

THE VEGETATIONAL AND ARCHAEOLOGICAL HISTORY OF ROMBALDS MOOR
WEST YORKSHIRE

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ABSTRACT

The archaeology of Rombalds Moor, West Yorkshire, is reviewed and discussed. Vegetational information is provided by thirteen pollen diagrams (nine percentage diagrams and four influx diagrams) for seven sites on the moor.

At the end of the Late-Devensian period Rombalds Moor was a species-rich grassland. Following the Post-glacial warming of the climate there was a succession of trees arriving in the area, but true woodland was not established until c.8800 years BP.

Dates are proposed for two early Mesolithic forest burnings, and late Mesolithic disturbance has been noted, particularly at the Alnus rise. The morphology of the Alnus rise differs in diagrams from different parts of the moor. Differences in diagrams from the same site, together with radiocarbon dating evidence, points to the presence of one or more hiatuses in the late Boreal/early Atlantic. At this site there is evidence that Pinus persisted long after the Alnus rise.

There was a small amount of clearance, but no agriculture, in the Neolithic period. In the Bronze Age there was more extensive clearance, some pastoralism, and a limited amount of cereal cultivation in the east of the moor. Pollen analysis of a buried soil provides evidence that a supposed 'Bronze Age' cairn represents a burial, but the radiocarbon date is Iron Age.

Major deforestation took place in the Iron Age when the population moved from the higher land into the valleys and there were significant increases in both pastoral and arable farming.

Cultivation stopped and woodland regrew in some areas towards the end of the Roman period. There is evidence that removal of the woodland cover led to soil degeneration on the higher parts of the moor which prevented later regrowth of woodland.

In the late 13th and early 14th centuries remaining woodland was cleared and agriculture increased, particularly pastoralism. Recent changes involve the decline of heather as a result of overgrazing.

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1. INTRODUCTION

It has long been recognised that Rombalds Moor is an area rich in prehistoric remains (Forrest and Grainge, 1867, Holmes, 1885, Cudworth, 1910). At the same time that this project was initiated a detailed survey of the remains on the moor, and of West Yorkshire as a whole, was being undertaken by the West Yorkshire County Council Archaeology Unit. The information they had already obtained confirmed the importance of the remains on the moor, but highlighted the lack of any real understanding of their age and function. It was thought, from the sheer extent of the material in some areas, that man had, at some time, occupied the moor, but many questions remained, such as the size of the population involved, whether there was more than one occupation involved and the ages of these, the type or types of economy employed, whether occupation was seasonal, and so on. Very little recent field work had been carried out on the Rombalds Moor remains, and in any case, pure archaeological studies were not yielding answers to the types of questions posed above. It was decided, therefore, that there was a need for more information, and a different approach. Perhaps by studying the vegetation history of the moor and then relating this to the archaeology it might be possible to learn more about the history of man on Rombalds Moor.

There has been much work published on the vegetation history of the central and southern Pennines (Conway, 1954, Tallis, 1964, Hicks, 1971, Tallis, 1972, Bartley, 1975, Williams, 1983). These sites are all some distance from Rombalds Moor, which is an eastern outlier of the Pennines. The nearest published work is north of the moor, in the Craven District (Piggot and Piggot, 1959, Jones, 1977), but the majority of these sites are in limestone areas and so are of little relevance to an acid moorland area such as Rombalds Moor.

Rombalds Moor is an ideal area for a detailed study of vegetation history since it has many peat deposits, of various ages, suitable for pollen analysis. Also a preliminary diagram by undergraduate students at Leeds University suggested that

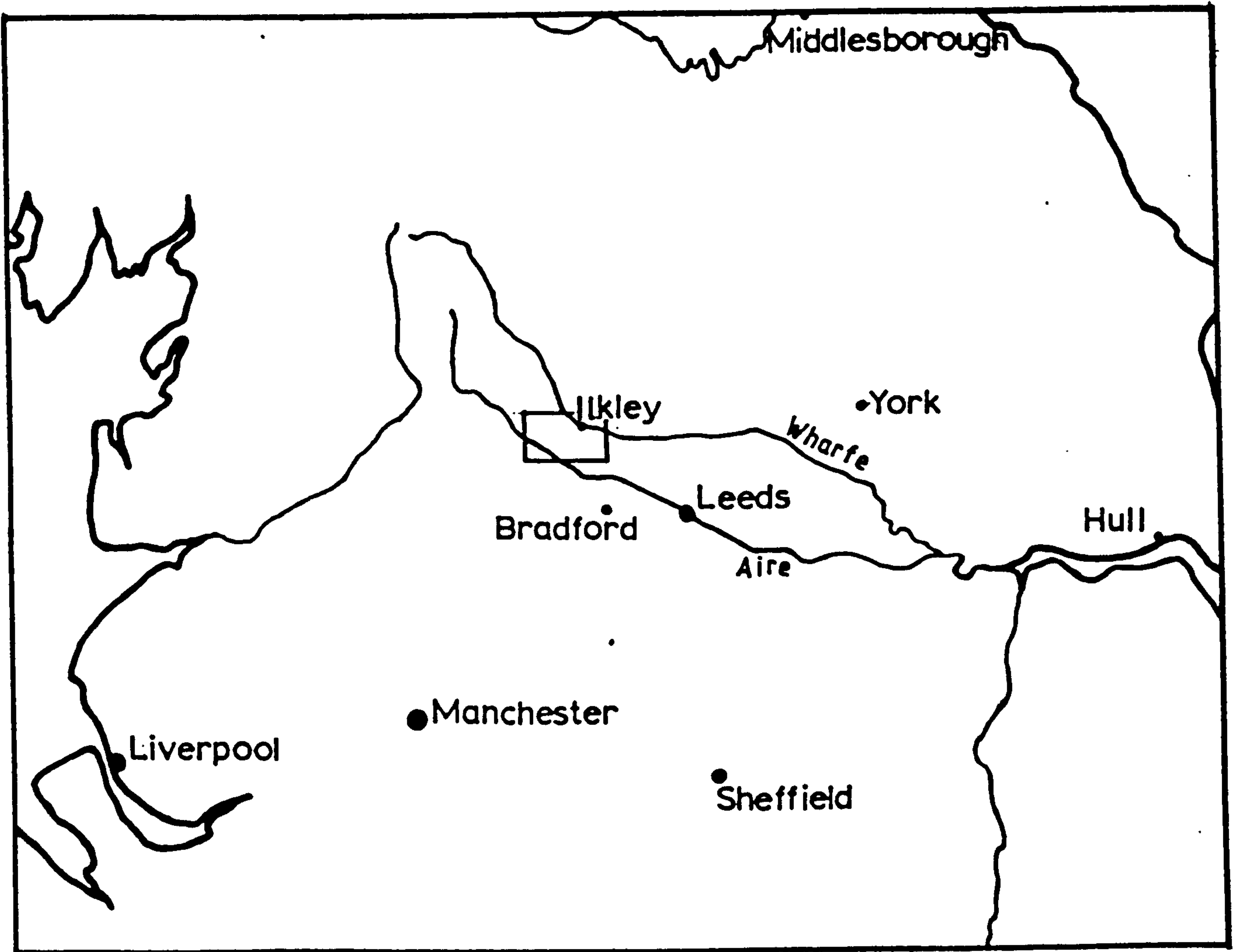


Fig. 1 : The location of Rombalds Moor.

the vegetation record at one site, Lanshaw, might cover the entire Flandrian period. This is important since very early vegetation records are rare in the Pennines.

It was hoped, therefore, that pollen analysis of widely-spaced peat deposits on Rombalds Moor would provide a long and detailed vegetation history. Also by combining vegetational and archaeological information it was hoped to learn more about the history of man's usage and occupation of the moor.

2. THE PHYSICAL ENVIRONMENT

2.1 Situation

Rombalds Moor is an eastern spur of the Pennines, approximately seven miles north-east of Bradford. It lies between the valleys of the River Aire and the River Wharfe and consists of 90 square kilometres of rough moorland, the majority of which is above 275 metres O.D. The highest point is 402 metres at White Crag. (see figs.1 and 2)

2.2 Geology

The bulk of the moor is formed of alternating bands of 'hard' Millstone Grit and 'softer' shales. The beds dip to the south and differential erosion has resulted in a series of scarps on the northern slope. There are occasional thin bands of limestone which outcrop on the northern edge of the moor as at Backstone Beck (Lamming, 1969). Lamming also noted the presence of marine rocks at Spicey Gill. Boulder clay and gravels make up the low hummocks known as Lanshaw Delves. This is believed to be a lateral moraine of the Devensian Wharfe valley glacier (Versey, 1948) and has been extensively quarried for limestone boulders.

2.3 Soils

Soils are generally acid due to the low base content of the underlying rocks. They grade from stagnopodzols on the lower slopes to peat which blankets the higher ground and has formed in all depressions and in poorly drained areas (Carroll et. al. 1979). There are at least three places where soils are more basic, at Spicey Gill the source of these bases is the rock face which includes a small band of bullions containing a variety of fossils. In other cases the source is more difficult to locate, but may originate in pockets of limestone erratics.

2.4 Climate

No meteorological data is available for the moor itself. The nearest weather station is Ilkley in the Wharfe valley,

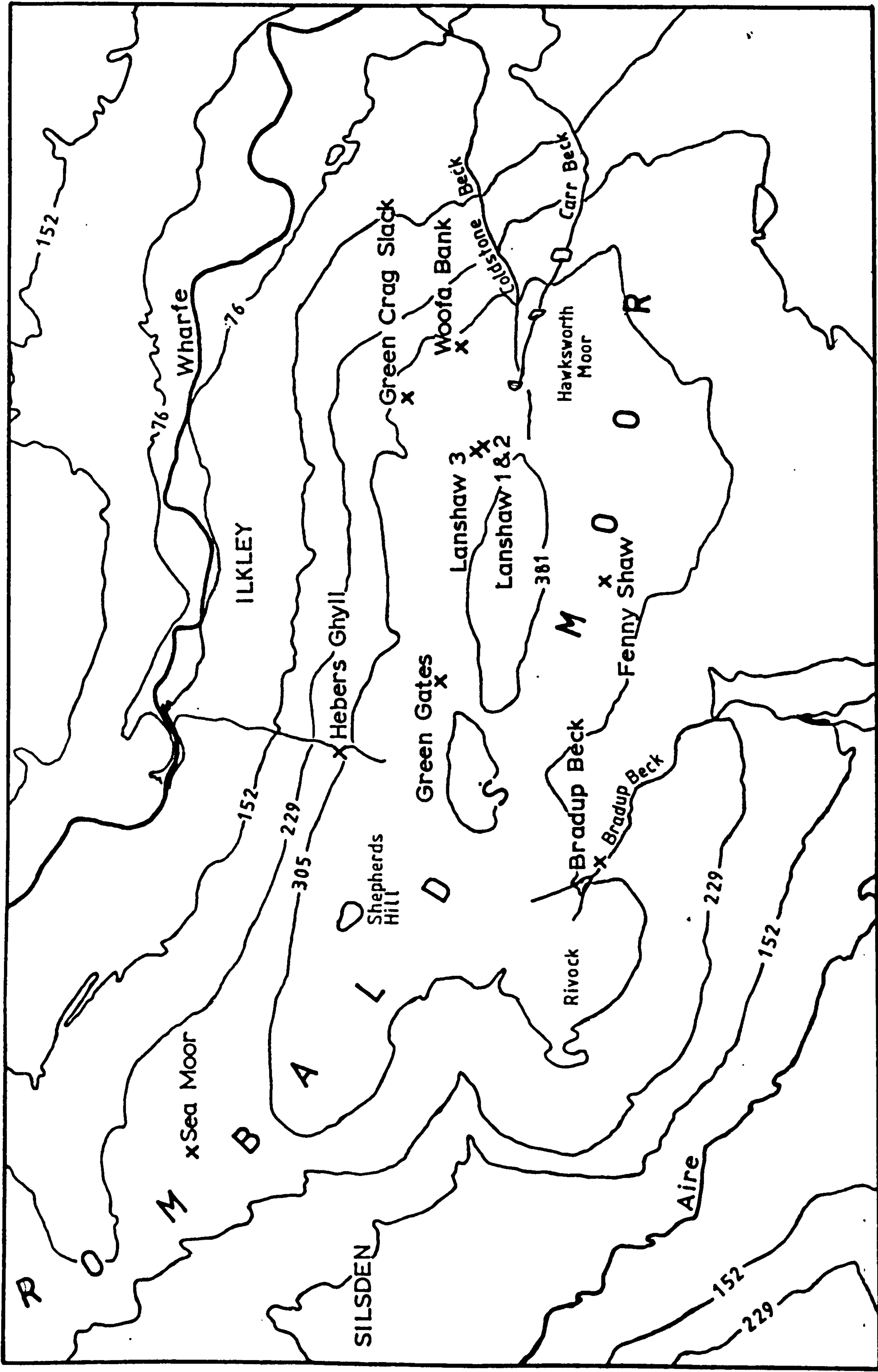


Fig. 2 : Situation of Rombalds Moor and sites of pollen analysis. (x)

which probably has a similar climate to the higher land around it. However, in winter the moor has a greater proportion of its precipitation as snow, and this tends to lie longer than in the valley. It must, therefore, experience slightly colder weather than Ilkley.

Average daily mean temperatures between 1941 and 1970 for Ilkley were 2.7°C in January and 15.4°C in July. The average yearly total rainfall for Ilkley between 1941 and 1970 was 917.5 mm.

2.5 Present Day Vegetation

At the beginning of this century Rombalds Moor was a heather moorland,

'Everywhere from the watershed to the dale edges; sweeps a continuous surface of undulating turfy heather-land'

(Forrest and Grainge, 1868)

Heather is now absent in some parts of the moor and the most widespread species today is the crowberry (Empetrum nigrum). It seems likely that the disappearance of heather and the spread of crowberry have been caused by overgrazing. During this century, and particularly since 1940, the moor has been heavily stocked with sheep (Dalby, 1961). Sheep will eat the young shoots of heather but find crowberry unpalatable, and the many grouse on the moor also graze on heather. In a fenced enclosure on Hawksworth Moor, where grazing has been carefully controlled, there is very little crowberry, but heather is abundant, tall and luxuriant. Immediately outside the enclosure there has been no control over the amount of grazing; crowberry is the dominant species, and heather is found only occasionally in small, poor-looking patches.

It appears then that under low grazing pressure heather will out-compete the slower growing crowberry, but at a higher, undetermined, level of grazing pressure heather cannot regenerate and is replaced by crowberry.

Other factors, such as trampling, may also be important. Crowberry withstands trampling better than heather and will, therefore, often become dominant in areas frequented by walkers. The Clouston Report on Ilkley Moor in 1974 concluded that the spread of crowberry has largely been due

to overgrazing but they also stressed the damage caused by visitors to the natural vegetation, particularly on slopes of more than 20° (Clouston, 1974).

Another species which has spread as a result of overgrazing, and also burning, is bracken. This dominates large areas of the northern slope, particularly the drier slopes below 338m (1100ft.) (Fidler et al. 1970)

These recent changes in vegetation are reflected in changes at the top of some of the pollen diagrams. At Hebers Ghyll the uppermost level is dominated by Empetrum pollen and Pteridium spores with some Gramineae pollen. This is very much a reflection of the present day vegetation which can be seen in the photograph on p. 112.

Nardus grassland also seems to have increased during this century and is found on well-drained land particularly on the eastern slope. Eriophorum and Juncus spp. are important in poorly-drained areas on the northern slope, whilst Vaccinium myrtillus dominated vegetation is found in small patches in dry areas with little grazing pressure, and especially on steep slopes. (Fidler et al. 1970)

In all these communities the total number of species is low even for acid moorland. Fidler (1970) suggests that this may be due to the invasion of all communities by crowberry but does not explain why this should have brought about a reduction in species diversity. Crowberry dominates large areas of Rombalds Moor but can also be found in every other community on the Moor.

There are several locations where flushes have formed due to the presence of springs. In some flushes where the pH reaches above 4.5 there is a greater variety of species than is normally found on the moor. Carbottom flush (Grid.ref. SE 147444) has a pH of 6.9 and supports a wide range of bryophytes including 9 species of Sphagnum. the majority of bogs and flushes have less than 4 species of Sphagnum, and in some Sphagnum recurvum is the only bryophyte present. (Dalby, 1973)

There are very few trees on the moor apart from some small conifer plantations at the western edge around Rivock. This area was afforested between 1973 and 1976 (Ilkley

Archaeology Group [IAG] Cup-and-ring rock report, unpublished). The only deciduous trees are found in a few of the more sheltered ghylls.

There have been attempts by Bradford City Council over the past few years to increase the area under heather by planting young, nursery grown, heather plants on the moor. It is not yet known whether this will succeed in turning Rombalds Moor back into a heather moorland.

3. MATERIALS AND METHODS

3.1 Choice of Sites for Pollen Analysis

The original aim was to find sites in all areas of the moor, at different altitudes, and with contrasting types and amounts of archaeological remains. This was greatly limited by the distribution of suitable deposits, the eastern slope, in particular, has been so effectively drained that no deep peat could be found.

Lanshaw was known from previous borings to have the deepest peat on the moor and a preliminary diagram suggested that the pollen record might cover the entire Flandrian period (Dr. D. D. Bartley, University of Leeds, personal communication). The Lanshaw area is rich in archaeological finds especially Mesolithic flints. It was, therefore, decided to construct a detailed diagram from this site and to obtain radiocarbon dates for the profile. A boring was taken from what was believed to be the deepest part of the bog. The site was marked with a bamboo and paced out from two boundary stones. The core obtained was used to construct the Lanshaw 1 diagram. On returning to the site to obtain material for radiocarbon analysis the marker could not be found and it was concluded that it had been removed or destroyed. Borings were taken from the point believed to be Lanshaw 1 and the pollen examined. This was sufficiently different from the Lanshaw 1 diagram to warrant the construction of a new diagram, Lanshaw 2, for which eight radiocarbon dates have been obtained.

Lanshaw 3 is near the western edge of the bog. A boring here revealed a clay layer which interrupts the peat sequence from 138cm to 151 cm, and it was considered worth investigating this by pollen and microfossil analysis.

Green Crag Slack has a higher concentration of archaeological remains than any other part of the moor. It was hoped that the shallow peat deposits which have formed in the lowest parts of the slack would provide evidence of an early settlement and agriculture.

There are very few archaeological finds from the Green

Gates area. It is, therefore, a suitable site for a comparison with areas such as Green Crag Slack and Lanshaw, which show evidence of extensive prehistoric occupation or visitation.

Sea Moor is a marshy pasture in the north-east of Rombalds Moor. Its name suggests that it may have been a lake and as such it was thought likely to provide a long vegetation record. It is lower than the other sites on the moor and might be expected to have had a different history of land use.

Hebers Ghyll was chosen as a site for pollen analysis because preliminary diagrams by final year students at Leeds University suggested that the bog has grown rapidly, and it was hoped that it might show evidence of recent changes in land use.

Fenny Shaw and Bradup Beck were chosen to provide information about the vegetation history of the southern slope.

The excavation of the Woofa Bank cairn provided an excellent opportunity to link the archaeological and vegetational aspects of this study in a very direct way. It was hoped that pollen analysis of the buried soil would provide information about the age and function of the cairn.

3.2 Collection and Storage

Material for pollen and macrofossil analysis was collected in most cases by the use of a Russian-type peat borer, but soil boxes were used for the Woofa Bank cairn samples, and peat monoliths were taken for the Fenny Shaw diagram, for 0 to 140cm at Hebers Ghyll, and for 0 to 90cm at Lanshaw 2. All material for analysis was stored at 2°C and in polythene bags to prevent drying.

3.3 Percentage Pollen Diagrams

For each sample 0.5 to 2cm³ peat was heated in 7% sodium hydroxide, or potassium hydroxide, for between 20 and 40 minutes. This was then passed through a 150µm sieve and the residue washed with distilled water. Pollen was concentrated by centrifuging at 8000 r.p.m. for at least 2 minutes. Erdtman's acetolysis was used except for wood peats where it

was found to be of little help in concentrating pollen. The Woofa Bank samples were not acetolysed as the pollen was poorly preserved. Samples with high proportions of mineral material were treated by bromoform flotation (Moore and Webb, 1978,p.26).

The samples were then stained with safranin and mounted in glycerine jelly. Two slides were prepared for each sample and a total of 250 land pollen grains was counted per slide. Proportions of each species are expressed as percentages of the total land pollen, excluding aquatics and spores.

3.4 Absolute Pollen Diagrams

1cm³ or 0.5cm³ samples of peat were measured by displacement of water in a 10ml measuring cylinder. The method then followed that described for the percentage diagrams up to the end of sieving and the concentration of pollen by centrifugation.

A suspension of Ailanthus glandulosa pollen in glycerol was prepared following the method described by Bonny(1971). The suspension was mixed, using a magnetic stirrer, for 2 hours. Bonny showed that stirring for 45 minutes was enough to achieve homogeneity. A series of counts, using a haemocytometer slide, were then undertaken to find the mean number of Ailanthus grains per slide. This figure was then used to calculate the concentration of the exotic pollen suspension, (see section 3.5.1). The haemocytometer counts are shown in table 1 on p.12.

The Ailanthus suspension can be used as an exotic 'marker' to provide an estimate of the total fossil pollen in a sample. The method is described by Matthews(1969). After digestion in sodium hydroxide and centrifugation, the pollen samples were weighed, to an accuracy of 0.0001g. Drops of Ailanthus suspension were added with a pipette, and the samples were reweighed. The difference between the two weights was taken as the weight of Ailanthus suspension added. The suspension was added after sodium hydroxide digestion because Matthews (1969) noted that the exotic suspension did not settle in 10% sodium hydroxide. Where acetolysis or bromoform flotation

251	245	226	216	224
237	238	216	223	232
235	247	228	243	237
220	248	227	229	226
249	242	236	218	230

$$\bar{x} = 232.92$$

Table 1. Results of successive counts of Ailanthus pollen on a haemocytometer slide.

was carried out the exotic pollen was added at the end of the preparation, as recommended by Matthews (1969), and Bonny (1971).

Samples were stained with safranin and mounted in glycerine jelly. Two slides per sample were made, and a total of 500 land pollen grains, including Ailanthus, was counted per slide. Preparations containing less than 20% or more than 40% Ailanthus were rejected, and re-prepared, according to the recommendations of Bonny (1971).

3.5 Calculations

3.5.1 Concentration of Ailanthus Suspension

The mean number of Ailanthus grains in one millilitre of suspension is given by;

$$s = \bar{x} \cdot \frac{(1000)}{c} \quad (\text{Bonny, 1971})$$

\bar{x} = the arithmetic mean from 25 haemocytometer counts,
(see table 1)

c = volume of the haemocytometer in μl ,

$$\begin{aligned} \text{therefore, } s &= 232.92 \frac{(1000)}{1.8}, \\ &= 129400 \text{ grains/ml.} \end{aligned}$$

3.5.2 Total number of Ailanthus grains added.(a)

$$a = s \frac{(w)}{\text{S.G.}}$$

w = the known weight of suspension added,

S.G. = the specific gravity of the glycerol used.

For the 58cm level in the Green Crag Slack diagram,

$$\begin{aligned} a &= 129400 \frac{(0.1797)}{1.28036} \\ &= 18161.439 \text{ grains } \underline{\text{Ailanthus}} \end{aligned}$$

3.5.3 Total Fossil Pollen Concentration

This is given by,

$$a. \frac{(\text{count of fossil grains})}{(\text{count of } \underline{\text{Ailanthus}} \text{ grains})}$$

For level 58cm at Green Crag Slack the total fossil pollen concentration is,

$$18161. \frac{672}{328} = 37209 \text{ grains cm}^{-3}$$

3.5.4 Fossil Pollen Influx

The fossil pollen influx is the number of pollen grains falling on a cm² peat in one year. This is obtained by dividing the fossil pollen concentration by the sedimentation rate. The latter is calculated by dividing the difference in years between two radiocarbon dates by the increment in peat in cm between the two dates.

e.g. The total fossil pollen concentration for the 58cm level in the Green Crag Slack diagram is 37209 grains cm⁻³. There are two radiocarbon dates which can be used to calculate the sedimentation rate, 1300BP at 54cm and 3320BP at 66cm. The sedimentation rate is,

$$\begin{aligned} \frac{3320\text{yrs} - 1300\text{yrs}}{66\text{cm} - 54\text{cm}} &= \frac{2020\text{yrs}}{12\text{cm}}, \\ &= 168\text{yrs. cm}^{-1} \end{aligned}$$

The fossil pollen influx is,

$$\begin{aligned} & \frac{\text{fossil pollen concentration,}}{\text{sedimentation rate}} \\ & = \frac{37209 \text{ grains cm}^{-3}}{168 \text{ yrs cm}^{-1}}, \\ & = 221 \text{ grains cm}^{-2} \text{ yr}^{-1}. \end{aligned}$$

3.5.5 Influx of Each Pollen Type

The influx of each pollen type can be calculated by using the percentage of that type and the total fossil pollen influx.

e.g. Betula is 27%TP at 58cm in the Green Crag Slack diagram. The influx of Betula is, therefore, 27% of the total fossil pollen influx

$$\begin{aligned} & \frac{27}{100} \cdot 221 \text{ grains cm}^{-2} \text{ yr}^{-1}, \\ & = 60 \text{ grains cm}^{-2} \text{ yr}^{-1} \end{aligned}$$

3.6 Macrofossil Analysis

Samples of between 2cm³ and 5cm³ peat were digested in 60% nitric acid. This was then diluted by 50% and left overnight. The samples were then sieved using a 70 mesh sieve and the residue washed and examined for recognisable plant remains.

3.7 Collection of Archaeological Information

Most of the archaeological information was gathered from the record cards of the West Yorkshire County Archaeological Unit at Wakefield, and from a survey of the literature.

In addition much useful information was given during discussions with Mrs.J.Keighley (Prehistorian at the Wakefield Archaeology Unit), with the Ilkley Archaeology Group, and with Stephen Kerry (Assistant Keeper, History[Archaeology], Cliffe Castle Museum, Keighley, West Yorkshire).

3.8 Radiocarbon Dating

A total of 19 radiocarbon dates have been obtained from 5 different sites, and are listed in table 2. The radiocarbon analysis was carried out by Dr.D.D.Harkness at the N.E.R.C. Radiocarbon Laboratory, East Kilbride.

Site	Lab.Number	Depth(cm)	Age(yrs BP)
Lanshaw 2	SRR-2471	24.5-25.5	2170±50
	SRR-2472	51.5-52.5	3760±50
	SRR-2473	83.5-84.5	5250±50
	SRR-2474	111-113	5840±80
	SRR-2475	131-133	8160±90
	SRR-2476	161-163	9680±90
	SRR-2477	223-225	9520±120
	SRR-2478	265-266	10250±100
Green Crag Slack re-check series	SRR-2464	51-53	1230±80
	SRR-2538	37-38	670±40
	SRR-2539	54-55	1300±40
	SRR-2540	59-60	3320±40
Hebers Ghyll	SRR-2465	33.5-34.5	590±40
	SRR-2466	73.5-74.5	1650±50
	SRR-2467	137.5 - 138.5	2470±50
Green Gates	SRR-2468	20-24	1680±70
	SRR-2469	56-60	1270±80
	SRR-2470	73-75	2170±80
Woofa Bank	SRR-2479	0-2	2480±90

Table 2. List of Radiocarbon Dates

4. THE PREHISTORY OF ROMBALDS MOOR

4.1 Introduction

Despite the many and varied archaeological remains on Rombalds Moor little is known about the history of man's activities in the area. The two major reasons for this lack of knowledge are that first, many of the remains are too fragmentary to reveal their purpose, and secondly, no dateable material has been found. Most of the artifacts from the moor are thought to have had a long history of usage throughout prehistory.

In this chapter the remains on the moor are described, and, as far as is possible, they have been divided into the traditional periods ie. Palaeolithic, Mesolithic, Neolithic, Bronze Age, and Iron Age. It should be stressed, however, that in West Yorkshire it is very difficult to date the end of one period and the beginning of the next. This is not simply due to a lack of evidence, the main reason is that there were no sharp divisions between the different prehistoric periods, but, instead, there was a gradual change and development of customs and practices. At the end of each section the archaeological evidence has been used to suggest ways in which man might have been exploiting Rombalds Moor at that time.

Rombalds Moor, and West Yorkshire as a whole, have often been regarded as areas of secondary settlement, populated by the overflow from other areas. (Watson, 1952. Keighley, 1981, p.93) Even within West Yorkshire there are areas which would have been more desirable for settlement than Rombalds Moor, such as the Magnesian Limestone region in the east of the county, where there may have been important settlements from the earliest times. (Keighley, 1981 p.109)

It is likely that cultural development, in remote gritstone areas such as Rombalds Moor, lagged behind the regions of primary settlement, eg. the Yorkshire Wolds, and that early traditions were continued well into the next period. If this is the case it makes the dating of the Rombalds Moor remains even more difficult.

4.2 The Palaeolithic Period

There is no certain evidence for Palaeolithic man on Rombalds Moor or in the surrounding area. Parts of the moor may have been ice-free in the Devensian, but it was certainly surrounded by ice of the Wharfe glacier to the north, and the Aire glacier to the south. There is evidence that the Wharfe glacier covered the northern side of the moor as far as Lanshaw, since the Lanshaw Delves have been interpreted as a lateral moraine of this glacier (Versey, 1948, Yarwood, 1981, p41).

Flint blades of possible Upper Palaeolithic date have been found on Rombalds Moor (held in the Crowther and Turner Collection, Manor House Museum, Ilkley), and a possible late Upper Palaeolithic, open-air, lowland site has been recorded at Washburn Foot, Farnley (Grid Reference; SE229463) (Wymer and Bonsall, 1977, p432).

As West Yorkshire was ice-free by c.10000 BC an Upper Palaeolithic presence in the area is possible.

4.3 The Mesolithic Period

4.3.1 Evidence

The substantial evidence of the presence of Mesolithic man, on and around Rombalds Moor, is in the form of large flint collections. Fig.3 shows the distribution of finds, the majority of which are above 244m OD. There is a concentration to the north-east and particularly on Green Crag Slack. Within the Slack there are at least three concentrations of flints, which suggest the possibility of more than one site. Large numbers of Mesolithic flints have been found in the Lanshaw area especially around Lanshaw Delves. Another important site is Cranshaw Thorn Hill (Grid Reference; SE12054610) where 121 flints have been found and it appears to have been a flaking site. There is a marked lack of finds on the south side of the moor.

A photograph of some of the Mesolithic flints found on Rombalds Moor is shown on p.19. Mesolithic flints have been divided into two main groups, the broad-blade industries of

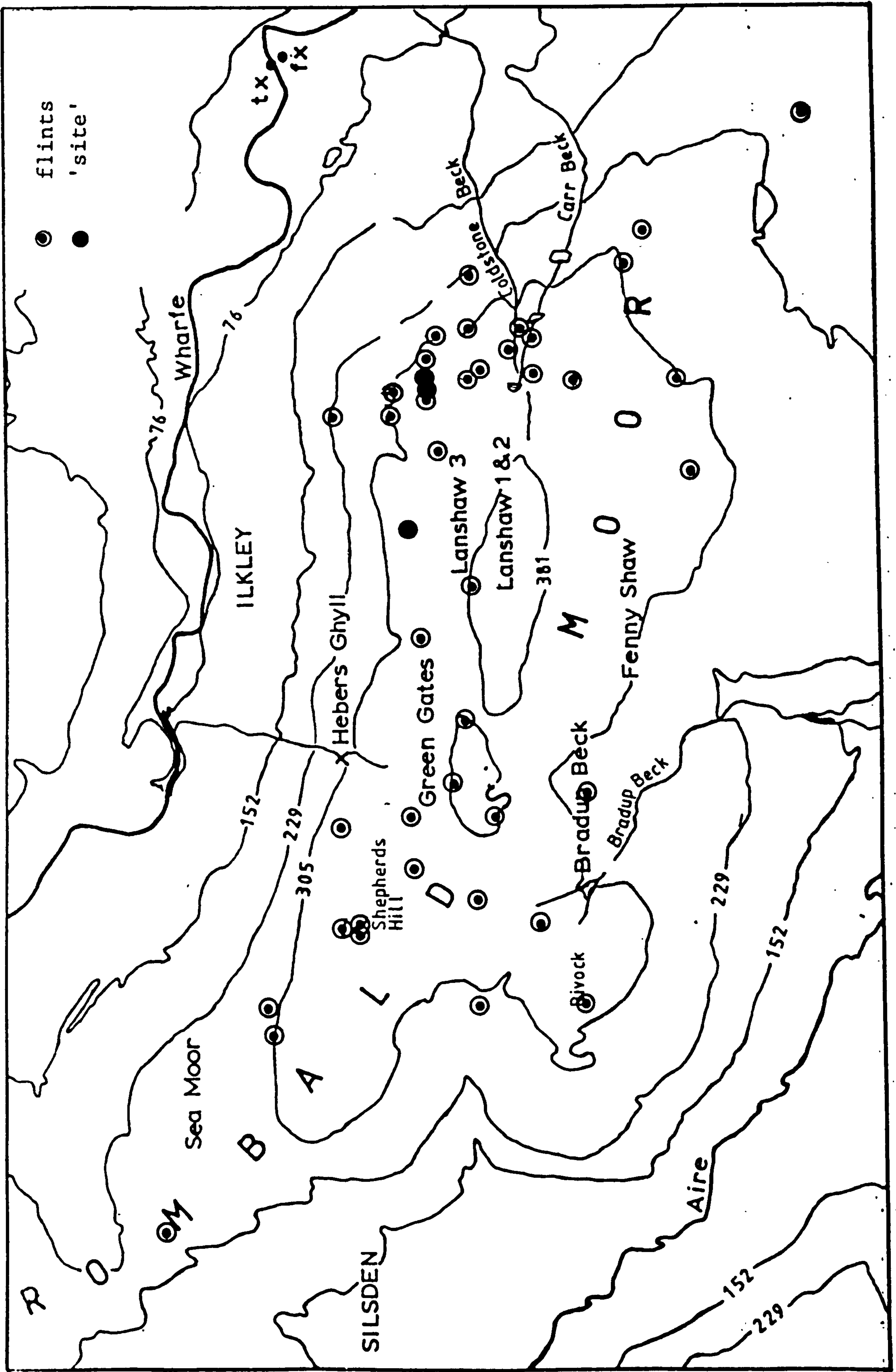


Fig. 3 : Distribution of Mesolithic Flint Finds

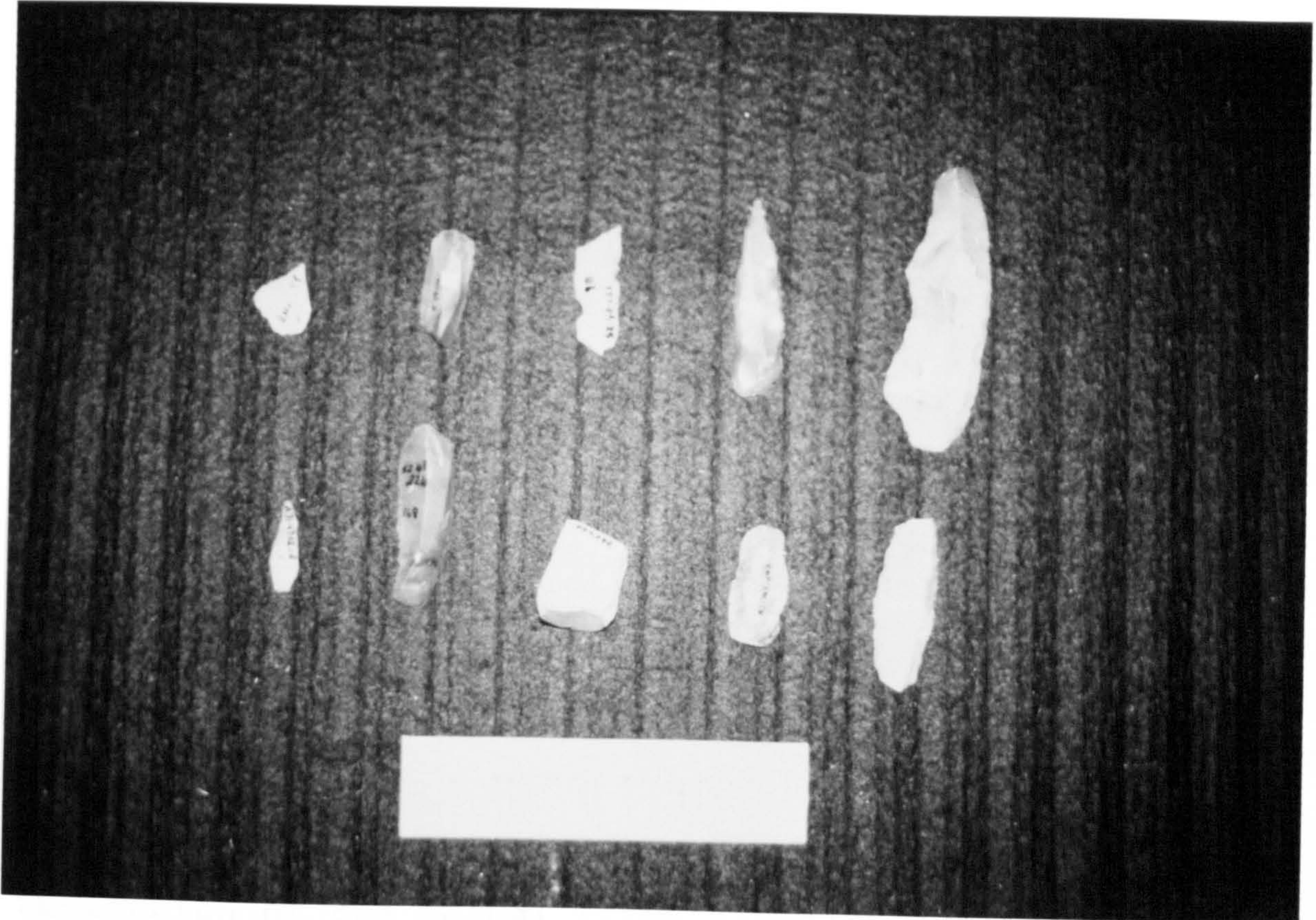


Fig.4 : Mesolithic flints from Rombalds Moor

the early Mesolithic and the narrow-blade industries of the late Mesolithic. The majority of the finds from Rombalds Moor are the broad-blade, early Mesolithic type, but there have also been finds of later narrow-blade types, on Green Crag Slack, near the Grubstones stone circle (Grid Reference; SE13644472), and in the Lanshaw area.

4.3.2 Discussion

It is not known if the distribution of finds as illustrated in fig.3 is a true representation of the actual distribution of flints. A number of factors could have influenced the location of the finds. Above 244m OD there are many areas of eroding peat and it is in such areas that the majority of finds have been made. Erosion is also more common on the steeper parts of the northern slope than on the gentler southern slope. The north side of the moor is more frequently visited by walkers, as it is more attractive, and also more accessible than the south side due to its proximity to Ilkley and its extensive footpaths. It is, therefore, possible that it has been more thoroughly searched than the southern slope.

If, however, the distribution of finds is a true reflection of the actual flint distributions it would mean that the higher, northern slopes of the moor were the parts most frequented by Mesolithic man. The higher land was probably only lightly wooded in the early Mesolithic which would make it more favourable for hunting than the denser forest of the lowlands. Mellars(1976) argues that light woodland cover was preferred by Mesolithic hunters due to better mobility and less chance of deer escaping the hunt. The steep 'steps' of the northern slope would have provided natural breaks in the forest.

The large numbers of flints found, particularly on Green Crag Slack, have led to suggestions that Mesolithic man not only hunted on the moor but also lived there in permanent or temporary occupation sites(Keighley,1981,p79). The distinction between an occupation site and a hunting camp can only be made by studying the nature of the flint assemblage

In general terms sites with high proportions of domestic tools such as scrapers (probably used for cleaning animal skins and perhaps woodworking) and gravers (used for wood and leather working) have been regarded as occupation sites, and sites with high proportions of microliths and few domestic tools, have been associated with hunting activities (Keighley, 1981, p.80).

Mr. W. Godfrey of the Ilkley Archaeological Group has studied the flint collections in the Manor House Museum, Ilkley, and also a private collection containing some 10000 flints from the moor. In his opinion the vast majority of Mesolithic flints from the moor are microliths, although some scrapers and gravers have also been found. He concludes that Mesolithic man used Rombalds Moor for hunting and did not live there permanently. However, the sheer size of the collections from some sites such as Green Crag Slack and Cranshaw Thorn Hill, infers more than transitory hunting camps. Green Crag Slack would have provided an ideal location for a summer occupation site with good water supplies, excellent views and easy access to the higher parts of the moor. It is possible that the moor was occupied on a seasonal basis.

The problem remains of where the permanent or winter occupation sites were located. A number of important Mesolithic sites have been found to the east of the moor in the Wharfe valley. The Sandbeds site (Grid Reference; SE209462) is in fact four concentrations of flints on a river terrace at 53m OD (175 feet) (Mellars, 1973). Cowling (1973) suggests that this terrace was the northern boundary of a post-glacial lake. It yielded a variety of flints from the Mesolithic, Neolithic and Bronze Age, (Cowling, 1973) and represents one of the largest collections in the north of England (Mellars, 1973). The majority of the Mesolithic flints are of the early Mesolithic type and predominantly grey-white Wold flint. Of the 1915 artefacts only 35 were microliths with 34 gravers and 33 scrapers suggesting a predominance of domestic, rather than hunting, activity (Cowling, 1973). This fact together with the predominance of early Mesolithic types

makes the Sandbeds a very good candidate for the permanent occupation site of the people hunting on Rombalds Moor. Mellars(1973) concluded that the Sandbeds would have been a good winter site with reasonable protection from the weather, and with access to land above 300m (1000ft.) within five miles. Both Cowling(1973), and Mellars(1973) say that the four concentrations of flints suggest that this site was the scene of many temporary winter settlements.

Flints have been found south of the moor in the Aire valley (S.Kerry, personal communication) and particularly at Charlestown, near Baildon, which appears to have been an important site and may have had the same function as the Sandbeds site (Keighley,1981,p.81).

Dating the Mesolithic period on Rombalds Moor is very difficult as there have been no stratified finds with dateable material. Pierpoint(1981) gives general dates for the British flint industries, of 8300 to 6000 BC for the early Mesolithic and 6000 to 4000+BC for the later Mesolithic. How far this is applicable to Rombalds Moor is not known. An estimate of the date of the early Mesolithic on Rombalds Moor can be obtained by comparison with other sites in the north of England.

Jacobi(1978) recognises two distinct flint traditions in the early Mesolithic in the north of England. The Deepcar type includes sites with grey-white flint from the Yorkshire Wolds e.g. Deepcar (Radley and Mellars, 1964), and several sites in the surrounding Pennines such as Pike Low in the southern Pennines and Lominot Hill, West Yorkshire (Radley and Marshall, 1965). The Starr Carr type sites have mainly translucent flints from the Yorkshire coast, which range in colour from a mottled yellow to brown or black (Radley and Mellars, 1964). Sites with these flints include Starr Carr and Flixton in North Yorkshire, and Warcock Hill South, near Marsden, in the Pennines. Both types of flint have been found on Rombalds Moor but at different sites.

Radley and Marshall(1964) suggest that the elaboration of the Deepcar type of flints points to a later date for sites with these flints than those sites with the simpler Starr Carr types. However, radiocarbon dates from early Mesolithic sites

show that the two industries were contemporary with each other and both date from the mid to late 8th millennium BC (Jacobi, 1978).

It is likely then that the early Mesolithic flints from Rombalds Moor date from ca. 7500 BC and that the moor was being used at this time by two distinct groups of people. This is later than dates for southern England e.g. Thatcham III Berkshire (Grid Reference; SU5256) at 8415 BC (Jacobi, 1978). Jacobi proposes that the impetus for the change from a Palaeolithic type economy, based on hunting reindeer in an open environment, to a Mesolithic economy was the establishment of total woodland cover. He provides evidence that open conditions persisted later in the north and concludes that the impetus for a change of economy was, therefore, later than in the south.

4.4 The Neolithic Period

4.4.1 Evidence

Neolithic finds on Rombalds Moor are limited to flints, and a group of possible late Neolithic cairns. The distribution of flint finds is shown in fig.5, and is very similar to that of Mesolithic finds. Again there is a concentration on the north-eastern part of the moor but there are more finds on the southern side than in the earlier period, and particularly on Hawksworth Moor (see map on p.5). The photograph on p.25 shows some Neolithic finds from the moor, including 2 stone axes.

No settlement sites or pottery have been found. The only possible example of burial is a group of cairns on Hawksworth Moor centered around Grid Reference; SE142438. One of the cairns is shown in the photograph on p.25. They are larger than other cairns on the moor and are oval in outline rather than the more normal rounded types. Unlike some of the other cairns they do not have cup-and-ring marked rocks, (see p.26) incorporated in them and they are not associated with walling. Since they have not been excavated it is difficult to suggest their age but Mr.W.Godfrey believes they may be stone versions of Neolithic long barrows (personal communication).

