PALAEOECOLOGICAL EVIDENCE FOR HUMAN IMPACT ON THE NORTH ATLANTIC ISLANDS

By P.C. BUCKLAND [1], A.J. DUGMORE [2] & J.P. SADLER [3]

With 2 figures

ABSTRACT. European expansion across the North Atlantic began in the eighth century AD and by the end of the tenth had reached Newfoundland by way of the stepping stones provided by the Faroes, Iceland and Greenland. Lacking indigenous domestic herbivores, the introduced animals had a profound impact upon the landscape, leading to widespread soil erosion and, in some cases, abandonment. As well as the domestic stock, the Norse farmers introduced a number of crop plants and, more significantly, a range of plants and invertebrates, carried largely in the dunnage and ballast of the colonising ships. This paper concentrates upon the evidence for early introduction of biota from Europe, based upon the fossil record largely preserved in archaeological sites.

INTRODUCTION

The processes by which an essentially European system of subsistence were spread across the Atlantic and beyond have been the subject of much detailed study from both the sociological and ecological points of view (e.g. WOLF 1989; CROSBY 1994). The arrival of post-Columbian settlers in North America led to the decline and often the total destruction of usually better adapted native systems of land use (cf. CRONON 1983). The progress of 'Europeanisation', beginning with disease, alien crops and domestic stock, extended to the associated weeds, ectoparasites and invertebrate fauna (LINDROTH 1957; BUCKLAND *et al*. 1995a). In a recent study of archaeological deposits in seventeenth century Boston, USA, BAINES (1998) has shown that the associated beetle fauna is virtually wholly European. It is evident that there was little compromise in the creation of *New* England. This pattern is perhaps less evident in Spanish expansion further south, where native crops were more readily adopted. The impact of disease on indigenous peoples, however, was equally evident (SAUER 1971), and the cultivation of sugar cane on the Caribean islands led to widespread extinctions

[1] Dept. of Archaeology & Prehistory, University of Sheffield, Sheffield, S10 2TN, UK.
[2] Dept. of Geography, University of Edinburgh, Edinburgh, EH1 1NR, UK.
[3] School of Geography, University of Birmingham, Birmingham, B15 2TT, UK.

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in the biota (WATTS 1995).

In the North, initial westward expansion was both earlier and facilitated by a series of stepping stones, the Faroe Islands, Iceland and Greenland (fig. 1), and culminated in the abortive attempt to colonise Newfoundland *ca*. AD 1000. The failure of the Norse Vinland venture has been discussed by MCGOVERN (1981) and, viewed from the perspective of one of his native American students, Vinland was the one occasion in the history of North Atlantic colonisation when "the good guys won".

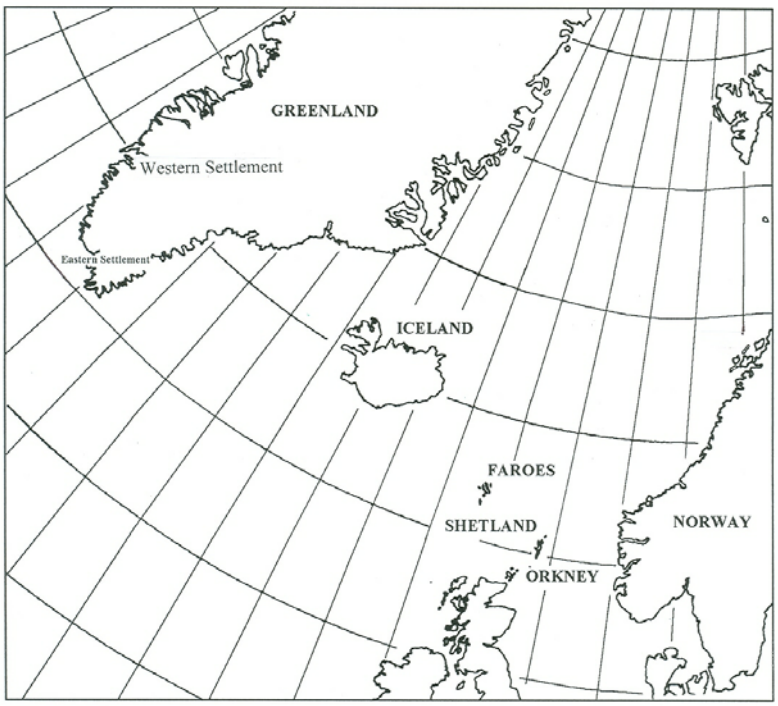

Fig. 1 - Location Map: the islands of the North Atlantic.

