

Pollen analysis of a radiocarbon-dated core from North Mains, Strathallan, Perthshire

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SUMMARY

Cores for pollen and macrofossil analysis and radiocarbon dating were collected from a 6 m deep deposit near the North Mains excavation area. Results are presented for the upper 3.4 m which was mostly deposited between late Palaeolithic and late Neolithic times. During the Mesolithic the local landscape was covered by woodland containing a variety of deciduous trees and large shrubs (birch, oak, elm and hazel); no indication of disturbance was found in the pollen profile. The first indication of human activity is the presence of charcoal around the 100 cm depth above which cereal type pollen and a number of weed pollen types signal the arrival of Neolithic people. A radiocarbon date indicates that this happened around 5600 bp and the pollen diagram shows that it preceded the elm decline. This is one of only a few sites in Britain where pre-elm decline cereal type pollen has been recorded. At a depth of 35 cm there is a gap in the pollen profile representing a period of at least 3000 years, starting at around 4000 bp. It is therefore probable that the core covers the period of ring ditch and henge construction but not the period of barrow construction.

INTRODUCTION

Archaeologically the North Mains area (NGR NN 926 163) is of great interest and previously contained a number of monuments, namely ring-ditches, a henge and a barrow, dated to the third and early second millennia bc. A rescue excavation was carried out in 1978 and 1979 by the Central Excavation Unit of the Scottish Development Department before destruction of the monuments.

The excavation report was published in Volume 113 of these *Proceedings* (Barclay 1983). It contains results of pollen analyses of soil samples from 'old land surfaces' found beneath the henge and barrow, and from the body of the monuments. These samples yielded few pollen grains and only tentative comments could be made about the agriculture and vegetation in the area around the time of henge and barrow construction (Hulme & Shirriffs 1983). However, a core from a kettle-hole deposit only 300 m W of the excavation site, thought to have accumulated during and prior to human occupation of the area, yielded abundant pollen. The results of this pollen investigation together with macrofossil analysis results and radiocarbon dates are presented here as one of the 'general discussion papers' of the excavation.

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METHODS

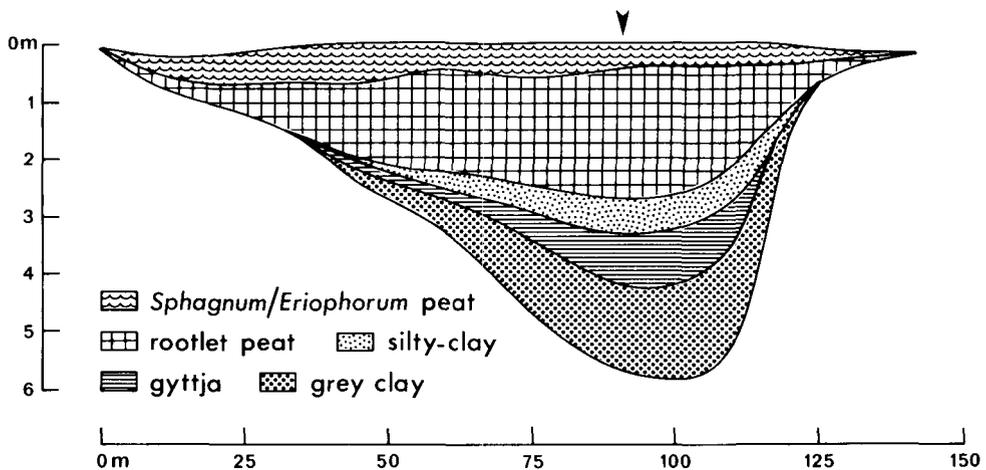
The site was cored using a Russian type sampler (Jowsey 1966) which was lifted from the deepest and stiffest horizons with the aid of a portable extractor (Blyth 1984). Cores were obtained for field examination to determine the general stratigraphy of the deposit and for laboratory analysis of the pollen and plant macrofossils. Samples were also taken for radiocarbon dating at Glasgow University's Radiocarbon Laboratory.

