BLACK LOCH

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Highlights

The sediments which infill the topographical basin at Black Loch have provided a great wealth of information on the palaeoecological and palaeoenvironmental changes in eastern Scotland during the Lateglacial and Holocene. Variations with depth in pollen content and type in the sediments have been studied in considerable detail, and extensive use has been made of radiocarbon dating, so that Black Loch is an indispensable reference site for future work in this field.

Introduction

Black Loch (NO 261150) lies in the Ochil Hills of northern Fife at an altitude of 90 m O.D. It has a relatively small surface area (0.015 km^2) and a maximum depth of approximately 3 m. The sediments of Black Loch have been accumulating since Late Devensian times and their pollen and spore records have proved to be of considerable interest for the vegetation history of eastern Scotland (Whittington *et al.*, 1990, 1991a). No site comparable to this has been investigated in Fife (although the detailed study at Pickletillem (Whittington *et al.*, 1991b) is worthy of note), but of greater importance than this purely regional consideration is the fact that eastern Scotland in general is poorly served by sites which can contribute to an understanding of the vegetation history on the national scale. Thus the sediments of Black Loch provide a potential link between the vegetation histories described from the areas to the north in Aberdeenshire (such as at Loch Davan and Braeroddach Loch, Edwards, 1978), the north-west in Perthshire (Stormont Loch, Caseldine, 1980a) and those to the south-east (for example, Newey, 1965b; Hibbert and Switsur, 1976; Mannion, 1978a).

Description

The sediments at Black Loch comprise a succession of clays and detritus muds (Figure 15.7). A representative relative pollen diagram showing selected pollen and spore taxa (Figure 15.7) is based on data from one of four cores which was 7.0 m in length taken in 3.0 m of water. There are 14 radiocarbon dates (SRR–2613 to SRR–2626) for the profile which features both Lateglacial and Holocene age deposits. In addition there are a further eleven radiocarbon dates (UB–2290 to UB–2300) from a second core. The vegetation history is based on the information available from all four cores.

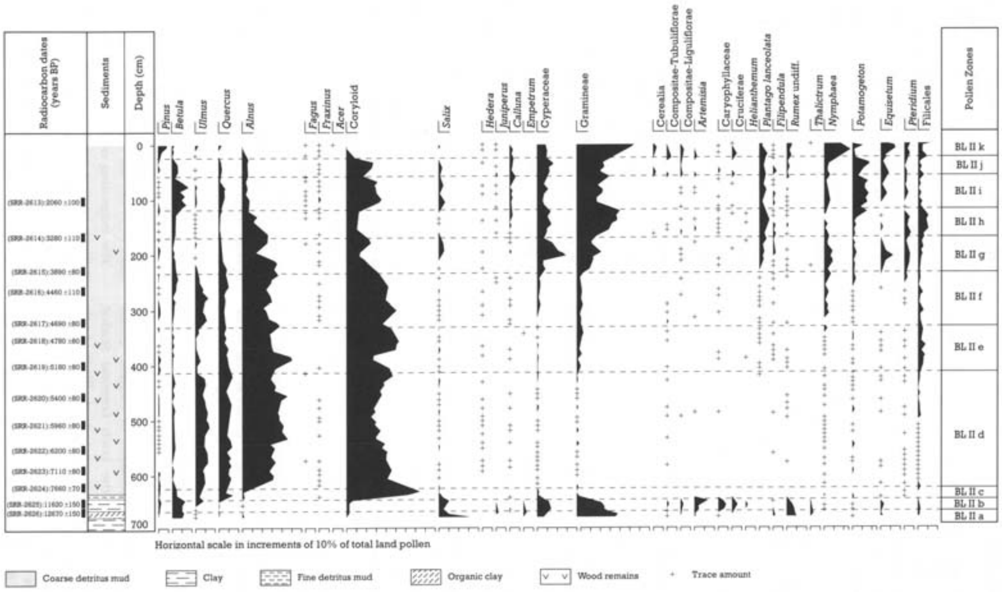

Figure 15.7: Black Loch: relative pollen diagram at coring site BL II showing selected taxa as percentages of total land pollen (from Whittington et al., 1990). Cannabis sativa is not represented in this diagram but in the other cores occurs in zones equivalent to BL II j.

Interpretation

The basal sediments (clay) of Black Loch are not polleniferous, but at some time before 12,670 + 150 BP (SRR–2626; determination on organic clay) pollen and spore taxa indicate the presence of a cold-climate vegetation pattern dominated by Gramineae and *Salix* with contributions from Cyperaceae, Caryophyllaceae, *Artemisia*, *Selaginella selaginoides,* and *Lycopodium* clavatum. Present also is the pollen of *Koenigia islandica*, a taxon often found in the Lateglacial deposits of sites in the west of Scotland; its presence here shows that it was probably common to the whole of Scotland at this time.

