Palynological investigations at hallowell moss near witton gilbert, Durham a history of man's impact on vegetation

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PALYNOLOGICAL INVESTIGATIONS AT HALLOWELL MOSS NEAR WITTON GILBERT, DURHAM.
A HISTORY OF MAN'S IMPACT ON VEGETATION.

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CONTENTS.

ABSTRACT

Hallowell Moss, near Durham, contains a continuous pollen record from about 3,700 B.C. until, probably, the present day. Having studied the history of the area, an attempt is made, with the assistance of radiocarbon dating, to correlate the vegetational phases recorded in the bog with the various archaeological and historical periods.

The area remained densely forested until Bronze Age times, when there is evidence for slight grazing pressure within the forest and a small temporary clearance. In the Romano-British period, an extensive clearance making the landscape about as open as that of today may be correlated with similar clearances in Weardale. This phase comes to a rather abrupt end, probably with the advent of Anglo-Saxon rule and throughout the Saxon and Mediaeval periods the area remains as managed woodland with some grass and arable land. Extensive, "permanent" clearance does not occur until probably the sixteenth and seventeenth centuries. Evidence for later afforestation is presented, and an explanation for recent changes in land use.

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INTRODUCTION

Not until the late 1950's did the idea become generally accepted that the disappearance of forest in Britain was largely the result of man's activities,rather than climatic changes.

Godwin in 1944 had recognised the importance of forest clearance by Neolithic man in the origin of the present-day heath communities of the Breckland. Evidence came from areas like the North York Moors (Dimbleby, 1952) and the southern Pennines (Conway, 1949), that the disappearance of forest often began with the first agricultural settlement of the area.

Slowly, a picture has been building up, through pollen analysis and radiocarbon dating, of the effects the various cultures and societies had on vegetation in many areas of Britain. Often, vegetational changes can be directly associated with a particular culture by the presence of artifacts or other evidence of occupation in an area. From the Anglo-Saxon, or even the Roman period onwards, documentary sources may also help in elucidating the pattern of vegetational change.

Even Mesolithic man is now thought to have had effects on vegetation out of proportion to his numbers. The use of fire for driving game (Dimbleby, 1962), the collection of hazel nuts (Godwin, 1956) and even the possibility of felling trees with small tranchet axes (Radley & Mellars, 1964) have been suggested as important factors. There is little evidence though for Mesolithic man directly influencing a general vegetational change, but he could, by "tipping" the ecological balance, have hastened changes already taking place.

With the advent of Neolithic man and agriculture, the first permanent effects on the forest occurred. The elm decline between zones VIIa and b has been explained by Troels-Smith (1960) as the result of the selective utilisation of elm shoots for fodder by early Neolithic man. Although there is no direct evidence for such utilisation in Britain, the wide range of radiocarbon dates for this boundary over the country, and the fact that only elm seems to be affected, have led many authors to accept an anthropogenic, rather than a climatic explanation, for this widespread effect.

During the Neolithic and Bronze Ages the small-scale "landnam" clearances, affecting all trees and after which the forest reverts to roughly its previous state, are attributed to the clearance of small areas for agriculture by felling and burning. Indeed, the pollen of cereals is first found during these periods. Although the tree to herb ratio is generally restored to its former state after such a clearance, the species composition of the forest is usually altered somewhat. Sometimes, especially in highland areas, the leaching of soils during clearance phases prevented the regeneration of forest (Pennington, 1965).

Vegetational change during the Neolithic and Bronze Ages is related to the advent of agriculture, the concurrent more settled way of life and the use of stone, later bronze axes for the actual felling of trees. In the Iron Age, forest clearance in many areas became more extensive with the advent of iron axes and the need for charcoal for smelting. But, especially from this time onwards, there was much regional variation in forest clearance and land use.

The history of forest clearance has now been studied in many regions of Britain, and an overall view is gradually being formed. As examples, sites have been studied in Somerset (Dewar & Godwin, 1963), Wales (Turner, 1964; Thomas, 1965; Moore & Chater, 1969), Kent (Godwin, 1962), Ireland (Mitchell, 1956 and 1965; Smith, 1958) and southern Scotland (Turner, 1965). Perhaps north-west England has received some of the most detailed studies (Smith, 1959; Oldfield, 1960; Oldfield & Statham, 1963; Birks, 1965; Pennington, 1965; Walker, 1966). In the Lake District, Pennington discusses the local variations in forest history in relation to the different culture and physical conditions in the area.

In the north-east, Teesdale and Weardale are the main areas so far studied. Chambers (1974) in studying the vegetational history of Teesdale during the whole Post-glacial period, found that woodland was being cleared in all parts of Teesdale during the Bronze Age, especially in the lower areas. Clearances seem to have been temporary and land use to have had a pastoral bias. Iron Age clearances were also found but land use and farming methods seem to have changed little. At Thorpe Bulmer in the Tees lowlands (Bartley, unpublished), there is evidence for Romano-British clearance, yet this did not seem to occur further up the dale.

In Weardale however (Roberts et al., 1973), there is evidence from two sites of extensive forest clearance beginning in the late Iron Age/Romano-British period. After the regeneration of woodland, there is evidence for renewed clearance and occupation in the Mediaeval/Modern period.

Until Hallowell Moss was studied, there was very little information on central County Durham. Apart from the local vegetational history, it would be interesting to know if the area had more in common with Weardale, the Tees lowlands or lower Teesdale.

County Durham is an area where rather little is known of the effects of the various cultures and societies on the countryside. Archaeologists naturally tend to study settlement sites, and for the Roman period for instance, a very detailed knowledge of military forts, lines of communication etc., has been built up, yet little is known of the countryside between, or of the native population. Later on, the Domesday Survey did not cover the area, so this detailed documentation of the landscape is missing, though there are some later surveys of church lands which are quite useful.

The aim of this study is to integrate the vegetational history recorded in the bog with archaeological and documentary evidence.

The geographical situation and site of Hallowell Moss

Two miles N.W. of Durham City, Hallowell Moss is a small raised bog in a depression within the Browney valley (see Map I).

The Browney is one of a series of streams separating spurs of higher land running eastwards from the Pennines to the Wear lowlands. East of the bog, the stream is deflected southwards by a sandstone ridge before joining the Wear. In effect, this means that the Bear Park/Witton Gilbert area is rather isolated from the main Wear valley and is certainly within the western, higher part of central County Durham. This basic subdivision is reflected, as we shall see later, in the human geography of the region.

Soils in the area are, for the most part, imperfectly-drained Brown Earths of low base status, developed over the till-covered carboniferous sandstones and coal measures (Stevens & Atkinson, 1970). They are potentially good agricultural soils but there are some areas of gleyed soils with surface water and some peaty areas, especially on the higher ridges. Today, it is an area of mixed farming, with acreage of grass and arable land being roughly equal, and considerable areas of mixed and coniferous plantations especially on the higher slopes and ridge tops.

Superimposed upon an agricultural landscape with villages of early foundation like Witton Gilbert, Esh and Brancepeth, are the nineteenth century colliery villages like Bear Park, Langley Park and New Brancepeth.

The bog itself (see Map and photograph) is in a hollow between the Lanchester road (A69) and the Browney. An Eriophorum-covered dome about 200 metres across, is partly surrounded by a wet muddy "lag" where Juncus species are dominant and there is a slow flow of water into the Stell, now channelled into a ditch which joins the Browney further north.

Precise records of local climate are not available but while working on the bog, we noticed how mist remained in the hollow much longer than in the surrounding areas. It was easy to imagine how peat could still be forming in such conditions of high humidity and free-standing water.

LEVELLING AND STRATIGRAPHY

Two transects, at right angles, were made across the bog and onto the surrounding land. Stakes at 10 metre intervals were levelled, then cones taken at those stakes on the bog surface. A Russian peat borer was used and results are shown in Figs. I and II.

The basin is lined with a rather uneven heterogeneous mixture of clay, silt and sand, with sandstone and coal particles. This is probably till, complicated by fluvial activity, sorting material in some areas.

The highly-humified wood peat which developed on top of the till contains birch wood and bark and the more decayed remains of alder. There are also seeds of Juncus effusus/conglomeratus in the lowest layers. One gets the impression of a Juncus fen being colonised by alder-birch woodland in this damp hollow. During this wooded phase, peat, consisting of forest debris, is accumulating very slowly.

Above this layer, the deposit changes to an Eriophorum peat, with remains of Sphagnum and Calluna with some birch wood. This means that the level of the peat surface had risen above the influence of a slow-flowing water table (rheophilous conditions) and instead became dependent on nutrient-poor rainwater, hence the growth of ombrophilous bog species like Sphagnum, Eriophorum and Calluna. As the peat continued to build up, a dome developed. The wood, fruits and catkin scales of birch are present in the *Eriophorum* peat until very near the surface, so there were probably trees growing on the bog surface until relatively recently. Birch is a tree found in climax ombrophilous vegetation, whereas the alder found lower down is a species of rheophilous climax. Within the *Eriophorum* peat there are variations, e.g. woody, mossy, or slightly more humified layers, but these proved rather difficult to delimit in the narrow cores from the Russian borer.

The *Juncus* area around the dome seems to have continued as a marshy, muddy area draining the dome and the surrounding slopes, and slowly depositing a dark, highly humified mud/ peat.

The point (stake 140), slightly off the apex of the dome, but with the greatest thickness of peat, was chosen for detailed pollen analysis. The stratigraphy (see main pollen diagram) is as follows:-

0-226 cm. *Eriophorum* peat.

- 0-68 cm. With *Sphagnum* and *Calluna*.
- 69-110 cm. Muddy, with *Sphagnum*, *Calluna* and remains of birch.
- 111-151 cm. Woody (birch).
- 152-155 cm. Unhumified, with *Polytrichum commune*.
- 156-157 cm. Abundant *Polytrichum commune*.
- 158-226 cm. Woody (birch) with *Sphagnum* and *Calluna*.

227-283 cm. Highly humified wood peat with remains of birch and alder.

284-308 cm. Transitional. Peat/clay.

309- Blue-grey clay.

COLLECTION OF RADIOCARBON AND POLLEN SAMPLES

A large pit was dug at stake 140 in order to expose a clean vertical section of peat. It was intended to collect a peat monolith from which samples for pollen analysis and dating could be taken in the laboratory.

Normally, from such a section, one simply cuts out a vertical monolith, in sections. Because of the cutting into horizontal sections, the peat either side of the cut can be contaminated with material of different date, and needs careful trimming in the laboratory. Effectively at least a centimetre of peat can be lost in this way, thus losing a potentially valuable sample in a detailed study, so it was necessary to think of an alternative method.

Two vertical sections were taken, adjacent to each other, but with the horizontal cuts in different places, the effect being rather like two rows of bricks. A horizontal line of coloured pins was made across both sections, so there was an equivalent level marked on both blocks. When taking samples in the laboratory and approaching the end of a block, one could transfer to the other block at this level, and collect contiguous samples. It is just possible that there could be some horizontal variation in stratigraphy or pollen content between the blocks, but this risk was considered minor compared with that of losing or contaminating samples.

Below the water level, cores were collected by "multiple-shot" boring with the Russian borer. Four cores were taken, close together and at the same depth.

In the laboratory the peat blocks were carefully trimmed, then cut into 1 cm. slices. The cores were treated similarly, amalgamating equivalent layers in the different cores. A pollen sample was taken from each slice, then the rest was stored at 4^{o}C to minimise fungal and bacterial growth in case it was required for radiocarbon dating.

LABORATORY TECHNIQUES

Samples for pollen analysis were given the standard sodium hydroxide and Erdtman's acetolysis treatments before being mounted in glycerine jelly stained with safranin. Those from the clay and transitional clay/peat layers were also treated with hydrofluoric and hydrochloric acids to remove inorganic material. Macroscopic plant remains were sieved out during the process and examined with a stereoscopic microscope.

Normally, 500 pollen grains (excluding spores) per sample were counted ($\Sigma P = 500$), the results expressed as a percentage of the total tree pollen (A.P.). The rest of the slide was scanned and if grains of any taxa not included in the original count were seen, they were recorded as being present ("+" on the diagram).

The only exception was if the tree pollen was extremely low, when, after the initial count of 500 grains, the rest of the slide was scanned, recording tree grains to give more accurate proportions of the individual trees.

