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Chat Moss, Lancashire

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ABSTRACT

A description is given of the geography, recent history, peat stratigraphy and pollen analysis of Chat Moss, Lancashire, a peat bog situated eight miles west of Manchester. The vegetational history of the area, although essentially similar to that of the rest of the British Isles, possesses several interesting features. It is suggested from comparison with studies on other nearby mosses that these features correspond to local ecological and climatic conditions. The lowermost deposits are shown to date from the Late-glacial Period. The bog began to grow in early Post-glacial times, although growth in some regions of the moss was initiated later. The pollen analyses reveal the effects of progressive forest clearance and the introduction of agriculture by prehistoric man.

Introduction

Data from several sources have been used to elucidate the vegetational history and ecological development of peat deposits at Chat Moss, Lancashire. These have included local historical and archaeological records, the study of peat stratigraphy and the application of pollen analysis. The latter technique involves the separation and concentration of pollen grains preserved in the peat deposit, the microscopic identification of the various pollen types, the determination of their relative proportions at different levels throughout the deposit, and the interpretation of the data in terms of vegetational development and forest history since the Ice Age.

An overall picture has thus been obtained of botanical, geological, climatic and cultural changes within the area during the period of peat accumulation.

Geography and Recent History

The South Lancashire Plain is low-lying with wide level areas between 50 and 100 feet (15—30 m.) Ordnance Datum (O.D.). To the north, the higher ground of the Lancashire Coal-field rises to over 200 feet (60 m.) and is backed by the gritstone scarps of the flank of Rossendale. To the east, the Southern Pennine Uplands consist of Millstone Grits and Shales raised into a broadly monoclinal structure. The solid rocks of the plain are Triassic Keuper Marls, Waterstones and Sandstones, overlying Bunter Sandstones. These rocks are rarely exposed,

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however, being overlaid by sandy outwash and boulder clay of the Newer Drift Glaciation.

Along the Mersey valley, a well-developed Terrace System has been recognised with the Upper Terrace representing the Late-glacial Flood Plain. The topography of the terrace is locally flat with gentle undulations within which peat has developed and subsequently extended over the equally featureless Boulder Clay.

Chat Moss (Nat. Grid Ref. SJ/702961) is about 8 miles (13 km.) west of Manchester and forms a bog system 5 miles (9 km.) long and 2½ miles (4½ km.) wide. It lies at about 75 feet (23 m.) O.D. in a series of enclosed hollows in either the Boulder Clay or the Upper Mersey Terrace. The moss is bounded by sandy alluvial soils along the course of Glazebrook in the west, Moss Brook in the north, and the Mersey-Irwell valley in the south.

Most of the moss is now under cultivation, only small areas being intensively cut or under birch scrub. The few remaining uncut areas are covered with plant communities dominated by *Calluna vulgaris*, *Molinia caerulea* and *Nardus stricta* and dotted with *Betula pubescens*. Stands of *Pteridium aquilinium* are frequent especially where the area has been recently burnt. In cut areas, the surface is covered with *Eriophorum vaginatum*, *Calluna vulgaris* and *Vaccinium oxycoccus* with occasional *Betula pubescens*. No *Sphagnum* species have been observed on the present bog surface.

Initial attempts at the drainage and reclamation of Chat Moss began in the late seventeenth and early eighteenth centuries (Leigh 1700). Large scale drainage was initiated by the Third Duke of Bridgewater in 1758 during the construction of the Worsley Canal and by 1773 areas were being rented for pasture. The construction of the Liverpool to Manchester railway across the moss in 1820–30 necessitated further drainage of the northern part of the moss (Bailey 1889). Drainage and cultivation activities were well under way in the southern part of the moss by 1850, and in 1900 over 3,240 of the 3,600 acres of the moss were under cultivation. To-day arable farming is dominant with an emphasis on root-crops, vegetables and short leys of rotational grassland.

There are many early theories of the origin of Chat Moss. Perhaps the earliest account was by Leland (1535–43) who described an eruption of the moss in 1526:

> " For Chateley Mosse that with breking up of abundance of water yn hit did much hurt to landes thereabout and rivers with wandering mosse and corrupte water...."

Contrary to Leland's report, the bog burst appears to have been local and of minor importance, occurring in the north-west corner of the moss (Crofton 1902). Baines (1836) and Watkin (1883) regarded the moss as having originated as a forest which was destroyed by fire during the Roman occupation. By the end of the nineteenth century, the idea that the moss had originated through the slow infilling of a lake was generally accepted (Bailey 1889).

Stratigraphy

Erdtman (1928) described a stratigraphic section of Chat Moss from " the Liverpool—Manchester railway to a drained moss meadow in the north " and he reported the moss to be resting on boulder clay with overlying layers of " forest peat " and " moss peat ".

In the winter of 1961–62 the stratigraphy of the moss was examined more closely. A levelled transect of drillings was made across the moss in a SW—NE direction (Fig. 1) to investigate the peat depth and to record the peat stratigraphy and the nature of the underlying substratum. A " Hiller " peat auger was used for all the borings.

The basal surface is undulating with occasional small hollows and consists of a stiff grey-brown rocky clay, interpreted as basal boulder clay. Occasional thin lenses of white outwash sand are found above the clay. Near the centre of the moss there is a deeper hollow containing a well defined alternation of strata above the basal till. The latter is overlaid by a stiff blue-grey clay with occasional black carbonaceous laminae. This is covered by a grey-brown clay mud and is in turn overlaid by a layer of soft unlaminated blue clay.

Above this a dark highly humified peat containing numerous bryophyte remains extends across the central hollow. Near the centre there is a lens of water abutting on this basal peat. The lens can be traced someway across the basin whilst at the margins a layer of *Sphagnum cuspidatum* mud is recorded with abundant rhizomes of *Scheuchzeria palustris* and seeds of *Menyanthes trifoliata*. An unhumified *Sphagnum imbricatum* peat with varying amounts of *Eriophorum* and *Calluna* remains has developed above the mud and water. The peat-type changes markedly into a humified *Sphagnum* peat up to about 2 m. from the present surface. Here the humified peat is superseded by a generally fresher *Sphagnum* peat. The transition is usually marked by a band of pool peat, rich in remains of *Sphagnum cuspidatum* and often with seeds of

Menyanthes trifoliata, fruits of *Rhynchospora alba*, remains of *Andromeda polifolia* and very occasionally, rhizomes of *Cladium mariscus*. The upper peat is not homogenous and contains a number of laterally intermittent " retardation layers " of highly humified peat where peat growth was evidently temporarily retarded and subsequently renewed.

