Reports from the Environmental Archaeology Unit, York

Technical report: Reconstruction of Lateglacial and Early Holocene mire succession and rates of climatic change from plant macrofossils, invertebrate remains and pollen at Church Moss, Davenham, Cheshire (site code: DV95)

by Paul Hughes, Harry Kenward, Allan Hall and Frances Large

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Summary

Excavations of deposits filling a closed basin within glacial drift at Davenham, near Northwich, Cheshire, revealed a sequence of Lateglacial and Early Holocene sediments.

Analyses of pollen and plant and invertebrate macrofossils were undertaken, together with loss-on-ignition analyses and a programme of radiocarbon (AMS) dating to provide a record of the biostratigraphic and changing climatic and ecological regimes. A secondary aim was to confirm the lack of evidence for human influence in the vicinity of the site.

What appeared to be the infilling of an ice-wedge in Trench B gave remains undoubtedly representing conditions of extreme cold, probably from early Pollen Zone I times.

The pollen record from a 3.5 m sequence 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.

Keywords: CHURCH MOSS; DAVENHAM; CHESHIRE; PLANT REMAINS; POLLEN ANALYSIS; INVERTEBRATE REMAINS; INSECTS; STRATIGRAPHY; PEAT; MIRE; VEGETATION HISTORY; CLIMATE CHANGE; LATE DEVENSIAN; EARLY HOLOCENE

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Technical report: Reconstruction of Lateglacial and Early Holocene mire succession and rates of climatic change from plant macrofossils, invertebrate remains and pollen at Church Moss, Davenham, Cheshire (site code: DV95)

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Introduction and sampling history

Plans for the construction of a by-pass for Davenham village, near Northwich, Cheshire (Figure 1), required the removal of organic deposits from Church Moss, located to the north and east of the village (centred on grid reference SJ 66357135). Excavations were undertaken by the University of Manchester Archaeological Unit (UMAU), to provide an evaluation of the archaeological potential of the site at the request of the Cheshire County Council. University of Manchester Archaeology Unit in turn commissioned a bioarchaeological evaluation from the Palaeoecological Research Unit (PRU), University of Manchester (Brayshay *et al.* 1995). This study examined the stratigraphy of the organic mud and peat deposits encountered at Church Moss, using preliminary analyses of pollen and some plant macrofossils, including wood and charcoal. Four samples of wood and peat were radiocarbon dated, the results placing the lower deposits in the Devensian Lateglacial and the upper levels in the early Holocene. The evaluation of this site by UMAU and PRU produced evidence interpreted as indicative of prehistoric occupation in the vicinity of the mire.

Prior to the commencement of road construction, Lancaster University Archaeology Unit (LUAU) was commissioned to undertake larger open-area excavations in order to investigate further the question of late palaeolithic/mesolithic human activity in the Church Moss area. The Environmental Archaeology Unit (EAU) was involved in the planning stages of this exercise in an advisory capacity and Palaeoecology Research Services (PRS) were subsequently appointed to carry out the bioarchaeological component of the post-excavation assessment. Evidence gathered from the open area excavations suggested that 'worked wood' and bark and charcoal 'spreads' were in all probability of natural origin. Similarly, the bioarchaeological assessment (Carrott *et al.* 1996) found no unambiguous evidence for the presence of humans in the Church Moss area during the period represented by the sampled deposits. However, the pollen and plant and invertebrate macrofossil records produced during the bioarchaeological assessment indicated that the deposits at Church Moss contained an important regional record of palaeoclimatic change covering the dramatic switch from full glacial to interglacial conditions at the transition from the Devensian Lateglacial to the Holocene. The analyses also showed that the mire development sequence was distinctive, for at Church Moss fen stages which are normally rapidly replaced through vegetational succession appeared to have been maintained over considerable periods of time.

In recognition of the high potential of the palaeoecological record at Church Moss and the rarity of such sites, PRS were appointed by LUAU to undertake main phase work on the sequence of mire development and palaeoclimatic change.

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) 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 (because tubs were in short supply). Subsequently, all samples in bags were stored in plastics 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 study reports the results of pollen, organic content, and plant and invertebrate macrofossil analyses on samples from Trench J, of pollen and macrofossil analyses from Trench E, and of macrofossil analysis alone from Trench A. Five samples from features revealed in Trench B, and interpreted in the field as ice-wedges, were also submitted to summary pollen analysis and sediment description, and insect remains were also recorded. A series of radiocarbon dates was obtained from various sequences (see below).

Loss-on-ignition analysis provided a record of mineral input into the forming deposits. Pollen analysis was carried out to provide a broad framework of vegetational change in and beyond the mire basin, and to set the sequence into the conventional pollen chronology. Plant macrofossils remains were analysed in order to reconstruct vegetation (and its changes) at and near to the point of deposition, and to provide evidence of water levels and water quality. Insect remains were studied in order to fill in details of the ecology of the basin which were not a given by the plant remains, including the presence of dung and litter, of dead wood, of plants not represented by their fossil remains, of bare soil, and concerning the detailed nature of water bodies. The principal interest of the insects at this site, however, lay in their potential for climatic reconstruction. The period covered by the main trench sequences was one known to have experienced both subtle and gross climatic changes (see for example Lowe and Walker 1997).

Methods

Sediment description

The GBA samples from Trenches E and J, and the samples from 'ice-wedge' fill contexts, were inspected in the laboratory and a description of their lithology recorded using a standard *pro forma*. These samples originally had a mass of between 2 and 5 kg, although in some cases rather little material remained after assessment. With the exception of the 'ice-wedge' fill contexts, the GBA samples represented contiguous 10 cm-thick slices of peat sampled through the complete depth of the peat sections from each of the trenches. The lithology of monolith samples ('gutter samples') taken from sections in Trenches A, E and J was logged using the Troels-Smith sediment classification system (Troels-Smith 1955). Monoliths were divided into stratigraphic units for the purposes of description.

Radiocarbon dating

Peat samples and selected macrofossil remains were submitted for accelerator mass spectroscopy (AMS) radiocarbon dating to provide a chronology for the biostratigraphic and palaeoclimatic analyses undertaken at Church Moss.

The initial four radiocarbon samples (Beta-93892, Beta-93893, Beta-93894 and Beta-93895) were taken from the GBA sequence during the assessment phase of the project. Whole-peat clasts, moss shoots and sedge nutlets were extracted from peat nodules having cleaned away the outer peat surface using cleaned steel spatulas, tweezers and scalpels. Samples were dried, weighed and wrapped in aluminium foil prior to labelling and sealing in air-tight polyethylene bags bearing a second external label. The stratigraphic context, depth, type of material and estimated age were submitted with the peat samples to Beta Analytic Inc., Miami, Florida, USA.

A second set of AMS radiocarbon dates was sampled from Trench J (six dates) and from the top of an ice-wedge fill (a single date) during the main phase of the project. Peat was sampled from the monolith sequence rather than the GBA samples in an attempt to improve the stratigraphic resolution of the age estimates, since the GBA samples each represented 10 cm slices of the peat sequence.

Loss-on-ignition

Sediment samples from Trench J were extracted at regular intervals through the monolith sequence and submitted to loss-on-ignition testing to establish the proportions of organic and inorganic material. Duplicate samples with a wet mass of approximately 15 g were placed in dry, pre-weighed crucibles. The wet mass of the sediment was recorded and the samples left to dry thoroughly in a drying cabinet at a temperature of 45 C for 48 hours. Samples were reweighed to record the dry mass of the whole sediment. Dried samples were fired at 850 C for one hour in a furnace. Samples were immediately reweighed once cool enough to handle. Results for each sample level are the average of two tests. Table 6 gives the average water content of the sediment and the average percentage of organic matter.

Pollen

Pollen investigations at Church Moss have been undertaken to establish the wider environmental history of the vegetation surrounding the peat complex, but also to contribute to the record of mire vegetation development and to assess the evidence for human activity in the area.

Peat slices with a volume of 1 cm^3 were sampled from the Trench E and Trench J monolith sequences and submitted to pollen analysis following routine methods described by Barber (1976) and Moore *et al.* (1991). Initially, a coarse sampling interval of 16 cm was selected to provide an outline diagram for Trench J. Further samples were used to provide closer intervals during the main phase analysis. Samples were treated successively with dilute sodium hydroxide, dilute mineral acid, and where necessary hydrofluoric acid (basal sample only). The preparations were subsequently passed through a 10 micron mesh sieve to remove fine clay-sized particles prior to treatment with an acetolysis mixture of acetic anhydride and concentrated sulphuric acid. Preparations were stained with aqueous safranin and mounted in silicone oil (2000 cs viscosity).

Subsamples of pollen were diluted in silicone oil to provide slides with a reasonable pollen density for counting. Counts were made by making traverses back and forth across the width of the cover-slip, moving the slide forwards by two fields of view at the end of each traverse to avoid 'double counting'. Generally, mounts contained sufficient pollen to reach the pollen sum of 400 trees, shrubs and herbs (excluding obligate aquatics and spores) before the end of the counting area was reached. Occasionally it was necessary to count a second or third slide were pollen concentrations were low. Routine counting was undertaken using x400 magnification on a Leitz microscope. Difficult specimens were examined at x1000 using oil immersion. Preliminary identifications were made with reference to the keys in Fægri *et al.* (1989) and Moore *et al.* (1991). Identifications were checked where possible against modern type material held at the Environmental Archaeology Unit (EAU).

For the purpose of calculating pollen percentages, a sum of trees+shrubs+herbs pollen sum, referred to as a 'Total Land Pollen' (TLP) sum in the text, was used. In practice, many of the species represented in the pollen types from all three categories may have been occupying damp woodland, marshland or semi-aquatic habitats within the peatland complex. It is often not possible to distinguish non-wetland pollen from that produced locally.

Plant macrofossils

Practical: Plant macrofossils were examined from 1 cm thick slices extracted from the plastic gutter sections, to provide fine resolution sampling. (Invertebrate remains were analysed from the GBA samples, each containing material from a 10 cm thick horizon, in view of the necessity for much larger sample sizes.) Plant remains were sieved through a 125 micron sieve using 5 l. of water, following the methods of Barber *et al.* (1994). The use of a constant water volume allowed the proportion of unidentifiable organic matter (UOM) to be compared more reliably between samples. For the peat sequence from Trench J, the quadrat and leaf count method (Barber *et al.* 1994) was used to estimate the proportions of all the larger macrofossil remains forming the main body of the peat. For this, a 'monolayer' of macrofossil remains was distributed over the base of a glass trough and 15 replicate scans were recorded for each sample using a microscope graticule bearing a 10x10 grid square. The percentage of each macrofossil type was recorded as the average of the 15 quadrat scans. Small macrofossil remains such as fruits, seeds, sclerenchyma spindles, and small leaves contributing only a very minor part of the peat volume were quantified using a five-point scale of abundance from rare to very abundant. On the macrofossil diagram for Trench J (Figure 5) the two methods of quantification have been expressed as different styles of histogram. Quadrat and leaf count data are presented as percentages in linked histograms with depth bars representing the sampling points. Five-point scale of abundance data have been have been displayed as unlinked histograms where rare = 10, occasional = 20, frequent = 30, very frequent = 40 and abundant = 50.

The quadrat and leaf count technique is very time-consuming. To allow for analyses of extra sample levels from in Trench E, the macrofossil diagram from this trench has been quantified using the five-point scale of abundance alone. All of the macrofossil remains in Figure 6 are displayed as unlinked histograms.

Macrofossil identifications have been made with reference to manuals of fruits and seeds (Beijerinck 1947), a manual of plant remains in peat (Katz *et al.* 1977) and standard texts on mosses, including Smith (1978) for non-*Sphagnum* mosses and Daniels and Eddy (1990) for sphagna. All identifications of 'problem taxa' have been made with reference to type material held at the EAU, with the exception of the non-British species *Stellaria crassifolia* for which there was no material available. At present this identification is tentative until comparisons with type material can be made.

Data analysis: Detrended correspondence analysis (DCA) was applied to the Trench J macrofossil data, using the CANOCO programme (ter Braak 1987), to explore the character of environmental gradients. The DCA orders samples and species along an as yet unidentified axis so that similar samples/species are placed close together. The resultant gradient is identified by considering the ecology and position of each species placed along the axis. Axis 1 describes the strongest gradient and therefore the greatest amount of variation in the data set. Further axes may be identified which are unrelated to the first axis; however, these are frequently difficult to interpret.

Down-weighting of rare species was specified for the DCA performed on the Trench J data to eliminate problems of over-sensitivity to species occurring at frequencies of less than 1%. Otherwise, all default settings were selected, including 'detrending by segments' (segments = 26, rescaling x4). Results of the DCA are given in Figures 16 and 17.

Insects

Practical: Subsamples were taken from the GBA series for processing for invertebrate macrofossils, broadly following techniques of Kenward *et al.* (1980). The results of the assessment had suggested that quite large subsamples (3-5 kg) should be used, but in many cases the amount of sediment was such that the entire sample was processed without achieving this weight.

Insects were identified by comparison with modern reference material and using the standard works. For some taxa, reliably-named fossil material from other sites was used for comparison. Adult beetles and bugs, other than aphids and scale insects, were almost always recorded fully quantitatively and a minimum number of individuals (MNI) estimated on the basis of counts of the fragments present. In one case, numbers of two very abundant taxa were estimated rather crudely, and in a few others the MNI was estimated by counting elytra and dividing by two. Other invertebrate macrofossils were recorded semi-quantitatively using the scale described by Kenward *et al.* (1986) and Kenward (1992), again using estimates for extremely abundant taxa.

Invertebrate remains were recorded on a paper *pro-forma* and subsequently transferred to a computer database (using *Paradox* software) for analysis and long-term storage.

Analytical: Basic species lists and assemblage statistics were produced by a data input and processing system written by J. Carrott and in routine use in the EAU. Species-richness was estimated using an index of diversity (alpha of Fisher *et al.* 1943). Ecological data were obtained from the standard works. For the bugs, Southwood and Leston (1959) and Wagner (1966; 1967) were primarily consulted. For the beetles Freude *et al.* (1964-1983), Friday (1988) and Hansen (1927-1966) were the principal sources. For Homoptera and various groups of beetles, the Royal Entomological Society's *Handbooks for the Identification of British Insects* were also used as a source of ecological information. Hostplants for reed beetles (*Donacia* and *Plateumaris*) were taken from Menzies and Cox (1996).

Distributions were mostly taken from Coulianos and Ossiannilsson (1976), Lindroth (1960; 1985-6), Massee (1955), and Southwood and Leston (1959), as well as the standard works for Coleoptera, and used to assign a code to each taxon as follows: S—of southerly distribution in north-west Europe; N—of northerly distribution in that area. For 'S' species, values were assigned as follows: S1—falls off distinctly in the far north of Scandinavia or Britain; S2—clearly not in northern areas; S3—only in the southern half of Sweden and/or not in the northern half of the British Isles; S4—present only in the extreme south of Sweden and/or the south of England; S5—barely known from Scandinavia and/or just established in the extreme south of England. For 'N' values: N1—not in southern England; N2—only in upland England; N3—very northerly or in high uplands in Great Britain; N4—not as far south as Great Britain, northerly in Scandinavia; N5—very northerly in Scandinavia. Assigning species to these codes was inevitably somewhat arbitrary in view of the nature of the data available.

Results

Results of radiocarbon assays for the monolith sequence from Trench J are given in Table 1. Sediment descriptions for each of the monoliths (A, E, H and J) studied for the main phase of this project appear in Tables 2, 3, 4 and 5 respectively. Table 6 gives the results of the loss-on-ignition tests for samples from the Trench J monolith sequence; both average water content and average organic content statistics are provided in the table. A complete list of plant species, including parts identified, from Church Moss is provided in Table 7; invertebrates are listed in Table 8. Table 9 gives the main statistics for assemblages of adult beetles and bugs from all samples analysed at Church Moss. A list of abbreviations for ecological codes and statistics used for the interpretation of insect remains is provided in Table 10. Tables 11 and 12 give records for strongly plant-associated insects and a sample-by-sample list of all insects identified from Church Moss, respectively. Timber identifications are given in Table 13, and Table 14 lists the 'spot' finds of plant remains from the mire.

The age/depth curve for Trench J constructed from the ten radiocarbon dates (see below) is presented in Figure 2. The main pollen results are presented in Figures 3 and 4. Macrofossil results for Trenches J, E and A appear in Figures 5 to 7 respectively. Values for the indices of 'northerliness' and 'southerliness' for the insect assemblages from Trenches J and E are plotted in Figures 8-11.

Detailed account

Radiocarbon dating

The results of accelerator mass spectroscopy (AMS) radiocarbon dating on samples of peat and individual macrofossils from Trench J are presented in Table 1. The uncalibrated dates show that the peat deposits represent roughly a 4550-year period of deposition covering the Lateglacial and the early Holocene up to about 7900 BP. The average rate of accumulation over the whole time period was estimated to be 16.1 years cm^{-1} with a maximum of 5.6 years cm^{-1} at 242-210 cm and a minimum of 41 years cm^{-1} between 297 and 242 cm. The average accumulation rate of Holocene peats was 10.1 years cm^{-1} (see Figure 2).

Figure 2 is a plot of radiocarbon age *versus* depth for the radiocarbon dates sampled from Trench J. The age/depth plot shows that most of the dates form a coherent accumulation curve, but that two dates appear to be anomalous. Beta-115980 (9830±60 BP) and Beta-115982 (9430±60 BP) are both significantly younger than overlying dates and clearly deviate rather substantially from the general accumulation curve. Both of these dates were sampled from the lower gutter section in order to date fine stratigraphic levels identified in the macrofossil diagram from Trench J. Some difficulty was experienced in obtaining the lowermost gutter sections in the field because site conditions were difficult. Despite taking precautions to clean the surface of the monolith sections prior to extraction of radiocarbon samples, it is possible that both of these age estimates have been contaminated by traces of younger material.

Loss-on-ignition analysis for Trench J

For most of the 3 metre sequence of monolith samples taken from Trench J, loss-on-ignition analyses gave losses (equivalent to organic content) of between 90 and 98%, values typical for autochthonous (formed *in situ*) peat deposits. There was little variation between different kinds of fen and fen-carr peat. Significantly lower values for loss-on-ignition were noted in the uppermost sample (0 cm, presumably resulting from the intrusion of mineral sediment through cultivation, which is recorded as having occurred during the present century); from the basal sample (296 cm); and from an interval between 270 and 220 cm depth. The minima for loss-on-ignition occurred at 238 cm, early in sub-zone LPZ-DVJ-Ab (see below), indicating a significant phase of mineral input into the mire system. The deposition of mineral grains is likely to have resulted from a major phase of soil destabilisation resulting from loss of vegetation cover in the area immediately surrounding the basin.

Pollen

Local pollen assemblage zones have been defined; the codes for them are constructed as follows: LPZ (local pollen zone)—DV (Davenham) J or E (trench)—**zone letter(s)**. Macrofossil zones have been distinguished with 'LMZ'.

Trench J

LPZ-DVJ-**Aa** 300-250 cm (Cyperaceae/ Gramineae zone)

The basal pollen assemblage zone was characterised by the dominance of Cyperaceae pollen after a brief initial phase in which Compositae (Liguliflorae), Compositae (Tubuliflorae) and Gramineae were all well represented. Near the upper zone boundary, Cyperaceae values declined to 60% TLP, whilst the representation of Gramineae increased to between 10 and 15% TLP. A range of fen herb species was found scattered through the zone in small quantities, generally at frequencies less than 2% TLP, although obligate aquatic taxa were almost completely absent at this stage. *Betula* was the only tree species to be consistently present, with values peaking at 10% TLP but mostly reaching no more than 5% TLP.

LPZ-DVJ-**Ab** 250-192 cm (Cyperaceae, Gramineae, *Betula*, *Salix* zone)

The lower boundary of zone -Ab marked the rational limit of *Salix* and it was also defined by a substantial increase in the representation of Gramineae pollen, which was accompanied by several other herb taxa (Caryophyllaceae, *Artemisia*, *Filipendula*, *Caltha*, *Thalictrum* and *Equisetum*), indicative of open fen conditions. (The *rational* limit is the level at which pollen of a taxon increases from trace levels to form a significant part of the assemblage; the *empirical* limit is the point of first occurrence.) All of the taxa mentioned above are commonly associated with Devensian Lateglacial environments and it is noticeable that their increased representation was coincident with a substantial decrease in loss-on-ignition values indicating greater deposition of inorganic material in the peatland system. This input of clay- and silt-sized particles may reflect a period of disturbance of the vegetation on the slopes surrounding the basin during the Loch Lomond Stadial as a consequence of climatic deterioration. Between 235 and 230 cm, several aquatic or semi-aquatic species became established on the mire, including *Myriophyllum verticillatum*, *M. spicatum*, *Potamogeton*, *Sparganium-type*, and *Typha latifolia*, indicating a significant rise in the water-table. Increased surface wetness was coincident with a decline in the quantity of inorganic input in the middle of sub-zone -Ab, perhaps suggesting a reduction in the severity of the prevailing climatic conditions and the start of a recovery of vegetation cover in the surrounding parts of the drainage basin.

LPZ-DVJ-**B** 192-123 cm (*Betula*, *Pinus*, *Salix*, Filicales zone)

In zone -B, *Betula* rose to dominance in the pollen spectra, reaching a peak of 90% TLP at the upper zone boundary, whilst *Pinus* registered a rather more subdued increase, fluctuating between 10 and 40% of TLP. Non-arboreal taxa showing significant increases in representation coincident with the increase in *Betula* included several fern taxa (*Thelypteris palustris*, *Dryopteris*, Filicales undiff.), which originated in plant which probably formed the field layer in a developing fen carr. (Macrofossil analyses demonstrate that *Betula* was present at the sampling point at the time at which *Betula* pollen frequencies begin to increase in the pollen diagram.) Open-fen taxa such as members of the Cyperaceae and Gramineae declined to intermittent traces by the upper part of zone -B. Similarly, *Salix* pollen, which increased in frequency just prior to the establishment of *Betula*, declined to <1% TLP at the upper zone boundary. The diversity of herb species dropped markedly through time in the lower part of the zone as the representation of various fern taxa and *Betula* increased. The umbellifers were the only herbs to register a significant increase in the zone. Towards the upper zone boundary, the records for *Sphagnum* (bog moss) spores and *Calluna* (heather) pollen became continuous, marking the first traces of acidification in the wetland basin.

LPZ-DVJ-**C** 123-78 cm (*Corylus*, *Betula*, *Ulmus*, *Pinus* zone)

The rational limits of *Corylus*, *Ulmus* and *Quercus* define the lower boundary of zone -C. *Corylus* peaked early in the zone at 80% TLP, declining slightly throughout the zone to approximately 60% TLP at the upper boundary with zone -D. *Pinus* began to increase in frequency for a second time at 100 cm depth reaching 50% TLP early in zone -D. *Ulmus* and *Quercus*, although consistently present, remained below 2% TLP. Both non-wetland and fen herb taxa were scarce; similarly, fern species were poorly represented, having declined sharply towards the top of the preceding zone.

LPZ-DVJ-**D** 78-0 cm (*Pinus*, *Corylus*, *Ulmus*, *Quercus* zone)

Pinus dominated the uppermost zone. Whilst *Corylus* pollen was still well represented, its frequency was inevitably depressed by the interdependence of variables expressed as percentage data. *Ulmus, Quercus* and *Salix* were present right through to the uppermost sample, though values for the three species never exceeded 2% TLP. Having been present at trace levels in the preceding two zones, *Sphagnum* spores increased sharply between 40-20 cm depth. One or more members of the Ericaceae registered a synchronous response at this depth interval, though *Calluna* became rare. At 10 cm depth, *Alnus* appeared in the pollen record for the first time (empirical limit for *Alnus*), rising to 14% TLP in the uppermost sample. Truncation of the peat profile prevents precise location of the upper zone boundary, which would traditionally be placed at the *Alnus* rise.

Trench E

An outline pollen diagram was prepared for the peats from Trench E to provide a means of correlating stratigraphic levels with those of the radiocarbon-dated profile from Trench J. Outline pollen counts were completed using a sum of 150 trees, shrubs and herbs. No attempt was made to identify 'difficult' grains and only selected taxa are displayed in the diagram.

LPZ-DVE-**A** (160-75 cm) Pollen Zones II and III

Pollen grains of Cyperaceae and Gramineae were abundant in the lowermost zone, jointly exceeding 80 % TLP. *Betula* accounted for just over 10% of the pollen sum in the basal sample, thereafter, declining to a zero value at 105 cm depth. The absence of *Betula* pollen at this level is significant because it coincides with the main phase of mineral input to the mire, noted in Zone LMZ-DVE-D of the macrofossil diagram for Trench E and interpreted as the Loch Lomond Stadial event ('Godwin Zone III'). *Pinus* contributed a maximum of 5% TLP at 145 cm depth, but remained at or below 2% TLP throughout the rest of the zone. The absence of any thermophilous trees and the presence of the mineral in-wash layer in the middle of the zone suggest that the unit may be correlated with Pollen Zones II and III (Godwin 1975). The correspondence of the pollen spectra from Trench E with those from the basal part of the radiocarbon-dated sequence from Trench J supports this inference.

LPZ-DVE-**B** (75-25 cm) Early Pollen Zone IV

A marked change in the pollen assemblages occurred at the boundary between Zones -A and -B. *Betula* pollen increased, reaching 60% TLP at the top of the diagram. A smaller rise in pine was also noted, occurring a little after the first rise in *Betula*. Filicales spores also registered a significant increase in their representation across the boundary, whilst Cyperaceae declined to 10% TLP. Clearly, the changes in the proportion of tree and herb taxa are intimately linked in a percentage pollen diagram; however, the macrofossil diagrams for both Trenches E and J show that peaks in the percentage of *Betula* pollen occurred at the same levels as concentrations of *Betula* macrofossils and that the decline in Cyperaceae pollen coincided with the reduction in the macrofossils of sedges (*Carex*).

A comparison of the Trench E pollen diagram with the one produced for Trench J, (described below) shows that the former peat sequence ends in the lower half of LPZ-DVJ-B. The depth of 25 cm in Trench E is, therefore, equivalent to a depth of approximately 165 cm in Trench J, dating to early Zone IV.

Charcoal record from Trench J

Microscopic charcoal appeared only rarely in the pollen slides prepared from Trench J. Three small peaks were noted between 76-90 cm, at 264 cm, and at 282-299 cm. Further evidence for the deposition of charcoal and burnt litter was noted amongst the macrofossil remains (see the diagram from Trench J, Figure 5. Macroscopic charcoal was noted at 60 cm, 70-82 cm, and 274 cm depth. Between 70 and 82 cm depth charred fragments included pieces of fen moss leaves and occasional small pieces of charred pine needles.

Plant macrofossils

Trench J

In common with Trench E, the peats of Trench J are underlain by grey sands. The pollen diagram for Trench J shows that the basal samples contain pre-Quaternary spores, which no doubt originated (together with the small fragments of coal identified in the macrofossil diagram) in local drift and which must have been transported to the site with the grey sand deposited during the later Devensian period.

LMZ-DVJ-**A** (322-312 cm), LMZ-DVJ-**B** (312-300 cm) and LMZ-DVJ-**C** (300-250 cm)

The basal peat bed was mainly composed of moderately humified sedge remains with some silt and sand grains and occasional pieces of horsetail (*Equisetum*). Very few other plant remains were found from this level suggesting a rather restricted flora. The fen moss *Cratoneuron commutatum* var. *falcatum* soon replaced the sedge community in Zone -B, with the re-establishment of sedges and in Zone -C. This alternation of peat types may simply reflect the movement of vegetation types within a patchy ecosystem rather than a significant oscillation in the direction of succession. The presence of C. *commutatum* var. *falcatum* in the assemblage implies a base-rich substratum since the species is a calcicole (requiring a good supply of calcium).

LMZ-DVJ-**D** (250-202 cm)

In Zone -D the moss flora returned to the mire at the sampling point. Although *C. commutatum* var. *falcatum* was again an important part of the mire vegetation it was joined by other fen mosses including *Calliergon cuspidatum*, traces of *Drepanocladus* sp(p). and *Scorpidium scorpioides*. The last taxon is only occasionally found in lowland areas today and has a distinctly northern distribution, being found as far north as Greenland and Iceland. The appearance of *S. scorpioides* at 240 cm depth during the phase of increased mineral input noted from the loss-on-ignition samples (see macrofossil diagram for Trench J, Figure 5), may be a response to significantly lower temperatures. The evidence from insect remains shows that temperatures plummeted dramatically in LMZ-DVJ-D, which represents the Loch Lomond Stadial (Pollen Zone II). Towards the top of LMZ-DVJ-D, the fen moss *Homalothecium nitens* dominated the macrofossil assemblage, accompanied by small quantities of common reed (*Phragmites australis*), demonstrating that surface conditions remained rather base-rich at this point.

LMZ-DVJ-**E** (202-123 cm)

By the start of Zone -E climatic conditions had clearly ameliorated significantly, indicated by the arrival of tree birch at the site. Other constituents of the peat assemblage at this point included common reed, ferns, bogbean (*Menyanthes*) and small quantities of fen mosses. The presence of birch catkin- and bud-scales, dicotyledon leaf fragments, and wood in the peat suggests that birch was growing on the site in damp carr conditions. Birch is able to tolerate significant amounts of waterlogging whilst nutrient levels remain high. The first traces of acidification on the mire surface were noted near the upper boundary of the zone with the arrival of small traces of hare's-tail cotton grass (*Eriophorum vaginatum*), bog myrtle (*Myrica gale*) and *Sphagnum* Sect. *Acutifolia*.

LMZ-DVJ-**F** (123-88 cm)

In Zone -F the poor-fen moss *Sphagnum palustre* became established, whilst all of the calcicole fen mosses and tree birch disappeared from the macrofossil assemblage, undoubtedly indicating a significant decrease in pH (acidification).

LMZ-DVJ-**G** (88-46 cm) and LMZ-DVJ-**H** (46-21 cm)

Scots pine, *Pinus sylvestris*, became established on the mire in Zone -G, accompanied by the mosses *Aulacomnium palustre*, *Polytrichum alpestre/juniperinum*, *Hypnum cupressiforme* and *Pleurozium schreberi*, indicating that conditions had become appreciably drier and more acidic. Other raised-bog indicators present in the assemblage included *Calluna vulgaris*, *Erica tetralix* and *Empetrum nigrum*. Towards the upper part of the zone, *Sphagnum palustre*, a poor-fen species typical of transitional mires, reappeared, becoming a dominant part of the assemblage early in Zone -H, and suggesting a minor reversal of the acidification trend. The reversal of the transition to raised-bog conditions is further indicated by the arrival of the moss *Meesia longiseta* in Zone -H. This plant is now extinct in Britain but Holocene records from the Somerset Levels (Beckett 1978) and Askham Bog (Hall 1979) suggest that the species once grew where base-rich waters flooded acidic peat. The presence of *M. longiseta* overlying *Pinus* and *Sphagnum palustre* peat in Zone -H may therefore represent a flooding phase during which the growing mire surface was briefly 'reconnected' to the groundwater supply.

LMZ-DVJ-**I** (21-5 cm)

The reappearance of *Eriophorum vaginatum* at the top of Zone -H and the subsequent establishment of the bog moss group *Sphagnum* Sect. *Acutifolia* suggests that acidic raised-bog conditions once again began to develop on the mire. The ecological status of the *S.* Sect. *Acutifolia* group is often difficult to determine because it includes species typical of fen, and raised-bog lawns and hummocks; however, in this zone the taxon was accompanied by traces of other raised-bog species, including *Calluna vulgaris* and *Erica tetralix*.

LMZ-DVJ-**J** (5-0 cm)

The uppermost peat sample was almost completely humified, being composed of 90% unidentifiable organic matter and 10% highly degraded monocotyledon rootlets which were too badly damaged to identify any further. The sample also contained frequent quartz sand grains and the sclerotia of the soil fungus *Cenococcum* which thrives in well-aerated peaty soil. The abrupt termination of the peat sequence at a point when raised bog conditions had just begun to establish on the mire suggests that the peat sequence has been truncated either by peat-cutting or other anthropogenic disturbances such as drainage. It is unlikely that the mire stopped growing naturally at this point. The date of 7900 radiocarbon years BP for the uppermost part of the Trench J sequence represents a period when many other British raised-bogs were beginning to extend beyond the basin in which they initially formed. Indeed, several metres of peat may be missing from the Trench J sequence.

Trench E

The succession in Trench E was based on grey sands, like those in Trench J located in the centre of the mire. It consisted of about 1.6 metres of well-preserved, alternating, monocotyledon and moss peats.

Zones LMZ-DVE-**A** to LMZ-DVE-**C** (160-126 cm)

Organic accumulation began in a fen-carr environment. The principal constituents of the highly humified, slightly silty peat were sedges (*Carex*), unidentifiable organic matter, monocotyledon rootlets, frequent pieces of degraded wood, and fern fragments. The high degree of humification probably reflects at least one and probably several phases of peat aeration. The poor-fen moss *Scorpidium scorpioides* was noted in the basal sample of the zone. At the upper zone boundary with Zone -B, greater tussock-sedge (*Carex paniculata*) nutlets were recovered in moderate numbers and traces of the fen-pool moss *Drepanocladus* were recorded. This assemblage suggests that the mire developed a tussocky surface, probably with intervening open pools, prior to the establishment of the fen moss *Homalothecium nitens* in Zone -B. Fen mosses decline in abundance in the superseding Zone (-C), to be replaced by a monocotyledon-rich peat containing wood fragments, with the remains of some dicotyledon leaves and significant quantities of unidentifiable organic matter (UOM). The alternation between moss and monocotyledon peat may reflect minor shifts in a mosaic of fen vegetation types.

LMZ-DVE-**D** (126-94 cm)

Zone -D is clearly distinguished by a significant phase of input to the mire surface of mineral particles. Quartz sand grains become very frequent at 114 cm and remain frequent throughout the rest of the zone. The vegetation displayed a coincident shift to dominance by a number of fen mosses including *Scorpidium scorpioides*, *Cratoneuron commutatum* var. *falcatum* and *Homalothecium nitens*. The aquatic taxa *Ranunculus* Subgenus *Batrachium, Myriophyllum* sp(p). and *Potamogeton* sp(p). became established on the mire with the fen mosses, most probably indicating that pools expanded or became established for the first time on the mire surface.

LMZ-DVE-**E** (94-80 cm)

In Zone -E most of the fen mosses disappeared from the fen surface; those that remained were only present in the samples as traces. Aquatic taxa including *Potamogeton* sp(p)., *Typha* sp(p). and *Ranunculus* Subgenus *Batrachium* were present throughout the zone; however, the main constituent of the peat was UOM. The relatively light colour of the deposits from this zone may indicate that the UOM was formed, at least in part, from the soft remains of aquatic algae rather than as a result high levels of decomposition of remains of higher plants. Quartz sand grains continued to appear through the zone, though in smaller quantities than in the previous unit.

LMZ-DVE-**F** (80-74 cm)

Various reedswamp taxa, including sedges, *Scirpus lacustris*, *Typha* (sp)p. and *Sparganium* cf.

emersum, were present on the mire surface between 80 and 70 cm depth, representing a significant rise in the mire water-table. At the base of the zone, sand grains became rare, disappearing altogether at the contact with Zone -G.

LMZ-DVE-**G** (74-72 cm)

Zone -G saw the recolonisation of the sampling site by *Scorpidium scorpioides* accompanied by two other fen mosses: *Calliergon cuspidatum* and *Rhizomnium* sp(p). Both bogbean (*Menyanthes trifoliata*) and common reed (*Phragmites australis*) became established for the first time during this brief phase of the mire's development. The establishment of this reedswamp flora represents the first stages of infilling after the flooding episode noted in the previous zone.

LMZ-DVE-**H** (72-57 cm)

Phragmites became dominant in zone -H and was accompanied by bogbean and small quantities of the fen mosses found in zone -G. The decline in the mosses was most probably caused by shading by the tall-growing reeds and ferns. At the upper zone boundary the first traces of *Sphagnum* were recorded. The macrofossils belonged to Section *Acutifolia*, which, as noted above, contains a range of species indicative of fens and raised-bog lawns and hummocks. Other species associated with the *Sphagnum* remains included the fen moss *Homalothecium nitens*; therefore, it seems likely that the *Sphagnum* present were also fen types.

LMZ-DVE-**I** (57-34 cm)

Sphagnum Sect. *Acutifolia* dominated the macrofossil assemblage in this local macrofossil zone, though it was also accompanied by significant quantities of the fen mosses *Calliergon giganteum* and *Homalothecium nitens*, suggesting that fen conditions prevailed throughout the zone. Remains of ferns and bogbean were also consistently present. *Phragmites* disappeared from the record at a depth of 48 cm, having declined in the early part of the zone, as the moss flora re-established.

LMZ-DVE-**J** (34-26 cm)

Once *Sphagnum* has become established on a mire surface it nearly always signals a dramatic change in the direction of succession towards increasing acidification and the establishment of raised-bog; however, this change does not seem to have followed from the first colonisation of *Sphagnum* bog mosses at the sampling site. In Zone -J *Sphagnum* disappeared completely from the local record to be replaced by the fen moss *Calliergon giganteum*, which was accompanied by various *Carex* sp(p). remains, fern fragments and bogbean, representing the continuation of fen conditions.

LMZ-DVE-**K** (26-25 cm)

The uppermost zone in the sequence (Zone -K) has been truncated, either by natural wastage or more likely by anthropogenic disturbance such as peat-cutting or drainage. The macrofossil diagram gives a brief glimpse of the assemblage that followed the resurgence of *Calliergon giganteum*: *Paludella squarrosa* became established with another fen moss *(Drepanocladus* sp(p).), sedges, and ferns. *Paludella squarrosa* is now extinct in Britain though it has been recorded as a fossil from many sites (Dickson 1973) and appears to have been essentially a fen species, indicating that the mire at Church Moss had not crossed the fen-bog transition in the last surviving zone of Trench E, despite an earlier significant phase of *Sphagnum* colonisation.

Comparisons of the radiocarbon-dated pollen diagram from Trench J with the diagram from Trench E suggest that the latter peat sequence ended early in Pollen Zone IV at *c.* 9500 BP. This raises the possibility that (as in the case of the sequence represented by material from Trench J) several metres of peat are missing from the record of Trench E.

Trench A

Trench A revealed a variable lithology whose lower part was locally either more sandy or more rich in clay. A somewhat unclear sequence of organic and sandy layers was then succeeded by highly humified peats which rapidly oxidised to a brown/black colour upon exposure to air. Visual inspection of the stratigraphy showed little evidence for change in the peat types deposited throughout the 21 cm unit. Five peat slices were extracted from the monolith tins for further investigation of the plant macrofossil remains; these were divided into two stratigraphic zones, '-A' and '-B' with a two-part prefix composed of the zone type 'Local Macrofossil Zone' (LMZ) and the trench code (DVA).

LMZ-DVA-**A** (31-29 cm)

The basal zone was dominated by unidentifiable organic matter (UOM) and quartz sand grains. Reedmace (*Typha*) seeds were very common in the sandy and slightly silty peat. Other plant remains were sparse, but included rather poorly preserved wood fragments, several leaves of the fen moss *Homalothecium nitens*, a small number of poorly preserved sedge (*Carex*) nutlets, rush (*Juncus*) seeds, and moderate quantities of the sclerotia of the soil fungus *Cenococcum* (indicative of aerated soils, particularly those rich in wood detritus, and desiccated peat).

LMZ-DVA-**B** (29-11 cm)

In zone -B wood fragments were more common (though they were still poorly preserved) and the quantity of unidentifiable organic material (UOM) remained high. *Cenococcum* sclerotia increased through the zone, becoming abundant at 11 cm depth. Quartz sand grains remained frequent in the crumbly peat soil; however, the wetland taxa noted in the basal zone were largely absent; rare occurrences of *Typha* seeds at 27 cm depth were the only exception. Charcoal was noted at 27 cm and 11 cm depth, though in both cases the number of fragments was very limited.

The brief peat sequence recovered from Trench A is not easy to interpret because of the high degree of decomposition. Zone -B may represent the development of a peaty soil in damp woodland fringing the mire; however, it is also possible that the presence of abundant soil fungi indicative of aerated conditions, represents secondary decomposition, possibly as a result of anthropogenic disturbances such as drainage and peat-cutting.

