Bigholm Burn

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Highlights

The stream section at Bigholm Burn demonstrates a sequence of glacial, lacustrine and fluvial deposits, with interbedded organic sediments including peat. These sediments, together with the pollen and coleopteran records from the organic horizons, have provided important evidence for palaeoclimatic conditions and environmental change during the Lateglacial.

Introduction

This site [NY 316 812] comprises a stream section located on the east bank of Bigholm Burn, 6 km south-west of Langholm. It is important in providing sedimentary and biostratigraphic evidence for the Lateglacial and early Holocene environmental history of south-west Scotland. The key interest includes assemblages of fossil Coleoptera, which, together with those from Redkirk Point and other sites in the region, reveal a significantly different pattern of Lateglacial climatic change to that suggested by pollen evidence: the mildest climate occurring about 13,000 BP, followed by a progressive deterioration throughout the Lateglacial Interstadial, which led into the severe conditions of the Loch Lomond Stadial. The sequence of sediments at Bigholm Burn and their lateral variations have been described by Moar (1964, 1969b) and Bishop and Coope (1977).

Description

The sequence of sediments is as follows (Moar, 1969b; Bishop and Coope, 1977):

7. Peat, comprising sedge peat passing up into woody peat and blanket bog peat	up to 2 m
6. Brown organic mud uncomformably overlying bed 5	up to c. 0.5 m
5. Lenses of dark-grey silt	0.15 m
4. Poorly bedded, subangular gravels dipping north-west, locally incorporating blocks of peat and clay	up to 3 m
3. Folded sedge peat	0.32 m
2. Blue-grey clay	c. 0.2 m
1. Grey, pebbly and clayey till largely derived from local Silurian rocks	1.5 m exposed

This sequence of sediments is calibrated by seven radiocarbon dates (Godwin and Willis, 1964; Godwin *et al.,* 1965): 11,820 ± 180 BP and 11,580 ± 180 BP (Q–694) from the peat below the gravel (bed 3); 10,820 ± 170 BP (Q–695) from a block of peat incorporated in the gravel (bed 4); 9590 ± 170 BP and 9470 ± 170 BP (Q–697) from the organic mud in bed 6; 8650 ± 165 BP (Q–699) from the transition between sedge and woody peat in bed 7; 7735 ± 155 BP(Q–700) from the base of the woody peat in bed 7; 7640 ± 160 BP (Q–701) from the base of the woody peat in bed 7 above the previous sample, and 5475 ± 120 BP (Q–702) in the blanket bog above in bed 7.

Interpretation

Bishop (Bishop and Coope, 1977) interpreted the succession as beginning with the accumulation of fine-grained sediments (bed 2) and then sedge peat (bed 3) in pools in the till surface. The coarse angular gravel above (bed 4) represented solifluction deposits formed during the Loch Lomond Stadial. The weight of this gravel compressed the peat and caused it to buckle, and in places to rupture, so that blocks became incorporated into the gravels. The radiocarbon

date of 10,820 ± 170 BP on one such block may indicate the end of the period of peat formation, but could be too young owing to enrichment by percolation of humic acid from the peat above. Small ponds appeared on the gravel surface towards the end of the stadial, and organic silts (bed 5) accumulated. These were subsequently eroded by lateral migration of the stream that deposited the alluvial mud (bed 6). Again the radiocarbon age of the organic mud is probably too young, since the coleopteran remains indicate the presence of species that imply stadial conditions (see below). Peat (represented by bed 7) finally became established on the alluvial surface during the Holocene.

Recent observations (A. M. Hall and C. M. White, unpublished data) have added further details to the stratigraphy. Bed 1 is poorly exposed at the base of the section and is much better represented in stream sections *c.* 1 km downstream ([NY 322 815] and [NY 324 817]), where up to 2 m of grey till, with Silurian pebbles, rests on a similar thickness of red-brown till, with abundant clasts of red sandstone. Bed 2 shows fine horizontal lamination and passes downstream into laminated clays and silts, with drop stones, and interbedded sand and gravel bands with a total exposed thickness of *c.* 4 m (at [NY 324 817]). These deposits suggest that during ice retreat from the area, a small lake was ponded within the Bigholm valley and partially infilled by glaciolacustrine deposits. Bed 4 includes locally imbricate gravel horizons and cross- and flat-bedded sand lenses, indicating that it is a braided stream deposit. The occasional presence of sand clasts within the gravels demonstrates transport of frozen sand blocks. The silts of bed 5 may represent fine-grained overbank deposition.

Moar (1964, 1969b) investigated the pollen stratigraphy at Bigholm Burn as part of a wider study of Late Devensian and Holocene vegetational history in south-west Scotland. Pollen grains in the basal peat (bed 3) and the peat included in the gravel (bed 4) are representative of an open-vegetation assemblage (including Cyperaceae, Gramineae, Compositae, *Filipendula* and *Empetrum*)and compatible with a Lateglacial Interstadial age. Pollen grains in the silts (bed 5) above the gravels are from dominantly herbaceous plants of types associated with open, unstable habitats (for example, Cyperaceae, Gramineae, Compositae, Cruciferae, *Epilobium, Saxifraga oppositifolia* type, *Thalictrum, Artemisia* and *Koenigia*)and suggest that the deposit originated during the Loch Lomond Stadial. In the transition to the milder climate of the Holocene, pollen zone FI (lower part of bed 6) shows a rise in *Betula, Juniperus* and *Salix,* high frequencies of non-arboreal pollen and a remarkable development of aquatic types. *Betula is* dominant in zone FII (upper part of bed 6) and in the early part of zone FIII (bed 7) before being replaced by *Pinus, Ulmus, Quercus* and *Alnus.* Radiocarbon dates from the Holocene sediments at Bigholm Burn are comparatively younger than those for equivalent pollen zones at Scaleby Moss 21 km to the south-east (Godwin *et al.,* 1957) and may reflect rootlet penetration from above or contamination by humic acid percolation (Bishop and Coope, 1977).

