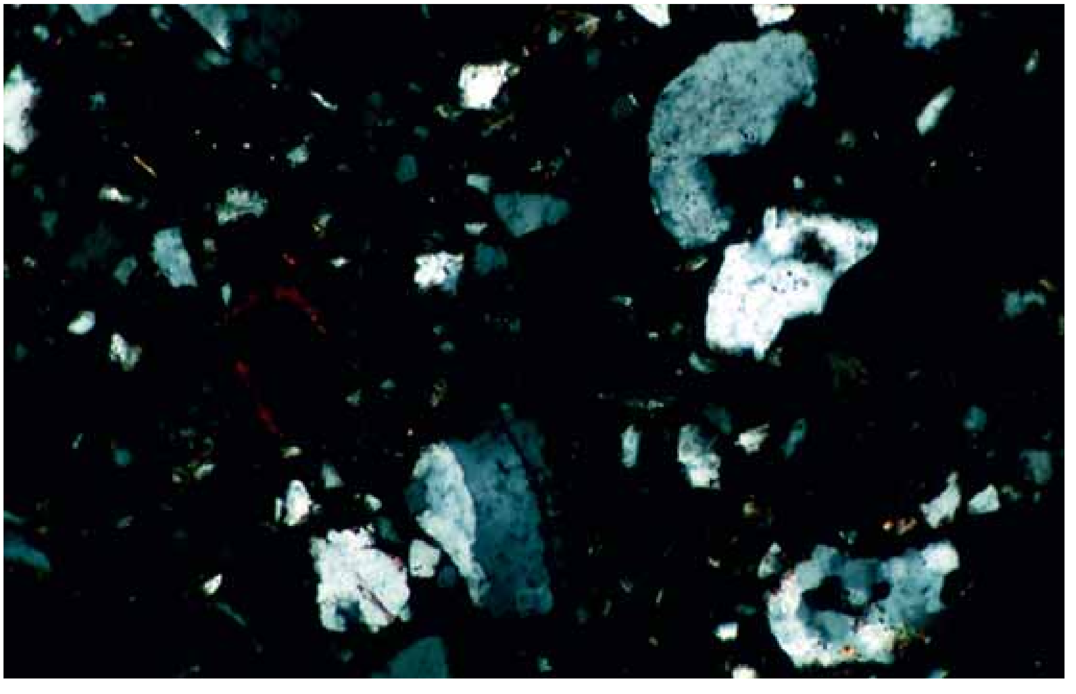


Figure SS4.66 Turf Mound: M38; Ap2/ridge and furrow; SMF2/1 – textural features; XPL, frame 1.5mm.

whilst the treethrow hole F62119 fills show high amounts of clay (mean 27%, *n*=5), a lateral control soil example from outside the treethrow hole is relatively clay-poor (9%; Table SS4.59).

Alluvial gley soils
The topography at Raunds is varied, despite the floodplain location, and this is reflected by the depth of alluvium that covers some parts of the site. As water tables rose during the post-prehistoric period, some soils became affected by hydromorphism (gleying), especially the treethrow holes on Irthlingborough island (Figs SS4.32–37). Rising water tables affected some sites by superimposing leached and mottled soil features (Tables SS4.58 and 61). At the Long Barrow, post-depositional fluctuations in base level led to pseudomorphic secondary biogenic calcite root replacement. Prehistoric soils in the Thames floodplain at the Drayton Cursus, Oxfordshire, were similarly affected by changes in base level (A Barclay *et al* 2003; Lambrick 1992).

The effects of burial on the soils
A number of general points can be made on this subject. Firstly, the dumping of poorly consolidated soil to make a mound during rainy conditions is believed to lead to soil slaking and the formation of clay coatings in the major pores in a mound (Romans and Robertson 1983c). On the other hand, no such clay coatings were formed by mound construction using turf and subsoil, at the Experimental Earthworks at Overton Down and Wareham (Crowther *et al* 1996; Macphail 1996; Macphail *et al* 2003). At Raunds, it is clear that most secondary, post-depositional clay movement occurred through later alluviation and medieval cultivation (see below). Secondly, there is commonly no sharp boundary between the mound and the underlying buried soil (an exception is the iron pan at Barrow 3). Evidence of burrowing by earthworms at Raunds in the mound and in the buried soils (Tables SS4.62, SS4.63) and results from Experimental Earthwork at Overton Down, indicate that the extant earthworm population, both in the buried soil and the turves of the mound, probably mixed the buried soil/mound boundary (Crowther *et al* 1996; Macphail and Cruise 1996). Other soil mesofauna, such as Enchytraeids and Collembola, probably further worked this boundary, with the result that there is no remaining plant evidence, such as litter and/or roots, of the humus type of the ancient land surface (Crowther *et al* 1996; Macphail *et al* 1987; Zachariae 1964). Thus there is only fragmentary and inferred evidence of the humus topsoil types, in the form of amorphous organic matter and soil structure, for the Neolithic and early Bronze Age soils. At the Long Barrow, topsoils appear to have been highly biologically worked mull horizons (SS4.8.1). In contrast, in the early Bronze Age mounds of the Turf Mound (south) and Barrow 5, the amount of pellety, dark amorphous humus present indicates that a much more acid, moder humus was likely to have been present (Tables SS4.61–63; Babel 1975). The inferred presence of this acid soil humus is consistent with the clay and iron-depleted Eb horizons (SMF4) and iron and clay-enriched subsoil Bt horizon occurring at these sites (Tables SS4.61–65). This finding is also consistent with the woodland history of the site and development of an acid Argillic Brown Earth soil. Argillic Brown Earth formation through physico-chemical clay translocation/lessivage has also led to the expected concentrations of clay, organic matter, phosphate and limpid and finely dusty ferriargillans (clay coatings) in the subsoil Bt horizons (Tables SS4.59–64; Duchaufour 1982; McKeague 1985; Parfenova *et al* 1964). Thus a history of forest soil formation is recorded by the humus content of the turf material in the mound, and the diagnostic presence of a depleted Eb (or A2) horizon and an enriched Bt horizon (Avery 1990; Duchaufour 1982; Staff 1975). This natural woodland soil pattern of clay translocation and illuviation thus makes the large numbers of textural features in the mounds, buried topsoils and upper subsoils completely anomalous in soils of the Neolithic and early Bronze Age landscape. In addition it can be noted that although textural features are present in the treethrow soils, they are many to abundant within the holes themselves, while only rare to occasional clay coatings are present in the soils outside them (Table SS4.64). Dark red clay and pan-like features are absent from the treethrow features.

Fifth to fourth millennium forest soils
Analysis of the treethrow hole soils in general and the detailed studies of the unfortunately undated prehistoric treethrow hole F62119 in particular indicate the following:

The early Holocene soils formed in an upward fining sequence of laminated sandy gravels, loamy sands and clay loams (Table SS4.59).

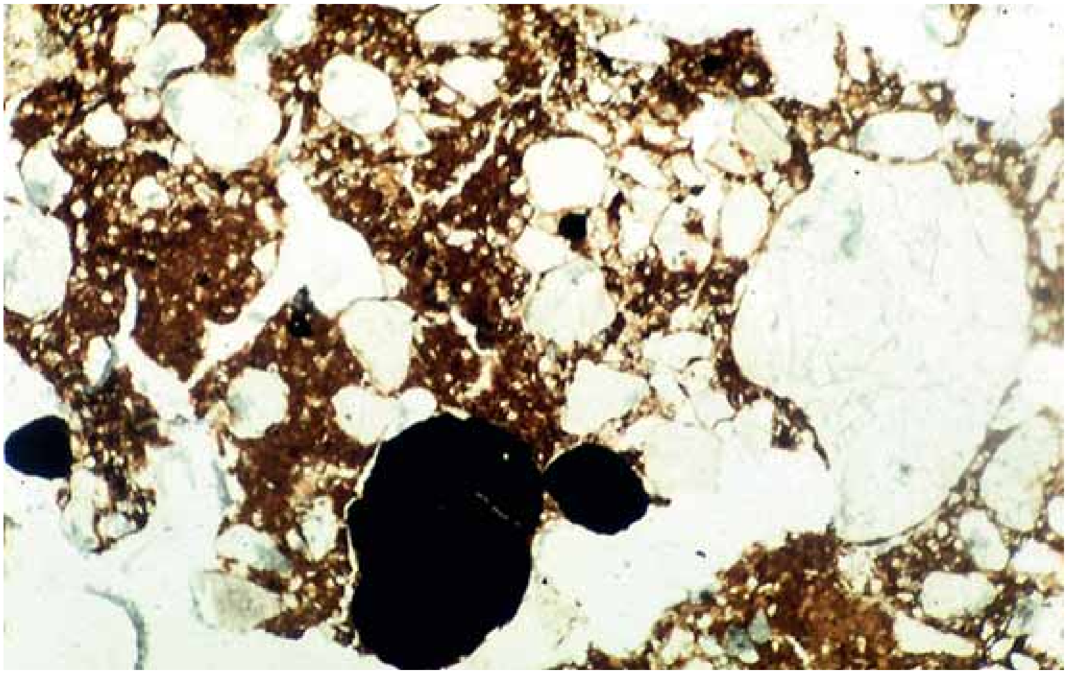


Figure SS4.67 Turf Mound: M39; mound; SMF3 – burrow-fill; PPL, frame 5.5mm.

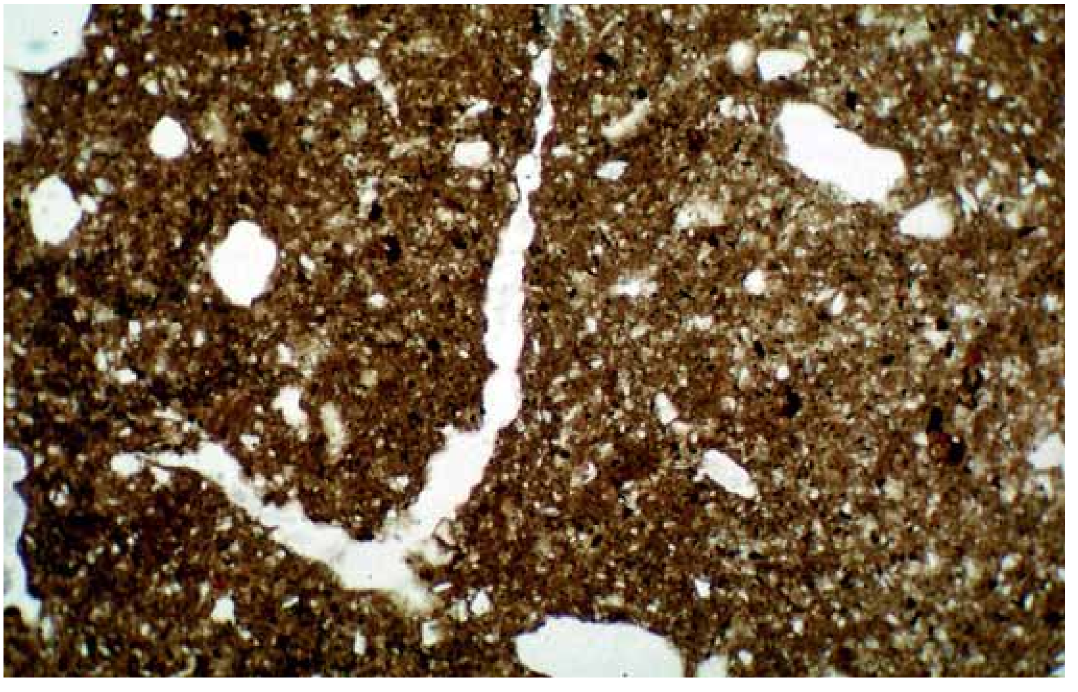


Figure SS4.68. Turf Mound: M39; mound; SMF3 – burrow-fill; XPL, frame 5.5mm.

Outside the treeholes, the deepest laminated sediments that were studied were found to be little-worked by biological activity (M26c), but up-profile were increasingly burrowed and rooted (M26b, M26a, M25; Table SS4.64).

Argillic Brown Earth soil formation and the physico-chemical translocation of clay (lessivage) was weak (only rare to occasional ferriargillans, dusty clay coatings and compound clay coatings), as noted in the soil profile between treethrow holes (M25 and M26).

As expected, textural features, in particular dusty clay coatings, are most abundant within the treethrow holes (eg M21, M22, M24), and, as argued elsewhere, this reflects mechanical soil disturbance induced by treethrow (Fisher 1982; Macphail 1992b; Macphail and Goldberg 1990). Similar treethrow disturbance has been recorded in the

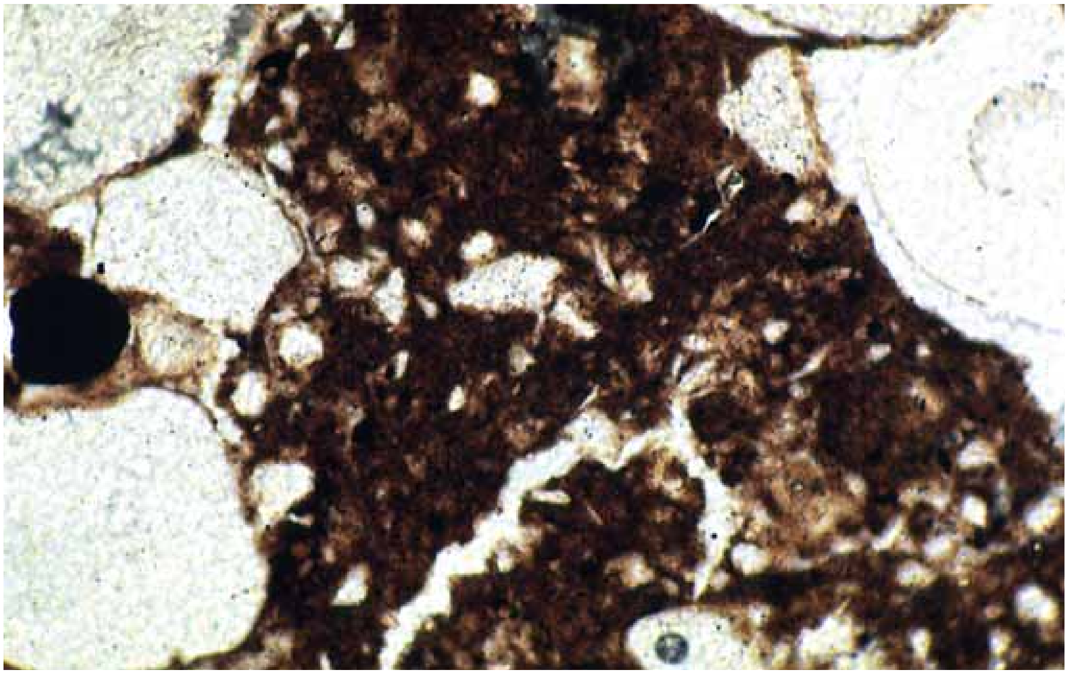


Figure SS4.69
Turf Mound:
M39; mound;
SMF3 – burrow-fill;
PPL, frame 0.33mm.

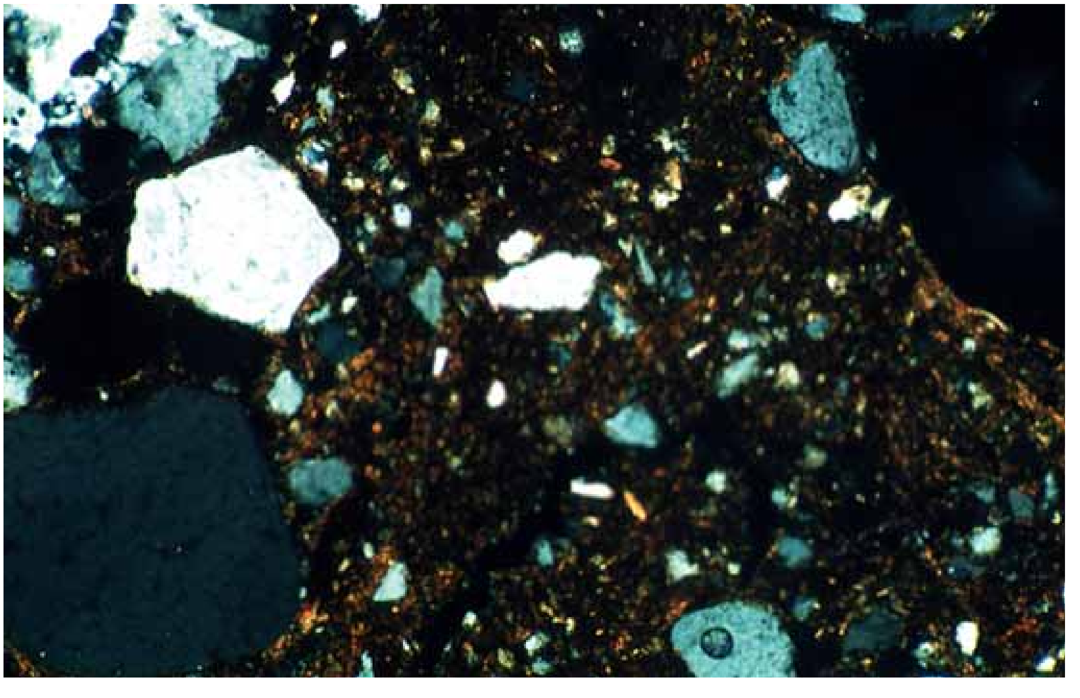


Figure SS4.70
Turf Mound:
M39; mound;
SMF3 – burrow-fill;
XPL, frame 0.33mm.

field in Belgium (Langohr 1993), and in thin section at Neolithic Hazleton and Drayton (for example Macphail in A Barclay *et al* 2003).

These findings indicate that, while the dating of major argillic B horizon formation to the forested Atlantic and Sub-boreal periods continues to be correct (Langohr and Vankliet 1979; Macphail 1987), lessivage (clay translocation) on its own may have led to little textural feature accumulation compared to the effects of treethrow (Macphail *et al* 1987; Romans unpublished).

Upper subsoil and topsoil horizons have not been preserved *in situ* in the fifth to fourth millennium (treethrow) landscape, but only occur as soil fragments or as darker fills, respectively. It is therefore difficult to argue that these soils were as mature as the later (Neolithic and early Bronze Age) argillic brown soils which are characterised by humic topsoil Ah and strongly iron and clay depleted Eb horizons (see above). In addition, the accumulation of translocated clay appears to be much more evident in the later barrow buried soils (Tables SS4.62–64).

All the above lead to the question, what landuse changes (fifth to early fourth millennium windthrow? Neolithic/early Bronze Age clearance? agriculture? animal management?) account for the differences in soil types present a) between treethrow holes, b) in treethrow holes and c) under the barrows.

