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**Assessment of plant and invertebrate remains from
Late Devensian and Early Flandrian mire deposits
at Church Moss, Davenham, Cheshire (site code DV95)**

by John Carrott, Allan Hall, Harry Kenward, Frances Large and Raimonda Usai

Summary

Excavations of deposits filling a closed basin within glacial drift at Davenham, near Northwich, Cheshire, revealed a sequence of late-glacial and early post-glacial sediments. This assessment discusses the results of analyses of pollen and of plant and invertebrate macrofossils from selected samples, together with estimates of organic and mineral content.

What appeared to be the infilling of a frost-crack in Trench B gave remains undoubtedly representing conditions of extreme cold, probably from early pollen zone I times.

The pollen record from a sequence of 3.5 m of peat towards the deepest part of the basin (Trench J), supported by radiocarbon dates, shows that organic deposition was initiated in pollen zones I or II and continued to the later part of zone VI. There was some evidence for the episode of cooling conventionally placed in zone III; this was more clearly demonstrable via the results of analyses of insect remains from a shorter sequence in Trench E. In both of these trenches, there was evidence for a mosaic of fen dominated by sedges and often also mosses, with short-lived small pools.

Trenches A and H gave sequences from the margins of the basin; that from H gave useful evidence concerning semi-terrestrial conditions.

Overall, the material provides an important opportunity to examine late- and early post-glacial climatic and ecological events in north-west England. Evidence of climatic change from fossil insects from this area would be particularly valuable for comparison with published results from elsewhere in the British Isles and for comparing terrestrial and global climatic changes during the conventional pollen zones I-IV.

A programme of further work, including additional sampling, is recommended.

Keywords: CHURCH MOSS; DAVENHAM; CHESHIRE; ENGLAND (NW); SEDIMENTS; PEAT; POLLEN ANALYSIS; PLANT MACROFOSSILS; INSECT REMAINS; LATE-GLACIAL; POST-GLACIAL;

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Assessment of plant and invertebrate remains from Late Devensian and Early Flandrian mire deposits at Church Moss, Davenham, Cheshire (site code DV95)

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Introduction and sampling history

Excavations at Church Moss, Davenham, near Northwich, Cheshire, were necessitated by plans for the construction of a by-pass for Davenham village. An evaluation was undertaken at the request of Cheshire County Council by University of Manchester Archaeological Unit, who in turn commissioned an evaluation of the bioarchaeological potential of the site from the Palaeoecological Research Unit, Department of Geography, University of Manchester (Brayshay *et al.* 1995). This study investigated the stratigraphy of the organic deposits at Church Moss and undertook preliminary analyses of pollen and some plant macrofossils, including wood and charcoal. Four radiocarbon dates on wood or peat were obtained which placed the deposits in the early Holocene and Late Devensian. The evaluation by UMAU and PRU produced evidence interpreted as indicative of prehistoric occupation in the vicinity of the mire at this site.

Subsequently, Lancaster University Archaeological Unit were commissioned by Cheshire County Council to undertake larger scale open area excavations ahead of road construction in order to investigate the question of late palaeolithic/mesolithic human activity. The Environmental Archaeology Unit was involved in the planning stages of this exercise in an advisory capacity and Palaeoecology Research Services were subsequently appointed to carry out the bioarchaeological component of the post-excavation assessment.

Samples for analysis of plant and invertebrate remains and for investigation of the nature of the sediments themselves were obtained during excavation of trenches by LUAU, and from four sections (in Trenches A, E, H and J, see Figure 1) sampled directly by EAU staff. Several kinds of samples were taken: (i) from open sections in

Trenches E and J, 0.5 m-long plastic gutter sections were used to obtain undisturbed sequences; (ii) from open sections in Trenches A and H rectangular aluminium boxes (Kubiena tins) were used to take shorter undisturbed sequences of sediment; and (iii) from all four sections (and from the open area excavations undertaken by LUAU), samples of whole sediment were taken in 10 litre plastic tubs (GBA samples *sensu* Dobney *et al.* 1992) or, in the case of the trenches sampled by EAU, polyethylene bags. Subsequently, all samples in bags were stored in plastic tubs. Some difficulty was experienced in sampling Trenches E and J, where rising water-levels precluded careful sampling of the lowest parts of the sequences. Trench J was sampled from a ladder and it was impracticable to collect large samples. Note that the use of single letters for borings and test pits in the UMAU study and the present work has led to some duplication.

This report is concerned with analyses of pollen, organic content, and plant and invertebrate macrofossils from *selected* samples from Trench J, and of macrofossils alone from Trenches A, B, D, and H.

Methods

Pollen

Pollen analysis has been employed to establish the broad outline of the vegetational and environmental history represented by the deposits in the basin at Church Moss, including assessment of the evidence for human activity in the area. For the purpose of this assessment, selected samples from the gutter sections from the longest sequence of peats (Trench J) were submitted to pollen analysis following routine methods. Subsamples of about 10 cm³ were treated successively with dilute alkali, dilute

mineral acid, hydrofluoric acid (particularly if mineral sediment was known or suspected to be present), and an acetolysis mixture of acetic anhydride and concentrated sulphuric acid. Preparations were stained with aqueous safranin and mounted in silicone oil (2000 cs viscosity).

Slides for counting were prepared by diluting sediment residues with silicone oil and generally sufficient traverses undertaken to achieve a total count for land pollen and spores of about 100-150 grains (in the event this figure varied rather greatly as some preparations were almost devoid of pollen whilst others were very rich). All easily identifiable pollen grains and spores were recorded but no attempt was made to pursue difficult specimens.

Plant and invertebrate macrofossils

Samples for analysis of macrofossil remains were selected from amongst those from the sequences from Trenches A, H and J and from the areas of open excavation undertaken by LUAU to provide a broad view of the nature of the sediments and the quality and quantity of preservation of remains, as well as to look for evidence of human activity.

Subsamples, usually of 1 kg, were processed following methods of Kenward *et al.* 1980; 1986), plant remains being examined from the residues, and insects from the flots. In many cases, the residues were large and aliquots amounting to at least 10% by volume of the residue only were examined for plant remains, these subsamples being resieved to 300 microns, 1 mm and 2 mm. Successive dishfuls from each fraction were examined under the low power microscope until it was felt that examination of further would yield no further useful information concerning the nature of the plant material present. Insects and other macro-invertebrates were recorded by scanning the flots in a Petri dish, principal taxa being noted. Some remains were removed to damp filter paper for critical examination. No reference material was available for some non-British taxa present at the site.

Results

Stratigraphy and dating

Trench J

A detailed lithological description of the deposits sampled by means of gutter sections in Trench J is presented in Appendix B. The earliest deposits sampled were humic sands (though the sands and clays beneath this were noted in material excavated by machine and deposited on the spoil heap; they were grey sandy clays and sands and lacked obvious organic matter. Above the basal sand was a sequence of peats, in places predominantly composed of moss, in others rich in wood fragments. For the most part these peats were free of mineral sediment, except for a band with silt and sand between -222 and -208 cm (the loss on ignition result for a subsample of sample 506 from this part of the sequence reflected this, see Appendix A). Mineral sediment was present again in the uppermost sampled deposits (sample 401), which were humic silts grading up into the modern silty clay topsoil. Although not recorded objectively, the degree of humification of the main sequence of peats varied somewhat and some phases of (relative) drying are suggested to have occurred (e.g. at +31 to +32 cm).

Four dates using radiocarbon assay were obtained from the long peat sequence in Trench J (see Table 1). They show that the basal organic deposits towards the centre of the basin began to form by about 12,400 BP (uncal.), i.e. probably in the later part of pollen zone I (*sensu* Godwin 1975). The next date in the sequence, about 1 m above, places these deposits somewhere in late zone III or early zone IV, and the material about 1 m above this, again, is probably of early zone VI date. The uppermost date, a little under a metre higher than and quite close to the present ground surface this is late zone VI or perhaps early zone VII. There is limited stratigraphic evidence for the climatic changes of zones I-IV, although the sandy horizon represented by sample 506 (Table 7) may indicate destabilisation of the landscape

Table 1. Radiocarbon dates from Trench J, Davenham Church Moss.

