ABERNETHY FOREST

J. E. Gordon

OS Grid Reference: NH967175

Highlights

Pollen and plant macro-fossils preserved in the sediments which infill a topographic depression at Abernethy Forest provide an important record of Lateglacial and Holocene vegetational history. This record is particularly important in the context of the development of native Scots pine forest.

Introduction

The site known as Abernethy Forest (NH 967175) comprises a bog infill of a glacial channel or kettle hole between Loch Garten and Loch Mallachie at an altitude of 221 m OD. It is a key biostratigraphic site representing the sequence of Lateglacial and Holocene vegetation development in the western Cairngorms area. It is notable for the length and completeness of its stratigraphic record, the radiocarbon time-scale calibration of the latter, and the detailed studies which have been carried out on its pollen and plant macrofossils (Birks, 1969, 1970; Vasari, 1977; Birks and Mathewes, 1978). One particularly important aspect of the vegetational history preserved in the deposits is a record of the development and evolution of the native Scots pine forest, remnants of which still occur near the site.

The Late Devensian pollen and plant macrofossils and their dating have also been considered by Vasari (1977). O'Sullivan (1970, 1974a, 1974b, 1975) studied the Holocene vegetational history of nearby sites at Loch Garten and Loch a'Chnuic within the wider area ofAbernethy Forest and also at Loch Pityoulish (O'Sullivan, 1976).

Description

The bog lies in an area of glaciofluvial deposits related to the downwastage of the Late Devensian ice-sheet (Young, 1977a). Cores from the bog have been described by Birks (1969, 1970) and Birks and Mathews (1978). The sequence of sediments in a 5 m long core (Birks and Matthews, 1978) comprises silt, sand, a series of detritus muds and peat (Figure9.12). Seven radiocarbon dates (Q-1266 to Q-1272) were obtained from the sediments (Figure9.12).

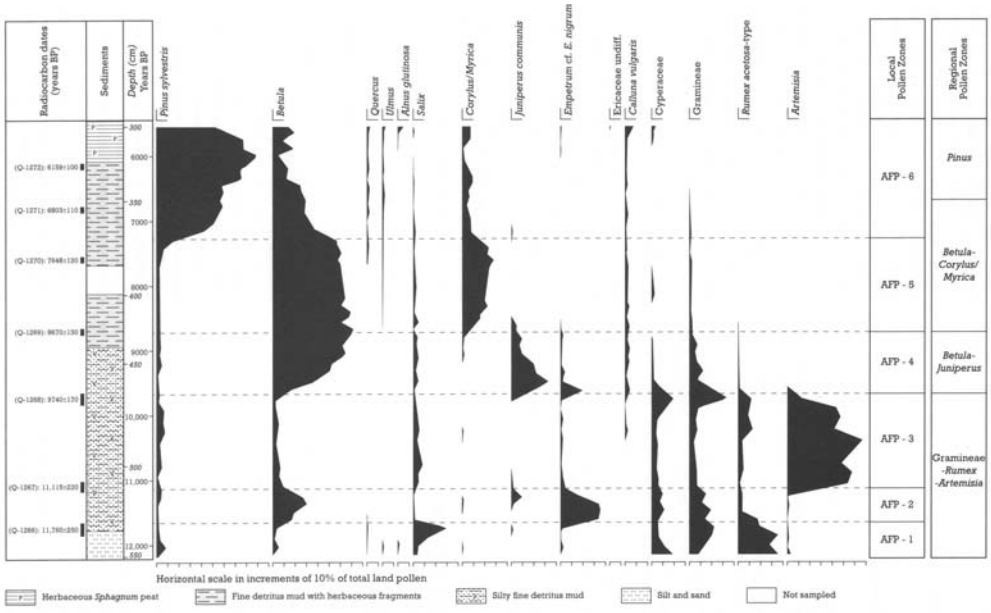

Figure 9.12: Abernethy Forest: relative pollen diagram showing selected taxa as percentages of total land pollen (from Birks and Mathewes, 1978). Regional pollen assemblage zones are from Birks (1970). Note that the data are plotted against a radiocarbon time-scale.