Preparation of samples for pollen analysis followed standard procedures (Faegri & Iversen 1974; Moore & Webb 1978). The extracted pollen was lightly stained with saffranin, mounted in glycerine jelly on microscope slides and counted using a Leitz Ortholux microscope fitted with phase contrast. Plant macrofossils were extracted by first heating core sections in 10% NaOH then sieving them under running water. The residues were examined using a stereomicroscope and, when necessary, the Ortholux microscope.

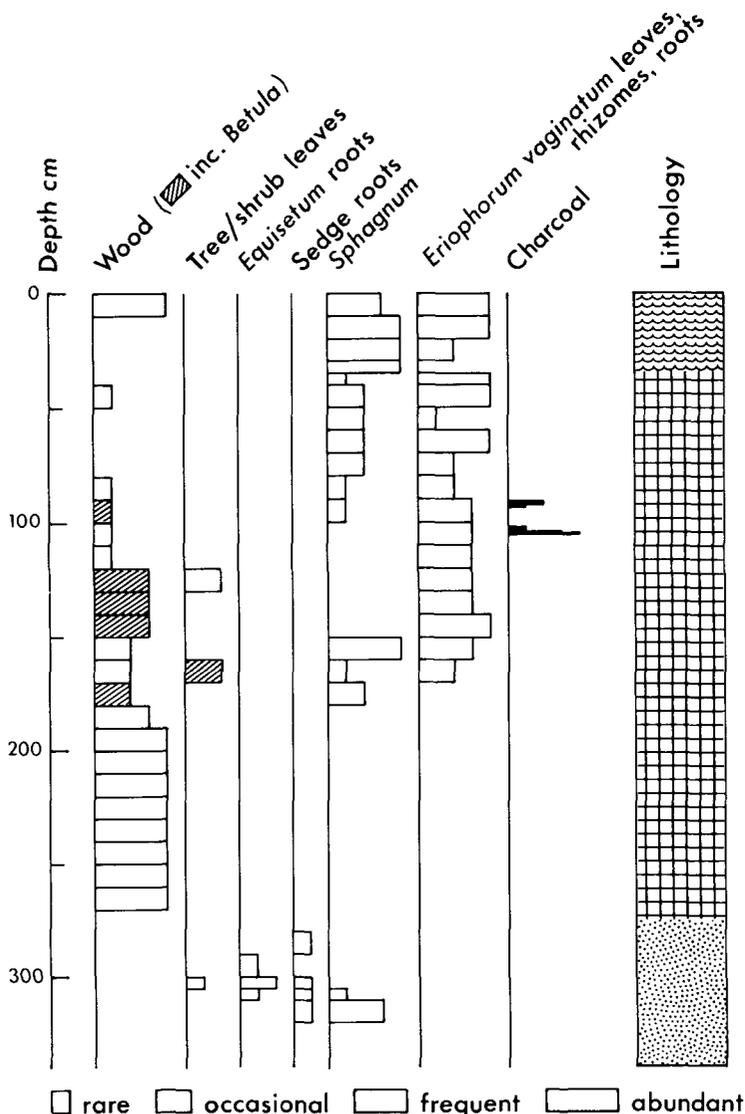
RESULTS

A generalized stratigraphical section based on the field examination of cores is presented in illus 1. It shows five main horizons. The deepest horizon consists of a thixotropic grey clay. Above this is a silty organic detritus (gyttja) which is overlain by a silty clay. These three horizons form a typical late glacial sequence. The rest of the deposit is composed of peat which forms a lower, moderately to highly decomposed rootlet peat horizon and an upper *Sphagnum/Eriophorum* peat horizon only slightly decomposed. Cores collected for pollen and macrofossil analysis were composed of grey clay from 570–430 cm, gyttja from 430–340 cm, silty clay from 340–275 cm, rootlet peat from 275–35 cm and *Sphagnum/Eriophorum* peat above 35 cm. In this paper pollen and macrofossil analysis results are presented for the upper three horizons only.

The depth distribution of selected macrofossils is shown in illus 2. The silty clay (340–275 cm) probably formed in shallow water prior to colonization by peat-forming plants. It contains remains of *Sphagnum* and other mosses, sedge and *Equisetum* roots and a few seeds. From 270 cm to 170 cm in addition to undifferentiated rootlets the main recognizable macrofossils are wood fragments. It therefore seems that once the peat started to accumulate trees or shrubs quickly became established on the mire surface. Above 170 cm *Eriophorum vaginatum* (cotton grass) roots and rhizomes become plentiful and are a major component of the peat through to the present surface. Wood is generally rare above 120 cm but again becomes plentiful in the top few centimetres. A number of wood fragments were sectioned and identified as *Betula*. Above 100 cm *Sphagnum* is constantly present but is a principal component of the peat only in the top 35 cm.



