Archaeological Services
University of Durham

Shakeholes F4 and F8, Nosterfield, North Yorkshire

palaeoecological assessment

Archaeological Services & Geography Department
Durham University

for
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Report 1647
April 2007

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Rec 4 May 07.

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Contents

1. Summary

1.1 *The project*

Sediment sequences were taken from two shakeholes (F4 and F8) at Nosterfield, North Yorkshire. This report presents the results of pollen, plant macrofossil and radiocarbon assessment of the deposits.

1.2 *Results*

All of the samples of peat from F4 were dominated by fragments of wood and woody roots, with a low diversity of other plant macrofossils. This abundance of arboreal remains suggests the local presence of carr throughout the accumulation of the deposit. The pollen record extends from the early Holocene rise of *Corylus* pollen (c.9000BP) to after the *Ulmus* decline (c.5000BP), but the lower profile appears mixed or contaminated. The radiocarbon dates are out of sequence.

A diverse range of plant macrofossils occurred in F8. These indicated fluctuations in the local watertable. An initial increase in wetter conditions resulted in the opening of the local woodland. Drier conditions returned for a period, but a subsequent increase in the watertable caused a succession to fen. A full pollen record is preserved from the start of the Holocene (c.10,000BP) to the late Roman period. The radiocarbon dates form a good sequence.

1.3 *Recommendations*

No further pollen or plant macrofossil analysis is recommended for F4 due to the low number and diversity of plant remains present, and the evidence that the profile is disturbed or contaminated. Full pollen and plant macrofossil analysis is recommended for F8, which will provide a detailed reconstruction of the local palaeoenvironment history for almost all of the Holocene.

2. Project background

2.1 *Location and background*

Shakeholes F4 and F8 were located at Nosterfield, North Yorkshire near to a scatter of worked flint from known Neolithic activity in the area. Two cores, F8 and F4, were collected in Summer 2006, from The Flasks at Nosterfield Quarry (Tarmac) by Mairead Rutherford (Durham University) and Richard Jackson (Mike Griffiths and Associates). The site is the subject of an archaeological investigation by Mike Griffiths and Associates, on behalf of Tarmac. Gouge cores were used to test the depth of peat at the two specific sites excavated by Richard Jackson. Russian cores were used to sample the peat. The upper sections of both sites were separately collected using monolith tins, by Richard Jackson. Pollen assessment was performed on 12 samples from F4 and 24 samples from F8. Plant macrofossil assessment was undertaken on 8 samples from F4, and 12 samples from F8.

2.2 *Objective*

The objective was to assess the potential of the material to provide information about vegetation history and human activity in the locality.

2.3 *Personnel*

Pollen assessments were carried out by Mairead Rutherford. Plant macrofossil assessment was by Dr Charlotte O'Brien. Report preparation was by Dr. Charlotte O'Brien and Dr. Jim Innes.

3. Methods

3.1 *Pollen*

Samples were prepared using standard techniques outlined in Moore ***et al.*** (1991), with alkali digestion of organic material, acid dissolution of mineral material and acetolysis oxidation of cellulose. At least 200 land pollen types per level were counted to provide a statistically viable count. The data are represented graphically (TGview) as Figs. 1 and 2. Assemblages are zoned without the use of a statistical package. The most accurate data are from the deeper core, F8. Samples from 20cm – 200cm only are presented for core F4 as the deeper data proved unreliable.

3.2 *Plant macrofossils*

A 50ml sub-sample from 8 levels of F4, and 12 levels of F8, was assessed for plant macrofossils. The sub-samples were disaggregated in warm water and washed through a nest of sieves ranging from 150-500μm size. The residues were scanned for plant macrofossils using a low power binocular microscope and identification was made by comparison with modem reference material. The results are presented in Tables 2 and 5. Plant taxonomic nomenclature follows Stace (1997). Assemblages are zoned without the use of a statistical package. Plant macrofossils are presented as relative abundance scores from 1-5 where:

1 = 1-2 macrofossils; 2 = 3-10 macrofossils; 3 = 11-40 macrofossils; 4 = 41-200 macrofossils; 5 = >200 macrofossils.

