Landscape Evolution in the Middle Thames Valley
Heathrow Terminal 5 Excavations Volume 2

Environmental Overview

(Section 21)

by Wendy Carruthers

SECTION 21

HEATHROW TERMINAL 5: ENVIRONMENTAL OVERVIEW

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Introduction

This section follows a narrative selected as highlighting the most likely sequence of changes occurring in the Heathrow landscape through time, drawing all of the strands of environmental evidence together. There are, however, other ways to interpret a complex mass of data such as this, and some alternative suggestions are presented in the individual specialist reports (*CD Sections 11-19*).

Sections of the printed volume have drawn on reports by environmental specialists where they were relevant to the features, farmsteads and settlements under discussion. In this section, an attempt has been made to integrate information from the different environmental disciplines in order to reconstruct the Heathrow landscape. Because the vast majority of evidence was recovered from Middle Bronze Age deposits, this period is described in some detail below. In later periods, where less environmental evidence was preserved and settlement may have been less extensive, comparisons have been made with the large MBA database. Specialist reports from Perry Oaks (Volume 1) and Terminal 5 form the basis of this reconstruction, and these have been cited as follows;

Perry Oaks

Perry Oaks wooden finds *by Steve Allen*: CD-Rom 6 [Perry Oaks wood tech SA]

Perry Oaks waterlogged plant remains *by Wendy J. Carruthers*: CD-Rom 9 [Perry Oaks macro WJC]

Perry Oaks wood charcoal and charred plant remains *by Dana Challinor*: CD-Rom 10 [Perry Oaks char DC]

Perry Oaks palynological analysis *by Pat Wiltshire*: CD Rom 11 [Perry Oaks pollen PW]

Perry Oaks insects *by Mark Robinson:* CD-Rom 12 [Perry Oaks insects MR]

Perry Oaks sediment Investigation *by Martin Bates*: CD-Rom 14 [soil MB]

Terminal 5

T5 woodworking technology by Steven Allen: CD-Rom 11 [wood tech SA]

T5 animal bone *by S Knight (and S.Hamilton-Dyer: birds) and J M Grimm*: CD-Rom 13 [bone SK, SH-D, JMG]

T5 charred and waterlogged plant remains *by Wendy J Carruthers*: CD-Rom 14 [macro WJC]

T5 wood charcoal *by Dana Challinor*: CD-Rom 15 [char DC]

T5 pollen *by Sylvia Peglar, Denise Druce and Elizabeth Huckerby*: CD-Rom 16 [pollen SP, DD & EH]

T5 insect remains *by Emma Tetlow*: CD-Rom 17 [insects ET]

T5 land and freshwater mollusca *by E C Stafford*: CD-Rom 18 [mollusc ECS]

T5 soil micromorphology by Richard MacPhail and John Crowther: CD-Rom 19 [soil RM & JC]

In order to make the narrative accessible to non-specialist readers the use of latin names has been kept to a minimum. For the same reason, the term 'seed' is used to include structures that are botanically speaking fruits and seeds. Full lists of taxa and notes on identification can be found in the specialists reports (*CD Sections 13-19*). Detailed descriptions of plant and animal assemblages have been avoided, since these can be obtained on the individual reports. However, in some instances it was important that the data on which the interpretation was based was described in some detail, in order to explain the reasoning. There are often several ways to interpret biological data, particularly when such unpredictable factors as human behaviour are taken into account. Fortunately at Heathrow it has often been possible to draw together several lines of evidence, for example pollen, insects and waterlogged plant remains in many of the waterhole deposits, and in these situations arguments are greatly strengthened. Unfortunately the acidity of the soils at Heathrow meant that evidence from molluscs and animal bones was severely limited and biased, so subjects such as animal husbandry could not be explored in depth, and spatial analysis of bone assemblages was not possible.

Full details of environmental sampling and processing methods have been given in the various specialist reports (*CD Sections 13-19* and *Vol. 1 Perry Oaks*). However, a note concerning the sampling of waterholes needs to be added, since much of the interpretation is based on remains from these well-preserved and abundant features. During the Perry Oaks excavation sample columns were taken through many of the best-preserved fills of the waterholes to look for sequences of change as the feature became silted up, abandoned and often backfilled with waste. The plant macrofossil results showed that in many cases the secondary fills were surprisingly uniform and, because of repeated recutting and re-use, subject to residuality and difficult to date. At Terminal 5, therefore, the analysis of plant macrofossils concentrated on the primary fills where they appeared to be undisturbed, in the hope that these would provide information about the local environment from the period of use of the feature that could be compared through time. Figures 1 to 3 (showing changes through the periods for the pits, ditches and waterholes), therefore, make use of only the Terminal 5 data, whilst Figures 4-6 (showing charred emmer/spelt chaff, charred plant remains concentrations and charred leguminous weed seeds) include the Romano-British charred plant remains from Perry Oaks [char DC].

The Pre-Monument Landscape

The Heathrow sites at Perry Oaks and Terminal 5 are situated on the edge of one of the gravel terraces that was formed as a result of migration of the River Thames during the Pleistocene. The Taplow Gravel is capped by brickearth, (the Langley Silt Complex), a loess loam of fluviatile origin. The River Colne, a tributary of the Thames, flows northwards about half a kilometre from the western edge of the excavated area. On lower ground and along the palaeochannel on the western edge of the site, silty clay alluvial soils indicate that flooding and high ground water levels were probably regular events in some areas throughout history. Thus, like many prehistoric sites along the Thames Valley, both the seasonally-replenished, damp alluvial soils and the better drained soils of the gravel terrace were available for exploitation by occupants of the site. In addition, areas of London Clay form higher ground to the north-east of the site. The middle reaches of the Thames are located roughly four kilometres to the south and south-west of the site.

It is unfortunate that little environmental evidence was recovered from the early prehistoric period and no buried soils survived [soils RM & JC] to provide baseline information about the ancient forests that became established following the last Ice Age in the Heathrow region. Therefore, information must be gleaned from other sites in the area. Environmental evidence from excavations along the middle and lower Thames Valley suggests that, as warming of the climate moved towards the 'climatic optimum', succession in the Heathrow area followed the classic Holocene pattern described by Godwin (1975), i.e. birch followed by pine, with hazel and other deciduous trees such as oak, elm and lime, becoming established as the climate warmed. Alder moved in to wetter soils at around 8000 BP [pollen PW]. Alder carr became a dominant vegetation type along the floodplains of river valleys in southern England, from the Mesolithic through to the Bronze Age. Thermophilous species such as beech and hornbeam only advanced into northern Europe when the climate was at its warmest (c.7000-5000 BP). Ash is also a thermophilous species, but it would have been unable to compete in dense oak and elm forests that had already become established. Once the canopy was opened up, especially following the elm decline when the rate of clearance increased, fast-growing ash was able to rapidly colonise areas until the canopy grew too dense again.

At Runnymede pollen evidence spanning the Boreal Mesolithic to the Late Bronze Age (c. 8000-1000 BC) demonstrated the transition from pine-dominated forests (with some hazel) to thermophilous deciduous species including oak and elm with hazel occurred at around 7790+-80 BP (BM-2550) (Scaife, 2000, p.181). Although under-represented in pollen assemblages, lime was also a dominant element of mixed deciduous oak forests on better drained, higher ground in southern England during the Atlantic Mesolithic period. Alder moved onto the damp, floodplain habitats around 8000-7500 BP at Runnymede, defining the Boreal/Atlantic transition. Insect evidence from Runnymede indicated a sharp transition from reed swamp along the river margins to alder carr and woodland on the drier banks (Robinson, 2000, p.149). Much of this information can be seen to have relevance to the sites at Heathrow, some 29 kilometres upstream from Runnymede. Of course, differences in the amount of anthropogenic activity in each area would have affected vegetation succession to different extents, but unfortunately these small events are difficult to detect in a largely forested landscape. Whilst stray finds of Palaeolithic artefacts were recovered from Heathrow, these finds were residual in the gravels so only provided evidence of activity in the wider area. Mesolithic flintwork was also scattered through later deposits suggesting that the level of activity was more widespread than the structural evidence suggested. However, in addition, a few Later Mesolithic features were identified, providing clear evidence for a human presence on the gravel terrace at Heathrow:

Late Mesolithic Pit Groups

The presence of Late Mesolithic pit groups in PSH02 and Perry Oaks WPR 98 provided some tangible evidence of human activity at Heathrow, as well as a small amount of environmental evidence. These features contained burnt flint (dated by thermoluminescence to the middle of the 7th millennium BC) and charcoal, but pollen preservation was very poor, with only pine and grass pollen, and fern spores surviving [Perry Oaks pollen PW]. Much of the charcoal was also in a poor state of preservation, but fragments of oak, hazel and hawthorn-type were identified [Perry Oaks & T5 char DC]. As a whole, the scant evidence suggested low levels of human activity within a mixed pine and oak woodland, with hazel and hawthorn as part of the understorey. The recovery of much larger numbers of Mesolithic flints that had been redeposited in later features, however, suggests that most of the anthropogenic activity taking place in the ancient woodland and along river channels in this period may remain undetected from an environmental point of view.

The Palaeochannel

Although it contained no artefacts or material suitable for radiocarbon dating, the palaeochannel produced a range of environmental evidence that characterised an important wetland habitat running along the western side of the excavated area. Flowing north-south along the edge of the Colne floodplain this watercourse appears to have silted up prior to the middle of the seventh millennium BC (Perry Oaks, p.43). However, it continued to influence the layout of the landscape for at least a further five thousand years, during the period of Neolithic monument construction along its eastern edge, and during the Middle Bronze Age division of the land into farmsteads and settlements. The location of features and the environmental evidence both demonstrated that the silted-up palaeochannel persisted as a boggy strip with areas of alder carr at least up to the Iron Age. The restricted distribution of waterlogged alder seeds and 'cones' in Middle and Late Bronze Age features along only the western side of the excavated area suggested that alder carr grew close by, and that periodic flooding washed these very buoyant remains into the waterholes and ditches closest to the palaeochannel [macro WJC].

Pollen sequences (monoliths 18154 and 19019) through palaeochannel sediments considered to be Mesolithic to Neolithic in date were dominated at their bases by tree pollen of primarily oak and hazel, with some pine, elm and willow, with occasional grains of alder [pollen SP, DD & EH]. It is clear that these samples pre-dated the spread of alder onto damp soils of the British Isles, an event dated to c. 8000 BP by Birks (1989) and 8000-7500 BP at Runnymede (Scaife, *ibid.*). In monolith 18154 grasses and sedges growing in open, marshy areas of the palaeochannel amounted to 20% of the total land pollen. Microscopic charcoal levels were high, perhaps due to burning activities taking place in the forest. This was followed by a sudden fall in tree pollen from 75% to 10%, accompanied by high values in fern spores. At this time marsh or fen appears to have been developing in cleared areas around the channel. The second series of pollen samples (sample 19019) through the palaeochannel produced similar evidence of high microscopic charcoal values, with marsh and damp grassland bordering the channel. A hiatus around this level was followed by a post-elm decline assemblage, with scarce elm pollen and evidence of aquatic plants growing in a flowing stream. Pollen from dry land trees was much reduced after this point and there was an abrupt rise in alder pollen, indicating that alder carr replaced willow on wet soils along the channel.

Unfortunately, none of the pollen diagrams from Heathrow or Runnymede provided detailed evidence of the elm decline, but published dates from the Upper Thames valley all place this important Neolithic marker at c. 5000 BP (e.g. Stone Marsh, Thames estuary, 4930+-110BP, Q-1336; Devoy 1979).

Insect evidence from Early Neolithic deposits at Runnymede suggested that domestic animals were being herded in closed woodlands in the early 4th millennium BC (Robinson, 2000). From c. 5500 to 4000 BP small clearances occurred but woodland was still the dominant vegetation type. Scaife (*ibid.*) suggests that the landscape probably comprised a mixture of woodland, scrub and clearings. The main phase of human activity on the floodplain at Runnymede occurred from c.4000 to 3500 cal BC, involving the construction of stake built structures. Arable cultivation was occurring in the catchment area but pastoral taxa were also common. Around this period at Heathrow the landscape in the area of the Stanwell Cursus (at least) was very open, a series of substantial monuments were constructed and major ceremonial activities are likely to have been taking place (see Chapter ##).

Neolithic Monument Building

Shortly before construction of the Stanwell cursus a rubbish pit was dug in the western half of the excavated area (pit 527200). This feature was later cut by the cursus ditch in the mid to late 4th millennium BC. A pollen monolith taken from the pit provided a glimpse (albeit possibly biased by poor preservation) of the landscape before the monument was constructed. The area around the pit was primarily open (c. 20% arboreal pollen), although some oak/hazel/lime woodland existed on drier ground, with the low count for elm confirming the post-elm decline date. The relatively high occurrence of lime suggested that clearance associated with the *Tilia* decline had not yet taken place when this feature was in use. Although the *Tilia* decline took place at different times in different locations, it occurred at around 3000-3700 years BP in other sites in the area such as West Heath Spa, Hampstead Heath (Greig, 1991) and Tilbury (Devoy, 1979). Herbaceous pollen was dominated by grasses and taxa associated with cultivated land and pastures. Cereal pollen was quite high suggesting that arable cultivation was occurring locally, and this included wheat and/or oat pollen. The presence of pollen from obligate aquatics such as duckweed indicated that there was standing water in the feature [pollen SP, DD & EH]. A second Early Neolithic pit cut by the west cursus ditch, pit 587028, contained evidence of burned humic topsoil indicating that grazing land may have been managed by fire at this time [sample 18078, soil RM & JC].

According to the ceramic dating evidence the two parallel ditches and central bank of the Stanwell Cursus were constructed in the mid to late 4th millennium BC. Soil micromorphological features in samples from the ditch (samples 18063, 18067), such as the appearance of reddened mineral grains and rubefied soil fragments with embedded charcoal, indicated that large scale woodland clearance by burning occurred in the area some time before the construction of the Stanwell Cursus. The release of potash from burnt vegetation encouraged the movement of clay within the soil, and some of this material was washed into the cursus ditches during the period of silting up. Relict organic matter that may have originated in dung were observed in thin sections from the western cursus ditch, sample 18463 [soil RM & JC].

Bulk soil samples from Neolithic features produced very few, poorly preserved charred plant remains and in some cases (gully 527233) radiocarbon dating revealed that upper fills had become contaminated. Tree throw 558057, however, produced a small number of charred emmer/spelt wheat grains and hazelnut shell fragments, demonstrating that both wild and cultivated foods were being consumed in the Early Neolithic period [macro WJC].

An Early or Middle Neolithic pit 836047 towards the eastern edge of the excavated area also produced a primarily 'open landscape' pollen assemblage (although no evidence of arable cultivation in this case), demonstrating that clearance was more extensive than just a corridor along the cursus [pollen SP, DD & EH]. By the time pit/waterhole 150011 was cut into the basal fills of the cursus ditch, however, substantial woodland regeneration had taken place, with up to 80% total land pollen and spores consisting of arboreal pollen [Perry Oaks pollen PW]. (N.B. The early radiocarbon date obtained from this feature (NZA14902) was considered to be suspect, possibly caused by the redeposition of organic material, since the pollen assemblage was clearly post elm-decline). The upper fills of pit 527200 also hinted at the beginnings of woodland regeneration, perhaps indicating some degree of abandonment of the area in the later Neolithic period.

Scaife (*ibid.*) notes that in many cases early clearances were only partial and short lived, with woodland regeneration occurring, indicated by the influx of taxa such as ash, holly and secondary elm (e.g. Gatcombe Withy Bed, Isle of Wight; Scaife, 1980, 1987). He suggests that in the Later Neolithic the economy of many sites moved towards woodland pastoralism. The relevance of this to Heathrow is discussed further below, but it is certainly a model that fits in with the scant evidence. A small waterlogged assemblage from Late Neolithic pit 833067 on the eastern edge of the site contained primarily hazelnut shell fragments, with a possible sloe stone fragment and a few weeds of disturbed ground [macro WJC]. Gathered foods were clearly important at this time and no evidence for cereal cultivation was recovered (although admittedly few samples were available for study). Samples from Late Neolithic and/or Early Bronze Age pits produced no cereal remains but strong evidence of thorny scrub, including sloe, purging buckthorn and hawthorn-type in the charcoal assemblage [wood DC], and these thorny taxa are at an advantage when woodland is grazed by large mammals.

Although soil acidity meant that few animal bones were recovered from the site and the assemblages may be biased, it was noteworthy that the remains of domestic animals including cattle were present in secondary deposits in the C1 Stanwell Cursus ditches and the HE1 enclosure [bone SK]. Sheep/goat teeth and gnawed ribs were present in secondary fills of the cursus ditches, some red deer antler fragments were present in the HE1 enclosure and cattle and pig remains (mostly teeth) were recovered from Grooved ware pit 631011 [bone SK, SH-D & JMG]. It is uncertain whether the antler had been used as a pick, or whether red deer had been hunter and eaten, because the state of preservation was so poor. Nor was it possible to determine the relative importance of different domestic species or to comment on animal husbandry, since the assemblages were too biased. However, the remains do confirm the fact that pastoral farming appears to have been taking place in the area, or at least that animals were being brought to the site, possibly for ritual purposes.

Tree throw features dotted across the excavated area provided further evidence of clearance, although no obvious pattern of felling was observed to confirm that humans were definitely involved. Most tree throws dated to the Neolithic period but others were dated to the Bronze Age, and one to the Romano-British period. In many cases tree throw hollows had been used to provide shelter for domestic fires, and a range of fuelwoods were present, for example (in order of frequency) ash, hazel, hawthorn-type, alder/hazel, sloe, and elm in two Early Neolithic tree throws, and oak, hawthorn-type, sloe, ash, hazel, alder and purging buckthorn in two mid or Late Neolithic tree throws [Perry Oaks & T5 char DC]. The change from ash to oak as the main fuel wood through time may reflect changes in forest composition, depletion of ash through over-use, or a more settled type of occupation in the later Neolithic. Ash can be burnt a short time after felling, whilst oak would need to be gathered as dead wood or seasoned for several months before it was suitable as fuelwood. Tree throws can occur naturally, but where they contain charcoal from only one species it is more likely that humans were involved in the clearance. One example of burning a small oak tree that was growing in the western Stanwell Cursus ditch was encountered [char DC], perhaps indicating that some maintenance of the structure was occurring.

The Later Neolithic to Early Bronze Age

Very little information exists for his period from either Heathrow or Runnymede, or from the Middle and Lower Thames Valley as a whole on the floodplain. However, monument construction was taking place on the gravel terraces during this period (Cotton, 2000). Robinson [Perry Oaks insects MR] mentions a poorly preserved insect assemblage from an Early Bronze Age pond at Shepperton, a few kilometres south of Heathrow, that indicated a substantially cleared landscape with grazed pastures and some thorn scrub. Molluscs from what was probably redeposited riverine tufa gravel and calcareous silts thought to date to the Late Neolithic/Early Bronze Age in a stretch of palaeochannel at Heathrow indicated that and some dry open grassland existed at this time, although it is not clear how extensive this was [molluscs ECS]. Freshwater taxa within the assemblage may have derived from the redeposited tufa.

