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Peter Murphy[1] with contributions by Jennifer Hillam[2] and Cathy Groves[2]

Summary

This review presents a synthetic account of archaeological wood and charcoal from sites of Palaeolithic to Post-Medieval date in the East and West Midland counties and the East of England. There are preliminary discussions of wood preservation, methodology and distribution. Some priorities for future work are defined.

Keywords

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Author's addresses
1Centre of East Anglian Studies, University of East Anglia, Norwich NR4 7TJ
[2]Department of Archaeology and Prehistory, University of Sheffield, West Court, 2 Mappin Street, Sheffield S1 4DT

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1. Introduction

Of all archaeological materials, wood demands the attention of the greatest range of workers: field archaeologists, environmental archaeologists, conservators, wood technologists, dendrochronologists, scientists concerned with radiocarbon dating and museum curators are all commonly involved (Brunning 1995). Types of archaeological information gained from the study of wood include environmental, technological and dating evidence, whilst the purpose of wooden artefacts may range from the functional (*e.g.* boats: McGrail 1979) to the ritual (*e.g.* anthropomorphic figurines: Coles 1990).

Reliable sources of constructional wood, timber and fuel have always been a fundamental requirement for any society, but only relatively recently have sufficient archaeological data become available to give a basis for discussing the changing organisation of supply through time. More recently still, issues relating to site conservation and management have achieved greater prominence as the widespread threat to waterlogged wood posed by de-watering has become more evident. Whilst there are practical problems of co-ordination, collaborative study of wood presents opportunities for an unusual degree of integration of results from several archaeological sub-disciplines.

The emphasis in this review, however, is on ***palaeoenvironmental*** aspects of wood studies, including the evidence for woodland composition, structure and early woodland management from the East and West Midland counties and the East of England. Environmental evidence for other situations in which trees and shrubs occur, including field hedgerows, defensive thorn hedges, gardens and heathlands is also outlined. Some consideration is given to the economic aspects of wood supply, but wooden artefacts and wood technology are considered here only where they provide information directly pertinent to woodland management, introductions of alien trees or importation of their wood, or (for the earliest periods) represent the only evidence for the use of wood. Apart from roundwood and basketry, other NTPPs (non-timber plant products, as defined by Cotton 1996, 192) are not included. Nayling (1989) has presented a Resource Assessment of waterlogged structural wood.

This paper is not intended as a comprehensive review listing every wood or charcoal report from the region: many reports give information on only a few samples or items of only local interest. Instead, attention is focused on the more substantial and/or informative reports from the Midlands and the East of England. Many of the more important recent studies are, unfortunately, unpublished. Some reference to these is unavoidable (particularly where they document the earliest or sole example of a particular type of wood utilisation) but in general the emphasis here will be on published reports.

A catalogue of dendrochronological reports from the region has kindly been supplied by Jennifer Hillam and Cathy Groves (Appendix 1), to which the writer has made a few additions, notably of work by Robert Howard (University of Nottingham).

2. Preservation of the material

In common with other plant macrofossils, wood may be preserved in waterlogged anoxic deposits, by charring or by mineral replacement. Wood and timber also survive, of course, in dry standing buildings of medieval and later date, and ancient living trees preserve palaeoecological and economic information, particularly on past climate, from ring-sequences, and management, from overall growth form.

Inhibition of bacterial and fungal activity in waterlogged deposits is largely a result of the development of anaerobic conditions: after burial, available oxygen is utilised, but since the diffusion of oxygen through pore waters is about 10^3 times slower than in air, saturated sediments become anaerobic, and reduction reactions involving iron, sulphur and nitrogen predominate thereafter (Ross 1988). Since anaerobic bacteria are unable to attack lignin, wood in waterlogged deposits preserves basically as a lignin 'skeleton' supported by water, which is not compressible. Other factors contributing to wood preservation may include constantly low temperatures and concentrations of polyphenolics, either derived from tannin-rich woods such as oak, or in the general matrix of the deposit. De-watering and consequent enhanced microbial activity result in very rapid degradation (*e.g.* Parker Pearson and Sydes 1995), besides the physical deformation resulting from the loss of water pressure.

Charcoal, like other charred plant macrofossils, is a very durable material. It is known that complex biomolecules can survive charring (Brown *et al* 1996), but charcoal is largely composed of elemental carbon, which is biologically inert. Charcoal is, however, subject to processes of physical weathering resulting in fragmentation, typically along natural planes of weakness such as medullary rays and the large spring vessels of ring-porous woods. The rarity or absence of charcoal from some species, such as *Tilia*, lime (known from palynology to have been an important component of prehistoric woodlands) could result either from differential preservation during charring or from post-depositional fragmentation. A study of differential preservation of charcoals from a range of tree species is clearly necessary, to aid interpretation of archaeological material.

Mineral-replacement of wood tissue occurs in a number of situations. Wood buried in association with metal artefacts may become partly or wholly replaced by corrosion products. The toxicity of some metal salts, particularly copper, inhibits or stops microbial activity, resulting in wood preservation even where complete replacement has not occurred. Iron corrosion products often form internal casts of vessels and other cells (Keepax 1975). Within burials, replacement may be a complex process; replaced wood from a 1st century burial at St Albans was generally black, brown or buff in colour reflecting replacement by iron and/or manganese compounds, though blueish flecks of vivianite were also noted. It appears that naturally translocated metal compounds, corrosion products and biogenic phosphate from the body all contributed to replacement (Murphy and Fryer 1999). Partial replacement of an oak coffin by manganese 'pan' has also been reported from a Bronze Age burial at Ponton Heath, Lincolnshire (Evans 1985). Replacement by calcium phosphate and/or carbonate also occurs. Green (1979) has described replacement of seeds in latrine pits by reaction of biogenic phosphate and lime (used as a sterilising agent), and replacement of wooden pit linings has also been noted in similar contexts.

Another form of mineral-replacement has been observed in waterlogged wood from clastic iron-rich sediments such as intertidal clays (Wilkinson and Murphy 1995, 132). Microscopically this takes the form of black sub-spherical inclusions, particularly in ray cells, pith and cambium/bark. Macroscopically, stems have an indurated coating of iron compounds, spreading inwards to impregnate the outermost rings, which severely hampers sectioning for identification. It seems likely that replacement by iron compounds - probably principally pyrite - is initiated by microbially-induced iron sulphide framboid formation in waterlogged sediments with adequate levels of organic material and sulphur (Wiltshire *et al* 1994). In intertidal sediments sulphate ions from sea-water would ensure that sulphur was not a limiting factor for framboid formation. On exposure and during storage, oxidation results in development of bright red iron oxide. Over longer time periods replacement results ultimately in the production of pyritised wood, such as the fossil wood common in the Eocene London Clay.

3. Methodology

3.1 Waterlogged wood

The recently-published English Heritage guidelines (Brunning 1995) present a clear account of methodologies for the study of waterlogged wood, both on-site and in the laboratory. A practical application of such techniques at Flag Fen, Peterborough - a complex stratified site with abundant wood - is outlined by Pryor and Taylor (1992). From an environmental viewpoint, for reconstruction of woodland composition and structure, fundamental aspects of study include species identification (Schweingruber 1978) and records of stem morphology. So far as roundwood is concerned, features to be recorded include stem diameters, stem ages, wide or narrow first rings, development of last ring, growth patterns, presence or absence of bark, and presence of coppiced heels or right-angle bends in stems (Morgan 1988; Rackham 1977; Taylor 1996). The interpretation of some aspects of roundwood is discussed in Box 1, and illustrated with some examples from sites in the Midland Region (Figures 1-8).

The form and size of trunks is frequently reconstructible from larger timber. Most wood is, of course, found in a secondary context in a converted and structural form. However, so-called 'submerged forests' present an unusual opportunity to observe *in situ* prehistoric woodlands directly, rather than inferring their composition from palynology. Three-dimensional recording techniques are described by Lageard *et al* (1995) who used these methods to reconstruct changes through time in woodland structure - notably a protracted decline in pine - at the site of White Moss, Cheshire. Boyd (1988) has discussed methodological problems associated with non-artefactual wood scatters, arguing that taphonomic studies are required.

3.2 *In situ* preservation

The conservation and management of wet sites with waterlogged wood is becoming increasingly important. The writer, and other environmental archaeologists are already involved in assessing the potential impacts of de-watering on waterlogged wood and contributing to the development of mitigation strategies, in collaboration with Local Authority curators and within the framework of PPG 16. This review is not primarily concerned with wet site management, though a few comments may be apt. The most important point to make is that monitoring techniques - both technical and managerial - are still developing.

At Outgang Road, Market Deeping, Lincolnshire (see below) a research project to monitor the effects of groundwater fluctuations and the previous archaeological excavation on the organic basal fills of an Iron Age palaeochannel and on modern wood samples buried in the deposits is being sponsored by English Heritage. The work is being undertaken collaboratively by EH, Hunting Technical Services and Stephen Pointing, Portsmouth University (Hunting Technical Services 1993). Groundwater monitoring is by means of piezometers, whilst *in situ* soil moisture content is measured using a neutron probe system. Plainly, the results of such basic research are fundamental, but of course full results will not be available for some years. Matthew Davis (pers comm) has emphasised that there have been technical advances even since the monitoring equipment was installed, and different procedures would probably now be followed.

Meanwhile, day-to-day decisions have to be made about the best means of preserving wooden structures, without having reliable information on the physical, chemical and biological processes degrading archaeological wood, and the rates at which they operate. Wooden structures are commonly encountered in gravel pits, where groundwater has already been lowered by pumping for extraction, though in some cases the structures lie in organic water-retentive palaeochannnel fills. In this situation, some temporary means of minimising de-watering until extraction and pumping cease and the site is re-flooded has to be devised, or else the site has to be excavated immediately.

Methods which have been tried include capping the structure with clay, to prevent surface evaporation and frost damage, and lining quarry faces with clay to reduce lateral water movement. For this type of strategy to work there must be close collaboration between the curatorial archaeologist, environmental archaeologist, field archaeological contractors and quarry operators. There have been problems, from which lessons may be learnt. In particular, it is suggested that wherever preservation strategies are reliant on quarry operators completing agreed works, monitoring by an archaeological scientist, reporting to the Local Authority curator, is a key component. To ensure that this happens, it is suggested that curators should stipulate that they must receive monitoring reports at agreed time intervals.

3.3 Charcoal and mineral-replaced wood

The study of wood charcoal has progressed from the stage where only large pieces were collected by hand during excavation, but there does not seem to be a published methodology, ensuring comparability between sites. Indeed, the only recent methodological innovation in charcoal analysis has been in terms of more rigorous selection of samples for radiocarbon dating: potential samples are now routinely identified and fragments from large or long-lived trees are rejected. However, many of the techniques used for studying waterlogged wood are immediately applicable to charred *in situ* structural wood and timber: examples are given below. Discussion between charcoal analysts to establish a consensus on methods of retrieval, identification and quantification is urgently needed (see below, 6.4).

Mineral-replaced wood generally requires scanning electron microscopy for identification (Keepax 1975). For this reason, sample preparation is time-consuming compared to wood preserved by waterlogging and charring, and is most commonly undertaken by conservators concerned with the investigation of particular artefacts.

4. Distribution of material from the study area

So far as the writer is aware no comprehensive catalogue of archaeological wood from Britain exists. However, reference to the distribution map in Coles *et al.* (1978: fig. 1) gives some indication of the distribution of prehistoric finds then known from the Midland Region. There was a marked concentration of wood finds in the lower Thames, on the Essex coast, in the Fen Basin and in Lincolnshire, in the Witham and Ancholme valleys. Further west, in the river valleys of Central England, sites were sparse. No comparable distribution map for Roman and later sites existed then, or now, but there is clearly a bias towards material from urban sites.

Fieldwork in the following twenty years has changed this distribution, for far more data are now available from Midland river valleys, particularly the Trent and Nene. Sub-fossil prehistoric trees and woodlands have been described (*e.g.* Brown 1997; Robinson 1992; Salisbury *et al* 1984). Wooden structures have been recorded from several rural sites, including the medieval bridges across the Trent at Hemington Fields, Leicestershire (Olivier 1994, 52-5; Cooper and Ripper 1997), Saxon bridge at Cromwell, Nottinghamshire (Salisbury 1995), Saxon and Norman mills and mill-dams at Tamworth, West Cotton and Hemington Fields (Rahtz and Meeson 1992; Robinson 1992, 199; Clay and Salisbury 1990) and a Saxon fish-weir at Colwick (Salisbury 1981). Over the same period, survey and excavation on the Essex coast (Wilkinson and Murphy 1995) and in the Fens (Hall and Coles 1994; Pryor 1991) have produced still more wooden structures and artefacts of Bronze Age to Post-Medieval date from those areas.

5. The data

Results will be presented here in broadly chronological order. The chronological sub-division adopted is related to major changes in economy and subsistence, and cuts across some conventional archaeological periods, whilst other periods are conflated together.

When a species or taxon is first mentioned, its common and Linnaean names are quoted, but thereafter only the common name is used. In many cases, wood cannot be identified beyond the generic level on morphological characteristics (Schweingrueber 1978), though a species identification may often be inferred from present-day plant distributions, or established from the presence of more diagnostic associated macrofossils (*e.g.* buds, leaves, thorns/spines, fruitstones, nuts). Genus names only are generally stated here. Other woods are identifiable only to broad taxonomic groups, notably those in the Pomoideae (pear/apple/hawthorn). Similarly *Populus* (poplar) and *Salix* (willow/sallow) are difficult to separate. Identifications of *Salix* by the writer, given here refer only to large groups of material **all** with heterogeneous rays. Other problematic families include the Ericaceae and Fabaceae. Identifications of *Calluna vulgaris* (ling), and the separations of *Cytisus* (broom) and *Ulex* (gorse), given below are based on other charred macrofossils associated with the charcoal.

Radiocarbon dates are quoted in the text in an uncalibrated form, for brevity, but calibrated date ranges are presented in the Tables.

5.1 *Hunter-gatherers: Palaeolithic and Mesolithic (c. 500,000 - 5500 BP)*

5.1.1 Palaeolithic

The only known wooden artefact of Palaeolithic date from Britain is the spear-point of yew (*Taxus* sp.), 36 mm in diameter, from Hoxnian sediments at Clacton, Essex (Oakley *et al* 1977). It is the sole representative of what must have an extensive wood technology. Yew is well known as a very tough wood, difficult to work, but this spear showed no sign of having been shaped by fire.

The earliest known charcoal from the region came from sediments of the Late Cromerian Complex (Isotope Stage 13, before 478,000 years ago) in association with a flint industry including hand-axes at High Lodge, Mildenhall, Suffolk (Cartwright 1992). Taxa included *Pinus* (pine) and *Betula* (birch). The results, though sparse, were consistent with palynological analyses of the clayey silts at this site indicating spruce-pine woodland with representation of birch. There is no reason to suppose that this charcoal was directly related to hominid activity: it could have derived from wildfires.

5.1.2 Mesolithic

In the Midland region there are no known waterlogged archaeological Mesolithic sites comparable to Star Carr (Clark 1954), where there was evidence for wood utilisation. Sub-fossil trees of late Mesolithic date are, however, represented by drifted trunks with attached root systems in estuarine sediments of the Thames II transgression at Purfleet, Essex. Taxa present include *elm* (Ulmus sp.), hazel (*Corylus* sp.), alder (*Alnus* sp.), poplar (*Populus* sp.) and ash (*Fraxinus* sp.) (Wilkinson and Murphy 1995, 97). There is potential at this site for more detailed work, recording growth forms. 'Submerged forests', some of Mesolithic date, are discussed below.

Studies of pollen, micro-charcoal and soil micromorphology demonstrate some Mesolithic impacts on woodland in the region, though the scale and intensity of these effects are much disputed (Bennett *et al* 1990; French and Pryor 1993, 31-61; Lewis, Wiltshire and Macphail 1992; Smith *et al* 1989; Waller 1994, 105). Microcharcoal falls outside the scope of this section of the review: it is recorded normally from palynological slides. However, Jonathan Hather (pers comm) has noted that some microcharcoal is sufficiently large and cytologically distinctive to establish at least whether it represents wood or other vegetative plant material.

At Spong Hill, Norfolk (Healy 1988, 104) charcoal of pine (*Pinus* sp) from a subsoil hollow including Mesolithic flints has been dated to 8230 ± 80 BP (HAR-7063), and residual pine charcoal from an undated hearth or oven gave dates of 8250 ± 90 BP (HAR-7025) and 8150 ± 100 BP (HAR-2903). On the line of the Norwich Southern By-Pass at Bixley pine charcoal from a subsoil feature was dated to 8990 ± 100 BP (GU-5186), and undated pine charcoal came from probable tree-throw holes with intensely reddened fills at Caistor St Edmunds (Murphy 2000). This is the only macroscopic evidence from the region for any use of Boreal woodland. Whether it relates to wildfires or to domestic hearths is unclear, though the reworking of large pine charcoal fragments into later feature fills certainly implies very high residual densities of charcoal in the soil, suggesting a fire extending over a substantial area. Further details, with calibrated date ranges, are given in Table 1.