Norse expansion from Scandinavia westwards met with native peoples in the British Isles from the eighth century onwards, and the nature of their northern island contact remains debatable (CRAWFORD 1981; RITCHIE 1974). In the few fossil bone assemblages examined from archaeological sites of the transition period, for example, on Shetland and at Buckquoy on Orkney (RITCHIE 1977), native Pictish cannot certainly be distinguished from invaders' use of the resources. Northwards and westwards of these islands, however, the Norse initially encountered a virtually empty landscape. The Irish monk, Dicuil, writing at the court of Charlemagne's successors in early ninth century France (TIERNEY 1958), in an otherwise rather fanciful description of the world, refers to islands, two days' sailing from northern

Britain, settled by hermits (culdees), which were, in his day, abandoned because of attacks by the northmen, and now only occupied by birds and sheep. These are generally taken to be the Faroes (*Færingyar* = Old Norse 'sheep islands') (e.g. JONES 1988; MARCUS 1980). His further comment, upon an island in the North, where at midnight, it was sufficiently light at midsummer to see to pick the lice from a man's shirt, is usually regarded as referring to Iceland. Dicuil is the only strictly contemporary source, however, and later saga and other references are perhaps more concerned to establish a prior, Christian claim to the landscape than to record history. The literary evidence appears to support Norse settlement in the Faroes by the mid-ninth century (ARGE 1989), Iceland shortly thereafter, and Greenland by the end of the tenth century (JONES 1986). Whether foundation myth or history, the Norse Atlantic saga (*ibid.*) shows an inexorable push westwards, fuelled by a fully owned and exploited landscape, a process which foundered against the coast of Newfoundland. What follows is a discussion of the palaeoecological evidence for the interplay between people, biota and environment on the North Atlantic islands, and the processes which have lead to the evolution of their present landscape.

The Palaeoecological Record of Landnám

Landnámabók, perhaps written down as early the first quarter of the twelfth century (Rafnsson 1977), is one of a number of sources which describe the settlement of Iceland. The palynologist, JOHANNES IVERSEN (1941) adopted the term *landnám* to describe the earliest evidence in pollen diagrams for human impact upon the landscape. In the Faroes, this evidence is controversial. The late JÓHANNES JÓHANSEN (1971; 1979) interpreted changes in the pollen spectra on Mýkines and at Tjørnuvík on Streymoy as evidence for the impact of a pre-Norse population, Irish settlers and their domestic animals, presumably Dicuil's sheep. Radiocarbon dates in the seventh century AD were used to support this interpretation, but archaeologists (e.g. ARGE 1989; KROGH 1986) have proved more sceptical. BUCKLAND (1992), on fossil insect evidence, has doubted the stratigraphic integrity of both sites. At Uldalíð on Mýkines, the eutrophic faunas imply intensive disturbance by burrowing puffins, and at Tjørnuvík, the proximity of the sampling site to steep slopes, rendered mobile by the clearance and grazing activities of the Norse settlers and their animals, allows the incorporation of old carbon into the sediments. On biogeographic grounds, the presence of the scarabaeid dung beetle, *Aphodius lapponum* GYLLENHAL, at the relevant horizon, whilst confirming the presence of introduced herbivores, also implies a northern source for the colonists; *A. lapponum* is more likely to be picked from a northern, perhaps Norwegian source than an Irish one. JÓHANSEN's (1989) claim for Bronze Age occupation, on the basis of the presence of pollen of *Plantago lanceolata* L., has been rebutted by HANSOM and BRIGGS (1992), and the case for pre-Norse settlement in the Faroes must remain a case not proven. Norse Landnám in the islands shows a rapid destruction of the scrub vegetation

cover, and a radical decline in willow and juniper scrub and in herb species, under the relentless pressure of the introduced herbivores (JÓHANSEN 1985).

