



HÁSKÓLI ÍSLANDS

Hugvísindasvið

A Palynological Study of Land Use in Medieval Mosfellsdalur

Pre-Landnám – AD 1226

MA-prófs í fornleifafræði

Scott J. Riddell

Mai 2014

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Abstract

Since the 1960's pollen studies have shown that *Hordeum*-type pollen was grown in south west Iceland in medieval times. More recently it has been inferred that cultivation in the medieval period may have been exclusive to high status farming estates e.g. Hrísbú in Mosfellsdalur. This raises the question of whether or not cereals were cultivated on smaller farm holdings. This study sought to address this question by comparing existing pollen data from Hrísbú, Mosfell and Leirvogstunga with new pollen data from Helgadalur and Skeggjastaðir. All are located within Mosfellsdalur and all have archaeological remains dated to c. AD 871-1226. Standard pollen counting and rapid scanning methods were applied and the chronological framework was constructed around a suite of tephra layers of known origin and date. Vegetation histories were reconstructed for Helgadalur and Skeggjastaðir that reveal the character of the environment before and after AD 871^{+/-2} (Landnám). Evidence was found of human activity at Skeggjastaðir immediately prior to the conventional date of settlement. Evidence also suggests a change in land use in Mosfellsdalur during the mid-12th century. More importantly, no *Hordeum*-type pollen was identified at either Helgadalur or Skeggjastaðir and it is concluded that cereal cultivation was the preserve of Hrísbú (and probably Mosfell) c. AD 871-1226.

Declaration

I hereby declare that this dissertation is an original piece of work and that all references used henceforth have been appropriately attributed to their original authors.

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Chapter 1: Introduction

1.1 Rationale & Objectives

Pollen studies in Iceland began in earnest with Þorleifur Einarsson (1962) who utilised palynology and tephrochronology to discern changes in vegetation during the Holocene at Skálholt, Árnessýsla, south west Iceland. These changes were either attributed to climate change or, after the late 9th century, human agency. A key finding of this work was that the native birch (*Betula pubescens*) woods of Iceland were “devastated rapidly” during *Landnám* (settlement, c. AD 871) and replaced by grassland. Einarsson also revealed evidence of cultivation following *Landnám* through the presence of barley (*Hordeum*-type) pollen in the soil column. Subsequent studies in west and south Iceland continue to find *Hordeum*-type pollen dated to the medieval period (Hallsdóttir 1987; Sveinbjarnardóttir *et al.* 2007; Erlendsson *et al.* in press). The significance of these findings cannot be overstated as they provide an insight into aspects of the subsistence economy in Iceland for a period that is essentially prehistoric, especially while archaeological evidence for cultivation remains inconclusive (Vésteinsson 1998; Guðmundsson 2010). It has recently been proposed that barley cultivation in medieval Iceland may be associated with “high status” farm sites e.g. Reykholt, Borgarfjörður and Hrísbú, Mosfellsdalur (Sveinbjarnardóttir *et al.* 2007; Zori *et al.* 2013). The basis for this is the presence of *Hordeum*-type pollen before, during and after *Landnám* in the pollen profiles for these sites (Erlendsson 2010; Erlendsson *et al.* in press). The confirmation of cultivation at these locations raises the question of whether or not barley was cultivated on smaller farms, especially as the record to date has been focussed upon major farm sites in southwest Iceland i.e. Skálholt (a bishop’s seat), Reykholt, Vatnsmýri, Mosfell í Grímsnes and Hrísbú (Einarsson 1962; Hallsdóttir 1987; Sveinbjarnardóttir 2012; Zori & Byock in press).

Therefore, it is the purpose of this study to compare the pollen data from the farmstead of Hrísbú in Mosfellsdalur with pollen data from other medieval farm sites in Mosfellsdalur in order to examine whether or not cereal cultivation was indeed exclusive to Hrísbú in this valley c. AD 871-1226. New standard pollen profiles are presented for the sites of Skeggjastaðir and Helgadalur (pre-AD 871-1226) while comparison with Hrísbú, Mosfell and Leirvogstunga will be possible via existing data (Erlendsson 2012c; Erlendsson 2014, Erlendsson *et al.* in press). The presence or absence of *Hordeum*-type pollen in the pollen

profiles from Skeggjastaðir and Helgadalur will be further verified by employing a secondary measure known as “rapid scanning” that will survey a greater proportion of the pollen assemblages than that of a standard pollen count (Tweddle *et al.* 2005). Irrespective of the presence or absence of cereal pollen, this process will allow for the reconstruction of the environment for two medieval farms in Mosfellsdalur. Environmental change will be noted and attributed to human agency, climate change or both. The period under scrutiny is conventionally split between the Settlement Period (Landnám), AD 871-930 and the Commonwealth Period, AD 930-1262 (Byock 1988, p. 2, Karlsson 2000, pp. 9-63) and incorporates the Viking Age, AD 800-1100 (Graham-Campbell, 1980, p.10; Magnusson, 1980 p. 7; Roesdahl 1998 p. 1). For convenience, here it will simply be referred to as the medieval period unless otherwise stated.

1.2 The Palaeoecology of Landnám in Iceland

Archaeological evidence of human activity in Iceland is almost entirely situated above the Landnám tephra AD 871^{+/-2} (discussed further in Chapter 3), and is consistent with the date of the Icelandic settlement described in The Book of the Icelanders (Íslendingabók) (Benediktsson 1968, pp. 3-28; Hallsdóttir 1987; Vésteinsson 1998; Karlsson 2000, pp. 9-15). Íslendingabók also describes Iceland at the time of settlement as covered in woodland from the mountains to the coast (Benediktsson 1968, p. 5). This description is perhaps a generalisation but pollen studies have shown that birch woodland was a primary habitat in lowland Iceland during the late 9th century, perhaps more open in character in the south and west of Iceland (Hallsdóttir & Caseldine 2005; Erlendsson & Edwards 2009). One model of colonisation suggests that Iceland’s first settlers sought out natural clearings within the woodland in order to establish farmsteads i.e. areas in close proximity to sedge (Cyperaceae) dominated wetlands, a potential source of winter fodder (Vésteinsson 1998).

An abrupt decline in birch pollen and a corresponding increase in grass (Poaceae) and Cyperaceae pollen in the pollen record above the Landnám tephra shows that the settlers began to alter the character of native vegetation communities almost immediately i.e. settlers were utilising woodland for fuel, crafts, timber, fodder and pannage (Einarsson 1962; Hallsdóttir 1987; Erlendsson *et al.* 2009; Gathorne-Hardy *et al.* 2009; Gísladóttir *et al.* 2011; Erlendsson *et al.* in press). Note however, that it is changes in the proportions of plants within

Icelandic vegetation communities that define the Icelandic pollen record from Landnám, not the presence of an introduced plant or plants (Edwards *et al.* 2011). Although rare, the presence of layers of charcoal in some soil profiles in association with vegetation change could also suggest that there was an active effort by the settlers to clear woodland with fire (Dugmore *et al.* 2005; Dugmore *et al.* 2009). Charcoal could also arise in the soil profile as a consequence of domestic activity or charcoal production (Vickers *et al.* 2011). Significant alterations to the character of the vegetation of Iceland from Landnám correlate with notable changes to the soils of Iceland including increased rates of sediment accumulation, increased mineral content, decreased organic matter and an altered water table; all symptoms of soil denudation (Thórarinnsson 1961; Dugmore & Buckland 1991; Hafliðason 1992; Dugmore & Erskine 1994; Dugmore *et al.* 2009; Gísladóttir *et al.* 2010; Gísladóttir *et al.* 2011). Studies indicate that the impact on soils was initially felt in the ecologically sensitive uplands before it encroached upon the more resilient lowlands (Dugmore *et al.* 2009).

The subsistence strategy imported by the colonists is believed to have been founded upon a pastoral model supplemented by cereals and the exploitation of wild resources. Large households reflected a chieftain based society with social status associated with raising beef cattle and ostentatious feasting traditions (Amorosi 1989; Vésteinsson 2002; Lucas 2010, pp. 404-407; Zori *et al.* 2013). Archaeofaunal assemblages show that pigs, sheep and goats also formed a component of the settlement package but by the 11th-12th century, farm methods largely excluded pigs and goats in favour of a sheep and cattle based economy, possibly centred on dairy production (McGovern *et al.* 2007). It is suggested that ratios between sheep and cattle continued to reflect social status rather than environmental limitations i.e. pasture was often reserved for cattle rather than sheep even though sheep were a more rational option in certain environmental contexts (Vésteinsson 2002). Seasonally occupied sites, “sheilings” (*sel*) arose in association with the exploitation of summer pastures. Some went on to become farms in their own right. Occasionally these farms reverted to sheilings while early farms established in marginal areas may have also converted to sheilings (Sveinbjarnardóttir 1991).

1.3 Cereal Cultivation in Medieval Iceland

Cereal cultivation in Iceland has been the subject of investigation for scholars from a range of academic fields. The following will summarise current understanding and draw attention to the key issues that arise when attempting to interpret written works and material remains.

Written in the 13th century, *Egils saga Skalla-Grímssonar* (Egils Saga) recounts details of the land claim made by Egill's father, Skallagrímr in Borgarfjörður during the late 9th century. The description includes details of how land and resources were apportioned during settlement including reference to sowing cereal and the naming of *Akrar* (lit: cornfield) (Nordal, ed. 1933, p.76). Unfortunately, it is virtually impossible for scholars to differentiate valid historical data from distorted accounts or fiction in the Sagas of the Icelanders (*Íslendingasögur*) and the period they describe is often rendered prehistoric (Vésteinsson *et al.* 2002; Friðriksson & Vésteinsson 2003). Nonetheless, the saga authors of the 12th to 14th centuries certainly assumed that their ancestors cultivated cereal crops; in keeping with a general awareness in the *Íslendingasögur* that social and environmental conditions were different during the period following the colonisation of Iceland (Vésteinsson *et al.* 2002). Moreover, they must have believed that cereal cultivation was a feasible endeavour. Modelling of soil attributes, climate and land management data from south-west Iceland demonstrates that this perception was valid, i.e. there was potential to support subsistence cultivation (Simpson *et al.* 2002). Saga authors may also have been encouraged by the numerous placenames in the Icelandic landscape suggestive of cultivation e.g. where *akur*, *ekra*, *rein*, *sáld*, *sað*, form a component of the placename. Despite the assertion of Adam of Bremen (AD 1075) that “*no crops grow there [in Iceland]*” Icelandic sources demonstrate that cereal cultivation was indeed a feature of life in Iceland during the time in which the sagas were written (Waitz 1876). Ecclesiastical inventories from Reykholt, Borgarfjörður mention cereal cultivation in AD 1185 and in AD 1224 (Sigurðsson *et al.* 1857-1976, vol. I, pp. 279-280, 466 & 122-123). Cultivation also occurred in the south as church inventories for Gaulverjbær, (Flói, Árnessýsla), AD 1331 and Rauðalækur (Öræfi, Skaftafellssýsla), AD 1343, list among their possessions ‘*korn i iordu*’ (barley in the ground) and ‘*korngard*’ (barley field) respectively (Sigurðsson *et al.* 1857-1976, vol. II, pp. 671 & 777).

The Icelandic archaeological record supports evidence of infrastructure associated with storing and processing cereals. Quern stones for grinding grain into flour have been found at a number of medieval sites in Iceland (e.g. Eldjárn & Gestsson 1952; Gestsson 1959; Magnússon 1973; Nordahl 1988, pp. 101-107; Hermanns-Auðurdóttir 1989). Furthermore, a medieval building in Reykjavík contained a stone box that was found to contain cereal grains and the remains of a sack. A hearth was orientated toward it, perhaps in order to keep the grain contained with the grain box dry (Nordahl 1988, pp. 101-107). More definitively, a drying kiln has been identified at Gröf, Skaftafellssýsla (AD 1362) (Gestsson 1959). The

presence of cereal grains in medieval archaeological contexts is more widespread (e.g. Friðriksson 1959; Nordahl 1988, pp. 101-107; Guðmundsson 2010). In an effort to summarise the difficulties in determining archaeologically whether or not cereals were ever cultivated in Iceland during the medieval period, reference will be made to recent excavations at Reykholt, Borgarfjörður (Sveinbjarnardóttir 2012). *Hordeum sativum* was found in two contexts at Reykholt; a hearth [context 99] dated to AD 875-1250 and a midden [context 577] dated to AD 980-1280. The hearth assemblage was composed of 152 charred, hulled, six-rowed, *Hordeum sativum* seeds believed to have been derived from material left over from sieving (before being cast into the hearth). Nine other seed types accompanied them, including the cultivar *Avena sp.* (oats) and cereal crop associates i.e. *Spergula arvensis* (corn spurrey), *Polygonum (=Fallopia) convolvulus* (black-bindweed), *Galeopsis tetrahit* (red hemp-nettle) and *Stellaria media* (common chickweed). The presence of such weeds, all native to Iceland, does not imply that the cereals were grown there and nor does it preclude it (Guðmundsson & Hillman 2012). The small size of *Hordeum sativum* grains found in the midden is attributed to poor growing conditions, perhaps related to climatic restrictions to the length of growing season. The midden weed assemblage was inconclusive (Guðmundsson 2012).

Ultimately, the problem of whether or not cereal (along with weed contaminants) was imported or grown locally persists (Guðmundsson 2010). Nonetheless, sub-surface samples from Reynistaður, Skagafjörður (AD 871-1000), included charred and uncharred seeds of hulled, six-rowed barley (*Hordeum*-type) and *Stellaria* spp. (e.g. chickweed). The grain and seeds were found encased in animal dung that had been used for fuel. It is proposed that livestock can only have acquired seed either from grazing harvested fields or being fed harvest waste, presumably based on the premise that imported grain would have been too valuable a commodity to feed to livestock (Trigg *et al.* 2009). Perhaps the best archaeological evidence for cultivation in medieval Iceland is the recent discovery of plough marks at Ingiriðarstaðir in Þengjandadalur, northern Iceland, tentatively dated to the AD 900-1400 (Lárusdóttir & Hreiðarsdóttir 2011, p.331).

1.4 Palynology & Cereal Cultivation in Iceland

Hordeum-type pollen is a potential indicator of settlement in Iceland, especially when considered as part of a suite of palynological and other palaeoecological indicators e.g. woodland decline, apophyte increase, soil property changes and charcoal etc. (Edwards *et al.*

2011). The poor dispersal ability of *Hordeum*-type pollen also lends itself to precisely pinpointing locations where cereals were grown in Iceland in the past (Tweddle *et al.* 2005). Evidence of *Hordeum*-type pollen in association with archaeological remains in Iceland is largely confined to south and west Iceland (Table 1). A summary of pollen studies from Skálholt (Einarsson 1962) and Reykholt (Erlendsson 2012a) is presented here along with a suite of sites investigated by Hallsdóttir (1987). Reference is also made to data from Ketilsstaðir, Mýrdalshreppur and Stóra Mörk, Eyjafjallasveit with regard to distinguishing *Hordeum*-type pollen from lyme grass (*Leymus arenarius*) (Erlendsson *et al.* 2009; Vickers *et al.* 2011). *Hordeum*-type pollen from Hrísbú will be considered separately in Chapter 2.

Pollen studies in Iceland began with the work of Sigurður Þórarinnsson (1944) but it wasn't until the 1960's that rigorous palynological analysis ensued with the publication of Einarsson's (1962) study from Skálholt, south west Iceland. Utilising palynology in conjunction with tephrochronology, Einarsson was able to reconstruct the late Holocene vegetation history of Skálholt and he attributed discernable changes in vegetation composition either to climate change or, following the late 9th century, human agency. In particular, Einarsson observed that the native birch woodlands of Iceland were 'devastated rapidly' during Landnám and replaced by grassland. The presence of *Hordeum*-type pollen in the pollen profile from the deposition of the Landnám tephra is cited by Einarsson as evidence of cereal cultivation during the earliest period of Iceland's history. Einarsson also concluded that cereals were not cultivated in Iceland following the 15th or 16th century, perhaps due to 'climatic, economic, or other reasons' although a small *Hordeum*-type maximum in the 17th century does reveal that it was attempted. Despite the fact that these findings are derived from a single site, and Einarsson's caution on the causes of abandonment, they have encouraged some scholars to conclude that arable farming was a feature of the settlement period across Iceland (in conjunction with the geographical spread of archaeological and placename evidence). They add that it was soon restricted to the south and west due to climate cooling and abandoned entirely by the 15th or 16th century (Gelsinger 1981, p. 9; Byock 1988, p. 81; Karlsson 2000, pp. 45-46).

Building upon Einarsson's work, Hallsdóttir (1987) considered a further three sites from southwest Iceland, Vatnsmýri I & II (Reykjavík), Mosfell (Grímsnes) and Þrándarholt (Hreppar). A lacustrine sequence was also secured from Svínvatn (Grímsnes). *Hordeum*-type pollen was found in the sample below the Landnám tephra at Vatnsmýri I, within the

Landnám tephra layer at Þrándarholt and in the sample immediately above the Landnám tephra at Vatnsmýri II and Mosfell. Cerealia pollen persists (to a greater or lesser extent) in all of the pollen profiles (Table 1). Further *Hordeum*-type pollen were found in deeper peat sections at Vatnsmýri I and Mosfell (Hallsdóttir attributes this to legendary Celtic hermits). Hallsdóttir also detected anthropogenic plant indicators occurring sporadically below the Landnám tephra in the sediments from Svínavatn (Grímsnes) i.e. *Plantago lanceolata*, *Artemisia*, Chenopodiaceae, Compositae Tubulifloreae-type, *Polygonum aviculare* and *Spergula arvense*. These were disregarded because low values suggested that they could have originated in naturally occurring habitats in Iceland or were transported there from overseas. Hallsdóttir (1987) also draws attention to the fact that *Hordeum*-type pollen could be derived from lyme grass, a fact also noted by Einarsson (1962). In Europe, lyme grass is restricted to coastal areas while in Iceland it can occupy any area with exposed soils (Fitter 1987, p. 145; Kristinsson 1986, pp. 252-253). Nonetheless, the *Hordeum*-type pollen from Vatnsmýri has been interpreted as evidence of arable farming in the Reykjavík area during the medieval period (Nordahl 1988, pp. 106). More recently, the pre-Landnám *Hordeum*-type pollen from Vatnsmýri I has been cited as evidence of colonisation prior to the conventional date of Landnám (Vésteinsson & McGovern 2012).

More recent studies have chosen to distinguish *Hordeum*-type pollen from lyme grass on the basis of context i.e. habitat, the presence of apophytes and evidence of active fertilisation (Tweddle *et al.* 2005; Erlendsson *et al.* 2006; Erlendsson *et al.* in press). For example, lyme grass is unlikely to be found in moist soils in the company of *Filipendula ulmaria* and *Angelica* spp. Conversely, this means that evidence for cereal cultivation remains inconclusive at sites where conditions favour lyme grass e.g. Ketilsstaðir (pre-Landnám – c. AD 1597), a farmstead situated near the coast and bounded by fluvio-glacial deposits (Erlendsson *et al.* 2009). Reference to palaeoecological studies at Stóra Mörk reveals how complex it is to disseminate the *Hordeum*-type pollen footprint from that of lyme grass. The presence of *Hordeum*-type pollen pre-Landnám is attributed to lyme grass as there are no other cultural plant indicators associated with its emergence in the pollen profile. Following Landnám (AD 871-920) *Hordeum*-type pollen is found in association with a suite of anthropogenic plant indicators e.g. woodland decline, apophytes (*Rumex* spp., *Galium* spp.) and plants associated with cultivation e.g. *Plantago lanceolata* (ribwort plantain) (Vickers *et al.* 2011).

Table 1: Cereal dates for sites in south and west Iceland (Einarsson 1962; Hallsdóttir 1987; Vickers *et al.* 2011; Erlendsson 2012a). Dates are based upon recent revision of Landnám AD 871^{+/-2} and the Reykjanes (Medieval) AD 1226 tephra (Hafliðason *et al.* 1992; Grönvold *et al.* 1995; Hafliðason *et al.* 2000).

