
MOLLANDS

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OS Grid Reference: NN628068

Highlights

The sediments that infill the floor of a kettle hole at Mollands provide an important record, supported by radiocarbon dating, of the Holocene vegetational history of this important ecological area located at the boundary between the Highlands and the Central Lowlands. Together with Tynaspirit, Mollands also provides significant evidence for establishing a glacial chronology for the area.

Introduction

The site at Mollands (NN 628068) is an infilled kettle hole located c. 1 km south of Bridgend, Callander. It is important for pollen stratigraphy at the Lateglacial-Holocene boundary and during the Holocene. It has also been significant in establishing a glacial chronology for the Callander area. The results obtained from Mollands (Lowe, 1977, 1978, 1982a, 1982b; Lowe and Walker, 1977) complement those from Tynaspirit (see below), and together these two sites provide one of the strongest lines of support for recently proposed schemes of the Late Devensian glacial chronology of Scotland (see Gray and Lowe, 1977b; Price, 1983; Lowe and Walker, 1984; Sutherland, 1984a).

Description

The limit of the last glacier advance in the Teith Valley is marked by a well-defined terminal moraine (the Callander Moraine) which can be observed on both sides of the river just downstream from Callander (Figure 13.9). Upstream of the moraine some sharply-delimited eskers occur, as for example around Clash and Gart (NN 636068 to NN 644064) and on both banks of the River Teith downstream of the site of Callander Castle (NN 632075 to NN 635073 and NN 632073 to Clash). A series of kame terraces has also been mapped in the area between the Callander Moraine and the town of Callander (Thompson, 1972; Merritt and Laxton, 1982). At Mollands, on the ice-proximal side of the moraine ridge (Figure 13.9), lake sediments and peats have filled a depression which exceeds 8 m in depth from the ground surface and which is bounded on its eastern and south-eastern edges by kame terraces. The site is therefore interpreted as a kettle hole, formed by melting of a block of buried ice that persisted until after the formation of the kame terraces. The sediment succession at Mollands should therefore provide a minimum age for the retreat of the Loch Lomond Readvance ice in the vicinity of Callander (see Sissons *et al.*, 1973; Lowe and Walker, 1977 for details of methodology).

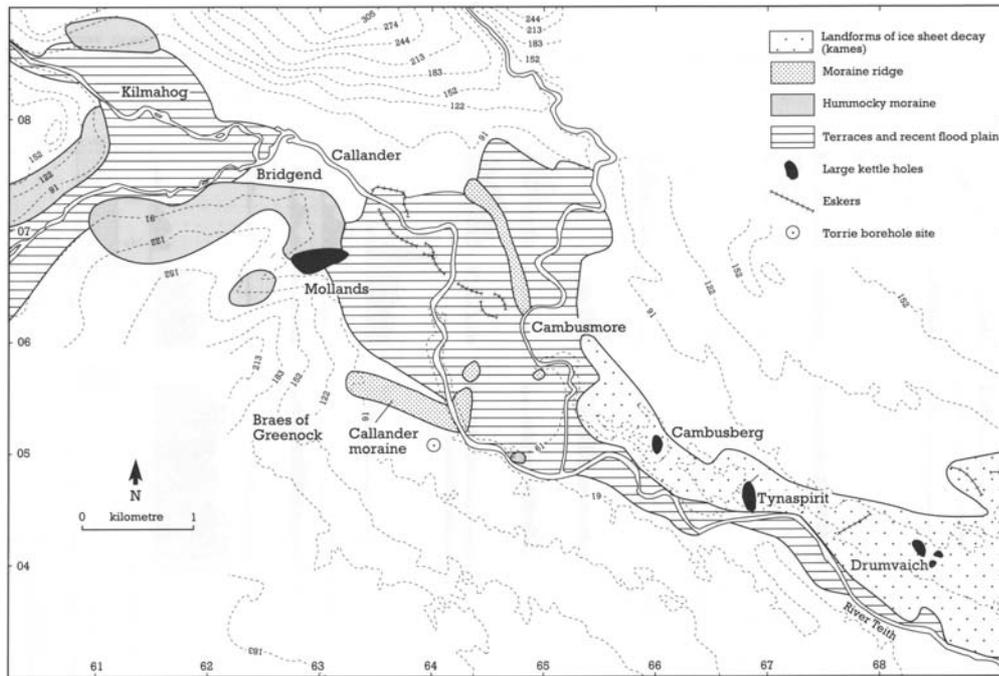


Figure 13.9: Glacial and glaciofluvial landforms of the Callander area (from Lowe, 1978, after Thompson, 1972).