In Iceland, study is facilitated by the frequent occurrence of volcanic eruptions, which provide tephra isochrones (BUCKLAND *et al*. 1981) over much of the country and beyond (DUGMORE, LARSEN & NEWTON 1994). The fortuitous occurrence of an eruption in Veiðivötn in southern Iceland in *ca*. 900 AD (LARSEN 1984), close to the historical date for Landnám in Iceland from 867 onwards, provides a marker horizon against which to interpret the palaeoecological record. On the island of Papey, off the east coast of Iceland, an integrated palaeoecological and tephrochronological study (BUCKLAND *et al*. 1995b) showed that clear evidence for a human presence, in the form of a synanthropic insect fauna, only appeared above the Landnám ash, although a peak in microscopic charcoal particles occurred immediately below it. This is likely to correlate with the initial burning of the birch and willow scrub to improve the grazing. On the mainland, the destruction of the birch forest, which Ari Froðinn in *Landnámabók* described as stretching from mountain top to sea shore, is evident in pollen diagrams from the south-west (EINARSSON 1963; HALLSDÓTTIR 1987) and north (BARTLEY 1973). A charcoal horizon, coincident with the tephra layer, had been noted by THORARINSSON (1944) in Þjórsárdalur, and he also found evidence for the introduction of both bog myrtle, *Myrica gale* L., and wormwood, *Artemisia* sp, perhaps for use in brewing and for medicinal purposes. Other crops, including barley, oats and flax, *Linum usitatissimum* L., also appear around Landnám, but, in the most recent review, HALLSDÓTTIR (1987) urges caution in the interpretation of the data, and despite claims by HERMANN-AUÐARDÓTTIR (1989;1991) to the contrary, there is no clear palaeoecological evidence for pre-Norse human impact.

In Greenland, whilst saga sources clearly indicate knowledge of a previous occupation by Inuit hunters (MAGNUSSON & PÁLSSON 1965), the Norse settlers again moved into an area devoid of human activity. FREDSKILD (1978; 1983) has shown that their initial reaction to an essentially scrub-wooded landscape of birch, willow, and, in the more northerly Western Settlement, alder, was to burn it. Their approach to the management of available resources reflects a mindset, which relied heavily upon the provision of sufficient winter grass hay to overwinter their domestic animals, stalled indoors for anything up to nine months of the year in Greenland. In the Western Settlement, despite abandonment for over six hundred years, the core areas of once manured hayfields around the farms are still visible in the landscape, retaining a distinctive, richer flora and fauna (SADLER & SKIDMORE 1995), and the cutting of sections over much of the surrounding area reveals a heavy charcoal, or Landnám layer.

Further west, in Newfoundland, the short occupation at L'Anse aux Meadows, perhaps by Leif Eriksson or Thorfinn Karlsefni, has left slight distinguishable trace in the pollen diagrams (DAVIS *et al*. 1988), although the site's buildings remain clearly visible (WALLACE 1991).

The faunal impact

The initial process of colonisation across the north Atlantic relied upon a spectrum of animals and crop plants, with which the settlers were familiar with in their Scandinavian and British homelands. The mix of cattle, sheep, goat, pig and horse was eventually varied as to local circumstance. Pig is not an ideal animal in the north, in the absence of a suitable substitute for pannage, and goat, although rarely distinguishable from sheep in animal bone collections, appears more frequent in Greenland collections than in Iceland (McGOVERN 1992; AMOROSI 1992). Restrictions on fodder availability and grazing probably made meat a secondary consideration and subsistence was largely based upon secondary products derived from milk, from cattle, sheep and goats, supplemented by additional protein sources, largely from fish in Faroe and Iceland, and from caribou and seal in Greenland (*ibid.*). Fodder requirements and grazing made the domestic animals, after fire, the prime movers in creating what, in Iceland, DUGMORE and BUCKLAND (1991) have termed an ovigenic landscape. The Faroes present a similar picture and South West Greenland, where the last Norse farmer died nearly five hundred years ago (BUCKLAND *et al*. 1996), shows similar trace of disturbance to the landscape (McGOVERN *et al*. 1988). Whilst Iceland shows the reduction of forest cover to a much modified 1% of its former extent and the loss of more than one quarter of its soils (RÚNOLFSSON 1978), the North Atlantic islands do not show the wave of total extinctions which characterise contact with other oceanic islands (Cronk, this vol.). This reflects not the scale of impact, which was at least as severe as on other islands, but the virtual lack of endemic taxa (but cf. BERGERSEN 1995). The *tabula rasa*, created by the latest and previous glaciations, left landscapes, which were re-occupied by an ice-rafted Palaearctic biota (BUCKLAND 1988; BUCKLAND & DUGMORE 1991), and elements of an aerial planktonic one, including a Nearctic one which barely extended beyond Greenland (DOWNES 1988; SKIDMORE, 1997). Extinctions and severe restrictions in range as a result of human impact, therefore, are local and species survive on the adjacent continents, largely Europe. The exception is provided by the great auk, *Pinguinus impennis* L., although this was once Amphi-Atlantic in distribution (LINDROTH 1957).