Depth below trench datum (cm)	Depth below pollen datum (cm)	Date	Calibrated date
approx. -258 to -295.5	approx. -296 to -297.5	12,450 \pm 60 BP	uncalibrated; too early for calibration
-153 to -163	-190 to -200	9790 \pm 60 BP	cal BC 9045 to 8895 and cal BC 8795 to 8655 (more probably the former)
-53 to -63	-90 to -100	9000 \pm 50 BP	cal BC 8080 to 7970
+17 to +27	-10 to -20	7900 \pm 50 BP	cal BC 6995-6580

through freeze-thaw during the zone III cold period (Loch Lomond stadial).

These dates show that the net accumulation of peat at the centre of the basin was rather slow (mean 0.37 mm yr⁻¹) in the period between about 12,400 BP and 9,700 BP (using the uncalibrated dates), but much faster (mean 1.1 mm yr⁻¹) between about 8970 and 8025 (using the midpoints of the calibrated BC date ranges); subsequently, growth was rather slower (mean 0.65 mm yr⁻¹) between about 8025 and 6788 (again using midpoints of cal. BC date ranges). The value for the uppermost date, less than 0.5 metre below the present land surface, indicates either that peat formation ceased some time after about 6800 cal BC or that later peat has been removed by cutting or by natural decay.

Trench H

In this sequence, grey silty sands gave way to more humic, finer-grained deposits with thin sandy layers. Above this were soft detritus peats with some wood, more strongly humified above. These were succeeded by pale brown sand, overlain by humic silts with modern rootlets (grading into the topsoil). Details of the lithology are given in Appendix B.

A single sample was submitted for dating by radiocarbon assay from the peat (depth -25 to -31 cm); the result was 11600 \pm 60 BP (uncalibrated; too early for calibration); this

suggests that the deposit was of zone II (Windermere interstadial) date.

Trench E

The succession in Trench E was based on grey sands like that in J. It consisted of about 1.5 m of organic deposits, mostly moss peat.

Other trenches

Trench A revealed a variable succession whose lower part was locally more sandy or more clay. A somewhat unclear sequence of organic and sandy layers was then succeeded by well-humified peats (LUAU's context 47) grading into silty topsoil. From Trench B two samples of the peat filling a putative frost crack were examined; the peat consisted largely of hypnoid mosses. Four samples from amongst those from deposits in Trench D were examined; they represented various aspects of the lithology encountered.

Biological remains

The results of the pollen analyses are presented in Figure 2. Results from the analyses of plant and insect macrofossils are presented in Tables 2-7.

Trench J

The long peat sequence from Trench J was examined in some detail to provide as complete a record of the infilling of the basin as practicable within the constraints of an assessment. Analyses have been made of pollen, plant and invertebrate macrofossils and organic/mineral content.

Pollen and spores were present in large enough concentrations through most of the sequence to permit counting within a reasonable time, though very low concentrations were experienced from the basal samples and from some of the middle and upper parts of the sequence where there was an abundance of wood and moss detritus.

The lowermost part of the pollen record (Figure 2) is marked by a predominance of non-arboreal pollen, primarily Cyperaceae with some Gramineae (and in the basal two samples also Compositae (Liguliflorae) = Asteraceae, Lactuceae). Not surprisingly, these basal samples contained rather large numbers of pre-Quaternary microfossils. Tree pollen was restricted to small amounts of *Betula* and sometimes also *Pinus*; the presence of well preserved *Corylus*-type pollen in this part of the sequence, and especially in the basal samples is difficult to explain if the pollen represents *Corylus*, but perhaps less so if it is *Myrica* (which is included in *Corylus*-type). This basal metre of stratigraphy is likely to represent pollen zones II to III. It may be that zone III is marked by the influx of mineral sediment which is clearly seen in the loss-on-ignition curve in Figure 2 at -235 to -240 cm, but the large climatic changes associated with late zone II and zone III are not evidence from the pollen record.

Herb pollen declines through the period represented by peats at -150 to -200 cm as the percentages of spores of various pteridophytes (and to a lesser extent pollen of trees) increase. The former are clearly part of the local flora of the mire, since sporangia and cluster of spores were noted from most of the sample with high counts for spores. This part of the sequence probably represents pollen zone IV.

The next stage in the sequence is marked by an increase in *Corylus*-type (probably marking pollen zone V), followed by a rise in *Pinus* (zone VI) and a concomitant increase in *Sphagnum*, indicating the local development of a *Sphagnum*-dominated mire. Only in the uppermost samples does pollen of thermophilous trees begin to appear: there are small amounts of oak, elm and alder. The uppermost sample might with justification be taken to mark the beginning of zone VII.

The macrofossil evidence is best reviewed on the basis of the pollen zonation discussed above. Plant remains were abundant and well preserved in most samples, though much of the material comprised unidentifiable herbaceous fragments. Invertebrates were present in modest numbers throughout the main part of the sequence.

The basal sample from the sequence in Trench J (a sample of sandy clay, 701, from immediately beneath the lowest organic horizon, collected from the spoil heap) contained no plant or invertebrate remains other than some possible rhizome fragments; these may have penetrated from later layers. This deposit was not subjected to pollen analysis, but is likely on stratigraphic grounds to represent pollen zone I. Samples 501 and 503 are regarded as of probable zone II date. The vegetation recorded in the peats comprised sedge swamp with some mosses, with no macrofossil evidence for trees. The invertebrate remains indicated aquatic and marshland environments, although the upper sample included some terrestrial taxa which may have been favoured by unstable soils—perhaps the result of climatic deterioration leading into zone III.

It is suggested that zone III is represented by sample 506. At this time there was an influx of mineral sediment onto a moss-dominated mire, the invertebrates continuing to suggest aquatic and marshland habitats. Significantly, this sample gave remains of several *Olophrum fuscum* (Gravenhorst) and some *Arpedium brachypterum* (Gravenhorst), probably indicating reduced temperatures, since they are absent from all the other Trench J samples (see also evidence from Trench E, below).

Samples 508, 511 and 514 probably belong to zone IV. The first of these gave evidence for tree birch remains and also for the rather thermophilous *Typha latifolia* L. (consistent with the appearance of *T. latifolia* in the pollen record). The invertebrates through this part of the sequence were predominantly aquatic and marshland forms, although there were some more terrestrial taxa, particularly in 508.

Zone V is probably represented by samples 518 and 521. The development of *Sphagnum* peat is clear from these samples, and in the part of the sequence represented by sample 521 it is evident that the mire surface dried out at least locally, since *Hylocomium splendens* (Hedw.) Br.Eur., *Pleurozium schreberi* (Brid.) Mitt. and *Hypnum* cf. *cupressiforme* Hedw. were recorded together with the more typically wetland mosses. There may have been growth of pine, birch and *Populus* (presumably aspen, *P. tremula*) onto the mire, too, at this time. The invertebrates also indicated a trend towards a less aquatic environment, and a single bark beetle was recorded.

There is further evidence for terrestrialisation from the plant and invertebrate macrofossils in the samples (406, 404 and 402) thought to represent zone VI. Particularly characteristic are the remains of the moss *Polytrichum* and again remains of pine are present. No aquatic insects were recorded from sample 404, and there was a single anobiid beetle, doubtless from dead wood. Notable in sample 402 were moderate amounts of *Pinus* charcoal, likely to be contemporaneous.

Thus it appears that there is a useful record from Trench J for vegetational changes in this basin for the period from zones II to VI. Invertebrates provide indications of climatic changes, particularly from zones II to IV.

Trench H

The plant remains from the four samples examined from the Trench H sequence essentially indicate sedge swamp with some pools and with trees nearby (or, in the case of sample 132, *in situ*), the latter including birch, willow and ?aspen. Invertebrates were present in

rather variable numbers, but suggested a range of aquatic to terrestrial habitats (and a somewhat open landscape) at the level represented by sample 161/102. with increasing terrestrialisation towards sample 132. Mosses were absent, in contrast to the bulk of the peats from Trenches J and E and the ?frost-crack filling in Trench B. The AMS date suggests these peats in Trench H formed during zone II, although there is some evidence of later intrusion into the uppermost part of the sequence which may represent an abbreviation of any post-zone II deposits.