5.2 *The rise of agriculture: Neolithic - Middle Bronze Age (c. 5500 - 3200 BP; c. 3500 - 1200 cal BC)*

5.2.1 Coastal submerged forests

So-called 'submerged forests' are exposed in the intertidal zone at many locations (see Table 2 for details and calibrated date ranges of all radiocarbon determinations). On the Essex coast isolated root systems of oak (*Quercus* sp), rooted into a mineral palaeosol, are widespread in the Blackwater Estuary and one has given a date of 4030 ± 80 BP (HAR-7056). Mid-Flandrian valley floor woodland is also represented: at Clementsgreen Creek in the Crouch Estuary submerged woodland of alder (*Alnus* sp) and oak is dated to 4100 ± 70 BP (HAR-5227); and in the Thames Estuary at Purfleet roots from woodland including ash (*Fraxinus* sp), alder, yew, elm (*Ulmus* sp) and holly (*Ilex* sp) yielded a radiocarbon date of 3910 ± 70 BP (HAR-8647) (Wilkinson and Murphy 1995, 28-34 and 90-100). In Norfolk, beach exposures of the Broadland Middle Peat with *in situ* stools of alder at Sea Palling are dated to between 5040 ± 70 BP (HAR-2612) and 2220 ± 70 BP (HAR-2602) (Murphy, unpublished data), whilst the submerged forest at Titchwell is attributed to Pollen Zone VIIb (Wymer and Robins 1994). The latter is said to include pine, though unpublished identifications by the writer were all of alder. Further north, on the Lincolnshire coast, 'forest beds' outcrop widely. Some are thought to be Neolithic, though at Immingham a date of 6681 ± 130 BP (Q-401) was obtained: dating evidence is reviewed by Van de Noort and Davies 1993). Reference to Table 2 will show a clear chronological pattern (north to south) related to differential subsidence in the North Sea Basin. 'Submerged forests' on the east coast have all been studied in outline only, usually during survey work, and their full potential for yielding information on prehistoric woodland composition and structure has yet to be realised (see below).

5.2.2 Fossil woodlands inland

Similar fossil woodlands occur beneath later sediment cover in the Fen Basin and in river valleys and mires throughout the region under alluvium and peat, though they are visible only when sediment cover is artificially removed, by quarrying or other activities. They are not essentially different from the coastal 'submerged forests' but obviously are less accessible for study. In river valleys, dense woodland of alder with some hazel and oak was widely established by the Neolithic (Brown 1997, 210-7; Robinson 1992). At very wet sites, alder woodlands appear to have been non-invadable by other species, due to the tree's ability to withstand flooding and rises in water-table by the production of adventitious roots. Brown and Keough (1992, 193; 1992a) have recorded fossil mid-Flandrian alder woodlands from the Nene valley at Raunds, Little Houghton and Wollaston, Northamptonshire. At coastal sites, the demise of valley floor alder woodland was a direct consequence of rising relative sea-level, resulting eventually in the development of saline conditions. Inland, the alder decline is considered to be a result of human disforestation. Brown and Keough (1992) suggest that multi-stemmed alder root clusters in the Nene valley may represent coppiced trees, a suggestion which needs further investigation, by detailed recording of growth patterns in sub-fossil trees and comparison with living ones.

(Salisbury *et al* 1984) have undertaken an extensive study of sub-fossil trees in the Trent at Colwick, Nottingham. Fluvially transported trunks and attached root systems, found in coarse minerogenic sediments representing point bars and shoals, were recorded and sampled for dendrochronology. They are considered to have originated upstream and to have been transported by successive floods (*c.f.* the Mesolithic trees from estuarine sediments at Purfleet, Essex, above). Of 133 trees examined, 124 were of oak, four of ash (*Fraxinus*) and one each of yew (*Taxus*), hazel (*Corylus*) and elder (*Sambucus*), with fragments of willow (*Salix*) and elm (*Ulmus*), though the predominance of oak was thought to result from preservation factors. The trunks were tall, straight and narrow with few side branches, usually with wide growth rings, indicating a source in a dense stand of floodplain forest. None showed any evidence of felling or other human modification. Two floating tree-ring chronologies, one of 576 years and a second of 280 years were obtained. Radiocarbon dates of 5335 ± 50 BP (Q-2029 and 5110 ± 45 BP (Q-2028) place the first chronology in the Neolithic, whilst a Bronze Age date for the second chronology is established by a radiocarbon date of 3420 ± 65 BP (Q-2044). Subsequently, this material was re-examined (Hillam *et al* 1990 and Hillam *pers comm*) and several dated tree-ring chrononologies were obtained (see Appendix 1): 4852-4426 BC, 4186-3833 BC, 3045-2697BC, 2792-2583 BC and 2563-2258 BC. More recently, similar Trent gravel oaks have been recovered from Langford Quarry, Nottinghamshire and chronologies of 4232-4021 BC, 2979-2858 and 2637-2125 BC obtained (Hillam, work in progress).

In palaeoenvironmental terms, perhaps the most significant result from Neolithic tree-ring sequences is the decline in 'bog oaks' from Britain and Ireland in the period around 4000 - 3800 BC, but increases on oaks from river gravels, submerged forests and trackways about this time (Hillam *et al* 1990). These authors suggest that there was a period of wetter climatic conditions at that time, necessitating trackway construction.

In the north and west of the region, fossil tree root systems and fallen trunks are widespread under blanket and raised bog peat, for example the buried pine woodlands of White Moss, Cheshire (Lageard *et al* 1995) and the remains of birch woodland beneath and within blanket bog peats on interfluve areas in the southern Pennines (Tallis 1964).

Pine woodland has also been reported at lowland sites, for example at Wood Fen, Ely (Godwin *et al* 1935). The fenland buried woodlands are of varied types, some representing dry-land vegetation rooted in underlying clays and some fen woods. The Sub-Boreal oaks of the fens were massive forest trees, with trunks of up to 27.5m before the first lateral branch (Godwin 1975, 278), but unfortunately Godwin does not give measurements of diameters. Presumably, though, trees of this type supplied the planks, up to 4m long and 1.3m wide, used to construct the earliest known surviving timber structure from the region: the Neolithic mortuary structure at Haddenham, Cambridgeshire (Hodder and Shand 1988, Morgan 1990).

5.2 3 Neolithic woodland management and clearance

The Neolithic causewayed enclosure at Etton, Cambridgeshire has produced the earliest evidence for coppicing and pollarding from the region (Pryor *et al* 1985; Taylor 1988).

Coppice stools and remains of small pollards, including alder and poplar/willow (*Populus/Salix*) were found within the enclosure ditch, associated with straight roundwood stems. The stems were removed by pulling from the stool, with only occasional axe-cuts, but were then trimmed with an axe to remove the coppiced heel. Waste wood was burnt nearby, and some charred pieces were incorporated into the ditch fills.

Direct evidence for activity during the Neolithic in woodland clearings is provided by areas of tree throw hollows on some Midland valley floodplains, sealed by alluvium. The interpretation of such sites is disputed; Macphail and Goldberg (1990) see them as evidence for anthropogenic clearance, whereas Brown and Keough (1992, 192 and pers comm) interpret them as opportunistic exploitation of natural clearings produced by wind-throw or other processes. Though tree throw hollows commonly show evidence of burning in terms of reddening of the surrounding soil, charcoal is not always present. Where charcoal does occur it is often predominantly of oak. Charcoals from hollows at Raunds, Northamptonshire were of oak, hazel and ash (Table 1: G. Campbell, pers. comm.). Mark Robinson (pers comm) speculates that this relates to different types of floodplain and terrace woodland: throw hollows largely devoid of charcoal could represent woodland dominated by trees such as lime (*Tilia*) which are poorly represented by charcoal in the archaeological record (for preservational or taphonomic processes of which we are currently ignorant), whereas features containing abundant oak charcoal may really represent oak-dominated woodlands. There are similar problems of interpretation with the extensive Later Neolithic charcoal spreads on palaeosols sealed by estuarine sediments on the Essex coast (Table 1: Wilkinson and Murphy 1995, 89). These are up to 3cm thick, extending for hundreds of metres in foreshore exposures, and are mainly of oak charcoal. Again, fire-clearance of oak woodland could be represented or alternatively taphonomic and preservational factors might be implicated.

Charcoal from pre-barrow contexts and barrow construction features at the Giants' Hills 2 long barrow, Skendleby, Lincolnshire was of oak, hazel, Pomoideae and field maple (*Acer*), whereas material from Late Neolithic ditch fills produced more taxa, with yew and hazel predominating (Morgan and Evans 1991). These results have been interpreted as indicating that regenerating Late Neolithic woodland was of yew and ash with oak and scrub of hazel, hawthorn-type and blackthorn.

5.2.4 Bronze Age woodland management, clearance and wood utilisation

Evidence for clearance of fen-edge woodland by burning at the beginning of the Bronze Age is provided by a dense oak charcoal deposit associated with an *in situ* root system (3650 $\pm$ 100 BP (HAR-5637)) from West Row Fen, Mildenhall, Suffolk (Martin and Murphy 1988). This site also produced an unusual charcoal assemblage from a long shallow pit, 3.6 x 0.9 x 0.25m deep, composed of oak charcoal from large wood with finely-preserved oak twigs, buds and immature acorns with cupules, besides remains of sloe, hawthorn, alder and hazel (4020 $\pm$ 120 BP). Preservation was so good that the presence of *Quercus robur* could be established from the presence of cilia on the oak bud scales and the stump of a long stalk attached to one cupule. This implies slow charring in oxygen-deficient conditions, and it is possible that this unusual feature-type was related to charcoal production, conceivably for metal-working (Martin and Murphy, ibid).

The most characteristic Early Bronze Age site-type in river valleys is the burnt mound (Table 3). Where later sediment cover has been lost by agricultural activities and deflation, field walking has demonstrated a spectacularly high density of such sites: Silvester (1991, 85) reports over 300 in the Wissey embayment of the Norfolk fen-edge alone. Similar sites are sporadically exposed elsewhere in the region, though this is fortuitous: many others must be concealed beneath later sediment cover. The function(s) of these sites are unclear: they may have been cooking sites (O'Drisceoil 1988), bathing sites (Barfield and Hodder 1987), industrial sites producing heat-shattered stone for pottery production or industrial processes (Peterson and Healy 1986,101) or for the heat-processing of wild plant foods (Wilkinson and Murphy 1995, 80): quite possibly all of these. Whatever their function, the existence of so many fuel-consuming sites along the fen- edge and in river valleys must have had an impact on valley floor vegetation. The charcoal and wood data summarised in Table 3 point to exploitation of locally-available fuel, commonly mostly from alder woodlands, though other woods were also burnt.

Some of these, and other Early-Middle Bronze Age fen-edge sites, have produced relatively small amounts of waterlogged wood, lining pits and shallow wells. For example, the Swales Fen site had a basal lining of split alder and hazel poles and at Godmanchester, Cambridgeshire a wattle pit-lining (3240 ± 50 BP (GU-5213) was constructed of straight roundwood stems, mostly of hazel, with field maple, ash, oak and guelder rose (*Viburnum*), showing a clustered age/size distribution, together with some larger roundwood (Murphy, in McAvoy, undated: figures 2 & 4).

The adoption of cremation as a burial rite would inevitably have increased fuel requirements; indeed it has been argued that in some treeless areas, such as Orkney, cremation would have been a highly visible reflection of status, involving intentional destruction of wood - a scarce resource (Downes 1997). This clearly could also apply to heathland areas of the Midland region, such as Breckland, where oak charcoal from mature trees has been recorded in cremation deposits, often as the main taxon (*e.g.* Murphy 1996). Oak, with some hazel, *Prunus* and Pomoideae, also predominated in the cremation deposits from the Norwich Southern By-Pass (Murphy 2000), though at Deeping St Nicholas, Lincolnshire on the fen-edge different assemblages were reported, in which *Prunus* predominated, with oak, ash, Pomoideae, alder, ash and buckthorn (*Rhamnus catharticus*) (Murphy 1994a). At this site, some exploitation of calcareous fen woods seems to be indicated, perhaps because oak was in short supply. Choice of fuels for cremation would have involved practicalities such as availability and calorific value, but also cultural considerations.

5.3 *Diversification and intensification: Late Bronze Age - Iron Age (c. 3200 - 1950 BP; c. 1200 cal BC - 50 cal AD)*

5.3.1 Flag Fen

By far the largest collection of Later Bronze Age wood from the region is that from Flag Fen, Cambridgeshire (Pryor 1991; Taylor 1992), where a tree-ring chronology spanning 1363-967 BC has been obtained (Neve 1992). This massive wooden platform and post alignment linking it to the fen edge includes timber, roundwood and woodworking debris. The lowest level, predominantly of alder, seems to represent trees felled nearby and placed in mud or shallow water to form a substrate for later layers, some of which consist mainly of small wood, apparently emplaced on a surface above the water level. The components of the platform include felled trunks, branch wood, wood chips and coppiced stems. Stems with coppiced heels and some coppice stools have been noted, besides long straight stems also probably from managed woodland. Most of this roundwood is of alder, though oak was also coppiced to produce large poles, >100mm in diameter. Large vertical posts from the platform are of oak, alder, ash and willow, with some field maple and apple (*Malus* sp), though the post alignment was all of oak. Some evidence for beaver-gnawing has been observed; abundant worked structural timber, split, hewn and sometimes jointed, some of it re-used, has been recorded; and portable artefacts including a willow scoop, oak-log vessel and tool handles and hafts recovered.

5.3.2 Hedges

Agricultural intensification, and particularly the development of extensive permanent field systems in later prehistory (Pryor 1996) led to the development of hedged boundaries. The evidence is summarised in Table 4. In floristic terms, hedgerows closely resemble scrub and woodland edge habitats, though where wood and macrofossil assemblages, preferably supported by pollen data, come from field boundaries, the presence of hedges may reasonably be inferred. Characteristic hedging features on roundwood include right-angle bends in stems, which may be generated by hedge-laying and management, as noted in Iron Age contexts from Fisherwick, Staffordshire (Williams 1979) and St Ives, Cambridgeshire (Taylor 1996), besides the characteristic growth pattern of coppiced wood - initially fast for a few years, then slowing as competition for water and nutrients increases (Rackham 1977). In addition, remains of tree roots may be found in field ditches as, for example, at West Deeping, Cambridgeshire (Taylor, in prep). When found in field ditches, material of this type relates to hedges designed to confine or exclude stock, though hedges could also have had a defensive function. For example, an Iron Age enclosure ditch at Wardy Hill, Coveney, Cambridgeshire included degraded roundwood with rosaceous thorns, macrofossils of bramble (*Rubus* section *Glandulosus*) and hawthorn (*Crataegus monogyna*), together with Rosaceae pollen (P.E.J. Wiltshire, in prep; Murphy 1992a). It seems reasonable to suppose that defensive thorn hedges were widespread in prehistory, but the evidence rarely survives.

5.2.3 Structural wood

During the Later Bronze Age and Iron Age, the extension of freshwater and estuarine wetland conditions over former dry land areas necessitated construction of trackways and hard-standings. On the Essex coast numerous wooden structures, dating from 2850 ± 70 BP (HAR-8879) onwards have been recorded (Wilkinson and Murphy 1995, 132-52). An example is a roundwood structure, thought to have bridged a partly infilled creek at The Stumble, Blackwater Site 28 (2360 ± 70 BP (HAR-7057). This was mainly of oak, with some hazel, and age/size distributions of stems imply a managed woodland source (Figures 6 & 8). Other structures in this area were mainly of oak, hazel and field maple, with some Pomoideae, ash, poplar, willow and, occasionally gorse. In general, straight poles were used, and some coppiced heels were recorded. Trackways of similar or earlier date are also known from Guy's Fen (French and Pryor 1993, 90-92) and, just outside the Midland region, in the Thames estuary wetlands (Meddens 1996).

Perhaps the largest Iron Age wood assemblage recently recovered from the region is that from the basal fills of a palaeochannel at Market Deeping, Lincolnshire (Murphy 1997). 1030 items were recovered, mainly unworked roundwood and woodworking debris, with some cut roundwood stakes and worked timber items. Evidence for woodland management was slight, though most roundwood stems were straight, one coppiced heel was recorded and there was some indication of size-selection of alder stems. The predominant woods were alder, willow/sallow and ash, with some hazel, *Prunus*, oak, yew and guelder rose. It appears that local fen woodland, or even just trees fringing the channel in an otherwise treeless landscape were exploited, and there was no evidence for importation of high-quality timber to the site. Roundwood > 60cm in diameter and timber off-cuts were very rare, implying that few trees in the vicinity were large standards. It is possible that progressive deforestation of the fen-edge and increasingly intensive exploitation of remaining woodlands necessitated the use of relatively sparse local resources: though palynological evidence post-dating the lime decline in the fens is generally poor and difficult to interpret (Waller 1994, 106), preliminary palynological results from the site do suggest a very open Iron Age landscape with few trees, mostly alder (P.E.J. Wiltshire, pers. comm.).

Wood from an enclosure and field boundary ditches associated with another Iron Age fenland site at the Upper Delphs, Haddenham, Cambridgeshire (Evans and Serjeantson 1988) included coppiced roundwood (with leaves) of willow, birch and alder, probably related to coppiced trees in the immediate vicinity. The larger timber, mainly of oak, with some willow, alder, ash and poplar, gave some indication that large oak was in short supply, for some of the wood was thought to be sub-fossil fen oak from peat. Moreover, charred structural timber from a roundhouse showed sign of re-use from an earlier structure. Beaver gnawing was not recorded, though beaver bones were unusually common at the site. It seems possible that local populations were being hunted to extinction at this time.