On the Faroes, birch, *Betula* sp., is evident in deposits around Landnám, but disappears shortly thereafter (MAHLER 1991). Dinnin (in prep.) found the small rove beetle, *Ochthephilum omalinus* (ERICHSON), to be frequent in pre-Landnám deposits at Tjørnuvík, and Henriksen (in JESSEN & RASMUSSEN 1922) had identified the ground beetle *Calathus micropterus* (DUFTSCHMIDT) in Holocene sediments from a site in Tórshavn; neither appear to be part of the modern Faroese fauna (BENGTSON 1981). LINDROTH (1985) records the latter as a largely forest species and its disappearance, as many old forest species in Britain (BUCKLAND & DINNIN 1992), may be a result of habitat destruction, but the rove beetle, living in wet moss by mountain streams (HARDE 1984) is less easily explained, although the pattern of severe restrictions in range is shared by many similar species on the

North Atlantic islands.

The small Hydraenid *Hydraena britteni* JOY appears in pre-Landnám sediments in south, central Iceland, but its distribution does not appear to have extended west of the barrier of the Markarfljót sandar. At Holt in Eyjafjallasveit, careful analysis in relation to the tephra stratigraphy shows that the beetle rapidly disappears when human activity leads to the eutrophication of waters (BUCKLAND *et al*. 1991a), but it continues through at least to the fifteenth century in localities more remote from farms (BUCKLAND *et al*. 1983). There is some suggestion of an association with *Sphagnum* in woodland pools for this species (HANSEN 1987), and it may have been a victim of forest destruction, although its distribution, in the warmest part of Iceland, would have made it particularly vulnerable to the cooling of the 'Little Ice Age' (cf. GROVE 1984). Climatic change may also have had its impact on the Greenland fauna, although the small ladybird, *Nephus redtenbacheri* (MULSANT), a predator on aphids (BÖCHER 1988), known fossil from Norse farm sites in the heart of the Western Settlement east of Nuuk (MCGOVERN *et al.* 1983), and formerly thought to have become restricted to sites some 500 km to the south by the 'Little Ice Age', is now known from pitfall traps on the site at GUS in the same region (BUCKLAND *et al.* 1998).

Although human impact upon the invertebrate fauna is largely indirect, the native vertebrates of the North Atlantic islands were the inevitable target of predation as part of the subsistence round of the colonists. The last great auk was shot off the south coast of Iceland in 1844 (CRAMP 1983); flightless and an easy prey to hunters, it is not surprising that it is not an infrequent fossil in archaeological bone assemblages from shortly after Landnám (AMOROSI 1991). In these same deposits in south west Iceland, walrus, *Odobenus rosmarus* L., bones, including neonatal ones, are present in sufficient quantity to imply local hunting, an interpretation supported by place name evidence in the Reykjanes Peninsula (*ibid.*). What impact the large number of bird, principally Alcid, and seal bones reflect on local bird cliffs and seal rookeries is less easily quantified, but it is evident that the settlers had to modify their patterns of wild animal exploitation in the medieval period as these resources were depleted. There is little comparative material from the Faroes, although DAHL (1970) notes cattle, sheep and pig bones, as well as seal, auks, cormorant and gull, from the Landnám farm at Kvívík on Streymoy. The remains of pilot whale, *Globicephala melas* (TRIALL), are also noted, but whether this reflects the organised *grind*, so much a part of present-day Faroese life (BLOCH 1992; WILLIAMSON 1948), is less certain. In contrast with the Faroes and Iceland, Greenland had large native terrestrial herbivores, and caribou (reindeer), *Rangifer tarandus* L., figure largely in the bone groups from the Norse farm sites (MCGOVERN 1988). Marine mammals are also present in significant numbers. As well as the debris of prestige export commodities, polar bear, *Thalassarctos maritimus* (PHIPPS), and walrus ivory, common, *Phoca vitulina* L., hooded, *Cystophora cristata* ERXLEBEN, and harp, *Phagophilus groenlandica* GRAY, seals are present in all middens (MCGOVERN 1992). Taken for their pelts, the Arctic fox, *Alopex lagopus* L., also appears in Greenlandic and Icelandic

archaeological deposits.