Trench E

It is likely that much of the peat sequence represented by the samples from Trench E was of zone II date; the vegetation at this location was predominantly of mosses but with some evidence for marsh/fen communities and sometimes open water, environments supported by the bulk of the invertebrate remains. Birch trees were probably present nearby. Sample 218 was notable for its mineral content, and perhaps represents zone III. This contention is supported by the presence of *Arpedium brachypterum* and *Olophrum fuscum*, probably indicating lower temperatures, in samples 221, 218 and 215. The insect assemblage from the uppermost sample examined (211) gave a subjective impression of higher temperatures, but no thermophiles were specifically identifiable within the constraints of the assessment.

Other trenches

The samples examined from Trench A proved to contain rather small amounts of identifiable biological remains; the organic sediments were evidently strongly humified. The presence of sclerotia (resting bodies) of the soil-dwelling fungus *Cenococcum* throughout the sequence perhaps argues for post-depositional decay.

The ?frost-crack fills from Trench B consisted largely of moss but with some plant remains indicating the presence of open water, perhaps only locally. The insects indicate extremely low temperatures, with records of *Diacheila ?arctica*

Gyllenhal, *Helophorus ?obscurellus* Poppius, *Arpedium brachypterum* (Gravenhorst), *Boreaphilus nordenskiöldi* (Makl.) and *?Simplocaria metallica* Stürm. It seems very likely that this, and various other features resembling it, were indeed frost-cracks and that they dated to the early part of the Late Glacial. This means that the biological record at this site extends back well into the Late Devensian.

The various samples from Trench D represented a variety of lithological types and their content of biological remains was not uniform. There was some evidence for intrusive material in sample 4211. Sample 4264 included a component of beetles probably associated with decaying wood, and wood fragments made up a large proportion of the deposit.

Wood/timber, nutshell and charcoal

The identifications of 'spot' finds of wood or timber collected during excavation by LUAU are listed in Appendix C. It can be seen that most of the material was pine, presumably *Pinus sylvestris* L. but that some material of birch, willow and *Populus* (presumably aspen) was also recorded; no remains of hazel wood were found, in contrast to Brayshay *et al's* (1995, p. 1) results, but there were several finds of hazel nuts and nutshell fragments. These latter are listed in Appendix D; one of the samples of 'nutshell' proved to be a fragment of female *Pinus* cone.

Microscopic charcoal was recorded from some of the lowermost pollen samples (there were traces at -285, -290 and -296 cm, and moderate amounts at -251.5, -258 and -299 cm) and macroscopic fragments were recorded from some of the GBA subsamples (Trench A: sample 312, -15 to -20 cm; Trench D: samples 4218, context 173 and 4265, 180; Trench H: samples 132 -5 to -10 cm and 162, -31 to -36 cm; and Trench J: samples 402, -10 to -20 below pollen datum, and 406, -52.5 to -65 cm bpd). There is no particular pattern to these results but some anomalies need explanation. This sample 4265 is described by the excavator as 'natural sand', whilst the results from Trench J are appear contrary. It is possible that the

'charcoal' from the lowest pollen samples is in fact coal (pre-Quaternary microfossils were often frequent in the basal samples) and that the macroscopic charcoal seen in samples 402 and 406 was localised and not present in the small amounts of material taken for pollen analysis.

Extinct mosses

In addition to the extinct species of moss recorded by Brayshay *et al.* (1995), *Paludella squarrosa* (Hedw.) Brid., recorded from sample 211 in Trench E, the present study has brought to light material of *Helodium blandowii* (Web. & Mohr) Warnst. from sample 511 in Trench J and a possible fragment of *Meesia longiseta* Hedw. All became extinct in Britain in the late Flandrian; in the case of *P. squarrosa* and *H. blandowii*, the extinctions occurred within the last century or so and Knutsford Moor, Cheshire, was one of the last sites where these two taxa were last recorded. It is of interest that the *Paludella* is from such early deposits (records from late Devensian/early Flandrian deposits appear to be confined to Scottish sites, cf. Dickson 1973, fig. 47).

Discussion and statement of potential

A peculiar feature of the main peat deposits in the Church Moss basin is their broad uniformity of lithology over a very long period of deposition and through a considerable depth. There is little evidence from Trenches J and E for a phase of open water early in the organic succession and the development of a relatively dry land surface seems only to have occurred in the very latest part of the succession. Most of it indicates a mosaic of pools and marsh or fen vegetation with phases in which trees or scrub grew out onto the still wet mire. This vegetational stasis in a habitat type where a rapid hydrosere succession would be expected requires explanation. A gradually rising water-table would produce this effect. Following Brayshay *et al's* suggestion that the basin formed as a result of solution of salt from saliferous deposits at depth, it is possible that

the gradual collapse of the basin approximated to the rate of peat formation, maintaining more or less constant hydrological conditions through a long period.

The deposits at Church Moss have proved to contain a rich assemblage of generally well preserved plant and insect remains. The sequence of deposits is not uniform across the body of the basin, however, as evidenced by the results presented here and in the evaluation report of Brayshay *et al.* (1995). The sampling carried out during the main excavation by LUAU appears fortuitously to have covered the late- and early post-glacial history of the basin (probably to pollen zone VI). The putative frost-crack fills from Trench B (which we consider to be almost certainly correctly identified) provide evidence concerning the ecology and climate in at least a limited episode of what is likely to be early zone I deposition.

The deposits encountered in Trench E provide a substantial sequence containing quite large numbers of insect remains which will provide insights into vegetation change and climatic variations in north-west England through what is likely to have been the warmer part of zone II, tracing the cooling in later zone II and the cold phase of zone III, in which respect the site is particularly interesting because, on the limited evidence available, zone III cooling may have been less intense in Cheshire than is accepted for Britain as a whole. Using the material from Trench J this same sequence of events can be examined (although less material is available), but the local ecology can be reconstructed through till the later stages of zone VI or even early zone VII. The material from the remaining trenches appears to be of rather more limited value, although some samples from Trench H are of interest. The deposits at Davenham thus contain plant and invertebrate evidence which would be of considerable value in provided an integrated reconstruction of local ecology and terrestrial climate. We consider that further work towards these ends is desirable to provide comparanda with parallel sequences elsewhere, especially in Wales, eastern England and the Midlands, and particularly to establish how uniform was the response of terrestrial climate to global climatic changes as recorded in ice-

and deep-sea cores.

A reconstruction of conditions at Davenham will provide a setting for the earliest post-glacial human colonisation of northern England—and we echo Brayshay *et al.*'s recommendations with regard to the need for the creation of a detailed record of the biostratigraphy of the deposits. In our opinion, however, there is no unambiguous evidence for the presence of humans in the vicinity of Church Moss during the period represented by the deposits discussed here. Further excavation suggests that the 'worked wood' and 'bark and charcoal spreads' are in all probability of natural origin, while the 'hoards' of hazelnuts may easily have been gathered by small mammals, particular since there is evidence from some of the 'spot' finds of nuts (Appendix D) for 'holing' by such animals. We can see no easy way of distinguishing charcoal resulting from natural fires from that produced by human activity.

Plant remains are present in sufficient concentration in the samples from Trenches B, E, H and J for macrofossil analyses to be undertaken using 1 kg or smaller subsamples. However, the concentration of insect remains is, as is typical of most late-glacial or early Holocene sedentary deposits, fairly low. It would be desirable to process between 3 and 10 litres of material such as this in order to recover useful assemblages from most sample units. It was only practicable to collect samples of about 3 kg from the section exposed in Trench J. Amalgamation of units would be possible in some parts of this sequence, but is not ideal, as subtle ecological and climatic changes may be obfuscated. The climatically most interesting part of the sequence is well represented by somewhat larger samples from Trench E, although ideally larger samples should be collected from new pits. The samples from the putative frost crack feature in Trench B similarly are of sufficient size to provide adequate insect assemblages, assuming the 1 kg subsamples processed for assessment are representative. Pollen preservation and concentrations in almost all of the material are adequate for detailed analysis, though in some cases it may be necessary to count more than

one slide to achieve a large enough total count. The continuous sequences in gutter sections and aluminium boxes are ideally suited to subsampling for pollen analysis. They will also provide material for further loss on ignition tests at close intervals, designed to detect short-lived episodes of mineral influx. A further approach to estimating mineral input and its nature would be the use of thin sections, for which the continuous samples are, again, suitable. All of the deposits which are of biological interest are suitable for radiocarbon dating using AMS techniques (the use of standard 'bulk' samples is to be avoided since roots and rhizomes, likely to be of later date than the horizon being dated, are frequent throughout the peats).

