Late Holocene Palaeoecology at Ketilsstadir in Mýrdalur, South Iceland

P.C. BUCKLAND,[1] A.J. GERRARD,[1] G. LARSEN,[2] D.W. PERRY,[3] D.R. SAVORY[4] & G. SVEINBJARNARDÓTTIR[5]

ABSTRACT

The late arrival of man in the landscape, with the potential for dating events through tephrochronology, makes Iceland of considerable interest in the study of the impact of simple agricultural systems upon a marginal environment. A multidisciplinary approach has been adopted for the examination of macrofossils from a bog at Ketilsstadir in Mýrdalur and these are discussed in the light of the geomorphological, historical and tephrochronological record. The natural bog environment of tussock and pool changes after Landnám, with the great influx of inorganic sediment occasioned by grazing pressure on the surrounding uplands. The insect fauna becomes more diverse, reflecting new habitats created by man. The massive fallout of tephra from the ~1357 eruption of Katla had considerable impact on the bog,although the full process of recovery of the biota could not be followed due to the attendant poor preservation.

INTRODUCTION

For those interested in late Holocene changes in the environment in Iceland, Mýrdalur in southern Iceland is a critical region. Lying between Sólheimasandur to the west and Mýrdalssandur to the east (fig. 1) at the most southerly point in the country, it is both the warmest and wettest part of Iceland with an average annual temperature of +5.7°C at Vík (1931–1960) and an average yearly rainfall of 2258mm (*Eythórsson & Sigtryggsson*, 1971). Any floral or faunal change resulting from a deteriorating climate should therefore be registered in Mýrdalur, a last refuge for any thermophilous elements in the biota. High rainfall also means that peat bogs are extensive; indeed, the place-name Mýrdalur may be translated as 'mire-dale'. Although most of the bogs have now been drained to provide better pasturage and increase hay yields, preservation of organic remains is good and the many recent ditch sections allow detailed examination of the stratigraphy, as well as effective sampling. In any study of environmental change, close dating and the ability to obtain further samples of the same date are problems. In Mýrdalur, however, an extensive study of the tephra layers from Katla and other volcanoes (*Larsen*, 1978; *Einarsson et al.*, 1980) provides a firm stratigraphic framework for research, which would be difficult to equal elsewhere. In 1979, therefore, a bog (fig. 2) near the modern farm Ketilsstadir was selected (G.L., P.C.B. & J.R.A. Greig) for an extensive palaeoecological sampling programme related to detailed tephrochronological research. Additional samples were taken in 1980, both to extend the chronological sequence and to provide further contemporaneous samples for comparative study.

LOCATION

Mýrdalur, bounded by sandur to the east and west, the icecap of Mýrdalsjökull to the north and the Atlantic Ocean to the south, appears as an oasis of cultivated land and settlement in a desert of sandur.

[1] *Department of Geography, University of Birmingham, P.O. Box 363, Birmingham. B15 2TT. England.*

[2] *Nordic Volcanological Institute, Geoscience Building, University of Iceland, Reykjavík 101, Iceland.*

[3] *Wesley House, Jesus Lane Cambridge, England*

[4] *Faculty of Education, Memorial University of Newfoundland, St. Johns, Newfoundland, Canada.*

[5] *Department of Scandinavian Studies, University College London, London, W1, England*

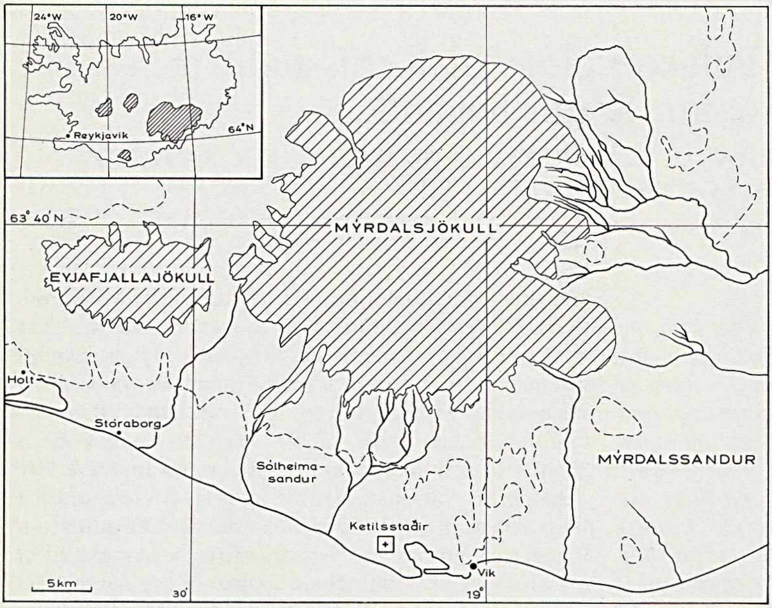


Fig. 1. The location of Ketilsstadir and other sites examined in southern Iceland — *Mynd 1. Rannsóknarstaðir á Suðurlandi.*

Fig. 2. The bog at Ketilsstadir looking north-westwards towards the icecap Eyjafjallajökull from Geitafjall (1980). — *Mynd 2. Mýrin við Ketilsstaði í Mýrdal. Horft frá Geitafjalli til norðvesturs. Eyjafjallajökull í baksýn. Myndin er tekin 1980.*

Along the edge of the icecap, the Pleistocene palagonite formation (*móberg*) is clothed in discontinuous heath vegetation and is dissected by several deep gorges, occupied by rivers draining from Mýrdalsjökull onto the sandur. The heath now provides summer pastures for the farms in the lower, more gently contoured land to the south. The sandur is poorly vegetated and has been much influenced by frequent 'jökulhlaup', caused by eruption of the sub-glacial volcano Katla, most recently in 1918 (*Jónsson*, 1980). Much of Sólheimasandur is thought to have been extensively modified in a 'hlaup' during the fourteenth century (*Einarsson* et al., 1980), which destroyed much of the vegetation and grazing pressure has further exacerbated the problem (*Runólfsson*, 1978). Recently, parts of the sandur have been reclaimed by seeding and are now available for hay crops.

The sampling locality selected (fig. 3) is now a completely drained bog of about 25 hectares lying south of the main Reykjavík to Vík road towards the western edge of Mýrdalur, 7km west of Vík. The modern farm of Ketilsstadir, the school and other farms of the area lie on land gently sloping up towards the heath and the small lake, Oddnýjartjörn, north of the road. The bog occupies a virtually enclosed basin, bounded to the east by the 154m a.s.l. ridge of Geitafjall and to the west by a low arcuate ridge, reaching 91m a.s.l.

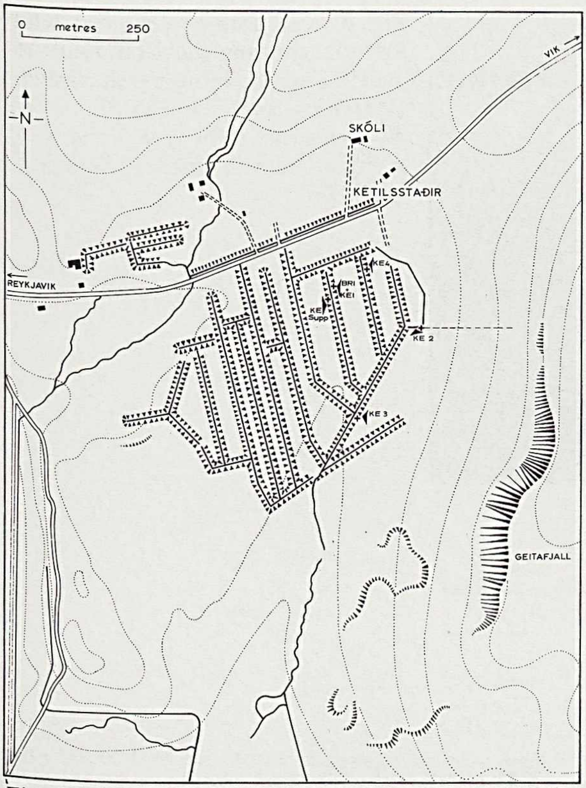


Fig. 3. Schematic plan of drainage ditches at Ketilsstadir, showing location of sampling localities. — *Mynd 3. Einfölduð teikning af framræsluskurðum við Ketilstaði, sýnatökustaðir merktir.*

The present surface of the bog lies at 40m a.s.l. and slopes gently towards the sea, 2km to the south. The surface is cut by an extensive system of drainage ditches dug during the last two decades. In an area of easy access, sheltered from the winds by low mountains on all sides, the farms around Ketilsstadir continue to be occupied and the land is intensively cultivated. As a result, the bog surface now has a largely anthropogenic vegetation.