Variation through the chronological sequence is evident in most archaeological bone assemblages, but how much this reflects taphonomic problems, rather than the depletion of local wild vertebrate communities is often less certain. Arctic fox occurs in the early bone assemblages (AMOROSI 1991), but Icelandic farmers still insist that the Arctic fox would be unable to persist in the country without predation on lambs and moribund sheep, yet foxes follow polar bears out onto the ice to scavenge seal kills and, in areas of Greenland without domestic stock, they make a healthy living from now much reduced bird colonies and stranded fish in the inner fjords. Other factors are also evident in the bone record. In north east Iceland, AMOROSI (1992) has identified the appearance of harp and some bearded seal, *Erignathus barbaratus* ERXLEBEN, walrus and polar bear bones as reflecting the colder parts of the 'Little Ice Age', when drift ice was more persistent along the north coast and this provided opportunities for people to hunt out on the land-fast ice.

As well as the Europeanising set of herbivores and crop plants, the Norse settlers also brought with them domestic dogs and cats, and both find reference in Sagas (AÐALSTEINSSON 1982). Cats, and also chickens, however, do not appear to have reached Greenland, although the dogs include both a small breed and large elk hound-sized animals, presumably utilised in the caribou hunt. The lack of cats may have been a source of regret to the farmers. The house mouse, *Mus musculus* L., accidentally introduced, occurs in profusion on most farm sites (DEGERBØL 1936). In contrast, it may have been absent from Iceland, where its place was taken by the long-tailed field mouse, *Apodemus sylvaticus* L. (DEGERBØL 1939), although there are unconfirmed reports of *M. musculus* from puffin burrows on Ingólfshofði on the south east coast, as well as in modern urban contexts. The biogeographic implications of this contrast have yet to be explored. Although the fossil record of neither species extends back to Landnám in Iceland or the Faroes, it is presumed to be the house mouse that is first referred to in the Faroes in 1592 (REINHERT 1982), and both AÐALSTEINSSON (1982) and ÓSKARSSON (1981) regarded it as likely to have been introduced with the Landnámsmen in Iceland. The house mouse became extinct with their farmer hosts in Greenland in the late medieval period, whilst the field mouse finds abundant suitable habitats away from farm buildings in Iceland and only moves indoors in severe winters (DEGERBØL 1939).

The accidental transport of mice in the ships of the early colonists is the most obvious case of stowaways on the North Atlantic route. SADLER (1991) has considered the fossil record of the insects, either carried as ectoparasites on the humans and their animals or in dunnage and foodstuffs in the holds. The so-called human flea, *Pulex irritans* L. is present in many samples from the Western Settlement of Greenland. Apparently of American origin (BUCKLAND & SADLER 1989), it had reached Orkney by the third millennium BC (SADLER & BUCKLAND, this vol), and must have completed the circuit of the subarctic with the ships of Erik the Red and his son Leif. Human head and body lice, *Pediculus humanus* L. subspp,

also formed part of the Landnám package (SVEINBJARNARDÓTTIR & BUCKLAND 1983; SADLER 1990), although they also occur in the pre-Norse (*ca.* 3900-3100 BP) palaeo-Eskimo midden at Qeqertasussuk, near Disko in Greenland (BUCKLAND, unpubl; BÖCHER & FREDSKILD 1993); they appear to have been a habitual fellow traveller with Man. The record of the pubic louse, *Pthirus pubis* (L.), however, is restricted to the post-medieval high-status farm at Reykholt in western Iceland (BUCKLAND *et al*. 1992). The fossil record of the parasites of domestic animals is so far restricted to those of sheep. The ked, a wingless, blood-sucking fly, *Melophagus ovinus* L.*,* and the fleece louse, *Damalinia ovis* L., are common in suitable archaeological deposits in both Iceland and Greenland, and this probably relates to wool processing activities as much as the immediate presence of the animals (BUCKLAND & PERRY 1989).