Other trenches

Trench B, ('Ice-wedge' samples)

Sample 4075 (Context 105)

The 0.5 kg subsample of organic rich sandy clay silt contained numerous fine but rather poorly preserved herbaceous rootlets. Quartz sand grains formed approximately one quarter of the volume of the moderate-sized residue. A small quantity of herbaceous stem/rhizome material was present, accompanied by small highly degraded wood fragments.

Sample 4076 (Context 99)

The 1 kg subsample was a dark brown, brittle to layered (working crumbly), amorphous organic sediment with traces of sand and hypnoid moss.

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 remains of the moss *Calliergon giganteum* with a trace of *C. cuspidatum*. Some unidentifiable herbaceous stem/rhizome material was also present. The only other remains were fruits of *Potamogeton* and *Ranunculus* Subgenus *Batrachium*, and 'sclerenchyma spindles' of *Eriophorum vaginatum*.

Sample 4077 (Context 108)

The 1 kg subsample of dark brown, granular (working crumbly) detritus peat contained abundant moderately well preserved remains of the fen moss *Calliergon giganteum*. The only other macrofossil remains were a small quantity of unidentifiable herbaceous stem/rhizome material, frequent fine herbaceous rootlets and occasional pieces of highly degraded wood. Quartz sand grains were numerous throughout the sediment.

Sample 4078 (Context 109)

The 1 kg subsample of dark brown/black amorphous peat contained a significant fraction of quartz sand, clay, and silt. The only identifiable macrofossil remains were small fragments of woody detritus. Humification of the sample was almost complete.

Sample 4079 (Context 110)

A 0.5 kg subsample consisted of a mid-dark orange-brown, hypnoid moss peat of low density, with a little sand. The large residue was composed of moss stems and leaves, mainly *Drepanocladus* sp(p)., with traces of *Scorpidium scorpioides* and perhaps *Cratoneuron commutatum* var. *falcatum*. There were moderate numbers of *Ranunculus* Subgenus *Batrachium* achenes and traces of *Carex* nutlets, a little very decayed wood to 5 mm, and a trace of quartz sand.

Trench D (examined during the assessment)

Sample 4211 (Context 154)

The 3 kg subsample was a dark grey, plastic to crumbly humic clay silt. 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 *Urtica dioica*, *Viola* and tree *Betula* propagules, with moderate numbers of *Cenococcum* sclerotia. 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.

Sample 4218 (Context 173)

The 1 kg subsample was 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 were present. There was a very small residue of quartz sand, a washover which comprised a few cubic centimetres of rootlets (mostly modern) and *Cenococcum* sclerotia, with traces of bark (to 30 mm), charcoal (to 10 mm) and coal (to 5 mm) with one charred *Corylus* nutshell fragment (to 10 mm).

Sample 4264 (Context 178)

The subsample of 1 kg was a dark grey-brown, crumbly to soft, coarse detritus peat, slightly woody (with some bark fragments). The moderately large residue was about 50% by volume wood (to 20 mm, and probably including *Salix*), 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 *Carex* nutlets.

Sample 4265 (Context 180)

The 13 kg subsample was composed of light grey-brown sand with traces of woody and herbaceous detritus. 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 *Betula*), twigs (to 35 x 15 mm), and 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 from *Equisetum*. The identifiable plant remains included small numbers of *Ajuga* (cf. *reptans*), *Rubus idaeus* and *Ranunculus* Section *Ranunculus*. A *Betula* cf. *nana* fruit was also noted. There was a trace of charcoal to 2 mm which may have included pine, and small numbers of *Cenococcum* sclerotia.

Trench H (analysed during the assessment)

All of the subsample taken from this Trench were of 1 kg.

Sample 132 (5 -10 cm)

The well-humified material was a dark brown, crumbly, slightly sandy amorphous peat. 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 via later activity from deposits above). Identifiable plant macrofossils were limited to moderate numbers of sedge nutlets and rare *Potamogeton* pyrenes and *Chara* (stonewort) oogonia. One sedge nutlet was charred.

Sample 1522 (22.5-25 cm)

The subsample was composed of very dark brown, more-or-less felted, compressed, slightly indurated detritus with monocotyledon stem/rhizome fragments. 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 *Salix*), the residue was rather rich in identifiable remains, especially tree *Betula* fruits and *Carex* nutlets, together with moderate numbers of *Salix* fruits, birch female catkin-scales, and *Populus* (poplar/aspen) bud-scales. Small numbers of *Potentilla palustris*, *Filipendula ulmaria* and *Potamogeton* propagules were also present and there was at least one birch fruit which may have been dwarf birch, *Betula nana*.

Sample 161/102 (25-31 cm)

1 kg subsample taken for AMS dating.

The dark brown woody detritus peat contained modern *Cirsium arvense* plants growing from live rhizome fragments. An AMS date on *Carex* nutlets from the sample was 11,600±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. *Carex* nutlets were abundant and there were traces of *Salix* fruits and *Betula* female catkin scales (again, at least one *B.* cf. *nana* fruit was recorded). The only other identifiable macrofossil plant remains were rare *Ranunculus* Subgenus *Batrachium* achenes.

Sample 162 (31-36 cm)

The subsample was a mid greyish-brown, slightly humic silty sand to dark brown, slightly sandy amorphous organic sediment. There was a small residue, mainly of woody fragments (non-coniferous, up to about 10 mm, probably including *Salix*), 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 *Salix* fruits, *Carex* nutlets, tree *Betula* fruits and *Filipendula* achenes. A trace of charcoal to 10 mm was noted. Invertebrate remains were rare in the flot.

The DCA analysis

The results of detrended correspondence analysis on the plant macrofossil dataset from Trench J produced a gradient on axis 1 accounting for 77% of the species variation. Examination of the positions of species with respect to this gradient (refer to the biplot of axis 1 vs axis 2 scores, Figure 16) revealed a clear trend from base-rich fen to acidic bog taxa. The gradient was relatively long, spanning approximately five standard deviation (SD) units, meaning that almost no species occurring at one end of the gradient were present at the other end. A plot of sample scores for DCA axis 1 ('fen-bog' gradient) against depth clearly demonstrated that the change in the gradient had occurred gradually throughout almost the entire depth of the preserved sequence. This is in sharp contrast to many other fen-bog transitions at sites located in other parts of the country (Hughes 1997). Figure 18 shows a comparable plot of the fen-bog gradient for Bolton Fell Moss, Cumbria (also DCA axis 1). The rapid switch from fen to bog conditions is most striking and very different from the situation at Davenham.

Insect remains

All but one of the samples yielded useful numbers of beetle (Coleoptera) and bug (Hemiptera) remains, and often abundant fossils of other groups. The numbers of individuals recovered (Table 9) were substantially larger in many cases than predicted on the basis of the numbers of remains recovered from the 1 kg subsamples used in the assessment. Thus the processing seems to have failed during assessment, suggesting concentrations much lower than those revealed subsequently. This observation fits a pattern, for at about the same time assessments for at least two other sites gave too-low estimates for concentration of remains. Limits were placed on what could be recorded within project constraints as a result, since subsampling of extracted remains is impracticable and entire large assemblages needed to be recorded.

Sample-by-sample species lists are presented in Table 12, and a complete list of invertebrate taxa recorded from the site (together with their ecological and distribution codings) in Table 8. Some principal statistics for the assemblages are presented in Table 9 and summarised in Figures 8-12.

Notes on certain insect taxa

Identification has tended to be cautious in view of the fact that many non-British species closely related to those now found in these islands may have been present in the Late Devensian and Early Flandrian. Identification was made difficult in a number of the samples by poor preservation, remains showing strong chemical degradation and in some cases a high degree of fragmentation. A number of identifications has been made from very small fragments; while these were sometimes confident (e.g. of *Silpha atrata* from several samples and *Cychrus rostratus* from one), they were often left as tentative (?).

Trapezonotus desertus: Remains of the groundbug genus *Trapezonotus* were found in two samples; in one case specific identification could not be reasonably attempted, but in the other an elytron showed the colour pattern illustrated by Wagner (1966, 172) for *T. desertus* and matched the specimen in the collection available.

?Stignocoris sp.: Pronota of a *Stignocoris*-like lygaeid bug from Sample 217 could not be placed in any genus with confidence; further investigation is desirable.

Cymus glandicolor and *melanocephalus*: Numerous fossils of *Cymus* bugs were recovered but their identification proved very difficult, critical features being unclear in what were mostly discoloured and collapsed fossils.

Hebrus ruficeps: The material of theses tiny water bugs was examined carefully under high power and there is little doubt that *H. ruficeps* rather than *H. pusillus* is represented.

Microvelia reticulata: Identification of this water bug was difficult, but careful comparison with reference material and the figures given by Savage (1989) allowed the remains to be assigned confidently to *M. reticulata* in most cases.

Bembidion spp.: Several, generally poorly-reserved, *Bembidion* were recovered which could not be matched with taxa for which reference material was available; one or two may be non-British species.

Agonum spp.: The identification of *Agonum* (*Europhilus*) species was abandoned in several cases where it appeared that two or three 'difficult' species were present in a small group of remains.

Hydroporus scalesianus: most of the assemblages included larger or smaller numbers of a very small *Hydroporus* sp. water beetles which, when well-preserved, were identified as *H. scalesianus* with some certainty; poorly-preserved remains could not be identified confidently, but were probably of this species. Duff (1993) describes *H. scalesianus* as 'A flightless species with a strongly relict distribution in the British Isles, now very local in peaty pools in N. & E. England and Ireland'.

Hydroporus spp.: Most of the *Hydroporus* other than those assigned to *H. scalesianus* were of medium size and dull colouration, with puncturation and sculpture of a type common in the genus. Confident identification was not found to be possible.

Agabus, *Ilybius* and *Rhantus* spp.: All three genera were often represented by fragments of sclerites and confident identification consequently found to be impossible.

Helophorus sibiricus: Reference material was not available but the figures and description given by Angus (1970) allowed confident identification of the better-preserved fossils.

Ochthebius minimus: Identifications were made as *O. ?minimus* or *O. minimus* group in certain cases, in recognition of the difficulty of separating some closely-related species from it; the remains were almost certainly of *O. minimus* itself.

Hydraena britteni: This species is difficult to separate from close relatives, especially when poorly preserved or represented only by elytra. It seems likely that most of the *Hydraena* at the site were this species.

Olophrum assimile: Several samples yielded small numbers of pronota and apparently related elytra, ascribed to this species on the basis of illustrations and rather poor fossil material from others sites.

Pycnoglypta lurida: A tiny staphylinid, with a rather characteristic pronotum, a reasonably easily-recognised head, but very characterless elytra which are hard to identify confidently in isolation or when poorly preserved; some of the identifications are tentative but probably correct.

Boreaphilus henningsianus: Identified by comparison with fossil material from other sites.

Pselaphaulax dresdensis and *Pselaphus heisei*: Both of these rather similar species were present, sometimes in the same sample; they were separated on the basis of the pores at the base of the elytra.

Cyphon spp.: The small and characteristically-patterned *C. padi* was usually present; where preservation was poor it was named provisionally, but these records are almost certainly of this species. At least two, and probably more, other species in this genus were present; although very difficult to identify to species on fossil material, they included remains of species in the *ochraceus* and *pubescens* groups.

Adoxus obscurus: Identified on the basis of a very small fragment of elytral apex, unmistakably this species, however.

Limnobaris pilistriata: Most of the *Limnobaris* were clearly this species, but some remains were less diagnostic; all were probably *L. pilistriata*.

Dryophthorus corticalis: Remains, almost certainly of this species, were found in two samples; confirmation awaits access to suitable reference material.

Curculionidae spp.: Perhaps ten species of weevils were represented by small fragments or very poorly preserved sclerites and could not be named within project constraints.

Detailed account of analysis of insect remains by trench and sample

Trench J

Dating for these deposits is given in Table 1 and Figure 2; N-S index values in Figures 8 and 10; proportions of aquatics in Figure 12; and values for the index of diversity (alpha of Fisher *et al.* 1943) in Figure 14.

Sample 701 (from spoil heap, representing basal mineral sediments)

Invertebrates were absent from the 0.5 kg subsample examined.

*Sample 501 (below 290; LMZ-DVJ-**B** or **C**)*

This sample represents material dug from under water at the bottom of the pit and not precisely located beyond being 'stratigraphically below Sample 503'. A subsample of 2.9 kg was processed, from which 139 individuals of 42 taxa were recorded.

Ecology: Only 9% of the fauna was contributed by aquatics (although a fifth of the *taxa* were aquatic). Waterside habitats were indicated by *Cercyon tristis* (4 individuals) and *Drops* sp., and damp vegetation by *Cyphon* spp. (7+2). Much the most abundant taxon (47) was an un-named delphacid (the Delphacidae are a family of planthoppers, associated with a range of vegetation). Other than these, the best-represented ecological group was of species associated with natural litter and moss: *Arpedium brachypterum* (11); *Olophrum assimile* (7); and *Euaesthetus laeviusculus* (5). This is the fauna of a barren environment with small pools and scattered vegetation and litter.

Climate: Most of the species are eurythermal or somewhat northern. The climate was perhaps like that of upland northern Britain today; the absence of strongly boreo-montane taxa may suggest a period of declining temperatures in which there was no well-established balanced community (diversity was quite low, alpha = 21, SE = 3), perhaps the cool period towards the end of the Windermere Interstadial. This is unlikely to be a periglacial assemblage dating to early in the interstadial (cf. the highly characteristic fauna of the ice-wedge fills, below).

*Sample 503 (280-290, lower part of LMZ-DVJ-**C**)*

The lowest sample in the main sequence; a 1.31 kg subsample was processed, 225 individuals of 65 taxa being recovered.

Ecology: Nearly a fifth of the individuals (19%) were aquatics, the most abundant being the tiny water beetle *Hydroporus scalesianus* (15), typical of boggy pools; there were nine *Ochthebius minimus*, found in stagnant water, often in or on mud, and smaller numbers of twelve other species of water beetles and bugs. Most of these were eurytopic, although the minute bug *Hebrus ruficeps* (?1) is typically found in wet moss (*Sphagnum* and *Amblystegium*) at the edge of acid waters. The assemblage was dominated by insects likely to have co-existed on waterside and damp-ground vegetation: a delphacid bug (27), *Cyphon* sp. (also 27) and *Cyphon padi* (?17). *Cercyon tristis* (5) is associated with waterside mud and litter. Plant litter or moss habitats were indicated by *Acrotrichis* sp. and *Pselaphaulax dresdensis* (both 8) and smaller numbers of a range of other taxa.

Climate: The presence of some taxa which do not extend into the far north of Europe and the absence of clear cold-indicators suggest some amelioration; a stabilisation of the environment is perhaps indicated by the rise in diversity of the fauna (although only to a modest level: alpha = 31. SE = 3). *Olophrum assimile* (?4) and the non-British *Pycnoglypta lurida* (?1) suggest cool conditions, probably like those of upland and northern Britain.

*Sample 504 (270-280; middle part of LMZ-DVJ-**C**)*

A subsample of 2.75 kg was processed and 229 individuals of 65 beetle and bug taxa recorded.

Ecology: The fauna was very similar to that of Sample 503, again dominated by Delphacidae sp. (54) and *Cyphon* spp. (20 *C.* sp., 8 *C. padi*), with a fifth of the fauna contributed by aquatics (*H. ?scalesianus* being the most abundant with 21 individuals). The damp-ground and 'dry land' fauna was a little richer than in Sample 503 (although the value of alpha was effectively identical: alpha = 30. SE = 3). Habitats away from water were suggested by the ground bug *Stignocoris pedestris* (2), typically found on the ground at the roots of herbaceous vegetation, and the chafer *Serica brunnea* (1), whose larva feeds at plant roots, typically of fairly short vegetation. Other than these, however, there was little indication of a fauna of habitats away from water and its margins.

Climate: There was again some evidence of ameliorated conditions, but nothing to suggest that temperatures had risen above those typical of upland or northern Britain.

*Sample 505 (255-270; upper part of LMZ-DVJ-**C**)*

A small assemblage of beetles and bugs (65 adult individuals of 33 taxa) was recovered from the 2.5 kg subsample examined, although remains of various other invertebrates were abundant.

Ecology: The range of habitats suggested remained much as for the underlying sample; a somewhat barren landscape with low vegetation and marshy pools. Diversity of the beetle and bug assemblage remained about the same (alpha = 27, SE = 6).

Climate: Although there is little clear evidence, there had probably been a slight decline in temperatures.

*Sample 506 (240-255; uppermost part of LMZ-DVJ-**C** and lower part of LMZ-DVJ-**D**)*

The processed subsample was of 1.85 kg; it yielded 183 individuals of 35 taxa of adult beetles and bugs.

Ecology: Although by this stage in the sequence there had been a substantial change in the composition of the fauna, the broad conditions suggested were much the same as for the levels below: an open marshy landscape with pools and litter or moss. A very substantial drop in species diversity suggested a restriction of the range of habitats suitable for insects, however. The aquatic fauna was weakly represented (although *Daphnia* ephippia, water flea resting eggs, were abundant).

Climate: An apparently rapid climatic change of substantial magnitude occurred between the periods represented by Samples 505 and 506, probably at or very close to the 255 cm level. The fauna became one very typical of cold stages in Britain, the most abundant species being *Olophrum fuscum* (79) and *Arpedium brachypterum* (45), both northerly in Britain and perhaps best regarded as boreo-montane. A range of non-British species had arrived to supplement these, and together these suggest that in fact temperatures had fallen to those of the far north of Europe or northern Siberia: *Boreaphilus henningsianus* (6); *Diacheila arctica* (2); *Helophorus sibiricus* (2); and *Simplocaria metallica* (2). The remaining fauna would have tolerated the same conditions as these.

*Sample 507 (230-240; lower middle part of LMZ-DVJ-**D**)*

The processed subsample weighed 1.7 kg. A total of 131 individuals of 57 taxa of adult beetles and bugs was recorded, together with numerous other invertebrates.

Ecology: While the fauna remained essentially similar at this level, with the same two dominant taxa and the same range of northern species as in Sample 506 (with the addition of *Helophorus ?glacialis*), there seems to have been an enrichment of the fauna, diversity rising substantially (alpha = 39, SE =6). Presumably conditions had remained reasonably stable for a while and a range of additional species had invaded.

Climate: The representation of southerly taxa was even lower than in Sample 506, perhaps because they had succumbed to sustained low temperatures.

*Sample 508 (222-230; upper middle part of LMZ-DVJ-**D**)*

A very small subsample was processed (0.9 kg) but yielded 347 individuals of 104 taxa of adult beetles and bugs.

Ecology: The fauna had changed substantially from that seen in the underlying layer, *O. fuscum* and *A. brachypterum* becoming much rarer. The predominant ecological groups were aquatic and waterside. The former was represented by *Ochthebius minimus* (50), *Hydraena britteni* (?5), *Coelostoma orbiculare* (4: found typically in wet moss) and an *Enochrus* species (4), and a range of others in smaller numbers. *Daphnia* ephippia were also abundant. Species from waterside habitats (litter, mud and emergent vegetation) included *Cercyon tristis* (18), an unidentified *Cyphon* sp. (13), *Cercyon convexiusculus* (8), *Cyphon padi* (6), and various others. Indeed, the whole terrestrial fauna could have existed in a marshy landscape; the groundbug *Stignocoris pedestris* perhaps being the least typical of damp conditions, but still able to exist in them. Several species were associated with what was probably a rich and varied emergent and waterside vegetation: the Delphacidae, the *Cyphon* species and *Microcara testacea* (all on various plants); *Chilacis typhae* (on great reedmace, *Typha latifolia*); *Cymus melanocephalus* (*Juncus*); *Donacia simplex* (on bur-reeds, *Sparganium* spp.); *Plateumaris sericea* (usually on *Sparganium*); *Limnobaris ?pilistriata* (associated with sedges and rushes) and others. Overall, then, there had been a great ecological enrichment, which is reflected in the substantial increase in diversity (alpha = 50, SE = 4).

Climate: There is no doubt that temperatures rose substantially, and it would appear rapidly, between the deposition of the layers represented by Samples 507 and 508. *Cercyon convexiusculus*, *Chilacis typhae*, *Cymus melanocephalus*, *Donacia simplex* and *Hydrochus brevis* all have somewhat southerly distributions in north-west Europe, but the ecological enrichment perhaps argues even more strongly for amelioration.

*Sample 509 (210-222; upper part of LMZ-DVJ-**D**)*

Processed but not recorded. A rapid examination of part of the flot suggested that the fauna had many similarities to that seen in Samples 510 and 511. *Microvelia ?reticulata* was abundant (cf Samples 217-8 in Trench E, the layers following the phase of amelioration recorded for that trench); it is associated with thick aquatic-emergent vegetation.

*Sample 510 (200-210; upper part of LMZ-DVJ-**D**, just entering LMZ-DVJ-**E**)*

This sample was processed but only rapid-scan recorded. The fauna resembled (in broad terms) that of Sample 511, including a record of *?Lamproplax picea* (see below). *Microvelia ?reticulata* was again abundant (it was not recorded from Sample 511, however).

*Sample 511 (190-200; lower part of LMZ-DVJ-**E**)*

A subsample of only 0.85 kg was processed, giving only 96 individuals of 37 beetle and bug taxa.

Ecology: Although only a small assemblage was recovered, it gave an impression of a less rich environment, *Cyphon padi* (?39) dominating the assemblage and the remaining taxa represented by more than a single individuals all suggesting pools, emergent and damp-ground vegetation, and moist litter. Reflecting this, diversity had dropped sharply (alpha = 22, SE = 4). Two notable records were the shieldbug *Picromerus bidens*, very much at home in the drier parts of swamps, and the groundbug *Lamproplax picea*, found in and around small sphagnum bogs with rushes on heaths, usually where there are trees nearby (there are also records from fen litter).

Climate: The only strongly southerly species was *L. picea* (which occurs only as far north as Dumfries in Britain and does not reach northern Sweden), but temperatures probably remained unchanged from the period represented by Sample 508, the decline in diversity probably resulting from the development of dense stands of rather uniform vegetation.

*Sample 512 (180-190; lower middle part of LMZ-DVJ-**E**), Sample 513 (170-180; lower middle part of LMZ-DVJ-**E**)*

Not examined.

*Sample 514 (160-170; middle of LMZ-DVJ-**C**)*

A subsample of 2.05 kg was processed and a large assemblage of invertebrates recovered, including 423 adult individuals of 68 beetle and bug taxa.

Ecology: This period saw the development of the habitats represented by the assemblage from Sample 511: pools, emergent and waterside vegetation, mud and moist litter. Diversity remained unchanged (alpha = 23, SE = 2). Swamp conditions were indicated by *Cyphon padi* (68), *C.* sp. (44), *Chaetarthria seminulum* (33), probably Delphacidae sp. (28), *Anacaena limbata* (26), *Limnebius aluta* (10) and many less abundant species. Pools supported *Hydroporus scalesianus*, a second *H.* species (both 25) and smaller numbers of various other aquatics. Mud and damp to wet litter were colonised by *Bryaxis* sp. (21), *Cercyon convexiusculus* (14), *Pselaphus heisei* (11), *Agonum fuliginosum* (6), *Pterostichus diligens* (4), and others. *Lamproplax picea* was again present, as was the shieldbug *Rhacognathus punctatus*, another species typical of swamps and bogs; both are often associated with *Sphagnum*. More truly terrestrial habitats were still weakly represented, by single individuals of *Silpha atrata*, *?Cytilus sericeus*, and *Dalopius marginatus*. Conditions may not always have been waterlogged at the point of deposition; two larvae of the soil-dwelling click beetle genus *Athous* sp. were present.

Climate: The near-total lack of terrestrial fauna reduces the climatic sensitivity of this assemblage, as is the case for many others from the site. *Lamproplax picea*, *Limnebius aluta* and *Metopsia retusa* all have quite southerly distributions in Scandinavia, while *Cercyon convexiusculus*, *Hydroporus scalesianus* and *Silpha atrata* all fail to reach the far north. Temperatures like those of the present day are indicated.

*Sample 515 (150-160; upper middle of LMZ-DVJ-**E**), Sample 516 (140-150; upper middle of LMZ-DVJ-**E**), Sample 517 (130-140; upper part of LMZ-DVJ-**E**)*

Not examined.

*Sample 518 (120-130; very top of LMZ-DVJ-**E** and lower part of LMZ-DVJ-**F**)*

A subsample of 1.21 kg was processed but only 58 individuals of 34 beetle and bug taxa recovered.

Ecology: Although this was clearly still a rather damp place (as indicated by all the more abundant taxa), terrestrial conditions had developed, with few habitats for aquatics, which were weakly represented. Reflecting this, assemblage diversity was considerably higher (alpha = 35, SE = 8). Terrestrial insects included the snail predator *Cychrus rostratus*, the wood-boring *Ptilinus pectinicornis*, *Rhysodes sulcatus* (which lives under bark and in rotting wood) and the heather-feeding weevil *Micrelus ericae*. There were also five larvae of the click beetle *Actenicerus sjaelandicus*.

Climate: *Ptilinus pectinicornis* has a southerly distribution in Scandinavia, and *Rhysodes sulcatus* is present only in the extreme south, and absent from Britain. Presumably temperatures were at least as high as those of the 20th century.

*Sample 519 (110-120; lower part of LMZ-DVJ-**F**), Sample 520 (100-120; middle of LMZ-DVJ-**F**)*

Not examined.

*Sample 521 (90-100; upper part of LMZ-DVJ-**F**)*

The processed subsample was small: 0.95 kg. Even so, the 17 taxa, represented by 42 individuals, indicate a low concentration of remains.

Ecology: The assemblage probably represented swamp with pools, but was too small for any clear interpretation. Diversity had dropped sharply (alpha = 11, SE = 3), suggesting that the range of habitats was small.

Climate: No clear climatic signal can be divined.

*Sample 408 (77.5-90; lower part of LMZ-DVJ-**G**), Sample 407 (65-77.5; middle part of LMZ-DVJ-**G**)*

Not examined.

*Sample 406 (52.5-65; upper part of LMZ-DVJ-**G**)*

The processed subsample was of 1.65 kg, and 149 individuals of 44 beetle and bug taxa were recovered.

Ecology: The fauna was dominated by species favoured by marshy vegetation and associated litter: *Cyphon* sp. (34), *C. padi* (28) and *?Bryaxis* sp. (15). There were at least occasionally pools to support water beetles (several species, including nine *Hydroporus* sp. and three *H. scalesianus*). However, drier land existed, for a range of terrestrial forms was present. These included the heather-feeding *Micrelus ericae* (3), single individuals of the bark beetles *Pityophthorus pubescens* (found in pine) and *Phloeophthorus rhododactylus* (typically found in broom stems), *Cerylon ferrugineum* (under bark of both conifers and broadleaved trees), and the chafer *Serica brunnea*, whose larvae occur in soil.

Climate: *Phloeophthorus rhododactylus* appears to be strongly thermophilous, and is absent from Fennoscandia; *Pityophthorus pubescens* has a very southerly distribution in Scandinavia, *Olophrum piceum* has a distinctly southerly range in north-west Europe, and *Hydroporus scalesianus* and *Thryogenes* sp. are rather southerly in Scandinavia. Clearly temperatures remained at least at present-day levels.

*Sample 405 (38-52.5; uppermost part of LMZ-DVJ-**G** and lowest part of LMZ-DVJ-**H**)*

Not examined.

*Sample 404 (30-38; lower part of LMZ-DVJ-**H**)*

This layer was represented by a subsample of only 0.97 kg, and although 153 adult beetles and bugs were recorded, a mere 29 taxa were included.

Ecology: The fauna was dominated by swamp taxa: *Cyphon* sp. (61), *C. padi* (31), *?Bryaxis* sp. (11), *Chaetarthria seminulum* (9), *Pterostichus diligens* (4), and various others. There were a few aquatics, so pools existed at least occasionally, and other taxa probably lived *in situ* in litter. This limited range of ecologies was reflected by the very low mathematical diversity (alpha = 11, SE = 1).

Climate: The restricted fauna offers little climatic evidence, although *?Dryophthorus corticalis* and *Olophrum piceum* have rather southerly ranges in Scandinavia, and *Hydroporus scalesianus* does not extend too far north. Temperatures again seem to have been much as at the present day.

*Sample 403 (20-30; upper part of LMZ-DVJ-**H** and lowest part of LMZ-DVJ-**I**)*

Not examined.

*Sample 402 (10-20; most of LMZ-DVJ-**I**)*

The 1.3 kg subsample provided 130 individuals of 30 taxa of adult beetles and bugs.

Ecology: The fauna was almost identical to that of Sample 404, including the presence of *?Dryophthorus corticalis*.

Climate: There was little evidence for climatic conditions; *?Dryophthorus corticalis* was present, while *Brachygluta ?fossulata* and *Hydroporus scalesianus* are a little southerly in Scandinavia.

*Sample 401 (0-10; uppermost part of LMZ-DVJ-**I** and LMZ-DVJ-**J**)*

Not examined; not suitable for analysis.

Trench E

N-S index values are given in Figures 9 and 11; proportion of aquatics in Figure 13; and values of alpha in Figure 15.

Sample 227 (180 cm and lower, below base of macrofossil sequence)

A subsample of 2.7 kg was processed, and produced 117 individuals of 64 taxa of adult beetles and bugs.

Ecology: Aquatics were well-represented, with 20 species and 46 individuals (39% of the assemblage), the most abundant species being *Ochthebius minimus* (?13). A range of waterside taxa included *Bembidion doris* and a *Cyphon* species (both 5). Moss and litter habitats would have supported several taxa, including *Olophrum fuscum* (6) and *Arpedium brachypterum* (5), the most numerous of the 'terrestrial' species. This was an ecologically-restricted area.

Climate: *Olophrum fuscum*, *Arpedium brachypterum* and *Notaris aethiops* indicate temperatures resembling those of present-day northern upland Britain. A few of the taxa have somewhat southerly distributions in Scandinavia. Perhaps this was a phase of gradually declining temperatures, something which may be supported by the high diversity of the assemblage (alpha = 58, SE = 9); while rapid change may be expected to reduce diversity drastically, gentle changes may allow a wider range of species to co-exist at least for a while (alternatively, the sample may span more than one climate type so apparent diversity is increased by summation of different communities).

Sample 226 (165-about 175 cm, below base of macrofossil sequence)

Not examined.

*Sample 225 (155-165 cm; upper part lies in LMZ-DVE-**A**)*

A subsample of 1.7 kg produced a large assemblage of adult beetles and bugs (N = 558; S = 90), and an abundance of other arthropods.

Ecology: Although many taxa were recorded, they provided a very consistent picture of rich swamp with moss and litter. Much the most abundant beetles were *Cyphon padi* (215) and a second *Cyphon* species (57). This genus is typical of marshy vegetation, and the Delphacidae (13) probably co-existed with them, as did *Cymus glandicolor* (6). Open water was present, a wide range of aquatics being recorded. Among these, the most abundant was *Hydroporus scalesianus* (32), found in boggy pools. There was a range of species found in damp moss and waterside mud and litter, among which the more abundant were the tiny bug *Hebrus ruficeps* (33; usually in wet moss at the edge of acid waters), *Anacaena globulus* (9); *Cercyon convexiusculus* (7) and *Coelostoma orbiculare* (4). Slightly drier areas were indicated by the groundbugs *Drymus brunneus* (2) and *Stignocoris pedestris*, neither at all xerophilic, however (and indeed *D. brunneus* has been found in *Sphagnum* bogs. There was a single individual of *Limnius volckmari*, found in flowing water and presumably either a stray or carried in by a stream inflow. Diversity was fairly low (alpha = 30, SE = 2), although this value was depressed by the abundant *Cyphon* spp. and removing them gave alpha = 44, SE = 4.

Climate: Three taxa with distinctly southerly distributions in Scandinavia were present *(Hydraena palustris*, *Limnebius aluta*, *Micropeplus* sp.), while *Agonum thoreyi*, *Cercyon convexiusculus*, *Cymus glandicolor* and *Hydroporus scalesianus* are all somewhat southerly in north-west Europe. Only a single, tentatively-identified *Olophrum fuscum* could be seen as 'northerly'. Temperatures were perhaps a little below those of the present day in the north of England, but not cooler than in lowland north Britain.

Sample 224 (150-155 cm; across boundary of LMZ-DVE-A and *LMZ-DVE-**B**)*

Not examined.

*Sample 223 (145-150 cm; within LMZ-DVE-**B**)*

The processed subsample was of 2.7 kg and it yielded 183 individuals of only 49 beetle and bug taxa; other remains were present in rather small numbers, too.

Ecology: This assemblage strongly resembled that from Sample 225, with abundant *Cyphon* spp. (61 *C.* sp. and 13 *C. padi*), numerous *Hebrus ruficeps* (11) and a somewhat more limited range of swamp and moist litter dwellers. Diversity had dropped further (alpha = 22, SE = 3), although it was depressed by the abundant *Cyphon*, rising to alpha = 32 (SE = 5) when they were removed.

Climate: Although falling diversity may have reflected habitat restriction in a developing swamp, declining temperatures may have been responsible. The appearance of *Pycnoglypta lurida* (?1) perhaps supports this interpretation. On the other hand, some species with slightly southern distributions remained: *Cercyon convexiusculus*, *Hydroporus ?scalesianus* and *Silpha atrata*.

*Sample 222 (135-145 cm; across boundary of LMZ-DVE-**B** and LMZ-DVE-**C**)*

A large (5 kg) subsample provided a moderate-sized assemblage of adult Coleoptera and Hemiptera (S = 66, N = 167).

Ecology: Although swamp habitats persisted, there seems to have been some change, perhaps towards a slightly less completely vegetated, more varied, mire surface with more pools and bare mud. Perhaps reflecting this, diversity had risen (alpha = 40, SE = 5). A delphacid and a *Cyphon* sp. (both 12) were the most abundant taxa. *Hebrus ruficeps* remained rather abundant (7), suggesting the presence of acidic conditions and wet moss, probably *Sphagnum*. Ground beetles increased in relative importance.

Climate: *Olophrum fuscum* stood among the more abundant taxa, together with *Arpedium brachypterum*, *Otiorhynchus nodosus* and the boreo-montane *Boreaphilus henningsianus* and *Pycnoglypta lurida* (neither found in Britain at the present day), forming a group of species very typical of cold stages in Britain. This was supported by the presence of *Elaphrus lapponicus*, a ground beetle with a strongly northern distribution. Temperatures had fallen to those of northern or montane Scandinavia, although some taxa whose distributions do not extend into the extreme north had survived.

*Sample 221 (125-135 cm; upper part of LMZ-DVE-**C**)*

The subsample examined was of 3.9 kg, and yielded 133 individuals of 53 beetle and bug taxa; there were also large numbers of mites.

Ecology: The trend seen in the previous samples, towards a more open environment, continued. Diversity had fallen again, doubtless as certain habitat types disappeared. Swamp taxa became unimportant, and the remaining fauna (dominated by *Olophrum fuscum*—22 individuals—and *Arpedium brachypterum*—9) were even more typical of open, tundra-like, vegetation.

Climate: The decline in temperatures probably continued. There were only traces of taxa with even slightly southerly ranges, and *Diacheila arctica*, indicative of very low temperatures, was present.

*Sample 220 (115-125 cm; lower part of LMZ-DVE-**D**)*

Not examined.

*Sample 219 (105-115 cm; middle part of LMZ-DVE-**D**)*

A very large subsample (6.4 kg) was processed, and a fairly large group of beetles and bugs recovered (211 individuals, although of only 52 taxa).

Ecology: The fauna indicated open, tundra-like conditions, with occasional pools. Among the aquatics, *Agabus arcticus* was the most abundant (6). Diversity was low (alpha = 22, SE = 2).

Climate: The fauna had by this stage become strongly boreal in character, dominated by *Olophrum fuscum* (99) and *Arpedium brachypterum* (23), and again with *Pycnoglypta lurida* (?) and *Otiorhynchus nodosus*. *Diacheila arctica* was joined by the even more cold-stenothermic *D. polita*, while *Agabus arcticus* has a distinctly northern range. This deposit probably represents the coldest part of the Loch Lomond Stadial, with conditions perhaps resembling those in north-eastern Scandinavia today.

*Sample 218 (95-105 cm; upper part of LMZ-DVE-**D**)*

A subsample of 2.6 kg was analysed, producing 241 individuals of 99 taxa of adult beetles and bugs.

Ecology: Conditions probably remained rather as in the period represented by Sample 219, but the passage of time (or slight amelioration) seems to have allowed the development of a richer fauna. Diversity had increased dramatically as more species arrived (alpha = 63, SE = 7). Aquatic habitats supported *Ochthebius minimus* (?24) and a wide range of other water beetles (33 species in total, contributing over two fifths of the fauna). *Microvelia reticulata*, another tiny bug related to the pondskaters and found amongst thick, often shaded, emergent vegetation with clear patches of water between, was rather abundant (20). There was little to indicate drier environments—*Stignocoris pedestris* (3), *Trapezonotus desertus* (?1) and *Silpha atrata* (1) being the least hygrophilous species. Notable in this assemblage is the leaf beetle *Adoxus obscurus*, associated with willowherbs.

Climate: The climate probably remained essentially similar to that during the deposition of the layer represented by Sample 219. *Olophrum fuscum* and *Arpedium brachypterum* remained the dominant species, while *Boreaphilus henningsianus*, *Pycnoglypta lurida*, *Agabus arcticus* and *Diacheila arctica* all indicate a climate not far from that of the extreme north of Scandinavia. Three taxa with somewhat southerly distributions were present, including *Potamonectes griseostriatus*, which does not extend into the north of Scandinavia. This is a water beetle, however, and aquatics may have been able to exist under harsher climates at low latitude than suggested by their present ranges.

*Sample 217 (85-95 cm; LMZ-DVE-**E**)*

The processed subsample was large (5.6 kg) and produced a very large assemblage of adult beetles and bugs: 980 individuals of 153 taxa. Many other invertebrates were present, some in abundance.

Ecology: The junction of Samples 218 and 217 appears, by good fortune, to have more or less coincided with a sudden and substantial change Although the environment was still open and pools remained, it appears than many new insect species were able to colonise, and that a rich herbaceous vegetation had developed. Diversity was a little lower if the whole assemblage was measured (alpha = 51, SE = 3), but the value of alpha rose to 60 (SE = 4) if the very large number of *Ochthebius minimus* was removed. Resting eggs of *Daphnia* and another cladoceran were abundant. The dominant *O. minimus* was accompanied by a substantial number of other aquatics (a total of 36 taxa and 365 individuals, representing 46% of the assemblage), and formed a coherent community of pools supporting a rich aquatic vegetation. Species which lived at water margins included the shorebug *Chartoscirta cincta* (29), *Cercyon tristis* (15), *C. convexiusculus* and *C. marinus* (13 of each), *Bledius* sp. (12), two *Carpelimus* species (12 and 11) and many others. Emergent and swamp vegetation was indicated by *Cyphon* sp. (32), *C. padi* (17), *Donacia vulgaris* (13; on *Sparganium* and *Typha*), *D. obscura* (9; on club-rushes and sedges, especially *Carex rostrata*), and among the less abundant taxa, the weevil *Limnobaris pilistriata* (4, associated with sedges and rushes), the capsid bug *Cyrtorhinus caricis* (3, found around clumps of sedges and rushes, feeding on leafhopper, especially delphacid, eggs), *Chilacis typhae* (2, on great reedmace), and *Prasocuris phellandrii* (2, on waterside umbellifers). Species associated with vegetation on somewhat damp substrata included the shieldbugs *Picromerus bidens* and *Zicrona caerulea* (single individuals of each); the latter is most typically found on heaths. Otherwise, 'dry land' habitats were not represented by the fauna apart from the dung beetle *Aphodius ater*; bearing in mind the great mobility of insects this seems likely to reflect a generally wet landscape rather than the specialised nature of the deposit.

Climate: There was a dramatic climatic change close to the junction of this and the underlying deposit. Seventeen taxa with somewhat to distinctly southernly distributions in north-west Europe were recorded, including *Chilacis typhae*, *Dinarda dentata* and *Hygrotus decoratus* (all restricted to the southern half of Scandinavia) and *Pterostichus gracilis* and *Sitona griseus*, both confined to the far south of Scandinavia. It appears probable that temperatures were at least as high as at the present day.

*Sample 216 (75-85 cm upper part of LMZ-DVE-**E** and LMZ-DVE-**F**), Sample 215 (65-75 cm; LMZ-DVE-**G** and lower part of LMZ-DVE-**H**), Sample 214 (55-65 cm; upper part of LMZ-DVE-**H**)*

Not examined.