The widespread effect of the lowering of temperatures during the Loch Lomond Stadial is confirmed by the pollen taxa for this period at Black Loch (pollen zone BLIIb), and the features generally described for Stormont Loch (Caseldine, 1980a) and at Pickletillem (Whittington *et al.*, 1991b) are reproduced. Conditions of extreme soil instability affected the vegetation and those, together with the restricted growing season, led to a ground cover which principally included *Empetrum nigrum*, *Juniperus communis*, Compositae, *Artemisia*, Caryophyllaceae, Cruciferae, *Rumex*, and *Thalictrum*.

Following the amelioration of climatic conditions at the end of the Loch Lomond Stadial, *Betula* pollen totals increased at Black Loch, indicating the presence of birch woodland. The isochrone map of Birks (1989) suggests that this vegetation stage dates to around 10,000 BP in Fife and the Black Loch pollen diagrams add support to this. By approximately 9000 BP the immigrating *Corylus avellana* had achieved a dramatic rise (pollen zone BLIIc). This timing is later than that of *c.* 9350 for Pickletillem and lies between the date of 9300 BP for southern Scotland (Hibbert and Switsur, 1976) and that of 8700 BP for the central Grampians (Birks and Mathewes, 1978). Other extrapolated dates for Fife are closer to the central Grampians date (for example, 8640 BP at Creich, Cundill and Whittington, 1983; 8690 BP for Loch Rossie in the Howe of Fife, P.R. Cundill, unpublished data).

As elsewhere in eastern Scotland the domination of the vegetation by arboreal taxa reached an important stage with the arrival of *Ulmus* and *Quercus*. At Black Loch, *Ulmus* appears to have expanded at the same time as *Corylus*, whereas *Quercus* made a later entry. The pollen spectra indicate that a mixed deciduous woodland of *Ulmus* and *Quercus*, along with *Betula* and *Corylus*, existed around Black Loch from approximately 8500 BP; isochrone maps (Birks, 1989) had suggested that such a tree cover did not come into being until after 8000 BP.

Relative *Pinus* pollen values at Black Loch were low throughout the Holocene but increased to about 8% after the *Ulmus* and *Quercus* rise. Bennett (1984) has argued that where *Pinus* values are below 20% of total pollen, pine trees did not grow locally and where deciduous woodland dominated by *Quercus* and *Corylus* occupied an area, *Pinus* could not compete successfully. Thus the presence of *Pinus* pollen at Black Loch at this time would have to be attributed to wind transport, but a major problem exists in finding a source which could have provided such a consistent and large volume of pollen. The pine expansion at Black Loch is dated to before 8000 BP, which is earlier than dates given by O'Sullivan (1976) and Huntley and Birks (1983) for the major development of pine in upland areas to the north and south of Fife. Thus it appears that a more local source needs to be found and one might be provided by the stretch of glaciofluvial sands in the Howe of Fife which lies several kilometres to the south of Black Loch. This would parallel the situation predicated by Birks (1972a) for south-west Scotland.

The beginning of the middle Holocene period at Black Loch is associated with a marked change in the woodland composition (pollen zone BLIId). *Alnus* becomes a major component and it seems to have taken about 400 radiocarbon years to achieve its main expansion. Again, the importance of Black Loch as a source of evidence for an understanding of the vegetation history of Scotland is underlined because the main *Alnus* rise is dated here to near 7300 BP, a date which is earlier than most others from Scotland, for example, around 6800 BP for southern Scotland (Hibbert and Switsur, 1976) and 6200 BP for western Scotland (for example, Birks, 1972a; Pennington *et al*., 1972; Williams, 1977). The relative isolation of Fife flanked by the Firths of Forth and Tay, and the attendant widespread development of estuarine conditions, could well have encouraged an earlier migration of *Alnus* into eastern Scotland (compare Smith, 1984) but this is difficult to reconcile with a date of *c.* 6500 BP for the main alder rise at the near coastal site of Pickletillem. Interpreting the spread of alder in the British Isles is, however, a notoriously difficult process (Chambers and Elliot, 1989; Bennett and Birks, 1990).

Signs of anthropogenic impact on the middle Holocene vegetation (Edwards and Ralston, 1984) have not been discovered at Black Loch. This was the period of densest forest cover at the site, with samples yielding non-arboreal pollen values frequently below 5% of total pollen.

