Woodland Clearance In West - Central Scotland During The Past 3000 Years.

Susan Ramsay

Thesis submitted to the University of Glasgow for the degree of Ph.D.

Division of Environmental & Evolutionary Biology

September 1995.

ABSTRACT.

Pollen diagrams were produced from peat profiles taken from four raised bogs in west-central Scotland : Walls Hill Bog, Lochend Loch Bog, Lenzie Moss and Gartlea Bog. These sites have produced a detailed overview of the vegetation changes brought about by human impact in the area over the last three thousand years.

This picture has been enhanced by peat stratigraphy diagrams, charcoal estimations and suites of accelerator radiocarbon dates from three of the four sites. Pollen influx data was also collected but not used in the final interpretations as it added little of value to the results from the relative pollen diagrams.

The evidence is for low levels of woodland clearance in the Bronze Age followed by an increase to extensive clearance in the late pre-Roman Iron Age at Walls Hill Bog and Lochend Loch Bog. Lenzie Moss and Gartlea Bog show clearance to be slightly later, around the time of the Roman invasion and occupation. Clearance is maintained throughout the Roman period and for several centuries after the Roman withdrawal at all the sites, except for Walls Hill Bog. All the clearance activity seems to have been to produce pastoral rather than arable agricultural land. Throughout the Dark Ages agriculture declined and there was extensive woodland regeneration, first of *Betula* and then the other major tree taxa.

Extensive clearance is next apparent between 800 - 1000 cal AD (perhaps slightly earlier at Gartlea Bog) with the cleared land again used for grazing. There is then a short period of woodland regeneration at all but one of the sites before the more extensive clearances of the Medieval and post-Medieval period are seen. These are again characterised by pastoral indicators although cereal cultivation may have become more important during this period. Evidence for modern tree planting is evident at some of the sites and all but Gartlea Bog show some truncation of the top of the peat profile.

CONTENTS.

LIST OF TABLES.

LIST OF ILLUSTRATIONS.

ACKNOWLEDGEMENTS.

I would like to thank my supervisor Dr. Jim Dickson for his interest, enthusiasm and advice during the period of this research. I am indebted to Camilla Dickson and Hanneke Bos for their help with identification of difficult pollen types and to Jennifer Miller and Diane Alldritt for archaeological and botanical discussions.

Thanks are also due to the many people who assisted with peat sampling, in particular the staff of Drumpellier Country Park, the owner of Gartlea Farm, Mrs. Beveridge and the 1993 Junior Honours Botany class.

Special thanks go to my mum, dad (who helped with the surface vegetation study) and my brother Scot (who helped sample Walls Hill Bog) for their encouragement and for putting up with me during the writing of this thesis.

I would like to dedicate this thesis to Glasgow University Botany Department in which I began the work for this study but which has since been abolished. It is sadly missed by all who were part of it.

1. INTRODUCTION.

1.1 Aims.

The aim of this research was to investigate the changes in the vegetation cover of west-central Scotland over the past 3000 years. The main focus for the research was to investigate the influence that human interference had had on woodland cover, in particular, and to try and determine what type of vegetation had replaced the cleared woodland.

By using the technique of pollen analysis coupled with radiocarbon dating it was hoped that it would be possible to determine the date of the first extensive woodland clearances in the area and, by comparing a number of sites, to determine whether the dates of clearance were consistent over the whole area.

The area in question contains many sites of archaeological importance most significantly those of the Roman period, in particular the Antonine Wall, as well as several Iron Age occupation sites. By studying sites that lie in close proximity to remains of both of these periods it was hoped that it would be possible to shed some light on the problem of whether the first major deforestation of central Scotland was undertaken by the pre-Roman Iron Age peoples (as indicated by studies on material from the Antonine Wall itself (Boyd 1984a, 1984b, 1985; Dickson et al. 1985; Dickson & Dickson 1988; Dickson 1992), by the Romans during the period of their occupation of the area (as at Flanders Moss (Turner 1965)) or in the post Roman period (as at Bloak Moss (Turner 1975)). Recent work by Dumayne (1992, 1993a, 1993b) and Dumayne & Barber 1994) has lent more weight to the pre-Roman clearance view. The results of this research should help to clarify the situation.

1.2 Pollen Analysis.

Pollen Production.

Pollen analysis depends on the fact that plants produce pollen which is adapted for transport some distance from the parent plant. This dispersal mechanism may take several forms: wind, water, insects or other animals. Some autogamous species, which are dependent on self pollination, will always be absent or very underrepresented in any pollen diagram.

Water pollination is rare but plants which make use of this method should be well represented if they occur in an aquatic study site. However many of the species with this method of pollination have pollen grains with very thin exines and, consequently, are unlikely to survive to become fossils.

Pollination by animals (zoomophily) and in particular insects (entomophily) is much more common although the quantity of pollen produced by plants using this method is small. Pollen transported by this method often has an ornately structured exine which aids with adherence to its transporter. Very little pollen from these plants will ever find its way into a suitable deposit for pollen analysis and so the absence of these grains from a pollen spectrum does not necessarily indicate their absence from the vegetation which produced that spectrum. Certain entomophilous species, e.g. *Calluna* do produce large amounts of pollen much of which becomes "lost" to the wind and consequently these species can often be well represented in pollen diagrams.

Wind pollination is the most important dispersal method for the purposes of the pollen analyst. Large quantities of pollen are produced and released into the air to be dispersed by air currents. Pollen transported by this method is usually less ornate than entomophilous pollen with a relatively smooth surface to provide little wind resistance and so aid dispersal. Some anemophilous species, particularly members of the Pinaceae, have air sacs or "wings" attached to them, increasing their buoyancy and hence the distance over which they can be dispersed.

Very few of these grains will actually fulfil their purpose and land on a stigma of the same species. The vast majority will, in effect, be lost and will land on the ground as pollen rain.

Pollen dispersal and deposition.

The interpretation of any pollen diagram must take into account the processes by which the pollen arrived at the site. The choice of site very much depends on the problem being investigated. If the study is involved in looking at regional vegetation or climate change then the site required to produce meaningful results will differ from that required to give the best results for a local vegetation study.

Sites studied by pollen analysis will have received their pollen from a number of different sources i.e. not only from different plants but by different methods of transport to the site.

Tauber (1965) constructed a model to account for the various ways in which pollen could arrive at a particular site. The assumptions behind the model were that the site was surrounded by woodland and that there were no inflowing streams. He proposed that three components made up the pollen arriving at any site :

Trunk space component (Ct)

Canopy component (Cc)

Rain component (Cr)

The trunk space component is that pollen produced by the trees, shrubs and understorey herbs surrounding the site. The majority of this pollen is carried by wind through the "trunk space" beneath the woodland canopy and may be carried out varying distances onto the site depending on the strength of the air currents.

The canopy component consists of pollen produced by the woodland canopy or "escaped" pollen from below the canopy. This pollen component is carried along by air currents just above the canopy and this pollen will land on the site if the area of open space is large enough to disrupt the air currents to provide enough downward movement of air to deposit the pollen on the ground.

The rain component is formed when raindrops fall through the air collecting pollen and other small particles on their way down. This is probably the most important process for removing pollen from the air and depositing it on the ground.

Other pollen inputs have been proposed to improve the Tauber model.

The gravity component (Cg) has been proposed by Moore, Webb & Collinson (1991) and Jacobsen & Bradshaw (1981). This is produced by plants growing on, or overhanging the site. A large proportion of their pollen will fall directly onto the site without there being much horizontal movement. This component may make up a large proportion of the total pollen found at a particular site, e.g. *Calluna* on bogs, Poaceae and Cyperaceae around lake margins.

Moore, Webb & Collinson (1991) also propose a secondary or inwashed component (Cw). This pollen may be recently deposited by inflowing streams or may have come from eroded sediments and so may not be contemporary with the sediment into which it is deposited. The sediment will then contain levels of mixed ages leading to problems with interpretation.

Site Size.

Site size must be taken into consideration when determining the pollen catchment area of any site. A small site will be dominated by local and trunk space components. A large site will have a more regional pollen input. Jacobsen and Bradshaw (1981) have produced a diagrammatic representation of the different pollen inputs to a site depending on its size. The sites used in this study will have a regional as well as a local input of pollen.

Site Type.

a) Peat Deposits

Peat deposits can be classified according to the source of the water which enables them to form.

Deposits formed as a result of ground water are termed rheotrophic (Moore, Webb & Collinson 1991). Those which also form where there is either high precipitation or low evaporation and transpiration may eventually grow to a level higher than the ground water table and so receive all their water from rain. These are termed ombrotrophic bogs or raised bogs because of their domed shape. If ombrotrophic bog forms over sloping ground then it is termed blanket bog.

The peat deposits from this study are all of the ombrotrophic type although the earlier layers of the deposit may well have been rheotrophic.

The most important property of peat deposits in relation to pollen analysis is that they build up in a stratified sequence. The conditions in the peat, i.e. waterlogged, anaerobic, little microbial activity, all contribute to the preservation of pollen.

The peat deposit may be formed from several plant species with the most important peat formers in Scotland being *Sphagnum* and Cyperaceae, in particular *Eriophorum*.

b) Lake Sites.

Lake sediment is made up from mineral inputs as well as inputs from plants growing within the lake (autochthonous) and outwith the lake (allochthonous) whereas peat sites are almost entirely autochthonous. Lakes receive water from their catchment as well as from rainfall and so the Cw component, as well as the Cr component, is important. The size and shape of the lake basin can also affect how the deposits are formed. The lake sediments are usually stratified but "sediment focusing" can occur when sediment is eroded and washed from shallow areas of lakes, usually at the edge, to deeper areas in the middle of the lake (Whittington, Edwards & Cundill 1990). Mixing of the surface sediment can also occur as a result of bioturbation caused by animals feeding or physical mixing as a result of water movement. These processes must be taken into account when interpreting a lake pollen diagram as they can have a significant effect on the results of any pollen analysis study.

1.3 Woodland History of Central Scotland.

McVean and Ratcliffe (1962) divide Scotland into three major areas each with its own potential woodland type deduced from existing fragments of native woodland, the known ecological requirements of these, pollen analysis and sub-fossil remains in peat. Their maps showing actual woodland cover for the present day compared with a reconstruction of the distribution of these woodland types (during the present climatic period but prior to the onset of large-scale human interference), vividly illustrate how much deforestation has taken place over approximately the last five millennia in Scotland. Rackham (1994) estimates that in Britain as a whole 99% of the original wildwood has been lost with even the remaining 1% affected by human interference. Bennett (1989) has also produced a map of Scotland to illustrate the probable woodland cover of Scotland at 5000BP. This map is similar to that of McVean & Ratcliffe (1962) but suggests a wider distribution for *Quercus* dominated woodland.

In central Scotland (for this study central Scotland is loosely defined as the area covering the Forth and Clyde valleys) the potential is for mixed *Quercus* and *Betula* woodland with a variety of minor components such as *Ulmus* and *Fraxinus* on more basic soils, *Corylus* in more open areas, *Alnus* in wetter areas, *Sorbus* and *Salix* with other more shrubby species as understorey vegetation. This woodland type also extends southwards and as far north as the Grampian Highlands. To the north of this area in the central Highlands *Pinus sylvestris* woodland becomes dominant and further north still *Betula* itself becomes the major woodland type.

Certain tree species common in England were probably never native in central Scotland, for example *Fagus sylvatica* and *Tilia* spp. These species usually only occur as single grains in pollen diagrams from central and northern Scotland and this trace presence is usually explained by long distance transport of pollen from England. The *Fagus* and *Tilia* which grow in central Scotland at present have all been planted or in the case of *Fagus* are often self sown.

Pinus sylvestris was probably never a major component of the woodlands of central Scotland although evidence has been accumulating to support the hypothesis that *Pinus sylvestris* did grow in central Scotland but was confined to areas of drier raised bog (evidence from stumps of *Pinus sylvestris* found at Lochend Loch Bog, Walls Hill Bog and Drumbow Bog all dated in the range of approximately 3000 - 5000 BP (Dickson 1988; Dickson 1992)).

The process of woodland clearance for the purposes of producing agricultural land is a difficult process in areas of temperate woodland. According to Rackham (1994) most British trees are very difficult to kill, with the majority of them able to survive after felling (as witnessed by the techniques of coppicing and pollarding) unless the new shoots are removed by grazing. It is also impossible to destroy deciduous woodlands in Britain using fire as they burn like "wet asbestos" (p.35). The clearance of large tracts of woodland was therefore a major undertaking at any point in history and probably required a degree of organisation and co-operation.

1.4 Anthropogenic Impact Recorded in Pollen Diagrams.

To understand human influences on vegetation from pollen diagrams it is necessary to identify those indicator species with ecologies linked to anthropogenic aspects of the environment, e.g. fire, disturbed soils, open canopies, nitrogen and phosphorus enrichment, etc. Behre (1988) produced a table of the main anthropogenic indicators in pollen diagrams and related their presence to various farming methods and situations. The increases in anthropogenic indicators were only noted close to sites of known human habitation which suggests that they are a very localised component of the pollen rain. Increases in Poaceae and *Calluna* were linked to extensive forest grazing and these taxa were detected at greater distances from the sites of habitation than the other (usually zoomophilous) anthropogenic indicators.

The main anthropogenic indicators used by many pollen analysts, e.g. Turner (1965), are Cereals, Poaceae (Grasses), *Plantago lanceolata* (Ribwort plantain) and *Pteridium aquilinum* (Bracken). These taxa often show synchrony in their curves in pollen diagrams with each peaking at times of human activity in particular woodland clearance leading to pastoral or arable agriculture.

Poaceae is the main taxon to increase with decreasing tree cover. However it is not possible to say for certain whether the Poaceae recorded in a pollen diagram was a constituent of the vegetation of farmed land, the bog, or lake margins. The growth of Poaceae on the bog itself can probably be discounted if macrofossil evidence of *Molinia*, for example, is absent from the peat.

Plantago lanceolata is much more specific to farmed land. Grime, Hodgson & Hunt (1990) give its commonest habitats in the Sheffield area as meadows, rock outcrops, limestone pastures, lead mine spoil and limestone quarries i.e. all situations associated with man and especially pastoral farming.

Pteridium aquilinum has as its habitats coniferous plantations (not relevant when considering any time up until the last several hundred years), scrub, acidic woodland, pasture and wasteland. *Pteridium aquilinum* can grow in shaded or unshaded sites but tends to be a woodland plant. However its spore production (and hence its representation in pollen diagrams) and subsequent prothallus growth is greater in unshaded habitats (Grime, Hodgson & Hunt 1990; Moore 1992). Therefore an increase in *Pteridium aquilinum* spores indicates an opening of the woodland canopy.

Cereal pollen grains are the most conclusive anthropogenic indicators as they are produced in small quantities and most do not travel far from their site of release. Therefore if cereal pollen grains are identified from a site there is a reasonable certainty that arable agriculture was being practised nearby.

Turner (1965) postulates values of grass pollen (as a percentage of arboreal pollen (AP)) which correspond to different extents of woodland clearance:-

1. small temporary clearance - Poaceae 20% of AP
   small area cleared and trees soon regenerate
2. extensive clearance - Poaceae > 100% of AP
   half the pollen catchment area cleared of trees
3. complete clearance - Poaceae > 200% of AP

Dumayne (1992) uses a different pollen sum i.e. Non Mire Pollen (NMP) but also sets values of Poaceae corresponding to the extent of woodland clearance:-

1. small temporary clearance - Poaceae > 15% of NMP for a short time

2. extensive clearance - Poaceae > 30% of NMP

3. Complete clearance - Poaceae > 60% of NMP

Turner (1965) identifies another group of anthropogenic indicators: the "weedy herbs", that is herbs which grow on arable fields and/or pastoral land. These include such taxa as Asteraceae, *Rumex* spp., Chenopodiaceae and Ranunculaceae. The usefulness of taxa such as these as anthropogenic indicators is, to a large extent, based on the taxonomic level to which they have been identified during pollen analysis. Relating groups such as *Potentilla* type to agriculture (Dumayne & Barber 1994) is not valid as species within this type have varied habitats including peat bogs themselves. Improving the level of pollen identification would greatly help in the detection and understanding of past systems of agriculture.

1.5 Literature Review.

The study of the vegetation of central and southern Scotland using the technique of pollen analysis has been developing for many years. The effect that human impact has had on the landscape is one of the questions which has been addressed by many of the researchers in this field. Interest in the Roman occupation and its effect on the vegetation has continued and although many papers have been published on the subject, different interpretations of the available data continue to fuel the debate. The view that the Romans, and only the Romans, could have been responsible for any substantial deforestation of Scotland has been around now for many years. Information contradicting this view has been widely published (Boyd 1984a, 1984b, 1985; Dickson et al. 1985; Dickson & Dickson 1988) but even now authors are still reiterating the Roman clearance view (Van der Veen 1992).

This study will address the question of what effect, if any, the Romans had on the vegetation of central Scotland but will also investigate the wider aspect of human impact on this landscape during the last 3000 years.

Some of the first and best known regional pollen diagrams of this area were produced by Turner from sites at Bloak Moss and Kennox Moss in Ayrshire and Flanders Moss in Perthshire. The pollen diagram from Bloak Moss, site A (Turner 1975) was part of a study to determine the effect of the location of a sampling site in relation to its pollen influx from possible areas of farming activity. The results of this study indicated that a very different picture of agricultural activity was obtained when the sampling site was in the middle of a bog compared to when the site was situated at near the margin of a bog. Sampling from the middle of the bog produced a pollen diagram showing a regional vegetation picture in which local occurrences of temporary woodland clearance were not always detected. Sampling from close to the bog margin gave a much more local vegetation picture and picked up more of the minor clearance episodes as well as more agricultural indicators, if they were present.

The Bloak Moss diagram has a distinctive pattern of clearance episodes. There are a number of small temporary clearances in the Bronze Age / Iron Age followed by an extensive clearance, woodland regeneration, clearance, regeneration and finally the almost total woodland clearance of more recent times. This pattern indicates shifting populations in this area with little evidence for arable agriculture.

The first extensive woodland clearance at Bloak Moss has been dated to c. 1500 BP i.e. post-Roman. However the radiocarbon dates from Bloak Moss show inversions (unusual in peat deposits) as well as similar dates widely spaced in the sequence and very dissimilar dates close together, coupled with insignificant changes in the stratigraphy.

The dates are difficult to interpret and another radiocarbon dated site close to this one would greatly aid its interpretation.

The diagram from Kennox Moss shows the same pattern of clearance as at Bloak Moss and supports the theory that these anthropogenic effects are regional and not purely local. However there are no radiocarbon dates from Kennox Moss. Turner suggested that these regional effects were the result of human activity up to 10km from the bog. Turner also suggested that the lack of small temporary clearances at Kennox Moss was due to the sampling site being too far away from the woodland margin to detect any local clearance effects. Again there is little evidence for arable agriculture having been practised.

Turner also suggested that there were no Iron Age clearances at these sites simply because there were too few Iron Age people living in the area of north Britain to undertake the task of widespread woodland clearance. The site of Walls Hill fort, only 14 km from Bloak Moss, has been shown to be an Iron Age tribal stronghold and it would seem unlikely that the building and occupation of a site such as this would leave no mark on the vegetation record of the area.

The Flanders Moss diagram (Turner 1965) shows a very different picture to that from Bloak Moss. There is little evidence for the Bronze Age/Iron Age small temporary clearances seen in the Bloak Moss diagram. The first clearance phase is extensive and has been dated to 1745-1730 BP i.e. within the period of the Roman occupation of Britain. The dates from Flanders Moss are also difficult to interpret as three dates, 1850 BP, 1745 BP and 1730 BP are statistically the same but were obtained over a peat depth of 60cm.

Several pollen diagrams have been published from the north of England (Donaldson & Turner, 1977; Davies & Turner, 1979; Turner, 1979) which show extensive woodland clearance ranging from Iron Age to Roman times. Davies and

Turner produced pollen diagrams from Fellend Moss, Steng Moss, Broad Moss and Camp Hill Moss, all in Northumberland. The first extensive clearances at these sites were dated to 1970 BP at Steng Moss and 1948 BP at Fellend Moss i.e. slightly pre-Roman or early Roman in age (when the margins of the dating error are considered). The sites reviewed by Turner (1979) are all from north-east England and have clearance dates ranging from 1730 BP (190-240 cal AD) at Bollihope Bog to 2215 BP (280-420 cal AD) at Valley Bog. These sites are in fairly close proximity to one another and suggest that it is not possible to infer from one pollen diagram the vegetation history of the region.

In more recent years several papers have been published which support the theory that west central Scotland was already extensively cleared of woodland before the Roman invasion. A number of these publications have been associated with archaeological work undertaken on forts along the Antonine Wall. Boyd (1984a, 1984b, 1985) investigated soil turves which had been used to infill ditches around the Roman forts at Bar Hill and Mollins. This infilling had occurred when the Agricolan forts were being constructed and the pollen preserved in them should be pre-Roman in date although no radiocarbon dates are available from the turves themselves.

Both sites show evidence of substantial woodland clearance with pastoral rather than arable indicators present. Boyd suggests that the woodland clearance resulted more from grazing pressure than a deliberate policy of felling, although at Mollins he does note that *Quercus* appears to have declined faster than other tree species perhaps as a result of selective felling. During the years before turf cutting the landscape around these Roman forts was characterised by open, scattered woodland, mainly of *Alnus* and *Corylus*, followed by woodland clearance associated with grazing and finally a partial expansion of *Calluna* heath as grazing pressure declined. Boyd also found samples of twigs and wood of *Crataegus monogyna* (Hawthorn) at Bar Hill in sufficient numbers and of such shapes as to suggest that they may have been the remains of Iron Age hedges which would in turn indicate that a sophisticated system of agriculture was being practised in the area. It is not possible to extrapolate from these results and produce a regional vegetation picture of the area as the findings from Bar Hill and Mollins may only give an indication of local vegetation events.

Dickson & Dickson (1988) and Dickson (1991) carried out pollen and macrofossil analyses on sewage and turves from another Roman fort, at Bearsden. They discovered that the vegetation around the fort had remained unaltered during its brief period of occupation (16 years) and concluded that there had been much pre-Roman clearance of the woodland with the Romans probably having little further effect on the vegetation.

Evidence from the site of a minor enclosure on the Antonine Wall at Wilderness Plantation (Newell, 1983) also suggests that when the Romans invaded, the area was open heathland although trees were present some distance from the site.

Birks (1988) states that the pre-Roman Iron Age clearances in Scotland were confined to areas of *Betula-Corylus* dominated woodland in the far north and west and that post-Roman clearances occurred in the mixed deciduous woodland areas of western Scotland. In this paper Birks is considering upland areas which appear to have had a very different vegetation history to the lowland sites mentioned above.

More recently Lisa Dumayne (Dumayne 1992, 1993a) has undertaken pollen analysis of several sites between Hadrian's Wall and the Antonine Wall, as well as one site north of the Antonine Wall : Letham Moss. All these sites, with the exception of Fozy Moss (close to Hadrian's Wall), show extensive pre-Roman clearance continuing into and often increasing in the Roman period. The site at Fozy Moss is an exception with clearance delayed until the Roman invasion. The study was primarily concerned with Roman impact on the vegetation although Iron Age impact was included when it became apparent that it was equally, if not more, important. This study will improve on Dumayne's work as a result of the greater number of radiocarbon dates available from each site and will provide a substantial amount of additional information on human impact during the Dark Ages, Medieval and more modern times.

Whittington, Edwards & Cundill (1990, 1991) used a multiple core approach to investigate the vegetation history of Black Loch in Fife. Some of the cores extend back to late glacial times whilst others contain only the last few thousand years but in much greater detail. Their findings show an extensively cleared landscape by 1350 cal BC with *Ulmus* and *Quercus* almost completely removed and replaced by *Alnus* and Coryloid (probably *Corylus*). There is a corresponding increase in microscopic charcoal at the time of these clearances. The Black Loch diagrams show a decline in agriculture between 40 - 640 cal AD (spanning the Roman occupation) with a complete lack of cereal pollen during this time. It is postulated that the Romans either destroyed or confiscated cattle and grain from the native peoples of this area forcing them to either relocate or die of starvation. This contrasts with other accounts in that it suggests that woodland cover increased rather than decreased with the invasion and occupation by the Romans. Approximately 500 years passed before agriculture again became widespread.

Whittington and Edwards (1993) have discussed the difficulties surrounding the investigation of woodland clearance and the problems of finding sites which will provide worthwhile data on agricultural practices during the late pre-Roman Iron Age and Roman periods. They state that "The most favourable sites for agriculture, along with intensive settlement, during the Roman period are those which offer the same potential today. Land improvement and wetland reclamation in the post-Roman era, and especially since the late eighteenth century, have severely reduced the appropriate deposits and hence the potential for palynological investigation over much of lowland Scotland." Some of the sites in this study have been chosen to try and overcome this bias although the perfect sites for pollen analysis in relation to arable agriculture in central Scotland probably no longer exist.

It can be seen from the above that the vegetation cover of Scotland and northern England was not uniform during the late Iron Age/Roman period. However the body of evidence supporting the theory that the Romans invaded an already cleared landscape is growing with each new site investigated.

2. HISTORY AND ARCHAEOLOGY.

2.1 Mesolithic.

During the Mesolithic period people first began to settle in Scotland. The earliest settlements probably lay near the sea. Most of the traces of Mesolithic people are from a few centuries before 4000 BC. The archaeological evidence for Mesolithic people is mainly in the form of flints and bone worked into tools and weapons and refuse consisting mainly of shells and bones. This reflects the hunter-gather way of life practised by these people.

2.2 Neolithic.

During the Neolithic the people who settled south-west Scotland were the first farmers. Neolithic agriculture was very primitive with probably only very small areas of land roughly cleared of woodland and then cultivated using hand tools. When the soil became exhausted the people moved on to new areas. Their animals grazed the land around their settlements thus helping to prevent woodland regeneration.

The Neolithic people left many enduring structures in particular cairns consisting of a burial chamber constructed using slabs of stone with a capstone for a roof and covered by a cairn of stones. Later in the Neolithic these tombs became increasingly more elaborate.

2.3 Bronze Age.

The beginning of the Bronze Age, around 2000 BC, was the time that knowledge of metalworking was introduced to Scotland. The results of this, in the form of bronze daggers and armlets, are often found as grave-goods in cist burials of this period. These bronze objects are often accompanied by jewellery of gold or jet and the beaker type pottery vessels characteristic of this age. As the Bronze Age progressed metalworking techniques improved and the tools and weapons produced became more sophisticated.

Although many burial sites, in the form of cists and cairns, have been discovered which date to this period much less evidence has been found for field systems and settlements.

2.4 Pre-Roman Iron Age.

According to Scott (1966) the early Iron Age in west central Scotland was a violent and unsettled period marked by numerous invasions by Celtic warriors who finally settled in the area and brought their customs and language with them. The warrior chief became the most important member of society and as a result most of the artefacts recovered from this time reflect the warrior society. These Celts came mainly from eastern and south west England and brought with them their skills as well as their weapons. The Iron Age is characterised by its defensive and fortified structures. The hillfort became a common sight of the Iron Age landscape as did fortified settlements, while the skill of the crannog builders was used more and more. The tribe which occupied this area of Scotland was known as the Dumnonii, similar in name to the Damnonii of Devon and Cornwall and perhaps related to them. They controlled a large part of Scotland as their lands incorporated north Ayrshire, Lanarkshire, Renfrewshire and parts of Stirlingshire. Although the Celts are most famous for their skill in battle they are, conversely, almost equally famous for their artistic talents, in particular their abstract art still much copied today.

Hillforts varied greatly in size ranging from the smallest representing the stronghold of a minor chief ruling a small community to the largest thought to be tribal strongholds, not permanently occupied but available as safe havens when the people of the tribe were threatened.

Buildings were built of stone and timber and so woodland clearance, at least on a small scale, must have already been underway to provide timber for construction, cleared areas around defensive structures and land for agricultural use. To try and estimate from archaeological finds how many settlements and hence how much cleared land was present during the Iron Age is almost impossible. Not all the sites occupied during this time will have been discovered by archaeologists and many will have long since been destroyed; the phrase "absence of evidence is not evidence of absence" (Moore, Webb & Collinson 1991) holds true. Any estimate of land clearance based on archaeological finds discovered so far will be a significant underestimate. Pollen analysis may be able to give a regional picture of Iron Age occupation (or at least the vegetational effects of Iron Age occupation) which cannot be obtained from the archaeological record.

2.5 Roman.

Invasion and occupation.

The first Roman occupation of Britain began in 43 AD and campaigning began to conquer Britain as a whole. As the Roman army moved through southern Britain native tribes were either brought under direct Roman control or made into allied kingdoms of Rome. These kingdoms allowed Roman influence to spread without the need for a continuous Roman military presence in each tribal area. The people of these kingdoms were left relatively unhindered to run their own affairs. Forts, with roads connecting them, were built throughout Roman Britain soon after the initial conquest.

Interest in Britain by Rome seemed to diminish after the initial successes. It was not until the reign of Vespasian (69-79 AD) and later his sons (79-96 AD) that the

Romans once again pushed forward, unchecked, into Wales and the north. The appointment of Gneus Julius Agricola as governor of Britain (78-84 AD) brought the north of Britain into Roman control. In 81 AD he pushed as far north as the river Tay meeting little resistance in the Scottish lowlands. He secured the area between the Forth and Clyde estuaries with a line of forts and created the first purpose built frontier in Roman Britain. Agricola continued campaigning north of the Forth with victory over the Caledonians at Mons Graupius (83 or 84 AD); the only recorded battle between the Romans and the Caledonians. During the years that followed Agricola, and his unknown successor, built a series of forts up the eastern side of Scotland although none of these were occupied for long.

Disaster on the Danube front around 86-92 AD (Maxwell 1983) caused approximately one quarter of the Roman soldiers in Britain to be removed to fight on the continent. The soldiers remaining in Scotland could not sustain the occupation of the country and during Trajan's reign (98-117 AD) they were withdrawn.

Unrest in Britain continued into Hadrian's reign (117-138 AD) culminating in the building of Hadrian's Wall, begun in 122 AD. This barrier was built between the Tyne in the east and the Solway in the west. However fighting continued until finally, during the reign of Antoninus Pius (138-161 AD) it was decided to retake lowland Scotland. Again the Forth/Clyde line became a Roman frontier; this time with its own wall named after the current emperor.

Antonine Wall.

The Antonine Wall followed the route previously set out by the forts of Agricola's Forth/Clyde line. It stretched from Bo'ness on the Forth to Old Kilpatrick on the Clyde, a distance of 40 Roman miles (37 miles, 60 km.). The "Wall" in fact consisted of a ditch, a wall and, running behind the wall, a military way.

The ditch measured 6-12m in width and 2-4m in depth, with approximately 6-9m between the ditch and the wall. Earth from the ditch was not required in the construction of the wall and so was tipped onto the northern side to form a wide, low outer mound or glacis.

The wall was built of turf on a cobble stone foundation. Some sections of the wall, in particular the eastern end between Watling Lodge and Falkirk, were built of clay blocks presumably because suitable turf was not available. This may have been because the land around that area was either already under arable cultivation or was covered by heath or woodland. The amount of turf required for the construction of the wall has been calculated by Hanson & Maxwell (1983 p.132) as follows:

"Taking the estimated dimensions of the rampart as discussed in Ch.5 (p.77ff), the size of the individual turf blocks as a half by one-and-a-half by one Roman foot (Vegetius II, 8) and allowing for the limited use of turf in the first 11 Roman miles of the wall, the total number of turf blocks required would have been of the order of 25-30 million, which represents the stripping of some 800-950 acres (325-385 ha) of turf."

At least 18 main forts were built along the Antonine Wall. Forts were usually built with turf ramparts, sometimes on stone foundations with internal buildings constructed of stone and timber.

From this it can be seen that significant amounts of turf were used during this construction period and presumably must have been readily available to the Roman army. This suggests that the area was already, at least partly, cleared of woodland and had been for some time as recently cleared woodland would not have left areas of turf suitable for cutting into uniform blocks.

An estimated 6000-7000 men were stationed on the wall although some only temporarily.

The Wall was abandoned in c. 155 AD, reoccupied and finally abandoned before 165 AD as a result of external and internal pressures on the Roman empire.

2.6 Dark Ages.

The period between the departure of the Romans and the arrival of the Vikings is often termed the Dark Ages and is a period about which little archaeological information is available in Scotland. This is the period during which the British kingdoms were converted to Christianity (Ritchie & Ritchie, 1991) and saints such as Ninian and Kentigern travelled the country spreading their faith. The Scots from the kingdom of Dalriada in Ireland entered present day Scotland during this time and periods of instability followed with land changing hands with increased frequency.

Lamb (1977) suggests that there were some reversions to a colder and wetter climate during the sixth and ninth centuries AD.

2.7 Viking.

There is little archaeological evidence for Viking influence in this area but the effect of their raids and occupation of other parts of Scotland may well have had an indirect influence on the people and hence the environment of central Scotland.

The climate of Scotland during the Viking and the subsequent early Medieval period (from 900 - 1300 cal AD) is considered to have been particularly favourable (Lamb, 1977) with temperatures perhaps being as much as 1-2 °C warmer than those of the present day. It would be reasonable to assume that agriculture would have prospered during this period and this should be visible in pollen diagrams of the area.

2.8 Medieval.

During the Medieval period, from approximately 1300 AD, the climate deteriorated again and as a result crop failure and famine became widespread across the country. The Black Death (1347 - 1351 AD) also took its toll during this period not only in Britain but across Europe. The results of these disasters was a reduction in population and hence a reduction in the workforce available to farm the land. This period should show a marked decrease in agricultural indicators in pollen diagrams.

2.9 Post-Medieval.

During the post-Medieval period woodland clearance and agriculture continued to increase and have done so up until the present day. Improvements in agricultural practices combined with increased mechanisation produced pronounced changes in the environment which should be detectable in pollen diagrams.

In the last few hundred years tree planting (in particular exotic conifers) for timber and wood pulp has increased the amounts of tree pollen seen in pollen diagrams. This increase, of Pine pollen in particular, is a good indication that the bog surface of a pollen study site is more or less intact. Sites with a pollen catchment including managed estates may also have received pollen from ornamental trees, shrubs and herbs grown purely for their aesthetic appeal.

3. MATERIALS AND METHODS.

3.1 Site Selection.

The sites were primarily selected for their proximity to the Antonine Wall and, if possible, to native Iron Age sites as well. It was thought to be important to choose sites that were comparable, that is raised bogs, although one lake site was included in the study as a comparison. The peat sites have all been extensive areas of raised bog and, although now much reduced in extent, are still of significant size. All the bogs have been affected by human interference whether it be cutting, draining or burning but in studying the densely populated area of west-central Scotland it is almost, if not totally, impossible to find significant tracts of undisturbed bog. The sites which were finally chosen all had areas of apparently undamaged or relatively undamaged *Sphagnum* bog and the pollen cores were taken from these areas. In the case of Walls Hill Bog a cut face of peat was used for ease of sampling although the surface appeared to be as intact as could be expected.

Sampling sites were chosen near to the edge of the bog although far enough away from any visible natural margin to try and avoid complications caused by pollen produced by the lagg vegetation. When studying regional vegetation changes it is usual to sample from the middle of the bog but it was felt that as agriculture and especially arable agriculture were to be investigated, it would be more appropriate to sample sites nearer to areas of farmable land. Many of the pollen types associated with arable farming are very poorly distributed as a result of being entomophilous (insect pollinated) or poor pollen producers in the case of cereals (which tend to be largely self pollinating) and so these types rarely make up a significant proportion of the pollen rain. The nearer the study site is to the site of farming the more chance there is of detecting the pollen evidence for agriculture.

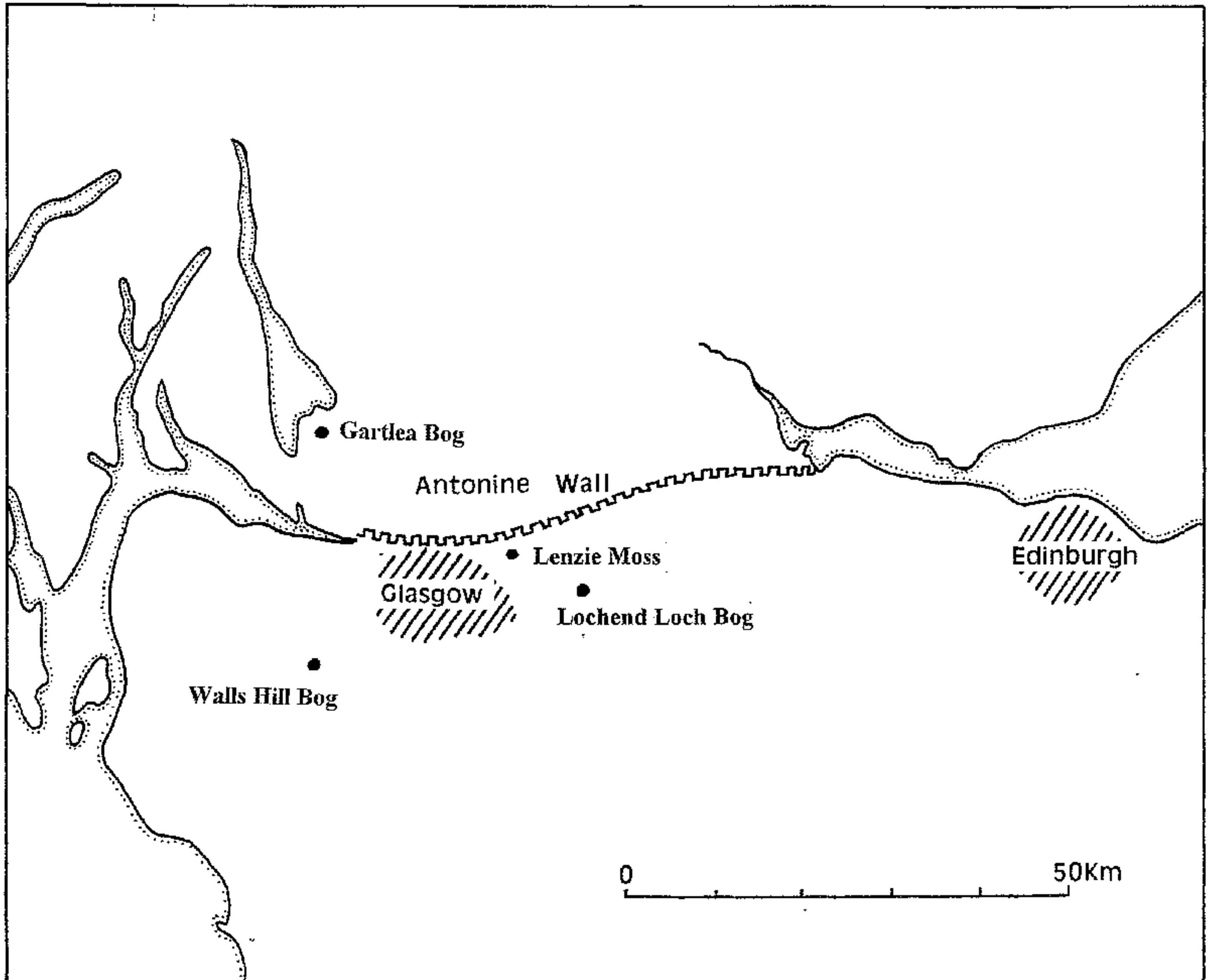


Fig. 3.1 : Map of study sites

3.2 Collection of Cores and Monoliths.

Walls Hill Bog.

The Walls Hill sample was taken by Dr. J.H. Dickson, Scot Ramsay, Ewan Stewart and myself on the 16th Aug. 1991. The sampling site had a long, exposed peat face of which a section was carefully cleaned ready for sampling. Six steel monolith tins (40cm x 10cm x10cm) were hammered into the peat face with a small overlap (4-5cm) between tins. The monoliths were then carefully removed using a sharp knife to cut away the peat from the rear of the tin. After collection the tins were wrapped in polythene and sealed with Sellotape before being transported back to the lab where they were stored in a cold room at 4 °C until required.

Lochend Loch Bog.

The Lochend Loch bog samples were collected by Dr. J.H. Dickson, several of the employees of Drumpellier Country Park and myself on 12th Dec. 1991. No exposed peat face was available and so a hole (approx. 1.5m deep) was dug in the peat to provide a clean face for sampling. Three monolith tins (50cm x 20cm x 10cm) were hammered into the peat, one below the other. It was thought that this might be an insufficient depth of peat to contain the period being investigated and so two "Russian" cores (Jowsey, 1966) were taken from the peat below the monolith tins. The samples were removed, wrapped and stored as above.

Lenzie Moss.

The Lenzie Moss samples were collected by Dr. J.H. Dickson, Junior Honours Botany class and myself on the 21st April 1993. An exposed peat face was unavailable and so a hole was dug to a depth of 0.5m and a monolith tin (50cm x 20cm x 10cm) was used to sample this depth of peat. The remaining depth of peat was sampled using a Russian corer. The monolith tin was wrapped in polythene and sealed with Sellotape. The Russian cores were wrapped first in "cling film" then polythene and sealed with Sellotape. The samples were stored in the same way as those from Walls Hill Bog.