The part of Avenue analysed by thin sections M52–54, dated to 4040–3530 cal BC (4990±110 BP; GU-5319) by a measurement on the large oak charcoal fragment shown in Fig SS4.38, can also contribute to our understanding of the mid-Holocene

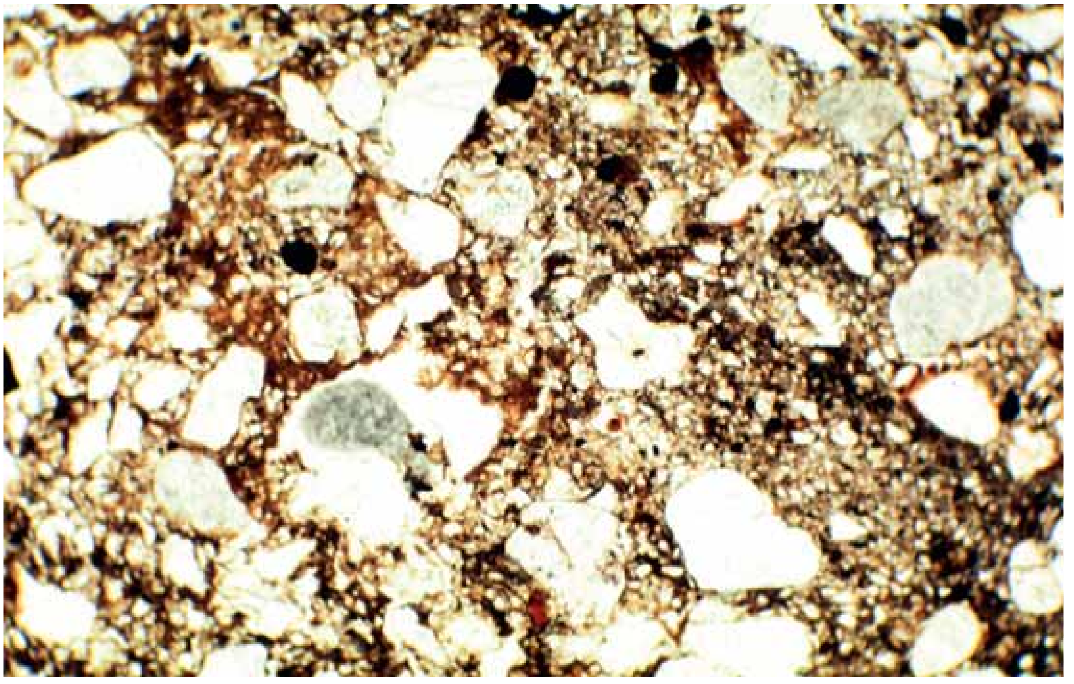


Figure SS4.71 Turf Mound: M40: bB; SMF3, 4: PPL, frame 3.3mm.

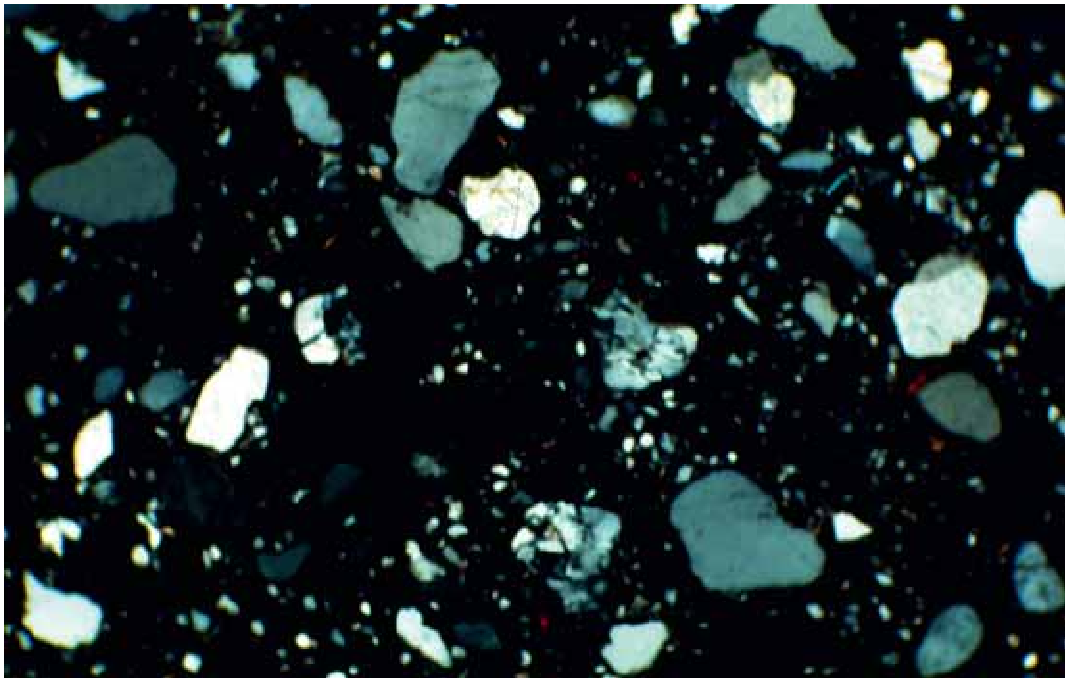


Figure SS4.72 Turf Mound: M40: bB; SMF3, 4: XPL, frame 3.3mm.

forested landscape (Fig SS4.38). The basal sample demonstrated the rather shallow depth of pedogenesis affecting the still partially bedded coarse and fine alluvium (SMF 16), as analysed in detail at undated tree-throw hole F62119 (SMF 11–13), while the central red soil area (SMF 14) and surrounding charcoal-rich (SMF 15) soils contain an excremental soil fabric probably relict of an acidophyle mesofauna (Table SS4.61). The soils here are therefore probably relict of a still-forested soil landscape (Babel 1975).

Distribution of phosphate and textural pedofeatures

Soil micromorphology identified textural features associated with the alluvial soils that bury Barrow 5 and the Turf Mound. Field

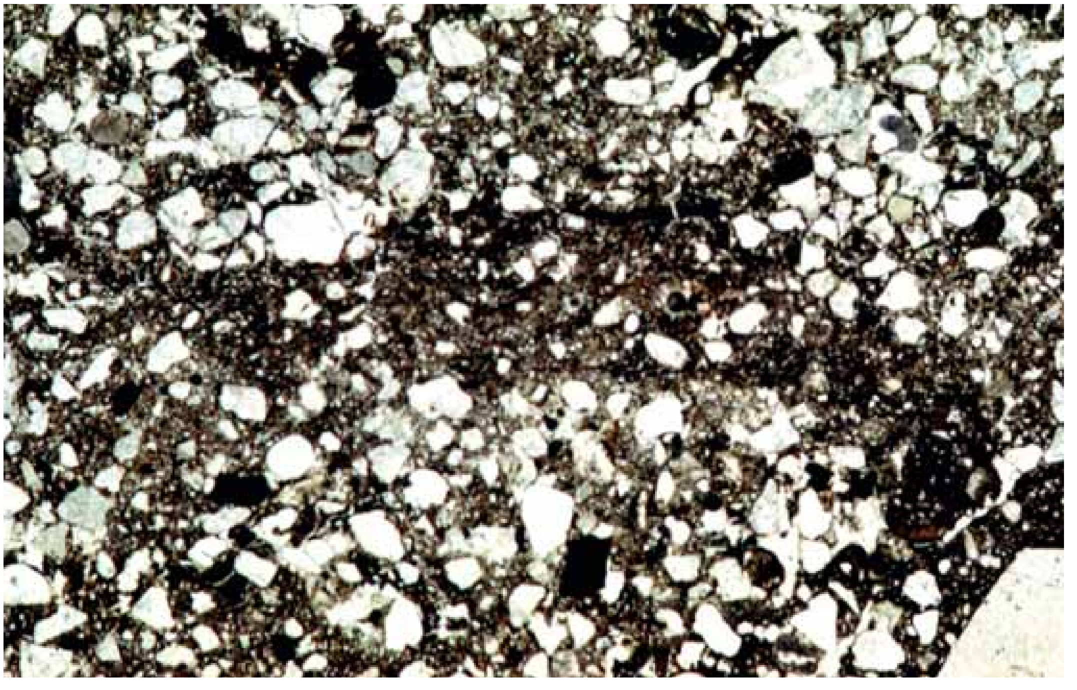


Figure SS4.73 Turf Mound: M40: bB; SMF4 – pan: PPL, frame 9mm.

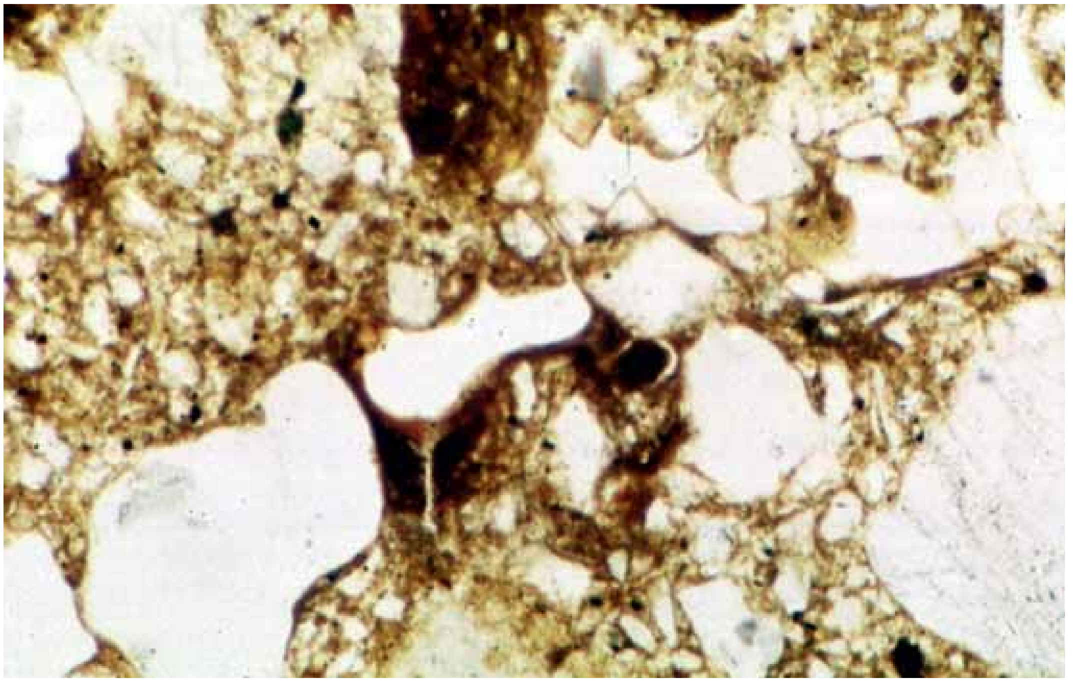


Figure SS4.74 Turf Mound: M40: bB; SMF4 – textural features: PPL, frame 3.3mm.

features of ridge and furrow, and a plough headland are evidence of cultivation. The bright yellowish clay textural features that are associated with the fine alluvium (M37; SMF1) and occur throughout the sampled profile in major pores, are linked to alluvial flooding and wet conditions, and the down-wash of clay (Tables SS4.61–62). Wet conditions and medieval ploughing also account for the pan-like textural features in these horizons (Jongerius 1970, 1983; Jongerius and Jager 1964). This activity, on the other hand, does not account for the high amount of dark red clay and pan-like textural features present in the mounds and upper buried soils, especially as the yellowish clay textural features present in coarse pores, are so easily differentiated.

Microprobe studies also demonstrate that these red clay textural features are preferentially rich in P compared to the soil matrix. There is an association between organic matter and clay movement, and organic matter is naturally present along with phosphate in clay coatings (McKeague 1985; Parfenova *et al* 1964). This is consistent with the findings from Raunds, which moreover show that a high proportion of the phosphate is in an organic form (eg P ratio 2.6). Data from the moder humus and Ah of the late Bronze Age/early Iron Age forest soil at Hengistbury Head and modern Wormley Wood, showing P ratios of >20 (Fig SS4.30). The dark colour of the dark red clay coatings is a likely result of their containing organic matter – 'forest humus' (as well as iron and manganese – see Table SS4.65; Fedoroff *et al* 1990; Parfenova *et al* 1964). The concentrations of clay, organic matter and phosphate in the Bt horizons relative to the underlying bC and overlying bB and bB2 horizons at Raunds, in the counted profiles at the Turf Mound and Barrow 5, support such a view (Tables SS4.59–65). The ancient topsoils are moderately humic (4.8% LOI) and phosphate-rich (Tables SS4.59 and SS4.66). Such amounts could simply relate to natural topsoil phosphate content, but forest humus at Raunds (fill of treethrow hole F62119) seems to contain less phosphate (290 ppm $P_2O_{5ignited}$) although more organic matter is present (cf 5.7% LOI; Table SS4.66; Figs SS4.30–31). At Hengistbury Head, a longer history (late Bronze Age/early Iron Age) of humus accumulation under oak produced high amounts of organic matter (3.1–21.1% LOI), but again less phosphate (100–330 ppm $P_2O_{5ignited}$) occurs than in the Raunds topsoils (Table SS4.66). Hengistbury Head is located on a different parent material (Tertiary sands) to Raunds, and so this finding has to be treated with caution. Nevertheless, at Hengistbury Head moder humus and amorphous organic matter must be considered the main source of this organic phosphate in such impoverished soils as podzols (Macphail 1992a; Macphail *et al* 2003). Similarly, at Wormley Wood and again on impoverished soils, the

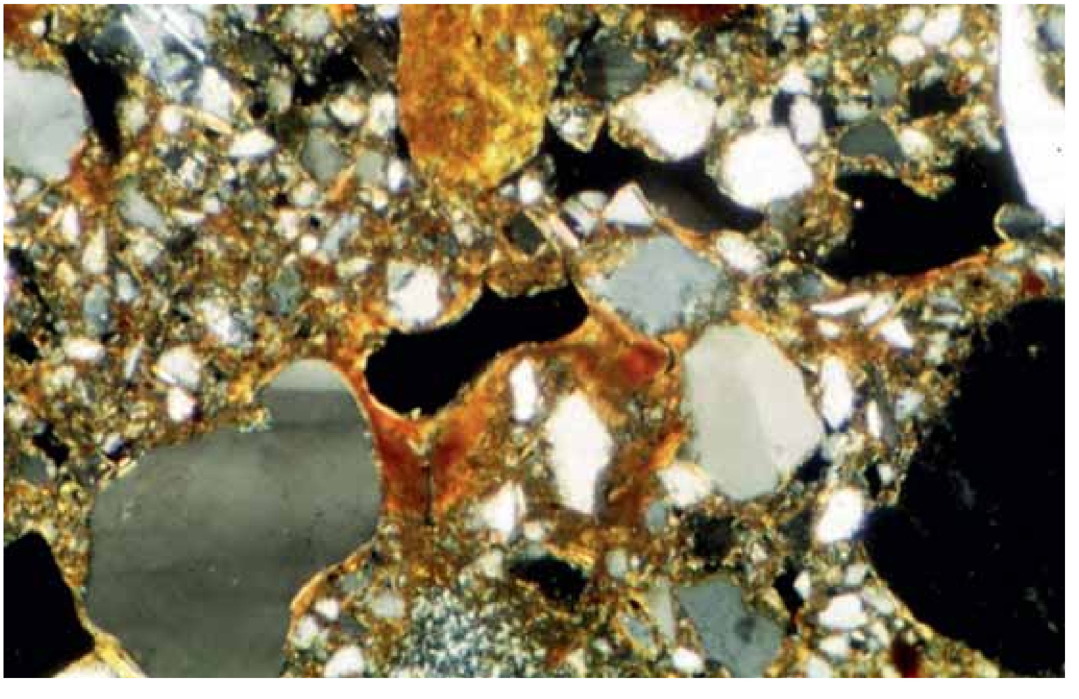


Figure SS4.75 Turf Mound: M40: bB; SMF4 – textural features: XPL, frame 3.3mm.

modern humic soil is rich in phosphate (680 ppm $P_2O_{5ignited}$, P ratio >20), compared to the aged and oxidised prehistoric buried topsoil that shows organic matter (2.6% LOI) and phosphate (330 ppm $P_2O_{5ignited}$, P ratio 6.5) levels more akin to those at Raunds. P ratios in the prehistoric topsoils at Raunds are also much lower (mean 2.9) than found at Hengistbury Head and modern Wormley Wood (>20). Finally, it can be noted that the accumulation of phosphate in the Neolithic and early Bronze Age soils is not due to concentrations of inorganic ash, bone and mineralised coprolites, as found in concentrated Neolithic dwelling areas such as in Mediterranean caves (Macphail *et al* 1997; Boschian 1997) or the open air late Bronze Age/early Iron Age sites of Potterne and

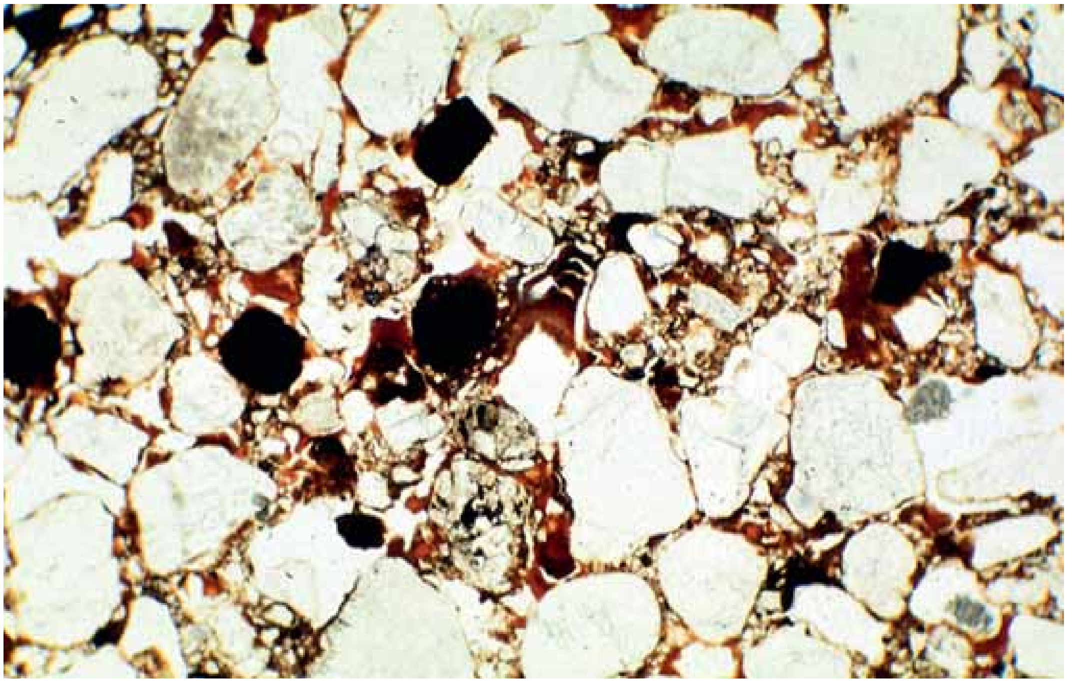


Figure SS4.76 Turf Mound: M41: bB't; SMF5; PPL, frame 3.3mm.