Site	Pollen Type	Chronology
Skálholt (Árnessýsla)	<i>Hordeum</i> -type	AD 871 ^{+/-2} -15 th /16 th century (17 th century)
Vatnsmýri I (Reykjavík)	<i>Hordeum</i> -type	Pre-AD 871 ^{+/-2} -1226
Vatnsmýri II (Reykjavík)	<i>Avena</i> -type Cerealia	AD 871 ^{+/-2} -920 or 934
Mosfell (Grímsnes)	<i>Hordeum</i> -type	AD 871 ^{+/-2} -16 th century (13 th century hiatus)
Bráðarholt (Hreppar)	Cerealia	AD 871 ^{+/-2} -12 th century
Reykholt (Borgarfjörður)	<i>Hordeum</i> -type	AD 871 ^{+/-2} -1280
Stóra Mörk (Eyjafjallahreppur)	<i>Hordeum</i> -type	AD 871 ^{+/-2} -1500

At Reykholt, the cultivation of barley is inferred by the near-continuous presence of *Hordeum*-type pollen from AD 870-1200 in pollen profiles from nearby fields (Erlendsson 2012a). The presence of cereal type pollen and cereal grains in a sub-sampled midden context [context 577: AD 980-1280] and cereal grains from a hearth [context 99: AD 875-1250] also support the suggestion that cereal was grown at Reykholt, or at least, do not rule it out (Erlendsson 2012b; Guðmundsson 2012; Guðmundsson & Hillman 2012). According to Sveinbjarnardóttir *et al.* (2007) both sets of palaeoecological data correspond with written accounts that she believes imply that cereal cultivation at Reykholt ended sometime between the 13th and 14th century. The possible cessation of cereal cultivation at Reykholt is presented as a consequence of social change rather than environmental change, cultivation perhaps giving way to cereal importation (Sveinbjarnardóttir 2012, p. 263). Both early cultivation and the later importation of cereals have been linked to the wealth and the high status of the farm at Reykholt (Sveinbjarnardóttir 2007). A similar premise has been posited for the medieval farmstead of Hrísbú in Mosfellsdalur (Zori *et al.* 2013).

Chapter 2: Mosfellsdalur

This chapter will provide details of the modern context of Mosfellsdalur and a summary of archaeological and palynological work that has been conducted there in recent years.

2.1 Environment & Modern Land Use in Mosfelldalur

Mosfellsdalur is effectively a suburb of Reykjavík. New woodlands and shelterbelts have grown in association with residential, horticultural and tourist developments while Leirvogstunga is the preserve of the Hringvegur (Route 1), quarries, warehouses, housing and recreational greenspace. The valley is bounded to the north by the Esja massif (909 m) and to the south by a small mountain range culminating with Grímmannsfell (482 m). Mosfell (275 m) is a palagonite (*móberg*) ridge situated centrally within the valley (Jóhannesson & Sæmundsson 1998; Guðmundsson 2007, p. 180). The Kaldakvísl and Leirvogsa, divided by Mosfell, rise on Mosfellsheiði and traverse the valley down to the small fjord of Leiruvogur. The Norðureykjaá drains Helgadalur, a tributary of the Kaldakvísl.

The drift geology of Mosfellsdalur is predominantly of glacial till and rock exposure arising from the last glaciation (Thordarson & Höskuldsson 2002, p. 51). Soils are of Holocene age, volcanic in origin, free draining and are classified as Brown Andosols, symptomatic of increased aeolian deposition during the last 1200 years. Organic Histosols survive in wetland areas east of Mosfell, south of Leirvogsa (Arnalds *et al.* 2001; Arnalds 2004; Arnalds 2008). The modified pastures and hayfields of the Kaldakvísl and Norðureykjaá valleys, formerly sloping mires (*hallamýri*), are maintained by a 20th century drainage network which gives way to sheep range on Mosfellsheiði and the surrounding mountains. Increasing numbers of grazing horses in Mosfellsdalur are a cause for concern with regard to erosion and soil conditions appear to have deteriorated since the last national soil survey (Arnalds *et al.* 2001) e.g. soil exposures can be seen on either side of Þingvallavegur (Route 36), upper Mosfellsdalur. Severe erosion is visible on Mosfell and the southern the slopes of Esja while the Grímmannsfell range experiences considerable-to-extreme erosion (Arnalds *et al.* 2001, pp. 76-81).

The only temperature data available relative to Mosfellsdalur is from Reykjavík, c. 16 km from Mosfell. The average temperature in Reykjavík for June, July and August is 9.0 °C, 10.6

°C and 10.3 °C respectively (1961-1990; Icelandic Meteorological Office 2013). The average temperature in Reykjavík for December, January and February is -0.2 °C, -0.5 °C and 0.4 °C respectively (1961-1990; Icelandic Meteorological Office 2013). Rainfall data from Stardalur, upper Mosfellsdalur, provides an average precipitation of 1496 mm per annum between 1964 and 2007 (Icelandic Meteorological Office 2013). The prevailing wind travels eastward up Mosfellsdalur (Einarsson 1984).

2.2 The Archaeology of Mosfellsdalur

The following will focus upon archaeological sites in Mosfellsdalur for which palynological data are available with archaeological data derived primarily from work conducted under the auspices of the Mosfell Archaeological Project.

Archaeological excavation has unearthed the remains of a medieval (Viking Age) *skáli* (hall) at Hrísrú (Fig. 1) which is among the larger structures of this type found in Iceland for this period. Based upon tephra layers encapsulated within turves used to construct the walls of the *skáli*, the rationale of Zori (in press) is that the original house must have been built relatively soon after the deposition of the AD 871 tephra. As one section of wall also incorporates either the Katla R AD 920 or the Eldgjá 1 AD 934 tephra, this is envisaged as a repair to the original building which must therefore predate the 10th century ash falls (Zori in press). Radiocarbon dates derived from cereal grains gathered from the floor of the *skáli* straddle the 10th and 11th century while beads also recovered in the *skáli* are all common to the 10th and early 11th century (Hreiðarsdóttir 2010). The *skáli* is therefore believed to have been abandoned during the 11th century whereupon it became a midden which continued to accumulate waste until just after the deposition of the Katla AD 1500 tephra (Zori in press; Zori & Byock in press).

The artefact assemblage associated with the *skáli* included 36 beads which seem to be almost exclusively imported, the majority perhaps originating in the eastern Mediterranean. According to Hreiðardóttir (2010), this is unusual on two counts:

- This is a high concentration of beads for a single building in medieval Iceland.

- The majority of beads associated with medieval structures in Iceland are usually of native origin.

The bead assemblage incorporates the largest collection of imported glass beads (34) found in association with a skáli to date and has more in common with bead collections from pagan burial sites. One possible explanation proffered is that glass beads accompanying burials were considered of high value, therefore the similarities with the Hrisbrú collection might suggest that the skáli at Hrisbrú was of high status (Hreiðarsdóttir 2010). In contrast, metal goods from Hrisbrú suggest scarcity and seem to have been recycled, repaired or modified according to need. The presence of tin rather than zinc in bronze artefacts suggests some connection with the island of Britain (Wärmländer *et al.* 2010). The archaeofaunal assemblage derived from the occupation layers of the skáli is typical of Icelandic settlement sites in the medieval period in that it is comprised mainly of domesticates supplemented by shellfish, fish, marine mammals and seabirds (Amorosi 1996). However, a relatively high percentage of fish bone is noted. Pigs were present initially although cattle were ultimately to form the basis of subsistence at Hrisbrú, apparent in high ratios of cattle to caprine bones (Zori *et al.* 2013; Zori *et al.* in press).

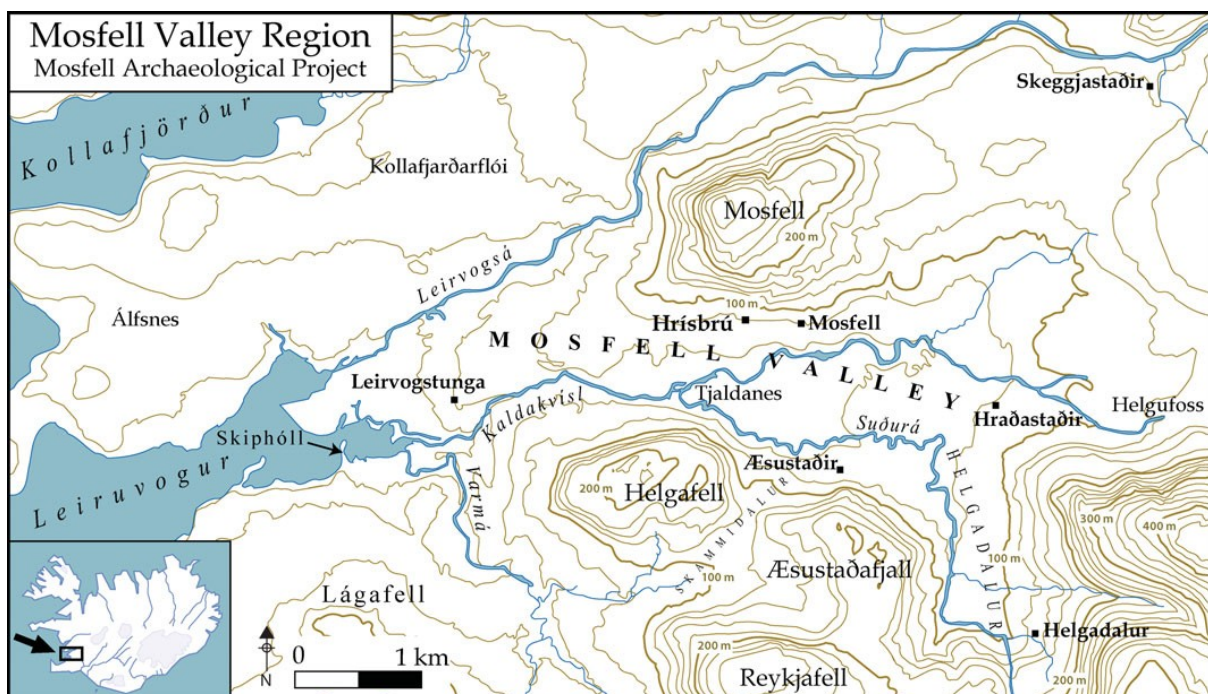


Fig 1: Location Map. Hrisbrú, Mosfell, Helgadalur, Leirvogstunga, Hraðastaðir, Æsustaðir and Skeggjastaðir, Mosfellsdalur, Iceland (Source: Zori & Byock, in press).

Vésteinsson (2004) provisionally outlined criteria for the identification of high status sites by period in Iceland. Status was ascribed according to the size of structures, artefact collections and historical records. Zori *et al* (2013) adapt this approach by utilising structure size, the presence of imported artefacts and historical records to conclude that Hrísrú was a farmstead of high rank during the Viking Age. This perception is perhaps enhanced by the presence of the nearby church and high ratios of cattle to caprine bones in the archaeofauna, the latter among the highest in Iceland (Vésteinsson 2002; Zori *et al.* 2013; Zori *et al.* in press). Zori *et al.* (2013) also argue that the presence of cereal grains in the Skáli (27) in association with *Hordeum*-type pollen from a nearby pollen profile (Erlendsson *et al.* in press) represents a further correlate of high status. This assertion will be tested via this study, however it is worth noting that 27 cereal grains is a relatively small number when compared with the amounts from other medieval sites e.g. Reykjavík (6 kg, inc. sacking; Nordahl 1988, pp. 101-107) and Reykholt (152 grains; Guðmundsson & Hillman 2012). Excavation of further farms in Mosfellsdalur should shed further light on the nature of Hrísrú's status within the context of the valley and the region beyond.

Given the location of Hrísrú in relation to Mosfell (the mountain) and its abandonment in the 11th century, it is proposed that Hrísrú is actually the original farm of Mosfell as described in Egils Saga (Nordal, ed. 1933; Byock *et al.* 2005; Zori in press;). An accumulation of midden deposits atop the skáli suggests that occupation continued within the vicinity of Hrísrú until AD 1500, perhaps as a subsidiary farm to the new centre now known as Mosfell (Fig. 1) (Zori in press). The skáli at Hrísrú is situated in close proximity to a conversion period church (AD 1000) and cemetery while the presence of human skull fragments and metal items amid a concentration of charcoal and ash is believed to be indicative of a pre-Christian cremation site (Byock *et al.* 2005; Zori in press). The church at Hrísrú was established AD 960-1010 while radiocarbon dates from the cemetery show that it was in use until the mid-11th century. Some burials were exhumed in the medieval period suggesting that they were moved to another location (Byock & Zori in press, pp.11-12). Limited archaeological investigation has revealed a structure at Mosfell, also believed to be a church, dated by tephra to between AD 871 and 1500 (Zori in press). Descriptions in Egils Saga imply a relationship between the two churches (Nordal, ed. 1933; Byock *et al.* 2005). The relationship between the skáli at Hrísrú and the farmstead of Mosfell remains inconclusive and no archaeological remains of a farm have as yet been recovered from Mosfell (Zori in press).

Archaeological excavations reveal that Leirvogstunga was a moderately large farm AD 1226-1500. The prevalence of fish bone in many floor layers suggests that a portion of the farms economy looked to the sea. Earlier structures predate the deposition of the AD 1226 tephra while the Landnám AD 871^{+/-2} tephra is present within the turf blocks used to construct them. At Helgadalur, systematic sub-surface sampling just west of the modern farm has revealed the presence of cultural deposits of charcoal, burnt bone and compacted soil situated just above the Landnám AD 871^{+/-2} tephra. Downslope of the sampling area (south) a riverbank exposure revealed a midden deposit composed of charcoal, bone, peat ash and re-deposited cut-turves. The turves contained the Landnám AD 871^{+/-2} tephra. A core taken through this profile revealed a stratified sequence of turf blocks containing the Landnám AD 871^{+/-2} tephra and tephra from either Katla R AD 920 or Eldgjá 1 AD 934 (Zori in press). With regard to Skeggjastaðir, the Book of Settlements (Landnámabók) identifies it as the earliest settlement in Mosfellsdalur (Benediktsson 1968, p. 312). Systematic sub-surface sampling near the modern farm of Skeggjastaðir revealed the presence of peat ash, middens, turf walls and compacted surfaces. All lay beneath the AD 1500 Katla tephra while some of the turf wall material contained the Landnám AD 871^{+/-2} tephra (Zori in press).

2.3 The Palynology of Mosfellsdalur

The use of palynological data in association with archaeological studies allows for the reconstruction of past environments contextualised by human activities whilst simultaneously providing a contiguous record of environmental change that can support the interpretation of archaeological material (Whittington & Edwards 1994; Erlendsson *et al.* 2006). This principle has been adopted by the Mosfellsdalur Archaeological Project with pollen profiles now available for Hrísbú, Mosfell and Leirvogstunga (Erlendsson. 2012c; Erlendsson 2014; Erlendsson *et al.* in press). The pollen sampling sites for each were situated as close as was feasibly possible to identified archaeological remains. The chronological framework for all three sample sites was constructed around the Landnám AD 871^{+/-2}, the Medieval AD 1226 and Katla AD 1500 tephras with intervening dates intercalated. Pollen profiles for Helgadalur and Skeggjastaðir will be presented in Chapter 5 and discussed in Chapter 6.

At Hrísbú the pollen data describes a pre-settlement flora suggestive of a relatively open wetland area; exactly the type of area sought out by the early settlers for conversion to wet hay meadow according to Vésteinsson's (1998) model. Indicators of human activity in the

form of charcoal, coprophilous (dung loving) fungi and altered vegetation communities (inc. *Hordeum*-type pollen) begin immediately below the Landnám AD 871^{+/-2} tephra i.e. the pollen data imply that settlement here occurred prior to the conventional date (Erlendsson *et al.* in press). The charcoal is believed to have been derived either from domestic fires or slash and burn land clearance. Charcoal may also have been used along with domestic waste to fertilise soils for hay making and cereal cultivation; early *Hordeum*-type pollen at Hrísrú coincides with a charcoal peak just after AD 871^{+/-2} while the peak in *Hordeum*-type pollen in the 12th century is also coincident with a peak in charcoal. Fertilisation, the presence of *Hordeum*-type pollen and arable weeds persist at Hrísrú until AD 1226. Only a single *Hordeum*-type is found (immediately) following this date while arable weed taxa and charcoal decline considerably in comparison with levels prior to AD 1226. Indeed, a gradual cessation in the correlates of arable farming can be observed in the pollen profile from the mid-12th century when grazing sensitive taxa begin to disappear or decline while species tolerant of grazing become more prominent (Erlendsson *et al.* in press). This date is comparable with the disappearance of *Hordeum*-type pollen from Vatnsmýri I, Mosfell (Grímsnes) and Bráðarholt (Table 1) and is broadly in keeping with changes in archaeofaunas across Iceland i.e. greater emphasis on sheep and cattle (Dugmore *et al.* 2005; Erlendsson *et al.* in press). This change may also be linked to the abandonment of the skáli at Hrísrú (Erlendsson *et al.* in press)

It is possible that lyme grass is represented by the *Hordeum*-type pollen at Hrísrú. Erlendsson *et al.* (in press) suggests that the combination of fertilisation, arable weeds and the general unsuitability of the habitats apparent in the pollen record for colonisation by lyme grass, eliminate it as a potential alternative to barley. Furthermore, although it is inconclusive with regard to cultivation, 27 barley seeds were also recovered from archaeological contexts at Hrísrú (Erlendsson *et al.* in press; Zori *et al.* 2013). Zori *et al.* (2013) argue that the presence of barley pollen and grains in the pollen and archaeological record is one of two correlates linked to feasting in early medieval Iceland with feasting activity seen as the primary means of securing prestige and political alliances. As such, barley cultivation is seen by Zori *et al.* (2013) as an activity that was exclusive to high status farms i.e. Hrísrú.

At Mosfell (AD 871^{+/-2}-AD 1500) we witness a transition from an open scrub, wetland c. AD 871^{+/-2} to pasture by AD 1500. An initial change to the vegetation community c. AD 880-920 is observed where *Sphagnum* and other grazing sensitive taxa are reduced to trace levels. The period that follows AD 920 is difficult to interpret on two counts (Erlendsson 2012c):

- Age-determination of the upper zone is uncertain due to a change in sediments for AD 920-1226 that disrupts simple straight-line interpolation between the two control points.
- The sedimentology suggests an influx of re-worked soil also reflected in the pollen sequence by an influx of *Pteropsida* (monolete) indet. This spore taxon is very resilient and can contaminate sediments that incorporate redeposited soil and is thereby over represented in the pollen profile (Schofield *et al.* 2007).

Erlendsson (2012c) concludes however, that these features are probably indicative of intensive agriculture from AD 920 until AD 1140 (or AD 1090). The cessation of soil redeposition from AD 1140 (or AD 1090) suggests a change in the agricultural regime, perhaps an abandonment of cereal cultivation. Unfortunately, evidence for cultivation at Mosfell is inconclusive. *Hordeum*-type pollen is only present sporadically until the early 13th century whereupon it disappears from the pollen profile. Values are always low (<1% of total land pollen per sample), especially when compared with those from Hrísbú (Erlendsson 2012c; Erlendsson *et al.* in press). Nonetheless, the end of cultivation at Mosfell is coincident with abandonment of cultivation at Hrísbú and Þrándarholt (Table 1). The proposed relocation of the main farm from Hrísbú to Mosfell is not obvious in the pollen record. This is probably due to the simple fact that a change of farmstead need not necessarily equate with a change in the agricultural regime.

Leirvogstunga (AD 871^{+/-2}-AD 1500) seems to have been largely wooded prior to Landnám and the greatest change in vegetation occurs just after the deposition of the Landnám tephra (AD 871^{+/-2}). Woodland cover and grazing sensitive plants such as *Filipendula ulmaria* and *Angelica* spp. are considerably reduced while Cyperaceae and Poaceae increase (therefore both wet and dry habitats are altered). Initially, high levels of charcoal suggest human activity and coprophilous fungi imply the presence of grazing animals. Two *Hordeum*-type pollen grains are present; one located in the sample just below the Landnám tephra and the other 10 cm above. Two *Hordeum*-type pollen grains are insufficient means by which to infer arable farming at Leirvogstunga. This is especially so as they are not contiguous in the pollen profile, the later pollen grain arises after a decline in charcoal and there is a general absence of plant species associated with cultivation overall. The coastal context also introduces an increased possibility of *Hordeum*-type pollen derived from *Leymus arenarius* (Erlendsson 2014).

Woodland seems to disappear from lowland areas in Mosfellsdalur almost immediately during or just after Landnám as is apparent with regard to findings from Hrísbú, Mosfell and Leirvogstunga (Erlendsson & Pétursdóttir 2013). Human incursion into woodland in upper Mosfellsdalur (200-300 m) is more gradual. At Sauðafellsflói a drop in arboreal taxa does not appear in the pollen record until AD 1000 and the woodland recovers from AD 1300. At Litla Sauðafell woodland survives more or less intact until AD 1500 (Erlendsson & Pétursdóttir 2013). This is not unexpected as temporal and spatial variation in woodland continuity following Landnám is found elsewhere e.g. Eyjafjallahreppur (Church *et al.* 2007), Örnólfsdalur (Gísladóttir *et al.* 2011) and Þjórsárdalur (Vésteinsson & Simpson 2004). In particular, as lowland woodlands disappeared, highland woodlands became increasingly more valuable to settlers as a source of summer grazing, fodder and charcoal (Amorosi *et al.* 1997; Vésteinsson 1998; Gísladóttir *et al.* 2011). This may be apparent in the upland zone of Breiðavatn on the Reykholt estate where the greatest decline in woodland occurred in the 13th century (Gathorne-Hardy *et al.* 2009; Sveinbjarnardóttir 2007). Ultimately, temporal and spatial variation in ecological impact reflects variation in subsistence strategies and patterns of colonisation (Vésteinsson 1998; Erlendsson *et al.* 2006).