Gartlea Bog.

The Gartlea samples were collected by Dr. J.H. Dickson, Mrs. Beveridge and myself on the 10th November 1993. The sampling procedure followed that for Lenzie moss with the following alterations. The monolith tin used was only 40cm x 10cm x10cm and a 5cm deep surface block was removed (and kept) before the monolith tin sample was taken.

3.3 Pollen Analysis.

Pollen sample preparation.

1. 5mm slices of sediment were removed and stored in individual, sealed polythene bags.
2. Sediment slices subsampled to give $2cm^3$ samples by displacement of water in a 10 cm^3 measuring cylinder (Bonny 1972).
3. 4 tablets of *Lycopodium* spores (Stockmarr, 1971) were added to each sample to allow for absolute results to be obtained.
4. Treatment with hot 10% NaOH to break down the sediment, followed by sieving through a 150μm mesh to remove coarse plant debris and large mineral particles (the sievings were retained in Petri dishes for later examination).
5. The Old Loch samples contained a high proportion of mineral and so were treated first with 0.1M sodium pyrophosphate to remove clay, then with cold 40% hydrofluoric acid for 24-48 hours to remove the remaining mineral.

6. All samples were subjected to Erdtman's acetolysis: a 9 : 1 mixture of acetic anhydride and conc. sulphuric acid was added to the sample tubes which were then placed in a boiling water bath for 3 mins.
7. Some samples were stained with aqueous safranin before dehydration with tertiary butyl alcohol (TBA) and subsequent mounting in silicone oil.

Microscopy and Pollen Identification.

All slides were counted at x 520 magnification on a Vickers Patholux binocular microscope. Critical determinations were made at x 1300 using an oil immersion lens with anisol as the medium between the objective lens and the coverslip. Counts of at least 300 grains (excluding *Sphagnum*) were made at each level with more grains counted when pollen concentration was good. For Old Loch all counts were at least 500 grains because of the higher pollen concentration. Slides were counted using traverses spaced equally across the slide so that any problems of non-random distribution of grains could be avoided (Brooks & Thomas, 1967). In most cases several slides had to be counted for each level to reach the required number of grains.

Pollen and spore identifications were made primarily with the pollen key in Moore, Webb & Collinson (1991). Reference was also made to the Northwest European Pollen Flora Vols. 1-6 (Punt 1976 -). All critical determinations were checked against the pollen reference slide collection in the Department of Botany, University of Glasgow. Pollen nomenclature is after Moore, Webb & Collinson (1991) and where further determination was carried out using the Northwest European Pollen Flora, this nomenclature was used.

Vascular plant nomenclature follows Stace (1991).

Exception is : - Coryloid covers both *Corylus avellana* and *Myrica gale* because of the difficulties surrounding the separation of these grains using the light microscope (Edwards, 1981).

Pollen Sum.

The simplest pollen sum includes all the taxa counted although when the object of the research is to investigate regional vegetation events, fluctuations in very local taxa can obscure the regional picture. As a result local pollen taxa are often omitted from the general pollen sum for example *Sphagnum* from bog sites and aquatics from lake sites. However it is often very difficult to determine exactly which taxa are purely local and should be left out.

Barber (1981) used the sum "non mire pollen" (NMP) for bog sites. In this sum Ericaceae, Cyperaceae, *Sphagnum* and other spores were all left out of the pollen sum, for the reason that these species are present on the bog itself and so interfere with the regional picture. However *Calluna vulgaris* and members of the Cyperaceae can be constituents of many vegetation types and by leaving them out regional information may be lost rather than elucidated.

A standard sum from earlier research was arboreal pollen (AP) in which all taxa were expressed as percentages of the total number of tree pollen grains. This sum was popular when the topic being investigated was woodland history but its main disadvantage is that it is possible to get values for a particular taxon of over 100% and if the landscape is relatively treeless it is possible to get values of Poaceae, for example, of several hundred percent (Turner, 1965). It is still necessary to use the AP pollen sum if current work is to be compared easily with earlier work.

It is very difficult to determine which is the best pollen sum to use and each site must be considered in its own right. It is probably better to include taxa if unsure rather than leave them out and risk losing valuable information.

Perhaps the best method is to present data using several different pollen sums each of which contribute something to the final interpretation of results.

In this research it has been decided that three pollen sums would be used for each site:-

TP	Total Pollen + Spores (excluding *Sphagnum*)
AP	Arboreal Pollen (excluding Coryloid + *Salix*)
NMP	Non Mire Pollen

Pollen diagram production and zonation.

Pollen diagrams were produced using the spreadsheet and graph drawing computer programs included in the TILIA package (Grimm, 1991). Using these programs it was possible to try a number of different ways of expressing the data to find the best method of presentation. This program also allows for the production of concentration and influx pollen diagrams. Problems have been experienced using calibrated radiocarbon dates with age ranges rather than a central date with an accompanying error which is the form of date that this program is designed to use.

The pollen diagrams were zoned by eye into local pollen assemblage zones. Statistical methods were tried (using the statistical programs also included in the TILIA package) but it was found that the position of the zones depended very much on the statistical method chosen to produce them. It was decided that the zones should be determined from the Total Pollen (excluding *Sphagnum*) diagrams and then for these same zones to be applied to the diagrams produced using the alternative pollen sums as well as to the diagrams produced using absolute pollen techniques.

As the emphasis of this thesis is the effect that human impact has had on the vegetation, with particular reference to woodland clearance and agriculture, the zonation of the diagrams has been undertaken with the same emphasis in mind.

Absolute Pollen Analysis.

The problem with expressing the results of any pollen analysis as relative values, that is as percentages of a pollen sum, is that a change in the value of any single taxon will always be accompanied by a compensating change in the values of the other taxa to maintain the pollen sum at 100%. Overrepresentation of local taxa can swamp changes in more regional types producing pollen curves which are either very erratic or which are very uniform throughout their depth. Both of these results produce curves in which it is very difficult to separate the changes in the regional from the local pollen producers. Some of these problems can be overcome by using the technique of absolute pollen analysis.

Absolute pollen analysis allows the value of each taxon to be expressed independently of all others. It is expressed as the number of grains per unit volume of sediment (e.g. grains / cm^3). However, pollen concentration values are also subject to problems. Sediments that accumulate quickly will have a lower pollen concentration than those which accumulate more slowly.

Absolute pollen analysis can be further refined to give pollen influx data, overcoming the problem of varying sediment accumulation rates. This method expresses the pollen data as the number of grains incorporated into a given area of sediment over a given time (e.g. grains / cm^2 / year). For this method to be used it is necessary to know the accumulation rate of the sediment. This is best calculated from a time / depth curve produced from a series of radiocarbon dates taken from the sediment being studied. The more dates available, the more accurate the resulting time / depth curve and subsequent influx values will be.

Absolute pollen analysis methods fall into two types: direct and indirect methods. Direct methods involve using known volumes or weights of sediment for the pollen preparation and then counting the pollen grains in a known aliquot of the resulting pollen sample. Indirect methods involve adding known concentrations of exotic pollen grains or spores to a known volume of sediment and counting the exotic grains as well as the fossil grains during routine analysis. The exotic addition method was first developed by Benninghoff (1962) with the exotic grains added as a suspension. The method was further developed by Matthews (1969), Pennington and Bonny (1970) and Bonny (1972). The exotic grain or spore chosen must be easily identifiable as the exotic and so must not occur in the area in which the work is being carried out or must have been treated in some way (e.g. staining) which makes it separable from fossil grains of the same type. The suspensions must be checked for contamination before use. The difficulty with this method was in keeping the grains uniformly distributed throughout the suspension so that the concentration of grains in any subsample of the suspension would be the same.

This problem was overcome by Stockmarr (1971) with the production of tablets containing *Lycopodium clavatum* spores as the exotic in a calcium carbonate matrix. Each tablet contained a known number of spores and these tablets could then be added to known volumes of sediment before pollen preparation techniques were begun. The exotic spores then underwent the same treatment as the fossil grains. Any losses suffered during preparation would tend to occur to both the exotic and the fossil grains equally thus maintaining a constant ratio of each to the other. Moore, Webb & Collinson (1991) suggest that the ratio of exotic spores to fossil grains in the final preparation should be between 1:5 and 2:5 although it is not always possible to know if the correct number of tablets have been added at the beginning to produce the correct ratio at the end. Experience of different sediment types and their likely pollen concentrations is the only help in predicting the number of exotic tablets required.

The exotic spore tablet method is quick, convenient and appears to be reproducible as the concentration of spores in any tablet should always be known. The only problem occurs when *Lycopodium clavatum* is, or has been, present as a component of the vegetation of the area being investigated. Information on the history of this species may be lost although some workers are confident in being able to distinguish between the fossil spores and those added as exotics.

The fossil pollen concentration and influx values are calculated from the fossil pollen and exotic spore counts using the following equations :-

$$P_{conc.} = \frac{\text{Number of exotic spores added}}{\text{Number of exotic spores counted}} \times \frac{\text{Number of fossil grains counted}}{\text{Sediment volume (cm}^3\text{)}}$$

$$P_{influx} = P_{conc.}\ (\text{grains / cm}^3) \times \text{ accumulation rate (cm / year)}$$

$$= \text{grains / cm}^2 \text{ / year}$$

Absolute pollen analysis has usually been carried out on lake sediment samples rather than peat deposits and therefore most of the literature pertaining to the subject is biased towards lake sites (Birks & Birks 1980, p206-230). Lake deposits are considered to be more suitable for this technique in that the sediments tend to be homogeneous and fine grained making accurate volumetric sampling of a core possible. Unlike peat bogs the rate of sedimentation appears to be fairly uniform and is much less dependent on the climatic conditions prevalent at the time of deposition. With lake sediments it is easy to discount the pollen grains of plants growing within the lake while plants growing on bogs, apart from *Sphagnum*, tend to colonise a wider range of habitats. The above information would suggest that only lake sites should be used for absolute pollen analysis but they do also have disadvantages such as pollen redeposition and inwash of older carbon to the sediments which affects radiocarbon dating and can cause dating inversions when a time/depth curve is plotted. Peat bogs do not suffer these particular drawbacks but do have other problems when it comes to using this technique.

Peat deposits tend to have a heterogeneous structure with various species being the dominant peat formers at different time. Even in a predominantly *Sphagnum* rich deposit it is likely that there will be layers in which other taxa such as *Eriophorum* become dominant. The easiest peat to get accurate volumetric samples for is well humified "greasy" *Sphagnum* peat with unhumified *Sphagnum* peat more difficult to sample and fibrous *Eriophorum* peat very difficult to sample accurately. The rate of growth of *Sphagnum* peat can vary enormously depending on the amount of rainfall at any particular time and so pollen accumulations will vary greatly depending on the speed of growth of the deposit.

3.4 Sediment Description.

Pollen sievings.

During the preparation of the pollen samples coarse plant remains were removed by sieving. This material was retained and examined under a low power dissecting microscope. Any recognisable plant remains were identified. The proportion of *Sphagnum* spp. in each sample was estimated and these amounts subdivided into *Sphagnum* sect. Sphagnum and *Sphagnum* sect. other. A note was also made if

Sphagnum imbricatum (the most readily identifiable of the *S.* sect. Sphagnum group) was present in the sample as this was the major species used for radiocarbon dating. These results are not presented separately here as they contribute to the Troels Smith analysis.

Troels-Smith Analysis.

The stratigraphy of all the sections was described using a reduced form of the Troels-Smith (1955) system for unconsolidated sediments. This system provides a method for the field description of sediments although it is often more practical to wait and carry out the analysis in the laboratory with the additional aid of a low power binocular microscope. The original Troels-Smith system had three distinct areas to be considered :

1. The physical properties of the sediment
2. Humification of the organic part of the sediment
3. Composition of the sediment

In this study it was considered that only areas (2) and (3) would be investigated as they would provide the most useful information for aiding the interpretation of the pollen results.

Humification.

The humification (or degree of humicity) of a peat deposit sample is associated with the decomposition of the organic material which constitutes the sediment. Troels-Smith uses a five-point scale for the humicity of peat which is defined as follows :

humo. 0 ...... plant structure fresh and well preserved, no homogeneous ground substance present.

humo. 1 ...... plant structure well preserved, homogeneous ground substance present in slight quantities.

humo. 2 ...... plant structure partly decayed, though distinct.

humo. 3 ...... plant structure in advanced state of decay and indistinct.

humo. 4 ...... plant structure hardly discernible or completely absent.

Composition.

The sediment composition is often difficult to determine in the field and so was investigated in the laboratory with the aid of the information gleaned from studying the pollen sievings under the microscope. The proportions of the major components in the deposit are estimated on a five-point scale beginning with (+) for a trace occurrence up to (4) for total presence. The scores for all the components which make up the deposit must total 4 (although the trace values are not included). The nomenclature used to describe the components of the deposits follows Troels-Smith (1955).

Troels-Smith stratigraphy diagrams were drawn for each site using the recognised Troels-Smith symbols.

3.5 Charcoal Content.

The charcoal content of each sample was estimated when the pollen sievings were being studied. The amount of charcoal visible under a low powered binocular microscope was scored in much the same way as the other organic elements noted in the Troels-Smith analysis, that is on a scale from 0 representing absence, + representing trace, up to 4 indicating that almost all of the sample consisted of charcoal. (The charcoal scores are not included when the Troels-Smith elements are totalled to give a sum of four.) The charcoal scores were graphed in such a way as to make comparison with the pollen curves possible and the results are included on the pollen diagrams.

Charcoal content of pollen analysis samples is measured in almost as many ways as there are people working in the field. Many workers count pieces of charcoal on the pollen slides during routine counting but for this method a number of criteria have to be decided beforehand. If a count is made of every piece of charcoal, no matter what its size, the results obtained are more likely to be related to how vigorous the stirring was during pollen preparation than the actual amount of charcoal in the sample. Using this method one reasonable sized piece of charcoal in the untreated sample could become many thousands of pieces on the pollen slide. Many people have tried to overcome this problem by setting size limits for the pieces counted and ignoring all the pieces smaller than this limit. This technique may help but is not likely to overcome the problem completely. Another method which has been fairly widely used is to measure the total area of charcoal found on the slide during pollen counting. This is usually done by starting out with a series of size categories into which each piece of charcoal is assigned during counting. From this it is possible to estimate the total area of charcoal found on each slide and this value can then be quoted either as a ratio to the number of pollen grains counted or, if absolute pollen analysis is being undertaken, as a charcoal accumulation rate or influx value.

Much of the charcoal noted on the pollen slides will have had its source some distance from the study site and may even have travelled many kilometres. This method will therefore give a very regional record of the frequency and extent of fire from the charcoal detected. It can be very time consuming to carry out this form of analysis accurately if certain pollen samples have very high charcoal values.

It was decided that for this study a different approach would be taken which was more subjective but much quicker and would still indicate the changing fire history of each site. Looking at charcoal remaining in the pollen sievings (which are obtained near the beginning of the pollen preparation and so have been subjected to only minimal stirring) gives a record of the fire history of the site itself rather than a fire history of the region. The pieces of charcoal retained on the sieve are, in this case, bigger than 150μm in diameter (the size of the sieve meshes) and so are much more likely to be from either the site itself or from a very localised area around it. The fire history of a bog can do much to explain the changing species composition of the major peat formers of that bog and can also give some clues as to possible human activity on or in the vicinity of the bog.

3.6 Surface Vegetation Description and Pollen Sampling.

At all sites (except Gartlea Bog) surface samples were collected to study the composition of the modern pollen rain and its relationship to the very local vegetation of the site. A 5 x 5 metre quadrat was marked out on the bog as close as possible to the pollen sampling site. The vegetation present in the quadrat was identified and its abundance estimated using the Domin scale. *Sphagnum* was present in all the quadrats and so this was collected as the surface pollen sample. Handfuls of *Sphagnum* were collected at random from within the quadrat until a polythene bag 30 x 15cm was filled.

The surface samples were prepared for pollen analysis in the following manner:-

1. 2 litre glass beaker filled to 1250ml with distilled water and *Sphagnum* added until the water level had risen to 1500 ml (a 250ml sample of moss).
2. The sample was boiled in the beaker for approximately 45-60 mins., stirring frequently.
3. The sample was sieved through a 150 μm mesh to remove the coarse material and then centrifuged at 3000 r.p.m. to produce a pellet.

4. The pellet was then treated as a normal pollen sample beginning with sodium hydroxide treatment.

No volumetric measurement of the pellet was made and *Lycopodium* tablets were omitted from the pollen preparation.

3.7 Radiocarbon Dating.

Conventional ^{14}C dating and A.M.S. dating.

Two methods of radiocarbon dating were used in this research:

- conventional ^{14}C dating
- accelerator ^{14}C dating

Conventional ^{14}C dating measures the radioactive decay rate of ^{14}C in the dating sample. This is based on the radioactive half life of ^{14}C as 5568 years. Several grams, if not more, of material containing 50% carbon are required for counting. Smaller samples can be dated but the counting times required are prohibitively long.

Accelerator dating, or accelerator mass spectrometry (A.M.S.), was developed in 1977. This method dates samples by measuring the ^{14}C concentration in the sample. The advantage of this method is that only very small samples, e.g. milligram quantities, are required and the counting time is much reduced.

Radiocarbon dates always have uncertainty attached to them. The date is usually given as a date plus or minus one or two standard deviations. The uncertainty inherent in ^{14}C dating must always be taken into account when drawing any conclusion from the dates.

Calibration.

One of the main assumptions made when ^{14}C dating is carried out is that there has been a constant atmospheric concentration of ^{14}C over the period for which ^{14}C dating is useful. ^{14}C dating of dendrochronologically dated trees has shown this assumption to be inaccurate. Many dendrochronological sequences have been published and calibration curves are now routinely used to convert ^{14}C dates (in radiocarbon years) into calendar years. This is important when the dates are to be related to archaeological evidence. The dates from this research were calibrated using the OxCal v.2.14 computer program produced by the Oxford Radiocarbon Laboratory.

Calibration results in a calibrated age range rather than a single date. A date with a standard deviation cannot be quoted because the uncertainty attached to the calibrated date is non-linear. The range may be quoted at the 1σ (68.3%) or 2σ (95.4%) confidence limits. After calibration it is possible for the range of dates produced to be a set of discrete ranges. Each of these ranges has a probability attached to it. The probabilities of these ranges add up to one. When constructing time/depth curves using calibrated ^{14}C dates it was difficult to determine the best line through the dates. It was decided to calculate the mid point of the range for each date at the 1σ (68.3%) and 2σ (95.4%) confidence limits and then to join these mid points to produce the curve. The curves produced were very similar and so it was then decided to use the curves produced using the 1σ confidence level. The curves, and dates extrapolated from them, are only approximations and will have error ranges attached to them. These dates are not accurate enough to be used to correlate known archaeological events with regions of the pollen diagrams but may be used to indicate approximate time periods.

The following dating nomenclature has been used throughout this thesis :-

bp - for uncalibrated radiocarbon years before present

cal BC / cal AD - for calibrated radiocarbon dates

BC / AD - for historical dates

Sample Preparation.

In this study both methods of ^{14}C dating were used. Two conventional dates were obtained from the Scottish Universities Research and Reactor Centre (S.U.R.R.C.), East Kilbride. Samples were removed from monolith tins using a clean scalpel, sealed in plastic bags and sent for dating.

The accelerator dates were carried out on samples of *Sphagnum* moss rather than on bulk samples of peat. Slices of peat, 0.5cm thick, were removed from either cores or monoliths, dispersed in distilled water and placed in a clean glass Petri dish. The samples were examined under a low power binocular microscope and stems and leaves of *Sphagnum* moss, preferably *Sphagnum imbricatum*, were picked out with forceps and placed on a clean watch glass. When sufficient material had been collected it was allowed to dry out completely (covered to prevent dust contamination) then placed in a labelled glass vial with a plastic lid. The samples sent for dating normally contained at least 50mg dry weight of *Sphagnum*. The dating was carried out by the Oxford Radiocarbon Accelerator Unit.

Accelerator dating was required for most of the samples because only 9cm diameter Russian cores were available from many of the sites. To obtain a conventional date from these cores would have required large depths of peat to have been used for the dating sample. This may have covered several hundred years adding to the inaccuracy already inherent in ^{14}C dating. By using accelerator dating much smaller depths (0.5cm) could be used and the same genus could be dated at all levels i.e. *Sphagnum*. This gave consistent dating material free from contamination by rootlets penetrating the sample from above.

4. WALLS HILL BOG.

4.1 Site Description.

Geography, Geology and Vegetation.

Walls Hill Bog (NS 419591) is situated near Howwood, approximately 9.5 km south-west of Paisley, in Renfrewshire (see Fig. 4.1) at a height of 180 m. The bog is rimmed on the south-east by the Lochliboside Hills and on the north-west by Broadfield Hill. To the south-west the land drains gently towards the lower ground of Ayrshire.

The bog is a remnant of a larger area of bog which was substantially reduced in size as a result of the cutting of a reservoir, known as Whittliemuir Midton Reservoir, into the bog in the mid 19th century. The reservoir is now disused and is therefore much more prone to fluctuations in water level due to the weather.

There is a long peat face where the reservoir adjoins the remains of the bog and this was the area sampled. The majority of the bog is now very dry and almost entirely colonised by *Calluna vulgaris* although one small area remains waterlogged and consequently supports a variety of plants which are characteristic of bogs. These include *Narthecium ossifragum* (Bog Asphodel), *Vaccinium oxycoccus* (Cranberry), *Potentilla palustris* (Marsh Cinquefoil), *Menyanthes trifoliata* (Bog bean), *Drosera rotundifolia* (Round leaved Sundew) and several species of *Sphagnum*.

As consequence of the water level fluctuations at the time of sampling the reservoir was almost empty of water and it was possible to walk on the peaty bed. The floor of the reservoir was covered in pieces of *Betula* wood and stumps, as well as two stumps of *Pinus sylvestris*, the only reliably authenticated ancient Pine stumps to have been found west of Glasgow. One stump has subsequently been dated to 4270 ± 50 radiocarbon years bp (2920 - 2705 cal BC at the 1σ level).

The land around Walls Hill Bog is generally used for pasture and in particular for sheep grazing. According to the British Geological Survey Land Use maps the land is classified as being (4) - narrow arable, primarily grassland and (5) - improved pasture land. The equivalent Soil Survey maps score the land as 149 & 150 i.e. in general brown forest soils with undulating lowlands and hills with gentle and strong, sometimes slightly rocky, slopes.

Archaeology.

Walls Hill Bog is situated 700m to the north-east of Walls Hill fort (NS 411588), an Iron Age hillfort in Renfrewshire, about 9.5 km south-west of Paisley. The fort measures 470 m by 200 m enclosing an area of 7.3 ha. It occupies the summit of a rocky hill which has a highest point of 229 m and slopes steeply on all sides apart from a 120m section on the north-west which has a much gentler relief. The rampart enclosing the summit was built of earth with stone kerbs, probably with a timber revetment at the front (Feacham 1977). There are no surface traces of dwellings on Walls Hill but an excavation undertaken in 1956 (Newall 1960) revealed two early Iron Age occupations with circular timber-framed houses.

The size of this fort would indicate that it may well have been a tribal stronghold and may even have been the tribal stronghold of the Damnonii. It is likely that forts such as Walls Hill were not permanently occupied but were available for the tribe's protection when they were threatened. Strongholds such as these would be the recognised centre of their tribe and as a result were termed *oppida*, or towns by the Romans.

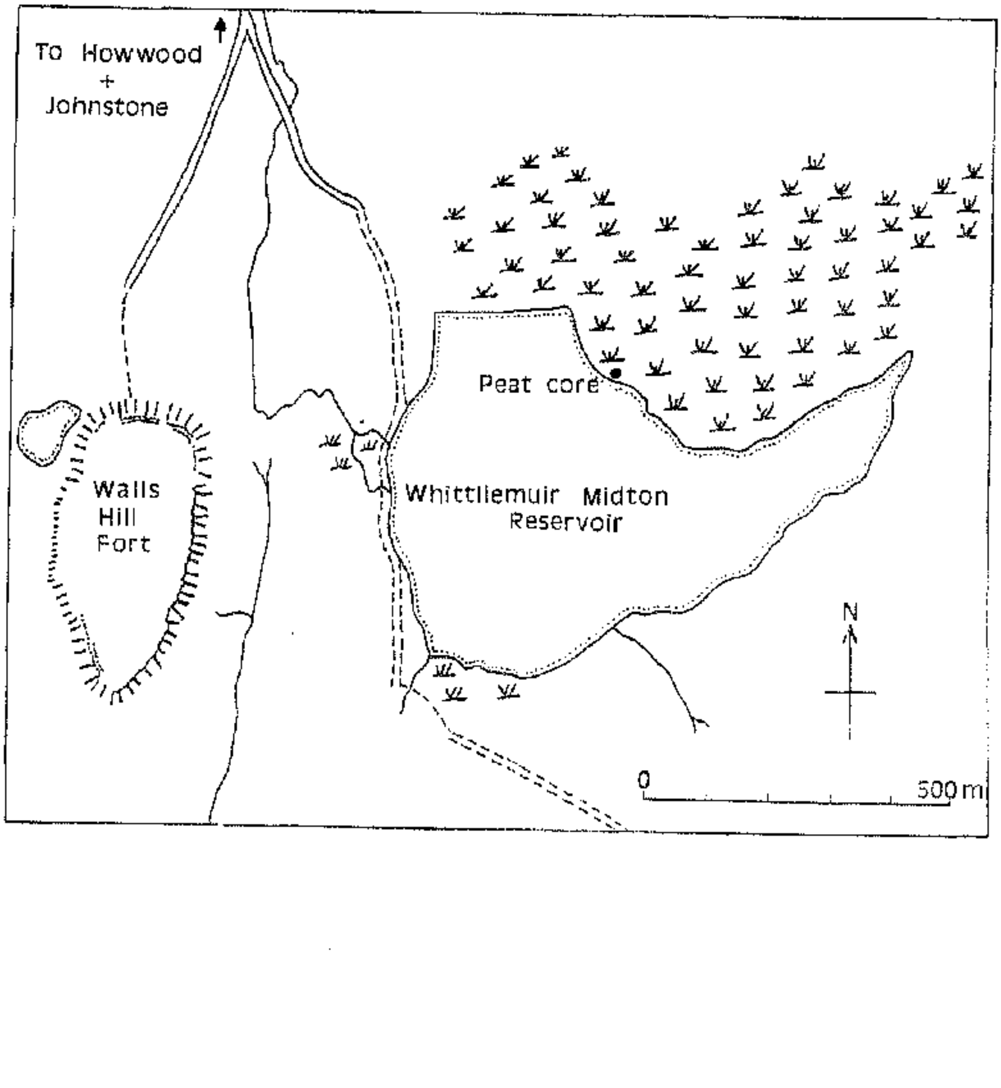


Fig. 4.1 : Walls Hill Bog location map.

Newall (1960) states that the site was exploited in the "first century AD and perhaps somewhat earlier" and suggests that the initial occupation ceased on the arrival of the Romans since the fort overlooked the Antonine Wall which lies only 16 km to the north. Newall also suggests that the site was reoccupied between the 4th and the 11th centuries.

A farmstead site exists between the fort and the bog. A preliminary investigation of this site was undertaken in 1991 by Archaeology Projects Glasgow [APG] (now Glasgow University Archaeological Research Division). It was found to contain buildings, enclosures, yards and a possible midden. No ^{14}C dates were obtained from the site but documentary evidence was studied to try and attach a date to the site. The first edition (1860) 1:10000 O.S. map of the area shows the farmstead to be deserted. A map of c.1650 and Roy's map of 1770 have no mention of the farmstead. Neither is it mentioned in the Poll tax rolls of 1695 which may indicate that the farm had not yet come into existence. Going by the references available it would appear that the site had a history of only about half a century i.e. not mentioned in 1770, inhabited in 1796 and abandoned by 1850. It was considered by the archaeologists who investigated the site that this would have been too short a time to have produced the remains found on the ground. These appear to represent several periods of activity and it was considered that the lack of documentary evidence may have been due to the unreliability of the sources themselves (Pollard 1991). Newall (1960) puts the date of the farmstead site as 14th century but gives no reasons for his assertions.

Walls Hill Bog was greatly modified in the mid 19th century. Part of it was destroyed during the construction of Whittliemuir Midton Reservoir, built to provide a water source for the bleaching mill at Midton. The reservoir is now disused and during dry spells the peat floor of the reservoir is visible. Recently the reservoir has been further modified: drainage channels have been dug into the peat covering the floor of the reservoir and dams connected with the reservoir have been breached. This has caused the water level on the reservoir to fall even further and may affect the small area of actively growing bog which had survived the previous interference.

4.2 Surface Vegetation and Pollen.

Surface Vegetation.

Taxa	Domin Value
Calluna vulgaris	9
Vaccinium myrtillus	3
Eriophorum vaginatum	2
Erica tetralix	2
Polytrichum commune	4
Sphagnum	3
Other bryophytes	8

Table 4.1 : Walls Hill Bog surface vegetation

The surface vegetation of the major part of Walls Hill Bog is dominated by *Calluna vulgaris,* an indication of the disturbance induced drying of the bog surface. The cutting of the reservoir into Walls Hill Bog has resulted in there being cut peat faces approximately 1.5m high which contribute to the extensive drying of the peat. The other species, *Erica tetralix, Eriophorum vaginatum* and *Vaccinium myrtillus,* are also common on bogs and heathland. *Sphagnum* moss is present on the surface of the bog indicating that there are also some wetter hollows on the bog allowing this more hydrophilous taxon to survive. The ground under the low heather canopy was almost completely covered by bryophytes.

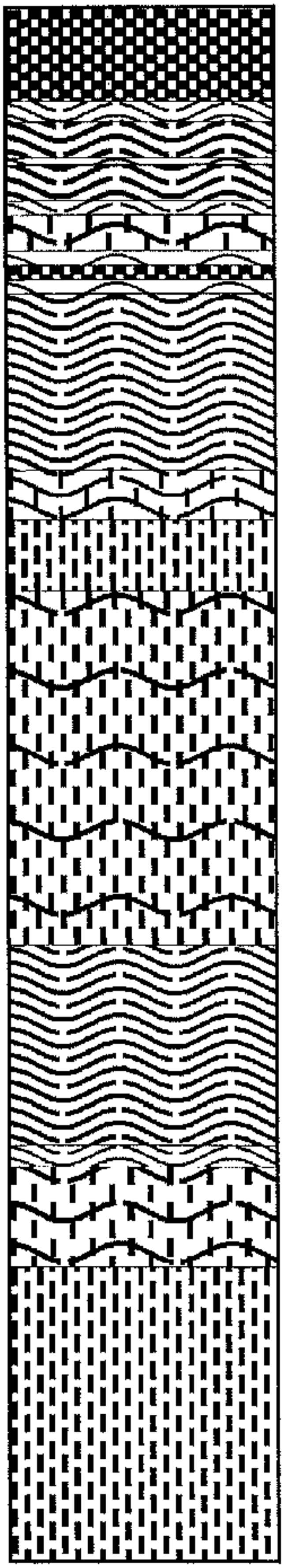
Surface Pollen Results.

Pollen taxa	% Total Pollen
Betula	5.3
Alnus	1.4
Pinus	12.2
Picea	0.3
Ulmus	0.7
Fagus	1.4
Tilia	0.1
Salix	0.1
Coryloid	0.3
Calluna vulgaris	58.2
Poaceae	16.8
Cyperaceae	0.6
Plantago lanceolata	0.1
Sinapis type	0.4
Liguliflorae	0.2
Succisa	0.2
Potentilla type	0.1
Anthemis type	0.1
Ranunculus acris group	0.1
Rumex acetosa	0.1
Cerastium type	0.1
Pteridium aquilinum	0.4
Filicales	0.6
Sphagnum	0.3

Table 4.2 : Walls Hill Bog surface pollen

The surface pollen study generally reflects the vegetation growing on the bog with *Calluna vulgaris* being by far the greatest contributor to the local pollen rain. This may partly be due, in part, to the fact that the *Sphagnum* moss samples used for the surface pollen samples were collected on the 1st Sept. 1993 when the *Calluna vulgaris* was in flower and so producing pollen. The only other taxa which make up a significant proportion of the pollen sum are Poaceae and *Pinus*. The Poaceae value is not as high as might have been expected for a site surrounded by large tracts of pasture land. However, as these results are proportional, the large amount of *Calluna* pollen has depressed the value for the amount of Poaceae detected. The *Pinus* pollen has probably come from a coniferous plantation which lies 1.5-2 km to the south-east of the site. Apart from the *Pinus* pollen tree pollen is very low reflecting the open nature of the site. Herb taxa are present at low levels but are indicative of taxa which colonise pasture land. The value for *Sphagnum* is very low considering that *Sphagnum* made up the matrix of the surface pollen sample studied and *Sphagnum* was also relatively common on the wetter area of bog close by. This result may be due to the unpredictable nature of *Sphagnum* spore production.

4.3 Peat Stratigraphy.



0 - 13 cm	Sh 4	
13 - 16 cm	Tb^1 (sphagni) 4	
16 - 21 cm	Tb^3 (sphagni) 4	
21 - 22 cm	Tb^1 (sphagni) 4	
22 - 27 cm	Tb^3 (sphagni) 4	
27 - 29 cm	Tb^1 (sphagni) 4	
29 - 34 cm	Tb^3 (sphagni) 2	Th^3 2
34 - 36 cm	Tb^1 (sphagni) 4	
36 - 38 cm	Sh 4	
38 - 40 cm	Tb^1 (sphagni) 4	
40 - 65 cm	Tb^2 (sphagni) 4	
65 - 72 cm	Tb^2 (sphagni) 3	Th^2 1
72 - 82 cm	Tb^3 (sphagni) +	Th^3 4
82 - 132 cm	Tb^3 (sphagni) 1	Th^3 3
132 - 160 cm	Tb^2 (sphagni) 4	Dl +
160 - 163 cm	Tb^1 (sphagni) 4	
163 - 177 cm	Tb^3 (sphagni) 2	Th^3 2
177 - 220 cm	Th^3 4	Dl +

Fig. 4.2 Walls Hill Bog stratigraphy

4.4 Pollen Zone Descriptions.

The following pollen zone descriptions are based on a sum of :-

Total Pollen and Spores (excluding *Sphagnum*) : see Fig. 4.3

WH-1 (211 - 182cm)

Tree pollen values are moderate. Coryloid is very high (45%). *Calluna vulgaris* pollen decreases from 37% to 11% from the beginning to the end of the zone. Poaceae and Cyperaceae values are very low and the only other herb taxa present are *Lysimachia vulgaris* type, *Plantago lanceolata*, *Filipendula* and *Potentilla* type. *Pteridium aquilinum* and *Sphagnum* are very low.

WH-2 (182 - 74cm)

This zone covers a long time period and consists of a sequence of similar changes in pollen types. Tree pollen is generally stable with only minor fluctuations. *Fagus* and *Hedera helix* occur for the first time in this zone. *Calluna vulgaris* values are quite erratic but show a general decline towards the middle of the zone and somewhat of an increase towards the end. Poaceae shows a number of small peaks in this zone as do Cyperaceae, *Plantago lanceolata* and *Pteridium aquilinum*. Many herb taxa occur for the first time in this zone although these first occurrences seem to cluster at two distinct levels i.e. 102-110cm and 170-182cm. Cereal type also occurs for the first time. *Sphagnum* is very erratic in this zone.

WH-3 (74 - 56cm)

Tree pollen, in particular that of *Alnus*, declines slightly as does that of Coryloid. Poaceae peaks in this zone, reaching 23%. Cereal type is present and there are increases in both *Plantago lanceolata* (to 5%) and *Pteridium aquilinum* (to 4%). *Calluna vulgaris* also increases reaching 44%.

WH-4 (56 - 37cm)

Betula, Quercus, Alnus and Coryloid increase. There are sharp declines in Poaceae (to 3%) and in Cyperaceae (to 3%). *Plantago lanceolata* and *Pteridium aquilinum* both decline and are absent from some of the levels in this zone.

WH-5 (37 - 14cm)

Betula decreases and, while *Quercus* and *Alnus* decrease initially, they increase again slightly prior to a second decline. *Calluna vulgaris* also declines somewhat. Poaceae and *Plantago lanceolata* increase at the beginning of the zone (Poaceae reaches 19%) but gradually decline again towards the end of the zone. Cyperaceae increases steeply reaching 43%. *Rumex acetosa* group, *Succisa / Scabiosa*, and Brassicaceae (including *Sinapis* type) all occur for the first time in this zone.

WH-6 (14 - 0cm)

Tree pollen declines steadily as does that of Coryloid. *Calluna vulgaris* increases rapidly reaching 80% while Poaceae peaks at the beginning of this zone (reaching 22%) before slowly declining again. *Plantago lanceolata* follows a similar pattern, reaching a maximum of 8%. *Rumex obtusifolius* group, *Cannabis* type and *Trifolium* type all occur for the first time. *Sphagnum* declines sharply from the beginning to the end of the zone.

The following brief pollen zone descriptions are based on a sum of :-

Arboreal Pollen (Coryloid and Salix) : see Fig. 4.4

WH-1 (211 - 182cm)

Coryloid pollen is high (up to 153%) but although *Calluna vulgaris* starts off high (158%) it declines to 35% towards the end of the zone. Poaceae, *Plantago lanceolata* and *Pteridium aquilinum* are all low. There are peaks in both *Filipendula* (7%) and *Potentilla* type (3%).

WH-2 (182 - 74cm)

Coryloid has declined from WH-1. Poaceae, Cyperaceae, *Plantago lanceolata* and *Pteridium aquilinum* show a number of small peaks throughout the zone. *Filipendula* is consistently present towards the end of the zone (at >1%) whereas *Polypodium vulgare* type declines towards the end of the zone.

WH-3 (74 - 56cm)

Calluna vulgaris peaks in this zone (up to 266%) as does Poaceae (133%), *Plantago lanceolata* (30%) and *Pteridium aquilinum* (20%). There are small peaks in *Artemisia* (6%) and *Filipendula* (7%).

WH-4 (56 - 37cm)

There are marked declines in *Calluna vulgaris* (to 18%), Poaceae (to 8%), *Plantago lanceolata* (to <1%) and *Pteridium aquilinum* (to 0%) while Cyperaceae increases first before also declining.

WH-5 (37 - 14cm)

There are initial increases in *Calluna vulgaris* (186%), Poaceae (96%) and *Plantago lanceolata* (14%) but all decline again towards the end of the zone. Conversely there are increases in Cyperaceae (283%) and *Pteridium aquilinum* (19%) towards the end of the zone. Three is also a small peak in *Filipendula* (7%).

WH-6 (14 - 0cm)

Calluna vulgaris increases during this zone (reaching 3580%) as do Poaceae (207%), Cyperaceae (340%), *Plantago lanceolata* (100%) and *Pteridium aquilinum* (11%). Many herb taxa increase in this zone in particular *Trifolium* type (20%). *Polypodium vulgare* type and *Huperzia selago* reach 10%.

The following brief pollen zone descriptions are based on a sum of :-

Non Mire Pollen : see Fig. 4.5

WH-1 (211 - 182cm)

Poaceae, *Plantago lanceolata* and *Pteridium aquilinum* are very low. *Pinus* declines slightly from 3% at the beginning of the zone to <1% at the end.

WH-2 (182 - 74cm)

Poaceae, *Plantago lanceolata* and *Pteridium aquilinum* show several small peaks throughout the zone.

<u>WH-3 (74 - 56cm)</u>

Alnus declines while there are increases in Poaceae (40%), *Plantago lanceolata* (9%) and *Pteridium aquilinum* (4%).

<u>WH-4 (56 - 37cm)</u>

Betula increases slightly whilst there are declines in Poaceae (to 4%), *Plantago lanceolata* (to 0%) and *Pteridium aquilinum* (to 0%).

<u>WH-5 (37 - 14cm)</u>

At the beginning of the zone there are increases in Poaceae (31%) and *Plantago lanceolata* (5%) but they decline again towards the end of the zone.

<u>WH-6 (14 - 0cm)</u>

There are declines in *Betula* (6%), *Quercus* (2%) and Coryloid (9%) while *Alnus* increases slightly to 12%. There are also increases in Poaceae (48%), *Plantago lanceolata* (19%) and Cereal type (6%).

4.5 Radiocarbon Dates.

* Conventional radiocarbon date. All other dates are accelerator dates.