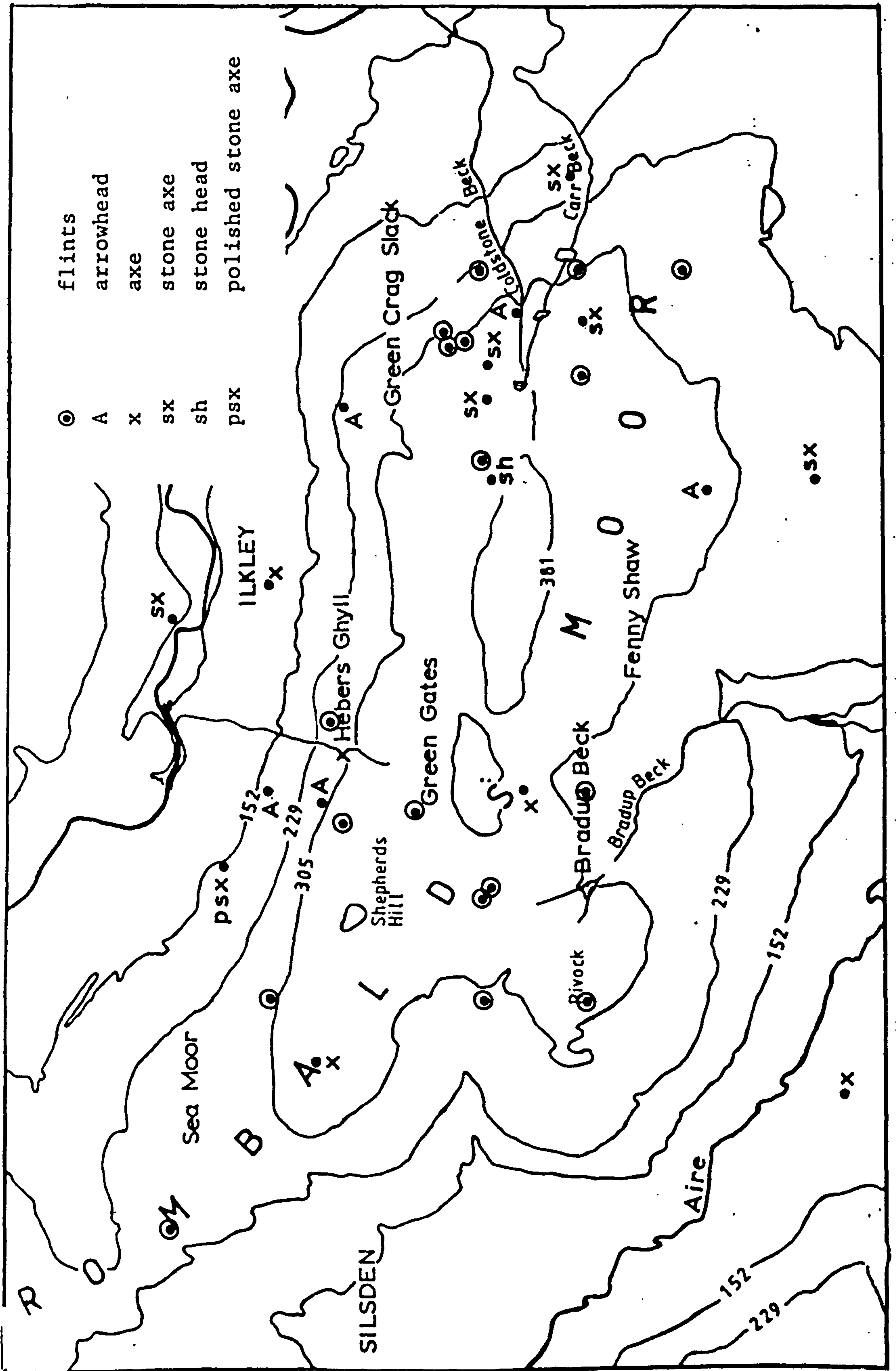


Fig. 5. : Distribution of Neolithic Flints



Fig.6 : Neolithic flints from Rombalds Moor
(the axe at the top of the picture is from Keighley)



Fig.7 : A cairn on Hawksworth Moor

(Photo S.Kerry)

4.4.2 Discussion

There are several points about the flint collections which suggest that some occupation, and perhaps farming, did take place on Rombalds Moor during the Neolithic period. The great numbers of flints found suggest the presence of some settlement on the moor rather than occasional hunting losses, and also there is less difference between the types of tools found on upland sites and those from lowland sites than in the Mesolithic.

The large numbers of axes found could indicate that some clearance was taking place, but it is interesting that they tend to have been found alongside streams. This may mean that they were being used not to clear areas for agriculture, but to clear pathways for access to the higher land.

It is impossible to suggest dates for the Neolithic period in this area as there have been no stratified finds with dateable material.

4.5 The Bronze Age

4.5.1 Introduction

There is more evidence for Bronze Age activity on Rombalds Moor and a greater variety of remains than for any other period of prehistory. The distribution of these remains is shown in fig. 27. The overall pattern is similar to the previous periods with a major concentration in the north-east but Bronze Age remains have been found in all areas of the moor. There is also an important concentration on Baildon Moor 2½ miles south of Rombalds Moor. The different types of remains which are believed to date from the Bronze Age will be discussed separately.

4.5.2 Cup-and-ring rocks

Other than flints, cup-and-ring rocks are the most frequently occurring prehistoric remains on Rombalds Moor, but they are the least understood. They consist of carvings on gritstone boulders which usually include small hollows, or 'cups', with or without one or more surrounding grooves, or 'rings'. A survey conducted by the Ilkley Archaeology Group

Fig.9 : Cup-and-ring rocks from Rombalds Moor



Fig.9a : Hanginstone quarry stone



Fig.9b : The Idol stone



Fig.9c : A cup-and-ring on Green Crag Slack

(I.A.G.) has recorded 218 cup-and-ring rocks on the moor, (I.A.G. Cup-and-ring Rock Report, unpublished) and it is likely that more are yet to be discovered.

Most cup-and-ring rocks on Rombalds Moor are found between 275m and 335m. An important group lies on or above an escarpment overlooking Addingham, Ilkley, and Burley, and include some of the most complex designs, four of which are unique to Britain. Some cup-and-ring rocks on Rombalds Moor are shown in the photographs on the following pages. Many of the rocks are in prominent positions on the vertical edge of the escarpment, and one third of all the rocks on the moor are in Green Crag Slack. There is also a concentration around Rivoock Edge in the west.

Cup-and-ring rocks are also found in other parts of the north of England, especially Northumberland, and also in Scotland, but the Rombalds Moor group is one of the largest. Although the rocks are believed to date from the Bronze Age this is by no means certain. They have been assigned to this period due to their association with Bronze Age remains. In Cleveland several barrows, some of which yielded cremations, were found to have cup-and-ring rocks incorporated in the structures (Hornsby and Laverick, 1918). A large barrow on Hinderwell Beacon, Cleveland, contained several cremations, and nearly 150 cup-and-ring rocks were found above and around the burials (Hornsby and Laverick, 1920).

On Rombalds Moor cup-and-ring rocks have been found in all enclosures, and two were found in amongst the walling material. Five have been found incorporated in cairns and others are located within cairnfields, such as the Woofa Bank cairnfield, described on p.33. This relationship has also been noticed on Snowden Moor, Grid Reference; SE 1852, on the North York Moors, and in Swaledale and Derbyshire, and has led to the suggestion that they form part of an Early Bronze Age tradition from 2000 to 1500BC (I.A.G., Cup-and-ring Rock Report, unpublished).

The function of cup-and-ring rocks is even less clear than their age. None of the designs seem to involve figures of humans or animals but many of them do appear to be representational rather than simply patterns. Many are

suggestive of maps of settlements or perhaps burials, e.g. the Hangingstone Quarry stone (see p.28). Their often dramatic positions could mean that they served as boundary markers. Other suggestions are that they are maps of the stars or Druid altars (Forrest and Grainge, 1868). Hornsby and Stanton (1916) suggest that cup-and ring rocks were brought instead of flowers to burials. Taking into account the great variety of designs and the range of positions of these rocks it may be more realistic to believe that different rocks had different purposes.

4.5.3 Flints

The distribution of finds of Bronze Age flints is similar to those of earlier periods, with concentrations in the north-east, and particularly on Green Crag Slack and around Lanshaw Delves. The majority found on Rombalds Moor are typical of the Bronze Age, and a selection is shown on p.32.

Fig.8 shows the distribution of flint axes. It is noticeable that, as for Neolithic axes, Bronze Age axes have been found along the major valleys and following the lines of the smaller streams up on to the moor top. This could mean that rather than representing widespread clearance, the axes were instead being used to clear pathways. The valleys provide good natural routeways onto the moor and many of today's foot-paths still follow them. It may be, therefore, that the areas along the pathways have been the most thoroughly searched for flints, but the general flint distribution does not support this view.

4.5.4 Metalwork

The scarcity of finds of Bronze Age metal implements in this area suggests that it may have been economically rather a poor area. Some finds have been made in isolated, surface locations, and a hoard was discovered at Brunthwaite, Silsden containing a palstave (a bronze axe shaped to fit into a split wooden handle) and socketed axes (a hollow bronze axe shaped to fit onto a wooden handle)(Keighley, 1981, p.99).

There is only one record of a bronze implement from a burial in this area. A bronze, tanged knife was found in a burial on Pennythorne Hill, Baildon, accompanied by an urn



Fig.10 : Bronze Age flints from Rombalds Moor, and two swords
from Ben Rhydding, near Ilkley

containing a cremation (Keighley,1981,p.104).

The Early Bronze Age axes found at Keighley and Silsden may be evidence for the early use of the Aire Gap as a trade route (Keighley,1981,p.100).

4.5.5 Funerary Remains

The many examples of funerary remains on the moor are concentrated to the east of Burley Moor and on Woofa Bank. On Burley Moor there are considerable numbers of cairns, barrows, and earth and stone circles. The Grubstones stone circle (Grid Reference; SE13644472) is described by the Ordnance Survey as a 'well-defined circle.....the remains of a robbed cairn' (Waight,1965). Raistrick (1929) recorded that a cremation, accompanied by a flint spearhead, was found c.1846, beneath three large stones at the centre of the circle. It appears then that it is not a true stone circle but is instead a burial cairn. Near to the Grubstones circle are two ring barrows, described by Colls (1846,p.305), and the Ordnance Survey mentions another at Grid Reference; SE14584410 (Keighley,1981,p.103). It seems likely that the Burley Moor remains represent a major Bronze Age site.

The Woofa Bank cairn field is located on a very gently sloping, north-east facing slope, at an altitude of around 305m. It has two concentrations, one centered around Grid Reference; SE13774586, on Stead Crag, and another some 100m to the south, centered around Grid Reference; SE13704563. Each group consists of 30 to 40 small, round cairns, which are only clearly visible when the vegetation is burnt off. and are almost totally invisible under the normal vegetation cover. The cairns are associated with short lengths of walling and some of them, particularly of the Stead Crag group, seem to be part of the walling. The cairns are also associated with a number of cup-and-ring rocks.

The two groups may not have been constructed in the same period as there are differences between them. The Stead Crag group are often touching each other and some cairns are arranged in lines. Also, as mentioned above, some of them appear to be part of the walling. This could be due to later



Fig.11a : The Woofa Bank cairn with the vegetation cover removed



Fig.11b : During excavation

(Photos S.Kerry)

wall builders using the cairns as useful additions to the walling.

In March 1983 one of the cairns from the group to the south was excavated by the Ilkley Archaeology Group, under the supervision of the West Yorkshire Metropolitan Council Archaeology Unit. The cairn was chosen from a number which had been exposed by a burning of the heather cover, and was singled out because of its apparent undisturbed condition. Its exact Grid Reference is SE13774559. Photographs of the cairn during excavation are shown on p.34. The excavation yielded no artefacts or burial remains and there was no cist i.e. a central stone chamber which would have contained a burial. A soil sample was taken from beneath a 'master' stone for pollen analysis, the results of which are discussed in Chapter 12.

It was not possible to suggest a date for the cairn on the basis of its construction or on the pollen analysis, so the top 2cm of the buried soil was sent for radiocarbon analysis. The ^{14}C date for the buried soil is 2480 ± 90 BP (530 BC). This is unusual because it is generally accepted that the cairnfields such as Woofa Bank belong to the Early Bronze Age (Challis and Harding, 1975), whereas this date is either very late Bronze Age or early Iron Age.

There has been considerable discussion in the literature concerning the reason for building cairnfields such as that on Woofa Bank (Ashbee, 1956, Graham, 1956. Hayes and Rutter, 1975, Challis and Harding, 1975, Walker, 1965) Some authors have tended to the view that they represent, primarily, clearance heaps, i.e. that they are the result of land cleared of trees and stones for agriculture (Challis and Harding, 1975, Walker, 1965). Ashbee (1956) working on Kildale Moor, North Yorkshire, believes that they are more likely to represent burials, whilst Graham (1956) suggests that, in Scotland, the two functions are not necessarily exclusive.

The excavation of the Woofa Bank cairn did not yield any clues as to its purpose, but the pollen analysis was more informative. The question as to whether the Woofa Bank cairns

represent clearance or burials will be discussed more fully with reference to the pollen results in Chapter 12.

There is an important concentration of Bronze Age funerary remains on Baildon Moor including cairnfields and earthworks described by Colls (1846, p.301) and which probably represent an extensive settlement (Keighley, 1981, p.103). Several barrows on Baildon Moor have been excavated and have yielded cremations, a collared urn and a food vessel, bowl barrows and the bronze tanged knife mentioned on p.31. Keighley concludes that the remains on Baildon probably represent settlements similar to those on Rombalds Moor (Keighley, 1981, p.104).

There is a noticeable lack of funerary remains on the western side of Rombalds Moor, but the large flint collections from Shepherds Hill, Rivoock Edge, and Bucking Hill (Grid Reference; SE085454) suggests a considerable Bronze Age presence on this part of the moor.

4.5.6 Stone Circles

South-east of the Grubstones stone circle is the Twelve Apostles stone circle, at Grid reference; SE 12594506. In 1929 Raistrick recorded this as being 52 feet in diameter, and lying upon an earthen bank of 4 feet wide and up to 2 feet high (Raistrick, 1929). In the List of Ancient Monuments it is recorded as having 12 stones, and possibly, at one time, 20, which are probably the peristaliths of a burial (List of Ancient Monuments, 1961, number 111). However, the Ordnance Survey Field Investigator considered it more likely to be the remains of a true stone circle, and not a burial (Foster, 1965).

The Bradup stone circle (Grid Reference; SE 08954392) which, perhaps significantly, is situated in a pasture known as Brass Castle, is 30 feet in diameter (Raistrick, 1929). Raistrick says that in 1885 18 stones were standing, but that in 1929 only 12 stones remained. It is not thought to be associated with a burial.

The Horncliffe stone circle (Grid Reference; SE 13343530) has an almost complete ring of stones set edge to edge. Its interior contains a small, stone-lined depression, and it may be that it represents a cairn rather than a true stone circle.

4.5.7 Enclosures and Walling

There are many examples of apparently prehistoric walling and several enclosures on Rombalds Moor. The age of the walling is not known since, unfortunately, most of it is too fragmentary to reveal much about its age or function, and no absolute dating evidence has been found. It is possible that much of the walling belongs to the Bronze Age, but it is equally likely that it is Iron Age, or even later. A section of walling on Woofa Bank, which is associated with the cairnfield and hence is believed to be Bronze Age, is shown in the photograph on p.38.

The most extensive system of walling and enclosures on the moor is on Green Crag Slack. The shape of the most well preserved enclosure compares with enclosures from other areas which have been dated to the Iron Age, and, therefore, the Green Crag Slack enclosures are discussed in the next section.

4.5.8 Discussion

Although there is no definite evidence of Bronze Age settlement on Rombalds Moor (no hut circles have been found) several areas, such as the Green Crag Slack-Woofa Bank area, Burley Moor, and also Baildon Moor, have such high concentrations of various types of remains that it does seem likely that there was settlement in these parts.

There are fewer remains on the western side of the moor and no burial remains. It may be that there was no settlement in the west of Rombalds Moor during the Bronze Age. The presence of the Bradup stone circle in the west is not likely to indicate settlement because stone circles are believed to have been ritual sites, and as such were often located away from settlement sites. It is interesting that there is a concentration of cup-and-ring rocks in the west, around Rivoock Edge (see fig.2). This rather weakens the theory that, these rocks at least, represent maps of burials, and also suggests that they are not related to settlement.

The fewer finds of Late Bronze Age flints might indicate a decreased presence on the moor at this time. A similar situation in the Pennines led Barnes (1982) to suggest that



Fig.12 : Prehistoric Walling on Woofa Bank

that there was an abandonment of the uplands during the Late Bronze Age. He proposes that this was due to a deterioration in the climate towards cooler and wetter weather starting at around 1000BC. This agrees with the work of Van Geel (1978) which shows an unstable, but deteriorating, climate during the Bronze Age, and a 'catastrophic decline' starting at about 900BC. The scarcity of Late Bronze Age flints on Rombalds Moor may, therefore, be due to a movement of the population to the lowlands as a result of a rapidly deteriorating climate. Another possible explanation is that most of the Early Bronze Age flints from the moor are types associated with hunting activities, and perhaps by the Late Bronze Age there was little, or no, game left on the moor.

The date of the Woofa Bank cairn throws doubt on the idea of an abandonment during the Late Bronze Age, and also on the suggestion that the cairnfield as a whole dates from the Early Bronze Age. However, Burial sites are not necessarily associated with settlement, and it is quite feasible that the builders of the cairn were living in the Wharfe valley and buried their dead high up on the moor. Secondly, a date for one cairn cannot be accepted as a date for the entire cairnfield. It is possible that the Woofa Bank cairns were built over a long period of time.

4.6 The Iron Age

4.6.1 Evidence

Iron Age finds on Rombalds Moor are limited to beehive querns (grinding stones), which, although they are domestic objects, do not necessarily indicate settlement since they are moveable. A group of querns were found on Hawksworth Moor where there was no previous evidence of Iron Age activity (Keighley, 1981, p.130). The upper half of a beehive quern is shown in the photograph on p.41.

On Green Crag Slack the walling and enclosures have been carefully recorded by the Ilkley Archaeology Group, but their results have not yet been published. One of these enclosures is shown in the photograph on p.41. No dateable material was

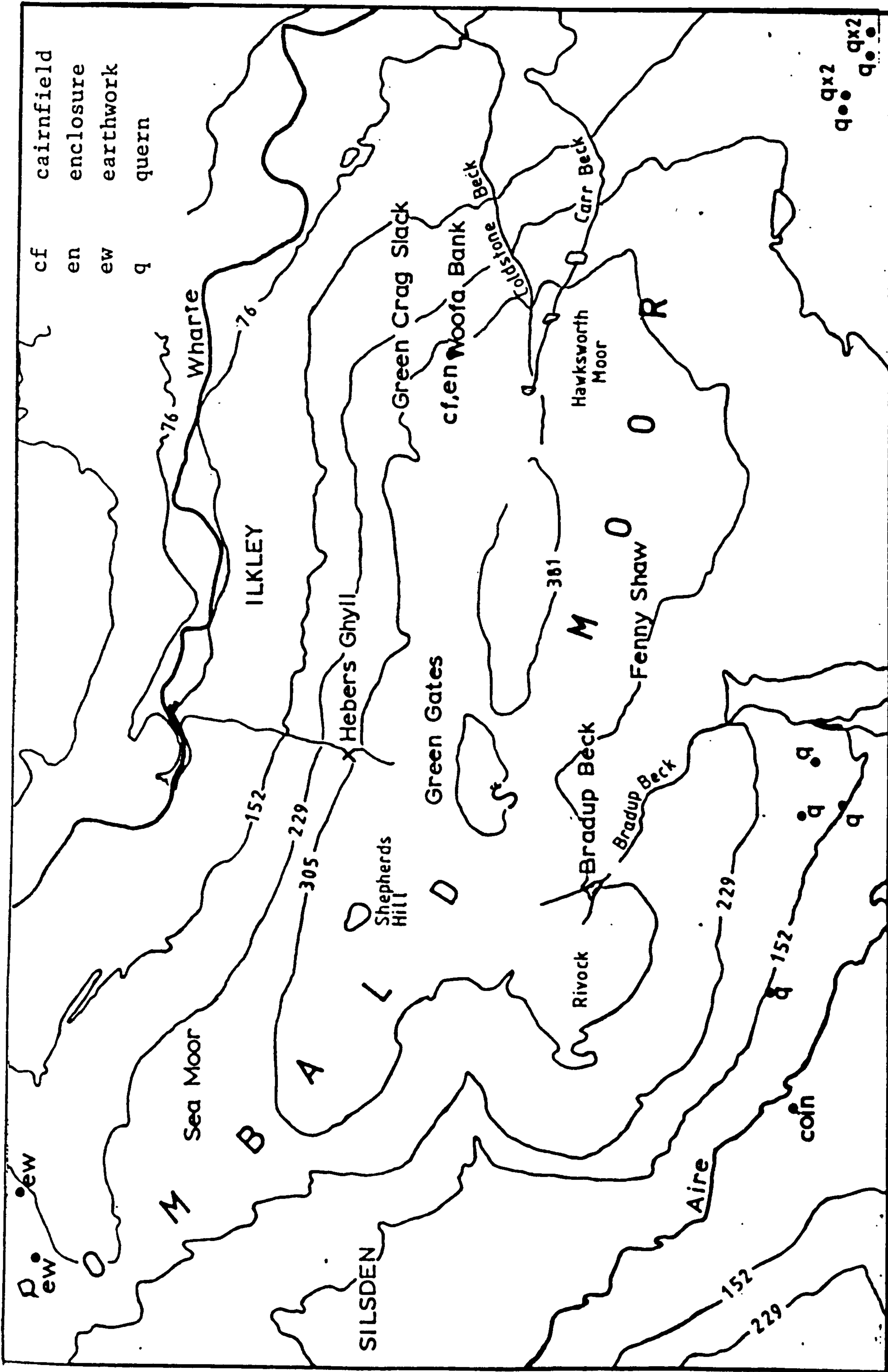


Fig. 13. : Distribution of Iron Age Finds in the Romalds Moor Area



Fig.14 : The upper half of a beehive quern



Fig.15 : An enclosure on Green Crag Slack

found in this, or in any of the enclosures or pieces of walling, so they cannot be said to be definitely Iron Age and could instead be Bronze Age, and may not even be contemporary with each other. Some of the walling has cup-and-ring rocks incorporated in it, which might suggest that the walling is Bronze Age. However, it is, perhaps, more likely that carved rocks were simply used by later people as building material. The survey did not reveal the function, or functions, of the walling and enclosures. No hut circles were found, which would indicate settlement, so it may be that enclosures were used for containing stock.

Remains similar to those on Green Crag Slack have been found in Danefield Wood, near Otley. Cowling (1946) considered these to be Iron Age, though there is no absolute dating evidence. Beehive querns found nearby are further evidence of Iron Age activity in the area (Keighley, 1981, p.121).

Half a mile north-west of Rombalds moor, near Addingham, are two earthworks; Woofa Bank (Grid Reference:SE 04784987), and Round Dykes (Grid Reference:SE 05525011). Both are curvilinear enclosures which are still well-defined, and both are of types assigned in West Yorkshire to the Iron Age (Ordnance Survey record card:SE05 SE7). They are both overlooked by steeply rising land and were, therefore, probably non-defensive. Round Dykes appears to have been a settlement site since nine hut circles have been defined by M.Walker (Keighley, 1981, p.127).

No Iron Age pottery or metalwork has been found on the moor but a sickle, believed to be Iron Age, was found nearby at Brunthwaite Crag, Silsden (Grid Reference:SE 06344645), and a torc was reported to have been found in 1953 in Ilkley at Grid Reference:SE117511, but this is now lost (Keighley, 1981, p.131).

4.6.2 Discussion

The lack of evidence for Iron Age occupation of Rombalds Moor, compared to the Bronze Age, agrees with studies of other upland areas in Britain (Barnes, 1982). Barnes suggests that Bronze Age traits may have persisted in upland areas until

Roman times. However, even in lowland West Yorkshire there is little material earlier than the first century A.D., and this has led to the suggestion that bronze working traditions were continued into the Iron Age in this region (Keighley, 1981, p.115).

Without any dateable material it is impossible to be certain about the date of the enclosures on Green Crag Slack, and, bearing in mind the careful survey by the Ilkley Archaeology Group, it is unlikely that any dateable artifacts will be found in the future. One method of further investigation would be to excavate part of the walling, and to take soil samples from below the wall for pollen analysis and perhaps radiocarbon analysis. This would at least give an earliest possible date, but it would not solve the question of whether Iron Age man lived on the moor, since the enclosures may simply have been for stock rather than occupation sites.

Hicks (1971) considers that the population of East Moor, Derbyshire, moved to the lowlands during the Iron Age and used the uplands as grazing land. A similar withdrawal of settlement during the Iron Age has been proposed for Dartmoor (Becket, 1981). The reason suggested for the movement to lowland sites is the deterioration of climate which began in the Late Bronze Age (see p.39). This is also likely to be the reason for the fortification of settlements during the Iron Age. As the upland areas became too cold and wet to support agriculture there was increased land pressure for well-drained sites, which led to the construction of hillforts such as Castle Hill (Almondbury) (Keighley, 1981, p.116),

4.7 Conclusions

The first definite signs of man on Rombalds Moor are in the early Mesolithic period and it has been suggested that this presence dates from c.7500 BC. There is evidence that at this time there was a major occupation of the Wharfe valley and, to a lesser extent, of the Aire valley. The nature of the flint collections from sites in the valleys and on the moor suggests that these areas were part of the same economy. It is likely that there was permanent occu-

pation in the valleys, and that the higher land was used not for settlement but, primarily, for hunting. Sites on Rombalds Moor such as Green Crag Slack represent seasonal or temporary hunting camps used by sections of the population, most probably in the summer months. There is some evidence that there were two distinct groups of early Mesolithic people in northern England and that both of them visited Rombalds Moor (see p.23).

The smaller flint collection from the later Mesolithic period may indicate that the Rombalds Moor area was less heavily populated at this time, but it could also mean that early Mesolithic traditions were continued into the late Mesolithic period.

There is no definite archaeological evidence for occupation or farming on Rombalds Moor in the Neolithic period. The only finds positively dated to the Neolithic are flints and these are not necessarily associated with settlement. However, the flint evidence does infer that some form of, at least, temporary or seasonal occupation took place on the north-eastern side of the moor and possibly on Hawksworth Moor. There is, however, no indication of permanent settlement sites and no evidence for a change from the Mesolithic hunter-gatherer economy to Neolithic farming. It is possible that upland gritstone areas such as Rombalds Moor were largely ignored by Neolithic farmers and that in these areas a Mesolithic type of economy persisted into the Neolithic period.

During the early Bronze Age there is substantial evidence of extensive settlement on Green Crag Slack and Burley Moor and to the south on Baildon Moor. However, in spite of the many remains and artifacts believed to date from this time virtually nothing is known about the type of economy practised, except that hunting was still taking place, and the scarcity of finds of metalwork and pottery suggest that it was a poor area. The western side of the moor seems to have been ignored for settlement purposes but it was frequented by Early Bronze Age hunters who may have been the sculptors of the many cup-and-ring rocks found in that area.

The Early Bronze Age would seem to represent the peak of

prehistoric activity on Rombalds Moor. It is suggested that the scarcity of Late Bronze Age and Iron Age finds on the moor points to a depopulation of the higher land as a result of a deterioration in climate, and a move to lower sites such as Round Dykes, near Addingham. It is possible, however, that the moor was still being used at this time, not for settlement but for burial grounds, e.g. the Woofa Bank cairnfield, and, perhaps, for pastureland. Both these points can only be clarified by obtaining more radiocarbon dates from cairns and enclosures on the moor.

This chapter has illustrated the difficulties in obtaining a useful interpretation of the archaeological remains on Rombalds Moor, and the need for a different approach. It is hoped that the results of the pollen analyses will provide the type of information necessary for a more detailed account of the history of man's usage and occupation of the moor.

5. LANSHAW

5.1 Introduction

Lanshaw bog lies in the eastern section of Rombalds Moor, centered around Grid Reference: SE130453. The bog has formed in a valley around the headwaters of Carr Beck, at an altitude of 335m O.D. It is about 250m in length, east to west, and 100m across at its widest point. The present day vegetation is dominated by Eriophorum vaginatum and E.angustifolium, with Sphagnum spp. in the wetter areas, and Calluna vulgaris and Empetrum nigrum in the drier parts. The course of the stream is marked by a change to Juncus effusus dominated vegetation.

Carr Beck was dammed at the eastern end of the Lanshaw bog to provide water for nearby towns. The main effect on the bog has been that its eastern edge has been eroded.

The choice of sites at Lanshaw for pollen analysis was explained in section 3.1. The Lanshaw 2 site can be seen in the photograph on page 47. Influx diagrams have been constructed for two sites, Lanshaw 1 and Lanshaw 2, and peat growth curves for these two sites can be seen in figs.17 and 18. Since the profile from Lanshaw 2 has been radiocarbon dated this will be discussed first.

5.2 Lanshaw 2

5.2.1 Stratigraphy

0 to 3cm	Root mat
4 to 25cm	<u>Calluna-Eriophorum-Sphagnum</u> peat with abundant stems leaves and flowers of <u>Calluna</u> , occasional <u>Juncus</u> seeds and many insect eggs.
26 to 201cm	Finely-divided wood peat with a small amount of monocot material throughout. Leaves of <u>Sphagnum tenellum</u> and <u>S.papillosum</u> from 26 to 40cm, occasional moss stems, nutlets of <u>Carex</u> spp. throughout, and <u>Juncus squarrosus</u> seeds to 100cm. Many <u>Betula</u> catkin scales and seeds from 100cm with occasional seeds of <u>Menyanthes trifoliata</u>

Fig.16 : Lanshaw Bog



Fig.16a : Looking west towards the Lanshaw basin



Fig.16b : Looking north across the bog to Lanshaw Delves
(the author marks the Lanshaw 2 boring site)

- One seed each of Rubus idaeus, Potentilla erecta and a Potamogeton sp. at 100cm. A seed of Ranunculus flammula and a Salix bud at 125cm and a seed of Viola riviniana at 65cm.
- 202 to 266cm Moss-Carex peat with nutlets of Carex spp. throughout, and occasional Betula fruits and twigs in the upper layers. Mosses are more abundant from 220cm and include Drepanocladus aduncus, Calliergon giganteum, Scorpidium scorpioides, a Homalothecium sp., and Polytrichum stems. One seed each of Lychnis-flos-cuculi, Empetrum nigrum and a Ranunculus sp..
- 267 to 280cm Grey clay containing some monocot. material, occasional seeds of Juncus articulatus, nutlets of Carex spp. and a Betula fruit. Some carbonised material and Polytrichum stems.

5.2.2 Description of the Lanshaw 2 Pollen Diagrams

Zone A : Cyperaceae-Gramineae p.a.z.(pollen assemblage zone)

Total pollen influx is low and is mainly NAP (non-arboreal pollen). Betula and Pinus are the only tree pollen types present but are at such low levels that it is unlikely they were growing locally, and the pollen is probably the result of long-distance transport. The dominant pollen types are Cyperaceae, Gramineae and Filipendula. Some of the NAP types represented are typically found in open environments e.g. Thalictrum (probably T.flavum), Empetrum nigrum, Rumex acetosa type, and Saxifraga oppositifolia type.

The macrofossils show that the vegetation on the site during this zone was at first dominated by Carex spp. and Juncus articulatus, but from 266cm Juncus seeds are no longer found and there is a change in the stratigraphy from clay to a moss-Carex peat. This level has been radiocarbon dated to 10250±100 years BP.

The end of zone A has been placed at 252cm at the start of the expansion of the Betula curve, which is best seen in the influx diagram.

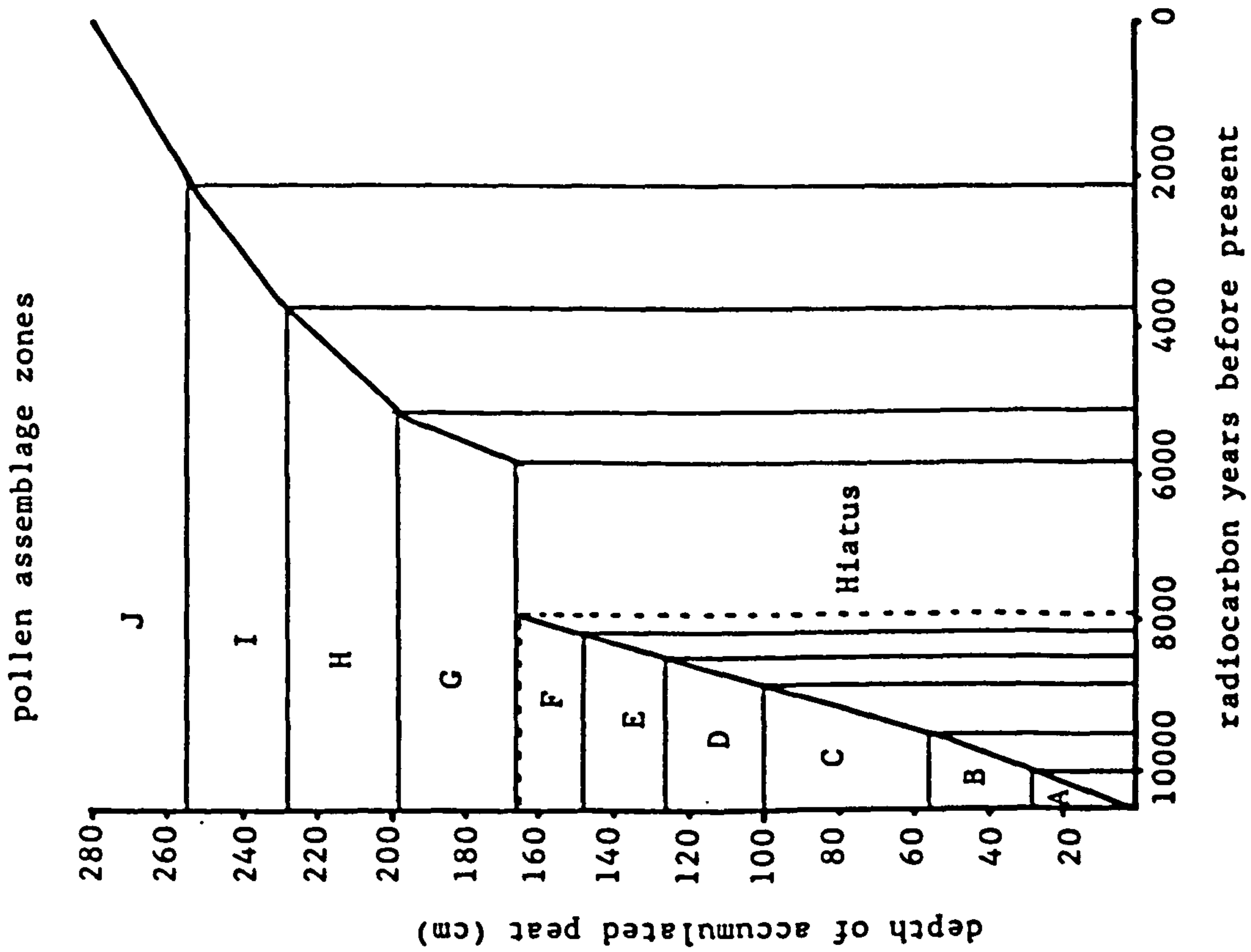


Fig. 17 : Lanshaw 2 peat growth curve.

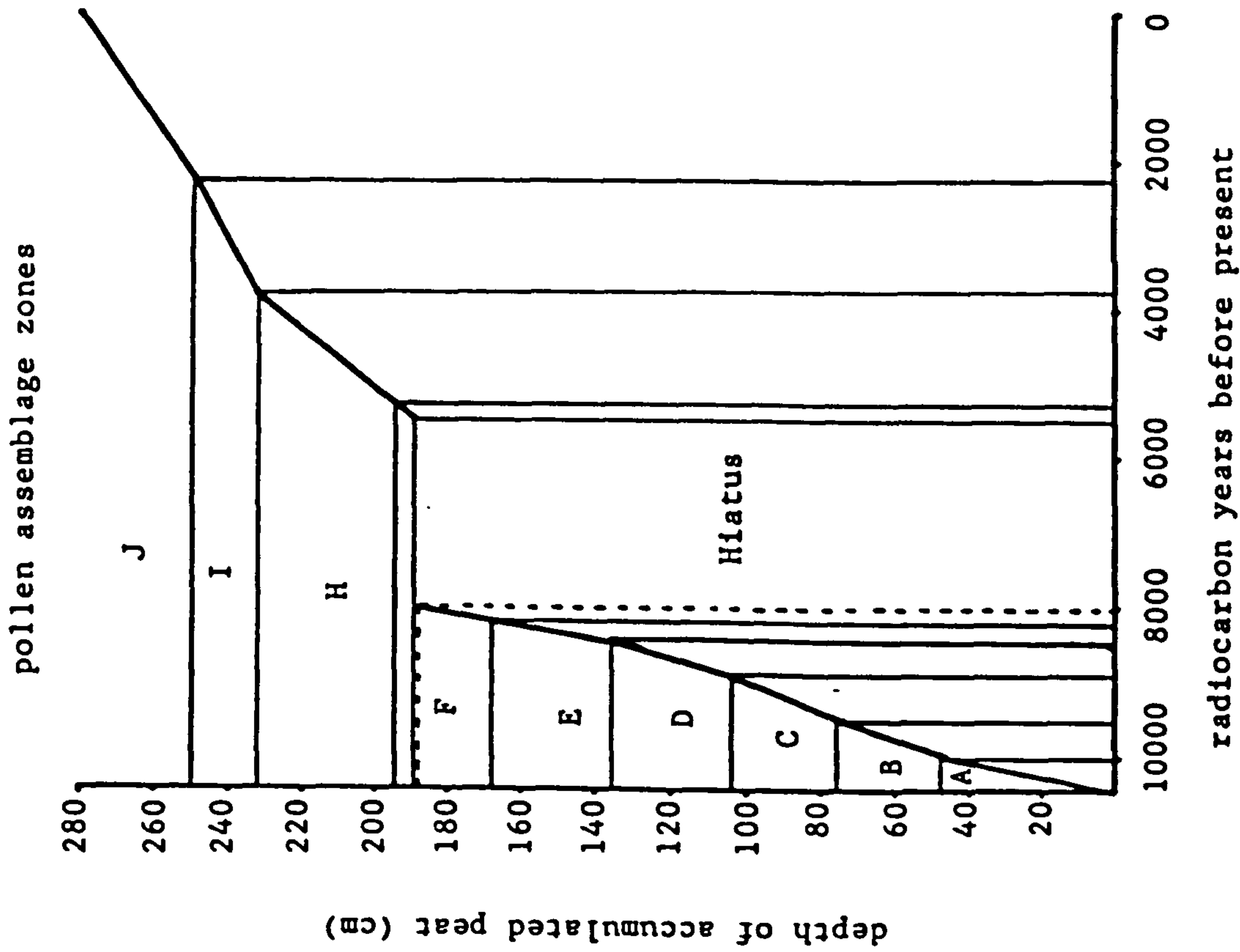


Fig. 18 : Lanshaw 1 peat growth curve.

Zone B : Betula-Cyperaceae p.a.z.

Using the rate of peat growth shown in fig.17 a date of 10000 BP can be suggested for the start of this zone. It is marked by an expansion of Betula pollen, which probably represents the arrival of the first trees on the moor, and also by a small peak of Juniperus pollen. The AP (arboreal pollen) curve rises but NAP also increases, suggesting an overall increase in pollen productivity.

Some of the least shade tolerant species of the previous zone e.g. Thalictrum, are not recorded in this zone, but there is still some pollen of types typical of open environments, such as Rumex acetosa type and Caryophyllaceae.

The appearance of a curve for Menyanthes suggests that the bog surface was quite wet in this zone, and the macro-fossil evidence shows that it supported a wide variety of mosses and Carex spp. At the top of the zone Betula falls to a very low level and Filicales spores increase.

Zone C : Betula-Pinus-Corylus p.a.z.

The beginning of zone C marks the expansion of the Pinus curve and the start of the Corylus curve. It has been radio-carbon dated to 9520±120 BP. As the zone progresses more tree pollen types are recorded, first Quercus, then Alnus, and finally a single occurrence of Ulmus. These trees remain at low levels, although Alnus does have a small peak at 192cm. Corylus increases until by the end of the zone it reaches 20% TP (total pollen). Percentages of Betula and Pinus pollen are erratic, as is the Cyperaceae curve which generally is lower than in zone B except for a large peak at 208cm. NAP is lower than in zone B except at 208cm due to the large Cyperaceae peak.

For the first time in the diagram AP is greater than NAP, but the influx diagram shows that total pollen influx is low at around 2000 to 3000 grains cm⁻²/yr.

There are several NAP types present, such as Caryophyllaceae, Empetrum, and Rumex acetosa type, which suggest that open conditions persisted throughout this zone.

Zone D : Betula-Corylus p.a.z.

Using the rate of peat growth shown in fig.17 the date of the beginning of zone D can be estimated at about 8870 years BP. There is a large increase in pollen influx to a maximum for the zone of 9400 grains cm^{-2}/yr . The majority of this is AP, and the macrofossils provide evidence that trees were growing on the site during this zone. The most important types are Betula and Corylus. Pinus is at much lower levels than before in the percentage diagram, but shows little change in the influx diagram. Alnus and Quercus remain at low levels, but there is a second small, though more marked, peak in Alnus pollen at 162cm, which has been radiocarbon dated to 9680 ± 90 years BP.

All herbaceous pollen types are at low levels, apart from a large peak in Filipendula pollen at 178cm. Above this level NAP reaches its lowest values and there are very few types present.

Zone E : Corylus p.a.z.

Using fig.17 the start of zone E can be estimated at about 8480 years BP. Corylus is the dominant pollen type reaching 60% at the top of the zone. Salix is also important but Betula is very much reduced. Pinus pollen is at first more abundant than in zone D but it falls to very low levels at the top of the zone.

Total pollen influx is at a similar level to that of zone D, but differs in that most of it is shrub pollen rather than tree pollen. NAP is again at low levels and there are very few types represented.

Zone F : Corylus-Alnus-Filipendula p.a.z.

The start of this zone has been radiocarbon dated to 8160 ± 90 years BP and marks a limited expansion of the Alnus curve to about 15% total pollen. At the same time Quercus and Pinus values rise. Betula pollen is at first abundant and then falls but maintains a higher level than in the previous zone. Tilia and Fraxinus pollen appear for the first time and the Ulmus curve becomes continuous. These increases in the percentages of tree pollen types cause what is only a relative

reduction in the percentage of Corylus pollen since it shows no decrease in the influx diagram.

NAP remains at low levels but there are more types present than in zone D with the appearance of herbaceous pollens such as, Caryophyllaceae, Ranunculaceae and Rumex acetosa type. This zone also marks the start of curves for Pteridium and Polypodium and the expansion of the Filicales, Sphagnum and Filipendula curves.

It is difficult to interpret the diagram in this zone and there are particular problems with calculating the peat growth rate. The level above the top of the zone, 112cm, has been radiocarbon dated to 5840±80 years BP. This means either that only 20cm peat accumulated over 2320 years (a growth rate of 116 years cm⁻¹), or that at some stage peat growth stopped. There is no obvious change in stratigraphy to indicate either but the results of a test for the level of humification are discussed on p.85 . The changes which occur in the pollen assemblage at the beginning and the end of this zone are both so sudden as to suggest hiatuses. This is particularly true of the zone F/G boundary and for the purpose of constructing the influx diagram this has been regarded as an hiatus. However, an alternative diagram assuming a slow but continued peat growth is shown on p.80 and discussed on p.79.

Zone G : Alnus-Corylus-Pinus

The zone opens with a sudden increase in Alnus pollen to 45% total pollen which has been radiocarbon dated to 5840±80 BP. It causes significant decreases in all major pollen types in the percentage diagram some of which, such as Betula, Corylus and Pinus, reflect actual decreases as they also show decreases in the influx diagram. Quercus, however, does not decline in the influx diagram and Tilia and Fraxinus show small increases. Filipendula becomes important in this zone and there are smaller increases in the other NAP types such as Potentilla and Rumex acetosa type.

Starting at 100cm there is a large rise in total pollen influx which reaches over 32000 grains cm⁻² yr⁻¹ at 96cm. This is reflected by rises in all species present. The top of the zone is placed at a fall in Pinus pollen, radiocarbon dated to 5250±50 BP, giving a rate of peat growth for the zone of

1cm in 21.07 years which is much faster than previously (see fig.17). There is evidence from the macrofossils that the site was wetter during this zone, at 100cm a Potamogeton seed was found and Juncus squarrosus seeds are common in the peat above this level, and it may be that faster peat growth and wetter conditions led to better preservation of pollen. There is a noticeable improvement in the condition of the pollen grains at the beginning of this zone.

Zone H : Alnus-Quercus-Corylus p.a.z.

Alnus remains the dominant pollen type at slightly higher frequencies than in zone G. Quercus is more abundant, but Corylus and, to a lesser extent, Tilia are reduced, and the Pinus and Ulmus curves become discontinuous. There is a small rise in NAP due mainly to a rise in Gramineae, but this falls to its previously low level at the top of the zone. Filipendula and Filicales are less important than in the previous zone.

Fig.17 shows that peat growth slowed to 1cm in 46.5 years during this zone. If this was a result of increased dryness it would explain the fall in total pollen influx, i.e. less pollen was preserved. This is supported by the poor condition of many of the pollen grains in this zone, particularly at 72cm where pollen influx falls to 3300 grains $\text{cm}^{-2}\text{yr}^{-1}$

Zone I : Alnus-Gramineae p.a.z.

The beginning of this zone is placed at the start of the Plantago lanceolata curve and at a rise in Gramineae pollen. It has been radiocarbon dated to 3760±50 years BP. Alnus falls slightly at the beginning of the zone but it recovers and reaches its maximum of over 70% at 32cm. Quercus also declines at the beginning of the zone and is much less important than in zone H. The Betula curve is erratic but is generally higher than in the two previous zones. Tilia is completely missing from this zone.

The NAP curve rises at first mainly as a result of the higher frequencies of Gramineae pollen but it falls in the latter half of the zone. At the same time as the rise in

Gramineae pollen and the appearance of Plantago lanceolata pollen there is a peak in Artemisia pollen followed by a peak in Rumex acetosa type.

Fig.17 shows that the rate of peat growth in this zone is similar to that of the previous zone but there is a marked increase in pollen influx. This suggests that there was an increase in pollen production. There is, however, a marked improvement in the standard of pollen preservation and evidence from the macrofossils that the site was wetter in the latter half of the zone. From 40cm leaves of Sphagnum tenellum and S.papillosum are common in the peat indicating a change to wetter conditions. It may be that peat growth was slow during the first part of the zone but speeded up after 40cm giving an overall growth rate which is similar to the last zone.

Zone J : Gramineae-Calluna p.a.z.

The changes in the pollen assemblage between zones I and J are very sudden but there does not appear to be an hiatus. There is a massive fall in Alnus pollen from over 60% to 6% total pollen and a smaller fall in Betula followed by an immediate rise in Gramineae to nearly 60% of total pollen. The level separating these changes has been dated to 2170±50 years BP. There is also a change in stratigraphy from wood-peat to Sphagnum-Eriophorum-Calluna peat. After its initial sharp rise Gramineae pollen falls to around 25% total pollen and the Calluna curve expands until by the end of the zone it is the dominant pollen type.

