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CENTRAL ROSSENDALE: THE EVOLUTION OF AN UPLAND VEGETATION

I. THE CLEARANCE OF WOODLAND

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INTRODUCTION

This paper and a subsequent one examine the relative importance of environmental and human agencies in determining the present-day vegetation of an upland area where the physical environment must always have presented extreme problems to the people who settled there. The study area comprises approximately 23 km^2 of Central Rossendale, Lancashire, between Haslingden and Edgworth (Fig. 1), and consists of a more or less flat and elevated plateau surface at 330–360 m (rising to 418 m at Bull Hill) dissected by narrow steep-sided valleys (cloughs). Alternating and almost horizontal beds of millstone grit and shale have weathered to produce a characteristic 'edge and ledge' topography, with the resistant grits forming the broad and gently undulating plateau surfaces and the softer shales the slopes of steeper gradient. Pleistocene boulder clays mask the solid geology to varying depths. These frequently cover the shelves and slopes up to an altitude of 330 m, filling in irregularities and producing smooth gradients. The upper limit of this drift is a significant line in the agricultural geography of the uplands, and the contrast in land-use between the pastures on the drift and the rough grass-heath and bog beyond is obvious throughout the region.

The high altitude of the land, combined with its westerly aspect on the windward side of the Pennines, results in a heavy rainfall, averaging 1511 mm a year at Helmshore (altitude 258 m) in the period 1952–58. Measurable rain falls on six days out of ten on average, and mean annual humidities are correspondingly high (in the upper eighties). The study area records one of the lowest sunshine totals in England and Wales, resulting not only from the prevailing cloudy weather but also from large amounts of industrial smoke (there is a population of almost one million within a 16 km radius of the study area). On the other hand, because of the westerly aspect, winter temperatures are rarely extreme, and at 300 m the air temperature fails to rise above freezing point on only eight days in the year on average. The number of days in winter with minimum temperatures below freezing point averages less than 50 at 300 m, while the frost-free period generally lasts from mid-April to early November. Conversely, however, there are fewer than fifteen days in the year when temperatures exceed 21° C.

Soils throughout the study area are uniformly base-deficient, as a consequence of the high rainfall and humidity and the siliceous parent materials. Within a given small area, however, there are frequently great variations in soil type produced by the numerous permutations of parent material, gradient, drainage, and vegetation. Peat is ubiquitous

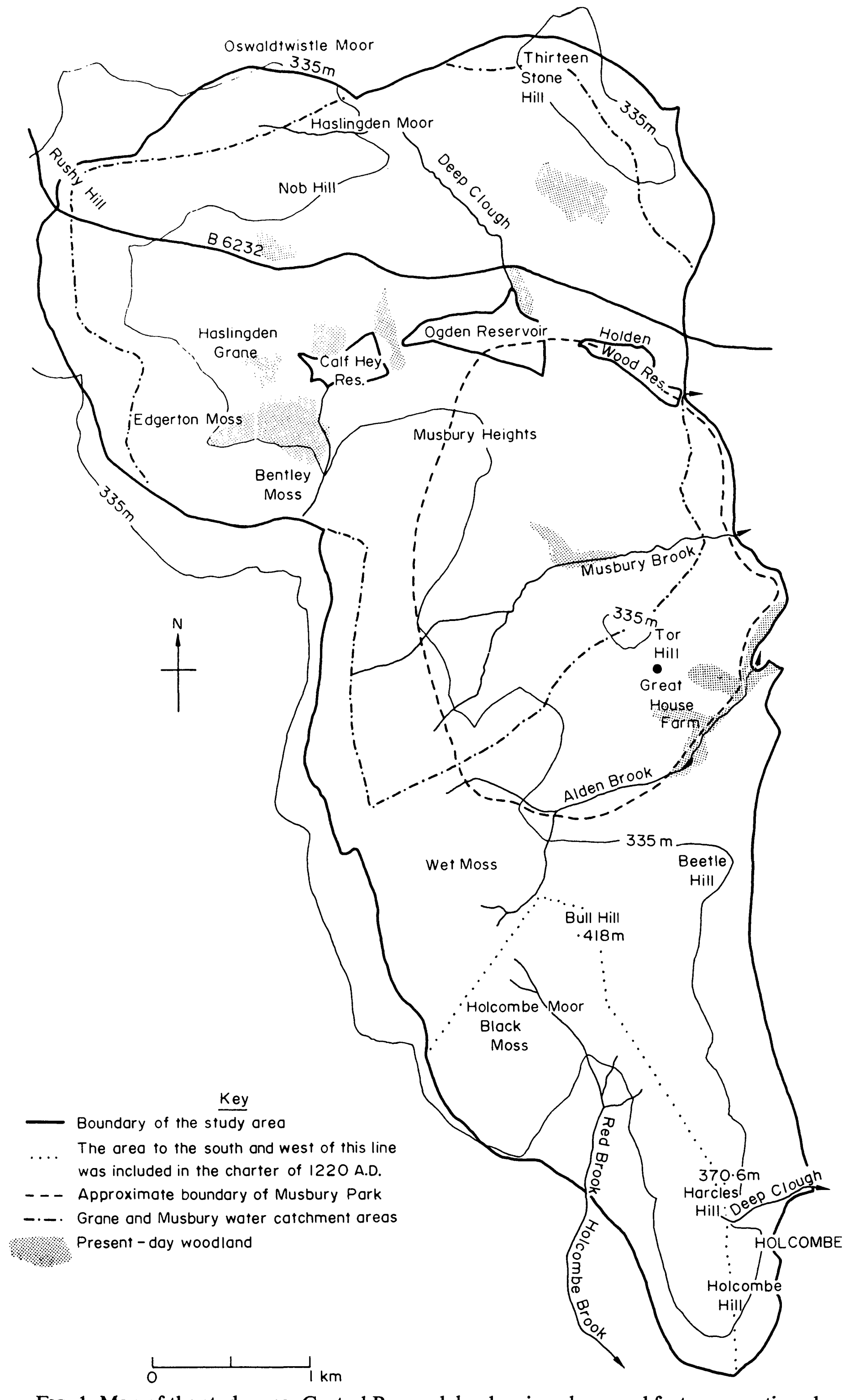


FIG. 1. Map of the study area, Central Rossendale, showing places and features mentioned in the text.

on the flatter ground, and extends almost continuously across the central plateau from Rushy Hill in the north to Black Moss in the south. Areas of restricted drainage overlying boulder clay are widespread, and are characterized by gleyed soils with up to 30 cm of accumulated organic matter. On the steeper slopes shallow podsols or acid brown-earths are developed, but these are frequently immature or truncated. On the steepest slopes (in excess of 25°) ranker soils are present, with a thin layer of acid humus resting directly on little-weathered parent material.

SOURCES OF DATA

Relevant original material was obtained as follows.

Present-day vegetation (J.M.)

Mapping of the study area was carried out by reference to detailed transect records and to aerial photographs (McGuire 1971). The present-day vegetation was characterized on the basis of the distribution of seven major dominants: *Eriophorum* spp., *Molinia caerulea**, *Empetrum nigrum*, *Vaccinium myrtillus*, *Nardus stricta*, *Agrostis* and *Festuca* spp., and *Pteridium aquilinum*. Their distribution and status are considered in a subsequent paper.

Documentary evidence (J.M.)

In mediaeval times the study area was subject to Forest Law, and there are many extant records of sources of forest revenue, of court proceedings brought against those breaking the forest laws, and of specific grants of land to individuals. Subsequent to disafforestation in A.D. 1507 frequent proceedings were also brought against squatters encroaching on the common lands of the study area. Most of these court rolls, accounts, feet of fines, charters, and wills are preserved at the Public Record Office, London, and the Lancashire Records Office, Preston. Further information was also obtained from title deeds kindly made available by Bolton Corporation Waterworks.

Pollen analysis (J.H.T.)

The major pollen evidence was derived from the Deep Clough site described below, but information was also gained from a crude pollen diagram drawn up in 1961 for peat on Wet Moss (Grid Ref. SD 762195, altitude 380 m, peat depth 225 cm), from pollen counts of a podsol buried below the Bronze Age barrow at Wind Hill (Grid Ref. SD 832147, altitude 305 m), and from pollen counts of soil immediately underlying the Roman road at Ainsworth (Grid Ref. SD 7710, altitude 135 m). The soils from which these two last counts were made were kindly provided by the Bury Archaeological Society.

