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# Kirkjubæjarklaustur: a barrel, a midden, and pollen

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# Contents

## 1. Introduction

The following palynological research was commissioned by Professor Steinunn Kristjánsdóttir, University of Iceland, for the Samspil manns og náttúru (Man Before Nature) archaeological project. There are two aspects to the analysis; 1) The analysis of pollen derived from a barrel found within a medieval structure at Kirkjubærklaustur in 2002. These material remains were uncovered during an archaeological campaign led by Dr Bjarni F. Einarsson of Fornleifafræðistofan (The Archaeological Office) between 1995 and 2006. 2) The analysis of pollen from a short sedimentary sequence derived from the medieval strata of a midden at Kirkjubæjarklaustur excavated 2021-2023 by the Man Before Nature archaeological project. With reference to the barrel, the goal of analysis was to utilise pollen data to determine whether or not the barrel and its contents were of local origin or from overseas. With regard to the midden, the primary aim was to determine the character of the local vegetation during the medieval period, with a sub-objective to search for evidence of introduced plant species used for foodstuffs, medicines and industrial processes e.g. dyeing (Kristjánsdóttir et al. 2014; Åsen 2021; Riddell et al. 2023).

## 2. Kirkjubæjarklaustur

Kirkjubæjarklaustur, a town in southeast Iceland, was once the site of a medieval monastery (AD 1186-1543; Kristjánsdóttir 2023). There have been two archaeological investigations at the monastic site in Kirkjubærklaustur since the turn of the millennium. Those overseen by Dr Einarsson uncovered structures and associated material culture dated to the monastic period (Mímisson & Einarsson 2008). Excavations overseen by Professor Kristjánsdóttir have largely been centred upon a midden to the south west of Dr Einarsson's excavations, just beyond the south west wall of the church cemetery (54°6749,94 E, 36°5408,31 N; Jónsson et al. 2022; Jónsson & Kristjánsdótttir 2023). A review of historical documents suggests that the nuns' incumbent at Kirkjubæjarklaustur in the medieval period were heavily engaged in textile production and among the assets belonging to the monastery were a particularly large number of sheep, with obvious implications with regard to vegetation and land use (Kristjánsdóttir 2023).

## 3. The Barrel

In 2015, bulk sample material from the Kirkjubæjarklaustur excavations of 1995-2006 was delivered to Dr Scott Riddell, Dept. of Geography, University of Iceland. In a box labelled "Sýni 04" were a number of bulk samples associated with a barrel found *in situ* within what is believed to have been the medieval monastic complex (Fig. 1 & Table 1). Those samples labelled A, F, G, H & M10 were described as from within the barrel while B was derived from within the immediate vicinity of the barrel. Most of the sample bags did not feature a collection date, but F and M10 were dated to 2002 and it is assumed that the other samples relating to the barrel share this date. The conditions under which the bulk samples were stored prior to delivery to the Dept. of Geography is unknown. From 2015, the samples were stored in dry conditions (not temperature controlled) in Askja. Details pertaining to the archaeological context in which the barrel was found are described in Mímisson & Einarsson (2002).

**Fig. 1:** The *in situ* remains of the barrel from Kirkjubæjarklaustur.

**Table 1:** Descriptions of bulk samples associated with the barrel from Kirkjubæjarklaustur.

| Sample | Bulk Sample Description (2002) | Bulk Sample Description (2023) |
|---|---|---|
| A | Fibre from inside of the barrel, close to the base. | Remains of wood and bark. |
| B | Wadding found close to the barrel. | "Wadding" implies a material used to pack a gap or hole, usually cloth, but can be plant or mineral. This material is not cloth, and seems to be a mineral soil (clay and silt) incorporating bits of bone and possibly fragments of plant material. If a clay, it may have been used to seal the barrel and make it watertight. On general inspection, the soil appears to be indigenous to Iceland (andosol). |
| F | Remains of the bottom of the barrel. | Material included twigs (1 cm diameter, 2 cm long) |
| G | Sample from the base of the barrel. | Material included twigs (*Betula*, ≤0.5 mm diameter, 2 cm long). |
| H | From base of barrel. | |
| M10 | From within barrel. | Bone and plant fragments. |