Recommendations

We recommend that funding be provided for a full programme of further analysis of pollen and plant and invertebrate macrofossils from the main peat sequence (as seen in Trenches J and E), from the 'frost crack' fills (Trench B) and from the marginal sequence in Trench H. Ideally, further sampling should be carried out to obtain large samples from the peat, in order to permit recovery of substantial and therefore ecologically and climatically interpretable insect assemblages at 5 or 10 cm intervals.

The existing samples should be examined as follows:

(i) Dating

Each sequence examined should be dated at sufficiently close intervals to provide a detailed chronological framework. For Trench B a minimum of two dates is required and for Trench H three additional dates; for Trench J, an additional six dates are needed, with a contingency of two or three more to investigate details of events at the horizons tentatively identified with zones II-IV. Eight dates would be needed for the peats in Trench E. A contingency of six further dates should be allowed for any material from the remaining trenches which prove to contain important fossil assemblages.

(ii) Further review of samples

Having established that the site has potential for bioarchaeological analysis, a selection of perhaps 20 of the unassessed samples should be examined for macrofossils using 1 kg 'test' subsamples in order to determine whether any have particular ecological or climatic significance.

(iii) Pollen

A complete diagram should be constructed for the full sequences from Trenches J, E, and H, with counts at an interval somewhat closer than that used for the assessment of the Trench J sequence—probably 5 cm. Pollen concentration data should be recorded, as well as pollen percentages. 'Spot' samples from the material from the frost-crack in Trench B should be analysed palynologically to supplement the dating framework.

(iv) Loss on ignition

Loss on ignition data should be obtained from the sequences from Trenches J, E, and H, at the same sampling interval as for the pollen analyses, to provide a measure of mineral influx and thus of changing hydrology within the basin and soil stability in its catchment.

(v) Plant macrofossils

A continuous record of plant macrofossils from the sequences in Trenches J, E, and H should be made, using the material already processed together with 0.5 to 1 kg subsamples of the remaining samples. The residues from these latter subsamples should be made available for analysis of invertebrate remains.

In addition, detailed analyses should be made of all of the samples from the frost-crack in Trench B and of samples selected in the light of the review under (ii) above.

(vi) Invertebrate macrofossils

All of the available sample material should be processed for Trenches J, E and H to provide the largest possible assemblages throughout the sequences. For the frost crack material from

Trench B, all of the sample material should be processed, apart from a small 'voucher' (perhaps 10-50 g) retained to represent the sediment. The residues from the subsamples processed for plant macrofossils should be amalgamated with the subsamples processed for invertebrates before paraffin flotation.

In addition, detailed analyses should be made of all of the samples from the frost crack in Trench B and of samples selected in the light of the review under (ii) above.

(vi) Thin sections

The parts of the Trench J, E and H sequences believed to represent the zone II-III-IV transitions should be examined through thin sections in order to observe the quantity, nature and spatial distribution of the mineral sediment, particularly in order to detect any evidence of deposition by moving water or wind.

In addition to these analyses of the existing material, we recommend that ideally further sampling should take place using a test pit located between the positions of Trenches E and J to obtain large samples at close intervals, primarily for the investigation of climate through invertebrate remains (but with supporting analyses of pollen and plant macrofossils and the use of several radiocarbon dates). We also recommend that a second sample pit should be located to the north-west of Trench J in order to sample the stratigraphy in this area. Material from such a pit would require review and probably some subsequent detailed analysis (as a minimum a pollen and dating framework and strategic analyses of plant and invertebrate macrofossils). If this strategy is to be adopted, the scale of work on Trenches J and E could be reduced but, bearing in mind the differences between these two sequences, some detailed analyses of them and the establishment of a pollen and dating framework would still be necessary.

Resources required

The recommended programme of further study, including work on two new sequences, has

considerable implications for specialist resources. We do not propose to produce a detailed estimate of time and costs without further discussion, but in broad terms the following would be needed:

- (a) approximately 40-45 radiocarbon dates
- (b) pollen analysis of probably five sequences totalling about 10 m (perhaps 200-220 samples), requiring at least 2 months technician time and 8 months specialist time
- (c) loss on ignition estimates for about 220 samples, requiring at least 2 weeks technician time
- (d) plant macrofossils analysis of four long sequences and perhaps 15-20 further samples from the other trenches, requiring at least 1 month technician time and 2 months of specialist time
- (e) invertebrate macrofossils of four long sequences and perhaps 15-20 further samples from the other trenches, requiring at least 3 months technician time and 12 months of specialist time, including museum study of climatically significant taxa

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Table 2. Results of assessment of plant and invertebrate macrofossils from samples from Trench A, Davenham Church Moss.

Trench/ Pit	Context	Sample	Depth within section (cm)	Sediment description	Wt	Comments
A		312	-15 to -20	very dark greyish-brown crumbly amorphous organic sediment to humic silt with modern roots; occasional lighter patches of silt to a few mm across	1 kg	There was a very small residue of unidentifiable fine herbaceous stem fragments together with traces of wood (including <i>Pinus</i>) to 25 x 2 mm and moderate amounts of charcoal (to 10 mm, again, most or all of it <i>Pinus</i>). <i>Cenococcum</i> sclerotia were abundant and there were traces of earthworm egg capsules. Quartz sand made up a modest proportion of the residue. There were only traces of invertebrate remains in the flot, including earthworm egg capsules.
A		314	-25 to -30	very dark brown, crumbly (somewhat granular) slightly woody well humified peat	1 kg	The very large residue consisted mainly of granular undisaggregated amorphous and highly humified peat, and would undoubtedly have been very much smaller if it had been more thoroughly disaggregated. There were moderate amounts of bark (including <i>Betula</i>) and non-coniferous wood to 10 mm and of <i>Cenococcum</i> sclerotia, but the only other identifiable plant fragment was a piece of uncharred <i>Corylus</i> nutshell to 10 mm. There were traces of aquatic and terrestrial beetles and several earthworm egg capsules in the flot.
A		316	-37 to -45	patchily mid grey-brown to dark brown sandy humic silt to silty amorphous organic sediment	1 kg	The very small residue consisted mainly of quartz sand with a few cubic centimetres of herbaceous detritus including rootlets; there were some <i>Cenococcum</i> sclerotia and traces of bark (to 10 mm) and earthworm egg capsules; a single worm egg capsule was the only invertebrate recorded from the flot.

Table 2. Results of assessment of plant and invertebrate macrofossils from samples from Trench B, Davenham Church Moss.

Trench/ Pit	Context	Sample	Depth within section (cm)	Sediment description	Wt	Comments
B	99	4076		dark brown, brittle to layered (working crumbly) amorphous organic sediment with traces of sand and hypnoid moss	1 kg	Most of the small-sized residue was in the <1 mm fraction; the coarser clasts were mainly undisaggregated silty moss peat. There was a moderate amount of quartz sand. The moss stems, which made up the bulk of the organic fraction, were mostly unidentifiable; there was however some <i>Calliergon giganteum</i> with a trace of <i>C. cuspidatum</i> . Some unidentifiable herbaceous stem/rhizome material was also present. The only other remains were fruits of <i>Potamogeton</i> and <i>Ranunculus</i> Subg. <i>Batrachium</i> and 'sclerenchyma spindles' of <i>Eriophorum vaginatum</i> . Beetles were moderately abundant in the flot and included aquatic and terrestrial species. Some cold-stage taxa were present (<i>Diacheila ?arctica</i> , <i>Helophorus ?obscurus</i> , <i>Arpedium brachypterum</i> , and <i>?Simplocaria metallica</i>), the entire fauna being compatible with very low temperatures.
B	110	4079		mid-dark orange-brown, undense hypnoid moss peat with a little sand	0.5 kg	A large residue mainly of moss stems and leaves, mainly <i>Drepanocladus</i> sp(p)., with traces of <i>Scorpidium scorpioides</i> and perhaps <i>Cratoneuron commutatum</i> var. <i>falcatum</i> . There were moderate numbers of <i>Ranunculus</i> Subg. <i>Batrachium</i> achenes and traces of <i>Carex</i> nutlets, a little very decayed wood to 5 mm and a trace of quartz sand. A small group of insect remains was recovered in the flot, including cold indicators (several <i>Arpedium brachypterum</i> and a single <i>Boreaphilus nordenskiöldi</i>) and several aquatics.