Chapter 3: Methodology

3.1 Sample Site Identification

For the purposes of this study, the key factor in selecting sampling sites is their proximity to known archaeological features. Equally important is the desire to secure a soil column from a wetland area rather than a lacustrine environment as it is more likely to capture the pollen rain of the immediate locale rather than that of the entire water catchment. Wetland sampling is also favoured over dry soil sampling as pollen preservation is superior in anaerobic conditions (Moore *et al.* 1991, pp. 10-28). Once these prerequisites have been met, the selected area is sampled until a soil profile with a sufficient suite of identifiable tephras is located. In this instance, the presence of the Landnám AD 871^{+/-2} tephra is important due to its value as a verifiable chronological marker (Grönvold *et al.* 1995). The absence of any signs of disturbance to the sediments within the soil profile is equally important, for example, peat cutting in the past can result in a hiatus in the development of the soil stratigraphy (Moore *et al.* 1991, p. 11; Whittington 1993). Once these criteria have been met a c. 1 m² pit is dug at

the chosen spot to a depth sufficient to reveal pre-settlement soils. A soil monolith is retained in the corner of the pit. Once the presence of tephra sequences and an intact stratigraphy is verified, the soil monolith is cut free. The soil monolith is protected in plastic guttering and wrapped in cling film to inhibit contamination of the sample before being transported to the lab for further analysis. The soil samples/pollen profiles for Helgadalur and Skeggjastaðir will be known henceforth as HEL and SKE respectively.

3.2 Tephrochronology

“Tephra” (from *tephra*, Gk ‘ashes’) is a collective term for airborne pyroclasts derived from volcanism and with regard to the stratigraphic record, usually pyroclastic fragments defined as “ash” (<2.00mm). During a volcanic eruption, tephra is rapidly distributed across a relatively wide area covering contemporary surfaces; glaciers, peat bogs, lake beds, estuarine mud, the ocean bed etc. In effect, the deposition of volcanic ash is an instantaneous event in geological terms, with tephra layers providing a widespread and isochronous marker distinct from other sedimentary deposits (Bell & Walker 1992, p.19; Hafliðason *et al.* 2000; Larsen & Eiríksson 2008b). Scientists interpret, correlate and synchronise the relationships between such deposits and other sequences and events in the geological, palaeoenvironmental and archaeological record (Lowe 2011, pp.107-108). The distinct petrographic character of tephra and a unique geochemical identifier make it possible to isolate and distinguish volcanic glass shards with high precision at source and associate them with respective tephra horizons (Hafliðason *et al.* 2000; Larsen & Eiríksson 2008a; Larsen & Eiríksson 2008b).

Dates for tephra layers must be secured before they can be integrated into a chronological framework. This can be achieved via:

- Radiometric dates (numerical age) can be acquired directly from the glass shards or the primary minerals of which the tephra is composed (both difficult) or can be acquired indirectly via enclosing or encapsulated organic materials such as charcoal, wood, peat or organic material encased within lacustrine sediments etc. (Lowe & Walker 1997, pp. 280-284; Bell & Walker 1992, pp.16-23; Larsen & Eiríksson 2008b; Lowe 2011).
- Incremental dating methods are a further indirect means of securing a numerical age where the stratigraphic position of the tephra within a sequence of annually accumulated

sediments is identified e.g. glaciers, ocean bed and lake bed (varves) (Bell & Walker 1992, pp. 16-23; Lowe & Walker, 1997, pp. 280-284).

- Relative chronological frameworks are secured via correlation with other tephra horizons, historical texts, inter-bedded archaeological artefacts and pollen stratigraphies (Bell & Walker 1992, pp. 16-23; Dugmore *et al.* 1995; Lowe & Walker 1997, pp. 280-284; Larsen & Eiríksson 2008a; Larsen & Eiríksson 2008b).

The ability to transfer the characteristics and the date of a tephra layer between sites has made tephrochronology the conventional mechanism for dating archaeological and palaeoenvironmental contexts in Iceland (Vilhjálmsson 1990; Larsen & Eiríksson 2008b). Those tephras of particular relevance to Mosfellsdalur are detailed in Table 2. The Landnám tephra in particular is utilised as a convention for dating the period of human settlement in Iceland by the scientific and archaeological community (Guðmundsson 1997; Vésteinsson 1998; Hafliðason *et al.* 2000; Wastgård *et al.* 2003; Dugmore *et al.* 2005; Erlendsson *et al.* 2006; Newton *et al.* 2007; Larsen 2008; Dugmore *et al.* 2009; Vickers *et al.* 2011).

In order to construct a rigorous chronological framework in which to place the pollen sequence, it is necessary to further corroborate tephra date and origin beyond initial field assessment. This can be secured to some degree by assessing tephra morphological characteristics e.g. ruggedness, circularity, elongation and sphericity (Hafliðason *et al.* 2000; Guðmundsdóttir *et al.* 2011). Greater rigour is acquired via geochemical analyses of tephra. In this instance, the tephras for profile SKE were subjected to geochemical analysis in order to match them with sources of origin (Hafliðason *et al.* 2000). Tephra samples were cleaned in 10% NaOH (sodium hydroxide), mounted on slides, ground, polished and carbon coated. Analysis of tephra samples was performed using a Hitachi TH3000[®] Scanning Electron Microscope (SEM) equipped with a Bruker X-Flash silicon drift detector (SSD) and recorded with Bruker Espirit analysis software. Analysis employed a 15 kV beam voltage applied to a surface of at least 10x10 µm; this point size reduces sodium (Na) loss. The system was operated in precision mode, 250,000 pulses at each point. Calibration of raw, normalised data from the counter was made with reference to ordinary microprobe standards analysed under the same conditions. Calibration lines were constructed for all major elements by Niels Óskarsson (University of Iceland, unpublished data) and then calculated as normalised (100%) weight percentage.

Table 2: Identified and dated tephra horizons for Mosfellsdalur.

Origin	Eruption	Dating method	Nomenclature	Author
Katla	AD 1500	Interpolated via sediment accumulation rates, Þingvallavatn	K-1500	Haflíðason <i>et al.</i> 2000 Haflíðason <i>et al.</i> 1992
Reykjanes (sub-aqueous)	AD 1226	Interpolated via sediment accumulation rates, Þingvallavatn	The Medieval Tephra	Haflíðason <i>et al.</i> 2000 Haflíðason <i>et al.</i> 1992 Jóhannesson & Einarsson 1988
Katla	AD 920	Interpolated via sediment accumulation rates, Þingvallavatn	R-920	Haflíðason <i>et al.</i> 2000 Haflíðason <i>et al.</i> 1992
Vatnöldur Torfajökull	AD 871 ^{+/-2}	Greenland ice core (GRIP): light, rhyolitic, lower horizon and dark, basaltic, upper horizon	Settlement Layer <i>Landnámslag</i> VIIa+b G Vö~900	Haflíðason <i>et al.</i> 2000 Grönvold <i>et al.</i> 1995 Hallsdóttir 1987
Hekla	600 BC	Intercalation from tephra of known origin and date.	Hekla A	Róbertsdóttir <i>et al.</i> 2002

3.3 Lithology

Magnetic susceptibility (MS) measurements provide information about changes in the magnetised content of wetland sediments arising from environmental or anthropogenic induced erosion; especially in Iceland where soils (Andosols) are derived from weathered volcanic ash containing high levels of magnetite (Oldfield 1991; Einarsson 1994; Arnalds 2004). Increases in minerals in otherwise organic (diamagnetic) deposits can be detected by their response to being magnetised and thereby reveal incidents of soil redeposition that will reflect the erosion processes underway in the surrounding landscape (Dearing 1999). Every centimetre of the soil columns for HEL and SKE were measured for MS using a Bartington MS2 meter and MS2E probe. Soil Moisture Content (SMC) is measured as a percentage of H₂O weight (g) against dry soil weight (g). SMC measures the ability of a soil to retain water. Organic soils can retain great quantities of water while fine-grained soils can retain greater quantities of water than sandy soils (Gísladóttir *et al.* 2010). Dry Bulk Density (DBD) is measured as weight (g) per 1 cm³ soil. Organic deposits are lighter than less organic soils, thus increased DBD at wetland sites is indicative of greater minerogenic input (Burt 2004). Organic Matter (loss on ignition, OM) is measured as percentage of 1 cm³ soil samples. Like SMC and DBD, this provides information about changes in the organic content of the

analysed deposits and provides information about soil transport and landscape stability in the vicinity of the sample sites (Heiri *et al.* 2001; Burt 2004). For HEL, information about SMC, DBD and OM was gathered by measuring samples extracted at every 2 cm (volume: 7.9 cm³). For SKE the same proxies were measured at 1 or 0.5 cm increments (volume: 1 cm³).

3.4 Palynology

A 1 cm³ sample was cut every centimetre between 28 cm and 43 cm in the HEL soil column (16 samples). For SKE 1 cm³ samples were cut contiguously at every cm between 33.5 cm and 37.5 cm with a greater concentration of 0.5 cm contiguous samples (1 cm³) between 37.5 cm and 48.5 cm (16 samples). The greater resolution acquired by the latter measure sought to capture pollen located in an altered lithology at SKE prior to, during and after Landnám (43-44 cm). The upper limit for both profiles was defined by the Medieval AD 1226 tephra (Table 2). Volume of pollen samples was determined by displacement in 10% hydrochloric acid (HCl) (Bonny 1972). The samples were subjected to further treatments in 10% sodium hydroxide (NaOH), 40% hydrofluoric acid (HF) and acetolysis mixture and sieved (150 µm). One *Lycopodium clavatum* tablet (Batch no. 1031) was added to each sample (Stockmarr 1971). Each tablet contains c. 20848 spores and provides a control for the calculation of palynomorph concentrations. Pollen grains were slide mounted with silicone oil (Moore *et al.* 1991, pp. 48-49).

Pollen counts were conducted using a microscope at 400x magnification (600x magnification for detail). A minimum of 300 pollen grains were counted for each site. As sedge was overly dominant at SKE it was necessary to count beyond 300 grains in order to ensure sufficient pollen representation of other species (100 pollen grains non-sedge). Coprophilous fungi were counted as it has been shown that there is a relationship between spore concentration and grazing intensity (Cugny *et al.* 2010) and were identified according van Geel *et al.* (2003). Pteropsida and Bryophyte spores were also counted. All Poaceae pollen was evaluated as potential *Hordeum*-type i.e. grain size >37 µm, annulus diameter >8 µm (Andersen 1978). Accumulated data was entered into the TILIA1 database and subjected to a Total Sum of Squares Analysis that produced a stratigraphically constrained dendrogram for each site (Grimm 1991). De-trended Correspondence Analysis (DCA) allowed identified Local Pollen Assemblage Zones (LPAZ) to be verified (Hill & Gauch 1980). Field identification guides were used to interpret the habitat associations of the various plant species found within the

two pollen profiles (Rose 1981; Kristinsson 1986; Fitter 1987). Plant nomenclature follows that of Kristinsson (1986). Pollen and spore nomenclature follows Bennett (2014) but is amended to better reflect the Icelandic flora (Erlendsson 2007). Interpretation of pollen diagrams is based primarily upon pollen percentages as a means of ascertaining the relative proportions of pollen taxa within a sample (Birks & Birks 1980, pp. 166-172). As percentage variables are co-dependent, irregularities may arise. For example, high values in Cyperaceae may exaggerate low values in other taxa. This can be resolved by excluding Cyperaceae from the percentage calculation (Moore *et al.* 1991, p. 170-174). Alternatively, clarification can be sought with reference to absolute data expressed as pollen concentration.

In order to maximise the opportunity to capture *Hordeum*-type pollen, a rapid scanning method was employed (Tweddle *et al.* 2005). This process entailed examining an estimated minimum of 1500 pollen grains at x200 magnification for each sample. Coprophilous fungi were counted during the rapid scanning procedure and charcoal fragments were counted for SKE due to the altered lithology there pre-Landnám AD 871^{+/-2}. Microscopic charcoal has the potential to reveal human presence at SKE prior to that indicated by archaeological features (Patterson *et al.* 1987; Erlendsson *et al.* 2006). Primary identifying features of charcoal were colour (black/opaque), clearly defined edges and angularity (Patterson *et al.* 1987; Tinner & Sheng Hu 2003).

Chapter 4: Sampling Sites

4.1 Helgadalur (HEL) Sample Site, 25th October, 2013

Archaeological remains have been identified in fields immediately west of the modern farmstead at Helgadalur (Fig.?) (Zori in press). The search for a suitable soil profile focussed upon an area to the north and west of the archaeological interest and within 500 m of it. This encompassed an area of semi-improved pasture maintained by a 20th century drainage network and grazed by horses and sheep. The sward was close-cropped with grass dominant with Cyperaceae, Bryophytes (inc. *Polytrichum* spp. and *Rhytidiadelphus* spp.) and dog lichen. Prior to agricultural improvement, the site was most likely hallamýri. Hummocks, characteristic of cryo-turbation, supported Icelandic moss (*Cetraria islandica*), *Polytrichum* spp. and *Rhytidiadelphus* spp. (Arnalds 2008). Broken hummocks, erosion spots and trampling suggest overgrazing. Nearby summerhouse gardens comprise of mixed-plantation woodlands, and conifer seedlings and Alaskan lupin (*Lupinus nootkatensis*) are colonising barren ground on the lower, enveloping, slopes of Grímmannsfell. Soil core HEL is located at ISNET 93: E 373.855, N 409.355, altitude c. 97 m (Fig. 2) and the pit was dug to a depth of c. 1 m. At least three tephra layers were identified and decomposed wood fragments and small twigs were found within the sediment matrix below the Landnám tephra layer (Fig. 3).



Fig. 2: Location of soil sample site HEL.

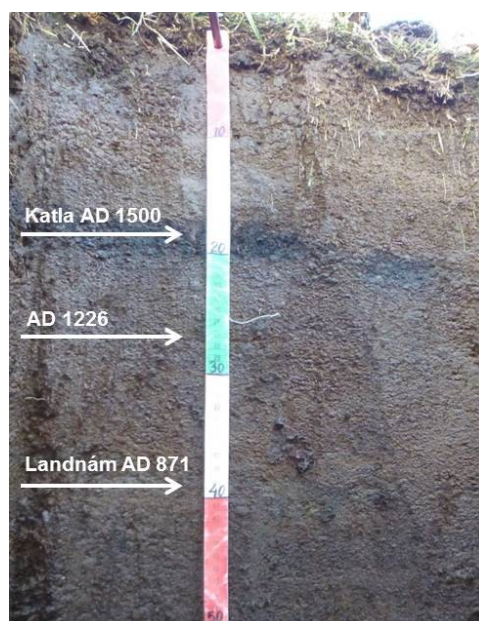


Fig. 3: *In situ* wetland soil profile (sampled sequence) from HEL.

4.2 Skeggjastaðir (SKE) Sample Site, 25th October, 2013

Archaeological remains have been identified in the field immediately east of the modern farmstead at Skeggjastaðir (Fig.?) (Zori in press). The search for a suitable soil profile focussed upon an area south of the archaeological interest and within 200 m of it. This encompasses an area of semi-improved pasture maintained by a 20th century drainage network and grazed by horses. The sward is close-cropped with grass dominant along with Cyperaceae, Bryophytes (inc. *Polytrichum* spp. and *Rhytidiadelphus* spp.) and dog lichen (*Peltigera canina*). *Alchemilla filicaulis* is also present. Prior to agricultural improvement, the site was most likely *hallamýri*. To the west, the eastern tail of Mosfell is sparsely vegetated with bare rock and glacial till exposures. The same applies to the Skeggjastaðahólar to the east of the survey area. Further erosion and trampling is apparent along the drainage ditches and natural watercourses that drain into the Leirvogsá to the north. Trampling also occurs on the pasture itself and the area is clearly overgrazed. Soil core SKE is located at ISNET 93: E 375.766, N 413.621, altitude c. 118 m (Fig. 4) and the pit was dug to a depth of c. 0.5 m. At least three tephra layers were identified and decomposed wood fragments and small twigs were found within the sediment matrix below the Landnám tephra layer (Fig. 5).



Fig. 4: Location of soil sample site SKE.

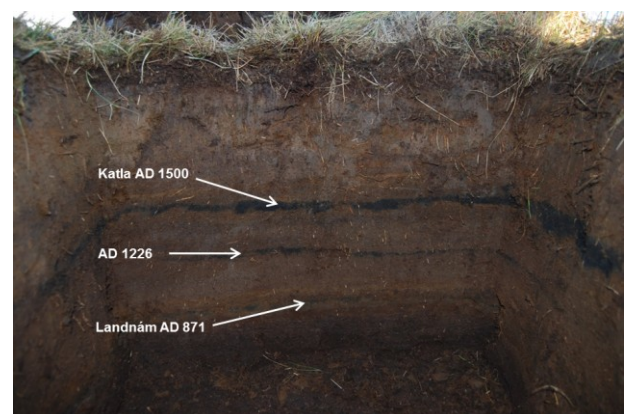


Fig. 5: *In situ* wetland soil profile (sampled sequence) from SKE (Photo: D. Zori).

Chapter 5: Results

5.1 Chronology & Age-Depth Modelling

Based upon colour, texture, grain size and stratigraphic order, fieldwork at Helgastaðir and Skeggjastaðir identified the tephra's Katla AD 1500, Medieval AD 1226 and Landnám AD 871^{+/-2}. Katla-R AD 920 was identified in the laboratory. Geochemical analysis of tephra from SKE conclusively established that the sequence is composed of a Torfajökull tephra (43-44 cm), a Katla tephra (41.5-42 cm), a Reykjanes tephra (33-33.5 cm), and another Katla tephra at 23-24 cm (Fig. 6). This sequence supports the field and laboratory identification of the tephra and allows a secure tephrochronology to be constructed for SKE. Although not analysed for geochemistry, the HEL sequence corresponds with that of SKE (Fig. 7). The two sites therefore have identical chronological control points which correspond with previous palynological and archaeological work in the valley (Erlendsson 2012c; Erlendsson & Petursdóttir 2013; Erlendsson 2014; Erlendsson *et al.* in press, Zori in press). The field and laboratory visual identification of a Hekla-A~600 BC (HEL: 63.5-66 cm) is consistent with what has been recorded elsewhere in south west Iceland (e.g. Gísladóttir *et al.* 2010; Sigurgeirsson & Hjartarson 2011; Erlendsson 2012c).

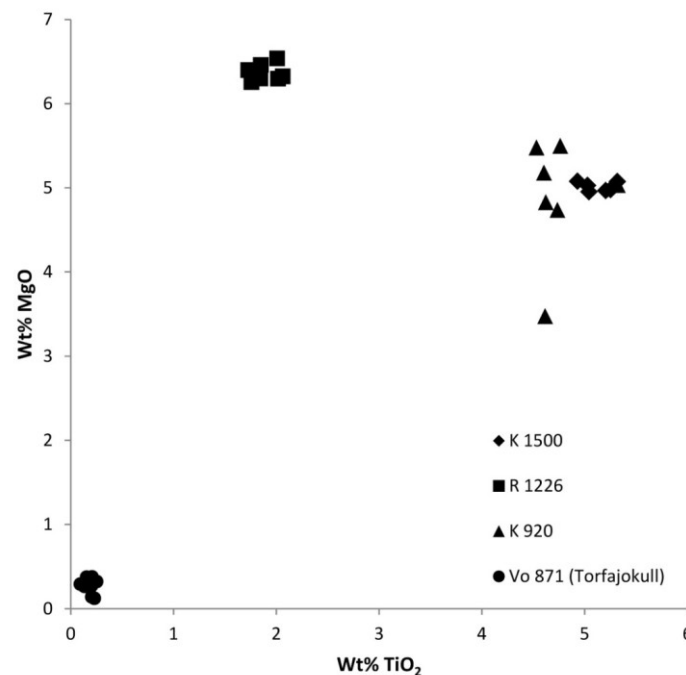


Fig. 6: Geochemical analysis of tephra shards from SKE. Three different volcanic sources identified by plotting TiO₂ (titanium) against MgO (magnesium) (Source: Egill Erlendsson, University of Iceland).