Soil samples from a fill of Early Bronze Age Ring Ditch 584080 [sample 22551, soils RM&JC], located to the west of the palaeochannel, provided evidence of inwash possibly affected by alluvial activity, but there was no evidence of anthropogenic activity. Unfortunately no plant macrofossils and very few animal bones were found in features dated to this period, and poor bone preservation will again inevitably have biased the assemblage in favour of large animals.

Sample 17010, from a waterlogged basal fill of early-middle Bronze Age pit 527069 near the Cursus produced a very 'open landscape' pollen assemblage, perhaps with some hedgerows or scrub. Livestock were grazing areas of grassland (indicated by pollen species characteristic of nutrient-enriched soils), and cereals and flax were being grown [pollen SP, DD and EH]. Perhaps this cultivation represents small-scale, early stages of development of the MBA settlements, since cereals and flax were also the main crops grown at the later date. Animal bone was also recovered from within this fill.

The Middle Bronze Age Agricultural Landscape

Major reorganisation of the land occurred during the second millennium BC in the formation of at least six farmsteads across the excavated area at Heathrow. Each farmstead consisted of settlement features, field systems, waterholes, enclosures and double ditched trackways connecting the farmsteads. The farmsteads are described in detail in Chapter 3, but additional information about the environment and economy recovered from the rich assemblages of charred and waterlogged environmental remains has been drawn together in this chapter. Fifty-five plant macrofossil samples, seventeen insect samples, twenty one charcoal samples, and twelve pollen cores were fully analysed at Terminal 5, and this information has been added to the data from Perry Oaks (2006).

Because the taphonomy of waterlogged deposits can be complex, it was important that large numbers of features of different types and in different areas were analysed in order to understand which biological components related to the local vegetation, which material had been deposited as waste, and which assemblages characterised wider landscape changes. Distinguishing geographic differences from temporal ones was also complex, particularly when large features such as waterholes may have remained open for many years and accumulated evidence from the period of use and also after abandonment. Comparison with other periods of occupation has helped to identify changes in the landscape, as shown in Figures 1 to 3 for the plant macrofossils (discussed further below).

MBA field boundaries can be traced right up to the palaeochannel which was located on the western side of the excavated area separating Farmsteads 1 and 2. Although the palaeochannel had silted-up by this time, the alignment of field systems with the watercourse suggests that the channel was probably still visible as a marshy strip running North-South through the western edge of the site. Marshland can be a valuable source of game, rushes and reeds for thatching, flooring, basketry, cordage, and marsh hay. Seasonal flooding of the floodplain would have been beneficial in replenishing the soils with nutrients, although there is some evidence that this may have become excessive towards the end of the period of occupation.

The preservation of waterlogged plant and insect remains in all types of features (pits, ditches and waterholes) during the MBA indicated that water levels were high during this period, particularly when comparisons were made with later periods (Figures 1 - 3). The only other period when all three types of features were waterlogged was the Early/Middle Romano-British period, and the four features from this period were all located in the central Twin Rivers area, Area 61, which may explain the extensive waterlogging. The numbers of MBA features sampled was high and their distribution was widespread across the excavated area, indicating that it was not simply the influence of the palaeochannel in the west that led to the waterlogging. Even allowing for truncation of the deposits by the construction of the sewage works (Perry Oaks figure 1.6), soils must have been damp and seasonal waterlogging must have been a regular occurrence for many of the settlements. The numerous field boundary and trackway ditches dug during this period, therefore, were probably just as important for drainage as for marking boundaries and controlling livestock. The scarcity of obligate aquatics in the ditch samples (only a few duckweed seeds in two out of eleven ditch samples) demonstrated that they functioned well, since standing water cannot have been present for much of the year. In contrast, eight of the fifteen M to LBA waterholes and five of the eight waterlogged pits contained the remains of some obligate aquatic plants, such as water-starwort and water-plantain. Whilst waterholes obviously were deliberately dug down to below water level, digging below ground water level to dispose of rubbish would seem to be less desirable – digging in waterlogged soil is a difficult and messy task, and it makes the feature less useful for waste disposal since waste does not rot away and become compacted. It is, therefore, possible that water levels rose during the period of occupation or soon after abandonment, or at least before all of the organic remains in the soil were lost through decay. Comparing Figures 7 to 9, the concentration of waterlogged plant remains per litre of soil processed was lower for the MBA pits than the ditches and waterholes, and lower than well-preserved waterlogged pits from other phases. This may be due to some loss of organic material during the occupation of the site, prior to more prolonged flooding of the site. It should be noted, however, that interpreting waterlogged ‘fragments per litre’ (fpl) figures is far more complex than charred fpl figures, since factors such as dilution due to the presence of large quantities of leaves, or high figures due to prolific seed producers growing nearby, can have large affects.

One possible explanation is that occupation of the site was seasonal during this period, as suggested for the Middle Iron Age site at Farmoor, located in the Upper Thames Valley on the floodplain and first gravel terrace (Robinson, 1979). Alternatively, water levels may have risen during the period of occupation and may have been a contributory factor in the decline in activity at around 1200 cal BC (see Chapter 3), particularly if crops and livestock were affected. Even so, evidence presented below relating to the unusually limited distribution and use of hazel during the MBA [macros, wood tech. & charcoal] indicates that the Heathrow soils were at least damp throughout the life of the farmsteads, since hazel is a small tree/shrub that cannot thrive in permanently damp soils.

Damp soils can provide lush pastures and hay crops, particularly if seasonal flooding replenishes the soil with nutrients. Cattle require a large amount of drinking water and are well suited to grazing damp pastures. Their predominance along the Thames Valley floodplain is typical during the Bronze Age and Iron Age, according to the published literature [bones SK]. Sheep, on the other hand, are prone to liver fluke and foot rot, and horses can cause serious poaching on wet ground. Flax requires moist soils to grow well, but cereals can be susceptible to a variety of diseases, such as bunt and powdery mildew, in damp conditions. Of the cereals grown during the MBA (the hulled wheats emmer and spelt, and hulled barley) barley is possibly the most tolerant of wet soils, although it favours well-drained calcareous soils. Oats can also tolerate damp ground, but it was not known whether the small number of oat grains found in the samples represented a crop or weed species.

Charred fruits and seeds from plants that grow on wet-ground (i.e. charred because they were probably growing as crop weeds and became charred during crop processing) were not particularly frequent in any of the cereal and cereal processing waste assemblages. They occurred most frequently in samples containing charred flax seeds and capsule fragments (e.g. ditch 527080). This suggests that flax was being grown on the damper soils along the floodplain of the River Colne, and that either the cereals were grown on higher ground to the east, away from the area excavated, or that the water table was much lower on the gravel terrace during the main period of occupation of the settlements. Arable cultivation during the M and M/LBA is discussed in more detail below.

All of the environmental evidence indicated that the landscape was predominantly open in character, with grassland (probably both pastures and meadows) being the main vegetation type, according to the pollen and insect data. The insect fauna was dominated by terrestrial species characteristic of well-drained, warm, open habitats, with frequent evidence for grazing animals in the form of dung beetles [Perry Oaks insects MR]. Wood and tree dependent insects made up a small percentage of the records (1.2 – 6.4% at Perry Oaks). Arboreal pollen from the lowest levels of MBA features amounted to around 5 to 25% of total land pollen, although waterhole 823181 in the east of the site contained 60% arboreal pollen, with a high count for oak. This suggests that areas of London Clay to the east may have remained wooded, perhaps consisting of fairly open oak / hazel wood pasture that could have been used for grazing as well as a source of fuel wood. Features dating to the M/LBA and LBA showed an increase in tree pollen to around 40%, indicating some reduction in agricultural activity followed by woodland regeneration in the area towards the end of the Bronze Age [pollen SP, DD & EH]. By the Middle Iron Age, however, very little woodland remained in the Heathrow area.

The general picture of predominantly open, grazed grassland has been found at many sites along the Thames Valley, from as far afield as Ashton Keynes (MIA; Stevens in Powell *et al*. 2008), Mingies Ditch (MIA; Robinson, 1993) and Farmoor (MIA; Robinson, 1979) in the Upper Thames Valley, to Thorpe Lea (LBA, Robinson forthcoming) in the Middle Thames Valley. It is unfortunate that soils had become too acidic for molluscs to survive at Heathrow, as an important molluscan sequence from alluvium in the Upper Thames Valley at Wallingford (Robinson, 1986) demonstrated that occupation during the Late Bronze Age ended when the site became wetter and alluviation occurred. Further downstream, at Heathrow, this sequence of events may have occurred a little earlier, perhaps cutting short the LBA occupation and preventing a return to agricultural activities in the area until the Middle Iron Age.

Evidence for hedges, scrub and woodland

Although it is clear from the pollen and insect data that the landscape was predominantly open, most of the MBA and LBA waterholes contained abundant plant macrofossil evidence consisting of leaf fragments, twigs, rose/blackberry-type and hawthorn/sloe-type thorns and a variety of fruits and seeds from thorny and scrubby bushes. These included remains from several thorny species such as hawthorn, sloe, blackberry, and rose, as well as from small trees and shrubs such as maple, dogwood, alder buckthorn, crab apple and elderberry. Waterlogged hazelnut shall fragments were not frequent and only occasional charred fragments were present. According to the charcoal evidence, hazel may not have been common in the area, since it amounted to less than 1% of the identified charcoal fragments from MBA features [wood DC]. As discussed above, soils were probably too damp for hazel to thrive. Of course, hedgerow resources such as hazelnuts and fruits such as blackberries, crab apples and sloes would have been gathered for food, medicinal use and dyes, but there would have been plenty of shrivelled and immature fruits left behind each year to fall into the features. There was no evidence that the fruit remains had entered the features in human sewage, and the presence of leaves, twigs and thorns suggested otherwise. Birds and rodents drinking at the features may also have deposited seeds from many of the species recorded.

Waterlogged remains from wet ground taxa (alder and willow) were confined to pits, waterholes and ditches on the western side of the excavated area, i.e. closest to the palaeochannel, and waterlogged acorn fragments were only found in the east of the site where the ground was higher, in waterholes along Trackway 6 (see further discussion below). The only acorns to be found in the west were two charred acorn cup fragments in ditch 527080, a feature containing abundant charred crop processing waste. These remains were probably collected amongst fuel used for parching the grain, and their presence on a different farmstead to their probable source is interesting, perhaps indicating the trading of resources between settlements.

This restricted distribution of particular taxa suggests that woody material was falling from vegetation close to its source, rather than being casually deposited in the waterholes by humans as mixed waste. Infact, apart from deliberate placing of artefacts in some features (see Chapter 3), there was very little evidence for the dumping of waste in the waterholes as a whole, in contrast with the ditches and pits (see discussion below). The main source of the environmental remains appears to have been the immediate area in and around the waterholes, perhaps with some material being brought in by livestock in their dung and on hooves.

Thirteen of the seventeen MBA to LBA waterholes contained frequent woodland/scrub/hedgerow plant macrofossils, and the remaining four contained a few woody remains. Some woodland and hedgerow herbaceous plant macrofossils were also present, including three-nerved sandwort and ground ivy seeds. The insect evidence for woody taxa was less clear cut, although Robinson [Perry Oaks, 2006] listed some species characteristic of scrub and hedgerows (maximum = 6.4% of terrestrial Coleoptera) and suggested that the landscape was open but divided by thorn hedges.

The palynological evidence was also more difficult to interpret, since most of the features produced fairly low arboreal pollen counts of around 10 to 20% total land pollen. To maintain a hedgerow that is dense enough to control livestock regular cutting is required. Severe cutting reduces flowering and the production of pollen, perhaps accounting for the low arboreal pollen counts. However, depending on how the hedge is cut, it can also increase flowering in the older parts of the hedge by allowing more light in to lower levels. Since fruits were recovered, some pollen must have been produced, but as most of the hedgerow taxa are insect pollinated they may not be accurately represented in the pollen record. Robinson noted this problem of under-representation of thorny hedgerow taxa in the pollen record at Mingies Ditch (1993, p.113) and pointed out that these particular pollen grains also do not preserve well. Deciduous leaves, small twigs and thorns, and winged fruits such as maple can be blown for several metres in open areas. In addition, birds consume most of the fruits produced by thorny hedgerows and can carry them long distances. Nevertheless, the fact that the macrofossil evidence for thorny shrubs was consistently abundant in most of the Bronze Age features (see Figures 1 to 3) but the pollen evidence did not produce strong woodland signals suggests that hedgerows existed close to the features. In many cases the waterholes were located in the corners of field, and in others they occurred close to hedged enclosures and trackways. An additional possibility is that areas of woodland pasture may have existed in some areas, as noted above for the eastern area [pollen SP, DD & EH], with livestock reducing pollination to some extent by browsing. This would not explain the presence of woodland herb macrofossils, but could apply to some areas of the site.

Although in the Perry Oaks volume there was some discussion as to the age of the hedgerows, formulae using species diversity (Hooper *et al*, 1974) should be used with caution in the modern landscape, and are unlikely to be applicable to ancient landscapes. Colonisation by new species depends on factors such as the proximity of woodland, scrub or other hedges producing seed, levels of activity of fruit-eating wildlife, the amount of competition for space within the hedge and management of the hedge banks and hedge species. In addition, a community that is firmly based on agriculture would easily be able to grasp concepts such as transplanting seedlings growing on the woodland floor, and gathering fruits and nuts to sow. The case for hedging, however, should not be overstated, and it is unlikely that all of the ditches were hedged. Many may have served primarily for drainage or to mark boundaries. Soil analysis suggested that the ever-present evidence of trampling, dung residues, enhanced phosphate levels etc. along the ditches may have been due to livestock being able to roam between areas for most of the time, rather than being confined within enclosures for long periods [soils RM & JC]. If soils were fairly damp, confining livestock in a small area for a long period would cause severe poaching of the soil and soon destroy pasture.

Because of the extensive waterlogging, a wide range of wooden artefacts and fragments of worked wood were recovered from the MBA and LBA features, including alder (SF 24001) and oak (SF 29725) log ladders, a willow bark container (SF 29560), and a poplar carved wooden bowl (SF 12045). A Late Bronze Age waterhole produced fragments of rope made from willow (SF 20030) and alder buckthorn (SF 20033) shoots. Ash had been used to make the bottom of a bucket or similar container (SF 20035) and beaters, probably used as bar-shares i.e. the working tips of an early form of plough, were made from field maple (SF12060) and Pomoideae (SF323; includes apple, hawthorn, whitebeam etc.) wood. The carved bowl had been broken and then carefully repaired, demonstrating the high value placed on this item, and the possible bar-shares, perhaps the first to be identified in the British Isles, may have been deposited as some sort of ‘sacrifice’ since they were undamaged [wood tech SA]. All of these taxa were readily available close-by, as indicated by pollen, insect and plant macrofossil evidence. It is possible that woodland management was taking place in some areas, since wattle-revetted waterholes such as 698028 consisted of frequent roundwood fragments from willow, ash and oak. All of these species can be coppiced or pollarded, but unfortunately it was not possible to confirm that this had taken place. It is interesting to see that hazel was not used for wattling or artefacts until the Early Romano-British period although it was frequent amongst the worked wood assemblage by the LRB [wood tech SA]. Confirmed hazel charcoal (as opposed to hazel/alder) was present but not frequent until the Medieval period [char DC]. Hazel pollen was generally present in the features but at fairly low levels, particularly in the west of the site where soils were wetter. As with the oak remains on higher ground to the east (described above), hazel was probably growing in oak woodland to the east where the soils were drier. The fact that hazel was not being used for construction, craft and only rarely for fuel, even though it is well suited to all of these purposes, suggests that the supply was limited in the MBA. This confirms that the soils were damp in the western half of the site during the life of the settlements, rather than just around the time of abandonment.

Although alder carr and old woodland had been cleared from the Runnymede area by the MBA, at Heathrow alder carr persisted along the palaeochannel until the Iron Age. If not in the immediate area, this vegetation was growing close enough for buoyant alder seeds and 'cones' to be washed into features along the western side of the site. This suggests that the three pits and two waterholes containing alder remains had stayed open for some time. Alder, willow and alder buckthorn would have grown well in the peaty soils along the palaeochannel.

These differences in woodland cover, with increased oak/hazel woodland to the east were noted in the pollen report [pollen, SP, DD & EH]. It was suggested that this may have consisted of open, grazed woodland pasture. The upper fills of two waterholes on the eastern side provided evidence of woodland regeneration in the Late Bronze Age, accompanied by reduction in cereal and hedgerow pollen. This was interpreted as possible abandonment of the area during this period.

Economy

Arable agriculture was a major component of the economy of the MBA settlements, as indicated by the large quantities of charred cereal remains recovered from the samples. Comparisons between the concentrations of charred cereal remains through the periods in Figure 5 show that the average number of charred cereal remains per 10 litre soil sample (pits and ditches only) was almost as high in the MBA as in the Romano-British period and higher than in the Iron Age and Medieval periods. In part, this may have been due to the exceptional state of preservation found in the waterlogged ditch 539096, but increases in survival of delicate charred plant remains in waterlogged deposits (through protection from compaction and abrasion) are counterbalanced by the dilution effect of waterlogged material in the sample, so the high average concentration in the MBA shown in Figure 5 is significant.

The principal crops grown during the MBA at Heathrow were emmer (*Triticum dicoccum*) and spelt (*T. spelta*) wheat, hulled barley (most likely 6-row hulled barley; *Hordeum vulgare*) and flax (*Linum usitatissimum*). Spelt wheat was a newly introduced crop at this time, and some of the earliest published radiocarbon dates for spelt have come from the Upper Thames Valley at Yarnton, Oxfordshire (Robinson in Campbell & Straker, 2003): 1690-1390 (95.4%) cal BC (OxA-6548). As Figure 4 shows, emmer was much more frequent than spelt in the MBA and LBA charred samples. This is likely to be due to limited availability of seed corn, since over time, and prior to the widespread cultivation of free-threshing bread-type wheats in post-Roman Britain, spelt became the dominant cereal crop grown in southern England. Van der Veen (1995) suggests that, if grown as a mixed crop (maslin), this gradual increase in spelt at the expense of emmer would have taken place even without deliberate selection for spelt, since spelt usually produces higher yields than emmer. Experimental cereal cultivation in different regions of Britain co-ordinated by van der Veen and Palmer (1997) demonstrated that the exception to this was in areas with warmer winter temperatures, when emmer could outperform spelt. If grown as separate crops, the general increased dominance of spelt over time in The British Isles may reflect a deliberate choice for the higher yielding, hardier cereal, coupled with greater availability of seed corn. The cultivation of bread-type wheat was not confirmed for this period, but the fact that it is less able to cope with unfavourable growing conditions such as wet soils may have made it unsuitable for low-lying areas, despite the advantages of being free-threshing. Because evidence for free-threshing wheat is scarce and accurate identification is problematic, its status as a crop plant in southern Britain prior to the Iron Age has been questioned (Campbell & Straker, 2003).

