THE ECONOMY OF THE NORSE SETTLEMENT OF THE NORTH ATLANTIC ISLANDS AND ITS ENVIRONMENTAL IMPACT: AN ARCHAEOBOTANICAL ASSESSMENT.

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ABSTRACT

The objective of the archaeobotanical research presented here is to assess the introduction of Norse agricultural economies to Iceland and the Faroe Islands during the 9th and 10th centuries AD, and the impact of the settlers' behaviour on plant communities until AD 1500. The major themes concern the pre-settlement landscape and environmental conditions, the impact of human activity on these landscapes, the non-native plant taxa introduced, the short and long-term change in local environments, and the adaptation of the Norse economic system and living conditions to the new environments. These themes are approached through the comparison of two datasets, one based on material from monoliths taken from peat sequences ('off-site' samples) and the other on the analysis of samples of deposits from archaeological sites ('on-site' samples).

Pre-settlement conditions consisted of a mosaic of acidic, nutrient-poor wetland, grassland or heath in the valley bottoms. Woodland cover was dominated by *Betula* and *Salix*, which was denser in Iceland than in the Faroe Islands. Pre-Norse changes in the Faroese landscape are evident, which relate to an increasing body of material that has been interpreted as evidence for pre-Norse settlement. At the time of *landnám,* there is evidence for woodland clearance, although this does not happen uniformly across the landscape. Clearance can be interpreted as a change in the landscape due to the introduction of an economy based on animal grazing, and the collection of wood and twigs for fuel and fodder.

Crop and wild plant taxa were introduced, although the range of plants is not as broad as in Scandinavia and the British Isles. Fuel collection and building construction were determined by the lack of suitable wood sources in the newly settled areas. In the longer term, there is evidence for soil enrichment in the areas around settlements, continuing deforestation and erosion.

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CHAPTER 1: INTRODUCTION

The Norse expansion in the north Atlantic region took place during the 9th and 10th centuries AD and two of the areas settled, the Faroe Islands and Iceland, show no archaeological evidence of a pre-Norse occupation. The settlers introduced an economic system based on the exploitation of domestic animals with some cultivation of cereal crops. This system is generally considered to have had a considerable effect on the virgin environments, with the construction of farmsteads, laying out of infield areas which were enriched by manuring, and extensive grazing of the unenclosed outfields.

Sites with good organic preservation were selected from the Faroe Islands and Iceland for plant macrofossil analysis. Monoliths from peat bogs provided sequential assemblages that indicated changes in the local plant community over time and indicate that the effects of the Norse settlement included changes to the plant community in both the areas near to settlements and in the wider landscape. Plant macrofossil assemblages from archaeological sites (a longhouse and a midden) were used to indicate the range of plant material being used by the Norse inhabitants, showing the introduction of non-native plant species (accidentally and deliberately e.g. cereal grain for cultivation) and the use of plant resources for fuel, construction and food. The Norse use of plant resources affected, and was in turn affected by, the degeneration of the Faroese and Icelandic environments over the first 500 years of settlement.

1.1. THE CONTEXT OF RESEARCH

1.1.1. A pre-Norse settlement of the North Atlantic islands?

There has been considerable debate between historians, linguists and archaeologists over the first settlement of Iceland and the Faroe Islands. Literary sources are considered by some scholars to describe pre-Norse settlement of the Faroes, including a description by the Irish monk Dicuil, writing in the Frankish court around AD 825, of islands:

> '...reached from the northern British Isles in two days' and two nights' direct sailing with a full sail and a favourable wind. ...These islands are

for the most part small; nearly all are divided from each other by narrow sounds' (Marcus 1980: 22)

He also mentions their habitation in previous times by Irish anchorites who fled the Norse, probably about AD 700 (Marcus 1980). Evidence of place names with possible Celtic origins (such as Dímun) and names relating to the Norse word 'papa' or monk (e.g. Paparøkur) (e.g. Arge 1991, but see Hermanns-Auðardóttir 1992: 89 on place name changes in recent times) have been interpreted as relating to interaction between the Irish and Norse (although the southerly links of the first Norse settlers at Toftanes - Stummann Hansen 1995 - indicates that these linguistic associations may not be so straightforward). A detailed summary of the discussion of the first settlement has been published by Arge (1991).

Archaeological evidence in the form of field systems described as resembling 'the stone walls found in Celtic regions' (Dahl 1970: 63) are nowadays only visible in marginal areas of the islands (for example the steep slopes of Mykines). No other evidence of pre-Norse settlement has been discovered, and it is difficult to envisage that it was necessary for a small community of hermits, who have left no other trace of occupation, to have found it necessary to have cultivated such marginal areas. Jóhansen (1978) took pollen cores from these areas and claimed to have found oat and barley pollen, but there is extensive burrowing of puffins in the area (Buckland 1989-90), the broad range of dates resulting from a plateau in the radiocarbon dating calibration curve (Dugmore *et al.* 2000) and the difficulty of identifying cereal pollen grains in small datasets (Tweddle *et al.* 2005) make the reliability of this study difficult to assess.

The 'papa' names also exist in Iceland, and Dicuil mentions that Irish hermits reached a land called 'Thile' (or Thule) to the north of Ireland where, at the summer solstice, the sun barely dipped below the horizon and it was so light in the summer nights that they could pick the lice from their shirts (Marcus 1980). The *Íslendingabók*, written in the 12th-century, also implies that the Norse settlers knew the whereabouts and approximate number of hermits, who left the island when the Norse arrived (Marcus 1980). The current state of research, including detailed archaeological and palaeoecological investigations in areas

associated with pre-Norse settlement (e.g. the island of Papey in south-east Iceland) has so far produced no concrete evidence for pre-Norse settlement (Buckland *et al.* 1995), although recent work on artificial caves in Seljaland, south Iceland, may date construction at Kverkarhellir to the pre-Norse period (Ahronson 2003).

1.1.2. The Norse *Landnám*

The expansion of the Norse from their Scandinavian homeland began at the end of the 8th-century AD (Fig. 1.1), with the settlement of the Faroes ca. AD 825, Iceland between AD 870 and AD 930, and Greenland from the late 10th-century onwards (although radiocarbon dating of material from this period is often problematic due to a plateau in the calibration curve which results in a broad range of statistically likely dates, early evidence for human occupation and environmental impact is often associated with the '*Landnám* tephra'. This tephra fall was produced by simultaneous activity in both the Veiðivötn and Torfajökull volcanic systems in Iceland and is dated to AD 871±2. It is roughly contemporary with a Norse settlement after AD 870, as described in the saga *Íslendingabók* or *Book of Icelanders* – Dugmore *et al.* 2000; Jones 1986). This was a period of general expansion, and settlements were established as far afield as what is now Newfoundland, and Russia. The reasons for the expansion are varied, but population growth in the Scandinavian homelands (evident from the settlement of inner fjords and marginal land in Norway - Johansen 1982) and shifting power both within the region and in the Frankish kingdom are often cited as important factors (Marcus 1980). A culture of maritime transport had existed since prehistoric times and developments in shipbuilding technology facilitated the expansion (Marcus 1980), as did the development of commercial activity between western and northern Europe (Sawyer 2003). The outward-focussing of the ambitions of individual chieftains and their families in an area with no single authority, and a culture of adventure and greed for plunder, undoubtedly spurred the expansion (Hunter 1997; Sawyer 2003).

After a period of small-scale, later more organised, attacks on communities on the coasts of the British Isles and Ireland in the late 8th and early 9th centuries, more permanent bases were established in Ireland, Normandy and the Danelaw in England (Marcus 1980). The push to settle the north Atlantic islands came from the established communities on the Shetland Islands, Orkney Islands, Northern Scotland and Ireland, as well as Scandinavia itself (Ólafsson 2000). Although the *Landnámabók*, a description of the initial settlement of Iceland written in the 13th-century, states that 'Iceland was discovered and settled by Norwegians' (Urbańczyk 2003: 45), this can be seen as a later attempt to develop a common ethnicity/history and legitimise the land rights of certain families (Einarsson 1994). Even within the text, the mention of Hebridean origins of many of the settlers (Batey 2003), as well as the inclusion of names of apparently Celtic and Frankish/Saxon, and possibly Sámi, origin indicates a more complex situation (Urbańczyk 2003). Archaeological finds also indicate southerly as well as easterly connections - Irish style ringed pins and sword hilts from Scandinavia are found throughout the North Atlantic (Vésteinsson 2000), and studies of DNA sequences indicate that the present day population of Iceland is of mixed Norse and Celtic ancestry. It has particularly strong matrilineal links (from mitochondrial DNA) with the Western Isles of Scotland, but stronger patrilineal (Y chromosome) links with Scandinavia, indicating a different parent population for male and female settlers (Helgason *et al.* 2001). In the initial stages of settlement, the communities of the continuous coastal occupation from Norway to Greenland may not have perceived a conceptual difference of regional identity, due at least in part to the ease of travelling by sea as opposed to overland (Lynnerup 1998; Cunliffe 2001; but see Stummann Hansen 2003a who points to evidence of the early development of insular identity based on portable material culture).

The work of Small (1996-9) on the location of Norse settlements in Faroe, which is largely supported by more recent research, suggests that the 'model settlement unit' has:

> '...certain specific requirements of which the most important are: (1) access to the sea, with a reasonable place to pull up a boat; (2) a patch of fairly flat, reasonably well-drained land suitable for the construction of a

> farmstead and with the potential for some grain cultivation; and (3) extensive grazing areas, since the number of animals which the poor vegetation of the islands could support would be rather low.' (Small 1966-69: 149)

The areas considered as suitable by Small's model coincide with the known and suspected locations of early Norse settlements of the Faroe Islands (Arge *et al.* 2005), and it is likely that similar environmental requirements were desirable in Iceland.

In Iceland, archaeological and historical evidence indicates that, after an initial exploratory phase, the first wave of settlers rapidly claimed the prime land, settling areas with extensive meadows and access to wild resources. As the landscape filled up, new arrivals could only claim the less desirable lands, such as those further up the fjords or where trees had to be cleared. The only option for later settlers was to become tenant farmers, usually on the land of the richer landholders, who had effectively become the upper class. This resulted in a tiered social system, and the sagas tell of the preoccupation of the upper classes with the need to protect resources (Vésteinsson 2000). The geography of the Faroe Islands severely limits the areas available for settlement, and a similar state of affairs can be imagined (Arge *et al.* 2005).

1.1.3. Settlement from *landnám* to AD 1500

The Norse settlements in the North Atlantic thrived over the next few hundred years. After a period of complete independence during which they are considered to have become Christian (around AD 1000), the Faroe Islands became a province of Norway by declaring Magnus the Good their king in AD 1035. Although this was a period of favourable economic conditions in Faroe, the islands became increasingly isolated and dependent on Norwegian shipping connections. This resulted in a period of decline, with a Norwegian trade monopoly and the imposition of Norwegian law by the *Lagting* (the old Faroese legislative body) by AD 1300. In AD 1300, St Magnus Cathedral at Kirkjubør was constructed and, in AD 1361, the ban on trade with Hanseatic merchants was lifted. The later 14th-century was a period of economic decline, possibly

due to colder, wetter climatic conditions or the impact of the Black Death (although there is no direct evidence for this in the Faroe Islands). In AD 1380, after the union of Norway and Denmark, the Faroes came under Danish rule as a Norwegian province (rather than part of the Kingdom itself) and church and foreign ownership of land increased. By AD 1500, less than half the land was owned by Faroese landholders (Schei 2003; Jones 1970).

In Iceland, the situation was more complex. During the 'Age of Settlement' (ca. AD 874-930), the social system was based on chieftains (*goðar*) with inherited titles. In AD 930, the *Alþing* was established, a national assembly of chieftains where laws were reviewed and disputes settled. This was also the place where Christianity was adopted as the official religion in AD 1000. The power of chieftains during this 'Free State' or 'Commonwealth' was based on alliances with non-elite householders (rather than control of a territory) and allegiances could be changed by declaration at the assembly. Power struggles during the late 12th-century changed this system to one of geographically bounded polities and, by AD 1220, power was held by six warring factions (big chieftains or *stórgoðar*). In AD 1246, Þórður Kakali Sighvatsson gained the upper hand and unified Iceland. His disappearance on a journey to Norway led to further infighting and a covenant with the Norwegian state in AD 1264 that offered stability, whilst allowing Iceland to function as a semi-autonomous state (Byock 2001; Thorsson 2000; Smith 2004). From around AD 1320, the economic basis of Iceland started to change. The stockfish trade gained importance, and certain coastal communities became wealthier. For farmers, the situation was not so good due to continuing erosion and the advent of the Little Ice Age (Byock 2001). This shift to a cooler, wetter climate is apparent from the study of oxygen isotopes in ice cores (see, for example, Barlow *et al.* 1993), and would have resulted in lower yields of hay and crops, leading to hardship and abandonment in the more marginal areas pioneered by the Norse settlers (Sveinbjarnardóttir 1992). The spread of the first plague across Iceland in AD 1402 is thought to have killed about a third of the population and caused great upheaval of property ownership (Byock 2001).

1.2. THE RESEARCH OBJECTIVE

The summary of research presented above shows some significant gaps. The absence of archaeobotanical work, and limited scope of environmental work, in the Faroe Islands must addressed, and any contribution is valuable.

The research presented here was carried out as part of the inter-disciplinary research project 'Landscapes circum-*Landnám*: Viking settlement in the North Atlantic and its human and ecological consequences' (LCL), headed by Prof. Kevin Edwards at the University of Aberdeen.

1.2.1. Research objectives of the Landscapes circum-*Landnám* project

The period of interest for investigation for the monoliths, as defined by the LCL project, was AD 500 to AD 1500. Tephra deposits can often be identified in stratigraphic sequences from the North Atlantic islands and can be related to volcanic activity of a known date or narrow range of dates. Tephra deposits from AD 500 and AD 1500 were recognisable in the Icelandic monoliths, so were selected as useful beginning and end points for the study. This period covers significant social and economic changes in the North Atlantic, which can be summarised as:

1. Pre-settlement – AD 500 to *landnám* (Faroes ca. AD 825, Iceland between AD 870 and AD 930) – to establish environmental conditions in the North Atlantic islands before the settlement;
2. The Viking period – *landnám* to AD 1050 – the arrival of the Norse settlers, construction of longhouses with a uniform architectural style and the introduction of an economic strategy based largely on domesticated animals;
3. 'Europeanization' – around AD 1050 to AD 1350 – Norwegian royal authority and ecclesiastical organisation – adoption of new cultural features but still uniform architectural style – generally

self-sufficient economy with reliance on trade for items not obtainable locally;

4. 'Marginalisation' – around AD 1350 to AD 1600 – shift to dried fish as major export and reliance on foreign interaction via trade – regional developments in house styles etc. (Stoklund 1996).

The LCL project employed various techniques, especially entomology, palynology, soil analyses, tephra analyses, geomorphological mapping, zooarchaeology and archaeobotany. The focus of this interdisciplinary research is on archaeological sites of key interest due to their environmental context, allowing for high-resolution and spatially precise studies. Several sites were selected for study and the results of the analysis of their plant macrofossil assemblage are presented in this thesis (unless otherwise stated).

1.2.2. Key objectives of the archaeobotanical research presented in this thesis

The key objective of the archaeobotanical research presented here is to assess the introduction of agriculturally based economies to the Iceland and the Faroes. Principally the thesis seeks to answer the following questions:

1. What were the 'natural' landscape and environmental conditions of Iceland and the Faroes like when the Norse arrived?
2. What was the impact of human activity on the landscape and environment of the settled areas?
3. What plants were brought by the settlers, either as deliberate imports or accidentally?
4. How was the local environment adapted to suit the Norse economic system, and how were the economic system and living conditions adapted to meet the environment of the newly settled areas?
5. What were the longer-term effects on the landscape and environment of the Norse settlement and did they necessarily lead to landscape degradation and abandonment?

These objectives were approached through the analysis and comparison of two sets of data one based on the analysis of material from monoliths taken from peat sequences ('off-site' samples) and the other based on the analysis of samples of deposits from archaeological sites ('on-site' samples).

Monolith samples taken from a range of 'off-site' peat sequences were used to indicate changes in the plant communities chronologically and spatially whether as the result of 'natural' events or human activity. If possible, several areas of the landscape were sampled to investigate local patterns, especially to compare the 'infield' and 'outfield' of Norse farmsteads. Secondly 'on-site' samples i.e. from features on archaeological sites (Toftanes and Sondum) were analysed. This material, from a farmhouse and midden respectively, were used to investigate questions related to the use and disposal of plant resources by the Norse settlers. The selection of material from the many samples taken for the 'LCL' project as a whole was made under the guidance of the project management team (i.e. Prof. Paul Buckland and Prof. Kevin Edwards).

The archaeobotanical assemblage from Toftanes, a farmstead on the island of Eysturoy was the first from a settlement to be analysed. Material from the midden at Sondum on Sandoy complements results from the Undir Junkarinsfløtti midden in the same area (also analysed as part of the LCL project by Mike Church). These provide good comparative material for similar sites excavated in Greenland, Iceland, Britain and Scandinavia. The work on the monolith from Hov adds a southern site to compare with the recent work by Hannon (1996) on the northerly Faroe Islands, integrating the local and regional vegetation.

In Iceland, there has been little work on vegetation change in the west of the island, most studies focussing on the south. The monoliths from Reykholtsdalur and Halsasveit are essential in understanding change in this area. The sampling of several sites in the same valley gives a good spatial range, and the selection of material from settlements with different functions in their early phase of occupation (agricultural or ironworking) gives an idea of the

impact of different activities on the landscape. Stóramörk has been continuously occupied since the settlement period and is located in an area adjacent to a dynamic sandur environment in the area and has been extensively settled in the past. Recent work in the area indicates that sediment accumulation rates were low below the *landnám* tephra, and that, by AD 920, substantial sediment flux variations had began, continuing to the late 14th-century (Mairs *et al.* in press). The analysis of the monolith from Stóramörk indicates how these changes affected the plant community in the area adjacent to the farmstead.

From the samples from the monoliths, changes in the ecology of the bog are indicated. The dating of the core helps us to relate this to the historical events occurring in the islands, and integrate changes in the plant macrofossils with the pollen diagrams produced by researchers in Aberdeen. Long-term perspectives on the accumulation of plant remains help to establish the plant community and resource base from AD 500 to the *landnám* - the species present and, therefore, the ecological conditions. It is possible to establish whether this was naturally stable or prone to change over time. The depth of the layer representing the initial phase of settlement in the monoliths, which is marked by the *landnám* tephra horizon (AD 871±2), should allow us to assess how quickly the impact of human activity on the environment was felt by the vegetation of the immediate area, and whether the vegetation was depleted or enriched in species after settlement. In the period from *landnám* to AD 1500, the effects of environmental changes, both natural and human induced, should be visible.

The plant macrofossil assemblages from archaeological contexts give more information on the human interaction with the plant community. The species exploited by the Norse – for food, shelter, fuel, animal fodder, bedding, storage and many other purposes - are represented. Changes in plant exploitation may indicate adaptation of the Norse subsistence strategy over time. The resources exploited on the first settlement of the new island environment, for fuel, fodder and construction, may have been different from those used in the Scandinavian homelands, as the Norse quickly adapted to the pristine environments. For successive generations effects of changes in the environment, caused by both nature and human actions, would have led to constant adaptation of the resource

base, and it needs to be understood how later generations were constrained by the choices of their forefathers. These remains allow us to interpret the different plant communities exploited and manipulated by the Norse, and perhaps to establish some idea of the seasonality and importance of plant resources.

1.3. STRUCTURE OF THE THESIS

The research is presented in seven chapters. After the brief introduction and chapter summary presented in Chapter 1, Chapter 2 describes the geographical and environmental conditions in the Faroe Islands and Iceland, the archaeological and historical context of the settlement of the study areas, the current state of archaeobotanical research in the area of Norse influence and the aims of the research presented in later chapters; Chapter 3 describes the sites investigated in this thesis and their importance for the research questions outlined in Chapter 2; Chapter 4 outlines the methodology used to collect data relevant to the research questions outlined in Chapter 2 from the sites described in Chapter 3; Chapter 5 presents the results of the investigations described in Chapter 4; Chapter 6 discusses the results presented in the preceding chapter in terms of the wider context of research and research aims outlined in Chapter 2 and Chapter 7 summarises and concludes the preceding chapters.

From Chapter 5 onwards, the results of plant macrofossil analysis are integrated with previous and current research using a variety of techniques (notably the analysis of pollen, beetles and soils) and discussed in the context of the wider Norse area of influence.

CHAPTER 2: CONTEXT OF RESEARCH

2.1. GEOGRAPHY OF THE NORTH ATLANTIC ISLANDS

The islands under investigation are located in the north Atlantic Ocean, between Scandinavia and Greenland.

2.1.1. The Faroe Islands

The Faroe Islands are located in the north Atlantic Ocean, almost midway between Scotland (Shetland 300 km), Norway (675 km) and Iceland (450 km) (Fig. 2.1). They are situated between 61°20' and 62°24' N and 6°15' and 7°41' W (Tukhanen 1987).

The climate of the Faroe Islands is strongly maritime, characterised by cool summers (maximum mean 11° C), mild winters (minimum mean 4° C), cloudy skies, high precipitation (annual average of 1500 mm in the capital Tórshavn) and strong prevailing winds from the south-west (Tukhanen 1987). These features are a result of the islands' position on the North Atlantic polar front, where the cold Arctic air masses meet the warm, humid ones associated with the Azores anticyclone further south in the Atlantic Ocean, as well as the effect of the Gulf Stream. The topography of the Faroe Islands is mountainous (the highest point, Slættaratindur is 882 m above sea level), and this forces the humid air at sea level upwards, increasing condensation and producing precipitation (Arge 2000). The climate is similar to that in Shetland and the outermost coastal areas of western Norway (e.g. Lerwick and Ona), as well as a sector of upland Scotland (e.g. Eskdalemuir).

The Faroes comprise of some 18 islands plus a number of islets and skerries, separated by narrow sounds and fjords, which cover an area approximately 118 km from north to south and 75 km east to west, and 1400 km² in land area (Tukhanen 1987). Geologically, the islands consist of plateau basalts, separated by layers of volcanic ash, tuff, shale, clay, coal and sandstone. This layering of the bedrock results in a terraced effect in the landscape, because the basalt

layers are harder, and therefore more resilient to erosion, than the softer tuff. The basalt dips slightly from the north-west to the south-east, producing steep cliffs on the western and northern shores, whilst those in the east slopes gently to the sea (Rasmussen and Noe-Nygaard 1970). The Faroe Islands were covered by their own ice cap during the last glaciation (Jóhansen 1985) and the landscape was shaped by glacial erosion and the deposition of sediments by the melting ice. The re-working of glacial deposits in the post-glacial period has altered the form of the landscape, with the post-glacial development of soils, peatlands, gullies and other features. The soils consist of till, gravel or peat, or the weathering products of exposed bare bedrock. They are nutrient-poor due to leaching, with high calcium content due to the basalt bedrock. Faroese soils have a pH of 4.6-5.3 (-6.5) (Tukhanen 1987).

The vegetation of the Faroe Islands consists of plants that can thrive in the prevailing climatic conditions of high rainfall and constant winds, a considerable annual variation in the length of day, and a long, cool growing season with few extremes of temperature. The steep topography of the landscape means that altitude is a major factor affecting the zoning of vegetation, and the sharp climatic gradients on the coast mean that vegetation zones also change with the distance inland. Plants need to be able to complete their growing cycle at low temperatures with snowless winters (there is no permanent snow cover in winter in the lowlands, which can disturb the winter dormancy). They need to be able to cope with constant wind, but in general do not need to be adapted to temperature extremes, although drought does occur in some habitats (Tukhanen 1987).

The modern vegetation, even on uninhabited skerries, is dominated by grassland. This is largely the product of sheep grazing, although the islands are currently stocked at a level which does not risk overgrazing (about 70 000 head of sheep - Tukhanen 1987). 'Natural' (i.e. ungrazed) communities are restricted to inaccessible places, such as cliffs. In the lowlands, *Calluna* heaths with a mixture of grasses, herbs and mosses are common. Snow-bed vegetation and fell-fields occur in the alpine regions. Mires, but not raised bogs, are also found, and a few areas of sand dunes and salt marshes occur in the otherwise

cliffed coastline (Fosaa 2001). Cultivated land is about 6% of the total area of the islands, generally near the coast, and hay is the main crop (Hannon *et al.* 2001). Of the 400 species of flowering plants recorded for the islands, 310 are considered indigenous, with 30 species naturalised since the settlement and 60 occurring as weeds on cultivated land or in urban areas. The flora is dominated by perennial herbaceous plants (Hansen and Johansen 1982). Around 50 species are historically known to have medicinal uses, 20 are known to have been used as food, 22 as dye plants and 28 some other practical purpose (Svanberg 1996-7 – see also Section 6.2.4).

2.1.2. Iceland

Iceland is located in the North Atlantic region, 970 km west of Norway and 290 km east of Greenland (Fig. 2.1). It is situated between 66°32' and 63°23N and 24°32' and 13°30W, and covers an area of 103, 600 km².

The climate of Iceland is transitional between the cool temperate and sub-polar oceanic zones, and the movement of the polar air front. As it is warmed by the Gulf Stream, summers are cooler and winters milder than other places of similar latitude. Temperatures average between -4 and -6° C for much of the coastal area in January, and over 10° C in July (1931-1960 figures). Conditions tend to be milder but wetter in the south and west, and drier with icy winds and more frequent blizzards in the north and east (Preusser 1976). Annual precipitation varies from around 400 mm in the north to 3600 mm in the south-east (Einarsson and Albertsson 1988). Wind strength, and the frequency of strong winds, varies greatly from region to region. The prevailing winds are from the west, although in many coastal areas there is a diurnal change of wind direction from land to sea. As with the Faroes, the northerly location means that the length of day varies greatly between winter and summer, and the low angle of the sun's rays (up to 50° even in June) means that the location of settlements is often influenced by the slope of hillside. Settlements are often located on south-facing slopes, taking advantage of longer hours of direct sunlight (Preusser 1976).

Iceland is part of the mid-Atlantic ridge, and 90% of the landmass is made up of volcanic rocks, with 10% consolidated sediments (Geologie 1980). The Tertiary basalts of the island are split into eastern and western parts by the Central Icelandic Graben, a region of tectonic activity, and are often separated by layers of tephra, tuff-conglomerates, fluvial sediments and/or aeolian deposits (Preusser 1976). Hot springs and steam fields are common, and the heat of the output varies from one location to another (Geologie 1980). These areas often support species of plant and animal more adapted to warmer conditions (Preusser 1976). The landscape is highly variable and is characterised by vegetated lowlands, fjords, tundra plateaux, highlands, volcanic landscapes, sandur (sand deltas) and icecaps - only 21% is considered to be arable and habitable, mostly near the coast and where river valleys extend inland (Preusser 1976).

The general pattern can be categorised as follows:

1. low-lying areas with bogs and meadows, also isolated remnants of birch woods,
2. slopes with scrub heath and meadows,
3. low highlands (up to 600 m) scrub 'tundra', 'tundra' bogs and moss or lichen tundra, also deserts resulting form deflation,
4. 600-900 m almost completely without vegetation due to low summer temperatures,
5. uplands (above 900 m) - ‘cold desert' with isolated plants.

These patterns of a decrease in the number of species and an increase in arctic species with increasing elevation is, however, often modified due to the effects of factors such as the height of the water table and exposure (particularly to wind).

Although Iceland climatically falls in the boreal zone, its vegetation has been referred to as 'pseudotundra' because the treelessness is considered to be human in origin (Hustich 1960) although Dugmore and Buckland (1991) refer to it as ‘ovigenic’ due to the impact of sheep grazing. As with the Faroes, grasslands dominate the vegetated areas of Iceland, with woodlands *(Betula pubescens*,

Salix phylicifolia, *Sorbus aucuparia* and *Juniperus communis*) confined to the more inaccessible places.

2.2. THE VEGETATION OF THE NORTH ATLANTIC ISLANDS

2.2.1. Modern plant communities

The vegetation of the North Atlantic islands is characterised by low species diversity, with the Faroe Islands having around 400 species and Iceland around 440. Iceland and the Faroes have a very low number of possibly endemic species, suggesting a young flora whose parent populations originated to the east and south in Europe (the Icelandic flora has a 98% European affinity – Einarsson and Albertsson 1988). Iceland and Faroe have one local endemic species each (*Euphrasia atropurpurea* in Faroe - Tukhanen 1987, *Carex lyngbyei* in Iceland - Einarsson 1963), and *Alchemilla faeroensis* is considered endemic for the Faroe-Iceland region (Kristinsson 1987).

2.2.2. The origin of the biota

The origin of the biota of the north Atlantic islands is the subject of much debate. Based on observations of the similarity of the basalt geology in the regions, early investigators proposed a land bridge (that was subsequently flooded), or a series of islands, connecting the British Isles to the Faroe Islands, Iceland and Greenland. The proposal would allow species to 'island hop' across the region. Later work indicated that this division took place as early as the mid-Tertiary, and that the survival of species through several glacial cycles would have to be proven (Coope 1986).

The debate continues as to whether plants survived the last glaciation in refugia, or were completely wiped out, and subsequently re-colonised from unglaciated areas (the '*tabula rasa*' or 'clean slate' hypothesis) (Buckland and Dugmore 1991). The concept was first proposed for Iceland regarding the survival of invertebrates by Lindroth (1931), and for plants Steindórsson (1963). The

centric distribution of some species, even though there was no physical barrier to their continuous distribution, was interpreted as indicating six districts as probable refugia. The refugia hypothesis was supported by the work of the geologist Sigurvinsson (1983) and the botanists Rundgren and Ingólfsson (1999) who proposed an ice-free area in north-west Iceland. The Faroe Islands were, however, entirely covered by their own ice sheet during the last glacial maximum (Jóhansen 1985), but exhibit a more diverse flora and insect fauna than Iceland (Coope 1986). Although there is no exact date for the retreat of the ice from the Faroes, Jóhansen (1985) supposes that around 10 000 BP would be a sensible estimate. This is based on a ^{14}C date of 9600±150 BP from Hoydalar, taken from 10-20 cm above the basal organic deposit, indicating that soils began to form in the area before this date.

Some of the more recent input into the debate has been made by Buckland and Dugmore (1991), who proposed that the cool temperate character of the flora and fauna, and the low number of endemic plant and animal species, does not support the idea of refugia (where one would expect arctic biota and a higher number of endemics). They also state that the low dispersal powers of the biota make colonisation by atmospheric and/or oceanic currents unlikely to have been a major route. They proposed an alternative model (Buckland and Dugmore 1991) based on the premise that the colonisation of the north Atlantic biota from Scandinavia took place during the transition from the late glacial to the early Holocene (ca. 10 000 BP) when flood debris and massive ice-rafts detached from the melting ice sheet were being carried across the North Atlantic by the prevailing sea currents of the time. Evidence for sea currents during this period indicates that flows of warm water could have carried material in an east-west direction across the North Atlantic (Jansen *et al.* 1986). Vectors of colonization such as air and sea currents, driftwood, birds and, in later periods humans, are also proposed to have had an impact on the flora of the islands (Rundgren and Ingólfsson 1999).

Whichever vectors resulted in the transport of a viable seed to the island, the severe filters and 'sweepstake' nature of the process would have resulted in the selection of species exhibiting particular adaptive features – factors such as the

distance and time to travel from the area of origin (seeds with long dormancy capabilities would be more likely to survive), the differential adaptations of species to the vector (e.g. robust enough to survive digestion by birds or adapted for aerial dispersal) (Williamson 1981). The genetic 'bottle-necking' which occurred as the few viable seeds to survive the journey, as well as successfully germinate, mature and seed in the sterile post-glacial soils, often led to phenotypic forms in the island populations which are noticeably different from those of the parent populations, due to the restricted genetic range of the founder population.

2.2.3. Pre-settlement vegetation

Work by Jóhansen (1985) on pollen from the Faroe Islands indicates that the period from 6000-1300 BP was characterised by stable, *Juniperus* shrub, *Calluna* and tall-herb vegetation, although other areas show less stability during this period (e.g. Gróthúsvatn on Sandoy with a change from herb-rich fen to shrub woodland ca. 2250 BC – Hannon *et al.* 2001). Peat formation began spreading from low-lying areas from around 5000 BP (Jóhansen 1985). The distribution of birch and willow was probably always restricted to the most sheltered areas (Arge 2000). In Iceland the climax vegetation appears from pollen analysis to be birch (*Betula pubescens*) and willow (*Salix* sp.) forests, with unwooded areas at higher altitudes (Hallsdóttir 1987).

A substantial amount of work has already been carried out into long-term vegetation changes in the North Atlantic Islands. Jóhansen interprets a pre-Norse (Irish) occupation around AD 600-700 from the Faroese pollen diagrams (Jóhansen 1971). This is indicated by the presence of cereal pollen, increases in *Rumex* and *Plantago lanceolata,* and decreases in the proportion of *Juniperus* and Filicales (*Dryopteris*-type ferns which are not tolerant of trampling). Hannon and Bradshaw (2000) interpret changes in the landscape such as the presence of cultivated crops (based on the presence of Cerealia pollen), charcoal and a shift from woodland scrub and herb-rich plant communities to heathland and peat from deposits, ^{14}C dated to AD 500-700, to be the result of an early settlement. These results are still the matter of some discussion as the dating of

some of these cores (Buckland 1989-90), and the positive identification of cereal pollen in wet northern habitats is problematic, especially if the dataset is not large (Moore *et al.* 1991).

2.2.4. *Landnám* - the effects of the Norse settlement

Ari *inn Froði* (the Wise) Þorgilsson, writing about the settlement of Iceland in AD 1120, states:

> 'At that time the land was wooded from beach to mountain'
> (Eysteinsson and Blöndal 2003: 411).

His use of the past tense indicates there had been a significant impact on the native forests by the time of writing (Eysteinsson and Blöndal 2003; Hastrup 1985), which is reflected in palynological and other studies in both Iceland and the Faroes.

The management of woodland by pollarding and coppicing is thought to have been practised in western and northern Norway by the Viking period (Hallsdóttir 1987; Austad 1988), and it is likely that the farmers who settled in the Faroe Islands and Iceland were aware of techniques of forest management. The settlers are likely to have had some degree of awareness of the effects of their behaviour on the woodlands. Across the North Atlantic islands, different strategies for wood and shrub clearance such as burning and manual clearance by axe are evident. The strategy selected may have depended on a variety of factors, such as the condition of the vegetation (treeless areas or areas of open scrub such as the Faroes, Papey and the shifting sandur of Iceland versus the more dense woodlands of lowland Iceland and Greenland), the suitability of the area for grazing (e.g. wind speed, slope), the use of wood as a resource (e.g. fuel, fodder), and the intended use of the land (e.g. cleared fields versus rough grazing).

The impact of human settlement on the woodlands of the North Atlantic varied from region to region. In Iceland, the impact of the settlers was significant, and is generally indicated by decreasing amounts of birch (Einarsson 1963). Woodland clearance is evident to a lesser extent in the Faroes due to the more

open nature of the vegetation at the time of settlement (Jóhansen 1985). In Greenland clearance seems to have been limited to areas around the settlements (Fredskild 1978). It is possible this was due to the different nature of the forest plant community in the new regions. Re-growth was perhaps not as vigorous in the new regions due to a more limited range of tree species and a shorter growing season than in Scandinavia, and the climax vegetation may have been more susceptible to anthropogenic changes to the environment outside the natural range of conditions than the Scandinavian forests with their long history of human exploitation.

The adaptability of the settlers' resource management strategy to the new resource base of the islands may have affected the values placed on resources. Local wood is likely to have had a more limited range of uses than in Scandinavia due to its poorer quality (large trees for tasks such as boatbuilding probably always had to be imported or gathered from driftwood - Stoklund 1984), and the widespread availability of peat as an alternative fuel may have led to a perception of low use-potential of woodland resources during the settlement period. If domestic animals were the main source of status and the focus of the economy, the opening of new areas for grazing may have taken priority over the preservation of woodland. The concern with recording access rights to the remaining woodland resources in Icelandic documents from the 12th-century onwards (Sveinbjarnardóttir 2004) indicates that this attitude was short-lived, and that the rapid rate of tree and dwarf shrub clearance may have led to a need to preserve and manage the woodland that remained.
Archaeological excavations indicate that initial settlement favoured open locations on the coast or broad river valleys, while a secondary phase of settlement was located in wooded areas of land already claimed by the first wave of settlers (Vésteinsson 2000). For the second wave of settlers, the removal of trees to clear space for the construction of settlements and the laying out of infields would have been necessary. The charcoal layer below the initial phase of building at Ísleifsstaðir in Borgarfjörður (Roussell 1943a) has been interpreted as indicating the use of burning to clear woodland.

Grass and sedge pollen increased, an indicator of the rapid expansion of new ecological niches of grazed pasture and managed meadow (Hannon and Bradshaw 2000 for Faroe; Einarsson 1963 for Iceland), and the collection of wood for fuel is also likely to have been widespread (Simpson *et al.* 2003). This clearance of vegetation by humans, and the subsequent grazing by livestock, left the Icelandic landscape prone to rapid soil erosion by wind and rain (Fridriksson 1978), although this varied depending on the altitude of the land (Dugmore and Buckland 1991; Dugmore *et al.* 2000) and management strategies may have limited the effects of grazing in some areas (Simpson *et al.* 2004). The impact of grazing in the Faroe Islands seems to have been less severe, at least in some areas (Humlum and Christiansen 1998; Mairs 2003; Lawson *et al.* 2005).

During the longer-term settlement period, soil erosion continued to be a problem, resulting in the loss of farmland. The climatic cooling of the Little Ice Age, beginning about AD 1350, reduced the vegetation growing season and thus hay yields and herd size. Changes in land management practices and the drainage of wetlands also altered the ecology of the islands (Sveinbjarnardóttir 1992). In Iceland, although woodland was severely diminished, access to wood as a resource was maintained until the historical period by management strategies such as coppicing (Dugmore *et al.* 2005). In historical records from Iceland, the erosion of the landscape has been a matter of grave concern in terms of its impact on domestic animals, and therefore on humans, from Ari the Wise's account to the present day (Fridriksson 1972).

2.2.5. Introduced and Anthropochorus Taxa

Contrary to the established theory of island biogeography (see Williamson 1981 and others), the wave of extinction predicted for island biota resulting from human occupation did not occur in the north Atlantic islands. This is considered indicative of a young biota, as both deliberate and accidental introductions were able to move into vacant niches, and native plants took advantage of the new niches created by the settlers (Sadler 1999). According to Jóhansen (1985), *Rumex acetosa*, a native plant which would have grown in

low-lying regions, on rock ledges and hill plateaux before *landnám,* shows greatly increased pollen values from *landnám* onwards, as it colonised the new habitat created in fertilized homefields. The extent of the infield of abandoned farmsteads is still visible today as they maintain a plant community distinct from that of the outfield due to nutrient-enrichment (e.g. at Háls in Icleand – Dixon 1997). It is likely that up to 20% of flora of Iceland (excluding *Hieracium* and *Taraxacum*) is anthropochorus (Steindórsson 1963), and 23% for the Faroe Islands (Hansen and Johansen 1982).

The movement of the Norse across the north Atlantic, as well as the deliberate introduction of their economic staples – sheep and cattle and crops - to their new settlements, would have resulted in the transport of a number of 'stowaways'. It is generally considered that the majority of new species introductions took place during the first occupation by the Norse settlers, and that there was a tail-off before the fashion for ornamental plants and new crops in the 20th-century (Davidsson 1967; Steindórsson 1962), although the movement of goods via the Newfoundland trade routes in the 17th and 18th centuries is also likely to have led to introductions (Lindroth 1957). Hay imported by the first settlers, cleaning of ships (including food, fodder and dung) and the import of barley (for seed-corn and consumption) are all likely to have resulted in the introduction of new species into the coastal districts occupied by the new settlers (Steindórsson 1962). It is also possible that useful plants, such as *Corylus avellana, Rumex domesticus* (syn. *R. longifolius*) and *Urtica dioica*. were deliberately introduced by the settlers as food and textile plants (Davidsson 1967).

During the 20th-century, various schemes have used introduced or native plants in an attempt to manage soil erosion. The introduction of the Alaska lupin (*Lupinus nootkatensis*) and a lyme grass (*Elymus mossis*) (Bjarnason 1978) and sowing of native lymegrass (*Elymus arenarius*) are examples of these projects (Runolfsson 1978).

2.3. THE CURRENT STATE OF RESEARCH ON THE NORSE PERIOD FLORA

The current state of research into vegetation and plant use during the Norse period is very varied. Archaeobotanical material from Norse/Viking period sites varies greatly, from urban deposits with good organic preservation to assemblages of charred grain from individual features at settlement sites. Similarly, research into vegetation changes at a landscape level from pollen analysis vary in number of sites and resolution of analysis from region to region.

2.3.1. Scandinavia

The location of the sites mentioned in the text is shown in Fig. 2.2.

2.3.1.1. Landscape and vegetation

The environmental impact of the developments outlined above varied in Scandinavia, although the Viking Age is broadly considered to be one of expansion in outland use (Svensson 1998; Mogren 1998). In rich agricultural areas such as Skåne and Dalarna, Sweden, and areas of Denmark, pollen diagrams indicate an increased human impact on vegetation from ca. AD 700 (Gaillard and Berglund 1988; Berglund 1988; Emanuelsson and Segerström 1998). An increase in the pollen of *Secale*, Cannabaceae (possibly hemp or hop) and wild plants associated with cultivated fields and ruderal areas is associated with a decrease in pasture and forest types. *Hordeum* is also present, indicating its continuation as a major cereal crop alongside *Secale*. In areas of Dalarna, an increase in Cyperaceae pollen may indicate deliberate flooding to manage hay production (Emanuelsson and Segerström 1998). In more marginal areas, such as upland Romeleåsen, southern Skåne, there is also evidence of intensified utilization or colonization of marginal areas between ca. AD 800 and 1000 (Berglund 1988) and, in northern Sweden (Luleälv River Valley, Norrland), the impact of human activity on vegetation is evident from around AD 500 and becomes more intense over time, resulting in permanent fields and continuous agricultural land use by AD 1000 (Segerström 1990).

In other regions, there is evidence for abandonment of land during the Viking period. At Bøstad, in the north of Norway, there is evidence for a shift from grassland to heath shortly before AD 950, possibly due to the overexploitation and the abandonment of the area (Vorren 1979). A decline in plants associated with mire margins (e.g. *Filipendula ulmaria*) and Poaceae is accompanied by an increase in Ericales, particularly *Empetrum*-type. At the transition between Viking and Early Medieval deposits, *Humulus/Cannabis* pollen is present, which may represent the introduction of hops to the region. Cerealia, *Rumex acetosa* and *Ranunculus acris*-type pollen decline slightly higher up the profile, and may relate to the abandonment of the area during the Black Death (AD 1349). In other areas, such as Abkær and Holmegaard Bog in Denmark, there is evidence for the regeneration of *Fagus*-dominated vegetation from ca. AD 400, and this pattern continues throughout the Viking Age (Andersen 1988; Aaby 1988). At Holmegaard Bog, the accompanying increase in dry-land herbs and shrubs (e.g. *Crataegus* and *Sorbus*) is interpreted as indicating the presence of woodland glades and conditions suitable for cattle grazing (Andersen 1988). Although woodland regeneration is often interpreted as abandonment, it may indicate a shift in focus of the agricultural regime, for example from cereal production to cattle grazing.

2.3.1.2. Archaeobotanical research

A survey of archaeobotanical assemblages recovered from Viking Age sites in Scandinavia indicates that barley, rye and oats were the major cereal crops, and wheat, flax and pea, were also widespread (Table 2.1). From the end of the Iron Age/Vendel Period in Denmark, southern Sweden and south west Finland there is evidence of changes in the agricultural system. Rye and winter annual weeds become more abundant and widespread through the Viking Age and into the Middle Ages (Robinson 1994; Engelmark 1992; Helbæk 1966; Onnela *et al.* 1996). As well as giving acceptable yields on poor soils and being more tolerant of frost and low temperatures (Viklund 1994), the fact that rye is an autumn-sown crop would have been advantageous when combined with the cultivation of spring-sown crops to stagger the agricultural workload more

evenly over the year (Robinson 1994). Storage samples from Ilstorp indicate a shift from the infield-outfield system to a three-field rotation system (Hjelmqvist 1992). Social developments, including craft specialisation in proto-towns and increased social stratification, would have necessitated surplus production for trade and tribute, providing a stimulus for agricultural intensification (Hansson 1997). In Denmark, evidence for the support of specialist groups with imported plants comes from Fyrkat, a 10th-century military camp (Helbaek 1974). The assemblage recovered from a storage context at the site contained rye grains that were considerably larger than other finds from Denmark, and a low number of seeds of other taxa. Taxa present in the assemblage included the exotic species coriander (*Coriandum sativum*) and bishop's weed (*Aegopodium podagraria*) and may indicate an easterly origin for the grain (Jensen 1985; Robinson 1991). At Borg, the site with the most northerly Viking archaeobotanical assemblage, this intensification of agriculture is not evident. Hulled barley is the only cereal present and is considered to have been grown locally due to the presence of sickles and scythes at the site (Hansson 1997). In the Viking Age, settlements in marginal areas were predominantly (although not solely) suppliers of raw materials for processing in the central areas (Martens 1998). The participation of Borg in international contact networks is evident from artefacts at the site, and the basis of its wealth may have been the trade in furs and stockfish. Although it is not evident in the archaeobotanical assemblage, it is possible that food resources (such as wheat flour) arrived at Borg as part of exchange transactions, as described in Egill Skallagrimsson's saga for Norway during the Viking Period (Hansson 1997).

Wild plants are widespread in Viking Age archaeobotanical assemblages from Scandinavia, and are likely to represent the supplementation of the cultivated component of the diet with wild resources. Hazel nut shell is commonly recovered, as well as the seeds of wild strawberries, raspberry, blackberry and elderberry and the pips of crab apple. Imported foods such as walnut (*Juglans regia*) and fig (*Ficus carica*) were not present until the Medieval Period.

Several other plants present in the archaeobotanical assemblages also have uses. Brewing is indicated by the germinated barley and other cereal grains present at

Bryggen (Krzywinski *et al.* 1983). Hops (*Humulus lupulus*) and bog myrtle (*Myrica gale*) are both known as flavouring and preservatives used in the manufacture of beer, and have been found at several of the proto-urban sites in Denmark and Norway (Jørgensen 1986; Robinson 1994; Jensen 1986; Hall and Kenward 2003-4), and in deposits at Birka in Sweden (Hansson and Dixon 1997; Hansson 1997). The high number of *Sambucus* seeds recovered from several Norse and Medieval sites in Denmark is likely to indicate some kind of collection/cultivation for use (C. Malmros pers. comm.). Another cereal product, flour, is evident from finds of bread at several sites in Sweden, including cremation graves at Birka (dated to AD 600-1050 and containing hulled barley and oat - Hansson and Isaksson 1994) and Ljunga (containing a mixture of cereal, pea and Scots Pine bark – Hansson 1997). The dye plant woad (*Isatis tinctoria*) is present at Kaupang (Hall and Kenward 2003) and was also recovered from the Oseberg boat burial (Holmboe 1927), indicating that, as well as its potential industrial use in the proto-urban town, it may have had some sort of ritual/spiritual symbolism. The presence of flax (*Linum usitatissimum*) may indicate the production of linen from the stem or the pressing of seeds for oil (Bond and Hunter 1987). It is notable that plants potentially used in brewing and the production of cloth are not present at Borg. Although this absence should be treated with caution, this may relate to the fact that the role of Borg was to supply furs and stockfish, so plants and plant products were supplied from urban centres by exchange and were not processed at a household level.

The use of plants for activities other than consumption is particularly evident from sites with high levels of organic preservation. The interpretation of *Sphagnum* moss in latrine deposits as toilet 'paper' in urban deposits from Norway (Griffin 1988; Krzywinski *et al.* 1983), and layers of woodchips and peat which may have functioned as insulating for floors at Gamlebyen (Griffin 1988) indicate the extent to which the evidence for the use of plants is lacking at archaeological sites without organic preservation. The most widespread potential fuel types present are wood and charcoal, although seaweed is also present at Kaupang (Hall and Kenward 2003).

Although changes in agricultural practice took place in Scandinavia during the Viking Age, it was the infield-outfield system, based on the cultivation of barley, which was taken west to the Faroe Islands and Iceland. The settlers are generally considered to have come from the west coast of Norway, which is an under-represented area in terms of archaeobotanical research. Comparison of the archaeobotanical assemblage from Borg with those in Southern Scandinavia indicates that the increased importance of rye, and the system of crop-rotation, may not have reached more northerly areas of the country by the time of the westward emigration. It is unlikely, however, that the emigrants were unaware of developments in agricultural techniques to the south, and that groups settling in areas to the west consisted exclusively of immigrants from the Norwegian coast. The role of the more northerly settlements involved supply of resources for trade, as well as agricultural production, and they therefore had a different place in the economic system. It could also be suggested that, as one potential stimulus for the changes in cereal cultivation was surplus production to support the proto-urban craft specialists, the infield-outfield system was more suitable in areas where these centres had not developed, or where land was not already settled. The supplementation of cultivated resources with wild fruits and berries was a widespread practice.

2.3.2. Russia

The location of the sites mentioned in the text is shown in Fig. 2.2.

2.3.2.1. Landscape and vegetation

Analysis of pollen from a fen south-west of Novgorod indicates an intensification of agriculture which corresponds to the earliest known presence of Norse settlers and the immigration of Slavonic tribes around AD 800 (Köningsson and Possnert 1997).

2.3.2.2. Archaeobotanical research

Although little work has been published on botanical material from Norse sites in Russia, rich waterlogged and charred material from a 9^{th}-10^{th}-century pit at Staraja Ladoga (Aalto and Heinäjoki-Majander 1997) includes a range of plant

macrofossils. Barley, oat, emmer wheat, rye, millet, linseed, cannabis seed, hop, hazelnuts and wild seeds with medicinal uses were recovered, as well as hemp rope, wood, conifer needles and cones. Wild seeds that indicated plants from various habitats, including fields, grazing land, riverbank and ruderal areas were present in the deposit.

2.3.3. The Northern and Western Isles of Scotland and Caithness

The location of the sites mentioned in the text is shown in Fig. 2.3.

2.3.3.1. Landscape and vegetation

Although there are few sites with well-dated pollen assemblages from the Viking Age on the Scottish Mainland, and only one from the islands (Dark 2000), the evidence indicates an increase in forest clearance, usually accompanied by cereal cultivation (e.g. Machrie Moor, Burnfoothill Moss, Lón Mór, Gallanach Beg and Black Loch - Huntley 1995). At Hill of Harley, a site 1.5 km from Freswick Links in Caithness, the landscape during the Viking Age consisted of areas of moorland, grassland and mixed farmland, and the occurrence of cereal pollen indicates that at least some of the cereals recovered from the site were grown locally (Huntley 1995). The expansion of cereal cultivation into more marginal areas was made possible by warmer climatic conditions (Robinson and Dickson 1988), and the clearance of woodland may have also related to the increased use of and/or trade in timber, although it is unclear in many areas if and how these trends related to Viking activity or influence due to lack of archaeological data (Macklin *et al.* 2000).

2.3.3.2. Archaeobotanical research

The Norse colonisation of the Northern and Western Isles of Scotland by the early- or mid-9th-century had significant effects on the plant economy. Hulled six-row barley continued to be cultivated, with an increase in the importance of oat (Table 2.2). New crops were introduced which are particularly suited to the free-draining soils, which are present in areas such as the machair on Uist and

Sanday in the Orkneys, and which do not seem to have been exploited to any great extent in the preceding periods. Rye was introduced at Pool in the Northern Isles, and is likely to have been cultivated as a crop at both Kilpheder and Bornish in the Western Isles (Smith and Mulville 2004; Hunter 1997). Flax, although known in the Iron Age in both the Northern and Western Isles, occurred in greater quantities and was introduced to islands where it was previously unrecorded (e.g. the southerly Outer Hebrides). Although both oil and fibre can be obtained from *Linum usitatissimum* plants, there may be selection for larger seeds or better fibres if production is specialised. Charred seeds from sites in Orkney (Saevar Howe and Pool) were smaller than those from contemporary deposits in Carrigalla, Ireland, and the Broch Period deposits at Crosskirk, Caithness, indicating that oil production was not the only concern (Bond and Hunter 1987). At Pool, flax was introduced at the interface between Iron Age and Norse occupation, when the settlement consisted of only a small number of buildings. This may indicate market considerations as a stimulus for the introduction of flax, rather than local/domestic use of the fibres (Hunter 1997), or may relate to the use of linen for fishing line and nets (Bond and Hunter 1987). However, the fact that the seeds are charred, which is unlikely to happen during processing for fibre, may indicate that the seeds were also used in a domestic context (Bond and Hunter 1987). Equally, the preservation of the seeds by charring may be the result of disposal methods of discarded material. By-products of both oil and fibre production (e.g. pressed seeds, chaff and stems) may have been fed to the cattle (Bond and Hunter 1987).

As well as a broadening in the range of crops cultivated, there is evidence of new areas coming under cultivation during the Norse period. Alongside the introduction of crops tolerant of free-draining soils, there are changes in the weed assemblage at some sites. At Pool, there is a shift from a weed assemblage dominated by species associated with damper habitats in the Iron Age, to those preferring dry sandy soils (e.g. *Urtica urens* and *Spergula arvensis*) in the Norse Period. This indicates that poorer sandy areas were being brought under cultivation (Bond 1998) and may indicate the development of an infield-outfield system (Hunter 1997).

Charcoal and seaweed are both present at sites on the Northern and Western Isles, and are potential fuel sources. Local trees and dwarf shrubs (e.g. *Calluna, Alnus, Betula* and *Corylus*), imported wood (*Quercus, Tilia* and perhaps *Pinus* sect. *sylvestris*) and driftwood (*Picea/Larix* and perhaps *Pinus* sect. *sylvestris*) would have been exploited for fuel, as is evident from charcoal assemblages from the Norse settlement of Sandwick-North, Unst, Shetland (Malmros in press). Wild resources were gathered, but the range of types is narrow (e.g. two types of wild berries – *Empetrum nigrum* and *Sorbus* sp. - at Kilpheder and one – *Rubus* sp. at Bornish – Smith and Mulville 2004).

The Norse influence on agriculture in the Northern and Western Isles is significant. Although the intensification of agriculture seen in Scandinavia is evident, especially in the introduction of crops, it is adapted to local conditions on the islands. The introduction of rye and flax potentially enabled production to be increased by opening up new areas to cultivation, probably in an infield-outfield system, rather than the imposition of the crop rotation regime evident in southern Scandinavia. The small range of wild berries and other fruit may be in part due to the conditions of preservation (seeds of berries and other fruit pips are unlikely to be charred if the berries are eaten fresh, and are more often recovered from waterlogged deposits, especially faeces) but may also reflect the fact that they only made a small contribution to the diet during this period.

2.3.4. The rest of Britain and Ireland

The location of the sites mentioned in the text is shown in Fig. 2.3.

2.3.4.1. Landscape and vegetation

In northern England, the environmental impact of Viking settlement and influence was complex. In some areas, there is evidence for forest clearance and cereal cultivation (e.g. Glasson Moss, Steng Moss), whilst at others, there is a period of woodland generation and abandonment of cleared areas followed in the late 10th-century by renewed clearance and cereal cultivation (e.g. Fellend

Moss, Bolton Fell Moss). As with Scotland, there are few pollen analyses that cover the Viking Age and are well-dated (Dark 2000).

2.3.4.2. Archaeobotanical research

The waterlogged deposits of the proto-urban sites of York and Dublin contained plant macrofossil assemblages comparable to those recovered from similar sites in Scandinavia. Barley, oat and wheat were present at both sites, with rye and a range of legumes also recovered from York (Table 2.3). It is likely that these crops, as well as the gathered resources (berries at both sites, plus other fruit and nuts at Dublin), were brought in from the rural hinterland of the sites (Geraghty 1996; Hall and Kenward 2004). Limited archaeobotanical evidence from concentrations of grain at rural sites (including *rath* sites) from the Early Historic Period (AD 400-1186) in Ireland show a similar range of crops to those recovered from the proto-urban sites with six-row hulled barley and oat occurring most commonly, and wheat and rye present at lower levels. Hazelnuts were also present (Monk 1991). A variety of herbs such as dill and coriander were recovered from York as well as leek, which was identified from its leaf tissue (Hall and Kenward 2004). The presence of rare grape and fig pips may indicate a trade in dried fruit (Kenward and Hall 1995).

There is evidence for the production of non-food plant products. Flax was recovered at Dublin and York, as well as Irish rural sites of the Early Historic Period. There is evidence for flax-retting in the basal deposits of a mid-/late-10th-century pit in Dublin (Geraghty 1996) and the presence of stem fragments that probably represent scutching (fibre extraction) waste at Coppergate (Kenward and Hall 1995). Another potential fibre or oil plant, hemp, was recovered at York (Hall *et al.* 1983). Hops and bog myrtle may have been used in the production of beer at York, although they were not found in any great concentrations (Hall and Kenward 2004). A survey of potential dyeplants from York included woad, dyer's greenweed and madder, and Scandinavian clubmoss may have been used as a mordant (Hall and Tomlinson 1990). There is evidence that patches of 'burgundy' coloured material at Coppergate are the result of the disposal of dyebath waste within the settlement (Hall and Kenward

2004). Clubmoss may have been imported from Scandinavia, as it is unlikely to have grown in Britain (Kenward and Hall 1995). In Dublin, turf seems to have been used in the construction of houses, possibly as roofing. This would have contributed to the plant macrofossil assemblage at the site by providing an environment where plants could grow and releasing component parts during use and decay (Geraghty 1996).

The proto-urban centres of Britain and Scandinavia also seem to share similar plant-related activities. Wild and cultivated food resources, turfs and wood for construction, were brought in from the hinterland of the site. These products were exchanged for goods produced in urban areas, many of which were produced from plants. There is evidence for the production of plant products such as linen, which may have been traded for food supplies. At York, there is evidence for a greater variety of food flavourings than at other sites with comparable levels of preservation, as well as evidence for plant products which may have been traded to the site.

2.3.5. Greenland

The location of the sites mentioned in the text is shown in Fig. 2.4.

2.3.5.1. Landscape and vegetation

Pollen and plant macrofossil evidence from sequences of peat in both the Eastern and Western Settlements indicate that the pre-*landnám* plant community was *Salix*, *Juniperus* and *Betula* scrub, with open areas of ferns, *Angelica* and other herbs (Fredskild 1981; Fredskild and Hulme 1991). At *landnám* the dwarf shrubs decreased in prominence, and there is evidence of land clearance by fire in some areas of the Western Settlement (e.g. Sandnes). The resultant landscape was humid fen with areas of dwarf-shrub heath (Fredskild and Hulme 1991). In the Eastern Settlement, this resulted in the flourishing of a plant community similar to the post-glacial pioneer vegetation, i.e. low-growing species that are sensitive to shade, with the addition of foreign species such as *Rumex acetosa, R. acetosella, Stellaria media* and *Polygonum aviculare* (Fredskild 1978; 1981). The abandonment of the Eastern Settlement,

some time during the 15th-century, leads to the disappearance of annuals and recovery of willow scrub (Fredskild 1981).

2.3.5.2. Archaeobotanical research

There are few plant macrofossil assemblages identified in detail in Greenland. Greenland is considered to be outside the environmental zone where cereals can be cultivated, and no cereal grain has been recovered indicating that, if it was imported, this was not done to any great extent (McGovern *et al.* 1996; Buckland *et al.* 1996), or grains were not frequently lost or discarded. Crowberry, bilberry and the seeds of other wild berries have been recovered from the middens at Nipaatsoq and Niaquussat (McGovern *et al.* 1983), although it is unclear whether the crowberries present in the midden at Sandnes represent gathered wild food resources as they may have arrived at the site accidentally, attached to twigs (Fredskild and Hulme 1991) or as components in peat. Flax was recovered at two sites in the Western Settlement from midden deposits. There is no evidence for the processing of flax fibre (e.g. tools), and seeds were recovered in midden deposits containing faeces, so the seeds may represent use for oil or food (Fredskild and Hulme 1991).

As the plant macrofossil assemblages exhibit high levels of organic preservation, much of the material not represented in the charred assemblage is preserved, and the sites yield information about living conditions and the recycling of plant material through the site. Material from the midden at Sandnes represents a mixture of peat-mould (decomposed peat), hay, dung, twig and woodchips, probably intended for manuring the fields (Fredskild and Hulme 1991). Twigs, woodchips and peat-mould have been recovered from both floors and middens (probably comprising, at least in part, material cleared from floors). They may have been used to line the floor within houses and byres, to soak up liquids, and provide insulation against the underlying permafrost. The decay of organic matter would have provided warmth (Buckland *et al.* 1993).

In Greenland, fires are always associated with human activity, and the *landnám* is reflected in some places in the Western Settlement by the presence of windborne charcoal in ancient deposits (Fredskild 1983). A charcoal layer underlies the Norse church at Ujarassuit and is present in various soil profiles throughout the area of the Western Settlement (Fredskild and Hulme 1991; McGovern and Jordan 1982). In the Eastern Settlement, the evidence for landscape clearance with fire is less conclusive (Fredskild and Hulme 1991).

2.3.6. Newfoundland

The location of the sites mentioned in the text is shown in Fig. 2.4.

2.3.6.1. Landscape and vegetation

Pollen analysis from several sites around L'Anse aux Meadows indicated there was no evidence of changes in vegetation at the time of the Norse settlement (Henningsmoen 1985; Davis *et al.* 1998). Henningsmoen considered the settlement 'too small and too short-lived to leave its mark on the vegetation' (Henningsmoen 1985: 348), and the availability of deadwood and driftwood would have made cutting of fresh wood unnecessary. The most significant disturbance to the landscape would have been the stripping of turves for construction (Davis *et al.* 1988). There is no evidence for the introduction of crop plants (Henningsmoen 1985).

2.3.6.2. Archaeobotanical research

Recent work at the short-lived settlement at L'Anse Aux Meadows excavated accommodation, storage and workshop space, but there is no evidence for barns, byres, livestock enclosures or the consumption of domestic animals, so it seems that this was not a regular Norse settlement based on farming (Wallace 2003). However, the construction of the walls, an earth core with sod covering, indicated that it was intended to withstand the winter, and it has been suggested it served as a base for further exploration along the coast. The turves used in construction were generally highly humified, and contained few recognisable plant macrofossils (Henningsmoen 1985). Sods for the walls of the Norse buildings contained high percentages of Gramineae and/or Cyperaceae and

were highly likely to have come from the immediate vicinity the site (Henningsmoen 1985). The sturdier sedge peat sods were used to reinforce the corners of the buildings (Wallace 2003). Worked wood waste, including chips and discarded objects, was also recovered from the bog (Wallace 2003), and local tree and dwarf shrub species and driftwood species were present in the charcoal assemblage (Paulssen 1985).

2.3.7. The Faroe Islands

The location of the sites mentioned in the text is shown in Fig. 2.5.

2.3.7.1. Landscape and vegetation

The pre-settlement vegetation of the Faroe Islands and the impact of human activity on the plant communities are summarised above (Sections 2.2.3 and 2.2.4). The identification of cereal pollen present in peat deposits is significant for the discussion of cereal cultivation in the Faroe Islands. Work on abandoned fields in Mykines indicated cultivation of cereals from ca. AD 600, first of oat, and later barley (Jóhansen 1978). At Tjörnuvik, *Avena/Hordeum* pollen is present from layers dated to AD 680-860 and is associated with wild types indicating clearance and cultivation. Pollen grains resembling *Secale* occur in deposits dated some time before AD 1070. As mentioned in Section 2.2.3, the early date of vegetation change has been questioned (Buckland 1989-90), and the positive identification of cereal pollen in wet northern habitats is problematic (Tweddle *et al.* 2005). The validity of the use of small quantities of pollen of taxa such as *Plantago lanceolata* as indicators of human impact, when not in association with other indicators (Jóhansen 1989), has also been called into question (Hansom and Briggs 1989-90). In the profiles from Eiði, Tjörnuvík and Korkadalur, the first appearance of Cerealia pollen is associated with large wild Gramineae pollen grains, indicating that this distinction should be treated with care (Hannon *et al.* 2001).

2.3.7.2. Archaeobotanical research

Little archaeobotanical work has been done in the Faroe Islands. Hulled six-row barley was the major cereal crop (Table 2.4). Oat was present at Undir Junkarinsfløtti at low levels, but it is unclear whether this was a wild or domesticated type. The presence of *Stellaria media* at Undir Junkarinsfløtti, which prefers nutrient-rich conditions, may indicate the enrichment of arable land with manure (Lawson *et al.* 2005). Peat, turf, local wood and driftwood/imported wood may have been used as fuel. The identification of wood from Argisbrekka indicated that local wood and driftwood (indicated by holes bored by ship worms, and probably from Siberia due to the prevailing ocean currents in the region) were worked at the site. Imported wood, probably from Western Norway, is likely to have arrived mostly as timber or finished objects, rather than as raw material (Malmros 1994).

The limited evidence for plant use on the Faroe Islands indicates that barley was the main cereal crop. The introduction of barley by the Norse settlers and the presence of weeds associated with cultivated ground indicate that fields were established for the cultivation of grain. There is no evidence for the cultivation of oat or rye from the plant macrofossil assemblages (although see Section 2.3.7.1). There is no evidence for the processing of plants for brewing, or the production of goods that may have been traded, such as linen or dyed cloth. The evidence to date may suggest subsistence cereal production, although because the dataset is limited the absence of evidence must be treated with caution.

Historically, the use of wild plants for food was insignificant in the Faroe Islands, becoming more significant during times of shortage of animal products, and was mostly used as refreshments for children or people out in the mountains (Svanberg 1996-7).

2.3.8. Iceland

The location of the sites mentioned in the text is shown in Fig. 2.6.

2.3.8.1. Landscape and vegetation

The pre-settlement vegetation of Iceland and the impact of human activity on the plant communities are summarised above (Sections 2.2.3 and 2.2.4). Pollen sequences from south Iceland show that tree and dwarf shrub types, most notably *Betula* and *Salix*, were widespread, but were beginning to retreat due to climatic deterioration before the settlement. Taxa often associated with human activity, such as *Plantago lanceolata*, also occur below the *landnám* tephra due to these changes (Hallsdóttir 1987; Einarsson 1961, 1963). Human activity, including the collection of wood for fuel (Simpson *et al.* 2003) and the clearance of land with fire (indicated by layers of charcoal in peat bog at several sites (Buckland *et al.* 1998a), coupled with the grazing and trampling of newly introduced domestic animals, greatly accelerated these trends. This resulted in an open landscape prone to soil erosion, indicated by an increase in grassland taxa at the expense of woodland, and higher representation of Filicales due to easier spore distribution in a more open landscape (Hallsdóttir 1987; Einarsson 1961, 1963; Gísladóttir 1998).

2.3.8.2. Archaeobotanical research

In Iceland, the only cereal crop recovered is barley. Cereal crops could have been grown in the south and west of the country, especially during the warmer climate of the early settlement (Buckland *et al.* 1998a), and there is place-name evidence from other areas (e.g. the element *akur* meaning arable land in names such as Akurtorfa, Gilijar, South Iceland - Buckland *et al.* 1986). The archaeobotanical assemblages from the west of the country seem to confirm that barley was grown locally. The assemblages of grain from the corn receptacle at Suðurgata 3-5 in Reykjavík, and from the midden at Reykholt, contain no alien weeds (Nordahl 1988; Guðmundsson 2002), and the small size of grains from Reykholt may indicate that the barley was grown in marginal conditions, i.e. not imported from Scandinavia (although it is possible that they were tail grains from a more well-developed crop - Guðmundsson 2002). At Gröf and Berg Þórshvoll, fragments of cereal stalks and leaves were recovered (Friðriksson 1959, 1960). The fact that these had not been separated from the barley grain indicates that they were produced locally (Nordahl 1988). At some sites, e.g.

Granastaðir in the north of Iceland, no evidence for cereal grain, cereal pollen or processing equipment such as quern stones has been recovered, and the economy seems to have been entirely based on the exploitation of domestic and wild animals (Einarsson 1994).

The presence of crop weeds in imported grain is one of the means by which alien plant species may have been introduced by the Norse settlers. Several species present have become permanently established in the niches provided by nutrient-rich areas around farm buildings and animal shelters (e.g. *Stellaria media* – Buckland *et al.* 1998a).

The presence of crowberry seeds at several sites indicates that they may have been collected from the heaths for food, but there is no other evidence of the supplementation of cultivated foods with wild plants. *Stellaria media* and *Rumex* sp. may also have been gathered as food (Guðmundsson 2002). The presence of wild seeds from ruderal and/or cultivated fields indicates that these new habitats were well-established in Iceland. There is a lack of evidence for plants used in craft production e.g. linen production and dyeing, although pollen assemblages indicate that *Myrica gale* was introduced, either for use in brewing or for medicinal purposes (Einarsson 1961).

The presence of the edible seeds and berry pips at some sites may provide evidence of the supplementation of cereal products in the diet with wild plant resources, but the extent to which this occurred is unclear. If brewing, linen production and cloth dyeing took place, this is not evident from the plant macrofossil assemblages (although wool processing may be evident from the presence of sheep keds and lice in a late medieval drain at Stóraborg - Buckland and Perry 1989 - and the 17th/18th-century passageway house at Reykholt - Buckland *et al.* 1992). Evidence of imported plant resources comes from grape pips in a sample dated to before ca. AD 1485 at Bessastaðir (Amorosi *et al.* 1992)

Archaeobotanical material from sites in Iceland, such as the Svalbarð midden (11th- to 17th-century - Zutter 1992), Reykholt (an undated deposit lying on the

natural soil - Guðmundson 2002) and Stóraborg (upper deposit of midden and 17th-century floor - Sveinbjarnardóttir *et al.* 1980), are remarkably similar. The seeds of wild species recovered represent a wide range of habitats - weeds associated with farm sites, cultivated and waste places, species from homefields, pastures, grassland and heathland, and plants that grow in moist damp soils. The presence of hay has been inferred for the middens at Stóraborg and Svalbarð, and the practice of spreading plant matter on the floor of the house is inferred from both sites. At Reykholt, the most abundant type of plant remains recovered were club- and/or spike-mosses (not identified to species), which grow in pastures and heathland. These were present in all samples, and may have been spread on floors to clean or dry them, or used for 'toilet paper' (Guðmundson 2002).

In Iceland, some local species historically played an important part in the local economy e.g. lyme grass (*Elymus arenarius*), Icelandic lichen (*Cetraria islandica*), a kind of seaweed (*Rhodymenia palmata*) and garden angelica (*Angelica archangelica*) (Svanberg 1996-7).

2.4. SETTLEMENT LAYOUT AND USE OF SPACE OF NORSE SETTLEMENTS

Rectangular sunken huts with flat floors and stone ovens have been excavated at several sites in Iceland, including Sveigakot, Háls and Granastaðir. They tend to be stratigrapically earlier than the Scandinavian-style longhouses at sites where the latter also occur, and are likely to represent a temporary shelter constructed by the settlers while they were building the longhouses (Vésteinsson 2000), although they have been variously interpreted as workshops, sheds, steam baths or an indication of Slavic or Saami ethnic building traditions which were superseded by Scandinavian styles (Urbańczyk 2003; Einarsson 1994). Other occupation sites thought to be of early date include the artificial caves of southern Iceland, although their origins and history remain obscure (Ahronson 2003).

The range of suitable building materials available in the North Atlantic islands was more similar to that in the treeless Scottish Islands such as Shetland than in the settlers' Scandinavian homelands. Forests were not dense enough to provide materials for timber-based constructions as in Scandinavia, and other materials had to be used (potentially stone, turf, earth, peat, sand, mosses, grasses, heather and driftwood) and the local environment demanded strong, warm and wind-resistant houses (Bigelow 1987). The buildings of the Faroe Islands and Iceland were constructed from driftwood, stone and turf in a similar manner to Norse settlements excavated to date in northern Norway (Scott 1994), the Scottish Islands (Stummann Hansen 2000), and in later settlements in Greenland and at L'Anse aux Meadows in Newfoundland (Stoklund 1984).

Although a variety of house plans are known from Norway in the Merovingian and Viking periods, the longhouse similar to that of the high-status settlement at Oma in the wealthy region of Time is the most similar to those found in the North Atlantic (Scott 1994). The farmstead had a role in Norse society as the centre of society and civilization, and was taken by the settlers throughout the North Atlantic as a marker of cultural identity and homogeneity in the initial phase of settlement (Stummann Hansen 2000). The longhouse cannot be considered well-adapted to the North Atlantic islands, with the long hearth in a large living area an inefficient method of heating unsuitable in an area with limited fuel choices and the panelled walls requiring the import of wood. The use of longhouses may relate to the desire to show affiliation to elite groups from rich regions of Norway, or to distance themselves from other groups (e.g. the Picts in the Scottish Isles) and/or the lower levels of society (Stoklund 1984).

The earliest Norse phase of construction in the North Atlantic is typified by two parallel longhouses with curved walls, aligned down-slope, with at least one house interpreted as a dwelling house due to the presence of a longfire flanked by benches (Stummann Hansen 2003b). Post holes for roof supports are often found in the floor, and there is often evidence for wood panelling and/or partitions (Stoklund 1984; Roussell 1943a). These houses were often expanded by the addition of one or two smaller rooms to one of the long sides (Roussell

1943a). It is debated whether byres were attached to the living area or in a separate building in the Faroe Islands and Shetland but elsewhere, farm buildings, such as barns, animal sheds and forges, were usually separate from the main house (Stummann Hansen 2003b; Scott 1994). The re-building of farm buildings often took place in the same location and this 'stationary' nature of the settlement indicates the importance of the farmstead in linking its inhabitants to the landscape over time (Stummann Hansen 2002).

Driftwood or imported wood was used to provide structural timbers for the longhouses as local woodland did not provide timbers of sufficient quality for construction, and the amount used probably varied depending on the wealth and ability to access resources of the inhabitants (Stoklund 1996). Stone and turf for the construction of walls was likely to have been sourced from the surrounding area. Local supplies of basalt which broke horizontally and did not need extensive working were abundant in the North Atlantic (Stoklund 1996). Turf consists of the active growing layer of vegetation cut from both infield and outfield areas. Historically the best turf is obtained from grassland, where grazing has led to the development of a strongly intermeshed root mat, although these conditions would not have been present at the initial *landnám* settlement (unless a case is made for pre- or early-Norse settlers bringing animals cf. Hannon and Bradshaw 2000).

The lush grasslands around puffinries (*lundasina* – Williamson 1948) and other bird cliffs are also considered to produce structurally strong turves, as the vegetation would be matted. Although it has been considered that these may have been selected by the settlers to provide strength to turf walls (Buckland 2000), evidence from sites in the North Atlantic indicates that structural turves were sourced from around the site. At L'Anse aux Meadows, Newfoundland, pollen analysis also indicates that structural turves are likely to have come from the immediate vicinity of the site (Wallace 2003). Excavations at Aðalstræti 14/ Grjótagata in Reykjavík, Iceland (Nordahl 1988) indicate that the area under and around the structures was stripped to the underlying pebbles by the removal of turf. This pebble layer and the surrounding ground surface were later covered by the *landnám* tephra, indicating that the turf-stripping took place in

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the initial stages of the occupation. The removal of turves for the construction of the *landnám* farm is likely to have taken place as a matter of urgency to provide shelter, and the cost in terms of time and labour of transporting heavy turves from the cliffs to the settlement areas is likely to have been high.

In the Faroe Islands, the earliest phase of construction is typical of Norse settlements in the north Atlantic, with two parallel buildings often aligned downslope, one interpreted as a dwelling house due to the presence of a longfire (Stummann Hansen 2003b). Other farm buildings, such as barns, animal sheds and forges, were sometimes separate from the main house (Price 1995), although there is some debate for sites in the Faroe Islands and Shetland as to whether the byre was typically separate from the dwelling house in the 9th and 10th-century settlements (see below), or were integrated. This style is found across the North Atlantic to Greenland and L'Anse aux Meadows in Newfoundland, indicating a significant degree of cultural homogeneity (Stoklund 1980; 1996). These houses were often expanded by the addition of one or two smaller rooms to one of the long sides (Roussell 1943a). In the Faroe Islands smaller rectangular buildings with less solid construction than the long houses and with the hearth placed against one wall have been excavated at several sites, often in remote areas high in the hills and associated with mainly locally-sourced finds (e.g. Norðuri í Forna at Syðrugøta and í Kassunum on Nólsoy – Arge 1991). These are interpreted as 'shieling' sites, semi-permanent structures used for shelter and a base for work in summer when flocks are taken out to pasture in the outfields (Arge 1991).

In the 12th and 13th centuries, more developed building complexes became common (Price 1995). Across the North Atlantic and Northern Norway, new buildings tended to be placed on the levelled remains of the previous structures, resulting in the accumulation of farm mounds (Bertelsen and Lamb 1993). Many of these are occupied in the present day, and it is only where locations were abandoned (e.g. due to erosion - Sveinbjarnardóttir 1992) that excavations can take place.

Passage-houses (*ganghus*) were a later development, from the mid-14th-century (Stoklund 1996; Roussell 1943a), with rooms in rows arranged around one or more passages with heavy turf walls, and were probably the result of expansion and rebuilding based on functional needs, the surrounding terrain and resources. The sheds, barns and some other buildings remained separate, but more functional areas were housed in the main building than in the previous phase (Albrethsen 2003; Roussell 1941).

Although the buildings are more-or-less standardised in terms of the overall shape and internal layout of features as visible when the site is excavated, the use of space within the structures has been investigated through the analysis of floor deposits. At Kilpheder, Smith *et al.* (2001) used the distribution of bone, pottery, cereal and charcoal fragments in thick floor deposits, as well as phosphorous concentrations and magnetic susceptibility, to reconstruct activity areas within one of the Norse period houses. The patterns indicated an area for cooking at the west end of the house around the 'second hearth', with the central hearth being used for working and/or food consumption. The presence of some kind of partition that could not be recognised archaeologically was indicated by differences in the phosphorous concentrations. The floor deposits were generally very mixed, indicating repeated trampling and sweeping.

A similar approach has been applied to recently excavated longhouses in Iceland by Milek (2005 - Sveigakot and Hofstaðir in the northeast and Aðalstræti 14-18 in Reykjavík). A variety of techniques, including micromorphology, electron probe microanalysis, magnetic susceptibility and loss-on-ignition for organic content have been applied to floor deposits. These have indicated patters which can be interpreted in terms of activity areas, such as animal stalls, zones of heavy traffic and food processing areas, and the partitioning of internal areas that would otherwise be invisible archaeologically. Recent work at Borg by Hansson (1997), a high-status longhouse in northern Norway, indicated distinct spatial patterning in the distribution of plant macrofossils recovered from post holes. The north-east part was dominated by plants associated with meadow and wet meadow habitats, such as *Carex*, *Alchemilla* and Poaceae, as well as a high number of seeds of wild berries

(including bilberry, lingon and cloudberry). This was interpreted as a stable area that was also used as a latrine. The hall had lower concentrations of plant remains, mostly barley grain and their associated weeds, indicating an area for food preparation. The floor layers were uniform in character, and contained soot, ash, burned stones and charcoal (Hansson 1997). Where organic preservation is better, areas can be identified in other ways, for example the preservation of large numbers of ked and lice in a drain from Medieval Stóraborg may indicate the disposal of liquid from wool processing (Buckland and Perrry 1989).

There is some debate for sites in the Faroe Islands (e.g. Toftanes) and Shetland (e.g. Jarlshof) as to whether the byre was typically separate from the dwelling house in the 9th- and 10th-century settlements (cf. Kvívík – Dahl 1970), or whether this interpretation is spuriously based on comparison with the above model of medieval farmsteads in Greenland and that the byre and dwelling house were end-to-end under one roof (Stummann Hansen 2002; 2003b). The development of the settlement of Jarlshof, Shetland, is often used as evidence that initial Norse settlements had the dwelling house and byre in separate structures, although the evidence for this is questionable. The original plan of the primary longhouse (ca. AD 800-850) appears to have been for human occupation only, and Building IC is identified as a possible byre or barn due to the absence of features such as a hearth (Hamilton 1956), rather than positive indicators of its use. The second (ca. AD 850-900) and third (10th-century AD) longhouses to be erected had integral byres, and it was not until the late 11th or early 12th-century that an area interpreted as a byre was added to the eastern gable of the primary longhouse (Hamilton 1956). In Iceland, sites such as Stöng indicate a clear separation of human and animal accommodation, as they have evidence for stone-partitioned animal stalls and a central drain in a structure separate from the main dwelling house (Buckland *et al.* 1993).

Where organic preservation is good, thick floor deposits are typically found. Investigations at various sites indicate that living conditions inside the farmsteads would be considered unsanitary by the 'over-hygienic' modern society (Buckland *et al.* 1995), and floors often incorporated stone-built drains

to remove liquid from the floors (Stummann Hansen 2002). Such conditions were not only typical of the time, but also widespread across Europe until relatively recently (Sveinbjarnardóttir *et al.* 1980):

> '…where organic waste was produced in huge quantities, and where floors were damp, there would inevitably have been a net accumulation of biological (and other) remains on floors, even if they were occasionally swept or scraped off.' (Hall and Kenward 2004: 383).

This cleaning is evident in the floors from Fishamble Street, Dublin, where the larger debris from food consumption (most notably hazel nut shells) has not been recovered from the main floors, but from the less accessible areas around the roof columns and benches (Geraghty 1996).

Recent work by K. Milek (2005 and pers. comm.) indicates that the nature of the material is important in interpreting the quality of buildings from floor deposits. Based on ethnoarchaeological studies of turf house floors from a 19th-century farm at Thverá, turf and ash were intentionally deposited on floors, and may be an indicator of maintenance, rather than 'squalid' conditions. The correlation of high levels of magnetic enhancement and carbonised plant macrofossils from the floors of several sites on Lewis, the Hebrides, indicates that this practice can be traced back as far as the Iron Age (Church and Peters 2004). The apparently deliberate construction techniques of floors at Fishamble Street, with coarse material in the lower floor layers and finer wood chips and sand/gravel in the upper layers, and low proportion of food refuse indicates these floors were not 'the product of a particularly sordid life-style.' (Geraghty 1996: 21). The interpretation of thick rotting floor layers from Dublin and settlements in Greenland, comprising wood chips, twigs and other organic matter, as insulation against cold conditions, also indicates this may have been functional, rather than the build up of carelessly discarded waste (Buckland *et al.* 1994; Geraghty 1996).

2.5. THE ECONOMIC BASIS OF THE NORSE SETTLEMENTS, LAND-USE AND RESOURCES

The Norse settlers imported what they probably considered to be the 'ideal' economic system from Scandinavia into the newly settled areas - archaeozoological evidence indicates that sheep, goats, pigs, cows, horses and dogs were introduced - but the range and proportion of each species, and the relative importance of cereal cultivation, pastoralism and wild resources was adapted over time to become more suitable for the new environmental conditions (Dugmore *et al.* 2005; Amorosi *et al.* 1992; Mahler 1993; Lawson *et al.* 2005). They divided up the landscape into distinctive functional areas, which had an effect on the nature of the soils, and procured essential resources from the landscape. The use of resources such as wood and peat for fuel, and local, imported and driftwood for wood-working and house construction fulfilled many of the basic requirements of the settlers.

2.5.1. The economic system

The cultivation of grain and other crops was carried out in the areas of Norse influence, and cereal cultivation was introduced to the newly-settled areas, but with varying degrees of success. In milder climates such as the Faroe Islands and south and west Iceland grain cultivation is likely to have taken place, but in Greenland and other areas of Iceland it was soon abandoned, if introduced at all. A range of wild plant resources were also exploited (see Section 2.3).

In Scandinavia and the Scottish Isles, the economy during the Norse period was based on mixed farming, with cereal production taking place alongside herding. Grazing animals were of importance to the economy, with cattle providing traction, meat and milk, and sheep and goat providing meat and milk. Wool production seems to have been a feature of the economy, and pigs (a high-status food) and horses (for traction and meat) were common. Goats were introduced to the Outer Hebrides during the Norse period, and reflect a general agricultural intensification in the Scottish Isles during the Norse period. Domesticated resources were supplemented by wild resources such as fish (especially in

coastal areas), birds and gathered plant food (Kaland and Martens 2000; Smith and Mulville 2004).

There is limited faunal evidence from the Faroe Islands, but the work that has been done indicates that both domesticated and wild animals were important in the economic strategy. Bone preservation at Toftanes was poor due to acidic conditions and the excavation method (deposits were not sieved), but the sparse data suggest that sheep was the dominant animal with only a few burnt bones of cow and pig present (Stummann Hansen 1988, 1990; Edwards *et al.* 1998). At the 9th- to 13th-century Undir Junkarinsfløtti midden, the faunal assemblage is dominated by wild species (birds, fish and shellfish), which contrasts with the general pattern of the high proportion of domesticates from assemblages in Iceland and Greenland (Lawson *et al.* 2005). It is obviously unclear how representative the Undir Junkarinsfløtti material is, but if the economy of the Faroes was not as heavily reliant on domestic animals as in Iceland and Greenland, it has implications for the impact of the settlers on their landscape.