Interpretation

Birks (1969, 1970) defined five regional pollen assemblage zones in the sequence atAbernethy Forest (Figure 9.12). The Gramineae – *Rumex* – *Artemisia* assemblage zone at the base was subsequently confirmed to be of Late Devensian age byBirks and Mathewes (1978) and was subdivided by them into three parts. The first, (AFP-1) (Figure9.12) dated between 12,150 and 11,650 BP, was characterized by a low pollen influx dominated by*Salix*, Cyperaceae, Gramineae and *Rumex acetosa* type, indicating tundra conditions and an open treeless vegetation of largely sedge and grass pioneer communities colonizing recently deglaciated moraine. Similar plant assemblages have been reported fromLoch Etteridge (Walker, 1975a), Loch of Park and Loch Kinord (see Muir of Dinnet) (Vasari and Vasari, 1968) and Garral Hill (Donner, 1957). The second part (AFP-2), dated between 11,650–11,150 BP, was characterized by a higher pollen influx representative of arctic shrub-tundra dominated by *Betula nana* and *Empetrum*. Around 11,220 BP birch trees began to colonize at the site. Similar assemblages occur at Loch Etteridge (Walker, 1975a) and Loch Kinord (Vasari and Vasari, 1968), and, with slight variations, at Loch of Park (Vasari and Vasari, 1968) and Garral Hill (Donner, 1957). The third phase (AFP-3), dated between 11,190 and 9670 BP, showed a marked vegetational "revertance' during the Loch Lomond Stadial. The low pollen influx is typical of exposed, unstable habitats and snowbed sites. The high percentage of*Artemisia* pollen, which is characteristic of Loch Lomond Stadial pollen assemblages at sites in Strathspey (for example at Tom na Moine (MacPherson, 1980), Loch Etteridge (Walker, 1975a) and Loch a'Chnuic (O'Sullivan, 1974a)), suggests a relatively arid climatic regime, whereas in lower Deeside (Vasari and Vasari, 1968), parts of the south-east Grampians (Walker, 1975b; Lowe and Walker, 1977) and western Scotland (Pennington *et al.*, 1972; Birks, 1973) less arid conditions appear to have prevailed. Birks and Mathewes (1978) consider that this pattern reflects a precipitation shadow effect in the Cairngorm area and Strathspey (see alsoSissons, 1979d, 1980b; MacPherson, 1980; Walker, 1984b). After about 9910 BP there are signs of increasing vegetational stability and climatic improvement prior to the spread of*Betula* and *Juniperus* in the early Holocene which has been dated to*c.* 9670 BP.

Birks and Mathewes (1978) noted a broadly consistent Late Devensian pollen stratigraphy between sites in Strathspey (Abernethy Forest, Loch a'Chnuic and Loch Etteridge) and Deeside (Loch Kinord). However, the radiocarbon geochronology forLoch Etteridge (Walker, 1975a) suggests that the three corresponding pollen zones at that site are 300–500 years younger. Birks and Mathewes suggested that the higher altitude of the Etteridge site (300 m OD) might explain later climatic amelioration, but this did not satisfactorily account for the apparently

later onset of the Loch Lomond Stadial.

Vasari (1977) has also investigated the Lateglacial pollen and plant macrofossils of a core from the Abernethy Forest site. He subdivided the profile into conventional Lateglacial pollen zones following principles outlined in his earlier work (Vasari and Vasari, 1968). The succession was generally in agreement with that of Birks and Mathewes (1978), although there were some differences in the relative dating of particular events. Vasari obtained the following dates for zone boundaries of the Jessen–Godwin scheme: 12,710 + 270 BP (Hel-424) (I/II), 11,260 + 240 BP (Hel-423) (II/III), and 10,230 + 220 BP (Hel-422) (III/III–IV). The middle date was similar to that of the corresponding boundary in the zonation scheme of Birks and Mathewes (1978). However, Vasari's dates implied that organic sedimentation began rather earlier than suggested by Birks and Mathewes. The date obtained on the lowermost level was earlier than that for the start of the AllerØd chronozone (*sensu stricto*) and the corresponding boundary in Birks and Mathewes' scheme. The basal Holocene date was also somewhat earlier than that obtained by Birks and Mathewes. Vasari's Abernethy Forest dates were also consistently older than those he obtained for corresponding zones at Loch Kinord and Loch of Park, although the youngest is broadly comparable in the latter case. He raised the possibility of a hard-water error in the Abernethy Forest dates, but based his deductions on the assumption that they were correct. He inferred that climatic amelioration began relatively early and progressed in an uninterrupted manner until the middle of the AllerØd.

Vasari's (1977) date of 10,230 + 220 BP (Hel-422) for the zone III–zone III/IV boundary at Abernethy Forest is broadly comparable to those from a variety of sites, both in eastern and western Scotland (see Gray and Lowe, 1977b, table 1). If correct, this suggests some degree of regional synchroneity.