The presence of the arable weed cleavers (*Galium aparine*) in the charred assemblages indicated that at least some crop were autumn sown. Bogaard *et al.* (2001) suggest that the onset and length of the flowering period of arable weeds are useful indicators of sowing time (see Bogaard *et al.* (2001) for details of the FIBS method of analysis). According to this method of analysis, autumn sowing predominated (i.e. mid summer flowering weed species such as vetches were most frequent) but some spring sowing was taking place (i.e. some late flowering weed taxa, such as scentless mayweed, were present). Because all of the charred assemblages at Heathrow were from mixed secondary deposits, this information is difficult to interpret. It is likely that cultivation of the soil was spread out through year and varied according to a particular season's weather, with damper areas being spring sown and drier, better drained soils being autumn sown.

Comparisons of crops being cultivated in different parts of Southern Britain are limited by the scarcity of MBA sites. However, there appears to be some degree of uniformity in the Bronze Age as a whole along the Thames Valley, with emmer, spelt, six-row hulled barley and flax being typically found (Campbell & Straker, 2003). Three other MBA sites further afield in south and south-west England (Trethellan, Cornwall, Straker (1991); Bestwall Quarry, Wareham, Carruthers, (2009); Rowden, Dorset, Carruthers (1990)) have produced very different assemblages, consisting of primarily hulled and naked barley, with very little hulled wheat and relatively frequent Celtic beans. The coastal locations of these sites and poor, acidic soils may account for these large differences. However, it is also likely that the Thames Valley provided a route into more fertile areas of southern England along which new crops such as spelt and perhaps cotton thistle (see below) travelled. By the LBA at Runnymede spelt wheat had become the dominant crop by about 3 : 1 spelt to emmer (Greig, 1991, p.254) and barley was only a minor crop. As at Heathrow, flax was relatively frequent and pulses (peas and beans) were not found.

The small and biased (through poor preservation) animal bone assemblages from Perry Oaks and T5 provided conflicting information, with cattle being dominant in the Perry Oaks assemblage and sheep dominating the three MBA features from T5. Ditch 539283 on the western edge of the excavated area in Farmstead 1 contained primary butchery waste with a high proportion of burnt bone. Large mammals were not represented but sheep and pig were identified, possibly as a result of differential treatment of carcasses. Fragments of bone from the waterholes were fairly complete, possibly due to the better preservation conditions, but perhaps also indicating a special type of deposition (such as ritual placed material) or non-intensive use of resources. Waterhole 557027 contained a relatively large and well preserved assemblage, including bones from cattle and sheep/goat, some neonatal and at least some of which are likely to have been deposited as articulated or semi-articulated carcasses. In this case the absence of bones from the heads and feet suggested that skins may have been taken elsewhere. Although sheep were said to be fairly large for the period, this could be because the number of males represented was large. A single large red deer skull with antler attached was recovered from the re-cut waterhole 594272 and may represent a special deposit. The Late Bronze Age features also produced very little bone, but the burnt diverse assemblage from pit 609020 was noteworthy in possibly representing ceremonial activity or feasting waste. There was some evidence from gnawed bones in a waterhole fill that dogs had access to food waste. No secure information about animal husbandry could be gleaned from the poor assemblages [bones SK, SH-D, JMG].

Activities around the settlement including waste disposal in the Middle and Late Bronze Age

Taken together, the environmental information has helped to 'flesh out' the details of the layout and activities taking place on the Bronze Age Farmsteads. These are described in relation to specific features and Farmsteads in Chapter 3 and are given in full in the specialist reports on the *CD-Rom Sections 13-19*, but some examples of the range of information retrieved are presented here. Soil samples from many of the trackways and enclosure ditches revealed enriched phosphate levels and textural pedofeatures indicative of trampling by livestock and the deposition of dung [soils RM & JC]. Waterholes and pits along some of the trackways contained diverse assemblages of waterlogged plant remains from thorny shrubs, suggesting that hedges were growing along many of the trackways to help control livestock [macros WJC].

The remains of bark beetles, bugs and weevils that are found on hawthorn, sloe and rose bushes (e.g. *Magdalis ruficornis* and *Dolycornus baccarum*) were present in features next to the D-shaped enclosure (Settlement 4) and a field boundary in Farmstead 3, again indicating the presence of thorn hedging [Perry Oaks insects MR]. Plant macrofossil evidence also strongly supported the suggestion of thorny hedges composed of blackberry, hawthorn, rose and sloe around the D-shaped enclosure, as well as the presence of grazing animals (due to the abundance of remains from nitrophilous plants such as nettles). Textural pedofeatures in the enclosure ditch sediments suggested inputs of animal slurry and trampling by livestock [soils RM & JC]. The strongest signs of indoor synanthropic beetles (such as *Ptinus fur*) were found in features close to the west side of the enclosure, but charred crop processing waste was frequent in a pit cutting the east side. Settlement 4 is thought to have been a larger and possibly higher status enclosure (Chapter 3.1, p.9), so perhaps buildings existed within the enclosure and hedges were present to keep livestock out, rather than using this impressive enclosure merely for grazing. Evidence for internal structures may have been lost through truncation, particularly if occupation levels had been raised to escape the damp. The recovery of honey bee remains from pit 178108 [Perry Oaks insects MR] located next to the D-shaped enclosure provided tantalising evidence for other activities that might have been taking place in Settlement 4. It is uncertain whether this early record indicated beekeeping, but wax may have been collected for use in casting bronzes, and honey may have been collected as a sweetner. Honey bee remains were also present in LBA deposits at Runnymede and a number of Iron Age sites along the Thames Valley [Perry Oaks insects MR].

Comparing different features type between the periods, it can be seen that the disposal of domestic waste was not haphazard. Charred and waterlogged plant macrofossil evidence showed that in almost all of the periods the waterholes appear to have been deliberately kept clear of domestic waste during the period of use (Figure 3). Although it is difficult to tell if many of the waterlogged weed seeds had been deposited in waste or were growing as weeds of disturbed ground nearby, the absence of chaff fragments and straw (apart from one or two glume bases and spikelet forks) from the primary fills indicated that very little burnt or unburnt food waste was deposited during the period of use. Small amounts of waterlogged chaff and weed seeds may have entered the waterholes in dung, having been used as fodder. Burnt cereal processing waste was equally as scarce, even though preservation conditions were very good in these well-protected deposits. Differences were observed in the LIA/ERB and Later Medieval periods and these are discussed below. The examination of secondary fills at Perry Oaks [macro WJC] demonstrated that, as might be expected, after abandonment waterholes were often backfilled with waste materials including charred and waterlogged cereal processing waste.

Many of the waterholes were surprisingly free of remains from weeds of disturbed, nutrient-enriched soils such as stinging nettles. Waterholes used intensively by livestock are likely to have areas of trampling and poaching around the margins, and areas where dung has encouraged stinging nettles, docks and other nitrophilous plant to become established. Nettles are generally not grazed by livestock and can colonise large areas over a period of time. Waterholes with few or no nettle seeds were mainly located along Trackway 6 in the east (five waterholes), perhaps indicating an area of low-intensity use or increased management. The pollen evidence broadly fitted in with this pattern. Interestingly, the distribution of elderberry seeds also followed the pattern, with almost all of the seeds occurring in the west and central areas of the site. Elderberry grows in nutrient-enriched soils but, being a shrub (albeit fast-growing) is clearly a longer-term indicator of enhanced human and/or animal activity than nettles. If used as food or to make dye, the distribution may also be affected. This also could apply to nettles, since they are a valuable source of bast fibres and have been made into textiles and cordage in the past (Hurcombe 2000). The fact that both species were concentrated in the west and central areas suggests an increased level of intensity of human and animal activity, in comparison with the eastern area. The main exception to this distribution was waterhole 559328 which cut the southern end of the D-shaped enclosure, Settlement 4. This feature was nettle-free, as was the enclosure ditch, suggesting that deliberate clearance had taken place. Perhaps the waterhole had been selected for human use, for both drinking and bathing, in which case it would seem sensible to prevent souring of the water with waste, and to remove nettles and floating aquatic vegetation.

The absence of aquatic plant macrofossil, pollen and insect remains from many of the waterholes (as mentioned above) was notable and difficult to explain, since the features had obviously remained waterlogged enough to ensure good organic preservation. Nine of the seventeen MBA and LBA waterholes produced no plant macrofossils from obligate aquatics and only four contained frequent remains from floating aquatic plants such as duckweed (*Lemna* sp.). Marginal plants and marsh plants were more common but not always frequent. When compared with the pits, 24% of the waterholes contained frequent aquatics compared with 64% of the pits, even though the waterholes were clearly much deeper and must have remained water-filled for longer than the pits. Frequent use by grazing animals may have reduced flowering sufficiently to prevent pollination and fruiting, or removed vegetation cover altogether thus removing the insect fauna. Small floating aquatics, however, like duckweed are often encouraged by the high nutrient levels created by grazing animals. As the name suggests, ducks would quickly clear this type of vegetation. Unfortunately poor preservation of the bone meant that virtually no bird bone was recovered from the site. It is also possible that, as perhaps with other vegetation such as nettles, humans carried out some maintenance of waterholes used to provide drinking water and for bathing. Waterhole 559328 by the D-shaped enclosure contained virtually no aquatics - only a single duckweed seed.

During the MBA the highest concentrations of burnt cereal processing waste were found in the ditches and pits. Figure 5 shows a high concentration for the ditches, but this is mainly due to the very rich samples from ditch 539096 skewing the data. It is interesting to note, however, that in all other periods apart from the Medieval period, ditches contained very little charred waste, perhaps because they were much drier so preservation conditions were poorer. It is also possible they were cleaned out more frequently or flushed through by seasonal flooding events. Analysis of the seven richest charred assemblages demonstrated that mixed cereal processing, domestic waste and possibly fodder was present in all cases. No examples of pure crop processing waste (i.e. primarily chaff and weed seeds), or clean processed grain were found. Although chaff fragments and weed seeds were frequent in samples such as pit 546202, cereal grains still made up 24% of the assemblage and both hulled wheats and barley were equally frequent. The 'purest' sample was recovered from pit 543201, which contained 95% hulled wheat, possibly originally in cleaned spikelet form (41% grain to 56% chaff with only 3% weed seeds). This sample was unique in being the only sample to contain a higher proportion of spelt than emmer chaff (ratio of 32:39 emmer to spelt glume bases, whilst the other rich samples averaged around 30 : 1 emmer : spelt). The recovery of this deposit of accidentally burnt stored spelt and emmer spikelets suggests that hulled wheats were probably being grown as a mixed crop or 'maslin' at this time, with hulled barley probably being grown mainly for fodder as a separate crop. Oats never amounted to more than 5% of the grain, so were probably growing as a weed (although no identifiable chaff was recovered to confirm this suggestion).

Charred mixed domestic waste (e.g. grain spilt and burnt during cooking) and cereal processing waste is commonly found on prehistoric sites where grain that had been stored as semi-processed spikelets (Hillman, 1981) was de-husked on a small-scale day-to-day basis prior to cooking. The small quantities of processing waste produced (mostly small chaff fragments and small weed seeds) were probably used as tinder for domestic hearths or fed to livestock housed close-by. Larger scale processing that took place at a later date, during the Iron Age and Romano-British periods, meant that chaff could more easily be collected in bulk for fodder, fuel, temper etc. Plotting the locations of the seven rich contexts revealed that they were all located in the west and central areas of the site in or close to settlement features. Farmstead 1, settlement 7 produced the most features containing rich charred deposits (two ditches and a pit), whilst settlements 2 and 4 contained a rich sample from a waterhole backfill and a Late Bronze Age pit. These features, located close to domestic structures, were probably repeatedly used over a period of time to dump burnt material swept from hearths and floors. Although cereal processing may also have been carried in different areas of the farmsteads, and processing waste transported to livestock in the fields, it is the combination of processing and domestic hearths that is likely to have created the distribution of concentrated charred waste in this case.

Crop Husbandry

The most important assemblages of charred cereal remains were recovered from two layers in ditch 536096 in Farmstead 1. The exceptional state of preservation of these charred remains, protected from crushing and weathering by waterlogged organic material, provided the least biased assemblage of cereal processing waste from the site, including items that are usually broken up and destroyed, such as whole weed seed heads and straw fragments. The frequency of straw stem bases complete with rootlets indicated that cereal crops had been harvested by uprooting. Farmsteads 1, 2 and 5 all produced evidence for uprooting, demonstrating that it was a widely practiced method of harvesting cereals. Although it is difficult to compare these results with smaller numbers of less well-preserved samples from other periods, the evidence suggests that by the LBA harvesting methods probably changed to cutting below the ear with a sickle or knife [macros WJC]. In addition to cereal stem bases being rare in later periods, much fewer low-growing, twining and scrambling weeds were recovered, for example clovers, vetches, cleavers, black bindweed and small-flowered buttercup. When cereals are harvested by uprooting the stems must be grasped fairly low on the stem, and a wide range of weeds are gathered at the same time. Cutting high up the stem, just below the ear, changes a number of factors; fewer weeds are collected with the ears so the crop becomes less contaminated in time; the straw can be left to stand and be grazed from the field by livestock in the autumn, thus manuring the land; or alternatively, the straw can be harvested separately and is not damaged during harvesting and threshing, so is more suitable for thatching. On the other hand, uprooting leaves a clear field ready for re-sowing. Manuring would have to be carried out manually, and there is an indication that, although manuring was probably taking place in the MBA, this was not occurring in a uniform way, since both nutrient-rich and nutrient-poor weed seeds were recovered. Soil analyses suggested that some sort of fallow-manuring was taking place, so perhaps livestock was allowed to graze-off weed and volunteer plant re-growth, prior to sowing a crop in the following spring. Some fields may also have been left to lie fallow for a longer period, and animal may have been allowed to graze these areas freely. Since soil studies indicated that stock were not permanently excluded from arable areas [soils RM & JC], it is clear that fields were not continuously cropped in quick succession as occurs today, but perhaps were cultivated on a much less intensive, drawn out form of rotation. Some of the charred remains from grassland taxa such as buttercup and grass seeds could be evidence for long fallowing, but it would be difficult to distinguish this from burnt hay.

Because the charred cereal deposits consisted of mixed waste, including both hulled wheats and barley, it is uncertain which arable weeds were growing with which crops. However, it was notable that where barley was high in frequency, such as in the post-abandonment backfill of waterhole 563060, small-seeded leguminous weeds (clovers, trefoils, vetches etc.) were also frequent, and vice versa. As leguminous weeds are indicators of nutritionally poor soils (Moss, 2004), this suggests that barley was being grown on the poorer land or was not valued to the same extent as wheat and so was manured less frequently (if at all). Barley is a very tolerant crop, growing on a wide range of soil types and requiring only moderate amounts of nutrients. It was probably primarily grown for fodder so may have been considered to be less important than emmer and, in particular, spelt – a recently introduced cereal. Although spelt is a more robust and higher yielding crop than emmer, it is more demanding of nutrients. Increased cultivation of this crop at the expense of emmer during the MBA may have contributed towards soil impoverishment and acidification that appears to have been taking place on the river terrace gravels.

Soil acidification

The removal of woodland, cultivation of the soil and grazing over many centuries would have caused the gradual loss of calcium from the terrace gravels and alluvial soils. Two shrubs of base-rich soils, purging buckthorn (*Rhamnus catharticus*) and dogwood, (*Cornus sanguinea*) were represented at low levels by plant macrofossils, charcoal and pollen in Neolithic to M/LBA features but not after the Bronze Age, and this may signify changes in the soils. Unfortunately, the scarcity of remains from trees and shrubs from later periods makes comparisons difficult. This process of acidification was confirmed by the appearance of remains from heathland vegetation in the samples in the Iron Age. Charred and waterlogged heather fruits and shoot tips were first found in Late Iron Age samples, and were most frequent in LIA to MRB features. There was little evidence from the charcoal that heathland vegetation was widely used for fuel until the medieval period [charcoal DC]. Low levels of heather pollen from Perry Oaks and T5 suggested that heathland may have been developing in the locality as early as the MBA and LBA, but this may have been some distance from the site. Even in the LIA and RB periods heathland taxa were not very well represented in the pollen diagrams, although this may be because they are insect-pollinated. The fact that bone was scarce and very poorly preserved, and molluscs were only preserved in tufaceous deposits in the cursus ditch and palaeochannel, attest to the acidic nature of the soils today. The name Heathrow suggests that this type of vegetation was prominent in the area.

Decline during the Late Bronze Age

Continued use of some of the Farmsteads into the LBA, including the large D-shaped enclosure, meant that changes in the environment from the MBA to LBA period were not easy to identify. The waterholes continued to contain frequent woodland

/hedgerow plant macrofossils and alder carr still occupied the area along the palaeochannel. For this reason some discussion of the LBA economy has already been given above. The most obvious change was the difference in level of activity between the periods producing a general impression of decline. Reduction in the numbers of features and finds dated to the LBA suggested that, in the excavated area at least, anthropogenic activity decreased. With smaller numbers of environmental samples being available for study it was difficult to characterise this decline, but pollen samples from LBA pit 509174 and from upper levels of several MBA waterholes (e.g. 708014) indicated that open woodland continued to occupy areas in the east of the site, and that grazed pastures still dominated the landscape as a whole. Hedgerows may have diminished in some areas [pollen SP, DD & EH] and hedgerow species were frequent amongst the charcoal assemblages, including sloe, hawthorn-group, buckthorn, maple, hazel and ash [char DC]. However, oak was still the main fuel wood being used. Waterhole 726001 in the north of the site (Area LFA 05) contained plentiful plant macrofossil evidence for thorny and shrubby taxa such as blackberry, maple and dogwood [macros WJC], as well as seeds and cones of alder washed in from alder carr persisting nearby. Areas of burning, wasteground and disturbed ground were indicated by the pollen, charcoal and plant macrofossil evidence, and there may have been some colonisation of abandoned areas by scrub. Pit 546202 in the west of the site contained frequent alder and willow/poplar charcoal indicating the burning of wood from the surrounding alder carr vegetation [char DC].

Cereal cultivation was still taking place in the area [pollen SP, DD & EH] but this was undoubtedly on a much smaller scale than before (see Figure 5). The only useful assemblage of charred plant remains was recovered from midden material deposited in a pit/waterhole above a ritually placed pot (Feature 663167). It consisted of burnt cereal processing waste containing primarily six-row hulled barley chaff with some emmer chaff. The presence of a charred corn spurrey seed indicated that crops were being grown on acidic soils, but no wetland weeds were present and it is uncertain whether or not the cereals were locally grown. As noted above, some areas of the Thames gravels may have become acidic enough to support this arable weed, as they are very variable and patchy (R, Macphail, pers.com.). It is tempting to suggest that spelt crops may have been failing at this point, perhaps due to increasing wetness and impoverishment of the soil, but unfortunately the evidence is too slight. Being midden material, the assemblage could represent mixed waste containing burnt animal fodder, bedding and dung, and this would explain the absence of spelt wheat.

