9 Palynological Analyses at Allt Dail an Dubh-asaidh

9.1 Introduction and Summary

This section presents the results of pollen analysis of deep peat deposit at Allt Dail an Dubh-asaidh (NGR: NM 6714 9054) on the line of the re-aligned A830 road, between Arisaig and Mallaig.

The 6.67m pollen core was analysed at a sample resolution of 4cm, giving a total of 160 samples. Radiocarbon dating of pollen zones throughout the core has indicated a date range from 8900 BP to the present day. Analysis of the pollen core at a resolution of approximately 50 years has illustrated a full Holocene sequence from open water prior to 8900 years BP.

This open water was colonized by willow carr, which after an open marsh phase with grasses, sedges and some fen species, was in turn colonized by alder carr at about 6000 years BP. Alder declined at about 4500 years BP to give way to a ling-dominated heath locally with birch–hazel–oak woodland in the wider area, with pine and elm. From this time, there is continuous evidence for low levels of disturbance relating to human activity. In addition, the extra-local and regional birch–hazel–oak woodland shows a gradual decline, with, at first, high frequencies of charcoal. With a local change to bog myrtle heath, charcoal frequencies decline; woodland pollen continues to decrease and ruderal pollen types, indicating disturbance, are consistently recorded. From 4500 BP, the sequence is interpreted as reflecting extensive grazing impacts which, particularly from about 2500 years BP, maintained a regionally open vegetation, with ruderal herbs and a continuing but gradual decline in woodland. This is proposed as an extensive, yet continuous, model of human use of the west coast of Scotland from late Neolithic times to the present day.

9.2 Methodology

An eigelkampf corer was used to take 3-cm diameter cores of sediments along two transects (see Illus 22) from across the Allt Dail an Dubh-asaidh basin at 70m OD. In total 12 cores were sampled to assess basin profile (Illus 23, Illus 24). At the deepest point (marked 4* on Illus 22–24), a Russian corer was used to retrieve a 6-cm diameter core for palaeo-environmental analyses with a sediment block for the top 20cm. Stratigraphic descriptions of the sediments were carried out in the laboratory on cleaned sediment surfaces. Descriptions use the conventions of Troels Smith in Table 5 (Troels Smith 1955). Colours were described using international Munsell colour charts.

Pollen samples were prepared following standard procedures (Moore *et al.* 1991); Hydrofluoric acid (HF) was used to remove silica at the base of the profile. Marker spores were added to allow the calculation of pollen concentrations (Stockmarr 1972). Identifications were achieved using standard keys and a comprehensive reference collection; pollen taxonomy follows the *Cataolgue of Pollen Types* (Bennett 1995). English names for plants, pollen and spores are used where possible throughout the report, although the pollen diagrams use Latin names. Where possible, bog myrtle (*Myrica gale)* and hazel type (*Corylus avellana* type) pollen have been separated. However, identifications cannot be made consistently (Edwards 1981) and hence the bog myrtle curve in this diagram represents a minimum, while the hazel curve in Zone 1F is likely to be enhanced through the inclusion of undifferentiated *Myrica* pollen. Counts to at least 300 land pollen grains were made to achieve statistically reliable counts, although at some levels this total was not achieved because of high accumulation rates, particularly in Zones 1A and 1C. Each grain was also assigned to one of five preservation classes (well-preserved, corroded, degraded, crumpled and broken), according to the dominant state of preservation (cf Cushing 1967, Tipping 1987). Routine counts of microscopic charcoal were made and were calculated as concentrations. Pollen percentages were calculated on the basis of total land pollen (TLP). Other types were calculated as a percentage of TLP plus group.

The resolution adopted here at 4cm gives an approximate resolution of 50 years, which in Zones 1E and 1F where human activity is reflected in the vegetation and archaeological record represents approximately two generations in human terms.

9.3 Radiocarbon dates

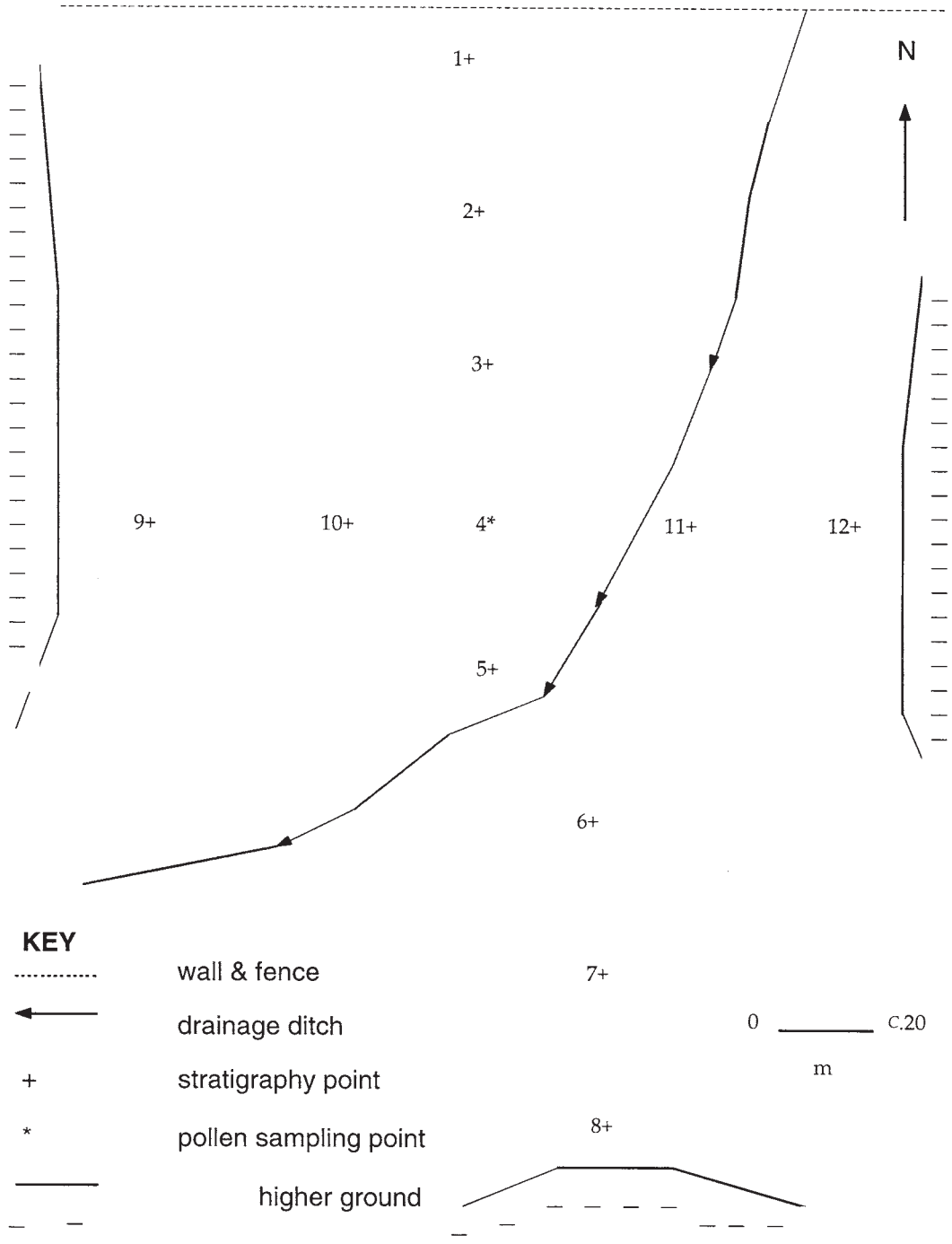
Six pollen zones have been identified, primarily reflecting changes in vegetation within the basin from open water through marsh to alder carr and then heath. Five radiocarbon dates taken at the zone boundaries have demonstrated that a full Holocene sequence is present with no evidence for truncation or major hiatuses. Accumulation rates have varied between 0.5 and 1.0cm per decade, giving a high temporal resolution (Table 5).