Outside the central hollow, a basal amorphous peat rich in cf. *Alnus* and *Betula* wood remains directly overlies the Boulder Clay or outwash sand. A humified *Sphagnum* peat with remains of *Eriophorum* and *Calluna* has developed above the wood peat. A change from the humified peat to the fresh peat, similar to that already described in the central deposits, occurs at all the borings examined. Again numerous intermittent " retardation layers " were observed in the upper peat, especially towards the outer margins of the moss.

The Pollen Diagrams

(*a*) *Methods*

Samples for pollen analysis were taken from the cores obtained from borings with a " Hiller " peat auger at a selected site in the central hollow (Site A) and at a selected site at the shallower margin (Site B). A further set of samples was collected from the central hollow (Site C) to permit more detailed examination of the bottom deposits and to obtain a complete sequence through the level corresponding to the water lens. Slides for pollen analysis were prepared by Erdtman's acetolysis method as described by Faegri and Iversen (1950) and minerogenic samples were treated with hydrofluoric acid. All the samples were mounted in glycerine jelly and stained with either basic fuchsin or safranin.

The pollen diagrams (Figs. 3—8) are based upon counts of at least 150 arboreal pollen grains per sample, excluding *Corylus*, *Salix* and *Fraxinus* and the values for the individual pollen types are expressed as percentages of the tree pollen sum, in accordance with general practice in Great Britain (Godwin 1956).

(*b*) *Zonation*

The zonation scheme applied to the pollen diagrams is that in current use for Great Britain (Godwin 1956), although precise identity of zones and zone boundaries is not claimed. There are, however, two local modifications: the fusion of Zones IV and V, and the apparent absence of a natural zonation scheme above

Zone VIIA. The vegetational features on which the present division is based are generally exhibited by a number of diagrams from neighbouring deposits in Lancashire and Cheshire (Birks unpublished) and for other areas in N.W. England, in particular North Lancashire (Oldfield 1960, Oldfield and Statham 1963, Moseley and Walker 1952), the Lake District (Walker 1955, Smith 1958) and Cumberland (Godwin, Walker and Willis 1957).

The Late-glacial zones are considered in detail elsewhere (Birks 1964) and only a brief outline of their vegetational nature is given here.

The pollen zones distinguished are as follows:

Late-glacial *Zone I.* C 770—760 cm.
Herbaceous dominance. Gramineae, Cyperaceae, *Rumex* and *Artemisia* are the dominant pollen types with a wide assemblage of herbs. *Betula* is the most important arboreal type, although a large fraction is tentatively referred to *B.nana*. *Juniperus* pollen rises to a maximum at the end of the zone and is paralleled by the *Empetrum* curve.

Zone II. A 800—820 cm. C745—760 cm.
Partially reduced herbaceous dominance. Gramineae, Cyperaceae, *Artemisia* and *Rumex*, although still present are not so abundant as in the adjacent zones. *Filipendula* is, however, consistently higher. *Betula*, is the dominant tree pollen type, although there is an increase in *Pinus* frequencies.

Zone III. A 750—800 cm. C 730—745 cm.
Herbaceous dominance. Gramineae, Cyperaceae, *Artemisia* *Rumex* and *Empetrum* are more frequent than in Zone II and numerous other herbaceous pollen types are present. *Betula* is the dominant arboreal type with high values of *B.* cf. *nana*. The shrubs *Juniperus* and *Empetrum* both have maxima at the Zone III—IV transition.

Post-glacial *Zone IV—V.* A 680—750 cm. C 710—730 cm.
Betula dominance with *Corylus* rising rapidly. The dry land shrub including *B.* cf. *nana* and herb pollen curves fall throughout the zone whilst *Salix* has a peak early in the zone.

Zone VI. A 660—680 cm. C 620—710 cm.
Joint dominance of *Corylus*, *Betula*, *Pinus* and *Quercus*. *Corylus* reaches very high values at the beginning of the zone after which both *Corylus* and *Betula* fall as *Pinus* and, later, *Ulmus*

and *Quercus* rise. *Alnus* is present in small quantities throughout. Occasional grains of *Hedera* are recorded.

Zone VII A. A 375—600 cm. B 350—440 cm. C 500—620 cm. Joint dominance of *Alnus Betula, Corylus, Quercus* and *Ulmus.* The boundary between Zone VI and Zone VII is drawn where the *Pinus* percentages begin to fall rapidly accompanied by the beginnings of a rise in the *Alnus*, *Ulmus* and *Quercus* values. At this level the *Corylus* percentages are minimal as in Ireland (Mitchell 1951) and subsequently rise in the early part of Zone VIIA to maintain moderate frequencies. Later in the zone *Alnus* rises to joint dominance with *Quercus, Ulmus, Corylus* and *Betula.* The *Ulmus* percentages are higher in this zone than in Zone VI and *Tilia* cf. *cordata* is present throughout.

Zones VIIB—VIII.

In the light of the work of Turner (1962) on the *Tilia* decline and its relation to the Zone VII—VIII boundary, no attempt has been made to differentiate between these two zones. There is, however, strong evidence of forest clearance at various distinct horizons which justifies a tentative subdivision of the diagrams into seven phases. A similar pattern of clearance phases has been detected in unpublished diagrams from Holcroft Moss, Lancashire, Wybunbury Moss, Lindow Moss and Danes Moss, Cheshire.

The lower limit of the zone is drawn at a sharp decline in *Ulmus* values accompanied by a rise in *Betula* and dry land herb pollen percentages. *Fraxinus* and *Plantago lanceolata* make their first appearance at this level.

Seven phases are distinguished.

(i) A 375—275 cm. B 350—275 cm. *Betula—Quercus* dominance with significant amounts of *Alnus, Tilia* and *Corylus* and occasional *Plantago lanceolata* grains. *Ulmus* values are considerably reduced.

(ii) A 275—200 cm. B 275—200 cm. *Alnus—Quercus—Corylus* dominance. *Ulmus* and *Fraxinus* values are higher than in (i).

(iii) A 200—150 cm. B 200—110 cm. Herbaceous dominance by Gramineae, Cyperaceae, Ericaceae and *Plantago.* *Tilia* values are much reduced. *Fagus* makes its first appearance.