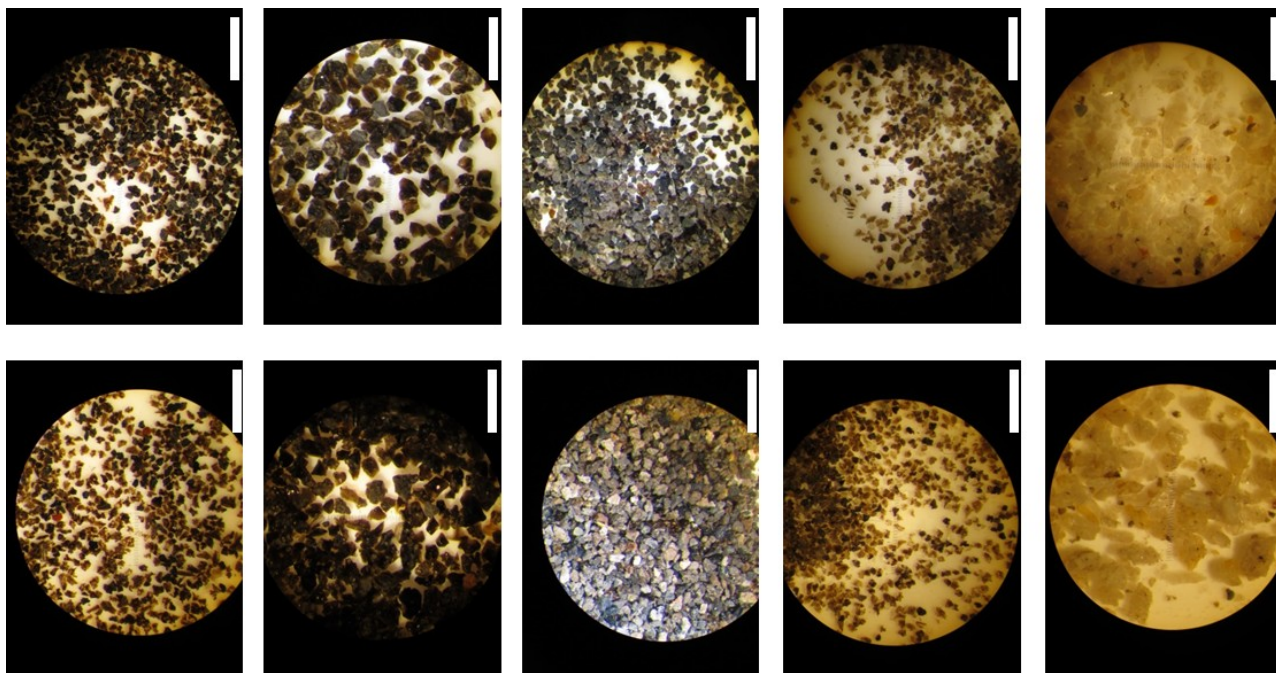


Fig. 7: Matched tephra sequences from SKE (bottom) & HEL (top). From left to right: Katla AD 1500; Medieval AD 1226; Katla AD 920; Landnám AD 871^{+/-2} (basaltic); Landnám AD 871^{+/-2} (silicic). Magnification x60, scale 1 mm. (Source: Egill Erlendsson, University of Iceland).

Successful identification of tephra according to source and age allowed an age/depth model to be constructed for each site and sediment accumulation rates (SAR) interpolated accordingly (Fig. 8 & Table 3). The determination of the dates for the Local Pollen Assemblage Zones are also intercalated via this model.

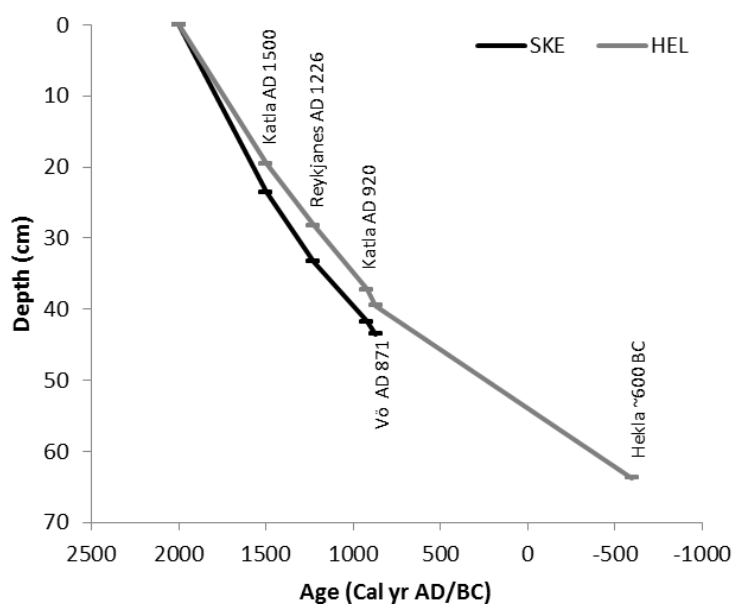


Fig. 8: Age-depth model for HEL and SKE with identified tephras. Note that there are no pre-AD 871 tephras available for SKE.

Table 3: Sediment Accumulation Rates for HEL and SKE.

Tephra (Cal. yr AD/BC)	HEL SAR (mm/yr)	SKE SAR (mm/yr)
K 1500		
	0.29	0.35
R 1226		
	0.27	0.27
K 920		
	0.1	0.2
Vö 871^{+/-2}		
	0.16	n/a
H ~600 BC		

5.2 Soil Properties

5.2.1 Soil Results: HEL I-IV

Interpretation of soil properties will focus upon the identified local pollen assemblage zones (LPAZ I-IV) for Helgadalur (HEL) (Fig. 9). Dates are interpolated according to the tephra sequence described for HEL (section 5.1).

HEL-I. 44-42 cm (AD c. 630-c. 750): This unit is dominated by a dark woody peat that incorporates decomposed wood fragments and small twigs thereby revealing a high concentration of organic material (Fig. 3). Loss on ignition presents a figure of up to 65% OM. This and relatively high SMC are consistent with a wetland environment. DBD remains within the range of late Holocene levels while MS is comparatively low. The increasing trend in MS may derive from the AD 871^{+/-2} tephra leaching into the unit.

HEL-II. 42-38 cm (AD c. 750-871): There is an immediate change across all soil properties in this unit, SMC and OM decrease while DBD and MS increase. This may be a direct consequence of the Landnám AD 871^{+/-2} tephra deposition. However, the transformation in the lithology from a woody peat to a silty peat is significant across the span of the soil sequence (c. 1600 BC - AD 2000).

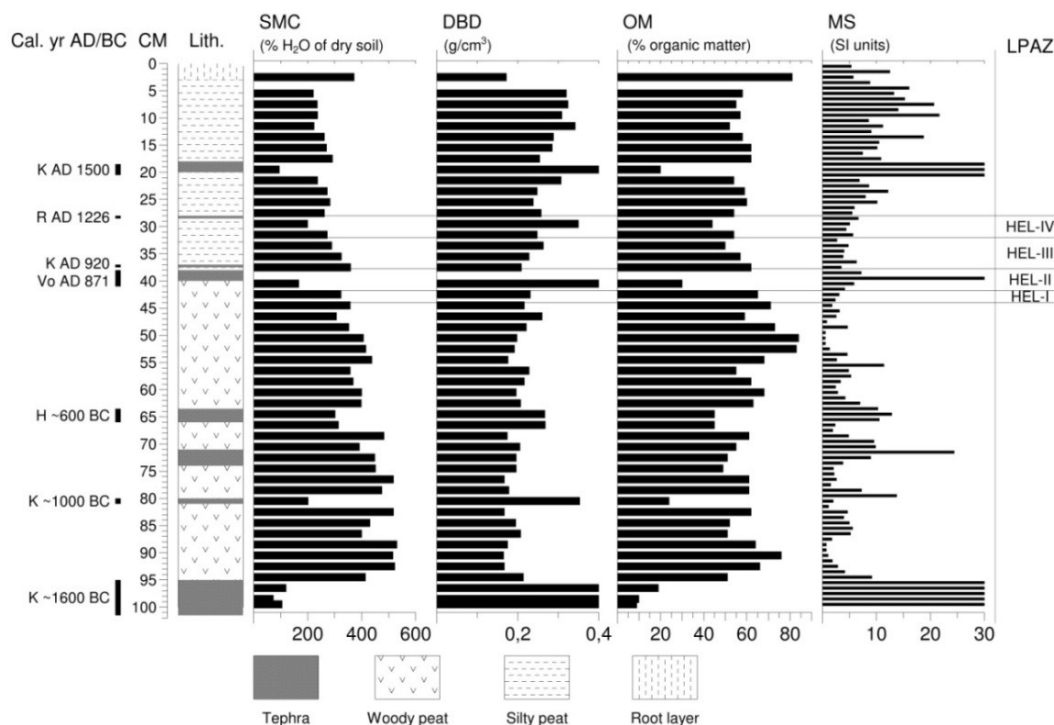


Fig. 9: Soil properties at HEL, LPAZ I-IV (Source: Egill Erlendsson, University of Iceland).

HEL-III. 38-32 cm (AD 871-c. 1100): An initial recovery in SMC and OM values and a matching decrease in DBD are gradually reversed in this unit with an overall trend toward a drier soil. Silty peats are maintained throughout the unit.

HEL-IV. 32-28 cm (AD c. 1100-1226): SMC and OM continue to decline from the previous unit. Both could reflect anthropogenic activity in the form of drainage and fertilization of pastures. DBD increases disproportionately which could mark the onset of erosion in the surrounding uplands. This may be equally apparent in the progressive increase in MS values and persistent silty peat across this sequence.

5.2.2 Soils Results: SKE I-IV

Interpretation of soil properties will focus upon the identified local pollen assemblage zones (LPAZ I-IV) for SKE (Fig. 10). Dates are interpolated according to the tephra sequence described for SKE (section 5.1). As there is no pre-Landnám tephra available for this site, no pre-Landnám dates are available.

SKE-I. 49-44 cm (Pre-Landnám): The deeper part of this unit is composed of a dark woody peat that incorporates decomposed wood fragments and small twigs within the sediment matrix indicative of a high concentration of organic material (Fig.5). Loss on ignition presents a figure of up to 75% OM. This and relatively high SMC correspond with a wetland environment. However, OM and SMC values are progressively declining from the beginning of this unit while DBD and MS values increase. This suggests a gradual influx of silty material. This is particularly marked around 47 cm with a change in the soil character from woody peat to silty peat. Silt influx reaches its zenith during Landnám AD 871^{+/-2}, values perhaps exaggerated by the presence of the Landnám tephra.

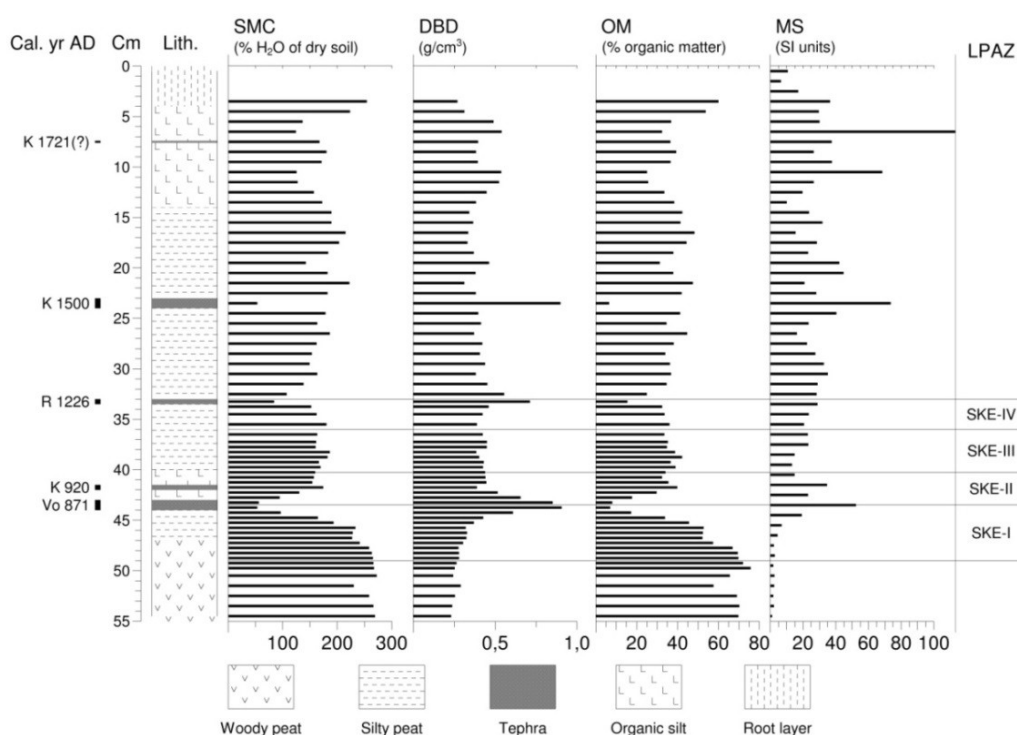


Fig. 10: Soil properties at SKE, LPAZ I-IV (Source: Egill Erlendsson, University of Iceland).

SKE-II. 44-40 cm (Pre-Landnám – AD c. 977): The key feature of this unit is the abrupt transition from a silty peat to organic silt at Landnám AD 871^{+/-2} (43 cm). The transition from an organic to a silty soil begun in the last unit continues. However, OM and SMC values are recovering while DBD declines. MS is also reduced, despite the spikes due to the Landnám AD 871^{+/-2} and Katla AD 920 eruptions. The trend toward a silty soil is stalling in this unit.

SKE-III. 40-36 cm (AD c. 977-c. 1130): Organic silts revert to silty peats at the beginning of the unit. There is a slight increase in OM and SMC and decrease in DBD and overall, values are fairly stable. However, MS values show a trend toward increasing silt and the trend in the other values is reversed marginally from c. AD 1092 (37 cm).

SKE-IV. 36-33 cm (AD 1130-1226): Silty peats persist despite a general decline in OM and SMC and an increase in DBD and MS values.

5.3 Palynology

5.3.1 De-trended Correspondence Analysis (DCA)

The aim of DCA is to identify groupings within the data sets that can aid interpretation and verify the delimitation of the LPAZ. DCA sample scores for HEL reveal a clear division between LPAZ HEL-I-IV with some overlap in the transition between LPAZ HEL-III and HEL-IV (Fig. 11). DCA samples scores for SKE reveal divisions between LPAZ SKE-I-IV although the transitions between the LPAZ are less abrupt (Fig. 12). That LPAZ SKE-II shares characteristics with LPAZ SKE-IV suggests that the latter is reverting to the character of the former after the intervening developments of LPAZ SKE-III.

DCA variable scores for HEL discriminate between pre-Landnám and post-Landnám vegetation communities, the latter composed of a range of apophytes and the former a selection of grazing sensitive taxa (Fig. 13). Coprophilous fungi representing grazing animals are situated within the range of the apophytic taxa. *Salix*, Cyperaceae, *Equisetum* and Pteropsida (monol) indet. are centrally placed suggesting they occur throughout the sequence. Although an outlier, *Sagina* is situated within the sphere of the apophytic taxa along Axis 1.

DCA variable scores for SKE discriminate pre-Landnám and post-Landnám vegetation communities although the distinction is poorly defined (Fig. 14). *Salix* and *Equisetum* are centrally placed suggesting they occur throughout the sequence. The position of coprophilous fungi in the sphere of the pre-Landnám flora suggests grazing early on in the settlement process, perhaps also apparent in the presence of taxa associated with open habitats e.g. *Botrychium* and *Thalictrum alpinum*. The later apophytic vegetation community is infiltrated by grazing intolerant taxa e.g. *Filipendula ulmaria* and *Sphagnum*, i.e. increasing moisture.

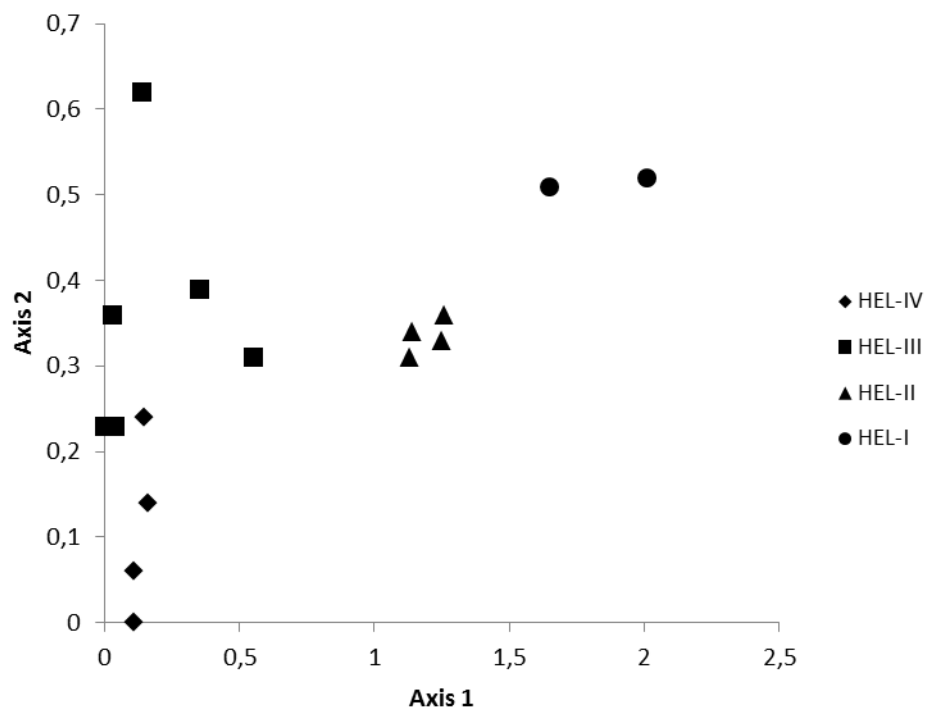


Fig. 11: DCA sample scores verifying the divisions between HEL LPAZ I-IV.

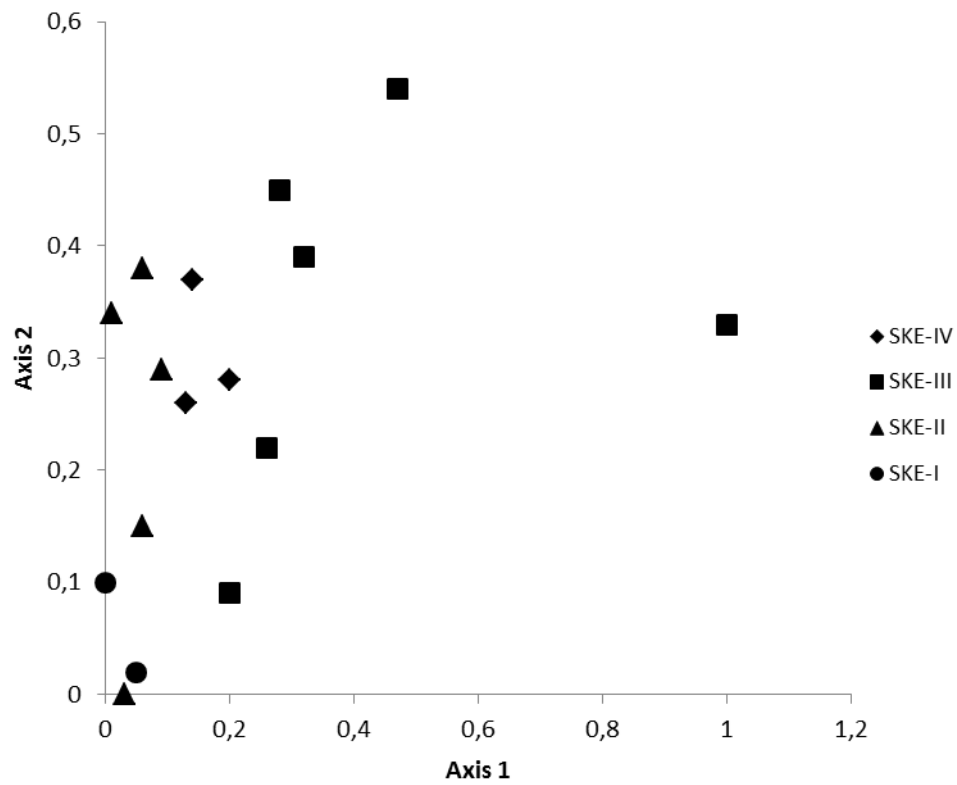


Fig. 12: DCA sample scores verifying the divisions between SKE LPAZ I-IV.