THE DEEP CLOUGH SITE

The Deep Clough site (Grid Ref. SD 777169) occurs at the head of a small tributary stream of the River Irwell draining eastward from the watershed between Holcombe Hill and Harcles Hill at 340 m (Fig. 2). The watershed and adjoining gentle slopes are peat-covered, but the peat rarely exceeds 30 cm in depth, and is often considerably less. In the

* Nomenclature follows Clapham, Tutin & Warburg (1962).

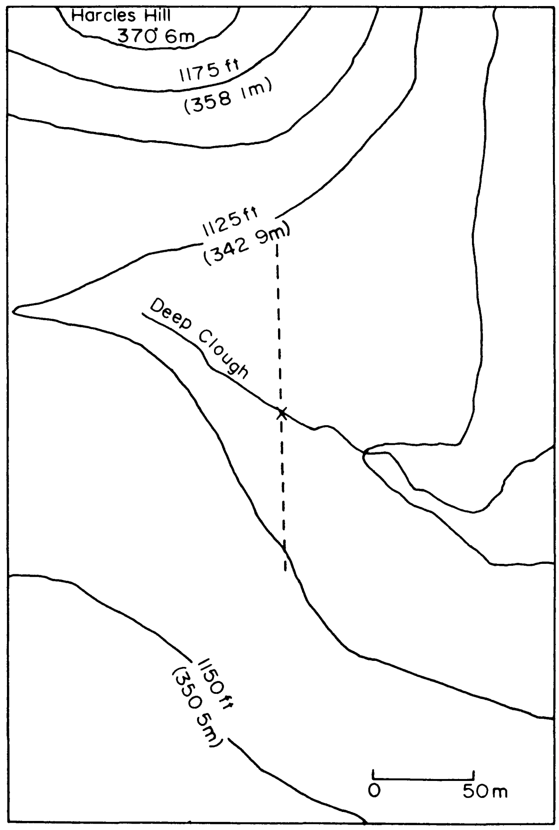


FIG. 2. Sketch map of the Deep Clough site. ×, Site of pollen diagram A. – – –, Line of transect shown in Fig. 3.

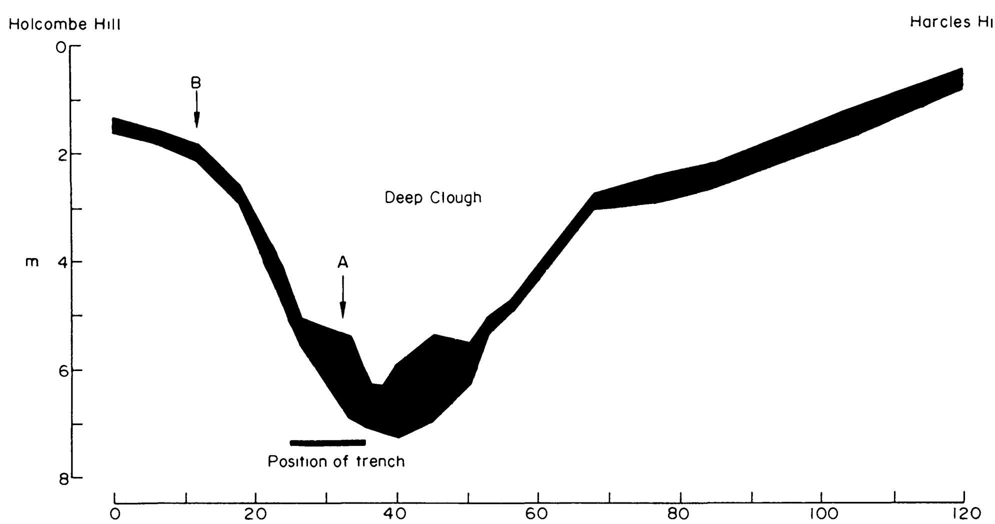


FIG. 3. Profile of the Deep Clough site along the line shown in Fig. 2. Peat is shown black. The arrows mark the positions of the two pollen diagrams mentioned in the text.

upper reaches of Deep Clough, however, peat depths exceed 1 m (Fig. 3). Abundant large roots of *Betula* occur in the mineral soil below the peat here, and branches and smaller twigs are present in the overlying peat for a distance of some 25 cm. The peats at the head of Deep Clough also contain several prominent bands of mineral particles, varying in thickness from 1 to 12 cm. The mineral particles are mostly of small size, but there are occasional larger angular fragments up to 5 cm in diameter. Fig. 4 shows the lateral extent of these mineral bands, as determined by peat borings and by direct observations along the face of a trench cut through the peat to the underlying mineral soil. The bands extend for different distances laterally, but all are confined to the original 'stream-bed' of the site. It is probable that the mineral bands represent successive episodes of soil erosion, during which mineral particles were washed into the Deep Clough peats from the surrounding slopes; and that some at least of these episodes of soil erosion took place at a time when the peat blanket was less extensive than it is today.

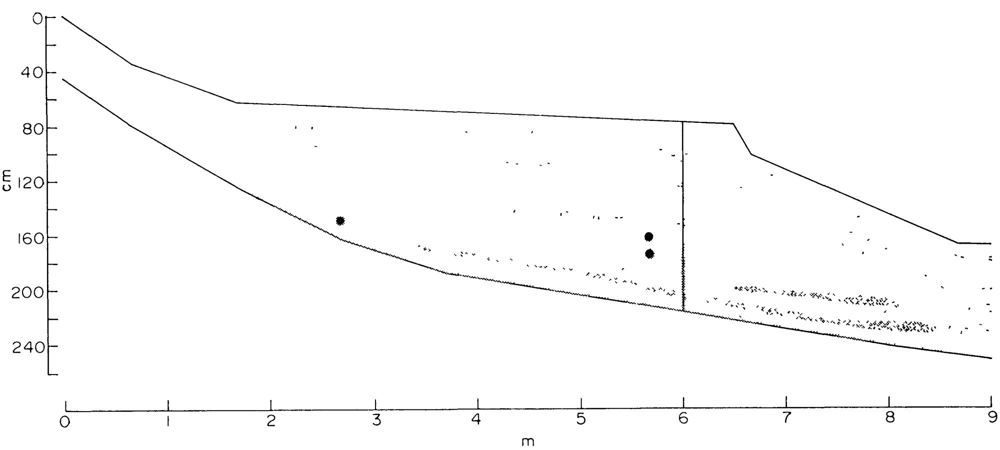


FIG. 4. Detail of the peat stratigraphy in the stream-bed of Deep Clough. Mineral bands are shown stippled, charcoal records black. The shaded area represents the zone of birch remains. The vertical line shows the position of pollen diagram A.

Pollen diagrams were compiled from two sites (Fig. 3)—site A, with a peat depth of 90 cm, and site B, with a peat depth of 27 cm. A continuous monolith of peat was taken from both sites, and divided subsequently into 1 cm slices; contiguous or alternate slices were then analysed as appropriate. Pollen samples were prepared by the standard acetolysis treatment, approximately equal initial weights of peat being used. At least 150 tree pollen grains (including *Corylus*) were counted for each sample. Individual tree pollen counts were expressed as percentage total tree pollen (including *Corylus*); so too were individual weed pollen counts (*Plantago*, *Rumex*, *Artemisia*, Chenopodiaceae, and Compositae, and also Cerealia and *Pteridium*), since most of this pollen was presumed to be of adventive origin and directly related to woodland clearance. Because, however, the pollen diagrams refer to an upland area which appears to have been largely treeless for much of the time covered by the diagrams, it was felt that the customary method of expressing *all* herbaceous pollen types as percentage total tree pollen was not appropriate. What was required, rather, was an assessment of the contribution made by the various herbaceous components to the total vegetation of the region. Accordingly, all other herbaceous pollen components (Ericaceae, Cyperaceae, Gramineae, *Galium*, *Potentilla*, *Succisa*, and also *Sphagnum* and other spore types) were expressed as percentage total land pollen.