Sample Code	Depth (cm)	Radiocarbon Date (uncalib. years BP)	Calibrated Date (1σ)	Calibrated Date (2σ)
OxA-4218	13-13.5	725 ± 65	1235 - 1384 AD	1196 - 1400 AD
OxA-4477	33-33.5	1115 ± 55	888 - 990 AD	792 - 1019 AD
OxA-4219	52-52.5	2030 ± 70	104 BC - 67 AD	195 BC - 129 AD
GU-3177*	68-70	2020 ± 100	160 BC - 112 AD	355 BC - 233AD
OxA-4220	70-70.5	2180 ± 75	362 - 118 BC	387 - 44 BC
OxA-4221	86-86.5	2395 ± 70	755 - 390 BC	770 - 366 BC
OxA-4222	102-102.5	2675 ± 75	908 - 793 BC	1003 - 548 BC

Table 4.3 : Walls Hill Bog radiocarbon dates

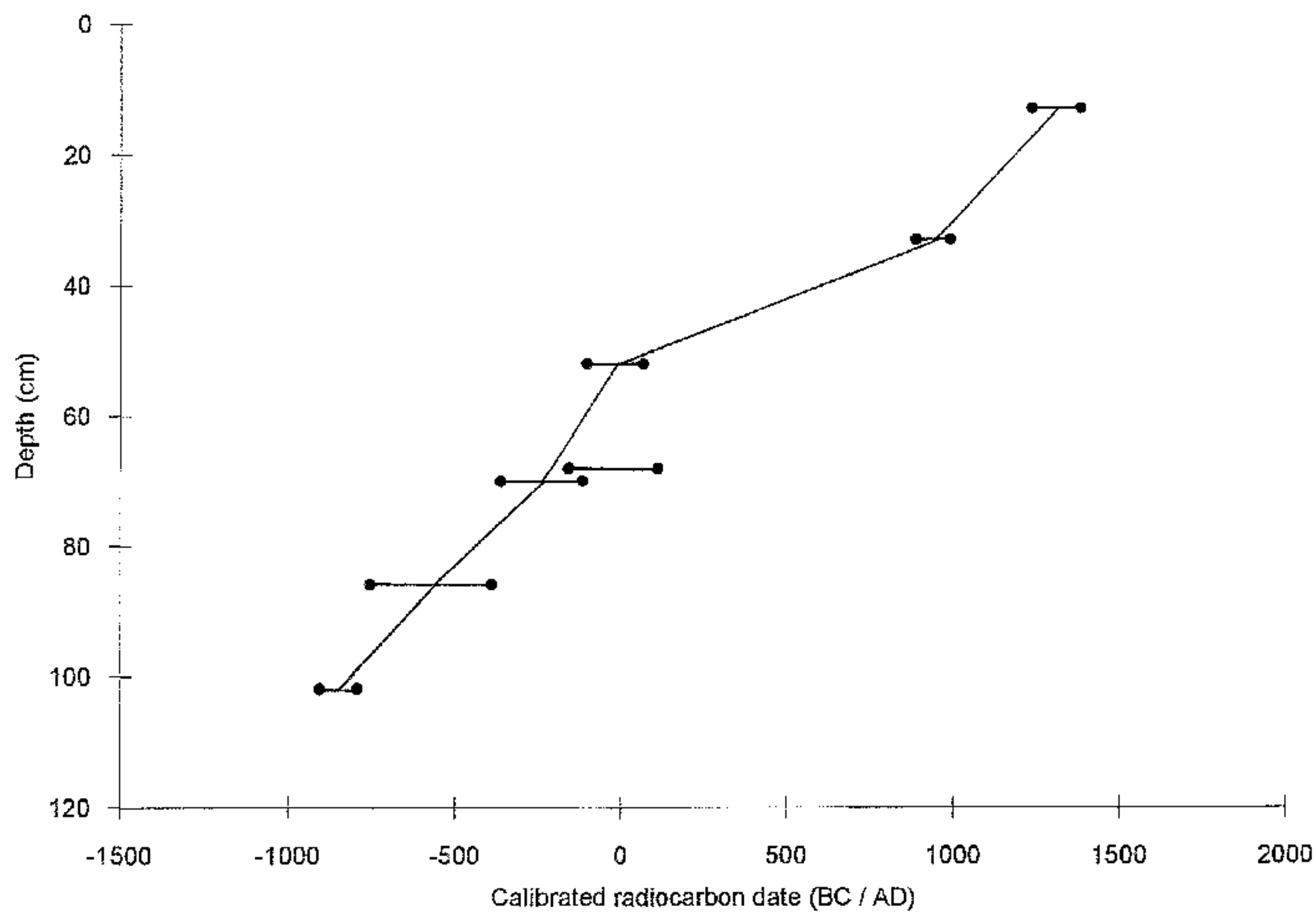


Fig. 4.6 : Walls Hill Bog time / depth plot.
Dates shown at 1σ level

4.6 Absolute Pollen Results.

The influx diagram resulting from the absolute pollen analysis of the peat profile from Walls Hill Bog is shown in Fig 4.7. Only the main taxa have been plotted and the zones shown on the diagram correspond to those shown on the relative pollen diagrams. These zones have been drawn on the influx diagram as an aid to comparison.

The time/depth curve for this site shows varying peat accumulation rates for the profile during the period being investigated. The pollen influx for the profile has been calculated by assuming a constant accumulation rate between radiocarbon dates. Considering the non uniform peat stratigraphy this assumption cannot be verified. The influx diagram is difficult to interpret as the curves are very erratic. It would appear that the curves have been significantly influenced by the assumption of uniform accumulation rates between dates and so are reflecting the peat deposition rate rather than the changing composition of the vegetation surrounding the site. It is not possible to draw any relevant conclusions concerning the vegetation of the Walls Hill area from the pollen influx diagram. The influx diagrams from the other sites are subject to similar problems and so have not been included.

This type of relationship i.e. that pollen concentration is related more closely to accumulation rate than pollen influx was also noted by Rowell & Turner (1985) at Quick Moss, Northumberland.

4.7 Interpretation and Discussion.

WH-1 (211 - 182cm)

Tree pollen is moderate in this zone but is augmented by very high values of Coryloid. This may be due to *Corylus avellana* but is perhaps more likely to be from *Myrica gale* (Bog Myrtle) considering the wet, heathy nature of the present land surrounding the site.

The suite of tree pollen present suggests trees were growing near the site with *Betula* and *Alnus*, both capable of growing in wet areas, being predominant. *Quercus* does not make up a large proportion of the tree taxa which again may be due to the heathy nature of the surrounding land. It may never have supported large tracts of Oak woodland even though this area is within the *Quercus* zone of McVean & Ratcliffe (1962) and Bennett (1989). Poaceae, Cyperaceae and other herb taxa are very low indicating a wooded or at least non grassland landscape surrounding the site. *Calluna vulgaris* values are high pointing towards a heathy rather than densely wooded local vegetation. The diversity of herb taxa is very low with only *Filipendula* and *Potentilla* type reaching >1%. These two taxa can be indicative of wet, or at least damp places but as *Potentilla* type includes such a large number of species with a wide variety of habitat types that it is not possible to assign a precise environmental interpretation to this pollen type. The lack of *Sphagnum* spores in this zone is supported by the stratigraphic macrofossil analysis of the peat section corresponding to this zone which shows a purely herbaceous origin for the peat with the most likely peat forming taxon being *Eriophorum*. There is no convincing evidence of any human activity in this zone although there is one level with a significant charcoal score which could possibly be linked to human activity. However the charcoal is more likely to be present as a result of a natural heathland fire considering the large proportion of heather in the vicinity which burns readily during dry weather and which can ignite easily. This zone has not been dated by radiocarbon methods and extrapolation from the oldest radiocarbon date available from this site is not considered to be appropriate. This date is more than 80 cm further up the sequence, while the time/depth curve plotted for this site indicates that the peat accumulation rate for this profile is very erratic. However it is possible to estimate an approximate time period into which it is possible to place this zone. By considering the *Ulmus* curve it would appear that the zone is post Elm Decline i.e. more recent than 5000 BP if it is assumed that the site is within an area which would show an Elm Decline if one were present. An Elm Decline is clearly visible in the pollen diagrams from Bloak Moss (Turner 1975) which is only 14 km from Walls Hill Bog. At the bottom of the zone there are slightly elevated *Pinus* levels which may suggest that these levels correspond to the period during which the dated Pine stump, found on the bed of Whittliemuir Midton reservoir, was growing. This date has been calibrated to 2920-2705 cal BC so that these elevated Pine levels may be the very end of the period of Pine growth on the site. A date of 2000-3000 cal BC would be a reasonable estimate for this zone considering that the oldest radiocarbon date for the site is around 800-900 cal BC more than 80 cm further up the sequence.

WH-2 (182 - 74cm)

This zone may span anywhere from many hundreds up to two thousand years. It has been delimited as a zone not because it contains a uniform assemblage of plant taxa but because it encloses a series of very similar vegetation changes. These changes consist of small scale increases in Poaceae to > 10% total pollen (TP) [15-25% non mire pollen (NMP) and 30-40% arboreal pollen (AP)] which last for probably only a few hundred years. These increases in Poaceae are accompanied by corresponding peaks in *Plantago lanceolata*, most noticeably in the AP pollen diagram but also to a lesser extent in the NMP and TP diagrams. This is also the zone during which there is a large increase in the diversity of herb taxa round the site. Few of these taxa reach > 1% in any of the diagrams but the fact of the increasing diversity coupled with the periodic increases in Poaceae and *Plantago lanceolata* would point to human interference in the area probably taking the form of small scale woodland clearance for agriculture, most probably for woodland pasture. There are two occurrences of cereal type pollen in this zone but is unlikely that any significant cereal cultivation was being undertaken around the site considering the very poor nature of the local soil. The cumulative effects of the changes in the herb taxa are most clearly seen in the summary diagram of the TP diagram. The AP diagram shows periodic fluctuations in *Pteridium aquilinum* spores which also suggests decreasing woodland cover or at least a thinning of the woodland canopy which would encourage increased *Pteridium aquilinum* spore production. There is little evidence for a significant decline in the pollen production of any particular tree taxa so any deliberate clearance activity was probably not selective. These small clearances are analogous to the "small temporary clearances" of Turner (1975) which she defines as short periods of time during which Poaceae pollen reaches more than 20% AP but does not exceed 100% AP. Dumayne (1992) also uses the term small temporary clearance which she defines as being short periods during which Poaceae pollen values exceed 15% but does not exceed 30% NMP. The values which Poaceae reaches during the peaks in this zone fit the definitions of small temporary clearance given by both Turner and Dumayne. Two radiocarbon dates were obtained near the top of the zone each of which are attached to one of these small temporary clearance episodes. The dates obtained were 908-793 cal BC and 755-390 cal BC. There are at least two other discernible small temporary clearances earlier in this zone.

The total time span of the small temporary clearance phases therefore cover a period spanning the Bronze Age and early Iron Age. There is a similar sequence of small temporary clearances in the Bloak Moss diagram (Turner 1975). The dates for the Bloak Moss diagram are uncalibrated but after calibration with the OxCal program the small temporary clearances cover a period stretching from 2450-2060 cal BC up until 760-270 cal BC. Therefore the Bloak Moss small temporary clearances and the same type of clearances seen at Walls Hill cover a very similar period and as the sites are only 14 km apart it is possible that the clearances at both these sites are result of small populations moving around the area, clearing woodland and exploiting the cleared land as grazing for animals until the land became exhausted at which point they would move on to another site. There are a number of peaks in charcoal in this zone only some of which correspond to the peaks in Poaceae. These may be from burning as a result of human habitation or interference in the area but are equally likely to be natural burning of heather on the bog or surrounding heathland. The latter explanation may be more likely as the peaks in charcoal are at the beginning and end of the zone. These correspond with the heather curve which also peaks at the beginning and end of the zone suggesting it was heather which was burning. *Sphagnum* begins to make up a significant proportion of the peat in this zone although it only becomes the sole contributor from 132-163 cm. The rest of the time it is mixed with herbaceous peat, probably resulting from *Eriophorum*. There are significant variations in the humification of the peat in this zone with humicity values ranging from 1-4. This may suggest fluctuations in the climate or, more likely, are the result of local variations in bog surface wetness. The pure *Sphagnum* regions of the core are of humicity 1-2 so probably grew quickly in a wetter local environment than those regions with mixed *Sphagnum* and herbaceous peat which tend to be more humified and so suggest drier conditions. The majority of the small temporary clearances occur in the drier period indicated by the peat stratigraphy i.e. in the upper half of the zone. It is reasonable to assume that people would exploit this land during periods when the land was drier or in times of climatic favourability as it is relatively poor agricultural land and would have been difficult to farm during periods when the water table was high or there was increased rainfall.

WH-3 (74 - 56cm)

This zone is characterised by a decline in tree pollen to <20% with *Quercus* and *Alnus* being most affected. Coryloid is also dramatically reduced from 40% in WH-2 to <10% in this zone. This suggests relatively widespread clearance of both woodland and possibly scrubland (of *Myrica*) in the vicinity of the site. Poaceae increases, reaching 23% TP.

The peak can be seen better in the AP and NMP diagrams where Poaceae reaches >100% AP and 40% NMP. This takes the amount of woodland removal into the "extensive clearance" classification which is defined by Turner (1965) as Poaceae >100% AP (signifying half the pollen catchment cleared of woodland) and by Dumayne (1992) as Poaceae >30% NMP. The rise in Poaceae is accompanied by correspondingly large increases in both *Plantago lanceolata* and *Pteridium aquilinum*. Again there is little evidence for arable cultivation with only one occurrence of cereal type pollen in this zone. *Ranunculus acris* type pollen becomes almost continuous in this zone and is accompanied by occurrences of other grassland herbs such as *Rumex acetosella*, Chenopodiaceae, Tubuliflorae (including *Anthemis* type), *Artemisia*, *Rumex crispus* and *Cirsium*. The clearance phase at the beginning of this zone has been dated to 362-118 cal BC at the 1σ level and 387-44 cal BC at the 2σ level putting the clearance phase into the late Iron Age and almost certainly making it pre-Roman. The dating of this clearance episode would probably make it contemporary with the occupation of the hill fort and so clearance may also have been undertaken for defensive purposes - to give a clear area around the fort - as well as for agricultural purposes. *Calluna vulgaris* also increases in this zone so it may be that if land around the fort was cleared for defensive purposes it may not, subsequently, have been farmed but was allowed to revert to heather heathland. By the end of the zone the clearance indicators have again declined. This decline is dated to around 100 cal BC using the time/depth curve but it must be remembered that an error range would be attached to this date as with any other radiocarbon date. The next date in the sequence at 52 cm is 104 cal BC - 67 cal AD at the 1 σ level (195 cal BC - 129 cal AD at the 2σ level) so it would be a reasonable assumption that the date of the end of the clearance must fall before the youngest range of this date making the end of the clearance phase and the beginning of regeneration probably pre-Roman and more certainly pre-Antonine Wall in age. This conflicts with the theory that the fort was abandoned because of its position overlooking the Antonine Wall and suggests that another reason was behind the end of the hillfort's occupation. Newall's assertion that the fort was occupied in the first century AD is not disproved by these results but his summary of his findings " The natural defences of Walls Hill were first exploited during the first century A.D., and perhaps somewhat earlier......" (Newall (1960) p.25) should probably put more emphasis on the "somewhat earlier" phrase. The woodland regeneration which takes place at the end of this zone is mainly the result of increasing *Betula*, *Alnus* and Coryloid suggesting scrubby woodland with an increase in *Calluna vulgaris* perhaps the result of once farmed land reverting to heathland.

The peat stratigraphy diagram shows that the period of woodland regeneration corresponds with renewed growth in *Sphagnum* peat (of only moderate humicity - 2 on the Troels-Smith scale). This might suggest a period of increasing wetness, encouraging rapid *Sphagnum* growth (an accumulation rate of 10 years/cm is obtained from the time/depth curve; the fastest rate for the whole sequence) resulting in increased difficulty maintaining agriculture in the vicinity and consequently abandonment of the area for more favourable sites.

WH-4 (56 - 37cm)

This zone shows further woodland regeneration with *Betula*, *Quercus* and *Alnus* all increasing. Again Coryloid increases with AP (which has reached 40% TP) and when AP and tall shrub pollen are taken together they make up approximately 80% of the total pollen input to the site. *Calluna vulgaris* declines in this zone perhaps because heather heathland was becoming wooded or *Myrica* was becoming increasingly established. Poaceae values decline rapidly reaching a low of 3% TP and few herbaceous agricultural indicators are present in this zone. *Plantago lanceolata* and *Pteridium aquilinum* are both very low or even absent in this zone. It would appear that the land around the bog had been completely abandoned during this period. Trees were allowed to recolonise the whole area and no evidence of human interference is found in the pollen record. There is one radiocarbon date from the beginning of this zone i.e. 104 cal BC - 67 cal AD at the 1σ level (195 cal BC - 129 cal AD at the 2σ level) at 52 cm. Using the time/depth curve the end of the zone can be dated to 800-900 cal AD as a rough estimate bearing in mind the errors associated with ^{14}C dates and extrapolation between dates. This gives a period of up to 1000 years during which there is no recognisable human activity, detectable by pollen analysis, in the area. During this time *Sphagnum* continued to be the dominant peat former suggesting the climate remained relatively wet and continued to keep the surrounding land marginal and generally unsuitable for agriculture. The local area appears to have been unaffected by the arrival of the Romans in other parts of the region and shows no changes after their departure. In fact the Roman invasion of Scotland appears to have gone unrecorded, at least in the form of changes in the pollen rain, in this part of west-central Scotland.

<u>WH-5 (37 - 14cm)</u>

This zone shows a return of human influence to the area after nearly 1000 years of absence. Tree pollen declines to around 20% with *Betula*, *Quercus* and *Alnus* all being affected, presumably as a result of clear felling for agriculture rather than selective felling for timber. Poaceae increases to 19% TP (96% AP, 31% NMP), in effect putting it into the extensive clearance classification. *Plantago lanceolata* and *Pteridium aquilinum* both increase and herb taxa such as *Rumex acetosella*, Chenopodiaceae, *Ranunculus acris* group and type, *Rumex acetosa* group and *Succisa / Scabiosa* are present at the same time. This association again suggests clearance of woodland for pastoral agriculture.

There are no occurrences of cereal-type at the same time as these peaks in agricultural indicators. There is little evidence for burning being associated with this activity. The radiocarbon date obtained for this clearance was 888-990 cal AD at 1σ (792-1019 cal AD at 2σ) putting it into the Viking / Early Mediaeval period. It was noted earlier that Newall (1960) stated that the Walls Hill fort site had been reoccupied sometime between the fourth and the eleventh centuries on the grounds of archaeological evidence. It is now possible to refine that estimate and say that the reoccupation was more likely to have been towards the end of Newall's time frame. However this reoccupation did not last for long because by the middle of the zone (about 1000-1100 cal AD estimated from the time/depth curve) woodland regeneration was already occurring although this too was short lived and by the end of the zone (approximately 1200 cal AD) there are again signs of human interference by way of agriculture. This is shown by a slight increase in Poaceae in the NMP diagram and a cluster of agricultural indicators including cereal-type, Caryophyllaceae, Tubuliflorae, *Ranunculus acris* group, *Artemisia*, *Rumex acetosa* group and *Sinapis* type in the last two levels of the zone.

Looking at the stratigraphy for this profile the main peat formers are still *Sphagnum* species in the main but the degree of humification of *Sphagnum* fluctuates between 1 and 3 throughout the zone. This suggests erratic peat growth and perhaps a fluctuating water table as a result of the changes in woodland cover around the site..

<u>WH-6 (14 - 0cm)</u>

Tree pollen declines dramatically in this zone with AP falling to < 5% of the total pollen input at the end of the zone. Coryloid pollen also declines during the zone also falling to < 5% total pollen by the end of the zone. Poaceae decreases again towards the top of the zone in the total pollen diagram although this is probably result of very high *Calluna* *vulgaris* values. By looking at the NMP and AP diagrams it is clear that Poaceae values remain high throughout the zone reaching 48% NMP and 207% AP. This puts the removal of woodland well into the extensive clearance category of Turner (1965). *Plantago lanceolata* also shows a dramatic increase reaching 19% NMP and 100% AP. This strongly suggests intensive pastoral agriculture being practised on the surrounding land. Such high values of *Plantago lanceolata* may be attributable to the type of animals grazing the land as Grime, Hodgson & Hunt (1988) state that *Plantago lanceolata* is "palatable to sheep, but because of its appressed rosettes in short turf the foliage is not readily eaten in cattle pastures". However this is contradicted by the observation that the land around Walls Hill bog and in fact Walls Hill itself is currently grazed by sheep and *Plantago lanceolata* appears to be thriving. *Pteridium aquilinum* seems less important in this clearance phase although still reaches significant amounts in the arboreal pollen diagram. Many agricultural indicators are present in this zone including Tubuliflorae (both *Anthemis* type and *Aster* type), Liguliflorae, Apiaceae, *Artemisia*, *Rumex acetosa* group, Brassicaceae (including *Sinapis* type) and *Trifolium* type. There is also the first and only appearance of *Cannabis* type which was only found as a single grain and so was not classified as *Cannabis sativa* although it was that species which the grain most resembled using the criteria of Whittington & Gordon (1987) and Punt & Malotaux (1984). Neither species is native in Scotland and so was probably being grown as a crop especially true for *Cannabis sativa* which was widely grown to produce hemp fibre. Herb pollen reaches > 70% NMP in this zone so clearly indicates a very open, grassland environment. *Calluna* pollen shows the most dramatic increase in this zone reaching 80% TP and a massive 3580% AP. It is likely that this *Calluna vulgaris* was growing on the bog itself resulting in an overrepresentation similar to that seen in the surface pollen sample from this site. The peat stratigraphy diagram shows the peat to be 'Sh 4' i.e. so humified that it was not possible to determine which plant taxa had been involved in peat formation. This suggests significant drying out and oxidation of the top layers of peat perhaps as a result of an amelioration of the climate or as a result of human interference with the water balance of the site either by peat cutting or drainage. The beginning of this zone was dated to 1235-1384 cal AD at 1σ (1196-1400 cal AD at 2σ) and by extrapolation from the time/depth curve the present bog surface dates to 1500-1600 cal AD. The top of the profile has probably been severely truncated. There is also evidence of burning at the top of the profile which may have removed a significant proportion of the more recent peat.

The evidence from the farmstead site dated by Newall (1960) to the fourteenth century and by Pollard (1991) as pre 1850 shows that there were people living very close to the bog who could have been burning the surface of the bog or removing the topmost peat for fuel. The cutting of the reservoir into the bog in the mid nineteenth century greatly disrupted the water balance of the site and would have contributed greatly to the drying, subsequent oxidation and finally loss of the topmost layers of peat.

4.8 Conclusions

The Walls Hill Bog pollen diagram charts the changes in vegetation around the site from a post-Elm decline period up until the last few hundred years. The first evidence of human activity in the area was shown in zone WH-2 during which time there was a sequence of small temporary woodland clearances which occurred during a period spanning the Bronze Age and early Iron Age. Similar clearances spanning a similar time period were noted by Turner (1975) at Bloak Moss in Ayrshire, 14 km from Walls Hill Bog. These clearances were probably linked to shifting pastoral agriculture practised by small groups of people.

The first extensive clearances occurred during the late pre-Roman Iron Age with evidence for pastoral rather than arable agriculture. This disproves van der Veen's statement that "the landscape in northwest England and Scotland was not cleared until the Roman period" (van der Veen 1992). Turner (1975) noted a similar extensive clearance at Bloak Moss but it was dated to much later at between 400-600 cal AD. The suite of dates from Bloak Moss are difficult to interpret as there are inversions, dates statistically the same but widely separated in depth, widely differing dates closely spaced and little evidence of stratigraphic change to explain these anomalies. It may be that the Walls Hill Bog and Bloak Moss diagrams are recording completely different events but the overall appearance of the diagrams is so similar that this seems unlikely. It may be that the peat samples dated from Bloak Moss contained younger rootlets which made the resulting dates artificially young. At Walls Hill during the period when the Bloak Moss extensive clearance appears to have taken place there was almost complete woodland regeneration at Walls Hill. Without redating the Bloak Moss profile it is impossible to determine whether these two diagrams are recording the same large scale event or are each simply recording different, more local events. Tipping (1995) also notes what is probably late pre-Roman Iron Age woodland clearance at Burnfoothill Moss on the shore of the Solway Firth although the radiocarbon dates obtained could also point to an early Roman date for the clearance although this is less likely. Pre-Roman clearance was identified by Dumayne (1993a, 1993b) and Dumayne & Barber (1994) at sites in northern England, southern and central Scotland.

There is significant woodland regeneration at Walls Hill from either the first century BC or the first century AD up until 800-900 cal AD. This period includes the Roman invasion and occupation of Scotland. No evidence of Roman effects on the vegetation were recorded at Walls Hill Bog. This period of woodland regeneration is similar to that seen at Black Loch, Fife by Whittington and Edwards (1993). Here a decline in agricultural activity begins at approximately 40 cal AD and lasts until 640 cal AD. This regeneration is similar to that seen at Walls Hill in that it involves most tree taxa and also Coryloid. Whittington and Edwards rule out soil degradation or climatic change as being the cause of this abandonment of agriculture and regeneration of woodland. They also describe similar regeneration at Loch Davan, Aberdeenshire which lasts from 35 cal AD to 1125 cal AD. They suggest that the regeneration is a consequence of the Roman invasion and occupation of Scotland and that an antagonistic relationship between Romans and natives led to widespread destruction of farmland and a decline in agriculture. The dating of the beginning of the woodland clearance at Walls Hill would make it unlikely to be a result of the Roman presence in the area. The Walls Hill results are more in line with the statement by Hanson & Breeze (1991) that "..... the pattern which is beginning to emerge suggests that the effect of the Roman army's presence was minimal", a statement which is challenged by Whittington & Edwards (1993).

Human influences on the vegetation around Walls Hill are next noticed around 800-1000 cal AD and again are most noticeable for increases in Poaceae, *Plantago lanceolata* and *Pteridium aquilinum*. This clearance episode is extensive in nature but of short duration and may be related to a period of reoccupation of the hillfort site noted by Newall (1960). A similar clearance appears in the Bloak Moss diagram (Turner 1975) but is undated. As a result of the difficult nature of the Bloak Moss dates it is not possible to produce an extrapolated date for this clearance episode but it is of very short duration and hence similar to that seen at Walls Hill. Again the clearances recorded at these sites are so similar as to make it seem likely that they are contemporaneous but again the radiocarbon dates do not help to confirm this.

There is a short period of woodland regeneration before massive deforestation begins again and this time reaches the complete clearance stage. This clearance begins around 1200-1400 cal AD and lasts until the top of the profile. A farmstead site is located close to the bog and may have played a large part in the maintenance of this final clearance phase.

The top of the peat profile is likely to have been truncated either by burning, cutting for fuel or drainage and the cutting of the reservoir into the bog has certainly caused drying, shrinkage and oxidation of the top layers of peat in the profile.

5. LOCHEND LOCH BOG.

5.1 Site Description.

Geography, Geology and Vegetation.

Lochend Loch Bog (NS 704659) is situated to the south of Lochend Loch in Drumpellier Country Park, near Coatbridge (see Fig. 5.1). Lochend Loch is one of a group of three lochs, Old Loch (also known as Woodend Loch) and Bishop Loch being the other two, which were formed at the end of the last Ice Age, 10 000 years ago. The bog lies at a height of about 80m OD and is surrounded by large areas of relatively flat land.

Lochend Loch Bog is part of a more extensive landscape of bog, heathland and open water encompassing the area around the three lochs mentioned above. Much of the peatland has been removed as a result of industrialisation of the area but the bog and heathland around Lochend Loch were gifted to the town of Coatbridge as a public park and, as a result, have been protected.

Lochend Loch Bog lies within a very industrialised part of west-central Scotland and is within the area covered by the Central coalfield. Coalmining was a very important industry in the area as was steel manufacturing; the site of the Gartcosh Steel Works is only 2 km to the north of the coring site. There is no evidence for cutting of the bog surface although drainage of the bog has been carried out in the past as evidenced by drainage ditches which cross the bog surface. The rangers working in the country park are attempting to restore the water balance of the site by blocking up these drainage ditches and removing young birch trees which are currently colonising the dry surface of the bog and contributing to the water loss from it.

As the area has been part of a managed estate and is now a park there are many sections of planted woodland in the vicinity of the bog. These include native taxa such as

Oak (*Quercus*), Ash (*Fraxinus*) and Birch (*Betula*) as well as non native taxa such as Beech (*Fagus*), Sycamore (*Acer pseudoplatanus*) and Horse Chestnut (*Aesculus hippocastanum*). As well as these broad-leaved species there are also areas of coniferous woodland containing Scots Pine (*Pinus sylvestris*) as well as more exotic species.

Archaeology.

The earliest record for human presence in the area comes from the shores of Old Loch where approximately 800 pieces of flint and chert chips were found which provide evidence for the presence of Mesolithic hunter-gatherers in the area around 6000 years ago.

There is evidence for Bronze Age occupations in the form of a number of Bronze Age burial cists which have been found in the area including two discoveries of cists in the vicinity of Drumpellier House itself. In 1852 while sand was being extracted from a field about 1.1 km south of the house a group of nine cists was uncovered (Grid ref. NS 705646). These formed a circle about 13m in diameter. Most of the cists contained recognisable fragments of human bone within what was described as an urn. In 1960 a single cist was discovered (Grid ref. NS 715646) about 280m south of the house. In 1936-37 during work in a field belonging to Springhill farm a Bronze Age cist and a series of burials were uncovered. Two deposits of cremated bone were found within the cist. The partial remains of at least six inhumation burials were also found but these are not securely dated to the Bronze Age (RCAHMS, 1978).

A crannog (man made lake dwelling) in Lochend Loch provides evidence for Iron Age occupation of the area (Monteith, 1932). The crannog was discovered in 1931

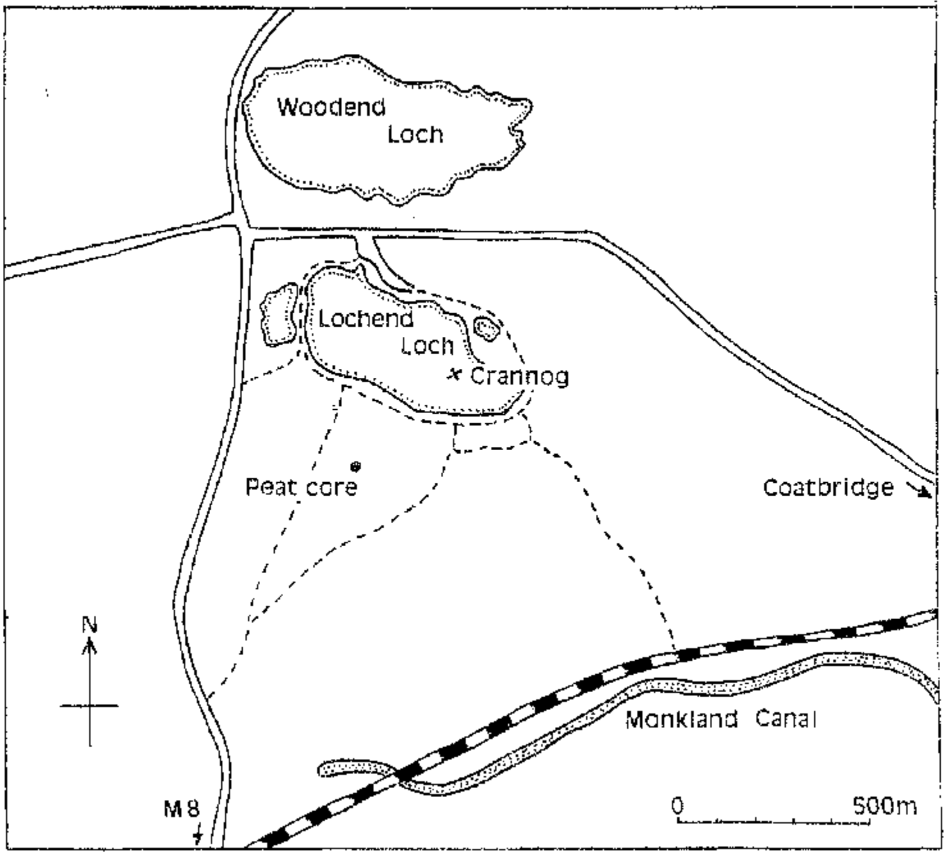


Fig. 5.1 : **Lochend Loch Bog location map.**

while a draining and dredging operation was being carried out on the loch. The crannog was situated approximately 65m from the north-east shore of the loch and measured 37m from east to west and 20m north to south. Removal of peat from the eastern side exposed more than eighty wooden piles edging a wooden platform, up to 1.5m thick, built of horizontally laid timber filled in with around 500 tons of stones, clay and brushwood. Only a small area of the crannog was excavated due to time limitations. Three occupation levels were discovered. The latest phase was constructed using timber beams some of which were oak. The excavators concluded that the crannog had carried a circular house supported by wooden posts and probably thatched with heather. The house had been destroyed by fire on more than one occasion. Finds from the excavation included fragments of pottery, animal bones (mainly ox), three small perforated lignite discs, half a jet bracelet, two quern stones and a large number of hazelnut shells. Human bones belonging to two individuals were also found, one of which showed evidence of having been burnt. This would suggest that the last occupants of the crannog came to a violent end possibly at the hands of a hostile tribe. The total occupation time for the crannog has been estimated as 100 BC - 500 AD (RCAHMS 1978).

The evidence for Roman influence in the area comes from the fact that the Antonine Wall lies only 7 miles (11 km) north of the park. There are no Roman remains in the park itself but it would be reasonable to assume that there must have been some Roman influence on the area.

There is little indication of any human occupation throughout the Dark Ages and it is not until early medieval times that there is again evidence for human influence in the Drumpellier area. In 1161 King Malcolm signed a Charter at Edinburgh Castle granting the area now known as Monklands to the Cistercian monks of Newbattle Abbey, south of Edinburgh. The document mentions that the land included forests, fields, streams and meadows. There is no mention of any buildings in the charter and later commentators record the whole district as "uncultivated and devoted to flocks and beasts of the chase". It is said that the monks cleared great areas of forest and gained a reputation for building oak wagons (Peden, 1992).

In the 16th century the monks leased their land to farmers and after the Reformation the land was sold to the Hamiltons and later the Colquouns. Finally in 1739 it was sold to the Buchanans who began improvements by planting trees and draining the surrounding fields. In 1919 the estate was gifted to the town of Coatbridge.

5.2 Surface Vegetation and Pollen.

Surface Vegetation.

Taxa	Domin Value
Betula pendula	4
Calluna vulgaris	8
Erica tetralix	2
Eriophorum vaginatum	7
Eriophorum angustifolium	6
Other Bryophytes	8
Sphagnum	3

Table 5.1 : Lochend Loch Bog surface vegetation

The surface vegetation of Lochend Loch Bog is dominated by *Calluna vulgaris* and *Eriophorum vaginatum*. These species coupled with the number of small *Betula pendula* trees illustrate the dry nature of the bog surface. However *Eriophorum angustifolium* and *Sphagnum* species are favoured by wetter conditions and may be increasing as a result of the rangers' attempts to stem the water loss from the bog. During examination of the bog it was noted that areas from which the *Betula* had been removed and drainage ditches blocked were noticeably wetter underfoot and suggest that the rangers' efforts are having the desired affect. However the removal of *Betula* from the bog surface will have to be an ongoing project as new seedlings are appearing all the time.

Surface Pollen Results.

Pollen taxon	% Total Pollen
Betula	16.2
Quercus	0.3
Alnus	0.7
Pinus	14.0
Picea	0.5
Fraxinus	0.1
Ulmus	0.3
Fagus	1.2
Acer campestre type	0.3
Tilia	0.1
Salix	0.2
Calluna vulgaris	48.7
Poaceae	15.2
Cyperaceae	0.5
Plantago lanceolata	0.3
Aster type	0.2
Rosaceae	0.1
Sinapis type	0.1
Galium type	0.1
Ranunculaceae	0.1
Rumex acetosella	0.1
Pteridium aquilinum	0.1
Filicales	0.6

Table 5.2 : Lochend Loch Bog surface pollen

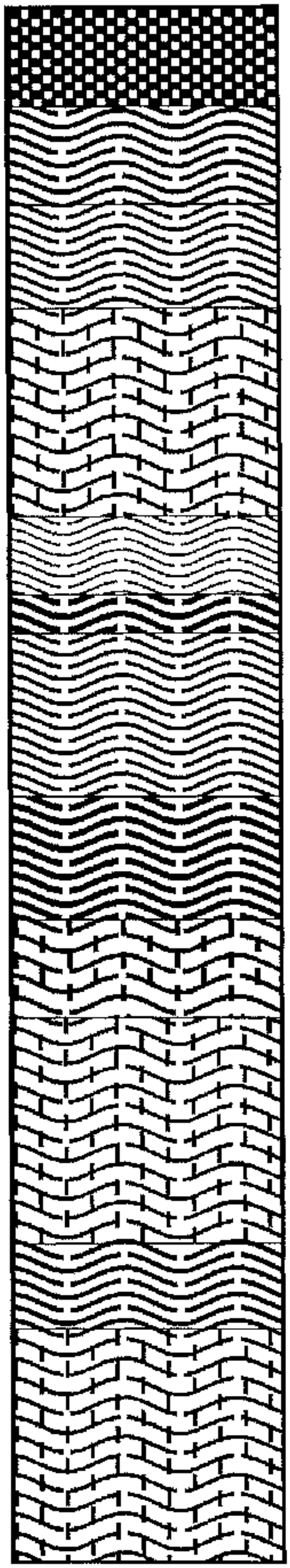
The surface pollen study generally reflects the vegetation growing on the bog and to at least 1km from the sampling site. *Calluna vulgaris* is, as at Walls Hill Bog, the greatest contributor to the pollen rain. Other taxa which make up significant proportions of the pollen sum are Poaceae, *Betula* and *Pinus*. There are large areas of grassland round the site which are used for recreational purposes by the visitors to the park. There are also significant amounts of Poaceae species growing as marginal plants around the edges of the loch. These species are encouraged by the management of the park to provide cover for the many water birds and other wildlife that live around the loch.

The large value for *Betula* reflects *Betula* growing on but more significantly around the margins of the bog. The *Betula* trees growing on the bog are quite young, small trees and so have only a limited capacity for pollen production. However the *Betula* trees growing around the margins of the bog are large, mature trees and will be capable of producing large volumes of pollen.

The high value for *Pinus* reflects the fact that there is a fairly extensive coniferous plantation less than 1 km from the sampling site. There is pollen evidence for the planted trees in the park with trace amounts of *Picea*, *Fagus*, *Acer campestre* type (most likely from *Acer pseudoplatanus*) and *Tilia*.

Herb taxa, other than Poaceae, are at low levels but include taxa indicative of grassland habitats. There were no occurrences of *Sphagnum* spores in this sample even though *Sphagnum* was the genus picked to provide the surface pollen sample. This clearly illustrates that absence of *Sphagnum* spores from a pollen diagram does not necessarily mean absence of *Sphagnum* from the vegetation which produced the samples. It is necessary to check the peat for *Sphagnum* macrofossils before deciding whether *Sphagnum* was present or not.

5.3 Peat Stratigraphy.



0 - 15 cm	Sh 4	Dl +
15 - 30 cm	Tb^3 (sphagni) 4	Th^3 +
30 - 46 cm	Tb^2 (sphagni) 4	Th^2 +
46 - 78 cm	Tb^2 (sphagni) 3	Th^2 1
78 - 90 cm	Tb^1 (sphagni) 4	Th^2 +
90 - 96 cm	Tb^4 (sphagni) 4	Th^4 +
96 - 121 cm	Tb^2 (sphagni) 4	Th^2 +
121 - 140 cm	Tb^4 (sphagni) 4	Th^4 +
140 - 155 cm	Tb^3 (sphagni) 3	Th^3 1
155 - 190 cm	Tb^2 (sphagni) 3	Th^2 1
190 - 203 cm	Tb^3 (sphagni) 4	Th^3 +
203 - 240 cm	Tb^2 (sphagni) 3	Th^2 1

Fig. 5.2 : Lochend Loch Bog stratigraphy.

5.4 Pollen Zone Descriptions.

The following pollen zone descriptions are based on a sum of :-

Total Pollen and Spores (excluding *Sphagnum*) : see Fig. 5.3

LLB-1(240 - 194cm)

This zone is characterised by high values of tree pollen and Coryloid. *Tilia* has its only occurrence in this zone. Poaceae pollen is very low (<5%). Cereal type pollen is absent. Cyperaceae pollen is also very low (<5%). Other herb taxa are restricted to *Plantago lanceolata, Ranunculus acris* type, *Anemone nemorosa* group, Liguliflorae, *Artemisia* and Brassicaceae. *Pteridium aquilinum* is present at <1% but *Polypodium vulgare* type is consistently present and reaches values of 2%.

LLB-2 (194 - 157cm)

Tree pollen is still relatively high although *Betula* and *Quercus* show some signs of decline. *Calluna vulgaris* shows a definite decline reaching its lowest level (6%) in this zone. Poaceae begins to increase steadily reaching 12%. Cyperaceae has increased dramatically from the zone below (up to 39%) and there is one occurrence of Cereal type pollen - the first in the profile. *Plantago lanceolata* also increases reaching a high of 3%. There is an increase in the diversity of herb taxa present. Those recorded in the zone below (except Brassicaceae) are still present and taxa which occur for the first time include *Filipendula, Potentilla* type, *Rumex acetosa* group, *Rumex acetosella, Silene dioica* type and Chenopodiaceae. *Pteridium aquilinum* values increase to 2% and values of *Polypodium vulgare* type and other ferns fall to trace levels. There is a large increase in *Sphagnum* spores in this zone reaching a high of 47%.