Due to the richness of wild resources and the potential for cereal production, the land may never have been stocked to full capacity in the Faroes, and was, therefore, not subjected to severe erosion as a result of the settlement (as is evident in the Faroes from the work of Mairs 2003; Edwards *et al.* 2005; Lawson *et al.* 2005). The continuing presence of pigs from the 9th- to the 13th-century at Undir Junkarinsfløtti is also interesting, and contrasts with the pattern in Iceland and Greenland, where they are present in *landnám* period assemblages, but are rarely present beyond the mid-11th-century (McGovern *et al.* 2001). Woodland is often used for pannage, and the reduction in woodland cover in Iceland is often proposed as a result of and reason for the abandonment of pigs (Bjørk 1970), even though pork is thought to have been considered a high-status food (Kaland and Martens 2000). The more open vegetation of the Faroes from *landnám* onwards indicates that the lack of woodland cover cannot be the only reason, and indicates a different economic strategy at Undir Junkarinsfløtti than is evident in other areas of the North Atlantic.

As well as plant resources and domestic animal resources, there is also evidence from Toftanes in the Faroe Islands of the gathering of wild animals and their products. The egg shell membrane and the bivalve periostracum recovered indicate that eggs and shellfish were present at the site, and are likely to have been exploited by the inhabitants of Toftanes. The absence of the shells themselves (as well as the scarcity of animal bone) is probably due to the acidic depositional environment at the site. Shellfish seem to have been an important resource at Undir Junkarinsfløtti in the Faroe Islands, where there is a far higher proportion of wild resources (bird and fish bone and shellfish) than at sites in Iceland and Greenland (Lawson *et al.* 2005). As this is the only published faunal assemblage from the Faroe Islands, it is unclear whether this pattern is common to the islands as a whole, or specific to Undir Junkarinsfløtti. Although the Faroese sites are located near to the coast, and are likely to represent locally acquired resources, more complex procurement methods such as trade or claims to coastal land are indicated by the import of shellfish to inland sites in Iceland, such as Reykholt (Guðmundsson 2002) and Granastaðir (Dugmore *et al.* 2005).

The range of domestic animals introduced to Iceland and Greenland is similar to that found in chieftain farms in Norway, emulating the high-status end of production, with sheep, goat, pig, horse and cattle. The animal economy is later adapted to the local conditions, with a far lower number of pigs present in the later phases of settlement in Iceland and Greenland than in the earlier settlements (McGovern 2000). The fact that pigs were introduced to Greenland, even though they were rare in Iceland by the time of the settlement, indicates the strong hold that the production of high-status meat had on the Norse farmers. Whichever wild resources were abundant in the area were exploited by the Norse. In Iceland, fish and wild birds were the primary wild resource exploited in the south and east, and marine fish in the north and north-east, whilst seal, caribou and walrus were more commonly exploited in Greenland (McGovern 2000). The strategies employed in the centuries after settlement also diversified, with Iceland increasingly reliant on the export of marine fish and Greenland continuing with a pattern of seal and walrus hunting, perhaps a factor in the demise of the communities in the 15th-century.

The foddering of animals over winter took place in Iceland and Greenland, and the success of haymaking and storage was always crucial to survival in these marginal regions (Adalsteinsson 1990). This is attested by the beetle assemblage characteristic of hay storage found in middens from the first phase of settlement onwards (Buckland *et al.* 1993). Recent palaeoentomological evidence from the site of Toftanes suggests that this may also have been the case in the Faroes (Kim Vickers pers. comm.), contrary to the results of previous studies of the site (Edwards *et al.* 1998). The supplementation of farmed produce with wild resources was significant and flexible over time and space, depending on the resources available. Historically, lyme grass (*Elymus arenarius*) was manipulated or cultivated in Iceland (Guðmundson 1996). Bone assemblages from middens associated with sites of similar status and size in Iceland and Greenland indicate that fish were the primary wild resource exploited in Iceland, whilst seal and walrus (for hides and ivory) were far more common in Greenland (McGovern 2000).

Although the economic system was almost completely self-sufficient on a day-to-day level, the communities were reliant on trade contacts with Scandinavia and beyond to provide the items that could not be obtained locally. References in the sagas, as well as archaeological evidence, attest to the importance of the trade in grain, tools, iron, timber and luxury goods in exchange for local commodities such as furs, skins and, in Greenland, walrus ivory (Amorosi *et al.* 1997).

2.5.2. The land-use system and its effect on soils

The system of land use, based on the Norwegian model, consisted of spatially distinct areas: the farmstead, the enclosed, cultivated 'infield', where grain and hay were grown, and the uncultivated 'outfields', used for pasture and the exploitation of natural resources such as peat and turf cutting (Small 1966-9). These areas were conceptual as well as practical, and embodied the Norse distinction between the 'inside' (household, owner, cultural) and 'outside' (uncontrolled, strange) (Hastrup 1990). Seasonal summer pastures, known as

shielings (*ærgi* in Faroese, *sel* in Icelandic) were located in the outfields where grazing was richest, and semi-permanent shelters were constructed (e.g. Ergidali, Faroe, located c. 3 km from the bay at Hov – Edwards *et al.* 2005). This protected the fodder which would be collected for winter stall-feeding, and meant that activities associated with livestock (e.g. milking, wool processing) were moved from the central farm in spring. Other tasks such as winter fodder collection (e.g. leaves and twigs) and peat cutting would also take place at the shieling site (Mahler 1993).

The area around the settlement and areas of the infield were likely to become enriched due to activities such as waste disposal and manuring, while the soil in these areas was disturbed frequently by the movement of people and livestock, and the cultivation of garden plots. These anthropogenic nutrient-rich, disturbed conditions were sufficiently analogous to the natural environment of the bird cliffs for native species common in this niche quickly to colonise the new habitat, increasing the diversity of the local plant community compared to areas with less intensive human activity away from areas of settlement (Lawson *et al.* 2005). Around settlements, a limited area of the infield was purposefully improved to increase yields on the naturally nutrient-poor soils, the extent of which is likely to have been related to the amount of labour and fertilizer available.

In the wider landscape, there is evidence that attempts were made in some areas to improve soils by drainage (Edwards *et al.* 2005), and the opening of the landscape to increase the area under grazing would have left soils open to erosion. These factors often led to changes in the nature of the soils in the areas concerned, including a decrease in organic content and mineral leaching, but their effects varied from region to region (Faroe - Humlum and Christiansen 1998; Mairs 2003; Iceland - Dugmore and Buckland 1991; Dugmore *et al.* 2000).

2.5.3. Potential sources of fuel

In the cool, wet climate of the North Atlantic Islands, the provision of fuel was essential to the survival of the settlers. In landscapes with limited areas of woodland, other sources of fuel were essential, and the settlers are likely to have been aware of these from their contacts with the Northern and Western Isles of Scotland.

The use of wood and twigs for fuel is documented by the presence of charcoal at settlement sites across the North Atlantic region, and includes material collected from live plants, deadwood or driftwood that washed up on the shore. In Shetland, a range of native, imported and driftwood seems to have been exploited for fuel (Malmros in press) but, in the Faroe Islands, only local woody types were recovered in a charred state: *Betula, Salix, Calluna* and *Juniperus* (Toftanes and Sondum, presented here, and Argisbrekka - Malmros 1994). Charcoal pits are evident from the late 9th- to 10th-century onwards at Syðstamörk and other areas in South Iceland, and indicate that the exploitation of wood as a fuel was a well-planned process (Mairs *et al.* in press). The collection of wood and twigs for fuel is likely to have contributed to the damage of woodland in the North Atlantic islands, as described in Section 2.2.4.

The domestic animals of the Norse agricultural system produced dung. This could have been prepared and dried to make dung cakes, which are commonly used in areas where wood and other fuels are scarce, and are well-known ethnographically throughout the North Atlantic (e.g. Williamson 1948; Fenton 1978; Warming 1908). It could have been collected from the outfields, and material from byres and animal pens would have provided concentrations of dung and other material (e.g. bedding) that may also have been utilized. Roussell (1941) identified slabs of dung next to the hearth at Ánavík (V7) in Greenland, which he interpreted as fuel. Analysis of fuel ash from the low-status site of Sveigakot indicates that cow dung was used as a fuel, especially in the later years of occupation before the site was abandoned (Simpson *et al.* 2003). The strategic and social elements of access to fuels and other resources

is thought to have been important in the survival or demise of marginal settlements Iceland (Sveinbjarnardóttir 1992).

Peat is another source of fuel, and is widely known ethnographically in the North Atlantic region (e.g. Williamson 1948; Fenton 1978; Warming 1908). Relict peat cuttings from Ketilsstaðir in Iceland are filled with tephra from the Katla eruption ca.1357 (Buckland *et al.* 1986) and indicate that peat cutting was taking place before this date in Iceland.

2.5.4. Potential sources of wood for woodworking

The open nature of the woodlands in the North Atlantic islands (described in Section 2.2.3) meant that timbers of a suitable size and quality for tasks such as boat building and house construction are likely to have been rare. The settlers probably imported timber by ship from Scandinavia, where building-quality timber was common in the dense forests, although the cost of transport and access to ships may mean it was a resource restricted to members of the higher social strata. Driftwood is washed naturally onto the shores of the North Atlantic islands and, although the amount varies from region to region, can be found on almost every beach (Eggertsson 1994). In Iceland it comes from the boreal forests of Russia/Siberia and, in Greenland, wood from North America is found alongside the Russian/Siberian taxa (Eggertsson 1994). At the time of settlement driftwood is likely to have been widely available due to the accumulation of centuries of wood on the shores, and it was undoubtedly an important resource for fuel and construction from the time of the first settlement (Haggblom 1982). The economic role of driftwood as a resource and the importance of rights to collect driftwood are known from the medieval period onwards in Iceland. The high-status farmstead at Reykholt is known from references in legal documents to have had rights over driftwood collection in an area of the western fjords by AD 1478 (Sveinbjarnardóttir 2004), indicating it was perceived to be a resource valuable enough to legislate over.

Non-charred wood is common at sites throughout the Norse sphere of influence where organic preservation is good, and it seems that wood and wood chips

were common features of living floors and the surrounding areas (Buckland *et al.* 1993). Wood recovered at Toftanes and Sondum was of both native (*Calluna, Juniperus, Salix* and possibly *Betula*) and non-native types (*Picea/Pinus* and possibly *Quercus*). It is difficult to say whether the *Picea/Pinus* wood was imported or collected from beaches where driftwood washes up, as different sections of the genus *Pinus* are considered to have different origins (Malmros 1994). There was no evidence of the holes bored by worms often found in driftwood in the fragments analysed, although the dataset was probably too small to allow any conclusion about the source of the wood to be drawn. *Quercus* is likely to have been imported (Malmros 1994). It is of some interest that, while native wood types were found both charred and non-charred, non-native types were only found non-charred. The apparent distinction between the method of preservation between native and non-native taxa may indicate that, whilst local wood resources were used as fuel (as well as for other purposes that did not involve contact with fire), non-local types were not used as fuel. It would follow that there was some conceptual differentiation between the resources, perhaps based on availability i.e. the rarity of imported/driftwood types may have increased status compared to more easily accessed native species.

Driftwood and imported wood would have been essential in the construction of the farmstead in Iceland and the Faroe Islands, due to the relatively sparse nature of the woodland, and was extensively used in construction at Gård under Sandet in Greenland (Arneborg 2000). The roof in the western part of House II at Toftanes was supported by five pairs of posts, which would have been too large to have grown locally (Edwards *et al.* 1998; Malmros 1994). During the excavation, a wooden door plank with a handle and evidence of wooden posts was recovered, and the presence of wooden walls was indicated by a sill in House XII (Edwards *et al.* 1998). Stone sills or emplacements were commonly used at Norse sites in the North Atlantic to protect wooden posts and panelling from damp and decay (Einarsson 1994).

The economic basis of the settlements varied spatially and temporally across the North Atlantic Islands, based at least in part on the perceived importance of

different resources for status and economic survival, the suitability of the area for different types of animal production and the range of wild resources available. The strategy of exploitation of wild resources seems to have been largely based on local availability, and meant that the economies of the North Atlantic islands were very different in nature. The land-use system had an impact on the landscape of the islands – enriching some areas and degrading others. Resources were procured from a range of sources for essential tasks such as burning and woodworking.

2.6. SETTLEMENT FROM *LANDNÁM* TO AD 1500

Adaptations to the environmental conditions of the North Atlantic Islands led to the demise of pigs in Iceland and Greenland, although they were kept in the Faroes until the 13th-century. The secondary products of cows, sheep and goat, became increasingly important in the diet of the settlers (McGovern 2000). Sheep were favoured in the less heavily wooded areas of the Faroes and Iceland while, in Greenland, goats were more common due to their ability to graze on twigs (Lawson *et al.* 2005).

The expansion of the Norse area of influence resulted in economic changes in already settled areas, as well as the settlement of previously uninhabited regions. The environments of the Faroe Islands and Iceland provided a range of resources that were exploited and modified by the Norse settlers. The construction of settlements and the development of agriculture led to the purposeful and accidental introduction of plant species that were not native to the islands. The introduction of domestic animals and their grazing also modified the native flora, although the extent of this varies across the study area.

CHAPTER 3: SITES UNDER INVESTIGATION

As part of the LCL project a series of samples were taken from the Faroe Islands and Iceland. Off-site monoliths were taken from Hov in the Faroe Islands and Reykholtsdalur 2, Reykholtsdalur 3 and Breiðabólsstadavatn 2 in Iceland. The plant macrofossil assemblage from a monolith taken from Háls South Pit, previously presented by Dixon (1997), is re-analysed in terms of a new sequence of ^{14}C dates. The on-site assemblages are based on samples from two archaeological sites, the farmstead at Toftanes and Sondum Midden, both in the Faroe Islands.

3.1. THE FAROE ISLANDS

3.1.1. Hov Monolith

The village of Hov (*Hof*) is situated on Suðuroy, the most southerly island in the Faroes (Fig. 3.1). The sampling site was chosen because it appears from references in the *Færeyinga Saga* to be in the vicinity of the location of an early settlement on the Faroe Islands (Small 1966-9; Dahl 1971). Evidence for early Norse occupation 4 km higher up the valley exists from the excavation of a shieling site called *Ergidalur* (Dahl 1971). Ancient 'Celtic' fields are also present in the vicinity (Adderley and Simpson 2005) (Fig. 3.2). The valley conforms with Small's (1966-9) model of the location of primary farmsteads by Norse settlers in the North Atlantic, where access to the sea, a flat well-drained area for construction and cultivation (infield) and an extensive grazing area (outfield) are primary factors in the choice of location. The freshwater river contains salmon and trout (Edwards *et al.* 2005). The valley was subject to phases of erosion and stability between the glacial retreat and settlement, evident from a peat horizon cut by gullies and relict fans that pre-date the *landnám* (Mairs 2003).

Two cores have previously been analysed for pollen from the valley (Hovi A and B - Jóhansen 1985), and the intention of work by the LCL was to complement and test the conclusions of previous pollen work. The monolith for

plant macrofossil analysis and core of samples were taken as part of the LCL as close as possible to Jóhansen's Hovi B column (Fig. 3.2 - Edwards *et al.* 2005). Jóhansen's work placed the *landnám* at the first occurrence of *Plantago lanceloata* pollen, about AD 850-900, but the work by Edwards *et al.* (2005) dated the occurrence of the first evidence for human impact several hundred years earlier ca. AD 560. They interpreted human impact due to the correspondence of a charcoal peak and the first presence of *Hordeum*-type pollen, with more widespread changes in the plant community occurring around AD 890 (the first sustained reduction in tree birch percentages, the beginning of a marked rise in Poaceae pollen values and falls in the heath taxa such as *Calluna vulgaris* and *Empetrum nigrum*) (Edwards *et al.* 2005). All of the studies outlined above indicate a pre-*landnám* plant community dominated by Cyperaceae and Poaceae, with areas of peatland, tall herb wetland and shrub components (Jóhansen 1985; Edwards *et al.* 2005). The tall herb flora (*Filipendula, Caltha, Sedum/Rhodiola*, Apiaceae and Polypodiaceae) disappears after the *landnám*, as does *Betula pubescens* (Edwards *et al.* 2005), and *Potentilla* and *Rumex acetosa* increase (although *R. acetosa* falls quickly - Jóhansen 1985). The tall herb plants are confined in modern times to areas protected from, or inaccessible to, sheep grazing, such as meadows and gorges (Jóhansen 1985). The vegetation cover of the north (south-facing) slope of Hovsdalur at *landnám* has been reconstructed by Thompson *et al.* (2005) and is shown in Fig. 3.3. Geological surveys of the valley noted that the majority of evidence for soil erosion appeared to date from before the *landnám*. Human activity (e.g. peat cutting evident from relic peat stacks and management via the cutting of drainage ditches) and animal grazing was not, in the past or present, a major cause of erosion in the area although it did result in the formation of a slightly organic yellow brown soil (Mairs 2003; Edwards *et al.* 2005). The homefield area (shaded in dark grey in Fig. 3.2) is dominated by clay- and silt-rich soils which have been enriched by manuring over a long period of time (Adderley and Simpson 2005).

The sampling site lies at the base of a cirque valley which was formerly a lake basin (Fig. 3.2). During the early Holocene, the basin became filled with sediments and now contains a peat bog whose surface is 12 m above sea level

(Mairs 2003; Jóhansen 1985). The sampling site is located approximately 0.25 km from the present day shore line and approximately 0.75 km south-west of the modern settlement (Fig. 3.2). The sampling site is currently used for grazing, with vegetation dominated by grazed grass and sedge communities and no extensive areas of open water. Samples were taken through a section of mire recently cut by a slow-running stream.

3.1.2. Toftanes Farmstead

The archaeological site of Toftanes (*á Toftanesi* = the headland of the ruins) is situated on the east coast of the island of Eysturoy, to the north-west of the modern village of Leirvík (Fig. 3.1). Toftanes is one of three ancient settlements (*býling-farms*) in the vicinity of the modern village, along with Við Garð (*vi Gar*) and um Á (*Uttan Á*). There is evidence that the valley has been continuously settled since the *landnám* and it contains various undated archaeological features, including a 'Celtic'-style church with a circular cemetery enclosure, and the excavated sites of Við Garð (early Medieval) and Í Uppistovubeitinum (12th-14th-century) (Fig. 3.4 - Arge 1997). Toftanes itself is situated on a broad amphitheatre of coastal lowland, surrounded by high peaks (up to 640 m) on the south side of a small stream (Stummann Hansen 1990). As at Hov, the location of Toftanes conforms to Small's (1966-9) model of the location of primary farmsteads by Norse settlers in the North Atlantic, with good access to the sea, a flat well-drained area for construction and cultivation (infield) and an extensive grazing area (outfield) (Fig. 3.5). The infield area of Leirvík consists today of sand-rich soils which have been subjected to long-term manure application, although this enrichment seems to have ceased in recent times (Adderley and Simpson 2005).

The site was excavated by Føroya Forminnssavn (The Faroese National Museum) between 1982 and 1987 who uncovered approximately 900 m² of the site, containing four structures (Fig. 3.6):

- Building I, 13 m long by 4 m wide (internal measurements), was constructed of a single stone wall with no turf coursing, and had been

partially eroded by the stream. It was provisionally interpreted as an outhouse.

- House II, approximately 20 m long by 5 m wide (internal measurements), was more substantially constructed than Building I, and is interpreted as a dwelling house. It had curved walls approximately one metre thick, consisting of an inner and outer wall of dry stone and turf coursing. Evidence for five pairs of posts supporting the roof, a fireplace and benches along the walls was recovered. The eastern end of the building has been tentatively interpreted as a byre, with a complex system of drains under the floor. A paved staircase connected Building I and House II.
- House XI, added to the southern wall of House II, with a floor area of 4 m by 3 m was of a similar construction to House II, possibly with a wooden wall at the west end. The function of the building is unclear.
- House XII, 5 m by 3 m, may have had wooden walls to the west and east. It had a stone-paved floor, covered by a thick deposit of ash and charcoal. It has been interpreted as a fire-house or kitchen (*eldhús*).

The buildings were all part of the same complex, with Building I and House II as the primary phase of construction, and XI and XII added later. After abandonment, a smaller building (House IIa) was erected on the foundations of House II (Stummann Hansen 1990). The form and construction of the buildings are typical of Norse settlements in the North Atlantic (Stummann Hansen 1995), and compare well with the Icelandic pattern of a simple longhouse with separate outbuildings in the primary phase of construction, with integral outbuildings added at a later stage (Price 1995).

Thousands of artefacts were recovered from the excavation, including objects made locally and imported. Steatite (soapstone) objects indicate connections with Shetland and/or Norway where it was quarried - more than 700 were recovered, including spindle whorls. Objects of schist, including two quern uppers, must also have been imported, as it is not present in the Faroe Islands. Very few artefacts of the local stones, tuff and basalt, were recovered. Three metal brooches, one in the Borre style and comparable with finds from Sweden,

Denmark and Northern Germany, the others ringheaded pins of a 10th-century type found across the western part of the Norse world, also indicate contacts. Wooden objects, many from tree species not native to the Faroe Islands, indicate the import of wood or the use of driftwood. Local wood species were also utilised. A sheaf of juniper branches (*Juniperus communis*) was found at the entrance of House II. Pieces of rope made from twined juniper branches totalling 100 m were recovered, including a piece attached to a stone (Fig. 3.7) that may have been used to weigh down the roof (Larsen 1990). The range of objects recovered indicates that weaving, woodworking and grinding took place at the site.

The original set of three ^{14}C dates from the floor layers in Building I indicate that Toftanes is the earliest settlement dated on the Faroe Islands (Table 3.1 – laboratory codes beginning with K). As these were taken from bulk floor layer materials (Stummann Hansen 1990), and could be considered to represent a material of a range of ages, six new AMS (accelerator mass spectrometry) ^{14}C radioacarbon age measurements were obtained from individual plant macrofossils retrieved from the floor in Building I and the floor in House IIa (Table 3.1 – laboratory codes beginning with GU - Note the two pairs of duplicate measurements: GU-12169/GU-12170 and GU-12171/ GU-12172). The new radiocarbon measurements are consistent with those already obtained from the site. The full calendar age range for all ^{14}C dates (at 2 σ and using maximum probabilities) is cal. AD 760-1040.

The assemblage of artefacts recovered from the site indicates that occupation of the house took place in the Viking or early Norse period. The absence of objects from later phases indicates that it was abandoned during the early Norse period (Edwards *et al.* 1998).

Toftanes was the first Viking farmstead and outbuildings in the Faroe Islands to be comprehensively excavated, and is the earliest settlement dated on the islands (Edwards *et al.* 1998). The conditions at the site, with deposits covering the buildings up to a depth of 1 m, resulted in good organic preservation (Stummann Hansen 1995), and the collection of samples for palaeoecological

analysis was the first to take place from an archaeological site in the islands. Pollen samples were taken from the area between Building I and House II, and indicated an un-wooded landscape in which grazing was the dominant agricultural activity, and cereal cultivation was not of major importance (Edwards *et al.* 1998). The analysis of plant macrofossils will shed light on the use of plant resources within the settlement and enable comparison with other sites across the North Atlantic.

3.1.3. Sondum Midden

The Sondum (*á Sondum*) midden is located on the island of Sandoy, approximately 0.75 km north-east of the settlement of Sandur (Fig. 3.1). The Sondum midden was part of one of three original holdings identified in Sandur, the others being *Uti á Bø* and norðri á Bø (*Norri á Bø*) (Fig. 3.8 - Arge *et al.* 2005). There is also place-name evidence for a shieling site 8 km north-west of Sandur (Thompson *et al.* 2005), and an ancient 'Celtic' field system is present within 1 km of the midden (Adderley and Simpson 2005). Excavations at the church in Sandur indicate at least five successive phases of church construction, with the earliest an 11th-century construction resembling a Norwegian stave church. A Norse burial ground was also excavated to the south of the church (Arge 2001). To the north of the church, excavations have revealed settlement remains which may belong to the earliest settlement in the area, Undir Junkarinsfløtti (*Junkarinsfløttur*) (dates of AD 785–875 and AD 900–960 - calibrated 1 st. dev.) (Arge 2001). Along with the dates from Toftanes on Esturoy (Vickers *et al.* 2005), these are the earliest dated settlement remains in the Faroe Islands so far. A hoard of silver coins buried around AD 1090 is the only one found in the Faroes, and is taken by Arge *et al.* (2005) to indicate that the area has been one of the largest and wealthiest agricultural areas in the Faroes from *landnám*.

Because of the range of evidence for early settlement in this area, extensive investigations of local conditions and their potential for agriculture have taken place. Modelling of the potential resource base of the outfield area around Sandur (based on the topography of the area, vegetation at the time from pollen

analysis and soils) indicates that the productivity of area was more than able to support a small subsistence community and their livestock, indicating that the richness of the settlement seems to have been based on the productivity of the local area (Thompson *et al.* 2005). Soil profiles from the infield area of Sondum consists of sand-rich soils which, although subjected to regular manuring, were not farmed as intensively as they could have been, which may have resulted in subsistence-level barley yield (Adderley and Simpson 2005). Pollen, chironomid and sedimentological studies indicate a pre-*landnám* vegetation mosaic of Juniper scrub, grass, sedge, Ericaceous heath and mire with restricted pockets of woodland (Fig. 3.9) (Lawson *et al.* 2005). Peat formation (from ca. 5000 BP) and erosion (from ca. 4000 BP) were features of the pre-*landnám* landscape (Lawson *et al.* 2005). Evidence for changes at *landnám* indicates that they took place slowly, probably due to specific topographic, climatic and economic features of island. A gradual decline in *Calluna* and *Juniperus*, a rise in grasses and the occasional occurrence of *Hordeum*-type pollen is evident (Lawson *et al.* 2005). The severity of erosion varies between the lake sites analysed. At Lítlavatn (4.5 km south east) the rate of erosion seems to have been high, but at Gróthúsvatn (1 km west from Sandur) there is no evidence for erosion (although this may be the result of topological differences in the catchment area of each lake - Lawson *et al.* 2005).

Excavations from the 9th- to 13th-century midden of Undir Junkarinsfløtti, which was built over a late Norse stone structure, revealed a matrix of shell sand, peat ash and fire-cracked stones, with large quantities of animal bone and shell. Work on bones and plant macrofossils from the site have yielded information about the economy of the settlement. A high proportion of wild bird bones and shellfish, and the presence of pigs throughout the sequence, are unique in the North Atlantic. The plant macrofossil assemblage (charred preservation only) is similar to other sites, with six-row hulled barley, a small number of oat grains and wild seeds from a range of habitats recovered. Burnt peat and charcoal indicated the potential fuels at the site (Lawson *et al.* 2005).

At Sondum, a 3.5 m south-facing section through the midden has been exposed by coastal erosion in the Sandsvágur bay, consisting of organic sands at the base

of the section, overlain by Norse and Medieval middens, with pre-modern material in the upper strata. Bulk samples were taken at intervals during the 2002 and 2003 excavation seasons to assess preservation and for dating. Dating of the material recovered indicated some inversions in the sequence, likely to be the result of mixing and/or redeposition of midden material. Several of the dates have a range covering the late 9th-century, with the sample taken from the lowest deposit containing evidence of human activity (S2/9) resulting in a range from AD 590-780 (2σ calibration). Although this date is earlier than the traditionally accepted late 9th-century date for *landnám*, it was taken from a barley grain (which could not be present in the Faroes without human intervention), and is in line with the early dates for human-induced impact inferred from the pollen sequence at Hov (Edwards *et al.* 2005) and other sites in the Faroe Islands (cf. Jóhansen 1985; Hannon and Bradshaw 2000). Material from the midden was sampled to complement the assemblage from Toftanes i.e. to establish how the plant macrofossil composition of refuse might differ from that of occupation. Ideally, samples from an associated midden and farmstead would have been analysed, but excavation of both features from the same site has not taken place to date. The assemblage from the midden will also complement the plant macrofossil assemblage from Undir Junkarinsfløtti, where only charred remains were recovered, with an assemblage consisting of both charred and uncharred organic material.

3.2. ICELAND

Sites in two regions of Iceland were investigated: Reykholtsdalur and Halsasveit, located close to each other in the west of the country, and Stóramörk in the south (Fig. 3.10). Off-site monoliths were taken from areas adjacent to settlement sites, in order to assess the impact of human activity on the wider landscape.

3.2.1. Reykholtsdalur and Halsasveit Monoliths

The fertile, wide valley of Reykholtsdalur is located in the west of Iceland, approximately 25 km from the sea (Fig. 3.10). It is the location of several

ancient settlement sites (Fig. 3.11), and the farm of Hólakot is thought to be the location of the earliest farm in the valley. The nearby farm of Reykholt has been significant throughout its history. It is mentioned in the *Landnámbók* (The Book of Settlements) as the location of warm springs used for bathing by the inhabitants of the farm at Breiðabólsstaður, and as a settlement in its own right in the 12th-century *Sturlunga saga*. A charter from the 1180s mentions the presence of a church and, during the 13th-century, the farm was the home of Snorri Sturluson, a politician, historian, and one of the most famous saga writers. The farm was abandoned in the 1930s and the buildings pulled down. Excavations at the farm site have revealed various phases of farm construction, including a passageway farmhouse with the remains of buildings underneath, and a passage leading from the house to the hot water pool (Buckland *et al.* 1992). The area surrounding the settlements is known to have been managed for the production of hay, which formed the basis of the wealth of Reykholt both in the past and at present.

A palaeoenvironmental sampling programme was planned from the start of the most recent phase of excavation at Reykholt, and the results of beetle and plant macrofossil analysis from the 17th/18th-century passageway house and midden (Zutter 1992; Buckland *et al.* 1992), and a preliminary report into the plant macrofossils from context 577 an extensive deposit overlying the natural soil (interpreted as a dump) (Guðmundson 2002), have been published.

Halsasveit is located immediately upstream from Rekholtsdalur. At Háls, located 10 km from Reykholt, evidence of a large ironworking complex and a semi-subterranean structure ('pit house') has been excavated. The floor of the ironworking complex lies just above the *landnám* tephra and the pit house is thought to be contemporaneous. In the mid-10th-century AD, ironworking was abandoned and the site changed function to agricultural activity. Occupation was continuous until the 13th-century, when the settlement was abandoned. There is, however, evidence for continuing agricultural activity in the area, with the construction of two haybarns (13th-15th or 16th-century) and a later sheepfold (in use until ca. AD 1900). At present, the mire is subject to drainage via ditches cut into the surface, and is occasionally burned. Although it is not

purposefully manured, it is subject to animal grazing which results in the addition of dung (Dixon 1997).

Several exposed sections of sedimentary sequences covering the period under investigation by the project were identified, and contained bands of volcanic tephra visible in the sections, which are likely to relate to volcanic eruptions of known date. The sampling sites were selected to provide an insight into the localised vegetation communities and environmental conditions across the landscape before settlement, and to assess the speed and nature of human impact on the landscape after the settlement. The farmsteads of Reykholt and Hólakot were agricultural in function, whilst Háls was an ironworking centre in the earliest phase of occupation, changing in the 10th-century to an agricultural function. Monoliths from areas in the vicinity of these sites will give an idea of the impact of different activities on the landscape. The locations of the monolith samples are shown in Fig. 3.12.

Háls South Pit is located to the east of the sampling sites described above. Pollen and plant macrofossil analysis was carried out on a monolith from Háls South Pit by Alexander Dixon (1997) for his MSc thesis. The dating of the monolith was based on observations of tephra deposits made in the field, and has since been revised. New dates were provided by Dr Kevin Smith, the site director. This sampling site was selected for presentation in this thesis as Dixon's original interpretation must be revised in the light of the new dates, to give a comparative site further inland from Reykholtsdalur 2 and Breiðabólsstadavatn 2, and to provide a comparison with a site where the initial phase of occupation was non-agricultural.

3.2.2. Stóramörk Monolith

Stóramörk is located in Eyjafjallsdalur in southern Iceland, in an area with basalt bedrock adjacent to the sandur of Markafljót and the broad coastal plain deposited by the meltwater of nearby icecaps (Fig. 3.13) (Haraldsson 1981). The meltwaters are known to have changed course over a large area in the past, although mainly in the area to the south of Stóramörk (Haraldsson 1981;

Buckland *et al.* 1991), and this dynamic environment appears to have affected the extent of wood/scrub cover in the area, both before and after the settlement (Haraldsson 1981; Påhlsson 1981). This is one of the warmest, wettest areas in Iceland (Preusser 1976) and has been extensively settled in the past (Sveinbjarnardóttir 1992). The farm at Stóramörk is considered from medieval sources to have been one of the principal farm groupings of the early settlement period, and is presently a working farm (Mairs *et al.* in press). The farm is important enough to have possessed a chapel, and is surrounded by extensive infields which are historically known to have been productive compared to others in the region (Mairs *et al.* in press). The farm also has access to outfield resources, such as grazing land, woodland and sources of driftwood (Mairs *et al.* in press). Recent work on sediment accumulation rates at several locations in the area surrounding the Mörk farm groupings (one of which is Stóramörk) indicates that sediment accumulation rates were low below the *landnám* tephra, and that, by AD 920, substantial sediment flux variations begin, continuing to the late 14th-century (Mairs *et al.* in press). The analysis of the monolith from Stóramörk will indicate how these changes affected the plant community in the area adjacent to the farmstead.

CHAPTER 4: METHODOLOGY

This chapter describes the methodology used for the sampling, processing and analysis of material from all sites. The methods are discussed in relation to the two distinct types of samples mentioned in Section 1.2.2 – those from monoliths taken from peat sequences ('off-site' samples) and those from archaeological sites ('on-site' samples). Due to the nature of the material recovered from the 'on-site' and 'off-site' deposits, different methodologies were required for sampling and these are discussed below.

4.1. FIELD METHODS

4.1.1. 'Off-site' samples

Sections were prepared by scraping approximately 30 cm of soil from the vertical face to minimise contamination and damage to the plant macrofossil contents caused by fungal attack and drying (Coope 1986). Sections were described, drawn and photographed in the field, and the location of samples in relation to stratigraphical features noted. A monolith for the recovery of plant macrofossils and beetles was recovered from the cleaned section, and divided into contiguous blocks of a suitable size for transport and storage (usually cubes of approximately 20 cm). Enough material was taken to allow a sample of 5 litres to be taken every 5 cm in depth (this is the recommended resolution and volume for the analysis of beetles - Coope 1986 – less material is required for the analysis of plant macrofossils, as discussed below). The division of the monolith into blocks was staggered, to ensure all depths were sampled adequately (i.e. so there was material available for each depth from the middle of a block – see, for example, Fig. 4.1). The blocks were wrapped in plastic and labelled so the monolith could be reassembled at a later date. Cores for the analysis of pollen were taken from as near to the monolith as possible.

4.1.1.1. The Faroe Islands

The sampling site at Hov is located approximately 0.25 km from the present day shore line and approximately 0.75 km south-west of the modern settlement. The monolith was taken through a section of mire recently cut by a stream feeding from higher up the valley. All sediments consisted of peat and conditions appeared good for the preservation of organic matter. The monolith was 110 cm wide and 115 cm deep, and crossed six different sediment layers (Fig. 4.1; Table 4.1).

4.1.1.2. Iceland

4.1.1.2.1. Reykholtsdalur and Halsasveit

Several exposed sections of sedimentary sequences spanning the *landnám* tephra were identified in the valley of Reykholtsdalur, Borgarfjörður.

1. The Reykholtsdalur 2 monolith was located in the meadow in the lower part of the river valley, near the settlement of Reykholt. Six bulk samples were taken at 5 cm intervals across the *landnám* tephra - one above and five below (Fig. 4.2; Table 4.2).

2. The Reykholtsdalur 3 monolith was taken from an eroding river bank, near the settlement of Reykholt. The monolith was 95 cm and thought to include the *landnám* tephra within a peaty deposit (Fig. 4.3; Table 4.3). The upper 80 cm was not sampled as it was considered too desiccated and therefore unsuitable for organic preservation. ^{14}C dates later indicated that the entire sequence is pre-*landnám* (3200-2700 BC to AD 70-320).

3. The Breiðabólsstadavatn 2 monolith was located near to Hólakot, supposedly the earliest farm in the valley, and approximately 1 km northeast of the lake of Breiðabólsstadavatn (i.e. the nearest exposed peat section to Hólakot). A monolith 1.65 m deep was taken, containing the *landnám* tephra at 23 cm depth (Fig. 4.4; Table 4.4) and ^{14}C dated to 2280-1980 BC at 67 cm depth.

4. At Háls South Pit a monolith approximately 120 cm deep was taken from a 1.5 m by 1 m test pit dug into the mire surface (Fig. 4.5; Table 4.5). The monolith was taken for plant macrofossil analysis, with 2 litres to 5 litres bulk volume per sample at approximately 5 cm depths (with allowance made for changes in stratigraphy). A core was also taken for pollen analysis, microcharcoal and loss-on- ignition (LOI) (Dixon 1997).

4.1.1.2.2. Stóramörk

The sampling site was located in the hayfields of the modern farm. A monolith was taken from a ditch-cutting about 500 m from the modern farm, approximately 30 m from a stream. The cutting exposed 3 m of deposits, containing a full suite of medieval tephras in peaty deposits, and a monolith was taken from the surface turf to a depth of 1.40 m (Fig. 4.6 - no lithographic description was taken by the excavators). Birch wood and a tree stump were preserved in the lower layers, and organic preservation was considered to be good.

4.1.2. 'On-site' samples

Samples from the archaeological deposits were taken as bulk samples.

4.1.2.1. Toftanes

Toftanes was excavated between 1982 and 1987 under the direction of Steffan Stumman Hansen, and samples for beetle and plant macrofossil analysis were taken by Phil Buckland. Bulk soil samples ranging in size from around 10 litres to a handful of material were taken from a range of contexts during excavation (Fig. 4.7; Table 4.6). Both archaeological contexts and sterile deposits underlying the structures were sampled.

4.1.2.2. Sondum Midden

Work on the Sondum midden was carried out in the 2002 and 2003 seasons by Mike Church, Kim Vickers and Kerry-Anne Mairs. In the 2002 season, eight

bulk samples were taken at intervals through the midden (Fig. 4.8 – marked as S2/2 to S2/9; Table 4.7). These were wet sieved in Edinburgh by Mike Church, and scanned to assess the richness of the deposits, and the degree of preservation. The organic content of the midden was assessed at 2 cm depth intervals using the loss-on- ignition technique. In 2003, six contiguous bulk samples, each 10 cm in depth, were taken between 144 cm and 204 cm (Fig. 4.8 – marked with dashed lines). This material had proved to be the richest from the 2002 test samples, covering the depths where the higher percentages of organic content were located. These six samples taken in 2003, plus the plant macrofossil content of the 2002 samples, were sent to Sheffield for analysis.

4.2. LABORATORY METHODS

4.2.1. Storage

All 'off-site' samples and the samples from Sondum were shipped to Sheffield and put into cold storage when not being worked on. Samples from Toftanes had been in storage in Sheffield since excavation, but had not been stored in cold conditions. All samples had dried out, and were rehydrated by soaking in water for two days, as advised by Dr Allan Hall. Although these conditions are not ideal for the preservation of organic remains, soaking in water seemed to be adequate for the sample matrix to disaggregate for paraffin flotation and wet sieving. Once processed, material from each sieve was stored in ethanol in a glass jar and labelled inside.

4.2.2. Dating of Material

The following samples were provided for dating by the 'LCL' project.

4.2.2.1. 'Off-site' samples

4.2.2.1.1. Faroe

A column of material 5 cm by 10 cm was taken from the full length of the Hov monolith for ^{14}C dating and tephra analysis.

4.2.2.1.2. Iceland

A column of material 5 cm by 10 cm was taken from the full length of each monolith for tephra analysis. Samples for ^{14}C dating were provided by E. Erlendsson from the University of Aberdeen.

4.2.2.2. 'On-site' samples

4.2.2.2.1. Toftanes

Several contexts had already been selected for radiocarbon dating and the results published in Edwards *et al.* (1998). New dates were obtained from the floor in Building I (sample 1964) and the floor in House IIa (sample 1400).

4.2.2.2.2. Sondum

Samples from the 2002 season were submitted for ^{14}C dating, but the results were problematic because the dates for cultural deposits were far older than the currently accepted date of human occupation in the Faroe Islands. Further material was submitted for dating by Mike Church.

4.3. SAMPLE PROCESSING

The 'on-site' and 'off-site' samples differed considerably in their physical make-up, and thus it was necessary to develop different processing techniques to separate the plant macrofossils from the 'matrix' (inorganic material or unidentifiable organic matter) of the samples.

4.3.1. Preparation of 'off-site' samples

Each of the monoliths described in Chapter 3 consisted of several blocks, which were then sub-divided into samples. The methodology outlined below was used

for all sites except for Háls South Pit. The processing techniques used at Háls South Pit are described in Dixon (1997).

4.3.1.1. Sampling resolution and cutting

The blocks cut in the field were unwrapped in the laboratory, scraped clean using a trowel to avoid contamination, and loose material removed. Contiguous samples were taken from the blocks at 2.5 cm intervals beginning from the surface level, making allowance for features of the stratigraphy, especially the location and morphology of the tephra bands (e.g. if the tepha band was thin and lay within the 2.5 cm interval, the material from above and below the tephra would not be mixed). This allowed a suitable degree of resolution for the plant macrofossil samples, and two samples could be combined to give the 5 litres per 5 cm depth required for the analysis of beetles. Half a litre of bulk sample was required for the plant macrofossil samples (A. McMullen, pers. com.), and there was enough material from the Hov monolith to set aside material especially for this purpose. The other monoliths did not contain enough material for this to be possible, so the same material was used for the plant macrofossils and beetles. Laboratory sketches were made to relate the blocks and samples to the stratigraphic context.

Samples were selected at depth intervals (e.g. every fourth sample) to establish at a basic level the condition of preservation and richness of the plant macrofossils.

4.3.1.2. Selection of a suitable method for sample processing

The most common method of sample preparation is to sieve peat samples through a stack of sieves of various sizes, to separate the different sized components and make sorting easier, although other techniques have also been employed (see Grosse-Brauckmann 1986 regarding collecting macrofossils from the surface of the sample). As there is no universally established method for processing material from waterlogged samples for plant macrofossil analysis, it was necessary to develop an appropriate technique for separating out

and concentrating the plant macrofossils required for study from the 'matrix' of inorganic material and unidentifiable organic remains.

Based on recent work on Neolithic Swiss Lake villages (Hosch and Jacomet 2001), it was decided that material would be wet sieved through a series of five sieves to divide up the material. 4 mm, 2 mm, 1 mm, 0.3 mm and 0.2 mm mesh sieves were used - 0.2 mm was the finest sieve size as it is necessary to catch all seeds for the investigation of natural vegetation (Hosch and Jacomet 2001). Experimentation with different processing techniques took place, to assess the effectiveness of washover (placing the sample in a bucket of water, disaggregating it and swirling the water whilst pouring off the floating and suspended fraction into a stack of sieves), paraffin flotation (placing the sample in a bucket of water with paraffin and pouring off the floating fraction into a stack of sieves) and wet sieving (putting the sample directly into a stack of sieves and washing through with water). Each sample was processed, and then the resultant fractions scanned under a low-power binocular microscope to assess the way the plant macrofossil content had been divided up. Washover and paraffin flotation were not effective methods of separating identifiable plant macrofossils from the 'matrix' of inorganic material and unidentifiable organic remains. Wet sieving seemed to be the most appropriate method for dealing with the material, but the scanning of the material indicated that sorting had the potential to be very time-consuming, due to the richness of the samples.

4.3.1.2.1. Laboratory preparation of 'off-site' samples

The processing of a few samples of peats from Hov by wet sieving (with 4 mm, 2 mm, 1 mm, 0.3 mm and 0.2 mm meshed sieves), indicated that there was a problem with the disaggregation of the material - peat fragments clogged the smaller meshed sieves, so the plant macrofossils were not adequately concentrated. The large retent would then have to be sorted in its entirety, which would be very time-consuming, or sub-sampled, which would provide too little material. There was also a concern that smaller plant macrofossils would remain embedded in the undisaggregated sediments and not be recognised. Clearly some method of disaggregation was needed to concentrate

the samples and reduce sorting time. Experimental work was carried out to ascertain the effectiveness of processing using an ultra-sonic bath, sodium carbonate and potassium hydroxide for disaggregating the samples. Alongside this, experiments were designed to assess the amount of damage caused to various modern plant parts. The full details of these experiments are published in Bending (2005).

The results indicated that the methods can be evaluated as follows:

1. Hot potassium hydroxide (5%) – effective in disaggregating the matrix of the sample but causes a lot of damage to the plant material in a relatively short time.
2. Cold potassium hydroxide (5%) – also disaggregates the sample quickly, but more experimental work would have to be done to investigate the balance between the amount of damage with the amount of decrease in the sample volume.
3. Sodium carbonate (10 ml/1 litre water) – disaggregates the sample matrix more slowly, with superficial damage only.

To conclude, sodium carbonate seems to be the most useful technique for disaggregating peat deposits and concentrating the plant macrofossil components, and was used where necessary to disaggregate samples i.e. an attempt was made to wet-sieve the sample, and if it could not be disaggregated sufficiently, it was soaked in sodium carbonate solution for up to 24 hours.

Sample size for the 'off-site' samples was 0.25 litres.

4.3.2. Preparation of 'on-site' samples

For Toftanes, the samples were first subjected to paraffin flotation to recover Coleoptera. The heavy residues from paraffin flotation were sub-divided using the 'squares' method outlined by van der Veen and Fieller (1982) to an equivalent of c. 0.5 litre bulk volume (i.e. if the original bulk volume was five litres, the residue would be divided by 10, whatever the volume of the residue). From Sondum, enough bulk sample was available that a separate sub-sample could be taken for plant macrofossil analysis. For the first four samples,

0.5 litres was processed, but initial sorting indicated that a volume of 0.125 litres would provide sufficient plant macrofossils for analysis, and this volume was processed for the last two samples.

4.3.3. Scanning and final selection of samples

Initially all the 'on-site' samples from Toftanes and Sondum, and selected 'off-site' samples (usually every fourth sample, but allowance was made for the position of tephras and other features) were scanned under a binocular microscope (magnification x7 to x10). The major components of the matrix of the sample were recorded (e.g. if the sample was woody or stony), as well as the contents of each sieve (seed and other plant macrofossil types, plus other notable items e.g. beetles). The general degree of preservation was assessed on a five-point scale (see Table. 4.8). This information was then used to select samples for further analysis.

4.3.3.1. 'Off-site' samples

The information from the scan was used to establish whether any basic patterns were apparent in the plant macrofossil content of the monoliths. Samples were selected at points of stratigraphic interest (e.g. above and below tephras), and at intervals (usually every fourth sample) through seemingly uniform deposits.

4.3.3.2. 'On-site' samples

4.3.3.2.1. Toftanes

Samples were selected in collaboration with Kim Vickers. Samples with at least 5 litres of material and with adequate context information were listed, and one sample for each archaeological layer selected.

4.3.3.2.2. Sondum

All six samples taken in 2003 were analysed. Plant macrofossils from the test samples taken during 2002 and were added to the database.

4.3.4. Sorting

The intention was to provide at least 300 quantifiable items for analysis from each sample, and sieved fractions were sub-divided when necessary using the 'grid' method and random numbers (van der Veen and Fieller 1982). While this was usually achieved from the archaeological samples, the poor preservation and low concentration of identifiable material in the environmental samples often meant that this was not possible, as the time taken to sort more than 30 items would have been extremely long.

Samples were sorted in water under a low-powered binocular microscope (magnification x7 to x45). All items from the 2 mm mesh sieve fraction were removed, including charcoal and mosses. From the finer mesh sieves, seeds and identifiable plant macrofossils too small to be represented in the 2 mm fraction were removed, along with beetles and other items of potential interest. The content of the 0.2 mm mesh sieve was not sorted as it was not likely to contain taxa not recovered in the 0.3 mm sieve. It was, however, scanned to ensure this was true. The floating fractions from the paraffin flotation were sorted in their entirety.

4.4. IDENTIFICATION AND QUANTIFICATION OF MATERIAL

The number of samples available for analysis and the number finally selected for identification and quantification are summarised in Table 4.9.

4.4.1. Identification

In order to identify the material, a database of species possibly present in Iceland and the Faroe Islands was constructed from a range of published Floras

and other publications on plant species (Warming 1908; Fosaa 2000, 2001; Bloch 1980; Tukhanen 1987; Ostenfeld and Grötvend 1934; Tutin *et al.* 1964-1980; Kristinsson 1987). The habitat preferences of each species were noted, along with any other useful information. All plant macrofossils were grouped into types based on morphological similarity and each type was assigned a number and described (i.e. if a family or genus name could be suggested, it was noted; if not, a brief description of the shape or distinctive feature was made). For each type, seed atlases (Berggren 1969, 1981; Anderberg 1994) and any other useful references were used to suggest families or genera which displayed morphological similarity with the archaeological material. When a suitable group was found, a list of its members was retrieved from the database of plant species present in the region, and as much information colleted about the species as possible. Seed atlases were used for size measurements and surface texture descriptions. Where information was not available, data was compiled from the material held in the reference collection at the Bioarchaeology Laboratory of the Department of Archaeology at the University of Sheffield for comparison. If species were not held, material was ordered from botanical gardens, or located in he reference collections held in the Environmental Archaeology Laboratory of the Department of Archaeology and Sami Studies at the University of Umeå, Sweden, or the Department of Archaeology at the University of York. The characteristics of the modern seeds would be compared and eliminated if they bore less similarity to the archaeological material than other taxa present in the study area. Due to the limited flora in the study area, most of the well-preserved material could be identified to species. If this was not possible, either because the modern material could not be differentiated, or the archaeological material was in too poor a state of preservation for distinguishing features to be identified, a 'slash' category was constructed of the possible species (e.g. *Eleocharis palustris/uniglumis*) or, if no species from the genus could be discounted, the identification was left at a higher taxonomic level (e.g. *Cerastium* sp.). Dr Mike Charles, Prof. Roger Engelmark (Umeå), Dr Allan Hall (York) and Dr Carol Palmer (Sheffield) gave invaluable advice on the identification of material. Dr Jennifer Miller (Glasgow) provided an unpublished key and laboratory notes on the identification of Cyperaceae nutlets.

Where possible, all material was identified to the highest taxonomic level possible. As there was a limited range of material recovered from the samples, and in the flora of the north Atlantic region, all taxa were identified. Some categories were, however, very time-consuming to identify (e.g. *Juncus* seeds, Gramineae seed coats and wood). In these cases, samples were selected for detailed identification to represent various contexts (e.g. floors and outside areas). Within this, samples which contained a high proportion of the type were given preference. Material of the same type from other samples was left at a general level of identification.

A full list of published and unpublished criteria used in the identification of plant macrofossils is presented in Appendix A. It was decided to refer to taxa throughout the thesis with Latin names (rather than English common names) due to the international interest in this research.

4.4.2. Quantification

Seeds and other quantifiable items (e.g. buds) were counted. Half seeds and fragments of seeds were quantified by counting a unique feature (e.g. radicle tip or attachment scar), depending on the morphology of the seed. For seeds that became fragmented but did not have a unique feature that was preserved, fragments were used to estimate a minimum number of individual seeds.

In cases where the quantification of items was not possible, or would not be appropriate (e.g. charcoal, where fragmentation could have occurred post-deposition, and may over-estimate its presence), a five-point scale of frequency, based on that used by Allan Hall (University of York) was developed.

Comparison was made of the frequency of the plant macrofossil type with the bulk volume of the sample, rather than with other items in the sample, to establish the importance of the material in the archaeological deposit. The definitions of scale ratings are presented in Table 4.10.

4.5. METHODS OF ANALYSIS

4.5.1. Habitat and potential source categorisation of plant macrofossil types

As discussed in Section 1.2.2, it is likely that the plant macrofossils contained in the 'off-site' environmental samples represent the local plant community, and the habitat association of each species or category was investigated, to infer the environmental conditions present at the time the deposits formed. In the case of the 'on-site' archaeological samples, there are many ways that assemblages could have formed, either due to human agency (e.g. useful resources being brought onto the site) or to accidental deposition (e.g. coming in attached to clothing). It is also expected that plants growing around the site would have contributed to the assemblage. It was necessary to investigate the ecological preference of the taxa to suggest the location of a source (e.g. plants from the heaths are likely to have been brought in by human agency, whereas ruderal plants are more likely to have become incorporated into the deposit by accident). The possibility that plant material became incorporated in the archaeological deposits due to its inclusion in another resource (e.g. components of peat or turf) was also investigated.

Habitat information from several published Floras covering Iceland and the Faroe Islands (Warming 1908; Fosaa 2000, 2001; Bloch 1980; Tukhanen 1987; Ostenfeld and Grötvend 1934; Tutin *et al.* 1964- 1980; Kristinsson 1987 and Grime 1992) was used to construct habitat association categories for each identification category (i.e. species, 'slash category' or genus level identification). In addition, Ellenberg's indicator values (1992) were tabulated for each identification category. The environmental categories covered by Ellenberg were: light, moisture, nitrogen (related to soil fertility), reaction (i.e. soil or water pH) and salinity, and were used to support the (sometimes anecdotal) information in the published Floras. Where available, the calibrated figures for the Faroe Islands (Lawesson *et al.* 2003) were used. If no value based on the Faroese study was available, Hill's (1999) values for British plants were taken. The values for temperature, continentality and resistance to heavy

metals (from the Central European surveys in presented in Ellenberg 1992) were not used as these factors do not have much of a range in the Faroe Islands – it is a cool oceanic climate with no extremes in temperature, and there are no natural metal sources on the islands apart from bog iron. As the values for light and salinity did not show any significant range, types were grouped using the Ellenberg values for the three most variable categories: moisture, nitrogen and reaction. The resulting groups compared well with the habitat association categories, and the final categorisation was evaluated by Allan Hall and John Hodgson, and amendments made accordingly (the addition of categories for taxa occurring in various conditions but generally associated with hayfields or ruderal-arable conditions were based on the advice of John Hodgson). For the types preferring nutrient-enriched conditions, their status as annual or perennial plants was used to establish whether they are tolerant of the disturbance occurring in ruderal conditions, cereal fields and the bird cliffs (generally annuals), or prefer the undisturbed conditions more common in the hayfields (generally perennials). The habitat association categories, environmental categories and final categorisation are presented in Table A.7.

The classification of *Montia fontana* ssp. *fontana,* the most commonly occurring seed type at Toftanes and also present at Sondum, had been problematic. Ellenberg numbers (Hill *et al.* 1999) associate it with wet conditions of intermediate fertility but, as it can occur as an annual or perennial, it is tolerant of both disturbed and undisturbed conditions, so could occur in both the wetter areas of hayfields and as a ruderal. *Montia fontana* is noted by Bloch (1980) as a troublesome weed in newly cultivated areas and Warming (1908) records it as occurring around habitations, as well as on the bird cliffs and in wet areas such as stream banks. The short height of the plant (up to 15 cm tall – Ostenfeld and Grotvend 1934), would make it unlikely that it would be collected in scythe-cut hay or cereal crops, especially if the fields had an uneven surface and *Montia fontana* was growing in the lower, wetter areas of the hummocks and drainage ditches. Based on habitat considerations, it seems likely that *Montia fontana* ssp. *fontana* was growing around the buildings as a ruderal, and this is supported by its frequent occurrence, both in terms of the number of samples, and the proportion of the assemblages in which it is present

(this is in agreement with Hansson's (1997) analysis of plant macrofossils from Borg). However, in samples from Fishamble Street in Viking period Dublin, *Montia fontana* subsp. *chondrosperma* is the dominant seed type in samples consisting entirely of decayed turfs (Geraghty 1996). Both *M. fontana* ssp. *fontana* and *M. fontana* ssp. *chondrosperma* are found in the same range of habitats (EUNIS 2006), and the presence of *M. fontana* subsp. *chondrosperma* at Fishamble Street is proposed to relate to the system of water meadows, where areas are flooded in winter, to protect against frost, and drained in spring (Geraghty 1996). The resulting areas of riverine silt would have provided a perfect habitat for *M. fontana* ssp. *chondrosperma,* and heavy grazing of the water meadows would have led to the development of the strong root mat desirable for building turfs (Geraghty 1996). The creation of water meadows is not historically known in the Faroe Islands, and is considered unlikely due to the lack of floodable rivers and the necessity of drainage as part of the historically known land management strategy. It should not, however, be ruled out that *M. fontana* ssp. *fontana* arrived at the site as part of a resource. Hall (2003), in an overview plant macrofossil assemblages from contexts identified as turf-rich at sites in Britain and Northern Ireland, concludes that perhaps all subspecies of *M. fontana* should be considered as potential turf indicators (in association with other plant macrofossil types), although *M. fontana* ssp. *chondrosperma* is most frequently mentioned in the species lists. As the status of M. *fontana* ssp. *fontana* was unclear, and it occurred frequently, it was decided to label it separately in the analyses to check whether it was possible to determine its origin, or whether it was generally present in the assemblages.

4.5.2. Summary statistics (all sites)

Data from all sites were summarised using the identification categories, as well as the habitat association categories to investigate meaningful patterns. Various techniques were used, depending on the nature of the site and the richness of the material.

4.5.2.1. 'Off-site' samples and Sondum

The results from sites where samples were taken in a vertical sequence from the section were presented as TILIA graphs (i.e. the 'off-site' samples and Sondum). TILIA (Grimm 1991-1993a) is a programme used for analysing the content of samples taken from a stratified sequence, usually the results of pollen analysis from stratified sediments. Graphs were prepared using TGView (Grimm 1991-1993b), a drawing package which creates graphical representations of the results of analysis in TILIA. Results were presented based on the absolute numbers of seeds in a sample (i.e. the concentration per unit volume) with summary percentages of the total seed count in each sample. Taxa were categorised by their habitat association category (see Appendix Table A.7) and the presence of 'Unquantifiable' types was indicated with a circle. The sequences were divided into zones based on the plant macrofossil content. These divided the graph into units which were internally fairly homogeneous, and were distinct from adjacent zones.

At Sondum, a graph of absolute numbers was prepared using TILIA and TGView. The samples from Sondum were rich enough that percentage bars were prepared for the major seed taxa (i.e. those making up more than 2% of the sample). At all sites, taxa were categorised by their habitat association category. These graphs are presented in Chapter 5.

4.5.2.2. Toftanes

Pie charts were prepared for the samples from Toftanes. For the assessment of the relationship between the charred and non-charred assemblage, all seeds were included. For consideration of the ecological preference of the taxa present in the sample, only samples containing more than 50 seeds, taxa present in more than 10 % of samples, and taxa that could be assigned an ecological preference category were included. This made the pie charts comparable with those produced by correspondence analysis (described in Section 4.5.3). Bar charts were also produced for each sample showing the frequency of

unquantifiable types on the five point scale described in Section 4.4.2. These charts are presented in Chapter 5.

4.5.3. Statistical analyses (Toftanes and Sondum)

The seed assemblages from Toftanes and Sondum were investigated using correspondence analysis. This is a multivariate statistical technique used to search for patterns in complex data that is based on the quantifiable composition of samples (i.e. plant macrofossil taxa in samples). The samples are plotted spatially along axes, depending on their composition, and in relation to other samples i.e. the distance between the samples in the diagram relates to the similarity or dissimilarity of their species composition. Correspondence analysis produces two-dimensional scatter-plots, where the first axis accounts for the most significant variation in the data, and the second counts for the next most significant variation (further pairs of axes can be plotted if necessary). Species which are plotted near to the origin of the scatter-plot tend to be common, while samples plotted in the same location tend to have a composition consisting of commonly occurring species (i.e. what is 'normal' for the samples included in the analysis). The distance of samples and species from the origin indicates how different they are from the 'norm' (i.e. how unusual the sample composition is, or how rarely the species occurs), and the direction of the divergence reflects the association of samples and species. The distance between points can be used to assess their degree of similarity (i.e. the similarity of sample composition and the likelihood of species occurring in the same sample).

CANOCO for Windows (ter Braak and Smilauer 1997-1999) was used to carry out the correspondence analysis, and CANODRAW was used to plot the results (Smilauer 1992). Both the species and samples were coded in a variety of ways in an attempt to discover meaningful patterns in the material (e.g. relating to context type, house area). In order to prevent the skewing of the results by rare species or samples, species present in less than 10% of samples, and samples containing less than 50 seeds were not used in the analysis. A series of analyses were run, containing samples from both Sondum and Toftanes or only samples

from Toftanes. For consideration of the ecological preference of the taxa present in the sample, only taxa that could be assigned a habitat association category were included. For the assessment of the relationship between charred and non-charred assemblage at Toftanes, all seeds which fitted the above criteria were included. Where useful, the sample symbols were replaced by pie charts showing the classification of species by habitat association category. The data were refined by the inclusion or exclusion of samples or species plotted as outliers on the scatter-plots because of their unusual composition or rare occurrence (i.e. to 'zoom in' on clusters of samples). A selection of these charts is presented in Chapter 5.

CHAPTER 5: RESULTS

The results of the archaeobotanical analyses of the samples listed in Table 5.1 are presented in this chapter beginning with a general overview of the on-site and off-site assemblages (preservation, range of plant macrofossil types, richness) and continuing with a more detailed description of the results of the analysis of assemblages from each of the on-site and off-site locations. The counts for each sample are presented in Appendix B: Table B.1 – Hov; Table B.2 – Reykholtsdalur 2; Table B.3 – Reykholtsdalur 3; Table B.4 - Breiðabólsstadavatn 2; Table B.5 – Stóramörk; Table B.6 – Toftanes and Table B.7 – Sondum.

The material from the on-site samples was generally richer than those from the off-site samples, in terms of the degree of preservation of the botanical remains and the range of taxa that could be identified (Table 5.2). Organic matter made up the bulk of the on-site samples in almost all cases, and a variety of seeds, leaves and wood, as well as peat/dung 'nodules' (undisaggregated sediments that were distinct in texture from the matrix of the sample, indicating that they were from a different source) were preserved at both Toftanes and Sondum. As neither site was submerged under water, it is likely that the material was preserved by anoxic waterlogging i.e. decay has been inhibited by insufficient drainage and a lack of oxygen due to poor aeration of the material (cf. Hall and Kenward, 2004).

Off-site samples tended to contain lower concentrations of identifiable plant material than those from on-site samples, as well as a narrower range of types (Table 5.2) and the degree of preservation tended to be poorer than for the on-site material. Macrofossils with a poor state of preservation may lose diagnostic features, so the poor preservation and lower concentrations of identifiable plant material are not unrelated. The most commonly retrieved identifiable plant macrofossils from off-site samples were seeds and bud scales, probably because they were more robust than other parts of the plant.

5.1. 'OFF-SITE' SAMPLES

5.1.1. Faroe Islands - Hov

The Hov monolith covered the period AD 500 to 1500 between c. 10 cm and c. 55 cm depth, although deposits from outside this range of dates will be discussed where noteworthy. Notable lithographic changes occurred at 46 cm (from grey/dark brown peat with wood below to recently humified black pseudo-fibrous peat above), at 22 cm (from recently humified black pseudo-fibrous peat below to dark brown fibrous peat with possible burnt inclusions above) and at 8 cm (from dark brown fibrous peat with possible burnt inclusions below to turf and black fibrous peat above) (see Table 4.1 for full descriptions). The age-depth curve shows that the deposition of older material is evident between 25 cm and 35 cm (Fig. 5.1).

The preservation of plant macrofossils was fair to poor overall (see Table 4.8 for definition of terms). Very little material was recovered from the layers below c. 50 cm, and there was a there was a marked increase in the number of seeds from 42.5 cm to 45 cm, followed by a slight decrease in numbers in the samples above (Fig. 5.2). Habitat preference categories and Ellenberg numbers are presented in Table 5.3 and Fig. 5.3. All types recovered were tolerant of well-lit conditions or were light-loving (Ellenberg values between 6 and 8), and had no or a slight tolerance of saline conditions (values of 0 or 0-1). As well as the analyses mentioned above, pollen (by Edwards *et al.* 2005), beetle (by Kim Vickers) and soil (by Mairs 2003) analyses were carried out at Hov.

5.1.1.1. Zone 1

Zone I, between 108.0 cm and 52.5 cm (1 BC and AD 422-579), was defined by high proportions of *Selaginella selaginoides* megaspores, and by the presence of Poaceae seed coats (which could not be identified due to poor preservation). *Viola canina/palustris* and *Juncus trifidus* were also present. In the deposit between 46 cm and 76 cm, wood was noted in the sediment description taken in the field (see Table 4.1). No plant macrofossil wood was recovered, which may indicate that the fragments were in too poor a state of preservation to survive

processing. In this Zone, seed counts were low (less than 15 – Fig. 5.2), but increased in the upper sample.

Classification of the plant macrofossil taxa according to their ecological preferences (Fig. 5.3) indicates moist grassland, heath and/or rocky areas, with no evidence of species preferring consistently moist or wetter areas (although this is based on few categorised types). The range of plants present in the assemblage suggests that soil conditions are likely to have been acidic to moderately acidic, and soil fertility generally poor. Richer conditions are indicated between 92.5 cm and 95.0 cm, but this is based on the tolerance range of one classified type, so caution is necessary when discussing this result. The poor preservation of plant material below c. 50 cm is reflected in the comparatively low loss-on-ignition values below 48 cm (Fig. 5.3), which indicate that there is a low organic content (below 45%) and it is possible that much of the organic component has decayed.

Nutrient-poor open grassland heath, wetland and meadow are evident in the pre-*landnám* pollen assemblage (Edwards *et al.* 2005), and the plant macrofossil evidence suggests that the sampling site was probably located within one of the drier areas indicated by the results of pollen analysis (Jóhansen 1985; Edwards *et al.* 2005). *Betula* pollen is present at low levels (Edwards *et al.* 2005) and wood macrofossils were noted in sedimentary sequences at various points in the landscape (Mairs 2003). The loss-on-ignition results are consistent with those expected in grass or heath soils. The classification of the area as moist grassland or heath is in contrast to the results of the analysis of beetles, which indicate nutrient-rich, wet peatland.

5.1.1.2. Zone 2

In Zone II, above 45.0 cm (after AD 467-650), the most general change is that Gramineae disappear and *Carex* and *Juncus* are present, indicating wetter conditions than previously. *Carex echinata, Juncus articulatus/bulbosus, Potentilla crantzii/erecta* are the most commonly occurring taxa, while *Selaginella selginoides* is present at lower levels than in the underlying deposits

(Fig. 5.3). A much greater concentration of seeds were recovered than in the underlying deposit (Fig. 5.2).

The classification of taxa according to ecological preferences (Fig. 5.3) shows that species associated with wet boggy conditions (e.g. *Carex echinata* and *Juncus articulatus/bulbosus*) are present for the first time, and that the proportion of *Selaginella selginoides,* a clubmoss associated with open grassland, heath or rocky areas, decreases. Species associated with grassland and heath communities (e.g. *Carex pilulifera, Hypericum pulchrum, Potentilla crantzii/erecta*) are also present, and seem to suggest a more varied range of habitats - acidic to moderately acidic, nutrient-poor conditions with moist and wet areas, as well as areas of shallow water (Table 5.3).

The greatly increased preservation of plant material above 45 cm relates to the increasing loss-on-ignition values above 48 cm (Fig. 5.3), i.e. the organic proportion of the matrix increases between 48 cm and 38 cm. ^{14}C dates (based on the 2σ variation) between 25 cm and 35 cm (ca. AD 1025) show that the material is older at 28-29 cm and 32-33 cm than that at 35-36 cm (Fig. 5.1), and that at least 10 cm of material was deposited in a short period of time (at the most 136 years). This, at least in part, corresponds to a decrease in otherwise high loss-on-ignition values between 30 cm and 35 cm, which indicates an input of non-organic material (between 63% and 85%, falling to 55% - Fig. 5.3).

The increased diversity in the local plant community compared to the preceding zone, including wetter boggy areas as well as drier grass and heathland areas, is reflected in other features of the monolith. The wetter conditions have allowed better preservation of organic material (seed numbers and organic content is higher), which can also be seen in a change in the lithography from grey/dark brown peat with wood below to recently humified black peat above. Both pollen and beetle assemblages indicate grazed land during this period with a loss of taxa associated with luxuriant herb vegetation, and dung beetles indicating grazing in the immediate area (Edwards *et al.* 2005; K. Vickers pers. comm.). Cereal pollen is present in the pollen assemblage from about AD 560, and is recorded consistently from AD 680. *Betula* and *Juniperus* decrease from

around AD 890 in the pollen assemblages, and are accompanied by a rise in Poaceae, indicating deforestation in the wider landscape post-*landnám* (Edwards *et al.* 2005).

The changes described above are associated with the peak in charcoal concentration noted in the pollen profile and the presence of an obligate dung beetle interpreted as possible evidence of domesticated animals (Edwards *et al.* 2005; K. Vickers pers. comm.). These are both present at the level dated to ca. AD 560 (Edwards *et al.* 2005), and have been tentatively interpreted as evidence for an early settlement of the Faroe Islands.

Mairs (2003) found that the effects of post-*landnám* erosion (resulting from grazing and vegetation clearance) were not as significant as the effects of erosion from before settlement. The area sampled seems to have been affected by an influx of material at this time, indicating local patterns of erosion and deposition of sediments relating to the settlement period. The ^{14}C dates and depressed loss-on- ignition values from 25 cm to 35 cm indicate that material may have been eroded from the surrounding landscape and incorporated into the sequence in the base of the valley, or the river may have flooded or changed its course, resulting in the deposition of sediments in the area. The presence of taxa such as *Rumex acetosa, Sedum* and *Succisa* in pollen assemblages reflect this input of eroded material, indicating a change from periods of stability to periods of landscape disturbance over the period in question (D. Borthwick pers. comm.).

5.1.1.3. Summary

The area appears to have been open throughout the period sampled, with light-demanding species and plants preferring well-lit or partially shady conditions. Vegetation seems to have been a mosaic of grassland, wetland and heath with woodland or scrub present at low levels. After the settlement, the area of the sampling site seems to have become wetter, with some areas of shallow water. Although tree/dwarf shrub cover seems to have become somewhat reduced, the surrounding vegetation remained varied. The range of plant macrofossils

preserved becomes more diverse in the post-*landnám* deposits, although this may be due to the increased degree of preservation of organic remains, rather than a change in the diversity of the plant community. The age-depth curve does not show any evidence for disruption in the column caused by peat-cutting, although the deposition of older material evident between 25 cm and 35 cm (ca. AD 1025) may be the result of changes in the local erosion and deposition regime, perhaps caused by hydrological changes to the river system or the deposition of older peat from within the valley system.

5.1.2. Iceland

5.1.2.1. Reykholtsdalur 2

Laboratory dating of the deposits produced interesting results. The tephra was identified by microprobe analysis to be a Katla tephra, and not the *landnám* tephra as expected. Because of this, samples were taken from the Reykholtsdalur 1 column for ^{14}C dating. This column of material was taken for pollen analysis and contained the same tephra deposit as the Reykholtsdalur 2 bulk samples. The calibrated ^{14}C dates were in agreement with the original identification of the tephra – dates of AD 770-980 from the deposit below the tephra and AD 780-990 from above the tephra indicate that the tephra is likely to have been deposited some time around the *landnám.*

Preservation of plant macrofossils from Reykholtsdalur 2 was good in the pre-tephra deposits, but was poor above the tephra. This is reflected in a decrease in the seed density over time (Fig. 5.4). These changes in plant macrofossil preservation corresponded with significant lithological changes in the deposits. The pre-tephra deposit is a highly organic (78% L.O.I. - Fig. 5.5), dark-coloured peat, while the the post–tephra deposit is a less organic (18% L.O.I. - Fig. 5.5) lighter-coloured silty-clay.

Habitat preference categories and Ellenberg numbers are presented in Fig. 5.5 and Table 5.4 respectively. All types recovered were tolerant of well-lit conditions or were light-loving (Ellenberg values of 7 or 8), indicating that

tree/dwarf shrub cover was open, and had no or a slight tolerance to saline conditions (values of 0, 1 or 0-1).

As well as the analyses mentioned above, beetle analysis was also carried out at Reykholtsdalur 2 (by K. Vickers).

5.1.2.1.1. Zone 1

The samples below the tephra contained evidence of several taxa of trees and/or dwarf shrubs in the vicinity of the sampling site. Both the seeds and wood of *Betula* were present, as were *Salix* bud scales – both the seeds and bud covers are present in lower numbers in the sample immediately below the tephra (Pre-1) compared with the sample below (Pre-5 – Fig. 5.5). Twigs of shrub plants were also present, although they could not be identified beyond broad family groups.

The ecological preferences of the seed taxa indicate that shallow water was present in the area, and this is backed up by the presence of a fragment of mesh from the stem of a water plant. Conditions were nutrient-poor to nutrient-intermediate, and acidic, becoming less acidic in the sample immediately below the tephra (Table 5.4).

The plant macrofossil content of the Zone I samples indicates a wet area with trees/dwarf shrubs and areas of shallow water. The beetle assemblage is in agreement, with species representing water and waterbanks, moss, bog and wet grassland common in the pre-tephra samples. Beetle species associated with dry vegetation are also present, indicating that the area may have been hummocky, with drier and wetter conditions. The combination of a decrease in the number of *Betula* seeds and *Salix* bud scales, and a general decrease in wood in the sample just below the tephra (indicated by the wood rating - Fig. 5.5) may represent a decrease in the amount of tree/dwarf shrub cover in the area. This shift in vegetation is accompanied by a broadening in the range of conditions present in the area from acidic to moderate-to-acidic conditions, with nutrient-poor to nutrient-intermediate levels throughout. In the beetle

assemblage, the sample below the tephra contains species associated with rotting vegetation. The presence of rotting vegetation in the vicinity of the sample site may be reflected in the decrease in seed density compared to the earliest sample. These changes indicate shifts in the vegetation below the *landnám* tephra, which could represent the dynamic nature of the pre-settlement vegetation or the impact of an early settlement.

5.1.2.1.2. Zone II

In the sample above the tephra, wood/scrub types are almost absent (Fig. 5.5). The presence of *Salix* bud scales indicates that this genus was still present in the area, but the absence of wood in the matrix of the sample makes it unlikely any trees or dwarf shrubs were growing at the sampling site. The presence of *Selaginella selaginoides* supports the idea that the vegetation was open. *Hippuris vulgaris/tetraphylla* and *Potamogeton* sp. indicate the continuing presence of water in the area.

The plant macrofossil assemblage indicates moderately acidic and nutrient-poor to nutrient-intermediate conditions with open vegetation. Both consistently moist areas and areas of water are indicated, although the organic content of the soil decreases significantly and preservation of both plant macrofossils and beetles is poor compared with samples taken from below the tephra.

5.1.2.1.3. Summary

The area seems to have been open during the period represented by the samples, with areas of shallow water as well as drier areas. The most significant change is from the open *Betula-Salix* scrub evident pre-*landnám* to a woodless environment after the tephra. This change is accompanied by changes in the soil, from highly organic peat to silty-clay. A decrease in trees/dwarf shrubs is evident in the sample immediately below the tephra, which may be the result of natural changes or the impact of early settlement in the area. The taxa associated with water in the acidic, nutrient-poor conditions of the earliest sample are gradually replaced in the later deposits by other taxa. This may

reflect the presence of more moderately acidic areas in the landscape compared with the earliest sample.

5.1.2.2. Reykholtsdalur 3

Although the sedimentary sequence from Reykholtsdalur 3 was originally thought to cover the *landnám* tephra, ^{14}C dates later confirmed that the sampled sequence was dated to between 3200-2700 BC (extrapolated from a linear trendline of ^{14}C dates - Fig. 5.6) and AD 70-320 (^{14}C date at 47-48 cm). The age-depth curve does not show any evidence for the removal or re-deposition of sediments in the section covered by ^{14}C dates (Fig. 5.7). There are several changes in the lithology of the monolith, most notably from silty peat to clayey silt at c. 50 cm (Table 4.3).

The preservation of plant macrofossils at Reykholtsdalur 3 varied depending on the depth of the deposit. Material below 112.5 cm and above 97.5 cm was fairly well preserved – seeds and wood were present (although wood was too degraded to be identifiable, and there was only one delicate Gramineae seed coat, which could not be identified due to poor preservation). Between 112.5 cm and 97.5 cm, plant macrofossils were poorly preserved – no seeds were present and the wood present was very degraded. This is reflected in the seed density of the samples, which is greater below 125 cm and above 95 cm (Fig. 5.8).

Habitat preference categories and Ellenberg numbers are presented in Fig. 5.9 and Table 5.5 respectively. All types recovered were light-loving (Ellenberg values of 8), and had no tolerance of saline conditions (values of 0).

As well as the analyses mentioned above, beetle analysis was also carried out at Reykholtsdalur 3 (by K. Vickers).

5.1.2.2.1. Zone I

Between the base of the monolith at 140 cm and 122.5 cm (dated to 3200-2700 BC to 1850-1480 BC by extrapolation) wood is present, and *Betula* sp. seeds indicate that this genus was present in the area. Seeds of *Carex rostrata* and *Menyanthes trifoliata* are present, as are megaspores of *Selaginella selaginoides*. The number of *Cenococcum geophilum* sclerotia (resting bodies) is low (Fig. 5.9).

The assemblage indicates open, moderately acidic, nutrient-poor to nutrient-intermediate conditions with areas of shallow water and trees/scrub in the vicinity (Table 5.5).

The associated beetle assemblage has similar ecological associations to the plant macrofossil assemblage – an area of mossy bog with wet grassland, and *Salix* present (K. Vickers pers. comm.).

5.1.2.2.2. Zone II

The plant macrofossils present between 112.5 cm and 97.5 cm (dated to 1850-1480 BC to 1680-1320 BC by extrapolation) are very poorly preserved. Seeds are almost absent from the samples (Fig. 5.8), and could not be identified beyond family where they were present, and wood is poorly preserved. The number of *Cenococcum geophilum* fruiting bodies increases (Fig. 5.9).

This zone seems to represent a change in conditions, perhaps becoming drier and more prone to humification (this may be reflected in the increased levels of *C. geophilum*).

Drier conditions are, in part, supported by the beetle assemblage, where species associated with dry vegetated places occur in greater numbers and more consistently. However, species associated with wet grassland, moss/bog are still present, and species associated with water are present. This may indicate a mosaic landscape of water, wet and drier areas.

5.1.2.2.3. Zone III

Between 97.5 cm and 60 cm (1320-1680 BC (extrapolated) to 400-200 BC (^{14}C)) plant macrofossils are preserved (Fig. 5.9), including nutlets of *Carex rostrata, Carex pulicaris* and *Carex nigra*-type and seeds of *Menyanthes trifoliata.* Wood is present, and the number of *Cenococcum geophilum* sclerotia is low. In the most recent two samples, moss is present.

Conditions in the area were unwooded, nutrient-poor and moderately acidic. Areas of shallow water were also present (Table 5.5).

The beetle assemblage is difficult to interpret as it is dominated by species that tolerate a range of environmental conditions, although species associated with water continue to be present, and those associate with drier conditions decrease. The presence of moss in the upper two samples may be the result of better preservation of more recent material, rather than a change in conditions.

5.1.2.2.4. Summary

In Zones I and III (the upper and lower parts of the monolith, below 112.5 cm – i.e. before 1850-1480 BC and above 70 cm – i.e. after 680-420 BC), the ecological associations of the taxa present are with shallow water, generally nutrient-poor, moderately acidic conditions. *Salix and Betula* were present in the area, although levels of wood are consistently low, indicating that the area was not heavily wooded during the period. Taxa associated with consistently moist conditions are also present. This is probably the result of a greater number of taxa being classified, rather than changes in the conditions. In the intervening period, between 1480 BC and 680 BC, conditions may have become drier in the local area, although water, and damp to wet well-vegetated conditions were not far away.

5.1.2.3. Breiðabólsstadavatn 2

Material analysed from Breiðabólsstadavatn 2 covered the period from before 2280-1980 BC to the present surface vegetation. Several changes in the lithography are noted in Table 4.4, the most major being a shift from the underlying brown-black peat (stratum bii and below) to the upper peaty silt (strata a and b) some time around AD 900-1160. The organic content of deposits fluctuates significantly in the material below 50 cm, from highly organic (86% loss-on- ignition) to highly inorganic (8% loss-on- ignition). The organic content of the material deposited above 50 cm is comparatively more consistent, although variation still occurs (32 – 79%) (Fig. 5.10). The position of the *landnám* tephra in relation to the age-depth curve provided by ^{14}C dates, at a deeper level than predicted by the curve, may show evidence for disruption in the column caused by peat-cutting around 40 cm (Fig. 5.11). The deposition of older material is evident at 20 cm (although the material dated was taken from layer bi that was quite thin – see Fig. 4.4).

The preservation of plant macrofossils from Breiðabólsstadavatn 2 was fair. Wood was preserved throughout the monolith, and was common below 40 cm. The range of taxa was poor (up to three identifiable seed types) in the material deposited before AD 900-1160, but increased in the more recent material (four or five seed types – Fig. 5.10). This increase in the range of taxa was accompanied by an increase in seed density (Fig. 5.12).

Habitat preference categories and Ellenberg numbers are presented in Fig. 5.10 and Table 5.6 respectively. All taxa recovered are tolerant of well-lit conditions or are light-loving (Ellenberg values of 7 to 8), and had no tolerance of saline conditions (values of 0).

As well as the analyses mentioned above, beetle analysis was also carried out at Breiðabólsstadavatn 2 (by K. Vickers).

5.1.2.3.1. Zone I

Zone I covered material from 117.5 cm to 32.5 cm, the latter depth dated to 90 BC to AD 90 (Fig. 5.10). It was characterised by the presence of *Carex rostrata* and moderate to high amounts of wood, accompanied by *Betula* sp. seeds in the majority of samples. *Betula* sp. and *Arctostaphylos uva-ursi* were present in the samples where wood identification was attempted (60.0-62.5 cm and 95.0-97.5 cm).

Consideration of the ecological preferences of the species present indicates acidic, nutrient-poor to nutrient–intermediate conditions (Table 5.6). Areas of shallow water were present throughout the period represented by Zone I, and moist and constantly moist conditions are evident in some samples (the range of conditions seems to reflect the number of classified types, so it is possible that these conditions were present more consistently than indicated).

The combination of *Carex rostrata* seeds, *Betula* sp. seeds and wood, and *Arctostaphylos uva-ursi* wood indicate the presence of tree/dwarf shrub vegetation in an area with both moist soils and wet boggy conditions. These ecological conditions and the narrow range of taxa are also reflected in the beetle assemblage. Species associated with moss/bogs and wet grassland were present in the samples which correspond with Zone I. Species associated with water are present in the two basal samples (before 2280-1980 BC) and species associated with dry vegetation occur intermittently between 55 cm and 102.5 cm.

5.1.2.3.2. Zone II

The samples taken from deposits dated between 90 BC and AD 90 and between AD 900 and AD 1160 (above and below the *landnám* tephra - ^{14}C dates calibrated to 2σ variation) contain moderate levels of wood (making up about half of the bulk volume of the sample). Neither sample contained seeds (Fig. 5.10).

These samples indicate a change in conditions before settlement, followed by a continuity of conditions until around AD 900-1160. Dwarf shrub/trees were still present in the area, and the degree of preservation indicates that the area was likely to have low levels of microbic activity, perhaps due to wet or acidic conditions e.g. flooding of the local area. Due to the position of the *landnám* tephra in the sequence, deeper than predicted by the age-depth curve, it is possible that material was removed from the bog (e.g. the area was cut for peat). This would be in keeping with the reduction of growing vegetation, caused by the removal of the surface and possibly the subsequent flooding of the peat cutting. Beetles were not analysed from material in Zone II, so this interpretation must remain speculative.

5.1.2.3.3. Zone III

The samples more recent than AD 900 and AD 1160 were significantly different from earlier deposits (Fig. 5.10). Wood was present at low levels, but the presence of *Potentilla palustris* and *Betula* sp. seeds, and a *Salix* sp. bud scale in the sample at 12.5-15.0 cm indicate that water and trees/dwarf shrubs were still present in the area when the earliest Zone III sample was deposited. The range of seed taxa increased, and taxa not present in underlying deposits were recovered, most notably *Selaginella selaginoides* (indicative of open vegetation). A single charred seed of *Carex nigra*-type is present, the significance of which will be discussed in Section 6.3.3.

Soil conditions were nutrient-poor to nutrient–intermediate and moderately acidic to weakly basic (Table 5.6). This change from the preceding acidic conditions may reflect the absence of taxa associated with shallow water in the upper sample, which may indicate that conditions became drier over time. Beetles were not analysed from material in Zone III. Shallow water seems to have been absent from the area.