It is around the zones I/J boundary that cereal pollen is first recorded. Its only other occurrence is at 8cm at the top of the zone. Cannabis pollen is recorded at 12cm following a peak in Alnus pollen, which is accompanied by falls in Betula and Corylus. It is after this second fall in AP that Calluna rises sharply to become the dominant pollen type.

More NAP types are present than at any other time and many are at their highest levels. The Potentilla curve expands dramatically at the start of the zone but falls off later. There are also expansions of the Plantago lanceolata, Rumex acetosa type and Pteridium curves. Empetrum increases in the

second half of the zone but it is never very important. Sphagnum spores reach their maximum early in the zone, reflecting the change from a wood peat to a partly Sphagnum peat.

Total pollen influx is much lower during this zone, probably as a result of the disappearance of trees which produce great quantities of pollen, and which were replaced by herbaceous species producing much smaller amounts of pollen.

5.3 Lanshaw 1

5.3.1 Stratigraphy

- 0 to 7cm Root mat
- 8 to 29cm Dark, amorphous Eriophorum vaginatum peat with some Sphagnum, and many Calluna seeds from 18cm. Occasional Carex nutlets and seeds of Juncus spp. Small amounts of charcoal throughout and wood from 25cm. One seed each of Potentilla erecta and Hypericum tetrapterum.
- 30 to 189cm Finely-divided, mid-brown coloured wood peat, becoming coarser from 160cm, with a small amount of monocot. material and Carex nutlets throughout. Eriophorum angustifolium roots from 35 to 51cm, and Juncus seeds from 30 to 86cm. Occasional Alnus and Betula fruits and a Salix bud at 100cm. Many Betula fruits from 170cm. A small amount of Sphagnum from 100cm and leaves of Eurynchium praelongum at 100cm. Small amounts of charcoal at

40cm and 156cm, and a concentration at 92cm.

Mineral material from 156 to 172cm.

190 to 257cm Dark, amorphous moss-Carex peat which is very decomposed. Many fungal sclerotia at 200cm and becoming less humified and lighter in colour from 223 to 247cm, with Carex nutlets throughout.

Mosses include Calliergon cuspidatum, Drepanocladus revolvens and Homalothecium spp.

258 to 280cm Grey clay containing much monocot.material and many trigonous Carex nutlets, both becoming less frequent from 262cm where there are more biconvex Carex nutlets. A few small pieces of wood at 260cm. Occasional Juncus seeds and a seed each of Potentilla palustris and a Stellaria sp. A Salix bud at 260cm. Mosses include Drepanocladus cf. aduncus, Amblystegium tenax, Calliergon cuspidatum and Homalothecium sp. at 280cm.

5.3.2 Description of the Lanshaw 1 Pollen Diagrams

Zone A : Cyperaceae-Gramineae p.a.z.

Cyperaceae is the most abundant pollen type reaching 86% TP at 256cm, and Gramineae is the only other pollen which reaches more than 6% TP. Total pollen influx is very low at less than 4000 grains $\text{cm}^{-2} \text{yr}^{-1}$ and the majority of this is NAP. The only tree pollens present are Betula and Pinus but the influx diagram, in particular, shows that they are at such low levels that they are unlikely to have been growing in the Rombalds Moor area.

The Typha angustifolia pollen suggests that there was some standing water near to the site during this zone. Peat growth starts at 257cm about halfway through the zone and the macrofossils show that it is a very decomposed moss-Carex peat.

There are many NAP types present some of which are typical of open habitats such as Rumex acetosa type, Caryophyllaceae and Thalictrum, and several are typically found in late-glacial deposits e.g. Epilobium, Thalictrum and Empetrum.

Zone B : Cyperaceae-Betula p.a.z.

The zone opens with an expansion of the Betula curve which then declines, followed by a smaller increase in Pinus pollen apparent only in the influx diagram. This latter is caused mainly by the large increase in pollen influx to over 24000 grains $\text{cm}^{-2} \text{yr}^{-1}$ at 216cm. The major part of this increase consists of Cyperaceae pollen which is still the dominant pollen type but is at slightly lower levels than in zone A. Filicales, spores and to a lesser extent Filipendula pollen, are more abundant than previously but other NAP types are either reduced or absent. There are only six NAP types in this zone compared with fourteen in zone A.

The peat is less humified between 223 and 247cm, and the presence of Drepanocladus aduncus in the peat suggests that the site may have been wetter. Watson(1981) describes D.aduncus as a plant of bog pools and wet peaty places. This could explain the increase in pollen influx as more pollen would be preserved in a wetter deposit, but it could also be due to increased pollen production as a result of higher temperatures and an increased amount of vegetation.

Zone C : Betula-Pinus p.a.z.

The Betula curve expands again during this zone as does the Pinus curve. Ulmus, Quercus and Alnus pollen types appear in very small numbers and the Corylus curve becomes continuous but remains below 5% TP. The rises and falls of many pollen types during this zone are probably relative effects due to the unusually large amount of Salix pollen at 200cm and the high percentage of Cyperaceae pollen at 176cm. Clumps of Salix were noticed on the pollen slides for the 200cm sample so it is likely that the 15000 Salix grains recorded at this level are the result of a catkin, or part of a catkin, falling onto the site where the boring was taken.

The peak in Salix pollen also makes the fall in pollen influx during this zone appear very dramatic. If it is taken into account a fall of pollen influx is still apparent but begins one level higher between 192 and 184cm. The reason for this fall may be a lowered rate of pollen preservation, and also the change from a moss-Carex peat to a wood peat at 190cm.

There are few NAP types present in this zone except at 190cm where there are isolated occurrences of Chenopodiaceae, Caryophyllaceae and Potentilla.

Zone D : Betula-Corylus-Pinus

The most obvious feature of this zone is the rapid expansion of the Corylus curve to nearly 30% TP. Betula and Pinus are still important but at slightly lower levels than in zone C. Cyperaceae and Gramineae are also less important than in the previous zone.

The very low pollen influx values are thought to be largely the result of the very coarse wood peat making accurate estimates of pollen concentration impossible.

There are some indications from the pollen assemblage of this zone that disturbance may have been taking place in the woodland around Lanshaw. There is a small peak in Alnus pollen, starting at 160cm, which also marks the start of the Calluna and Polypodium curves and a small peak in Empetrum pollen. This coincides with the appearance of mineral material in the peat from 172 to 156cm suggesting that there may have been some erosion in the surrounding area leading to the deposition of mineral material at the Lanshaw 1 site. At level 152cm much finely-divided, carbonised material was found in the peat, which could mean that some burning of the woodland was taking place. At this point in the diagram there is a small peak in Pteridium spores and a single occurrence of Plantago lanceolata pollen both of which could indicate disturbance.

Zone E : Corylus p.a.z.

Corylus is the dominant pollen type reaching its maximum during this zone of 56% TP. Salix is at higher levels than previously, particularly in the middle of the zone. Betula is at its lowest levels but Pinus, although reduced, is still important. Ulmus and Alnus remain at low levels but there is slightly more Quercus than previously, and at the top of the zone there is a single occurrence of Fraxinus pollen.

NAP is at low levels but increases towards the end of the zone due to an expansion of the Cyperaceae curve. The summary

diagram shows a massive increase of shrub pollen at the expense mainly of tree pollen. Pollen influx values are fairly constant at between 4000 to 5000 grains $\text{cm}^{-2} \text{yr}^{-1}$.

Zone F : Corylus-Pinus p.a.z.

Corylus is still the dominant pollen type but falls to 32% TP in the middle of the zone and recovers to its former levels at 96cm. Pinus pollen increases to over 20% TP. The Quercus, Alnus and Ulmus curves become continuous, the former two remaining at low levels but the Ulmus curve, though erratic, reaches 5% TP.

NAP is at low levels and few NAP types are present at the start of the zone. More types appear during the zone including Chenopodiaceae pollen at 96cm. NAP values rise mainly as a result of a peak in Cyperaceae pollen and there is also an increase in Filicales spores and, to a lesser extent, Pteridium spores. Pollen influx rises from nearly 5000 grains $\text{cm}^{-2} \text{yr}^{-1}$ at the beginning of the zone to over 16000 grains $\text{cm}^{-2} \text{yr}^{-1}$ at the end of the zone.

Zone G : Corylus-Alnus-Pinus p.a.z.

This is essentially a transition zone, in which very rapid and major changes take place in the pollen diagram, even though it is only represented by 6cm peat. At 92cm Corylus and Pinus pollen levels are high and Alnus and Quercus are at low levels. By 88cm this situation is reversed with Alnus as the dominant pollen type at nearly 50% TP.

Pollen influx is at the high levels reached at the end of zone F but falls slightly at 88cm. The majority of this is tree and shrub pollen. This zone marks the appearance of Tilia which begins a continuous curve but Ulmus is at lower levels than in the previous zone.

NAP is at lower levels than before but this is due to a fall in Cyperaceae pollen, all other NAP types are increased including Caryophyllaceae and Chenopodiaceae, and Filicales spores are at particularly high levels. The charcoal in the peat at 92cm may mean that there was some opening of the forest due to fire, which would explain the presence of Empetrum,

Artemisia, Caryophyllaceae and Chenopodiaceae pollen at that level. There are also small peaks in the Gramineae and Fraxinus pollen curves and of Pteridium spores, all of which could indicate a slight opening of the forest. Polypodium and Filipendula are increased in this zone and were probably important constituents of the ground-flora.

Zone H : Alnus-Corylus p.a.z.

Alnus and Corylus are the dominant pollen types and both show a slight rise and then a fall. Quercus reaches its maximum of 15% TP in the early part of the zone but then falls gradually to around 8% TP. Ulmus, Pinus and Betula are present at low levels and Fraxinus is absent except at the top of the zone. The Tilia curve is at its maximum during this zone but never reaches more than 2% TP. Pollen influx is much lower than in the previous zone at only 4000 grains $\text{cm}^{-2} \text{yr}^{-1}$.

The macrofossils show that trees were still growing on the site in this zone but it may have been wetter since seeds of Juncus species are recorded from the beginning of the zone, and Potamogeton pollen is present in the pollen diagram.

Zone I : Alnus-Gramineae p.a.z.

The start of zone I marks the first appearance of cereal pollen and the beginning of a rise in Gramineae pollen. Corylus and Quercus are at lower levels than in zone H and the Tilia and Pinus curves are discontinuous, but Betula pollen is more abundant than in the previous zone.

Cereal pollen appears in the diagram for the first time at 48cm and is then recorded at every level in this zone. The 48cm level also marks the start of a continuous curve for Caryophyllaceae. The increase in NAP is largely due to the rise in Gramineae pollen but other NAP types show small rises and several NAP types appear or reappear during this zone.

Pollen influx rises sharply at the beginning of the zone to nearly 20000 grains $\text{cm}^{-2} \text{yr}^{-1}$, the majority of which is tree pollen. At the same level Eriophorum angustifolium becomes a constituent of the peat and the Sphagnum curve is continuous, suggesting that the site may have become wetter.

Zone J : Gramineae-Calluna

The boundary between zones I and J is placed at a sharp and major fall in Alnus pollen, and at the point of smaller falls in the Corylus and Quercus curves. The Gramineae and Betula curves rise immediately but Betula falls again to its former levels. Calluna and Cyperaceae are both at higher levels than before but both curves are erratic. These changes in the pollen assemblage occur at the same point as a major change in the peat stratigraphy from a wood peat to an Eriophorum vaginatum peat, indicating the disappearance of trees from the site.

There is a large expansion of the NAP curve with 20 types represented, and with particularly large increases of Plantago lanceolata, Potentilla and Rumex acetosa type, and also of Pteridium and Sphagnum spores. Cereal pollen is recorded intermittently throughout the zone.

Salix pollen increases gradually in the first half of the zone reaching a peak at 18cm. It then falls sharply at the same time as a smaller fall in Gramineae pollen. Following this there is a second decline in AP types including Betula, Quercus, Alnus and Corylus. At the same time Calluna pollen rises, to reach 58% at the top of the diagram. The uppermost level counted, 6cm, shows an increase of Empetrum pollen to 16% TP.

The fall in pollen influx during this zone is probably the result of the removal of trees from the site, and their replacement by herbaceous species which produce much less pollen than trees.

5.3.3 Discussion

Although Betula and Pinus are present in the basal clays the influx diagrams show that they are at such low levels that they are likely to be the result of long-distance transport. The absence of trees and the presence of light-demanding species such as Thalictrum and the ruderal Rumex acetosa type suggest a Younger Dryas age for the clays. This is supported by the radiocarbon date of 10250±100 years BP for Lanshaw 2 at 252cm which marks the beginning of peat growth, a

surprisingly early date for a Pennine peat deposit. The pollen of the basal peat layers is very similar to the assemblage from the clay, with Cyperaceae and Gramineae the dominant types. The vegetation of the site during zone A must have consisted largely of sedges, and perhaps Juncus spp. as their seeds are found in the clay. The surrounding vegetation was probably a species rich grassland. The presence of light-demanding species such as Thalictrum and Saxifraga oppositifolia type indicates that the vegetation must have been low-growing. There must also have been some disturbance in the environment, perhaps caused by freeze-thaw action, to provide suitable habitats for ruderals.

The end of zone A in both diagrams is marked by a small peak in Juniperus pollen. Bartley(1962) considers that the Juniperus peak at Tadcaster marks the end of the late-Devensian period and therefore the transition between Godwin's zones III and IV. This transition is traditionally placed at the beginning of the expansion of the Betula curve. Both influx diagrams show that there are increases in Betula pollen at the boundary between zones A and B.

Using the rate of peat growth shown in fig.17 the beginning of zone B can be estimated at 10000 years BP. At about this time the climate of England began a period of very rapid warming which allowed the migration of trees northwards (Lamb,1982,p.24). Pennington(1975) gives this date as the approximate start of the Flandrian period. The expansion of the Betula curve during zone B is likely to be evidence of the arrival of the first trees in the Lanshaw area. Some of the herbaceous pollen types recorded in zone A are absent from this zone, notably Thalictrum and Saxifraga oppositifolia type.

The amount of Betula pollen present suggests that only a few trees were growing near to the site and certainly not enough to cause the disappearance of light-demanding herbs. A more likely reason for their absence in this zone is that with increasing temperatures the productivity of the environment increased so that grasses, sedges, ferns and Filipendula became taller and more abundant and it was these that outshaded

some of the low-growing herbs. The cessation of freeze-thaw conditions would lead to a more stable environment with less new ground available for ruderals. There is, however, still pollen present from light demanding species such as Rumex acetosa type and Caryophyllaceae. The vegetation around Lanshaw at this time must therefore have remained fairly open with light birch woodland in places.

The second tree pollen curve to expand is Pinus during zone C. It is likely, therefore, that Pinus was the second tree to arrive on the moor at around 9500 years BP. Zone C, opens at both sites, with a peak in Salix pollen and marks the beginning of the Corylus curve, and the first recordings of Quercus, Ulmus and Alnus pollen types. This is clearly a result of the continued rise in temperatures allowing the migration northwards of more thermophilous tree species. Wood is found in the peat during zone C though it is not a true wood peat until part-way through the zone. This indicates that trees were growing on the site, most probably Betula and Salix and perhaps Alnus. The pollen of Ulmus and Quercus is at such low levels that it is unlikely they were growing on the moor itself. The end of zone C can be tentatively dated to 8870 years BP. During this zone peat growth was quicker at Lanshaw 2 (1cm in 15 years) than at Lanshaw 1 (1cm in 23 years) even though the two sites are very close.

Although many trees are represented in the pollen diagram during zone C total pollen influx is low at around 2000-3000 grains $\text{cm}^{-2} \text{yr}^{-1}$ and this level of production according to Birks(1982) is more representative of Forest-Tundra type vegetation than of Boreal Forest. This view is supported by the presence of pollen of light-demanding species such as Caryophyllaceae, Empetrum and Rumex acetosa type and the importance of Cyperaceae and Filipendula.

The small peak in Alnus pollen in the Lanshaw 2 diagram at 192cm is not easily explained. It has been suggested by Smith(1970,1984) that early appearances of Alnus are related to disturbances of the vegetation by Mesolithic man. This is discussed in more detail below and on p.87 . Although Lanshaw 1 zone C does not show an Alnus peak, Alnus pollen was recorded

at one level.

From the evidence of the influx diagrams one can propose that forest was not established in the Lanshaw area until the beginning of zone D, when total pollen influx at Lanshaw 2 reaches values of over 8000 grains $\text{cm}^{-2} \text{yr}^{-1}$, a level of production which compares with figures for present day Boreal forest (Birks, 1982). Fig. 17 provides an estimate for the start of zone D of 8870 years BP. Betula, Corylus and Salix appear to have been the most abundant trees locally, probably with Betula and Salix more important on wetter land. Betula was almost certainly growing on the site at this time as the peat contains numerous Betula catkin scales and seeds. The low levels of NAP during this zone point to the development of a relatively dense woodland cover in the Lanshaw area. It is not clear why Pinus pollen is at such low levels in Lanshaw 2 zone D compared with the previous zone, and with Lanshaw 1 zone D. It may be that Pinus was never growing near to the site, and that during zone D the increased presence of Betula and Corylus trees in the Lanshaw area prevented much Pinus from reaching the Lanshaw 2 site. However, the Lanshaw 2 influx diagram shows only a small decrease in Pinus pollen so much of the decrease in the percentage diagram must be a relative effect due to increased amounts of other pollen types.

Both sites show a small peak in Alnus pollen in the second half of zone D. these are similar to an early Alnus peak at Tadcaster (Bartley, 1962), which was considered to be the result of downwash of pollen through the lake sediments. This is most unlikely to have occurred at Lanshaw in a wood peat. Smith (1970) suggests that Alnus was sensitive to interference with the forest by Mesolithic man and it increased by moving into cleared areas. There are certainly signs of forest disturbance in the pollen diagrams at the time of the early Alnus peaks. The presence of charcoal in the deposits suggests that some forest burning was taking place, which led to small increases of bracken, heather and grasses. This clearance would have resulted in increased erosion and runoff into the Lanshaw basin, thus explaining the deposition of mineral material at the Lanshaw 1 site.

The second Alnus peak has been radiocarbon dated to 9680±90 years BP. This date has been rejected as being too old, partly on the basis of its non-conformity with the other Lanshaw dates, but also because this is much too early a date for the establishment of dense hazel woodland, which was dated at 8880±170 years BP at Red Moss, Lancashire (Hibbert, Switsur and West, 1971). The reason for this early date is not known, but it is discussed on p.149.

During zone E after about 8500 years BP, Corylus becomes the dominant pollen type but Betula is greatly reduced. The pollen assemblage infers a dense hazel-willow woodland in which birch has been shaded out. Ulmus and Alnus pollen are at low levels, and Quercus pollen is absent and it seems unlikely that any of these were growing near to the site during this zone.

It is difficult to correlate Lanshaw 1 zone F with the Lanshaw 2 diagram. The changes in the pollen assemblage at the beginning of the zone, i.e. a fall in Corylus pollen and increases of Pinus and Ulmus pollen, are probably contemporary with similar changes at 136cm at the top of Lanshaw 2 zone E. According to the peat growth curve this dates to about 8200 years BP. The changes which occur at the beginning of Lanshaw 1 zone G, most notably the rises of Quercus and Alnus and the start of the Tilia curve, appear to be the same as at 128cm at the base of Lanshaw 2 zone F. This correlation is supported by the presence of Cyperaceae peaks at 132cm in the Lanshaw 2 diagram and at 104cm in the Lanshaw 1 diagram. If this correlation is correct it means that only 8cm of peat at Lanshaw 2 records the same vegetation changes as 20cm of peat at Lanshaw 1.

It is likely that important changes were taking place in the woodland on the drier land surrounding Lanshaw 1 at this time. In the pollen diagrams the dominance of hazel and willow is decreased and pine and elm are more important. It is probable, therefore, that the hazel woodland of zone E was being replaced by a pine-elm woodland in which ferns were important elements of the ground flora.

The pollen assemblage in Lanshaw 2 zone F points to the

establishment of a mixed deciduous forest in the Lanshaw area. The vegetation on and immediately around the site is likely to have been a birch-alder carr, with a ground flora including many ferns and frequent Filipendula, with Sphagnum in wetter parts and heather and crowberry in drier parts. This must have been more open than the hazel woodland of the previous zone since NAP is increased, there are more NAP types, and pollen of Caryophyllaceae, Rumex acetosa type and Empetrum appear.

The drier land surrounding the site probably supported a mixed hazel-oak-pine woodland with occasional lime and elm and rarely ash. The increased levels of birch in this zone are further evidence that the woodland cover was not as complete as in the previous zone. It is interesting that the rise in Alnus coincides with the beginnings of an opening in the forest. This would support Smith's (1970, 1984) view that there is a link between increased Alnus levels and forest disturbance.

It is mentioned on p. 52 that there is uncertainty about the interpretation of Lanshaw 2 zone F and its boundaries, because there is only 20cm peat representing some 2300 years and there are important and abrupt changes in the pollen assemblage. There are several possible interpretations: (i) An hiatus at the end of zone F. Fig. 17 shows that such an hiatus would mean that peat growth stopped for over 2000 years between about 7900 years BP and 5840±80 years BP. This would infer dry conditions in the late Boreal period stretching well into the Atlantic period. The problem with this is that the Boreal-Atlantic transition has been regarded as a time of increased rainfall, though this has largely been inferred from the rise of Alnus and the spread of upland peats in Britain, and Smith (1984) illustrates that the rational limit of Alnus is not synchronous and notes that the date of the spread of upland peats has been shown to be variable. Magny (1982) points out that Alnus is an unsuitable indicator of increased wetness since it can instead indicate a drying out of the bog. Bellamy (1966) suggested that bogs stopped growing in the Atlantic period if they became too wet. (ii) An hiatus at the beginning of zone F. If peat growth is assumed to have stopped and re-

started between 132 and 128cm, and the peat growth rate of zone G is applied to zone F, it would mean that peat growth stopped at around 8100 years BP and restarted around 6200 years BP. This interpretation gives similar results to (i) but it would mean peat growth starting somewhat earlier in the Atlantic. (iii) Hiatuses at both the beginning and end of zone F. In this case it would not be possible to date zone F except to say that it lay between 8160 ± 90 years BP and 5840 ± 80 years BP. (iv) Continued, but very slow, growth at a rate of 116 yrs cm^{-1}

In order to construct the influx diagram one of these interpretations had to be accepted and since the changes in pollen diagram are so abrupt at the zone F/G boundary it was assumed that there was an hiatus here. However, an alternative part-diagram was constructed assuming continued, slow growth and is discussed on p.79. The results of a test for the level of humification of both deposits are also relevant (see p.85).

It is recognised that any one of the above interpretations could be correct and that, without closer sampling and the aid of more radiocarbon dates it is impossible to decide which, if any, is the correct hypothesis. The situation is complicated further by attempting to correlate the Lanshaw 1 and 2 diagrams. The changes in the pollen assemblage of Lanshaw 1 zone G involve rises in Alnus and Quercus and a fall in Pinus pollen, all compressed into 4cm of peat. Whereas in the Lanshaw 2 diagram the initial rise in Alnus and the fall of Pinus are separated by 44cm peat. This suggests that there was also an hiatus at Lanshaw 1 during the BAT but that it lasted longer than at the Lanshaw 2 site.

It is difficult to imagine that type of conditions which could have affected peat growth so differently at the two sites which lie within a few metres of each other. The problem of the BAT at Lanshaw, and particularly differences in peat growth rate, forms the basis of a study presently being undertaken by Miss J.Shore (Leeds University), which, it is hoped, will provide some answers to the questions posed by this work.

An unusual feature of the Lanshaw diagrams is the late rise of Quercus, at the same time as the Alnus rise. This has been noted in other diagrams from northern England such as at

Pow Hill, Co. Durham (Turner, 1981), where Quercus and Alnus rise together at 5300±40 years BP. Turner suggests that on low-mid altitude Millstone Grit sites the low nutrient status and slow soil development allowed birch and pine to remain dominant delaying the expansion of oak and alder. The Pow Hill diagram is similar to the Lanshaw 2 diagram in another way in that Pinus pollen does not fall at the Alnus rise but persisted even longer than at Lanshaw until the forests were removed by man in late prehistoric times. The persistence of Pinus after the Alnus rise is also apparent in diagrams from Soyland Moor in the Central Pennines (Williams, 1983), where a very gradual decline of Pinus begins at about 7300 years BP but it does not fall below 5% TP until 6110 years BP, some 1500 years after the Alnus rise.

Alnus has a second, more important rise at the beginning of Lanshaw 2 zone G, dated to 5840±80 years BP. This two stage rise of Alnus is also present in diagrams from Ingleborough, N. Yorkshire (S. Swales, unpublished) where the initial rise has been dated to 7450±80 years BP and the second, larger rise to 6140±80 years BP. The macrofossil evidence and the increased rate of peat growth in zone G points to increased wetness of the site. Zone G probably represents the optimum forest period with high pollen productivity as shown by the high pollen influx. Corylus and Betula were less important constituents of the forest of this zone which seems to have been dominated by Alnus and Quercus with Tilia and Fraxinus more abundant than before and Filipendula dominating the ground flora.

There are some indications in the later stages of Lanshaw 2 zone G that a limited amount of clearance may have taken place. There is a slight rise in Gramineae pollen and increased amounts of Caryophyllaceae, Compositae, Rumex acetosa type and Pteridium all of which can indicate open conditions. The fall in Pinus pollen at the top of Lanshaw 2 zone G, dated to 5250±50 years BP, is not easily explained. It is also apparent in the influx diagram and is, therefore, not a relative effect caused by the increase in Alnus pollen. Most tree pollens, apart from Corylus, show an increase at this point in the pollen diagram, so the fall in Pinus pollen is unlikely to

represent a major clearance event. It is close in age to the 5490±40 years BP date of the elm decline at Rishworth, West Yorkshire, some 15 miles south of Rombalds Moor (Bartley, 1964). It is known that the behaviour of Pinus in the Pennines differs very much from one locality to another, but the reasons for this are not understood. Although the fall in Pinus does occur at a point in the Lanshaw 2 diagram where there is some evidence of forest disturbance it is difficult to suggest why Pinus should have been selectively cleared.

During zone H in both the Lanshaw 1 and 2 diagrams the pollen assemblages infer an alder carr with a ground flora including ferns, Filipendula and members of the Compositae and Ranunculaceae. Quercus and Tilia were probably more important in the surrounding woodland than their levels in the pollen diagrams would suggest since both types tend to be under represented. There is also evidence of a continuation of the opening of the forest which began during the previous zone. The presence of Rumex acetosa type pollen, the appearance of Artemisia and Ilex, and the small rise in Gramineae pollen all suggest limited clearance. Both influx diagrams show a decrease in pollen influx in zone H which, it was suggested on p.53, may be the result of pollen degradation.

Plantago lanceolata pollen does not appear in the Lanshaw 2 diagram until 3760±50 years BP at the start of zone I and is associated with a peak in Artemisia pollen followed by a peak in Rumex acetosa type pollen. This is probably close to the date of the start of Lanshaw 1 zone I which is placed at the beginning of a curve for cereal pollen, and just above the first appearance of Plantago lanceolata. NAP values rise in both diagrams during zone I due mainly to rises in Gramineae pollen, but with increases also of Calluna and Potentilla, and, in the Lanshaw 1 diagram, of Caryophyllaceae.

This evidence, together with the falls in Quercus and Tilia pollen, points to a more substantial clearance than in the previous zones and to a very limited amount of cultivation. It may be that the clearance was greater than it appears to have been. It is unlikely that the area immediately

around the sites would have been cleared since it was probably quite wet. It is possible, therefore, that the local vegetation, which from the macrofossil evidence appears to have been a wet woodland, most probably Alnus dominated, was producing so much pollen that it masked the true amount of clearance taking place in the surrounding woodland. It is possible that in drier areas and also at lower altitudes substantial clearance was taking place and caused the decline in the Quercus curve and the disappearance of the Tilia curve. The increase in Betula pollen, particularly apparent in Lanshaw 1 zone I, can be explained by the spread of birch trees into cleared areas.

No cereal pollen is recorded in Lanshaw 2 zone I and only single grains are present in Lanshaw 1 zone I, so it is unlikely that the main purpose of the clearance at the beginning of this zone was to provide land for growing crops. It must instead have been for pasture-land or settlement, or simply for the timber. Cereal pollen does not appear in the Lanshaw 2 diagram until the end of zone I just below the 25cm level which has been radiocarbon dated to 2170±50 years BP. This probably means that the source of the cereal pollen grains in Lanshaw 2 zone I was some distance from Lanshaw and the area under cereals quite small.

The boundary between zones I and J is placed, in both diagrams, at the point of sudden falls in Alnus pollen followed by increased levels of Gramineae, Cyperaceae and later of Calluna. This must represent a major clearance event and the presence of cereal pollen suggests that at least some of this clearance was for agriculture. The low percentages of cereal pollen probably means that the agricultural land was not close to the site.

Open conditions during zone J are indicated by the amount of Plantago lanceolata, Rumex acetosa type and Potentilla pollen all of which are at their highest levels. The initial effect of the clearance seems to have been an increase in grassland and, to a lesser extent, heathland. The rises in Salix and Betula pollen in the Lanshaw 2 diagram

suggest that some of this cleared land was allowed to regenerate to scrub-type woodland. The Lanshaw 2 diagram shows evidence of a later regrowth of Alnus and Corylus and both diagrams show a clearance of this secondary woodland. This second clearance was accompanied by a much smaller spread of grassland than the first and it appears that instead there was an important spread of heathland, indicated by the large rises of Calluna pollen and smaller rises of Empetrum pollen. Immediately after the clearance in the Lanshaw 2 diagram there is a single occurrence of Cannabis pollen, followed by a reappearance of cereal pollen. It is not possible to date these events since it is not known if the top of the diagram represents the present-day. This seems unlikely, however, because Empetrum is less than 5% TP, whereas today it is an important constituent of the vegetation around the Lanshaw 2 site. However, Empetrum pollen does not travel far from the parent plant and is only very locally represented (Bartley, 1967). If the top of the diagram does represent the present it would give a peat growth rate for the zone of 1cm in 87 years. This is slow, and infers dry conditions which is inconsistent with the macrofossil evidence. It is possible that the second clearance is contemporary with the second clearance at Hebers Ghyll, dated to 590±40 BP, which also marks the appearance of Cannabis pollen in that diagram.

5.4 Lanshaw 3

5.4.1 Stratigraphy

0 to 4cm	Root mat
5 to 45cm	Dark fibrous <u>Sphagnum</u> peat with roots of <u>Eriophorum vaginatum</u> and <u>E.angustifolium</u> . Many seeds of <u>Juncus squarrosus</u> and some of <u>Juncus articulatus</u> . Many small pieces of charcoal, less frequent after 13cm. A small amount of <u>Rhytidiadelphus squarrosus</u> . After 30cm there is less <u>Eriophorum</u> and <u>Carex</u> rootlets appear. Some wood from 40cm.
46 to 59cm	Coarse wood peat with seeds of <u>Juncus squarrosus</u> .
60 to 137cm	Finely-divided wood peat containing occasional leaves of <u>Sphagnum</u> spp. and <u>Thuidium tamariscinum</u> . Occasional seeds of <u>Juncus squarrosus</u> and <u>Juncus effusus</u> and a cruciferous seed at 80cm. Monocot.

material and Carex rootlets appear from 110cm.

138 to 151cm Grey clay with pieces of bark and wood and much monocot. material. Some Betula twigs and a fruit, and a Salix bud scale. A small amount of charcoal at 151cm.

152 to 178cm Wood peat containing monocot. stems and Alnus buds.

179 to 199cm Finely-divided monocot. peat with some small pieces of wood.

200 to 214cm Grey clay containing some monocot. material, small pieces of wood, and a fruit of Ranunculus repens.

5.4.2 Description of the Pollen Diagram

Zone A : Cyperaceae-Gramineae p.a.z.

The basal clay contains very little tree pollen but a great variety of NAP types including Thalictrum, Rumex acetosa type and Empetrum. The most abundant pollen types are Cyperaceae and Gramineae. The pollen assemblage is similar to that from zone A at Lanshaw 1 and as such it is likely that this is a Late-glacial clay.

Zone B : Corylus-Salix p.a.z.

Corylus pollen rises to over 40% TP but then falls to less than 20% TP. The Salix curve is erratic but reaches levels almost as high as the Corylus curve. The Betula curve is also erratic, it is generally higher than in zone A but falls to only 2% TP at 168cm and then rises to 25% TP at the top of the zone. Pinus is also increased and Quercus pollen is present, though at very low levels. Cyperaceae and Gramineae are much reduced in this zone as are all other NAP types, except for Filipendula and Umbelliferae, which both show significant increases. Filicales spores are at very high levels reaching 63% TP in the middle of the zone.

An unusual feature of the zone is the continuous curve of Alnus which peaks towards the end of the zone at 11% TP.

Evidence that Alnus was growing on, or near to, the site is shown in the stratigraphy by the presence of Alnus buds in the

peat.

Zone C : Corylus p.a.z.

This has been divided into two sub-zones

Sub-zone C(i)

Corylus pollen rises to its maximum of 75% TP and dominates the sub-zone. All other pollen types are at low levels, many are lower than in zone B, but Pinus maintains its former levels at around 10% TP. The Alnus curve, although much reduced, is still continuous, as is the Quercus curve, and Ulmus pollen appears for the first time.

Very few NAP types are present and they are less abundant than before, except Cyperaceae which shows a small and gradual rise. The sub-zone is associated with a layer of clay from 138 to 151cm at the bottom of which some charcoal was found.

Sub-zone C(ii)

Corylus levels fall and at the same time there are small rises in Cyperaceae, Alnus and Gramineae. Ulmus pollen is also more abundant in this zone but declines between 120 and 112cm, at the same time as the start of the Tilia curve and the beginning of a continuous Calluna curve. Other NAP types remain at low levels though a few more types, mainly Compositae, are present. The start of the sub-zone also marks the beginning of continuous curves for Pteridium and Polypodium spores.

Zone D : Alnus-Gramineae p.a.z.

The zone opens with falls of Pinus and Corylus, and a large rise in Alnus pollen to over 40% TP. There are smaller rises in Betula and Quercus, and Gramineae pollen rises throughout the zone to become the second most abundant pollen type. There are also increases in other NAP types such as Potentilla and Ranunculaceae, and two types appear (namely Caryophyllaceae and Chenopodiaceae) which are often indicative of open conditions. The small expansion of the Pteridium curve and the appearance of Fraxinus pollen is further evidence that more open conditions existed in this zone.

Zone E : Alnus-Cyperaceae p.a.z.

Alnus pollen is less abundant in this zone but is still

at about 30% TP and Corylus pollen is also reduced, falling to less than 10% TP. The Tilia curve ends at the start of this zone but the Ulmus curve reappears. The beginning of the zone is also the point of the first appearances of Plantago lanceolata and P. major/media type pollen. Since Rumex acetosa type and Caryophyllaceae are also present it could be that this represents a phase of limited clearance activity, although Gramineae pollen values are low.

Salix pollen has a sharp peak in the middle of the zone at the same level as an isolated occurrence of Chenopodiaceae pollen, and at the point where a cruciferous species was found in the peat. At the level above this Cyperaceae, which is increasing, reaches its maximum of nearly 40% TP. These high values can be explained by observing the stratigraphic notes which show that Carex species were growing on the site during this zone.

Zone F : Alnus-Betula p.a.z.

AP values are much higher due to a large increase in Betula pollen and smaller rises of Alnus, Corylus and Fraxinus pollen types. In spite of these increases the Gramineae curve rises initially but falls off at the end of the zone. At the top of the zone Cyperaceae and other NAP types are at very low levels and there is a large peak in Betula pollen.

Zone G : Gramineae-Calluna p.a.z.

The beginning of the zone is marked by sudden, major falls of Alnus and Betula pollen and by a smaller fall of Corylus pollen. At the same time there are rises in the Gramineae, Cyperaceae and Calluna curves, and increases of Sphagnum and Pteridium spores. Other NAP types also show increases, particularly Plantago lanceolata, and there is an initial peak of Potentilla. These changes in the pollen diagram coincide with a major stratigraphical change from a coarse wood peat to a Sphagnum peat containing remains of Eriophorum vaginatum and E. angustifolium.

Gramineae is, at first, more important than Calluna, but the situation is reversed after a fall in Gramineae pollen at 24cm. A grain of Cannabis pollen was found at this level, and the Empetrum and Plantago major/media type curves begin.

Cereal pollen is only present at 16cm and 8cm, and then only in small quantities. At the top of the diagram there is a small increase in AP values.

5.4.3 Discussion

The pollen assemblage of the basal clay, with its low AP and variety of NAP types, suggests that it is of Late-glacial origin and that zone A is contemporary with zone A at Lanshaw 1 and 2.

The age of zone B is not as clear, Corylus pollen is abundant but has not yet reached its maximum. This must mean that zone B is earlier than Lanshaw 1 zone E, (the Corylus maximum) but later than Lanshaw 1 zone B in which Corylus is absent. The high levels of Corylus and Salix in this zone and the low level of Cyperaceae suggest that it is contemporary with Lanshaw 1 zone D. Even more significant is that both these zones incorporate unusually high percentages of Alnus pollen. The Alnus peak is particularly marked in the Lanshaw 3 diagram so perhaps this site was nearer to the source of the pollen than the other two sites.

Zones B and C at Lanshaw 1 and 2 do not appear to be represented in the Lanshaw 3 diagram, which must mean that peat growth at this site started about 1000 years later at around 8800 to 9000 years BP. This might be expected since today the Lanshaw 3 site is the nearest to the edge of the bog.

It is difficult to decide which changes in the pollen diagram are relative effects caused by increases or decreases in other species. An influx diagram would decide this question but there is no such diagram available for the Lanshaw 3 site. It may be that the decline in Corylus pollen at the end of zone B is due to increases of, first, Salix and then Betula.

Sub-zone C(i) probably represents the establishment of dense hazel woodland in which many other species have been outshaded, including Betula and most herbaceous species. It is likely to be contemporary with the zones of the hazel maxima at Lanshaw 1 and 2, which are believed to have started around 8500 years ago. The charcoal in the clay at the beginning of sub-zone C(i) suggests that some burning of the forest

may have been taking place. If this is the case it is possible that it caused increased runoff and erosion of the burned area, which led to the deposition of clay at the Lanshaw 3 site. There is a similar occurrence of charcoal in the peat at Lanshaw 1, above the zone D early alder peak, and although there is no clay layer the charcoal is associated with mineral material found in the peat. It is possible that the same forest burning has been recorded at both sites. In each case the charcoal occurs just before the hazel maximum, which is interesting because it has been suggested that forest burnings in the Mesolithic period encouraged the spread of hazel (Smith, 1970). A similar occurrence of a silt layer containing charcoal was found in peat of Boreal age at Ewe Crag Slack on the North York Moors, it coincided with fluctuations in the pollen diagram and Simmons et. al. (1975) interpreted it as evidence of disturbance by man. There are also numerous occurrences of charcoal and silt in Atlantic age peats on the North York Moors which are considered to be the result of man's activities (Jones et. al. 1979).

The small increases in Alnus and Ulmus, and the decrease in Corylus pollen, which occur in zone C(ii) suggest that it is contemporary with zone F at Lanshaw 1 and Lanshaw 2, giving a date for the beginning of the zone of 8160 years BP. The end of the zone is marked by a fall in Pinus pollen and a sharp rise of Alnus pollen, and just before this the Tilia curve begins and Ulmus pollen declines. The fall in Pinus in the Lanshaw 2 diagram has been radiocarbon dated to 5250 years BP, but in that diagram the fall of Pinus and the beginning of the Tilia curve are separated by 40cm peat, whereas the Lanshaw 3 diagram is similar to the Lanshaw 1 diagram in that the falls of Pinus and Ulmus, the large rise of Alnus pollen and the start of the Tilia curve all occur within 10cm of each other. It is thus difficult to suggest a date for the end of zone C.

During zone D there are some indications that the woodland cover was not as complete as in zone C. The rise of Gramineae pollen, the presence of Caryophyllaceae, Rumex acetosa type and Fraxinus pollen, and the expansion of the

Pteridium curve could all be the result of small Neolithic clearances taking place in the surrounding woodland, but there is no firm evidence of such clearances.

There is more definite evidence of clearance activity in zone E where Alnus and Corylus values fall at the same time as the first appearances of Plantago lanceolata and Plantago major/media type pollen. Although cereal pollen is not recorded, other pollen types are present which are regarded as indicators of agricultural activity, ie. Artemisia, Chenopodiaceae and P. major/media type pollen, and a cruciferous seed was found in the peat. It may be significant that the Tilia curve ends at the beginning of this zone, since Turner has suggested that human interference was the immediate cause of the Tilia decline (Turner, 1962). The start of zone E appears to record the same vegetation changes as at the Lanshaw 2 zones H/I boundary, which has been dated to 3760 years BP, a Bronze Age date. It is not clear why forest clearance should have brought about a large peak in Salix pollen in zone E but since this is not recorded in the other diagrams it must have been a very localised event.

There are fewer agricultural indicators in zone F, where the Alnus and Corylus curves recover, and there is a large expansion of the Betula curve. It may be that during this zone clearances were abandoned which led to the regrowth of woodland, particularly of Betula which is quick to recolonise forest clearings. This zone may be contemporary with the top of zone I at Lanshaw 2 where there is a fall in Gramineae pollen and an increase in Alnus pollen.

The large fall of Alnus pollen at the end of zone F probably represents the same major forest clearance recorded at the top of the Lanshaw 1 and 2 diagrams. This has been dated at Lanshaw 2 to 2170 years BP, which is an early Iron Age date. In all three cases the clearance is associated with a large peak in Betula pollen which could mean that much of the clearance was not to provide land for settlement or agriculture but simply for the timber, in which case the cleared land would be rapidly invaded by Betula which was then also cleared.

The change from a wood peat to a Sphagnum peat at 45cm

shows that trees disappeared from the site quite early on. Unlike the other Lanshaw diagrams there is little evidence here that some of the clearance was for agriculture. Cereal and Cannabis pollen only appears in the upper part of zone G. However this diagram is similar to the other Lanshaw diagrams in that the pollen suggests that the immediate effect of clearance was a spread of grassland followed by a spread of heathland.

5.5 Alternative Lanshaw 2 Diagram

5.5.1 Introduction

An alternative pollen influx diagram has been provided for the 100cm to 150cm section of the Lanshaw 2 profile on p.80. This involved assuming continued peat growth throughout zones F and G rather than, as for the main diagram, an hiatus at the zone F/G boundary. Only the major pollen types are illustrated. In addition there is an alternative peat growth rate curve, shown in fig. 20.

5.5.2 Description of the Pollen Diagram

The zones marked on the pollen diagram refer to those on the main Lanshaw 2 diagram. During zone E there is no difference between the alternative and the original diagram, the two diverge at the beginning of zone F where, in the main diagram, the growth rate of the previous zone was assumed to have continued into this zone. For the alternative diagram a growth rate of 116 yrs cm^{-1} has been calculated between the two radio-carbon dates at 132cm and 112cm. The effect this has on the influx diagram is to bring the total pollen influx down to less than $2000 \text{ grains cm}^{-2} \text{ yr}^{-1}$, which causes the alder rise to appear insignificant until the start of zone G at 5840 ± 80 years BP.

5.5.3 Discussion

Fig. 20 shows a very slow rate of peat growth from 8160 ± 90 years BP to 5840 ± 80 years BP which infers dry conditions at the Lanshaw 2 site in the Late Boreal period stretching well into the Atlantic period. This is obviously a problem since it is generally assumed that the climate became wetter at the Boreal-Atlantic transition. However, the original interpretation of the Lanshaw diagrams presents the same problem since, in that case, an hiatus is assumed from c. 7850 years BP to 5840 ± 80 years BP.

The main difference between the two diagrams is the very low pollen influx during zone F in the alternative diagram. It is not clear how this might have arisen. If dry conditions were prevalent this should not have lowered pollen productivity,

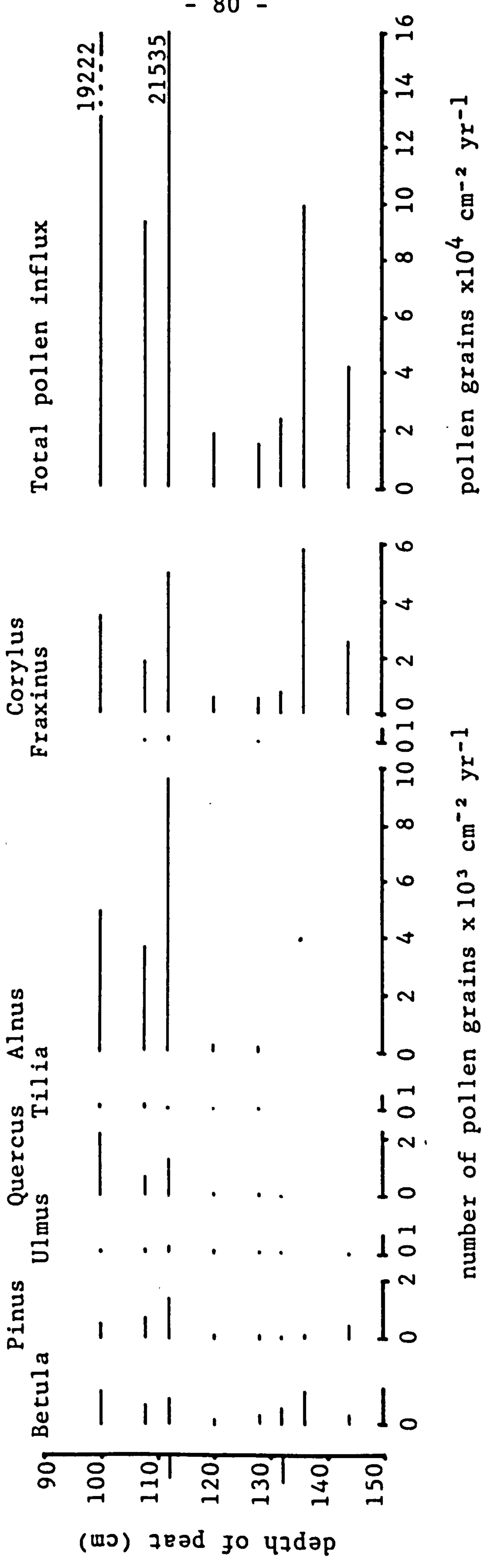


Fig. 19 : Alternative Lanshaw 2 influx diagram.