<u>LLB-3 (157 - 124cm)</u>

Tree pollen values decline in this zone with *Betula*, *Quercus* and *Alnus* all falling to very low levels. *Quercus* is below 1% in almost half the samples in this zone. *Carpinus* makes its first appearance in this zone. Coryloid declines to 5% while *Calluna vulgaris* values increase from 10% at the end of LLB-2 to a high of 72% in this zone. Poaceae has its highest values (25%) at the beginning of the zone but declines slowly towards the end. Cereal type is again present as trace values. Cyperaceae values fluctuate in this zone but there is a general decline towards the end of the zone. *Plantago lanceolata* is generally above 2%. Several herb taxa make a first appearance in this zone including Apiaceae, *Stellaria holostea*, Caryophyllaceae (indet.), *Succisa / Scabiosa*, *Lysimachia vulgaris* type and *Urtica*. A cluster of samples containing *Artemisia* is also found in this zone. *Pteridium aquilinum* values fluctuate but reach a high of 2%. *Polypodium vulgare* type is almost absent from this zone with only one trace occurrence. *Sphagnum* fluctuates between high and very low values throughout this zone.

<u>LLB-4 (124 - 54cm)</u>

Tree pollen gradually recovers in this zone but tends to fluctuate rather than increasing steadily. *Fagus* makes its first appearance. Coryloid values increase from the zone below but *Calluna vulgaris* falls steadily from the beginning of the zone towards the end. Poaceae falls from the beginning of the zone towards the middle but shows a slight recovery towards the end of the zone. Cyperaceae values are very low. *Plantago lanceolata* is generally present at <1% throughout the zone. The diversity of herb taxa declines in this zone with the only new herb taxa in this zone being single occurrences of *Rumex crispus*, *Rumex obtusifolius* group and *Sinapis* type. *Pteridium aquilinum* occurs sporadically at <1% in most levels. *Sphagnum* again fluctuates wildly.

LLB-5 (54 - 0cm)

Tree pollen fluctuates at the beginning of this zone but declines sharply towards the end. *Quercus* and *Alnus* are absent at the end of the zone. *Ulmus* shows an increase in the topmost sample, reaching 2%. Coryloid values also decline towards the end of the zone. *Calluna vulgaris* increases rapidly from 27% at the start of the zone to 81% near the end of the zone. Poaceae values are consistently above 5% and peak at 17% at the beginning of the zone and 14% at the end of the zone. Cereal type is present sporadically throughout the zone and has its only occurrence of >1% in this zone. Cyperaceae increases steeply at the start of the zone but gradually declines towards the end. *Plantago lanceolata* increases from LLB-4. *Cannabis* type has its only occurrence in this zone. Other herb taxa occurring for the first time are *Aster* type, *Anthemis* type, *Veronica* type, *Cerastium* type, and Fabaceae. *Sphagnum* shows a decline towards the end of this zone.

The following brief pollen zone descriptions are based on a sum of :-

Arboreal Pollen (Coryloid and Salix) : see Fig. 5.4

LLB-1 (240 - 194cm)

Very low values of Poaceae, *Calluna vulgaris* and Cyperaceae.

LLB-2 (194 - 157cm)

Calluna vulgaris pollen is very low. Poaceae increases slightly while Cyperaceae reaches very high values (138%). There are also increases in *Plantago lanceolata, Pteridium aquilinum* and *Sphagnum*.

LLB-3 (157 - 124cm)

There are large increases in *Calluna vulgaris* (973%), Poaceae (252%) and *Plantago lanceolata* (32%) but all decline towards the end of the zone. There are also high values of *Filipendula*, *Rumex acetosa* group and *Artemisia*. *Pteridium aquilinum* values are high but decline towards the end of the zone. *Sphagnum* is generally low.

LLB-4 (124 - 54cm)

Quercus increases steadily from the beginning to the end of the zone. *Calluna vulgaris* decreases towards the end of the zone. Poaceae values are low (4%) as are those of Cyperaceae and *Plantago lanceolata*. Herb pollen is, in general, low. *Sphagnum* is very low apart from two very high levels.

LLB-5 (54 - 0cm)

At the end of this zone there are high values of *Ulmus* (23%) and *Fagus* (8%). *Calluna vulgaris* rises steeply to 1815% towards the end of the zone. Poaceae is high at the beginning of the zone (reaching 91%) and again at the end (175%). *Plantago lanceolata* is high at the end of the zone (reaching 45%). Several herb taxa have high values near the end of the zone, in particular *Rumex acetosa* group (9%), *Artemisia* (5%), *Sinapis* type (6%), Caryophyllaceae (indet.) (10%) and Fabaceae (5%). *Sphagnum* declines towards the end of the zone.

The following brief pollen zone descriptions are based on a sum of :-

Non Mire Pollen : see Fig. 5.5

<u>LLB-1 (240 - 194cm)</u>

Betula increases and other tree taxa values are high as are those of Coryloid (45%). Poaceae and *Plantago lanceolata* are very low.

<u>LLB-2 (194 - 157cm)</u>

Tree taxa values fluctuate but remain moderate. There are increases in Poaceae (17%) and *Plantago lanceolata* (4%) towards the end of the zone.

<u>LLB-3 (157 - 124cm)</u>

Betula gradually increases towards the end of the zone while *Quercus* and *Alnus* values decline. There is also a decline in Coryloid but it recovers towards the end of the zone. There are increases in Poaceae (52%), *Plantago lanceolata* (7%), *Filipendula* (3%) and *Artemisia* (2%) .

<u>LLB-4 (124 - 54cm)</u>

Betula is very high (45%). There are increases in *Alnus* (19%) and *Quercus* (13%) towards the end of the zone. Poaceae is generally low throughout the zone as are *Plantago lanceolata* and the other herb taxa.

<u>LLB-5 (54 - 0cm)</u>

Quercus and *Alnus* decline sharply (to zero) at the end of the zone. Poaceae is high at the beginning (34%) and the end (49%) of the zone. *Plantago lanceolata* increases to 12% towards the end of the zone.

5.5 Radiocarbon Dates.

* Conventional radiocarbon date. All other dates are accelerator dates.

Sample Code	Sample Depth (cm)	Radiocarbon Date (uncalib.years BP)	Calibrated Date (1σ)	Calibrated Date (2σ)
OxA-4531	47-47.5	1170 ± 50	792 - 959 AD	723 - 991 AD
OxA-4223	65-65.5	1235 ± 60	713 - 883 AD	671 - 955 AD
OxA-4224	75-75.5	1440 ± 60	560 - 662 AD	447 - 697 AD
OxA-4225	109-109.5	1630 ± 65	383 - 538 AD	257 - 595 AD
OxA-4226	125-125.5	1765 ± 65	221 - 384 AD	127 - 418 AD
GU-3258 *	135-135.5	1860 ± 70	83 - 239 AD	11 - 341 AD
OxA-4227	145-145.5	2025 ± 80	114 BC - 76 AD	342 BC- 207 AD
OxA-4228	155-155.5	2155 ± 65	354 - 63 BC	374 - 36 BC

Table 5.3 : Lochend Loch Bog radiocarbon dates

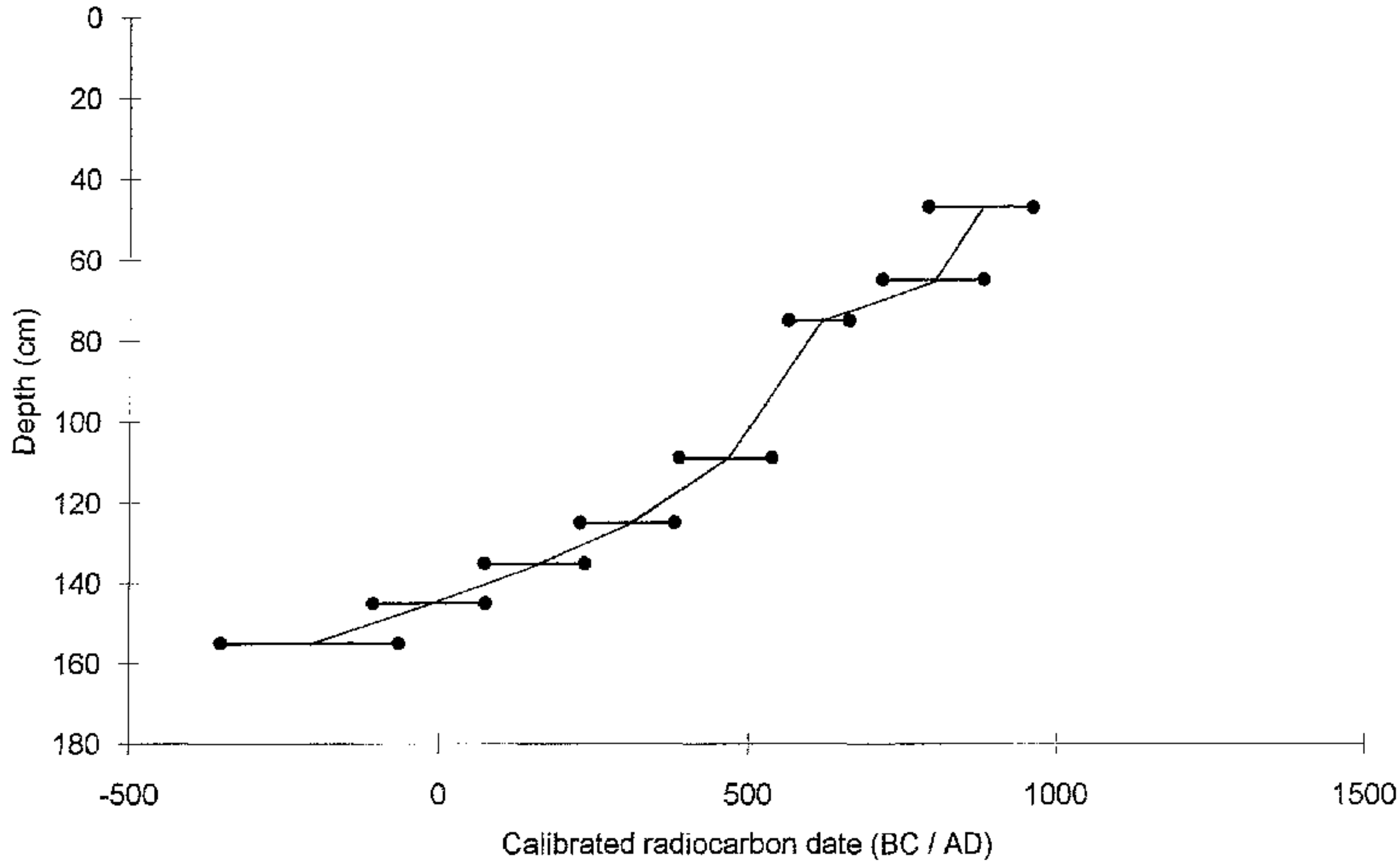


Fig. 5.6 : Lochend Loch Bog time / depth plot.
Dates shown at 1σ level

5.6 Interpretation and Discussion

LLB-1 (240 - 194cm)

Tree pollen is moderate in this zone but is augmented by high values for tall shrubs and heaths leaving only 5-10% of the total pollen belonging to herbaceous taxa. The tree pollen probably reflects trees growing on and off the site. *Betula* pollen is generally a significant proportion of the pollen rain and may have been growing around the bog margins as it does today. Values for *Alnus* are significant and may also reflect woodland growing around the margins of the bog or perhaps more likely associated with fen-carr type woodland growing around the nearby lochs. *Quercus* is generally 5-10% of the total pollen sum and is likely to have been growing some distance from the site on somewhat better and drier soils. There are three occurrences of *Tilia* pollen in this zone but it is unlikely that they reflect local growth of *Tilia* as this taxon is not thought to be native in Scotland. These pollen grains are more likely the result of long distance pollen transport from England.

Poaceae, Cyperaceae and other herb taxa are low although *Calluna vulgaris* values are high. This points to a wooded landscape, perhaps with an understorey of *Corylus avellana,* as well as significant areas of heather heathland which may have also supported *Myrica gale*. The diversity of herb taxa is low. *Plantago lanceolata* is present and does reach > 1%. This may have been growing around the lochs on ground which had been disturbed by animals coming to find water. Another possible habitat would have been small clearings in the woodland which may have been caused by wild grazing animals or animals associated with small scale human presence in the area.

The peat in this zone is mainly composed of *Sphagnum* with a small amount of herbaceous peat also present. The *Sphagnum* is also reflected in the pollen diagram where values for *Sphagnum* spores range from about 5-15%. The bog was actively growing during this phase and would have probably been very wet. There is little charcoal evidence in this zone perhaps indicating that the bog was too wet for natural fires to start. This in turn would suggest that *Calluna vulgaris* was not growing on the bog itself because of excessive waterlogging but was part of a separate heathland community.

This zone has not been dated by radiocarbon methods and extrapolation from the time/depth curve is not appropriate because of the changing peat deposition rate for the profile. It is possible to estimate an age range for the zone. As at Walls Hill Bog this first zone appears to be post-Elm Decline (more recent than 5000 years BP) assuming that an Elm decline would have been visible if the analysis of this profile had been extended to a greater depth. An unpublished diagram from another site on Lochend Loch Bog (Ramsay 1991) does show an Elm decline at a depth of 270cm i.e. before the first sample in the profile currently being discussed. The Elm decline in the unpublished diagram is very pronounced and so unlikely to have been overlooked if it had been within the profile under discussion. The nearest radiocarbon date in the profile is 354 - 63 cal BC, 80 cm further up the profile. Therefore, dating for this zone is probably in the range 2500 - 1000 cal BC. This date range covers part of the Neolithic and the early to middle Bronze Age. There is archaeological evidence for Bronze Age habitation in the area but whether it was as early as this is unknown. However there is little pollen evidence for any significant human influence on the vegetation during this period.

LLB-2 (194 - 157cm)

This zone is characterised by a decline in tree pollen in particular *Betula* although *Quercus* declines more steeply towards the end of the zone. However Coryloid appears to be unaffected. Either understorey *Corylus avellana* has not declined at the same time as the canopy taxa or *Myrica gale* was growing unaffected by woodland clearance either on the bog or nearby heathland. *Calluna vulgaris* shows a significant decline in this zone while conversely Cyperaceae increases. There is an increase in *Sphagnum* spores reflecting the peat stratigraphy diagram which shows that the *Sphagnum* made up the majority of the peat matrix with a small amount of herbaceous peat (probably *Eriophorum*). However this small amount of possible *Eriophorum* would not have contributed enough pollen to account for the large amount of Cyperaceae pollen seen in this zone. It seems more likely that the Cyperaceae took over the habitat which *Calluna vulgaris* had previously occupied. The Cyperaceae species in question may have been *Eriophorum vaginatum* as Grime, Hodgson & Hunt (1988) state that " *E.v.* [*Eriophorum vaginatum*] may expand at the expense of *Calluna vulgaris* in response to increased grazing ......". *Eriophorum* and other members of the Cyperaceae may have colonised the heather heathland as a result of increased grazing pressure brought about by an influx of people and their livestock to the area. This human influence in the area is also seen in the decreasing woodland cover and increasing levels of Poaceae pollen during this zone. Poaceae reaches > 10% total pollen (>15% NMP, >20% AP) putting this event into the small temporary clearance classification. Cereal type pollen has a single occurrence in this zone. *Plantago lanceolata* and *Pteridium aquilinum* both increase (most clearly seen in the AP pollen diagram). The diversity of herbaceous taxa also increases during this zone. These herbs include taxa indicative of agriculture such as *Ranunculus acris* group, *Rumex acetosa* group, *Artemisia* and Chenopodiaceae. *Silene dioica* type appears only in this zone. This probably represents *Silene dioica* growing nearby as the other species in this type tend to be uncommon in this part of Scotland. This species is associated with lightly shaded habitats although can survive in deep shade but does not flower. According to Grime, Hodgson & Hunt (1988) this species flowers most profusely at woodland margins pointing towards changes in woodland covering the area with an opening of the woodland canopy or clearances within the woodland which created more areas of woodland margin.

There are no radiocarbon dates available for this zone although there is a radiocarbon date at the beginning of the zone above i.e. 354 - 63 cal BC. The zone below was given an approximate end date of 1000 cal BC which would put this zone into the late Bronze Age and possibly early Iron Age period. This probably precedes the occupation of the crannog in Lochend Loch and is more likely to be contemporaneous with the known Bronze Age activity in the area.

LLB-3 (157 - 124cm)

This zone covers a period of accelerated woodland clearance. Tree pollen falls to < 10% total pollen and < 20% NMP. All the major tree taxa show significant declines, especially *Quercus* which has values of <1% total pollen for most of the zone. This indicates general woodland clearance for agriculture with perhaps some favouring of *Quercus* most probably for building purposes. The *Betula* and *Alnus* woodland remaining was probably restricted to wetter marginal areas around the lochs and edges of the bog. Coryloid also declines in this zone adding to the evidence for clear felling of woodland and its accompanying understorey vegetation to provide land for agriculture. Poaceae increases steeply at the beginning of the zone reaching 25% total pollen (252% AP, 52% NMP); complete clearance by Turner's (1975) definition and well into Dumayne's (1992) extensive clearance classification. There are high values of *Plantago lanceolata* and *Pteridium aquilinum* (seen most clearly in the AP and NMP diagrams). The diversity of herb taxa again increases with several agricultural indicators present including *Ranunculus acris* group and type, *Rumex acetosa* group, *Artemisia*, Apiaceae, Chenopodiaceae and *Urtica*. The increase in *Artemisia* is very noticeable in the AP pollen diagram where it reaches 5 - 10% AP. Cereal type pollen occurs at <1% in this zone. As with Walls Hill Bog the pollen evidence points to pastoral rather than arable agriculture predominating. *Calluna vulgaris* increases steeply in this zone with a corresponding decrease in Cyperaceae. This is a reverse of the trend seen in the previous zone, LLB-2. Grazing may have moved from the heathland / Cyperaceae area to the grassland areas produced by woodland clearance so allowing regeneration of the *Calluna vulgaris* at the expense of Cyperaceae. There are several high values for charcoal during this period either as a result of natural heathland fires or perhaps as a result of the human presence in the area.

By the end of the zone Poaceae has begun to decline again although there is only a slight increase in tree pollen. The vegetation which replaced the grassland appears to have been heathland perhaps with *Myrica gale* or a separate area of *Corylus avellana* scrub.

Calluna may have colonised the bog as well during this latter period. The peat stratigraphy diagram for this later part of the zone shows an increase in humification to four on the Troels-Smith scale. This suggests that the bog was drier during this period, allowing oxidation of the newly formed peat. This reduction in waterlogging would have enabled *Calluna vulgaris* to colonise the bog surface itself.

This zone has the greatest number of radiocarbon dates attached to it. The dates show some degree of overlap because of the errors associated with them. The date at the bottom of the zone is 354 - 63 cal BC at 155cm. The top of the zone is dated to 221 - 384 cal AD. The period of maximum clearance activity occurs in the lower part of the zone between 354 -63 cal BC and 114 cal BC - 76 cal AD. This would put the most extensive clearance phase into the late pre-Roman Iron Age. However taking the 2σ confidence limits for the dates gives 374 - 36 cal BC for the start and 342 cal BC - 207 cal AD for the end of the of the extensive clearance phase. This second date has a wide error range which takes it well into the Roman period. At most it can be said that this extensive woodland clearance phase began during the late pre-Roman Iron Age. It is likely that this clearance is contemporary with the occupation of the crannog in Lochend Loch. The cleared areas declined towards the middle of the zone either just before or during the Roman occupation of the region. The area remained extensively cleared during the second half of the zone although at a lower level than previously. This second period spans the dates 83 - 239 cal AD at 1σ (11 - 341 cal AD at 2σ) and 221 - 384 cal AD at 1σ (127 - 418 cal AD at 2σ) showing that the area remained cleared throughout the period of the Roman occupation.

LLB-4 (124 - 54cm)

This zone is characterised by woodland regeneration. Tree pollen increases steeply to > 45% total pollen and > 60% NMP. *Betula* increases first, probably as the first stage in the recolonisation of the agricultural land. *Alnus* remains relatively stable throughout the zone. Its habitats were probably confined to those which it had colonised previously i.e. the wetter areas around the lochs and bog margins. *Quercus* values increase later in the zone when *Quercus* may have begun to recolonise the areas on which *Betula* had already regenerated. The subsequent decline in *Betula* can be seen most clearly in the NMP and AP pollen diagrams. Coryloid pollen increases in conjunction with the tree pollen showing that previously agricultural land was reverting to woodland or scrubland. *Calluna vulgaris* begins the zone with high values but declines towards the end of the zone. Pasture land which had the grazing pressure removed would first revert to heather heathland before gradually being colonised by woodland which would in turn cause the *Calluna* to decline. Poaceae declines significantly in this zone falling to <1% total pollen at some levels as do values for *Plantago lanceolata* and *Pteridium aquilinum*.

Cyperaceae values are also very low throughout this zone. There are few herbaceous indicators of agriculture although at the end of the zone there is a slight increase in Poaceae and occurrences of cereal type along with trace occurrences of *Rumex acetosa* group and Chenopodiaceae indicating the beginnings of a return to agriculture in the area.

The peat stratigraphy diagram shows fluctuations in the humification of the peat but little change in its composition throughout this zone with *Sphagnum* being the major peat former with only small amounts of herbaceous peat present. There is little evidence for worsening climate to explain the abandonment of agriculture during this period.

Using the radiocarbon dates obtained for this zone along with the time / depth curve the beginning of this zone can be dated to around 300 - 400 cal AD that is at, or soon after, the end of the Roman occupation of Scotland. This woodland phase continued to the end of this zone dated to around 700 - 900 cal AD.

LLB-5 (54 - 0cm)

At the beginning of this zone there is a short period during which there is a decline in tree pollen, in particular *Betula*, (AP around 20% TP), and Coryloid pollen. There is a corresponding increase in Poaceae to 17% total pollen (91% AP, 34% NMP) i.e. approaching the amount required for the event to be classified as an extensive woodland clearance. There are also increases in *Ranunculus acris* group, *Artemisia, Cerastium* type and Chenopodiaceae as well as a single occurrence of cereal type pollen and increases in *Plantago lanceolata* and *Pteridium aquilinum*. Cyperaceae pollen also shows a significant increase during this period. This clearance episode lasts for a short period of time and can probably be dated to a time frame of approximately 800 - 1000 cal AD.

After this short period of woodland clearance there is another period of woodland regeneration during which tree pollen recovers to a level of nearly 50% total pollen and Poaceae, Cyperaceae , *Plantago lanceolata* and *Pteridium aquilinum* all decline. Again looking at the peat stratigraphy diagram there would appear to be no evidence for climatic change to explain this decline in agriculture. However this decline is also of relatively short duration. A lack of radiocarbon dates for this period makes it difficult to assign an age range for this regeneration phase. It is difficult to extrapolate from the time / depth curve as it is likely that there is an unquantified depth of peat missing from the surface of the bog and so the topmost peat and pollen samples may be anything up to several hundred years old. It is estimated that the start date for this period is about 1000 cal AD and an end date is tentatively put as between 1300-1600 cal AD.

After this period of woodland regeneration there is another period of substantial woodland clearance. *Quercus* and *Alnus* are absent from the topmost levels of the zone and the amount of tree pollen in general has fallen to 5-10% total pollen. There is also a substantial reduction in Coryloid to approximately 2% total pollen. The only tree taxa which appear to be increasing in representation are *Ulmus* and *Fagus*. As *Fagus* is not a Scottish native and *Ulmus* has not been seen at significant levels for several thousand years in this diagram the most likely explanation is that the pollen of these taxa has come from trees which were planted in the area. Poaceae increases in this zone although this is only clearly seen in the NMP and AP diagrams. A massive rise in *Calluna vulgaris* pollen during this period masks the corresponding Poaceae rise in the total pollen diagram. *Plantago lanceolata* also peaks during this period but the representation of *Pteridium aquilinum* is more erratic. There is a cluster of cereal type pollen occurrences in this period and at one level cereal type is >1% for the only time. Herb taxa diversity does not increase greatly in this zone. The taxon which shows the largest rise in this zone is *Calluna vulgaris*. The peat stratigraphy diagram for this period shows that the peat was so humified that it was not possible to determine its original composition. There is little evidence for *Sphagnum* growth from the pollen diagram either. This implies that the bog surface was very dry and therefore suitable for colonisation by *Calluna*. The bog surface probably became densely covered by heather and would therefore have looked much like it does today. There are high levels of charcoal in the topmost layers of the peat. These may have been due to natural fires on the bog or a result of deliberate burning of the heather by man to produce vegetation suitable for grazing. Dating of this period is difficult for the same reasons stated previously. An estimate for the beginning of this period would be around 1300-1600 cal AD. The estimate for the end date could be anything from about 1500-1900 cal AD although a date as late as 1900 cal AD is unlikely because of the discrepancies between the topmost pollen sample from the profile and the present day surface pollen sample. The profile sample shows no evidence of the coniferous plantations or the exotic tree taxa such as *Picea* and *Acer pseudoplatanus*. It is more likely that the end date for this zone is before approximately 1800 cal AD.

5.7 Conclusions.

The Lochend Loch Bog pollen diagram described the changes in vegetation from a period post- Elm decline up until the last few hundred years.

During the Neolithic and early to middle Bronze Age the vegetation around Lochend Loch Bog was essentially deciduous woodland but with significant areas of *Calluna* heathland. To judge from the very low values of Poaceae and *Plantago lanceolata*, the impact of humans, if any were present, was very slight.

The first pollen evidence for human presence in the area is found in zone LLB-2 during the late Bronze Age or early Iron Age. The magnitude of clearance indicators suggests small temporary clearances although there is no evidence for discrete clearance phases. The clearance indicators are continually present at the small temporary clearance level. This would indicate a stable population in the area but with a relatively low density. This is unlike Bloak Moss in Ayrshire (Turner 1975) which shows discrete episodes of small temporary clearance during this period. The woodland clearance during this zone appears comparable with that ascribed to the early Iron Age by Dumayne and Barber (1994) at Walton Moss and Glasson Moss, Cumbria, in particular. Like the clearance in LLB-2 these clearance episodes show a gradual rise, then stable levels of clearance indicators in particular Poaceae. The other herb taxa involved are similar in that *Plantago lanceolata*, Ranunculaceae and *Rumex acetosa* predominate indicating pastoral rather than arable agriculture. Dumayne and Barber state that these low levels of clearance indicators are in agreement with the scarcity of archaeological evidence around these sites. However in the Lochend Loch Bog area there is substantial archaeological evidence for the presence of Bronze Age burials close to the site, although no direct evidence for settlement, and this is also related to fairly low levels of clearance activity. This shows that it is difficult to relate the extent of clearance with known archaeological evidence. However it suggests that lack of Bronze Age / Iron Age finds around Walton Moss and Glasson Moss may only be because they have not yet been found. The nearest fully published pollen diagram to Lochend Loch Bog is Turner's site at Flanders Moss, Perthshire (Turner 1965). During the late Bronze Age / early Iron Age this site shows little, if any, evidence for minor clearance. The Flanders Moss diagram shows a well wooded landscape during this period with *Alnus* being by far the largest contributor to the pollen rain.

The first extensive woodland clearances began during the late pre-Roman Iron Age with pollen evidence for pastoral rather than arable agriculture. This clearance continued into the Roman period, though probably at a slightly reduced level. A similar clearance was described by Turner at Flanders Moss but was dated to within the Roman period (at around 1850-1730 BP). The radiocarbon dates from Flanders Moss are difficult to interpret (as they were at Bloak Moss) with statistically identical dates spanning a significant depth of peat. In this case a date of 1745 BP at 50cm and a date of 1730 BP at around 110cm depth, a separation of 60cm for the "same" date. There is also a date of 1850 BP just above 50cm depth, i.e. either a dating inversion or at least a statistically similar date to the other two.

The clearance levels seen at Flanders Moss are not as sustained as those seen at Lochend Loch Bog, where clearance is apparent for several hundred years. It is likely that this clearance is associated with the occupation of the crannog in Lochend Loch. However a lack of secure dating for the occupation period of the crannog does not allow a definite link to be drawn between the crannog dwellers and the initiation of extensive woodland clearance in the area. During the excavation of the crannog it was noted that the majority of the timber involved in the construction was *Quercus*. However during this period the representation of *Quercus* in the pollen diagram was very low. This may be due to the preferential removal of *Quercus* to provide building material, in particular for the construction of the crannog. If the crannog had been built during the middle or end of this period the availability of *Quercus* would have been much reduced and the builders would presumably have had to travel some distance from the site to obtain suitable wood. In summary it would be more likely for the crannog to have been constructed towards the beginning of this zone, because of the availability of suitable Oak for building, and almost certainly before the Roman arrival as it seems unlikely that the Romans would have allowed the building of a defended structure so close to the line of the Antonine Wall.

As extensive clearance was almost certainly begun pre-Roman this would have meant large areas of established grassland would have been available to the Roman army from which they could have cut suitable turves for the construction of the Antonine Wall.

The cleared landscape was maintained throughout the Roman period either for use as pasture land and/or as a clear area behind the Wall for ease of troop movement, viewing and signalling and to prevent surprise attacks. Even if the land was kept clear predominately for military purposes it seems unlikely that it would not have been taken advantage of it for grazing.

By the end of the Roman occupation, or soon after, woodland regeneration began again and continued until 700 - 900 cal AD. This regeneration is comparable with that seen at Burnfoothill Moss (Tipping 1995) which shows woodland regeneration from approximately 300 cal AD. Tipping is reluctant to correlate this with a collapse in agriculture as a result of the departure of the Roman army but considers it to be a possibility. This explanation is also possible for the vegetation around Lochend Loch Bog but as Tipping (1995) states "...the temptation to relate radiocarbon-dated vegetation and land-use changes to known historical events needs to be resisted, given that each date is imprecise". This woodland regeneration period is also noted by

Whittington and Edwards (1993) from their sites on the East coast of Scotland (as discussed earlier in section 4.8 - Walls Hill Bog Conclusions).

The next pollen evidence for human presence in the area was noted around 800 - 1000 cal AD (corresponding to that seen at Walls Hill Bog). However there is no archaeological evidence for occupation during this period to explain this clearance episode.

There is a short period of woodland regeneration before extensive/complete clearance begins again. An estimate for the beginning of this clearance episode would be 1300 - 1600 cal AD and this cleared landscape lasts until the top of the profile. This clearance may be related to the management of the area by the monks of Newbattle Abbey who established a sheep grange at Drumpellier during this period (Peden 1992). A reference in Peden (1992) to the monks having a thriving business manufacturing "massive oak wagons" is difficult to relate to the small amount of *Quercus* pollen represented in the pollen diagram during this period. If the statement concerning wagons is accepted then this may suggest that the Oaks were being managed (perhaps by coppicing) to provide a constant supply of wood and consequently pollen production would have been suppressed.

There is archaeological and historical evidence for management of the vegetation around Lochend Loch Bog from the time of the Cistercian monks up until the present day. Large scale tree planting was undertaken on the Drumpellier estate during the eighteenth century although little of this is apparent from the pollen diagram. This suggests that approximately two hundred years is missing from the top of the peat profile either as a result of drainage or burning of the heather on the bog surface.

6. LENZIE MOSS.

6.1 Site Description.

Geography, Geology and Vegetation.

Lenzie Moss (NS 650715) is situated close to the town of Lenzie which encloses the north and east margins of the bog (see Fig. 6.1). The bog itself is divided into two parts by the main Edinburgh to Glasgow railway line which runs approximately east to west through the middle of the bog.

The area to the north of the railway line is badly disturbed with most of the bog having been cut for fuel. Baulks of peat form a grid system on which it is possible to walk amongst the peat cuttings. These raised areas of peat have been colonised by *Betula, Salix* and *Calluna vulgaris* while the ditches between the baulks contain more moisture loving taxa such as *Sphagnum*, *Eriophorum* and *Juncus*.

The area of bog to the south of the railway line is relatively undisturbed with little evidence for peat cutting having taken place. Between the southern part of the bog and the railway line there is a line of *Betula* trees and saplings. This southern section of the bog adjoins extensive areas of grassland currently used for pasture. According to the Soil Survey maps the land around Lenzie Moss is classified as being "moderate arable" meaning that both pastoral and some arable agriculture is possible around the site.

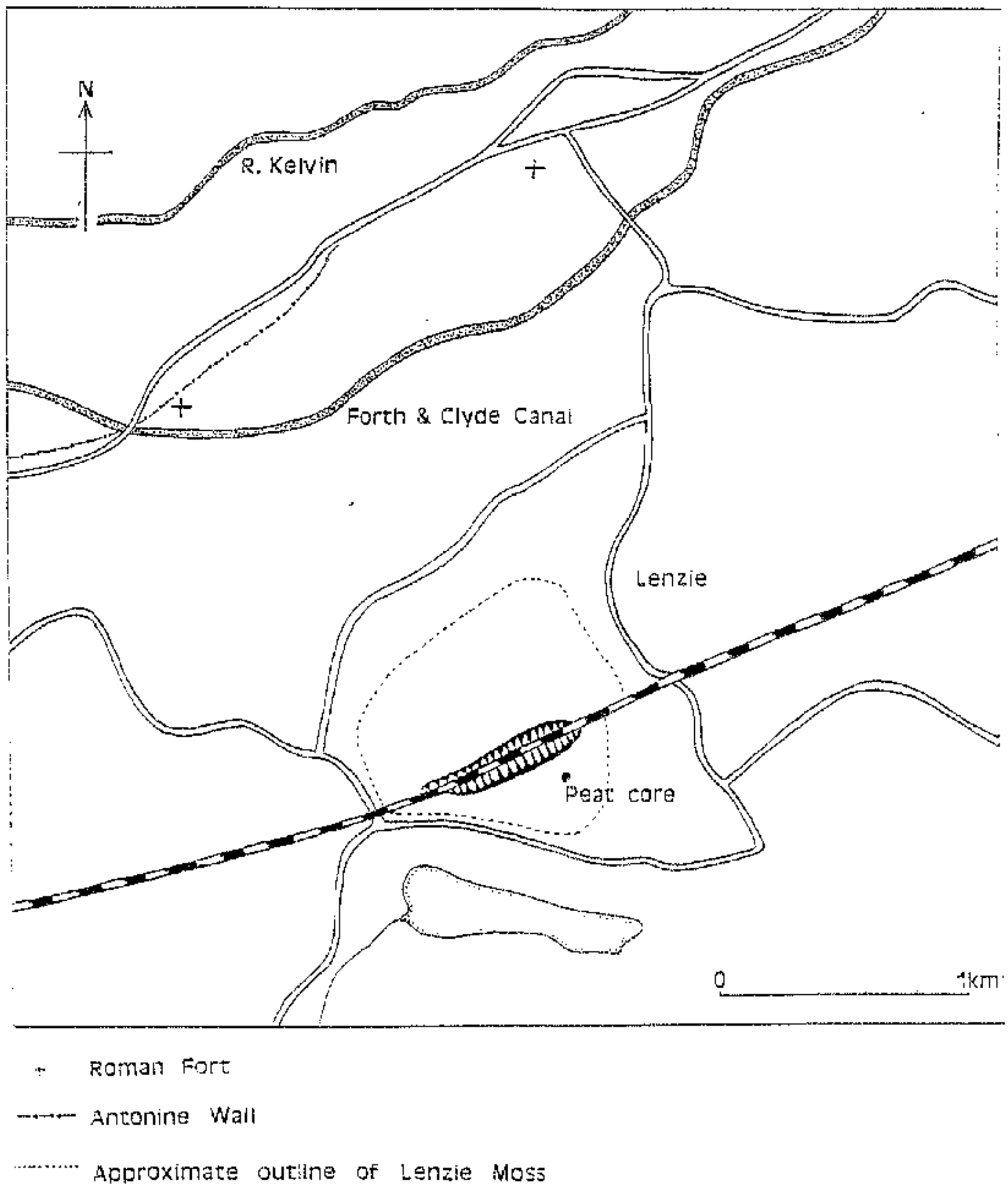


Fig. 6.1 : Lenzie Moss location map.

Archaeology.

Lenzie Moss lies only 8km north-west of Lochend Loch Bog so is likely to have been subject to the influences of similar groups of people during the past three thousand years.

The first evidence for human presence close to Lenzie Moss is during the Bronze Age with finds of a number of cinerary urns and cairns similar to those found near Lochend Loch Bog. The Bronze Age finds from both sites may be contemporaneous but as none of the finds have been radiocarbon dated it is not possible to confirm this.

There are no recorded Iron Age sites close to Lenzie Moss although the presence of the Iron Age crannog at Lochend Loch at least confirms an Iron Age human presence in the region.

The coring site at Lenzie Moss lies only 2km south-east of the line of the Antonine Wall and close to the Roman forts at Cadder, Glasgow Bridge and Kirkintilloch. Any Roman impact on the vegetation of this area should be well recorded at this site.

Again there is little archaeological evidence for human occupation in the area until the medieval period when the area would have been subject to similar pressures to those of Lochend Loch Bog.

There is documentary evidence for peat cutting for fuel in the area. The monks of Cambuskenneth had turbary rights in the late 13th century and the Cadder Parish records give the income provided from peat cutting in the area during the late eighteenth century (Dickson 1991).

6.2 Surface Vegetation and Pollen.

Surface Vegetation.

Taxon	Domin Value
Calluna vulgaris	8
Trichophorum cespitosum	7
Eriophorum vaginatum	7
Erica tetralix	5
Drosera rotundifolia	2
Andromeda polifolia	2
Sphagnum	5
Other Bryophytes	5

Table 6.1 : Lenzie Moss surface vegetation

The surface vegetation is dominated by *Calluna vulgaris*, *Eriophorum vaginatum* and *Trichophorum cespitosum*. Although *Calluna vulgaris* is growing on the bog many of the other species present are indicative of fairly wet conditions. *Trichophorum cespitosum* is common on wet bogs, moors and heaths as is *Erica tetralix*. *Andromeda polifolia* (Bog-rosemary) and *Drosera rotundifolia* (Round-leaved sundew) are both indicative of wetter peatland habitats.

Sphagnum was present in significant amounts (approx. 20% of the total vegetation cover) again emphasising the wet nature of the bog surface. There was no evidence for the growth of *Betula* on the bog surface as was seen at Lochend Loch Bog. The southern section of Lenzie Moss is sufficiently wet to prevent *Betula* from colonising the surface peat.

Surface Pollen Results.

Taxon	% Total Pollen
Betula	7.4
Quercus	0.2
Alnus	0.4
Acer campestre type	0.1
Pinus	10.7
Picea	0.1
Ulmus	0.6
Fagus	1.0
Salix	0.3
Coryloid	0.1
Calluna vulgaris	50.3
Poaceae	26.5
Poaceae (D>39μm, A>8μm)	0.5
Cyperaceae	0.6
Aster type	0.3
Sinapis type	0.2
Centaurea nigra type	0.1
Ranunculaceae	0.1
Liguliflorae	0.1
Hornungia type	0.1
Veronica type	0.1
Chamerion angustifolium type	0.1
Pteridium aquilinum	0.2
Sphagnum	0.3

Table 6.2 : Lenzie Moss surface pollen

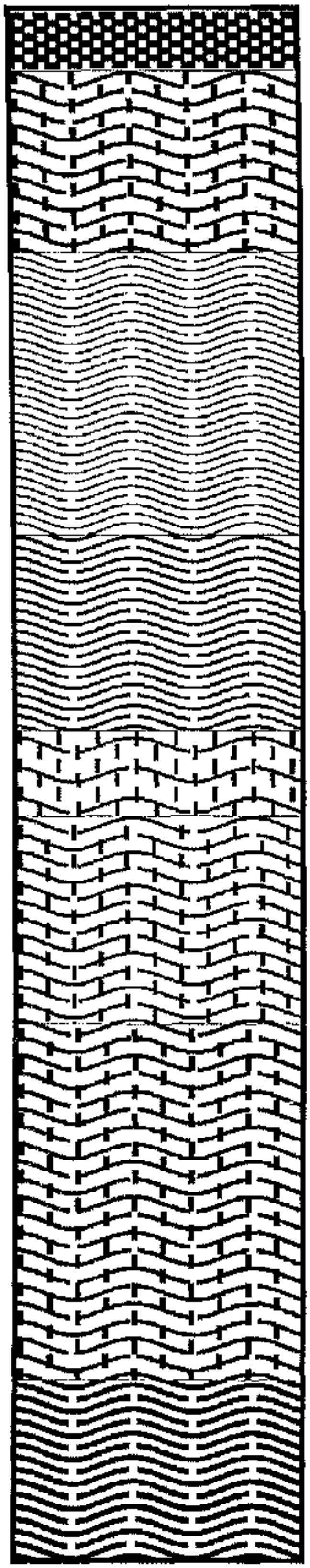
The surface pollen results generally reflect vegetation growing on or close to the bog. *Calluna vulgaris* is the dominant contributor to the pollen rain (as was also seen at Walls Hill Bog and Lochend Loch Bog) illustrating how *Calluna vulgaris* growing on the bog surface can be significantly over-represented when considering a pollen spectrum which is supposed to provide a regional view. Poaceae also makes up a significant proportion of the total pollen found in the surface sample. This reflects the extensive areas of grassland surrounding the site which are managed for pastoral agriculture. There is little evidence for Cyperaceae pollen in the surface pollen spectrum even though there are significant amounts of Cyperaceae growing on the bog. This suggests that the pollen of *Eriophorum* and *Trichophorum* is quickly destroyed or, less likely, transported in such a way that they it is not detected in the peat on which the parent plants were growing.