(iv) A 150—125 cm. B 110—80 cm. Trees regain dominance and herbs fall to low values. At Chat Moss B *Betula* and *Fraxinus* extend first, then *Betula* falls as *Quercus*, *Ulmus* and *Corylus* rise.

(v) A 125—80 cm. B 80—40 cm. Incomplete herbaceous dominance with high values of *Plantago*. Cereal-type (criterion 60 μ) and *Humulus*-type pollen, appearing for the first time, are present in considerable frequency. Amongst the trees *Ulmus* and *Quercus* fall, followed by a rise in *Fraxinus* and *Betula*.

(vi) A 80—25 cm. B 40—20 cm. Trees partially regain dominance with *Betula* rising early followed by *Ulmus*, *Quercus*, *Tilia* and *Corylus*, and *Alnus* consequently falling. *Plantago* values are considerably reduced.

(vii) A 25—0 cm. B 20—0 cm. Herbaceous dominance with Gramineae, Ericaceae, Filicales, *Sphagnum*, *Plantago*, *Pteridium* and Cereal-type pollen very abundant. *Betula* falls very rapidly whilst in the uppermost sample both *Pinus* and *Ulmus* are present in quantity.

Discussion

It will be necessary to distinguish, throughout this discussion, between the history of the vegetation growing locally on the bog and of that growing regionally on the mineral soil of the surrounding area. The stratigraphical records and macroscopic remains represent plants in the former category, but the microscopic pollen and spores may be derived either locally or regionally.

(*a*) *Stratigraphic sequences and bog development*

The relative uniformity and low organic content of the silty clay of Zone I suggests that it was deposited in open water under periglacial conditions prior to the establishment of a proper soil or vegetational cover in the area. The carbonaceous material in this clay could have been derived by periglacial activity in the nearby Lancashire coal-field. The overlying clay-mud with a higher organic content represents more temperate conditions and has been shown to correspond to Zone II. The uppermost soft blue-grey clay of Zone III is interpreted as material soliflucted from the surrounding slopes and deposited in open water. Such a deposit could only originate from unstabilised margins with no continuous vegetational cover.

With the beginnings of the Post-glacial period, solifluction activities appear to have ceased and peat development to have initiated in the central hollow. Several additional pollen analyses of the lowermost peat occupying smaller hollows refer the beginnings of peat formation to Zone VIIA. Thus only in the central hollow was the drainage regime such as to permit the development of oligotrophic plant communities in Zone IV. The dark humified peat contains abundant bryophyte remains including *Sphagnum palustre*, *S.tenellum*, *S.rubellum*, *S.acutifolia*, *S.cuspidatum*, *S.magellanicum*, *S.imbricatum*, *Aulacomnium palustre*, *Polytrichum alpinum*, *P. alpestre*, *Pohlia nutans*, *Dicranium spurium* and *Drepanocladus* spp. Such a bryophyte assemblage suggests that the peat is of "valley-bog" type which has accumulated where the drainage water from the relatively base-poor rocks has stagnated in the flat-bottomed hollow.

A marked change in peat type and bog development occurred in Zone VI with *Scheuchzeria palustris* and *Sphagnum cuspidatum* invading the margins of the hollow. At the centre this is represented by a water lens and corresponds to an onset of wetter conditions either by increased precipitation or by changes in the drainage pattern. The pollen of *Utricularia*, *Scheuchzeria* and *Menyanthes*, spores of *Osmunda* and *Pediastrum* colonies found around the level all testify to the wet ombrogenous conditions. It is perhaps significant that Walker (1955) and Walker and Lambert (1955) record a rise in water-level towards the end of Zone VI at Skelsmergh Tarn and Kirkby Thore, Westmorland. The author has noted a similar flooding level at this time at Danes Moss, Cheshire. *Sphagnum imbricatum* peat appears to have developed out from the margins, thereby forming a floating raft of peat ("Schwingmoor"). Wybunbury Moss in Cheshire is a current example of a "Schwingmoor", with a small central pool of open water surrounded by an encroaching *Sphagnum recurvum* mat. This floating *Sphagnum* mat, about 4 m. thick overlies up to 10 metres of water with a basal fen wood peat (Poore & Walker 1959, Birks and Green unpublished).

The unhumified *Sphagnum imbricatum* peat that overlies the water lens corresponds to early Zone VIIA and to the start of peat growth in numerous other small hollows in response to the climatic changes associated with the Boreal-Atlantic Transition. The growth of *Scheuchzeria palustris* and *Sphagnum cuspidatum* and the water-gap are regarded as another expression of the onset of the Atlantic period. A more humified *Sphagnum* peat developed in the central hollow throughout Zone VIIA and the early part of Zone VIIB whilst nearer the margins basal wood peat is found. Early in Zone VIIB, tree birches grew on the bog surface for abundant birch wood remains are found in the peat, with the exception of the central hollow.

It should be noted that a local spread of *Betula* in Zone VIIB is recorded at numerous sites in Lancashire and Cheshire (Birks unpublished). The change in humification type, from a dark highly humified peat to a pale fresh *Sphagnum imbricatum* peat, has been detected throughout the bog system and coincides with a pronounced forest clearance phase during which *Tilia* values are reduced and herbaceous pollen percentages rise. The remains of such plants as *Sphagnum cuspidatum*, *Menyanthes trifoliata*, *Rhynchospora alba* and *Andromeda polifolia* suggest a definite flooding horizon at the transition with active *Sphagnum* bog growth being renewed after a phase of dryness and arrest. However, the occasional finds of *Cladium mariscus* at the level suggest flooding by eutrophic water, as for example in Somerset (Clapham and Godwin 1948). A suitable source of such water in South Lancashire is difficult to envisage, although base-rich water may have drained on to the moss as a result of the forest clearance activities in the vicinity. *Cladium mariscus* grows to-day on Wybunbury Moss where eutrophic water drains from nearby farmland on to the moss.

(*b*) *Regional vegetational history*

In considering the vegetational history of South Lancashire as represented by the pollen composition at each level, a picture emerges of open conditions during the Late-glacial Period, of forest development in the early Post-glacial Period and of the influence of prehistoric man on the natural vegetation by his forest clearance and agricultural activities.