Further evidence for soil acidification was provided by a few waterlogged plant macrofossils from a Late Bronze Age well at Perry Oaks (180080). Heather shoot tips and cross-leaved heath leaves indicated that sandy, peaty and boggy areas had developed a heathland flora. Although a few MBA waterholes contained traces of *Calluna vulgaris* and Ericales pollen, only one feature in the east of the site, waterhole 815041, contained it in the lowest level of the sequence; the others were from upper fills. Heathland formation, therefore, may have begun a little earlier some distance to the east of the site. However, it was not until the MIA that pollen of this group was found throughout the profile [Perry Oaks pollen PW] and only in the MRB and Medieval periods did levels reach more than '+' trace level. The LIA plant macrofossil samples were the first to contain notable quantities of charred heather remains, indicating the use of vegetation for fuel (see below).

Bronze Age cremations

Three LBA cremation from Perry Oaks, seven M/LBA cremations from LFA05 and two from TEC05 were analysed [Perry Oaks & T5 char DC]. A surprising range of taxa were used, and oak, the principal wood used for cremations because of its superior burning properties, was dominant in only five cases. It has been suggested that the dominance of particular species in Bronze Age cremations may have ritual significance (Thompson, 1999). Dominant taxa found in these cremations included two dominated by hazel/alder (probably hazel as alder does not burn well), one dominated by *Prunus* sp. (cherry-type) and hawthorn-group, one almost exclusively sloe (*Prunus spinosa*), one dominated by field maple and two dominated by hawthorn-group. Small amounts of ash, buckthorn and elm were also present. A study of E/MBA cremations at Raunds (Campbell & Robinson 2007) suggested that the cremations of children were often associated with mixed species whilst adults and infants were associated with single species of fuel wood, and some of the Heathrow results fitted this pattern. Links with gender could not be made due to lack of information. Three of the cremations contained onion couch tubers (*Arrhenatherum elatius* var. *tuberosum*), perhaps because they were used as tinder, but possibly because they were of ritual significance, since they are commonly found in cremation deposits.

The Middle Iron Age Nucleated Settlement

None of the environmental samples were dated to the Early Iron Age period, but it appears that very little human activity was taking place in the area at this time. By the time the Middle Iron Age nucleated settlement was established the landscape was extremely open with very few trees and shrubs, and there was no obvious pollen or plant macrofossil evidence of hedgerows [Perry Oaks pollen PW; macro WJC]. However, woodland fuel resources were available in the area, albeit perhaps in short supply, since species such as alder and sloe were recorded amongst the charcoal assemblage, as well as oak and elm [char DC]. Although oak and elm burn well, alder (the dominant taxon from pit 529306) burns poorly unless well seasoned or made into charcoal. Perhaps close cropping of hedgerows, and regular pollarding and coppicing of the limited woodland resources reduced pollen and seed production to a minimum. Since the overall organisation of the land and many of the field systems remained intact, and the positions of LBA/EIA and MIA waterholes indicated that some of the Bronze Age field boundaries and trackways were still in use, it seems likely that barriers such as hedges would be needed to control livestock. The large number of stock pens, some of which were rebuilt several times over this period, demonstrated the importance of pastoral farming to the MIA economy at Heathrow.

Pollen evidence indicated that some arable cultivation and animal husbandry was occurring locally, and that grazing pressure, although initially high may have fallen later in the sequence. Alternatively the large increase in grass pollen seen in the upper levels in pit 178015 could be explained by increased cultivation of hay [Perry Oaks pollen PW]. The latter explanation seems likely in view of the substantial evidence for rebuilding stock enclosures throughout the period, and the reduced reliance on grain and cereal processing waste for winter fodder [macros WJC]. Charred cereal remains were very scarce (see Figure 5: concentration = c.1 fragment per litre (fpl)) and were poorly preserved, such that the only cereals identified were emmer/spelt and barley. The small charred weed assemblages indicated that damp, acidic and clay soils were being cultivated, and that soil impoverishment may have been a problem (indicated by the relatively high number of small-seeded weedy vetch seeds). Stinking chamomile, a weed of heavy, damp clay soils, which was first present as an uncharred ruderal weed in the LBA, was now present as a charred arable weed seed, perhaps indicating the start of bringing into cultivation heavy, clay soils that had previously been used as wood pasture and meadows. Areas of London Clay forming higher ground to the north-east of the site would have been well-suited to the cultivation of hexaploid wheats such as spelt and bread-type wheats. The development of iron-tipped ploughshares during the Iron Age made the cultivation of heavy soils possible (Jones, 1981). The movement onto heavy soils is seen in other parts of the country during the Iron Age and Roman periods and may relate to increased cultivation of bread wheat and spelt; two crops that are well-suited to these soils. The cultivation of bread wheat in this period at Heathrow, however, was not confirmed as the few bread-type wheat grains present could have been a rounded 'aestivoid' form of spelt wheat.

The cultivation of heavier soils to the east suggests that soils on the gravel terrace may have become too acidic, impoverished and perhaps damp to produce good yields, and this may have been one factor leading the change to a pastoral-based economy. Primarily pastoral settlements also dominate other parts of the Thames Valley, from Ashton Keynes (Stevens in Powell *et al*., 2008), Mingies Ditch (Robinson, 1993) and Farmoor (Robinson, 1979) in the upper reaches to Thorpe Lea (Robinson in Hayman forthcoming) in the Middle Thames, close to Heathrow. At all of these sites charred cereal remains were scarce indicating very limited cultivation of cereals, if any at all, since grain may have been brought on to the settlements. Seasonal occupation due to flooding was suggested for some sites, e.g. Farmoor, although this is not always easy to detect, or distinguish from short-lived sites, in the environmental record.

At Heathrow, waterlogged plant macrofossils from Late Iron Age waterhole 521098, a recut of Middle-Late Iron Age waterhole 521069 in the centre of the site revealed that damp grassland and disturbed ground were the main habitats in the vicinity of the waterhole (Figure 3). Aquatic plants were growing in and around the edges of the feature, suggesting that a lower level of management and use was probably occurring than in the MBA. Livestock drinking from the feature had caused some nutrient-enrichment and trampling around the edges of the waterhole.

Poorly preserved cattle and sheep/goat bones and teeth were recovered from Middle or Late Iron Age enclosure ditch 588260, and cattle bones were the dominant component of features at Perry Oaks [bone SK]. Young pig, sheep and dog were also represented. A better preserved selection of cattle, horse and sheep limb bones were present in a shallow pit that cut through the top of the East Cursus ditch, 529306, dated to the Iron Age by a barley grain in its fill (Wk19335 (NZA-26292)) [bones SK, SH-D, JMG]

In contrast to the scant bone and plant remains evidence, soil micromorphology indicated that the droveways were heavily used, showing signs of trampling and slurry deposition [soils RM & JC]. Perhaps the small open settlement, consisting of scattered roundhouses, stockades and enclosures, functioned as a stopping off point along an important route to nearby markets. If so, the scarce cereals found on the site may not all have been grown locally, but may also represent food and fodder brought with the drovers.

It has been suggested that midden-like deposits were accumulating at this time, perhaps as a result of increased stock pounding and reduced need for (or use of) manure following decreased levels of arable cultivation (Chapter 4). The small amount of cereal evidence certainly suggests that manuring of arable fields was not taking place, although why this was so is difficult to understand, since the crops consumed on this site appear to have been suffering impoverishment as a result. It is possible that continued occupation over many centuries in this central area of the site was creating midden-type accumulations of nutrients and waste and encouraging the growth of many weeds of disturbed, nutrient-enriched ground. The occurrence of nitrophilous weeds around waterhole 521069, however, was lower than in all of the other periods (Figure 3), reflecting the relative low intensity of occupation at this time.

Late Iron Age/Early Romano-British period

The Late Iron Age to Early Romano-British period saw the start of a return to arable cultivation on a similar level to the MBA period (Figure 5). This intensification continued into the later Roman period, perhaps in response to the emergence and development of towns at Staines and London nearby (see Chapter 4). Changes in the balance between arable and pastoral farming must have involved reorganisation of field systems and the ploughing up of some pastures or new areas of land. Some gradual, piecemeal changes to the eastern and southern fields are described in Chapter 4, although the main focus of settlement remained in the central area of the site. The Bronze Age field system on the floodplain in the west remained largely unchanged, and it is likely that summer grazing and hay-making occurred in this area into the late Roman period. New areas of arable cultivation are likely to have been located on higher ground on the gravel terrace in the eastern half of the site, and probably also beyond the excavated area. As in the MIA, the presence of charred and uncharred stinking chamomile seeds in some of the assemblages indicated that some cultivation probably took place on the London Clay to the north-east.

By the LIA spelt wheat had become the dominant cereal grown for human consumption, although emmer was still an important crop (Figure 4). Oats (with cultivated oats (*Avena sativa*) confirmed as being present) and hulled barley were probably primarily grown for fodder (Figure 10). The introduction of cultivated oats to the Heathrow area must have been a significant advance, since oats are well suited to poor acidic, damp soils. They are a high-energy fodder crop and their introduction is often linked to increased use of horses for traction. At Heathrow oats appear to have replaced barley as a fodder crop to some extent, particularly in this period (Figure 10). Whether this was because the barley crop was failing, or because the use of horses increased, is difficult to determine because the bone evidence was so poor in all periods. However, several horse bones and teeth were amongst cattle butchery waste and sheep/goat bones from MIA/ERB waterhole 593190 in the central area of the site, and equid bones were present in three other M/LIA and LIA/ERB waterholes [bone SK, SH-D, JMG]. The high incidence of horse in the Iron Age assemblages was also noted in the Perry Oaks samples, although cattle were still by far the dominant species [bone SK]. Butchery waste from large mammal bones and domestic processing /consumption waste including frequent burnt bone were recovered from different waterholes. Systems of waste management were proposed perhaps involving communal middens as temporary stores prior to backfilling abandoned waterholes and pits. One feature of note, pit 728003, cutting a Late Bronze Age field boundary ditch, contained an almost complete cattle skeleton from a young adult of around 30-36 months. Animal burials are fairly common in the Iron Age although their significance is uncertain, perhaps indicating the disposal of a diseased animal on the edges of the settlement, or having some ritual meaning [bone SK, SH-D, JMG].

The disposal of waste was also noteworthy from a plant macrofossil point of view, since during this period large amounts of charred cereal processing waste were found in secondary fills of wells and waterholes (Figure 3). Burnt crop processing waste was present in all three types of features; pits, ditches and waterholes. Its more widespread distribution than in earlier periods may reflect increased levels of cereal processing in different areas of the site, or may result from the use of burnt waste for specific purposes, e.g. to help dampen odours. Alternatively it may indicate less regulated methods of waste disposal in this period. The insect assemblage from well/waterhole 593207 contained a variety of dung beetles and beetles indicative of accumulated foul, rotting material (e.g. *Oxyomus silvestris*) but no truly aquatic taxa. Scarabaeoid beetles commonly found in dung on open heathland and sandy ground included *Onthophagus ovatus* and *Aphodius rufipes* [insects ET]. Perhaps dung from livestock that had been grazing on nearby heathland areas was deposited in the feature. Waterlogged plant macrofossils from weeds of nutrient-rich midden-type habitats were abundant, including numerous stinging nettle and small nettle seeds, and seeds from fat hen, henbane and chickweed, although no obligate aquatics were represented. A remarkably similar type of plant assemblage was recovered as mineralised plant remains from the Late Bronze Age midden-type deposit at Potterne (Carruthers, 2000), suggesting that material in the well at Heathrow may have been accumulating for some time as a midden prior to being deposited in the features. Since two placed pots were also found in the same secondary fill of well 593207 (context 593201) the deposition of midden material may also have served some sort of ritual function, perhaps signifying the end of use of the well.

A large number of cotton thistle seeds (*Onopordum acanthium*; 116 achenes) were recovered from several samples through this feature. The record is of particular note and could suggest that the plant had a special significance. This tall, fiercely spiny and densly-haired biennial thistle (also known as Scottish thistle and adopted as the emblem of Scotland) is thought to have been introduced from Europe but is possibly native in East Anglia (Stace, 1997). The complete covering of woolly hairs gives it a silver appearance which would have been very usual to Iron Age people, since this type of adaptation to hot, dry European summers is not often found in the British native flora. It is understandable how the silvery appearance may have given it some association with water in the minds of Iron Age people. In addition, it has great economic value since different parts of the plant can be used in a variety of ways; the stems can be boiled, peeled and eaten, the large seeds provide oil that can be used for cooking and lighting (roughly 1.5 litres of oil from 10 plants); downy fibres from the plant have been used to stuff pillows and mattresses in the past; Pliny (AD 23-79), Dioscorides (c.40-c.90 BC) and Theophrastus (372 BCE – 286 BCE) mention cures ranging from baldness and a crick in the neck to curing ulcers and cancer. Some of these qualities and its impressive two metre plus height may well have given cotton thistle a special status. Of course, since it grows in waste places it may have colonised the disturbed soils around the well as a garden escape, or post-abandonment. Even so, its introduction to the site confirms that it was valued for one or other of these reasons. This Late Iron Age record is the most substantial of seven Iron Age records from southern England on the Archaeobotanical Database (ABCD; Allan Hall, pers. comm.), six of which lie along the Thames Valley. The earliest site is an EIA hill fort at Asheldham Camp, Dengie Peninsula, (Bedwin, 1991) situated at the mouth of the Thames, and this probably indicates its route of entry into Britain from the continent. Five records in the ABCD date from the Romano-British period, including twenty-six seeds recovered from Iron Age features at Farmoor (Robinson, 1979). Nine Romano-British sites in London have produced cotton thistle remains (Anne Davis, pers. comm.) suggesting that it remained particularly important to the Thames Valley area. At Heathrow three Early to Late Romano-British waterholes and a pit, and an Early-Middle Saxon waterhole also produced cotton thistle seeds, demonstrating that it continued to be important in the area for many centuries. Although it may have grown as a casual on wasteground following its introduction, its large size and the fact that Roman authors were well-aware of its medicinal value make it inevitable that the plant was at least encouraged (or more probably, cultivated) and exploited in the Romano British period. It is interesting to see that five of the six features on this site were wells or waterholes, even though (as far as the author is aware) water was not involved in any kind of processing.

Although settlement features such as pits and ditches were not waterlogged in the LIA/ERB period (Figures 1 and 2), a number of wet-ground taxa that had previously only been present as waterlogged remains were found as charred plant remains in the LIA to MRB assemblages such as lesser spearwort, blinks and meadowsweet. Charred spike-rush, sedge and buttercup seeds were also present, indicating that burnt waste from marsh or damp meadow hay from wetter soils on the floodplain was present in the features. Pollen and waterlogged seeds from species-rich damp meadows (including damp meadow taxa such as meadowsweet and ragged robin) were also present in the LIA features (see below), representing hay meadows in the vicinity and/or unburnt hay that had been deposited as waste but had rotted away. These remains may have been derived from hay burnt as tinder, or midden deposits of mixed animal byre and domestic waste. Their widespread occurrence in the features confirms the importance of hay production during this period.

The LIA/ERB features produced the only possible evidence for the use of heathland vegetation for fuel prior to the Medieval period, with charred heather (*Calluna vulgaris*) and cross-leaved heath fruits and shoot tips (*Erica tetralix*) being relatively frequent in LIA/ERB waterhole 627042. No Ericaceous charcoal was recovered, however, so the burnt remains could represent small scale collection for some other use, such as bedding, thatching, packing material or fodder. The absence of charcoal suggests either that heathland was not located close enough to make collection for fuel convenient, and/or that other valuable types of fuel wood (such as oak) were still readily available locally. Charcoal from LIA pit 538348 consisted of primarily ash and maple, with oak, birch and hawthorn-group fragments. Challinor [charcoal DC] notes that the frequency of maple and the composition of the assemblage suggest relatively mature woodland or hedgerows that were being managed for fuel by regular pollarding or coppicing, thus producing a very small woodland signal in the pollen record. Pollen evidence for this period, from well 593207 and waterhole 649010 in the central area of the site, continued to indicate a very open landscape with meadows and grassland, cereal cultivation and areas of waste ground [pollen SP, DD & EH]. Traces of *Calluna* pollen were present in most of the samples through these profiles, but the absence of insect species that feed on heathland vegetation suggested that this habitat was located some distance from the features [Perry Oaks insects MR& T5 insects ET].

The Early/Mid Romano-British and Mid/Late Romano-British periods

According to the structural evidence (Chapter 4) changes through the LIA to LRB periods were primarily gradual and piecemeal, with the core of the LIA/ERB settlement remaining intact but increased construction of enclosures suggesting some degree of intensification in the RB period. The most obvious change was alteration to field boundaries in the eastern area during the 3rd century AD, creating a 'ladder enclosure' complex system with a central wide droveway. It is possible that this extra-wide corridor was created in response to increased demand for meat products in the developing market towns of Staines and London to the south and east, and that drovers were passing through on a regular basis. Unfortunately poor preservation of the bone meant that it was difficult to detect any changes affecting livestock as a result of intensification or 'Romanisation'. As with previous periods, cattle continued to be the most abundant species with some horse, sheep, sheep/goat and pig. Traces of red deer and roe deer were found, but no dog or bird bone. However, preservation biases may have operated against many of the smaller species [bone SK]. A M/LRB waterhole from Terminal 5 also produced cattle (including one large bull), sheep/goat and equid remains, with some signs of gnawing and some of butchery. Both meat and waste bones had been deposited in the feature [bone SK, SH-D, JMG].

Plant macrofossil evidence suggested that water levels may have risen at the start of the Romano-British period, probably causing increased seasonal flooding and waterlogging in some areas of the site. Whilst LIA/ERB ditches and pits located in the central area of the site did not contain waterlogged plant macrofossils, pits and ditches dated to the E/MRB and pits dated to the M-LRB in the same area, and with a similar range of depths, contained well-preserved waterlogged assemblages (Figures 1 and 2, 7 to 9). Although standing water was not present on a permanent basis (since obligate aquatic plants were not represented), organic material was well preserved, particularly in the E/MRB pits. It is possible that by the M-LRB period more effective drainage systems (or reduced water levels) had improved the soils to some extent, since ditches from this period onwards did not contain organic material preserved by waterlogging (Figure 2). Levels of maintenance may also have been greater, with ditches being cleaned out on a regular basis.