Pinus is also well represented in the surface pollen results although there are no coniferous plantations near the site. It is likely that the pine pollen has come from a large coniferous plantation 6km to the north-west of the site. This plantation, to the west of Lennoxtown at the foot of the Campsie fells, covers approximately 7 km^2 and would be a major source of pine pollen.

The herb taxa present are consistent with the pastoral grassland surrounding the bog. However *Chamerion angustifolium* (Rose-bay willow-herb) is an indicator of industrial and derelict land and has only become common during this century. At the Lenzie Moss site large areas of the railway embankments have been colonised by this species.

Again the value for *Sphagnum* spores is very low even though *Sphagnum* is fairly common on the site, just as was seen at Walls Hill Bog and Lochend Loch Bog.

6.3 Peat Stratigraphy.



0 - 12 cm	Sh 4		
12 - 43 cm	Tb^3 (sphagni) 3	Th^3 1	
43 - 93 cm	Tb^1 (sphagni) 4	Th^1 +	Dl (Eric.) +
93 - 128 cm	Tb^2 (sphagni) 4	Th^2 +	
128 - 143 cm	Tb^2 (sphagni) 2	Th^2 2	
143 - 180 cm	Tb^2 (sphagni) 3	Th^2 1	
180 - 243 cm	Tb^3 (sphagni) 3	Th^3 1	
243 - 293 cm	Tb^4 (sphagni) 4	Th^4 +	Dl (Eric.) +

Fig. 6.2 : Lenzie Moss stratigraphy.

6.4 Pollen Zone Descriptions.

The following pollen zone descriptions are based on a sum of :-

Total Pollen and Spores (excluding *Sphagnum*) : see Fig. 6.3

LM-1 (256 - 212cm)

Tree pollen is moderately high as are Coryloid and *Calluna vulgaris*. Poaceae values are very low (<3%) and Cereal type pollen is absent. Cyperaceae pollen is also very low. *Plantago lanceolata* is only present at <1%. Other herb taxa present are *Ranunculus acris* type, *Aster* type and *Filipendula* all of which are single occurrences of <1%. *Pteridium aquilinum* is absent from this zone although *Polypodium vulgare* type and other Filicales are present. *Sphagnum* is present at low levels.

LM-2 (212 - 180cm)

Tree pollen is moderate, although *Quercus* does have one very low level (2%). Coryloid is high (37%) but *Calluna vulgaris* has declined slightly from the zone below. Poaceae remains low (<4%) but Cyperaceae shows a steep increase (25%). *Plantago lanceolata* is still low (<1%). Other herb taxa found for the first time in this zone are *Stellaria holostea*, *Artemisia* and *Lysimachia vulgaris* type. *Pteridium aquilinum* is still absent and *Sphagnum* values remain low.

LM-3 (180 - 130cm)

Tree taxa values decline slightly towards the end of the zone. Coryloid remains steady but *Calluna* shows a further decline to 10%. Poaceae shows a gradual but continuous increase towards the end of the zone (reaching 14%) and Cyperaceae is generally high throughout the zone. *Plantago lanceolata* also increases towards the end of the zone reaching 2%. Several herb taxa including *Rumex acetosa* group, Liguliflorae and Chenopodiaceae appear for the first time in this zone. *Pteridium aquilinum* is present for the first time and reaches a value of 2% at the end of the zone. *Sphagnum* values are erratic but in general increase towards the end of the zone.

LM-4 (130 - 93cm)

Tree taxa show a marked decline in this zone with *Quercus* falling to <1% in several samples. *Fagus* and *Carpinus* appear for the first time in this zone. Coryloid declines in the middle of the zone reaching some of its lowest values (4%) in the whole profile but recovers slightly towards the end of the zone. *Calluna vulgaris* increases steeply to 49% and remains consistently high throughout the zone. Poaceae values are high (10-20%) and Cereal type pollen makes its first appearance in this zone. Cyperaceae values are generally high although they show a marked decline in the middle of the zone. *Plantago lanceolata* is generally 1-3% throughout the zone. Herb taxa which appear for the first time are *Plantago major*, *Sinapis* type, *Cerastium* type, Apiaceae, *Potentilla* type, *Rumex acetosella*, *Anthemis* type and *Drosera rotundifolia* type.

Pteridium aquilinum is present at moderate levels throughout this zone.

LM-5 (93 - 42cm)

Betula increases steeply at the beginning of this zone but decreases gradually towards the end. *Quercus* increases reaching 8% while *Alnus* also increases gradually. *Populus* makes its first appearance in this zone. Coryloid increases slightly at the beginning of the zone and then remains constant throughout the rest of the zone. *Calluna vulgaris* is generally high (23-43%). Poaceae declines sharply to 2% and remains low throughout the zone. Cyperaceae is low at the beginning of the zone but increases gradually towards the end of the zone. *Plantago lanceolata* occurs intermittently throughout the zone. Herb taxa which appear for the first time include *Silene dioica* type, *Succisa / Scabiosa*, *Urtica* and *Galium* type. *Pteridium aquilinum* is present at <1% through most of the zone but increases to 2% at the end. *Sphagnum* is erratic but increases towards the end of the zone.

LM-6 (42 - 0cm)

Tree pollen values are low at the beginning of the zone but increase towards the middle before declining sharply at the end of the zone. *Quercus* is absent from the final level in this zone and *Alnus* occurs at <1%. *Ulmus* shows a slight increase (1%) at the end of the zone. Coryloid gradually decreases towards the end of the zone while conversely, *Calluna* increases reaching 64%. Poaceae peaks at the beginning (22%) and the end (25%) of the zone. Cereal type is present throughout the zone. Cyperaceae gradually declines while *Plantago lanceolata* is generally 1-3%. Herb taxa occurring for the first time are *Hornungia* type, *Anemone nemorosa* group, *Lychnis flos-cuculi*, *Spergula* type and cf. *Geum*. *Pteridium aquilinum* values fluctuate in this zone and *Huperzia selago* appears for the first time at the end of the zone. *Sphagnum* declines at the end of the zone.

The following pollen zone descriptions are based on a sum of :-

Arboreal Pollen (excluding Coryloid and *Salix*) : see Fig. 6.4

LM-1 (256 - 212cm)

Coryloid values are high (19-40%). *Calluna vulgaris*, Poaceae, Cyperaceae and *Plantago lanceolata* are all very low. *Sphagnum* values are also very low.

LM-2 (212 - 180cm)

Coryloid reaches very high levels (92%). *Calluna vulgaris*, Poaceae and *Plantago lanceolata* remain very low although Cyperaceae shows an increase to 63%. *Sphagnum* is again very low.

LM-3 (180 - 130cm)

Quercus declines towards the end of the zone. Coryloid fluctuates from moderate to high values throughout the zone. *Calluna vulgaris* remains low throughout the zone but there are increases in Poaceae (53%), *Plantago lanceolata* (6%) and *Pteridium aquilinum* (7%) towards the end of the zone.

LM-4 (130 - 93cm)

Pinus, *Fraxinus* and *Ulmus* increase slightly. Coryloid is generally high but fluctuates somewhat. There are steep increases in *Calluna vulgaris* (432%) and Poaceae (146%). There are also increases in Cereal type (3%), Cyperaceae (266%), *Plantago lanceolata* (27%) and *Pteridium aquilinum* (22%). Many herb taxa show peaks in this zone.

LM-5 (93 - 42cm)

Betula declines while *Quercus*, *Alnus* and Coryloid increase towards the end of the zone. *Calluna vulgaris*, Poaceae, Cyperaceae, *Plantago lanceolata* and *Pteridium aquilinum* all show marked declines in this zone.

LM-6 (42 - 0cm)

Ulmus and *Fagus* reach high values at the end of this zone (reaching 20% and 10% respectively). Coryloid decreases to its lowest level in the profile at the end of this zone (10%). There are peaks in *Calluna vulgaris*, Poaceae and *Plantago lanceolata* at the beginning of the zone (to 33%, 146% and 23% respectively) and again at the end of the zone (to 1090%, 435% and 40% respectively) with declines in the middle of the zone. Cereal type increases to 7% at the end of the zone whereas Cyperaceae shows a decline. *Pteridium aquilinum* peaks at the beginning of the zone (12%) as do other Filicales. Many herb taxa reach significant values in this zone and *Ranunculus acris* group reaches 30% at the end of the zone.

The following pollen zone descriptions are based on a sum of :-

Non Mire Pollen : see Fig. 6.5

<u>LM-1 (256 - 212cm)</u>

Tree pollen values are high as are those of Coryloid and *Calluna vulgaris*. Poaceae and *Plantago lanceolata* are low.

<u>LM-2 (212 - 180cm)</u>

Tree pollen remains steady during this zone but Coryloid increases. Poaceae and *Plantago lanceolata* remain low.

<u>LM-3 (180 - 130cm)</u>

Quercus declines towards the end of the zone while there are increases in Poaceae (23%) and *Plantago lanceolata* (3%).

LM-4 (130 - 93cm)

Trees generally decline although *Pinus*, *Fraxinus* and *Ulmus* increase slightly. Coryloid declines while there are increases in Poaceae (45%) and *Plantago lanceolata* (9%). Many herbs increase in this zone.

LM-5 (93 - 42cm)

Betula increases then decreases while *Quercus* and *Alnus* increase towards the end of the zone. There are sharp declines in Poaceae (to 4%) and *Plantago lanceolata* (to 0%).

LM-6 (42 - 0cm)

Tree taxa values remain steady but decline towards the end of the zone. Poaceae and *Plantago lanceolata* peak at the beginning of the zone (to 43% and 7% respectively) and again at the end (to 67% and 6% respectively). Other herb taxa increase in this zone.

6.5 Radiocarbon Dates.

Sample Code	Sample Depth (cm)	Radiocarbon Date (uncalib.years BP)	Calibrated Date (1σ)	Calibrated Date (2σ)
OxA-4560	16-16.5	740 ± 100	1205 - 1393 AD	1043 - 1411 AD
OxA-4561	34-34.5	1145 ± 75	816 - 985 AD	699 -1023 AD
OxA-4562	68-68.5	1430 ± 75	552 - 671 AD	445 - 771 AD
OxA-4563	92-92.5	1530 ± 75	447 - 607 AD	402 - 658 AD
OxA-4564	112-112.5	1785 ± 75	145 - 339 AD	83 - 415 AD
OxA-4565	126-126.5	2005 ± 75	94 BC - 112 AD	189 BC - 203 AD

Table 6.3 : Lenzie Moss radiocarbon dates

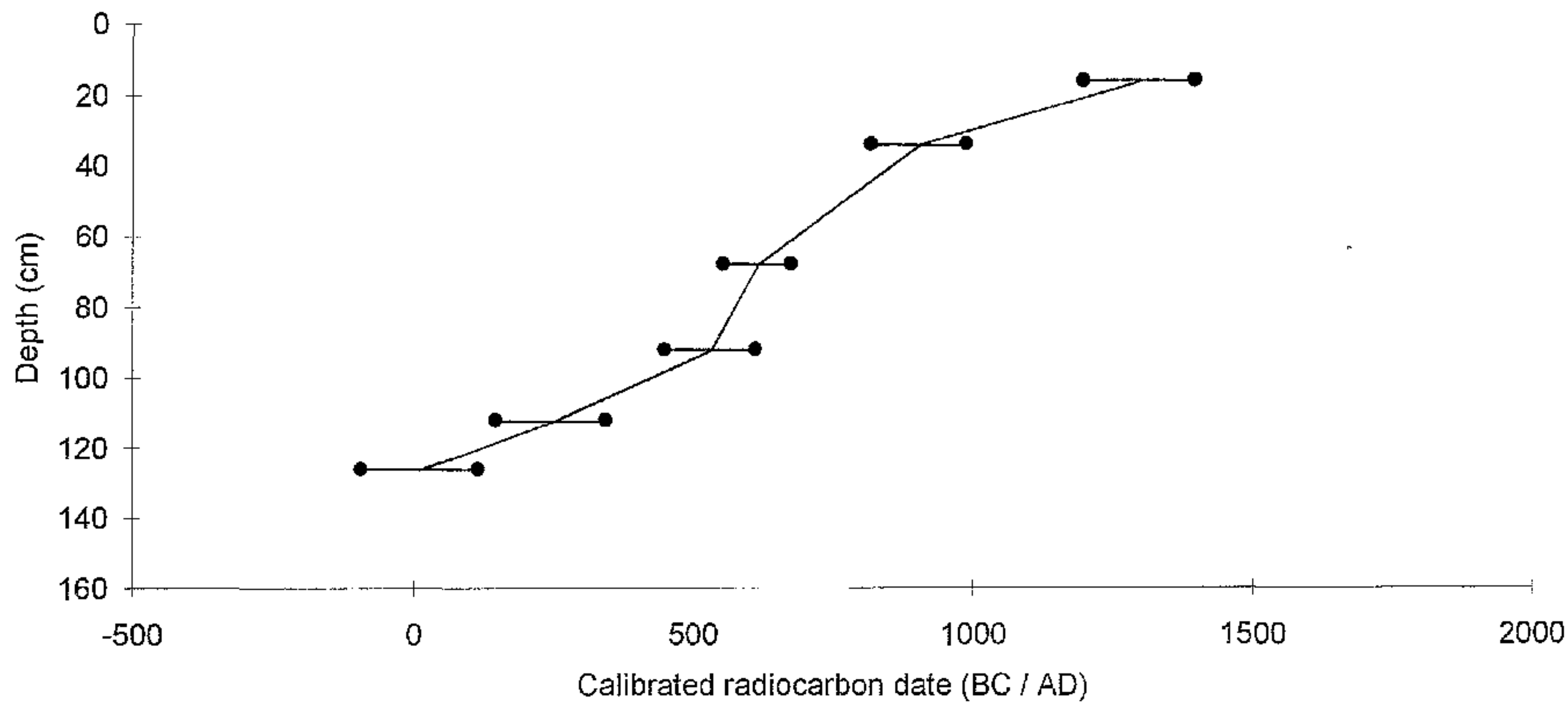


Fig. 6.6 : Lenzie Moss time / depth plot.
Dates shown at 1σ level

6.6 Interpretation and Discussion.

LM-1 (256 - 212cm)

Tree pollen is high in this zone reaching 60% TP and 80% NMP. This is in association with values for Coryloid of around 20% TP which reflects a densely wooded environment perhaps with an understorey of *Corylus*. Values for *Calluna vulgaris* are also high (20-50% TP) indicating that any land that was not wooded was in the main heather heathland. The main tree taxon growing in the region was *Betula* perhaps reflecting growth of birch around the margins of the bog similar to that seen today. *Alnus* also makes up a significant proportion of the tree pollen while *Quercus* values are usually around 10%. There is little evidence for open grassland habitats during this zone. Poaceae values are very low as are those of Cyperaceae. The only other herbaceous taxa present in this zone are trace occurrences of *Plantago lanceolata*, *Ranunculus acris* type, *Aster* type and *Filipendula*. *Pteridium aquilinum* is completely absent from this zone indicating that woodland cover was so dense as to suppress spore production by any *Pteridium aquilinum* growing under the woodland canopy. *Sphagnum* values are relatively low even though the peat stratigraphy for this period shows *Sphagnum* to be the dominant peat former. The peat stratigraphy diagram shows the peat in this zone to be very highly humified. This coupled with the finds of Ericaceous twigs within the peat suggests that the bog was not excessively wet during this period allowing the peat to become oxidised and Ericaceae to colonise the bog surface. There is little evidence for burning during this zone with charcoal generally present at trace levels. Only one level shows a slightly raised level of charcoal but this is probably due to natural burning, perhaps of heather, on the bog surface. There is no evidence for human impact on the vegetation in this zone.

This zone has not been dated by radiocarbon methods and extrapolation from the time/depth curve is not appropriate because this zone is far below the first radiocarbon date for the profile. It is possible to provide an estimate for the age range of this zone. As at Walls Hill and Lochend Loch Bog this first zone appears to be post-Elm decline (more recent than 5000 BP) again assuming that an Elm decline would be visible if the profile had been extended to a greater depth. The nearest radiocarbon date in the profile is 94 cal BC - 112 cal AD, 90cm further up the profile. Therefore the dating for this zone is probably in the range 4500 - 3000 BP (approx. 2500 - 1000 cal BC), i.e. spanning part of the Neolithic and the early to middle Bronze Age.

LM-2 (212 - 180cm)

Tree pollen is still relatively high although has declined slightly from LM-1 and is now down to around 40% TP. Coryloid levels remain high, even showing a slight increase. The tree pollen decline is distributed evenly amongst the main three taxa i.e. *Betula, Quercus* and *Alnus* although *Quercus* does have one level at which it falls to around 2% TP. It is difficult to explain this other than as an anomalous sample. Agricultural indicators remain very low in this zone making the unexpectedly low *Quercus* level unlikely to be the result of human interference. Poaceae values are generally unchanged from LM-1 and remain low. However Cyperaceae does show an increase in this zone. Other herbaceous taxa are still scarce with only *Plantago lanceolata*, *Ranunculus acris* type, *Stellaria holostea*, *Artemisia* and *Lysimachia vulgaris* type present occasionally. The contribution made by *Calluna vulgaris* is still relatively high although it has declined slightly from the zone below. Again *Pteridium aquilinum* is absent from the zone suggesting that the woodland canopy was dense enough to prevent spore production by any *Pteridium aquilinum* present. However the canopy may have been made up of a greater proportion of understorey shrubs than in the previous zone.

The slight decline in *Calluna vulgaris* and the corresponding rise in Cyperaceae may be explained by looking at the peat stratigraphy diagram. The peat is still predominately *Sphagnum* (although *Sphagnum* spore values are again low) but it is less humified than in LM-1 and there is a greater proportion of herbaceous peat present as well. There is no evidence in the form of macrofossils to show that any Ericaceae were growing on the bog itself. This suggests that the peat had become more waterlogged, reducing its humification and discouraging the growth of Ericaceae but encouraging the colonisation of the bog by members of the Cyperaceae.

Again there are no radiocarbon dates available for this zone. An estimate for the start of this zone would be around 1000 cal BC as this was the approximate date for the end of the zone below. An estimate for the end date of this zone would be sometime around 500 cal BC because of comparison with the Lochend Loch Bog diagram and the lack of any evidence for human impact on the area.

LM-3 (180 - 130cm)

This zone is characterised by a decline in tree pollen with all the major tree taxa being affected but *Quercus* suffering the greatest fall. During this period Coryloid still remains unaffected although fluctuations in representation do occur. This zone shows the first evidence for agriculture in the area. Poaceae values increase towards the top of the zone reaching 14% TP (53% AP, 23% NMP) putting this land-use change well into the small temporary clearance category. However like the corresponding clearance seen at Lochend Loch Bog in zone LLB-2 this clearance is not a series of discrete episodes but is a gradual rise then levelling out of clearance at a small temporary clearance level. This rise in Poaceae is accompanied by an increase in *Plantago lanceolata* and *Pteridium aquilinum* appears for the first time, increasing towards the end of the zone and indicating an opening out of the woodland canopy. These increases in agricultural indicators are accompanied by increases in herbaceous taxa associated with pastoral grassland. These include *Ranunculus acris* group and type, *Rumex acetosa* group, Liguliflorae, *Artemisia* and Chenopodiaceae. Cereal type pollen is still absent from this zone implying that the land was being farmed primarily to provide grazing for livestock.

Calluna vulgaris declines again in this zone while there is a corresponding rise in Cyperaceae. The peat stratigraphy diagram shows an increasing proportion of herbaceous peat in the profile which may account for some of the increase in the representation of Cyperaceae. However this decline of *Calluna vulgaris* and increase in Cyperaceae was also seen at Walls Hill Bog and again it is possible that an increase in grazing pressure favoured Cyperaceae over *Calluna vulgaris* reducing the amount of heather heathland and increasing Cyperaceae dominated plant communities.

Again there are no radiocarbon dates available for this zone however the beginning of the zone above has been dated to 94 cal BC - 112 cal AD. Taking into account the estimated end date for the zone below an approximate age range for this zone would be from approximately 500 cal BC up until the end of the first century BC or the beginning of the first century AD. This puts the zone into the late Bronze Age / pre-Roman Iron Age period.

LM-4 (130 - 93cm)

This zone covers a period of woodland clearance on a massive scale. Tree pollen falls to around 10% TP with all the main tree taxa declining although *Alnus* and especially *Quercus* are most affected. Coryloid is also greatly affected indicating clear felling for agriculture with understorey vegetation being affected as much as the major tree taxa. Poaceae increases to 20% TP (146% AP, 45% NMP) putting the event into the extensive clearance category of both Turner (1965) and Dumayne (1992). This increase in Poaceae is accompanied by corresponding increases in *Plantago lanceolata* and

Pteridium aquilinum. Cereal type pollen occurs for the first time in this zone. There is an increase in the diversity of herb taxa in particular those associated with human impact and agriculture. These include *Plantago major*, *Sinapis* type, *Ranunculus acris* group and type, *Cerastium* type, Apiaceae, *Rumex acetosa* group, *Rumex acetosella*, Liguliflorae, *Anthemis* type, *Artemisia* and Chenopodiaceae. This implies widespread pastoral agriculture was being practised in the area along with a smaller amount of arable agriculture perhaps on better soils.

Calluna increases dramatically in this zone (49% TP, 432% AP) but there is no evidence from macrofossils in the peat stratigraphy that *Calluna vulgaris* was growing on the bog itself. In fact the *Sphagnum* peat in this zone is only slightly humified suggesting that it grew relatively quickly in wet conditions which would not be conducive to *Calluna* colonisation of the bog surface. The *Calluna* must have been growing as part of a heathland community perhaps on poorer soils or soils depleted in nutrients by agriculture.

The agricultural indicators remain relatively stable throughout this zone implying initial large scale woodland clearance followed by maintenance of the cleared landscape as a result of widespread pastoral agriculture.

There are two radiocarbon dates associated with this zone. The date near the bottom of the zone is 94 cal BC - 112 cal AD at 1σ level (189 cal BC - 203 cal AD at 2σ). This date makes it difficult to determine whether the first extensive clearance was pre-Roman or Roman in origin although the zone below shows a gradual increase in clearance undertaken by the native population and it may be that the extensive clearances were a continuation of this native activity. The clearance was maintained throughout the Roman period.

The date for the middle of the zone is 145 - 339 cal AD at 1σ (83 - 415 cal AD at 2σ) i.e. spanning the Roman occupation period. Using the time/depth curve for this site an age range of approximately 400 - 600 cal AD is obtained for the end of this zone. This indicates that the cleared land around Lenzie Moss was maintained for some time after the Roman withdrawal from Scotland. A stable population must have been present in the area, who were presumably not hostile to the Roman invaders and were allowed to continue farming the area during the Roman occupation and subsequent withdrawal and for several centuries afterwards.

LM-5 (93 - 42cm)

This zone is characterised by woodland regeneration. Tree pollen increases to approximately 60% TP and 75% NMP. *Betula* increases first and to high levels presumably as the first stage of woodland regeneration on land previously used for agriculture. However there is also a dramatic reduction in *Calluna vulgaris* during this zone (especially noticeable in the tree pollen diagram) suggesting that *Betula* was also colonising the large areas of heather heathland which had been present in the zone below. After the initial large increase in *Betula* the other main tree taxa i.e. *Quercus* and *Alnus* begin to increase while *Betula* shows a decline. *Betula* dominated scrubby woodland would have been replaced by *Quercus* dominated woodland on drier soils and *Alnus* dominated woodland in wetter areas. Coryloid also increases slightly during this zone perhaps as *Corylus* began to establish as part of the understorey vegetation.

Poaceae values have fallen to very low levels in this zone with correspondingly low values for *Plantago lanceolata* and *Pteridium aquilinum*. The representation of herbaceous taxa associated with agriculture has declined with some taxa common in the zone below (in particular *Ranunculus acris* group, *Artemisia* and Chenopodiaceae) absent from this zone. The herbaceous taxa present in this zone may be related to human impact and occupation but most can occur equally in natural plant communities. There is only one occurrence of cereal type pollen at the very top of the zone. Agriculture seems to have been abandoned in this area during this time and any farming which did continue had little effect on the vegetation recorded by the pollen diagram.

The peat stratigraphy diagram shows *Sphagnum* to have been the major peat former during this period. The *Sphagnum* present is only slightly humified implying that it grew during a period of increased wetness possibly as a result of a deterioration in climate which may go some way to explain the abandonment of agriculture in the area.

There are two radiocarbon dates attached to this zone. The beginning of the zone is dated to 447 - 607 cal AD at 1σ (402 - 658 cal AD at 2σ) and the date for the middle of the zone is 552 - 671 cal AD at 1σ (445 - 771 cal AD at 2σ). Using the time/depth curve the end of the zone has an estimated age range of approximately 800 - 900 cal AD. This zone therefore covers a period from one or two centuries after the Roman withdrawal from Scotland , through the Dark Ages and into the Viking period.

<u>LM-6 (42 - 0cm)</u>

Near the beginning of the zone there is a short-lived decline in tree pollen (to 10% TP) with all the major tree taxa affected, especially *Quercus* which falls to around 2% TP. This is accompanied by a fall in Coryloid pollen as well. Poaceae increases during this period reaching around 20% TP (146% AP, 43% NMP) i.e. well into the extensive clearance classification. This is accompanied by corresponding rises in *Plantago lanceolata* and *Pteridium aquilinum* (most clearly seen in the AP and NMP diagrams). This period of clearance activity is also associated with occurrences of herbaceous taxa associated with human impact and agriculture. These include *Hornungia* type, *Ranunculus acris* group, Apiaceae, *Rumex acetosa* group, Liguliflorae, *Aster* type, *Anthemis* type, *Artemisia* and Chenopodiaceae. There is also a small increase in cereal type pollen during this period. A small increase in *Calluna vulgaris* suggests that heathland as well as grassland was increasing in response to woodland clearance. This clearance period is one of the only ones seen which is accompanied by a definite peak in charcoal. It is unlikely that fire was used to clear standing trees but may have been used to clear understorey vegetation once the mature trees had been removed. It may also reflect burning on the bog itself perhaps to increase its grazing potential. The peak of this period of clearance activity is radiocarbon dated to 816 - 985 cal AD at 1σ (699 - 1023 cal AD at 2σ).

This short period of woodland clearance is followed by a longer period of woodland regeneration during which all the major tree taxa show significant increases in pollen representation. Tree pollen increases to around 45% TP with a corresponding increase in Coryloid. Agricultural indicators including Poaceae, cereal type, *Plantago lanceolata* and other herb taxa decline during this period. The amount of charcoal present in the peat declines but the peat stratigraphy diagram gives no indication of a deterioration in climate to explain this decline in agriculture. The peak in this period of woodland regeneration is dated to 1205 - 1393 cal AD at 1σ (1043 - 1411 cal AD at 2σ).

Following this period of woodland regeneration there is a subsequent period of woodland clearance which continues until the top of the diagram. Tree pollen declines to around 10% TP with *Quercus* and *Alnus* being worst affected. The *Betula* which is still present was probably growing on the bog or around the bog margins. The only tree taxa which increase their representation are *Pinus*, *Ulmus* and *Fagus*. This suggests that planting of these taxa was being undertaken either for timber or as ornamentals by landowners on estates. Coryloid also declines dramatically at the top of this zone falling to < 1% TP. Poaceae increases steeply at the top of the zone reaching very high levels (>20% TP, 435% AP, 67% NMP) which indicate complete clearance of woodland from the area. These high values for Poaceae are accompanied by a large increase in *Plantago lanceolata*. Cereal type pollen is present and herbaceous agricultural indicators such as *Ranunculus acris* group, *Sinapis* type, *Hornungia* type and *Artemisia* increase their representation. This indicates that the majority of the land around Lenzie Moss was being farmed during this period and that pastoral rather than arable agriculture was being practised. *Calluna vulgaris* values show huge increases at the top of the zone reaching >60% TP. This may be reflecting heather heathland but is more likely to be *Calluna vulgaris* growing on the bog itself. The peat stratigraphy diagram shows that the topmost peat is very humified and relatively dry therefore providing suitable conditions for the growth of *Calluna*. The present day surface vegetation and pollen study showed the link described by Moore (1985) between high *Calluna* pollen values and a bog surface densely colonised by *Calluna*. High charcoal values are also seen at the top of the profile and these are likely to be the result of heather burning, either naturally or as a result of human activity, on the bog surface.

This final period of woodland clearance began around 1300 - 1400 cal AD and continued to the top of the profile. As has been seen at the other sites it is likely that the profile does not extend to the present day. The top of the profile probably dates to 1600 - 1800 cal AD because of the evidence for tree planting, but does not reach this century because of the lack of evidence for extensive coniferous plantations which is noted in the modern pollen rain.

6.7 Conclusions.

The Lenzie Moss pollen diagram charts the changes in vegetation around the site from a post- Elm decline period up until the last few hundred years.

During the Neolithic and early to middle Bronze Age the area around Lenzie Moss was densely wooded but with some areas of *Calluna vulgaris* present. There are no indications for agriculture having been practised in the area during this period and no evidence for any other human impact on the vegetation.

During the middle to late Bronze Age there is a slight decline in tree pollen but this does not seem to be linked to human impact as none of the usual agricultural indicators increase during this period. The peat stratigraphy suggests that there may have been a slight deterioration in climate; *Sphagnum* peat becomes less humified while *Calluna vulgaris* declines and Cyperaceae increases possibly as a result of waterlogging of the bog surface.

The first evidence for human impact on the vegetation around Lenzie Moss is found in zone LM-3 during the late Bronze Age / early Iron Age. The clearance indicators suggest small temporary clearances but, as was seen at Lochend Loch Bog, the clearance indicators are not present in discrete clearance phases but increase steadily to slightly above small temporary clearance levels and then remain relatively stable. Again it is likely that this is reflecting a small but stable level of population around Lenzie Moss. The herbaceous agricultural indicators present suggest pastoral agriculture and this is backed up by an absence of cereal type pollen from this zone. There is archaeological evidence for Bronze Age human presence in the area in the form of Bronze Age cinerary urns and cairns found near the site.

The first extensive woodland clearances began during the late pre-Roman Iron Age or during the early part of the Roman occupation of the area. These were maintained throughout the Roman period and beyond. These clearances are characterised by plant taxa associated with pastoral agriculture although some cleared areas may have been maintained for military purposes due to the proximity of the site to the Antonine Wall and the forts which preceded its construction.

This woodland clearance is similar to that seen at Flanders Moss (Turner 1965) which was dated to around 1850-1750 BP (see 5.8 Lochend Loch Bog conclusions). However the clearance is more sustained at Lenzie Moss than that seen at Flanders Moss.

Pollen analysis of turves from Roman forts in the area have also provided evidence for a landscape cleared of woodland. The excavations of the forts at Bar Hill and Mollins provided turves which were pollen analysed by Boyd (1984). These analyses showed that when the pollen preserved in the turves was deposited the vegetation was relatively cleared of woodland. The agricultural indicators present also suggested pastoral rather than arable agriculture was being practised. An increase in *Calluna vulgaris* heathland is also recorded from the turves from Bar Hill and Mollins and this corresponds with the large increase in *Calluna vulgaris* recorded at Lenzie Moss during this period. Pollen analysis of turves from Bearsden Roman fort (Dickson & Dickson 1988) also recorded an open landscape prior to the cutting of the turves suggesting clearance was already well under way by the time the Antonine Wall was constructed.

The cleared landscape was maintained after the Roman withdrawal until approximately 400 - 600 cal AD when woodland regeneration began again and continued until approximately 800 - 900 cal AD. As has been discussed earlier this period of Dark Ages woodland regeneration is recorded from a number of sites including Burnfoothill Moss (Tipping 1995) and Whittington & Edwards (1993) sites on the east coast of Scotland. However at Lenzie Moss there is some evidence from the peat stratigraphy that there may have been a slight deterioration in climate during this period.

The next pollen evidence for human impact on the vegetation of the area is seen between 800 - 1000 cal AD. This is similar to the clearances noted at Walls Hill Bog and Lochend Loch Bog.

There is a further period of woodland regeneration during which the evidence for agriculture declines. This lasts until around 1200 - 1400 cal AD before massive woodland clearance again occurs. This woodland clearance reaches the complete clearance classification but again the evidence is for mainly pastoral rather than arable agriculture taking place. There is evidence for possible estate type management of the area as witnessed by the apparent planting of tree such as Elm and Beech.

During this period it would appear that the bog surface dried out significantly resulting in a huge increase in *Calluna vulgaris* presumably growing on the bog itself. This colonising of the bog surface by heather in recent centuries is seen at all the sites showing how human interference on and around these sites has caused large changes in their water balance and consequently accelerated the drying of the bog surfaces. Taking into account this drying of the top of the bog along with evidence for the topmost peat having been subjected to serious burning it is likely that at least 100 years of peat is missing from the top of the profile.

7. GARTLEA BOG.

7.1 Site Description.

Geography, Geology and Vegetation.

Gartlea Bog (NS 450837) is situated approximately 500m to the north-west of Gartlea Farm and some 4km south of Loch Lomond (see Fig. 7.1). The bog lies at a height of 70m OD in an open landscape of low hills and wide valleys. This is in contrast to the landscape to the north which lies across the Highland Boundary fault and is characterised by steep, mountainous terrain and the land to the south and east which, although classified as Lowland also rises steeply to form the Kilpatrick Hills to the south and the Campsie Fells to the east.

The bog has been subjected to cutting around the margins and is enclosed by farmland on three sides and by a strip of *Betula* and *Pinus* woodland to the west. The bog itself is grazed by livestock from the surrounding pastoral land and the surface vegetation is dominated by species such as *Molinia caerulea*, heavily grazed *Myrica gale* and *Betula* and smaller amounts of *Calluna vulgaris*, *Erica tetralix* and *Vaccinium myrtillus*. Several species of *Sphagnum* and many other bryophytes are also present.

In the middle of the bog there is an area which has been fenced to remove the grazing pressure. Tree and shrub species have been favoured in this area where *Myrica gale* is abundant and much taller than that growing on the grazed area. Small trees of *Betula* and *Pinus* are also present in this fenced area.

The land around the bog is classified by the Soil Survey maps as being capable of supporting "improved grassland" and "moderate arable". The land immediately around the bog is used only as pasture although some arable agriculture is practised further from the bog site.

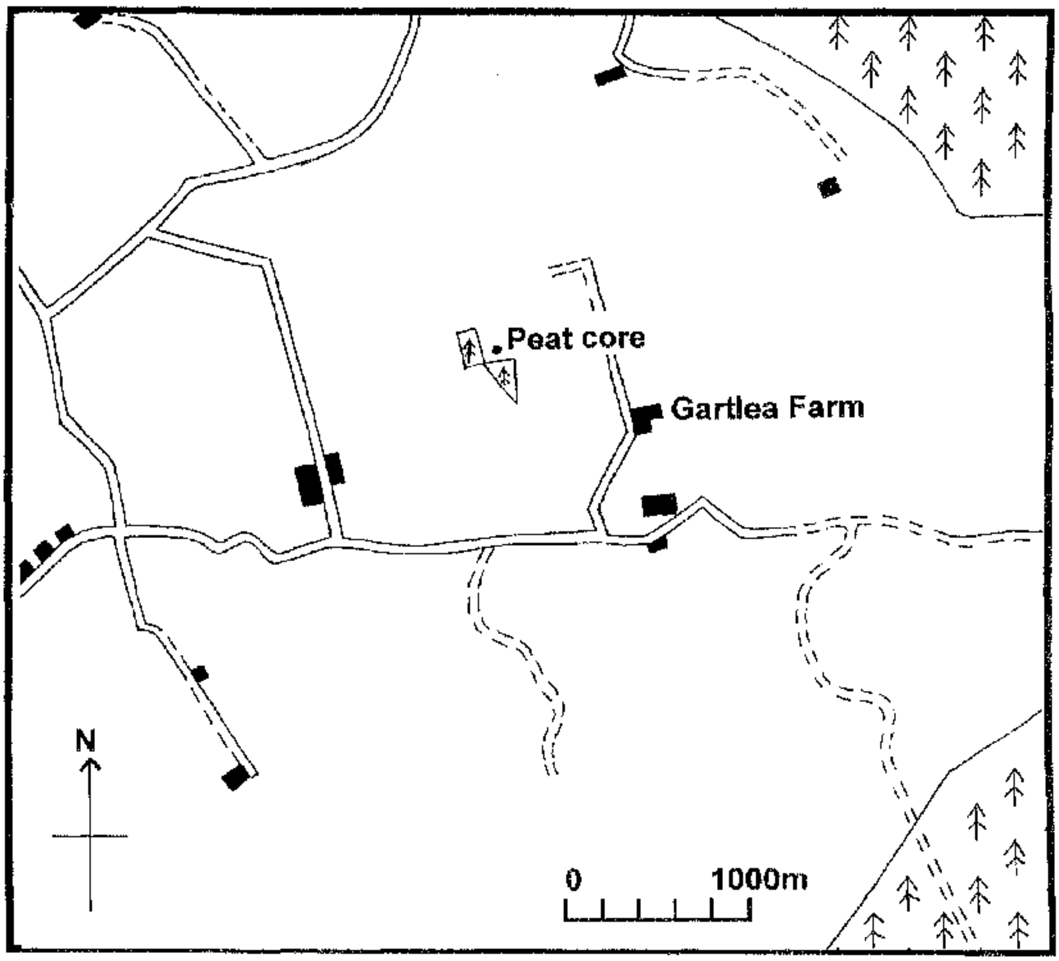


Fig. 7.1 Gartlea Bog location map.

Archaeology.

Gartlea Bog lies in an area rich in archaeological sites. The first evidence for human presence in the area is from about 5000 BP and is represented by chambered cairns of the Clyde-Solway group. These were communal burial chambers built of stone a number of which lie relatively close to Gartlea Bog. These include one discovered to the south at the Sheils of Gartlea, on Dumbarton Muir and another to the east at Aucheneck on Stockie Muir (Morrison 1974).

Evidence for Bronze Age occupation is also represented by funerary evidence in the form of a cist burial found at Old Kirk Farm approximately 8km west of Gartlea Bog. This cist contained a food vessel and cremated remains.

At Sheep Hill, near Dumbarton there is evidence of a timber-laced hillfort which has been dated to the Iron Age as has a dun on Dunbuie Hill, also near Dumbarton, the finds from which suggest an early Iron Age occupation.

The most imposing geological formation in the area is Dumbarton Rock (NS 400745) which rises to a height of 70m above the surrounding landscape. Although no remains of a prehistoric fort have been found on the Rock it is considered extremely likely that such a strategic site would have been occupied from at least the Iron Age period (Feachem 1977).

During the Roman period it is likely that there was a harbour near Dumbarton which would have been used to supply the westernmost forts of the Antonine Wall and also to control the upper Clyde region (Morrison 1974).

By the Dark Ages Dumbarton Rock was the capital of the Britons of the kingdom of Strathclyde and during this period there are records of Christian missionary activity in the area with the building of monasteries and churches including the missions of St.

Kessog and St. Kentigern on Loch Lomondside in the sixth and eighth centuries (Morrison, 1974 ; Idle 1974).

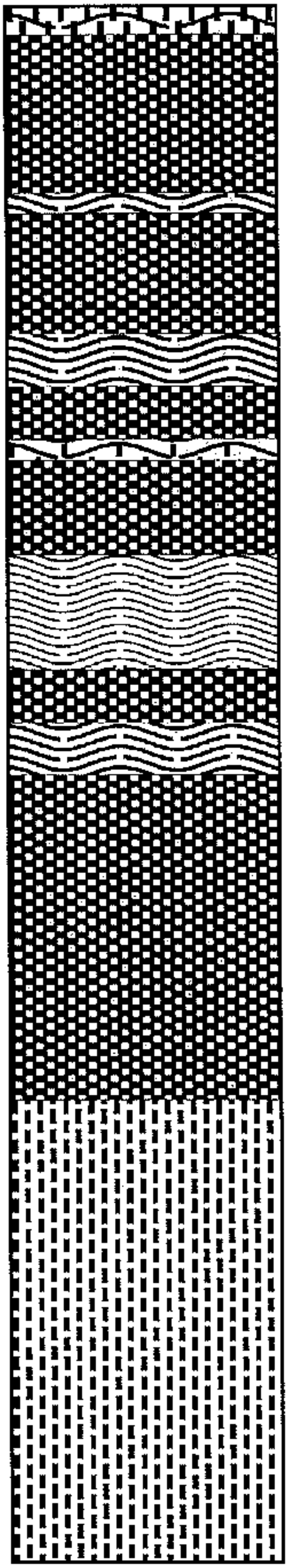
Viking influences were felt in this area from around 800 AD during which time Dumbarton Rock was captured. The attacks on this area, in particular on religious sites continued on and off for several hundred years.