## 4. The Midden (KBKL-C)

Ceramic material derived from midden Area B (no context) has been dated to the medieval period thus suggesting that the midden contains strata potentially contemporary with the monastery (Jónsson et al. 2022). During field excavations in the summer of 2023, it was realised that the core taken from the midden in 2022 (Area B; KBKL-A) may have been cut through a former turf wall extending from Area A to Area B, thereby compromising both the integrity of the sedimentary sequence and the pollen assemblage contained within (Riddell 2022). Therefore, another core (KBKL-C: ISJ3823) was taken from the eastern section of area B, avoiding the turf wall (Fig 2. & Table 2). The topmost end of the core is from 100 cm, the lowermost at 218 cm (at the water table), with the section 0-100 cm excluded due to its friable, sandy, nature (and also unlikely to harbour well preserved pollen suitable for analysis).


**Fig. 2:** Extraction of core KBKL-C (ISJ3823) from the midden (Area B, east section), Kirkjubæjarklaustur. Note presence of volcanic ash layer thought to be derived from the Öræfajökull eruption of AD 1362.

**Table 2:** Field description of eastern section of midden Area B from which KBKL-C (ISJ3823) was extracted.

| Depth (cm) | Description | Note |
|---|---|---|
| 0-19 | brown andosol | |
| 19-20 | course, dark, grey, tephra | |
| 20-22 | brown andosol | |
| 22-100 | windblown sand and andosol (banded) | From $17^{th}$ century? |
| 100-161 | iron pan | Contains cultural material. |
| 161-217.2 | cultural layers (midden) | |
| 217.2-217.4 | tephra layer | Ö 1362? |
| 217.4-218 | cultural layers (midden) | Midden continues below 218 cm. |

The vegetation in the immediate vicinity of the midden is currently comprised of a rank, unimproved grassland (Poaceae) incorporating *Alchemilla vulgaris*, *Equisteum* sp., *Galium verum*, *Potentilla anserine*, *Ranunculus acris*, *Rumex acetosa* and *Salix* spp. *Betula pubescens* (downy birch) growing in the nearby cemetery overhangs the excavation area. A defunct livestock fence enclosing the area suggests that it may have been grazed until fairly recently, and there are drainage features i.e. a culvert at the junction of Skríðuvellir and Klausturvegur.

# 5. Methods & Results

## 5a. Sedimentology (KBKL-C)

A detailed soil description is provided for KBKL-C (Table 3) based upon Troels-Smith as adapted by Aaby and Berglund (1986). This represents an estimate of the organic and minerogenic content of the strata, supplemented further by a consideration of colour (Munsell Soil Color Charts, 2009). The aim of this exercise is to identify tephra layers by which to define the chronology of the sediments containing pollen (Thorarinsson, 1944).

## 5b. Chronology (KBKL-C)

A single tephra situated at 217.2-217.4 cm in the KBKL-C core has nominally been attributed to the eruption of Öræfajökull in AD 1362 (Fig. 2). A sample of this tephra was cleaned of humic material (10% NaOH) and sieved (63 µm) in preparation for geochemical analysis. The results of the analysis will be supplied in a separate report by Dr Solveig Beck (Fornleifastöfnun Íslands). An overview of the tephra layers encountered by the Man Before Nature archaeological project at Kirkjubærklaustur can be found in Sigurgeirsson (2023).

## 5c. Palynology (Barrel & KBKL-C)

Six sediment layers from KBKL-C (between 212-218 cm) and six of the bulk samples derived from the barrel (Table 1) were sub-sampled for pollen analysis. The volume of the sub-samples was determined by displacement in HCl (Bonny 1972). One lycopodium tablet (Batch No. 050220211) was added to each sub-sample as a control necessary to calculate palynomorph concentrations (Stockmarr 1971). Humic material and residual glue from the tablets was removed following Moore et al. (1991), with minerogenic material removed via dense media seperation (Nakagawa et al. 1998). Extraneous organic material was removed via acetolysis (Moore et al. 1991). For the midden samples, a minimum of 300 pollen grains were counted. Where Poaceae was found to be dominant, counting continued until a minimum of 100 non-Poaceae-type pollen were counted, values expressed as a percentage of Total Land Pollen (TLP; Fig. 3). This was done to ensure that a sufficient range of pollen taxa are identified to aid interpretation (Erlendsson 2007). For the six samples from the barrel, a simple list of pollen taxa was compiled via rapid scanning (Table 4. Tweddle et al. 2005). In both cases, the identification of palynomorphs followed Moore et al. 1991, with pollen and spore nomenclature adjusted to reflect Icelandic circumstances (Erlendsson 2007; Kristinsson 1986).

