Fifth International Palynological Conference 1980

Guidebook for Excursion C8

QUATERNARY VEGETATIONAL HISTORY OF WESTERN SCOTLAND

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INTRODUCTION

In Scotland today, four major potential vegetation regions are deducable from existing woodland fragments on islands, in ravines and gullies, on cliffs, and on steep blocky slopes (McVean and Ratcliffe, 1962). South of the Grampian Highlands and up the west coast as far north as southern Skye oak forest with birch, elm, oak and alder would predominate (see Fig. 1); in central Scotland pine forest would predominate with some birch and oak; to the north and west birch forest would predominate with hazel and rowan; and in exposed coastal areas in the far north, on the smaller Hebridean islands, and on Orkney and Shetland the landscape would be naturally treeless, even at low altitudes.

The existence of this pattern poses several important ecological questions, answers to which can be provided by palaeoecological studies of Holocene (Flandrian) deposits. When did the pattern originate and how did it develop? What factors controlled the vegetational differentiation? What were the relative importance of local environmental factors, plant migration, and man's activities in influencing the pattern? Has the pattern existed throughout the Holocene, and have the boundaries between forest regions changed in position with time?

Prior to the reforestation of Scotland after the end of the last glaciation, complex but major environmental changes occurred between about 13500 and 10000 yrs B.P., with the development of corrie glaciers on many Scottish mountains and of a large ice-cap in western Scotland during the Loch Lomond stadial of between 11000 and 10000 yrs B.P. (Sissons, 1979). The elucidation of the environmental changes during the Devensian late-glacial represents a major challenge to Quaternary palaeoecologists and it requires detailed pollen analytical studies, precise dating, and thorough mapping of the glacial landforms and deposits formed during the Loch Lomond stadial. In the last 15 years considerable advances have been made in our knowledge of the Devensian late-glacial of Scotland, and some of the major study areas will be visited on the excursion.

The aims of this excursion are threefold.

(1) We will visit representative stands of the major forest types existing in western Scotland today and we will visit several sites where detailed Holocene pollen diagrams are available. Consideration of these diagrams and also of diagrams from sites elsewhere in western Scotland, which, because of shortage of time, we will not be able to visit will provide some insights into the historical and ecological development of the Holocene forest patterns of western Scotland.

(2) We will visit areas where the Devensian late-glacial vegetational history has been studied in detail, often in relation to glacial landforms. A general picture of spatial and temporal variation in the vegetation of western Scotland between 13000 and 10000 yr B.P. will emerge as the excursion travels from south to north.

(3) Because the flora and vegetation of western Scotland are so diverse, we will visit some areas of considerable botanical interest even though very little, if anything, is known about the Quaternary vegetational history of these areas.

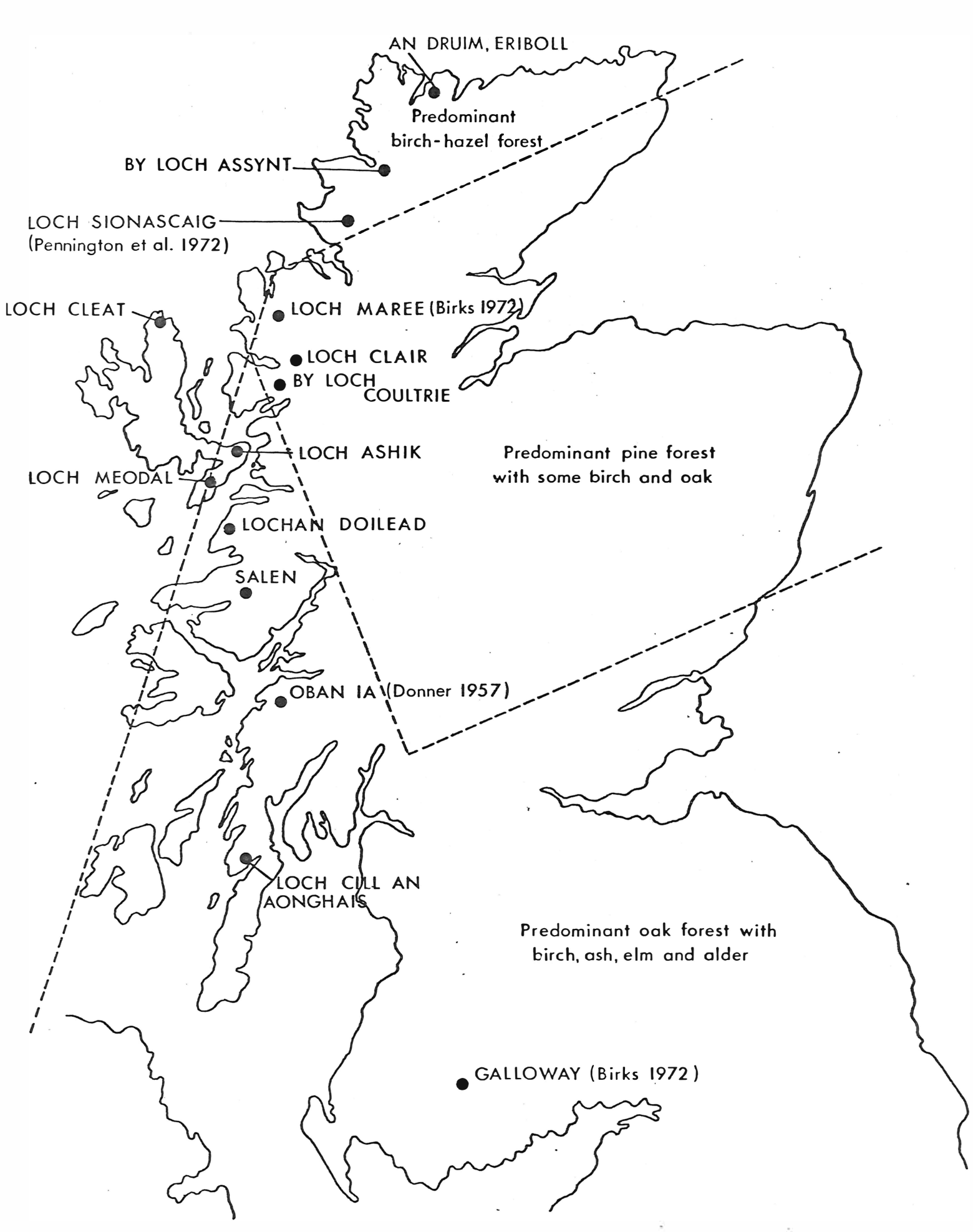

AN DRUIM, ERIBOLL
Predominant
birch-hazel forest
BY LOCH ASSYNT
LOCH SIONASCAIG
(Pennington et al. 1972)
LOCH CLEAT
LOCH MAREE (Birks 1972)
LOCH CLAIR
BY LOCH
COULTRIE
LOCH ASHIK
Predominant pine forest
with some birch and oak
LOCH MEODAL
LOCHAN DOILEAD
SALEN
OBAN IA (Donner 1957)
LOCH CILL AN
AONGHAIS
Predominant oak forest with
birch, ash, elm and alder
GALLOWAY (Birks 1972)

Fig.1.

DAY 1 (JULY 6) CAMBRIDGE TO DRYMEN

This is a day of travel with no scientific stops. The vegetational history of southern Scotland in general closely resembles that of northern England. Holocene diagrams from Loch Dungeon in the Galloway Hills (H.H. Birks, 1972) to the west of the main Carlisle to Glasgow road and from Loch Cill on Aonghais in south Argyll (Fig. 1) are shown in Figures 2 and 3 as representative of the Holocene pollen stratigraphy of southern Scotland.

At the close of the Devensian late-glacial (zones LD-1 and LCA-2) Juniperus and Empedtrum heaths were widespread, interspaced with herb dominated grass and sedge communities in which grew competition-intolerant herbs such as Thalictrum, Saxifraga spp., Rumex acetosa, and Artemisia norvegica. By 9800 B.P. Betula (probably B. pubescens) expanded rapidly to form open birch woods with Populus and willows, tall-herbs such as Filipendula, and ferns such as Dryo pteris filix-mas. Corylus avellana (hazel) spread rapidly at about 9500 B.P. to form mixed birch-hazel woods, perhaps differentiated by edaphic factors with hazel favouring the richer soils and birch confined to the more acidic sites.

Quercus and Ulmus expanded in Galloway at 8500 B.P. and in southern Argyll at 8000 B.P. to form mixed deciduous forest, with Hedera helix (Ivy), Ilex aquifolium (holly), Sorbus aucuparia (rowan), and Lonicera periclymenum (honeysuckle). In Galloway Pinus sylvestris arrived at about 8000 B.P. but remained rare, occupying marginal habitats, such as near tree-line (ca. 610 m) and dried peat-bog surfaces between 7500 and 6800 B.P. Fossil pine stumps dating to these times are common in the Galloway Hills (H.H. Birks, 1975; Fig. 4) where, as a result of subsequent bog development they were buried by peat. The lime (Tilia cordata), to judge by its low fossil pollen values, was absent from southern Scotland. There is no evidence that it was ever a native tree in Scotland. Pine was never important in south Argyll (Figs. 3 and 4).

At 7500 B.P. Alnus glutinosa (alder) expanded, perhaps largely replacing Salix and Betula in wet habitats. This date for the expansion of alder is the same as in areas further south but is 1000 years older than in parts of central Scotland and is 2000 years older than in northernmost Scotland. The dynamics of the expansion of alder are not clear but there is good evidence for its local growth in southern Argyll from at least 7985 B.P., nearly 500 years prior to its regional expansion there.

The decline in Ulmus pollen at 5000 B.P. may mark the beginning of human interference on the vegetation of the area, with some forest clearance, small pastoral farming, and phases of forest regeneration, often involving Fraxinus excelsior (ash). Extensive clearance occurred in the last 2000 years, with the development of grassland, heath, and bog until the largely treeless conditions of southern Scotland were reached. During recent times conifers have been widely planted commercially, and an increase in Pinus and Picea pollen is detectable in pollen diagrams that extend to the present day.

All the pollen diagrams from southern Scotland indicate that oak forest with birch and hazel was the natural forest vegetation of the area. Although important before 5000 B.P. Ulmus was reduced by man's activities and by progressive soil deterioration, leaving oak, birch, and hazel the major forest trees, with alder and willow on wetter sites and ash on damp, mildly basic soils.

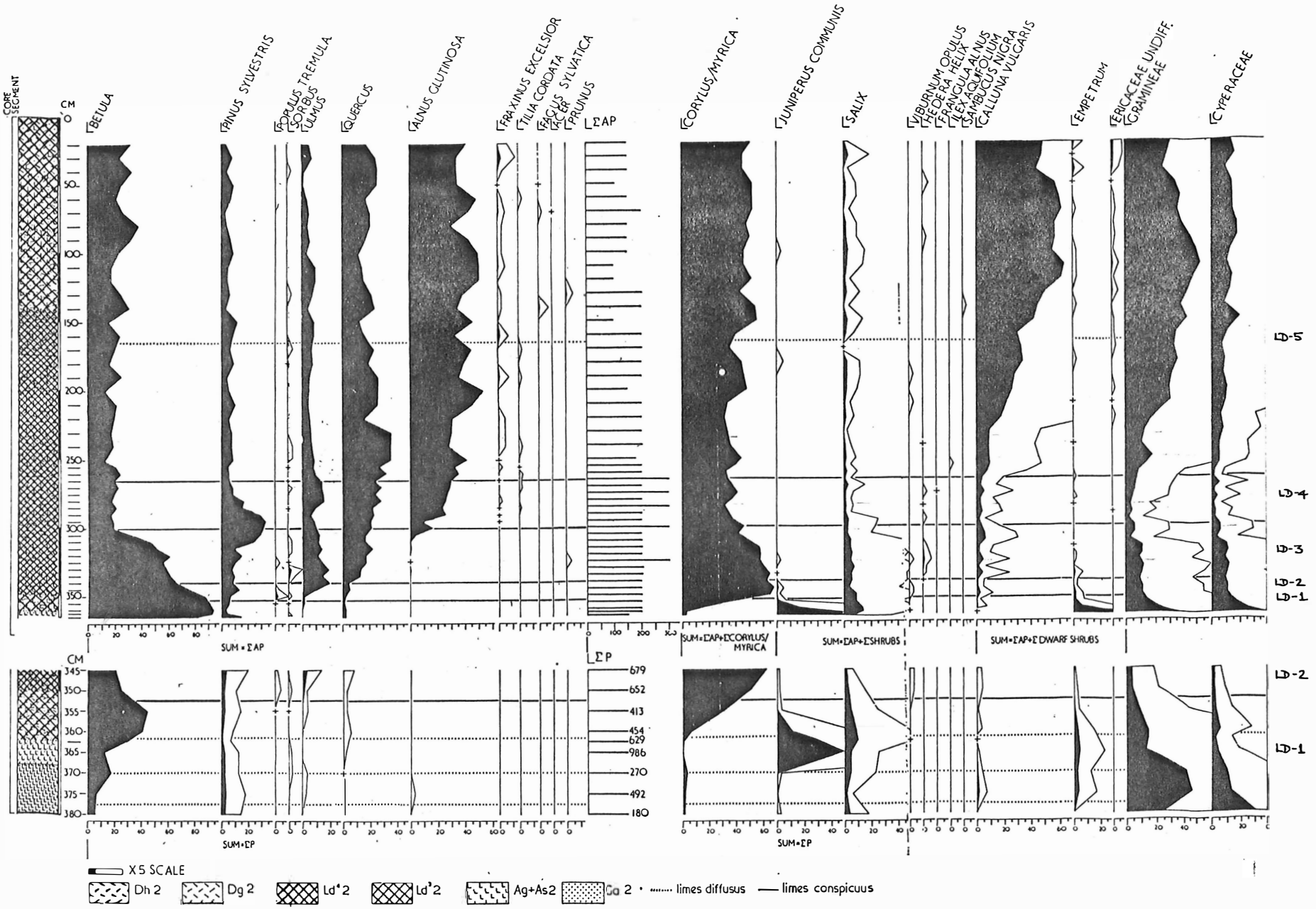
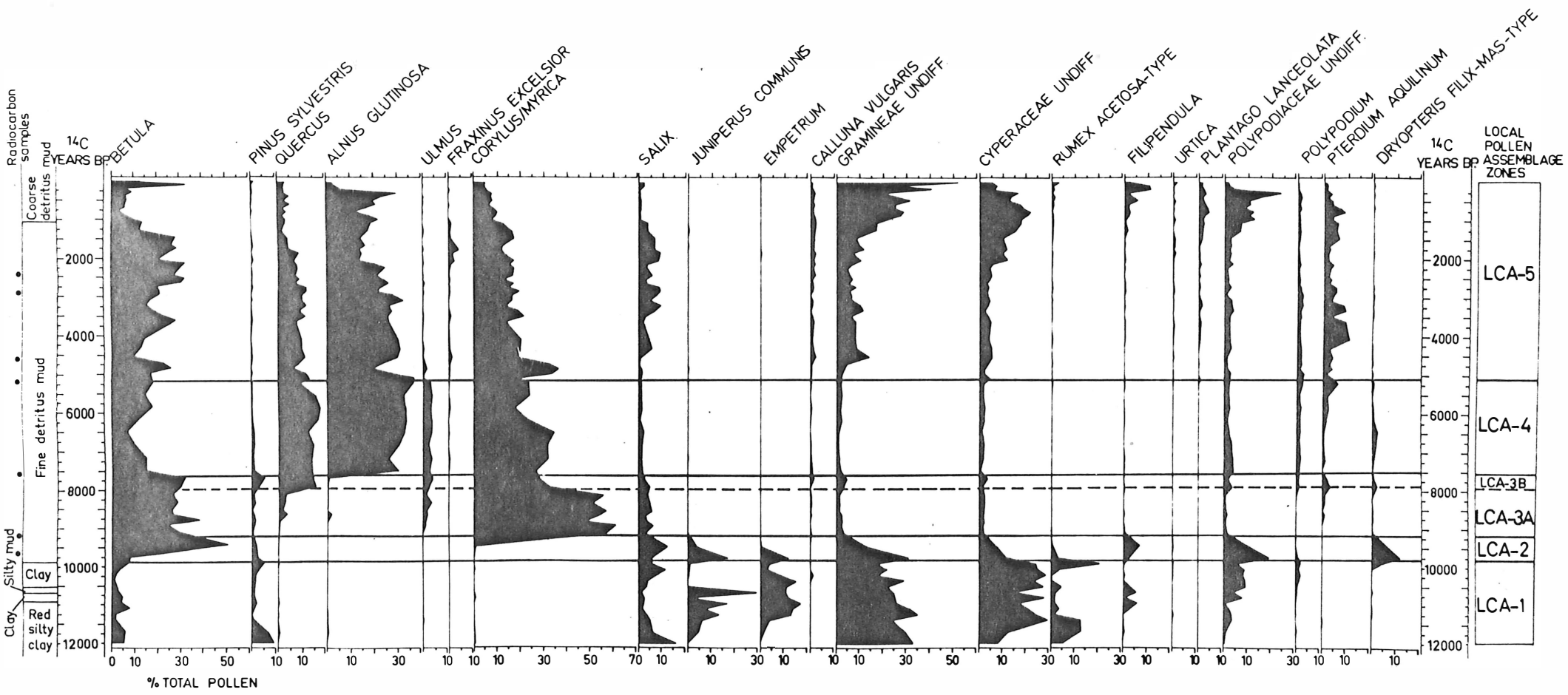


Fig.2. Pollen diagram from Loch Dungeon, Kirkcudbrightshire. Calculation base is sum arboreal pollen (ΣAP).

Scale at base of diagram gives % for black silhouettes, white silhouettes are x5 exaggeration.

Fig. 3.

LOCH CILL AN AONGHAIS, ARGYLL. ANAL. SYLVIA PEGLAR 1976-77.



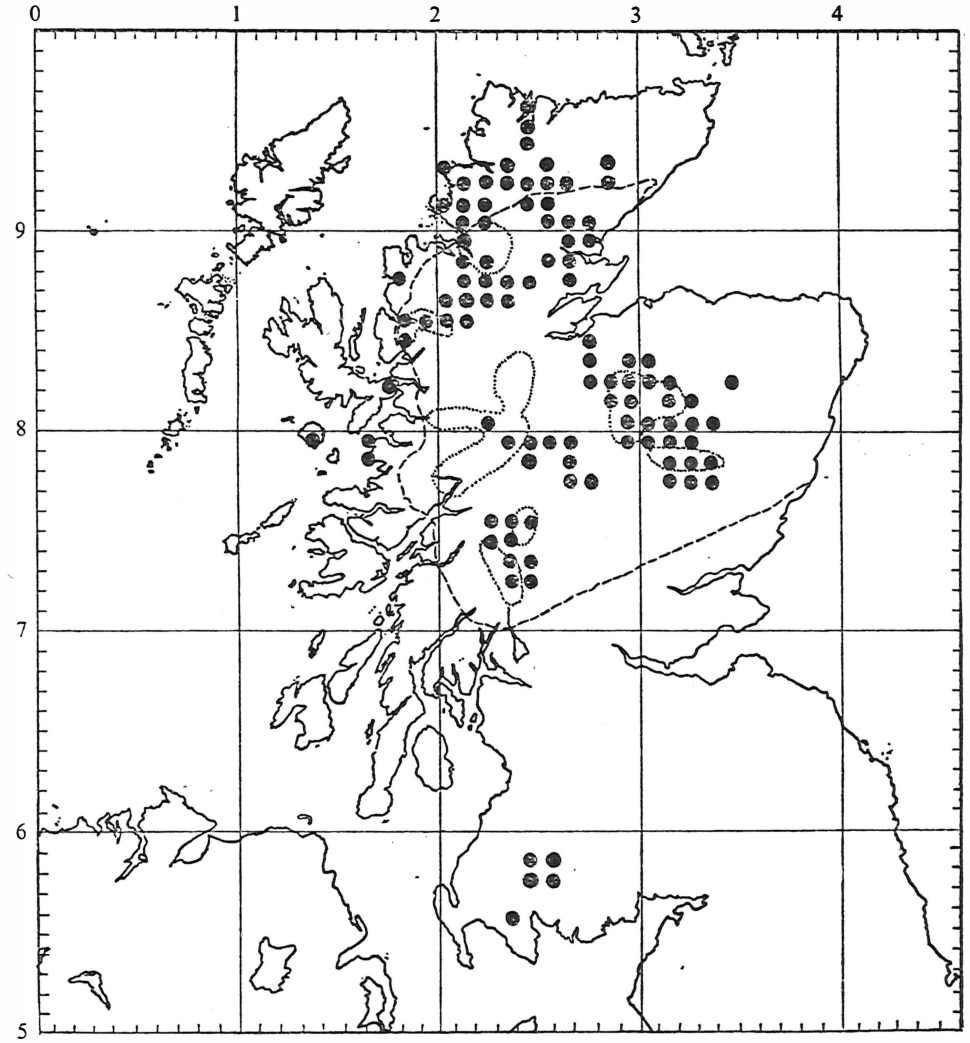


FIGURE 4. The distribution of pine stumps in peat, of native pine at the present day, and the probable limit of native pine had not man been active. ●, Pine stump record in a 10 km × 10 km grid square; ...., present limit; ----, probable limit.

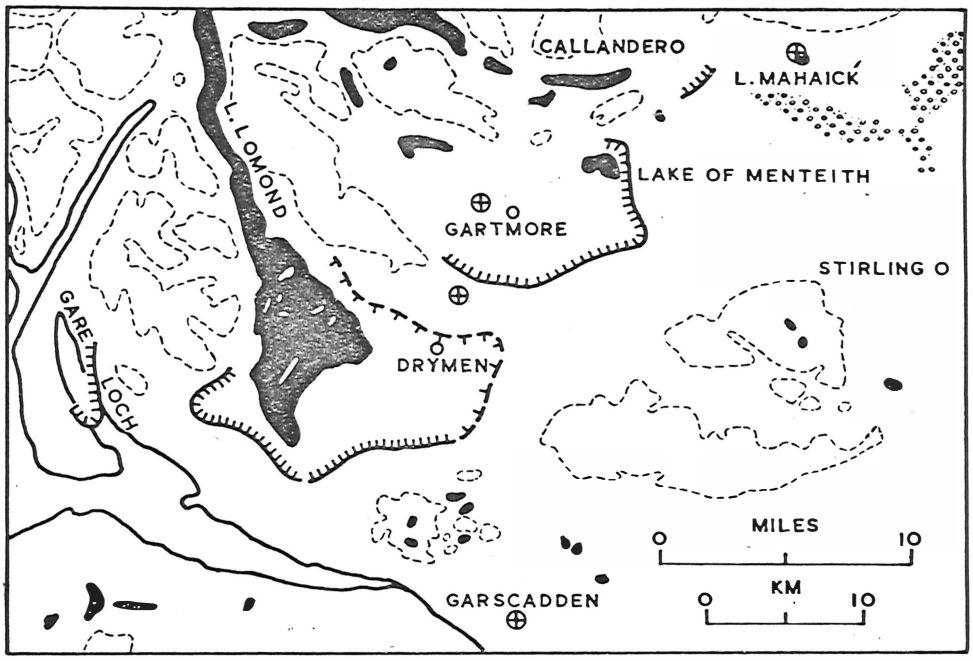


FIG. 5.—Map of the Loch Lomond area showing the Highland Readvance Moraines, the Perth Readvance outwash plain north of Stirling and the investigated sites in this area. Contour 1000 feet.

1 2 3 4 5

1, outwash sands and gravels; 2, dead-ice topography; 3, end-moraine ridge; 4, discontinuous end-moraine; 5, studied site.

DAY 2 (JULY 7) DRYMEN, LOCH LOMOND, AND RANNOCH MOOR.

1. DRYMEN

The Drymen-Loch Lomond area is a classic area for investigations on the Devensian late-glacial. Donner (1957) studied the pollen stratigraphy of two sites near Drymen, one outside the end moraines of the Loch Lomond readvance glaciers, the other (Gartmore) inside the end-moraines (Fig. 5).

The stratigraphy at Muir Park Reservoir, Drymen (26/490 923) shows (Fig. 6) a basal tripartite sequence of clay/clay-gyttja/clay, overlain by Holocene gyttjas and peat. Radiocarbon dates obtained by Vasari (1977) from this site are as follows:

Zone III/IV boundary	10010 ± 230 B.P.
Zone II/III boundary	12060 ± 320 B.P.
Zone I/II boundary	12510 ± 310 B.P.

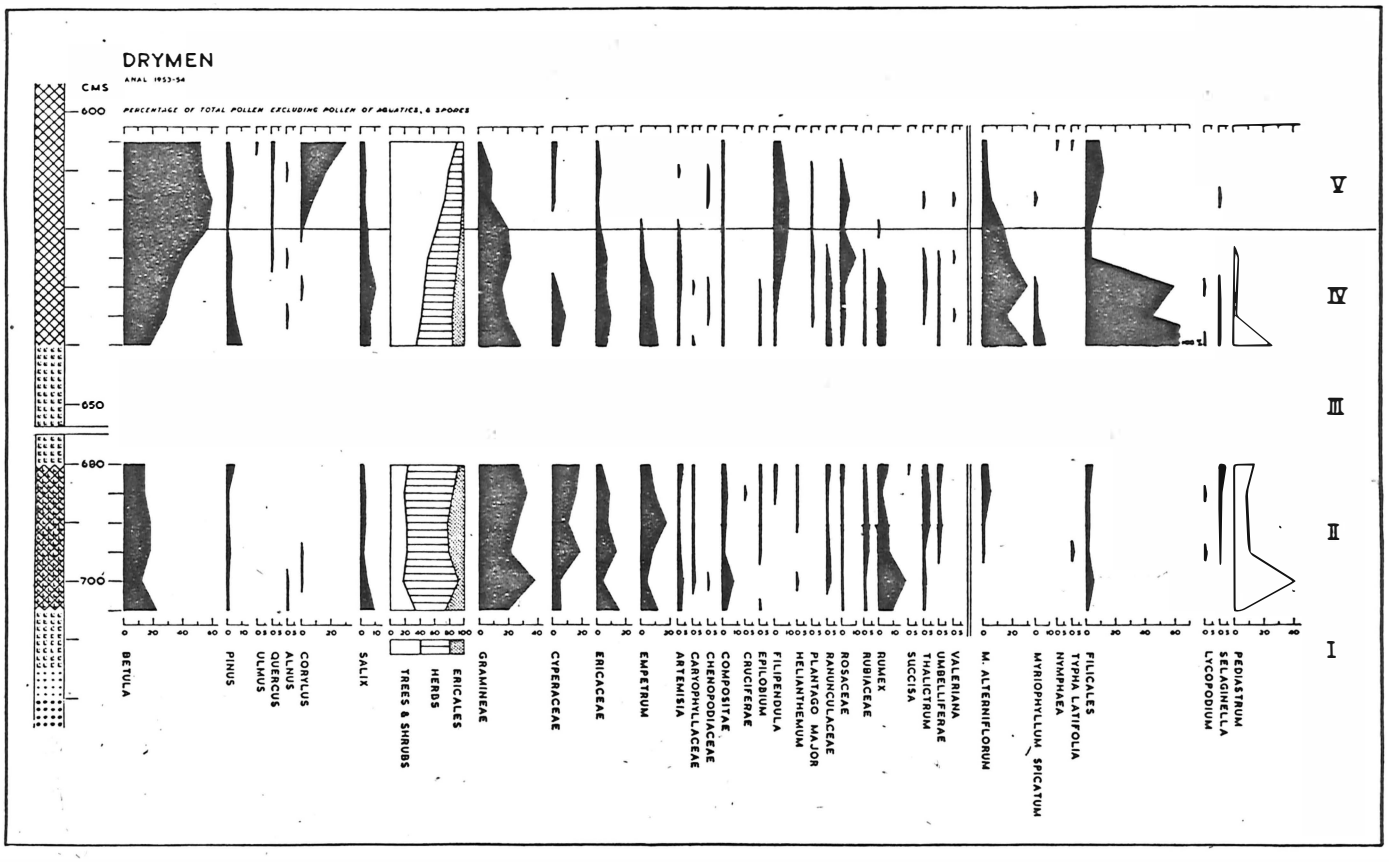


FIG. 6.—Drymen: total diagram of the Late-glacial and early Post-glacial.

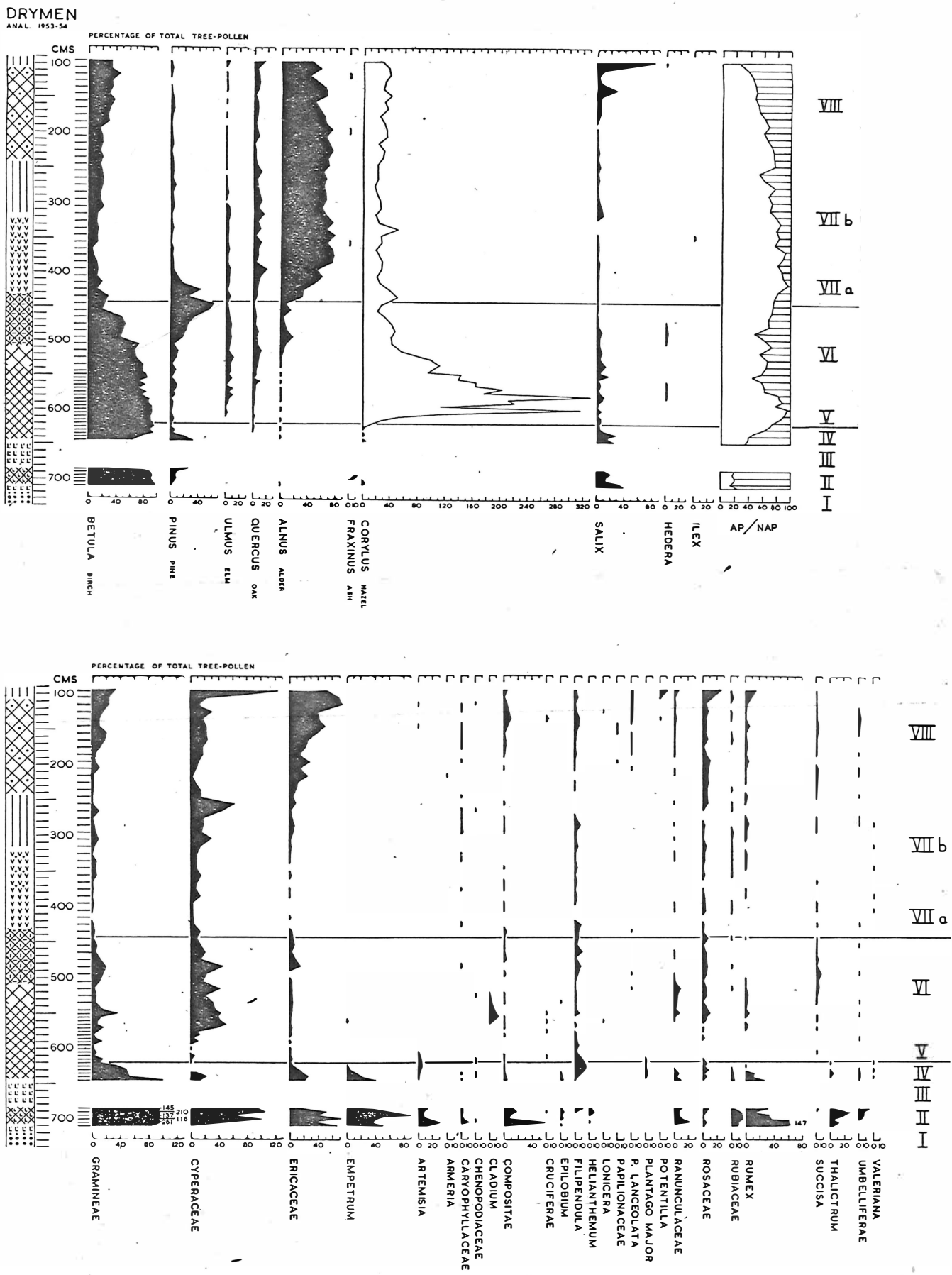


Fig. 6. continued. Holocene pollen diagram from Drymen.