5.1.2.3.4. Summary

The location of Breiðabólsstadavatn 2 consisted of a mosaic of moist and wet, watery ground with *Betula* and *Arcostaphylos uva-ursi* before 90 BC – AD 90. In the deposits above this level, the *landnám* tephra occurs at a deeper level than predicted by the age-depth curve based on the sequence of ^{14}C dates, which may be the result of the removal of material, e.g. by peat cutting. This coincides with a change in the plant macrofossil assemblage, notably an absence of seeds (i.e. growing plants), which may be the result of the removal of the active vegetation surface and/or flooding of a peat cutting. After AD 900-1160, there is a decrease in the amount of wood present at the site, although *Betula* seeds and *Salix* bud scales indicate these genera were present in the surrounding area. Soil conditions become less acidic than in the preceding period, but remain nutrient-poor to nutrient-intermediate.

5.1.2.4. Háls South Pit

In the light of new dates provided by K. Smith (pers. comm.), the stratigraphy of the section of the Háls South Pit monolith analysed by Dixon (1997) is now considered to cover the period from the *landnám* tephra at c. 63.5 cm below the surface to AD 1693 at 19-20 cm, with the tentatively identified as the tephra dated to AD 1226/7 at 42-45 cm and a 14th-century Hekla tephra (probably AD 1341) at 34-35 cm. When the age-depth curve is plotted to the surface, there does not appear to be any evidence for disturbance in the stratigraphy due to peat-cutting (Fig. 5.13), and AD 1500 is estimated to lie c. 28 cm below the surface. The monolith consists of a sequence of yellow and brown peat deposits, with woody brown peat between 57 cm and 70 cm (Table 4.5). Below 70 cm, in deposits that were not processed as part of Dixon's work, branches of tree birch were recovered. He describes them as large, although he does not say how big, and interprets them as indicating that the area was wooded pre-*landnám.*

Dixon does not comment on the degree of preservation of the plant macrofossils. The presence of delicate seeds such as *Juncus* and Poaceae

indicate that it was fairly good, but he notes that the wood recovered from the samples was too poorly preserved for their original size to be assessed (no attempt was made to identify the material microscopically).

The categorisation of taxa by Ellenberg numbers is presented in Table 5.7. All taxa were tolerant of well-lit conditions or were light-loving (Ellenberg values of 7 to 8), and were indicative of non-saline habitats (values of 0).

5.1.2.4.1. Zone I

Between the *landnám* tephra at c. 63.5 cm and 57 cm (AD 871±2 to ca. AD 1000) samples are wood-rich, and contained *Betula* sp. fruit and *Salix* sp. buds (Fig. 5.14). The seed assemblage included *Juncus* spp., Poaceae, *Ranunculus reptans/hyperboreus, Cerastium* spp. and various species of *Carex*.

Classification of the plant macrofossil taxa according to their ecological preferences indicated that conditions were acidic and ranged from extremely infertile to intermediately fertile and from damp to wet soils with areas of shallow water (Table 5.7). Although tree/dwarf shrub species were present, no shade-tolerant taxa were present, so the vegetation in the local area seems to have been open. The organic content of the sample matrix in this zone was high, indicated by loss-on- ignition values up to 70% (Fig. 5.15).

The plant macrofossil assemblages from Zone I indicate that this was an area of scrub or open woodland in the period just after *landnám*, probably with hummocky, boggy ground and shallow pools of water. Pollen analysis (Dixon 1997) indicates that these conditions were common in the wider landscape, with *Betula,* Poaceae and Cyperaceae as commonly occurring types and with *Salix* also present (Fig. 5.16). The woodland understorey consisted of tall herbs (Apiaceae) and horsetail (*Equisetum*), and areas of grassland (evident from taxa such as Poaceae, *Ranunculus acris*-type) were also present. Levels of Cyperaceae, and to a lesser extent Poaceae, pollen increased throughout this period, at the expense of *Betula* pollen and *Equisetum* spores, probably indicating the clearance of woodland and increasing expanses of wet grassland

and/or bog. During the accumulation of Zone I deposits, there was a shift in site use at Háls from ironworking to agriculture (mid-10th-century, c. 60 cm depth). Although this does not seem to have affected the general trends in vegetation change, low levels of charcoal were noted above 61.5 cm. It would be expected that ironworking, with its extensive use of fire in production and working as well as the production of charcoal, would produce a more distinct charcoal signal than agricultural activity.

5.1.2.4.2. Zone II

In the accumulation of material between 52 cm and 32 cm, representing the period from ca. AD 1000 to ca. AD 1425, wood is present at low levels and a *Salix* bud is present in the earliest sample in the zone (Fig. 5.14). No macroscopic charcoal was recovered, indicating that the decrease of wood compared to Zone I was unlikely to be the result of burning in the local area. The seed assemblage was similar to the preceding zone, but with several taxa decreasing in numbers over time (e.g. *Juncus* spp., *Carex canescens, Cerastium* spp.).

Ecological preferences of the taxa present indicate increasing diversity of conditions over time, from only moist conditions, to moist-wet conditions with areas of shallow water, from basic to acidic-moderately acidic and from infertile to infertile-intermediately fertile (Table 5.7).

Pollen analysis from the Háls (Dixon 1997) shows *Betula* pollen peaking at 47 cm then falling over time, while counts of the forest-floor taxon *Equisetum* falls more smoothly (Fig. 5.16). *Salix* is also present, but at low levels. The decrease in *Betula* and increase in *Selaginella* indicate more open vegetation than indicated in the previous zone. Counts of Cyperaceae, Asteraceae and *Thalictrum* increase, and *Empetrum* and *Vaccinium* are present, possibly reflecting the changes in the ecological conditions to drier heath and pasture and a shift from tree to dwarf shrub cover. This final decrease in *Betula* pollen corresponds with the abandonment of the farmstead at Háls during the 13th-century (38-46 cm), and the construction of a haybarn soon after. The shift in

landscape use to haymaking perhaps warranted further clearance of wood and scrub to create more extensive meadows. The combination of increasing dominance of Cyperaceae with lower levels of Poaceae may reflect the flowering regimes of the different families in relation to hay-cutting or grazing. Although both families are likely to have been present in great numbers in hayfields, Poaceae tend to flower later in the year than Cyperaceae and, if the hay is cut in the intervening period, Poaceae pollen may be under-represented in pollen assemblages (Fridriksson 1972). Equally, Poaceae are favoured over Cyperaceae by sheep when grazing and would not mature to produce pollen in heavily grazed areas (Fridriksson 1972). The presence of the dung beetle *Aphodius lapponum* in sample 6 (32-35 cm) may indicate the presence of grazing animals in the area, or manuring. This species is not native to the Icelandic fauna and is considered an introduction with grazing animals by the Norse (Buckland 1989-90). The period of tree/dwarf shrub decline is associated in its early phase with a peak in charcoal counts (46-45 cm), this may reflect the clearance of woodland enabling increased incorporation of charcoal into the soil rather than landscape clearance by fire.

5.1.2.4.3. Zone III

Between 32 cm and 20 cm, from ca. AD 1425 to ca. AD 1693, conditions are relatively stable, with *Potentilla palustris* and various types of *Carex* increasing in numbers compared to Zone II (Fig. 5.14). There is no evidence for tree or dwarf shrub types in the immediate vicinity. In the material that accumulated between ca. AD 1693 and ca. AD 1900 (7 cm, i.e. below the topsoil) *Rumex* cf. *longifolius* and Polygonaceae are also present.

The ecological preferences of the taxa present indicate damp to wet soils and areas of shallow water, with acidic to weakly basic, infertile to intermediately fertile soils (Table 5.7). *Rumex* cf. *longifolius* is associated with nutrient-rich conditions of the infield, and is likely to indicate the richly fertile nutrient-status of some parts of the landscape.

The conditions at the end of Zone II are maintained in the vegetation of the wider landscape (indicated by pollen anlaysis), with low levels of *Equisetum* spores, *Betula* and *Salix* pollen, increasing levels of Cyperaceae and fairly constant levels of Asteraceae, *Thalictrum* and *Selaginella* indicating open, dry pasture. The continuation of open conditions with no evidence for forest regeneration is likely to indicate maintenance of the landscape, either due to grazing pressure or human activity such as fodder cutting. The heath taxa *Empetrum* and *Vaccinium* are present at the transition between Zones II and IIIa, but are present infrequently above 30 cm, indicating that open grassland and pasture with wetter areas of bog are present in the landscape.

The plant macrofossil evidence in the upper deposits for nutrient-enrichment in the local area is in contrast with the almost complete domination of regional vegetation by Cyperaceae in the wider landscape, and the presence of *Selaginella selaginoides* indicates that open areas were maintained, probably by grazing as indicated by the presence of a sheepfold in the area. Asteraceae and *Thalictrum* decrease in numbers and *Equisetum* rises slightly. Pollen of tree and dwarf shrub types occurs at very low levels, indicating a further reduction in tree/dwarf shrub cover. The 18th and 19th centuries are known historically to have been a time of general hardship in Iceland, with cutting of the last remnants of woodland due to necessity in the area around Háls (Dixon 1997).

5.1.2.4.4. Summary

The vegetation at Háls South Pit changed over time from one of *Betula* and *Salix* tree cover in both the local area and wider landscape before ca. AD 1000 (Zone I), to generally more open conditions. There was a period of transition where woody plants decreased gradually across the landscape and a mosaic of open grassland and areas of bog developed (Zones II and III), possibly with extensive hay cultivation and/or grazing. There is archaeological evidence of a settlement directly under the *landnám* tephra, and the early phase of human activity is interpreted as associated with ironworking (and therefore a consumer of fuel and producer of charcoal). It is not, however, until there is an archaeologically visible shift in the use of the site from ironworking to

agriculture that a change in the vegetation and charcoal peak is evident. There is no sudden increase of taxa associated with human activity (including cereal pollen) in the plant macrofossil assemblage after *landnám*, indicating that changes to the vegetation were more subtle than at other sites, or that the vegetation was not affected by human activity. After ca. AD 1693, there is plant macrofossil evidence of nutrient-enrichment in the local area.

5.1.2.5. Stóramörk

Material was analysed from the Stóramörk monolith between the AD 500 and AD 1500 tephras.

The preservation of plant macrofossils was generally fair, although there was some damage to thinner parts (e.g. the wings of *Betula* seeds). The seed density varied throughout the monolith (Fig. 5.17), and no overall pattern could be established. The highest density was in the sample above the *landnám* tephra (97.5-100.0 cm), followed by the samples at 85.0-87.5 cm and 130.0-132.5 cm, and was notably lower in other samples. Wood was very degraded, usually beyond identification. The age-depth curve for Stóramörk (Fig. 5.18) suggests that accumulation was fairly consistent over time, and there was no evidence of inversion of sediments in the age-depth profile, indicating that there was no significant deposition of eroded material in the area.

The habitat preference categories and Ellenberg numbers are presented in Fig. 5.19 and Table 5.8 respectively. All types recovered were tolerant of well-lit conditions or were light-loving (Ellenberg values between 7 and 8).

As well as the analyses mentioned above, pollen analysis (by E. Erlendsson) and beetle analysis (by K. Vickers) were also carried out at Stóramörk.

5.1.2.5.1. Zone I

From the lowest deposits (i.e. between AD 130 and AD 680) to the *landnám* tephra, the plant macrofossil assemblages are similar, containing a combination

of *Betula* seeds and catkin, *Salix* bud scales and wood (possibly *Betula* and *Salix* – Fig. 5.19). A fragment of the mesh reinforcement from the stem of a water plant was also recovered. In the upper sample, *Carex nigra*-type seeds were also present.

The ecological preference of *Betula pubescens*, the species probably present at Stóramörk, would indicate constantly moist, acidic, saline-free and nutrient-intermediate conditions in the area (Table 5.8).

The interpretation of *Betula* and *Salix* woodland or scrub with areas of water is in agreement with the pre-*landnám* Coleoptera assemblages, which indicate open *Salix* woodland or scrub with pools surrounded by boggy damp and drier areas (K. Vickers pers. comm.). The local presence of *Betula* is confirmed by the identification in the field of roots and fragments of trunk (E. Erlendsson pers. comm.).

5.1.2.5.2. Zone II

Above the *landnám* tephra, there is a change in the vegetation (Fig. 5.19). Although dwarf shrubs are still evident and the wood rating is still high, the plant macrofossil assemblage becomes more diverse. *Carex rostrata, Potentilla* cf. *palustris* and *Cerastium* spp. are present, and the proportion of *Carex nigra*-type increases compared to the sample underlying the tephra. Shrubs are present until AD 920, followed by a sharp decline in the number of *Betula* seeds and *Salix* bud scales. *Eleocharis palustris/uniglumis* is consistently present from AD 920 onwards, and one seed of *Stellaria media* was recovered at 72.5-75.0 cm. *Selaginella selaginoides* is present in the uppermost sample.

The classification of plant macrofossil taxa by their ecological preference indicates that soil conditions were probably nutrient-poor to nutrient-intermediate, moderately acidic, and saline-free (Table. 5.8). The area is likely to have been moist with consistently moist areas throughout the deposition of

Zone II material, with areas of shallow water in the period immediately after the fall of the *landnám* tephra. Although there is no change in the range of soil moisture represented by the taxa present over time, there is a distinct increase in the proportion of taxa associated with wetland or water, predominantly *Eleocharis palustris/uniglumis* (Fig. 5.19). Above 87.5 cm, soil nitrogen values increase to intermediate, and species indicative of areas with slightly saline conditions or freshwater coastal areas are present alongside those with no saline tolerance (Table 5.8). In the uppermost sample, the ecological preferences of the taxa present indicates that conditions may have been slightly wetter and less nutrient-rich than in the zone below.

Above the *landnám* tephra, there is an increase in plant taxa associated with wetland and shallow water. This is also reflected in the beetle assemblage, where species preferring stagnant or slow-running water and acidic conditions increase, but are found in association with those associated with dry grassland and meadow (K. Vickers pers. comm.). The sharp decrease in the presence of tree/dwarf shrub indicators after AD 920 indicates their removal from the sampling site, but the continuing presence of low levels of shrub plants until 72.5 cm, accompanied by the reduced presence of Coleoptera associated with woodland and scrub vegetation in the early post-*landnám* samples (K. Vickers pers. comm.), suggests that remnants of *Betula* and *Salix* woodland are present in the surrounding area. As there are still taxa with no tolerance to saline conditions present in the samples, the area must still have been free of salt water.

Above the *landnám* tephra an increase in the sediment accumulation rate can be seen (8 cm in 50 years - Fig. 5.18). After this the organic content of the monolith is relatively stable, increasing slightly over time (Fig. 5.19), and is associated with increasing soil nitrogen values. This may reflect the addition of organic material to the soil, perhaps indicating the deliberate management of the area surrounding the farm by manuring (which has been suggested as a possible source of synanthropic Coleoptera in the post-*landnám* samples – K. Vickers pers. comm.).

During the late 1400s (55.0-57.5 cm), conditions seem to have become slightly wetter and less nutrient-rich (Table 5.8), and an increase in the rate of sediment accumulation is apparent (Fig. 5.18). As the date of the tephra at 50 cm is unconfirmed, the rate of change in the age-depth curve is not certain. However, there is a gradual decrease in the organic content of the deposits over this period (Fig. 5.19). This may be the result of gradually increasing input of inorganic material, for example due to erosion, or a decrease in the input of organic material, due to the abandonment of manuring.

5.1.2.5.3. Summary

The variation in plant macrofossil assemblages over time in the Stóramörk monolith exhibits a very clear pattern. *Betula* and *Salix* growing on constantly moist, acidic, nutrient-intermediate soils are evident in the earliest deposits, but gradually disappear from the *landnám* tephra onwards. The range of plants becomes slightly more diverse before the *landnám* tephra, and noticeably so in the deposits overlying the *landnám* tephra. There is an increase in the proportion of wetland species and possible evidence of landscape management by manuring. In the uppermost sample (AD 1400s) conditions may have been slightly wetter and less nutrient-rich, and there is possible evidence for changes in the proportion of organic and inorganic soil components compared to the previous phase. There was no evidence of inversion of sediments in the age-depth profile, indicating that there was no significant deposition of eroded material in the area.

5.1.2.6. Summary of off-site results

5.1.2.6.1. Pre-landnám

All sites analysed showed distinct patterns in the plant macrofossil assemblages over time. The monolith from Hov on the Faroe Islands indicates pre-*landnám* conditions to have been moist grassland, heath and/or rocky areas. There is no evidence of trees or dwarf shrubs in the area. Before AD 833 there is a shift to

more varied conditions, with wetter boggy areas as well as heath and grassland. This is disrupted by an erosion event, with a rapid input of inorganic material and plant macrofossils associated with grass and heathland, plant communities likely to have been present in the slopes above the sampling site. The situation at Hov contrasts with the Icelandic sites. At Reykholtsdalur 2, Breiðabólsstadavatn 2 and Stóramörk the pre-*landnám* vegetation consisted of dwarf shrubs and/or trees and plants associated with wet conditions and areas of shallow water. *Betula* is present at all sites, accompanied by *Salix* at Reykholtsdalur 2 and Stóramörk, and *Arctostaphylos uva-ursi* at Breiðabólsstadavatn 2.

Changes in the vegetation occur in Iceland over time, but are different at each site, indicating the dynamic nature of the pre-*landnám* vegetation and the different rates and results of human impact. At Reykholtsdalur 2, although there is some evidence for changes in the vegetation before the fall of the *landnám* tephra, the most distinct change in vegetation coincides with the tephra fall, with a decrease in wood and shift to open, watery conditions. At Breiðabólsstadavatn 2 and Stóramörk there are pre-*landnám* changes to the plant macrofossil assemblages. At Stóramörk there is a slight increase in diversity beginning around AD 800, while at Breiðabólsstadavatn 2 diversity decreases and only wood is preserved, perhaps relating to the area being cut over for peat.

5.1.2.6.2. Landnám and post-landnám

After the settlement, distinct changes in vegetation also occur. At Breiðabólsstadavatn 2 there is a shift beginning after AD 1160 to more open conditions, possibly becoming drier over time, and at Stóramörk a reduction in tree/scrub cover and a possible increase in nutrient levels beginning after AD 920.

By AD 1500, the vegetation of the areas sampled has changed considerably from pre-settlement conditions. At Hov, the area is wet and open, with areas of heath and grassland, at Reykholtsdalur 2 the area is open with areas of shallow

water, at Breiðabólsstadavatn 2 it is open, possibly becoming drier over time and at Stóramörk it is open and wet, with some woody species present.

In summary, the *landnám* results in changes in the vegetation of all areas sampled, but the nature of the changes varies between sites. In Iceland, there is a trend for the overall reduction of tree and/or dwarf shrub cover, the opening up of the landscape and an increase in wetness (except for at Breiðabólsstadavatn 2, where conditions become drier).

5.2. ON-SITE SAMPLES

Comparison of the seed assemblages from Toftanes and Sondum indicated that, although both contained well-preserved organic plant material, with a low concentration of charred remains, there was some difference in the composition of the assemblages between the sites. Samples from Toftanes were more diverse in terms of the range of plant macrofossil types, as mentioned above, although this is due at least in part to the difference in the volume of material analysed from each site, and the greater range of context types sampled at Toftanes (two floors, a hearth, drains etc.) than at Sondum (midden only). See Fig. 5.20 for the key to all figures in this section.

There was a difference in the seed composition of the samples between Toftanes and Sondum. When the results of correspondence analysis on samples from both sites were plotted there was a clear distinction between sites on the first axis (Fig. 5.21a). This distinction could be related to the habitat association of the taxa (Fig. 5.21b). Samples from Sondum at the positive end of the first axis tended to contain a greater proportion of seeds from nutrient-rich habitats (both disturbed and undisturbed) than the Toftanes samples at the negative end of the first axis, which tended to contain a high proportion of taxa from the nutrient-poor outfield, and *Montia fontana* ssp. *fontana*. Two samples from Toftanes (1399 and 2265 – from deposits near the fireplace) had positive values on the first axis, due to high proportions of taxa tending to occur in hayfields and low values of *Montia fontana* ssp. *fontana*.

5.2.1. Toftanes – Faroe Islands

Analysis of the Toftanes samples indicated that both charred and non-charred items were recovered. Charred material was recovered from 28 of the 30 samples analysed, and non-charred from 29 of the 30 samples. The common plant macrofossil constituents of the sample matrix were moss, fragments of wood, twigs, charcoal, charred twigs, seeds, charred seeds and charred seaweed. Samples from occupation layers tended to be more diverse in terms of the presence of these types (with five or more of eight types considered being present in each sample) than those from external areas, abandonment debris and pre-*landnám* deposits (Fig. 5.22). There are, however, exceptions to this, notably samples 1761 (from the abandonment of the settlement), 2752 (from the fireplace) and 1475 (from the floor), which are taken from internal areas of the settlement, but exhibit a low diversity of constituents.

Preservation of plant material was considered to be good as delicate items such as *Juncus* seeds and Gramineae seed coats were often preserved well enough to be identified to species. Potential human foodstuffs include barley grain, hazel nuts, *Empetrum nigrum, Brassica* sp. (a member of the Cruciferae or cabbage family, including several crop plants, some with edible seeds) and possibly *Carum carvi* (caraway). Non-charred seeds tended to be common in each sample, with species such as *Montia fontana* ssp. *fontana,* members of the genus *Carex* and *Juniperus communis* occurring most frequently. Charred material included nodules of peat/dung, wild seeds, cereal grain, leaves, chaff, wood, twigs and seaweed. Leaves, seed capsules, twigs and fragments of wood were also preserved, both charred and non-charred. Chips of worked wood (i.e. fragments of wood with cut marks) were non-charred.

Sampling locations were not provided by the site director, but 19 samples could be located fairly accurately as some layers were present in section drawings, or the sampled feature was present on the site plan. The 19 samples that could be located spatially on a plan of the site are represented as pie charts based on the habitat association of the taxa in Fig. 23. Pre-*lándnam* samples tended to contain taxa associated with wet conditions or water, including *Sphagnum* and

Hippuris vulgaris. Regarding the occupation deposits, although there is no strong patterning, it would appear that samples located in Building I and the central area of House II were more mixed in composition than those from either end of House II, the outside areas and the abandonment layers. The samples taken from around the fireplace (2265 and 1399) contained less *Montia fontana* ssp. *fontana* and a lower proportion of outfield types than the other floor deposits.

Some of the contexts categorised as 'abandonment' by the excavators of Toftanes are very similar archaeobotanically to those from occupation deposits from the same area of the excavation. The summary of the habitat associations of the seed assemblage mentioned above (Fig. 5.23) and a consideration of the contribution of the major constituents of the matrix of the sample (Fig. 5.22) show that some samples from occupation and abandonment deposits located near to each other have a similar composition (1597 and 2925, and to a lesser extent 1016 and 1963). This is also apparent in a correspondence analysis of the samples from Toftanes, where these two pairs of samples are placed close to one another on the basis of their species composition (Fig. 5.24). In the following analyses, samples will be grouped by phase and structure: pre-*landnám*, Building I, House II, House IIa and from the outside yard area, ignoring the excavators' assignment to occupation and abandonment phases.

5.2.1.1. Investigation of source of charred material in the Toftanes samples

To establish the significance of the charred material recovered from the site, it was necessary to investigate the source of the material, and to establish whether the material was part of the non-charred assemblage that had become charred, or was charred in another location and mixed with the non-charred material.

Of the 30 samples analysed, 22 contained charred material (73%) (Table 5.9). The most commonly occurring types were wood (20 samples – 67%) and charred nodules of peat/dung (17 samples – 57%), and wild seeds (12 samples – 40%), cereal grain (11 samples – 37%), seaweed (6 samples – 20%), *Juniperus*

communis leaf (2 samples – 7%) and *Calluna vulgaris* leaf (1 sample – 3%) were also present.

Charred wild seeds and seaweed were only present in samples taken from within the buildings or from the drain associated with the eastern end of House II (Fig. 5.25). Charred cereal grain occurred in low numbers in samples from external areas but was predominantly recovered from inside the buildings. This suggests that the wild seeds and seaweed are likely to have become charred within the buildings, and that charred material from the buildings was not dumped in the yard in any great amounts. Charred cereal grains found in the outside area may have been carried on feet from the interior floors, or may indicate that cereal grain was brought in from another area in the farmstead where it had been in proximity to fire (e.g. after drying). Charcoal and charred nodules of peat or dung are present in the outside area. This may be due to the general ubiquity of these types (they may be more common than charred seeds as they are purposefully burned for fuel, and therefore more commonly available to be incorporated into the deposits in and around the settlement), or the removal and discard of spent fuel from the house.

5.2.1.1.1. The charred seed assemblage

The proportion of charred seeds in the 16 samples varied from 100% (sample 2752, which did not have a non-charred component) to 0.05%, but was less than 5% for the majority of samples (Fig. 5.26). Charred cereal grain was the most common type (11 samples), and most (10) samples contained only one or two types of charred seeds. Charred seed types occur slightly more frequently in the same samples as non-charred versions of the same type – of the 58 occurrences of charred seed types identified to genus or above, 31 (56%) occurred in conjunction with non-charred seeds of the same type. This suggests the charred component of the samples does not originate entirely from the same source as the non-charred component, although some of it may do so i.e. the charred assemblage is not (only) made up of material present in the area being charred *in situ* (e.g. by lamps or fire which charred seeds present in the floor, roof or walls).

Charred seed types from a range of habitats were present, including species associated with bogs, heath or rocky areas in the outfield, and both disturbed and undisturbed nutrient-rich habitats. Of the types recovered, the seeds of *Empetrum nigrum, Corylus* nuts and cereal grain could have been brought on to the site as food resources. The combination of seeds from foods and cereal grain with taxa associated with various habitats make it unlikely that the charred assemblage came to the site from one source (i.e. it is not solely the refuse from cereal grain drying, peat burning or another single activity that brings plant material into proximity to fire).

Correspondence analysis was used to see whether there was any pattern in the charred component of the samples. Twenty-three samples each with more than 30 seed items, and all 52 charred and non-charred seed types occurring in more than 10% of the samples were included (Fig. 5.27a). Samples 595 and 2752 were not included as sample 595 had an exceptionally high proportion of *Selaginella selaginoides* megaspores and sample 2752 contained less than 30 quantifiable items – they were clearly different from other samples, and their presence in the analysis would have resulted in outlying samples which would have obscured the scatter of the other samples. The samples containing over 10% charred seeds were located on both the positive and negative arms of the first axis, and along the positive arm of the second axis. Samples with a smaller charred seed component (samples 2147, 1622, 1963, 2645 and, to a lesser extent, 1400) were also located in this zone. The analysis grouped the charred types with low positive and negative values on the first axis, and on the positive arm of the second axis (Fig. 5.27b).

The charred seed assemblages in the samples differ – 1964 (at the positive end of the second axis) contains cereal grain and various wild seeds from nutrient-rich habitats, sample 2653 only *Stellaria media* and sample 2654 only seeds of Poaceae. The charred seed types in samples 2653 and 2654 both occur as non-charred seeds in the samples. In sample 1964, three of the eight charred seed types occur independently of non-charred material, indicating that they may

have become incorporated in the sample via a different taphonomic path to the non-charred assemblage.

5.2.1.1.2. Other charred material

Regarding the vegetative material (Table 5.9), charred *Calluna vulgaris* and *Juniperus communis* leaves only occur with non-charred leaves of the same type, indicating that they may have arrived as part of the non-charred assemblage and become charred once the material had been deposited in the settlement (although the low density of charred material recovered compared to non-charred material indicates that this does not appear to have happened frequently). Charcoal occurs in the same samples as non-charred wood in 89% of the samples (this is based on unidentified wood and twigs, as the level of identification for the non-charred wood was sometimes poor), and charred peat/dung nodules occur in 94% of the same samples as non-charred ones. Wood and peat/dung are both likely to have been used as fuel. Although they would generally have been burned to ash, the close proximity of these materials to fire on a regular basis would have meant that they were also likely to become charred and, therefore, to survive archaeologically. Although they may have become charred in a similar way to the leaves discussed above, it is likely the high percentage of their occurrence in conjunction with non-charred material is a factor of their widespread presence at the site (86% and 77% of samples containing charred material). Charred and non-charred wood and peat/dung nodules may occur together simply because they are all present in a high number of samples, and may not necessarily originate from a common source. The only identification category to occur independently of non-charred material is seaweed. This is highly likely to be due to preservation – non-charred seaweed is very unlikely to survive, even with very good levels of preservation. Fragments of burnt bone were also recovered from two samples, but they were too small to be identifiable. These may represent another fuel at the site or waste from cooking.

5.2.1.2. The non-charred assemblage

5.2.1.2.1. The non-charred seed assemblage

The non-charred seed assemblage was analysed by correspondence analysis. All charred seed types were excluded from the analysis, as were types which could not be assigned to habitat association categories. Samples were not included if, after removing the charred and unassigned types, they contained less than 30 items (samples 393, 1475, 1682, 1964, 2147, 2219, 2734 and 2752 were not included for this reason). All seed types included in the analysis were present in at least 10% of the samples included in the analysis. Nineteen samples and 33 types were included in the analysis. The resulting correspondence analysis plot (Fig. 5.28) shows that several samples with had a high score on at least one axis due to a high proportion of one particular taxon (sample 1641 due to a high proportion of *Hippuris vulgaris*, samples 595 and 1760 due to a high proportion of *Selaginella selaginoides*). These were excluded from subsequent analyses to allow more detailed analysis of the remaining samples. Samples were categorised by archaeological context. The plant macrofossil types were categorised by habitat association categories, and the samples represented as pie charts. The classification of *Montia fontana* ssp. *fontana,* the most commonly occurring seed type at the site, was problematic (see Section 4.5.1). It may have originated from a number of sources, including arriving at the site as a component of turves or growing around the settlement. In the correspondence analysis plots *M. fontana* ssp. *fontana* is associated with types which tend to occur in a range of habitats, especially those that tend to be present in hayfields, although this may just be an indication that these are all commonly occurring types.

The majority of samples were situated in a single spread drawn out along the first axis (Fig. 5.29a, but also see Fig. 5.24 above). The first axis differentiates at the positive end the samples with a higher contribution from types associated with the less fertile soil conditions of the outfield and the nutrient-poor or nutrient–intermediate wet soils or water (Fig. 5.29b). Most of the samples have low or negative values on the first axis, and tend to have a greater contribution of types from nutrient-rich habitats such as ruderal areas and hayfields. The

pattern of samples on the second axis seems to distinguish the ruderal component which is more significant at the positive end. Samples 570 (outside area between Building I and House II) and 1400 (House IIa floor) are located at the positive end of the second axis, due to the high proportion of *Alopecurus geniculatus* and *Juncus bufonius* in 570 and *Juncus bufonius* in 1400.

The samples located at the positive end of the first axis (samples 2711, 2665, 1622, 2653 and 2654) and the second axis (samples 570 and 1400) were excluded as they were responsible for the most significant difference between samples in the previous analysis. *Alopecurus geniculatus, Hippuris vulgaris* and *Rhinanthus minor* were also removed as they were present in less than 10% of the remaining samples. The analysis was then repeated. Samples 1399, 1963 and 2265 were differentiated from the rest of the samples by high positive values on the first axis (Fig. 5.30a). They had a higher proportions of taxa occurring in various habitats but tending to occur in hayfields and lower proportions of *M. fontana* ssp. *fontana* than other samples (Fig. 5.30b).

5.2.1.2.2. Other non-charred material

Various kinds of non-charred vegetative material were present in the Toftanes samples. The matrix of several samples (1682 from outside Building I, and 2665 and 2734 from the pre-occupation deposits) was dominated by *Sphagnum*. This may have been naturally present in the area, although it would be unusual to build a house on an area of land wet enough for *Sphagnum* to grow.

Samples taken from the interior of the buildings, especially from the floors, contain the greatest diversity of vegetative material. Wood and twigs were generally present in the floors, but only dominated the matrix of sample 1995. The types of wood present included both genera native to the Faroe Islands and non-native types, which may have been imported or to have arrived as driftwood. Twigs and fragments of dwarf shrubs which would have grown locally (*Calluna, Salix, Juniper* and possibly *Betula*) were recovered both charred and non-charred, whilst non-native types (*Picea/Pinus* and possibly *Quercus*) were found non-charred. Several pieces of *Juniperus communis* and

both of the non-native taxa exhibited cut marks. This seems to indicate that, whilst local wood resources were used as fuel (as well as for other purposes that did not involve contact with fire), non-local types were not. Wood and twigs were present in the majority of samples in similar quantities. The richest sample in terms of wood content was located in Building I (sample 1995), and contained a concentration of twigs (predominantly non-charred *Calluna vulgaris*, with some charred *Calluna vulgaris* and *Juniperus communis*) and moss. This could indicate storage of resources before use, their accidental incorporation into the floor due to use in the area, deliberate incorporation to level the floor or absorb liquid, or the collapse of roof material (some of which may have been charred by lamp flames or sooty deposits on the thatch, cf. Letts 1999) during abandonment.

The leaves, seed capsules and twigs of *Calluna vulgaris* and the leaves and twig segments of *Juniperus communis* are almost entirely confined to samples from within the buildings. They are likely to have been brought to the site from the dwarf shrub heath attached to twigs, and indicate that the twigs were not stripped of their leaves and other attachments prior to being brought into the settlement (although this would not be expected from ethnographic, historical or archaeological comparison – A. Hall pers. comm.). They may have been brought to the site for construction, floor-lining or other purposes within the settlement. Leaves, seed capsules and twigs of *Calluna vulgaris* and *Juniperus communis* are less frequent in the abandonment phase of House II, which may indicate that their use was more often associated with occupation, rather than the construction of the building itself (although the presence of a Juniper rope with a weight attached, interpreted as a roof weight, may be evidence of its use in construction).

The floors contain evidence of other resources used at the site. Charred and non-charred nodules of peat/dung were present in most samples, and dominate the matrix of samples 393 and 1475. Fragments of burnt bone may indicate a possible fuel, or may be the waste from cooking or consumption. Fragments of periostracum from a marine mollusc and eggshell membrane are evidence for

the exploitation of wild resources, and a leather strip and possible fragments of horn may indicate handicrafts or the breakage of objects used in the settlement.

5.2.1.3. Integration of results of plant macrofossil analysis with results of Coleoptera analysis (based on information provided by K. Vickers pers. comm.)

The pre-*landnám* and sample 1682 plant macrofossil and beetle assemblages both indicate wet conditions. Beetles were identified that are found in bog and wet grassland with decaying organic material, and indicated that *Calluna vulgaris* and nutrient-rich areas were present in the vicinity.

The beetle assemblage from the occupation levels of Toftanes was generally in agreement with the interpretation of the plant macrofossil assemblage indicating resources being brought in from various areas of the landscape. The beetle assemblage contained species associated with decaying organic matter, peat and turf. A high proportion of the assemblage consisted of synanthropic taxa. Species associated with dry waste dominate over those associated with foul waste, indicating that stalled animals were unlikely to have been present in the areas sampled. Human and animal parasites are absent, and beetle species associated with wrack and the shoreline are present only at low levels (probably background fauna due to the position of the site on the shore).

The plant macrofossil assemblages from outside the structures contained a fairly similar range of types to those from the interiors, which may have indicated that processes involving these taxa too place inside and outside. However, the beetle taxa recovered outside the structures were largely associated with outside areas, indicating the material sampled in the outside areas represents the general build-up of detritus around the settlement, and that it did not originate in the houses.

Pollen analysis indicated a landscape largely dominated by peat/grass, heathland and areas of wet pasture. The level of cereal and arable weed pollen

was low, indicating that the landscape was largely dominated by pastoral activity. The presence of tree/dwarf shrub pollen at low levels indicated remnant woodland in cliff areas which were inaccessible to grazing (Vickers *et al.* 2005).

5.2.2. Sondum – Faroe Islands

The samples from Sondum were very rich in non-charred organic material. Charcoal, charred twigs and small quantities of charred seeds were also recovered. Charred cereal grain was not present in the six samples analysed from the 2003 excavation, but were recovered by Mike Church in the test samples taken in 2002 (it is unclear whether this is a result of a greater volume of material being sampled in the 2002 season). Preservation of plant material was considered to be good, as delicate items such as *Juncus* seeds and Gramineae seed coats were often preserved well enough to be identified to species. The seed assemblage was dominated by *Urtica dioica, Ranunculus acris/repens, Rumex* spp., *Juncus* spp. and Poaceae. *Empetrum nigrum* and *Brassica* sp. were potential human foodstuffs. Leaves and seed capsules, wood and twigs were present in both a charred and non-charred state. Nodules of peat/dung were recovered in both charred and non-charred states.

5.2.2.1. The seed assemblage

The content of the samples from Sondum is presented as a TILIA graph including all the seed types present (Fig. 5.31). A dendrogram was also constructed using TILIA graph. The dendrogram indicates that the samples were most similar to their adjacent samples, except for the top (144-154 cm) and bottom (194-204 cm) samples, and the TILIA graph indicated that there were no significant trends in the data – the majority of types were either present so infrequently that a pattern was not established, or were present in all levels.

Percentage bar charts were based on the habitat association categories of the plant types represented (Fig. 5.32). Seed types of uncertain category were excluded. The seed assemblage was dominated by types associated with

nutrient-rich soils, especially types that occur in various habitats but tend to be found in hayfields. The proportion of seeds associated with wet soils or water was always less than 20%. Types from nutrient-poor conditions, both moist and wet-water, made up between 9% and 28% of the samples. The types present were generally similar to those found in the buildings at Toftanes, indicating they may have originated in a farmstead. Of the twelve types present at Sondum but not at Toftanes, four were frequently occurring (more than 2% of the assemblage), and tended to be associated with nutrient-rich conditions (e.g. *Urtica dioica* and *Capsella bursa-pastoris,* which are common ruderals and likely to have been growing on or around the midden). Of the 29 types present at Toftanes and not Sondum, 17 were frequently present (in more than 10% of the samples), and tended to be associated with hayfields, the outfield or wet-water conditions. This indicates that the midden had a generally higher proportion of types associated with nutrient-rich conditions, but a lower proportion of hayfield, outfield and wet-water associated types than the settlement site. The material dumped on the midden may have come from an area where peat, turf and hay were either not being used, or were being 'consumed' in some way that led to their destruction. Alternatively, the input of seeds from plants growing on the midden may have increased the proportion of taxa associated with nutrient-rich conditions.

5.2.2.2. Other material

The woody types present at Sondum were similar to those found at Toftanes. Wood of *Juniperus communis* and *Calluna vulgaris*, both native species, were found both charred and non-charred, indicating their use as fuel as well as for other purposes (although non-charred wood may have been waiting to be used as fuel). *Empetrum* was only found charred. As at Toftanes, non-native wood identified as *Picea* or *Pinus* was only found in a non-charred state. Cut surfaces could not be identified on any of the pieces of wood, unlike at Toftanes, where woodchips with cut surfaces occurred in several samples. Other vegetative material included a possible *Calluna vulgaris* seed capsule, a *Viola* sp. seed capsule and a *Salix* bud scale. Fragments of tooth and bone, some of it charred,

were also recovered, as were fragments of a compacted material that may have been peat or dung.

5.2.2.3. Integration of results of plant macrofossil analysis with results of Coleoptera analysis (based on information provided by K. Vickers pers. comm.)

As with the plant macrofossil assemblages, the preservation of Coleoptera in the samples was good, and the assemblages were all similar in composition, even though they were taken from different stratigraphic layers.

Several of the beetle species present at Sondum are associated with seaweed or dry sandy environments, reflecting the location of the midden close to the coast. Some plants that may have been growing on the midden have a slight tolerance of saline conditions, and can survive in conditions subject to saline water spray if the groundwater is fresh (e.g. *Poa annua, Potentilla anserina, Ranunculus acris/repens, Leontodon autumnalis, Juncus bufonius* – Hill *et al.* 1999). Others, such as *Urtica dioica*, are not saline tolerant, and are not persistent in coastal situations if subjected to saline spray or water. This indicates that, although the site may have been near enough to the coast to be subject to sea spray, this may have been only occasional, and perhaps most affected the seaward side of the mound. Alternatively, they may have been brought from further inland to be used for some purpose e.g. the stems used for twine.

Beetle species associated with wet foul waste such as dung, carrion (either meat waste or the carcass of an animal that died on the midden), rotting fungus and compost are well-represented in the midden samples (9-11%), and are likely to represent conditions on the midden. These conditions were rarely represented at Toftanes, mirroring the situation in the plant macrofossil assemblage where the taxa present at Sondum and not Toftanes are associated with nutrient-rich conditions and likely to have grown on the midden itself.

The beetle assemblage also suggests associations with plant taxa not present in the macrofossil assemblage. Although no seeds of *Rumex acetosella* or *Vicia* spp. were recovered from Sondum, the beetle species *Apion haematodes* and *A. aethiops* were recovered from the site, and are oligophagous on (i.e. restricted to) *Rumex acetosella* and *Vicia* spp. respectively. *R. acetosella* is found in anthropogenic habitats, especially on bare ground, and the two types of *Vicia* found in the Faroes (*V. cracca* and *V. sepium*) are found in grassy, weedy habitats and rough ground. They may, therefore, represent plants growing on the midden itself, although they are not represented in the plant macrofossil assemblage in spite of good preservation.

The beetle assemblage from Sondum was dominated by synanthropic species found inside or close to buildings (50-61%). This suggests the presence of breeding populations which are unlikely to occur away from human habitats. This in turn suggests that, along with plant macrofossils, other material derives from refuse from the settlement associated with the midden, and represent resources used there.

Both the plant macrofossil and beetle assemblages contain low proportions of taxa associated with nutrient-poor water and/or very wet conditions in bogs and other habitats (less than 20% and less than 10% respectively) and, in both datasets, the proportion decreases from the deepest to the highest deposits sampled. These wetland taxa are likely to represent material brought to the site as components of peat, which was used then discarded on the midden. Taxa associated with the nutrient-poor conditions of the outfield in general may also have arrived as components of peat, turf or other outfield resources. A number of beetle species associated with nutrient-poor heathland and *Calluna* are present at Sondum and, although interpreted as background fauna (K. Vickers pers. comm.), may have arrived at the settlement with the plant taxa associated with moist, nutrient-poor conditions, perhaps as components of turf used and later discarded on the midden. The presence of other material, such as charcoal, charred peat/dung and fire-cracked pebbles in the samples is indicative of fire-related activities which are often carried out within buildings. The charred

material may represent fire ash deposted on the midden, or arriving as components of living floors.

The analysis of material from on-site samples indicated that plant resources from various plant communities in the landscape were being used for a variety of puropses. Human activity created environments with increased nutrient-richness, which supported plants and beetles associated with these habitats.

CHAPTER 6: PLANT AND ANIMAL HUSBANDRY AND ITS IMPACT ON THE LANDSCAPE

This chapter will bring together the results of the studies described above and discusses them in the context of previously published research, both locally and regionally. Conditions before the time of settlement are considered in terms of the resource base available to the settlers on their arrival. Changes to the environment resulting from human activity at Toftanes and Sondum are discussed in terms of plant and animal use. The continuing impact of human occupation on the landscape is then discussed for the period to AD 1500.

6.1. PRE-*LANDNÁM* VEGETATION – 500 BC TO *LANDNÁM*

There is no direct evidence for settlement in The Faroe Islands or Iceland before the Norse period, making them unique in the settlement history of the North Atlantic Islands. The initial settlement seems to have taken place during a mild climatic period, and the virgin vegetation offered by these uninhabited landscapes is likely to have seemed rich and fertile to the settlers. The vegetation in the period leading up to the settlement was dominated by open grassland (of Gramineae and Cyperaceae), with stands of trees (mainly *Betula* and *Salix*) in the Faroes (Fig. 6.1), and more substantial woodland (of a similar composition) in lowland Iceland (Fig. 6.2). In both regions, the lack of grazing mammals and litter-consuming invertebrate species would have resulted in deep layers of vegetative litter within a landscape of acidic bog, shallow water and drier areas (Buckland 2000). Unlike the Scottish Islands, the Faroe Islands and Iceland were unclaimed territories and are likely to have been attractive to the first Norse settlers as a contrast to the political turmoil of their Scandinavian homelands, as well as offering the potential for the creation of the extensive grazing areas.

6.1.1. Faroe Islands

The steep topography of the islands means that a range of ecological niches are found in close proximity to each other, with sheltered lowland areas surrounded by steeper vegetated slopes and rocky cliff faces supporting characteristic plant and animal communities. The maritime climate, with high levels of precipitation, cool summers and mild winters, is similar to that found in Shetland and the outermost coastal areas of western Norway, around Lerwick and Ona (Tukhanen 1987), so would have been familiar to the settlers. They are likely to have seen it as suitable for an economy based on grazing, due to a long growing season for Gramineae and other vegetation compared to inland regions of the Scandinavian mainland, with their harsh winters. Due to the northerly latitude, the length of day varies greatly between winter and summer, (Preusser 1976), and the length of daylight is the main factor limiting plant growth in the Faroe Islands (Tukhanen 1987). South-facing locations would have been more suitable for vegetative growth than areas permanently shaded by hills. This is a similar situation to the fjords of the Norwegian coast, and settlements would have been located accordingly. The indigenous Faroese flora is dominated by perennial herbaceous plants and, though limited in range, many are suitable for grazing and fodder.

Conditions in the immediate vicinity of Hov were acidic, nutrient poor grassland or heath in the valley bottom, with pollen evidence indicating widespread growth of tall herbs in the area (Edwards *et al.* 2005). Trees or shrubs are evident upslope of the sampling site to the west and south (Mairs 2003).

The location of Toftanes was surrounded by water or wet conditions (e.g. *Sphagnum* spp. and *Hippuris vulgaris*) with heath communities, wet grassland and nutrient-rich areas in the vicinity.

Various resources in the surrounding area made Hov suitable for settlement. There was nutrient-poor grassland or heath in the valley bottom, which could easily be drained to improve vegetative growth, and pollen evidence indicates

widespread growth of tall herbs in the area (Edwards *et al.* 2005). Trees or shrubs are evident upslope of the sampling site to the west and south (Mairs 2003), and may have been perceived as a desirable source of fuel or building material by the settlers. Although they have not been dated or described in detail, some wood macrofossils exhibit cut-marks, indicating human intervention in their clearance rather than a 'natural' cause of tree decline before the settlement (Mairs 2003). Peat accumulation in the valley bottom would have provided a further potential source of fuel. Pollen analysis from Hovsdalur, near to the shieling site situated above Hov, indicates a dominance of Gramineae and Cyperaceae during the period from Cal. AD 220–610, with *Betula* percentages consistently around 7% (Edwards *et al.* 2005), which would have provided the extensive outfield grazing areas required by the settlers to support livestock (Small 1966-9).

At Toftanes, nutrient-enrichment in the landscape was often associated with the accumulation of manure on the bird cliffs (Buckland *et al.* 1998a), and may indicate that this natural habitat with the potential for economic exploitation was located in the vicinity of the site.

The results of the analysis at Hov and Toftanes are in keeping with the general pattern of Faroese vegetation before the *landnám*, and conditions are likely to have made them attractive locations for early settlement.

6.1.2. Iceland

Conditions in Iceland were more diverse than in the Faroes, and presented more of a challenge to the settlers. The landscape is characterised by vegetated lowlands, fjords, tundra plateaux, highlands, volcanic landscapes, sandur (sand deltas) and icecaps, which support their own plant and animal communities. The climate of Iceland varies from cool temperate to sub-polar oceanic, although conditions remain cooler in summer and winters are milder than other places of similar latitude. Conditions tend to be milder but wetter in the south and west, and drier with icy winds and more frequent blizzards in the north and east (Preusser 1976). Temperatures vary from a few degrees below freezing to

around 10 °C in the coastal areas, and annual precipitation varies from around 400 mm in the north to 3600 mm in the south-east (Einarsson and Albertsson 1988). Wind strength and frequencies vary greatly from region to region. As in the Faroe Islands, the length of day varies greatly between winter and summer due to the northerly latitude (up to 50° even in June - Preusser 1976).

The results of plant macrofossil and beetle analysis from sites in Reykholtsdalur, Halsasveit and Stóramörk provide a picture of the local vegetation, thus adding an important dimension to existing, mainly large-scale, analyses. Reykholtsdalur and Halsasveit would have provided suitable locations for settlement, with extensive flat land for hayfields in the wide valley, surrounded by gentle slopes for grazing. The open nature of the valley provided good access to direct sunlight. Several hot springs are present and would have proved an attractive resource for the settlers, providing warm water for bathing and heating. The hot spring at Reykholt is mentioned in the *Landnámbók*, indicating its status. The pre-*landnám* vegetation consisted of bog, areas of shallow water and wet grassland. These conditions seem to have been consistent across the landscape, evident from the plant macrofossil assemblages analysed here, supported by beetle and pollen analysis. Reykholtsdalur 2, Breiðabólsstadavatn 2 and Háls South Pit show evidence of *Betula* (*B. pubescens* at Reykholtsdalur 2 and Háls South Pit; *B.* cf. *nana x pubescens* at Breiðabólsstadavatn 2 – see Appendix Section A.2.1.1) and *Salix* wood/scrub, although the associated evidence for water and wet conditions indicate that the area may have been too wet for thick woodland to form. The area around Reykholtsdalur 3 was probably open, although not located far from trees and/or dwarf shrubs. The presence of relatively sparse tree and/or dwarf shrub cover in the valley would have made this area attractive to the settlers as it would have been easy to clear to create an area for the settlement and infields, and the wood could be used in construction or for fuel (either as wood or for the production of charcoal). At the time of settlement there was an accumulation of peat and soils, with a high organic content in the valley bottom, which had potential to be improved by drainage and manuring once cleared of trees and shrubs, and the gentle slopes of the valley sides supported extensive areas

suitable for grazing. Peat deposits would have provided a source of fuel, especially for the ironworking at Háls.

The landscape in southern Iceland is apparently more diverse and more changeable than in Reykholtsdalur and Halsasveit. The south coast of Iceland is the warmest, wettest region of the country, with extensive south-facing slopes providing good conditions for plant growth. Suitable land for settlement is located in areas of stable land between the steep slopes of the interior and the unstable areas of coastal sands and deltas created by the dumping of eroded material from the glacial meltwater streams. Pollen evidence from the Markafljót sandur at Lágafell indicates a changeable plant community in the period from 500 BC to *landnám*, due to the unstable nature of the land surface in an area of shifting glacial meltwater courses on sandy ground (Påhlsson 1981), with fluctuations in the presence and degree of cover of birch trees and shrubs (Haraldsson 1981). At Stóramörk, located on the more stable landscape of basalt bedrock above the sandur plain, vegetation seems to have been more stable, with plant macrofossil evidence for the presence of *Betula pubescens* and *Salix* trees and dwarf shrubs, with drier areas and areas of bog and shallow water. At Ketilsstadir there was a stable *Sphagnum* bog, with trees occasionally gaining a foothold in drier areas for several hundred years before settlement (Buckland *et al.* 1986). Conditions were similar at Markafljót, where trees were initially present on the margins of the bog, nearer drier sand ridges and hillocks, but soon moved out further onto bogs (Haraldsson 1981). Areas such as Stóramörk, Ketilsstadir and Markafljót would have proved suitable for settlement due to the presence of flat, stable land for construction of the farmstead and laying out of the infield, slopes for grazing and easy access to coastal resources and bird cliffs.

6.1.3. The North Atlantic

The long-term impact of human occupation in Scandinavia, the British Isles and Ireland meant that, during the Viking period, there was not such a dramatic shift in conditions as is evident in the Faroe Islands and Iceland. Existing settlements, agricultural regimes and trading networks had already modified

plant communities and the landscape, and ecological niches that did not previously exist in the North Atlantic islands (e.g. nutrient-rich areas around the farmstead, cultivated fields and grazed pasture) were already present. In Shetland, for example, the *landnám* is dated to around 3465 BC and is indicated by the decline of shrub, tall herbs and ferns coupled with an increase in *Calluna* and the first appearance of *Plantago lanceolata* (Jóhansen 1985) – all changes that are seen in the Faroes at the time of the Norse settlement.

The uninhabited environments of the Faroe Islands and Iceland would have provided suitable landscapes for economies based on grazing. Relatively mild climates (for their latitude) and high levels of precipitation that would have encouraged plant growth. Areas of flat land for settlement and cultivation were surrounded by extensive areas with potential for grazing. The range and richness of natural resources would also have been an advantage, with bird cliffs occupied seasonally by migrating flocks to provide meat and eggs, and thick peat deposits which could be exploited for fuel. Although the trees were generally too small to produce trunks for construction, the presence of driftwood would have compensated for this, and scrubby woodland would have provided a potential source of fuel, fodder and lighter building materials.

The landscape of Greenland would have had suitable conditions for the settlers and would have provided an opportunity to expand into fresh areas as the landscape of Iceland became increasingly degraded and unable to support the population. Although Greenland was inhabited, the Thule Inuit communities were based to the north of the areas suitable for agricultural activity, and the fact that the economy was based on hunting, rather than livestock management, meant the two cultures were not in direct competition for land or resources. In Greenland, the pre-*landnám* vegetation consisted of scrubby *Salix*, *Juniperus* and *Betula* shrub, with open areas of ferns, *Angelica* and other herbs (Fredskild 1981; Fredskild and Hulme 1991). The south and south-west coasts provided the best conditions for settlement, with a mild climate comparable to Iceland where the sea was warmed by the Gulf Stream and sheltered inner fjord areas were located (Buckland 2000). Woodland was dense enough to make clearance necessary to create areas for settlement, cultivation and grazing. As in Iceland,

areas of sparse vegetation would have been preferred for settlement, although techniques for forest clearance such as burning were already well-known from experience in Iceland.

The islands of the North Atlantic provided a contrast with Scandinavia and the other areas of Norse influence in that land was unclaimed by previous settlers. Although the islands are at northerly latitudes, they are warmer than continental regions at similar latitudes due to maritime climates along the coasts and the fact the seas are warmed by the Gulf Stream. The islands exhibit areas of flat land, surrounded by rougher terrain and supporting a range of natural resources which would have been necessary for the settlers to establish a pastoral economy. The Faroes did not exhibit heavy tree cover at the time of settlement, which would have been ideal for the creation of extensive grazing areas. In Iceland and Greenland, open areas or areas of sparse woodland would have been ideal for the construction of the initial settlement, and woodland could be cleared in the surrounding area for grazing.

6.2. NORSE *LANDNÁM*

The Norse settlement can be shown to have had an impact on the North Atlantic island environments in various ways. These will be discussed in terms of the

- Initial clearance of land for settlement and development of agricultural land
- Use of naturally occurring resources (plant and animal) for food, shelter, medicine etc.
- Introduction of new plant and animal taxa
- Animal economy
- The impact on soils
- Range of fuels used
- Evidence for woodworking
- Use of resources in construction
- Living conditions of the settlers.

These themes enable an integration of the results of on- and off-site investigations.

6.2.1. The date of *landnám* in the Faroe Islands

As outlined in Section 2.2.3, there is some debate about the evidence for human impact on the Faroese plant communities prior to the more generally accepted date of ca. AD 825.

The results from the Hov monolith are well-dated with a sequence of ^{14}C dates, and add to the evidence for an early human impact on the environment of the Faroe Islands. After about AD 467-650, plant macrofossil assemblages indicate that conditions become wetter at Hov and the area seems to have consisted of wetter boggy areas and areas of heath or grassland nearby. This is coincident with a peak in charcoal noted during pollen analysis, the first appearance of *Hordeum*-type pollen and possible evidence of the presence of domesticated animals (Edwards *et al.* 2005; K. Vickers pers. comm.). Further up the valley at Hovsdalur, changes dated to Cal. AD 610–1460 indicate an impact possibly associated with summer grazing, and the proportion of birch falls slightly compared with the pre-*landnám* conditions (from 7% to 5% - Edwards *et al.* 2005). Although changes in vegetation may have occurred naturally (pre-settlement conditions in the catchment area of Hov have been proven to have been far from stable - Mairs 2003; Edwards *et al.* 2005), fires do not occur naturally on the Faroes and seem to be a clear indicator of anthropogenic impact. The presence of charcoal in the majority of pollen profiles from the Faroe Islands has been used as an indicator of human activity and, as at Hov, often coincides with the presence of Cerealia pollen and other changes in plant communities (Hannon *et al.* 2001; Hannon and Bradshaw 2000; Lawson *et al.* 2005).

All of this evidence suggests an change in the Faroese environment before the date traditionally assumed for the Norse *landnám*, and the indication of increased burning in the landscape means it is likely to be associated with human activity. The presence of humans during this period is yet to be

substantiated by archaeological evidence so it is, therefore, unclear whether these environmental changes are the result of an earlier Norse settlement, or the activities of Irish hermit communities or an as yet unknown cultural group.

6.2.2. Woodland clearance and utilization

The decrease of tree and dwarf shrub cover in the landscape is a feature of the *landnám* across the North Atlantic, although the extent and method of clearance used seems to have varied from region to region. Although tree and dwarf shrub cover is not considered to have been extensive in the Faroe Islands before *landnám,* and is not evident at the sampling site at Hov, there is evidence from Hovsdalur for both the (undated) clearance of trees with cutting tools (Mairs 2003) and a general decrease in tree cover in the landscape (Edwards *et al.* 2005). There is no evidence from the Faroe Islands for the clearance of trees and shrubs by burning, perhaps due to the fact that the woodland cover was light enough for manual clearance, or was too sparse for fire to be an efficient method of clearance. The fact that wood was evidently a scarce resource on the islands at the time of settlement may have meant that the settlers used the wood they removed for fuel or other purposes.

In the more heavily wooded landscape of Iceland, the decrease of tree and dwarf shrub types in pollen diagrams is perhaps the most visible vegetation change at the time of *landnám,* and is attested by decreasing amounts of birch pollen compared to the pre-settlement period (Einarsson 1961, 1963; Hallsdóttir 1987). This change is reflected in the local vegetation at Reykholtsdalur 2, Háls South Pit and Stóramörk, where the decrease in tree/dwarf shrub species is the most apparent change in vegetation to occur, although the timing and severity of the decrease varies from site to site. In the valley bottom of Reykholtsdalur, at Reykholtsdalur 2, a decrease in tree and/or dwarf shrub species is evident from the plant macrofossil assemblage from deposits overlying the *landnám* tephra (ca. AD 874), indicating that human activity in the area may have been responsible for significant changes in the vegetation community. The role of Reykholt as a farm with an economy based on domestic livestock would have meant that extensive areas of grazing and hayfields were essential, and that

there was a strong incentive to clear the landscape of the valley bottom to increase the potential for fodder production and so increase the capacity for over-wintering the animals. Grazing animals would also have caused damage to trees and dwarf shrubs, further decreasing scrub cover in the landscape. Further inland, the results of excavation of the site at Háls indicate that it seems to have initially functioned as an ironworking complex from *landnám* until the mid-10th-century AD. It would be expected that this would lead to the destruction of woodland for use as fuel but, at Háls South Pit, there is no sudden change in the plant macrofossil assemblage after *landnám*. This indicates that vegetation probably remained more stable than at other sites. This evidence for the gradual clearance of woodland may indicate that any fuel procurement was well-managed and that activity at the site did not have a detrimental effect on the surrounding woodland (although as little pre-settlement material has been analysed it is difficult to assess the stability of, or form the basis of comparison with, pre-*landnám* vegetation cover). It is also likely that peat was important in the high-temperature production activity taking place at Háls (Simpson *et al.* 2003) so woodland resources may not have been under great pressure for the provision of fuel. It is only later, when there was an incentive for woodland clearance due to a shift in activity from ironworking to haymaking at Háls in the 13th-century, that there is a shift to an open landscape dominated by Gramineae and Cyperaceae. This variation in the timing and severity of the impact of settlement on tree and dwarf shrub cover between Reykholtsdalur and Halsasveit indicates that different settlement functions in the landscape resulted in different strategies for manipulating local resources.

At Stóramörk in southern Iceland, plant macrofossil evidence for the post-*landnám* disappearance of *Betula* and *Salix* from the area, combined with the increase in the number of taxa and possible evidence of landscape management by manuring, is likely to indicate the clearance and management of the area to maximise fodder production to support livestock at the nearby farmstead.

In Greenland, the pattern of human impact on vegetation communities consisting of scrubby *Salix*, *Juniperus* and *Betula* shrub, with open areas of ferns and other herbs such as *Angelica* at the time of settlement (Fredskild

1981; Fredskild and Hulme 1991) was more similar to the changes evident in the sequences in Iceland than in the Faroe Islands, due to the absence of scrub in all but the most sheltered areas in the Faroes (Arge 2000; Hannon *et al.* 2001). The clearance of *Betula* (especially tree taxa) and *Salix* wood/shrub and woodland at *landnám* is evident from pollen analysis (Fredskild and Hulme 1991; Fredskild 1978, 1981, 1992), and may relate to the clearance of woodland to create settlements and infields, and to provide grazing for livestock.

Evidence for land clearance by burning is absent from the (off-site) samples from the Faroes and Iceland presented here, but it is evident at several other sites in Iceland and Greenland. As in the Hov samples from the Faroes (Edwards *et al.* 2005), peaks in microscopic charcoal frequency at Papey occur just below and just above the *landnám* tephra. These are likely to be the result of small-scale fires such as household or smithy fires burning shrub and twig wood or peat with twig components, as the pre-settlement landscape was treeless (or at least not heavily wooded) and would not have required woodland clearance (Buckland *et al.* 1995). In Iceland, layers of charcoal in off-site peat bog sections (Buckland *et al.* 1998a) and on-site deposits below the *landnám* house at Ísleifsstaðir in Borgarfjörður (Roussell 1943a) may indicate that fire was one method used to clear vegetation. The presence of continuous charcoal layers in sections in the vicinity of the Western Settlement in Greenland (Fredskild and Hulme 1991; McGovern and Jordan 1982) indicates that this method of clearance was employed alongside manual clearance (Fredskild 1981). In the Eastern Settlement in Greenland, the evidence for landscape clearance by fire is less conclusive (Fredskild and Hulme 1991). The high proportion of woodchips compared to charcoal fragments recovered from the stratigraphic sequence at Qagssiarssuk indicates that axes were used in this area (Fredskild 1981).

In areas where manual clearance was used, it is likely that the wood was valued as a resource, although it still may have been necessary to clear the landscape for other purposes, such as grazing. The collection of wood for fuel and other uses is also likely to have been widespread (Simpson *et al.* 2003), and is supported by a range of on-site evidence indicating its use for various tasks,

including fuel, construction and fodder. Plant macrofossil evidence for possible fuels from Toftanes and Sondum includes charred twigs (e.g. *Calluna* and *Juniperus*) and other charcoal (e.g. *Salix* and *Juniperus*). These genera of shrub are all native to the Faroe Islands, and probably indicate a locally collected resource. Wood and twigs are common components of peat, as can be seen from the off-site samples, so it is possible that some charcoal and charred twigs recovered from on-site deposits may represent components of peat that were charred, rather than wood being burned as a fuel in its own right. Charred nodules of peat/dung were recovered at Toftanes and Sondum, indicating this was a fuel used alongside wood and twigs, either to supplement meagre wood supplies or when different heating regimes were required. The analysis of fuel ash from Hofstaðir and Sveigakot in Mývatnssveit, north-east Iceland, indicates that wood and peat were used as fuel resources at both high and low status sites in Iceland (Simpson *et al.* 2003). In Iceland, charcoal pits from several locations in Southern Iceland (Þórsmörk - Dugmore *et al.* 2005; Langanes and Gígjökull near Mörk – Mairs *et al.* in press) indicate that woodland was being used for this purpose from the 9th-century onwards. The collection of wood and twig fuel in the North Atlantic Islands led, at least in part, to its decline in the landscape (Simpson *et al.* 2003).

As well as the provision of heat and a means of cooking food, fuel would also have been used in the processing and preparation of foods for storage. Observations made during the 19th and 20th centuries in the Faroe Islands indicate that, due to the short growing season for cereals, the grains did not often ripen fully, and needed to be artificially dried after harvesting (Williamson 1948; Fenton 1978; Warming 1908). This process would have required fuel, and accounts of life in the Faroe Islands highlight the importance of *Juniperus communis* and *Calluna vulgaris* for smoking/curing meat as early as AD 1699 and AD 1800 respectively (Svanberg 1996-7).

The sheltered stands of trees and shrubs in the Faroe Islands are generally considered unlikely to have produced trunks substantial enough to be used as major construction features (Malmros 1994), such as the posts supporting the roof at Toftanes (Malmros 1994), although they are likely to have been used for

other purposes. The pieces of juniper rope totalling 100 m in length found in the Toftanes excavations may relate to its use in roofing, perhaps to weigh down thatch (Stummann Hansen 1990) as it was nearly always found outside the buildings, and one piece was found attached to a large stone (Larsen 1990). It is unclear what sort of material was used for the construction of the roofs at Toftanes, as material from the collapsed roofs was not distinguished from other abandonment deposits (e.g. wall collapse) during excavation. The combination of turf, twigs and wood may represent material used for roofing and/or walls, as is found throughout the region (Stoklund 1984, 1996). The concentration of twigs in Building I may represent roof collapse, although the storage of twigs or the addition of the twigs to the floor deposits to maintain them are also possibilities.

In Iceland, more substantial woodland cover would have produced better quality trunks for construction, and trees and shrubs are likely to have been exploited for a greater range of purposes.

6.2.3. Plant use – crop growing and the exploitation of wild resources?

The development of agriculture in Scandinavia can be seen as a continuation of trends starting in the Iron Age, with a shift to the production of autumn-sown rye alongside barley and oats as the major cereal crops (Robinson 1994), and the introduction of crop rotation systems (Hjelmqvist 1992). Changes in the agricultural system during the Viking period in Scandinavia generally resulted in an expansion of outland use, generally in rich agricultural areas such as Skåne (Svensson 1998; Mogren 1998), although some areas show evidence of abandonment or a change from cereal production to grazing (e.g. Bøstad, north Norway - Vorren 1979). The influence of Norse contact seems to have provided a stimulus to agriculture in the Northern and Western Isles of Scotland and the Norse-influenced area of the mainland, with crop introductions (notably rye and flax) and new areas coming under exploitation in some areas (Bond 1998; Hunter 1997; Dark 2000). A summary of the crops recovered from

archaeobotanical assemblages from sites in the region of Norse influence is shown in Table 6.1.

In the Faroe Islands and Iceland, although cereal cultivation was carried out, the shorter growing season was less suitable for cereal production than in the British Isles and southern Scandinavia. Barley and oats were two of the most widespread cereal crops in the area of Norse influence, and the settlers could have imported seed grain from either the Scandinavian mainland or the British Isles. The availability of cereals to the inhabitants of Toftanes and Sondum is indicated by charred grains of 6-rowed hulled barley (*Hordeum vulgare* L. subsp. *vulgare*) recovered from Toftanes and Sondum, and a possible grain of *Avena sativa* recovered from the floor of Building I at Toftanes. The same taxa were recovered from the only other archaeobotanical assemblage in the Faroes, the Undir Junkarinsfløtti midden (Lawson *et al.* 2005). Due to their scarcity, it cannot be ascertained whether the oat grains represent a crop cultivated in its own right, or if they were weeds of the barley crop. There are several indications that cereals are likely to have been grown locally. *Hordeum*-type pollen was recovered from the settlement at Toftanes and at sites in the vicinity of Sondum (Edwards *et al.* 1998; Lawson *et al.* 2005). The presence of non-native weeds would indicate imported grain, and grain pests are unlikely to be able to maintain a breeding population in small stores with low temperatures (K. Vickers pers. comm., Buckland *et al.* 1993). The absence of non-native weeds and grain pests associated with cereal grain at Toftanes and Sondum, in association with the evidence for *Hordeum*-type pollen, makes it likely that the cereals were produced locally. *Avena*-type (Jóhansen 1985; Hannon 1996) and *Secale cereale* (Hannon 1996) pollen has also been identified in the Faroe Islands, but the difficulty surrounding the identification of cereal pollen to genus in wet northern habitats should be taken into account (Tweddle *et al.* 2005). *Hordeum vulgare* rachis and seeds of wild species were recovered at Undir Junkarinsfløtti (Lawson *et al.* 2005). This indicates that the barley grain was not completely clean when it arrived at the site, and that it may have been grown and processed in the local area (although it does not rule out the possibility that it was imported as ears or spikelets and had not been cleaned of weed seeds).

The position regarding the status of cereals is more complex for Iceland. Barley is the only cereal crop found in plant macrofossil assemblages in Iceland, and assemblages indicate that at least some of the grain recovered was probably locally grown, especially in the warmer south and west of the island (Nordahl 1988; Guðmundsson 2002; Friðriksson 1959, 1960). However, the presence of grain pests at later sites such as Bessastaðir (13th – 16th-century) is likely to indicate imported grain, as the pests are unlikely to be able to maintain a breeding population in Iceland (Buckland *et al.* 1993). This pattern of local production of grain in the Norse period, followed by later imports is mirrored at Toftanes, where grain pests only occur in the 18th-century deposits (K. Vickers pers. comm.). Cereals are absent from some sites in Iceland, especially in the north of the country (e.g. Granastaðir, where neither macrofossils nor processing equipment were recovered – Einarsson 1994), and have not been recovered from Greenland (McGovern *et al.* 1996; Buckland *et al.* 1996).

The fact that the cereal grain recovered from the on-site samples is charred may indicate a processing accident, or may be the result of other processes such as the disposal of spoiled grain. If the drying of grain was necessary during the Norse period, as has been documented ethnographically for the 19th and 20th centuries (Williamson 1948; Fenton 1978; Warming 1908), it would mean that at least some cereal grain would be likely to have come into contact with fire. This may be a possible source of the charred cereal grain and at least some of the charred wild seed assembage (which includes common crop weeds such as *Spergula arvensis* and *Stellaria media*). Evidence for corn drying in the Norse period comes from Suðurgata 3-5 in Reykjavík, Iceland, where the granary contained a receptacle of stone slabs for the storage of grain, probably in sacks of thin woollen fabric. This was associated with a hearth, which has been interpreted as being used for drying grain (Nordahl 1988). Two upper parts of querns found in Houses II and XI at Toftanes may have been used to process cereals, indicating the preparation of flour at the site (Edwards *et al.* 1998).

Rye, wheat, flax and pea were widespread crops in Scandinavia. Rye and flax were introduced to the Northern and Western Isles of Scotland and Greenland

(Smith and Mulville 2004; Hunter 1997; Bond and Hunter 1987; Fredskild and Hulme 1991). Whilst there is some pollen evidence indicating that flax may have been introduced in Iceland (Einarsson 1963) there is no evidence for the introduction of either taxon in the Faroe Islands, or for rye to Iceland. This is likely, at least in part, to be a result of the relatively small number of assemblages analysed from the Faroe Islands and Iceland, so the absence of any species should be interpreted with caution. It is possible that the species were introduced with the initial settlement, as part of the 'ideal' agricultural system interpreted from the animal bone assemblages (e.g. Dugmore *et al.* 2005), but that conditions in the newly settled areas were not suitable for flax or rye. The heavily organic, wet soils of the Faroes were not suitable for species which are considered to favour free-draining soils and, as with pigs in Iceland, they were quickly dropped from the suite of domesticates in favour of species that were more suited to local conditions. This is not the entire story, however, as the soils in the area around Sondum in the Faroes and several areas of Iceland are sandy and free-draining. It has been suggested that flax production in Scotland may have related to production of fibre for a wider market and/or for fishing nets and line (Hunter 1997; Bond and Hunter 1987). The presence of line- or net-sinkers at Toftanes (Edwards *et al.* 1998) and archaeozoological data from the Faroes (Lawson *et al.* 2005) and Iceland (Dugmore *et al.* 2005) indicate that fishing was one of the activities in which the inhabitants participated. It is possible that the relative proximity of areas where flax was produced meant that its products could be easily traded. The richness of resources in the newly settled areas, and the absence of proto-urban settlements (and thus the stimulus for surplus food production), as well as the more marginal conditions for agriculture, may mean that the intensification seen in the economies of Scandinavia and the Northern and Western Isles was not necessary in the Faroes and Iceland – they could produce wool products for trade when necessary, but were otherwise largely self-sufficient. The finds of flax seeds at Sandnes in Greenland, for example, seem to indicate its use for food rather than for fibre. They were present in a context which included faeces, and there is no evidence of tools for flax processing at the site (Fredskild and Hulme 1991). This indicates that, in spite of their role in the trade of luxury goods such as walrus ivory, the inhabitants do not seem to have engaged in the production of

domesticated resources for trade. It is likely that further sampling of sites in Iceland and the Faroes may shed light on the issue of whether the absence of flax in the Faroes is 'real' or the result of an insufficient dataset.

The absence of rye is unlikely to be the result of climate, as it is tolerant of frost and low temperatures (Viklund 1994). In Scandinavia and Britain, the increasing presence of rye cultivation is interpreted as being part of a general intensification of agriculture as a result of a social stimulus, i.e. the need to support the inhabitants of proto-towns such as craft specialists and to pay tributes in an increasingly stratified society (Hansson 1997). Rye is found at proto-urban York and Dublin along with barley and oat (Geraghty 1996; Hall and Kenward 2004), and is likely to have been brought in from the rural hinterland of the sites (Monk 1991). In the newly colonized areas of the Faroe Islands and Iceland, the absence of pressure to support the craft specialists and other inhabitants of the proto-urban centres who did not produce food may mean that it was not a necessary part of the subsistence system.

The presence of *Empetrum nigrum* (crowberry) at both Toftanes and Sondum suggests exploitation of the dwarf shrub heath plant community for food resources. Crowberries are edible, and would have provided a source of vitamin C. The seeds were recovered in low quantities at both sites, which is more likely to indicate their incidental discard after consumption (e.g. spitting out of seeds), or arrival at the site as components of peat, than discard from processing (e.g. for preserving) or latrine deposits (the insect assemblage from Toftanes contained few species associated with fetid waste or dung, indicating this was not a major component in the floors – K. Vickers pers. comm.).

The supplementation of cultivated food crops with wild plant foods is well attested throughout the Norse area of influence, especially at sites where deposits are preserved by waterlogging (e.g. York – Hall and Kenward 2004; Dublin – Geraghty 1996; Niaqussat and Nipaitsoq - McGovern *et al.* 1983). The range of types recovered varies, and is often greatest where latrine deposits

are preserved, due to the fact that many fruit seeds survive digestion well, and to the concentration of faecal material (e.g. York – Hall and Kenward 2004; Svendborg - Jørgensen 1986). At Toftanes and Sondum, as well as Reykholt, Stóraborg and Svalbarð in Iceland (Guðmundsson 2002; Sveinbjarnardóttir *et al.* 1980; Zutter 1992), it is surprising that crowberry is the only type of fruit present. There are several species of fruit present in the Faroe Islands and Iceland that are known to have been exploited in the area of Norse influence, and in the Faroe Islands in historical times, including *Juniperus communis, Vaccinium myrtillus, V. uliginosum* and *V. vitis-idaea* (Svandberg 1996-7). The pattern of a narrow range of wild berries being collected is also apparent in Greenland (*Empetrum nigrum* and *Vaccinium uliginosum* at Niaqussat and Nipaitsoq - McGovern *et al.* 1983) and in the Western Isles (*Empetrum nigrum* and *Sorbus* sp. at Kilpheder and *Rubus* sp. at Bornish – Smith and Mulville 2004). Although it could simply be the case that evidence for other species of berry was not preserved or recovered, even though they were being exploited, it is also possible that they were not utilised. One interpretation of the relative social importance of resources in Norse cosmology is based upon evidence from the medieval sagas and lawbooks of the importance of domestic animals and their products, where wild resources such as fish were seen as less valuable than domestic resources (Hastrup 1989). Based on this categorisation, it could be argued that gathered plant resources may have been seen as less valuable and, although used, may have been under-exploited when other resources were rich. It is possible that, due to good levels of production in the domestic sphere of the economy during the Norse period, it was not necessary to exploit fully the low-status gathered plant resources such as fruits.

Corylus avellana (hazel) nut shell was recovered from House II at Toftanes. They are a protein-rich foodstuff, and may have been a resource imported from mainland Europe. Malmros (1994), however, reports that a hazel trunk with basal cut marks, as well as nuts, was found in the refuse layer at the shieling site of Argisbrekka, and this may indicate that it grew locally. Pollen diagrams from the Faroes show very little *Corylus avellana*-type pollen in either pre- or post-*landnám* contexts (cf. Jóhansen 1985), so little light is shed light on whether the trees did grow locally or whether the presence of *Corylus avellana*-

type pollen is the result of long distance transport. Hazelnuts have also been found from archaeological deposits at Kvívík (Dahl 1951) and Fuglafjørður (Dahl 1958), as well as from Norse period cultural layers at Brattahlíð/Qagssiarssuk in southern Greeland (Fredskild 1978). If *Corylus avellana* was growing on the North Atlantic Islands, its introduction would have had to be by human agency (either intentionally for exploitation or accidentally, for example as ballast) as the nuts could not naturally be transported by sea (Malmros 1994).

The presence of grape and fig pips in Anglo-Scandinavian deposits at York (ca. AD 780-10th-century) may indicate that a trade in dried fruit existing in this period (Kenward and Hall 1995). The absence of imported exotic food at Toftanes fits with information from Scandinavia and Iceland, where imports such as grapes are not evident until the medieval period (Hanson 1997), indicating that this trade may not have been part of the economic strategy. In Iceland, the presence of grape pips at Bessastadir dates to ca. AD 1226-1485 (Amorosi *et al.* 1992), a period when Iceland was becoming increasingly reliant on foreign contacts (Stoklund 1996), and may represent a product being traded.

6.2.4. Plant use - medicinal and 'industrial' uses

The flora of the Faroe Islands and Iceland, although limited in diversity, have an almost complete overlap with the European flora (Einarsson and Albertsson 1988). The Norse settlers may have been aware of the medicinal and other uses of various species from the Scandinavian homelands and the British Isles, and would have been able to transfer this knowledge easily to the newly settled areas.

It should be noted that the majority of the potentially useful species present at Toftanes and Sondum are represented at the archaeological sites by their seeds only, and this does not necessarily relate to the useful parts. For example, the leaves of some species of *Rumex* are edible or used for medicinal purposes (Svanberg 1996-7), but only the seeds were recovered from archaeological samples – it is likely that leaves were collected when tender, and therefore

before the plant had set seed, so the presence of *Rumex* seeds cannot be used to infer the consumption of leaves. Taxa which could be used in other ways, such as *Juncus* stems for lamp wicks (Svanberg 1996-7) and *Rumex* and *Stellaria media* as dyeplants (Svanberg 1996-7) are not represented in the archaeobotanical assemblages by their 'useful' parts. The most direct evidence of uses from the list may be the presence of *Juniperus communis* leaves in the floors of the house at Toftanes, which may relate to their traditional uses in Iceland and Norway. They have antiseptic properties (Lindroth 1937) and were used in cleaning, as well as to sweeten the air in houses (C. Keller pers. comm.).

In Viking Age Scandinavia it is generally considered that settlements in agriculturally marginal areas were predominantly (although not solely) suppliers of raw materials for processing in the central areas (Martens 1998). The potentially useful plants from the archeobotanical assemblages from Sondum and Toftanes are almost all the same taxa which have been recovered from the site of Borg in Northern Norway, which has been interpreted as a settlement which traded stockfish and/or furs for products from the south (e.g. linen, flour). *Hordeum* is likely to have been locally grown, and wild berries were collected, although there is an absence of plants found at Viking sites further south in Scandinavia, such as *Secale cereale, Linum usitatissimum*, *Humulus lupulus* (hops) and *Myrica gale* (bog myrtle) (Hansson 1997). *Humulus lupulus* and *Myrica gale* are both used as flavouring and preservatives in the manufacture of beer, and have been found at several proto-urban sites in Denmark and Norway (Jørgensen 1986; Robinson 1994; Jensen 1996; Hall and Kenward 2003-4), and in deposits associated with Birka in Sweden (Hansson and Dixon 1997; Hansson 1997). In the Faroes and Iceland there is a lack of evidence for plants used in craft production, e.g. linen production and dyeing. As discussed above, the soils of Iceland and the Faroes were generally less suitable for the production of *Linum usitatissimum* than in other areas of Norse influence (Smith and Mulville 2004), and the high potential for wool production may have meant that it was not necessary to grow flax. The absence of dyeplants in a region where cloth production was one of the foci of the economy is interesting, and may be a result of few sites being sampled or the fact that the messy task of dyeing took place in areas away from the settlement

site (as is known ethnographically in the Faroes – Warming 1908) that have not been sampled to date. Although pollen assemblages indicate that *Myrica gale* was introduced to Iceland (Einarsson 1961), no macrofossils have been recovered to date and it is unclear whether it was a deliberate or accidental introduction.

6.2.5. Introduction of wild plant (weed) taxa

As well as the deliberate introduction of useful species discussed above, plants were introduced accidentally due to the incorporation of viable seed in the ballast, dunnage, seed grain, fodder and other commodities carried on the Norse ships (Sadler 1991). Across the North Atlantic area, the species diversity of the flora increased dramatically with the Norse *landnám*, as the settlers brought new species with them. It is likely that up to 20% of the flora of Iceland is introduced (excluding *Hieracium* and *Taraxacum*) (Steindórsson 1963), and 23% in the Faroe Islands (Hannon *et al.* 2001). Two of the wild taxa present at Toftanes may have been introduced to the Faroe Islands. *Spergula arvensis,* for example, is considered to be a Norse introduction (Ostenfeld and Gröntved 1934) and, as a weed of cultivation, is likely to have arrived with imported grain. *Rumex acetosella*, a seed of which was found at Toftanes, is considered by some to be introduced (Ostenfeld and Gröntved 1934), but the presence of an apparently monophagous weevil in pre-*landnám* deposits on the islands, suggests that the plant may be indigenous (Bengtson 1981; Buckland *et al.* 1998b). The introduced species tend to be associated with nutrient-rich, disturbed conditions around settlements or in the infields (Sadler 1999; Sadler and Skidmore 1995).

6.2.6. Animal production - grazing and fodder

Due to the importance of domestic animal production in the economy of the North Atlantic islands, as outlined in Section 2.3.4, access to good-quality grazing and the provision of fodder would have been necessary considerations for animal production. In Scandinavia and the Scottish Islands there is evidence for changes in outland use during the Viking period. In some areas, such as

Skåne and the Outer Hebrides, this is associated with an increase of cultivated land at the expense of pasture and forest (Berglund 1988; Smith and Mulville 2004) but in others this seems to relate to an abandonment of cultivation and an increase in grazing (e.g. Holmegaard Bog - Andersen 1988). This may indicate an increase in the importance of grazed animals in the economy of some areas during this period, although whether this is due to a shift in economic strategy or landscape degradation is open to question.

6.2.6.1. Grazing

The products of domestic animals seem to have been an important aspect of the North Atlantic economy, and would have been the main focus of production in areas where cereal crops could not be grown (Lawson *et al.* 2005; Amorosi *et al.* 1992). Faunal assemblages indicate that cattle, sheep and goats were the main domesticated animals exploited (McGovern 2000). This would have required extensive grazing areas, which were created by the settlers through the clearance of dwarf shrub and tree cover, increasing the area of grassland, indicated in the pollen record of the Faroes and Iceland by an increase in Gramineae and Cyperaceae pollen. The collection of leaves and twigs for fodder, and the damage caused to trees and shrubs by grazing animals, would also have had an impact on the vegetation in the Faroes and Iceland. Sheep in Iceland seem to exhibit a grazing preference for broad-leaved herbs, then move on to woody species as these become scarce (þorsteinsson and Ólafsson 1973), although the management of grazing could have lessened the impact of herds. It is thought that it is not the number of sheep grazing an area, but the management of grazing regimes e.g. restricting grazing by area and/or season that contributes to land degradation (Olafsdóttir 2001). A decrease in taxa susceptible to damage by grazing (e.g. tall herbs) also occurs at *landnám,* and is associated with the opening of the vegetation (Hannon and Bradshaw 2000; Hallsdóttir 1987). The importance of hay and fodder for overwintering livestock in the North Atlantic islands is discussed in Section 6.2.6.2.

The nature of the natural vegetative cover was different in the Faroe Islands and Iceland, and this affects the way pollen and spore analysis results are

interpreted. In the Faroe Islands, the decrease in Filicales, a family sensitive to damage by trampling, is interpreted as an indication of the rapid expansion of the new ecological niches of grazed pasture and managed meadow (Hannon and Bradshaw 2000; Jóhansen 1985). In Iceland, Filicales tend to show an increase at *landnám* due to tree clearance and more open conditions allowing for wider dispersal of spores (Hallsdóttir 1987), although a decrease in Filicales similar to that shown in the Faroes is seen in treeless areas, such as Papey (Buckland *et al.* 1995). The presence of *Selaginella selaginoides* megaspores in the initial post-*landnám* plant macrofossil samples from Reykholtsdalur 2, Breiðabólsstadavatn 2 and Stóramörk is likely to be the result of a more open landscape allowing an increase in light-loving plants and also increasing the potential for the dispersal of their spores. This is reflected in pollen assemblages at several sites (e.g. Hallsdóttir 1987), and is in keeping with the increase in Gramineae and Cyperaceae pollen generally seen in pollen diagrams from Iceland at *landnám*, an indicator of the rapid expansion of new ecological niches of grazed pasture and managed meadow (Einarsson 1961, 1963). The presence of *Potentilla* at Breiðabólsstadavatn 2 and Stóramörk (and later at Háls South Pit 1341, which may relate to 13th-century shift from arable agriculture to haymaking), may indicate a similar trend to that represented by an increase in the plant macrofossil assemblages at several other sites. On Papey (Buckland *et al.* 1995), the rise in *Potentilla* is contemporaneous with insect evidence for sheep grazing, and it is a feature more generally in pollen diagrams covering the *landnám* (Hallsdóttir 1987). The first presence or increase of *Potentilla* may be a response to grazing pressure in areas with heathland vegetation (Moore *et al.* 1986). In Greenland, the removal of scrub in the areas near settlements resulted in a landscape of damp fen with areas of dwarf-shrub heath, a range of introduced weeds and a flourishing of herbs associated with treeless soils (Fredskild 1981; Fredskild and Hulme 1991).