ILLUS 1 Stratigraphical section of the North Mains kettle-hole deposit

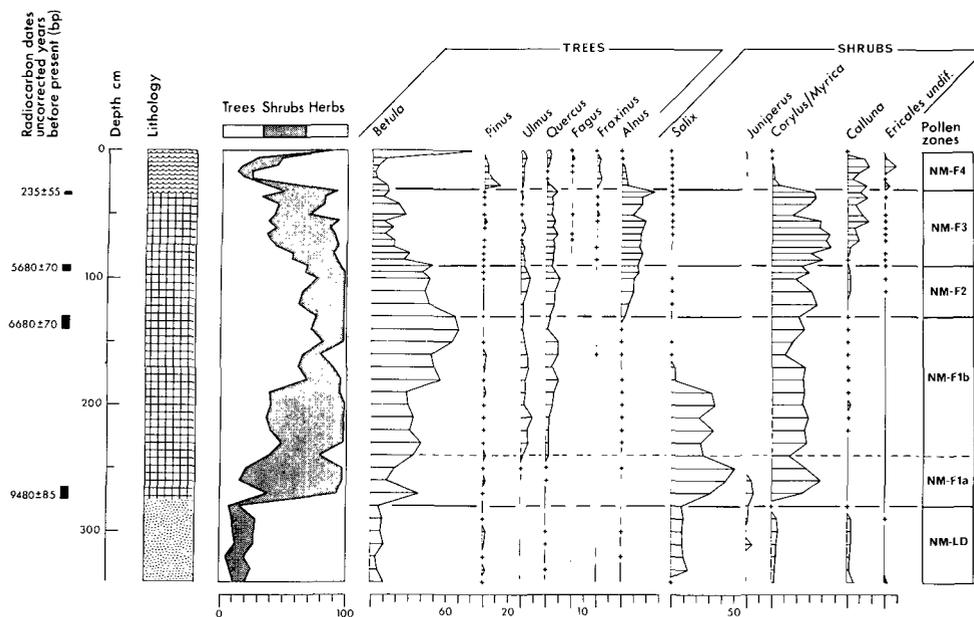


ILLUS 2 Selected plant macrofossils from North Mains

Charcoal occurred in two 10 cm peat sections between 110 cm and 90 cm which represent several hundred years of peat accumulation. As charcoal is often associated with human activity it was decided to obtain more information about its distribution within this layer. One centimetre contiguous samples were therefore taken between 110 and 90 cm and examined for charcoal only (illus 2).

The pollen analysis results are presented as a conventional pollen diagram (illus 3). Five pollen zones are identified and the notation of these zones represents the locality name North Mains (NM) and whether the zone is Late Devensian (LD) or Flandrian (F) in origin.

Zone NM-LD occurs between 340 and 280 cm depth and represents the silty clay horizon. No date was obtained for the start of this zone, but a radiocarbon date of 9480 ± 85 bp (GU-1727) for the start of the overlying zone (NM-F1) implies that the conclusion of NM-LD was around 9500 bp. The pollen evidence, however, which will be discussed later, suggests that there is a gap between the two zones. Herb pollen



ILLUS 3 Pollen percentage diagram from North Mains. The pollen sum includes all non aquatic pollen taxa; spore and aquatic taxa are represented as a percentage of the pollen sum. All values of less than 1% are shown as +. A number of rarely recorded taxa are not included in the diagram. The omitted tree and shrub taxa, their depth and percentage (if greater than 1%) are as follows: *Acer* 42 cm; *Picea* 0 cm, 6 cm (2.4%), 12 cm; *Hippophae* 340 cm; *Empetrum* 160 cm, 330 cm; *Crataegus* cf 6 cm (3.2%), 12 cm; *Ilex* 6 cm.