At Gartmore (26/500 976) 5.5 km north of Muir Park, but inside the moraines of the Loch Lomond readvance ice, Donner (1957) found no Devensian late-glacial deposits (Fig. 7). Organic sedimentation began early in the Holocene.

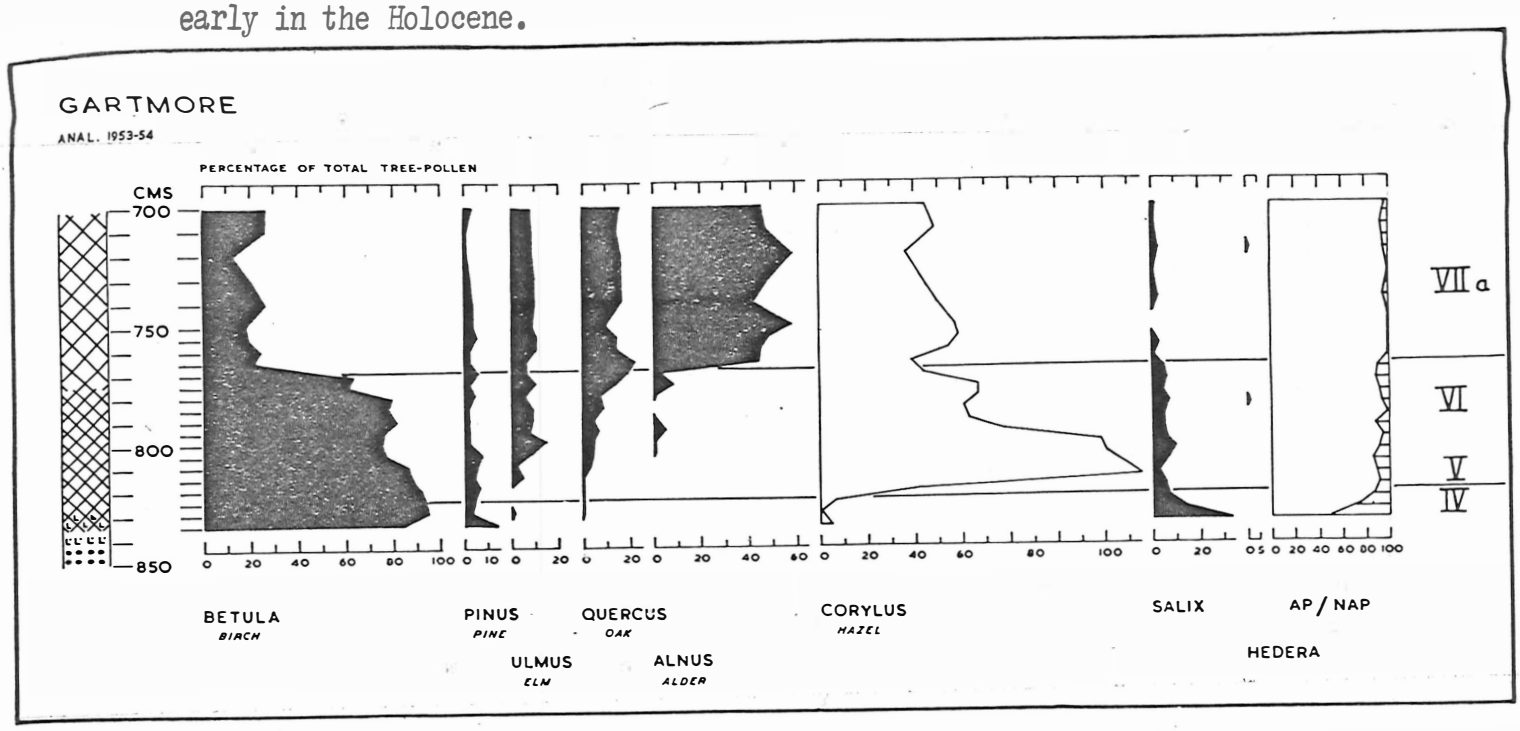


Fig. 7 Gartmore: tree pollen diagram.

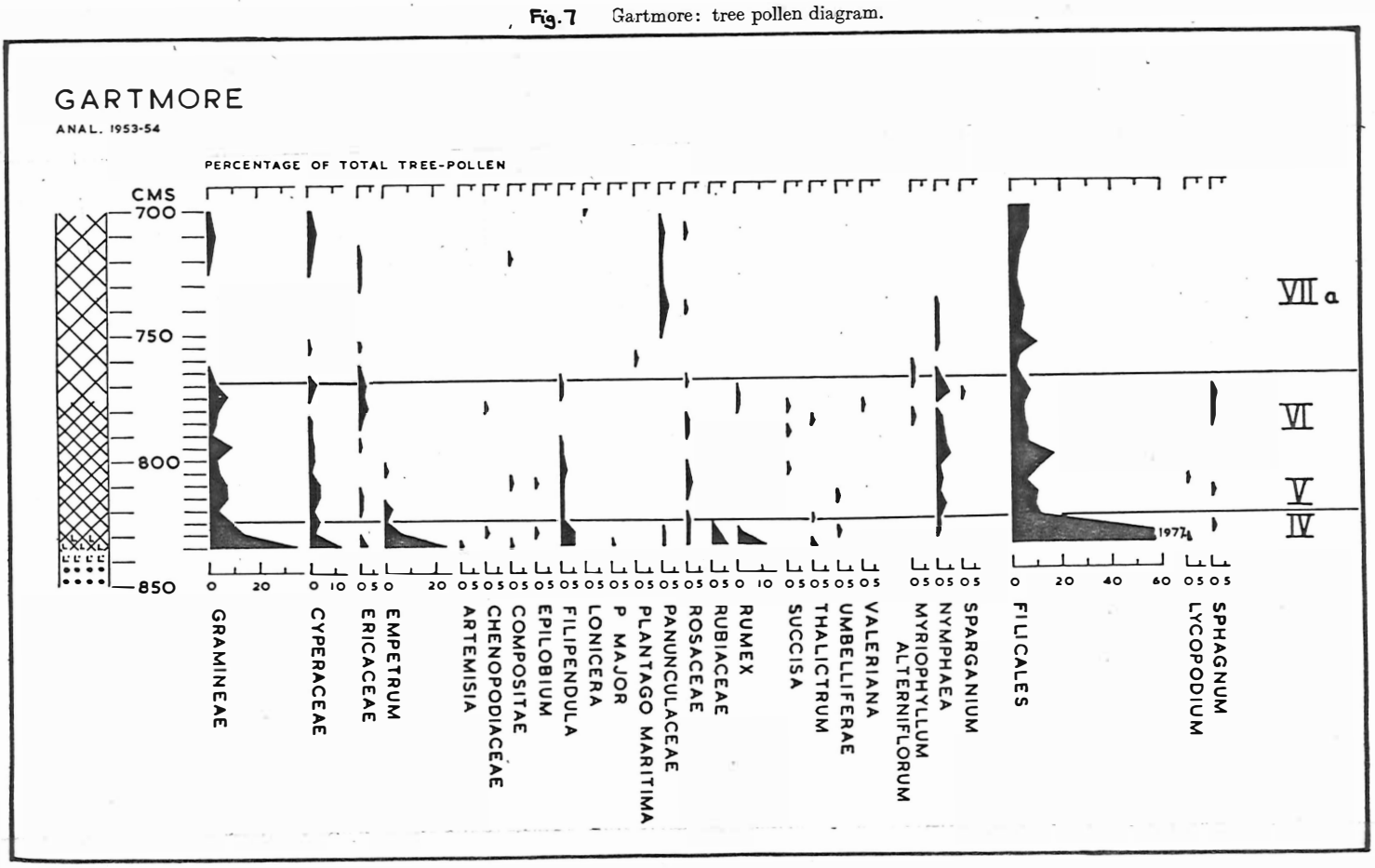


FIG. 7.—Gartmore: non-tree pollen diagram.

No datable material other than reworked marine shells has yet been found in deposits of the Loch Lomond readvance. The dates are 11800 ± 170, 11700 ± 170, 11330 ± 170, 11430 ± 220, 11530 ± 210, and 11805 ± 185 B.P. for shells within the moraines or from within glacially-disturbed marine clay beneath readvance deposits. The Loch Lomond readvance is therefore assigned to the only subsequent cold period, which is generally assumed to have extended from about 11000 to 10000 yr B.P. The chronology of the Loch Lomond readvance needs detailed work.

2. LOCH LOMOND

The surface of Loch Lomond, one of the largest and deepest lakes in the British Isles, lies at only 9 m O.D. The Loch straddles the Highland Boundary Fault which delimits the Highlands from the Midland Valley of Scotland. The islands at the south end lie on the Highland Boundary Fault.

The eastern and western sides of the Loch as well as the islands support extensive stands ofoak woodland with birch, rowan, hazel, and ash. Although these woods may appear natural, Tittensor (1970) has shown from detailed examination of estate records that from the late 17th century onwards the woods were managed as oak coppice with an approximately 21-year cycle. Oak was used not only for timber, but for charcoal used for iron smelting, and for bark tanning and pyroligneous acid production. Other trees, less valued and termed 'barren timber' were removed to favour the growth of oak.

Although these woods have been intensively managed, many of them would have had a continuity of tree cover over several hundred years. The composition of the field layers of these woods is primarily a function of soil-type and grazing pressure (see Tittensor and Steele, 1971). On acid soils (pH 3.5-4.5) with heavy grazing by sheep and deer Pteridium aquilinum and grasses (mainly Deschampsia flexuosa) predominate. With less grazing Vaccinium myrtillus is often abundant. Ungrazed areas are dominated by V. myrtillus, Luzula sylvatica, and ferns such as Blechnum spicant, Dryopteris borreri, and D. aemula.

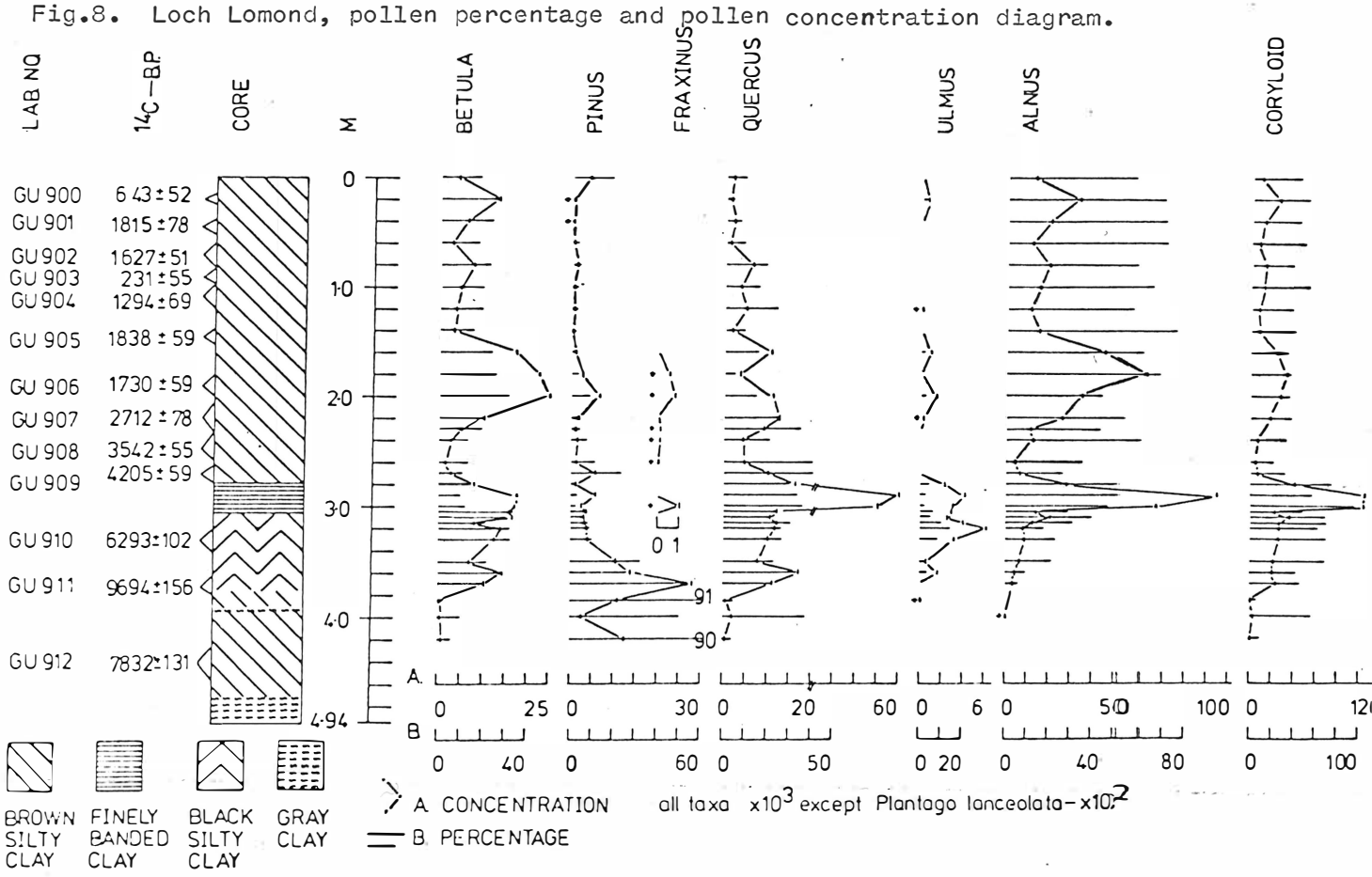
On more basic soils (pH 4.5-6.0), the field layer of ungrazed woods is rich in herbs, such as Anemone nemorosa, Endymion non-scriptus, Oxalis acetosella, Primula vulgaris, and Sanicula europea. With heavy grazing grasses, mainly Anthoxanthum odoratum, Festuca ovina, and Agrostis spp., and Pteridium aquilinum dominate.

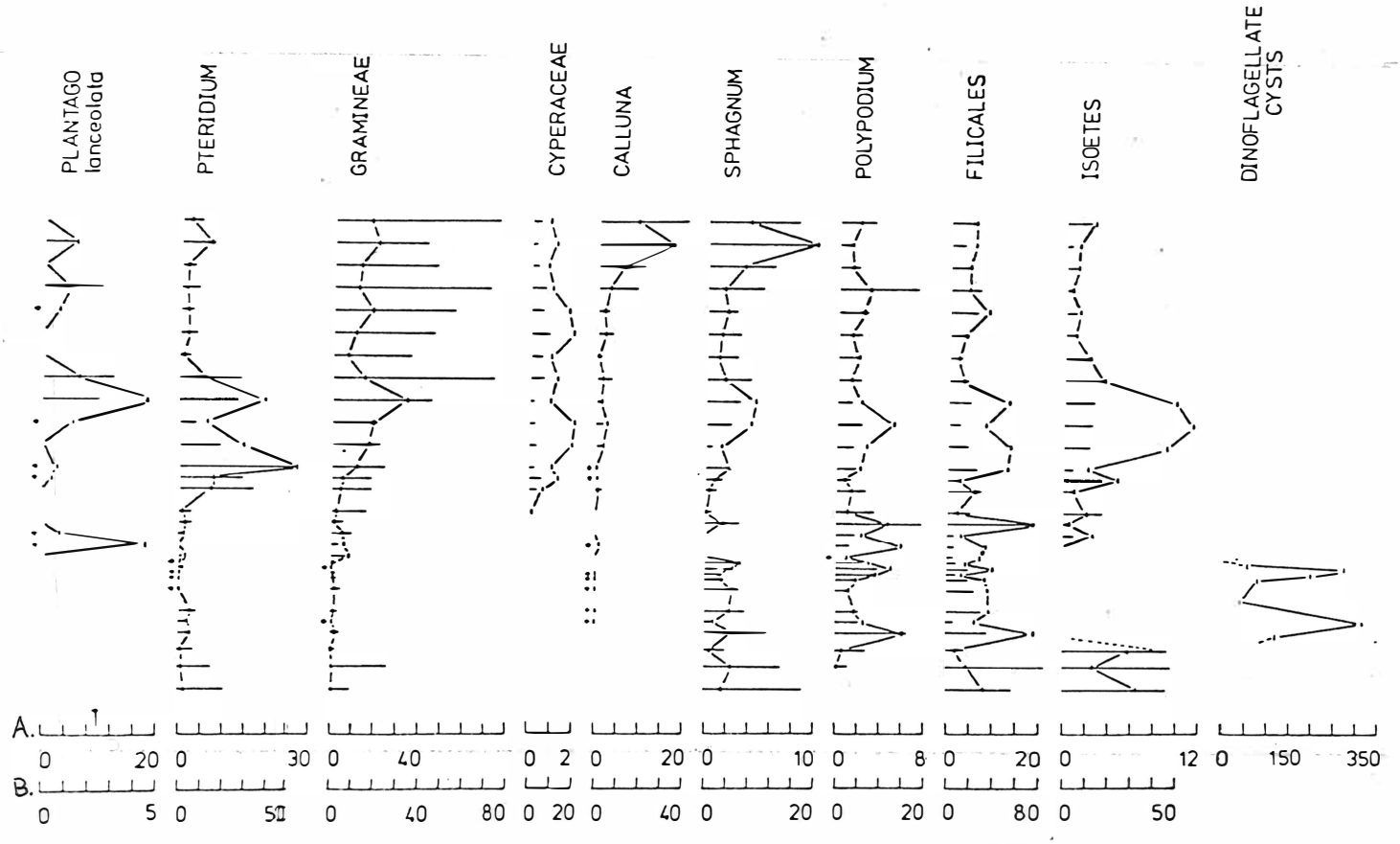
Many of the woods occur on steep boulder-strewn slopes and in the oceanic climate of western Scotland (190-240 wet days a year) mosses, liverworts, filmy ferns, and lichens cover the boulders, tree trunks, and fallen logs. Many of these cryptogams have markedly western or oceanic distributions in Europe and, on a world scale, have sub-tropical distributions. Common oceanic species we are likely to see include in the Loch Lomond woods are:

Hymenophyllum wilsonii	Plagiochila spinulosa
Scapania gracilis	Saccogyna viticulosa
Sticta fuliginosa	Lobaria pulmonaria
Hyocomium flagellare	Heterocladium heteropterum

The three basins of Loch Lomond contrast in morphometry and trophic status, with the southern basin being the broadest and most eutrophic whereas the northern basin is narrow (< 1 km), very deep (180 m), and oligotrophic. Recent work by Dickson et al. (1978) on cores from the southern basin has shown that Loch Lomond was part of the sea not only in the Devensian late-glacial but also between 6900 and 5500 yr B.P. Marine dinoflagellate cysts occur in the lake sediments (Fig. 8).

Fig.8. Loch Lomond, pollen percentage and pollen concentration diagram.





3. GLEN FALLOCH (27/365 238)

In Glen Falloch at the northern end of Loch Lomond we pass from the oak-forest zone to that of pine forest. Scattered, poorly grown pines to the east of the main road may be remnants of natural pine forests in this area. Fossil pine stumps found within the eroding blanket peat are some of the southernmost fossil pine stumps in Scotland (Fig. 4), other than those in Galloway. Hummocky moraines of Loch Lomond readvance age abound in the area.

4. TYNDRUM (27/335 293)

Excellent hummock moraine of Loch Lomond stadial age with numerous kettle holes can be seen from the road. One of these kettle holes has been investigated in detail by J.J. Lowe and M.J.C. Walker (unpublished). The pollen stratigraphy shows an early Holocene succession from herb-dominated spectra, to a phase of Empetrum dominance, to Juniperus dominance, and finally to the expansion of Betula. Radiocarbon dates for the basal organic materials are 8340 ± 160, 8180 ± 140, and 8120 ± 140 yr B.P., all of which are nearly 2000 years too young for the deglaciation of the area. One explanation is contamination with humus-rich water draining through the kettle hole.

5. LOCH TULLA (27/305 456)

Pine forests can be seen at Doire Darach at the south side of Loch Tulla, on the islands in Loch Tulla, and to the east of Crannaeh.

Shorelines of former ice-dammed lakes can be seen high above the present Loch Tulla (Ballantyne, 1979) at 332 m, 323 m, 319 m, 315 m, and 248 m O.D. They were probably formed by an ice-dammed lake created by valley glaciers of the Loch Lomond stadial blocking the outlet valleys to the north, west, south-west, and south-east. Alternatively the shorelines were formed on the eastern margin of a mass of down-wasting glacier ice, and the lowest lake probably drained englacially through the downwasting ice mass.

6. RANNOCH MOOR near LOCHAN GAINEAMHACH (27/299 529).

Rannoch Moor is situated between 300-500 m O.D. It is a vast and often bleak wilderness of bog, lochs, boulder-strewn hillocks, and low hills covering about 140 sq km. The bleakness stems from the present treeless character, in contrast to the abundant trees on ungrazed, uncleared, and unburnt islands in the larger lochs (e.g. Loch Ba) and to the abundant fossil pine stumps preserved in the peat.

It is one of the most extensive areas of blanket bog in western Scotland. The vegetation is a mosaic of wet Trichophorum - Eriophorum angustifolium bog with abundant Calluna vulgaris, Myrica gale, Molinia caerulea, Sphagnum spp., and Pleurozia purpurea, soligenous areas with Narthecium ossifragum and Myrica gale, and areas of very wet Sphagnum lawns with Carex rostrata, C. limosa, C. pauciflora, and Eriophorum angustifolium Scheuchzeria palustris has its sole British locality on Rannoch Moor. Betula nana, the dwarf birch, is a local rarity of the area, occurring in narrow transitional areas between deep peat and dry morainic hummocks. In contrast to its ecology in Scandinavia, all its British localities are on acid blanket peat.

Where erosion has removed the peat, tree stumps and fallen pine trunks are conspicuous. Radiocarbon dates for these stumps range from 6139 ± 110, 5850 ± 70, to 4395 ± 90 B.P. The stumps are mainly rooted in mesotrophic peat (H.H. Birks, 1975) but are overlain by ombrotrophic peat rich in Calluna remains. Dry conditions permitted the growth of pine on the bogs, but increased wetness may have resulted in their death. Whether these changes were local or of regional significance is not known. As we go further north all fossil pine stumps are about 4000-4200 B.P. in age, suggesting a major regional change in moisture at that time leading to the demise of pine.

Investigations by Walker and Lowe (1977) of infilled kettle holes near Kingshouse (Figs. 9 and 10) provide a detailed pollen stratigraphy for the Rannoch Moor area and show the vegetational succession after the deglaciation of the area, and the development of pine-birch forests with some alder in mid-Holocene times. Basal radiocarbon dates from kettle holes on Rannoch Moor are 10520 ± 350, 10660 ± 240, 9440 ± 310, and 10390 ± 200 yr B.P. Whether these dates are reliable ages for the disappearance of the vast amount of Loch Lomond stadial ice (Fig. 11) from the area is open to discussion (see Lowe and Walker, 1980).

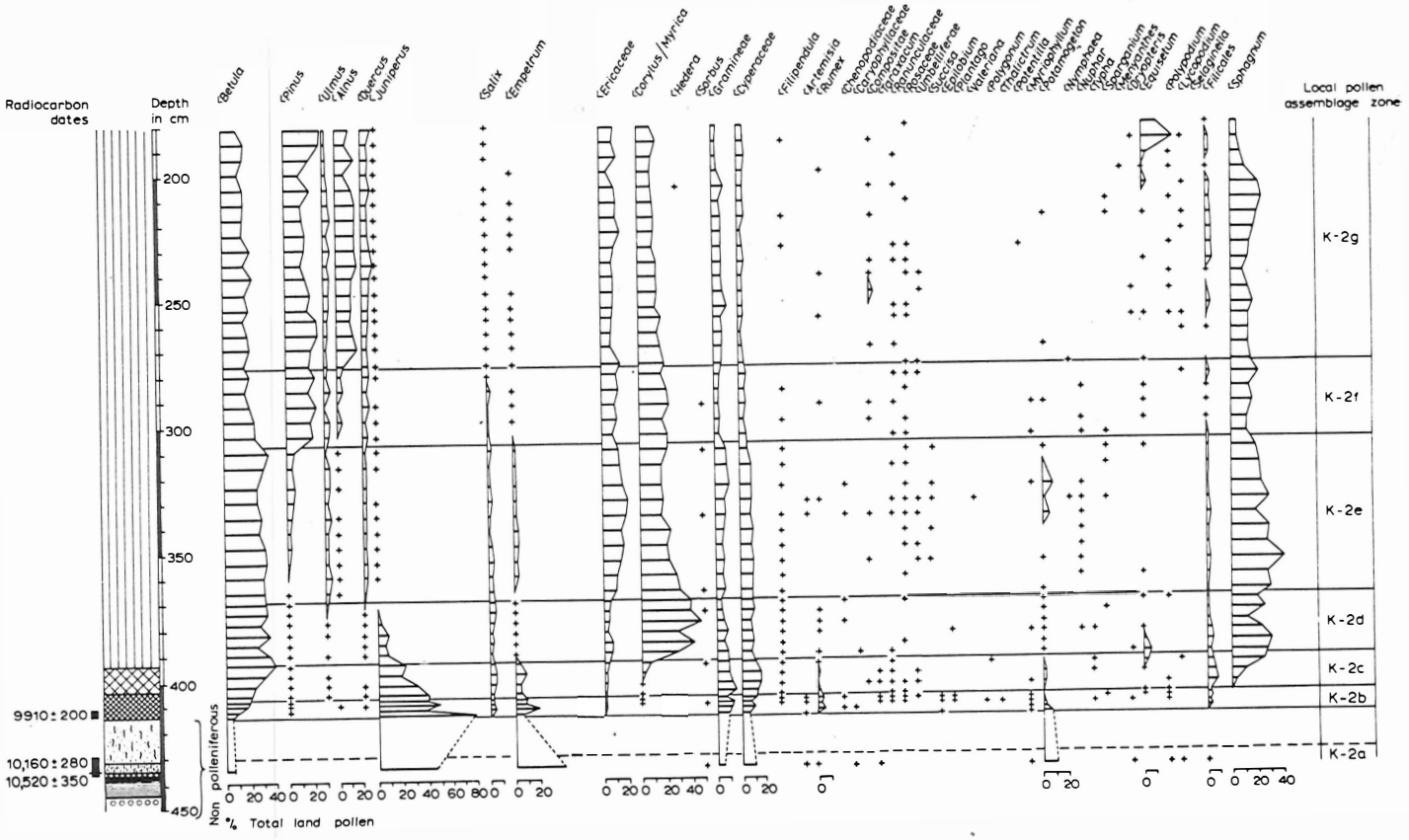


FIG. 9. Pollen diagram from Kingshouse 2 (1976). The values are percentages of total dry land pollen.

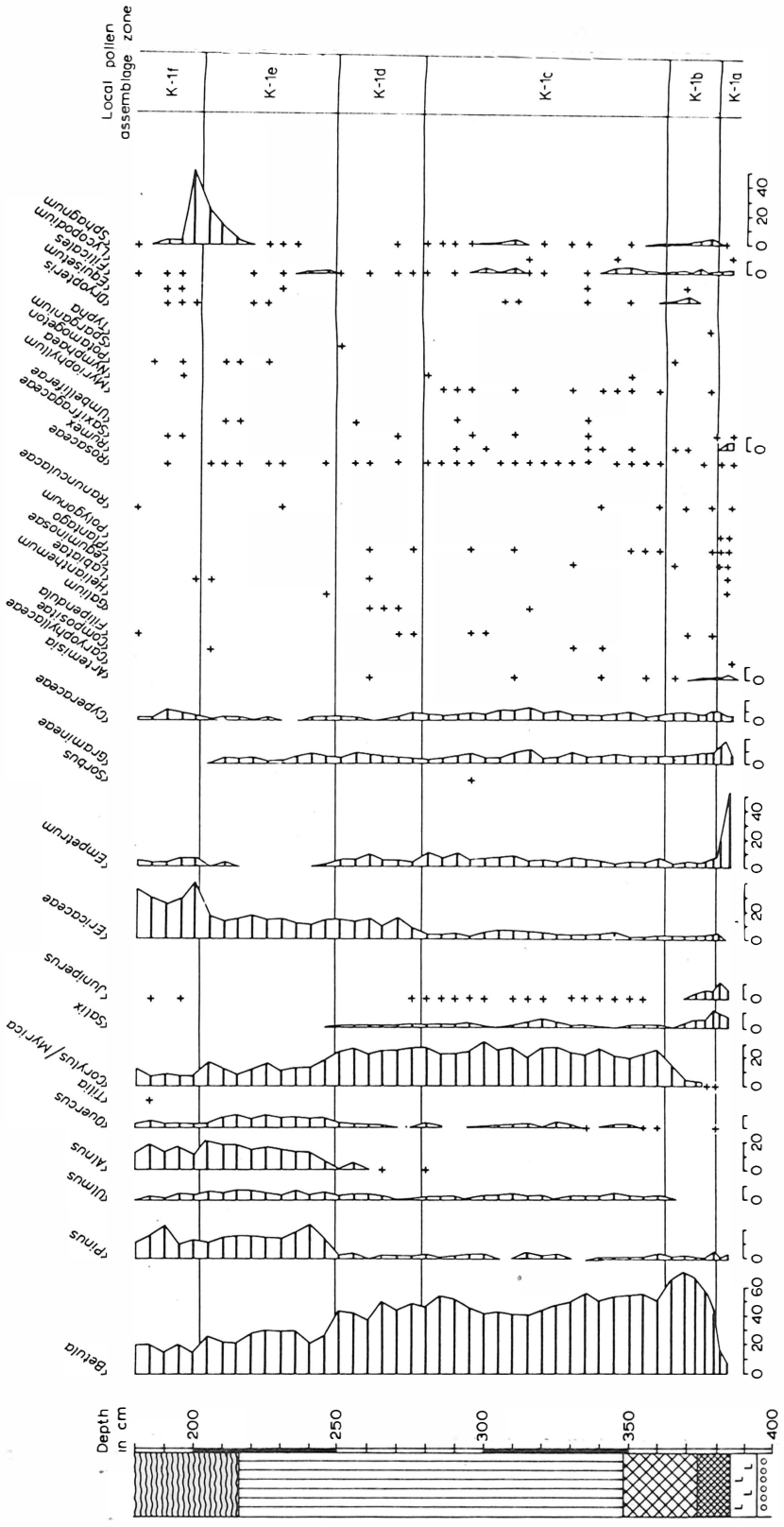


FIG.10. Pollen diagram from Kingshouse 1 (1976). The values are percentages of total dry land pollen.