Rather than the creation of a more uniform treeless landscape of grassland and meadow (cf. Edwards *et al.* in press), the increased diversity of the ecological conditions associated with the plant macrofossil taxa present at Hov indicates that, at a local level, different changes took place. There is evidence for moist and wet areas at the Hov sample site, as well as areas of fresh shallow water,

which may be the result of changes in the local hydrology either to purposefully create areas of wet meadow or bog or as an indirect result of human activity in the area. The beetle evidence for animal dung in the area may indicate the presence of animals, or the spreading of manure to enhance the nutrient-status of the area. Research from other sites in the Faroes indicates a post-*landnám* increase in nutrient status in the majority of areas investigated, with the presence of ruderal taxa and arable weeds (Hannon *et al.* 2001; Hannon and Bradshaw 2000; Jóhansen 1985; Lawson *et al.* 2005). At Tjörnuvik, plant macrofossils of species associated with clearance and cultivation are present in the upper layers of the column, including *Montia fontana, Stellaria media, Filipendula ulmaria* and *Rumex* cf. *longifolius* (Hannon 1996), and Filicales, an order sensitive to trampling, decreases (Jóhansen 1971). Although there are not such clear indicators of human impact at Hov, Buckland (2000) states that the vegetation of infield areas during the settlement period would have been dominated by Gramineae and Cyperaceae, so the increasing wetness in the area around the sample site does not rule out the laying out of fields associated with the farmstead (although there is no evidence to indicate that the area was enclosed at the time). The impact of settlement was also not equally rapid at all sites. At Grótúsvatn (pollen sequence from lake sediment) and Millum Vatna (pollen sequence from peat succession) changes in taxa that are effected rapidly at some sites (e.g. *Juniperus*) occur more slowly. This may be an indication of the intensiveness of land-use at settlement, with areas near settlement or other archaeological sites showing a distinct and rapid impact due to the need for immediate land clearance (e.g. Tjörnuvik - Hannon 1996), and outfield areas showing more gradual, insubstantial changes due to the less intensive nature of activity (e.g. Millum Vatna – Lawson *et al.* 2005). The labour required to clear or otherwise improve outfield grazing areas is likely to have been used when needed, initially to enable the livestock arriving with the settlers to graze (although grazing livestock would have damaged trees and dwarf shrubs, resulting in a more open landscape over time), and later if the herds increased in size or as new farms were built.

6.2.6.2. Fodder

As well as grazing animals in the outfield area, hay and other sorts of fodder had a role in the North Atlantic economies for over-wintering animals, although its importance seems to vary from area to area. In Iceland and Greenland, hay was of great importance for over-wintering (Fridriksson 1972), and was supplemented by sources of outfield fodder, such as leaves, twigs and seaweed (Hallsson 1961). The amount of hay and other fodder that could be collected was the essential factor in the calculation of how many animals could be over-wintered, and therefore the survival and well-being of the inhabitants of the farmstead (Adalsteinsson 1990). The milder climatic conditions of the Faroes mean that winter feeding may not have been so essential for the survival of herds, although it was probably necessary for weaker animals and during harsh winters. Hay and other sorts of fodder are difficult to distinguish in the archaeological record due to their potentially diverse nature, their similar composition to dung, and the multiple uses of potential hay constituents (Kenward and Hall 1997). The combination of archaeological context and plant macrofossil and beetle assemblages from Toftanes and Sondum can shed some light on the subject. Hay seems to have been a low-level constituent of the assemblages due to the presence of plant species associated with the nutrient-rich, undisturbed conditions of the hayfield (including the grasses *Alopecurus geniculatus* and *Poa nemoralis/palustris,* as well as *Prunella vulgaris*) and beetles associated with stored hay environments. Hayfield taxa never made up more than 6% of the seed assemblage, with types that are likely to be from hayfields but are also found in other areas (e.g. *Rumex* sp.) contributing to the assemblages in addition to the 6%. They make up the highest percentage of the seed assemblage in the area around the hearth, but this area of general activity is unlikely to be the location of a store of hay for feeding the animals and the concentrations may represent the use of hay for another purpose, e.g. bedding. They therefore seem to represent plants being incorporated into living floors to provide comfort and a level surface (see Section 2.3.5.2). There are no concentrations of any of the plants likely to be collected as outfield fodder except for a concentration of twigs in Building I (sample 1995 - predominantly non-charred *Calluna vulgaris*, with some charred *Calluna vulgaris* and

Juniperus communis, and moss). Although the possibility of the storage of twigs for fodder cannot be ruled out, other possibilities such as roof collapse, fuel/tinder, floor packing/levelling and bedding must also be considered. It seems that the storage of hay and fodder did not take place within the areas sampled at Toftanes, although it is possible that this occurred in other areas of the settlement. The assemblage from Sondum is more difficult to interpret. It represents discarded material, probably largely from house-floors, and plants growing on the midden, and may indicate hay was also spread on floors in the structure with which it was associated (see Section 5.2.2).

In Iceland, hay and fodder seem to have been more important due to the more marginal conditions for stock rearing than in the Faroe Islands. There is evidence for stored hay from the initial phases of settlement (Buckland *et al.* 1993), and Saga references to the first settlers encountering hardship because they were pre-occupied with exploiting wild bird communities rather than gathering fodder for overwintering the domestic livestock (Buckland 2000). Grazing resulted in severe erosion in many areas (Sveinbjarnardóttir 1992) and by AD 1281, attempts were made to regulate the use of outfield grazing areas by restricting, for example, the number of months they could be used (*Jónsbók* - Hastrup 1989). This can be seen as an attempt to protect the grazing quality of both the outfield and infield areas, lifting pressure on the infield in summer by moving the animals to outfield areas and securing the best grazing conditions for livestock by exploiting freshly growing plants with higher nutritional value (Hastrup 1989).

6.2.7. Soils – nutrient-enriched areas and changes in the wider landscape

The creation of settlements in Iceland and the Faroe Islands modified existing plant communities, often resulting in the destabilisation of largely virgin landscapes and soil erosion, and created new ecological niches due to changes in the nutrient-cycling of the islands.

6.2.7.1. 'Nutrient-enriched areas'

Enrichment of the landscape was a feature of the settlement area, due to the concentration of resources from throughout the landscape through human activity and the disposal of waste. It was found that the homefield area at Hov is dominated by clay- and silt-rich soils which have been enriched by manuring over a long period of time (Adderley and Simpson 2005). The infield area of Leirvík, which included Toftanes, consists of sand-rich soils which have been subjected to long-term manure application, although this enrichment seems to have ceased in recent times (Adderley and Simpson 2005).

The plant macrofossil assemblage from external areas around the farmstead at Toftanes (e.g. sample 570) showed a considerable diversity of plant taxa, indicating that the area was well used by the inhabitants. The range of plant macrofossils was similar to those from the interior of the buildings, but the virtual absence of a charred seed assemblage in samples from the external areas, and their presence within the houses, indicates that the source of the plant material in the outside area was unlikely to be the interior floors. This indicates that a similar range of plants and plant-based resources was being used in the internal and external areas, rather than material from household floors being dumped outside the houses. This is reflected in the beetle assemblage, where species characteristic of the assemblages within the houses are absent (K. Vickers pers. com.). At Niaqussat (V48) and Sandnæs (V51) in Greenland, the plant community and insect fauna of the disturbed, organically rich ground around the farmhouse are considered to have been indistinguishable from those of the midden and were dominated by species that were present at the Norse settlement (e.g. *Stellaria media* and *Capsella bursa-pastoris* – Fredskild and Hulme 1991). The introduction of new species is not evident in the off-site samples studied here, perhaps due to their location in infield areas rather than immediately adjacent to the settlement site, but an increase in the diversity of the plant macrofossil assemblage in the sample above the *landnám* tephra can be seen at Stóramörk in Iceland. This may be a continuation of a trend seen in the sample below (dated AD 805-920), but the change is more distinct in the sample above the tephra. This change is also reflected at Ketilsstadir, where the

most diverse plant macrofossil assemblage occurs between the *landnám* tephra and AD 1357 and includes anthropochorous plants such as *Stellaria media* (Buckland *et al.* 1986). Similarly, at Holt 15 km to the south-east of Stóramörk in Iceland, anthropochorous plants and synanthropic insects were recovered in areas up to 100 m away from the farm mound, indicating the extensive impact the site had on the surrounding area, increasing the diversity of the biota (Buckland *et al.* 1990). A similar situation can be envisaged at Toftanes, where the enriched nutrient status of the farmstead and the surrounding area, as well as the use of materials from these areas within the settlement, resulted in some degree of similarity between the internal and external plant macrofossil assemblages, even though household material was not being dumped in the yard area. Human activity also increased the diversity of the plant communities in the area surrounding the settlement, creating nutrient-enriched niches.

Human activity would have resulted in the accumulation of waste material in middens in the area around the farmstead. The Sondum midden seems to comprise of material from a variety of sources, and incorporates material growing on the surface of the midden as well as refuse from habitation and other areas. The plant macrofossil assemblage is dominated by taxa likely to have colonised the surface of the midden, especially perennials such as *Urtica dioica* and *Rumex acetosa/longifolius*, which may indicate that the surface was undisturbed for a number of years (Kenward and Hall 1997). In the case of the Sondum midden, the source of the material has not been excavated, so it is not possible to compare the evidence for activity within the settlement to the material discarded on the midden. At least three different depositional events seem to have occurred during the accumulation of the material analysed from Sondum (represented by different stratigraphic layers), and the midden seems to have incorporated plant material from undisturbed nutrient-rich areas, probably on the surface of the midden. This is consistent with other middens in the North Atlantic islands including the Niaqussat (V48) and Sandnæs (V51) middens, where discontinuous lenses and layers of material included twigs mixed with dung, probably the result of the clearing of byre or stable, as well as other dwelling debris, e.g. bones, antler chips, wood shavings, discarded turves and the growth of vegetation on the mound (McGovern *et al.* 1983; Buckland *et al.*

1993). As at Sondum, some stability in the surface of the midden between depositional events is suggested. The deposition of material from the dwelling rooms seems to have occurred less than once a year (McGovern *et al.* 1983). Historically in Greenland, byre deposits were allowed to reach a thickness of 1-1.5 m before being cleared out for use as manure on fields (Fredskild and Hulme 1991) and, in Iceland, byres were cleaned out annually when the sheep were let out to pasture (Adalsteinsson 1990). Although the material was discarded onto the midden, its properties as fertilizer would have been exploited by the farmers, and soil profiles in the area around Sondum indicate that the soils were subjected to manuring over long periods of time (Adderley and Simpson 2005). The midden is likely to have been re-worked, for example by the removal of material to fertilise the infield, which would have contributed to changes in the vegetation community due to nutrient-enrichment. As the midden material originally came from a variety of locations in the landscape, each with its own plant community, the addition of viable seeds from a variety of ecological niches to the soil would have increased the diversity of the infield plant community. Nutrient-rich soil conditions increased yields in the infield and are likely to have increased grain yields and produced high-quality hay.

In the broader context of the North Atlantic, middening practices seem to have resulted in similar plant macrofossil assemblages across time and space. Where organic preservation is good, assemblages are directly comparable. Midden assemblages in the Faroe Islands and Iceland consist of macrofossils from a range of plant communities, including ruderals and weeds of cultivation, and species of homefield, pasture, grassland, heath and wet areas. The material from Sondum, probably spanning the period from the settlement to the 11th- or 13th-century AD, shows a similar range of vegetation communities to that from Reykholt (probably the initial settlement phase - Guðmundsson 2002) and Svalbard (11th – 19th-century AD - Zutter 1992). The fact that the samples from Sondum contained similar plant macrofossil and beetle assemblages, even though they are taken from at least three stratigraphic layers, may indicate some degree of mixing of deposits, which would be expected in a midden context. However, the fact that stratigraphic layers, likely to relate to depositional events, were visible in the section of the midden, indicates that the content of

the material deposited is likely to have been more-or-less consistent over time, another similarity with the middens at Reykholt and Svalbard. This indicates that a similar range of plant material and plant-based resources were being exploited by the settlers and their descendants, and that similar strategies of resource exploitation and disposal were employed throughout the region.

6.2.7.2. Changes to soils in the wider landscape

Away from the nutrient-enriched soils of the areas around the settlement and infield, human impact on the landscape was of a different nature. Attempts to improve the landscape, by drainage or woodland clearance, had an impact on the underlying soils.

As well as the poor nutrient status of soils in the Faroe Islands and Iceland, soil wetness was a major constraint on plant production, especially for cereals. Edwards *et al.* (2005) state that the improvement of soils around Hov was intended to reduce soil wetness by increasing drainage, rather than enriching the nutritional status to increase cereal production, although the plant macrofossil assemblage indicates that the local area sampled became wetter, with areas of shallow water. In Iceland, a change at *landnám* from soils with high moisture retention due to a high proportion of organic matter to lighter and less organic sediments after settlement is noted at several sites, and is considered to be due at least in part to the removal of vegetation due to grazing (Fridriksson 1978). There is evidence for the clearance of trees and shrubs at several sites investigated in this research, but it does not seem that improvement of the land by drainage was a feature of the settlement period in these areas. At Reykholtsdalur 2 there is a distinct change from organic soils with good preservation below the *landnám* tephra to more minerogenic soils with poor organic preservation above the tephra. However, the plant macrofossil assemblage indicates that wet conditions were maintained across the *landnám,* with a change in the species associated with shallow water, shifting from an assemblage containing *Carex rostrata* to one containing *Hippuris vulgaris* and *Potamogeton* sp. This sort of change has been noted at Eiði in the Faroe Islands, where the proportion of *Potamogeton* and *Myriophyllum* pollen grains

increases from a deposit dated to AD 430-650. This is assocated with a slightly earlier increase in diatoms associated with nutrient enrichment, and may relate to changes in the condition of the catchment area affecting the nutrient status of the lake (Hannon *et al.* 2001). Conditions at Stóramörk also remained wet in the period after human impact was evident. Although it is possible that drainage was being carried out in the wider landscape, its impact on the local areas sampled does not seem to have been significant. Perhaps their location in relatively flat, lowland areas meant that drained water did not flow away quickly, and areas of shallow water accumulated, or that only selected areas of the infield were improved by drainage.

The impact of human behaviour on the vegetation of the Faroe Islands and Iceland, particularly the removal of trees and dwarf shrubs to create areas of extensive grazing, resulted in changes to the soils in the regions. The removal of trees and dwarf shrubs described above meant that soil was less protected from the wind and rain by vegetation cover, and stability was no longer provided by deep roots. The further destruction of vegetation by grazing animals cropping the vegetation to soil level, damaging the remaining trees and dwarf shrubs, and disturbing the soil by trampling is also likely to have affected slope morphology. Soil erosion from slopes and deposition in lowland areas was a common feature of the impact of the Norse settlement across the North Atlantic islands (e.g. Iceland - Fridriksson 1978; Faroe - Mairs 2003; Greenland - Fredskild 1992; Sandgren and Fredskild 1991), although the timing and severity seems to have varied on both a regional and a local scale (Faroe - Humlum and Christiansen 1998; Mairs 2003; Iceland - Dugmore and Buckland 1991; Dugmore *et al.* 2000; Greenland – Dugmore *et al.* 2005). In the Faroe Islands, landscapes were already fairly open, and some areas do not exhibit a significant increase in the rate of deposition around the time of the settlement (Mairs 2003). In some areas of Iceland, such as Þórsmörk, soil erosion was so severe that farmsteads in marginal areas were abandoned (Sveinbjarnardóttir 1992). It is unlikely that the settlers, coming from landscapes that were already occupied by humans or which had relatively open vegetation, would have foreseen the impact of woodland clearance on virgin slopes as it was outside the range of their experience.

6.2.8. Resources used as fuel

A range of potential fuels were available to the settlers of the Faroe Islands and Iceland, including wood and twigs from dwarf shrubs and trees, thick deposits of peat, turf, seaweed and driftwood that washed up along the shore (Table 6.2). Although wood was widely available in Scandinavia, the experience of settlers in the treeless or near-treeless Northern and Western Isles of Scotland meant that the settlers would have been aware of other potential fuels in treeless landscapes, their methods of preparation and the heating regimes provided.

Charred nodules of peat or dung recovered at Sondum and Toftanes indicate that at least one of these was also used as fuel. The material from Toftanes and Sondum may represent one or both of these potential fuels, and further study is necessary to confirm which resources were being used. Peat/dung was the only fuel recovered from a hearth from 10th-12th-century Reykholt, even though it is known from charters that the church owned access to woodland at least as early as ca. AD 1185, and access to driftwood in western fjords by 1478 (Sveinbjarnardóttir 2004), indicating that wood was available as a fuel. Analysis of fuel ash from two sites in north-east Iceland indicates that peat is associated with the high-status settlement at Hofstaðir and was not found at the low-status settlement of Sveigakot, even though there is a source within three kilometres of the site. It is likely that control over access to fuel resources was exerted by the more powerful farmsteads (Simpson *et al.* 2003). Peat is also important as a fuel when high temperatures are required, for example in industrial processes (Simpson *et al.* 2003), and it is possible that the Reykholt fireplace was used for a task needing a fire with a high temperature heating regime.

The presence of charred seaweed in the Toftanes floor deposits indicates that this too may have been used as a fuel at the site, as is known elsewhere in the North Atlantic, Ireland and Scandinavia ethnographically (cf. Fenton 1978; Henderson 1819; Kampp 1964; Evans 1957) and suggested archaeologically (e.g. at Kaupang – Hall and Kenward 2003). Due to its acrid fumes it may only

have been used when other resources were scarce (Hallsson 1961; Church pers. comm.) or have been burned to provide salt for flavouring or food preservation (cf. Buckland 1997) or mineral-rich ash (Church pers. comm.).

In areas with a scarcity of fuel, bone may also have been burnt, and small chips of charred bone present in the floor levels at Toftanes may represent the incorporation of the residues from the fire into floors. This is also evident at Nipaitsoq in Greenland, where an exceptionally large number of fragments of burnt bone were recovered from the floor deposit of the main living room (Room III), and the high degree of fragmentation and charring is considered unlikely to have happened during cooking (Buckland *et al.* 1983). It is also likely that a range of fuel conservation techniques were carried out to reduce the amount of fuel needed. Historically in Iceland, prepared foods (e.g. smoked meats and jellied preparations) were made at slaughter time in the autumn, which reduced the amount of fuel needed for cooking at other times of year. Once lit, the fire was used for multiple purposes for maximum fuel efficiency, for example burning the wool off sheep heads while smoking joints of meat and preparing blood pudding (Adalsteinsson 1990).

6.2.9. Woodworking: the role of local wood, imported wood and driftwood

Due to the open nature of the woodland in the North Atlantic islands, the potential for acquiring wood for working from locally growing supplies was more-or-less limited to the production of small objects. However, wood suitable for more substantial work could be imported (probably at great cost) and found washed up on the shore as driftwood.

Many wooden objects were recovered from Toftanes, including bowls, gaming pieces, spoons and barrel staves, but the wood types have not been identified to date (Stummann Hansen 1990). At Toftanes, several pieces of native *Juniperus communis* and non-native types exhibited cut marks, but worked wood was not recovered from Sondum. As we do not have any indication of the composition

of the floor material that may have been deposited on the Sondum midden, or the midden associated with the farmstead at Toftanes, the presence of cut wood chips at Toftanes and their absence at Sondum is difficult to interpret. It is possible that the chips in the Toftanes floors are remnants of whittling taking place in the buildings (the spatial resolution of sampling is not adequate to differentiate activity areas) and, as the chips were not cleared away, it could be proposed that the occupants were at least indifferent to the presence of discarded chips on the floor. Alternatively, they may have been seen as a desirable contribution to the floor deposits, and wood chips may also have been brought from wood working in outside areas to provide additional floor material along with other plant material such as *Calluna* and *Juniperus*. The value of wood chips and other material for flooring has been suggested for the thick chip, twig and moss floors in Norse Greenland and other contexts (de Laguna 1977; Buckland *et al.* 1993) where, as well as providing insulation from the permafrost (cf. Zimmermann 1999), the layers are thought to have absorbed the detritus of living. The aromatic properties of *Juniperus cmmunis* may also have led to its incorporation in the floor in an attempt to sweeten the air. Traditionally in Norway, the sprouting tips of Juniper branches are spread on the floors of summer houses and shielings to freshen the air before they are left for the winter (C. Keller pers. comm.), and it is possible that this property was recognised by the Norse.

A slightly wider range of wood types was recovered from the shieling site of Argisbrekka than at Toftanes and Sondum – worked waste of the driftwood types *Picea* and *Larix* was recovered, and imported wood such as *Quercus, Alnus* and *Fraxinus* was present only as finished objects. Native taxa including *Juniperus, Betula, Salix, Corylus, Calluna, Empetrum* and *Vaccinium* were also present (Malmros 1994). This indicates that native wood, driftwood and imported wood was used at both farmstead and shieling sites, a pattern reflected in material from the settlement site of Sandwick-North, Shetlands (Malmros in press). This pattern of worked driftwood taxa and twig material of local types is reflected in the wood assemblage from Sandnes in the Western Settlement of Greenland, where charcoal is also largely of native species (Buckland *et al.* 1993). At sites in both the west and east settlements of Greenland, the majority

of household objects were made of driftwood, although some smaller ones were of local wood such as *Juniperus, Salix* and *Betula* (Arneborg 2000).

6.2.10. Use of outfield resources for building materials and construction

The buildings of the Faroe Islands and Iceland were constructed from driftwood, stone and turf in a similar manner to Norse settlements excavated to date across the North Atlantic. As suitable wood for heavy construction was not available locally, buildings were constructed largely from turf and stone, with imported wood or driftwood providing support where necessary.

The excavation of the structures at Toftanes indicated that different methods of construction were used for each building. The curved walls of House II were 1 m thick, with outer and inner walls of dry stone. These were coursed with turf, making the structure more windproof. These turves seem to have contributed to the organic deposits at Toftanes - seeds from plants associated with moist, nutrient-poor, undisturbed conditions in the outfield may have arrived at the site as components of turf (along with seeds from wetter outfield areas) and beetle species found in turf are also present (K. Vickers pers. comm.). The seeds of *Montia fontana* (Hall 2003) are commonly found in turf-rich archaeological deposits and their presence may result, at least in part, from the decay of turves. Building I was constructed from a single stone-built wall, and the lack of turf construction meant that the wind could probably blow straight through the walls. The seeds of plants associated with the outfield were recovered within Building I, indicating that turves may also have been used or stored in the buildings, for example as fuel or to spread on the floor. Houses XI and XII had walls of similar construction to House II, but both houses are thought to have had at least one wooden wall, indicated by a sill in House XII. Stone sills and packing to protect wooden supports from decay were common in damp areas (e.g. Shetland – Bigelow 1987). Stone was used to construct drains under the floor of House II, and also to pave the floor in House XII (Stummann Hansen 1990).

There is little direct evidence for the type of roof present at Toftanes and other sites (Bigelow 1987). At Toftanes, the roof of House II was supported by five pairs of posts in the western half, evident from stone-packed post holes (some containing remains of the posts). Small wooden posts were recovered along the walls in the eastern part of the building, but their function is unclear. Collapsed layers of roofing material were not identified at the time of excavation, and the plant macrofossil assemblages identified during excavation as from the collapse of the building during abandonment could not be distinguished from assemblages from occupation deposits. It likely that the roof consisted largely of the same range of material as the rest of the building (i.e. turf and brushwood) making phases difficult to distinguish during excavation. Local trees and dwarf shrubs may have been used in the roof construction, and juniper rope recovered at Toftanes, including a length attached to a stone, have been interpreted as used to weigh down the roofing material (Edwards *et. al.* 1998). The concentration of twigs and moss in Building I may represent roof collapse, but other sources (such as flooring or storage of twigs) can be suggested.

6.2.11. Living conditions and use of space at Toftanes

The Toftanes farmstead is comparable with other Norse sites in the North Atlantic region in terms of its location in the landscape, architectural style, resource base and material culture, and is the first assemblage which sheds light on the living conditions of Norse settlers in the Faroe Islands and their attempts to improve conditions around them.

6.2.11.1. Location of the settlement

The fact that *Sphagnum* underlies the settlement could be considered to make the area too wet to be suitable for occupation (A. Hall pers. comm.), but it seems that the construction at Suðurgata-Tjarnargata in Iceland was also built on a damp area which was filled in with wood chip and other material in the wettest areas along the original lakeside of Tjörnin (Nordahl 1988). Other sites in Iceland, however, tend to be on slopes with drains in the floors to avoid

accumulation of water (Nordahl 1988), and the motivation for choosing an apparently wet area for construction is unclear.

6.2.11.2. Period of occupation

The plant macrofossil assemblage recovered from Toftanes cannot be seen as a direct representation of the use of plants and plant-based resources at the time of occupation. The mixing of deposits during and after occupation and differential preservation are likely to have had an effect on the distribution of the plant material and its relationship with excavated features. The settlement may have been occupied for several generations (see Chapter 2) and, within this time, floor deposits would have built up, been reworked and discarded. Even if the functional use of space remained constant (and this cannot be assumed), the addition of material (such as peat) to the floor to improve living conditions and the movement of people and animals around the settlement would have blurred distinct activity areas. The possibility of clearance of floor deposits to middens or fields may mean that the accumulated floor deposits do not span the entire period of occupation. The gradual decay of the turf structures, both during and after occupation, would have contributed plant material to the site, and would further blur the distinction between deposits. The poor spatial resolution of sampling for plant macrofossil analysis at the site during excavation, and lack of accurate plans locating the samples, compounds the problem of the analysis of the plant macrofossil assemblage. Any patterning of plant macrofossils within the excavated floor deposits must, therefore, be interpreted with caution.

6.2.11.3. Floor deposits and living conditions

Norse longhouses generally consisted of one living area, with a longfire in the centre of the space. Benches were situated around the longfire, in a multi-functional space that was used for eating, sleeping and social activity. This layout seems to have been culturally important in Norse society, as it was used throughout the region in spite of being poorly adapted to fuel-poor areas (Stoklund 1984). Although the central living area was multi-functional, other areas of the longhouse and additional offshoot rooms may have had specific

uses, and the living area may have been divided with partitions of light wattle or wood panelling. Wood panelling lining the walls is indicated by the presence of sills in excavations of Icelandic houses and is also mentioned in the sagas (Bigelow 1987). The wood for panelling is likely to have been imported, and is likely to have only been available to the higher classes of society (Stoklund 1984). The mixed nature of the well-preserved organic material from the Toftanes floors makes it typical of houses analysed from the Norse region of influence where organic preservation is good. Evidence from across the Norse region of influence indicates that floors frequently composed of a mass of decomposing and fermenting vegetation (e.g. twigs, moss and hay), carrion, peat, turf, faecal material and other by-products of human life (e.g. wood chippings and leather offcuts) (e.g. York – Hall and Kenward 2004; Dublin – Geraghty 1996; Niaqussat and Nipaitsoq - McGovern *et al.* 1983). The suggestion that this thick floor layer provided insulation from cold surfaces, based on sites in Greenland (Buckland *et al.* 1994), is supported by experimental work in a Lower-German byre-cum-dwelling house at Visbek, Germany which indicated that dung-filled sunken byres gave good protection against the frost, which came in more through the floors than the walls and roof, whilst the fireplace and warmth of the cattle made little contribution to the internal temperature of the living area (Zimmermann 1999). At sites where organic preservation is lacking, such as Jarlshof, it has been suggested that floors would have been kept clean, with refuse moved to pits and middens (Hamilton 1956). However, the degree of cleanliness on sites with no or poor organic preservation needs to be reassessed in the light of the context of sites with good organic assemblages, such as Toftanes – were the inhabitants of Jarlshof unusually clean for the period, or is this a result of preservation bias?

There is evidence at some sites, such as Sandnes in Greenland, that the floor layers were carefully prepared and only replaced when they ceased to function properly, for example if their capacity for draining away moisture was not adequate (Buckland *et al.* 1994). Although the careful deposition of floor layers has not been suggested for Toftanes, stone-built under-floor drains were constructed in House II, and indicate that a need to allow liquids to drain from the floor layers was present from the time the floors were constructed

(Stummann Hansen 1990). Drains are known from other sites, where they were probably covered by wood (e.g. Í Uppistovubeitinum – Arge 1997) or stone (cf. 'slab house', Reykjavík - Nordahl 1988). As discussed in Sections 6.2.4 and 6.2.9, the addition of fragrant material, such as *Juniperus communis* wood and leaves, to the floor deposits may be an attempt to sweeten the air in the structures (C. Keller pers. comm.). This has been suggested for Nipaitsoq, where the sweet smell of decaying hay may have masked the stench of faecal and other decaying material in the floors (Buckland *et al.* 1993). It was also common practice to spread cut Gramineae and Cyperaceae throughout houses on floors in Iceland to soak up foul residues and to sweeten the air (Sveinbjarnardóttir *et al.* 1980). Micromorphological analysis of house floors in Norse longhouses in Iceland shows that charred material is often a constituent of floors, and is likely to have been deliberately incorporated into the floors in an attempt to maintain them, absorbing moisture and odours (K. Milek pers. comm.; Simpson *et al.* 1999). At Toftanes, charred material was present across the site, although charred seeds were largely confined to the interior of structures and features draining floors, and seem to be the result of several deposition events taking place across the floors. This management of house floors to improve living conditions may have taken place at Toftanes, as *Juniperus communis* wood and leaves were present in the floors, charred material seems to have been added to the floors and seeds of Gramineae and Cyperaceae may indicate that these plants were also spread on the floors.

Although the basic structure of Norse longhouses described above is similar across the North Atlantic, similarity in the internal use of space cannot be assumed (K. Milek pers. comm.) and more detailed investigations are necessary to investigate how these spaces were used, partitioned and accessed. The use of space within houses is not random, and is constructed through movement and activity which are in turn rooted in social interaction and ideas of 'appropriate' behaviour (cf. Price 1995). If continuity over time in the use of space and regularity of activity can be assumed (cf. Samson 1990), the samples from Toftanes could potentially have shed light on the use of space within the structures. However, the mixed nature of the floor deposits from most Norse sites with good organic preservation means that 'most samples are time-

averaged, but, occasionally, a particular activity may be recognized' (Buckland *et al.* 1993: 516). Although there is no strong patterning in the content of samples at Toftanes relating to their spatial distribution, and the spatial resolution of the location of samples on a site plan may not be exact, some of the similarities and differences between samples may relate to the use of space within the site.

In general, no distinction in the use of plant material is apparent between the buildings. Samples from within Building I and House II cannot be differentiated due to their seed content alone (see Section 5.2.1.2), and some samples have a similar seed content in spite of being taken from different structures. However, the location of entrances to Building I and House II, from the yard between the houses, means that much of the movement of the inhabitants and resources between the structures would have taken place through this yard area. The more mixed composition of samples located in Building I and the central area of House II, compared to those from either end of House II, the outside areas and the abandonment layers, may indicate an area of general use, with a mixture of plant resources and resources containing plant remains. The movement of people through this space may also have led to the spreading of plant material through attachment to feet, which would have mixed deposits. Samples taken from the western end of House II, around the fireplace, are also mixed, but contained a high proportion of *Rumex* sp. (found in various habitats, but often hayfields), less *Montia fontana* ssp. *fontana* and a lower proportion of outfield types than the other floor deposits in House II. This area is likely to be a multi-functional area, with the fireplace and surrounding benches a focus for social gathering, eating and sleeping (Stoklund 1984) and, although the western end of the house was destroyed before the time of excavation (Stummann Hansen 1990), comparison with other sites indicates that it is unlikely there would have been another entrance at this end. Longhouses tend to have the entrance(s) in the long wall (Price 1995; Stoklund 1984). The earliest Norse phase at Jarlshof has an opening interpreted as an entrance in the gable end (Hamilton 1956), but this has been re-interpreted as a drain (Stummann Hansen 2003b). This difference in the composition of the floors indicates that different material was being deposited in each area. The low

proportion of outfield types is perhaps a result of a smaller contribution from the outfield taxa contained in turves in the floor deposits at this end of the house (turves may also be a source of *Montia fontana* ssp. *fontana* – see Section 4.5.1), or indicates a particular use of *Rumex* sp. in the area. The difference in the composition of the floors may be the result of different intentional construction of floor layers (more *Rumex* plants spread around the fire, with a greater proportion of turf in other areas), differences in the use of space (*Rumex* being prepared around the fire and therefore being over-represented in the assemblages) or different construction methods of the walls and roof. The set of five pairs of post holes in the western end of the house may indicate a different construction from that in the eastern part, where small wooden posts were placed at 60 cm intervals along the walls, perhaps indicating a different wooden construction (Stummann Hansen 1990). The different method of construction of the eastern end would have allowed a greater input from roof and/or wall turves than that in the western end.

Although there was no archaeological evidence for the partition of the interior of House II, it may have been achieved by wooden or cloth partitions which were not evident archaeologically (cf. Stoklund 1984). Internal partitioning of buildings is common in Norse longhouses, and is usually inferred from features visible during excavation such as the settings for plank walls or boards as at Stöng (Roussell 1943b). At Kilpheder, there is an indication of some kind of partition that could not be recognized archaeologically, where the chemical analysis of floor deposits indicated distinct differences in concentrations of phosphorus in one area of the floor (Smith *et al.* 2001). In spite of these distinctions between areas, an element of mixing of the floor deposits was evident at both Toftanes and Kilpheder (Smith *et al.* 2001), indicating that activities were not completely segregated, or that floor deposits became mixed as the occupants moved around the buildings or swept the floors.

6.2.11.4. The byre

An area of recent debate in North Atlantic archaeology is the importance of the stalling of animals through the winter. Although stalling is generally

considered to have been essential to survival in Greenland and Northern Iceland (Buckland *et al.* 1994; Dugmore *et al.* 2005), the relatively mild climate of the Faroe Islands may mean there was no need to stall the majority of animals indoors, except in particular circumstances, e.g. if they were sick (Edwards *et al.* 1998; Dugmore *et al.* 2005). Historically, animals were often housed in the same building as the human inhabitants of farmsteads in the Faroe Islands (Williamson 1948), and the practice is evident from medieval insect assemblages from Iceland and Greenland (Buckland *et al.* 1994). The interpretation of the layout of excavated Norse period farmsteads is the subject of some debate – byres are usually identified by the presence of paving down middle of room, a general lack of finds, an absence of an important fireplace and the placement of a cow path outside the house (Scott 1994). Although it has been suggested that animals were stalled in separate buildings at some sites (e.g. Stenberger 1943; Hamilton 1956; Hermanns-Auðardóttir 1992), the contemporary dating of the byres has been questioned (see, for example, Stummann Hansen 2003b).

The eastern end of House II at Toftanes was interpreted as a possible byre by the site director (Stummann Hansen 1990) due to the system of under-floor drains, some stone-built, although it does not exhibit the stone partitions commonly associated with byres (e.g. Niðri á Toft, Kvívík – Dahl 1968). If the area was used for stalling animals, it might be expected that the floor deposits would have a different composition to areas inhabited by the human occupants of the farmstead, for example the presence of hay and other fodder, bedding and animal faeces. It is difficult to distinguish hay and other animal fodder in the archaeobotanical record. Although stalled animals would have been fed on the hay produced in the nutrient-enriched, cultivated infield, this is likely to have been supplemented by fodder collected from outfield areas (e.g. stands of wild Gramineae, twigs and leafy branches – cf. Kenward and Hall 1997). In the North Atlantic, the same resources were used for a range of tasks (e.g. spreading hay on the floor to improve the surface, the use of twigs for roofing and fuel, as well as their presence in peat and turf), so the use of plants for fodder cannot be interpreted from the species alone.

At Toftanes, however, the similarity between plant macrofossil assemblages in the central and 'byre' end of House II indicates that there is no reason to infer functional differences in the use of space from the plant macrofossil assemblages. The non-seed assemblage is also made up of a similar range of material – wood (mostly *Calluna* twigs), charcoal and peat nodules (charred and non-charred). Although a high proportion of peat and/or turf might be expected in a byre (both resources are commonly used for bedding in byres in the North Atlantic – e.g. Warming 1908), there is no reason to differentiate the sample taken from the eastern end of House II from those in the central floor on the basis of their plant macrofossil content. The insect evidence from the site indicates a low number of species associated with foul waste such as dung, suggesting that animals were not stalled within any of the areas sampled at Toftanes (K. Vickers pers. comm.).

The internal areas of Toftanes have much in common with other longhouses in the North Atlantic region where organic preservation is good. The layout of the longhouse, with benches around a central longfire, is typical of Norse houses in the North Atlantic region. A thick floor layer is present, made up of various components which may have improved the atmosphere of the house. Drains and the addition of charred material to the floor may indicate attempts to manage the build-up of moisture in the living area. There is no evidence of stalling animals within the longhouse, as previously suggested (e.g. Stummann Hansen 1990).

6.2.11.5. External areas

The area surrounding the buildings at Toftanes would have been the focus of human activity, with movement through the area and its use as the location for various tasks.

Many of the samples taken from around the farmstead at Toftanes showed a considerable diversity of plant taxa, which may be the result of the area being used frequently by the inhabitants. The range of plant macrofossils was similar to those from the interior of the buildings, but a charred seed assemblage (which

was present within the houses) and beetle species characteristic of assemblages within the houses (K. Vickers pers. comm.) were virtually absent in samples from the external areas. This indicates that the source of the plant material in the outside area is unlikely to be the interior floors. Therefore, a similar range of plants and plant-based resources was being used in the internal and external areas, rather than material from household floors being dumped outside the houses.

The seed assemblage of some samples from the external areas at Toftanes was largely made up of taxa associated with wet or watery conditions or the moist outfield, including whole plants of *Sphagnum* spp. The content of these samples bore a resemblance to samples from the pre-*landnám* layer underlying the settlement, and may represent material from the underlying deposit. It is unlikely that wet, nutrient-poor conditions continued in the area immediately adjacent to the structures during occupation, as it is likely that the inhabitants would seek to drain or otherwise manage the wetter areas around the settlement, and their behaviour would not fail to enrich the surrounding area. The presence of these taxa may therefore be the result of human intervention. Peat is evident from the plant taxa and the presence of oligotrophic water beetles (K. Vickers pers. comm.) and may represent a surface laid down intentionally over a wet area of the yard. It is possible that the external areas were perceived as integral parts of the living area, and their surfaces managed in a similar way to the interior floors (as described in Section 6.2.11.3), and that activities which took place in the houses also took place outside in fair weather.

6.2.11.6. Occupation areas and middens

A comparison of the plant macrofossil and beetle assemblages recovered from Toftanes and Sondum – occupation deposits compared with midden material – indicates that both assemblages consist of material from house floors plus a range of material that was particular to each site. At Toftanes there was a greater input of species associated with peat and turf than at Sondum and, interestingly, the beetles at Toftanes included more outdoor species than indoor species. The species present at Sondum and not at Toftanes tended to be

associated with nutrient-rich (evident from the plant macrofossils) and wet foul waste (evident from the beetles) conditions, with an input of beetles associated with building interiors, peat, turf and other domestic refuse.

6.2.11.7. Abandonment

Settlement sites in the North Atlantic have often been occupied from the *landnám* to the present due to the construction of new buildings on the levelled remains of previous structures (Stummann Hansen 2002). In Iceland, research suggests that abandoned sites tend to occur when an area is no longer viable for habitation, perhaps due to a combination of factors such as landscape degradation and lack of access to resources, as in Þórsmörk (Sveinbjarnardóttir 2004). Toftanes seems to have been occupied and abandoned during the Viking or Early Norse period (Edwards *et al.* 1998). Settlement in the Leirvík area seems to have been continuous from *landnám* (Arge 1997), and it is possible that Toftanes was abandoned due to some sort of reorganisation or consolidation of settlements in the area. Deposits were identified as resulting from the 'destruction' of the settlement of Toftanes during excavation, although this should perhaps be termed abandonment as there is no indication of the intentionality implied by the term 'destruction' in the archaeological evidence. The plant macrofossil assemblage tended to consist of taxa associated with the moist outfield, nutrient-rich conditions and possibly hayfields. This is likely to represent the remains of structural turves, plus ruderals growing on the nutrient-rich abandoned site (e.g. *Stellaria media*, *Rumex* spp.). Slightly higher concentrations of moss in some samples associated with abandonment (1582; 1761), compared with samples from the floors, may represent species growing on the decaying roofs and walls of the buildings. Sample 1016, although interpreted as abandonment, is most similar in content to the floor deposit 1400, and may incorporate occupation deposits or have been mis-classified during excavation.

6.3. POST-*LANDNÁM* CONDITIONS TO AD 1500

In the longer term, there is a contrast in the histories and landscapes of Greenland on the one hand and Iceland and the Faroe Islands on the other. In Greenland, the demise of the Norse settlements led to the disappearance of annuals and the recovery of willow scrub due to lack of maintenance (Fredskild 1981), although the distinctive flora of nutrient-enriched areas such as middens and the abandoned infields of farmsteads can still be observed at the present day (Christensen 1991). In contrast, human occupation of Iceland and the Faroes has continued to the present day, with the resulting maintenance of grazed and treeless landscapes.

6.3.1. Woodland clearance

Although the Faroe Islands are unlikely to have been heavily wooded before the settlement, there is evidence for a general decrease in tree/dwarf shrub cover after the settlement. As mentioned above (Section 6.2.2), there is evidence of human intervention in tree/shrub clearance in Hovsdalur (Mairs 2003), and pollen analysis indicates a decrease in the proportion of *Betula* and *Juniperus* from Cal. AD 610, dropping to low values between AD 1460 and AD 1510, with an absence of *Juniperus* in the latter part of this period. This decline in tree/ dwarf shrub taxa is accompanied by a rise in Cyperaceae. These changes are likely to relate to human activity, possibly the establishment of summer grazing at the shieling site, Ergidali, located c. 700 m upslope from the sampling site at Hovsdalur (Edwards *et al.* 2005).

In Iceland, a range of activities would have resulted in the clearance of woodlands. Wood would have been used for construction and as a fuel, either directly or for the production of charcoal (charcoal pits are evident from the late 9^{th}-10^{th}-century onwards at Syðstamörk and other areas in South Iceland - Mairs *et al.* in press). The use of twigs and leaves as fodder, and damage to trees by grazing animals, would also have had an effect on tree cover. The removal of woodland from Reykholtsdalur was not complete, however, as indicated by charters of the church of Reykholt dated to ca. AD 1185 stating that the church

owned access to woodland (Sveinbjarnardóttir 2004). Historical records indicate that more than half of Iceland's farms still had rights of access to woodland in the eighteenth century, although managed coppice had probably replaced wild woodland. Fragments of these coppiced landscapes survive in the present day in Þórsmörk in the south of Iceland, in Hallormsstaður in the east, and in Fnjóskadalur in the north (Hallsdóttir 1987).

6.3.2. Erosion

The clearance of tree and dwarf shrub vegetation by humans, and the subsequent grazing by livestock, left the Icelandic landscape generally prone to rapid soil erosion by wind and rain (Fridriksson 1978), although this varied depending on the altitude of the land (Dugmore and Buckland 1991; Dugmore *et al.* 2000). At both Breiðabólsstadavatn 2 and Stóramörk there is evidence for erosion events dated to AD 900-1160 at Breiðabólsstadavatn 2 and beginning around AD 1477 at Stóramörk. This pattern of post-*landnám* erosion has been noted in other areas of Iceland. The area of Þórsmörk, upstream from Stóramörk, was settled in the 9th-10th-century and suffered from severe human-induced soil degradation and erosion which resulted in its abandonment in the 12th-century (Sveinbjarnardóttir 1991, 1992). Further south, a number of coastal sites relocated in the post-medieval period due to encroaching river and coastal erosion (Sveinbjarnardóttir 1991, 1992). However, the abandonment of farms was related to more factors than just soil erosion. A small number of dependent farms in Mörk endured in spite of significantly enhanced erosion from the early 10th-century, due to resource rights such as access to woodland further up the valley (Mairs *et al.* in press).

6.3.3. 'Nutrient-enriched areas' and management of the wider landscape

At Hov in the Faroe Islands, the landscape of moist and wet areas with shallow water is disturbed some time around AD 900 by an event which involved an influx of inorganic material, and increased minerogenic input to the soil is also noted further up the valley at Hovsdalur (Edwards *et al.* 2005). Although the

post-*landnám* impact of human activity and animal grazing on erosion rates in the catchment area of Hov seems to have been less severe than some pre-*landnám* erosion events (Mairs 2003; Edwards *et al.* 2005), the sample site for plant macrofossil analysis is in an area not directly covered by the survey. The influx of material may represent a localised erosion of material from grassland or heath areas, or changes in the hydrology of the river resulting in the deposition of sediments. The erosion seems to have taken place over a very short period - the dates above and below the event have ranges which overlap entirely (AD 890-1030 at both 24-25 cm and 35-36 cm). After this, conditions return to a mosaic of moist and wet areas, with areas of fresh shallow water and heath/grassland, and remain as such until AD 1500.

The expansion of nutrient-rich ruderal and infield areas is a consistent feature of pollen profiles in the Faroe Islands in the post-*landnám* period, and indicates the creation and maintenance of new habitats by the Norse (e.g. Sandoy - Lawson *et al.* 2005; Tjörnuvik - Hannon 1996; Hannon and Bradshaw 2000; Jóhansen 1971; Korkadalur - Hannon *et al.* 2001). The presence of beetles indicating animal dung at Hov (K. Vickers pers. comm.) may be the result of grazing in the area or manuring of the infield area to enrich the soil and encourage production of plant resources such as hay and barley, as is evident in other areas of the Faroes and elsewhere in the North Atlantic (Adderley and Simpson 2005).

The longer term impact of human settlement in Iceland seems to have varied from region to region, and on a local scale. The post-*landnám* conditions at Stóramörk – treeless and wet with some evidence for nutrient-enrichment and synanthropic beetle species – fit well with other pollen evidence for south Iceland (Hallsdóttir 1987). Changes in the vegetation of Reykholtsdalur, possibly due to the impact of human behaviour, do not seem to have been consistent across the landscape, both in terms of the localised plant macrofossil evidence and the wider range of pollen profiles. Although Reykholtsdalur 2, in the base of the valley, shows changes in the vegetation immediately above the *landnám* tephra, changes at Breiðabólsstadavatn 2 are not apparent until sometime after AD 900, possibly due to the abandonment of peat cutting in the

area and the succession of vegetation on the surface. There is a decrease in wood and evidence of more open conditions, changes similar to those that occurred at Stóramörk and Reykholtsdalur 2. At Háls South Pit, the process of tree and dwarf shrub clearance is more gradual, taking place in the immediate area between the *landnám* and AD 1341, and continuing in the wider area until AD 1500.

According to Dixon (1997), the priest at Reykholt remembered that areas of the valley had been maintained by regular burning when he was a child (probably in the mid-20th-century), and the improvement of grazing land by burning dead Gramineae and Cyperaceae in the spring is noted more generally in Iceland by Fridriksson (1978). A single charred *Carex nigra*-type seed was recovered from Breiðabólsstadavatn 2 in deposits that accumulated after AD 900 (dated AD 1775 to AD 1825 from the age-depth curve if the anomalous date is ignored, and assuming the area has not been cut-over or eroded). In the monolith from Breiðabólsstadavatn 2 there was no evidence of *in situ* burning (e.g. charcoal or soil discolouration), and the presence of the charred seed may be the result of the incorporation of household waste into manure for spreading (cf. Adderley and Simpson 2005). The importance of the maintenance of open landscapes in Iceland by grazing or burning, is indicated by the rapid regeneration of vegetation in areas fenced off for soil management in recent times. If *Betula* has survived in the vicinity of the fenced area, it will establish itself on nearby ground by seeding as soon as soil is partially vegetated with pioneer plants (Bjarnason 1978). The presence of charred waste in off-site samples is also evident at Tjornuvík, where macrofossils of plant species which favour nutrient-enriched conditions were accompanied by small pieces of burnt or dried peat (no attempt was made to identify these further) and an absence of evidence for *in situ* burning (Jóhansen 1971). Nodules of charred and non-charred peat were common in on-site samples from Toftanes and Sondum, and their presence in the post-*landnám* sequence at Tjornuvík may be evidence for the spreading of domestic refuse in the landscape.

The abandonment of the settlement at Háls during the 13th-century, and a shift in the use of the surrounding area for grazing, corresponds with the final

decrease in *Betula* pollen and an increase in Cyperaceae in the pollen profile. The presence of animal dung in the area, either as a result of the presence of grazing animals or the application of manure to improve yields, is a development not evident in earlier periods. This shift in landscape usage, from permanent settlement to grazing, is mirrored in other areas of Iceland, such as Vaðbrekka in Hrafnkellsdalur in the interior of Eastern Iceland. Pollen profiles indicate the Vaðbrekka farm was abandoned some time before AD 1158, although grazing activity continued, possibly focussed on a shieling (Hallsdóttir 1987).

CHAPTER 7: CONCLUSION

The research presented in this thesis has shed light on the plant-based economy of the settlement of Iceland and the Faroe Islands by the Norse during the 9th- and 10th-centuries AD, and the impact the settlers' behaviour had on the local plant communities in the period until AD 1500. These investigations have added greatly to the amount of data available, including the first extensive analysis of well-preserved plant macrofossil assemblages from a settlement site in the Faroe Islands. Using archaeological data from a range of contexts, it is possible to address the original research questions outlined in Section 1.2.

7.1. WHAT WERE THE 'NATURAL' LANDSCAPE AND ENVIRONMENT CONDITIONS OF ICELAND AND THE FAROES LIKE WHEN THE NORSE ARRIVED?

Archaeobotanical analysis has indicated that vegetation in the Faroe Islands and Iceland during the period from AD 500 to the Norse *landnám* consisted of a mosaic of acidic, nutrient poor wetland, grassland or heath in the valley bottoms. The Faroes did not exhibit heavy tree cover at the time of the Norse settlement, which was ideal for the creation of extensive grazing areas. In Iceland (and Greenland), open areas or areas of sparse *Betula* and *Salix* woodland would have been ideal for the construction of the initial settlement, and woodland could be cleared in the surrounding area for grazing.

7.2. WHAT WAS THE IMPACT OF HUMAN ACTIVITY ON THE LANDSCAPE AND ENVIRONMENT OF THE SETTLED AREAS?

The North Atlantic Islands were part of a continuous Norse settlement stretching from the Scandinavian homelands as far as Greenland and eventually Newfoundland. The effects of the Norse *landnám* on plant communities in the region can be seen in both the 'on-site' and 'off-site' samples.

7.2.1. The date of *landnám* in the Faroe Islands

The evidence for pre-Norse changes in the landscape of the Faroe Islands after about AD 467-650 is in keeping with previous pollen analysis from the islands. This adds to the body of evidence in support of some kind of human activity on the Islands prior to the Norse *landnám*.

7.2.2. Woodland clearance

The pre-settlement degree of tree cover varied across the North Atlantic islands, from the relatively open Faroes to the thicker woodland of Iceland and Greenland. Extensive grazing areas were necessary for the settling farmers, and provided one incentive for opening up the landscape, and the collection of wood for fuel and construction materials would also have had an effect on the virgin woodland, although the impact human activity had on the vegetation surrounding the settlement varied from place to place. The method of tree clearance seems to have varied, with evidence for manual clearance (with cutting tools) in the Faroe Islands, and burning in some areas of Iceland and Greenland. The choice of method would have been governed by a number of factors, including the density of the forest, the amount of labour available and whether the wood needed to be used for another purpose once the land was cleared. It is necessary to investigate landscape clearance at both local and regional scales, and evidence to date suggests a complex combination of different landscape management strategies with different functions throughout the region. The evidence for the use of fire in several regions of Iceland and Greenland indicates that the opening of the landscape to increase the potential for hay production and grazing was the major motivation in removing the tree cover, and that woodland was thick enough that burning was possible and more efficient than manual clearance.

7.3. WHAT PLANTS WERE BROUGHT BY THE SETTLERS, EITHER AS DELIBERATE IMPORTS OR ACCIDENTALLY?

7.3.1. Plant use – food

The range of plant foods exploited across the North Atlantic islands is far narrower than in southern Scandinavia and the Scottish Islands, probably due to a variety of factors. The shorter growing season and cooler temperatures of the North Atlantic make conditions less favourable than in Scotland and southern Scandinavia for cereal production, while the economic focus on animal production and absence of proto-urban centres with craft specialists means that there was not a stimulus to intensify production. The only crop for which there is widespread evidence is *Hordeum vulgare* which was introduced to the Faroe Islands and Iceland (though not in the north of the island), and it seems it was locally cultivated. *Hordeum vulgare* was possibly accompanied by *Avena* (represented by a single seed). The pattern of local production of grain in the Norse period, followed by later imports is is seen at both Toftanes (Faroes) and Bessastaðir (Iceland). There is, as yet, no evidence for the cultivation of cereals in Greenland.

Corylus avellana (hazel) nut shell was recovered from House II at Toftanes and may have been a resource imported from mainland Europe. Though there is evidence that it grew locally (a hazel trunk with basal cut marks, as well as nuts, was found in the refuse layer at the shieling site of Argisbrekka)

There is as yet no evidence in the Faroe Islands or Iceland for the introduction of several crops (e.g. flax and rye) or other useful plants (e.g. dyeplants) found in Scandinavia and the Norse areas of influence in Scotland and Ireland. This may be due to differences in economic structure (the provision of surplus to feed craft specialists in proto-urban settlements in Scandinavia and Britain versus the farmstead-based economy in the North Atlantic Islands), or may be the result of the small amount of archaeobotanical work done on the North Atlantic Islands.

Berries were exploited throughout the region, but at Toftanes and Sondum, as well as several other sites in Iceland, it is surprising that crowberry is the only type of fruit present. Although this may be the result of poor preservation or recovery techniques, it is also possible that wild plants were perceived as low-status foods, and were not extensively exploited in the resource-rich years following the *landnám.* Imported exotic foods are not documented in the North Atlantic Islands until well after the *landnám* period.

7.3.2. Plant use - medicinal and industrial

The settlers were probably aware of the medicinal use of plants, and the similarity of the flora of the North Atlantic islands to other areas of Norse influence would have meant that their knowledge could have been easily transferred to the new environments. The absence of proto-urban centres and the need to support craft specialists in the North Atlantic islands meant that the economies of the region may have differed from those in other areas of Norse influence. It is likely that the Faroes and Iceland traded wool or other products for items that were not produced locally (e.g. metal tools). The lack of archaeobotanical evidence for plants used in dyeing is likely to be the result of the small number of plant macrofossil assemblages that have been analysed and the fact that some taxa (e.g. lichens) are highly unlikely to survive archaeologically. The production of woollen cloth is likely to have been a feature of the economy.

7.3.3. Introduction of wild plant species

As well as the introduction of crops, such as *Hordeum* and *Corylus*, viable seeds of wild plants were accidentally introduced to the North Atlantic islands by the settlers. In the landscape, the introduced plants became a feature of the new ecological niche associated with human activity – crop weeds, fodder plants and ruderals – and were usually found in nutrient-rich areas around the settlement and infields.

7.4. HOW WAS THE LOCAL ENVIRONMENT ADAPTED TO SUIT THE NORSE ECONOMIC SYSTEM, AND HOW WERE THE ECONOMIC SYSTEM AND LIVING CONDITIONS ADAPTED TO MEET THE ENVIRONMENT OF THE NEWLY SETTLED AREAS?

The settlers introduced their economic system to the newly settled areas and brought with them ideas of building construction and living space. On their arrival in the Faroe Islands and Iceland, they were able to adapt the pristine environments to suit these needs to a certain extent. In turn, constraints of the new environments necesitated changes in their techniques, resulting in practices particularly adapted to the newly settled areas.

7.4.1. Animal production

The central role of domestic animal production in the Norse economy meant that extensive grazing areas were required. Trees and dwarf shrubs were cleared from the landscape, and these open spaces would have been maintained by the damage to fresh tree and dwarf shrub growth by grazing animals. The resulting landscape was a mosaic of conditions in the cleared areas, with Gramineae and Cyperaceae dominating the vegetation, areas of bog and heath, and an absence of tall herbs. The production of hay and collection of fodder to overwinter livestock increased the carrying capacity of the area, and was more important in the colder climates of Iceland and Greenland than in the Faroe Islands. Hay was grown in the enriched infields, and would have been collected opportunistically in the outfield area. Other fodder, such as twigs and leaves, would also have been used to support the herd, and would have had an impact on tree and dwarf shrub growth.

7.4.2. Soils – nutrient enrichment and management

Human activity on the North Atlantic islands had an impact on the soils in a variety of ways. New nutrient-enriched habitats were created as an incidental result of activities such as middening around the settlements (e.g. Sondum), and

due to the purposeful enrichment and/or drainage of soils to increase plant production. These areas supported a range of plant species associated with nitrogen-enriched conditions, including many of the wild plants that were accidentally introduced by the settlers. Soil wetness is likely to have been managed in some areas to improve plant yields, although was not inidcated in any of the sites studied in this research.

7.4.3. Fuel

Although the main source of fuel in the Scandinavian homelands, wood, was limited in the Faroe Islands and Iceland, the settlers took advantage of the wide range of potential fuels available in the North Atlantic islands at the time of settlement. There is evidence that wood and twigs, peat, turf and seaweed were all burnt. The collection of wood and twigs for fuel would have had an impact on tree and dwarf shrub cover. Although techniques of forest management were known in the Scandinavian homelands, the very different nature of the woodland in the newly settled areas may have meant that these techniques were no longer appropriate to maintain woodland communities in the long-term. Peat cutting for fuel and flooring would have disrupted the plant communtites in the landscape, leaving areas stripped of the growing layer. The animal-based economy of the settlers provided further potential fuels, including dung and bone.

7.4.4. Woodworking - the role of local wood, imported wood and driftwood

There seems to be a broad pattern in the use of imported wood and driftwood in contrast to local wood across the North Atlantic islands, with driftwood and imported wood being used for construction and the production of household objects, and local wood for fuel and other uses. This may be the result of practical considerations – with driftwood and imported wood being available as more suitable timbers for construction and the production of large objects while the smaller trunks of local wood were more suitable for fuel and smaller objects. The cost of imported woods, and the ability to access boats for import,

is likely to have meant that this resource was only available to the richer landholders. Although driftwood would have been common at the time of settlement, access was controlled in later years by laws, in a similar way that access to remaining woodland was controlled. The ability to access these resources was based on land ownership, and would have excluded poorer farmers.

7.4.5. Outfield resources for building

In areas of Norse influence where local timber was not available, building techniques were adapted to provide warm, windproof structures using local turf and stone, combined with imported wood or driftwood. The considerable degree of similarity in house plans across the North Atlantic region seems to constitute a marker of cultural homogeneity in the settlement period. The occupation of Toftanes during the Viking/Early Norse period seems to have been typical of Norse settlements in the North Atlantic in terms of the architecture of the buildings and the living conditions of the inhabitants.

7.4.6. Living conditions

Toftanes is the first settlement site in the Faroe Islands where the plant macrofossil assemblage has been analysed and the material recovered bore similarities to assemblages from comparable sites found across the region. The use of plant material, peat and/or turf for flooring and the incorportation of twigs and chipped wood into floor deposits has parallels in sites in Scandinavia, Iceland and Greenland. The generally uniform content of the plant macrofossil assemblages across the site (especially in Building I and the central area of House II, but also in the eastern end interpreted as a byre during excavation) indicates that all areas were used in the same way, that deposits were mixed, or both. The different composition of plant macrofossil assemblages in the west end of House II, around the fireplace, indicates that different activities took place in this area, or that differences in the construction of the building resulted in the input of different material. A similar range of plant materials seems to have been used in the external areas of the settlement as in the buildings.

At Toftanes, domesticated resources seem to have been supplemented by wild plant and marine resources such as berries (and shellfish), and seaweed may have been used as a fuel or to produce salt.

7.5. WHAT WERE THE LONGER-TERM EFFECTS ON THE LANDSCAPE AND ENVIRONMENT OF THE NORSE SETTLEMENT AND DID THEY NECESSARILY LEAD TO LANDSCAPE DEGRADATION AND ABANDONMENT?

The longer term impact of the settlement of the North Atlantic Islands had a different impact depending on local conditions and activity. In the period from the settlement to ca. AD 1500 further changes to the landscape of the Faroe Islands and Iceland took place. The enrichment of soils in the area surrounding the settlements, continuing deforestation to increase areas suitable for grazing and the management of remaining woodland areas were governed by the intensity of human activity, the amount of labour available and the length of the period of human occupation. The result of these activities included landscape degradation, the severity of which varied across time and space. In some cases it was severe enough to result, with the addition of social restrictions governing access to resources, in the abandonment of areas previously settled. The climatic cooling of the Little Ice Age began about AD 1350 and reduced the vegetation growing season, affecting hay yields and herd size.

7.6 FURTHER WORK

Due to the fact so little research has been done in the North Atlantic Islands, there is great potential for further work in this field.

Thegrowing body of evidence from pollen and other analyses for a pre-Norse settlement of the Faroe Islands certainly warrants attention. Consolidation of the existing evidence would seem to be useful at this point, with further

investigations in areas that have been previously neglected, or for which the dates have been questioned.

In terms of investigations of Norse settlements, the full excavation of a complete settlement and its surrounding area would greatly increase our knowledge. This would establish the relationship between different deposits within the same settlement (e.g. taphonomic relationship between living floors, middens and infields). High-resolution sampling of the area using a variety of techniques (c.f. the ongoing work of H. Smith and K. Milek) would enable detailed analysis of the use-of-space within the settlement to take place. The extent of the impact of the settlement on the surrounding infield and outfield could also be assessed. A sound understanding of the processes within one site would also further our understanding of sites already excavated (e.g. Sondm midden, where the associated settlement has not been excavated).

Further work could also be carried out to increase our understanding of the sites investigated here. At Toftanes and Sondum, the nodules of peat and/or dung that have been recovered warrant further investigation. They are ubiquitous at the site, and occur charred and uncharred, indicating this resource was used for fuel. If these nodules were identified as dung, it would give us a further insight into the cycling of material within the settlement. If they represent peat, this would confirm the exploitation of another outfield resource by the inhabitants of the settlements.

7.7 CONCLUDING COMMENTS

The plant macrofossil assemblages analysed in this thesis have shed further light on the vegetation of the Faroe Islands and Iceland before they were settled by humans, the ways in which plant resources were used by the settlers and the short- and long-term impact this had on vegetation communities in the surrounding area. Some of the interpretation is in keeping with patterns already recognised in the region (e.g. an early date for human impact in the Faroe Islands), and add important weight to these arguments. Others (e.g. the spatial distribution of plant macrofossils in and around the settlement at Toftanes) have

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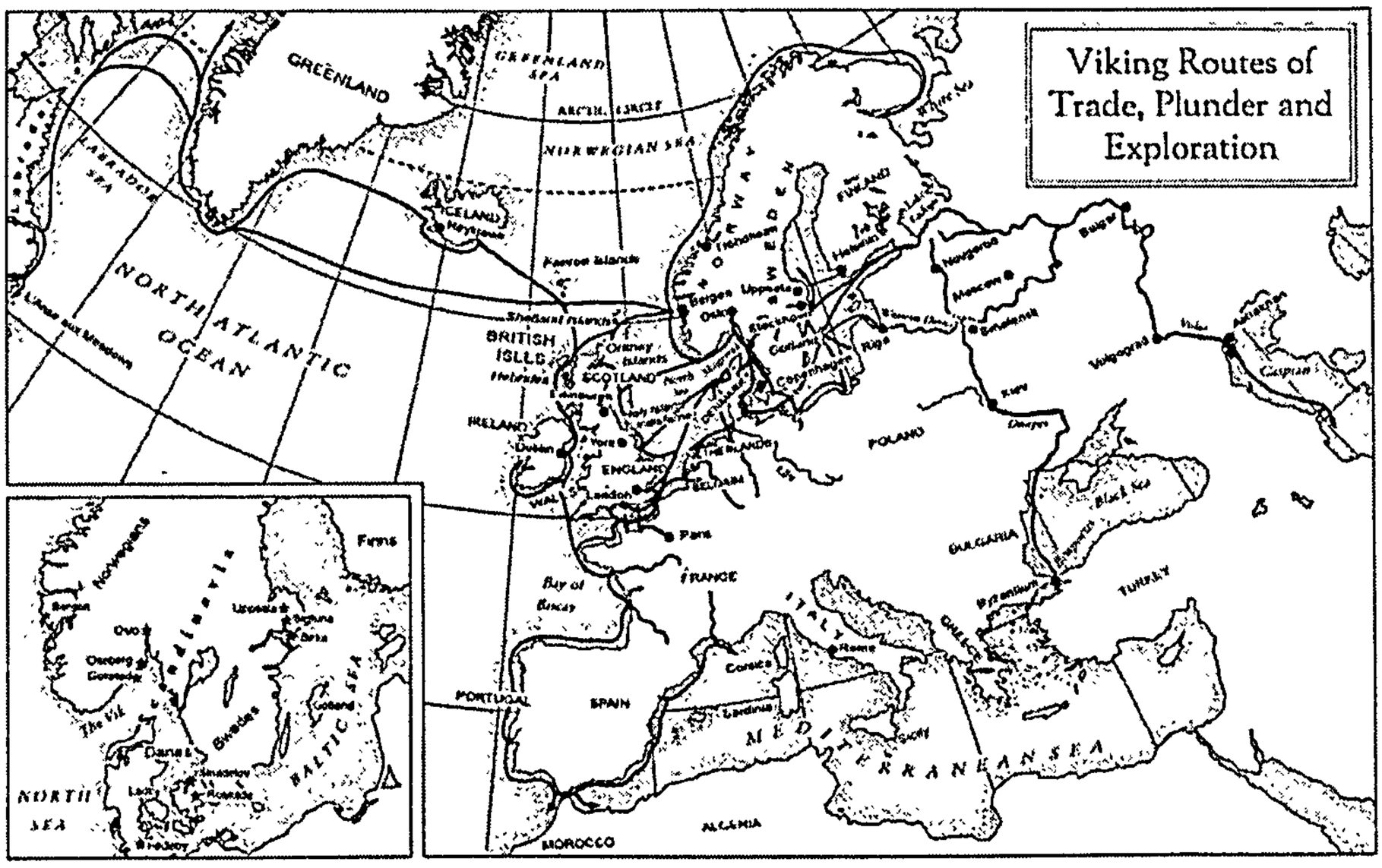

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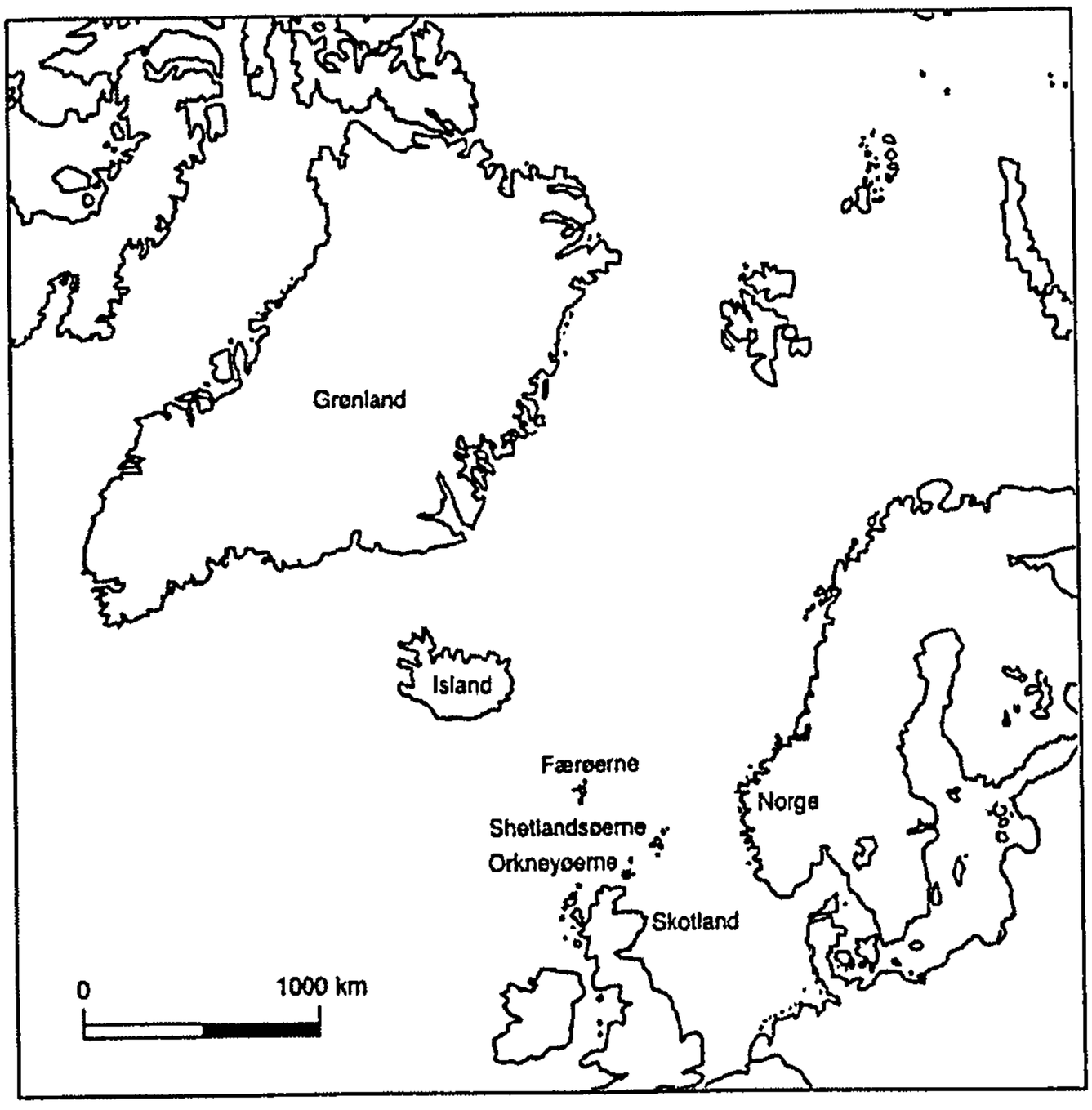

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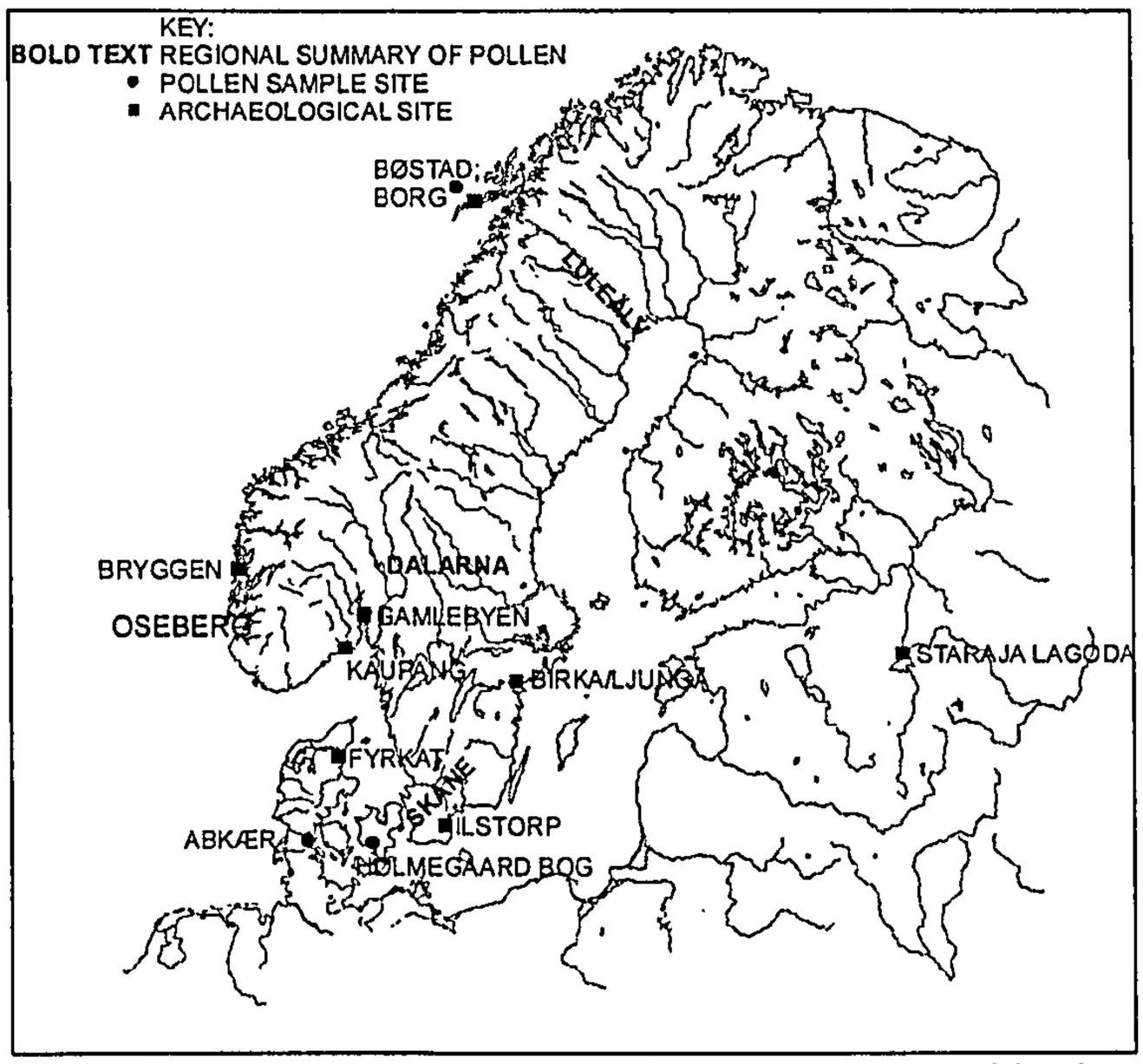

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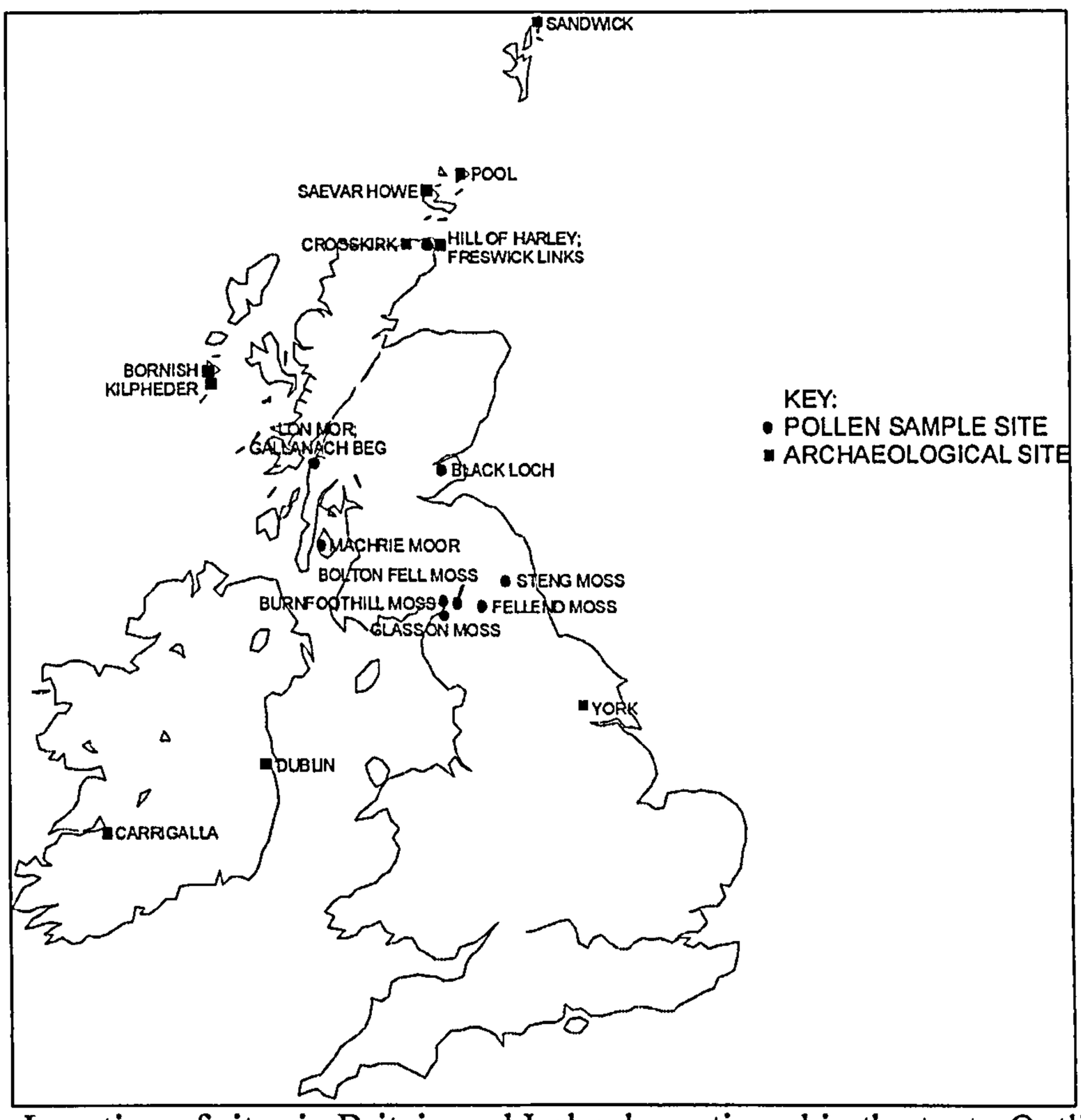

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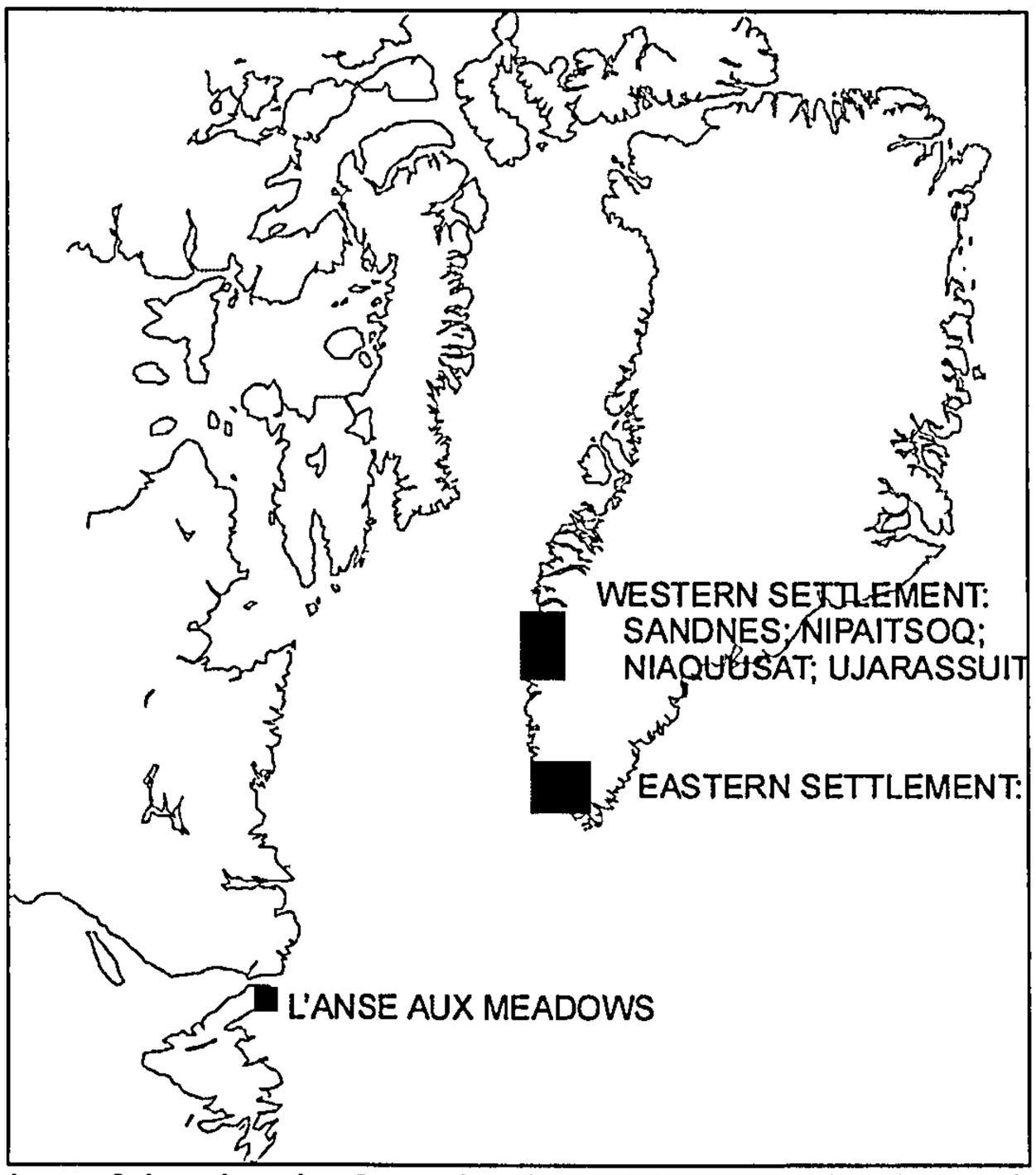

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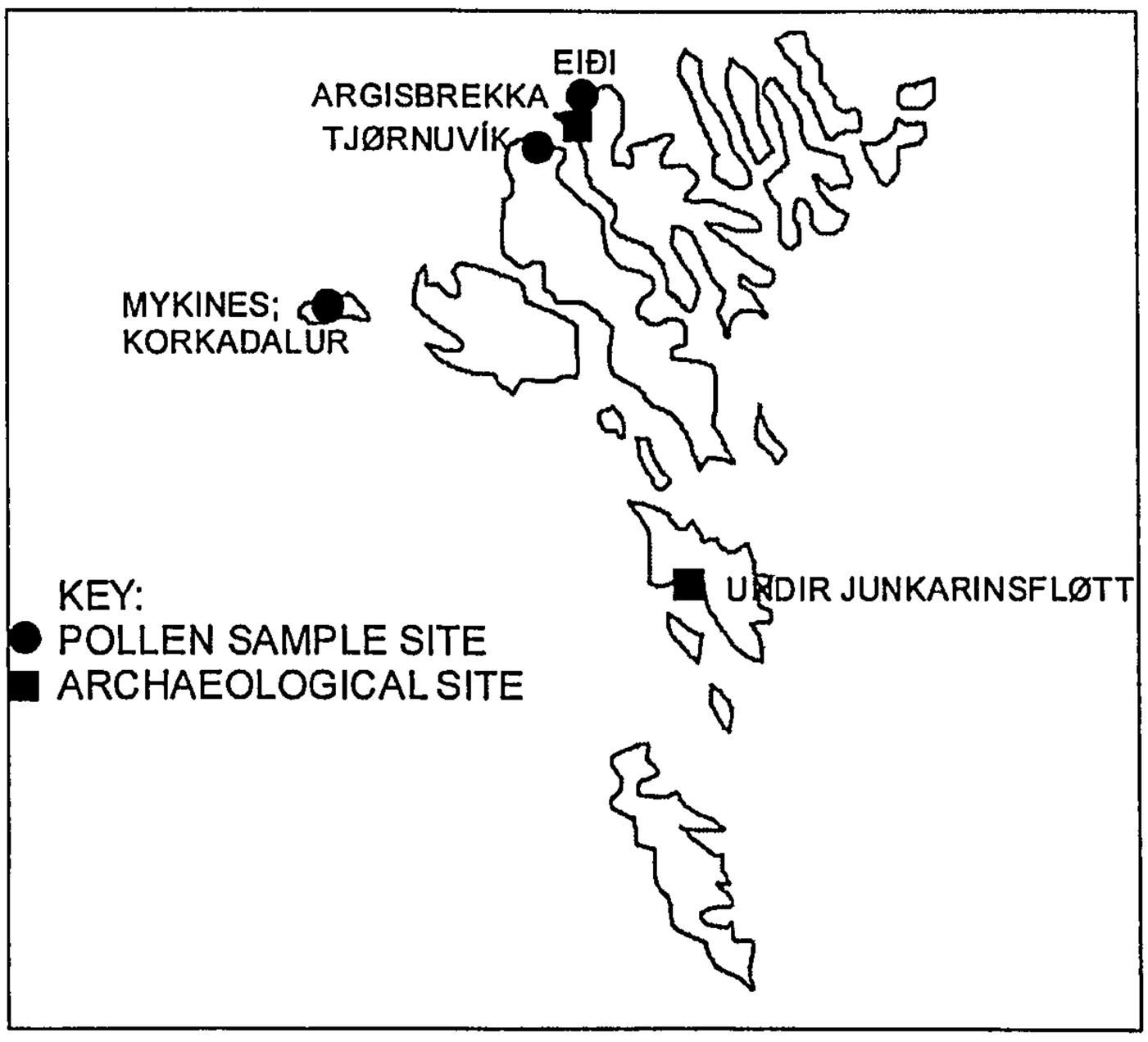