The vegetational alternation from herbaceous dominance to partial birch woodland and back to herbaceous dominance, represented by Zones I, II and III and associated with stratigraphic changes, implies a climatic oscillation that can be equated with the Allerød oscillation of N.W. Europe and the British Isles (Godwin 1956). The high proportion of herb pollen throughout the Late-glacial period at Chat Moss suggests that the Late-glacial vegetation was predominantly open. A feature of many sites in Western Britain is this sparsity of tree growth, for example at Bagmere, Cheshire (Birks, 1964); Moss Lake, Liverpool (Godwin 1959); Scaleby Moss, Cumberland (Godwin, Walker and Willis 1957); Ireland (Jessen 1949, Mitchell 1951) and Scotland (Donner 1957).

In Zone I the abundance of Gramineae and Cyperaceae associated with an assemblage of shade-intolerant plants (*Artemisia, Plantago, Helianthemum*) suggests that an open sward of grasses and sedges prevailed with a wide variety of associated herbs. The shrubs *Juniperus* and *Empetrum* possibly formed low scrub in the herbaceous sward. As the climate ameliorated, Zone II saw an increase in the tree birches and the beginnings of organic mud deposition. The increased *Pinus* values may be locally significant as a similar feature is noted at Bagmere and Moss Lake, Liverpool, although the possibility of long distance transport cannot be disregarded. The appearance of *Filipendula ulmaria* in Zone II is regarded as an indication of a temperature rise as this species has its present northern limit at the 14° C. July isotherm (Iversen 1954).

In Zone III herbaceous communities again dominated with trees possibly surviving only in the most sheltered localities. The general composition of the flora closely resembled that of Zone I, although there is stronger representation of plants that prefer freshly disturbed soils where the soil nutrient supply is constantly replenished (e.g. *Polemonium, Armeria*). Solifluction activities, such as could lead to the deposition of the Zone III clay, could have played a large part in disturbing the soil. The increased abundance of *Empetrum* in Zone III is also seen at Bagmere and Moss Lake and suggests some oceanicity of climate. The maxima of the shrubs *Juniperus, Betula nana* and *Empetrum* at the Zone III—IV transition represent the transition between the open vegetation of the Late-glacial Period and the forests of the Post-glacial Period.

At the beginning of the Post-glacial period birch woodland quickly spread, replacing the open vegetation of the Late-glacial Period. The persistence of many herbs that had been particularly abundant in the Late-glacial zones suggests that an open birch woodland type prevailed (cf. Godwin 1959). The small peak in *Salix* values in the zone is probably associated with local and temporary development of willow in marshy areas.

The arrival of the thermophilous trees, *Quercus* and *Ulmus* and the rapid expansion of *Corylus* at the beginning of Zone VI marked the establishment of the mixed oak forest. The hitherto abundant *Betula* was suppressed, possibly through its inability to regenerate with an undergrowth of hazel. As the mixed oak forest expanded and occupied ground first colonized by hazel, the latter diminished in importance. The area covered by pine seems to have increased slowly, probably occupying sandy outcrops in the light drift soils. Of particular interest in the herbaceous pollen records for this zone are the finds of *Circaea* grains at a site near Chat Moss C as it is only recorded from Zone VI at Kirkby Thore, Westmorland (Walker and Lambert 1955), from Zones II, IV and VII at Moss Lake (Godwin 1959) and Zone VI at Wybunbury Moss, Cheshire (Birks unpublished).

The now numerous pollen records of *Alnus* in Zone VI in N.W. England show that *Alnus* was growing in this area throughout the Boreal Period, perhaps only in a few particularly favourable habitats. The recent finds of *Alnus* fruits at Tadcaster, Yorkshire (Bartley 1962) in Zone VI provide strong confirmation of the validity of the pollen records.

At about the same time as the spread of alder, peat development commenced at many lowland areas in Lancashire and Cheshire (e.g. Lindow Moss, Holcroft Moss) and in coastal vicinities in North Lancashire and South Westmorland (Smith, 1959, Oldfield and Statham 1963). Blanket peat also began to accumulate on the Pennine Uplands at a similar time (Conway 1954, Moseley and Walker 1952, Johnson and Dunham 1963).

Once alder was well established, occupying all suitable habitats, little change occurred in the forest composition during the Atlantic period. *Pinus* continued throughout the zone, as it did in Ireland (Jessen 1949) but was probably restricted to dry, sandy soils. The mixed oak forests changed little, although *Quercus* achieved some supremacy over *Ulmus* later in the zone. *Betula*, although well represented in the pollen spectrum was probably restricted to the drier margins of the raised bogs.

No satisfactory sub-division of the period after the end of Zone VIIa is possible in this area on the pollen-analytical data alone, as the changes in the vegetation, especially of the forests, can be ascribed partially to climatic changes and partially to human activity. During the period many important changes occurred in the forests, for the last fragments of pine woodland died out, ash established itself locally and elm and lime decreased in abundance. The remaining forests were dominated by oak and alder with some hazel and increasing quantities of birch. The finds of *Fagus* and *Carpinus* could represent long distance pollen dispersal from Southern England since there is no definite evidence for the natural growth of these trees in Northern England.

The dramatic and comparatively short-lived rise in *Betula* pollen, associated with birch wood remains, at the opening of the Post-Atlantic period can be ascribed to a climatic change, as a result of which birch scrub colonized the dry bog surfaces. A similar feature has been detected in Somerset (Godwin 1948), in Westmorland (Smith 1959) and in some areas of Wales (Hyde 1940) and it suggests that conditions of extreme dryness prevailed in Western Britain during the early Sub-Boreal period.

The most notable vegetational changes of the period were those produced by increasing human activity, and the decline in *Ulmus* values, the appearance of *Fraxinus* and *Plantago lanceolata*, and the increased representation of many dry land herbs can be attributed to this cause. Throughout the period, progressive phases of forest clearance, regeneration and further clearance occurred.

At the beginning of the Post-Atlantic Period, the occasional and sporadic occurrence of *Plantago lanceolata* and *Pteridium* associated with reduced *Ulmus* values suggest some clearance activities. More detailed investigations of other deposits in the area have failed to reveal the presence of a specific " landnam " phase and it may be that the population density was too small to produce such an effect. This is in accordance with the almost complete absence of local archaeological records that can be ascribed to the Neolithic Period.

The first well-defined clearance phase is marked by a reduction in *Tilia* values and a rise in dry land herbs and probably involved the use of fire, for the *Pteridium* curve becomes continuous and rises to high values as *Tilia* declines. A feature of the ecology of bracken is its ability to colonize freshly burnt areas. The pollen assemblage as a whole and the absence of Cereal-type pollen suggest that the activities of the early farmers responsible for the deforestation were mainly pastoral. The beginning of the clearance phase coincides with the " flooding horizon " that could be tentatively referred to Weber's " Grenzhorizont " of about 500 B.C. (Godwin 1956). This would suggest that Late Bronze or Early Iron Age communities may have been responsible for this deforestation phase. There are numerous local archaeological records for this period, providing evidence of human occupation of the area at that time.