3.3 *Radiocarbon dating*

Based upon the pollen assessment results, six samples were sent to Beta Analytic, Miami for AMS radiocarbon dating, four from F8 and two from F4. Each shakehole already had one radiocarbon date on the top of the organic sediments before this assessment project.

4. Shakehole F4 Results

4.1 *Stratigraphy*

The stratigraphy of F4 is presented in Table 1.

Table 1: Strafigraphy of F4

Depth (cm)	Description
0 - 18	Disturbed soil
18 - 150	Dark brown amorphous peat
150 - 200	Black amorphous peat with moss remains
200-250	Laminated mud with gravel at base

4.2 *Pollen assessment*

The levels below 140cm contained pollen data that appeared to be a mixture of later pollen zones and this part of the profile is believed to be contaminated with later sediment. The pollen data from 140cm upwards are presented in Fig.1. Radiocarbon dates are shown on the diagram.

Zone F4a (140cm) Dominated by *Pinus* (pine) and *Betula* (birch), with high frequencies of Cyperaceae (sedges).

Zone F4b (120cm) Dominated by *Corylus* (hazel) with high Cyperaceae and lesser values of *Pinus*.

Zone F4c (60, 80 and 100cm) Dominated by high *Pinus* and *Corylus*, with some *Quercus* (oak) and *Ulmus* (elm) and lesser values for Cyperaceae. Filicales (fern) spores are particularly high at 60cm.

Zone F4d (40cm) Dominated by *Pinus* and *Alnus* (alder) with lesser frequencies for *Tilia* (lime) and *Corylus*.

Zone F4e (20cm) Dominated by high *Almus* and *Corylus*, with lesser *Pinus* and *Tilia*. Poaceae (grass) pollen rises and *Plantago lanceolata* (ribwort plantain) and ***Senecio*** (ragwort)-type occur.