The basal sediments are very variable, with a number of thinly-bedded units, including rhythmites (Figure 13.10). Collectively, the basal sediments comprise a fining-upwards sequence from compact sands at the base (8.32 m to 7.50 m) through finely-laminated silts, sands and clays (7.50 m to 7.30 m) to laminated organic and inorganic muds (see Lowe, 1978). The sediments proved to be non-polleniferous below 7.32 m, but a detailed pollen stratigraphy was based on samples obtained from the remainder of the succession. Three radiocarbon dates (HV-5645 to HV-5647) were obtained from the profile (Figure 13.10).

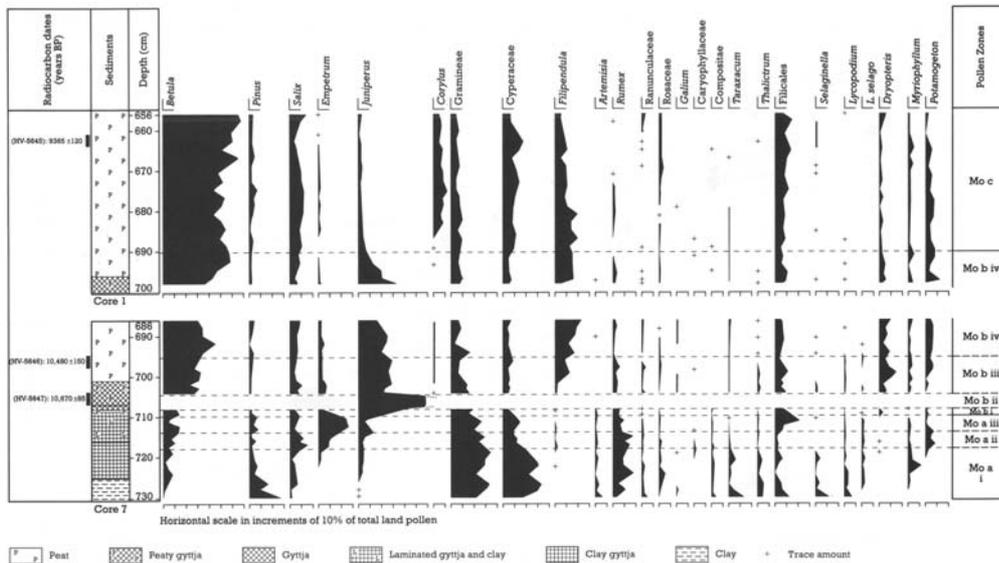


Figure 13.10: Mollands: Lateglacial and early Holocene relative pollen diagram showing selected taxa as percentages of total land pollen (from Lowe, 1978).

Interpretation

The vegetational succession (Figure 13.10) that can be inferred is one of successive plant colonisation of the slopes around the site from initially bare, stony surfaces to a woodland cover. The lowermost pollen zone (Moa I) is dominated by pollen of grasses, sedges, sorrel, the

dandelion group (*Taraxacum*) and meadow rues (*Thalictrum*), with spores of the clubmosses (*Selaginella* and *Lycopodium*) also well-represented. These species thrive on bare, gravelly or stony surfaces free of competition from shrub and woodland associations. The zones Moa II to Moc record successive invasions of the district first by heath (crowberry and dwarf willows), followed by juniper, then birch and eventually hazel. This sequence is characteristic of the early Holocene in Scottish sites.

The dominant juniper phase at the site has been dated to 10,670 ± 85 BP (Hv-5647), a date which compares well with that of 10,420 ± 160 BP (Hv-4985) obtained for the immigration of juniper at Tynaspirit. Juniper remained a dominant species until shaded out by birch, and hazel colonisation appears to have been well under way in southern Perthshire by 9,365 ± 120 BP (Hv-5645), an age estimate that compares favourably with that of 9,260 ± 100 BP (Hv-4984) obtained from a comparable biostratigraphic level at Tynaspirit.