Succeeding this phase of forest clearance, there appears to have been an ill-defined forest regeneration phase, during the course of which *Betula* and *Fraxinus* expanded initially, followed by *Quercus*, *Corylus* and to a smaller extent *Ulmus*. The area covered by dry land herbs was correspondingly reduced.

The second Post-Atlantic clearance phase is even more difficult to correlate with any archaeological period. It is characterized by high values of dry land herb pollen and by the appearance and abundance of Cereal-type and *Humulus*-type pollen, suggesting that arable farming may have predominated. Possibly both arable and pastoral economies co-existed at this time. In the light of the abundance of archaeological evidence for Roman occupation in the area (Watkin 1883) the phase under discussion could be very tentatively referred to the Romano-British Period.

It seems likely that the rise in *Betula* pollen, coming as it does after the maxima of the weed pollen curves, is an effect of human activity. As there is no evidence to suggest birch invasion on the bog surfaces at this time, it seems probably that birch quickly colonized the recently abandoned fields and pastures during a phase of reduced human activity. A similar pioneer phase of birch has been recorded in S.W. Westmorland (Smith 1959).

The uppermost clearance phase corresponds to recent times and represents the expansion and development of agriculture in South Lancashire and Cheshire, associated with the drainage and cutting of many of the lowland peat mosses. The abundance of herbaceous types suggests a rapid expansion of the cleared land and some diversification of activity (cf. Rodgers 1955). The rise in *Pinus* and *Ulmus* frequencies in the very uppermost samples is probably associated with the establishment of conifer plantations in the Cheshire Plain and the effects of selective preservation of *Ulmus* as a hedgerow tree in Northern England.

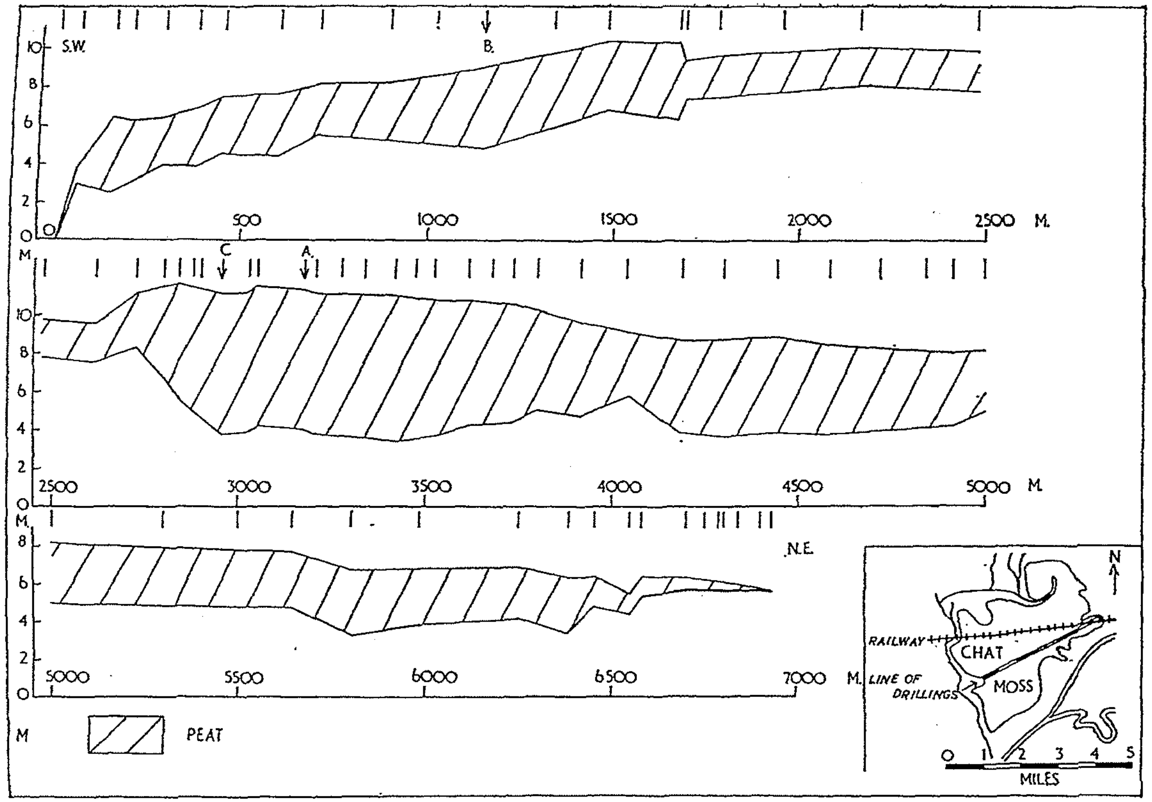

FIG. 1. Profile constructed across Chat Moss from a series of drillings along the line shown in the sketch map.

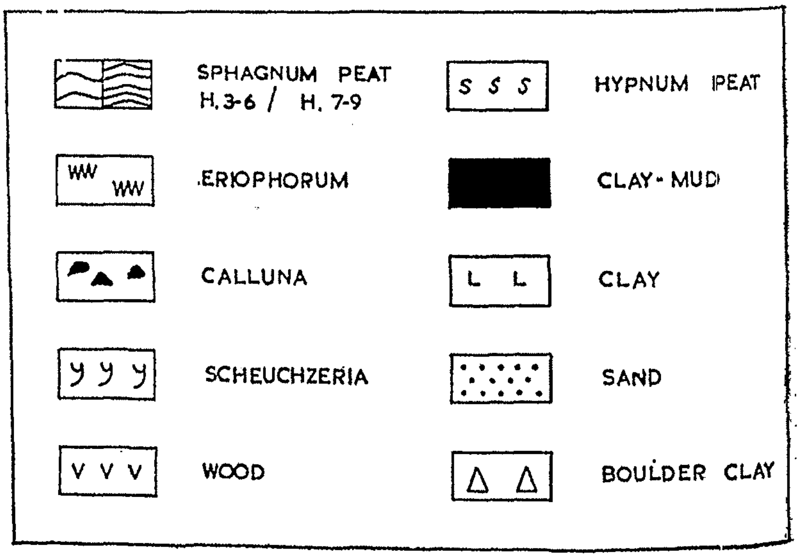

FIG. 2. Key to stratigraphical symbols used in Figs. 3—8.