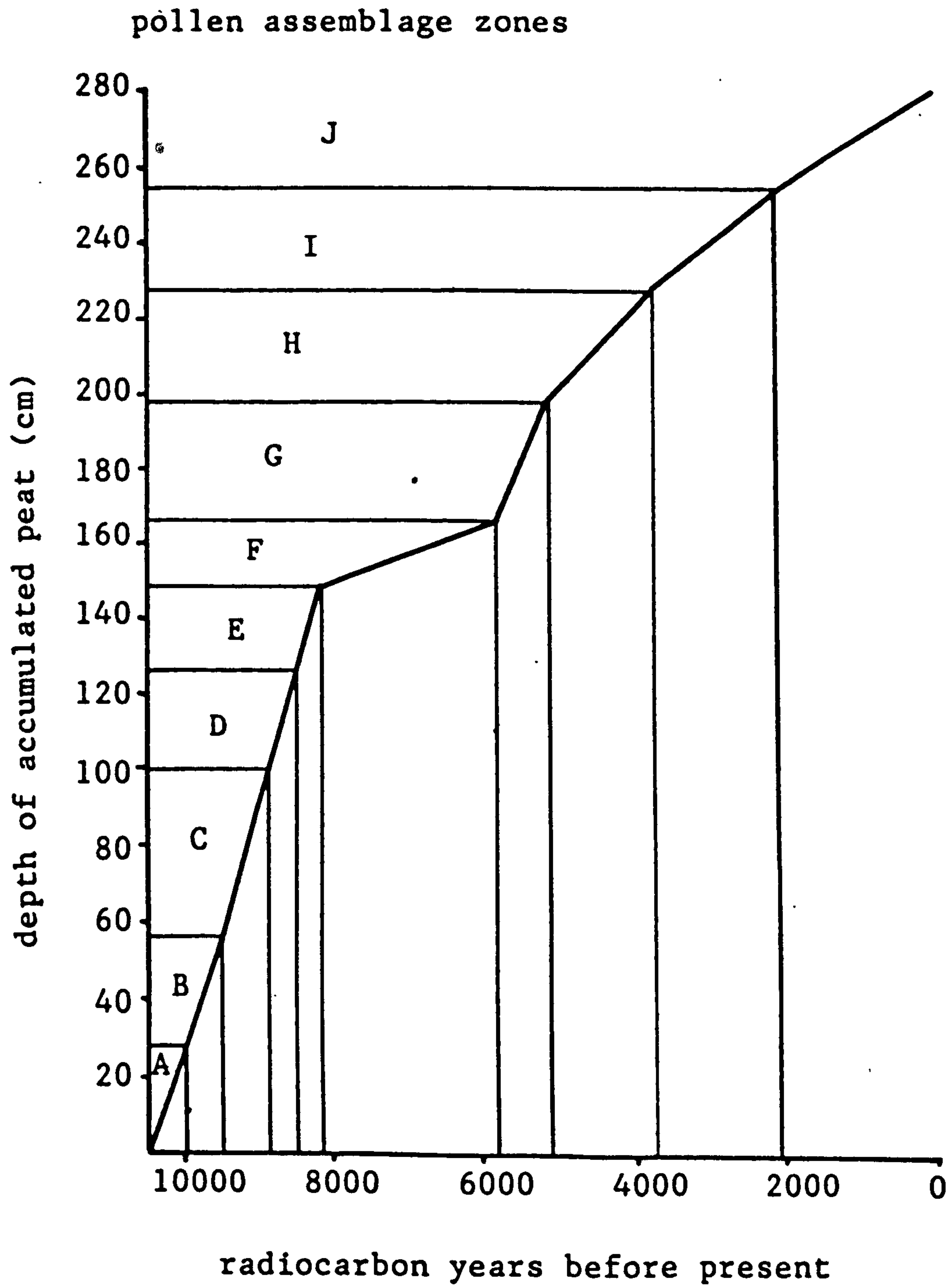


Fig. 20 : Alternative Lanshaw 2 peat growth curve.

but it could have affected the pollen preservation rate. If the Lanshaw 2 site was subjected to repeated drying out this would have led to the degradation of much pollen and an apparently low pollen influx rate. Miss J.Shore (Leeds University) is at present counting the number of degraded pollen grains across the BAT at Lanshaw to try and detect this kind of activity.

One point of interest is that the alternative influx diagram is more like the Lanshaw 1 influx diagram than the original diagram is. The former two show large rises in pollen influx to similar levels at the same time as the Alnus rise, although the Lanshaw 1 diagram does not show a drop in pollen influx prior to the Alnus rise.

5.5.4 Conclusion

It is not possible to decide whether there is an hiatus in the Lanshaw 2 diagram without the aid of further radiocarbon dates, but the fact that the alternative Lanshaw 2 diagram is more like the Lanshaw 1 influx diagram than the original diagram suggests that there may have been continued, although very slow, growth at Lanshaw 2.

5.6 Test for Humification

5.6.1 Introduction

Humification is the process by which plant and animal remains decompose to become humus, i.e. dark-brown to black, amorphous colloidal organic material. A highly humified peat is, therefore, one in which much decomposition has taken place and which is dark in colour. Peat which is little humified is pale-coloured and usually contains plant and animal remains which can easily be recognised. Such a peat will have grown quickly whereas highly humified peats, for example those formed in many bogs during the late Boreal period, are the result of very slow growth allowing much decomposition to take place. There is, therefore, a relationship between the rate of peat growth and the colour of the peat, in that the slower the growth rate the darker the peat. It was decided to use this relationship to study the peat around the Boreal-Atlantic transition at Lanshaw sites 1 and 2, in order to discover whether any differences exist between the level of humification, and hence the rate of peat growth, at the two sites.

5.6.2. Method

1cm³ samples of peat were taken at 1cm to 4cm intervals from depths between 80cm and 109cm in the Lanshaw 1 profile, and from between 84cm and 126cm in the Lanshaw 2 profile. The samples were measured by the displacement of water in a measuring cylinder. They were then boiled in 0.2 litres of 7 per cent sodium hydroxide for 30 minutes and then filtered into boiling tubes. The filtrates were very concentrated so they were diluted by 10 per cent and then tested for light

Lanshaw 2

Lanshaw 1

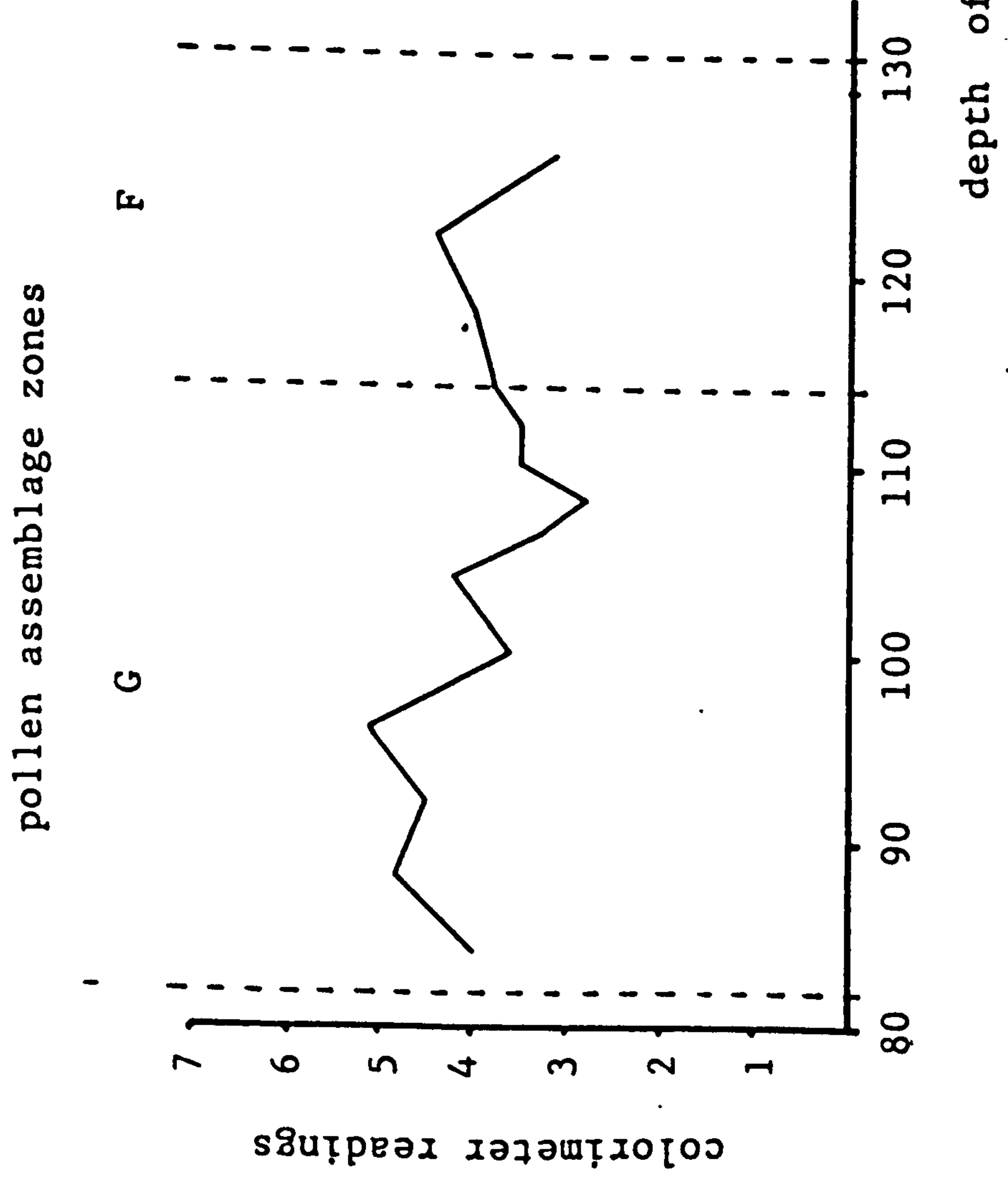
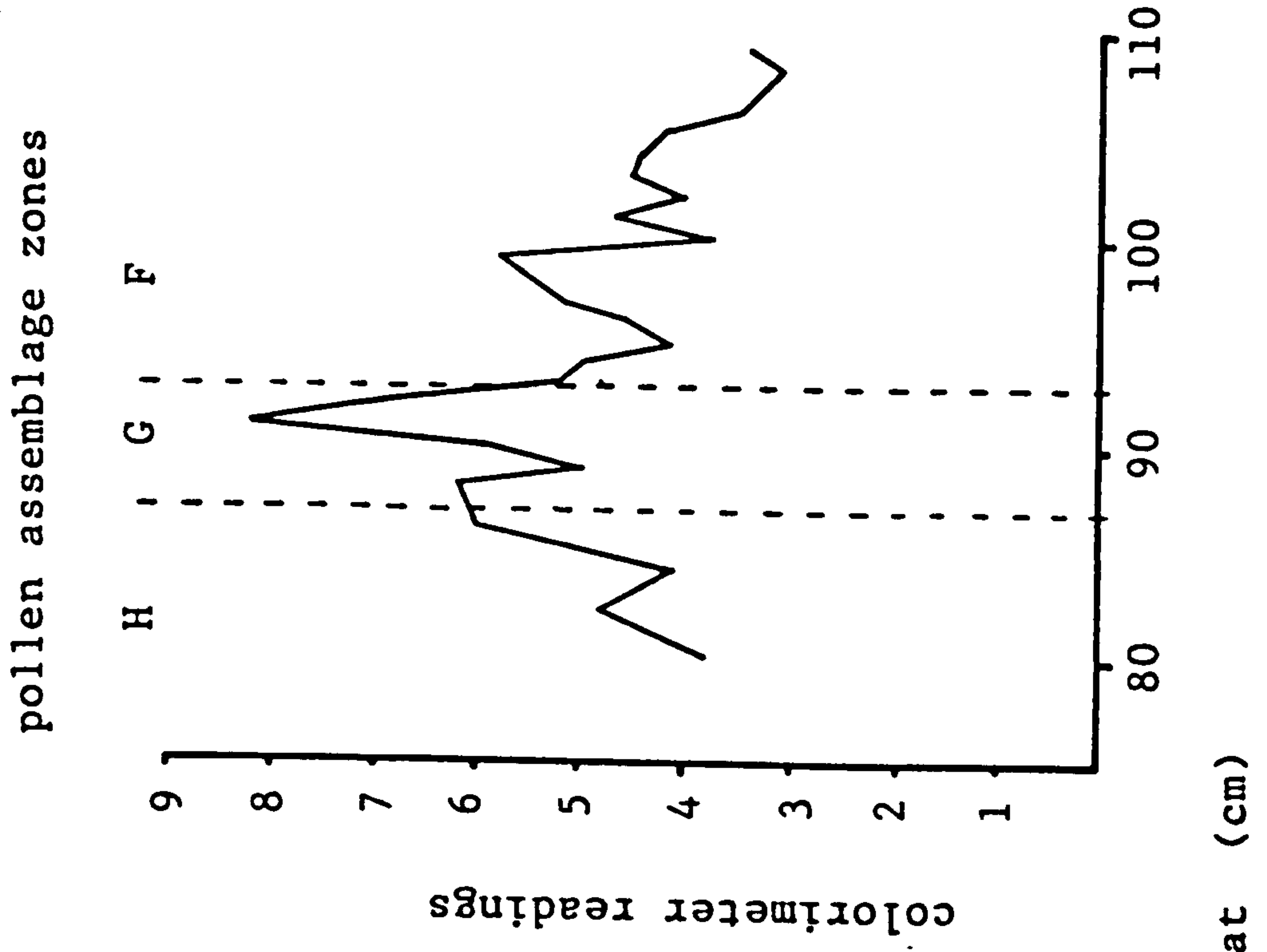


Fig. 21 : Test for humification :- Colorimeter readings.

absorption using a colorimeter. The readings from the colorimeter have been plotted against depth in the diagrams on p.84.

5.6.3 Results

The Lanshaw 1 samples gave, mainly , somewhat higher readings on the colorimeter than the Lanshaw 2 samples, with a marked peak at 92cm. There was, compared to the Lanshaw 1 diagram, little fluctuation in the Lanshaw 2 readings.

5.6.4 Discussion

Since this method has not previously been used or tested, the results cannot be given too much importance. Nevertheless the results are interesting and do appear to be significant. The peak in light absorption at 92cm in the Lanshaw 1 profile, if the method is valid, would mean high humification and hence slow peat growth. It coincides with the bottom of zone G in the pollen diagram for which slow growth, and perhaps an hiatus, has already been suggested (see p.66). The results of this test support the possibility of an hiatus at 92cm.

The generally lower level of light absorption in the samples from Lanshaw 2 suggests that humification is lower in that profile and that the peat at Lanshaw 2 grew slightly faster than the peat at Lanshaw 1, or that it continued to grow when growth stopped at Lanshaw 1. There is little indication in fig.21 of an hiatus at the F/G boundary although light absorption is somewhat lower initially in zone G. In retrospect it would have been desirable to extend the analysis of the Lanshaw 2 profile to include the zones E/F boundary and the zone G/H boundary.

5.7 Vegetation Change and Correlation of the Lanshaw Diagrams

Although correlations have been suggested in the description of each diagram it would seem helpful to bring the evidence together at this stage and also to give a summary of the vegetational changes that have taken place at Lanshaw.

The suggested correlation for the three Lanshaw diagrams is illustrated in Fig.22 . At the base of all three profiles

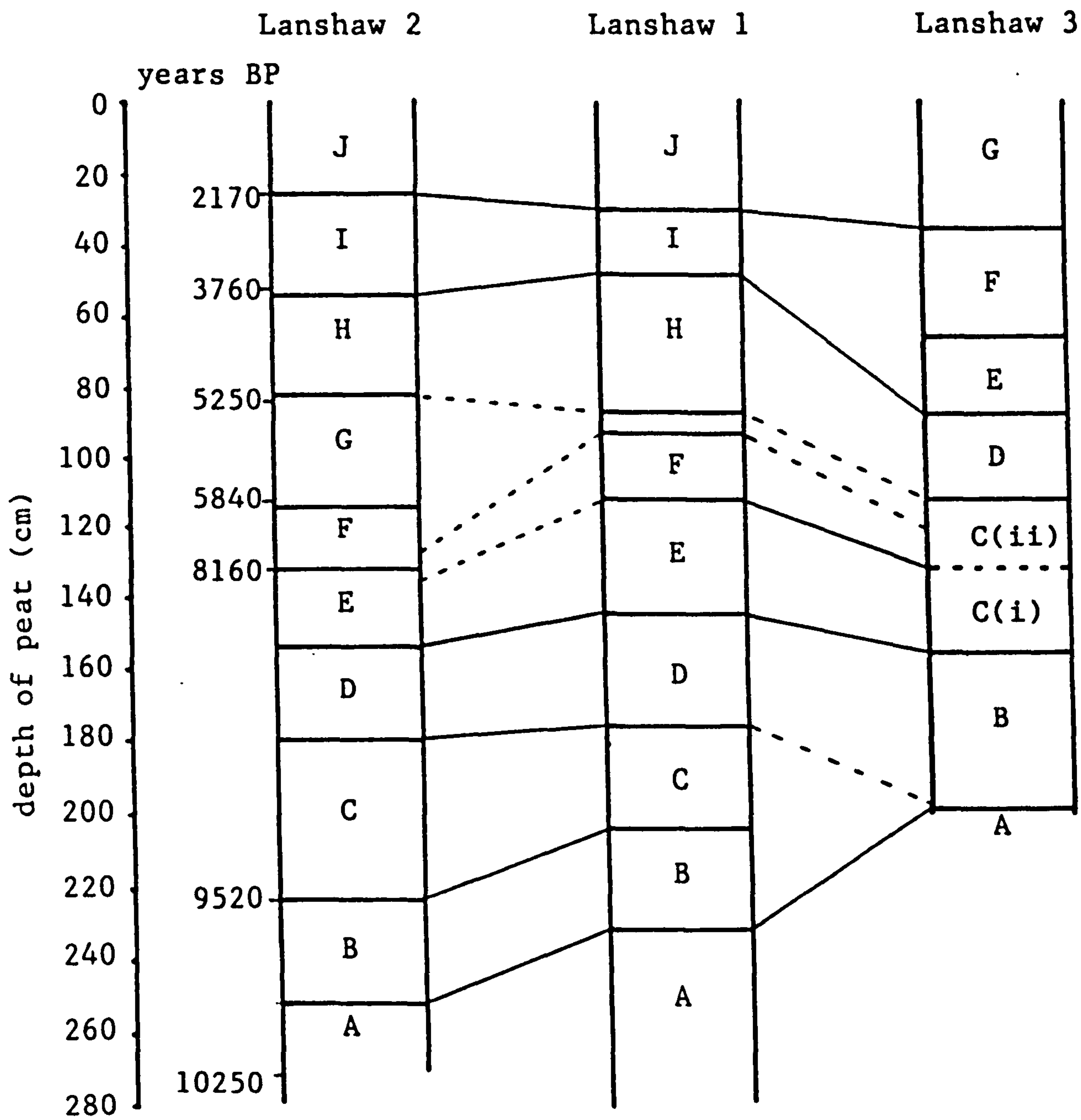


Fig. 22 : Correlation of the Lanshaw pollen diagrams.

is a clay which dates from the end of the Late-Devensian period. Pollen analysis of this clay has shown that the vegetation of the Lanshaw area at that time was treeless, but with small amounts of dwarf birch and juniper, and was dominated by members of the Juncaceae and Cyperaceae locally and on drier land by a relatively species-rich, low-growing grassland.

Peat growth started at 10250 ± 100 years BP at Lanshaw 2 and at approximately the same time at Lanshaw 1, but not until about 8900 years BP at Lanshaw 3, which is nearer to the edge of the bog. This means that since the sites are about 100m apart the peat was spreading laterally at a rate of approximately 7cm yr^{-1} . It was also growing vertically relatively quickly at rates of approximately 1cm in 14 years at Lanshaw 1 and 1cm in 17 years at Lanshaw 2.

The vegetational changes inferred by the early parts of the diagrams are very similar at Lanshaw 1 and 2, with evidence that birch was the first tree to reach the Lanshaw area at around 10000 years BP, and with increased Pinus and Corylus from about 9500 years BP.

In Lanshaw 2 zone C there is an early Alnus peak which is associated with low Pinus values, high Betula and Filicales, and is just below a peak in Gramineae pollen and isolated occurrences of Caryophyllaceae, Chenopodiaceae and Rumex acetosa type. Alnus pollen is only recorded at one level in Lanshaw 1 zone C and corresponds to high Betula and Gramineae values, low Pinus values and is just above isolated occurrences of Caryophyllaceae, Chenopodiaceae and Potentilla. It is mentioned on p.63 that Smith(1970,1984) believes early appearances of Alnus are related to Mesolithic interference with the forest. Smith considers that Alnus spread into the small clearings created by Mesolithic man. There does seem to be evidence that a small amount of clearance was taking place at the same time as the early Alnus appearances in zone C. Taking both diagrams

together Alnus is associated with increased Betula, Filicales and Gramineae, the presence of Caryophyllaceae, Chenopodiaceae Rumex acetosa type and Potentilla, and with decreased Pinus values. This suggests that Pinus may have been cleared by Mesolithic man and as a result Betula, Alnus, grasses and ferns spread into the cleared area or areas. There is certainly good evidence that Mesolithic man was in the Lanshaw area at this time (see p.23).

All three diagrams show a period of rapid expansion of the Corylus curve from about 8900 years BP to 8500 years BP and an early Alnus peak at about 8600 years BP. These features are particularly marked in the Lanshaw 3 diagram where ^hFilicales levels are also unusually high. Smith(1984) notes that Filicales spp, today are often abundant in small woodland clearings, and considers the fern spore maximum which is near the rational Alnus limit at Newferry to be evidence of local human interference with the forest. The presence of Alnus buds in the peat shows that the tree was growing near to the Lanshaw 3 site during the early alder peak. The charcoal in the Lanshaw peat at 151cm is evidence that some burning was taking place near to the time of the early alder peak, and this burning may have been the cause of the erosion which led to the formation of the clay layer from 151cm to 138cm. Since this clay layer is not associated with high Alnus values it is unlikely that the argument for increased erosion leading to increased wet area for Alnus to invade is valid.

At Lanshaw 1 the 152cm and 160cm levels have more than 2% Alnus pollen, which is the percentage regarded by Huntley and Birks (1983) as representing a local but sparse presence of Alnus. These levels also have slightly raised values of Salix, Gramineae and Pteridium all of which could indicate a small amount of forest clearance. Further evidence for clearance is the fine, burnt material in the peat at 156cm and the mineral from 172cm to 156cm.

Smith(1970) proposed that the spread of Corylus in Mesolithic times was largely due to man's burning of the forest. It may therefore be significant that the early Alnus peaks in the Lanshaw diagrams all occur at the same time as rises in the

Corylus curve, and that where the hazel rise is more prominent, as at Lanshaw 3, the Alnus rise is also more important.

The zone of the Corylus maximum is similar in all three diagrams with Salix the second most abundant type and with few NAP types present. It is at the end of this zone that correlation of the diagrams becomes more difficult. The Lanshaw 1 and 3 diagrams both have a zone or sub-zone above the Corylus maximum where Corylus pollen falls there is a peak in Cyperaceae pollen and there are small increases in Ulmus, Alnus, Salix, and Filicales spores. As shown in Fig.22 it appears that the first part of Lanshaw 3 sub-zone C(ii) covers the whole of Lanshaw 1 zone F and that this in turn correlates with the top of Lanshaw 2 zone E and the beginning of zone F. If this is so it would mean that the peat growth rate at Lanshaw 1 was twice as fast as at Lanshaw 2 and a third faster than at Lanshaw 3. Although sites 1 and 2 are believed to be within a few metres of each other it is not impossible that the peat growth rate at each site at the same time was very different. There are other points in the profiles where there are significant differences such as in zone C when the peat at Lanshaw 1 grew fastest. In general, however, peat growth at Lanshaw was relatively fast during the Corylus expansion and maximum, at rates, in the centre of the bog, of around 1cm in 15 years.

It is very difficult to correlate the diagrams around the time of the Alnus rise since this part of the individual diagrams is not fully understood. Even though it has been suggested on p.66 that peat growth stopped once or perhaps twice at Lanshaw 2 the vegetational record at this site appears to be more complete than at the other two sites. It is not certain if there is an hiatus in the Lanshaw 2 diagram. The conclusion to section 5.5 notes that the closest fit between the Lanshaw 1 and 2 influx diagrams is obtained when very slow, but continued growth, is assumed for Lanshaw 2, and an hiatus at 92cm in the Lanshaw 1 diagram. The test for humification, described in section 5.6 provided no evidence for and hiatus at Lanshaw 2, but did point to an hiatus at 92cm at Lanshaw 1. It may be, then, that following the Corylus maximum, and some time after 8160±90 years BP, peat growth slowed

considerably to 1cm in 116 years at Lanshaw 1 and stopped completely in other parts of the bog.

It is difficult to say when more rapid peat growth began. There is evidence in the stratigraphy that wetter conditions existed above 100cm, and the increased level of pollen preservation above 112cm suggests that rapid growth may have begun at 5840 ± 80 years BP. The problem with this theory is, as mentioned on p.66 that it assumes slow peat growth in the early Atlantic period when it is generally assumed that wetter conditions began. It is possible that the bog became too wet for peat growth and was inundated, but one might expect to find evidence of this in the stratigraphy. It is also possible that rapid peat growth began earlier in zone F, but unfortunately no radiocarbon dates are available for this zone, and, in any case, this would give a date for the start of rapid peat growth of around 6200 years BP which is still late.

It is evident that more work is needed involving closer sampling, and most importantly more radiocarbon dates, before the Boreal-Atlantic transition at Lanshaw will be understood. These techniques form the basis of the study presently being undertaken by J.Shore (see p.67)

Following the fall in Pinus pollen, dated to 5250 ± 50 yrs BP at Lanshaw 2, correlation of the diagrams becomes easier. All three diagrams show a period during which alder and oak were dominant and other trees were less important than before. The first real signs of human activity have been dated to 3760 ± 50 years BP at Lanshaw 2 and again the diagrams are consistent in showing a decline of Tilia and Quercus pollen, and an increase in NAP, the appearance of Plantago lanceolata pollen and other cultural indicators, and, in the Lanshaw 1 diagram, the appearance of cereal pollen. The Lanshaw 3 diagram also shows a significant decrease in Alnus and Corylus which, since this is near to the edge of the bog, probably indicates local clearance of these trees.

The Lanshaw 3 diagram has an additional zone during which clearances appear to have been abandoned and there was regrowth of woodland and particularly Betula. These effects can be seen to a much lesser extent in the Lanshaw 2 diagram. It may be

that clearance in this, the Late Bronze Age, was discontinued in the Lanshaw area but continued in other parts of the moor.

The upper parts of the diagrams are very similar showing a major clearance, dated to 2170 ± 50 years BP at Lanshaw 2, which resulted in a spread of grassland, and Lanshaw 1 and 2 show evidence of later clearance which was followed by a spread of heathland.

6. GREEN CRAG SLACK

6.1 Introduction

Green Crag Slack is a shelf on the northern slope of Rombalds Moor which lies at an altitude of between 305m and 320m. Small areas of peat have formed in several areas of the Slack. The site of the boring is at Grid Reference; SE133461 and can be seen in the photograph on p.96.

Originally only one radiocarbon date (SRR-2464) was obtained for the Green Crag Slack diagram in order to date the beginning of the cereal curve. The Green Crag Slack area is so rich in Bronze Age remains that it was expected that cereal cultivation would have started in that period, however, the date obtained was surprisingly late at 1230±80 years BP (A.D.720). It was decided to check this date by obtaining a further radiocarbon date, and at the same time to date two other levels (see table 1 - recheck series). Since the part of the core relating to the start of the cereal curve had been used up in the first radiocarbon analysis it was necessary to obtain more material. to this end a monolith was cut from the original boring site. The pollen of the monolith was examined and was found to match the original diagram well, except that the same changes in the pollen assemblage are not necessarily found at the same depth in the original diagram and in the monolith, and can be separated by, at the most, 7cm, but usually by not more than 3cm. The diagram provided is from the original boring because it was not considered necessary to produce a completely new diagram from the monolith, but the radiocarbon dates from the monolith have been used to date the various zones, and to construct the pollen influx diagram and the peat growth rate curve, shown in fig.24

6.2 Stratigraphy

0 to 12cm Calluna-Eriophorum-Sphagnum peat containing many Calluna seeds and remains of Eriophorum vaginatum.

- 13 to 20cm Darker, more humified Eriophorum peat with some leaves of Sphagnum spp. and stems of Calluna.
- 21 to 53cm Amorphous, brown Sphagnum papillosum peat with occasional E.vaginatum stems.
- 54 to 63cm Finely-divided E.vaginatum peat with large amounts of charcoal and occasional pieces of wood. Charcoal concentrated into a dark band at 55 to 58cm.
- 64 to 66cm Finely-divided amorphous wood and monocot. material containing a Betula fruit and mineral material.
- 67 to 70cm Grey clay with sand and pebbles.

6.3 Description of the Pollen Diagram

Zone A : Alnus-Betula p.a.z.

Alnus and Betula are the dominant types with some Corylus and little pollen of other types. NAP is very low with few types represented. Pollen influx is also very low at less than 1000 grains $\text{cm}^{-1} \text{yr}^{-1}$ which must be a reflection of a poor preservation rate, since the pollen of this zone is very degraded. The presence of a Potamogeton curve suggests that there was a pool on or near the site, and the Betula fruit found in the deposit at the top of zone A infers that Betula was growing near to the site.

Zone B : Alnus-Betula-Calluna p.a.z.

This is essentially a zone of clearance activity which varied in character and intensity, and forms the basis of a division into five sub-zones.

Sub-zone B(i) : Alnus-Betula

AP falls due to a reduction in Alnus and to a lesser extent Betula. This first fall in AP has been dated to 3320±40 years BP (SRR-2540). Other AP types show small increases and several appear for the first time. NAP rises, particularly Gramineae, and several new types appear including Compositae, Caryophyllaceae and Chenopodiaceae and a grain of Plantago lanceolata. There is also a small short-lived peak in Filicales

spores and a smaller increase in Pteridium spores. There is less wood in the peat of this zone and the latter part of the zone corresponds to a dark band of charcoal from 55 to 58cm. Pollen influx is still very low and the state of the pollen is poor indicating a low preservation rate.

Sub-zone B(ii) : Alnus-Betula-Calluna

Cereal pollen appears at the beginning of this sub-zone, which was dated to 1300±40 years BP in the monolith. There is a further decrease in AP in sub-zone B(ii) but in this case all AP types are affected. The increase in NAP is largely due to higher levels of Calluna pollen with a smaller increase in Cyperaceae. Many other NAP types also increase, particularly Plantago lanceolata and Ranunculaceae, and Plantago major/media type is recorded at the top of the zone. The stratigraphical change to a Sphagnum peat at the beginning of this sub-zone is reflected by an increase in Sphagnum spores in the diagram. This probably means that the site was wetter during sub-zone B(ii) and so more pollen would be preserved than before thus explaining the large rise in pollen influx during this sub-zone.

Sub-zone B(iii) : Alnus-Betula

All AP types rise but Betula and Alnus do not reach their zone A levels. NAP falls, particularly Calluna, the cereal curve becomes discontinuous and there is less Plantago lanceolata than in B(ii). Total pollen influx is very high in this sub-zone reaching over 25000 grains cm⁻² yr⁻¹.

Sub-zone B(iv) : Calluna-Alnus

There is a large fall in AP which affects all AP types. For the first time NAP is over 50% TP and consists mainly of Calluna pollen. There is a small rise in Gramineae pollen and in the Pteridium and Plantago lanceolata curves, and there is more cereal pollen than before. Pollen influx is much lower than in B(iii) at around 2000 grains cm⁻² yr⁻¹.

Sub-zone B(v) : Alnus-Corylus-Calluna

AP rises again to nearly 70% TP mainly due to increases in Alnus and Corylus, the latter reaching its highest levels so far. The fall in NAP is most noticeable in the drop of the Calluna curve but also fewer NAP types are present. No cereal pollen was recorded and there is less Plantago lanceo-

lata and Pteridium, but Empetrum shows a small increase.

Total pollen influx is at similar levels to the previous sub-zone.

Zone C : Calluna-Gramineae p.a.z.

This has been divided into two sub-zones.

Sub-zone C(i) : Calluna

The sharp fall in AP at the beginning of this zone has been radiocarbon dated to 670±40 years BP. AP falls from 66% TP to 15% TP and the immediate response is a massive increase in Calluna pollen to over 70% TP. This is followed by small peaks of Gramineae and Cyperaceae and cereals reappear at 26cm and 22cm. In addition the Plantago lanceolata curve expands and there is an increase of Rumex acetosa type pollen.

Sub-zone C(ii) : Calluna-Gramineae

At the beginning of the sub-zone there is a rise in Empetrum pollen to 20% TP which then falls again. Throughout this sub-zone Calluna levels fall as the Gramineae and Pteridium curves expand until by the end of the sub-zone Gramineae and Pteridium are the dominant types. AP remains at low levels and no cereal pollen is present. Although there is an initial rise in Plantago lanceolata it then falls to only 1% TP at the top of the diagram, but two other NAP types, Chenopodiaceae and Rumex acetosa type both increase slightly towards the end of the sub-zone.

6.4 Discussion

A peat growth rate curve has been constructed using the radiocarbon dates, but since only three dates are available the curve must be regarded as an approximation (see Fig.24).

The pollen assemblage of zone A points to the existence of an alder-birch carr on Green Crag Slack, in which little, if any, clearance had taken place. The low amounts of pollen of other trees do not necessarily mean that they were not growing in the surrounding area, but could be due partly to over-representation of the local vegetation (both birch and alder tend to be over-represented in pollen diagrams) and



Fig.23a : Looking east along Green Crag Slack



Fig.23b : The Green Crag Slack boring site
(immediately to the right of the small pool)

also as a result of a screening effect of the local carr vegetation intercepting pollen that would have otherwise landed on the site. This must have been a dense carr since there is little evidence of a ground flora apart from some Filicales.

The reduction in Alnus and Betula pollen at the beginning of zone B, dated to 3320±40 years BP, may indicate the start of clearance activity, but equally it could point to the disappearance of trees from the site as a result of increased wetness. The evidence for the latter is a change at 63cm to Eriophorum vaginatum peat and the start of the Sphagnum curve at 62cm. There are, in fact, few cultural indicators in sub-zone B(i) apart from a grain of Chenopodiaceae at 62cm and a grain of Plantago lanceolata at 58cm. Using the peat growth curve in Fig. 24 an approximate date of 2150 years BP (300BC) can be given for the first appearance of P.lanceolata in the Green Crag Slack diagram, which, interestingly, is very close to the 2170 years BP date of the major clearances at Lanshaw and Green Gates.

From 58cm there is more substantial evidence that clearance was taking place as charcoal is found in large quantities in the peat. The first evidence for any agricultural activity is at the beginning of sub-zone B(ii), dated to 1300±40 years BP (AD650), when cereal pollen appears and a continuous curve of Plantago lanceolata begins. At the same time there is a small rise in Calluna suggesting that there was a limited spread of heathland as a result of the clearance. There does not appear to be any great historical significance to the date of AD650, it falls in the early Anglo-Saxon period when West Yorkshire formed part of the British kingdom of Elmet, which had been annexed in AD617 by the Englishman Edwin of Northumbria (Faull, 1981, p.189). It may be, however, that the start of agriculture relates to a change of ownership which took place in AD678 when Ecgfrith of Northumbria gave lands, which are thought to have included the Otley estate, to St. Wilfred. (The Otley estate included most of the northern part of Rombalds Moor) (Faull, 1981, p.189).

Sub-zone B(iii) appears to represent a period of regrowth

of woodland and of low agricultural activity. Total pollen influx rises as the AP levels rise which shows that the pattern of decreasing pollen influx following clearance can also work in reverse. Using the peat growth curve in Fig.24 a date of AD750 can be suggested for the start of regrowth, and a date of AD950 for the end of this period. It is not clear why land should have been abandoned at around AD750 but it is known that the time from AD867 to AD954 was a very unsettled period during which the Vikings had control of West Yorkshire from York (Faull,1981,p.187). West Yorkshire was never an important centre for Viking activities and remained peripheral to the major Scandinavian settlement areas. The climate is a further factor to consider since Barber(1982) proposes that from AD600 to AD800, and AD860 to AD1100 the climate was wet and/or cold and it may be that by AD750 the conditions were no longer suitable for agriculture.

The renewal of clearance activity and the increased evidence of agriculture in sub-zone B(iii) probably dates to about AD950. This may relate to a period of increased stability in the area following the defeat of Eric Bloodaxe in AD954 by the southern kings who regained control of Northumbria, including the West Yorkshire area (Faull,1981,p.187). This clearance appears to have brought about a more substantial spread of heathland than the previous one and there is good evidence of open conditions in the rises of Plantago lanceolata and Pteridium curves. Pollen influx again follows the pattern described above of falling during a clearance event. The return of agricultural activity at a time which Barber(1982) considers was part of a cold and/or wet period discounts the idea discussed above that climate was a limiting factor on agriculture in this area in the 10th century.

There is a further period of regrowth during sub-zone B(v) which probably dates from AD1050 to AD1280. It is known that there was a revolt in AD1065 which spread throughout the whole of Northumbria (Faull,1981,p.187) and there are references to Archbishop Oswald, owner of the Otley Estate, losing part of his lands, including Addingham, Ilkley, Menston and Burley at the end of the 10th century and in the early 11th century due

to the "troubled conditions of the time" (Faull, 1981, p. 189). So it is possible that these "troubled conditions" were the reason for a cessation of agricultural activity near to Green Crag Slack which lasted for over two hundred years.

The final clearance episode has been dated to 670±40 years BP (AD1280) and agriculture seems to have restarted after this at about AD1350. This final attack on the woodland appears to have removed trees completely from the Green Crag Slack area since the AP level is very similar to modern AP levels and there are no trees on the Slack today. The immediate result of the fall in AP is a massive rise in Calluna pollen which must represent a vegetational change since it is also apparent in the influx diagram. This spread of heathland involved slightly more Empetrum than in the previous clearances and the open conditions are indicated by rises in pollen of Plantago lanceolata, Rumex acetosa, Gramineae and to a lesser extent in Pteridium spores.

The date of AD1350 is very close to the date of the final clearance at Hebers Ghyll (590±40 years BP, AD1360) and the historical significance of this date is discussed on p. 116.

At Green Crag the period of agriculture seems to have been brief ending at about AD1450. In sub-zone C(ii) the absence of cereals and the initial increase in Plantago lanceolata indicates that pastoral farming was the only type practiced in the Green Crag Slack area. The expansion of the Empetrum curve and the decline of the Calluna curve suggest that there may have been overgrazing as early as the 16th century, if the peat growth rate curve in Fig. 24 is accurate. However, as has already been stated, Fig. 24 is only an approximation and the start of sub-zone C(ii) could be much later. The stratigraphy suggests that the site was drier at first in sub-zone C(ii) since the peat is more humified, but this in itself would not bring about a rise in Empetrum at the expense of Calluna. Towards the top of sub-zone C(ii) Gramineae and Pteridium also rise and Calluna falls to 20%TP by the top of the diagram perhaps indicating overgrazing. The final level in the diagram infers a species-poor vegetation dominated by Gramineae and Pteridium with Calluna and Empetrum of lesser and roughly equal importance.

7. GREEN GATES

7.1 Introduction

Green Gates is a large area of gently sloping land on the north side of the moor at an altitude of around 350m OD. Today the site is poorly drained and is covered by blanket bog to a depth of about 1m. This supports a vegetation dominated by Eriophorum vaginatum with Juncus spp important in some areas. The boring was taken from Grid Reference; SE105458.

7.2 Stratigraphy

- 0 to 13cm Unhumified Sphagnum tenellum peat with many leaves and stems of Drepanocladus fluitans and some burnt material at 12cm.
- 14 to 27cm More humified Sphagnum papillosum peat with occasional Calluna vulgaris stems and burnt material at 20cm.
- 28 to 39cm Less humified S.papillosum peat with a leaf of S.cuspidatum.
- 40 to 74cm More humified Sphagnum/Polytrichum commune peat with some Drepanodadus fluitans, Juncus squarrosus seeds, and leaves and stems of Vaccinium oxycoccus.
- 75 to 91cm Finely-divided wood peat with many Juncus squarrosus seeds, very humified and amorphous and containing mineral material, frequent pieces of charcoal and remains of Eriophorum vaginatum.
- 91 to 100cm Sandy clay containing small pieces of charcoal and some stems of Eriophorum vaginatum and a little woody material.

7.3 Description of the Pollen Diagrams

Zone A : Alnus-Corylus p.a.z.

Zone A is only represented by one level in the pollen diagram, but the pollen assemblage is quite different from that of the next level at 92cm. Corylus and Alnus values are both at high levels with very little pollen of other tree species. Total pollen influx is low at less than 4000 grains cm⁻² yr⁻¹

and most of this is tree and shrub pollen. NAP is at a low level with four species represented. Apart from Corylus and Alnus the only other types reaching more than 4% TP are Filicales and Polypodium spores.

Zone B : Alnus-Betula p.a.z.

Pollen influx is high reaching over 30000 grains $\text{cm}^{-2} \text{yr}^{-1}$ in the middle of the zone. The major part of this is AP, particularly Alnus and Betula, and with some Quercus and Corylus, other AP types are at very low levels. NAP is more important than in zone A though it is still scarce. The increase is due mainly to a small rise of Gramineae pollen and to a lesser extent Calluna pollen, but there are still relatively few types represented. More NAP types appear as the zone progresses including Plantago lanceolata, Caryophyllaceae and Chenopodiaceae.

There is a major change in the stratigraphy early in the zone from clay to a wood peat. It is likely, therefore, that trees, which would almost certainly be Alnus and Betula, were growing on the site in this zone.

Zone C : Gramineae-Calluna p.a.z.

The beginning of this zone has been radiocarbon dated to 2170 \pm 80 years BP. It opens with a major fall of Alnus pollen to less than 10% TP, and smaller falls of Betula, Corylus and Quercus. There is a subsequent rise of NAP, and particularly of Gramineae, Calluna and Cyperaceae and there is a small rise in Fraxinus pollen. Many NAP types start their curves at 74cm, most notably cereals, Cannabis and Cruciferae and other types show increases at this level particularly Plantago lanceolata, Potentilla, Ranunculaceae and Rumex acetosa spp. The Cannabis curve ends at 58cm, which has been dated to 1270 \pm 80 years BP, but the cereal curve continues almost unbroken to the end of the zone.

Total pollen influx falls dramatically at the end of zone B and remains at low levels, less than 2000 grains $\text{cm}^{-2} \text{yr}^{-1}$, until the end of zone C. The main reason for this is probably the replacement of trees by herbaceous species which generally produce much smaller amounts of pollen.

There is a small rise in Pteridium spores at the beginning of the zone, but other Filicales types are at low levels. At 74cm there is a massive expansion of the Sphagnum curve, reflecting the stratigraphical change from a wood peat to a Sphagnum peat. The Sphagnum curve is somewhat erratic but its large rise and fall in the latter part of the zone correlates with the band of relatively unhumified S.papillosum peat from 28cm to 39cm.

Except for a small peak in Alnus pollen at 72cm there is no recovery of tree pollen. Calluna and Gramineae remain the dominant pollen types with a small but increasing amount of Empetrum.

Near the top of the zone there is a small rise in pollen influx which has been radiocarbon dated to 1680±70 years BP.

Zone D : Cyperaceae p.a.z.

The final change in the diagram, represented by the highest level counted, is to a pollen assemblage completely dominated by Cyperaceae. Gramineae and Empetrum are the only other types which reach over 5% TP. Most other types, AP and NAP, are less abundant than before and fewer types are represented. Cereals were not recorded and only one grain of Calluna was counted. Total pollen influx is again at a very low level, less than 1000 grains cm⁻² yr⁻¹.

7.4 Discussion

The small amount of NAP in zone A and the fact that few NAP types are represented suggests that the vegetation of this zone was a closed woodland. Alnus and Corylus are the only abundant pollen types, all other tree pollen types are at very low levels. It may be that Alnus was dominant on the wetter ground on, and around the site, and Corylus was more important on drier land. The ground flora seems to have consisted mainly of ferns with a little Filipendula.

The change, from closed Corylus and Alnus wood^dland with low

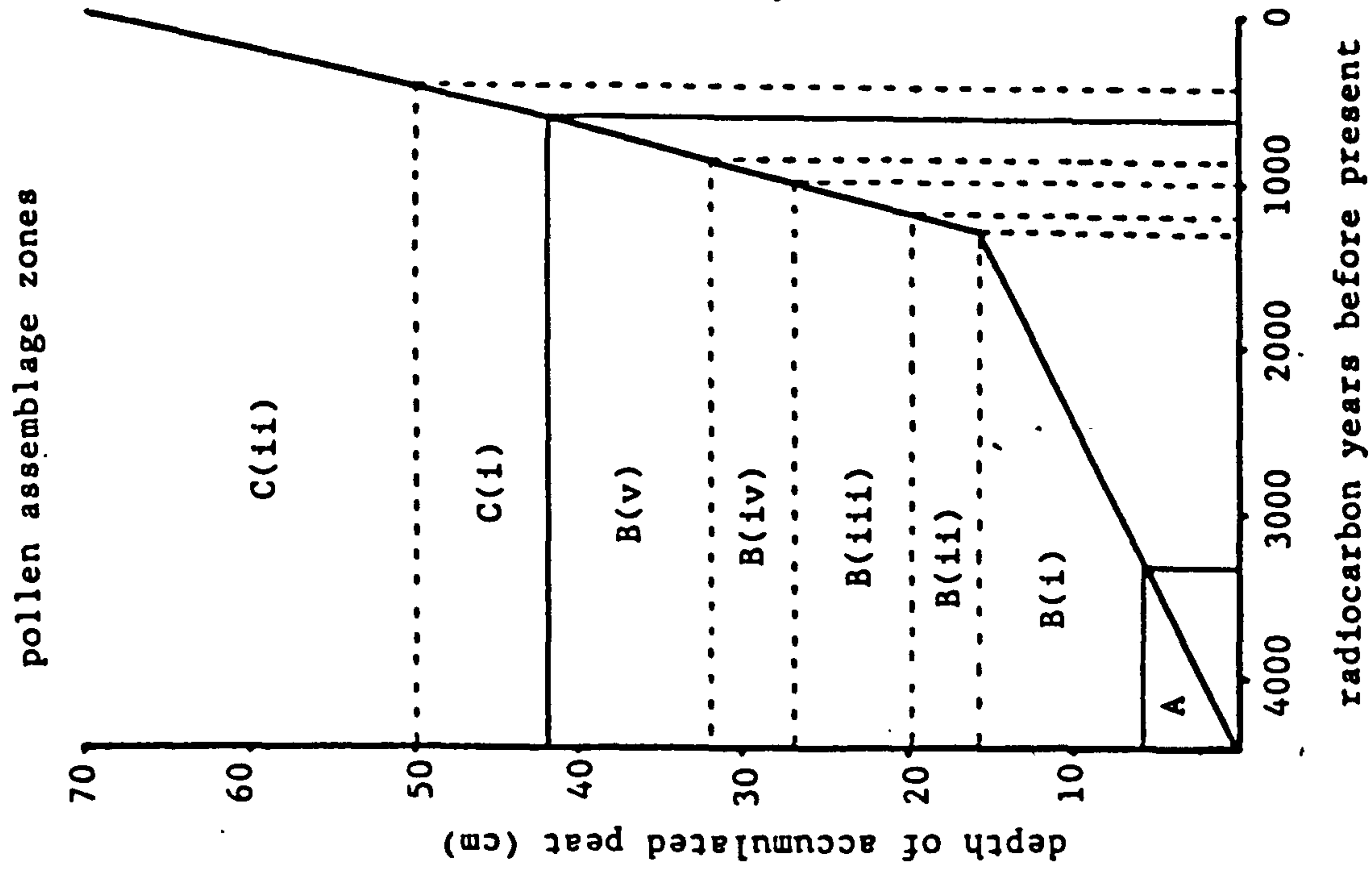


Fig. 24 : Green Crag Slack peat growth curve.

