Chapter 3 The Shetland Islands

Introduction

D.G. Sutherland and J.E. Gordon

The Shetland Islands (Figure 3.1) are located approximately equidistant from Norway and the mainland of Scotland, and at the junction of three distinct oceanic areas: the North Sea to the east and south-east, the Norwegian Sea to the north, and the Atlantic Ocean to the west. Their situation is thus critical both for the study of the extent of the Scandinavian and Scottish ice-sheets and for the derivation of terrestrial palaeoclimatic information that may be compared with the contrasting marine records from the surrounding seas. The importance of Shetland's location was recognized in the last century by Croll (1870a, 1875), who considered it possible that the islands had been glaciated by ice originating in Scandinavia rather than in Scotland. Peach and Horne (1879) sought to test Croll's hypothesis in the field. They interpreted an initial ice-sheet glaciation from an external source, possibly Scandinavia, followed by a phase of local ice-cap glaciation. These ideas have formed the basis of subsequent studies of the glaciation of Shetland (Sutherland, 1991b). Shetland is also notable for the preservation of two probable interglacial deposits which suggest that the local Quaternary stratigraphy may cover, albeit sporadically, approximately the last 400 ka (Sutherland, 1984a).

Organic deposits that are older than 13,000 BP and overlain by till are uncommon in Scotland (Sissons, 1981b; Lowe, 1984; Sutherland, 1984a; Bowen *et al.,* 1986). Two such deposits, probably interglacial in origin and probably dating from different Pleistocene stages, occur on the Mainland of Shetland. These two deposits, at Fugla Ness and Sel Ayre, have been studied in detail for both pollen and plant macrofossils (Birks and Ransom, 1969; Birks and Peglar, 1979). The plant assemblages contain several taxa that are now either extinct on Shetland or extinct in the British Isles. Even though the pollen assemblages are dominated by dwarf-shrub and herb pollen, comparisons with Holocene assemblages from Murraster, on the Mainland (Johansen, 1975), suggest that the Fugla Ness and Sel Ayre assemblages are interglacial (*sensu* Jessen and Milthers, 1928) in character. Numerical comparisons of the pollen spectra at Fugla Ness and Sel Ayre indicate that they differ in composition and that they are thus probably of different ages.

The site at Fugla Ness contains the earliest known Quaternary sequence in Shetland as well as the best documented, most northerly and one of the oldest interglacial deposits in Scotland. On the basis of the pollen content and plant macrofossil remains, Birks and Ransom (1969) suggested that the Fugla Ness peat may date from the Hoxnian, but the basis for this correlation is not secure (Lowe, 1984). Accepting that certain aspects of the pollen record imply a Middle Pleistocene age and that the thermophilous nature of the macrofossils indicates correlation with a period of very mild oceanic climate, Sutherland (1984a) suggested that the Fugla Ness peat may correlate with the event recorded in deep-sea cores at around 380 ka.

A further peat bed underlying till has been reported from Shetland, at Sel Ayre (Mykura and Phemister, 1976; Birks and Peglar, 1979). On the basis of its pollen content this peat has been tentatively assigned to the Ipswichian (Birks and Peglar, 1979), but both its interglacial status and its correlation with the Ipswichian may be questioned (Lowe, 1984). There is no information from Sel Ayre about glaciation prior to the deposition of the peat. However, the overlying till contains erratics of local sandstone as well as rare basic lavas which have been derived from the south-east (Mykura and Phemister, 1976). The ice that deposited this till may therefore be correlated with local ice-cap glaciation during the Late Devensian.

Investigations of the glacial history of Shetland have generated different interpretations of events (Coque-Delhuille and Veyret, 1988). Early studies (Hibbert, 1831; Peach, 1865a; Croll, 1870a; Helland, 1879) recorded the presence of striations and erratics, but until recently the definitive work on the glaciation of Shetland was that of Peach and Horne (1879) which was based on extensive field observations relating to roches moutonnees, striations, distributions of erratics and lithological variations in till composition. This evidence was interpreted as indicating ice movement from the North Sea towards the Atlantic, ice of Scandinavian origin possibly being deflected to the north-west by the presence of a Scottish ice-sheet further south. Evidence from striations and till lithologies on the eastern side of Shetland, together with morainic deposits in the valleys, was also used to demonstrate that local glaciers moved off the higher ground and into the valleys after the recession of the ice-sheet. Subsequently, in response to critical comments from Milne Home (1880b, 1881a, 1881b, 1881d), Peach and Horne (1881a, 1881b) elaborated both on the field evidence and their interpretation of it.