Levels for dating were dried at 100°C then dated, using the radiocarbon method, at the Scottish Reactor Centre, East Kilbride.

RESULTS

The pollen diagram is shown in Figs. IV-VIII . The curve of each species represents the number of grains counted at each level, expressed as a percentage of the total tree pollen (AP) at that level. The curves therefore show the relative frequency of pollen types throughout the period of the diagram.

In the percentage composition of total grains counted, the very local bog and aquatic species were included as a separate category because they would distort the conventional tree/shrub/herb divisions if included as herbaceous species.

The pastoral/arable index follows an idea in Godwin (1968), though the species involved have been altered somewhat. The percentage of those species often associated with a pastoral land use is compared with that of species often occurring ~~as~~ on arable land. It must be stressed that this index is not infallible, as the species involved are not always connected with one form of land use only. Differential pollen productivity and distance from the bog are also involved. It should be interpreted as a general impression of land use in the area rather than a statistical measurement. The taxa involved are:-

Pastoral	Arable
Plantago lanceolata	Cereals
Rumex acetosa/acetosella	Compositae
Ranunculus spp.	Cruciferae
Bellis type (probably *Bellis perennis*)	*Polygonum* spp.
	Trifolium

The index is only included when these species occur in such quantities to suggest their association with agriculture.

The radiocarbon dates are shown in Table 1.

INTERPRETATION OF THE POLLEN DIAGRAM

General

Throughout the diagram, the unknown factor is the area represented by the pollen spectrum at different levels.

Tauber (1965) divides the pollen being deposited onto a bog or lake surface in forested areas into three components; that travelling via the trunk space of the forest, that travelling above the canopy, and that which is brought down from higher levels by rain. The significance is that trunk-space pollen will be local in origin, whereas that from the canopy and rainout components will be from a wider area. He estimates that the pollen falling onto a bog 100-200 metres in diameter, surrounded by forest, would consist of about 80% trunk-space component. Horizontal drift near ground level would continue in the lee of the forest and it is unlikely that significant downward mixing of air from higher levels would occur in such a short distance. He estimates the effective source area for pollen as being about 300-1000 metres from the basin, depending on the species involved and filtration by vegetation.

Hallowell Moss is about 200 metres in diameter and during forested periods, i.e. phases a-d of the diagram, when it was surrounded by forest and often wooded itself, it is likely that most of the pollen originated within a kilometre of the basin and that this is largely the area represented by the pollen spectrum.

As soon as extensive forest clearance takes place however, Tauber's model cannot be applied. However, as the horizontal transport of pollen is less impeded and there is more opportunity for mixture with air from higher levels, the pollen deposited is probably more "regional" in origin, though it is not possible to estimate the proportions of different components or the effective source area without more knowledge of past landscapes, wind direction, etc. Being more exposed to the west and north-west and the present prevailing wind being from the south-west (Smith, 1970), the bog may be expected to have had a source area spreading more in a westerly direction, but conditions may have been different in the past.

The pollen spectrum does not directly represent the frequency of the taxa in the surrounding vegetation. Variations in the size of area represented and differential pollen productivity were taken into account when interpreting the diagram.

From the pollen diagram, seven phases in the vegetational history of the area were distinguished. The terms pollen zone and pollen assemblage zone are deliberately not used. Although the diagram must contain at least part of Godwin's standard zones VIIb and VIII, it was considered both impossible and rather meaningless to draw the division between them, based on forest composition, during a period of human interference. Neither is the term assemblage zone used, which conveys rather static conditions. Instead the diagram is divided into "phases", during which changes may be occurring but the type of interference, if any, with the natural vegetation is of a constant type. An attempt is made to equate the vegetational phases with archaeological and historical evidence, to build up an impression of former landscapes and environments.

Divisions of the pollen diagram

309-284 cm (Clay and clay/peat transition).

These deposits, with high pine and birch pollen, yet considerable amounts of alder, plus pollen of aquatic species are difficult to assign to a standard pollen zone.

The clay element must have been transported laterally before deposition, as it has been well sorted. Pollen grains reworked from earlier sediments could have been brought in and deposited with the clay. This "inwash" component would affect the proportions of the different species in a pollen count, and for this reason the deposits containing clay are thought not to represent the vegetation of the time.

Phase HMa (283-246 cm).

As soon as the element of horizontal sediment transport ceases, one passes into an autochthonous, highly humified wood peat in which the pollen represents contemporary vegetation.

The formation of peat requires a rising water table. The macroscopic remains and pollen spectrum indicate that this was a forested area with forest debris being preserved under the influence of a slowly-rising water table. The rate of peat growth averages about 1 cm per 46 years. Trees still grew in the hollow, keeping pace with the slowly rising peat surface.

A higher water table occurs when rainfall exceeds loss by evaporation and drainage. The cause can be either climatic or because of impeded drainage. From the radiocarbon date of 4938 ± 60 radiocarbon years BP and the pollen spectrum with very low elm and no *Fagus* or *Carpinus*, it was concluded that peat formation began in the Sub-Boreal (zone VIIb), a period normally considered to be rather dry. Peat formation is more widespread in the preceding, Atlantic or later, Sub-Atlantic, wetter periods. It is more likely therefore that peat started to form because of a back-up of drainage.

The pollen spectrum shows that during this phase, both the hollow and the surrounding slopes must have been densely forested. Tree pollen is over 80% of the total pollen during this period. The spectrum is interpreted as representing an alder-birch wood growing in the hollow, with mixed oak forest, including lime, on the surrounding slopes. The percentage of hazel, a light-demanding shrub, is rather low so the forest must have been quite dense. The ground flora is probably represented by the pollen or spores of Anemone, Filipendula, Polypodium, Ranunculus (possibly celandine), Succisa and Lonicera.

Elm forms a very small constituent of the forest. If one accepts the anthropogenic explanation of the elm decline (Troels Smith, 1960), it means that man has already left his mark on the forest by feeding elm shoots to his cattle during Neolithic times, and the elm population never recovered. So even at this early stage the forest is not entirely "natural", though it is probably not being interfered with at the time.

Phase HMb (245-156 cm)

This phase begins within the wood peat but there is a gradual change to Eriophorum peat. Raised bog species increase as at least some parts of the peat surface become dependent on rain, rather than ground water. It would appear that much of the woodland on the site of the present bog was overcome by a faster rate of peat growth (averaging about

1 cm per 13 years) and Eriophorum became dominant.

At the beginning of this phase, however, there is a very slight, but permanent rise in grass pollen, plus the appearance in small amounts of species often associated with more open areas or forest clearance, like Plantago lanceolata and Pteridium. It might be argued that this simply represents the spread of more open habitat plants onto the bog surface, were it not for a considerable increase in the proportion of shrubs to trees at the same level. Hazel (Corylus) increases and holly (Ilex) and ivy (Hedera) appear for the first time. These are not colonisers of bogs, but species of clearings in woodland. The early relative increase and consistently fairly high levels of birch and the later appearance of ash (Fraxinus), both light-demanding trees, could also be significant. It would appear that some opening-out of the forest canopy has occurred.

Also at this level, lime (Tilia), which has been a consistent member of the forest community, probably under-represented because of its low pollen productivity, virtually disappears from the area after a short lag.

This slight opening-out of the forest canopy is interpreted as the result of grazing pressure, affecting the regeneration of trees. The increase in herbaceous and shrub pollen is sudden and permanent at a time when there is no evidence for widespread climatic change. The virtual disappearance of _Tilia_, which is very slow to regenerate, is often connected with human interference (Turner, 1962).

No pollen of cereals was found and it is suggested that the forest was used for grazing cattle on young shoots and herbaceous plants, and the coppicing and harvesting of the hazel scrub. The radiocarbon date (1695 BC ± 60) suggests an Early Bronze Age beginning to this period and indeed a few hand axes of this date have been found in the region, together with a burial cyst near West Brandon (see Map II), indicating at least temporary occupation of the region.

This way of life seems to have continued throughout HMb. Many minor variations in the pollen spectrum could be explained by the distance of grazing areas from the bog. The net effect was to alter the forest of HMa, but some form of "steady-state" conditions seems to have been achieved by the end of the period.

Phase HMc (155-150 cm)

During this short stage grass pollen rises to about 10% AP and herbs often connected with forest clearance rise proportionately. This is interpreted as a "landnam" type clearance, small scale and temporary, after which the woodland regenerates to roughly its original state.

The proportion of birch pollen falls suddenly at the beginning of this phase, and it is suggested that the clearance took place actually on or near the bog, where birch would be growing. It is possible that the episode is simply an intensification of grazing pressure near the place where vegetational changes were being recorded, but the hazel count is not particularly high, so perhaps this area was actually cleared of trees and for a while was a grassy clearing rather than open scrubby woodland.

This type of clearance during later Bronze Age times fits in with the generally accepted view of a semi-nomadic population making temporary clearances in the forest for timber, bark and fodder, and an area on which to graze wild or domesticated animals. There is no evidence for the cultivation of cereals however, in contrast to similar clearances in the lowlands of Somerset (Dewar and Godwin, 1963) and Cumberland (Walker, 1966).

Phase HMd (149-91 cm)

After the landnam phase, the forest regenerates and is very similar in composition to that of HMb, except that ash (*Fraxinus*) is now a permanent member of the forest community. Birch trees returned to the bog surface, as indicated by the wood preserved in the *Eriophorum* peat of this stage. Peat growth in HMd averages about 1 cm per 7 years.

Grasses and clearance indicators are still present at low percentages. Whether temporary clearances are being made constantly in the region and allowed to regenerate or whether the secondary community is being stabilised by grazing pressure over a larger area based on more stable settlement, is difficult to determine from pollen evidence.

The Iron Age farmstead at West Brandon (Jobey, 1962) which predates the Romano-British period, probably indicates a more settled form of agriculture during this period, though seems to have had little effect on the environment.

There is still no evidence of cereal cultivation and indeed the whole of northern Britain, with its pastoral emphasis, contrasts with the area south and east of the Jurassic ridge, where the "Woodbury-type" economy of the Iron Age is based on intensive corn growing (Piggott 1961). The amount of forest clearance was often much greater in the south (Turner, 1970).

Towards the end of the period, grass and *Plantago lanceolata* curves rise slightly and there are more clearance indicators present.

Phase HMe (90-73 cm)

This is a phase of extensive forest clearance. Because trees have been removed and lateral transport of pollen facilitated, it is likely that the pollen spectrum represents a larger area than previously.

Trees are reduced to a minimum of under 5% of the total pollen. Early on birch, and later, oak are the trees which seem to suffer most, while the proportion of alder and willow increases. Perhaps the wetter areas were left uncleared.

The proportion of shrubs to trees remains about the same as in Phase HMd. This probably means that the newly-cleared areas were efficiently managed and the growth of scrub prevented.

Grasses, after the initial increase, rise fairly steadily to a maximum of 512% of the tree pollen, at 72 cm, before falling dramatically to about 40% in the next phase. The pollen of clearance and agricultural indicators form curves roughly parallel to that of grass. Bracken (*Pteridium aquilinum*) is an exception and forms an earlier peak, being an early coloniser of more open woodland and woodland margins rather than of completely cleared areas. Land use seems to have been largely pastoral throughout, with high grass and plantain percentages and buttercups, daisies and sorrel in abundance. Cereals make their first appearance, together with "arable" weeds at such concentrations to suggest their association with cultivation. There is also a general increase in species of more open habitat as woodland disappears. One gets the impression of a landscape probably as open as that of today, with large areas devoted to pasture and meadow for cattle or sheep, plus a limited acreage of cereals.

The radiocarbon dates show the phase to be Romano-British in age. The beginning date of AD 40-90 (see Table 1), could easily coincide with the arrival of the Romans, reflected in the building of Dere Street and the forts of Piercebridge, Binchester, Ebchester and Corbridge under Agricola (AD 78-84/5). Very little is known about the countryside and civilian population of this period (Dobson, 1970), but recently several sites of farmsteads, probably of the Romano-British period, have been spotted on aerial photographs of this region (B. K. Roberts, pers. commun.) (see Map III). Two of these, at Lodge Hill, are within 1½ miles of Hallowell Moss. This scattered rural settlement is in keeping with a predominantly pastoral land use, and it could be that the area supplied the surrounding Roman forts as well as the rural population. The building of Lanchester fort (Longovicium) in about AD 140 after the evacuation of Binchester, would ensure the continuing importance of the area. Unfortunately, little is known of the extent of "influence" of Lanchester.