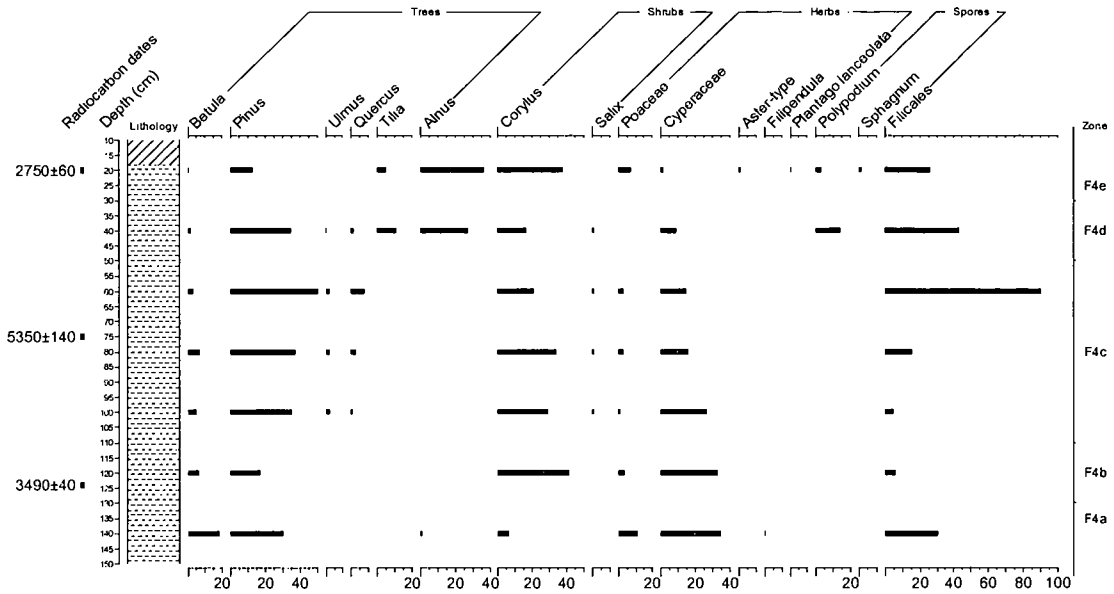

Figure 1: Percentage pollen diagram from Shakehole F4

4.3 *Macrofossil assessment*

Macrofossils are low in number and diversity throughout the peat. The remains have been tentatively grouped into three assemblage zones F4m1-F4m3. The results are presented in Table 2.

Only the top 140cm of F4 were assessed as pollen assessment showed that the sequence was disturbed below this level. All of the samples were dominated by fragments of wood and woody roots, with a low diversity of other plant macrofossils. This abundance of arboreal remains suggests the local presence of carr throughout the accumulation of the deposit.

A single *Betula pendula/pubescens* (silver/downy birch) fruit in F4m1 indicates that this taxon formed a component of the local wet woodland. The occurrence of *Cladium mariscus* (great fen-sedge) suggests it was an open, fen carr, with oligotrophic to mesotrophic, calcareous substrate (Preston *et al* 2002). *Juncus* sp(p) (rushes) and Pteridophyta sp(p) (ferns) also grew in the understorey.

Menyanthes trifoliata (bogbean) and *Chara* sp (stonewort) occurred in F4m2. These aquatic plants grow in shallow, calcareous water and may indicate slightly wetter conditions than the previous zone. The open nature of the woodland is again indicated by the fact that *Menyanthes trifoliata* is intolerant of shade (Preston *et al* 2002).

Table 2: Relative abundance scores for plant macrofossils from Shakehole F4

Depth (cm)		0-10	20-30	40-50	60-70	80-90	100-110	120-130	130-140
Charcoal		-	1	-	1	-	-	1	-
Insects		-	-	-	-	-	-	-	1
Rootlets		-	-	-	2	5	5	4	4
Wood/woody roots		3	4	4	4	5	5	4	4
Woodland									
Betula pendula/pubescens fruit (Silver/downy birch)	Fruit	-	-	-	1	-	-	-	1
Rubus idaeus (Raspberry)	Fruitstone	2	-	-	-	-	-	-	-
Sambucus nigra (Elder)	Fruitstone	-	1	-	-	-	-	-	-
Waterside/damp ground									
Ajuga reptans (Bugle)	Seed	-	1	-	-	-	-	-	-
Cladium mariscus (Great fen-sedge)	Nutlet	-	-	-	-	-	-	3	3
Juncus sp(p) (Rushes)	Seed	3	-	1	4	1	-	-	1
Mentha cf. *aquatica* (Aquatic mint)	Seed	-	1	1	1	-	-	-	-
Aquatic									
Chara sp (Stonewort)	Oogonia	-	-	-	-	-	1	-	-
Menyanthes trifoliata (Bogbean)	Seed	-	-	-	2	1	2	-	-
Unclassified									
Cenococcum geophilum (Soil fungus)	Sclerotia	1	-	-	-	-	-	-	-
Pteridophyta sp(p) (Ferns)	Sporangium	-	-	-	2	-	-	1	-
Zones		F4m3			F4m2			F4m1	

Relative abundance is based on a scale from 1 (lowest) to 5 (highest)

In F4m3, the woodland taxa *Sambucus nigra* (elder) and ***Rubus idaeus*** (raspberry) were recorded. *Ajuga reptans* (Bugle), *Juncus* sp(p) and *Mentha* cf. *aquatica* (aquatic mint) formed the understorcy vegetation.

A small amount of charcoal occurred in one sample from each zone, suggesting local fires of either natural or anthropogenic origin.

4.4 *Radiocarbon analyses*

The results of the two new radiocarbon analyses from shakehole F4 are shown in Table 3, together with the earlier radiocarbon assay from the top of the organic profile. Because of the paucity of macrofossils the dates were on bulk organic sediment.