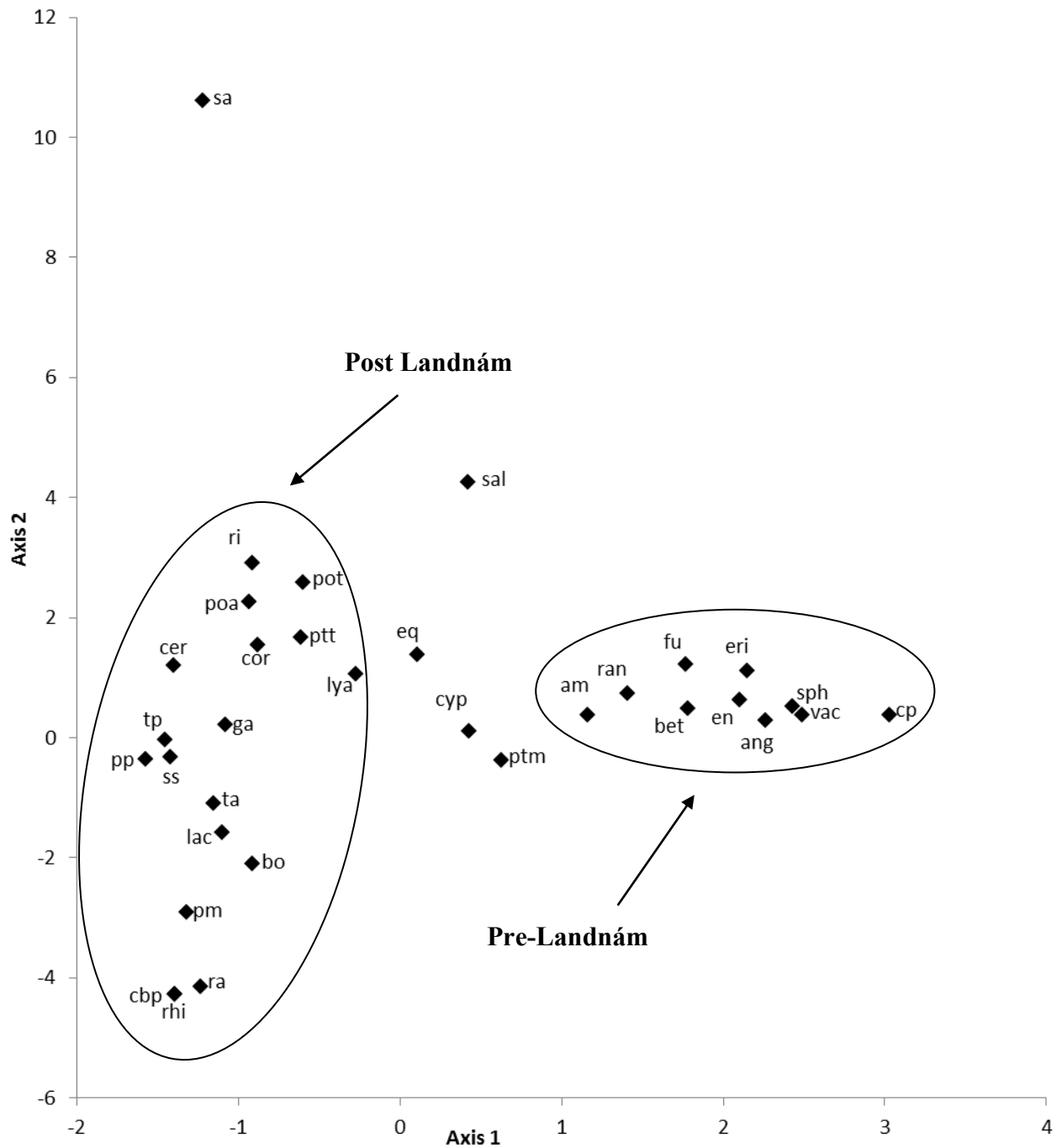


Fig. 13: De-trended Correspondence Analysis Axes 1 & 2 variables plotted for HEL. Pre-settlement and post-settlement floras identified. **Taxa abbreviations:** *Angelica* un-differentiated (an), *Armeria maritima* (am), *Betula* (bet), *Botrychium* (bo), *Caltha palustris* (cp), *Capsella-bursa pastoris* (cbp), *Cerastium*-type (cer), *Coprophilous fungi* (cor), *Cyperaceae* (cyp), *Empetrum nigrum* (en), *Equisetum* (eq), *Filipendula ulmaria* (fu), *Galium* (ga), *Heaths* un-diff. (eri), *Lactuceae* (la), *Lycopodium annotinum* (lyc), *Parnassia palustris* (pp), *Plantago maritima* (pm), *Poaceae* (poa), *Potentilla*-type (pot), *Pteropsida* (monol) indet. (ptm), *Pteropsida* (trilete) indet. (ptt), *Ranunculus acris* (ra), *Rhinanthus*-type (rhi), *Rumex acetosa* (ra), *Rumex* un-diff. (ri), *Sagina* (sa), *Salix* (sa), *Selaginella selaginoides* (ss), *Sphagnum* (sph), *Thalictrum alpinum* (ta), *Thymus praecox* (pt), *Vaccinium*-type (vac). **Note:** *Capsella-bursa pastoris* and *Rhinanthus*-type share the same co-ordinate.

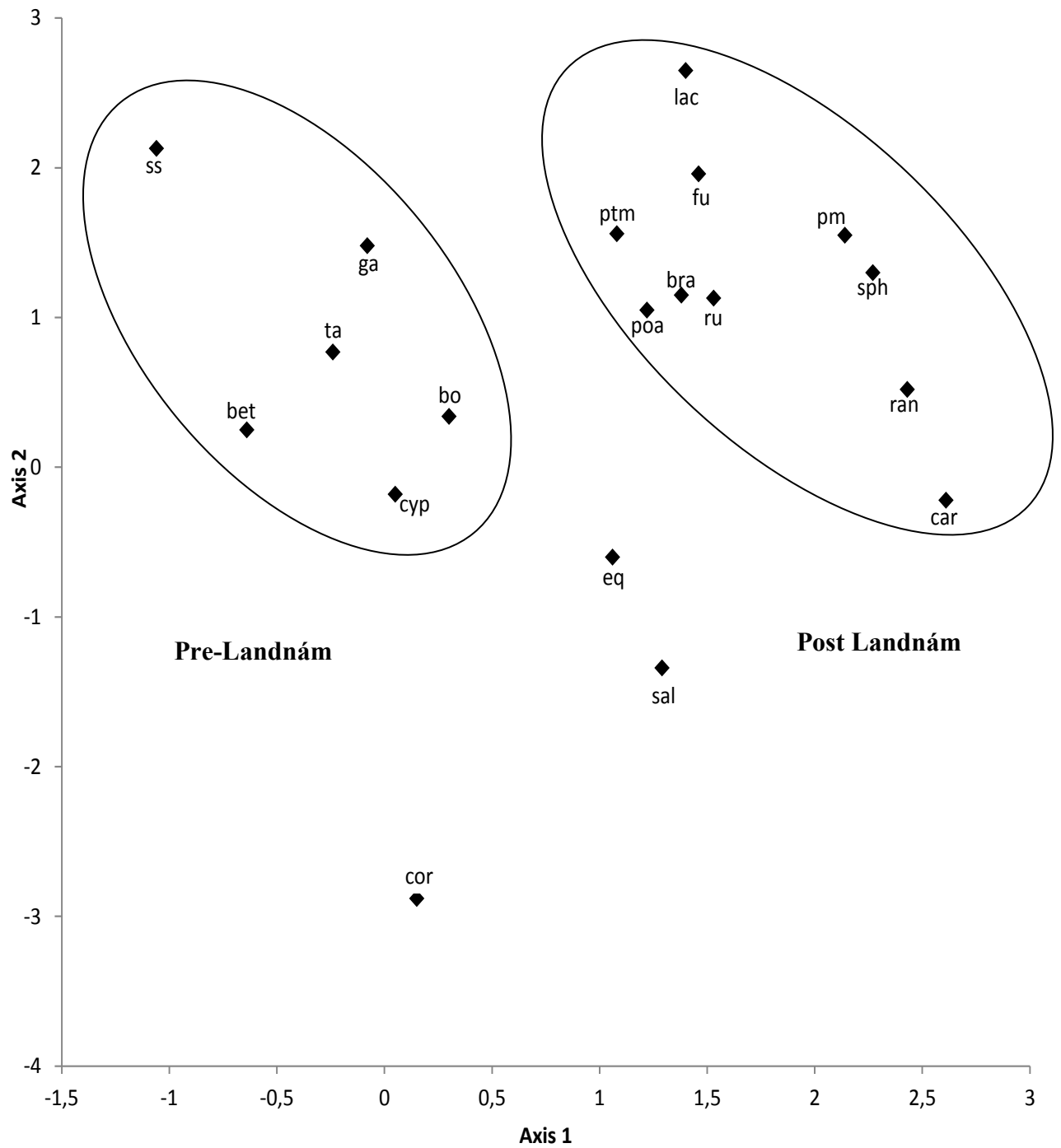


Fig. 14: De-trended Correspondence Analysis Axes 1 & 2 variables plotted for SKE. Pre-settlement and post-settlement floras identified. **Taxa abbreviations:** *Betula* (bet), Brassiaceae (bra), *Botrychium* (bo), Coprophilous fungi (cor), Cyperaceae (cyp), *Equisetum* (eq), *Filipendula ulmaria* (fu), *Galium* (ga), Lactuceae (la), *Plantago maritima* (pm), Poaceae (poa), Pteropsida (monol) indet. (ptm), *Ranunculus acris*-type (ra), *Rumex* un-diff. (ri), *Salix* (sa), *Selaginella selaginoides* (ss), *Sphagnum* (sph), *Thalictrum alpinum* (ta).

5.3.2 Local Pollen Assemblage Zones: HEL-I-IV (Figs. 15, 16 & 17)

The following descriptions of the LPAZ for HEL emphasise the percentage data calculated with Cyperaceae as part of the total local pollen (TLP) assemblage (Fig. 15). Comparisons are made with percentage data where Cyperaceae are excluded from the calculation and with pollen concentration (absolute) data (Figs. 16 & 17). Discrepancies, if any, are described. Dates have been interpolated according to the identified tephra sequence for HEL. No *Hordeum*-type pollen was identified during the course of the standard pollen count for HEL.

LPAZ HEL-I. 44-42 cm (AD c. 630-c. 750): The earliest section of this unit suggests birch woodland (20% TLP; Fig. 15) situated within or around a wetland. However, later conditions become even wetter to allow for a considerable increase in *Sphagnum*. Birchwood (10% TLP; Fig. 15) may have retreated to free-draining slopes surrounding the wetland during this phase, *Salix* disappears and Pteropsida (monol.) indet. decrease. A woodland-wetland eco-tone may be sustaining *Angelica* spp., *Filipendula ulmaria*, *Caltha palustris*, *Ranunculus acris*-type and *Equisetum*. High Cyperaceae values (c. 35-45% TLP; Fig. 15) remain constant throughout as do low background values for Poaceae (<5% TLP; Fig. 15). *Thalictrum alpinum* is perhaps associated with thin soils, soil exposures and rock outcrops in the surrounding mountains.

LPAZ HEL-II. 42-38 cm (AD c. 750-871): An increasing trend in birch values culminates at Landnám with the highest levels attained for birch throughout the HEL sequence (35% TLP; Fig. 15). *Angelica* spp. almost disappear. *Filipendula ulmaria* values are half that of the previous LPAZ (HEL-I) and decline further at Landnám. *Sphagnum* and *Empetrum nigrum* decline significantly and *Equisetum* appears to struggle, perhaps a wetland species e.g. *Equisetum fluviatile* or *Equisetum palustre*. Conversely, Cyperaceae values increase (60% TLP; Fig. 15). Pteropsida (monol.) indet. and *Ranunculus acris*-type values fluctuate but there is little overall change. Grassland becomes almost imperceptible as percentage values for Poaceae fall from <5% TLP to <1% TLP (Fig. 15). Woodland seems to have colonised both wetland and grassland areas.

LPAZ HEL-III. 38-32 cm (AD 871-c. 1100): The most striking feature is the immediate ascendancy of Cyperaceae as the dominant species (80-85% TLP; Fig. 15) c. AD 871. Poaceae values also begin to increase (<5% TLP; Fig. 15) and *Equisetum* recovers (5% TLP; Fig. 15). *Rumex* spp. arrive in the profile coincident with the appearance of coprophilous

fungi; both features infer the presence of grazing animals. Birch values decline significantly (45% TLP; Fig. 15) and birch all but disappears after AD 920 (<5% TLP; Fig. 15) as does *Sphagnum*. *Filipendula ulmaria* is an immediate beneficiary of the receding woodland but disappears itself c. AD 992 (35 cm). This is coincident with the arrival of *Cerastium*-type in the pollen profile, a significant increase in Poaceae (20% TLP; Fig. 15) and *Selaginella selaginoides* (<1% to 5% TLP; Fig. 15) c. AD 956-992 (36-35 cm). *Thalictrum alpinum* values increase from <1% to 10% TLP c. AD 992 (35 cm) and to 15% TLP c. AD 1064-1100 (33-32 cm) (Fig. 15). The latter is coincident with a slight increase in *Botrychium* and the disappearance of *Empetrum nigrum*. Coprophilous fungi are also absent by this time.

LPAZ HEL-IV. 32-28 cm (AD c. 1100-1226): Cyperaceae values remain high throughout the entire unit (80-85% TLP; Fig. 15) as does *Thalictrum alpinum* (10% TLP; Fig. 15) and *Selaginella selaginoides* (5-10%; Fig. 15). *Plantago maritima* appears in the pollen profile and persists throughout LPAZ HEL-IV. *Capsella bursa-pastoris* and *Rhinanthus*-type also appear for the first time (<1% TLP; Fig. ?). Poaceae values decline from the previous LPAZ (10-15% TLP; Fig. 15). Coprophilous fungi are present c. AD 1172-1208 (30-29 cm), coincident with the strongest signal (<5% TLP; Fig. 15) from *Plantago maritima*, Lactuceae and *Rumex* spp. in LPAZ HEL-IV. *Equisetum* reaches its highest value for the entire pollen profile c. AD 1208-1226 (29-28 cm).

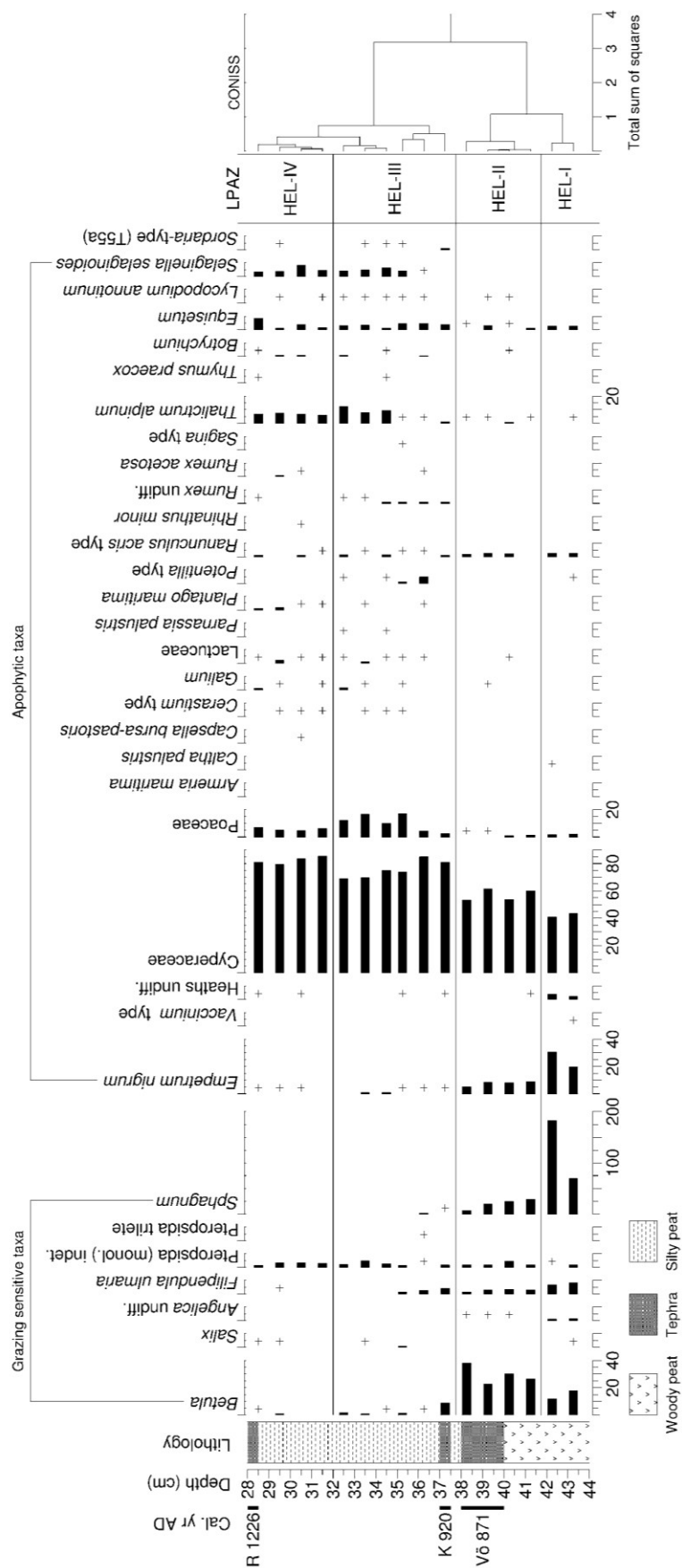


Fig. 15: Pollen percentage diagram for Helgadalur (HEL) with LPAZ dendrogram. Crosses signify taxa with values below 1% TLP.

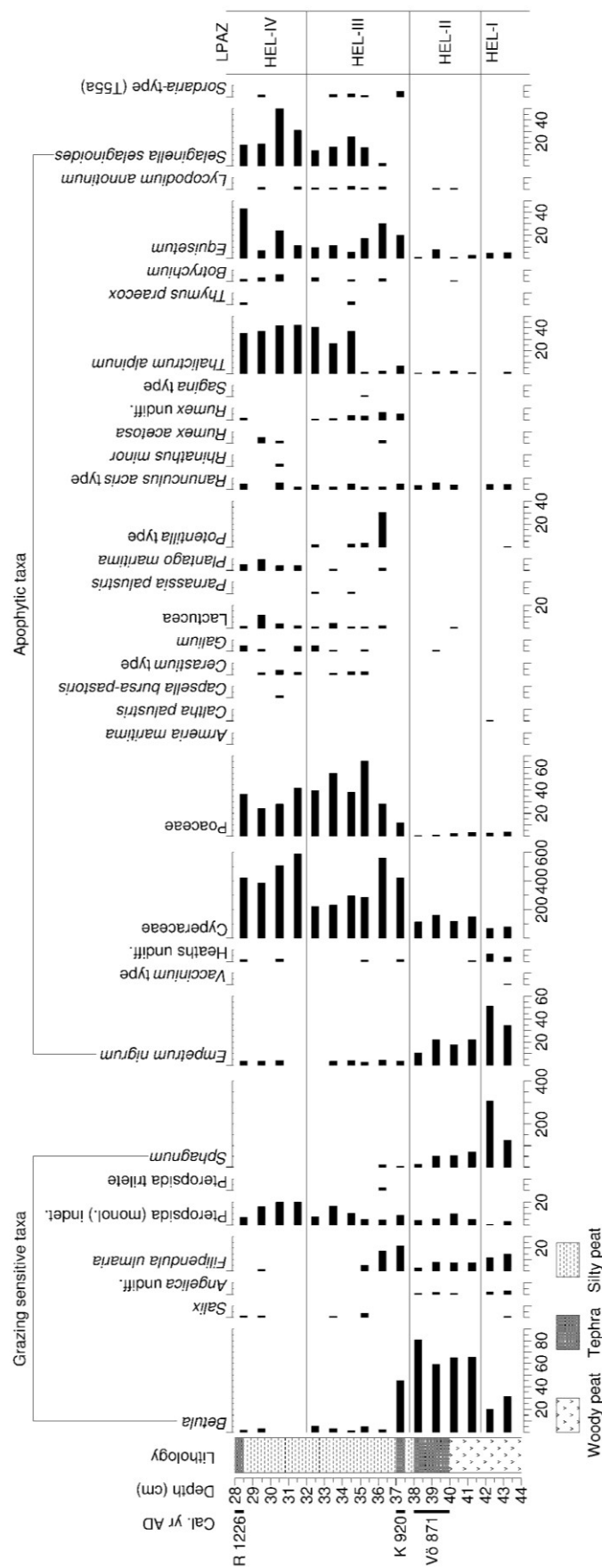


Fig. 16: Pollen percentage diagram for Helgadalur (HEL). Cyperaceae excluded from the percentage calculation sum.