THE DISTRIBUTION OF WOODLAND

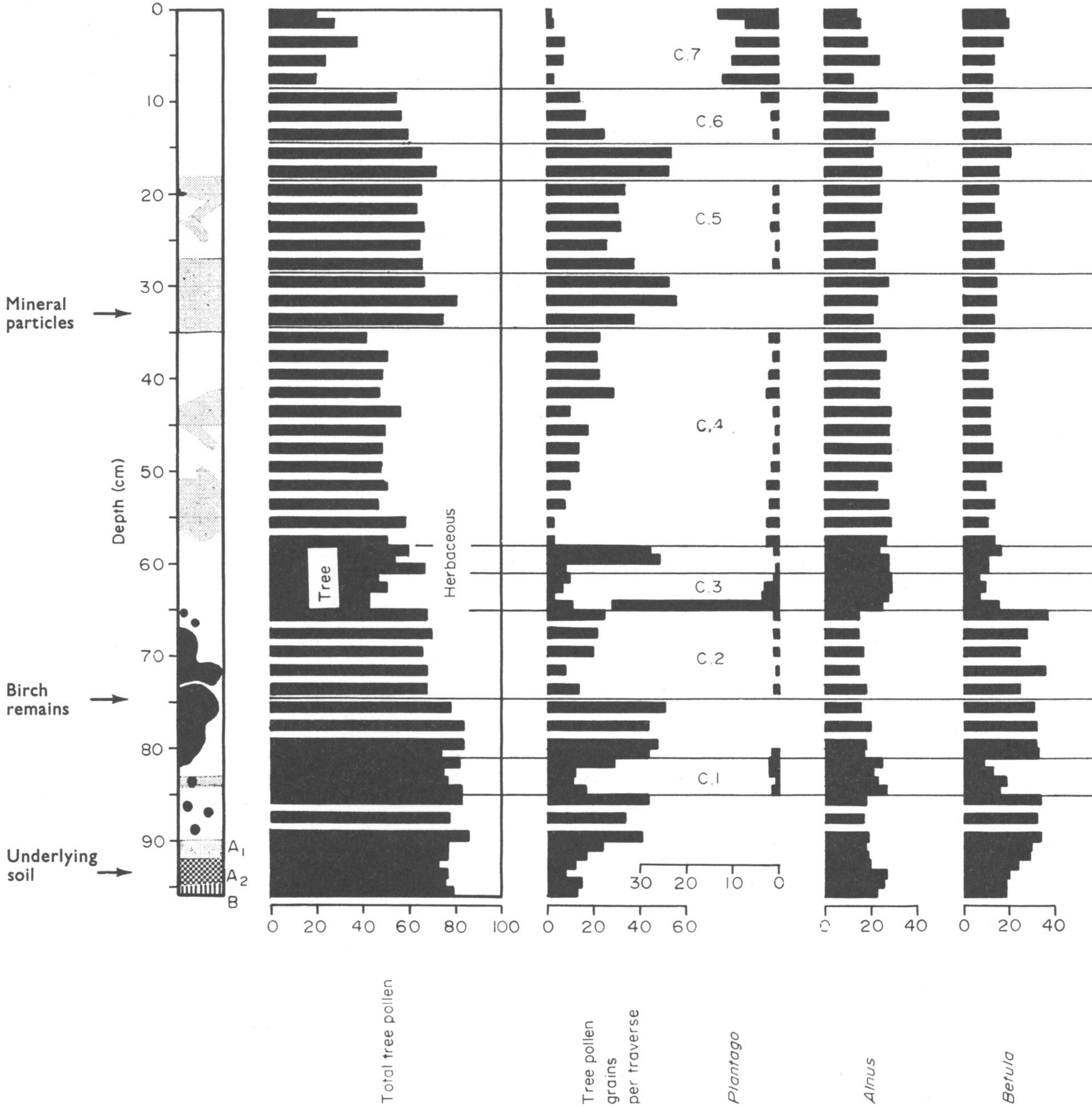
Today the tree vegetation of the Rossendale uplands is extremely sparse, and the only remnants of the former woodland cover are to be found lining the deep valleys of the streams which cut back into the plateau. *Acer pseudoplatanus*, *Alnus glutinosa*, *Betula pendula*, *Crataegus monogyna*, and *Fraxinus excelsior* are the main species to be found in these situations, though isolated trees still survive elsewhere, either as shelter for sheep and cattle or as part of the hawthorn boundaries planted within recent centuries. Deciduous trees also occur in clumps near the now-derelict farm buildings round which they were planted to serve as shelter belts. The most extensive deciduous woodlands in the study area occur within the estates of the nineteenth century factory masters, who were conscious of the amenity value of planted trees to relieve the otherwise bleak and open landscape. In the north of the region local areas have been planted by the Forestry Commission since 1958, to serve as pilot schemes to explore the problems of afforesting smoky and relatively infertile upland areas. The most suitable species are proving to be *Pinus contorta* and *Acer pseudoplatanus*. Fig. 1 shows the present-day extent of woodland in the study area, based largely on Forestry Commission maps.

The former extent of woodland in the region is difficult to ascertain, but since today the presumed tree-line even in Scotland occurs at a considerably higher altitude (640 m—Pears 1967) than any attained in the study area, it is unlikely that altitude as such can ever have been a limiting factor. Tree growth in the past may, however, have been limited by exposure on higher isolated summits such as Bull Hill (418 m), and by shallow or waterlogged soils—though many of the present-day shallow soils in the region probably originated as the result of soil erosion following destruction of the woodland cover (see next Section). Waterlogged soils with varying depths of peat occur on 40–45% of the study area today, but the present-day peat blanket appears to have arisen by the gradual encroachment of peat on to mineral soil over a period of some 6000 years, and prior to the advent of Neolithic man tree growth may have been excluded by waterlogging from only relatively few areas—notably the Black Moss and Wet Moss areas. Here peat depths of up to 4·5 m occur. Pollen counts from the basal peats on Wet Moss (Zone VIIa) contain 75–80% tree pollen (including *Corylus*), so that it is unlikely that extensive areas can have been unwooded then. Direct evidence of the former existence of woodland at higher altitudes comes from the Deep Clough site, where birch remains occur at an altitude of 330 m. Pollen counts from the basal peats and underlying mineral soil here (Zone VIIb) again contain 75–80% tree pollen.

The composition of the original forest cover can only be inferred, using the Wet Moss pollen counts referred to above. The tree pollen spectrum for Zone VIIa here is summarized in Table 1, together with counts, also from Zone VIIa, from the southern Pennines and from Lowland Cheshire. It is clear that no great difference existed between these three dissimilar regions, and that the forest cover over much of north-west England during Zone VIIa must have been composed largely of *Quercus*, *Alnus*, and *Corylus*, with smaller amounts of *Ulmus* and *Betula*.

PREHISTORIC WOODLAND CLEARANCE

The pollen diagram from site A at Deep Clough (Fig. 5) shows a series of correlated



Mineral particles
Birch remains
Underlying soil
Depth (cm)
A1
A2
B
Tree
Herbaceous
C.7
C.6
C.5
C.4
C.3
C.2
C.1
Total tree pollen
Tree pollen grains per traverse
Plantago
Alnus
Betula

(Facing p. 726)