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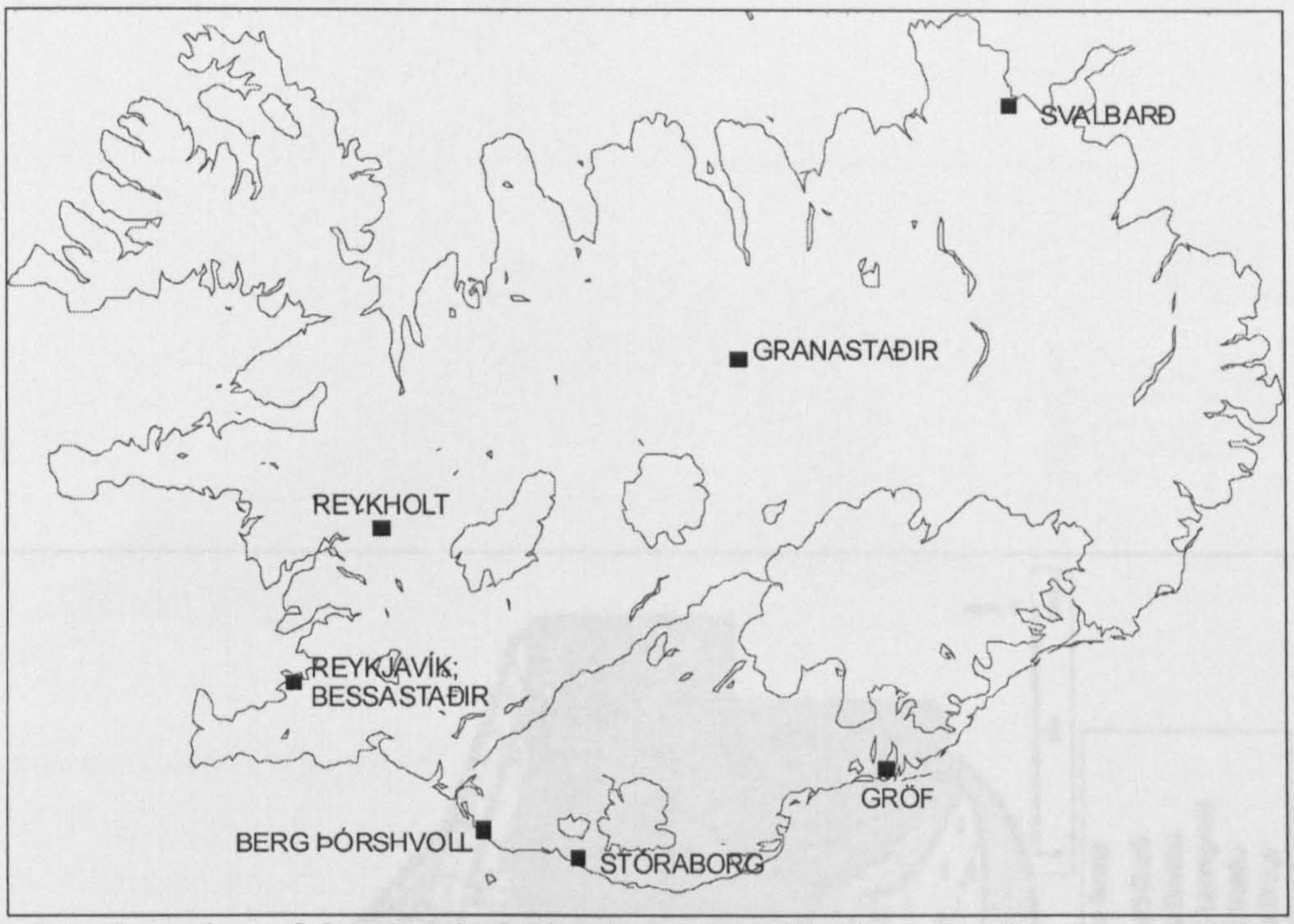

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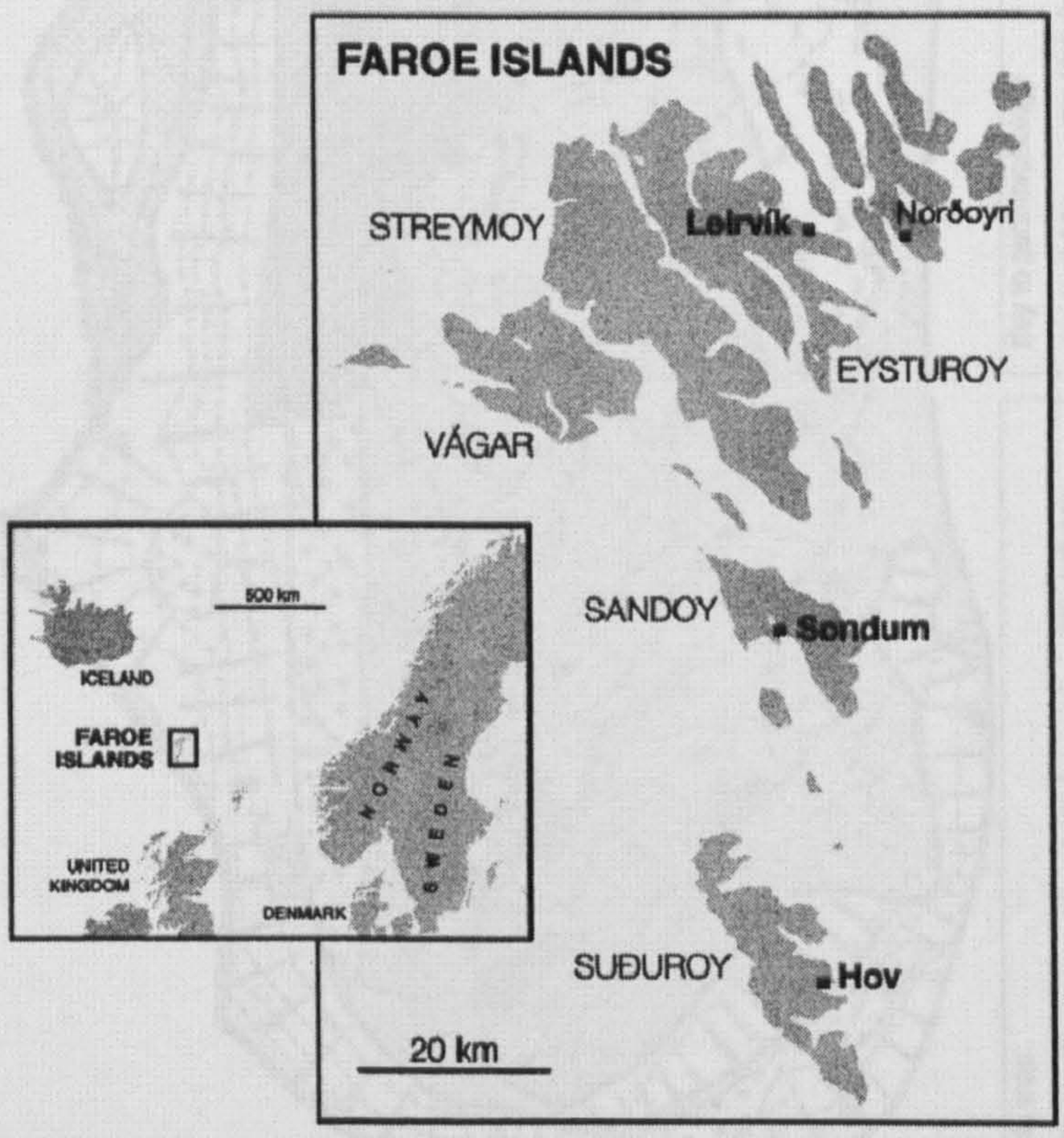

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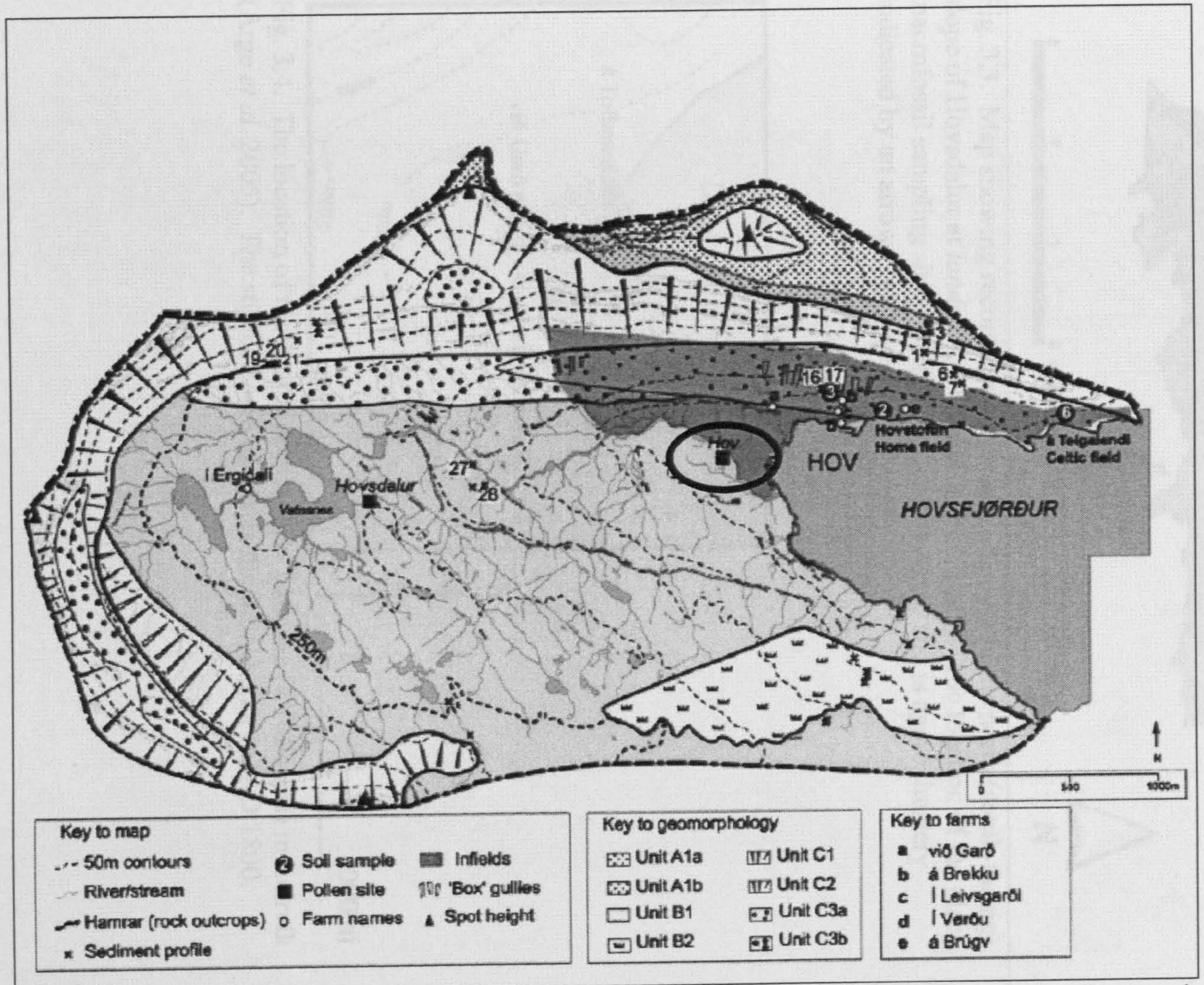

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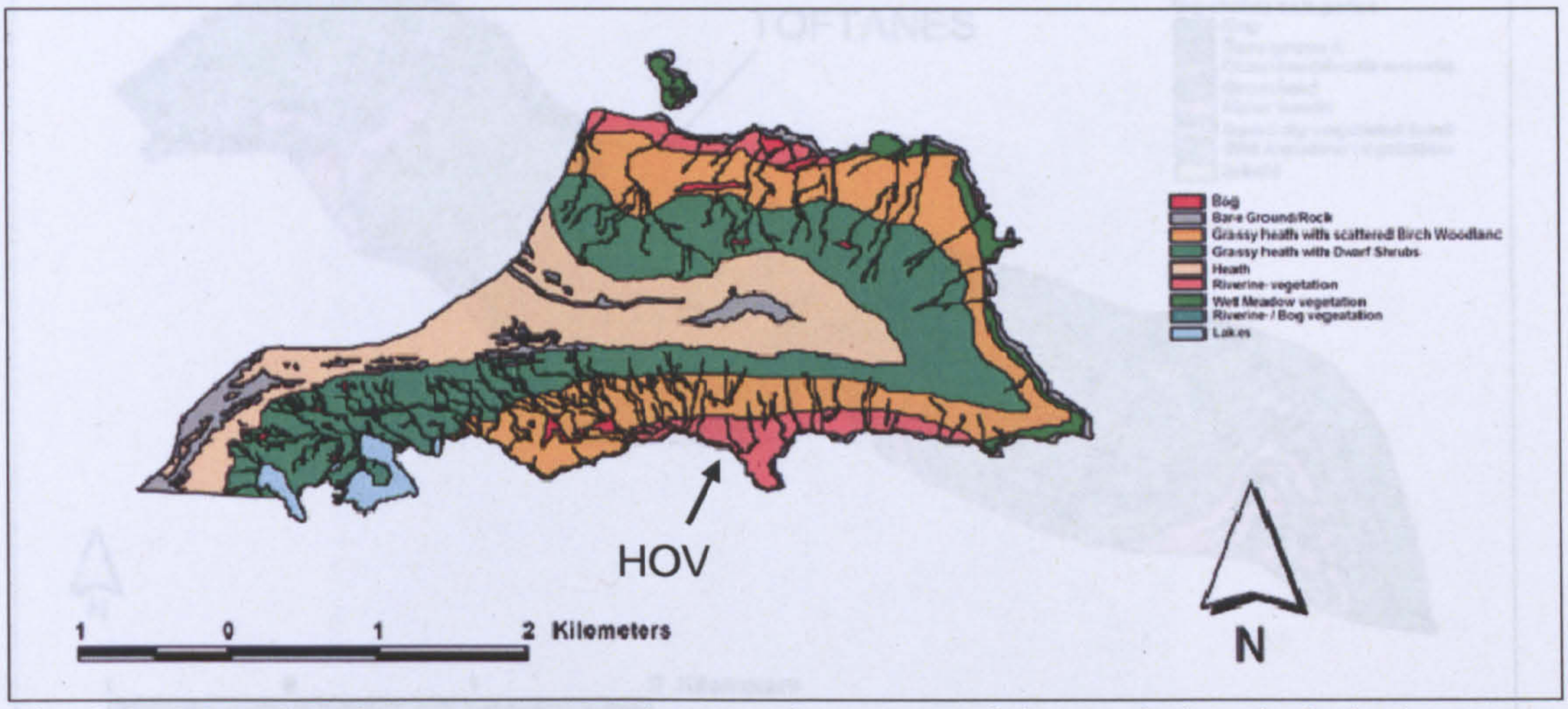

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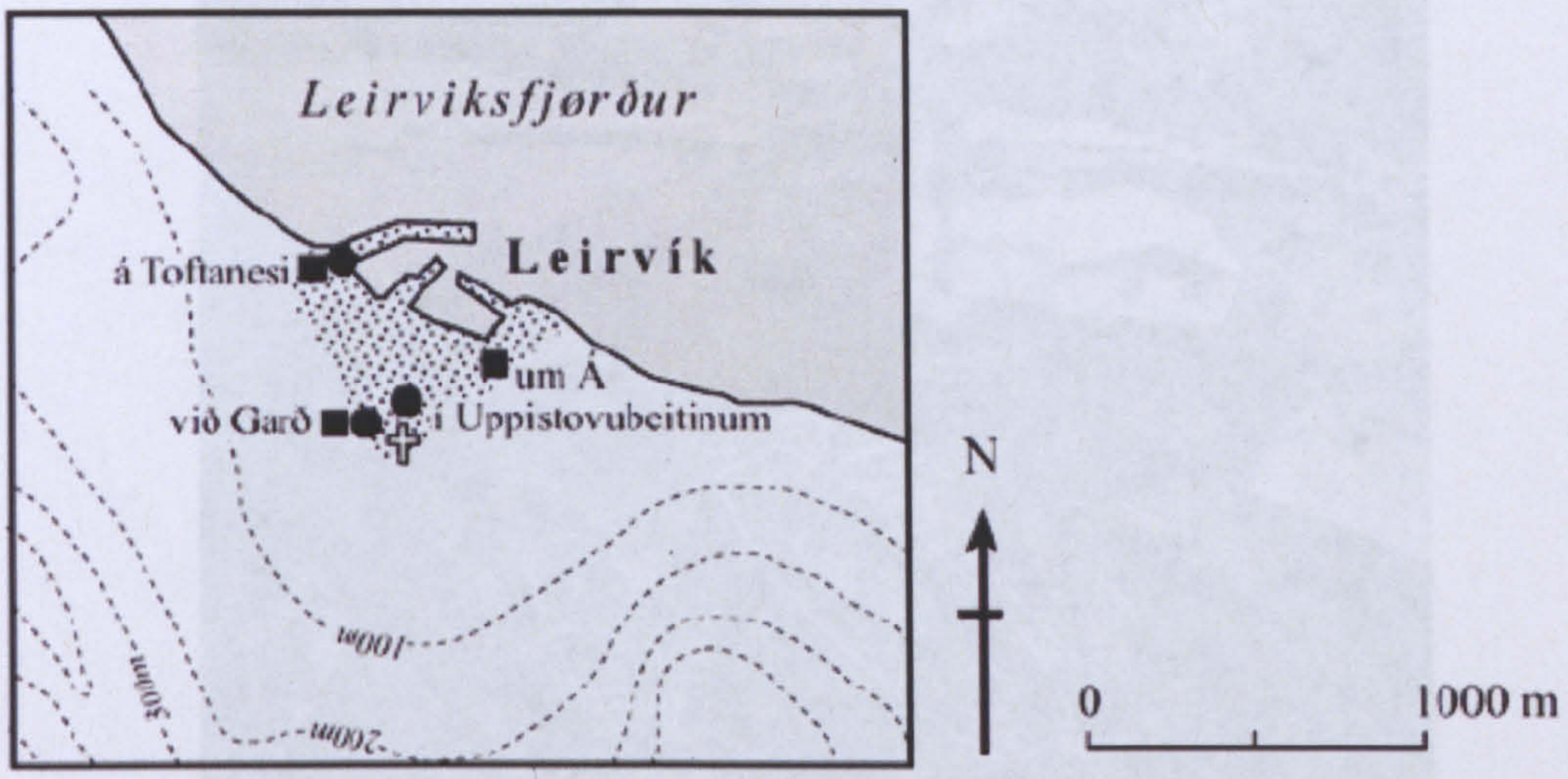

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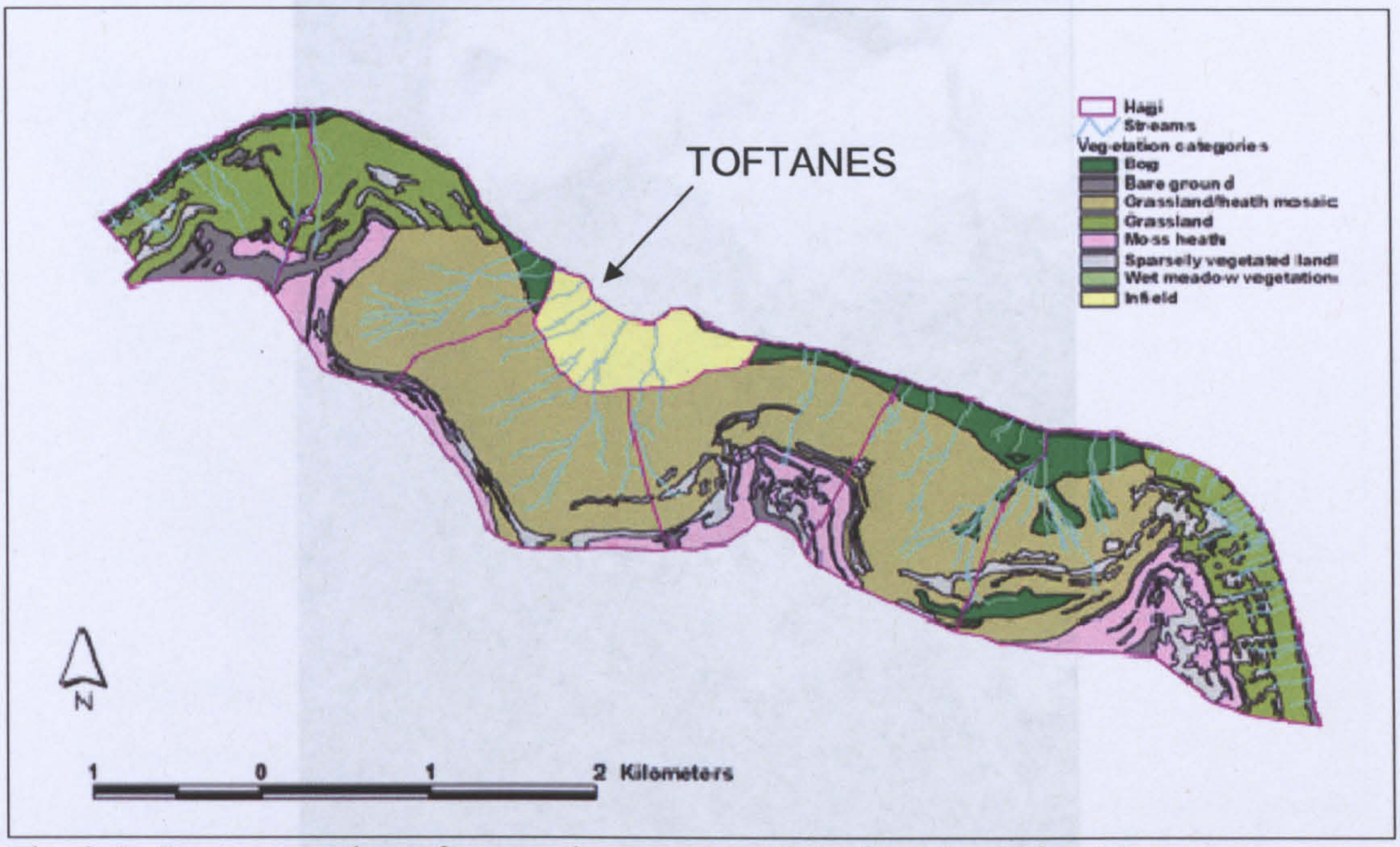

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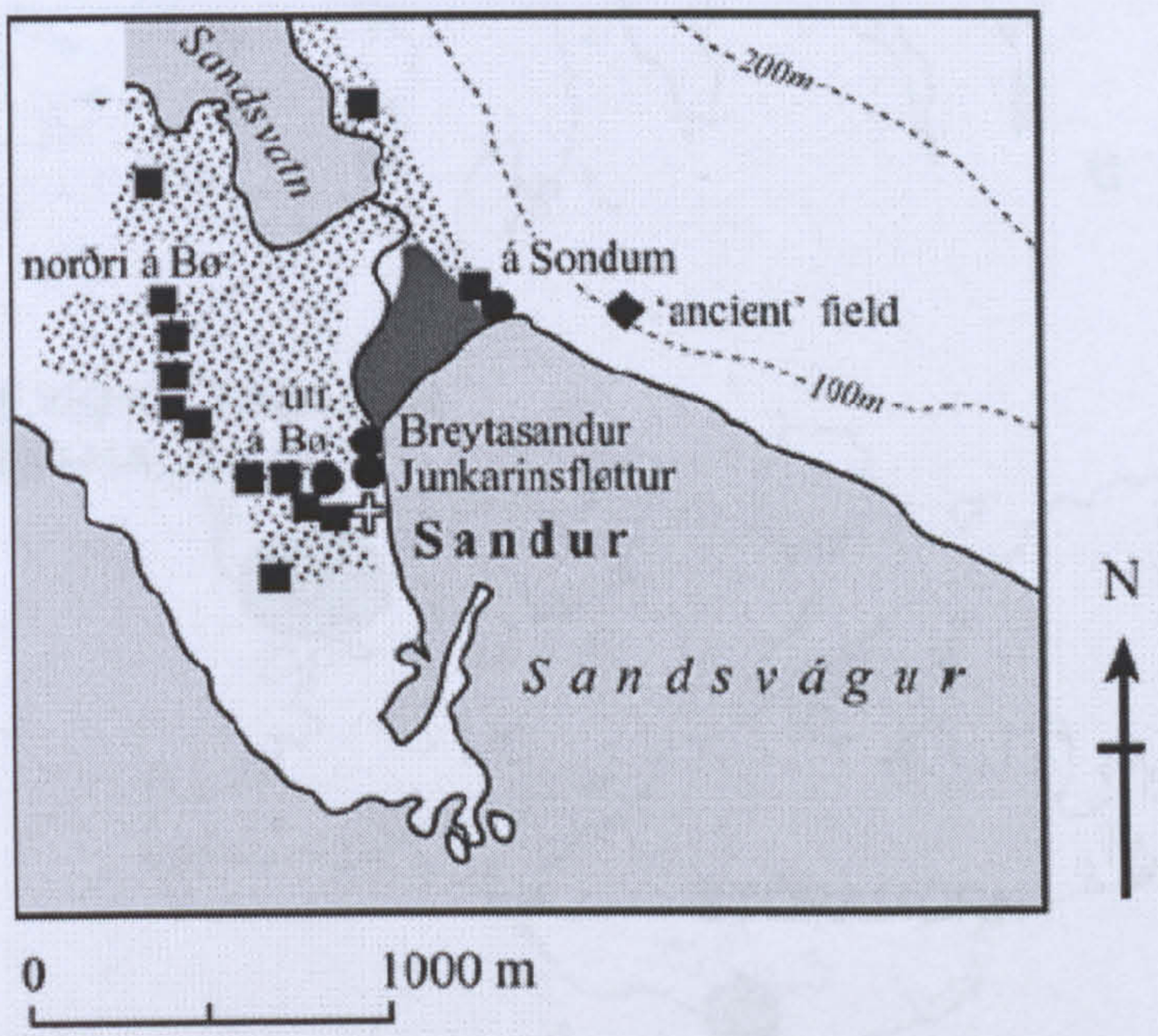

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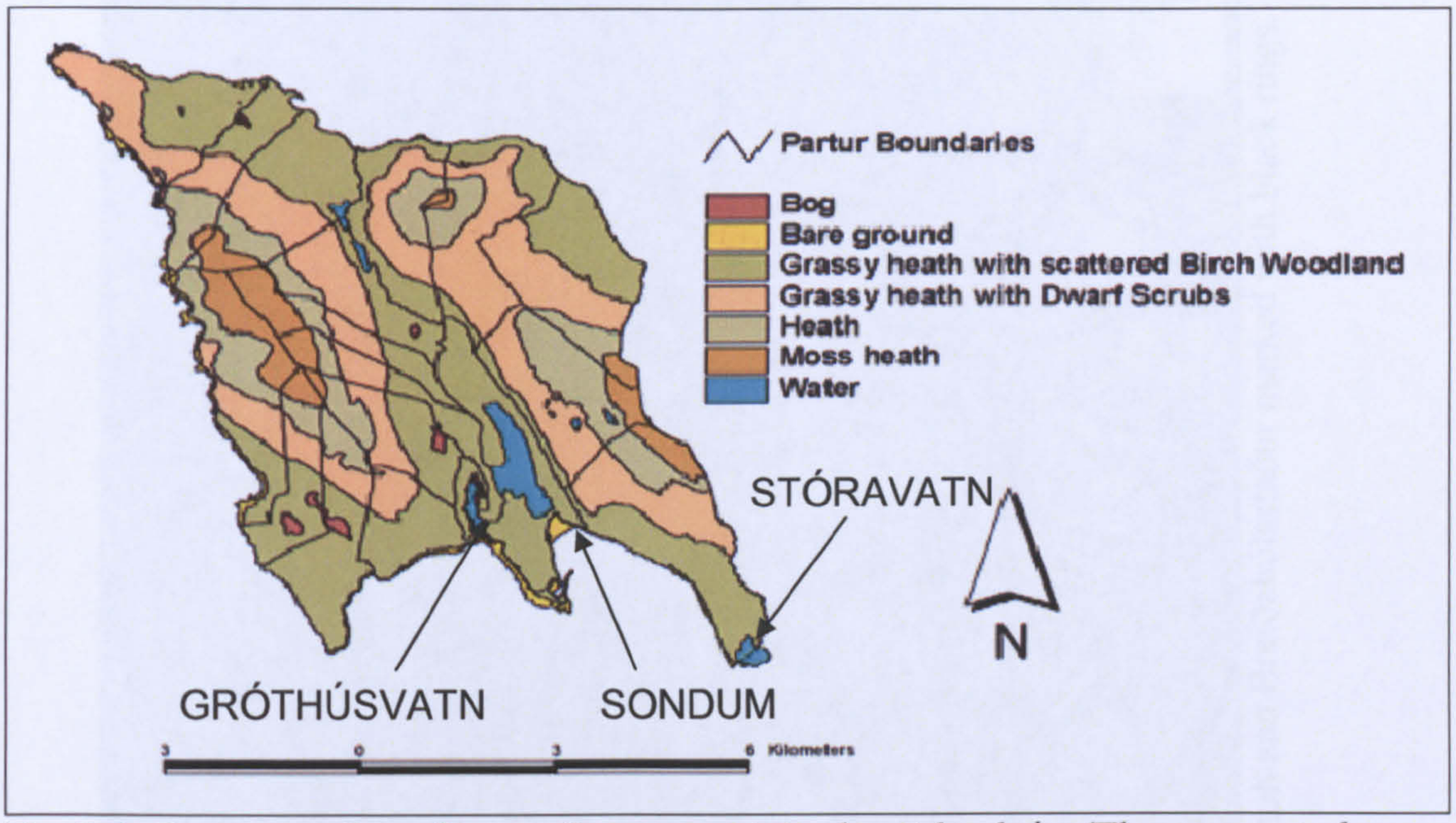

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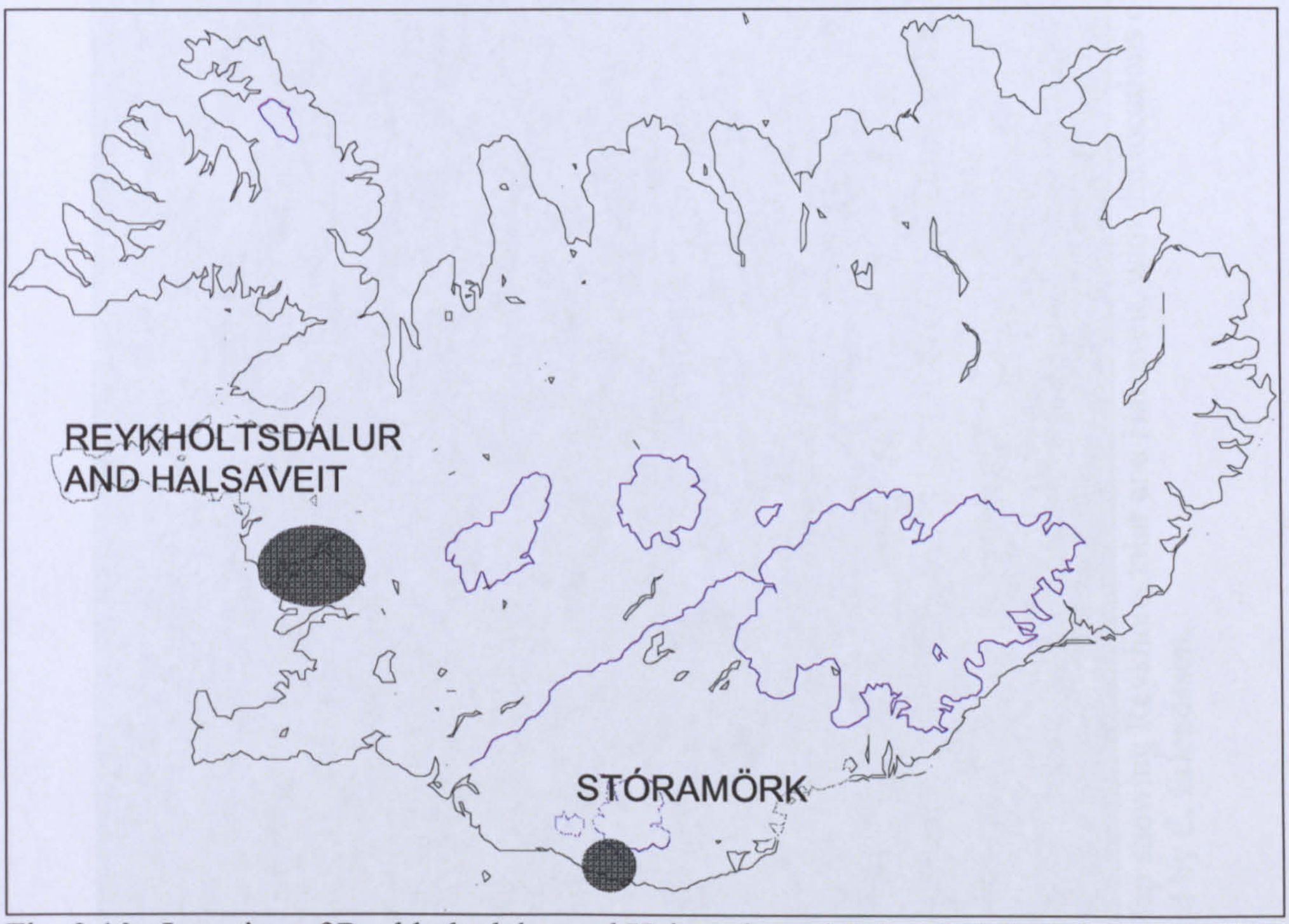

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a)

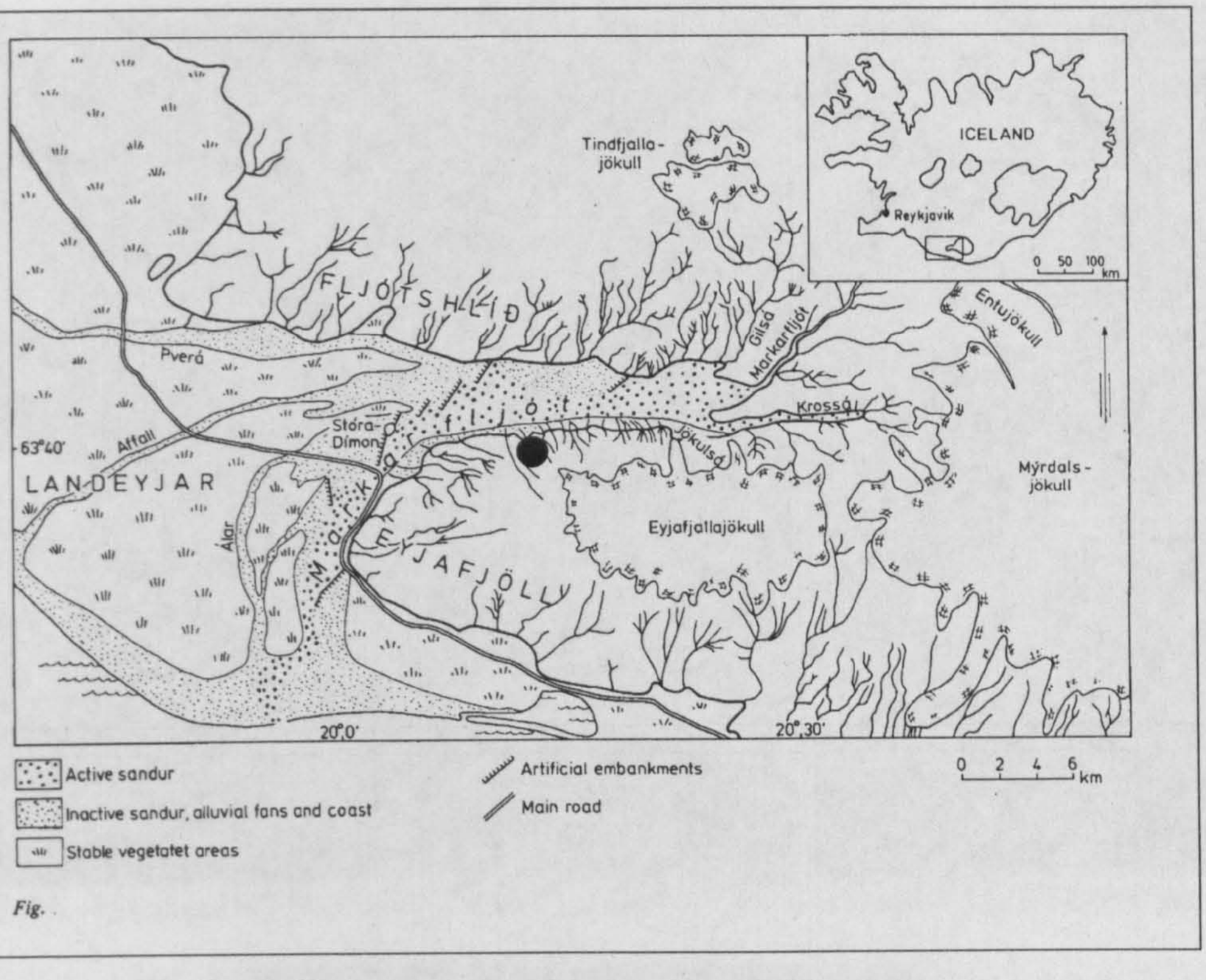
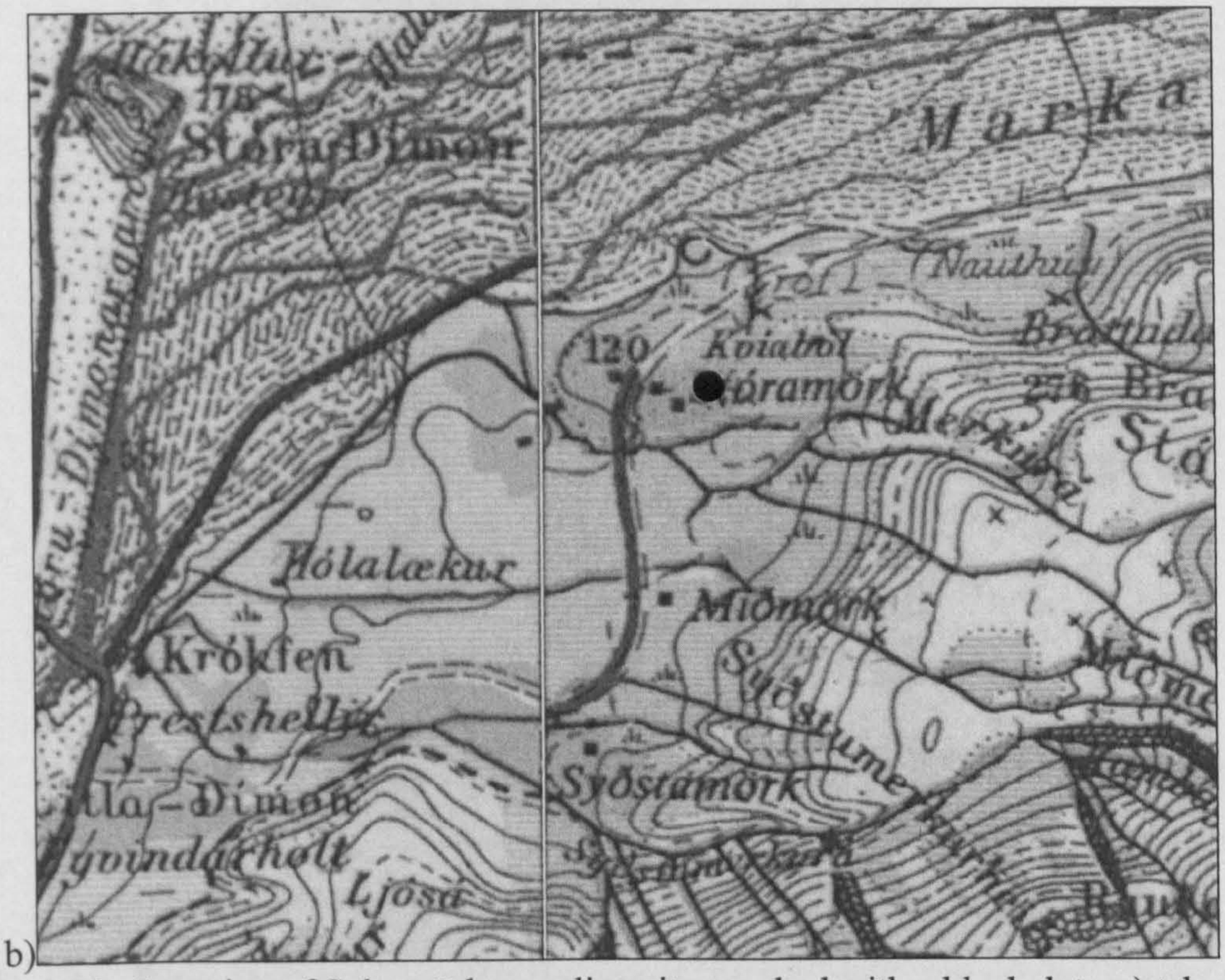


Fig.

b)



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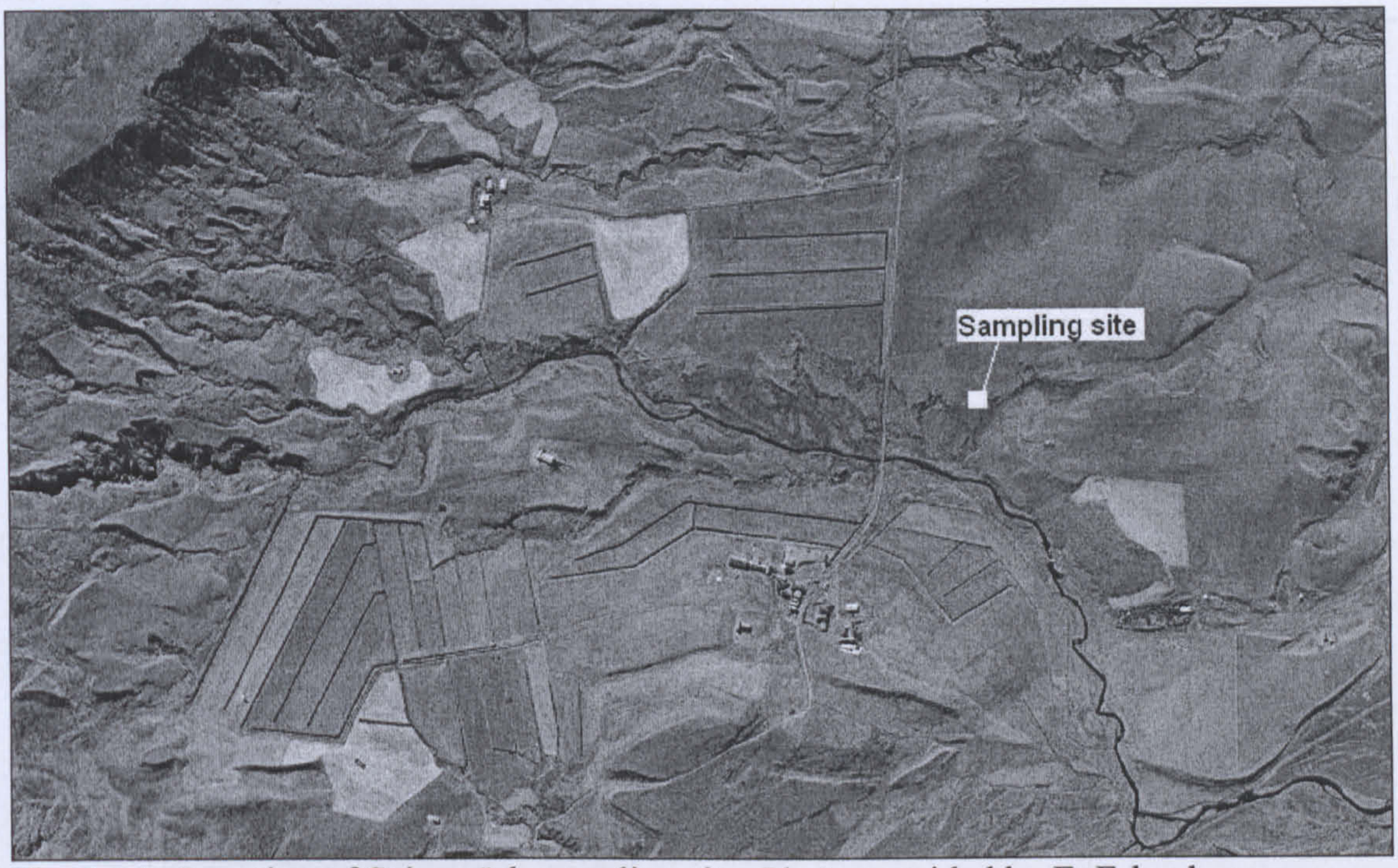

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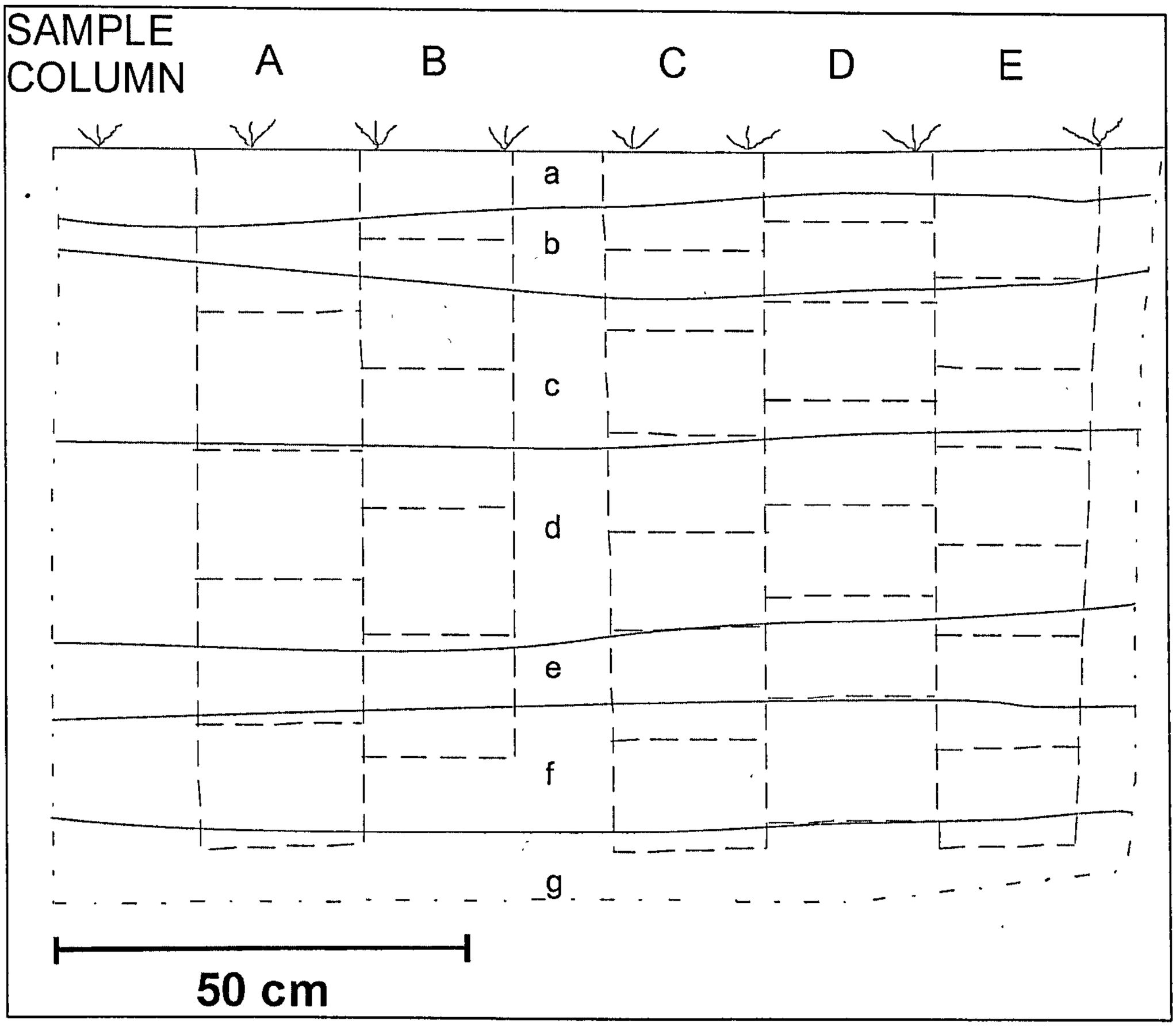
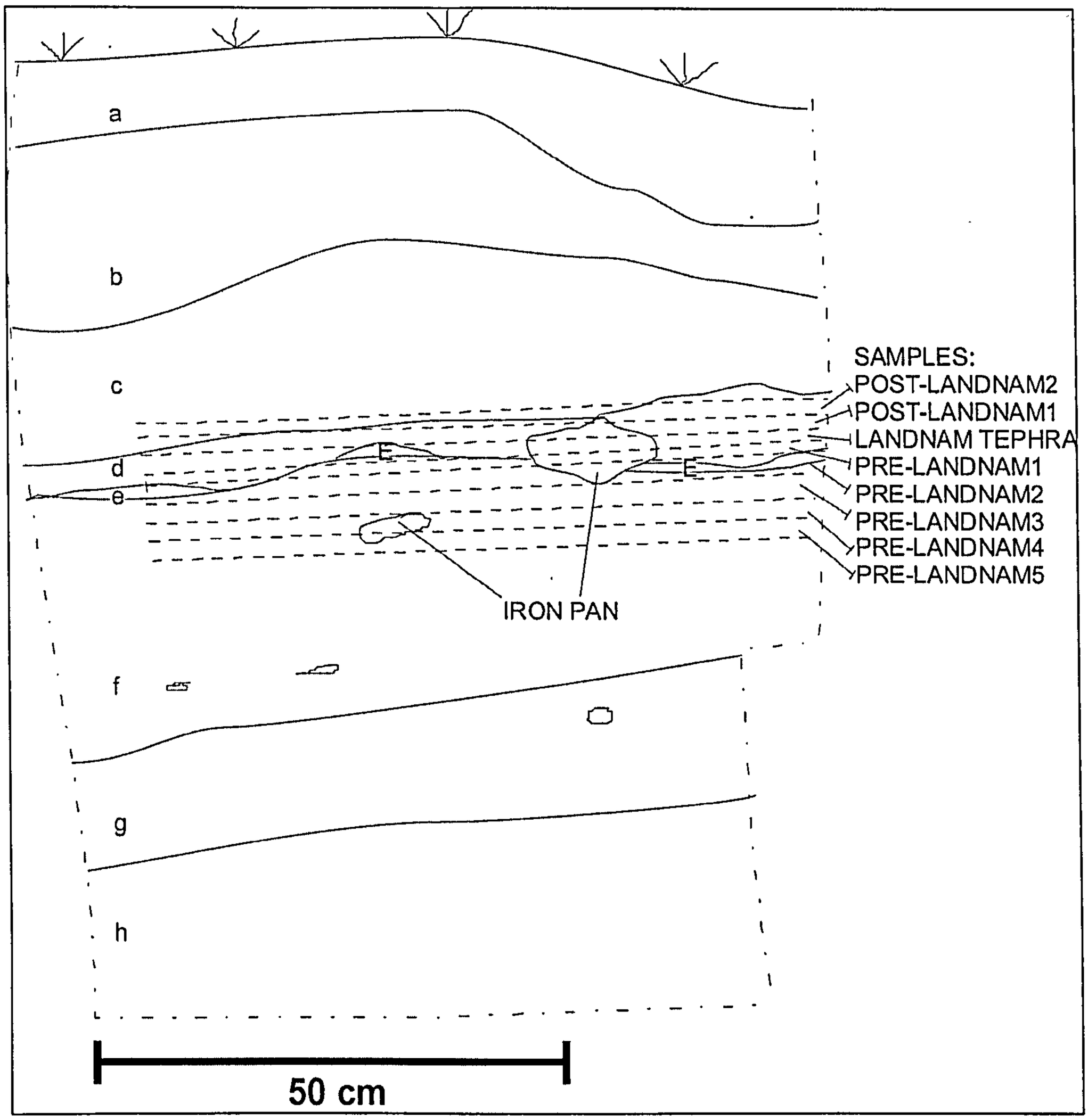


Fig. 4.1. Section drawing of Hov monolith. Dashed line indicates position of sample block cuts. See Table 4.1 for description of sediments. (Drawing made in the field by K. Vickers).



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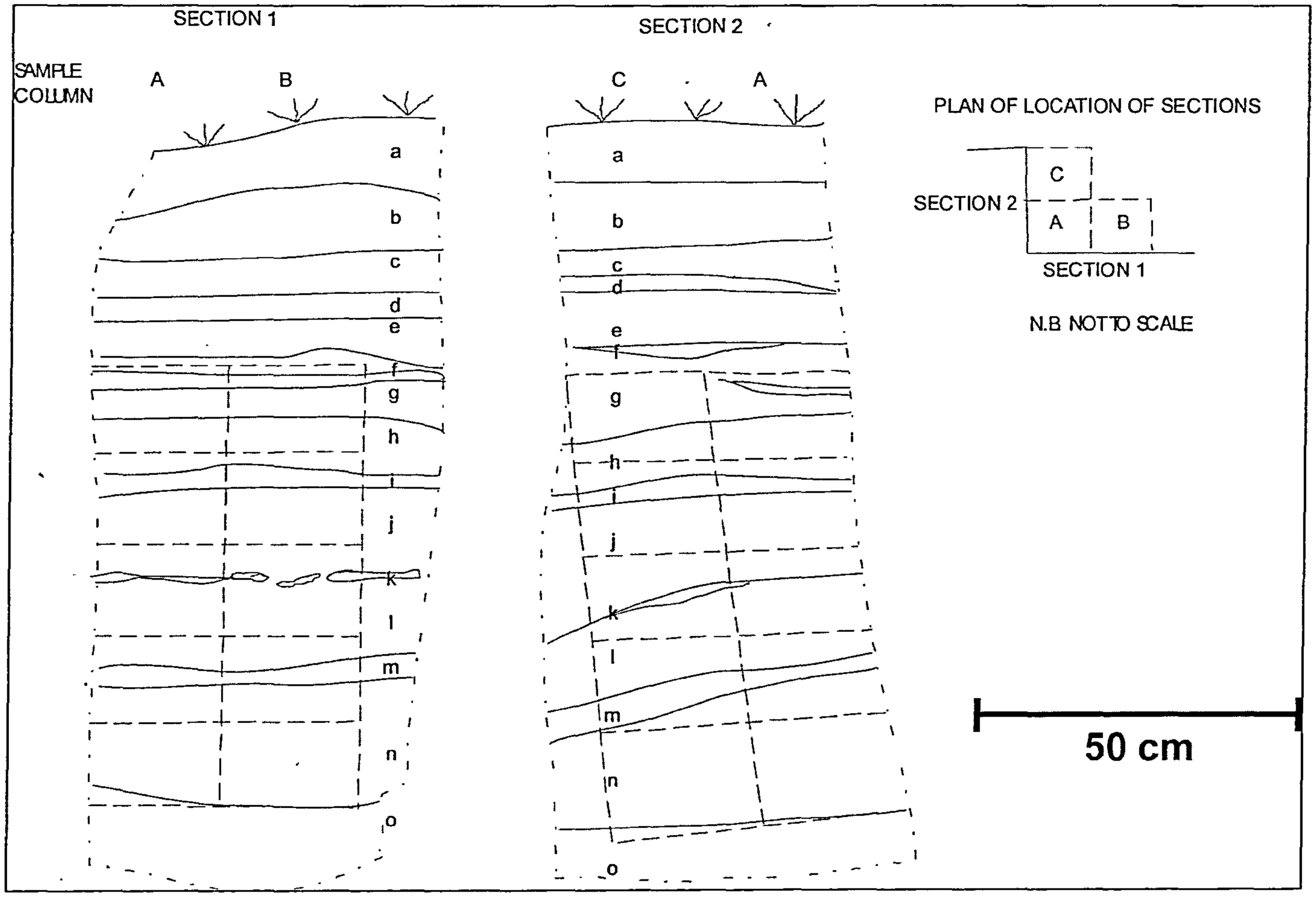

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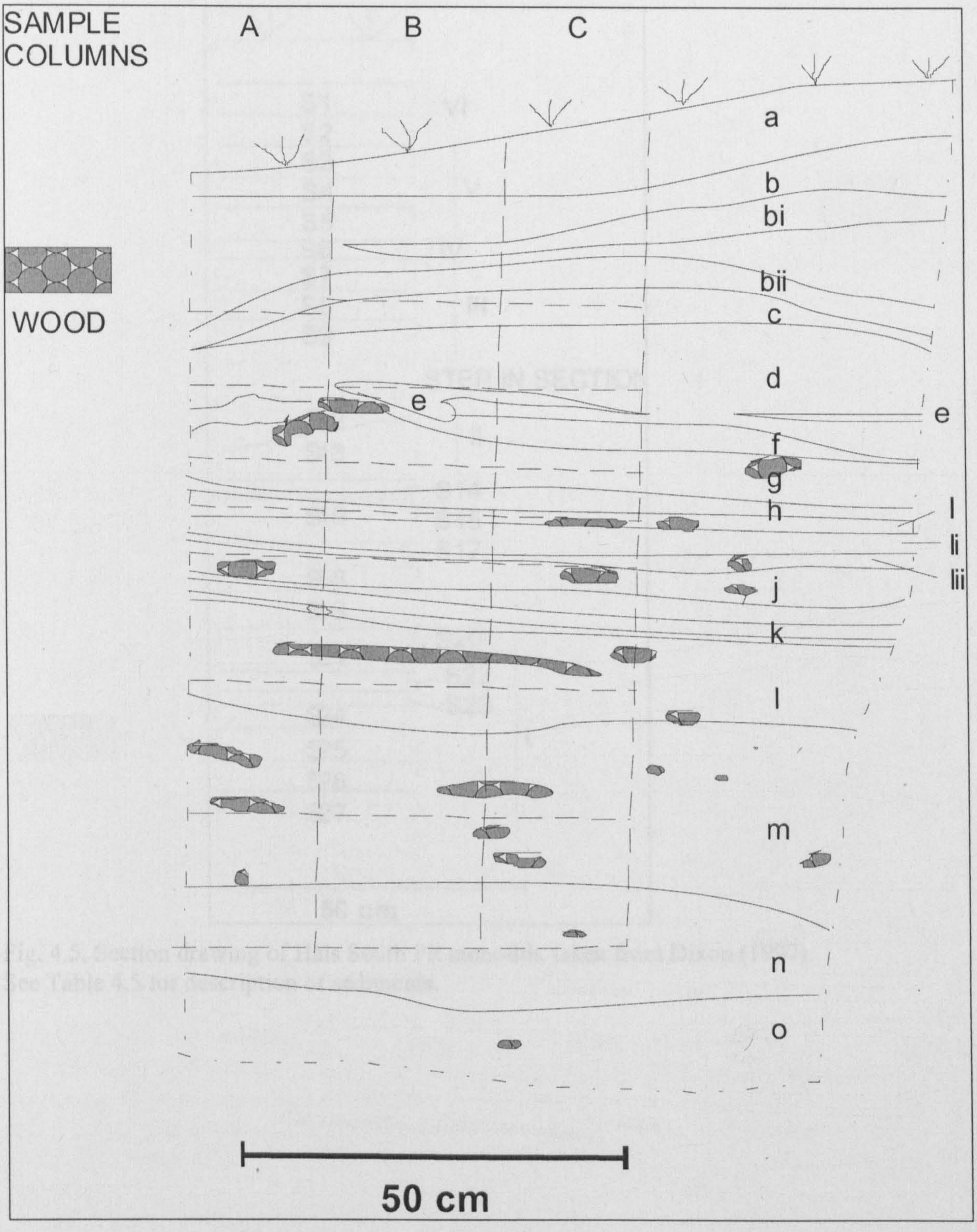

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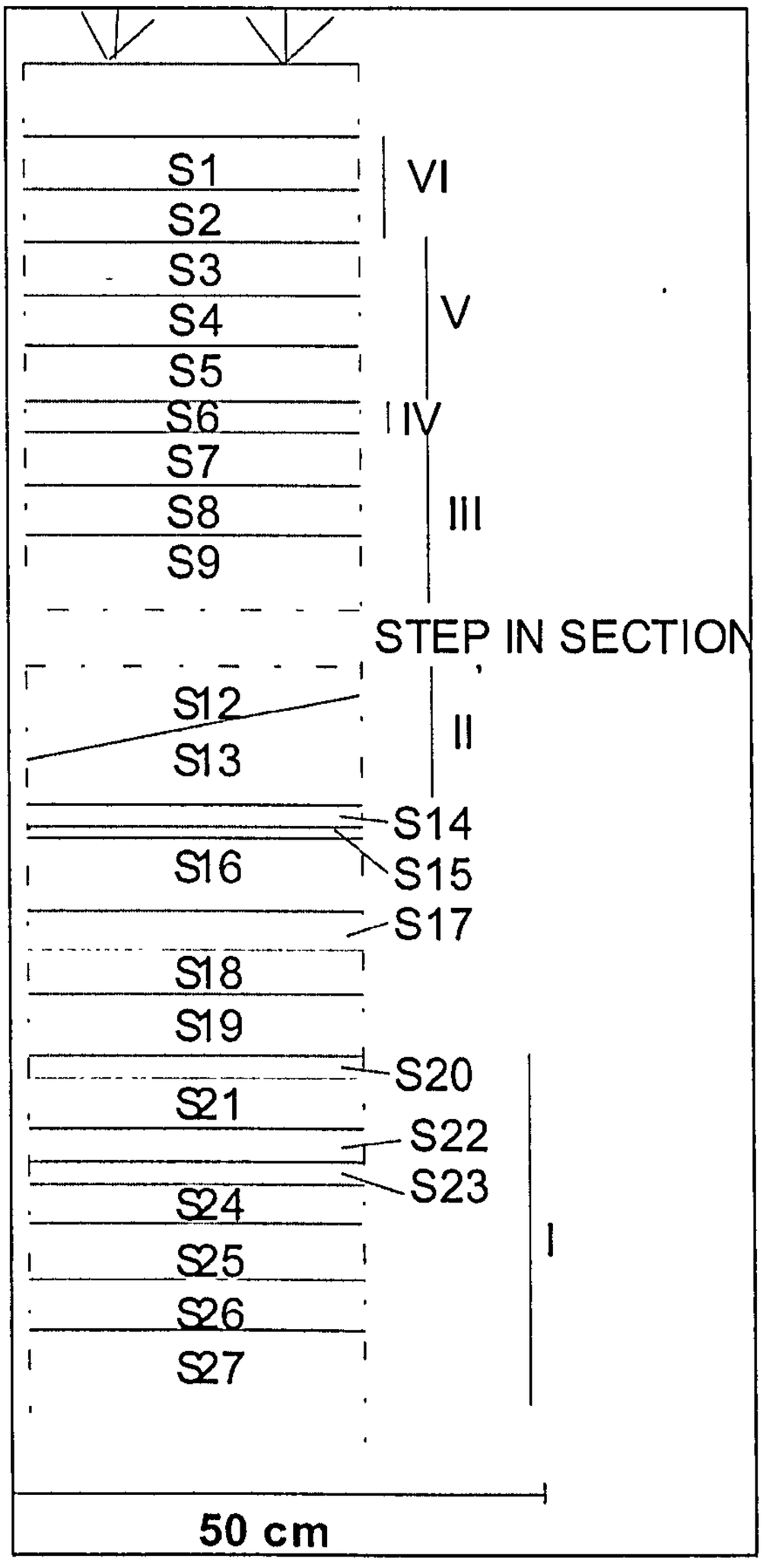

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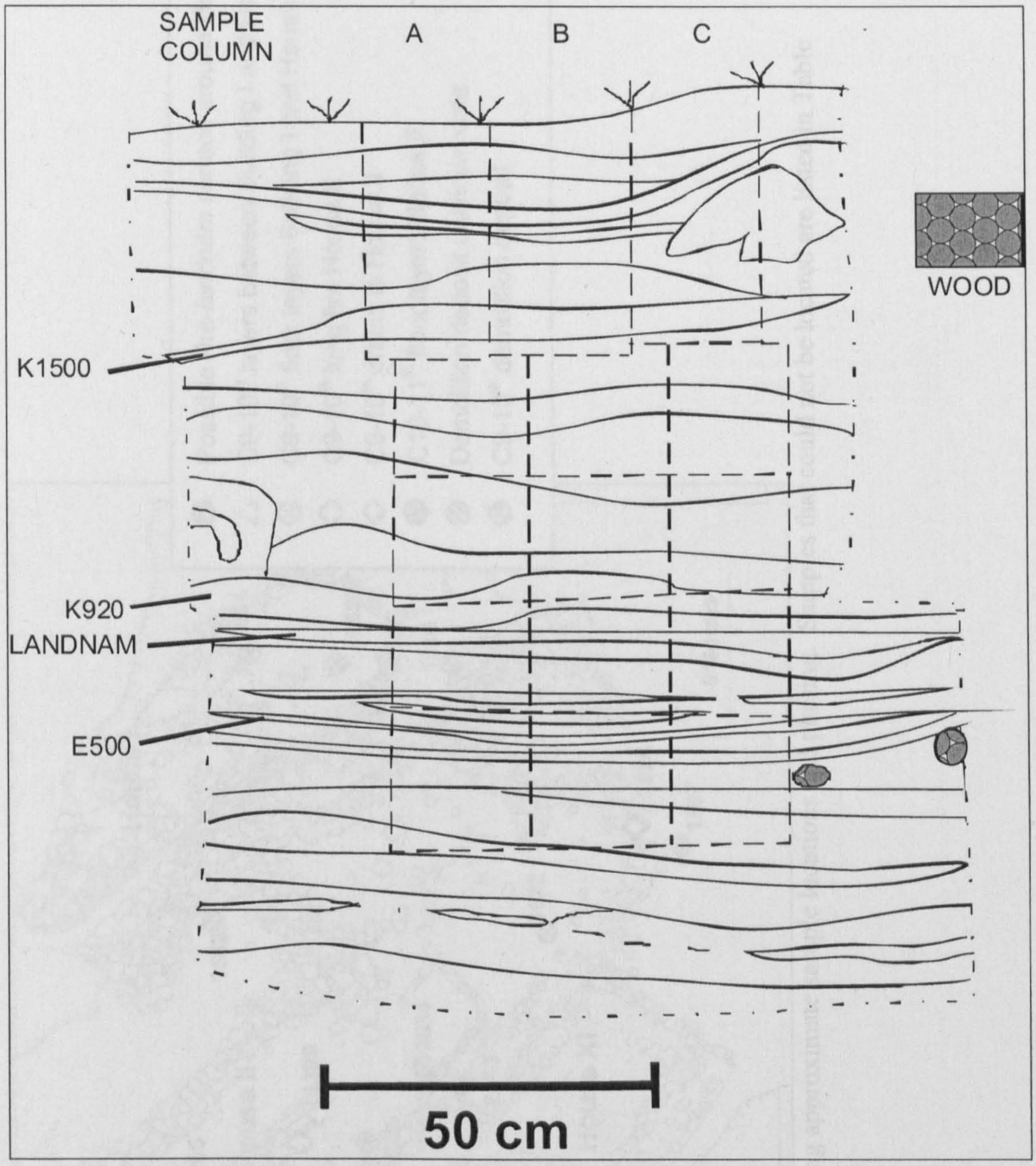

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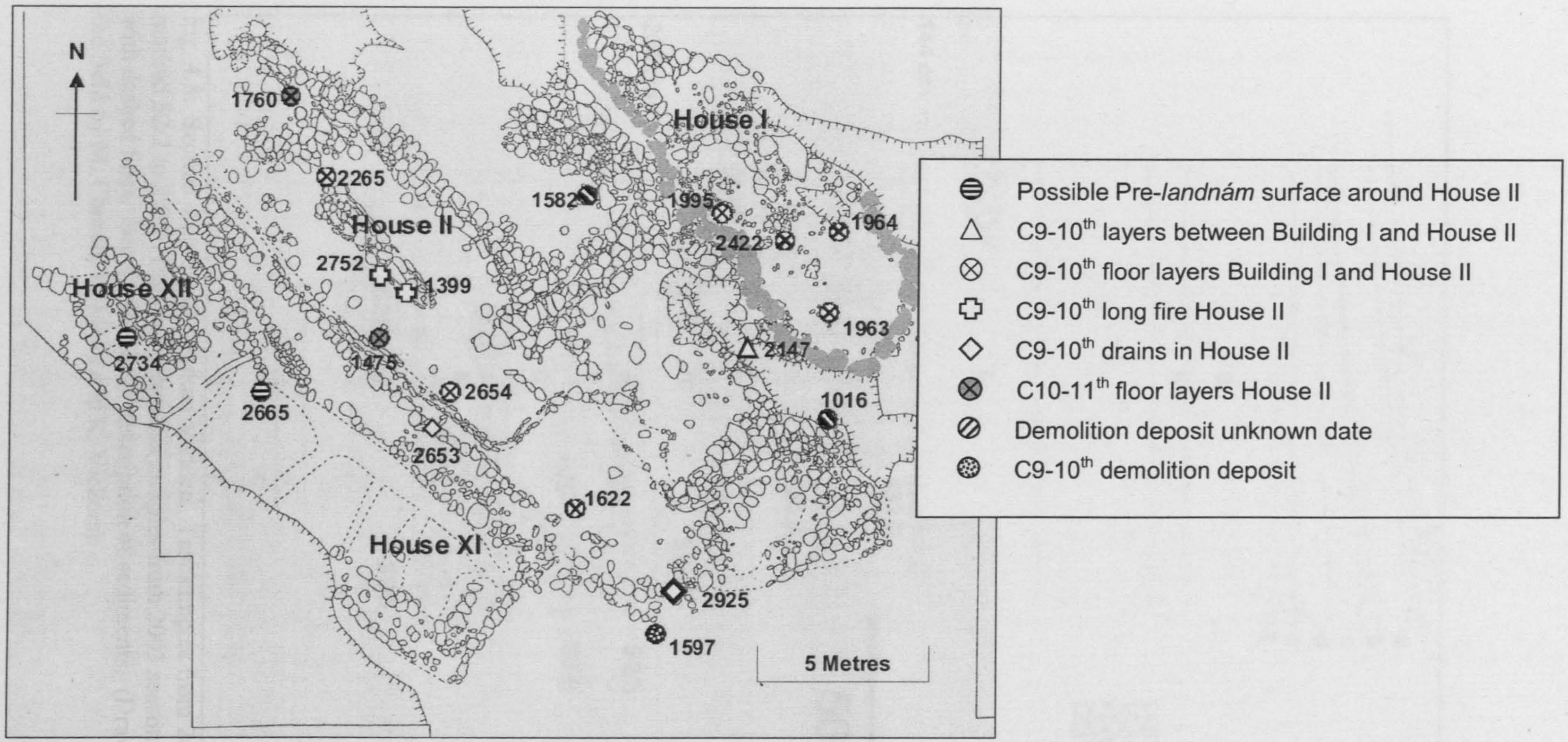
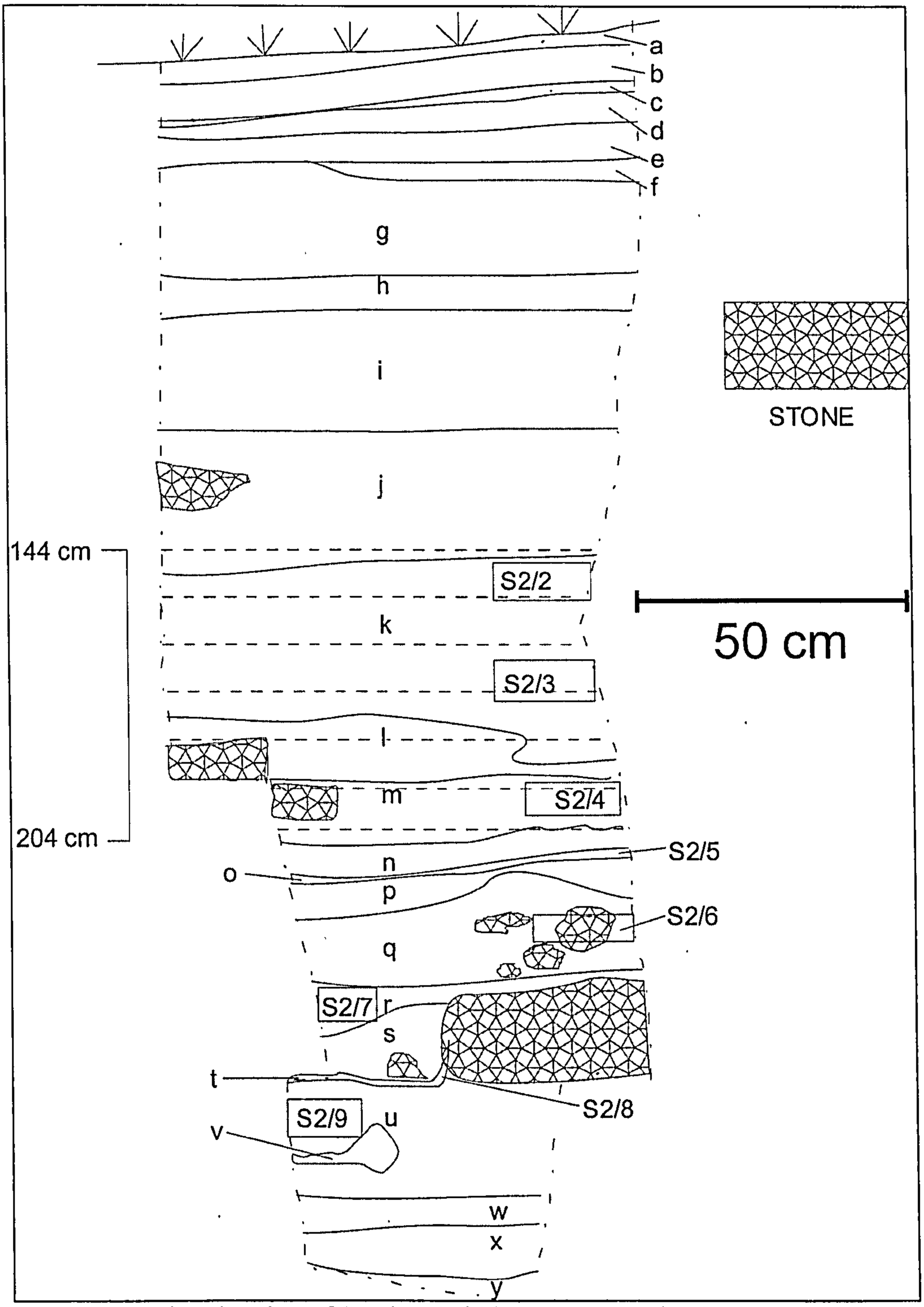


Fig. 4.7. Plan of Toftanes showing approximate sample locations and phasing. Samples that could not be located are listed in Table 4.7. (Prepared by K. Vickers).



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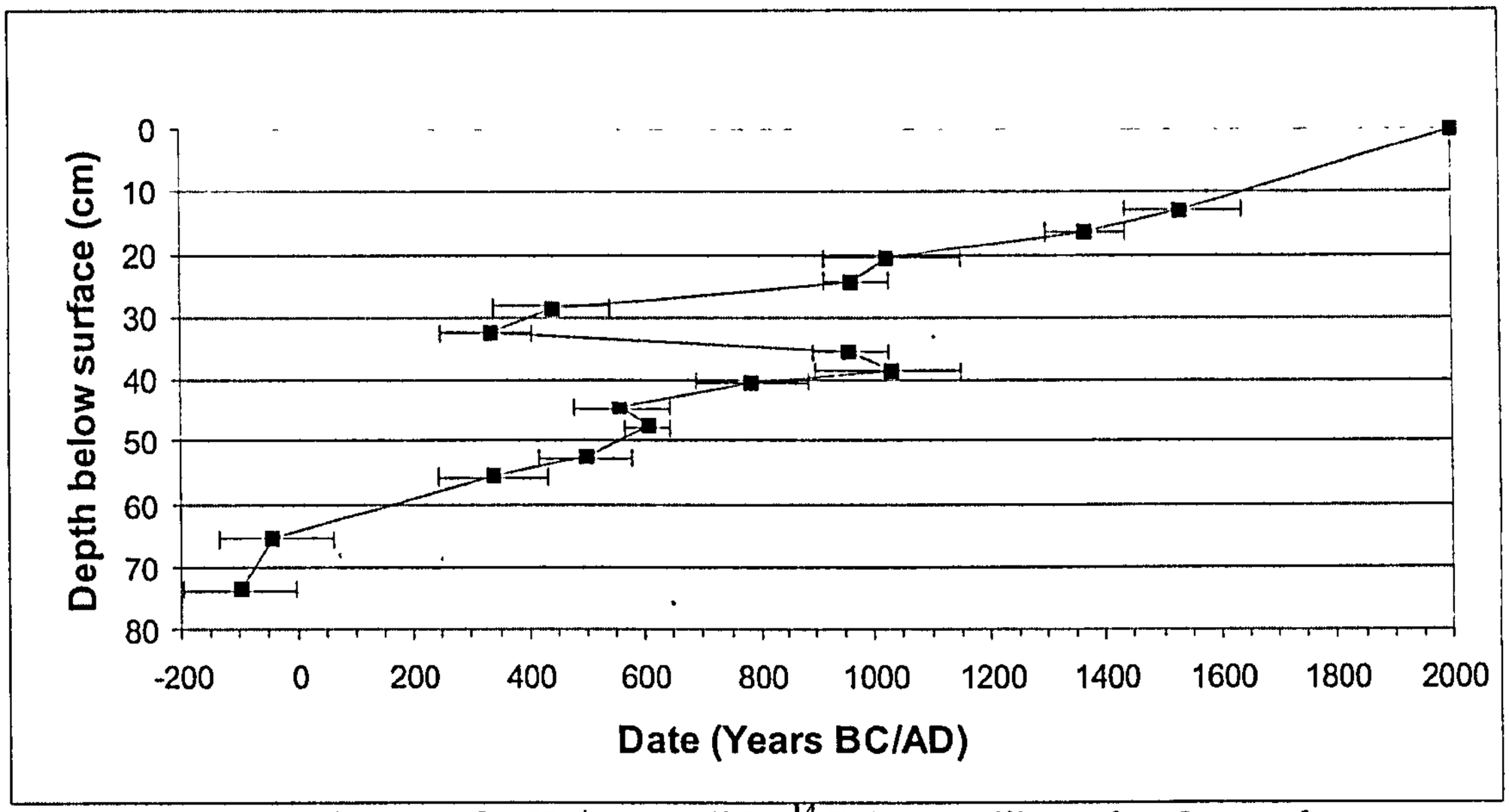


Fig. 5.1. Age-depth curve for Hov monolith (^{14}C dates calibrated to 2 σ st. dev. with CALIB 5.0.1. Stuiver *et al.* 2005).

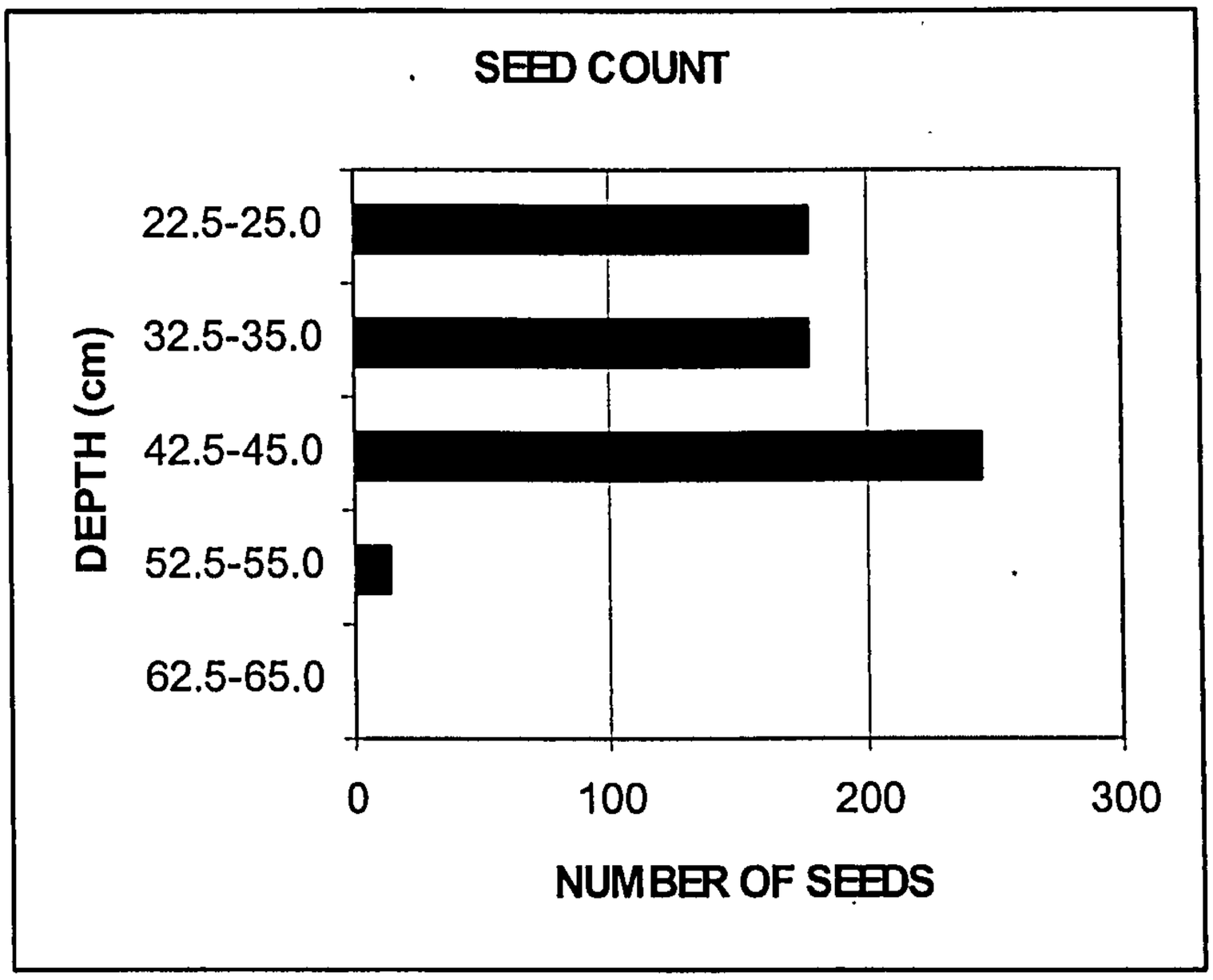
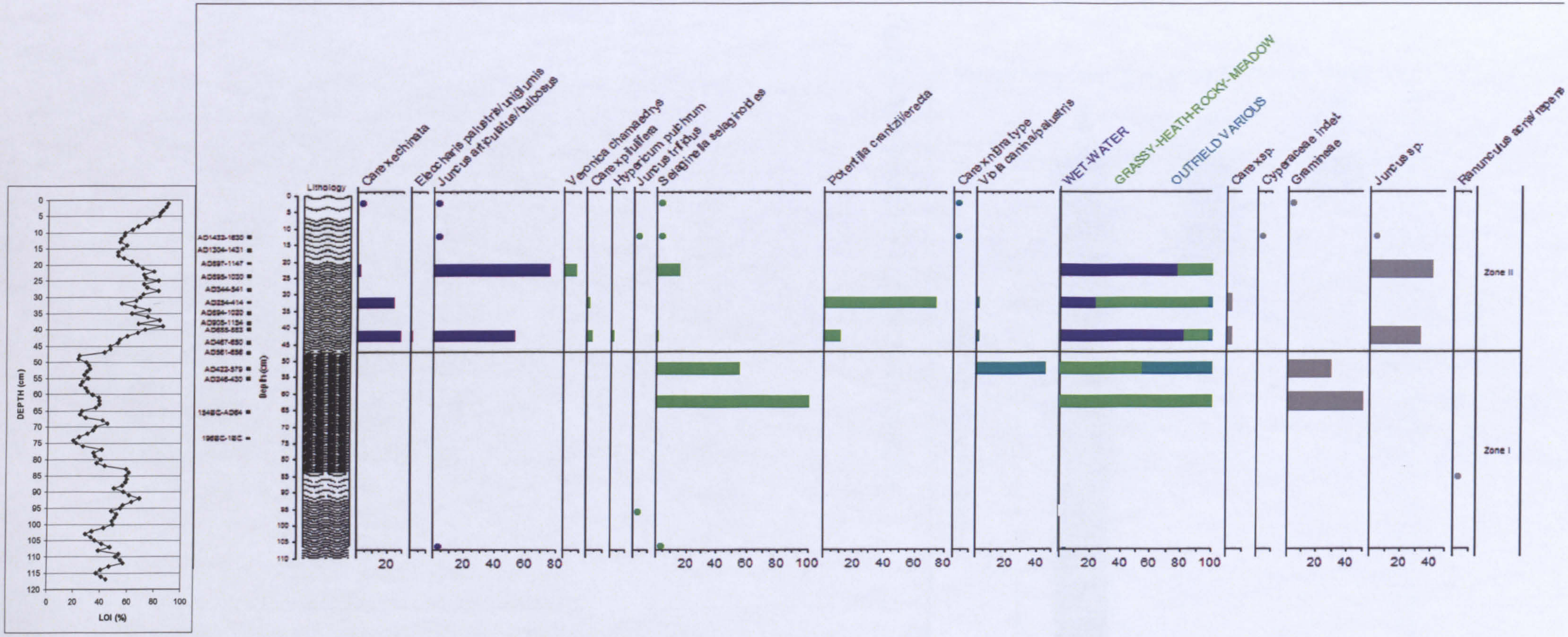


Fig. 5.2. Seed count from Hov monolith by sample.