Table 4. Results of assessment of plant and invertebrate macrofossils from samples from Trench D, Davenham Church Moss.

Trench/Pit	Context	Sample	Depth within section (cm)	Sediment description	Wt	Comments
D	154	4211		dark grey, plastic to crumbly humic clay silt	3 kg	The residue was tiny, given the large size of the subsample processed. It was about 50:50 sand/gravel (to 15 mm) and herbaceous detritus. The latter included traces of <i>Urtica dioica</i> , <i>Viola</i> and tree <i>Betula</i> fruits, with moderate numbers of <i>Cenococcum sclerotia</i> . In the mineral fraction there were fragments of coal shale and cinder (to 15 mm), coal (to 10 mm) and brick/tile and ?slag to 5 mm, presumably intrusive from layers above. Worm egg capsules were abundant in the flot and the small insect assemblage, although indicative of water and marshland, was nondescript.
D	173	4218		mid-dark grey, crumbly (working plastic), slightly sandy clay silt with patches of slightly brownish, more humic silt and paler sandy grey clay; traces of bark present	1 kg	There was a very small residue of quartz sand, a washover from which comprised a few cubic centimetres of rootlets (mostly modern) and <i>Cenococcum sclerotia</i> with traces of bark (to 30 mm), charcoal (to 10 mm) and coal (to 5 mm) with one charred <i>Corylus</i> nutshell fragment (to 10 mm). There were only traces of invertebrate remains in the flot.
D	178	4264		dark grey-brown crumbly to soft coarse detritus peat, slightly woody (with some bark fragments)	1 kg	The moderately large residue was about 50% by volume wood (to 20 mm, probably including <i>Salix</i>), twigs (to 30 x 5 mm) and bark (to 25 mm); there were only traces of rootlets and other herbaceous detritus. The only identifiable remains were traces of <i>Carex</i> nutlets. The flot included several earthworm egg capsules and <i>Daphnia</i> (water flea) ephippia (resting eggs), together with a modest-sized assemblage of beetles indicating swamp with some open water, with a few taxa probably indicative of 'dry land' habitats. Several elaterids and two <i>Rhizophagus</i> sp. may have been associated with decaying wood.
D	180	4265		light grey-brown sand with traces of woody and herbaceous detritus	13 kg	This very large subsample yielded a residue of about 2 litres of quartz sand with a 10-15% content of wood (to 20 mm, including <i>Betula</i>), twigs (to 35 x 15 mm), bark (to 10 mm) with traces of roots and other herbaceous debris. There were some conspicuous dark brown tubular sheets of epidermis which may have been <i>Equisetum</i> . The identifiable plant remains included small numbers of <i>Ajuga</i> (cf. <i>reptans</i>), <i>Rubus idaeus</i> and <i>Ranunculus</i> Section <i>Ranunculus</i> . A <i>Betula</i> cf. <i>nana</i> fruit was also noted. There was a trace of charcoal to 2 mm which may have included pine, and small numbers of <i>Cenococcum sclerotia</i> . Invertebrates were present in the flot in rather small numbers, and indicated a range of habitats, primarily marshland

Table 5. Results of assessment of plant and invertebrate macrofossils from samples from Trench E, Davenham Church Moss.

Trench/Pit	Context	Sample	Depth within section (cm)	Sediment description	Wt	Comments
E		211	-25 to -35	dark orangish-brown (oxidising dark brown), √felted, compressed moss peat with some rare twigs and modern roots	1 kg	There was a very large residue consisting mainly of moss (mostly <i>Calliergon giganteum</i> and <i>Paludella squarrosa</i> with some <i>Homalothecium nitens</i> and traces of <i>Sphagnum</i>). Apart from <i>Carex</i> nutlets, recorded in moderate numbers, other identifiable plant remains were sparse: traces of tree <i>Betula</i> fruits, bud-scales and ?also female catkin scales, and a <i>B. cf. nana</i> fruit. There was also a trace of wood to 5 mm. Invertebrate remains were moderately abundant in the flot. The beetles and bugs included a range of aquatics, the remaining fauna mostly being associated with marshland or damp ground.
E		215	-65 to -75	dark golden-brown, oxidising dark brown, felted, compressed moss peat with <i>Menyanthes</i> seeds and modern roots	1 kg	There was a large residue which consisted mainly of moss stems and leaves of which a very large part was formed of <i>Rhizomnium</i> sp. with smaller amounts of <i>Calliergon cuspidatum</i> . There were moderate numbers of <i>Carex</i> nutlets, tree <i>Betula</i> fruits and <i>Menyanthes</i> seeds. The remaining material was unidentifiable stem/rhizome detritus. Invertebrate remains were quite abundant in the flot, the beetles including a range of taxa of swamp and water. There were two <i>Arpedium brachypterum</i> , a northern and upland beetle.
E		218	95 to -105	dark brown, crumbly, sandy silty detritus peat to humic silt	1 kg	Most of the moderately large residue consisted of plant detritus <1 mm, of which a large proportion was moss stem and leaf debris. The following moss taxa were identified from amongst this: <i>Homalothecium nitens</i> , <i>Drepanocladus</i> sp(p). and <i>Scorpidium scorpioides</i> . Moderate numbers of <i>Potamogeton</i> , tree <i>Betula</i> , <i>Ranunculus</i> Subg. <i>Batrachium</i> and <i>Carex</i> fruits were present, along with traces of <i>R. flammula</i> , <i>Empetrum</i> , <i>Myriophyllum</i> and Characeae oogonia. There were some stem and leaf fragments thought to be from an aquatic taxon such as <i>Myriophyllum</i> . The numerous invertebrate remains in the flot included substantial numbers of ostracod valves and <i>Daphnia</i> ephippia. The insects indicated open water as well as aquatic-marginal habitats. Terrestrial forms included some <i>Olophrum fuscum</i> and <i>Arpedium brachypterum</i> . Mites were abundant.

Trench/Pit	Context	Sample	Depth within section (cm)	Sediment description	Wt	Comments
E		221	-125 to -135	dark brown, crumbly detritus peat with twig fragments; rather well humified	1 kg	In the large residue the bulk of the material comprised fine roots with some stem/rhizome fragments and moderate numbers of moss shoots, the last of these mostly not identifiable further than 'hypnoid', though some <i>Calliergon giganteum</i> was noted. Apart from traces of twig fragments to 25 x 3 mm, the only other plant material was <i>Carex</i> nutlets, present in moderate numbers. The flot included numerous mites and a group of beetles predominantly indicative of aquatic-marginal habitats; there were two <i>Arpedium brachypterum</i> and several <i>Olophrum fuscum</i> .
E		225	-155 to -165	golden-brown, oxidising very dark brown to black, felted moss peat with some monocot stem/rhizome fragments	1 kg	The huge residue consisted largely of monocot stem and rhizome fragments with very large amounts of moss, amongst which <i>Calliergon giganteum</i> made up the bulk, along with moderate amounts of <i>C. cuspidatum</i> and traces of <i>Drepanocladus</i> and <i>Bryum</i> spp. There were moderate numbers of tree <i>Betula</i> fruits and traces of bark and dicot (?tree) leaf fragments. The flot included quite large numbers of invertebrates, with numerous mites and spiders and several fly puparia. The beetles ranged from dry-land forms (e.g. <i>Metabletus</i> sp.) to swamp and aquatic taxa, the last two groups being predominant.
E		227	-180 and lower	golden-brown, oxidising to ∇black, slightly sandy detritus peat with moss, rootlets and monocot stem/rhizome fragments	1 kg	The small to moderate-sized residue was mostly plant detritus with modest amounts of quartz sand. The former consisted mainly of rootlets with traces of <i>Calliergon giganteum</i> shoot fragments, <i>Carex</i> nutlets, <i>Potentilla palustris</i> achenes and dicot (?tree) leaf fragments. There were numerous beetle and other insect larvae, and mites, in the flot, with a range of aquatic and marshland beetles.

