Minchery Farm, Littlemore, Oxford – Geoarchaeology and Palaeoenvironments

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Introduction

The geology of the Oxford Region is dominated by gently tilted limestones and clay strata (Parker and Goudie, 1998). The juxtaposition of these strata has given rise to numerous springs and seepages, which in some instances has led to the formation of peat. Such deposits provide important archives of environmental change. By analysing the physical, chemical and biological characteristics of the sediments preserved in these peat deposits change in the development of the landscape can be determined. Landscape change may be brought about via 'natural' or 'human' induced events.

The Minchery Farm area, between Littlemore and the Kassam Stadium, has been a major focus for archaeological investigation associated with developer funding archaeology. Infrastructure developments in the area include the Oxford Science Park, the Kassam Stadium and Hotel complexes, and the multiplex cinema site. Archaeological excavation shws human occupation and impact on the landscape spanning from the Mesolithic period to the late Mediaeval period (approximately the last 10,000 years). Finds include Mesolithic flints, Neolithic pottery, early prehistoric post-holes, Bronze Age pottery, Roman pottery kilns and pottery amongst others.

The site is located on the southern boundary of the Northfield Brook, the source of which rises 5km to the north-west (Parker and Anderson, 1996). Extensive peat deposits exist along this shallow valley, which preserve waterlogged materials suitable for geoarchaeological and palaeoenvironmental reconstruction. The area of peat blankets the slope below springs which issue from the base of the Beckley Sand Member, which is comprised of fine to medium grained quartz sands (Horton et al., 1995). Excavations at the Oxford Science Park site revealed evidence for two beaver dams across the Northfield Brook. One of these was dated to the Iron Age (Moore, 2001).

Detailed pollen analysis from the Kassam Stadium site revealed a 175 cm deep section spanning the last 10,000 years which tracked changes in the vegetation, climate and human impact from the surrounding region (Parker and Anderson, 1996). Within the extensive peat deposits, Roman pottery from the 2nd and 3rd centuries AD was found t the site of the Multiplex Cinema complex (RPS. Unpubl.), a horses head with associated Roman Pottery was found at the Oxford Science Park site (Moore, 2001).

In 2012 Archaeox: The East Oxford Archaeology & History Project excavated trenches to the east of Minchery Farm and the also on the site of the Medieval priory at Minchery Farm Paddock. An evaluation trench was extended towards the Northfield Brook, which revealed peat buried underneath topsoil. 1.2 m of sediment was recovered using three overlapping monolith-sampling boxes. On the basis of pottery found in the trench it is thought that the peat here accumulated during the Roman period.

Methods

The excavation trench profile revealed several units as shown in Table1. The monolith sections cut through all of the units except for the Topsoil/Turf unit 100.

Unit	Description
1000	Topsoil/turf - 100mm
1002	Firm/mid blue grey (with frequent mid orange veins)/Clay silt - 140mm
1008	Similar to 1002 above but with higher clay content -260mm
1001	Friable/dark brown black/clayey silt with very high organic component = Peat - 500mm
1003	Firm/light grey/silty clay – 220mm
1006	Firm/light grey/silty clay (60%)/ sub angular gravel (40%) 50mm+

Table 1: Sedimentary units described in the MP12 TR1 south facing trench.

A 1.20 m long sediment sequence was collected in the field from an open trench section using three 50 cm long, over-lapping monolith tins. The depths are reported in m OD. The tops of each monolith tin were as follows:

Top of 1012 58.14m OD
Top of 1011 57.86m OD
Top of 1010 57.56m OD

Several techniques were employed to characterise the nature of the sediments and depositional history of the sequence. Bulk density (ρ) expresses the relationship of sediment mass to its volume (g/cm^3). Changes in bulk density may be related to a rise in the degree of organic decomposition, a change in the botanical composition of the sediment or due to an increase in the abiotic component of the sediment. This technique provides an indicator of changing sedimentary characteristics, which may help infer changes in the environmental history of the site (Bengtsen and Enell, 1996). Moisture content is associated with bulk density and will depend upon the volume and size of the pores in the sediment mass. As bulk density increases, the water holding capacity generally decreases. Bulk density measurements were made using calibrated brass pots (Parker, 1995) and placed in a drying oven overnight at 105°C.