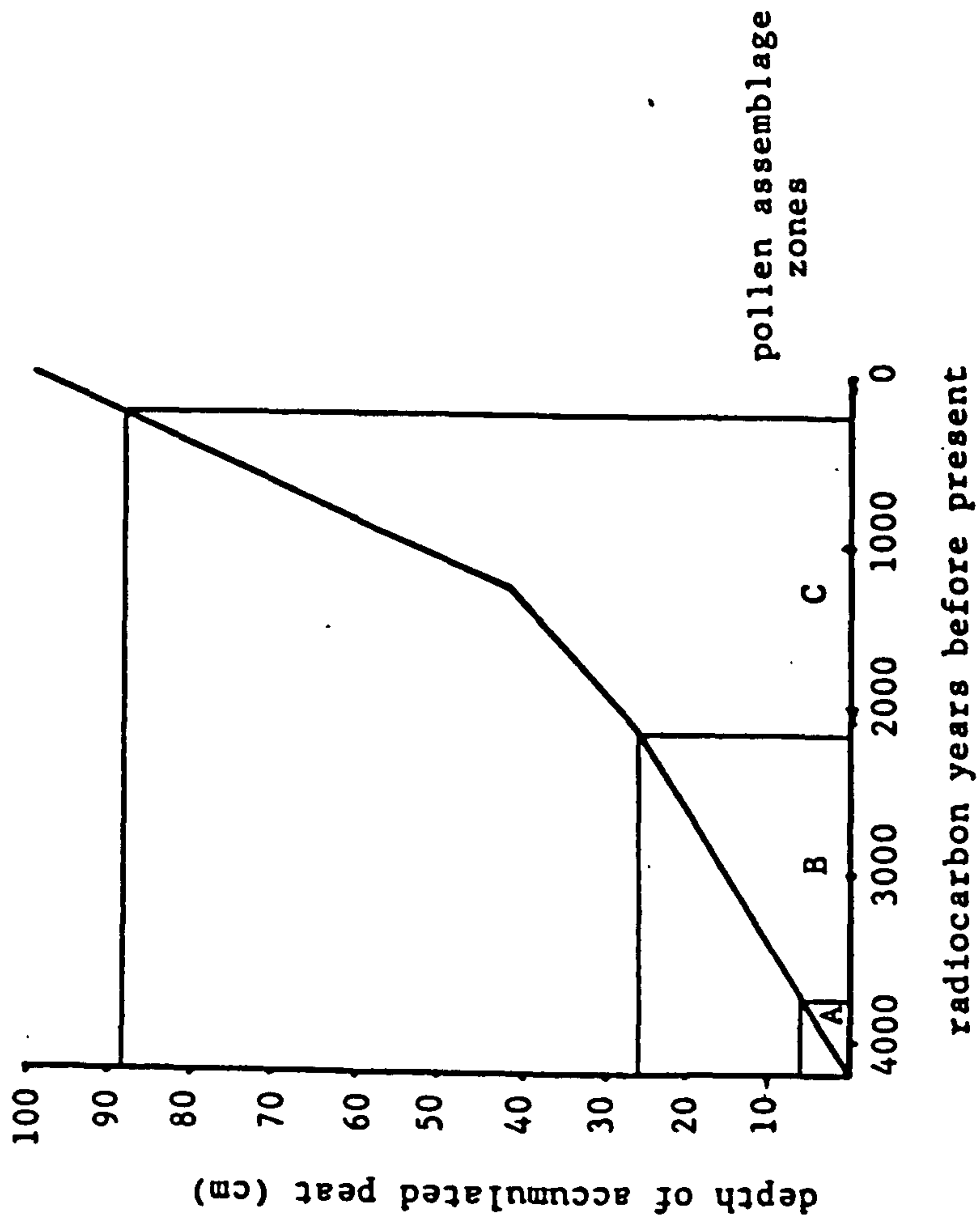


Fig. 25 : Green Gates peat growth curve.

NAP to an Alnus-Betula woodland with some evidence of opening in the woodland, at the zone A/B boundary is probably contemporary with the zone H/I boundary at Lanshaw which has been radiocarbon dated to 3760±50 years BP. This date has therefore been taken as the age of the zone A/B boundary for the construction of the influx diagram.

The evidence that some clearance activity was taking place during zone B consists of a small rise in NAP, mainly Gramineae and Calluna, and the appearance of the cultural indicator Plantago lanceolata. The presence of charcoal in the peat suggests that fire may have played a part in these clearances. A limited opening of the forest would explain the appearance of Caryophyllaceae pollen, and also the increase in Betula pollen since this tree would have been out-shaded in the denser woodland of zone A.

Using the date of 3760 BP for the zone A/B boundary, a date of about 3000 BP can be proposed for the initiation of peat growth at the Green Gates site. This is close to the date of 2850 BP suggested by Van Geel for the start of a 'catastrophic decline' in the climate towards cooler and wetter weather (Van Geel, 1977). It may be that it was a combination of climatic deterioration and clearance activity which caused the start of peat growth at Green Gates.

The falls in AP and the subsequent rises in many NAP types at the beginning of zone C must represent a major clearance. The date of this event, 2170±80 years BP, is the same as the date of the major clearance at Lanshaw 2, which infers that the higher parts of Rombalds Moor were cleared at the same time, in the early Iron Age. The result of this clearance at Green Gates was an immediate spread of heath and grassland and increased, but probably local, importance of members of the Cyperaceae. The stratigraphical change from a wood peat to a Sphagnum/Polytrichum peat is further evidence of the disappearance of trees from the site.

The clearance coincides with the start of agricultural activity as shown by the beginnings of cereal and Cannabis curves, and also by the presence of agricultural indicators such as Cruciferae and Plantago major/media type. The end of

the Cannabis curve has been dated to 1270±80 years BP after which cereal pollen is less abundant suggesting a decline in agricultural activity.

As mentioned above there is no regrowth of trees and the vegetation of zone C appears to have been relatively species-rich with a mixture of heath and grassland. The open conditions are reflected in the high percentages of Plantago lanceolata, Rumex acetosa type and Pteridium.

The date of 1680±70 years BP for 19 to 25cm near the top of zone C has been rejected as being too old for several reasons. It is older than the date for the end of the Cannabis curve at 55 to 61cm which means that there is a reversal of date. It is very near to the surface of the deposit and if it were correct it would give a growth rate of 1cm in 76 years for the upper part of the deposit compared to 1cm in 10 years for the lower part of zone C. This does not agree with the stratigraphic evidence which points to, if anything, a faster growth rate for the upper part since this peat is the least humified. It is therefore unlikely that this date is a correct estimate of the age of the 19 to 25cm level. This problem of anomalous dates is discussed on p.149.

The final change in the diagram to a species-poor Cyperaceae dominated vegetation is probably very recent. The only other significant pollen types are Gramineae and Empetrum, and Calluna is almost absent. This is very similar to the present day vegetation.

8. HEBERS GHYLL

8.1 Introduction

The Hebers Ghyll boring was taken from Grid Reference; SE098468 at an altitude of 275m O.D.. The boggy area is very small, only 10m across, and has developed in a small depression to the side of a small stream, Hebers Ghyll. The vegetation on the wet area is dominated by Empetrum nigrum, with a small amount of Calluna, and it is surrounded by rough grassland on the lower slopes and braken on the higher slopes. A photograph of the site can be seen on p.112.

8.2 Stratigraphy

- 0 to 15cm Dark, fibrous Eriophorum vaginatum peat with many insect remains.
- 16 to 34cm Finely divided Sphagnum peat containing many fungal sclerotia.
- 35 to 74cm E.vaginatum peat with much wood, Carex nutlets and seeds of Juncus spp., some Betula twigs and a seed each of Ranunculus flammula and Lychnis-flos-cuculi.
- 75 to 110cm Coarse monocot./Sphagnum peat containing many Carex nutlets and rootlets, a seed each of Viola palustris, Potentilla erecta, a Stellaria sp. and three seeds of Ranunculus flammula.
- 111 to 140cm Finely-divided monocot. peat with much wood and containing twigs, seeds and bud scales of Betula. Many nutlets and rootlets of Carex spp. and seeds of Juncus spp.. Some grass caryopsis, a Ranunculus flammula seed, a bud of Salix and a Betula fruit.
- 141 to 178cm Finely-divided wood peat with occasional Betula twigs, catkins and fruits. Some monocot. material and Carex nutlets and an Alnus fruit. Becoming more amorphous from 160cm and with mineral material and seeds of Juncus spp. from 165cm.
- 178 to 200cm Grey clay containing finely-divided wood.

8.3 Description of the Pollen Diagram

Zone A : Alnus-Corylus p.a.z.

This has been divided into two sub-zones.

Sub-zone A(i) : Alnus-Corylus

Alnus is the most abundant pollen type reaching over 50% TP. Corylus is also important at over 20% TP but there are only small amounts of pollen of other trees. There is much wood in the clay and peat during this zone and identifiable remains of Betula and Alnus which probably means that these trees were growing on the site.

NAP types are at low levels, Gramineae pollen reaches 15% TP and there are continuous curves for Caryophyllaceae and Plantago lanceolata, and Artemisia was also recorded. All three of these types usually indicate the presence of open conditions.

Sub-zone A(ii) : Alnus

Alnus is at higher levels than in sub-zone A(i) reaching over 70% TP and, probably as a consequence of this, nearly all other pollen types are reduced. Betula is the only exception, showing a slight increase which could represent a large increase in absolute terms.

NAP remains at low levels, there is less Caryophyllaceae pollen and no Plantago lanceolata or Artemisia but there is a small amount of Rumex acetosa type pollen.

Zone B : Alnus-Betula-Filicales p.a.z.

This is essentially a transition zone but the changes in the pollen assemblage are complex and not all synchronous, so it is convenient to divide it into three sub-zones, which allows a more detailed investigation of the transition.

Sub-zone B(i) : Alnus-Betula

The sub-zone opens with a fall in Alnus pollen which has been radiocarbon dated to 2470±50 years BP. All other AP types, and particularly Betula, are at higher levels than in zone A. The summary diagram shows that NAP is slightly increased due mainly to a small increase in Gramineae pollen, but other types

also show small increases, first Potentilla and Filipendula and then several other types including Plantago lanceolata and Caryophyllaceae. Some NAP types, such as Urtica and Chenopodiaceae appear for the first time in this sub-zone. All fern spores are at higher levels than before and Filicales types spores reach over 30% TP.

Sub-zone B(ii) : Betula

Betula is the dominant pollen type at over 50% TP. All other AP types are at lower levels than before and Fraxinus is absent. Gramineae pollen is slightly increased and there is a small rise in NAP at 126cm but Filicales spores are reduced.

Sub-zone B(iii) : Gramineae-Filicales

There is a large increase in Gramineae pollen and in total NAP in this sub-zone. Gramineae is the dominant pollen type by the end of the zone. Cereal pollen is recorded for the first time at the beginning of this sub-zone, though only one grain was found. At the same time many NAP types increase, including Calluna and Plantago lanceolata, and also Caryophyllaceae, Chenopodiaceae and Rumex acetosa type.

As Gramineae pollen increases, Betula pollen and total AP fall. Alnus pollen continues its decline, but not all AP types are at lower levels than in the previous sub-zone. Fraxinus pollen, in particular, shows an increase, and at 118cm there are small increases in Salix, Pinus and Quercus.

A significant feature of this sub-zone is the massive rise in Filicales spores and there is also a smaller rise in Sphagnum spores.

Zone C : Gramineae p.a.z.

The beginning of this zone coincides with a stratigraphical change from a monocot. peat containing wood to a monocot.-Sphagnum peat in which there is no wood. This correlates well with the pollen evidence which shows that all AP types are at very low levels and remain so throughout this zone. Gramineae is the dominant pollen type with Calluna and, later, Cyperaceae being the only other types to reach 10% TP. Cereal pollen is recorded at every level but it is less abundant in the upper half of the zone. Other NAP curves are erratic but are generally

at higher levels than before. Plantago lanceolata, Rumex acetosa and Potentilla all peak in the middle of the zone. Filicales spores return to their zone A levels and Polypodium is almost absent.

A curious feature of this zone is the large peak in Lotus pollen which reaches 17% TP at the top of the zone. This peak is only recorded by 6cm of peat and is particularly strange because it is the only occurrence of Lotus pollen in the diagram.

Zone D : Betula-Salix p.a.z.

The boundary between zones C and D has been placed at 74cm, since this separates the high Gramineae-low Betula of zone C and the low Gramineae-high Betula of zone D, and it has been radiocarbon dated to 1650±50 years BP. However, some changes in the pollen assemblage begin to take place just before this. At 78cm there is a small rise in Quercus and Fraxinus pollen, and Lotus pollen appears. At 76cm there are rises in Betula and Salix pollen and a small fall in Gramineae pollen. The major changes occur between 74cm and 72cm, Betula rises to 50% TP whilst Gramineae falls to less than 10% TP. Most other pollen types decrease but this is particularly marked in the Calluna, Cyperaceae, Compositae, Plantago lanceolata and Potentilla curves. The summary diagram shows that total NAP falls from 54% to 13% between 74cm and 72cm. There is also an important stratigraphical change at the beginning of the zone, to an Eriophorum vaginatum peat containing much wood.

Betula reaches very high levels at the beginning of zone D but is reduced to around 30% TP after 70cm, when Salix pollen rises to become the dominant type. Both curves are somewhat erratic and rise and fall alternately, Betula having three peaks and Salix two. Corylus pollen is increased above 54cm and so to a lesser extent is Alnus pollen.

Most NAP types are at lower levels than in the previous zone. Cereal pollen is absent, and in a typical sample the number of NAP types recorded is only half that of the previous zone. There is, however, a small increase in both

the number of types present and in their abundance in the latter half of the zone and cereal pollen reappears at the top.

Zone E : Cyperaceae-Calluna p.a.z.

This zone has been divided into two sub-zones.

Sub-zone E(i) : Cyperaceae

The first level of this sub-zone, 34cm, has been radio-carbon dated to 590±40 years BP. It marks a stratigraphical change to a Sphagnum peat but the pollen diagram shows only a small increase in Sphagnum spores. The sub-zone opens with falls in Betula and Salix, and a rise of Cyperaceae to 40% TP with smaller rises of Gramineae and Calluna.

The summary diagram shows that this sub-zone is characterised by very high NAP values and many other NAP types increase at the beginning of the zone, particularly Plantago lanceolata and Potentilla, and there are more types present than in the previous zone. The Empetrum curve starts at the beginning of zone E but remains below 5% TP. Pteridium spores are also at high levels. Cereal pollen is present in small amounts and Cannabis pollen is recorded at 30cm and 26cm.

Although AP is low most tree curves are still continuous and Fraxinus pollen is at its highest levels.

Sub-zone E(ii) : Calluna p.a.z.

Calluna pollen is the dominant type with Cyperaceae no longer important. Most other pollen types are at lower levels in this zone, probably as a result of the massive rise in Calluna pollen, but Empetrum rises to about 10% TP and Pteridium spores show a slight increase. AP pollen is at its lowest frequencies and the Alnus and Quercus curves are discontinuous. The end of the Sphagnum curve, between 14cm and 22cm, coincides with a change in stratigraphy at 15cm from a Sphagnum peat to an Eriophorum peat.

Zone F : Empetrum-Pteridium p.a.z.

Zone F is represented by the uppermost level of the pollen diagram. Empetrum is the most abundant type at 60% TP and Gramineae is also increased, but all other pollen types are at low levels. There is also a large increase in Pteridium spores

to nearly 40% TP. Cereal pollen is absent, but one grain of Cannabis was recorded. Very few NAP types are present.

8.4 Discussion

Hebers Ghyll is such a small bog that the pollen diagram must represent only very local vegetation particularly when AP is high. Nevertheless these local clearances may be part of more widespread activity in the area.

Using the three radiocarbon dates shown on the diagram a peat growth rate curve has been constructed (see Fig.27). This must be regarded as a very rough approximation since three dates are not sufficient to allow an accurate estimate of peat growth rate, particularly when there is no data available for a stratigraphical change such as that at 178cm.

The pollen assemblage of zone A suggests that the vegetation on and immediately around the site was an alder-birch carr with a ground flora in which Carex spp. and Juncus spp. were important on the wetter ground and grasses on the drier parts. On the drier land away from the site, hazel and oak were more abundant with ferns and grasses important in clearings.

There is evidence, particularly in sub-zone A(i), that some clearings did exist (see p107) but there are fewer indications of open conditions in sub-zone A(ii) where Alnus pollen is much more dominant. The effect of an increased presence of Alnus at the site would be to decrease representation of other species in the pollen diagram in two ways; (i) the increased amount of Alnus pollen falling onto the boring site would cause relative decreases in other species, and, (ii) a denser growth of Alnus trees around the site would prevent pollen of the surrounding vegetation from reaching the site. It is impossible therefore to decide whether there was actually less cleared land in the surrounding woodland of sub-zone A(ii) or whether it is being underrepresented in the pollen diagram.

The reason for the increase of Alnus pollen in sub-zone A(ii) has been interpreted as an increase in the number of Alnus trees at the site, probably as a response to wetter conditions. Using the growth rate curve a date of 2860 years BP



Fig.26 : Hebers Ghyll, looking north towards Ilkley

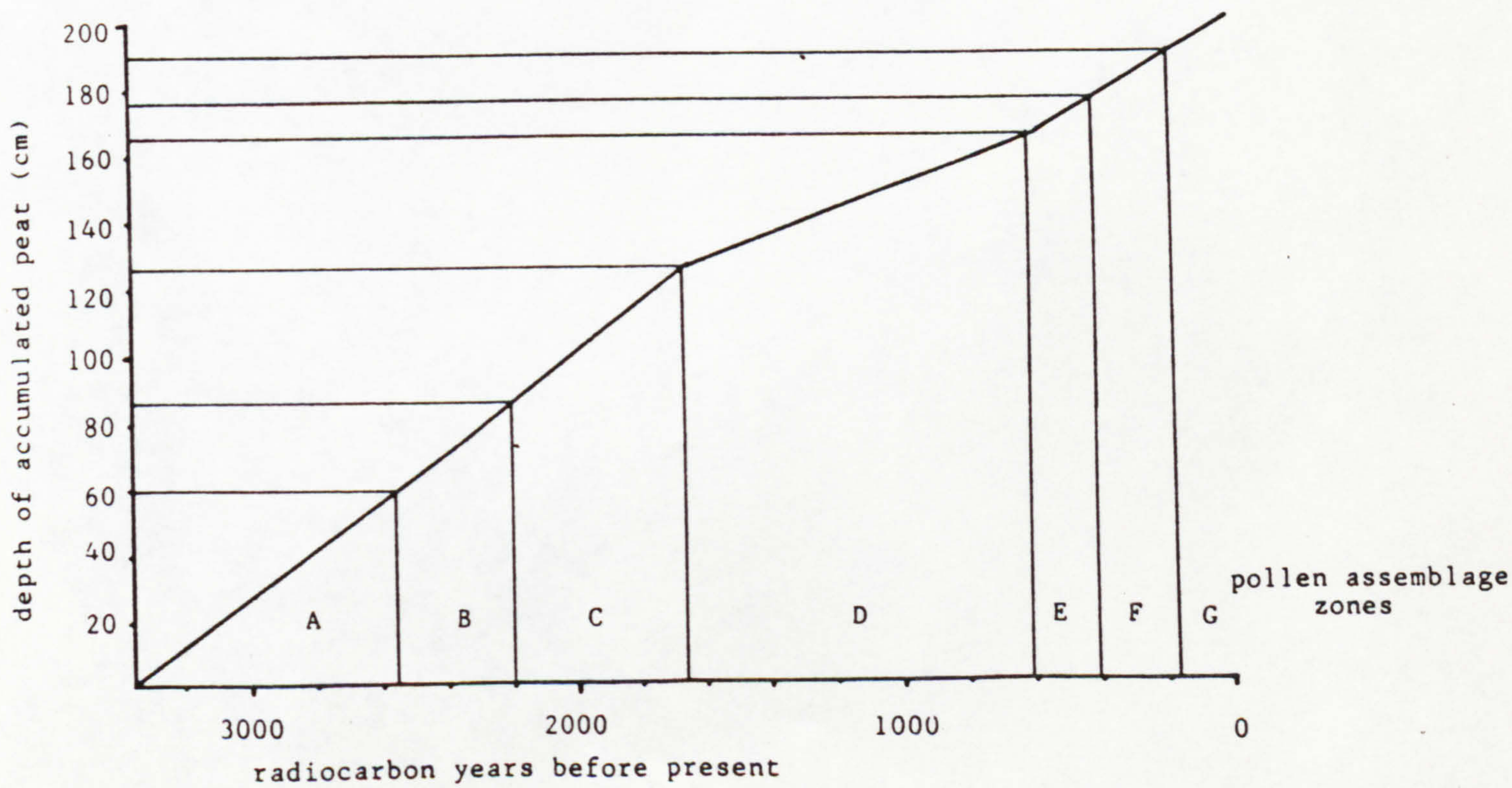


Fig. 27 : Hebers Ghyll peat growth curve.

can be suggested for the zone A(i)/A(ii) transition, which is very close to the 2850 years BP suggested by Van Geel as the age of a catastrophic decline in climate (Van Geel, 1977). It is interesting that a similar change to higher Alnus and lower Gramineae values occurs at approximately 2750 years BP in the Lanshaw 2 diagram.

Zone B represents a period of intense clearance activity which lasted some 300 years from 2470±50 years BP to ca. 2140 years BP. Even taking into account confidence limits this clearance began 200 years earlier than the major clearance at Lanshaw and Green Gates, providing evidence that the lower slopes of Rombalds Moor were cleared earlier than the higher land. The date of 2140 BP (190BC), by which time clearance was complete, is very close to the 2170±70 years BP (220BC) date of the Lanshaw and Green Gates clearances, suggesting that the upper parts of the moor were only cleared after the lower slopes had been completely deforested.

The period of active clearance at Hebers Ghyll as represented by zone B appears to have had three phases represented by the three sub-zones. In sub-zone B(i) Alnus pollen decreases and there are rises in all other pollen types present. This is likely to be a relative effect caused by the reduction in Alnus pollen as trees were cleared from the site. The removal of Alnus trees would also allow a greater representation of pollen from the proposed surrounding hazel-oak woodland, hence the rises in Quercus and Corylus pollen. The rises of Betula pollen, and later Filicales spores, are particularly marked and, therefore, probably represent real increases in these species. As alder was cleared there seems to have been a spread of birch woodland possibly recolonising in patches and in which ferns must have been an important constituent of the ground flora. This woodland appears to have been fairly dense during zone B(ii) and would have prevented much pollen from the surrounding woods from reaching the site thus explaining the small decreases of other AP types. It was, however, much more open than the alder woodland of zone A since there are many indicators of open conditions present including Plantago lanceolata, Rumex acetosa type, Caryophyllaceae and Potentilla, and there is

also an expansion of the Pteridium curve.

There is no firm evidence in sub-zones B(i) and B(ii) that the early clearance was for arable agriculture. No cereal pollen was recorded but the small amount of Chenopodiaceae and Cruciferae pollen could indicate very limited cultivation. The low level of Plantago lanceolata does not necessarily mean that pastoralism was limited since the grasslands of Rombalds Moor today have little or no P.lanceolata. Also the increase of Gramineae pollen does suggest that the purpose of this early clearance was at least in part to provide grazing land.

Cereal pollen is first recorded, though only one grain, in sub-zone B(iii), at about 2265 years BP (315BC). In this sub-zone the decline of the Betula curve indicates a more intensive phase of clearance, during which the birch scrub was removed, and there followed a rapid spread of grassland in which Plantago lanceolata and Potentilla spp. were important. The small increases in AP types in this sub-zone, other than Alnus and Betula, probably means that these types were not growing immediately around the Hebers Ghyll site, and the removal of Alnus and Betula from the site caused an increase in the representation of pollen of other trees. It is difficult to know whether clearance was also taking place in the mixed hazel-oak woodland because with Hebers Ghyll being such a small bog the pollen diagram is dominated by the local vegetation.

One of the most noticeable effects in the pollen diagram of the removal of the birch woodland between about 2265 years BP and 2140 years BP is a massive increase in Filicales spores. It is likely that Filicales spp. were important constituents of the ground flora of the birch woodland and that once the trees were removed Filicales were more strongly represented in the pollen diagram but they seem to have been quickly replaced by grassland.

By the end of zone B there is no wood in the deposit and AP falls below 10% suggesting that the area had been completely deforested. There is a significant increase in cereal pollen at this time which, as mentioned on p.113, dates to approximately the same time as the start of clearance activity at

Lanshaw and Green Gates dated to ca.200BC. It may be that it was the same people who were growing cereals on and had deforested the lower slopes, who then began to clear the upper slopes, perhaps to provide grazing land.

The open conditions of zone C are indicated by the dominance of Gramineae pollen and the relatively high percentages of other NAP species, in particular, of Calluna. Cereal pollen is less abundant above 102cm, which dates to ca.60BC and which perhaps means that cereal cultivation was less important after this date. However, other NAP types such as Plantago lanceolata, Potentilla and Rumex acetosa type continue to increase and peak at 94cm.

The period of cultivation lasted for some 550 years through the Iron Age and into the Romano-British period ending at about AD250. This may coincide with the temporary abandonment of the Ilkley fort by the Romans during the period AD286 to AD296, when Carausius gained control of Britain. Faull (1981, p.150) notes that the Ilkley fort was neglected in this period. The agricultural land appears to have been abandoned since there was a rapid invasion by first birch and later willow. The presence of wood in the peat shows that trees were growing on the site and the vegetation was probably a birch-willow carr. It is difficult with such a small site, particularly when it is wooded, to determine the nature of the surrounding vegetation. It seems likely, however, that Corylus was important with some Alnus and Quercus. It is also likely that some grassland persisted throughout the zone since the Gramineae curve reaches over 10% TP and many NAP types, including Plantago lanceolata, Potentilla and Rumex acetosa continue to be recorded.

The Ilkley fort underwent reconstruction and presumably reoccupation after Constantius regained control of Britain and Faull(1981,p.150) considers it likely that occupation was almost continuous until the end of the 4th century AD, but, there is no evidence in the pollen diagram of a re-clearing of land or of continuation of agriculture. However, bearing in mind the size of the bog and the fact that birch and willow were growing on the site, even if agriculture did restart

near to Hebers Ghyll in zone E it seems unlikely that cereal pollen would reach the boring site.

Clearance did not take place until 590±40 years BP(AD1360) a date which does not appear to have much historical significance. However, the records of the Wakefield court rolls show that there was a period of intense clearance in the Wakefield area in the early 14th century (Faull,1981,p.415) and, taking into account the confidence limits, the Hebers Ghyll clearance could date from this time. Also Faull states that the expansion of cultivated and pastoral land in West Yorkshire during the 13th and 14th centuries was often at the expense of woodland. That woodland still existed in the area some 50 years earlier than this is shown by the grant from Peter de Percy, of Bolton Percy, of three cartloads of wood annually from between 1253 and 1267 from his wood at Ilkley to the abbot of Sawley (Faull, 1981,p.415).

Following the first clearance there was a spread of grassland and only a small increase in heath species. The second clearance also resulted, initially, in a spread of grassland which is relatively species rich. Although some cereal pollen and a small amount of Cannabis pollen was recorded, indicating some arable activity, their low levels together with the high levels of Gramineae, Plantago lanceolata and Potentilla suggest that pastoralism was much more important. It appears that trees were not at first completely removed from the surrounding area since AP remains at around 20% TP during zone E. However, substantial clearance did take place at the beginning of the zone and the increased runoff likely to have resulted from such a vegetation change was the probable cause of increased wetness of the bog indicated by the stratigraphical change to Sphagnum peat.

The second clearance differed from the first in that grassland was superseded by heathland at a time around the middle of the 16th century with a massive spread of Calluna and increases in Empetrum and Pteridium. At this point in the pollen diagram AP values fall to their lowest levels and species diversity is low. The reason for this vegetation change was probably a decrease in grazing pressure allowing

heath to invade. In fact indicators of both pastoral and arable activity are much lower in sub-zone E(ii) than in sub-zone E(i).

The last vegetation change recorded in the diagram is to a species poor Empetrum dominated community with much Pteridium, some Gramineae and a small amount of Calluna. As discussed on p.16 it is known that this change took place in many parts of Rombalds Moor within this century and is the result of over-grazing.

9. SEA MOOR

9.1 Introduction

Sea Moor is a 2-3 acre area of marsh which is believed to have its origins in a post-glacial lake (see p.119). It is centred around a small stream at Grid Reference; SE 060482 at an altitude of about 270m O.D.. A survey of the vegetation conducted in July 1982 by the Biological Data Bank, West Yorkshire Region, (unpublished) revealed that it comprises three main zones,

1. A central area of deep water (3-4ft deep) colonised mainly by Potamogeton natans.
2. A surrounding zone of shallower standing water (1-2ft deep) dominated by a virtually pure stand of Carex rostrata.
3. The remainder of the marsh which is under 6 inches to 1ft of water in places and semi-consolidated in others, and which is dominated by Juncus effusus.

In addition a small area of the marsh has a few Alnus glutinosa and Salix caprea trees. A photograph of the site can be seen on p.119

The boring was taken from area 2 and the total depth of clay and mud was 550cm. A preliminary investigation revealed that the bulk of this represents the Late-Glacial period but unfortunately there was insufficient time to study this part of the deposit. Only the top 95cm is represented by the pollen diagram which includes the end of the Late-glacial and some of the Post-glacial period.

9.2 Stratigraphy

- 0 to 66cm Coarse, brown detritus containing, from 0 to 28cm, seeds of Juncus effusus and monocot. stems. Finely divided wood from 25 to 50cm, with Alnus buds and Betula fruits and bud scales. Red wood from 56 to 58cm
- 66 to 83cm Coarse, darker brown mud.



Fig.28a : Sea Moor (the arrows converge on the boring site)



Fig.28b : The centre of Sea Moor

- 83 to 156cm Brown-grey clay becoming blue-grey.
156 to 172cm Slightly darker clay with sand.
172 to 187cm Darker clay with more sand.
187 to 280cm As 172 to 187cm but containing plant remains,
and with darker bands from 233 to 234cm and
240 to 242cm. Becoming darker from 243cm.
281 to 312cm Very smooth, dark, banded clay.
313 to 329cm Lighter coloured clay.
330 to 360cm Moss remains in light coloured clay with dark
bands.
361 to 474cm Highly banded smooth clay with occasional moss
remains. Bands becoming narrower.
474 to 550cm Pale, blue-grey clay with no plant remains.
Very dark band 457 to 459cm.

9.3 Description of the Pollen Diagram

Zone A : Gramineae p.a.z.

NAP is at high levels in this zone which is represented by a brown-grey clay. Pollen of Gramineae is dominant and Cyperaceae, Filipendula and Ranunculaceae are also important. Many NAP types are present, some of which are typical of open habitats, including Rumex acetosa type and Empetrum, and some which are typically found in Late-glacial deposits such as Thalictrum and Polemonium.

The low AP values consist mainly of shrub pollen, Salix, Juniperus and Betula nana, together with a small amount of Pinus and Betula pollen. Pollen from many aquatic species was recorded suggesting the presence of open water.

Zone B : Betula p.a.z.

Although this zone is only represented by one level in the pollen diagram the pollen assemblage is very different from the zones above and below. AP is high consisting mainly of Betula with only small amounts of pollen of other trees. Corylus, which is absent from zone A, is over 10% TP and the Ulmus curve begins. Betula nana is absent and Juniperus is much reduced, as are most of the NAP types which were present in Zone A, but Filicales spores rise to 15% TP. There are

fewer NAP types than in zone A and, in particular, fewer aquatic species. It may be that the area of open water was smaller during this zone.

Zone C : Corylus p.a.z.

Corylus reaches its maximum of over 50% TP in zone C. AP is high and most AP types are at higher levels than before particularly Ulmus and Quercus. The Alnus curve, although at a low level, is continuous and has a small peak at 75cm.

There is a change in stratigraphy at the beginning of the zone to a coarse, dark-brown mud. NAP pollen is at a low level with only 8 types represented, excluding aquatics, compared to 22 in zone A and 12 in zone B. There is, however, a slight increase in the variety and amount of aquatic pollen in this zone.

Zone D : Betula-Corylus p.a.z.

AP maintains very high levels with Betula and Corylus as joint dominants. Other tree pollen types show increases in zone D particularly Pinus, and Quercus reaches over 15% TP. Three new AP types are recorded, Fraxinus, Tilia and Populus.

NAP levels are similar to the previous zone though there is less pollen of aquatics. The presence of a cereal and a Cannabis grain may be the result of downward movement of pollen through the sediment or contamination due to the difficult sampling conditions. Near the top of the zone Pinus values fall to about 5% TP.

Zone E : Betula-Corylus-Alnus-Quercus p.a.z.

The beginning of zone E is marked by a rise in Alnus pollen and a fall in Ulmus pollen. It has been divided into two sub-zones.

Sub-zone E(i)

Betula is the most abundant pollen type followed closely by Corylus and then Alnus and Quercus. Pinus and Ulmus are less important than before but Tilia and Fraxinus, although they are at relatively low levels, both show increases in this sub-zone. It seems likely that trees, especially Alnus and Betula were actually growing on the site in this sub-zone since their remains were found in the deposit.

NAP is still at a very low level but there are small increases in Gramineae and Calluna. A cereal grain was recorded at 50cm but, being at the top of a core it is likely to be the result of contamination since there is little or no evidence for human activity at this level. There are, however, a few indications that the forest of this sub-zone was not as closed as in zone D. Rumex acetosa pollen is present at the beginning of the sub-zone and from 45cm there are continuous curves for Plantago lanceolata and Fraxinus.

Only an occasional aquatic pollen grain is recorded in this sub-zone suggesting that there was very little open water.
Sub-zone E(ii)

In this sub-zone there is some evidence for human activity in the Sea Moor area. The start of the sub-zone is marked by a small fall in Ulmus pollen and by the end of a continuous Tilia curve. At the same time there is an isolated occurrence of cereal pollen and the beginning of a continuous Potentilla curve, followed by the start of the Rumex acetosa type curve, but there is a gap in the Plantago lanceolata curve until the 20cm level. It is from this point that there is most evidence for clearance activity, all AP types apart from Fraxinus show decreases at either 17.5cm or 15cm on the pollen diagram, continuous curves begin for cereals and Plantago lanceolata, there are increases in Calluna and Gramineae and isolated occurrences of Urtica and Cruciferae. AP recovers at 10cm but then falls again at 0cm where Gramineae increases. It seems certain that trees were removed from the site in this sub-zone since there is no longer any wood in the sediment.

9.4 Discussion

The clay of zone A almost certainly represents the end of the Late Devensian period. The pollen assemblage of this zone points to a largely treeless vegetation which included dwarf birch and Juniper but which was dominated by grasses. Filipendula and Ranunculaceae seem to have been abundant and there was a high species diversity compared to the present day vegetation at the site. The peak in Juniperus pollen at the end of zone A probably correspond to the Juniperus peaks

in the Lanshaw diagrams which date to ca.10000 years BP. The presence of pollen of so many aquatic species must mean that Sea Moor was a shallow lake at this time.

The pollen assemblage of zone B is dominated by Betula with a substantial amount of Corylus and with many of the NAP types of zone A absent. This is such a sudden change in the pollen diagram in just 5cm sediment that it suggests either very slow sedimentation or a gap in the pollen record. In the Lanshaw 2 diagram this change from a Late Devesian vegetation to a Betula dominated vegetation, including significant amounts of Corylus, took some 1000 years. It is quite possible that the Sea Moor site dried out for some time in the very early Post glacial but it would require very close sampling to decide this question.

Zone C highlights an important difference between this diagram and the Lanshaw diagrams. This is the zone of the Corylus maximum and at the same time as the Corylus rise, Ulmus and Quercus also rise. In the Lanshaw diagrams these trees rise much later than this, Ulmus rises just after the Corylus maximum and to a higher level than in the Lanshaw diagrams and Quercus rises even later at the Alnus rise. Unfortunately radiocarbon dates are not available for the Sea Moor diagram. The differences must be due to the different altitudes of the two sites and are discussed further on p.159.

During zone D hazel's abundance was reduced as other trees, notably Pinus, became more important. In this respect the diagram compares well with the Lanshaw diagrams showing an increase in Pinus and a small rise in Alnus after the hazel maximum. However, Pinus falls earlier than in the Lanshaw diagrams and even after its rise remains second to Betula.

It is difficult to suggest a date for the E(i)/E(ii) boundary and hence for the first definite evidence of agriculture and small-scale clearance activity. Many aspects of the boundary such as the small increase in Gramineae pollen, and the falls in most tree pollen suggest a correlation with the H/I boundary at Lanshaw, thus giving a Bronze Age date. The only problem is that Betula pollen falls at this point whereas in the Lanshaw diagrams it increases. However, since

Betula behaves very differently throughout both diagrams it seems reasonable to regard this as a local event. A Bronze Age date is further supported since AP is still at around 50% at the top of the Sea Moor diagram which must mean that it pre-dates the Iron Age clearance which is known to have taken place on most parts of Rombalds Moor.

It is clear that the top of the diagram, involving perhaps some of the Bronze Age and certainly all of the Iron Age to the present day, is missing as a result of peat cutting which is known, from records held by the present owners of the site, to have taken place during the 17th century.

10. BRADUP BECK

10.1 Introduction

The peaty area from which the boring was taken (Grid Reference; SE08754424) has developed, at an altitude of 290m O.D., around a small stream, Bradup Beck. Although the boring contained a substantial amount of clay no other suitable deposits could be found in the south-western part of Rombalds Moor. The area today supports a Juncus squarrosus dominated vegetation surrounded by rough grassland which is grazed by sheep.

10.2 Stratigraphy

- | | |
|------------|---|
| 0 to 2cm | Living <u>Sphagnum</u> spp. |
| 3 to 5cm | Black monocot peat with many seeds of <u>Juncus squarrosus</u> and <u>J. effusus</u> , some nutlets of <u>Carex</u> spp. and leaves of <u>Sphagnum recurvum</u> . |
| 6 to 22cm | Mid-brown monocot. peat with many <u>Juncus effusus</u> seeds, some leaves of <u>Sphagnum recurvum</u> , one seed each of <u>Ranunculus flammula</u> and nutlets of <u>Carex</u> spp. Much mineral material and a small amount of charcoal. |
| 23 to 27cm | Dark-brown monocot. peat with many <u>Juncus</u> seeds and much charcoal. |
| 28 to 43cm | Light-brown clay containing much monocot material, <u>Juncus</u> seeds and some <u>Eriophorum vaginatum</u> stems. |
| 44 to 54cm | Mid-brown peaty-clay becoming lighter in colour and containing finely-divided wood and monocot. material. Many <u>Juncus</u> seeds, a <u>Betula</u> fruit and a grass seed. Some leaves of <u>Sphagnum recurvum</u> . |
| 55 to 66cm | Darker brown, clay-peat becoming lighter in colour and containing finely-divided wood and monocot. material with some <u>Juncus effusus</u> seeds. |
| 67 to 79cm | Lighter brown clay containing finely-divided wood and much monocot. material. |
| 80 to 85cm | Grey-brown clay-peat containing finely-divided wood and monocot material, some <u>Juncus squarrosus</u> |



Fig.29 : Bradup Beck (the arrows converge on the boring site)

seeds and an Alnus flower.

86 to 90cm Dark brown, clay-peat with finely-divided wood and monocot.material. Wood from 89 to 92cm.

91 to 105cm Light grey/brown peaty clay containing coarse wood and monocot. material and many fungal sclerotia.

106 to 114cm Grey clay containing coarse wood and Eriophorum vaginatum stems with a small amount of Sphagnum recurvum.

115 to 120cm Very dark clay containing coarse wood and Eriophorum vaginatum stems and some Juncus squarrosus seeds.

10.3 Description of the Pollen Diagram

Zone A : Corylus-Pinus p.a.z.

Pinus and Corylus are the most abundant pollen types but Alnus pollen rises rapidly to reach over 20% TP by the end of the zone. Betula and Quercus pollen are less important and only one grain of Tilia was recorded, at 120cm. At the start of the zone Ulmus is at 4% TP but it falls gradually to 2% TP. NAP is at low levels with few types represented, Gramineae and Filipendula are the most important NAP types but for the most part they remain below 5% TP. Filicales spores are particularly abundant at the beginning of the zone and Polypodium and Pteridium are present but are less important.

Zone B : Alnus p.a.z.

This zone is represented by 76cm of clay and peat and has been divided into two sub-zones. It is, however, difficult to place a boundary accurately between the two sub-zones since although their pollen assemblages are somewhat different, the changes that occur in each pollen type are gradual and not always synchronous. The position of the boundary should therefore be regarded as an approximation.

Sub-zone B(i)

The beginning of this sub-zone is placed at a fall in Pinus pollen and at the start of the Tilia curve. Pinus falls

to around 2% TP and remains at this low level. Alnus, after rising rapidly during the previous zone, reaches its maximum of nearly 70% TP and is by far the most frequent pollen type. Corylus is the second most abundant type, starting the zone at over 20% TP, but its curve gradually decreases, in a series of rises and falls, to below 10% TP. Quercus does not show a significant increase at the same time as the Alnus rise but it does increase gradually, though not to a high level. All other tree pollens are at low levels in this sub-zone, Fraxinus is only occasionally recorded and Tilia and Ulmus are particularly infrequent above 88cm.

NAP is at low levels, though higher than in zone A, with Filipendula the most important type. There is little Gramineae pollen but it increases slightly at the top of the sub-zone. There are more types present than in zone A, notably Lonicera, and also several types usually associated with clearance activity or open conditions i.e. Plantago lanceolata, Artemisia, Caryophyllaceae and Rumex acetosa type. No cereal pollen was recorded but Chenopodiaceae is present at two levels, just below and at the same point as the slight falls in Tilia and Ulmus pollen at 88cm.

The peak in Lemna pollen at 68cm, and the beginning of the Potamogeton curve are probably associated with the change in the stratigraphy from a clay containing wood and monocot. material to a clay-peat containing some wood, monocot. material and Juncus effusus seeds. This may have been the result of increased wetness of the site.

Sub-zone B(ii)

Alnus is still the dominant pollen type and maintains its high levels but Corylus is slightly less abundant than in the previous sub-zone. Quercus pollen declines and Tilia, Ulmus and Pinus are at very low levels, and their curves become discontinuous.

Betula and Gramineae are the only pollen types which show significant, although small, increases. Filipendula pollen and Filicales and Polypodium spores are much reduced, and several NAP types are either less frequent or absent including Rumex acetosa type, Plantago lanceolata, Artemisia and Lonicera.

Zone C : Gramineae p.a.z.

Zone C opens with a large fall in Alnus pollen and smaller falls in Betula and Corylus. These are accompanied by a major rise in Gramineae pollen and small increases in Calluna and Cyperaceae pollen. Ulmus pollen is absent and the Tilia curve ends at the zone B/C boundary but Fraxinus and Salix pollen increase slightly.

There are more NAP types present in this zone and several such as Plantago lanceolata, Ranunculaceae and Rumex acetosa type show significant increases. The only occurrence of Plantago major/media type pollen is at the beginning of the zone and Urtica pollen is present at the top of the zone. The Filicales and Polypodium curves are at much lower levels than before but Sphagnum spores are slightly increased.

The stratigraphy notes show that this zone corresponds to a dark monocot. peat which contains much charcoal.

Zone D : Alnus-Gramineae p.a.z.

This is only represented by the 20cm level in the diagram, with the upper boundary to the zone being placed at the 16cm level, but the pollen assemblage is quite different to that of zone C.

Alnus pollen is much higher than in zone C at 37% TP and Corylus, Salix and Quercus are slightly increased. Gramineae pollen is lower than before though it is still at a high level and most other NAP types are also reduced. Filipendula does not decrease whilst Filicales spores show a significant increase. Fagus pollen is recorded for the first time in the diagram.

Zone E : Gramineae-Calluna p.a.z.

At the zone D/E boundary the first cereal grains are recorded at the same point as the first appearances of Cruciferae and Rumex cf. crispus. Cereals are recorded again at 12cm but are absent at the top of the zone. In zone E Alnus pollen falls to levels similar to those of zone C. There are smaller falls of Salix, Corylus and Quercus pollen, but Fraxinus pollen increases. In zone C the Alnus fall was followed by

a rise in Gramineae pollen, but in zone E Gramineae falls to less than 30% TP. There is instead a large increase in Calluna pollen and a smaller rise of Cyperaceae pollen. Most other NAP types also increase, in particular Plantago lanceolata and Potentilla.

Zone F : Gramineae p.a.z.