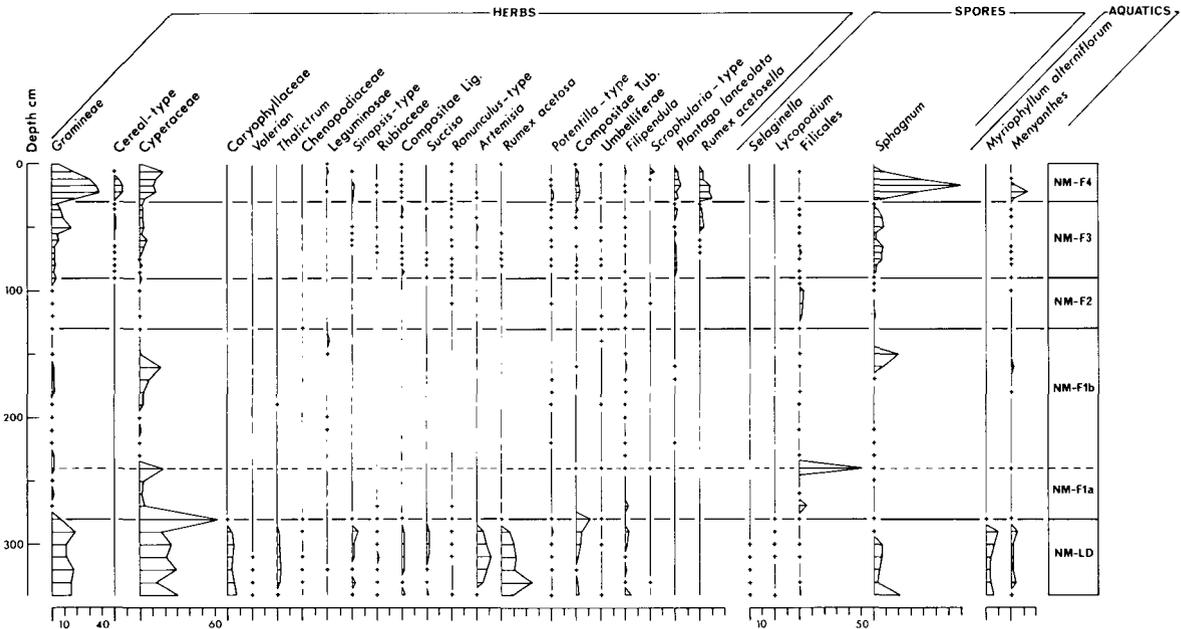
types are predominant and represent more than 70% of the pollen sum throughout NM-LD. The major herb types are Gramineae (grasses), Cyperaceae (sedges), Caryophyllaceae, *Artemisia* and *Rumex*.

Zone NM-F1 occurs between 280 cm and 130 cm and spans the time interval of 9480±85 bp to 6680±70 bp (GU-1726). It can be divided into two sub zones (NM-F1a and NM-F1b) at a depth of 240 cm (interpolated date 8500 bp). Throughout the zone tree pollen values steadily rise until they reach a maximum of 80%. Shrub pollen values rise rapidly at the onset of the zone but decrease as tree pollen values increase. Both numbers and values of herb pollen types drop sharply at the end of NM-LD and remain low throughout NM-F1.

At the start of sub zone NM-F1a *Betula*, *Corylus/Myrica* and *Salix* increase and account for nearly all the tree and shrub pollen. Except for a sharp decline of *Salix* at 180 cm sub-zone NM-F1b shares the above features. However, it is distinguished by an increase of *Ulmus* and *Quercus* pollen which reach maxima of around 10%.

Zone NM-F2 occurs between 130 cm and 90 cm and is dated to between 6680±70 bp and 5680±70 bp (GI-1725). Tree values are between 60% and 80% and herb values are around 2%. The beginning of the zone corresponds with the start of the *Alnus* rise and the abundance of *Alnus* pollen distinguishes this zone from NM-F1.

Zone NM-F3 occurs between 90 cm and 30 cm and its start is dated to 5680±70 bp. The radiocarbon date for peat from 35–33 cm is 235±55 bp (GU-1724). However this is unlikely to indicate the date for the close of NM-F3 but rather suggests a gap in the pollen record. If there were no gap the peat accumulation rate between 90 cm and 35 cm would have been only 25% of that for the underlying peat. This seems unlikely, especially as there is no visible or textural change in the peat below 35 cm. An extrapolation of the earlier radiocarbon-dates gives a date lying between 4300 and 4000 bp for peat of a depth of 35 cm. Therefore a gap of at least 3000 years is assumed. This probably results from the upper peat layers being cut away for use as fuel or animal litter within the past few hundred years.