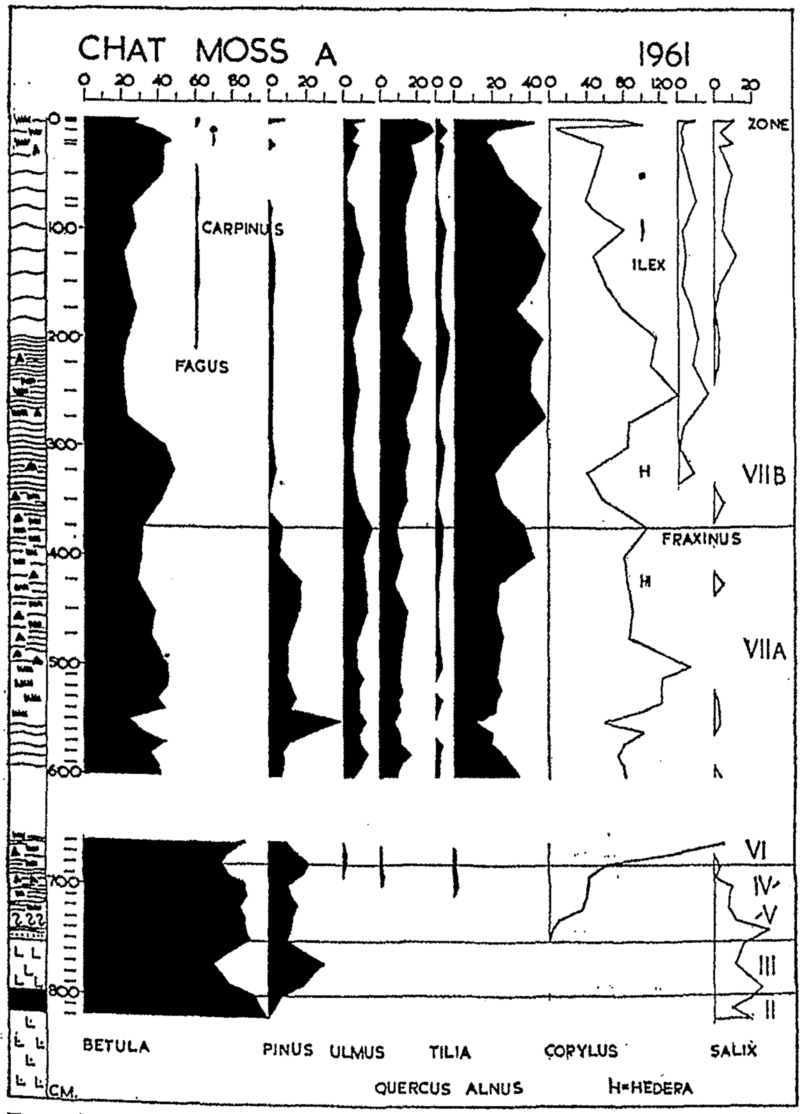

Fig. 3. Chat Moss A: tree and shrub pollen diagram. Percentages calculated on the total tree pollen sum. For stratigraphical symbols see Fig. 2.

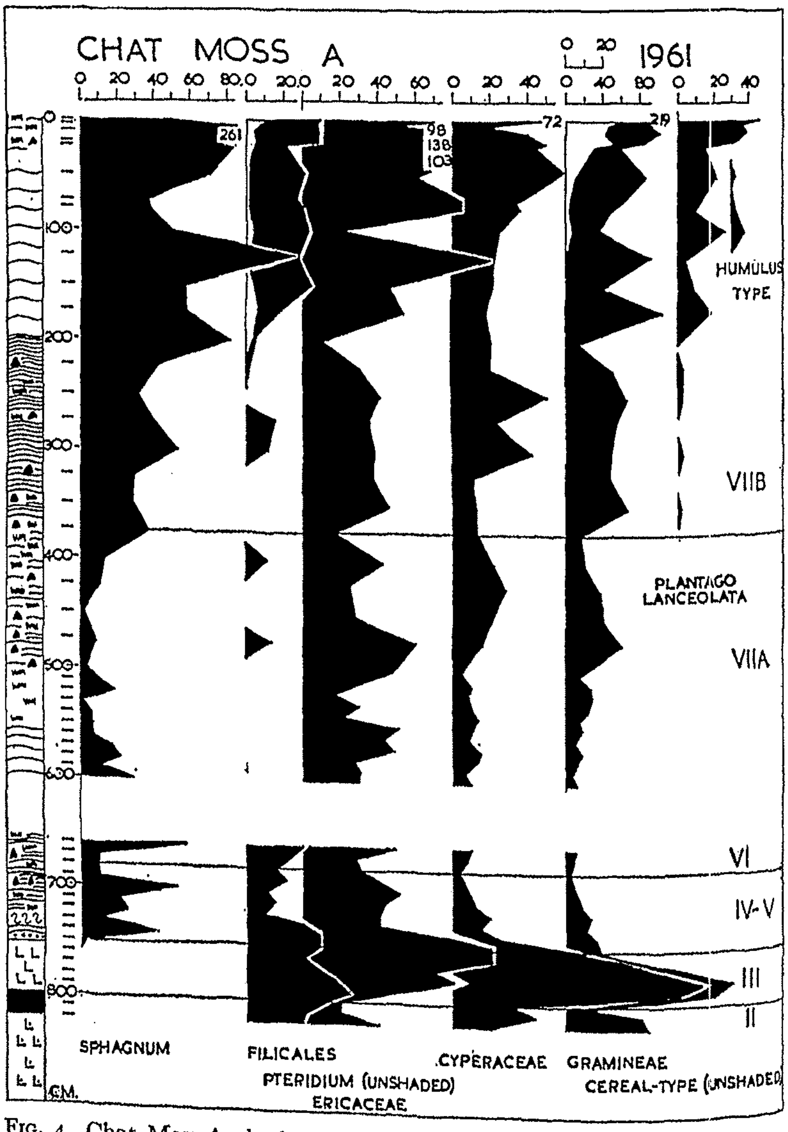

FIG. 4. Chat Moss A: herb pollen diagram. Percentages calculated on the total tree pollen sum. For stratigraphical symbols see Fig. 2.