Figure 13.11 presents the results of pollen analysis of the main Holocene organic sequence at Mollands (excluding the uppermost 0.4 m of disturbed sediments). The diagram indicates that an early Holocene phase of birch-hazel woodland (zones Mob to Moe) gave way to a mixed deciduous woodland, where alder, elm and oak were important constituents. The relatively high representation of pine at the site (zones Mof to Mog) suggests that the middle Holocene woodlands of the Teith Valley were transitional between the deciduous forests of the central lowlands of Scotland and the dominant pine woodlands of the Highlands. An 'Elm Decline' occurs at the Mog/Moh boundary, suggesting an age for this part of the record of about 5,000 BP (Hibbert *et al.*, 1971; Smith and Pilcher, 1973; Godwin, 1975). Zone Moh is characterised by the virtual disappearance of pine, by reductions in the percentages of oak and tree pollen generally, and by renewed growth of birch and hazel. These vegetational changes are likely to reflect anthropogenically-induced, selective forest clearance in the Teith Valley from about 5,000 BP onwards (Lowe, 1982a).

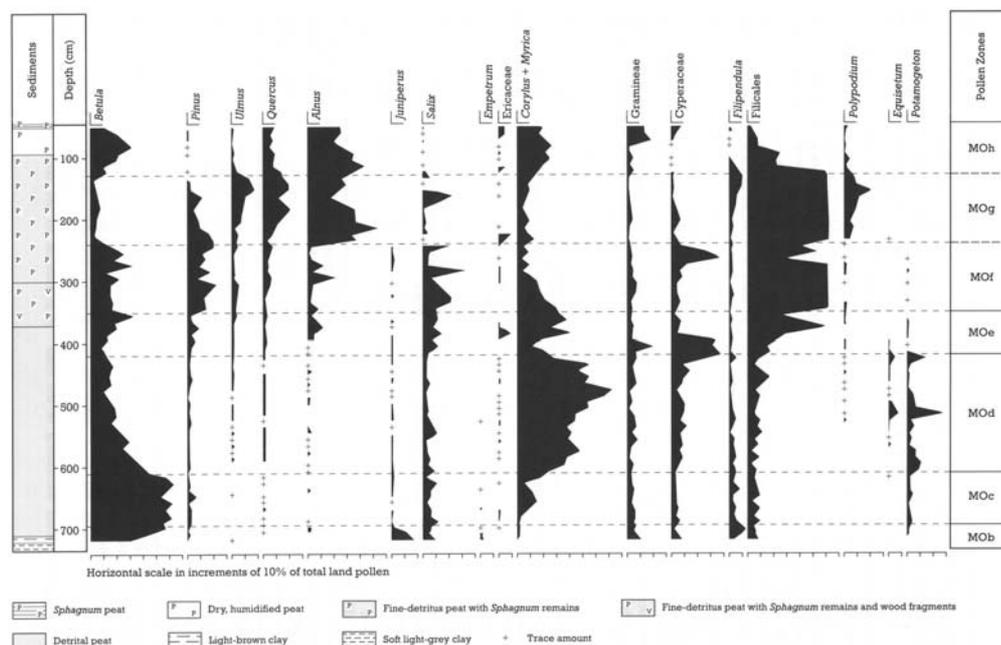


Figure 13.11: Mollands: main Holocene relative pollen diagram showing selected taxa as percentages of total land pollen (from Lowe, 1982a).

The principal points to emerge from the studies completed at Mollands so far, excluding the vegetational history which has been summarised above, relate to the time and sequence of deglaciation at the end of the Loch Lomond Readvance and to aspects of Holocene vegetational history. Taken together, the evidence from Mollands, Tynaspirit and Torrie (NN 638051) (Merritt *et al.*, 1990) confirms that the ice limit at Callander is that of a Loch Lomond Readvance glacier. The date on the basal sediments at Mollands of 10,670 ± 85 BP (Hv-5647) suggested a much earlier withdrawal of the readvance ice in parts of Scotland than was generally accepted at the time of publication (Lowe, 1977; Lowe and Walker, 1977). Most