9.4 Results

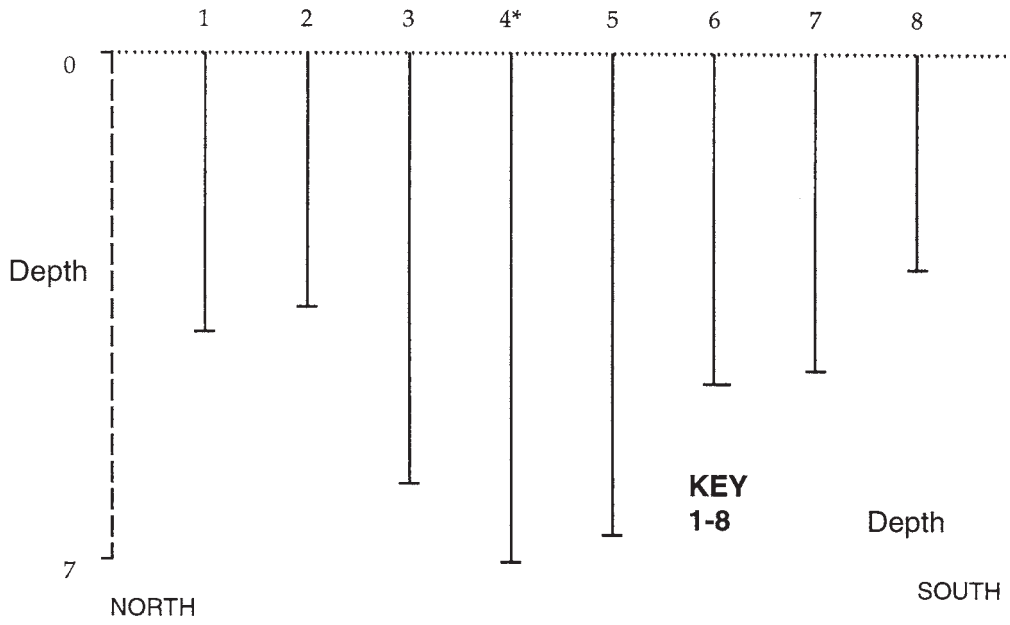
Results are presented in a percentage pollen diagram (Illus 25), and the main pollen, fern and moss

Table 5 Pollen zones with radiocarbon dates and accumulation rates

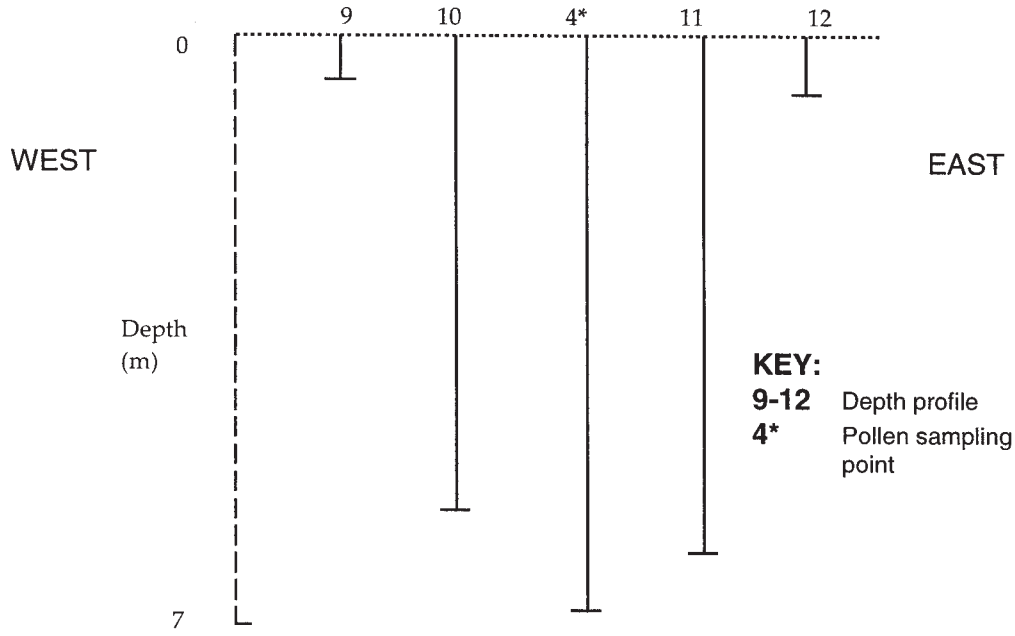
Pollen zone	Depth (cm)	Summary description	Radiocarbon date (from base of zone), BP	Accumulation rate (cm/year)	Sample resolution (years/4cm)
1F	176–0	Sedge–ling heath with birch–hazel–oak woodland	2410 ± 75	0.07	63
1E	368–176	Ling heath with birch–hazel–oak woodland	4520 ± 60	0.09	44
1D	480–368	Alder carr with Birch–hazel–oak woodland and elm and pine	6070 ± 65	0.07	57
1C	544–480	Open marsh with birch–hazel–oak woodland plus pine and elm	7245 ± 65	0.05	80
1B	640–544	Willow carr with birch–hazel–oak woodland with pine	8900 ± 100	0.06	67
1A	667–640	Open water with willow carr	–	–	–



Illus 22 Sketch map showing core locations



Illus 23 Long traverse basin depth profiles



Illus 24 Short traverse basin profiles

spore curves are also presented as concentration curves in Illus 26. These additional curves remove the relative influence of the percentage data on curves and are useful in discerning actual changes in the pollen curves. Illus 27 shows pollen preservation data. Table 6 details the stratigraphic description of the pollen core.