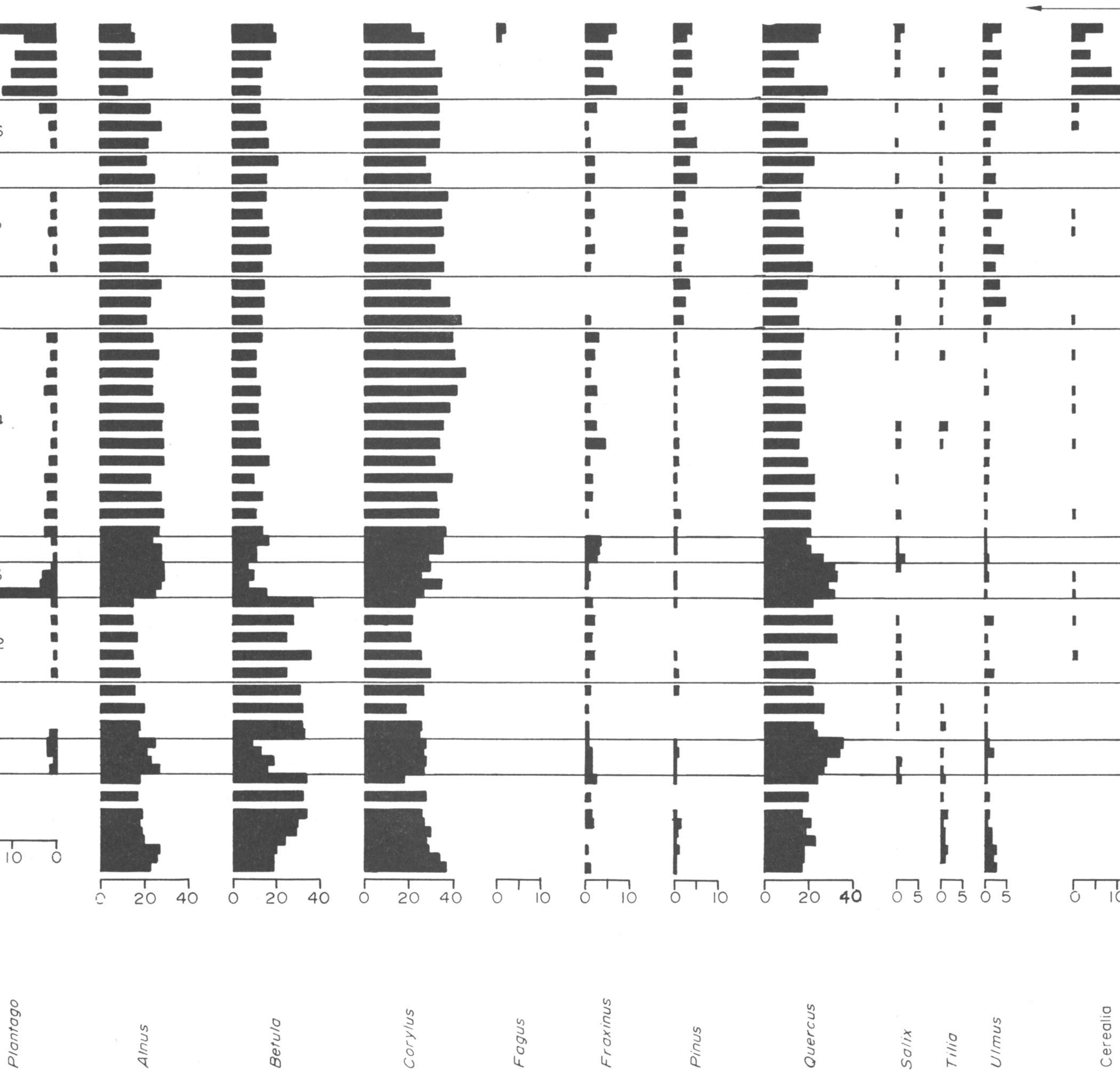


FIG. 5. Pollen diagram for site A, Deep

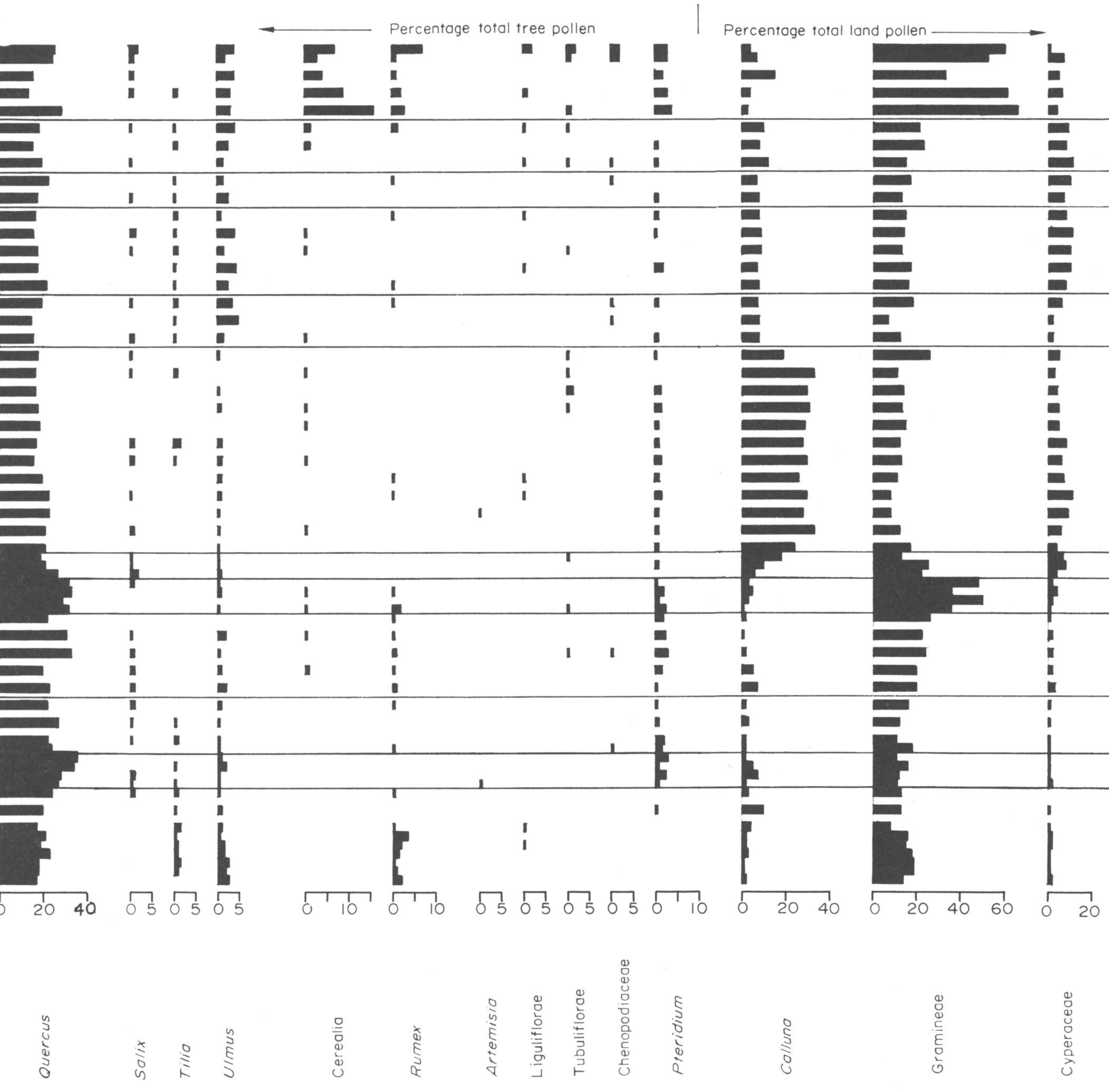
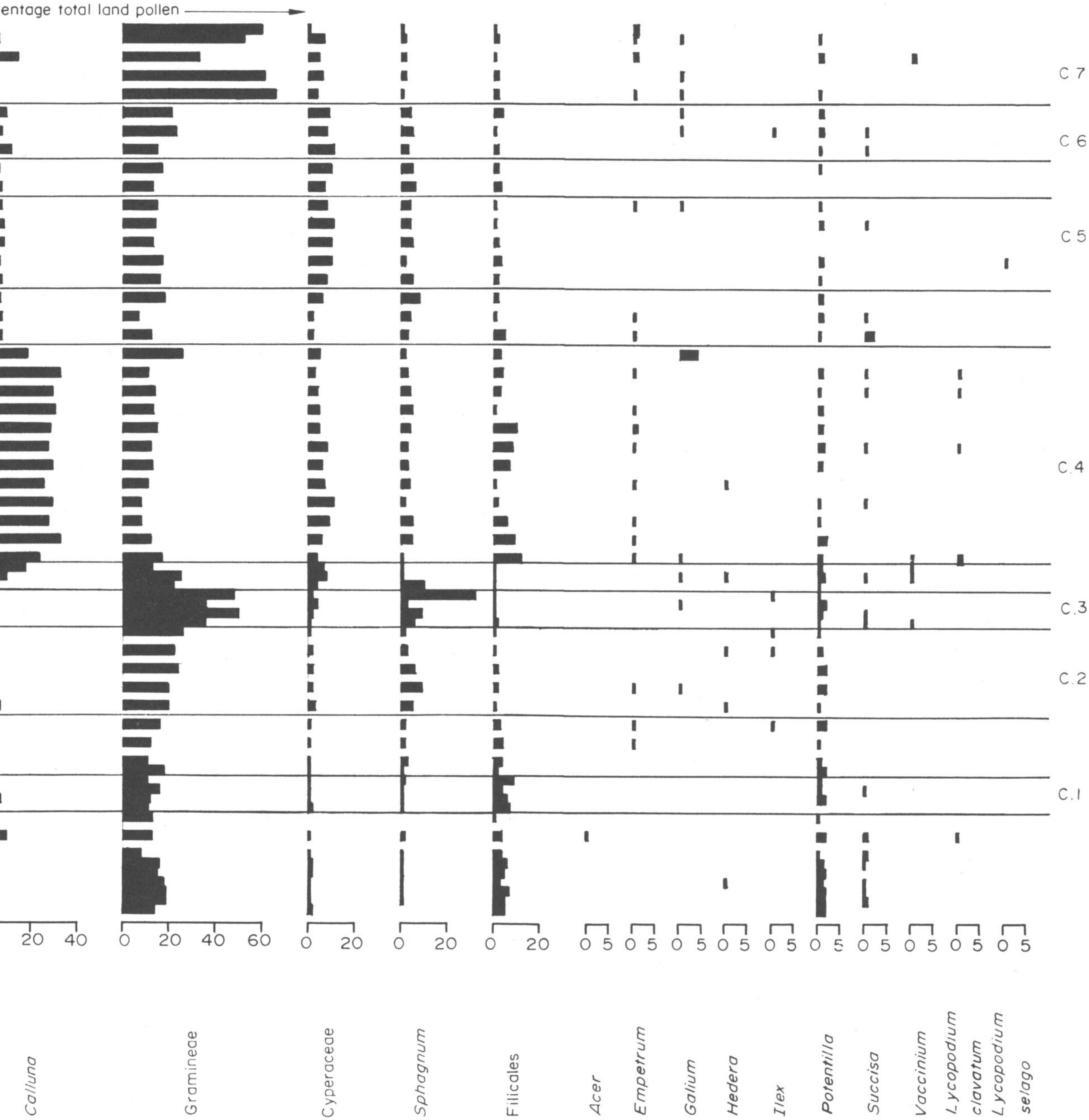