Further west near Oban (Fig. 1 and Donner, 1957) and Salen (Fig. 1) the pollen stratigraphy (Figs. 12 and 13) is almost identical to south-west Scotland and differs from the Rannoch Moor stratigraphy in the minor role that pine played in the extreme west. Interesting differences in dating of the major expansion of oak and alder exist, however, at the various sites in the west as one moves from south to north.

		Oak	Alder
South	Galloway	8500 B.P.	7500 B.P.
	Loch Cill An Aonghais	8000 B.P.	7500 B.P.
	Oban	6600 B.P.	6600 B.P.
North	Salen	6300 B.P.	6300 B.P.

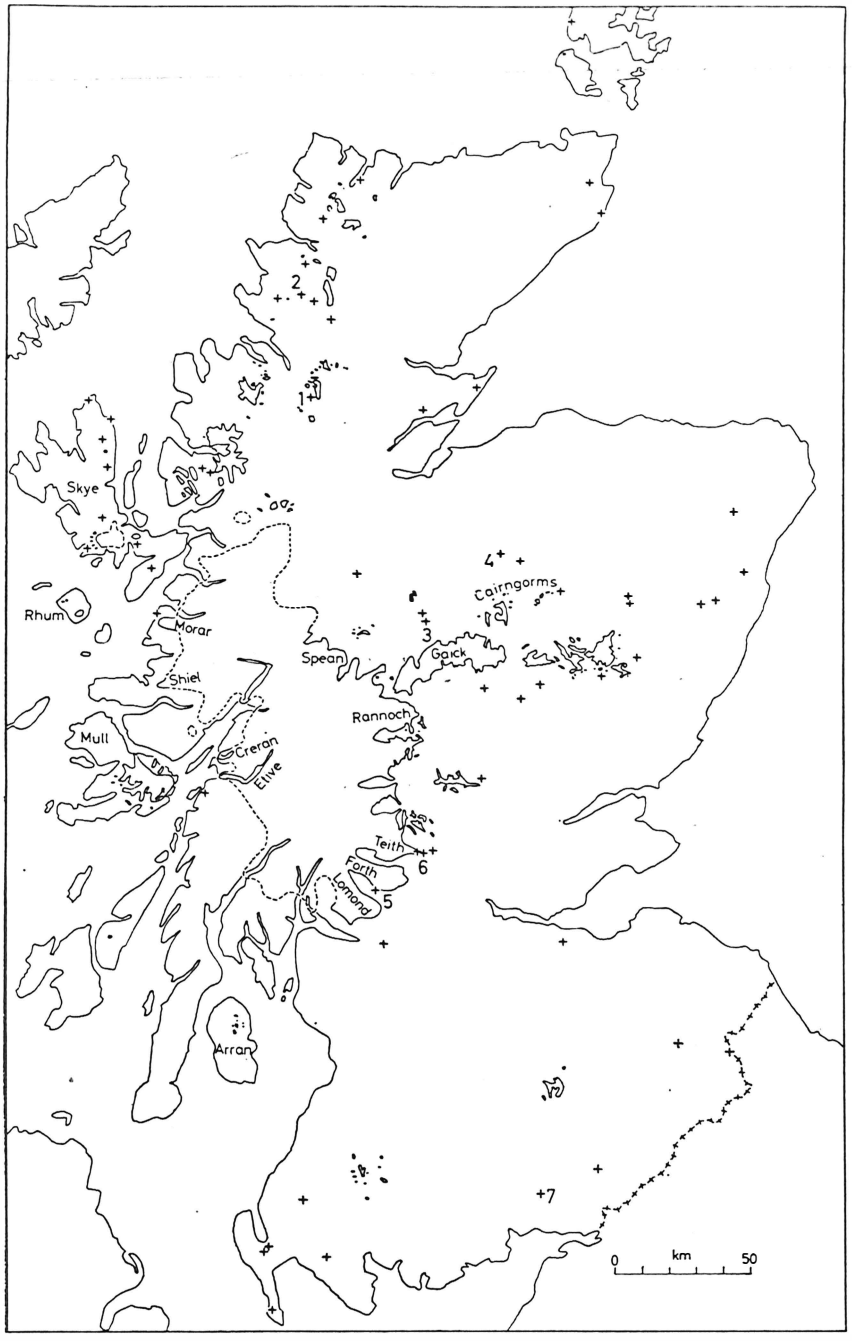


FIG. 11. Lateglacial pollen sites and the limit of the Loch Lomond Readvance. Sources for pollen sites: Birks 1973; Donner 1957, 1958; Durno 1970; Kirk and Godwin 1963; Mitchell 1948, 1952; Moar 1963, 1969*a*, 1969*b*; Newey 1970; Pennington *et al.* 1972; Switsur and West 1973; Vasari and Vasari 1968; H. J. B. Birks, C. M. Clapperton, J. H. Dickson, S. E. Durno, R. Gunson, M. Jackes, J. J. Lowe, J. Macpherson, P. E. O'Sullivan, W. Tutin, M. J. C. Walker and Y. Vasari, pers. comm. Sources for readvance limit: Clapperton and Sugden 1972; Gray and Brooks 1972; McCann 1966*a*; Peach *et al.* 1913; Peacock 1970*b*; J. B. Simpson 1933; Sissons 1972*a*, 1974*a*, unpubl.; Sissons and Grant 1972; Sissons *et al.* 1973; Thompson 1972; C. M. Clapperton, R. Cornish, M. Jackes, D. Rae and D. G. Sutherland, pers. comm.

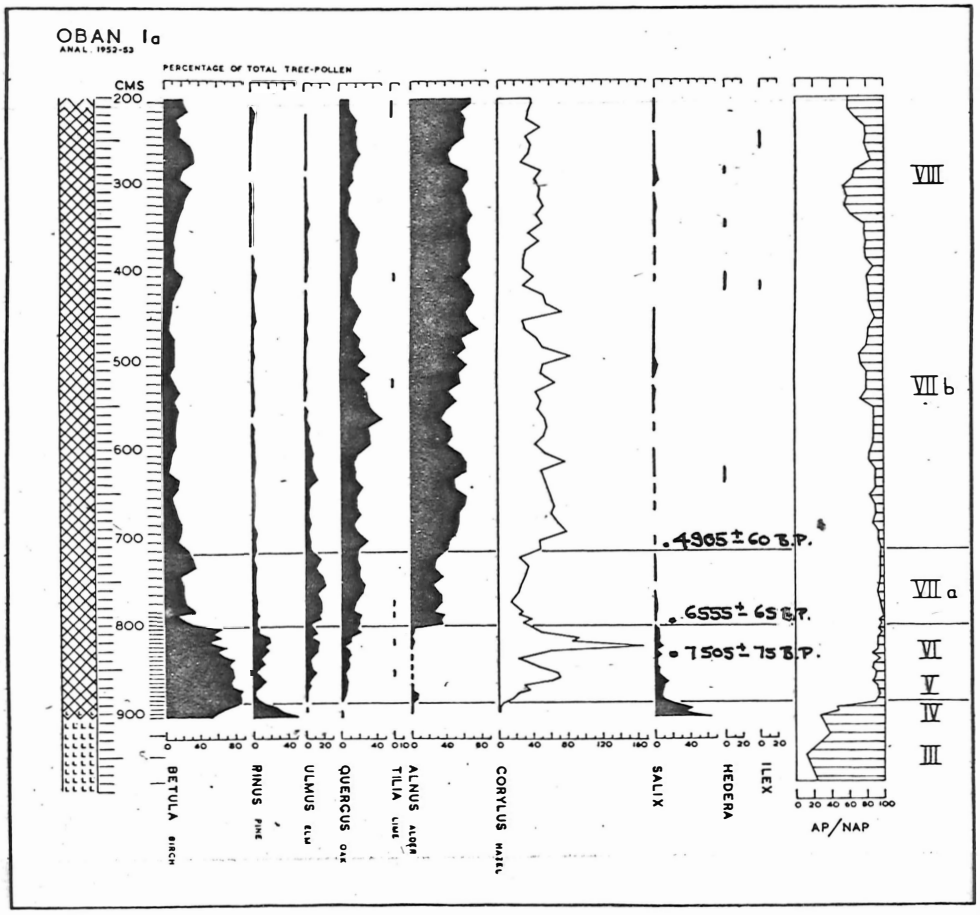


FIG. 12.—Oban 1*a* : tree pollen diagram.

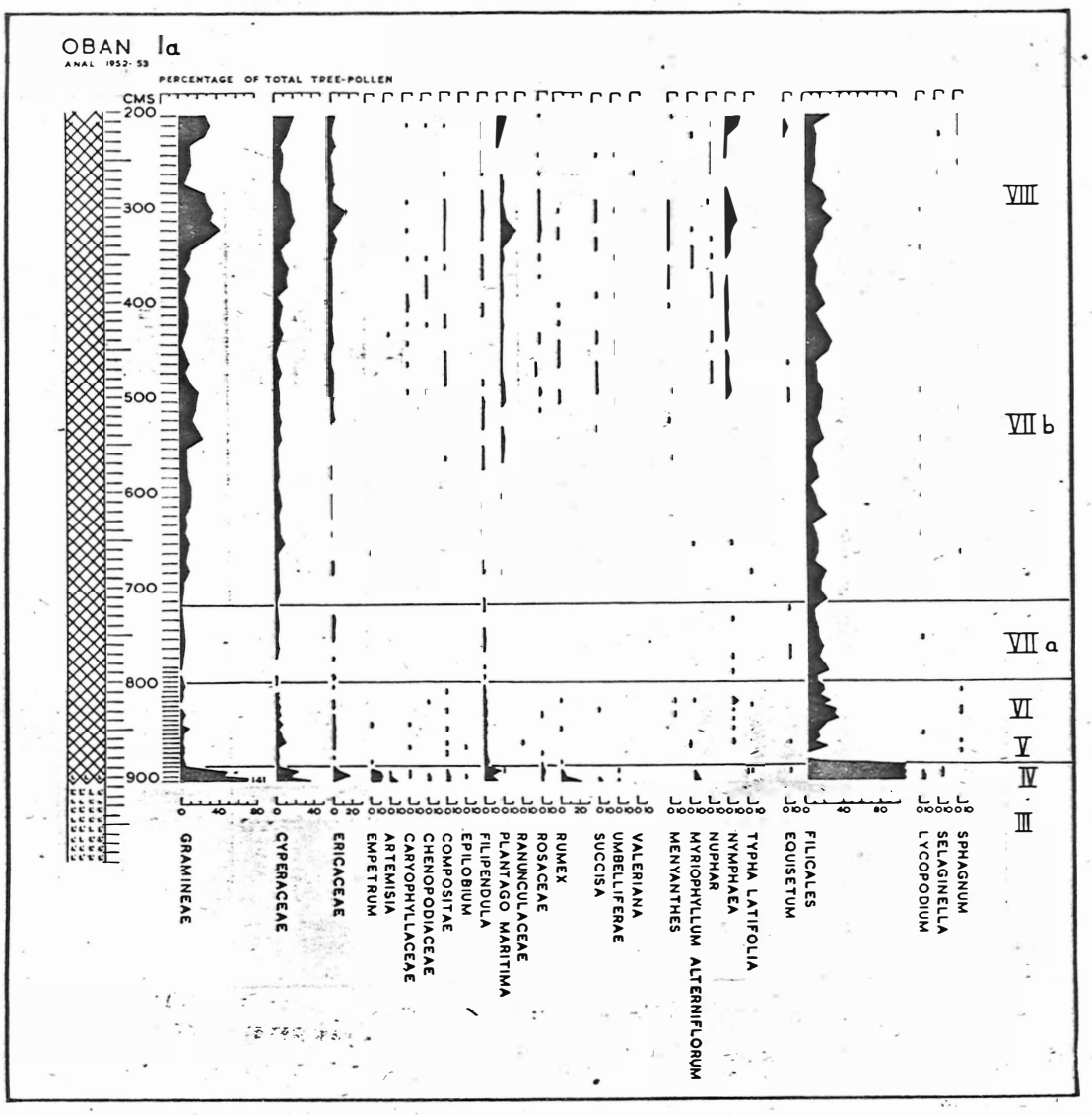


FIG. 12.—Oban 1*a* non-tree pollen diagram.

LOCH SALEN, ARDNAMURCHAN. ANAL. W. WILLIAMS, 1977.

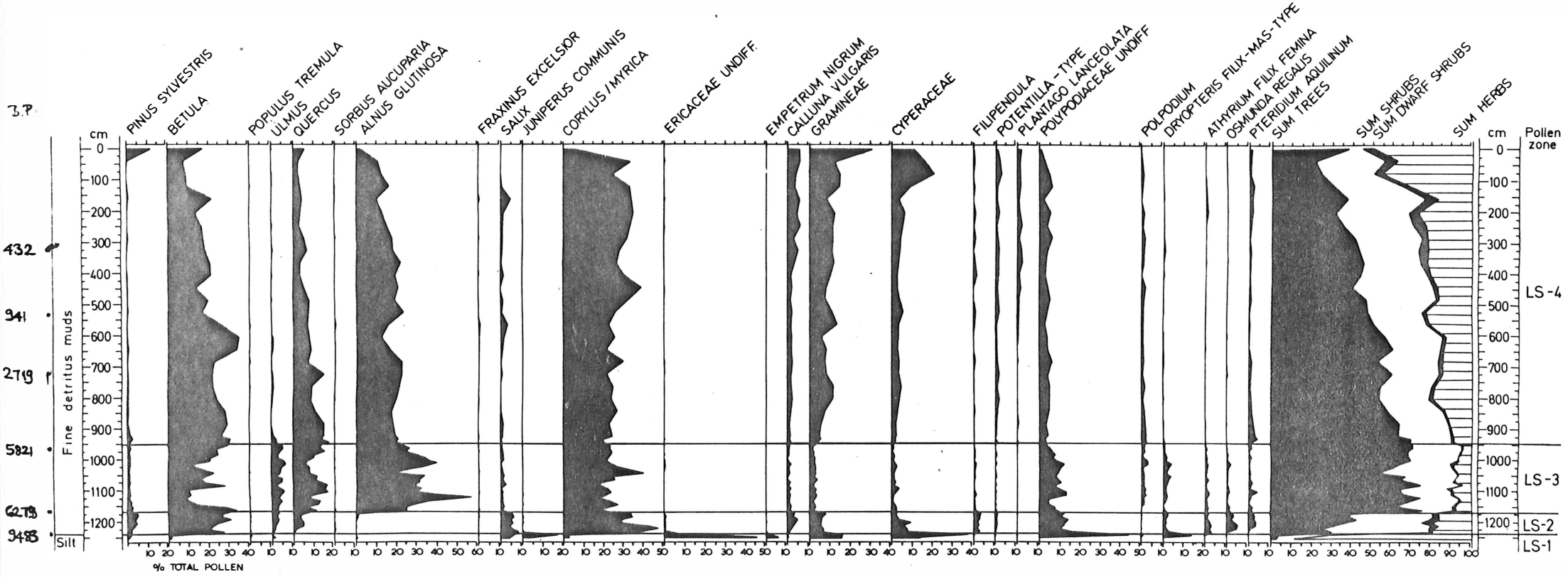


Fig. 13.

7. CREAG DUBH (27/257 520)

Weather and time permitting, we will use the chair lift at White Corries to ascend Creag Dubh (746 m). The full extent of Rannoch Moor can be seen from the summit. The bedrock is acid granite and the mountain flora is species-poor. Species of interest include

Rubus chamaemorus	Lycopodium selago
Vaccinium uliginosum	L. alpinum
Cornus suecica	Salix herbacea
Saxifraga stellaris	Gnaphalium supinum
Alchemilla alpina	Carex bigelowii
Juniperus communis ssp. nana	Juncus trifidus
Loiseleuria procumbens	

DAY 3 (JULY 8) APPIN TO DUNDONNELL

This is primarily a day of travel through the Great Glen northwards to Dundonnell in the north-west Highlands. We drive from Appin alongside Loch Linnhe north to Ballachulish. There are several distinct mid-Holocene raised-beach shorelines along Loch Linnhe and Loch Leven near Ballachulish. After crossing the Ballachulish bridge we drive north-east to Fort William. Towering above Fort William to the east is Ben Nevis, the highest mountain in the British Isles (4418 feet; 1453 m). We then drive through the Great Glen, a major fault valley, via Spean Bridge, along Loch Lochy and Loch Oich, to Fort Augustus at the south-western end of Loch Ness. From Loch Ness we drive to Inverness by the Moray Firth, and then westwards to Muir of Ord, Garve, and Dirrie More. Along this journey we cross the main west-east divide in Scotland, as we enter the spectacular sceneary of the north-west Highlands.

The hills around Dirrie More supported several glaciers during the Loch Lomond stadial (Fig. 14), with large corrie glaciers on Beinn Dearg and its surrounding hills (Fig. 15). The equilibrium firn-lines for the Loch Lomond stadial glaciers in north-west Scotland show an increase in altitude inland, suggesting that snowfall diminished inland (Fig. 16). The major pattern in the firn-lines suggests that snowfall was associated mainly with air streams from the west or south-west (Sissons, 1979a) and, in the eastern Grampians, from the south and south-east. Such circulation patterns may have been related to the junction of polar and relatively warm ocean waters at the latitude of south-west Ireland at the time of the Loch Lomond stadial.

Loch Droma (28/255 853) in Dirrie More is an important site in our understanding of the Devensian late-glacial deglaciation of Scotland (Kirk and Godwin, 1963). In excavations associated with the construction of a dam a deep section of late-glacial silts rich in macrofossils was discovered. Pollen analyses (Fig. 17) and radiocarbon dating (12810 ± 155 B.P.) indicate that this area was deglaciated earlier than had originally been thought, and that the vegetation at this time was Empetrum-dominated heaths. Macrofossils of interest include

Dryas octopetala	Polytrichum alpinum
Betula nana	P. norvegicum
Salix herbacea	Rhacomitrium lanuginosum
Brachythecium glaciale	

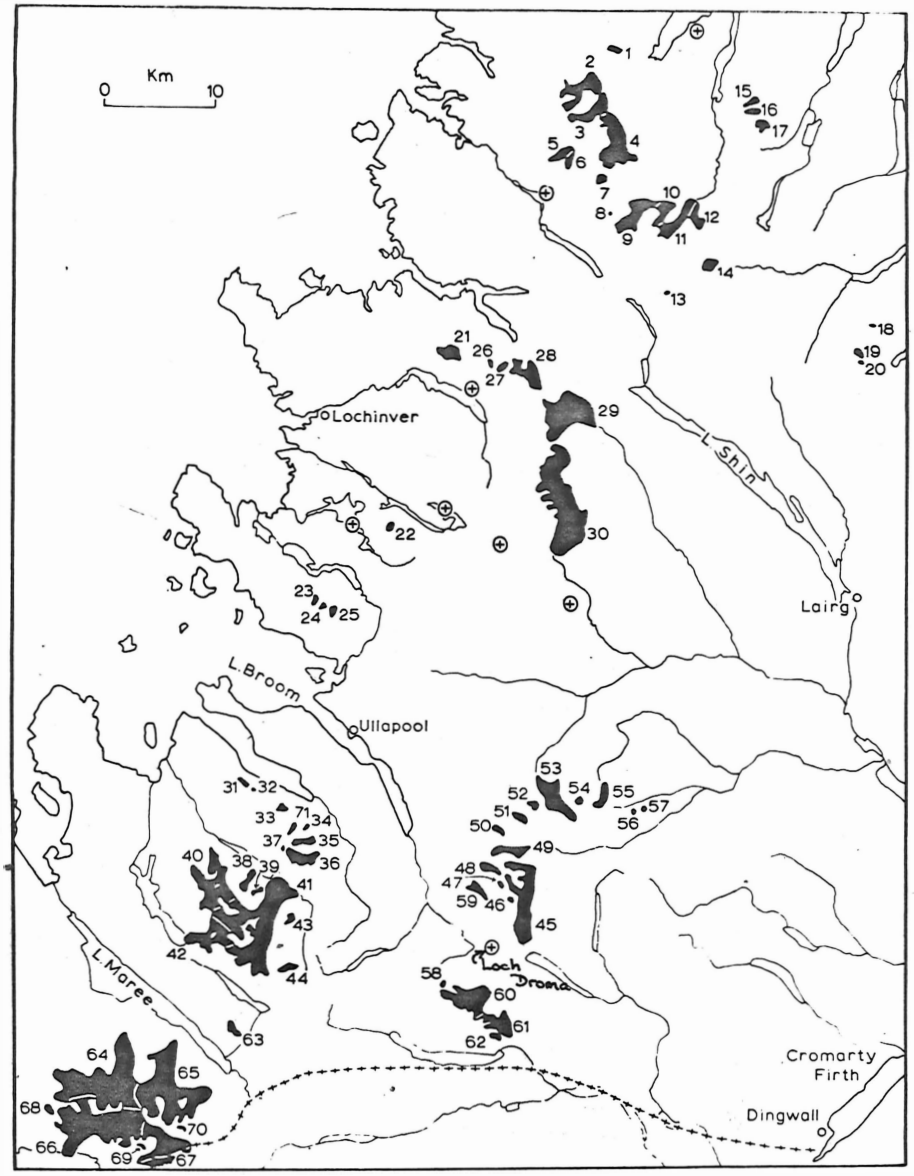


Fig. 14. Former glaciers and Lateglacial pollen sites in the northern mainland of Scotland. The broken line indicates the southern limit of the area investigated.

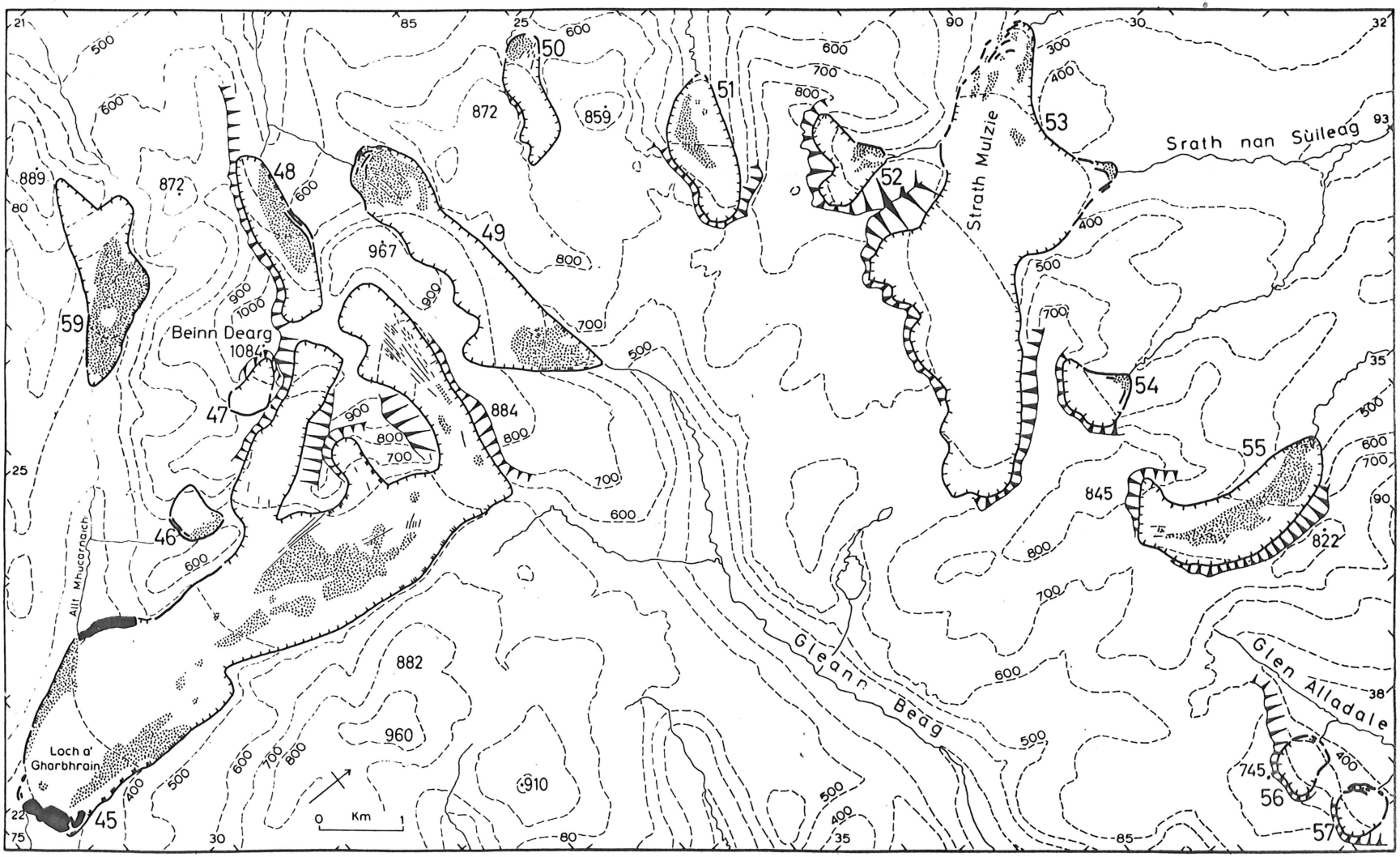


Fig.15. Former glaciers in the Beinn Dearg area.

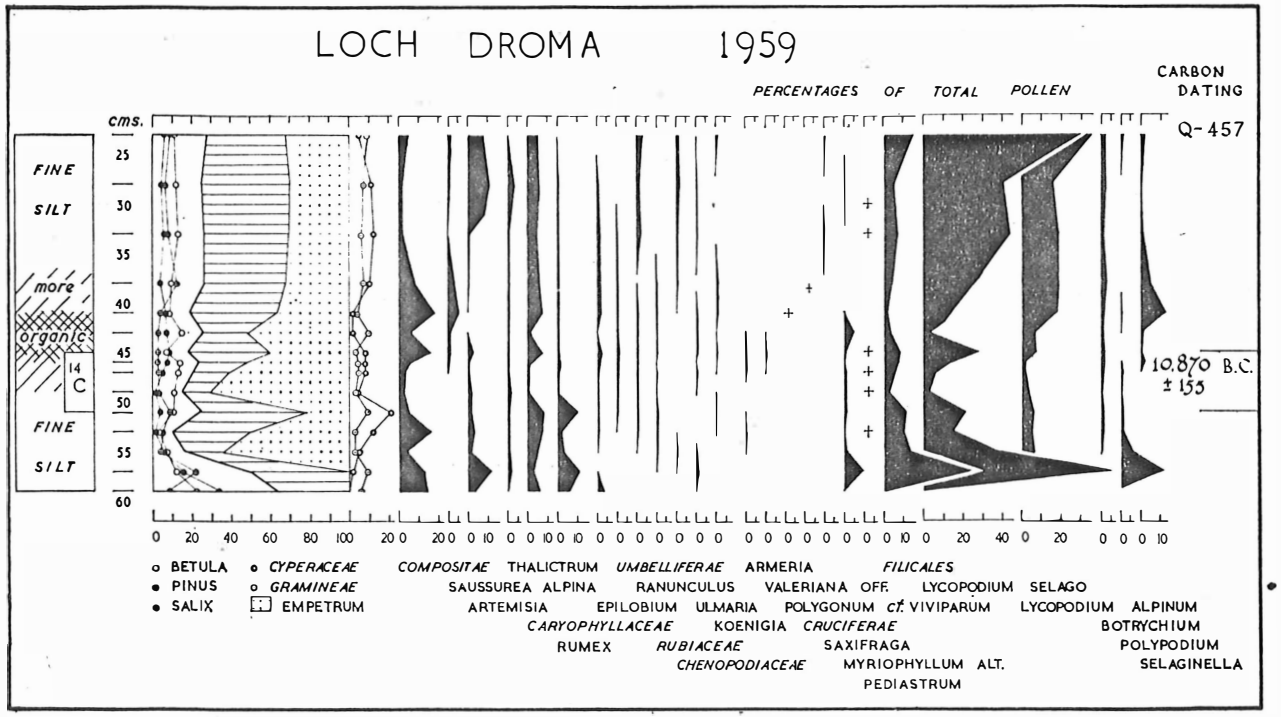


FIG. 17.—Pollen diagram of Silt monolith.