authorities generally accept an age of around 10,000 to 10,250 for the end of the Loch Lomond Stadial and accordingly for deglaciation. The data from Mollands contrast with this interpretation. There is much debate about the reliability of radiocarbon dates obtained from organic lake sediments that have accumulated in newly-deglaciated terrain (see Lowe and Walker, 1980; Sutherland, 1980), but the following points lend credence to the conclusion that deglaciation may have occurred in parts of Scotland as early as about 10,700 BP. First, two radiocarbon dates are available from the base of the sequence at Mollands which are internally consistent and which both have age ranges older than 10,250 BP. Second, those dates are consistent with the earliest post-stadial date from Tynaspirit which suggests major climatic improvements some time prior to 10,420 + 160 BP (Hv-4985). Third, a number of dates have now been obtained from several other sites in Scotland which may indicate that deglaciation was probably under way before 10,250 BP (Lowe and Walker, 1980; Walker and Lowe, 1980, 1982). However, results from Inverleven (Browne and Graham, 1981), Croftamie (Rose *et al.*, 1988) and South Shian and Balure of Shian (Peacock *et al.*, 1989) support the earlier model of relatively late deglaciation and that marine conditions were arctic until after 10,350 BP (Peacock *et al.*, 1978).

The interpretation of radiocarbon dates obtained from samples of last glacial-interglacial transition age (c. 14,000–10,000 BP) is, however, fraught with difficulty. Consistency in age measurements is no longer taken to be an indication of reliability, for there appear to have been short-term, temporal variations in radiocarbon activity (Ammann and Lotter, 1989), and it has been argued that the radiocarbon timescale deviated significantly from the calendar timescale over the period concerned (Bard *et al.*, 1990). The various problems affecting the dating of Lateglacial and early Holocene deposits are reviewed by Lowe (1991) and Pilcher (1991). In view of these problems, the precise timing of events and the conflicts in interpretation of chronology cannot, at present, be satisfactorily resolved.

The Loch Lomond Readvance ice masses are generally thought to have decayed rapidly, within the space of a few hundred years. This means that it is difficult to use conventional radiocarbon dates to assess the pattern and timing of deglaciation in Scotland owing mainly to a lack of resolution in the method (standard error ranges of Lateglacial/early Holocene dates are commonly of the order of 200 to 300 years) (see also Price, 1983) and to the methodological problems mentioned above. Recently, however, it has been proposed that patterns of ice retreat can be inferred from contrasts between the pollen assemblages recorded in the basal sediments from depressions that lie within the Loch Lomond Readvance limits and which have received sediment from the time of deglaciation (Lowe and Walker, 1981; Tipping, 1988). First proposed by Pennington (1978) for sites in the English Lake District, the conclusions are based upon the recognition of a full stadial-early Holocene pollen-stratigraphic sequence at sites where deglaciation occurred early, whereas curtailed sequences (the earlier pollen assemblages are not represented) characterise sites in areas of delayed deglaciation. The Mollands site has proved crucial in this developing argument.

Using this approach, Lowe and Walker (1981) have concluded that climatic amelioration, which promoted widespread glacier retreat, resulted in an immediate response near the termini of long valley glaciers (such as at Mollands), but ice-melt was delayed in areas where the ice was thicker or closer to source catchments (for example, parts of Rannoch Moor – see Kingshouse). On the basis of a comparison of pollen spectra from basal samples at three sites in Glen More (Isle of Mull), Walker and Lowe (1985) have also proposed that a pattern of valley retreat of Loch Lomond Readvance ice can be deciphered. A more recent study of four sites in the Varragill-Sligachan valleys of Skye, which lay within the Loch Lomond Readvance limits, also indicates progressive icefront retreat (Walker *et al.*, 1988; Lowe and Walker, 1991). Tipping (1988), however, has sounded a note of caution about the general applicability of this approach, finding that sites along Loch Awe did not show progressive changes in the pollen sequences in the basal sediments from the sites he examined.

This methodology therefore offers the prospect of determining general patterns of regional ice decay in Scotland, and may enable the distinction of areas characterised by progressive ice-margin retreat from those characterised by widespread downwasting of ice. The Mollands site contains the most detailed and fullest Late Devensian–Holocene pollen record so far reported from Britain. It has the added interest that radiocarbon dates obtained from the basal sediments support the contention that ice retreat may have occurred early at some valley-

glacier termini as an immediate response to changes in glacier budgets.