The organic content of the sediment was calculated as the percentage weight loss on ignition (LOI) at 550°C for 2 hours (Hieri et al., 2001). The carbonate content of the sediment was determined by heating the sediment to 925°C for 4 hours. The amount of carbon dioxide lost in the process, as carbonates are converted to oxides, can be used to determine the original carbonate content of the sediment by multiplying the weight lost by 1.36 (the difference between the molecular weights of CO_2 and CO_3) and expressed as a percentage (Bengtsen and Enell, 1996). The remaining residue is expressed as a percentage and reflects the inorganic sediment component.

Iron oxides form *ca* 2% of the constituents of the earth's crust, and are among the most sensitive indicators of environmental change conditions and processes (Oldfield, 1991). Different minerals exhibit distinct magnetic properties, allowing identification and differentiation of rock, and sediment types based purely on their magnetic characteristics (Walden *et al*., 1992). Such magnetic properties are often diagnostic of sources and of palaeoenvironmental processes including burning, slope instability and in wash of sediments. In washed material tends to have a greater magnetic signal than autochthonous, organically derived material generated *in situ*, providing that diagenetic processes are not prevalent. Increases in the magnetic signal from a sediment profile should reflect the extent of slope disturbance in response to human-induced phenomenon such as burning, clearance of vegetation and slope wash within the catchment. Sub-samples were dried overnight at 60°C and disaggregated using a rubber ended pestle and agate mortar. Samples were measured using a Bartington MS2 meter and 2b sensor.

Four pollen samples were examined in order to determine the vegetation characteristic of the site and surrounding region. 1cm 3 sub-samples were prepared using standard techniques (Moore et al, 1991). Samples were counted using a Nikon E400light microscope with phase contrast. Plant macrofossils samples were washed through a bank of sieves and picked under a low power binocular microscope.

Results:
Results from the core analyses are summarised in Figure 1. The diagram was divided into zones based on major changes observed and labelled from the base upwards with zone MF prefix and described from oldest to youngest.

MF1 (56.90 – 57.20 m OD)
The basal 5 cm of the sequence is characterised by inorganic-rich sediments (Unit 1006), which comprise firm, light grey, silty-clay (60%) and sub angular gravels (40%). No visible plant detritus was present. This was overlain by ~22 cm of firm/, light-grey, silty clay (Unit 1003). In this zone, bulk density figures are relatively high (1.5-1.0 g/cm^3). Moisture content is generally low at around 20%, inversely corresponding to the bulk density figures. Loss on ignition (LOI) 550°C values are low (~15%) and increase to ~60% at t he top of the zone. The LOI 950°C values are ~5% for much of the unit and decrease to ~2.5% at the top of the zone. Magnetic susceptibility of the sediment is low with a small peak at 56.95 m OD (~0.35 units) but starts to rise at the top of the zone. At 57.05 m OD the pollen was reasonably well preserved but sparse and only a low count was possible (n=136). The sample was dominated by open ground taxa including Gramineae, Cyperaceae and some Chenopodiaceae. Single grains of *Helianthemum* and Compositae

Liguliflorae were also present. Tree and shrub pollen levels were low and included *Pinus, Betula* and single grains *Corylus* and *Salix*. A single Nympheae grain was also present.

MF2 (57.20 – 57.45 m OD)
The sediment in this zone comprised ~50 cm of peat, which extended to the top of zone MF3 as well. This formed friable, dark-brown-black, clayey silt with very high organic component (Unit 1001). This zone is marked by a sharp increase in organic content and water content. This unit shows a large decrease in bulk density compared to the previous zone (values around 0.25 g/cm^3), indicating an increase in the organic composition of the sediment. A peak in bulk density (0.8 g/cm^3) occurs at 53.28 m OD. The moisture content in this zone is consistently high (relative to the previous zone) with values ranging from 50-70% - another indicator of an organic matter increase. LOI at 550°C values rise to around 60%. LOI at 950°C decreases to ~2.5%). Magnetic susceptibility values rise at the base of the zone to 0.4 x $10^{-6}m^3 kg^{-1}$and fall to lower values at the top of the zone ~ 0.1 x $10^{-6}m^3 kg^{-1}$. A pollen sample from MF2 was examined from 57.35 m OD. The sample contained well-preserved pollen. Tree and shrub pollen account for 57% of the total pollen sum. The level is dominated by *Betula* (37%) with *Pinus* (6%), *Corylus* (10%), *Ulmus* (2%) and *Salix* (1%) and *Alnus* (<1%). Non-arboreal herb pollen account for 30% of the pollen sum with Gramineae (17%) and Cyperaceae (11%) accounting for most of this component along with low frequencies of **Filipendula**, Umbelliferae, Compositae Liguliflorae and Chenopodiaceae. Filicales spores account for 12% of the total sum.