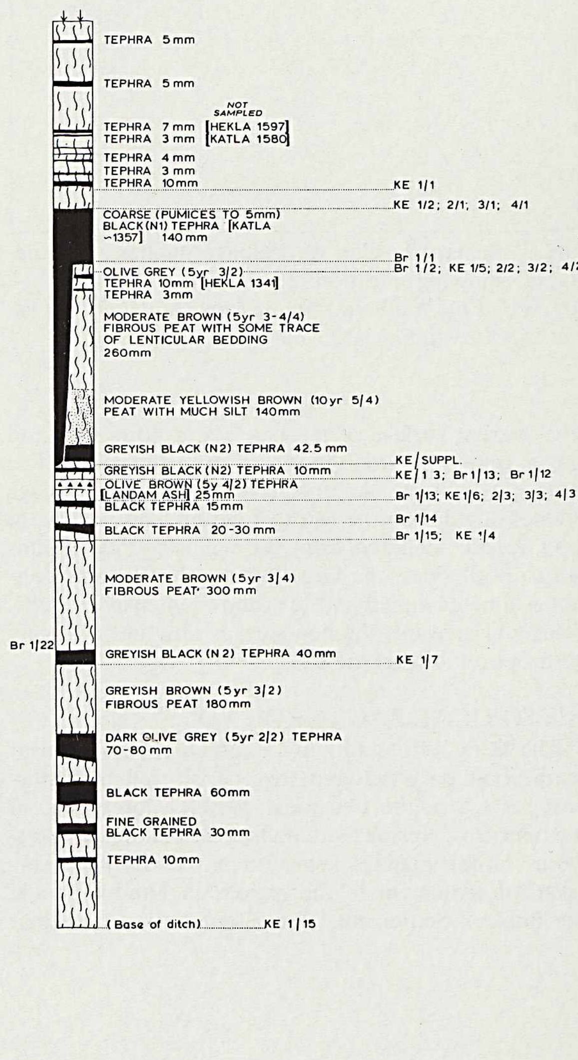
HISTORICAL BACKGROUND

The farm Ketilsstadir in Dyrhólahreppur lies near to the boundary between that parish and Hvammshreppur eystri, the two most westerly communes in the district of Vestur-Skaftafellssýsla, making up Mýrdalur. Unfortunately, few written records have survived of settlement in the region. In Landnámabók, the Book of Settlements[1], only four settlers and their farms are referred to in Mýrdalur and these do not include Ketilsstadir. The site seems, however, to have been settled early. It is mentioned in a terrier (*máldagi*) for the monastery of Thykkvibær from the year 1340 (*D.I.*2,738) and in a similar contemporary document for the church at Dyrhólar in Mýrdalur, tithes are detailed from Ketilsstadir (*op.cit.*, 742). The tephrochronological and archaeological evidence of peat cuttings filled with tephra from the ~1357 eruption of Katla imply the proximity of settlement to the bog (fig. 4) and there are indications in the fossil biota of earlier human influence. In a land register of 1639, the farm was of considerable tax value, being listed at 55h[2], land rent at 2h and 30 ells and having 7 hired cattle[3] (*Thjsk.* 167 Rtk.), large compared to the value of other farms in Iceland at that time (cf. *Lárusson*, 1967). In 1686, the tax value had risen to 60h and the land rent to 30h but by 1695/97 tax had slumped to 24h, although the land rent remained the same and the number of hired cattle had only been reduced by one (*ibid*, 399). Where the decrease in tax is explained in the land register of *Árni Magnússon* and *Páll Vídalín* (of 1702—14), the cause is always deterioration as a result of landslide, flooding or other geomorphological change (see e.g. *Jardabók 1*, 74—75). The land rent was not connected to value and its amount was subject to agreement between owner and occupier. The majority of farms in Dyrhólahreppur were subject to decrease in tax during the same period as Ketilsstadir. Unfortunately in the absence of the land register for the area, it can only be assumed that the decrease in tax of Ketilsstadir related to the deterioration in the quality of its land. This could have been partly a result of climatically severe years and volcanic eruptions, of which there are several accounts from the last quarter of the seventeenth century (*Ólason*, 1942, 403—4). One insect from Ketilsstadir, *Hydraena britteni*, might also be a victim of the colder years of the early post medieval period.

Since the Settlement, Mýrdalur has always relied principally upon pastoral farming with sheep as the main domestic animal. That some cereal cultivation was practised is suggested by place name evidence — *Akurtorfa* at the farm Giljar — and cultivation strips can apparently still be seen by the farm at Fagridalur (*Einarsson*, 1975, 19). Lyme grass (*Elymus arenarius*, Icel. *melgresi*) grows particularly well among the dunes of Mýrdalssandur and the seeds were widely collected and used as a substitute for grain until earlier this century (*Ólafsson*, 1943, 154—6). Fishing resources were also exploited and the same tephra horizon, which filled the peat cutting at Ketilsstadir

Fig. 4. Ketilsstadir: section at KE/ SUPPL. showing the tephra of the ~1357 eruption filling a peat cutting. — *Mynd 4. Snið. KE/SUPPL, í mýri við Ketilsstaði. Það sýnir forna mógröf sem fylltist af gjósku í Kötlugosi um 1357.*

Fig. 5. The stratigraphy of section BR1 at Ketilsstadir (1979). — *Mynd 5. Snið BR I í mýri við Ketilsstaði (1979). Jarðvegur og gjóskulög.*



(Katla ~1357) also sealed a midden at Fell containing an abundance of fish bones (*Thórarinsson*, 1972; *Einarsson*, 1975, 21; *Einarsson* et al., 1980, 4).

TEPHROCHRONOLOGICAL RECORD

The Mýrdalur district lies at the margin of the Eastern Volcanic Zone in southern Iceland. It has repeatedly been affected by tephra fall from the subglacial volcano Katla, below the icecap of Mýrdalsjökull some 20km to the north, and less frequently by tephra from more distant sources. The tephra forms distinct layers within the soil, which are well exposed in drainage ditches such as those found at the Ketilsstadir bog (fig. 4). The more or less continuous layers can be easily followed within the bog and conveniently used as stratigraphic markers; the age of several tephra layers is known, providing dated isochrones. Such dated horizons are, however, restricted to the last 1100 years, although earlier layers occur at the base of the exposed succession.

The tephra layers in the Ketilsstadir bog were identified by comparison with other recently studied soil sections in this area (*Larsen*, 1978; *Einarsson* et al., 1980). The stratigraphy is shown in figure 5. Black tephra layers from Katla are most prominent, ranging in thickness from a few mm to tens of cm. The most coarse grained tephra layer has a maximum grain size of 25 mm but submillimetre material is dominant in most Katla layers. Tephra from more distant sources is restricted to the submillimetre grain size and different chemical composition is reflected by different hue of colour, which is however often difficult to discern in the wet sediment of the bog. The tephra layers constitute roughly 27% of the total thickness of the sequence presented on figure 5 but this percentage is likely to vary within the bog.