Table 6. Results of assessment of plant and invertebrate macrofossils from samples from Trench H, Davenham Church Moss.

Trench/Pit	Context	Sample	Depth within section (cm)	Sediment description	Wt	Comments
H		132	-5 to -10	dark brown, crumbly, slightly sandy well humified amorphous peat	1 kg	The residue was small and consisted mainly of granular very decayed non-coniferous wood fragments to about 10 x 10 mm in moderate amounts with some herbaceous detritus and a trace of quartz sand and 10 mm gravel. Charcoal and coal, both up to 10 mm, were present and there was a fragment of a kind of glassy 'slag' of the same size (?introduced from later activity from deposits above). Identifiable plant macrofossils were limited to moderate numbers of sedge nutlets and rare <i>Potamogeton pyrenes</i> and <i>Chara oogonia</i> . One sedge nutlet was charred. Apart from earthworm egg capsules, invertebrate remains were rather rare in the flot; all of the beetles were terrestrial species.
H		1522	-22.5 to -25	very dark brown, √felted, compressed, slightly indurated detritus with monocot stem/rhizome fragments	1 kg	The moderate-sized residue contained quite a high proportion of material in the >2 mm fraction, though much of this comprised fine rootlets which 'clogged' the sieve and were difficult to remove. Within this 'matrix' of rootlets, along with some other, unidentifiable, herbaceous detritus, and twig fragments up to 25 x 10 mm (including <i>Salix</i>), the residue was rather rich in identifiable remains, especially tree <i>Betula</i> fruits and <i>Carex</i> nutlets, together with moderate numbers of <i>Salix</i> fruits, birch female catkin scales, <i>Populus</i> bud-scales. Small numbers of <i>Potentilla palustris</i> , <i>Filipendula ulmaria</i> and <i>Potamogeton</i> were also present and there was at least one birch fruit which may have been dwarf birch, <i>Betula nana</i> . Modest numbers of invertebrate remains were present in the flot, including abundant mites and earthworm egg capsules. Beetles represented waterside or swamp habitats, with a few aquatics.
H		161/102	-25 to -31	√felted woody dark brown detritus peat with modern <i>Cirsium arvense</i> plants growing from live rhizome fragments	1 kg taken for AMS date	An AMS date on <i>Carex</i> nutlets from the sample was 11600√60 BP, not calibrated (Beta-93896). The moderately large residue consisted mainly of wood (to 25 x 10 mm), bark and roots in the <2 mm fractions. There was a large amount of other unidentifiable herbaceous detritus from stem and rhizome material. <i>Carex</i> nutlets were abundant and there were traces of <i>Salix</i> fruits and <i>Betula</i> female catkin scales (again, at least one <i>B. cf. nana</i> fruit was recorded). The only other identifiable macrofossil plant remains were one or a few <i>Ranunculus</i> Subg. <i>Batrachium</i> achenes. There were numerous invertebrates in the flot, with 'many' mites and a group of aquatic, waterside/swamp, and an appreciable component of terrestrial beetles, the last hinting at a somewhat open landscape.

Trench/Pit	Context	Sample	Depth within section (cm)	Sediment description	Wt	Comments
H		162	-31 to -36	mid greyish-brown, slightly humic silty sand to dark brown, slightly sandy amorphous organic sediment	1 kg	There was a small residue, mainly of woody fragments (non-coniferous, up to about 10 mm, probably including <i>Salix</i>) with some bark; the remainder of the organic fraction comprised fine roots with some stem/rhizome material. About 40% of the residue consisted of quartz sand and a little gravel (to 20 mm). There were few identifiable remains: traces of <i>Salix</i> fruits, <i>Carex</i> nutlets, tree <i>Betula</i> fruits and <i>Filipendula</i> achenes. A trace of charcoal to 10 mm was noted. Invertebrate remains were rare in the flot.

Table 7. Results of assessment of plant and invertebrate macrofossils from samples from Trench J, Davenham Church Moss.

Trench/ Pit	Context	Sample	Depth within section (depth within pollen sequence) (cm)	Sediment description	Wt	Comments
J		402	+17 to +27 (-10 to -20)	∇felted, rather indurated and compressed dark brown peat with fine (modern) roots;	1 kg	<p>An initial 1 kg subsample was used to obtain material for AMS date; a separate 1 kg subsample processed for plant and invertebrate macrofossils</p> <p>There was a very large residue, although it proved difficult to disaggregate completely and much of the material consisted of undisaggregated humified peat. Most of the coarse fraction comprised leafless moss stems, probably all <i>Sphagnum</i>; leaves of this species formed the bulk of the finer fractions. There were also moderate amounts of charcoal to 15 mm (including <i>Pinus</i>) and traces of <i>Polytrichum</i> stem fragments and leaf-bases. One modern grass caryopsis was noted. Invertebrates were rare in the flot but included at least one taxon associated with trees.</p> <p>An AMS was obtained on date on clasts of <i>Sphagnum</i> peat separated from roots: 7900∇50 BP, cal. BC 6995-6580 (Beta-93892)</p> <p>Rare clay silt lumps and a patch of charcoal were recorded during processing of the subsample for material for the AMS date.</p>

Trench/ Pit	Context	Sample	Depth within section (depth within pollen sequence) (cm)	Sediment description	Wt	Comments
J		404	+7 to -1 (-30 to --38)	dark brown, crumbly, slightly woody herbaceous detritus with modern rootlets	1 kg	The large residue contained considerable amounts of <i>Sphagnum</i> and <i>Polytrichum</i> debris, the latter too eroded to identify further. Together with shoots and leaf-bases of <i>Polytrichum</i> there were numerous 'flowers' though to be of this genus. There were some fragments of bark and ?needles which may have been <i>Pinus</i> and perhaps also a <i>Calluna</i> capsule. There were rare tree <i>Betula</i> fruits and a single stem of a moss which is thought to be <i>Meesia longiseta</i> . The flot contained modest numbers of beetle remains and numerous mites. The former indicated swamp habitats (there were no aquatics), although there was a single anobiid, presumably from wood or twigs.
J		406	-15.5 to -28 (-52.5 to -65)	very dark brown, √crumbly detritus peat with wood (<i>Salix</i>) to 200 mm	1 kg	The moderately large residue of woody and herbaceous detritus included moss stems, (probably mostly <i>Sphagnum</i>), roots, and large numbers of <i>Carex</i> nutlets; there were also some <i>Polytrichum</i> leaf-bases, <i>Sphagnum</i> capsules and <i>Cenococcum</i> sclerotia. Present in moderate amounts were sheets of tissue (up to 10 mm) which may be from pine bark. A trace of charcoal to 5 mm and a single charred <i>Carex</i> nutlet were also noted. There were small numbers of beetles in the flot, indicating aquatic and (probably damp) terrestrial habitats.