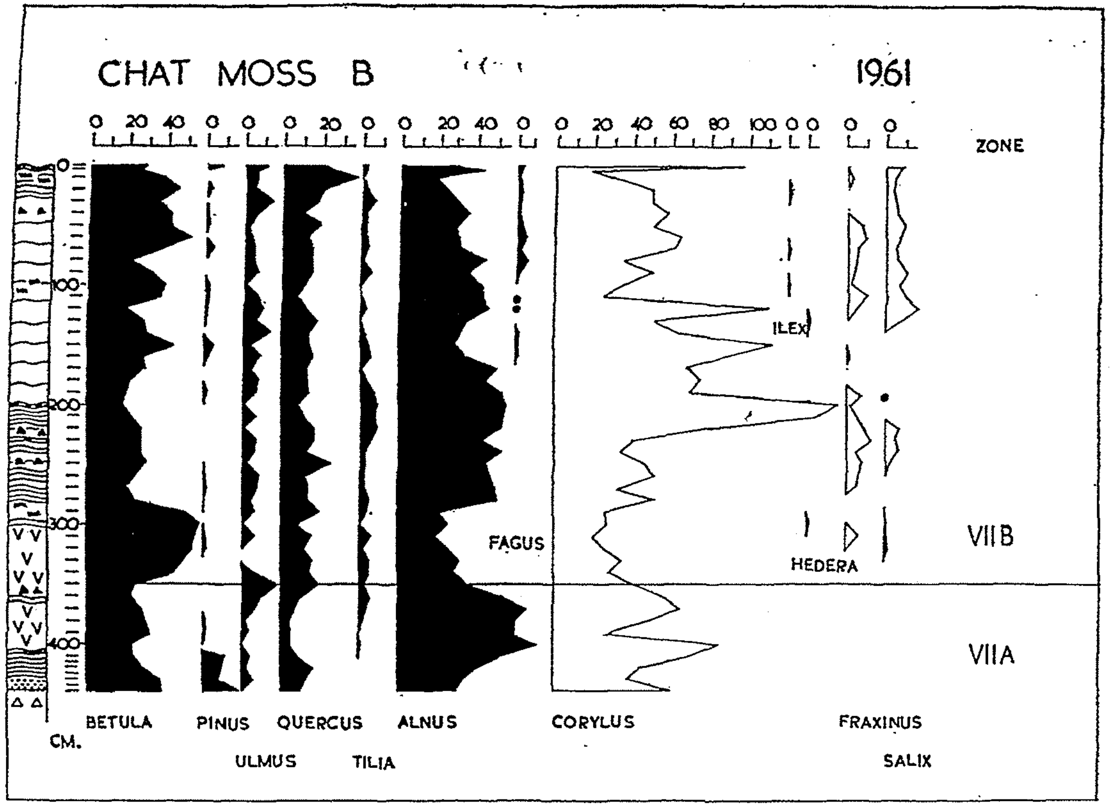

FIG. 5. Chat Moss B: tree and shrub pollen diagram. Percentages calculated on the total tree pollen sum. For stratigraphical symbols see Fig. 2.

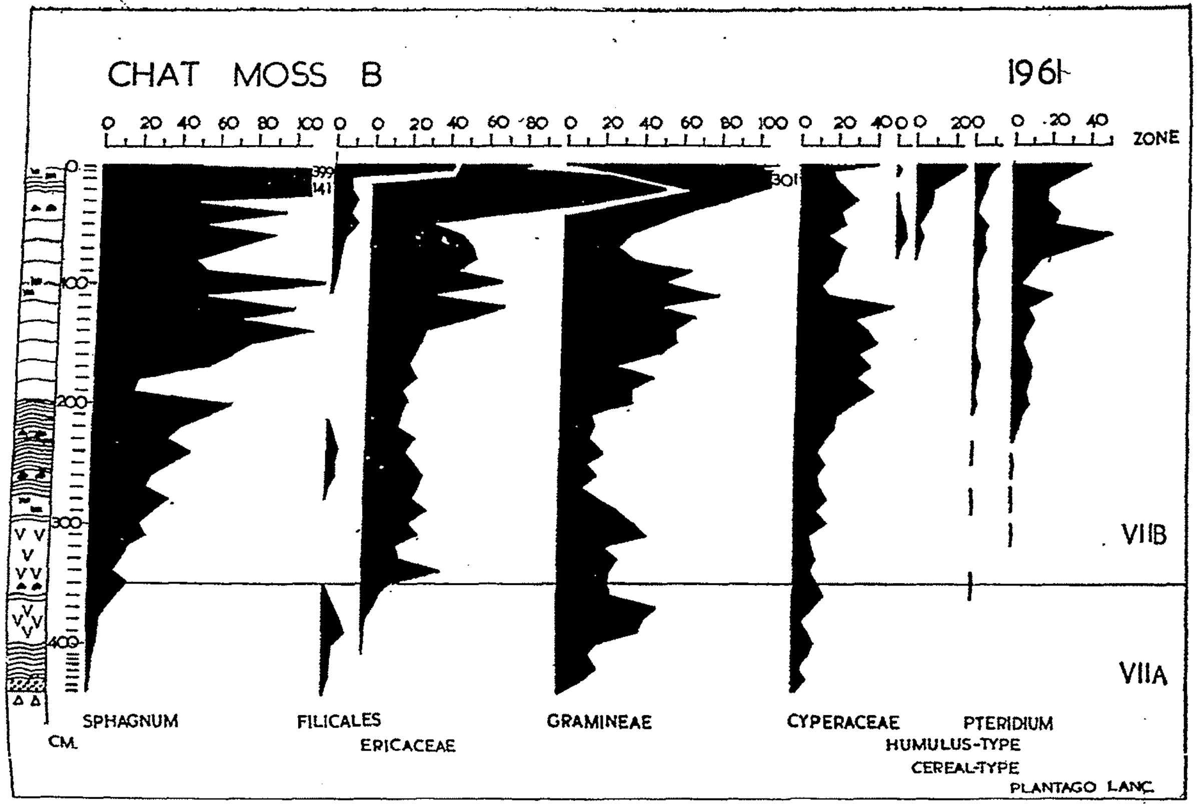

FIG. 6. Chat Moss B: herb pollen diagram. Percentages calculated on the total tree pollen sum. For stratigraphical symbols see Fig. 2.