FIG. 5. Pollen diagram for site A, Deep Clough.



entage total land pollen
C 7
C 6
C 5
C.4
C.3
C.2
C.1
20 40
0 20 40 60
0 20
0 20
0 20
0 5 0 5 0 5 0 5 0 5 0 5 0 5 0 5 0 5 0 5
Calluna
Gramineae
Cyperaceae
Sphagnum
Filicales
Acer
Empetrum
Galium
Hedera
Ilex
Potentilla
Succisa
Vaccinium
Lycopodium clavatum
Lycopodium selago

Table 1. *Pollen counts for Zone VIIa for three sites in north-west England (1, Rossendale uplands, Lancashire (Wet Moss, altitude* 380 *m); 2, southern Pennines, Derbyshire (Featherbed Moss, altitude* 510 *m); 3, lowland Cheshire (Flaxmere, altitude* 80 *m)) expressed as percentage total tree pollen, including* Corylus

	1	2	3
Alnus	23–28	22–27	14–19
Betula	4–5	6–12	10–17
Corylus	36–42	28–42	30–36
Fraxinus	0–1	1–3	0–1
Pinus	0–1	2–4	2–8
Quercus	23–25	20–30	24–34
Salix	0	0–1	0–1
Tilia	1–3	1–4	0–1
Ulmus	3–6	4–6	3–6

fluctuations in the values for total tree pollen, tree pollen frequency, and *Plantago* pollen, which can be interpreted as a succession of woodland clearance phases of finite duration, interrupted by periods of woodland regeneration. The presence of the bands of inwashed mineral material in the peat suggests that the sharpness of some of the fluctuations may have been artificially accentuated as a result of surface peat erosion at the times of mineral inwash (thus producing discontinuities in the pollen diagram), but the general pattern of attack on the forest cover seems clear: a series of local clearances, differing in character and intensity, and perhaps associated with heightened soil instability (giving rise to the inwashed mineral particles in the peat). Seven phases of woodland clearance are shown on the pollen diagram, and their main characteristics are summarized in Table 2.

The most striking feature of these woodland clearances in the Deep Clough pollen diagram is the decline in *Betula* values from 37% to 7% in phase C.3, and this appears to mark the permanent disappearance of birch woodland or scrub from the site. The high *Betula* values below 65 cm in the Deep Clough diagram are not reproduced anywhere in the Wet Moss diagram, and must accordingly be interpreted as resulting from the presence of local birch woodland only. The mineral soil below the peat at Deep Clough contains lower percentages of *Betula* pollen, and increasing *Betula* values are associated with the onset of peat accumulation and with declining values of *Alnus*, *Corylus*, *Tilia*, and *Ulmus*. There is no clear evidence from the pollen counts of human activity concomitant with these changes, apart from increased *Rumex* pollen values, and it is possible that the spread of birch resulted naturally from soil deterioration and waterlogging. Pollen

Table 2. *Summary of the characteristics of the main clearance phases in the Deep Clough pollen diagram, with tentative datings (see Appendix) and mean values of the arable:pastoral index* (*Turner* 1964) *for each phase*

Phase	Trees affected	Arable/pastoral index	Soil erosion	Inferred type of clearance	Tentative datings
C.1	Birch (+hazel?)	87	+	Upland	1650–1410 B.C.
C.2	Oak, hazel, lime	57	–	Lowland	1170–690 B.C.
C.3	Birch	92	–	Upland	690–500 B.C.
C.4	Oak	73	++	Lowland+upland	350 B.C.–A.D. 290
C.5	Oak	57	+	Lowland+upland	A.D. 700–1090
C.6	Oak, birch, pine, ash	46	–	Lowland	A.D. 1230–1570
C.7	Oak, alder, hazel	40	–	Widespread	A.D. 1570 onwards

diagrams from Leash Fen and Hipper Sick, north Derbyshire (Hicks 1971), show a similar expansion of *Betula*, and at these sites the expansion took place in Zone VIIa so that human activity is unlikely as a reason. Presumably the birch trees thus established in Deep Clough would also eventually have been overwhelmed by the accumulating peat, so that the striking decline in *Betula* pollen at 65 cm could possibly represent natural death from waterlogging. However, the high *Plantago* pollen counts associated with the *Betula* decline show clearly the existence of deliberate woodland clearance at this time, as do the occasional charcoal fragments in the peat, although the absence of any indications of soil erosion (i.e. inwashed mineral particles) at this level is somewhat surprising.

A temporary decline in *Betula* pollen values also occurs at a depth of 81–85 cm, and small twigs collected from this level in the peat gave a radiocarbon age of 3540 ± 120 years (Birm. 147, by courtesy of Professor F. W. Shotton). Such an age establishes a Bronze Age dating (i.e. 1590 B.C.) for the clearance (and possibly also for the later clearance phases C.2 and C.3). Small twigs from this level in the peat rather than larger roots or branches were used in order to minimize the errors inherent in the bulk-dating of the remains of long-lived perennial plants. Further radiocarbon determinations were not sought since the peat was obviously slow-growing, and samples of sufficient size for ^{14}C estimation would have covered too great a time interval.

There is indisputable archaeological evidence of widespread human activity in the Holcombe area during the Middle and Late Bronze Ages (*c.* 1700 B.C. onwards). For example Jackson (1935) refers to finds of palstaves and axes on Ashworth Moor (3 km to the east of the Deep Clough site) and at Turton (less than 3 km to the west). Several Middle Bronze Age burial mounds occur on the surrounding uplands: the nearest, at Whitelow Hill near Bury, contained twelve–thirteen cremation burials accompanied by urns and artifacts, and was dated on typological grounds to 1650 B.C. (Bu'Lock 1961). The use of wood for cremation indicates the need for some woodland clearance. Jackson (1935) suggests that the Middle Bronze Age settlers lived like gypsies in tents in the open; if this were so, it would help to explain the absence of camp remains in the Holcombe area. Presumably these camps would be near to the burial grounds, but it is not known how far the burials represent population totals: they could be only the burials of the tribal leaders.

The initial Bronze Age clearances at Deep Clough resulted in a drastic local reduction of birch, and an increase in non-wooded communities in which grasses were predominant. Thus following clearance, non-arboreal pollen counts rise from 30 to 57% total pollen, and indicate the creation of a largely open landscape. Further evidence of Bronze Age clearances comes from burial mounds at Winter Hill (Bu'Lock, Rosser & Dimbleby 1960) and Wind Hill, where pollen counts were made from the turf layers buried below the mounds, and at Winter Hill from the turves composing the mound itself. These counts are summarized in Table 3. At Winter Hill (dated on typological grounds to 1600–1400 B.C.), non-arboreal pollen totals are lower than at Deep Clough, and the authors conclude that 'the barrow was built in a treeless clearing, whereas the turves came from open woodland or glades'. *Quercus* and *Alnus* are the predominant tree pollen types. At Wind Hill non-arboreal pollen counts from the buried turf layer considerably exceed tree pollen counts, and substantial woodland clearance appears to have preceded the construction of the barrow here. As at Deep Clough birch was a prominent component of the cleared woodland. Substantial clearance of birch woodland is also shown in two pollen diagrams from north Derbyshire (Hicks 1971), at a period dated on radiocarbon evidence to around 1500 B.C.