As in the Iron Age, the landscape appears to have been extremely open during the Romano-British period, with very little woodland apart from perhaps a few scattered trees and possibly old, gappy, impoverished hedgerows [Perry Oaks pollen PW]. Waterlogged 'woods and hedgerow' remains shown in Figures 1 and 2 in the M-LRB pits and ditches consisted of seeds from blackberries (*Rubus* sect. *Glandulosus*), elderberries (*Sambucus nigra*) and, in the E/MRB ditches, raspberries (*Rubus* cf. *idaeus*) rather than true woodland species, perhaps originating from gathered wild and garden fruit from hedgerows, bird droppings or possibly 'night soil' spread on fields. The pollen evidence suggested that grassland and meadows would have dominated the landscape, although evidence for cereal cultivation was more prominent than in earlier periods, particularly in MRB waterhole 527388 [pollen SP, DD & EH]. This feature also produced a single grain of hemp/hop (*Cannabis/Humulus*), hinting at other possible horticultural crops being grown for fibres, flavouring/preservative or medicinal use. Hops are native to Britain so could have been growing in hedgerows or woodland margins, but since these habitats were scarce by the RB period or were being carefully managed, cultivation in gardens is also a possibility Both hemp (7 records in the ABCD) and hop (3 records in the ABCD) macrofossils have been recorded in Roman samples in Britain, including sites in London (hemp - Gray, 2002; hops - Gray 2001). However, these have primarily been military and town sites (van der Veen *et al*, 2008)

The scarcity of woodland taxa in the pollen diagrams was not borne out by the charcoal evidence. Romano-British charcoal samples from Perry Oaks showed that oak was being selected for specific purposes, suggesting that there was no shortage of supply of fuel wood [Perry Oaks char DC]. Possible explanations for this dichotomy are either that a rigorous management regime was in operation, reducing tree/shrub flowering to a minimum, or that wood was brought in from some distance, perhaps being traded for agricultural produce. There was no evidence for the exploitation of heathland for fuel, despite traces of shoots and leaves being found amongst the charred and waterlogged plant macrofossils. This rapid-burning, hot fuel was often used for ovens and furnaces, but there was no evidence for crafts or metalworking from this site. It is presumed, therefore, that adequate supplies of oak were available for fuel and structural timbers, although they may have been located some distance from the settlement, thus providing little pollen evidence. Oak is an anemophilous (wind borne pollen) species, so coppicing or pollarding must have been taking place to reduce its count to '+' trace levels.

According to charred cereal and crop processing waste concentrations, arable cultivation appears to have increased gradually from the LIA period through to the LRB (see Figure 5; average fragments per 10 litre sample). This may have been achieved by improvements in crop husbandry practices and improvements to the land, such as increased drainage (shown by modifications and extensions to field system ditches) and manuring. Evidence for the creation of middens was described above from the MIA and LIA periods, and this appears to have continued into the RB period, since nitrophilous plants such as henbane, black nightshade, hemlock and nettles were common. The effect of increased use of midden material for manuring arable crops can be seen in the weed assemblages, since leguminous weeds such as vetches and clovers decreased significantly from the MIA to the Saxon periods (Figure 6). These weeds are indicators of nutrient-poor soils, as they have a competitive advantage in impoverished soils, being able to fix their own nutrients from atmospheric nitrogen (Moss, 2004). Other improvements in comparison with the MBA include changes in harvesting methods, from uprooting in the MBA to cutting below the ear in later periods. An iron reaping hook was recovered from the ditch of Enclosure E1, providing evidence for this activity, and perhaps the development of tools such as these promoted the change. This change would have greatly reduced weed contamination over time, as described above, and would have enabled livestock to be moved onto arable fields following the harvest to graze off the straw. Alternatively, if cut high enough on the straw, the straw could be harvested undamaged, and would then be more effective as thatch.

An additional factor may have been the movement onto different soils accompanied by changes in the range of crops being grown. The evidence for cultivation of the London Clay was much more substantial in the Romano-British samples, with fragments of stinking chamomile seed heads and numerous (>500) seeds being recorded in one large charred cereal deposit in RB pit 666001. Spelt and hulled six-row barley were the main components of this deposit, and its origin may have been accidentally burnt semi-processed spikelets, in view of the fact that cereal grains were abundant and large contaminants such as weed seeds heads and straw nodes had not yet been removed by sieving. It is likely that the clay soils would have primarily been used for growing spelt wheat, although a little more evidence for the cultivation of bread wheat was recovered from the M/LRB samples (masked in Figure 10 by the large assemblage in pit 666001), and this would also have been suited to heavier, clay soils [macro WJC].

The gradual transition from cultivating primarily emmer in the MBA to primarily spelt in the LIA and RB periods was almost complete by the M/LRB, as seen in Figure 4. As noted above, this change may have been an unconscious process; the effect of growing the two hulled wheats as a maslin, with the higher yielding crop gradually becoming dominant. Small amounts of oats were probably grown for fodder during the RB period, although the presence of cultivated rather than weed oats could not be confirmed in this period. The constant but low occurrence of oats as charred remains is characteristic of crops being used for fodder, since they are less likely to have been parched and fully processed, so had less exposure to fire. Hulled six-row barley was also present as a constant but minor component of the assemblages. However, in pit 666001 much larger quantities were preserved, perhaps reflecting the accidental nature of this charring event. An additional crop that may have been introduced to cope with poor, acidic but well-drained soils in the area was rye (*Secale cereale*). The long root-run of rye makes it useful in well-drained sandy soils, and it can be grown both as an early-bite fodder crop over winter, or for grain. The main concentration (though still small) of rye grains and rachis fragments was found in the gullies of MRB structure B1, perhaps representing the remnants of a stored crop or byre waste. Hulled six-row barley and spelt were also present in this building, but the trace of oats identified probably represented a weed contaminant [Perry Oaks char DC].

The most notable plant macrofossil recovered from this period was a single grape pip from MRB pit 658175. This item was the only evidence to demonstrate that luxury foods were being consumed on the site, from any period. It probably represents imported dried grapes or raisins being purchased from a town nearby – perhaps Staines or London, although vineyards were established in some parts of Britain during the Roman period. Van der Veen (2008) mentions records of eight possible vineyards in Britain, with the most convincing example being at Wollaston in the Nene Valley (Brown *et al*, 2001). The only other non-native economically important plant remains were fifty-five cotton thistle seeds in an E/MRB waterhole and pit, as mentioned with the LIA seeds above. This oil-seed crop (and vegetable, fibre and medicinal plant) may have been continually grown on the site from the LIA to E/MRB periods. Other potential garden plants included raspberry (mentioned above) and mallow (*Malva* sp.) – a native plant for which the record increases notably in the Roman period. Pliny listed a wide range of medicinal uses for mallow and recommended the taking of a spoonful of juice from any of the mallow species each day to guard against diseases in general (Culpepper, 1826). Its large leaves can also be eaten as a vegetable like spinach and the seeds were eaten in the past as a snack. Other Roman farmsteads in the area have produced similarly limited evidence for a 'Romanised' diet, with just the occasional imported, exotic species to hint at the much wider range of fruits, nuts and spices available in the towns. At Thorpe Lea (Robinson in Hayman forthcoming), close to Staines, a single coriander seed was recovered. At Horton (Chaffey *et al.* forthcoming) plums may have been grown (cf. *Prunus domestica*). An additional 'treat' available to several farmsteads was honey, and the recovery of frequent honey bee (*Apis mellifera*) remains from a LRB waterhole, feature 174069, at Perry Oaks confirmed that beekeeping was taking place. At least sixteen worker bees were recovered from the 3 litre sample, indicating that the bees had probably used the waterhole to dilute the honey when they were feeding on it during the winter [Perry Oaks insects MR].

Although settlement structures were difficult to identify during this period, insects from LRB waterhole 174069 were strongly indicative of timber structures and buildings. Woodworm (*Anobium punctatum*), *Ptinus fur* – an species that occurs in stable debris, old hay and granary waste and *Mycetaea hirta*, a fungal feeder indicative of damp places inside buildings, were all present, sometimes in large numbers [Perry Oaks insects MR].

Early /Middle Saxon

Sometime in the late 4th or early 5th century the Romano-British site was abandoned. No evidence for continued post-Roman occupation of the main excavated area was found, but Early Saxon features were revealed in Area 14, a short distance south of the present village of Longford. Although no link to the Medieval village of Longford could be proved, the settlement features lay within the enclosed tofts of the village (Chapter 5).

Three pits, the construction cut for a Sunken Featured Building and a waterhole produced charred and waterlogged (waterhole 555805 only) plant macrofossils. Charcoal was analysed from the SFB, two pits and a posthole. This discrete group of features, although limited in scale, provided a small insight into the environment and economy of a period that is poorly understood. It also enabled comparisons to be made with other periods, although questions must remain as to whether the few samples from periods such as the LBA/EIA, MIA and E/M Saxon were representative. Animal bone was recovered from the waterhole, eleven pits and the SFB backfill.

Because pollen and insect evidence were not recovered from this period, the only sources of information about woodland cover and the overall appearance of the landscape were the charcoal assemblage and waterlogged plant macrofossils from waterhole 555805. The charred cereal and weed assemblages, and the bone assemblages, also provided a little information about the economy of the site, including animal husbandry, the importance of cereal cultivation and types of soils being cultivated.

Charcoal from SFB group 1 was dominated by oak, perhaps reflecting structural timbers but also possibly deriving from post-abandonment dumping of domestic waste. Maple, ash and hawthorn-group fragments were also recorded. Samples from the pit clusters also primarily consisted of oak with some hazel and sloe. Clearly, oak was still readily available, although scrub or hedgerow species were also being used, perhaps from hedge-cutting or scrub clearance. It is interesting to note that heathland was still not being used as a fuel source, even though there was evidence for this at the nearby Saxon sites at Hounslow and Kingston upon Thames (Smith, 2002, p.33) [char DC]. Despite its current name, Heathrow, heathland vegetation does not appear to have been growing close to Area 14. In addition, no heathland remains were recovered from the charred or waterlogged plant macrofossil assemblages.

Although Figure 3 does not show a strong presence of woodland (due to masking by abundant stinging nettle seeds), frequent twigs and wood fragments in the waterhole and a few fruits and thorns from shrubby species suggested that hedgerows or scrub was growing nearby. Hawthorn, hazel and blackberry macrofossils were present, fitting in with the charcoal evidence and suggesting that soils in the western area of the site might have become drier during this period (indicated by the presence of hazel). Supporting this suggestion, pits and ditches were not waterlogged in Area 14, as shown in Figures 1 and 2.

The dominant habitat represented by waterlogged plant macrofossils from the waterhole was one of disturbed, nutrient-enriched soils, as indicated by the abundance of stinging nettle, fat hen, chickweed, dock and henbane seeds. Since one of the samples came from the base of the waterhole and the second contained a very similar assemblage, the remains are unlikely to represent dumped midden material in this case (unlike the Iron Age deposits).The evidence suggests disturbance and nutrient-enrichment around the waterhole, although how characteristic this type of habitat was of the rest of the settlement cannot be known. The feature must have been used by livestock fairly intensively over a long period, since both annuals and perennials were present and a diverse wasteground flora was indicated. Secondary fills contained waste deposits consisting (according to the bone evidence) of general refuse resulting from butchery and consumption. Cattle, sheep/goat and a young male pig were represented, but the level of deposition was not large scale [bone SK, SH-D, JMG].

Bone assemblages were examined from eleven pits, some of which contained small quantities of bone originating from specific activities such as butchery or table waste. This suggests piecemeal deposition of waste into whichever feature was open and convenient at the time, rather than an organised waste disposal strategy [bone SK, SH-D, JMG]. The SFB, on the other hand, contained large quantities of bone, including some large elements, indicating deliberate backfilling post-abandonment. Only a few charred cereal grains were present in the backfill, including bread-type wheat and barley, but it is interesting to note that the only non-cereal item was a charred sedge seed. Charred sedge seeds and tubers were frequent in a large number of SFB's at West Heslerton, Yorkshire (Carruthers & Hunter, forthcoming) leading to suggestions that turves had been used as walling of roofing materials. The other items of note were a couple of mineralised 'nodules' that are commonly found in mineralised faecal deposits. Although sample residues were not available to confirm the presence of faeces, secondary deposition of this type of waste has been found on other sites, for example Abbots Worthy, Hampshire (Carruthers, 1991) and West Heslerton.

Taking the bone assemblage as a whole, butchery evidence such as cut marks and fragmentation were typical for the period, and there was some evidence of small scale antler working. The evidence for the exploitation of wild resources and fowl was very limited (a red deer metapodial and foot bones of domestic fowl), as is typical for the period, and a single dog tooth was the only evidence for this species. It is uncertain how representative the species composition was from this relatively small number of features, but minimum number of individuals suggested that sheep were the most frequent species (though making up a smaller proportion of the bones than on other Saxon sites), but pig and horse were common and cattle comprised a lower proportion than before. The relative frequency of pigs when compared with the general trend of decline in pig numbers in the Saxon period (King, 1991) could indicate that areas of scrub and woodland were readily available as wood pasture. Some other Saxon sites in the area have also produced high pig numbers (Cowie & Harding, 2000). Aging information indicated that pig and sheep/goat breeding was occurring on site. Mature cattle and horse remains may have been from working animals, and this suggestion was supported to some extent by pathological evidence observed on some horse bones. The absence of butchery marks indicated that horses were not being eaten, possibly because of the church ban on horse meat. Sheep and horse sizes appear to have increased over time, perhaps as a result of breeding programs and/or the importation of new bloodstock during the Romano-British period [bone SK, SH-D, JMG].

Alongside the evidence for a reasonably diverse pastoral aspect to the economy, the evidence for arable cultivation was fairly minimal (Figure 5). The average charred fragments per litre was only 0.3 (the lowest from all of the periods) and no concentrations of charred cereal remains were found. The only chaff to be found (a barley rachis fragment and an emmer/spelt spikelet fork) was recovered from the waterhole, perhaps because preservation conditions were better in this waterlogged feature. However, chaff is often scarce on post-Roman sites because of the change from cultivating hulled wheat for human consumption to free-threshing wheats, which do not require parching prior to threshing. This change can be seen in Figure 10, which also shows a major increase in barley cultivation when compared to earlier periods. Although it is uncertain whether the few cereal remains in these samples were representative of the settlement as a whole, the change to the production of more fodder crops than grain for human consumption could mirror changes seen in the Late Bronze Age to Middle Iron Age, when charred fragments per litre were similarly low (Figure 5) and, in the LBA at least, barley was more frequent than wheat. This suggests a change in the arable / pastoral balance towards pastoralism. Barley is an excellent fodder crop, the straw can be fed to livestock as well as the grain, it will grow on a range of soils and does not require too much manuring. During these periods pastoral farming appears to have been the major component of the economy, with small amounts of cereals possibly being grown for fodder, and hence not becoming charred in any quantity, or maybe being brought onto the site. The small amount of evidence from the arable weed ecology indicated that clay soils were being cultivated, perhaps with some damp areas and manuring was probably taking place. No new weed taxa were present to indicate long distance importation of grain, but no doubt a similar range of weeds would have been found amongst much of the grain being sold in markets such as Staines, so the question of producer / consumer is difficult to answer. It may be significant that no grain processing equipment was found on the site (although negative evidence should always be viewed with caution). Cereals being used on the site during this period included bread-type wheat, barley and probably oats. It is uncertain whether the single emmer/spelt spikelet fork was residual or indicated the continued cultivation of some hulled wheat for fodder, but this has been proved to occur on some sites through radiocarbon dating. Sites of this period are quite varied in which cereal was the dominant crop, perhaps because it depended more on the qualities of the available soils at a time when crop husbandry methods were fairly basic. With increased availability of wheat, barley, oats and rye a wide range of soils could now be cultivated for different purposes.

Environmental evidence for small scale craft working on the site was more notable. The waterhole produced anaerobically preserved evidence of crops that probably were being grown on the settlement, perhaps on a garden scale for personal use rather than as major crops for market. The remains from three different species of plant used to produce fibres were present, perhaps indicating small-scale craft activities taking place on the site. As in the Late Iron Age and RB samples, cotton thistle seeds were present, and this plant produces downy fibres used to stuff pillows, mattresses etc. No doubt the valuable oil from the seeds would also have been extracted, but it is not known whether the plant was used in other ways (e.g. as a vegetable, or medicinal uses). Secondly, a few fragments of possible hemp (cf. *Cannabis* sp.) seed were present along with twelve small fragments of cultivated flax capsule (*Linum usitatissimum*), suggesting that the waterhole may have been used for retting. Since retting would cause pollution and eutrophication of standing water, the remains must represent a secondary use of the feature, having been abandoned as a waterhole. Even if retting was not taking place in the waterhole, it was probably occurring nearby for waste materials to have been deposited, perhaps in the margins of the River Colne, since slow flowing water is more effective for this process. An alternative explanation is that flax rippling waste (suggested by the small size of the capsule fragments) and hemp processing waste (possibly involving crushing because of the fragmented seeds) had been used to temper daub that was being prepared in the waterhole (as suggested in Chapter 5), since use of these types of waste materials has been found in daub from other sites (e.g. Althrey Hall, Wrexham; Carruthers, 1990).

Once the outer tissues of the plant stems have rotted away, the bast fibres from both of these plants can be made into textiles and cordage, with hemp being coarser and better suited to cordage and sacking, and flax producing finer linen fabrics. An additional potential fibre crop that was used in Northern Europe until recently, and that is often overlooked, would have been nettles. Although the fibres are coarse and can be more difficult to extract, they would have been readily available around the settlement or easy to grow. Perhaps some of the abundant stinging and small nettle seeds found in the waterhole originated from plants being retted. It is also possible that some of the other remains were derived from plants used for dyeing, since plants producing coloured berries such as bittersweet (*Solanum dulcamara*), hawthorn and blackberry have been used to dye textiles in the past. Although no textile-working artefacts were recovered from this site, none of the tools are likely to have survived, being made of wood, for example rippling combs (used to remove seed heads prior to retting) and scutching blades (used to break the retted fibres from the stems).

The Medieval Period

Medieval settlement appears to have originated in the C11th-C12th, centred on Area 49 in the main excavated area. Details of the buildings and enclosures of what might be the settlement of Burrow Hill Closes are described in Chapter 5. A small number of samples from settlement features provided information about the local environment and the economy of the settlement.

Multidisciplinary analyses of waterhole 529139 (located close to the east Stanwell Cursus ditch) revealed that changes to the landscape had taken place since the Saxon period. Although the landscape was still predominantly open, woodland taxa were much more in evidence than at any time since the Bronze Age. The plant macrofossil assemblage from this feature contained abundant leaf, bud and twig fragments, with frequent acorn fragments, rose and blackberry seeds and seeds from the woodland herb, three-nerved sandwort (Figure 3) [macro WJC]. The pollen evidence showed that arboreal pollen in the area had increased to relatively high levels (15% to over 20%), particularly oak and ash pollen. Ash is a tree that will rapidly colonise cleared areas within woodlands. The high oak values may indicate areas of wood pasture, consisting of large standard oak and ash trees surrounded by grazed grassland. The wide range of other woody taxa included holly, rose, elder and honeysuckle [pollen SP, DD & EH]. The insect assemblage in this feature also provided evidence for woodland, with tree-dependant species including beetles found on ash (scolytid beetles *Hylesinus oleiperda* and *Leperisinus varius*), and willow/poplar (curculionid beetle *Dorytomous* spp.) [insects ET]. This pear-shaped waterhole at the northern end of a Medieval enclosure must have been located close to, if not adjacent to, woodland or wood pasture, since acorns indicate the presence of mature oaks. An alternative interpretation is that leaf fodder had been brought into the enclosure to feed livestock. However, the abundance of leaves and twigs in the waterhole suggests that it is more likely that woodland existed very close to the feature. It is interesting to note that the character of the plant macrofossil assemblage in this waterhole closely matched that of the Bronze Age waterholes, with no charred cereal remains and abundant woody material [macro WJC].