Poaceae were scrutinised for features characteristic of cereal taxa (Andersen 1979; Table 5). The identification of coprophilous fungal spores (CFS) as an indicator of livestock presence followed Cugny et al. 2010 and van Geel et al. 2003 (Davies 2019; Edwards et al. 2021).

Table 3: Sediment description for KBKL-C. featuring strata (86-186 cm depth) from which pollen and tephra samples have been extracted.

| Depth (cm) | Sediment (after Troels-Smith) | Colour (after Munsell) | Note |
|---|---|---|---|
| 100–102 | n/a | n/a | upper 2 cm broken off |
| 102–105 | As/Gs | 10YR 2/1 black | material fragmenting, silt (yellowish mottling) |
| 105-107 | Gs | | tephra (red, iron) |
| 107–113.5 | As/Gs | 10YR 2/2 black | material fragmenting, silt (yellowish mottling), iron pan (red), bone flecks, |
| 113.5–114 | Gs | | tephra (dark grey) |
| 113–128 | As/Gs | 10YR 2/2 very dark brown | silt (yellowish mottling), iron pan (red), bone flecks |
| 128–130 | Gs | | tephra (dark grey) |
| 130–146 | As/Gs | 10YR 2/2 very dark brown | silt (yellowish mottling), iron pan (red), bone flecks |
| 146–148 | As | 2.5YR 4/8 red | clay, iron pan (red) |
| 148–149 | Gs | | tephra (dark grey) |
| 149–161 | Ag | 5YR 4/3 reddish brown | silt, iron pan, *equisetum* |
| 161–166 | Ag | 7YR 2.5/1 black | silt, iron pan (red) |
| 166–166.5 | Ga | | tephra (black) |
| 166.5–173 | Ag | 5YR 2.5/1 black | silt (yellowish mottling), iron pan (red) |
| 173–174 | Ga | | tephra (black) |
| 174–184 | Ag | 5YR 2.5/1 black | silt (yellowish mottling) |
| 184–187.5 | As | 5YR 4/6 yellowish red | clay (red turf) |
| 187.5–191 | Ag | 7.5YR 2.5/3 very dark brown | silt |
| 191–191.8 | As | 7.5YR 4/3 brown | clay |
| 191.8–192 | Ga | | tephra (dark grey) |
| 192–208.1 | Ag | 7.5YR 2.5/3 very dark brown | silt, charcoal flecks |
| 208.1–208.3 | Ga | | tephra (black) |
| 208.3–211.5 | As/Ga | 5YR 3/3 dark reddish brown | silt/sand (tephra?), charcoal flecks |
| 211.5–215 | Ag | 2.5YR 2.5/3 dark reddish brown | silt, iron pan mottling (red) |
| 215–217.2 | Ag | 10YR 2/1 black | silt |
| 217.2–217.4 | Ag | | Öræfajökull (Ö 1362) |
| 217.4–218 | Ag | 10YR 2/1 black | silt |