This zone is marked by a massive rise in Gramineae pollen to over 70% TP. All other pollen types are at low levels and there is very little AP. There is however quite a variety of tree and shrub pollen with ten types represented, including Fagus and Sambucus, and Ulmus, which reappears at the top of zone F. There are fewer NAP types in this zone and only two, Ranunculaceae and Rumex acetosa type are at higher levels than in the previous zone.

10.4 Discussion

When interpreting the Bradup Beck diagram it is important to remember that the boring was taken from a small area of peaty-clay in a steep-sided valley. It is likely that at times there was erosion of the valley sides and, perhaps, flooding of the stream, which led to deposition of material on the flat area around the stream. The substantial amount of clay in the profile is evidence that this process has taken place. It is, therefore, possible that, at times, older pollen has been incorporated in the deposit leading to a mixing of the pollen assemblage.

During zone A Corylus and Pinus values are high, there is relatively little Alnus pollen and NAP is low. The vegetation in the Bradup area at this time must have been a fairly closed hazel-pine woodland with some elm, oak and birch. There are, however, significant amounts of Gramineae pollen and Pteridium spores, and Calluna and Caryophyllaceae are present. There must therefore have been some opening of the tree cover, but there may simply have been a natural break in the woodland around the beck. The presence of wood in the deposits shows that trees, probably birch, were growing on the site at this time. The changes that occur at the end of zone A

would appear to represent a normal Boreal/Atlantic transition with a fall in Pinus and rising Alnus values, but the fall in Pinus at Lanshaw 2 has been dated to 5250 years BP which is a Late Atlantic / Early Sub-Boreal date. It is, however, unlikely that both diagrams have recorded the same fall in Pinus, since at Lanshaw 2 the start of the Tilia curve and the rise in Alnus pollen occur well before the Pinus fall, whereas in the Bradup diagram all three of these changes occur within 4cm of each other. Without a radiocarbon date it can only be said that the age of the zone A/B boundary is probably earlier than 5840 BP (the date of the rise of Alnus pollen to over 40% TP at Lanshaw 2), and, since Corylus has already fallen from its maximum and the Alnus curve is expanding throughout zone A, it is probably considerably later than 8160 years BP.

During sub-zone B(i) the vegetation around the site appears to have been dominated by Alnus with Corylus and perhaps Quercus the only other important trees. The ground flora probably consisted of ferns and meadowsweet. There is little evidence of clearance activity, although there are some occurrences of cultural indicators such as Plantago lanceolata. The association of Chenopodiaceae pollen with small falls in Ulmus and Tilia pollen at 88cm is interesting, but both trees are already at such very low levels that it would be unwise to attach great significance to it.

The vegetation of sub-zone B(ii) was probably similar to that of the earlier sub-zone, with alder still dominating the vegetation, but with other trees, particularly elm and oak, even less important than before. Betula pollen, however, shows a small increase in this sub-zone, and the presence of Betula fruit in the clay is evidence that the tree was growing on the site. The ground flora of the woodland during sub-zone B(ii) appears to have included less ferns and meadowsweet than before, and grasses became more important. The low NAP values for this zone suggest that the woodland cover remained quite dense until the end of zone B, though wood is absent from the stratigraphy from 43cm. The increase in Gramineae pollen may represent a very local event i.e. the disappearance of trees from the boring site, which was then invaded by grasses.

The changes in the pollen assemblage at the zone B/C boundary indicate a partial clearance of woodland which allowed Fraxinus to increase and which led to a spread of grassland, and, to a lesser extent, of heather. At the same time there are increases of other NAP types and the start of the Plantago lanceolata and Rumex acetosa type curves, providing further evidence of clearance activity. The presence of charcoal in the peat suggests that some of the clearance may have been effected by the use of fire. It is unlikely that the purpose of the clearance was to provide agricultural land since no cereal pollen was recorded.

This clearance is likely to be contemporary with the major land clearance at Lanshaw 2 which has been dated to 2170±50 years BP and which is also followed by a large rise of Gramineae pollen. It would mean that there was little, if any, clearance and no agriculture in the Bradup area prior to the Iron Age.

Following the clearance there appears to have been a regrowth of woodland during zone D. It is possible that this is contemporary with the period of regrowth at Hebers Ghyll, on the north side of the moor, which has been dated to 1650 ±50 years BP. However, it is also possible that zone D represents a period of more intense erosion of the surrounding land leading to deposition of earlier pollen at the bore-hole site. There is a noticeable change in the stratigraphy at the beginning of this zone to a lighter coloured peat containing a large proportion of mineral material which does suggest an increase in erosion of the surrounding higher land. However, if the latter interpretation is correct there should be a decrease in mineral material in the deposit at the end of the zone where tree pollen falls again, but this is not the case.

The second fall in tree pollen in zone E seems to have led to a greater spread of heathland than the first. The presence of cereal pollen is evidence that some of this clearance may have been associated with agricultural activity. The second clearance at Hebers Ghyll, which similarly led to a spread of heathland has been dated to 590±40 years BP.

The final change in the pollen diagram to high levels

of Gramineae pollen and low levels of Calluna pollen is representative of the present day vegetation surrounding the site which is a rough, species-poor grassland.

11. FENNY SHAW

11.1 Introduction

Fenny Shaw is a large area of gently sloping blanket bog on the southern side of Rombalds Moor. The boring was taken at Grid Reference; SE115442 at an altitude of 340m O.D.. The site is now quite dry due to an extensive system of drainage ditches which are maintained by the Yorkshire Water Authority. The vegetation of this area is dominated by heather but with frequent large tracts of bracken.

11.2 Stratigraphy

- 0 to 15cm Very unhumified, light-coloured Sphagnum cuspidatum-S.recurvum-Eriophorum vaginatum peat, with occasional flowers and leaves of Calluna
- 16 to 18cm Dark-brown, more humified Sphagnum-Calluna peat with occasional caryopses of grasses and remains of Drepanocladus aduncus. There are also frequent remains of Eriophorum vaginatum and many pieces of charcoal.
- 19 to 42cm Mid-brown coloured Sphagnum recurvum peat with some S.cuspidatum, Polytrichum spp., Scorpidium scorpioides, Drepanocladus fluitans and Calluna flowers.
- 43 to 55cm Very unhumified S.recurvum peat with many leaves and flowers of Calluna and much Eriophorum vaginatum. Other mosses present are Rhytidiadelphus loreus and Hypnum cupressiforme and also a seed of Urtica dioica.
- 56 to 63cm Darker, more humified Sphagnum papillosum and S.recurvum peat with leaves and flowers of Calluna to 58cm. Frequent remains of Hypnum cupressiforme, occasional Juncus squarrosus seeds and some remains of Calliargon cuspidatum and Rhytidiadelphus leaves. Also a seed of each of Erica tetralix and a Stellaria spp. and a small amount of charcoal.



Fig.30 : The south side of the moor near to Fenny Shaw

64 to 84cm Finely divided, dark brown wood peat with some Eriophorum vaginatum, a small amount of charcoal and an increasing mineral content.

84 to 110cm Dark coloured clay with wood and some E.vaginatum.

11.3 Description of the Pollen Diagram

Zone A : Alnus-Betula p.a.z.

Alnus and Betula are the dominant pollen types with small amounts of Corylus and Quercus but little pollen of other trees. The macrofossil evidence of clay with wood, followed by a wood peat suggests that trees, most likely Alnus and Betula, were growing on the site during this zone.

The Gramineae curve is generally at about 10% TP, but is lower in the middle of the zone. There is very little Cyperaceae pollen, and the Calluna curve, although continuous, is at low levels. Similarly other NAP types, although occurring frequently, are in small quantities. Plantago lanceolata and Caryophyllaceae are recorded in the majority of sampling levels, and Rumex acetosa type and Chenopodiaceae are also present.

Zone B : Calluna-Gramineae p.a.z.

The zone opens with large and sudden falls of Alnus and Betula pollen followed by a dramatic rise in Gramineae to nearly 50% TP. These changes in the pollen diagram coincide with a stratigraphical change from wood peat to Sphagnum peat. Most tree pollen types decline at this point and remain at low levels throughout the zone, but Fraxinus and Pinus have small peaks at 60cm and 56cm respectively. Fagus pollen appears for the first time in the diagram between 44 and 32cm.

At the same time as the rise in Gramineae pollen other NAP types also rise, particularly Calluna, Plantago lanceolata, Potentilla, and Rumex acetosa type. Several new types appear such as Cruciferae and Galium type, and others reappear such as Chenopodiaceae. After its large initial rise Gramineae pollen falls at the next level to only 6% TP and Calluna pollen rises sharply to over 80% TP. Calluna then dominates the zone

although Gramineae pollen slowly increases and there is a peak of Cyperaceae pollen at 32cm.

Cereal pollen appears together with Cannabis at 56cm, at the same time as the large rise in Calluna pollen. Cereals then occur intermittently throughout the zone, but Cannabis pollen appears to have two concentrations one near the beginning and one near the end of the zone.

Most NAP types do not sustain the high levels they reached at 60cm and the majority of curves are discontinuous, but new types continue to appear such as Urtica at 52cm and Ligustrum at 32cm. Some types, notably Plantago lanceolata and Rumex acetosa type and Urtica show significant increases above 36cm but this level also marks the end of a continuous Potentilla curve, Many NAP types are reduced or absent from the 20cm level, only 8 types are present compared with 16 types in the previous level, no cereal or Cannabis pollen was recorded, Plantago lanceolata is very much reduced and there are obvious gaps in the Rumex acetosa type and Urtica pollen curves. The only NAP types which are increased at this level are Calluna, Cyperaceae and to a lesser extent Empetrum. At 16cm, which marks the end of the zone, many NAP types reappear and some are at their former levels.

Zone C : Gramineae-Calluna

At the beginning of the zone Gramineae pollen rises to 70% TP and Calluna falls and remains at relatively low levels. AP continues at its previously low levels but a new type, Acer, appears, and is then recorded at each level, and there is a single occurrence of Juglans pollen.

There are fewer NAP types in this zone than in zone B and cereals and Cannabis are absent, except for an isolated occurrence of cereal pollen at 8cm. Several NAP types have peaks at this level but since most AP types also peak it is likely to be a relative effect caused by the fall in Gramineae pollen.

At the top of the diagram there are small increases of Empetrum and Pinus. These may represent very recent vegetation changes resulting from the establishment of pine plantations and the spread of Empetrum nigrum. (discussed on p.6)

11.4 Discussion

Although this diagram has not been radiocarbon dated it is possible to suggest a chronology based on comparison with some of the dated diagrams. The pollen record is similar to the Green Gates diagram, which might be expected from the similar positions and topographies of the two sites. It seems likely therefore that the clearance at the end of zone A is the same as the clearance dated to 2170 ± 80 years BP at Green Gates. It is more difficult to date the base of the diagram, but since Betula is at relatively high levels, and Plantago lanceolata pollen is present, it is probably later than the 3760 ± 50 years BP date which marks an increase in Betula and the appearance of Plantago lanceolata in the Lanshaw 2 diagram. The date of the start of peat growth at 84cm must therefore lie somewhere between 3760 and 2170 years BP.

Although no cereal pollen was recorded in zone A there is evidence that some forest clearance was taking place, pollen of Caryophyllaceae, Plantago lanceolata and Rumex acetosa type is common and Gramineae pollen occasionally reaches over 10% TP. The immediate effect of clearance seems to have been an increase in grassland followed later by a spread of heathland. Cereal pollen appears, together with Cannabis, at 56cm, where Calluna reaches its maximum. These events agree well with the Bradup Beck diagram.

Whilst cereals appear to have been grown more or less continually throughout zone B there may have been two or three periods of Cannabis cultivation. There is evidence that grazing was more important in the latter half of the zone as there are increases in Plantago lanceolata, and Gramineae.

There is no obvious explanation for the gaps which occur in the curves of several NAP types at the 20cm level. The end of the Cannabis curve and the large gap in the cereal curve suggests that there was a decrease or cessation of agricultural activity at this time, but this does not seem to have caused an immediate change in the vegetation which could explain the absence of so many NAP types.

There does appear to have been a change in the vegetation at 16cm from heathland to grassland and with a small but

increasing amount of bracken. Unfortunately, it is not possible to suggest the age of this change without a radiocarbon date, but if the Acer pollen recorded is A.pseudopiantanus it would infer a late 16th or early 17th century date for the beginning of zone C.

At the top of the diagram are small increases in Pinus pollen and Empetrum pollen which are likely to represent very recent changes, probably within this century.

12. WOOFA BANK CAIRN : Pollen Analysis

12.1 Introduction

The Woofa Bank cairnfield is described on p.33 and illustrated on p.34. Three soil monoliths were taken for pollen analysis from the area of the excavated cairn. WB1 is a sample of the soil buried beneath a large stone central to the cairn (in the bottom right corner of fig.33b). Of the two large stones in the centre of the cairn only one lay on top of soil, the other lay on the bedrock. It was thought that the latter was probably in place before the construction of the cairn but that the former was likely to have been placed during the building of the cairn, and may have covered a cremation. WB2 is a sample taken from just outside the perimeter of the cairn to use as a comparison with the buried soil. WB3 was taken some 15m south of the cairn to check that the profile of WB2 had not been disturbed during the construction of the cairn. Since the pollen diagram from this site did not differ significantly from that at WB2 it is assumed that there has been no disturbance at WB2. The WB3 diagram is not illustrated.

None of the samples for pollen analysis were subjected to acetolysis as the pollen was generally in a poor condition.

12.2 WB1

12.2.1 Stratigraphy

The profile consisted of 10 to 11cm of a red sandy podsol. It was covered in parts by up to 1cm of a dark, finely-divided, peaty soil which is represented in the pollen diagram by the uppermost level. The top 2cm of the profile has been radiocarbon dated to 2480±90 years BP. There was a well developed iron-pan at the base of the soil.

12.2.2 Description of the Pollen Diagram

In the top half of the diagram Corylus is the most abundant type, but at some levels it is equalled by Tilia.

Betula and Alnus are the only other AP types which reach over 5% TP, and there are smaller amounts of Pinus, Quercus and Salix, and one occurrence of Fraxinus. The total AP is, generally between 70% and 80% TP. Of the 20% to 30% NAP the majority is Gramineae and Calluna but Caltha pollen is also important and reaches 6% TP. Filicales spores, and particularly Polypodium, are at high levels, and there is a small curve for Pteridium. There are continuous curves for Ranunculaceae and Caryophyllaceae, and almost continuous curves for Filipendula, Potentilla and Lonicera. There are also small amounts of Plantago lanceolata and Rumex acetosa type, and at the top of the diagram a small amount of Urtica and one grain of Circaea.

In the lower part of the diagram there are very high percentages of Tilia and Polypodium. Filicales is the only other type which is at a higher level than at the top of the diagram, most other types are reduced and some are absent.

12.3 WB2

12.3.1 Stratigraphy

The profile at this site was as follows,

0 to 18cm	Dark-brown, peaty soil with living roots to 5cm
18 to 37cm	Chocolate brown sandy soil
37 to 51cm	Orange, sandy soil with iron-pan at 51cm

The orange soil was thought to correspond to the red podsol beneath the cairn so it was considered reasonable to look only at the pollen from 18cm of the profile including all of the orange soil and the lower 4cm of the chocolate brown soil.

12.3.2 Description of the Pollen Diagram

Zone A : Corylus-Alnus-Filicales p.a.z.

AP is very high at over 95% TP, the majority of which is Corylus, with smaller amounts of Alnus. Betula reaches just over 10% TP, Quercus and Tilia are between 2% and 4% TP, and the one grain of Salix pollen at 18cm is the only other AP type present. There are very few NAP types present. Filicales spores are high at around 30% TP and Polypodium is also abundant.

Zone B : Corylus-Betula-Gramineae p.a.z.

Corylus remains at high levels, but, in spite of an increase in Betula pollen, AP is lower than previously at around 75% TP. There is less Alnus, Tilia and, at first, Quercus than in zone A. Filicales are also reduced and Polypodium falls to below 5% TP but Pteridium increases, and peaks near the top of the zone at 13% TP. The increase of NAP is mainly due to an expansion of the Gramineae curve. Cyperaceae and Calluna also increase but then fall again to around 2% TP. More NAP types are present than before but most are only occasionally represented.

Zone C : Calluna p.a.z.

The major feature of the zone is the increase of Calluna to 67% TP. Nearly all other types show decreases, probably as the result of the large rise in Calluna pollen, but there are small increases of Empetrum and Sphagnum, and an initial increase of Alnus, which falls at the top of the diagram.

12.4 Discussion

The pollen diagram of the control sample (WB2) infers two major vegetation changes. The first was from a Corylus, Alnus, Betula woodland with a ground flora including Polypodium and other ferns, to a woodland in which clearance was taking place leading to an increased importance of Betula and a spread of Gramineae and Pteridium. There are, however, few indications of either pastoral or arable farming. The second change involved a removal of trees and a massive spread of heathland, and again there is little sign that farming was important and few cultural indicators are present.

The nearest pollen site to Woofa Bank is the Green Crag Slack site, which is only 700m to the west. The beginning of clearance and the initial rise of Gramineae pollen in that diagram has been radiocarbon dated to 3320±40 years BP, and the final clearance of trees and major spread of Calluna was dated to 670±40 years BP. It is likely that these two dates will be close to the ages of the WB2 zones A/B and B/C boundaries.

There was a difference in the composition of the pre-

clearance woodland at the two sites. The Green Crag Slack woodland contained more Alnus and less Corylus than at Woofa Bank, which must reflect the tendency for Alnus to grow on wet areas such as the Green Crag Slack boring site.

The buried soil contains substantial amounts of Corylus which suggests that it is earlier than WB2 zone C, but also significant amounts of Gramineae and Calluna pointing to a correlation with WB2 zone B. The relatively small amount of Betula pollen and the large number of Polypodium spores indicates that it must be contemporary with the early part of zone B, and its radiocarbon date of 2480 ± 90 years BP supports this view.

The WB2 control pollen diagram has been interpreted as a heterogenous pollen profile i.e. it shows a sequence of changes in the pollen assemblage which reflect true vegetational changes, and is not a mixed, or homogenous, pollen profile. This agrees with the view expressed by Havinga (1974) that podsoles have heterogenous pollen profiles. Havinga says that such profiles develop in soils where the morphology indicates a wet soil, or other conditions unsuitable for soil fauna, as a result of downwash of pollen. WB1, the buried soil, is a podsol with a pH of 3.1, which is unsuitable for most soil fauna, so it follows that it ought to have a heterogenous pollen profile formed through downwash of pollen. However, this process depends upon a constant input of pollen at the soil surface, so that if this is stopped, as it was when the cairn was built, the result would be a largely homogenous pollen profile.

The most striking feature of the buried soil pollen diagram is the remarkably high percentages of Tilia pollen which in the lower parts of the diagram reaches over 60% TP compared to a maximum of 2% in the control sample. There are only four possible ways for such large amounts of Tilia pollen to occur in the soil.

- (1) The pollen is a true representation of the amount of Tilia in the vegetation at the time the cairn was built.
- (2) It has resulted from the concentration of Tilia pollen due to the differential decay of other pollen types.
- (3) It is the result of contamination by modern pollen.

(4) It was introduced, in some form, by man.

There are two problems with the first hypothesis. Greig (1982) surveys the amounts of Tilia pollen recorded in pollen diagrams from all over England and Wales and calculates the corrected values for Tilia(Tc) using Andersen's(1973) correction factors. Applying the same method to 0 to 5cm of the Woofa Bank buried soil gives an average Tc value of 83%, and for the lower levels a Tc of 90%. Greig says that a Tc of 60%+ means that Tilia was the major forest component. This seems highly unlikely on an acid moorland such as Rombalds Moor and Greig says that Tilia was never a major part of the forest cover of the Central Pennines. The main problem with the theory of a lime woodland on Woofa Bank, however, is that during zone B in the WB2 diagram Tilia is 1% TP or less and there is no way that a lime woodland could have been recorded in one soil and not in another only two metres away. In fact, Tilia never reaches more than 2% TP in any of the Rombalds Moor diagrams.

It is difficult to see why there should have been more erosion of pollen in the buried soil than in the control sample, however, it is known that Tilia pollen is robust and is differentially preserved (Dimbleby, 1967). It is still difficult to envisage the scale of deterioration which would result in the concentration of Tilia from the 1% found in the control sample to the 60% found at the base of the buried soil or even the 30% near the top. It was decided to investigate whether differing amounts of destruction of pollen had taken place in each soil, and whether there is any relationship between the number of badly corroded and unrecognisable pollen grains and the percentage of Tilia pollen. Table 3 shows the number of corroded and crumpled pollen grains, expressed as a percentage of total land pollen, for several samples from each soil, and the percentage of Tilia pollen in these samples is also shown. The results show that there is no relationship between the Tilia percentage and the percentage of corroded grains, and there is no evidence that more erosion of pollen has taken place in the buried soil, or at the bases of each profile.

<u>Site</u>	<u>Depth(cm)</u>	<u>% corroded grains</u>	<u>% Tilia</u>
WB1	0 - 1	33	28
	8 - 9	28	60
WB2	3 - 4	51	<1
	18 - 19	42	2

Table 3 : Comparison of Percentages of Corroded Pollen Grains in Two Woofa Bank Soils

It is impossible for the high Tilia percentages to have resulted from contamination by modern pollen since there are no Tilia trees growing near to the site, and the soil sections were very quickly bagged and sealed. In any case, the soil samples for analysis were taken from 2 to 3cm below the cut surface of each monolith.

The only possible explanation is that the Tilia pollen was introduced in some form by man. There are at least two records of high percentages of Tilia pollen being found associated with prehistoric burials. In the grave of Egtved girl a mixture of beer and fruit wine was found to which honey had been added (Glob, 1970). The honey appeared in the form of a quantity of pollen of, amongst others, lime. In a grave at Ashgrove, Fife, the scrapings from inside a beaker contained much pollen of which 53% was Tilia (Dickson, 1978). This was interpreted by Dickson as having been honey or, he considers, more probably mead. The radiocarbon date of plant debris found in this grave is 3046 ± 150 years BP which means that it is some 300 to 800 years earlier than the date of the Woofa Bank cairn soil sample.

It appears, then, that the most likely explanation for the high percentages of Tilia pollen in the buried soil is the placing of honey or mead beneath the cairn. The pouring of mead, in particular, onto the soil would explain why there are such high percentages of Tilia at the base of the profile just above the iron-pan, since the liquid would probably have penetrated that far into the soil.

There are several other unusual features of the buried soil pollen profiles such as the well developed curve for

Caltha palustris which reaches 6% TP. Caltha pollen is only occasionally recorded in the Rombalds Moor pollen diagrams and is absent from the control diagram. There is also more Lonicera pollen present than might be expected from other diagrams on Rombalds Moor, especially since this too is absent from the control sample, and percentages of Polypodium are higher than in the control. One very unusual pollen type is Circaea, found at the top of the WBl diagram. This is Circaea lutetiana, the Enchanter's Nightshade, which, although only one grain was recorded, may be significant since it is very unlikely that it was growing on the moor near to Woofa Bank. Clapham, Tutin and Warburg (1952) describe it as a plant of woods and shady places on base-rich soil. The Woofa Bank soil is quite the opposite of base-rich, and there are no other records of Circaea pollen in any of the Rombalds Moor pollen diagrams.

It is quite possible that the Caltha and Lonicera pollen entered the soil as constituents of honey or mead. Both flowers are visited by bees for their pollen and nectar (Clapham et al., 1952). This could not, however, explain the high percentage of Polypodium pollen at the base of the diagram, or the presence of Circaea since this is a primarily self-pollinating plant and is visited by only a few small Diptera (Clapham et al., 1952). If the Circaea pollen did not enter the soil naturally or as a constituent of honey then the placing of the plant itself beneath the cairn is the only other explanation. Perhaps Circaea was included for believed magical or healing properties. In Germany it has been linked with witchcraft (Grigson, 1975) and a plant known to the Anglo-Saxons as aelfthone, and used as a cure for elf-sickness has been equated to Circaea. There are records of plants and flowers being placed in burials. The Skrydstrup girl was buried with grasses and wood-chervil, and the Egtved girl's burial included Yarrow flowers, heather, moss and an unidentified leaf (Glob, 1970). The burial at Ashgrove, mentioned above, was covered with plant material which included dicotyledonous leaf fragments, bark, twigs, a fern rhizome and Sphagnum. The reasons for placing some of these plants in the graves are easily understood, yarrow is

described by Glob(1970) as one of the world's most sought after healing plants, and mosses such as Sphagnum were used in the past to staunch wounds, but there is no obvious reason for including plants such as heather and ferns. Perhaps, then, Polypodium was also placed beneath the Woofa Bank cairn.

These results do suggest that the Woofa Bank cairn covered a burial, but the question of burial or clearance has not yet been fully debated. Is there any evidence that it is a clearance cairn? Fleming(1971) considers that in north-east Yorkshire it would not have been economical to have cleared land of stones for pasture, since forest browsing would have provided adequate nutrition. This view is supported by Challis and Harding(1975), and there is no reason why this argument should not apply equally to Woofa Bank. Fleming(1971) concludes that stone clearance would only have been carried out to prepare land for cultivation. If this is the case there should be some indication of agriculture having started at around the time of the construction of the cairn, or after its construction, in the WB2 pollen diagram. However, as already mentioned, there is little, if any, sign of agriculture at any point in that diagram, no cereal pollen is present, and in nearby Green Crag Slack cereal cultivation did not start until 1300±40 years BP. There is also very little to indicate pastoralism.

The late date of the buried soil might infer that it is a clearance cairn rather than a burial cairn, since cairnfields such as Woofa Bank are generally attributed to the early Bronze Age (Challis and Harding,1975). However, Iron Age dates have also been obtained from two burials on Ampleforth Moor, Yorkshire (Wainwright and Longworth,1969). These were from two barrows of a group of nine which were believed to have been robbed, and yielded only a few sherds of pottery, a few flints, and a fragment of bronze. The dates obtained were 2487±90 years BP and 2532±90 years BP for the top of the old soil surfaces and both dates are within the confidence limits of the Woofa Bank cairn. Also Hayes and Rutter(1975) consider that two large groups of cairns of the North York Moors were probably built from the Bronze Age to the Dark Ages.

12.5 Conclusions

Prior to the building of the Woofa Bank cairn the vegetation in the area consisted of a Corylus-dominated woodland in which Betula was becoming increasingly important, and grasses and Pteridium were spreading as a result of a limited amount of clearance. The clearance does not appear to have been for agriculture and it is unlikely that land would have been cleared for pasture. It must, therefore, have been the result of clearance for timber, or removal of the woodland through the effects of grazing animals, though there is little evidence of such grazing.

The clearance, which probably began at about the same time on Green Crag Slack i.e. 3320±40 years BP, must have led to a certain amount of podsolisation of the soils at Woofa Bank, since the soil beneath the cairn is a podsol with a well developed iron-pan.

There is no evidence to suggest that the cairn is a clearance-heap resulting from land cleared of stones for agriculture, since there is no evidence of agriculture having taken place. There is, however, circumstantial evidence that the cairn covered a burial. The pollen diagram contains quantities of Tilia, and other types, which it is considered could only be the result of honey or mead being placed beneath the cairn, and there are records of this practice being associated with burials in Denmark and Scotland. There is also a possibility that other plants, Circaea and Polypodium were included with a burial.

The date of the cairn, whilst late for what is considered to be an early Bronze Age type of field monument, is consistent with the archaeological evidence that Bronze Age traditions were continued into the Iron Age in the Rombalds Moor area.

13. ANOMALOUS RADIOCARBON DATES

Two radiocarbon dates from the Rombalds Moor series are considered to be too old for the peat samples they represent. The first is Lanshaw 2 (SRR-2488) 161cm to 163cm:9680±90 years BP, and the second, Green Gates (SRR-2468) 20cm to 24cm:1680±70 years BP. The reasons for regarding these dates as anomalous are discussed on pages 65 and 105.

Terasmae(1984) considers that there are five reasons why radiocarbon dates might be too old;(a) dissolved humus products from older deposits,(b) dissolved groundwater carbonate,(c) eroded or reworked deposits,(d) older organic particles,(e) coal,lignite or graphite particles.

(e) is most unlikely to be the cause of either of the Rombalds Moor anomalous dates since there are no such deposits near to either of the sites. Similarly (b) can be discounted since the groundrock at both sites is a base-deficient millstone grit.

Contamination by dissolved humus products from older deposits,(a), would occur in soils if there was a rise in groundwater. In bogs such as Green Gates and in wet carrs, such as that which existed at Lanshaw, the groundwater level is always at, or near to, the surface so it is unlikely that contamination from older, dissolved humus products would have occurred.

There is no evidence in the Green Gates stratigraphy that any erosion or deposition of eroded material has taken place at the boring site so (c) can also be discounted. This only leaves the possibility that older organic particles have been incorporated in the Green Gates material. It is not known how this might have occurred but perhaps it is related to the presence of charcoal in the sample which was sent for radiocarbon analysis.

It is possible that the Lanshaw 2. sample may have contained some old wood. However, since there is good evidence that erosion of the land surrounding Lanshaw was taking place and that eroded material was being deposited at the Lanshaw 2 site, it is more likely that (c) is the explanation for the

anomalous Lanshaw 2 date i.e. older deposits were eroded,
deposited at Lanshaw 2 and included in the peat.

14. CORRELATION OF ROMBALDS MOOR POLLEN DIAGRAMS

The suggested correlation of all the Rombalds Moor pollen diagrams is summarised in Fig.22. The solid lines between each profile represent correlations which are either supported by radiocarbon dates, or which appear certain due to obvious changes in the pollen assemblages. The dotted lines represent correlations which seem likely, but about which there is some doubt. Of the Lanshaw diagrams only the Lanshaw 2 diagram has been illustrated since this has been radiocarbon dated. Correlations which have already been discussed in the sections on individual sites are either not discussed here or are only referred to.

The zones of the Corylus maxima at Lanshaw 2 (zone E) and Sea Moor (zone C) have been regarded as contemporary. In both cases Corylus dominates the pollen assemblage and Betula is less important than previously. In the next zone in each diagram Corylus is at lower levels and there are increases of Pinus, Alnus, and Quercus. Bradup Beck zone A is almost certainly contemporary with these zones since Alnus values are rising and the Pinus curve is at a high level.

The tops of these three zones (Sea Moor zone D, Lanshaw 2 zone F, and Bradup Beck zone A) are all believed to be of the same age. The Sea Moor and Bradup Beck diagrams show a decline of Pinus and an increase of Tilia, the Lanshaw and Sea Moor diagrams show decreased levels of Corylus and small increases of NAP, and all three diagrams show high values of Alnus pollen in the next zone. It is, of course, difficult to correlate this part of the Lanshaw diagram since it is so little understood. The fact that the Sea Moor and Bradup Beck diagrams appear to show a normal Boreal-Atlantic transition (BAT) at this point, which would mean a date of around 7000 years BP, whilst the first level of high Alnus values in the Lanshaw 2 diagram has been dated to 5840±80 years BP, suggests that there may be a hiatus at the top of zone E at Lanshaw 2 (see p.66).

There are, however, some features of the Sea Moor D/E boundary which point to a later date than the BAT. There is a distinct fall in Ulmus pollen accompanied by small rises in Gramineae and Calluna pollen, which just precede the start of

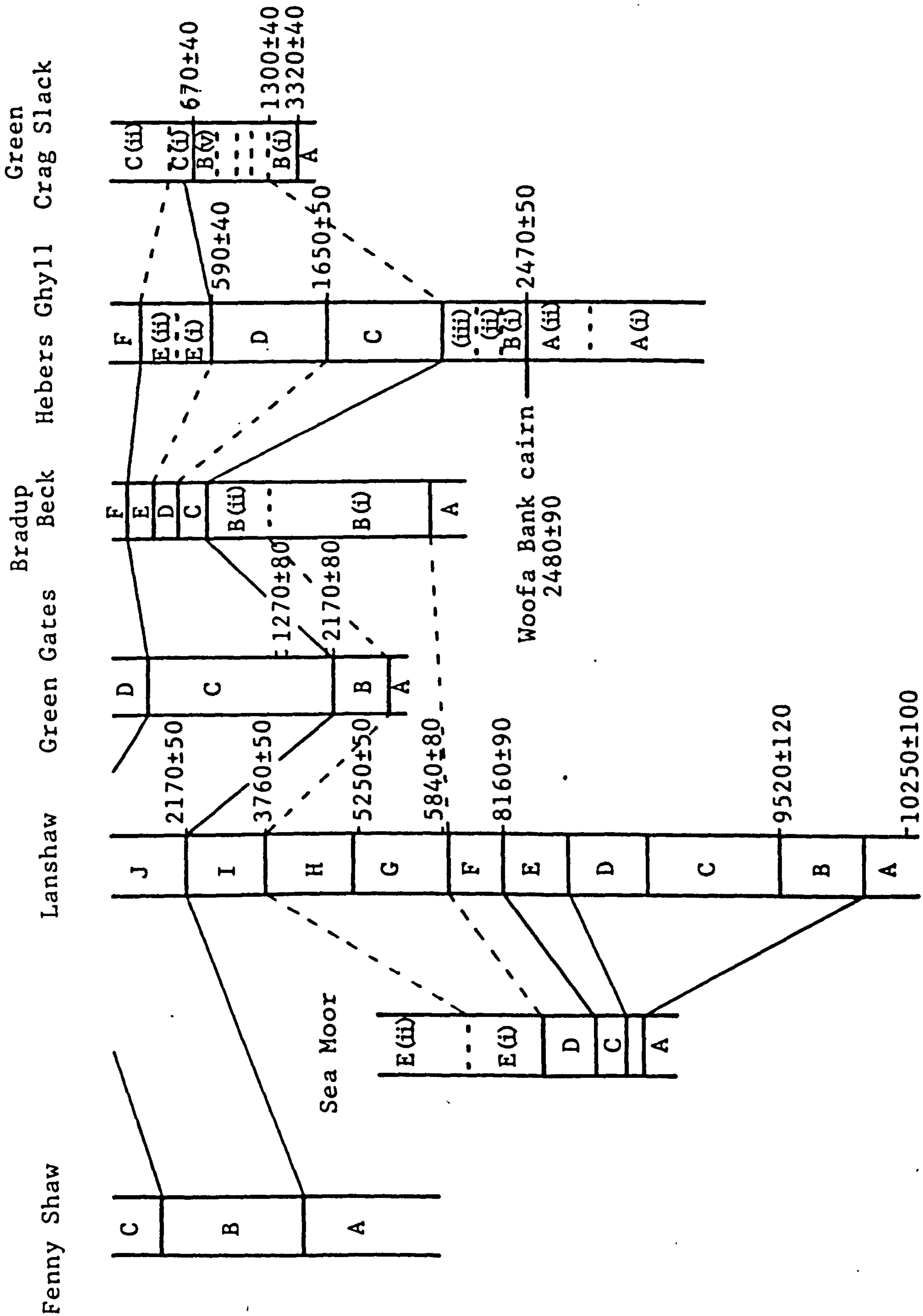


Fig. 31 : Correlation of the Rombalds Moor pollen diagrams.

the curve for Rumex acetosa type and Plantago lanceolata. Cereal pollen was recorded both below, and just above, this boundary but was earlier regarded as resulting from contamination or downward movement of pollen. Also there is a small drop in AP at the D/E boundary which recovers as Betula becomes more important. There are indications, then, of clearance from this point in the Sea Moor diagram and it could be that the drop in elm pollen represents the Elm Decline. In this case it would be possible for the cereal pollen at 65cm to represent a true occurrence of agriculture, since pre-Elm Decline agriculture has been reported in other areas (Edwards and Hiron, 1984). If this interpretation is correct it would mean a correlation with the G/H boundary at Lanshaw and would also mean that pine persisted in the Sea Moor area after the BAT, as it appears to have done at Lanshaw. Clearly there is a need to obtain radiocarbon dates for this part of the Sea Moor diagram.

The first definite signs of human interference seen in the Lanshaw 2 diagram are in zone I, the start of which has been radiocarbon dated to 3760 ± 50 years BP. It has already been suggested that this zone correlates with zone B at Green Gates, zone A at Fenny Shaw and sub-zone E(ii) at Sea Moor. It is probably also contemporary with sub-zone B(ii) at Bradup Beck, during which there are signs of limited interference with the forest.

The major clearances in the Lanshaw 2 and Green Gates diagrams, dated to 2170 ± 50 years BP and 2170 ± 80 years BP respectively, can also be seen in the Fenny Shaw and Bradup Beck diagrams. The clearances correlate with the completion of clearance at Hebers Ghyll, at the end of zone B, and perhaps with the first appearance of Plantago lanceolata pollen in the Green Crag Slack diagram. (see p. 97).

The second clearance at Bradup Beck was probably contemporary with the second clearance at Hebers Ghyll (radiocarbon dated to 590 ± 40 years BP). The final clearance at Green Crag Slack was radiocarbon dated to 670 ± 40 years BP, which means that the lower confidence limit meets the upper limit of the Hebers Ghyll date. So clearance could have occurred at the same

time at both sites, but it was probably slightly earlier at Green Crag Slack. In fact, the correlation shown in Fig.31 is between the Hebers Ghyll D/E boundary, and the reappearance of cereal pollen in the Green Crag Slack diagram, which, as mentioned on p.99, probably dates from the same time as the clearance at Hebers Ghyll.

The Green Crag Slack zone C(i)/C(ii) boundary and the Hebers Ghyll zone E(i)/E(ii) boundary, date, according to their peat growth curves, from the early to mid 16th century. There are some similarities in the pollen diagrams at this point such as the rise in Empetrum pollen. However, it is very unlikely that the peat growth rate was constant at either of the sites in the upper levels. At Green Crag Slack, for instance, there are changes at 20cm from a Sphagnum papillosum peat to a humified Eriophorum peat, and then at 12cm to a Calluna-Eriophorum-Sphagnum peat, and these must have resulted in significantly different peat growth rates. Too much reliance should not, therefore, be placed upon the upper part of the peat growth curves for which no radiocarbon dates are available.

The Green Crag Slack zone C(i)/C(ii) boundary is, in fact, more like the Hebers Ghyll E/F boundary. At both sites Calluna is decreasing and Gramineae, Empetrum and Pteridium increasing. The Hebers Ghyll E/F boundary is also believed to be contemporary with the final change in the Bradup Beck, Green Gates and Fenny Shaw diagrams, with all sites showing a decline in Calluna, probably as a result of over-grazing.

15. FINAL DISCUSSION

The vegetational and archaeological information discussed in this chapter is summarised in two diagrams; fig.32 covers the period from the end of the late-Devensian to 3760 years BP, and fig.33 covers the period from 3760 years BP to the present day.

The two sites with the earliest vegetation records on Rombalds Moor are Lanshaw and Sea Moor. There is good evidence that Sea Moor originated as a lake and it is possible that extensive clays at the base of the deposits represent much of the Late-Devensian period. If this is so it would be an important site as there are no other pollen records of the Late-Devensian in West Yorkshire.

There is no evidence of a similar lake at Lanshaw but it is possible that any evidence that existed was removed during the construction of the Higher Lanshaw Dam. The first zone of both the Lanshaw and Sea Moor diagrams represents the very end of the Late-Devensian period. Although both diagrams point to the existence of a treeless, low-growing grassland there seem to have been some differences between the vegetation at the two sites. The Sea Moor site had more juniper and dwarf birch than Lanshaw, and a more diverse flora. Twenty land pollen types are recorded at Sea Moor compared to thirteen at Lanshaw. These differences are probably because of the different altitudes of the two sites. Sea Moor, being 65m lower than Lanshaw, probably experienced a less severe climate in the Late-Devensian.

The expansion of the Betula curve and the increase of pollen influx values are tentatively dated at Lanshaw to 10000 years BP. This is later than the date given by West(1970) for the transition from Godwin's zone III to zone IV, and is later than the date of the rational Betula limit at Scaleby Moss (10160±193 years BP just above the Betula limit, and 10325±215 years BP just below the Betula limit). However, later dates for the beginning of the Flandrian have been obtained from other upland areas such as in Upper Red Sike Moss (9900±190 years BP) and Weelhead Moss (10020±210 years BP)(Turner, et. al., 1973).

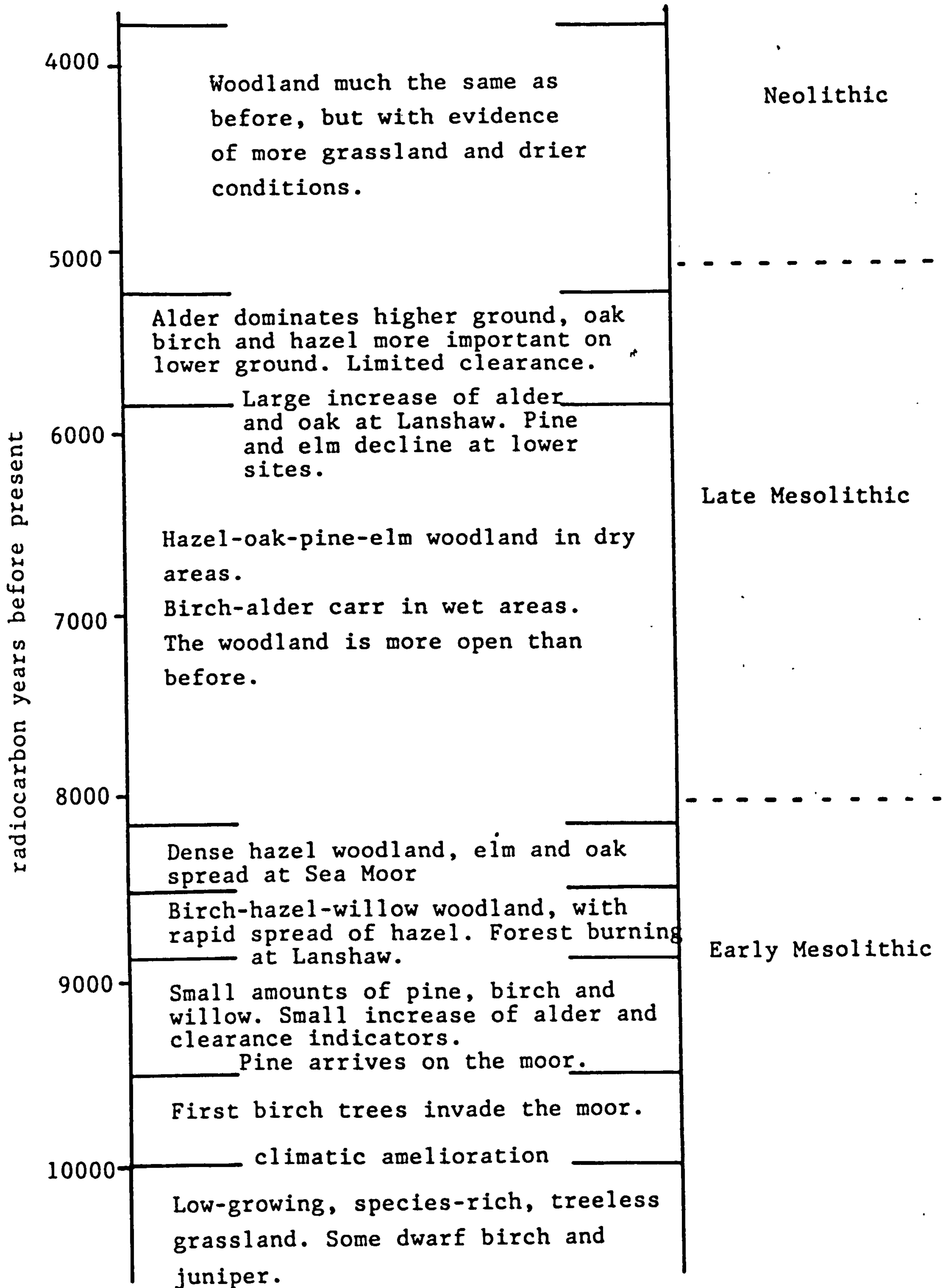


Fig. 32 : Vegetation change and archaeology on Rombalds Moor from the Late-Devensian to 3760 BP.

The spread of Pinus at Lanshaw has been tentatively dated to 9500 years BP. Pinus pollen increases to a maximum of 35% TP but is generally below 20%, suggesting that on the tops of the moor it never became dominant. This agrees with evidence from White Moss, Lancashire, some 20 miles west of Rombalds Moor, which, although it is in the Craven District, has more in common with the Rombalds Moor sites since it lies on acidic soils (Jones, 1977). Bartley (unpublished) states that whilst over much of the Craven District Pinus became the dominant tree pollen, at White Moss, although present, it did not become important until much later, and was never as abundant as in the limestone areas.

It appears that true woodland was not established in the Lanshaw area until about 8900 years BP. It is mentioned on p. 23 that Jacobi (1978) considers the later date of a transition from a Palaeolithic economy to an early Mesolithic type of economy in the north of England, is due to the later establishment of woodland in the north. Jacobi points out that at Thatcham, in the south of England, an early Mesolithic site, dated to 9840 ± 160 years BP, is associated with 48% combined birch and pine pollen, whilst at Anston Cave, South Yorkshire, a Palaeolithic site dated to about 9800 years BP is associated with a pollen spectrum including only 17-29% AP, the majority of which is willow, but with some pine and birch. The Lanshaw pollen diagram supports the view of a later establishment of woodland. Birch and pine first reach over 48% TP at about 9000 years BP, but they fall again immediately and only maintain high levels after about 8650 years BP.

It was originally suggested on p. 23 that the earliest Mesolithic presence on Rombalds Moor dates from about 9500 BP. However, the earliest signs of human activity in the Lanshaw diagrams, the first early Alnus peak, is somewhat younger than this and probably dates from between 9200 years BP and 8950 years BP. This correlates with the 9210 ± 340 years BP date for the Mesolithic site on Warcock Hill South. Since that site is the only other site in the Pennines with the Starr Carr type, translucent flints it seems reasonable to suggest that at the time of the early Alnus peak at Lanshaw there was a

small group of Mesolithic hunters on Rombalds Moor, who were in some way related to the people at Warcock Hill South and perhaps also to those at Starr Carr.

The second Alnus peak at about 8600 years BP seems to represent a greater amount of activity than the first. There are a number of sites in the Pennines with dates close to 8600 years BP, such as Broomhead Moor Site 5 :- 8573±110 years BP, and Warcock Hill :- 8606±110 years BP (Radley et.al.,1974) These sites have yielded the grey-white Drift flint which has been found in large quantities on Rombalds Moor and in the Wharfe Valley. It may be then that at about 8600 years BP there were bands of hunters on Rombalds Moor using fire, perhaps to drive game, and with permanent occupation sites in the Wharfe Valley.

