Mollands

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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 628 068] 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 636 068] to [NN 644 064]) and on both banks of the River Teith downstream of the site of Callander Castle ([NN 632 075] to [NN 635 073] and [NN 632 073] 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 Callan-der (see Sissons *et al.,* 1973; Lowe and Walker, 1977 for details of methodology).

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).

Interpretation

The vegetational succession (Figure 13.10) that can be inferred is one of successive plant colonization of the slopes around the site from initially bare, stoney surfaces to a woodland cover. The lowermost pollen zone (Mo a 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 stoney surfaces free of competition from shrub and woodland associations. The zones Mo a II to Mo c 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 at 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 colonization appears to have been well under way in southern Perthshire by 9365 ± 120 BP (Hv–5645), an age estimate that compares favourably with that of 9260 ± 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 Mo b to Mo e) 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 Mo f to Mo g) 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 Mo g/Mo h boundary, suggesting an age for this part of the record of about 5000 BP (Hibbert *et al.,* 1971; Smith and Pilcher, 1973; Godwin, 1975). Zone Mo h is characterized 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 5000 BP onwards (Lowe, 1982a).

The principal points to emerge from the studies completed at Mollands so far, excluding the vegetational history which has been summarized 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 638 051] (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 BP 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 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 (Hy–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 time-scale deviated significantly from the calendar time-scale 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 de-glaciation occurred

early, whereas curtailed sequences (the earlier pollen assemblages are not represented) characterize 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 ice-front retreat (Walker *et al.,* 1988; Lowe and Walker, 1991; Benn *et al.,* 1992). 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.

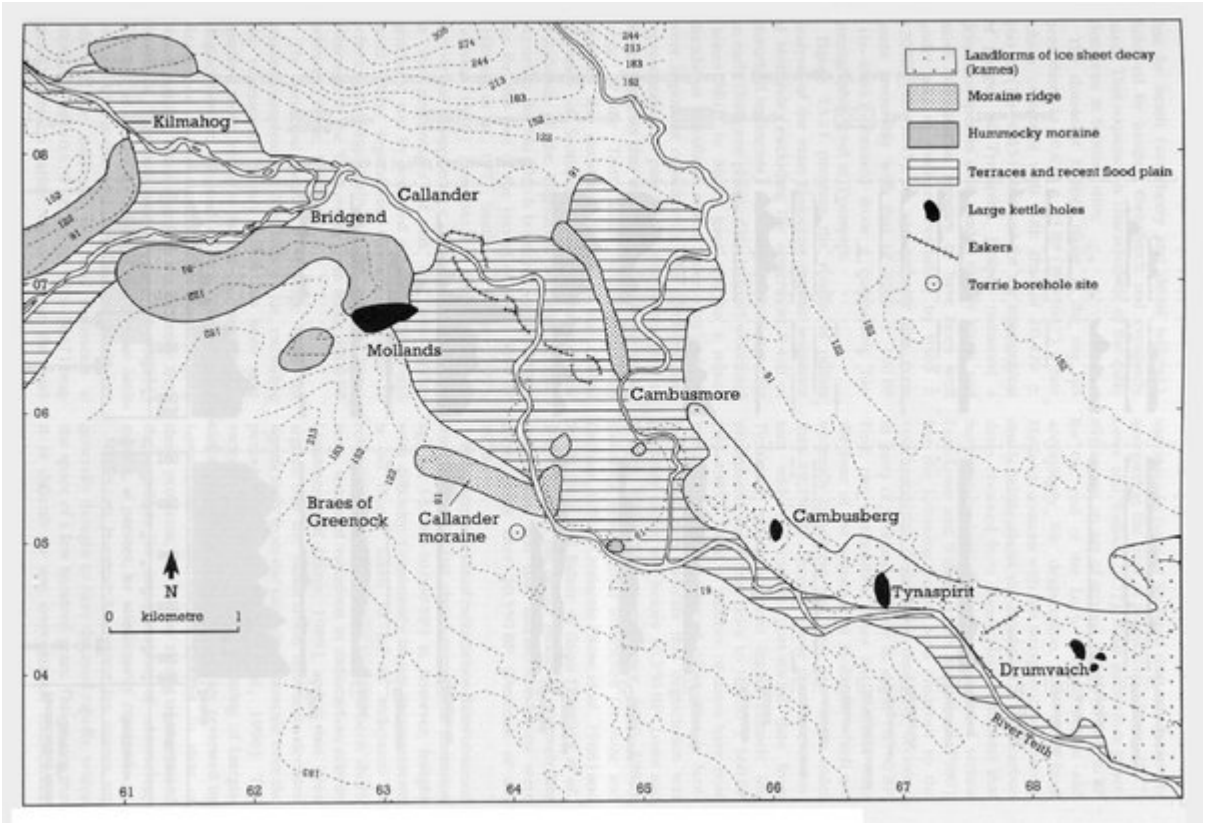
This methodology therefore offers the prospect of determining general patterns of regional ice decay in Scotland, and may enable the distinction of areas characterized by progressive ice-margin retreat from those characterized by widespread downwasting of ice. The Mollands site contains the most detailed 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.