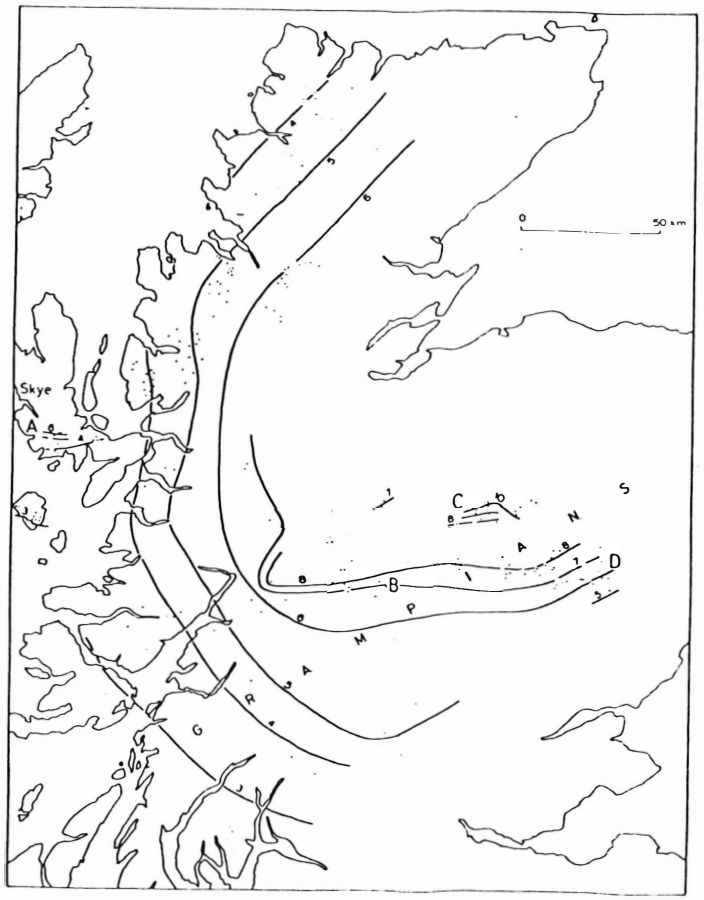


Fig. 16. Equilibrium firn line altitudes for Loch Lomond Advance glaciers in the Highlands and Inner Hebrides. Altitudes in hundreds of metres.

Above Loch Droma at Loch a' Gharbhrain there are well-defined end moraines of Loch Lomond stadial glaciers, suggesting that the valley of Dirrie More has been free of ice since at least 12810 B.P.

Just below Dirrie More is the spectacular Corrieshalloch Gorge owned by the National Trust of Scotland. The Gorge is 70 m deep, 1 km long, 25 m wide, and the waterfall has a sheer drop of 55 m. The origin of the gorge is unclear, but it is possible that as the ice melted, water roaring down to Loch Broom cut the gorge through sold rock.

From Corrieshalloch Gorge we drive west to Dundonnell at the head of Little Loch Broom on to slopes below An Teallach (meaning the Forge), one of the most spectacular mountain ridges in western Scotland. As we drive to Dundonnell we will notice that the surviving woodland fragments along the Dundonnell River are primarily dominated by birch with some rowan, hazel, and willow. Dundonnell is in the predominantly birch-forest region of Fig. 1.

DAY 4 (JULY 9) LOCH MAREE-GLEN TORRIDON-SHIELDAIG

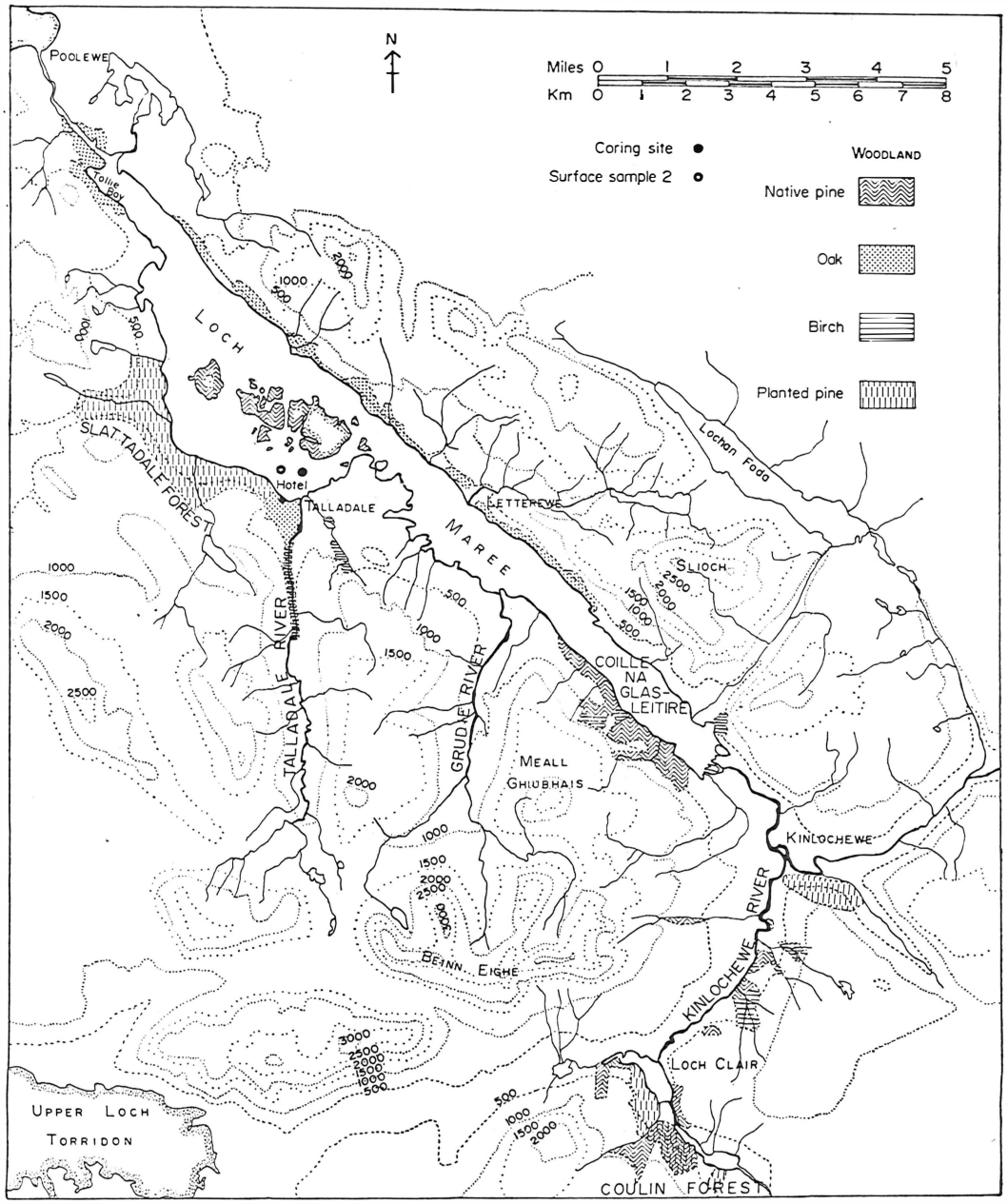
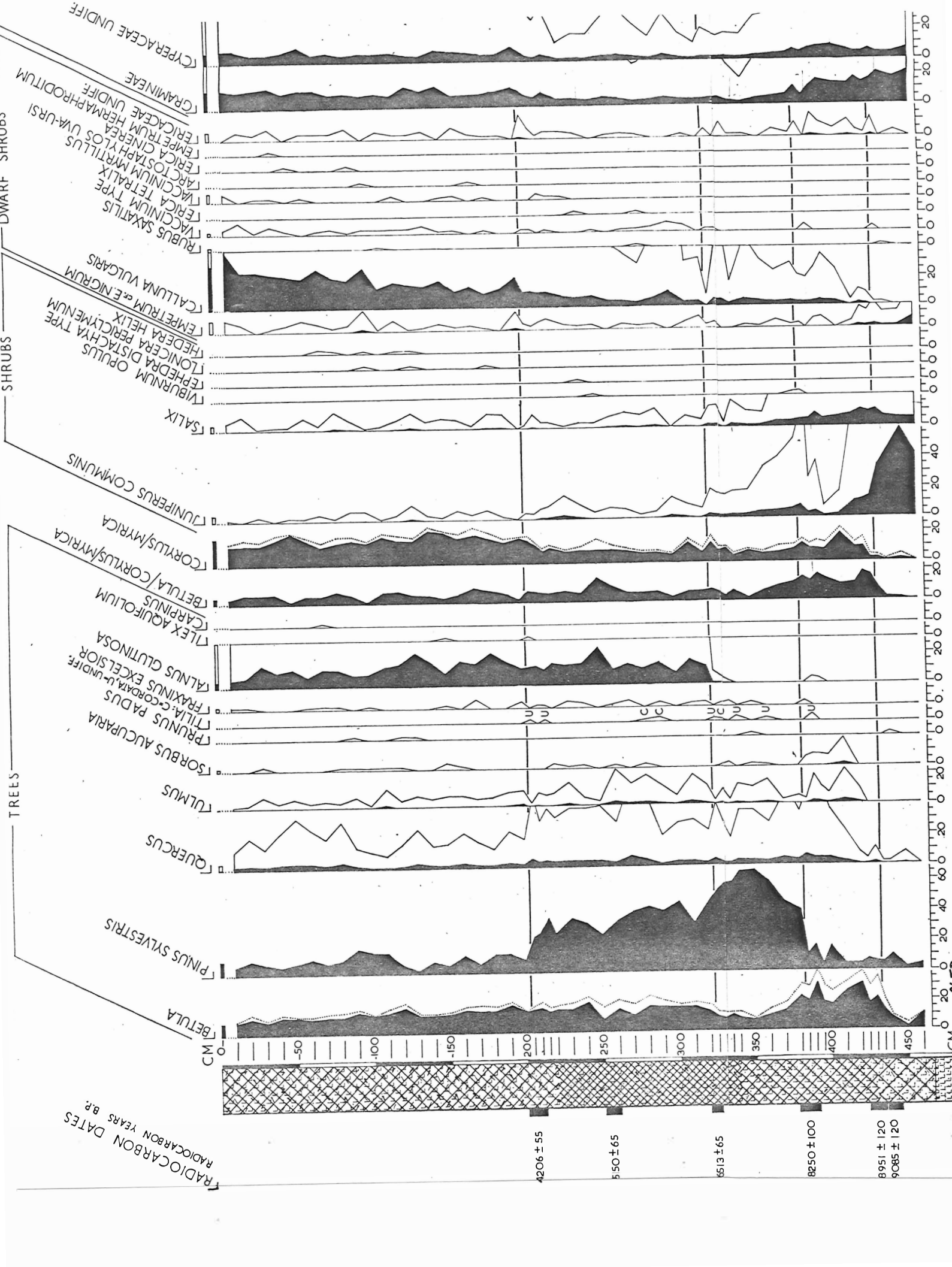


Fig.18. Map of catchment area of Loch Maree omitting Coulin Forest, showing sampling sites, present distribution of woodland types, and topography.

Fig. 19. Pollen diagram from Loch Maree.



We drive from Dundonnell around Little Loch Brrom to Gruinard Bay and Loch Ewe, and then south via Gairloch to Loch Maree.

1. LOCH MAREE (18/890 715)

Loch Maree is a long, deep, narrow loch surrounded by a diverse flora and vegetation. It lies primarily within the pine-forest region of Fig. 1. Along the western side of the loch and on the islands near Talladale there are extensive areas of native pinewoods (Fig. 18).

The ecological history of the Loch Maree islands is currently under investigation by Paul D. Kerslake at the University of Cambridge. The islands are well-wooded with Scots pine and well-grown juniper. There *is a mosaic of woodland, bog, and lake and cores from several bogs and* lakes were obtained in the summer of 1979. Many of the pine trees on the islands have fire scars, suggesting that fire may be an important ecological factor here despite the highly oceanic climate.

A pollen diagram from a core collected from under 29 m of water in Loch Maree Hotel Bay has been published by H.H. Birks (1972a) (Fig. 19). At the onset of the Holocene Juniperus formed widespread fern-rich juniper scrub. Betula and Corylus expanded at about 8950 B.P. to form open birch-hazel woods with Sorbus aucuparia, ferns, and tall herbs.

At 8250 B.P. Pinus sylvestris expanded and replaced birch and, to a lesser extent, hazel. Ulmus and Quercus were both very rare. Alnus glutinosa expanded at 6500 B.P. and Pinus began a slow decline at about 7000 B.P., perhaps as a result of paludification in the oceanic climate of the area. However, it decreased sharply at about 4000 B.P. This was the time of the demise of pine growing on peat in north-west Scotland, and radiocarbon dates for pine stumps in peat in north-west Scotland are all between 4400 and 4000 B.P. (Fig. 20).

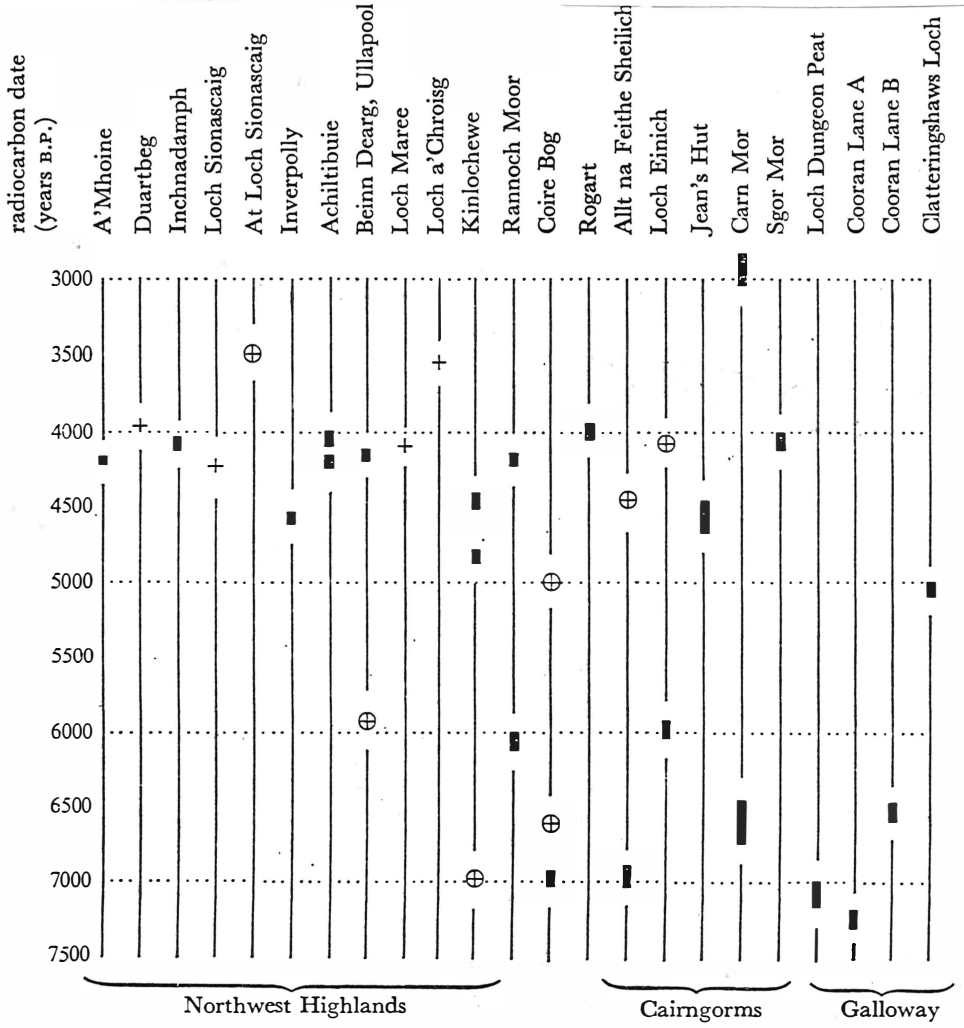


FIGURE 20. Table of radioacarbon dates in relation to their ages. The sites are arranged in geographical order with the northernmost at the left. The height of the symbol represents one standard deviation. |, Pine stump; ⊕, birch wood; +, pollen diagram.

The reasons for this widespread and spectacular decline in pine are not clear, but a combination of climatic changes and human activity including burning may have initiated the replacement of pine forest on flat and gently sloping ground by treeless blanket bog. There is independent evidence from chemical analyses of lake sediments (Pennington et al., 1972) to indicate a change to a more oceanic climate with strong winds and increased precipitation at this time. This would inhibit the regeneration of pine on mineral soils by reducing the number of good seed years and would also cause waterlogging to be more widespread and hence encourage the expansion of blanket bog.

2. COILLE NA GLAS-LEITIRE (28/004 647)

This wood covers the quartzitic lower slopes of Beinn Eighe and extends from the shore of Loch Maree (12 m) to over 300 m. This was once one of the finest pine woods in Scotland surviving after the main period of forest clearance, but it was devastated by timber extraction and felling in the Second World War.

Where the tree cover is dense, Vaccinium myrtillus, V. vitis-idaea, and mosses such as Hylocomium splendens and Ptilium crista-castrensis are prominent. In more open areas of pine forest, tall bushy Calluna vulgaris and Vaccinium myrtillus are characteristic with abundant Sphagnum carpets below the dwarf shrubs. Ilex aquifolium, Hedera helix, and Sorbus aucuparia are locally frequent in the pine woods.

On more fertile soils birch dominates with a species-rich field layer of Primula vulgaris and Endymion non-scriptus.

Within the wood there are open areas of pine heath and several small damp hollows and bogs, some of which contain up to 4 m of sediment. Preliminary pollen analyses show local changes in the pine woods over the last 6000 years.

The wood is rich in oceanic bryophytes and ferns including

Hymeniphyllum wilsonii	Scapania gracilis
Herberta adunca	Hylocomium umbratum
Plagiochila spinulosa	Mylia taylori
Anastrepta orcadensis	Sphagnum quinquefarium

3. LETTEREWE WOODS (28/981 687)

On the opposite side of Loch Maree there are extensive areas of oakwood occurring on flushed brown-earth soils derived from Lewisian gneiss. Associated trees include ash, elm, aspen, alder, hazel, and rowan. The field layers tend to be grass-dominated with Anthoxanthum odoratum and Festuca ovina. Small groups of pines occur on rocky crags above the oak zone and on shallow acid soils within the oak forest.

4. LOCH CLAIR (28/000 574)

This lake has been intensively studied by W. Pennington (Mrs. T.G. Tutin) and colleagues. The pollen stratigraphy (Fig. 21) is very similar to that at Loch Maree.

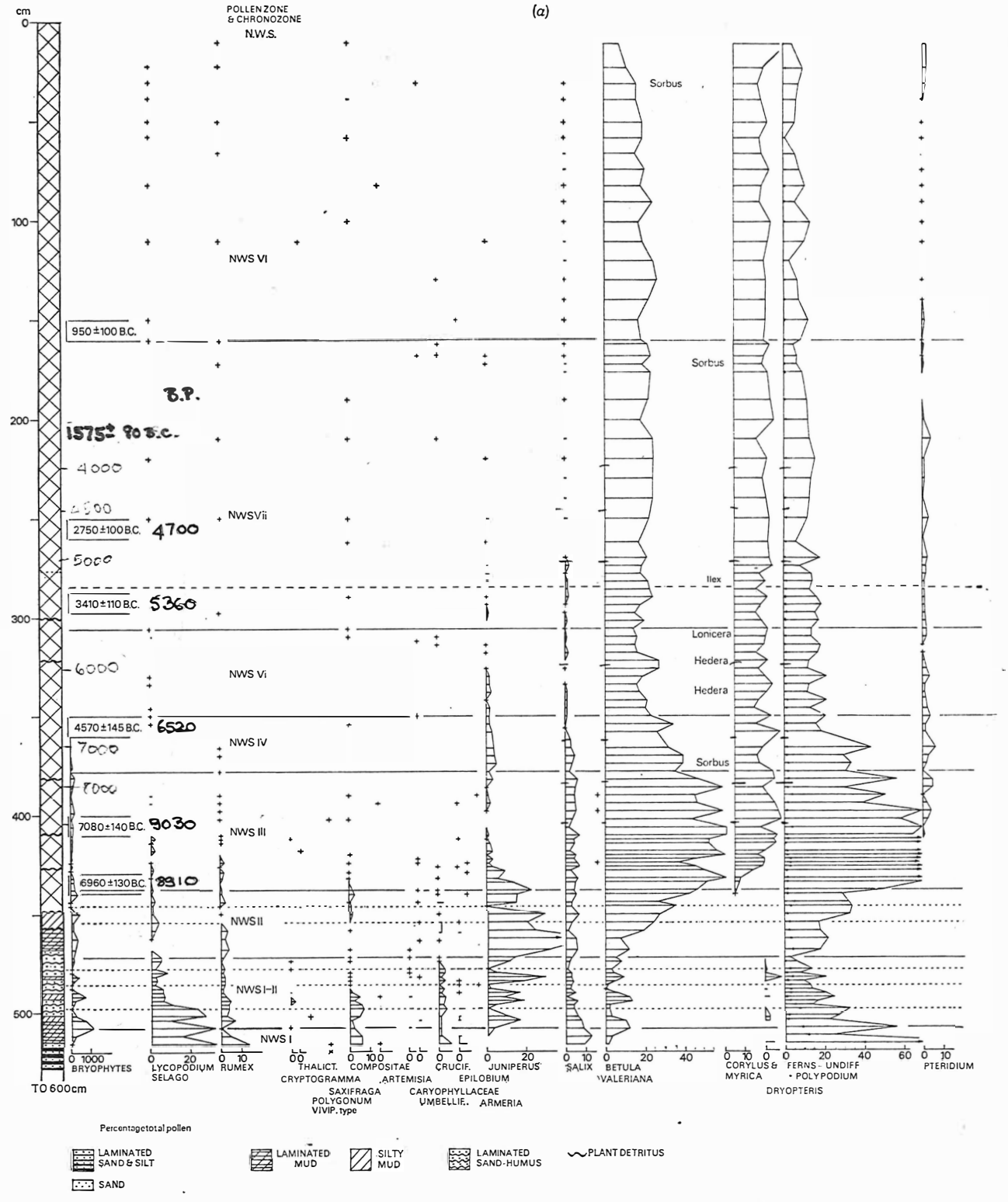


FIGURE 21.(*a*) and (*b*). Loch Clair: full pollen diagram.

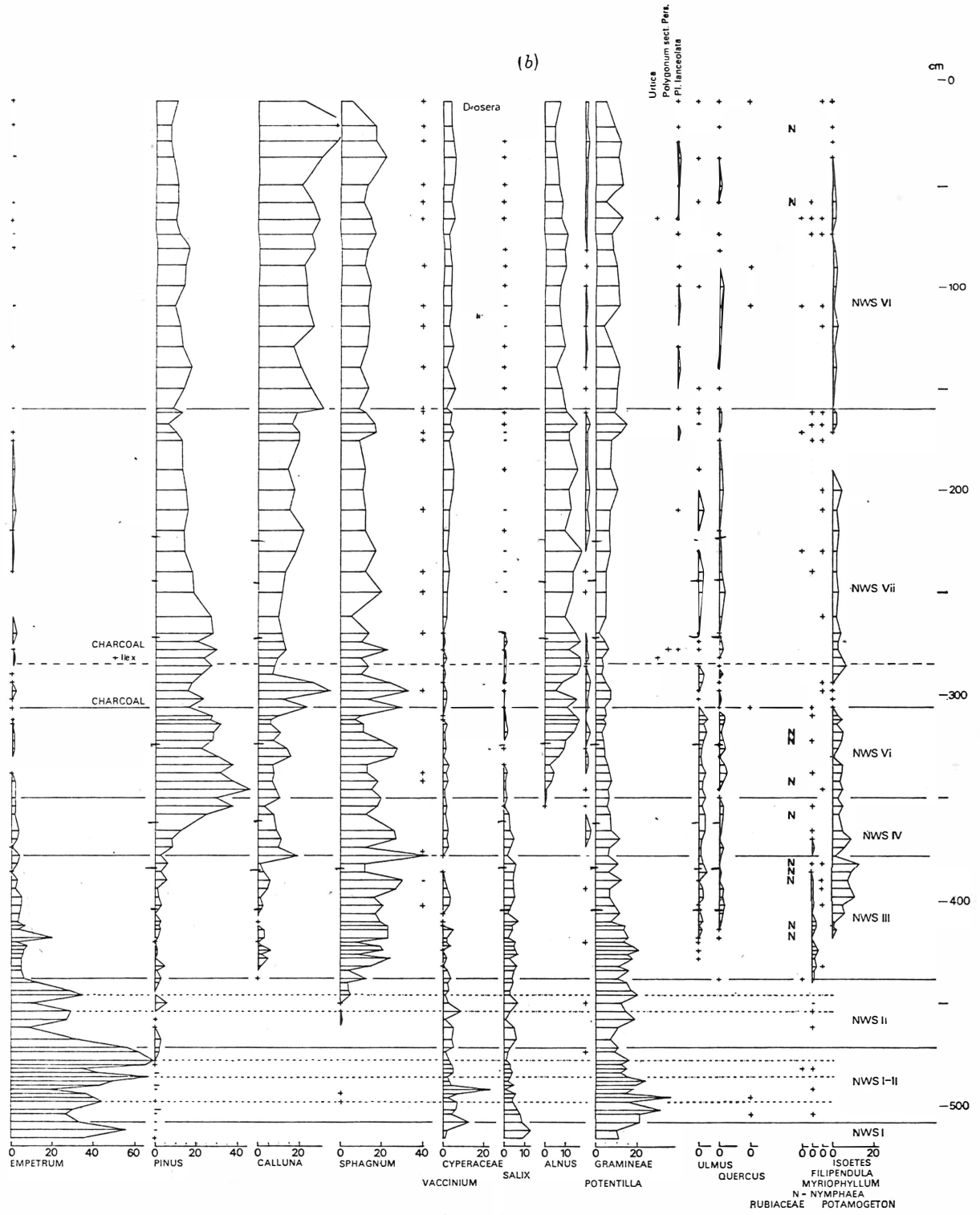

(b)
cm
Urtica
Polygonum sect. Pers.
+ Pl. lanceolata
Drosera
CHARCOAL
+ Ilex
CHARCOAL
NWS VI
NWS Vii
NWS Vi
NWS IV
NWS III
NWS Ii
NWS I-II
NWS I
EMPETRUM
PINUS
CALLUNA
SPHAGNUM
VACCINIUM
CYPERACEAE
SALIX
ALNUS
GRAMINEAE
POTENTILLA
ULMUS
QUERCUS
RUBIACEAE
ISOETES
FILIPENDULA
MYRIOPHYLLUM
N - NYMPHAEA
POTAMOGETON

FIGURE 21(b).

5. GLEN TORRIDON (18/957 568)

Like Dirrie More, part of Glen Torridon was surrounded by glaciers in the Loch Lomond stadial (Fig. 22). In the glen moraine hummocks are abundant and near Lochan an Iasgaich there is one of the finest areas of hummocky moraine in Scotland.

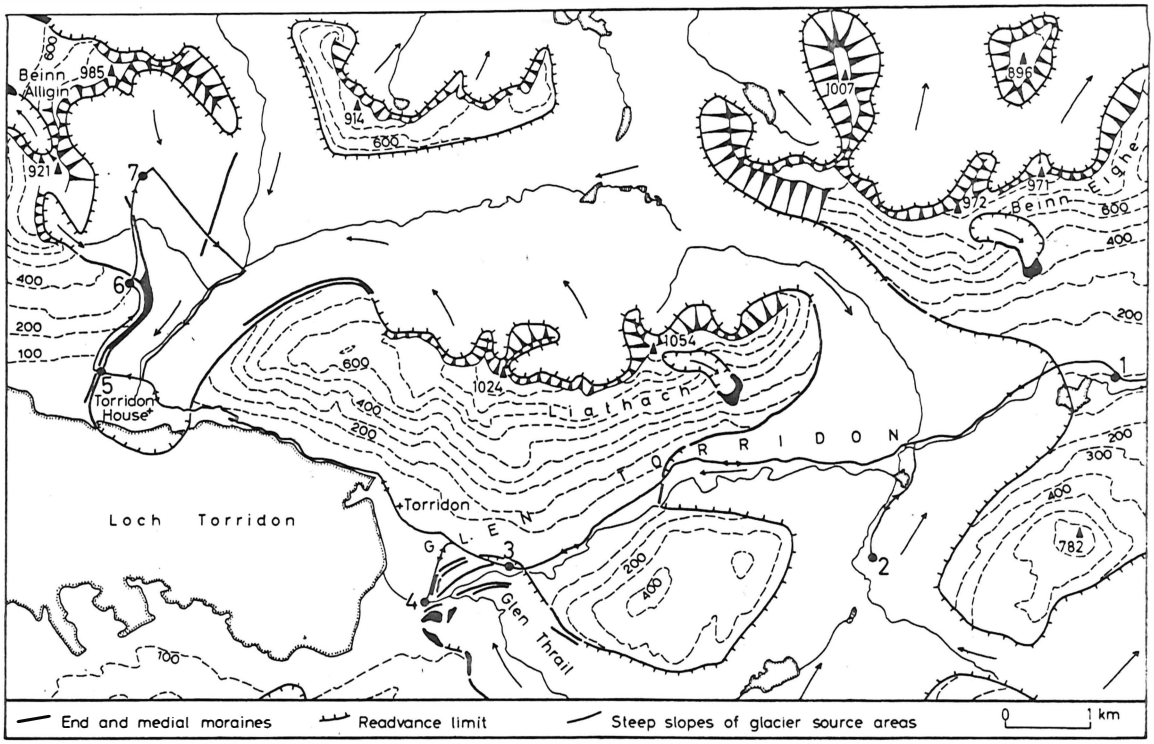


Fig. 22. Limit of the Loch Lomond Readvance in the Torridon area. Partly based on mapping by M. Robinson (pers. comm.).

6. SHIELDAIG (18/825 536 - 18/825 520)

The effects of aspect on the composition and structure of forest vegetation in north-west Scotland are clearly shown in this area. On the north-facing slopes at Ob Mheallaidh birch-dominated forest with abundant bryophytes is the major forest vegetation. On the same bedrock and altitude but on a south-west facing slope open pine woods occur at Coille Creag-loch. This wood is notable for good pine regeneration in places, but the wood was badly damaged by an accidental fire in 1973.

7. SURFACE POLLEN SAMPLES IN WESTERN SCOTLAND

In a landscape such as that in western Scotland, there are no extensive, almost continuous areas of natural of semi-natural forest comparable to what must once have clothed the Scottish landscape. There are, however, many small areas of natural or semi-natural woodlands surviving in western Scotland. To study how modern pollen reflects modern woodland composition, 84 surface samples were collected from clearings, bogs, or lakes with diameters between 100-300 m within existing woodland stands. Such sites are viewed as roughly analogous to small lakes within the once more continuously forested landscape

SCOTTISH SURFACE SAMPLES. ANAL. H.H.B., H.J.B.B., S.M.P., 1976 – 77.