Table 3: Shakehole F4 AMS radiocarbon date results

Shakehole F4 20cm 2750±60 BP Beta-211629 (previously dated) 2 Sigma Calibration : Cal BC 1020 to 800 (Cal BP 2970 to 2760)
Shakehole F4 75cm 5350±40 BP Beta - 228494 2 Sigma Calibration : Cal BC 4320 to 4050 (Cal BP 6280 to 6000)
Shakehole F4 124cm 3490±40 BP Beta-228495 2 Sigma Calibration : Cal BC 1890 to 1680 (Cal BP 3840 to 3630)

5. Shakehole F8 Results

5.1 *Stratigraphy*

The strafigraphy of F8 is presented in Table 4.

Table 4: Stratigraphy of F8

Depth (cm)	Description
0 – 17	Unconsolidated topsoil
17-54	Peat with some silt and clay
54-75	Paler brown fine-grained sandy sih with wood and numerous mollusks
75-165	Dark brown/black peat with silt/clay
165-465	Peat
465-475	Sand/gravel

5.2 *Pollen assesment*

The pollen results from Shakehole F8 are presented in Fig. 2 and are sub-divided into seven pollen assemblage zones. Pollen was not preserved at level 60cm. radiocarbon dates are shown on the diagram.

Zone F8a (460cm) Dominated by *Salix* (willow) with low frequencies of *Juniperus* (juniper) and *Betula*. A few grains of wetland herbs *Filipendula* (meadowsweet), Umbelliferae (umbellifers) and *Mentha* (watermint)-type occur.

Zone F8b (380, 400, 420 and 440cm) Dominated by Cyperaceae with lesser frequencies of *Betula* and *Pinus*. Poaceae and *Corylus* increase late in the zone.

Zone F8c (320, 340 and 360cm) Dominated by *Corylus*, *Pinus* and Cyperaceae with low *Betula* frequencies. *Ulnius* and *Quercus* curves begin.

Zone F8d (260, 280 and 300cm) Dominated by *Pinus* with *Corylus* and Cyperaceae also important. *Ulmus* increases and the *Alnus* curve begins.

Zone F8e (220 and 240cm) Dominated by *Alnus*, with lesser *Tilia*, *Betula* and *Corylus*. Cyperaceae is also important and peak values for *Nuphar* (yellow water-lily) occur.

Zone F8f (140, 160, 180 and 200cm) Dominated hy *Alnus*, with lesser *Quercus*, *Corylus*, Poaceae and Cyperaceae. *Uhnus* fades from the record. Consistent low curves for *Pteridium* (bracken) and *Plantago lanceolata* occur.

Zone F8g (20, 40, 80, 100 and 120cm) Dominated by Cyperaceae, with lesser frequencies of Poaceae. Peak *Pteriilium* values occur early in the zone. *P. lanceolata* is still consistently recorded and other open ground weeds like *Taraxacum* (dandelion)-type occur.

5.3 *Macrofossil assessment*

A diverse range of well-preserved plant macrofossils is present in F8. The remains have been grouped into four assemblage zones F8m1-F8m4. The results are listed in Table 5.

Zone F8m1. Wood fragments are abundant indicating that the local landscape was wooded. Fruits of *Betula pendula/pubescens* and *Populus* sp (poplar) buds indicate that these species were among those growing at the sampling site. *Carex* sp(p) (sedges) and Pteridophyta sp(p) were present in the understorey, and the fungus *Cenococcum geophilum* occurred in the woodland soil. This ectomycorrhizal species has mutualistic associations with some tree roots, particularly members of the Fagaceae, Pinaceae and Betulaceae (Hudson 1986). The relatively low number and diversity of understorey taxa may indicate a closed-canopy woodland.