At these sites large timber was poorly represented. Evidence for Iron Age timber use is, however, provided by material from a causeway at Fiskerton, Lincolnshire and a 'raft' from Brigg in the same county. A very precise chronology for the Fiskerton causeway was established: the oldest oak posts were felled in the summer of 456 BC, and the structure was subsequently repaired at 16-18 year intervals up to after 375 BC (Hillam 1992). The Brigg raft was constructed from woodland oaks at least 0.6 - 0.8m in diameter and *c.* 170 years old when felled. Each tree produced two strakes − longitudinal planks (Hillam 1981).

Charred Iron Age structural wood has come from Asheldham Camp, Essex. Oak charcoal representing squared posts and boards was recovered, with evidence for sophisticated carpentry (Murphy 1991). Plainly, the demand for structural timber for hillfort defences, housing and other purposes would have increased through time as populations rose.

5.2.4 Fuels

An additional pressure on woodland resources from later prehistory onwards was the increasing requirement for industrial fuels (Table 5). The earliest evidence for salt production is from the Late Bronze Age site at Fenn Creek, Essex (Wilkinson and Murphy 1995, 157) but by the Late Iron Age numerous salterns existed in Essex and on the Lincolnshire fen-edge

(Hall and Coles 1994, 94-6). It seems probable that management of local woodlands to ensure continuity of fuel supply would have been necessary in areas of intense industrial activity, though there is little evidence for this. The Iron Age saltern at Cowbit, Lincolnshire produced only alder and willow/poplar charcoal, in contrast to some later sites mentioned below (Gale, in press). Stems were up to 30mm in diameter or more, representing several years growth, and probably came from carr fringing the fen. Gale notes that these are all lightweight woods making poor fuel, and speculates that they may have been converted to charcoal before use as fuel. This was commonplace in historic times (Edlin 1949).

5.4 *Roman (c. 43 - 450 AD)*

5.4.1 Oak timbers and dendrochronology

The most characteristic Roman timber structures throughout the region are timber-lined wells, though structures associated with salt production, a causeway and bridge have also been recorded. Usually, these structures were of large oak timbers, frequently sufficiently large for tree-ring dating to be possible (See Appendix 1). Tyers, Hillam and Groves (1994) note that at sites in the Midland region and elsewhere most tree-ring chronologies constructed from 1st century timbers extend back 250-350 years, whereas most of those from 3rd century timbers only extend back 100 years. These younger trees were fast-grown and knotty (R. Darrah, *pers comm*). This reduction in the age of trees used for construction is thought by Tyers *et al* to indicate more intensive exploitation of available resources for structural wood and fuel (discussed further below).

Jennifer Hillam (*pers comm*) notes that of the hundreds of dated timbers from Roman London only five have rings starting before 200 BC, whereas there is abundant timber from sites in the north, at Carlisle, Vindolanda and Ribchester, from trees which began growth before 300 BC. Very different types of woodland were therefore being exploited in the two areas. The paucity of structural timber from Roman sites in the Midlands means that no generalisation is possible for this region at present. However, at the other end of the Roman period, Godmanchester, Cambridgeshire is the only site to have produced timber dating to the early 4th century.

5.4.2 Roundwood and basketry

Comparatively little work has been done on roundwood structures of Roman date, though collapsed hurdle structures dated to 1900 $\pm$ 70 BP (HAR-9644) have been examined from Blackwater Site 28, Essex (Wilkinson and Murphy 1995). These were made largely of hazel with some Pomoideae and *Ulex/Cytisus* (gorse/broom). They showed a double-sailed construction, possibly because hazel roundwood stout enough for single sails was not available locally. A 'sump' at the Roman site of Stonea Grange, Cambridgeshire has produced a much larger collection of material - over 98,000 items - much of it unworked or split roundwood (Cartwright 1996). Ash, oak and hazel predominated. From distributions of stem diameters, Cartwright argues that this roundwood came from managed woodlands.

Basketry must have been widely used throughout prehistory, but survival is poor and the earliest examples in the Midlands come from Roman sites (Table 6). Cartwright (1996) reports withy bundles and twisted strands from Stonea Grange, identified as willow, hazel and ash. A well at Oakley, Suffolk showed a two-phase wooden lining (Murphy, unpublished). The original lining was made of vertical radially-split oak laths up to 40 x 8mm in cross-section, with interwoven roundwood stems, mostly of hazel and generally 2-3 years old and 5-9mm in diameter; the upper 'repair' to the lining was of more typical wattling. The very fine construction of the basal lining may imply that it was a re-used large basketry container, though the absence of any evidence for a base could indicate that it was custom-made. Production of narrow roundwood for basketry would have involved very short-cycle coppicing and/or pollarding.

5.4.3 Introduced trees and imported timber

Fruits and nuts of exotic tree species have been widely reported from the region, and will be considered in the Regional Review of plant macrofossils. Results from rural sites such as Great Holts Farm, Boreham, Essex, which produced macrofossils of *Pinus pinea* (Mediterranean stone-pine), *Castanea sativa* (sweet chestnut), *Juglans regia* (walnut), *Olea europaea* (olive), *Vitis vinifera* (grape) and *Prunus* spp (large bullace and cherry), show that these products were reaching the countryside and were not just the preserve of the urban elite (Murphy *et al* 2000). Furthermore there was some use of 'exotic' timber for fine carpentry (Table 7), including a furniture leg of walnut from Scole, Norfolk (Liversidge 1977). To what extent these products represent imports or introduced trees is unclear, though the barrels of *Abies* (silver fir) and *Larix* (larch) from Droitwich, Hereford and Worcester (Crone 1992), may be assumed to be Continental imports, no doubt containing wine or other liquid commodities.

Apart from olive, which would be excluded on climatic grounds, all the other species mentioned above could have been grown in this country. Direct evidence for local cultivation of an introduced tree is provided by seeds, cones, leaves, twigs and wood of spruce (*Picea abies*) from ponds at the site of Rectory Farm, Godmanchester, Cambridgeshire (Murphy in McAvoy, undated). The presence of spruce pollen from other contexts at the site confirms that spruce was growing locally (P.E.J. Wiltshire, pers comm). Cartwright (1996) also illustrates cones from Stonea Grange, Cambridgeshire. [Andrew van Wyke provided the identification for these as *Pinus sylvestris* (C. Cartwright, pers comm), though re-examination shows that they are of *P. abies*]. The Godmanchester ponds also produced roundwood of oak, hazel, Prunus, willow, alder, ash and yew, together with leaves of box (*Buxus sempervirens*). The association of spruce, yew and box is of particular interest: evergreens, either clipped or as standards in formal or informal plantings, were characteristic features of Roman gardens in Italy, as described by Pliny (Zeepvat 1991). The presence of other plants typical of gardens supports the view that these ponds were ornamental and it seems reasonable to suggest that the use of spruce, yew and box, replacing the bay and cypress of the Mediterranean, was an adaptation of the classical style to the British climate.

5.4.4 Industrial fuels

Roman industrial activity was plainly on a much greater scale than in prehistory (Table 5). In some areas there is evidence to suggest that woodland fuel resources were under pressure, particularly in the fens and heathlands where trees were few. A saltern site at Morton Fen, Lincolnshire (Crowson *et al*. 2000, 138) produced a similar range of wood charcoals to the Iron Age Cowbit saltern (see above), comprising alder, ash and willow/poplar, but charcoal was much sparser and stem diameters, where determinable, much narrower (<5mm) implying that cutting was too frequent for regenerating stems to reach a large size. Moreover, other charred plant material including bracken and *Equisetum* (horsetail) stems with very abundant cereal processing waste was more common than wood charcoal. The Roman saltern at Middleton, Norfolk produced a very diverse range of wood charcoals - alder, birch, hazel, Ericaeae (heather family), Pomoideae, *Prunus*, oak, willow/poplar, yew and *Ulex/Cytisus* (gorse/broom) - indicating that fuels had to be obtained from a variety of habitats, including woodland on dry soils, carr and heathland (Gale, in press). A Roman iron smelting furnace at Valley Belt, Trowse, Norfolk produced a similarly wide range of woods - oak, hazel/alder, Pomoideae, broom (including young stems) and Ericaceae (including a capsule of *Calluna*, ling) - again pointing to use of heathland fuel sources (Murphy 2000). The occurrence of charred spelt processing waste in Roman a pottery kiln at Stowmarket, Suffolk (Murphy 1989) and the extensive Roman fenland peat-cuttings (Hall and Coles 1994, 117) show that supplementary fuel sources were used to augment supplies of woodland fuels.

5.5 *Anglo Saxon - Medieval (c. 450 - 1400 AD)*

5.5.1 Post-Roman woodland regeneration?

The extent of woodland regeneration during the fifth century AD, clearly a point of considerable significance for understanding the Late Roman/Early Anglo-Saxon environment (Rackham 1994) is much disputed. Palynological and macrofossil evidence from the east of the region is thought to indicate that any regeneration was of limited extent (Murphy 1994). However, there is dendrochronological evidence from sites spread across the region for widespread use, in Later Saxon structures, of trees which began growth in the first decades of the fifth century (Tyers *et al* 1994). This could indicate that management of short-cycle coppice ceased at that time, resulting in development of timber trees from the stools and/or that abandoned areas of farmland were colonised by seedlings. However, R. Darrah (*pers comm*) points out that most of these trees are maidens, not multi-stemmed trees growing from stools, and that natural regeneration produces large numbers of seedlings in woods. Definition of the spatial extent of such processes is still, however, unclear.

5.5.2 Early Anglo-Saxon

Evidence for the use of wood in the early Anglo-Saxon period is very sparse, for waterlogged deposits of this date are virtually unknown. Watson (1994) has reported on wood associated with knives, awls and other tools and preserved by corrosion products in cremations from Spong Hill, Norfolk: handles were of willow/poplar, alder, hazel, box, ash and beech. Wood preserved by metal oxide replacement also occurred in the Sutton Hoo ship burial of c. 625 AD, possibly the tomb of the East Anglian King Raedwald (Bruce-Mitford 1975). It included oak from the ship itself, a shield-board mainly of lime, ash spear-shafts, a bucket of yew and a musical instrument and cups of field maple (*Acer campestre*). In a burial of such high status the presence of 'exotic' wood of unusual form, probably imported, is unsurprising: the remains of eight small cups made of burr walnut were found (Cutler 1983).

5.5.3 Middle Saxon - Medieval structural wood

From the beginning of the Middle Saxon period, *c.* 650 AD, however, the quantity and variety of recorded wooden structures and artefacts increases markedly. The growth of Saxon and Medieval towns, almost entirely consisting of wooden structures, would have had substantial resource implications: a large-scale infra-structure supplying constructional timber, wood and fuel must have existed. This was supplemented by the use of imported wood and timber: some medieval wells and waterfront structures at Ipswich included Baltic oak, for example (Hillam 1979, 1985: see Table 7). In the countryside, too, the construction of large fish-traps and causeways would also have resulted in substantial demands for wood. The Anglo-Saxon fish trap complexes in the Blackwater Estuary, Essex, for example, consist of series of post alignments, extending over mud flats for up to a kilometre, with posts at intervals of 0.5 - 1.0 m, associated with huge numbers of wattle panels (Strachan 1997). The largest site, at Collins Creek, covers an area of about 2 x 1 km, making it the largest exposure of archaeological wood in Britain. Calibrated radiocarbon dates in the range (at 2 sigma) of 650 - 957 AD have been obtained on posts and hurdling of hazel, oak and alder (Strachan 1997, Appendix 1). Construction projects of this scale plainly would have placed an exceptional demand on woodland resources, and must have been centrally-directed, perhaps under ecclesiastical control (S. Rippon, pers. comm.). Fish-weirs are also known from inland sites, notably on the Trent at Colwick, Nottinghamshire (Salisbury 1981).

Late Saxon to early Medieval cellared buildings at Foundation Street and the Buttermarket, Ipswich (Murphy 1990) had been destroyed by fire, so that the post and plank timber structure of the cellar linings was preserved by charring. The buildings were almost entirely of oak timber, with some ash, willow/poplar, elm, Pomoideae and alder, together with charred roundwood of hazel, Prunus, Pomoideae and a conifer, probably in part representing collapsed and fragmented wattle panels. At the Buttermarket hazel roundwood fell into two size classes (6-19 mm and 21-25 mm), perhaps representing rods and sails respectively. Remains of portable artefacts included thin boards/staves of ash, oak and elm thought to be from buckets or small barrels, wooden bungs, dowels/pegs and wedges.

Other wooden structures from both urban and rural sites include causeways, bridges, water mills, waterfronts and wood-lined wells and pits. Saxon piled causeways, crossing river valleys and channels, are known from a number of locations. Some were of oak timber, including the Middle Saxon causeway from Staunch Meadow, Brandon, Suffolk, with a tree-ring sequence of 417-597 AD (Groves and Hillam 1986) and the half-mile long causeway, built between 684 and 702 AD, linking Mersea Island, Essex with the mainland (Crummy et al 1982). A short 6th century AD causeway at Oakley, Suffolk, however, was represented by some 600 roundwood stakes. These were mostly entire stems of oak, 0.05 - 0.2m in diameter, thought to represent size-selective draw-felling of young trees or large coppice poles in managed woodland (Darrah 1996). Large timber, mostly oak, from Saxon and medieval bridges (e.g. Willaston, Cheshire; Southchurch Hall, Essex; South Witham, Lincolnshire; Bilby, Nottinghamshire), a Saxon watermill at Tamworth, Staffordshire, urban waterfronts (e.g. at Grimsby, Lincoln, Norwich and Ipswich) and wells (e.g. Odell, Bedfordshire; Milton Keynes, Buckinghamshire; Slough House Farm, Essex; Ware, Hertfordshire) is listed in Appendix 1. Wood from the Tamworth mill included a wheel-paddle (Rahtz and Meeson

1992, 100-104).

At Bridge Street, Ipswich successive waterfront structures of Middle Saxon to late Medieval date were excavated and sampled (Murphy, unpublished). The Saxon structures were relatively insubstantial, consisting of post revetments of hazel, oak, ash, alder, Pomoideae, birch, holly, willow/poplar and Prunus roundwood, mostly 30 -100 mm in diameter, but by the 11th century structures at this site were mainly of oak timber. This shift from the use of 'renewable' roundwood to timber could reflect a change in function related to the beaching or berthing of vessels. By comparison, at St Martin-at-Palace Plain, Norwich the 11th-12th century waterfront was simply demarcated by roundwood wicker fences of hazel and other species (Murphy 1988a) alongside which vessels were beached, whereas higher-sided vessels would need to be berthed alongside a quay. Alternatively, the increased trade of medieval Ipswich may simply have meant that large timber, some of it imported from the Baltic, was more readily available than earlier periods.

Well and cess pit linings of wicker construction and hurdle panels are also widespread. Sites include Brayford Pool, Lincoln (Early medieval: willow, hazel, oak: Morgan 1985), St Martin-at-Place Plain, Norwich (11th-12th century: alder, oak, willow/poplar, hazel, ash: Murphy 1988) and Godmanchester, Cambridgeshire (Anglo-Saxon: hazel, field maple, ash: Murphy, in McAvoy, undated). Hurdles were used in fish weirs and traps, as in the 9th century weir from Colwick, Nottinghamshire, of hazel, willow, and ash roundwood (Salisbury 1981). However, by far the largest collection of material is from the Anglo-Saxon fish-traps at Collins Creek, Essex (Murphy 1995). Hurdles were used as part of the trap, fixed between upright posts, and also as walkways for use when collecting the catch. A very small sub-sample of seven panels has been examined. They were made of oak, willow, birch and hazel roundwood. The distribution of stem age/size did not show any clear clustering, as would be expected in managed woodland (Figures 7 & 9): presumably this relates to the enormous amounts of wood required, so that roundwood from many woodlands managed in different ways was stock-piled and mixed together before final use.

5.5.4 Imported timber

There is substantial documentary evidence for importation of timber in the Middle Ages. Straight-grown woodland oak was imported as quarter-sawn or riven boards, known as 'wainscots' or 'clapboards' from the Baltic and Scandinavia. Henry III imported Norwegian pine boards for Winchester Castle as early as 1252 (Chinnery 1979, 154-5 and 164). Archaeological evidence for imported wood and timber includes a Middle Saxon well from Greyfriars Road, Ipswich lined with re-used oak barrel staves of south German origin (Hillam 1989) and oak from the Baltic with a tree-ring chronology of 1128-1293 from Bridge Street, Ipswich (Hillam 1985).

5.5.5 Basketry

Of particular note at the Buttermarket, Ipswich were two areas of charred basketry (Table 6). One example was constructed of longitudinally split hazel roundwood with interwoven whole stems of willow, 2-5 mm in diameter, one year old. Associated abundant charred cereals implied that it was a grain container. A second comprised split hazel and oak roundwood, with interwoven whole hazel stems, 3-7 mm in diameter. A basketry fragment of Anglo-Saxon date has also come from intertidal muds at Collins Creek (Murphy 1995). This was beautifully made from whole hazel stems, 9-10 mm in diameter, 2-3 years old, longitudinally-trimmed to produce a uniform size, with interwoven whole hazel stems, 5-7 mm in diameter and 1-2 years old. These are the sole representatives of what must have been a very commonplace type of artefact. Management of osier beds and hazel coppice/pollards on a very short cycle would have been necessary to provide the raw material.