ILLUS 3 cont. The herb taxa not included in the diagram are: *Epilobium*-type 340 cm; *Helianthemum* 330 cm, 340 cm; *Parnassia* 320 cm; *Plantago medialis* 330 cm; *Polygonum* cf 12 cm, 250 cm; Rosaceae undif. 240 cm, 260 cm, 330 cm; *Spergula*-type 0 cm, 6 cm, 12 cm; *Stachys*-type 0 cm

The pollen zone boundary between NM-F3 and NM-F4 does not coincide with the start of recent peat accumulation (a 5 cm discrepancy) but this may be an artefact resulting from disturbance when the peat was cut.

During NM-F3 there is a steady decline in the tree pollen curve, predominantly due to decreasing *Betula* pollen values. Herb pollen values correspondingly rise throughout the zone and the number of herb taxa greatly increases. The first cereal-type pollen grain was recorded at the start of the zone (90 cm) and at the same time, or shortly after, several taxa indicative of disturbance or agriculture occur or increase, eg Ranunculaceae, *Rumex*, *Potentilla*-type, Compositae, *Plantago lanceolata* and Gramineae. Also an elm (*Ulmus*) decline can be detected in this zone although it is not as distinct as that seen in diagrams for more southerly areas of Britain.

Zone NM-F4 occurs between 30 and 0 cm. For the first time *Pinus* pollen is present in substantial quantities. *Betula* pollen is generally low but its curve suddenly spikes (80%) in the topmost sample. The highest values for Gramineae pollen (38%) and cereal-type pollen (7%) occur in this zone.

DISCUSSION

Radiocarbon dates from several archaeological sites in Scotland indicate that man dispersed throughout much of the country during the centuries prior to 8000 bp (Coles 1971; Mercer 1979; Masters 1981; Robinson 1983). However, it has been tentatively suggested that Palaeolithic man could have reached Scotland (Jura) between 11 000 and 9000 bp (Mercer 1979). There is also some evidence that Palaeolithic man lived in Ireland (Woodman 1978; Mitchell & Sieveking 1972). If man did reach Scotland sometime between these dates he would have arrived while the silty clay or lower peat layers were accumulating. However, the predominance of herbs and weed taxa (illus 3) throughout pollen zone NM-LD (silty clay) is not associated with human activity but is due to disturbance of the soil by frost during the concluding cold phase (Loch Lomond Stadial) of the Late

Devensian. The pollen spectrum indicates a bleak landscape with open vegetation and few if any trees. Radiocarbon dates generally place the end of this phase between 10 500 and 10 000 bp (Lowe 1978; 1982; Vasari 1977).

The transition from the Late Devensian to the Flandrian was marked by a climatic warming which generally produced a well defined *Juniperus* pollen peak (Birks & Mathewes 1978; Lowe 1978; 1982; Mangerud 1970), a sharp increase of *Betula* pollen as birch woodland rapidly spread at the start of the Flandrian and a similar increase of *Corylus* pollen higher up the profile as hazel became established several centuries later. In contrast, the North Mains pollen diagram shows relatively low values of *Juniperus* pollen and a simultaneous rise of *Betula* and *Corylus* pollen (*Corylus/Myrica* pollen curve) at the start of the first Flandrian pollen zone. These features suggest a break in sedimentation between zones NM-LD and NM-F1. This is supported by the unusually late date of 9480 ± 85 bp for the deepest Flandrian deposits. O'Sullivan (1976) recorded a similarly positioned hiatus of 500 to 1000 years in a core from Loch Pityoulish, Speyside.

For a period of about 3800 years (9500–5700 bp) woodland dominated the landscape around North Mains. As a result, little herb pollen was produced or reached the peat deposit. The two temporary peaks on the herb pollen curve during this time correspond to peaks of Cyperaceae pollen which probably reflect vegetation changes on the mire rather than in the surrounding woodland. During these 3800 years woodland composition underwent changes but one constant feature revealed by the pollen diagram is that, in this part of Perthshire, pine was never an important woodland species.