*Sample 213 (45-55 cm; lower part of LMZ-DVE-**I**)*

The subsample of 3.9 kg produced another very large assemblage, 767 adult beetles and bugs, but the number of taxa was quite low (59).

Ecology: Much the most numerous beetles were *Cyphon padi* (268) and *C.* sp. (154). They seem to have lived on waterside and emergent vegetation, for water beetles were abundant (15 taxa, 211 individuals, 26% of the assemblage). In this category, *Limnebius aluta* (84) and *Hydroporus scalesianus* (20) were the most numerous. There was wet moss and litter to support *Chaetarthria seminulum* (64), *Ochthephilum fracticorne* (14), *Bryaxis* sp. (?13), *Pselaphus heisei* (12), *Hebrus ruficeps* (4), and others. *Pachybrachius fracticollis* (2) is associated with bogs and fens, characteristically where there is cotton grass and bog myrtle. *Stignocoris pedestris* (6) and *Drymus brunneus* (1) probably lived on the ground beneath trees, shrubs and taller herbs. There were some species dependent upon trees (all recorded as single individuals): the shieldbug *Elasmostethus interstinctus* (usually found on birch), *Cerylon ferrugineum* (under broadleaf and conifer bark) and *Pityophthorus pubescens* (in pine). *Cryptolestes spartii*, according to Fowler (1889, 299), lives in dead stems of broom. Thus, by this stage terrestrialisation had occurred at least here and there.

Climate: Temperatures were at least as high as at the present day. *Cryptolestes spartii*, *Metopsia retusa* and *Pityophthorus pubescens* are all restricted to the south of Scandinavia, and *Hydraena palustris*, *Limnebius aluta* and *Pachybrachius fracticollis* are all restricted to the southern half of that area. In addition, *Coccidula rufa*, *Cymus ?glandicolor*, *Hydroporus scalesianus* and *Limnebius ?papposus* do not extend into northern areas of Scandinavia.

*Sample 211 (25-35 cm; LMZ-DVE-**J** and LMZ-DVE-**K**)*

Not examined.

Trench B

Four samples were collected from fills of features interpreted in the field as ice-wedges.

Sample 99 (Context 4076)

The large (5 kg) subsample produced an assemblage of beetles and bugs of moderate size (121 individuals, although only 19 taxa).

Ecology: The entire fauna, dominated by *Olophrum fuscum* and *Arpedium brachypterum*, would be at home in a barren landscape with scattered pools and an incomplete cover of short vegetation.

Climate: The characteristic and extremely restricted fauna (alpha = 6, SE =1), and specifically the presence of *Diacheila arctica* and *Simplocaria metallica*, indicate extremely low temperatures, resembling northern Scandinavia.

Sample 105 (Context 4075)

A 2.5 kg subsample was processed but produced no invertebrate remains.

Sample 108 (Context 4077)

The subsample of 3.0 kg yielded a large assemblage of beetles and bugs (S = 18, N = 308). Some other remains were present in small numbers.

Ecology: Conditions were as indicated by the fauna of Sample 99; diversity was astonishingly low (alpha = 4, SE = 1). This implies that only 70 taxa would be recovered were 1000 million individuals collected (using alpha equations of Fisher *et al.* (1943), see below)—clearly a most impoverished environment.

Climate: The cold stenotherm taxa present in Sample 99 were supplemented by *Boreaphilus henningsianus*, *Helophorus sibiricus*, *Diacheila polita* and *Pycnoglypta lurida* (?). Extreme tundra conditions obtained.

Sample 109 (Context 4078)

A small assemblage (41 individuals of 13 beetle taxa) was recovered from the 1.7 kg subsample processed.

Ecology and climate: Doubtless this deposit formed under the same conditions as the previous two.

Sample 110 (Context 4079)

A 2 kg subsample was analysed and a rather substantial assemblage of beetles (and a single bug) recovered (N = 148, although S only 27).

Ecology and climate: This assemblage had a similar composition to, and the same implications as, the others from the ice-wedges.

Trench A

Insects were only examined during assessment; the subsamples were of 1 kg.

Sample 312 (15-20 cm)

The subsample gave only traces of invertebrate remains, including earthworm egg capsules.

Sample 314 (25-30 cm)

There were traces of aquatic and terrestrial beetles and several earthworm egg capsules in the flot.

Sample 316 (37-45 cm)

A single worm egg capsule was the only invertebrate recorded from the flot.

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.

Trench D

The samples from Trench D were examined only during assessment.

Sample 4211, Context 154

A 3 kg subsample was examined; worm egg capsules were abundant in the flot and the small insect assemblage, although indicative of water and marshland, was nondescript.

Sample 4218, Context 173

A subsample of 1 kg yielded only traces of invertebrate remains.

Sample 4264, Context 178

The 1 kg subsample gave a flot which included several earthworm egg capsules and *Daphnia* (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 *Rhizophagus* sp. may have been associated with decaying wood.

Sample 4265, Context 180

A very large subsample (13 kg) was processed. Invertebrates were present in the flot in rather small numbers, and indicated a range of habitats, primarily marshland

Trench H

This material was examined only during assessment; subsamples of 1 kg were employed.

Sample 132 (5-10 cm)

Apart from earthworm egg capsules, invertebrate remains were rather rare in the flot; all of the beetles were terrestrial species.

Sample 1522 (22.5-25 cm)

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.

Sample 161/102 (25-31 cm)

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.

Sample 162 (31-36 cm)

Invertebrate remains were rare in the flot.

Summary of climatic implications of the insect assemblages

The ice-wedge fills

The ice-wedge deposits yielded a characteristic and extremely restricted fauna of very low diversity. A range of taxa indicate extremely low temperatures, resembling those in far northern Scandinavia today: *Diacheila arctica*; *Diacheila polita*; *Agabus arcticus*; *Helophorus sibiricus; Pycnoglypta lurida*; *Boreaphilus henningsianus*; and *Simplocaria metallica*. Undoubtedly, tundra conditions obtained.

Trench J

Stage 1: cool-slight amelioration-cooler

Below 290 cm: Most of the insects recorded were eurythermal or somewhat northern. Thermal climate was perhaps like that of upland and northern Britain; the absence of strongly boreo-montane taxa may suggest a period of declining temperatures in which there was no well-established balanced community. This may perhaps represent the phase of cooling during the Windermere Interstadial.

280-290 cm: The presence of some taxa which do not extend into the far north of Europe and the absence of clear cold-indicators suggested some amelioration; a stabilisation of the environment perhaps having occurred. Cool conditions, probably like those of upland Britain, are probably indicated.

270-280 cm: There was again some evidence of ameliorated conditions, but nothing to suggest that temperatures had risen above those typical of upland or northern Britain.

255-270 cm: Although there is little clear evidence, there had probably been a slight decline in temperatures.

Stage 2: extreme cold

240-255 cm: An apparently rapid climatic change of substantial magnitude occurred at or very close to the 255 cm level. The fauna became one very typical of cold stages in Britain, a range of non-British species was present, and temperatures had fallen to those of the far north of Europe or northern Siberia.

230-240 cm: The representation of southerly taxa was even lower than in the previous unit, perhaps because they had succumbed to sustained low temperatures.

Stage 3: sudden amelioration

222-230 cm: Temperatures rose substantially, and it would appear rapidly, between the deposition of the layers below and above 230 cm.

Stage 4: temperate

200-222 cm: Not examined.

190-200 cm: Temperatures probably remained unchanged from those for the period represented by 222-230 cm.

170-190 cm: Not examined.

160-170 cm: Limited evidence, but temperatures were probably like those of the present day.

130-160 cm: Not examined.

120-130 cm: Temperatures were at least as high as those of the 20th century.

100-120 cm: Not examined.

90-100 cm: No clear climatic signal could be divined.

65-90 cm: Not examined.

52.5-65 cm: Temperatures remained at least at present-day levels.

38-52.5 cm: Not examined.

30-38 cm: The restricted fauna offered little climatic evidence, although temperatures again seem to have been much as at the present day.

20-30 cm: Not examined.

10-20 cm: There was little evidence for climate.

0-10 cm: Not examined.

Trench E

Stage 0—temperate

180 cm and lower: Three taxa indicated temperatures resembling those of present-day northern upland Britain, but a few others now have somewhat southerly distributions in Scandinavia. This may have been a phase of gradually declining temperatures.

165-about 175 cm: Not examined.

155-165 cm: Three taxa with distinctly southerly distributions in Scandinavia were present while some others are somewhat southerly in north-west Europe. Only a single, tentatively-identified, individual could be seen as ‘northerly’. Temperatures were perhaps a little below those of the present day, but not cooler than in lowland northern Britain.

150-155 cm: Not examined.

Stage 1—cool

145-150 cm: Although falling diversity may have reflected habitat restriction in a developing swamp, declining temperatures may have been responsible. One boreo-montane species appeared, but some species with slightly southern distributions remained.

Stage 2—cold

135-145 cm: A group of species very typical of cold stages in Britain was present.. Temperatures had fallen to those of northern or montane Scandinavia, although some taxa whose distributions do not extend into the extreme north had survived.

125-135 cm: The gradual decline in temperatures probably continued. There were only traces of taxa with even slightly southerly ranges, and species indicative of very low temperatures were present.

115-125 cm: Not examined.

105-115 cm: The fauna had by this stage become strongly boreal in character. This deposit probably represents the coldest part of the Loch Lomond Stadial, with conditions perhaps resembling those in north-eastern Scandinavia.

95-105 cm: The climate probably remained essentially similar to that obtaining as the underlying layer formed, a climate not far from that of the extreme north of Scandinavia. Three taxa with somewhat southerly distributions were present, however.

Stage 3—sudden amelioration

85-95 cm: There was a dramatic climatic change close to the junction of this and the underlying deposit. Seventeen taxa with somewhat to distinctly southerly distributions in north-west Europe were recorded. It appears probable that temperatures were at least as high as at the present day.

Stage 4—temperate

55-85 cm: Not examined.

45-55 cm: Temperatures were at least as high as at the present day. There were three species restricted to the south of Scandinavia, others restricted to the southern half of that area, and some which do not extend into northern areas of Scandinavia.

0-35 cm: Not examined.

Correlation of Trenches J and E by insect remains

The pattern of ecological change in the two main sequences is remarkably similar; this is reflected in Figures 8-13. At the species level, the following are notable: the presence of *Hebrus ruficeps* prior to the extreme cold of the Loch Lomond Stadial (Samples 503, and 223/222); the great similarity of the cold stage fauna (Samples 506/507 and 218/219); and the appearance of *Microvelia reticulata* (Samples 509 and 218).

Comparison of insect fauna with other sites

The sites most relevant to Church Moss, Davenham, are Red Moss, Lancashire (Ashworth 1972), St Bees, Cumbria (Coope and Joachim 1980), Glanllynnau, North Wales (Coope and Brophy 1972) and Gransmoor, East Yorkshire (Walker *et al.* 1993). A review of Late Devensian/Early Holocene climate change as indicated by insect remains is given by Lowe and Walker (1997).

Insects (and a few other invertebrates) from a Devensian Lateglacial and Early Holocene sequence of peats and muds at Red Moss, Lancashire, exposed during construction of the M61 motorway, were described by Ashworth (1972). The succession of insect assemblages started rather earlier than for the main trenches at Davenham, and ended at about the post-Loch Lomond amelioration. The earliest part of the sequence, corresponding to the 'Older Dryas', appeared on entomological evidence to reflect warm conditions, and there was cooling then warming during the later part of the interstadial, as seems to have been the case at Davenham. Very

The subsample examined was of 3.9 kg, and yielded 133 individuals of 53 beetle and bug taxa; there were also large numbers of mites.

Ecology: The trend seen in the previous samples, towards a more open environment, continued. Diversity had fallen again, doubtless as certain habitat types disappeared. Swamp taxa became unimportant, and the remaining fauna (dominated by *Olophrum fuscum*—22 individuals—and *Arpedium brachypterum*—9) were even more typical of open, tundra-like, vegetation.

Climate: The decline in temperatures probably continued. There were only traces of taxa with even slightly southerly ranges, and *Diacheila arctica*, indicative of very low temperatures, was present.

*Sample 220 (115-125 cm; lower part of LMZ-DVE-**D**)*

Not examined.

*Sample 219 (105-115 cm; middle part of LMZ-DVE-**D**)*

A very large subsample (6.4 kg) was processed, and a fairly large group of beetles and bugs recovered (211 individuals, although of only 52 taxa).

Ecology: The fauna indicated open, tundra-like conditions, with occasional pools. Among the aquatics, *Agabus arcticus* was the most abundant (6). Diversity was low (alpha = 22, SE = 2).

Climate: The fauna had by this stage become strongly boreal in character, dominated by *Olophrum fuscum* (99) and *Arpedium brachypterum* (23), and again with *Pycnoglypta lurida* (?) and *Otiorhynchus nodosus*. *Diacheila arctica* was joined by the even more cold-stenothermic *D. polita*, while *Agabus arcticus* has a distinctly northern range. This deposit probably represents the coldest part of the Loch Lomond Stadial, with conditions perhaps resembling those in north-eastern Scandinavia today.

*Sample 218 (95-105 cm; upper part of LMZ-DVE-**D**)*

A subsample of 2.6 kg was analysed, producing 241 individuals of 99 taxa of adult beetles and bugs.

Ecology: Conditions probably remained rather as in the period represented by Sample 219, but the passage of time (or slight amelioration) seems to have allowed the development of a richer fauna. Diversity had increased dramatically as more species arrived (alpha = 63, SE = 7). Aquatic habitats supported *Ochthebius minimus* (?24) and a wide range of other water beetles (33 species in total, contributing over two fifths of the fauna). *Microvelia reticulata*, another tiny bug related to the pondskaters and found amongst thick, often shaded, emergent vegetation with clear patches of water between, was rather abundant (20). There was little to indicate drier environments—*Stignocoris pedestris* (3), *Trapezonotus desertus* (?1) and *Silpha atrata* (1) being the least hygrophilous species. Notable in this assemblage is the leaf beetle *Adoxus obscurus*, associated with willowherbs.

Climate: The climate probably remained essentially similar to that during the deposition of the layer represented by Sample 219. *Olophrum fuscum* and *Arpedium brachypterum* remained the dominant species, while *Boreaphilus henningsianus*, *Pycnoglypta lurida*, *Agabus arcticus* and *Diacheila arctica* all indicate a climate not far from that of the extreme north of Scandinavia. Three taxa with somewhat southerly distributions were present, including *Potamonectes griseostriatus*, which does not extend into the north of Scandinavia. This is a water beetle, however, and aquatics may have been able to exist under harsher climates at low latitude than suggested by their present ranges.

*Sample 217 (85-95 cm; LMZ-DVE-**E**)*

The processed subsample was large (5.6 kg) and produced a very large assemblage of adult beetles and bugs: 980 individuals of 153 taxa. Many other invertebrates were present, some in abundance.

Ecology: The junction of Samples 218 and 217 appears, by good fortune, to have more or less coincided with a sudden and substantial change Although the environment was still open and pools remained, it appears than many new insect species were able to colonise, and that a rich herbaceous vegetation had developed. Diversity was a little lower if the whole assemblage was measured (alpha = 51, SE = 3), but the value of alpha rose to 60 (SE = 4) if the very large number of *Ochthebius minimus* was removed. Resting eggs of *Daphnia* and another cladoceran were abundant. The dominant *O. minimus* was accompanied by a substantial number of other aquatics (a total of 36 taxa and 365 individuals, representing 46% of the assemblage), and formed a coherent community of pools supporting a rich aquatic vegetation. Species which lived at water margins included the shorebug *Chartoscirta cincta* (29), *Cercyon tristis* (15), *C. convexiusculus* and *C. marinus* (13 of each), *Bledius* sp. (12), two *Carpelimus* species (12 and 11) and many others. Emergent and swamp vegetation was indicated by *Cyphon* sp. (32), *C. padi* (17), *Donacia vulgaris* (13; on *Sparganium* and *Typha*), *D. obscura* (9; on club-rushes and sedges, especially *Carex rostrata*), and among the less abundant taxa, the weevil *Limnobaris pilistriata* (4, associated with sedges and rushes), the capsid bug *Cyrtorhinus caricis* (3, found around clumps of sedges and rushes, feeding on leafhopper, especially delphacid, eggs), *Chilacis typhae* (2, on great reedmace), and *Prasocuris phellandrii* (2, on waterside umbellifers). Species associated with vegetation on somewhat damp substrata included the shieldbugs *Picromerus bidens* and *Zicrona caerulea* (single individuals of each); the latter is most typically found on heaths. Otherwise, 'dry land' habitats were not represented by the fauna apart from the dung beetle *Aphodius ater*; bearing in mind the great mobility of insects this seems likely to reflect a generally wet landscape rather than the specialised nature of the deposit.

Climate: There was a dramatic climatic change close to the junction of this and the underlying deposit. Seventeen taxa with somewhat to distinctly southernly distributions in north-west Europe were recorded, including *Chilacis typhae*, *Dinarda dentata* and *Hygrotus decoratus* (all restricted to the southern half of Scandinavia) and *Pterostichus gracilis* and *Sitona griseus*, both confined to the far south of Scandinavia. It appears probable that temperatures were at least as high as at the present day.

*Sample 216 (75-85 cm upper part of LMZ-DVE-**E** and LMZ-DVE-**F**), Sample 215 (65-75 cm; LMZ-DVE-**G** and lower part of LMZ-DVE-**H**), Sample 214 (55-65 cm; upper part of LMZ-DVE-**H**)*

Not examined.

*Sample 213 (45-55 cm; lower part of LMZ-DVE-**I**)*

The subsample of 3.9 kg produced another very large assemblage, 767 adult beetles and bugs, but the number of taxa was quite low (59).

Ecology: Much the most numerous beetles were *Cyphon padi* (268) and *C.* sp. (154). They seem to have lived on waterside and emergent vegetation, for water beetles were abundant (15 taxa, 211 individuals, 26% of the assemblage). In this category, *Limnebius aluta* (84) and *Hydroporus scalesianus* (20) were the most numerous. There was wet moss and litter to support *Chaetarthria seminulum* (64), *Ochthephilum fracticorne* (14), *Bryaxis* sp. (?13), *Pselaphus heisei* (12), *Hebrus ruficeps* (4), and others. *Pachybrachius fracticollis* (2) is associated with bogs and fens, characteristically where there is cotton grass and bog myrtle. *Stignocoris pedestris* (6) and *Drymus brunneus* (1) probably lived on the ground beneath trees, shrubs and taller herbs. There were some species dependent upon trees (all recorded as single individuals): the shieldbug *Elasmostethus interstinctus* (usually found on birch), *Cerylon ferrugineum* (under broadleaf and conifer bark) and *Pityophthorus pubescens* (in pine). *Cryptolestes spartii*, according to Fowler (1889, 299), lives in dead stems of broom. Thus, by this stage terrestrialisation had occurred at least here and there.

Climate: Temperatures were at least as high as at the present day. *Cryptolestes spartii*, *Metopsia retusa* and *Pityophthorus pubescens* are all restricted to the south of Scandinavia, and *Hydraena palustris*, *Limnebius aluta* and *Pachybrachius fracticollis* are all restricted to the southern half of that area. In addition, *Coccidula rufa*, *Cymus ?glandicolor*, *Hydroporus scalesianus* and *Limnebius ?papposus* do not extend into northern areas of Scandinavia.

*Sample 211 (25-35 cm; LMZ-DVE-**J** and LMZ-DVE-**K**)*

Not examined.

Trench B

Four samples were collected from fills of features interpreted in the field as ice-wedges.

Sample 99 (Context 4076)

The large (5 kg) subsample produced an assemblage of beetles and bugs of moderate size (121 individuals, although only 19 taxa).

Ecology: The entire fauna, dominated by *Olophrum fuscum* and *Arpedium brachypterum*, would be at home in a barren landscape with scattered pools and an incomplete cover of short vegetation.

Climate: The characteristic and extremely restricted fauna (alpha = 6, SE =1), and specifically the presence of *Diacheila arctica* and *Simplocaria metallica*, indicate extremely low temperatures, resembling northern Scandinavia.

Sample 105 (Context 4075)

A 2.5 kg subsample was processed but produced no invertebrate remains.

Sample 108 (Context 4077)

The subsample of 3.0 kg yielded a large assemblage of beetles and bugs (S = 18, N = 308). Some other remains were present in small numbers.

Ecology: Conditions were as indicated by the fauna of Sample 99; diversity was astonishingly low (alpha = 4, SE = 1). This implies that only 70 taxa would be recovered were 1000 million individuals collected (using alpha equations of Fisher *et al.* (1943), see below)—clearly a most impoverished environment.

Climate: The cold stenotherm taxa present in Sample 99 were supplemented by *Boreaphilus henningsianus*, *Helophorus sibiricus*, *Diacheila polita* and *Pycnoglypta lurida* (?). Extreme tundra conditions obtained.

Sample 109 (Context 4078)

A small assemblage (41 individuals of 13 beetle taxa) was recovered from the 1.7 kg subsample processed.

Ecology and climate: Doubtless this deposit formed under the same conditions as the previous two.

Sample 110 (Context 4079)

A 2 kg subsample was analysed and a rather substantial assemblage of beetles (and a single bug) recovered (N = 148, although S only 27).

Ecology and climate: This assemblage had a similar composition to, and the same implications as, the others from the ice-wedges.

Trench A

Insects were only examined during assessment; the subsamples were of 1 kg.

Sample 312 (15-20 cm)

The subsample gave only traces of invertebrate remains, including earthworm egg capsules.

Sample 314 (25-30 cm)

There were traces of aquatic and terrestrial beetles and several earthworm egg capsules in the flot.

Sample 316 (37-45 cm)

A single worm egg capsule was the only invertebrate recorded from the flot.

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.

Trench D

The samples from Trench D were examined only during assessment.

Sample 4211, Context 154

A 3 kg subsample was examined; worm egg capsules were abundant in the flot and the small insect assemblage, although indicative of water and marshland, was nondescript.

Sample 4218, Context 173

A subsample of 1 kg yielded only traces of invertebrate remains.

Sample 4264, Context 178

The 1 kg subsample gave a flot which included several earthworm egg capsules and *Daphnia* (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 *Rhizophagus* sp. may have been associated with decaying wood.

Sample 4265, Context 180

A very large subsample (13 kg) was processed. Invertebrates were present in the flot in rather small numbers, and indicated a range of habitats, primarily marshland

Trench H

This material was examined only during assessment; subsamples of 1 kg were employed.

Sample 132 (5-10 cm)

Apart from earthworm egg capsules, invertebrate remains were rather rare in the flot; all of the beetles were terrestrial species.

Sample 1522 (22.5-25 cm)

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.

Sample 161/102 (25-31 cm)

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.

Sample 162 (31-36 cm)

Invertebrate remains were rare in the flot.

Summary of climatic implications of the insect assemblages

The ice-wedge fills

The ice-wedge deposits yielded a characteristic and extremely restricted fauna of very low diversity. A range of taxa indicate extremely low temperatures, resembling those in far northern Scandinavia today: *Diacheila arctica*; *Diacheila polita*; *Agabus arcticus*; *Helophorus sibiricus; Pycnoglypta lurida*; *Boreaphilus henningsianus*; and *Simplocaria metallica*. Undoubtedly, tundra conditions obtained.

Trench J

Stage 1: cool-slight amelioration-cooler

Below 290 cm: Most of the insects recorded were eurythermal or somewhat northern. Thermal climate was perhaps like that of upland and northern Britain; the absence of strongly boreo-montane taxa may suggest a period of declining temperatures in which there was no well-established balanced community. This may perhaps represent the phase of cooling during the Windermere Interstadial.

280-290 cm: The presence of some taxa which do not extend into the far north of Europe and the absence of clear cold-indicators suggested some amelioration; a stabilisation of the environment perhaps having occurred. Cool conditions, probably like those of upland Britain, are probably indicated.

270-280 cm: There was again some evidence of ameliorated conditions, but nothing to suggest that temperatures had risen above those typical of upland or northern Britain.

255-270 cm: Although there is little clear evidence, there had probably been a slight decline in temperatures.

Stage 2: extreme cold

240-255 cm: An apparently rapid climatic change of substantial magnitude occurred at or very close to the 255 cm level. The fauna became one very typical of cold stages in Britain, a range of non-British species was present, and temperatures had fallen to those of the far north of Europe or northern Siberia.

230-240 cm: The representation of southerly taxa was even lower than in the previous unit, perhaps because they had succumbed to sustained low temperatures.

Stage 3: sudden amelioration

222-230 cm: Temperatures rose substantially, and it would appear rapidly, between the deposition of the layers below and above 230 cm.

Stage 4: temperate

200-222 cm: Not examined.

190-200 cm: Temperatures probably remained unchanged from those for the period represented by 222-230 cm.

170-190 cm: Not examined.

160-170 cm: Limited evidence, but temperatures were probably like those of the present day.

130-160 cm: Not examined.

120-130 cm: Temperatures were at least as high as those of the 20th century.

100-120 cm: Not examined.

90-100 cm: No clear climatic signal could be divined.

65-90 cm: Not examined.

52.5-65 cm: Temperatures remained at least at present-day levels.

38-52.5 cm: Not examined.

30-38 cm: The restricted fauna offered little climatic evidence, although temperatures again seem to have been much as at the present day.

20-30 cm: Not examined.

10-20 cm: There was little evidence for climate.

0-10 cm: Not examined.

Trench E

Stage 0—temperate

180 cm and lower: Three taxa indicated temperatures resembling those of present-day northern upland Britain, but a few others now have somewhat southerly distributions in Scandinavia. This may have been a phase of gradually declining temperatures.

165-about 175 cm: Not examined.

155-165 cm: Three taxa with distinctly southerly distributions in Scandinavia were present while some others are somewhat southerly in north-west Europe. Only a single, tentatively-identified, individual could be seen as 'northerly'. Temperatures were perhaps a little below those of the present day, but not cooler than in lowland northern Britain.

150-155 cm: Not examined.

Stage 1—cool

145-150 cm: Although falling diversity may have reflected habitat restriction in a developing swamp, declining temperatures may have been responsible. One boreo-montane species appeared, but some species with slightly southern distributions remained.

Stage 2—cold

135-145 cm: A group of species very typical of cold stages in Britain was present.. Temperatures had fallen to those of northern or montane Scandinavia, although some taxa whose distributions do not extend into the extreme north had survived.

125-135 cm: The gradual decline in temperatures probably continued. There were only traces of taxa with even slightly southerly ranges, and species indicative of very low temperatures were present.

115-125 cm: Not examined.

105-115 cm: The fauna had by this stage become strongly boreal in character. This deposit probably represents the coldest part of the Loch Lomond Stadial, with conditions perhaps resembling those in north-eastern Scandinavia.

95-105 cm: The climate probably remained essentially similar to that obtaining as the underlying layer formed, a climate not far from that of the extreme north of Scandinavia. Three taxa with somewhat southerly distributions were present, however.

Stage 3—sudden amelioration

85-95 cm: There was a dramatic climatic change close to the junction of this and the underlying deposit. Seventeen taxa with somewhat to distinctly southerly distributions in north-west Europe were recorded. It appears probable that temperatures were at least as high as at the present day.

Stage 4—temperate

55-85 cm: Not examined.

45-55 cm: Temperatures were at least as high as at the present day. There were three species restricted to the south of Scandinavia, others restricted to the southern half of that area, and some which do not extend into northern areas of Scandinavia.

0-35 cm: Not examined.

Correlation of Trenches J and E by insect remains

The pattern of ecological change in the two main sequences is remarkably similar; this is reflected in Figures 8-13. At the species level, the following are notable: the presence of *Hebrus ruficeps* prior to the extreme cold of the Loch Lomond Stadial (Samples 503, and 223/222); the great similarity of the cold stage fauna (Samples 506/507 and 218/219); and the appearance of *Microvelia reticulata* (Samples 509 and 218).

Comparison of insect fauna with other sites

The sites most relevant to Church Moss, Davenham, are Red Moss, Lancashire (Ashworth 1972), St Bees, Cumbria (Coope and Joachim 1980), Glanllynnau, North Wales (Coope and Brophy 1972) and Gransmoor, East Yorkshire (Walker *et al.* 1993). A review of Late Devensian/Early Holocene climate change as indicated by insect remains is given by Lowe and Walker (1997).

Insects (and a few other invertebrates) from a Devensian Lateglacial and Early Holocene sequence of peats and muds at Red Moss, Lancashire, exposed during construction of the M61 motorway, were described by Ashworth (1972). The succession of insect assemblages started rather earlier than for the main trenches at Davenham, and ended at about the post-Loch Lomond amelioration. The earliest part of the sequence, corresponding to the 'Older Dryas', appeared on entomological evidence to reflect warm conditions, and there was cooling then warming during the later part of the interstadial, as seems to have been the case at Davenham. Very low temperatures prevailed during the 'Younger Dryas' (Loch Lomond Stadial), and warming corresponding with the 'Pre-Boreal' was detectable. The warming following the stadial appeared to have been rapid: of the order of 6 C (from 10 to 16 C) over 300-400 years.

Coleoptera from a lateglacial section exposed in the sea cliffs at St Bees, Cumbria, were studied by Coope and Joachim (1980; see also Coope 1978). The sequence again started before that in the main trenches at Davenham. The climatic optimum of the Windermere (Lateglacial) Interstadial was placed prior to 12 ka BP, being somewhat warmer than the present. Climatic amelioration preceded the deposition of organic-rich sediments. Later in the interstadial temperatures declined, and in classical Pollen Zone III (Loch Lomond Stadial) very cold conditions were indicated by obligate arctic-alpine taxa, several of them no longer found in Britain.

At Glanllynnau, sedimentation in a kettlehole begain at *c.* 14,000 BP and continued to *c.* 10,000 BP. At about 13,000 BP intense cold continentality gave way to a climate at least as warm as the 20th century. As trees invaded, temperatures gradually declined, and by the time birch forest was established, the climate was distinctly cooler than now. This part of the sequence corresponds roughly to the lower parts of the successions in Trenches J and E at Davenham.

Walker *et al.* (1993) gave data for pollen and Coleoptera from an important Lateglacial succession at Gransmoor, East Yorkshire. A detailed temperature curve was obtained for the beetles using the mutual climatic range method of Atkinson *et al.* (1987). The beetles indicated a climatic optimum (mean July temperatures perhaps in excess of 18 C) prior to the deposition of a pollen record. Temperatures had fallen by 2-4 C (to levels rather like those of the 20th century) by the time of *Juniperus* expansion, and fell further following the expansion of *Betula* during the later interstadial. There was a further decline at the boundary of the Lateglacial Interstadial and the Loch Lomond Stadial. During the latter, mean July temperatures of 9-11 C prevailed, winter temperatures dropping to -15 to -20 C. During the first part of the Lateglacial Interstadial there was 'disequilibrium' between the pollen and insect evidence, reflecting differential migration rates, but the evidence was in accord later on (after the first 1000 years). As at Davenham, there seemed to be evidence of an episode of low temperatures during the middle and later parts of the interstadial, reflected in fluctuations in birch pollen and parallelled in proxy data from various other sites and in Greenland ice-cores and Atlantic sediments. A mutual climatic range curve for the site at St Bees (above) was also presented.

Thus the succession at Davenham parallels climatic events at other sites in the region rather well, even though it was of a rather different ecological type. The rapidity of amelioration following the Loch Lomond Stadial is strikingly underlined (parallelling that interpreted as having occurred during Zone I), and the occurrence of a decline of temperatures followed by an amelioration during the middle to late part of the Windermere Interstadial is supported.

Although several sites of this period have been investigated in varying degrees of detail, producing important results, there is much left to do. The changing ecology and climate of the region can only be understood by examining numerous sites, building up a mosaic picture, and it will be important to compare rates and patterns of climatic change north-south and east-west, building on the work of Coope and others. Here, collaborative studies of invertebrates and plant macrofossils will be invaluable; the pollen evidence appears much more limited in its ability to reveal climatic change and local ecology by comparison. The relative rates of plant and invertebrate invasion in response to climatic change can be followed in detail at this time, providing a yardstick for work on earlier, less well understood, periods. Determining rates of climatic change will require sampling at close intervals; with hindsight, the deposits at Davenham would usefully have been sampled at perhaps 2-3 cm intervals. Comparison of terrestrial climate in North Britain with the marine and ice-core records in this period of rapid and large-scale change will provide a valuable insight into the likely effects of future global climatic change on human culture, and there are also aspects of invertebrate biogeography (rates of invasion, causes of exclusion, persistence in changing environments) to be pursued.

Overview of climate change and vegetation development at Church Moss

The Late Devensian (Pollen Zone I)

The organic sediments at Church Moss overlie grey clayey sands deposited during the Devensian glaciation. Within the parent material there is evidence for the development of sizeable ice-wedge features formed as a results of repeated freeze-thaw cycles within a tundra environment. Analysis of insect remains collected from the sediment infilling the ice-wedges clearly reveals extremely low temperatures, resembling those of present day northern Scandinavia.

Ice-wedges form when water freed during the brief continental summer freezes in a small fissure, expanding and opening up the crack further. Repeated freeze-thaw cycles rapidly produce significant fissures which become sediment traps in the sparsely vegetated tundra environment. The hollows created by frost action provide small loci for the formation of fen pools during the summer. Analysis of plant macrofossils from Trench B showed that several fen mosses which have modern distributions reaching as far north as Iceland and Greenland were able to survive in the hollows accompanied by pondweeds and water crowfoot. Several species of water crowfoot presently occupy habitats where the water supply is ephemeral, a capability that would have been important for survival in shallow tundra pools subject to both desiccation and freezing. Remains of hare's-tail cotton grass were also identified from the hollows. This species is particularly common in tundra regions at present, being adapted to withstand deep winter freezing, flooding in spring, and desiccation in late summer. The clear periglacial features underlying the Holocene deposits at Church Moss, and a radiocarbon date for the basal sediments from Trench J, which gave an age estimate of 12450 BP, suggest that the earliest organic fills from the ice-wedges date from the end of the Devensian glaciation.

The Windermere Interstadial (later Pollen Zone I and zone II)

The history of climate change and vegetation development is next taken up from the two main peat sequences in Trenches J and E. At both sampling sites the lowermost peat deposits in contact with the underlying sands and clays gave insect assemblages indicative of cool temperatures similar to the modern climate of northern upland Britain (see Figure 8 to 11). This suggests that the main sequence of peat accumulation began some time after the beginning of the Windermere Interstadial (Pollen Zone II), a period lasting approximately 1000 years during which time the climate ameliorated sufficiently to allow the colonisation of parts of Britain by birch and pine. The basal plant macrofossil and pollen assemblages show that a sedge-dominated mire covered much of the basin, probably spreading from loci in the ice-wedge hollows. The diversity of the initial swamp appears to have been rather low, including marsh cinquefoil, male fern, several members of the Compositae (daisy/dandelion family) and a limited range of fen mosses. The insects also suggest a rather barren environment with small open pools and scattered vegetation and litter. However, tree birch had clearly reached the margin of the mire by the time the main peat sequence began accumulating, as evidenced by the presence of bud-scales, catkin-scales and fruits in the lowermost zone of the Trench E macrofossil diagram.

Samples 503 and 504 in Trench J and Samples 225-221 in Trench E, all lying just above the basal peat samples, provide evidence for the continuation of a relatively mild climate throughout Pollen Zone II, corresponding to the latter part of the Windermere Interstadial. Insect remains from Trench J suggest that temperatures ameliorated, but were still slightly cooler than present and similar to those of the uplands of northern Britain at present. Taxa from the equivalent level in Trench E have distinctly southerly modern distributions in Scandinavia, suggesting temperatures no cooler than those of present day lowland northern Britain.

During the middle and later parts of the Windermere Interstadial the diversity of the sedge swamp increased. The pollen diagram for Trench J shows that a range of fen herbs such as taxa included amongst the pollen types *Filipendula* (presumably *F. ulmaria*), *Potentilla*-type, *Succisa* and *Thalictrum* joined the sedge community. Insect remains support the view that within the basin at Church Moss a rich swamp with moss and abundant litter had developed. Open pools were present, some with exposed muddy fringes. One beetle present in the assemblage indicated flowing water and was either carried to the site via a stream inflow or was a stray.

The Loch Lomond Stadial (Pollen Zone III)

At some point between Samples 505 and 506 from Trench J (and most probably at a depth of 255 cm in the sequence) the insect assemblages record an apparently very rapid climatic switch back to periglacial conditions similar to those of the Late Devensian. The fauna became one very typical of cold stages in Britain with species found in boreo-montane environments supplemented by presently non-British species with distinctly northern distributions. The complete assemblages from both Trench J and Trench E suggest that temperatures had fallen to those experienced today in the far north of Europe and northern Siberia.

Given the stratigraphic position of the sediments which contain the evidence for the switch to cold conditions, and the age estimate of 12450+/-60 BP obtained from a depth of 258-295.5 cm, the unit clearly represents the Loch Lomond Lateglacial Stadial.

Loss-on-ignition tests on sediment from Trench J show that inorganic content increased significantly from a depth of 250 cm to 225 cm, marking a phase of input of clay silt and sand onto the mire surface. The mineral input was no doubt caused by the destabilisation of soils surrounding the mire basin as the vegetation cover became intermittent in response to the rapidly deteriorating climatic conditions. The diversity of pollen types recorded in the lower half of the inwashing phase dropped slightly with *Caltha*, *Filipendula*, Caryophyllaceae and *Artemisia* being the main herb taxa represented. *Artemisia* contains several species with distinctly northern distributions. *A. vulgaris* is found at 74° N in Siberia, *A. norvegica* is presently found in Norway and the Ural Mountains and *A. absinthium* is found as far north as Lapland and S. Siberia. The *Artemisia* pollen type is a very frequent member of lateglacial pollen assemblages at many sites throughout Britain. *Caltha palustris*, which lives in marshes fens and wet woods, is presently found at altitudes up to 1100 m in Scotland and has a distribution which extends well into arctic Russia. *Filipendula* is another pollen type that is characteristic of lateglacial assemblages. *F. ulmaria*, perhaps the most likely species to be represented, is found in a variety of base-rich damp fen and swamp environments, even colonising wet rock-ledges to an altitude of 915 m in Britain.

During the Loch Lomond Stadial the beetles indicate the re-establishment of an open tundra environment with occasional shallow pools and a rather low diversity of insect species. Both the Trench J and Trench E macrofossil diagrams show that fen moss cushions replaced the sedge sward at the two sampling sites and the Trench J pollen diagram registers a significant concomitant decline in the frequency of Cyperaceae pollen. *Scorpidium scorpioides* and *Cratoneuron commutatum* var. *falcatum* were the principal fen mosses growing at the sampling sites during the stadial. The latter species is typical of montane parts of mainland Europe, the Faroes and Iceland, occurring in suitable base-rich habitats. *S. scorpioides* may be found occasionally in lowland habitats; however, it is more common in upland areas and has a distribution as far north as Greenland.

Clearly not all of the taller-growing vegetation disappeared from Church Moss during the colder conditions of the stadial. The insect assemblages from Trench E included some beetles that live in the shade of emergent vegetation and a species of leaf beetle associated with willow-herbs; at a similar stratigraphic level (252 cm) the pollen of *Chamaenerion angustifolium* (rosebay willow-herb) was noted in Trench J. This species thrives on poor, disturbed or rocky ground to an altitude of 975 m in Scotland. At Church Moss, rosebay willow-herb may well have been exploiting the exposed patches of sandy ground on the slopes surrounding the mire, vacated by more thermophilous species that had previously occupied the area during the Windermere Interstadial.

The beginning of the Holocene (Pollen Zone IV)

The insect remains show another substantial shift in environmental conditions between Samples 507 and 508 (240-230 to 230-222 cm depth respectively) in Trench J. In Sample 507 the very low representation of southerly species indicates sustained low temperatures, though species diversity was higher than that recorded from the early Loch Lomond Stadial, presumably because conditions had remained stable for a while giving time for the arrival of a range of suitably adapted beetles and bugs. In sharp contrast, Sample 508 contained a range of beetles that presently have somewhat southerly distributions within north-west Europe. Just as significant is the dramatic increase in species diversity which is strongly suggestive of a major climatic amelioration, marking the opening of the Holocene.

