Chapter 14 Eastern Highland Boundary

Introduction

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The Eastern Highland Boundary region extends from west of Perth and the Tay Valley through Strathmore to Aberdeen (Figure 14.1). It incorporates the coastline from south of Montrose to Aberdeen. Glaciation of the area has been dominantly by ice originating in the western Highlands, with relatively little contribution from ice sources in the south-eastern Grampians. The eastern parts of the region are therefore located towards the periphery of the intensely glaciated zone and contain evidence of Pleistocene events pre-dating the Late Devensian; to the west the increasing intensity of glaciation has resulted in only deposits relating to the last phase of ice-sheet glaciation (the Late Devensian) being present. The region is important, too, for the development of vegetation during both the Lateglacial Interstadial and the Holocene as it is adjacent to the Highland Boundary Fault, one of the major topographical, geological and ecotonal boundaries in Scotland.

The eastern seaboard of the region contains a number of pre-Late Devensian landforms and deposits. The coast is flanked by two glaciated rock platforms, a higher one at around 23 m OD (Bremner, 1925b) and a lower one only slightly above present sea level (Synge, 1956). This latter platform is a clear feature at Milton Ness. The ages of the platforms are unknown. Evidence for glaciation prior to the Late Devensian is also preserved in the basal deposits at Nigg Bay (Bremner, 1934a; Synge, 1956, 1963; Chester, 1975) where the presence of erratics with a Norwegian origin points to an earlier glacial event with ice possibly moving onshore. This latter idea has also been suggested to explain shelly clays below till at Burn of Benholm and other neighbouring localities (Campbell, 1934).

An alternative explanation for these shelly deposits was advanced by Sutherland (1981a), who suggested that they may have formed from *in situ* marine clays deposited during the buildup of the last ice-sheet during the Early Devensian. More information is awaited on these deposits before their true nature is clear. Also at Burn of Benholm, lenses of peat have been found interbedded with the red till that overlies the shelly clays. Pollen analysis initially led Donner (1960) to hypothesize a Lateglacial age for the peat, and consequently that the enclosing till was soliflucted. However, radiocarbon dating indicated the age of the peat to be greater than 42,000 BP and Donner (1979) revised his interpretation, suggesting that the peat accumulated during a Middle or Early Devensian interstadial.

The great majority of the glacial deposits and landforms of the region have been interpreted as the product of the last ice-sheet. Armstrong *et al.* (1985) have provided evidence of two distinct phases of ice movement, an earlier period in which ice was directed towards the south-east and a later period when ice flowed towards the east-north-east. Sutherland (1984a) suggested that this reorientation of ice flow on the eastern side of Scotland was a result of the expansion of the Southern Uplands ice as the last glaciation progressed (see Chapters 15, 16 and 17). The east-north-east flow of ice originating in the south-west Highlands extended throughout the region and beyond the coast. It was sufficiently powerful to flow into the mouths of the Highland valleys such as Glen Clova and Glen Esk (Bremner, 1934b, 1936; Synge, 1956) and it left behind a characteristic red till. This till is well exposed at both Burn of Benholm and Nigg Bay and at the latter locality it overlies a grey till deposited by ice moving from the eastern Grampians, again indicating the relative timing and strengths of the two ice flows (cf. Chapter 8).

Deglaciation took place broadly from northeast to south-west, although large areas of 'dead' ice became isolated in the low ground of Strathmore and in the adjacent Highland valleys, giving rise to extensive areas of lames, kettle holes and eskers (Rice, 1959; Rose and McLellan, 1967; Paterson, 1974; Ellis, 1975; Insch, 1976; Armstrong *et al.,* 1985; Auton *et al,* 1988; Auton et al*,* 1990). Meltwater channels, both ice-directed and topographically controlled, occur extensively along the Highland margins (Bremner, 1925b, 1934b; Watson, 1945; Synge, 1956; Sissons, 1961a; Rose and McLellan, 1967; Ellis, 1975; Insch, 1976; Auton et al*,* 1988; Auton et al*,* 1990). The earliest area deglaciated was the eastern coast where a series of raised shorelines (Cullingford and Smith, 1980) was formed while ice decayed in the adjacent valleys. These shorelines are well exposed at Milton Ness and at Dryleys in the Montrose basin where their relationship to the fossiliferous Errol beds (Late Devensian estuarine sediments) has also been established. These shorelines are likely to have been formed between 17,000 BP and 14,000 BP (Sutherland, 1984a).