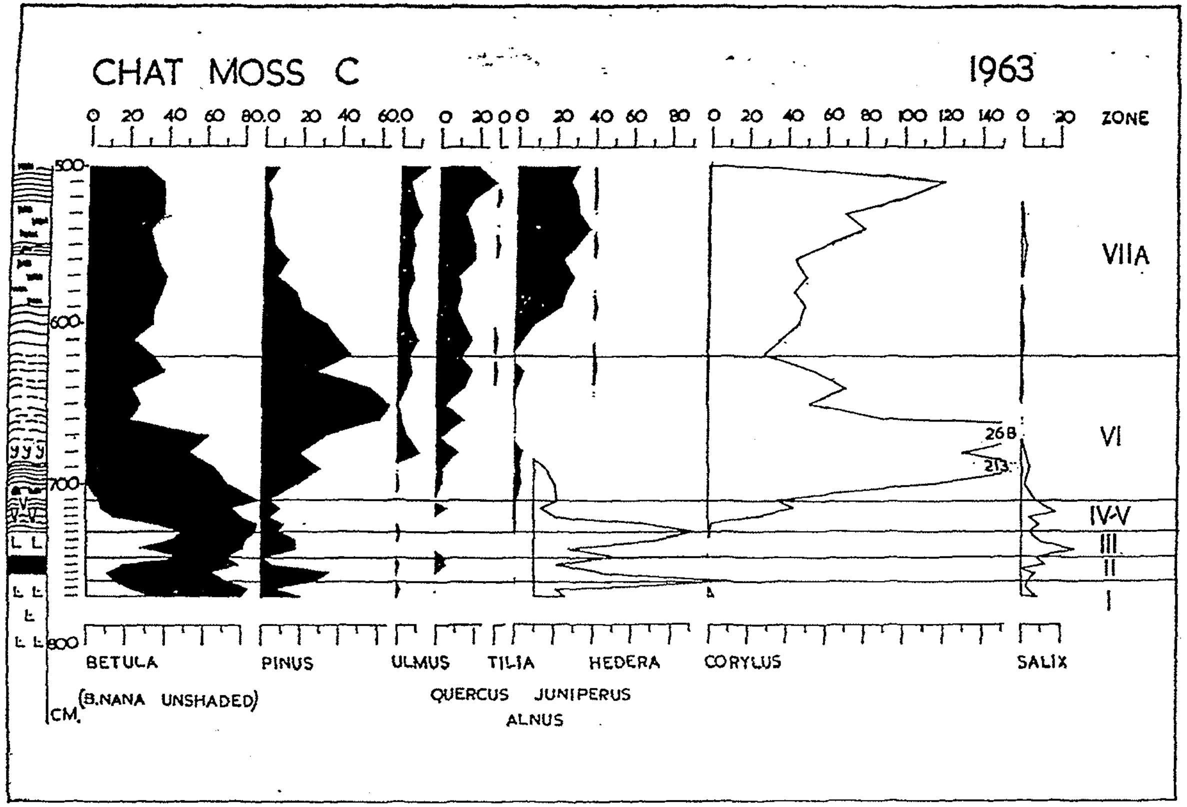

FIG. 7. Chat Moss C: tree and shrub pollen diagram. Percentages calculated on the total tree pollen sum. For stratigraphical symbols see Fig. 2.

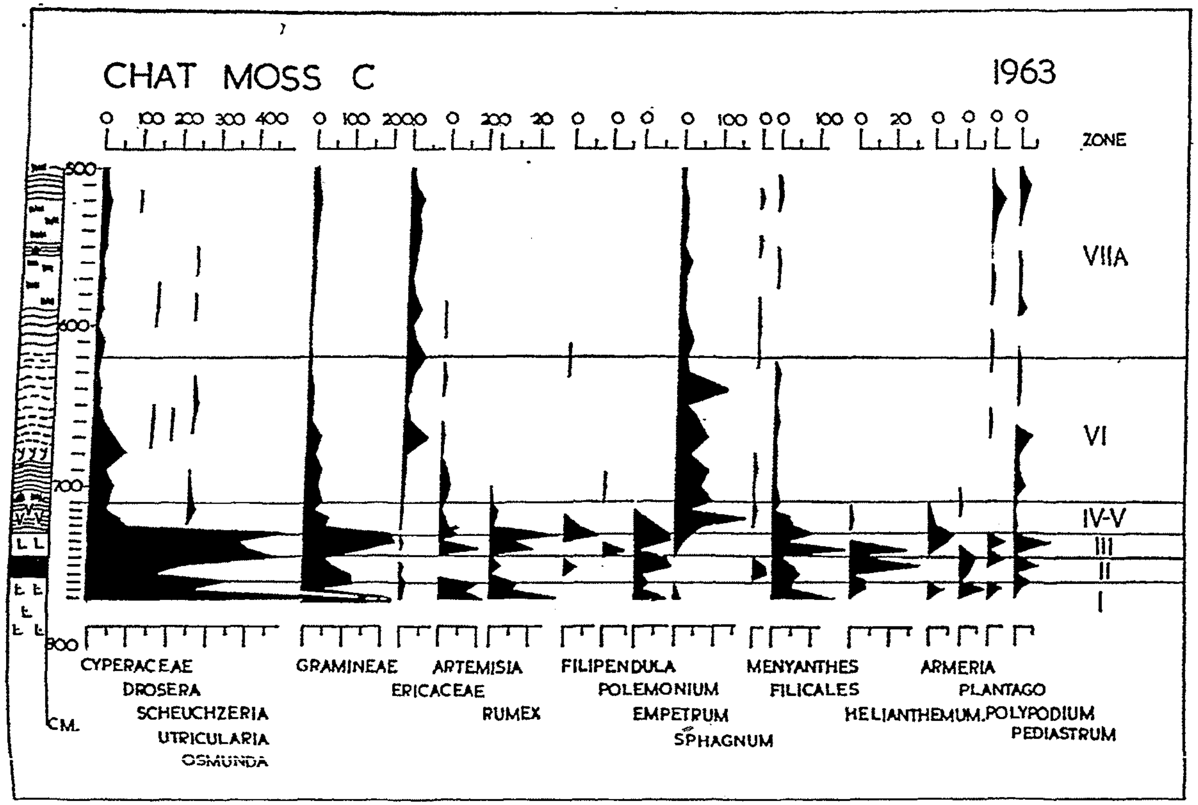

Fig. 8. Chat Moss C: herb pollen diagram. Percentages calculated on the total tree pollen sum. For stratigraphical symbols see Fig. [illegible]

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