MF3 (57.45 – 57.72 m OD)
The zone was characterised by peat sediment (Unit 1001) with an increased clay and silt content towards the top of the unit. The sediment in this section shows some degree of humification with woody detritus and some minor iron staining. Some inclusions of sand and gravel were also present. Low BD (0.3-0.05 g/cm^3) and relatively high moisture content (75%) characterise the lower half of the zone. This falls to ~55% towards the top of the zone. Magnetic susceptibility are the highest in this unit than compared to the rest of the sequence. Values are variable with two major peaks observed at 57.55 m OD ($0.6x10^{-6}m^3 kg^{-1}$) and at 57.70 m OD ($0.8x10^{-6}m^3 kg^{-1}$). LOI 550°C values decline up zone from ~60% to 40%. LOI 990°C values increase to ~ 3%). Pollen from 57.66 m OD comprised 145 tree and shrubs with *Alnus* (9%) and *Corylus* the main types found. A single grain of *Tilia* was also found. The herbaceous pollen types were dominated by Gramineae (24%), Cyperaceae (46%) and Compositae Liguliflorae (9%). Caryophyllaceae, Chenopodiaceae, *Filipendula* and Umbelliferae were also observed in small amounts. A single cereal sized grain was also noted.

MF4 (57.72 – 57.88 m OD)
This zone is characterised by higher silt and clay content and a high degree of humification (Unit 1008). Some woody plant matter, fine detritus and charcoal were identified. The presence of some amounts iron oxide was also visible. The zone was characterised by little low values in BD (~0.2 g/cm^3), moisture content (about 60 – 70 %) and inorganic residue (about 20-40%). Magnetic

susceptibility values fall compared with MF3 with values ~ $0.3x10^{-6}m^3 kg^{-1}$. The LOI 550°C values are highly variable ranging from 10% to 60% and 950°C were almost the mirror images of each other, with high values of LOI 550°C (about 70-58%) and general low values of LOI 950°C (about 2.5-7.5%). The maximum values of LOI 950°C and inorganic residue correspond with the minimum values of LOI 550°C. The pollen from 57.76 m OD mainly comprised open ground taxa. Gramineae (30%) and Cyperaceae (42%) dominate the signal. Low frequencies of Chenopodiaceae, Caryophyllaceae, *Filpendula*, Composiate Liguliflorae and Umbeliferae were also present. Cereal pollen types comprised 2% of the pollen sum. Filicales spores account for 6% of the sum. Numerous microscopic particles of charcoal were observed on the pollen slide.

MF5 (57.88 – 58.14 m OD)
Unit 1008 extended into the lower half of zone MF5. This is overlain by 14 cm of firm, mid-blue-grey (with frequent mid orange veins) silt (75%-80%), clay and a minor sand component (Unit 1002). There was some reported presence of iron oxides, humus and fine detritus, but no charcoal or woody plant matter. This zone was characterised by a steady increase in BD (up to 0.65 g/cm^3 towards the surface), and inorganic residue (reaching 80%). LOI 950°C (about 6-5%) values are generally higher than in MF4. A steady decline was recorded for moisture content (40% at surface from an initial 65% at the base of the zone). LOI 550°C values fall to very low levels ~2% in this zone. Relatively stable and low magnetic susceptibility values were recorded in this zone ~$0.25x10^{-6}m^3 kg^{-1}$.

Discussion:

Zone MF1 (Units 1006, 1003)
Results from the BD and moisture contents from MF1 showed high values in mineral residue with low quantities of organic matter. This may have been influenced by a period of sparse vegetation cover with inwash of sediment from the surrounding slopes into the stream channel with the deposition of clastic sand and sub-angular gravels along with finer grained silts and clays. Pollen in MF1 comprised open ground taxa dominated by grasses and sedges. Some tree pollen was present including Birch, Pine, and trace levels of Hazel and Willow. Similar results were observed at Minchery Farm (Parker and Anderson, 1996) and the Oxford Science Park (Parker, 2002) from basal, grey, inorganic silt-rich sediments. The basal sediments may reflect the end late glacial (Younger Dryas) and very early Holocene. During this phase the Upper Thames Valley was characterised by cold, tundra conditions dominated by grass, herbs, and sporadic trees cover including Birch (*Betula* sp.) and some Pine (*Pinus sylvestris*) (Day, 1991; Parker, 2000). Pollen from a tree-throw pit, underlying the main peat bed, at the Oxford Science Park showed an open environment dominated by grasses and sedges with some birch and pine present. This deposit was dated to 9945$\pm$50 BP (11291-11531 cal. BP 1σ; 9461$\pm$60 cal. BC) and 9896$\pm$50 ^{14}C BP (11250-11376 cal BP 1σ; 9366$\pm$60 cal. BC) (Moore et al., 2001). Similar environmental conditions have also been reported at Cothill Fen and Sidlings Copse (Day, 1991), Spartum Fen (Parker 2002), and Mingies Ditch (Allen and Robinson, 1993) at this time.