Two sites in Weardale have similar clearance phases about this time (Roberts *et al*., 1972). At Steward Shield, the uncorrected date for the beginning of the phase is

110 BC ± 100 years and that at Bollihope AD 220 ± 100 years. Associated with the Bollihope site are the remains of huts and enclosures almost certainly Romano-British in date. So one gets an impression of considerable, organised forest clearance in at least some areas of the Pennine foothills and dales.

If one examines the clearance phase at Hallowell Moss in more detail, it is apparent that the maximum extent of clearance is towards the end of the phase. If the phase ends about AD 600, it seems that there is a period of comparative prosperity continuing through and after the official withdrawal of the Romans in AD 410.

Prosperity and military strength during this period of native British kingdoms is indicated by the fact that the Anglo-Saxons did not achieve supremacy in northern England until the very end of the sixth century. It has been suggested (Hunter Blair, 1956) that there was a renaissance of British military strength in the north after the overthrow of Hadrian's Wall by the Picts and Scots in AD 367, and Bede also mentions a period of great material prosperity after the separation from Rome (Bede, 732).

<u>Phase HMf</u> (72-15 cm)

Phase HMe seems to come to a fairly abrupt end and there is considerable regeneration of woodland. The radiocarbon dates suggest that this phase covers the Anglo-Saxon and at least some of the Mediaeval period, and it is tempting to connect the ending of Phase e with the arrival of the Anglo-Saxons in the late sixth-century.

Recent opinion has tended towards a relatively peaceful "take-over" of the north by the Anglo-Saxons, and continuity of occupation of settlements (Cramp, 1970). At least in the Hallowell Moss area it appears that something more drastic happened. Agricultural land seems to have been abandoned rather suddenly and the Romano-British farmsteads seen from the air seem entirely unconnected with later farms or villages, though some may have been obliterated.

The only tentative evidence for a large military battle with the Saxons comes from a Welsh elegaic poem, Gododdin, probably originating in the sixth-century. It laments the loss of many Welshmen in a battle at a place called Catroeth, thought to be Catterick (in Hunter Blair, 1956, and Cramp, 1970). Certainly something happened to the native communities near Hallowell Moss to cause economic decay.

The area seems to have been rather a "backwater" in Anglo-Saxon and Mediaeval times. Probably more intensive farming was practised in the more amenable eastern lowlands. Looking at the Boldon Book, a survey made in 1183, one can already subdivide central County Durham into two distinct areas (Roberts, 1970). East of the Wear was, and still is, a "land of villages", each with its own field system, while west of the Wear there were very few villages founded by this time and much more moorland showing the relative unimportance of the area.

Conditions seem to have been fairly constant during this phase, with much more woodland than the previous phase. Birch and hazel percentages are high throughout. These are both light-demanding species and would be the first to invade cleared land after its abandonment, but to explain their consistently high levels, it is suggested that a fairly open woodland was maintained artificially, probably by grazing pressure and the coppicing and harvesting of hazel.

There was probably also some permanently cleared land in the area, with grass and pasture species being present at a constant level, though not on the scale of phase e. A few pollen grains of cereals were found in the latter half of the phase. There is evidence for some arable land at Witton Gilbert in 1183, when the Boldon Book mentions the villeins ploughing, mowing meadows and reaping corn, while at Lanchester it refers to meadows, cow pastures and the pannage of swine. Apart from Lanchester, many of the pre-nineteenth century settlements like Witton Gilbert, Brandon, Esh, Langley and Hamsteels, have names deriving from Old

English (Ekwall, 1960) and were probably founded during this vegetational phase.

It is interesting that the environmental conditions seem rather similar throughout the Anglo-Saxon and Mediaeval periods. The Middle Ages are often thought of as a time of penetration of settlement and farmland into the forest and general economic improvement. Perhaps the "harrowing of the North" by William the Conqueror and the later Scottish raids tended to minimise expansion into the more remote, undefended areas.

Hallowell Moss was, in fact, part of the Mediaeval Beaurepaire (Fr. "beautiful retreat"), later corrupted to Bear Park, a country retreat for the Prior and monks of Durham. In 1242 the Bishop granted the Prior a plot bounded by the bank by Ivesmoss (Hallowell Moss), a thicket at Holdene, and the high road between Lanchester and Durham (Feodarium Prioratus Dunelmensis, 1873). The area was later enlarged and emparked. Game and stock were kept within the park, as on several occasions they were driven out by the Scots, and once by Bishop Bek after a dispute with the Prior. The name Swynehurst, of a wood felled in 1356-7, suggests that pigs were also kept at the same time. In the thirteenth century the park was described as containing woods, meadows and arable land (Durham Dean and Chapter Muniments). The importance of woodland seems to have been realised, for although some areas were felled for timber, the Prior ordered the sowing of acorns in the park in 1430. The woodland resources were jealously guarded, for the keeper of Beaurepaire once stabbed a man suspected of stealing hazelnuts from the park and was given a free pardon by the Bishop (in Surtees, 1820).

So the impression of Mediaeval times from the pollen diagram, of managed woodland with some meadows or pastures and arable land, is in keeping with historical evidence.

Phase HMq (14-0 cm)

Figs.VII-VIII show this phase in more detail than the large pollen diagram.

This phase is one of permanent clearance of extensive areas of woodland and although there is evidence of the re-planting of trees in the latter stages, there has probably been no regeneration of cleared areas through natural succession. No radiocarbon dates were obtained for this period as it was considered that modern rootlets etc. could contaminate samples, so the interpretation of this part of the diagram on a historical scale can only be conjectural.

The lower boundary is drawn where the tree pollen drops and the percentage of herbs becomes the greater. Shrubs are drastically reduced and it is plain that a change in land use has occurred, probably from woodland management with small-scale farming to the more extensive farming of cleared land.

Trees fall to a minimum of about 3% total pollen at 12 cm, while herb pollen increases towards this depth. It is suggested that these few centimetres represent the sixteenth and seventeenth centuries, a time when there was a great drain on timber resources for bridges and ships. One thousand, four hundred oak trees were felled at Brancepeth in 1634-6 to build the first three-decker ship (Cox and Forbes, 1907). Coal mining was also beginning in the Wear valley (James, 1970), with the concurrent demand for meat and grain from the early mining communities. This was a period, especially in the seventeenth century, of great improvements in agricultural practices and the first wave of land enclosure by private agreements, with or without Chancery Decree, was in progress (Hodgson, 1970). The concentration on a pastoral economy was probably a realistic appraisal of land potential and markets, while much grain was being imported from the rest of the country. Bear Park was probably split up into separate farms during this period as there are references to subletting to several tenants by 1636 in the Deanery leases.

After 12 cm the tree curve rises slightly and is thought to represent eighteenth and nineteenth century plantations. Pine probably did not grow naturally in this area during the period of the pollen diagram and in earlier phases the percentage probably represents a regional, "background" level which might be expected to rise proportionately in periods of extensive clearance. Here however, it does so on a much larger scale than in the previous clearance, so is taken to represent planting. Elm, ash and sycamore, which also increase proportionately, are trees which are often planted as windbreaks. Early eighteenth century plantations were usually deciduous and on private estates whereas, after the Enclosure Acts of the latter half of the century, considerable areas were planted with coniferous trees.

By looking at the Enclosure, Tithe and early Ordinance Survey maps of the area, one can determine the approximate age of many plantations. Many of those on former common land had been planted by about 1840 and often enlarged by 1857, whereas those on the older estates were often established before this time, the exception being the coniferous plantations on the Earl of Durham's estate near Langley, which were probably planted sometime between 1843 and 1857. Use of timber in the nineteenth century was mainly for pit props and mining equipment.

During the blockade of the Napoleonic Wars which caused high grain prices, vast areas of upland County Durham were ploughed up for arable farming. The sudden dip in the pastoral/arable index around 10 cm is thought to be of this date. In about 1840, the local Tithe maps and Davidson's Survey of the farms of Bear Park still show approximately equal acreages of grass and arable land. The general decline in indicator species and the pastoral emphasis after this dip in the curve could represent the period of agricultural depression which followed (see Fig. IX).

Approaching 6 cm, the tree percentage again falls extremely low, and could represent the great demand for timber in the first World War, 1914-18. The increase in all agricultural indicators around this time could represent the increased acreage common during times of economic blockade, though agricultural statistics were not available for the war years.

The large increase in tree pollen after this level surely represents replanting and the large-scale plantations of the Forestry Commission, set up in 1919 to restore timber resources and to make marginal agricultural land more profitable. The apparent trend towards more mixed farming, with an increase of arable indicators fits in with agricultural statistics (Fig. IX) and present-day land use maps of the area, which show approximately equal areas of grass and arable land.

Looking at the bog itself during this phase, it would seem that a slight drying out of the bog surface occurred with Sphagnum levels falling and Calluna, then Eriophorum taking over as the dominant bog species represented. The disappearance of Sphagnum may also have been influenced by atmospheric pollution. However, in the very top few centimetres the Eriophorum level falls off and there may be a slight recovery of Sphagnum. By studying old Ordinance Survey maps of the bog, one can see an increasing area of marsh symbols around the dome of the bog, probably due to mining subsidence, but this could raise the water table sufficiently to ensure continuing peat development up to the present day.