At Abernethy Forest, in the profile examined by Birks and Mathewes (1978), the Holocene part of the sequence commences with the *Betula – Juniperus* zone, dated between 9670 and 8740 BP. This zone records the replacement of open, unstable habitats by a stable, shrub-dominated vegetation, particularly *Juniperus* (which increased to a peak and then declined) and *Betula nana* scrub. Birch forest, probably open at the start of the zone, progressively increased in density as colonization by tree *Betula* and then *Corylus* took place. Similar assemblage zones are recorded at Loch a'Chnuic (O'Sullivan, 1974a), Loch Etteridge and Drumochter (Walker, 1975a), Tom na Moine (MacPherson, 1980), Loch Kinord and Loch of Park (Vasari and Vasari, 1968), Roineach Mhor and Blackness (Walker, 1975b), and possibly Morrone (Huntley, 1976).

The succeeding *Betula* and Corylus/Myrica assemblage zone, dated between 8740 – 7230 BP probably reflects dense birch–hazel forest. *Quercus* and *Ulmus* pollen are recorded continuously for the first time, but these trees were probably very local in their distribution and confined to the valleys. This zone is also represented at Allt na Feithe Sheilich and Loch Einich (Birks, 1969, 1970), Loch Garten and Loch a'Chnuic (O'Sullivan, 1974a), Tom na Moine (MacPherson, 1980), and in a large number of profiles throughout north and west Britain (Birks, 1970).

In the core examined by Birks and Mathewes (1978), the *Pinus* assemblage zone at Abernethy Forest commenced at 7230 BP and lasted until 5520 BP. From considerations of pollen influx as well as the occurrence of *Pinus* macrofossils in the sediment, Birks and Mathewes inferred that pine first arrived in the area about 7165 BP, but that it did not become established close to the site until about 6800 BP. A similar *Pinus*-dominated pollen zone has been widely recorded in the Cairngorm area, Deeside and Speyside, at Allt na Feithe Sheilich and Loch Einich (Birks, 1969, 1970, 1975), Glen Eidart, Sgòr M¢r and Carn M¢r (Pears, 1968), Allachy Moss (Durno, 1959), Loch Kinord (Vasari and Vasari, 1968), Loch Etteridge and Drumochter (Walker, 1975a), Tom na Moine (MacPherson, 1980), Morrone (Huntley, 1976), and Loch Garten, Loch a'Chnuic and Loch Pityoulish (O'Sullivan, 1974a, 1975, 1976). Apparent discrepancies in the rate and timing of the pine expansion in the area were discussed by O'Sullivan (1975) and explained in terms of differential sediment accumulation rates, possibly during periods of low or falling lake levels. However, Birks and Mathewes' (1978) date of 7165 BP is comparable to the age determination of 7000 BP derived by Birks (1969, 1970) from pine stumps at Loch Einich and Allt na Feithe Sheilich and with a date of 7100 BP interpolated by Birks and Mathewes from O'Sullivan's (1975) results at Loch Pityoulish. It is also comparable with the oldest date of 7350 + 85 (IRPA-594) obtained by Dubois and Ferguson (1985) from pine stumps on the northern slopes of the Cairngorms. In addition Birks and Mathewes point out that a date of 7585 + 335

BP (UB-852) from Loch Garten (O'Sullivan, 1974a) accords with the others if its large standard deviation is taken into account.

Following its establishment, pine came to dominate the natural forest on the more acid, well-drained soils of the Cairngorm area up to a treeline altitude of 793 m OD (Pears, 1968, 1972), and formed an important unit of one of the major distinctive forest regions of Scotland (McVean and Ratcliffe, 1962). The pollen evidence shows that thermophilous deciduous trees, such as *Ulmus* and *Quercus*, were comparatively rare in the area during the Holocene, probably due to the relatively continental climate, particularly the severe winters.

Alnus also appears to have been relatively rare in the area during the Holocene, being confined to stream-sides and fens. The *Alnus* rise at Abernethy Forest was estimated at 5520 BP (Birks and Mathewes, 1978), which is in agreement with the date of 5548 + 50 BP (SRR-459) from Loch Pityoulish (O'Sullivan, 1975, 1976). A slightly older date of 5860 + 100 BP (UB-851) was obtained from Loch Garten but, like the date for the *Pinus* expansion, the difference is probably not significant in palaeoecological terms (Birks and Mathewes, 1978). On Deeside, also, the pine forest appears to have been established before the alder rise, which occurred there sometime after 6700 BP (O'Sullivan, 1975).

Birks and Mathewes (1978) did not sample the sediments corresponding with the *Calluna – Plantago lanceolata* zone, which had previously been reported by Birks (1969, 1970). The zone is characterized by a reduction in woodland cover and increased non-arboreal pollen frequencies, especially *Calluna*. The decline of woodland is more marked in upland sites, for example at the Loch Einich type locality for the zone (Birks, 1969, 1970), than at Abernethy Forest where the pine forest, although it may have thinned, never entirely disappeared. The evolution of the pine forest in the Abernethy area during the late Holocene, when anthropogenic effects intruded, has been considered by Steven and Carlise (1959) and O'Sullivan (1970, 1973a, 1973b, 1974a, 1974b, 1976, 1977).