Zone MF2 (Unit 1001)
High values in LOI, moisture content and corresponding low values in BD reflect a change to organic-rich peats in MF2. Pollen from the base of the zone shows the development of Birch, Pine and Hazel woodland. Open grassland and sedges were also present, most likely in the vicinity of the river valley. The presence of Elm but not Oak suggests a time period around 8800 BP (Day, 1991; Parker 2000). Archaeological analysis of faunal assemblages at Mingies Ditch demonstrates that a transition to warmer climates occurred around 9380 BP (Allen and Robinson, 1993). The increase in magnetic susceptibility values reflects the hypothesised use of fire by hunter-gatherers as a technique for hunting and browsing (Edwards, 1988). This was corroborated by the presence of microscopes charcoal fragments on the pollen slide at 57.35 m OD. A small quantity of Mesolithic debitage was found at Minchery Farm (Beckley et al. 2012).

During the Early Neolithic the Oxford region was heavily wooded with Alder, Lime, Oak, Hazel, Ash and Elm (which began to decline at ~5,000 BP) (Parker and Anderson, 1996). Woodland clearance was not widespread during this period and impacts of agriculture are quite small. Cultivation did not replace wild food plant collection until well into the Bronze Age (Parker, 2000). Increasingly dry conditions during this period may be responsible for the absence of cereal cultivation in Oxford (Robinson and Lambrick, 2009). From the analyses to date at MF it has not yet been ascertained whether this period is covered in the sequence. The proposed radiocarbon dating programme will elucidate this point.

Zone MF3 (Unit 1001)
Magnetic susceptibility values increase overall in MF3 with two major peaks. Evidence for burning is corroborated by high levels of microscopic charcoal observed on the pollen slide at the top of the zone. Pollen from this level (57.66 m OD) revealed an open landscape with grasses and sedges dominating the signal. Disturbed ground indicators included Compositae Liguliflorae, which suggest grazing and trampling/disturbance in close proximity to the site. Evidence for the presence of some cereal cultivation was also noted. The presence of some Alder carr along the valley is also suggested with Hazel and a trace of Lime on drier ground in the surrounding landscape in magnetic susceptibility. In the upper part of the zone there is some evidence for the inwash of minerogenic sediment most likely associated with soil erosion as shown by the increase in bulk density, inorganic residue and decrease in moisture content. The erosion appears to be associated with burning as shown by the increase and highest peak in magnetic susceptibility.

This part of the sequence could represent the period from the middle Bronze Age to the Roman. Major disruption of woodland cover in the Upper Thames valley occurred from the middle Bronze Age. Zone MF3 shows evidence for widespread burning throughout much of the zone (high magnetic susceptibility values). Archaeological and palaeoenvironmental sites in the Thames Valley highlight a largely cleared landscape, increased pasture for grazing, and cereal cropping. Intensified erosion, alluviation and a rise in the regional water table was enhanced during the Iron Age (Jones, 1988; Lambrick and Robinson, 1988). The rise in water table may have been a contributing factor for the continued presence of peat formation along the Northfield Brook, however, the presence of beaver dams noted earlier should also be considered. The largest peak in magnetics at the top of zone MF3 might be associated with the Roman pottery industry associated with area surrounding the site, and the use of coppiced wood as a source of fuel (Holliday, 2004; Tite, 1999; Booth and Edgeley-Long, 2003; Macklin *et al.,* 2006). The scale of the pottery industry in Oxford suggests that a managed system existed to provide an adequate fuel supply (Beckley and Radford, 2012b).

MF 4 & 5 (Unit 1008 and 1002)
The sediments comprise clay and silt-rich gleyed sediments with iron mottling characteristic of overbank alluvium. Increasing values for dry bulk density, decrease in moisture content and magnetic susceptibility denote this unit. Pollen from the lower part of MF4 at 57.76 m OD shows the continued presence of a largely open landscape dominated by grasses and sedges around the site with a slight increase in the presence of cereal grains. There is a slight increase in the Alder with a continued presence of Hazel and very low levels of Lime and some Blackthorn. Pollen analysis and sedimentology from Minchery Farm by Anderson and Parker (1996) indicates that the open grassland landscape from the Roman period was likely maintained into Saxon and Mediaeval times.