The age/depth curve (Figure 2) constructed from radiocarbon dates given in Table 1, suggests that peat accumulated at a rate of approximately 5.6 years cm^{-1} between the depths of 242 cm and 210 cm in Trench J. The 18 cm unit of sediment represented by Samples 507 and 508 falls within this interval and represents 100 years of mire development; therefore, the record presented here, although based on a coarse sampling resolution of 10 cm sediment slices, suggests that warming from full stadial to temperate conditions, took no more than one century and quite possibly much less. (It should be noted, however, that a third radiocarbon date placed within the depth interval in question, produced an inverted age estimate calling into question the reliability of the age/depth relationship).

The rapid climatic amelioration referred to above falls in the middle part of the local pollen zone LPZ-DVJ-**Ab**, which registers increases in several of the fen and swamp taxa such as *Typha latifolia*, *Potentilla*-type, *Filipendula* and, slightly later, a significant increase in the frequency of willow pollen. However, there was little change in the mire stratigraphy in Trenches J and E at this point, with fen mosses forming the bulk of the peat at the two locations. Loss-on-ignition results show that inwashing of inorganic material dropped markedly to less than 10% of the sediment volume at the point at which the insects remains register the dramatic warming event. This most probably reflects the restabilisation of the slopes surrounding the mire with a thicker cover of vegetation. It is interesting to note, however, that the moss-sedge swamp continued little changed for sometime after the climatic amelioration, though the increase in the frequency of willow pollen to more than 10% TLP at 220 cm depth in Trench J, suggests that at least one member of the genus had colonised the mire fairly rapidly, close to the sampling site. Willow pollen is usually rather poorly represented in the pollen spectra because the genus is entomophilous (insect pollinated).

Local pollen zones LPZ-DVJ-**B** and LPZ-DVE-**B** mark the first major vegetation changes of the Early Holocene (Pollen Zone IV) in the Church Moss area. Tree birch began to colonise the centre of the mire and may well have been growing on surrounding the slopes as well. The birch was accompanied by *Menyanthes trifoliata*, *Phragmites australis* and *Equisetum,* suggesting that swamp or fen carr conditions prevailed. Birch is capable of tolerating waterlogged conditions when nutrient levels are high. The continued presence of calcicole fen mosses such as *Homalothecium nitens* suggests that mire conditions remained base-rich well into the birch carr zone. The pollen diagram for Trench J clearly shows that ferns such as *Dryopteris* and *Thelypteris palustris* became an important part of the ground layer in the carr woodland. Surface conditions appear to have been somewhat different during the same time interval at the margin of the mire. Here the dramatic warming phase that marked the start of the Holocene is correlated with a phase of flooding. The Trench E macrofossil diagram shows that *Sparganium*, *Lemna*, *Scirpus lacustris* and *Carex pseudocyperus* replaced the sedge-moss fen that prevailed during the Loch Lomond Stadial. Thereafter, a *Phragmites/Thelypteris palustris* reedswamp developed rather than birch carr. The wetter character of the marginal sampling site may have resulted from differential subsidence of the underlying salt-bearing geology or more likely the development of lag conditions as the developing peat mass in the centre of the mire altered the hydrological conditions throughout the rest of the basin.

Throughout the rest of the Trench J sequence the insect remains indicate that temperatures remained high. Assemblages from samples 514, 518, 406, and 404 all suggest that temperatures had already reached values similar to those of the 20th Century during the first few centuries of the Holocene. Temperature clearly remained close to modern values for a sustained period of time, lasting from *c.* 10,000 BP to the end of the truncated peat sequence at 7900 BP. The relatively stable climate cleared the way for both wetland and dry land vegetation to develop unhindered by severe changes in temperature.

The early Holocene (Pollen Zones V and VI)

In Pollen Zones V and VI the character of the non-peatland vegetation changed significantly with the arrival of hazel followed shortly after by oak and elm. Immigration of these species was probably primarily controlled by rates of migration and the availability of suitable soils rather by climatic conditions. At the beginning of Pollen Zone V, the birch carr woodland in the centre of the mire began to decline as the peatland system acidified. *Sphagnum palustre*-dominated poor-fen gradually replaced the carr. The insect remains at this stage were rather restricted, suggesting only that open pools were present.

The low insect diversity probably indicates that the range of habitats had become much more limited.

The upper part of the Trench J peat sequence shows that pine woodland invaded the *Sphagnum* bog, possibly reflecting a fall in the mire water-table. Pine can survive on base-poor peaty substrates by growing very slowly and only reaching the size of a dwarf shrub after several decades, such as at Cranesmoor in the New Forest. The pine present at Church Moss may have existed in similar conditions and need not represent the development of a substantial woodland (although a number of substantial, but undated, pine trunks were present in the shallower parts of the peats at the site).

The succession towards ombrotrophic bog appears to have been interrupted by a phase of flooding by calcareous waters in local macrofossil zone LMZ-DVJ-**H**. This is indicated by the arrival of the moss *Meesia longiseta* which became extinct in Britain during the last century as a result of habitat loss. Holocene records of *M. longiseta* show that the species invades acid peat soils that have been flooded by calcium-rich groundwaters. The interruption to the succession was probably only brief since bog mosses in *Sphagnum* Section *Acutifolia,* accompanied by small traces of several Ericaceae species, formed the final peat unit in the sequence. Although *Sphagnum* Section *Acutifolia* contains species typical of both fens and raised bogs the other taxa in the samples from these levels are all typical of acidic peatlands. In addition, the insect assemblages from the upper samples in Trench J suggest a low habitat diversity, in keeping with the existence of a base-poor, relatively species-poor, raised-bog.

Given the evidence for minor reversals in the succession towards raised-bog and the fact that the peat profile is truncated it is not possible to say with any certainty whether the upper acidic bog peat represented the final establishment of stable true raised-bog.

Further discussion

Changes in insect diversity as a measure of total species pool and rates of environmental change

The index of diversity alpha of Fisher *et al.* (1943) has been used in palaeoentomology as a means of determining the degree of mixture of communities and their development—both mixture and 'maturity' of fauna raising alpha (eg. Kenward 1978; Kenward and Large in press). However, for sites such as Davenham, climate and climatic change may be important determinants of alpha. Periods of change may reduce the range of taxa and thus alpha (the fauna of the old regime has died out, that of the new one has not arrived) or bring about an apparent increase (by allowing the mixing of successive faunas). Alpha values for the assemblages of adult beetles and bugs from the main successions at Davenham are presented in Figures 14-15. The values are presented for both whole assemblages and after removing *Cyphon* spp., whose numbers fluctuate wildly. The possible significance of the changes has been mentioned briefly in the sample-by-sample discussion of the invertebrate assemblages. The alpha values for the ice-wedge assemblages are strikingly low, and undoubtedly reflect an extreme environment which could be tolerated by only a few species. For Sample 108, for example, it is estimated that the total species pool (Coleoptera and Hemiptera) was possibly less than 100 (alpha = 4; about 70 taxa would be recovered from a sample of 1000 million individuals). The sudden drop in diversity between Samples 505 and 506 in Trench J almost certainly resulted from climatic change and the failure of cold-adapted species to colonise as fast as the pre-existing cool temperature fauna was extinguished (alpha for Sample 505 = 27/33; for 506 = 13/12). The period represented by Sample 506 had a far richer fauna than the periglacial conditions of the ice-wedges allowed (1000 million individuals would provide of the order of 200 species). It seems unlikely that the increase in diversity in Sample 507 (alpha = 39/37) reflects climatic amelioration; more probably a range of cold-tolerant taxa had been able to invade by this time. The increase in the diversity of the assemblage from Sample 508 (alpha = 50/51), by contrast, was almost certainly a result of a sudden amelioration and the arrival of numerous temperate species.

Subsequent variations in insect diversity undoubtedly reflect changes in ecological diversity—variations in the richness of the local vegetation, with periods when a restricted flora limited the range of insects able to find habitats. However, at times (Samples 511, 518) the value of alpha was distorted by large numbers of *Cyphon* spp.; when these are removed alpha rises dramatically (22 -> 50 and 35 -> 62 respectively). Clearly diversity estimates have considerable value in the context of Quaternary palaeoecology. However, the multiple causes of diversity changes must be recognised.

Mire development pathways and rates of hydroseral succession

The pathways of mire development recorded in the detailed reconstructions of macrofossil and pollen assemblages from Church Moss are highly distinctive because of the protracted phase of base-rich swamp and fen development. The growing surface of the mire remained connected to a base-rich water supply for almost all of the 4500 year period of deposition represented by the deepest sequence of preserved peats from Trench J. This slow rate of change is quite extraordinary for a mire developing in a relatively small, confined basin. Analyses of sediments from the basal sections of four mires in Cumbria (Hughes 1997) with similar basin sizes, displayed much more rapid transitions to fully ombrotrophic raised-bog, having spent between 500 and 1000 years in the fen phase (compare Figures 17 and 18). Similar analyses of macrofossils from larger basins such as the Tregaron peat complex in Mid-Wales and Mongan Bog in Co. Offaly, Ireland (Hughes 1997), demonstrated that infilling of deeper lakes could take as little as 2000-2500 years. Church Moss, by contrast, remained a base-rich mosaic of marsh and fen pools for over 4000 years, yet there is little evidence from Trenches J and E for an initial phase of open water early in the mire succession. Peat accumulation began in a rich marsh environment without the need for development to be delayed by a phase of lake infilling. Given stable environmental conditions, the peatland should have been able to develop relatively rapidly towards ombrotrophic bog. Analyses from Abbey-knockmoy bog in Ireland (Hughes 1997) show that, even when a succession begins on a calcium-rich substrate such as a lake marl, acidification can be relatively rapid once the developing peat mass has isolated the mire surface from the influence of the groundwater supply.

The final transition to acidic conditions at the top of the preserved peat sequences at Church Moss was also much slower than the transitions observed in the stratigraphy at many other sites. A minor reversal in the direction of succession is hinted at in Trench J, just prior to the arrival of the main raised-bog hummock-builder, *Sphagnum* Section *Acutifolia*. The now extinct moss *Meesia longiseta* displaced a relatively acidic *Pinus/Sphagnum palustre* community, suggesting that the mire was flooded by base-rich waters. Macrofossil evidence from Trench E also suggests that the margin of the mire experienced a significant phase of rising water-levels at the beginning of Pollen Zone IV, which may be regarded as a reversal in the direction of hydroseral succession.

The longevity of swamp and fen stages and the very slow rate of transition from fen to raised-bog (compared with similar-sized peatlands in other regions), punctuated by minor reversal in the hydroseral succession, requires explanation. Brayshay *et al.* (1995) proposed that the mire basin at Church Moss formed as a result of the solution of saliferous rocks at depth and that the continued subsidence of the basin could have resulted in gradually rising water-tables relative to the mire surface. The consequence of rising water-tables would be to extend the duration of the phase in which the mire surface was subject to inundation by base-rich groundwater. The more detailed pollen and macrofossil evidence presented in this report supports the original hypothesis of Brayshay *et al.* (1995). Minor reversal in succession noted in the macrofossil diagrams from Trenches J and E may reflect brief periods when the rate of groundwater rise resulting from subsidence exceeded the rate of peat accumulation.

Evidence for human activity at Church Moss, Davenham?

The assessment of plant and invertebrate remains from Church Moss found *'no unambiguous evidence for the presence of humans in the vicinity of Church Moss during the period represented by the deposits'* (Carrott *et al.* 1996). This finding supported the results of large open-area excavations designed to address the question of late palaeolithic/mesolithic human activity at Church Moss. The excavation suggested that the 'worked wood' and 'bark and charcoal spreads' were in all probability of natural origin. Similarly, 'hoards' of hazel nuts may simply have been gathered by small mammals. Close inspection of the spot finds (Table 14) revealed that several of the hazel nutshell fragments showed signs of having been gnawed by animals.

The detailed macrofossil and pollen analyses undertaken during the main phase work at Church Moss lend further support to the findings of the Lancaster University Archaeological Unit excavations and the biological assessment undertaken by Carrott *et al.* (1996). There was no clear evidence of human activity in the palaeoecological records investigated from Church Moss. The pollen diagram from trench J did provide evidence for at least three small peaks in microscopic charcoal particles at 299-282 cm, 264 cm and 90-76 cm; however, the uppermost burning episode, at least, is clearly related to burning on the mire surface rather than in the surrounding woodland since the macrofossil diagram records charcoal peaks at 80-70 cm, which included fragments of burnt fen moss leaves. At present there is no easy way of distinguishing between charcoal and burnt litter resulting from natural fires and those set by humans. It is entirely possible that the burning episodes at Church Moss were all natural. Records of Early Holocene burning events from several of the Cumbrian mires studied by Hughes (1997) showed increased incidence of burning when suitable litter was available and protracted phases of low fire incidence when the mires were wet. Similarly, at Church Moss (Trench J) the largest burning event(s) occurred in the 'pine phase' when the mire was probably quite dry and plenty of fuel was available. It is noticeable that there is little evidence of burning in the preceding damp birch carr phase in Trench J, when the surface of the mire was clearly much wetter. However, the burning events seen in the monolith sequences may only represent a very local record of lightning strikes or spontaneous methane ignition. Multiple stratigraphy cores across the mire would be required to determine whether the whole mire surface or small localised patches were affected by each event.

Extinct species

In addition to the extinct species of moss recorded by Brayshay *et al.* (1995), *Paludella squarrosa*, recorded from sample 211 in Trench E, the assessment phase of this project (Carrott *et al.* 1996) brought to light material of *Helodium blandowii* from sample 511 in Trench J and a possible fragment of *Meesia longiseta.* All became extinct in Britain in the late Holocene; 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 recorded. It is of interest that the remains of *Paludella* are from such early deposits (records from Late Devensian/Early Holocene deposits appear to be confined to Scottish sites, cf. Dickson 1973, fig. 47).

During the present phase of work tentatively identified seeds of *Stellaria crassifolia* were recorded from Trench E at 130 and 138 cm depth. This species is now extinct in Britain; however, it is a plant which grows commonly in Scandinavia, extending as far as the North Cape on the west coast and southwards into Germany (Godwin 1975). In the arctic regions *S. crassifolia* grows in damp grassy habitats frequently close to the seashore. Godwin (1975) cites six lateglacial sites with records for *S. crassifolia* in Britain, many of them in Scotland. The new record from Church Moss, if it is, indeed, this species, is one of the most southerly. Further detailed analyses of macrofossil remains may well extend the lateglacial distribution of the plant further. The evidence strongly suggests that *S. crassifolia* survived until Pollen Zones II or III, suffering extinction during the Early Holocene.

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Figure 1. Church Moss, Davenham: 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 approximate.

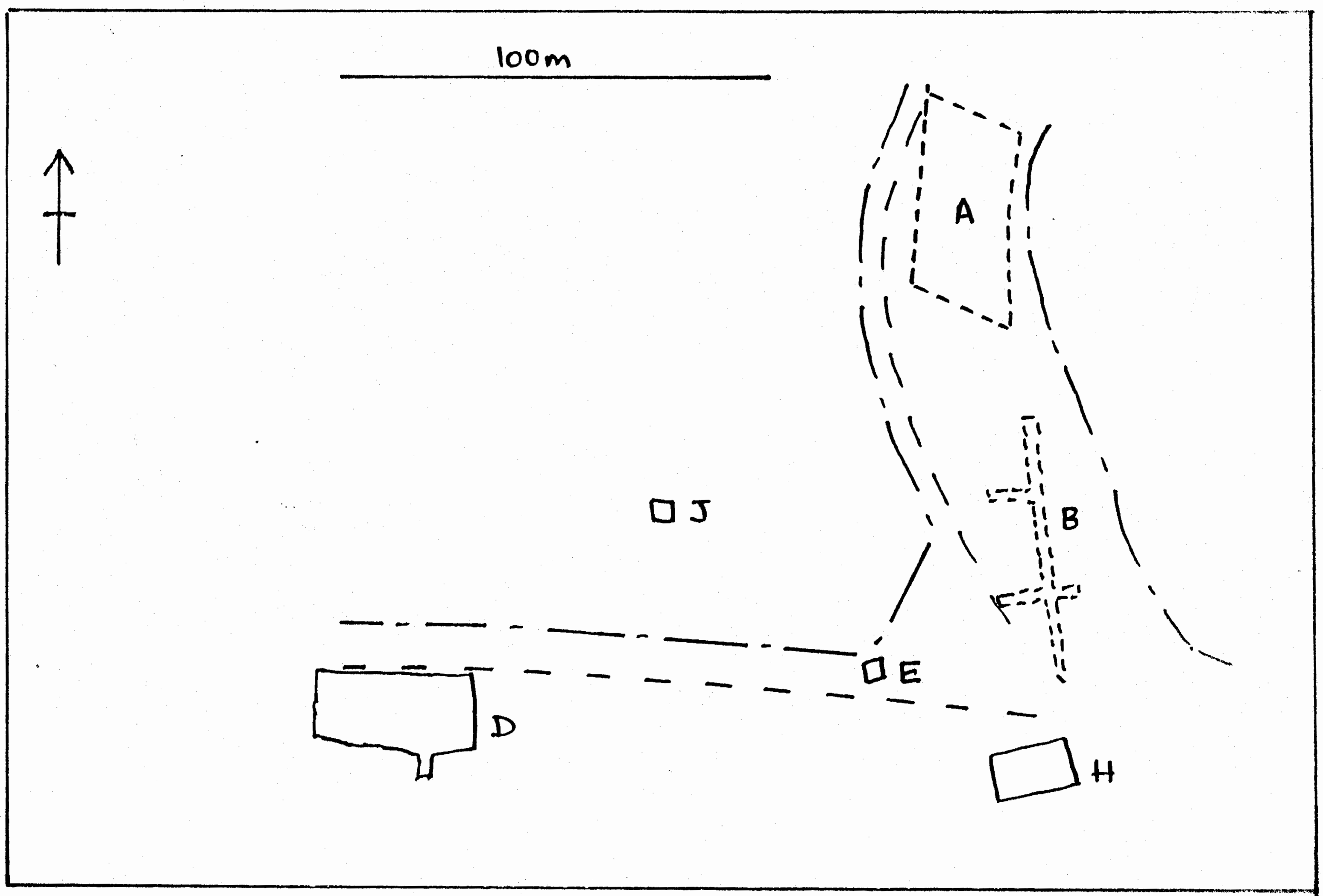

Figure 2. Church Moss, Davenham: Age/depth curve for Trench J constructed from AMS radiocarbon dates (see Table 1). Ages are quoted in conventional radiocarbon BP. Open circles denote dates which clearly do not fit the general trend (see text).

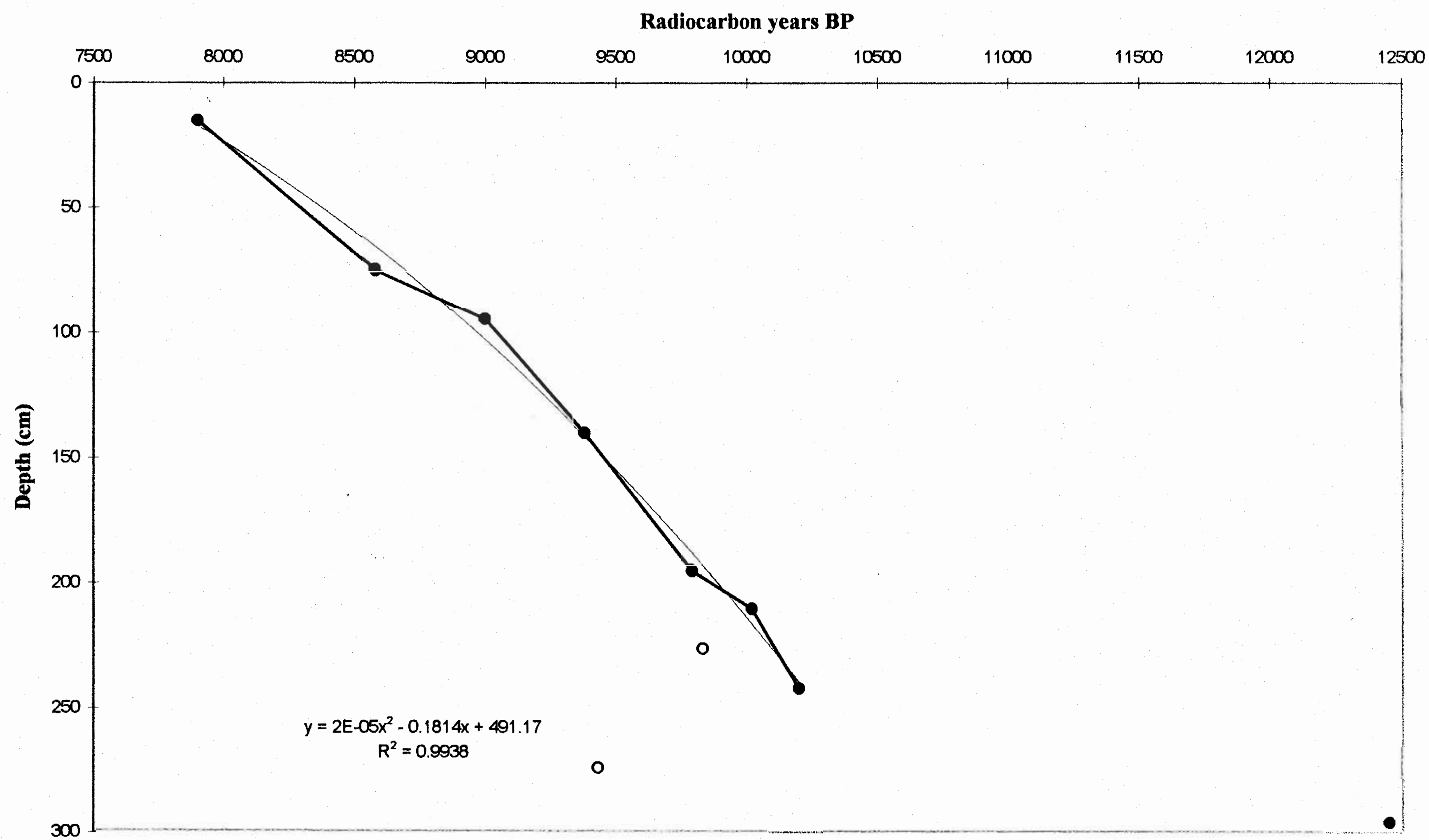

Figure 3. Church Moss, Davenham: percentage pollen diagram for samples from Trench J. Pollen sum is trees+shrubs+herbs. Note that for technical reasons it has not been possible to show 'rare' taxa by means of '+' signs. (For selected graphs containing species appearing at very low frequencies a x5 exaggeration shadow has been applied to the curve. The baselines of all graphs have been presented as dots to enable low frequencies to be distinguished from the baseline).

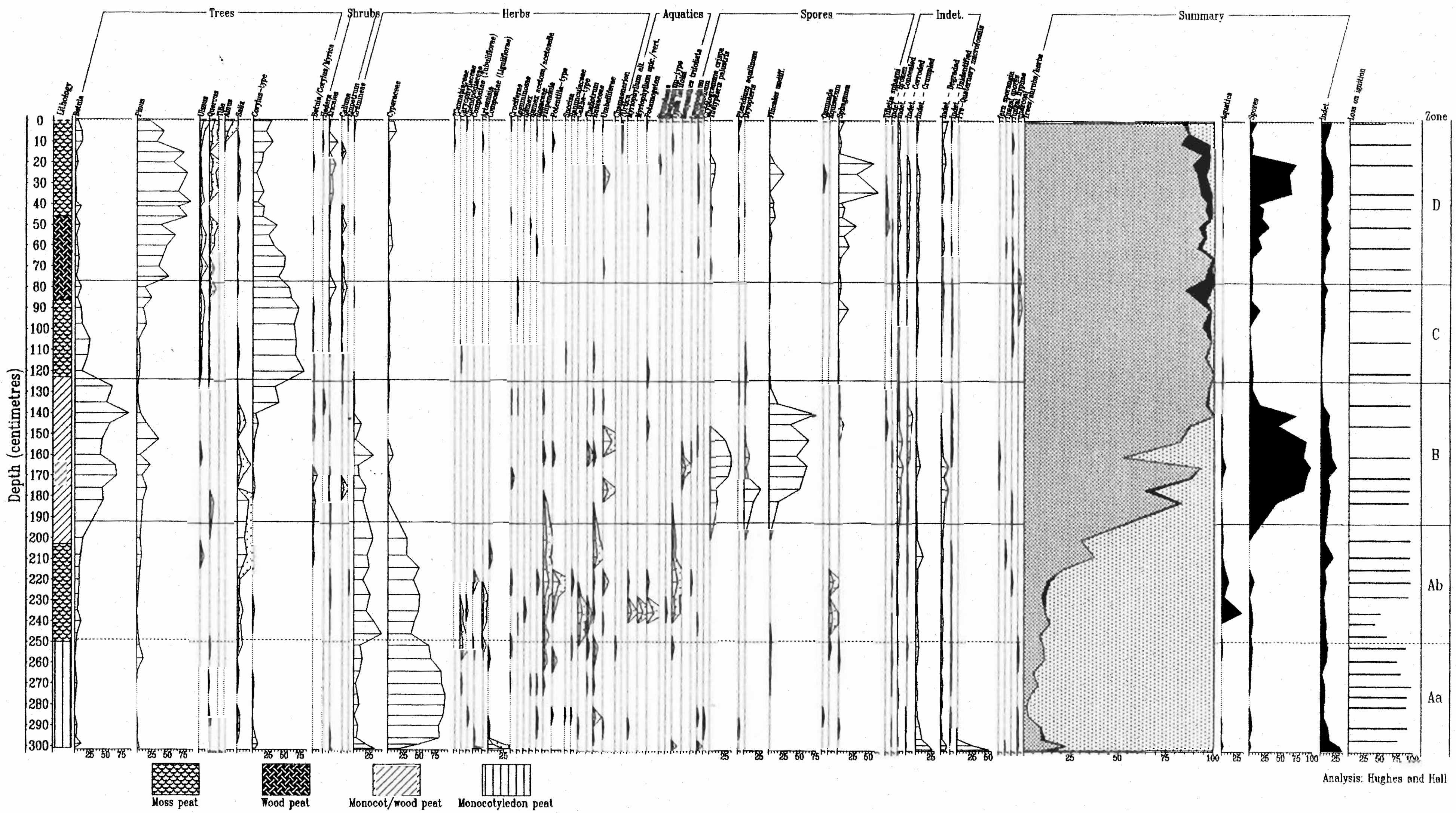

Figure 4. Church Moss, Davenham: percentage pollen diagram for samples from Trench E (pollen sum = 100 trees+shrubs+herbs).

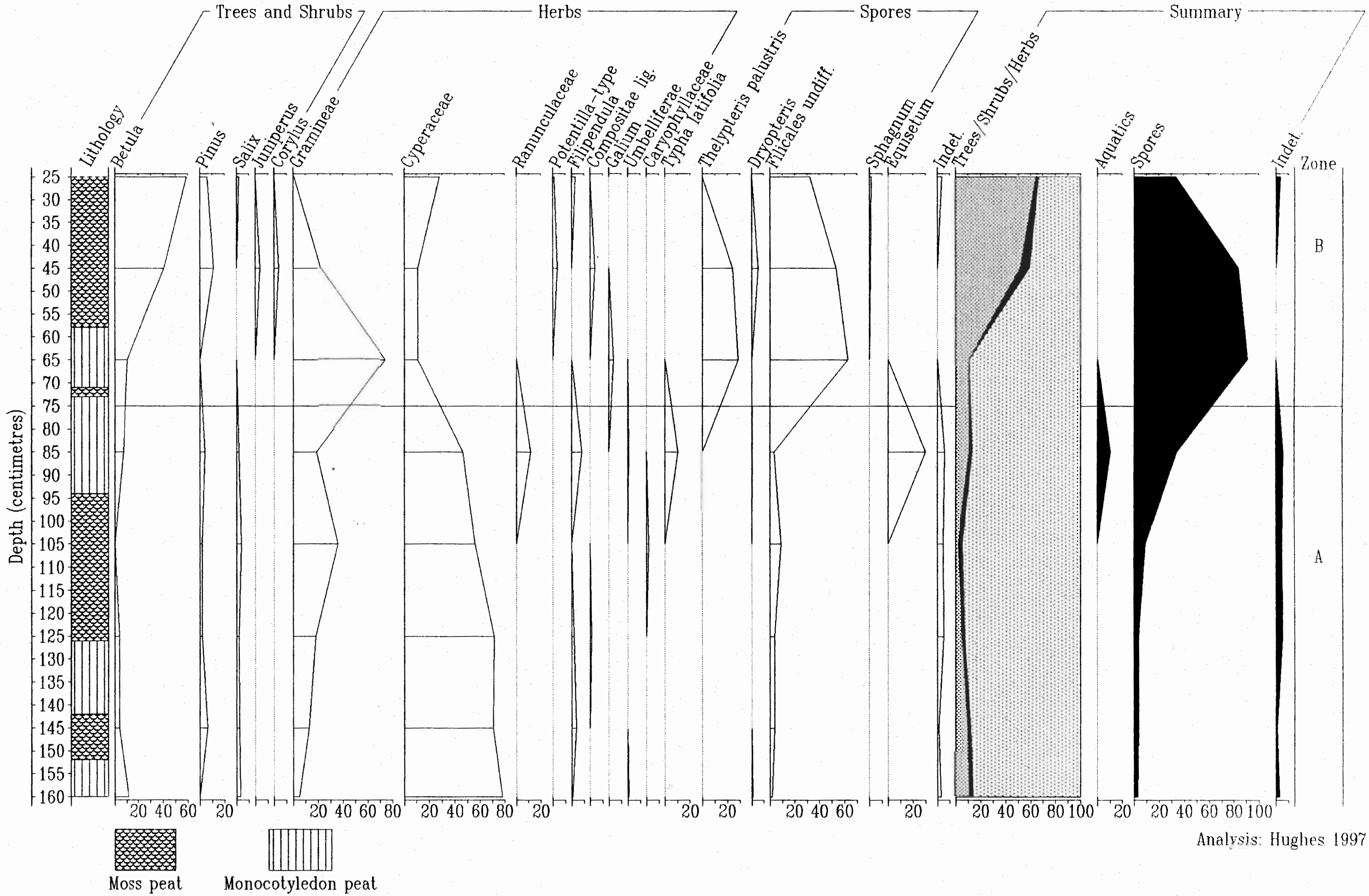

Figure 5.Church Moss, Davenham: plant macrofossil diagram for samples from Trench J (percentage cover and 5-point scale of abundance quantification).

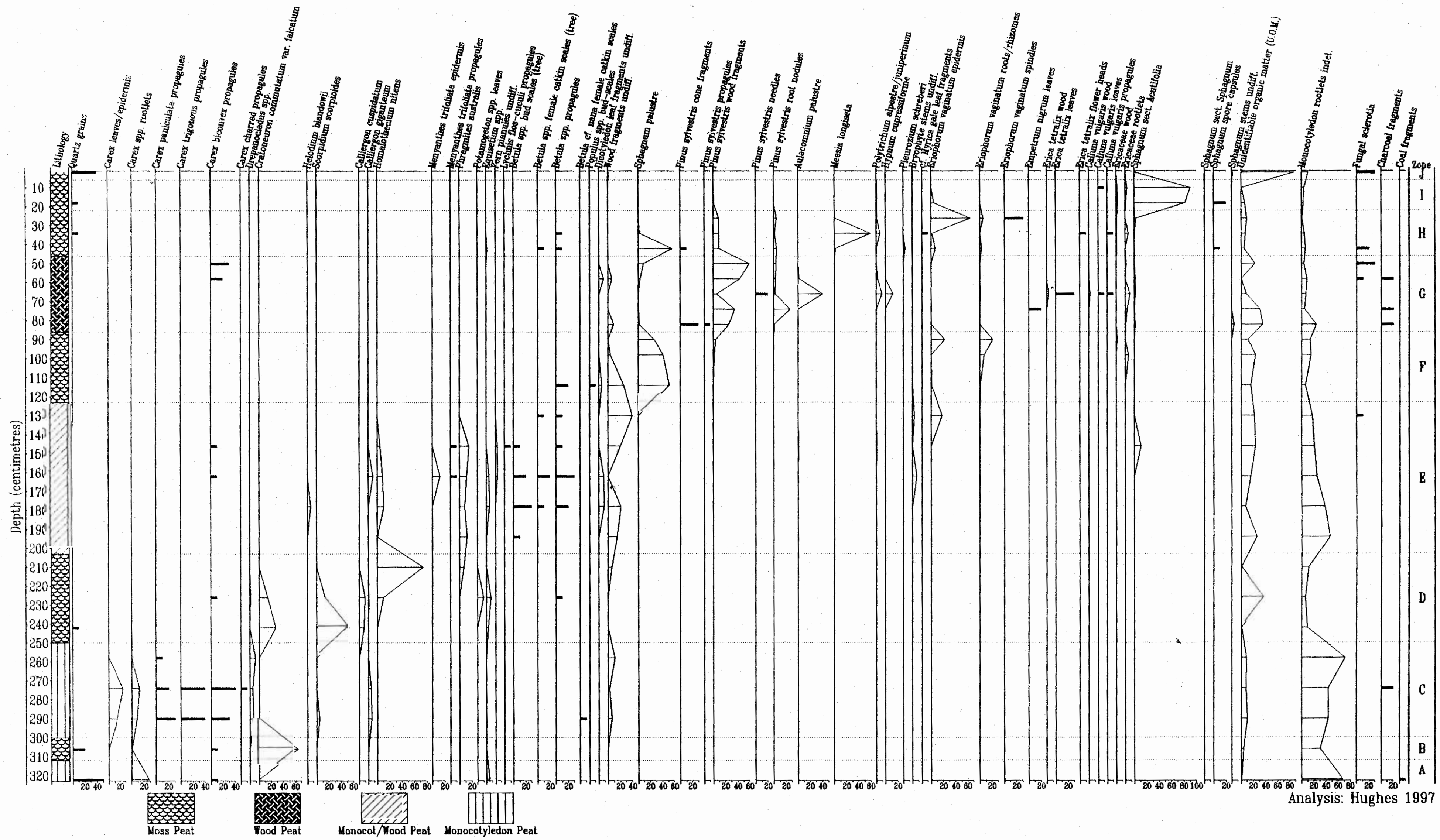

Figure 6. Church Moss, Davenham: plant macrofossil diagram for samples from Trench E (5-point scale of abundance quantification).

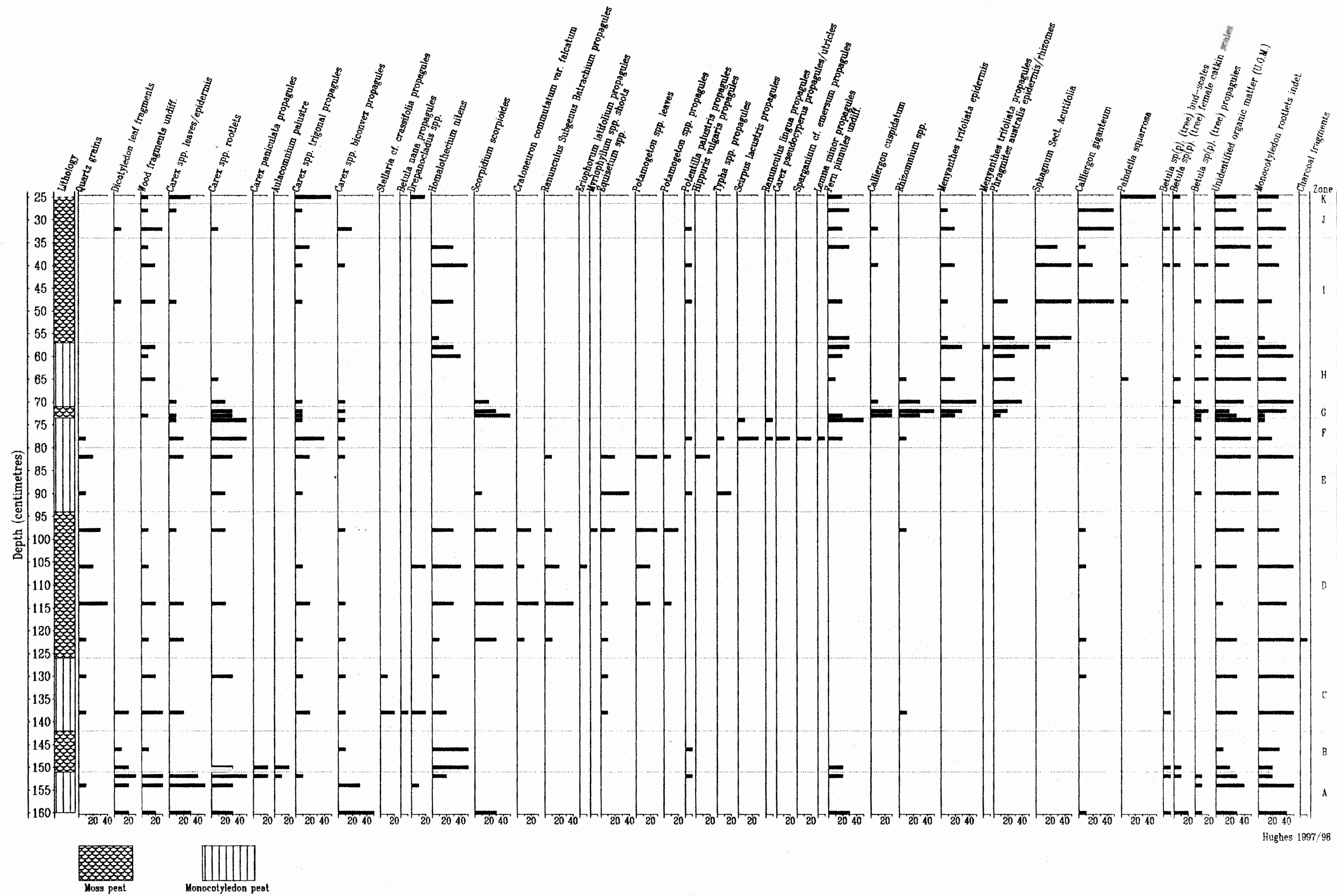

Figure 7. Church Moss, Davenham: plant macrofossil diagram for samples from Trench A (5-point scale of abundance quantification).

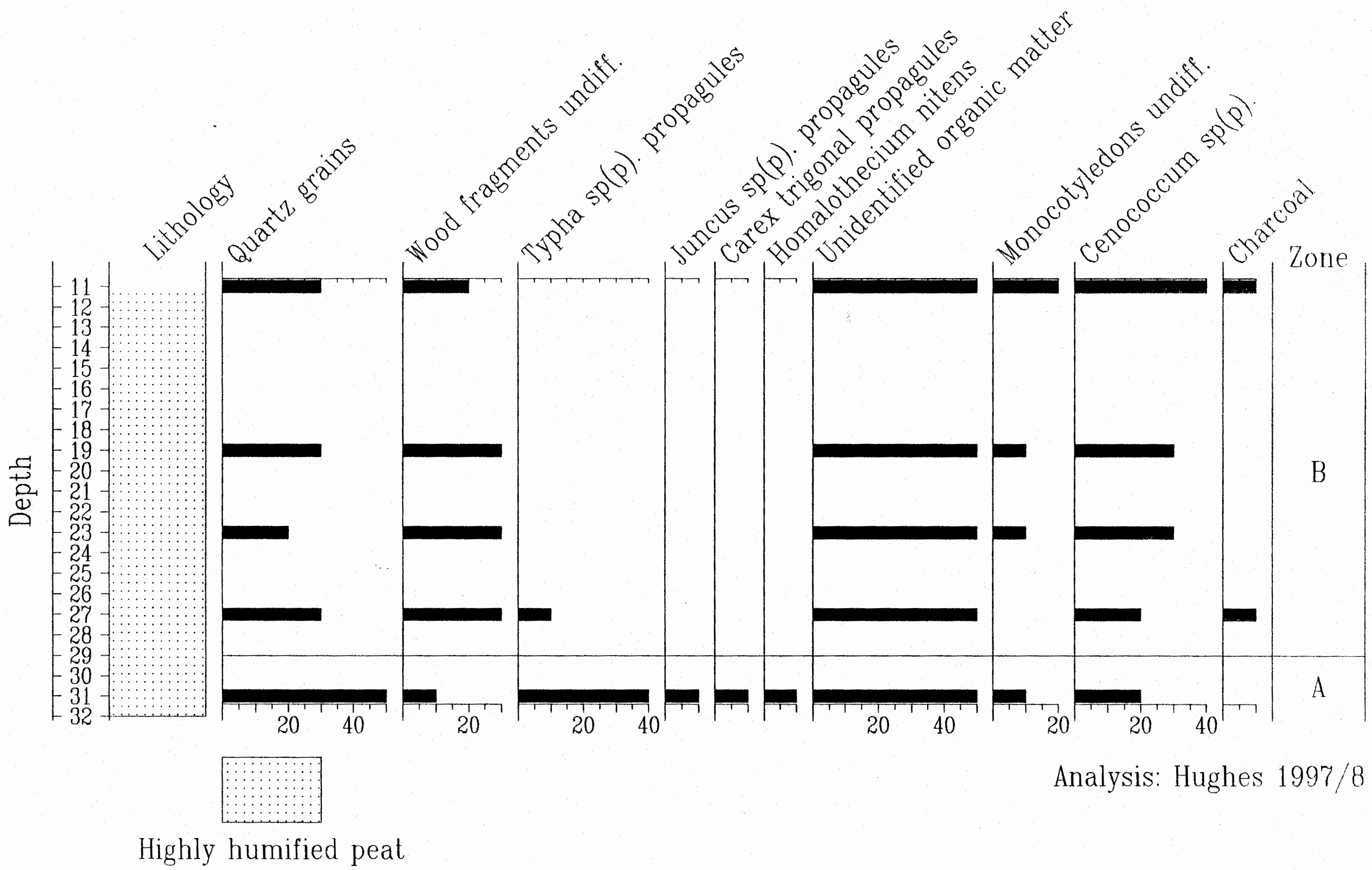

Figure 8. Northerly/Southerly index reconstructed from insect remains for Church Moss, Davenham, Trench J (S or N multiplied by n); S positive, N negative.