5.5.6 Fuels

Information on fuel supply is sparse, but clearly in some areas it must have posed problems. The Middle Saxon pottery industry producing Ipswich-type ware at Ipswich was located in an area of extensive heathlands - the Suffolk Sandlings - where woodland was comparatively sparse. One pottery kiln at the Buttermarket, Ipswich was fuelled with oak but also broom, which must have been cut on nearby heaths (Murphy 1990). It is unclear whether fuel was supplied as wood or as charcoal, produced in heathland clamps.

5.6 *Late and Post-Medieval (c. 1400 AD to present)*

Biological remains from later medieval and early modern buried archaeological sites have not been widely studied in Britain, and wood is no exception. Within the Midland region very few reports have been published. This may be in part because so much material survives above ground in standing structures, particularly in timber-framed buildings, and as furniture. However, it is very likely that the material surviving above ground is far from representative of what was actually in use: high-status buildings and furniture made from durable woods less susceptible to woodworm attack, particularly oak, have certainly survived better than their cheaper counterparts (Knell 1992, 31). Archaeological wooden artefacts, such as those from the wreck of the *Mary Rose* (1545) give a much more reliable idea of wood and timber use (Rule 1982).

Some information on the condition of late medieval urban buildings is provided by large pieces of charcoal from structural wood relating to the fire of 25th March 1507 from Pottergate, Norwich (Murphy 1985). Finds from the cellars of these buildings point to a high standard of living for the occupants, yet much of the charcoal showed evidence of insect attack, including a pole of ash showing well-preserved surface borings of the ash bark beetle (*Hylesinus fraxini*) and part of an oak beam showing large exit-holes, probably of the deathwatch beetle (*Xestobium rufovillosum*). The ash bark beetle tends to infest freshly felled timber (R. Darrah, *pers comm*) and does little damage as its borings are superficial. However, insect pests would plainly have limited the life of such buildings.

The timber trade with the Baltic and Scandinavia, begun in the earlier Middle Ages, has continued up until present times. Indeed during the Napoleonic period, the threat to supplies of imported timber, tar and hemp for the Royal Navy was one of the precipitating factors of the Baltic naval campaign, which culminated in Horatio Nelson's victory at Copenhagen in 1801. Dendrochronological studies on archaeological timber also provide evidence for this trade. Material includes 15th century Baltic oak from New Baxtergate, Grimsby (Groves 1992), and there are late medieval to 18th century records of pine, walnut, sweet chestnut and spruce which could represent either imported timber or wood from English plantations of foreign trees (Table 7).

Waterlogged wood from features associated with a 16th century garden at Hill Hall, Essex included a dump of thorny twigs of blackthorn (*Prunus spinosa*), thought to represent hedge-trimmings, together with leaves of holly (*Ilex aquifolium*) and oak (*Quercus* sp) and other macrofossils of cherry, bullace, rose (*Rosa* sp), hornbeam (*Carpinus betulus*) (Murphy and Scaife 1991). There is clearly considerable scope for studies of wood from post-medieval gardens for providing a basis for authentic re-plantings.

6. Priorities for future work

6.1 Gaps in the record.

The study of wood and charcoal has expanded remarkably in recent years, and there is now some basis for beginning to discuss woodland structure and composition, management of woodlands and other habitats including trees and shrubs, the organisation of supply of structural timber and wood and fuel, and the uses of this fundamental resource by past human communities. There is no period for which it can be said we have enough information: in contrast to many other aspects of environmental archaeology, wood and charcoal studies are still at the basic stage of data accumulation. Nevertheless, it is possible to highlight some periods for which we have virtually no archaeological information at all in the Midland region. These are: the Palaeolithic, Mesolithic, Early Anglo-Saxon and Post-Medieval periods.

6.2 Submerged forests.

Woodland composition in prehistoric England is usually inferred from the proxy evidence of palynology. However, submerged forests provide an accessible opportunity to observe ancient woodlands directly: to record the species, sizes and spacing of tree stumps and growth form of fallen trees, and to reconstruct changes in composition through time. It should even be possible to apply many of the techniques commonly used in modern ecological field survey (such as transect and quadrat studies) to a study of spatial variation in the ground flora and shrub layer by sampling between the tree root systems.

It is important to recognise that many of these 'submerged forests' show signs of human presence, commonly lithic scatters or isolated artefacts, so they are fossil cultural landscapes rather than untouched primary woodland. It would be of particular significance to detect *in situ* evidence of prehistoric woodland management. The suggestion of Brown and Keough (1992a) that multi-stemmed fossil alder trees represent coppicing certainly requires further investigation, by means of detailed recording of overall growth form and ring patterns, by comparison with modern coppiced and uncoppiced trees. Detailed studies of this potentially informative, and eroding, resource are plainly required.

6.3 Modern analogues.

Morgan (1988) noted that interpretation of archaeological wood assemblages is hampered at present by a lack of data on the age and size distributions (and growth forms) of wood grown under different systems of management or none. Little progress has been made over the last ten years, and Morgan's plea can only be reiterated.

6.4 *Charcoal analysis*

Methodology. As noted above, there appears to be no published standard methodology for charcoal analysis, at least in the British literature. Plainly, this needs to be addressed. Minimum requirements for examining charcoal from 'spreads' and more diffuse deposits need to be agreed. Techniques will probably prove to include the application of conventional flotation techniques for objective retrieval and clear statement of the size categories of fragments identified (for charcoals from some species are more prone to fragmentation than others). Quantification presents severe problems which need discussing: fragment counts are probably not meaningful and weights are of doubtful value. It may emerge that frequency (the number of samples in which a given species occurs) is the only helpful means of quantification, but this too needs consideration. The application of novel methods such as reflectance measurements, which probably relate to the temperature of charring need to be thought about. Jennifer Hillam notes that dendrochronology on charcoal is done routinely on the Continent, but almost never in the UK. Baillie (1982, 171-2) gives the only published account of the technique in Britain.

Interpretation. As discussed above, charcoal analyses undertaken in the Midland region in recent years have been focused on very specific types of context where taphonomy is relatively simple and interpretation fairly unambiguous. These include:

Charcoal produced from the burning of *in situ* vegetation
Charcoal from hearths/ovens related to specific industrial processes
Charcoal representing the charred remains of wooden structures or artefacts

Additionally, charcoal analysis has been employed during the selection of samples for submission for radiocarbon dating, so as to exclude large timber of long-lived species.

Applications have therefore been very limited compared to studies of sites on the Continent, where charcoal analysis is commonly employed as an indicator of changing woodland composition through time. British workers, in general, see wood charcoal as essentially an artefact, and only indirectly an ecological indicator. Whilst charcoal identifications clearly establish a minimum range of taxa present, and may be helpful for enhancing the crude taxonomic resolution of palynology, few workers in Britain would be prepared to use charcoal for more than base-line palaeoecology. They are well aware that charcoal assemblages are related to surrounding woodland vegetation, but only indirectly, through culturally modifying stages involving ready availability and suitability of wood for construction or fuel, besides factors now unknowable, such as culturally-induced prohibitions of the use of certain species. Moreover, there are preservational and taphonomic considerations: some taxa (*e.g.* lime), known to have been important components of mid-Flandrian woodlands are hardly ever reported as wood or charcoal from archaeological deposits.

This approach is in marked contrast to workers in France, based at Montpellier, who are prepared to use dispersed scatters of charcoal in archaeological deposits as direct palaeoecological indicators. It is remarkable that workers in adjacent countries should be operating within such opposed paradigms.

It seems plain that wide discussion of both methodology and interpretation of charcoal assemblages is urgently required. English Heritage has previously taken a lead role in developing methodology for waterlogged wood (Brunning 1995) and it would be timely for a comparable initiative for charcoal.

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References

Baillie, M.G.L, 1982 *Tree-ring dating and archaeology*, Croom Helm, London

Barfield, L. and Hodder, M, 1987 Burnt mounds as saunas and the prehistory of bathing, *Antiquity* **61**, 370-79

Bates, S, in press Excavation of a burnt mound at Feltwell Anchor, Norfolk (FWL 171 - Site 23650), *Norfolk Archaeology*

Bennett, K.D, Simpson, W.D. and Peglar, S.M. 1990 Fire and man in the post-glacial woodlands of eastern England, *Journal of Archaeological Science* **17**, 635-642

Boyd, W.E, 1988 Methodological problems in the analysis of fossil non-artefactual wood assemblages from archaeological sites, *Journal of Archaeological Science* **15**, 603-619

Brown, A.G, 1997 *Alluvial geoarchaeology. Floodplain archaeology and environmental change.* Cambridge University Press, Cambridge

Brown, A.G. and Keough, M.K, 1992 Palaeochannels and palaeolandsurfaces: the geoarchaeological potential of some Midland floodplains, in *Alluvial archaeology in Britain* (eds) Needham, S. and Macklin, M.G, Oxbow Monograph **27**, 185-196, London

Brown, A.G. and Keough, M, K, 1992a Palaeochannels, palaeolandsurfaces and the 3-D reconstruction of environmental change, in Carling, P.A. and Petts, G.E. (eds), *Lowland floodplain rivers: a geomorphological perspective*, 185-202, Wiley, chichester

Brown, T, Jones, G, Sallares, R and Allaby, R, 1996
Genes from prehistoric wheats, *Ancient Biomolecules Initiative Newsletter* **3**, 39-43, University of Bristol

Bruce-Mitford, R, 1975 *The Sutton Hoo Ship Burial, Volume* **1**, British Museum, London

Brunning, R (ed), 1995 *Waterlogged wood. Guidelines on the recording, sampling, conservation and curation of waterlogged wood*, English Heritage, London

Cartwright, C, 1992 Charcoal from High Lodge, in Ashton, N.M., Cook, J., Lewis, S.G. and Rose, J, (eds) *High Lodge. Excavations by G. de G. Sieveking, 1962-8, and J. Cook, 1988,* 116, British Museum, London

Cartwright, C, 1996 Waterlogged wood from the sump, in *Excavations at Stonea, Cambridgeshire 1980-85*, Jackson, R.P.J. and Potter,T.W, 552-571, British Museum Press, London

Chinnery, V, 1979 *Oak furniture. The British tradition*, Antique Collectors Club, Woodbridge

Clark, J.G.D, 1954 *Excavations at Star Carr: an Early Mesolithic site at Seamer, near Scarborough, Yorkshire*, University Press, Cambridge

Clay, P. and Salisbury, C.R, 1990 A Norman mill-dam and other sites at Hemington Fields, Castle Donington, Leicestershire, *Archaeol. J.* **147**, 276-307

Coles, B, 1990 Anthropomorphic wooden figurines from Britain and Ireland, *Proc. Prehist. Soc.* **56**, 315-333.

Coles, J.M., Heal, S.V.E. and Orme, B.J, 1978 The use and character of wood in Prehistoric Britain and Ireland, *Proc. Prehist. Soc.* **44**, 1-45

Colledge, S. and Greig, J, 1992 Environment, in Woodiwiss, S. (ed) Iron Age and roman salt production and the medieval town of Droitwich. Excavations at the Old Bowling Green and Friar Street. *Council for British Archaeology Research Report* **81**, 96-105, CBA, London

Cooper, L. and Ripper, S, 1997 *The Hemington Bridges. The excavation of three medieval bridges at Hemington Fields, Leicestershire*, University of Leicester Archaeological Services report 97/27

Cotton, M, 1996 *Ethnobotany: principles and applications*, John Wiley, New York

Crone, A, 1992 Wood, in Woodiwiss, S. (ed) Iron Age and roman salt production and the medieval town of Droitwich. Excavations at the Old Bowling Green and Friar Street, *Council for British Archaeology Research Report* **81**, 106 -113, CBA, London

Crowson, A., Lane, T. and J. Reeve (eds.) 2000 Fenland Management Project Excavations 1991-1995. *Lincolnshire Archaeology and Heritage Reports Series* **No. 3.** Heritage Lincolnshire: Heckington.

Crummy, P, Hillam, J, and Crossan, C, 1982 Mersea Island: the Anglo-Saxon causeway, *Essex Archaeology and History* **14**, 77-86

Cutler, D.F, 1983 Botanical Reports, in *The Sutton Hoo Ship Burial, Volume 3* (ed) R. Bruce-Mitford, 402-4, British Museum, London

Darrah, R, 1996 *Oakley Anglo-Saxon post alignment*, unpublished report

Downes, J, 1997 Immolation and resources: an account of cremation in Bronze Age Orkney, Paper given at the conference *Fire and the palaeoenvironment*, Sheffield, April 1997

Edlin, H.L, 1949 *Woodland crafts in Britain*, Batsford, London

Evans, C. and Serjeantson, D, 1988 The backwater economy of a fen-edge community in the Iron Age: the Upper Delphs, Haddenham, *Antiquity* **62**, 360-70

Evans, J, 1985 Examination of soil samples, in Greenfield, E, Five Bronze Age round barrows at Ponton Heath, Stroxton, Lincolnshire, *Lincolnshire History and Archaeology* **20**, 43

French, C.A.I. and Pryor, F.M.M, 1993 The South-West Fen Dyke Survey Project 1982-86, *East Anglian Archaeology* **59**, Peterborough

Fryer, V. and Murphy, P, in press Plant macrofossils from Ditch 81295, Scole/Stuston By-Pass, Suffolk (OKY 005)

Fryer, V. and Murphy, P, unpublished Charred plant macrofossils and other remains from Two Mile Bottom, Thetford, Norfolk (5738 THD): an assessment

Godwin, H, 1975 *History of the British Flora* (2nd edn.), Cambridge

Godwin, H, Godwin, M.E. and Clifford, M.H, 1935 Controlling processes in the formation of fen deposits, as shown by peat investigations at Wood Fen, near Ely, *Journal of Ecology* **23:2**, 509

Green, F.J, 1979 Phosphatic mineralization of seeds from archaeological sites, *Journal of Archaeological Science* **6**, 279-284

Greig, J.R.A, 1994 A possible hedgerow flora of Iron Age date from Alcester, Warwickshire, *Circaea* **11(1)**, 7-16

Groves, C, 1992 Dendrochronological analysis of timbers from New Baxtergate, Grimsby, Humberside, 1986, *Ancient Monuments Laboratory Report* **8/92**, English Heritage, London

Groves, C, 1993 Tree-ring analysis of a wood assemblage from Tilbury Fort, Essex, 1988-89, *Ancient Monuments Laboratory Report* **20/93**, English Heritage, London

Groves, C, and Hillam, J, 1986 Tree-ring analysis of oak timbers from Brandon, Suffolk, *Ancient Monuments Laboratory Report* **4793**, English Heritage, London

Hall, D. and Coles, J, 1994 *Fenland Survey. An essay in landscape and persistence*, English Heritage Archaeological Report **1**, London

Healy, F, 1988 The Anglo-Saxon cemetery at Spong Hill, North Elmham, Part VI: occupation during the seventh to second millennia BC, *East Anglian Archaeology* **39**, Gressenhall

Hillam, J, 1979 Cecilia Street, Ipswich (IAS 5001) - tree-ring analysis, *Ancient Monuments Laboratory Report* **3006**, English Heritage, London

Hillam, J, 1981 Tree ring analysis of the Brigg 'raft' timbers, in *The Brigg 'raft' and her prehistoric environment* (ed) McGrail, S., British Archaeological Reports **89**, 103-116, Oxford

Hillam, J, 1985 Tree-ring analysis of timbers from Bridge Street, Ipswich, *Ancient Monuments Laboratory Report* **4555**, English Heritage, London

Hillam, J, 1989 Tree-ring analysis of two timber wells from Greyfriars's Road, Ipswich, Suffolk, *Ancient Monuments Laboratory Report* **134/89**, English Heritage, London

Hillam, J, 1991 Tree-ring analysis, in Excavations at St Martin-at-Palace Plain, Norwich, 1981, (Ayers, B.S.), *East Anglian Archaeology* **37**, 128-131

Hillam, J, 1992 Dendrochronology in England: the dating of a wooden causeway from Lincolnshire and a log boat from Humberside, in *Proceedings of the 13th Colloquium of the AFEAF, Guerat 1989*, 13-141, Guerat

Hillam, J, Groves, C.M, Brown, D.M, Baillie, M.G.L, Coles, J.M. and Coles, B.J, 1990 Dendrochronology of the English Neolithic, *Antiquity* **64**, 210-220

Hodder, I. and Shand, S, 1988 The Haddenham long barrow; an interim statement, *Antiquity* **62**, 349-53

Hunting Technical Services, 1993, *Market Deeping Site Monitoring. Report detailing the installation of monitoring points and survey of project site.* **R797: HER-04**, February 2nd 1993

Jones, A, 1976 The charcoal, in Excavations at Langhale, Kirstead (K. Wade), *East Anglian Archaeology* **2**, 127

Jones, A, 1977 Plant remains, in Rogerson, A, Excavations at Scole, 1973, *East Anglian Archaeology* **5**, 218-221

Keepax, C, 1975 Scanning electron microscopy of wood replaced by iron corrosion products, *Journal of Archaeological Science* **2**, 145-150