It is interesting that the suggested dates for the Mesolithic presence on Rombalds Moor fall during a period when hazel was spreading rapidly. Simmons and Tooley(1981) note that the predominance of hazel does not occur in any previous inter-glacial period, and several authors have proposed that the rise of hazel is due to anthropogeny (Smith,1970,Jacobi, 1978,Scaife,1982). Scaife(1982) considers that organic sediments found in the Medina valley (Isle of Wight) dated to the Boreal period, and similar deposits in Sussex, are likely to have been caused by firing rather than clearance. If these authors are correct and the rise of hazel in Britain was caused by man then the effect of early Mesolithic man on the vegetation of Rombalds Moor would have been much more extensive than has already been proposed.

It is suggested in section 4.3.2 that the upland distribution of flints on Rombalds Moor reflects the tendency for hunters to frequent the higher land which may have been less heavily wooded than the lowlands. Although some of the early Mesolithic period is not represented in the Sea Moor diagram there is a record from about 8700years BP, and, whilst Sea Moor could not be called a lowland site, it is 65m lower than Lanshaw and might therefore give an idea of the differences in density between the lowland and upland forests. AP values in the Sea Moor diagram prior to the Alnus rise, are consistently higher than at Lanshaw, at around 95% TP. At Lanshaw, AP

starts at between 20% and 40% TP in the zone of Betula dominance and rises to between 40% and 80% TP just before the Alnus rise. So it seems that even at Sea Moor the pre-Alnus rise woodlands were denser than on the moor tops near Lanshaw.

The tentative date for the beginning of the Corylus maximum at Lanshaw is 8500 years BP. This is slightly later than the date for the rational limit of Corylus at Red Moss, Lancs. (8880±170 years BP) (Hibbert et al., 1971), but is closer to the approximate date for the beginning of the Corylus maximum at Tregaron S.E. bog, Dyfedd, (8700 years BP) (Hibbert and Switsur, 1976).

The composition of the woodland, prior to the Alnus rise, also appears to have differed at Lanshaw and Sea Moor. In the Lanshaw diagrams there is very little pollen of Quercus and Ulmus, whereas at Sea Moor these types reach 11% TP and 7% TP respectively. At the lower site, Ulmus and Quercus appear to have spread at the same time as Corylus, but at Lanshaw they spread much later. Ulmus was never as important at Lanshaw as at Sea Moor, which has the highest percentages of Ulmus pollen of any of the Rombalds Moor diagrams, inferring that altitude may have limited the spread of elm on Rombalds Moor. At Pow Hill, Co. Durham, Turner and Hodgson (1981) considered that the spread of Ulmus was inhibited by the low nutrient status of the low to mid-altitude Millstone Grits, which might explain why Ulmus percentages are generally low in all the Rombalds Moor diagrams, including Sea Moor.

The delayed expansion of Ulmus and Quercus can also be seen in the Martons Both, N. Yorks. diagram (I. Jones, unpublished), and at Hutton Henry, Co. Durham (Bartley et al., 1976). At both these sites Ulmus and Quercus do not expand until after the Corylus maximum. At Bishop Middleham, Co. Durham, the rises of Quercus and Ulmus are delayed until the expansion of Alnus (Bartley et al., 1976). The authors considered that oak and elm only increased gradually at Bishop Middleham, at the expense of pine, and that pine must have persisted longer on the well-drained limestone to the north of the site. This explanation could not apply to Lanshaw since there is no limestone nearby. At Soyland Moor, some 18 miles south of

Rombalds Moor, the late expansion of oak is also attributed to an extended pine maximum preventing the spread of oak woodland (Williams, 1983). Smith (1958) says that the slow spread of oak, and an extended pine maximum, may mean that conditions were at the limits for the expansion of oak woodland.

Corylus pollen falls at 132cm in the Lanshaw 2 diagram, dated 8160±90 years BP, and at the same time there are increases in Pinus, Quercus and Ulmus. This compares with a date of 8120 ±120 years BP for similar changes in a diagram from Nant Ffrancon (Hibbert and Switsur, 1976), and with an approximate date of 8200 years BP for the same changes in the White Moss, Lancs. diagram (Jones, 1977). At 128cm in the Lanshaw 2 diagram there is a small increase in Alnus pollen, further increases of Pinus and Quercus and the appearance of Tilia and Fraxinus pollen. Similar changes in the pollen assemblage can be seen in the Sea Moor diagram. At White Moss the fall in Corylus pollen and the initial rise in Alnus are separated by nearly 600 years so the fact that in the Lanshaw 2 diagram these changes are separated by only 8cm of peat suggests that there is an hiatus in the Lanshaw 2 diagram at this point, as proposed on p.66.

Alnus rises in two stages at Sea Moor and Lanshaw 2, but at Bradup Beck the rise is smooth and continuous. Turner (1973) noted that a diachroneity in the spread and expansion of alder can occur between sites situated close together. Bradup Beck occupies a position which is intermediate in altitude between Lanshaw and Sea Moor. Features of the vegetation which were controlled by altitude might, therefore, be expected to be intermediate at Bradup Beck, between the extremes of Lanshaw and Sea Moor. Two such 'intermediate' features of the pollen diagram are first; the percentage AP during the Alnus rise, which is 60 to 80% TP at Lanshaw, between 80 to 90% TP at Bradup, and from 90 to 95% TP at Sea Moor. Secondly, the percentage of Ulmus pollen, which is 1 to 2% TP, and 2 to 4% TP, and 5 to 6% TP at Lanshaw, Bradup Beck and Sea Moor, respectively. It does appear, then, that the total amount of tree cover and the importance of Ulmus were controlled by altitude on Rombalds Moor, and that both were diminished at higher altitudes.

Several other sites in the North of England have Alnus rises which are in stages rather than the more usual one sudden rise. The pollen diagram from Ingleborough which has a two stage Alnus rise has already been mentioned on p.68. The White Moss, Lancs. diagram also has a two stage Alnus rise (Jones 1977) with dates similar to those at Ingleborough. At Martins Both, N. Yorks. Alnus rises in three stages, dated to 7680±100 BP, 6930±90 BP and 6080±90 BP (I Jones unpublished).

It appears, then, that although Alnus was established early in the Lanshaw area, it did not expand greatly until some 1200 years after the 7107±120 years BP date of the B.A.T. at Red Moss, Lancs. (Hibbert et.al. 1971). An even later date of 5300±40BP was obtained for the expansion of oak and alder at Pow Hill Co. Durham (Turner and Hodgson 1981). Turner and Hodgson considered that slow soil development in the Pow Hill area allowed pioneer woods to persist and that shallow, sandy soils enabled birch and pine to remain dominant, thus delaying the expansion of oak and alder. Smith and Pilcher (1973) considered that the alder expansion must have been controlled by several factors such as migration rate, soil development and inertia of the existing vegetation. Smith (1984) discusses the possibility that the late expansion of Alnus was due to the late crossing of a critical threshold, but he points out that the areas with late Alnus expansions tend to be northern, western and upland, and these are the sites that one would expect to be early if the Alnus expansion was due to increased wetness. Oldfield (1965) considers that in Lonsdale Alnus was established before the pine maximum but depended on the creation of suitable habitats for its expansion. Huntley and Birks (1983) consider that the timing of the Alnus expansion was controlled by its rate of migration, but this cannot be true at sites such as Lanshaw and in Lonsdale since Alnus was already well established in these areas before the major Alnus expansion.

Smith (1984) notes that the rational Alnus limit is not synchronous in Britain and varies from 7500 BP to 5000 BP, and that although at some sites its rise is rapid, as might be

expected if the primary cause was climatic changes, at others such as Weelhead Moss, Upper Teesdale (Turner 1973), and also in Ireland, the Alnus rise is very gradual. Smith points to the evidence for a small amount of opening of the forest and for a limited amount of burning of the forest at Newferry, Co. Antrim. He concludes that Mesolithic man aided the rise of alder by opening the forest canopy and thus reducing competition.

There is some evidence of disturbance in the Lanshaw diagrams at both stages of the Alnus rise. There are increases in Gramineae and Fraxinus, which are more marked at the second, larger Alnus rise, and which could indicate some opening of the forest. The Alnus rises are also associated with the presence of cultural and / or clearance indicators such as Rumex acetosa type, Potentilla, Artemisia and Chenopodiaceae. Also between the two rises continuous curves start for Calluna and Pteridium. Scaife (1982) notes that Pteridium spores can be an indication of human disturbance from occupation sites and after forest fires, and he considers that Pteridium spores and Calluna pollen found in the Mesolithic period on Dartmoor may indicate soil degeneration as a consequence of fire and subsequent leaching.

The early Alnus rise at Lanshaw falls into the early Mesolithic period. Megaw and Simpson (1979) say that there was an increase in the variety of types and techniques used by Mesolithic man at around the beginning of the 7th millenium (7000BP), which, if it applies to the Lanshaw area means that the later Mesolithic period started mid-way between the Corylus decline and the large expansion of Alnus at 5840± years BP. In the southern Pennines two late Mesolithic sites were dated to 5850±80 BP, and 5380±80 BP (Radley et.al. 1974), so there is a good case for activities of Mesolithic people using later types of flints. The archaeological evidence, however, is of a much smaller flint collection for the later Mesolithic. This must mean that either the population of Rombalds Moor was extremely backward and were still using early types of flints, or that there was a smaller population than in the early Mesolithic but they were causing at least as much change in

the vegetation as the earlier peoples.

There is a good tie-up between the vegetational and archaeological evidence in that many fewer Mesolithic flints have been found in the Bradup Beck area than in the Lanshaw area, and the Bradup Beck pollen diagram shows much less evidence of interference and opening of the forest during the Alnus rise.

At most sites in England and Wales Pinus pollen decreases as Alnus increases at the B.A.T., and this happens in the Sea Moor and Bradup Beck diagrams. However, the Lanshaw 2 diagram shows that a small amount of pine persisted in the Lanshaw area until 5250 ± 50 BP. A late decline of Pinus has also been recorded at other sites in the Pennines. At Valley Bog on the Moorhouse National Nature Reserve, the Pinus curves continues after the alder rise and falls below 20% T_P after 5900 BP (Chambers, 1978). At Bradwell Sitch, N. Derbyshire pine does not decline until after the Elm Decline i.e. even later than at Lanshaw (Tallis and Johnson 1980). At nearby Soyland Moor pine values show a slight decline after 7640 ± 40 BP but do not reach low levels until 6110 ± 40 BP (Williams 1983). Williams concludes that the final pine decline is unconnected with the B.A.T. and that pine was growing in large stands across the plateau top on well-drained areas. Williams believes that pine could out-compete oak at high altitudes, and that long pine maxima with alder rising whilst pine was still dominant may be the hallmark of the central Pennines, together with the late expansion of oak. Pine was probably never dominant at Lanshaw since its pollen frequencies are low compared to other trees, but its behaviour on the moor may have been related to altitude since neither of the lower Rombalds Moor sites have extended pine maxima.

Godwin (1975) states that in most situations Pinus cannot compete with broad-leaved forest and can only become established within deciduous forest where altitude, exposure, or poor, acidic soil limits the growth of other taxa. It is unlikely that the altitude of the Lanshaw site was of primary importance in delaying the development of deciduous woodland, since there are sites at higher altitudes which have a more normal succession e.g. Ingleborough (S. Swales, unpublished). But it

may have been the combination of high altitude and poor soils which retarded the development of deciduous woodland, and allowed Pinus to persist until after the B.A.T..

There is no evidence of early Neolithic activity in the pollen diagrams. There is no Elm Decline at Lanshaw since there is little elm pollen in the diagram, and there is only a suggestion of an Elm Decline in the Bradup Beck diagram, but without any accompanying pollen types of clearance evidence. It is impossible to say when agriculture began in the Sea Moor diagram without a radiocarbon date since it is difficult to correlate the Sea Moor diagram with diagrams which have been dated. It is possible that agriculture began earlier here than at the other Rombalds Moor sites, but the archaeological evidence of very few Neolithic finds in the area would tend to discount this theory.

The lack of evidence for Neolithic farming on Rombalds Moor agrees with Hicks' (1971) work on the southern Pennines where she concludes that there is very little evidence for Neolithic activity on gritstone uplands. Figs. 5 and 6 show that there have been Neolithic finds on Rombalds Moor, but there does not necessarily have to be an association between Neolithic remains and agriculture. Simmons et.al. (1983) found no evidence of Neolithic farming in pollen diagrams from Dartmoor even though there were Neolithic sites near to the pollen sites.

Although there is no evidence of agriculture there is evidence of small amounts of clearance activity. There is a significant increase in Gramineae pollen in the Lanshaw diagrams after 5250±50 years BP, and there are appearances of Rumex acetosa type, Artemisia and Ilex pollen, all of which can indicate the presence of cleared land. The fact that total NAP apparently only rises very slightly is mainly due to a decrease in Filipendula. Also Godwin (1975) says that Alnus tends to maintain its percentages throughout Neolithic temporary clearances. Presumably this is because Alnus would have been growing on or very close to the sampling sites which would have been wet and therefore avoided by Neolithic people. This may also be true of birch at Lanshaw, and the only

other trees with more than 5% TP prior to 5250±50 years BP, Pinus and Corylus, are less abundant during the Neolithic period. So the true amount of Neolithic clearance could be greater than it appears at first.

There is less evidence of Neolithic clearance in the Bradup Beck diagram, which agrees with the archaeological results of much fewer finds in the Bradup Beck area than from around Lanshaw.

The question remains of what form the clearance around Lanshaw took. The finds of Neolithic axes in this area and in several other parts of the moor indicates that some clearance was taking place, but given the lack of evidence for cultivation, the suggestion of section 4.4.2 is valid i.e. that these axes were used primarily by hunters, to open and maintain pathways to the upland hunting areas, and perhaps also by primitive pastoralists to clear small areas for temporary camps and/or grazing land.

The beginning of more extensive clearance at Lanshaw has been dated to 3760±50 years BP. After this date clearance is indicated by falls in Corylus and Quercus pollen, the end of a continuous Tilia curve, and by increases of Betula and Gramineae and other NAP types. Cereal pollen is recorded for the first time, although only single grains, and Plantago lanceolata pollen appears. This clearly marks the beginning of permanent clearance and the start of a very small amount of cultivation. It probably coincides with evidence for a more limited amount of clearance at Bradup Beck and Green Gates and perhaps with the beginning of cultivation at Sea Moor.

It is difficult to know whether this agricultural and clearance activity was the result of Neolithic or early Bronze Age peoples, since no dates are available for the transition between these two periods in West Yorkshire. Megaw(1979) gives dates for the late Neolithic of 4450 years BP to 3650 years BP, and for the early Bronze Age of 3950 to 3250 years BP, illustrating that there is an overlap between the two periods. Barnes (1982) gives dates for the early Bronze Age in northern England of 3550 to 3450 years BP, which would put the beginnings of the Rombalds Moor clearance in the late Neolithic. If this was

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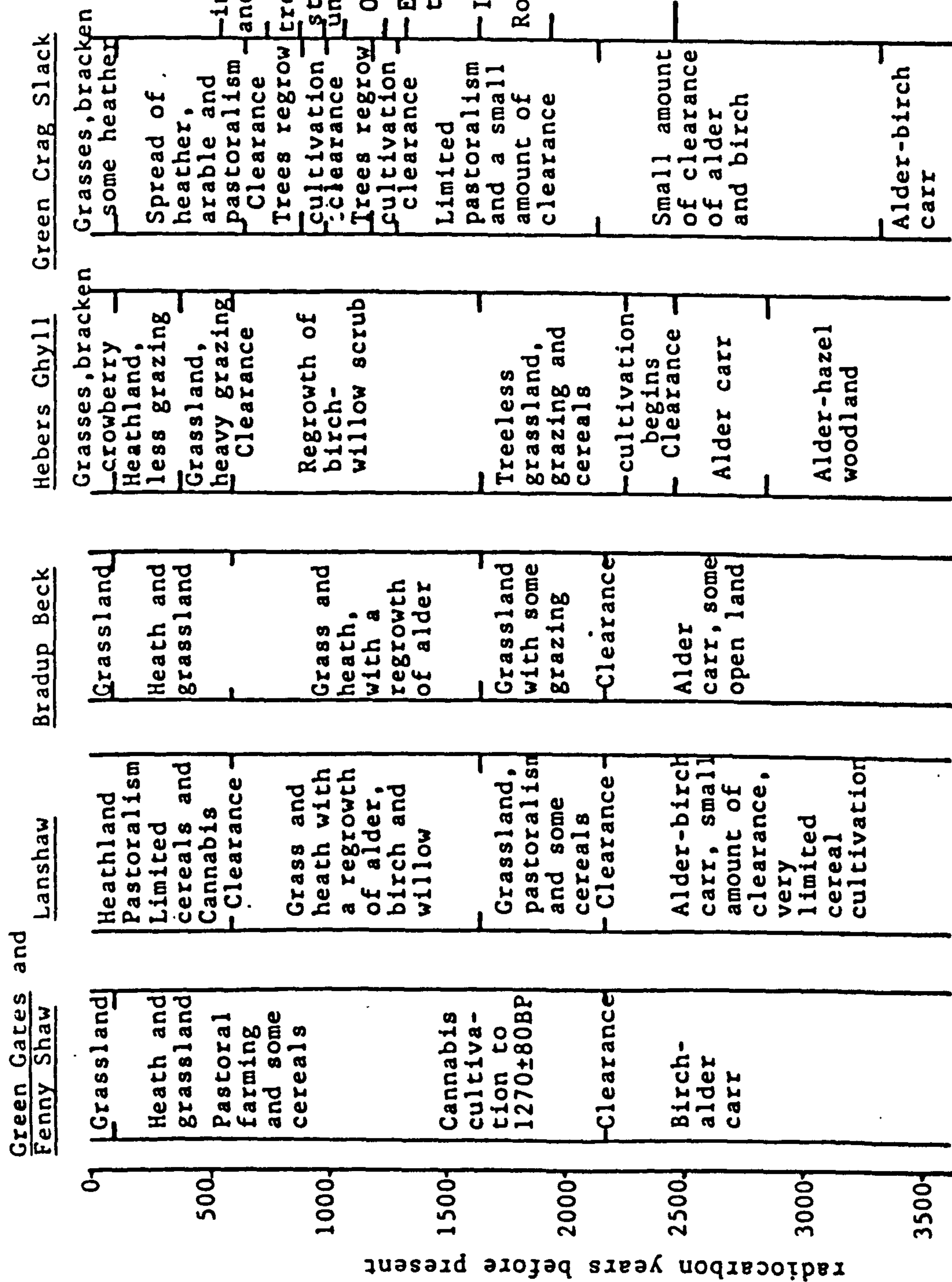


Fig. 33 : Vegetation change and archaeology on Rombalds Moor from 3760 BP to the present.

the case it would lend weight to the theory that the cairns on Hawksworth Moor, mentioned on p.23, are late Neolithic (see fig.7). However, there have been relatively few Neolithic finds compared to the great number and variety of early Bronze Age finds and remains on the moor. Since the pollen evidence points to a change to an economy which lasted from 3760±50 years BP throughout most of the Bronze Age, it seems more likely that the people who instigated these changes were early Bronze Age people.

From 3760±50 years BP a small amount of clearance was taking place in all parts of Rombalds Moor, but particularly in the east. The purpose of the clearance is unlikely to have been to provide land for cultivation since there is only evidence for a limited amount of cereal cultivation at one site. It may have been to provide land for settlement, or perhaps it was brought about by the actions of grazing animals. The presence of many Bronze Age microliths on the moor shows that hunting was still an important part of the economy, so perhaps the clearance was effected to provide better browse for game.

The vegetation of the moor was significantly altered by Bronze Age people, with the virtual disappearance of Tilia, the decline of Quercus and Corylus and the spread of Betula. In addition there were more areas of open grassland, but it is difficult to tell how extensive they were because the sampling sites were all wet carrs at the time and were all still covered with alder and birch.

The pollen evidence suggests the possibility of a small settlement near to Lanshaw linked perhaps with the ritual site of the Twelve Apostles stone circle. It was, almost certainly, a poor settlement since cultivation was so limited and there have been very few finds of metalwork and pottery.

The wide distribution of cup-and-ring rocks, and in particular their abundance on the apparently uninhabited western side of the moor, suggests that these rocks are not associated with agriculture or settlement, and may instead be the work of early Bronze Age hunters.

On the basis of the archaeological evidence alone the

best candidate for an early Bronze Age settlement site is Green Crag Slack, but the pollen evidence discounts this. The start of clearance at Green Crag Slack has been dated to 3320±40 years BP which, according to Barnes(1982) and Megaw(1979) is a mid-Bronze Age date. Rather than suggest that early Bronze Age people did settle here but did not affect the vegetation as they did at Lanshaw, it seems more logical to conclude that many of the remains on Green Crag Slack date from the mid- rather than the early Bronze Age. The pollen diagram shows no evidence of agriculture on Green Crag Slack during the Bronze Age. This does not necessarily rule out the possibility of cultivation, since the wet area on Green Crag Slack is so small (see photograph on p.96) and trees were growing on the site in the Bronze Age. It is therefore possible that cereal pollen, even from land very close-by, would not have reached the site.

It was proposed on p.39 that there was a decreased population in the late Bronze Age, since there are fewer remains on the moor ascribed to this period. It is suggested that this movement of population was linked to a deteriorating climate. There is only a little evidence in the pollen diagrams which might support these theories. The Lanshaw and Hebers Ghyll diagrams show increased Alnus values in the late Bronze Age which could be the result of an increasingly wet climate. There are also slightly fewer clearance indicators in the pollen diagrams in the late Bronze Age, but the decrease is not sufficient to infer an abandonment of the moor. It may be then that fewer late Bronze Age flints have been found because, as suggested on p.39, there was little game on the moor by this time so there was less hunting.

There are very few Iron Age remains on the moor, although the soil beneath the Woofa Bank cairn has an Iron Age date. This might suggest an Iron Age abandonment of the moor in the face of an increasingly cold and wet climate, as has been proposed for other areas such as North Derbyshire (Hick's, 1971). However, the pollen diagrams show a great increase in activity with the disappearance of trees from most parts of the moor, and the start of cultivation at many sites. It might be

argued that the trees disappeared as a result of soil deterioration and peat formation, caused by the worsening climate. This cannot be so because in many areas woodland returned at a later date, which would have been impossible if the soils had deteriorated. In any case the increases of pollen of cultural indicators and indicators of pastoral and arable farming, are evidence that in spite of the few archaeological remains there was a great deal of human activity in the Iron Age. Although there are marked increases of cereal pollen and of arable indicators such as *Cruciferae* and *Plantago major/ media* type, and at Green Gates the *Cannabis* curve begins, there is a much greater increase of pollen of pastoral indicators, such as *Rumex acetosa* type, *Plantago lanceolata* and *Ranunculaceae*. It is likely, therefore, that even in the Iron Age cereal and *Cannabis* cultivation was of secondary importance on the moor compared to pastoral farming. It may be that the major cause of the widespread deforestation was the destruction of saplings and general damage to the woodland by grazing animals, most probably sheep.

Very similar results have been obtained for the East Moor, Derbyshire (Hicks, 1971) and for Rishworth, West Yorkshire (Bartley, 1975). In both cases the authors found widespread clearance in the Iron Age but with few Iron Age remains. Both authors concluded that there had been a movement of the population into the valleys during the Iron Age, whilst the gritstone uplands were used for grazing land. This seems to be the best way to explain the Rombalds Moor results, so that during the Iron Age there was little or no settlement on the moor, thus explaining the lack of remains and artifacts. Instead the moor was heavily stocked with sheep which, probably together with clearance by man, brought about the deforestation of most of Rombalds Moor.

The only pollen diagram which does not show a major clearance in the Iron Age is from Green Crag Slack. This throws doubt on the idea that the enclosures on the Slack are Iron Age (see fig.15 and p.39), and suggests that they date either from the Bronze Age or from later than the Iron Age.

Following the major clearance there was a spread of grassland at Lanshaw, Bradup Beck, Fenny Shaw and Hebers Ghyll, but

at Fenny Shaw this was short-lived and Calluna rapidly became the dominant species. At Green Gates Calluna was as important as Gramineae immediately following the clearance. Perhaps at the higher sites of Green Gates and Fenny Shaw the grazing pressure was not as high as on the lower sites so Calluna was able to invade the cleared land, and particularly the boggy areas. It was certainly growing on the Fenny Shaw boring site because the peat contains its leaves and flowers. The summary diagram shows that throughout the Iron Age farming remained predominantly pastoral, but with some cultivation on the northern side of the moor, and that this type of economy persisted throughout much of the Romano-British period.

Cereal cultivation stopped at Hebers Ghyll at 1650 ± 50 years BP and birch and willow woodland subsequently grew on and around the site. The regrowth of woodland at Bradup Beck and Lanshaw are also thought to date from this time. These events have been interpreted as an abandonment of the agricultural land, and were probably linked to the unrest in Britain in the second half of the 3rd century A.D. which culminated in Carausius gaining control of Britain in 286 or 287 A.D. (Faull, 1981). There is a problem with this interpretation because the abandonment of agricultural land could not explain the increases of Alnus at Lanshaw and Bradup Beck, since Alnus is likely to have grown on wet areas which would have been unsuitable for agriculture. Since grazing was probably the cause of deforestation it is likely that trees regrew when there was a release of grazing pressure.

It is interesting that trees did not grow back at the highest sites. Presumably, the removal of the woodland cover together with the deteriorating climate caused a deterioration of soils on the moor tops so that trees were unable to return when the grazing pressure decreased. There are decreases in the Plantago lanceolata, Rumex acetosa type and Ranunculaceae curves in both diagrams, which supports the idea of decreased grazing pressure and in the Green Gates diagram these fall between the 2170 ± 80 years BP and 1270 ± 80 years BP radiocarbon dates. The cereal and Cannabis curves are continuous in the Green Gates diagram between these two dates, which shows that

cultivation did not stop in all areas at 1650 years BP. It may be that cultivation also continued near to Hebers Ghyll but that the growth of trees on and immediately around the site prevented cereal pollen from landing at the boring site.

Green Crag Slack is the only site on the moor where a substantial amount of woodland remained throughout the Iron Age which must mean that it was not as heavily grazed as other parts of the moor. Cereal pollen is not recorded until 1300 ± 40 years BP, which is within the confidence limits of the 1270 ± 80 years BP date for the end of the Cannabis curve at Green Gates. There were no significant changes in the land use at any of the other sites at this time, so it is likely that the changes at Green Gates and Green Crag Slack were the result of a change of ownership of the Otley estate, mentioned on p.97, which included much of the northern side of Rombalds Moor.

The beginning of the cereal curve in the Green Crag Slack diagram coincided with a clearance in which the woodland was reduced but not removed. There is no evidence of clearance at other sites and the spread of Calluna at Green Crag Slack suggests that there was little grazing.

This period of clearance at Green Crag Slack lasted only 100 years and trees regrew during the period that the Vikings were in control of most of Yorkshire. Woodland continued to increase on all but the highest parts of the moor. There was a further period of partial clearance at Green Crag Slack from about 1000 years BP to 900 years BP which is probably contemporary with a stable period in West Yorkshire's history following the defeat of Eric Bloodaxe in 954 AD (see p.98). Again there was little activity on the rest of the moor with no other clearances recorded. The second regrowth of woodland at Green Crag Slack may be related to the troubled period following a revolt in 1065 A.D. (see p.98).

Clearance occurred on all parts of the moor, where woodland remained, in the late 13th and early 14th centuries, when there was an expansion of cultivated and pastoral land and intense clearance in many parts of West Yorkshire (Faull, 1981). Cereal pollen reappears at this time in most of the pollen diagrams and appears for the first time in the Bradup Beck

diagram. Again pastoral farming appears to have been more important than arable but a greater area was under cultivation than before and Cannabis cultivation was more widespread. In all areas of the moor the vegetation consisted of a mixture of grassland and heathland

The final vegetation change which has been recorded in all but the Lanshaw diagrams is a decline of heather ., which is believed to have been caused by recent overgrazing and burning of the moorland, and which has resulted in the spread of Empetrum nigrum and Pteridium, particularly on the northern slope, and of species-poor acid grasslands.

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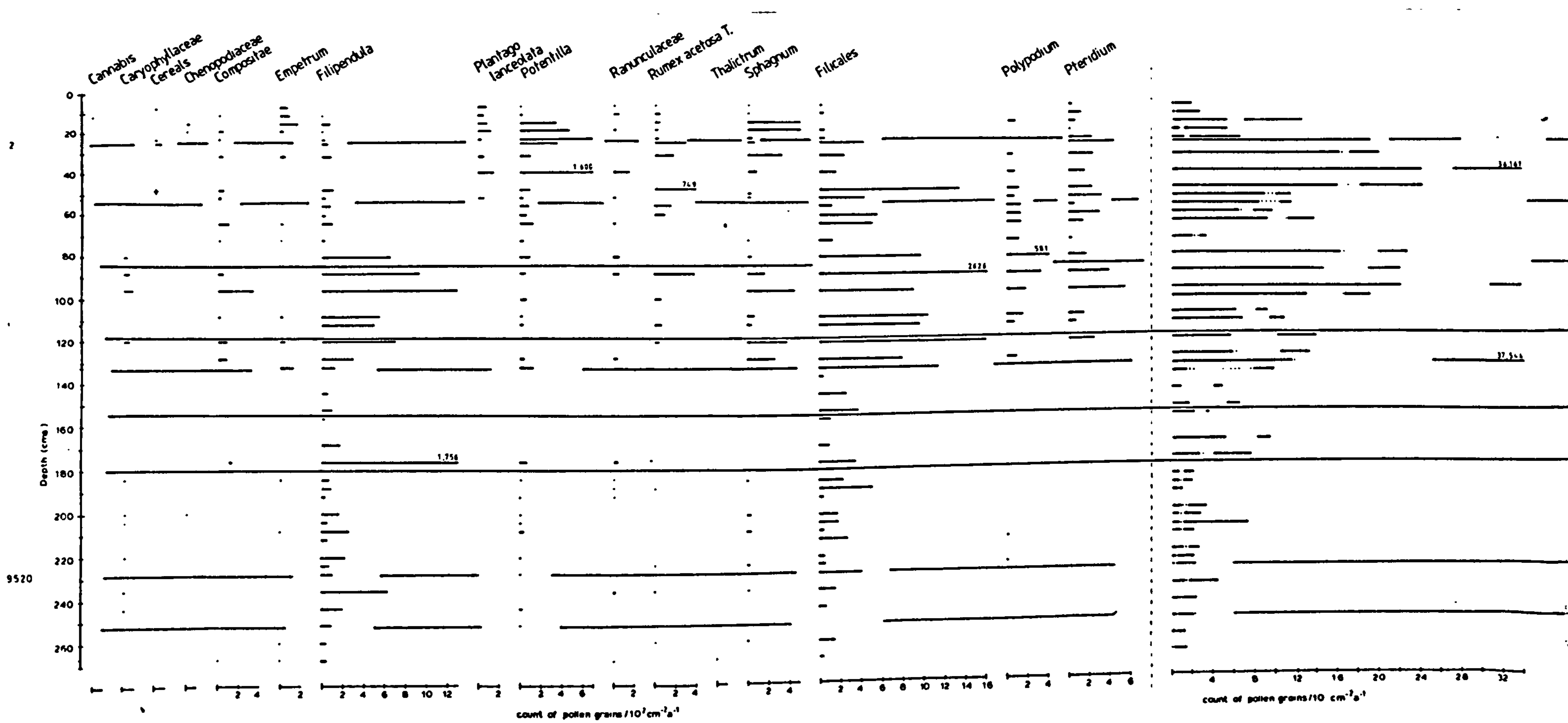
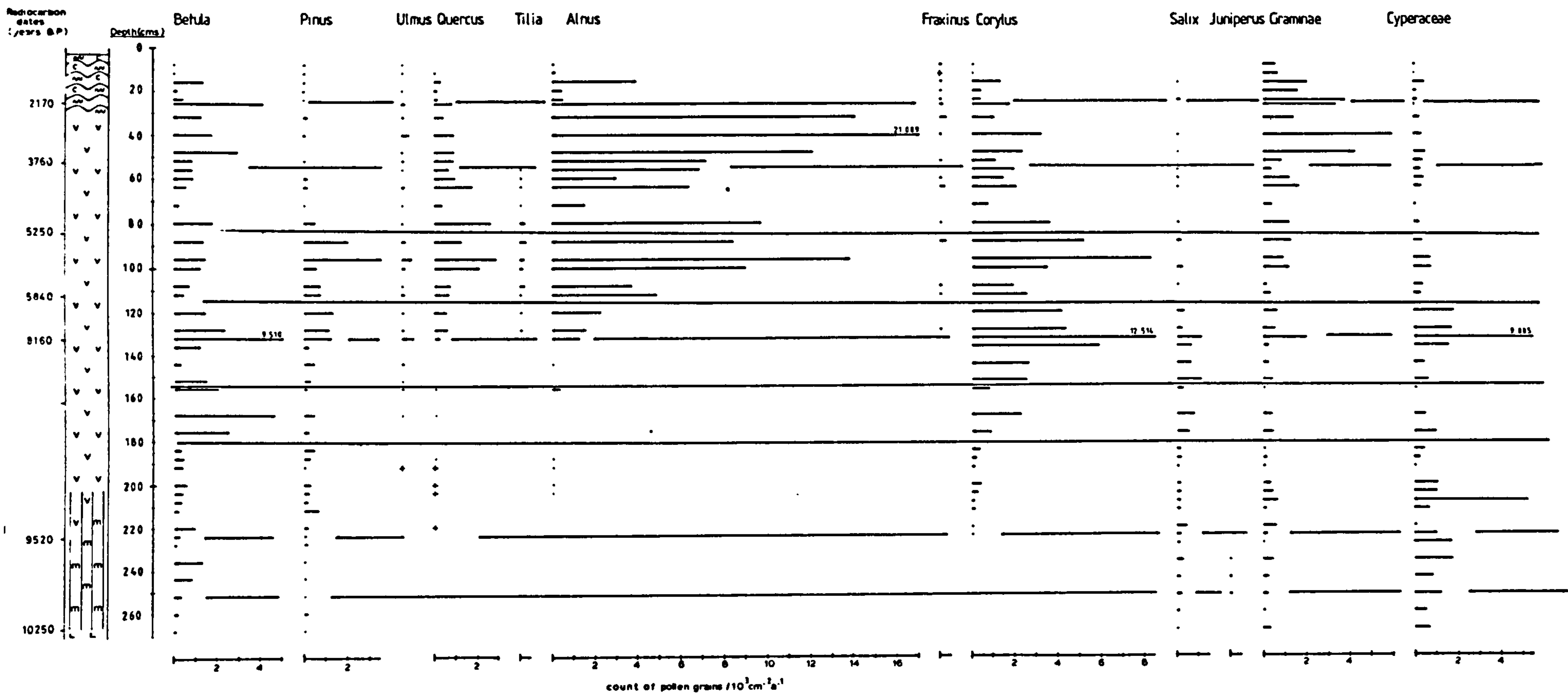
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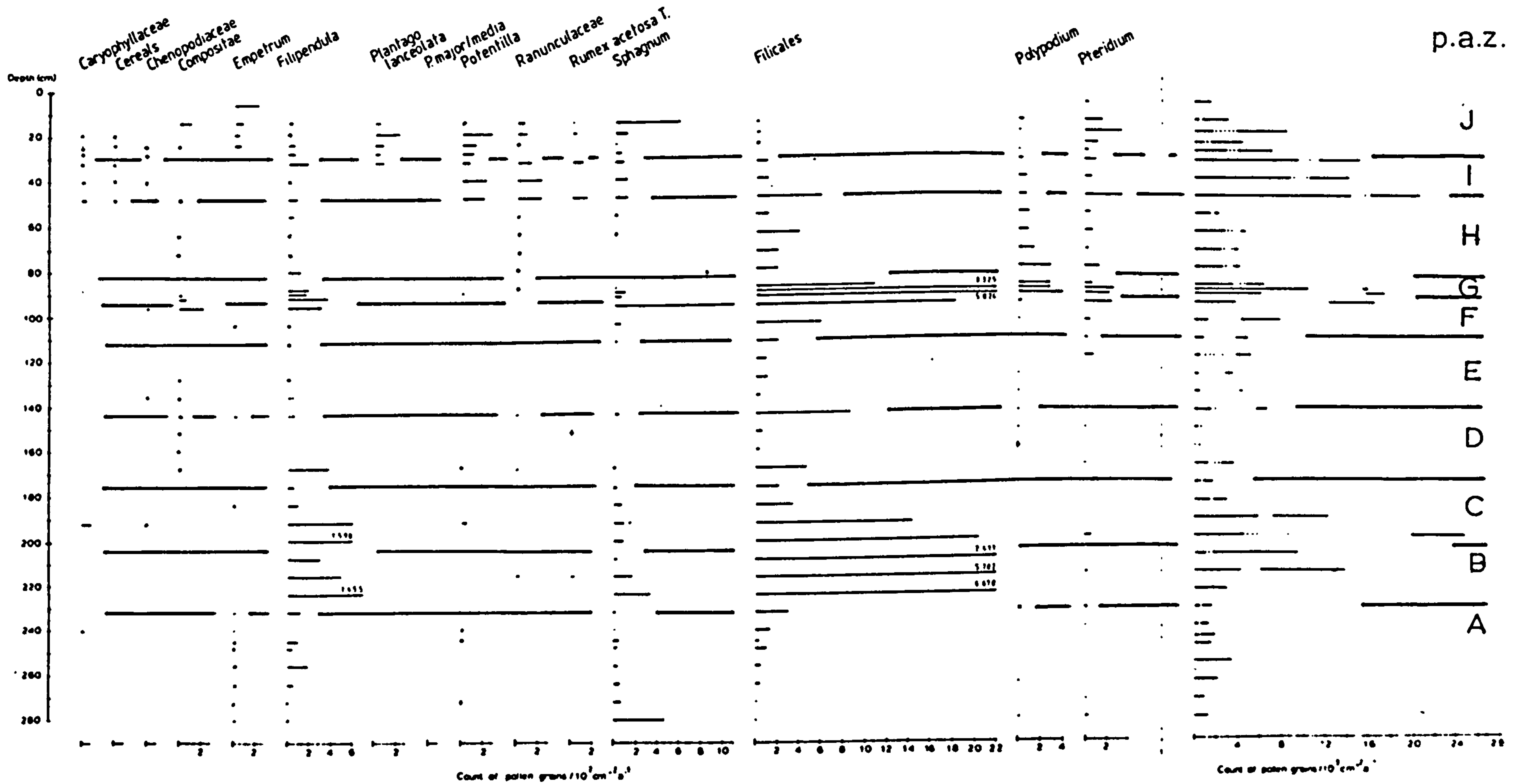
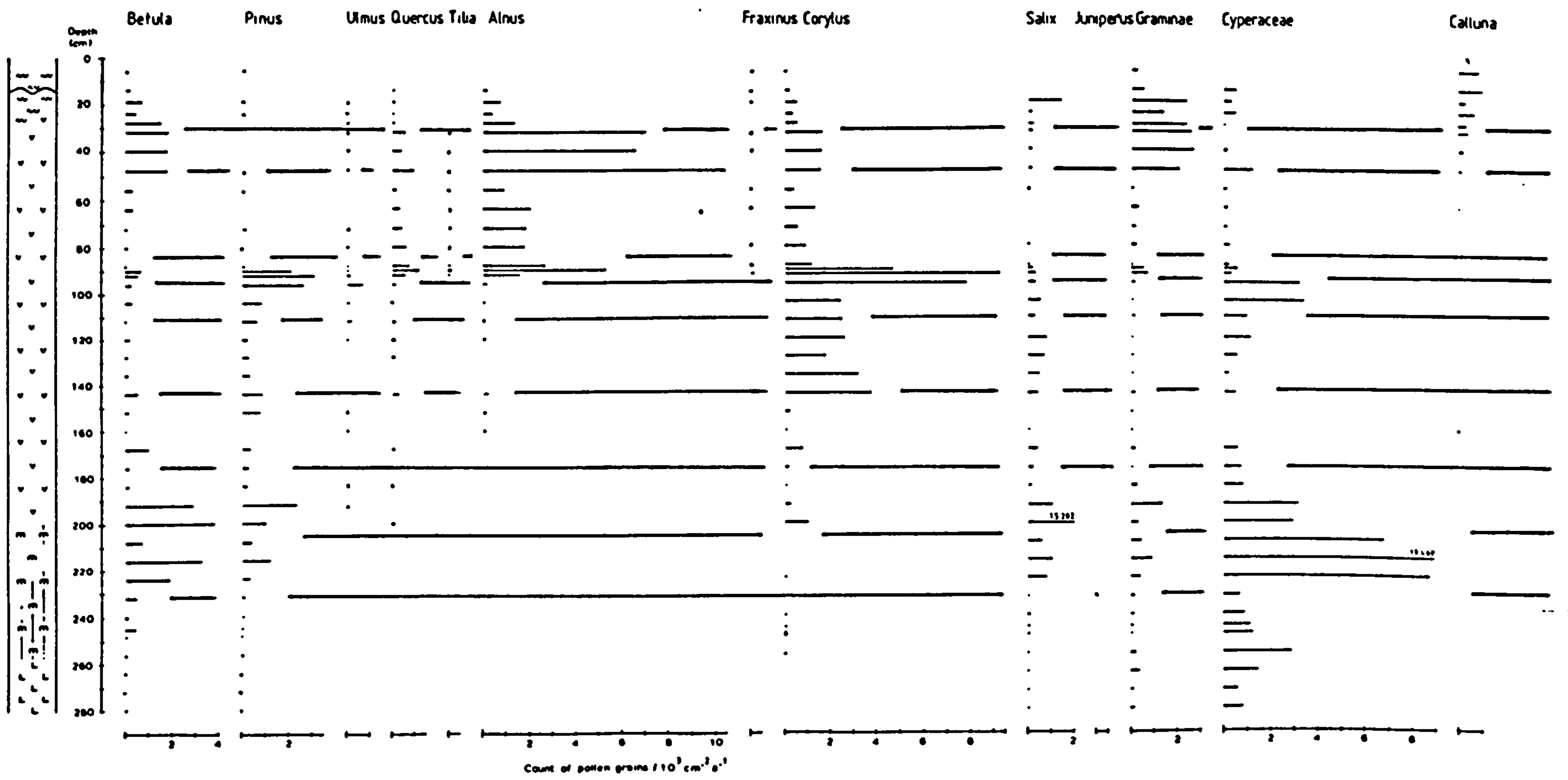
APPENDIX 1. LIST OF ABBREVIATIONS IN THE TEXT

- O.D. - Ordnance datum
- Grid ref. - National grid reference
- TP - Total land pollen
- BP - Before present
- p.a.z. - Pollen assemblage zone
- AP - Arboreal pollen
- NAP - Non-arboreal pollen
- BAT - Boreal-Atlantic-transition

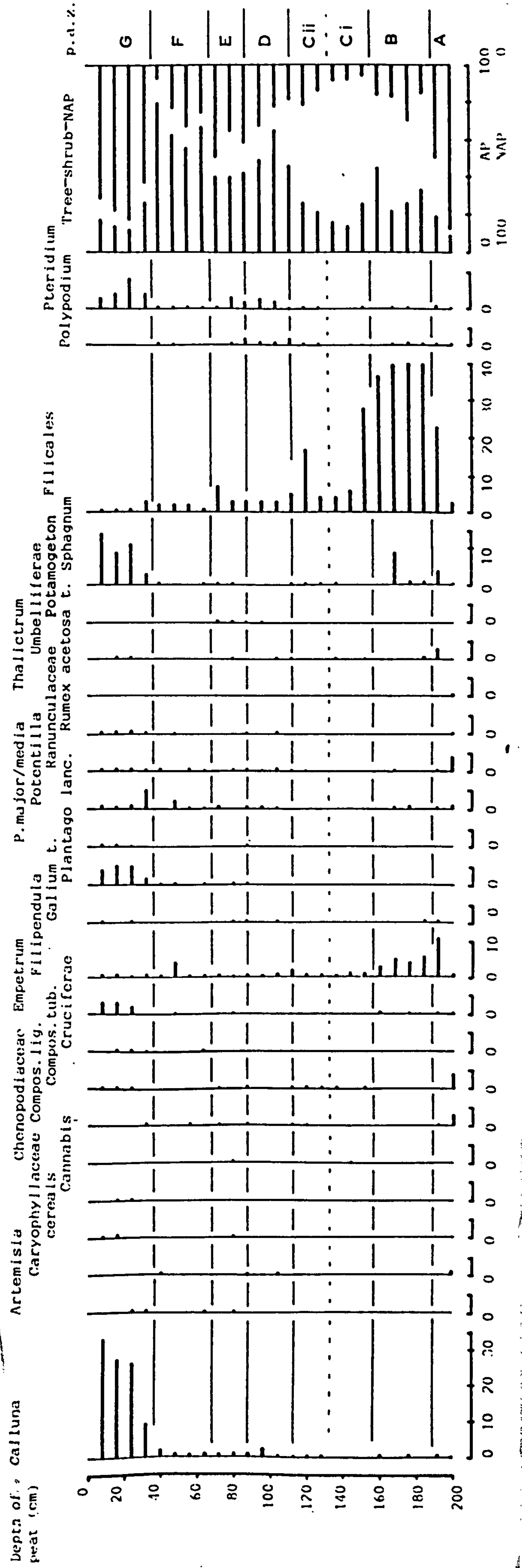
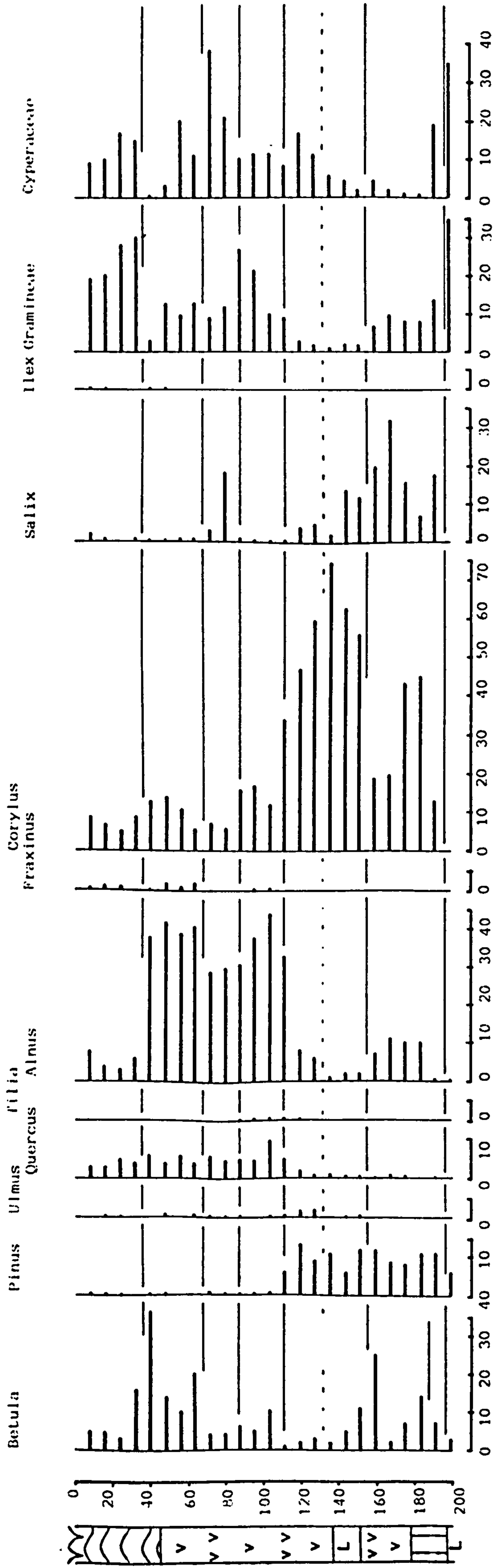
2 LANSHAW 2 Influx Diagram