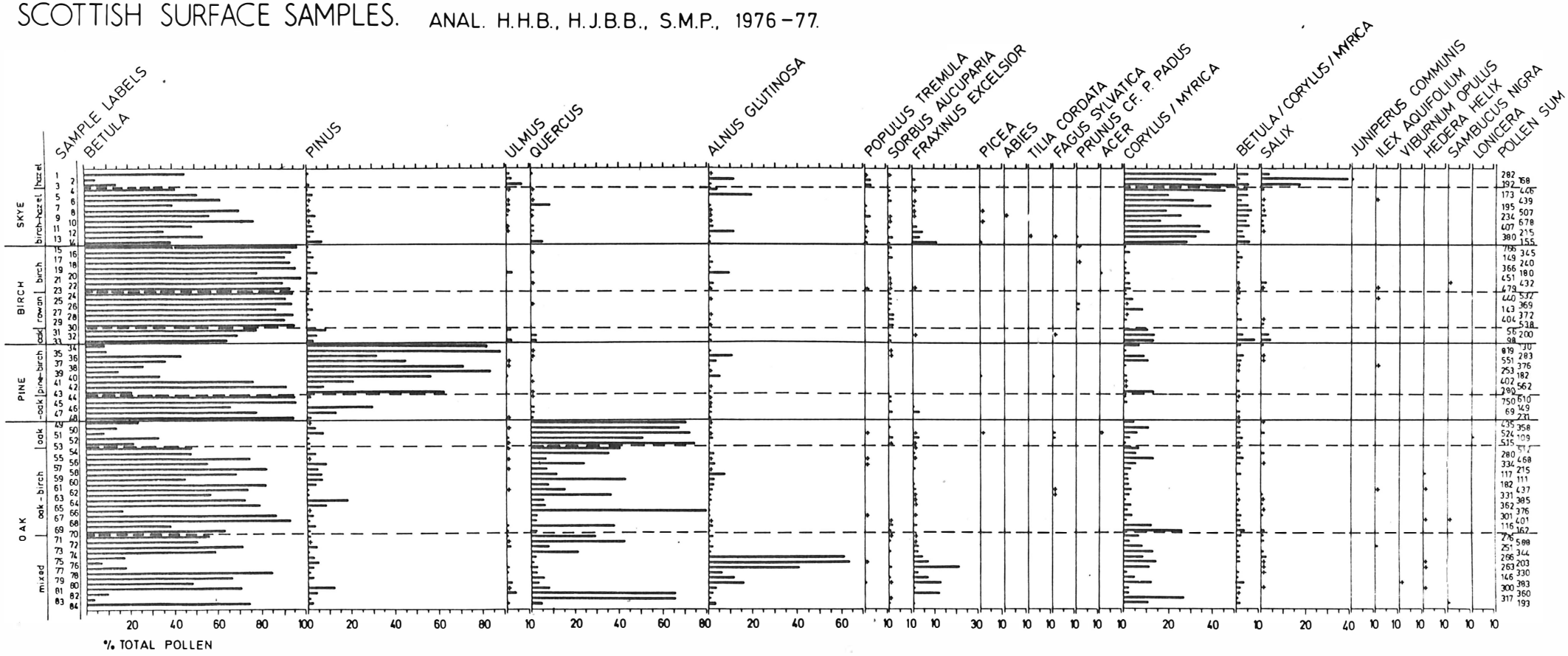


Fig. 23.

SCOTTISH WOODLAND VEGETATION DATA

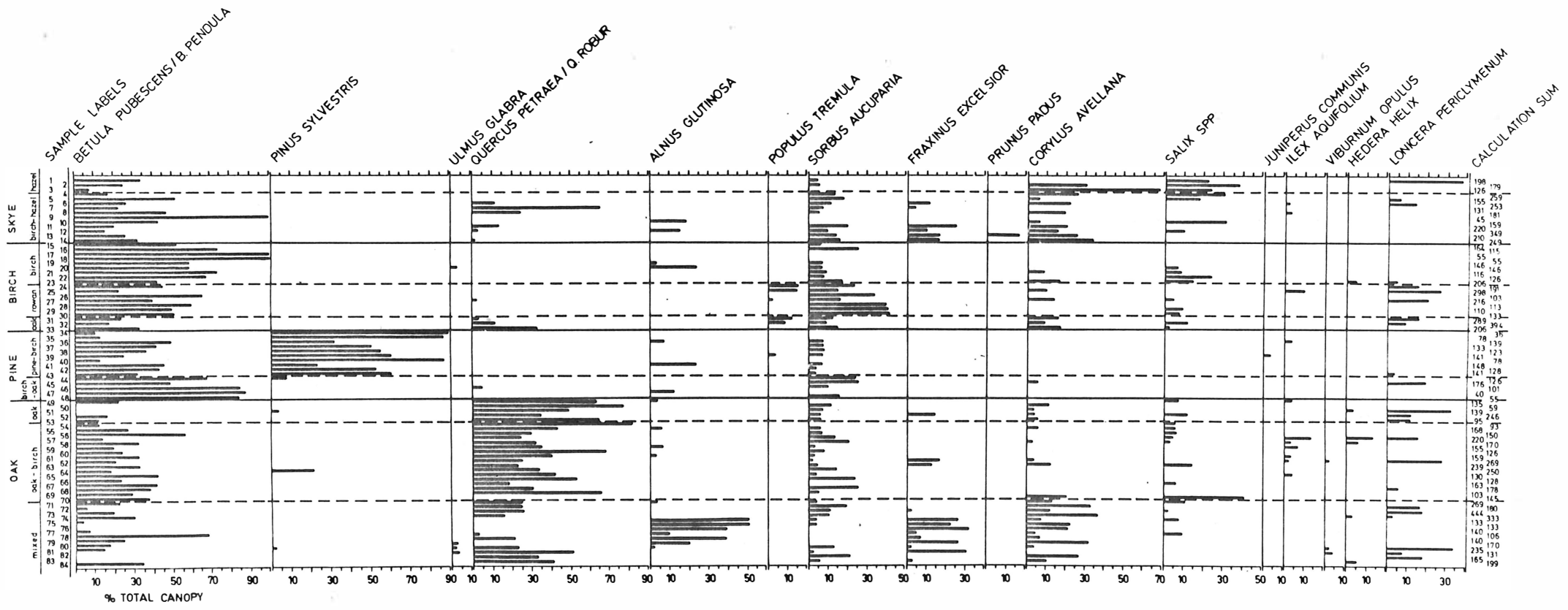


Fig. 24.

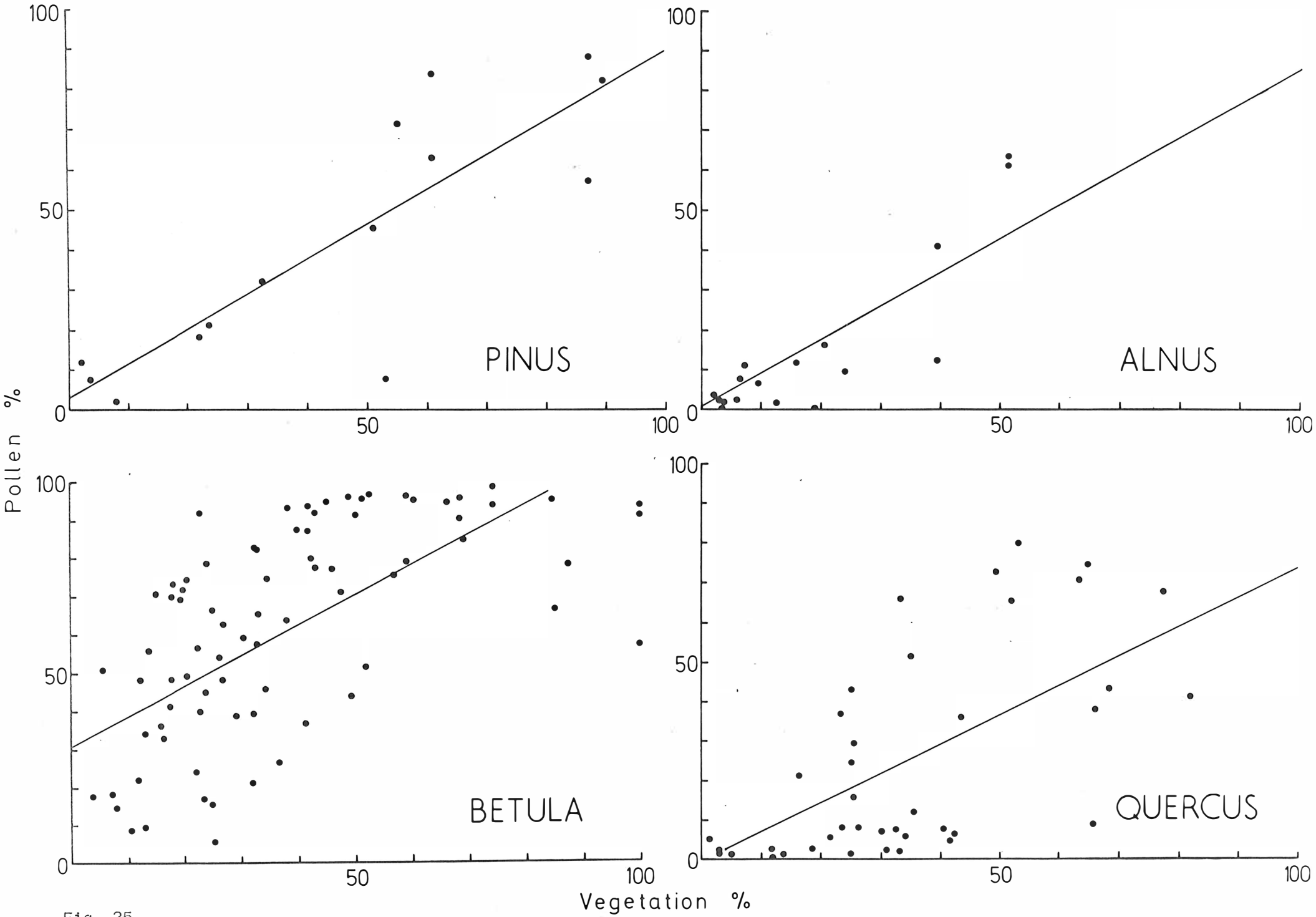


Fig. 25.

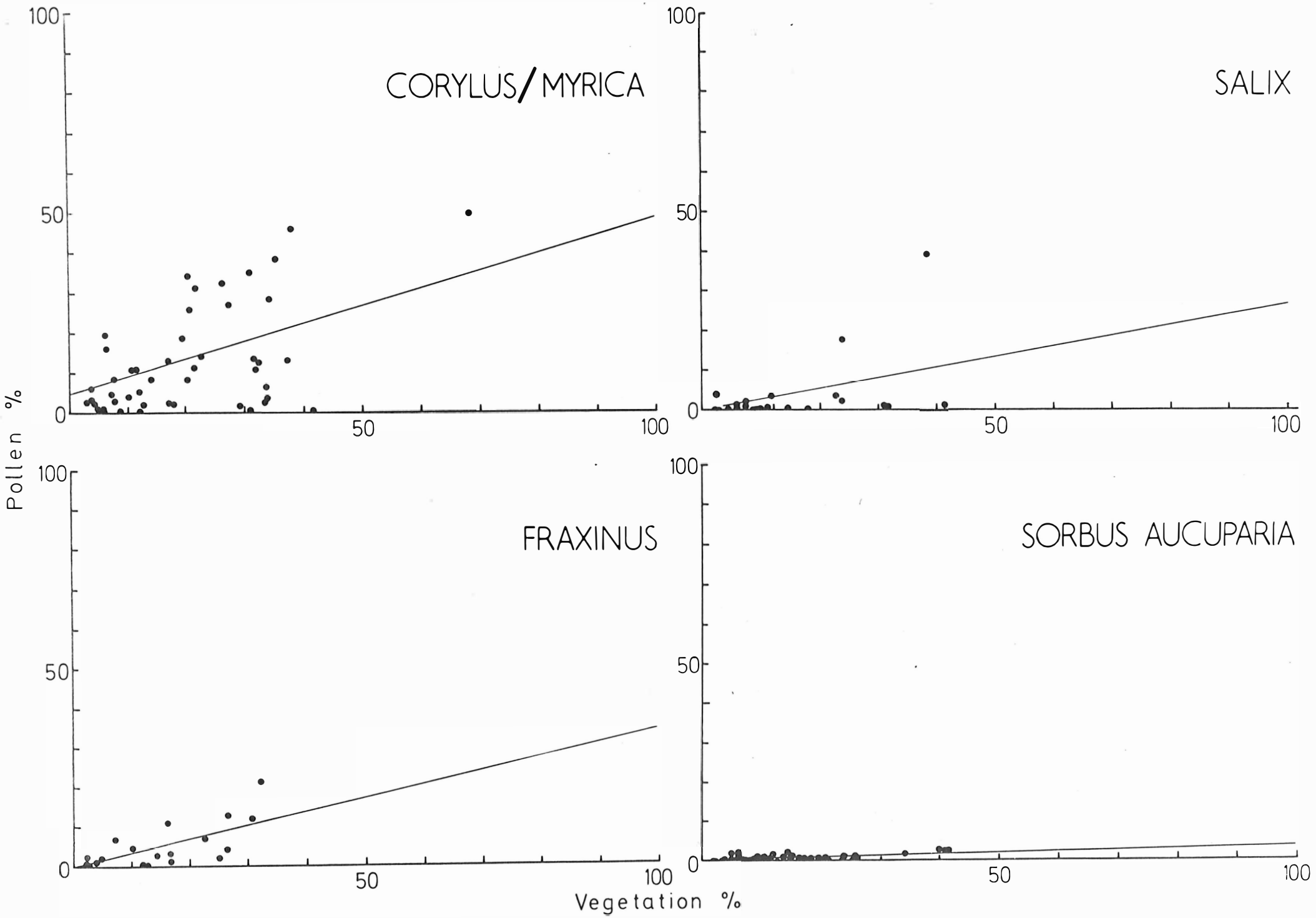

CORYLUS/MYRICA
SALIX
FRAXINUS
SORBUS AUCUPARIA
Pollen %
Vegetation %
100
50
0
50
100

Fig. 26.

landscape from which Holocene pollen diagrams have been prepared (Fig. 1).

Besides collecting surface samples the composition of the canopy was measured in several plots around each sample site. The pollen and vegetation data are shown in Figures 23 and 24 and are arranged according to the major forest regions of western Scotland.

To quantify the pollen-vegetation relationship at this scale, scatter plots of pollen and vegetational percentages for the 84 sites are shown in Figures 25 and 26. Principal axes were fitted to these plots. The slopes of the principal axes are a function of pollen representation and when expressed relative to a selected taxon can provide pollen representation or correction factors that can be used to correct fossil pollen spectra collected from sites at this scale. The slopes and proposed correction factors are as follows:

	Slope	Rrel. (relative to Quercus)	Suggested correction factor
Sorbus aucuparia	0.037	0.04	÷ 0.04
Fraxinus excelsior	0.365	0.38	÷ 0.4
Corylus / Myrica	0.755	0.80	÷ 0.8
Salix	0.330	0.35	÷ 0.4
Betula	1.300	1.37	÷ 1.4
Pinus	0.934	0.98	÷ 1.0
Quercus	0.949	1.00	÷ 1.0
Alnus	1.004	1.06	÷ 1.1

DAY 5 (JULY 10) INVERPOLLY - LOCH ASSYNT - INCHNADAMPH

We drive northwards from Dundonnell past Ullapool to the Inverpolly National Nature Reserve and north to the Loch Assynt area to visit the Inchnadamph National Nature Reserve.

1. INVERPOLLY (29/127 091)

This area is an area of contrasting relief and topography, with an intensively glaciated foreland of hard, acid Lewisian greiss overlain by massive horizontally bedded mountains of Torridonian sandstone such as Cul Mor, Cul Beag, and Stac Polly.

The vegetation of the area is a mosaic of Trichophorum-Eriophorum blanket-bog in areas of deep wet peat, of Trichophorum-Calluna bog on shallower, drier peat, of Calluna vulgaris heath on steep rocky areas with shallow, humus-rich soils, of species-poor Agrostis-Festuca grasslands on well-drained, heavily grazed sites, and of Molinia caerulea-dominated stands wherever there is some soligenous influence.

Betula pubescens dominates the several woods in this area on steep, often block-strewn slopes. Corylus avellana and Sorbus aucuparia are locally frequent. The field layers of these woods vary in relation to soil base-status and intensity of grazing. Atlantic bryophytes abound, particularly in woods on north- or east-facing slopes. There is no native pine in the area.

Pollen diagrams from Loch Sionascaig (Fig. 27) (Pennington et al., 1972). from Dubh Loch, a small loch to the west of Loch Sionascaig (P.D. Kerslake, unpublished data), and from a small bog on Eilean Mor, an island in the centre of Loch Sionascaig (P.D. Kerslake, unpublished data) show that from about 7900 to 4000 B.P. Pinus was the dominant tree of the area. As the Inverpolly area lies to the north of the present pine-forest region some northward extension of pine clearly occurred in mid-Holocene times. Chemical analyses of the Loch Sionascaig profiles (Pennington et al., 1972) (Fig. 28) suggest that between 8000 and 6500 B.P. soils were relatively dry but leached mineral soils. From 6500 B.P. increases in iron and manganese suggest increasingly waterlogged soils. By 5000 B.P. blanket bog began to accumulate in the area, although widespread bog development do not occur until about 4000 B.P. Pine stumps in the area are all about 4000 B.P. in age (H.H. Birks, 1975; Lamb, 1964). The birch woods of the area are all today confined to slopes too steep for the development of blanket bog. The widespread development of blanket bog in north-west Scotland represents a major environmental change, and we are, at present, very ignorant about the mechanism and causes for the spread of blanket bog in mid- and late-Holocene times.

2. CAM LOCH (29/220 121)

Pennington (1975) has published a detailed radiocarbon-dated digram for the Devensian late-glacial from Cam Loch (Figs. 29 and 30). The major pollen assemblages and their correlation with the chronozones of Scandinavia are shown in Fig. 31.

The pollen stratigraphy shows a succession from pioneer and snow-bed vegetation (zone Ca) to herb-rich grasslands with Rumex, Empetrum, and Juniperus (zone Cb). Pennington (1975) interprets the second phase of zone Cb as representing a climatic deterioration with an expansion of Artemisia and a decrease in Juniperus pollen. Zones C-c and C-d reflect the widespread development of sedge and grass-dominated communities with Empetrum and some Betula. Zones C-e and C-f witness an increase of Artemisia and Caryophyllaceae values at the time of the Loch Lomond stadial (≡ Younger Dryas). The opening of the Holocene is marked by an expansion of Empetrum and Juniperus in zone C-g.

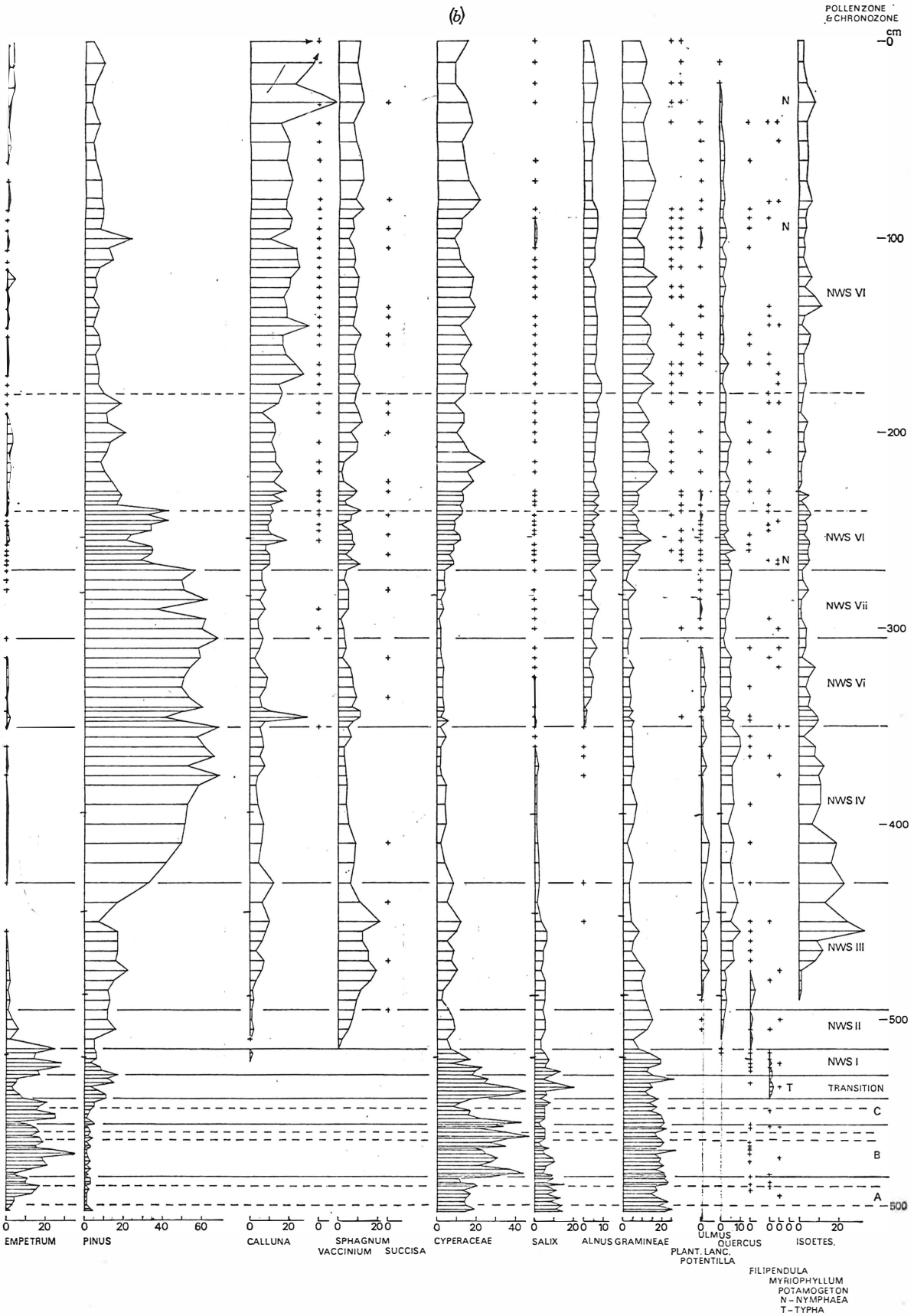


FIGURE 27 Loch Sionascaig: full pollen diagram. From left to right the taxa are arranged in groups of curves which show some correlation. 1, Late-glacial taxa which almost disappear in post-glacial; 2, *Juniperus* – replaced in zone NS III by *Betula–Corylus*–ferns; 3, *Empetrum* – replaced above zones III–IV by *Pinus–Calluna–Sphagnum–Pteridium*; 4, Cyperaceae and Gramineae; 5, *Salix–Alnus*; 6, *Quercus, Ulmus, P. lanceolata* etc. – all of minor importance.

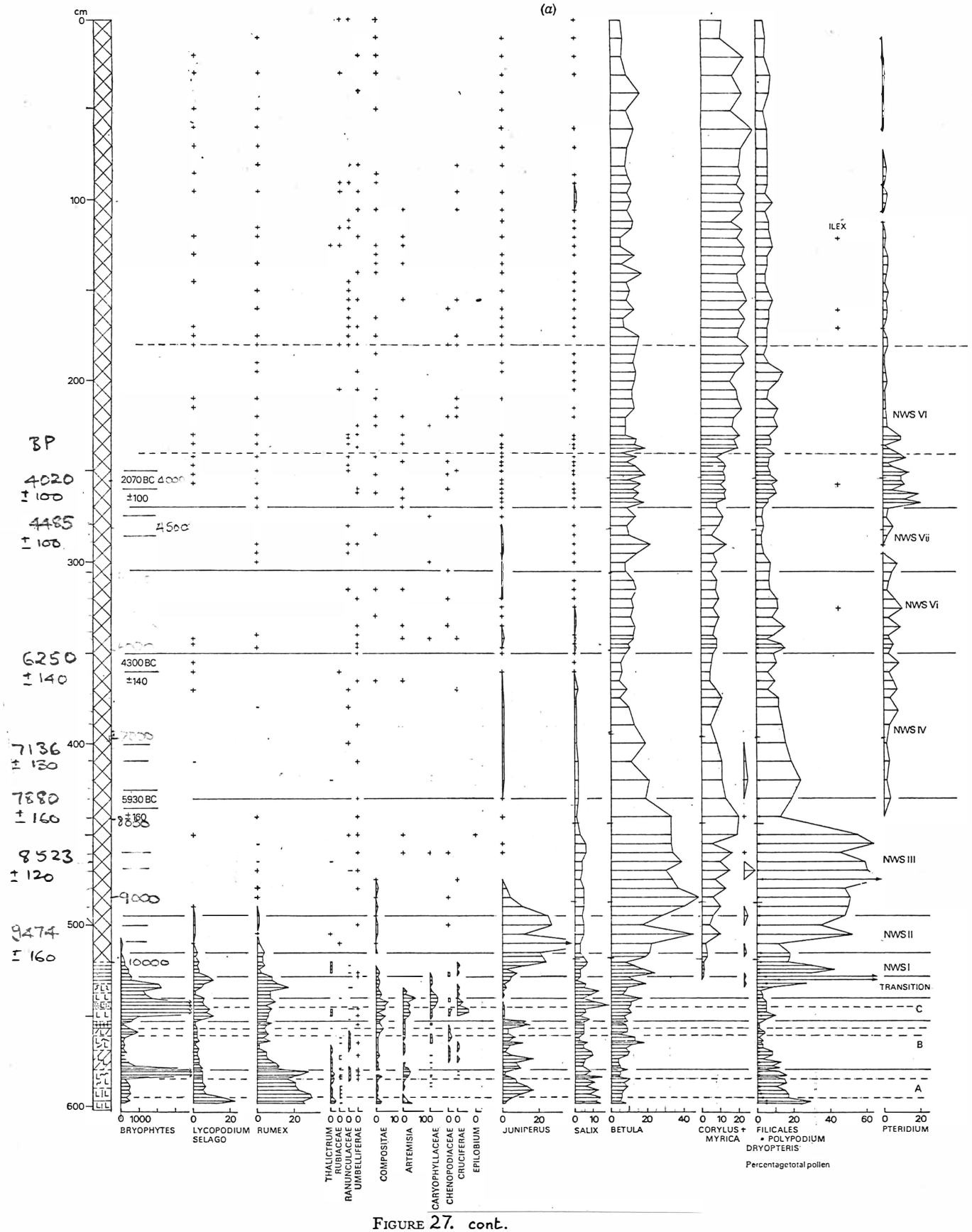


FIGURE 27. cont.

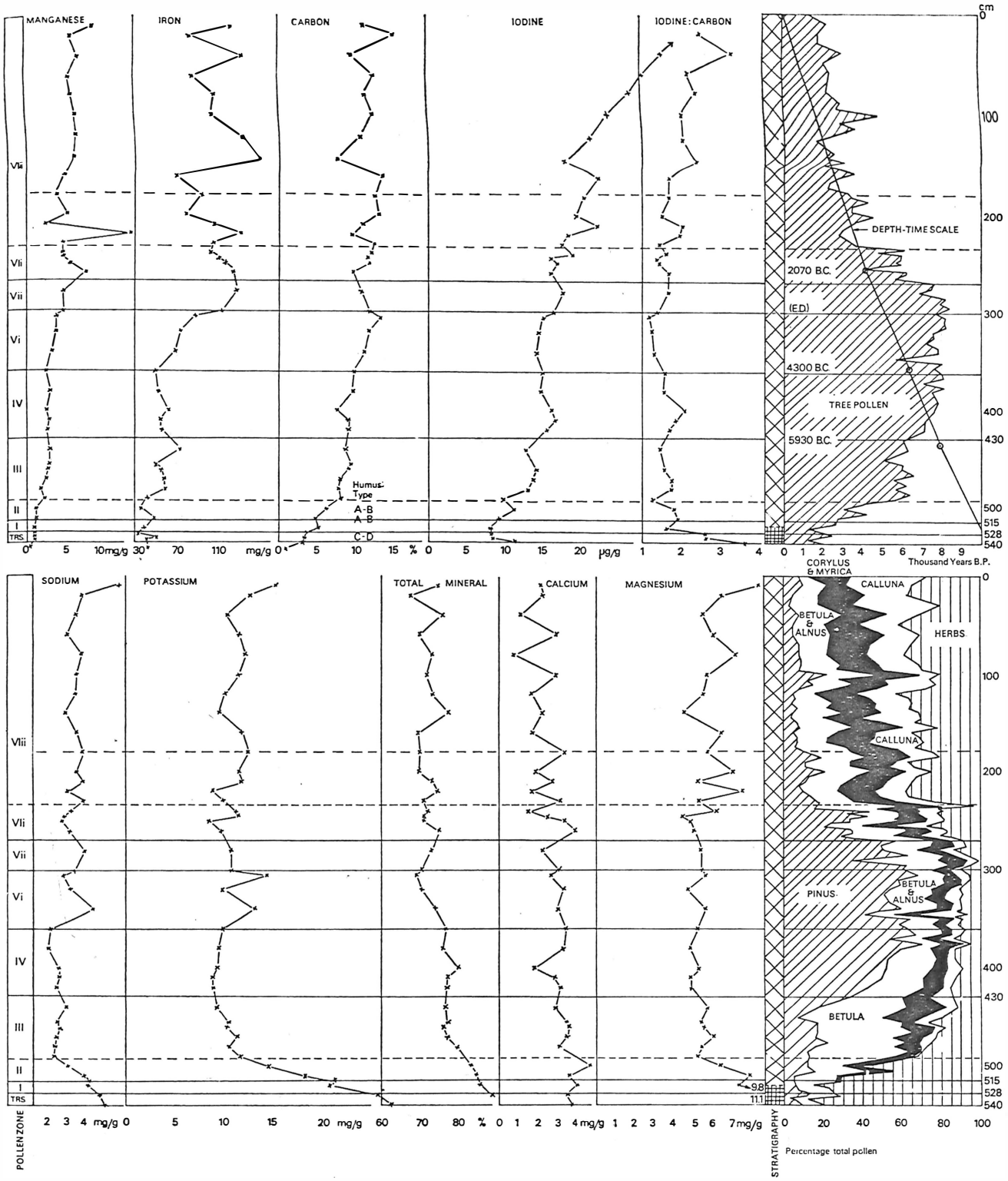


FIGURE 28. Loch Sionascaig: post-glacial chemical diagram, divided horizontally at pollen zone boundaries, with analyses of composition of pollen spectra.