From the medieval period onwards the area was managed as part of the Lennox estates undergoing many changes of ownership as feuds and infighting were rife during this time.

There is written evidence for extensive arable agriculture and grazing for cattle and sheep in the region during the fourteenth century. Idle (1974) suggests that agriculture declined between the fourteenth and seventeenth centuries but that exploitation of woodland continued with Oak particularly felled for use in shipbuilding. During the seventeenth century woodland continued to be exploited in this case for charcoal for iron smelting and later Oak woodland was again exploited this time for its bark for use in the leather tanning industry. There is evidence for coppicing of Oak to ensure a continuous supply of bark and wood.

During this period land was being farmed in particular as grazing for sheep and agricultural improvements in the form of enclosures and drainage began to take effect (Idle 1974).

7.2 Peat Stratigraphy.



0 - 5cm	Tb^3 (sphagni) 1	Th^3 3
5 - 35 cm	Sh 4	
35 - 39 cm	Tb^3 (sphagni) 4	
39 - 62 cm	Sh 4	Th^4 +
62 - 72 cm	Tb^3 (sphagni) 4	Th^3 +
72 - 82 cm	Tb^4 (sphagni) +	Sh 4
82 - 86 cm	Tb^3 (sphagni) 3	Th^3 1
86 - 104 cm	Tb^4 (sphagni) +	Sh 4
104 - 126 cm	Tb^1 (sphagni) 4	
126 - 136 cm	Sh 4	
136 - 146 cm	Tb^3 (sphagni) 4	
146 - 208 cm	Sh 4	Dl +
208 - 296 cm	Th^3 4	

Fig. 7.2 : Gartlea Bog stratigraphy.

7.3 Pollen Zone Descriptions.

The following pollen zone descriptions are based on a sum of :-

Total Pollen and Spores (excluding *Sphagnum*) : see Fig. 7.3

GB-1 (288 - 248cm)

Tree pollen is high especially *Alnus* (33%) and *Ulmus* (6%). Coryloid values are also high (33%). *Calluna vulgaris* values are low (3-12%). Poaceae values are very low (<2%) and Cereal type is absent. Cyperaceae is very low (<5%). *Plantago lanceolata* has only one occurrence (<1%) in this zone. The only other herb taxa present are single trace occurrences of *Sinapis* type and *Ranunculus acris* type. *Pteridium aquilinum* is present at <1% in this zone. *Sphagnum* values are also very low (5%).

GB-2 (248 - 168cm)

Quercus declines from 10% to 5% and *Alnus* declines from 29% to 14%. *Ulmus* has declined to <1% from the zone below. *Fraxinus* makes its first appearance in this zone. Coryloid remains steady (26-32%) throughout this zone. *Calluna vulgaris* increases steadily to 29%. Poaceae, Cyperaceae and *Plantago lanceolata* all remain low in this zone. Liguliflorae and *Ranunculus acris* group both appear for the first time in this zone. *Pteridium aquilinum* is absent and *Sphagnum* values are very low (<3%).

GB-3 (168 - 122cm)

Tree values fluctuate slightly in this zone. *Fagus* and *Hedera helix* appear for the first time. Coryloid declines slightly from 30% to 14% towards the end of the zone while *Calluna vulgaris* peaks in the middle (46%) and end (39%) of the zone. Poaceae increases slightly as do Cyperaceae and *Plantago lanceolata*. Several herb taxa make their first appearance in this zone including *Galium* type, Apiaceae, *Potentilla* type, *Rumex acetosella* and *Artemisia*. *Pteridium aquilinum* reappears in this zone. *Sphagnum* increases steeply in this zone (57%) but declines again towards the end.

GB-4 (122 - 90cm)

Tree pollen remains relatively stable as does Coryloid. *Calluna vulgaris* peaks at the beginning (55%) and end (46%) of the zone. Poaceae declines very gradually to <1% at the end of the zone while Cyperaceae stays at very low levels (<3%). *Plantago lanceolata* is uncommon in this zone with only two occurrences of <1%. Herb taxa occurring for the first time in this zone are *Rumex acetosa* group, *Anthemis* type and Chenopodiaceae. *Pteridium aquilinum* is also scarce in this zone. *Sphagnum* increases to 56% but declines steeply towards the end of the zone.

GB-5 (90 - 61cm)

Betula and *Alnus* remain steady but *Quercus* shows a slight decline (from 8% to 3%) towards the end of the zone. cf. *Sorbus* type makes its sole appearance in this zone. Coryloid and *Calluna vulgaris* both decline towards the end of this zone. Poaceae has several small peaks (maximum 10%) in this zone and Cyperaceae increases towards the end of the zone (reaching 42%). *Plantago lanceolata* occurs throughout the zone with a maximum of 3%. Many herb taxa appear for the first time during this zone including *Hornungia* type, *Succisa / Scabiosa*, *Ranunculus ficaria* group, *Filipendula*, *Anemone nemorosa* group. *Pteridium aquilinum* is present at <2% throughout the zone. *Sphagnum* is present at moderate levels (4-15%) throughout the zone.

GB-6 (61 - 49cm)

Tree pollen varies only slightly. There are increases in *Calluna vulgaris* (20%), Poaceae (14%) and *Plantago lanceolata* (5%) while Cyperaceae declines steeply from 39% to 7%. Cereal type is present as a trace in this zone. Only one herb taxon occurs for the first time in this zone, namely *Helianthemum*. *Sphagnum* values increase in this zone reaching 38%.

GB-7 (49 - 22cm)

Quercus increases towards the middle of the zone (reaching 14%) before decreasing again (to 3%). *Alnus* shows a decline from GB-6. *Carpinus* and *Sambucus* occur for the first time in this zone. *Calluna vulgaris* increases to 49% and *Empetrum nigrum* occurs for the only time. Poaceae declines (minimum of 1%) as does Cyperaceae and *Plantago lanceolata* although all three show a slight recovery towards the end of the zone. *Centaurea nigra* type occurs for the first time at the end of the zone where there is also a single occurrence of Cereal type. *Sphagnum* fluctuates between high and low values in this zone (1-50%).

GB-8 (22 - 0cm)

There are declines in *Betula* (from 15% to 6%), *Quercus* (from 3% to <1%), *Alnus* (from 11% to <1%) and Coryloid (from 32% to 7%) but *Ulmus* and *Pinus* increase slightly towards the end of the zone (to 2% and 6% respectively). *Calluna vulgaris* declines and then recovers again. Poaceae increases steadily (to 17%), Cyperaceae values increase from 8% to 61% and Cereal type is consistently present in this zone. *Scleranthus* and *Chamerion angustifolium* type occur for the first time. *Polypodium vulgare* type declines as does *Sphagnum*.

The following pollen zone descriptions are based on a sum of :-

Arboreal Pollen (excluding Coryloid and *Salix*) : see Fig. 7.4

GB-1 (288 - 248cm)

Ulmus makes up a significant proportion of the tree taxa (reaching 11%). *Calluna*, Poaceae, Cyperaceae, *Plantago lanceolata* and *Pteridium aquilinum* are very low. *Sphagnum* is <8%.

GB-2 (248 - 168cm)

Ulmus values have declined to <1%. *Calluna vulgaris* increases while Poaceae, Cyperaceae and *Plantago lanceolata* remain low. *Pteridium aquilinum* is absent. *Sphagnum* is still <8%.

GB-3 (168 - 122cm)

Calluna vulgaris peaks in the middle of the zone (to 130%). Poaceae, Cyperaceae, *Plantago lanceolata* and *Pteridium aquilinum* increase slightly. *Sphagnum* values rise steeply reaching 301%.

GB-4 (122 - 90cm)

Poaceae, Cyperaceae, *Plantago lanceolata* and *Pteridium aquilinum* all decline slightly. *Sphagnum* values remain generally high.

GB-5 (90 - 61cm)

Quercus declines towards the end of the zone. Coryloid and *Calluna vulgaris* both peak before declining again. There are several taxa which show small peaks including Poaceae (29%), Cyperaceae, *Plantago lanceolata* (8%) and *Pteridium aquilinum* (8%). *Sphagnum* values decline.

GB-6 (61 - 49cm)

Calluna vulgaris shows a slight peak. There are increases in Poaceae (73%), Cyperaceae (249%), *Plantago lanceolata* (34%) and *Pteridium aquilinum* (6%). There are also small peaks in *Artemisia* (3%) and Chenopodiaceae (2%)

GB-7 (49 - 22cm)

Calluna vulgaris increases. Poaceae, Cyperaceae, *Plantago lanceolata* and *Pteridium aquilinum* all decline but recover towards the end of the zone, as does *Sphagnum*. *Artemisia* peaks near the end of the zone (reaching 4%).

GB-8 (22 - 0cm)

Quercus declines from 8% to 1% and *Alnus* declines from 27% to 8% while *Pinus*, *Ulmus* and *Fagus* all increase with *Pinus* reaching 36%. There are significant increases in Coryloid, *Calluna vulgaris*, Poaceae (to 100%), Cereal type (to 3%), Cyperaceae, *Plantago lanceolata* (to 23%), *Ranunculus acris* type (to 3%), *Rumex acetosa* group (to 5%) and *Pteridium aquilinum* (to 6%). *Sphagnum* values fall steeply from 57% to 12%.

The following pollen zone descriptions are based on a sum of :-

Non Mire Pollen : see Fig. 7.5

GB-1 (288 - 248cm)

Tree pollen is high and *Ulmus* reaches 7%. All herb taxa values are low.

GB-2 (248 - 168cm)

There is a decline in *Ulmus* to <1%, although it recovers slightly towards the middle of the zone (2%) before declining to <1% again at the end of the zone. All herb pollen values are still low.

GB-3 168 - 122cm)

Tree pollen is still high but there are slight increases in Poaceae (to 7%) and *Plantago lanceolata* (2%).

GB-4 (122 - 90cm)

Same as GB-3 but there is a decline in *Plantago lanceolata* to <1%.

GB-5 (90 - 61cm)

Coryloid declines while there are increases in Poaceae (16%) and *Plantago lanceolata* (5%).

GB-6 (61 - 49cm)

Trees decline slightly but there are increases in Poaceae (25%) and *Plantago lanceolata* (11%).

GB-7 (49 - 22cm)

Trees increase slightly while Poaceae declines to 2% and *Plantago lanceolata* declines to zero. However they both increase slightly towards the end of the zone with Poaceae reaching 16% and *Plantago lanceolata* reaching 4%.

GB-8 (22 - 0cm)

There are declines in *Quercus* (<1%), *Betula* (15%), and *Alnus* (3%) whereas there are increases in *Pinus* (to 15%), *Ulmus* (5%) and *Fagus* (2%). There are increases in Poaceae (to 39%), *Plantago lanceolata* (to 8%), *Ranunculus acris* type (to 1%) and *Rumex acetosa* group (2%).

7.4 Interpretation and Discussion.

GB-1(288 - 248cm)

This zone is characterised by high values of tree pollen (50-60% TP, 60-70% NMP). *Alnus* is the most common taxon (reaching >30% TP) presumably growing in wetter areas on the valley floor and along the banks of the numerous rivers and streams which run through this area. *Ulmus* pollen is well represented during this zone reaching >5% TP (>10% AP) but declines towards the end of the zone and the zone boundary marks the point when pollen drops to <1% i.e. a significant Elm-decline. The Elm decline at Dubh Loch (Stewart, Walker & Dickson 1984) has been dated to around 4913 ± 85 BP. At Black Loch in Fife a series of Elm declines has been noted, the first of which is dated to c. 5200 BP (Whittington, Edwards & Cundill 1991) while at Burnfoothill Moss on the Solway Firth (Tipping 1995) two Elm declines are apparent, the first of which is dated to c. 4800 BP.

Many explanations for the Elm decline have been postulated since it was first noted in pollen diagrams from north-western Europe. The rapidity of the decline at many sites would appear to rule out explanations such as climate change or human activity (either by felling or use as leaf fodder) being solely responsible. It is now considered that disease is the most likely explanation for the decline but may be enhanced by human activity (Peglar 1993; Peglar & Birks 1993).

Coryloid pollen is also high during this zone but this may be from *Myrica* rather than *Corylus* as *Myrica* still grows on the site today. *Calluna vulgaris* is very low as are Poaceae and Cyperaceae indicating that the area was densely wooded with little open land either as heathland or grassland. Very few additional herbaceous taxa are represented with only trace occurrences of *Sinapis* type, *Ranunculus acris* type and *Plantago lanceolata*. *Pteridium aquilinum* is only present at trace levels in this zone.

The peat stratigraphy diagram shows that the peat from this zone is purely herbaceous in nature and this is in agreement with the very low representation of *Sphagnum* spores in the pollen diagram. The pollen evidence gives little indication as to which herb taxa may have been the major peat former during this time as both Poaceae and Cyperaceae pollen is low. However the surface pollen studies from the other sites showed that herbaceous taxa in particular *Eriophorum* could dominate the surface flora but be very underrepresented in the corresponding pollen profile.

This zone has already been estimated to have ended at approx. 4900 BP. The beginning of the zone can be put at around 6000-7000 BP. *Alnus* is already well established so the beginning of the zone must be later than 6500-7000 BP i.e. the approximate date of the Alder rise in this area (Dickson *et al.* 1978).

GB-2(248 - 168cm)

Tree pollen declines in this zone falling to around 40% TP. *Alnus* shows the greatest decline with *Quercus* declining slightly and *Betula* remaining relatively constant. *Ulmus* is present at only low levels throughout this zone confirming this zone as post-Elm decline. Coryloid pollen remains stable but it is not possible to determine whether this was *Myrica* growing on the bog or *Corylus* growing as understorey vegetation. Poaceae remains very low as do other indicators of human impact with only trace occurrences of *Plantago lanceolata*, *Plantago* spp. (indet.), Liguliflorae and *Ranunculus acris* group while *Pteridium aquilinum* is absent from this zone. Only *Calluna vulgaris* increases in this zone reaching 30% TP. This *Calluna* may have been growing as areas of heather heathland but may have been growing on the bog itself. The peat stratigraphy diagram shows a change from herbaceous peat to very humified peat of indeterminate origin which contained fragments of Ericaceous twigs. This suggests drying of the bog surface leading to increased oxidation of the peat, enabling *Calluna vulgaris* to establish on the bog surface.

There is no evidence for human impact on the vegetation during this zone. The beginning of the zone has already been estimated at approximately 5000 BP but it is more difficult to date the end of the zone. The zone above contains trace amounts of *Fagus* pollen which is absent from this zone. Although *Fagus* is not native to Scotland it is often seen at very low levels in Scottish pollen diagrams as a result of long distance transport from England. *Fagus* reached its greatest extent around 3000 BP (Birks 1989) and before this it is unlikely that even far travelled *Fagus* pollen would have reached Scotland. From this a rough estimate of 4000 - 3500 BP may be attached to the end of the zone.

GB-3(168 - 122cm)

The zone begins with high levels of tree pollen but these fluctuate somewhat through to the end of the zone. However Coryloid declines somewhat during this period. There is a slight increase in Poaceae during this zone with corresponding small increases in Cyperaceae, *Plantago lanceolata* and *Pteridium aquilinum*. There is also an increase in the diversity of herbaceous taxa including Liguliflorae, *Galium* type, *Rumex acetosa* group, *Artemisia* and cereal type pollen which occurs for the first time during this zone. This suggests some slight human activity in the area. Even though clearance indicators do not reach even the small temporary clearance level, the pollen evidence does suggest a very low level of human impact in the area with small scale agriculture either pastoral or arable. *Calluna vulgaris* increases towards the middle of the zone but declines again towards the end. This decline may be the result of grazing out of the heather by livestock which may have been pastured on the surface of the bog or heathland while the small woodland clearances were used to grow crops.

The peat stratigraphy diagram again shows a very humified peat in this zone with one band of recognisable though very humified *Sphagnum* peat again suggesting a drier bog surface. The start of this zone has already been estimated to 4000 - 3500 BP (approx. 2000 - 1500 cal BC) and again it is difficult to put an end date on the zone. The clearances are unlikely to be as late as either late Bronze Age or early Iron Age as they are probably too limited and at too low a level considering the extensive archaeological evidence for habitation during those periods. They are more likely to be early to middle Bronze Age in date and so a possible end date for the zone may be in the range 1500 - 1000 cal BC.

GB-4(122 - 90cm)

Tree pollen remains generally high during this zone but again shows significant fluctuations although Coryloid shows a slight decline. There are also declines in Poaceae, Cyperaceae, *Plantago lanceolata* and *Pteridium aquilinum* to very low levels. The only other herbaceous taxa present are single occurrences of *Ranunculus acris* type, *Rumex acetosa* group, *Anthemis* type and Chenopodiaceae. It appears that the small scale agriculture which was noted in the zone below has been abandoned during this period. *Calluna* values have increased again suggesting that grazing pressure may have declined and *Calluna* growth resumed.

The peat stratigraphy diagram shows a definite change at the beginning of the zone. The peat changes from very humified indeterminate peat to very unhumified

Sphagnum peat, also marked by high values of *Sphagnum* spores in the pollen diagram. This indicates a large increase in the surface wetness of the bog which may have been associated with a deterioration in climate. This could explain why agriculture appears to have been abandoned during this period.

Charcoal is absent from this wetter part of the zone. This suggests previously high values of charcoal reflected natural burning on the bog and that during this period the bog surface was too wet to burn.

The beginning of this zone was dated to approx. 1500 - 1000 cal BC. The end of the zone is pre-significant agriculture and human occupation and so is likely to be no later than late Bronze Age / early Iron Age and so a possible end range for the zone would be around 600 - 300 cal BC.

GB-5(90 - 61cm)

Tree pollen declines in this zone with all the major tree taxa affected as is Coryloid. This suggests clear felling of both mature trees and understorey vegetation. Poaceae shows a number of small peaks in this zone (reaching 29% AP, 16% NMP) which just reach small temporary clearance level. These peaks in Poaceae are accompanied by increases in *Plantago lanceolata* and, to a lesser extent, *Pteridium aquilinum*. There is a large increase in the diversity of herbaceous taxa with several agricultural indicator taxa. These include *Ranunculus acris* group and type, Apiaceae, *Artemisia*, *Rumex acetosa* group, Chenopodiaceae and *Hornungia* type. However cereal type pollen is absent from this zone. This points to small scale woodland clearance to provide grazing for livestock with no evidence for arable agriculture having been practised. These discrete clearance episodes point to shifting populations clearing woodland, farming until the land became exhausted and then moving on to other sites.

Cyperaceae increases during this zone while conversely *Calluna vulgaris* declines. This pattern has been seen at the other sites and again it is possible that increased grazing pressure depleted the amount of *Calluna vulgaris* while favouring the growth of Cyperaceae.

The peat stratigraphy diagram shows periods of very humified indeterminate or *Sphagnum* peat. This points to a drier bog surface than was seen in the zone below and may account for the increased agricultural activity around the bog.

The beginning of this zone was estimated to be around 600 - 300 cal BC and the zone probably extends to a period either slightly pre-Roman or Roman in date. This is assuming that the period of small temporary clearances is of similar date to those seen at Bloak Moss and Flanders Moss (Turner 1965).

GB-6(61 - 49cm)

Tree pollen fluctuates in this zone with *Quercus* in general declining while *Betula* and *Alnus* increase somewhat. Values for Coryloid remain stable. Poaceae values increase in this zone reaching 14% TP (73% AP, 25% NMP) i.e. between small temporary and extensive clearance levels. This peak is accompanied by a significant peak in *Plantago lanceolata* and other herbaceous taxa including *Ranunculus acris* group, *Artemisia*, *Rumex acetosa* group and Chenopodiaceae. There is also a single occurrence of cereal type pollen. This indicates relatively widespread agriculture being practised with pastoral rather than arable agriculture predominating.

Calluna vulgaris pollen increases in this zone as a result either of increasing heather heathland or *Calluna vulgaris* recolonising the bog surface. The latter is less likely as there are high values of *Sphagnum* spores throughout this zone in the pollen diagram, although there is no evidence of *Sphagnum* from the peat stratigraphy. This would indicate that the bog surface was relatively wet and so unsuitable for widespread colonisation by *Calluna vulgaris*.

The beginning of this zone was estimated as dating to either the late pre-Roman Iron Age or the beginning of the Roman period. The clearances are of short duration and regeneration probably took place soon after the withdrawal of the Roman army putting the end of the zone around 300 - 400 cal AD.

GB-7(49 - 22cm)

Tree pollen increases in this zone with *Betula* and *Quercus* recovering to pre-clearance levels although both decline again towards the top of the zone. There is a corresponding decline in *Plantago lanceolata* and the only other herbaceous taxa present during this first period are *Ranunculus acris* group and *Rumex acetosa* group. However there is a recovery in agricultural indicators towards the end of the zone with Poaceae and *Plantago lanceolata* increasing and an increase in the diversity of herbaceous taxa. There is also a single occurrence of cereal type at the top of this zone. This subsequent clearance is still at a very small scale.

Calluna vulgaris values are generally high suggesting that either there were significant areas of heather heathland in the region or that the bog itself was densely colonised by *Calluna vulgaris*. The beginning of this zone was dated to around 300 - 400 cal AD and because of the evidence for Christian missions at around 600 - 800 AD it is likely that the slight increase in clearance may date to this period.

GB-8(22 - 0cm)

This zone is characterised by a steep decline in tree pollen. Both *Quercus* and *Alnus* fall to <1% by the top of the zone and Coryloid also falls to its lowest levels. Poaceae increases to 17% TP (100% AP, 39% NMP) i.e. into the extensive clearance category.

This is accompanied by increases in *Plantago lanceolata* and cereal type pollen is present in all but one of the levels in this zone. Herbaceous taxa which are indicators of agriculture are also present. These include *Ranunculus acris* type, Liguliflorae, *Artemisia*, *Rumex acetosa* group and *Scleranthus*. This indicates mixed pastoral and arable agriculture.

Some tree taxa show an increase at the top of the profile i.e. *Pinus*, *Ulmus* and *Fagus*. These are likely to have been planted rather than occurring naturally.

The beginning of this zone was estimated to around 600 - 800 cal AD. As has already been noted there is evidence for tree planting at the top of this zone. There is also a single occurrence of *Chamerion angustifolium* at the top of the zone which has only become common this century. This indicates that the top of the bog is relatively intact and the pollen profile extends to the present day.

7.5 Conclusions.

The Gartlea Bog pollen diagram charts the changes in vegetation around the site from approximately 6500 - 7000 BP up until the present day. As this site has not been radiocarbon dated the dates in the following conclusions are only estimates based on other dated sites.

The first significant vegetation change recorded in the pollen diagram is an Elm decline probably dating to around 5000 BP but with no evidence for it having an anthropogenic origin.

Even though there is archaeological evidence for human presence during the Neolithic period in this area the pollen diagram from Gartlea Bog does not show any vegetational changes which can be attributed to human impact. According to Morrison (1974) the Neolithic farmers would probably have avoided the low lying area around the southern end of Loch Lomond because the soil would have been too marshy or of heavy clay and difficult to cultivate with the tools available. Morrison suggests that Neolithic farming would have been undertaken on hill slopes and upland soils which would have been better drained and easier to cultivate. If this explanation is correct it would be unlikely that the Gartlea Bog pollen diagram would record this agricultural activity. It would have been small scale and at too great a distance for agricultural pollen indicators to be noted against the large amounts of tree pollen being produced by the dense local woodland.

The first evidence for possible agriculture occurs in zone GB-3 but is at very low levels. This may be attributable to the early to middle Bronze Age. The agricultural pollen indicators may reflect very small scale farming close to Gartlea bog or more extensive agriculture being practised at a greater distance from the site perhaps on upland soils as was postulated for the Neolithic period.

By zone GB-4 this agricultural activity has stopped. The peat stratigraphy strongly suggests increased waterlogging of the bog and perhaps the low lying land around the bog. This would have made farming very difficult and Bronze Age people would have had to move to drier areas. A return to agriculture is noted in GB-5 from the late Bronze Age / early Iron Age up until the beginning of the Roman period. This agriculture takes the form of small temporary woodland clearances to provide grazing land for livestock. A decline in *Calluna vulgaris* during this zone suggests that the heather heathland was also being used as supplementary grazing.

By the Roman period more extensive woodland clearance was underway indicating a stable population was present in the area. The Roman army may have controlled most of this area to prevent attacks, by hostile natives from the north, on their harbour at Dumbarton. This would have required clearance of land for military purposes to improve visibility and prevent surprise attacks. However the pollen indicators show that pastoral agriculture was being practised in the area perhaps as a by-product of military clearance or perhaps in its own right to provide food for the Roman army. Large areas of heather heathland were also present during this period indicating that not all the cleared land was being farmed and that some of the poorer cleared land reverted to heather heathland.

After the Roman withdrawal it appears that woodland regeneration resumed but only for a few hundred years. By 600 - 800 AD Christian missionaries were active in the area and missions, monasteries and churches were being built. This implies a population for these missionaries to preach to. It is likely that the episode of clearance at the top of GB-7 relates to this period.

From this period onwards woodland clearance became more widespread with *Quercus* and *Alnus* worst affected. It was during this time that *Quercus* woodland was exploited extensively for timber for ships, then for charcoal and later still for bark required for tanning. During this period *Quercus* pollen is very low but significant areas of Oak woodland must have been present. This anomaly would be explained if the Oak woodland was being managed by coppicing thus providing a continuous supply of wood but probably suppressing *Quercus* pollen production.

8. DISCUSSION.

8.1 Introduction.

At the beginning of this study the aim was to investigate the period during which extensive woodland clearance was first undertaken in west-central Scotland and, in particular, to determine whether this clearance was initiated in pre-Roman rather than Roman times.

As the study was continued other periods of clearance activity requiring explanation were noted at the study sites and so the project was extended to cover human impact on the vegetation of west-central Scotland during the last 3000 years. One site, Gartlea Bog, actually extends to over 5000 BP and this earlier period has been included in the following discussion to give an overview of the vegetation, in particular the tree cover present, before human interference was evident.

The data resulting from the sites has already been discussed in chapters four to seven with each site considered individually. However the extensive radiocarbon dating schemes attached to three of the four sites allows them to be discussed together in a chronological manner. Even though Gartlea Bog has not been dated by radiocarbon methods it has still been included in this discussion as the patterns of vegetation change appear to be similar to those seen at the other sites.

The discussion has been organised on the basis of recognised archaeological periods even though these may show some degree of overlap. This is considered to be more useful than discussing the profiles using precise calendar dates to delimit arbitrary time periods (e.g. 1000 year blocks). The errors associated with the radiocarbon dates makes it undesirable to use them in such a specific manner.

8.2 Mesolithic & Neolithic.

The woodland composition reflected in the pollen diagrams is consistent with that which would have been expected from the woodland cover maps of McVean & Ratcliffe (1962) and Bennett (1989) and the tree pollen isochrone maps of Birks (1989)). That is, a mixed deciduous woodland with *Betula, Quercus* and *Alnus* dominating though perhaps colonising slightly different soil types. There is also evidence for an understorey vegetation probably including *Corylus avellana*. During the period before 5000 BP *Ulmus* was also a significant component of the woodland, though not as great a contributor to the pollen rain as *Betula, Quercus* or *Alnus*. However at around 5000 BP there is a decline in Elm to trace levels most probably as a result of a disease specific to *Ulmus* as other tree taxa appear to be unaffected. It is unlikely that the Elm decline is associated with human activity in this area as there is no indication of an increase in the usual agricultural indicators during this period.

There is archaeological evidence for human presence in the area around Lochend Loch Bog in the Mesolithic and Gartlea Bog in the Neolithic. The Mesolithic people would have been hunter / gatherers and unlikely to have had a significant impact on the surrounding vegetation (as the Lochend Loch Bog pollen diagram does not extend to this period this assumption cannot be confirmed). However there is archaeological evidence for Mesolithic presence in Fife but only minimal pollen evidence for any impact on the vegetation (Whittington, Edwards & Cundill, 1991). Neolithic farming activity has not been recognised in the Gartlea pollen diagram but this may be because agriculture was being practised on a small scale on the drier hill slopes and upland soils, some distance from the site, rather than on the wet, clay soils around the bog.

8.3 Bronze Age.

During the Bronze Age the first evidence of human activity is seen in the pollen diagrams. This takes the form of woodland clearance for agriculture. The earliest activity is seen at Gartlea Bog by way of slightly depressed levels of tree pollen with raised levels of Poaceae and *Plantago lanceolata*. However this activity does not continue throughout the Bronze Age and a subsequent decline in agriculture is noted from the middle to late Bronze Age.

At Walls Hill Bog the classic small temporary clearance episodes of Turner (1965) are apparent. These discrete clearance phases, which are characterised by Poaceae reaching 20% AP accompanied by increases in *Plantago lanceolata* and *Pteridium aquilinum*, are very similar to those noted by Turner (1975) at Bloak Moss and Kennox Moss in Ayrshire and at Fellend Moss in Northumberland (Davies & Turner, 1979). This type of clearance activity is consistent with a small, shifting population practising small scale woodland clearance for pastoral agriculture.

This type of clearance is slightly different to that seen at Lochend Loch Bog where the clearance activity increases gradually to the small temporary clearance level without any discrete clearance episodes being discernible. Again these clearances were primarily to provide land for pastoral agriculture.

Both Walls Hill Bog and Gartlea Bog show some evidence for the woodland clearance and agricultural activity taking place during periods in which the peat stratigraphy indicates a decrease in bog surface wetness with an abandonment of agriculture during periods when the bog surface wetness increased. These are the same sites which show discrete periods of woodland clearance. This suggests that these sites may have been more susceptible to waterlogging or have had soils which could only have been farmed during periods of climatic favourability. At Lochend Loch Bog there are no discrete clearance phases, only a steady increase in clearance activity. The peat stratigraphy diagram for Lochend Loch Bog shows little evidence for fluctuations in bog surface wetness with the peat consisting mostly of moderately humified *Sphagnum* moss. This suggests that the Lochend Loch Bog during the Bronze Age was less susceptible to changing bog surface wetness or that in this more central part of Scotland these changes were not so pronounced as those at Walls Hill and Gartlea. Walls Hill Bog lies at a height of 180m suggesting altitude may have been a factor in making any increased wetness more serious for agriculture at this site. At Gartlea Bog it was suggested earlier that farming was being practised on hill slopes and upland soils some distance from the bog itself. Again it may be that any worsening of the conditions was felt more strongly, in terms of the increased difficulty of farming, in upland areas rather than in lowland central Scotland.

8.4 Pre-Roman Iron Age.

The pre-Roman Iron Age was the period during which extensive woodland clearance began in this area.

Tree felling was not selective with mature trees and understorey vegetation cleared to produce land for agriculture. There is no evidence that fire was ever an important tool for woodland clearance in this area. It would not have been a practical method for clearing significant tracts of deciduous woodland as this type of standing woodland burns very slowly or not at all.

Extensive clearance is noted first at Walls Hill Bog during the third to first centuries BC. This is also the approximate date for the beginning of extensive clearance at Lochend Loch Bog. Both sites show clearance for pastoral rather than arable agriculture although both sites do show occasional traces of cereal type pollen. This suggests that arable agriculture was being practised but on a small scale, perhaps some distance from the sample sites. Similar agricultural indicator types are seen at both locations; *Plantago lanceolata* increases significantly along with *Ranunculus acris* type and *Rumex acetosa* group, both of which are considered by Vorren (1986) and Behre (1988) to be indicators of meadows and pastures. These sites also show increased levels of Chenopodiaceae (often associated with fields, field margins and other ruderal habitats) and *Artemisia* (probably *Artemisia vulgaris*) an indicator of fallow land and ruderal communities.

Both sites show significant increases in *Calluna vulgaris* during this agricultural phase. It may be that when large areas were cleared of woodland some of the poorer soils may have been colonised by heather heathland rather than grassland. Another explanation may be that grazing pressure moved from heathland type vegetation to open grassland allowing the *Calluna* to recover on the heathland.

By the end of the pre-Roman Iron Age woodland regeneration was already underway at Walls Hill Bog with *Betula* and *Alnus* recolonising the land which had previously been farmed. Evidence from the peat stratigraphy again that the bog surface became much wetter during this period. However at Lochend Loch Bog the clearance is maintained until after the end of this pre-Roman period.

This type of extensive woodland clearance in the pre-Roman Iron Age is also seen at Burnfoothill Moss, on the Solway Firth (Tipping 1995) and at Glasson Moss and Walton Moss near Hadrian's Wall (Dumayne & Barber 1994) where there is evidence for both pastoral and arable agriculture.

Lenzie Moss and Gartlea Bog show some evidence for woodland clearance during this period but not to the same extent as that seen at Walls Hill Bog and Lochend Loch Bog. The former sites exhibit the extent of clearance seen at Walls Hill Bog and Lochend Loch Bog during the late Bronze Age. Gartlea shows discrete small temporary clearances akin to those seen at Walls Hill Bog while Lenzie Moss shows a gradual increase in clearance indicators in a manner similar to that seen previously at Lochend Loch Bog. Cereal type pollen is absent from both Lenzie Moss and Gartlea Bog during this period pointing towards pastoral rather than arable agriculture being practised. The herbaceous taxa found during these less substantial clearances are very similar to those seen during the contemporary extensive clearances of Walls Hill Bog and Lochend Loch Bog. Again *Ranunculus acris* type, *Rumex acetosa* group, *Artemisia* and Chenopodiaceae are present indicating meadows or pastures and areas of ruderal vegetation.

Calluna vulgaris declines at both Gartlea Bog and Lenzie Moss during this period. The grazing in small temporary clearances may have been augmented by grazing of livestock on heather heathland reducing the abundance of *Calluna vulgaris* and subsequently lowering its pollen production.

It appears that the sites associated with Iron Age remains i.e. Walls Hill fort at Walls Hill Bog and the crannog (in Lochend Loch) next to Lochend Loch Bog, show earlier extensive clearances than those with no known associated sites. A stable population with a defended settlement may have been a necessity in order to first clear and then maintain an extensive area of agricultural land during this pre-Roman Iron Age period. Having a suitably defended refuge in times of attack may have encouraged a population to remain in one place rather than moving on in times of hardship.

8.5 Roman Period.

During the Roman occupation the pollen diagrams from Lochend Loch Bog, Lenzie Moss, and probably Gartlea Bog all reflect an extensively cleared landscape with pastoral agriculture being practised.

Walls Hill Bog shows woodland regeneration probably beginning before the Roman invasion and almost certainly before the construction of the Antonine Wall. During the Roman period the area around Walls Hill Bog returned to a densely wooded state with both canopy and understorey taxa present. Agricultural indicators are virtually absent from Walls Hill Bog during and after this period. The peat stratigraphy from this site shows that *Sphagnum* was still the dominant peat former and may suggest that this long period of woodland regeneration following the abandonment of agriculture continued because the surrounding land was too wet to farm effectively. The Walls Hill area shows no apparent impact by the Roman army on the surrounding vegetation. This is similar to the period of woodland regeneration noted by Whittington & Edwards (1993) at Black Loch, Fife and dated to 40 - 640 cal AD although this regeneration is attributed to the detrimental effect of the Roman invasion and occupation on agriculture in the area.

All the other study sites show an extensively cleared landscape throughout the Roman period. Lochend Loch Bog reflects a maintenance of clearance which had been initiated in the pre-Roman Iron Age whereas at Lenzie Moss and Gartlea Bog the extensive clearances may have begun slightly pre-Roman or during the Roman occupation and then continued for at least the duration of the Roman presence in the area. As was seen in the pre-Roman Iron Age the most important weedy herbaceous taxa present during these extensive clearance periods are *Plantago lanceolata*, *Ranunculus acris* type, *Rumex acetosa* group, *Artemisia* and Chenopodiaceae. Again this reflects a landscape of meadows and pastures with accompanying ruderal habitats. Cereal type pollen is present at very low levels at all three sites indicating that any arable agriculture was practised on a very small scale or some distance from the sites.

This pattern is similar to the clearances noted by Davies & Turner (1979) from several sites in Northumberland where the clearance was initiated in either the late pre-

Roman Iron Age or the beginning of the Roman period. The extensive clearances noted at Fozy Moss, near Hadrian's Wall by Dumayne *et al.* (1995) are later than at most other sites in the north of England and central and southern Scotland. The clearance at Fozy Moss is dated to 70 - 333 cal AD. Dumayne states that the greatest probability is for the date of clearance to be after 130 cal AD and therefore according to Dumayne apparently too late to be associated with the construction of Hadrian's Wall (126 - 130 AD). The use of radiocarbon dates in such a precise manner is not a valid argument although Dumayne then acknowledges that the date is imprecise and so the clearance could date from the construction of the Wall. However in a reverse of the above assertions it is then argued that because Hadrian's Wall was constructed in this period the extensive clearance must therefore date to this event. This assumes that only the construction of the Wall could have resulted in the clearances seen at Fozy Moss. This is also not a valid assumption and again falls into the trap of putting too much faith in being able to directly correlate a historical event with a vegetation event in a pollen diagram. All that can be said about Fozy Moss is that it was extensively cleared sometime during the Roman period and that perhaps the building of Hadrian's Wall may have contributed to the initiation of this clearance or have provided a reason for maintenance of an already cleared landscape.

Lochend Loch Bog, Lenzie Moss and Gartlea Bog all show significant increases in *Calluna vulgaris* during the Roman period. This may have been growing on the bogs but probably indicates that there were large areas of poor grassland which reverted to heathland or areas close to Roman sites which were for military reasons not used for agriculture but which were kept clear of woodland to provide clear lines of sight and therefore were colonised by *Calluna vulgaris* heathland. This is consistent with pollen evidence from rampart turves from Bearsden Roman fort on the Antonine Wall which show evidence of having been cut from a damp well-grazed pasture with significant patches of heather heathland (Dickson 1989). Pollen analysis of an old land surface from Wilderness Plantation, a minor enclosure on the Antonine Wall, suggested that the enclosure had actually been built on an area of open heather heathland (Newell 1983).

8.6 Dark Age and Viking Period.

During the Dark Ages all the sites show extensive woodland regeneration. This began sometime between 400 - 600 cal AD depending on the site. This implies that agriculture in the area did not collapse as a result of the Roman withdrawal but that woodland clearance was maintained for several centuries after the Roman army departed central Scotland. This is consistent with Turner's sites in north-east England where clearance was also maintained until one to two centuries after the Roman withdrawal suggesting a period of post-Roman economic stability. However at Fozy Moss (Dumayne & Barber 1994) regeneration begins after 370 cal AD and at Burnfoothill Moss (Tipping 1995) woodland begins to recover around 300 - 400 cal AD. Dumayne interprets the regeneration as being a result of the Roman withdrawal but Tipping is more cautious suggesting this as only a possible explanation.

For the sites in this study woodland regeneration began with *Betula* being the first coloniser of the previously farmed land. During this time evidence for agriculture, in particular *Plantago lanceolata, Ranunculus acris* type and *Rumex acetosa* group, declined significantly.

There is some evidence for an increase in bog surface wetness during this period from the peat stratigraphy at Lenzie Moss and Walls Hill Bog but this is by no means indicative of an overall deterioration in climate. If an increasingly wet climate was the reason for agricultural abandonment it should be reflected in all the peat stratigraphy diagrams. Wood (1991) tells of a plague which swept Europe in the mid fifth century AD which was comparable with the Black Death. This would have resulted in a fall in population and presumably a decline in agriculture. However the woodland regeneration period lasts for many hundreds of years, longer than the population would have taken to recover, suggesting that other factors were contributing to the lack of agriculture in the area.

The wooded landscape continued until around 800 cal AD (perhaps slightly earlier at Gartlea Bog) when there was another period of woodland clearance and subsequent agricultural activity. Again this was characterised by increases in Poaceae, *Plantago lanceolata* and the other common agricultural indicators including *Ranunculus acris* type, *Rumex acetosa* group and Chenopodiaceae. Cereal type pollen occurs at all the sites apart from Walls Hill Bog. At Walls Hill Bog, Lochend Loch Bog and Lenzie Moss this clearance phase lasts for only a few hundred years, until approximately 1000 cal AD or slightly later but there is little archaeological evidence to explain this period of increased agricultural activity. However during this period Christianity was spreading in Scotland with monasteries and churches being built. According to Driscoll (1991) these religious centres may have controlled and organised agriculture on the land surrounding them. This may have had the effect of increasing agriculture and therefore woodland clearance to provide more open land. This increased agriculture is seen first at Gartlea Bog where there is historical evidence for the founding of religious centres between 600 and 800 cal AD. Another explanation, put forward by Davies & Turner (1979) to explain extensive clearances in Northumberland during what they term the Scandinavian settlement period, is that, as a result of Viking attacks and settlement on land on the coast the native population may have moved inland and therefore have needed to clear significant areas of woodland to provide themselves with sufficient agricultural land. This explanation may well apply to this part of Scotland where there is evidence for Viking activity on the west coast but not inland.