The most important tephra layers for the present studies are the landnám layer and the K~1357 tephra layer. The former originated in the Vatnaöldur—Hrafntinnuhraun crater row some 70km to the north (*Larsen*, 1978; 1984), and is thought to have been deposited around A.D.900, near coincidently with Norse settlement in Iceland (*Einarsson*, 1963; *Thórarinsson*, 1967). This Landnám-tephra is a most valuable isochrone which divides the deposits into pre-Landnám and post-Landnám and greatly facilitates the observation of changes caused by the Settlement. The tephra from the Katla eruption of ~1357 forms the thickest tephra layer deposited in the Mýrdalur district during historical time. The Ketilsstadir bog lies within the 100mm isopach but locally thickness may exceed 200mm. This was probably the worst catastrophe that has hit the area since it was settled and damage to the vegetation must have been extensive. The tephra fall and abandoning of farms as a result of it are only vaguely mentioned in old annals (*Einarsson* et al., 1980).

Other dated tephra layers identified at Ketilsstadir are from the Hekla eruptions in 1341 and 1597 and the Katla eruption of 1580 (*Larsen*, 1978). No attempt was made to identify younger tephra layers because the topmost part of the soil at the Ketilsstadir bog has been disturbed by ploughing, prior to reseeding.

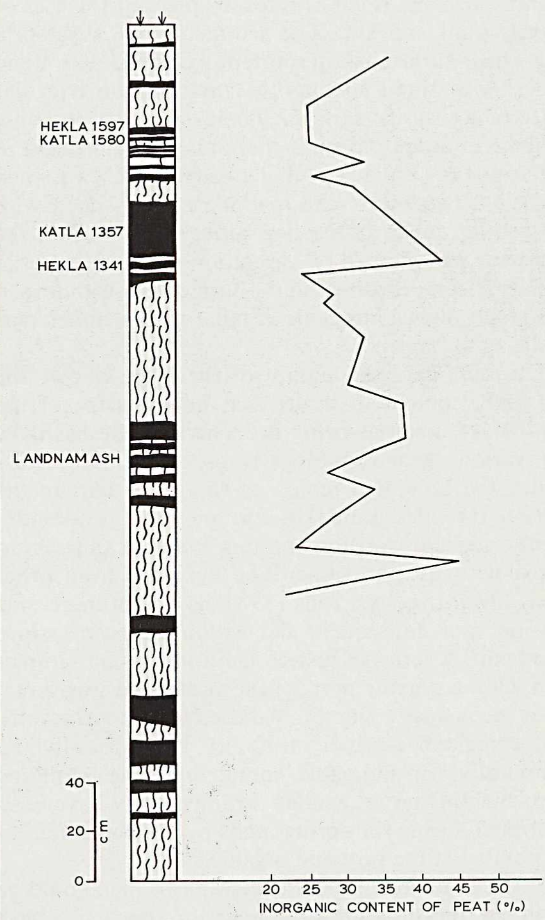


Fig. 6. Ketilsstadir: variation in inorganic content of peat at section BR1. — *Mynd 6. Breytingar á magni ólífræns efnis í mó úr sniði BR I í mýri við Ketilsstaði.*

GEOMORPHOLOGY

The basin is almost completely enclosed, one of a series of bogs that drop in a staircase from Oddnýjartjörn at 92m a.s.l. to sea level (fig. 2). The stream which drains from the lake and the upper basins now flows to the west in a steep-sided valley and avoids the main bog at Ketilsstadir, which is drained over a rock lip to the south and on to the lowest of the bogs, close to sea level. The basin appears to have been glacially overdeepened and much of the sediment brought into the basin during the Holocene has been trapped. Material moving off the encircling steep slopes and any aeolian sediment has also been caught. Sections through the bog thus provide information on the evolution of the area, perhaps since the end of the last glaciation, although present exposures only cover the last two thousand years.

A section, at about the centre of the basin, shows an intercalation of tephra layers with peat and organic silts (fig. 5). Close to the surface, the peat is extremely fibrous and of a reddish-brown colour but, at greater depths, it is more compressed and humified. Towards the margins of the bog, the sequence of peat and tephra horizons is interrupted in places by lenses of gravel, sand and silt. The sedimentology suggests a bog whose surface is intermittently covered with flood water, with small streams that move in an irregular pattern across its surface. These streams, probably ephemeral flow from snow melt, may have brought in material from the sides of the basin which was then deposited because of the low energy associated with the gentler angles of the bog surface and because the sediment was trapped by vegetation. Aeolian material has also been deposited on the surface, contributing to the much higher inorganic content of the upper part of the stratigraphy.

The semi-enclosed nature of the basin allows the inorganic content to be used as an indicator of the amount of material being brought into the basin by the various geomorphological processes. At Ketilsstadir, the Landnám tephra in the lower part of the section provides a marker for pre- and post-Settlement organic deposition and this content can be compared with the inorganic. The evidence from other areas (*Thórarinsson*, 1961; 1981) is one of increasing erosion and consequent deposition in basins since Landnám. A series of loss on ignition tests on samples through the organic parts of the succession was somewhat inconclusive (fig. 6). Valid conclusions are difficult to make because of variability, both spatially and temporally, in inorganic inputs and the sampling problems this poses; aeolian sediment may have been reworked during the spring melts before becoming incorporated in the peat and organic silts.

In the limited depth of stratigraphy which could be observed, the situation pre-Landnám appears to have been fairly stable, apart from one abnormally high value in the loss on ignition tests (fig. 6). There is a slight increase in inorganic content immediately after Landnám and then a gentle decline until the tephra layer associated with the ~1357 eruption of Katla is reached. This is by far the thickest tephra layer and the sample from the peat immediately below may have been contaminated, contributing to the high inorganic content. This thickness of tephra may have instigated local erosion by killing the vegetation as well as itself being weathered and moved by geomorphological processes. This is tentatively inferred from the higher inorganic content in the peat immediately above the tephra.

The modern drainage of the basin seems largely to have stabilised the former bog surface. Although some erosion continues on the *rofbards* of the surrounding overgrazed slopes, both screes and other surfaces show some evidence of revegetation and the major changes of the last one thousand years may be giving way to a new stasis.

MODERN FLORA AND FAUNA

A limited survey of modern flora and fauna was carried out so as to place in context the interpretation of the fossil remains. A survey of the area was made during two summers (D.R.S.) and the plant species recorded were assigned to five habitat zones. Within each of these, Domin cover values for all species in randomly located quadrats were recorded. These were converted to a percentage scale (*Bannister*, 1966) and analysed using the CLUSTAN computer package (*Wishart*, 1978). The resulting dendrograms support the subjective delineation of five habitat zones surrounding the Ketilsstadir sampling area:

1. *Hayfield* on the former bog surface, now drained and reseeded, dominated by the grasses *Phleum pratense*, *Festuca* spp. and *Poa* spp., with wetland species confined to ditches.
2. *Improved pasture*, formerly *scythed* hayfield; diverse, highly anthropogenic flora with many species typical of disturbed and broken ground (e.g. *Rumex acetosa*).
3. *Unimproved pasture*, lightly grazed by sheep; intermediate zone dominated by grasses with much *Equisetum arvense*, *Luzula multiflora* and *Alchemilla filicaulis*.
4. *Upper slopes*, discontinuous eroded pasture; grasses, mosses and much bare ground with extensive growth of arctic/alpine types (e.g. *Erigeron boreale*, *Alchemilla alpina* and *Potentilla crantzii*).
5. *Summit*, heavily grazed and nearly bare; cushions of *Silene acaulis* and *Thymus praecox*, with scattered *Cardaminopsis petraea*, *Galium normanii* and *Koenigia islandica*.