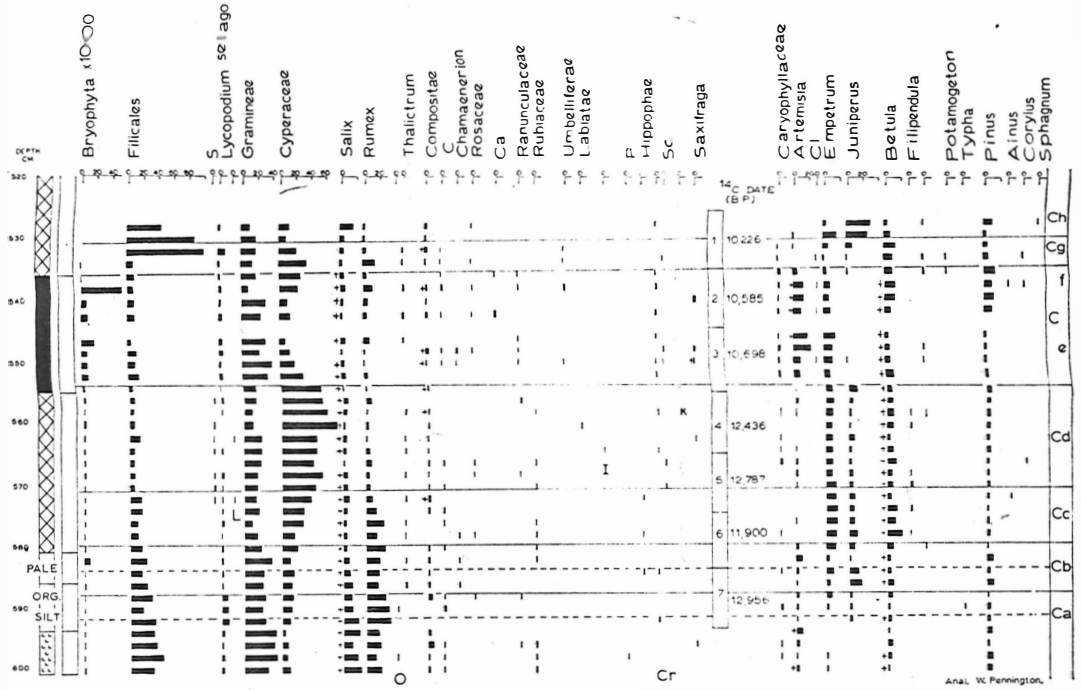


Fig. **29.** Pollen diagram from Cam Loch showing selected taxa as percentages of total pollen. C=Chenopodiaceae, Ca=*Caltha* type, Cl=*Calluna,* Cr=Cruciferae, I=*Iris,* K=*Koenigia,* L=*Lycopodium* sp., O=*Oxyria* type, P=*Plantago* spp., S=*Selaginella,* Sc=Scrophulariaceae. Stratigraphic symbols as in Fig. 5, +black=faintly banded clay.

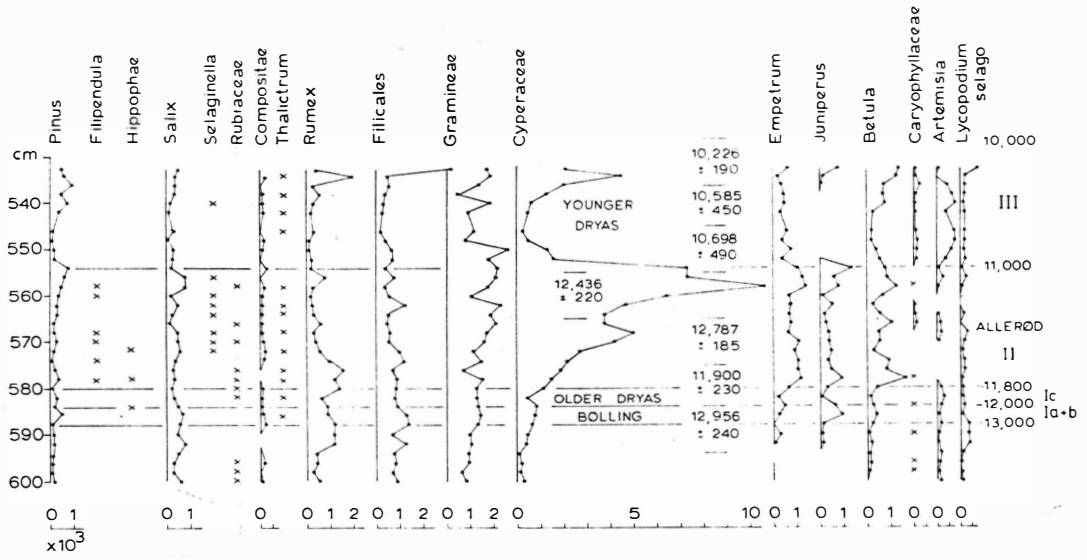


Fig. **30.** Absolute pollen diagram from Cam Loch showing concentration per c.c. of selected taxa.

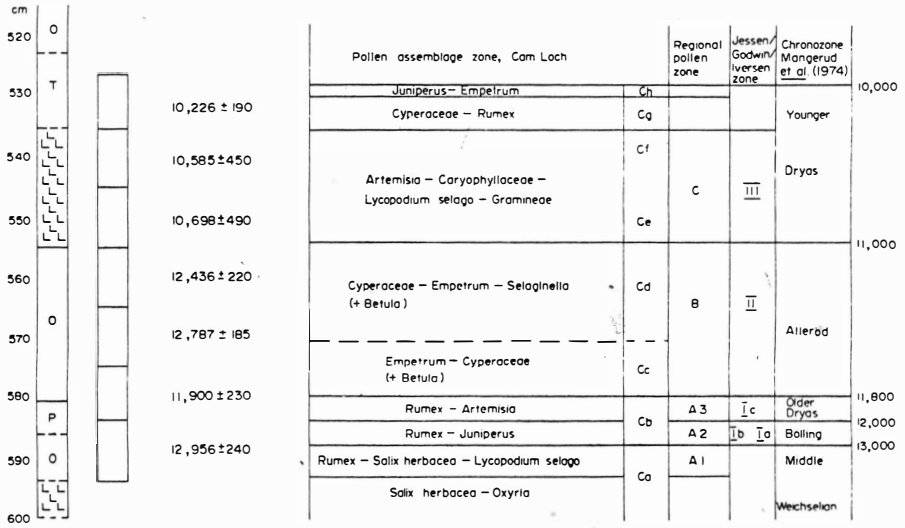


Fig. **31**. Correlation of chronostratigraphy and pollen assemblage zones at Cam Loch, Sutherland, with Late Devensian and Late Weichselian subdivisions. Radiocarbon dates are SRR-247 to 253.

3. LOCH ASSYNT (29/215 253)

Thirteen km north of Loch Sionascaig the pollen stratigraphy from a small in-filled hollow on the north side of Loch Assynt (Fig. 32) contrasts with that at Loch Sionascaig and Loch Maree. The replacement of juniper-dominated scrub by birch forest occurred at 9200 B.P. Corylus subsequently expanded at 8950 B.P. to form fern- and herb-rich birch-hazel woods with Populus tremula, Sorbus aucuparia, and Prunus padus. Whilst hazel expanded here, juniper-dominated vegetation was being replaced by Betula woodland in the Loch Maree area, illustrating the complex and, as yet, poorly understood chronology and mechanisms of early Holocene forest succession. At Loch Assynt a small rise in pine values at 8200 B.P. (Fig. 22) probably reflects long-distance dispersal of pine pollen from the Loch Maree area. Alnus glutinosa expanded at 6500 B.P. and at 5300 B.P. Pinus exapanded northwards from the Sionascaig area. This phase of pine growth ceased in the Loch Assynt area at 4000 B.P., as it did at Sionascaig, due to the spread of blanket bog and associated deforestation. More extensive deforestation of birch woods occurred about 1500 B.P., probably due to human activity. Scattered birchwoods survive today on steep rocky slopes and in ravines in an otherwise treeless landscape (e.g. An Coimhleum on the south side of Loch Assynt). It is clear that Quercus never extended this far north, its northernmost major Holocene extension in western Scotland was about southern Skye (Fig. 1).

Further north, at An Druim, Eriboll (Fig. 1) the pollen stratigraphy (Fig. 33) shows that neither pine not oak extended that far north, where as elm was locally frequent, perhaps on soils associated with the Durness limestone. Deforestation occurred progressively from about 5000 B.P., and there is palynological evidence to suggest both arable and pastoral farming in the Eriboll area.

4. INCHNADAMPH (29/251 212)

The impressive cliffs of Durness limestone are a major botanical locality. Despite their low altitude (300-500 m) they support a rich flora of arctic-alpine plants. Besides the cliffs, there are steep slopes with scree, limestone pavements, and several caves in which bones of northern lynx, bear, arctic fox, reindeer, and ptarmigan have been found.

Plants of interest on or near the cliffs include

Dryas octopetala
Polystichum lonchitis
Arenaria norvegica
Sorbus rupicola
Salix myrsinites
Alchemilla alpina
Galium boreale
Asplenium viride
Carex capillaris
C. rupestris
Epipactic atrorubens
Agropyron donianum
Saxifraga aizoides
Thalictrum alpinum
Polygonum viviparum

BY LOCH ASSYNT, WEST SUTHERLAND. ANAL. HILARY H. BIRKS, 1973-74.

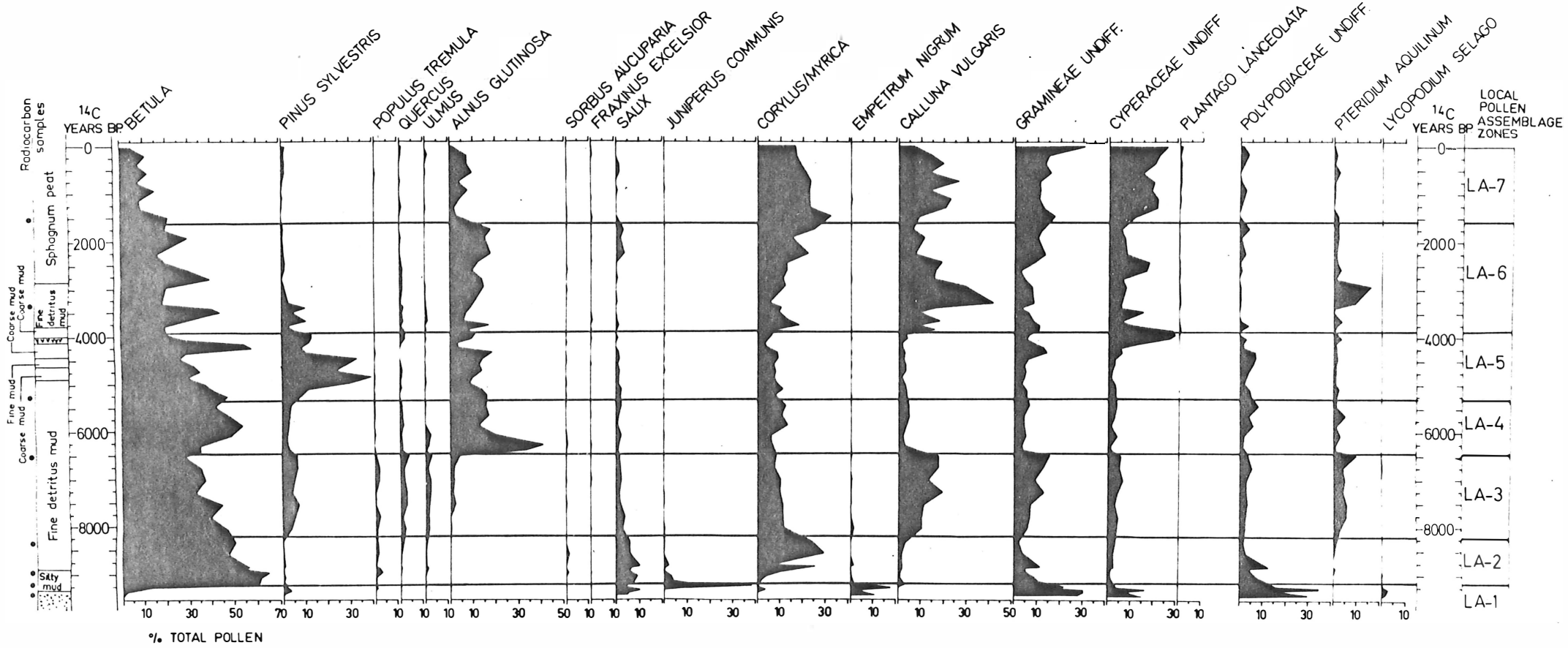


Fig. 32.

AN DRUIM, ERIBOLL, SUTHERLAND. ANAL. HILARY H. BIRKS, 1974-75.

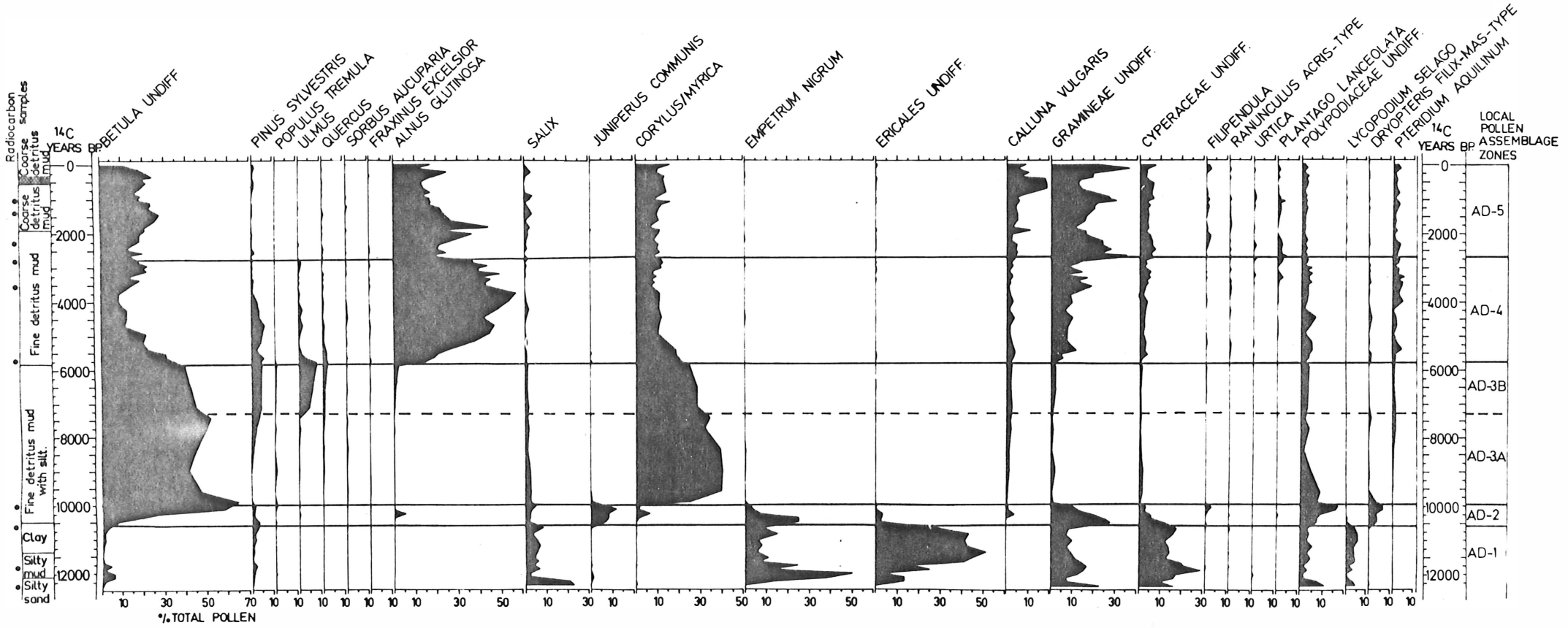


Fig. 33.

DAY 6 (JULY 11) DUNDONNELL - KYLE OF LOCHALSH - ISLE OF SKYE

We drive from Dundonnell to Dirrie More and Gorstan, and then travel westwards to Achnasheen, Strathcarron, and Kyle of Lochalsh. At Kyle of Lochalsh we take a ferry across Loch Alsh to Kyleakin on the Isle of Skye.

The present vegetation, present flora, and Devensian late-glacial vegetational history of Skye have been studied by Birks (1973), and the Holocene vegetational history by Williams (1977). Although only 77 km long and 84 km wide (total area 1720 km^2), Skye has a very varied flora and vegetation, primarily due to its great topographical diversity (Fig. 34) and geological diversity (Fig. 35).

Skye can be divided into six regions on the basis of its geology and topography (Fig. 36). The relative importance of the principal plant communities in these six regions can be assessed (see Fig.36). The plant communities are delimited from a phytosociological survey of Skye between 1966 and 1969 in which 540 quadrats or relevés were collected and analysed.

The six regions are as follows:

1. Sleat - Mainly lowlying Torridonian sandstone, Lewisian greiss, and Moine schist. All very acid. Vegetation is primarily bog and moorland with several birch woods in sheltered sites.

2. Kyleakin - As for Sleat, except that there are mountains up to 800 m altitude.

3. Suardal - Mainly lowlying Durness limestones (as at Inchnadamph) with Dryas octopetala heath and hazel woodland.

4. Red Hills - Mainly granite with mountain vegetation above 450 m and acid bog on the lower slopes.

5. Cullin Hills - Mainly gabbro forming spectacular mountain scenary of serrated peaks, narrow ridges, cliffs, and screes. Mountain vegetation above 450 m and extensive bog on the lower slopes.

6. Northern Skye - Tertiary basalts overlying Jurassic limestones, shales, and siltstones. Massive landslips in Trotternish. Species-rich meadows and bog in the lowlands. Woodland and scrub very rare and confined to sheltered areas. Mountain vegetation above 450 m.

To study spatial and temporal variations in the Devensian late-glacial flora and vegetation of Skye, I analysed cores (Fig. 37) from regions 1, 3, 5, and 6. For studies on the Holocene vegetational history Williams (1977)analysed (Fig. 1) sites from regions 1, 2, and 6.

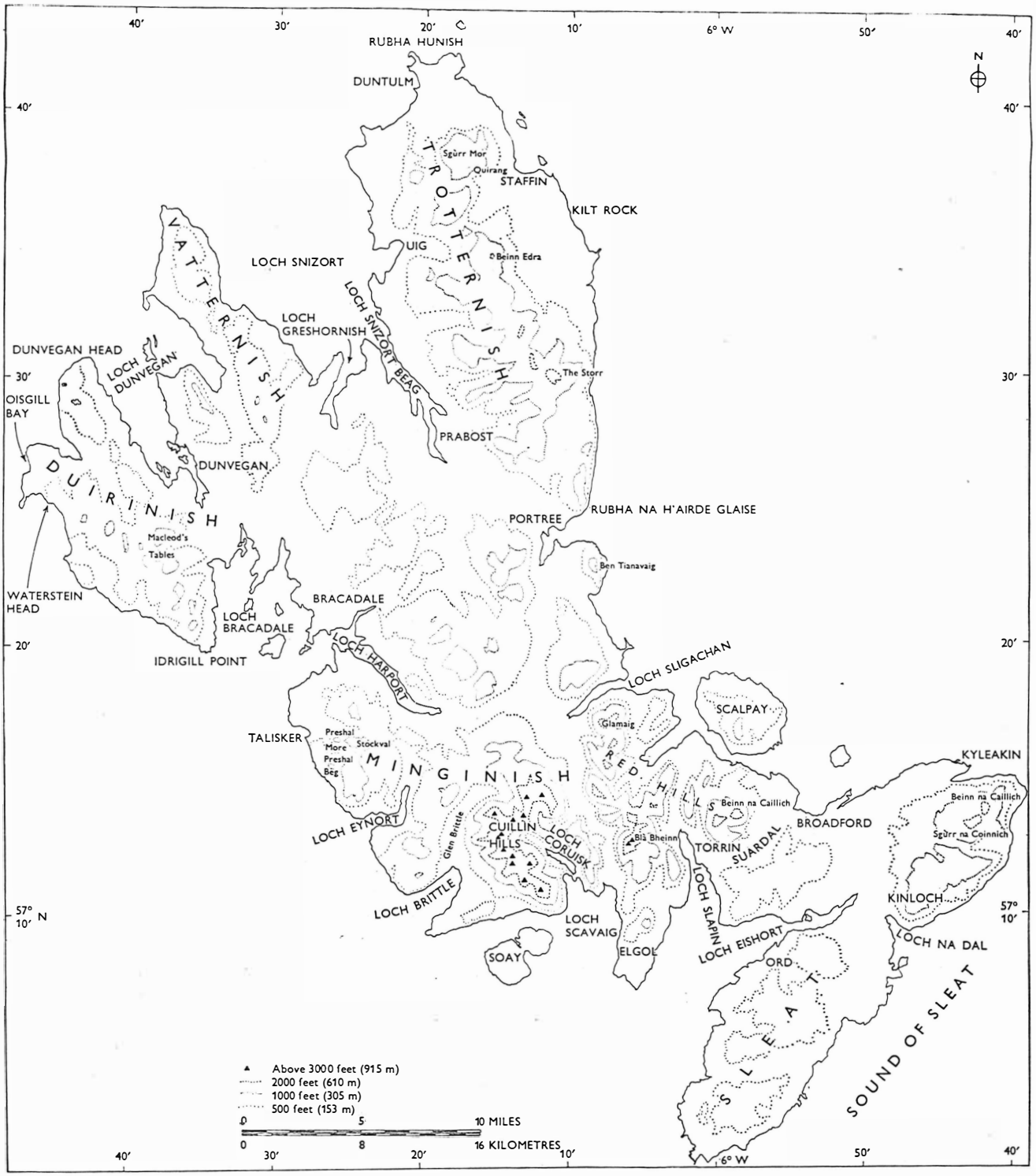


Figure 34. Topographical map of the Isle of Skye, with contours at 500 feet (153 m), 1000 feet (305 m), 2000 feet (610 m), and 3000 feet (915 m).

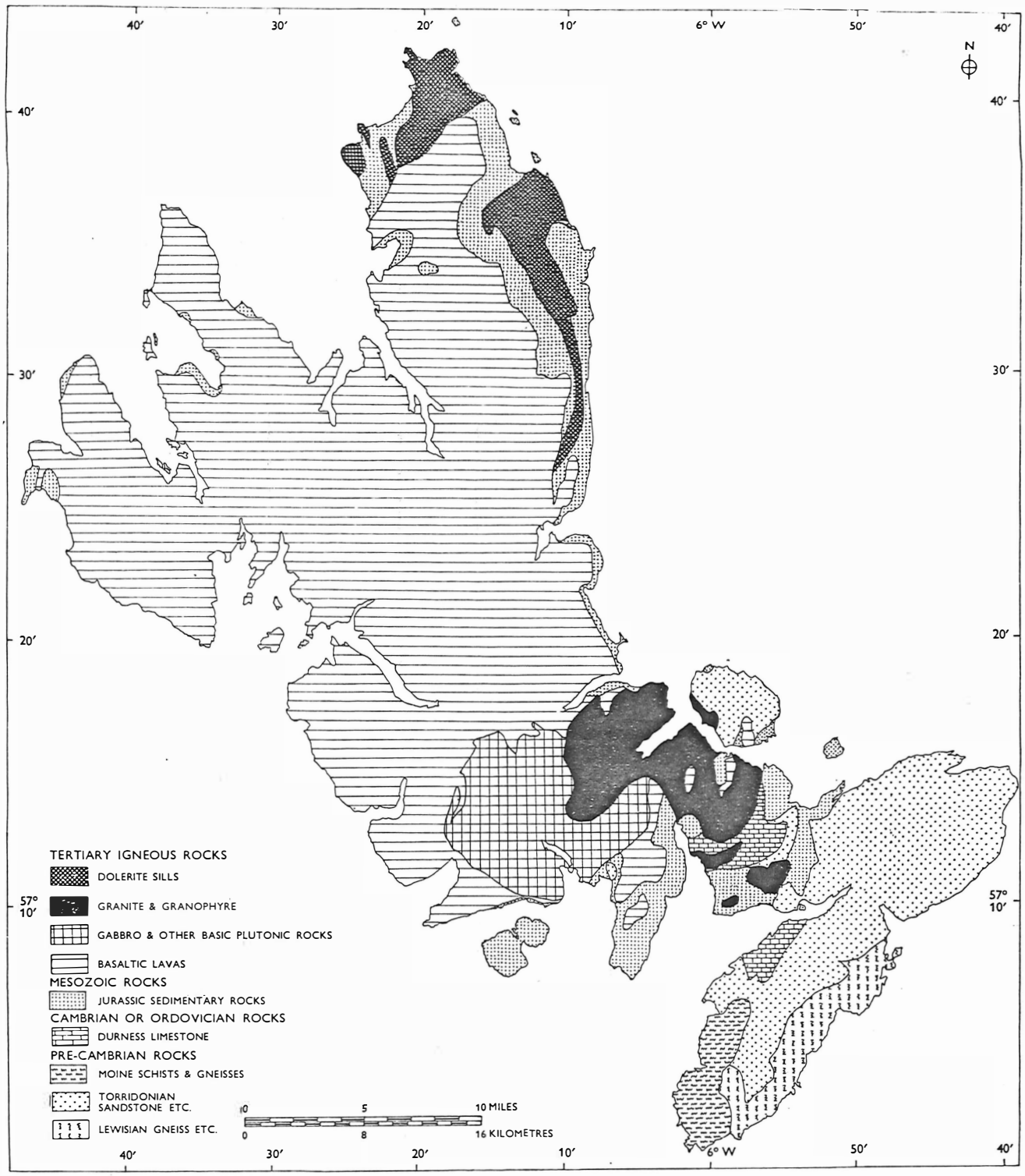


Figure 35. Simplified geological map of the Isle of Skye.

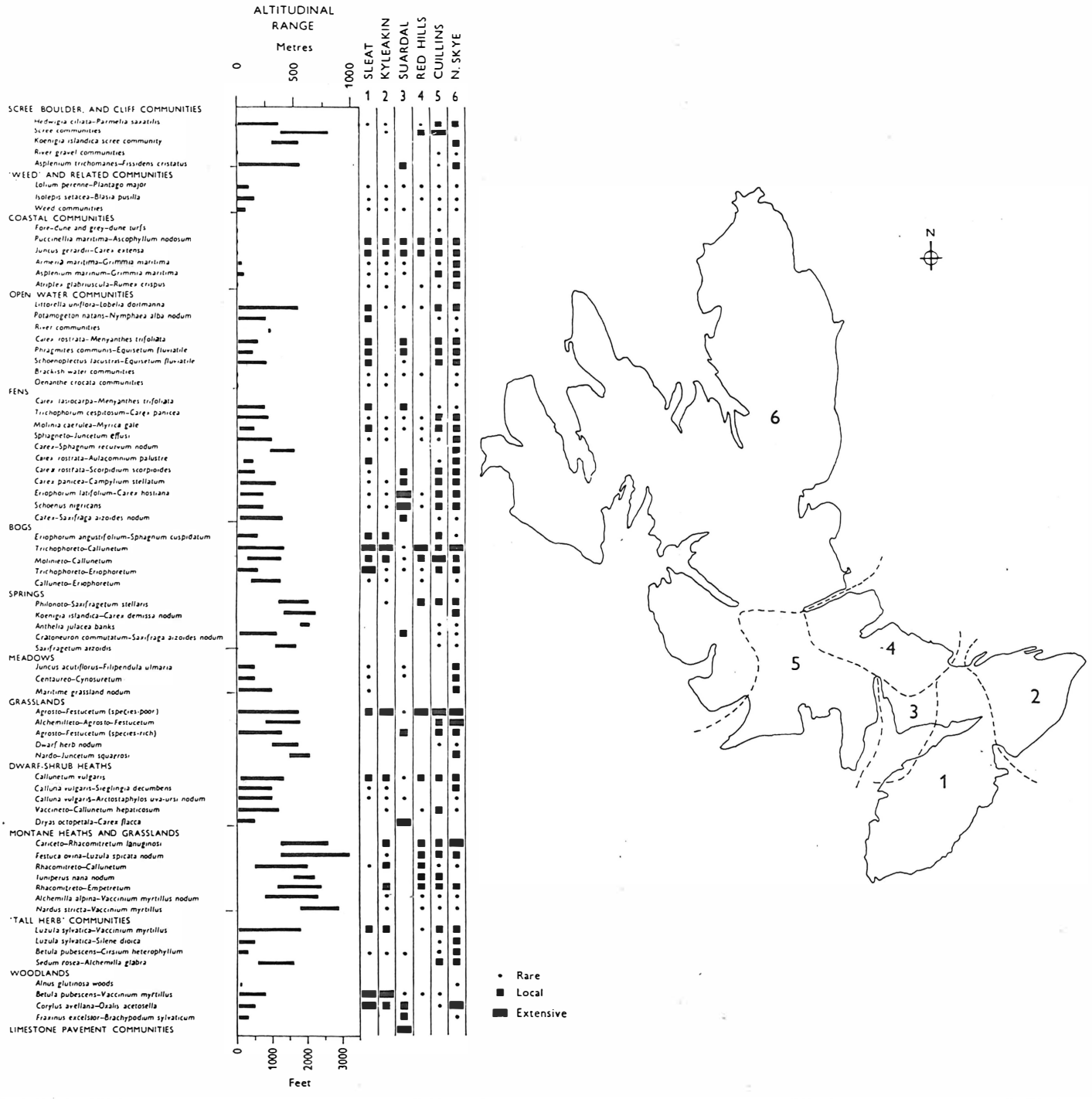


Figure 36 Present distribution of the principal vegetational types in the six regions of Skye. The nomenclature of the vegetational types follows Chapter 4, and the terms rare, local, and extensive are defined in Chapter 5.