The sharp decline of *Salix* pollen (illus 3), the appearance of *Eriophorum vaginatum* and *Sphagnum* macrofossils around 180 cm (illus 2) and the presence of *Betula* wood above 180 cm indicate that willows could have been growing on the mire until about 7700 bp and were then succeeded by birch. In general, however, the *Betula* pollen curve behaves in a characteristic way indicating that birch was widespread throughout the area. Therefore birch growing on the mire surface probably caused some over representation of *Betula* pollen but seems unlikely to have greatly distorted the pollen curve.

Between 9480 and 8700 (sub-zone NM-F1a) birch and hazel were the main woodland species. These were then joined by elm and oak (*Quercus*). The woodlands remained predominantly composed of these four species for the next 2000 years (sub-zone NM-F1b). However, all four species did not necessarily grow together in evenly mixed stands. For example hazel would have favoured the better soils and birch the poorer or lighter soils. The only other major woodland change before 5680 bp is indicated by the *Alnus* pollen rise, the start of which is dated to 6680 ± 70 bp. The expansion of alder probably took place along river valleys.

The pollen diagram therefore shows that during the Mesolithic period, man, if he were present locally, would have lived in a landscape predominantly covered with broadleaved woodland. However, for this period there are no changes in the pollen diagram that could be directly attributed to human activity. Such changes should not necessarily be expected since it seems that Mesolithic man had only a local impact in Scotland with disturbance effects probably not spreading much beyond his settlements (Edwards & Ralston 1984). Another factor to be considered is that traditional percentage pollen diagrams with sampling intervals of several centimetres are unlikely to show minor or very localized disturbances. It is not until the Neolithic agricultural revolution and population expansion that the level of disturbance became great enough to generally affect the pollen input of lakes and mires. Pollen diagrams based on contiguous sampling and high absolute pollen counts expressed as pollen influx values are more likely to show small, or very early disturbances. Unfortunately, the amount of time and effort needed to carry out such investigations is beyond the resources of most investigators.

In Arran, reed-swamp burning, possibly to flush out game, may have started as early as 8700 bp (Robinson 1983) but at North Mains charcoal was not observed in the peat until much later at 106–102 cm and 95–91 cm (illus 2), between 6000 and 5600 bp. Unlike conifers, temperate hardwood trees rarely sustain natural fires, so the most likely source of the charcoal is fire started by the local inhabitants. The charcoal at 106 cm may therefore be the earliest indication of man's (Mesolithic) presence in the area revealed by the palaeobotanical analyses. The occurrence of charcoal at 91 cm, immediately below the start of the cereal type pollen curve, suggests that fire was used to clear the land for cultivation; either the standing woodland or, more probably, piles of felled trees and brushwood would have been burnt.

According to Groenman-van Waateringe (1983) the only reliable indicator of Neolithic agriculture is cereal pollen since the occurrence of weed pollen may also be due to 'natural causes' (Groenman-van Waateringe 1968). In the North Mains diagram (illus 3) the presence of cereal-type pollen and several weed taxa (*Plantago lanceolata*, Compositae, Ranunculaceae, *Rumex*, *Succisa*, *Potentilla*-type) and an increase in Gramineae pollen above 90 cm are good indications of agricultural activity nearby. Although a few grasses produce pollen similar to cereal pollen, the absence of cereal-type pollen below 90 cm, its presence in all but two samples above 90 cm and its association with the weed taxa mentioned above suggest that most, if not all, is from cultivated cereal grasses.

It is not always possible to suggest with confidence whether individual taxa are associated with arable or with pastoral farming. However, non-cultivated grasses and *Plantago lanceolata* are mostly quoted as pastoral indicators (Buckland & Edwards 1984) and a number of *Ranunculus* species also thrive in pastures. In addition to cereal pollen, *Rumex acetosella* pollen is associated with arable farming.

Throughout the Neolithic period, even in the very early Neolithic, it seems that in western Europe arable farming and stock keeping were always associated (Behre 1981; Groenman-van Waateringe 1983). The pollen record gives no reason to doubt that this was also the situation in the North Mains area.