8.7 Medieval and Post - Medieval Period.

The agricultural landscape around Gartlea was maintained from this period onwards until the present day but at the other three sites this clearance phase was short lived and woodland regeneration began again after approximately 1000 cal AD. There is no evidence for a deterioration in climate from the peat stratigraphy diagrams during this period and little historical evidence to explain why agriculture should have been abandoned again so soon. It is difficult to determine how long this period of woodland regeneration lasted because of the lack of radiocarbon dates for the topmost sections of the pollen profiles and the truncation of the bog surfaces. Clearance seems to have begun again after 1200 cal AD at Walls Hill Bog, sometime between 1300 - 1400 cal AD at Lenzie Moss and 1300 - 1600 cal AD at Lochend Loch Bog. The approximate nature of these dates makes it difficult to determine whether the Black Death and other outbreaks of plague in the 14th century had an effect on prolonging the decline in agriculture in this area. It seems that at Walls Hill Bog this was not the case as agriculture was expanding during this period. This more isolated area may have escaped the worst of these plague outbreaks.

Once woodland clearance had begun again at these sites the cleared landscape was maintained until the present day. The agriculture practised was still in the main pastoral but with an increased diversity of weedy herbaceous taxa present. Cereal type pollen is present at all the sites indicating that arable agriculture was being practised but probably on more fertile land away from the study sites.

The taxon which shows the greatest increase in this period is *Calluna vulgaris*. This may have been growing on the bogs themselves. All the bogs show evidence of drying out and thus providing a more suitable habitat for *Calluna*. There is also a general increase in burning near the tops of the profiles suggesting natural or man-made fires becoming more frequent on the bog surfaces.

Some of the sites show evidence for peat cutting and / or drainage and the drying out of the bog surfaces reflects the drastic effect that human interference has had on the raised bogs of west-central Scotland. The bogs are now growing only very slowly or not at all and unless the water balance is restored to these sites the topmost peat will continue to dry out and oxidise and in turn becoming more susceptible to burning which will in turn remove the top layers of peat.

Evidence from the topmost pollen samples shows evidence for some degree of tree planting with deciduous taxa such as *Fagus* and *Ulmus* seemingly preferred as well as the establishment of significant areas of coniferous plantations planted in the last one hundred to two hundred years.

9. CONCLUSIONS.

At the beginning of this study the aim was primarily to investigate the first extensive woodland clearances in west-central Scotland. These clearances were considered to have been carried out either in the late pre-Roman Iron Age or during the Roman occupation of central Scotland.

Sites were chosen to give a broad coverage of west-central Scotland with the added proviso that they were close to the Antonine Wall and/or a known native preferably dating to the Iron Age. By studying sites which meet these criteria and are accompanied by good radiocarbon controls it has been possible to provide an insight into clearance activity not only during the Iron Age and Roman periods but also in the Bronze Age and post Roman times. A study of the peat stratigraphy has provided additional evidence for changes in bog surface wetness and charcoal evidence was also considered in case fire had been used as a tool for clearance, even though this was considered unlikely. Absolute pollen analysis was also undertaken but the results obtained were difficult to interpret and seemed to be influenced more by the peat accumulation rate than the influx of pollen. As a result the pollen influx results have not been considered in the interpretations of the vegetation changes from these sites.

Recognisable clearance activity is first noted in the Bronze Age at Walls Hill Bog, where it takes the form of discrete small temporary clearance phases, and at Lochend Loch Bog where the increase in clearance is more gradual and is not restricted to short term periods of activity. The clearances are characterised by declines in tree taxa and increases primarily in herbaceous taxa associated with pastoral rather than arable agriculture.

Extensive clearance is most evident from the sites with associated Iron Age archaeological remains. Due to the imprecisions associated with radiocarbon dating it is not possible to determine exactly when these clearances began but at Lochend Loch Bog and Walls Hill Bog they were almost certainly initiated in the late pre-Roman Iron Age whereas at Lenzie Moss and Gartlea Bog it is possible that they may have begun during the Roman period. It does not necessarily follow that the clearances were the result of Roman labour or for Roman purposes.

Again the cleared land was used primarily for pastoral agriculture although there are also very small traces of cereal type pollen present during this period. During the periods of most extensive clearance there are corresponding increases in *Calluna vulgaris* at all the sites. This is considered to be the result of areas of heathland on poor soils or soils exhausted by agriculture.

The extensive clearance phase ends first at Walls Hill Bog probably still during the pre-Roman Iron Age. It is considered that this may have been a result of a deterioration in climate felt most strongly at this higher altitude site. It is unlikely that the abandonment of agriculture was due to the Roman invasion and the construction of the Antonine Wall but this can not be confirmed due to the errors associated with the radiocarbon dates.

Lochend Loch Bog, Lenzie Moss and Gartlea Bog remain cleared of woodland throughout the Roman period and it is not until 400 - 600 cal AD that agriculture again declined and woodland regeneration took place. This makes it unlikely that the Roman withdrawal was the cause of the decline in agriculture at these sites and there is no conclusive evidence to suggest that a deterioration in climate occurred during this period. It is possible that there was a decline in population as a result of a plague which swept Europe during this time but again this is not a wholly satisfactory explanation.

A further period of extensive clearance is noted at around 800 - 1000 cal AD (perhaps slightly earlier at Gartlea Bog). Again this clearance provided land for mainly pastoral agriculture although this agricultural activity is difficult to explain in terms of archaeological events. This activity occurred around the time that Christianity was spreading in Scotland with monasteries, missions and churches being established. These would have provided a focus for the community and may have organised and controlled agriculture on the land surrounding them. This may, in turn, have led to an expansion of clearance activity. Another explanation for the clearance seen during this period is that Viking attacks and settlement on the coasts of Scotland drove the native peoples inland and required them to clear tracts of woodland in order to meet their requirement for agricultural land.

A short period of woodland regeneration is seen at all sites, apart from Gartlea, before the more substantial clearances of the later Medieval and post-Medieval period. Again these cleared areas are used mainly for pastoral agriculture although there is slightly more evidence for arable agriculture than seen previously. Improvements in agricultural practices may have made it possible to grow cereals on land that had previously been unsuitable.

Calluna vulgaris pollen increases significantly during this period and probably reflects colonisation of the bog surface as a result of drainage, cutting and burning of parts of the bogs. Trees make a slight recovery in the last hundred years or so as a result of planting of both native and exotic taxa either as ornamentals or for timber.

The results from this study provide a detailed account of the impact people have had on the vegetation of west-central Scotland during the last 3000 years and hopefully they discount the widely held view that the first extensive woodland clearances in this area were a Roman phenomenon.

APPENDIX 1 : Old Loch

Introduction.

A lake site was also analysed during this study. Old Loch is situated < 1km from Lochend Loch Bog (see Fig. 4.7). It was hoped that these sites would both show regional pollen changes and that by comparing the pollen diagrams from the two sites it might have been possible to discount the effects of local pollen (from vegetation growing on the sites) to leave only the regional information.

Old Loch was sampled three times although only the last (and best) set of cores was analysed. A scaffolding platform was constructed on the shore, taken to the coring site and lowered into the water until it rested on the bed of the Loch. A Livingstone corer (1m long and 5cm in diameter) was used to collect the samples, using a plastic drainpipe as a guide for the corer. However none of the cores were more than 80-90% complete and as a result it was not possible to construct a continuous sediment profile. The site has not been included in the main study because of the difficulty in interpreting the pollen diagram.

The pollen diagram (Fig. A1) has not been zoned. The sample cores have been shown individually on the diagram and not as a complete sequence. In the discussion of this site each core is considered as a zone.

Sediment Stratigraphy.

Core Number	Depth (cm)	Troels-Smith Analysis			
1	0 - 35	As 2	Ld^3 2	Ag +	Dl +
	35 - 50	As 2	Dh 1	Dl 1	
	50 - 83	As 2	Ld^3 2	Ag +	
2	0 - 30	As 2	Ld^3 2		
	30 - 40	As 2	Dh2		
	40 - 81	As 2	Ld^3 2	Dl +	
3	0 - 89	As 2	Ld^3 2	Dl +	
4	0 - 40	As 2	Ld^3 2		
	40 - 77	As 1	Ld^3 3	Lso +	

Table A1 : Old Loch sediment stratigraphy

Discussion.

Core 4

The core is dominated by *Betula* and *Alnus* presumably growing round the loch, as they do today. *Quercus* is present at low levels. *Ulmus* is only present at < 1% and so it is likely that this core is post-Elm decline in age. Poaceae and Cyperaceae are present at moderate amounts but again may be reflecting vegetation growing around the loch margins. There are many other herbaceous taxa present but only *Plantago lanceolata* occurs at > 1%. The herbaceous taxa include many which are typical of open agricultural land. There is an occurrence of *Cannabis* type (probably *Cannabis sativa*) which is only present in the topmost zone of the Lochend Loch Bog diagram. This may suggest that this core, although from a depth of around 4m is relatively young and may date from the Medieval period.

Core 3

Betula and *Alnus* are still very high but *Quercus* has declined slightly. There is an increase in *Calluna vulgaris* and a slight increase in Poaceae. The commonest herb taxa in this zone are *Plantago lanceolata, Ranunculus acris* group and type, *Rumex acetosella,* Apiaceae, *Artemisia*, *Galium* type, Liguliflorae, *Rumex acetosa* group, *Aster* type and *Anthemis* type. These types indicate that there were significant areas of grassland present probably used for pasture although there is evidence for cereals as well. *Cannabis* type is again present.

Core 2

The main taxa are still *Betula* and *Alnus* but *Pinus* is now consistently present at > 1%. Herb taxa still include many indicators of pastoral agriculture. *Cannabis* type is no longer present.

Core 1

Betula and *Alnus* are still dominant and *Pinus* is again consistently present. The diversity of herb taxa has declined slightly. This may be an indicator of improvements in agriculture which reduced the weedy species present in pastoral grassland or cereal crops.

Conclusions.

The results of this study are difficult to interpret because there are only slight changes in the pollen taxa over the 4m depth. However there are indications that the bottom of the sequence may be relatively young i.e. Medieval, because of the *Cannabis* type present. The top two cores show increased levels of *Pinus* which may reflect planting of conifers from the 1800's onwards. There appears to have been mixing of the sediment causing a smoothing of the pollen curves making it difficult to detect any significant vegetation changes. There are indications of pastoral and arable agriculture being undertaken which would fit with the results obtained from Lochend Loch Bog.

Unfortunately this site has added little to the overall picture of changing vegetation in west-central Scotland.

APPENDIX 2 : Pollen Types

The following list details the genera and/or species within each pollen type/group referred to in this thesis. Most of the identifications were made using the keys (and hence the types) in Moore, Webb & Collinson (1991). Those types identified using *The Northwest European Pollen Flora* (Punt 1976-) are marked with "NW". Where the species nomenclature in Stace (1991) differs from that of the pollen keys the Stace nomenclature is given in brackets.

***Anthemis* type** - *Anthemis, Achillea, Leucanthemum, Chrysanthemum, Tanacetum, Chamaemelum, Otanthus, Cotula, Matricaria.*

***Aster* type** - *Bidens, Galinosoga, Filago, Gnaphalium, Senecio, Tussilago, Petasites, Antennaria, Anaphalis, Inula, Conyza, Pulicaria, Solidago, Bellis, Aster, Arnica, Erigeron, Eupatorium, Carduus* and possibly more.

***Caltha* type** - *Caltha, Aquilegia*

***Cannabis* type** - *Cannabis sativa, Humulus lupulus*

***Centaurea nigra* type** - *C. nigra, C. nemoralis.*

***Cerastium* type** - includes *Cerastium*, most species of *Stellaria, Moenchia erecta, Holosteum umbellatum* and *Myosoton aquaticum.*

***Chamerion angustifolium* type** - was *Chamaenerion angustifolium* type in Moore, Webb & Collinson (1991) and includes *Chamerion, Oenothera* (not native in NW Europe) and occasional grains of *Epilobium.*

Coryloid - *Corylus avellana, Myrica gale.*

***Drosera rotundifolia* type** - *D. rotundifolia, D. anglica.*

***Galium* type** - *Galium, Asperula, Rubia* and *Sherardia.*

Hornungia type - group of Brassicaceae which includes many small weedy species as well as rarer plants. e.g. *Alyssum*, *Arabis glabra*, *A. hirsuta*, *Arabidopsis suecica*, *A. thaliana*, *Berteroa incana*, *Capsella bursa-pastoris*, *Cardamine amara*, *C. impatiens*, *Cardaria draba* (now *Lepidium draba*), *Descurainia sophia*, *Hornungia petraea*, *Lepidium campestre*, *L. densiflorum* (now *L. virginicum*), *Thlaspi alpestre* (now *T. caerulescens*), *T. arvense* and probably many more.

***Ilex* type** - *Ilex* and *Nemopanthus* (not native to NW Europe)

Liguliflorae - subfamily of Asteraceae (now called Lactucoideae by Stace (1991) and Lactuceae by Moore, Webb & Collinson (1991))

***Lotus* type** - *Lotus* and *Tetragonolobus*.

***Lysimachia vulgaris* type** - *L. vulgaris*, *L. thyrsiflora*, *L. nummularia*, *L. punctata*.

***Mentha* type** - *Mentha*, *Lycopus*, *Thymus*, *Origanum*, *Clinopodium*, *Acinos*, and possibly others.

***Nymphaea alba* type** - *Nymphaea alba*, *N. candida*.

Poaceae (A>8μm, D>37μm) - those Poaceae pollen grains most likely to have come from cereal crops.

***Polygonum aviculare* type** - *P. aviculare*, *P. arenastrum*, *P. boreale*, *P. maritimum*, *P. oxyspermum*, *P. patulum* and *P. rurivagum*.

***Polypodium vulgare* type** - *P. vulgare*, *P. australe* (now *P. cambricum*) and *P. interjectum*.

***Potentilla* type** - *Potentilla*, *Sibbaldia* and *Fragaria*.

***Ranunculus acris* type** (NW) - split into the following groups (only those groups found during this study have been further described) :-

***Anemone nemorosa* group** - *A. nemorosa, A. apennina, A. ranunculoides, A. sylvestris.*

***Clematis vitalba* group**

***Pulsatilla vulgaris* group**

***Ranunculus acris* group** - *R. acris, R. bulbosus, R. illyricus, R. lanuginosus, R. monspeliacus, R. muricatus, R. nemorosus, R. paludosus, R. polyanthemos, R. repens, R. sardous, R. trilobus.*

***Ranunculus aquatilus* group**

***Ranunculus auricomus* group**

***Ranunculus flammula* group**

***Ranunculus glacialis* group**

***Ranunculus ficaria* group** - *Ranunculus ficaria*

***Ranunculus lingua* group**

***Ranunculus nivalis* group**

***Ranunculus sceleratus* group**

Rumex acetosa type (NW) - splits into the following groups and species :-

Rumex alpestris

Rumex triangulivalvis

Rumex crispus (p.p.)

***Rumex acetosa* group** - *R. acetosa, R. thyrsiflorus*

***Rumex sanguineus* group** - *R. bucephalophorus, R. rupestris, R. sanguineus, R. crispus* (p.p.)

***Rumex conglomeratus* group** - *R. conglomeratus, R. maritimus, R. pulcher, R. scutatus.*

Rumex acetosella

Oxyria digyna

***Rumex aquaticus* group** - *R. aquaticus*, *R. hydrolapathum*

***Rumex palustris* group** - *R. palustris*, *R. patientia* (p.p.), *Rumex crispus* (p.p.)

***Rumex obtusifolius* group** - *R. longifolius*, *R. obtusifolius*, *R. patientia* (p.p.), *R. crispus* (rarely).

***Silene dioica* type** - includes *S. dioica*, *S. noctiflora*, *S. gallica*, and possibly others.

***Sinapis* type** - all the remaining Brassicaceae not covered by *Hornungia* type, i.e. *Alliaria*, *Arabis alpina*, *Armoracia*, *Barbarea*, *Braja linearis*, *Brassica*, *Bunis*, *Cakile*, *Camelina microcarpa*, *Cardamine bulbifera*, *C. flexuosa*, *C. pratensis*, *Cardaminopsis arenosa* (now *Arabis arenosa*), *Cochlearia*, *Crambe*, *Diplotaxis*, *Draba*, *Erophila*, *Erucastrum*, *Erysimum*, *Isatis*, *Lepidium latifolium*, *L. ruderale*, *Lunaria*, *Matthiola*, *Raphanus*, *Rorippa*, *Sinapis*, *Sisymbrium*, *Subularia*, *Teesdalia*, possibly more.

***Sorbus* type** - *Malus sylvestris*, *Pyrus pyraster*, *Sorbus aucuparia*, *S. rupicola*, *S. torminalis* and possibly other *Sorbus* subspecies.

***Spergula* type** - *Spergula*, *Spergularia*, *Polycarpon*.

Tricolporate - *Betula*, *Corylus avellana*, *Myrica gale*

***Trifolium* type** - *T. pratense*, *T. repens*, *T. scabrum*, *T. squamosum*, *T. incarnatum*, *T. medium*, *T. fragiferum*, *T. striatum*, *T. subterraneum*, *T. campestre*, *T. arvense*, *T. dubium*, *T. micranthum*, *T. badium*, *T. montanum*, *T. hybridum*, *T. ornithopodioides*, *Medicago lupulina*, *M. minima* and possibly *M. polymorpha* and *M. arabica*.

Tubuliflorae - subfamily of Asteraceae (now called Asteroideae by Stace (1991))

***Veronica* type** - most *Veronica* species, *Odontites* and *Lamium album*.

***Vicia* type** - *V. sylvatica*, *V. hirsuta*, *V. sativa*, *V. faba*, *V. sepium*, *V. lutea*, *V. orobus*, *V. tetrasperma*, *Lathyrus sylvestris*, *L. japonicus*, *L. pratensis*, *L. montanus* (now *L. linifolius*) *L. palustris*, *L. nissolia* and possibly introduced *Lupinus* and *Lathyrus* species.

APPENDIX 3 : Stratigraphy Symbols Key

The stratigraphy of each core is described using the nomenclature and symbols of Troels-Smith (1955). The humicity of each part of the deposit is represented by the thickness of the line used to draw the symbols, with increasing line thickness corresponding to increasing humicity. The density of symbols for each element in the deposit corresponds with the proportion of that element in the deposit. A summary of the Troels-Smith nomenclature and symbols follows.

Sh1 Substantia humosa - very humified organic matter without any microscopic structure.

Sh2

Sh3

Sh4

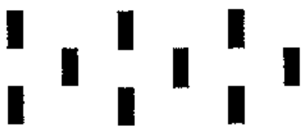
Tb (sphagni)1 Turfa bryophytica (sphagni) - *Sphagnum* moss peat

Tb2

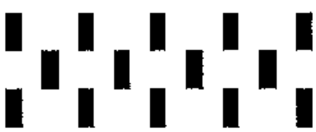
Tb3

Tb4

Th1 Turfa herbacea - herbaceous peat (in this study the main component of the herbaceous peat was *Eriophorum*)



Th2



Th3

Th4

Other Troels-Smith abbreviations used in describing the deposits studied during the course of this work are :

As Argilla steatodes - mineral particles < 0.002mm.

Ag Argilla granosa - mineral particles in the range 0.002 - 0.06mm.

Dl Detritus lignosus - fragments of wood and bark > 2mm.

Dh Detritus herbosus - fragments of herbaceous plants or parts of plants > 2mm.

Ld Limus detrituosus - mudlike, homogeneous soil consisting of more or less decomposed micro-organisms or parts of higher plants < 0.1mm.

Lso Limus siliceus organogenes - homogeneous deposit consisting of siliceous plants or animals. Skeletons of diatoms are the most common example.

REFERENCES.

Barber, K.E. (1981). *Peat stratigraphy and climatic change.* A.A. Balkema, Rotterdam.

Behre, K.E. (1988). The role of man in European vegetation history. In Huntley, B. & Webb, T. (eds.) *Vegetation History*. Kluwer Academic Publishers, Dordrecht.

Bennett, K.D. (1989). A provisional map of forest types for the British Isles 5000 Years ago. *Journal of Quaternary Science*. **4 (2)**, 141-144.

Benninghoff, W.S. (1962). Calculation of pollen and spore density in sediments by addition of exotic pollen in known quantities. *Pollen Spores*. **4**, 332-333.

Bonny, A.P. (1972). A method for determining absolute pollen frequencies in lake sediments. *New Phytologist*. **71**, 393-405.

Birks, H.J.B. (1988). Long-term change in the British Uplands. In B.M. Usher & Thompson, D.B.A. (eds) *Ecological Change in the British Uplands*. Blackwell, Oxford.

Birks, H.J.B. (1989). Holocene isochrone maps and patterns of tree spreading in the British Isles. *Journal of Biogeography*. **16**, 503-540.

Birks, H.J.B. & Birks, H.H. (1980). *Quaternary Palaeoecology*. Edward Arnold Ltd., London.

Boyd, W.E. (1984a). Environmental change and Iron Age land management in the area of the Antonine Wall, Central Scotland: A summary. *Glasgow Archaeological Journal*. **11**, 75-81.

Boyd, W.E. (1984b). Prehistoric hedges: Roman Iron Age hedges from Barhill. Scottish *Archaeological Review*. **3 (1)**, 32-34.

Boyd, W.E. (1985). Palaeobotanical evidence from Mollins. *Britannia*. **16**, 37-48.

Brooks, D. & Thomas, K.W. (1967). The distribution of grains on microscope slides. I. The non-randomness of the distribution. *Pollen Spores.* **9**, 621-629.

Davies, G. & Turner, J. (1979). Pollen diagrams from Northumberland. *New Phytologist.* **82**, 783-804.

Dickson, C.A. (1989). The Roman army in Britain and Germany. *Archäobotanik Dissertationes Botanicae.* **133**, 135-154.

Dickson, C.A. (1989). The Roman Army diet in Britain and Germany. *Archäobotanik Dissertationes Botanicae.* **133**, 135-154.

Dickson, C.A. (1991). Memoirs of a Midden Mavis: The study of ancient diets and environments from plant remains. *Glasgow Naturalist.* **22 (I)**, 65-76.

Dickson, C.A. & Dickson, J.H. (1988). The diet of the Roman Army in deforested central Scotland. *Plants Today.* **July-Aug.**, 121-126.

Dickson, J.H. (1988). Post-glacial pine stumps in central Scotland. *Scottish Forestry.* **42(3)**, 192-199.

Dickson, J.H. (1991). *Wild Plants of Glasgow.* Aberdeen University Press, Aberdeen.

Dickson, J.H. (1992). Scottish Woodlands: Their Ancient Past and Precarious Present. *Botanical Journal of Scotland.* **46 (2)**, 155-165.

Dickson, J.H., Dickson, C.A., Boyd, W.E., Newell, P.J. & Robinson, D.E. (1985). The vegetation of Central Scotland in Roman times. *Ecologia Mediterranea.* **XI**, 1.

Dickson, J.H., Stewart, D.A., Thompson, R., Turner, G., Baxter, M.S., Drndarsky, N.D. & Rose, J. (1978). Palynology, palaeomagnetism and radiometric dating of Flandrian marine and freshwater sediments of Loch Lomond. *Nature.* **274**, 548-553.

Donaldson, A.M. & Turner, J. (1977). A pollen diagram from Hallowell Moss, near Durham City, UK *Journal of Biogeography.* **4**, 25-33.

Driscoll, S.T. (1991). The archaeology of state formation in Scotland. In W.S. Hanson & E.A. Slater (eds). *Scottish Archaeology: New Perceptions.* Aberdeen University Press, Aberdeen.

Dumayne, L. (1992). *Late Holocene Palaeoecology and Human Impact on the Environment of North Britain.* Unpublished Ph.D. Thesis, University of Southampton.

Dumayne, L. (1993a). Invader or native?-vegetation clearance in northern Britain during the Romano-British time. *Vegetation History and Archaeobotany.* **2**, 29-36.

Dumayne, L. (1993b). Iron Age and Roman vegetation clearance in northern Britain.: further evidence. *Botanical Journal of Scotland.* **46**, 385-392.

Dumayne, L. & Barber, K.E. (1994). The impact of the Romans on the environment of northern England : pollen data from three sites close to Hadrian's Wall. *The Holocene.* **4(2)**, 165-173.

Dumayne, L., Stoneman, R., Barber, K.E. & Harkness, D. (1995). Problems associated with correlating radiocarbon-dated pollen diagrams with historical events. *The Holocene.* **5**, 118-123.

Edwards, K.J. (1981). The separation of Corylus and Myrica pollen in modern and fossil samples. *Pollen et Spores.* **22(2)**, 205-218.

Evans, A.T. & Moore, P.D. (1985). Surface pollen studies of Calluna vulgaris (L.) Hull and their relevance to the interpretation of bog and moorland pollen diagrams. *Circaea.* **3(3)**, 173-178.

Feachem, R. (1963). *A Guide to Prehistoric Scotland.* B.T. Batsford Ltd., London.

Grime, J.P., Hodgson, J.G. & Hunt, R. (1988). *Comparative Plant Ecology.* Unwin Hyman, London.

Grimm, E. (1991). *TILIA and TILIA.GRAPH.* Illinois State Museum, Illinois.

Hanson, W.S. & Breeze, D.J. (1991). The future of Roman Scotland. In W.S. Hanson & E.A. Slater (eds). *Scottish Archaeology: New Perceptions.* Aberdeen University Press, Aberdeen.

Hanson, W.S. & Maxwell, G.S. (1983). Minor enclosures on the Antonine Wall at Wilderness Plantation. *Britannia.* **14**, 227-243.

Idle, E.T. (1974). Land Use. In *A Natural History of Loch Lomond.* University of Glasgow Press, Glasgow.

Jacobsen, G.L. & Bradshaw, R.H.W. (1981). The selection of sites for palaeovegetational studies. *Quaternary Research.* **16**, 80-96.

Jowsey, P.C. (1966). An improved peat sampler. *New Phytologist.* **65**, 245-248.

Lamb, H.H. (1977). The late Quaternary history of the climate of the British Isles. In F.W. Shotton (ed) British Quaternary Studies. Clarendon Press, Oxford. pp 283-208.

Matthews, J. (1969). The assessment of a method for the determination of absolute pollen frequencies. *New Phytologist.* **68**, 161-166.

Maxwell, G.S. (1983). *Rome's north-west frontier.* Edinburgh University Press, Edinburgh.

McVean, D.N. & Ratcliffe, D.A. (1962). *Plant communities of the Scottish Highlands.* HMSO, London.

Monteith, J. (1932). The Crannog at Lochend, Coatbridge. *Transactions of the Glasgow Archaeological Society.* **XI (I)**, 26-43.

Moore, P.D. (1992). The value of pollen analysis in elucidating the Iron Age and Roman Environment in Southern Britain. *Anthrop. Anz.* **50(3)**, 191-199.

Moore, P.D., Webb, J.A. & Collinson, M.E. (1991). *Pollen Analysis*. 2nd edition. Blackwell Scientific Publications, Oxford.

Morrison, A. (1974). Archaeology. In *A Natural History of Loch Lomond.* University of Glasgow Press, Glasgow.

Newall, F. (1960). *Excavations at Walls Hill Fort, Renfrewshire*. Paisley Museum.

Newell, P.J. (1983). Pollen Analysis Report. In Hanson, W.S. & Maxwell, G.S. (1983). Minor Enclosures on the Antonine Wall at Wilderness Plantation. *Britannia*. **14**, 227-243.

Peden, A. (1992). *The Monklands - An Illustrated Architectural Guide*. Royal Incorporation of Architects, Glasgow.

Peglar, S.M. (1993). The mid-Holocene *Ulmus* decline at Diss Mere, Norfolk, UK: a year-by-year pollen stratigraphy from annual laminations. *The Holocene*. **3(1)**, 1-13.

Peglar, S.M. & Birks, H.J.B. (1993). The mid-Holocene *Ulmus* fall at Diss Mere, south-east England - disease and human impact? *Vegetation History and Archaeobotany*. **2**, 61-68.

Pennington, W. & Bonney, A.P. (1970). Absolute pollen diagrams from the British late-glacial. *Nature*. **226**, 871-872.

Pollard, A. (1991). *Archaeological survey and environmental assessment of the area adjacent to Whittliemuir / Midton reservoir, Howwood, Renfrewshire*. APG Report No. 41.2. University of Glasgow, Glasgow.

Punt, W. (1976 -). *The Northwest European Pollen Flora*. Vol. 1-6. Elsevier, Amsterdam.

Rackham, O. (1994). *The Illustrated History of the Countryside*. Weidenfeld & Nicolson Ltd., London.

Ramsay, S. (1991). *Palaeoecology of Ancient Pine Stumps in Central Scotland.* Unpublished B.Sc. Thesis, University of Glasgow.

R.C.A.H.M.S. (1978). *Lanarkshire: an Inventory of the Prehistoric and Roman Monuments*. Edinburgh.

Ritchie, G. & Ritchie, A. (1991). *Scotland: Archaeology and early history.* Edinburgh University Press, Edinburgh.

Rowell, T.K. & Turner, J. (1985). Litho-, humic-, and pollen stratigraphy at Quick Moss, Northumberland. *Journal of Ecology*. **73**, 11-25.

Scott, J.G. (1967). *Regional archaeologies: South-West Scotland.* Heinemann Educational Books Ltd., London.

Stace, C. (1991). *New Flora of the British Isles.* Cambridge University Press, Cambridge.

Stockmarr, J. (1971) Tablets with spores used in absolute pollen analysis. *Pollen Spores*. 13, 614-621.

Tauber, H. (1965). Differential pollen dispersion and the interpretation of pollen diagrams. *Danmarks Geologiske Undersøgelse Series II*. **89**, 1-69.

Tipping, R. (1995). Holocene evolution of a lowland Scottish landscape: Kirkpatrick Fleming. Part II, regional vegetation and land-use change. *The Holocene*. **5(1)**, 83-96.

Troels-Smith, J. (1955). Karakterisering af løse Jordater. Characterisation of unconsolidated sediments. *Danmarks Geologiske Undersogelse (ser. IV).* **3 (10)**, 1-73.

Turner, J. (1965). A contribution to the history of forest clearance. *Proceedings of the Royal Society.* **B. 161**, 343-354.

Turner, J. (1975). The evidence for land use by the prehistoric farming communities: the use of three-dimensional pollen diagrams. In. Evans, J.G. & Limbrey, S. (eds.) *The Effect of Man on the Landscape: Highland Zone.* C.B.A. pp.86-95.

Turner, J. (1979). The environment of northeast England during Roman times as shown by pollen analysis. *Journal of Archaeological Science.* **6**, 285-290.

Van der Veen, M. (1992). *Crop husbandry regimes: an archaeobotanical study of farming in northern England, 1000 BC - AD 500.* Sheffield Archaeological Monographs 3. J.R. Collis, Sheffield.

Whittington, G. & Edwards, K.J. (1993). *Ubi solitudinem faciunt pacem appellant:* the Romans in Scotland, a Palaeoenvironmental Contribution. *Britannia.* **24**, 13-25.

Whittington, G., Edwards, K.J. & Cundill, P.R. (1990). *Palaeoenvironmental Investigations at Black Loch, in the Ochil Hills of Fife, Scotland.* O'Dell Memorial Monograph no.22. Dept. of Geography, University of Aberdeen.

Whittington, G., Edwards, K.J. & Cundill, P.R. (1991). Late- and post-glacial vegetational change at Black Loch, Fife, eastern Scotland - a multiple core approach. *New Phytologist.* **118**, 147-166.

Whittington, G. & Gordon, A.D. (1987). The differentiation of the pollen of *Cannabis sativa* from *Humulus lupulus. Pollen et Spores.* **29(1)**, 111-120.

Wood, M. (1991). *In Search of the Dark Ages*. BBC Books, London.

Vorren, K.-D. (1986). The impact of early agriculture on the vegetation of Northern Norway: A discussion of anthropogenic indicators in biostratigraphical data. In K.-E. Behre (ed) *Anthropogenic Indicators in Pollen Diagrams*. Balkema, Rotterdam.

Fig. 4.5 WALLS HILL BOG

Sum = Non Mire Pollen

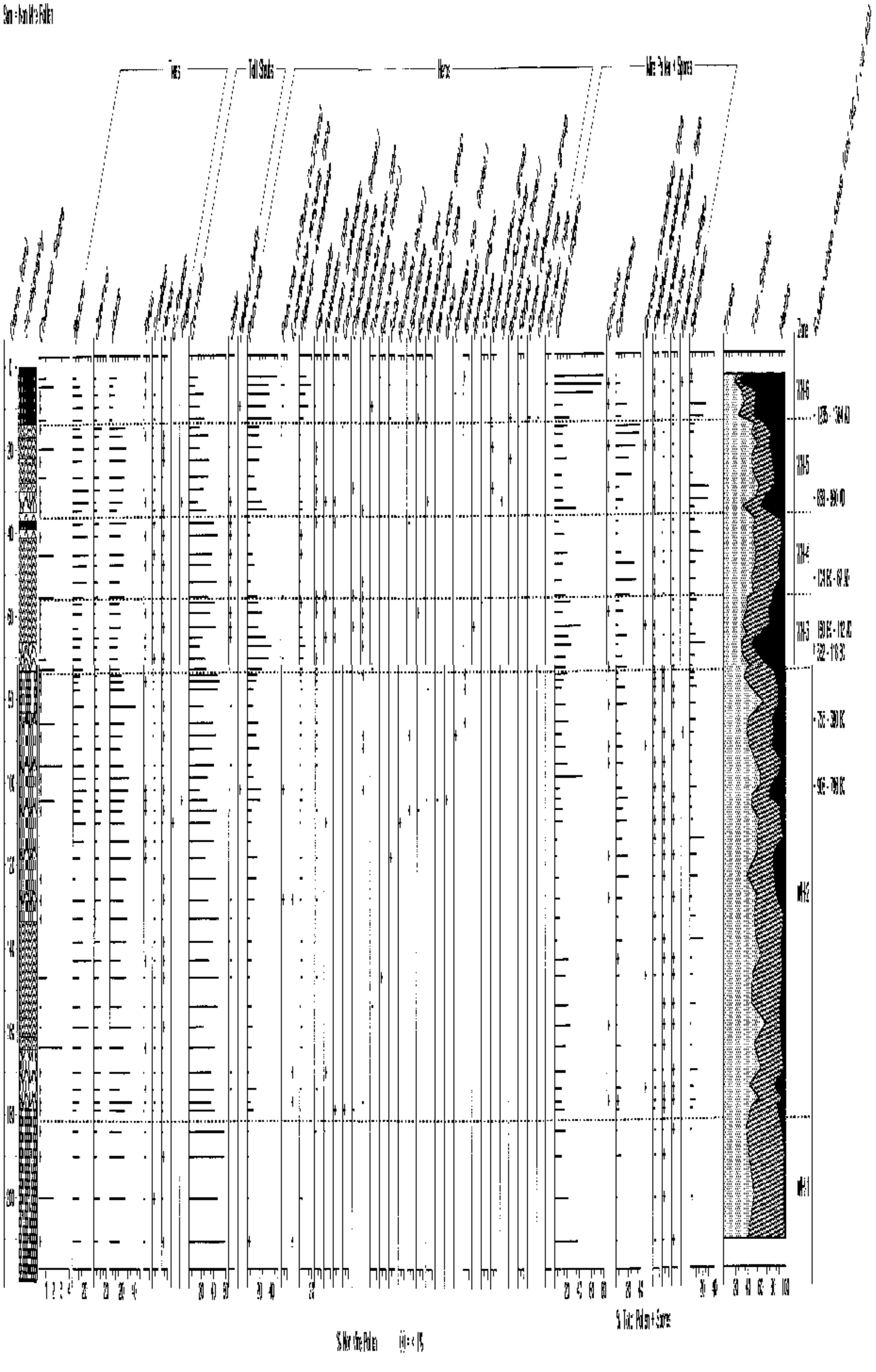


Fig. 4.7 WALLS HILL BOG
Pollen influx diagram

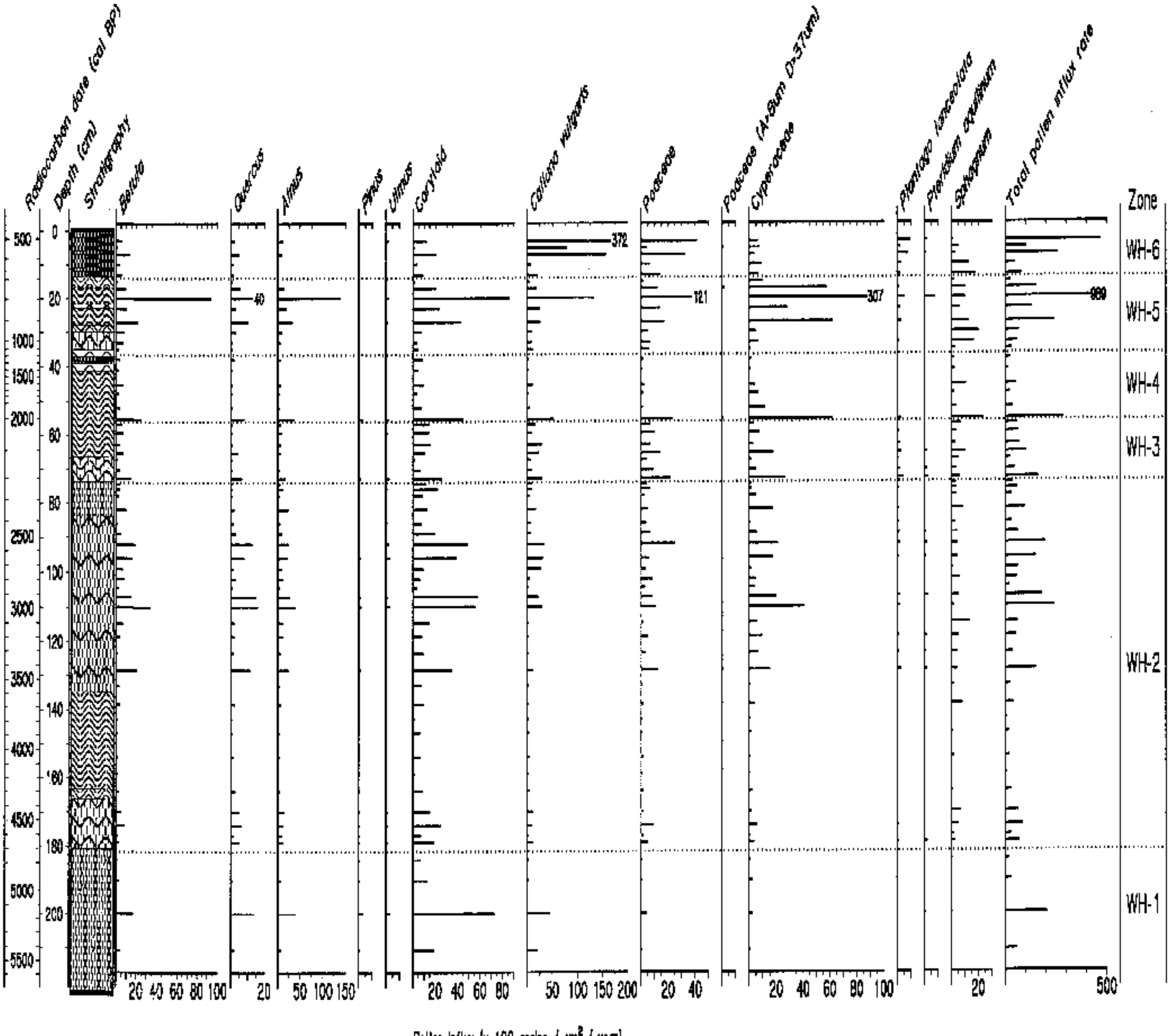
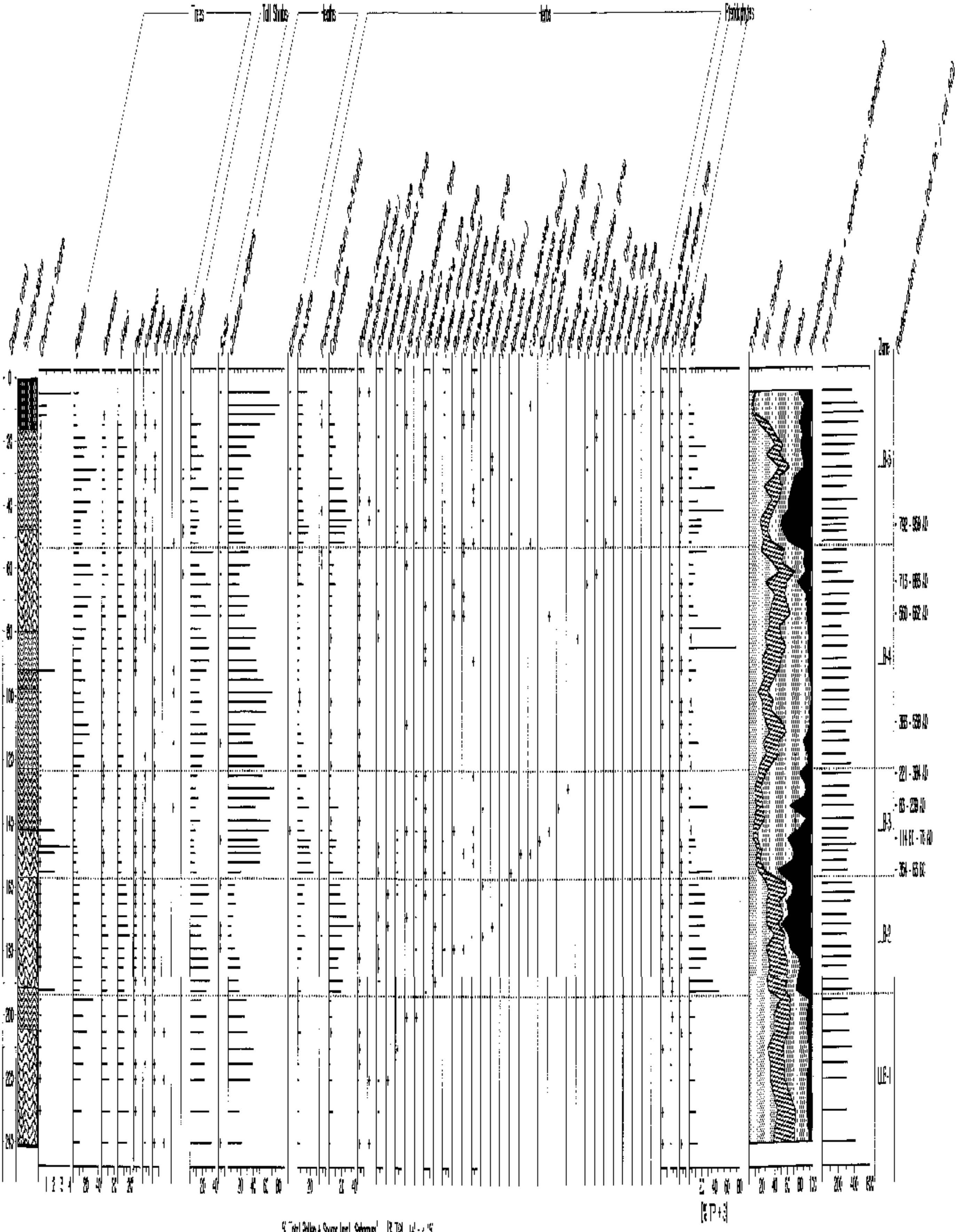