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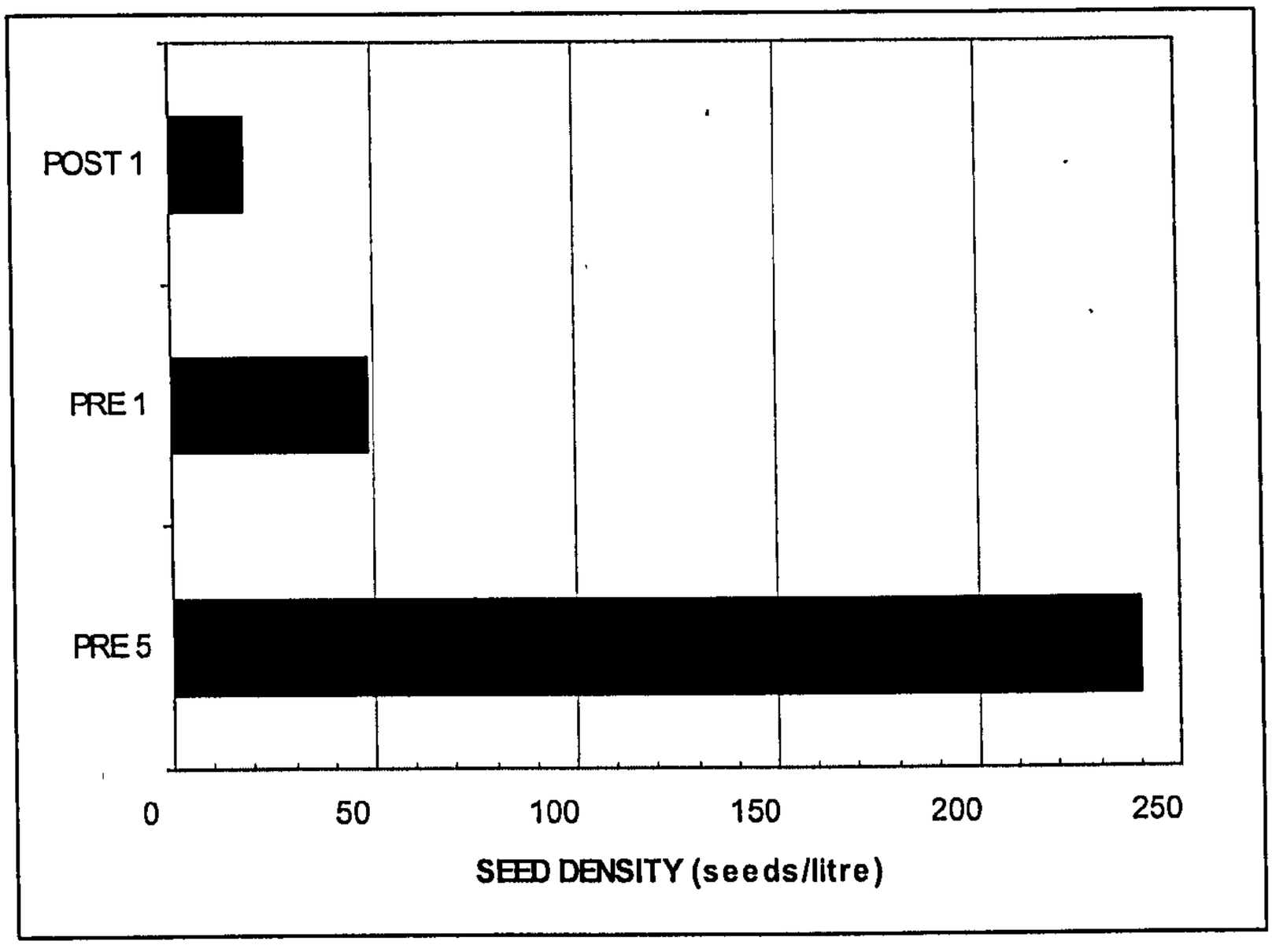

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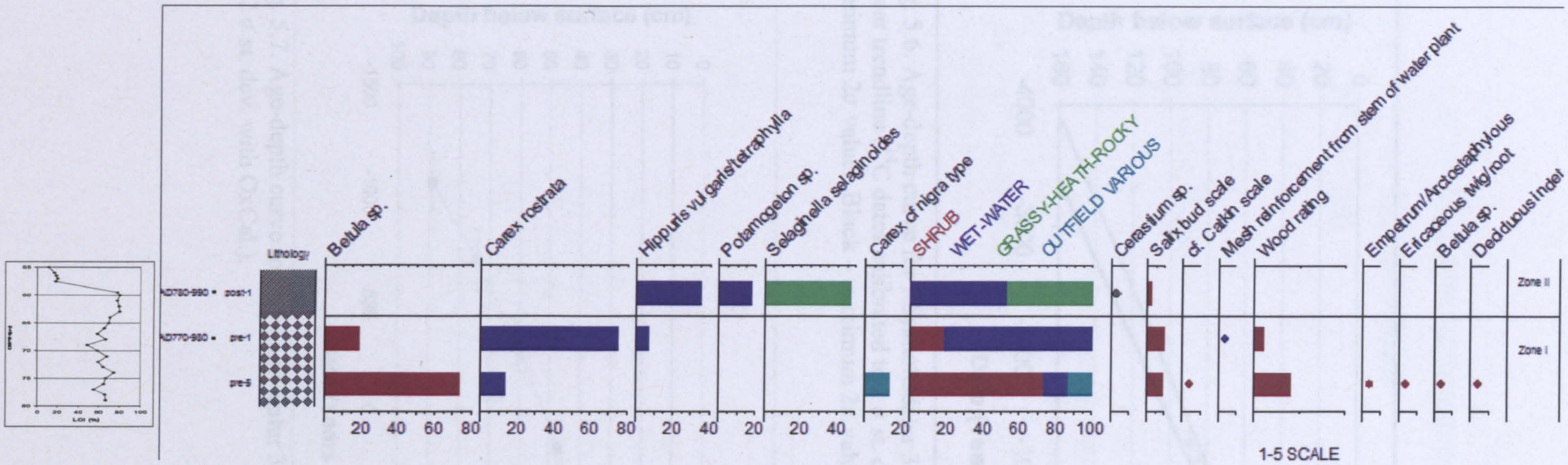


Fig. 5.5. TILIA graph of contents of Reykholtsdalur 2 monolith. Only types that could be given a habitat preference category are included in the percentage summary. The presence of non-categorised types is shown in grey. The graph is zoned according to changes in ecological associations which coincide with the *landnám* tephra. Data for percentage Loss on Ignition (LOI) from Reykholtsdalur 1 provided by M. Church. Only depths sampled for Reykholtsdalur 2 are shown. Tephra present between 58 cm and 59.5 cm and is marked with a dashed line.

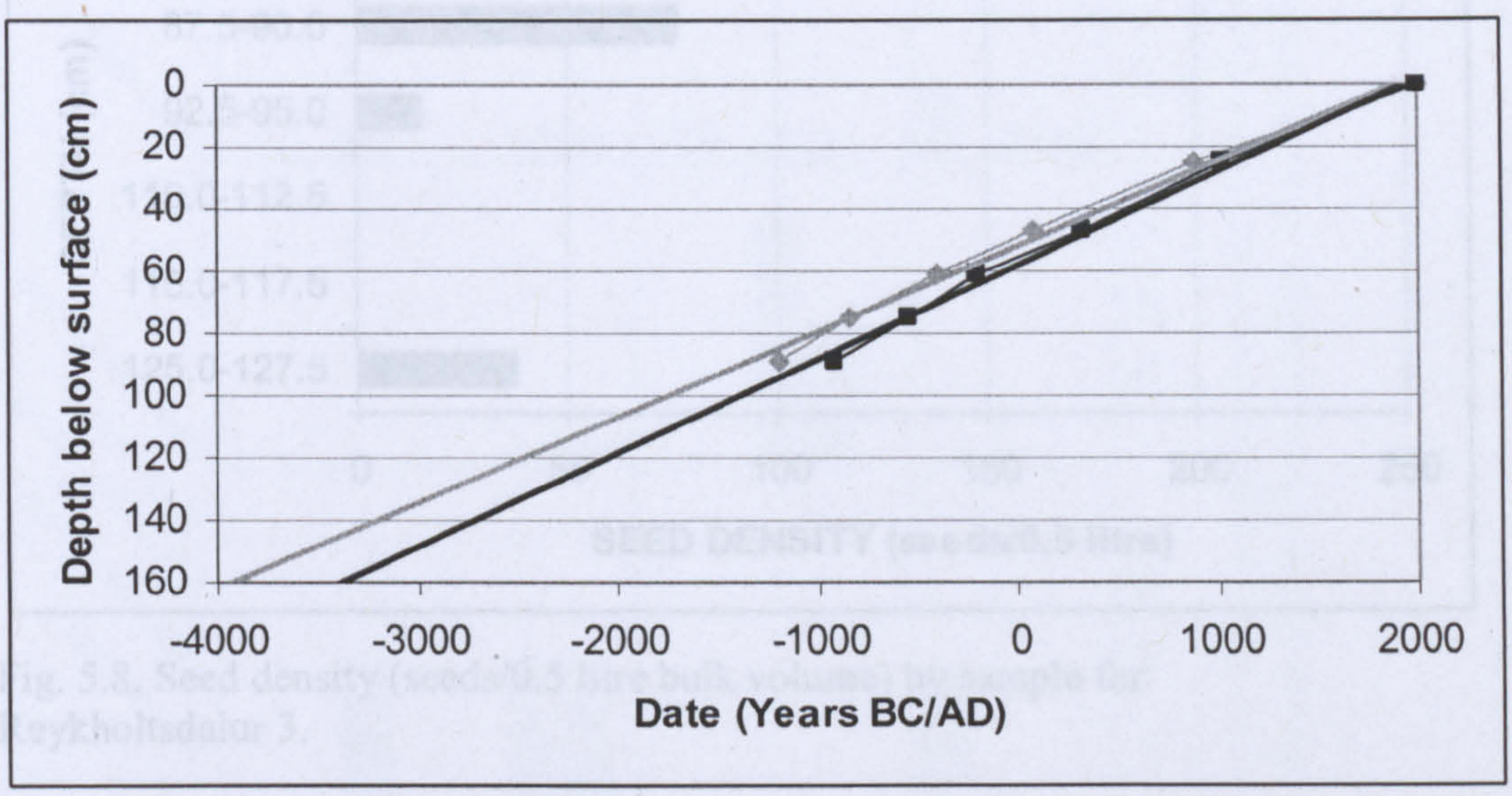


Fig. 5.6. Age-depth curve for Reykholtsdalur 3 monolith with extrapolated linear trendline (^{14}C dates calibrated to 2 σ st. dev. with OxCal). Grey – minimum 2σ value. Black – maximum 2σ value.

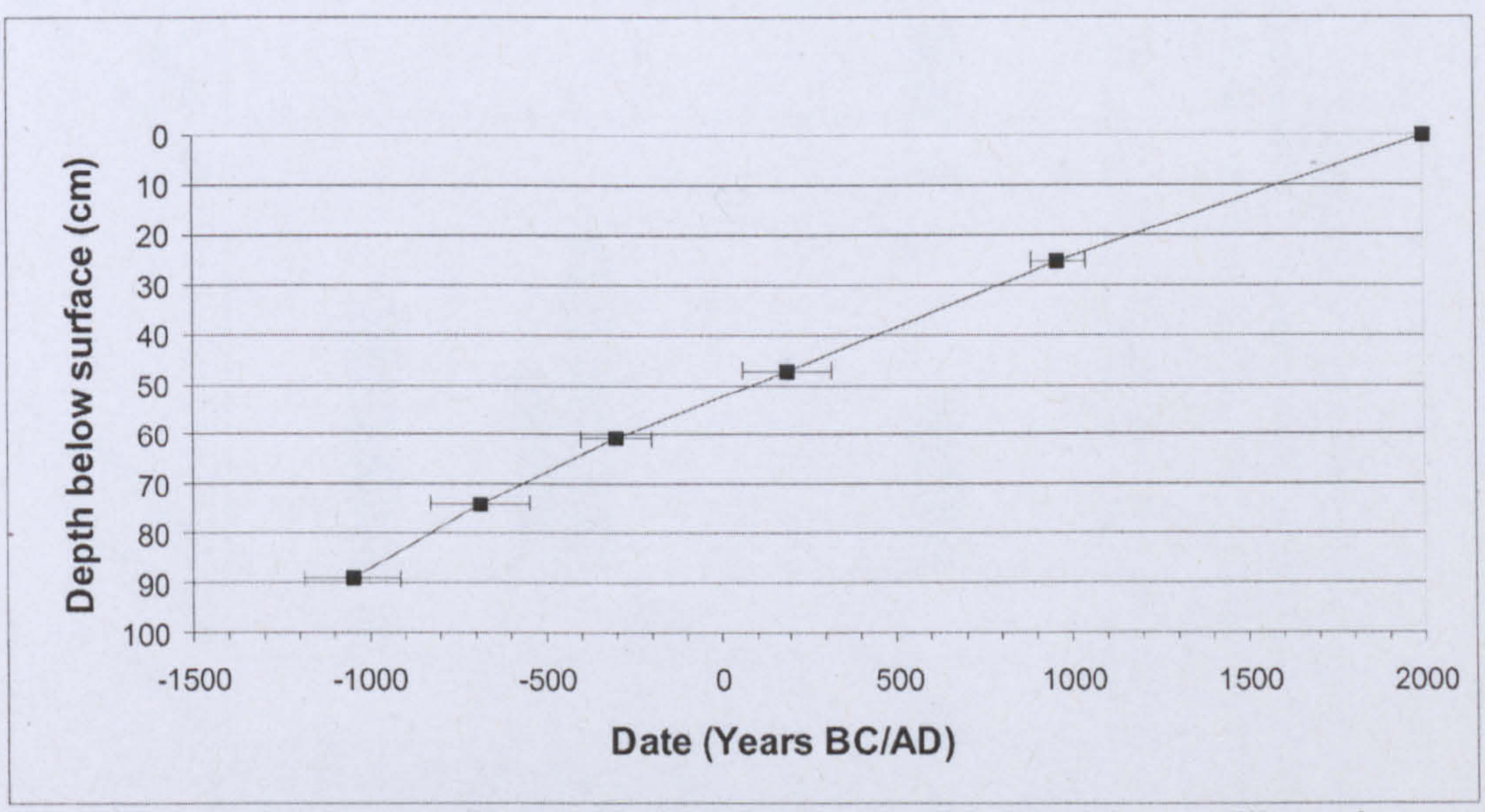


Fig. 5.7. Age-depth curve for Reykholtsdalur 3 monolith (C14 dates calibrated to 2 σ st. dev. with OxCal.).

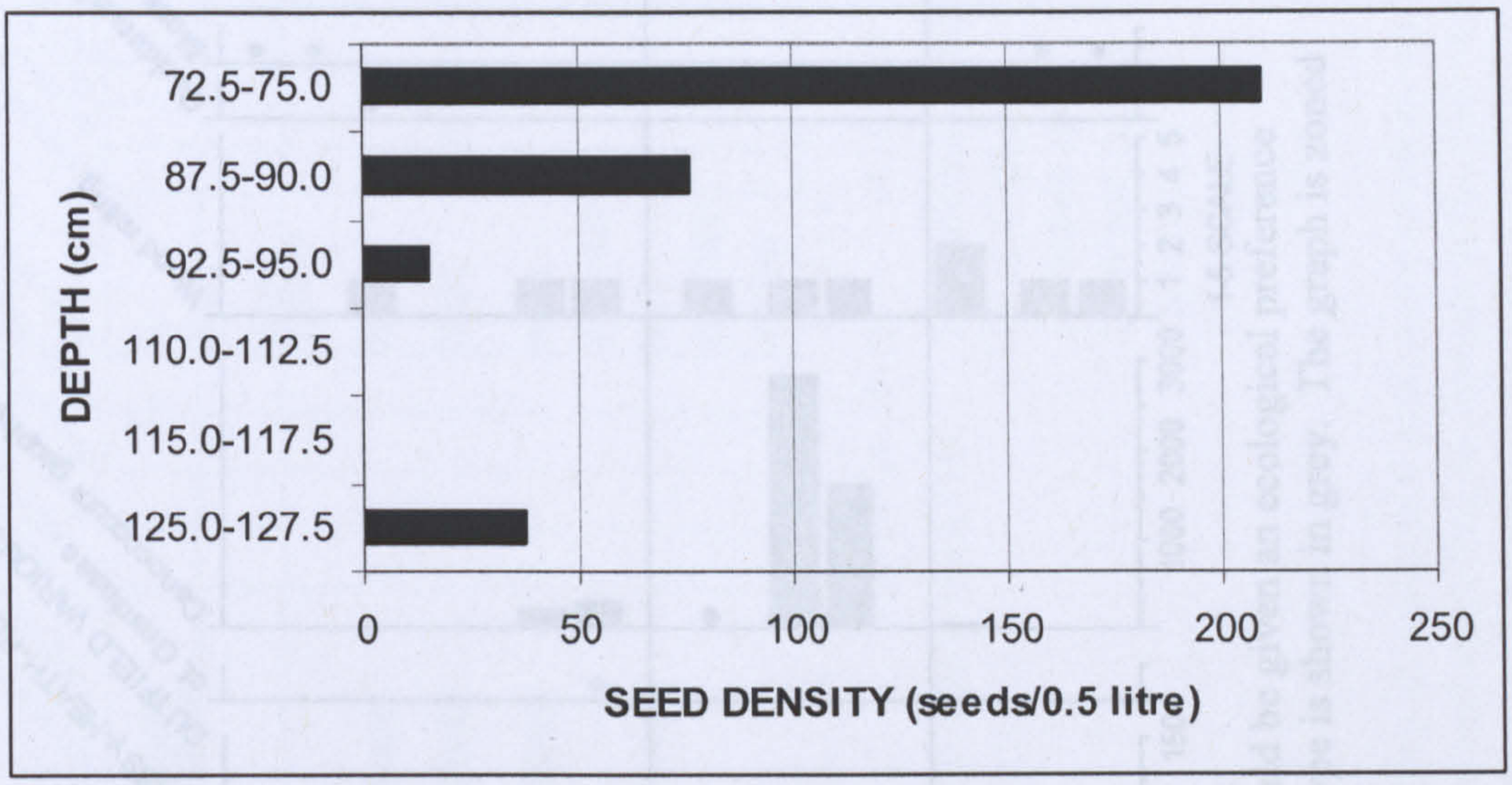


Fig. 5.8. Seed density (seeds/0.5 litre bulk volume) by sample for Reykholtsdalur 3.

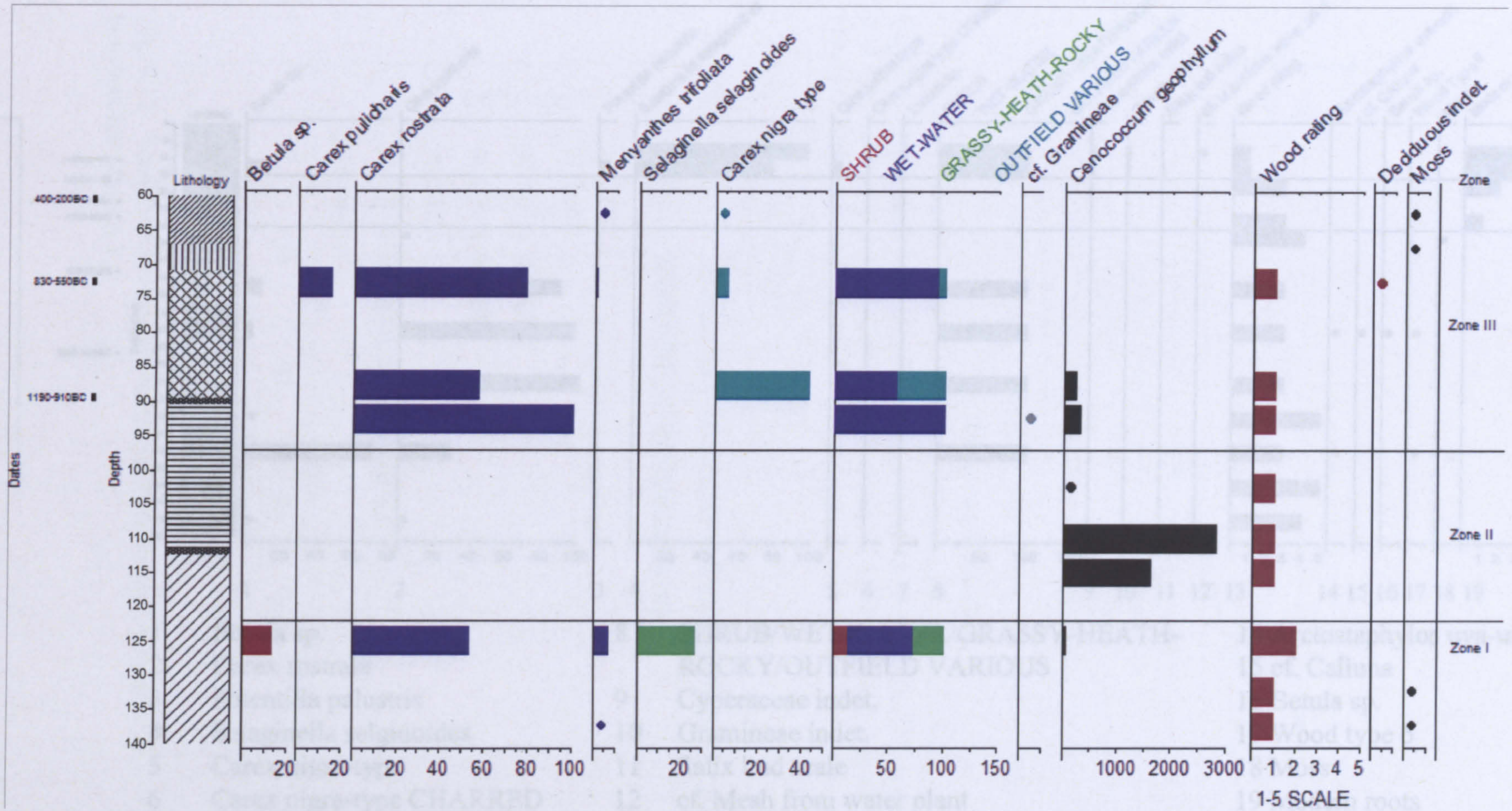
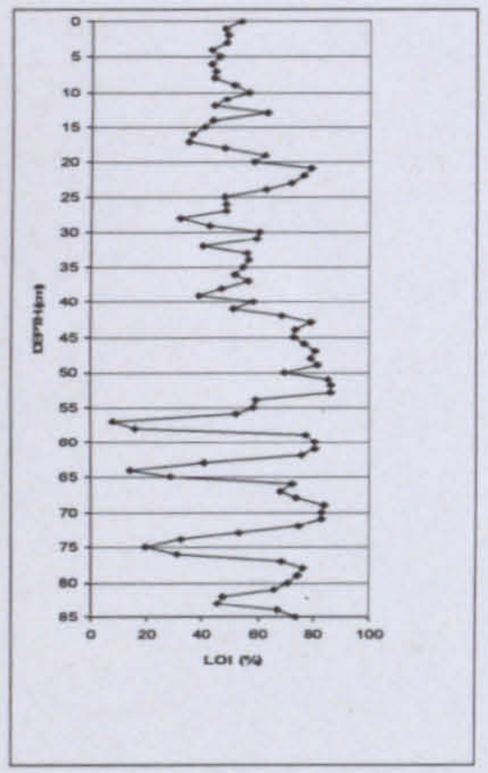
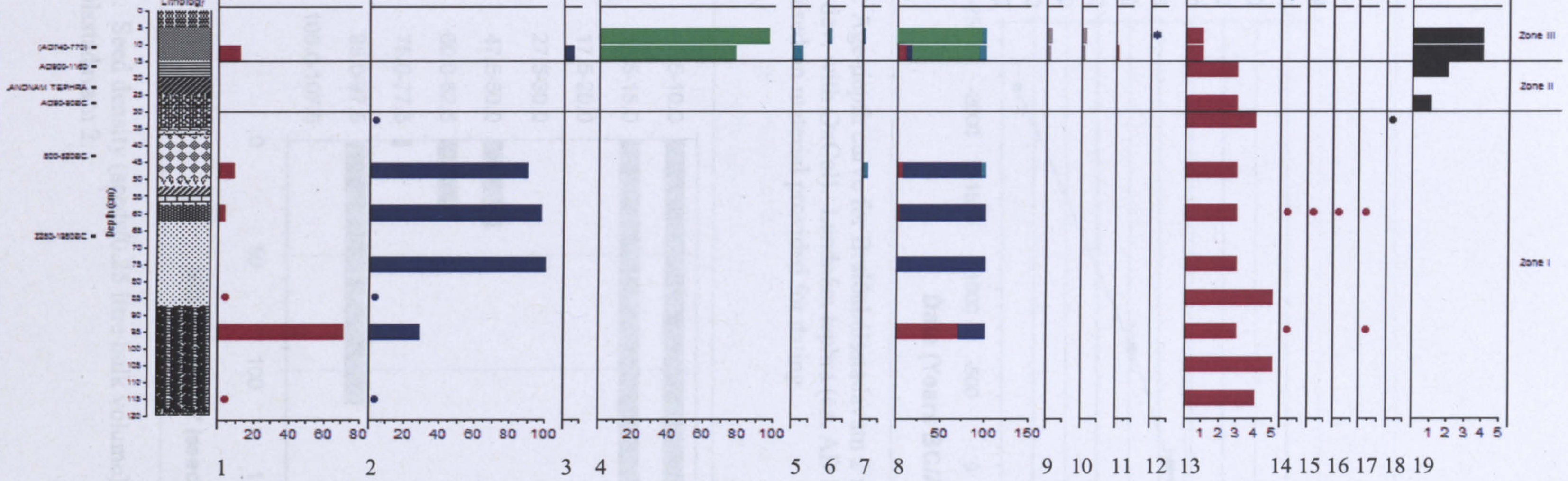


Fig 5.9. TILIA graph of contents of the Reykholtsdalur 3 monolith. Only types that could be given an ecological preference category are included in the percentage summary. The presence of a non-categorised type is shown in grey. The graph is zoned according to changes in the plant macrofossil assemblages.





1	Betula sp.	8	SHRUB/WET-WATER/GRASSY-HEATH-ROCKY/OUTFIELD VARIOUS	14	Arctostaphylos uva-ursi
2	Carex rostrata			15	cf. Calluna
3	Potentilla palustris	9	Cyperaceae indet.	16	Betula sp.
4	Selaginella selginoides	10	Gramineae indet.	17	Wood type 6
5	Carex nigra-type	11	Salix bud scale	18	Moss
6	Carex nigra-type CHARRED	12	cf. Mesh from water plant	19	Modern roots
7	Luzula sp.	13	Wood rating		

Fig. 5.10. TILIA graph of contents of Breiðabólsstadavatn 2 monolith. Only types that could be given an ecological preference category are included in the percentage summary. The presence of non-categorised types is shown in grey. The graph is zoned according to changes in the plant macrofossil assemblages. Individual charts are numbered and titles listed below for clarity. Data for percentage Loss on Ignition (LOI) curve supplied by E. Erlendsson.

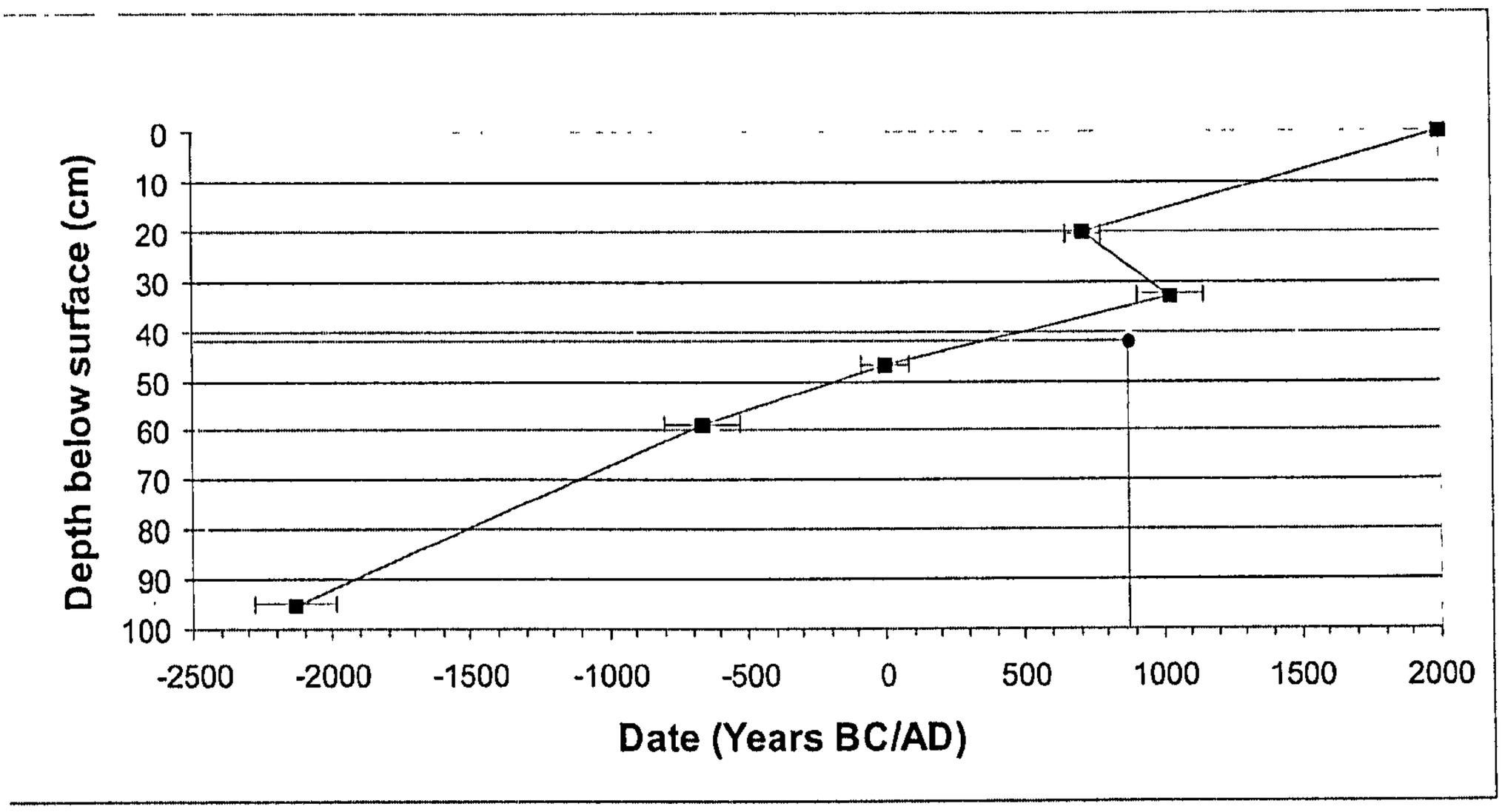


Fig. 5.11. Age-depth curve for Breiðabólsstadavatn 2 monolith (^{14}C dates calibrated to 2 σ st. dev. with OxCal). Landnám tephra (ca. AD 874) marked at 41.5 cm. Depths based on material provided for dating.

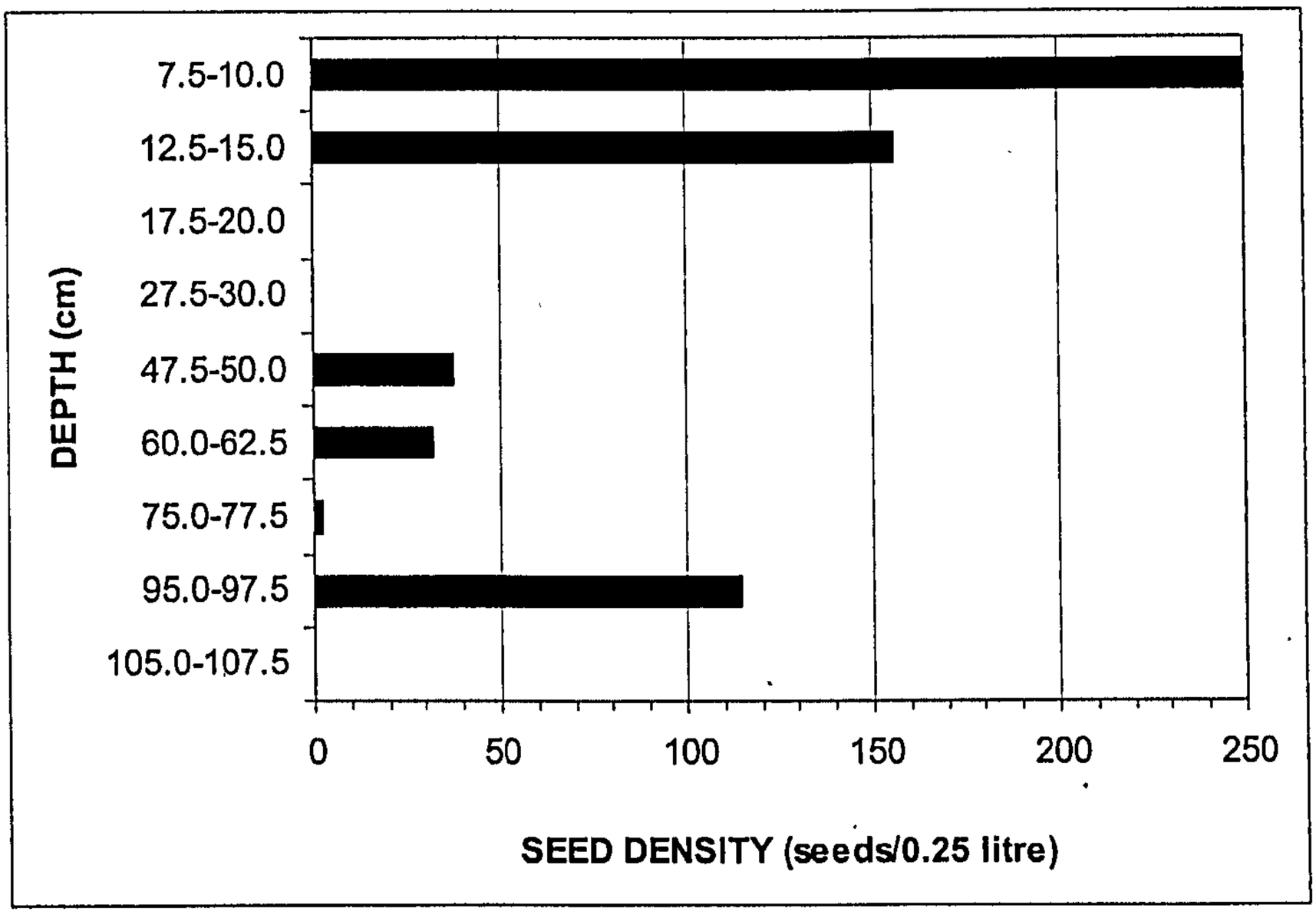


Fig. 5.12. Seed density (seeds/0.25 litre bulk volume) by sample for Breiðabólsstadavatn 2.

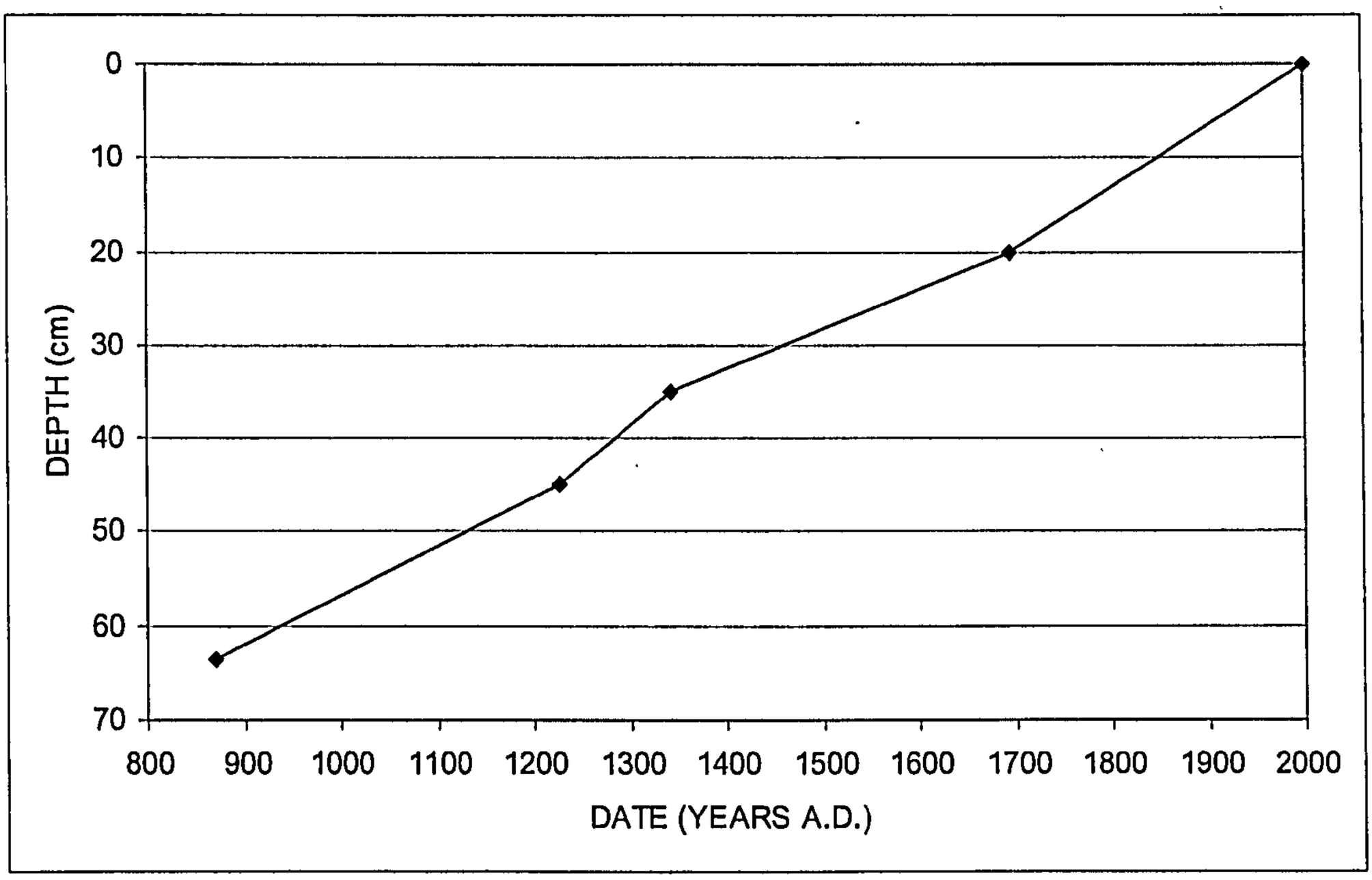


Fig 5.13. Age-depth curve for the Háls South Pit monolith. Dates based on tephra microprobe analysis provided by K. Smith (pers. comm.).

KEY TO FIG. 5.14

From left to right:

1	Carex canescens
2	Carex cf. capillaris
3	Carex chordorrhiza
4	Carex echinata.
5	Carex cf. limosa
6	Carex lyngbyei
7	Carex cf. magellanica
8	Carex maritima
9	Carex microglochin
10	Carex nigra type
11	Carex cf. norvegica
12	Carex cf. rostrata
13	Carex saxatilis type
14	Carex cf. serotina
15	Eleocharis palustris/uniglmis
16	Juncus spp.
17	Poaceae
18	Alchemilla spp.
19	Potentilla crantzii
20	Potentilla palustris
21	Ranunculus acris
22	Ranunculus reptans/hyperboreus
23	Thalictrum sp.
24	Cerastium spp.
25	Rumex indet./Polygonum aviculare
26	Rumex cf. longifolius
27	Calluna vulgaris
28	Empetrum nigrum
29	Betula spp. (fruit)
30	Salix xpp. (bud)
31	Wood indet.
32	cf. Saxifraga indet.
33	cf. Sedum indet.

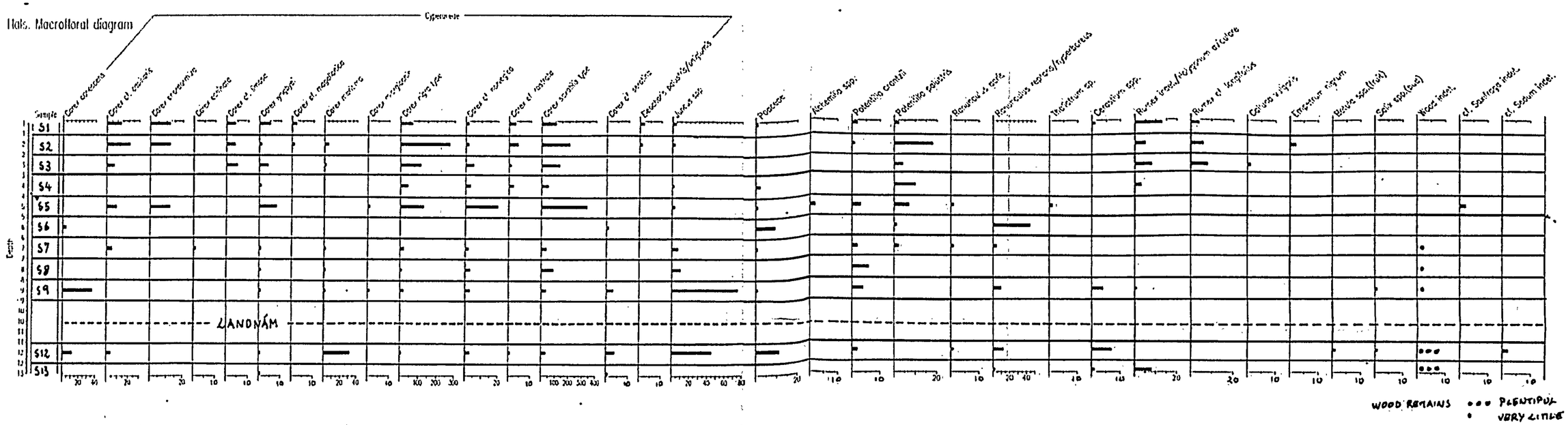


Fig. 5.14. Graph of plant macrofossil contents of Háls monolith. Taken from Dixon (1997).

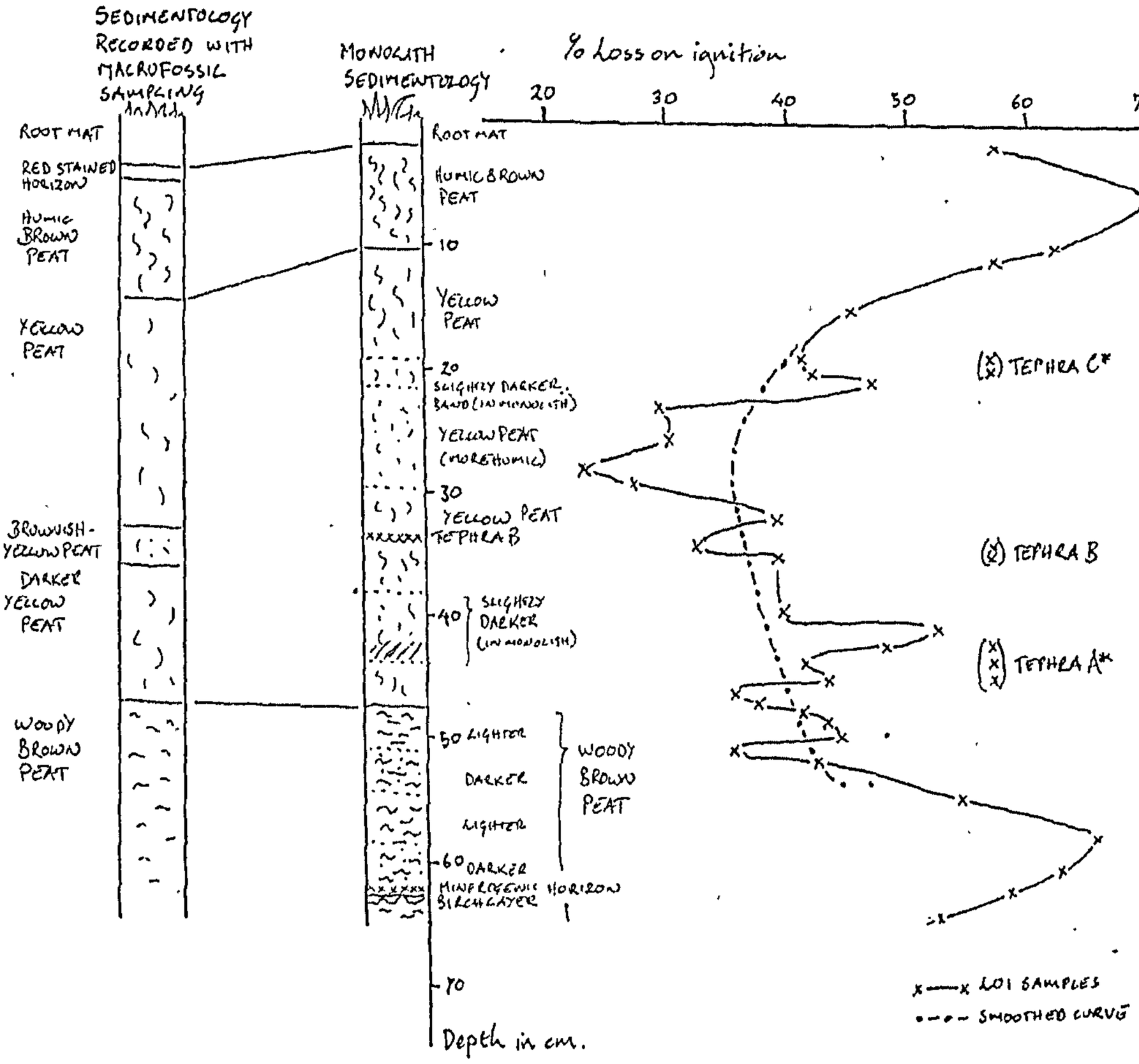


Fig 5.15 Loss on ignition and sedimentology of Háls monolith. Taken fron Dixon (1997).

KEY TO FIG. 5.16

From left to right:

1	Betula
2	Salix
3	Empetrum
4	Vaccinium type
5	Poaceae
6	Cyperaceae
7	Apiaceae
8	Artemisia
9	Asteraceae
10	Brassicaceae
11	Caltha
12	Caryophyllaceae (S. vulgaris type)
13	Caryophyllaceae (Spergula type)
14	Caryophyllaceae (Stellaria)
15	Filipendula
16	Gentianaceae
17	Geum
18	Parnassia palustris
19	Plantago lanceolata
20	Plantago maritima
21	Polygonum aviculare
22	Polygonum viviparum
23	Potentilla
24	Ranunculus acris type
25	Rubiaceae
26	Rumex acetosa
27	Rumex acétosella
28	Thalictrum
29	Botrychium
30	Dryopteris
31	Equisetum
32	Lycopodiella
33	Ophioglossum
34	Polypodium
35	Selaginella
36	Sphagnum
37	Pteropsida monolete indet.
38	Trees/Shrubs
39	Poaceae
40	Cyperaceae
41	Herbs
42	Aquatics
43	Heaths
44	Cryptograms
45	Total Land Pollen

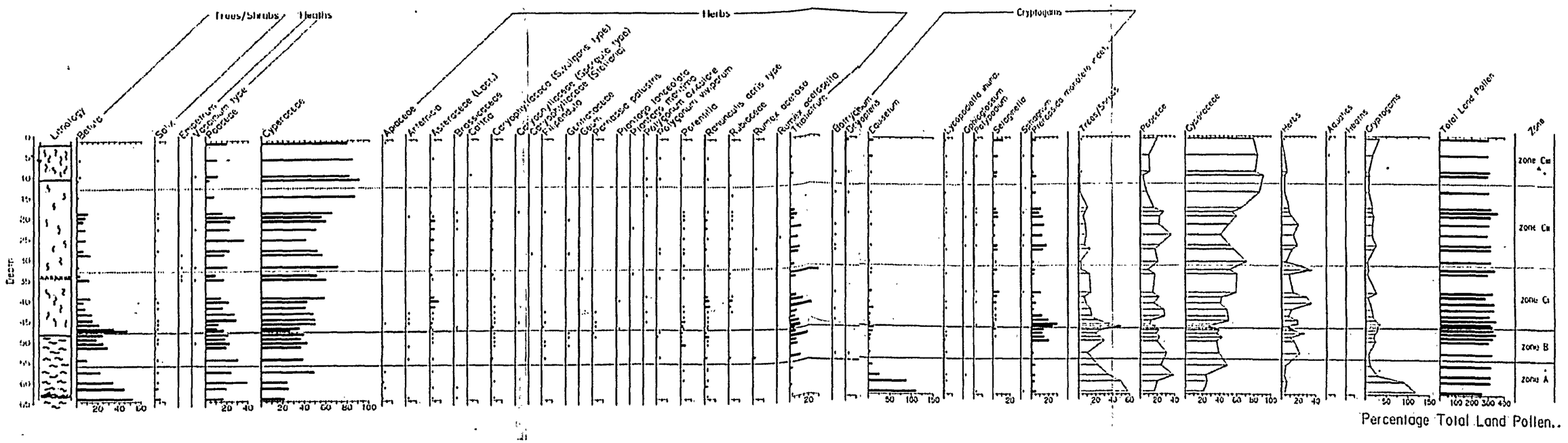


Fig. 5.16. Graph of pollen content of Háls monolith. Taken from Dixon (1997).

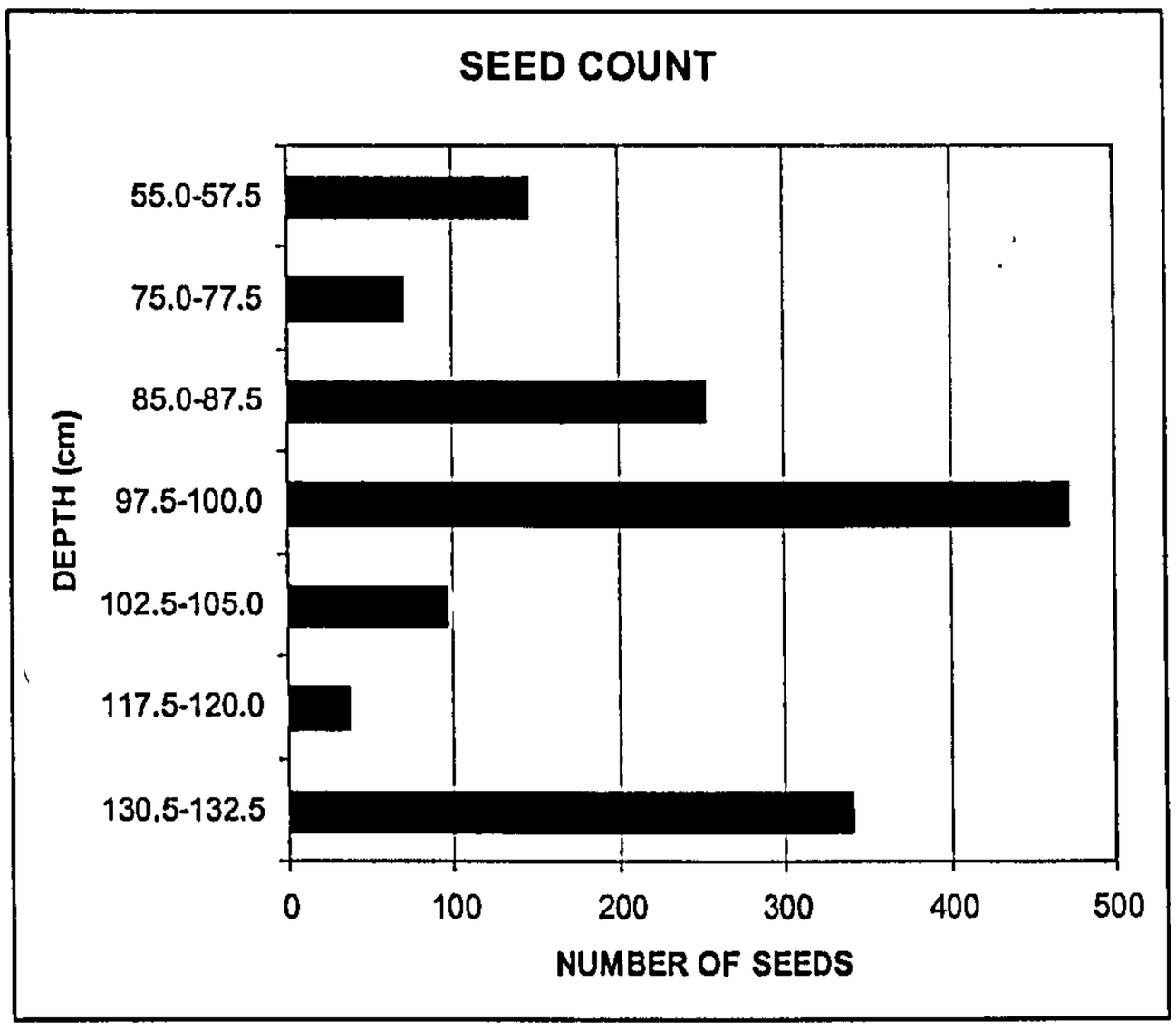


Fig. 5.17. Seed count per litre by depth for Stóramörk.

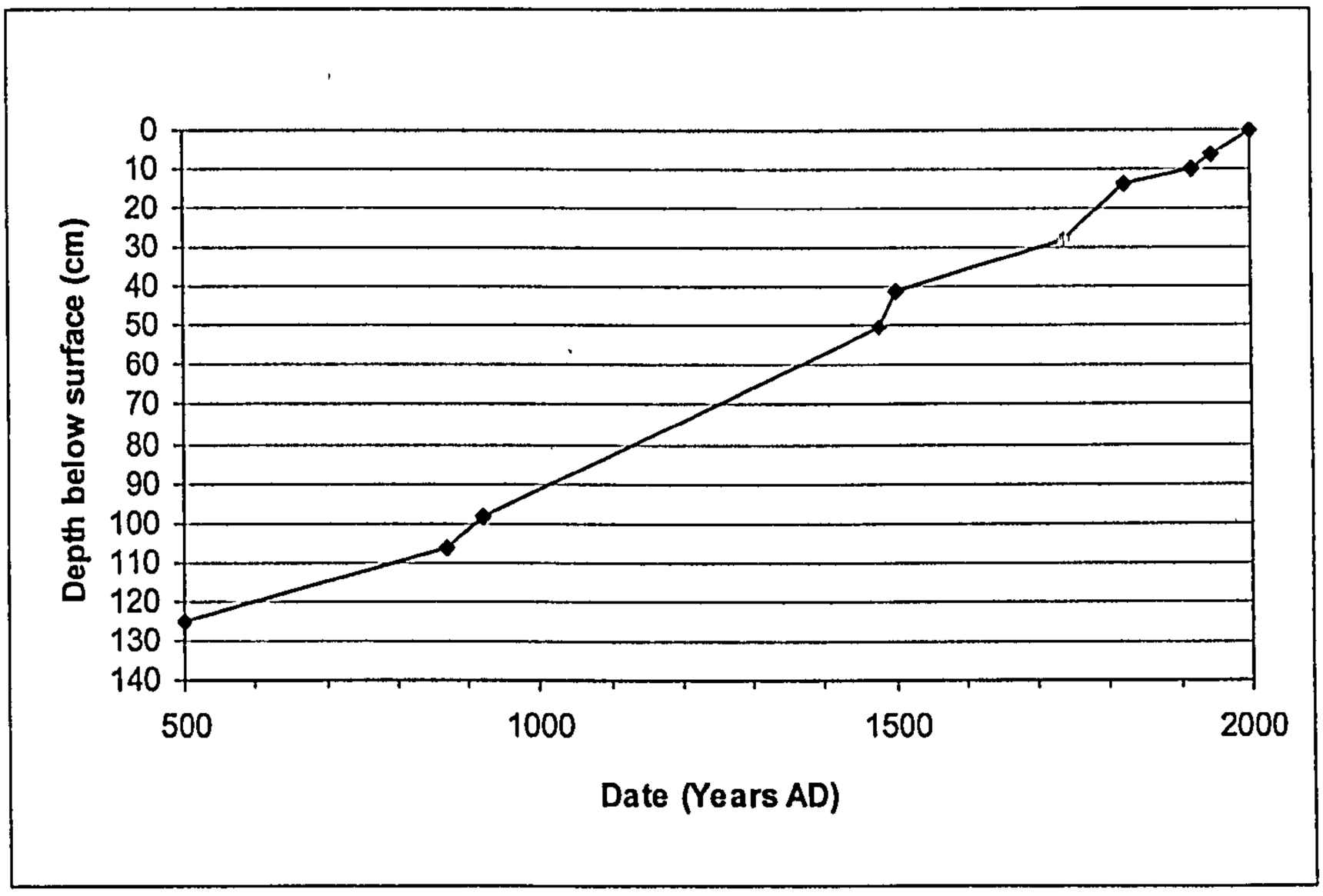


Fig. 5.18. Age-depth curve for Stóramörk monolith. Dates based on tephra microprobe analysis. Depths from column taken for tephra identification and pollen analysis, therefore there may be some discrepancy in depths with Fig. 5.21. The sequence of plant macrofossil samples is correct in terms of stratigraphic relationship to the tephras). Black – date confirmed by microprobe analysis. Light grey - average of two possible dates (AD 1755 and 1721). Dark grey – likely date due to position in tephra sequence, but identification not confirmed by microprobe analysis.

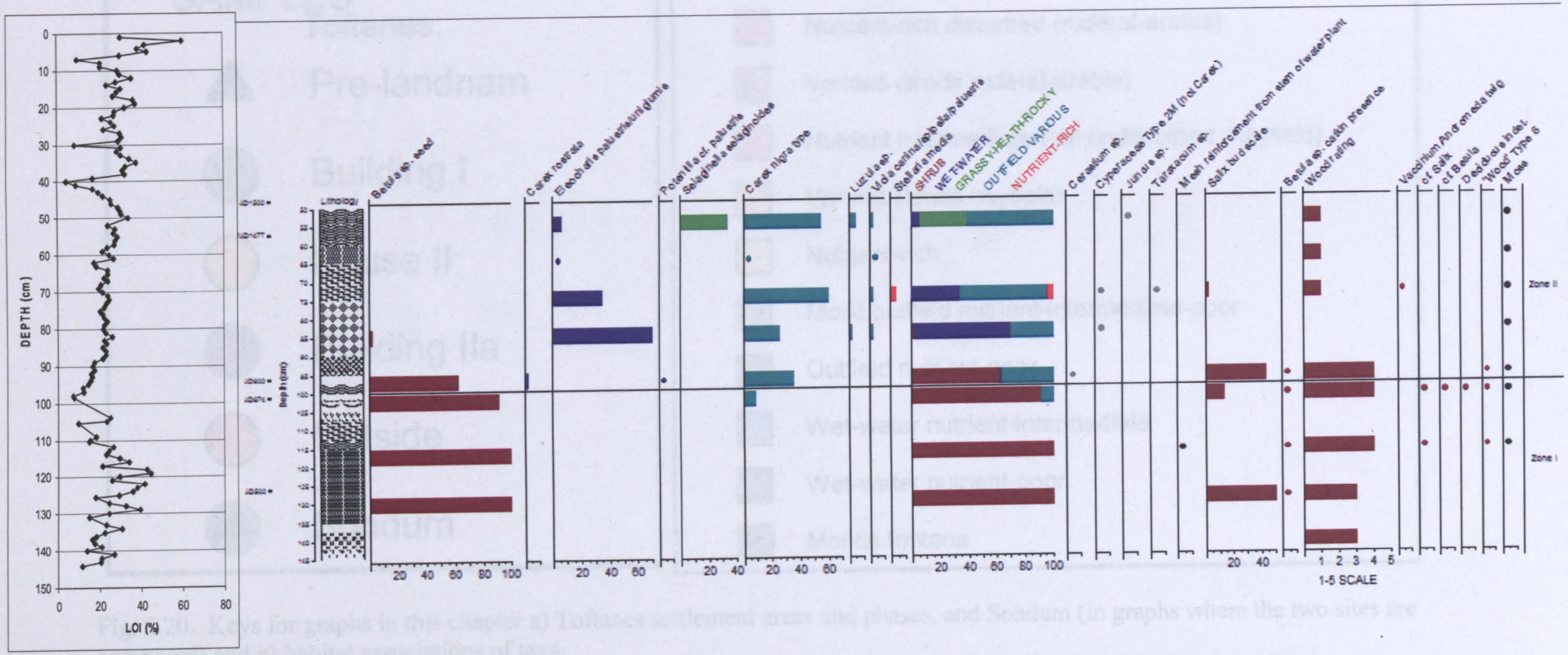


Fig. 5.19. TILIA graph of contents of Stóramörk monolith. Only types that could be given an ecological preference category are shown. The presence of non-categorised types is shown in grey. The graph is zoned according to changes in ecological associations, which coincide with the *landnám* tephra. Data for percentage Loss on Ignition (LOI) supplied by M. Church.

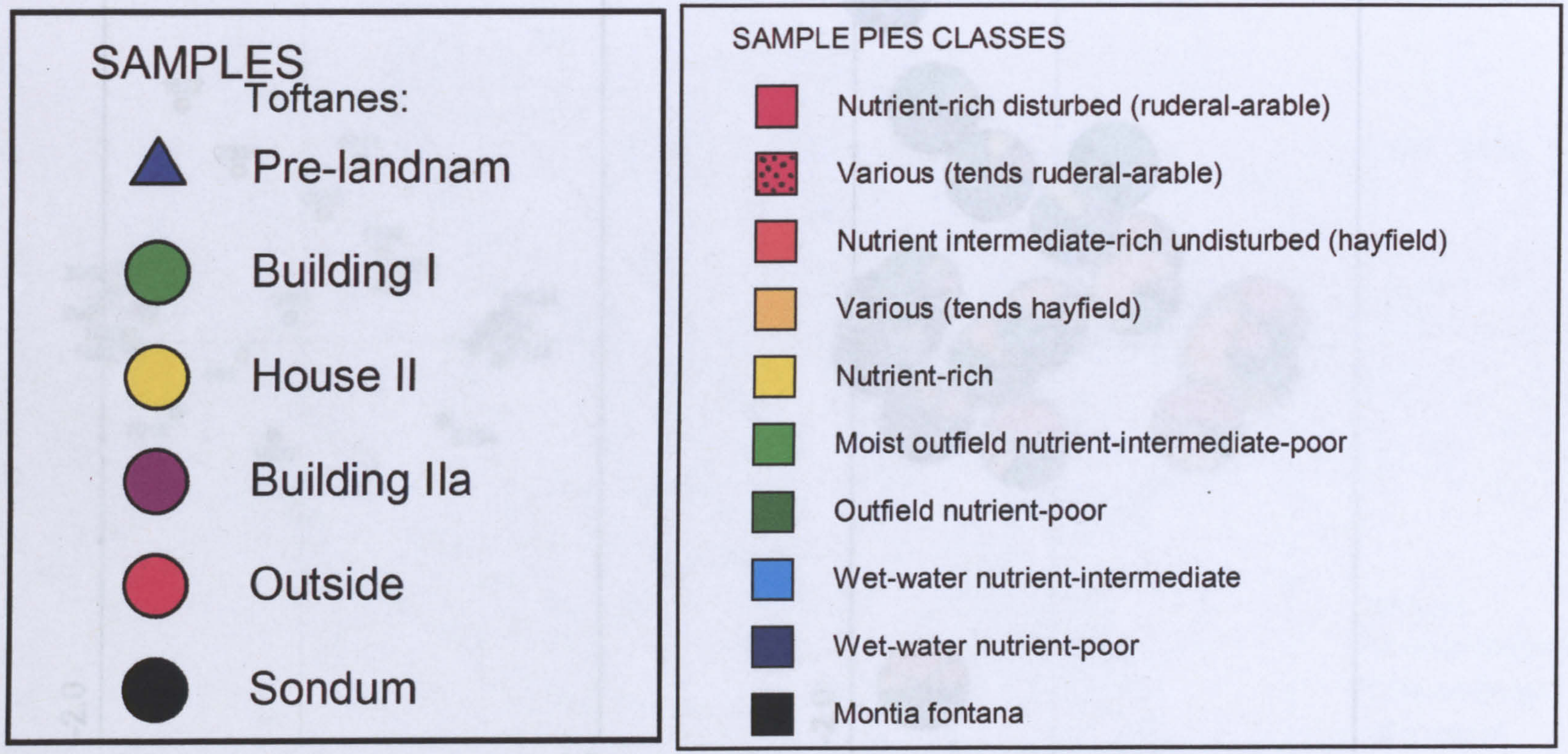


Fig. 5.20. Keys for graphs in this chapter a) Toftanes settlement areas and phases, and Sondum (in graphs where the two sites are compared) and b) habitat associations of taxa.

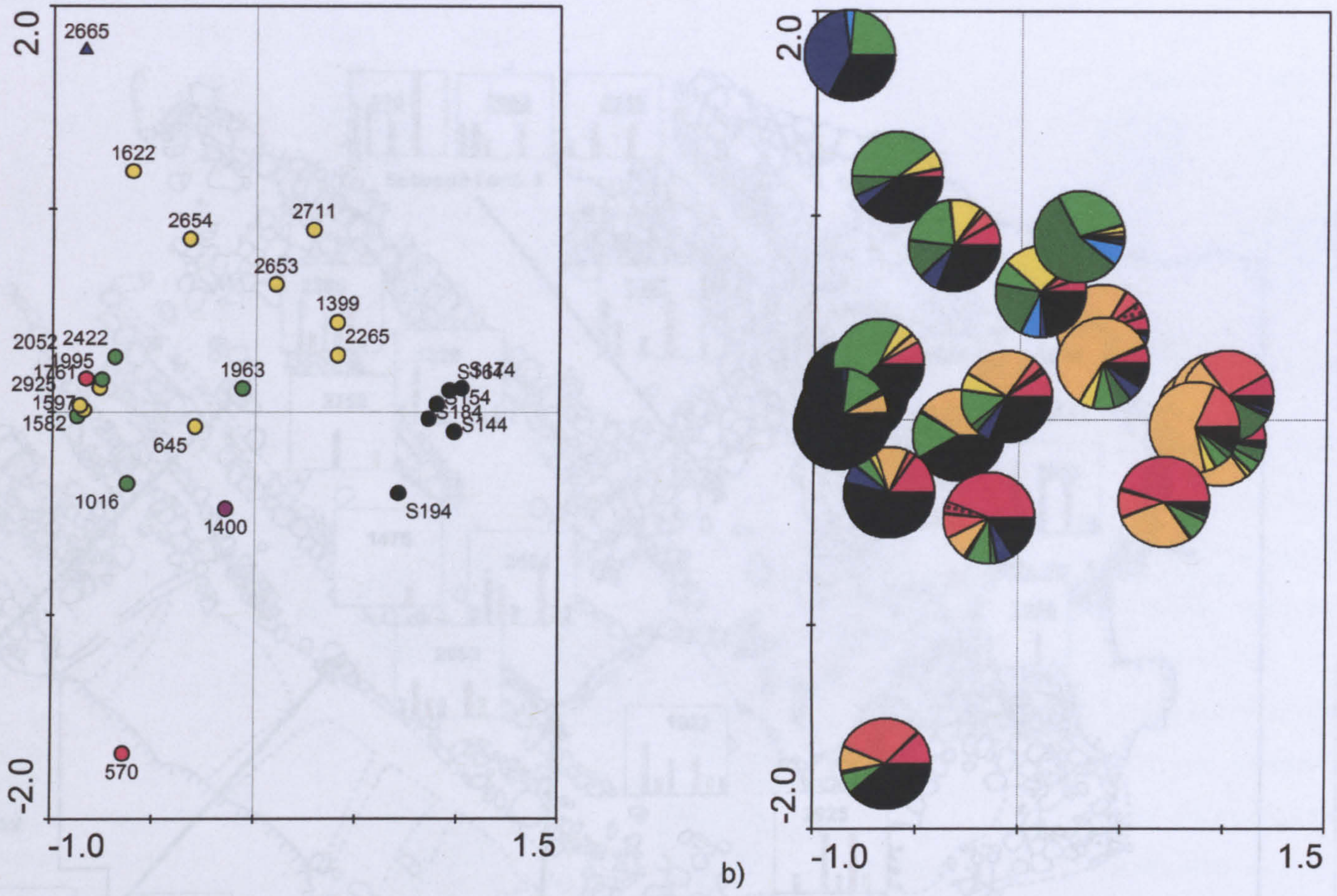


Fig. 5.21. Graphical representation of results of canonical analysis on samples from Toftanes and Sondum. All samples containing more than 50 counts were analysed, and all taxa present in more than 10% of samples. a) plot of samples categorised by archaeological context – see Fig. 5.20a for key; b) plot of samples represented as pie charts with species categorised by habitat association category.

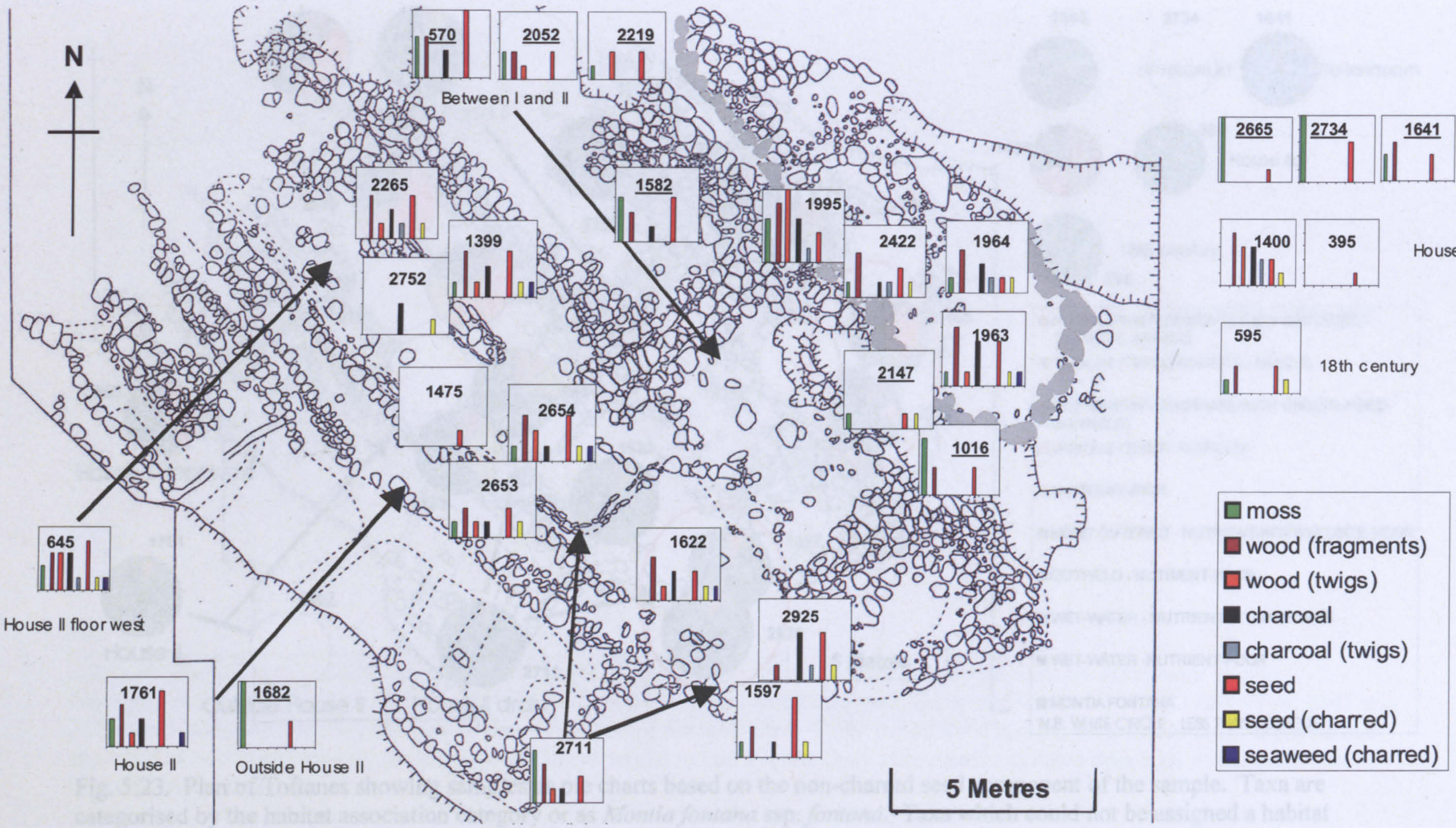


Fig. 5.22. Plan of Toftanes with bar charts indicating major constituents of the bulk sample matrix (the *y*-axis represents the 5 point scale presented in Table 4.10). Samples located on plan based on position in section drawings. Samples located with arrows indicate approximate location based on context description.

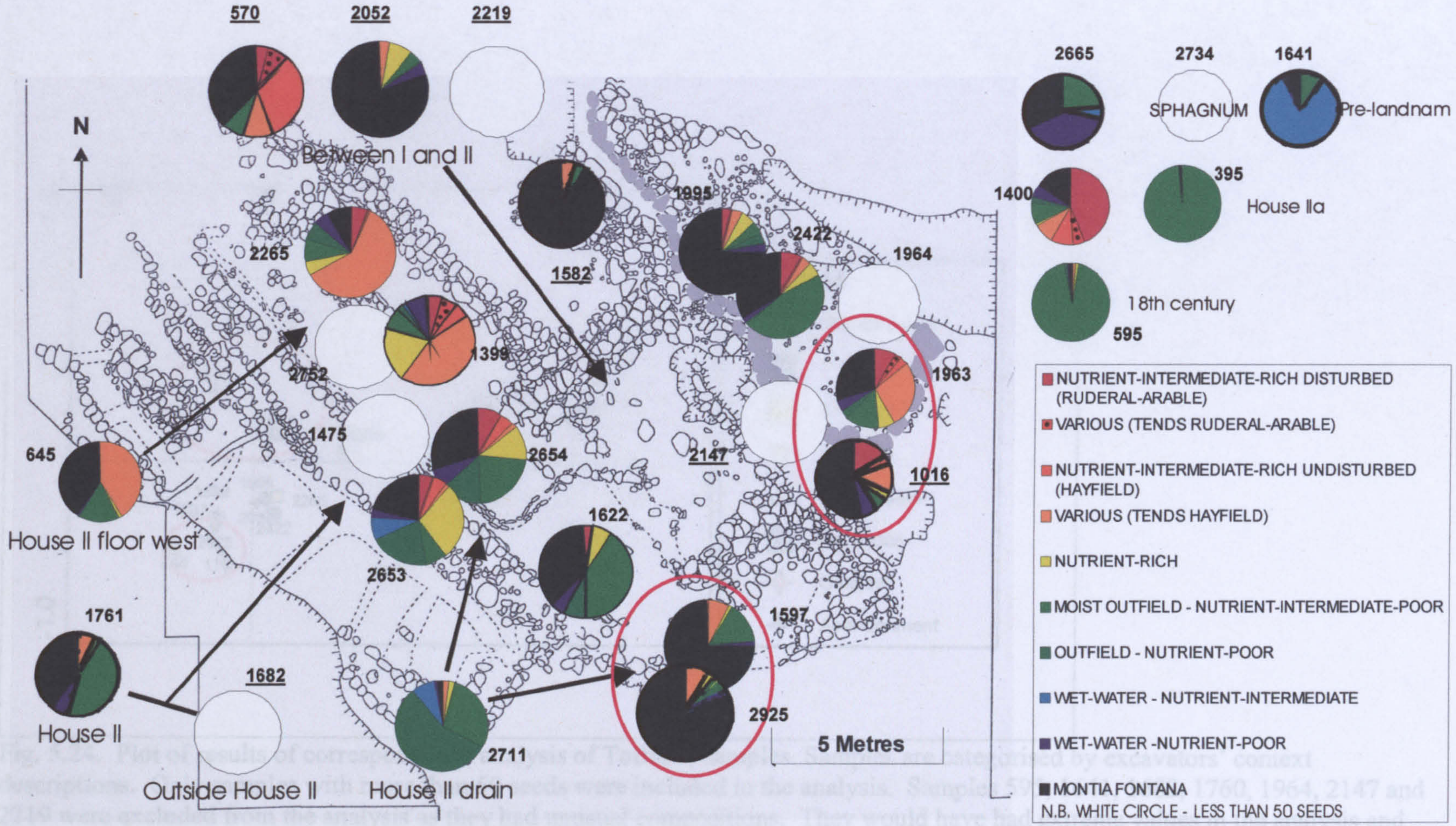


Fig. 5.23. Plan of Toftanes showing samples as pie charts based on the non-charred seed component of the sample. Taxa are categorised by the habitat association category or as *Montia fontana* ssp. *fontana*. Taxa which could not be assigned a habitat association category are not included in the counts. Samples located with arrows indicate approximate location based on context description. Samples with similar seed composition in spite of different archaeological phasing are marked with red circle.

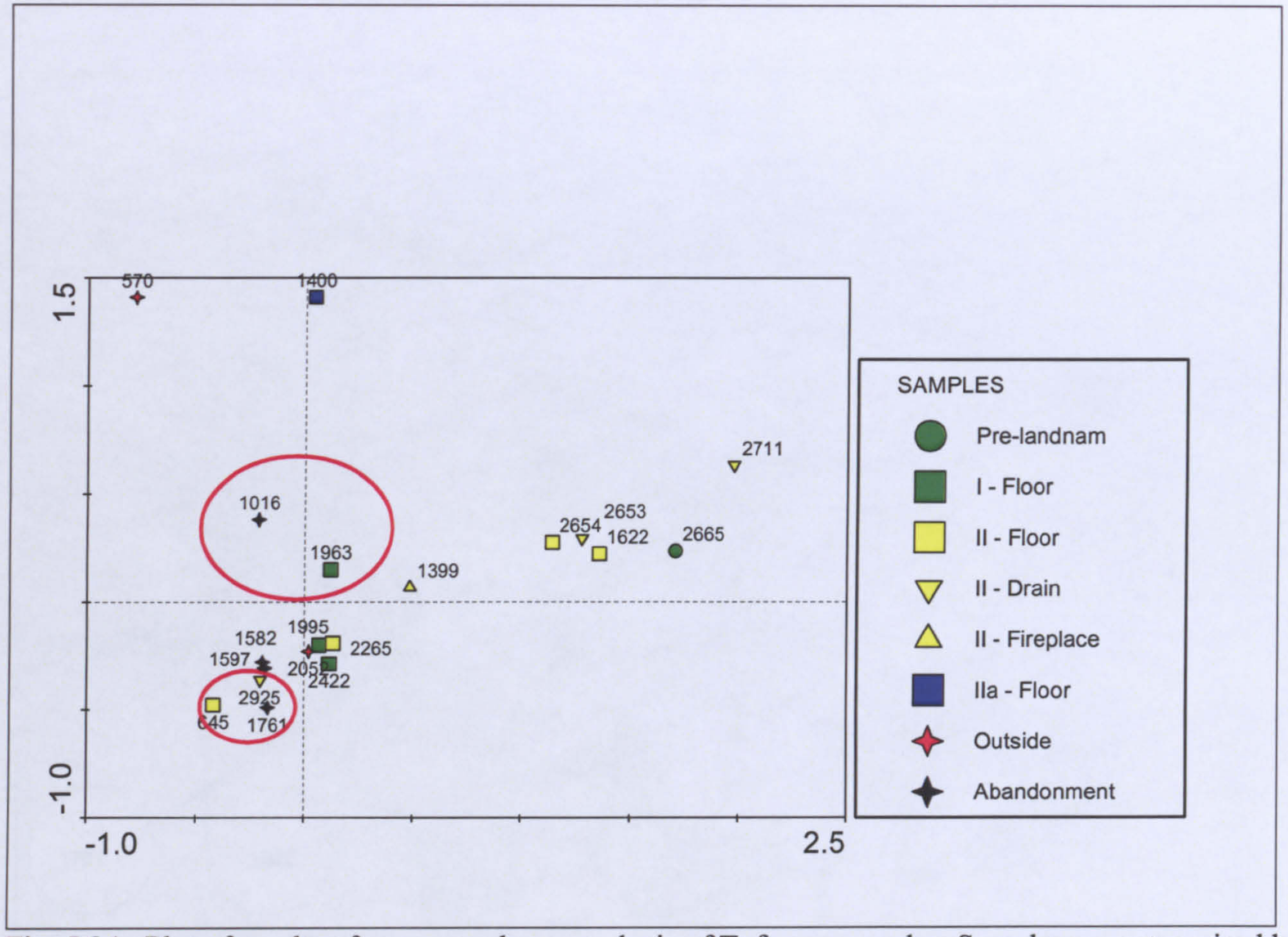


Fig. 5.24. Plot of results of correspondence analysis of Toftanes samples. Samples are categorised by excavators' context descriptions. Only samples with more than 50 seeds were included in the analysis. Samples 595, 1641, 1682, 1760, 1964, 2147 and 2219 were excluded from the analysis as they had unusual compositions. They would have had extreme values in the analysis and appeared as outliers in the plot, so the patterns above would not be visible. Only taxa present in more than 10% of samples were included in the analysis.