Collection of invertebrates was restricted to the Coleoptera (beetles), the group which provides the most frequent identifiable fossils. A transect from the ridge to the bog surface was searched and swept. Although variations in the physical environment influence capture and hence numbers of individuals, the resulting faunas may be compared with the fossil ones. The ground beetle *Notiophilus biguttatus* seemed the most eurytopic species, whilst *Nebria gyllenhali*, *Bembidion grapei*, *Amara quenseli*, *Lathrobium fulvipenne*, *Hypnoidus riparius* and *Otiorhynchus arcticus* are characteristic of the bare ridge crest (vegetation zone 5). *N. gyllenhali* was also found in open, unvegetated parts of the peaty ditch banks. In

Taxon	KE1/1	KE1/2	KE2/2	KE3/2	BR1/2	KE1/5	KE1/3	KE1/6	KE1/4	KE1/7	KE1/14
Selaginella selaginoides (L.) Link.	82.0	9.3	2.6	190.8	24.1	24.0	74.5	—	6.5	—	1.4
Rumex sp.	—	—	—	—	0.2	—	—	—	—	—	—
Montia fontana L.	—	—	—	—	—	—	—	—	—	0.1	—
Stellaria media L.	—	—	—	—	0.5	—	—	—	—	—	—
Cerastium sp.	—	—	—	—	2.0	—	—	—	—	0.1	—
Ranunculus cf. *acris* L.	0,3	0.4	—	—	0.1	—	—	—	—	—	—
Alchemilla sp.	9.5	35.8	—	0.2	1.2	1.5	10.4	—	—	—	—
Empetrum nigrum L.	—	—	—	—	1.0	—	—	—	—	—	—
Menyanthes trifoliolata L.	—	—	—	—	—	—	—	—	—	—	4.9
Gramineae (indet.)	—	—	—	—	0.9	—	—	—	—	—	—
cf. *Alopecurus geniculatus* L.	—	—	—	—	—	—	—	—	—	0.3	—
Carex spp.(indet.)	13.8	5.1	—	2.0	66.9	59.8	89.4	—	—	1.9	3.3
Juncus spp. (indet.)	—	0.1	—	0.1	8.1	0.3	0.7	—	—	—	—
Luzula cf. *multiflora* (Retz.) Lej	0.4	0.7	—	0.1	3.8	1.5	2.2	8.4	—	0.3	—
TOTAL seeds/100 g	106.0	51.4	2.6	192.3	108.8	77.1	177.2	8.4	6.5	2.7	9.6
Number of taxa.	5	6	1	5	12	5	5	1	1	5	3
	Post 1357		Pre-1357					Pre-Landnám			

Table 1:
Plant macrofossils from Ketilsstadir, southern Iceland (numbers expressed per 100 g of sample).
Det. D. Savory.

the more richly vegetated parts of the ditches occurred *Trechus obtusus*, *Stenus carbonarius* and *Lesteva longoelytrata* (within vegetation zone 1).

SAMPLING

In 1979, after detailed examination of the stratigraphy, a section was selected in one of the more recently cut ditches (fig. 5) for sampling. Taking due regard of the tephra stratigraphy, a sequence of 22 samples (BR1/1—22) was taken in slices roughly 100mm thick. Each sample, of about 2.5kg, was bagged in polythene and returned to Birmingham for processing. Separate samples were taken for tephrochronological study. Since it was important to examine spatial as well as temporal variation in flora and fauna, an additional sequence of samples, immediately adjacent to the 1979 samples, was taken in the following year (KE1/1—15), overlapping with the earlier samples and extending the succession to above the ~1357 horizon and to the base of the ditch. In addition, using the tephra horizons as isochrones (time stratigraphic markers, *Buckland* et al., 1981), further samples (KE1 suppl.; KE2; KE3; KE4) were collected from elsewhere in the bog (fig. 3) from above and below the ~1357 Katla ash (KE2—4/1—2) and from beneath the Landnám ash (KE2—4/3).

Processing of samples

The recovery of macrofossils from Quaternary sediments has been considered in some detail by *Kenward* et al. (1980) and the kerosene (paraffin) flotation technique, devised by *Coope* and *Osborne* (1968) for the recovery of insect remains has been discussed by *Coope* (1985) and *Sveinbjarnardóttir* et al. (1981). Samples are disaggregated in water over a 300 μm sieve, drained and kerosene added. This adsorbs onto the fragments of insect cuticle and these float with the kerosene when water is added; a reasonable subsample of the seed flora may also be obtained by this technique but it is necessary to sort a subsample of the whole, separated further into >2mm and >1mm fractions, before a representative flora can be obtained. For the Ketilsstadir samples, this was a tedious process and it was not possible to process as many samples for plant macrofossils as for insects. After flotation, both flotant and residue are separately washed in detergent and alcohol to remove the kerosene and are sorted in alcohol under a binocular microscope. Identification is carried out using extensive modern reference collections. Table 1 lists the number of seeds and macrospores per 100g of sample and table 2 lists the insect taxa recovered from the Ketilsstadir samples. The number of individuals is calculated on the basis of the minimum number of individuals needed to account for all of the exoskeletal parts recovered.

A total of 46 samples were examined for insect remains and 28 taxa of Coleoptera (beetle) were identified; 23 of the samples were from deposits previous to the deposition of the Landnám ash (~900). Fragments of Dipterous puparia, head capsules of Hymenoptera (Parasitica), a few larval fragments of Tricoptera and large numbers of mites, principally Oribatei, also occurred but only in the case of the Tricoptera (cf. *Buckland* et al., 1986) is knowledge of the fauna sufficiently advanced to allow identification. Only 11 samples, of which four were pre-Landnám, were processed for plant macrofossils.

NOTES UPON PARTICULAR TAXA

Hydraena britteni Joy

By far the most surprising find in the Ketilsstadir samples were large numbers of heads, thoraces and elytra of a small Hydraenid (sensu *Lohse*, 1971) beetle whose identification as *Hydraena britteni* Joy was confirmed by the recovery of an abdomen, complete with aedeagus, from sample BR1/8. This insect has yet to be found living at the present day in Iceland and some of the implications of its discovery have been discussed elsewhere (*Buckland* et al., 1983). An inhabitant of wet *Sphagnum* moss (*Lohse*, 1971) and shallow flooded grassland (*Balfour-Browne*, 1958), it is difficult to collect by standard entomological techniques and it may have been overlooked in Iceland. It has also been found fossil in ninth to fifteenth century deposits at Holt in Eyjafjallasveit, some 32km to the west (*Sveinbjarnardóttir*, 1983). Its presence in samples of sixteenth to seventeenth century age from archaeological deposits on the farm site at Stóraborg, east of Holt (*Perry et al.*, 1985), may, however, be related to peat taken to the site as fuel, a problem noted elsewhere in samples from wholly man-made deposits (*Hall* et al., 1981). In Iceland, there is some evidence to suggest that the post-medieval period includes some of the coldest years since the last glaciation (cf. *Thórarinsson*, 1981; *Buckland* et al., 1986) and the possibility of a 'Little Ice Age' extinction, as recently suggested by *Girling* (1984) for the water beetle *Gyrinus colymbus* Er. in England, has been considered (*Buckland* et al., 1983).

Lathrobium brunnipes Fabricius

Whilst the identification lacks the confirmatory evidence of the aedeagus, there can be little doubt that the many fragments of a species of *Lathrobium* in the Ketilsstadir samples belong to *L. brunnipes* F. and not the more widespread species at the present day, *L. fulvipenne*. The former is known in Iceland from a few specimens taken by *Lindroth* (1965) at two localities in Hornafjördur and a recent find in Landbrot, W.-Skaftafellssýsla (*Erling Ólafsson*, pers. comm.). Like *H. britteni*, it is also an insect of *Sphagnum* bogs and is widely distributed in upland areas of northern Europe (*Lohse*, 1964). This Staphylinid beetle is a much more common fossil than its present frequency would lead one to expect, occurring also at Holt in Eyjafjallasveit and Kópavogur, near Reykjavík (*Buckland* et al., 1986) in some numbers in both pre- and post-Landnám deposits. Whether the widespread drainage and improvement of suitable habitats has resulted in its present rarity is uncertain.