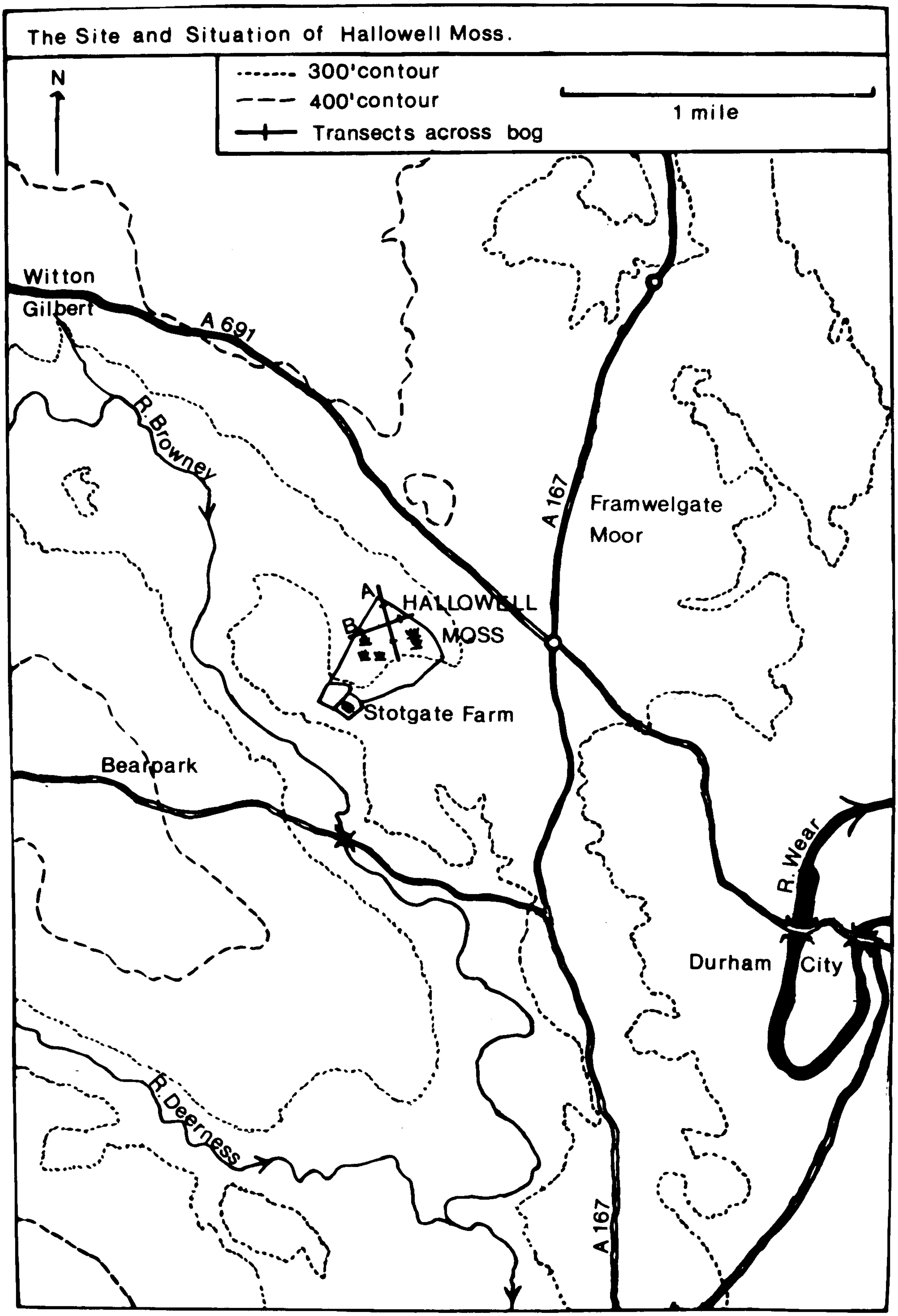
CONCLUSIONS

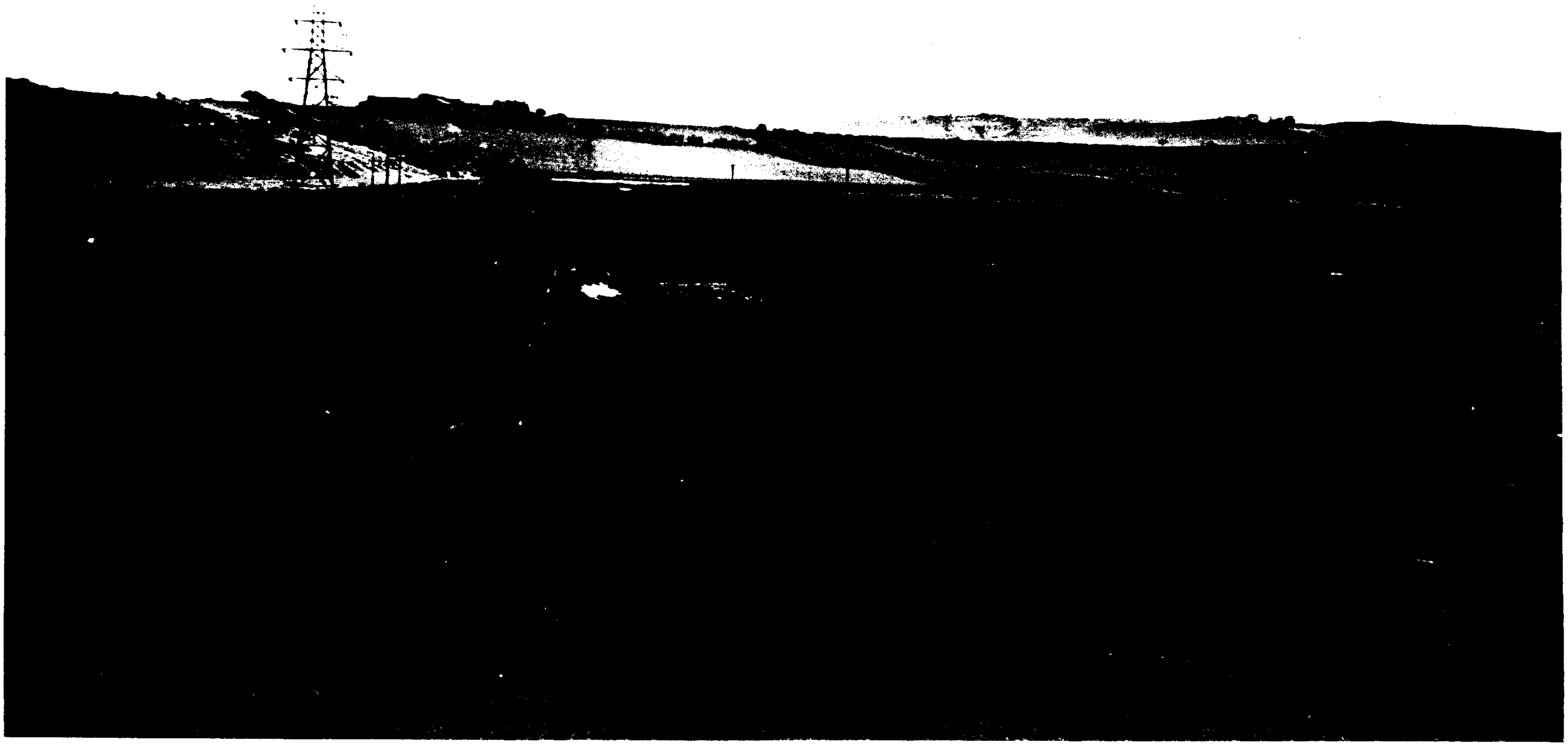
Not until Romano-British times did man have a great effect on the forest of this area. Clearance at this time was of a scale unparalleled until relatively recently and indicates extensive, organised clearance and agriculture in a region often described as a marginal, frontier zone of the Roman Empire.

The later regeneration of trees to be held in a balanced state by woodland management with some grassland and a little arable land, is an impression gained from both the pollen diagram and documentary sources.

The area was not used extensively for agriculture until relatively recently, at the same time as large areas of land were being enclosed, first privately then by Act of Parliament. Land use since the removal of much of the Mediaeval woodland and the later afforestation reflect both appraisal of the land's potential and changes in demand.

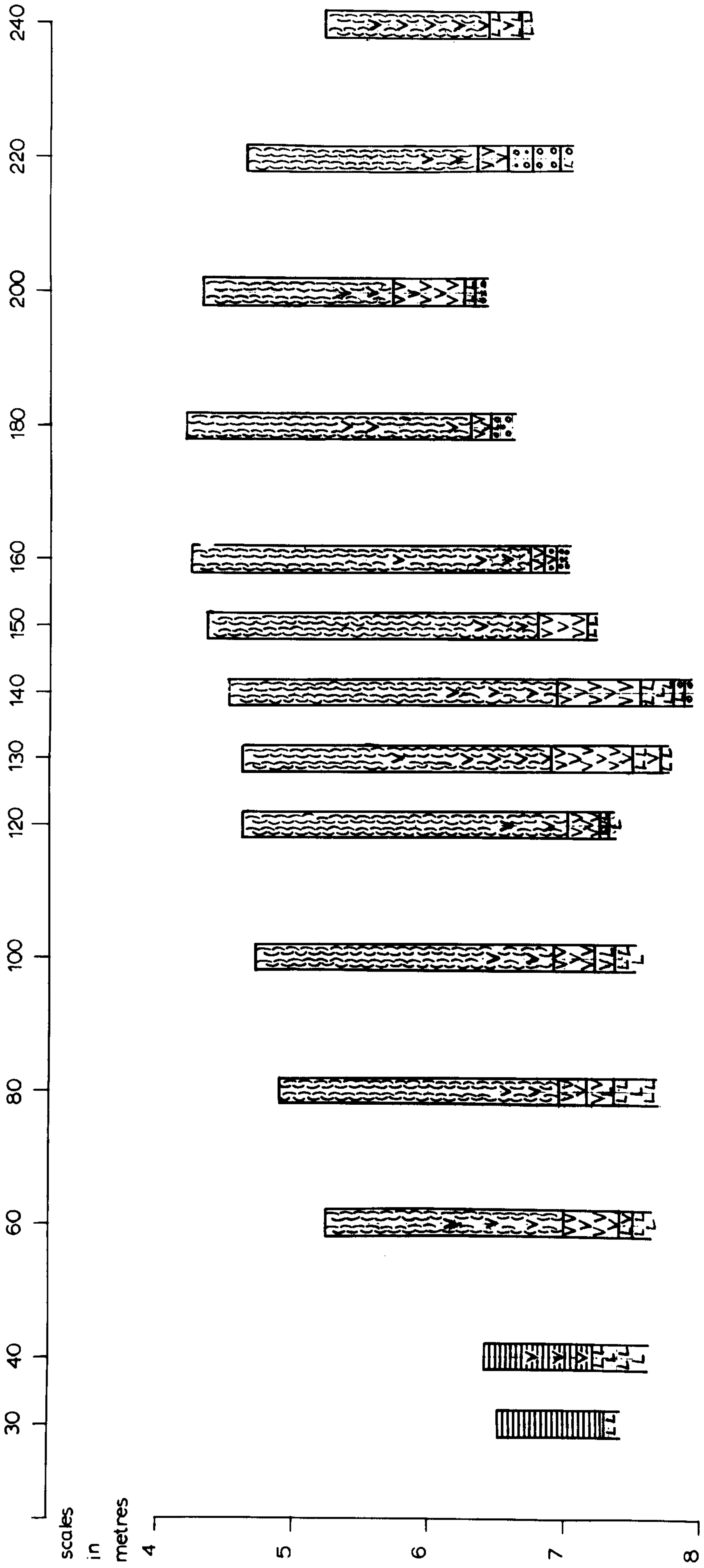
MAP I.


The Site and Situation of Hallowell Moss.
300'contour
400'contour
Transects across bog
1 mile
N
Witton
Gilbert
A 691
R.Browney
A
B
HALLOWELL
MOSS
Stotgate Farm
A 167
Framwelgate
Moor
Bearpark
R.Wear
Durham
City
R.Deerness
A 167



Hallowell Moss from the northeast.

FIG. I.



HALLOWELL MOSS.
Stratigraphy along Transect A.

FIG. II.

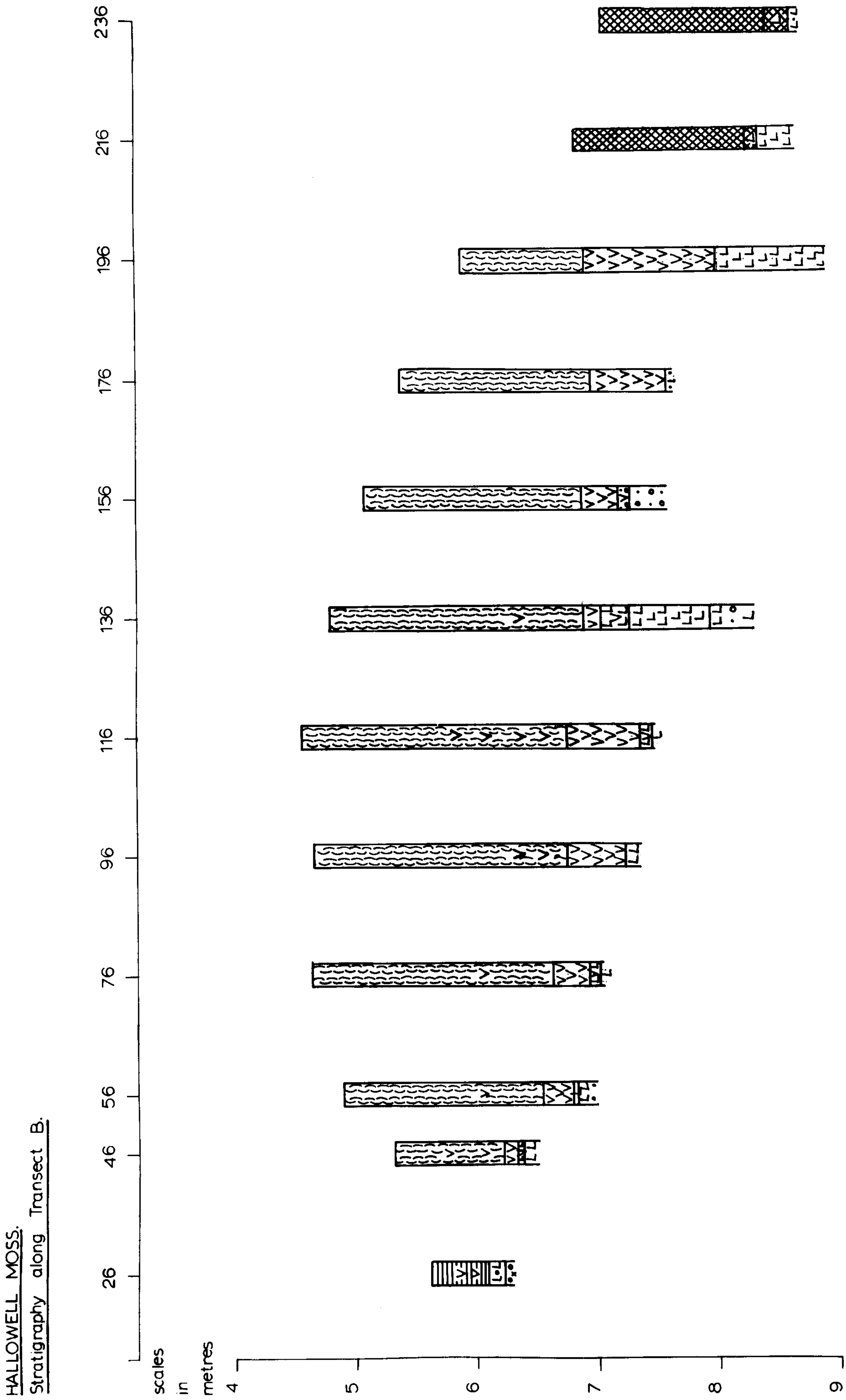

HALLOWELL MOSS.
Stratigraphy along Transect B.
26
46
56
76
96
116
136
156
176
196
216
236
scales
in
metres
4
5
6
7
8
9

FIG. III.