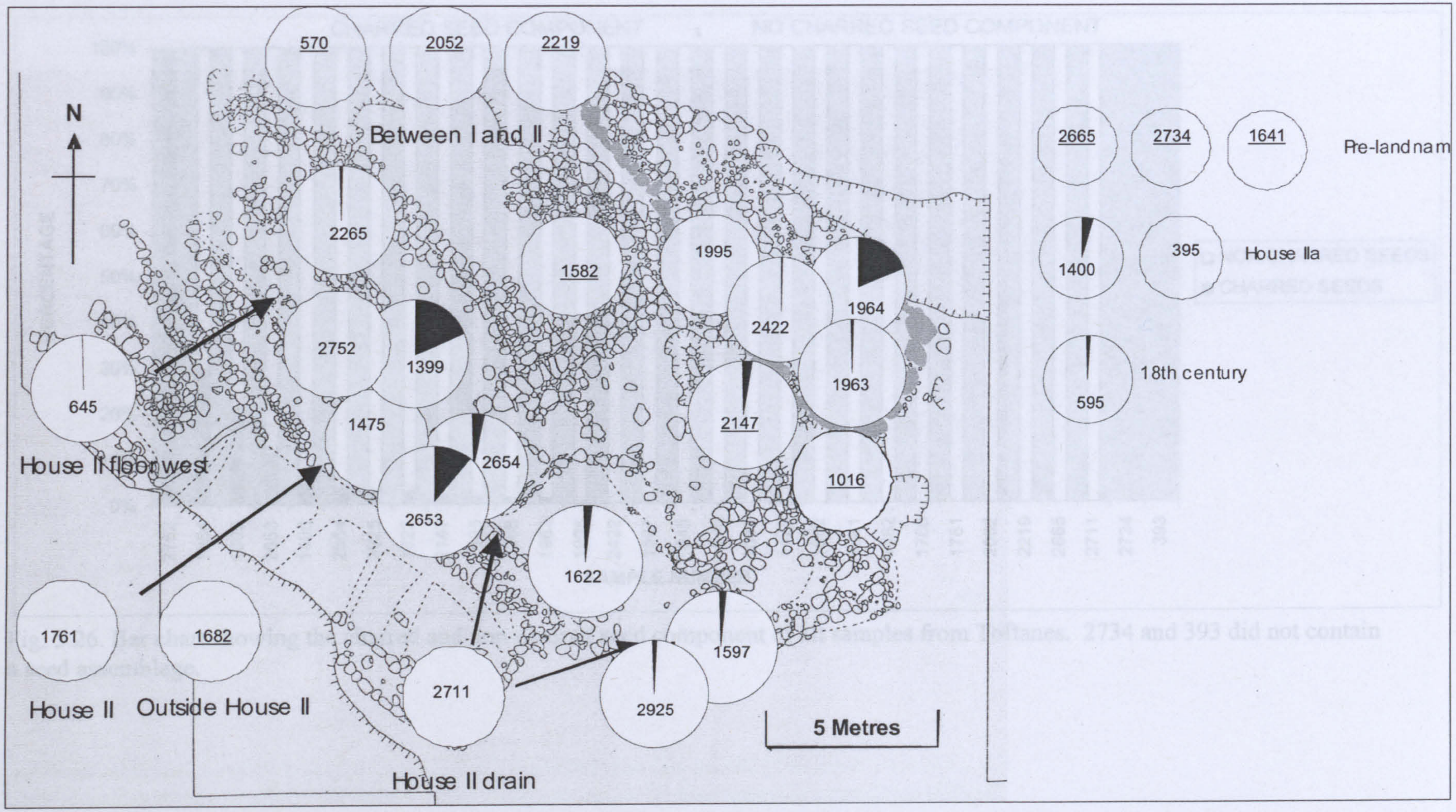


Fig. 5.25. Plan of Toftanes with samples represented as pie charts showing the charred (black) and non-charred (white) seed component. Samples located with arrows indicate approximate location based on context description. All seeds are included in the counts.

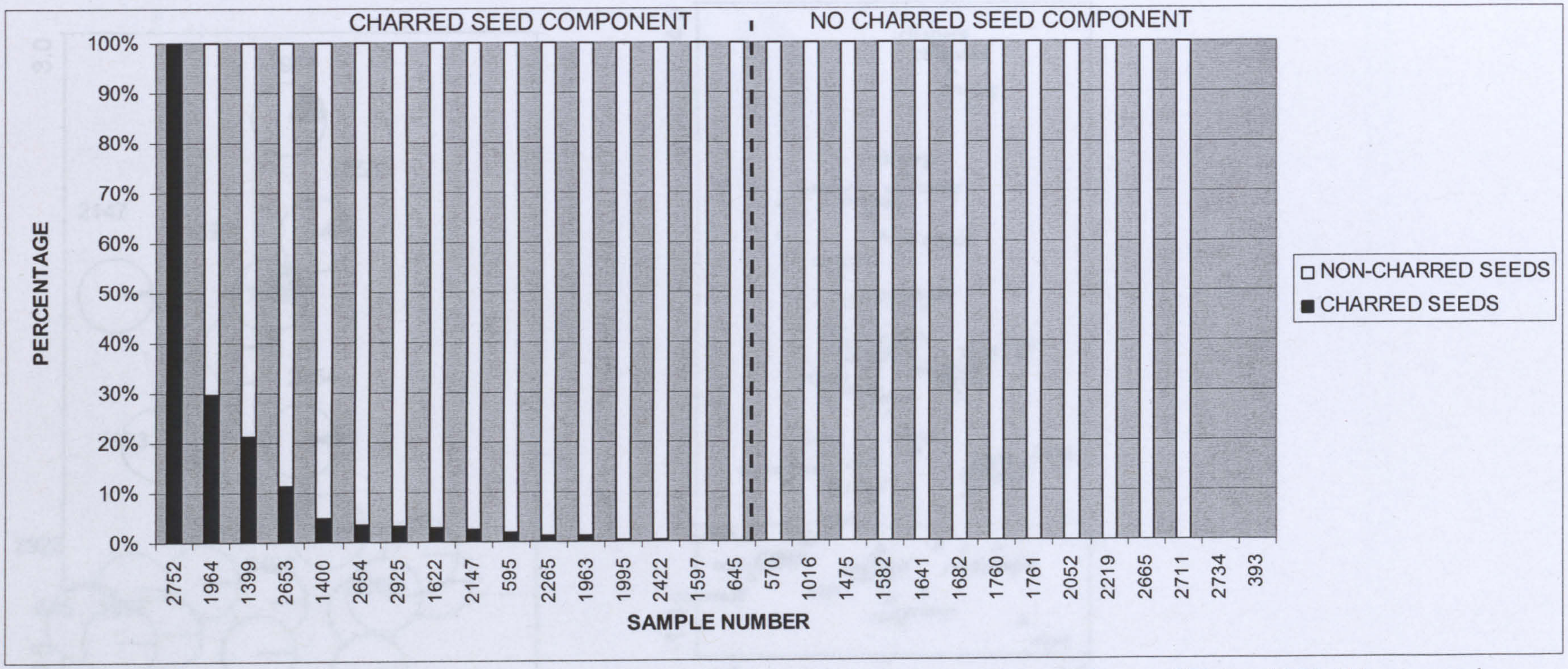
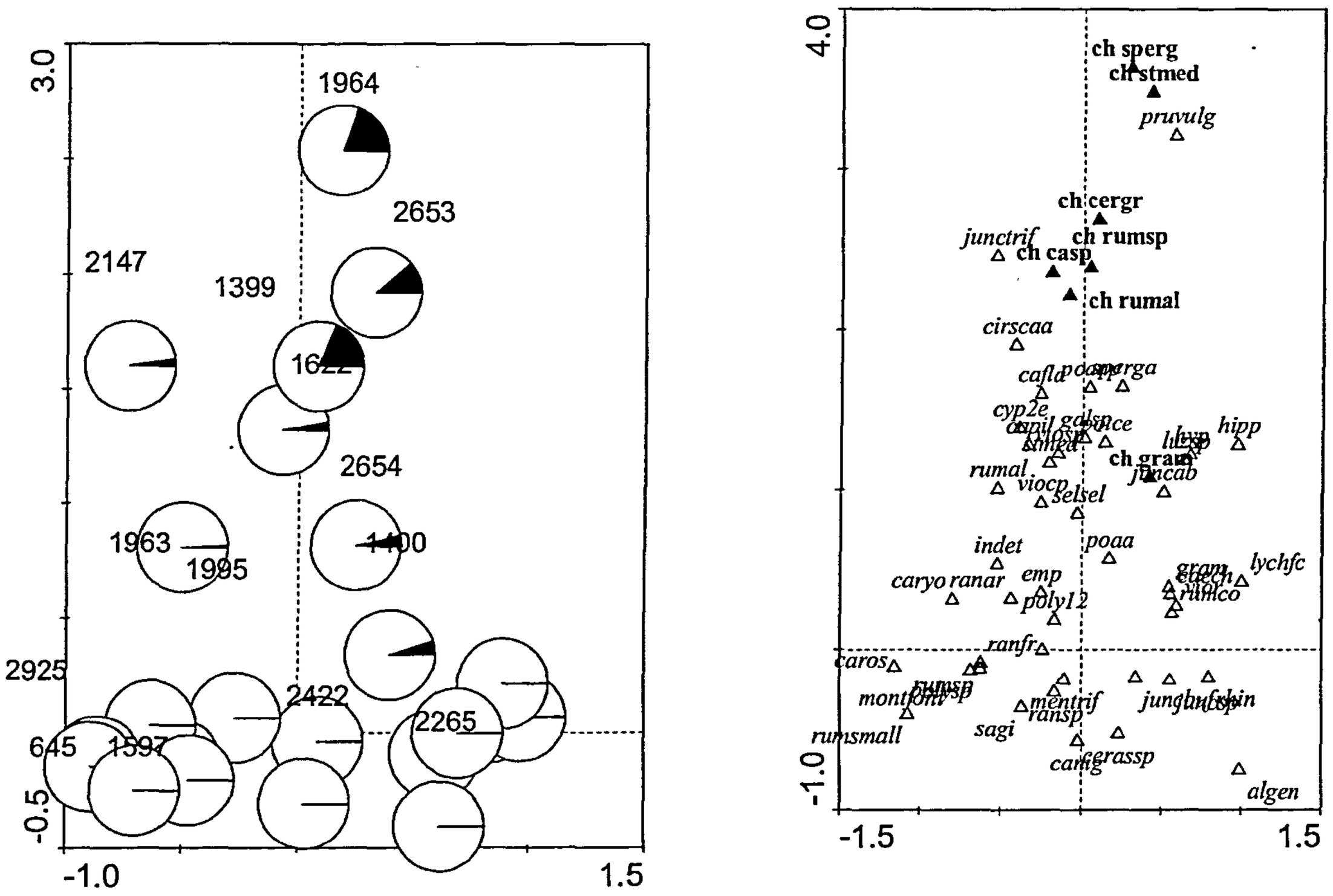


Fig. 5.26. Bar chart showing the charred and non-charred seed component of all samples from Toftanes. 2734 and 393 did not contain a seed assemblage.



a) b)

Fig. 5.27. Graphical representation of results of canonical analysis on samples from Toftanes. All samples containing more than 30 counts were analysed, and all taxa present in more than 10% of samples. a) showing samples represented as pie charts categorised by charred (black) and non-charred (white) seed component. Samples with a charred seed component are labelled with their sample number; b) Charred types are labelled in bold script and with black triangles, non-charred types are labelled in italics with white triangles.

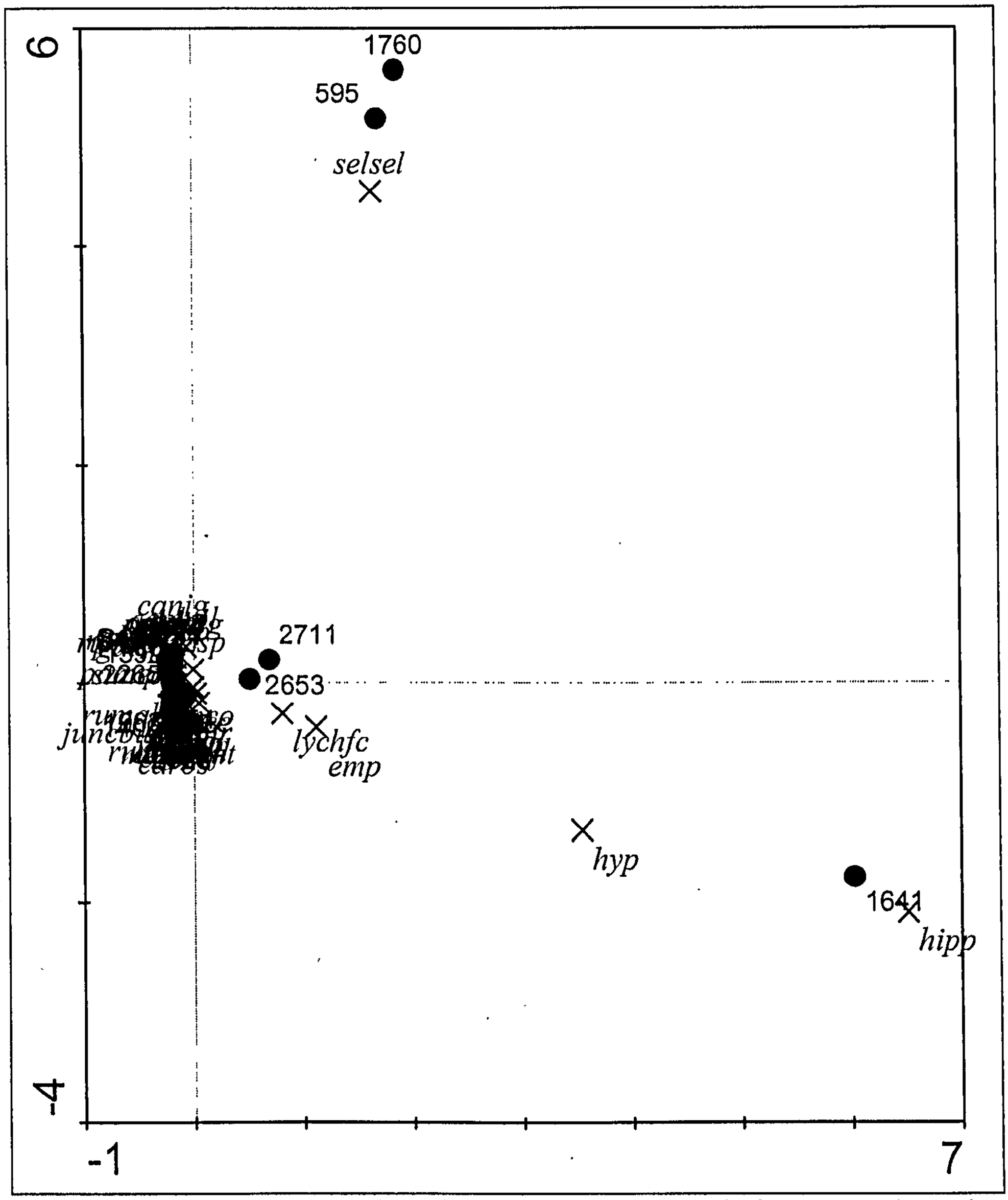


Fig. 5.28. Graphical representation of results of canonical analysis. 19 samples and 33 types were included in the analysis. Samples containing less than 30 items were excluded (samples 393, 1475, 1682, 1964, 2147, 2219, 2734 and 2752) as were seed types present in less than 10% of the samples. Samples are marked with circles and types with crosses. Hipp indicates *Hippuris vulgaris*, selsel indicates *Selaginella selaginoides*.

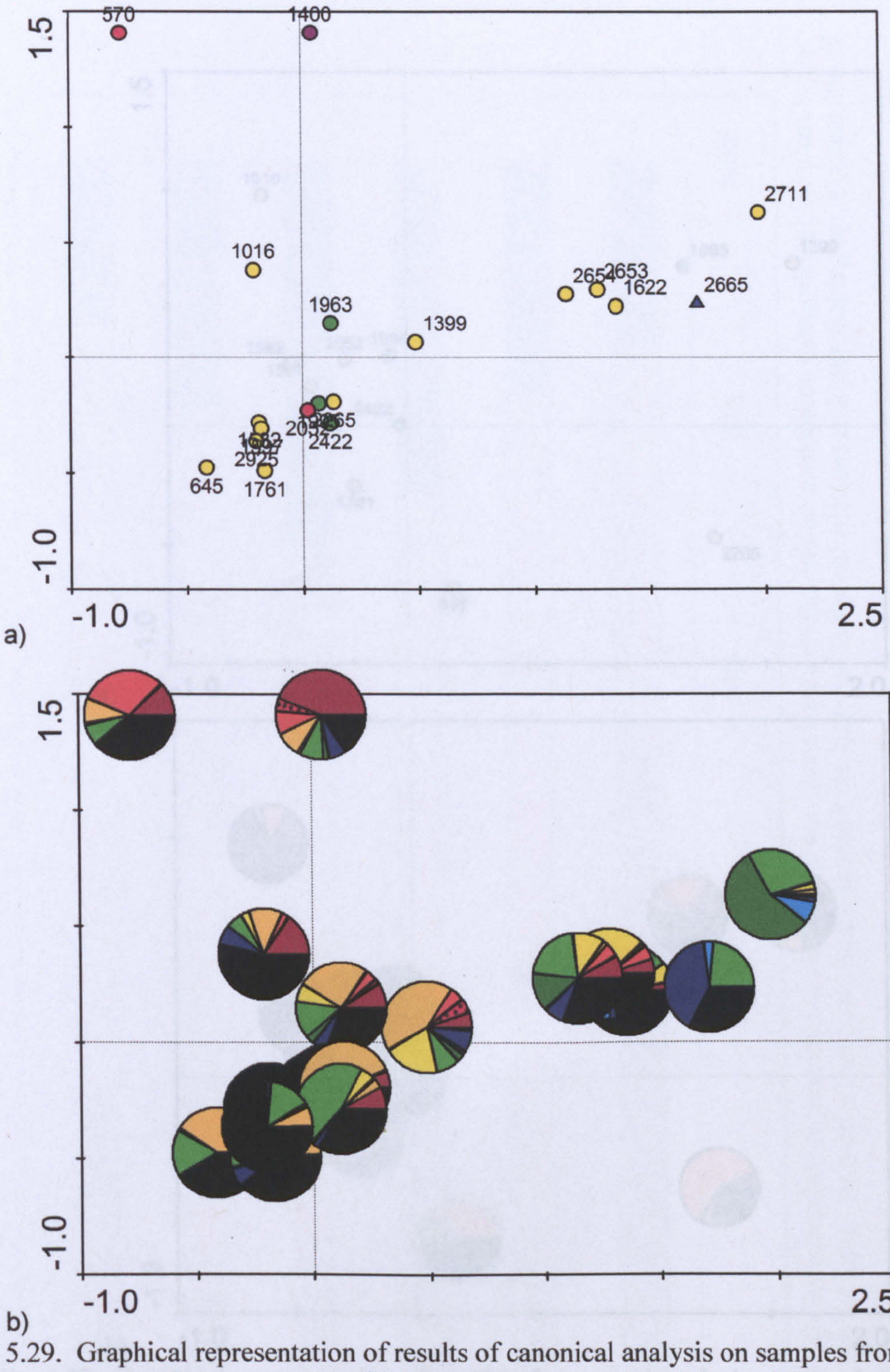


Fig. 5.29. Graphical representation of results of canonical analysis on samples from Toftanes. Only samples containing more than 30 items were analysed, and the outlying samples from Fig. 5.28 (595, 1641 and 1760) were excluded. All taxa present in more than 10% of samples were included. a) plot of samples categorised by archaeological context. See Fig. 5.20a for key; b) plot showing samples represented as pie charts based on the seed component of the samples, with taxa categorised by their habitat association category. See Fig. 5.20b for key.

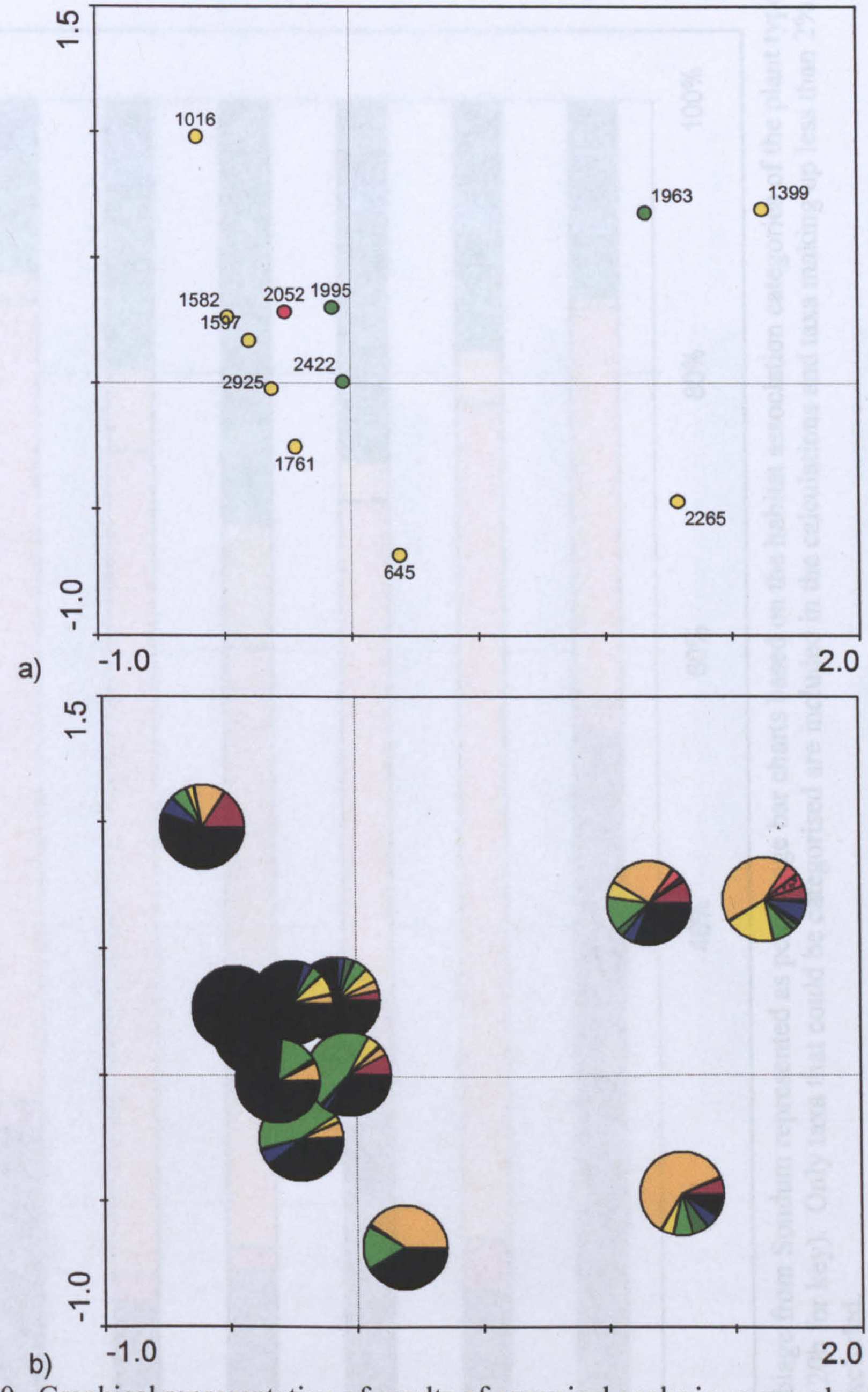
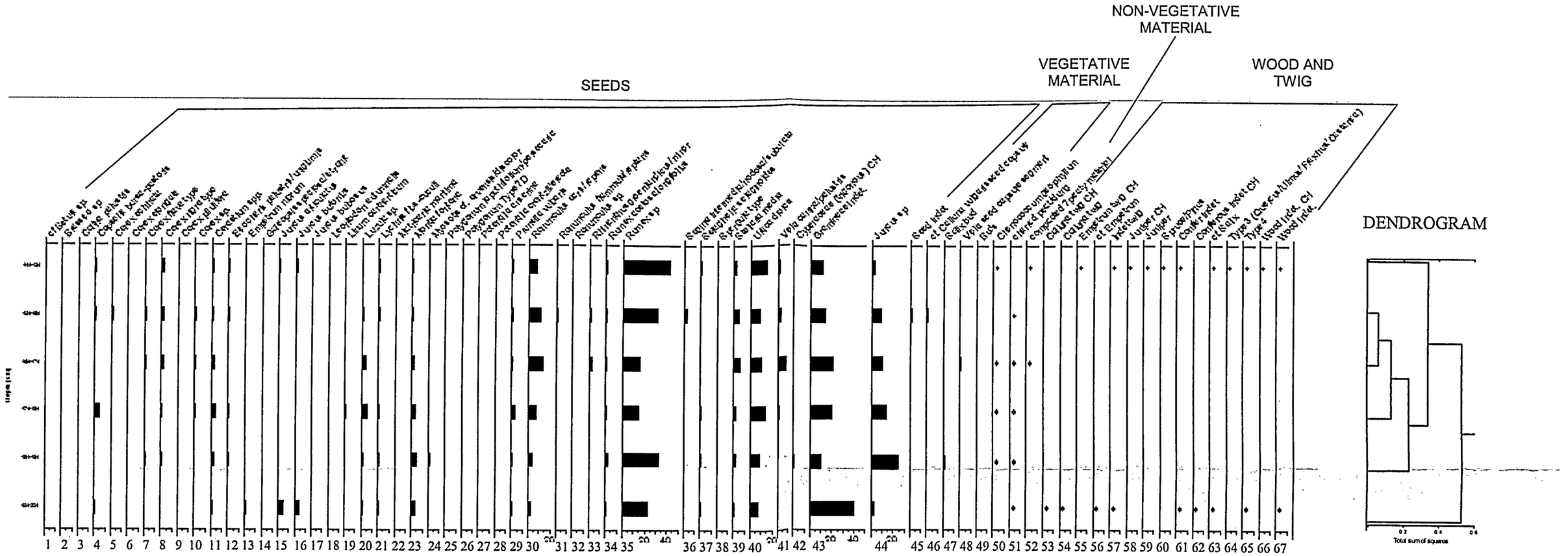


Fig. 5.30. Graphical representation of results of canonical analysis on samples from Toftanes. Only samples containing more than 30 items were analysed, and the outlying samples from Fig. 5.28 and 5.29 (570, 595, 1400, 1622, 1641, 1760, 2653, 2654, 2665 and 2711) were excluded. All taxa present in more than 10% of samples were included. a) plot of samples categorised by archaeological context. See Fig. 5.20a for key; b) plot showing samples represented as pie charts based on the seed component of the samples, with taxa categorised by their habitat association category. See Fig. 5.20b for key.



1	cf. Betula sp.	16	Juncus bufonius	31	Ranunculus flammula/reptans	46	cf. Calluna vulgaris seed capsule	61	Conifer indet.
2	Brassica sp.	17	Juncus bulbosus	32	Ranunculus sp.	47	Salix bud	62	Coniferous indet. – charred
3	Caltha palustris	18	Leontodon autumnalis	33	Rhinanthus groenlandicus/minor	48	Viola seed capsule segment	63	cf. Salix
4	Capsella bursa-pastoris	19	Linum cartharticum	34	Rumex acetosa/longifolius	49	Bud	64	Type 3 (Quercus/Ulmus/Fraxinus/Castanea)
5	Carex echinata	20	Luzula sp.	35	Rumex sp.	50	Cenococcum geophilum	65	Type 4
6	Carex elongata	21	Lychnis flos-cuculi	36	Sagina intermedia/nodosa/subulata	51	Charred peat/dung	66	Wood indet. – charred
7	Carex flava-type	22	Matricaria maritima	37	Selaginella selaginoides	52	Compacted ?peaty material	67	Wood indet.
8	Carex nigra-type	23	Montia fontana	38	Spergula type	53	Calluna vulgaris twig - charred		
9	Carex pilulifera	24	Myosotis cf. arvensis/discolor	39	Stellaria media (L.) Vill.	54	Calluna vulgaris twig		
10	Carex sp.	25	Polygonum lapathifolium/persecaria	40	Urtica dioica L.	55	Empetrum twig - charred		
11	Cerastium spp.	26	Polygonum Type ?D	41	Viola canina/palustris	56	cf. Empetrum		
12	Eleocharis palustris/uniglumis	27	Potentilla anserina L.	42	Cyperaceae - charred	57	Indet. twig		
13	Empetrum nigrum	28	Potentilla crantzii/erecta	43	Gramineae indet.	58	Juniperus communis – charred		
14	Galeopsis speciosa/tetrahit	29	Prunella vulgaris	44	Juncus sp.	59	Juniperus communis		
15	Juncus articulatus	30	Ranunculus acris/repens	45	Seed indet.	60	Spruce/Pinus		

Fig. 5.31. TILIA graph showing all taxa recovered from the Sondum midden. Individual charts are numbered and titles listed below for clarity.

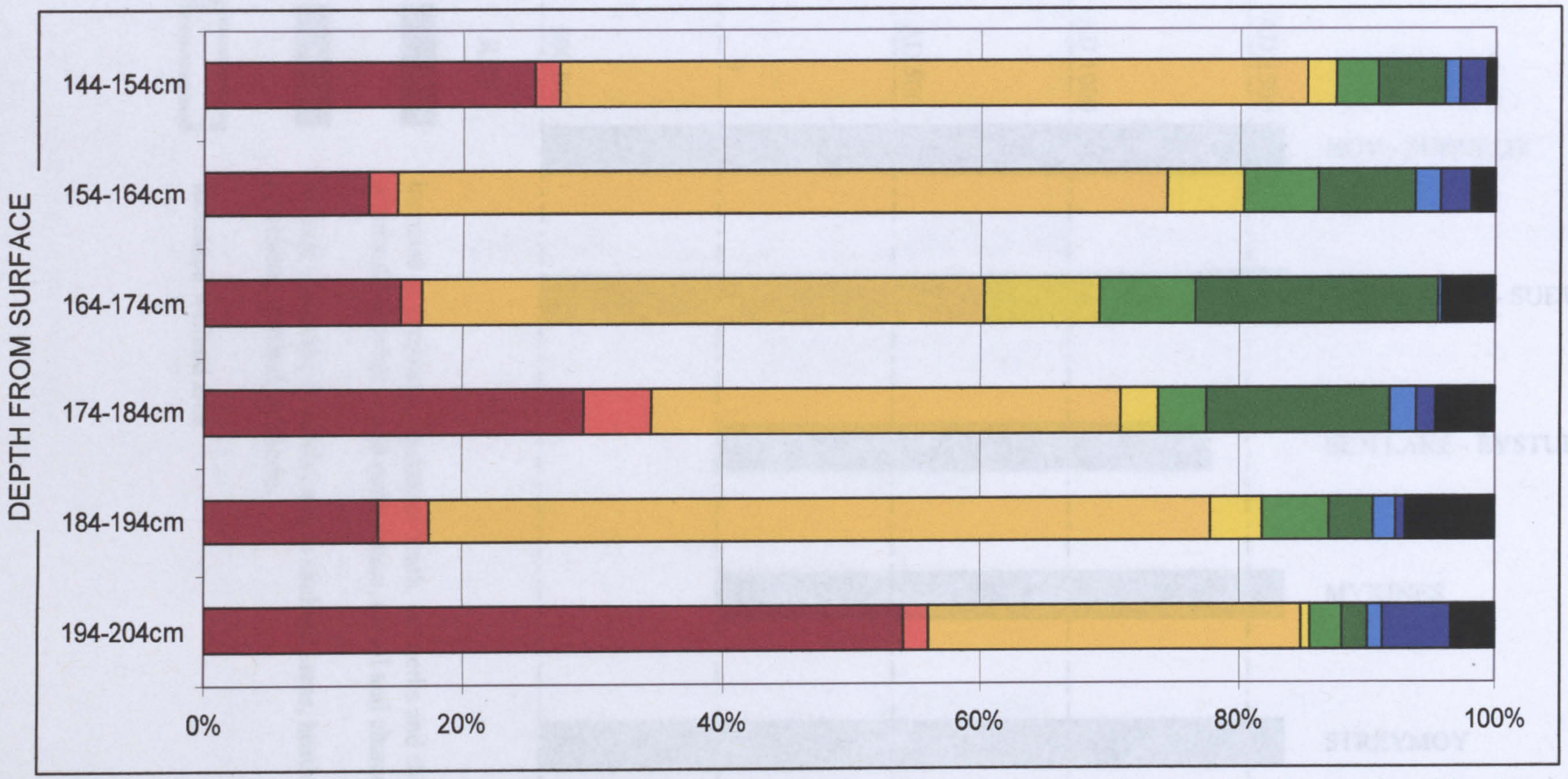


Fig. 5.32. Seed assemblage from Sondum represented as percentage bar charts based on the habitat association categories of the plant types represented (see Fig. 5.20b for key). Only taxa that could be categorised are included in the calculations and taxa making up less than 2% of the assemblage were excluded.

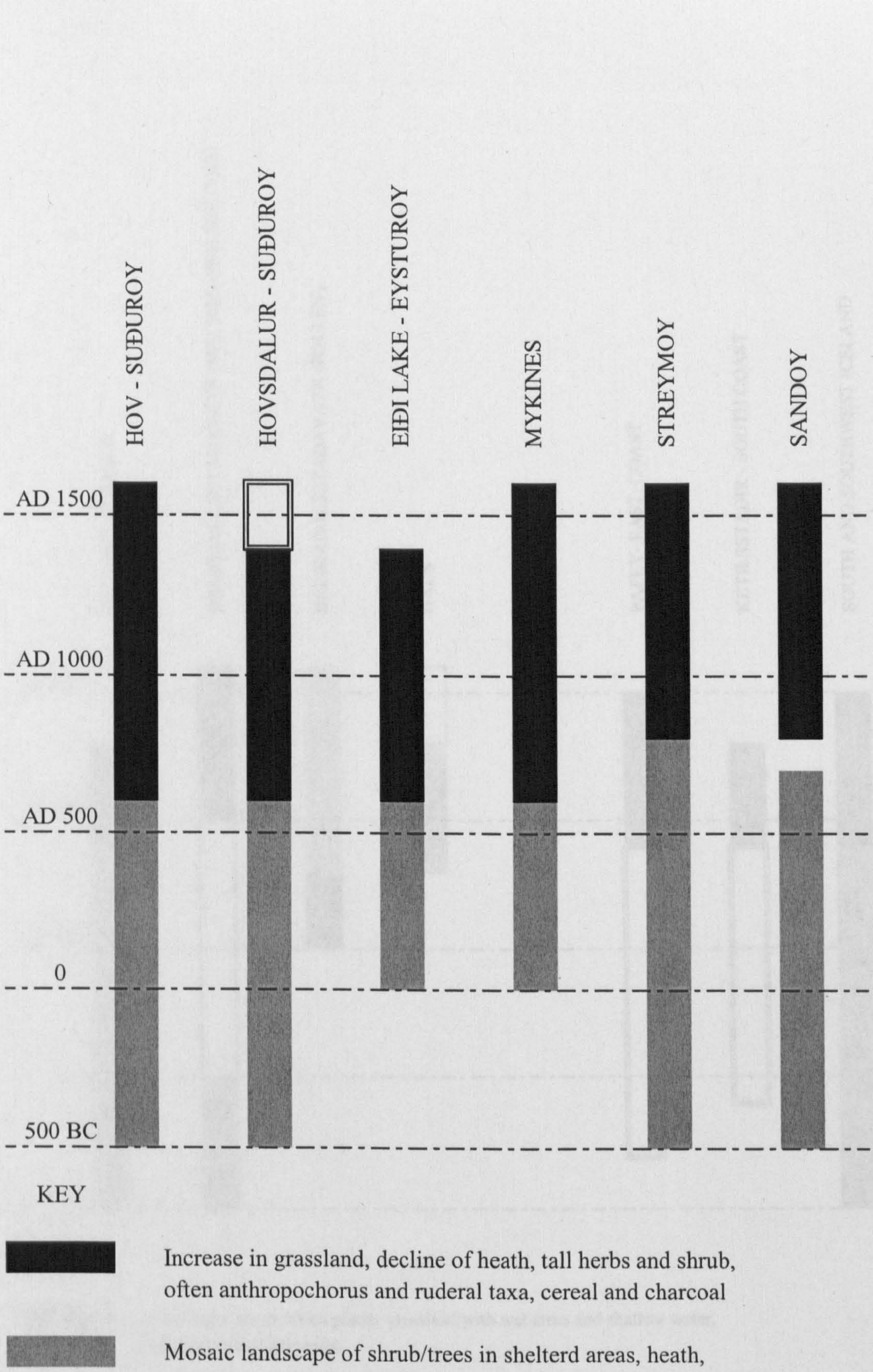
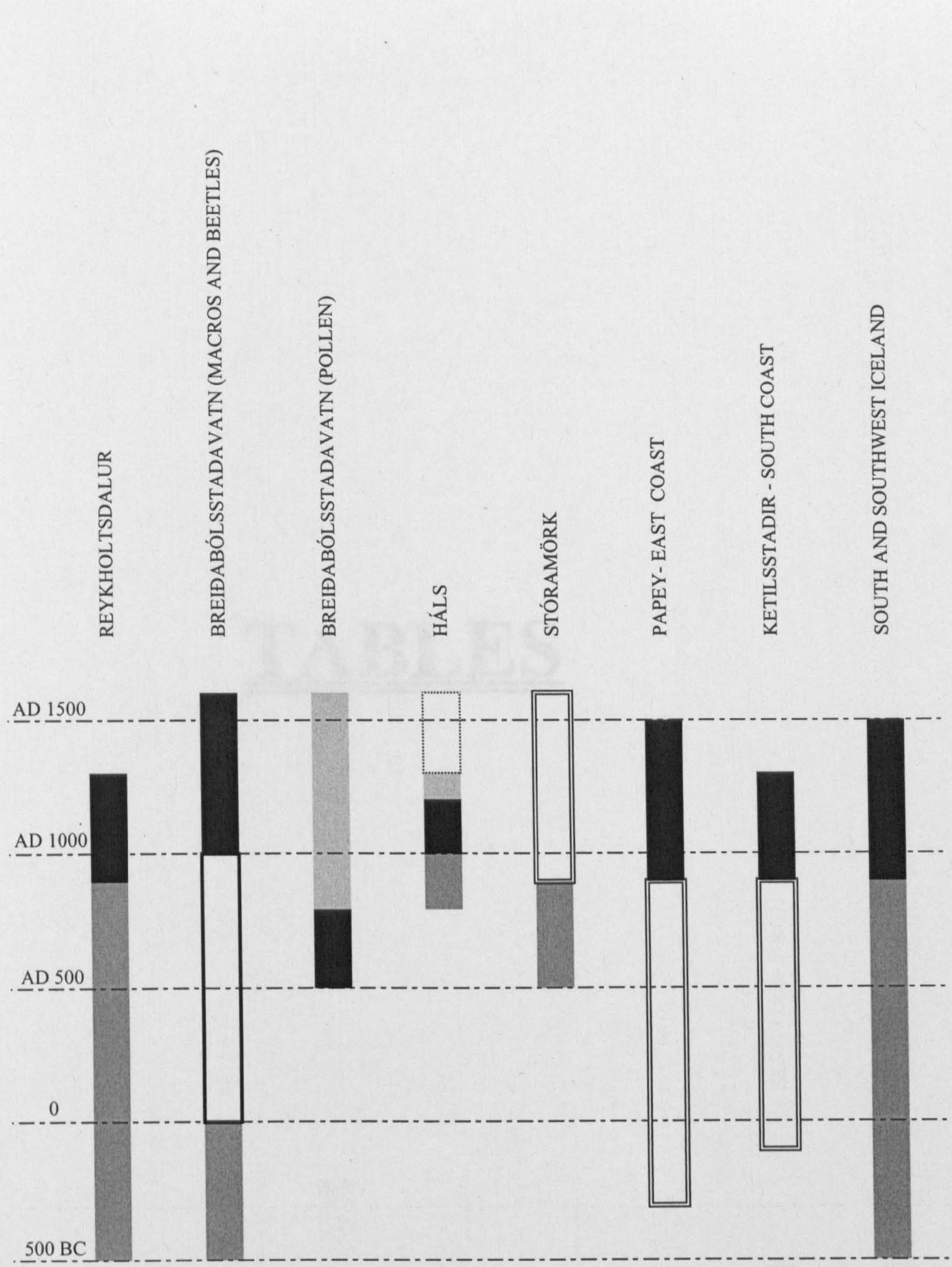


Fig. 6.1. Summary of changes in plant communities in the Faroe Islands from 500 BC to AD 1500, based on plant macrofossil, pollen and beetle research.



KEY

Betula and *Salix* scrub, heath plants, grassland with wet areas and shallow water, Cyperaceae and Gramineae

Open ground, wetland and grassland, high proportion of Gramineae, decreasing cover of shrub/trees, usually drier, often with anthropochores and charcoal.

Wetland/bog, open with no local trees

?Cut over

Open heath, Cyperaceae > Gramineae

Resurgence of *Betula*

Fig. 6.2. Summary of changes in plant communities in Iceland from 500 BC to AD 1500, based on plant macrofossil, pollen and beetle research.

TABLES

	COUNTRY	SITE	TYPE OF SITE	CONTEXT	DATE	CHARRED	NON-CHARRED	CEREAL										
								Hulled barley (Hordeum vulgare)	Naked barley (Hordeum vulgare)	Barley (Hordeum vulgare)	Rye (Secale cereale)	Oat (Avena sativa)	Bread wheat (Triticum aestivum)	Emmer (Triticum dicoccum)	Einkorn (Triticum monococcum)	Spelt (Triticum spelta)	Wheat (Triticum sp.)	Cereal	Millet (Panicum/Setaria)
Period of Atlantic settlement (=>900)	Denmark	Gammel Lejre	settlement	postholes, fill of pithouse, drying oven	c. 660-c. 900AD	present		##	#		##	##					#		
	Denmark	Ribe, Kunstmuseet	proto-town	yard	8th century		present			#									
	Denmark	Ribe, Dommerhaven	proto-town	manure layer	8th century		present												
	Denmark	Ribe, Tvedgade	proto-town	compressed manure with straw	?8th century		present												
	Denmark	Øster Aalum, Thy		fill of ?pithouse, ploughsoil and ditches	780-885	present		##			##	##							
	Denmark	Trabjerg		well	c. 873	some	present			#	##								#
	Denmark	Ejstrup		posthole and fill of pithouse	885-895	present		##			##	#							
	Finland	Pahamäki	cairn	ditch fill	700-900	present				##	##	#	#						
	Germany	Kosel	settlement		late 8th century	present				##	##	##	#	#					#
	Norway	Borg	longhouse	postholes	600-1000	present		#											
	Norway	Oseberg	ship burial	grave gifts	c. 800		present											#	
	Sweden	Ljunga	grave	bread		present												#	
Later Viking (900-1050)	Denmark	Aggersborg	village	rubbish pit	10th century	present			?	##	##	#							
	Denmark	Fyrkat	fort	longhouse	10th century	present		#			##								
	Denmark	Århus, Søndervold		fills of pithouses	late Viking		present			##	##								
	Germany	Haithabu	proto-urban		800-1000	present		##			##	##	#						#
	Norway	Kaupang	trading port		late 8th - mid 10th centuries	some	present			#	#	#					#		
	Sweden	Ystad	summary of several in area		Viking age	present		#			#								
	Sweden	Björkö Strait	outside Birka proto-town	waterside	pre-1000		present												
	Sweden	Birka	cremation graves	bread		present		#	#		#								
	Sweden	Birka	Black Earth (settlement area)					#		#	#	#	#						
Medieval (1050=>)	Denmark	Viborg St. Skt. Peterstræde	proto-town	ploughsoil, stable floor, pit, yard (successive phases)	1025-1125		present			#									
	Denmark	Viborg Søndersø	proto-town	middens, well, latrine, floor	11th century	some	present			##	##	##							
	Denmark	Svendborg	town	rubbish	1170-1190?					#	##	#							
	Denmark	Svendborg	proto-town		1308-1318	present		##			#	#							
	Denmark	Svendborg	proto-town	dung	1308-1318														
	Denmark	Svendborg	proto-town	latrine	1318-1543							#							
	Denmark	Svendborg	proto-town	dung	1543														
	Denmark	Ribe, Sønderportsgade 1	proto-town	yard/garden	c 440-1580		present			#									
	Denmark	Svendborg	proto-town	rubbish	?					#	#	#							
	Denmark	Svendborg	Foldagers Gård		1100+/-50 to c.1600					#									
	Denmark	Svendborg	Korsgade 4		before 1150-1200 to c.1400-1500					#									
	Denmark	Svendborg	Krøyers Have		1210+/-50 to c.1550														
	Denmark	Svendborg	Franciscan Monastery		early Medieval														
	Norway	Gamlebyen, Oslo	trading port	animal dung	1000-1100	few	present			#									
	Norway	Trondheim	proto-town		1100 onwards														
	Norway	Gamlebyen, Oslo	trading port		1150-1200		present												
	Norway	Gamlebyen, Oslo	trading port	between two logs in floor of house	1200-1300	present				#									
	Norway	Bryggen, Bergen	proto-town	occupation layers	1248	present				#		#							
	Norway	Bryggen, Bergen	proto-town	latrine	1250	present													
	Norway	Gamlebyen, Oslo	trading port	latrine	1300-1400		present												
	Norway	Bryggen, Bergen	proto-town	occupation layers	1350	present				##	##	#							
	Norway	Bryggen, Bergen	proto-town	occupation layers	1415	present				#									
	Norway	Bryggen, Bergen	proto-town	occupation layers	1702	present					#								
	Norway	Bryggen, Bergen	proto-town	occupation layers inbetween fire events			present												

KEY - ## indicates major component, # indicates presence, ? possible identification, 'pollen' indicates identified in pollen assemblages.

Table 2.1 Summary of details and major components of archaeobotanical assemblages from Scandinavia.

		PULSE				NUT			FRUIT			USEUL PLANTS																								OTHER MATERIAL									WILD PLANT HABITATS									
COUNTRY	SITE	Pea (Pisum sativum)	Celtic bean (Vicia faba)	Common vetch (Vicia sativa)	Vetch	Hazel nut (Corylus avellana)	Walnut (Juglans regia)	Nut	Fig (Ficus sp.)	Grape (Vitis sp.)	Wild berries	Fruit p/p	Bishop's weed (Aegopodioum poagraria)	Bog myrtle/Sweet gale (Myrica gale)	Brassica sp	Brome (Bromus spp.)	Caraway (Carum carvi)	Common mallow (Malva sylvestris)	Coriander (Coriandrum sativum)	Dill (Anethu graveolens)	Elder (Sambucus)	Fairy flax (Linum catharticum)	Flax (Linum usitatissium)	Gold of Pleasure (Camelina sativa)	Hemp (Cannabis sativa)	Henbane (Hyoscyamus niger)	Hop (Humulus lupus)	Meadowsweet (Filipendula ulmaria)	Opium poppy (Papaver sominferum)	Wild celery (Apium graveolens)	Woad (Isatis tinctoria)	Charcoal/twig	Woodchips	Scots Pine bark (Pinus scotia)	Peat	Dung	Moss	Straw	Seaweed	Tree/shrub	Ruderal	Arable Weed	Meadow	Grassland	Heath	Wetland	Shore	Aquatic	Range of habitats	REFERENCE
Denmark	Gammel Lejre					#										#																																	Robinson 1991, Robinson 1994
Denmark	Ribe, Kunstmuseet					#					#			#																											#							#	Jensen 1986
Denmark	Ribe, Dommerhaven										#																																				#	Jensen 1986
Denmark	Ribe, Tvedgade					#					#			#													#	#																		#	Jensen 1986
Denmark	Øster Aalum, Thy															#																																Robinson 1994
Denmark	Trabjerg																						#																									Robinson 1994
Denmark	Ejstrup															#							#																									Robinson 1994
Finland	Pahamäki	#																																			#												Onnela et al 1996
Germany	Kosel	#	#			#					#	#					#			#		#	#			#																					Müller-Wille et al 1988
Norway	Borg										#																						#								#								Hansson 1997
Norway	Oseberg							#				#																			#																	Holmboe 1927 in Hansson 1997
Sweden	Ljunga	#																																#													Hansson 1997
Denmark	Aggersborg					#																											#			#		#		#	#			#	#	#	#	Robinson 1994, Jensen 1985; Helbaek 1977
Denmark	Fyrkat										#							#														#															Robinson 1994, Jensen 1985; Helbaek 1977
Denmark	Århus, Søndervold	#														#							#																								Robinson 1994
Germany	Haithabu		#				#	#		#	#		#										#				#																				Behre 1983 in Geraghty 1996
Norway	Kaupang					#					#	#											#		#		#			#		#				#	#									Hall and Kenward 2003-4
Sweden	Ystad																					#					#							#													Engelmark 1992; Helbaek 1974
Sweden	Björkö Strait										#	#									#						#						#													Hansson and Dixon 1997, Hansson 1997
Sweden	Birka	#		#																		#																									Hansson 1997
Sweden	Birka					#					#	#															#	#																				Hansson 1997
Denmark	Viborg St. Skt. Peterstræde										#		#							#	#	#				#																					#	Jensen 1986
Denmark	Viborg Søndersø	#																					#																								Robinson 1994
Denmark	Svendborg					#					#			#			#			#		#							#										#		#		#	#	#	Jørgensen *et al.* 1986
Denmark	Svendborg																						#	#	#														#		#		#			Jørgensen *et al.* 1986
Denmark	Svendborg					#	#				#		#										##				#		#										#		#		#	#		Jørgensen *et al.* 1986
Denmark	Svendborg					#	#				#	#	#	#	#	#							##				#		#										#		#		#	#		Jørgensen *et al.* 1986
Denmark	Svendborg					#	#							#													#		#										#		#		#	#		Jørgensen *et al.* 1986
Denmark	Ribe, Sønderportsgade 1										#	#	#							#			#				#																		#	Jensen 1986
Denmark	Svendborg					#							#	#					#	#			#				#	#												#		#		#	#		Jørgensen *et al.* 1986
Denmark	Svendborg					#					#		#										#				#													#	#		#	#		Jensen 1979
Denmark	Svendborg					#					#		#										#				#													#	#	#	#	#		Jensen 1979
Denmark	Svendborg										#												#				#													#				#	#	Jensen 1979
Denmark	Svendborg										#		#										#				#					#								#	#	#	#	#		Jensen 1979
Denmark	Svendborg										#		#										#				#					#														Griffin 1988
Norway	Gamlebyen, Oslo																						#																	#	#						Griffin and Sandvik 1991 in Geraghty
Norway	Trondheim					#					#	#											#		#																					Griffin 1988
Norway	Gamlebyen, Oslo					#																										#															Griffin 1988
Norway	Gamlebyen, Oslo																																														Krzywinski et al 1983
Norway	Bryggen, Bergen																																														Krzywinski et al 1983
Norway	Bryggen, Bergen					#			#		#																																				Griffin 1988
Norway	Gamlebyen, Oslo					#					#	#																																				Krzywinski et al 1983
Norway	Bryggen, Bergen																																														Krzywinski et al 1983
Norway	Bryggen, Bergen																																														Krzywinski et al 1983
Norway	Bryggen, Bergen		#			#																										#	#													Krzywinski et al 1983
Norway	Bryggen, Bergen																																														

Table 2.1 Summary of details and major components of archaeobotanical assemblages from Scandinavia.

							CEREAL							PULSE	NUT	FRUIT	USEUL PLANTS					
REGION	SITE	TYPE OF SITE	CONTEXT	DATE	CHARRED	NON-CHARRED	6 row hulled barley (Hordeum vulgare)	Oat (Avena sativa)	Avena fatua	Cultivated oat (Avena strigosa-type)	Emmer wheat (Triticum dicoccum)	Triticum aestivum	Rye (Secale cereale)	Vicia faba	Hazel (Corylus avellana)	Wild berries	Calluna/Erica	Flax (Linum usitatissimum)	Oraches/Brassicas	Wild radish	Wild cabbage	Wild mustard
Caithness	Freswick Links	midden		Norse	present		##	#	##			#		#	#							
Hebrides	Baleshare and Hornish Point	midden		Viking	present		#				#					?	#	#	#			
Hebrides	Barvas Machair			Norse	present													#				
Hebrides	Bornish, South Uist			11-12th century	present		##	##					##			#		##	#			
Hebrides	Kilpheder,South Uist	farmstead		1020-1220	present		##	##					##			#		##	#			
Hebrides	Udal, North Uist				present																	
Orkney	Birsay		hearth		present		##	#														
Orkney	Birsay, South of Red Craig			600-910	present		#	#										#	#	#	#	#
Orkney	Buckquoy				present																	
Orkney .	Earl's Bu	midden		late Norse (c.11-12th century)	present		#	#									#	#				
Orkney	Pool, Sanday	farm mound		671-1270 (C14 range)	present		#			#								#				
Orkney	Saever Howe			Norse	present		#	#										##				
Orkney	Tuckquoy	farmstead	pit	885+/-65		present	pollen	pollen														
Orkney	Westness, Rousay	farmstead			present		#	pollen					#					#				
Shetland	Jarlshof				present																	
Shetland	Sandwick-North, Unst	settlement		Norse 1000-1200AD	present																	

KEY - ## indicates major component, # indicates presence, ? possible identification, 'pollen' indicates identified in pollen assemblages.

Table 2.2. Summary of details and major components of archaeobotanical assemblages from the Northern and Western Isles of Scotland and Caithness.

			OTHER MATERIAL															WILD PLANT HABITATS					
REGION	SITE .	Wild oat (Avena fatua) - introduction	Empetrum nigrum charcoal	Calluna vulgaris charcoal	Wood	Straw	Dung	Charcoal	Spruce/larch	Scots pine	Betula	Corylus avellana	Alnus	Quercus	Tilia	Peat	Seaweed	Arable weeds	Ruderal	Grassland	Heath/moorland	Rich, well-cultivated soil	Dry sandy soil
Caithness	Freswick Links			#				#								#		#	##	##	#		
Hebrides	Baleshare and Hornish Point																	#					
Hebrides	Barvas Machair																						
Hebrides	Bornish, South Uist																						
Hebrides	Kilpheder,South Uist		#	#													#						
Hebrides	Udal, North Uist																						
Orkney	Birsay	#						#								#	#						
Orkney	Birsay, South of Red Craig			#				#								#	#	#	#				
Orkney	Buckquoy																						
Orkney	Earl's Bu			#				#										#					
Orkney	Pool, Sanday							#									#					#	#
Orkney	Saever Howe																						
Orkney	Tuckquoy				#	#	#	#															
Orkney	Westness, Rousay																						
Shetland	Jarlshof																						
Shetland	Sandwick-North, Unst			local				#	driftwood	driftwood/imported	local	local	local	imported	imported								

Table 2.2. Summary of details and major components of archaeobotanical assemblages from the Northern and Western Isles of Scotland and Caithness.

REGION	SITE	REFERENCE
Caithness	Freswick Links	Morris *et al.* 1992
Hebrides	Baleshare and Hornish Point	Jones, Glynis 1987
Hebrides	Barvas Machair	Dickson 1983
Hebrides	Bornish, South Uist	Smith and Mulville 2004
Hebrides	Kilpheder,South Uist	Smith and Mulville 2004; M. Parker Pearson pers. comm.
Hebrides	Udal, North Uist	Crawford and Switsur 1977; Colledge 2000
Orkney	Birsay	Donaldson and Nye 1981
Orkney	Birsay, South of Red Craig	Morris 1993
Orkney	Buckquoy	Rackham *et al.* 1989
Orkney	Earl's Bu	Huntley 1992
Orkney	Pool, Sanday	Bond and Hunter 1987
Orkney	Saever Howe	Dickson 1983
Orkney	Tuckquoy	Owen 1993
Orkney	Westness, Rousay	Dickson and Dickson 2000; Kaland 1993
Shetland	Jarlshof	Hamilton 1956
Shetland	Sandwick-North, Unst	Malmros (in press)

Table 2.2. Summary of details and major components of archaeobotanical assemblages from the Northern and Western Isles of Scotland and Caithness.

| | | | | | | | CEREAL | | | | | | | | PULSE | | | | FRUIT | | | | NUT | | USEFUL PLANTS | | | | | | | |

REGION	SITE	Oplum poppy (Papaver somniferum)	Oraches/Brassicas	Parsnip (Pastinaca sativa)	Scandinavian clubmoss (Diphasim complanatum) - import	Summer savoury	Wild celery (Apium graveolens)	Wild radish (Raphanus raphanistrum)	Woad (Isatis tinctoria)	Moss	Wood	Charcoal	Dung	WILD PLANT HABITATS: Various wild habitats	REFERENCE
England	York	#		#	#	#	#		#	#	#			#	Hall and Kenward 2004; Hall and Tomlinson 1990; Hall *et al.* 1983; Kenward and Hall 1995
Ireland	Fishamble Street, Dublin		#					#			#	#	#		Geraghty 1996
Ireland	Carrigalla, Limerick														Jessen and Helbaek 1944
Ireland	Summary of various sites														Monk 1991
Ireland	Lisleagh I														Monk 1991

Table 2.3. Summary of details and major components of archaeobotanical assemblages from the rest of Britain and Ireland.

REGION	SITE	TYPE OF SITE	CONTEXT	DATE	CHARRED	NON-CHARRED	CEREAL: Six row hulled barley (Hordeum vulgare var. vulgare)	CEREAL: Naked barley	CEREAL: Oat (Avena sativa)	NUT: Hazel (Corylus)	USEFUL PLANT: Cabbage/mustard (Brassica/Sinapsis)	OTHER MATERIAL: Peat	OTHER MATERIAL: Turf	OTHER MATERIAL: Juniperus	OTHER MATERIAL: Birch (Betula)	OTHER MATERIAL: Betula bark	OTHER MATERIAL: Salix	OTHER MATERIAL: Corylus	OTHER MATERIAL: Empetrum	OTHER MATERIAL: Vaccinium myrtillis	OTHER MATERIAL: Vaccinium ulliginosum
Eysturoy	Argisbrekka	Shieling	occupation deposits	725-1015 C14 range	present	present		#		#				#		#	#	#	#	#	#
Eysturoy	Eide	Settlement		890		present									#						
Eysturoy	Toftanes	Settlement		9th -10th centuries		present				#					#						
Sandur	Undir Junkarinsfløtti (UJF)	Midden	Basal deposits	9th - 12th centuries	present		##		#			#	#								
Sandur	Sondum 2	Midden	Scan samples		present	present	#				#										

KEY - ## indicates major component, # indicates presence, ? possible identification, 'pollen' indicates identified in pollen assemblages.

Table 2.4. Summary of details and major components of archaeobotanical assemblages from the Faroe Islands.

REGION	SITE	OTHER MATERIAL									WILD PLANT HABITAT					reference
		Heather roundwood	Juniper roundwood	Alder (Alnus sp.)	Ash (Fraxinus sp.)	Oak (Quercus sp.)	Larch ((Larix sp.)	Pine (Pinus sp.)	Spruce (Picea sp.)	Coniferous	Rich soil	Ruderal	Cultivated ground	Wet pasture	Moorland	
Eysturoy	Argisbrekka	#		#	#	#	#	#	#							Malmros 1994; Mahler 1993
Eysturoy	Eide															Malmros 1994
Eysturoy	Toftanes															Malmros 1994
Sandur	Undir Junkarinsfløtti (UJF)	#	#				#	#	#		#		#	#	#	Lawson *et al.* 2005
Sandur	Sondum 2					#	?			#		#	#			Church pers comm.

Table 2.4. Summary of details and major components of archaeobotanical assemblages from the Faroe Islands.

LABORATORY CODE	CONTEXT	MATERIAL	DATE (^{14}C YEARS BP)	DATE (CAL AD; 2σ)	PROBABILITY
K-4441	Building I - Floor layer	Bulk sample	1085±65	780-1040	0.983
K-4442	Building I - Floor layer	Bulk sample	1115±65	770-1030	0.991
K-4443	Building I - Floor layer	Bulk sample	1150±50	770-1020	0.947
GU-12167	Building I - Floor layer	Barley grain	1155±35	780-970	1.000
GU-12168	Building I - Floor layer	Barley grain	1125±35	850-990	0.921
GU-12169	House IIa - Floor layer (Phase 3)	Hazel nut shell	1155±35	780-970	1.000
GU-12170	House IIa - Floor layer (Phase 3); 2nd half of GU-12169	Hazel nut shell	1110±35	870-1020	0.989
GU-12171	House IIa - Floor layer (Phase 3)	Hazel nut shell	1215±35	760-890	0.797
GU-12172	House IIa - Floor layer (Phase 3); 2nd half of GU-12171	Hazel nut shell	1170±35	770-910	0.798

Table 3.1. Radiocarbon age measurements from Toftanes. Calibration (two standard deviations) was undertaken via the program CALIB v. 5.0 (Stuiver *et al.* 2005) using the highest probability value, with calendar age ranges rounded to the nearest 10 years. Laboratory codes: K- Copenhagen, GU- Glasgow University.

DEPOSIT	DESCRIPTION
a	Peaty turf. Fibrous. Black.
b	Fibrous peat. Dark brown with few inclusions and small lenses of possibly burnt material.
c	Pseudo-fibrous peat with fewer roots and recently humified. Black.
d	Grey/dark brown with fewer roots and wood. Humified.
e	Increasingly fibrous dark brown/black peat. Poorly humified.
f	Dark brown/black moderately humified peat.
g	Black, moderately humified with an increase in silt.

Table 4.1. Lithographic description of deposits from Hov. Description of deposits taken in the field by K. Vickers.

DEPOSIT	DESCRIPTION
a	Mid-brown, dry, silty topsoil. Lots of roots. Charcoal flecks.
b	Red/orange brown silty clay. Paler. Very thin banding within it. Redder towards the bottom. Still lots of roots, but not as much as a. boundary with a clear, with c merging.
c	Pale orange/white silty clay. White clay banding. One or two roots. Boundaries merging.
d	White/brown silty clay. Few roots but some. Iron staining and iron pan nodules. Merging with c and tephra.
e	*Landnám* tephra, merging with d. Boundary with f clear.
f	Dark brown/black peat. Fibrous. H2. Highly organic. Contains wood fragments >4 cm long. Boundaries fairly clear. Compact.
g	Grey brown well humified silty peat. H2. Pseudo-fibrous. Contains wood and some iron staining. Boundaries fairly clear.
h	V. black soft silty peat. Less compact than above. Well humified. Pseudo-fibrous. Contains some modern roots.

Table 4.2. Lithographic description of deposits from Reykholtsdalur 2. Description of deposits taken in the field by K. Vickers.

DEPOSIT	DESCRIPTION
a	Turf and topsoil
b	Creamy brown clayey silt. Compact.
c	Crumbly, coherent lumps of clayey silt (dark creamy brown). Naturally breaking down colloids or element of redeposition.
d	Creamy brown, clayey silt. Compact.
e	Same as c.
f	Creamy brown, clayey silt. Compact.
g	Very silty (inorganic) peat/peaty silt with organic component. Very fibrous/poorly humified. Yellow brown.
h	Same as g but with greater organic component.
i	Fine greeny brown tephra.
j	Silty dark brown peat. Fibrous. Moderately humified. Relatively loose with material below.
k	Fine dark olive green tephra, perhaps with white crystals. ?*Landnám.*
l	Relatively compact silty. Moderately fibrous/moderately humified peat with subtle laminations of more or less inorganic components. Colour from dark brown to grey.
m	Fine olive green tephra with possible white crystals and a hint of lower white component. *Landnám*??? Area on drawing shows undulation area – actual tephra only 3 cm deep.
n	Similar to l.
o	Relatively compact silty peat. Moderately fibrous/moderately humified.

Table 4.3. Lithographic description of deposits from Reykholtsdalur 3. Description of deposits taken in the field by K. Vickers.

DEPOSIT	DESCRIPTION
a	Soft loose peaty silt. Lots of roots. Mid brown. Dry.
b	Red/brow loose peaty silt. Lots of roots. Dark stripes throughout.
bi	Dark brown peat. Compact. Some roots.
bii	Dark brown/black peat. Compact. Some roots.
c	Very fibrous organic light brown layer. Mossy.
d	Dark brown peat. Roots and wood present. Fairly loose consistency. Some roots.
e	V1477???? Tephra.
f	Mid brown silty peat. Pseudo-fibrous. Contains wood.
g	Dark brown/black well humified peat. Pseudo-fibrous. Wood/some roots.
h	Mid brown compact peat. H3. Pseudo-fibrous.
i	Light brown fibrous layer. Contains trace of tephra A.
ii	Mid brown semi humified fibrous peat.
iii	Dark brown well humified peat. Fibrous.
j	Very dark brown peat. Fibrous. H2. Possibly with charcoal flecks.
k	Tephra ?*Landnám.*
l	Dark brown fibrous peat. H2.
m	Dark brown fibrous peat.
n	Brown/black well humified peat. Very dark. H4.
o	Grey/black well humified silty peat.

Table 4.4. Lithographic description of deposits from Breiðabólsstadavatn 2. Tentative identifications of tephra deposits proved to be incorrect. Description of deposits taken in the field by K. Vickers.

DEPOSIT	DESCRIPTION	DEPTH BELOW SURFACE (cm)
-	Root mat and topsoil	0-7
VI	Brown peat soil	7-17
V	Yellow peat	17-32
IV	Brownish-yellow peat	32-35
III	Dark yellow peat	35-52
-	-	Step in section
II	Woody brown peat	57-70
-	Not described	70-96
I	Silt	96-base

Table 4.5. Description of deposits of Háls South Pit monolith, taken from Dixon (1997).

CONTEXT	LOCATION	PHASE NUMBER	PERIOD	SAMPLE NUMBER
Old surface (peat). Artificial?	Around House II	1	Viking/Pre-Viking	1641
Floor-layer	House II - western	1-2	Viking	645
Drains	House II	1	Viking ($C9^{th}$?)	2711
Floor-layer	House IIa	3	Viking	1400
Layer	Outside House II	1-2	Viking (C9th-10^{th})	1682
Surface layer	Between Building I and House II	1-2	Viking (C9th-10^{th})	570, 2052, 2219
Layer from abandonment	House II			1761
18^{th} century			18^{th} century	595

Table 4.6. Toftanes samples that could not be located on the plan (Fig. 4.7).

DEPOSIT	DESCRIPTION
a	Turf, moderately organic silty sand (brown).
b	Moderately organic silty sand 'b' horizon (brown) (burnt material). 7.5yr 4/4.
c	Peat ash, yellowy orange clay. 5yr 6/8.
d	Moderately organic silty sand (brown) with 10-20% small rounded clasts (x axis 4 mm -50 mm) with some peat ash and charcoal, bone. 7.5yr 4/4.
e	Same as layer above but with less stone. 7.5yr 4/2.
f	Moderately organic silty sand with mixed peat ash, charcoal and bone. 7.55yr 3/4.
g	Light brown slightly organic sand with occasional lenses of yellow wind blown sand and clasts. 10yr 4/3.
h	Slightly more organic brown sand with more frequent wind blown sand laminations. 10yr 4/2.
i	Moderately organic brown sand with occasional flecks of peat ash and burnt material. 5yr 4/2.
j	Moderately organic brown sand with occasional flecks of peat ash and burnt material. More obvious laminations within structure. 7.5yr 3/2.
k	Dark brown compacted silty humic material, malleable, dry, sand lenses, charcoal flecks 7.5yr 3/2.
l	Mixed dark/light layer of windblown sand – lenses of compacted humic material, clay and charcoal flecks. 10yr 4/2.
m	Very dark brown humic sandy silt, lenses of sand, red mottles, charcoal flecks. 5yr 2.5/2.
n	Mixed dark/light layer of windblown sand 5yr 2.5/1.
o	Thin black layer, silty.
p	Dark brown sandy loam, some red mottles. 5yr 2.5/2.
q	Darkbrwon/red sandy silt, clay and charcoal flecks, concentration of fire cracked pebbles, red mottles. 2.5yr 3/2.
r	Brown silty sand, few red mottles and charcoal flecks. 7.5yr 3/2.
s	Very dark brown silty humic layer, soft and malleable 7.5yr 3/2.
t	Very hard compact red sandy silt/iron pan. 2.5yr 3/4.
u	Grey brown sand, clay and charcoal flecks, some mottles 7.5yr 3/2.
v	Red/brown sand. 5yr 3/4.
w	Very hard red, sandy iron pan layer with lenses of lighter sand. 2.5yr 3/4.
x	Dark grey brown silty sand, some organic content? Wetter. 10yr 3/1.
y	Very hard red, sandy iron pan layer. 2.5yr 4/6.

Table 4.7. Lithographic description of deposits from Sondum midden. Description made in the field by M. Church, K. Mairs and K. Vickers.

RATING	PRESERVATION	DESCRIPTION
1	Perfect	All features needed for identification very clearly preserved – highly likely to be identifiable to species/'slash category'
2	Good	Most features preserved clearly – probably identifiable to species/'slash category'
3	Fair	Some features preserved, although not clearly – may be identifiable to a general level e.g. genus/family
4	Poor	Few features preserved and not clearly – may be identifiable to plant type e.g. seed/leaf
5	Not identifiable	No identifiable features c.f. organic matrix of peat

Table 4.8. Preservation rating scale for non-quantifiable plant macrofossil types.

SITE	TOTAL NUMBER OF SAMPLES AVAILABLE	SAMPLES SCANNED	SAMPLES SORTED	SAMPLES IDENTIFIED	SAMPLES QUANTIFIED
Toftanes	45	30	30	30	30
Sondum	6	6	6	7	6
Hov	42	11	10	10	10
RHD2	7	3	3	3	3
RHD3	37	11	6	6	6
BR2	34	8	4	4	4
Stóramörk	32	9	7	7	7

Table 4.9. Number of samples analysed from each site.

RATING	OCCURRENCE	DESCRIPTION
1	Rare	Present as a negligible proportion of the bulk volume
2	Occasional	Present as a low proportion of the bulk volume
3	Frequent	Making up about half of the bulk volume
4	Abundant	Present as a high proportion of the sample – making up the majority of the sample, but with a significant admixture of other items
5	Dominant	Making up the bulk of the matrix of the sample

Table 4.10. Abundance rating scale for non-quantifiable plant macrofossil types.

AREA	TYPE OF SAMPLE	NAME	SAMPLES AVAILABLE	SAMPLES SCANNED	SAMPLES FULLY ANALYSED	METHOD OF PRESERVATION	COUNT SHEET PRESENTED IN
FAROE	On-site	Toftanes	45	30	30	Charred and waterlogged	Table B.1
		Sondum	6	6	6	Charred and waterlogged	Table B.2
	Off-site	Hov	42	11	10	Waterlogged	Table B.3
ICELAND	Off-site	Reykholtsdalur 2	7	3	3	Waterlogged	Table B.4
		Reykholtsdalur 3	37	11	6	Waterlogged	Table B.5
		Breiðabólsstadavatn 2	34	8	4	Waterlogged	Table B.6
		Stóramörk	32	9	7	Waterlogged	Table B.7

Table 5.1. Summary table of samples available for analysis, scanned and fully analysed.

AREA	TYPE OF SAMPLE	NAME	NUMBER OF TAXA
FAROE	On-site	Toftanes	60
		Sondum	46
	Off-site	Hov	18
ICELAND	Off-site	Reykholtsdalur 2	9
		Reykholtsdalur 3	8
		Breiðabólsstadavatn 2	5
		Stóramörk	15

Table 5.2. Number of identifiable plant macrofossil taxa at each site.

DEPTH BELOW SURFACE (cm)	MOISTURE				pH			NITROGEN			NUMBER OF CLASSIFIED TYPES
	moist	constantly moist	wet - often saturated	shallow water	acidic	moderately acidic	weakly acidic	poor	intermediate	rich	
2.5-5.0		*	*	*	*	*		*			3
12.5-15.0	*	*	*	*	*	*	*	*			3
22.5-25.0	*	*	*	*	*	*	*	*	*		4
32.5-35.0	*	*			*			*			3
42.5-45.0	*	*	*	*	*	*		*			8
52.5-55.0	*				*	*		*			2
62.5-65.0	*					*		*			1
85.5-88.0	*					*		*	*	*	1
96.0-98.5	*				*			*			1
106.5-108.0	*		*	*	*	*		*			3

Table 5.3. Summary of results from Hov monolith based on Ellenberg numbers.

DEPTH FROM SURFACE (cm)	MOISTURE		pH		NITROGEN		NUMBER OF CLASSIFIED TYPES
	constantly moist	shallow water	acidic	moderately acidic	poor	intermediate	
post-1	*	*		*	*	*	3
pre-1	*	*	*	*	*	*	3
pre-5	*	*	*		*	*	2

Table 5.4. Summary of results from Reykholtsdalur 2 monolith based on Ellenberg numbers.

DEPTH BELOW SURFACE (cm)	MOSITURE constantly moist	shallow water	pH moderately acidic	NITROGEN poor	intermediate	NUMBER OF CLASSIFIED TYPES
62.5-65.0		*	*	*		1
72.5-75.0	*	*	*	*		3
87.5-90.0		*	*	*		1
92.5-95.0		*	*	*		1
125.0-127.5	*	*	*	*	*	4
137.5-140.0		*	*	*		1

Table 5.5. Summary of results from Reykholtsdalur 3 monolith based on Ellenberg numbers.

DEPTH BELOW SURFACE (cm)	MOISTURE moist	constantly moist	shallow water	pH weakly acidic-weakly basic	moderately acidic	acidic	NITROGEN poor	intermediate	NUMBER OF CLASSIFIED TYPES
7.5-10.0	*	*		*	*	*	*	*	2
12.5-15.0	*	*	*	*	*		*		2
32.5-35.0			*			*	*		1
47.5-50.0	*	*	*			*	*	*	3
60.0-62.5	*	*	*			*	*	*	3
75.0-77.5			*			*	*		1
85.0-82.5		*	*			*	*	*	2
95.0-97.5	*	*	*			*	*	*	3
115.0-117.5		*	*			*	*	*	2

Table 5.6. Summary of results from Breiðabólsstadavatn 2 monolith based on Ellenberg numbers.

DEPTH BELOW SURFACE (cm)	MOISTURE average dampness	constantly moist	wet	shallow water	pH extremely acidic	acidic	moderately acidic	weakly acidic-weakly basic	basic	NITROGEN extremely infertile	more or less infertile	intermediate fertility	richly fertile	NUMBER OF CLASSIFIED TYPES
7.0-12.0	*	*	*	*	*	*	*	*	*	*	*	*	*	10
12.0-17.0	*	*	*	*	*	*	*	*	*	*	*	*	*	12
17.0-22.0	*	*	*	*	*	*	*	*	*	*	*	*	*	8
22.0-27.0		*	*	*		*	*	*		*	*			3
27.0-32.0	*	*	*	*		*	*	*	*	*	*	*		7
32.0-35.0				*		*	*				*			1
35.0-40.0	*	*	*	*		*	*	*	*	*	*	*		7
40.0-45.0	*	*						*	*	*	*			3
45.0-52.0	*	*						*	*	*	*			4
57.0-66.0	*	*	*	*	*	*	*			*	*	*		7
66.0-70.0														0

Table 5.7. Summary of results from Háls South Pit monolith based on Ellenberg numbers.

DEPTH BELOW SURFACE (cm)	MOISTURE moist	constantly moist	wet - often saturated	shallow water	pH acidic	moderately acidic	weakly acidic	NITROGEN poor	intermediate	rich	SALT absent	slightly salt-tolerant	freshwater coastal	NUMBER OF CLASSIFIED TYPES
55.0-57.5		*	*	*	*	*		*	*		*	*	*	3
75.0-77.5	*		*	*		*			*	*	*	*	*	2
85.0-87.5	*	*	*	*	*	*	*		*		*	*	*	3
97.5-100.0	*	*		*		*		*	*		*			4
102.5-105.0		*			*				*		*			1
117.5-120.0		*			*				*		*			1
130.0-132.5		*			*				*		*			1

Table 5.8. Summary of results from Stóramörk monolith based on Ellenberg numbers.

TAXON	PRESERVATION	393	570	595	645	1016	1399	1400	1475	1582	1597	1622	1641	1682	1760	1761	1963	1964	1995	2052	2147	2219	2265	2422
CEREAL GRAIN	CHARRED			#			#	#			#	#					#	#			#		#	#
	NON-CHARRED																							
WILD SEED	CHARRED				#		#	#				#					#	#	#				#	
	NON-CHARRED		#	#	#	#	#	#		#	#	#	#	#	#	#	#	#	#	#	#	#	#	#
CORYLUS AVELLANA	CHARRED						#																	
	NON-CHARRED						#	#																
WOOD	CHARRED	#	#		#		#	#	#	#	#	#				#	#	#	#				#	#
	NON-CHARRED		#		#	#	#	#		#	#	#	#			#	#	#	#	#		#	#	#
CALLUNA VULGARIS LEAF	CHARRED																		#					
	NON-CHARRED				#		#	#				#					#	#	#				#	#
JUNIPERUS LEAF	CHARRED																#						#	
	NON-CHARRED				#		#	#				#		#			#	#	#				#	#
PEAT/DUNG NODULE	CHARRED	#	#	#	#		#	#		#	#					#	#	#	#		#		#	#
	NON-CHARRED	#	#	?	#	#	#	#	#		#	#				#	#	#	#	#	#		#	#
SEAWEED	CHARRED				#		#					#				#	#							
ANY TYPE OF CHARRED MATERIAL		#	#	#	#		#	#	#	#	#	#				#	#	#	#		#		#	#

Table 5.9. Presence of taxa in samples from Toftanes preserved in a charred and non-charred state. # indicates presence, ? possible identification.

TAXON	PRESERVATION	2653	2654	2665	2711	2734	2752	2925	NUMBER OF SAMPLES	PERCENTAGE OF SAMPLES
CEREAL GRAIN	CHARRED							#	11	37
	NON-CHARRED		#						1	3
WILD SEED	CHARRED	#	#				#	#	12	40
	NON-CHARRED	#	#	#	#			#	26	87
CORYLUS AVELLANA	CHARRED								1	3
	NON-CHARRED								2	7
WOOD	CHARRED	#	#		#		#	#	20	67
	NON-CHARRED	#	#		#			#	21	70
CALLUNA VULGARIS LEAF	CHARRED								1	3
	NON-CHARRED	#	#		#				12	40
JUNIPERUS LEAF	CHARRED								2	7
	NON-CHARRED	#	#						12	40
PEAT/DUNG NODULE	CHARRED		#					#	17	57
	NON-CHARRED	#	#				#	#	21	70
SEAWEED	CHARRED		#						6	20
ANY TYPE OF CHARRED MATERIAL		#	#		#		#	#	22	73

Table 5.9. Presence of taxa in samples from Toftanes preserved in a charred and non-charred state. # indicates presence, ? possible identification.

COUNTRY	SITE	CEREAL						PULSE	NUT		FRUIT			USEFUL PLANTS		
		Barley (Hordeum sp. and Hordeum vulgare)	Rye (Secale cereale)	Oat (Avena sp. and Avena sativa)	Wheat (Triticum sp.)	Cereal	Millet (Panicum/Setaria)	Legume-domesticated type-pea, celtic bean, common vetch, field bean	Hazel nut (Coryllus avellana)	Walnut (Juglans regia)	Fig (Ficus sp.)	Grape (Vitis sp.)	Wild berries	Fruit pip	Bog myrtle/Sweet gale (Myrica gale)	Flax (Linum usitatissium)	Hop (Humulus lupus)
Faroe Sandur	Undir Junkarinsfløtti (UJF)	##		#													
Faroe Sandur	Sondum 2	#															
Faroe Eysturoy	Argisbrekka	#						#									
Faroe Eysturoy	Toftanes							#									
Iceland	Reykholt	#											#				
Iceland	Suðurgata 3-5, Reykjavík	##															
Iceland	Gröf, Öræfi	#															
Iceland	Berg Þórshvoll, Vesturlandeyar	#															
Iceland	Stóraborg	#											#				
Iceland	Svalbarð												#				
Iceland	Bessastaðir												pre-1485				
Iceland	Herjolfsdalur	#															
Greenland east of	Niaqussat V45												#			#	
Greenland Weste	Sandnes, Kilaarsafik V51												#			#	
Greenland	Nipaitsoq V54												#				
Denmark	Gammel Lejre .	##	##	##	#				#								
Denmark	Ribe	#							#				#		#		#
Denmark	Øster Aalum, Thy	##	##	##													
Denmark	Trabjerg	#	##			#									#		
Denmark	Ejstrup	##	##	#											#		
Denmark	Aggersborg	##	##	#					#								
Denmark	Fyrkat	#	##											#			
Denmark	Århus, Søndervold	##	##					#							#		
Denmark	Viborg St. Skt. Peterstræde	#											#		#		
Denmark	Viborg Søndersø	##	##	##				#							#		
Denmark	Svendborg	##	##	#					#	#			#	#	#	##	#
Denmark	Ribe, Sønderportsgade 1	#											#	#	#	#	
Finland	Pahamäki	##	##	#	#			#									
Germany	Kosel	##	##	##	#		#	#	#				#	#		#	
Germany	Haithabu	##	##	##	#		#	#		#	#		#		#	#	#
Norway	Borg	#											#				
Norway	Oseberg					#								#			
Norway	Kaupang	#	#	#	#				#				#	#		#	#
Norway	Trondheim								#				#	#		#	
Norway	Gamlebyen, Oslo	#							#				#	#			
Norway	Bryggen, Bergen	#	##	#				#	#		#		#				
Sweden	Ljunga					#		#									
Sweden	Ystad	#	#														
Sweden	Björkö Strait												#	#			#
Sweden	Birka	#	#	#	#			#	#				#	#		#	#

Table 6.1. Presence of crop taxa and potentially useful plants at Norse archaeological sites.

| | | |

COUNTRY	SITE	CHARCOAL/TWIG	PEAT	TURF	DUNG	BONE	SEAWEED
Faroe - Sandoy	Undir Junkarinsfløtti (UJF)	#	#	#			
Faroe - Sandoy	Sondum	#					
Iceland	Reykholt	#					
Iceland	Suðurgata 3-5, Reykjavík	#					
Iceland	Herjolfsdalur	#					
Greenland	Sandnes, Kilaarsafik V51	#	~		~		
Greenland	Nipaitsoq					#	
Caithness	Freswick Links	#	#				
Shetland	Sandwick-North, Unst	#					
Orkney	Birsay	#	#				#
Orkney	Pool, Sanday	#					#
Orkney	Tuckquoy	#			#		
Orkney	Birsay, South of Red Craig	#	#				#
Orkney	Earl's Bu	#					
Hebrides	Kilpheder,South Uist						#
Ireland	Fishamble Street, Dublin	#			#		
Denmark	Aggersborg	#			#		
Denmark	Fyrkat	#					
Denmark	Svendborg						
Norway	Borg	#					
Norway	Kaupang						#
Norway	Gamlebyen, Oslo	#					
Norway	Bryggen, Bergen		#				

KEY

\# Evident from plant macrofossil analysis

~ Evident from insect analysis

Table 6.2. Presence of potential fuels evident at Norse archaeological sites.

APPENDIX A

APPENDIX A: METHOD OF IDENTIFICATION OF PLANT MACROFOSSIL TYPES

The method of identification for taxa present in on- and off-site samples is outlined below. Where identification was made from published sources, these are referenced (Table A.1). For material not covered in publications, a description of the material and the method of identification are presented.

A.1. TAXA IDENTIFIED USING PUBLISHED CRITERIA

The majority of seed and wood types could be identified using published methods and/or by consultation with other specialists. These are listed in Table A.1.

A.2. TAXA IDENTIFIED BY UNPUBLISHED METHODS

Taxa which were not covered by published keys or descriptions were identified by comparison with modern reference material.

A.2.1. Seeds

A.2.1.1.*Betula* sp.

The identification of *Betula* seeds was complex because the wings, the most diagnostic part, were not preserved. Although there is a tendency for the seed core of *B. pubescens* to be larger than that of *B. nana* (Dickson 1970; Freund *et al.* 2001), the seeds of *Betula nana* and *B. pubescens* exhibit considerable morphological variability and, due to cross-breeding, there is a continuum in the size of the seed core between the two species (Dickson 1970). All seeds with complete cores were measured and their size plotted on a scattergram (Fig. A.1) alongside published measurements for *Betula nana* and *B. pubescens* (Freund *et al.* 2001).

The resulting pattern indicated that all of the seed cores measured were within the range of *B. pubescens* or were larger, but with a similar length:width ratio. All seeds were less similar in size to *B. nana* than to *B. pubescens.* A comparison was also made with the ecological conditions at the monolith sites for each sample

containing *Betula* seeds (Table A.2). The Ellenberg values for salinity and light were the same for *B. nana* and *B. pubescens* (zero and four respectively) and were similar for moisture (eight for *B. nana* and seven for *B. pubescens*) and could not realistically be differentiated (Lawesson *et al.* 2003; Hill *et al.* 1999). In terms of pH ratings, all sites were more similar to *B. pubescens*. In terms of nitrogen, conditions at Reykholtsdalur 2, Reykholtsdalur 3, Stóramörk and Háls South Pit were more similar to the tolerance of *B. pubescens,* whilst Breiðabólsstadavatn 2 was more acidic, making conditions more similar to the tolerance of *B. nana* (Lawesson *et al.* 2003; Hill *et al.* 1999). This may be reflected in the comparative seed sizes presented in Fig. A.1. Seeds from Breiðabólsstadavatn 2 are notably shorter than those from other sites (less than 1.7 mm), and have a similar width range to *B. nana.* It is possible these seeds represent a hybrid between the two species that is more tolerant of extremely acidic conditions than *B. pubescens.*

Determination: Reykholtsdalur 2, Stóramörk, Reykholtsdalur 3 and Háls South Pit - *B. cf. pubescens*
Breiðabólsstadavatn 2 – cf. *B. nana x B. pubescens*

A.2.1.2. *Capsella bursa-pastoris* - Cruciferae

The radicle tip of these seeds was of equal length to the cotyledons, giving an elliptic oblong shape in plan, which was flattened in cross-section and slightly bi-convex. The surface texture was reticulate-scalariform.

Other members of the Cruciferae family were more spherical (e.g. *Brassica*) or had a smaller, less distinct surface pattern, and could be discounted.

Determination: *Capsella bursa-pastoris*

A.2.1.3. *Carex tumidicarpa* - Cyperaceae

The nutlets are tricarpellate, with flat, cuneiform or cuneiformly obovate faces and sharp angles.

Keys by Nilsson and Hjelmqvist (1967), Berggren (1969) and Stenberg and Ericsson (1992) were used to eliminate other species of *Carex*, as well as the advice of RE, and unpublished notes provided by JM. Although this seed type could not be morphologically distinguished from several others (e.g. *C. flava, C. oederi* and *C. serotina*) these species are not known to be present in the Faroese flora. No seeds of this type were recovered from Iceland.