Trench/ Pit	Context	Sample	Depth within section (depth within pollen sequence) (cm)	Sediment description	Wt	Comments
J		521	-53 to -63 (-90 to -100)	very soft, very dark brown, slightly fibrous peat with some wood, including fragments up to 20 cm in maximum dimension; some twigs; very unconsolidated and apparently strongly humified	1 kg	<p>A 1 kg subsample was taken for material for an AMS date; a further 1 kg was processed for plant and invertebrate remains.</p> <p>The moderately large residue consisted of woody and herbaceous detritus. The wood, to 15 mm, included <i>Pinus</i> and there was a twig of this plant as large as 40 x 10 mm there were large amounts of bark (to 10 mm) which may have been pine. Much of the remainder comprised leafless moss stems (probably mainly <i>Sphagnum</i>) and <i>Sphagnum</i> leaves, and there were frequent capsules of <i>Sphagnum</i>, too. Several mosses were present: <i>Scorpidium scorpioides</i>, <i>Calliergon cuspidatum</i>, <i>Hylocomium splendens</i>, <i>Hypnum</i> cf. <i>cupressiforme</i>, <i>Aulacomnium palustre</i> and <i>Polytrichum</i>. Traces of tree <i>Betula</i> fruits were present. Invertebrate remains were quite common in the flot, mites being abundant, and the beetles including rare aquatics, a substantial proportion of damp ground/waterside forms, and one bark beetle.</p> <p>AMS date on <i>Hylocomium splendens</i>, <i>Hypnum</i> cf. <i>cupressiforme</i>, and <i>Pleurozium schreberi</i>: 9000±50 BP, cal BC 8080-7970 (Beta-93893)</p>
J		518	-83 to -93 (-120 to -130)	black, soft (well humified?), slightly woody detritus peat	1 kg	<p>The moderately large residue included abundant leaves and stems of <i>Sphagnum</i> with some rootlets and other herbaceous detritus. There were fruits and bud-scales of tree <i>Betula</i> and bud-scales of <i>Populus</i>. Moderate amounts of bark fragments to 15 mm were observed, together with twig fragments to 15 x 5 mm; there were also some <i>Cenococcum</i> sclerotia. The flot included abundant earthworm egg capsules and beetles ranging from a few aquatics to (predominantly) species able to exploit swamps.</p>

Trench/ Pit	Context	Sample	Depth within section (depth within pollen sequence) (cm)	Sediment description	Wt	Comments
J		514	-123 to -133 (-160 to -170)	slightly orange-brown, oxidising √black, √fibrous, slightly woody moss/monocot peat with <i>Menyanthes</i> seeds	1 kg	There was a large residue in which the largest part was made up by moss stems and by rootlets; most of the former were probably from <i>Sphagnum</i> , whose leaves were moderately abundant. Also present in moderate numbers were tree <i>Betula</i> fruits, and there were buds, detached bud-scales, and female catkin scales of <i>Betula</i> , too. The only other identifiable remains were traces of seeds of <i>Menyanthes</i> and a leaf of the moss <i>Aulacomnium palustre</i> . In addition to modest numbers of beetles from aquatic and marshland habitats, the flot included numerous earthworm egg capsules.
J		511	-153 to -163 (-190 to -200)	moderately firm, dark-brown (internally red-brown), slightly woody, slightly fibrous peat, √felted in places; a few twig fragments	1 kg	A 1 kg subsample was taken for an AMS date; a separate 1 kg was processed to plant and invertebrate remains . The large residue included quite a large fraction >2 mm, amongst which there was wood of <i>Betula</i> to 50 x 15 mm and twig fragments to 10 x 2 mm; the remainder was mainly rootlets and other herbaceous detritus. There were moderate numbers of <i>Carex</i> nutlets and tree <i>Betula</i> fruits, with some <i>Betula</i> female catkin scales and a trace of the moss <i>Homalothecium nitens</i> . The flot included numerous earthworm egg capsules and an assemblage of aquatic and marshland beetles. An AMS date was made on shoots of the mire mosses <i>Helodium blandowii</i> and <i>Homalothecium nitens</i> : 9710 √60 BP, cal BC 9045-8895 and 8795-8655 (Beta-93894).

Trench/ Pit	Context	Sample	Depth within section (depth within pollen sequence) (cm)	Sediment description	Wt	Comments
J		508	-185 to -193 (-222 to -230)	golden-brown, oxidising ∇black, slightly felted crumbly moss/monocot peat	1 kg	The moderate-sized residue consisted mainly of detritus <2 mm, mainly unidentifiable stem/rhizome fragments and roots; there were a few twig fragments (including ? <i>Salix</i>) to 25 x 5 mm. There were traces of several mire-dwelling mosses and moderate numbers of <i>Potentilla palustris</i> achenes; a single <i>Typha</i> fruit was recorded. Invertebrate remains were rather abundant in the flot, and included numerous mites, larvae and fly puparia. The diverse assemblage of beetles and bugs included some aquatics but was dominated by marshland/waterside species; there were also some more terrestrial taxa.
J		506	-203 to -218 (-240 to -255)	dark brown, ∇crumbly, slightly sandy detritus peat	1 kg	The large residue consisted mainly of herbaceous detritus and moss, amongst which <i>Drepanocladus</i> , <i>Scorpidium scorpioides</i> , <i>Calliergon giganteum</i> , <i>C. cuspidatum</i> and perhaps also <i>Cratoneuron commutatum</i> var. <i>falcatum</i> were noted; there were traces of quartz sand and of <i>Carex</i> nutlets. Invertebrate remains were present in modest numbers in the flot and indicated aquatic and marshland environments; there were several <i>Olophrum fuscum</i> and some <i>Arpedium brachypterum</i> .

Trench/ Pit	Context	Sample	Depth within section (depth within pollen sequence) (cm)	Sediment description	Wt	Comments
J		503	-243 to -253 (-280 to -290)	very dark brown crumbly detritus peat	1 kg	The moderate-sized residue consisted mostly of plant fragments <1 mm of which the bulk were roots; there were moderate amounts of stem/rhizome fragments and large numbers of <i>Carex</i> nutlets. A trace of <i>Calliergon giganteum</i> was also recorded. Mites were abundant and insects fairly numerous in the flot, the beetles indicating aquatic/marshland deposition but with an appreciable terrestrial component, probably indicating unstable soils.
J		501	approx. -253 to -263 (approx. -290 to - 300)	slightly reddish golden-brown (oxidising ∇black), firm, fine- grained, slightly sandy monocot peat	0.5 kg	A very large residue was obtained from thus subsample, the bulk of which comprised leafy moss stem fragments (mainly <i>Drepanocladus</i> sp(p). with some <i>Scorpidium scorpioides</i> and perhaps also <i>Cratoneuron commutatum</i> var. <i>falcatum</i> . There were abundant fine rootlets and some herbaceous stem/rhizome fragments. <i>Carex</i> nutlets were moderately frequent and there were traces of <i>Menyanthes</i> seeds, but no other identifiable plant taxa. Earthworm egg capsules were quite frequent and there were some caddis larval cases. The small number of invertebrate remains in the flot indicated aquatic and marshland environments.
J		87	approx. -258 to -259.5 (approx. -296 to - 297.5)	reddish-brown (oxidising black) poorly humified detritus with traces of fine sand	9.5 g	(dry weight) subsample for AMS dating AMS date on humic fraction of whole sample: 12380∇60 BP (not calibrated) (Beta-93895)

Trench/ Pit	Context	Sample	Depth within section (depth within pollen sequence) (cm)	Sediment description	Wt	Comments
J		701	(from block of sediment on spoil heap, representing basal sediments reached)	mid-dark grey, stiff, slightly calcareous, slightly stony, sandy clay with some black organic debris and a lump (to 20 mm) of soft white calcareous material, perhaps rotted chalk or limestone	0.5 kg	There was a very small residue consisting of about 70% by volume quartz sand with some gravel to 25 mm; the remainder was herbaceous detritus to 20 mm, including some unidentified dark- coloured tubular structures (?rhizome fragments); there was a trace of coal to 2 mm. Invertebrates were absent.

Appendix A. Loss-on-ignition data for samples from Trench J. In each case, two subsamples were processed, and the mean values calculated.

Sample no.	Average water content (%)	Average organic content %
401	73	59
402	84	93
403	83	95
404	89	100
405	86	94
406	85	95
407	85	93
522/408	81	95
521	81	96
520	85	94
519	75	97
518	86	94
517	83	96
516	84	97
515	78	95
514	86	95
513	85	94
512	86	92
511	86	95
510	87	94
509	83	96
508	86	92
507	78	52
506	67	38
505	78	92
504	84	95
503	83	89
501	82	76

Appendix B. Detailed lithological descriptions of sequences from Trenches H and J at Church Moss, Davenham, sampled by the authors

Codified lithological descriptions after Troels-Smith (1955) are given in square brackets. Depths (in centimetres) relate to individual datum levels for each sequence.