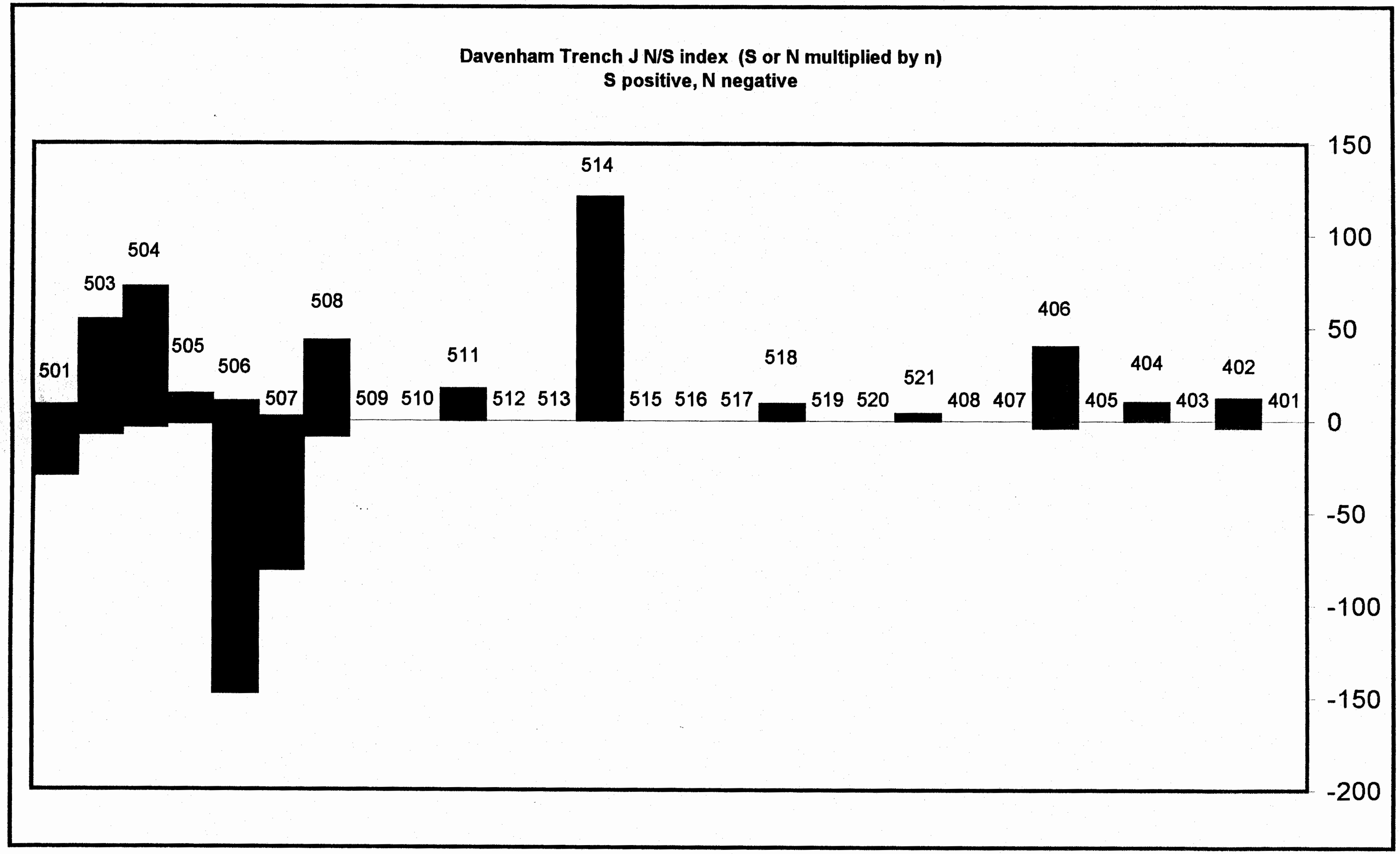

Figure 9. Northerly/Southerly index reconstructed from insect remains for Church Moss, Davenham, Trench E (S or N multiplied by n); S positive, N negative.

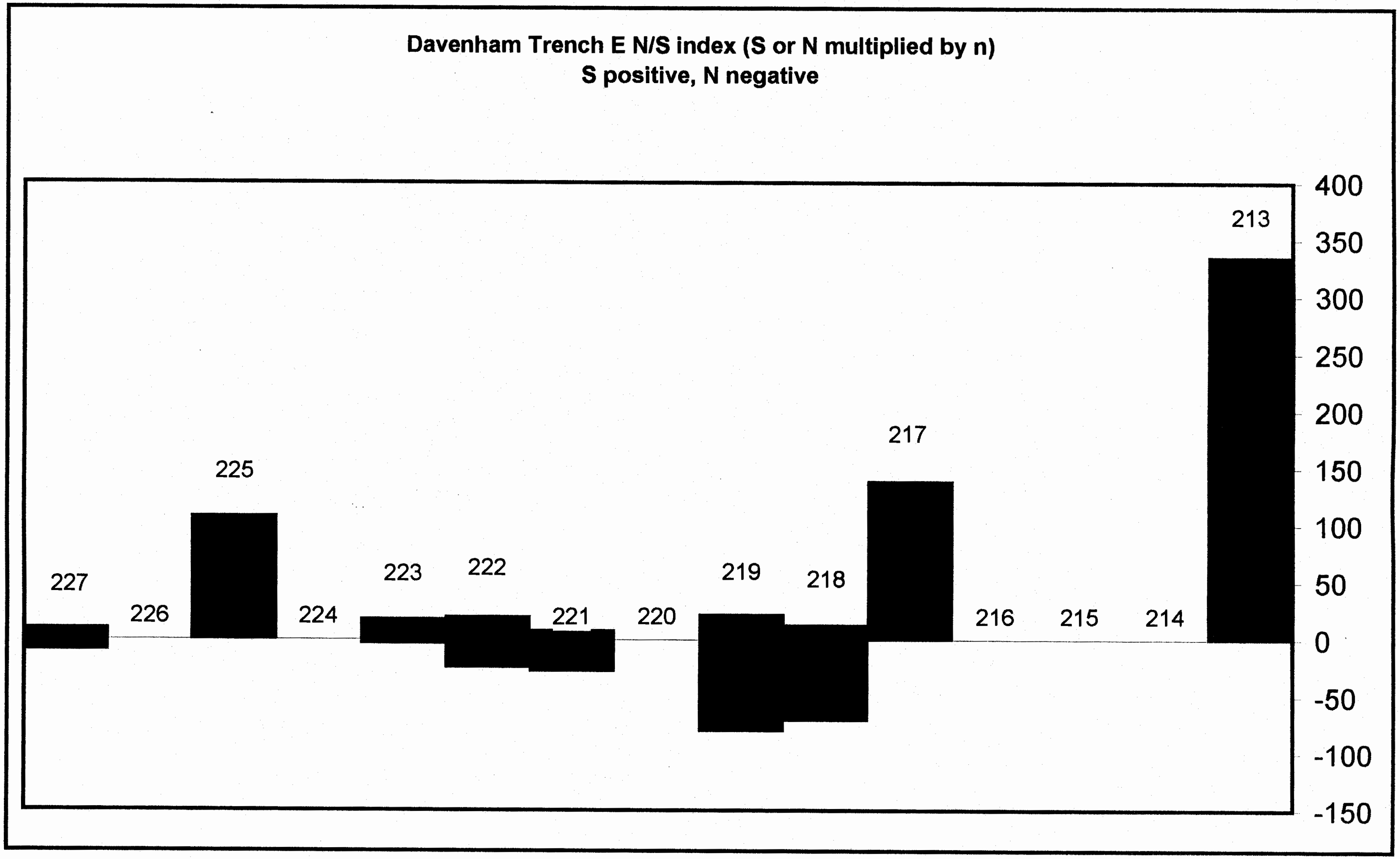

Figure 10. Northerly/Southerly index reconstructed from insect remains for Church Moss, Davenham, Trench J (N/S index sample sums/sample S); S positive, N negative.

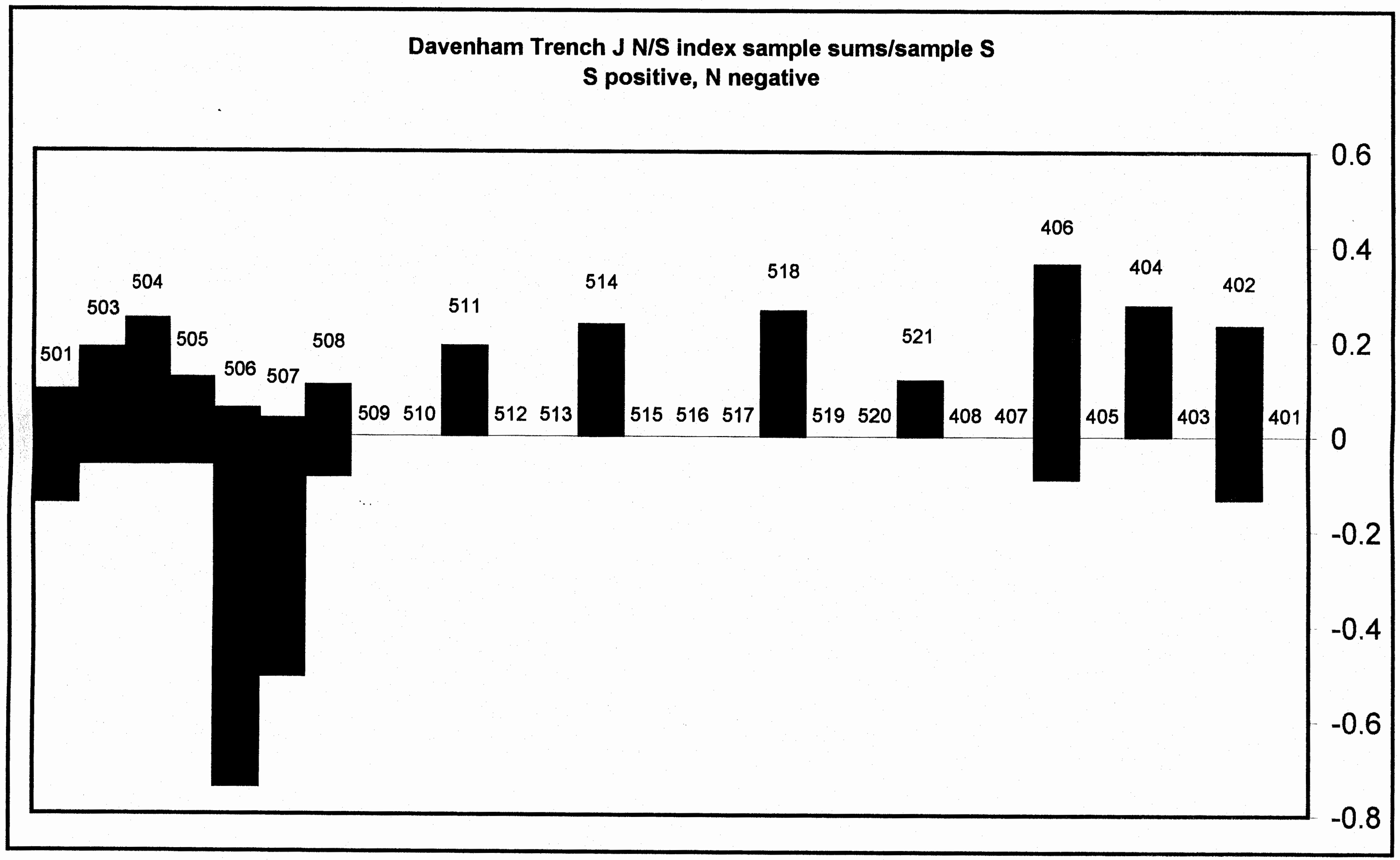

Figure 11. Northerly/Southerly index reconstructed from insect remains for Church Moss, Davenham, Trench E (N/S index sample sums/sample S); S positive, N negative.

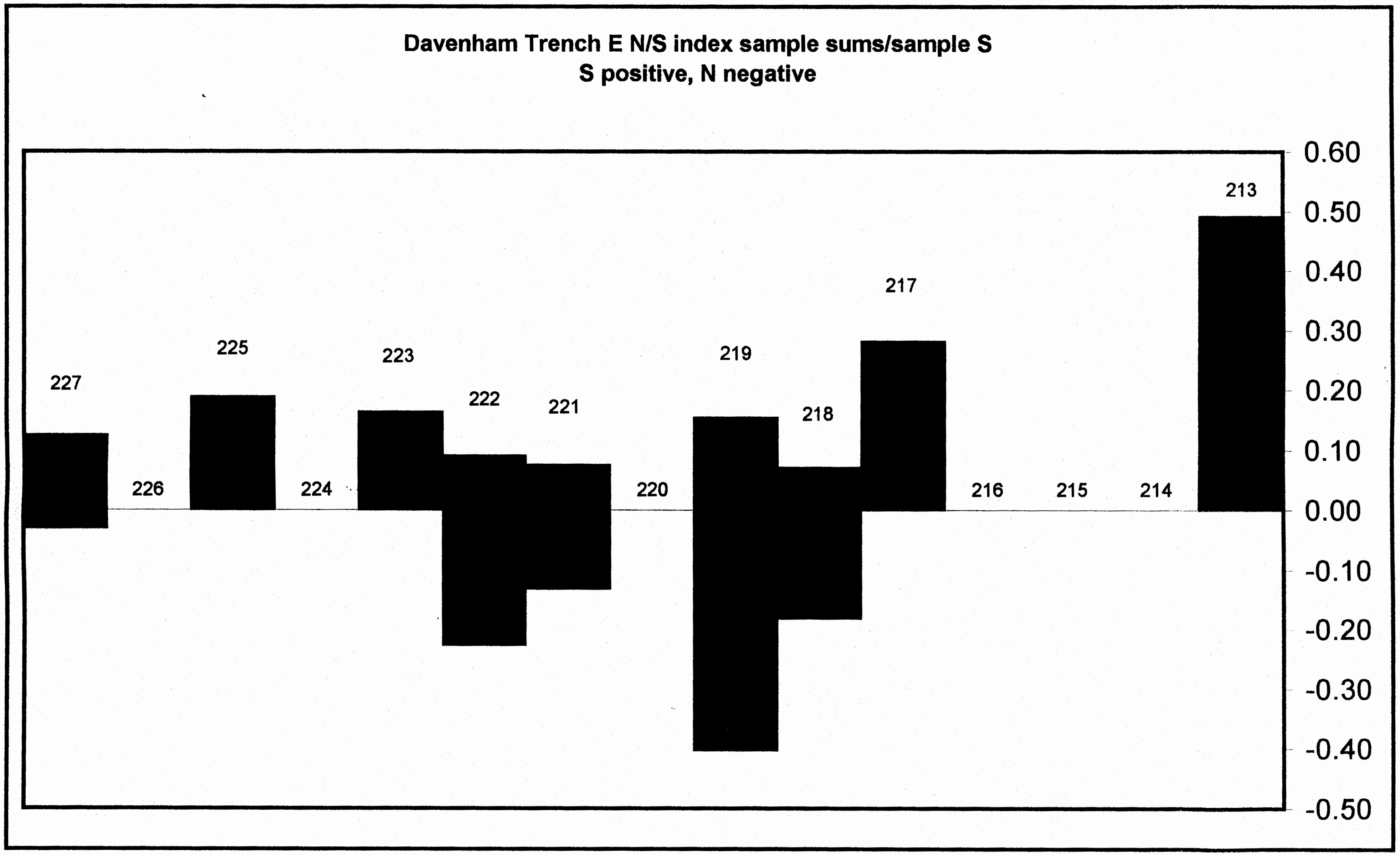

Figure 12. Values of the percentage of aquatic individuals (PNW) for the assemblages of adult beetles and bugs from Trench J, Church Moss, Davenham. For each pair: first bar—PNW; second bar—PNW recalculated after subtraction of Cyphon *spp.*

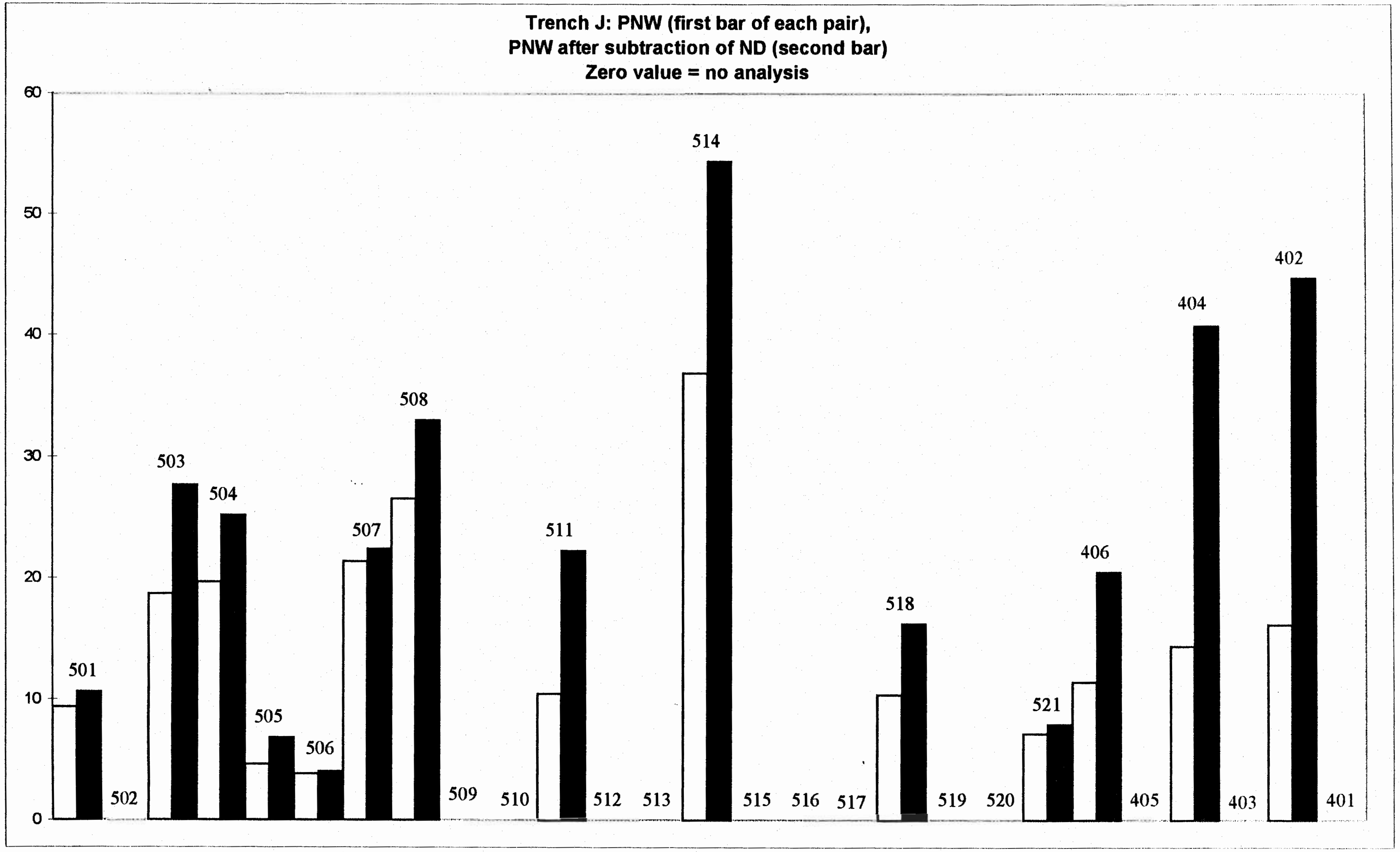

Figure 13. Values of the percentage of aquatic individuals (PNW) for the assemblages of adult beetles and bugs from Trench E, Church Moss, Davenham. For each pair: first bar—PNW; second bar—PNW recalculated after subtraction of Cyphon *spp.*

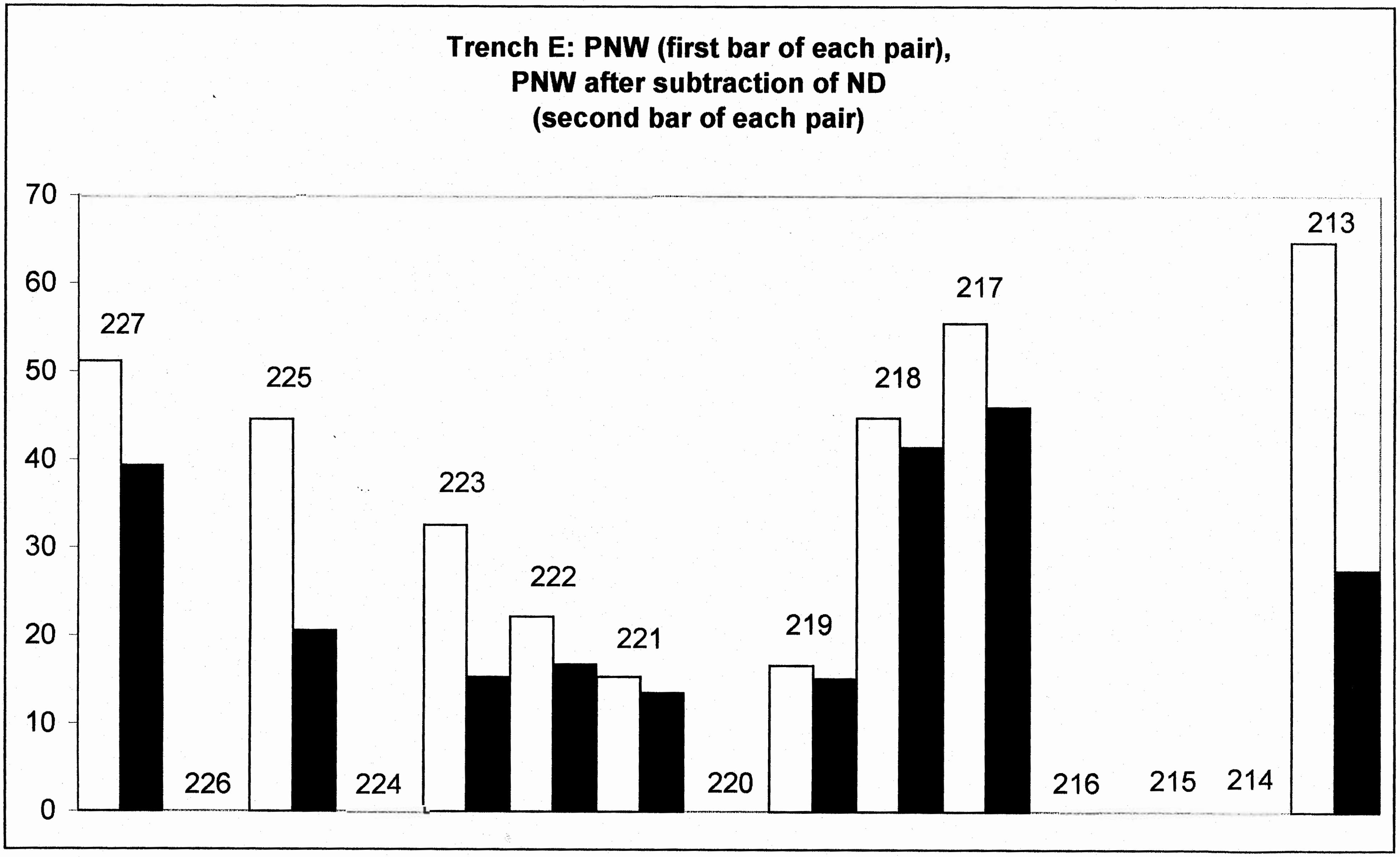

Figure 14. Values of the index of diversity (alpha of Fisher et al. *1943) for the assemblages of adult beetles and bugs from Trench J, Church Moss, Davenham. For each pair: first bar—alpha; second bar—alpha recalculated after subtraction of* Cyphon *spp.*

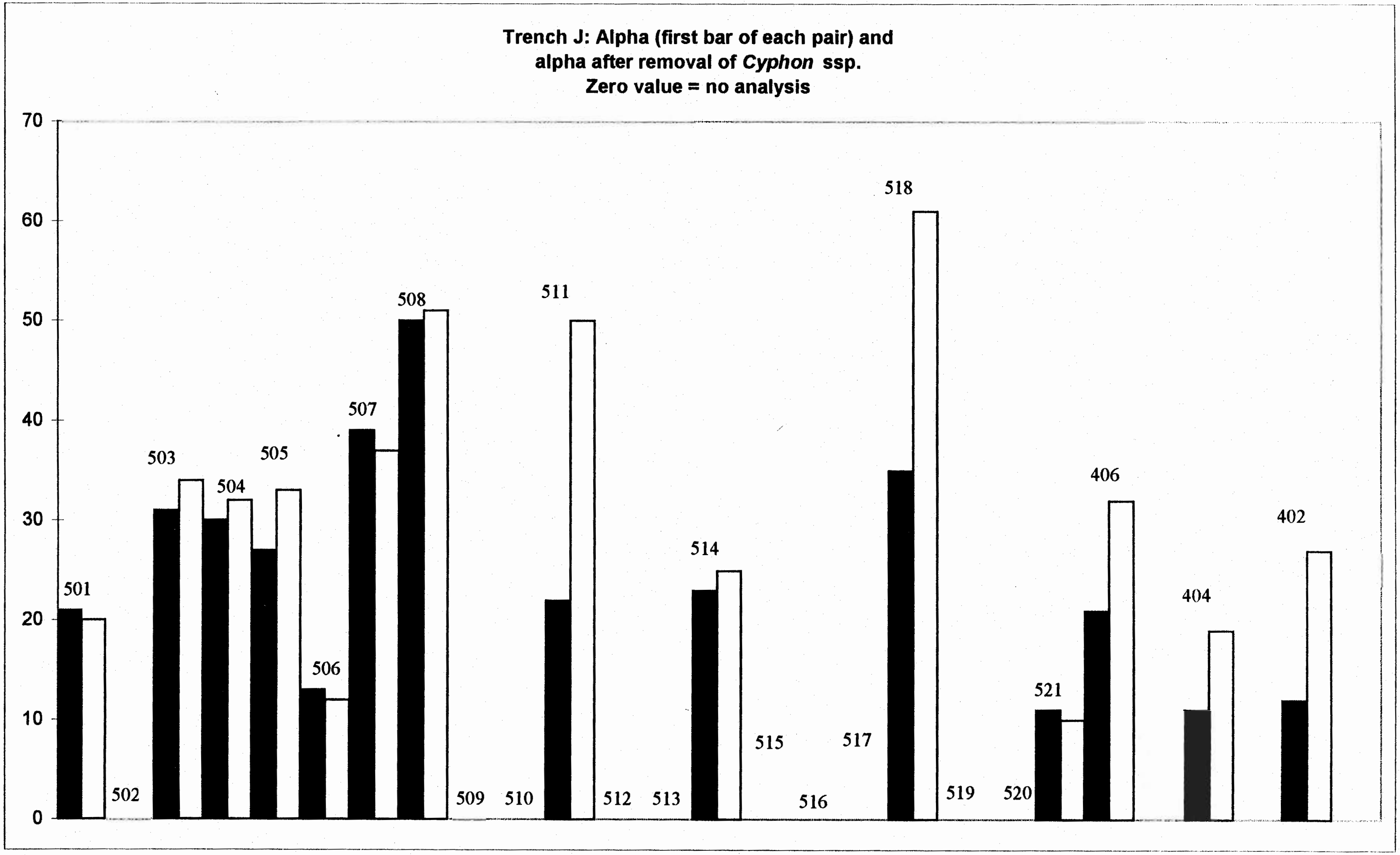

Figure 15. Values of the index of diversity (alpha of Fisher et al. *1943) for the assemblages of adult beetles and bugs from Trench E, Church Moss, Davenham. For each pair: first bar—alpha; second bar—alpha recalculated after subtraction of* Cyphon spp.

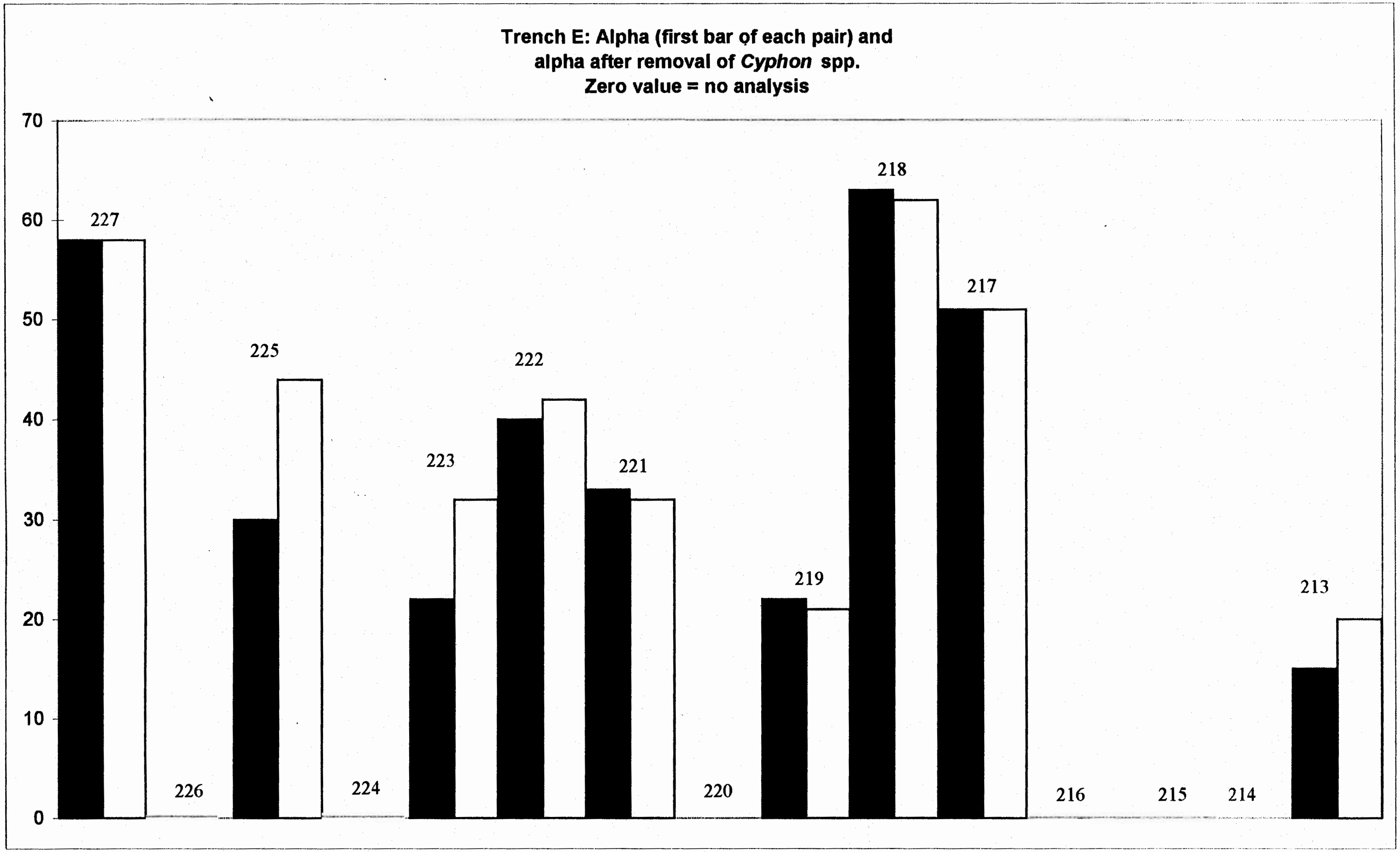

Figure 16. Detrended correspondence analysis (DCA) of macrofossil data from Trench J, Church Moss, Davenham: Axis 1 vs Axis 2 (with down-weighting of rare species). Solid circles represent DCA scores for species, grey squares represent DCA scores for samples.

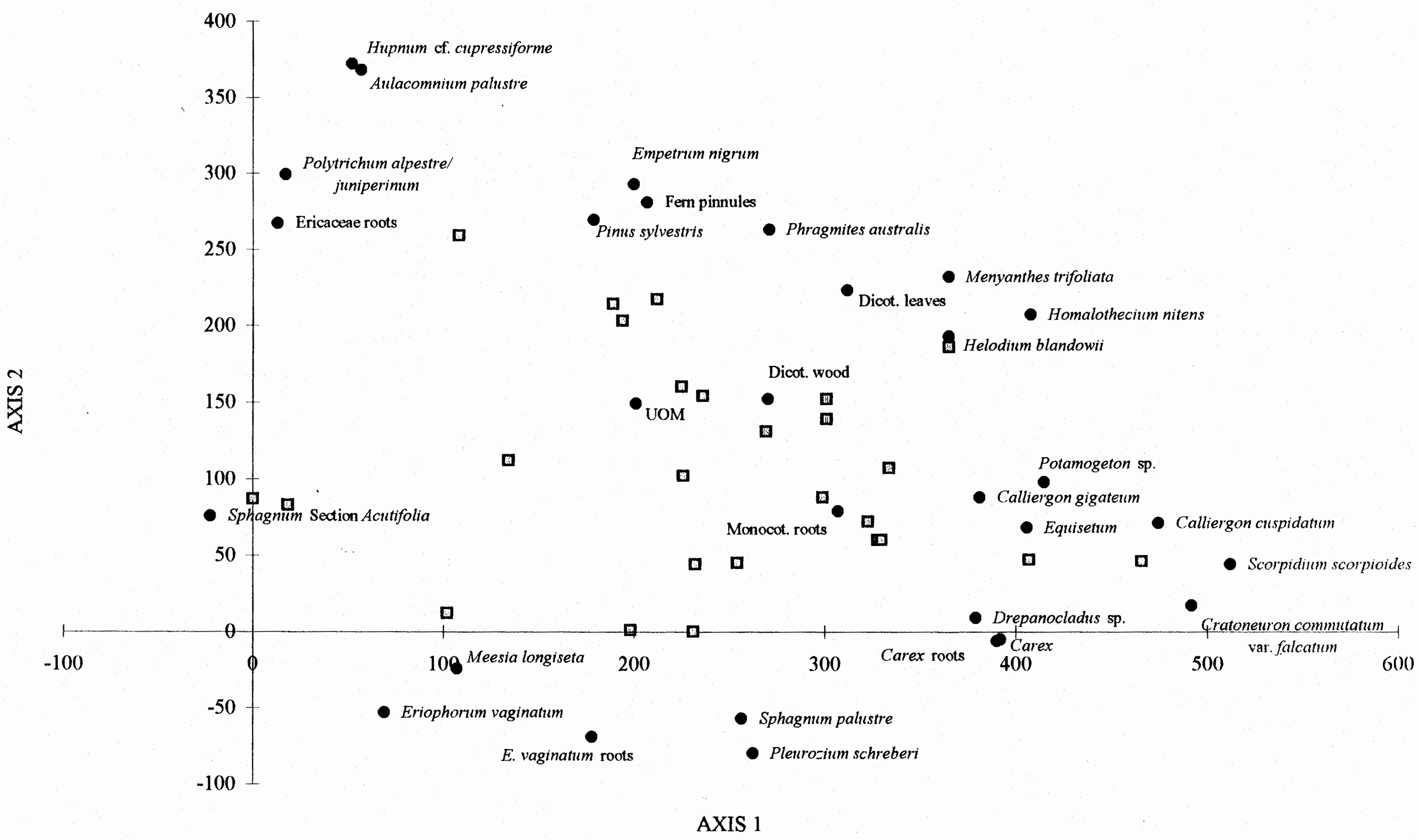

Figure 17. Detrended correspondence analysis (DCA) of macrofossil data from Trench J, Church Moss, Davenham: Axis 1 vs depth (with down-weighting of rare species).

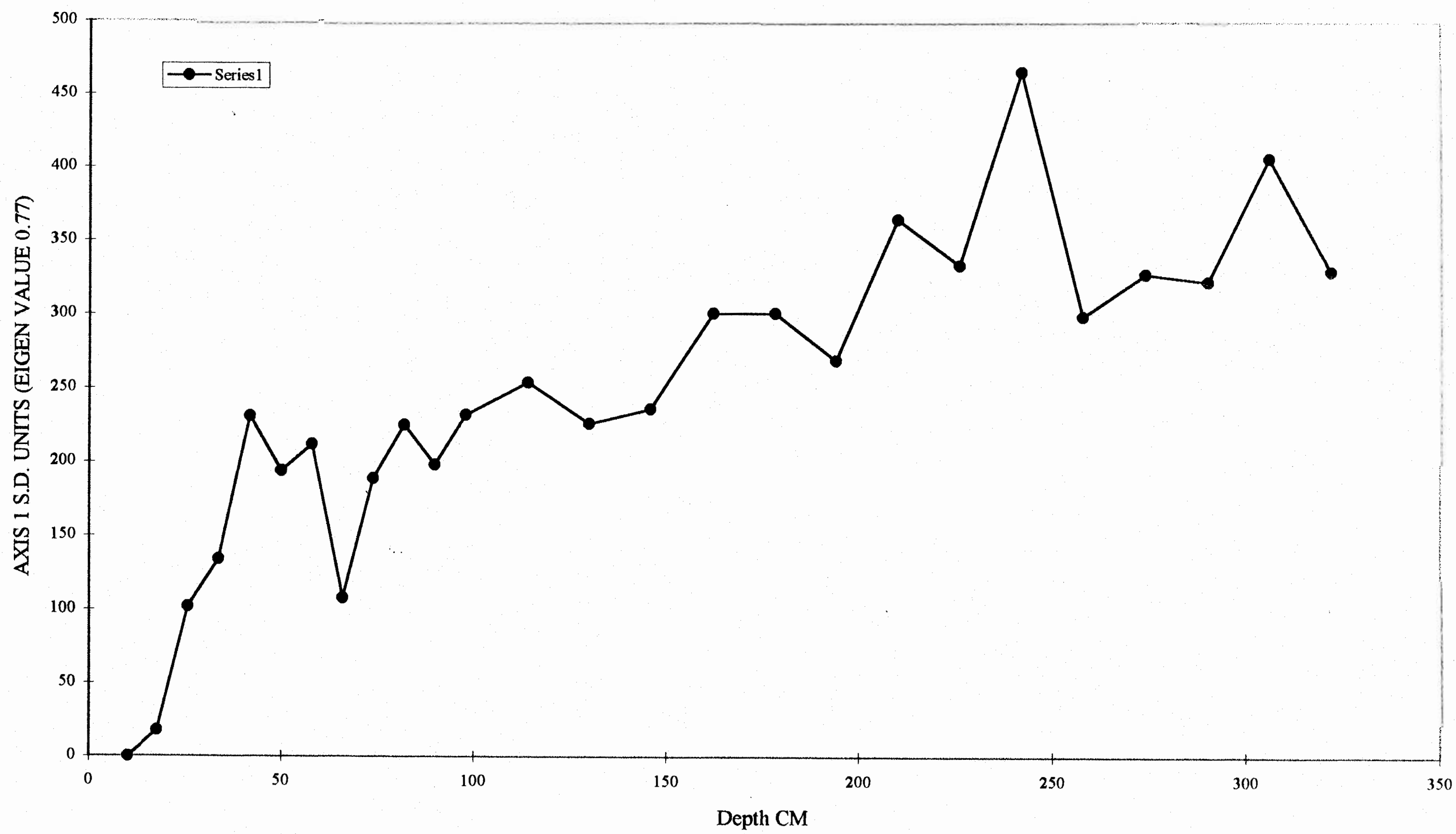

Figure 18. Detrended correspondence analysis (DCA) of macrofossil data from Core BFML, Bolton Fell Moss, Cumbria: Axis 1 vs depth (with down-weighting of rare species).