The pollen diagram has been divided into six zones, based on dominant pollen types. Table 4 (see Section 7.1) summarizes the main characteristics of the pollen zones and indicates the dominant local (within the basin) and extra-local and regional vegetation (on the basin sides and further afield).

9.5 Interpretation of pollen data

9.5.1 Zone 1A: Base to c 8900 BP

In the clay and silty clays of this zone, pollen concentrations are low and there are some remnants of a late glacial-type flora, including crowberry (*Empetrum nigrum*) and meadow rue (*Thalictrum*), indicative of tundra conditions. However, locally, the pollen spectra are dominated by aquatic plants, growing in slow-flowing/non-moving water. This community was surrounded by willow carr with grasses and sedges. There is no archaeological

Table 6 Stratigraphic descriptions of pollen core (Troels Smith notation)

Depth (cm)	Munsell colour	Troels Smith description	Notes
0–67	Very dark brown 10YR 2/2	Well-humified turfa peat Th2 Sh2	Grass and sedge roots
64–140	Black 5YR 2.5/1	Well-humified peat with *herbacea* fragments Sh3 Th1 Dh+	Fragments of sedge
140–159	Black 10YR 2/2	Well-humified peat with *herbacea* and woody fragments Sh2 Th1 Dh1 Dl+	Grass and sedge fragments with woody stems (ling) @ 150
159–227	Very dark brown 5YR 2/2	Very well-humified peat with *herbacea* and woody fragments Sh4 Th+ Tl+ Dl+	Woody stems (ling) @ 182 & 194 Large wood piece @ 209–210
227–324	Black 5YR 2.5/1	Well-humified peat with *herbacea* and woody fragments Sh3 Th1 Tl+ Dg+ Dl+	Fragments of grass and sedge stems, also ling
324–326		Well-humified detritus peat Sh2 Dl2	
326–338	Black 5YR 2.5/1	Well-humified peat with *herbacea* and woody fragments Sh3 Th1 Tl+ Dg+ Dl+	Fragments of grass and sedge stems, also ling
338–404	Black 5YR 2.5/1	Very well-humified peat Sh4 Th+ Dl+	
404–408	Black 10YR 2/1	Well-humified peat with *herbacea* and woody fragments Sh2 Dg1 Dl1 Th+ Dh+	Large wood pieces (diam > 2cm)
408–465	Black 5YR 2.5/1	Very well-humified peat Sh4 Th+ Dl+	Grass and sedge stem fragments
465–471	Black 10YR 2/1	Well-humified peat Sh3 Th1 Dh+	
471–651	Black 5YR 2.5/1	Well-humified peat with silt Sh4 Th+ Tl+ Dh+ As+	
651–657	Dark grey 10YR 4/1	Clay with organic and silty elements Ag3 Sh1 Th+ Dh+ As+	Mica present
657–662	Greyish-brown 10YR 5/2	Silty clay As2 Ag2 Sh+ Dh+	Mica present
662–667	Very dark greyish-brown 10YR 3/2	ClayAg 4 Sh+ Dh+	Mica present. Occasional herbaceous stem remains

evidence for any human activity at this time and the pollen spectra do not indicate any evidence of human activity.

9.5.2 Zone 1B: c 8900–7245 BP

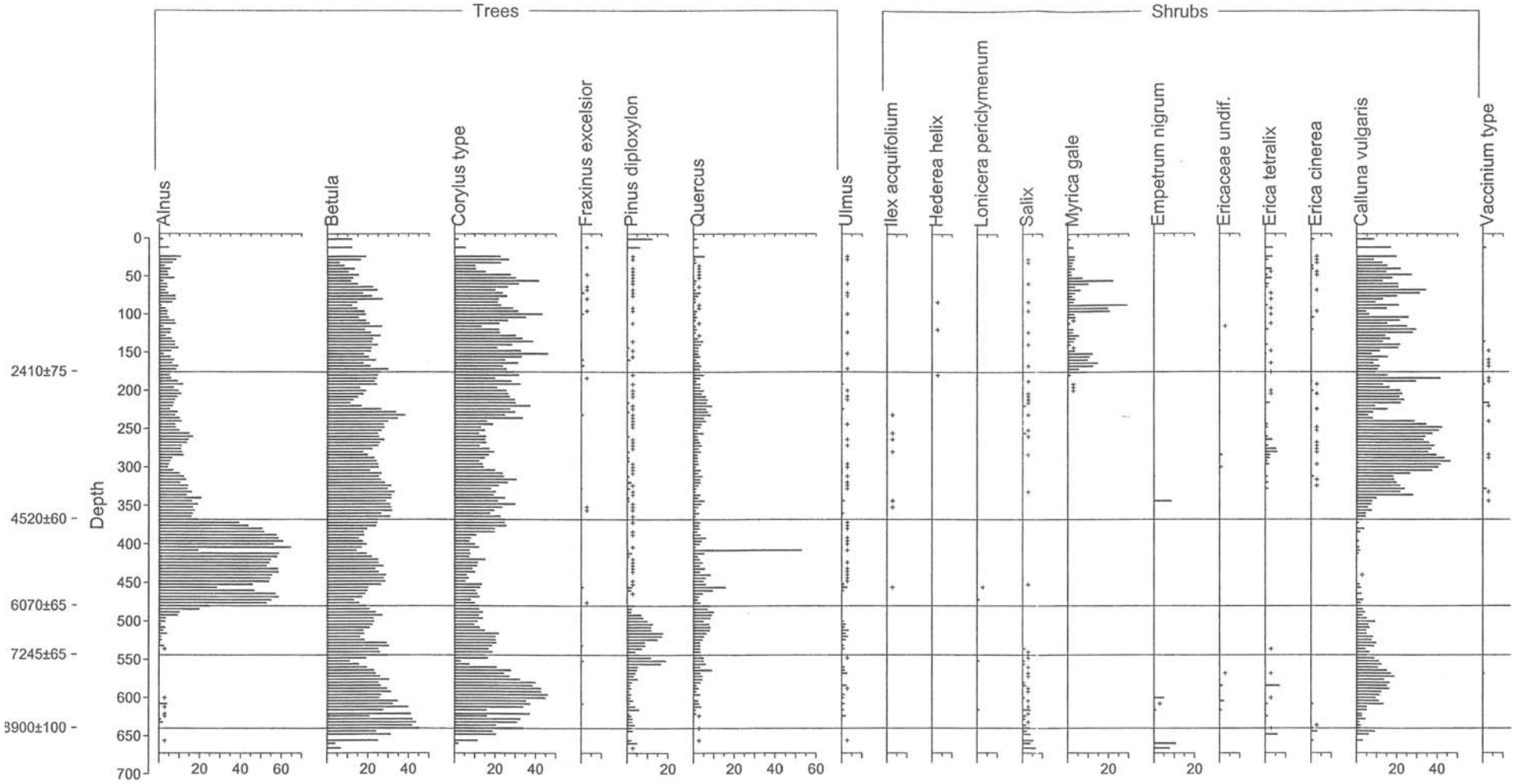
Locally, willow carr dominates and has colonized the open water in Zone 1A. As a component of the local vegetation, willow (*Salix*) is a low pollen producer (Bradshaw 1981) and its local presence is only shown in the concentration curves. Birch (*Betula*) and hazel (*Corylus* type) were also present locally in the canopy. The understory was composed of sedges (Cyperaceae), grasses (Poaceae), ling (*Calluna vulgaris*), *Sphagnum* mosses with some fen types, including meadowsweet (*Filipendula ulmaria*). Sphagnum is likely to have been restricted to discrete pockets where ground conditions were more acidic. Otherwise the vegetation indicates a neutral to slightly base environment.