Key to Stratigraphic Symbols.

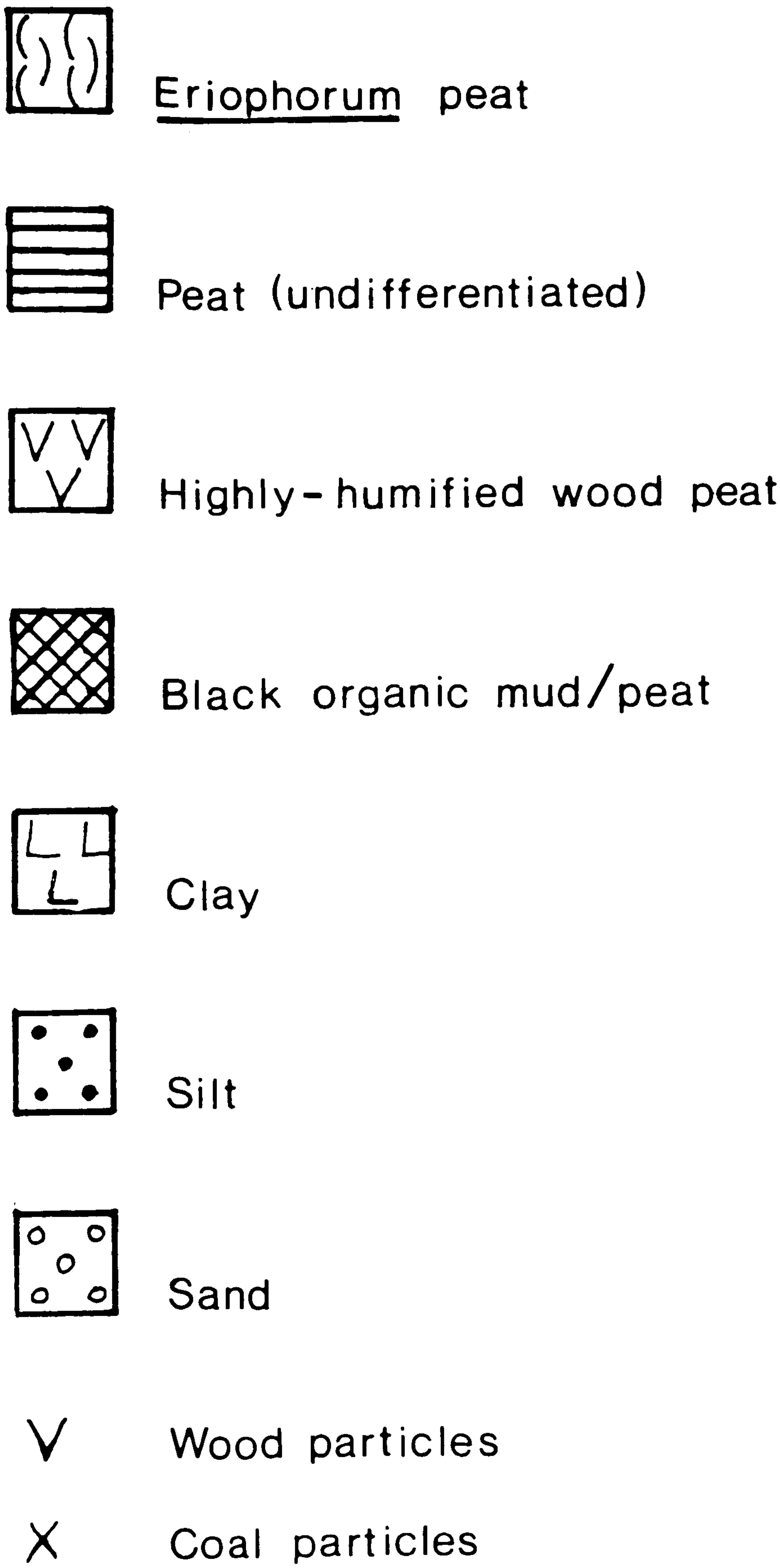


TABLE 1.

Radiocarbon Dates

The dates on the pollen diagrams are conventional radiocarbon dates, for easy comparison with other diagrams. However, for rates of peat accumulation and relationships to historic events, the dates have been corrected to actual calendar years, taking into account variations in atmospheric C^{14}, using the calibration curve in Suess (1970). The range in all dates if that of one standard deviation.

Ref. No.	Depth	Conventional radiocarbon date	Corrected date
SRR-411	50 cm	AD 1043 ± 55	AD 1030-1200
SRR-412	71 cm	AD 428 ± 65	AD 580- 600
SRR-413	73 cm	AD 595 ± 50	AD 630- 670
SRR-414	80 cm	AD 168 ± 60	AD 120- 260
SRR-415	90 cm	6 BC ± 70	AD 40- 90
SRR-416	133 cm	282 BC ± 80	200-440 BC
SRR-417	153 cm	482 BC ± 60	480-600 BC
SRR-418	243-5 cm	1695 BC ± 60	2080-2120 BC
SRR-419	279-81 cm	2988 BC ± 60	3670-3740 BC

FIG. IV.

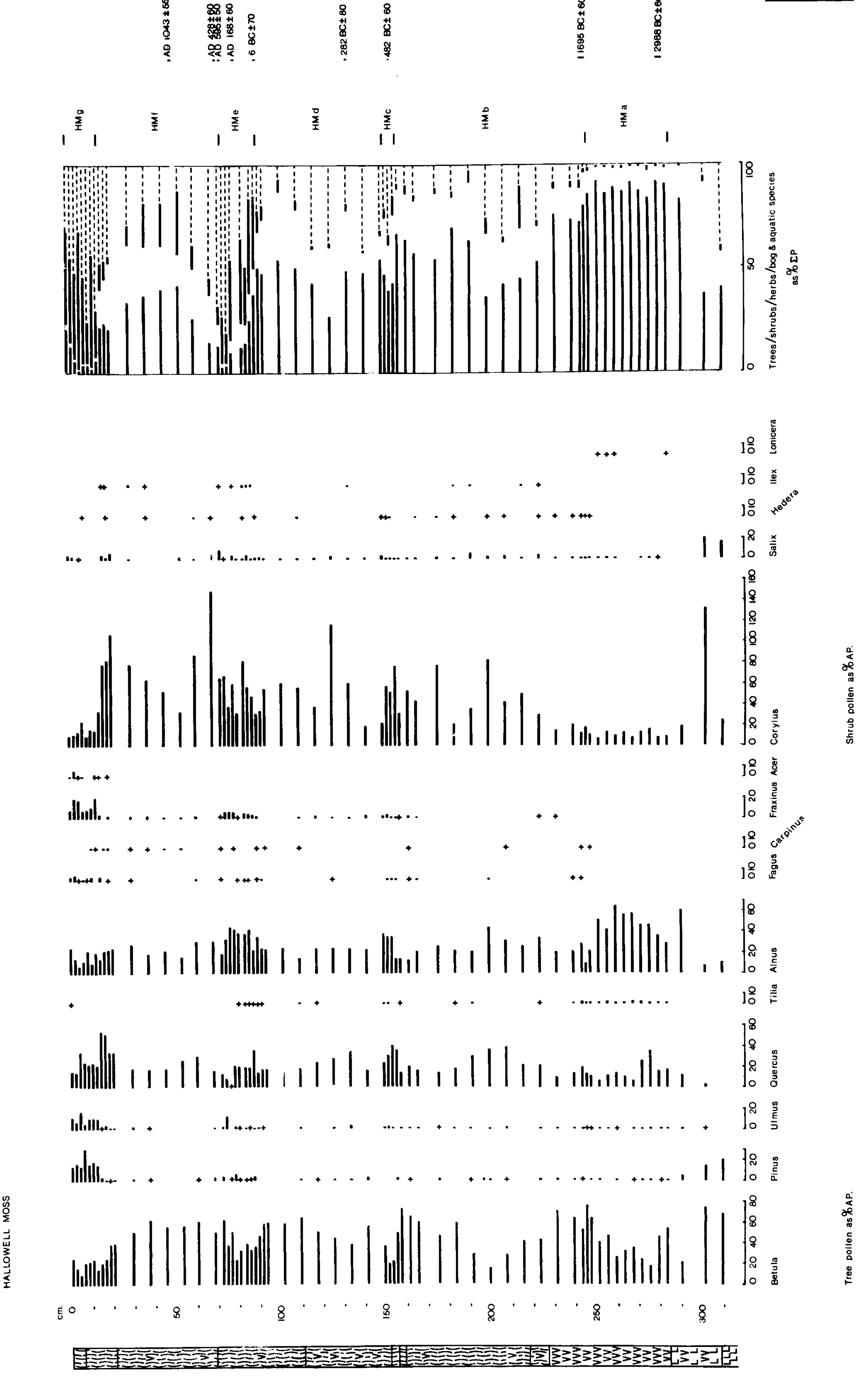

HALLOWELL MOSS
cm.
Betula
Pinus
Ulmus
Quercus
Tilia
Alnus
Fagus
Carpinus
Fraxinus
Acer
Corylus
Salix
Hedera
Ilex
Lonicera
Tree pollen as % AP.
Shrub pollen as % AP.
Trees/shrubs/herbs/bog & aquatic species as % ΣP
HMg
HMf
HMe
HMd
HMc
HMb
HMa
AD 1043 ± 55
AD 428 ± 60
AD 395 ± 50
AD 168 ± 60
6 BC ± 70
282 BC ± 80
482 BC ± 60
1695 BC ± 60
2988 BC ± 60

FIG. V.