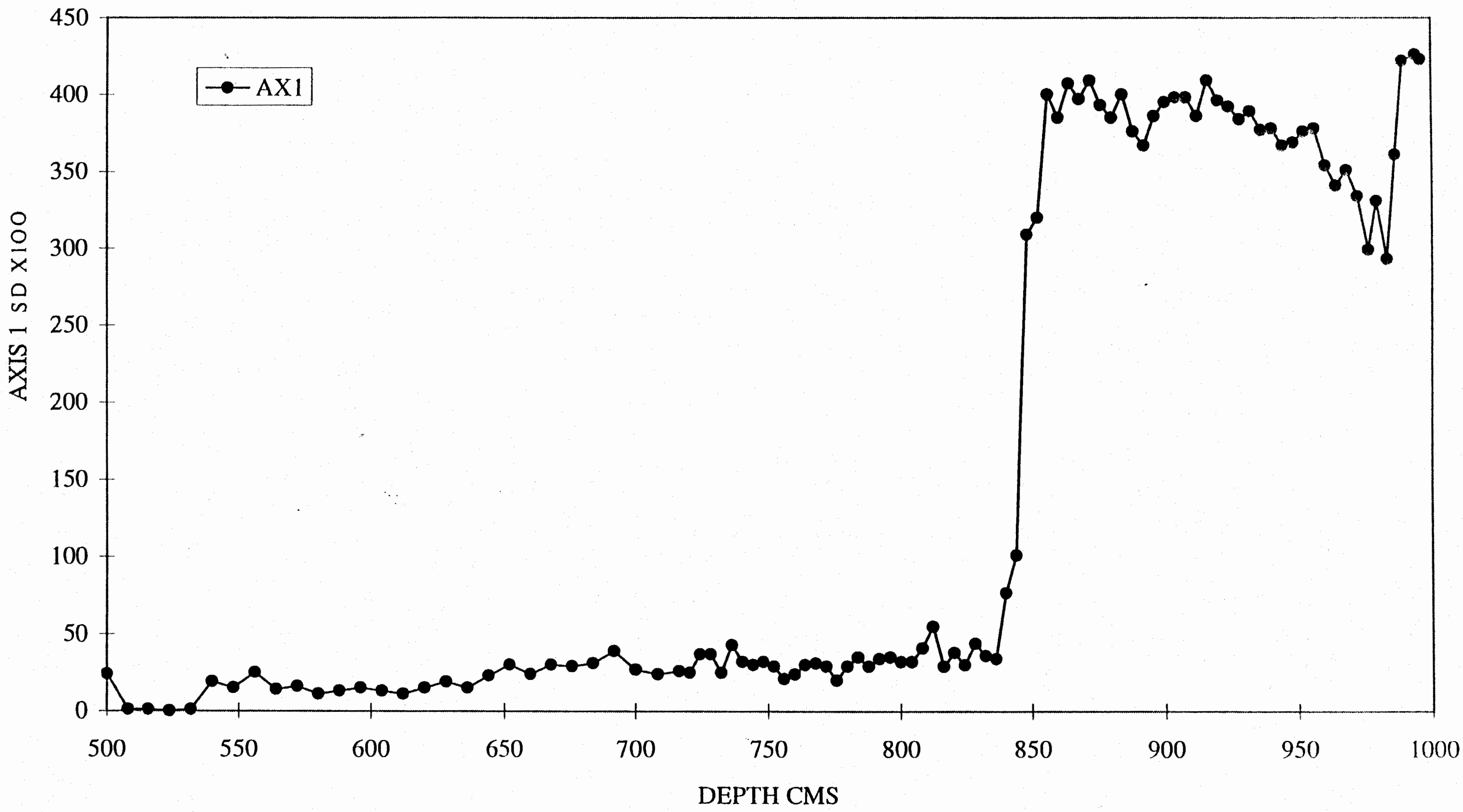

Table 1. Radiocarbon dates from Trench J, Church Moss, Davenham.

Laboratory code	**Depth below trench datum (cm)**	**Depth below pollen datum (cm)**	**Date (material analysed)**	**Calibrated date 2 sigma, 95% probability**
Beta-93895	approx. 258 to 260.5	approx. 296 to 297.5	12450±60 BP (whole peat)	uncalibrated; too early for calibration
Beta-115982	237	274	9430±60 BP (whole fen peat and *Carex* nutlets)	BC 8610-8365
Beta-115981	205	242	10200±70 BP (whole fen peat)	uncalibrated; too early for calibration
Beta-115980	189	226	9830±60 BP (*Scorpidium scorpioides*, *Calliergon giganteum* and peat matrix	BC 9120-9010
Beta-115979	173	210	10020± BP (*Homalothecium nitens* shoots)	uncalibrated; too early for calibration
Beta-93894	153 to 163	190 to 200	9790±60 BP (*Homalothecium nitens* and *Helodium blandowii* shoots)	cal BC 9045-8895 and cal BC 8795-8655 (more probably the former)
Beta-115978	103	140	9380±60 BP (whole fen peat)	BC 8555-8250
Beta-93893	53 to 63	90 to 100	9000±50 BP *(Hylocomium splendensl Hypnum* shoots)	cal BC 8080-7970
Beta-115977	38	75	8580±70 BP (whole fen peat)	BC 7700-7490
Beta-93892	+17 to +27	10 to 20	7900±50 BP (*Sphagnum* peat)	cal BC 6995-6580

Table 1a. Radiocarbon date from Trench B, (frost crack sample).

Laboratory code	**Depth below trench datum (cm)**	**Depth below pollen datum (cm)**	**Date (material analysed)**	**Calibrated date 2 sigma, 95% probability**
Beta-115983	N/A	N/A	10400±70 BP (whole peat)	uncalibrated; too early for calibration

Table 2. Detailed lithological descriptions of sequences from Trench J at Church Moss, Davenham, sampled by the authors. Codified lithological descriptions after Troels-Smith (1955) are give in square brackets. Depths (in centimetres) relate to individual datum levels for each sequence. 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/Dh2Dl1, locally Ld1Dg/Dh1Dl2], twigs to 10 mm max. diameter
-78 to -64	±fibrous (with moss stems), sometimes woody detritus [Ld2Dg/Dh2 to Ld1Dg/Dh2Dl1]
-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/Dh3Dl1 to Dh/Dh1Dl3] becoming very fibrous between +2 and +5 [Dh/Dg2Dl2 or Th2Dl2] and lacking wood component between +5 and +10 [Dg/Dh4]; often ±fibrous and sometimes slightly woody between +10 and +31 [Dg/Dh4Dl+]; 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+]

Table 3. Detailed lithological descriptions of sequences from Trench H at Church Moss, Davenham, sampled by the authors.

-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

Table 4. Detailed lithological descriptions of sequences from Trench E at Church Moss, Davenham, sampled by the authors. Depths are equivalent to those shown on the macrofossil and pollen diagrams for Trench E and represent depth from the surface of the peat section.

-25 to -57	soft mid brown, oxidising dark brown, moderately humified moss peat, with occasional wood fragments, sedge rootlets and fern fragments [Tb3-Sh1-Th+ -Tl+]; sharp transition to
-57 to -71	soft mid brown detritus reed peat containing wood fragments, fern fragments and occasional moss remains [Tb+-Sh+Dh2-Th+-Tl+]; gradational transition to
-71 to -74	soft mid brown slightly humified moss peat with some sedge rootlets [Tb3-Th1-Tl+]; sharp transition to
-74 to- 94	granular mid to dark brown highly humified detritus peat containing abundant sedge rootlets and fern fragments and variable amounts of sand and silt [Tb1-Dh2-Th1-As/Ag+-Ga+]
-94 to -126	Sandy moderate to well humified moss peat, mid brown oxidising black upon exposure to air and containing occasional sedge rootlets and wood fragments [Tb3-Dh+-Th+-As/Ag+-Ga1]
-126 to -142	Soft granular well humified dark drown detritus peat containing frequent wood fragments and occasional sand grains [Tb+-Dh3-Th+-Tl1-As/Ag+-Ga++]
-142 to -151	soft mid to dark brown well humified moss peat containing occasional herbaceous rootlets and rare wood fragments [Tb3-Dh1-Th+]
-151 to -160	well-humified dark brown to black detritus peat containing frequent wood fragments and abundant monocotyledon rootlets and rare sand grains [Tb+-Dh2-Th1-Tl1-Ga+]
-160 to -162	mid greyish-brown humic sandy clay silt with a few rootlets [Sh+As/Ag4Ga+ Th+]

Table 5. Detailed lithological descriptions of sequences from Trench A at Church Moss, Davenham, sampled by the authors. Depths are equivalent to those shown on the macrofossil diagram for Trench A and represent depth from the surface of the peat section.

-0 to -32	dark brown/black, humic peat, slightly sandy silt with occasional (modern) rootlets [Sh4-As/Ag+-3Ga+], slightly laminated in lowermost 3 cm of the unit
-32 to -34	mid greyish-brown humic sandy clay silt with a few rootlets [Sh+As/Ag4Ga+ Th+]

Table 6. 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*
212	*87*	*93*
216	*86*	*93*
508	*86*	*92*
223	*86*	*94*
230	*73*	*41*
507	*78*	*52*
237	*74*	*59*
506	*67*	*38*
244	*71*	*47*
250	*79*	*72*
505	*78*	*92*
255	*79*	*80*
260	*81*	*86*
265	*82*	*90*
504	*84*	*95*
503	*83*	*89*
501	*82*	*76*

Table 7. Complete list of plants identified from macrofossil remains from Church Moss, Davenham. Order and nomenclature follow Smith (1978) for mosses and Tutin et al. *(1964-90) for vascular plants.*

Mosses (all leaf/leaves and/or shoot fragment(s) unless otherwise indicated)
Sphagnum sp(p). (capsule(s))
Sphagnum palustre L.
Polytrichum juniperinum/alpestre
Aulacomnium palustre (Hedw.) Schwaegr.
Meesia longiseta Hedw.
Helodium blandowii (Web. & Mohr) Warnst.
Cratoneuron commutatum var. *falcatum* (Brid.) Monk.
Drepanocladus sp(p).
Scorpidium scorpioides (Hedw.) Limpr.
Calliergon giganteum (Schimp.) Kindb.
C. cuspidatum (Hedw.) Kindb.
Homalothecium nitens (Hedw.) Robins.
Hypnum cupressiforme Hedw.
Pleurozium schreberi (Brid.) Mitt.

Pteridophytes		
Equisetum sp(p).	horsetail	root(s), stem epidermis fragment(s)
Filicales	fern	pinnule fragment(s)
Pinus sylvestris L.	Scots pine	female cone fragment(s), leaf/leaves, root nodule(s), seed(s), wood fragment(s)
Flowering plants		
Populus sp(p).	poplar/aspen	bud(s) and/or bud-scale(s)
Myrica gale L.	bog myrtle/sweet gale	leaf fragment(s)
Betula sp(p).	birch	bud(s) and/or bud-scale(s), female catkin scale(s), fruit(s)
B. nana L.	dwarf birch	female catkin scale(s), fruit(s)
Corylus avellana L.	hazel	nut(s) and/or nutshell fragment(s)
Stellaria cf. *crassifolia* Ehrh.	[stitchwort]	seed(s)
Lychnis flos-cuculi L.	ragged robin	seed(s)
Ranunculus lingua L.	greater spearwort	achene(s)
R. Subgenus *Batrachium*	water crowfoots	achene(s)
Potentilla palustris (L.) Scop.	marsh cinquefoil	achene(s)

Myriophyllum sp(p).	water-milfoils	leaf fragment(s)
Hippuris vulgaris L.	mare's-tail	seed(s)
Ericaceae	heather family	root and/or twig fragment(s), root/rootlet fragment(s)
Erica tetralix L.	cross-leaved heath	flower(s), leaf/leaves, twig fragment(s)
Calluna vulgaris (L.) Hull	heather, ling	flower(s), leaf/leaves, root and/or twig fragment(s), seed(s)
Empetrum nigrum L.	crowberry	leaf/leaves
Menyanthes trifoliata L.	bogbean	seed(s), stem epidermis fragment(s)
Potamogeton sp(p).	pondweeds	leaf fragment(s), pyrene(s)
Juncus sp(p).	rushes	seed(s)
Phragmites australis (Cav.) Trin. ex Steudel	common reed	leaf and/or stem epidermis fragment(s), rhizome fragment(s)
Lemna minor L.	common duckweed	seed(s)
Sparganium cf. *emersum* Rehmann	?unbranched bur-reed	fruit(s)
Typha sp(p).	reedmace	seed(s)
Scirpus lacustris L.	bulrush	nutlet(s)
Eriophorum latifolium Hoppe	broad-leaved cotton-grass	nutlet(s)
E. vaginatum L.	cotton-grass	rhizome and/or stem epidermis fragment(s), rhizome fragment(s), sclerenchyma spindles (from leaf sheaths)
Carex sp(p).	sedges	charred nutlet(s), leaf epidermis fragment(s), nutlet(s), root/rootlet fragment(s)
Carex paniculata L.	greater tussock-sedge	nutlet(s)
C. pseudocyperus L.	cyperus sedge	nutlet(s)

*Table 8. Complete list of invertebrate taxa recorded in samples from Church Moss, Davenham. Conventions: 'sp(?).' indicates 'probable additional taxon'; 'sp(?). indet.' indicates 'may be (or includes) previously listed taxon or taxa'. Order and nomenclature for Insecta follow Kloet and Hincks (1964-77). The ecological codes and 'northerly' (N) and 'southerly' (S) values ascribed to species are appended. *—taxa not used in the calculation of main statistics.*

ANNELIDA	
*Oligochaeta sp. (egg capsule)	u
OSTRACODA	
*Ostracoda sp.	u
CLADOCERA	
**Daphnia* sp. (ephippium)	oa-w
*Cladocera sp. (ephippium)	oa
*Cladocera sp. (ephippium)	oa-w
INSECTA	
HEMPTERA	
Elasmostethus interstinctus (Linnaeus)	oa-p
Picromerus bidens (Linnaeus)	oa-p; S0
Rhacognathus punctatus (Linnaeus)	oa-p-m; S0
Zicrona caerulea (Linnaeus)	oa-p
*Pentatomidae sp. (nymph)	oa-p
Chilacis typhae (Perris)	oa-p-d; S3
Pachybrachius fracticollis (Schilling)	oa-p; S3
Trapezonotus ?desertus Seidenstucker	oa; S0
Stignocoris pedestris (Fallen)	oa
?Stignocoris sp.	oa
Drymus brunneus (Sahlberg)	oa-p
Drymus sp.	oa-p
Lamproplax picea (Flor)	oa-?; S3
Scolopostethus sp.	oa-p
Lygaeidae sp.	oa-p
Cymus ?melanocephalus Fieber	oa-p; S2
Cymus ?glandicolor Hahn	oa-p; S2
Cymus sp. indet.	oa-p
Cimicidae sp.	oa-p
Cyrtorhinus caricis (Fallen)	oa-p; S0
Capsus ?ater (Linnaeus)	oa-p
Miridae sp.	oa-p
Salda morio Zetterstedt	oa-d; N3
Saldula saltatoria v. *marginella*	oa-d
Saldula sp. indet.	oa-d
Chartoscirta cincta (Herrich-Schaeffer)	oa-w
Chartoscirta sp. indet.	oa-w
Saldidae sp. indet.	oa-d
Hebrus ruficeps (Thomson)	oa-w; S0
Hebrus sp. indet.	oa-w; S0
Microvelia reticulata (Burmeister)	oa-w; S0
Gerris ?argentatus Schummel	oa-w; S2
Gerris sp. indet.	oa-w
Hesperocorixa sp.	oa-w
Corixidae spp.	oa-w
*Corixidae sp. (nymph)	oa-w
Heteroptera spp.	u
*Heteroptera sp. (nymph)	u
Aphrodes flavostriatus (Donovan)	oa-p-d; S0
Aphrodes sp.	oa-p
?Conomelus anceps (Germar)	oa-p; S0
Delphacidae spp.	oa-p
Auchenorhyncha spp.	oa-p
*Aphidoidea sp.	u
Hemiptera sp. indet.	u
*Hemiptera sp. (nymph)	u
NEUROPTERA	
*Sialis sp.	oa
LEPIDOPTERA	
*Lepidoptera sp. (pupa)	u
TRICHOPTERA	
*Trichoptera sp.	oa-w
*Trichoptera sp. (case)	oa-w
DIPTERA	
**Bibio* sp.	oa
*Bibionidae sp. indet.	u
*Chironomidae sp. (larva)	w
*Chironomidae sp. (larva)	oa
*Diptera sp. (larva)	u
*Diptera sp. (pupa)	u
*Diptera sp. (puparium)	u
*Diptera sp. (adult)	u
HYMENOPTERA	
*Proctotrupoidea sp.	u
*Chalcidoidea sp.	u
*Formicidae sp.	u
*Formicidae sp. A	u
*Formicidae sp. B	u
*Hymenoptera Parasitica sp.	u
*Hymenoptera sp.	u
COLEOPTERA	
Cychrus rostratus (Linnaeus)	oa
Leistus rufescens (Fabricius)	oa-d
Notiophilus aquaticus (Linnaeus)	oa
Diacheila arctica Gyllenhal	oa; N5
Diacheila polita Faldermann	oa; N5
Elaphrus lapponicus Gyllenhal	oa-d; N3
Dyschirius globosus(Herbst)	oa
Dyschirius sp. indet.	oa
Patrobus sp.	oa
Trechus ?obtusus Erichson	oa
Trechus obtusus or *quadristriatus*	oa

Trechus rivularis (Gyllenhal)	oa-d
Trechus secalis (Paykull)	oa-d; S0
Bembidion ?transparens (Gebler)	oa-d
Bembidion doris (Panzer)	oa-d
Bembidion ?aeneum Germar	oa-d; S0
Bembidion guttula or *mannerheimi*	oa
Bembidion lunulatum (Fourcroy)	oa-d; S4
Bembidion sp.	oa
Pterostichus diligens (Sturm)	oa-d
Pterostichus gracilis (Dejean)	oa-d; S4
Pterostichus minor (Gyllenhal)	oa; S0
Pterostichus nigrita (Paykull)	oa-d; S0
Pterostichus sp. indet.	ob
Calathus ?melanocephalus (Linnaeus)	oa
Agonum fuliginosum (Panzer)	oa
Agonum obscurum (Herbst)	oa-d
Agonum thoreyi Dejean	oa-d; S2
Agonum (*Europhilus*) sp. and spp. indet.	oa
Agonum sp. indet.	oa
Amara sp.	oa
Bradycellus sp.	oa
Dromius sp.	oa
Carabidae sp. and spp. indet.	ob
Haliplus sp.	oa-w
Coelambus impressopunctatus (Schaller)	oa-w; S0
Coelambus sp.	oa-w
Hygrotus decoratus (Gyllenhal)	oa-w; S3
Hygrotus inaequalis (Fabricius)	oa-w; S0
Hydroporus scalesianus Stephens	oa-w; S2
Hydroporus spp.	oa-w
Potamonectes griseostriatus (Degeer)	oa-w; S3
Hydroporinae spp. and spp. indet.	oa-w
Agabus arcticus (Paykull)	oa-w; N3
Agabus bipustulatus (Linnaeus)	oa-w
Agabus spp. and spp. indet.	oa-w
Ilybius ater (Degeer)	oa-w
Ilybius sp.	oa-w
Agabus or *Ilybius* sp. indet.	oa-w
Rhantus aberratus or *suturellus*	oa-w
Rhantus sp. indet.	oa-w
Colymbetes fuscus (Linnaeus)	oa-w; S2
Colymbetinae spp. indet.	oa-w
Acilius canaliculatus (Nicolai)	oa-w; S0
Dytiscus sp.	oa-w
Dytiscidae sp. indet.	oa-w
Rhysodes sulcatus Fabricius	oa; S4
Hydrochus brevis (Herbst)	oa-w; S2
Hydrochus sp. indet.	oa-w
Helophorus ?aquaticus (Linnaeus)	oa-w; S0
Helophorus grandis Illiger	oa-w
Helophorus ?glacialis Villa	oa-w; N4
Helophorus nanus; Sturm	oa-w; S2
Helophorus sibiricus Motschulsky	oa; N5
Helophorus spp. and spp. indet.	oa-w
Coelostoma orbiculare (Fabricius)	oa-w; S0
Cercyon convexiusculus Stephens	oa-d; S2
Cercyon ?lateralis (Marsham)	rf
Cercyon marinus Thomson	oa-d
Cercyon tristis (Illiger)	oa-d; S0

Cercyon sp. and spp. indet.	u
Megasternum obscurum (Marsham)	rt
Hydrobius fuscipes (Linnaeus)	oa-w
Anacaena globulus (Paykull)	oa-w; S0
Anacaena limbata (Fabricius)	oa-w; S0
Anacaena sp. indet.	oa-w
Laccobius sp.	oa-w
Enochrus ?ochropterus (Marsham)	oa-w; S0
Enochrus testaceus (Fabricius)	oa-w; S0
Enochrus spp. and spp. indet.	oa-w
Chaetarthria seminulum (Herbst)	oa-w; S0
Berosus sp.	oa-w; S0
Hydrophilinae sp.	oa-w
Ochthebius minimus (Fabricius)	oa-w
Ochthebius sp.	oa-w
Hydraena ?britteni Joy	oa-w; S0
Hydraena gracilis Germar	oa-w; S0
Hydraena palustris Erichson	oa-w; S3
Hydraena sp. indet.	oa-w
Limnebius aluta (Bedel)	oa-w; S3
Limnebius papposus Mulsant	oa-w; S2
Limnebius sp. and sp. indet.	oa-w
Acrotrichis spp.	rt
Leiodes ?calcarata (Erichson)	u; S2
?Leiodes sp.	u
Colon sp.	u
Catopinae sp.	u
Silpha atrata Linnaeus	u; S2
Silphidae sp.	u
Scydmaenidae sp.	u
Micropeplus sp.	rt; S3
Metopsia retusa (Stephens)	u; S4
Proteinus sp.	rt
Olophrum assimile (Paykull)	oa; S0
Olophrum consimile (Gyllenhal)	oa; N0
Olophrum fuscum (Gravenhorst)	oa; N0
Olophrum piceum (Gyllenhal)	oa; S3
Olophrum sp. indet.	oa
Arpedium brachypterum (Gravenhorst)	oa; N2
Acidota crenata (Fabricius)	oa
Acidota cruentata Mannerheim	oa; S2
Eusphalerum minutum (Fabricius)	oa-d
Pycnoglypta lurida (Gyllenhal)	rt; N4
Omalium sp.	rt
Boreaphilus henningsianus Sahlberg	u; N4
Omaliinae spp. and spp. indet.	rt
Bledius sp.	oa-d
Carpelimus ?corticinus (Gravenhorst)	oa-d; S0
Carpelimus elongatulus (Erichson)	oa-d; S2
Carpelimus spp.	u
Aploderus caelatus (Gravenhorst)	rt
Platystethus nodifrons (Mannerheim)	oa-d
Anotylus rugosus (Fabricius)	rt
Stenus spp.	u
Euaesthetus bipunctatus (Ljungh)	oa
Euaesthetus laeviusculus Mannerheim	oa; S0
Euaesthetus sp. indet.	oa
Lathrobium ?geminum Kraatz	u; S0
Lathrobium spp. and spp. indet.	u

Ochthephilum fracticorne (Paykull)	oa-d; S0
Othius punctulatus (Goeze)	rt-st; S0
Othius sp.	rt
Xantholinus ?linearis (Olivier)	rt-sf; S0
Xantholinus linearis or *longiventris*	rt-sf
Xantholinus sp. indet.	u
Erichsonius cinerascens (Gravenhorst)	oa-d; S0
Philonthus spp.	u
Gabrius sp.	rt
Staphylinus sp.	u
Quedius boops group	u
Quedius sp.	u
Philonthus or *Quedius* sp. indet.	u
Staphylininae spp. indet.	u
Mycetoporus spp.	u
Tachyporus spp.	u
Tachinus ?signatus Gravenhorst	u
Tachinus sp.	u
Dinarda dentata (Gravenhorst)	u; S3
Aleocharinae spp.	u
?Amauronyx maerkeli (Aube)	u
Euplectini sp.	u
?Bryaxis sp.	u
Brachygluta ?fossulata (Reichenbach)	u; S2
Pselaphaulax dresdensis Herbst	u; S0
Pselaphus heisei (Herbst)	u
Pselaphidae spp. indet.	u
Aphodius ater (Degeer)	oa-rf; S0
Aphodius spp.	ob-rf
Serica brunnea (Linnaeus)	oa-p; S0
Clambus sp.	rt-sf
Microcara testacea (Linnaeus)	oa-p-d; S0
Cyphon padi (Linnaeus)	oa-d
Cyphon spp.	oa-d
Scirtidae sp.	oa-d
Simplocaria metallica Sturm	oa; N4
Simplocaria sp.	oa-p
Cytilus sericeus (Forster)	oa-p
Byrrhidae sp. and sp. indet.	oa-p
Dryops sp.	oa-d
Limnius volckmari (Panzer)	oa-w; S0
**Athous* sp. (larva)	u
Ctenicera pectinicornis (Linnaeus)	oa-p; S0
**Actenicerus sjaelandicus* (larva) (Muller)	oa; S0
Dalopius marginatus (Linnaeus)	oa-p
Elateridae sp.	ob
Ptilinus pectinicornis (Linnaeus)	l-sf; S3
Kateretes sp.	oa-p-d
Cryptolestes spartii (Curtis)	oa; S4
?*Cryptophagus* sp.	rd-sf
Cryptophagidae sp.	u
Atomaria spp.	rd
Phalacridae sp.	oa-p
Cerylon ferrugineum Stephens	l
Coccidula rufa (Herbst)	oa-p-d; S2
Coccinella sp.	oa-p
Coccinellidae spp.	oa-p
Enicmus sp.	rt-sf
Corticaria sp.	rt-sf
Corticarina sp.	rt
Cortinicara gibbosa (Herbst)	rt
Corticariinae sp. indet.	rt
Lagria hirta (Linnaeus)	oa-p; S0
Lagria sp. indet.	oa-p; S0
Anaspis sp.	ob
?Mordellidae sp.	u
Donacia vulgaris Zschach	oa-d; S0
Donacia simplex Fabricius	oa-d; S2
Donacia obscura Gyllenhal	oa-d
Donacia sp. indet.	oa-w-p
Plateumaris discolor (Panzer)	oa-w-p
Plateumaris sericea (Linnaeus)	oa-w-p
Plateumaris affinis (Kunze)	oa-w-p; S2
Plateumaris sp. indet.	oa-w-p
Donaciinae spp. indet.	oa-w-p
Adoxus obscurus (Linnaeus)	oa-p
Chrysolina staphylaea (Linnaeus)	oa-p
Phaedon sp.	oa-p
Prasocuris phellandrii (Linnaeus)	oa-p-d; S0
Phyllodecta polaris or *vitellinae*	oa-p
Chrysomelinae sp.	oa-p
Galerucella sp.	oa-p
Lochmaea caprea (Linnaeus)	oa-p
Phyllotreta sp.	oa-p
Longitarsus spp.	oa-p
Altica sp.	oa-p
Crepidodera sp.	oa-p
Chalcoides sp.	oa-p
Chaetocnema arida group	oa-p
Chaetocnema sp. indet.	oa-p
Halticinae sp. and spp. indet.	oa-p
Apion spp.	oa-p
Otiorhynchus nodosus (Muller)	oa-p; N2
Phyllobius sp.	oa-p
Barynotus sp.	oa-p
Sitona griseus (Fabricius)	oa-p; S4
Tanysphyrus lemnae (Paykull)	oa-w-p; S2
Eremotes ater (Linnaeus)	l
?Dryophthorus corticalis (Paykull)	l; S3
Bagous sp.	oa-w
Dorytomus sp.	oa-p
Notaris aethiops (Fabricius)	oa-p-d
Notaris sp.	oa-d-p
Thryogenes sp.	oa-p; S2
Micrelus ericae (Gyllenhal)	oa-p-m
Ceutorhynchus sp.	oa-p
?Rhinoncus sp.	oa-p
Phytobius ?quadricornis (Gyllenhal)	oa-p-d
Phytobius sp. indet.	oa-d
Ceuthorhynchinae sp.	oa-p
Limnobaris pilistriata (Stephens)	oa-p-d; S0
?Anthonomus sp.	oa-p
Gymnetron spp.	oa-p
Curculionidae spp. and spp. indet.	oa
Phloeophthorus rhododactylus (Marsham)	l; S5
Pityophthorus pubescens (Marsham)	l; S4
Scolytidae sp.	l
Coleoptera spp.	u

*Coleoptera sp. indet. (larva)	u
*Insecta sp. (larva)	u
*Insecta sp. pupa	u
ARACHNIDA	
*Acarina sp.	u
*Aranae sp.	u

Table 9. Main statistics for assemblages of adult beetles and bugs (excluding aphids and scale insects) from samples from Church Moss, Davenham. For explanation of abbreviations, see Table 10.

Context	0	0	0	0	0	0	0	0	0	0
Sample	213	217	218	219	221	222	223	225	227	402
Ext	/T	/1	/T	/1	/1	/T	/1	/1	/1	/1
S	59	153	99	52	53	66	49	90	64	30
N	767	980	241	211	133	167	183	558	117	130
ALPHA	15	51	63	22	33	40	22	30	58	12
SEALPHA	1	3	7	2	5	5	3	2	9	2
SOB	40	106	65	37	34	44	31	58	46	19
PSOB	68	69	66	71	64	67	63	64	72	63
NOB	684	703	185	184	91	114	153	461	94	110
PNOB	89	72	77	87	68	68	84	83	80	85
ALPHAOB	9	35	36	14	20	26	12	18	36	7
SEALPHAOB	1	2	4	2	3	4	2	1	6	1
SW	14	34	31	16	7	12	10	21	18	7
PSW	24	22	31	31	13	18	20	23	28	23
NW	210	445	96	32	18	28	28	114	44	20
PNW	27	45	40	15	14	17	15	20	38	15
ALPHAW	3	9	16	13	0	8	6	8	12	4
SEALPHAW	1	1	3	4	0	3	2	1	3	1
SD	9	23	12	8	9	12	10	16	16	6
PSD	15	15	12	15	17	18	20	18	25	20
ND	442	174	22	19	16	41	97	301	29	84
PND	58	18	9	9	12	25	53	54	25	65
ALPHAD	2	7	11	0	0	6	3	4	15	2
SEALPHAD	0	1	4	0	0	2	1	1	5	0
SP	16	38	14	5	8	11	8	19	5	4
PSP	27	25	14	10	15	17	16	21	8	13
NP	25	102	20	5	11	24	21	44	5	4
PNP	3	10	8	2	8	14	11	8	4	3
ALPHAP	20	22	21	0	0	8	5	13	0	0
SEALPHAP	8	4	10	0	0	3	2	3	0	0
SM	0	0	0	0	0	0	0	0	0	1
PSM	0	0	0	0	0	0	0	0	0	3
NM	0	0	0	0	0	0	0	0	0	1
PNM	0	0	0	0	0	0	0	0	0	1
ALPHAM	0	0	0	0	0	0	0	0	0	0
SEALPHAM	0	0	0	0	0	0	0	0	0	0
SL	2	0	0	0	0	0	0	0	0	2
PSL	3	0	0	0	0	0	0	0	0	7
NL	2	0	0	0	0	0	0	0	0	1
PNL	0	0	0	0	0	0	0	0	0	1
ALPHAL	0	0	0	0	0	0	0	0	0	0
SEALPHAL	0	0	0	0	0	0	0	0	0	0
SRT	1	15	12	2	6	5	3	6	3	1
PSRT	2	10	12	4	11	8	6	7	5	3
NRT	3	37	21	3	11	9	5	21	3	1

Context	0	0	0	0	0	0	0	0	0	0
Sample	213	217	218	219	221	222	223	225	227	402
Ext	/T	/1	/T	/1	/1	/T	/1	/1	/1	/1
PNRT	0	4	9	1	8	5	3	4	3	1
ALPHART	0	10	12	0	0	0	0	3	0	0
SEALPHART	0	3	5	0	0	0	0	1	0	0
SRD	0	3	4	0	0	0	0	0	0	0
PSRD	0	2	4	0	0	0	0	0	0	0
NRD	0	8	7	0	0	0	0	0	0	0
PNRD	0	1	3	0	0	0	0	0	0	0
ALPHARD	0	0	0	0	0	0	0	0	0	0
SEALPHARD	0	0	0	0	0	0	0	0	0	0
SRF	0	2	0	0	2	0	0	0	1	0
PSRF	0	1	0	0	4	0	0	0	2	0
NRF	0	2	0	0	2	0	0	0	1	0
PNRF	0	0	0	0	2	0	0	0	1	0
ALPHARF	0	0	0	0	0	0	0	0	0	0
SEALPHARF	0	0	0	0	0	0	0	0	0	0

Table 9 continued.

Context	0	0	0	0	0	0	0	0	0	0
Sample	404	406	501	503	504	505	506	507	508	510
Ext	/1	/T	/1	/1	/1	/1	/1	/1	/T	/T
S	29	44	42	65	65	33	35	57	104	27
N	153	149	139	225	229	65	183	131	347	82
ALPHA	11	21	21	31	30	27	13	39	50	14
SEALPHA	1	3	3	3	3	6	2	6	4	3
SOB	18	23	29	43	41	21	19	44	61	22
PSOB	62	52	69	66	63	64	54	77	59	81
NOB	129	104	117	166	165	40	154	107	209	72
PNOB	84	70	84	74	72	62	84	82	60	88
ALPHAOB	6	9	12	19	18	18	6	28	29	11
SEALPHAOB	1	2	2	2	2	5	1	4	3	2
SW	6	6	9	14	14	3	6	18	20	7
PSW	21	14	21	22	22	9	17	32	19	26
NW	21	17	13	41	44	3	7	27	89	37
PNW	14	11	9	18	19	5	4	21	26	45
ALPHAW	3	0	0	8	7	0	0	24	8	3
SEALPHAW	1	0	0	2	2	0	0	9	1	1
SD	7	5	6	14	14	7	3	5	16	6
PSD	24	11	14	22	22	21	9	9	15	22
ND	100	66	16	74	51	21	9	7	71	25
PND	65	44	12	33	22	32	5	5	20	30
ALPHAD	2	1	0	5	6	4	0	0	7	3
SEALPHAD	0	0	0	1	1	1	0	0	1	1
SP	4	8	6	10	12	9	2	8	20	8
PSP	14	18	14	15	18	27	6	14	19	30
NP	7	14	58	41	70	13	5	9	45	9
PNP	5	9	42	18	31	20	3	7	13	11
ALPHAP	0	0	2	4	4	0	0	0	14	0
SEALPHAP	0	0	0	1	1	0	0	0	4	0
SM	1	1	0	0	0	0	0	0	0	0
PSM	3	2	0	0	0	0	0	0	0	0
NM	2	3	0	0	0	0	0	0	0	0
PNM	1	2	0	0	0	0	0	0	0	0
ALPHAM	0	0	0	0	0	0	0	0	0	0
SEALPHAM	0	0	0	0	0	0	0	0	0	0
SL	1	5	0	0	0	0	0	0	0	0
PSL	3	11	0	0	0	0	0	0	0	0
NL	1	7	0	0	0	0	0	0	0	0
PNL	1	5	0	0	0	0	0	0	0	0
ALPHAL	0	0	0	0	0	0	0	0	0	0
SEALPHAL	0	0	0	0	0	0	0	0	0	0
SRT	0	1	5	7	8	2	1	2	12	0
PSRT	0	2	12	11	12	6	3	4	12	0
NRT	0	1	7	18	10	5	1	2	41	0
PNRT	0	1	5	8	4	8	1	2	12	0

Context	0	0	0	0	0	0	0	0	0	0
Sample	404	406	501	503	504	505	506	507	508	510
Ext	/1	/T	/1	/1	/1	/1	/1	/1	/T	/T
ALPHART	0	0	0	0	0	0	0	0	6	0
SEALPHART	0	0	0	0	0	0	0	0	2	0
SRD	0	0	0	1	1	0	0	0	1	0
PSRD	0	0	0	2	2	0	0	0	1	0
NRD	0	0	0	1	1	0	0	0	5	0
PNRD	0	0	0	0	0	0	0	0	1	0
ALPHARD	0	0	0	0	0	0	0	0	0	0
SEALPHARD	0	0	0	0	0	0	0	0	0	0
SRF	0	0	1	0	0	0	0	1	1	0
PSRF	0	0	2	0	0	0	0	2	1	0
NRF	0	0	1	0	0	0	0	1	1	0
PNRF	0	0	1	0	0	0	0	1	0	0
ALPHARF	0	0	0	0	0	0	0	0	0	0
SEALPHARF	0	0	0	0	0	0	0	0	0	0

Table 9 continued.

Context	0	0	0	0	4075	4076	4077	4078	4079	
Sample	511	514	518	521	105	99	108	109	110	Site
Ext	/1	/1	/1	/1	/T	/T	/T	/T	/T	
S	37	68	34	17	0	19	18	13	27	449
N	96	423	58	42	0	121	308	41	148	6427
ALPHA	22	23	35	11	0	6	4	7	10	110
SEALPHA	4	2	8	3	0	1	1	2	1	3
SOB	29	44	24	11	0	14	11	8	19	323
PSOB	78	65	71	65	0	74	61	62	70	72
NOB	88	346	46	34	0	116	286	36	135	5129
PNOB	92	82	79	81	0	96	93	88	91	80
ALPHAOB	15	13	21	6	0	4	2	3	6	77
SEALPHAOB	3	1	5	2	0	1	0	1	1	2
SW	8	17	5	2	0	7	2	1	6	97
PSW	22	25	15	12	0	37	11	8	22	22
NW	10	155	6	3	0	10	5	1	13	1537
PNW	10	37	10	7	0	8	2	2	9	24
ALPHAW	0	5	0	0	0	0	0	0	0	23
SEALPHAW	0	1	0	0	0	0	0	0	0	1
SD	5	9	6	2	0	0	1	1	2	67
PSD	14	13	18	12	0	0	6	8	7	15
ND	52	138	21	4	0	0	1	1	5	1887
PND	54	33	36	10	0	0	0	2	3	29
ALPHAD	1	2	3	0	0	0	0	0	0	14
SEALPHAD	0	0	1	0	0	0	0	0	0	1
SP	11	14	10	4	0	0	1	0	2	110
PSP	30	21	29	24	0	0	6	0	7	24
NP	21	43	16	24	0	0	1	0	2	639
PNP	22	10	28	57	0	0	0	0	1	10
ALPHAP	10	7	0	1	0	0	0	0	0	38
SEALPHAP	4	2	0	1	0	0	0	0	0	3
SM	0	1	1	0	0	0	0	0	0	2
PSM	0	1	3	0	0	0	0	0	0	0
NM	0	1	1	0	0	0	0	0	0	8
PNM	0	0	2	0	0	0	0	0	0	0
ALPHAM	0	0	0	0	0	0	0	0	0	0
SEALPHAM	0	0	0	0	0	0	0	0	0	0
SL	0	0	1	1	0	0	0	0	0	7
PSL	0	0	3	6	0	0	0	0	0	2
NL	0	0	1	1	0	0	0	0	0	13
PNL	0	0	2	2	0	0	0	0	0	0
ALPHAL	0	0	0	0	0	0	0	0	0	0
SEALPHAL	0	0	0	0	0	0	0	0	0	0
SRT	2	1	1	0	0	1	1	0	1	90
PSRT	5	1	3	0	0	5	6	0	4	20
NRT	2	1	2	0	0	1	1	0	1	207
PNRT	2	0	3	0	0	1	0	0	1	3

Context	0	0	0	0	4075	4076	4077	4078	4079	
Sample	511	514	518	521	105	99	108	109	110	Site
Ext	/1	/1	/1	/1	/T	/T	/T	/T	/T	
ALPHART	0	0	0	0	0	0	0	0	0	61
SEALPHART	0	0	0	0	0	0	0	0	0	7
SRD	0	0	0	0	0	0	0	0	0	10
PSRD	0	0	0	0	0	0	0	0	0	2
NRD	0	0	0	0	0	0	0	0	0	22
PNRD	0	0	0	0	0	0	0	0	0	0
ALPHARD	0	0	0	0	0	0	0	0	0	7
SEALPHARD	0	0	0	0	0	0	0	0	0	3
SRF	1	0	0	0	0	0	0	0	1	10
PSRF	3	0	0	0	0	0	0	0	4	2
NRF	1	0	0	0	0	0	0	0	1	10
PNRF	1	0	0	0	0	0	0	0	1	0
ALPHARF	0	0	0	0	0	0	0	0	0	0
SEALPHARF	0	0	0	0	0	0	0	0	0	0

Table 10. Abbreviations for ecological codes and statistics used for interpretation of insect remains in text and tables. Lower case codes in parentheses are those assigned to taxa and used to calculate the group values (the codes in capitals). See Table 8 for codes assigned to taxa from Church Moss, Davenham. Indivs—individuals (based on MNI); No—number.