Other insect taxa found in the waterhole were indicative of heathland (e.g. curclionid *Strophosoma capitatus*) [insect ET]. Heather (*Calluna vulgaris*) pollen was also quite frequent in the waterhole [pollen SP, DD & EH]. The exploitation and possible proximity of this habitat was confirmed by the recovery of frequent charred heather capsules (*Erica* sp./*Calluna vulgaris*) from two Medieval pits and a ditch [macro WJC]. In addition, gorse/broom charcoal was present in a ditch and a pit [char DC]. As with the woodland taxa, heathland vegetation could have been brought onto the site for use as fuel, bedding, fodder and thatch. However, evidence for use of this valuable resource was very limited from earlier periods (mainly LIA/ERB), despite pollen and some macrofossil evidence for heathland development in the area from at least the Iron Age. Therefore, evidence for use in the Medieval period either suggests that heathland was growing very much closer to the site at this time, or that rapid-burning gorse/broom and heather was being brought onto the site as fuel for a particular purpose. It would appear that good fuel wood such as oak was not in short supply, as four charcoal samples from pits and ditches produced predominantly oak, but with beech being used in reasonable quantities for the first time.

The fact that oak may have been growing so near to the western side of the excavated area and beech was more readily available suggest that water levels may have fallen by this period, a theory supported to some extent by the scarcity of waterlogged plant remains in pits, ditches and waterholes (apart from 529139, the deepest of the medieval waterholes at 1.55 m) from all areas of the site (Figures 1-3 and 7-9). Waterhole 529139, however, clearly held standing water, since obligate aquatic plants such as water-starwort and duckweed were represented. Water-beetles (including *Hydrobius fuscipes*, a species of stagnant water with lush vegetation) also indicated that fairly deep, permanent water existed in this feature [insects ET]. Other plant macrofossil and insect species represented open grassland and disturbed habitats, including some plants of grazed meadows (e.g. thistles; *Cirsium/Carduus* sp.) and some of drier hay meadows (e.g. fairy flax; *Linum catharticum*). This may have originated from hay brought into the enclosure for winter fodder.

The animal bone assemblage indicated that by the Medieval period further specialisation in animal husbandry could be seen, with pigs being killed relatively young for meat and cattle kept to maturity to provide secondary products such as milk, manure and traction. The main species of livestock represented were horses and cattle, with smaller proportions of sheep/goat and pig. Possible skinning marks and cuts on some of the horse bones suggested that, although horse meat was probably not eaten by humans, the skin would have been used and the meat fed to dogs. The small proportion of sheep in what might be assumed to have been a wool-based economy was notable. However, preservation was often poor and the origin of the remains in many of the waterholes was probably trampled material eroding in from the sides. Both butchery waste and food remains were present in the features, and there were signs of gnawing on some bones. Roe deer was also present, indicating occasional consumption of game. The recovery of four roe deer bones from pit 555777 may indicate deliberate burial, perhaps to avoid detection of venison that had been illicitly hunted [bone SK, SH-D, JMG]. The presence of pig and deer could be seen as further evidence for the existence of woodland close to the site.

Comparisons between excavated bone data and documentary records from Harmondsworth (see Chapter 5 Table 5.21) revealed vast discrepancies, particularly with smaller species such as sheep/goat and pig which were greatly under-represented in the archaeological record. A range of birds including ducks, geese, swans, peacocks, capons chicken and pullets were totally absent from the bone record, indicating the extent of information that was also likely to be missing from the Heathrow records. Although not included in Table 5.21, fish would also have been an important food source to occupants of a major river valley.

Three pits and a ditch from the west (Area 51, ditch 559118), east (Area 77) and north (area 58) of the excavated area produced high concentrations of charred cereals and crop processing waste, indicating that arable cultivation was taking place on the site. Ditch 559118 in the south-west corner produced a particularly rich assemblage (254.6 fragments per litre of soil sieved), possibly because it appears to have been part of a barn that burnt down. Accidental burning may be the reason why preservation conditions were particularly good and chaff fragments were unusually high, since charred domestic waste from Medieval sites usually contains very little chaff. The assemblage included weed seeds such as corn cockle (*Agrostemma githago*) and stinking chamomile still fused together (due to charring) as if still inside the capsule / seed head. Straw nodes (the ‘joints’ in the stem) were also preserved and these are easily crushed. This assemblage was very similar to a large deposit of grain from a barn at Wharram Percy that was burnt down in 1553 which provided evidence of several crops in different parts of the barn, including bread-type wheat stored as unprocessed sheaves. Ratios of grain to chaff, and grain to straw nodes, were very similar to some of the samples from the Wharram barn (see Carruthers *CD Section 14*) suggesting that crops stored in sheaves may have been preserved at Heathrow. This would explain the high incidence of weeds (ratio of 8 : 1 : 6 grain to chaff fragments to weed seeds) and the fact that whole seed heads of weeds were still present. Accidentally burnt unprocessed assemblages of this kind provide useful information about crop husbandry, since the composition has not been biased by crop processing or (to a lesser extent at least) by differential preservation.

The high levels of weed infestation in this crop, in particular leguminous vetches and clovers (Figure 6), suggest that impoverished, heavy clay soils were being cultivated. Since a mixture of stored crops consisting of bread-type wheat, hulled six-row barley, oats and rye were present (ratio 19 : 1 : 1 : 3, wheat to barley to oats to rye), the accompanying weeds for each crop will also have been mixed, making it difficult to interpret information from the weed ecology. Ideally, bread wheat would have been grown on clay soils (available to the east of the site) which would probably require manuring, barley would have been grown on lighter, well drained soils on the gravel terrace, and oats and rye would have been useful for poorer, acidic soils. The damp alluvial soils of the floodplain would have been used for hay meadows and summer grazing, as in the centuries before. Figure 11 shows that bread-type wheat was always the dominant cereal in the four features. Although weed associations could not be confirmed in these mixed assemblages, the highest occurrence of small-seeded weed vetches were found in the feature with the highest proportion of rye, and vice versa, perhaps supporting the suggestion that fodder crops such as rye were grown on the poorest soils. Using a different approach and comparing weed indicators of spring sown crops with indicators of autumn sown crops (Bogaard *et al* 2001) produced no clear relationships, which may be because sowing times were fairly flexible, fitting in with rotation systems and changes in weather patterns from year to year.

Additional crops grown during this period may indicate that crop rotation was taking place in order to help restore soil fertility. Cultivated vetch (*Vicia sativa* ssp. *sativa*), Celtic beans (*Vicia faba* var. *minor*) and possibly peas (cf. *Pisum sativum*) are leguminous plants that were commonly grown during the Saxon and Medieval periods for fodder, and sometimes for human consumption. Peas and beans may have been grown as garden plants, or on a larger scale in rotation with cereals. It appears that at this site they were probably being grown as field crops since they were found amongst charred cereals in all four samples. At Wharram there was evidence to suggest that cultivated vetch was being grown as a maslin with wheat, perhaps helping to prevent lodging as well as improving soil fertility. Small numbers of charred peas were found in one area of Wharram barn. Spatial evidence at Wharram demonstrated that barley and oats had been grown as the maslin, dredge, and this type of crop, which was commonly grown during the medieval period for fodder, may have been grown at Heathrow. Figure 11 shows that where barley was most frequent (pit 537105), oats were also most frequent, and vice versa in ditch 559118.

The presence of several charred hazelnut shell fragments and a sloe/cherry/plum (*Prunus* sp.) stone fragment in the pits hints at other wild and possibly garden fruits and nuts that were being consumed. A poorly preserved possible charred flax seed was also present, suggesting that flax cultivation continued into the Medieval period.

The Later Medieval Period, C13th – C14th

A C13th-C14th waterhole in Area 49 (569022) to the south of Medieval waterhole 529139 was found to contain only a little waterlogged material in its lowest level. All of the sampled deposits contained some charred plant remains, indicating that small amounts of domestic waste had been deposited in the feature. The fact that all but the very lowest deposit had dried out is of interest, since several waterlogged deposits within the Medieval waterhole 100 metres to the north were well preserved, although this may be due to the greater depth of this feature (1.55 m as opposed to 1.28 m). The waterlogged assemblage from the lowest level of waterhole 569022 may also have been affected by differential preservation, since tough-coated seeds like elderberry were frequent. For this reason it provided little information about the surrounding environment except to demonstrate that weeds of disturbed, nutrient-enriched soils were common [macro WJC]. Soil samples from two other features in Area 49 also showed marked phosphate enrichment when compared to prehistoric levels [soils RM & JC].

The charred cereal assemblages showed that more or less the same range of crops were being grown as in the previous two centuries of occupation, including bread-type wheat, hulled six-row barley, oats, rye, cultivated vetch (Figure 11) and possibly peas. It is impossible to know whether samples from this single feature were representative of the settlement as a whole, but there may have been an increase in rye since the C10th-C11th, as it was the most frequent cereal in two of the five samples. This could suggest difficulties in maintaining the fertility of the soils. The presence of a charred henbane seed indicates that middening was probably taking place, but few other weed seeds were present to provide this kind of information, since most of the charred remains came from processed domestic food waste. It is interesting to note that the pottery from this settlement included fine glazed wares and continental imports, suggesting high status occupants. There were no signs from the charred plant remains in this feature that the diet included imported luxury foods, although well-preserved waterlogged and mineralised cess pit deposits would be the best sources of this type of information. Perhaps the slight hint of increased cultivation of rye indicated a diet influenced by Continental Europe, too, since rye was the principal cereal consumed in Western Continental Europe for much of the Medieval period (Bakels, 1991), in contrast with most areas of Britain.

The only other environmental information recovered from this period was a deposit of charcoal from kiln 523075 which was made up entirely of oak. It is possible that the oak had first been made into charcoal before being used as fuel for the kiln, but this could not be proved. It demonstrates that deliberate selection of the best fuel for the job was taking place at this time [char DC].

Post-Medieval

Documentary records provided information about changes to the landscape occurring in the post-medieval period, in particular, enclosure of the land which eventually transformed its appearance to the patchwork of fields that we have today (Chapter 5). The only environmental samples examined from this period came from a subrectangular pit in Area 17 that was cut into the upper layers of the palaeochannel. This feature (pit 546437) may have been wattle-lined and was thought to have been a retting pit. It was filled with a very organic deposit with clay lenses that indicated periodic flooding episodes. A gully may have fed water into its northern end. Pollen and plant macrofossils from several layers within the feature were analysed.

Although both pollen and plant macrofossil assemblages were well-preserved and diverse, the results were not as conclusive as might be hoped. Small quantities of probable hemp pollen and possible hemp seed fragments were found, perhaps indicating use for retting hemp. Flax was not present but several hop seeds were found. Since woodland remains from floodplain alder carr were common, including leaf, bud and seed fragments of willow, ash and alder, the hop remains may have been washed in from woodland growing nearby. Hops can be used for dying, and of course for flavouring and preserving beer, but it is uncertain whether deliberate or accidental inclusion had occurred in this case.

The pollen evidence for woodland was similar to the level in medieval pit 529139 in Area 49 (around 20% TLP), although it increased in the upper part of the sequence through the pit, with ash and oak showing notable rises in frequency. This may suggest some reduction in farming intensity, enabling ash and then oak to become established in drier areas that were no longer farmed.

Remains such as a charred rye grain and barley rachis fragment (chaff) and three cherry stones (*Prunus avium*) were the only other evidence of cultivated plants, with the charred cereal remains probably having been washed into the palaeochannel from manured fields and the cherry stones having been collected by rodents from a garden nearby, since they showed signs of nibbling. Remains from aquatic and marsh plants (including duckweed, water crowfoot and flote-grass) provided information about vegetation possibly growing in and around the pit, or perhaps washed in to the pit during flooding episodes. Plant macrofossils from meadow plants such as meadowsweet and buttercups represented floodplain meadows growing along the Colne valley.

Although the evidence for hemp retting in the pit was slim, this could be explained by examination of methods that were probably used. Hemp was commonly grown as a garden plant or a crop during the medieval period, since it could be used to provide fibre and for medicinal purposes. Plants are considered ready for retting shortly after pollination, when the first seeds are developing in the female plants (perhaps explaining low seed numbers). Male plants are said to produce the finest quality fibre

(Horkay & Bosca, 1996) so frequent pollen might be expected. Since the flowering heads of the plant are most effective for medicinal use, these may have been removed prior to transportation to the retting pit. The plants are also stripped of leaves, and bundles of stems are left in water for 7 to 10 days for the tissues surrounding the bast fibres to rot away. Continuous trickling or periodic washing through with water to speed up retting and the stripping of leaves and flowers would probably remove most of the pollen and seeds, explaining the scarcity of evidence in the feature. Enrichment of the soil around this feature due to retting may have encouraged weeds like nettles to grow. However, periodic flooding of the palaeochannel area might remove waste and vegetation. Although fairly frequent nettle seeds were present, other nitrophilous weeds were scarce. It is possible, therefore, that nettles were also being retted in the pit from time to time, even though pollen levels were not particularly high.

Conclusions

Multidisciplinary studies of this extensive area of waterlogged and dry deposits has enabled a sequence of changes to the landscape to be proposed that extends for ##### thousand years. The examination of large numbers of Middle Bronze Age environmental samples has provided a detailed picture of settlement, economy and the wider environment. This could then be compared to other, less well-represented periods in order to investigate topics such as changes in woodland cover, changes in water levels and changes to the soils. The economic information concerning arable crops fits in well with other sites excavated along the Thames Valley for most periods. Unfortunately poor bone preservation meant that pastoral aspects of the economy could not be fully investigated.

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Figure 1: Pits (no. of features)

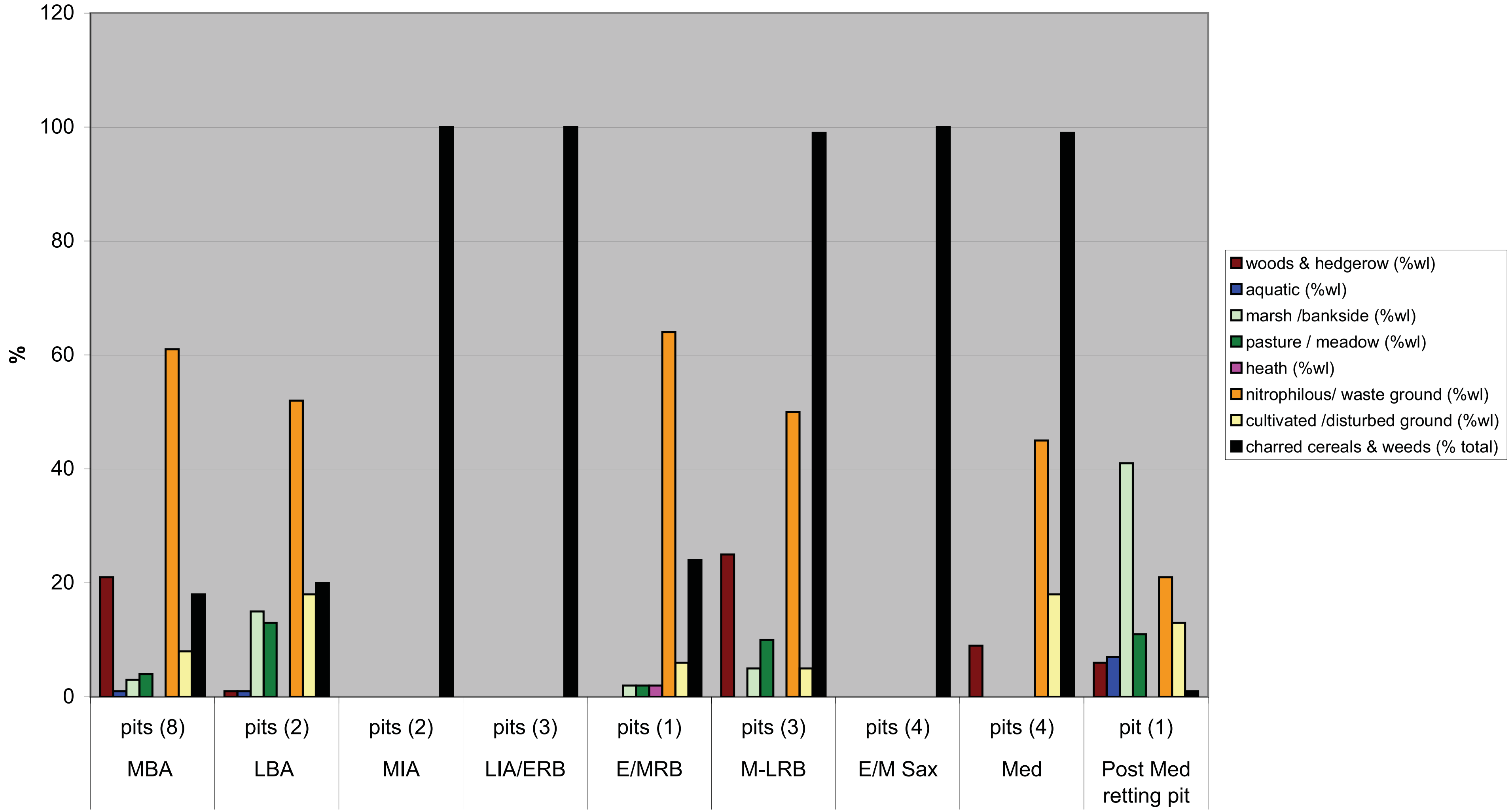


Figure 2 : ditches (no. of features)