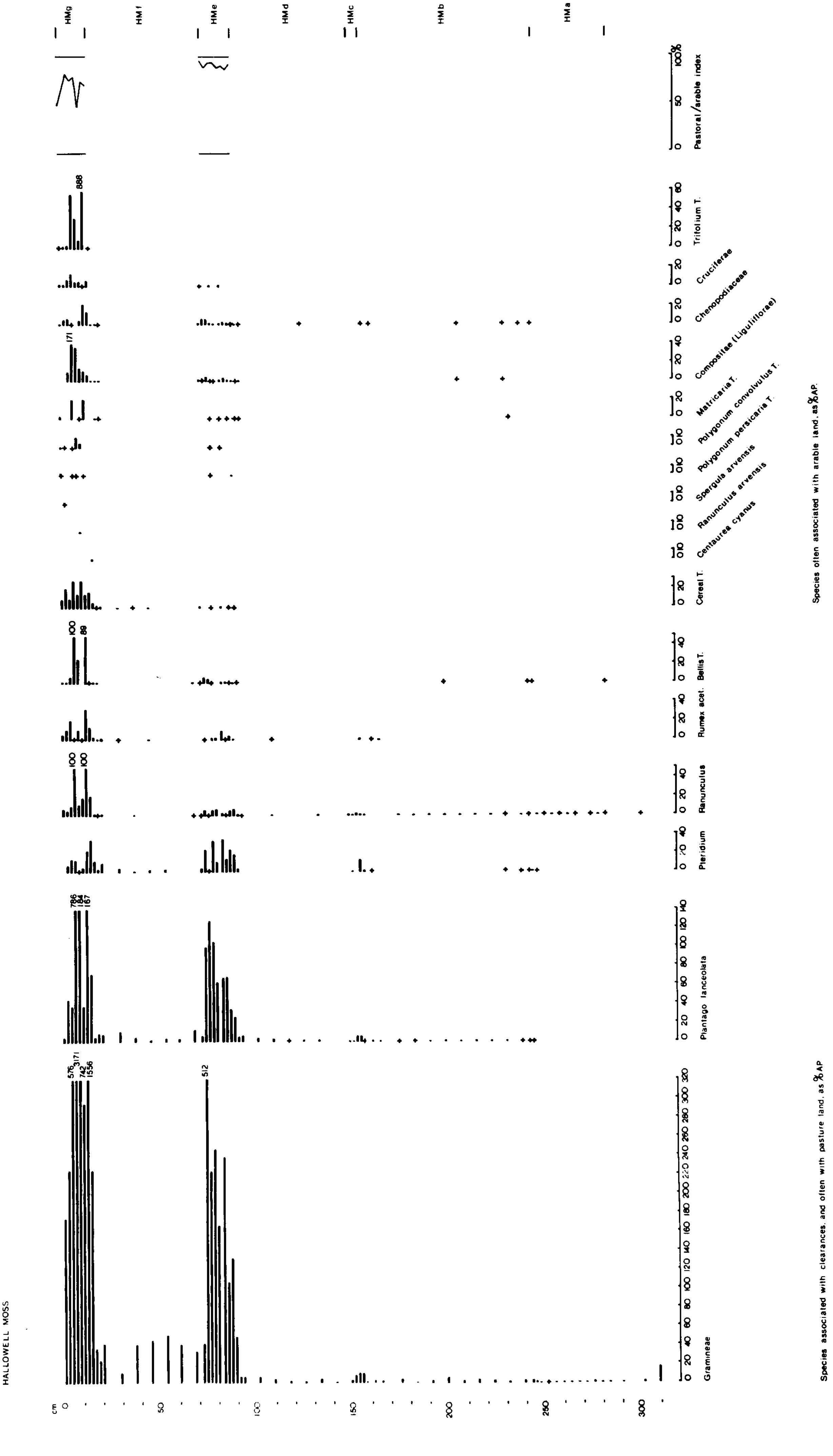
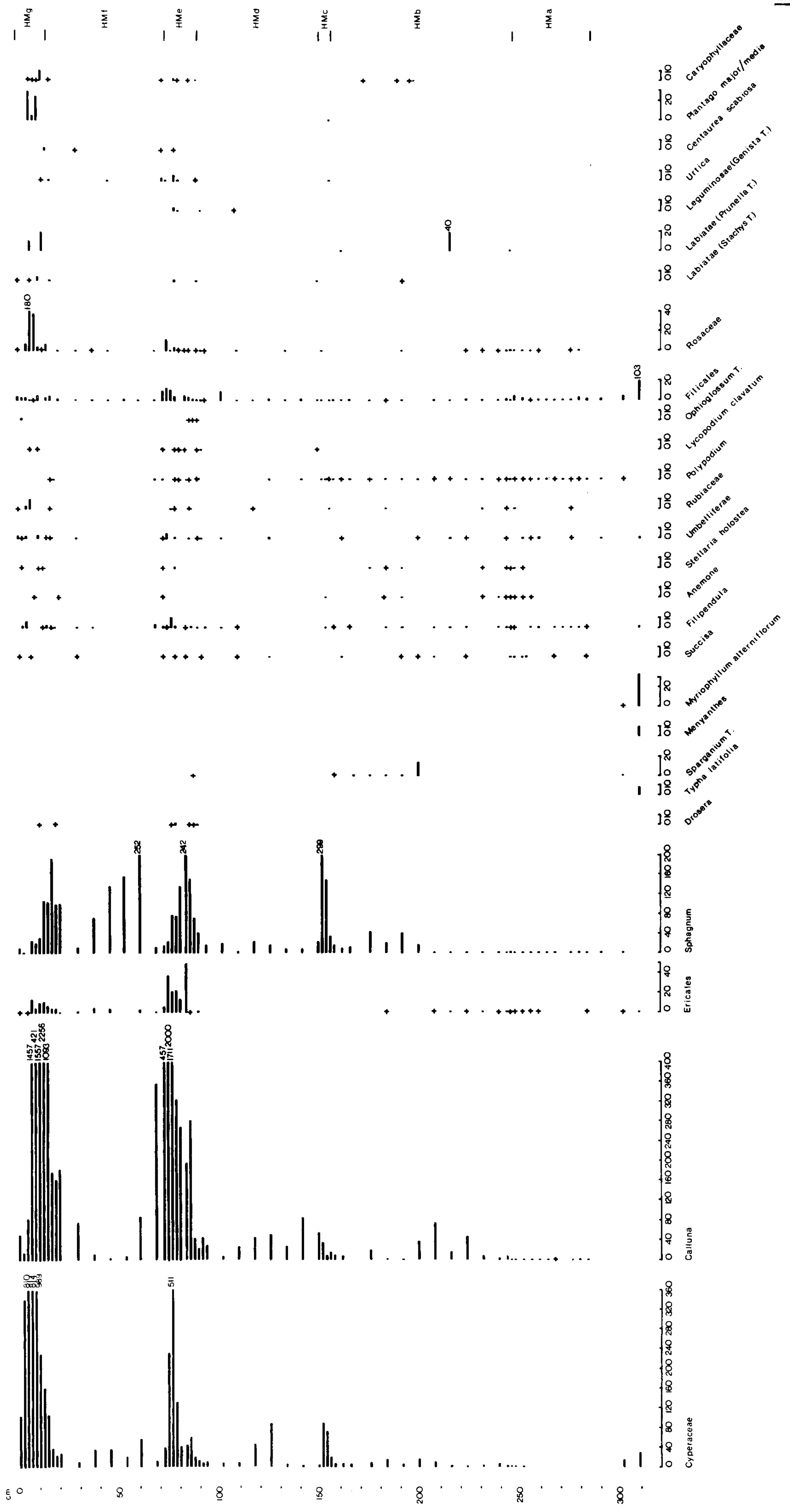

HALLOWELL MOSS
HMg
HMf
HMe
HMd
HMc
HMb
HMa
cm
Gramineae
Plantago lanceolata
Pteridium
Ranunculus
Rumex acet.
Bellis T.
Cereal T.
Centaurea cyanus
Ranunculus arvensis
Spergula arvensis
Polygonum persicaria T.
Polygonum convolvulus T.
Matricaria T.
Compositae (Liguliflorae)
Chenopodiaceae
Cruciferae
Trifolium T.
Pastoral/arable index
Species associated with clearances, and often with pasture land, as %AP
Species often associated with arable land, as %AP

FIG. VI.

HALLOWELL MOSS



Bog, aquatic, and some herbaceous species, as % A.P.

FIG. VII.

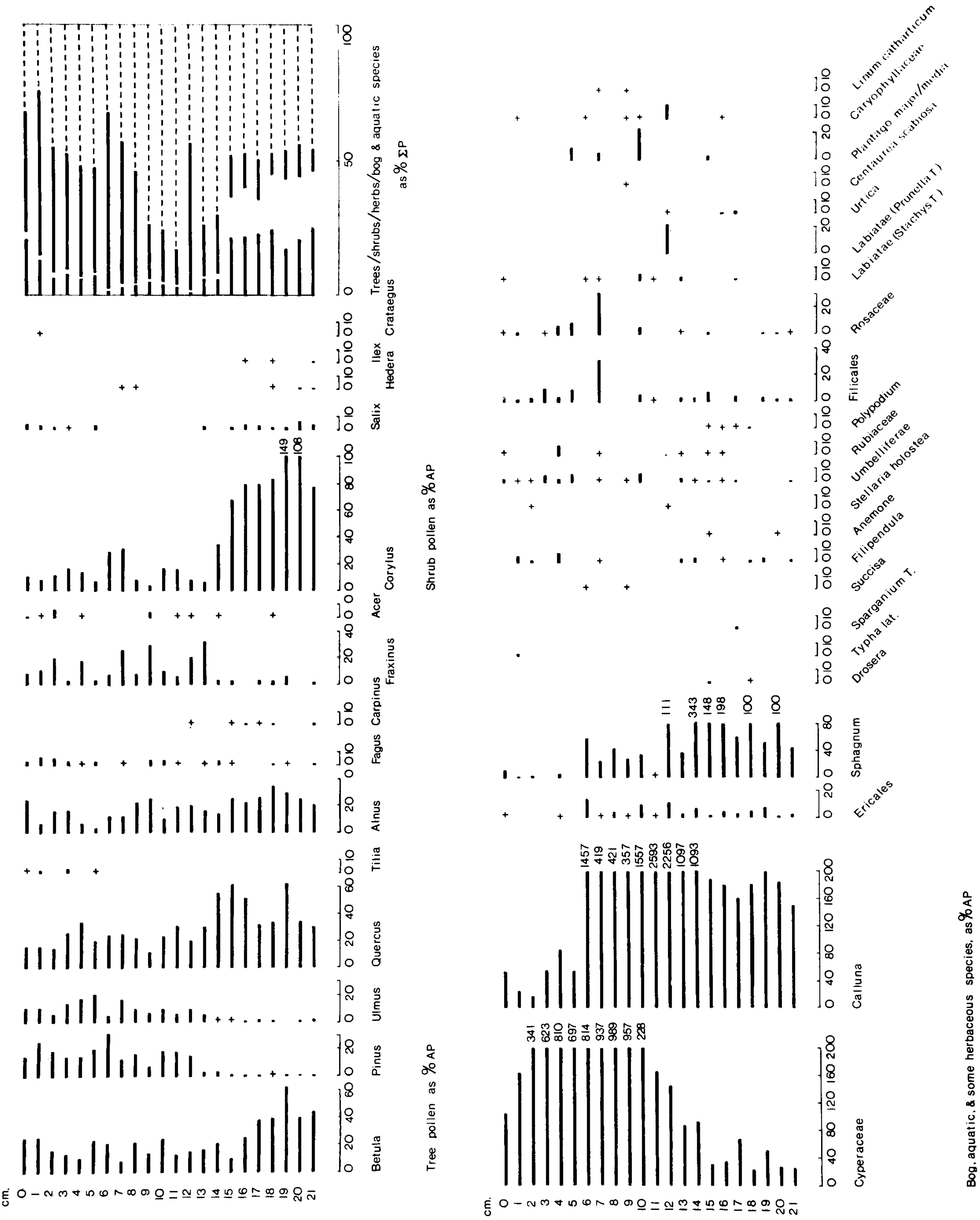
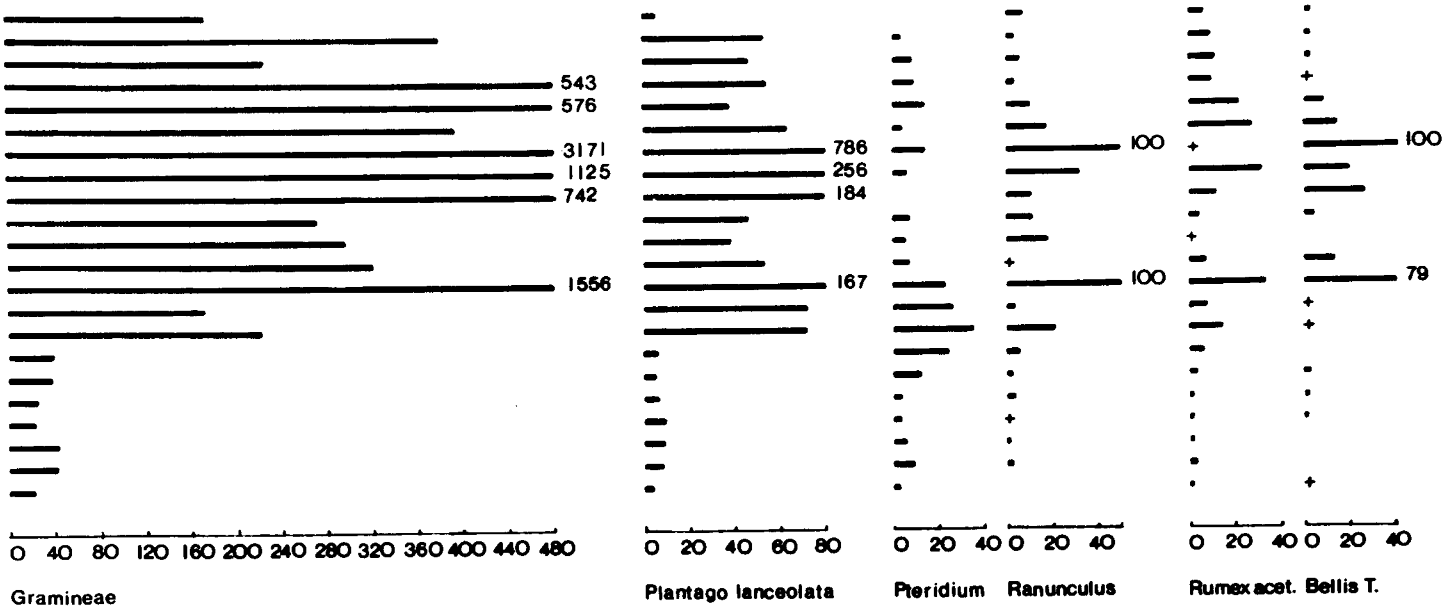
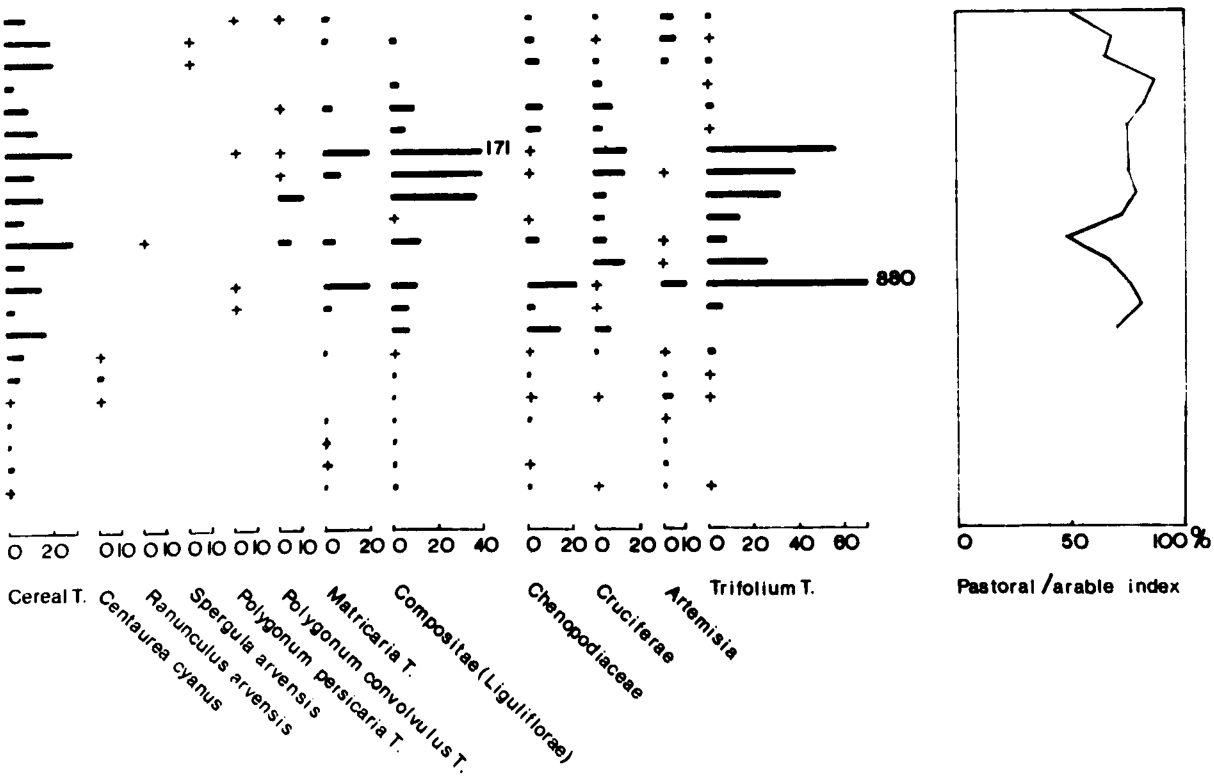