For some time after the deglaciation of the eastern coast the Tay estuary remained blocked by ice, and meltwater drainage was directed through the 'dead' ice in Strathmore. Eventually the ice in the Tay–Earn area receded and the sea flooded as far west as Crieff (Browne, 1980) and into the lower Tay valley to the north of Perth (Armstrong *et* al., 1985). This is thought to have occurred at about or slightly before 13,000 BP. The meltwater from decaying ice in the Highland valleys produced large outwash fans at the mouths of those valleys, extending considerable distances into the lowland area; for example, along the River North Esk (Sissons, 1967a; Paterson, 1974; Insch, 1976; Maizels, 1983a). The earliest interpretation of the sequences where these outwash deposits were found to overlie laminated estuarine sediments (Errol beds) was that they were the product of a major readvance of the ice-sheet, the Perth Readvance (Simpson, 1933; Sissons, 1963a, 1964). The classic section in such a sequence is at Almondbank. However, Paterson (1974) has demonstrated that it is not necessary to invoke a readvance to explain the stratigraphic sequence in this area. The only section that may indicate at least a local readvance of the retreating ice-sheet is at Shochie Burn.

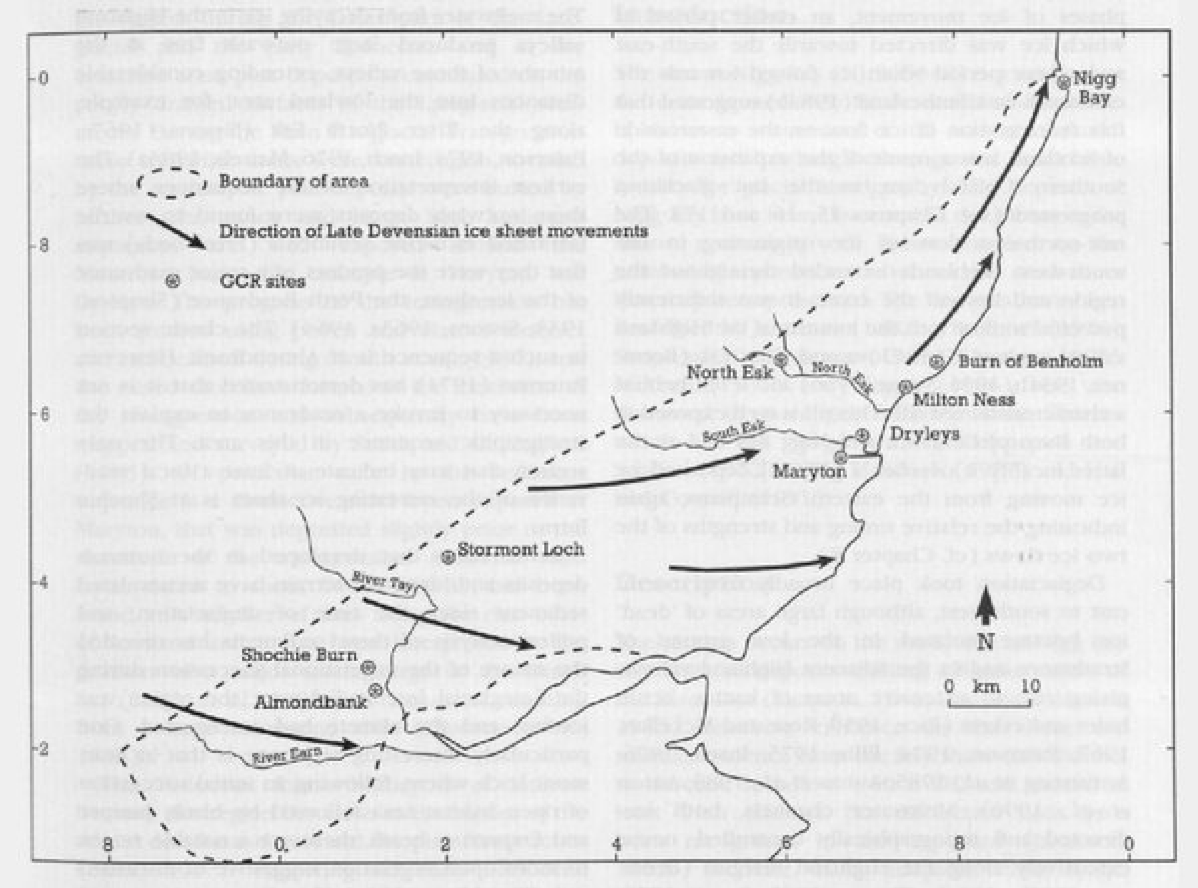
Kettle holes that developed in the outwash deposits and 'dead'-ice terrain have accumulated sediment since the time of deglaciation, and pollen analysis of these sediments has revealed the nature of the vegetational succession during the Lateglacial Interstadial once the region was ice-free and the climate had ameliorated. One particularly interesting sequence is that at Stormont Loch where, following an initial succession of open habitat taxa followed by birch, juniper and *Empetrum* heath, there was a notable return to more open vegetation suggestive of disturbed soils (Caseldine, 1980a). This distinct 'revertance' phase, which is not found in all Lateglacial pollen diagrams (Walker, 1984b; Tipping, 1991b), has been correlated with the Older Dryas 'chronozone' of the Scandinavian sequence. However, there is no radiocarbon evidence from Stormont Loch to support this correlation. Subsequent to this period, woody species again expanded, giving rise to a juniper-dominated heath with scattered copses of tree birches, the more typical vegetation of the Lateglacial Interstadial in this part of Scotland.