Table 3. *Pollen counts from Bronze Age burial mounds* (1, *Winter Hill, old surface;* 2, *Winter Hill, turves from mound;* 3, *Wind Hill, old surface*)*; the tree pollen counts expressed as percentage total tree pollen, including* Corylus; *the herbaceous pollen counts expressed as percentage total land pollen* (*the Winter Hill values have been re-calculated from Bu'Lock* et al. (1960))

	1	2	3
Alnus	28	29	29
Betula	11	7	18
Corylus	28	36	37
Fraxinus	1	1	3
Pinus	1	1	–
Quercus	30	25	12
Tilia	1	1	–
Ulmus	1	1	–
Total tree pollen as % total land pollen	50	61	22
Calluna	22	15	43
Gramineae	22	17	25
Cyperaceae	3	7	4

At both Winter Hill and Wind Hill the soils below the barrows show a developing podsol structure, with thin iron pan layers at 20 cm and 15 cm respectively. The pollen spectra indicate local establishment of heathland communities. Dimbleby (1962), on the basis of countrywide pollen analyses of buried soils, concludes that 'in the majority of cases the degraded soils covering extensive areas are secondary and were not the soil types in equilibrium with the uncleared forest'. There is, therefore, a strong likelihood of local woodland clearance in the Rossendale uplands prior to the Bronze Age, resulting in a spread of either birch or heather. Several Neolithic tumuli and camp sites are known from the moorlands, and numerous artifacts have been found in the near vicinity of the Deep Clough site (Fig. 6). These include a large flint axe from Cinder Hill, Bury, and flint knives, scrapers, arrowheads, spear-tips, and chippings from several localities within

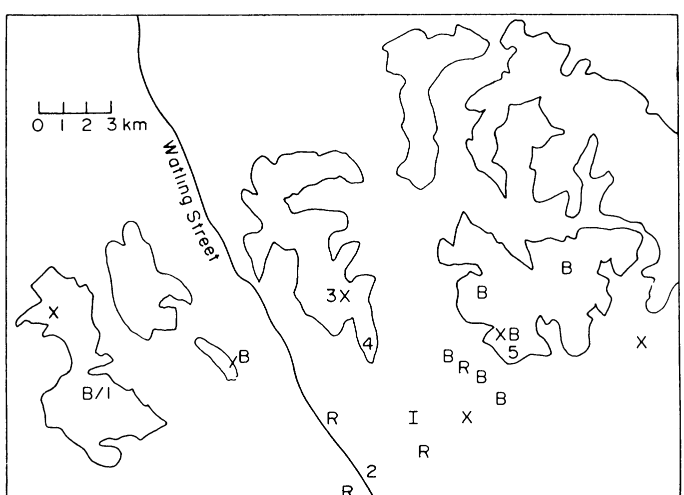


FIG. 6. Sketch map showing the location of archaeological finds and pollen counts within the study area. Only the 1000 ft (305 m) contour is shown. Archaeological finds: ×, Neolithic; B, Bronze Age; I, Iron Age; R, Roman. Pollen counts: 1, Winter Hill; 2, Roman Road; 3, Wet Moss; 4, Deep Clough; 5, Wind Hill.

a 12-km radius of the Deep Clough site. The nearest locality, Bull Hill, yielded fifty–sixty flakes and chips of flint, an arrowhead, and a flint core, from what was probably the site of a Neolithic weapon factory. Although finds are scattered, there seems to be sufficient evidence to suggest Neolithic activities on the moorlands in the study area.

A tentative reconstruction can be made of a number of vegetation types already in existence by the close of the Bronze Age in the Rossendale uplands as follows.

(1) Largely undisturbed woodland, in which the major components were oak, alder, and hazel.

(2) Secondary or degenerating woodlands with birch as an important component, or even locally dominant.

(3) Local bracken-infested areas, within or around degenerating woodland (as shown by the records for *Pteridium* spores in Fig. 5).

(4) Bog vegetation, as yet on relatively shallow peat, with *Eriophorum vaginatum* or *Molinia caerulea* predominant.

(5) *Calluna* moorland on developing podsols.

(6) Pastureland, perhaps on the deeper soils, with a variety of associated forbs. There is, however, no evidence of any significant arable cultivation during the Neolithic and Bronze Ages.

In the Deep Clough pollen diagram there are indications of a major change in the non-tree vegetation a short distance above the *Betula* decline. *Sphagnum* spore values rise to a peak at 61–62 cm, and this peak is immediately followed by a sudden replacement of Gramineae by *Calluna* as the predominant herbaceous pollen type, and by a smaller rise in Cyperaceae pollen values. These changes suggest an increase in site-moisture, perhaps resulting from the climatic deterioration at the beginning of Zone VIII (500–600 B.C.). Such a suggestion is in accord with the Bronze Age dating of the preceding clearance phase (and with the tentative calculated datings given in Table 2), and is supported by two further lines of evidence which are as follows.

(1) Pollen grains of *Ilex* and *Hedera* occur consistently in the peat only below 59 cm, and since these are well-known thermophilic plants their virtual disappearance higher up could be a reflection of climatic deterioration.

(2) At the Deep Clough site peat formation was confined initially to the wetter valley floor of the upper reaches, where the slope was not sufficient to maintain a permanent water course but where the soil was kept waterlogged by slowly-moving ground water. Only later did peat spread on to the surrounding gentler slopes. Thus the pollen diagram for site B (Fig. 7) lacks the high *Betula* values characteristic of the basal 25 cm of the diagram from site A. The pattern of *Plantago* and Gramineae values in diagram B suggests that the increased *Plantago* values between 16 and 20 cm correspond to part of phase C.4 in diagram A, and this is corroborated by the *Calluna* values. The base of diagram B thus appears to coincide more or less with the 60 cm level in A, at which the changes mentioned above occur. The most probable time, on theoretical grounds, for an extension of peat formation in Deep Clough would have been about 500 B.C.

In the pollen diagram from site A there follows a prolonged clearance phase (C.4), associated with considerable inwash of mineral material; because of the mineral inwash it is not possible to define the length of time occupied by this clearance phase, but it is likely to be contemporaneous in part with the Iron Age and Roman Occupation. The Iron Age is not well represented in the archaeological record of the study area. There is an almost complete absence of material of this period, although there is a possibility that a ditch-and-bank site soon to be excavated near the River Irwell at Walmersley will