The effective exploitation of cattle, sheep, goat and horse, north of their natural range, required the acquisition of sufficient hay to overwinter at least the core stock, and it is not surprising that the synanthropic insect fauna associated with the decay of stored hay is widespread in archaeological deposits from immediately after Landnám through to the present day, although current changes in agriculture have tended to modify the assemblage (BUCKLAND *et al.* 1991b). The fauna includes the mould feeding beetles, *Lathridius minutus* L., *Corticaria elongata* (GYLLENHAL), *Typhaea stercorea* (L.), and various species of *Cryptophagus* and *Atomaria*, and their associated predators, *Xylodromus concinnus* (MARSHAM), *X. depressus* (GRAVENHORST), *Quedius mesomelinus* (MARSHAM) and *Creophilus maxillosus* (L.). At Toftanes on Esturoy on the Faroes, the manured infield fauna is supplemented by the small hydrophilid *Megasternum obscurum* MARSHAM after Landnám, and several of the staphylinids are also likely to be anthropochorous (EDWARDS *et al*., in press.). In the sweepstake of gaining a place on the boats, not all reached Greenland, and *C. elongata* appears to be replaced there by a congener, *C. rubripes* MANNERHEIM (= *linearis* (PAYKULL) of MCGOVERN *et al.* 1983), which is known from earlier palaeo-Eskimo middens (BÖCHER & FREDSKILD 1993), and is found at the present day in natural habitats (BÖCHER 1988). Skidmore (1995) has recently added the Dipterous element to this fauna, including, *Telomerina flavipes* (MEIGHEN), a species that completed its entire life cycle within the farm buildings, breeding in the accumulations of faeces and similar materials on the house floors (BUCKLAND *et al.* 1994). Many such obligatory synanthropes became extinct with their unwilling hosts in the late medieval period (BUCKLAND *et al.* 1996). In stark contrast to the situation in Greenland, the maintenance of settlement since Landnám in Faroe and Iceland ensured a continuity of habitat for these European introductions (SADLER & SKIDMORE 1995). Even with this buffer, however, several species gained only a temporary foothold. With no convincing evidence for cereals, the grain fauna is absent from Norse Greenland, but two species, the grain weevil, *Sitophilus granarius* (L.), and the saw-toothed grain beetle, *Oryzaephilus surinamensis* (L.), appear intermittently in Iceland, presumably a trace after imported grain, rather than native grown crops, in that the small supplies of most

farms would be unable to maintain breeding populations (SVEINBJARNARDÓTTIR 1982).

The introduced faunas are not restricted to strictly synanthropous elements and several species were able to expand into the newly created habitats provided by the immigrants. The best example is provided by the dung beetle, *Aphodius lapponum*, able to exploit the excrement of the introduced herbivores in the Faroes and Iceland. It is absent from fossil assemblages from Norse Greenland, however. This may reflect biogeographic accident in the immigration process, but SKIDMORE (1997) has pointed out that a dung fauna is largely absent in the Arctic and Subarctic, presumably because of climatic limitations rather than availability of habitat. Other species which clearly belong with the introduced dung fauna, for example, various species of rove beetle, particularly amongst the Aleocharinae, have problems of identification to the species level in the fossil record. The flies, *Heleomyza serrata* L. and *H. borealis* BOHEMAN, provide a relevant example. Both are associated with guano deposits, the latter around bird cliffs in Greenland, ranging into the High Arctic, as well as with human habitations, where accumulations of excrement and decaying animal matter are widespread. These species clearly deserve the label of the 'Viking housefly', because they accounts for some fifty-three per cent of the total number of recorded individuals of Diptera from Norse fossil assemblages (SKIDMORE 1995).