Conclusion
The sediments from Minchery Farm provide an important environmental record from the Oxford region. The results enhance the previous studies undertaken along the Northfield Brook. The results document an extensive period from just before the onset of the Mesolithic to well after the period of intense landscape exploitation of the Roman period. Radiocarbon dating will enhance the record by proving the first comprehensive chronology and provide a detailed framework against which the archaeology can be set.

References:

Beckley and Radford

Bengtsson, L. and Enell, M. (1986) Chemical analysis. In. Berglund, B.E. (ed.) *Handbook of Holocene Palaeoecology and Palaeohydrology*. John Wiley, Chichester, pp 423-454

Booth, P., and Edgeley-Long, G. (2003). Prehistoric settlement and Roman pottery production at Blackbird Leys. Oxford. *Oxoniensia.* 68 (1), 201-63

Day, S.P. (1991). Post-glacial vegetational history of the Oxford region. *New Phytologist*. 119 (1), p445-470.

Holliday, V.T. (2004). *Soils in Archaeological Research*. Oxford: Oxford University Press.

Jones, M.K. (1988). *Archaeology and the Flora of the British Isles: Human Influence on the Evolution of Plant Communities.* Oxford: Oxford University Committee for Archaeology.

Lambrick, G. and Robinson, M.A. (1988)

Macklin, M.G., Benito, G., Gregory, K.J., Johnstone, E., Lewin, J., Michczyńska, D.J., Soja, R., Starkel, L., Thorndycraft, V.R. (2006). Past hydrological events reflected in the Holocene fluvial record of Europe. *Catena*. 66 (1-2), p145-154.

Oldfield, F. (1991) Environmental magnetism: a personal perspective. *Quaternary Science Reviews* 10: 73-85

Parker, A.G. and Anderson, D.E. (1996) A note on the peat deposits at Minchery Farm, Littlemore, Oxford, and their implications for palaeoenvironmental reconstruction. *Proceedings of the Cotteswold Naturalists' Field Club*, XLI (I): 129-138

Parker, A.G. and Chambers, F.M. (1997) Late Quaternary palaeoecology of the Severn, Wye and Upper Thames. In, Lewis, S.G. and Maddy, D. (eds*) The Quaternary of the South Midlands and the Welsh Marches*. Quaternary Research Association, Cheltenham, England: 31-48

Parker, A.G. and Goudie, A.S. (1998) The distribution and modes of origin of peat and tufa deposits in the upper Thames valley. *Proceedings of the Cotteswold Naturalists' Field Club*, XLI (II): 230-248

Parker, A.G. (2000) Biotic response to Late Quaternary global change - the pollen record: a case study from the Upper Thames Valley, England. In Culver, S.J. and Rawson, P. (eds*) Biotic Response to Global Change: the Last 145 Million Years*. Cambridge University Press, Cambridge: 265-287

Tite, M.S. (1999). Pottery Production, Distribution, and Consumption: The Contribution of the Physical Sciences. *Journal of Archaeological Method and Theory*. 6 (3), p181-233.

Walden, J., Smith, J.P. and Dackcombe, R.V. (1992) Mineral magnetic analyses as a means of lithostratigraphic correlation and provenance indication of glacial diamicts: intra- and inter- unit variation. *Journal of Quaternary Science* 7: 257-270