From 624cm, near the base of this zone, oak (*Quercus*) and elm (*Ulmus*) start to increase. Beyond the local carr, a mixed woodland with birch, hazel, elm, oak and pine (*Pinus* diploxlon type) occurred. The presence of elm, in particular, in the extra-local and regional woodland is shown in the pollen concentrations in Zone 1B.

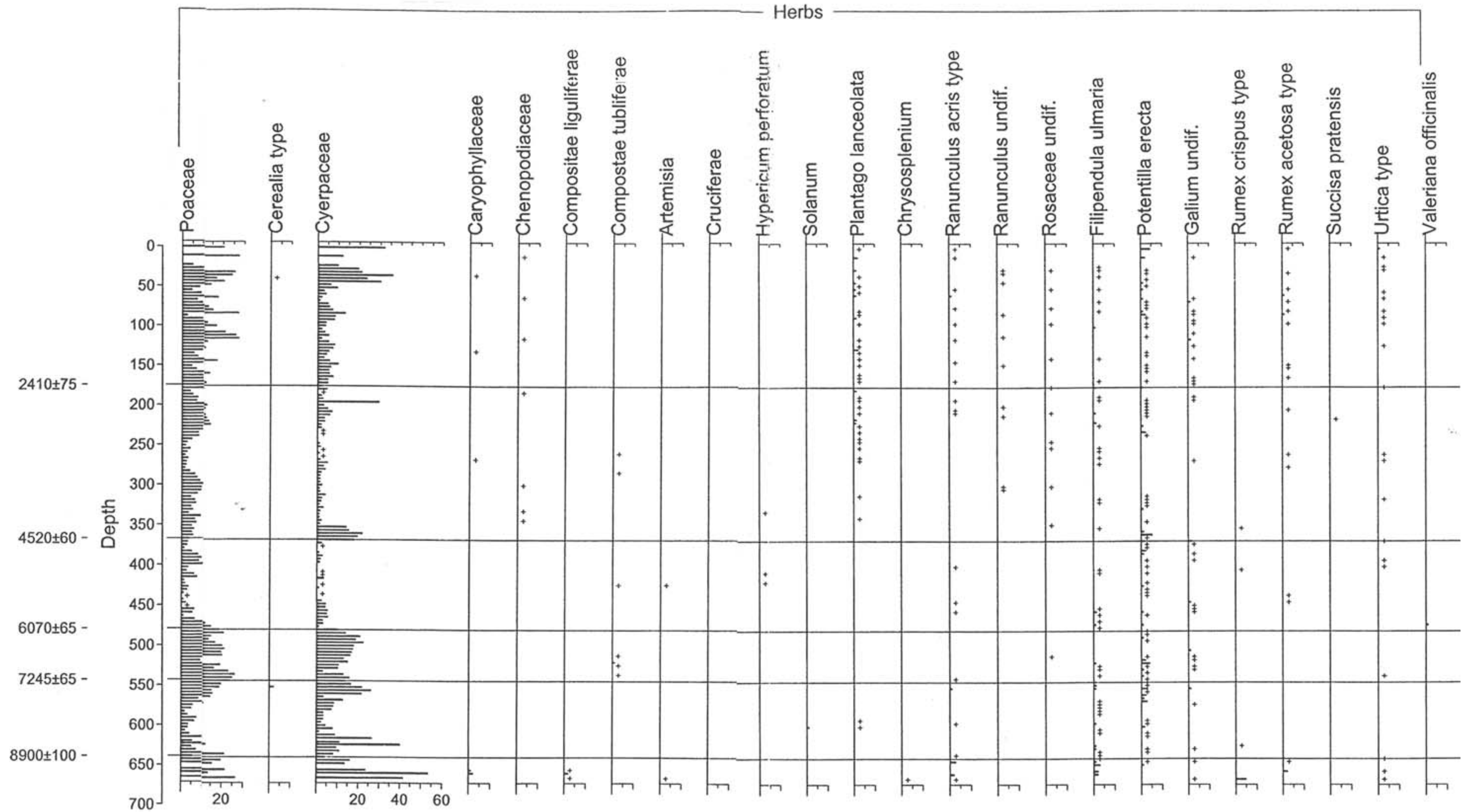
There are some indications of very low levels of disturbance in the vegetation reflected by the occasional presence of ruderal herbs but it is difficult to relate these entirely to human activity. Such low levels of disturbance could equally be the result of natural disturbance in the birch–hazel woodland.