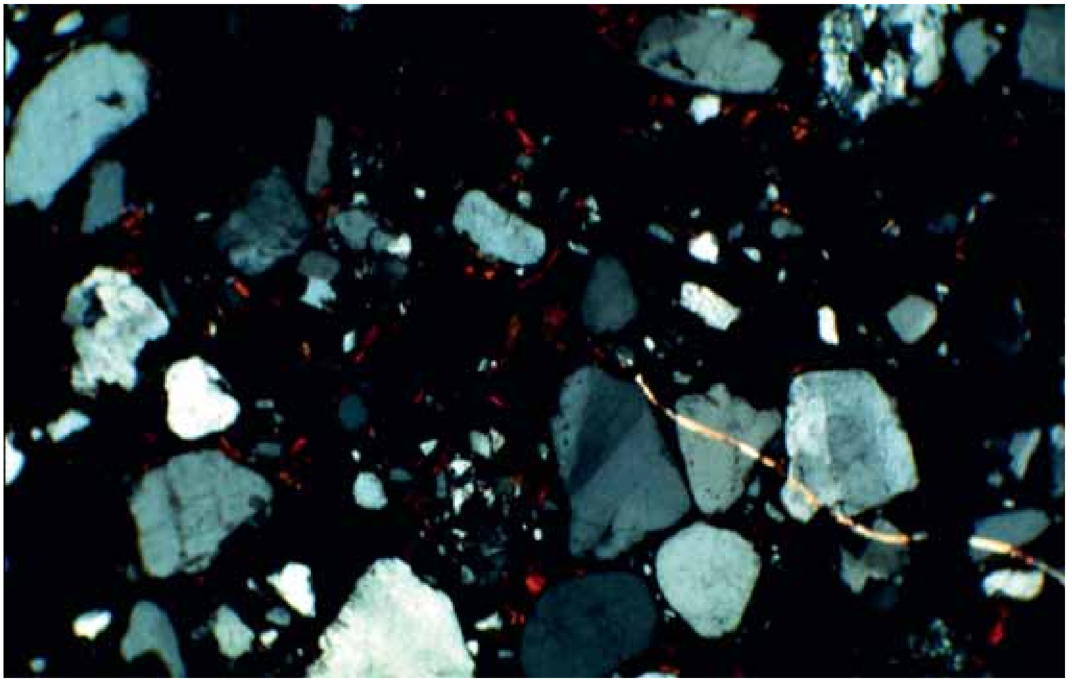


Figure SS4.77 Turf Mound: M41: bB't; SMF5; XPL, frame 3.3mm

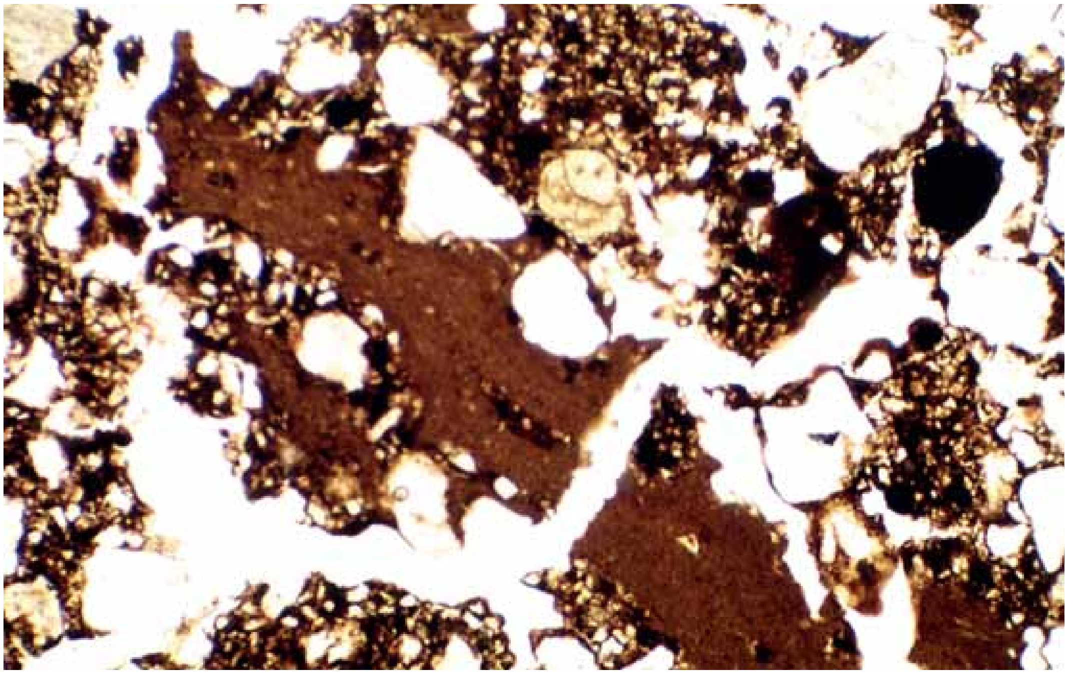


Figure SS4.78 Long Mound: M35; alluvium washed into the mound; PPL, frame 3.3mm.

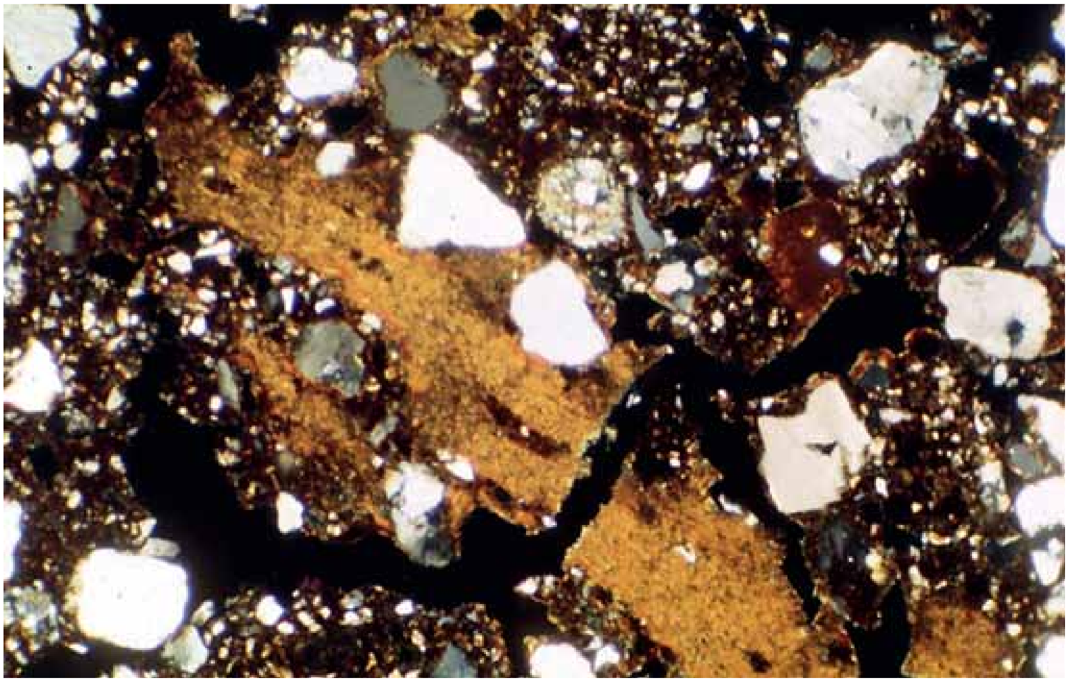


Figure SS4.79 Long Mound: M35; alluvium washed into the mound; XPL, frame 3.3mm.

Chisenbury, Wiltshire (Lawson, 2000). This is inferred from both the soil micromorphology and the enhanced P ratios at Raunds (3.0), and is consistent with soils that have received inputs of organic phosphate (Engelmark and Linderholm 1996). Thus, like the presence and amount of textural features in the Neolithic and Bronze topsoils, this accumulation of organic phosphate at Raunds needs explaining. A similar pattern is present at Eton and Hazleton, even though a scatter of bone is present at these early Neolithic occupation 'midden' sites (Macphail 1999b).

At Raunds, organic phosphate is probably both distributed in the amorphous organic matter of the Turf Mound material and, as has been argued, in textural features. It can be repeated that textural features within natural topsoils and Eb horizons, are anomalous. At the Turf Mound and at Barrow 5,

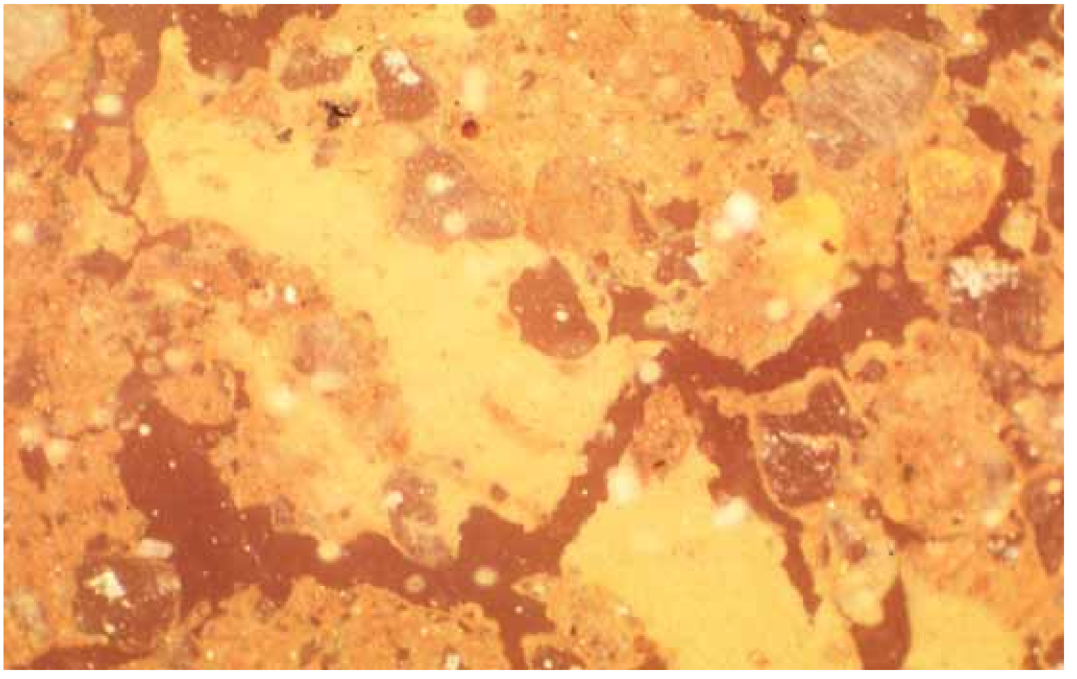


Figure SS4.80 Long Mound: M35; alluvium washed into the mound; OIL, frame 3.3mm.

the dark red clay textural features also have no relationship with the overlying alluvium, and as they occur away from the major pores (which can contain yellowish clay) these are not thought to be a result of mound construction. Further, the pan-like textural features that contain fine sand and silt, especially those in the buried A and Eb horizons, can only have resulted from very localised surface soil disturbance (Boiffin and Bresson 1987). The accumulation of dark red clay and associated pan-like textural features, concentrations of phosphate and moderately high P ratios, all have to be accounted for in the ancient topsoils and upper subsoils at Raunds. The fact that such textural features are absent from the earlier (Mesolithic) treethrow soils also argues for dark red clay and associated pan-like textural feature formation to be dated to the Neolithic and early Bronze Age.

Animal activity

Inputs of dung raise levels of soil phosphate and produce P ratios of >1.0 (Engelmark and Linderholm 1996). Various forms of soil mixing, compaction, structural collapse, and the formation of pan-like textural features and an associated closed vughy porosity, can all be a consequence of animal trampling that forms poached soils (Beckman and Smith 1974; Courty *et al* 1994; Kemp *et al* 1994; Macphail *et al* 1998b; Heathcote, 2002), the fine and medium loamy soils at Raunds (Shabbington soil series) having a designated slight to major modern day poaching risk from grazing animals (Jarvis *et al* 1984, table 40). It is suggested that the dark red clay coatings are so dark, because they relate to acid humus deposition – iron-bacterial precipitation giving them this black colour (Courty, pers comm; Table SS4.65). These textural features are finely laminated (originally organic bands) and display very fine cracking, indicative of organic matter breakdown under bacterial attack. It can also be considered from the review of manuring by Jongerius (1983, 120) that inputs of nitrogen and phosphate both increase biological activity in acidic topsoils and bring about the illuviation of humic substances into the upper subsoil. At the Turf Mound (SS4.8.2.3), it was suggested from the data that animal liquid waste, when passing through an acid humus turf, produced such dark red clay coatings. The same kind of coatings were found in an acid turf-built Iron Age dwelling in Denmark and where manured soils had high proportions of organic phosphate (Courty *et al* 1994; Nørnberg and Courty 1985). In addition, inferred animal activity at Romano-British Folly Lane, St Albans, apparently produced trampled turf, with finely laminated amorphous organic matter and phosphate, the last determined by microprobe analysis (Macphail *et al* 1998a). Lastly, overwintering of cattle at the experimental Moel-y-Gar roundhouse at Butser Ancient Farm, Hampshire, led to both the formation of a surface crust and the movement of phosphate down-profile, and this stained both chalk clasts and the calcareous soil (Macphail and Goldberg 1995; Macphail and Cruise 2001). A Bronze Age (*c* 1500 BC) trackway at Southern Sallerup, Skania, Sweden has been studied through soil micromorphology and chemistry. Here, not only are dark clay coatings very abundant but the soils are moderately humic (LOI mean 3.3%, range 2.1–4.9%, *n*=14) and highly phosphate-rich ($P_2O_{5ignited}$, mean 1040 ppm, range 450–2138 ppm). This seems clearly linked to animal concentrations with clay deposition, organic matter and phosphate, an inference at Raunds that is supported by the strongly significant correlations (99.9% level) of clay and Org C (r_s value 0.6779) and clay and P_{nitric} (r_s value

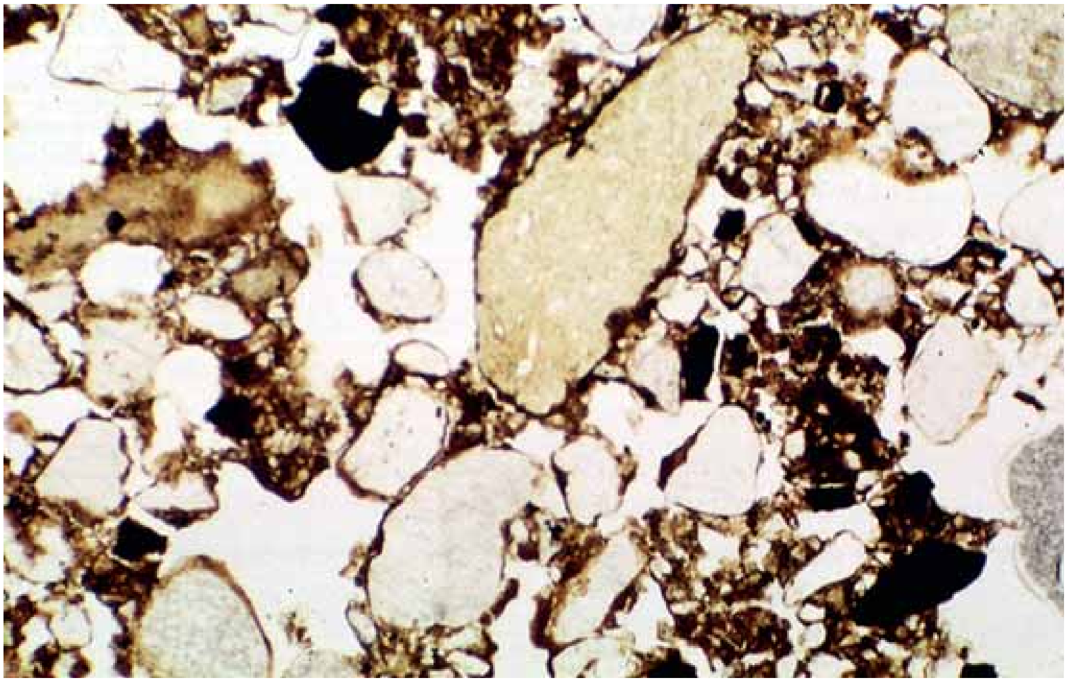


Figure SS4.81 Long Mound: M36; bB; textural features; PPL, frame 3.3mm.

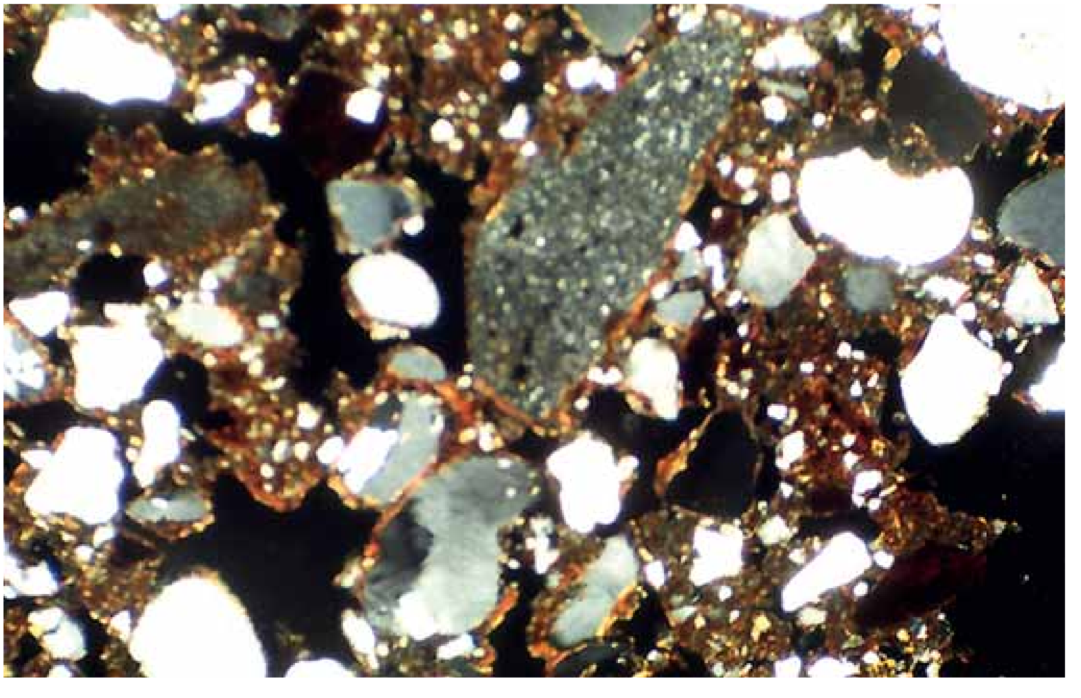


Figure SS4.82 Long Mound: M36; bB; textural features; XPL, frame 3.3mm.

0.9364), with clay and LOI being less significantly correlated (r_s value 0.7572, 95% level). As expected clay, P and organic matter are concentrated in the bBt horizons, but amounts of clay, P and organic matter are also higher in the ancient topsoils and mounds compared to the bB horizons. Red coloured clay is also concentrated in the ancient topsoils/mound and bBt horizons. These findings and the accepted literature on clay illuviation and the association of phosphate and domestic stock, all support the conjectural presence of domestic animals at Raunds (Parfenova *et al* 1964, Proudfoot 1976; Bethell and Mátè 1989).