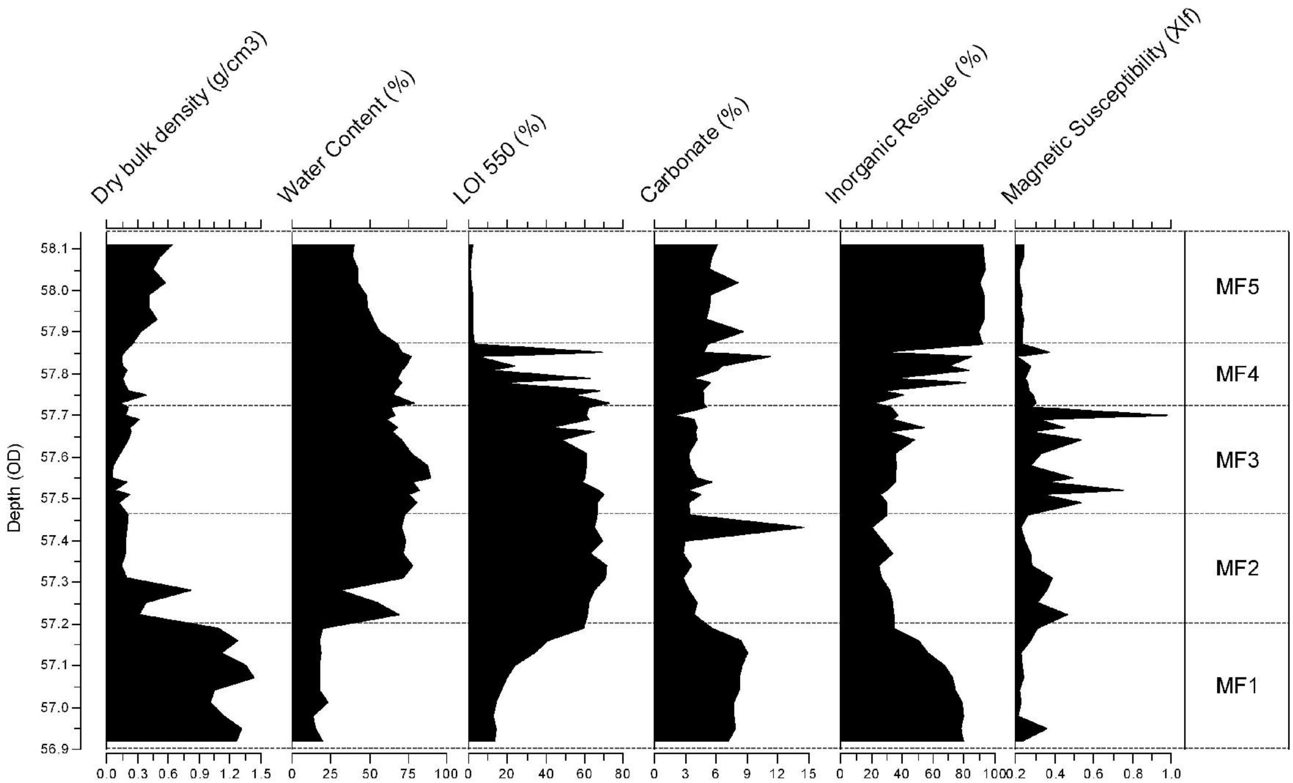

Figure 1: Stratigraphy and physical properties of a sediment sequence taken at Minchery Farm, Oxford (UK).

Depth m OD	57.76		57.66		57.35		57.05	
Trees and shrubs	n	%	n	%	n	%	n	%
Betula	1	0.43	0	0.00	94	37.01	3	2.21
Pinus	0	0.00	0	0.00	15	5.91	7	5.15
Ulmus	0	0.00	0	0.00	5	1.97	0	0.00
Alnus	32	13.73	20	8.81	2	0.79	0	0.00
Tilia	1	0.43	1	0.44	0	0.00	0	0.00
Corylus	5	2.15	11	4.85	27	10.63	1	0.74
Salix	0	0.00	0	0.00	3	1.18	1	0.74
Crataegus	1	0.43	0	0.00	0	0.00	0	0.00
Herbs								
Gramineae	70	30.04	55	24.23	44	17.32	44	32.35
Cerealia	4	1.72	1	0.44	0	0.00	0	0.00
Cyperaceae	97	41.63	105	46.26	27	10.63	73	53.68
Chenopodiceae	1	0.43	1	0.44	1	0.39	4	2.94
Caryphyllaceae	7	3.00	4	1.76	0	0.00	0	0.00
Filipendula	2	0.86	1	0.44	2	0.79	0	0.00
Compositae Liguliflorae	4	1.72	21	9.25	2	0.79	1	0.74
Umbelliferae	2	0.86	2	0.88	1	0.39	0	0.00
Helianthemum	0	0.00	0	0.00	0	0.00	1	0.74
Spores								
Filicales	6	2.58	5	2.20	31	12.20	0	0.00
Aquatics								
Nympheae	0	0.00	0	0.00	0	0.00	1	0.74
Trees and Shrubs	40	17.17	32	14.10	146	57.48	12	8.82
Herbs	187	80.26	190	83.70	77	30.31	123	90.44
Spores	6	2.58	5	2.20	31	12.20	0	0.00
Aquatics	0	0.00	0	0.00	0	0.00	1	0.74
Total Sum	233	100.00	227	100.00	254	100.00	136	100.00

Table 2: Pollen data from Minchery Farm