Keepax, C. and Morgan, G.C, 1989 Identification of charcoal from site B, in Miles, P, Young, J. and Wacher, J, A Late Saxon kiln site at Silver Street, Lincoln, *The Archaeology of Lincoln*, Vol **XVII-3**, Microfiche E, City of Lincoln Archaeological Unit, Lincoln

Knell, D, 1992 *English country furniture. The national and regional vernacular, 1500 - 1900*, Barrie and Jenkins, London

Lageard, J.G.A, Chambers, F.M. and Thomas, P.A, 1995 Recording and reconstruction of wood macrofossils in three dimensions, *Journal of Archaeological Science* **22**, 561-567

Lewis, J.S.C, Wiltshire, P.E.J. and Macphail, R.I, 1992 A Late Devensian/Early Flandrian site at Three Ways Wharf, Uxbridge: environmental implications, in *Alluvial archaeology in Britain* (eds) Needham, S. and Macklin, G, Oxbow Monograph **27**, 235-247, Oxford

Liversidge, J, 1977 Wooden furniture fragments, in Excavations at Scole, 1973 (A. Rogerson), *East Anglian Archaeology* **5**, 204-6

MacPhail, R.I. and Goldberg, P, 1990 The micromorphology of tree subsoil hollows: their significance to soil,science and archaeology, in *Soil micromorphology* (ed) L.A. Douglas, Amsterdam, Elsevier

Martin, E, 1988 Swales Fen, Suffolk: a Bronze Age cooking pit? *Antiquity* **62**, 358-59

Martin, E. and Murphy, P, 1988 West Row Fen, Suffolk: a Bronze Age fen-edge settlement site, *Antiquity* **62**, 353-8

McAvoy, F, undated *Rectory Farm, Godmanchester: Assessment and Updated Project design*

McGrail, S, 1979 Prehistoric boats, timber and woodworking technology, *Proc. Prehist. Soc.* **45**, 159-163

Meddens, F.M, 1996 Sites from the Thames estuary wetlands, England, and their Bronze Age use, *Antiquity* **70**, 325-34

Morgan, G. and Evans, J.G, 1991 Charcoal, in Evans, J.G. and Simpson,D.D.A. Giants' Hill 2 Long Barrow, Skendleby, Lincolnshire, *Archaeologia* **109**, 25

Morgan, R.A, 1985 Brayford Pool, Lincoln, *Ancient Monuments Laboratory Report* **4687**, English Heritage, London

Morgan, R.A, 1988 The case for wattling - what tree rings could reveal, in *The exploitation of wetlands* (eds) Murphy, P. and French, C, British Archaeological Reports (British Series), **186**, 77-91

Morgan, R.A, 1990 Reconstructing a Neolithic wooden mortuary chamber from the fens of eastern England through tree-ring study, in Robinson, D (ed), *Experimentation and reconstruction in Environmental Archaeology*, Symposia of the Association for Environmental Archaeology **9,** 101-118

Murphy, P, 1985 Charcoal, in Evans, D.H. and Carter, A, Excavations at 31-51 Pottergate (Site 149N), *East Anglian Archaeology* **26**, 66

Murphy, P, 1988 Palaeoecological studies of three Bronze age 'burnt flint' sites near West Row, Mildenhall, Suffolk, *Ancient Monuments Laboratory Report* **165/88**, English Heritage, London

Murphy, P, 1988a Wood, in Excavations at St Martin-at-Palace Plain, Norwich, 1981, B.S. Ayers, *East Anglian Archaeology* **37**, 127-8

Murphy, P, 1989 Plant remains, in A Romano-British pottery kiln at Stowmarket (Plouviez, J), *Proceedings of the Suffolk Institute of Archaeology* **XXXVII**, 8-10

Murphy, P, 1990 Buttermarket, Ipswich, Suffolk (IAS 3104): charcoal, *Ancient Monuments Laboratory Report* **74/90**, English Heritage, London

Murphy, P, 1991 Ipswich, Suffolk; plant macrofossils from sites IAS 3104 (Buttermarket), IAS 3201 (ABC Cinema) and IAS 5203 (Greyfriars Road), *Ancient Monuments Laboratory Report* **33/91**, English Heritage, London

Murphy, P, 1991a Charcoal, in Asheldham Camp - an early Iron Age hillfort (Bedwin, O), *Essex Archaeology and History* **22**, 34-5

Murphy, P, 1992a Environmental archaeology: a review of progress, *Fenland Research* **7**, 35-9

Murphy, P, 1994 The Anglo-Saxon landscape and rural economy: some results from East Anglia and Essex, in *Environment and economy in Anglo-Saxon England* (ed) J. Rackham, Council for British Archaeology Research Report **89**, 23-39, London

Murphy, P, 1994a The plant macrofossils, in Excavation of the Deeping St Nicholas barrow complex, South Lincolnshire (C.A.I. French), *Lincolnshire Archaeology and Heritage Report Series* **1**, 74-9

Murphy, P, 1995 Anglo-Saxon hurdles and basketry: Collins Creek, Blackwater Estuary, Essex, *Ancient Monuments Laboratory Report* **5/95**, English Heritage, London

Murphy, P, 1996 Charcoal, in The excavation of a round barrow at Bawsey, near King's Lynn, 1984 (J.J. Wymer), *East Anglian Archaeology* **77**, 24-6

Murphy, P, 1997 Fenland Management Project. Outgang Road, Market Deeping, Lincolnshire (MAD 2: NGR TF 1587 1154). Wood, plant macrofossils and molluscs from an Iron Age and Roman fen-edge site, *Ancient Monuments Laboratory Report*, English Heritage, London

Murphy, P, 2000 Environmental and botanical evidence, in Ashwin, T, and Bates, S. Excavations on the Norwich Southern By-Pass Part 1: Excavations at Bixley, Caistor St Edmund, Trowse, Cringleford and Little Melton, *East Anglian Archaeology* **91**, 217-227

Murphy, P, in prep Scole/Stuston By-Pass, Suffolk (Oakley, OKY 005): wood from wicker-lined wells

Murphy, P, Albarella, U, Germany, M and Locker, A. 2000 Production, imports and status: biological remains from a Late Roman farm at Great Holts Farm, Boreham, Essex, *Environmental Archaeology* **5**, 35-48

Murphy, P, and Fryer, V. 1999 Plant macrofossils, in Niblett, R. The excavation of a ceremonial site at Folly Lane, Verulamium. *Britannia Monograph Series* No. **14**, 384-8. Society for the Promotion of Roman Studies, London.

Murphy, P. and Fryer, V, in press Rectory Farm, West Deeping, Lincolnshire: plant macrofossils and molluscs from Bronze Age to Romano-British field ditches

Murphy, P. and Macphail, R, 1985 The environmental evidence, in Excavations within the north-east bailey of Norwich Castle, 1979 (B.S. Ayers), *East Anglian Archaeology* **28**, 59-62

Murphy, P. and Scaife, R, 1991 The environmental archaeology of gardens, in *Garden archaeology* (ed) Brown, A.E. Council for British Archaeology Research Report **78**, 83-99, London

Nayling, N, 1989 The archaeological wood survey: a review of the potential and problems of waterlogged structural wood, *Ancient Monuments Laboratory Report* **62/89**, English Heritage, London

Neve, J, 1992, An interim report on the dendrochronology of Flag Fen and Fengate, *Antiquity* **66**, 470-75

Oakley, K.P, Andrews, P, Keeley, L.H. and Clark, J.G.D, 1977 A reappraisal of the Clacton spearpoint, *Proc. Prehist. Soc.* **43**, 13-30

O'Driscеoil, D.A, 1988 Burnt mounds: cooking or bathing? *Antiquity* **62**, 671-80

Olivier, A.C.H, 1994 *Archaeology Review 1993-4*, English Heritage, London

Parker Pearson, M. and Sydes, R, 1995 Sutton Common: a South Yorkshire wetland, in *Wetlands: archaeology and nature conservation* (eds) M. Cox, V. Straker and D. Taylor), 86-96, HMSO, London

Peterson, F.F. and Healy, F, 1986 The excavation of two round barrows and a ditched enclosure at Weasenham Lyngs, 1972, *East Anglian Archaeology* **29**, 70-103

Pryor, F, 1991 *Flag Fen. Prehistoric Fenland centre*, English Heritage/Batsford, London

Pryor, F, 1996 Sheep, stockyards and field systems: Bronze Age livestock populations in the fenlands of eastern England, *Antiquity* **70**, 313-24

Pryor, F. and Taylor, M, 1992 Flag Fen, Fengate, Peterborough II: further definition, techniques and assessment (1986-90) in, *The wetland revolution in prehistory* (ed) Coles, B, 37-46, The Prehistoric Society/WARP, Exeter

Pryor, F.M.M., French, C.A.I. and Taylor, M, 1985 An interim report on the excavations at Etton, Maxey, Cambridgeshire 1982-84, *The Antiquaries Journal* **XLV (2)**, 275-311

Rackham, O, 1977 Neolithic woodland management in the Somerset Levels: Garvin's, Walton Heath and Rowland's Tracks, *Somerset Levels Papers*, **3**, 65-71

Rackham, O, 1994 Trees and woodland in Anglo-Saxon England: the documentary evidence, in *Environment and economy in Anglo-Saxon England* (ed) Rackham, J, Council for British Archaeology Research Report **89**, 7-11

Rahtz, P. and Meeson, R, 1992 An Anglo-Saxon watermill at Tamworth. Excavations in the Bolebridge Street area of Tamworth, Staffordshire in 1971 and 1978, *Council for British Archaeology Research Report* **83**, CBA, London

Robinson, M, 1992 Environment, archaeology and alluvium on the river gravels of the south Midlands, in *Alluvial archaeology in Britain* (eds) Needham, S. and Macklin, M.G, Oxbow Monograph **27**, 197-208

Ross, S.M, 1988 The use of peat chemistry to interpret past wetland environments, in *The exploitation of wetlands* (eds) P. Murphy and C. French, British Archaeological Reports (British Series) **186**, 25-46, Oxford

Rule, M, 1983 *The Mary Rose. The excavation and raising of Henry VIII's flagship*, Windward, London

Salisbury, C, 1981 An Anglo-Saxon fish weir at Colwick, Nottinghamshire, *Transactions of the Thoroton Society of Nottinghamshire*, **85**, 26-36

Salisbury, C.R, Whitley, P.J, Litton, C,D. and Fox, J.L, 1984 Flandrian courses of the River Trent at Colwick, Nottingham, *Mercian Geologist*, **9**(4), 189-207

Salisbury, C, 1995 An 8th century Mercian bridge over the Trent at Cromwell, Nottinghamshire, England, *Antiquity* **69**, 1015-8

Schweingruber, F.H, 1978 *Microscopic wood anatomy*, F. Flueck-Wirth, Teufen

Silvester, R.J, 1991 The Fenland Project No.4: Norfolk Survey, the Wissey embayment and

Fen Causeway, *East Anglian Archaeology* **52**

Smith, A.G, Whittle, A, Cloutman, E.W. and Morgan, L.A, 1989 Mesolithic and Neolithic activity and environmental impact on the south-east fen-edge in Cambridgeshire, *Proc. Prehist. Soc.* **55**, 207-249

Strachan, D, 1997 Blackwater Estuary Management Plan (BEMP) Area Archaeological Report No. 1: *C14 dating of some intertidal fish-weirs in Essex: dates and discussion*, RCHME/Essex County Council, Chelmsford

Tallis, J.H, 1964 Studies on the southern Pennine peats, 1. The general pollen record, *Journal of Ecology* **52**, 323

Taylor, M, 1988 Some preliminary thoughts on coppicing and pollarding at Etton, in *The exploitation of wetlands* (eds) Murphy, P. and French, C, British Archaeological Reports (British Series) **186**, 93-100, Oxford

Taylor, M, 1992 Flag Fen: the wood, *Antiquity* **66**, 476-98

Taylor, M, 1996 Worked wood, in Iron Age riverside pit alignments at St Ives, Cambridgeshire, Pollard, J, *Proc. Prehist. Soc.* **62**, 93-115

Taylor, M, in prep West Deeping

Tyers, I, Hillam, J and Groves, C, 1994 Trees and woodland in the Saxon period: the dendrochronological evidence, in *Environment and economy in Anglo-Saxon England* (ed) Rackham, J, Council for British Archaeology Research Report **89**, 12-22, London

Van de Noort, R. and Davies, P, 1993 *Wetland Heritage. An archaeological assessment of the Humber wetlands*, English Heritage, London

Waller, M, 1994 The Fenland Project, Number 9: Flandrian environmental change in fenland, *East Anglian Archaeology* **70**, Cambridge

Watson, J, 1994 Organic material associated with metalwork, in Spong Hill, Part V, Catalogue of cremations, Hills, C, Penn, K. and Rickett, R, *East Anglian Archaeology* **67**, 22-3

Wilkinson, T.J. and Murphy, P.L, 1995 Archaeology of the Essex coast, Volume 1: the Hullbridge Survey, *East Anglian Archaeology* **71**, Chelmsford

Williams, P, 1979 Waterlogged wood remains, in *Fisherwick: the reconstruction of an Iron Age landscape*, Smith, C.A. British Archaeological Reports **61**, 71-77, Oxford

Wiltshire, P.E.J, Edwards, K.J. and Bond, S, 1994
Microbially-derived metallic sulphide spherules and the waterlogging of archaeological sites, *American Association of Sedimentary Palynologists Contributions Series* **29**, 207-221

Wymer, J.J. and Robins, P.A, 1994 A Long Blade flint industry beneath Boreal peat at Titchwell, Norfolk, *Norfolk Archaeology* **XLII (1)**, 13-37

Zeepvat, R.J, 1991 Roman gardens in Britain, in *Garden Archaeology* (ed) A.E. Brown, Council for British Archaeology Research Report **78**, 53-69, London

Table 1: Radiocarbon-dated charcoal assemblages thought to represent areal burning of in situ vegetation.

Site/area	Contexts	C14	Calibrated date range (one sigma)	Calibrated date range (two sigma)	Charcoals	Other macrofossils	References
Bixley, Norfolk	Subsoil hollow	8990 +/- 100 BP	cal BC 8090-7950	cal BC 8330-7730	Pine		Murphy 1992
Spong Hill, Norfolk	Subsoil hollows and residual charcoal in later features.	8230 +/- 80 BP (HAR-7063) 8150 +/- 100 BP (HAR-2903) 8250 +/- 90 BP (HAR-7025)	cal BC 7420-7040 cal BC 7290-7010 cal BC 7430-7040	cal BC 7480-7030 cal BC 7430-6720 cal BC 7490-7030	Pine		Healy 1988, 104
Raunds, Northants.	Tree throw hollows	6130 +/- 80 BP (OxA-3059) 5370 +/- 80 BP (OxA-3057) 4700 +/- 80 BP (OxA-3058)	cal BC 5230-4940 cal BC 4350-4040 cal BC 3630-3360	cal BC 5240-4850 cal BC 4360-4000 cal BC 3690-3190	Oak Ash Hazel		Robinson 1992
Dovercourt Bay, Essex (Site 2)	Charcoal spread on palaeosol.	4020 +/- 70 BP (HAR-8876)	cal BC 2860-2460	cal BC 2870-2390	Oak	Fabaceae cotyledons	Wilkinson and Murphy 1995, 89
Blackwater Estuary, Essex (Site 7)	Charcoal spread on palaeosol.	3990 +/- 70 BP (HAR-6604	cal BC 2590-2460	cal BC 2870-2330	Oak Prunus		
Blackwater Estuary, Essex (Site 8)	Charcoal spreads on palaeosol	4000 +/- 70 BP (HAR-6618) 4690 +/- 70 BP (HAR-6617)	cal BC 2610-2460 cal BC 3620-3360	cal BC 2870-2340 cal BC 3640-3200	Oak Oak	Vicia/Lathyrus	
Blackwater Estuary, Essex (Site 18)	Charcoal spread on palaeosol.	4180 +/- 70 BP (HAR-7060)	cal BC 2900-2620	cal BC 2920-2580	Oak		
West Row Fen, Mildenhall, Suffolk (MNL 165)	Charred trunk and associated in situ root system.	3650 +/- 100 BP (HAR-5637)	cal BC 2200-1890	cal BC 2340-1750	Oak, ash, hazel/alder		Martin and Murphy 1988
Staunch Meadow, Brandon, Suffolk.	Charcoal layers in fen peat.	1350 +/- 70 BP (HAR-4086) 1330 +/- 80 BP (HAR-6605)	cal AD 630-690 cal AD 640-780	cal AD 560-790 cal AD 560-880	Calluna (ling), ash, oak.	Phragmites, Juncus, other wetland plants, cereals.	Murphy 1994

Table 2: Submerged forests visible in the intertidal zone between Lincolnshire and the Thames estuary

Site/area	Stratigraphic context	Trees	C14/other dating evidence	Calibrated date ranges (one sigam)	Calibrated date ranges (two sigma)	References
Lincolnshire coast	Rooted in boulder clay, covered by peat	Quercus (oak), Alnus (alder), Betula (birch), Taxus (yew), Prunus spp (sloe etc)	Immingham: 6681 +/- 130 BP (Q-401). Other exposures (at higher elevations) probably Neolithic	cal BC 5650-5480	cal BC 5790-5350	Van de Noort and Davies 1993
Titchwell, Norfolk	Rooted in peat and intertidal sediments	Said to include Pinus (pine), though only alder noted by PM (unpublished)	Palynology indicates associated peat is of Pollen Zone VIIb			Wymer and Robins 1994
Sea Palling, Norfolk	Rooted in boulder clay, covered by peat	Alder, oak	5040 +/- 70 BP (HAR-2612 to 2220 +/- 70 BP (HAR-2602)	cal BC 3970-3720 cal BC 400-190	cal BC 3990-3700 cal BC 400-100	Murphy, unpublished
Blackwater Estuary, Essex	Rooted in London Clay Head, covered by intertidal sediments	Oak	Site 18: 4030 +/- 80 BP (HAR-7056)	cal BC 2860-2460	cal BC 2880-2350	Wilkinson and Murphy 1995
Clementsgreen Creek, Crouch Estuary, Essex	Rooted in intertidal clay, covered by peat	Alder, oak, elm	Site 8: 4100 +/- 70 BP (HAR-5227)	cal BC 2880-2500	cal BC 2890-2470	Wilkinson and Murphy 1995
Purfleet, Essex (Thames Estuary)	Rooted in peat and intertidal sediments	Alder, ash, yew, elm (Ulmus sp), holly (Ilex sp)	Site 2: 3910 +/- 70 BP (HAR-8647)	cal BC 2560-2320	cal BC 2580-2150	Wilkinson and Murphy 1995

Table 3: Charcoal, wood and other plant macrofossils from prehistoric 'burnt flint mounds' in the Midlands and Eastern England.