An important point made by Birks (1970) about the vegetation succession in the area following the climatic amelioration at the beginning of the Holocene is that it can be explained in terms of biological and environmental factors without invoking further climatic change. She concluded that the order of immigration of species reflected the distance from their refuge and their rate of migration, and that their relative abundance was a function of the regional climate of the area, soil factors, and competition among species. More recently human interference has been an additional factor. Such variables also account for the distinctive forest history and patterns of the Cairngorm area when seen in an overall national perspective (Birks, 1977).

The development of the hydrosere at Abernethy Forest through lake to bog communities was traced by Birks and Mathewes (1978), mainly from the macrofossil stratigraphy. In general the aquatic plant succession is similar to that at the other sites so far investigated in Scotland, at Loch of Park, Loch Kinord and Drymen (Vasari and Vasari, 1968), although there are some local differences at Abernethy Forest, including a delay to the typical early Holocene plant expansion. Birks and Mathewes note that Abernethy Forest is additionally interesting for the record it provides of hydroseral development from open water through a relatively brief poor-fen stage to a Sphagnum-dominated acid mire.

Abernethy Forest is an outstanding biostratigraphic locality and is particularly important in demonstrating the Lateglacial and Holocene vegetation history of the Strathspey and Cairngorm area. It is especially significant in the context of the development and history of the native pine forest. It has also been studied in greater detail than most other sites in terms of combined pollen and plant-macrofossil analyses. Furthermore, it provides important contrasts with sites further west in Scotland. In a wider context, the Loch Lomond Stadial in Scotland is more pronounced and more intensively recorded biostratigraphically than anywhere else in north-west Europe, and Abernethy Forest contributes significantly to the detail of this record.

Conclusions

Abernethy Forest is an important reference site for studies of environmental changes during the Lateglacial and Holocene, that is approximately the last 11,000 years. The pollen and larger plant remains preserved in the sediments have been studied in considerable detail and

they allow valuable comparisons with records from sites in other areas.Abernethy Forest is an integral member of the network of sites recording the vegetational history of Scotland and its major regional variations. It also contributes significantly to understanding the development of the native pine forest.

Reference list

Birks, H.H. (1969) Studies in the vegetational history of Scotland. Unpublished PhD thesis, University of Cambridge.

Birks, H.H. (1970) Studies in the vegetational history of Scotland I. A pollen diagram from Abernethy Forest, Inverness-shire. *Journal of Ecology*, **58**, 827–46.

Birks, H.J.B. (1973) *Past and Present Vegetation of the Isle of Skye. A Palaeoecological Study*. Cambridge, Cambridge University Press, 415pp.

Birks, H.H. (1975) Studies in the vegetational history of Scotland IV. Pine stumps in Scottish blanket peats. *Philosophical Transactions of the Royal Society of London*, **B 270**, 181–226.

Birks, H.J.B. (1977) The Flandrian forest history of Scotland: a preliminary synthesis. In*British Quaternary Studies*: *Recent Advances* (ed. F.W. Shotton). Oxford, Clarendon Press, 119–35.

Birks, H.H. and Mathewes, R.W. (1978) Studies in the vegetational history of Scotland. V. Late Devensian and early Flandrian pollen and macrofossil stratigraphy at Abernethy Forest, Inverness-shire. *New Phytologist*, **80**, 455–84.

Donner, J.J. (1957) The geology and vegetation of Late-glacial retreat stages in Scotland. *Transactions of the Royal Society of Edinburgh*, **63**, 221–64.

Dubois, A.D. and Ferguson, D.K. (1985) The climatic history of pine in the Cairngorms based on radiocarbon dates and stable isotope analysis, with an account of the events leading up to its colonisation. *Review of Palaeobotany and Palynology*, **46**, 55–80.

Durno, S.E. (1959) Pollen analysis of peat deposits in the eastern Grampians.*Scottish Geographical Magazine*, **75**, 102–11.

Gray, J.M. and Lowe, J.J. (1977b) The Scottish Lateglacial environment: a synthesis. In*Studies in the Scottish Lateglacial Environment* (eds J.M. Gray and J.J. Lowe). Oxford, Pergamon Press, 163–81.

Huntley, B. (1976) The past and present vegetation of the Morrone Birkwoods and Caenlochan National Nature Reserve. Unpublished PhD thesis, University of Cambridge.