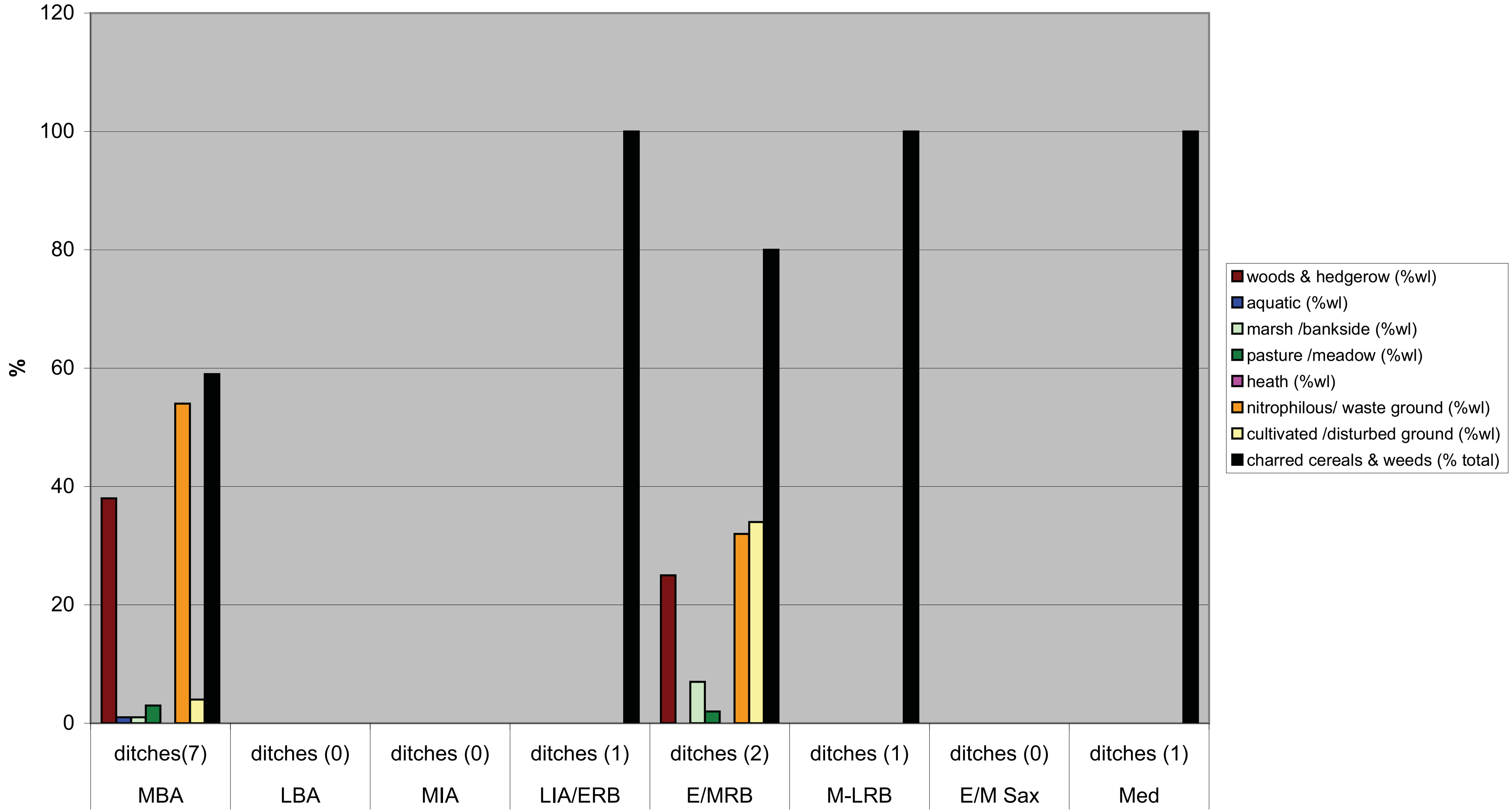


Figure 3 : waterholes (no. of features)

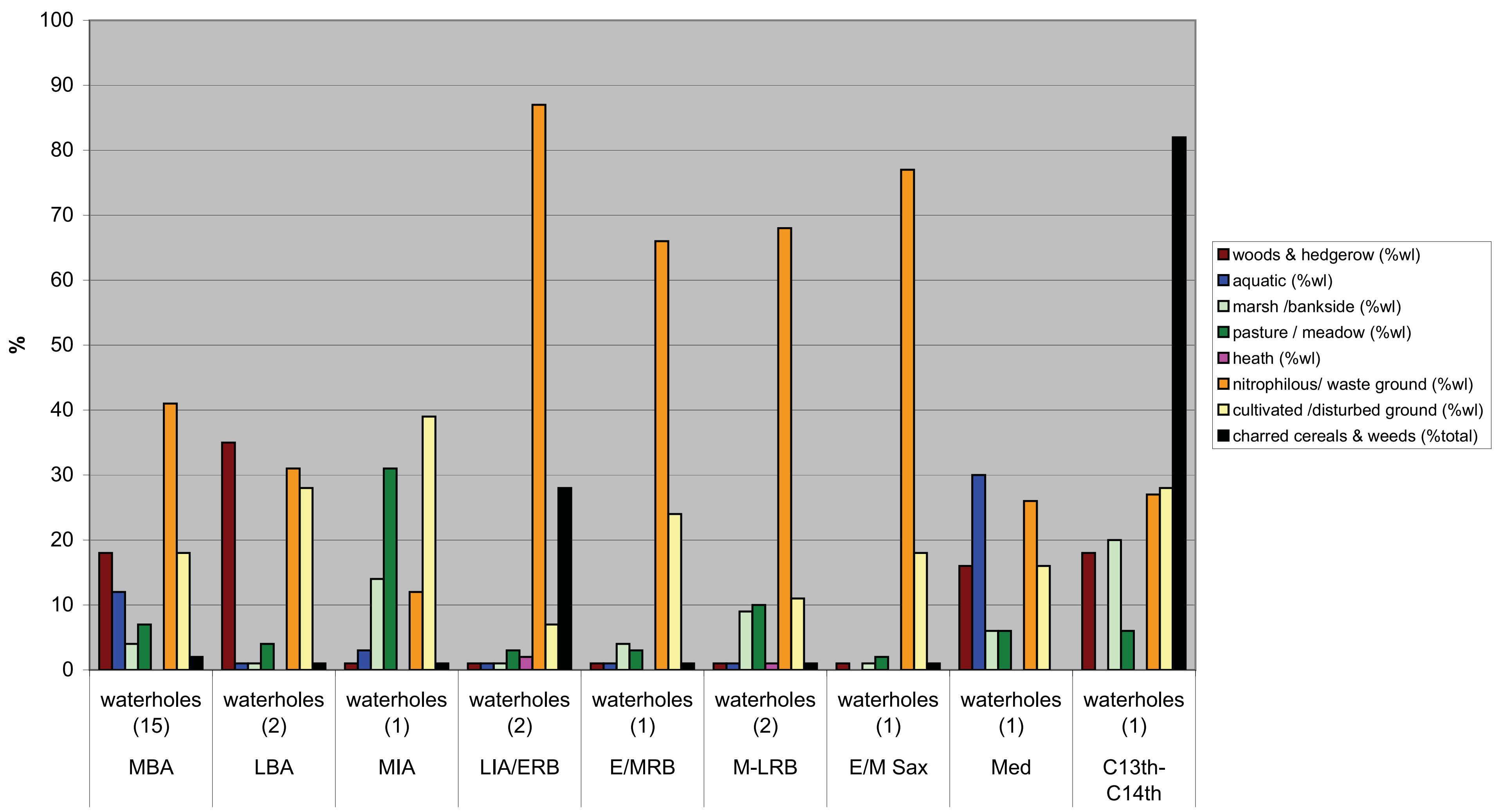


Figure 4: Perryoaks & Terminal 5 transition from emmer to spelt wheat cultivation (total no. of identifiable glume bases)

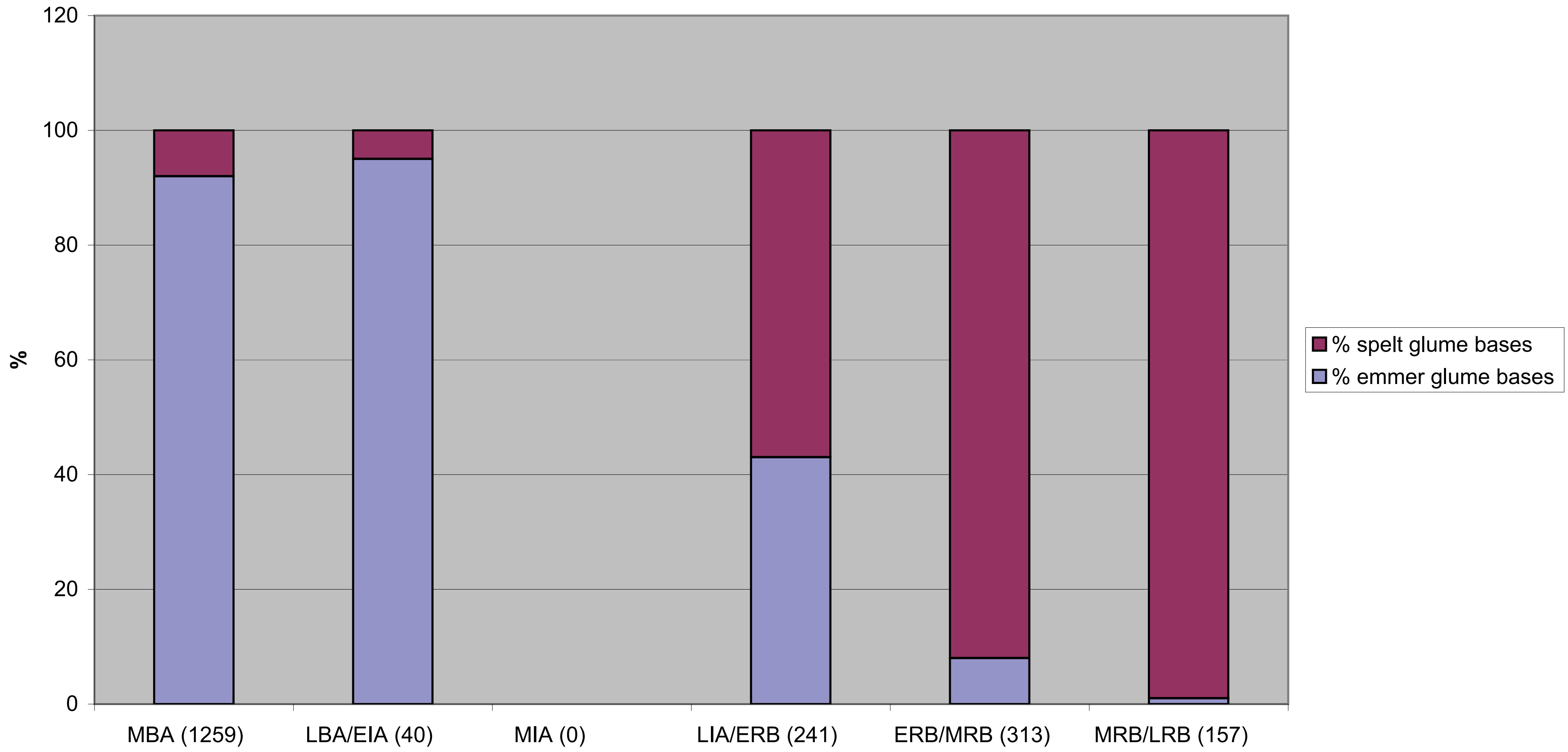


Figure 5 : charred fragments per litre (no. of samples)

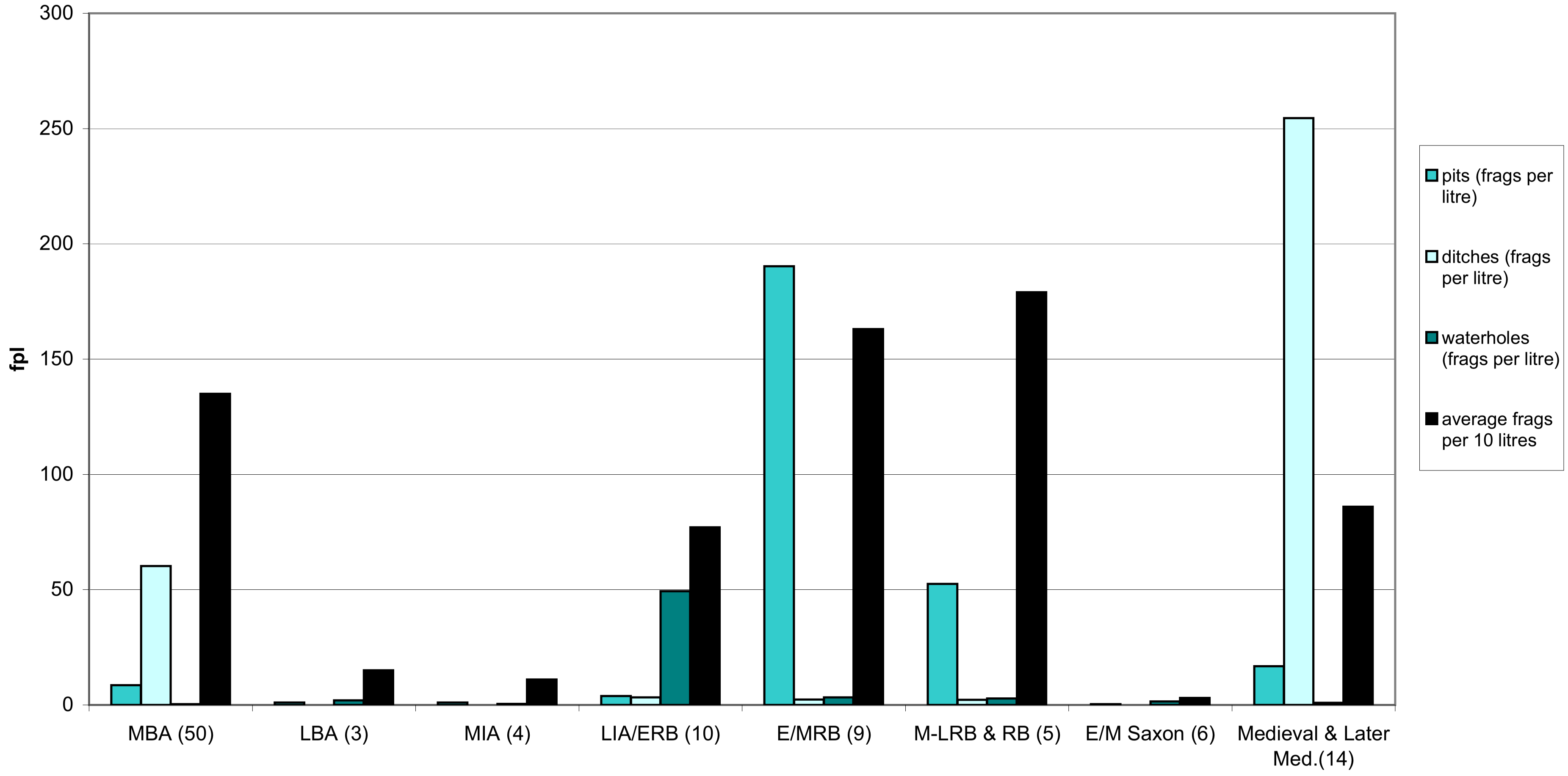


Figure 6: small legume seeds per 10 litre soil sample (pits and ditches only)

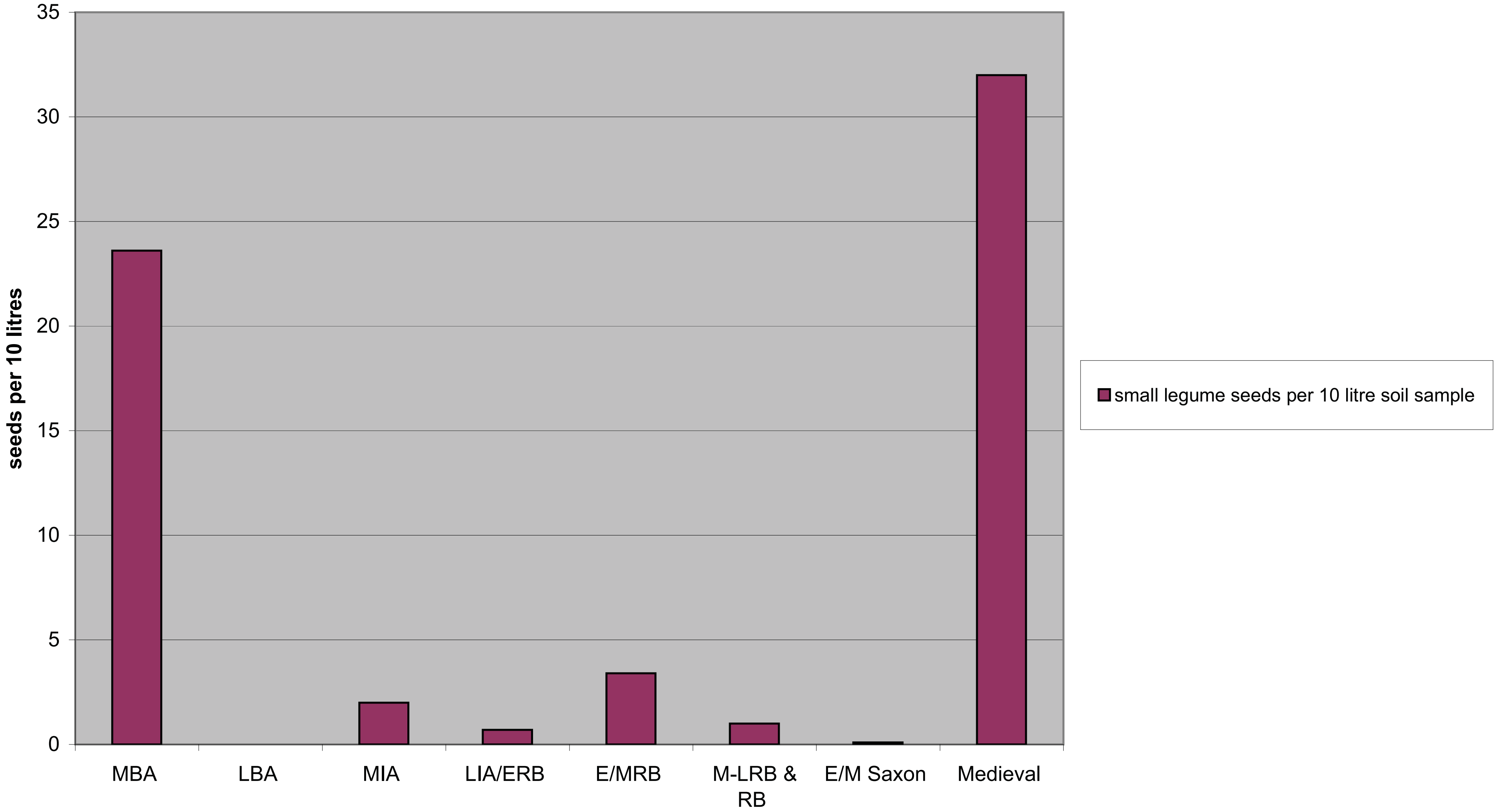


Figure 7: Concentration of waterlogged remains in the pits (no. of samples)