Site	Location	C14	Calibrated date range (1 sigma)	Calibrated date range (2 sigma)	Charcoals	Wood	Other macrofossils of woodland plants	Reference
The Stumble, Blackwater Estuary, Essex (BL 28)	Now intertidal, formerly valley floor location	3885 +/- 70 BP (OxA-2297)	cal BC 2470-2280	cal BC 2580-2140	Indeterminate	No preservation	Hazel nutshell, apple endocarp (charred)	Wilkinson and Murphy 1995, 80.
West Row, Mildenhall, Suffolk (MNL 124)	Fen-edge, on peaty soil formed over chalky drift	3720 +/- 70 BP (HAR-1876)	cal BC 2280-2030	cal BC 2350-1930	Alder, hazel, Pomoideae, Prunus, oak	Fen-oak trunk	Alder, hazel, woody nightshade (Solanum nigrum), elder	Murphy 1988
West Row, Mildenhall, Suffolk (MNL 137)	Fen-edge, on calcareous soil formed on chalk marl	3650 +/-100 BP (HAR-2690)	cal BC 2200-1890	cal BC 2340-1750	Ash, oak, hazel, hazel/alder			Murphy 1988
Swales Fen, Mildenhall, Suffolk (MNL 204)	Fen-edge, in fen and wood peat over stony sand	3760 +/- 60 BP (HAR-9271	cal BC 2290-2040	cal BC 2460-2030	Alder	Alder, hazel	Alder, sloe, hawthorn, dogwood (Cornus sanguinea), hazel, elder, bramble, 3-nerved sandwort (Moehringia trinervia)	Martin 1988 Murphy 1988
Lackford Bridge, Suffolk	Valley of River Lark, in wood peat	3940 +/- 70 BP (HAR-2484	cal BC 2570-2350	cal BC 2860-2200	Alder	Alder		Murphy, unpublished
Feltwell, Norfolk (FWL 171)	Fen-edge, on sand	3720+/- 80 BP (GU-5573) 3770+/- 50 BP (GU-5574)	cal BC 2280-2030 cal BC 2290-2130	cal BC 2460-1910 cal BC 2460-2030	Alder, with some oak, Prunus, Pomoideae, ash, elder, field maple.	Alder trough. Fen oaks	Bramble, elder, oak (leaves)	Crowson *et al.* 2000, 187
Northwold, Norfolk (23680 NWD)	Fen-edge	18 dates (range) 3840+/- 55BP (OxA -6823) 3650+/-45 BP (OxA-6895)		cal BC 2265-2165 to cal BC 2140-2065	Hazel, hazel/alder, oak, Prunus, Pomoideae	Alder, hazel, oak	Alder, birch, hazel, oak, bramble, elder, woody nightshade (fruits, seeds leaves)	Crowson *et al*. 2000, 191

Table 4: Evidence for early hedgerows in the Midlands and Eastern England.

Site	Period	Wood	Other macrofossils of woody plants	Reference
West Deeping, Lincs.	Late Bronze Age	Pomoideae	Cornus sanguinea (dogwood), Crataegus monogyna (hawthorn), Prunus domestica (bullace), Prunus spinosa (sloe), Rubus fruticosus (bramble), Sambucus nigra (elder)	Murphy, Taylor, in prep
	Early Iron Age	Alnus/Corylus (alder/hazel): roots	Elder	
	Mid-Late Iron Age	Fraxinus (ash) - coppice heel	Bramble, elder	
	Late Iron Age/Roman	Quercus (oak), Populus/Salix (poplar/willow) - roots	Bramble, elder, sloe, Rosa sp (wild rose), hazel	
	Roman	Ash (roots)	Bramble, elder, Prunus, willow	
Fisherwick, Staffs.	Iron Age	Alder, hazel, hawthorn, ash, Prunus, oak, willow, elder: mostly alder and hawthorn		Williams 1979
St Ives, Cambs.	Iron Age	Sloe, oak, willow, Acer campestre (field maple)	Prunus sp	Taylor 1996
Coveney, Cambs.	Iron Age	Wood degraded but Rosaceae thorns	Hawthorn, bramble	Murphy, in prep.
Alcester, Warks.	Iron Age		Hawthorn, sloe, field maple, (Rhamnus catharticus (buckthorn)	Greig 1994
Oakley, Suffolk	Roman	Wood degraded, but Roasceae thorns	Elder, willow, Prunus avium (wild cherry), bramble.	Murphy and Fryer, in press

Table 5: Examples of wood and charcoal as industrial fuels

Site	Period	Industry	Charcoals	Other charred plant material	References
Fenn Creek (Site 2), Woodham Ferrers, Essex.	Late Bronze Age	Salt	Quercus (oak) mature wood Corylus/Alnus (hazel/alder) twigs	Rare cereal remains	Wilkinson and Murphy 1995, 157
Cowbit, Lincolnshire	Iron Age	Salt	Alnus (alder), Salix/Populus (willow/poplar), Acer (field maple)		Gale, in Lane, in press
Morton Fen, Lincolnshire	Roman	Salt	Alnus (alder), Fraxinus (ash), Salix/Populus (willow/poplar), rare, narrow stems.	Abundant cereal remains (mainly Hordeum vulgare (barley) processing waste.	Gale, in Lane, in press
Middleton, Norfolk	Roman	Salt	Alnus (alder), Betula (birch), Corylus (hazel), Ericaceae, Pomoideae, Prunus, Quercus (oak), Salix/Populus (willow/ poplar), Ulex/Cytisus (gorse/ broom), ?Taxus (yew).	Rare cereal remains	Gale, in Lane, in press
Valley Belt, Trowse, Norfolk	Roman	Iron smelting	Quercus (oak), Corylus/Alnus (hazel/ alder), Pomoideae (hawthorn etc), Cytisus (broom), Ericaceae (heathers). Also charred capsule of Calluna vulgaris (ling).	Rare badly preserved cereal grains	Murphy 2000
Stowmarket, Suffolk	Roman	Pottery	Fraxinus (ash), Pomoideae	Abundant cereal remains (mainly Triticum spelta (spelt) processing waste.	Murphy 1989
Buttermarket, Ipswich, Suffolk	Middle Saxon	Pottery	Quercus (oak) mature wood, Cytisus (broom)	Very rare cereals, Carex, Scirpus, and Pteridium (bracken)	Murphy 1990
Silver Street, Lincoln	10th century	Pottery	Quercus (oak), Corylus (hazel), Salix (willow), Alnus (alder), Pomoideae, Betula (birch), Prunus, Fraxinus (ash), cf Helianthemum (rock-rose)		Keepax and Morgan 1989
Langhale, Norfolk	11th century	Pottery	Betula (birch), Castanea (chestnut), Corylus (hazel), Fagus (beech), Alnus (alder)		Jones 1976

Table 6: Basketry and related materials.

Site	Context no.	Description	Sails	Rods	Reference
Stonea Grange, Cambs.	1201	Twisted withy strands of Salix stems up to 10mm diameter. Bucket handles? Also stick bundles of willow, Corylus (hazel) and Fraxinus (ash). From fill of Roman sump.			Cartwright 1996
Oakley, Suffolk	80252	Lower lining of Roman well.	Split laths of Quercus sp (oak) up to 40 x 8 mm	Corylus sp (hazel), some Fraxinus sp (ash) and ?Betula sp (birch). Stems 5-9 mm diameter, 2-3 years old.	Murphy, in press
Buttermarket, Ipswich, Suffolk (IAS 3104)	2252	Charred basketry from burnt Late Saxon cellared building, associated with charred oat grains etc. Probably a grain bin.	Split (halved) roundwood stems of Corylus sp (hazel). 7-13 mm diameter.	Whole, unpeeled stems of Salix (willow). 2-5mm diameter, one year old.	Murphy 1990
	4093	Charred distorted basket from burnt Late Saxon cellared building. Hazel nutshells associated, but perhaps not the original contents.	Split (halved) roundwood stems of hazel and Quercus sp (oak), 12-17 mm diameter, with an oak slat 15 x 6mm.	Whole stems of hazel, 3-7 mm diameter.	Murphy 1990
Collins Creek, Blackwater Estuary, Essex.	Area B	Crushed waterlogged basketry from intertidal mud, associated with Late Saxon fish trap. Probably a fish basket.	Whole stems of hazel, 9-10 mm in diameter, 2-3 years old. Neat longitudinal trimming of some to reduce them to about 5-6mm. rectangular cross-section Oak fragments associated, but probably not part of structure.	Whole stems of hazel, 5-7 mm in diameter, 1-2 years old.	Murphy 1995a
Droitwich, Hereford and Worcester		Fragment of a post-medieval 'barrow' or conical wicker basket for drying salt crystals.	Wooden laths, no identification.	Wooden laths, not identified.	Colledge and Greig 1992

Table 7: Evidence from wood and charcoal for introduced trees and imported timber (chronological order).

Site	Tree/wood	Structure/context	Tree-ring dating	Other dating	Comments	References
Scole, Norfolk	Juglans (walnut)	Furniture leg from well		Roman		Liversidge 1977
Rectory Farm, Godmanchester, Cambs.	Picea (spruce)	Pond		Roman	Twigs, associated with seeds, cones, leaves. Pollen from site.	Murphy, in McAvoy, undated
Droitwich, Hereford and Worcester	Abies (silver fir) Larix (larch)	Barrels		Roman	Hoop bindings of hazel and oak.	Crone 1992
Sutton Hoo, Suffolk	Juglans (walnut)	Eight small cups from kingly burial		c. 625 AD	Burr walnut, perhaps imported from Mediterranean.	Cutler 1983
Greyfriars Road, Ipswich, Suffolk	Quercus (oak)	Barrel-lined well	AD 539-744		Tree ring chronology of barrel staves indicates mid-south German origin for barrel.	Hillam 1989
Buttermarket, Ipswich, Suffolk	Pinus (pine)	Charred plank in cellared building		Late Saxon		Murphy 1990
Anglia Television site, Norwich	Castanea (sweet chestnut)	Charcoal in post-hole fills		Late Saxon		Murphy and Macphail 1985
Langhale, Norfolk	Castanea (sweet chestnut)	Charcoal from pottery kiln		11th century		Jones 1976
Bridge Street, Ipswich, Suffolk	Quercus (oak)	Waterfront	AD 1128 - 1293		Imported timber with tree-ring chronology indicating a Baltic origin.	Hillam 1985
Cecelia Street, Ipswich	Quercus (oak)	Plank/post structure		Medieval	Possible that some timber was from Baltic region.	Hillam 1979
Barton-on-Humber Church, Lincs.	Pinus (pine)	Coffin		Saxon/Medieval		Hillam, pers comm
New Baxtergate, Grimsby, Lincs.	Quercus (oak)	Waterfront	AD 1100-1405		Imported oak with tree-ring chronology indicating an eastern Baltic origin.	Groves 1992
Bridge Street, Ipswich, Suffolk	Pinus (pine)	Waterfront		14th/15th century		Murphy, unpublished
Magistrates' Courts, Norwich, Norfolk	Castanea (sweet chestnut)	Boards from barrel well		Post-medieval		Hillam 1991
Mary Rose wreck, Solent	Juglans (walnut) Pinus (pine)	Wooden chest		Sunk 1545	Multiple dovetail construction suggests a Continental origin.	Knell 1992
Tilbury Fort, Essex	Picea (spruce)	Building	158 year undated spruce chronology; oak chronology 1678-1777 AD			Groves 1993

COUNTY	SITE DETAILS AND SUMMARY OF RESULTS[1]	BIBLIOGRAPHY
Beds	**Odell 1974-78,** SP956568 Saxon wells dated; trc[2] AD 478-623	Hillam, J, 1980 *Tree-ring analysis of the Odell oak timbers*, Anc Mon Lab Rep, **3263**; excavation report by Brian Dix - not seen.
	Sandy, Warren Villas, TL18274698 Medieval hurdle structures dating to late eleventh- and early twelth centuries; trc AD 960-1125	Hillam, J, 1991 *Tree-ring dating of oak timbers from Warren Villas, Sandy*, Anc Mon Lab Rep, **44/91**
Bucks	**Milton Keynes, Pennyland,** SP862411 Saxon well timbers produced 2 undated master curves of 85 and 68 years	Hillam, J, and Groves, C, 1985 *Milton Keynes: Pennyland 1981. Dendrochronology - interim report*, Anc Mon Lab Rep, **4689**; Williams, R J, 1993 *Pennyland and Hartigans. Two Iron Age and Saxon sites in Milton Keynes*, Bucks Archaeol Soc monograph series, **4**
Cambs	**Flag Fen Basin,** TL225989 Bronze Age timbers from Flag Fen platform and Fengate post alignment; trc 1406-937 BC	Neve, J, 1992 An interim report on the dendrochronology of Flag Fen and Fengate, *Antiquity*, **66**, 470-75
	Godmanchester, TL25607140 Late Roman wells, early fourth century AD; trc AD 209-315	Hillam, J, 1993 *Tree-ring analysis of well timbers from Godmanchester, Cambridgeshire*, Anc Mon Lab Rep, **97/93**
	Haddenham Neolithic wooden mortuary chamber; wood very compressed - floating trc	Morgan, RA, 1990 Reconstructing a Neolithic wooden mortuary chamber from the Fens in eastern England through tree-ring study, in *Experimentation and reconstruction in environmental archaeology* (ed D W Robinson), AEA symposium rep, **9**, Oxford
	Peterborough, Lynch Farm Late Roman well timbers; 94-year undated trc	Morgan, R, ?Anc Mon Lab Rep
Cheshire	**Chester, Arrowcroft Scheme** Oak stakes and planks - unsuitable for dating.	Hillam, J, 1979 *'Arrowcroft Scheme' 1978-9, Chester. Wood identification and tree-ring analysis*, Anc Mon Lab Rep, **3007**
	Chester, Balderton Brook, SJ37856231 Medieval timbers of uknown function - 1 dated to AD 1101-1264	Groves, C, 1987 unpubl
	Nantwich, SJ650523 Medieval timbers; trc AD 930-1330	Leggett, P A, 1980 *The use of tree-ring analyses in the absolute dating of historical sites and their use in the interpretation of past climatic trends*, unpubl PhD Thesis, CNAA (Liverpool Polytechnic)
	Nantwich, Bowers Row Car Park, SJ65005199 Medieval timbers from a drain or sewer; trc AD 920-1244	Hillam, J, 1994 unpubl
	Willaston moated site, SJ67055248	Groves, C, 1990 *Tree-ring analysis of medieval bridge timbers from Willaston*

[1] timbers examined by dendrochronology are oak unless stated otherwise
[2] trc - tree-ring chronology