cm.
Betula
Pinus
Ulmus
Quercus
Tilia
Alnus
Fagus
Carpinus
Fraxinus
Acer
Corylus
Salix
Hedera
Ilex
Crataegus
Tree pollen as %AP
Shrub pollen as %AP
Trees/shrubs/herbs/bog & aquatic species as % ΣP
Cyperaceae
Calluna
Ericales
Sphagnum
Drosera
Typha lat.
Sparganium T.
Succisa
Filipendula
Anemone
Stellaria holostea
Umbelliferae
Rubiaceae
Polypodium
Filicales
Rosaceae
Labiatae (Stachys T.)
Labiatae (Prunella T.)
Urtica
Bog, aquatic, & some herbaceous species, as %AP

FIG. VIII.

HALLOWELL MOSS

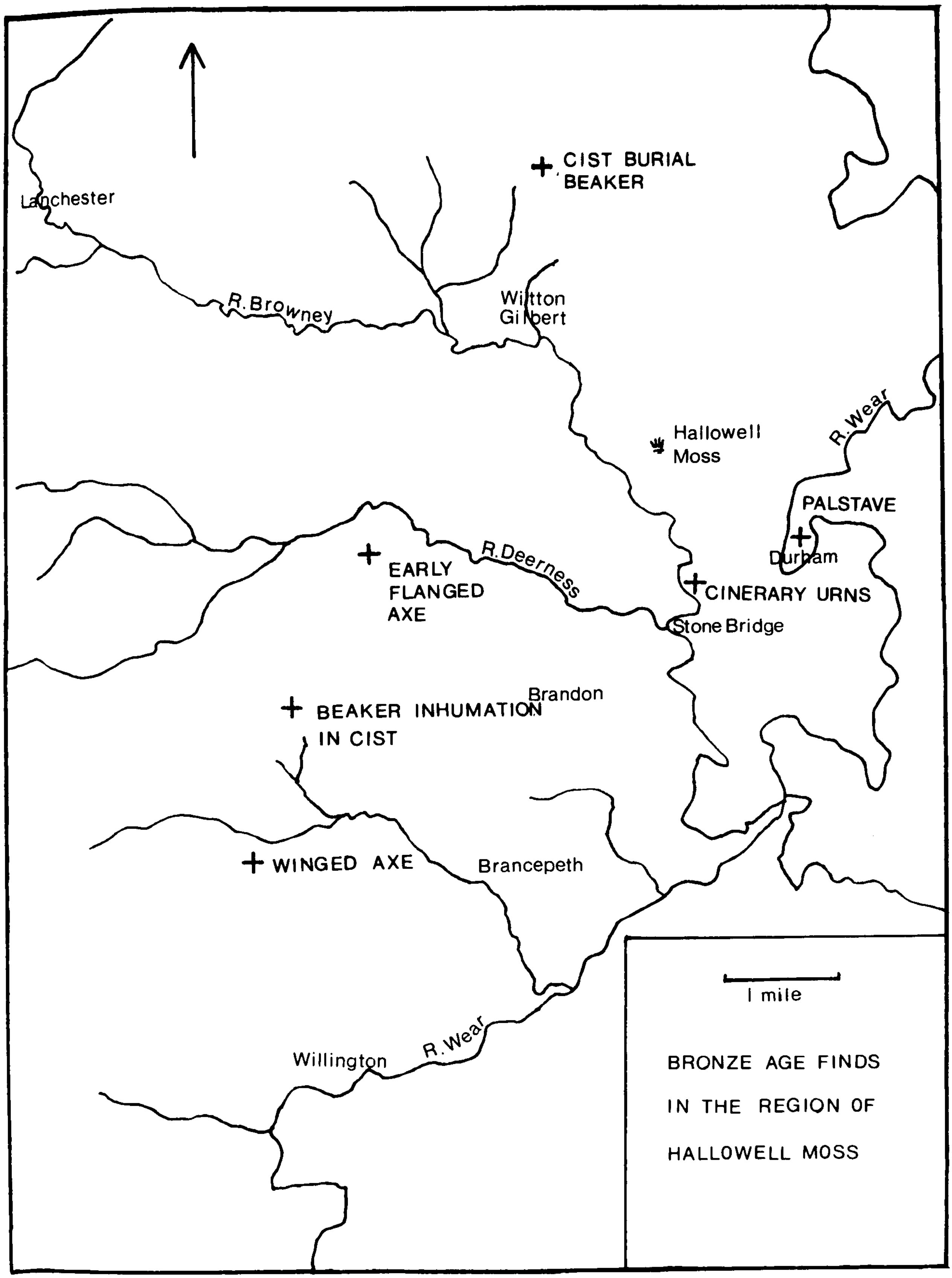


Species associated with clearances, and often with pasture land, as %AP.

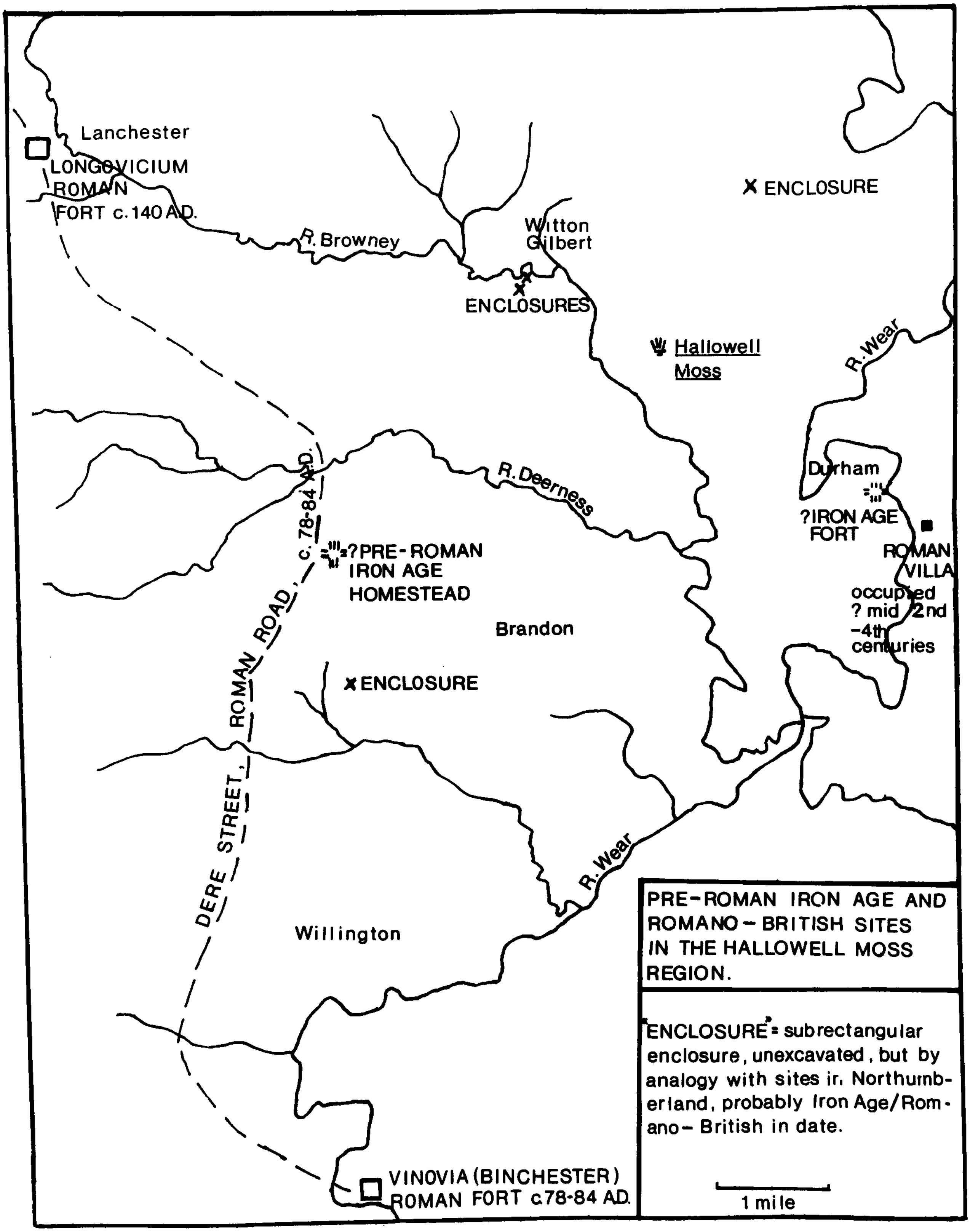


Species often associated with arable land, as %AP.