9.5.3 Zone 1C: c 7245–6070 BP

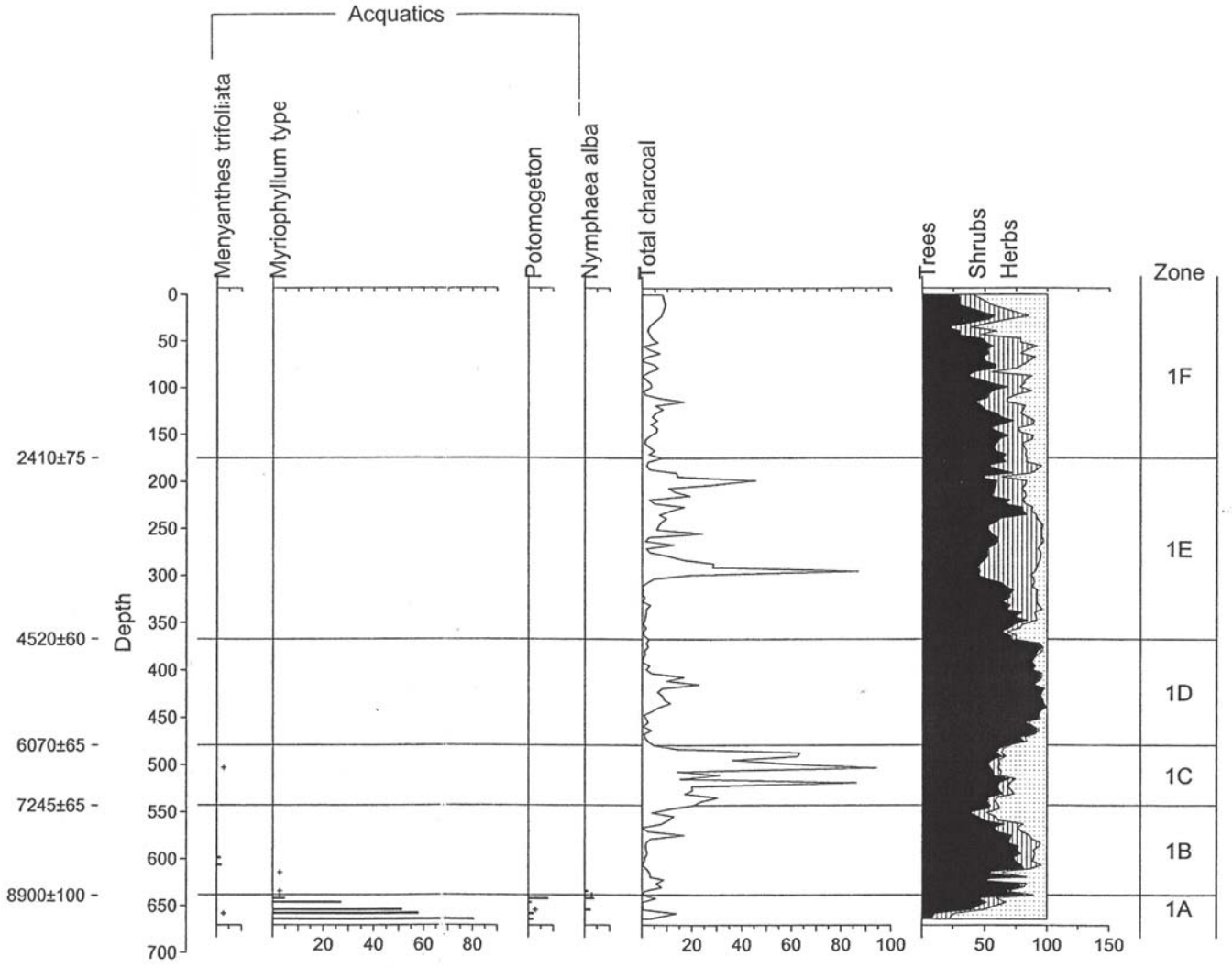
The pollen diagrams both show an open marsh with sedges and grasses and some fen herb species in Zone 1C. The increases in pine pollen and microscopic charcoal may reflect an increased recruitment area



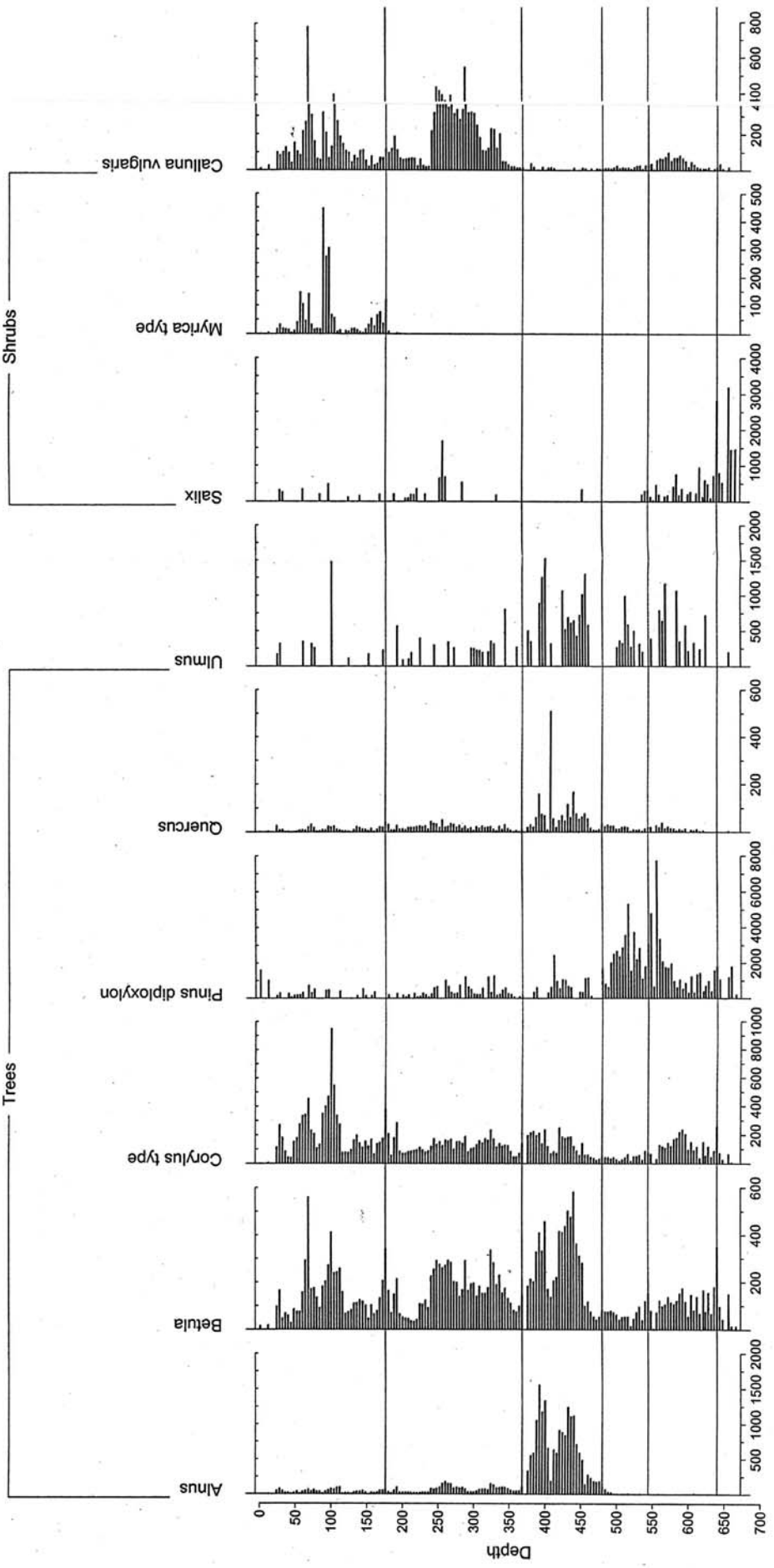
Illus 25a Allt Dail an Dubh-asaidh: percentage pollen diagrams for trees and shrubs