	Medieval bridge timbers felled after AD 1215; trc AD 917-1205	*moated site, near Nantwich, Cheshire, 1990*, Anc Mon Lab Rep, **79/90**
Essex	**Chigborough Farm,** TL880081 Roman well - timbers unsuitable for dating; Iron Age structure - undated 68 year tree-ring sequence	Hillam, J, 1991 *Tree-ring analysis of timbers from Chigborough Farm, Essex*, Anc Mon Lab Rep, **105/91**
	Collins Creek, TL945075 Timbers from inter-tidal post alignments in the Blackwater Estuary; mostly oak, some birch and willow/poplar - unsuitable for dating purposes	Groves, C, 1987 *Identification and tree-ring analysis of wood from Collins Creek, Blackwater inter-tidal zone, Essex, 1993 - a pilot study*, Anc Mon Lab Rep, **104/93**
	Great Holts Farm, Boreham, TL752119 Well timbers from Roman farm; trc AD 66-178	Groves, C, 1995 unpubl
	Heybridge, Elms Farm, TL860085 Roman well timbers; trc AD 27-205	Hillam, J, work in progress
	Heybridge, Lofts Farm, TL866092 Late Bronze Age well timbers; undated 88-year ring sequence	Hillam, J, 1988 unpubl
	Hullbridge Survey, River Crouch site 29 Bronze Age timbers - undated, short ring sequences	Hillam, J, 1989 *Tree-ring analysis of Bronze Age wood from the Hullbridge Survey, Essex*, Anc Mon Lab Rep, **94/89**; Wilkinsin, T J, and Murphy, P L, 1995 *Archaeology of the Essex Coast, Vol I: The Hullbridge Survey*, East Anglian Archaeol Rep, **71**
	Mersea Strood Saxon causeway timbers; trc AD 682-918	Hillam, J, 1981 *The dating of Mersea Strood timbers*, Anc Mon Lab Rep, **3261**; Crummy, P, Crossan, C, and Hillam, J, 1982 Mersea Island: the Anglo-Saxon causeway, *Essex Archaeology and History*, **14**, 77-86
	Rook Hall Farm, site 2, TL880087 Single timber, possible post at bottom of well; ring sequence dates to 1264-1106 BC	Hillam, J, 1991 unpubl
	Slough House Farm, TL870092 Two Saxon wells: well F130 - high quality timber, early seventh century; well F2957 - poorer quality timber, collapsed shaft mid-sixth century, replaced early seventh century; trc AD 406-602	Hillam, J, 1990 *Tree-ring analysis of well timbers from Slough House Farm, Great Totham Parish, Essex*, Anc Mon Lab Rep, **81/90**
	Southchurch Hall, TQ895855 Medieval bridge and revetment timbers; no dating	Morgan, RA, 1987 *Tree-ring analysis of bridge and revetment timbers from the moat at Southchurch Hall, Essex*, ?Anc Mon Lab Rep
	Tilbury Fort, TQ65097549 Post-medieval oak and spruce timbers; oak trc AD 1678-1777; 158-year imported spruce chronology - undated	Groves, C, 1993 *Tree-ring analysis of a wood assemblage from Tilbury Fort, Essex, 1988-89*, Anc Mon Lab Rep, **20/93**
Herts	**Ware, Allen and Hanburys** Timbers from a late Roman well - 4 oak and 1 birch; insufficient rings for dating purposes	Hillam, J, 1988 *The dating of well timbers from Allen and Hanburys, Ware*, Anc Mon Lab Rep, **3004**

H & Worcs	**Droitwich, Friar Street,** SO88996299 Timbers from pit lining and superstructure within the pit; trc 141 BC-AD 44	Hillam, J, 1982 *The dating of Roman timbers from Friar Street 1, Droitwich*, Anc Mon Lab Rep, **3754**; Woodiwiss, S, 1992 *Iron Age and Roman Salt Production and the medieval town of Droitwich*, CBA Res Rep, **81**, London
	Droitwich, Old Bowling Green, SO89936350 Roman timbers; trc 215 BC-AD25	Crone, A, ?
	Droitwich, Upwich, SO90106350 Salt-working structures of Roman to post-medieval date. Roman trc 256 BC-AD 61; Saxon timbers unsuitable; medieval brine shaft and pump support dated AD 1264 and AD 1420-22 respectively. Medieval trc AD 955-1415; barrel timbers trc AD 946-1218 and AD 1454-1642. Post-medieval structures of oak and elm dated to AD 1745/46; oak trc AD 1685-1742, elm trc AD 1692-1745	Groves, C, 1988 *Tree-ring analysis of timbers from Upwich, Droitwich, 1983-84*, Anc Mon Lab Rep, **134/88;** Groves, C, and Hillam, J, forthcoming Tree-ring analysis and dating of timbers, in *Multiperiod Saltmaking at Droitwich, Hereford and Worcester - excavations at Upwich 1983-4* (ed J D Hurst), CBA Res Rep; Hillam, J, 1985 *The dating of oak cores from two structures in Droitwich*, Anc Mon Lab Rep, **4694**; Hillam, J, 1989 *Tree-ring analysis of barrel timbers from Upwich, Droitwich, Hereford and Worcester, 1983-84*, Anc Mon Lab Rep, **84/89**
Leics	-	-
Lincs	**Barton-upon-Humber Church,** TA034220 Saxon/medieval coffins - all oak except for 1 pine coffin made for a child. 1 oak dated so far, AD 907-1103	Groves, C, and Hillam, J, work in progress
	Brigg 'raft', SE99290763 Oak strakes from an Iron Age boat - 135-year undated trc	Hillam, J, 1978 *Tree-ring analysis of the Brigg 'Raft' timbers*, Anc Mon Lab Rep, **2720**; Hillam, J, 1981 Tree-ring analysis of the Brigg "raft" timbers, in *The Brigg "raft" and her prehistoric environment* (ed S McGrail), BAR, **89**, 103-16, Oxford
	Fiskerton, 1981, TF050716 Iron Age causeway of oak and alder posts; constructed/repaired over at least 150 years - precise felling dates range from spring 456 BC to 375 BC, other timbers felled after this; trc 505-339 BC	Hillam, J, 1985 *Fiskerton: Tree-ring analysis of an Iron Age structure*, Anc Mon Lab Rep, **4692**; Hillam, J, 1992 Dendrochronology in England: the dating of a wooden causeway from Lincolnshire and a logboat from Humberside, in *Proc 13th Colloquim of the AFEAF, Guerat 1989*, Guerat, 137-41
	Glebe Farm, Barton-upon-Humber, TA048218 Romano-British site; timbers fomr lining of shallow well or water hole, trc AD 59-193	Hillam, J, and Groves, C, 1993
	Grimsby, New Baxtergate Waterfront structures containing local oak and imported oak from the eatern Baltic region; local trc AD 1148-1284, imported AD 1100-1405	Groves, C, 1992 *Dendrochronological analysis of timbers from New Baxtergate, Grimsby, Humberside, 1986*, Anc Mon Lab Rep, **8/92**
	Lincoln, Brayford Wharf East Late Saxon/early medieval wattle structures	Morgan, R, ?Anc Mon Lab Rep
	South Witham Twelth century timber - undated	Morgan, RA, 1987 *Tree-ring analysis of bridge and revetment timbers from the moat at Southchurch Hall, Essex*, ?Anc Mon Lab Rep

	Winterton Roman well timbers - no dating	Morgan, R, 1976 *Winterton, Lincs - Roman well*, ?Anc Mon Lab Rep
Norfolk	**Billingford** Causeway timbers of Roman date - no dating	Groves, C, 1993 unpubl
	Castle Acre Priory, 1981 Oak timbers (mostly unsuitable) plus alder, ash, poplar/willow from a medieval structure; no dating	Hillam, J, unpubl
	Norwich, Courts Site Medieval oak timbers plus 1 alder timber; most unsuitable for dating. 1 oak dated to late twelth-early thirteenth century; undated samples may be imported. 24 post-medieval boards from a barrel well were identified as sweet chestnut	Hillam, J, 1991 *Tree-ring analysis of timbers from Norwich: Courts Site, 1981*, Anc Mon Lab Rep, **4554**; Ayers, B, 1988 *Excavations at St Martin-at-Palace Plain, Norwich, 1981*, East Anglian Archaeol Rep, **37**
	Norwich, Duke's Palace Medieval timber - unsuitable for dating	Morgan, R, ?Anc Mon Lab Rep
	Norwich, Fishergate Two medieval timbers - no dating	Ayers, B S, 1994 *Excavations at Fishergate, Norwich, 1985*, East Anglian Archaeol Rep, **68**
	Norwich, Quayside, TG23350905 Two timbers from a medieval quayside structure; trc AD 972-1145	Groves, C, 1993 unpubl
	Norwich, Wensum Street Post-medieval timber - unsuitable for dating	Morgan, R, ?Anc Mon Lab Rep
	Norwich, Whitefriars Car Park Site Medieval timbers, mostly unsuitable for dating. One dated timber - AD 781-1024	Hillam, J, 1980 *Norwich, Whitefriars Car Park Site. Tree-ring analysis*, Anc Mon Lab Rep, **3265**; Ayers, B, and Murphy, P, 1983 *A waterfront excavation at Whitefriars Street Car Park, Norwich, 1979*, East Anglian Archaeol Rep, **17**
	Scole Roman wells - no dating	Morgan, R, 197? Tree-ring analysis of the timbers from wells I and II, in *Excavations at Scole* (A Rogerson), East Anglian Archaeol Rep, **5**, 213-18
	Scole Bypass (also in Suffolk), TM1597 99 Roman timbers - trc 71 BC-AD 172	Tyers, I G, and Groves, C, 1996 *Tree-ring analysis and wood identification of timber excavated on the A140 and A143 Scole Bypass Schemes*, ARCUS rep **267/268**; see also Flitcroft, M, and Tester, A, 1994 Scole, *Current Archaeol*, **140**, 322-25
	Snettisham By-Pass, TL67703296 Timbers from 2 Roman wells, one dated to second century; trc 112 BC-AD 90	Hillam, J, 1991 *Tree-ring analysis of well timbers from Snettisham By-Pass, Norfolk*, Anc Mon Lab Rep, **5/91**
	Weeting Roman well timbers - insufficient rings for dating purposes	Gregory, T, (ed D Gurney) 1996 *A Romano-British farmyard at Weeting, Norfolk*, East Anglian Archaeol occ paper, **1**
	West Acre, Home Farm Earth-fast post beneath sixteenth century house; no dating	Groves, C, unpubl

Northants	**Aldwincle,** SP999801 Roman bridge timbers - undated	Morgan, R, ?Anc Mon Lab Rep
	West Cotton, SP976725 Late Saxon /early medieval timbers of oak and alder - no dating	Groves, C, 1989 *Tree-ring analysis of timbers from West Cotton, Northamptonshire, 1988*, Anc Mon Lab Rep, **95/89**
Notts	**Bilby,** SK638832 Medieval bridge on River Ryton; trc AD 1084-1311	Original work by R Morgan - no ref.
	Langford Quarry, SK818608 Trent gravel oaks; some possibly associated with human and animal bones excavated by Trent and Peak Archaeol Unit. trc - 4232-4021 BC, 2979-2858 BC, and 2637-2125 BC	Hillam, J, work in progress
	Retford, Bridgegate Bridge, SK703813 Medieval bridge timbers; some dated	Morgan, RA, 1990 unpubl; Groves, C, 1996 unpubl
	Scaftworth Roman timbers - undated	Hillam, J, 1983 unpubl
Oxford	**Oxford, Shire Lake Project,** SP514056 Timbers from 6 sites along river channel forming medieval boundary between City of Oxford and county of Berks. Mid-Shire Lake, LAPS87 - no dating; north bank Shire Lake, PS88 - trc AD 850-966; south bank Shire Lake, SASL88 - trc AD 968-1089; mid-shire Lake, 33STA - undated timber; Trill Mill Stream, TMS85 - trc AD 632-925; BT tunnel, SAM91 - trc AD 435-577	Hillam, J, and Miles, D, 1992 *Tree-ring analysis of timbers from the Oxford Shire Lake Project*, Anc Mon Lab Rep, **75/92**
Shropshire	**Shackerley Mound,** SJ81100644 Medieval timbers - all oak except for 1 elm; trc AD 1008-1266	Hillam, J, 1984 *Shackerley Mound - Tree-ring analysis*, Anc Mon Lab Rep, **4166** (brief summary only)
	Shrewsbury Abbey, SJ49001199 Timbers mostly alder with a few oak; oak trc AD 1268-1310	Groves, C, 1988 *Tree-ring analysis of timbers from Shrewsbury Abbey, Shropshire, 1985-1987*, Anc Mon Lab Rep, **194/88**
Staffs	**Stafford, Eastgate Street,** SJ920230 Late Saxon and medieval oak timbers, poplar also present. Oak dated to twelth/thirteenth centuries	Groves, C, 1987 *Tree-ring analysis of timbers from Eastgate Street, Stafford, 1982-84*, Anc Mon Lab Rep, **135/87**
	Stafford, St Mary's Grove, SJ920230 Late Saxon and medieval oak timbers dated	Groves, C, 1987 *Tree-ring analysis of timbers from St Mary's Grove, Stafford, 1980-84*, Anc Mon Lab Rep, **132/87**
Suffolk	**Brandon,** TL77008599 Oak timbers from Saxon structures; 2 undated chronologies, third dating to AD 417-597	Groves, C, and Hillam, J, 1986 *Tree-ring analysis of oak timbers from Brandon, Suffolk*, Anc Mon Lab Rep, **4793**
	Ipswich, Bridge Street, TM164440 Saxon and medieval revetments containing local and imported timbers; trc AD 1106-1190 (local) and AD 1128-1293 (Baltic)	Hillam, J, 1985 *Tree-ring analysis of timbers from Bridge Street, Ipswich*, Anc Mon Lab Rep, **4555**

	Ipswich, Cecelia Street Medieval post and plank structure - no dating; possibility that at least some of the timbers imported from Baltic region	Hillam, J, 1979 *Cecelia Street, Ipswich (IAS5001) - Tree-ring analysis*, Anc Mon Lab Rep, **3006**
	Ipswich, Friars Road Saxon well lining timbers - no dating	Groves, C, 1991 unpubl
	Ipswich, Greyfriar's Road, TM163442 Two Saxon wells: well 0630 from hollowed-out tree, local timber, trc AD 585-688; well 0697 from reused barrel staves imported from Germany, trc AD 539-744	Hillam, J, 1989 *Tree-ring analysis of two timber wells from Greyfriar's Road, Ipswich, Suffolk*, Anc Mon Lab Rep, **134/89**
	Ipswich, Lower Brook Street, TM165443 Reused barrel staves with ash bands; staves probably came from 2 trees - dating given in AML Rep not confirmed	Hillam, J, 1984 *Lower Brook Street, Ipswich: Tree-ring analysis of well timbers*, Anc Mon Lab Rep, **4274**
	Ipswich, Neptune Quay Two posts, possible driftwood, of late Saxon/early medieval date - no dating	Groves, C, 1990 unpubl
	Ipswich, St Nicholas Church Hall site Timbers from mid to late Saxon barrel well - 86-year undated trc	Groves, C, 1990 unpubl
	Ipswich, School Street Saxon well timbers - undated chronology of 88 years	Groves, C, 1987 *Tree-ring analysis of Saxon well timbers from School Street, Ipswich, 1983-85*, Anc Mon Lab Rep, **41/87**
	Ipswich, Smart Street, TM167443 Timbers from 2 Saxon wells; all oak except one. Well 0053 undated; timbers from well 0026 felled after AD 712, trc AD 499-682	Groves, C, 1987 *Tree-ring analysis of Saxon well timbers from Smart Street, Ipswich, 1984*, Anc Mon Lab Rep, **42/87**
	Mildenhall, West Row Fen Bronze Age timbers - trees examined in 1982 very stressed; undated trc of 185 years	Hillam, J, 1979 *Tree-ring analysis of fen oaks from the Bronze Age settlement at West Row Fen, Mildenhall, Suffolk*, Anc Mon Lab Rep, **3003**; Hillam, J, 1988 *Tree-ring analysis of Bronze Age timbers from the 1982 excavation at West Row Fen, Mildenhall, Suffolk*, Anc Mon Lab Rep, **119/88**
	Scole Bypass - see under Norfolk	
	Walpole Saxon timbers from possible causeway structure in the River Blyth flood plain - no dating	Groves, C, 1994 unpubl
Warks	**Alcester, Gateway site** Alder or oak timbers of late Roman date - some relative dating but no absolute dates	Groves, C, 1987 *Dendrochronological analysis of wood from Alcester, 1985-86*, Anc Mon Lab Rep, **134/87**
	Alcester, Lloyd's Bank site, SP088574 Roman timbers examined by Belfast Tree-Ring Lab; 2	Baillie, MGL, and Brown, D, pers comm; dating by Sheffield

	chronologies - 1 undated, other 184 BC-AD100	
	Mancetter, SP32609669 Roman timbers from a disused well; trc 139 BC-AD 33	Hillam, J, 1991 *Mancetter excavations 1977. Tree-ring analysis*, Anc Mon Lab Rep, **4169**
W Midlands	-	-

Box 1. Methodology: interpreting roundwood data.

Quantifiable features of roundwood stem collections include stem diameter (mm) and stem age (ring counts). Morgan (1988) argues that examining the distributions of these two variables gives an indication of woodland management techniques. Stem diameters commonly show a narrow distribution, reflecting the selection of uniformly-sized stems by the craftsman. More significantly, stem collections with a narrow age range, showing a high proportion of stems within a 2-3 year age bracket, are likely to have come from woodlands under some form of coppice management.

There are, however, problems. As Darrah (1996) points out, the true age of a stem can only be determined when its very base can be examined: lengths of roundwood in wattling or other structures may have had their bases trimmed off before use, and several separate rods could have been cut from one stem, at different points along its length. In addition, he points out that hazel naturally throws out multiple young stems from the base of the stool (*pers comm*). He suggests that many of the apparently coppiced stems from Neolithic sites were produced by this means, and that intentional coppicing can only be demonstrated where cut stems are seen embedded in stools. He finds it suspicious that Neolithic hurdling tends to be mainly of hazel, and speculates that these stems came from woodland managed primarily for nut production. From the Bronze Age onwards, however, a wider range of species provided roundwood, including species which are not naturally 'self-coppicing'.