Traditionally the elm decline was thought to coincide with the establishment of arable farming and, therefore, with the start of the Neolithic period. Edwards and Hiron (1984) and Groenman-van Waateringe (1983) have shown that this connection can no longer be assumed since there are now a number of sites in the British Isles where pre-elm decline cereal pollen has been found. Edwards and Hiron (1984) report that these sites numbered eight when they wrote their paper; five in Ireland, two in England and one in Scotland (Arran). The elm decline dates for these sites range from 5320 bp to 4740 bp and the dates for the earliest pre-elm decline cereal-type pollen range from 5845 bp to 5350 bp. On average the earliest cereal-type pollen pre-dates the elm decline by 630 years. It is therefore suggested by Edwards and Ralston (1984) that Neolithic people arrived some centuries before the elm decline and that there was an overlap period (possibly lasting several centuries) during which late Mesolithic hunter-gatherer communities existed alongside early Neolithic farmers.

The commencement of the North Mains cereal-type pollen curve at 5680 ± 70 bp (3730 bc) indicates that Neolithic people arrived in the area before the elm decline. This is confirmed by the pollen diagram. Despite elm being relatively poorly represented an apparent elm decline can be seen at a depth of 75 cm. This shows that there was arable farming in the area for around 400 years before the elm decline (based on extrapolation of radiocarbon dates).

The earliest radiocarbon dates associated with the excavated monuments are 3805 ± 100 bp (1855 bc) for the barrow, 4105 ± 60 bp (2155 bc) for the henge (period II – primary) and 4640 ± 65 bp (2690 bc) for the ring ditches (Stenhouse 1983). Because of the hiatus at 35cm it is unlikely that the period of barrow construction is included in the pollen diagram. However, the henge and, almost certainly, the ring ditch construction periods are represented.

In the 'Conclusions' of the excavation report Barclay (1983) states that occupation of the area before barrow and henge construction is demonstrated by the extended cultivation of the old land surfaces preserved beneath the monuments (Romans & Robertson, 1983), the radiocarbon date associated with one of the ring ditches and the scattered occurrence of 'Western Neolithic' pottery from the early 3rd millennium bc (Cowie 1983). The radiocarbon dated pollen profile confirms this, showing that Neolithic occupation probably started 1800 to 2000 years before the barrow was constructed, 1000 years before the earliest radiocarbon date associated with the monuments and several hundred years before the elm decline.

Wood is almost totally absent from the peat formed during the period of Neolithic occupation (illus 2) indicating that trees and shrubs had ceased to be a significant component of the mire flora. Changes in the tree pollen curve during zone NM-F3 (illus 3) are therefore due to woodland changes mainly around the kettle hole. The steady decline of the tree pollen curve and the increase of herb and shrub pollen in this zone point to continuing woodland clearance and farm expansion as the Neolithic population increased. Birch was the main species affected by woodland clearance. In contrast hazel was apparently undisturbed, probably because it supplied nuts and thin pliable branches suitable for making wattle fencing. A few centuries later wattle fencing was used during barrow construction, but as only imprints remained the species used could not be identified.

The close of NM-F3 and the start of NM-F4, distinguished by the sudden decline of *Alnus*, *Quercus* and *Corylus* pollen and the sharp rise of *Pinus* and Gramineae pollen, correspond to the leap in time from the late Neolithic to modern times. The abundance of pine pollen in particular shows that NM-F4 represents only the 18th century onwards when the planting of coniferous trees became fashionable and widespread.