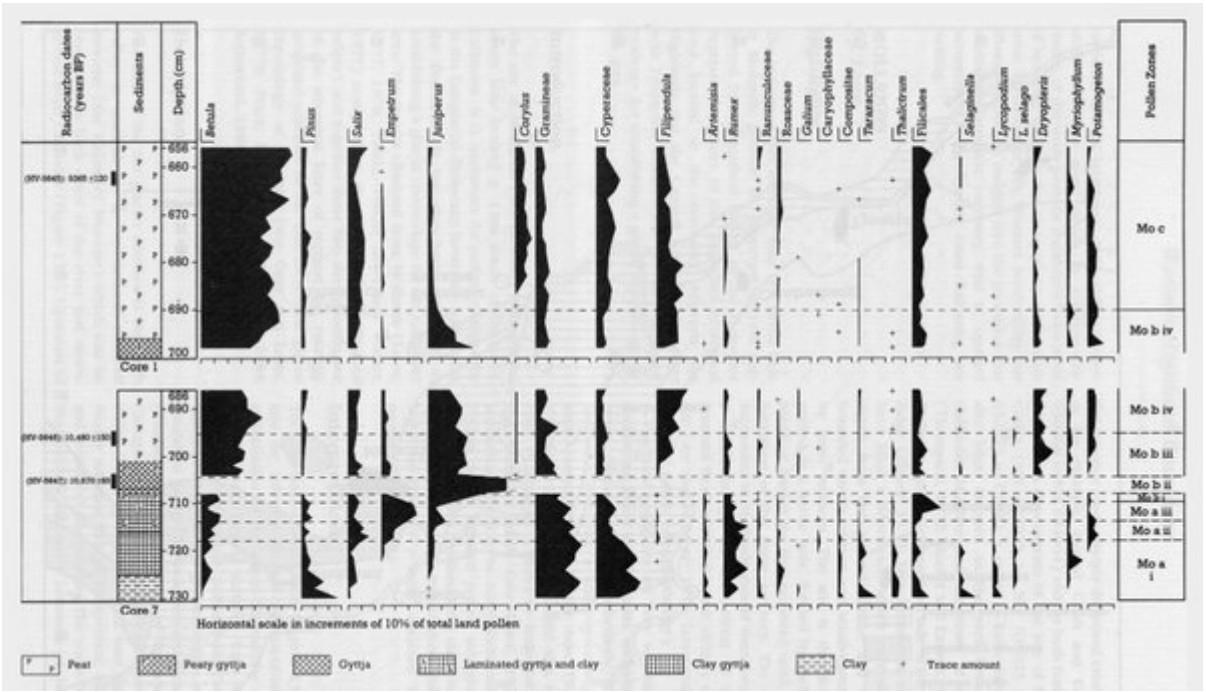
Conclusion

Mollands is important in two main respects. First, the pollen grains preserved in the sediments provide a valuable and detailed record of vegetational 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.

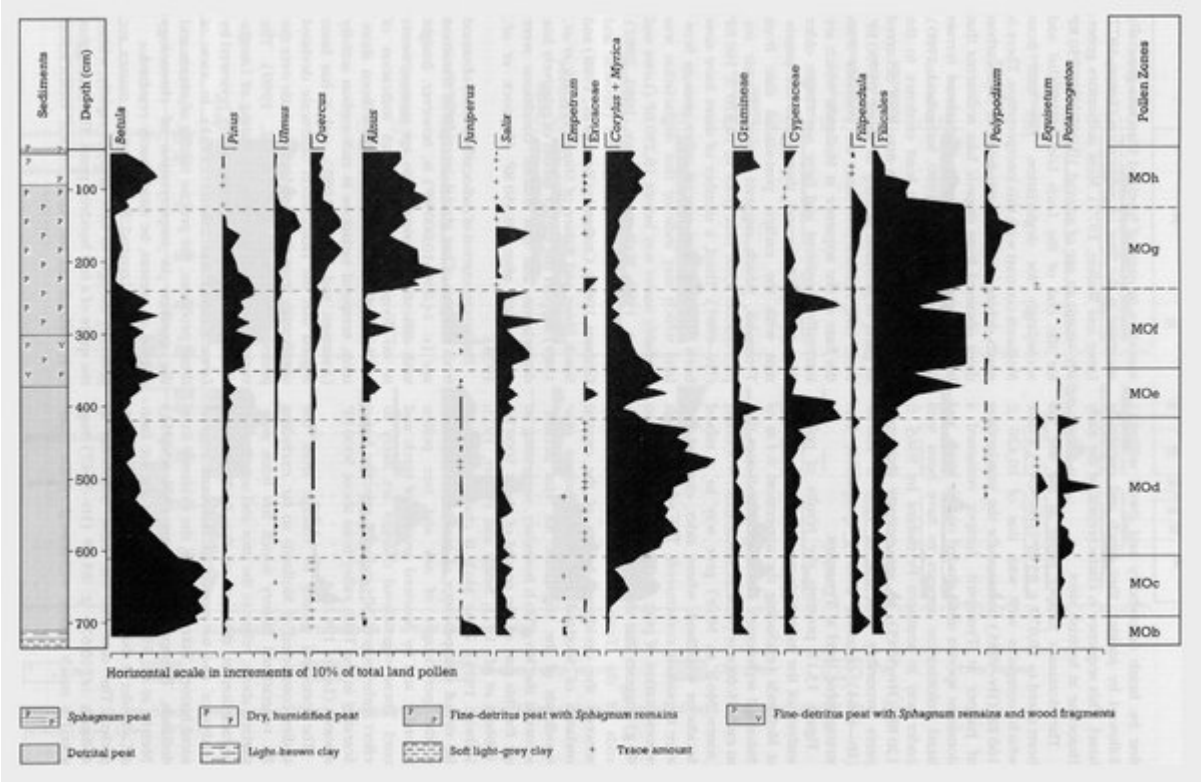
References



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



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



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