Bryaxis puncticollis Denny

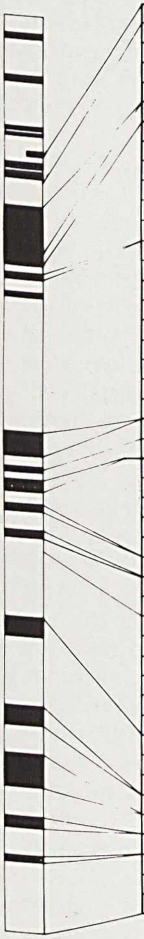
Six individuals of the minute Pselaphid beetle *Bryaxis puncticollis* were found in Ketilsstadir deposits and the species is clearly part of the fauna which predates the arrival of man in Iceland. It is known at the present day from only two localities, Dynjandi in Hornafjördur (*Lindroth*, 1931) and Ásólfsskáli in Eyjafjallasveit (*Lindroth* et al., 1973). The modern Icelandic records are from grassland but, in Central Europe, the species is a pronounced forest animal, occurring "in withered leaves at the base of old tree stumps" (*Larsson & Gígja*, 1959). It is possible, therefore, that it should be regarded as an *Urwaldrelikt* in the Icelandic fauna (cf. *Buckland* (1979) on the British forest fauna), although *Pierce* (1957) notes the beetle from habitats similar to its Icelandic one in Britain.

THE PALAEOENVIRONMENT

Pre-Landnám

Whilst there is evidence from elsewhere in southern Iceland for settlement before the eruption which distributed the so-called 'Landnám tephra' over much of the country (*Larsen*, 1984), this distinctive layer provides a suitable horizon before which the landscape is essentially unaffected by man. For several hundred years, until Landnám, the bog at Ketilsstadir shows relatively little environmental change. Neither stratigraphy nor macrofossils provide evidence for birch woodland occupying the surface of the bog, although fragments of wood occur in several pre-Landnám samples, suggesting that trees occasionally gained a foothold on temporarily drier areas. Whilst

Table 2:
Insect fossils from Ketilsstadir, southern Iceland. Taxonomy follows *Larsson & Gígja* (1959), with revisions from *Lindroth* et al. (1973) and *Kloet & Hincks* (1977). Det. D.W. Perry & P.C. Buckland.



Sample	TOTAL NUMBER OF INDIVIDUALS	Patrobus septentrionis (Dej)	Trechus obtusus (Er)	Pterostichus adstrictus (Esch)	P. diligens (Stm)	P. nigrita (Pk)	Calathus melanocephalus (L)	Amara quenseli (Sch)	Hydroporus nigrita (F)	Agabus bipustulatus (L)	Stenichnus collaris (Mull)	Hydraena britteni (Joy)	Lesteva longoelytrata (Goez)	Stenus spp (2 spp)	Lathrobium brunnipes (F)	Othius angustus (Steph)	Gabrius prob. trossulus (von N	Quedius boops (Grav)/ fulvicollis	Quedius umbrinus (Er)	Aleocharinae indet	Bryaxis puncticollis (Den)	Aphodius lapponum (Gyll)	Byrrhus fasciatus (Forst)	Hypnoidus riparius (F)	Lathridius minutus (group)	Otiorhynchus nodosus	Strophosomus melanogramm	Tropiphorus obtusus Bons	Ceutorhynchus contractus (	DIPTERA (indet)	TRICHOPTERA (indet)	Isochronous samples in parenthesis
		CARABIDAE							DYTISCIDAE		SCYDMAENIDAE	HYDRAENIDAE	STAPHYLINIDAE								PSELAPHIDAE	SCARABAEIDAE	BYRRHIDAE	ELATERIDAE	LATHRIDIIDAE	CURCULIONIDAE						
KE 1/1	9	1											1	1				2	2	1				1								
1/2	4														1			2	2							1						}
2/1	0																															}
3/1	6												1		1				3	1												}
4/1	3								1			1							1													}
BR 1/1	0																															
1/2	28	1				1			1			2	2	1			2		6	9		1		1		1						}
KE 1/5	6					1								2			1		1	1												}
2/2	12															1						3				4		4				} ~1357
3/2	1				1														1													}
4/2	2												1						1													}
SUPP	22	1			1				2	2		3	1	1	1	1	1	3	2	2		1		2	1	1				1		}
BR 1/3	3								1							1																
1/4	43	1		1		1		1			2	6	5	1	1	5	1		8	6	1	1		2								
1/5	18	1							1				1		3	4			5					1		1			1			
1/6	19						1	1	3					3	3				6	1							1					
1/7	18	1							2			6	3	2					2	1						1						
1/8	46	1		1					10	1		15	1	1					2	3		1	2	2		1					3	
1/9	3								1						1				2									1				
1/10	1																			1												
KE 1/3	23	1											1	1	1	1	7		6	1				2		1				1		}
BR 1/11	2																		2											1		}
1/12	1											1																				POST LANDNÁM
1/13	31								2			22		4	1				1		1											PRE LANDNÁM
KE 1/6	10	1												1	2				4							2						}
2/3	0																															}
3/3	0																															}
4/3	10	1			2									1	2				1		2									1		}
BR 1/14	15								2			2		3					8													
1/15	5													2					1	1						1						}
KE 1/4	4									1		1		2	1				7							1				1		}
BR 1/17	9													1	1				4	1						1				1		
1/18	6													1	1				3							1						
1/19	15		1		1							3		4	2				3									1				
1/20	24	1							5	2		1		3	6				4											2		
1/21	19					1						2		3	4				4											5		
1/22	24				1							8		6	1				8													
KE 1/7	31					1			2			12		6	3				5	1	1											
1/8	4													2	1				1													
1/9	3	1												1	1																	
1/10	3				1									1					1													
1/11	0																															
1/12	14											6		3	1				4													
1/13	3				1							1							1													
1/14	28	1				1			3	1		13		3	2				2		1								1			
1/15	20								4			9		3	2				2													

occasional variations in the fossil biota imply varying degrees of local wetness on the surface, there is insufficient evidence to regard this as anything other than the result of the natural processes of bog growth (cf. *Moore & Bellamy*, 1973), rather than as indications of climatic change.

The limited evidence from the fossil seeds and megaspores is shown in table 1. Only 5 taxa, distributed among 4 samples are recorded, the matrix of each being dominated by poorly preserved *Sphagnum*. Most of the plants can be found on the bog at the present day but clubmoss, *Selaginella selaginoides*, represented by large numbers of megaspores in several samples, is now confined to the upper slopes of Geitafjall, presumably having been shaded out by the denser growth of grasses and sedges on the now drier bog surface. The bog bean, *Menyanthes trifoliata*, appears in KE1/4, a sample which is considerably earlier than Landnám, the drier nature of the surface is probably the reason for its absence from the bog at the present day.

In virtually all samples, the beetle fauna (table 2) is, not surprisingly, indicative of a bog environment. Small pools of open water are indicated by the Dytiscid water beetles *Hydroporus nigrita* and *Agabus bipustulatus*. *Hydraena britteni*, on evidence from elsewhere in Europe (*Lohse*, 1971; *Balfour-Browne*, 1958), probably lives in amongst the wet *Sphagnum* cushions at the sides of the pools. Several of the Staphylinids would also appear in the wet habitats on the bog surface, including species of *Stenus* and *Lathrobium brunnipes*. Somewhat drier areas are implied by some of the Carabids but all might be found in an intermittently rather less damp tussock and pool environment, where beetles such as *Pterostichus diligens*, *P. nigrita* and *Quedius umbrinus* could occur among the grasses and sedges and in the accumulation of decaying plant debris. The paucity of phytophages in the Icelandic fauna means that little can be added to the list of plant species by way of the insects which feed upon them. Both of the weevils *Otiorhynchus nodosus* and *Tropiphorus obtusus* are polyphagous on a wide variety of plants, the larvae feeding on the roots (*Lindroth* et al., 1973).