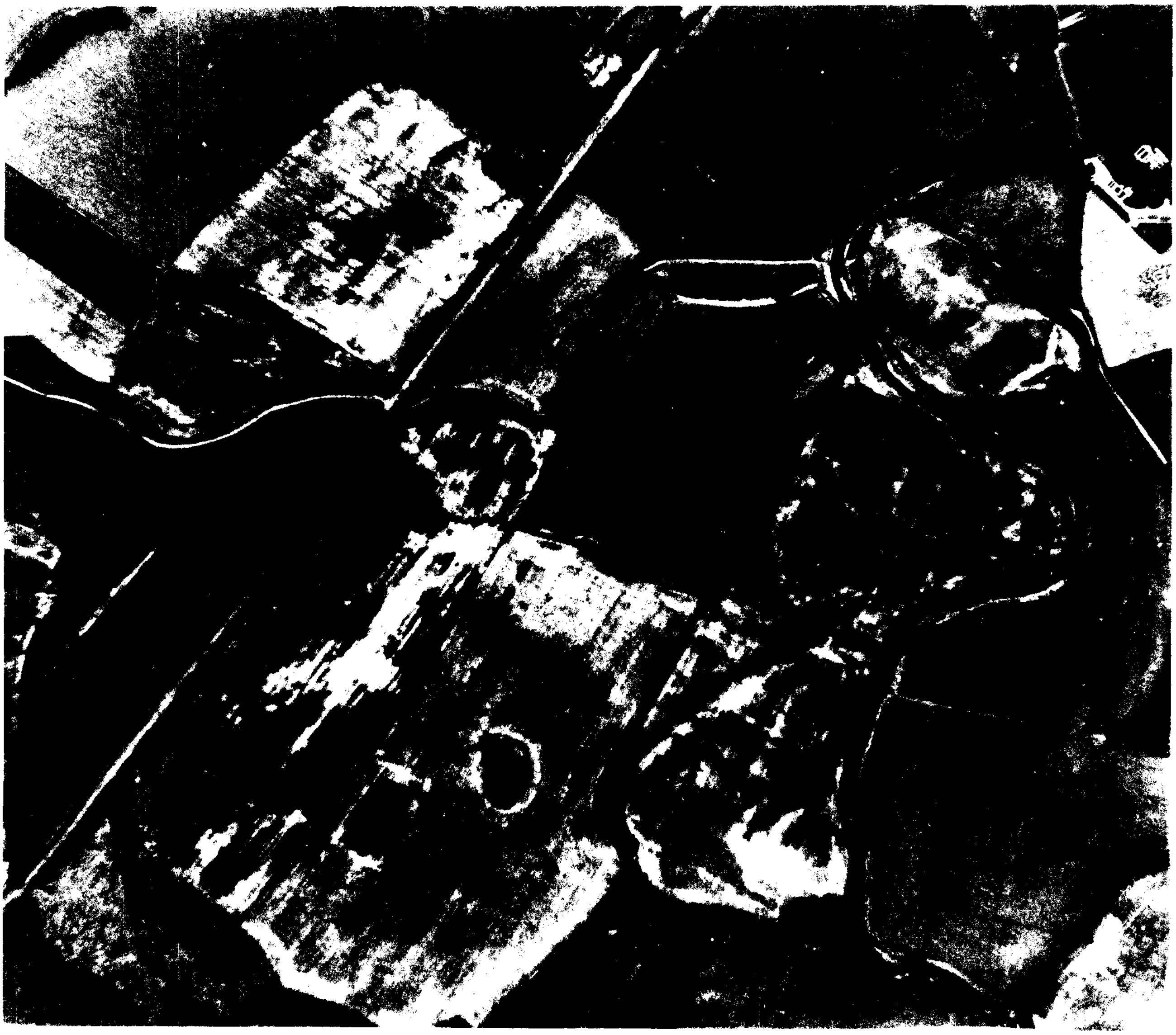
MAP II.


CIST BURIAL
BEAKER
Lanchester
R. Browney
Witton
Gilbert
Hallowell
Moss
R. Wear
PALSTAVE
Durham
R. Deerness
EARLY
FLANGED
AXE
CINERARY URNS
Stone Bridge
Brandon
BEAKER INHUMATION
IN CIST
WINGED AXE
Brancepeth
1 mile
Willington
R. Wear
BRONZE AGE FINDS
IN THE REGION OF
HALLOWELL MOSS

MAP III.



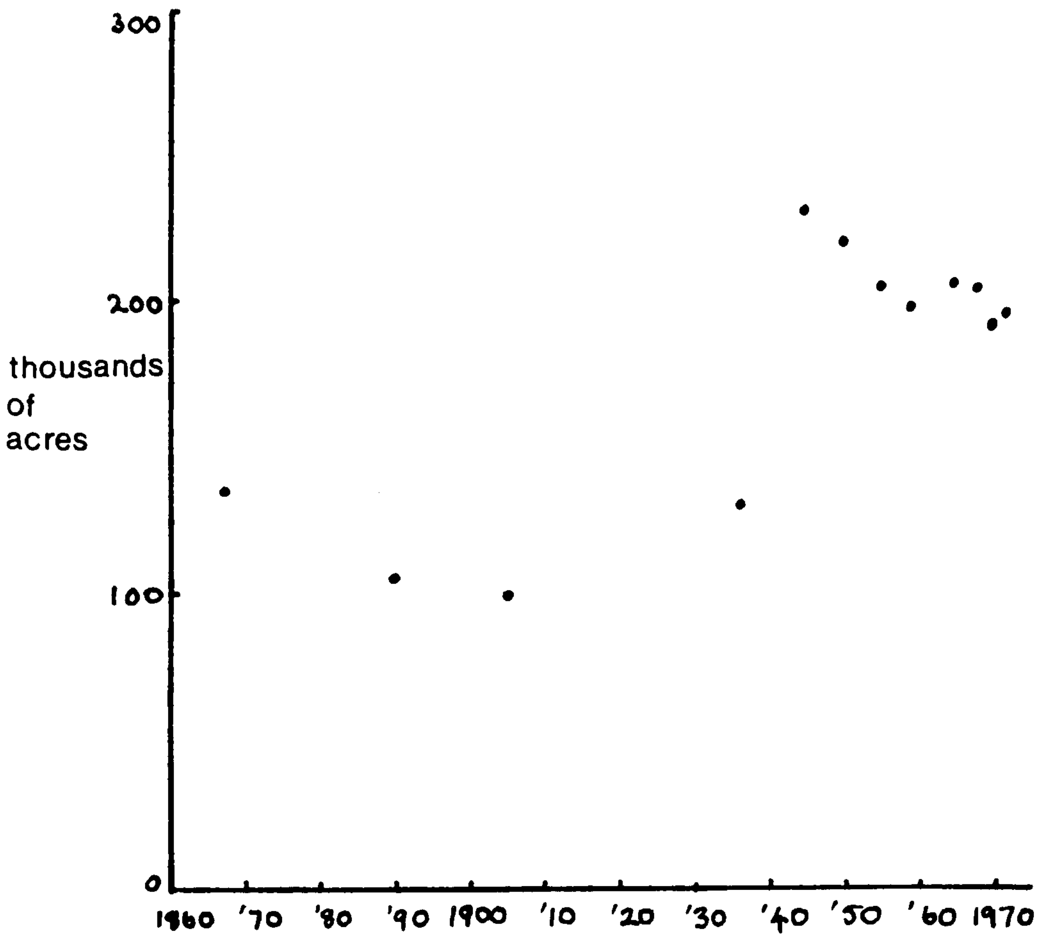
Lanchester
LONGOVICIUM ROMAN FORT c.140 A.D.
R. Browney
Witton Gilbert
ENCLOSURES
X ENCLOSURE
Hallowell Moss
R. Wear
R. Deerness
Durham
?IRON AGE FORT
ROMAN VILLA occupied ? mid 2nd -4th centuries
?PRE-ROMAN IRON AGE HOMESTEAD
DERE STREET, ROMAN ROAD, c. 78-84 A.D.
Brandon
X ENCLOSURE
R. Wear
Willington
VINOVIA (BINCHESTER) ROMAN FORT c.78-84 A.D.
PRE-ROMAN IRON AGE AND ROMANO-BRITISH SITES IN THE HALLOWELL MOSS REGION.
"ENCLOSURE" = subrectangular enclosure, unexcavated, but by analogy with sites in Northumberland, probably Iron Age/Romano-British in date.
1 mile



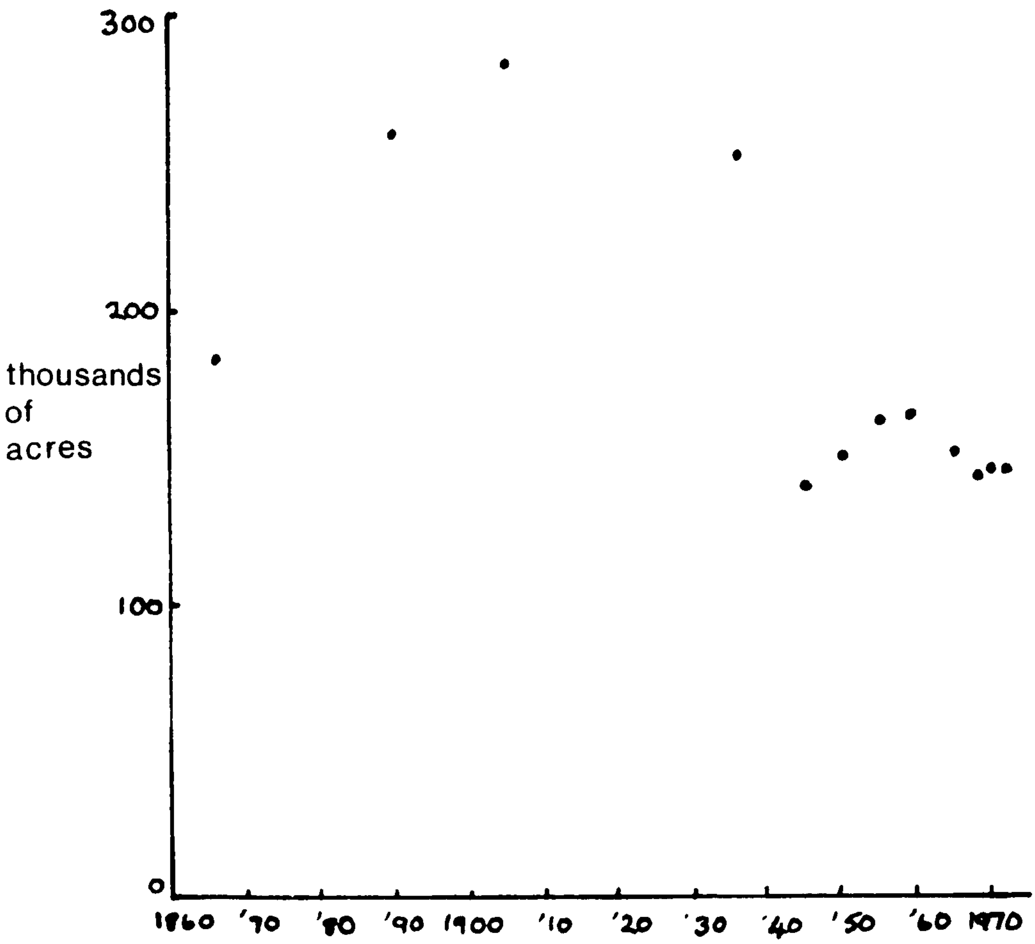
Enclosures near the river Browney (see Map III) which, by analogy, may be Romano-British in date. One is just to the left of the centre of the photograph and another to the left of the river in the bottom right-hand corner. NZ 233447.

FIG. IX.

Acreage of Arable land in Co. Durham.



Acreage of Permanent Pasture (excl. rough grazing) in Co. Durham.



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