Since the paper by Peach and Horne (1879) the debate as to the nature of the last glaciation of Shetland and the relative importance of Scandinavian and local ice has been concerned almost exclusively with two types of evidence: striated and ice-moulded rock surfaces and the distribution of erratics (Figure 3.1). In assessing the influence of Scandanavian ice, Hoppe (1974) placed emphasis on an older set of striations occurring on and to the west of Bressay, which he considered to have been formed by ice flowing from the north-east. However, this interpretation of the sense of direction of some of these striations has been contradicted by Flinn (1977, p. 141). Hoppe inferred that during an early stage of glaciation Shetland was overridden by an ice-sheet from the east, probably from Scandinavia; during a later stage, a local ice-cap formed over the islands. Further, since the patterns of striations suggested progressive change in the ice movements, Hoppe concluded that both stages were of Late Devensian age. Following the ice maximum, rapid calving of the margin of the Scandinavian ice in the northern part of the North Sea led to the isolation of the local Shetland ice-cap.

Flinn (1977, 1978a) argued that the only evidence for the glaciation of Shetland by Scandinavian ice was in the southern part of the islands. There, westward transport of certain local rock types across the reconstructed ice shed of the later local ice-cap, at least as far as Foula, indicated that Scandinavian ice crossed the area during either a previous glaciation or an early phase of the last glaciation. It is also in this area, at Dalsetter, that the only Scandinavian erratic that has been found in Shetland occurs (Finlay, 1926). However, the history of transport of a single erratic may be complex (Hoppe, 1974). The westward transport of erratics has also been described from certain of the northern isles and here too the influence of Scandinavian ice has been invoked (Mykura, 1976).

The evidence for Scandinavian ice reaching Shetland is therefore rather weak and relates solely to the margins of the island group. In particular, it may be noted that no shelly tills or North Sea Basin erratics have been reported from Shetland, a situation in marked contrast to the eastern Orkney Islands. It may be concluded that if Scandinavian ice did cross the Shetland Islands, the evidence for this has been largely obliterated by the subsequent local glaciation(s). It is also clear that any such ice movements pre-dated the Late Devensian, since offshore studies have shown that the floor of the central North Sea was unglaciated at that time (Jansen, 1976; Flinn, 1978a; Cameron *et al.,* 1987; Sejrup *et al.,* 1987).

The distribution of most erratics and ice-moulded surfaces can be explained by a local icecap having covered the Shetland Islands, with ice flowing outwards from an ice shed located along the long axis of the islands. Since westerly-directed ice moulding and erratic transport on the western side of the islands is compatible with local as well as Scandinavian glaciation, more significance has been given to the evidence for eastward movement of ice on the eastern side of the islands. Such evidence includes, for example, the transport of erratics from the Mainland as far east as the Out Skerries (Mykura, 1976) and has been found along the length of the eastern Mainland and other islands.

All workers since Peach and Horne (1879) agree that Shetland has been glaciated by a local ice-cap, but the age and extent of this ice-cap have been the subject of debate. Although it is broadly agreed that the last phase of local ice-cap glaciation dates from the Late Devensian, direct evidence for this is lacking (Sisson, 1981b). If the Sel Ayre peat is indeed of Ipswichian age and the overlying till relates to the latest, local icecap, then this only indicates Devensian glaciation. It is generally accepted that the ice-cap extended on to the adjacent shelf, but in the north of the islands there is some recent evidence that the ice margin during the last glacial maximum may have been located relatively close inshore (Flinn, 1983; Long and Skinner, 1985).

Similarly, little is known about the mode and timing of retreat of the local ice-cap. A 'moraine belt' has been described from the western island of Papa Stour (Mykura and Phemister, 1976) but its significance is unclear. The absence of raised shorelines limits the possibilities for studying icecap retreat: Hoppe (1974), on the basis that striation patterns reflect calving during deglaciation, has suggested that the contemporaneous sea level was only 20–25 m lower than it is today, but this figure must be regarded as speculative. A minimum age for the termination of the local icecap is provided by radiocarbon dates on basal organic sediments resting on the glacial deposits. The oldest such date is 13,680 ± 110

BP (at Burn of Aith), but this is not critically linked to glacier retreat.