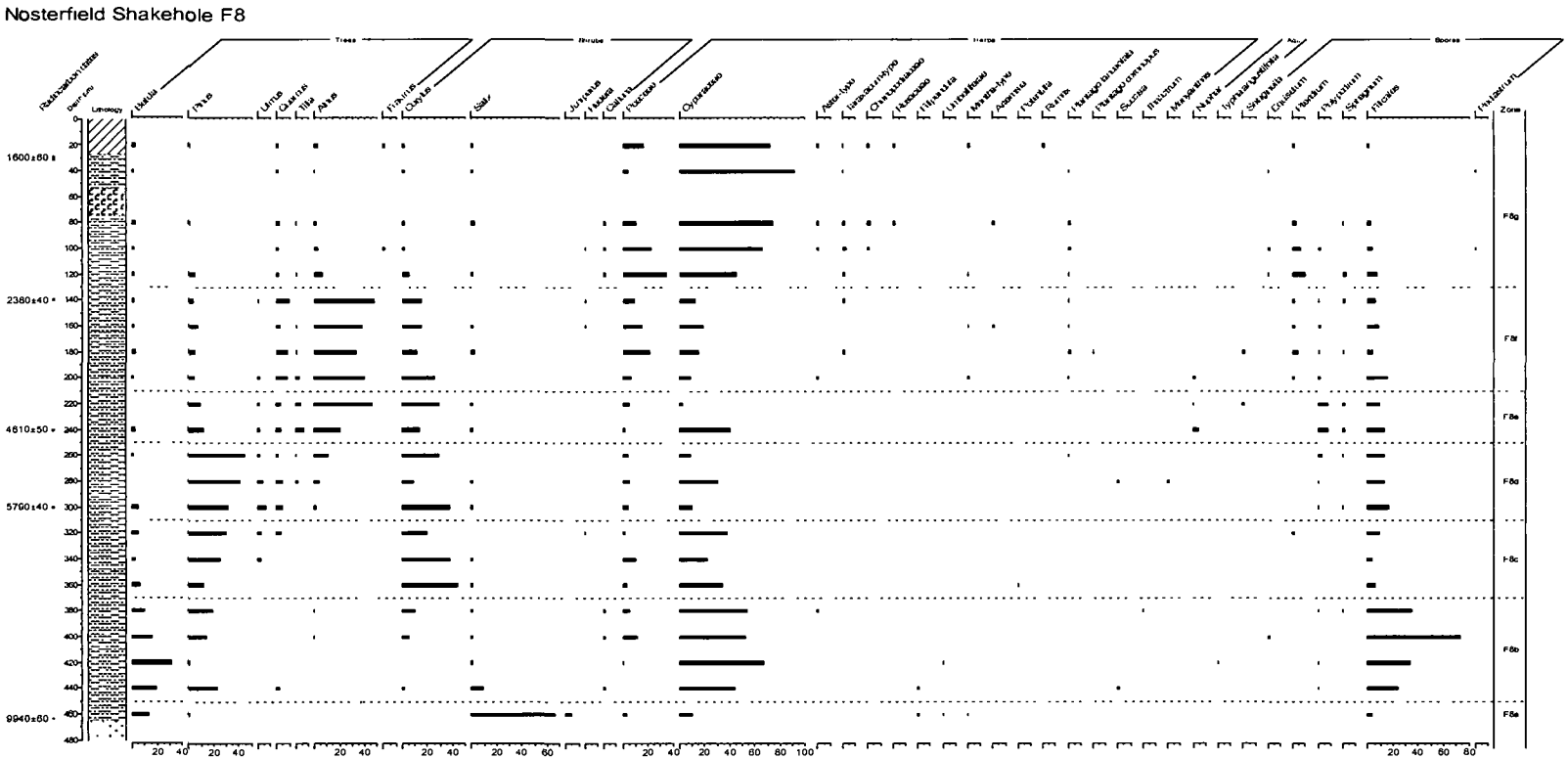

Figure 2: Percentage pollen diagram from Shakehole F8

Zone F8m2. There is a decline in the number of wood fragments and this zone is also characterized by an increase in *Carex* sp(p) and the appearance of *Cladium mariscus* and *Menyanthes trifoliata*. Monocot leaves and stems are also more abundant than in the previous zone. These changes indicate a rise in the watertable resulting in the development of open, fen carr. *Cladium mariscus* suggests oligotrophic to mesotrophic conditions (Preston *et al* 2002). Pteridophyta sp(p), *Mentha* cf. *aquatica*, *Juncus* sp(p) and Musci sp(p) (mosses) were also present.

Zone F8m3. There is an increase in wood fragments, reduction in sedges and disappearance of aquatic taxa. This may indicate a return to a more closed-canopy woodland and a lowering of the watertable, in response to drier conditions. *Rubus fruticosus* agg. (bramble) and *Rubus idaeus* formed the shrubby understorey, with the damp ground herbaceous taxa *Eupatorium cannabinum* (hemp-agrimony) and *Hydrocotyle vulgaris* (marsh pennywort) also present. The presence of *Urtica dioica* (common nettle) suggests relatively nutrient-rich soils (Preston *et al* 2002).

Zone F8m4. Wood fragments and other woodland remains are absent and the assemblage from this zone is dominated by aquatic and damp ground taxa indicative of the shallow, open water conditions of a fen. Oogonia of *Chara* sp are the most abundant aquatic taxon, with large numbers of *Menyanthes trifoliata* occurring towards the latter end of the zone. Low numbers of *Potamogeton coloratus* (fen pondweed) are present throughout the zone and *Ranunculus* subgenus *Batrachium* (crowfoot) is present between 55-65cm.

These taxa indicate calcium-rich but nutrient-poor water (Preston *et al* 2002; Preston 1995). *Baldellia ranunculoides* (lesser water-plantain) would have grown at the water's edge, where potential competitors are restricted by fluctuating water levels, disturbance or moderate exposure (Preston *et al* 2002). Mollusc shells are abundant between 55-65cm. *Carex* spp and *Eleocharis* sp(p) (spike-rush) are abundant in the fen vegetation, which also includes *Schoenoplectus lacustris* (common club-rush), *Lycopus europaeus* (gypsywort), *Mentha* cf. *aquatica* and *Juncus* sp(p).

A few small pieces of charcoal occurred in F8m1, F8m2 and F8m3 suggesting local fires of either natural or anthropogenic origin.