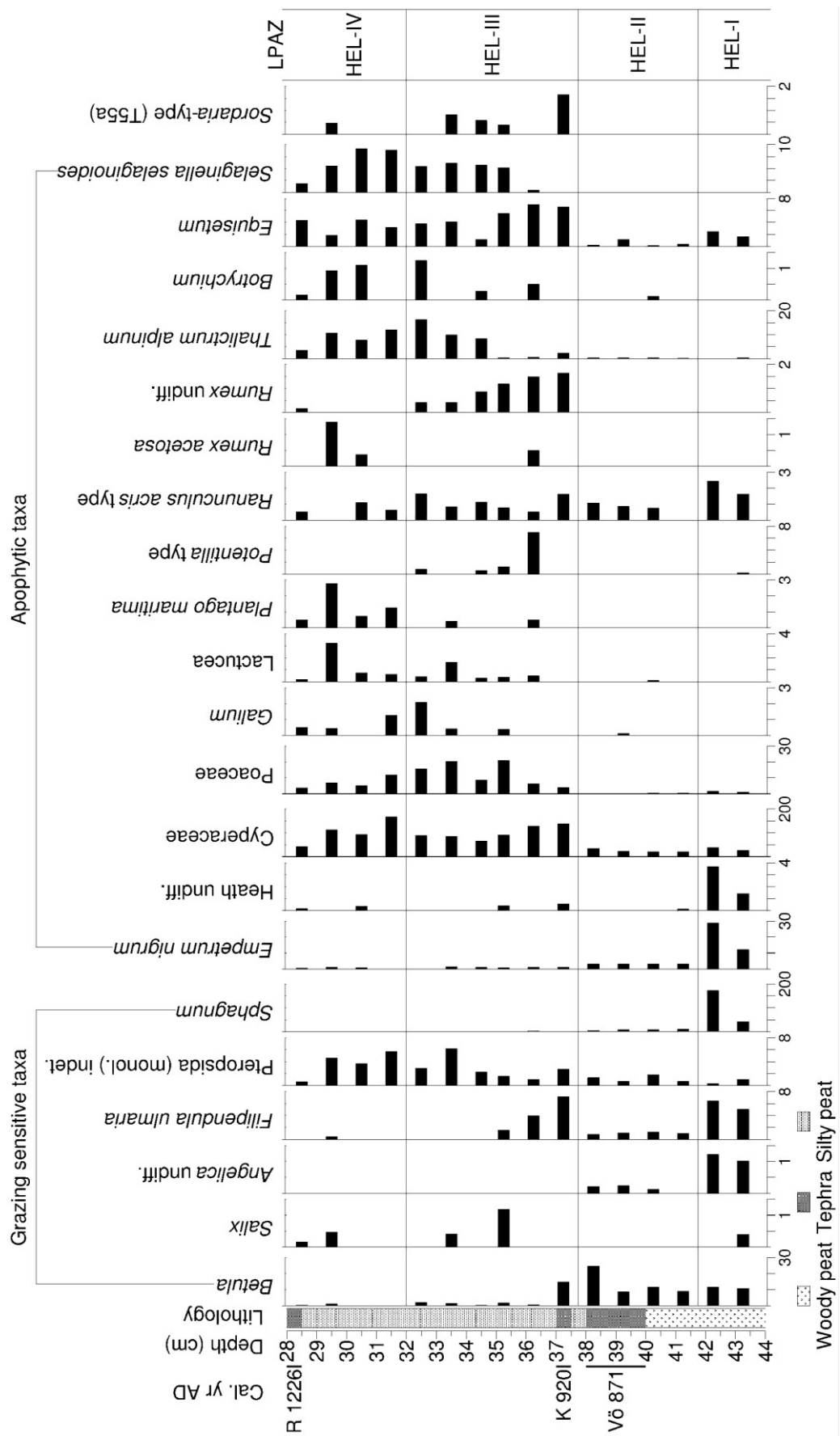


Fig. 17: Pollen concentration diagram for Helgadalur (HEL) for all taxa $\geq 1\%$ TLP.

5.3.3 Local Pollen Assemblage Zones: SKE-I-IV (Figs. 18, 19 & 20)

The following descriptions of the LPAZ for SKE emphasise the percentage data calculated with Cyperaceae as part of the TLP (Fig. 18). Comparisons are made with percentage data where Cyperaceae are excluded from the calculation and with pollen concentration (absolute) data (Figs. 19 & 20). Discrepancies, if any, are described. Dates have been interpolated according to the identified tephra sequence for SKE. No *Hordeum*-type pollen were identified during the course of the standard pollen count for SKE.

LPAZ SKE-I. 49-44 cm (Pre-Landnám-AD 871): Cyperaceae is the dominant taxon throughout LPAZ SKE-I (>80% TLP; Fig. 18) suggesting a wetland context. Only trace values of *Sphagnum* are discernable (<1%; Fig. 18). Birch values (\leq 15% TLP; Fig. 18) are low, with only a trace of *Salix* and *Empetrum nigrum* while heath taxa are absent. An open landscape would explain the presence of *Selaginella selaginoides* (5-15% TLP; Fig. 18) *Rumex* spp., Lactuceae, *Thalictrum alpinum*, Pteropsida (monol.) indet. and *Equisetum* (values ranging between \leq 1-10% TLP; Fig. 18). It is also inferred by the relative persistence of taxa such as *Lycopodium annotinum*, *Botrychium*, *Ranunculus acris*-type, *Galium*, Brassiaceae, *Filipendula ulmaria* and *Angelica* spp. Of note is a reduction in birch values (<10% TLP; Fig. 18) from 47 cm coincident with a transition from woody peat to silty peat and an expansion in Cyperaceae (90% TLP; Fig. 18). Birch recovers slightly at 44 cm (10% TLP; Fig. 18) coincident with a slight drop in Cyperaceae values (75% TLP; Fig. 18). This is also coincident with the appearance of coprophilous fungi and (tentatively) *Rumex acetosella* (45-44 cm). Poaceae values are low (\leq 5% TLP; Fig. 18) throughout LPAZ SKE-I although they can be seen to progressively increase through time.

LPAZ SKE-II. 44-40 cm (AD 871-c. 977): Coprophilous fungi indicative of domestic animals remain a feature of the pollen profile immediately following the deposition of the Landnám AD 871^{+/-2} tephra (43 cm, AD 871) and there is a further shift toward a more silty soil (organic silt). Despite the apparent soil drainage, the *Sphagnum* signal is stronger (<5% TLP; Fig. 18) than in LPAZ SKE-I. Fluctuations in Cyperaceae (75-80% TLP; Fig. 18) prior to AD 920 (41 cm) are mirrored in woodland and grassland; Birch (\leq 10% TLP; Fig. 18), *Salix* (<1-<5% TLP; Fig. ?) and Poaceae (10-15% TLP; Fig. ?). Coprophilous fungi disappear from LPAZ SKE-II by AD 920. A decline in Cyperaceae and birch simultaneously c. AD 920-977 (41-40 cm) without a corresponding alteration to Poaceae is unusual. Reference to relative

percentages calculated without Cyperaceae (Fig. 19) suggests this decline may be linked to an actual expansion in grassland area. A peak in *Equisetum* and the arrival of further of grazing tolerant plant species e.g. *Anthemis*-type, *Cerastium*-type and *Thymus praecox*, may support this inference. However, there is also a coincidental peak in *Sphagnum* values (5% TLP; Fig. 18) suggesting that a portion of the wetland was getting wetter. Furthermore, *Filipendula ulmaria* seems to be flourishing (>1-<5% TLP; Fig. 18) in comparison with the previous LPAZ. The high values for *Ranunculus acris*-type (20% TLP; Fig. 18) at c. AD 920-977 are probably aberrant and may arise from the presence of an anther or flower in the sample.

LPAZ SKE-III. 40-36 cm (AD 977-1130): Sedimentology reveals an immediate reversion to a silty peat. Birch values fluctuate between 5-10% TLP (Fig. 18) tracked by low *Salix* values (<1-<5% TLP; Fig. 18). Cyperaceae values decline (80% to 45% TLP; Fig. 18) while Poaceae values increase (10% to 30% TLP; Fig. 18). The persistence or increasing representation of Brassiaceae, *Galium*, Lactuceae, *Ranunculus acris*-type and *Thalictrum alpinum* further suggest a transition toward grassland. *Selaginella selaginoides* appears to be the greatest beneficiary. Nonetheless, *Filipendula ulmaria* also persists, perhaps amid the Cyperaceae. *Equisetum* values (<5% TLP; Fig. 18), although relatively stable, are lower than in previous LPAZ and could also be associated with Cyperaceae dominated habitats. Pteropsida (monol.) indet. values increase (5-10% TLP; Fig. 18) as does the amount of undifferentiated pollen (10-15% TLP; Fig. 18) i.e. damaged pollen. A notable difference from the previous LPAZ's is the absence of *Sphagnum* and coprophilous fungi.

LPAZ SKE-IV. 36-33 cm (AD 1130-1226): Coprophilous fungi suggest that livestock were present AD 1130-1169 (36-35 cm). Coprophilous fungi are absent afterwards. *Sphagnum* reappears in the pollen profile (1% TLP; Fig. 18) suggesting wet conditions. Cyperaceae recovers from previous declines to remain stable at 65% TLP (Fig. 18) at the expense of Poaceae. *Selaginella selaginoides* values (10-5% TLP; Fig. 18) are also indicative of a decline in grassland area. Poaceae values (10-15% TLP; Fig. 18) appear to have an inverse relationship with those of birch (5-10% TLP; Fig. 18). *Galium* (1-<5% TLP; Fig. 18) and *Equisetum* (1-<5% TLP; Fig. 18) values are low and track those of Poaceae. The increasing presence of *Botrychium* (<1->1% TLP; Fig. 18) and *Thalictrum alpinum* (<5-10% TLP; Fig. 18) c. AD 1207-1226 (34-33 cm) suggests a close cropped sward. Pteropsida (monol.) indet. values show a declining trend (10-5% TLP; Fig. 18) while undifferentiated pollen values drop significantly (15-<5% TLP; Fig. 18) suggesting a reduction in soil influx.

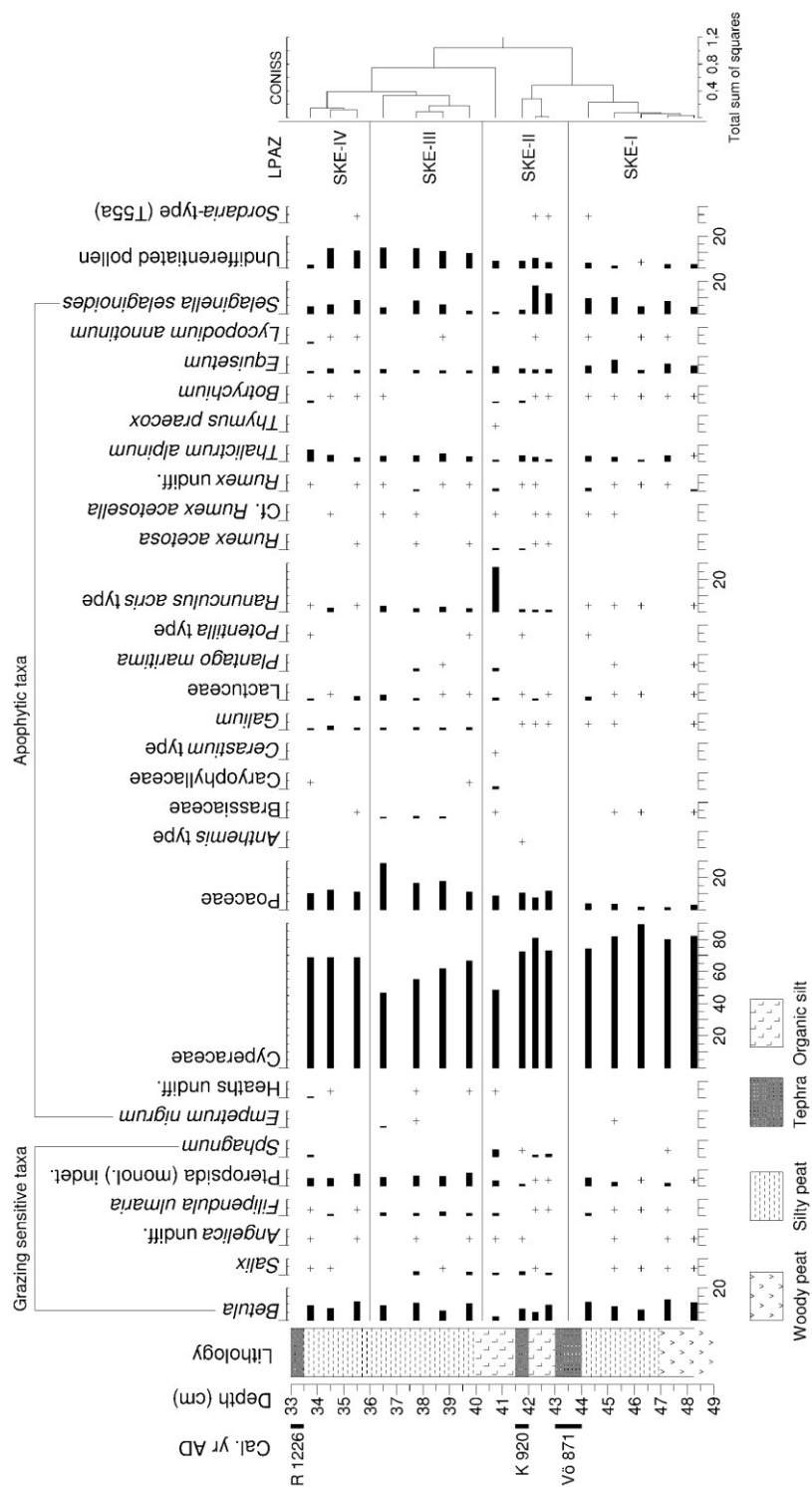


Fig. 18: Pollen percentage diagram for Skeggjastaðir (SKE) with LPAZ dendrogram. Crosses signify taxa with values below 1% TLP.

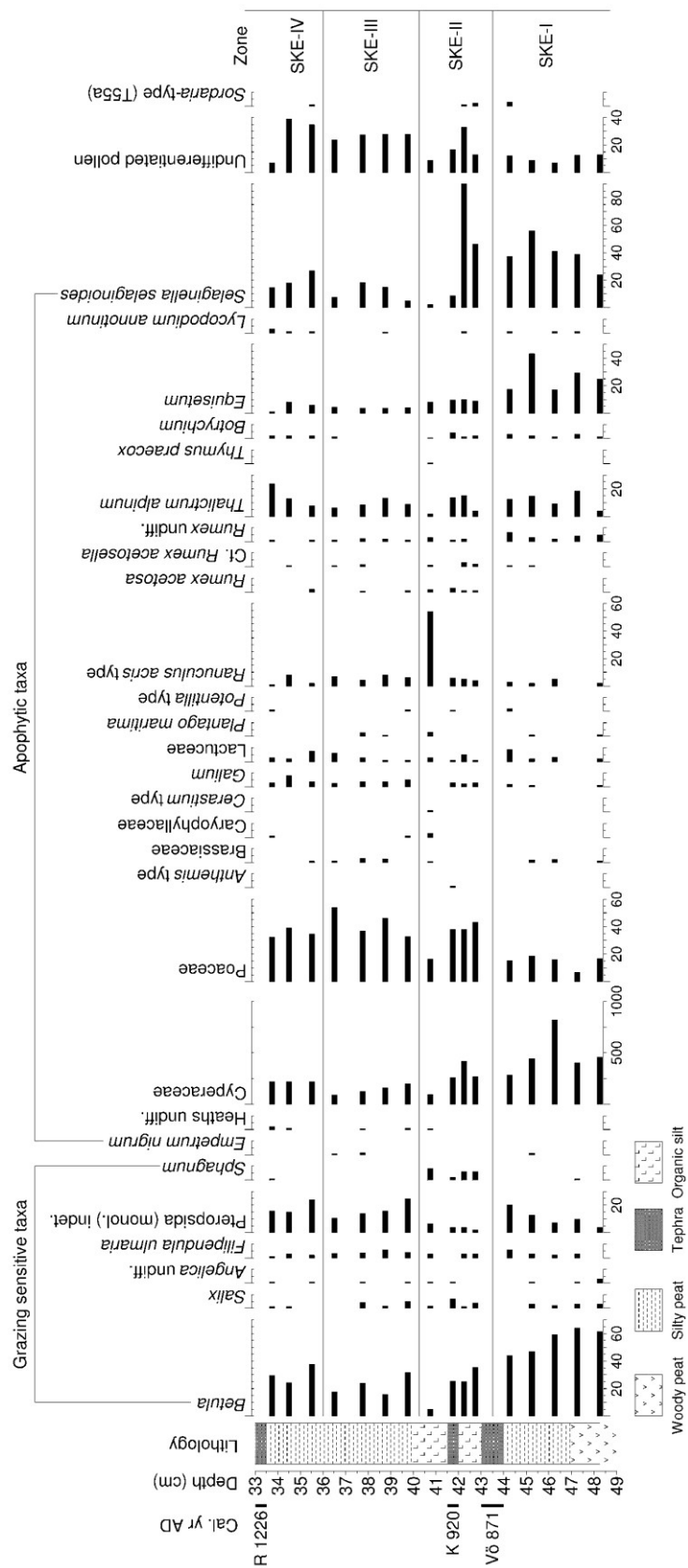


Fig. 19: Pollen percentage diagram for Skeggiastaðir (SKE). Cyperaceae excluded from the percentage calculation sum.

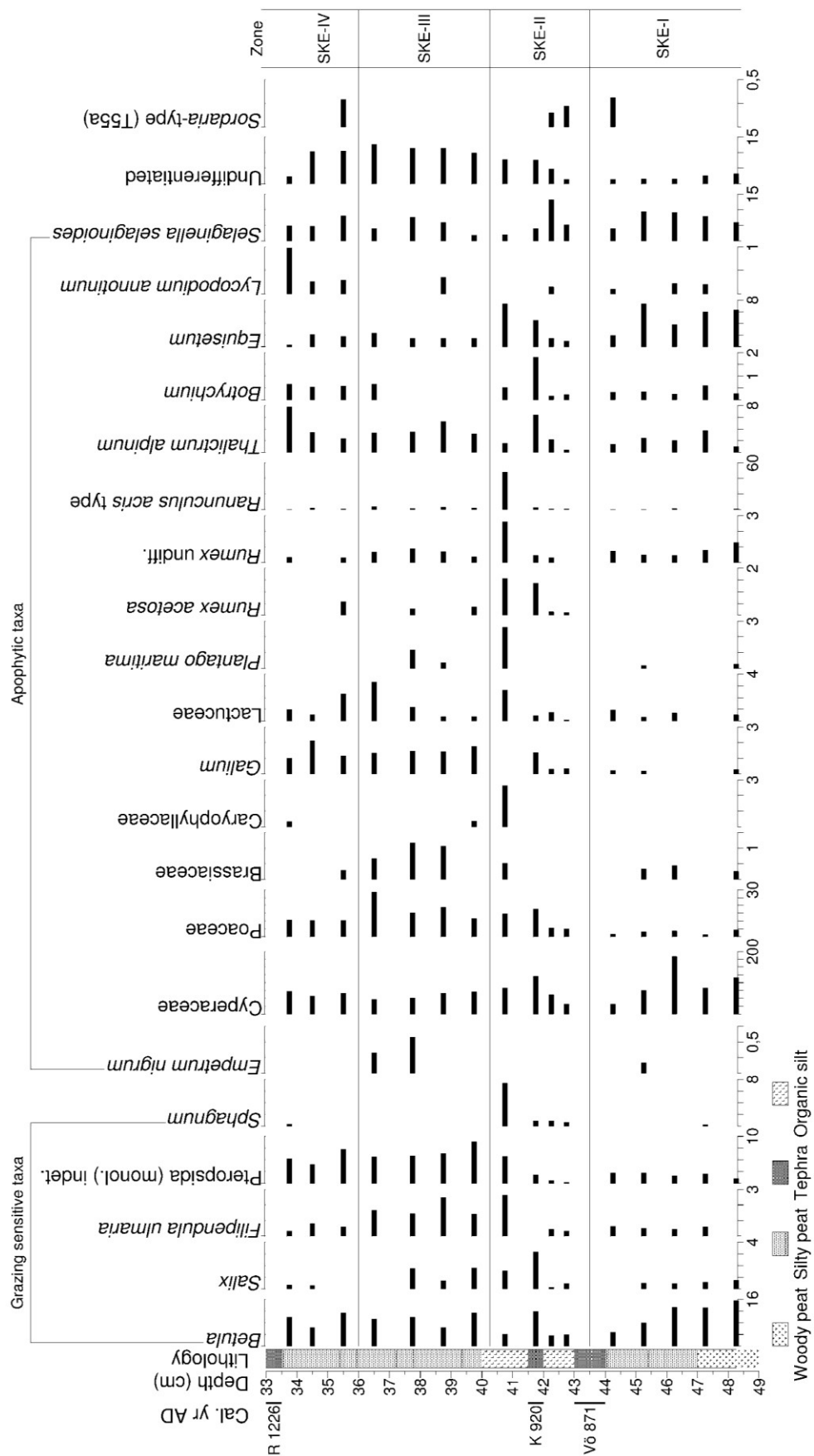


Fig. 20: Pollen concentration diagram for Skeggjastaðir (SKE) for all taxa $\geq 1\%$ TLP.