No taxa	S
Estimated number of indivs (MNI)	N
Index of diversity (α)	alpha
Standard error of alpha	SE alpha
No 'certain' outdoor taxa (oa)	SOA
Percentage of 'certain' outdoor taxa	PSOA
No 'certain' outdoor indivs	NOA
Percentage of 'certain' outdoor indivs	PNOA
No OA and probable outdoor taxa (oa+ob)	SOB
Percentage of OB taxa	PSOB
No OB indivs	NOB
Percentage OB indivs	PNOB
Index of diversity of the OB component	alphaOB
Standard error	SEalphaOB
No aquatic taxa (w)	SW
Percentage of aquatic taxa	PSW
No aquatic indivs	NW
Percentage of W indivs	PNW
Index of diversity of the W component	alphaW
Standard error	SEalphaW
No damp ground/waterside taxa (d)	SD
Percentage D taxa	PSD
No damp D indivs	ND
Percentage of D indivs	PND
Index of diversity of the D component	alphaD
Standard error	SEalphaD
No strongly plant-associated taxa (p)	SP
Percentage of P taxa	PSP
No strongly P indivs	NP
Percentage of P indivs	PNP
Index of diversity of the P component	alphaP
Standard error	SEalphaP
No heathland/moorland taxa (m)	SM
Percentage of M taxa	PSM
No M indivs	NM
Percentage of M indivs	PNM
Index of diversity of the M component	alphaM
Standard error	SEalphaM
No wood-associated taxa (l)	SL
Percentage of L taxa	PSL
No L indivs	NL
Percentage of L indivs	PNL
Index of diversity of the L component	alphaL
Standard error	SEalphaL
No decomposer taxa (rt + rd + rf)	SRT
Percentage of RT taxa	PSRT
No RT indivs	NRT
Percentage of RT indivs	PNRT
Index of diversity of RT component	alpha RT
Standard error	SEalphaRT
No 'dry' decomposer taxa (rd)	SRD Percentage of RD
taxa	PSRD
No RD indivs	NRD
Percentage of RD indivs	PNRD
Index of diversity of the RD component	alphaRD
Standard error	SEalphaRD
No 'foul' decomposer taxa (rf)	SRF
Percentage of RF taxa	PSRF
No RF indivs	NRF
Percentage of RF indivs	PNRF
Index of diversity of the RF component	alphaRF
Standard error	SEalphaRF

Table 11. Records of strongly plant-associated Coleoptera and Hemiptera from Church Moss, Davenham. Eurytopic taxa removed.

Taxon	Plant associates	213	217	218	219	221	222	223	225	227	402	404	406	501	503	504	505	506	507	508	510	511	514	518	521	Σ
Elasmostethus interstinctus	birch (rarely hazel and aspen)	1																								1
Chilacis typhae	great reedmace		2																	3						5
Pachybraqchius fracticollis	perhaps sedges	2																								2
Cymus ?melanocephalus	*Juncus*		2					1								2	3			3						11
Cymus ?glandicolor	sedges	1							6						3				1							11
Cymus sp.	rushes and sedges												1	2												3
Cyrtorhinus caricis	rushes and sedges		3																							3
Capsus ?ater	grasses		2																							2
Aphrodes flavostriatus	grasses																								1	1
?Conomelus anceps	*Juncus*																					4				4
Simplocaria sp.	mosses				1																					1
Cytilus sericeus	mosses	1						?1	2														?1			5
Byrrhidae sp.	mosses					1	2									1			1		1	1				7
Donacia obscura	club-rushes and sedges, especially *Carex rostrata*		9																							9
Donacia vulgaris	bur-reeds (*Sparganium*) and reedmace (*Typha*)		13																							13
Donacia simplex	bur-reeds (*Sparganium*)																			3						3
Plateumaris discolor	usually associated with *Carex*										1															1
Plateumaris sericea	usually on *Sparganium*, especially *S. erectum*																			2						2
Plateumaris affinis	*Carex* at lake and pond margins		5																							5
Adoxus obscurus	willowherbs (*Chaemenerion*, sometimes *Epilobium*)			1																						1
Chrysolina staphylaea	*Mentha, Veronica, Ranunculus*		1																							1
Prasocuris phellandrii	aquatic umbellifers		2																							2
Phyllodecta polaris or *vitellinae*	v. on *Salix*								1																	1
Lochmaea caprea	willow, birch								2																	2
Sitona griseus	broom (*Sarothamnus scoparius*)		1																							1
Tanysphyrus lemnae	duckweeds (*Lemna*)		1																							1
Notaris aethiops	*?Sparganium*									1																1
Micrelus ericae	*Calluna, Erica*										1	2	3											1		7
Phytobius ?quadricornis	waterside *Polygonum*		16																							16
Limnobaris pilistriata	sedges and rushes	1	4	2			2	3			?1				1	4	?1			?1	1					21

Table 12. Species lists in rank order for invertebrate macrofossils from samples fromChurch Moss, Davenham. For each sample assemblage the adult Hemiptera (bugs) and Coleoptera (beetles) are listed first, followed by the remaining invertebrates (*). Weight is in kilogrammes, n = minimum number of individuals; SQ = semi-quantitative (e = estimate; - = fully quantitative, m = 'many', translated as 15 individuals; s = several, translated as 6). For translation of ecological codes, see Table 10. 'null' indicates that there were no recognisable remains of macro-invertebrates, although there may have been decayed scraps unassignable to class.

Context: 0 Sample: 213/T ReM: D
Weight: 3.90

Cyphon padi	268	n	oa-d
Cyphon sp.	154	n	oa-d
Limnebius aluta	84	n	oa-w
Chaetarthria seminulum	64	n	oa-w
Aleocharinae sp. B	30	n	u
Hydroporus scalesianus	20	n	oa-w
Ochthephilum fracticorne	14	n	oa-d
?Bryaxis sp.	13	n	u
Pselaphus heisei	12	n	u
Hydroporus sp.	10	n	oa-w
Hydraena ?britteni	7	n	oa-w
Altica sp.	7	n	oa-p
Stignocoris pedestris	6	n	oa
Aleocharinae sp. A	6	n	u
Agabus sp. A	5	n	oa-w
Hydraena palustris	5	n	oa-w
Hebrus ruficeps	4	n	oa-w
Delphacidae sp.	3	n	oa-p
Coelostoma orbiculare	3	n	oa-w
Lathrobium sp. A	3	n	u
Corticarina sp.	3	n	rt
Pachybrachius fracticollis	2	n	oa-p
Agonum ?fuliginosum	2	n	oa
Agabus sp. B	2	n	oa-w
Enochrus sp.	2	n	oa-w
Ochthebius ?minimus	2	n	oa-w
Metopsia retusa	2	n	u
Carpelimus sp.	2	n	u
Philonthus sp.	2	n	u
Elasmostethus interstinctus	1	n	oa-p
Drymus brunneus	1	n	oa-p
Cymus ?glandicolor	1	n	oa-p
Saldula sp.	1	n	oa-d
Auchenorhyncha sp.	1	n	oa-p
Pterostichus ?diligens	1	n	oa-d
?Anacaena sp.	1	n	oa-w
Limnebius ?papposus	1	n	oa-w
?Leiodes sp.	1	n	u
Catopinae sp.	1	n	u
Stenus sp. A	1	n	u
Stenus sp. B	1	n	u
?Xantholinus sp.	1	n	u
Erichsonius cinerascens	1	n	oa-d
Aleocharinae sp. C	1	n	u
Aleocharinae sp. D	1	n	u
Cytilus sericeus	1	n	oa-p
?Dalopius marginatus	1	n	oa-p
Cryptolestes spartii	1	n	oa
Cerylon ferrugineum	1	n	l
Coccidula rufa	1	n	oa-p-d
Coccinella sp.	1	n	oa-p
Lagria sp.	1	n	oa-p
Plateumaris sp.	1	n	oa-w-p
Chrysomelinae sp. A	1	n	oa-p
Ceutorhynchus sp.	1	n	oa-p
Limnobaris pilistriata	1	n	oa-p-d
Curculionidae sp. A	1	n	oa
Pityophthorus pubescens	1	n	l
Coleoptera sp. A	1	n	u
*Bibio sp.	1	n	oa
*Coleoptera sp. (larva)	15	m	u
*Acarina sp.	15	m	u
*Aranae sp.	15	m	u
*Diptera sp. (adult)	15	m	u
*Diptera sp. (puparium)	15	m	u
*Aranae sp.	6	s	u

Context: 0 Sample: 217/1 ReM: D
Weight: 5.60

Ochthebius minimus	279	n	oa-w
Aleocharinae sp. A	74	n	u
Aleocharinae sp. B	68	n	u
Cyphon sp.	32	n	oa-d
Chartoscirta cincta	29	n	oa-w
Cryptophagidae sp.	19	n	u
Cyphon padi	17	n	oa-d
Phytobius ?quadricornis	16	n	oa-p-d
Cercyon tristis	15	n	oa-d
Hydroporus sp. A	14	n	oa-w
Cercyon convexiusculus	13	n	oa-d
Cercyon marinus	13	n	oa-d
Donacia vulgaris	13	n	oa-d
Hydraena ?britteni	12	n	oa-w
Bledius sp.	12	n	oa-d
Carpelimus sp. A	12	n	u
Helophorus sp. C	11	n	oa-w
Carpelimus sp. B	11	n	u
Delphacidae sp. A	9	n	oa-p
Enochrus sp. A	9	n	oa-w
Limnebius papposus	9	n	oa-w
Aleocharinae sp. C	9	n	u
Donacia obscura	9	n	oa-d
Trechus obtusus or quadristriatus	8	n	oa
Hydroporus ?scalesianus	8	n	oa-w
Hydrochus brevis	8	n	oa-w
Enochrus ?testaceus	8	n	oa-w
Gabrius sp.	7	n	rt

Agonum (Europhilus) sp. A	6	n	oa
Aleocharinae sp. F	6	n	u
Corticarina sp.	6	n	rt
Saldula saltatoria v. marginella	5	n	oa-d
Hygrotus inaequalis	5	n	oa-w
Agabus sp.	5	n	oa-w
Rhantus sp.	5	n	oa-w
Helophorus ?aquaticus	5	n	oa-w
Helophorus sp. A	5	n	oa-w
Hydrobius fuscipes	5	n	oa-w
Enochrus sp. B	5	n	oa-w
Atomaria sp. B	5	n	rd
Plateumaris affinis	5	n	oa-w-p
Delphacidae sp. B	4	n	oa-p
Hygrotus decoratus	4	n	oa-w
Megasternum obscurum	4	n	rt
Stenus sp. A	4	n	u
Lathrobium ?geminum	4	n	u
Aleocharinae sp. I	4	n	u
Dryops sp.	4	n	oa-d
Phaedon sp.	4	n	oa-p
Limnobaris pilistriata	4	n	oa-p-d
Cyrtorhinus caricis	3	n	oa-p
Bembidion doris	3	n	oa-d
Agonum (Europhilus) sp. B	3	n	oa
Carpelimus elongatulus	3	n	oa-d
Anotylus rugosus	3	n	rt
Philonthus sp.	3	n	u
Chilacis typhae	2	n	oa-p-d
?Stignocoris sp.	2	n	oa
Cymus ?melanocephalus	2	n	oa-p
Capsus ?ater	2	n	oa-p
Microvelia ?reticulata	2	n	oa-w
Agabus bipustulatus	2	n	oa-w
Helophorus sp. B	2	n	oa-w
Acrotrichis sp.	2	n	rt
Leiodes ?calcarata	2	n	u
Stenus sp. C	2	n	u
Staphylininae sp. B	2	n	u
Aleocharinae sp. D	2	n	u
Aleocharinae sp. E	2	n	u
Ctenicera pectinicornis	2	n	oa-p
Atomaria sp. A	2	n	rd
Lagria hirta	2	n	oa-p
Prasocuris phellandrii	2	n	oa-p-d
Picromerus bidens	1	n	oa-p
Zicrona caerulea	1	n	oa-p
Trapezonotus sp.	1	n	oa-p
Stignocoris pedestris	1	n	oa
Lygaeidae sp. B	1	n	oa-p
Gerris ?argentatus	1	n	oa-w
Hesperocorixa sp.	1	n	oa-w
Corixidae sp.	1	n	oa-w
Heteroptera sp. A	1	n	u
Delphacidae sp. C	1	n	rt-sf
Auchenorhyncha sp. A	1	n	oa-p
Auchenorhyncha sp. B	1	n	oa-p
Auchenorhyncha sp. C	1	n	oa-p
Dyschirius sp.	1	n	oa
Trechus rivularis	1	n	oa-d
Bembidion guttula or mannerheimi	1	n	oa
Pterostichus gracilis	1	n	oa-d
Carabidae sp. A	1	n	ob
Carabidae sp. B	1	n	ob
Carabidae sp. C	1	n	ob
Haliplus sp.	1	n	oa-w
Coelambus impressopunctatus	1	n	oa-w
Hydroporus sp. B	1	n	oa-w
Ilybius ater	1	n	oa-w
Colymbetes fuscus	1	n	oa-w
Acilius canaliculatus	1	n	oa-w
Dytiscus sp.	1	n	oa-w
Helophorus ?nanus	1	n	oa-w
Cercyon ?lateralis	1	n	rf
Hydraena gracilis	1	n	oa-w
Proteinus sp.	1	n	rt
Olophrum ?fuscum	1	n	oa
Olophrum sp.	1	n	oa
Acidota cruentata	1	n	oa
Carpelimus sp. C	1	n	u
Aploderus caelatus	1	n	rt
Stenus sp. B	1	n	u
Othius sp.	1	n	rt
Xantholinus ?linearis	1	n	rt-sf
Erichsonius cinerascens	1	n	oa-d
Staphylininae sp. A	1	n	u
Mycetoporus sp. A	1	n	u
Mycetoporus sp. B	1	n	u
Tachyporus sp. A	1	n	u
Tachyporus sp. B	1	n	u
Tachyporus sp. C	1	n	u
Tachinus ?signatus	1	n	u
Tachinus sp.	1	n	u
Dinarda dentata	1	n	u
Aleocharinae sp. G	1	n	u
Aleocharinae sp. H	1	n	u
Aleocharinae sp. J	1	n	u
Aphodius ater	1	n	oa-rf
Scirtidae sp.	1	n	oa-d
Atomaria sp. C	1	n	rd
Phalacridae sp.	1	n	oa-p
?Coccinellidae sp.	1	n	oa-p
Coccinellidae sp. A	1	n	oa-p
Coccinellidae sp. B	1	n	oa-p
?Mordellidae sp.	1	n	u
Donacia sp.	1	n	oa-w-p
Chrysolina staphylaea	1	n	oa-p
Galerucella sp.	1	n	oa-p
Crepidodera sp.	1	n	oa-p
Apion sp. A	1	n	oa-p
Apion sp. B	1	n	oa-p
Phyllobius sp.	1	n	oa-p
Sitona griseus	1	n	oa-p
Tanysphyrus lemnae	1	n	oa-w-p
?Notaris sp.	1	n	oa-d-p
Ceuthorhynchinae sp.	1	n	oa-p
?Anthonomus sp.	1	n	oa-p
Curculionidae sp. A	1	n	oa
Curculionidae sp. B	1	n	oa
Curculionidae sp. D	1	n	oa

Curculionidae sp. E	1	n	oa
Curculionidae sp. F	1	n	oa
Curculionidae sp. G	1	n	oa
Coleoptera sp.	1	n	u
*Sialis sp.	1	n	oa
*Coleoptera sp. (larva)	15	m	u
*Acarina sp.	15	m	u
*Chironomidae sp. (larva)	15	m	w
*Cladocera sp. (ephippium)	15	m	oa
*Daphnia sp. (ephippium)	15	m	oa-w
*Diptera sp. (adult)	15	m	u
*Formicidae sp.	15	m	u
*Heteroptera sp. (nymph)	15	m	u
*Insecta sp. (larva)	15	m	u
*Diptera sp. (puparium)	15	m	u
*Hymenoptera Parasitica sp.	6	s	u
*Bibionidae sp.	3	n	u
*Chalcidoidea sp.	2	n	u
*Aranae sp.	1	n	u
*Ostracoda sp.	1	n	u
*Proctotrupoidea sp.	1	n	u
*Trichoptera sp.	1	n	oa-w

Context: 0 Sample: 218/T ReM: S
Weight: 2.60

Ochthebius ?minimus	24	n	oa-w
Olophrum fuscum	21	n	oa
Arpedium brachypterum	20	n	oa
Microvelia reticulata	15	n	oa-w
Helophorus sp.	7	n	oa-w
Hydraena sp.	5	n	oa-w
Rhantus sp.	4	n	oa-w
Megasternum obscurum	4	n	rt
Enochrus testaceus	4	n	oa-w
Boreaphilus henningsianus	4	n	u
Aleocharinae sp. C	4	n	u
Cyphon ?padi	4	n	oa-d
Stignocoris pedestris	3	n	oa
Chartoscirta ?cincta	3	n	oa-w
Corixidae sp. B	3	n	oa-w
Delphacidae sp.	3	n	oa-p
Potamonectes griseostriatus	3	n	oa-w
Enochrus sp.	3	n	oa-w
Stenus sp. B	3	n	u
Stenus sp. C	3	n	u
Aleocharinae sp. D	3	n	u
Cyphon sp. A	3	n	oa-d
Donacia sp.	3	n	oa-w-p
Gerris sp.	2	n	oa-w
Auchenorhyncha sp. A	2	n	oa-p
Trechus ?obtusus	2	n	oa
Hygrotus inaequalis	2	n	oa-w
Agabus arcticus	2	n	oa-w
Cercyon tristis	2	n	oa-d
Hydrobius fuscipes	2	n	oa-w
Acrotrichis sp.	2	n	rt
Eusphalerum ?minutum	2	n	oa-d
Othius punctulatus	2	n	rt-st
Gabrius sp.	2	n	rt
Aleocharinae sp. E	2	n	u
?Cryptophagus sp.	2	n	rd-sf
Atomaria sp. A	2	n	rd
Atomaria sp. B	2	n	rd
Limnobaris pilistriata	2	n	oa-p-d
Trapezonotus ?desertus	1	n	oa
Saldula saltatoria v. marginella	1	n	oa-d
Corixidae sp. A	1	n	oa-w
Auchenorhyncha sp. B	1	n	oa-p
Auchenorhyncha sp. C	1	n	oa-p
Auchenorhyncha sp. D	1	n	oa-p
Diacheila arctica	1	n	oa
Trechus rivularis	1	n	oa-d
Bembidion doris	1	n	oa-d
Agonum sp.	1	n	oa
Amara sp.	1	n	oa
Bradycellus sp.	1	n	oa
Carabidae sp.	1	n	ob
Haliplus sp.	1	n	oa-w
Hydroporus sp. A	1	n	oa-w
Hydroporus sp. B	1	n	oa-w
Hydroporinae sp.	1	n	oa-w
Agabus bipustulatus	1	n	oa-w
?Graphoderus sp.	1	n	oa-w
Dytiscus sp.	1	n	oa-w
Hydrochus sp.	1	n	oa-w
Helophorus ?aquaticus	1	n	oa-w
Coelostoma orbiculare	1	n	oa-w
Cercyon convexiusculus	1	n	oa-d
Anacaena sp.	1	n	oa-w
Laccobius sp.	1	n	oa-w
Berosus sp.	1	n	oa-w
Ochthebius sp.	1	n	oa-w
Silpha atrata	1	n	u
Silphidae sp.	1	n	u
Olophrum assimile	1	n	oa
Pycnoglypta lurida	1	n	rt
Carpelimus sp.	1	n	u
Stenus sp. A	1	n	u
Stenus sp. D	1	n	u
Stenus sp. E	1	n	u
Lathrobium sp. A	1	n	u
Lathrobium sp. B	1	n	u
Xantholinus linearis or longiventris	1	n	rt-sf
Staphylininae sp.	1	n	u
Tachinus sp.	1	n	u
Aleocharinae sp. A	1	n	u
Aleocharinae sp. B	1	n	u
Aleocharinae sp. F	1	n	u
Aleocharinae sp. G	1	n	u
Aleocharinae sp. H	1	n	u
Atomaria sp. C	1	n	rd
Coccinellidae sp.	1	n	oa-p
Corticaria sp.	1	n	rt-sf
Corticarina or Cortinicara sp.	1	n	rt
Plateumaris sp.	1	n	oa-w-p
Adoxus obscurus	1	n	oa-p
Halticinae sp. A	1	n	oa-p
Halticinae sp. B	1	n	oa-p

Apion sp.	1	n	oa-p
Bagous sp.	1	n	oa-w
Eubrychius velutus	1	n	oa-w
Phytobius sp.	1	n	oa-d
Ceuthorhynchinae sp.	1	n	oa-p
Coleoptera sp.	1	n	u
*Acarina sp.	15	m	u
*Daphnia sp. (ephippium)	15	m	oa-w
*Oligochaeta sp. (egg capsule)	15	m	u
*Chironomidae sp. (larva)	6	s	oa
*Diptera sp. (puparium)	6	s	u
*Corixidae sp. (nymph)	2	n	oa-w
*Aranae sp.	1	n	u
*Bibionidae sp.	1	n	u
*Diptera sp. (adult)	1	n	u
*Formicidae sp.	1	n	u
*Hymenoptera Parasitica sp.	1	n	u
*Trichoptera sp. (case)	1	n	oa-w

Context: 0 Sample: 219/1 ReM: D
Weight: 6.40

Olophrum fuscum	99	n	oa
Arpedium brachypterum	23	n	oa
Agonum thoreyi	6	n	oa-d
Agabus arcticus	6	n	oa-w
Lathrobium sp.	4	n	u
Coelambus sp.	3	n	oa-w
Agabus sp. C	3	n	oa-w
Helophorus sp. B	3	n	oa-w
Coelostoma orbiculare	3	n	oa-w
Stenus sp. A	3	n	u
Ochthephilum fracticorne	3	n	oa-d
Cyphon sp.	3	n	oa-d
Hebrus sp.	2	n	oa-w
Hydroporus ?scalesianus	2	n	oa-w
Agabus sp. B	2	n	oa-w
Cercyon ?convexiusculus	2	n	oa-d
Stenus sp. B	2	n	u
Stenus sp. C	2	n	u
Philonthus sp. A	2	n	u
Philonthus sp. B	2	n	u
?Gabrius sp.	2	n	rt
Aleocharinae sp. C	2	n	u
Aleocharinae sp. E	2	n	u
Cyphon ?padi	2	n	oa-d
?Saldidae sp.	1	n	oa-d
Delphacidae sp.	1	n	oa-p
Auchenorhyncha sp.	1	n	oa-p
Diacheila arctica	1	n	oa
Diacheila polita	1	n	oa
Dyschirius ?globosus	1	n	oa
Bembidion sp.	1	n	oa
Pterostichus ?nigrita	1	n	oa-d
Hydroporus sp. A	1	n	oa-w
Hydroporus sp. B	1	n	oa-w
Hydroporus sp. C	1	n	oa-w
Agabus sp. A	1	n	oa-w
Colymbetes ?fuscus	1	n	oa-w
Helophorus sp. A	1	n	oa-w
Helophorus sp. C	1	n	oa-w
Cercyon ?tristis	1	n	oa-d
Ochthebius ?minimus	1	n	oa-w
Olophrum assimile	1	n	oa
Olophrum sp.	1	n	oa
?Pycnoglypta lurida	1	n	rt
Aleocharinae sp. A	1	n	u
Aleocharinae sp. B	1	n	u
Aleocharinae sp. D	1	n	u
Aleocharinae sp. F	1	n	u
Aleocharinae sp. G	1	n	u
Simplocaria sp.	1	n	oa-p
Phalacridae sp.	1	n	oa-p
Otiorhynchus nodosus	1	n	oa-p
*Acarina sp.	6	s	u
*Chironomidae sp. (larva)	6	s	w
*Daphnia sp. (ephippium)	6	s	oa-w
*Insecta sp. (larva)	6	s	u
*Coleoptera sp. (larva)	1	n	u
*Formicidae sp.	1	n	u
*Hymenoptera Parasitica sp.	1	n	u

Context: 0 Sample: 221/1 ReM: S
Weight: 3.90

Olophrum fuscum	22	n	oa
Arpedium brachypterum	9	n	oa
Aleocharinae sp. B	9	n	u
Hydroporus sp. B	7	n	oa-w
Corticarina sp.	6	n	rt
*Sialis sp.	6	s	oa
Aleocharinae sp. A	5	n	u
Cyphon sp. A	5	n	oa-d
Delphacidae sp.	3	n	oa-p
Hydroporus sp. A	3	n	oa-w
Stenus sp. B	3	n	u
Stenus sp. C	3	n	u
Diacheila arctica	2	n	oa
Agonum thoreyi	2	n	oa-d
Agonum sp. B	2	n	oa
Hydroporus ?scalesianus	2	n	oa-w
Helophorus sp. A	2	n	oa-w
Helophorus sp. B	2	n	oa-w
Lathrobium sp.	2	n	u
Aleocharinae sp. C	2	n	u
Cyphon sp. B	2	n	oa-d
Coccinellidae sp.	2	n	oa-p
Phytobius sp.	2	n	oa-d
Cimicidae sp.	1	n	oa-p
Saldidae sp.	1	n	oa-d
Heteroptera sp. A	1	n	u
Heteroptera sp. B	1	n	u
Auchenorhyncha sp.	1	n	oa-p
Leistus rufescens	1	n	oa-d
Bembidion ?doris	1	n	oa-d
Pterostichus nigrita	1	n	oa-d
Agonum fuliginosum	1	n	oa
Agonum sp. A	1	n	oa

Agabus sp.	1	n	oa-w
Helophorus sp. C	1	n	oa-w
Olophrum assimile	1	n	oa
Acidota crenata	1	n	oa
Omaliinae sp.	1	n	rt
Stenus sp. A	1	n	u
Othius sp.	1	n	rt
Philonthus sp.	1	n	u
?Gabrius sp.	1	n	rt
Staphylininae sp. A	1	n	u
Staphylininae sp. B	1	n	u
Tachinus ?signatus	1	n	u
Aleocharinae sp. D	1	n	u
Aleocharinae sp. E	1	n	u
Aphodius sp. A	1	n	ob-rf
Aphodius sp. B	1	n	ob-rf
Byrrhidae sp.	1	n	oa-p
Halticinae sp.	1	n	oa-p
Notaris sp.	1	n	oa-d-p
Ceuthorhynchinae sp.	1	n	oa-p
*Bibio sp.	1	n	oa
*Acarina sp.	100	e	u
*Insecta sp. (larva)	15	m	u
*Hymenoptera sp.	6	s	u
*Diptera sp. (puparium)	6	s	u
*Aranae sp.	2	n	u
*Daphnia sp. (ephippium)	1	n	oa-w
*Formicidae sp.	1	n	u
*Hemiptera sp. (nymph)	1	n	u

Context: 0 Sample: 222/T ReM: S
Weight: 5.00

Delphacidae sp.	12	n	oa-p
Cyphon sp.	12	n	oa-d
Olophrum fuscum	9	n	oa
Hydroporus sp. A	8	n	oa-w
Hebrus ruficeps	7	n	oa-w
Cercyon convexiusculus	7	n	oa-d
Aleocharinae sp. D	6	n	u
Stenus sp. C	5	n	u
Lathrobium sp. B	5	n	u
Ochthephilum fracticorne	5	n	oa-d
Aleocharinae sp. C	5	n	u
Agonum sp. A	4	n	oa
Philonthus sp. B	4	n	u
Saldula saltatoria v. marginella	3	n	oa-d
Pterostichus nigrita	3	n	oa-d
Pycnoglypta lurida	3	n	rt
Philonthus sp. C	3	n	u
Aleocharinae sp. B	3	n	u
Aleocharinae sp. E	3	n	u
Corticarina or Cortinicara sp.	3	n	rt
Trechus rivularis	2	n	oa-d
Bembidion sp.	2	n	oa
Pterostichus diligens	2	n	oa-d
Hydroporus ?scalesianus	2	n	oa-w
Hydroporus sp. B	2	n	oa-w
Anacaena sp.	2	n	oa-w
Arpedium brachypterum	2	n	oa
Eusphalerum minutum	2	n	oa-d
Philonthus sp. A	2	n	u
Byrrhidae sp.	2	n	oa-p
Limnobaris pilistriata	2	n	oa-p-d
Chartoscirta ?cincta	1	n	oa-w
Auchenorhyncha sp. A	1	n	oa-p
Auchenorhyncha sp. B	1	n	oa-p
Elaphrus lapponicus	1	n	oa-d
Agonum sp. B	1	n	oa
Carabidae sp.	1	n	ob
Carabidae sp. A	1	n	ob
Carabidae sp. B	1	n	ob
Hydroporus sp. C	1	n	oa-w
Agabus sp.	1	n	oa-w
Colymbetes ?fuscus	1	n	oa-w
Coelostoma orbiculare	1	n	oa-w
Hydrobius fuscipes	1	n	oa-w
Ochthebius sp.	1	n	oa-w
Acrotrichis sp.	1	n	rt
Silphidae sp.	1	n	u
Olophrum ?assimile	1	n	oa
Omalium sp.	1	n	rt
Boreaphilus henningsianus	1	n	u
Platystethus nodifrons	1	n	oa-d
Stenus sp. A	1	n	u
Stenus sp. B	1	n	u
Lathrobium sp. A	1	n	u
Lathrobium sp. C	1	n	u
Aleocharinae sp. A	1	n	u
Pselaphaulax dresdensis	1	n	u
Elateridae sp.	1	n	ob
Corticaria sp.	1	n	rt-sf
Chrysomelinae sp.	1	n	oa-p
Phyllotreta sp.	1	n	oa-p
Longitarsus sp.	1	n	oa-p
?Altica sp.	1	n	oa-p
Chaetocnema sp.	1	n	oa-p
Otiorhynchus nodosus	1	n	oa-p
Phytobius sp.	1	n	oa-d

Context: 0 Sample: 223/1 ReM: S
Weight: 2.70

Cyphon sp.	61	n	oa-d
Cyphon padi	13	n	oa-d
Hebrus ruficeps	11	n	oa-w
Delphacidae sp. A	11	n	oa-p
Ochthephilum fracticorne	8	n	oa-d
*Sialis sp.	6	s	oa
Aleocharinae sp. C	5	n	u
Hydroporus ?scalesianus	4	n	oa-w
Coelostoma orbiculare	4	n	oa-w
Pterostichus diligens	3	n	oa-d
Cercyon convexiusculus	3	n	oa-d
Eusphalerum minutum	3	n	oa-d
Othius sp.	3	n	rt
Aleocharinae sp. A	3	n	u
Limnobaris pilistriata	3	n	oa-p-d

Chartoscirta ?cincta	2	n	oa-w
Delphacidae sp. B	2	n	oa-p
Agonum sp.	2	n	oa
Hydroporus sp.	2	n	oa-w
Lathrobium sp. A	2	n	u
Philonthus sp.	2	n	u
Aleocharinae sp. B	2	n	u
Pselaphus heisei	2	n	u
Cymus ?melanocephalus	1	n	oa-p
Saldula sp.	1	n	oa-d
Saldidae sp.	1	n	oa-d
Pterostichus nigrita	1	n	oa-d
Carabidae sp.	1	n	ob
Agabus sp.	1	n	oa-w
Helophorus sp. A	1	n	oa-w
Helophorus sp. B	1	n	oa-w
Hydrobius fuscipes	1	n	oa-w
Anacaena sp.	1	n	oa-w
Silpha atrata	1	n	u
Olophrum sp.	1	n	oa
?Pycnoglypta lurida	1	n	rt
Stenus sp.	1	n	u
Lathrobium sp. B	1	n	u
Lathrobium sp. C	1	n	u
Quedius sp.	1	n	u
Aleocharinae sp. D	1	n	u
Aleocharinae sp. E	1	n	u
Aleocharinae sp. F	1	n	u
Pselaphaulax dresdensis	1	n	u
?Cytilus sericeus	1	n	oa-p
Corticaria sp.	1	n	rt-sf
Longitarsus sp.	1	n	oa-p
Chaetocnema arida group	1	n	oa-p
Halticinae sp.	1	n	oa-p
*Coleoptera sp. (larva)	6	s	u
*Acarina sp.	6	s	u
*Diptera sp. (puparium)	6	s	u
*Aranae sp.	2	n	u
*Diptera sp. (adult)	1	n	u
*Hymenoptera sp.	1	n	u
*Diptera sp. (pupa)	1	n	u

Context: 0 Sample: 225/1 ReM: S
Weight: 1.70

Cyphon padi	215	n	oa-d
Cyphon sp.	57	n	oa-d
Hebrus ruficeps	33	n	oa-w
Hydroporus scalesianus	32	n	oa-w
Aleocharinae sp. A	29	n	u
Delphacidae sp. A	13	n	oa-p
Hydroporus sp. A	13	n	oa-w
Anacaena globulus	9	n	oa-w
Acrotrichis sp.	9	n	rt
Aleocharinae sp. B	9	n	u
Cercyon convexiusculus	7	n	oa-d
Cymus glandicolor	6	n	oa-p
Gabrius sp.	6	n	rt
Eusphalerum minutum	5	n	oa-d
Philonthus sp. A	5	n	u
Coelostoma orbiculare	4	n	oa-w
Pselaphaulax dresdensis	4	n	u
Auchenorhyncha sp. A	3	n	oa-p
Agonum thoreyi	3	n	oa-d
Lathrobium sp. A	3	n	u
Lathrobium sp. B	3	n	u
Corticaria sp.	3	n	rt-sf
Drymus brunneus	2	n	oa-p
Delphacidae sp. B	2	n	oa-p
Auchenorhyncha sp. B	2	n	oa-p
Trechus rivularis	2	n	oa-d
Pterostichus diligens	2	n	oa-d
Pterostichus nigrita	2	n	oa-d
Hydroporinae sp.	2	n	oa-w
Agabus sp.	2	n	oa-w
Helophorus sp. B	2	n	oa-w
Enochrus ?ochropterus	2	n	oa-w
Hydraena ?britteni	2	n	oa-w
Hydraena palustris	2	n	oa-w
Limnebius sp.	2	n	oa-w
Aleocharinae sp. G	2	n	u
Aleocharinae sp. I	2	n	u
Aleocharinae sp. J	2	n	u
Cytilus sericeus	2	n	oa-p
Lochmaea caprea	2	n	oa-p
Longitarsus sp.	2	n	oa-p
Stignocoris pedestris	1	n	oa
Scolopostethus sp.	1	n	oa-p
Chartoscirta ?cincta	1	n	oa-w
Auchenorhyncha sp. C	1	n	oa-p
Auchenorhyncha sp. D	1	n	oa-p
Leistus rufescens	1	n	oa-d
Trechus secalis	1	n	oa-d
Bembidion doris	1	n	oa-d
Hydroporus sp. B	1	n	oa-w
Helophorus sp. A	1	n	oa-w
Cercyon sp.	1	n	u
Enochrus sp. A	1	n	oa-w
Enochrus sp. B	1	n	oa-w
Chaetarthria seminulum	1	n	oa-w
Limnebius aluta	1	n	oa-w
Colon sp.	1	n	u
Micropeplus sp.	1	n	rt
Olophrum ?fuscum	1	n	oa
Omaliinae sp. A	1	n	u
Omaliinae sp. B	1	n	u
Carpelimus ?corticinus	1	n	oa-d
Stenus sp. A	1	n	u
Stenus sp. B	1	n	u
Stenus sp. C	1	n	u
Lathrobium sp. C	1	n	u
Ochthephilum fracticorne	1	n	oa-d
?Othius sp.	1	n	rt
Philonthus or Quedius sp.	1	n	u
Tachyporus sp.	1	n	u
Aleocharinae sp. C	1	n	u
Aleocharinae sp. D	1	n	u
Aleocharinae sp. E	1	n	u
Aleocharinae sp. F	1	n	u

Aleocharinae sp. H	1	n	u
Aleocharinae sp. J	1	n	u
Pselaphus heisei	1	n	u
Microcara testacea	1	n	oa-p-d
Limnius volckmari	1	n	oa-w
Kateretes sp.	1	n	oa-p-d
Cortinicara gibbosa	1	n	rt
Donaciinae sp.	1	n	oa-w-p
Phyllodecta polaris or vitellinae	1	n	oa-p
Altica sp.	1	n	oa-p
Crepidodera sp.	1	n	oa-p
Bagous sp.	1	n	oa-w
?Rhinoncus sp.	1	n	oa-p
Curculionidae sp. A	1	n	oa
Curculionidae sp. B	1	n	oa
Curculionidae sp. C	1	n	oa
*Coleoptera sp. (larva)	15	m	u
*Acarina sp.	15	m	u
*Aranae sp.	15	m	u
*Diptera sp. (adult)	15	m	u
*Diptera sp. (puparium)	15	m	u
*Insecta sp. pupa	15	m	u
*Hymenoptera sp.	6	s	u
*Aphidoidea sp.	2	n	u
*Formicidae sp.	1	n	u
*Ostracoda sp.	1	n	u

Context: 0 Sample: 227/1 ReM: S
Weight: 2.70

Ochthebius ?minimus	13	n	oa-w
Olophrum fuscum	6	n	oa
Bembidion doris	5	n	oa-d
Helophorus sp. A	5	n	oa-w
Arpedium brachypterum	5	n	oa
Cyphon sp.	5	n	oa-d
Rhantus aberratus or suturellus	3	n	oa-w
Helophorus sp. C	3	n	oa-w
Stenus sp. A	3	n	u
Aleocharinae sp. A	3	n	u
Dryops sp.	3	n	oa-d
Hydroporus sp.	2	n	oa-w
Ilybius sp.	2	n	oa-w
Cercyon convexiusculus	2	n	oa-d
Cercyon tristis	2	n	oa-d
Hydrobius fuscipes	2	n	oa-w
Enochrus sp. A	2	n	oa-w
Enochrus sp. B	2	n	oa-w
Hydraena sp.	2	n	oa-w
Stenus sp. B	2	n	u
Phytobius sp.	2	n	oa-d
Miridae sp.	1	n	oa-p
Saldidae sp.	1	n	oa-d
Gerris sp.	1	n	oa-w
Hemiptera sp.	1	n	u
Patrobus sp.	1	n	oa
Trechus rivularis	1	n	oa-d
Bembidion sp.	1	n	oa
Pterostichus diligens	1	n	oa-d
Agonum sp.	1	n	oa
Carabidae sp.	1	n	ob
Carabidae sp. B	1	n	ob
Haliplus sp.	1	n	oa-w
Hydroporus ?scalesianus	1	n	oa-w
Agabus sp.	1	n	oa-w
Colymbetes ?fuscus	1	n	oa-w
Dytiscidae sp.	1	n	oa-w
Helophorus sp. B	1	n	oa-w
Cercyon ?marinus	1	n	oa-d
Limnebius sp.	1	n	oa-w
Silpha atrata	1	n	u
Acidota crenata	1	n	oa
Eusphalerum ?minutum	1	n	oa-d
Platystethus nodifrons	1	n	oa-d
Othius sp.	1	n	rt
Philonthus sp.	1	n	u
Quedius sp.	1	n	u
Mycetoporus sp.	1	n	u
Tachyporus sp.	1	n	u
Aleocharinae sp. B	1	n	u
Aleocharinae sp. C	1	n	u
Aleocharinae sp. D	1	n	u
Aleocharinae sp. E	1	n	u
Aleocharinae sp. F	1	n	u
Aphodius sp.	1	n	ob-rf
Cyphon padi	1	n	oa-d
Corticarina sp.	1	n	rt
Donacia sp.	1	n	oa-w-p
Plateumaris sp.	1	n	oa-w-p
Longitarsus sp.	1	n	oa-p
Notaris aethiops	1	n	oa-p-d
Curculionidae sp. A	1	n	oa
Coleoptera sp.	1	n	u
*Pentatomidae sp. (nymph)	1	n	oa-p
*Coleoptera sp. (larva)	1	n	u
*Formicidae sp. A	1	n	u
*Formicidae sp. B	1	n	u