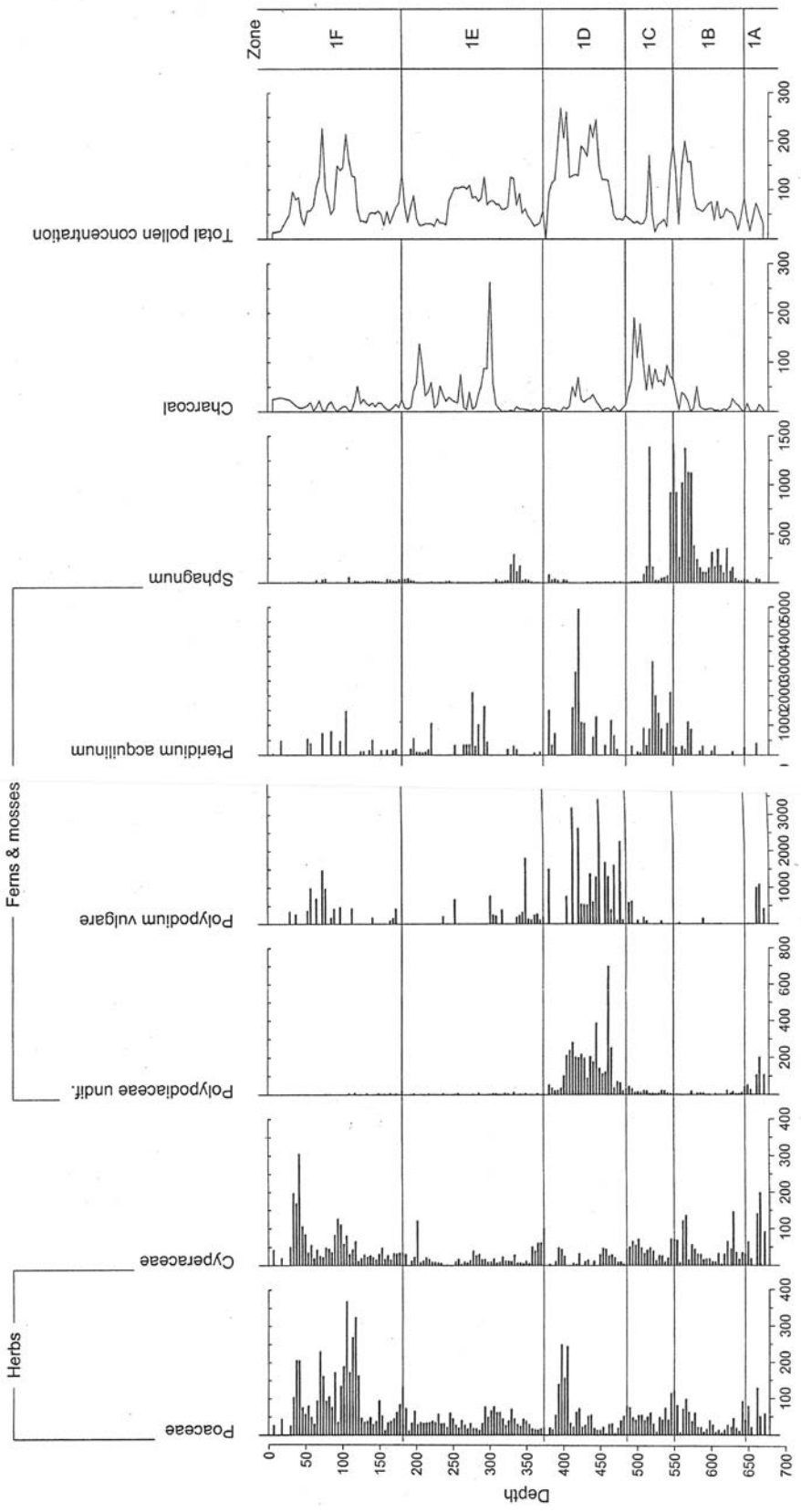
Illus 25b Allt Dail an Dubh-asaidh: percentage pollen diagrams for herbs



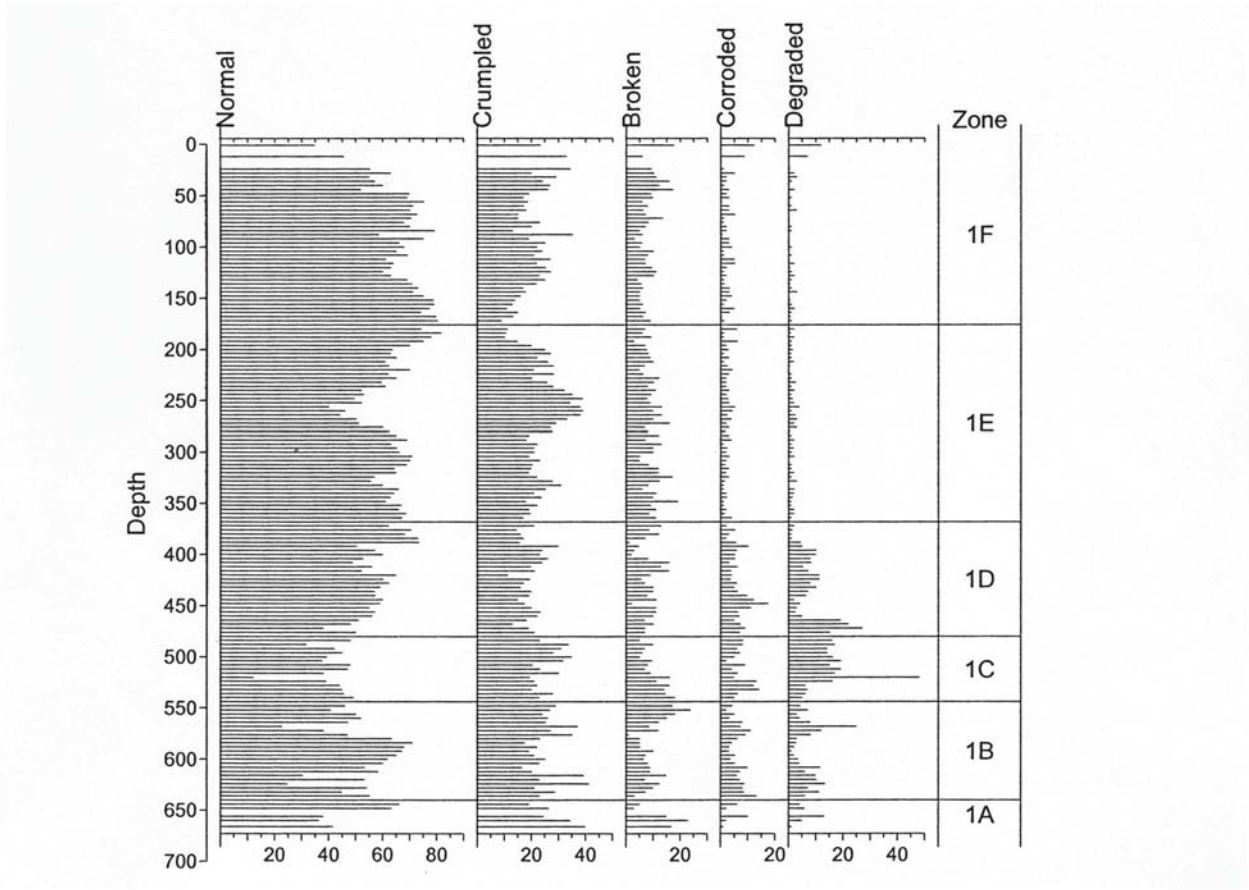
Illus 25c Allt Dail an Dubh-asaidh: percentage pollen diagrams for acquatics