5.4 Rapid Scanning

No *Hordeum*-type pollen grains were identified in the rapid scanning pollen profiles for either HEL or SKE.

5.4.1 HEL Rapid Scanning: Coprophilous Fungi

Coprophilous fungi rapid scanning values for HEL can be seen to match trends identified in the standard count and identify spores for periods where the standard pollen count did not. Of note is the strong peak at 37.5-37 cm (AD 871-920) (Fig. 21).

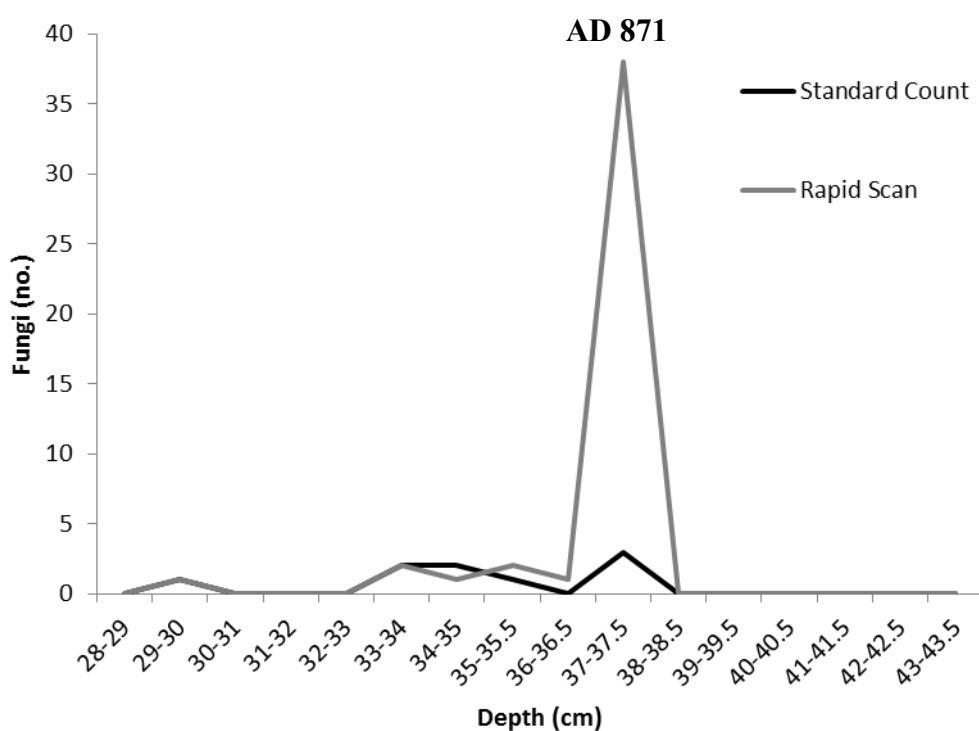


Fig. 21: Rapid scanning at HEL. This includes standard count results for coprophilous fungi (absolute number).

5.4.2 SKE Rapid Scanning: Charcoal & Coprophilous Fungi

Charcoal fragments were present throughout the entire SKE profile (Fig. 22). The presence of charcoal in the sediment profile prior to AD 871 is notable (Appendix 1). However, the most significant increase in values can be observed from AD 871-920 (43-42 cm). These persist until AD 1054 (38 cm) when there is a significant drop in values. Coprophilous fungi rapid scanning values for SKE did not match those of the standard count but can be seen to form a contiguous suite of samples with them for Pre-Landnám-c. AD 939 (45-41 cm). The trend seems to follow that of charcoal for said period.

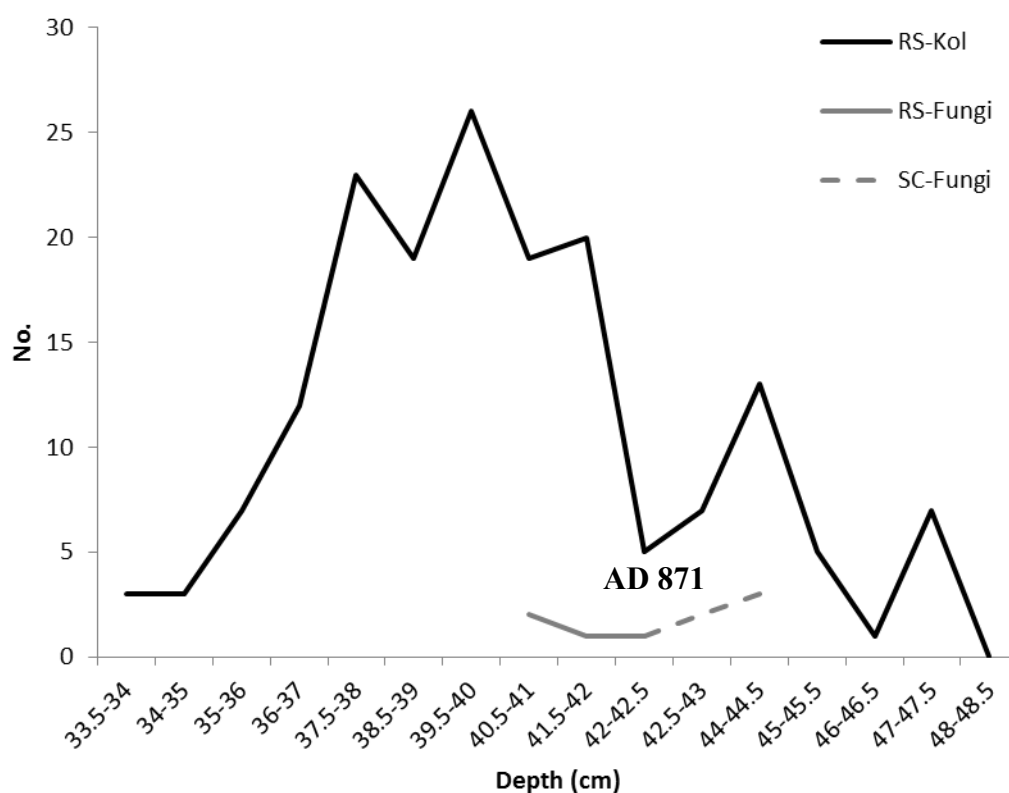


Fig. 22: Rapid scanning at SKE. Charcoal (kol) palynomorphs (absolute number) and rapid scanning and standard count results for coprophilous fungi (absolute number).

Chapter 6: The Vegetation History of Mosfellsdalur, Pre-Landnám-AD 1226

6.1 Soil & Vegetation History of Helgadalur c. AD 631-1226

The primary pre-Landnám habitat of Helgadalur was essentially a wetland as intimated by the strong presence of *Sphagnum* moss. Cyperaceae, heaths and *Empetrum nigrum* formed a further component of the wetland plant community, sustained by the hummock and hollow topography associated with *Sphagnum* dominated habitats (Hallsdóttir & Caseldine 2005; Erlendsson *et al.* 2009). Woodland and forbs were probably confined to the fringes of the wetland with arboreal taxa possibly extending onto the surrounding slopes (Erlendsson & Edwards 2009). Grassland (Poaceae) and *Thalictrum alpinum* were perhaps restricted to the free-draining slopes and thinner soils while *Ranunculus acris*-type probably occupied a transitional zone between wetland and relatively drier areas. Wetland habitats such as this seemed to dominate lowland areas in Iceland from c. 5,000 BC (c. 6000 ¹⁴C BP), particularly in the south (Hallsdóttir & Caseldine 2005).

A later reduction in *Sphagnum* in association with *Empetrum nigrum* and the heath communities suggests an alteration to the hydrology of the wetland. This is also coincident with an expansion in woodland which may either be responsible for altering the hydrology of the wetland or is simply benefitting from it. As woodland encroaches upon both wetland and grassland it is possible that the woodland is contributing to the drying out of the wetland, perhaps linked with altered climatological conditions favourable to woodland (Erlendsson & Edwards 2009). Woodland recovery immediately prior to Landnám has been noted from other locations in south and west Iceland for this period (Hallsdóttir & Caseldine 2005; Erlendsson & Edwards 2009). The coincident expansion in Cyperaceae is probably due to it representing a range of species that will exploit micro-habitats within and around the wetland according to moisture levels. Some species of Cyperaceae will have occupied areas vacated by *Sphagnum* that perhaps remained too wet to be colonised by woodland.

From Landnám (AD 871^{+/-2}) there is an alteration to the character of the vegetation communities and soils of Helgadalur (Figs. 11, 13 & 15). This may be a direct consequence of the Landnám AD 871^{+/-2} tephra deposition. However, the immediate transformation from a woody peat to a silty peat has no parallel across the span of the entire soil sequence (c. 1600

BC-AD 2000). This is also apparent in the properties of the soil i.e. OM, SMC, DBD & MS (Fig. 9) and in the altered trajectory of SAR (Fig. 8) from AD 871^{+/-2}. The long term alteration to soil properties and soil development would suggest that this was more than a single event and infers that it is either due to human agency and/or climate rather than volcanism. Cyperaceae remains dominant but grassland values begin to exceed pre-Landnám levels. This is initially at the expense of woodland but soon begins to encroach upon the Cyperaceae wetland. Grazing sensitive species progressively wane and vanish from the pollen profile e.g. *Salix*, heaths, *Empetrum nigrum*, *Sphagnum*, *Angelica* spp. and *Filipendula ulmaria*. Conversely, the signal for species tolerant of grazing becomes more persistent and/or stronger e.g. *Cerastium*-type, *Galium*, Lactuceae, *Rumex* spp., *Thalictrum alpinum*, *Equisetum*, *Selaginella selaginoides*. The occurrence of this change in conjunction with the arrival of coprophilous fungi would suggest that domestic animals have been introduced to the landscape of Helgadalur (Cugny *et al.* 2010) (Fig. 15 & 21). From c. AD 1100 *Botrychium* becomes more prominent and would suggest a close cropped sward while the presence of *Plantago maritima* could indicate an intensity of grazing that is beginning to break the vegetative surface. By AD 1226 a balance is struck between Cyperaceae and grassland, although the latter has given way somewhat to the former. Overall, the composition of the vegetation community from LPAZ HEL-III to LPAZ HEL-IV remains largely unaltered as demonstrated by DCA sample scores (Fig. 11). SAR has however more than doubled since AD 871^{+/-2} and indicates that soil denudation and redeposition was a feature of the valley by AD 1226 (Fig. 8 & Table 3).

Even though woodland was in the ascendancy immediately prior to settlement in Helgadalur, it was situated within a wetland context and Cyperaceae dominated. This is consistent with the impression that even though woodland was a primary habitat in south west Iceland before Landnám, it was open in character, and thus, probably attractive to early settlers for its grazing potential (Vésteinsson 1998, Hallsdóttir & Caseldine 2005). The subsequent transition from a natural habitat to one of anthropogenic modification can be seen clearly in the pollen diagram (Fig. 15) and the DCA variable scores (Fig. 11). This transition is also apparent in the lithology where woody peats are replaced by silty peats (histosols by histic-andosols) i.e. reduced organic matter and increased silt input (Fig. 9). Furthermore, both the pollen data and the lithological data imply a progressive intensification of grazing pressure, especially as SAR more than doubles between Landnám and AD 1226 compared with pre-Landnám values (Table 3). The threshold of change in both pollen and soils c. AD 871^{+/-2} is therefore

significant and is consistent with a dramatic alteration to the Icelandic landscape during settlement (Thórarinnsson 1961; Einarsson 1962; Hallsdóttir 1987). It is also consistent with a disappearance of woodland in lowland Mosfellsdalur and the development of agricultural landscapes at Hrísbú, Mosfell and Leirvogstunga c. AD 871^{+/-2} (Erlendsson 2012c; Erlendsson & Pétursdóttir 2013; Erlendsson 2014; Erlendsson *et al.* in press).

At Helgadalur, the emphasis is clearly upon an increasingly intensive pastoral regime. There is no indication that cereal cultivation was ever attempted. Nor is there any evidence of an infield (based upon the disappearance of *Filipendula ulmaria* as apophytes populate the area c. AD 992) and nor is there any indication that the area was ever abandoned following Landnám as there is no later reassertion of pre-Landnám vegetation communities. The eradication of woodland in favour of pasture is almost relentless. In this sense, Helgadalur conforms to Hallsdóttir's (1987) model of Equilibrium - Landnám Disturbance - New Equilibrium. Of course, these findings very much depend upon the location of the sampling site and its relationship to the archaeology c. 500 m distant. The pastoral impression may hold true for Helgadalur AD 871-1226 as a whole, however, the acquisition of a sample closer to the farmstead and archaeological remains may provide a more nuanced picture regarding hayfield and/or cereal cultivation.

6.2 Soil & Vegetation History of Skeggjastaðir, Pre-Landnám- AD 1226

The most striking feature of the Skeggjastaðir pollen profile is the dominance of Cyperaceae throughout i.e. this is fundamentally a wetland site (Fig. 18). The pre-Landnám composition of the plant community suggests a predominantly open landscape supporting pockets of scrub woodland. This is perhaps dictated by the topography of a glacially scoured landscape (Ólafsdóttir & Guðmundsson 2002). Hollows supported wetland plant communities of Cyperaceae, *Salix*, *Filipendula ulmaria* and *Angelica* spp. whereas thin soils, soil exposures and rock outcrops supported communities more akin to grassland e.g. Poaceae, *Selaginella selaginoides*, *Equisetum*, *Thalictrum alpinum*, *Rumex* spp. and Lactuceae. Woodland was interspersed between the two extremes.

Within this ecological context, there are three features of note pre-871^{+/-2}. First, rapid scanning reveals the presence of charcoal within the profile from 48-47 cm (Fig. 22, Appendix 1). This is unusual in the Icelandic context as natural fires are a rare occurrence

(Dugmore *et al.* 2005). Early incidence of charcoal could be derived from volcanic eruption and subsequent wildfire (Buckland *et al.* 1995). However, such an incident would be likely to have had a widespread impact within Mosfellsdalur which does not appear to be the case. There is no evidence of pre-Landnám charcoal from Leirvogstunga and only scant trace from Mosfell (<1% TLP) (Erlendsson 2012c; Erlendsson 2014). Charcoal rapid scanning values increase from Landnám (AD 871-920, 43-42 cm) suggesting a change in the prevailing fire regime (natural or otherwise) consistent with human activity and charcoal evidence from Hrísbú (Buckland *et al.* 1995, Erlendsson *et al.* in press).

Second, the lithology changes to silty peat from woody peat at 47 cm. This follows an ongoing trend toward a more silty soil type from 49 cm (Fig. 10). It is also coincident with a drop in birch values (15 > 5% TLP; Fig. 18) and, although Cyperaceae values are high, they begin to decline as grassland begins to expand (Fig. 18). An abrupt decline in birch prior to Landnám at this location is also noted by Erlendsson & Pétursdóttir (2013) who attribute the change to climate or hydrology. However, this event is situated within a period when climate is believed to have favoured birch and may even have nurtured an expansion of woodland cover in southern and western Iceland (Erlendsson & Edwards 2009; Vickers *et al.* 2011). Furthermore, the birch decline at Skeggjastaðir is extremely localised when compared with the other eight sites surveyed in Mosfellsdalur by Erlendsson & Pétursdóttir (2013). In light of the bigger picture, localised context and the alteration to the soil, a change in soil hydrology rather than climate may be inferred. However, the soil properties for Skeggjastaðir and the decline in Cyperaceae suggest that conditions were getting drier which should favour birch expansion (Erlendsson & Edwards 2009; Gísladóttir *et al.* 2010). Ultimately it does, until Landnám. However, this does not explain the initial drop in birch pollen values or the change in soil conditions. Charcoal rapid scanning values are low but retain a presence (Fig. 22).

Third, coprophilous fungi appear in the pollen profile 45-44 cm in association with an increase in the signal for apophytes (Lactuceae, *Rumex* spp. and *Selaginella selaginoides*) and a slight expansion in grassland (Poaceae) (Figs. 18 & 22). *Rumex* spp. includes tentatively identified *Rumex acetosella* from 46-44 cm. This species has been cited as a possible anthropochorous species as it usually only occurs consistently in the Icelandic pollen record following Landnám (AD 871^{+/-2}) (Schofield *et al.* 2013). Charcoal rapid scanning values also increase (Fig. 22). SMC and OM are at their lowest recorded value (Fig. 10). This represents a

suite of palynological and other proxy features commonly associated with human activity (Cugny *et al.* 2010; Gísladóttir *et al.* 2010; Edwards *et al.* 2011).

The indications are that humans were active within the vicinity of Skeggjastaðir prior to the conventional date of the Icelandic Landnám. Setting aside the presence of charcoal from 48-47 cm and alteration to the sediment profile 47 cm, there remains a suite of indicative proxies at 45-44 cm, just below the Landnám tephra. This does chime with the inference in Landnámabók that Skeggjastaðir was the location of the earliest settlement in Mosfellsdalur although the data is comparable with the pre-Landnám incidence of charcoal, coprophilous fungi and altered vegetation communities at Hrísbú (Benediktsson 1968, p. 312, Erlendsson *et al.* in press). None of the other sites investigated palynologically or archaeologically in Mosfellsdalur show any consistent signs of human activity prior to AD 871^{+/-2} (Erlendsson 2012c; Erlendsson & Pétursdóttir 2013; Erlendsson 2014; Zori in press).

Hallsdóttir (1987) notes the presence of *Hordeum*-type pollen at Vatnsmýri I and Mosfell (Grímsnes) and a suite of “anthropogenic indicators” at Svínavatn beneath the Landnám tephra. She considers human agency speculative, primarily due to the fact that the species concerned can all be found occurring naturally in the pre-Landnám Icelandic flora. She does however acknowledge the possibility and advocates the grouping of species as one means of discerning an early human footprint (as has been done here along with other proxy indicators). There is also archaeological evidence of two turf-built enclosures in south west Iceland situated beneath the Landnám AD 871^{+/-2} tephra (Vésteinsson & McGovern 2012). Nonetheless, Skeggjastaðir does require further consideration. For example, the identification of a pre-Landnám tephra would allow for the interpolation of a pre-Landnám chronological sequence and a determination of SAR at Skeggjastaðir for the period concerned. An extended Holocene pollen profile would also demonstrate whether or not the vegetation communities at Skeggjastaðir from 49 cm were indeed characteristic of the location.

Following Landnám (AD 871^{+/-2}, 43 cm) there is a further increase in the silt content of the wetland with a shift from silty peat to organic silt (Fig. 10). Conversely, conditions appear to be getting wetter as SMC and OM increase and *Sphagnum* communities are re-established (Fig. 10 & 18). A threshold has been crossed but it would appear that there is a certain degree of ecological resilience in the face of the altered lithology (Gísladóttir *et al.* 2011). This subsequently allows for a later reversion to silty peat c. AD 977 (40 cm) with a relative period

of stability in soil properties until c. AD 1130 (36 cm) (Fig. 10). Even so, *Sphagnum* disappears from the pollen profile once again and SAR rates do increase between AD 871^{+/-2} and AD 1226 (Fig. 18 & Table 3). The latter may also be apparent in increased values of Pteropsida (monol.) indet. and undifferentiated pollen, both perhaps symptoms of aeolian re-deposition of soils (Gathorne-Hardy *et al.* 2009).

The period c. AD 977-1130 is also marked by an absence of coprophilous dung fungi, a slight woodland expansion and an increase in values for *Filipendula ulmaria*, *Galium*, Lactuceae and *Ranunculus acris*-type. The area may have been abandoned for a term although increasing grassland and charcoal would suggest that this was not the case. A further possibility may be that this was an outlying shieling site, grazed only periodically or seasonally during this period (Sveinbjarnardóttir 1991). However, the relative stability in soil conditions and resurgence of grazing sensitive taxa (*Filipendula ulmaria*) may have arisen from the exclusion of animals from the area or an area nearby in order to cultivate hay (Erlendsson *et al.* 2009, Vickers *et al.* 2011). Rapid scanning reveals high charcoal values c. AD 920-1054 which is unlikely to be derived from woodland clearance (slash and burn) given the slight rise in woodland values in the standard count. Microscopic charcoal may therefore be derived from a domestic fire (wood smoke) or from the fertilisation of an infield (Erlendsson *et al.* in press, Vickers *et al.* 2011). The former is favoured on the assumption that fertiliser material (macro-charcoal) would have been visible as a cultural layer within the sediment sequence for this period. Either way, this in turn may be indicative of permanent habitation close to the sample site.