Lowe, J.J. and Walker, M.J.C. (1977) The reconstruction of the Lateglacial environment in the southern and eastern Grampian Highlands. In*Studies in the Scottish Lateglacial Environment* (eds J.M. Gray and J.J. Lowe). Oxford, Pergamon Press, 101–18.

MacPherson, J.B. (1980) Environmental change during the Loch Lomond Stadial: evidence from a site in the upper Spey Valley, Scotland. In*Studies in the Lateglacial of North-west Europe* (eds J.J. Lowe, J.M. Gray and J.E. Robinson). Oxford, Pergamon Press, 89–102.

McVean, D.N. and Ratcliffe, D.A. (1962) Plant Communities in the Scottish Highlands. A Study of Scottish Mountain Moorland and Forest Vegetation. London, HMSO, 445pp.

O'Sullivan, P.E. (1970) The ecological history of the Forest of Abernethy, Inverness-shire. Unpublished PhD thesis, New University of Ulster.

O'Sullivan, P.E. (1973a) Pollen analysis of mor humus layers from a native Scots Pine ecosystem, interpreted with surface samples. *Oikos*, **24**, 259–72.

O'Sullivan, P.E. (1973b) Land-use changes in the Forest of Abernethy, Inverness-shire (1750–1900@thin#AD). *Scottish Geographical Magazine*, **89**, 95–106.

O'Sullivan, P.E. (1974a) Two Flandrian pollen diagrams from the east-central Highlands of Scotland. *Pollen et Spores*, **16**, 33–57.

O'Sullivan, P.E. (1974b) Radiocarbon-dating and prehistoric forest clearance on Speyside (east-central Highlands of Scotland). *Proceedings of the Prehistoric Society*, **40**, 206–8.

O'Sullivan, P.E. (1975) Early and Middle-Flandrian pollen zonation in the Eastern Highlands of Scotland. *Boreas*, **4**, 197–207.

O'Sullivan, P.E. (1976) Pollen analysis and radiocarbon dating of a core from Loch Pityoulish, eastern Highlands of Scotland. *Journal of Biogeography*, **3**, 293–302.

O'Sullivan, P.E. (1977) Vegetation history and the native pinewoods. In*Native Pinewoods of Scotland* (eds R.G.H. Bunce and J.N.R. Jeffries). Cambridge, Institute of Terrestrial Ecology, 60–9.

Pears, N.V. (1968) Post-glacial tree-lines of the Cairngorm Mountains, Scotland.*Transactions of the Botanical Society of Edinburgh*, **40**, 361–94.

Pears, N.V. (1972) Interpretation problems in the study of tree-line fluctuations. In*Research Papers in Forest Meteorology, an Aberystwyth Symposium* (ed. J.A. Taylor). Aberystwyth, University College of Wales, 31–45.

Pennington, W., Haworth, E.Y., Bonny, A.P. and Lishman, J.P. (1972) Lake sediments in northern Scotland. *Philosophical Transactions of the Royal Society of London*, **264B**, 191–294.

Sissons, J.B. (1979d) Palaeoclimatic inferences from former glaciers in Scotland and the Lake District. *Nature*, **278**, 518–21.

Sissons, J.B. (1980b) Palaeoclimatic inferences from Loch Lomond Advance glaciers. In*Studies in the Lateglacial of North-west Europe* (eds J.J. Lowe, J.M. Gray and J.E. Robinson). Oxford, Pergamon Press, 31–43.

Vasari, Y. (1977) Radiocarbon dating of the Lateglacial and early Flandrian vegetational succession in the Scottish Highlands and the Isle of Skye. In*Studies in the Scottish Lateglacial Environment* (eds J.M. Gray and J.J. Lowe). Oxford, Pergamon Press, 143–62.

Vasari, Y. and Vasari, A. (1968) Late- and post-glacial macrophytic vegetation in the lochs of northern Scotland. *Acta Botanica Fennica*, **80**, 120pp.

Walker, M.J.C. (1975a) Late Glacial and Early Postglacial environmental history of the central Grampian Highlands, Scotland. *Journal of Biogeography*, **2**, 265–84.

Walker, M.J.C. (1975b) Two Lateglacial pollen diagrams from the eastern Grampian Highlands of Scotland. *Pollen et Spores*, **17**, 67–92.

Walker, M.J.C. (1984b) Pollen analysis and Quaternary research in Scotland.*Quaternary Science Reviews*, **4**, 369–404.

Young, J.A.T. (1977a) Glacial geomorphology of the Aviemore - Loch Garten area, Strathspey, Inverness-shire. *Geography*, **62**, 25–34.