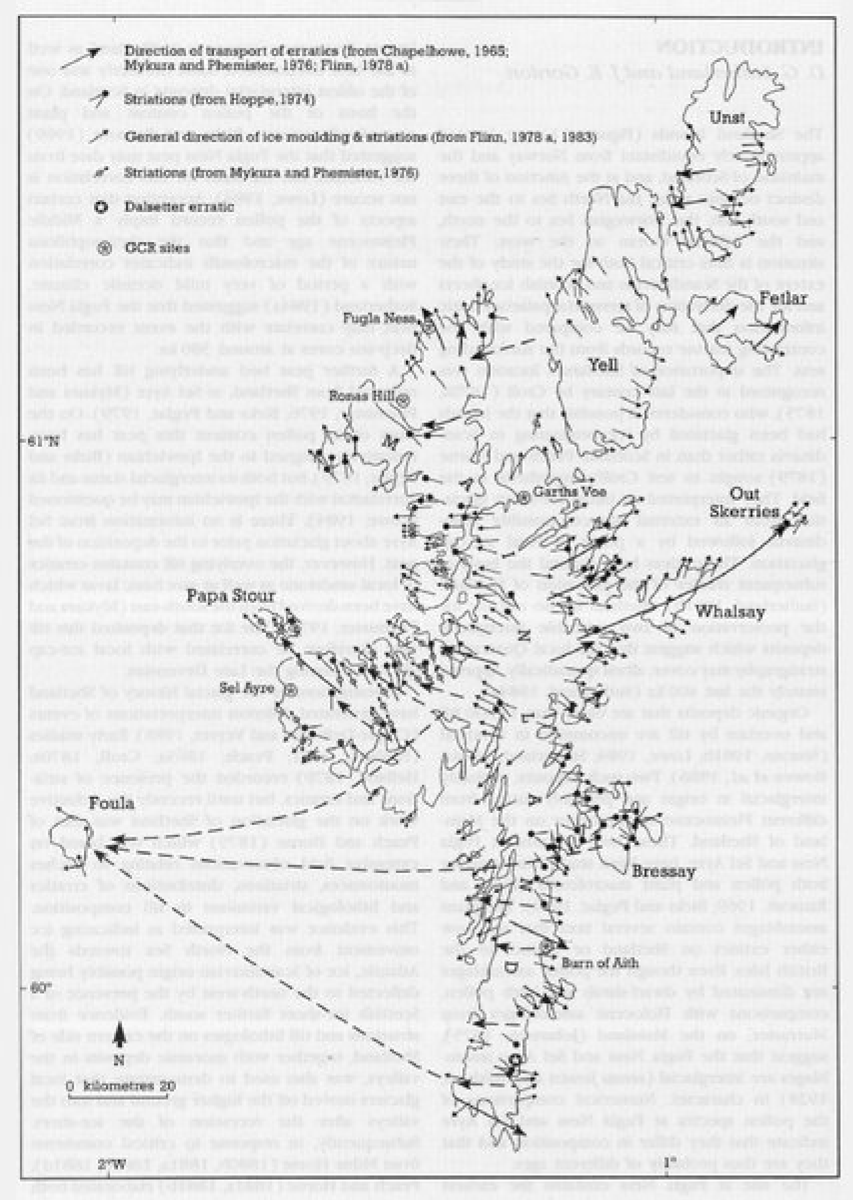
The only evidence for the vegetation history of Shetland during the Lateglacial comes from the detailed work of Birnie (1981) at the Burn of Aith. Her results suggest that a relatively mild phase occurred during the early Lateglacial Interstadial. During the middle part of the interstadial juniper and possibly some birch scrub was present on the islands prior to a return during the Loch Lomond Stadial to soil instability and a vegetation pattern dominated by open habitat species. Minor moraines have been described on some of the hills (Charlesworth, 1956; Mykura, 1976; Mykura and Phemister, 1976; Flinn, 1977) and attributed to the Loch Lomond Readvance, but which of these features are in fact moraines has been disputed among the authors quoted. Whichever interpretation is adopted, however, it is clear that the Loch Lomond Readvance was of very limited extent on Shetland.

In contrast, the Holocene vegetational history has been studied at a number of sites (Hawksworth, 1970; Johansen, 1975, 1978, 1985; Hulme and Durno, 1980; Birnie, 1981; Bennett *et al.,* 1992). Despite the early records of fossil wood within the peat on Shetland (Lewis, 1907, 1911), it was widely thought that Shetland had remained essentially treeless during the Holocene, a view supported by the relative scarcity of tree pollen (Erdtman, 1924). However, radiocarbon dating and pollen evidence from Garths Voe (Birnie, 1981, 1984) show beyond all doubt that during the middle Holocene there was a distinct phase when willow, birch or hazel developed widely. On Foula it seems probable that trees were restricted to sheltered areas (Hawksworth, 1970).

Shetland is also notable for certain periglacial landforms. Although the uplands seldom exceed 300 m in altitude, the highest area, Ronas Hill (450 m OD), has a notable range of both fossil and active periglacial features (Ball and Goodier, 1974). The original mountain-top detritus is likely to have been produced during the Late Devensian, but present activity, particularly influenced by the wind, is producing stripes, sand sheets ('dunes') and various types of terrace (Veyret and Coque-Delhuille, 1989). Elsewhere in Shetland, small, active stone stripes are present at 60 m OD on Keen of Hamar on Unst (Spence, 1957; Carter *et al.,* 1987).

The coastline of Shetland is essentially one of submergence (Flinn, 1974), but there have been few detailed studies of relative sea-level change. Submerged peat deposits are common (Finlay, 1930; Flinn, 1964, 1974; Chapelhowe, 1965; Birnie, 1981), and radiocarbon dates from Whalsay suggest relative sea level at least 9 m below present before 5500 BP (Hoppe, 1965). Birnie (1981) reported radiocarbon dates of 5840 ± 50 BP (SRR – 1796) and 4586 ± 40 BP (SRR – 1795) from intertidal peats at Leebotten and the Houb, respectively, and although these dates confirm the trend of submergence, they are not related to specific sea-level altitudes.

References



(Figure 3.1) Location map and principal features of the glaciation of Shetland, including pat-terns of striations, directions of transport of erratics and general directions of ice moulding (from Sutherland, 1991b).