Illus 26a Allt Dail an Dubh-asaidh: pollen concentration curves for trees and shrubs



Illus 26b Allt Dail an Dubh-asaidh: pollen concentration curves for herbs, ferns and mosses



Illus 27 Allt Dail an Dubh-asaidh: pollen condition classes

resulting from the opening up of the willow carr. This opening of the canopy may also account for the increase in bracken spores, although bracken produces spores on an irregular basis and the apparent increase may have been caused by other factors (Page 1982). Pine, as a component of the extra-local and regional woodland, is unlikely to have increased in occurrence in Zone 1C. Pine is notoriously over-represented in pollen diagrams, particularly those from open sites (Bennett 1984; Fossit 1994) and this probably accounts for the apparent increase in pine in this zone. Both pine and elm pollen concentrations remain approximately constant from Zone 1B, suggesting no real increase in trees in Zone 1C.

The extra-local and regional areas would have been characterized by woodland dominated by birch and hazel with oak, elm and pine. Concentrations of birch and hazel have declined in Zone 1C, which may be reflecting some low levels of woodland use and clearance by human populations. Of the herb types recorded, there is little evidence for higher levels of disturbance in open areas.

The charcoal curve indicates sustained level of burning in the area throughout Zone 1C, which could be reflecting some human activity in the wider area, although again the larger catchment area, resulting from the decrease in local tree canopy, is likely to be inflating charcoal concentrations.. This activity would be taking place in a late Mesolithic context and, given the very low levels of evidence in the pollen record, is likely to have been of low impact and dispersed across the wider pollen catchment.

The sediment accumulation rates are slow throughout Zone 1C (see Table 5) and this is reflected in the low pollen concentrations throughout this zone (Illus 26). This is also suggested by the increase in corroded pollen grains, which may also indicate fluctuating water tables (Illus 27). If this is the case, the higher concentrations of elm and pine pollen grains, which are both relatively robust pollen types, are also illustrating poorer preservation conditions as well as a wider catchment area.

It is likely that the vegetation of Zone 1C was subjected to low levels of disturbance, possibly with some influence from human activity. However, given the larger catchment of Zone 1C, this activity could have taken place throughout the wider area at the low levels of impact recorded in the pollen record.

9.5.4 Zone 1D: c *6070–4520 BP*

Zone 1D is dominated by the rise in alder (*Alnus glutinosa*) pollen, with ferns and herbs (Illus 25). The alder rise at other pollen sites in the Arisaig area is a clearly recognizable feature of pollen diagrams, although dates for its inception vary. The start of the alder rise at the end of Zone 1C, dated here to about

6000 BP, is much earlier than the alder rise dated at Mointeach Mhór, slightly further south (Shennan *et al*. 1995). This is reflecting local conditions and may reflect the local topography slightly above the Mointeach Mhór; the latter would have been subject to the maximum Holocene sea-levels at this time. At Lochan Doilead, the alder rise has also been dated to *c* 6000 years BP (Williams 1977).

This alder carr will have developed locally, with a dense canopy and the herbs represented would have been elements of the understory. These included *Ranunculus acris* type, which includes meadow buttercup, medowsweet, bedstraws (*Galium* type) and some ferns including lady fern (*Athyrium felix-femina*) and broad buckler fern (*Dryopteris dilatata*). Extra-locally, woodland would have been characterized by birch, hazel and oak woodland with elm and pine. Zone 1D covers the early Neolithic period and, with the dense local alder carr, any human activity outside the woodland is difficult to see because the filtering effect of the alder carr is significant.

There is no evidence in this zone. For the ubiquitous decline in elm pollen at about 5100 BP across north-west Europe (Whittington & Edwards 1997). The elm pollen concentrations in Zone 1D are consistently high and gradually decrease through Zone 1E along with other tree pollen. Low levels of woodland clearance dispersed throughout the area would be compatible with a gradual decrease in all woodland tree pollen, where any vector for elm decline, whether felling or dutch elm disease, probably the most likely causes (Rackham 1990), would be dispersed throughout a large area. The lack of a visible elm decline at about 5100 BP is likely to be reflecting low levels of human activity, in the form of felling and opening up the woodland and was dispersed widely enough across the area to prevent a marked decline in elm pollen.

9.5.5 Zone 1E: c 4520–2410 BP

The start of Zone 1E is defined by the decline in the alder pollen. This is replaced locally by ling with heather (*Erica tetralix* and *E. cinerea*) and grasses. The zone starts with a short transitory sedge phase. This mirrors the vegetation sequence illustrated further south at Mointeach Mhór (Shennan *et al*. 1995), following the decrease of alder, dated later at that site to 2565 ± 45 years BP. Again this later date reflects local site conditions at Mointeach Mhór. It is now widely accepted that the rise and fall of alder pollen in the early to mid-Holocene is driven by local topographic and environmental factors rather than a continuous spread from source areas (Whittington & Edwards 1997).

Although there are only low levels of indicators for human activity throughout the diagram in Zone 1E there is a continuous evidence for ribwort plantain (*Plantago lanceolata*), which is associated with disturbed habitats (Godwin 1975; Grime *et al*. 1992). Other ruderal herbs recorded that reflect disturbance include nettle and goosefoot. Their sustained curves indicate sustained levels of disturbance.

Zone 1E straddles the mid-Neolithic to the end of the Bronze Age. The locally open vegetation dominated by ling with grasses and heather reflects a wider pollen catchment area and indicators of low levels of human activity in the wider area are more evident. Zone 1E is also characterized by the start of a gradual decline in tree pollen, illustrated in the summary curves on Illus 25. All the tree curves show progressive declines throughout Zone 1E, reflecting steady continuous decrease in tree canopy. The slow decline of elm throughout Zone 1E is comparable to the decline in other tree pollen concentrations, which suggests low levels of woodland clearance in discrete areas, but not necessarily favouring elm, one of the theories for the widespread elm decline. Humans, as factors in woodland decline are implicated by the rise in ruderal herb pollen and charcoal, but the low levels of evidence reflects an extensive use of the area. This evidence for human activity in Bronze Age times is supported by archaeological evidence for Late Bronze Age sites in the Arisaig area.