At Raunds, there is evidence of all these processes, with in addition, the inclusion of 'foreign' soil clasts (as can be brought in on

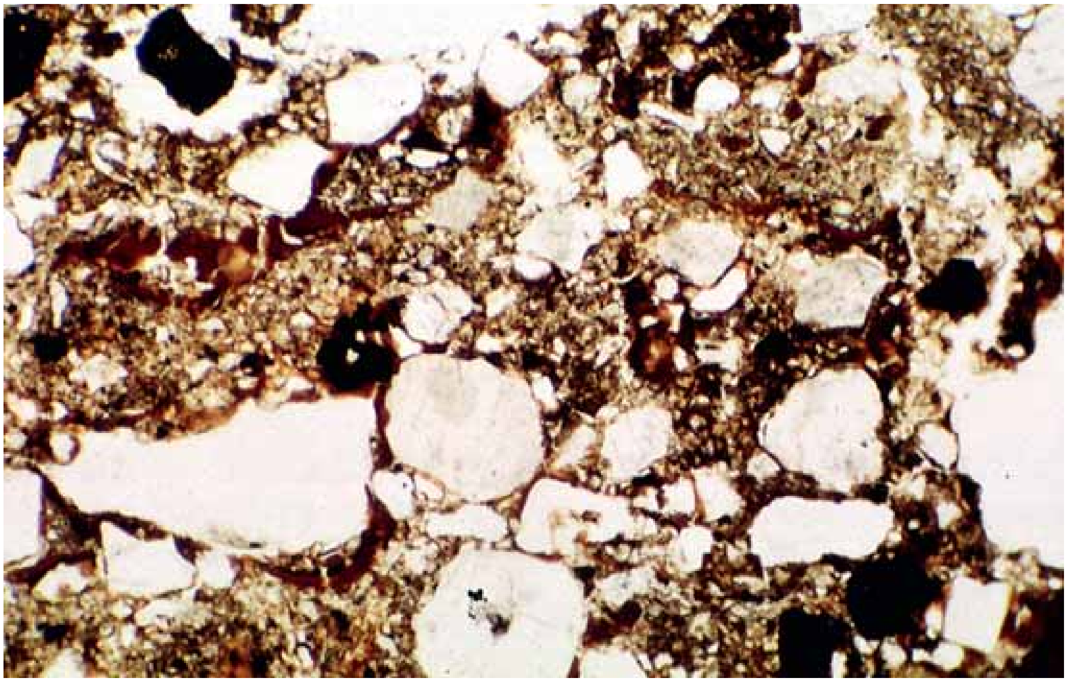


Figure SS4.83 Long Mound: M36; bB; dark reddish textural features; PPL, frame 1.3mm.

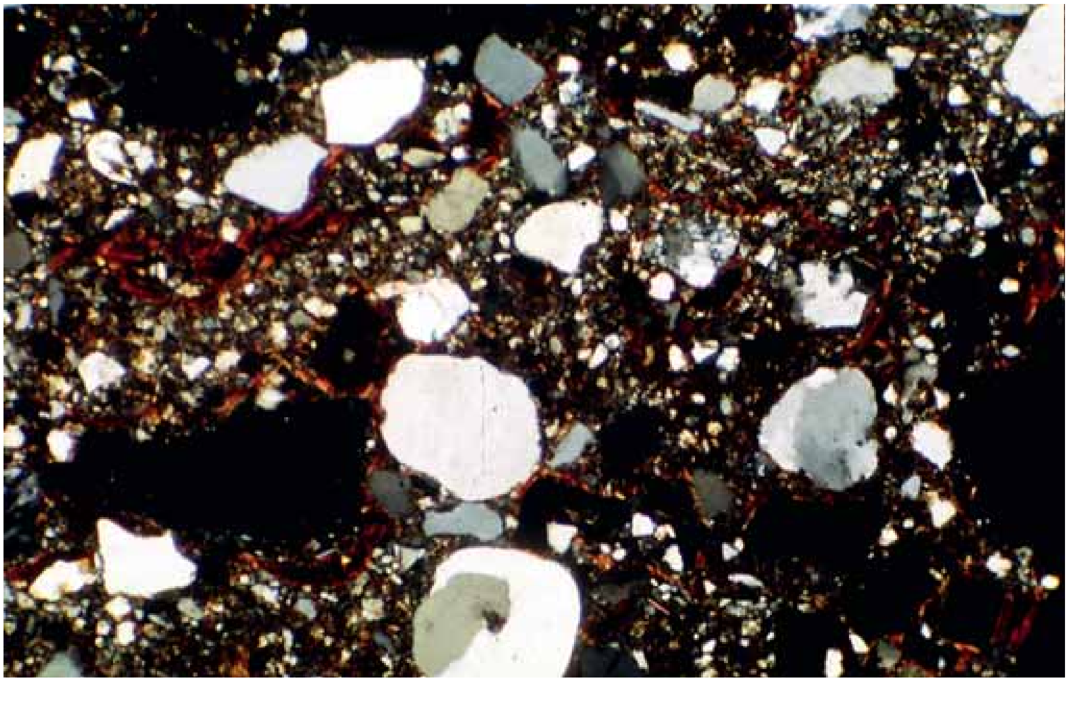


Figure SS4.84 Long Mound: M36; bB; dark reddish textural features; XPL, frame 1.3mm.

animal hooves) and earthworm burrowing, a biological activity encouraged by the presence of dung/manure (Jongerius 1983) and which eventually would work poached soils. The chemistry of a number of analogue sites is comparable (Figs SS4.30–31). Of these sites, dark coloured textural features indicative of surface soil disturbance occur at both Neolithic Hazleton, Gloucestershire (Argillic Brown Earth on Oolitic Limestone) and at early Iron Age Salford, Bedfordshire (Argillic Brown Earth on river terrace sands; Macphail 1990a; Macphail 1997). Another possible analogue is in Neolithic contexts (mean 7.4% LOI; 390 ppm $P_2O_{5ignited}$, P ratio 5.8, n=7) and Beaker ones (mean 5.6% LOI; 330 ppm $P_2O_{5ignited}$, P ratio 3.8, n=2) at Belle Tout, Sussex (Macphail in prep). These are mature decarbonated Rendzinas on chalk, and are representative of base-rich downland pasture soils (cf Overton Down and Butser Ancient Farm; Bell *et al* 1996; Macphail *et al* 2000). Links with ancient pasture and animal stocking have been inferred at all of these. Figures SS4.30–31 and the previous discussion show how ancient natural undisturbed forest soils (Hengistbury Head and Wormley Wood), at one end of the chemical spectrum, and intensive domestic occupation (Chisenbury and Potterne), at the other, are quite different chemically, the occupation soils at Easton Down having overall much higher amounts of P. On the basis of these findings and comparisons, it does not appear to be over-inventive to suggest that soils at Raunds were influenced by the management of large animals (mainly cattle; Campbell and Robinson 2007), as it has been demonstrated that keeping these animals leads to concentrated phosphate staining of the underlying soil (Macphail and Goldberg 1995; Macphail and Cruise 2001; Heathcote 2002). Moreover, the soil evidence for probable animal management at Raunds has already been mooted (Courty *et al* 1994; Macphail and Cruise, 2001). Independent evidence of animal management comes from, a) large numbers of cattle skulls at Barrow 1 (Davis and Payne 1993; Davis SS4.6.1), b) dung beetles at the Long Barrow and in early Bronze Age channel deposits (Robinson SS4.3) and c) inputs of dung (N and P) at the Long Barrow, inferred from the algae in the barrow ditch (Wiltshire SS4.2). The conversion of the forested landscape to a 'lightly grazed' pasture is also suggested from the presence of tubers of onion couch grass and Coleoptera (Campbell SS4.5; Robinson SS.4.3). At the Eton Rowing Lake Neolithic midden, the presence of domestic animals has been inferred from the relict presence of dark red clay coatings, a biologically homogenised dark soil and enhanced levels of organic phosphate (P ratio 2.1). This enhanced P ratio occurs despite the presence of inorganic phosphate in the form of fine bone and rare ash (Macphail 1999b). Here,

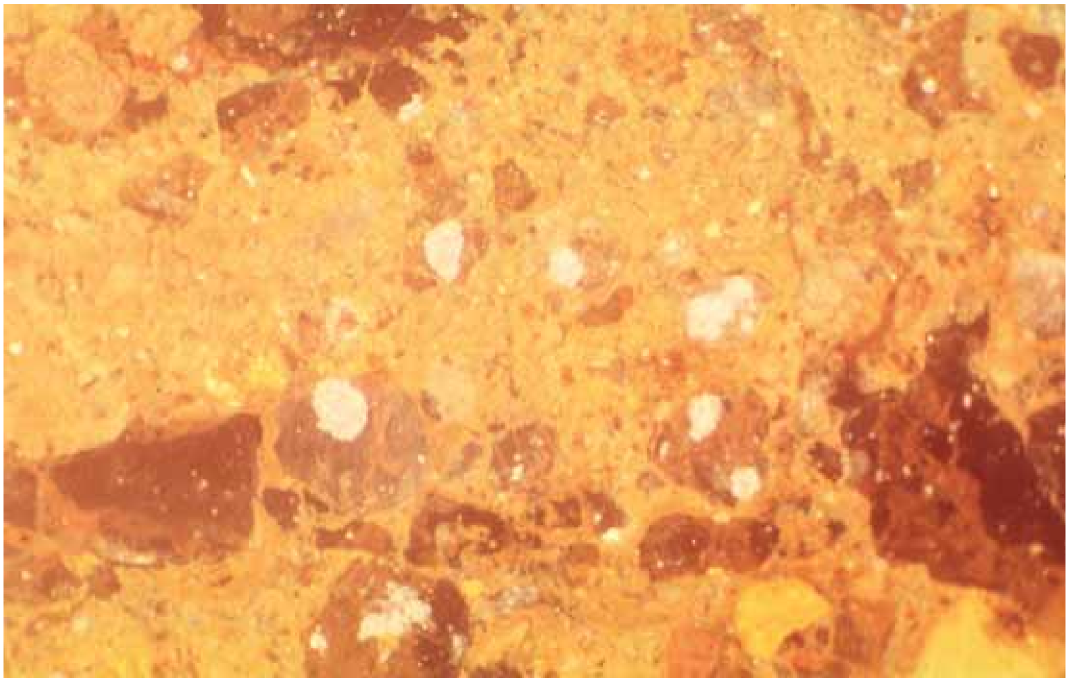


Figure SS4.85 Long Mound: M36; bB; dark reddish textural features; OIL, frame 1.3mm.

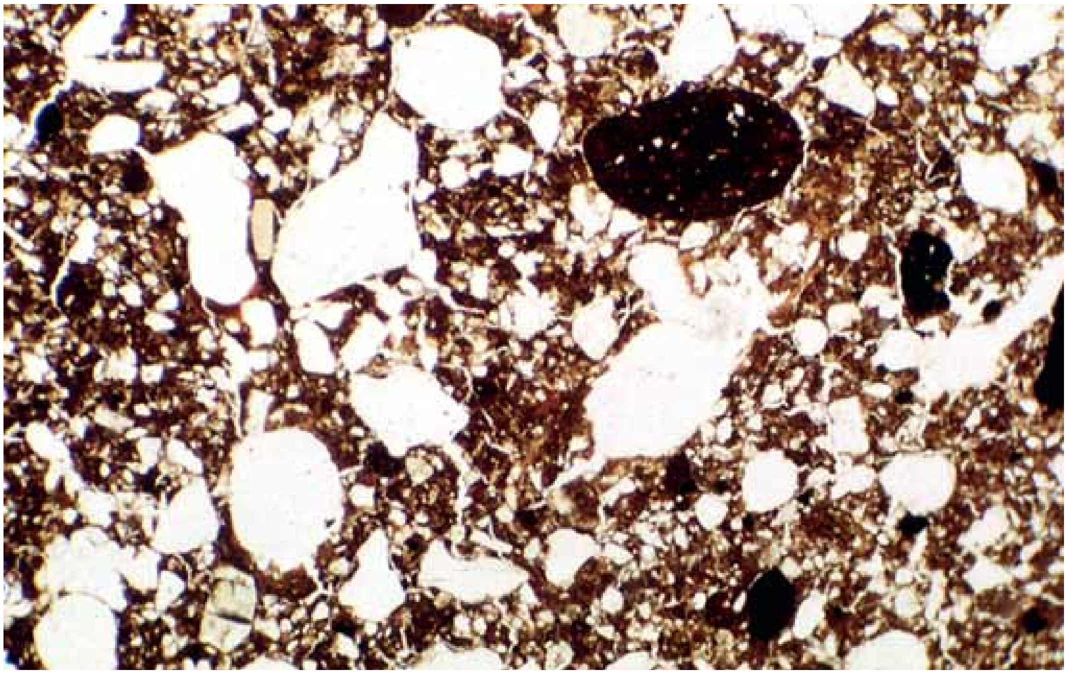


Figure SS4.86
Barrow 1:
M2: mound/bA:
SMF3 – textural features;
PPL, 3.3mm.

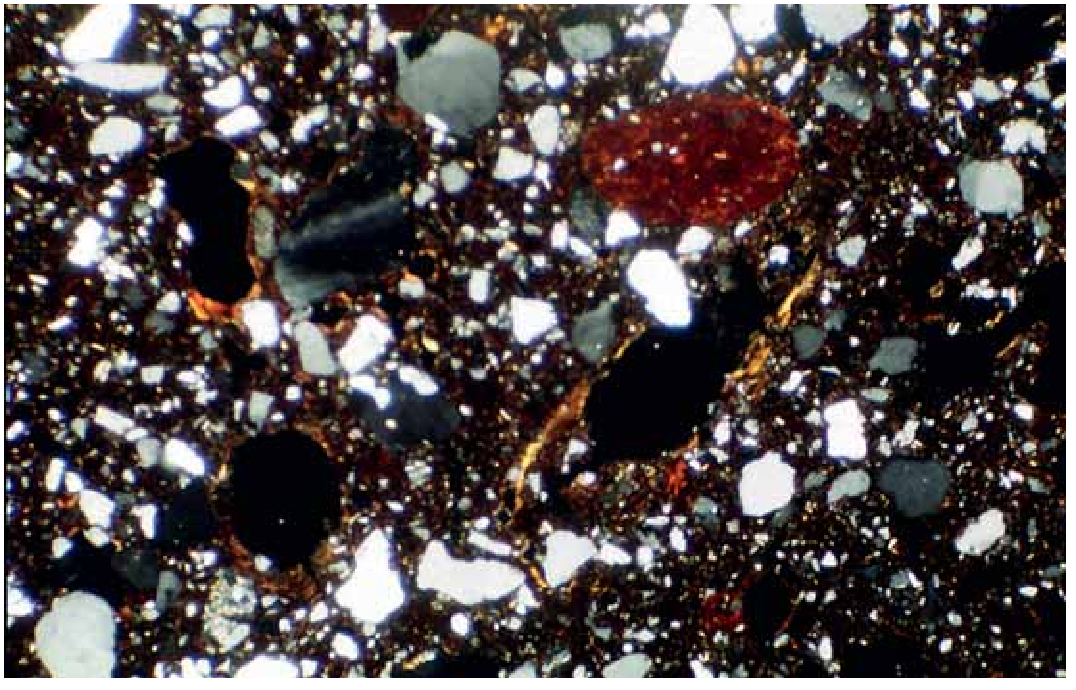


Figure SS4.87
Barrow 1:
M2: mound/bA:
SMF3 – textural features;
XPL, 3.3mm.

cattle husbandry is indicated by cattle bones and milk product residues (Allen in prep). It can also be suggested that the soil micromorphology and chemistry (Table SS4.66) of Hazleton could also indicate the concentrated presence of domestic animals (Macphail 1990a, Macphail in prep). Recent studies of the Neolithic midden at Tofts Ness, Orkney now reveal probable stabling activity, through relict fragments of organic byre floors and faecal spherulites (Simpson 1994; Simpson and Guttman unpub).

Arable cultivation

The above discussions have focused on the late Mesolithic and early Neolithic forest soils and evidence for Neolithic and early Bronze Age animal management. At Raunds, no field evidence of arable activity, such as ploughmarks, has been reported.

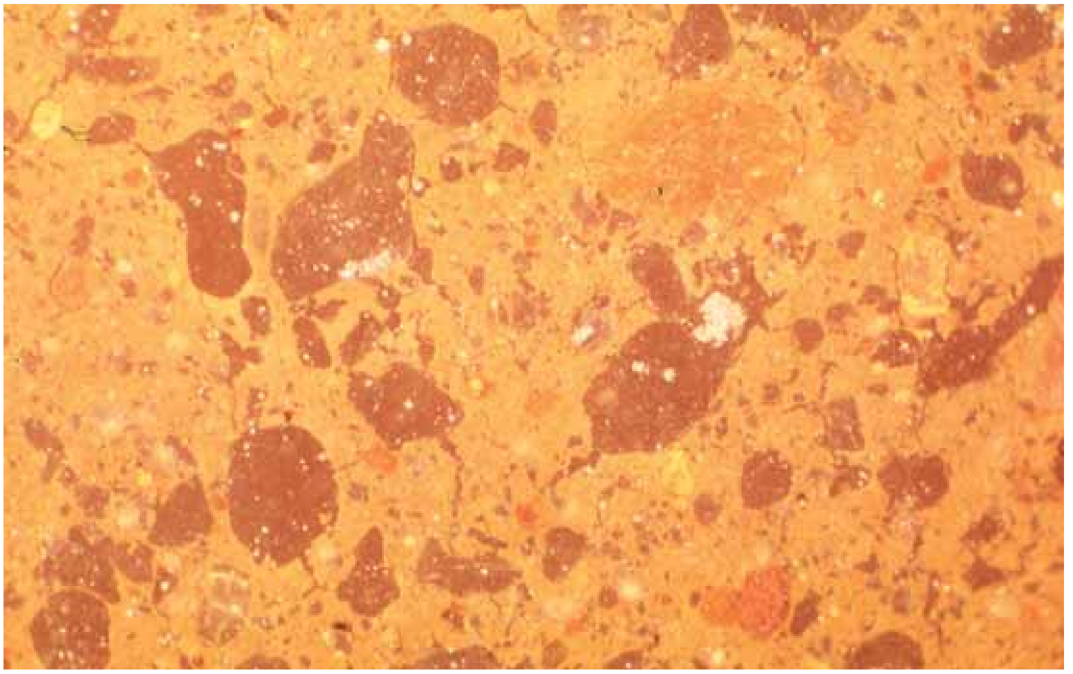


Figure SS4.88
Barrow 1:
M2: mound/bA:
SMF3 – textural features;
OIL, 3.3mm.