Post-Landnám

Above the Landnám tephra, the impact of man rapidly becomes apparent in the succession. The most diverse flora occurs in sample BR1/2, from immediately below the ~1357 tephra fall, a reflection of the increased habitat variety created by human activities. The flora includes the chickweed *Stellaria media*, a plant if not introduced by man (*Steindórsson*, 1962) much encouraged by his disturbance of the ground, and the buttercup *Ranunculus* cf. *acris* may also belong to the group of anthropochorous plants. The limited nature of the flora, however, allows few conclusions and the beetle fauna can add little in terms of information on the species of plant rather than the general nature of the vegetation. *Byrrhus fasciatus* is a moss feeder usually found in drier localities among stones and mosses rather than in bogs but it is a capable flier (*Lindroth* et al., 1973). The larvae of the click beetle *Hypnoidus riparius* are generalised feeders upon the roots of grassland vegetation and it is suggestive of a somewhat drier situation. Since the imago is flightless (*op. cit.*), it is probable that the area became at least intermittently less boggy after Settlement. In part, this may reflect the increased sediment input to the basin (fig. 6) but peat cutting for fuel (fig. 4) must also have altered the drainage pattern.

The weevils are more informative. Whilst *Strophosomus melanogrammus* has been taken in Iceland in localities away from scrub (*Larsson & Gígja*, 1959; *Lindroth et al.*, 1973), it is more characteristic of birch woodland, where the imago eats the leaves and young shoots; it may be regarded as an *Urwaldrelikt* in the Icelandic fauna, now surviving in such conserved areas of woodland as those in Thórsmörk. Crucifers are absent from the fossil record at Ketilsstadir, a contrast with the modern flora, where the shepherd's purse, *Capsella bursapastoris*, is frequent on the disturbed ground around the farm and along the sides of the road to Vík, and rock cress, *Cardaminopsis petraea*, grows abundantly on the bare slopes of Geitafjall (Greig, pers.comm.). The small weevil, *Ceutorhynchus contractus* breeds in many different species of Crucifer (*Dieckmann*, 1972) but the few modern Icelandic records, including one from Vík (*Larsson & Gígja*, 1959), tend to be coastal, where the species perhaps breeds in scurvy grass, *Cochlearia officinalis;* Lindroth (in *Lindroth* et al., 1973) also records the beetle from a whitlow grass, *Draba nemoralis*, in southern Iceland. Both Ketilsstadir records are post-Landnám but this weevil appears beneath the Thjórsárhraun at Thjórsárbrú in deposits of about 8,000 B.P. (*Buckland* et al. 1986).

Although the faunas become considerably more diverse after Landnám (fig. 7), only two species of beetle are directly associated with man. The dung beetle, *Aphodius lapponum*, could not have lived in Iceland before the introduction of large herbivores; it first appears in the Ketilsstadir succession in sample BR1/10, probably belonging to the eleventh century.

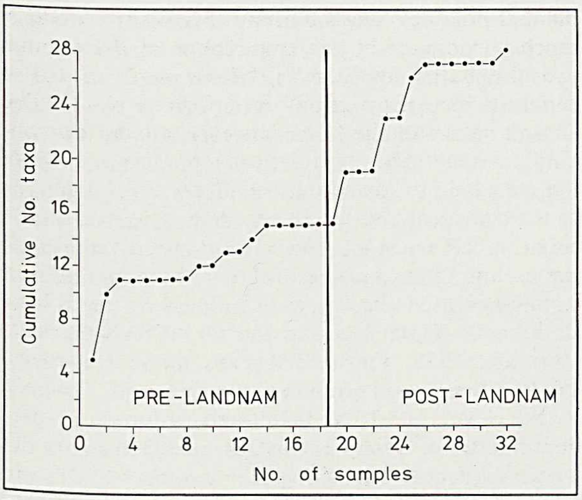


Fig. 7. Ketilsstadir: cumulative number of insect taxa plotted against the number of samples. – *Mynd 7. Graf sem sýnir tegundafjölda (safntölu) skordýra sem fall af sýnatöku.*

As well as the dung beetle, the greater part of the insect fauna associated with stored hay must have been introduced by man. At Holt (*Sveinbjarnardóttir*, 1983), much of the fauna has been found in deposits dating to shortly after Landnám, but at Ketilsstadir, probably because of the greater distance to an occupied farm, only one individual belonging to this group has been recorded. A single elytron of *Lathridius* sp. was found in sample KE/Supp., from the corner of a peat cutting infilled with ash from the ~1357 eruption of Katla (fig. 4). Whilst *Larsson and Gígja* (1959) list only *L. minutus* from Iceland, recent work on the genus (*Tozer*, 1973) has shown that this taxon consists of three species and specimens, taken by *Drugmore* (1981), from barns in Eyjafjallasveit, have been determined by Tozer (pers.comm.) as *L. minutus* L. and *L. anthracinus* Mannh. Since it is possible that the third species, *L. pseudominutus* Strand, may eventually be identified amongst Icelandic material, the identification of the fossil has to be left at *L.* (*minutus*) group. All three species are markedly synanthropous in the northern parts of their distribution, being common in the artificially warm environment of stored, mouldy hay, where they feed on fungi. They are, however, effective fliers, dispersing out into the hayfields on warm days in summer (*Dugmore*, 1981), and the presence of an individual in the Ketilsstadir peat cutting is not surprising.

Several other, less synanthropous taxa are only recorded from post-Landnám deposits (table 2) but their significance can only be assessed after the study of several comparative sites (cf. *Buckland et al.*, 1986), although some clearly reflect habitat variation on and around the bog. The opening up of the bog surface by peat cutting would have provided habitat for such species as *Lesteva longoelytrata* and several taxa must reflect changes in the immediate vicinity of the bog. It is probable that the poorly vegetated slopes of Geitafjall today are anthropogenic, a result of overgrazing by sheep. Some beetles, in particular, *Amara quenseli* and *Byrrhus fasciatus*, would have found an expansion of suitable habitats as a result of this loss of soil cover. Others, like the forest element represented by *Strophosomus melanogrammus*, have seen a progressive impoverishment of their biotope. Similarly, animals of wet meadowland and *Sphagnum* bog, like *Lathrobium brunnipes* and *Hydraena britteni* may also have seen a decline in their available habitats, particularly as modern drainage techniques have come to be more generally applied. More quantitative data on Coleopteran assemblages is, however, required before the impact of such changes can be fully understood.

DISCUSSION

A major problem in the more detailed interpretation of Coleopteran assemblages, living and fossil, remains the virtual lack of studies of living assemblages (biocoenoses) and the fate of insect fragments after death (taphonomy). Detailed examination of insect biocoenoses were carried out by *Lindroth* (1965) at Skaftafell and *Dugmore* (1981) has recently provided quantitative data in synanthropic, hayfield and bare ground situations by use of pitfall traps in Eyjafjallasveit. There are similar limitations to interpretation in detail elsewhere in Europe, particularly in archaeological contexts (cf. *Kenward*, 1978). The catchment of the Ketilsstadir bog and the representative nature of individual samples are difficult to assess. Preservation favouring aquatic species in the bog is perhaps evident in the BR1 succession, where the richer samples (table 2) are those containing water beetles and fragments of their larvae; a vertical succession of alternating tussocks and pools through time may be indicated by the fluctuating numbers. The contrast between BR1/2 and KE1/5, samples which were immediately adjacent and sealed by the ~1357 tephra present a cautionary tale, which may be explained by the irregular nature of the bog surface, although such is rarely evident in the disposition of

Table 3:
Sample groups 1 and 2 from Ketilsstadir (for discussion, see text).