Around 5180 + 80 BP (SRR–2619) a decline occurred in *Ulmus* pollen, accompanied by the appearance of *Plantago lanceolata* and increased values for Gramineae. The dating of these events is in accordance with those to the south (for example, 5390 BP at Din Moss, Hibbert and Switsur, 1976) and to the north (for example, 5295 BP and 5105 BP respectively at Braeroddach Loch and Loch Davan, Edwards, 1978). It is probable that human interference with the vegetation occurred at this time, a suggestion supported by the first appearance of cereal-type taxa, but natural explanations (disease, climate change) are not disproved. There is no evidence for a widespread environmental disturbance at this elm decline; the chemical and particle size analysis of the loch sediments also indicate this (Whittington *et al*., 1991c).

Above the level of this elm decline, the pollen values for *Ulmus* and *Quercus* are reduced and Gramineae and *Plantago lanceolata* values rise (pollen zone BLIIe). Taken together with an increased sediment accumulation rate (from 0.125 cm a-1 to a profile maximum of 0.333 cm a-1) and a sharp increase in clastic inputs, there would appear to have been a period of considerable environmental disturbance around the Loch. Subsequently *Ulmus* pollen totals recovered to pre-elm decline values (pollen zone BLIIf) and are matched by a decrease in sedimentation rates. This apparent return to vegetation conditions of the period before 5180 BP was brought to an end between 4460 + 110 BP (SRR–2616) and 3890 + 80 BP (SRR–2615), when a second major *Ulmus* decline occurred. This is accompanied in the samples by a fall in *Quercus* values, increased frequencies of herbaceous taxa, (especially Gramineae, Cyperaceae, *Plantago lanceolata* and the re-appearance of cereal-type pollen) and a rise in values for the spores of *Pteridium aquilinum* and *Equisetum*. (In core BLII only, a partial recovery of elm, followed by a minor decline, takes place at the 5070 BP and 4090 BP levels respectivly; this event, intermediate between the two major *Ulmus* declines, is discussed fully elsewhere – Whittington *et al*., 1991c).

Black Loch's importance as a site for demonstrating the vegetational history of this part of the Holocene is intimately bound up with the events associated with the apparent behaviour of *Ulmus*. Following the first decline of elm the area experienced vegetational disturbance, although it is unlikely, if solely of anthropogenic origin, that it was a discrete event, but rather an amalgam of different periods of human activity. The recovery of *Ulmus* pollen levels at 4690 + 80 BP (SRR–2617) presumably indicates a reduction in cultural activity (or a cessation of natural limiting factors) which lasted until the second major *Ulmus* decline. Those events occurred at other sites in Britain and western Europe although their marked collective nature at Black Loch, as at the Welsh site of Waun-Fignen-Felen (Smith and Cloutman, 1988), puts the site in the forefront of the continuing controversy and discussion regarding the cause (or perhaps more accurately the causes) of the repeated sudden demise of *Ulmus* (Janssen and Ten Hove, 1971; Tolonen, 1980; van Zeist and Spoel-Walvius, 1980; Sturlurdottir and Turner, 1985; Aaby, 1986; Hirons and Edwards, 1986; Perry and Moore, 1987).

After the second *Ulmus* decline the main vegetational characteristics at Black Loch were clearly related to an intensification of human activity (pollen zones BLIIg and h). Pollen of arboreal taxa decline continuously and overall, being replaced reciprocally by expansions, in particular, in Gramineae, Cyperaceae, *Plantago lanceolata*, and *Rumex*. The presence of the light-demanding *Fraxinus excelsior* denotes the existence of open ground and the identification of Hordeum-type cereal pollen is an indication of the reasons for the clearance of the woodland. Such events are usually recorded in pollen records from eastern Scotland, but the fine resolution possible due to the great depth of sediment (7.52 m after 3750 BP in the lake-centre core I) has allowed the identification of a phase of interruption in the progressive destruction of woodland. During the period which appears to correlate with the Roman incursion into Scotland (pollen zone BLIIi) there was a recovery (reflected in the relative and concentration pollen levels) of *Quercus*, *Ulmus* and Coryloid, with a concomitant decline in *Calluna vulgaris*, Gramineae, *Plantago lanceolata*, and *Pteridium aquilinum*. This evidence tends to confirm a similar event recorded in Loch Davan and Braeroddach Loch in Aberdeenshire (Edwards, 1978). Thereafter by 1429 BP, woodland was once more in retreat, agriculture was re-established, and the pollen spectra reveal a continuous curve for cereal-type pollen, not only of Hordeum-type, but also of Avena/Triticum-type. Chemical analyses of the sediments show increasing erosional activity, suggesting that the level of arable agriculture was becoming more intense.