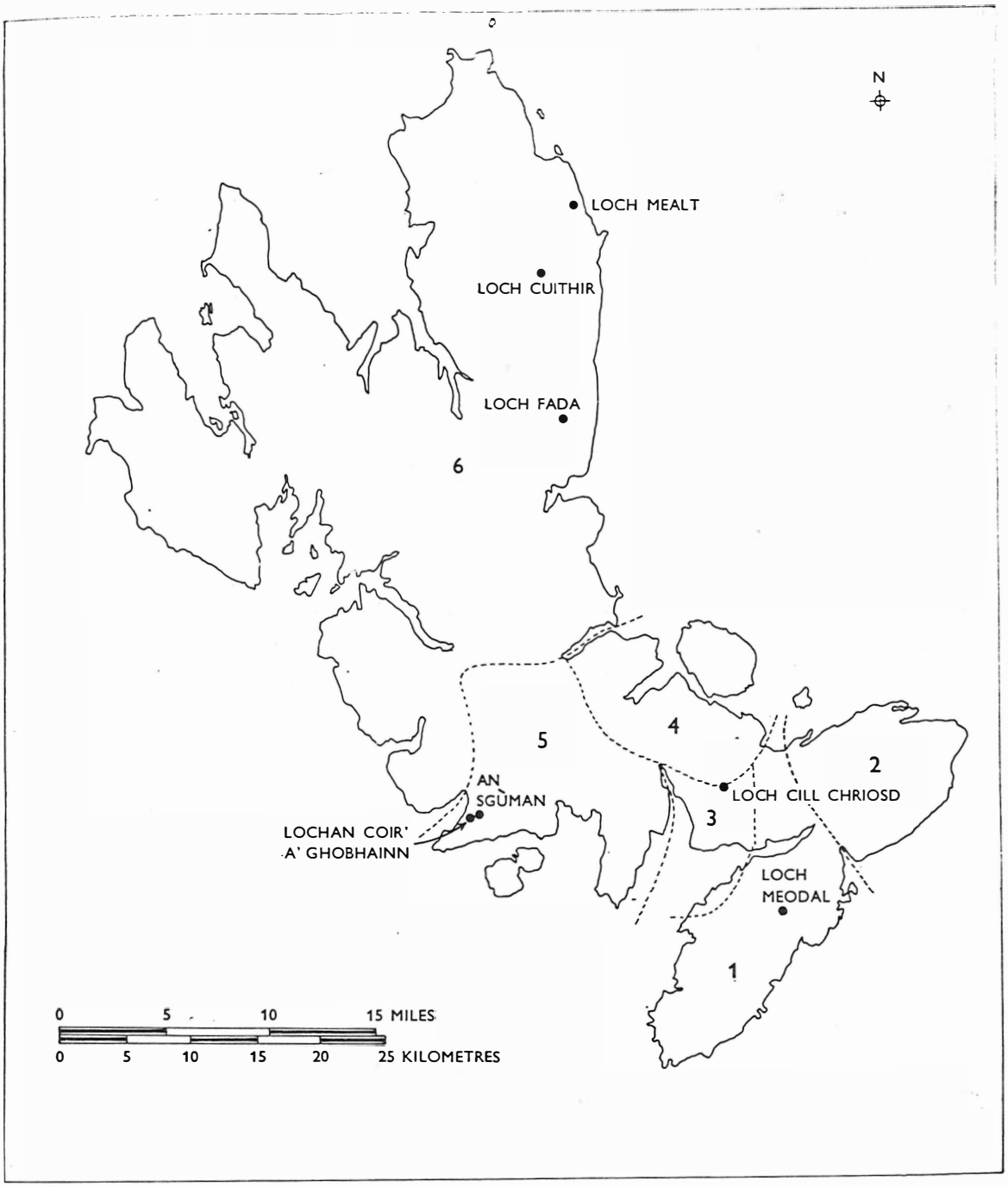


Figure 37. Index map of the Isle of Skye, showing location of sites that have been examined palynologically by the author or by Vasari & Vasari (1968) in relation to the six geological and topographical regions of the island.

LOCH ASHIK, ISLE OF SKYE. ANAL. W. WILLIAMS, 1975.

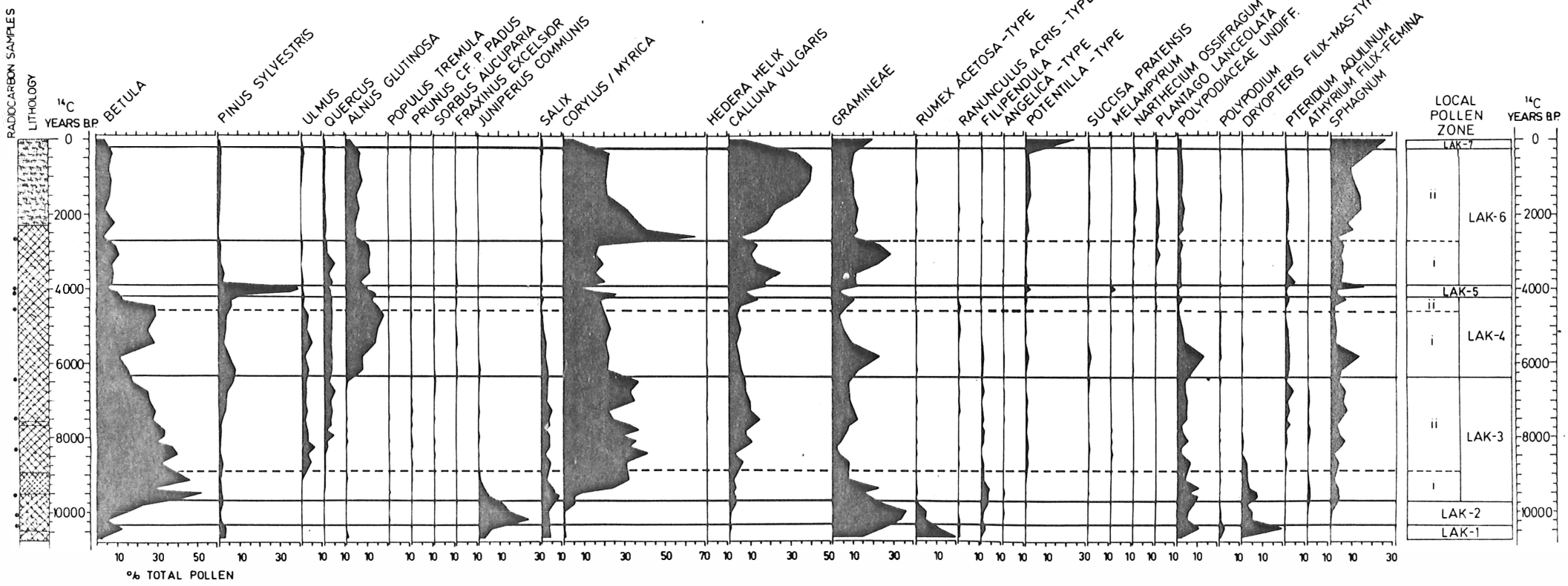


Fig. 37a.

1. LOCH ASHIK (18/691 233)

This site is situated within region 2 on the Torridonian sandstone. The Holocene pollen stratigraphy (Fig. 37a) shows that oak was never important in the forests of this area but that as in the Assynt area pine was a late arrival (4200-4400 B.P.) but declined abruptly just after 4000 B.P. Blanket bog spread at this time, with increases of Calluna, Corylus/Myrica (largely Myrica), Narthecium ossifragum, and Sphagnum. The Loch Ashik area is the only area on Skye where fossil pine stumps occur in the peat, indicating the westernmost extension of pine in the Holocene of northern Scotland.

2. LOCH CILL CHRIOSD (18/613 208)

This loch is situated in the Durness limestone of region 3. Only the Devensian late-glacial and early Holocene pollen stratigraphy have been worked out for this site (Fig. 38). The site was invaded by the sea several times up to the beginning of the upper Lycopodium - Cyperaceae pollen zone. The vegetational interpretation of the sequence is complex but it appears to reflect, after LCC-1, a phase of snow-beds and open grassland, followed by species-rich grassland with juniper scrub, by species-rich grassland with scattered birch copses, and by a revertence to snow-beds and open grassland at the time of the Loch Lomond stadial. Juniper scrub followed by birch-hazel woodland developed in the early Holocene.

3. LOCH NAN EILEAN (18/473 307)

This small lochan is situated on the northern side of the Cuillin Hills. It has a remarkable flora including the amphiatlantic Eriocaulon septangulare. The Skye populations, like the Irish ones are 2n = 64 whereas the eastern North America populations are 2n = 32. Other plants of note at Loch nan Eilean include

Eriophorum latifolium
Carex limosa
Lobelia dortmanna
Campylopus shawii
Littorella uniflora
Nymphaea alba ssp. occidentalis
Calliergon triforium

A pollen diagram for the Devensian late-glacial is available from a comparable site, Lochan Coir' a' Ghobhainn on the south-west slopes of the Cuillin (Figs. 39, 40, and 41).

Sissons (1977) has mapped the Loch Lomond stadial glaciers in the Cuillin Hills and has shown that of the 9 Cuillin glaciers those that flowed south and south-south-west were larger and had much lower equilibrium firn lines than those that flowed north and north-east. This pattern suggests that the principal snow-bearing winds were from the south (cf. Fig. 16).

The Lochan Coir 'a' Ghobhainn pollen stratigraphy (Fig. 39) suggests a pioneer vegetation on glacial outwash originally colonized the lower slopes of the Cuillin following deglaciation after the main Devensian glaciation. Rhacomitrium-heaths and snow-beds then developed. During the Loch Lomond stadial snow-beds expanded and extensive amorphous solifluction lead to the deposition of silts and sands in the site and the reworking of interstadial soils and the redeposition of high values of Ericaceae tetrads. In the

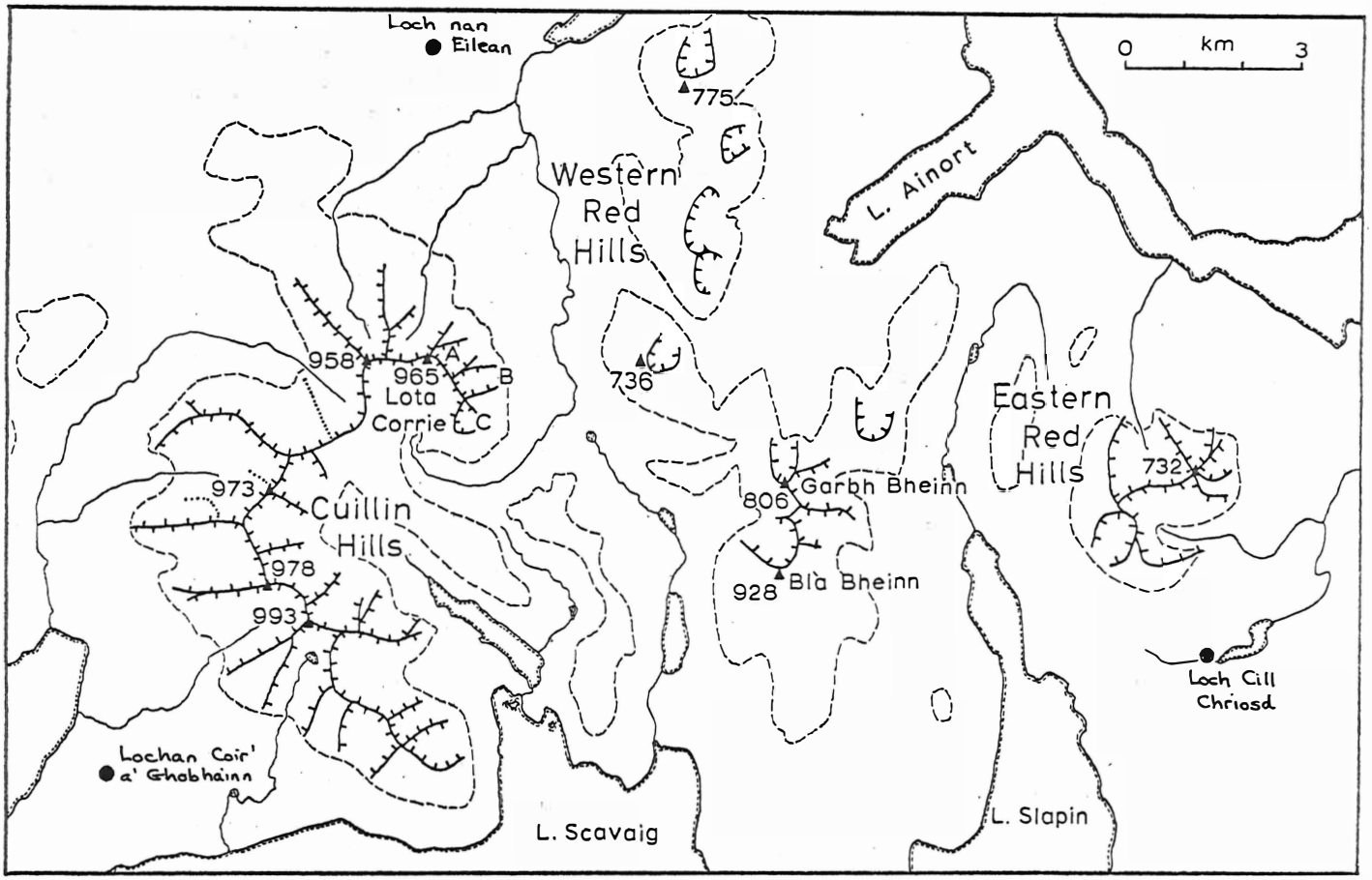


FIG. 40. Southern Skye, showing corries and other mountain-side hollows, three Lateglacial pollen sites and 300 m contour.

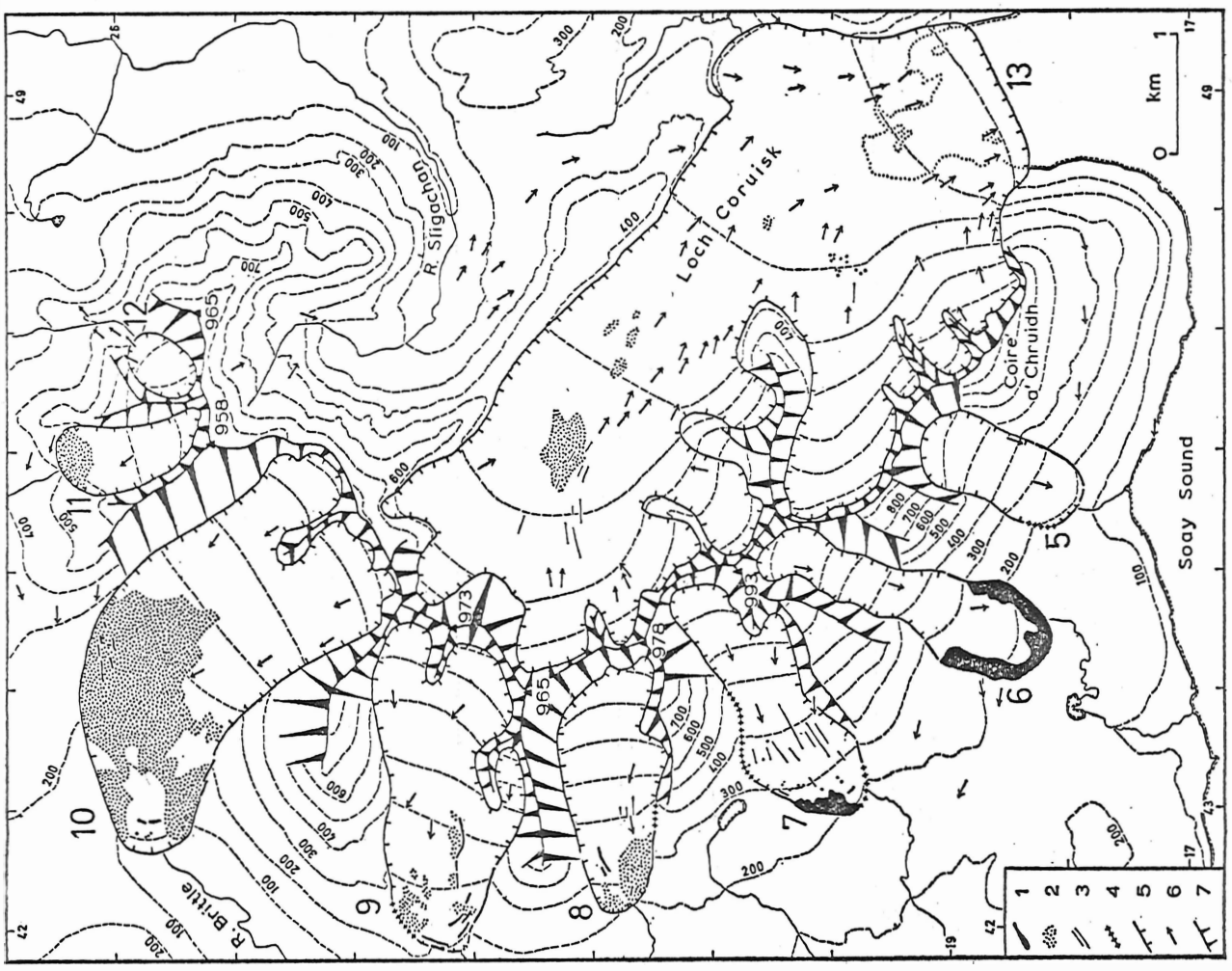


FIG. 41. The Loch Lomond Readvance in the Cuillins. 1, End moraines. 2, Hummocky moraine. 3, Fluted moraines. 4, Boulder limit. 5, Glacier limit where not indicated by other symbols. 6, Striae (from 1:63 360 Geological Survey map and measurements by the writer). 7, Very steep corrie walls rising above glacier surfaces. Contours follow reconstructed ice surfaces.

early Holocene juniper scrub and birch-hazel woodland developed locally.

4. LOCH FADA (18/493 493)

This site is situated below the spectacular basalt cliffs and landslips of the Trotternish basalt ridge. The Devensian late-glacial pollen stratigraphy (Fig. 42) shows an initial phase of *Rhacomitrium*-heaths and wind-blasted 'fell-fields' with *Artemisia norvegica*. This phase of open, wind-blasted vegetation was replaced by species-rich grassland with abundant tall-herbs, some juniper and willow, and local birch copses. At the time of the Loch Lomond stadial *Betula nana* heath expanded to be replaced in early Holocene times by local birch-hazel woodland.

In the basal silts and sands a 2 cm-thick layer of bryophyte remains occurs (Fig. 43). Detailed 1 cm contiguous analyses of this layer reveal differences in pollen composition, pollen deterioration, and microfossil composition that can be interpreted as resulting from the inwashing of a bryophyte-dominated spring community and its associated local pollen flora (e.g. *Saxifraga stellaris*, *Epilobium*, *Stellaria*, *Caltha*), its deteriorated pollen, and its soil fungi (mainly sétate ascomycete hyphae).

5. LOCH MEALT (18/507 655)

The Devensian late-glacial pollen stratigraphy at this site is identical to Loch Fada. If you wish you can walk to near the edge of the sea cliffs here and admire the Kilt Rock with its vertical, columnar basalt jointing. TAKE CARE!

6. LOCH CLEAT (18/416 744)

The Holocene pollen stratigraphy of this site (Fig. 44) at the exposed northern tip of Skye shows that after the Devensian late-glacial birch, rowan, hazel, and willow were the only major forest trees. Pine, oak, elm, and alder were all very rare or absent. In this regard northern Skye has affinities with the birch-hazel region of northern Scotland. (cf. An Druim, Eriboll.) Extensive clearance of scrub and woodland occurred from 5000 B.P. with an expansion of *Plantago lanceolata*, cereal-type, and *Potentilla*-type pollen. The area abounds in brochs, duns, and other archaeological remains. As on the mainland of Scotland the earliest and most extensive clearances appear to have occurred on peninsulas, in exposed areas, and in areas of light or very open forest cover.

From the Duntulm area we can look west across The Minch to the Outer Hebrides. Very little is known of their environmental history. The only radiocarbon-dated pollen profile from the Outer Hebrides is from Little Loch Roag on Lewis (Birks and Madsen, 1979; Fig. 45). The profile shows that for 9000 years there was virtually no forest cover, the vegetation being willow scrub, grassland, and tall-herb communities. In the last 4000 years human activities have favoured the expansion of heather and bog, the reduction of scrub and tall-herb communities, and the spread of pasture.

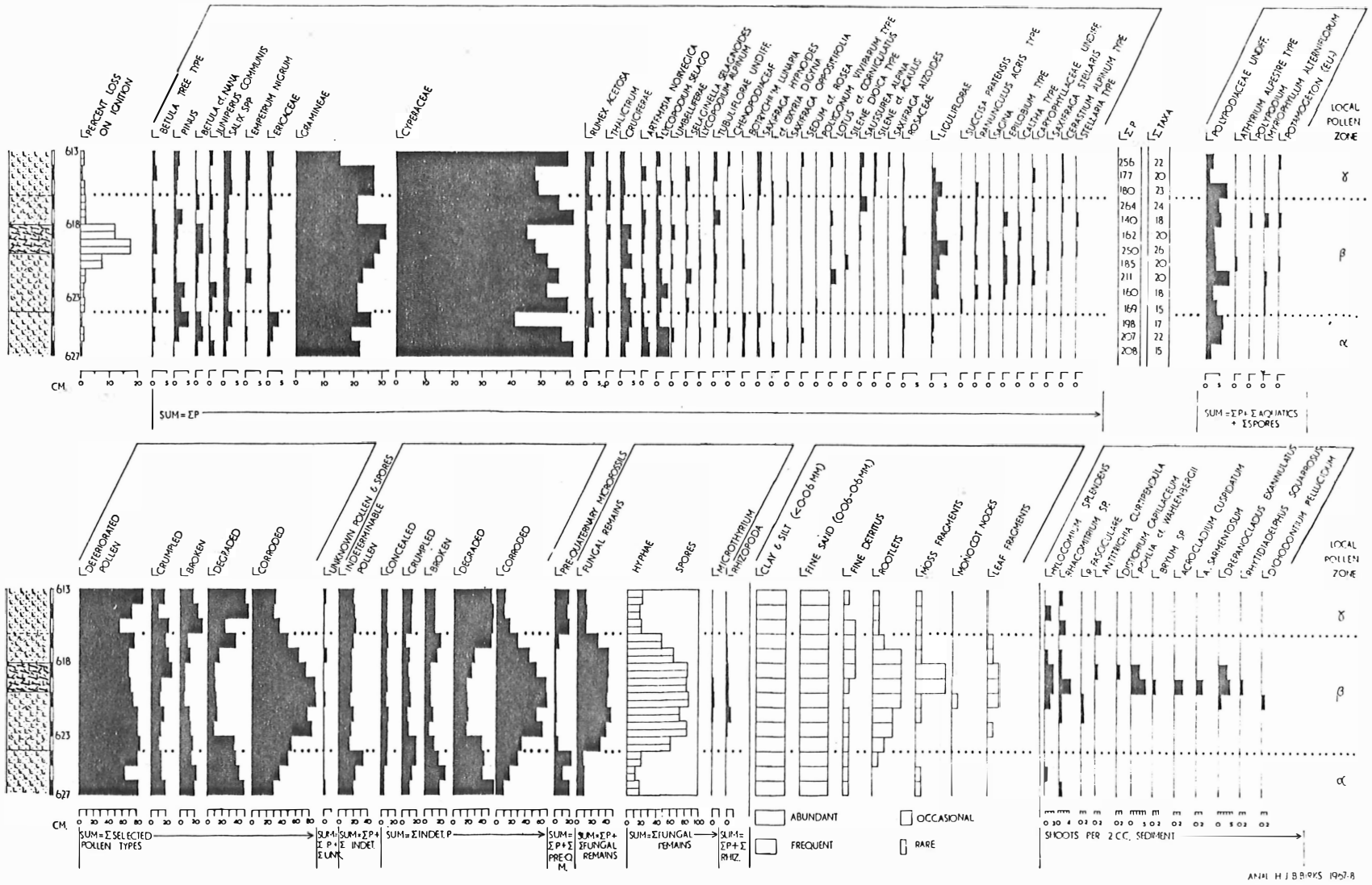


Fig. 43. Pollen and macrofossil diagram from Loch Fada (613–627 cm depth). Scale at base of diagrams gives percentages for bars. P, Pollen; indet., indeterminable; undiff., undifferentiated; unk., unknown; pre-Q., pre-Quaternary microfossils; rhiz., rhizopoda; anal., analysed. Symbols used in the sediment lithology column follow the system of Troels-Smith (1955) and are explained in Fig. 3. Density of symbols indicates the proportions of the component elements in the sediment.

LOCH CLEAT. ISLE OF SKYE. ANAL. W. WILLIAMS 1975-76

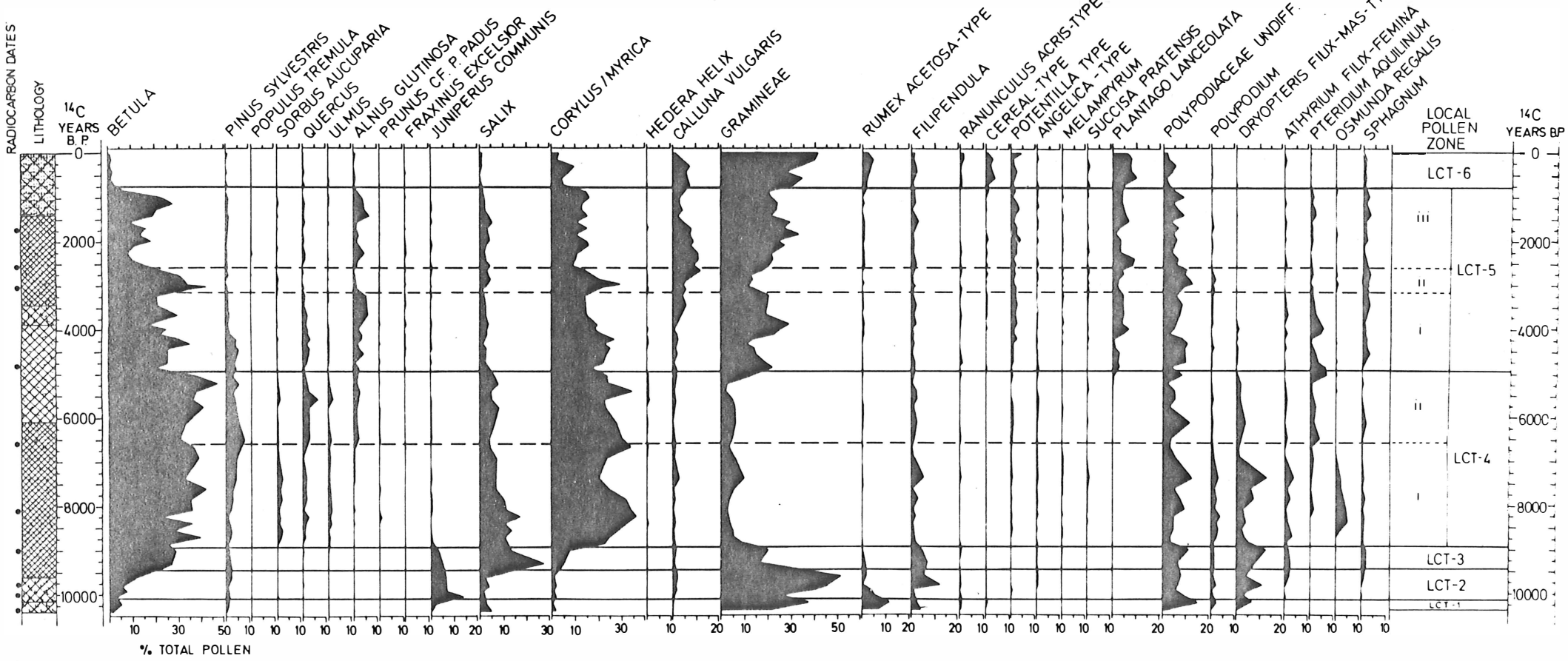


Fig. 44.

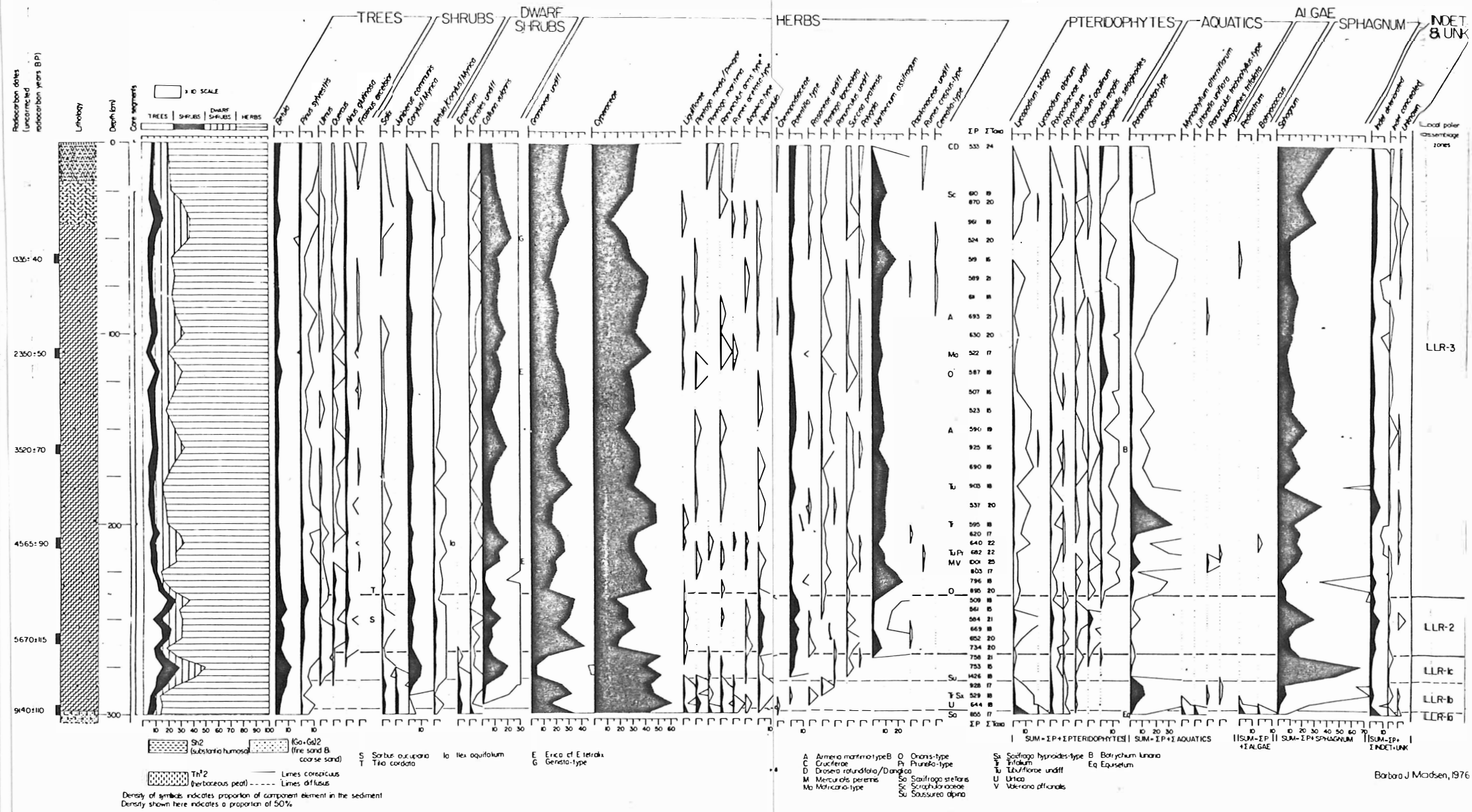


FIG. 4-5. Pollen percentage diagram from Little Loch Roag. The scale at the base of the diagram is in percentages of total pollen (ΣP) for black silhouettes; unshaded silhouettes are exaggerated 10 × scale. Pollen and spore types shown as letters rather than curves have values < 1·0%. Symbols used in the lithology column follow the system of Troels-Smith (1955) and are explained on the diagram. Abbreviations: undiff. = undifferentiated.