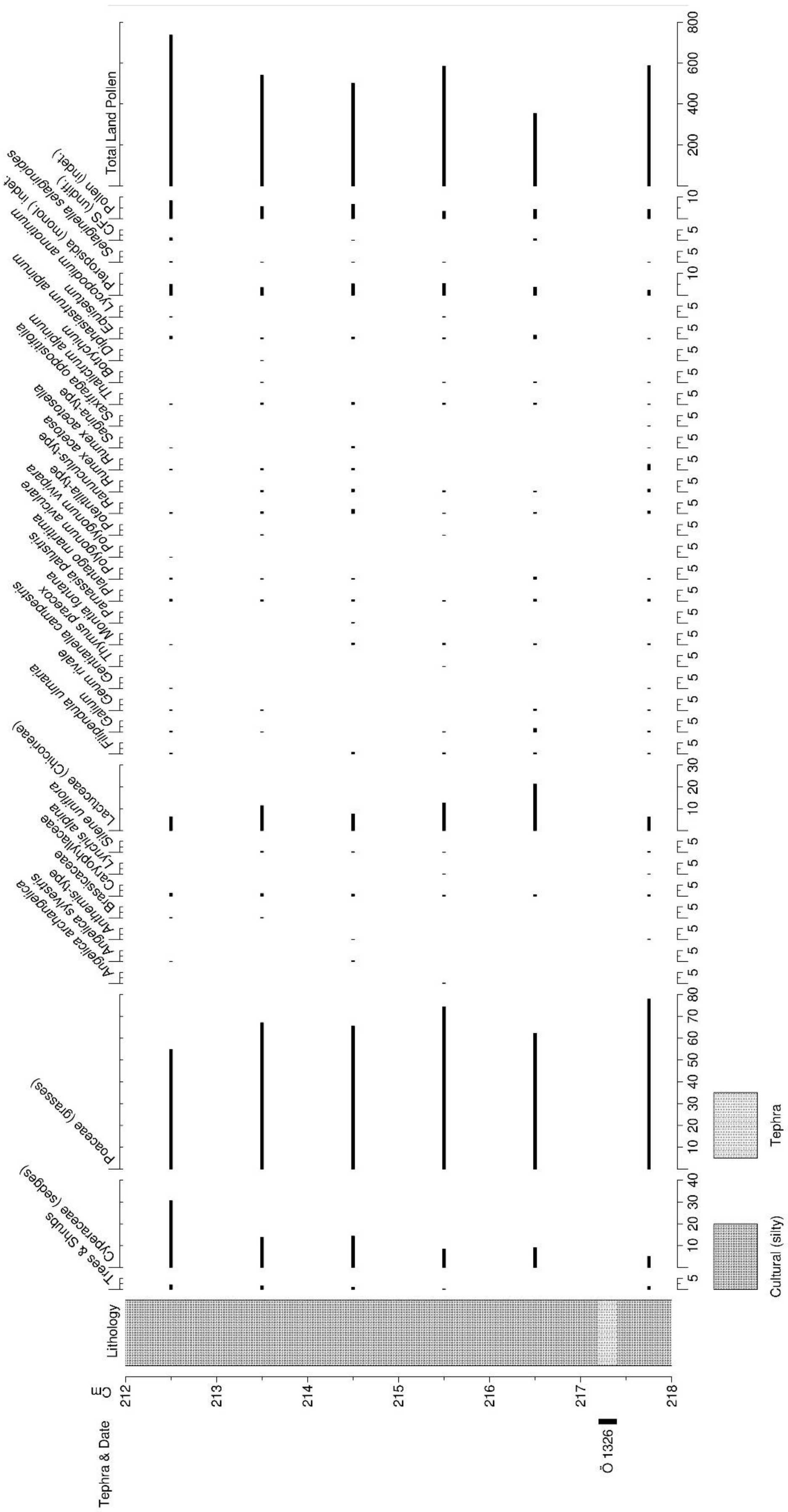


Fig. 3: Pollen percentage values for KBKL-C (212-218 cm).