The period following c. AD 1130 (Fig. 18; LPAZ SKE-IV) sees a return of coprophilous fungi, an increase in Cyperaceae and a decline in grassland, the latter cropped short as suggested by the presence of *Botrychium* and *Thalictrum alpinum*. By AD 1226, SAR has increased considerably since Landnám (Table 3). A re-intensification of grazing is underway, on a par with the period following Landnám (Fig. 18; LPAZ SKE-II) as is shown in the DCA samples score (Fig. 12). This latter change in agricultural practice is consistent with a similar mid-12th century move toward intensive grazing down the valley at Helgadalur (Fig. 15) and Hrísbú (Erlendsson *et al.* in press). It may also reflect a discernable alteration to the archaeofaunal record for Iceland where there is an increasing emphasis upon cattle and sheep grazing (Dugmore *et al.* 2005; McGovern *et al.* 2007).

6.3 The Pre-Landnám Environment of Mosfellsdalur

The pre-Landnam pollen profiles for Leirvogstunga and Hrisbrú describe a landscape that was predominantly wooded (Erlendsson 2014; Erlendsson *et al.* in press); further demonstrated by birch pollen profiles for Sauðafellsflói, Litla Sauðafell, Bugðuflói and Seljabrekka (Erlendsson & Pétursdóttir 2013). In effect, woodland was a primary habitat type within Mosfellsdalur from the coast inland as far as Mosfellsheiði. This may be considered as consistent with Íslendingabók descriptions of Iceland at the time of settlement (Benediktsson 1968, p. 5). However, the actual density and distribution of woodland is likely to have varied spatially and temporally according to environmental factors. This is exemplified at Helgadalur where wetland is colonised by woodland just prior to Landnám, probably during a period of climate amelioration (Fig. 15) (Erlendsson & Edwards 2009). Otherwise, wetlands inhibit birch woodland, with trees restricted to their fringe or to surrounding, free draining slopes with isolated clumps perhaps within the wetland itself. This is visible at Helgadalur prior to the pre-Landnám woodland expansion, at Mosfell prior to Landnám and was perhaps always the case at Stardalur where birch pollen values are low (Erlendsson 2012c; Erlendsson & Pétursdóttir 2013). The picture that develops is of a mosaic of woodland and wetland habitats. It is worth noting however that the pollen profiles for Skeggjastaðir and Mosfell are more nuanced with a suite of plants that imply a matrix of habitats ranging from wetland to rock or soil exposure as well as woodland, most probably a consequence of local geomorphology. Overall, the range of habitats described is consistent with the findings of Hallsdóttir and Caseldine (2005) who describe an open woodland context for south west Iceland. The fact that all of the pollen profiles discussed are from wetland sites will inevitably skew the vegetation description of Mosfellsdalur. As a note of caution, even though low pollen values are recorded for Mosfell, birch stumps were observed in the field within the immediate pre-Landnám stratigraphy (Erlendsson 2012c; Zori *et al.* 2013). This would suggest that woodland may have been more extensive in Mosfellsdalur, even in wetlands, but conditions were not optimal for pollen production.

6.4 Patterns of Settlement & Land Use in Mosfellsdalur c. AD 871-1226

Accepting that Mosfellsdalur was comprised of a range of habitat types, including large, open wetland areas, this may have made it an attractive location for settlement. Wetland areas would provide winter fodder while woodland provided the raw material for a range of needs

i.e. fuel, fodder, construction and crafts. The farmsteads of Helgadalur, Skeggjastaðir, Mosfell, Hrísbú and Leirvogstunga are all situated within pre-Landnám wetland contexts even though woodland is present and birch pollen values are high e.g. Helgadalur (40% TLP; Fig. 15) (Erlendsson 2012c; Erlendsson 2014; Erlendsson *et al.* in press). The establishment of farmsteads close to wetlands in Mosfellsdalur (Leirvogstunga, Hrísbú, Helgadalur and Skeggjastaðir), or even the introduction of livestock to these areas during Landnám (Mosfell), conforms with Vésteinsson's (1998) occupation model where natural clearings were sought out by the colonists in order to secure winter feed for livestock. However, the pollen sampling methodology used to obtain this data does skew interpretation toward wetland contexts.

Vegetation change at Landnám within the pollen profiles for Leirvogstunga, Mosfell and Helgadalur is virtually simultaneous, arising almost immediately after the deposition of the Landnám AD 871^{+/-2} tephra (Erlendsson 2012c; Erlendsson 2014). The values for grazing sensitive species decline e.g. birch, *Salix*, *Filipendula ulmaria*, *Angelica* spp. and *Sphagnum* while apophytic taxa either increase or begin to populate the pollen profiles e.g. Poaceae, *Anthemis*-type, *Rumex* spp., *Cerastium*-type, *Galium*, *Thalictrum alpinum*, *Selaginella selaginoides*, *Equisetum* and Lactuceae, all in association with coprophilous fungi. This is consistent with the proposition that Iceland's colonisation was effected over a very short period during the late 9th century (Vésteinsson & McGovern 2012). This model does allow for settlement prior to the conventional date of AD 871^{+/-2}, a pioneer phase occurring after AD 800. This is in recognition of two turf-built enclosures in south west Iceland situated beneath the Landnám AD 871^{+/-2} tephra and also cites the pre-Landnám pollen evidence from Vatnsmýri I (Hallsdóttir 1987). In Mosfellsdalur, the pre-Landnám charcoal, coprophilous fungi and pollen evidence from Hrísbú and Skeggjastaðir (section 6.2) may also be representative of this trailblazing period (Erlendsson *et al.* in press). Birch woodland pollen studies in Mosfellsdalur show that the initial impact of Landnám was largely restricted to the lowland zone with some woodlands surviving in upland areas into the 14th century (Erlendsson & Pétursdóttir 2013).

The cultivation of cereals at Hrísbú is precocious i.e. pre-Landnám, but does persist into the 13th century with a marked decline in cereal pollen from the mid-12th century and a correspondingly increased emphasis on pastoral habitats (Erlendsson *et al.* in press). The mid-12th century also witnesses a change of land use at Mosfell, perhaps the abandonment of cereal cultivation (Erlendsson 2012c). These circumstances are also mirrored at Skeggjastaðir

with the possible abandonment of a hayfield in favour of pasture (Fig. 18). At all three sites, pollen data suggest an intensification of grazing pressure during the 12th century in the form of taxa that favour a close-cropped sward or a broken vegetation surface. The latter is also apparent in the soil properties of Skeggjastaðir for this period (Figs. 8 & 10, Table 3). The subsistence focus at Helgadalur and Leirvogstunga since Landnám seems to have always been grazing. Once the pastoral regime was established at Leirvogstunga, it remained largely unaltered until AD 1226 although evidence of increasing erosion of soils is apparent (Erlendsson 2013). At Helgadalur, an intensification of grazing pressure can be detected in the pollen taxa and soil properties during the 12th century (Figs. 8, 9 & 15). One can only conclude the 12th century was a period of significant change in Mosfellsdalur, a period where a diverse subsistence strategy is replaced by one exclusively predicated upon grazing animals as inferred by the archaeofaunal evidence from elsewhere in Iceland (Dugmore *et al.* 2005; McGovern *et al.* 2007).

Of note is the apparent diverse character of farming in Mosfellsdalur between Landnám and the mid-12th century. Hrísrú, Mosfell and Skeggjastaðir all benefit from a southerly aspect which may explain the emphasis on hay or cereal cultivation, the latter perhaps inhibited at Skeggjastaðir due to altitude (c. 118 m). Although at a lower altitude (c. 97 m) Helgadalur is surrounded by the Grímmannsfell range to the east, south and west which is likely to reduce seasonal and daily exposure to sunlight and thereby making it an unfavourable location for cereal cultivation. Nor is there any evidence of arable farming at Leirvogstunga, despite an altitude of 10 m and potentially favourable aspects. The later economy at Leirvogstunga was linked to the exploitation of the sea and it may be that this was the case for earlier periods (Zori in press). However, it may also be the choice of sampling site that is influencing interpretation. That for Helgadalur is c. 500 m from the medieval archaeological remains while that for Leirvogstunga was derived from a north west facing slope rather than that of a slope facing the south (which is now a housing estate).

6.5 Cereal Cultivation in Mosfellsdalur c. AD 871-1226

The poor dispersal ability of *Hordeum*-type pollen lends itself to precisely pinpointing locations where cereals were grown in the past (Tweddle *et al.* 2005). The location of sampling site, standard pollen count and the rapid scanning method are all directed toward capitalising upon this characteristic of the *Hordeum*-type pollen. Nonetheless, neither the

standard pollen count nor the rapid scanning method encountered *Hordeum*-type pollen in the pollen samples for Helgadalur and Skeggjastaðir. The data from Skeggjastaðir seems to be situated within, or close to, an infield that has been interpreted as a hayfield (c. AD 977-1130). This would suggest that the placement of the sampling site was well located in terms of identifying a potential site for cereal cultivation there and that the absence of *Hordeum*-type pollen may be a genuine artefact of the pollen record. The general absence of arable apophytes further supports this. At Helgadalur, the distance of the sampling site from the archaeological remains may be a significant factor in the failure to identify *Hordeum*-type pollen there. Trace values (<1%; Fig. 15) of arable apophytes, *Cerastium*-type and *Capsella bursa-pastoris* could support this possibility. However, a consideration of aspect would suggest that the pollen sampling site was situated in the prime location within Helgadalur for optimum insolation and therefore the best location for detecting cereal type pollen (Pétursdóttir, unpublished thesis).

A comparison of Skeggjastaðir and Helgadalur with the other profiled sites in Mosfellsdalur i.e. Mosfell, Hrísbú and Leirvogstunga, would suggest that the cumulative body of evidence to date indicates that cereal cultivation in Mosfellsdalur was restricted to Hrísbú and probably Mosfell (as discussed in section 2.3) (Erlendsson 2012c, Erlendsson 2014; Erlendsson *et al.* in press). The inconclusive character of the Mosfell data could potentially be resolved via the application of the rapid scanning method to samples from this site. These two sites are also situated in relative close proximity to each other and are centrally located in the valley with a south facing aspect that allows for the maximum potential for seasonal and diurnal sunlight; a prime requirement for cereal production (Pétursdóttir, unpublished thesis). Leirvogstunga remains a candidate for cereal cultivation due to its altitude and access to sunlight. However, the limited presence of *Hordeum*-type pollen (possibly *Leymus arenarius*), despite the application of both the standard count and rapid scanning methodology, and lack of arable apophytes, argue against this. Zori *et al* (2013) argue that the presence of *Hordeum*-type pollen in association with cereal grains found within the skáli at Hrísbú are further evidence that Hrísbú was a site of high status. Now that five sites in Mosfellsdalur have been investigated for *Hordeum*-type pollen, with only Hrísbú providing a complete suite of evidence indicative of cultivation, it would appear that this inference may hold true.

Chapter 7: Conclusion

The period under investigation, c. AD 871-1226, essentially belongs to a prehistoric milieu in the Icelandic context. As a consequence, evidence of cereal cultivation during the years of Iceland's initial colonisation and the establishment of its society, is largely inferred from later writing (sagas), place names and the interpolation of historical accounts. Cereal grains and other material evidence from archaeological contexts provide a parallel source of inference. However, it has proven difficult to discern whether or not cereal remains are derived from locally grown or imported cereals while the infrastructure attached to cereal production or processing e.g. querns, kilns etc. is equally inconclusive. In contrast, pollen studies are able to shed light on the period in question by providing a contiguous record for a specific location as long as there is a sufficient means of constructing a chronology around the pollen data. This approach is especially effective with regard to cereal pollen as it is relatively easily distinguished by its size and it has a poor capacity for dispersal. Furthermore, there are a suite of proxy indicators that can be deployed in support of the cereal pollen data e.g. plant associates, soil properties and inferred changes in land use via coprophilous fungi and charcoal palynomorphs. This study has sought to deploy these methods in an effort to ascertain whether or not cereal cultivation was restricted to the farmstead of Hrísrú during Iceland's "prehistoric" period. The chronological framework was constructed around a suite of tephra layers of known origin and date.

Standard pollen counts found no evidence of *Hordeum*-type pollen at Skeggjastaðir or Helgadalur. Rapid scanning, a method that allows a greater number of pollen grains to be surveyed, also failed to find evidence of *Hordeum*-type pollen at Skeggjastaðir or Helgadalur. On the basis of the results from the two methods applied and the effort to secure a pollen sample sequence from as close as possible to archaeological remains dated to the period under question, *Hordeum*-type pollen does not appear to have been grown at either of the sites investigated. The evidence is supported by a general lack of arable apophytes at the two sites and a consideration of the environmental context within which the two sites are situated i.e. habitats, insolation and altitude. A comparison of these findings with other sites in Mosfellsdalur suggests that cereal cultivation in Mosfellsdalur was restricted to Hrísrú and probably Mosfell. This makes sense on the basis that these sites are situated at a moderate altitude and with the optimum capacity for insolation. This may support the inference that Hrísrú is a site of high status, at least within Mosfellsdalur, during the medieval period if we

accept that cereal cultivation is a correlate along with cattle, a large building, foreign goods, historical references and a church, as has been proposed.

Pollen and soil data from Skeggjastaðir and Helgadalur were also able to provide an indication of the manner in which land was utilised at these locations from Landnám until the early 13th century. Helgadalur seems to have always focussed upon the development of pasture in order to support livestock while Skeggjastaðir seems to have gone from pasture to hayfield and back to pasture based upon the relative proportions of grazing sensitive taxa to that of grazing tolerant taxa. A comparison of the data from these two sites, with that of Mosfell, Hrísbú and Leirvogstunga, suggest that a significant change in agricultural practice occurred in Mosfellsdalur during the mid-12th century which may be linked with changes in the archaeofaunal record in Iceland during this period. The data also conforms to current models of the colonisation process; that it was rapid and that colonists favoured open wetland areas for initial occupation. Furthermore, there is a suite of palynomorph, pollen and soil data for Skeggjastaðir that implies it was settled prior to the conventional date of Landnám c. AD 871 ^{+/-2}. Unfortunately there is no basal tephra available by which to interpolate a date for when this actually happened. The pre-Landnám pollen data for Helgadalur was found to correspond with a proposed woodland expansion in south west Iceland for this period due to climate amelioration.

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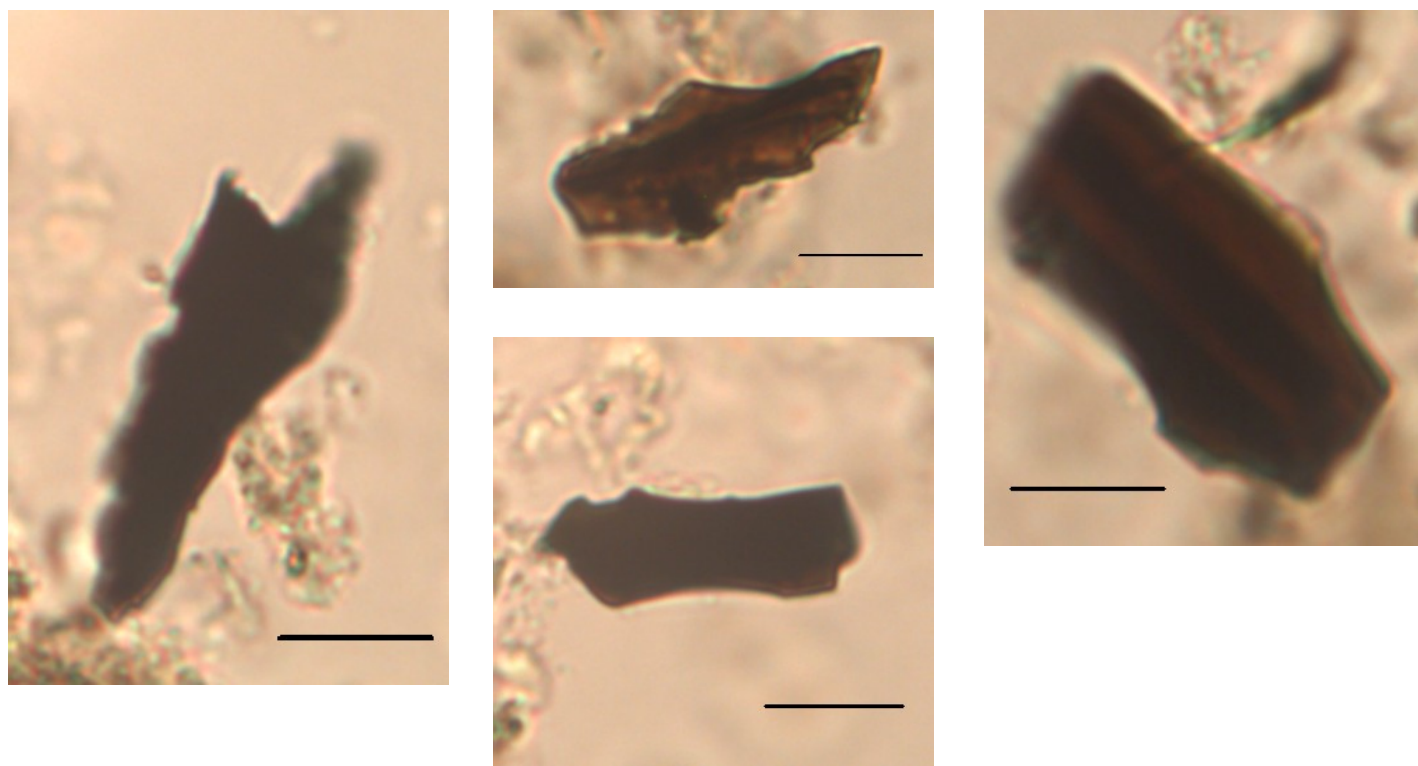
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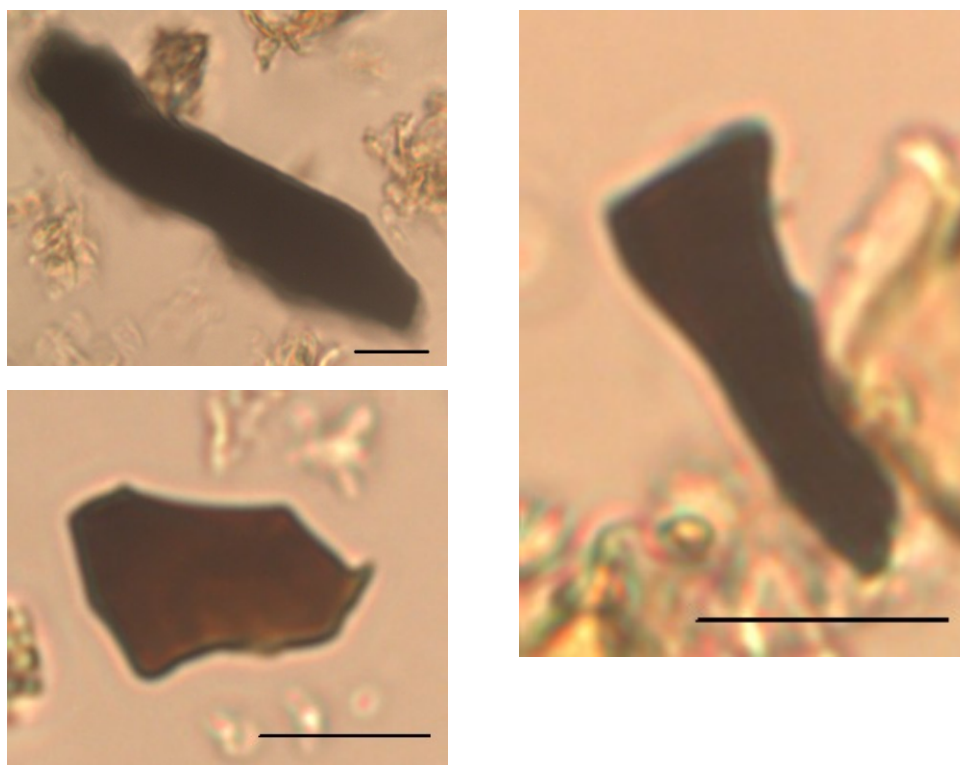
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APPENDIX I.



Charcoal fragments from Skeggjastaðir, depth 41.5-42 cm (scale: 10 μ m).



Charcoal fragments from Skeggjastaðir, depth 47-47.5 cm (scale: 10 μ m).