LOCH MEODAL, ISLE OF SKYE. ANAL. W. WILLIAMS. 1973-74.

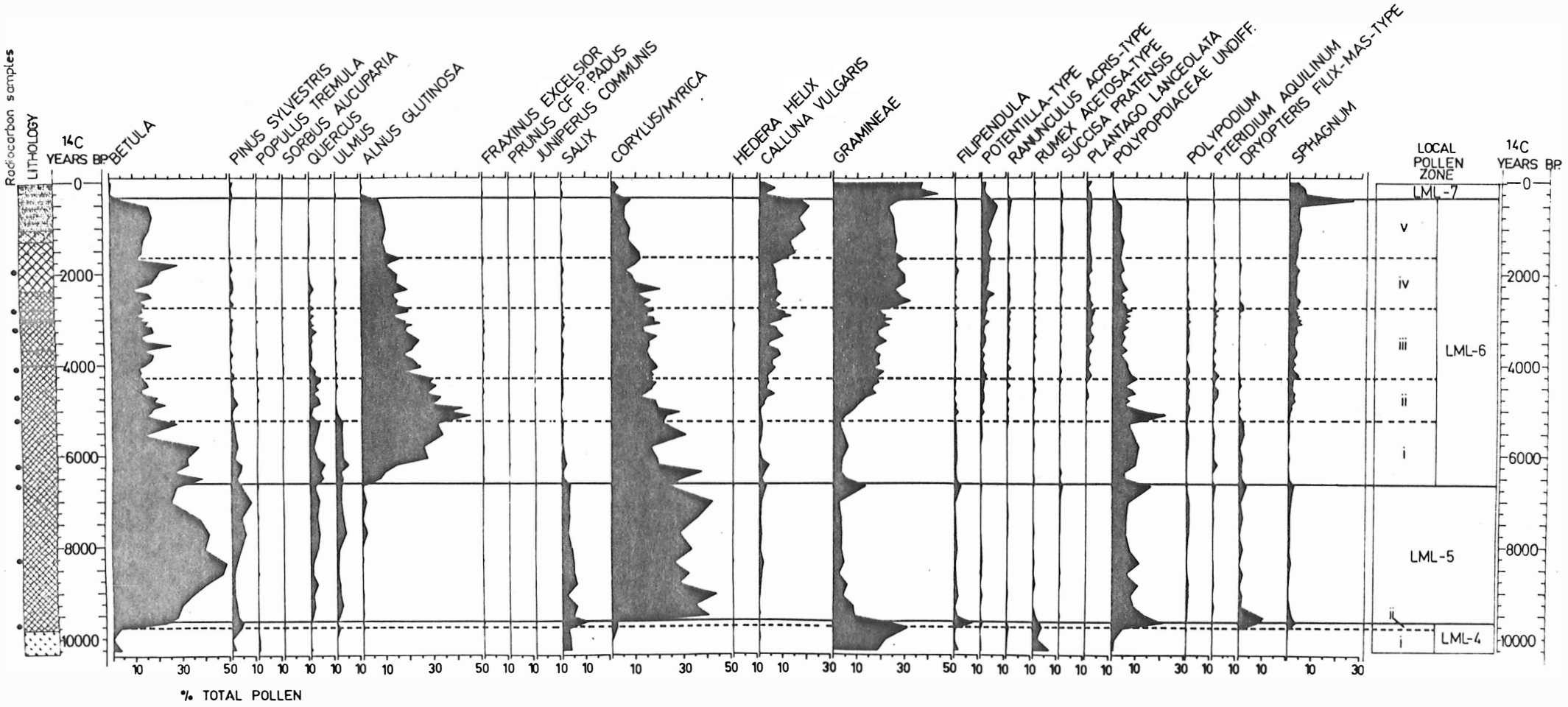


Fig. 47.

7. LOCH MEODAL (18/657 113)

The pollen stratigraphy of this site, situated within the sheltered southern Sleat Peninsula of Skye where birch-hazel woods rich in Atlantic bryophytes occur locally in sheltered, rocky sites, covers both the Devensian late-glacial (Fig. 46) and the Holocene (Fig. 47).

It is the only site on Skye where macrofossils of tree-birches and high Betula (tree-type) pollen percentages occur in the Devensian late-glacial, suggesting local areas of birch woodland in Sleat during the late-glacial interstadial. The inferred vegetational history for the Devensian late-glacial of Skye is summarised in Figs. 48 and 49. The principal directions of ecological variation in the Devensian late-glacial were exposure (woodland vs no-woodland), altitude (mountain vs lowland vegetation), and soil type (calcareous, basic, or acid soils; see Fig. 50).

The Holocene pollen stratigraphy (Fig. 47) closely resembles sites to the south (e.g. Salen, Oban, etc) except that Quercus pollen values never exceed 10% at Loch Meodal, suggesting, by comparison with modern surface samples (Figs. 23-25), that oak was never a major component of the forest vegetation of southern Skye.

In terms of Holocene forest vegetation there was clearly very considerable spatial variation in the forest patterns of Skye. Eastern Skye has greatest affinities with sites on the mainland near the northern limit of the present-day pine forest region; southern Skye has its greatest affinities with sites on the mainland in the present-day oak-forest region; northern Skye has its greatest affinities with sites on the mainland in the present-day birch-forest region.

Nowhere else in the British Isles can this diversity, past and present, of flora and vegetation be found in such a small area.

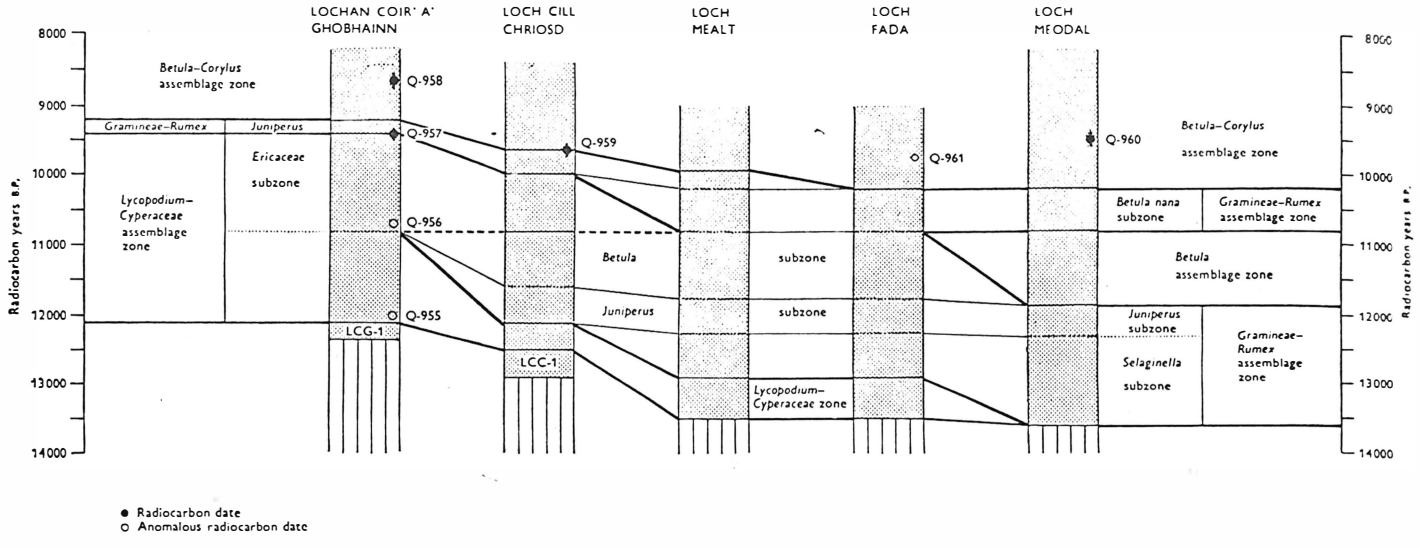


Figure 48. Correlation chart of Late-Devensian and early Flandrian pollen zones on the Isle of Skye. Radiocarbon dates are shown by solid circles; the vertical line indicates the reported single standard deviation. Anomalous radiocarbon dates are shown by open circles, and they are plotted by stratigraphic position, not age.

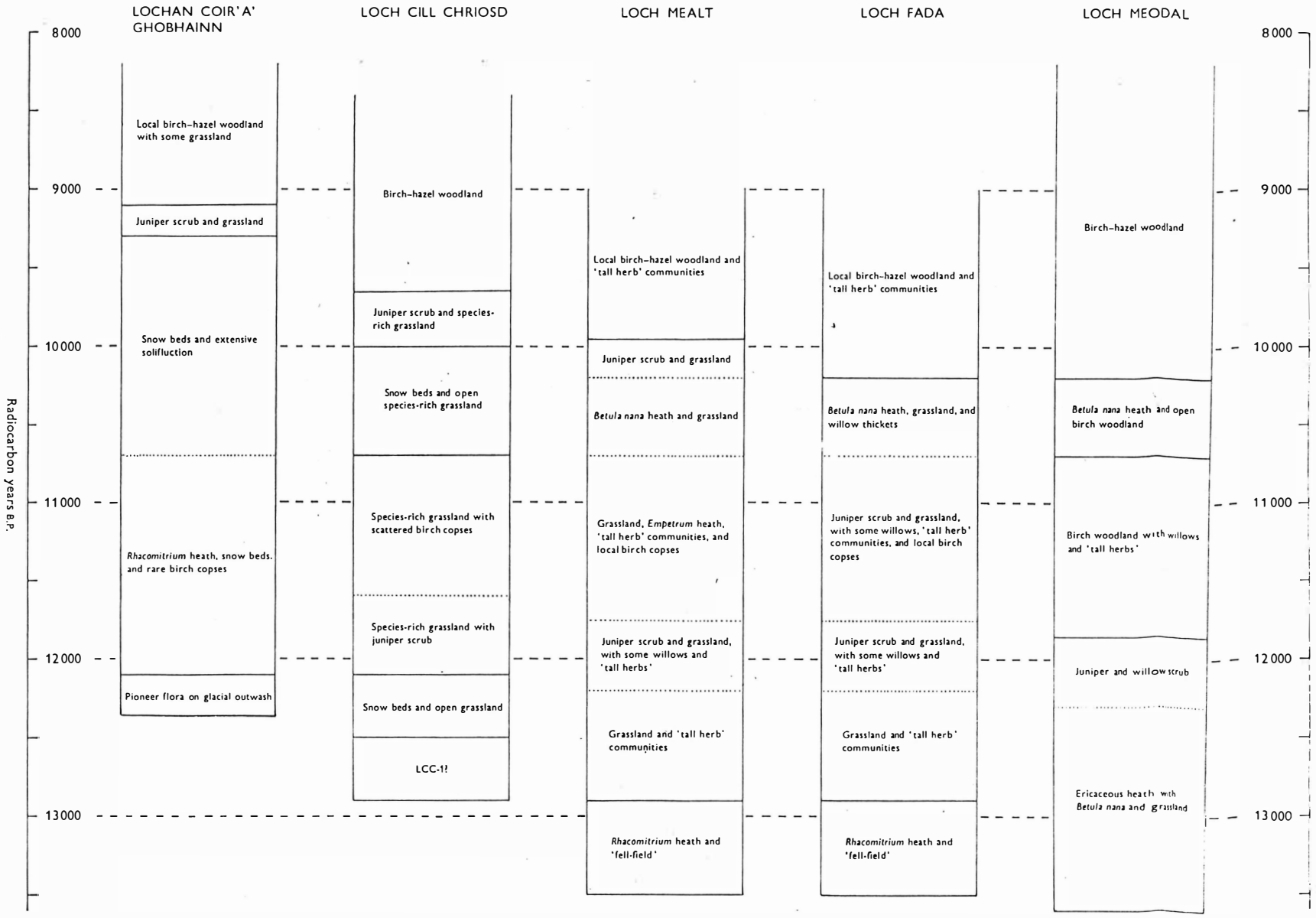


Figure 48. Generalised comparison of the inferred vegetational history at the five sites investigated, based on the correlation chart (Fig. 27) and on the vegetational reconstructions presented in Chapter 13.

cont.

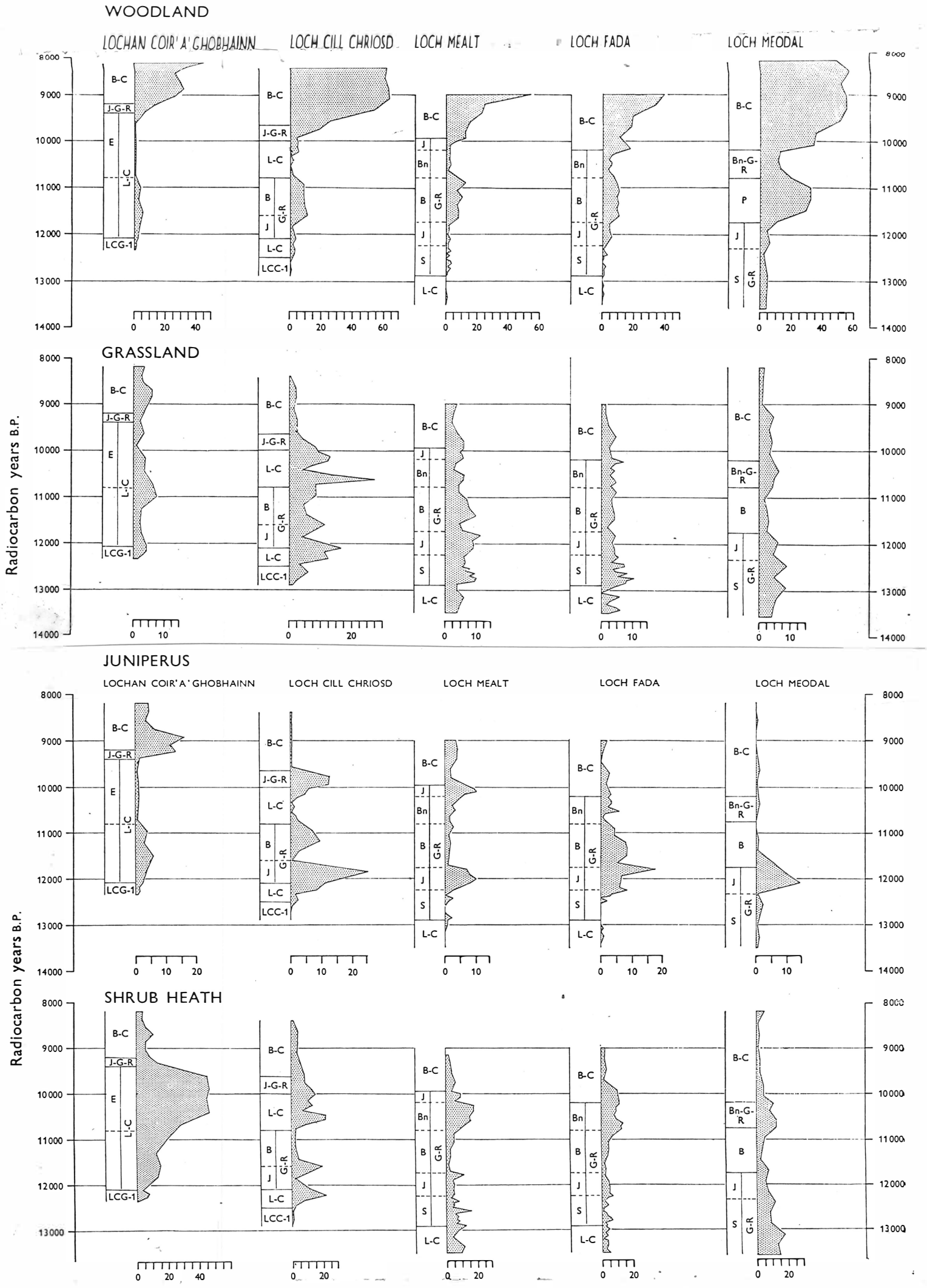


Figure 49. Summation curves for five groups of pollen and spore types based on the present ecological preferences of the taxa concerned at the five sites investigated.

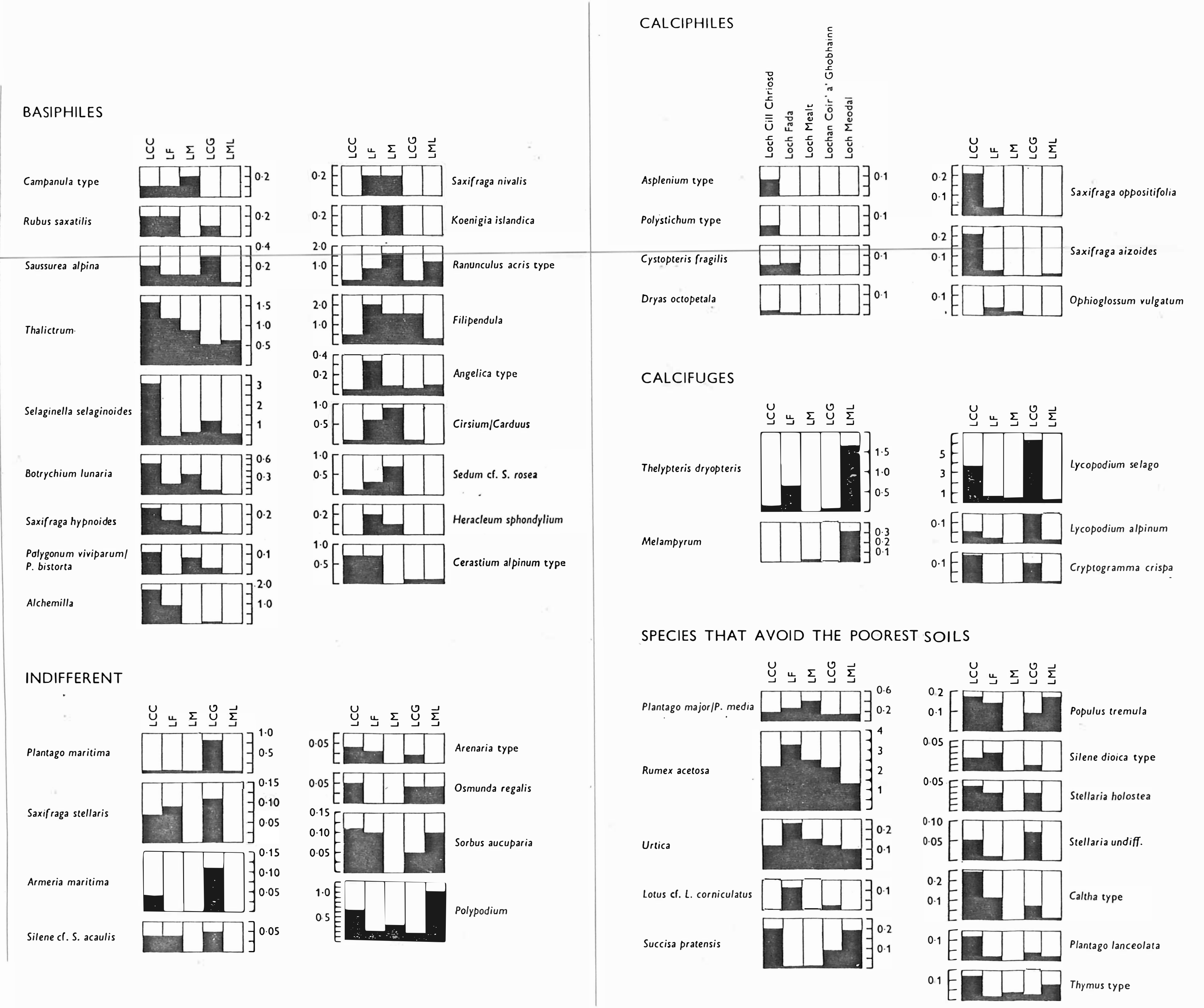


Figure 50. Relative frequencies for pollen and spore types of taxa that occur in the present edaphic categories defined in Chapter 5, expressed as a percentage of the total number of determinable pollen and spores, excluding obligate aquatic taxa. Pollen totals: Loch Cill Chriosd 8433; Loch Fada 10504; Loch Mealt 9215; Lochan Coir' a' Ghobhainn 21757; Loch Meodal 9074.

LOCHAN DOILEAD, MORAR PENINSULA. ANAL. W. WILLIAMS. 1974 - 75.

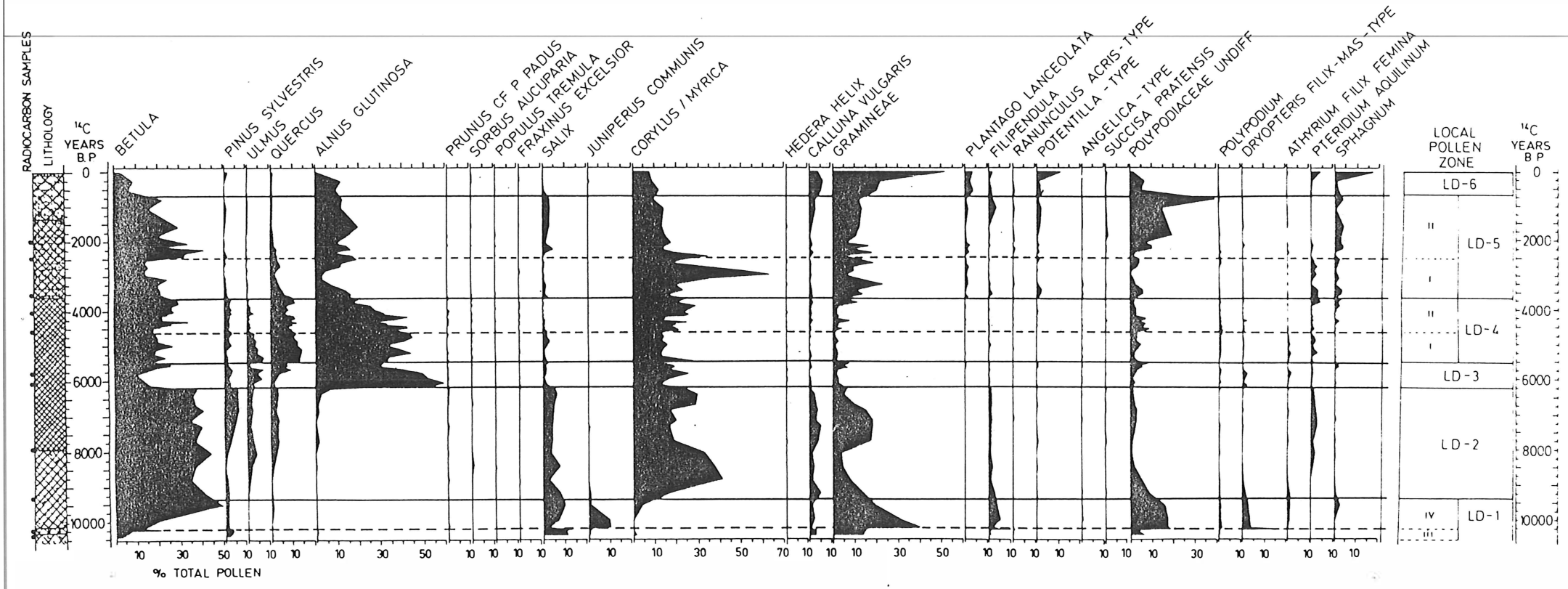


Fig. 51.

DAY 7 (JULY 12) ISLE OF SKYE - MALLAIG - GLASGOW

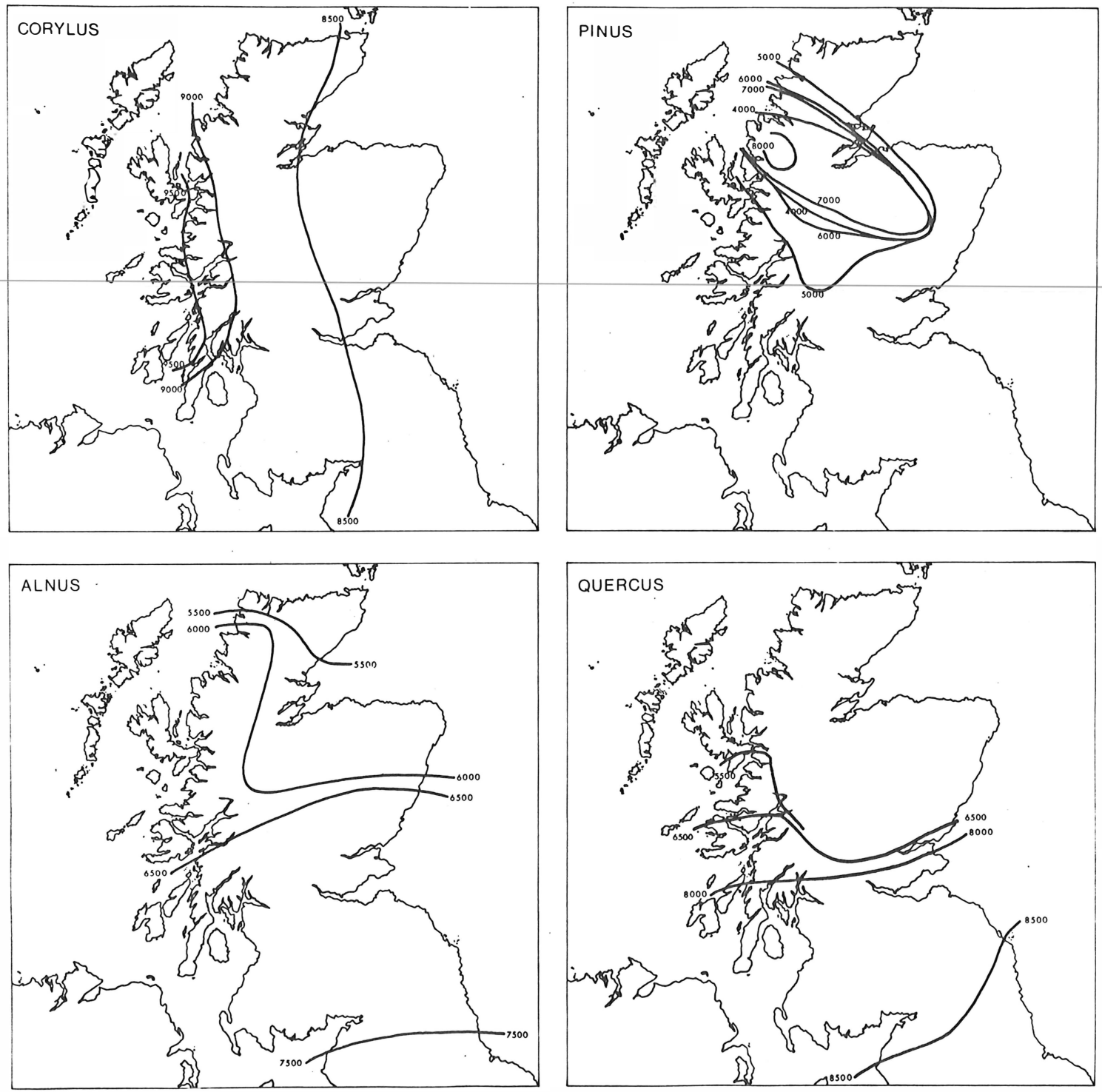
We drive to Armdale in southern Skye, cross by ferry to Mallaig, and travel via Glenfinnan, Fort William, Glencoe, and Loch Lomond to Glasgow.

The only Quaternary site of interest that we will see is Lochan Doilead just south of Mallaig on the Scottish mainland just opposite Skye (Fig. 51). The site (17/677 946) is situated near the northern limit of extensive oak woodland in Scotland. The pollen profile (Fig. 51) shows strong similarities with sites to the south such as Salen and Oban except that Quercus pollen values do not expand until 5500 B.P. and then decline at 3600 B.P. Pine was unimportant here, as elsewhere within the present oak-forest region.

There is a curious early elm-decline at this site at 5500 B.P. with a sharp fall in elm pollen values, a rise in Gramineae values, along with Plantago lanceolata and Potentilla-type pollen. The significance of this phase is not clear.

By way of summarising the Holocene forest history of western Scotland a time-space correlation diagram of the regional pollen assemblage zones is shown in Fig. 52. It shows the time-transgressive nature of vegetational change in western Scotland, the varying rates of change, and the expansion and contraction of the pine-dominated zone in northern Scotland.

In addition a series of isochrone maps (Fig. 53) showing the times of major expansion of Corylus, Pinus, Alnus, and Quercus in Scotland provide a geographical perspective to the forest history of Scotland. The west-to-east gradient in the expansion of hazel is intriguing. The early (8000 B.P.) expansion of pine in the Loch Maree area, followed by its rapid expansion to the eastern Highlands by 7000 B.P., its expansion northwards, southwards, westwards, and also altitudinally at 5000 B.P., and its collapse at 4000 B.P. indicate the complex history of Scots pine. The time-transgressive expansion of alder from 7500 B.P. in the south to 5500 B.P. in the north shows the effects of the main mountain massifs in the eastern Highlands in slowing the rate of migration. The migration patterns of oak are, by comparison, relatively simple to interpret in terms of probable Holocene climatic change.


CORYLUS
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6000
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QUERCUS
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6500
6500
8000
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Fig.53.

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