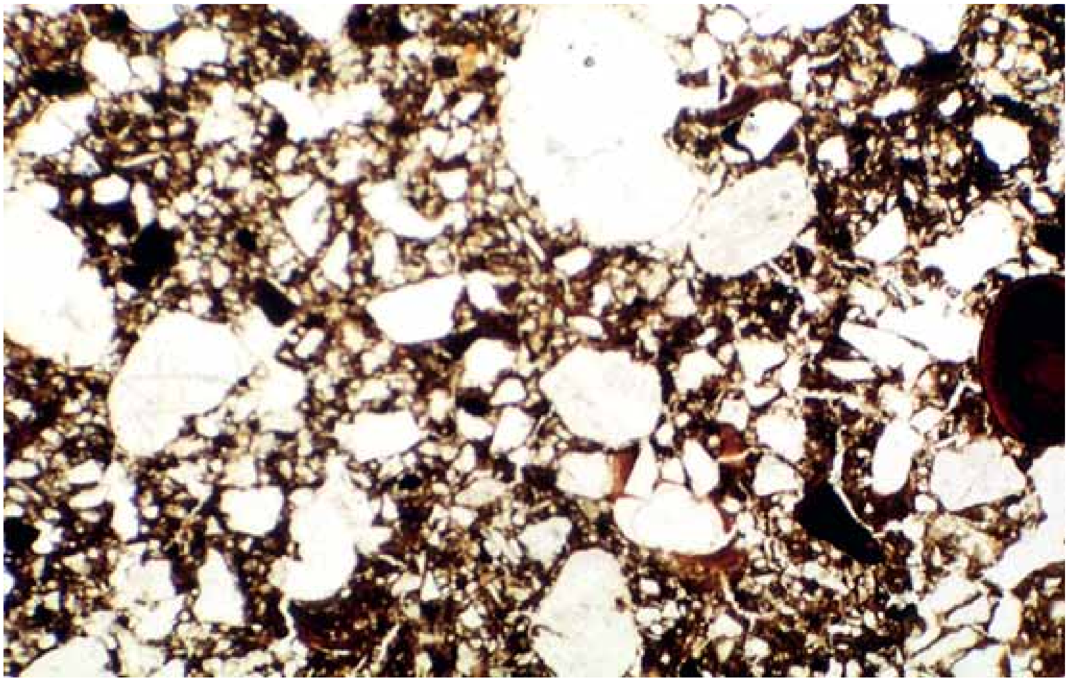


Figure SS4.89
Barrow 1:
M2: bB:
SMF3 – textural features;
PPL, 3.3mm.

Also it is well known that arable activity on its own can reduce the organic matter content and fertility of soils (Voroney *et al* 1981), while at Raunds the extant Neolithic and early Bronze Age topsoils had apparently accumulated both organic matter and phosphate. Prehistoric tillage, on the other hand, can produce textural features and accumulations of textural features down-profile, but dark red, humus and phosphate-rich clay coatings have not been reported from such sites (Macphail *et al* 1990; Romans and Robertson 1983c). On the other hand, clay, especially dusty clay, can be mobilised by tillage. At the comparable landscape site of Etton/Maxey, Cambridgeshire, the presence of dusty clay was employed to identify soil disturbance and infer a probably short history of cultivation (French 1998). At Raunds, the presence of dusty clay in sub-

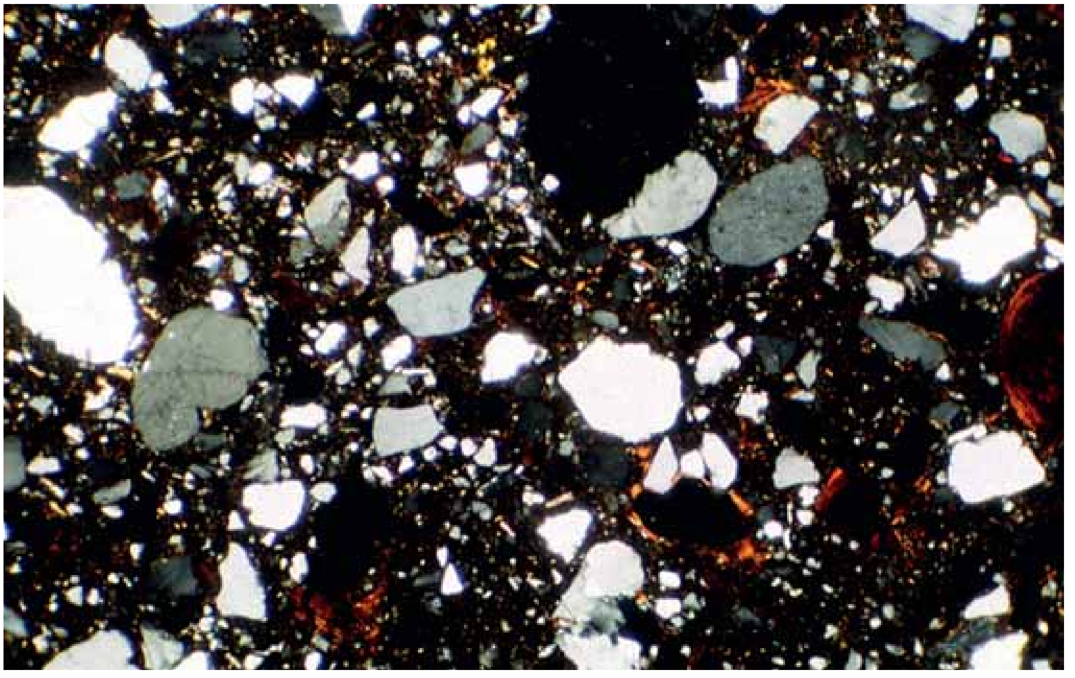


Figure SS4.90
Barrow 1:
M2: bB:
SMF3 – textural features;
XPL, 3.3mm.

soil bBt horizons at the Turf Mound and Barrow 5 (Tables SS4.62–SS4.63), and at the site of Barrow 6, supports the possibility that some arable cultivation was carried out. Pollen and macrofossil data do not indicate cultivation during the Neolithic or early Bronze Age, the periods covered by this soil study, although there is some support for cultivation in the late Bronze Age. As only the bottom 0.30–0.40m of the treethrow holes are preserved, it is not known whether their upper parts were infilled by colluvial soil derived from later prehistoric cultivation (as at Balksbury Camp, Hampshire; Macphail and Goldberg 1990), except that the preserved fills do not seem to record this. It also has to be remembered that treethrow holes only remain open for around 500 years in woodland conditions (Stephens 1956) and that the uppermost 0.40m of the prehistoric soil was transformed into topsoil by later prehistoric and early historic landuse prior to alluviation.

The earlier Holocene landscape: treethrow holes and the Avenue

Treethrow holes at Raunds range in date from 5300 to 3340 cal BC (SS6). Such features, their natural and implied anthropogenic origin, associated artefacts and wood charcoal content, have been the subject of study across Europe and the USA (A Barclay *et al* 2003; Crombé 1993; Langohr 1993; Macphail and Goldberg 1990; Newell 1980; Goldberg pers comm 1998). These features have been modelled (A Barclay *et al* 2003; Langohr 1993; Macphail 1992b), and probably at Raunds relate to Langohr's type *c* (Langohr 1993, fig 1), and probably represent complete tree fall of a deeply-rooted healthy tree on flat ground. Treethrow produces a 'pit (hole) and mound' microtopgraphy (Langohr 1993; Peterken 1996; Stephens 1956), and such a topography has to be imagined for the fifth to early fourth millennium landscape, even though this is no longer visible at Raunds.

Treethrow features are common at Raunds. Thirty-five, for example, were counted in one 30 x 22 metre trench, consistent with modern studies of natural woodland (Peterken 1996). Similar numbers of treethrow holes were noted under Thames alluvium at Drayton Cursus, Oxfordshire, and these were dated to two main periods, Neolithic and Beaker (A Barclay *et al* 2003; Lambrick 1992).

The treethrow holes examined at Raunds seem to date to several periods in prehistory, late Mesolithic/early Neolithic (eg treethrow hole F62123) and middle Neolithic (eg treethrow hole F62113), with palaeomagnetic dating linking some burning of trees to the early Bronze Age (SS6). On pedological grounds, treehole F62119 may be inferred to have formed before the major forest clearances of the early Bronze Age and the development of an open grassland (Tables SS4.61 and SS4.64; SS3–SS5). A probable major burnt surface post-dated the Southern

Enclosure, an undated but probably pre-middle Bronze Age monument. Large areas of red and burnt soil in Neolithic contexts on areas of Danish drift sand have been interpreted as bonfire sites produced during major clearance episodes (Mikkelsen and Langohr in prep).

Treethrow holes F62123 and F62119 contain deep dark soil infills, that may well have been quite organic (Table SS4.60, samples 36, 37, 41–45), and this suggests that they may have been open for a long time, allowing the accumulation of organic matter-rich soil infills (Langohr 1993; Macphail and Goldberg 1990). Treethrow hole F62123, may have been used as a flint working site. If the hollow was left to fill naturally, and as noted above this could have taken some 500 years (Stephens 1956), any burnt soil would have been exposed to weathering and biological activity for a long time, leading to its break up. On the other hand, if trees were systematically killed by ring barking (Robinson 1992a), and burnt *in situ*, and the holes rapidly infilled purposefully, this would allow large fragments of burnt soil to persist. At any event, burnt soil in treethrow hole F62123 has, on the evidence of the radiocarbon dates (Table SS4.57), apparently had some 500 years longer to weather compared with treethrow hole F62113, for example.

The Mesolithic soil landscape can be envisaged as one dominated by a dense growth of large trees (oak and lime, Campbell and Robinson 2007, with natural gaps formed by numerous windthrow holes and mounds (Peterken 1996; Tansley 1939). Treethrow holes are more than 0.5m deep and 2.5–3.0m across, and newly fallen trees are likely to have root plates (mounds) of upcast soil and roots standing up to 3.0 metres in height. Peterken (1996, fig 5.1) notes wads of roots and soil from upcast tree boles being as high as 6m in present day Oregon, USA. Tree saplings and tree suckers would have grown on rotting wood and newly upcast soil. Such a landscape would have been accessible only to hunter-gatherers and game, and little accessible to domestic animals of developing Neolithic cultures.

It is possible that wind-thrown trees were burnt *in situ* to help maintain gaps in this woodland. The 'cutting' of this fallen timber by controlled fires and burning out of tree stumps to prevent tree regeneration could have been some of the mechanisms leading to the burnt soil found in these treethrow holes (Stewart 1995, 37). Archaeological evidence shows that these gaps were utilised in the late fifth and early fourth millennium for ephemeral occupation (as at treethrow hole F62123), probably to encourage browsing by game, and also possibly to gain easier access to woodland resources, such as leaf fodder for domesticated animals (Evans 1975; Kirby and Watkins 1998; Langohr 1993). This slow form of clearance, composed of

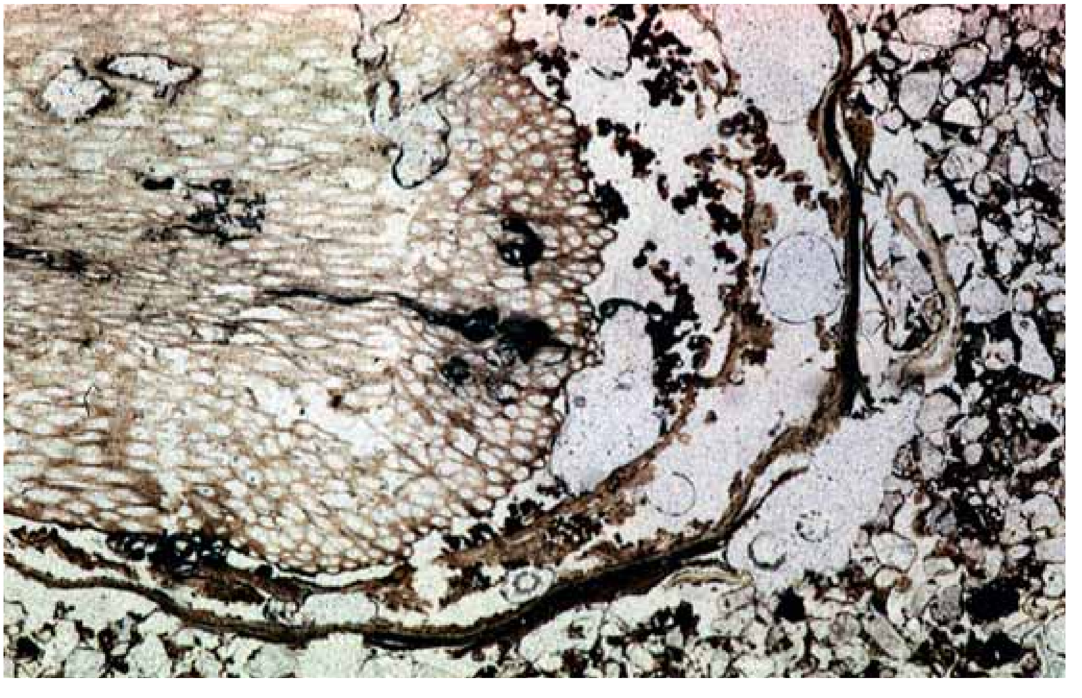


Figure SS4.91 Barrow 3: M5: bAg&Bg1; root/rhyzome; PPL, frame 9mm.

the burning of *in situ* wind-thrown trees and the maintenance of open areas, would have allowed treethrow holes to stay open for a long time. The use of leaf fodder has been recorded for the Neolithic in, for example, both Switzerland and Italy, and for Europe as a whole right up until present times (Troels-Smith 1984; Boschian 1997; Kirby and Watkins 1998; Macphail *et al* 1997; Robinson and Rasmussen 1989). The probable consequence of practices such as leaf foddering, would eventually have been smaller trees, and possibly smaller (1.5m) treethrow holes (Table SS4.69; Kirby and Watkins 1998). Further, the probable herding of herbivores, as discussed above, put increased pressure on woodland, inhibiting its regeneration. An overall impoverishment of the vegetation and the development of grassland cover are recorded for the Neolithic (see below and Etton/Maxey; Pryor 1998a). These vegetation changes would have encouraged soil deterioration, in the form of increased acidification as observed in the buried soils (eg the Long Mound; Dimbleby 1962; Duchaufour 1982). These treethrow holes were later affected by waterlogging linked to a rise in base levels and eventual medieval alluviation across the site, as found across the Midlands (Robinson 1992a).

The Neolithic

The opening up of the woodland, probably begun in the Mesolithic, increased in intensity during the Neolithic with the resulting formation of grasslands and an acidifying soil by the early Bronze Age (Table SS4.69). There is also clearance/treethrow evidence, in the form of subsoil fragments indicative of soil profile disruption, at the Long Mound, while the Long Barrow appears to be situated on a strongly eroded (and colluviated) gravel island. At the Avenue a series of enigmatic features are present, which superficially appeared to be treethrow holes. Their morphology of a central red burnt area surrounded by a charcoal-rich soil zone (Fig SS4.38), is atypical of treethrow holes at Raunds and elsewhere (see above) but could, on the other hand, represent a series of fires to clear individual trees (Courty *et al* 1989).

The ubiquity of fine charcoal in the Long Mound and its buried topsoils is also indicative of vegetation management by fire. The last appears to be contemporary with the grassland Mull-like Moder topsoils that were used to construct the Long Mound (and

Table SS4.69. Landscape and landuse stages (1–9), based on soil data

Cal BC	*Full-size stands of oak and lime woodland; increasing impact of Mesolithic/early Neolithic people; opening up of woodland for game and domestic animals – leaf hay foddering (?).*		*More intensive Neolithic occupation; browsing by stock and leaf hay foddering (?) leads to increasing soil acidity; clearance; no soil or other environmental evidence of cultivation.*		*Neolithic clearance, herding and soil erosion (eg Long Barrow), and stock concentrations (e g Long Mound); use of fire and grazing develop and maintain grasslands; no direct soil or other environmental evidence of cultivation.*	*Intensive early Bronze Age activity with possible secondary clearance cultivation (eg, Barrow 6), stock concentrations (Barrow 1, Barrow 5) causing colluviation (Barrow 4) and poached topsoils in low ground (Barrow 3).[Rare finds of cereal charcoal].*
2300–1500					9. As 7. Probable dung/phytolith-rich deposits and possible cattle hoof print.	
3300–2300	No soil evidence				8. Lull in ritual activity, minor woodland regeneration	
4000–3300	4. Continued clay (and iron) translocation and Bt horizon formation; initial acidification of Ah and leached Eb horizon.		5. Continued treethrow hole formation; strong argillic Bt development through treethrow soil turbation; *in situ* burning of wood and rubification of soil.	6. Probable rapid infilling of hole; preservation of large charcoal and rubified soil, the last with high MS attained by burning of iron and clay enriched Bt soil.	7. Transformation of acid forest Moder to grassland Moder-like Mull and anomalous accumulation of, a) textural features in topsoils and Eb horizon, b) more P in textural features in upper soils than in subsoil Bt, c) more P in topsoils compared to forest soils, d) 'foreign' soil clasts in upper soils, and e) statistical correlation between P and organic matter. Fine charcoal and burnt soil fragments present.	
5000–4000	2. Banana-shaped treethrow holes (2.50–3m across); strong 'argillic Bt formation' in fills through treethrow soil turbation; *in situ* burning of wood and baking (rubification) of soil.	3. Hole open a long time; accumulation of humus and break up of charcoal and burnt soil by biological activity.				
>5000 BC	1. Weathering of alluvium; weak clay translocation – B(t).					

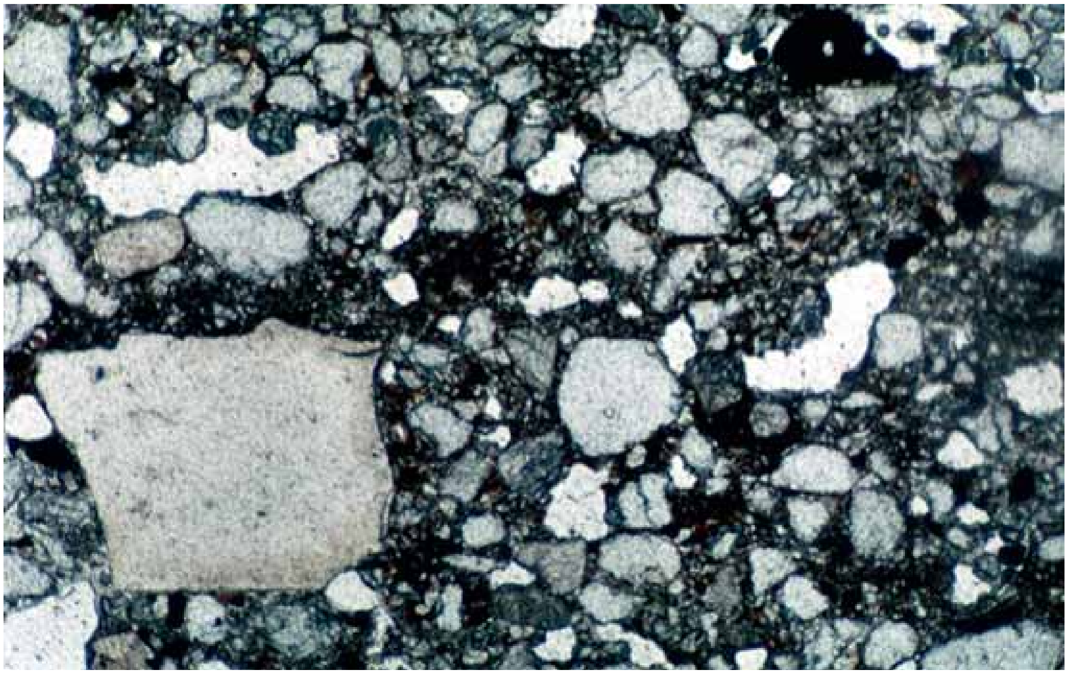


Figure SS4.92 Barrow 5: M9: bB; SMF3, 4 – capping/pan; PPL, frame 5.5mm.