Table 5: Relative abundance scores for plant macrofossils from Shakehole F8

Depth (cm)		40-50	55-65	80-90	120-130	155-165	200-210	240-250	280-290	320-330	360-370	400-410	455-465
Buds		-	-	-	-	-	-	-	-	-	1	-	2
Charcoal		-	-	-	1	-	-	-	-	-	1	1	-
Insects		2	1	-	1	1	-	-	-	1	1	1	1
Molluscs		-	3	-	-	-	-	-	-	-	-	-	-
Monocot leavees/stems		2	-	-	-	-	-	-	1	1	3	2	-
Rootlets		-	1	1	1	-	-	-	3	3	3	-	1
Wood		-	-	-	2	3	3	3	1	1	1	3	5
Woodland													
Betula pendula/pubescens fruit (Silver/downy birch)	Fruit	-	-	-	-	-	-	-	-	-	-	2	2
Populus sp (Poplar)	Bud	-	-	-	-	-	-	-	-	-	-	-	2
Rubus fruticosus agg. (Bramble)	Fruitstone	-	-	-	1	2	1	-	-	-	-	-	-
Rubus idaeus (Raspberry)	Fruitstone	-	-	-	1	1	-	-	-	-	-	-	-
Waterside/damp ground													
Baldellia ranunculoides (Lesser water-plantain)	Fruit	-	3	2	-	-	-	-	-	-	-	-	-
Carex sp(p) (Sedges)	Biconvex nutlet	3	1	-	-	-	-	-	-	-	-	1	-
Carex sp(p) (Sedges)	Trigonous nutlet	1	2	1	1	-	1	-	-	2	2	-	-
Cladium mariscus (Great fen-sedge)	Nutlet	-	-	-	-	-	-	-	-	2	2	-	-
Eleocharis sp(p) (Spike-rush)	Nutlet	1	3	-	-	-	-	-	-	-	-	-	-
Eupatorium cannabinum (Hemp-agrimony)	Achene	-	-	-	1	1	-	1	-	-	-	-	-
Hydrocotyle vulgaris (Marsh pennywort)	Fruit	1	-	1	1	-	-	-	-	-	-	-	-
Juncus sp(p) (Rushes)	Seed	-	2	2	2	2	-	-	1	-	-	-	-
Lycopus europaeus (Gypsywort)	Nutlet	1	-	-	-	-	-	-	-	-	-	-	-
Mentha cf. *aquatica* (Aquatic mint)	Seed	2	-	3	2	1	-	-	1	-	-	-	-
Schoenoplectus lacustris (Common club-rush)	Nutlet	-	1	-	-	-	-	-	-	-	-	-	-
Aquatic													
Chara sp (Stonewort)	Oogonia	3	5	3	-	-	-	-	-	-	-	-	-
Menyanthes trifoliata (Bogbean)	Seed	4	-	-	-	-	-	-	3	2	1	-	-
Potamogeton coloratus (Fen pondweed)	Fruit	1	2	1	-	-	-	-	-	-	-	-	-
Ranunculus subgenus *Batrachium* sp (Crowfoot)	Achene	-	1	-	-	-	-	-	-	-	-	-	-
Unclassified													
Cenococcum geophilum (Soil fungus)	Sclerotia	-	-	-	1	-	-	-	-	-	-	1	-
Cirsium sp (Thistle)	Achene	-	-	-	2	-	-	-	-	-	-	-	-
Musci sp(p) (Mosses)	Branch	2	-	-	-	-	1	-	-	-	1	-	-
Pteridophyta sp(p) (Ferns)	Sporangium	-	-	-	-	-	1	-	-	-	2	4	-
Urtica dioica (Common Nettle)	Achene	-	-	-	-	-	1	-	-	-	-	-	-
Viola sp (Violet)	Seed	-	-	-	2	-	1	-	-	-	-	-	-
Zones		F8m4			F8m3				F8m2			F8m1	

Relative abundance is based on a scale from 1 (lowest) to 5 (highest)

5.4 *Radiocarbon analyses*

The results of the four new radiocarbon analyses from shakehole F8 are shown in Table 6, together with the earlier radiocarbon assay from the top of the organic profile. Dates were on wood fragments, too small to identify to species.

Table 6: Shakehole F8 AMS radiocarbon date results

Shakehole F8 30cm **1600±60** BP Beta-211632 (previously dated) 2 Sigma Calibration : Cal AD 340 to 600 (Cal BP 1610 to 1350)
Shakehole F8 140cm **2380±40** BP Beta-2228497 2 Sigma Calibration : Cal BC 720 to 700 (Cal BP 2670 to 2650) and Cal BC 540 to 390 (Cal BP 2490 to 2340)
Shakehole F8 240cm **4610±50** BP Beta-228498 2 Sigma Calibration : Cal BC 3490 to 3460 (Cal BP 5440 to 5420) and Cal BC 3370 to 3090 (Cal BP 5320 to 5040)
Shakehole F8 300cm **5790±40** BP Beta-228499 2 Sigma Calibration : Cal BC 4710 to 4500 (Cal BP 6660 to 6450)
Shakehole F8 464cm **9940±60BP** Beta – 228500 2 Sigma Calibration : Cal BC 9670 to 9280 (Cal BP 11620 to 11230)