By 1000 BP the vegetation history at Black Loch enters its final stage, but one which shows two phases (pollen zones BLIIj and k). The first, approximately 1000–400 BP, continues the woodland shrinkage, apart from *Alnus* and *Salix* which survived in the carr at the edge of the loch. The pollen spectra record the strongest representation, in both relative and concentration terms, of Compositae, Cruciferae, *Plantago lanceolata*, *Artemisia*, Umbelliferae, and *Calluna vulgaris*.

A feature which attests to the importance of Black Loch in tracing vegetational change in Fife in particular, and in eastern Scotland in general, occurred near the beginning of this period. There is a sudden, strong (up to 12% TLP) and maintained presence of Cannabinaceae pollen. Such pollen can be derived from *Humulus lupulus*, which occurs naturally in fenland, or from *Cannabis sativa* which appears to have been introduced into Britain by the Romans. A more secure method now exists (Whittington and Gordon, 1987) for the separation of these two taxa and at Black Loch it is the latter which provides the majority (up to 70% at some levels) of the pollen. From around 1000 to 825 BP the growing of hemp, presumably for its useful fibres (Whittington and Edwards, 1990), must have added a distinctive aspect to the vegetation of the Black Loch area (Edwards and Whittington, 1990), providing the introduction of an alien vegetation component, to which might also be added *Juglans regia* (walnut). The growth of *Cannabis sativa* may have received encouragement from the Anglo-Norman penetration of Fife, a period which also witnessed the founding of a Tironesian abbey near Black Loch. The innovatory farming techniques of the monastic community could well have led to the intensification of arable practice which is revealed by the strong presence in the pollen spectra of cereal-type pollen, whereas the pastoral activities probably brought about the appearance of the pollen of *Vicia cracca* and *Trifolium* types. The increase in pollen influx rates and the sediment chemistry evidence indicate that throughout this period there must have been a continuing removal of the naturally occurring vegetation species and their replacement with cultigens and ruderals following upon increased ploughing activity.

In early modern and succeeding times, the agricultural modifications were maintained but appear to intensify. Again the fine resolution obtainable at Black Loch reveals quite clearly the marked impact on the vegetation engendered by changed attitudes to land management. The most striking feature lies in the re-establishment of arboreal species. The creation of coniferous plantations is marked by the sudden resurgence of *Pinus* pollen, to be followed by the appearance of such introduced species as *Abies*, *Larix* and *Picea*. The desire to beautify the landscape led to the planting of *Fagus* and encouraged a greater representation of *Ulmus* and Fraxinus.

In terms of unravelling the vegetational history of Scotland, the pollen spectra established from analysis of cores from Black Loch help to fill a large gap. Not only are pollen records from the Late Devensian to the present day not frequent in eastern Scotland, but the investigations undertaken at Black Loch have a base of multiple coring, frequent radiocarbon dating and sedimentological analysis; such a methodology enables corroborative checks to be made upon the representativeness of each core studied, while the differences between them provide important indications of taphonomic and spatial variability. The findings have confirmed in some instances the results of investigation at other sites (see Din Moss, Stormont Loch and other sites mentioned above). In others they have shown that the isopollen and isochrone maps for Scotland can now be further refined; a mixed deciduous woodland was present locally for at least 500 radiocarbon years before predicted, a local source for *Pinus* is suggested, and *Alnus* expanded some 500 radiocarbon years earlier than suggested by the mapping exercises. Above all, the findings reveal new aspects of the change and development of the vegetational history in Fife, in particular, and eastern Scotland in general. Of considerable interest in this connection is the existence of a multiple elm decline which continues to fuel the debate surrounding the frequently marked, but solitary, fall in *Ulmus* pollen values at *c.* 5100 BP, and the expansion of *Cannabis* pollen at *c.* 1000 BP, which denotes the probable cultivation of hemp within the local agricultural economy.

Conclusions

Black Loch is a key reference site, providing a record of the vegetation history in eastern Scotland from the time of melting and shrinkage (deglaciation) of the last ice sheet (around 13,000 years ago) up to the present. Its pollen and sediments have been studied in great detail and have provided a wealth of palaeoenvironmental and palaeoecological information, supported by extensive use of radiocarbon dating. Black Loch is also an integral member of the network of sites for establishing the pattern of variations in vegetation history in eastern Scotland.

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