There is no doubt that these problems introduce 'noise' into the data. An additional problem is the small sample size from some prehistoric sites. However, studies of stem/age distributions of archaeological roundwood have demonstrated marked variations between sites, which do seem to reflect sources in managed or unmanaged woodland and may also indicate whether more than one woodland source was being exploited at a given site. Morgan, writing nearly ten years ago, concluded that more quantitative data from archaeological material were needed, together with studies of growth patterns in modern woodlands. This is still true today (see 'Priorities for future work').

Examples of age/size distributions from some sites in the Midland Region are shown in Figures 1-4. Figures 1-2 show age/size distributions of hazel stems from a Bronze Age pit lining and Anglo-Saxon well-lining at Godmanchester, Cambridgeshire (Murphy, in McAvoy, undated). In both structures there was a concentration of stems 10-20 mm in diameter. In addition, the Anglo-Saxon structure included some rather larger, and older, sails. Growth rates of stems, as indicated by the trend of points on the scattergrams were similar.

Plots of data from an Iron Age 'creek bridge' (Site 28) in the Blackwater Estuary, Essex (Wilkinson and Murphy 1995) and Anglo-Saxon wattle panels from the fish-trap at Collins Creek, nearby (Murphy 1995) are shown in Figures 3-4. Both structures appear to have served a similar function, in providing firm footing on mud-flat surfaces. There are, however, very marked differences in the oak roundwood from them. Most conspicuously, the growth rate of oak from Site 28 was much more rapid than at Collins Creek. Interpretation is problematic without modern comparative data from the area, but it could conceivably reflect a difference between cutting maiden trees and coppice. At Site 28 there was a marked concentration of stems 4-6 years old, but at Collins Creek the age distribution was less clustered. The Collins Creek hurdles which were sampled were only a very small part of a much larger structure, and it seems likely that wood from more than one woodland had been stock-piled and mixed before use for hurdle construction.

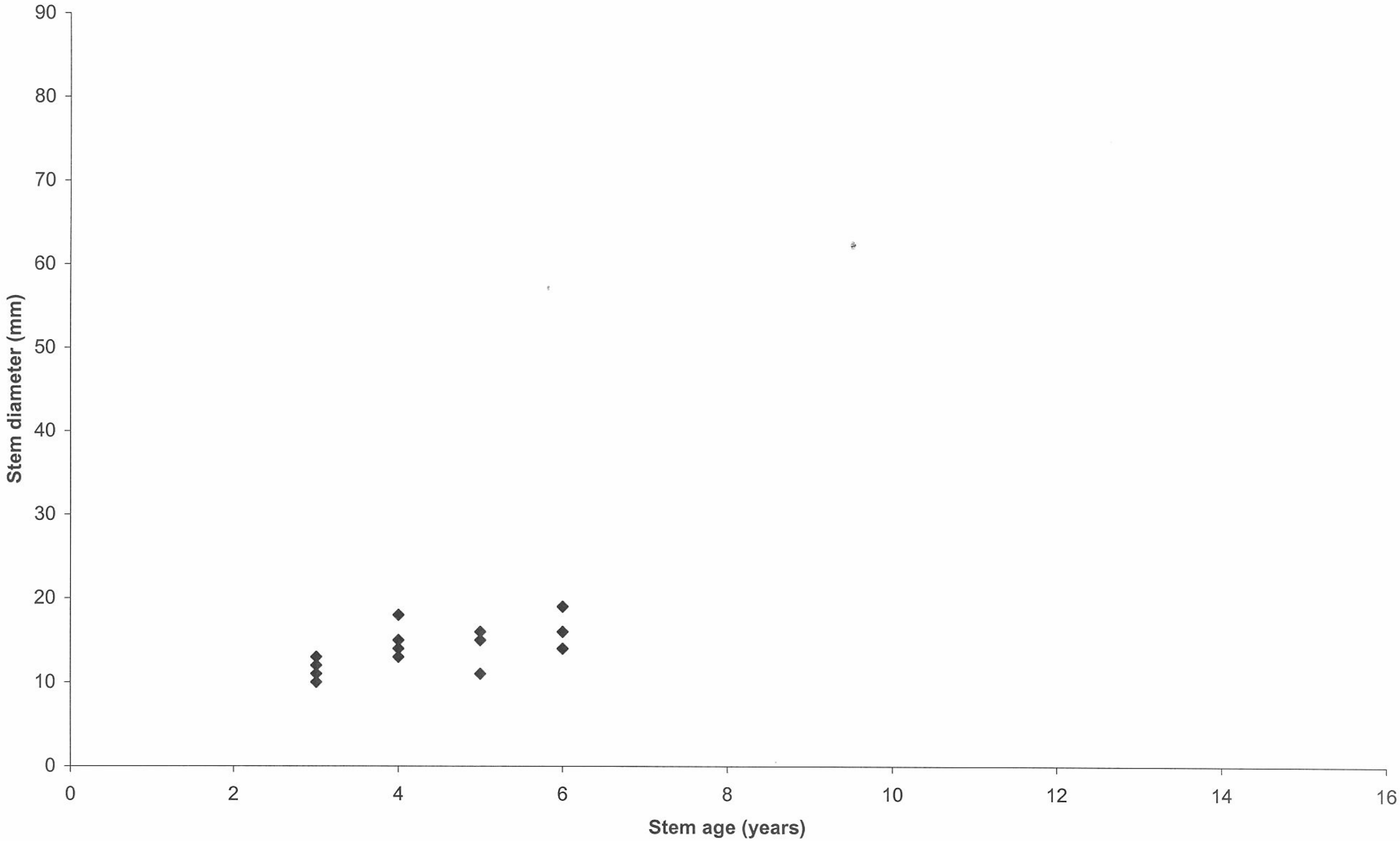

Figure 1. Rectory Farm, Godmanchester, Cambridgeshire. Hazel stems from Bronze Age well-lining.

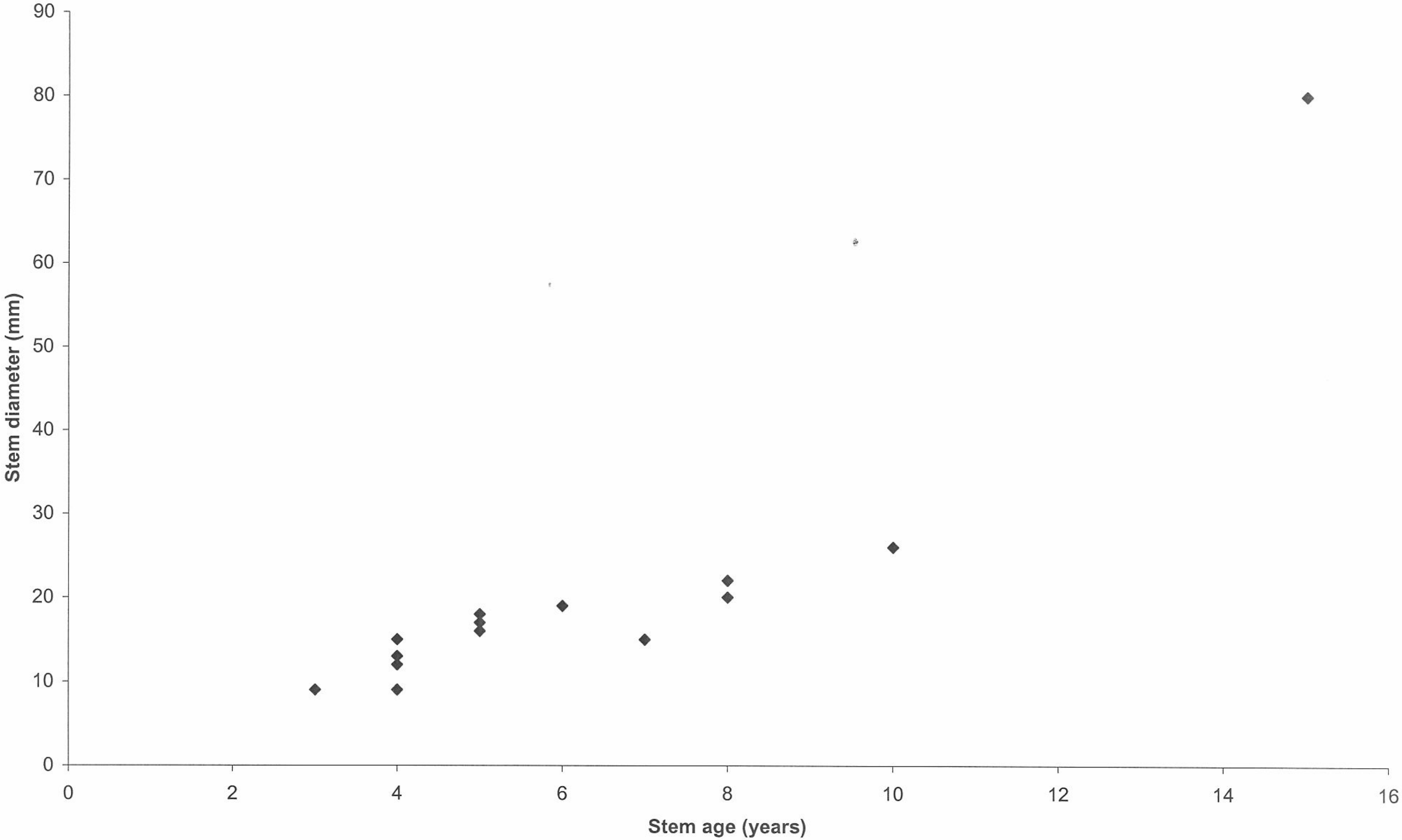

Figure 2. Rectory Farm, Godmanchester, Cambridgeshire. Hazel stems from Anglo-Saxon well-lining.

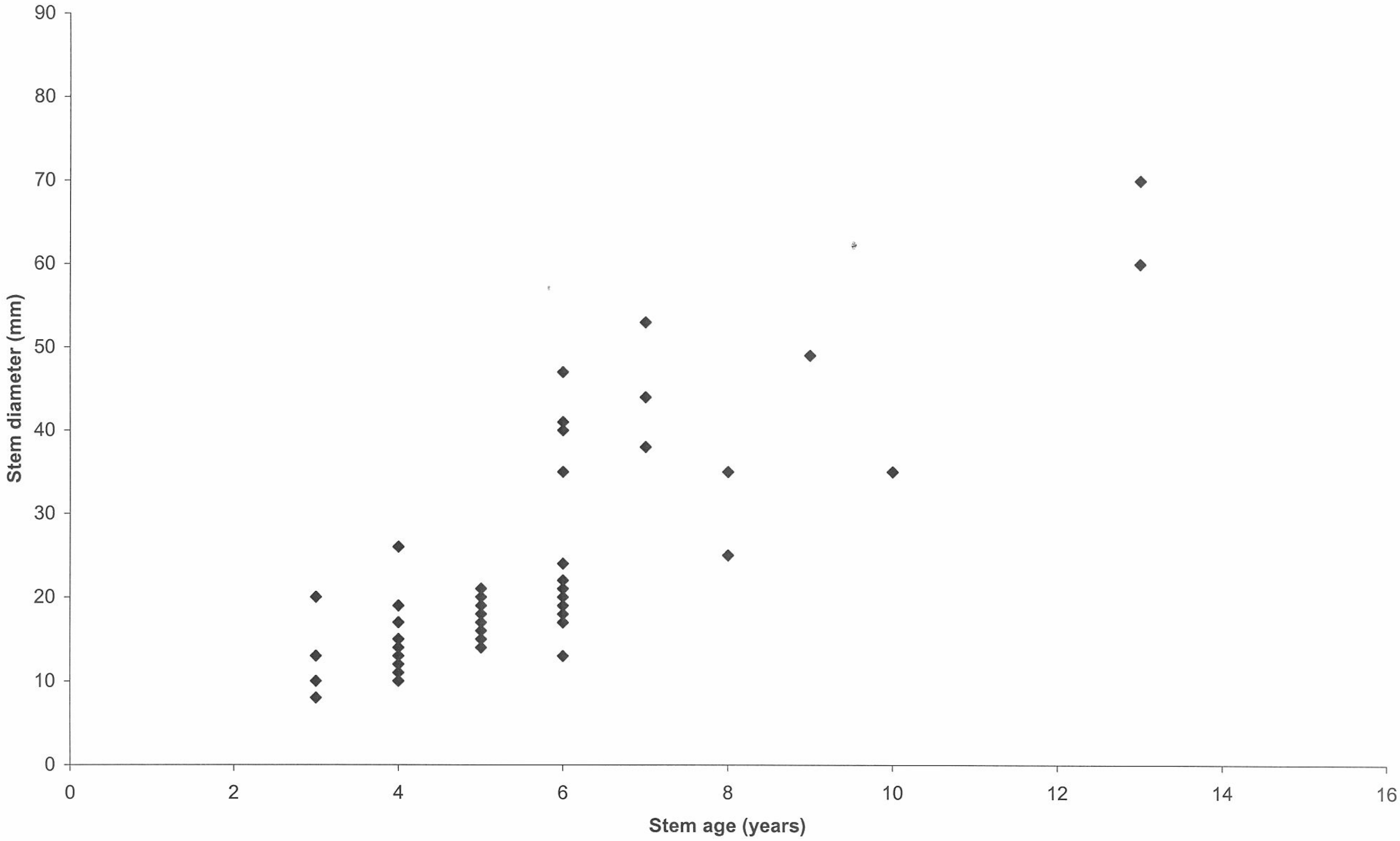

Figure 3. Blackwater Estuary, Site 28, Context 96. Oak stems from Iron Age creek-bridge.

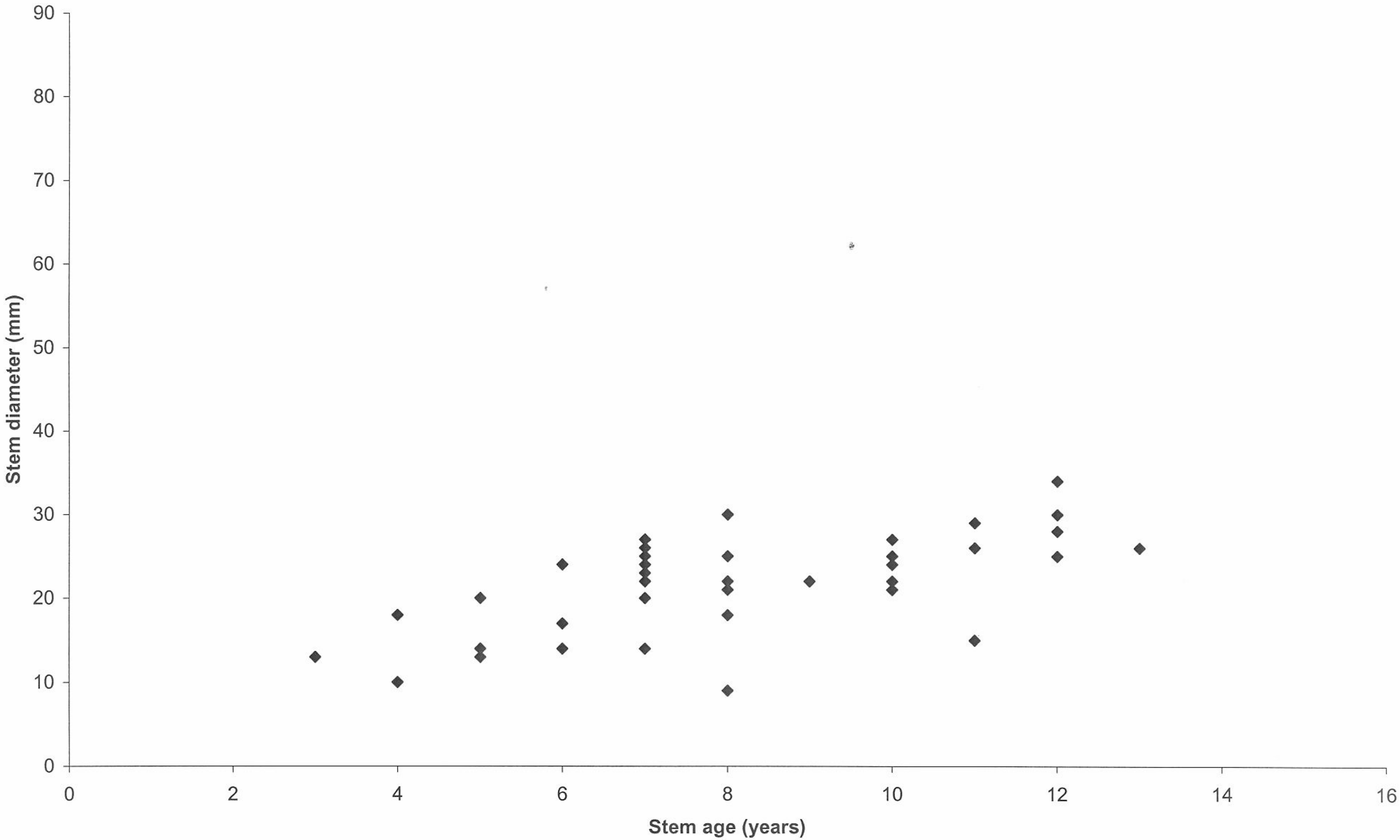

Figure 4. Collins Creek, Blackwater Estuary. Oak stems from Anglo-Saxon hurdle panels.