Ward's method/ Euclidean distance groupings		Sample number	Group average/ Jaccard groupings
3		KE1/1	3
2		1/2	2
3		3/1	3
3		4/1	3
1		BR1/2	1
3		KE1/5	3
2		2/2	2
3		3/2	3
2		4/2	2
1		KE/SUPP	1
2		BR1/3	2
1		1/4	1
1		1/5	1
3	Post Land-	1/6	3
3	nám	1/7	1
1		1/8	1
2		1/9	2
2		1/10	2
1		KE1/3	1
2		BR1/11	2
2		1/12	2
3		1/13	3
3		KE1/6	3
3		4/3	3
3		BR1/14	3
3		1/15	3
3		KE1/4	3
3		BR1/17	3
3	Pre Land-	1/18	3
3	nám	1/19	3
3		1/20	3
3		1/21	3
3		1/22	3
3		KE1/7	3
3		1/8	3
3		1/9	3
3		1/10	3
3		1/12	3
2		1/13	2
3		1/14	3
3		1/15	3

	Group 1	Group 2	Group 3
Post Landnám	7	8	6
Pre Landnám	0	1	19

the tephra layers. The use of several contemporaneous samples, facilitated by tracing tephra horizons across the former surface of the bog (*Buckland* et al., 1981), can help to clarify spatial variations in the palaeoenvironment, although the low diversity of the Icelandic fauna and the relatively small numbers of individuals in the Ketilsstadir samples raises doubts as to the statistical validity of any comparisons. In such situations, *Perry* et al. (1985) have recently advocated the use of cluster analysis and two of the hierarchical techniques used therein were applied to the Ketilsstadir data (table 3) using the CLUSTAN package (*Wishart*, 1978; for a further example, see *Perry*, 1981). Three broad groupings are apparent[4]. Group 1 is exclusively post-Landnám and group 2 is predominantly so. Group 3 is represented throughout the whole sequence. Taken together groups 1 and 2 are clearly indicative of a pronounced environmental change in the post-Landnám period (fig. 7). Taking group 1 to be the most extreme, the respective faunas clearly show the environmental impact of man's presence and the greater habitat diversity created by his activities. The analyses support the suggestion that the bog became intermittently less wet after Settlement, with an increased minerogenic input and a more diverse flora. Such effects can be explained by overgrazing on the surrounding slopes, medieval peat exploitation and introductions by man. That the Group 1 type faunas are not in the majority in the post-Landnám period is probably due in part to sampling effects, but, most importantly, seems to be a consequence of the ~1357 eruption of Katla. The post ~1357 faunas are markedly impoverished, suggesting that this ashfall had a major environmental impact, which is still evident in the highest samples.

Although the modern faunas grouped together with the post-Landnám samples, they were not in Group 1. There would seem to be two reasons for this: they represent a biased snapshot of the actual living faunas, and are necessarily less diverse because of this, and the present day environment at Ketilsstadir is undoubtedly a further development from the one under consideration.

Species groupings were also detected (table 4) and provide a more detailed indication of the impact of man and his livestock. Group 1 contains species which are the characteristic 'core assemblage' of the bog environment, occurring right through the succession. They emphasise the damp, vegetated nature of the former bog surface and the presence of ephemeral pools. This is not an association which can be regarded as typical at the present day, which presum-

Table 4: Species groups 1 and 2 from Ketilsstadir (for discussion, see text).

Species Group 1	Species Group 2
Lathrobium brunnipes	*Patrobus septentrionis*
Quedius umbrinus	*Lesteva longoelytrata*
Stenus spp.	*Hypnoidus riparius*
Hydroporus nigrita	*Othius angustus*
Hydraena britteni	*Gabrius trossulus*
	Aphodius lapponum
	Aleocharinae indet.
	Otiorhynchus nodosus

ably reflects the changing nature of the 'natural' environment. The most likely explanation of this discrepancy, aside from the possibility of climatic change, is the activity of man in altering the bog habitat for his own purposes.

Group 2 appears to be a characteristic post-Landnám association. Of these, *Patrobus septentrionis*, *Otiorhynchus nodosus* and the Aleocharinae occur pre-Landnám, the remainder are exclusively post-Landnám, although several are known elsewhere in earlier deposits (*Buckland* et al., 1986). Only *Aphodius lapponum* is directly associated with man. The species are all commensurate with a somewhat drier, more diverse habitat than that of the natural bog.

CONCLUSION

The overview obtained by a study of the macrofossils from the Ketilsstadir bog is one of relatively low species diversity but high numbers prior to the arrival of man. The bog surface seems to have been wetter before Landnám and the anthropogenic influence on the locality, reflected in an increased mineral component of the deposits and changes in the insect faunas, may well relate to grazing pressure, causing erosion of the surrounding slopes and modifying the flora of the bog and its environs. Some local drying of the surface may relate to medieval peat exploitation. The extensive and relatively frequent falls of tephra would seem to have had no significant long term effects upon the biota of the bog. As noted above, however, the faunas from above the 300mm thick tephra from the eruption of Katla in ~1357, which must have brought about widespread local extinction of biota and temporary abandonment of farms in the area, are much poorer than those immediately below, suggesting that reimmigration from the nearest 'refugia' may have been a protracted process, although a more extensive sampling programme would be necessary to test the statistical validity of this statement.

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FOOTNOTES

1. Landnámabók — an account of the discovery and settlement of Iceland, compiled in the late 13th century (*Benediktsson*, 1969) or even early 12th century (*Rafnsson*, 1974).
2. h = hundred, a measure usually expressed in long-hundreds = 120; lh = 120 ells homespun or one cow in value, i.e. the value of a 4—8 yr. old cow which had calved once.
3. Hired cattle provided a form of rent; the lease-holder was obliged to rent a certain number of cattle from the owner.
4. This information updates that previously published in *Buckland* et al., (1981). In that paper, a *lapsus calumni* allowed the weevil *Tropiphorus obtusus* to be listed as *Hypera suspiciosa.*

REFERENCES

Balfour-Browne, F. 1958: British Water Beetles, 3. Ray Society, London.

Bannister, P. 1960: The use of subjective estimates of cover-abundance as the basis of ordination. Journal of Ecology, 54: 665—674.

Benediktsson, J. 1969: Landnámabók. Some remarks on its value as a historical source. Saga-Book, 17: 275—292.

Buckland,P.C. 1979: Thorne Moors: a Palaeoecological Study of a Bronze Age Site. University of Birmingham, Department of Geography Occasional Paper 8.

Buckland, P.C., Foster, P., Perry, D.W. & Savory, D. 1981: Tephrochronology and palaeoecology: the value of isochrones. In S. Self & R.S.J. Sparks (Ed.) Tephra Studies: 381—390. D. Reidel, Dordrecht.

Buckland, P.C., Foster, P., Perry, D.W. & Savory, D. 1983: *Hydraena britteni* Joy (Coleoptera, Hydraenidae) fundin á Íslandi í setlögum frá því seint á Nútíma. Náttúrufræðingurinn, 52: 37—44.

Buckland, P.C., Perry, D.W., Gíslason, G.M. & Dugmore, A.J. 1986: The pre-Landnám fauna of Iceland: a palaeontological contribution. Boreas, 15: 173—184.

Coope, G.R. 1985: Coloeoptera analysis. In B.E. Berglund (Ed.) Handbook of Holocene Palaeoecology and Palaeohydrology, 703—714. J. Wiley & Sons, Chichester.

Coope, G.R. & Osborne, P.J. 1986: Report on the coleopterous fauna of the Roman well at Barnsley Park, Gloucestershire. Transactions of the Bristol and Gloucestershire Archaeological Society, 86: 84—87.

Dieckmann, L. 1972: Beiträge zur Insektenfauna der DDR: Coleoptera-Curculionidae: Ceutorhynchinae. Beiträge zur Entomologie, 22: 1—128.

D.I. -1867—1972: Diplomatarium Islandicum. Íslenzkt fornbréfasafn, Copenhagen & Reykjavík.

Dugmore, A.J. 1981: Icelandic Coleoptera: a study of the Coleopteran fauna of southern Iceland. Unpubl. B.Sc. dissertation, Department of Geography, University of Birmingham.

Einarsson, E. 1975: Mýrdalur. Árbók Ferdafélags Íslands 1975: 11—124.

Einarsson, E.H., Larsen, G. & Thórarinsson, S. 1980: The Sólheimar tephra layer and the Katla eruption of ~1357. Acta Naturalia Islandica, 28: 1—24.