Fig. 5.3 LOCHEND LOCH BOG

Sum = Total Pollen + Spores (excl. Sphagnum)



% Total Pollen + Spores (excl. Sphagnum) (% TP) (+) = < 1%

Fig. 5.4 LOCHEND LOCH BOG

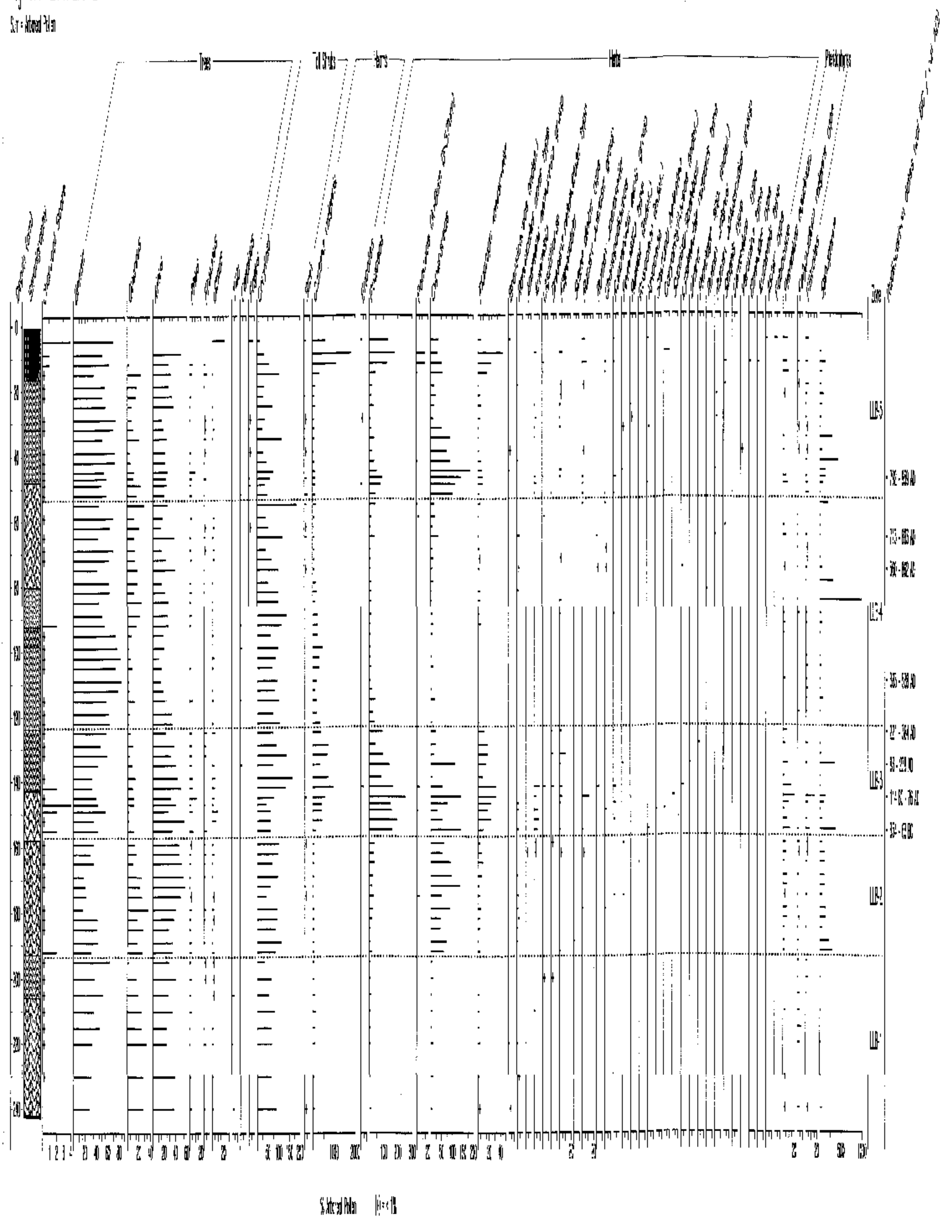


Fig. 5.5 LOC-END LOCH BOG

Sum = Non Mire Pollen

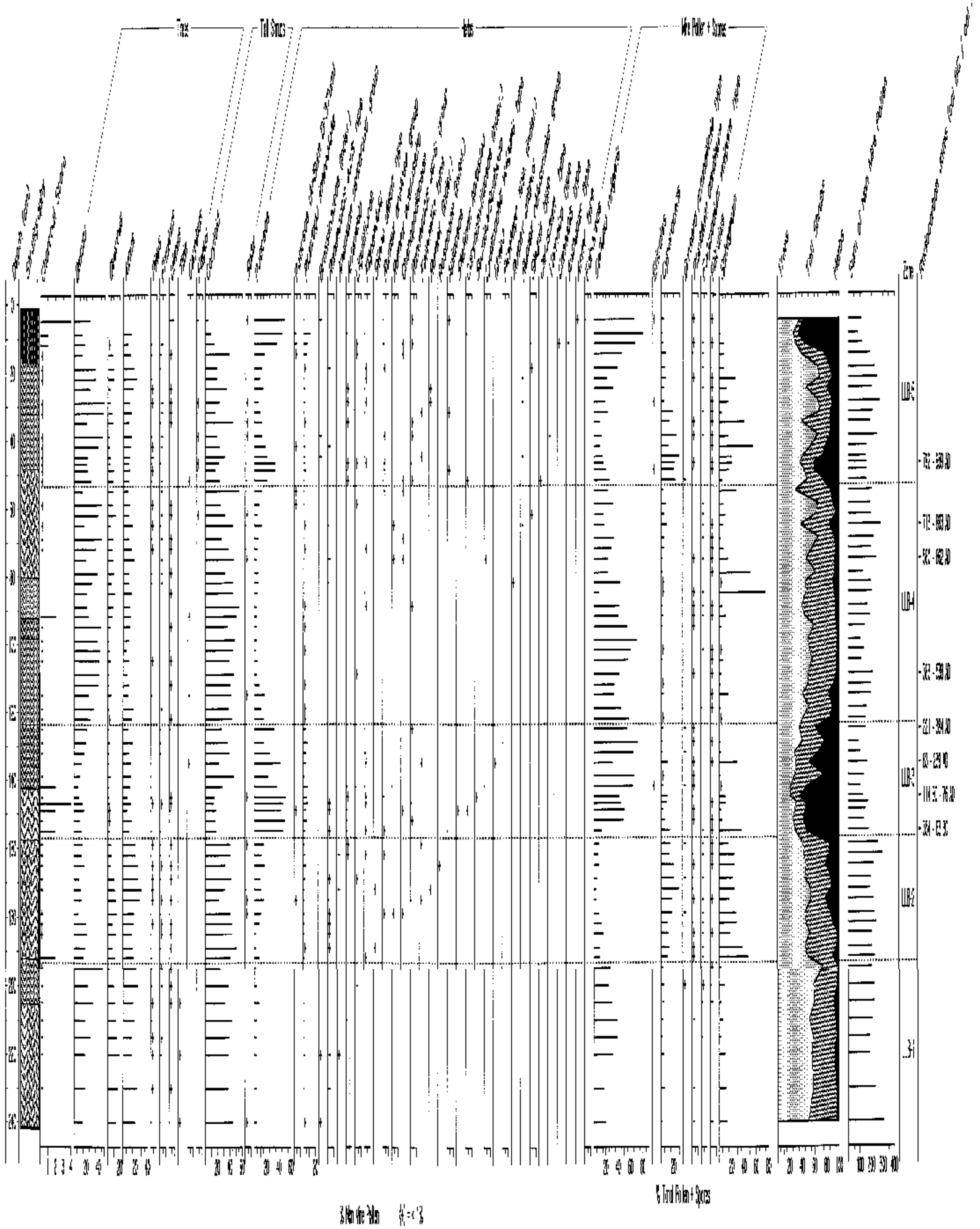
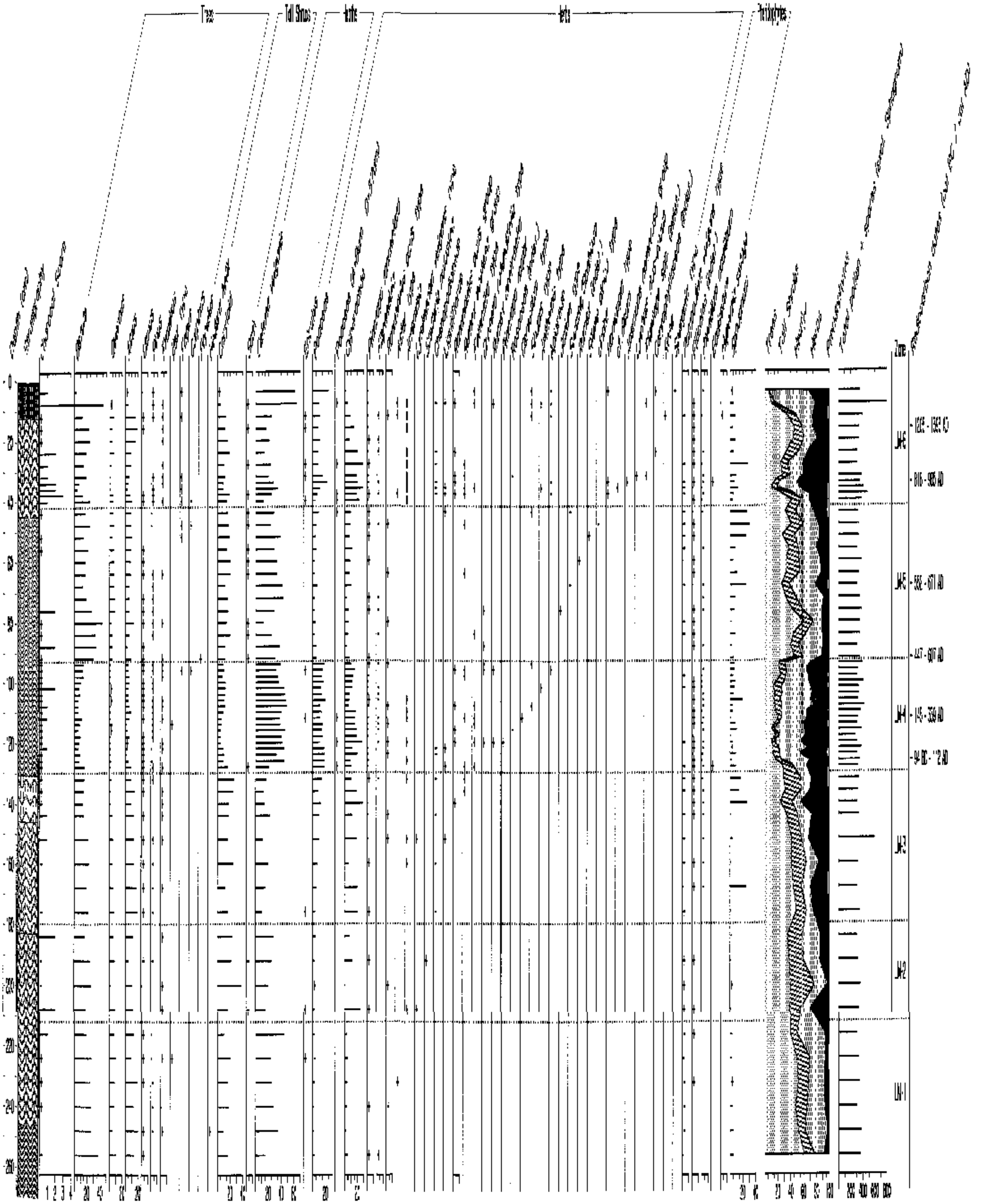


Fig. 6.3 LENZIE MOSS

Sum = Total Pollen (excl. Sphagnum)



% Total Pollen + Spores (excl. Sphagnum) (% TP) (+) = 1%

Fig. 6.4 LENZIE MOSS

Sum = Arboreal Pollen

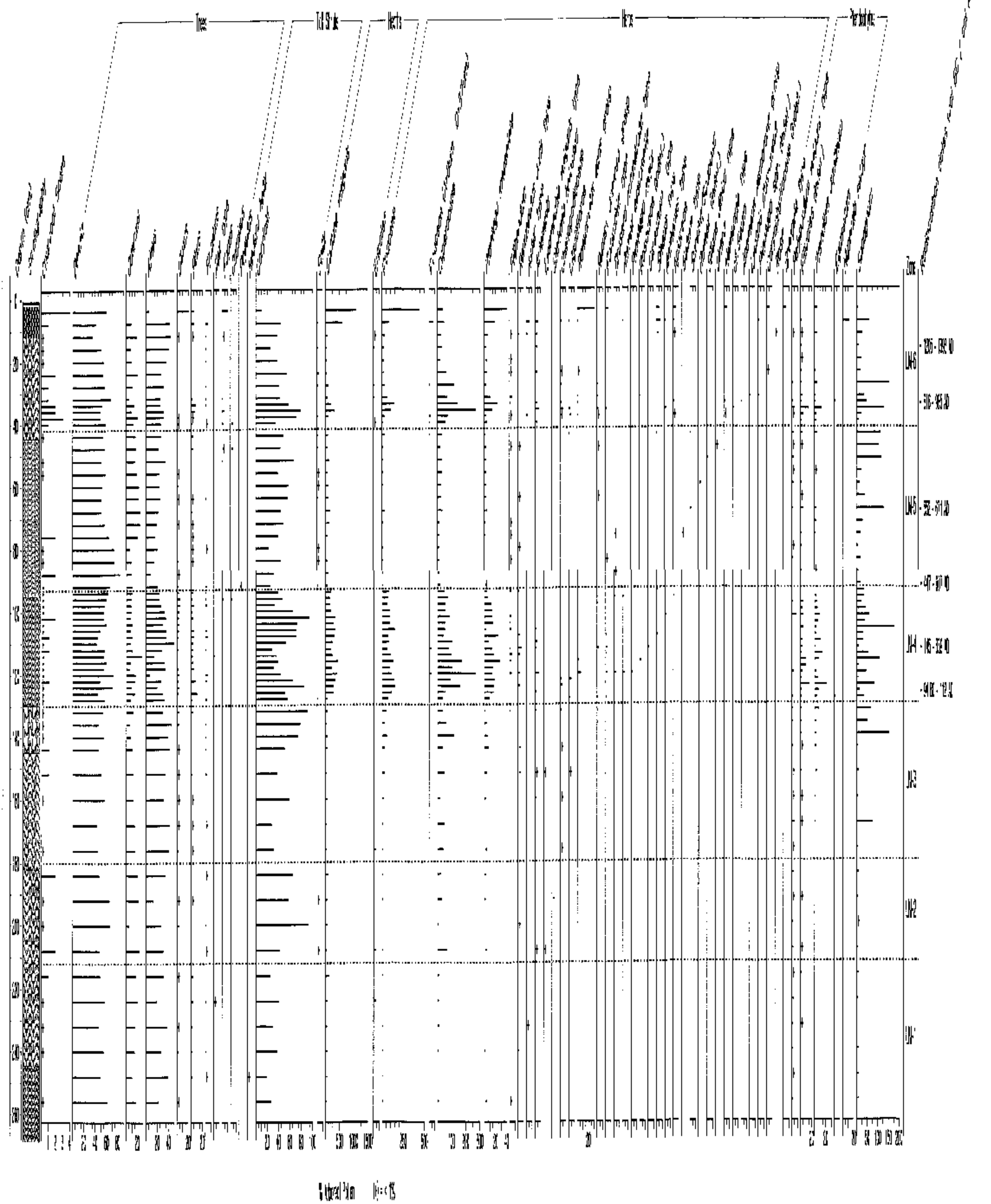


Fig. 6.5 LENZIE MOSS

Sum = Non Mire Pollen

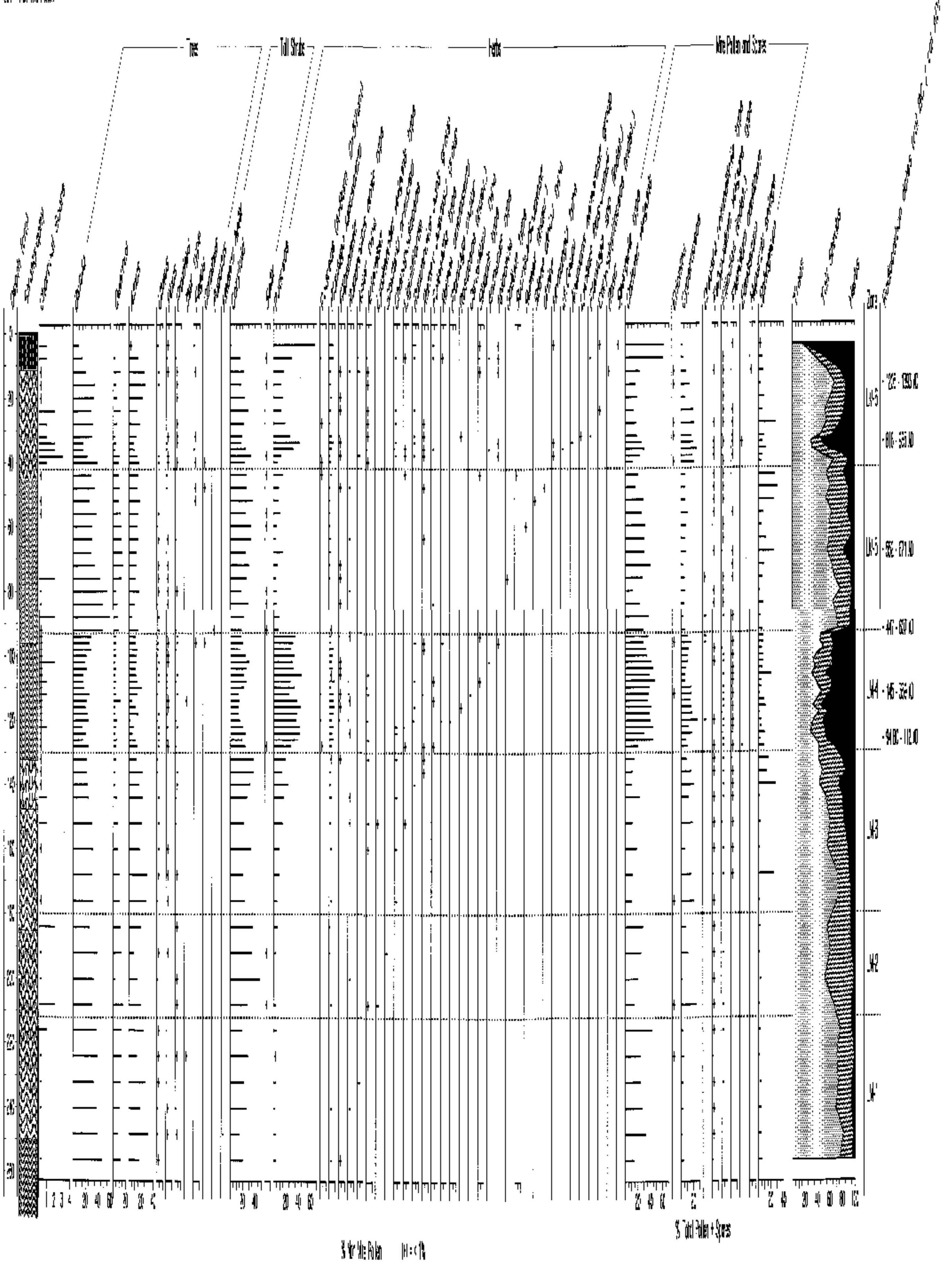
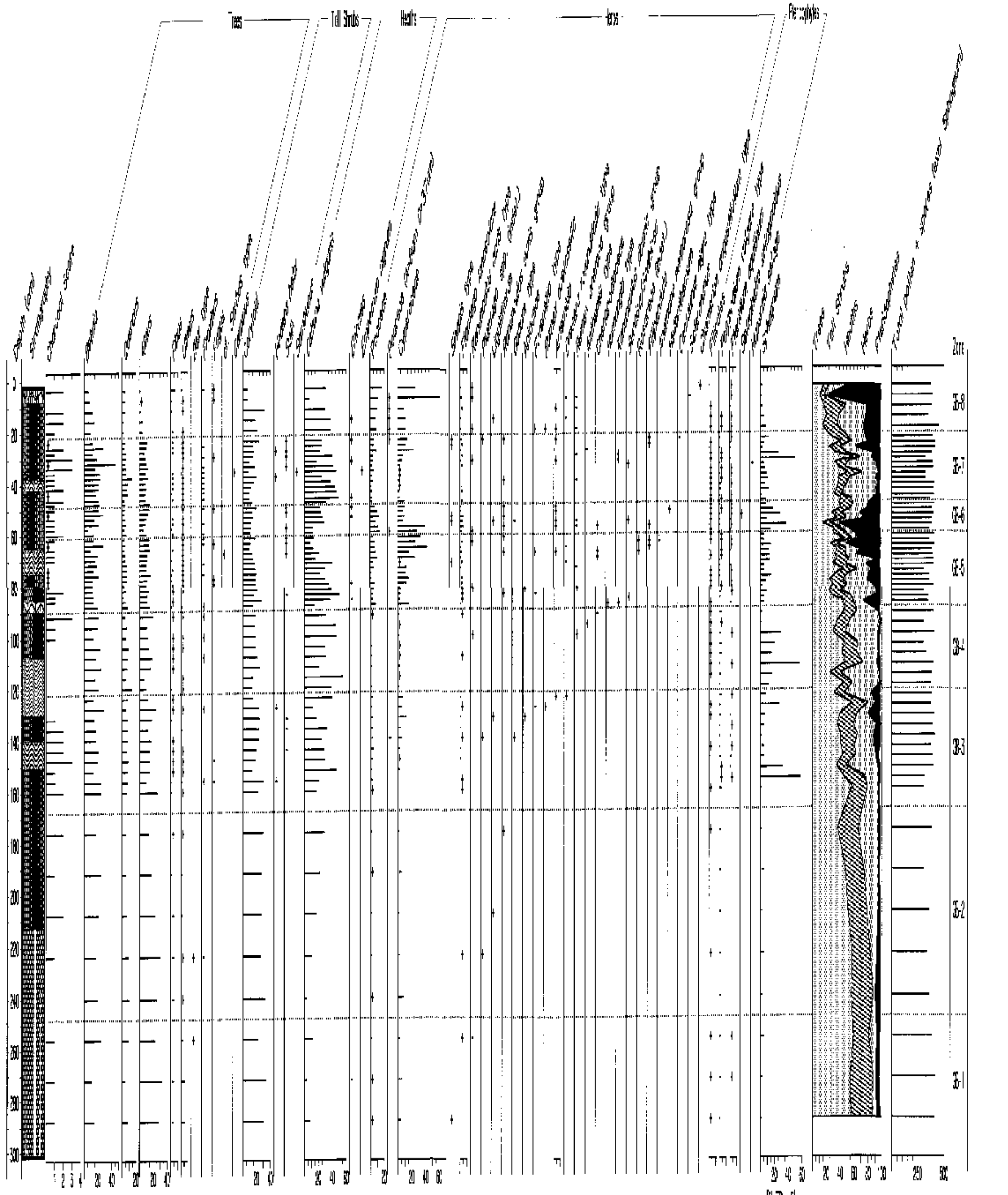


Fig. 7.3 GARTLEA BOG

Sum = Total Pollen + Spores (excl. Sphagnum)



% Total Pollen + Spores (excl. Sphagnum) [% TP] (+) = < 1%

Fig. 7.4 GARTLEA BOG

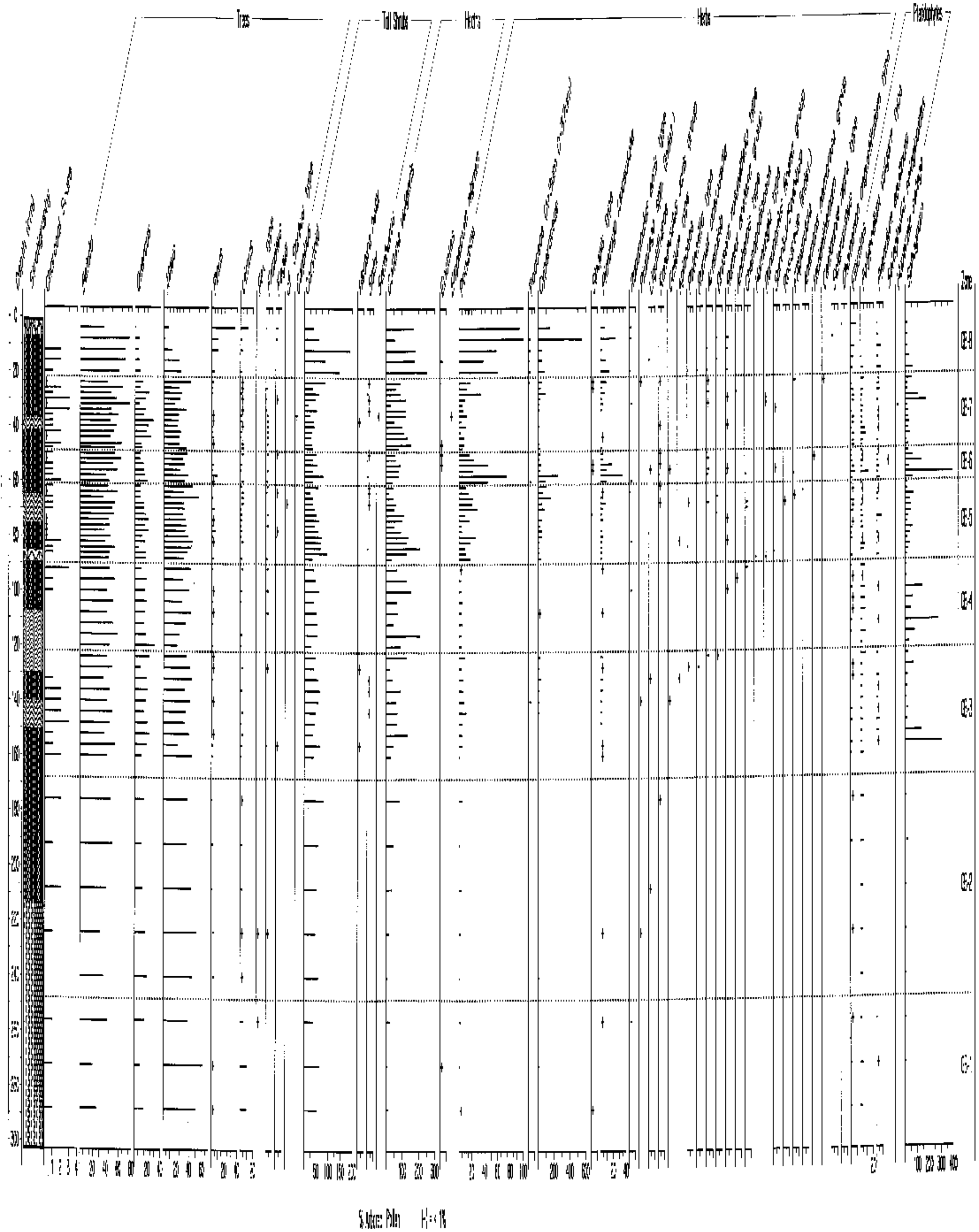
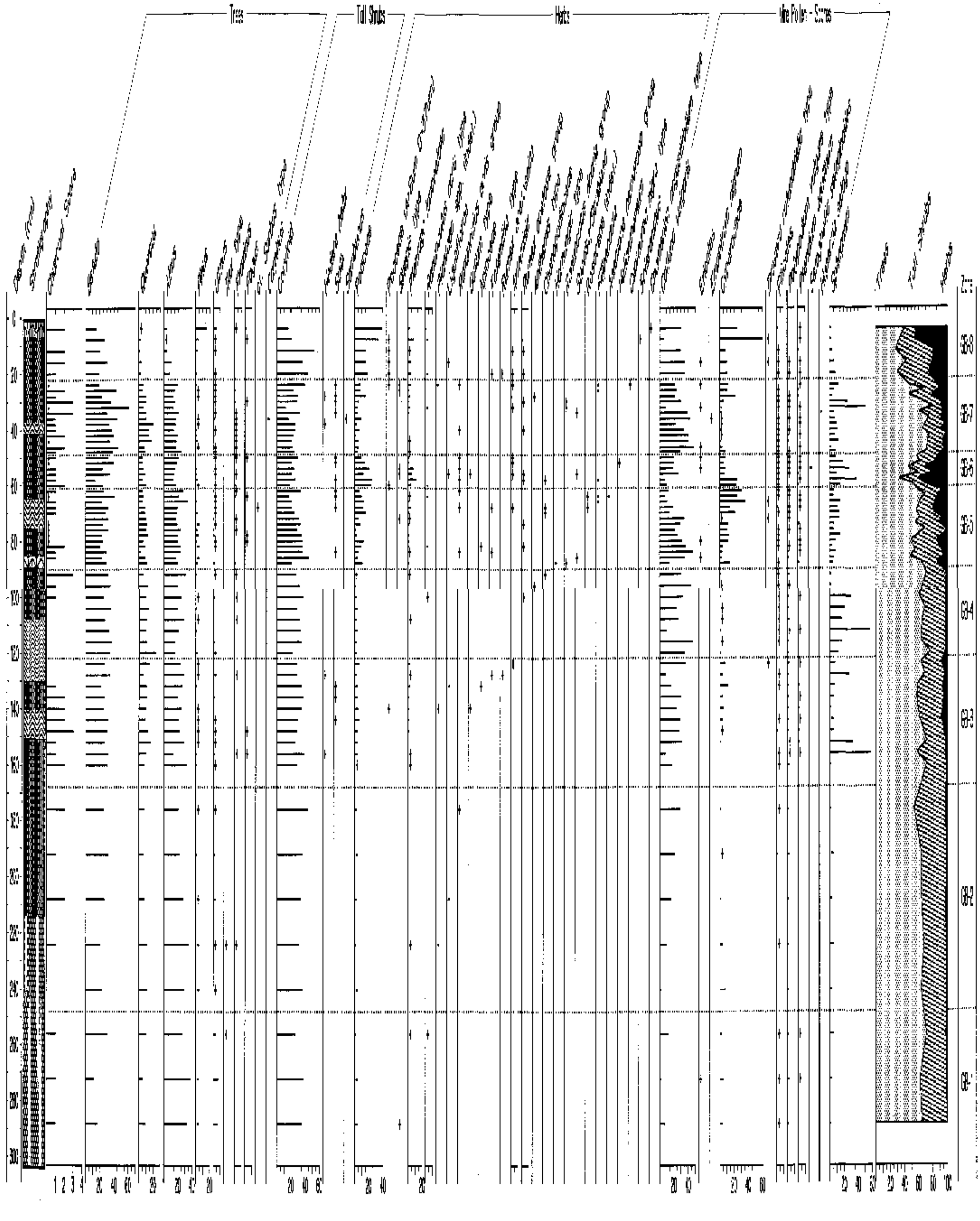


Fig. 7.5 GARTLEA BOG

Sum = Non Mire Pollen



% Non Mire Pollen + = < 1%

Fig. A.1 OLD LOCH

Sum = Total Pollen + Spores (excl. Aquatics)

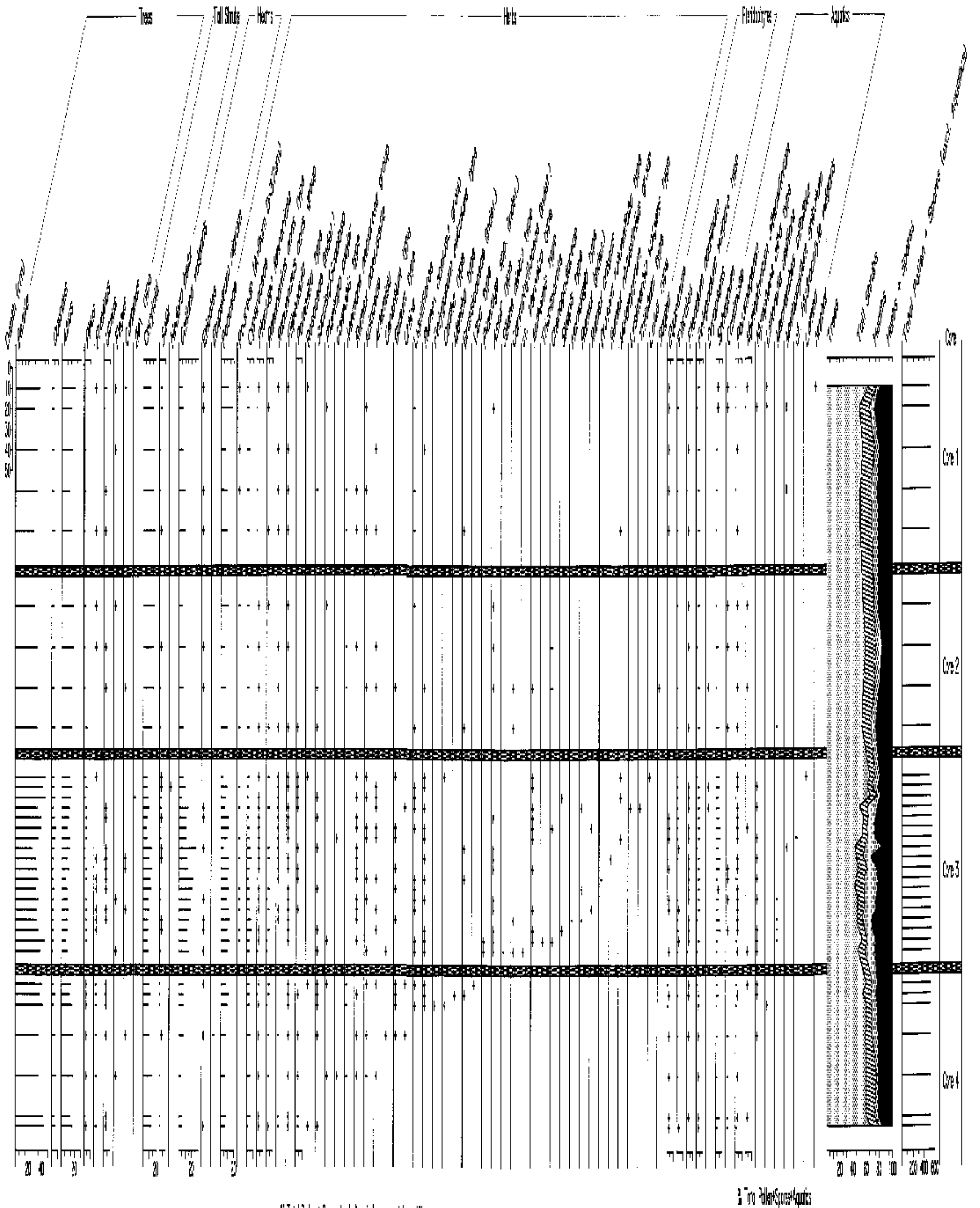
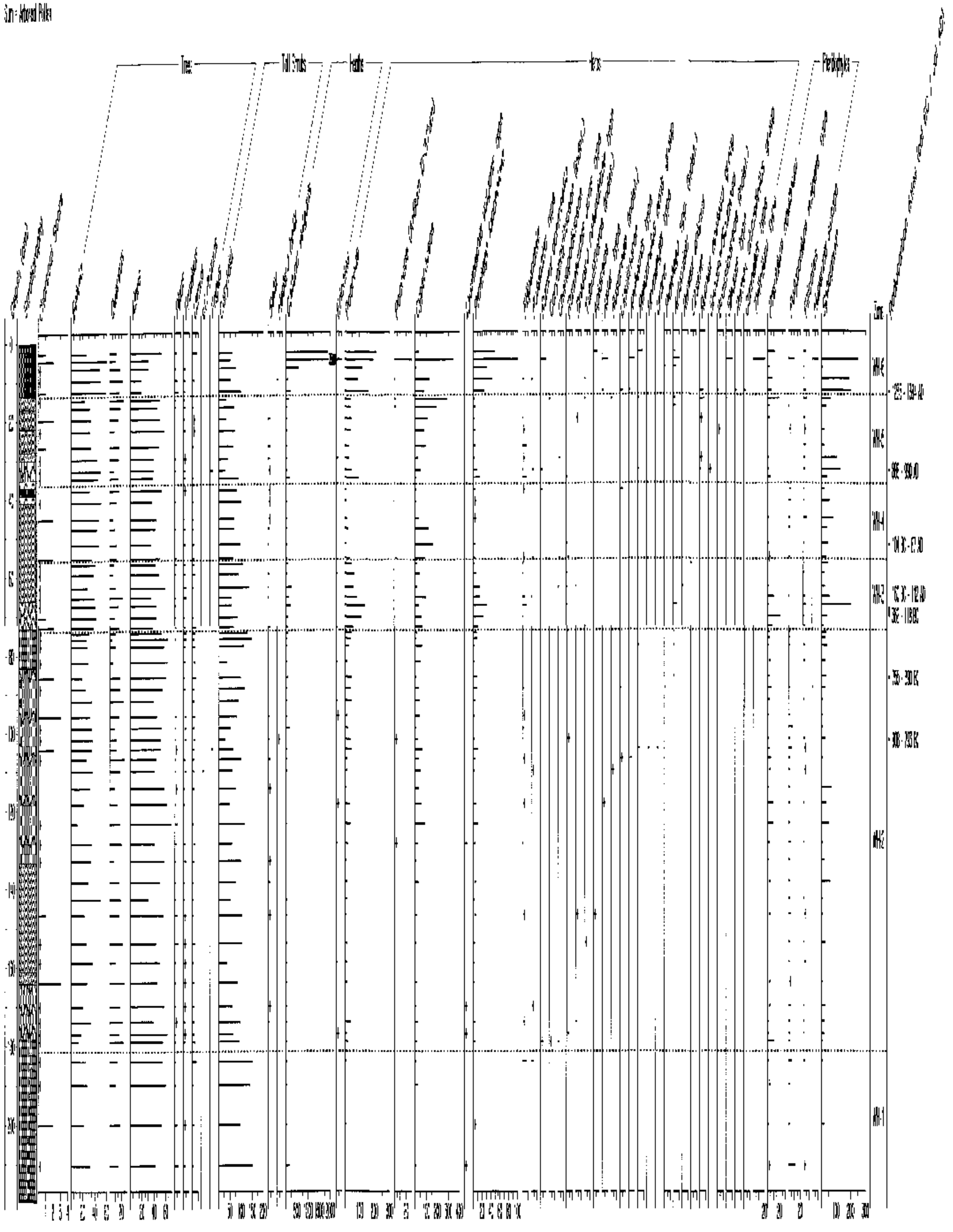


Fig. 4.4 WALLS HILL BOG

Sum = Arboreal Pollen



% Arboreal Pollen (+) = < 1%

Fig. 4.3 WALLS HILL BOG

Sum = % Total Pollen + Spores (excl. Sphagnum)