During the Loch Lomond Stadial there was a return to unstable soils, with a marked reduction in woody species and an increase in open-habitat species. There is an interesting trend in the values for pollen of *Artemisia* species during the stadial, from low values at the beginning to higher values in the latter part (Caseldine, 1980a). This has been interpreted as the result of a change from higher to lower precipitation as the stadial progressed.

Sea level was relatively low along the coasts of the region during the latter part of the Late-glacial and the early Holocene, and in the estuarine areas peat deposits accumulated on the poorly drained surfaces of the Lateglacial sediments. During the Main Postglacial Transgression these estuarine areas were once again invaded by the sea and the peat deposits were buried by further silts, sands and clays. Such sediment sequences are well exposed around the Montrose basin, for example at Maryton and Dryleys. The progress of the transgression has been studied using pollen and diatom analyses and radiocarbon dating (Smith *et al.,* 1980), and the raised shorelines formed at the maximum of the transgression and subsequently have been mapped and surveyed by Smith and Cullingford (1985). Of particular note in the sediment sequence is a distinctive sand layer, exposed at Maryton, that was deposited slightly prior to the maximum of the transgression. A similar sand layer, dated to about 7000–6800 BP, has been found at a number of sites along the east coast of Scotland and it has been interpreted as the product of a major storm surge in the North Sea (Smith *et al.,* 1985a) or a tsunami resulting from a large submarine slide (Dawson *et al.,* 1988).

The Holocene forest history is of interest because this region lies close to the border of the mixed deciduous forest and the pine forest zones (Birks, 1977). Following an early Holocene succession of juniper scrub to birch–hazel wood land, mixed deciduous forest with oak, birch and elm became established throughout most of the region, although pine may have occurred during the middle Holocene in edaphically favourable locations. Man's impact on the forests was initially recorded by the decline in elm at around 5000 BP.

References



(Figure 14.1) Location map of the Eastern Highland Boundary area.