6. Discussion

The record from shakehole F4 preserves a record from the time of the rise of hazel pollen, usually before c.9,000 BP, to after the elm decline, shown by the appearance of ribwort plantain. The sediment is compact, with several thousand years represented by only 1.5m of peat. The lower part of the profile below 140cm appears disturbed, and is unreliable. The macrofossil evidence is sparse and generally only indicates the presence of sedge dominated wetland vegetation. Site F4 is a poor environmental record, although the mid-Holocene pollen stratigraphy appears well preserved and reliable. The three radiocarbon dates are out of series and the lower two in particular are much too young for the associated pollen assemblages. Root penetration by scrub growing on the surface of F4 may have caused contamination of the section.

The pollen and macrofossil data for F8 complement each other very well. The birch and poplar macrofossil remains at the base of the peat are typical of early Holocene woodland and the pollen from this level, before the immigration of hazel, agrees well with this age. Poplar pollen is fragile and hardly ever preserved, even in peat sediments. The radiocarbon date of 9940±60 BP also agrees. The subsequent colonization of the site by sedges is reflected in both the macrofossils and pollen. The pollen record includes the successive immigration of the woodland trees in the first half of the Holocene. Hazel, pine, oak, elm, alder and lime are all introduced in turn. The rise of alder pollen and decline in pine pollen marks the start of the mid-Holocene forest maximum and occurs at F8

between zones F8d and F8e. The F8e to F8f boundary is interpreted as the elm decline that occurs around 5,000BP on most north-west European pollen diagrams (Parker *et al.* 2002). The whole of the first 5,000 years of the Holocene is therefore preserved in F8. The radiocarbon dates of 5790±40 BP and 4610±50 BP for this part of the profile are in sequence but young for the pollen data. A very late immigration of alder to this area would be required for the dates to be correct.

The occurrence of weeds, particularly ribwort plantain and bracken, at the start of zone F8f confirms the elm decline identification and marks the start of human woodland disturbance and agriculture. The radiocarbon date below this level seems rather young. Although never very well marked, indications of forest opening persist through the rest of the diagram. The major vegetation change occurs at the F8f to F8g zone boundary, when sedge pollen rises to dominate the record and all woodland types fall sharply. The herb indicators of human impact increase little however, and so this major vegetation change was probably due to climate change, with greatly increased bog surface wetness causing major sedge colonization. The presence of some *Pediastrum* algae in this upper zone also indicates standing surface water, and the macrofossil remains include many waterside and aquatic herbs that were previously absent. A major climatic deterioration and the swamping of the site by wetland vegetation occurred, and this may well be correlated with the major early Iron Age climate event around 2800BP (van Geel *et al.* 1996). The radiocarbon date of 2380±40 BP for this level is rather younger, although still Iron Age. Some deforestation may also have occurred to produce the almost total decline in tree pollen from this point onwards, and the layer of silty clay in the stratigraphy in this zone presumably was caused by inwash of material from around the depression.

Shakehole F8 therefore preserves an unbroken environmental record of about 8,000 years from the start of the Holocene until the post Iron Age period and is an extremely valuable site. It covers all of the environmental record preserved at F4, and extends further in time both before and after the F4 record. Its macrofossil record is also more diverse than that from F4.

7. Recommendations

No further pollen analysis is recommended for F4 because its lower profile appears to be mixed and unreliable, and its upper profile is no improvement on that from F8. The radiocarbon dates also indicate mixing or contamination of the profile.

Full pollen analysis is recommended for F8 as the profile provides an unbroken record from the start of the Holocene to the post Roman period, including indications of human activity from Neolithic times onwards and evidence of significant later Holocene climatic change. Except for the basal date, the

radiocarbon dates seem young for the pollen record, but they do form a good series. Further dates would help to assess the value of this dating series.

No further plant macrofossil analysis is recommended for F4 due to the low number and diversity of plant remains present.

Full plant macrofossil analysis is recommended for F8, which will provide a detailed reconstruction of the local environmental history.

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