The site offers one of the best resolutions of Holocene vegetational development reported from the south-east Grampians and adjacent lowlands, in particular in relation to the early Holocene part of the sequence. The biostratigraphic boundaries are distinct throughout, including the late Holocene 'Elm Decline'. The site appears to be located in what was an important ecotonal transition between the dominant mixed deciduous woodlands of the central lowlands of Scotland and the pine woods that dominated the Highlands (McVean and Ratcliffe, 1962). It is therefore an important reference site for the succession of Holocene pollen zones in the western Highland Boundary area.

Conclusions

Mollands is important in two main respects. First, the pollen grains preserved in the sediments provide a valuable and detailed record of vegetation history during the Holocene (last 10,000 years) in the west Highland boundary area, an important ecological zone of transition between the Highlands and Central Lowlands. Second, Mollands is important for establishing the timing of Loch Lomond Readvance deglaciation and, together with Tynaspirit, for establishing a chronological sequence of ice advance and retreat in the Callander area during the latter part of the last ice age.

Reference list

- Ammann, B. and Lotter, A.F. (1989) Late-Glacial radiocarbon and palynostratigraphy on the Swiss plateau. *Boreas*, **18**, 109–26.
- Bard, E., Hamelin, B., Fairbanks, R.G. and Zindler, A. (1990) Calibration of the 14C timescale over the past 30,000 years using mass spectrometric U-Th ages from Barbados. *Nature*, **345**, 405–10.
- Browne, M.A.E. and Graham, D.K. (1981) Glaciomarine deposits of the Loch Lomond stage glacier in the Vale of Leven between Dumbarton and Balloch, west-central Scotland. *Quaternary Newsletter*, **34**, 1–7.
- Godwin, H. (1975) *The History of the British Flora*. Cambridge, Cambridge University Press, 541pp.
- 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.
- Hibbert, F.A., Switsur, V.R. and West, R.G. (1971) Radiocarbon dating of the Flandrian pollen zones at Red Moss, Lancashire. *Proceedings of the Royal Society of London*, **B177**, 161–76.
- Lowe, J.J. (1977) Pollen analysis and radiocarbon dating of Lateglacial and Early Flandrian deposits in southern Perthshire. Unpublished PhD thesis, University of Edinburgh.
- Lowe, J.J. (1978) Radiocarbon-dated Lateglacial and early Flandrian pollen profiles from the Teith Valley, Perthshire, Scotland. *Pollen et Spores*, **20**, 367–97.
- Lowe, J.J. (1982a) Three Flandrian pollen profiles from the Teith Valley, Perthshire, Scotland. I. Vegetational history. *New Phytologist*, **90**, 355–70.
- Lowe, J.J. (1982b) Three Flandrian pollen profiles from the Teith Valley, Perthshire, Scotland. II. Analysis of deteriorated pollen. *New Phytologist*, **90**, 371–85.
- Lowe, J.J. (1991) Stratigraphic resolution and radiocarbon dating of Devensian Lateglacial sediments. In *Radiocarbon Dating: Recent Applications and Future Potential* (ed. J.J. Lowe). Quaternary Proceedings No. 1. Cambridge, Quaternary Research Association, 19–25.
- 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.
- Lowe, J.J. and Walker, M.J.C. (1980) Problems associated with radiocarbon dating the close of the Lateglacial period in the Rannoch Moor area, Scotland. In *Studies in the Lateglacial of North-west Europe* (eds J.J. Lowe, J.M. Gray and J.E. Robinson). Oxford, Pergamon Press, 123–38.
- Lowe, J.J. and Walker, M.J.C. (1981) The early Postglacial environment of Scotland: evidence from a site near Tyndrum, Perthshire. *Boreas*, **10**, 281–94.
- Lowe, J.J. and Walker, M.J.C. (1984) *Reconstructing Quaternary Environments*. London, Longman, 389pp.