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REFERENCES

- Barclay, G J 1983 'Sites of the third millennium bc to the first millennium ad at North Mains, Strathallan, Perthshire', *Proc Soc Antiq Scot*, 113 (1983), 122-281.
- Behre, K-E 1981 'The interpretation of anthropogenic indicators in pollen diagrams', *Pollen et Spores*, 23 (1981), 225-45.
- Birks, H H & Mathewes, R W 1978 'Studies on the vegetational history of Scotland V. Late Devensian and early Flandrian pollen and macrofossil stratigraphy at Abernethy Forest, Inverness-shire', *New Phytol*, 80 (1978), 455-84.
- Blyth, A W 1984 'A mechanical aid for use with peat samplers', *Proc 7th Int Peat Congr*, 1 (1984), 39-44. Dublin.
- Buckland, P C & Edwards, K J 1984 'The longevity of pastoral episodes of clearance activity in pollen diagrams: the role of post-occupation grazing', *J Biogeogr*, 11 (1984), 243-49.
- Coles, J M 1971 'The early settlement of Scotland: excavations at Morton, Fife', *Proc Prehist Soc*, 37 (1971), 284-366.
- Cowie, T G 1983 'The pottery from North Mains: general discussion', in Barclay 1983, 248-57.
- Edwards, K J & Hiron, K R 1984 'Cereal pollen grains in pre-elm decline deposits: implications for the earliest agriculture in Britain and Ireland', *J Archaeol Sci*, 11 (1984), 71-80.
- Edwards, K J & Ralston, IBM 1984 'Postglacial hunter-gatherers and vegetational history in Scotland', *Proc Soc Antiq Scot*, 114 (1984), 15-34.

- Faegri, K & Iversen, J 1974 *Textbook for Pollen Analysis*, 3 ed. Oxford.
- Groenman-van Waateringe, W 1968 'The elm decline and the first appearance of *Plantago major*', *Vegetatio*, 15 (1968) 292–96.
- Groenman-van Waateridge, W 1983 'The early agricultural utilization of the Irish Landscape: the last word on the elm decline', in Reeves-Smyth, T & Hamond, F (eds), *Landscape Archaeology in Ireland*, Oxford, 217–32. (*Brit Archaeol Rep*, 116.)
- Hulme, P D & Shirriffs, J 1983 'Note on the pollen content of soil samples from the mound and henge at North Mains', in Barclay 1983, 270–72.
- Jowsey, P C 1966 'An improved peat sampler', *New Phytol*, 65 (1966), 245–48.
- Lowe, J J 1978 'Radiocarbon dated Lateglacial and early Flandrian pollen profiles from the Teith Valley, Perthshire, Scotland', *Pollen et Spores*, 20 (1978), 367–97
- Lowe, J J 1982 'Three Flandrian pollen profiles from the Teith Valley, Perthshire, Scotland 1. Vegetational history', *New Phytol*, 90 (1982), 355–70.
- Mangerud, J 1970 'Late Weichselian vegetation and ice front oscillations in the Bergen District, Western Norway', *Norsk geogr Tidsskr*, 24 (1970), 121–48.
- Masters, L J 1981 'A mesolithic hearth at Redkirk Point, Gretna', *Trans Dumfriesshire Galloway Natur Hist Antiq Soc*, 56 (1981), 111–14.
- Mercer, J 1979 'The palaeolithic and mesolithic occupation of the Isle of Jura, Argyll, Scotland', *Almogaren*, 10 (1979), 347–67.
- Mitchell, G F & Sieveking, G deG 1972 'Flint flake, probably of Palaeolithic Age, from Mell Townland, near Drogheda, Co Louth, Ireland', *J Roy Soc Antiq Ir*, 102 (1972), 174–77.
- Moore, P D & Webb, J A 1978 *An Illustrated Guide to Pollen Analysis*. London.
- O'Sullivan, P E 1976 'Pollen analysis and radiocarbon dating of a core from Loch Pityoulish, Eastern Highlands of Scotland', *J Biogeogr*, 3 (1976), 293–302.
- Robinson, D 1983 'Possible mesolithic activity in the west of Arran: evidence from peat deposits', *Glasgow Archaeol J*, 10 (1983), 1–6.
- Romans, J C C & Robertson, L 1983 'An account of the soils at North Mains', in Barclay 1983, 260–69.
- Stenhouse, M 1983 'Radiocarbon dates from the North Mains sites', in Barclay 1983, 259.
- Vasari, Y 1977 'Radiocarbon dating of the Lateglacial and Early Flandrian Vegetational Succession in the Scottish Highlands and the Isle of Skye', in Gray, J M & Lowe, J J (eds), *Studies in the Scottish Lateglacial Environment*, Oxford, 143–62.
- Woodman, P C 1978 'The chronology and economy of the Irish Mesolithic: some working hypotheses', in Mellars, P A (ed), *The Early Postglacial Settlement of Europe*, London, 333–69.

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