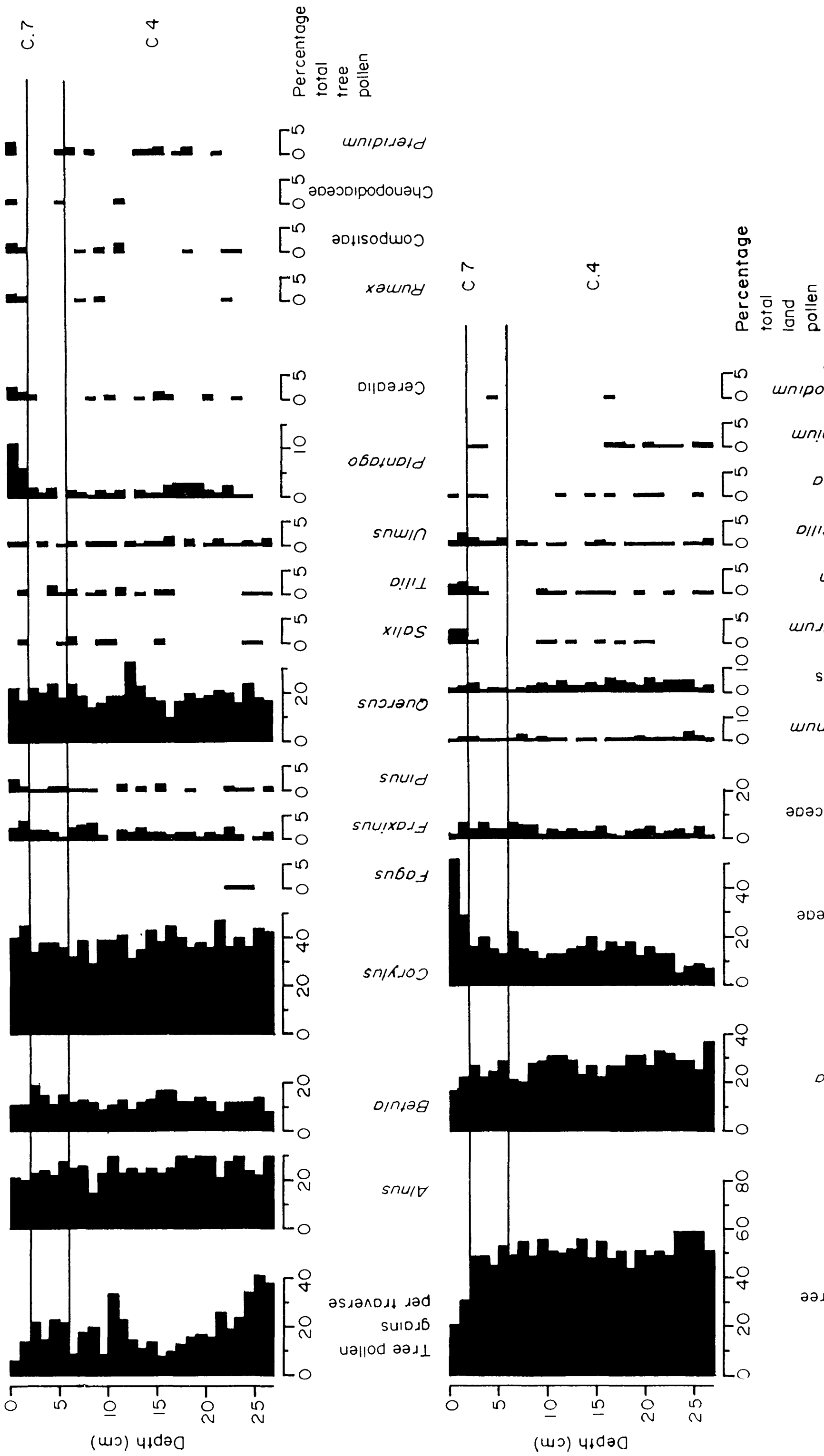


FIG. 7. Pollen diagram from site B, Deep Clough.

provide evidence of Iron Age activities in the area. Jackson (1935) suggests that the lack of evidence of an Iron Age culture generally in Lancashire and Cheshire is in part due to climatic changes. Unlike the greater part of the preceding Bronze Age, a dry warm period in which settlement in certain upland and valley areas was possible, the Iron Age appears to have had a comparatively wet and cool climate. This led to great changes in areas previously available for settlement, and could have resulted in a partial withdrawal of settlers from the Rossendale uplands. However, Hicks (1971) found that the two major woodland clearance episodes on the uplands of north Derbyshire could be dated on radiocarbon evidence to 140–340 B.C. (i.e. Iron Age) and A.D. 40–420 (i.e. Roman), and she suggested that 'the absence of archaeological finds from the upland itself may result from the population at this time becoming localised on the flanks of the hills, with cultivation taking place predominantly at lower levels. If this increased population ceased to be semi-nomadic in the way that the Neolithic and Bronze Age peoples had been, but instead began to practise transhumance (visiting the uplands mostly in summer to pasture herds) then the archaeological and pollen data are reconciled'.

Table 4. *Pollen counts from soil buried below the Roman road at Ainsworth, Lancashire (tree pollen counts expressed as percentage total tree pollen, including* Corylus; *herbaceous pollen counts expressed as percentage total land pollen)*

Alnus	43	*Calluna*	2
Betula	3	Cyperaceae	1
Corylus	32	*Plantago*	1
Quercus	17	*Succisa*	2
Ulmus	4	Filicales	17
Total tree pollen as % total land pollen	86	*Sphagnum*	36
Gramineae	8		

The persistence of dense forest, at least in the lowlands, at the start of the Roman period is shown by pollen counts from soil immediately below the Roman road at Ainsworth, some 6 km to the south of the study area (Table 4). This road, a continuation of Watling Street, was constructed along the western flank of the uplands in the first century A.D. as a military link between Manchester and Ribchester. Although pollen preservation in the soil was poor, so that firm identification of many grains was not possible, the counts show a great preponderance of tree pollen (86% of total pollen). The predominant pollen type is *Alnus*, and this and the high counts of *Sphagnum* spores suggest widespread alderwoods in the damper lowlands. The buried soil, moreover, contained large amounts of finely comminuted charcoal, presumably resulting from woodland clearance by burning prior to the construction of the road.

In the Deep Clough pollen diagram very considerable changes occur at the close of clearance phase C.4 in the interval 29–34 cm. Total tree pollen and tree pollen frequency values rise sharply, and weed and cereal pollen records cease. There is little doubt that these changes represent a phase of woodland regeneration, during which a woodland cover approximating in extent to that pertaining prior to the Bronze Age clearances was re-established (since tree pollen rises to 80% of total pollen again). In this regenerating woodland *Pinus*, *Ulmus*, and *Tilia* occur with increased frequency. At the same time *Calluna* and Cyperaceae pollen values decrease sharply, and since grass pollen totals remain substantially unchanged it appears that some at least of the woodland regeneration took place at higher altitudes at the expense of *Calluna*- and *Eriophorum*-dominated communities.

In the absence of firm datings for these changes in the pollen diagram it is not possible to correlate them with known historical events (though it is tempting to ascribe them to the so-called Dark Ages of the fifth and sixth centuries A.D.). What does seem clear, however, from the pollen evidence is that despite the widespread effects on the vegetation produced by the Bronze Age clearances, subsequent climatic deterioration in the Rossendale uplands lowered human population levels sufficiently to allow substantial woodland regeneration at lower altitudes, and probably also at higher altitudes; but that at higher altitudes the climatic deterioration resulted also in soil erosion and impoverishment, and the spread of peat.

DOCUMENTARY EVIDENCE OF WOODLAND CLEARANCE

Documentary evidence relating to woodland clearance does not begin until after the Norman Conquest, so that there is a gap of several centuries for which no direct evidence is available. Evidence from place names (McGuire 1971) suggests a gradual penetration of the Rossendale uplands by Anglian and Scandinavian settlers from the sixth century onwards. This penetration was temporarily checked after the Conquest as a result of the conversion of large areas of north-west England into forests and chases for hunting.

In mediaeval times the study area was divided between the Hundreds of Blackburn and Salford, both of which were granted to Roger of Poitou after the Norman Conquest.* Ownership of the Hundred of Blackburn, together with the hunting rights, passed to Robert de Lacy shortly before A.D. 1100, and the Manors of Tottington and Bury were added around A.D. 1230. Hunting rights over these properties were jealously guarded, and until Henry VII's disafforestation order in A.D. 1507 the area was subject to Forest Law. Infringement of the laws 'by cutting wood or by lopping the outer branches of trees, or by digging peats, or by stripping turf off the moor or by cutting underwood or by assart, or by purpresture by a ditch or hedge, or by removal of a mill or watercourse or of a sheepfold, or any house or by mowing hay outside ditches or hedges' rendered offenders liable to heavy fines (Forest Code of Henry II, A.D. 1184, quoted by Shaw 1956). Little encouragement was thus afforded to settlement, and agricultural activities were strictly curtailed. However, the forest lands were managed by a Master Forester and his assistants with a view to ensure not only a supply of game but also a source of revenue, so that pressure on the woodlands was never totally relaxed. Documentary evidence suggests that the trees were regularly lopped or pollarded to provide winter browse for the deer, and selected mature trees were cut out at intervals for timber; but since the forest accounts for Rossendale contain only occasional references to the sale of oaks for timber or to fines imposed for unlawful felling, it is probable that good quality trees were rare in the uplands. Deterioration of the woodlands would have been promoted by the practice of pannage, whereby pigs were allowed into the woodlands in autumn, on payment of a pannage fee (usually 1d per pig per year), to feed on the acorns. This source of income is not mentioned in the forest accounts after A.D. 1400, and the practice may have lapsed by then as a result of woodland degeneration. Brushwood was also intermittently sold to provide fuel for iron-smelting: this was never a regular practice, but is mentioned for Hoddlesden for 1295–6 and again for 1341–2, and for Tottington for 1305 (Lyons 1884).