The zone is also marked by microscopic charcoal throughout, which after the sharp increase halfway through the zone at 296cm, continues throughout the zone. Again this is likely to be reflecting human activity. Extra-locally the woodland remains characterized by birch and hazel, with lower levels of oak, elm and pine.

9.5.6 Zone 1F: c 2410–present

Zone 1F is marked by the local change from a ling-dominated heath to one with increased grasses, sedges and bog myrtle (*Myrica gale*). Despite the fact that the curve for bog myrtle is a minimum, because of the difficulties in distinguishing consistently between pollen from hazel and bog myrtle (Edwards 1981), there is nonetheless a definite change in the pollen record from ling to a bog myrtle heath. This type of succession has been associated with changes in climate, burning or grazing (Rodwell 1991). Microscopic charcoal is present at low levels throughout the zone. So unless the trigger was the consistently higher charcoal levels throughout Zone 1E, over a 2000-year period, then burning is unlikely as a major cause. The date at the start of Zone 1F (2410 BP) coincides with the end of the Bronze Age and a generally accepted change in climate to wetter conditions across Scotland (eg Dubois & Ferguson 1985; Gear & Huntley 1991). This could have triggered the change from woodland to heath with increased grasses, sedge and bog myrtle. The decline in woodland could also be related to increased grazing throughout Zone 1F, although this is difficult to distinguish directly in the pollen record (see below). It is more likely to be a combined change to a wetter climate alongside increased grazing regimens, reflected in the woodland decline but with low levels of burning.

Around the local sedge and bog myrtle heath, birch and hazel woodland with oak is found. Although the concentrations of hazel and birch seem high for an apparently open environment, these values are likely to be reflecting the local woodland to the south and east. In addition, research by Bunting indicates that these levels of arboreal pollen are consistent with an open environment on the west coast of Scotland with woodland in local pockets (Bunting 2002). The increase in pine pollen towards the top of Zone 1F (from 12cm) is likely to be reflecting modern plantations.

Throughout Zone 1F there are clear indications of sustained disturbance in the vegetation, although again at consistently low levels. Curves for ruderal herbs, including ribwort plantain, nettle, sorrel and goosefoot are sustained throughout. The pollen catchment area is gradually widened throughout Zone 1F because of the decline in woodland cover, although charcoal frequencies remain low, suggesting that burning was not a major activity. It is more likely that the sustained ruderal pollen curves and the gradual decline in tree pollen reflect increasing grazing levels throughout the region.

9.6 Interpretation of charcoal data

The charcoal curve in these diagrams (Illus 25, Illus 26) shows increased burning in Zones 1C and 1E. From 7200 to 6000 BP in Zone 1C, this is likely to reflect an increased pollen catchment area, following the opening up of the willow carr characterizing Zone 1B. There is very little pollen evidence for human activity throughout Zone 1C, which is consistent with the early dates, although the increased charcoal reflects a higher frequency of burning events than could be assumed to be natural.

In Zone 1E, from 4500 to 2400 BP, burning frequencies increase, with a decline in tree pollen and indicators of disturbance in the form of ruderal herbs. The burning in this zone is likely to be a result of human activity, although again at low levels and dispersed throughout the area.

9.7 Natural vegetation succession

Natural processes of succession account for most of the local vegetation changes recorded at Allt Dail an Dubh-asaidh. The colonization of open water by willow carr would have occurred with sedimentation of the basin. Willow carr occupies generally neutral to basic conditions and the apparently odd inclusion of *Sphagnum* in this local community is likely to reflect pockets where slight acidification can occur, perhaps at the basin edge (cf *Salix cinerea–Betula pubescens–Phragmites australis* woodland, Rodwell 1991). However, the generally neutral to basic nature of the area is maintained and *Sphagnum* disappears with the development of an open marsh characterized by sedges and grasses. This open phase allowed the colonization of the local area by alder carr. Towards the end of this phase, acidification seems to occur as alder dies away and ling takes over the basin. The increase in bog myrtle in Zone 1F is likely to relate to the continuing influence of water inflow, helping it compete with ling.

Changes in the extra-local and regional woodland are harder to interpret, although there are clearly fluctuations in canopy composition and extent. The changes from willow- to alder-dominated carr are likely to reflect natural successional changes, as above. In the wider landscape, the birch–hazel–oak woodland remains constant in Zone 1D, and its gradual decline starting in Zone 1E and continuing through Zone 1F is likely to relate more to human activity and possibly woodland decline as a result of increased grazing.

9.8 Human activity

There has been little archaeological evidence recorded for human activity in the area around Allt Dail an Dubh-asaidh until the 19th and 20th centuries and there is similarly little evidence for human activity affecting the vegetation, until Zone 1F, after about 2400 years BP. Most of the main changes in vegetation at the pollen site can be accounted for through natural succession.

However, human activity reflected in the pollen record is at a consistently low level throughout the diagram from the Mesolithic period to the present day. Woodland cover at a local and extra-local and regional scale is maintained to the start of Zone 1E at about 4500 BP. From this time, woodland declines gradually and is likely to be reflecting human activity throughout the area at sites local to and further away from the pollen core site. This sustained human activity at low levels throughout the area is supported by the curves for ruderal pollen types like ribwort plantain, nettle and goosefoot.

In Zone 1F, while the decline in woodland pollen continues along with sustained curves for ruderal pollen types, charcoal frequencies decline. This suggests sustained but low levels of disturbance with human activity throughout the area but with less impact from burning activity. The sustained disturbance that causes continued declines in tree pollen and an increase in open vegetation is likely to be increased grazing.

9.9 Conclusions

The vegetation record at Allt Dail an Dubh-asaidh, from the detailed pollen record described here, indicates low levels of disturbance, related to human activity from about 4500 years BP onwards. Before this time, any human activity would have caused even lower levels of disturbance that, although possible to discern in the pollen diagram, are likely to

have been masked by natural vegetation succession at the pollen site.

From 4500 BP, the pollen record includes low but continuous levels of human disturbance. This would be consistent with small discrete areas of human activity that were used in an extensive pattern, on a temporary basis. This small-scale activity, in the form of woodland clearance, with some burning, was not necessarily in the same location and it is more likely that the activity moved from one small area to another through time. This would produce the low but sustained levels of ruderal herb pollen along with a very gradual decline in tree pollen. It is also likely that grazing played an increasingly important role in the vegetation. Although there are very few direct indicators for grazing in the pollen record, the impact of increased grazing is reflected in the suppression of tree pollen production and the maintenance of open vegetation types, particularly through Zone 1F. From 2500 BP onwards, therefore, the vegetation was disturbed on a continuous basis, probably grazing. This could have been either through transhumance practice throughout the area or through maintained grazing at a network of small sites.