Trench H

-36 to -30.5	grey silty sand [As/Ag1Ga3] becoming darker, more fine-grained and more humic [As/Ag2Ga2, then Ld2Ga2] between -35.5 and -30.5 and with sandy layers [Ga4] up to 2 mm thick at -33 and -31.5; sharp transition to
-30.5 to -5	soft, dark brown granular detritus peat, occasionally with wood fragments [Sh/Ld3Dh/Dg1 to Sh/Ld3Dh/Dg1Dl+] and becoming more strongly humified and less granular in texture above -13.5
-5 to -3	pale brown sand [Ga4], increasingly silty upwards
-3 to +10	dark brown, humic, slightly sandy silt with (modern) rootlets [Sh1-2As/Ag2-3Ga+], the humic material unevenly distributed and perhaps slightly laminated in lowermost 2-2.5 cm of this stratum

Trench J

To convert depths to those shown on the pollen diagram, subtract 37 cm in each case, e.g. -250 becomes -287.

The sequence from -263 to -229 was retrieved from a 0.5 m gutter section driven obliquely into the sediment section beneath the water-level prevailing at the time of sampling; the depth is approximate, though the relative depths of units within this sequence are accurately recorded. In many cases the detritus was moss and should probably have been recorded as Tb rather than Dg/Dh.

-263 to -258	grey-brown, thixotropic slightly clay, slightly silty humic sand [Ld+As/Ag1Ga3] gradually becoming more highly humic sand [Dg2As/Ag+Ga2] to somewhat reddish-brown sandy detritus [Dg3Ga1] by -258; gradual transition to
-258 to -229	reddish-brown (oxidising black) detritus peat, with traces of mineral sediment [Dg/Dh4Ga+]
presumed overlap of about 10 cm with basal vertical gutter section:	
-253 to -222	red-brown (oxidising dark brown), soft, rather well humified detritus peat [Dg/Dh4]
-222 to -215	very slightly sandy detritus peat [Dh/Dg4Ga+]
-215 to -214	very sandy silty detritus peat, boundaries sharply defined [Dg/Dh2-3Ga1-2]
-214 to -208	slightly sandy detritus peat [[Dg/Dh4Ga+]; sharp transition to
-208 to -203	∇granular moss peat [Dg/Dh(bryo)4]
-203 to -193	mid brown (oxidising dark brown) slightly silty, slightly sandy detritus peat or mud [Ld1-2Dh/Dg2-3As/Ag+Ga+]; sharp transition to
-193 to -182	reddish-brown (oxidising very dark brown), rather well humified detritus peat [Ld1Dh/Dg3]
-182 to -178	becoming fibrous (with roots?) [Ld1Dg/Dh2Th1], pale to mid red-brown where not oxidised
-178 to -166	as unit between -193 and -182
-166 to -156	as -178 to -166 with wood fragments [Ld+Dg/Dh2Th1Dl1]
-156 to -153	as -193 to -182
-153 to -128	firm red-brown (oxidising dark brown) detritus peat with some wood [Dg/Dh2-3Dl1-2]
-128 to -103	rather soft to very soft red-brown (oxidising dark brown) detritus peat; less woody [Dg/Dh4Dl+]

-103 to -78	red-brown (oxidising black), soft, √woody detritus [Ld1Dg/Dh2D11, locally Ld1Dg/Dh1D12], twigs to 10 mm max. diameter
-78 to -64	√fibrous (with moss stems), sometimes woody detritus [Ld2Dg/Dh2 to Ld1Dg/Dh2D11]
-64 to -53	soft detritus [Ld2Dg/Dh2]
-53 to +2	dark (slightly reddish-) brown (oxidising dark brown) coarse fibrous detritus peat with a varying content of wood fragments, mainly in range 5-25 mm in maximum dimension [Dg/Dh3D11 to Dh/Dh1D13] becoming very fibrous between +2 and +5 [Dh/Dg2D12 or Th2D12] and lacking wood component between +5 and +10 [Dg/Dh4]; often √fibrous and sometimes slightly woody between +10 and +31 [Dg/Dh4D1+]; becoming darker and more highly humified at +31 to +32, with modern rootlets appearing; contact irregular to
+32 to +37	slightly pinkish-grey crumbly humic silt to dark brown silty amorphous organic sediment [Ld/Dg1As/Ag3 to Ld/Dg3As/Ag1]
+37 to +47	mid greyish-brown humic sandy clay silt with modern rootlets [Sh+As/Ag4Ga+]

Appendix C. Timber identifications for samples from Church Moss, Davenham.

Trench	Context/Location	Timber	Identification
A	10	4005	<i>Pinus sylvestris</i>
A	10	4006	<i>Pinus sylvestris</i>
A	10	4007	<i>Pinus sylvestris</i>
A		4008	<i>Pinus sylvestris</i>
A	10	4010	<i>Pinus sylvestris</i>
A	10	4022	<i>Pinus sylvestris</i>
A	10	4023	<i>Pinus sylvestris</i>
A	10	4024	<i>Pinus sylvestris</i>
A	11	4035	<i>Pinus sylvestris</i>
A	11	4263	<i>Pinus sylvestris</i>
A	47	4056	<i>Pinus sylvestris</i>
A	68	4060	<i>Pinus sylvestris</i> , ?from stump
A	111		<i>Salix</i>
D	161	4198	<i>Pinus sylvestris</i>
D	164	4222	<i>Pinus sylvestris</i> bark <i>Betula</i> wood and bark
D	162	4223	<i>Pinus sylvestris</i>
E	stump from topsoil	4038	<i>Pinus sylvestris</i>
H	126	4176	<i>Populus</i>

Appendix D. 'Spot' finds of biological remains from Church Moss, Davenham.

Trench	Context	Sample	Comments
A1	47	4127	approx. one half-nutshell fragment of <i>Corylus avellana</i> in a dark brown amorphous organic matrix
A1	47	4134	remains of approx. three nuts of <i>Corylus avellana</i> in a dark brown amorphous organic matrix
A1	67	4146	fragment of ?large puparium
A1	67	4155	distorted fragments of at least one <i>Corylus avellana</i> nut, the tissue rather strongly decayed; a few fragments of ?bark and so <i>Populus</i> bud-scales also present; matrix dark brown slightly sandy amorphous organic sediment
A1	67	4159	a fragment (to about 15 mm max. dimension) of female <i>Pinus sylvestris</i> cone with seeds at the bases of some of the cone scales; very compressed and decayed.
A1	bottom of 67	4160	fragment of iridescent beetle elytron in matrix of sandy amorphous organic sediment: <i>Cetonia</i>
A1	bottom of 67	4142	dark brown amorphous organic sediment with several <i>Populus</i> bud-scales and unidentified twigs a few mm in size; one very corroded, compressed nutshell fragment observed
A1	bottom of 67	4152	very decayed half-nutshell of <i>Corylus avellana</i> in a dark brown amorphous organic matrix with several <i>Populus</i> bud-scales
A1	top of 74	4161	there were no recognisable nutshell fragments, though a few fragments of very decayed <i>Pinus</i> wood to about 15 mm were noted
A1	168	4208	desiccated fragments of 1-2 <i>Corylus avellana</i> nutshells
B	15	4000	fragments of tooth enamel from large or medium mammal (det. K. M. Dobney)
D	150	4230	remains of approx. 30 <i>Corylus avellana</i> nuts in a dark grey sandy clay matrix; the shells were soft and the nuts compressed to varying degrees; none was complete but only one or two showed signs of having been holed by small mammals
D	154	4193	a few tens of flakes of pale brown bark, perhaps <i>Betula</i> , to 25 mm in a dark grey matrix of highly humic silt or amorphous organic material
D	157	4209	fragments of two lower 3rd molars from a sub-adult <i>Bos</i> (det. K. M. Dobney)
?	182	4231	approx. 4 whole <i>Corylus avellana</i> nuts, soft, flattened, in dark grey clay silt matrix; at least two nuts holed by small mammals

Figure 1. (see separate pdf) Davenham Church Moss: sketch plan of location of trenches discussed in this report, based on a plan by Lancaster University Archaeological Unit. The positions of Trenches H and J and the lateral extent of all the trenches are very approximate.

Figure 2. (see separate pdf) Davenham Church Moss: pollen diagram for selected samples from Trench J. Note that for technical reasons it has not been possible to show the lithological column (cf. Appendix B) or 'rare' taxa by means of '+' signs (for some graphs with only one or two very low percentages, there appears to be no record).