Einarsson, Th. 1963: Pollen analytical studies on the vegetation and climate history of Iceland in late and postglacial times. In A.Löve and D.Löve (Eds.) North Atlantic Biota and their History: 355—365. Pergamon Press, Oxford.

Eythórsson, Th. & Sigtryggsson, H. 1971: The Climate and Weather of Iceland. Zoology of Iceland, I, 3. Munksgaard, Copenhagen.

Girling, M.A. 1984: A Little Ice Age extinction of a water beetle from Britain. Boreas, 13: 1—4.

Hall, A.R., Kenward, H.K. & Williams, D. 1981: Environmental Evidence from Roman deposits at Skeldergate. Archaeology of York, 14/3, London.

Jónsson, J. 1980: Um Kötluhlaup. Náttúrufræðingurinn, 50: 81—86.

Kenward, H.K. 1978: The Analysis of Archaeological Insect Assemblages: a new Approach. Archaeology of York 19/1, London.

Kenward, H.K., Hall, A.R. & Jones, A.K. 1980: A tested set of techniques for the extraction of plant and animal macrofossils from waterlogged deposits. Science & Archaeology, 22: 3—15.

Kloet, G.S. & Hincks, W.D. 1977: A Checklist of British Insects, part 4: Coleoptera and Stepsiptera (revised R.d. Pope). Entomological Society, London.

Larsen, G. 1978: Gjóskulög í nágrenni Kötlu. Unpubl. B.Sc. dissertation, University of Iceland, Reykjavík.

Larsen, G. 1984: Recent volcanic history of the Veidivötn fissure swarm, southern Iceland — an approach to volcanic risk assessment. Journal of Volcanology and Geothermal Research, 22, 33—58.

Larsson, S.G. & Gígja, G. 1959: Coleoptera I. Synopsis. Zoology of Iceland, III, 46a. Munksgaard, Copenhagen.

Lárusson, B. 1967: The Old Icelandic Land Registers. Lund.

Lindroth, C.H. 1931: Die Insektenfauna Islands und ihre Probleme. Zool. Bidr. Uppsala, 13: 105—600.

Lindroth, C.H. 1965: Skaftafell, Iceland, a living glacial refugium. Oikos, Suppl. 6: 1—142.

Lindroth, C.H., Anderson, H., Bödvarsson, H. & Richter, S.H. 1973: Surtsey, Iceland. The Development of a New Fauna, 1963—1970. Terrestrial Invertebrates. Entomologica Scandinavica, Suppl., 5.

Lohse, G.A. 1964: Fam. Staphylinidae I (Micropeplinae bis Tachyporinae). In H. Freude, K.W. Harde & G.A. Lohse (eds.) Die Käfer Mitteleuropas, 4. Goecke & Evers, Krefeld.

Lohse, G.A. 1971: Fam. Hydraenidae. In H. Freude, K.W. Harde & G.A. Lohse (eds.) Die Käfer Mitteleuropas, 3: 95—125. Goecke & Evers, Krefeld.

Magnússon, A. & Vídalín, P. 1913—1917: Jardabók, 1. Hid íslenzka fræðafélag, Copenhagen.

Moore, P.D. & Bellamy, D.J. 1973: Peatlands. Elek Science, London.

Ólafsson, E. 1943: Ferdabók Eggerts Ólafssonar og Bjarna Pálssonar um ferdir þeirra á Íslandi árin 1752—1757. (2nd edition). Reykjavík.

Ólason, P.E. 1942: Saga Íslendinga, 5. Seytjánda Öld. Reykjavík.

Perry, D.W. 1981: The Application of Numerical Techniques to Insect Assemblages from beneath the 'Raft'. In S. McGrail (ed.) The brigg 'Raft' and her Prehistoric Environment, 176—182. British Archaeological Reports 89. Oxford.

Perry, D.W., Buckland, P.C. & Snæsdóttir, M. 1985: The application of numerical techniques to insect assemblages from the site of Stóraborg, Iceland. Journal of Archaeological Science, 12: 335—345.

Pierce, E.J. 1957: Coleoptera: Pselaphidae. Handbooks for the Identification of British Insects, IV, 9. Royal Entomological Society, London.

Rafnsson, S. 1974: Studier i Landnámabók. Kritiska bidrag till den islandska fristatstidens historia. Lund.

Runólfsson, S. 1978: Soil conservation in Iceland. In M.W. Holdgate & M.J. Woodman (eds.) The Breakdown and Restoration of Ecosystems: 231—240. Plenum Press, New York.

Steindórsson, S. 1962: On the Age and Immigration of the Icelandic Flora. Vísindafélag Íslendinga, 35: 1—157.

Sveinbjarnardóttir, G. 1983: Paleoekologiske undersøgelser på Holt i Eyjafjallasveit, Sydisland. In G.Ólafsson (ed.) Hus, Gård och Bebyggelse. Föredrag från det XVI Nordiska Arkeologmötet, Island 1982: 241—250. Thjódminjasafn Íslands, Reykjavík.

Sveinbjarnardóttir, G., Buckland. P.C., Gerrard, A.J., Greig, J.R.A., Perry, D.W., Savory, D. & Snæsdóttir, M. 1981: Excavations at Stóraborg: a palaeoecological approach. Arbók hins íslenzka fornleifafélags, (1980), 113—129.

Thjsk. 167 Rtk. Thjódskjalasafn. Rentukammerskjöl. Jardabók Johans Kleins, 1639.

Thórarinsson, S. 1961: Uppblástur á Íslandi í ljósi öskulagarannsókna. Ársrit Skógræktarfélags Íslands, (1960—1961), 17—54.

Thórarinsson, S. 1967: The eruptions of Hekla in historical times. In T. Einarsson, G. Kjartansson & S. Thórarinsson (eds.) The Eruption of Hekla 1947—1948, 1: 1—170. Soc. Sci. Islandica, Reykjavík.

Thórarinsson, S. 1972: Forn saumnál finnst ad Felli í Mýrdal. Árbók hins íslenzka fornleifafélags, (1971): 95—99.

Thórarinsson, S. 1981: The application of tephrochronology in Iceland. In S. Self & R.S.J. Sparks (eds.) Tephra Studies: 109—134. D. Reidel, Dordrecht.

Tozer, E.R. 1972: On the British species of *Lathridius* Herbst (Col. Lathridiidae). Entomologist's Monthly Magazine, 108: 193—197.

Wishart, D. 1978: Clustan User Manual (3rd Edition). Programme Library Unit, Edinburgh University.

ÁGRIP

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Á Íslandi eru aðstæður að mörgu leyti heppilegar til að kanna áhrif fábrotins landbúnaðar á náttúrulegt umhverfi, m.a. vegna þess hve seint landið byggist og vegna góðra möguleika á að tímasetja einstaka viðburði með gjóskutímatali. Rannsókn með þetta að markmiði var gerð á skordýra- og plöntuleifum úr mýri við Ketilsstaði í Mýrdal. Hún var gerð í tengslum við athuganir á landmótunarþáttum svæðisins og byggðasögðu þess og studdist einnig við tímatal byggt á gjóskulögum af þekktum aldri. Tilgangurinn var að athuga hvaða breytingar hefðu orðið á lífríki mýrarinnar í tímans rás, einkum eftir landnám.

Mýrin við Ketilsstaði var upphaflega þýft votlendi en tók að breytast þegar eftir landnám við að ólífrænt set barst í hana í auknum mæli, líklega vegna áhrifa beitar á þurrlendið umhverfis. Skordýrafánan varð jafnframt fjölbreyttari sem þýðir að ný kjörlendi hafa skapast vegna mannvistar í nágrenni hennar. Þar á meðal eru skordýr sem gátu ekki þrifist hér fyrr en menn komu hingað með búfénað sinn. Mikið gjóskufall í Kötlugosi um 1357 hafði veruleg og langvarandi áhrif álífríki mýrarinnar, en önnur gjóskulög, sem þar eru, virðast yfirleitt ekki hafa haft teljandi áhrif á lífríkið.