* Unacknowledged information in this Section is from Tupling (1927).

Since the forest records refer only to saleable timber it is not possible to gain from them any clear impression of the composition of the woodland at the time. However, the trees mentioned in the records are all sparse or absent in the Rossendale uplands today: oak, three records; holly, three records; lime, one record (Farrer 1913).

A major source of income from the forest lands was the granting of privileges to graze cattle and to cut hay within the boundaries, and areas were increasingly set aside for this purpose. Parts of Alden, Musden, and Ugden, within the ancient Forest of Tottington, were being so used by the end of the thirteenth century. A large tract of land in the south-west of the study area (Fig. 1) was granted by Roger de Lacy to the monks of Mountbegon in A.D. 1220 'to have and to hold all within the above the earth and below and to use with all the aforesaid according to their will and pleasure; . . . saving however venison and young falcons to me and my heirs within the said boundaries. Moreover I have given and granted to the said monks the whole of my forest and full feeding to their cattle of the forest within the said underwritten boundaries . . . saving however to the men of Tottington the common which of old time they were wont to have. Moreover I have given and granted to the said monks three acres of meadow below Arkilshou [i.e. Harcles Hill] next Pilgrimerosche and the said monks may make a hedge or ditch as they desire around the said meadow.' (Whitaker 1818).

The use of the term 'wood' as opposed to 'forest' elsewhere in this charter, and the reference to local place names indicative of woodland (Arkilshou, Titelshou) suggests that woodland may have been extensive within the study area at this time.

Over much of Rossendale permanent upland cattle ranches or vaccaries were established during the twelfth century, but none apparently occurred within the study area. However, the exact extent of these vaccaries is not known, and those in the Irwell valley may have included upland grazing within the study area itself; so, too, may the cattle farm at Hoddlesden, just outside the north-west boundary, which was used for gathering together cattle prior to re-distribution or sale. This is first mentioned in A.D. 1296, and had probably developed into a vaccary by 1323. Initially the vaccaries were established to maintain the plough teams of the Lord of the Manor (horses being little used for this purpose), but it was soon realized that revenue could be gained from the sale of cattle for beef. Increasingly during the fourteenth century, however, both the vaccaries and the lands from which the foresters had previously collected herbage and grazing fees were being let out to rent-paying tenants, whose livelihood was gained mainly by the rearing of stock. Thus the pastures of Alden, Musden, and Ogden were all yielding rent instead of grazing dues by 1341–2.

Increasing pressure by the local inhabitants on the forest lands is indicated by the decision of Henry de Lacy in A.D. 1304 to enclose 904 ac (366 ha) in the centre of the study area as a deer park, in order to restrict the movement of deer and to facilitate hunting (Tupling 1927). The boundary fence of Musbury Park had a circuit of $4\frac{1}{2}$ miles (7·2 km) (Fig. 1), and its construction must have made considerable inroads into the timber resources of the area. A local park-keeper was appointed to look after the welfare of the deer, but the office ceased to exist in 1480 since 'in our said parke there is no game to kepe'. Rights of herbage within the park had, in fact, been granted more or less continuously since 1360.

In A.D. 1507, as a result of a Commission set up to review the possibilities of improving the Crown Lands in Lancashire (Farrer 1897), enclosure of waste lands was permitted, provided the enclosure was legally registered at the Halmote Court and rent paid. Enclosure in Rossendale was carried out piecemeal, both by existing tenants and by new settlers, and continued well into the eighteenth century. In addition many former holdings were subdivided. The unenclosed land, many thousands of acres of which still survived at the end of the sixteenth century, was utilized by the local people for common grazing, peat-cutting, and timber. Common rights of timber extraction included 'housebote' (the right to cut timber for the repair of the house), 'hedgebote' (for repairing gates and hedges), and 'ploughbote' (for repairing the plough or cart). These rights were practised in the study area on the upland commons of Holcombe Moor, Tor Hill, Haslingden Moor, and Oswaldtwistle Moor, and no doubt caused a great reduction in the woodland that remained in the cloughs and on the moorland crests. A humble petition to James I in 1618 (Whitaker 1818) summarizes the condition of the Rossendale uplands as follows: 'The soil is extremely barren and as yet not capable of any other corn but oats, and that in dry years and not without continued manuring every third year, and that they have no timber within many miles thereof'.

Thus the documentary evidence indicates a gradual depletion of woodland resources in the three centuries prior to A.D. 1507, and the development of a pastoral economy based on cattle. The term 'arable' is seldom to be found in the mediaeval records as a description of land in the Rossendale district. 'If open arable fields existed, they must have been small, partly because of the small number of villein tenants, and partly because the nature

Table 5. *References in the Court Rolls to land-holdings of litigants in the Holcombe area in mediaeval times* (*Farrer* 1897, 1913)

Locality	Date	Acreage					
		Wood	Pasture	Meadow	Moor and moss	Park	Land
Tottington	1274	100	100				40
Turton	1303	16	10	4			20
Turton	1415	2		3			18
Turton	1505	4		10			30
Oswaldtwistle	1538			6	40	16	10
Turton	1546	4	200	80	300		100
Oswaldtwistle	1552		20	10	100		30
Eccleshill	1554		40	40	200		150

of the surface and the soil would not allow the laying down of large fields for tillage' (Tupling 1927). After 1507 there was a rapid increase in settlement, and the development of a more mixed farming economy. This changing pattern of land-use can be seen in Table 5, which summarizes references in the Court Rolls to land-holdings of litigants in the study area. The category 'land' in these records is rather vague, but may well indicate arable land since all other categories of land-use appear to be specified.

The changing patterns of land-use since the Norman Conquest are probably also recorded in the Deep Clough pollen diagram by clearance phases C.6 and C.7. Phase C.6 is of limited effectiveness, and is marked by clearance of *Quercus*, and to a lesser extent of *Betula*, *Pinus*, and *Fraxinus*. Only during phase C.7 is there evidence of widespread forest destruction. *Quercus*, *Alnus*, and *Corylus* decline successively, reflecting probably an initial clearance of the drier lowland oakwoods, then the wetter valley alderwoods, and finally of marginal hazel scrub. Pollen of cereals and agricultural weeds is present in quantity throughout the phase, and there are clear indications of increased arable land usage.

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SUMMARY

Pollen-analytical, archaeological, and documentary evidence is used to investigate the process of woodland clearance within a small upland area of Central Rossendale, Lancashire, from Neolithic times to the present day. There is direct evidence of massive local clearance of woodland, accompanied by soil erosion, in the Middle and Late Bronze Ages, and indirect evidence of further clearance in the Iron Age. However, woodland may have re-established itself subsequently over much of the study area, though restricted in the uplands by podsolization and soil erosion, and this woodland persisted until well after the Norman Conquest. The documentary evidence indicates a gradual depletion of woodland resources in the three centuries prior to A.D. 1507, and the development of a pastoral economy based on cattle. After 1507 there was a rapid increase in settlement, the development of a more mixed farming economy, and the almost total clearance of the remaining woodland.

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APPENDIX

Tentative datings for the clearance phases shown on the Deep Clough pollen diagram

Tentative datings for the durations of the seven clearance phases are given in Table 2, and are based on the method described below. It is recognized that the method is open to many criticisms, and that the datings can have validity only if supported by other, independent, evidence. This the archaeological and documentary evidence appears to provide.

The peat throughout the profile at site A in Deep Clough is of remarkably uniform consistency and density, with densities, as measured by the weight of wet peat necessary to displace 1 ml benzene, ranging from 1·06 to 1·24. There do not appear to have been any major differences in the rate of peat accumulation apart from the periods when mineral matter was being incorporated. There is no evidence from the state of pollen preservation that this incorporation of mineral matter involved any erosion of the peat, and the mineral bands *may* consequently represent merely an accelerated rate of deposition. On average some 40–50% by volume of the mineral bands consists of organic matter, so that the thickness of a mineral band is approximately twice that of a peat layer of equivalent age. If these assumptions are made, and if a more or less constant rate of peat accumulation is also assumed, then approximate datings for various levels in the pollen diagram based on the known dates of 1590 B.C. for 81–85 cm and A.D. 1950 for 0 cm can be estimated. These datings are given in Table 2.

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