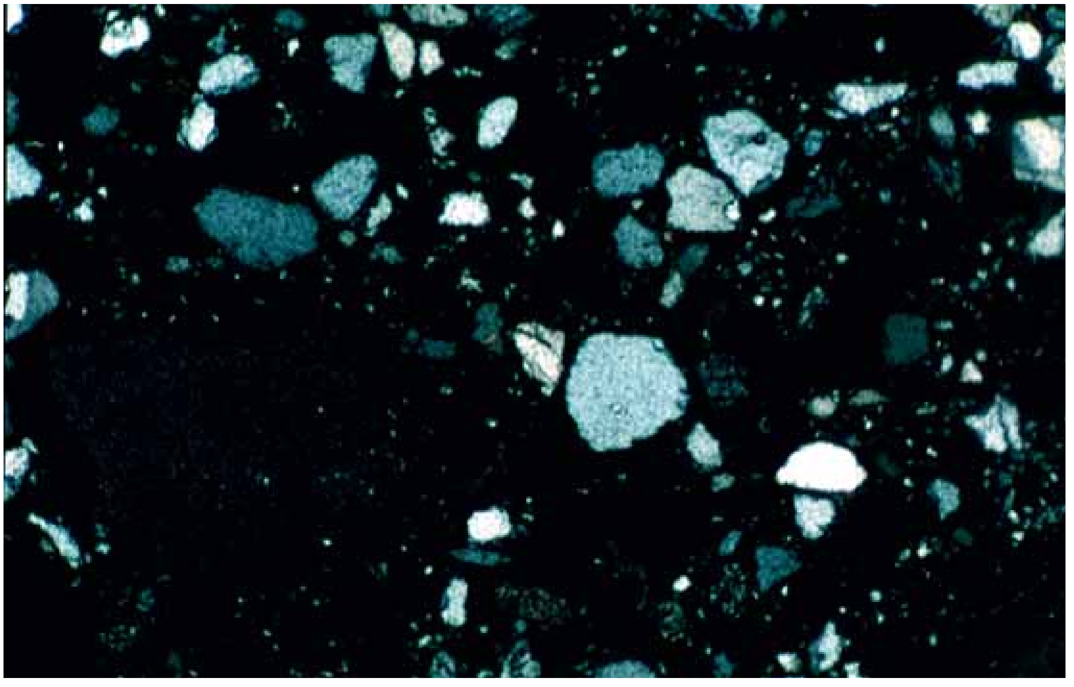


Figure SS4.93 Barrow 5: M9: bB; SMF3, 4 – capping/pan; XPL, frame 5.5mm.

later the south end of the Turf Mound). As discussed in detail earlier, the best explanation for anomalous amounts of textural features and organic phosphate in the Neolithic topsoils is to envisage a landscape employed, at least locally, for animal herding (Table SS4.69). Soil micromorphological and chemical data additionally allow the inference that the Long Mound and later the Turf Mound sites were probably areas of stock concentration. At the Long Barrow the presence of animals is probably recorded in the soil through phosphate accumulation, although the textural features data is more equivocal than on the site of the Long Mound to the north during the early fourth millennium BC (SS4.8.1). Nevertheless, the presence of dung beetles and nutrient enrichment of the ditch fills at the Long Barrow support the theory that grazing

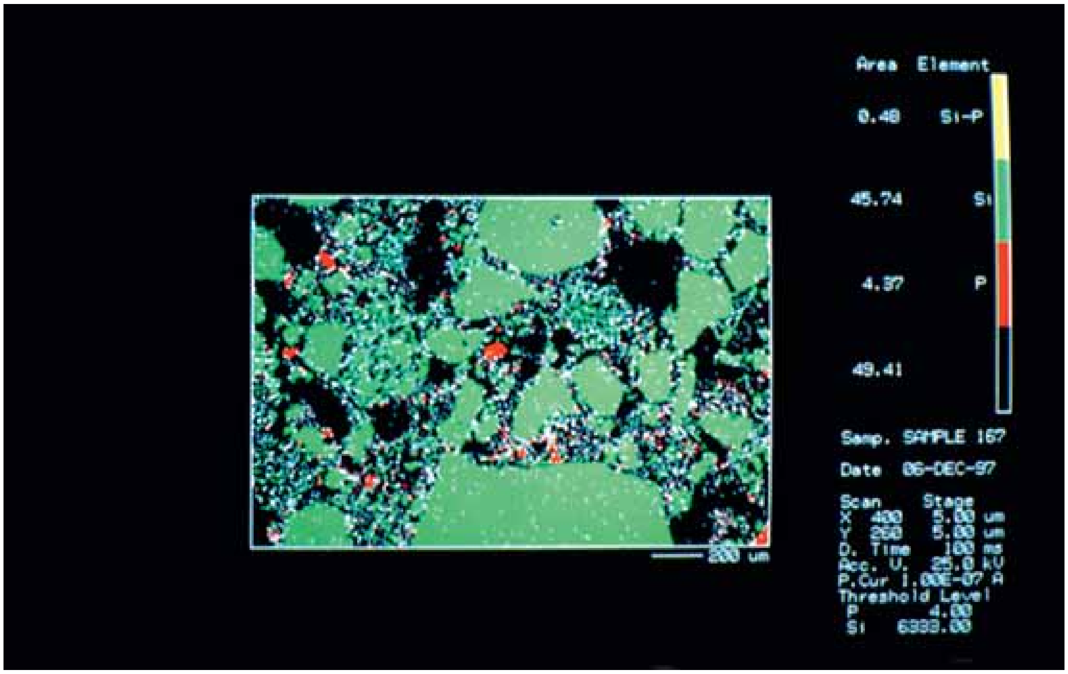


Figure SS4.94
Barrow 5:
M9: bB; SMF3,
4 – capping/pan;
Microprobe elemental map,
Si/P.

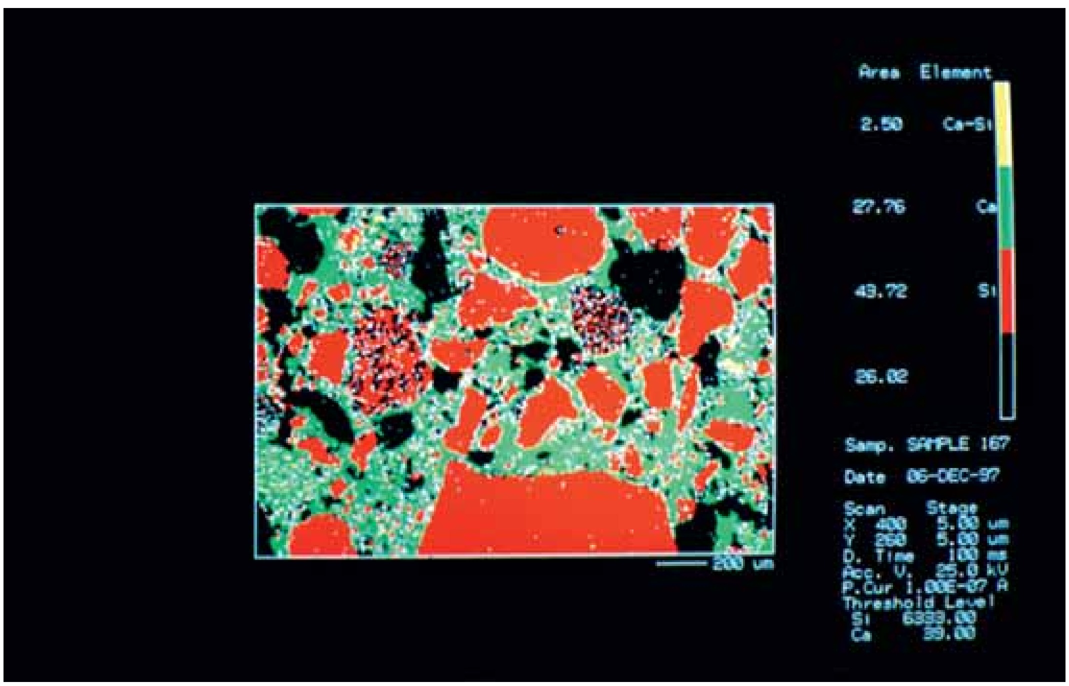


Figure SS4.95
Barrow 5:
M9: bB; SMF3,
4 – capping/pan;
Microprobe elemental map,
Si/Ca.

animals were present (Robinson SS4.3, Wiltshire SS4.2).

There is evidence that Neolithic activities such as the construction of Drayton Cursus, Oxfordshire, were coeval with the utilisation of gaps in the woodland formed by tree-throw, and the *in situ* burning of these (A Barclay *et al* 2003; Lambrick 1992). Drayton occupies exactly the same alluvial valley landscape position as Raunds, and a similar vegetation cover can be envisaged. The soils of two other comparable Neolithic river valley sites have been scrutinised, namely Bury Farm, Bedfordshire on the Great Ouse, and Eton Rowing Lake, on the Thames. Both feature dark red-coloured textural features and probably enhanced quantities of organic phosphate, which again are interpreted as evidence of animal herding (Table SS4.66; Macphail *et al* 2000). The Eton soil is

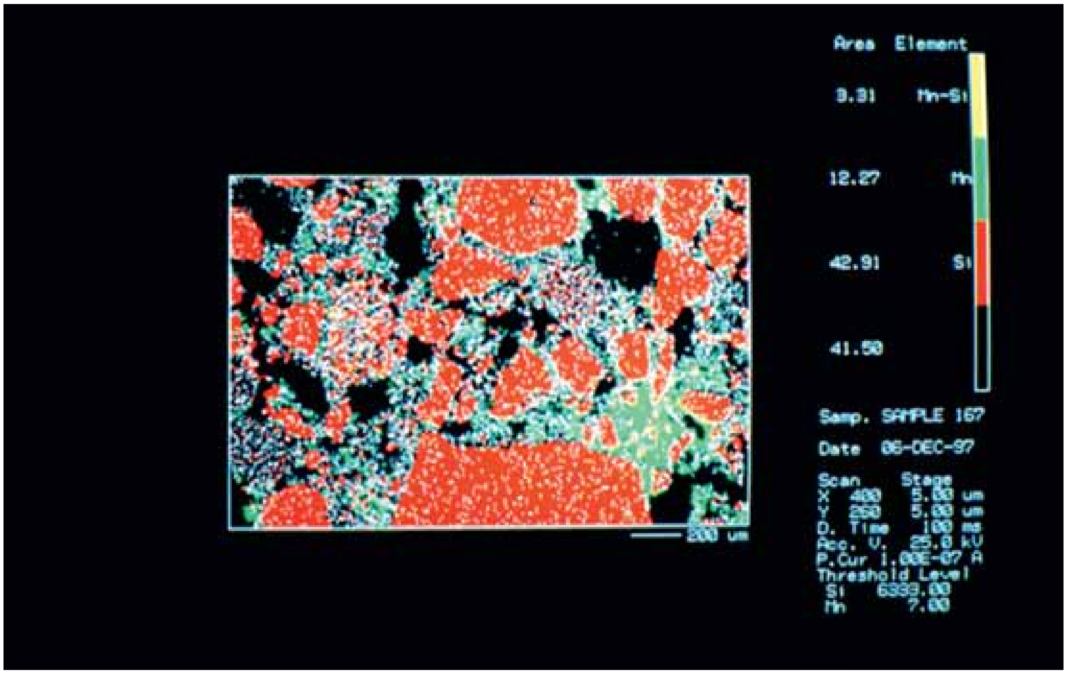


Figure SS4.96
Barrow 5:
M9: bB; SMF3,
4 – capping/pan;
Microprobe elemental map,
Si/Mn.

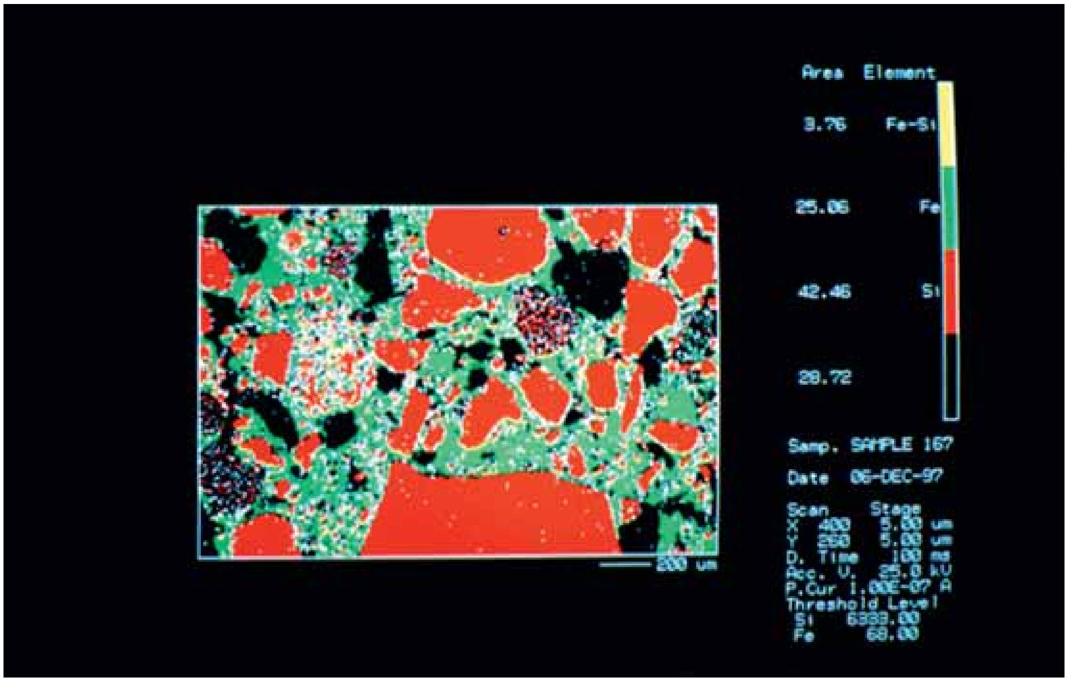


Figure SS4.97
Barrow 5:
M9: bB; SMF3,
4 – capping/pan;
Microprobe elemental map,
Si/Fe.

termed a 'Neolithic' midden, but the phosphate chemistry shows that organic phosphate is dominant in spite of the presence of fine bone and rare ash (Table SS4.66; Macphail 1999b). The Neolithic soils at Hazleton, Gloucestershire contain evidence of shifting occupation and although they were described by this present author as cultivated, it now seems likely that they may also have been additionally affected by the presence of herded animals, which led to a concentration of organic phosphate and dark clay textural features (Macphail 1990a). The Hazleton 'midden' also contained bone of domesticated animals in this small clearance site (Saville 1990). Soil studies on the more base-rich downland turf chalk soils (eg Easton Down and Windmill Hill in Wiltshire and Belle Tout in Sussex) show that textural feature evidence of animal herding is absent,

Figure SS4.98 Barrow 5: M9: bB; SMF3, 4 – textural features/ microprobe studies, PPL, frame 3.3mm.

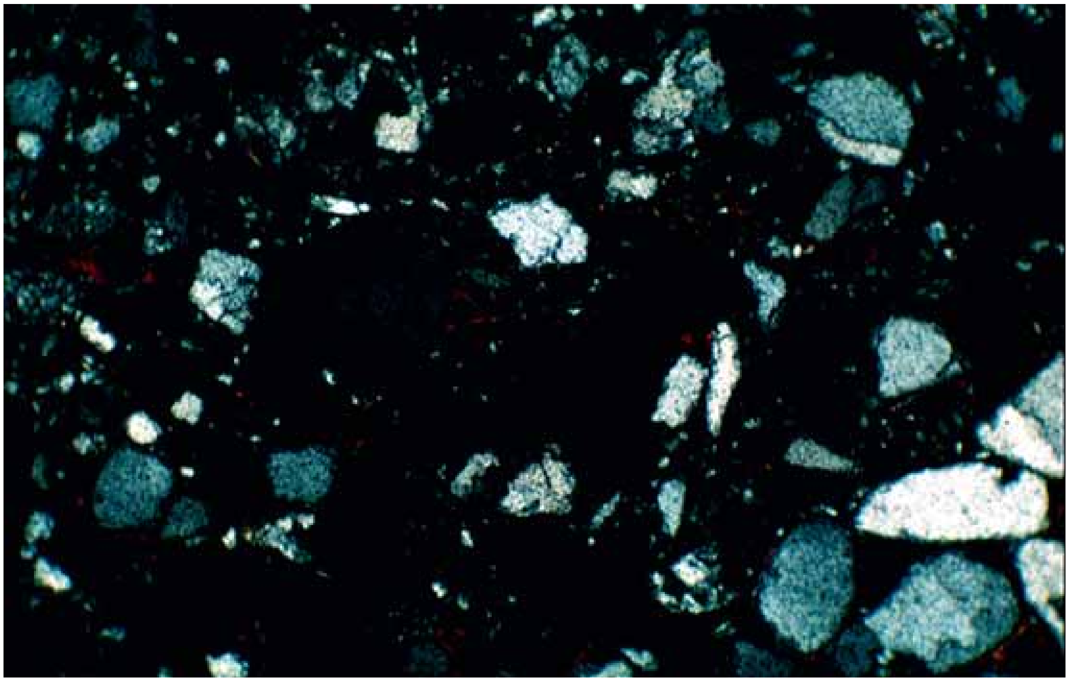


Figure SS4.99 Barrow 5: M9: bB; SMF3, 4 – textural features/ microprobe studies, XPL, frame 3.3mm.

even whilst bone data and enclosure features are indicative of animal management (Whittle *et al* 1999; Whittle *et al* 1993). This finding is consistent with examinations of reference thin sections of chalkland pasture turf soils from Butser Ancient Farm, Hampshire, which also show no textural feature formation, but a typical biologically active turf. On the other hand, while there is, for example, soil micromorphological, chemical and mineral magnetic evidence of camp fire occupation at Easton Down and Windmill Hill, pasture soils at Butser and Belle Tout are characterised by apparent concentrations of organic phosphate (Table SS4.66, Figs SS4.30–31; Crowther *et al* 1996; Whittle *et al* 1999). Examples of probably cultivated Neolithic soils have been investigated from Scotland to southern England, including those from a comparable landscape at Etton/Maxey

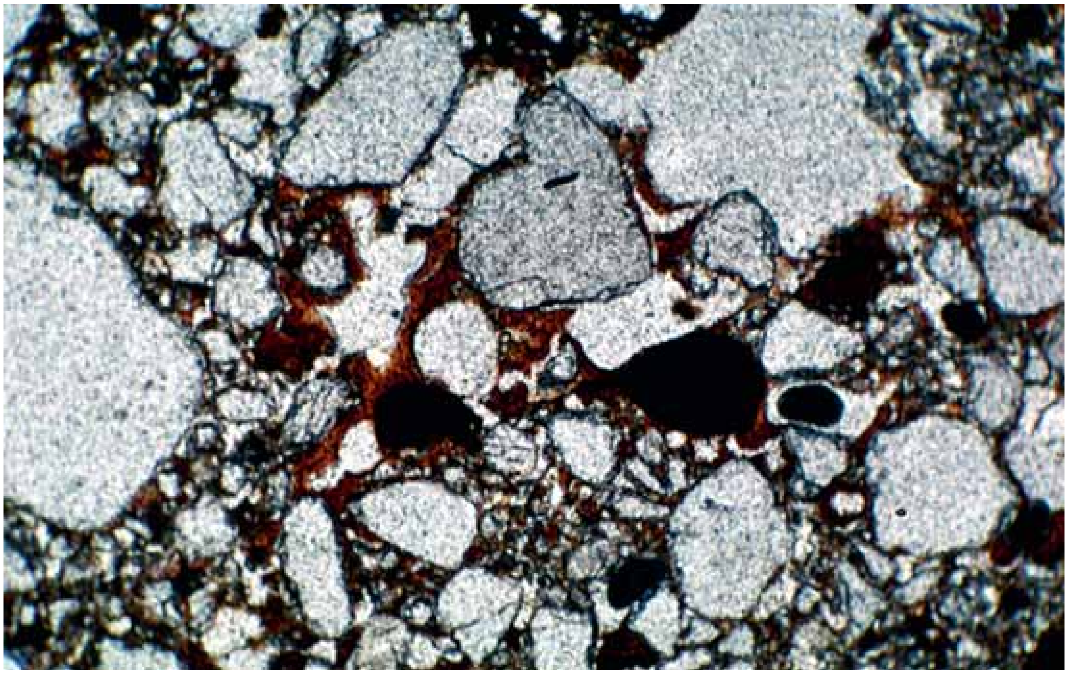


Figure SS4.100 Barrow 5: M11: bB't; SMF5 – textural features/ microprobe studies; PPL, frame 3.3mm.