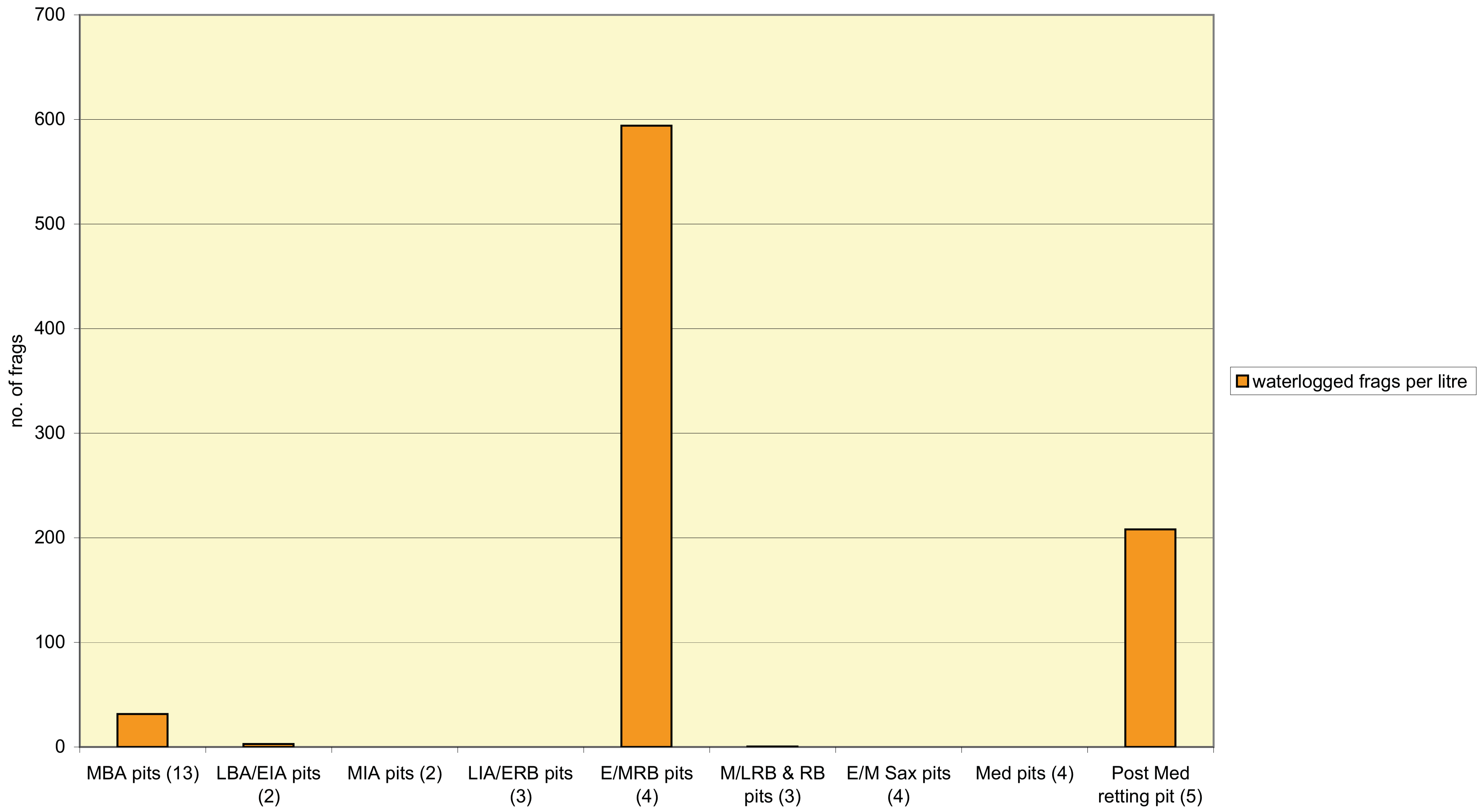


Figure 8: Concentration of waterlogged remains in the ditches (no. of samples)

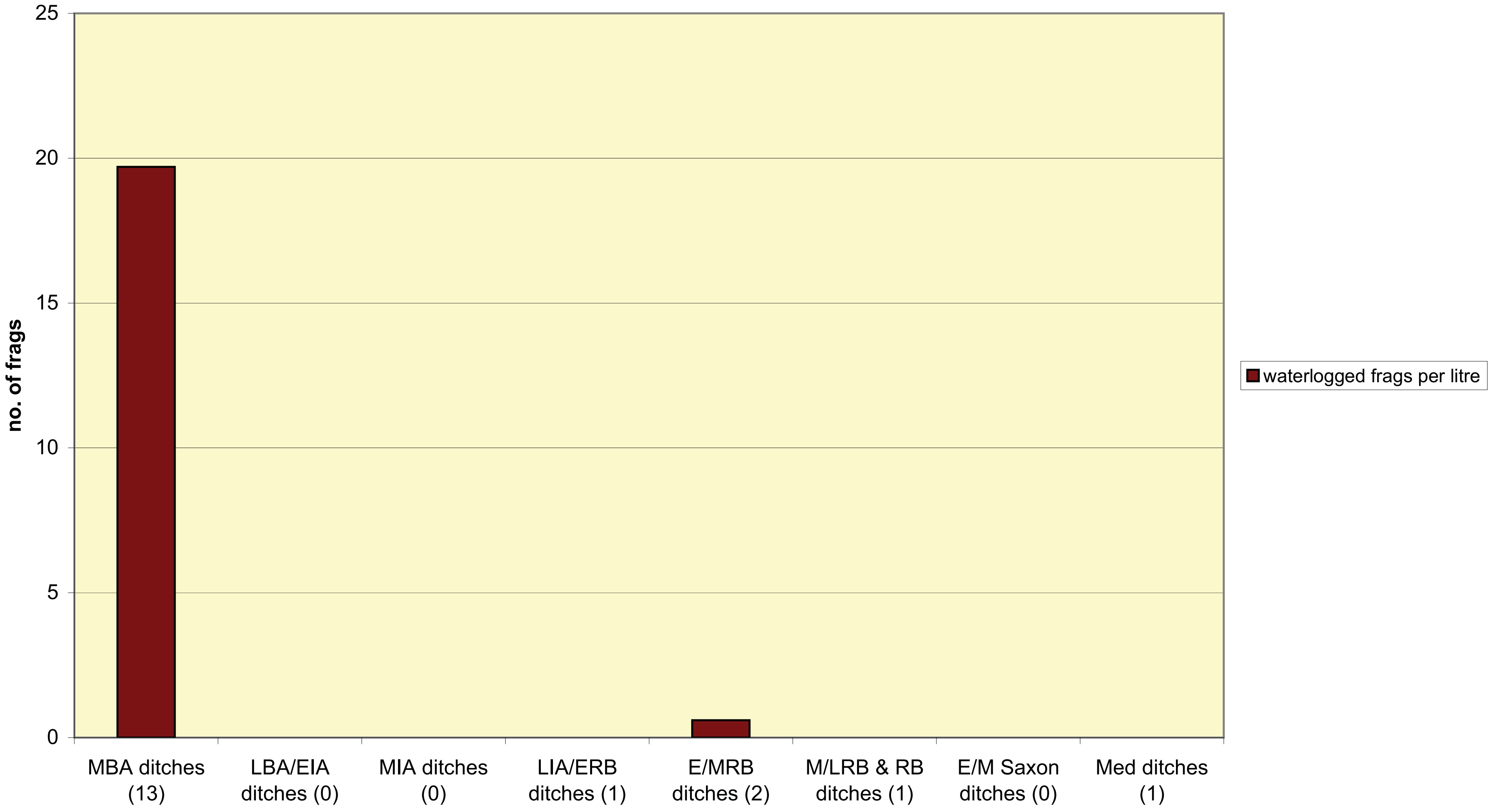


Figure 9: Concentration of waterlogged remains in the waterholes (no. of samples)

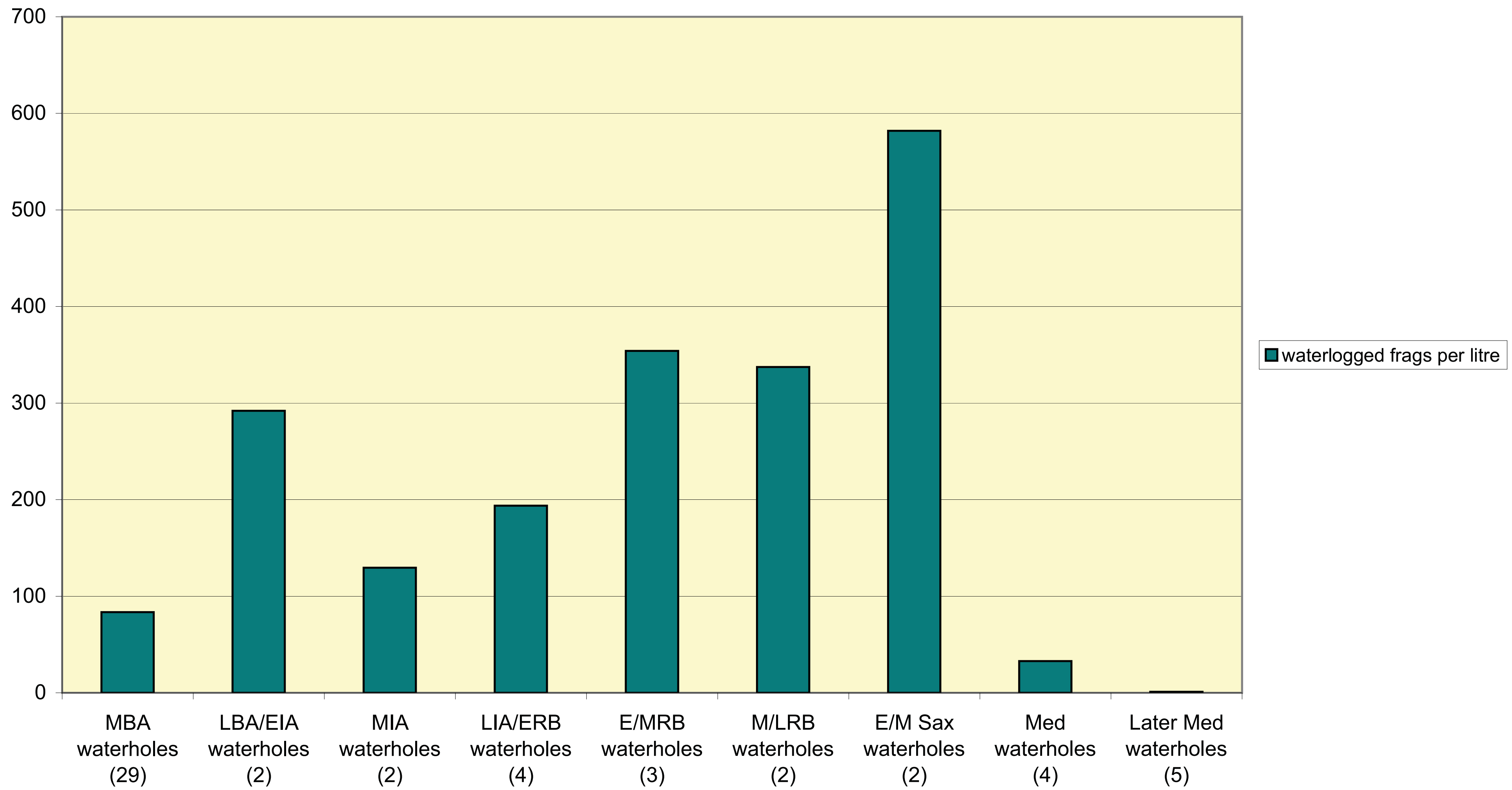
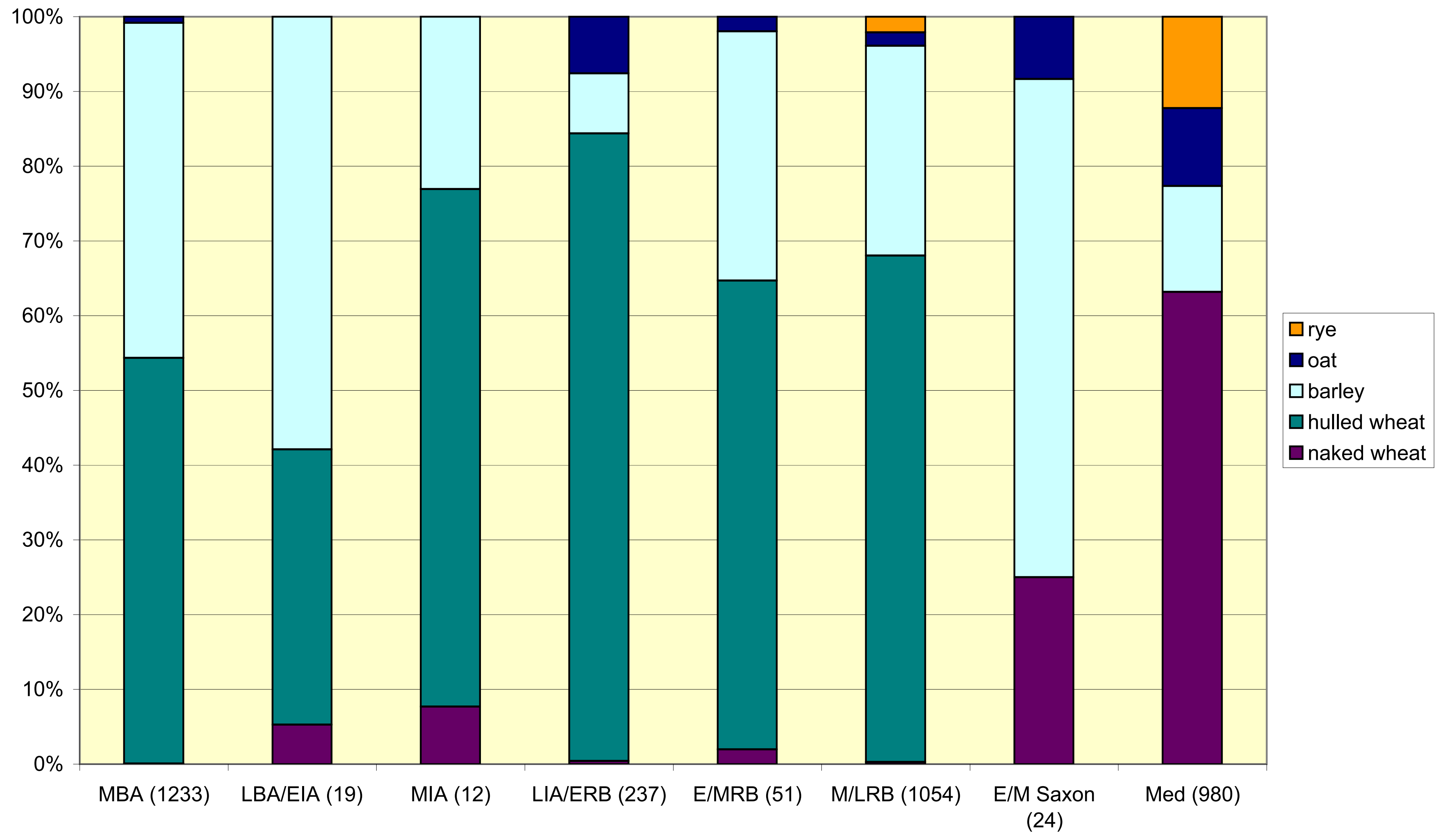


Figure 10: Cereal grains



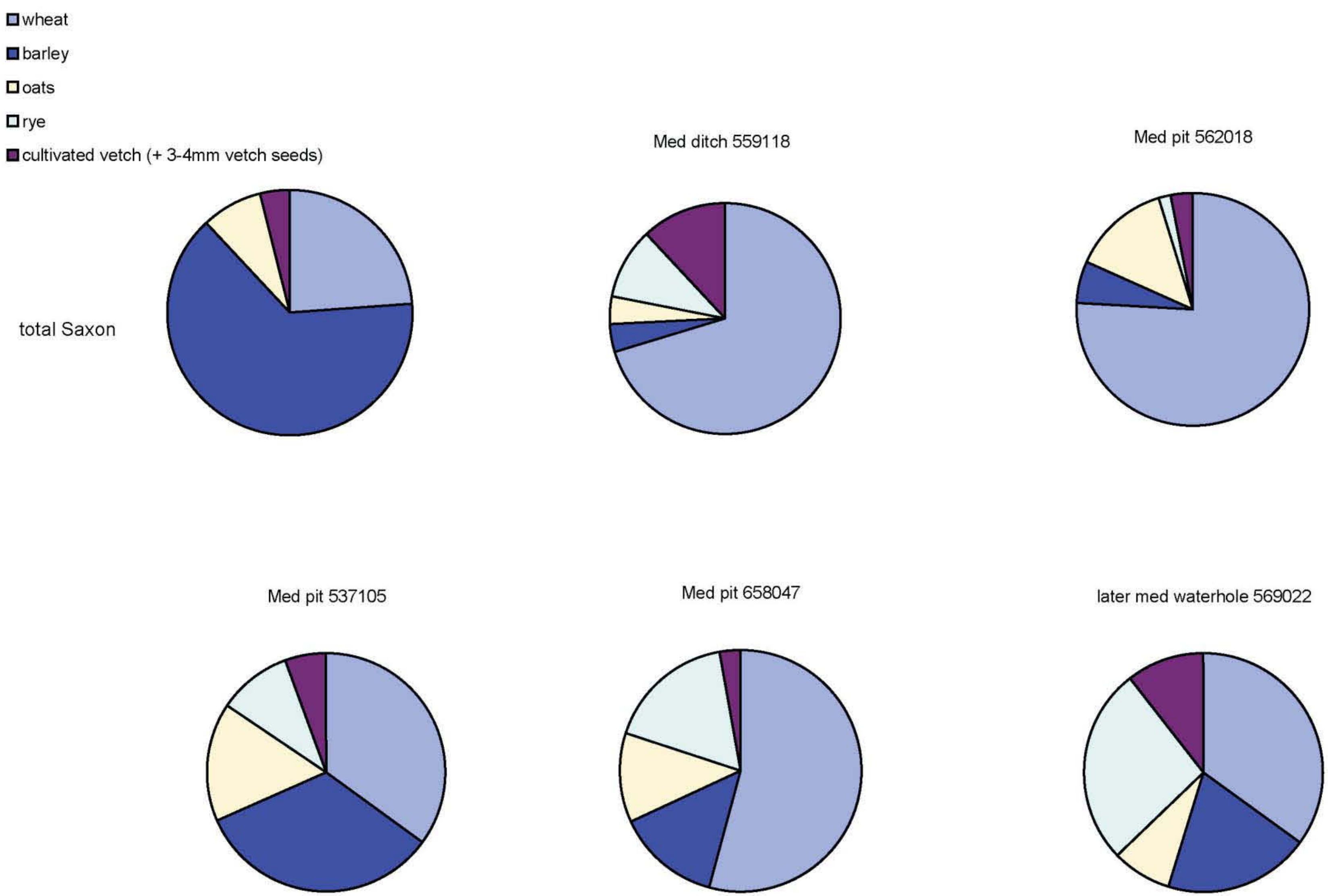


Figure 11: Post-Roman cereals

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