The overall regional pattern of the vegetational history of south-west Scotland to emerge from Moar's work was one of open, treeless vegetation during the Lateglacial. The regional Lateglacial pollen zone I was dominated by Gramineae, Cyperaceae and *Rumex* together with dwarf shrubs. In zone II the vegetation became more stable and denser. Herbs remained dominant, and shrubs increased. Zone III was characterized by a sharp increase of open, unstable habitats. Open vegetation persisted at the start of the Holocene before the slow spread of birch woodland into the area and its subsequent dominance until partly replaced by mixed oak forest in Holocene zone *N.*

Coope (Bishop and Coope, 1977) investigated the assemblages of fossil Coleoptera in the organic layers at Bigholm Burn and other sites in the region. The assemblage from the lower peat (bed 3) at Bigholm Burn includes *Diacheila arctica* Gyll., *Agonum consimile* Gyll., *Hydrorous arcticus* Th., *H. longicornis* Sharp, *Ilybius angustior* Gyll., *Helophorous aquaticus* L, *H. flavipes* F., *Pycnoglypta lurida* Gyll., *Olophrum assimile* Payk., *O. fuscum* Gr. and *Stenus* spp. It closely resembles the assemblage from a broadly contemporaneous peat dated at 11,205 ± 177 BP (Birm–41) at Redkirk Point (see below), although there is some indication from a slightly higher representation of phytophagous species that the vegetation was more diverse at Bigholm Burn. The assemblage at Bigholm Burn has a definite northern chatacter, but the presence of two relatively southern species (*Eubrychius velutus* Beck. and *Gymnetron beccabungae*) suggests slightly less severe conditions than at Redkirk Point, with an average July temperature of about 12°C. A second sample from the organic silt (bed 5) yielded an impoverished fauna dominated by *Olophrum boreale* Payk., suggesting little or no plant cover and average July temperatures well below 10°C at the time of the Loch Lomond Stadial. This sample from Bigholm Burn demonstrates further climatic deterioration after deposition of the Redkirk Point sample dated at 10,898 ± 127 BP (Birm–40) and is the only one of stadial age in Scotland so far investigated for fossil Coleoptera.

The combined evidence from the assemblages of fossil Coleoptera at Bigholm Burn, Redkirk Point and other sites discussed by Bishop and Coope (1977), each covering a slightly different time period, suggests a pattern of Lateglacial climatic change in which temperatures rose to as warm as present by about 13,000 BP (or possibly later — cf. Atkinson *et al.,* 1987). Temperatures then fell sharply in two stages between about 12,500–12,000 BP and 11,000–10,500 BP, culminating in the Loch Lomond Stadial. The drop in July temperatures inferred from the coleopteran assemblages was as much as 6–7°C. At the end of the stadial a temperature rise of similar magnitude occurred within 700 years. This interpretation differs from the traditional view based on pollen analysis (see above) that the Lateglacial thermal maximum occurred during pollen zone II of the Jessen–Godwin Scheme, usually equated with the Allerød Interstadial between about 11,800 and 11,000 BP. The evidence from the Coleoptera, however, indicates that the thermal maximum was already past by this time and that temperatures were decreasing. Such a pattern is substantiated by similar studies elsewhere in Britain (see Coope, 1977; Atkinson *et al.*, 1987). It appears that vegetation recolonization at the end of the Late Devensian ice-sheet glaciation lagged behind the climatic changes. In contrast, the more mobile beetles responded more rapidly to the changing climate, and hence fossil coleoptera are more sensitive indicators of past climate change than are pollen assemblages (cf. Coope and Brophy, 1972; Coope, 1975, 1981; Coope and Joachim, 1980).

Bigholm Burn is an important locality for interpreting the Lateglacial and early Holocene environmental history of south-west Scotland. The sedimentary and biostratigraphic evidence complements that at Redkirk Point, particularly the fossil coleopteran assemblages. The deposits show:

1. the transition from cold conditions, accompanied by glacial and glaciolacustrine sedimentation, at the end of the Late Devensian glaciation to the establishment of temperate conditions during the Lateglacial Interstadial;
2. subsequent climatic deterioration culminating in the Loch Lomond Stadial, with accelerated mass movement, frost weathering and associated cold-climate fluvial activity;
3. climatic amelioration at the start of the Holocene.

Conclusion

Bigholm Burn is important for studies of environmental history during the final phase of the Late Devensian, the Lateglacial (approximately 13,000–10,000 years ago). Detailed study of the sequence of deposits, including analysis of the pollen and beetle remains they contain, has provided a vital record of Lateglacial environmental conditions and geomorphological changes in south-west Scotland. The evidence from the fossil beetles, in conjunction with that from Redkirk Point, is particularly significant in showing rapid climatic warming early in the Lateglacial, followed by a considerable climatic deterioration in two steps. Bigholm Burn forms a key part of the network of sites for establishing Lateglacial environmental conditions.

References