The floral impact

The cultivation of cereals, first oats and then barley in the Faroes (JÓHANSEN 1985), and barley in Iceland (ÞÓRARINSSON 1944), declined in the late medieval period, probably as much a result of the growing market in fish with English and later Hansa traders for fish, as a cooling climate. Other crop plants are also recorded. Bog myrtle, wormwood and flax were introduced to Iceland shortly after Landnám, and flax is also recorded from the Western Settlement of Greenland (SØRENSEN 1982), where it appears to have been eaten by, or fed to stock (FREDSKILD & HUMLE 1991). The floras of the Atlantic islands include many species which were casually introduced by people (cf. DAVIÐSSON 1967; PEDERSEN 1972), and the fossil record takes a number of these back to Landnám. JÓHANSEN (1985) noted the early introduction of two species of dock, *Rumex longifolius* L. and *R. obtusifolius* L. in the Faroes. In Iceland, burnt grain from Bergþórshvoll (FRIDRIKSSON 1960), Gröf in Öræfi (FRIDRIKSSON 1959) and Reykjavík (NORDAHL 1988) includes the associated weed seeds and, on the basis of the species mix, the material has been claimed to be locally grown barley. Whilst it is difficult to be certain, the assemblage provides one mechanism, as weeds in seed corn, whereby plants could be introduced. The Bergþórshvoll and Reykjavík deposits have radiocarbon dates shortly after Landnám, and Gröf was destroyed by an eruption in 1362. The sites provide evidence for the early introduction of the common fodder grass, timothy, *Phleum pratense* L., chickweed, *Stellaria media* (L.) VILL, corn spurrey, *Spergula arvensis* L., knotweed, *Polygonum cf. aviculare* L., nettle, *Urtica* sp., a woundwort, *Stachys*

sp., a hemp nettle, *Galeopsis,* scentless mayweed, *Matricaria maritima* L. (= *M. inodora* L.*,* pennycress, *Thlaspi arvense* L., and black medick, *Medicago lupulina* L.. Not all of these established themselves permanently in Iceland, and many are restricted to the nutrient rich areas around farm buildings. Others, like the chickweeds, were eaten by sheep and spread through the landscape in their faeces, becoming common in places where the animals shelter from the weather, creating islands of nutrients. At Holt in Eyjafjallasveit, *S. media* occurs below the Landnám ash, and it may have arrived in Iceland before human settlement and flourished in the nutrient rich area of bird cliffs and nesting sites (BUCKLAND *et al.* 1991). Although a number of the common weeds were introduced with seed corn, other species are as likely to have travelled in the hay and dunnage in the ships of the settlers, to be spread around the farms and beyond by domestic stock. This is evident in Greenland, where cereal cultivation did not take place, and the farm middens produce extensive lists of species growing on the middens. *S. media*, mouse-ear chickweeds, *Cerastium* spp., shepherd's purse, *Capsella bursa-pastoris* (L.) Medik., knotgrass, *P. aviculare*, silverweed, *Potentilla anserina* L., autumn hawkbit, *Leontodon autumnalis* L. and blinks, *Montia fontana* L., the latter a native species, dominate these assemblages (MCGOVERN *et al*. 1983; FREDSKILD & HUMLE 1991). *P. aviculare* may have been eaten, at least as a famine food (MCGOVERN *et al*. 1983). One food item that failed to establish itself in Greenland is the single hazel nut, *Corylus avellana* L., recovered in a core from near Erik the Red's farm at Brattahlíð in the Eastern Settlement (FREDSKILD 1978).

Ovigenic Landscapes

The introduced package of animals and plants which accompanied Norse expansion in the North Atlantic inevitably had impacts beyond changes in the biota. Soils, in particular, after eight thousand years of relative stability, were exposed by clearance and grazing. In the Faroes, steep slopes were stripped of their soils (JÓHANSEN 1985) and similar erosion is evident in Greenland, where there is significant movement of sediment into lake basins after Landnám (FREDSKILD 1992). The nature of the impacts has been discussed by MCGOVERN and others (1988), and is best documented in Iceland, where the tephra sequence allows a detailed assessment of the rates and nature of soil erosion (THORARINSSON 1961; DUGMORE & BUCKLAND 1991; DUGMORE & ERSKINE 1993). The figure (fig. 2) summarises the various elements in the evolution of the Icelandic landscape from Landnám to the present day. As forest clearance and grazing pressure reduced the extent of woodland to limited areas of coppice, the loess-based soils became increasingly liable to wind erosion, further exacerbated by disruption of the vegetation cover and compaction of soils by the introduced domestic animals. The resulting loss of grazing and reduction of hay yields led to the earlier abandonment of farms at the pioneer fringe (SVEINBJARNARDÓTTIR 1992). Such sites were occasionally replaced by shielings and summer dairy farms, but these in turn were eventually