- Lowe, J.J. and Walker, M.J.C. (1991) Vegetational history of the Isle of Skye: II. The Flandrian. In *The Quaternary of the Isle of Skye. Field Guide* (eds C.K. Ballantyne, D.I. Benn, J.J. Lowe and M.J.C. Walker). Cambridge, Quaternary Research Association, 119–42.
- 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.
- Merritt, J.W. and Laxton, J.L. (1982) The sand and gravel resources of the country around Callander and Dunblane, Central Region. Description of 1:25,000 sheet NN60 and 70. *Mineral Assessment Report. Institute of Geological Sciences*, No. 121, 100pp.
- Merritt, J.W., Coope, G.R., Taylor, B.J. and Walker, M.J.C. (1990) Late Devensian organic deposits beneath till in the Teith Valley, Perthshire. *Scottish Journal of Geology*, **26**, 15–24.
- Peacock, J.D., Graham, D.K. and Wilkinson, I.P. (1978) Late-glacial and post-glacial marine environments at Ardyne, Scotland, and their significance in the interpretation of the history of the Clyde sea area. *Report of the Institute of Geological Sciences*, No. 78/17, 25pp.
- Peacock, J.D., Harkness, D.D., Housley, R.A., Little, J.A. and Paul, M.A. (1989) Radiocarbon ages for a glaciomarine bed associated with the maximum of the Loch Lomond Readvance in west Benderloch, Argyll. *Scottish Journal of Geology*, **25**, 69–79.
- Pennington, W. (1978) Quaternary geology. In *The Geology of the Lake District* (ed. F.M. Moseley). Leeds, Yorkshire Geological Society, Occasional Publication No. 3, 207–25.
- Pilcher, J. (1991) Radiocarbon dating for the Quaternary scientist. In *Radiocarbon Dating. Recent Applications and Future Potential* (ed. J.J. Lowe). Quaternary Proceedings No. 1. Cambridge, Quaternary Research Association, 27–33.
- Price, R.J. (1983) *Scotland's Environment During the Last 30,000 years*. Edinburgh, Scottish Academic Press, 224pp.
- Rose, J., Lowe, J.J., Switsur, R. (1988) A radiocarbon date on plant detritus beneath till from the type area of the Loch Lomond Readvance. *Scottish Journal of Geology*, **24**, 113–24.
- Sissons, J.B., Lowe, J.J., Thompson, K.S.R. and Walker, M.J.C. (1973) Loch Lomond Readvance in the Grampian Highlands of Scotland. *Nature Physical Science*, **244**, 75–7.
- Smith, A.G. and Pilcher, J.R. (1973) Radiocarbon dates and vegetational history of the British Isles. *New Phytologist*, **72**, 903–14.
- Sutherland, D.G. (1980) Problems of radiocarbon dating deposits from newly deglaciated terrain: examples from the Scottish Lateglacial. In *Studies in the Lateglacial of Northwest Europe* (eds J.J. Lowe, J.M. Gray and J.E. Robinson). Oxford, Pergamon Press, 139–49.
- Sutherland, D.G. (1984a) The Quaternary deposits and landforms of Scotland and the neighbouring shelves: a review. *Quaternary Science Reviews*, **3**, 157–254.
- Thompson, K.S.R. (1972) The last glaciers in western Perthshire. Unpublished PhD thesis, University of Edinburgh.
- Tipping, R. (1988) The recognition of glacial retreat from palynological data: a review of recent work in the British Isles. *Journal of Quaternary Science*, **3**, 171–82.
- Walker, M.J.C. and Lowe, J.J. (1980) Pollen analyses, radiocarbon dates and the deglaciation of Rannoch Moor, Scotland, following the Loch Lomond Advance. In *Timescales in Geomorphology* (eds R.A. Cullingford, D.A. Davidson and J. Lewin). Chichester, John Wiley, 247–59.
- Walker, M.J.C. and Lowe, J.J. (1982) Lateglacial and early Flandrian chronology of the Isle of Mull, Scotland. *Nature*, **296**, 558–61.
- Walker, M.J.C. and Lowe, J.J. (1985) Flandrian environmental history of the Isle of Mull, Scotland. I. Pollen-stratigraphic evidence and radiocarbon dates from Glen More, south-central Mull. *New Phytologist*, **99**, 587–610.
- Walker, M.J.C., Ballantyne, C.K., Lowe, J.J. and Sutherland, D.G. (1988) A reinterpretation of the Lateglacial environmental history of the Isle of Skye, Inner Hebrides, Scotland. *Journal of Quaternary Science*, **3**, 135–46.