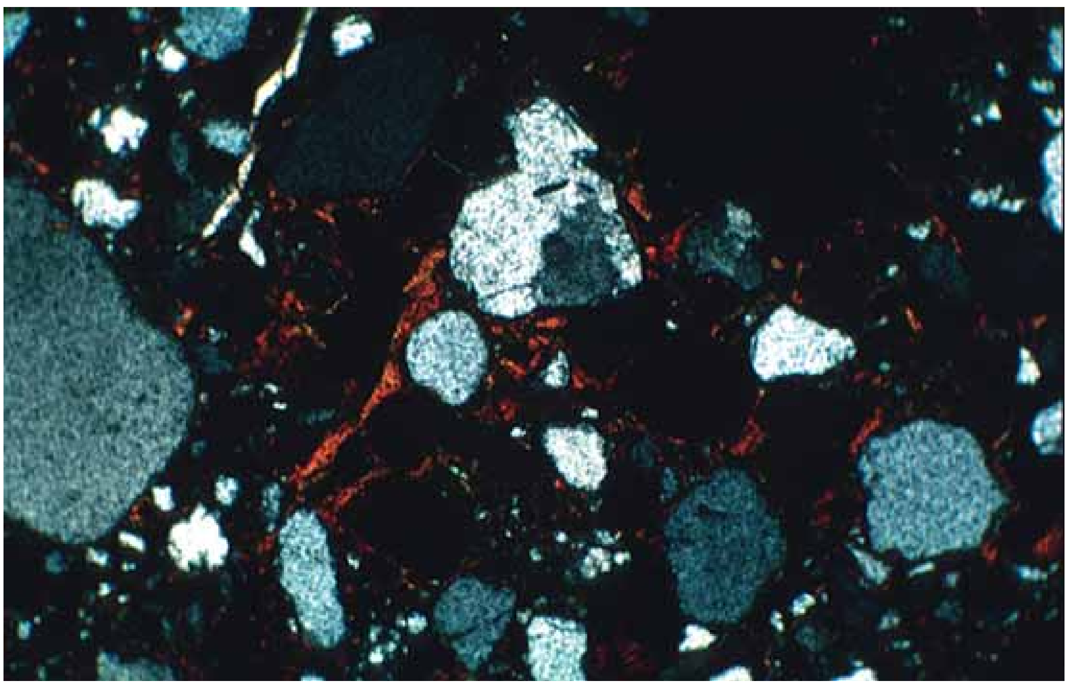


Figure SS4.101 Barrow 5: M11: bB't; SMF5 – textural features/ microprobe studies; XPL, frame 3.3mm.

(French 1998). Investigations suggest that on poorly stable soils dusty clay coatings can accumulate near the soil surface (eg Kilham, North Yorkshire) and clay can also be translocated and deposited in the subsoil (Strathallan mound and henge, Perthshire; Macphail *et al* 1990; Macphail *et al* 1987; Romans and Robertson 1983c). The presence of dusty clay in the Neolithic soils at Raunds means that an impact by cultivation cannot be ruled out, although, as discussed in SS4.8.2.3, the presence of pan-like features, dark red clay and accumulations of organic phosphate implies a much stronger impact by animals during the period leading up to monument construction at Raunds. Only at Barrow 6 do textural features clearly imply an earlier history of tillage, and this is preserved in the truncated remains of the probably pre-Bronze Age subsoil. As noted

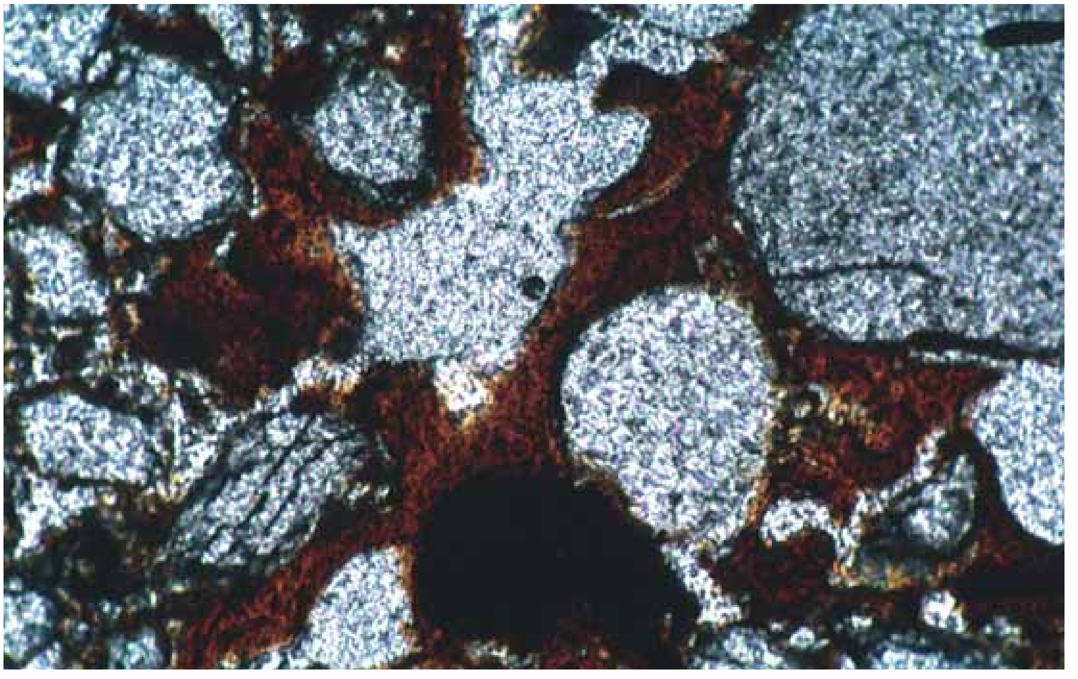


Figure SS4.102
Barrow 5:
M11: bB't;
SMF5 – textural features/
microprobe studies;
PPL, frame 3.3mm.

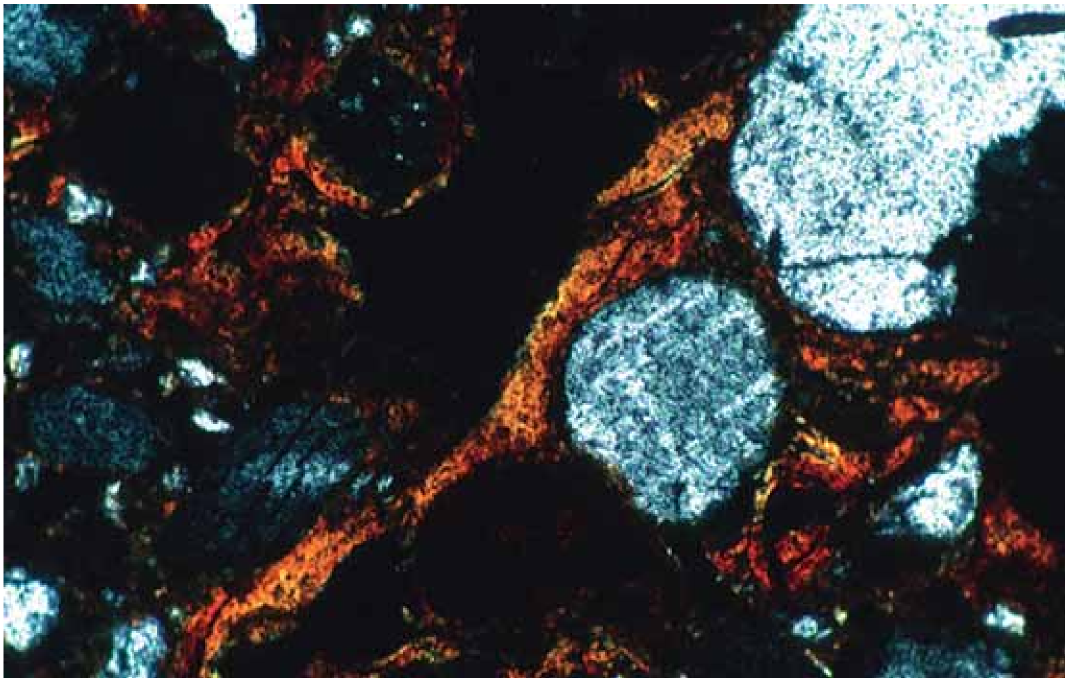


Figure SS4.103
Barrow 5:
M11: bB't;
SMF5 – textural features/
microprobe studies;
XPL, frame 0.33mm.

above, complementary environmental data for the Neolithic at Raunds argues against cultivation at this time.

This comparison of Neolithic soils at Raunds with other sites in Britain, permits the following suggestions concerning the Raunds Neolithic soils:

The Raunds Neolithic soils were strongly influenced by a history of clearance and grassland topsoil formation in a 'forest soil', at least at sites later employed for monuments.

A period or periods of cultivation are a conceivable but completely unproven Neolithic landuse at Raunds, and animal herding (see 3) has almost completely overprinted any evidence of such earlier practices, except at early Bronze Age Barrow 6.

Animal herding and vegetation management by fire were practiced in a probably largely open landscape, unlike the small

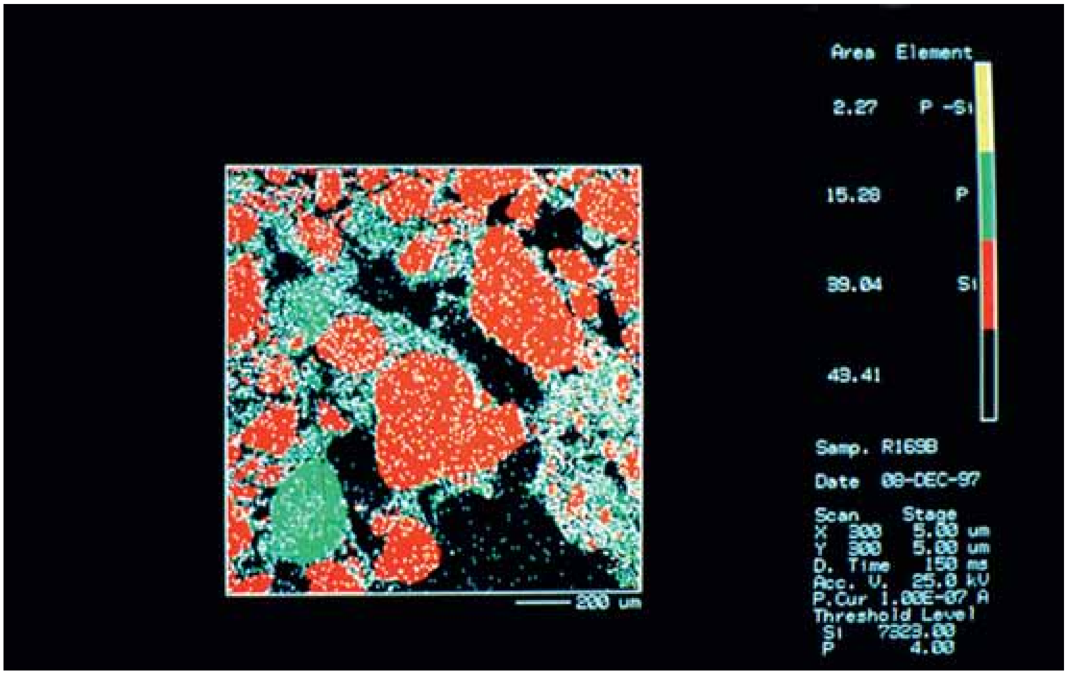


Figure SS4.104 Barrow 5: M11: bB't; SMF5 – textural features/ microprobe studies; microprobe elemental map Si/P.

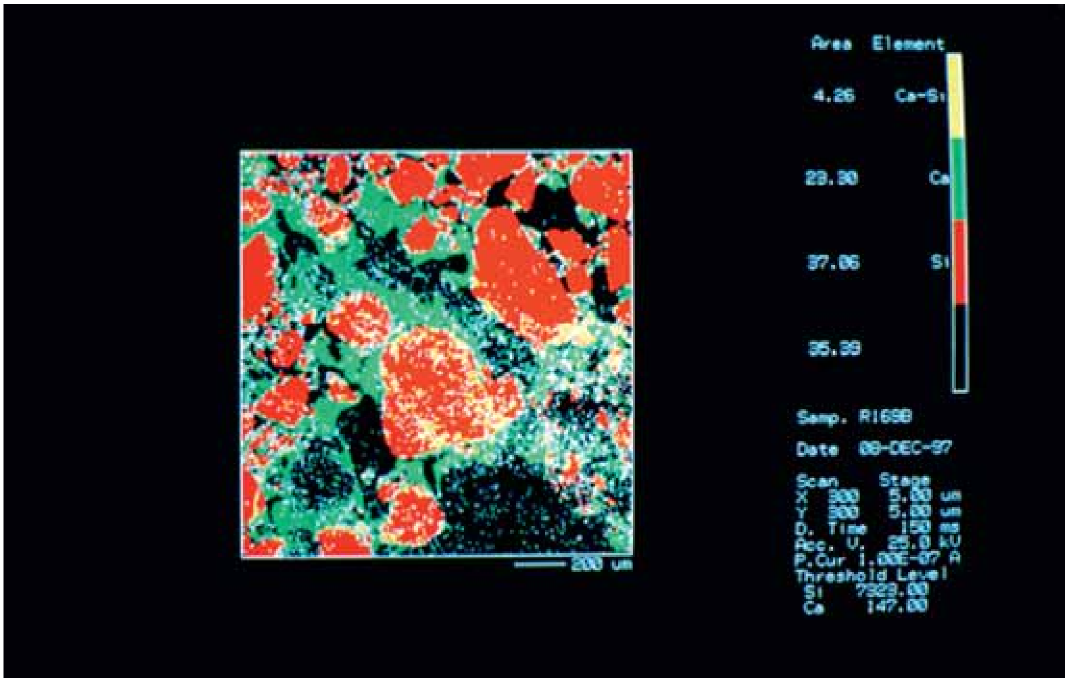


Figure SS4.105 Barrow 5: M11: bB't; SMF5 – textural features/ microprobe studies; microprobe elemental map Si/Ca.

cleared, 'camp site' areas of Easton Down and Hazleton.

Sites such as the Long Barrow and Long Mound were probably areas of stock concentration (cf Eton Rowing Lake), and not simply just part of a pasture.

The early Bronze Age

Soil evidence points to a dominant use of the Raunds early Bronze Age landscape for herding, and this is completely consistent with the macrobotanical and Coleoptera data (Parts II, II, V; Table SS4.69; see SS.4.4–7). The late Bronze Age/early Iron Age sites of Salford, Bedfordshire and Balksbury Camp, Hampshire have similar chemistry, and while Salford exhibits dark reddish clay textural features, some areas at Balksbury on the chalk seem to be trampled (poached) slurry soils (Table SS4.64, Figs

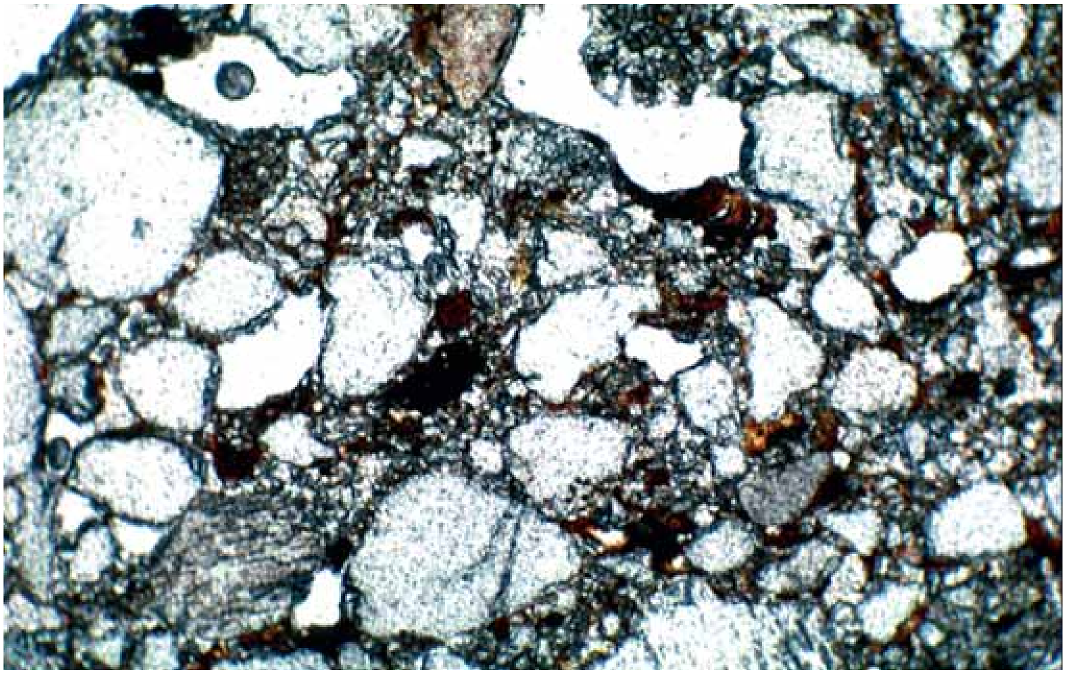


Figure SS4.106
Barrow 5:
M11: bB't;
SMF5 – textural features/ microprobe studies;
PPL, frame 3.3mm.