abandoned as erosion fronts moved downslope. Patterns of runoff were also modified by the increased silt input into the rivers consequent upon erosion. This led to damage to pasture at lower altitudes (BUCKLAND *et al.* 1991). In the post-medieval period, late lying snow on the inland pastures led to increased pressure upon middle range grasslands and, with increased stocking levels, further erosion (DUGMORE & BUCKLAND 1991) , a downhill process, which has only been partly alleviated by the widespread drainage of pasture and hayfields and the introduction of more effective fodder crops, in leys of such grasses as timothy, *P. pratense*. In the Faroes, the pattern is similar and it is often only in the manured infield areas that a significant depth of soil, with their anthropochorous biota (ENCKELL 1985), remains. In southern Greenland, the same processes were interrupted by the extinction of the Norse Greenlanders in the late medieval period (BUCKLAND *et al*. 1996), but began again in the former Eastern Settlement with the reintroduction of sheep in the present century (FREDSKILD 1992).

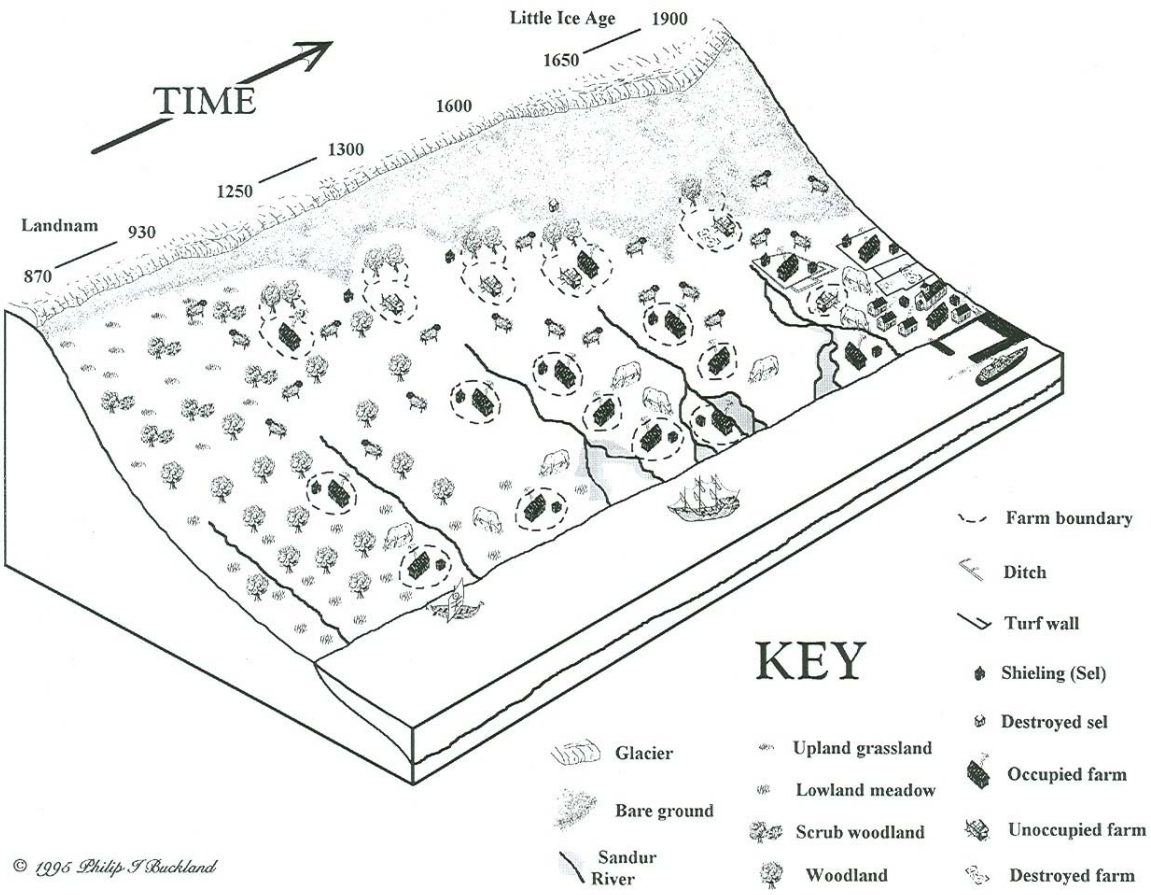

Fig. 2 - Changing Environments as a result of human impact in Iceland. A three-dimensional diagram in which time is on the *z*-axis and elevation from the coast on the *x* and *y*-axes.
Graphics: P.I. BUCKLAND.

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