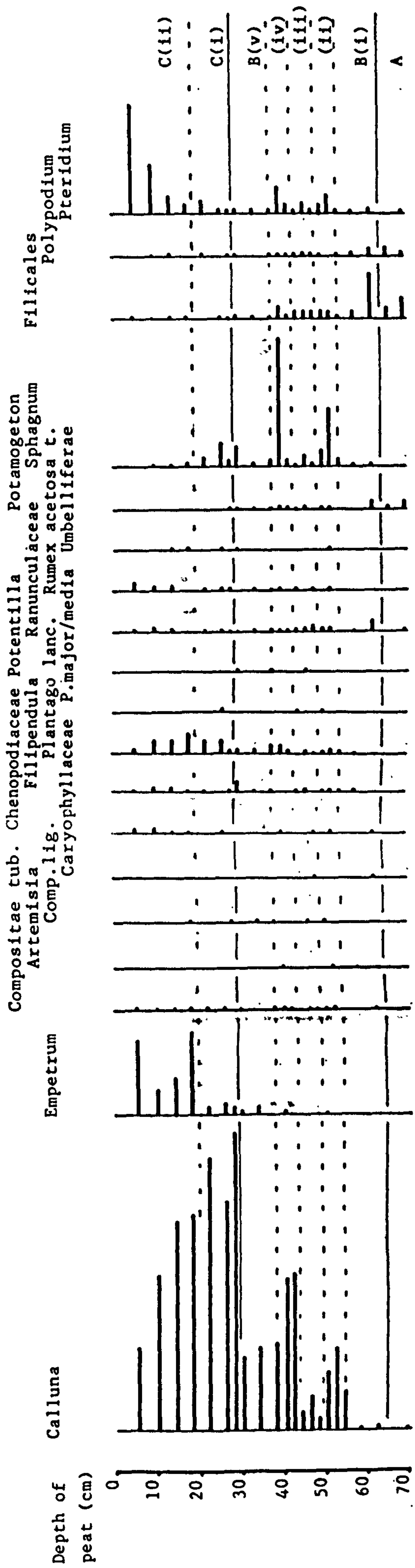
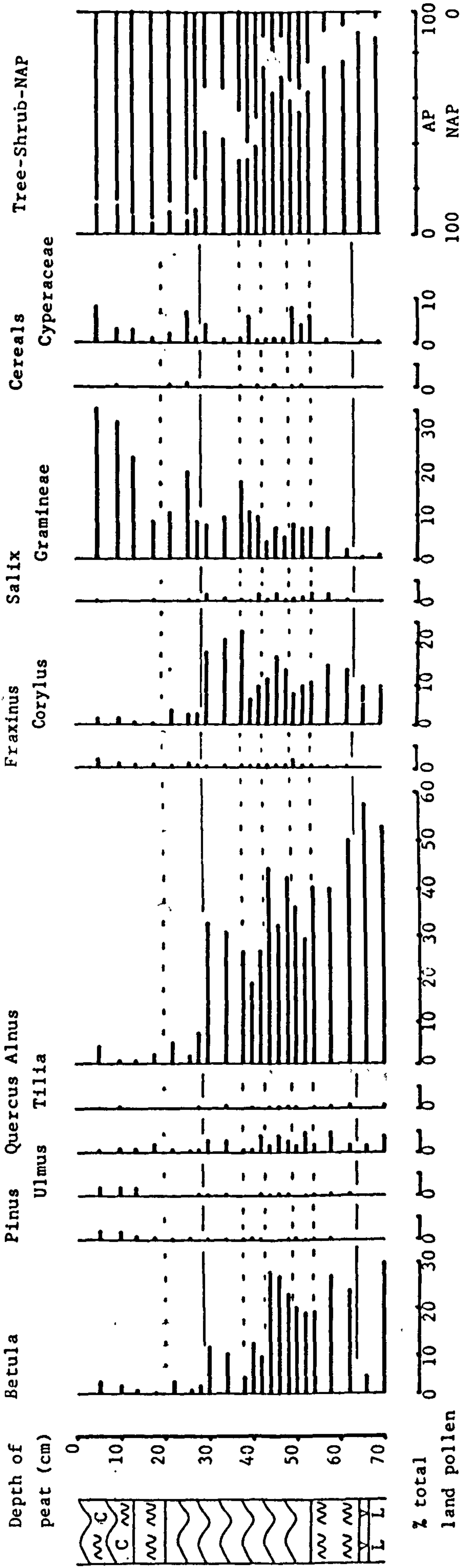
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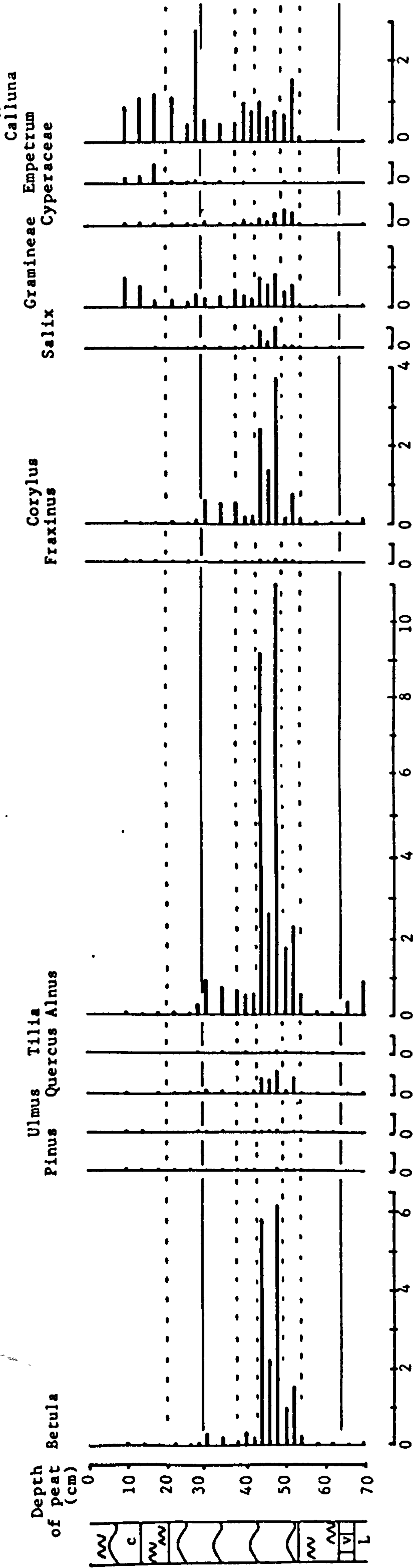
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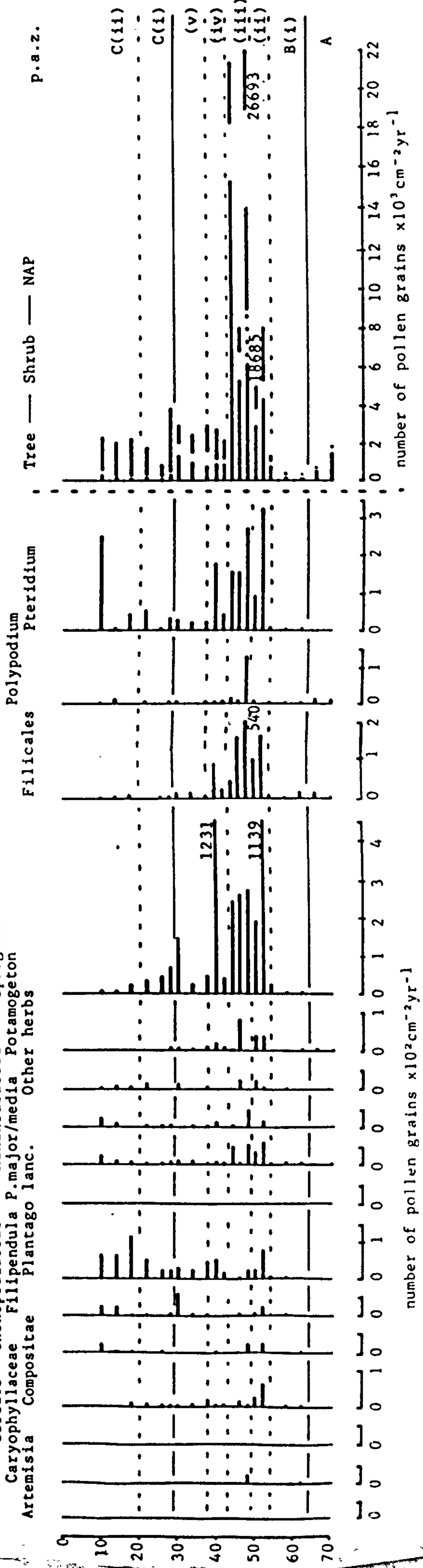
6. GREEN CRAG SLACK



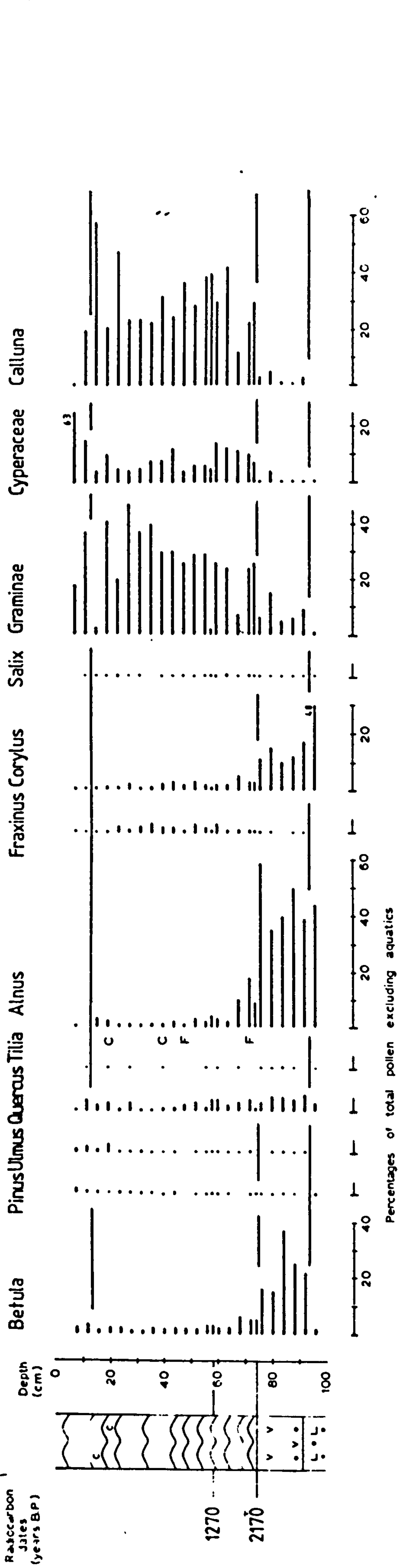
7. GREEN CRAG SLACK INFLUX DIAGRAM



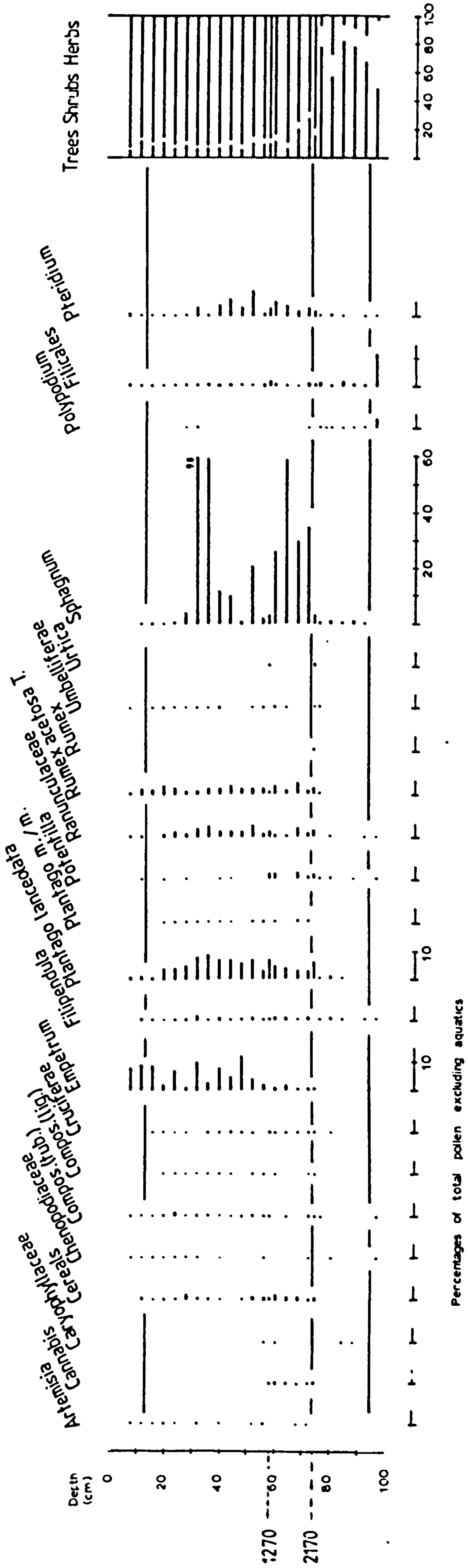
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 Caryophyllaceae Ranunculaceae Sphagnum
 Filipendula P.major/media Potamogeton
 Artemisia Compositae Plantago lanc. Other herbs

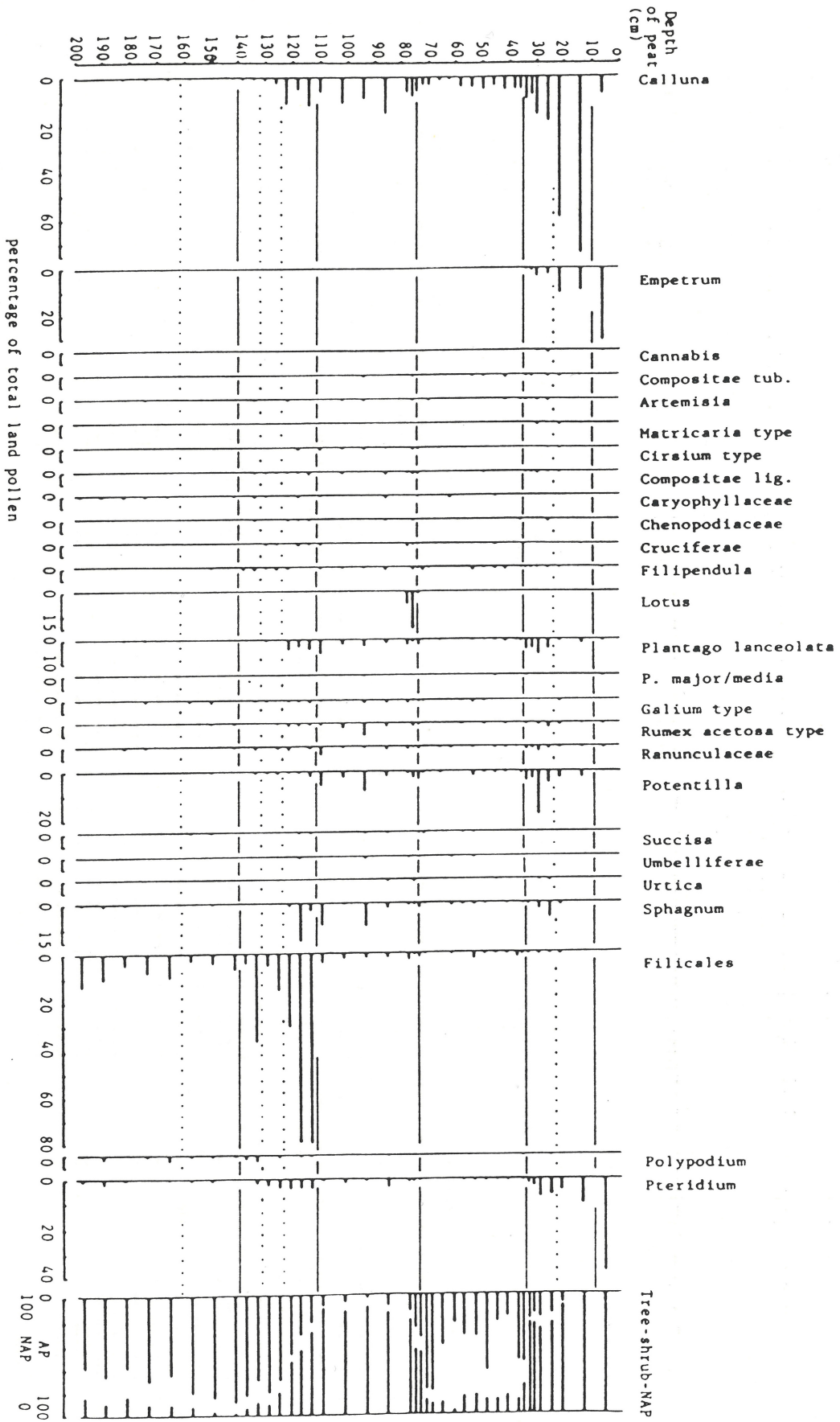
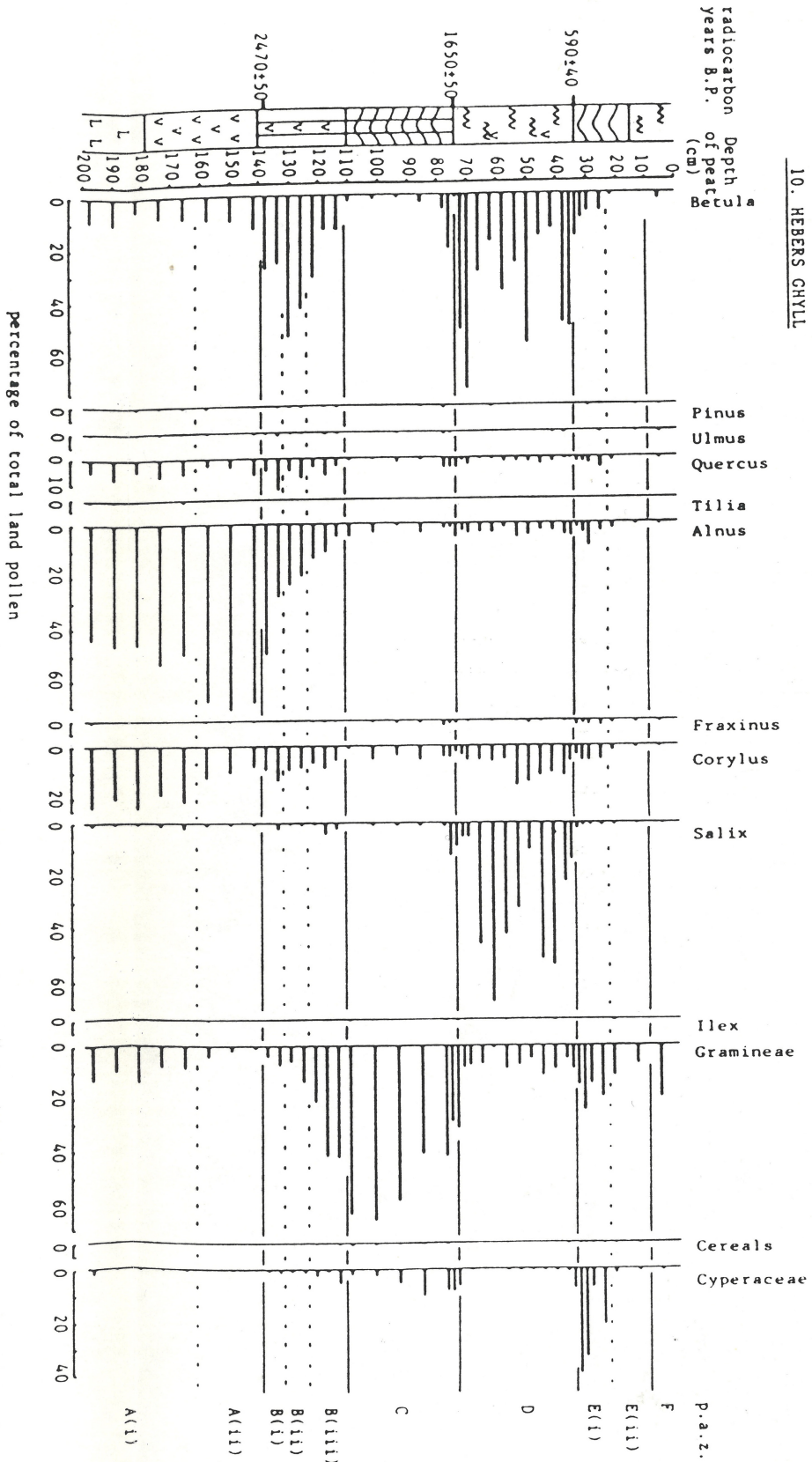


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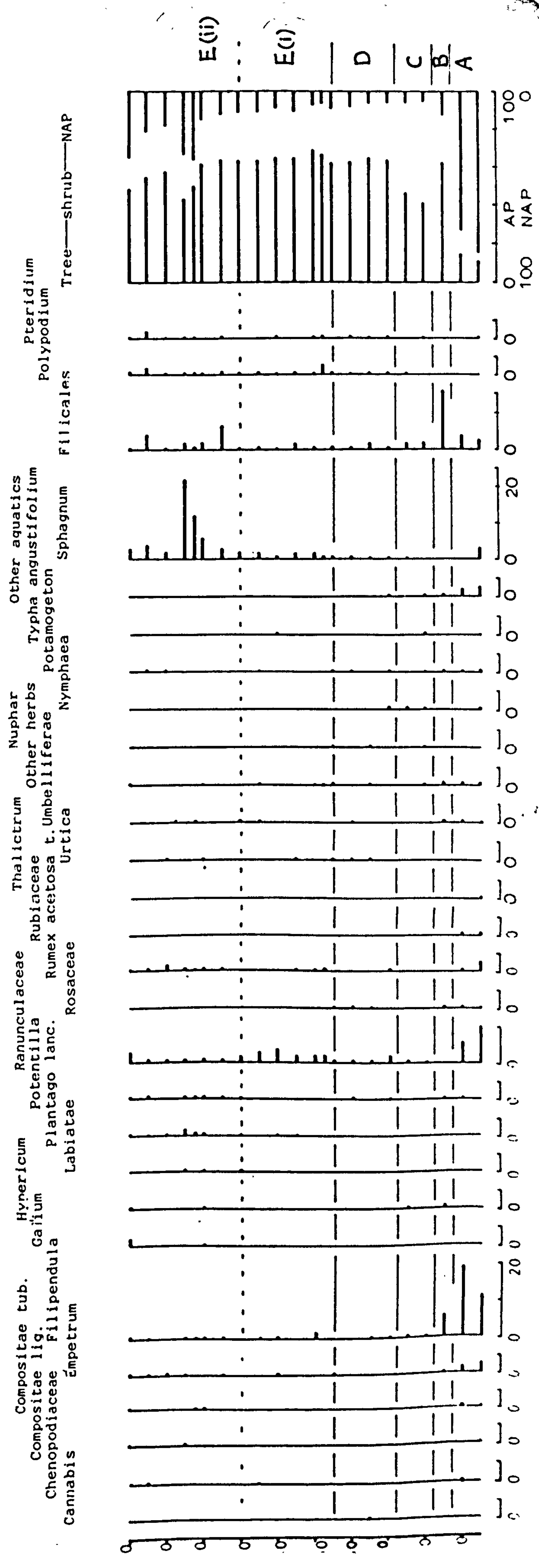
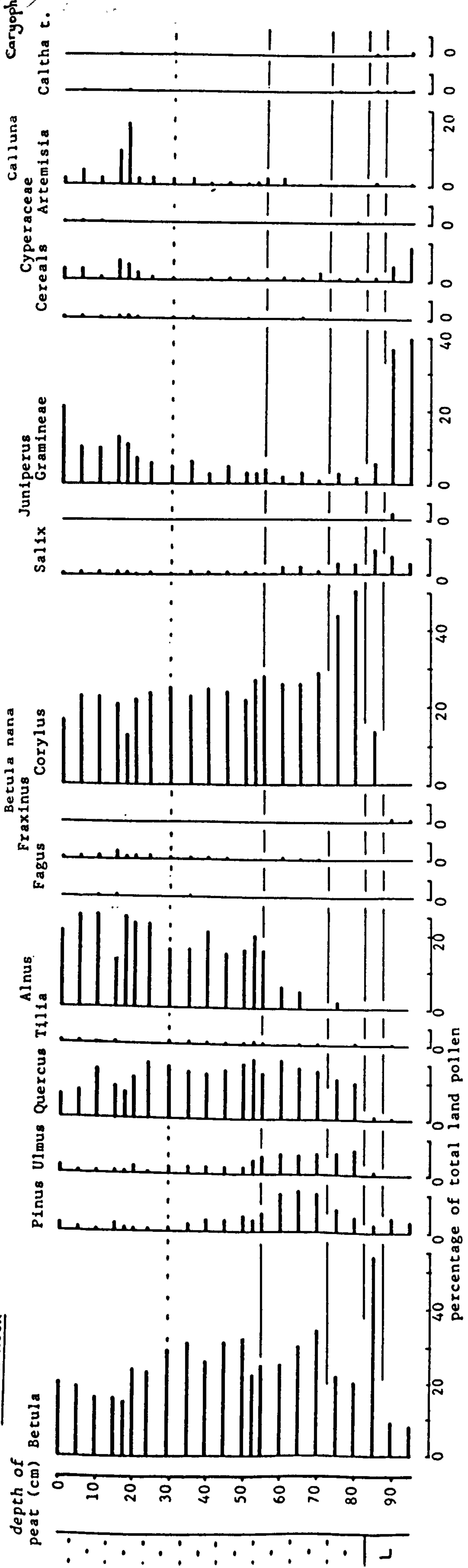


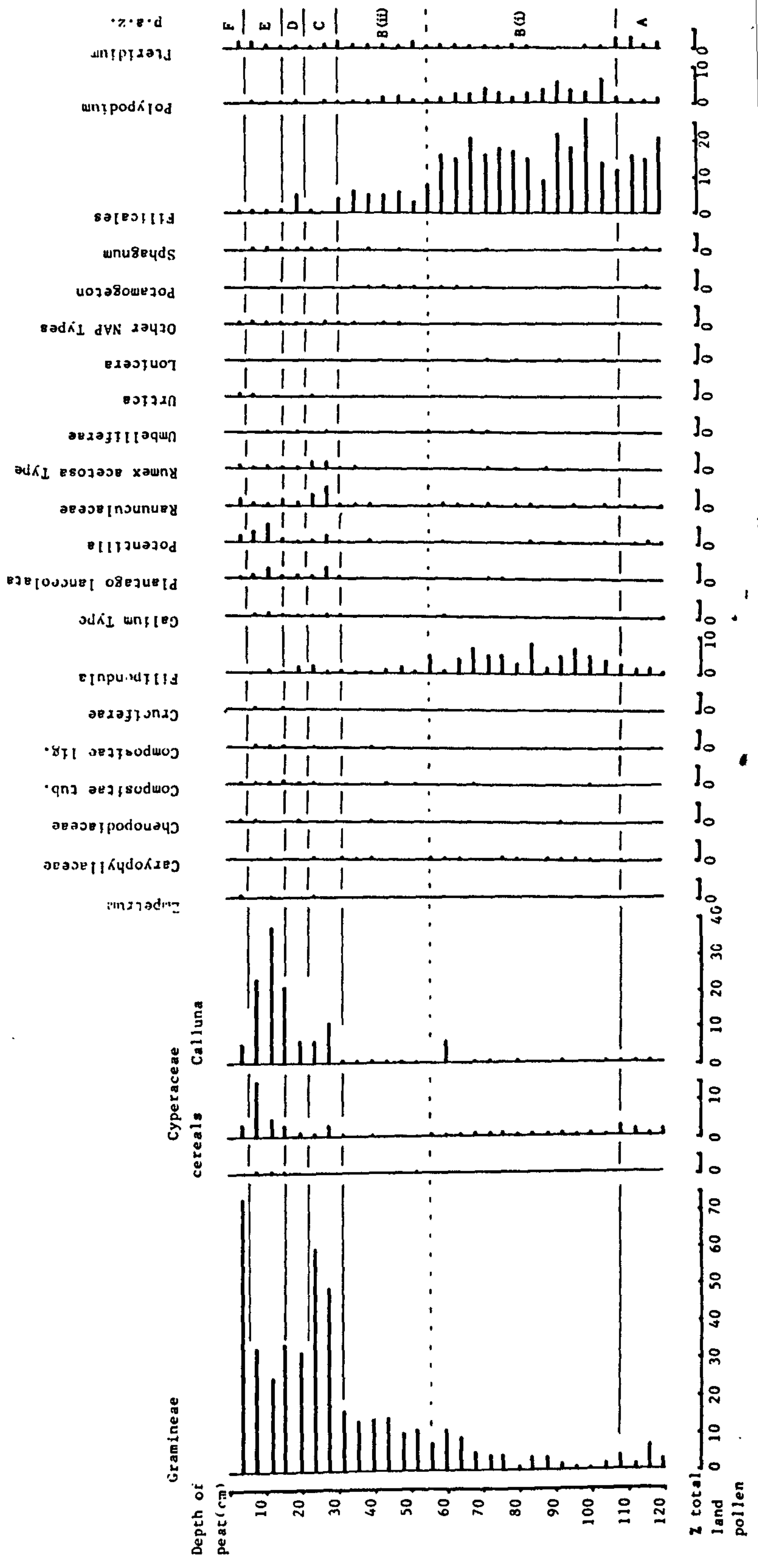
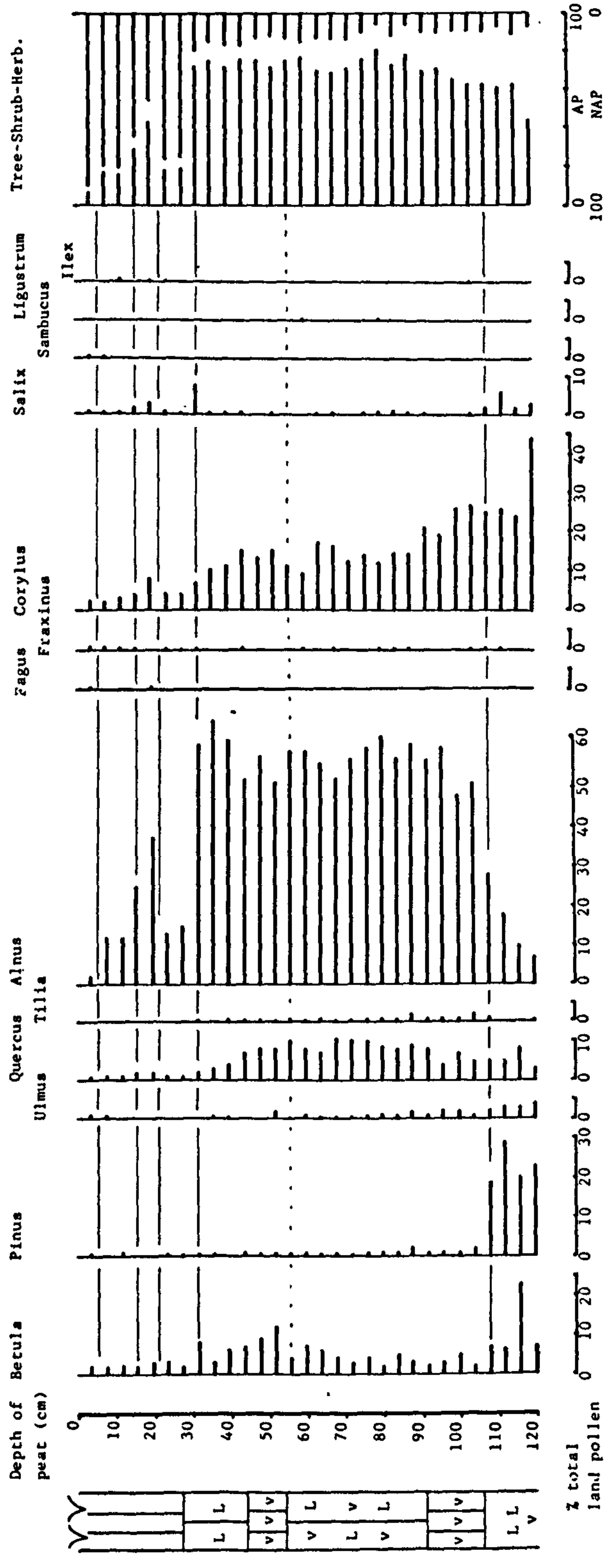
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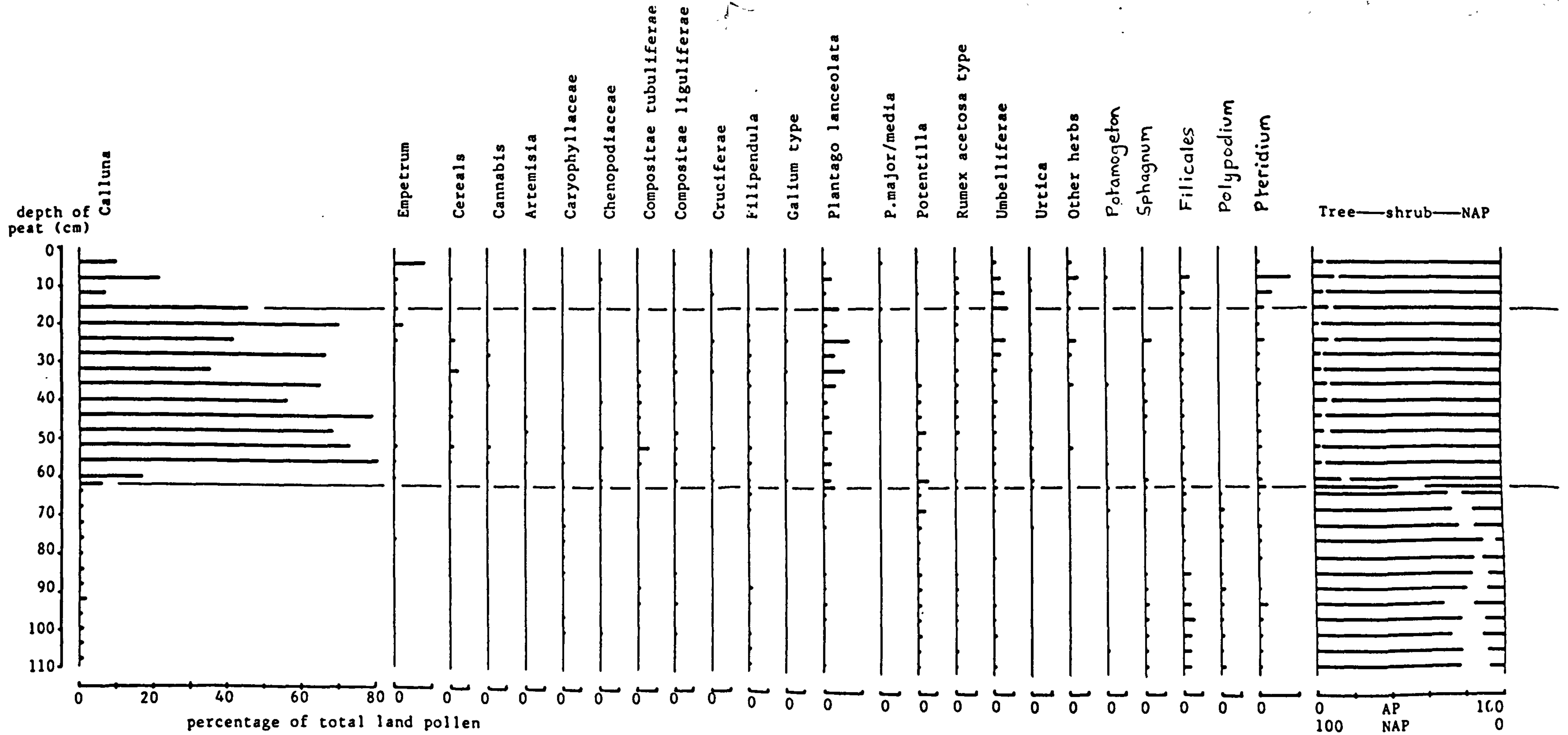
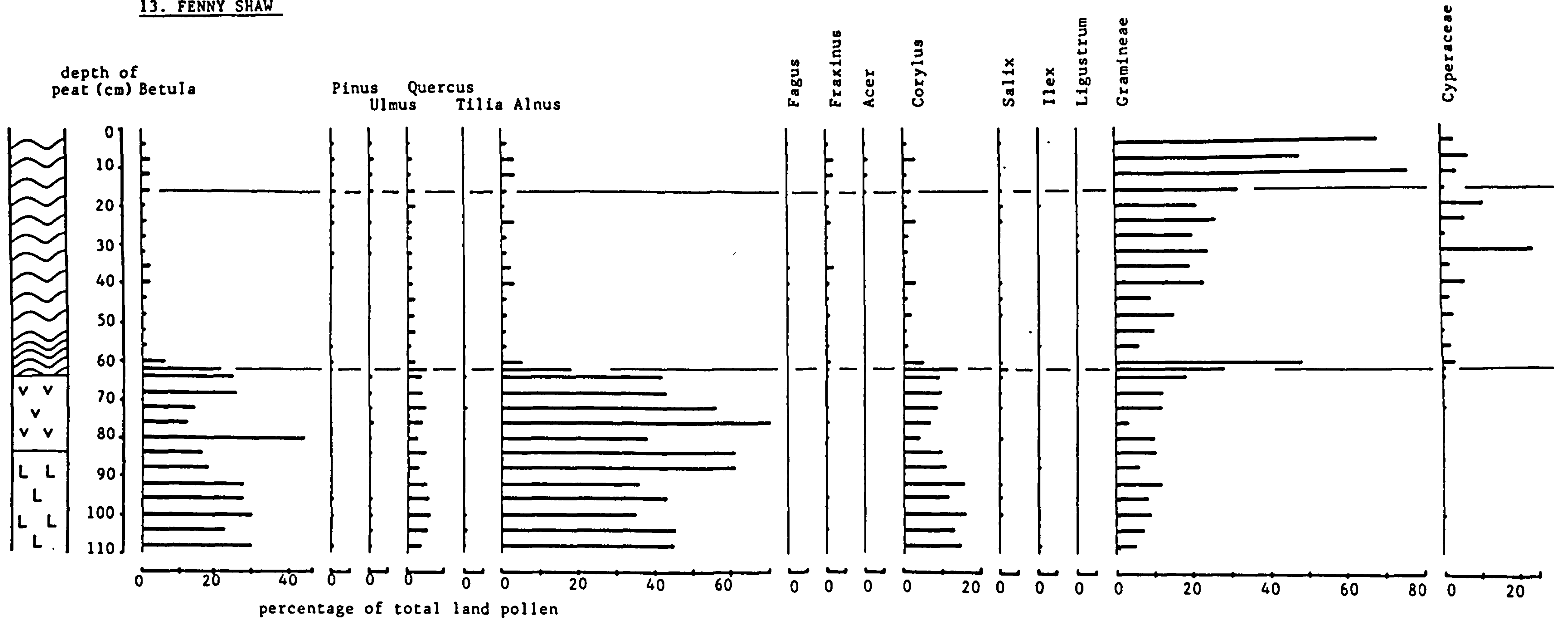


11. SEA MOOR

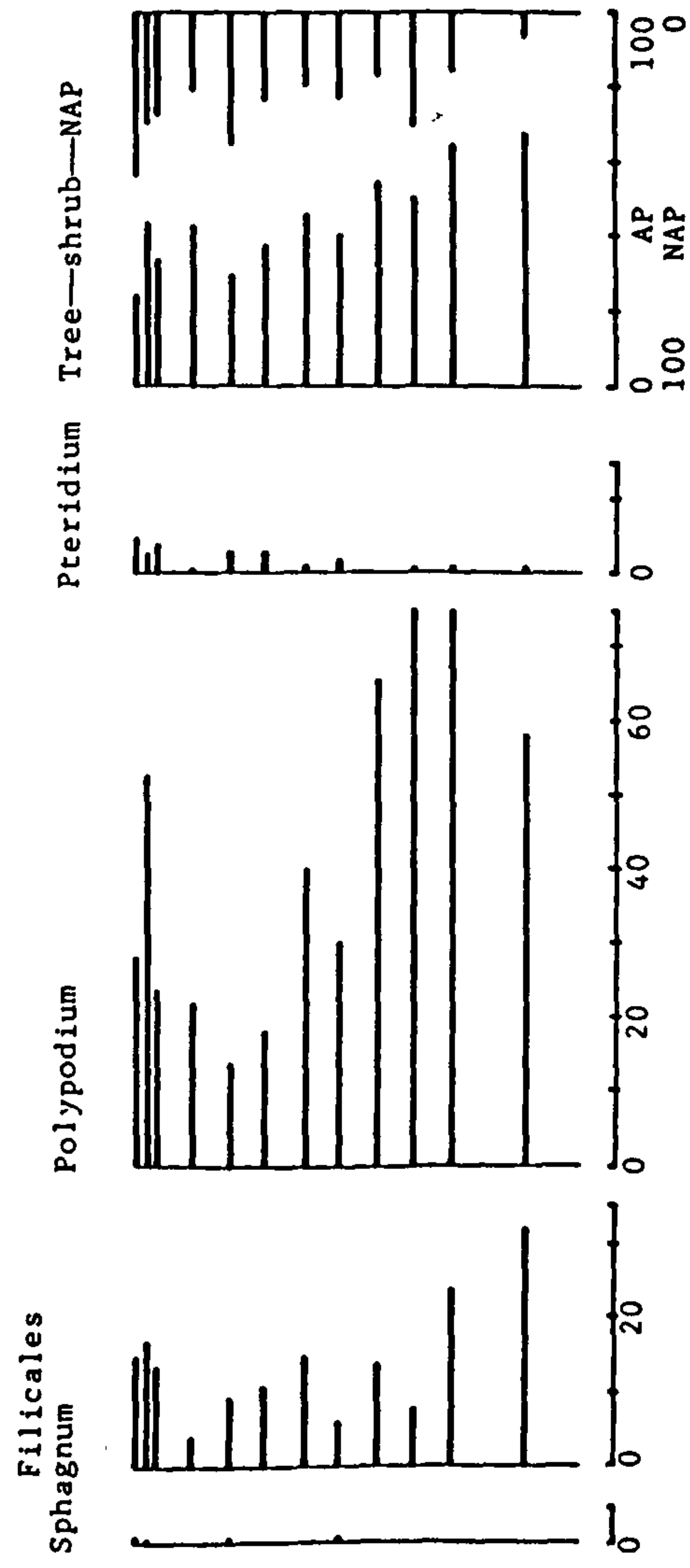
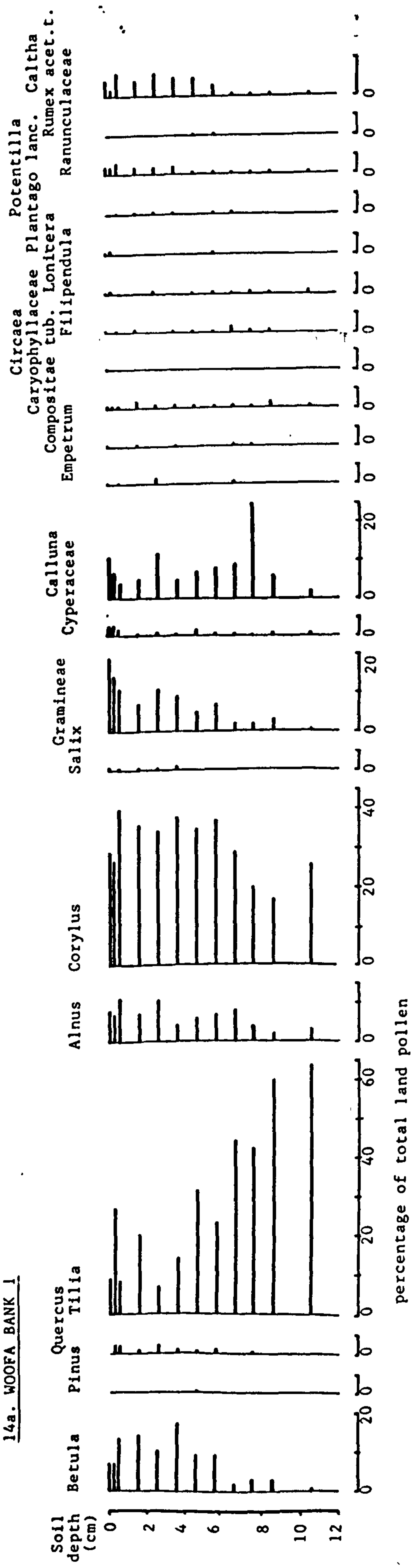




13. FENNY SHAW



14a. WOOFA BANK 1



14b. WOOFA BANK 2