Context: 0 Sample: 402/1 ReM: D
Weight: 0.00

Cyphon sp.	44	n	oa-d
Cyphon padi	36	n	oa-d
Aleocharinae sp.	6	n	u
Hydroporus scalesianus	5	n	oa-w
Chaetarthria seminulum	5	n	oa-w
?Bryaxis sp.	5	n	u
Enochrus sp.	3	n	oa-w
Hydroporus sp. A	2	n	oa-w
Hydroporus sp. B	2	n	oa-w
Coelostoma orbiculare	2	n	oa-w
Pselaphus heisei	2	n	u
Stignocoris pedestris	1	n	oa
Drymus sp.	1	n	oa-p
Agonum sp.	1	n	oa
Carabidae sp. A	1	n	ob
Colymbetinae sp.	1	n	oa-w
Olophrum sp.	1	n	oa

?Pycnoglypta lurida	1	n	rt
Stenus sp.	1	n	u
Lathrobium sp.	1	n	u
Ochthephilum fracticorne	1	n	oa-d
Staphylininae sp.	1	n	u
?Amauronyx maerkeli	1	n	u
Brachygluta ?fossulata	1	n	u
Scirtidae sp.	1	n	oa-d
Cerylon ferrugineum	1	n	l
Plateumaris discolor	1	n	oa-w-p
Micrelus ericae	1	n	oa-p-m
Limnobaris ?pilistriata	1	n	oa-p-d
?Dryophthorus corticalis		n	l
*Acarina sp.	15	m	u
*Coleoptera sp. (larva)	6	s	u
*Diptera sp. (puparium)	3	n	u

Context: 0 Sample: 404/1 ReM: S
Weight: 0.97

Cyphon sp.	61	n	oa-d
Cyphon padi	31	n	oa-d
?Bryaxis sp.	11	n	u
Chaetarthria seminulum	9	n	oa-w
Hydroporus sp.	6	n	oa-w
Pterostichus diligens	4	n	oa-d
Delphacidae sp.	3	n	oa-p
Pselaphus heisei	3	n	u
Hydroporus scalesianus	2	n	oa-w
Agabus sp.	2	n	oa-w
Lathrobium sp.	2	n	u
Micrelus ericae	2	n	oa-p-m
?Bradycellus sp.	1	n	oa
Ochthebius ?minimus	1	n	oa-w
Hydraena sp.	1	n	oa-w
Olophrum piceum	1	n	oa
Eusphalerum ?minutum	1	n	oa-d
Platystethus nodifrons	1	n	oa-d
Stenus sp.	1	n	u
Quedius sp.	1	n	u
Aleocharinae sp. A	1	n	u
Aleocharinae sp. B	1	n	u
Aleocharinae sp. C	1	n	u
Pselaphidae sp.	1	n	u
Dryops sp.	1	n	oa-d
Donaciinae sp.	1	n	oa-w-p
Altica sp.	1	n	oa-p
?Dryophthorus corticalis	1	n	l
Coleoptera sp.	1	n	u
*Acarina sp.	15	m	u
*Diptera sp. (puparium)	3	n	u
*Diptera sp. (adult)	1	n	u

Context: 0 Sample: 501/1 ReM: D
Weight: 0.00

Delphacidae sp.	47	n	oa-p
Arpedium brachypterum	11	n	oa
Olophrum assimile	7	n	oa
Cyphon sp. B	7	n	oa-d
Auchenorhyncha sp. B	5	n	oa-p
Euaesthetus laeviusculus	5	n	oa
Aleocharinae sp. B	5	n	u
Cercyon tristis	4	n	oa-d
Dyschirius globosus	3	n	oa
Hydroporus ?scalesianus	3	n	oa-w
Helophorus ?grandis	3	n	oa-w
Philonthus sp. B	3	n	u
Cymus sp.	2	n	oa-p
Helophorus sp.	2	n	oa-w
?Pycnoglypta lurida	2	n	rt
Stenus sp.	2	n	u
Cyphon sp. A	2	n	oa-d
Corticaria sp.	2	n	rt-sf
Gymnetron sp.	2	n	oa-p
Auchenorhyncha sp. A	1	n	oa-p
Trechus secalis	1	n	oa-d
Pterostichus sp.	1	n	ob
Agonum sp.	1	n	oa
?Bradycellus sp.	1	n	oa
Hydroporinae sp.	1	n	oa-w
Colymbetinae sp.	1	n	oa-w
Dytiscidae sp.	1	n	oa-w
Hydrobius fuscipes	1	n	oa-w
?Enochrus sp.	1	n	oa-w
Acrotrichis sp.	1	n	rt
Silpha atrata	1	n	u
Omaliinae sp.	1	n	rt
Lathrobium sp.	1	n	u
Ochthephilum fracticorne	1	n	oa-d
Philonthus sp. A	1	n	u
Aleocharinae sp. A	1	n	u
Aleocharinae sp. C	1	n	u
Aphodius sp.	1	n	ob-rf
Dryops sp.	1	n	oa-d
Ceuthorhynchinae sp.	1	n	oa-p
Coleoptera sp. B	1	n	u
Ochthebius sp.		n	oa-w
*Coleoptera sp. (larva)	15	m	u
*Acarina sp.	15	m	u
*Diptera sp. (larva)	15	m	u
*Diptera sp. (puparium)	15	m	u
*Daphnia sp. (ephippium)	1	n	oa-w

Context: 0 Sample: 503/1 ReM: D
Weight: 1.31

Delphacidae sp.	27	n	oa-p
Cyphon sp.	27	n	oa-d
Cyphon ?padi	17	n	oa-d
Hydroporus scalesianus	15	n	oa-w
Ochthebius ?minimus	9	n	oa-w
Acrotrichis sp.	8	n	rt
Aleocharinae sp. A	8	n	u
Pselaphaulax dresdensis	8	n	u
Hydroporus sp. A	5	n	oa-w
Cercyon tristis	5	n	oa-d

Lathrobium sp. A	5	n	u
Philonthus sp. A	5	n	u
Agonum fuliginosum	4	n	oa
Cercyon convexiusculus	4	n	oa-d
Olophrum ?assimile	4	n	oa
Phytobius sp.	4	n	oa-d
Cymus ?glandicolor	3	n	oa-p
Trechus rivularis	3	n	oa-d
Bembidion ?transparens	3	n	oa-d
Xantholinus ?linearis	3	n	rt-sf
Coccidula rufa	3	n	oa-p-d
Auchenorhyncha sp. A	2	n	oa-p
Pterostichus nigrita	2	n	oa-d
Helophorus sp. B	2	n	oa-w
?Pycnoglypta lurida	2	n	rt
Stenus sp. A	2	n	u
Euaesthetus laeviusculus	2	n	oa
Lathrobium sp. C	2	n	u
Ochthephilum fracticorne	2	n	oa-d
Philonthus sp. B	2	n	u
Aleocharinae sp. B	2	n	u
Corticaria sp.	2	n	rt-sf
Stignocoris ?pedestris	1	n	oa
Hebrus ?ruficeps	1	n	oa-w
Aphrodes sp.	1	n	oa-p
Auchenorhyncha sp. B	1	n	oa-p
Dromius sp.	1	n	oa
Carabidae sp.	1	n	ob
Hydroporus sp. B	1	n	oa-w
Agabus sp.	1	n	oa-w
Hydrochus sp.	1	n	oa-w
Helophorus ?grandis	1	n	oa-w
Helophorus nanus	1	n	oa-w
Helophorus sp. A	1	n	oa-w
Coelostoma orbiculare	1	n	oa-w
Cercyon ?marinus	1	n	oa-d
Hydrobius fuscipes	1	n	oa-w
Enochrus ?testaceus	1	n	oa-w
Silpha atrata	1	n	u
Omaliinae sp.	1	n	rt
Stenus sp. B	1	n	u
Lathrobium sp. B	1	n	u
Othius sp.	1	n	rt
Tachinus sp.	1	n	u
Aleocharinae sp. C	1	n	u
Aleocharinae sp. D	1	n	u
Dryops sp.	1	n	oa-d
Atomaria sp.	1	n	rd
Plateumaris sp.	1	n	oa-w-p
Ceuthorhynchinae sp.	1	n	oa-p
Limnobaris pilistriata	1	n	oa-p-d
?Gymnetron sp.	1	n	oa-p
Curculionidae sp. A	1	n	oa
Curculionidae sp. B	1	n	oa
Coleoptera sp.	1	n	u
*Acarina sp.	15	m	u
*Oligochaeta sp. (egg capsule)	15	m	u
*Insecta sp. (larva)	15	m	u
*Insecta sp. pupa	15	m	u
*Diptera sp. (puparium)	6	s	u
*Coleoptera sp. (larva)	1	n	u
*Daphnia sp. (ephippium)	1	n	oa-w

Context: 0 Sample: 504/1 ReM: D
Weight: 2.75

Delphacidae sp. A	54	n	oa-p
Hydroporus ?scalesianus	21	n	oa-w
Cyphon sp.	20	n	oa-d
Aleocharinae sp. E	15	n	u
Lathrobium sp. A	9	n	u
Cyphon ?padi	8	n	oa-d
Hydroporus sp. A	6	n	oa-w
Cercyon convexiusculus	6	n	oa-d
Lathrobium ?geminum	6	n	u
Pselaphaulax dresdensis	5	n	u
Stenus sp. B	4	n	u
Limnobaris pilistriata	4	n	oa-p-d
Hydrochus brevis	3	n	oa-w
Othius sp.	3	n	rt
Philonthus sp.	3	n	u
Phytobius sp.	3	n	oa-d
Stignocoris pedestris	2	n	oa
Drymus brunneus	2	n	oa-p
Cymus ?melanocephalus	2	n	oa-p
Trechus rivularis	2	n	oa-d
Agonum ?fuliginosum	2	n	oa
Helophorus sp. A	2	n	oa-w
Coelostoma orbiculare	2	n	oa-w
Enochrus sp.	2	n	oa-w
Aleocharinae sp. B	2	n	u
Aleocharinae sp. F	2	n	u
Saldidae sp.	1	n	oa-d
Hebrus ruficeps	1	n	oa-w
Delphacidae sp. B	1	n	oa-p
Delphacidae sp. C	1	n	rt-sf
Delphacidae sp. D	1	n	rt-sf
Delphacidae sp. E	1	n	rt-sf
Trechus secalis	1	n	oa-d
Bembidion lunulatum	1	n	oa-d
Bembidion sp.	1	n	oa
Agabus sp.	1	n	oa-w
Agabus or Ilybius sp.	1	n	oa-w
Colymbetes ?fuscus	1	n	oa-w
Helophorus sp. B	1	n	oa-w
Helophorus sp. C	1	n	oa-w
Cercyon tristis	1	n	oa-d
Hydrophilinae sp.	1	n	oa-w
Ochthebius ?minimus	1	n	oa-w
Olophrum ?assimile	1	n	oa
?Pycnoglypta lurida	1	n	rt
Stenus sp. A	1	n	u
Lathrobium sp. B	1	n	u
Ochthephilum fracticorne	1	n	oa-d
Tachinus sp.	1	n	u
Aleocharinae sp. A	1	n	u
Aleocharinae sp. C	1	n	u
Aleocharinae sp. D	1	n	u
Aleocharinae sp. G	1	n	u

Pselaphus heisei	1	n	u
Serica brunnea	1	n	oa-p
Byrrhidae sp.	1	n	oa-p
Dryops sp.	1	n	oa-d
?Atomaria sp.	1	n	rd
Coccidula rufa	1	n	oa-p-d
Corticaria sp.	1	n	rt-sf
Corticarina sp.	1	n	rt
Donaciinae sp.	1	n	oa-w-p
Longitarsus sp.	1	n	oa-p
Barynotus sp.	1	n	oa-p
?Gymnetron sp.	1	n	oa-p
*Coleoptera sp. (larva)	15	m	u
*Acarina sp.	15	m	u
*Oligochaeta sp. (egg capsule)	15	m	u
*Insecta sp. (larva)	15	m	u
*Diptera sp. (puparium)	6	s	u
*Cladocera sp. (ephippium)	2	n	oa-w
*Hymenoptera sp.	1	n	u

Context: 0 Sample: 505/1 ReM: S
Weight: 2.40

Cyphon sp. A	9	n	oa-d
Lathrobium sp. B	6	n	u
Delphacidae sp. C	4	n	rt-sf
Cercyon convexiusculus	4	n	oa-d
Cyphon sp. B	4	n	oa-d
Cymus ?melanocephalus	3	n	oa-p
Lathrobium sp. A	3	n	u
Aleocharinae sp. A	3	n	u
Delphacidae sp. B	2	n	oa-p
Acidota crenata	2	n	oa
Pselaphus heisei	2	n	u
Gymnetron sp. A	2	n	oa-p
Delphacidae sp. A	1	n	oa-p
Auchenorhyncha sp. A	1	n	oa-p
Auchenorhyncha sp. B	1	n	oa-p
Trechus rivularis	1	n	oa-d
Pterostichus sp.	1	n	ob
Hydroporus sp. A	1	n	oa-w
Hydroporus sp. B	1	n	oa-w
Rhantus sp.	1	n	oa-w
Colon sp.	1	n	u
Olophrum ?assimile	1	n	oa
Ochthephilum fracticorne	1	n	oa-d
Xantholinus sp.	1	n	u
Philonthus sp.	1	n	u
Staphylininae sp. A	1	n	u
Aleocharinae sp. B	1	n	u
Pselaphidae sp.	1	n	u
Clambus sp.	1	n	rt-sf
Otiorhynchus ?nodosus	1	n	oa-p
?Phytobius sp.	1	n	oa-d
Limnobaris ?pilistriata	1	n	oa-p-d
Gymnetron sp. B	1	n	oa-p
*Acarina sp.	15	m	u
*Daphnia sp. (ephippium)	1	n	oa-w

Context: 0 Sample: 506/1 ReM: D
Weight: 1.85

Olophrum fuscum	79	n	oa
Arpedium brachypterum	45	n	oa
Boreaphilus henningsianus	6	n	u
Cercyon convexiusculus	5	n	oa-d
Auchenorhyncha sp.	4	n	oa-p
Aleocharinae sp. B	4	n	u
Stenus sp. B	3	n	u
Aleocharinae sp. C	3	n	u
Diacheila arctica	2	n	oa
Hydroporinae sp. A	2	n	oa-w
Helophorus sibiricus	2	n	oa
Stenus sp. A	2	n	u
Cyphon sp.	2	n	oa-d
Simplocaria metallica	2	n	oa
Phytobius sp.	2	n	oa-d
Notiophilus aquaticus	1	n	oa
Bembidion sp.	1	n	oa
Carabidae sp.	1	n	ob
Hydroporinae sp. B	1	n	oa-w
Agabus sp.	1	n	oa-w
Agabus or Ilybius sp.	1	n	oa-w
Rhantus sp.	1	n	oa-w
Dytiscus sp.	1	n	oa-w
Silphidae sp.	1	n	u
?Pycnoglypta lurida	1	n	rt
Stenus sp. C	1	n	u
Lathrobium sp.	1	n	u
Philonthus sp.	1	n	u
Staphylininae sp. A	1	n	u
Staphylininae sp. B	1	n	u
Mycetoporus sp.	1	n	u
Tachinus sp.	1	n	u
Aleocharinae sp. A	1	n	u
Aleocharinae sp. D	1	n	u
Otiorhynchus ?nodosus	1	n	oa-p
*Acarina sp.	15	m	u
*Daphnia sp. (ephippium)	15	m	oa-w
*Lepidoptera sp. (pupa)	1	n	u

Context: 0 Sample: 507/1 ReM: D
Weight: 1.70

Olophrum fuscum	31	n	oa
Arpedium brachypterum	16	n	oa
Ochthebius ?minimus	8	n	oa-w
Curculionidae sp.	5	n	oa
Boreaphilus henningsianus	4	n	u
Aleocharinae sp. C	4	n	u
Hydroporinae sp. A	3	n	oa-w
Stenus sp.	3	n	u
Aleocharinae sp. B	3	n	u
?Aphrodes sp.	2	n	oa-p
Diacheila arctica	2	n	oa
Helophorus ?sibiricus	2	n	oa
Cercyon ?marinus	2	n	oa-d
Aleocharinae sp. D	2	n	u

Cyphon sp. A	2	n	oa-d
Cymus ?glandicolor	1	n	oa-p
Gerris sp.	1	n	oa-w
Auchenorhyncha sp. A	1	n	oa-p
Auchenorhyncha sp. B	1	n	oa-p
Diacheila polita	1	n	oa
Calathus ?melanocephalus	1	n	oa
?Agonum sp.	1	n	oa
Amara sp.	1	n	oa
Carabidae sp.	1	n	ob
Haliplus sp.	1	n	oa-w
Coelambus impressopunctatus	1	n	oa-w
Hydroporinae sp.	1	n	oa-w
Hydroporinae sp. B	1	n	oa-w
Hydroporinae sp. C	1	n	oa-w
Agabus sp.	1	n	oa-w
Ilybius sp.	1	n	oa-w
Rhantus sp.	1	n	oa-w
Dytiscus sp.	1	n	oa-w
Helophorus grandis	1	n	oa-w
Helophorus ?glacialis	1	n	oa-w
Coelostoma orbiculare	1	n	oa-w
Cercyon sp.	1	n	u
Hydrobius fuscipes	1	n	oa-w
Laccobius sp.	1	n	oa-w
Enochrus sp.	1	n	oa-w
Acrotrichis sp.	1	n	rt
Olophrum ?assimile	1	n	oa
Euaesthetus bipunctatus	1	n	oa
Quedius boops group	1	n	u
Staphylininae sp.	1	n	u
Tachinus ?signatus	1	n	u
Aleocharinae sp. A	1	n	u
Aphodius sp.	1	n	ob-rf
Cyphon sp. B	1	n	oa-d
Simplocaria metallica	1	n	oa
Byrrhidae sp.	1	n	oa-p
Dryops sp.	1	n	oa-d
Cryptophagidae sp.	1	n	u
Coccinellidae sp.	1	n	oa-p
Plateumaris sp.	1	n	oa-w-p
Chrysomelinae sp.	1	n	oa-p
Coleoptera sp.	1	n	u
*Acarina sp.	15	m	u
*Daphnia sp. (ephippium)	15	m	oa-w
*Diptera sp. (adult)	15	m	u
*Oligochaeta sp. (egg capsule)	15	m	u
*Insecta sp. (larva)	15	m	u

Context: 0 Sample: 508/T ReM: D
Weight: 0.90

Ochthebius minimus	50	n	oa-w
Aleocharinae sp. L	23	n	u
Cercyon tristis	18	n	oa-d
Aleocharinae sp. I	14	n	u
Cyphon sp.	13	n	oa-d
Acrotrichis sp. B	12	n	rt
Aleocharinae sp. M	12	n	u
Gabrius sp.	9	n	rt
Delphacidae sp. A	8	n	oa-p
Cercyon convexiusculus	8	n	oa-d
Delphacidae sp. B	7	n	oa-p
Aleocharinae sp. H	6	n	u
Cyphon padi	6	n	oa-d
Hydraena ?britteni	5	n	oa-w
Carpelimus ?corticinus	5	n	oa-d
Atomaria sp.	5	n	rd
Coelostoma orbiculare	4	n	oa-w
Enochrus sp. A	4	n	oa-w
Aleocharinae sp. F	4	n	u
Chilacis typhae	3	n	oa-p-d
Stignocoris pedestris	3	n	oa
Cymus ?melanocephalus	3	n	oa-p
Agonum (Europhilus) sp.	3	n	oa
Hydroporinae sp. B	3	n	oa-w
Hydrochus brevis	3	n	oa-w
Megasternum obscurum	3	n	rt
Laccobius sp.	3	n	oa-w
Acrotrichis sp. A	3	n	rt
Erichsonius cinerascens	3	n	oa-d
Mycetoporus sp. A	3	n	u
Aleocharinae sp. D	3	n	u
Aleocharinae sp. G	3	n	u
Dryops sp.	3	n	oa-d
Donacia simplex	3	n	oa-d
Hebrus ruficeps	2	n	oa-w
Auchenorhyncha sp. A	2	n	oa-p
Auchenorhyncha sp. B	2	n	oa-p
Helophorus sp. A	2	n	oa-w
Enochrus ?ochropterus	2	n	oa-w
Limnebius sp.	2	n	oa-w
Olophrum fuscum	2	n	oa
Stenus sp. B	2	n	u
Lathrobium sp. A	2	n	u
Lathrobium sp. B	2	n	u
Othius sp.	2	n	rt
Aleocharinae sp. E	2	n	u
Aleocharinae sp. J	2	n	u
Pselaphidae sp.	2	n	u
Microcara testacea	2	n	oa-p-d
Corticaria sp.	2	n	rt-sf
Plateumaris sericea	2	n	oa-w-p
Apion sp.	2	n	oa-p
Gymnetron sp.	2	n	oa-p
Salda morio	1	n	oa-d
Chartoscirta sp.	1	n	oa-w
Auchenorhyncha sp. C	1	n	oa-p
Auchenorhyncha sp. D	1	n	oa-p
Trechus obtusus or quadristriatus	1	n	oa
Bembidion doris	1	n	oa-d
Bembidion ?aeneum	1	n	oa-d
Pterostichus sp.	1	n	ob
Carabidae sp.	1	n	ob
Coelambus impressopunctatus	1	n	oa-w
Hydroporinae sp. A	1	n	oa-w
Agabus sp.	1	n	oa-w
Rhantus sp.	1	n	oa-w
Helophorus sp. B	1	n	oa-w

Cercyon sp.	1	n	u
Hydrobius fuscipes	1	n	oa-w
Enochrus sp. B	1	n	oa-w
Hydrophilinae sp.	1	n	oa-w
Olophrum sp.	1	n	oa
?Arpedium brachypterum	1	n	oa
Boreaphilus henningsianus	1	n	u
Aploderus caelatus	1	n	rt
Anotylus rugosus	1	n	rt
Stenus sp. A	1	n	u
Euaesthetus sp.	1	n	oa
Lathrobium sp. C	1	n	u
Philonthus sp. A	1	n	u
Philonthus sp. B	1	n	u
Philonthus sp. C	1	n	u
Philonthus sp. D	1	n	u
Staphylininae sp.	1	n	u
Mycetoporus sp. B	1	n	u
Tachyporus sp.	1	n	u
Tachinus ?signatus	1	n	u
Aleocharinae sp. A	1	n	u
Aleocharinae sp. B	1	n	u
Aleocharinae sp. C	1	n	u
Aleocharinae sp. K	1	n	u
Aphodius sp.	1	n	ob-rf
Enicmus sp.	1	n	rt-sf
Corticaria sp.	1	n	rt-sf
Anaspis sp.	1	n	ob
Donacia sp.	1	n	oa-w-p
Phaedon sp.	1	n	oa-p
Phyllotreta sp.	1	n	oa-p
Altica sp.	1	n	oa-p
Halticinae sp.	1	n	oa-p
Ceuthorhynchinae sp.	1	n	oa-p
Limnobaris ?pilistriata	1	n	oa-p-d
Coleoptera sp.	1	n	u
Coleoptera sp. B	1	n	u
*Coleoptera sp. (larva)	15	m	u
*Acarina sp.	15	m	u
*Daphnia sp. (ephippium)	15	m	oa-w
*Diptera sp. (adult)	15	m	u
*Diptera sp. (larva)	15	m	u
*Diptera sp. (puparium)	15	m	u
*Aranae sp.	6	s	u
*Bibionidae sp.	6	s	u
*Hemiptera sp. (nymph)	6	s	u
*Pentatomidae sp. (nymph)	1	n	oa-p
*Hymenoptera sp.	1	n	u

Context: 0 Sample: 510/T ReM: RS
Weight: 0.00

Microvelia ?reticulata	15	m	oa-w
Hydroporus sp.	15	m	oa-w
Cyphon padi	15	m	oa-d
Cyphon sp.	6	n	oa-d
Cercyon sp.	5	s	u
Delphacidae sp. B	2	n	oa-p
Auchenorhyncha sp. A	2	n	oa-p
Agabus sp.	2	n	oa-w
Coelostoma orbiculare	2	n	oa-w
Philonthus sp.	2	n	u
?Lamproplax picea	1	n	oa-d
Chartoscirta sp.	1	n	oa-w
*?Velia sp. (nymph)	1	n	oa-w
Auchenorhyncha sp. B	1	n	oa-p
Agonum sp.	1	n	oa
Hydrobius fuscipes	1	n	oa-w
Ochthebius sp.	1	n	oa-w
Paederus sp.	1	n	oa
Lathrobium sp.	1	n	u
Ochthephilum fracticorne	1	n	oa-d
Aleocharinae sp. A	1	n	u
Aleocharinae sp. B	1	n	u
Byrrhidae sp.	1	n	oa-p
Coccinellidae sp.	1	n	oa-p
Phytobius sp.	1	n	oa-d
Limnobaris pilistriata	1	n	oa-p-d
Gymnetron sp.	1	n	oa-p
Delphacidae sp. A		n	oa-p
*Acarina sp.	1	n	u
*Cladocera sp. (ephippium)	1	n	oa

Context: 0 Sample: 511/1 ReM: S
Weight: 0.85

Cyphon ?padi	39	n	oa-d
Delphacidae sp. A	6	n	oa-p
Cyphon sp. A	6	n	oa-d
?Conomelus anceps	4	n	oa-p
Cercyon convexiusculus	4	n	oa-d
Delphacidae sp. B	3	n	oa-p
Hydroporus ?scalesianus	3	n	oa-w
Cyphon sp. B	2	n	oa-d
Picromerus bidens	1	n	oa-p
Lamproplax picea	1	n	oa-?
Auchenorhyncha sp. D	1	n	oa-p
Auchenorhyncha sp. E	1	n	oa-p
Auchenorhyncha sp. F	1	n	oa-p
Pterostichus sp.	1	n	ob
Agonum (Europhilus) sp.	1	n	oa
Hydroporus sp. A	1	n	oa-w
Hydroporus sp. B	1	n	oa-w
Hydroporus sp. C	1	n	oa-w
?Agabus sp.	1	n	oa-w
Coelostoma orbiculare	1	n	oa-w
Hydrophilinae sp.	1	n	oa-w
Limnebius sp.	1	n	oa-w
Olophrum sp.	1	n	oa
Omaliinae sp.	1	n	rt
Stenus sp.	1	n	u
Lathrobium sp.	1	n	u
Philonthus sp.	1	n	u
Mycetoporus sp.	1	n	u
Aleocharinae sp. A	1	n	u
Aleocharinae sp. B	1	n	u
Aphodius sp.	1	n	ob-rf
Byrrhidae sp.	1	n	oa-p
Elateridae sp.	1	n	ob

Chrysomelinae sp.	1	n	oa-p
Galerucella sp.	1	n	oa-p
?Phyllobius sp.	1	n	oa-p
Coleoptera sp.	1	n	u
*Coleoptera sp. (larva)	6	s	u
*Acarina sp.	6	s	u
*Daphnia sp. (ephippium)	6	s	oa-w

Context: 0 Sample: 514/1 ReM: D
Weight: 2.05

Cyphon padi	68	n	oa-d
Cyphon sp. B	44	n	oa-d
Chaetarthria seminulum	33	n	oa-w
Delphacidae sp.	28	n	oa-p
Anacaena limbata	26	n	oa-w
Hydroporus scalesianus	25	n	oa-w
Hydroporus sp. B	25	n	oa-w
Bryaxis sp.	21	n	u
Hydraena ?britteni	18	n	oa-w
Cercyon convexiusculus	14	n	oa-d
Aleocharinae sp. A	11	n	u
Pselaphus heisei	11	n	u
Limnebius aluta	10	n	oa-w
Agonum fuliginosum	6	n	oa
Stenus sp.	6	n	u
Pterostichus diligens	4	n	oa-d
Philonthus sp. C	4	n	u
Agabus sp. B	3	n	oa-w
Ochthephilum fracticorne	3	n	oa-d
?Bagous sp.	3	n	oa-w
Stignocoris pedestris	2	n	oa
Drymus brunneus	2	n	oa-p
Pterostichus nigrita	2	n	oa-d
Hydroporus sp. A	2	n	oa-w
Anacaena ?globulus	2	n	oa-w
Ochthebius ?minimus	2	n	oa-w
Metopsia retusa	2	n	u
Lathrobium sp. C	2	n	u
Philonthus sp. A	2	n	u
Aleocharinae sp. B	2	n	u
Pselaphidae sp.	2	n	u
Coccinellidae sp.	2	n	oa-p
Rhacognathus punctatus	1	n	oa-p-m
Lamproplax picea	1	n	oa-?
Lygaeidae sp.	1	n	oa-p
Auchenorhyncha sp. A	1	n	oa-p
Auchenorhyncha sp. B	1	n	oa-p
Auchenorhyncha sp. C	1	n	oa-p
Agabus sp. A	1	n	oa-w
Ilybius ater	1	n	oa-w
Colymbetinae sp.	1	n	oa-w
Coelostoma orbiculare	1	n	oa-w
Hydrobius fuscipes	1	n	oa-w
Enochrus sp.	1	n	oa-w
Silpha atrata	1	n	u
Proteinus sp.	1	n	rt
Euaesthetus bipunctatus	1	n	oa
Lathrobium sp. A	1	n	u
Lathrobium sp. B	1	n	u
Philonthus sp. B	1	n	u
Staphylinus sp.	1	n	u
Mycetoporus sp.	1	n	u
Tachyporus sp.	1	n	u
Aleocharinae sp. C	1	n	u
Aleocharinae sp. D	1	n	u
Aleocharinae sp. E	1	n	u
Euplectini sp.	1	n	u
Cyphon sp. A	1	n	oa-d
?Cytilus sericeus	1	n	oa-p
Dalopius marginatus	1	n	oa-p
?Coccinella sp.	1	n	oa-p
Donaciinae sp.	1	n	oa-w-p
Chrysomelinae sp.	1	n	oa-p
Altica sp.	1	n	oa-p
Curculionidae sp.	1	n	oa
Curculionidae sp. B	1	n	oa
Coleoptera sp. A	1	n	u
Coleoptera sp. B	1	n	u
*Coleoptera sp. (larva)	15	m	u
*Acarina sp.	15	m	u
*Oligochaeta sp. (egg capsule)	15	m	u
*Diptera sp. (puparium)	15	m	u
*Insecta sp. (larva)	6	s	u
*Athous sp. (larva)	2	n	u
*Aphidoidea sp.	1	n	u

Context: 0 Sample: 518/1 ReM: D
Weight: 1.21

Cyphon sp.	9	n	oa-d
Cyphon padi	7	n	oa-d
Delphacidae sp.	5	n	oa-p
Aphrodes sp.	3	n	oa-p
Pterostichus diligens	2	n	oa-d
Ochthebius ?minimus	2	n	oa-w
Proteinus sp.	2	n	rt
Carpelimus sp.	2	n	u
Lygaeidae sp.	1	n	oa-p
Auchenorhyncha sp. A	1	n	oa-p
Cychrus rostratus	1	n	oa
Pterostichus minor	1	n	oa
Agonum obscurum	1	n	oa-d
Hydroporinae sp.	1	n	oa-w
Colymbetinae sp.	1	n	oa-w
Rhysodes sulcatus	1	n	oa
Cercyon convexiusculus	1	n	oa-d
Cercyon tristis	1	n	oa-d
Ochthebius sp.	1	n	oa-w
Hydraena ?britteni	1	n	oa-w
?Leiodes sp.	1	n	u
Scydmaenidae sp.	1	n	u
Lathrobium sp.	1	n	u
?Erichsonius sp.	1	n	u
Philonthus sp.	1	n	u
Quedius sp.	1	n	u
Ptilinus pectinicornis	1	n	l-sf
Phalacridae sp.	1	n	oa-p

Galerucella sp.	1	n	oa-p
Altica sp.	1	n	oa-p
Chalcoides sp.	1	n	oa-p
Dorytomus sp.	1	n	oa-p
Micrelus ericae	1	n	oa-p-m
Coleoptera sp.	1	n	u
*Coleoptera sp. (larva)	15	m	u
*Acarina sp.	15	m	u
*Oligochaeta sp. (egg capsule)	15	m	u
*Diptera sp. (adult)	6	s	u
*Insecta sp. pupa	6	s	u
*Actenicerus sjaelandicus (larva)	5	n	oa
*Diptera sp. (puparium)	3	n	u

Context: 0 Sample: 521/1 ReM: D
Weight: 0.95

Delphacidae sp. B	18	n	oa-p
Aphrodes sp.	4	n	oa-p
Cyphon sp.	3	n	oa-d
Hydroporus ?scalesianus	2	n	oa-w
Stenus sp.	2	n	u
Bryaxis sp.	2	n	u
Heteroptera sp.	1	n	u
Aphrodes flavostriatus	1	n	oa-p-d
Delphacidae sp. A	1	n	oa-p
Pterostichus sp.	1	n	ob
Hydroporinae sp.	1	n	oa-w
Olophrum sp.	1	n	oa
Aleocharinae sp.	1	n	u
Pselaphus heisei	1	n	u
Curculionidae sp. A	1	n	oa
Curculionidae sp. B	1	n	oa
Scolytidae sp.	1	n	l
*Acarina sp.	15	m	u
*Coleoptera sp. (larva)	6	s	u
*Oligochaeta sp. (egg capsule)	6	s	u
*Diptera sp. (puparium)	3	n	u
*Insecta sp. pupa	1	n	u

Context: 4075 Sample: 105/T ReM: S
Weight: 2.50

null	0	n	u

Context: 4076 Sample: 99/T ReM: SS
Weight: 5.00

Olophrum fuscum	50	e	oa
Arpedium brachypterum	50	e	oa
Diacheila arctica	2	n	oa
Colymbetinae sp.	2	n	oa-w
Helophorus sp. A	2	n	oa-w
Ochthebius sp.	2	n	oa-w
Agonum sp.	1	n	oa
Hydroporinae sp. A	1	n	oa-w
Hydroporinae sp. B	1	n	oa-w
Colymbetes ?fuscus	1	n	oa-w
Helophorus sp. B	1	n	oa-w
Stenus sp. A	1	n	u
Stenus sp. B	1	n	u
Lathrobium sp.	1	n	u
Aleocharinae sp.	1	n	u
Simplocaria metallica	1	n	oa
Elateridae sp.	1	n	ob
Corticariinae sp.	1	n	rt
Curculionidae sp.	1	n	oa

Context: 4077 Sample: 108/T ReM: D
Weight: 3.00

Olophrum fuscum	153	n	oa
Arpedium brachypterum	116	n	oa
Aleocharinae sp. A	9	n	u
Stenus sp. C	5	n	u
Hydroporus sp.	4	n	oa-w
Simplocaria metallica	4	n	oa
Boreaphilus henningsianus	3	n	u
Diacheila arctica	2	n	oa
Helophorus sibiricus	2	n	oa
Stenus sp. A	2	n	u
Diacheila polita	1	n	oa
Hydroporinae sp.	1	n	oa-w
?Pycnoglypta lurida	1	n	rt
Stenus sp. B	1	n	u
Euaesthetus sp.	1	n	oa
Aleocharinae sp. B	1	n	u
Cyphon sp.	1	n	oa-d
Ceuthorhynchinae sp.	1	n	oa-p
*Oligochaeta sp. (egg capsule)	15	m	u
*Acarina sp.	6	s	u
*Aranae sp.	6	s	u
*Diptera sp. (puparium)	6	s	u
*Coleoptera sp. (larva)	1	n	u
*Trichoptera sp. (case)	1	n	oa-w

Context: 4078 Sample: 109/T ReM: SS
Weight: 1.70

Olophrum fuscum	15	m	oa
Arpedium brachypterum	15	m	oa
Trechus rivularis	1	n	oa-d
Bembidion sp.	1	n	oa
Carabidae sp.	1	n	ob
Helophorus sp.	1	n	oa-w
Olophrum sp.	1	n	oa
Boreaphilus henningsianus	1	n	u
Stenus sp.	1	n	u
Philonthus sp.	1	n	u
Aleocharinae sp.	1	n	u
Coleoptera sp.	1	n	u
*Sialis sp.	1	n	oa

Context: 4079 Sample: 110/T ReM: D
Weight: 2.00

Olophrum fuscum	85	n	oa
Arpedium brachypterum	22	n	oa
Hydroporus sp.	7	n	oa-w
Aleocharinae sp. A	4	n	u
Cyphon sp.	3	n	oa-d
Helophorus sibiricus	2	n	oa
Coelostoma orbiculare	2	n	oa-w
Cercyon ?tristis	2	n	oa-d
Boreaphilus henningsianus	2	n	u
Stenus sp.	2	n	u
Lygaeidae sp.	1	n	oa-p
Diacheila arctica	1	n	oa
Hydroporinae sp.	1	n	oa-w
Agabus arcticus	1	n	oa-w
Colymbetinae sp. A	1	n	oa-w
Colymbetinae sp. B	1	n	oa-w
Olophrum consimile	1	n	oa
Lathrobium sp.	1	n	u
Quedius sp.	1	n	u
Mycetoporus sp.	1	n	u
Aleocharinae sp. B	1	n	u
Aphodius sp.	1	n	ob-rf
Simplocaria metallica	1	n	oa
Ceuthorhynchinae sp.	1	n	oa-p
Curculionidae sp. A	1	n	oa
Curculionidae sp. B	1	n	oa
Coleoptera sp.	1	n	u

Table 13. Timber identifications for samples from Church Moss, Davenham.

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

Table 14. 'Spot' finds of biological remains from Church Moss, Davenham.

Trench	Context	Sample	Comments
A1	47	4127	approx. one half-nutshell fragment of *Corylus avellana* in a dark brown amorphous organic matrix
A1	47	4134	remains of approx. three nuts of *Corylus avellana* in a dark brown amorphous organic matrix
A1	67	4146	fragment of ?large puparium
A1	67	4155	distorted fragments of at least one *Corylus avellana* nut, the tissue rather strongly decayed; a few fragments of ?bark and so *Populus* 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 *Pinus sylvestris* 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: *Cetonia*
A1	bottom of 67	4142	dark brown amorphous organic sediment with several *Populus* bud-scales and unidentified twigs a few mm in size; one very corroded, nutshell fragment observed
A1	bottom of 67	4152	very decayed half-nutshell of *Corylus avellana* in a dark brown amorphous organic matrix with several *Populus* bud-scales
A1	top of 74	4161	there were no recognisable nutshell fragments, though a few fragments of very decayed *Pinus* wood to about 15 mm were noted
A1	168	4208	desiccated fragments of 1-2 *Corylus avellana* nutshells
B	15	4000	fragments of tooth enamel from large or medium mammal (det. K. M. Dobney)
D	150	4230	remains of approx. 30 *Corylus avellana* 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 shoed signs of having been holed by small mammals
D	154	4193	a few tens of flakes of pale brown bark, perhaps *Betula*, 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 *Bos* (det. K. M. Dobney)
?	182	4231	approx. 4 whole *Corylus avellana* nuts, soft, flattened, in dark grey clay silt matrix; at least two nuts holed by small mammals