Determination: *Carex tumidicarpa*

A.2.1.4. *Carex nigra*-type - Cyperaceae

The nutlets are almost as broad as long, broadest at or a little above the middle, with a broad base and sharp edges. They are oval in cross-section, and the surface is covered with broad, low papillae.

Keys by Nilsson and Hjelmqvist (1967), Berggren (1969) and Stenberg and Ericsson (1992) were used in the identification of this category, as well as the advice of RE, and unpublished notes provided by JM. All the species of *Carex* with bicarpellate nutlets could be discounted apart from *C. capitata* and the members of *Carex* sect. Acutae, which are not invaginated near the middle of the seed.

This identification category comprises *Carex nigra, C. bigelowii* and *C. lyngbyei* present in both the Faroes and Iceland, plus *C. capitata, C. rufina* and *C. subspathacea* (the species that is not invaginated). The nutlets of these species exhibit similar morphological characteristics which overlap, so cannot be distinguished from each other. It may be possible to differentiate the species statistically if the number of seeds in the assemblage is large enough (RE pers. comm.), but this was not possible for the material presented here.

Determination: *Carex nigra*-type

A.2.1.5. *Corylus avellana* - Corylaceae

Fragments of the shell of *Corylus* nuts were identified by the shape of the attachment scar, as well as the thickness of the shell wall and the surface texture. They were identified as *Corylus avellana* as the attachment scar was smaller than that exhibited by *C. colurna*.

Determination: *Corylus avellana*

A.2.1.6. *Empetrum nigrum* - Empetraceae

The seeds are wedge-shaped with a curved outer edge and flat sides. The hilum is mid-way along the 'straight' side.

The wedge shaped seeds of *Empetrum nigrum* are clearly distinguished from those of other families and genera. Flora Europaea (Tutin 1968) notes that *E. nigrum* and *E. hermaphroditum* may be regarded as separate species or subspecies based on differences in chromosome number, but that vegetative characteristics overlap. In the archaeobotanical literature, there is no consensus in usage, and the examples present in the seed reference collection for *E. nigrum* ssp. *nigrum* and *E. nigrum* ssp. *hermaphroditum* could not be distinguished from each other.

Determination: *Empetrum nigrum* sl

A.2.1.7. *Galeopsis* - Labiatae

Thin-walled, ovate seeds with a smooth surface and a round attachment scar at the pointed end of one face. They are often broken into two halves.

Two species of *Galeopsis* occur in the Faroes in modern times, *G. speciosa* and *G. tetrahit*. Seeds of both species present in the reference collection could not be differentiated by size measurements, the examination of the surface texture or any other means.

Determination: *Galeopsis speciosa/tetrahit*

A.2.1.8. *Juncus* - Juncaceae

Seeds were very small (measurement of 10 seeds from Toftanes sample 1761 had a length range of 0.47 to 0.67 mm and a width range of 0.29 to 0.37) and oval, some slightly tapering at one end. The surface pattern was visible on well-preserved examples under high magnification using a pollen microscope.

A key for the identification of *Juncus* seeds was published by Körber-Grohne (1964) and is summarised for the species present in the study area in Table A.3. Although it did not cover all the species present in the modern flora of the Faroe Islands, these were present in the reference collection and could be described in terms of the features used in the key (marked with an asterisk in Table A.3). The seeds from the only Icelandic site to contain *Juncus* seeds were not well preserved enough to be identified to species, so only the Faroese species were considered for identification to species. The surfaces of *Juncus biglumis* and *J. triglumis* were reticulate, and that of *J. trifidus* elongated reticulate (similar to that of *Juncus conglomeratus* and *J. effusus*, but with no thickening of the walls). As the surface of *J. biglumis* and *J. triglumis* was similar to that of the inner coat of other species, and the pattern of the outer coat of other species may look similar when eroded, they were only identified if the outer coat was well preserved.

Determinations:

Juncus articulatus
Juncus trifidus
Juncus bufonius
Juncus bulbosus
Juncus biglumis/triglumis
Juncus cf. *conglomeratus/effusus*

A.2.1.9. *Luzula* - Juncaceae

Many of the archaeological examples were too badly damaged to identify beyond genus, including all the material from Iceland. The more complete specimens were elliptic in outline, with a distinctive raised attachment at one end. They had a honeycomb surface pattern.

Four species (of the five in the modern Faroese flora) were held by the reference collection, and the length and breadth of 10 examples of each were measured (with the exception of *L. arcuata*, where only seven examples were present). The measurement of the illustration of *L. sylvatica* was measured from Beijerinck (1947). These data are presented in Table A.4. The data were plotted on a scatterchart and measurements for all archaeological specimens complete enough for measurements to be taken plotted against them (Fig. A.2).

Although some of the archaeological seeds overlapped in size with the modern ones, there was a group of larger seeds which was out of this range. It is possible that these relate to the range of *L. sylvatica*, as this was the closest modern comparison, or that it is a result of the seeds swelling due to waterlogging.

The habitat tolerances of the five species of *Luzula* in the Faroe Islands are similar – *Luzula spicata* and *L. sylvatica* in grassland, rocky places and heathland, *L. arcuata* in heathland, *L. campestris* in grassland and pasture and *L. multiflora* in grassland, peaty places, heathland, pasture and meadow. Although *L. multiflora* is in meadows as well as 'outfield' habitats, the measurements of modern seeds indicate that they are intermediate in size between *L. campestris* and *L. arcuata*, so would be difficult to distinguish on size.

Determination: *Luzula* sp(p).

A.2.1.10. *Myosotis* - Boraginaceae

The faces of the seeds were obovate with an attachment scar on one face at the rounded end. In cross-section, the face with the scar had a slight keel, and the other side was unkeeled. The edges were sharp.

This type was only present in samples from the Faroe Islands. It could be identified to the genus *Myosotis*.

Ten seeds of each of the three species of *Myosotis* present in the region were in the reference collection in Sheffield were measured (*Myosotis arvensis, M. discolor* and *M. scorpioides*). A value for the seed length of *M. secunda* was given on the 'Ecoflora' database, but modern seeds could not be obtained for comparison. This taxon was only found at Sondum, and the length and width of all archaeological seeds were measured. The measurements of modern and archaeological material are presented in Table A.4 and were plotted on a scattergraph, Fig. A.3. The seeds from Sondum and fell within the length range of *M. arvensis*, though some were slimmer, overlapping with the width range of *M. discolor*. *M. scorpioides* and *M. secunda* could be discounted.

Determination: *Myosotis arvensis*

A.2.1.11. *Ranunculus* - Ranunculaceae

Seeds were obovate in outline, with the adaxial margin less convex than the abaxial. They were lateral-dorsally flattened but slightly biconvex. The surface textures were apparently reticulate, although some seeds exhibited patches of an overlying surface, and many seeds were abraded to a 'woody' appearance in parts. Two superficial types could initially be distinguished:

1. those with a list i.e. where the smooth curve of the outline changed direction sharply. This type of seed had a considerable range in sizes. It was unclear for the majority of seeds whether the reticulate surface was the original pattern, or due to abrasion.
2. those without (which tended to be smaller).

A description of the seeds of *R. reptans* was not presented in the *Ranunculus* section in Berggren (1981), but modern examples were present in the reference collection at the Department of Archaeology and Sami Studies at Umeå University. Fifty examples were measured and examined.

1. Seeds:
    a. with a fully abraded surface were identified as: *R. acris/repens*
    b. with some remaining smooth surface were identified as: *R.* cf. *acris*
2. Seeds of this type were identified as: *R. flammula/reptans*

A.2.2. Seaweed

These items were charred, flattened biconvex in cross-section. They were distinct from fragments of charcoal as they had a smooth surface on either face, and were more flattened in cross-section than charred twigs.

This material was identified by Dr Carol Palmer as seaweed, based on previous experience working with Scottish plant macrofossils.

A.2.3. Unidentified taxa

In several cases, no satisfactory identification of taxa could be made.

A.2.3.1. Anther

These items were elongated and were often recovered paired. They bore a strong resemblance to the anthers in the *Betula* sp. catkin. Pollen from the anthers was identified as *Betula*.

A.2.3.2. Cyperaceae Type 2E

These seeds were trigonous with relatively parallel sides i.e. seeds had a strong shoulder, with sides at almost right angles, gradually tapering to a point. They were approximately 2.65 mm long and 1.3 mm wide. The edges were blunt with a distinctive 'S' shape and the sides concave.

All species of Cyperaceae known in the modern Faroese flora were considered and most could be discounted due to the fact they were biconvex or had sharp edges or the sides were not parallel. For the species that remained, reference material was not held in the collection at the University of Sheffield, and the descriptions and photographs in Berggren (1969) were not sufficient to provide a positive

identification. They have been shown to AH and RE, but no further suggestions could be made.

A.2.3.3. Polygonaceae Type 12

These seeds were trigonous and distinctly pointed at the distal end, and measured approximately 2.3 mm long by 1.2 mm wide. The edge were sharp and appeared distinct at the tips of the seed, but less so along the margin. The surface was finely lined/wrinkled. The sides were concave, giving a sunken impression in cross-section.

These seeds could not be identified beyond the Polygonaceae family, although their sunken appearance in cross-section gave the impression they may have been under-developed or damaged examples of another type.

A.2.3.4. Cyperaceae Type 2M

These seeds were trigonous with a distinctive surface structure. They were also a darker colour than other types of Cyperaceae, although it was unclear whether this related to the original seed colour or conditions during preservation.

A.2.3.5. Wood Type 4 – spongy layer

Thin pieces with a woody outer layer with strong longitudinal ridges and a 'spongy' inner layer. The fragments bear a similar to Umbellifer stems, but have been shown to RE and no further suggestions could be made.

A.2.3.6. Wood Type 6 – large pores

Thin twigs with large pores in cross-section. The outer barky layer is never preserved. Probably the heartwood of twigs where the bark and inner layers have been abraded (R. Engelmark pers. comm.).

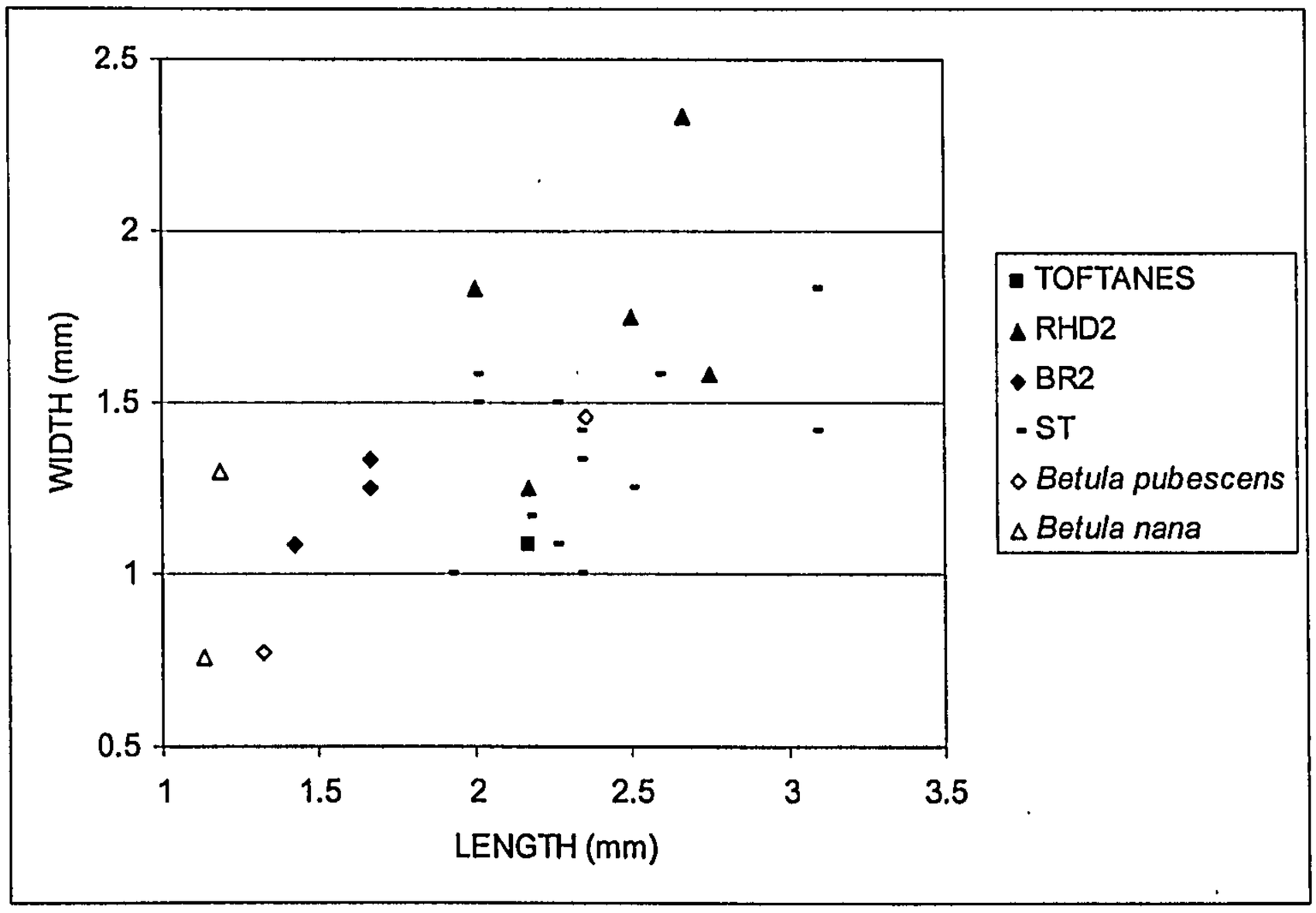


Fig. A.1. Scattergram showing length and breadth measurements for *Betula* sp. seed cores compared to published measurements for modern examples of *B. pubescens* and *B. nana* (Dickson 1970). RHD2 = Reykholtsdalur 2; BR2 = Breiðabólsstadavatn 2; ST = Stóramörk.

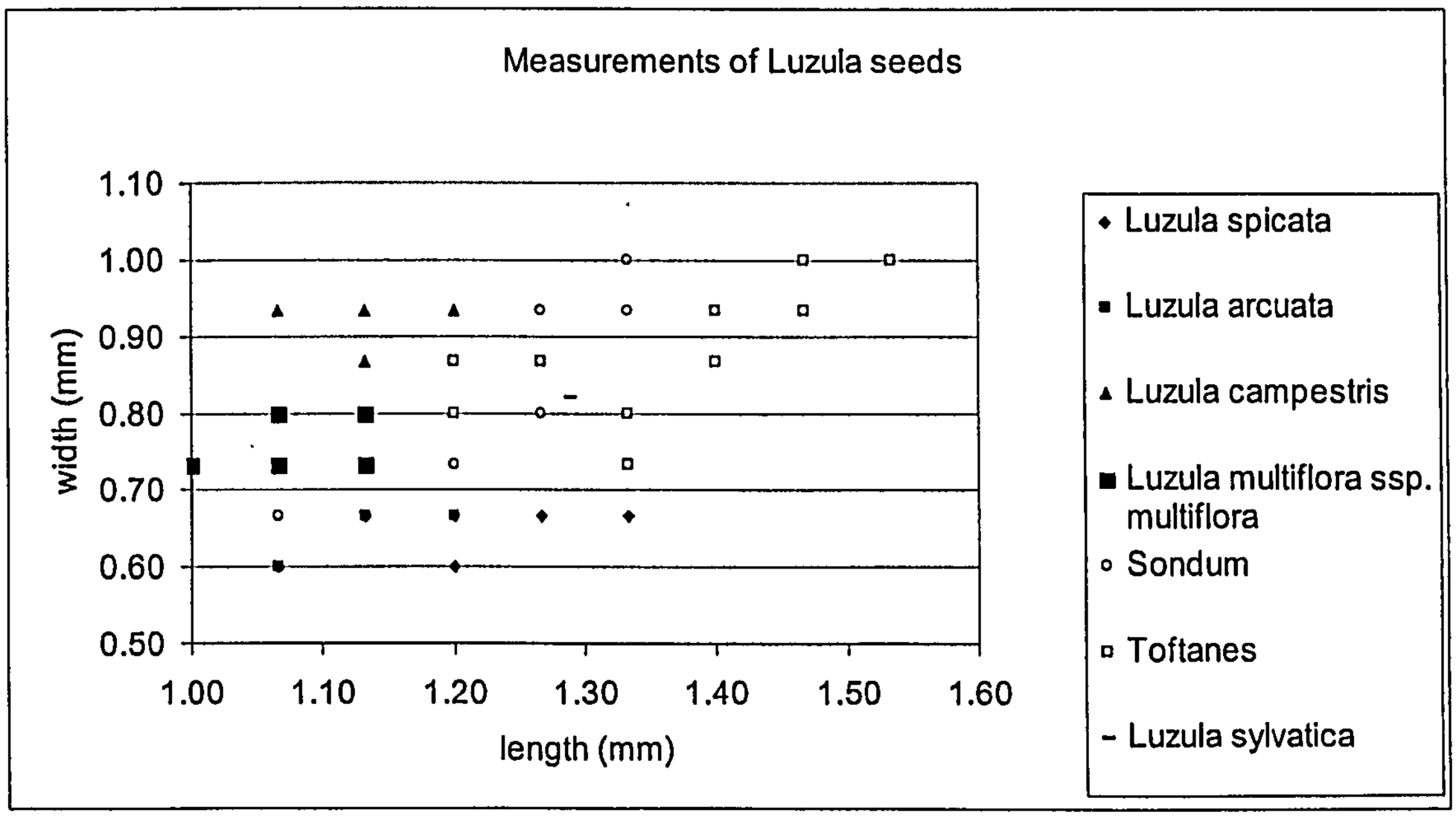


Fig. A.2. Scattergram showing length and breadth measurements for the seeds of species of *Luzula* present in the Faroe Islands, and the seeds recovered from archaeological deposits at Sondum and Toftanes.

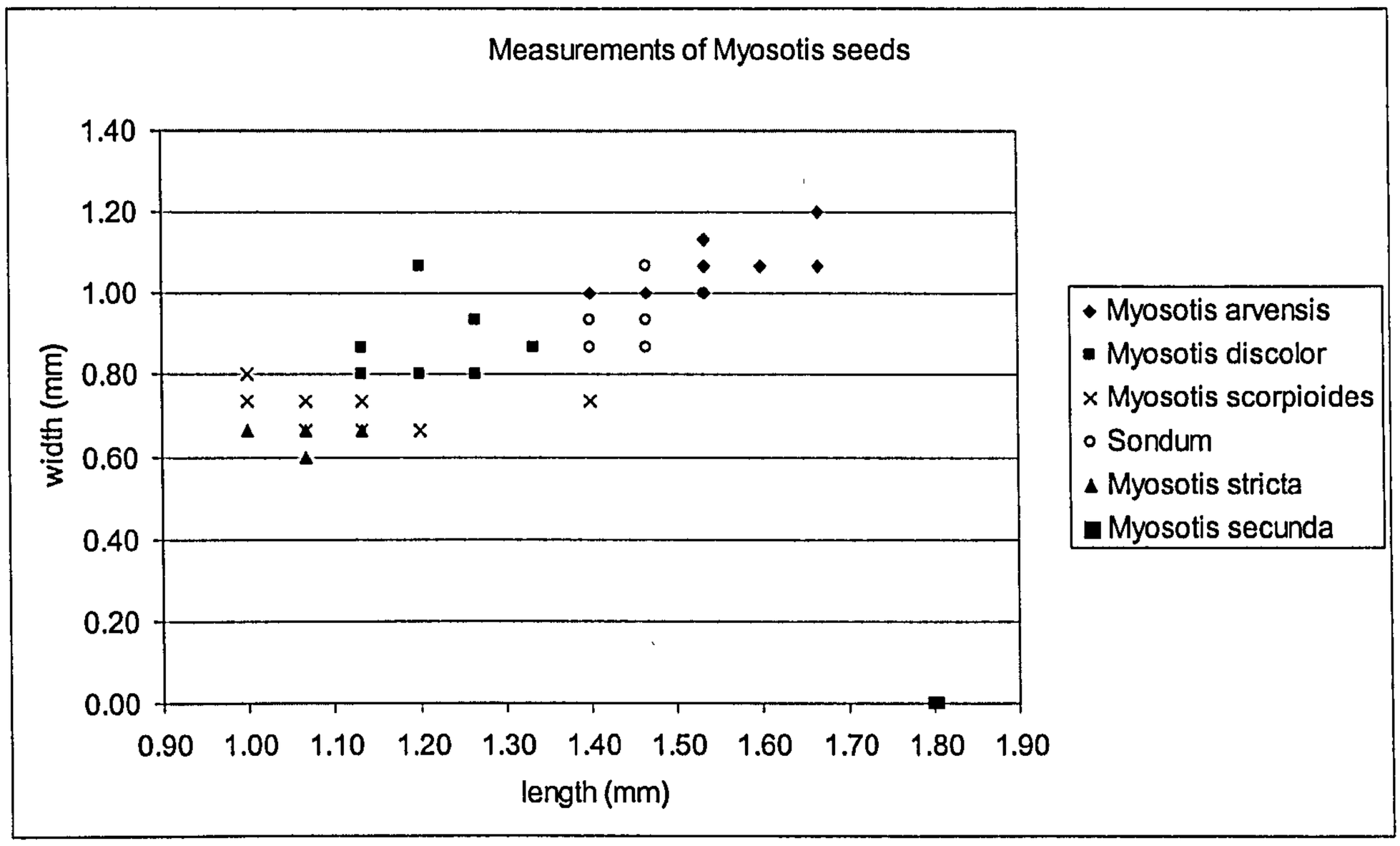


Fig. A.3. Length:width comparison for five species of *Myosotis* seeds. Material from the modern reference collection is compared with archaeological seeds from Sondum.

TAXA	PLANT PART	SOURCE OF IDENTIFICATION
Alopecurus geniculatus	Seed	Körber-Gröhne (1964; 1991); AH
Aquatic plant	'Mesh' from stem	AH
Atriplex glabriuscula	Seed	Berggren (1981)
Betula sp.	Catkin and scale	Tomlinson (1985); RE; AH
Brassica sp.	Seed	Berggren (1981)
Calluna vulgaris	Leaf	AH
Calluna vulgaris	Seed capsule	AH
Caltha palustris	Seed	Berggren (1981)
Carex echinata	Seed	Nilsson and Hjelmqvist (1967);
Carex elongata	Seed	Nilsson and Hjelmqvist (1967); Berggren (1969); Stenberg and Ericsson (1992); RE; JM
Carex pallescens	Seed	Nilsson and Hjelmqvist (1967); Berggren (1969); Stenberg and Ericsson (1992); RE; JM
Carex pilulifera	Seed	Nilsson and Hjelmqvist (1967); Berggren (1969); Stenberg and Ericsson (1992); RE; JM
Carex pulicaris	Seed	Nilsson and Hjelmqvist (1967); Berggren (1969); Stenberg and Ericsson (1992); RE; JM
Carex rostrata	Seed	Nilsson and Hjelmqvist (1967); Berggren (1969); Stenberg and Ericsson (1992); RE; JM
cf. Carum carvi	Seed	Anderberg (1994)
Cenococcum geophilum	Fruiting bodies	AH; RE
Cerastium spp.	Seed	Bergrren (1981)
Cirsium/Carduus	Seed	AH
Eleocharis palustris/uniglumis	Seed	Berggren (1969)
Equisetum sp.	Node	AH; RE
Gramineae	Culm node	MC
cf. Gramineae	Nodule from root/joint	RE
Hippuris vulgaris	Seed	Anderberg (1994)
Hippuris vulgaris/tetraphylla	Seed	Anderberg (1994); RE
Hordeum	Seed (charred)	MC
Hordeum	Seed (non-charred)	Körber-Gröhne (1964; 1991); AH
Hypericum pulchrum	Seed	Anderberg (1994)
Juniperus sp.	Needle	AH
Juniperus sp.	Segmented stem	AH
Leontodon autumnalis	Seed	Beijerinck (1947)
Linum cartharticum	Seed	Anderberg (1994)
Lychnis flos-cuculi	Seed	Bergrren (1981)

Table A.1. Taxa identified from published methods and the references for publications. Initials indicate where expert help and advice was provided (AH = Dr Allan Hall; RE = Prof. Roger Engelmark; JM = Dr Jennifer Miller; MC = Dr Mike Charles).

Matricaria maritima	Seed	AH
Menyanthes trifoliata	Seed	AH
Montia fontana ssp. fontana	Seed	Bergrren (1981)
Poa annua	Seed	Körber-Gröhne (1964; 1991); AH
Poa nemoralis/palustris	Seed	Körber-Gröhne (1964; 1991); AH
Poa cf. pratensis	Seed	Körber-Gröhne (1964; 1991); AH
cf. Polygonaceae	Leaflet/scale	AH; RE
Polygonum aviculare	Seed	Bergrren (1981)
Polygonum	Seed	Bergrren (1981)
Potamogeton sp.	Seed	Aalto (1970); AH
Potentilla anserina	Seed	Anderberg (1994)
Potentilla crantzii/erecta	Seed	Anderberg (1994)
Potentilla palustris	Seed	Anderberg (1994)
Prunella vulgaris	Seed	Schoch *et al.* (1988)
Rhinanthus groenlandicus/minor	Seed	AH
Rumex acetosa/longifolius	Seed	Bergrren (1981)
Rumex acetosella	Seed	Bergrren (1981)
Rumex crispus/obtusifolius	Seed	Bergrren (1981)
Rumex sp.	Seed	Bergrren (1981)
Sagina sp(p).	Seed	Bergrren (1981)
Salix sp.	Bud scale	Tomlinson (1985); RE; AH
Selaginella selaginoides	Seed	Minaki (1984); Berthet and Lecocq
Spergula arvensis	Seed	Bergrren (1981)
Stellaria media	Seed	Bergrren (1981)
Taraxacum sp.	Seed	Beijerinck (1947)
Urtica dioica	Seed	Bergrren (1981)
cf. Umbelliferae	Seed	Anderberg (1994)
Veronica chamaedrys	Seed	AH
Viola canina/palustris	Seed	Anderberg (1994)
Viola riviniana	Seed	Anderberg (1994)
Viola sp.	Capsule segment	AH
Wood and twig – all taxa	Stem or twig	Schweingruber (1978; 1990)

Table A.1. Taxa identified from published methods and the references for publications. Initials indicate where expert help and advice was provided (AH = Dr Allan Hall; RE = Prof. Roger Engelmark; JM = Dr Jennifer Miller; MC = Dr Mike Charles).

SITE	SAMPLE	MOSITURE	PH	NITROGEN	NUMBER OF CLASSIFIED TYPES (not including Betula)
Breiðabólsstadavatn 2	12.5-15.0	7-10	5-6	2-3	2
Breiðabólsstadavatn 2	47.5-50.0	5-7, 10	4	2	2
Breiðabólsstadavatn 2	60.0-62.5	10	4	2	1
Breiðabólsstadavatn 2	85.0-82.5	10	4	2	1
Breiðabólsstadavatn 2	95.0-97.5	10	4	2	1
Breiðabólsstadavatn 2	115.0-117.5	10	4	2	1
Reykholtsdalur 2	pre-1	10	4, 6	2, 4	2
Reykholtsdalur 2	pre-5	10	4	3	1
Stóramörk	85.0-87.5	5-7, 9-10	3-4, 6-7	4	2
Stóramörk	97.5-100.0	5-8, 10	4-5	2-3	3
Reykholtsdalur 3	125.0-127.5	7-10	4	3	1
Háls South Pit	57.0-66.0	5-10	4-8	2-4	6
Betula nana		8	1	1	
Betula pubescens		7	4	4	

Table A.2. Moisture, pH and nitrogen conditions for samples containing *Betula* sp. seeds based on Ellenberg numbers for other taxa present in the sample. Ellenberg values for *B. nana* and *B. pubescens* are listed for comparison.

SPECIES	FAROE					ICELAND
	SURFACE PATTERN	CELL WALL LINE	STRUCTURE BRANCHING	CELL WALL THICKENING LOCATION	LAYOUT OF ROWS OF CELLS	
Juncus alpinus						Present
Juncus arcticus						Present
Juncus articulatus		Curved	Yes	Regular punctuate, in region of projections		Present
Juncus balticus		Irregular			Irregular	Present
Juncus biglumis	Reticulate					Present
Juncus bufonius		Straight	No	None	Definite longitudinal	Present
Juncus bulbosus		Curved	Yes	Regular punctuate		Present
Juncus castaneus						Present
Juncus conglomeratus		Straight	No	Thickening of walls at corners*	Definite longitudinal	
Juncus effusus		Straight	No	Thickening of walls at corners*	Definite longitudinal	
Juncus filiformis						Present
Juncus gerardii						Present
Juncus ranarius						Present
Juncus squarrosus	Square			Thick walls		Present
Juncus trifidus	Elongated reticulate					Present
Juncus triglumis	Reticulate					Present

Table A.3. Summary of identification criteria used for *Juncus* spp. seeds, based on the key published in Korber-Gröhne (1964). Additional information is marked with an asterisk.

SPECIES	LENGTH MIN (mm)	LENGTH MAX (mm)	WIDTH MIN (mm)	WIDTH MAX (mm)
Luzula arcuata	1.07	1.20	0.60	0.73
Luzula campestris	1.07	1.20	0.87	0.93
Luzula multiflora	1.00	1.13	0.73	0.80
Luzula spicata	1.07	1.33	0.60	0.67
Luzula sylvatica	1.29		0.82	
ARCHAEOLOGICAL (Toftanes)	1.20	1.53	0.73	1.00
ARCHAEOLOGICAL (Sondum)	1.07	1.40	0.67	1.00

Table A.4. Measurements for published and archaeological seeds of *Luzula* sp. present in the Faroe Islands.

SPECIES	LENGTH MIN (mm)	LENGTH MAX (mm)	WIDTH MIN (mm)	WIDTH MAX (mm)
Myosotis arvensis	1.4	1.7	1.0	1.2
Myosotis discolour	1.1	1.3	0.8	1.1
Myosotis scorpioides	1.0	1.4	0.7	0.8
Myosotis secunda	1.8	1.8		
ARCHAEOLOGICAL (all seeds)	1.4	1.5	0.9	1.1

Table A.5. Measurements for published and archaeological seeds of *Myosotis* present in the Faroe Islands.

FAROE ONLY	REASON FOR DISCOUNTING	SIZE MIN (mm)	SIZE MAX (mm)	LIST	SURFACE
Ranunculus acris		1.9	3.6	Present	Smooth
Ranunculus auricomus	Glabrous surface				
Ranunculus ficaria	Round cross-section				
Ranunculus flammula		1.2	1.9	Absent	
Ranunculus glacialis	Sickle shape in side view				
Ranunculus repens		2.3	3.5	Present	Reticulate
Ranunculus reptans		1.1	1.9	Absent	

Table A.6. Measurements and morphological descriptions of published seeds of *Ranunculus* present in the study area.

SPECIES	HABITAT ASSOCIATION CATEGORY	ENVIRONMENTAL CATEGORIES			FINAL CATEGORISATION
		MOISTURE	ACIDITY	NITROGEN	
Alopecurus geniculatus	undisturbed nutrient-rich/grass	dry-moist-wet	acid	intermediate	NUTRIENT-INTERMEDIATE-RICH - UNDISTURBED (HAYFIELD)
Atriplex glabruiscula	disturbed nutrient-rich shore	moist	moderate	rich	NUTRIENT-INTERMEDIATE-RICH - DISTURBED (RUDERAL-ARABLE)
Betula sp.	outfield various				OUTFIELD
Brassica sp.	disturbed arable or related, nutrient-rich	moist	all	all	NUTRIENT-INTERMEDIATE-RICH - DISTURBED (RUDERAL-ARABLE)
Calluna vulgaris	heath-rocky	moist	acidic	poor	MOIST OUTFIELD - NUTRIENT-POOR
Caltha palustris	wet-water	wet-water	acidic	intermediate	WET-WATER - NUTRIENT-INTERMEDIATE
Capsella bursa-pastoris	disturbed nutrient-rich	moist	moderate	rich	NUTRIENT-INTERMEDIATE-RICH - DISTURBED (RUDERAL-ARABLE)
Carex binervis/capillaris	grassy-heath-rocky	all	all	poor	MOIST OUTFIELD - NUTRIENT-POOR
Carex demissa (C. flava type Faroe)	drier outfield	moist	acidic	poor	MOIST OUTFIELD - NUTRIENT-POOR
Carex echinata	marsh-bog	wet-water	acidic	poor	WET-WATER - NUTRIENT-POOR
Carex elongata	marsh-bog	wet-water	acidic	intermediate	WET-WATER - NUTRIENT-INTERMEDIATE
Carex flacca	grassy-heath-rocky-mountain	moist	acidic	poor	MOIST OUTFIELD - NUTRIENT-POOR
Carex flava type (Iceland)	wet-water	no data presented	no data presented	no data presented	WET-WATER
Carex nigra type	outfield various	no data presented	no data presented	no data presented	OUTFIELD - NUTRIENT-POOR
Carex pallescens	undisturbed grassland	dry-moist-wet	acid	intermediate	MOIST OUTFIELD - NUTRIENT-INTERMEDIATE
Carex pilulifera	grassy-heath-rocky	moist	acidic	poor	MOIST OUTFIELD - NUTRIENT-POOR
Carex pulicaris	marsh-bog	moist	acidic	poor	MOIST OUTFIELD - NUTRIENT-POOR
Carex rostrata	lake-marsh-bog	wet-water	acidic	poor	WET-WATER - NUTRIENT-POOR
Carum carvi	nutrient-rich/grass	no data presented	no data presented	no data presented	NUTRIENT-INTERMEDIATE-RICH - UNDISTURBED (HAYFIELD)
Cerastium sp.	undisturbed various	moist	all	all	VARIOUS
Cirsium arvense	undisturbed nutrient-rich	moist	moderate	rich	NUTRIENT-INTERMEDIATE-RICH - UNDISTURBED (HAYFIELD)
Corylus avellana	introduced?	dry-moist-wet	acid	intermediate	INTRODUCED?
Eleocharis palustris/uniglumis	wet-water	wet-water	acidic	intermediate	WET-WATER - NUTRIENT-INTERMEDIATE
Empetrum nigrum	heath-rocky	moist	acidic	poor	MOIST OUTFIELD - NUTRIENT-POOR
Galeopsis tetrahit/speciosa	various tends disturbed nutrient-rich	moist	all	all	VARIOUS TENDS NUTRIENT-RICH
Hippuris vulgaris	water	wet-water	acidic	intermediate	WET-WATER - NUTRIENT-INTERMEDIATE
Hippuris vulgaris/tetraphylla	water	wet-water	acidic	intermediate	WET-WATER - NUTRIENT-INTERMEDIATE
Hypericum pulchrum	grassy-heath-rocky	moist	acidic	poor	MOIST OUTFIELD - NUTRIENT-POOR
Hypericum pulchrum/maculatum	undisturbed various	moist	all	all	MOIST OUTFIELD - NUTRIENT-INTERMEDIATE-POOR
Juncus articulatus	wet-water	wet-water	acidic	poor	WET-WATER - NUTRIENT-POOR
Juncus articulatus/bulbosus	various	all	all	poor	OUTFIELD - NUTRIENT-POOR
Juncus biglumis/triglumis	outfield various	all	all	poor	OUTFIELD - NUTRIENT-POOR
Juncus bufonius	disturbed nutrient-rich; by water	dry-moist-wet	acid	intermediate	NUTRIENT-INTERMEDIATE-RICH - DISTURBED (RUDERAL-ARABLE)
Juncus bulbosus	lake-marsh-bog	wet-water	acidic	poor	WET-WATER - NUTRIENT-POOR
Juncus conglomeratus	marsh-bog	moist	acidic	poor	MOIST OUTFIELD - NUTRIENT-POOR
Juncus trifidus	grassy-heath-rocky-mountain	moist	acidic	poor	MOIST OUTFIELD - NUTRIENT-POOR
Juncus trifidus/bufonius	various	moist	all	all	VARIOUS TENDS NUTRIENT-RICH
Juniperus communis	heath-rocky	moist	acidic	poor	MOIST OUTFIELD - NUTRIENT-POOR
Leontodon autumnalis	undisturbed nutrient-rich/grazed	dry-moist-wet	acid	intermediate	NUTRIENT-INTERMEDIATE-RICH - UNDISTURBED (HAYFIELD)
Linum catharcticum	outfield various	all	all	poor	OUTFIELD - NUTRIENT-POOR
Luzula sp.	undisturbed outfield various	moist	all	all	OUTFIELD
Lychnis flos-cuculi	wet-water	wet-water	acidic	intermediate	WET-WATER - NUTRIENT-INTERMEDIATE
Matricaria maritima = Tripleurospermum maritima	nutrient-rich shore	dry-moist-wet	acid	intermediate	NUTRIENT-INTERMEDIATE-RICH - DISTURBED (RUDERAL-ARABLE)
Menyanthes trifoliata	lake-marsh-bog	wet-water	acidic	poor	WET-WATER - NUTRIENT-POOR

Table A.7. Habitat association categories (published Floras, environmental categories (Ellenberg numbers) and the final categorisation (the above plus advice from colleagues) for plant species represented at all sites).

SPECIES	HABITAT ASSOCIATION CATEGORY	ENVIRONMENTAL CATEGORIES			FINAL CATEGORISATION
Montia fontana ssp fontana	wet-water	wet-water	acidic	intermediate	SEE SECTION 4 6.1.
Myosotis arvensis	disturbed nutrient-rich/grass	dry-moist-wet	acid	intermediate	NUTRIENT-INTERMEDIATE-RICH - DISTURBED (RUDERAL-ARABLE)
Poa annua	disturbed nutrient-rich	moist	moderate	rich	NUTRIENT-INTERMEDIATE-RICH - DISTURBED (RUDERAL-ARABLE)
Poa nemoralis	heath-rocky	dry-moist-wet	acid	intermediate	MOIST OUTFIELD - NUTRIENT- INTERMEDIATE
Poa pratensis	undisturbed nutrient-rich	dry-moist-wet	acid	intermediate	NUTRIENT-INTERMEDIATE-RICH - UNDISTURBED (HAYFIELD)
Polygonum lapathifolium/persicaria	nutrient-rich; by water	no data presented	no data presented	no data presented	NUTRIENT-RICH
Potamogeton sp.	water	all	all	all	WET-WATER
Potentilla anserina	undisturbed shore/sandy; wet pasture	moist	moderate	rich	NUTRIENT-INTERMEDIATE-RICH - UNDISTURBED (HAYFIELD)
Potentilla anserina ssp anserina	undisturbed shore/sandy; wet pasture	moist	moderate	rich	NUTRIENT-INTERMEDIATE-RICH - UNDISTURBED (HAYFIELD)
Potentilla crantzii/erecta	grassy-heath-rocky-meadow	all	all	poor	MOIST OUTFIELD - NUTRIENT- POOR
Potentilla crantzii/erecta/palustris	outfield various	all	all	poor	OUTFIELD - NUTRIENT-POOR
Potentilla palustris	lake-marsh-bog	wet-water	acidic	poor	WET-WATER - NUTRIENT-POOR
Prunella vulgaris	undisturbed nutrient-rich/grass	dry-moist-wet	acid	intermediate	NUTRIENT INTERMEDIATE-RICH - UNDISTURBED (HAYFIELD)
Ranunculus acris/repens	various tends undisturbed nutrient-rich	moist	all	all	VARIOUS (TENDS HAYFIELD)
Ranunculus cf. acris	undisturbed nutrient-rich/grass	dry-moist-wet	acid	intermediate	NUTRIENT INTERMEDIATE-RICH - UNDISTURBED (HAYFIELD)
Ranunculus flammula	wet-water	wet-water	acidic	poor	WET-WATER - NUTRIENT-POOR
Ranunculus flammula/reptans	wet-water	wet-water	acidic	poor	WET-WATER - NUTRIENT-POOR
Rhinanthus minor	disturbed grassland	moist	acidic	poor	MOIST OUTFIELD - NUTRIENT-POOR
Rumex crispus/obtusifolius	various tends undisturbed nutrient-rich	moist	all	all	VARIOUS (TENDS HAYFIELD)
Rumex acetosa/longifolius	various tends undisturbed nutrient-rich	moist	all	all	VARIOUS (TENDS HAYFIELD)
Rumex acetosella	sandy-ruderal	moist	acidic	poor	VARIOUS
Sagina nivalis/nodosa/subulata	undisturbed grassy-heath-rocky	moist	all	all	MOIST OUTFIELD - NUTRIENT-POOR
Selaginella selaginoides	grassy-heath-rocky-mountain	moist	acidic	poor	MOIST OUTFIELD - NUTRIENT-POOR
Spergula arvensis	disturbed nutrient-rich/grass	dry-moist-wet	acid	intermediate	NUTRIENT-INTERMEDIATE-RICH - DISTURBED (RUDERAL-ARABLE)
Stellaria media	nutrient-rich	moist	moderate	rich	NUTRIENT-RICH
Taraxacum sp	nutrient-rich	no data presented	no data presented	no data presented	NUTRIENT-RICH
Urtica dioica	undisturbed nutrient-rich	moist	moderate	rich	NUTRIENT-INTERMEDIATE-RICH - UNDISTURBED (HAYFIELD)
Veronica chamaedrys	grassland	dry-moist-wet	acid	intermediate	MOIST OUTFIELD - NUTRIENT- INTERMEDIATE
Viola canina/palustris	outfield various	all	all	poor	OUTFIELD - NUTRIENT-POOR
Viola canina/palustris/epipsila	outfield various	no data presented for V. epipsila	no data presented for V. epipsila	no data presented for V. epipsila	OUTFIELD - NUTRIENT-POOR
Viola riviniana	undisturbed grassy-heath-rocky	dry-moist-wet	acid	intermediate	MOIST OUTFIELD - NUTRIENT-INTERMEDIATE

Table A.7. Habitat association categories (published Floras, environmental categories (Ellenberg numbers) and the final categorisation (the above plus advice from colleagues) for plant species represented at all sites).

APPENDIX B

DEPTH (cm)	2.5-5.0	12.5-15.0	22.5-25.0	32.5-35.0	42.5-45.0	52.5-55.0	62.5-65.0	92.0-95.5	103.0-105.5	113.0-115.5
BULK VOLUME (litres)	scan	scan	0.25	0.25	0.25	0.25	0.25	scan	scan	scan
	scan	scan	multiplied total	multiplied total	multiplied total	multiplied total	>0.5	multiplied total	scan	scan
MULTIPLIED TO	scan	scan	1	1	1	1	0.25	scan	scan	scan
Carex echinata Murray	#		2	41	43					
Carex nigra-type	#	#								
Carex pilulifera L.				2	4					
Carex sp.				6	7					
Carex tumidicarpa Anderss.					1					
cf. Luzula sp.										#
Cyperaceae indet.		#								
Cyperaceae Type 2E					5					
Eleocharis palustris/uniglumis					1					
Gramineae	#					4	1			
Hypericum pulchrum L.					3					
Juncus articulatus/bulbosus	#	#	80		80					#
Juncus trifidus L.		#							#	
Juncus Type 7		#								
Juncus sp.		#	72		80					
Potentilla crantzii/erecta				127	17					
Ranunculus acris/repens								#		
Selaginella selaginoides (L.) Beauv. Ex Mart. & Schrank	#	#	16		2	5	1			#
Veronica chamaedrys L.			8							
Viola canina/palustris				3	3	5				
Seed indet. (flat seed with wing?)								#		
Seed indet.									#	
TOTAL			178	178	245	14	2			

Table B.1. Content of samples analysed from Hov. # indicates present in scan.

SAMPLE	POST-LANDNAM 1	PRE-LANDNAM 1	PRE-LANDNAM 5
BULK VOLUME (litres)	0.5	0.5	0.25
	multiplied total	multiplied total	multiplied total
MULTIPLIED TO	1	1	1/8
Betula sp.		9	11
Carex cf. nigra-type			2
Carex rostrata Stokes		36	2
Carex sp. trigonous		1/2	
Cerastium sp.	1		
Hippuris vulgaris/tetraphylla	6	3	
Potamogeton sp.	3		
Selaginella selaginoides (L.) Beauv. Ex Mart. & Schrank	8		
TOTAL	**18**	**48 1/2**	**15**
Salix bud scale	2	10	9
cf. catkin scale			fragment
Mesh reinforcement from stem of water plant		fragments	
Cenococcum geophilum	14		2
Wood rating		1	1
Empetrum/Arctostaphylos			1
Ericaceous twig/root			4
Betula sp.			4
Deciduous indet.			8
Indet.		7	15

Table B.2. Content of samples analysed from Reykholtsdalur 2.

DEPTH (cm)	17.5-20.0	22.5-25.0	27.5-30.0	42.5-45.0	47.5-50.0	57.5-60.0
BULK VOLUME (litres)			0.25	0.25	0.25	
	scan	scan	multiplied total	multiplied total	multiplied total	scan
MULTIPLIED TO	scan	scan	1/8	1/8	1/4	scan
Betula sp.						
Carex nigra-type	#		2 1/2	6	0	
Carex pulicaris L.			7			
Carex rostrata Stokes			37	8	4	
Carex sp. trigonous	#	#	5 1/3	5	2/3	
Menyanthes trifoliata L.	#		1/2			
Polygonum indet.						
Selaginella selaginoides (L.) Beauv. Ex Mart. & Schrank						
Seed indet.					1	
cf. Gramineae					2	
TOTAL			**52 1/3**	**19**	**7 2/3**	
Cenococcum geophilum			4	230	300	#
Wood rating			**degraded wood and lots of fibres**	**degraded wood and lots of fibres**	**degraded wood and lots of fibres**	#
Deciduous indet.			#			
Indet.			#			
Moss	#	#				

Table B.3. Content of samples analysed from Reykholtsdalur 3. # indicates present in scan.

DEPTH (cm)	**65.0-67.5**	**70.0-72.5**	**80.0-82.5**	**87.5-90.0**	**92.5-95.0**
BULK VOLUME (litres)	0.25	0.25	0.25		
	multiplied total	multiplied total	multiplied total	scan	scan
MULTIPLIED TO	0.5	0.5	0.25		
Betula sp.			1		
Carex nigra-type	0	0			
Carex pulicaris L.					
Carex rostrata Stokes			4		
Carex sp. trigonous	2/3			#	#
Menyanthes trifoliata L.			1/2		#
Polygonum indet.			2		
Selaginella selaginoides (L.) Beauv. Ex Mart. & Schrank			2		
Seed indet.					
cf. Gramineae					
TOTAL	**2/3**	**0**	**9 1/2**		
Cenococcum geophilum	2809	1628	73		
Wood rating	**1**	**4**	**dominated by fibres and bark**	#	#
Deciduous indet.					
Indet.					
Moss				#	#

Table B.3. Content of samples analysed from Reykholtsdalur 3. # indicates present in scan.

DEPTH (cm)	**0.0-2.5**	**15.0-17.5**	**27.5-30.0**	**42.5-45.0**	**52.5-55.0**	**62.5-65.0**	**72.5-75.0**	**82.5-85.0**
BULK VOLUME (litres)	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
	scan	multiplied fraction	multiplied fraction	multiplied fraction	scan	multiplied fraction	scan	scan
MULTIPLIED TO	scan	1/4	1/2	1/2	scan	1	scan	scan
Betula sp.		3	1		#	81		#
Carex rostrata Stokes	#	33 1/3	31	2 1/3	#	33 1/3		#
Luzula sp.		1						
TOTAL		**37 1/3**	**32**	**2 1/3**		**114 1/3**		
Cenococcum geophilum	#	110	323	401	#	345		
Wood rating	#	**4**	**1**	**4**	#	**4 - degraded**	#	#
Arctostaphylos uva-ursi (L.) Spreng.			#			#		
cf. Calluna			#					
Betula sp.			#					
Type 6			#			#		
Indet.			#					
Moss	#							

Table B.4. Content of samples analysed from Breiðabólsstadavatn. # indicates present.

DEPTH	55.0-57.5	65.0-67.5	75.0-77.5	85.0-87.5	97.5-100.0	102.5-105.0	117.5-120.0	130.0-132.5	142.5-145.0
BULK VOLUME (litres)	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
	multiplied total	scan	multiplied total	multiplied total	multiplied total	multiplied total	multiplied total	multiplied total	scan
MULTIPLIED TO	0.25	scan	0.5	0.5	1	0.5	0.25	1	scan
Betula sp. seed				2	71	44	9	341	
Carex nigra-type	18	#	19	30	40	4			
Carex rostrata Stokes					1				
Cerastium sp.					4				
Cyperaceae indet.									
Cyperaceae Type 2M (not Carex)			3	9					
Eleocharis palustris/uniglumis	2	#	11	81 1/2					
Juncus sp.	3								
Luzula sp.	1 1/2			2					
Potentilla cf. palustris					1				
Selaginella selaginoides (L.) Beauv. Ex Mart. & Schrank	11								
Stellaria media (L.) Vill.			1						
Taraxacum sp.			1/2						
Viola canina/epipsila/palustris	1/2	#	1/2	2					
Seed indet.	1/2				1				
TOTAL	**36 1/2**		**35**	**126 1/2**	**118**	**48**	**9**	**341**	
Salix bud scale			2		43	13		50	
Cenococcum geophilum	10		81			2	12	8	
Betula sp. catkin presence					1	1	1	1	
Mesh reinforcement from stem of water plant							frags.		
Wood rating	**1**	**#**	**1**		**1**	**1**	**5 - very degraded**	**5**	**#**
Vaccinium/Andromeda twig			#						
cf. Salix						#			
cf. Betula						#			
Deciduous indet.						#			
Type 6					#	#	#		
Indet.					#	#	#		
Moss	1	#	1	1	5	1			

Table B.5. Content of samples analysed from Stóramörk. # indicates present.

SAMPLE NUMBER		393	570	595	645	1016	1622	1641	1682	1760	1761
BULK VOLUME (litres)		1.00	0.5	0.5	0.5	0.5	0.5	1	0.5	2.00	0.5
MULTIPLIED TO		1	1/2	1	1	1	1	1	1	1	1
Alopecurus geniculatus L.	non-charred		303 1/4			11 1/2					
Atriplex glabriuscula Edmonst.	charred										
cf. Avena sativa	non-charred										
Barley cf. hulled	charred										
Barley indet.	charred						1				
Barley seed coat	non-charred										
Betula sp.	non-charred										
cf. Boraginaceae	non-charred										
Brassica sp.	non-charred										
Carex echinata Murray	charred										
Carex echinata	non-charred		4		2	1			3 13/14		4 1/5
Carex cf. echinata	non-charred		1/4		1/2		12		2 6/7		32 1/10
Carex flava-type	charred						8				
Carex flava-type	non-charred		2 3/4	1 1/2	1 1/2		1				2
Carex cf. flava (4 sided)	non-charred										
Carex nigra-type	non-charred			3 1/2							2
Carex pallescens L.	non-charred										
Carex pilulifera L.	charred										
Carex pilulifera	non-charred		4 2/3	4 1/2	1						2/3
Carex cf. pilulifera	non-charred			2/3							
Carex rostrata Stokes	non-charred										
Carex cf. rostrata	charred										
Carex cf. rostrata	non-charred										
Carex sp. biconvex	non-charred						1				
Carex sp.	non-charred			1/4			8				
Carex trigonous indet.	charred										
Carex trigonous indet.	non-charred						1				
cf. Carum carvi L.	non-charred										
Caryophyllaceae indet.	non-charred			1/2							
Cerastium spp.	charred										
Cerastium spp.	non-charred		187 1/4			20 1/4					135
cf. Cerastium sp. (spiky)	non-charred										2
cf. Cerastium spp.	non-charred										1/20
Cereal grain	charred			3			1/2				
cf. cereal grain	charred										
cf. Cirsium/Carduus	non-charred										
Corylus avellana L.	charred										
Corylus avellana	non-charred										
Cyperaceae indet.	non-charred							2			
Cyperaceae Type 2E	charred										
Cyperaceae Type 2E	non-charred		1		1						
cf. Deschampsia caespitosa	charred										
Empetrum nigrum L.	charred										
Empetrum nigrum	non-charred		1					2			
Galeopsis sp(p)	charred										

Table B.6. Content of samples analysed from Toftanes.

SAMPLE NUMBER		393	570	595	645	1016	1622	1641	1682	1760	1761
Galeopsis sp(p)	non-charred		1	1							8 1/10
cf. Galeopsis sp(p)	non-charred			1/2			1				2
Gramineae group 1	non-charred										
Gramineae indet - spikelet	charred										
Gramineae indet. - in glumes	non-charred										
Gramineae indet.	charred										
Gramineae indet.	non-charred		96 1/2	1	8 1/2		32		4		40
cf. Gramineae	non-charred		4								8
Hippuris vulgaris L.	non-charred							254			
Hordeum sp.	non-charred										
Hulled barley cf. twisted	charred										
Hulled barley indet.	charred			2							
Hulled barley straight	charred										
Hulled barley twisted	charred										
Hypericum pulchrum L.	non-charred						8	12			
Hypericum pulchrum/maculatum	non-charred										
Juncus articulatus L.	non-charred					16	64				
Juncus articulatus/bulbosus	non-charred										
Juncus bufonius L.	charred										
Juncus bufonius	non-charred		80			64					
Juncus cf. conglomeratus	non-charred										
Juncus trifidus L.	non-charred						16				
Juncus trifidus/bufonius	non-charred										
Juncus sp.	charred										
Juncus sp.	non-charred		1702 1/4		360 1/2	21		272	40		882 2/5
Leontodon autumnalis L.	non-charred										
Luzula sp(p)	non-charred		3/8				20				1/20
cf. Luzula sp.	non-charred		8								
Lychnis flos-cuculi L.	non-charred		1/4			1/2		12	2		1
cf. Lychnis flos-cuculi	non-charred										
Menyanthes trifoliata L.	non-charred										
cf. Menyanthes trifoliata	non-charred										4
Montia fontana L.	charred										
Montia fontana	non-charred		357 1/4	4	658 3/4	219 1/2	104	24	2	1	433 3/5
cf. Montia fontana	non-charred										
Poa annua L.	non-charred		32								
Poa annua	non-charred										
cf. Poa annua	non-charred		8								
cf. Poa annua	non-charred										
Poa cf. nemoralis	non-charred										
Poa cf. pratensis	non-charred										
Poa cf. pratensis/trivialis	non-charred		1 3/4								
Poa sp.	non-charred										
Poa sp. (blunt end)	non-charred					1					
Poa sp. (not annua)	non-charred										
Polygonaceae indet.	non-charred		1								
Polygonaceae sp. (thin walled)	non-charred		3 1/4		40						

Table B.6. Content of samples analysed from Toftanes.

SAMPLE NUMBER		393	570	595	645	1016	1622	1641	1682	1760	1761
Polygonum aviculare L.	non-charred										2
Polygonum sp.	charred										
Polygonum sp.	non-charred				16						
Polygonum Type ?D	non-charred				1						
Polygonum Type 12	non-charred		2		21						
Potentilla crantzii/erecta	non-charred			2			25		1		
Potentilla crantzii/erecta/palustris	non-charred										
Potentilla palustris (L.) Scop.	non-charred										
Potentilla sp.	non-charred										
Prunella vulgaris L.	non-charred										
cf. Pucinellia sp	charred										
Ranunculus acris/repens	charred										
Ranunculus acris/repens	non-charred		10 3/4	4	5	24					64
Ranunculus flammula/reptans	non-charred		3	1/2		26 1/2	1 1/2	4			29
Ranunculus sp.	non-charred				1	1					8
cf. Ranunculus sp.	non-charred										
Rhinanthus groenlandicus/minor	non-charred		8				1				
cf. Rosaceae sp. (immature)	non-charred										
Rumex acetosa/longifolius	charred				1						
Rumex acetosa/longifolius	non-charred		1 1/2		18 1/2	3					
Rumex cf. acetosa/longifolius	non-charred				2						
Rumex acetosella L.	non-charred										
Rumex crispus/obtusifolius	charred										
Rumex crispus/obtusifolius	non-charred				1						
Rumex cf. crispus/obtusifolius	non-charred										
Rumex sp.	charred										
Rumex sp.	non-charred		24 1/4		367	6 1/6					4
Rumex sp. (runty <1mm)	non-charred				96	16					
Rumex sp. (runty)	non-charred		8								
Rumex sp. with leaves	non-charred		46		162						
Rumex trigonous core	charred										
cf. Rumex	non-charred										
Rumex/Polygonum	non-charred			1/2							
Sagina intermedia/nodosa/subulata	non-charred		48	1/2	266	8	8				480
Selaginella selaginoides (L.) Beauv. Ex Mart. & Schrank	non-charred		8	247 1/3				21 1/3		92	16 1/10
Spergula arvensis L.	charred										
Spergula arvensis	non-charred						8				
Spergula-type	core charred										
Spergula-type	non-charred										
Stellaria media (L.) Vill.	charred										
Stellaria media	non-charred		6 1/2	2	10	12 3/4	11		2		28 3/20
cf. Stellaria media	non-charred			1/2			8				
Taraxacum sp.	non-charred										
Viola canina/palustris	non-charred							2	1		
Viola riviniana Rchb.	non-charred								3		
Viola sp.	non-charred						2	1			
cf. Umbelliferae	charred										

Table B.6. Content of samples analysed from Toftanes.

SAMPLE NUMBER		393	570	595	645	1016	1622	1641	1682	1760	1761
Trignous seed indet.	non-charred							4			
Seed indet	non-charred										8
Seed indet (inner core?)	non-charred			1/2							
cf. seed	charred										
TOTAL		**0**	**2965 4/5**	**280 1/4**	**2041 1/4**	**452 1/6**	**342**	**610 1/3**	**61 7/9**	**93**	**2196 2/5**
Stigma/Stamen	non-charred										
Calluna vulgaris L. seed capsule	non-charred				45						
Type 6 node	charred										
Rachis/culm (grass)	charred										
?Grass nodule from root/joint	non-charred			1							
Culm node	charred										
Culm node	non-charred										
Chaff (grass)	non-charred										
Corylus nut shell	non-charred										
Viola seed capsule segment	non-charred										
Salix bud	non-charred										
Calluna vulgaris leaves	non-charred				1		1				
Calluna vulgaris leaves	charred										
Juniperus communis L. twig (segments)	non-charred		1				1		1		
Juniperus communis leaf	non-charred				1		1		1		
Juniperus communis leaf	charred										
Grass node	non-charred								1		
cf. Polygonaceae leaflet/scale	non-charred										
Culm node	charred										
Leather strip	non-charred										
Hair/fibre	non-charred						1				
Egg shell membrane	non-charred										
Bivalve pereostrachum	non-charred										
Moss	non-charred		3	1	2	4		2	5 Sphagnum		3
Peat nodules	charred	5	1	1	1						1
Peat nodules	non-charred	5	1	?	1	1	1				1
?seaweed	charred			-	1		1				1
Snail shell opening covers	non-charred										
Stones	non-charred										
?horn	non-charred										
Iron pan fragments	non-charred									1	
Wood rating	non-charred		1		1	1	1	3			1
Charcoal	charred	1	1		1		1				1

Table B.6. Content of samples analysed from Toftanes.

SAMPLE NUMBER		1963	1964	1995	2052	2147	2219	2265	2422	2653	2654	2665
BULK VOLUME (litres)		0.5	3.00	0.8	2.40	1	0.5	0.5	0.5	1	0.5	1
MULTIPLIED TO		1	1/8	1	1	1	1	1	1	1	1	1
Alopecurus geniculatus L.	non-charred											
Atriplex glabriuscula Edmonst.	charred		8									
cf. Avena sativa	non-charred		1/8									
Barley cf. hulled	charred		13/16									
Barley indet.	charred		1/8									
Barley seed coat	non-charred										1	
Betula sp.	non-charred										5/24	
cf. Boraginaceae	non-charred		1/4									
Brassica sp.	non-charred		1/8									
Carex echinata Murray	charred											
Carex echinata	non-charred	14 15/26	1/8	3	8		3/10	7 1/2	2 2/5	1/3	19 5/12	180 7/9
Carex cf. echinata	non-charred	6	1/8		7		1/10			1/3	5/8	4 22/27
Carex flava-type	charred											
Carex flava-type	non-charred	11	8 1/4	2				2		2	2 5/6	
Carex cf. flava (4 sided)	non-charred											
Carex nigra-type	non-charred											
Carex pallescens L.	non-charred											
Carex pilulifera L.	charred											
Carex pilulifera	non-charred	22 2/3		3 2/3				1	2			
Carex cf. pilulifera	non-charred											
Carex rostrata Stokes	non-charred											
Carex cf. rostrata	charred											
Carex cf. rostrata	non-charred										5/24	
Carex sp. biconvex	non-charred	20						1			5/24	
Carex sp.	non-charred	1									5/24	
Carex trigonous indet.	charred		1/8									
Carex trigonous indet.	non-charred	5/26									8	
cf. Carum carvi L.	non-charred				1							
Caryophyllaceae indet.	non-charred							1/2			4	
Cerastium spp.	charred							1/2				
Cerastium spp.	non-charred		1/8						4/5	4	4	
cf. Cerastium sp. (spiky)	non-charred											
cf. Cerastium spp.	non-charred											
Cereal grain	charred	1/2	1/2			2						
cf. cereal grain	charred											
cf. Cirsium/Carduus	non-charred	2	3/8									
Corylus avellana L.	charred											
Corylus avellana	non-charred											
Cyperaceae indet.	non-charred											
Cyperaceae Type 2E	charred											
Cyperaceae Type 2E	non-charred	6	1/8	1		1						
cf. Deschampsia caespitosa	charred											
Empetrum nigrum L.	charred											
Empetrum nigrum	non-charred	1			1						5/24	
Galeopsis sp(p)	charred											

Table B.6. Content of samples analysed from Toftanes.

SAMPLE NUMBER		1963	1964	1995	2052	2147	2219	2265	2422	2653	2654	2665
Galeopsis sp(p)	non-charred	4	1/8			1		1			5/8	
cf. Galeopsis sp(p)	non-charred	4			1/2							
Gramineae group 1	non-charred										20 5/24	
Gramineae indet - spikelet	charred							1/2				
Gramineae indet. - in glumes	non-charred		1/8									
Gramineae indet.	charred											
Gramineae indet.	non-charred	2	3 3/8	12	6			5		10 2/3	20 7/24	
cf. Gramineae	non-charred	2										
Hippuris vulgaris L.	non-charred				2		2 1/10			5 1/3	5/8	
Hordeum sp.	non-charred										1	
Hulled barley cf. twisted	charred											
Hulled barley indet.	charred		9/16					1 1/2	1/2			
Hulled barley straight	charred											
Hulled barley twisted	charred											
Hypericum pulchrum L.	non-charred		1/8	1/2	1/2		8	1/2		1/6	25/48	
Hypericum pulchrum/maculatum	non-charred								2/5			
Juncus articulatus L.	non-charred					1	9/10		4		40	96
Juncus articulatus/bulbosus	non-charred								4/5			
Juncus bufonius L.	charred		1/8									
Juncus bufonius	non-charred								2 2/5			
Juncus cf. conglomeratus	non-charred					1						
Juncus trifidus L.	non-charred					23						
Juncus trifidus/bufonius	non-charred						1/10					
Juncus sp.	charred		1/8									
Juncus sp.	non-charred	29 7/13	8 3/4	104	92	6	64 1/10	730	92	16	135 1/4	804 13/27
Leontodon autumnalis L.	non-charred											
Luzula sp(p)	non-charred	13		8	1			12	4/5	16	28 3/4	
cf. Luzula sp.	non-charred										16	
Lychnis flos-cuculi L.	non-charred				1/2		4 2/5	1/4		1/3		17 1/9
cf. Lychnis flos-cuculi	non-charred						1/10					
Menyanthes trifoliata L.	non-charred			1								
cf. Menyanthes trifoliata	non-charred			1								
Montia fontana L.	charred							1				
Montia fontana	non-charred	142	2	168	362	30		15 1/2	38 2/5	16 2/3	99 5/6	148 17/27
cf. Montia fontana	non-charred	1						1				
Poa annua L.	non-charred	38									4 5/8	
Poa annua	non-charred							2				
cf. Poa annua	non-charred	6										
cf. Poa annua	non-charred											
Poa cf. nemoralis	non-charred	16									12	
Poa cf. pratensis	non-charred	4									4	
Poa cf. pratensis/trivialis	non-charred											
Poa sp.	non-charred											
Poa sp. (blunt end)	non-charred	2									12	
Poa sp. (not annua)	non-charred	7									4	
Polygonaceae indet.	non-charred											
Polygonaceae sp. (thin walled)	non-charred				5		1/10			1/3		

Table B.6. Content of samples analysed from Toftanes.

SAMPLE NUMBER		1963	1964	1995	2052	2147	2219	2265	2422	2653	2654	2665
Polygonum aviculare L.	non-charred										1	
Polygonum sp.	charred	2						1/4				
Polygonum sp.	non-charred											
Polygonum Type ?D	non-charred				1							
Polygonum Type 12	non-charred	2 2/3	1/16		1	2		25				
Potentilla crantzii/erecta	non-charred	5/26		1 1/2	9			2 1/2			4 5/6	8 5/27
Potentilla crantzii/erecta/palustris	non-charred	2							2			
Potentilla palustris (L.) Scop.	non-charred											5/27
Potentilla sp.	non-charred											
Prunella vulgaris L.	non-charred							1/2		4		
cf. Pucinellia sp	charred											
Ranunculus acris/repens	charred		1/8									
Ranunculus acris/repens	non-charred	20		1	2	1	1 1/10	4 1/4			1 1/4	
Ranunculus flammula/reptans	non-charred	4	1/8	1 1/2	1/2		1 1/2	2		1 1/2	2 5/12	
Ranunculus sp.	non-charred	5/52	1/8	1/2			1	1/2			13/16	
cf. Ranunculus sp.	non-charred				1							
Rhinanthus groenlandicus/minor	non-charred										1	
cf. Rosaceae sp. (immature)	non-charred											
Rumex acetosa/longifolius	charred							1				
Rumex acetosa/longifolius	non-charred	48			4			14 1/2	1		5/24	
Rumex cf. acetosa/longifolius	non-charred										1	
Rumex acetosella L.	non-charred											
Rumex crispus/obtusifolius	charred											
Rumex crispus/obtusifolius	non-charred											
Rumex cf. crispus/obtusifolius	non-charred							2			1	
Rumex sp.	charred	2						5				
Rumex sp.	non-charred	48	1/8	7	10	1		65 5/6	3 1/3	1	1 5/9	
Rumex sp. (runty <1mm)	non-charred	2										
Rumex sp. (runty)	non-charred	4										
Rumex sp. with leaves	non-charred							26				
Rumex trigonous core	charred	2						1/2				
cf. Rumex	non-charred				1							
Rumex/Polygonum	non-charred	2			5				2			
Sagina intermedia/nodosa/subulata	non-charred	26		4	8	3		8	40 4/5		12	3 19/27
Selaginella selaginoides (L.) Beauv. Ex Mart. & Schrank	non-charred		13 1/3			1			4	4	8	
Spergula arvensis L.	charred		8 13/16					1 1/2				
Spergula arvensis	non-charred		5	4 1/2				9	6 4/5	4	17 5/6	
Spergula-type	core charred		1/8									
Spergula-type	non-charred			4				2		1/3	22 29/48	
Stellaria media (L.) Vill.	charred		7/16							14		
Stellaria media	non-charred	29 10/13	3 3/4	12	34	2		9 1/4	6	20 5/6	38 1/4	
cf. Stellaria media	non-charred				2						5/12	
Taraxacum sp.	non-charred										1/2	
Viola canina/palustris	non-charred	2									5/24	
Viola riviniana Rchb.	non-charred			1	1			1/2		1/3		
Viola sp.	non-charred				2			1		1	1	
cf. Umbelliferae	charred			1								

Table B.6. Content of samples analysed from Toftanes.

SAMPLE NUMBER		1963	1964	1995	2052	2147	2219	2265	2422	2653	2654	2665
Trignous seed indet.	non-charred											
Seed indet	non-charred										4	
Seed indet (inner core?)	non-charred		1/8									
cf. seed	charred											
TOTAL		**552 1/5**	**66 2/3**	**342 1/6**	**568**	**75**	**83 4/5**	**963 5/6**	**210 3/7**	**123 1/6**	**560 1/2**	**1263 8/9**
Stigma/Stamen	non-charred		18 9/16									
Calluna vulgaris L. seed capsule	non-charred			2				1				
Type 6 node	charred		1						1			
Rachis/culm (grass)	charred		2									
?Grass nodule from root/joint	non-charred											
Culm node	charred			1								
Culm node	non-charred		1									
Chaff (grass)	non-charred											
Corylus nut shell	non-charred											
Viola seed capsule segment	non-charred										1	
Salix bud	non-charred										1	
Calluna vulgaris leaves	non-charred	1	1	1				1	1	1	1	
Calluna vulgaris leaves	charred			1								
Juniperus communis L. twig (segments)	non-charred	1	1	1				1	1		1	
Juniperus communis leaf	non-charred	1	1	1				1	1	1	1	
Juniperus communis leaf	charred	1						1				
Grass node	non-charred											
cf. Polygonaceae leaflet/scale	non-charred											
Culm node	charred											
Leather strip	non-charred								1			
Hair/fibre	non-charred											
Egg shell membrane	non-charred		1									
Bivalve pereostrachum	non-charred								1			
Moss	non-charred	1	1	3	2	1	1		1	1	1	5 Sphagnum
Peat nodules	charred	1	1	1		1		1	1		1	
Peat nodules	non-charred	1	1	1	1	1		1	1	1	1	
?seaweed	charred	1									1	
Snail shell opening covers	non-charred											
Stones	non-charred					1			1	1	1	
?horn	non-charred											
Iron pan fragments	non-charred											
Wood rating	non-charred	1	1	1	1		1	1	1	1	1	
Charcoal	charred	1	1	1				1	1	1	1	

Table B.6. Content of samples analysed from Toftanes.

SAMPLE NUMBER		2711	2734	2752	2925	NUMBER OF SAMPLES CONTAINING TAXA
BULK VOLUME (litres)				0.5	0.50	
MULTIPLIED TO		1/8	1	1	1	
Alopecurus geniculatus L.	non-charred					3
Atriplex glabriuscula Edmonst.	charred					1
cf. Avena sativa	non-charred					1
Barley cf. hulled	charred					1
Barley indet.	charred					4
Barley seed coat	non-charred					1
Betula sp.	non-charred					1
cf. Boraginaceae	non-charred					1
Brassica sp.	non-charred					2
Carex echinata Murray	charred				1	1
Carex echinata	non-charred	7/8			6	21
Carex cf. echinata	non-charred				1 1/2	17
Carex flava-type	charred					1
Carex flava-type	non-charred				1 1/2	15
Carex cf. flava (4 sided)	non-charred					1
Carex nigra-type	non-charred					3
Carex pallescens L.	non-charred					1
Carex pilulifera L.	charred					1
Carex pilulifera	non-charred	1				12
Carex cf. pilulifera	non-charred					3
Carex rostrata Stokes	non-charred					1
Carex cf. rostrata	charred					1
Carex cf. rostrata	non-charred				1 1/2	2
Carex sp. biconvex	non-charred					7
Carex sp.	non-charred					5
Carex trigonous indet.	charred					1
Carex trigonous indet.	non-charred				1	4
cf. Carum carvi L.	non-charred					1
Caryophyllaceae indet.	non-charred					4
Cerastium spp.	charred					1
Cerastium spp.	non-charred	3/8			1 1/2	13
cf. Cerastium sp. (spiky)	non-charred					1
cf. Cerastium spp.	non-charred					1
Cereal grain	charred				1/4	6
cf. cereal grain	charred				1/4	3
cf. Cirsium/Carduus	non-charred	1/4				3
Corylus avellana L.	charred					1
Corylus avellana	non-charred					2
Cyperaceae indet.	non-charred					1
Cyperaceae Type 2E	charred			5/28		2
Cyperaceae Type 2E	non-charred	1				8
cf. Deschampsia caespitosa	charred					1
Empetrum nigrum L.	charred					1
Empetrum nigrum	non-charred					5
Galeopsis sp(p)	charred					1

Table B.6. Content of samples analysed from Toftanes.

SAMPLE NUMBER		2711	2734	2752	2925	NUMBER OF SAMPLES CONTAINING TAXA
Galeopsis sp(p)	non-charred				1/2	12
cf. Galeopsis sp(p)	non-charred					6
Gramineae group 1	non-charred					1
Gramineae indet - spikelet	charred				2 1/2	2
Gramineae indet. - in glumes	non-charred					1
Gramineae indet.	charred					1
Gramineae indet.	non-charred	101 1/2				17
cf. Gramineae	non-charred					4
Hippuris vulgaris L.	non-charred	9 1/8				6
Hordeum sp.	non-charred					1
Hulled barley cf. twisted	charred					1
Hulled barley indet.	charred					6
Hulled barley straight	charred					1
Hulled barley twisted	charred					1
Hypericum pulchrum L.	non-charred	1/16				11
Hypericum pulchrum/maculatum	non-charred					1
Juncus articulatus L.	non-charred					8
Juncus articulatus/bulbosus	non-charred					1
Juncus bufonius L.	charred					1
Juncus bufonius	non-charred					4
Juncus cf. conglomeratus	non-charred					1
Juncus trifidus L.	non-charred					3
Juncus trifidus/bufonius	non-charred					1
Juncus sp.	charred					2
Juncus sp.	non-charred	390 1/4			43	23
Leontodon autumnalis L.	non-charred					1
Luzula sp(p)	non-charred	56 1/2				14
cf. Luzula sp.	non-charred	8				3
Lychnis flos-cuculi L.	non-charred					12
cf. Lychnis flos-cuculi	non-charred					1
Menyanthes trifoliata L.	non-charred					1
cf. Menyanthes trifoliata	non-charred					3
Montia fontana L.	charred				9	2
Montia fontana	non-charred	1			388 1/2	25
cf. Montia fontana	non-charred					2
Poa annua L.	non-charred					5
Poa annua	non-charred			8		3
cf. Poa annua	non-charred					2
cf. Poa annua	non-charred					1
Poa cf. nemoralis	non-charred					4
Poa cf. pratensis	non-charred					2
Poa cf. pratensis/trivialis	non-charred					1
Poa sp.	non-charred					1
Poa sp. (blunt end)	non-charred					4
Poa sp. (not annua)	non-charred					3
Polygonaceae indet.	non-charred					1
Polygonaceae sp. (thin walled)	non-charred					5

Table B.6. Content of samples analysed from Toftanes.

SAMPLE NUMBER		2711	2734	2752	2925	NUMBER OF SAMPLES CONTAINING TAXA
Polygonum aviculare L.	non-charred					2
Polygonum sp.	charred					2
Polygonum sp.	non-charred					3
Polygonum Type ?D	non-charred					2
Polygonum Type 12	non-charred				5 1/2	9
Potentilla crantzii/erecta	non-charred	6 1/16			1	13
Potentilla crantzii/erecta/palustris	non-charred					2
Potentilla palustris (L.) Scop.	non-charred					1
Potentilla sp.	non-charred					0
Prunella vulgaris L.	non-charred					3
cf. Pucinellia sp	charred					1
Ranunculus acris/repens	charred					1
Ranunculus acris/repens	non-charred	1				17
Ranunculus flammula/reptans	non-charred	1				17
Ranunculus sp.	non-charred					11
cf. Ranunculus sp.	non-charred					1
Rhinanthus groenlandicus/minor	non-charred	1				5
cf. Rosaceae sp. (immature)	non-charred					1
Rumex acetosa/longifolius	charred				2	4
Rumex acetosa/longifolius	non-charred				10 1/2	12
Rumex cf. acetosa/longifolius	non-charred					2
Rumex acetosella L.	non-charred					1
Rumex crispus/obtusifolius	charred					1
Rumex crispus/obtusifolius	non-charred					1
Rumex cf. crispus/obtusifolius	non-charred	1				3
Rumex sp.	charred				4	4
Rumex sp.	non-charred	1/6			18 1/2	19
Rumex sp. (runty <1mm)	non-charred				1	5
Rumex sp. (runty)	non-charred					3
Rumex sp. with leaves	non-charred				7	5
Rumex trigonous core	charred					3
cf. Rumex	non-charred					2
Rumex/Polygonum	non-charred					4
Sagina intermedia/nodosa/subulata	non-charred	16			73 1/2	20
Selaginella selaginoides (L.) Beauv. Ex Mart. & Schrank	non-charred	8 1/8			1/2	15
Spergula arvensis L.	charred			5/28		4
Spergula arvensis	non-charred				2	9
Spergula-type	core charred					2
Spergula-type	non-charred					5
Stellaria media (L.) Vill.	charred					3
Stellaria media	non-charred	2 1/16			7	22
cf. Stellaria media	non-charred	1				7
Taraxacum sp.	non-charred					1
Viola canina/palustris	non-charred				1/2	5
Viola riviniana Rchb.	non-charred					5
Viola sp.	non-charred					8
cf. Umbelliferae	charred					1

Table B.6. Content of samples analysed from Toftanes.

SAMPLE NUMBER		2711	2734	2752	2925	NUMBER OF SAMPLES CONTAINING TAXA
Trignous seed indet.	non-charred					1
Seed indet	non-charred					3
Seed indet (inner core?)	non-charred					2
cf. seed	charred			1		1
TOTAL		607 1/3	0	9 1/3	591	
Stigma/Stamen	non-charred					1
Calluna vulgaris L. seed capsule	non-charred					3
Type 6 node	charred					2
Rachis/culm (grass)	charred					2
?Grass nodule from root/joint	non-charred					1
Culm node	charred					1
Culm node	non-charred					1
Chaff (grass)	non-charred					1
Corylus nut shell	non-charred					1
Viola seed capsule segment	non-charred					2
Salix bud	non-charred					1
Calluna vulgaris leaves	non-charred	1				12
Calluna vulgaris leaves	charred					1
Juniperus communis L. twig (segments)	non-charred					10
Juniperus communis leaf	non-charred					12
Juniperus communis leaf	charred					2
Grass node	non-charred					1
cf. Polygonaceae leaflet/scale	non-charred					1
Culm node	charred					1
Leather strip	non-charred					1
Hair/fibre	non-charred					1
Egg shell membrane	non-charred					2
Bivalve pereostrachum	non-charred					1
Moss	non-charred	4	5 Sphagnum			19
Peat nodules	charred				1	17
Peat nodules	non-charred			1	1	21
?seaweed	charred					6
Snail shell opening covers	non-charred					1
Stones	non-charred					4
?horn	non-charred					1
Iron pan fragments	non-charred					1
Wood rating	non-charred	1			1	21
Charcoal	charred	1		1	1	20

Table B.6. Content of samples analysed from Toftanes.

DEPTH (cm)		144-154cm	154-164cm	164-174cm	174-184cm	184-194cm	194-204cm	S2/5
		multiplied total	multiplied total	multiplied total	multiplied total	multiplied total	multiplied total	
MULTIPLIED TO		1	1/2	1/2	1	1	1	1
cf Betula sp.	non-charred				8			
Brassica sp.	non-charred		2 1/2					
Caltha palustris L.	non-charred	2					1	
cf. Caltha palustris	non-charred	8		2				
Capsella bursa-pastoris (L.) Medik.	non-charred	16	8		96		2	
Carex binervis/cappilaris	non-charred							1 1/2
Carex cf. pilulifera	non-charred				2/3			
Carex echinata Murray	non-charred		9					
Carex echinata with perigynium	non-charred	2			2			
Carex elongata L.	non-charred				2			
Carex flava-type	non-charred	18	9	20	4	7		
Carex nigra-type	non-charred	58	22	18	16	2		
Carex pilulifera L.	non-charred	8 2/3	1	2	1	2 2/3		
Carex sp. (biconvex)	non-charred		8	1	2			
Carex sp. (trigonous)	non-charred				2			
Cyperaceae (trigonous)	charred					2		
Cerastium spp.	non-charred	32	8	24	72	11	8	
Eleocharis palustris/uniglumis	non-charred	2	7			2		
cf. Eleocharis palustris/uniglumis	non-charred				8			
Empetrum nigrum L.	non-charred		1/2			2	3	
Galeopsis speciosa/tetrahit	non-charred	2	1	1	3	1	2 1/2	
cf. Galeopsis speciosa/tetrahit	non-charred		1					
Gramineae group 1	non-charred	80						
Gramineae indet.	non-charred	72	152	224	388	45	16	
Gramineae indet. - in glumes	non-charred					5		
Juncus articulatus L.	non-charred	24					20	2
Juncus bufonius L.	non-charred	48					20	
Juncus bulbosus L.	non-charred	8						
Juncus sp.	non-charred		96	104	256	128	8	1
Juncus sp. (not identified)	non-charred	80					4	
Leontodon autumnalis L.	non-charred	8			2			
cf. Leontodon sp.	non-charred			2				
Linum cartharticum L.	non-charred				16	2		
Luzula sp.	non-charred	24	16	38	106	6	7	
Lychnis flos-cuculi L.	non-charred	16	8		16	4	4	
Matricaria maritima L.	non-charred		3					
Montia fontana L.	non-charred	16	16	28	56	23	14	
Myosotis cf. arvensis/discolor	non-charred	8	8	8	10	8		
cf. Myosotis	non-charred						4	
Poa annua	non-charred	90					139	
cf. Poa annua	non-charred	8					18	
Poa cf. nemoralis	non-charred	24					2	
Poa cf. nemoralis - in spikelet	non-charred						1	
Poa sp.	non-charred						2	
Poa sp. (rounded end)	non-charred	8						
Polygonum lapathifolium/persecaria	non-charred				2			
Polygonum Type ?D	non-charred	2						
Potentilla anserina L.	non-charred	4					1/2	
Potentilla anserina ssp. anserina	non-charred		1			1		
Potentilla crantzii/erecta	non-charred		1	7				
Prunella vulgaris L.	non-charred	8	11	4	52	3	1	
cf. Prunella vulgaris	non-charred					2		
Ranunculus cf. acris	non-charred		1		4			
Ranunculus acris/repens	non-charred	184	122 1/2	137	142	20	10	
Ranunculus flammula/reptans	non-charred	9	11	2	15	2	1	

Table B.7. Content of samples analysed from Sondum. # indicates present.

DEPTH (cm)		144-154cm	154-164cm	164-174cm	174-184cm	184-194cm	194-204cm	S2/5
Ranunculus sp.	non-charred	2	1/2			1		
Rhinanthus groenlandicus/minor	non-charred	10	12	23	14	1 1/2	1	
Rumex sp.	non-charred	501	85	65	80	25	39	
Rumex sp. with leaves	non-charred	464	195	58	114	107	21	
Rumex sp. (runty <1mm)	non-charred		40	16	32	2	30	
Rumex sp. (runty)	non-charred	60	32	24	48	34	12	
Rumex acetosa/longifolius	non-charred	24	12	8	10	9	4	
Rumex sp. (thin walled)	non-charred				8			
cf. Polygonum	non-charred			2				
Rumex/Polygonum	non-charred	14						
Sagina intermedia/nodosa/subulata	non-charred		24		8			
Selaginella selaginoides (L.) Beauv. Ex Mart. & Schrank	non-charred	32			16	4	6	
Spergula type	non-charred						2	
Stellaria media (L.) Vill.	non-charred	49	49	63 1/3	36	13	3	
Urtica dioica L.	non-charred	368	90	104	252	42	33	
Viola canina/palustris	non-charred	4	19	58	12	1	1	
Viola sp.	non-charred	24	6	20	14			
Seed indet.	non-charred		16		10			
TOTAL		2421 2/3	1104	1063 1/3	1935 2/3	518 1/6	440	4 1/2
cf. Calluna vulgaris seed capsule	non-charred		1					
Salix bud	non-charred					1		
Viola seed capsule segment	non-charred			1				
Bud	non-charred	1	1					
Bone	charred	2			20 small frags			
Bone	non-charred	6				16 small frags	1 small frag	
Tooth	non-charred	fragments		fragments				
Fungal conglomeration	non-charred	1						
Cenococcum geophilum	non-charred			1	1	1		
Charred peat/dung	charred		1	1	1	1	1	
Compacted ?peaty material	non-charred	1		1				
Wood rating	non-charred	4	4	3	4	4	5	4
Calluna vulgaris twig	charred						#	
Calluna vulgaris twig	non-charred						#	
Empetrum twig	charred	#						
cf. Empetrum	non-charred						#	
Juniperus communis	charred	#						
Juniperus communis	non-charred	#						
Spruce/Pinus	non-charred	#						
Conifer indet.	non-charred	#					#	
Coniferous indet	charred						#	
cf. Salix	non-charred	#					#	
Type 3 (Quercus/Ulmus/Fraxinus/Castanea)	non-charred	#						
Type 4	non-charred	#					#	
Indet. twig	non-charred	#					#	
Indet.	charred	#						
Indet.	non-charred	#					#	

Table B.7. Content of samples analysed from Sondum. # indicates present.

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