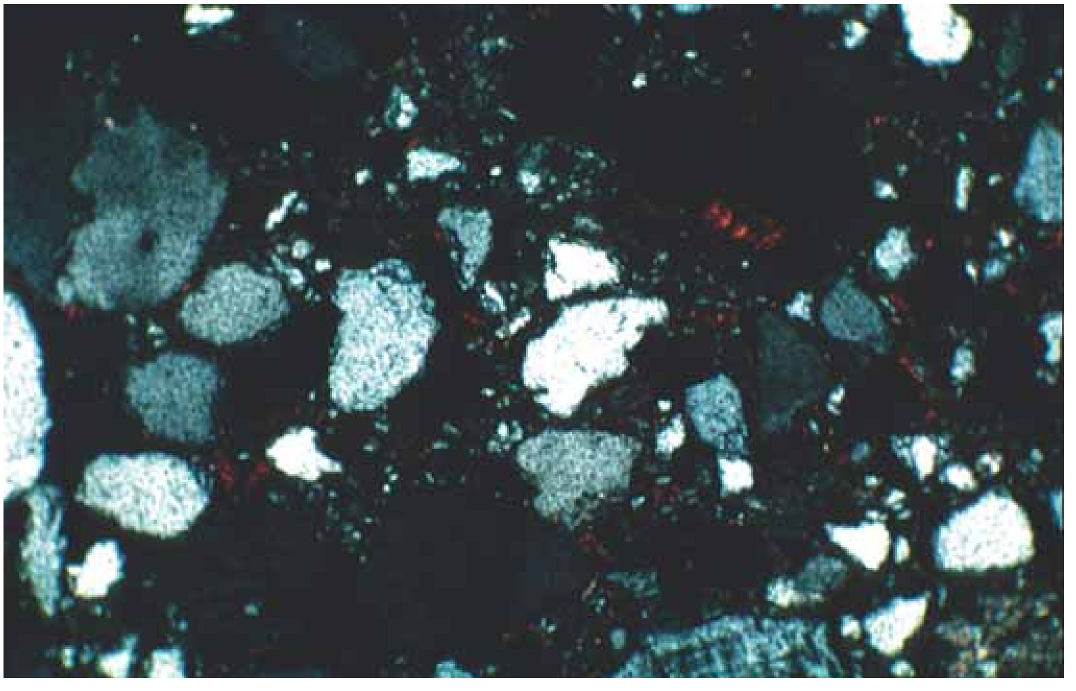


Figure SS4.107
Barrow 5:
M11: bB't;
SMF5 – textural features/ microprobe studies;
XPL, frame 3.3mm.

SS4.30–1; Macphail 1997; Macphail *et al* 1998a). Dark humic textural features (see Turf Mound and Barrow 5, Tables SS4.62–63 and b) that are thought to relate to cattle concentrations are ubiquitous at late Bronze Age/early Iron Age Potterne, Wiltshire, but here phosphate accumulation has been dominated by additional inputs of bone, ash and mineralised coprolitic remains, hence a P ratio of 0.8 (Lawson 2000; Macphail forthcoming c). Only at Barrow 1, where high MS values, burnt soil and a possible animal trampled stony surface is present, is there evidence of 'occupation' intensity greater than just for animal pounding at Raunds. It is also at Barrow 1 that over one hundred cattle skulls were piled over the cairn covering the primary burial (Davis and Payne 1993). Other indications of intensive stocking at Raunds come from soil

Figure SS4.108 Barrow 5: M11: bB't; SMF5 – textural features/ microprobe studies; PPL, frame 0.33mm.

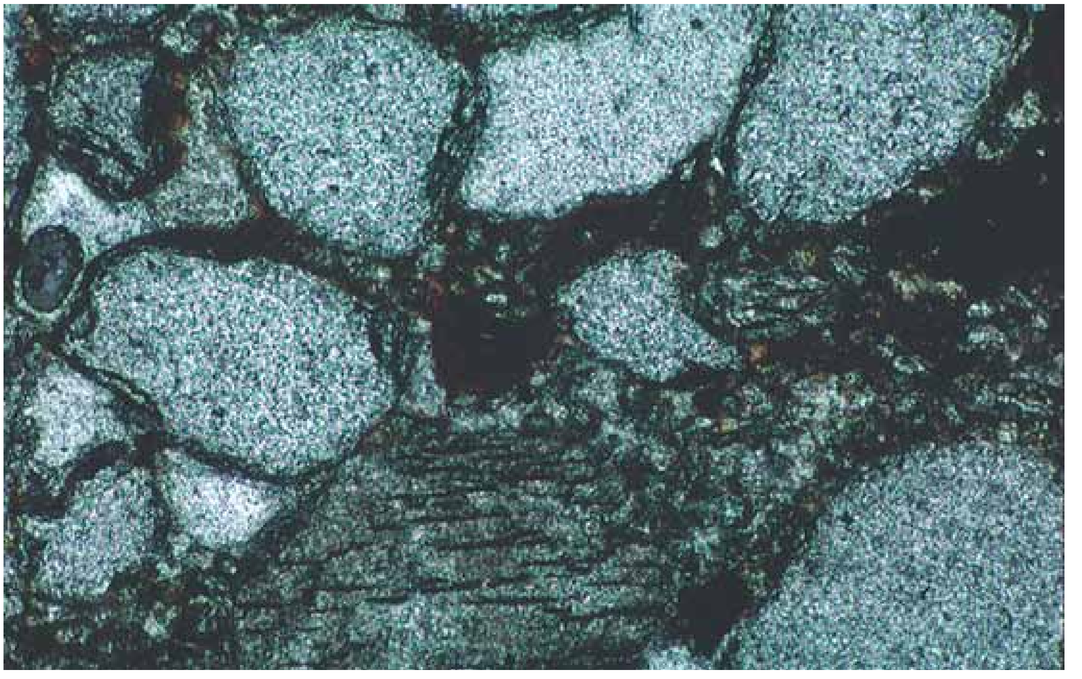
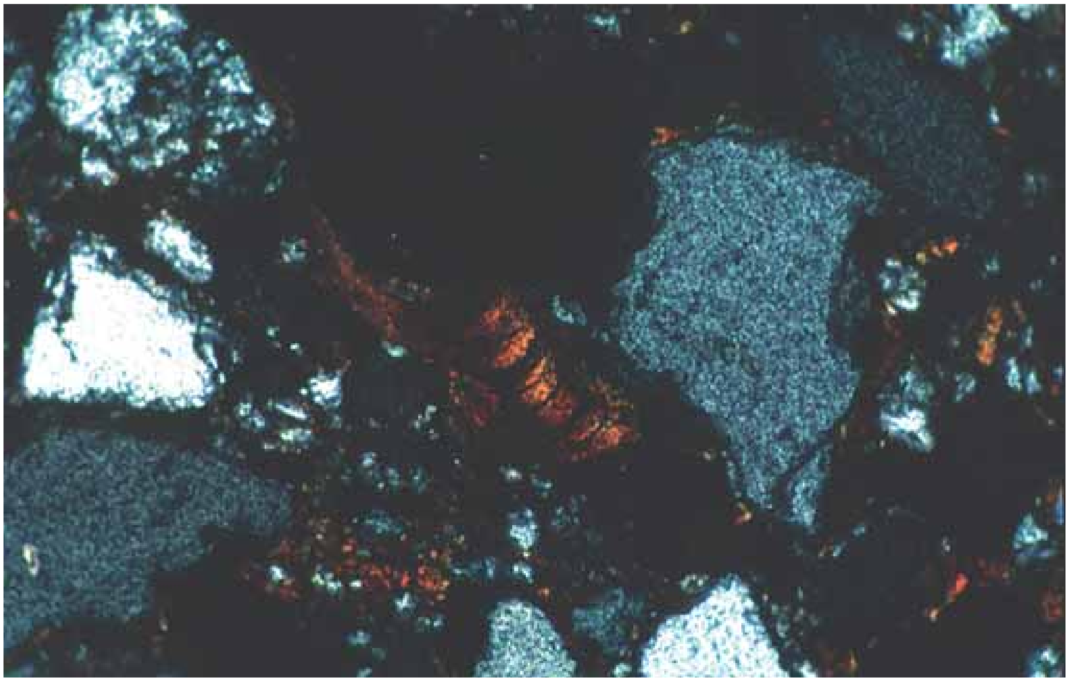


Figure SS4.109 Barrow 5: M11: bB't; SMF5 – textural features/ microprobe studies; XPL, frame 0.33mm.



micromorphological and chemical data at the Turf Mound and Barrows 1 and 5, and probable trampled/colluvial soil accumulations at Barrow 4. At Barrow 3, dung and phytoliths concentrated by dung inputs, and a possible cattle foot-print, are further indications of local landuse by domestic animals.

Lastly, it can be noted that there is little difference in the soil findings from the Long Mound and the Long Barrow, Neolithic monuments *c* 1.5km apart, and from two of the most intensively studied parts of the site, namely Barrow 5 and the south part of the Turf Mound, early Bronze Age monuments only some 150m apart. In the Neolithic clearance was probably succeeded by herding, which was locally concentrated, a landuse that seems to have re-emerged in greater intensity in the early Bronze Age. This and other data

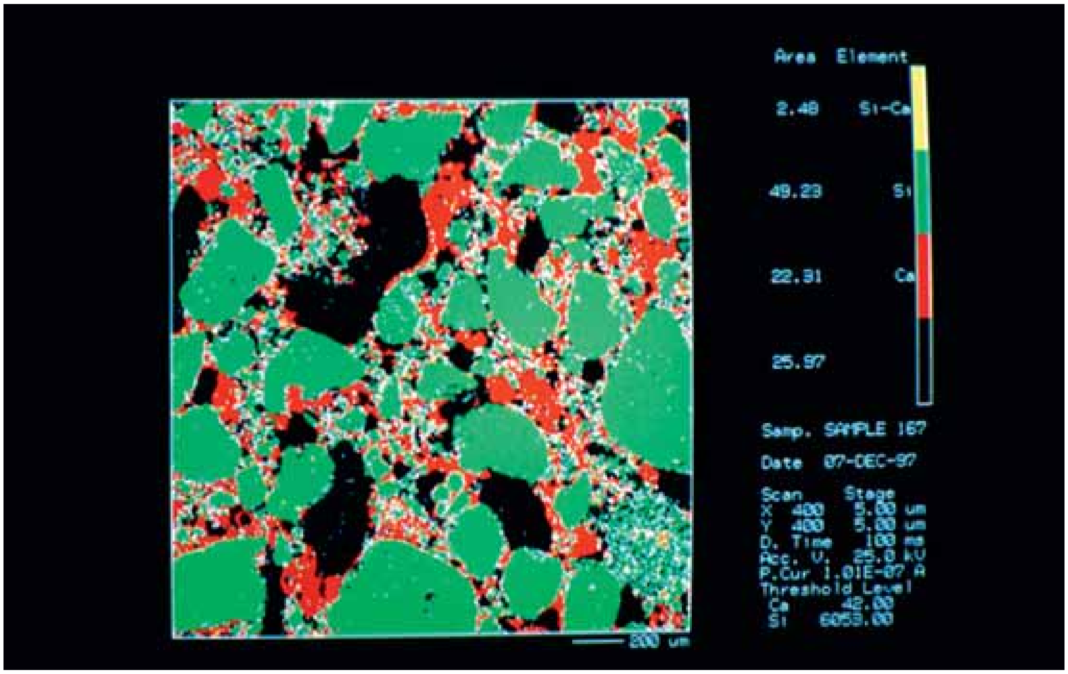


Figure SS4.110 Barrow 5: M11: bB't; SMF5 – textural features/ microprobe studies; microprobe elemental map Si/Ca (11b).

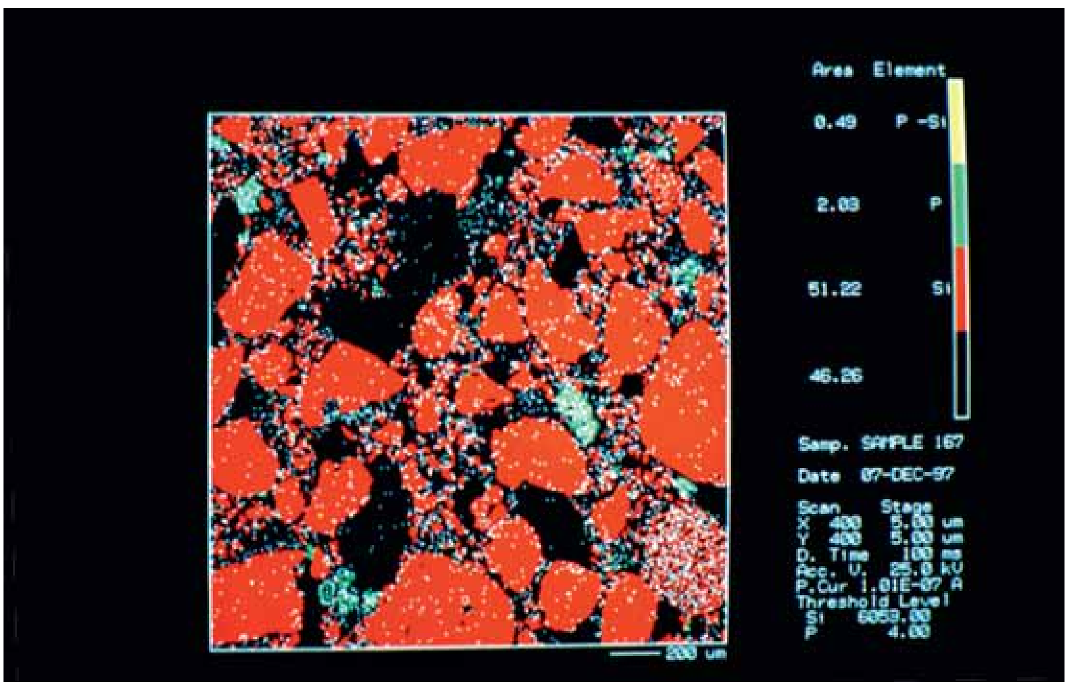


Figure SS4.111 Barrow 5: M11: bB't; SMF5 – textural features/ microprobe studies; microprobe elemental map Si/P (11b).

indicate that, despite a probable lull in activity, both the Neolithic and early Bronze Age saw marked periods of herding.

Conclusions

Soil and landscape changes at Raunds are suggested in Table SS4.69. Over the long investigative period of more than ten years, a number of approaches were applied, for example to understand better the forested landscape and to help make proxy identifications of herding activity through soil analyses. The combination of standard soil science techniques and linked soil micromorphological counting and microprobe studies, appear to have been successful. With hindsight, however, it may have been better to employ more widely nitric acid or another more robust extractant than citric acid, in order to make comparisons of total phosphate, even though citric acid has a proven record in effectively discriminating organic and inorganic phosphate on acid soil sites. The last was also demonstrated statistically at Raunds.

The fifth to fourth millennium and Neolithic/early Bronze Age landscapes are modelled in Table SS4.69. From two dated and two undated examples, treethrow holes are grouped as probably early (Mesolithic/Neolithic) and late (middle Neolithic) examples. The earlier ones have clear 'banana-shaped' outlines. They demonstrate organic matter infilling of hollows formed by treethrow, and probably represent long-lived open features. In these, the burnt clay and charcoal which provide evidence of *in situ* burning of soil are finely fragmented, probably because of prolonged biological working. On the other hand, the later treethrow holes are smaller and contain large fragments of burnt soil, and for this reason appear to have been possibly much shorter-lived as biologically worked open features (acidified?). At the time of the earliest treethrow features, natural argillic brown soil formation (ie 'chemical' clay translocation/lessivage) was still only very poorly developed, and now most clay coating pedofeatures are found within the treethrow holes themselves and thus appear to have resulted from the physical mechanism of treethrow soil disruption. A number of inferences concerning the fifth to fourth millennium soils can be made. It seems logical to suggest that the burning of fallen trees was carried out in order to encourage game and to improve access for browsing domestic animals. If the Neolithic practices of leaf hay gathering took place, this would also have had a cumulative effect on woodland and its replacement by grassland in specific open locations such as were later employed for monuments like the Long Mound. On the other hand, possible ritual activity took place within a still wooded environment as is likely at the Avenue. Still it is quite clear that gradually the leached and acidic moder forest topsoils were replaced in some locations during the Neolithic by a grassland mull-like moder humus. As these are rich in fine charcoal it is likely that fire was used as a management tool as also possibly identified as a possible clearance event postdating the Southern Enclosure.

There is little obvious evidence of tillage at Raunds, except for possibly in the lower part of the buried soil at early Bronze Age Barrow 6. This lack of clear indicators is the probable result of a more intensive and different landuse affecting the Neolithic soils, up and until before early Bronze Age burial. These, and the early Bronze Age buried soils and the turf forming the monuments themselves, contain a number of anomalous features. These are: a) the anomalous accumulation of textural features in topsoil Ah and upper subsoil Eb horizons; b) the unusually compact nature of some turf material; c) the presence of more P in topsoil textural features than in the subsoil Bt horizon; d) the concentration of more phosphate in topsoils than in natural forest topsoils; and e) the occurrence of 'foreign' soil clasts in upper soils. Further, organic and phosphate-rich dark red clay and laminar-structured /pan-like textural features are not present in the woodland soils that have an inferred fifth to early fourth millennium landscape character. All the above, are interpreted as evidence of animal stocking, the pan-like textural features and 'foreign' soil clasts being indicative of trampling and the accidental importation of soils from off-site on animal hooves. Results from comparable soil micromorphological and chemical studies of the Hazleton and Eton Rowing Lake middens indicate that at these sites Neolithic herding was probably secondary to domestic occupation, in contrast to Raunds where animal management was possibly the dominant pre-monument activity. This landuse apparently continued into or was resumed in the early Bronze Age, with possible mound turves in Barrow 3 preserving phytolith-rich probable dung layers and a possible cattle print. At Barrow 1, there is evidence of a trampled stony surface and soil accumulation indicative of animal management pre-dating the burial of a large number of cattle skulls. Possible animal induced-colluviation is recorded at Barrow 4, while at Barrow 6 inferred early Bronze Age animal herding resulted in deposition of soil that buried an eroded soil that possibly records an earlier episode of probable cultivation.

The above findings, and clear similarity between the most intensively studied Turf Mound and Barrow 5 sites, suggest that clearance was succeeded by herding in the Neolithic as interpreted from the Long Mound and Long Barrow, a landuse that continued into or was resumed in the early Bronze Age, with buried soils documenting some instances of probable stock concentrations.

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