**Table 4.** Pollen and spore taxa sub-sampled from the Kirkjubæjarklaustur.

| **Pollen taxa/Sample** | **A** | **B** | **F** | **G** | **H** | **M10** |
|---|---|---|---|---|---|---|
| **Pollen number** | 34,336 | 8,280 | 7,784 | 28,392 | 9,952 | 4,164 |
| *Alchemilla* | ● | ● | | ● | ● | |
| *Angelica sylvestris* | ● | ● | | | ● | |
| *Anthemis-type* | | ● | | | ● | |
| *Armeria maritima* | | | | ● | | |
| *Avena*-type | | | ● | ● | | |
| *Betula* (undiff.) | ● | ● | ● | ● | ● | ● |
| *Betula* (hybrid) | | | ● | ● | ● | ● |
| *Calluna vulgaris* | | ● | | ● | ● | |
| *Caltha palustris* | | ● | ● | | | |
| Brassicaceae | ● | ● | ● | ● | ● | |
| Caryophyllaceae | ● | ● | ● | ● | ● | ● |
| *Cerastium*-type | ● | ● | ● | ● | | |
| Cyperaceae | ● | ● | ● | ● | ● | ● |
| *Empetrum nigrum* | | ● | ● | | ● | |
| *Filipendula ulmaria* | ● | ● | ● | ● | ● | ● |
| *Galium* | ● | ● | ● | ● | ● | ● |
| *Geranium* | | | ● | | | |
| *Geum rivale* | ● | ● | ● | ● | ● | ● |
| *Hordeum*-type | | | ● | ● | | |
| Lactuceae (Chicoriodeae) | ● | ● | ● | ● | ● | ● |
| *Lychnis alpina* | ● | ● | ● | ● | | |
| *Thymus praecox* | ● | | ● | ● | ● | ● |
| *Menyanthes trifoliata* | | ● | | | | |
| *Montia fontana* | ● | ● | ● | | ● | ● |
| *Parnassia palustris* | ● | ● | ● | ● | | ● |
| *Picea* | | ● | | | | |
| *Pinus* | | | | | | ● |
| *Plantago lanceolata* | ● | ● | ● | ● | | |
| *Plantago maritima* | ● | ● | ● | ● | ● | ● |
| Poaceae | ● | ● | ● | ● | ● | ● |
| *Polygonum aviculare* | ● | ● | ● | ● | | ● |
| *Polygonum vivipara*) | ● | ● | ● | ● | ● | |
| *Potentilla*-type | ● | ● | ● | ● | ● | ● |
| *Ranunculus-type* | ● | ● | ● | ● | ● | ● |
| Rosaceae | ● | | | | ● | |
| *Rumex acetosa* | ● | ● | ● | ● | ● | ● |
| *Rumex acetosella* | ● | ● | ● | ● | ● | ● |
| *Sagina-type* | ● | | ● | | ● | |
| *Salix* | ● | ● | ● | ● | | ● |
| *Sedum* | ● | | | | | |
| *Silene uniflora* | | | | | ● | |
| *Sorbus aucuparia* | ● | ● | | | | |
| *Thalictrum alpinum* | ● | ● | ● | ● | ● | ● |
| *Vaccinium*-type | | ● | ● | | | |
| **Spores** | | | | | | |
| *Blechnum spicant* | ● | ● | | | | |
| *Botrychium* | | ● | | | | |
| *Diphasiastrum alpinum* | ● | | | ● | | |
| *Equisetum* | ● | ● | ● | ● | ● | |
| *Isoetes* | | | | | ● | |
| *Lycopodium annotinum* | | ● | | ● | ● | ● |
| *Pteropsida* (monolete) indet. | ● | ● | ● | ● | ● | ● |
| *Selaginella selaginoides* | ● | ● | ● | ● | ● | ● |
| *Sphagnum* | | | | | | ● |
| **CFS** | | | | | | |
| *Podospora* | ● | ● | ● | ● | ● | |
| *Sordaria*-type (HdV 55a) | ● | ● | ● | ● | ● | ● |
| *Sporomiella*-type (HdV 113) | ● | | ● | ● | ● | |

Table 5. Pollen grains from the barrel from Kirkjubæjarklaustur featuring *Hordeum*-type and *Avena*-type characteristics (Andersen 1979).

| Sample | Annulus ≥8 µm | Grain size ≥37 µm (*Hordeum*-type) | Grain size ≥45 µm (*Avena*-type) |
|---|---|---|---|
| F | 8 | - | 48 |
| F | 5 (partially obscured) | - | 47 |
| G | 8 | - | 61 |
| G | 8 | 39 | - |
| G | 8 | - | 45 |
| Average | 8 | 39 | 50.5 |

# 6. Discussion

## 6a. The Barrel

The barrel was described as virtually intact when it was excavated in 2002 (Fig. 1), and that the sediments within had been protected by later deposits (Mímisson & Einarsson 2002). As such, the barrel may have formerly functioned as a pollen trap, the pollen assemblages interred in the sediments contemporary with the vegetation in the immediate area of the building that housed the barrel when it was in use. The assumption is that the palynological assemblages sub-sampled from the bulk samples have not been compromised by older pollen originating from burnt peats or later redeposited sediments (Tables 1 & 4; Riddell et al. 2023); although it is worth bearing in mind that the barrel is associated with culverts and another vat as part of dairying, dyeing or tanning activity (Mímisson & Einarsson 2002, pp. 13-16). As the pollen assemblages were derived from within a barrel (except for B) inside a building (inc. B), there is the further assumption that this has limited the potential for far-travelled pollen to influence said pollen assemblages (Edwards et al. 2015). However, it is clear from the presence of *Piceae* (B) and *Pinus* (M10) that this is not a given (although neither are unusual in Icelandic pollen assemblages). In terms of preservation, the condition of the pollen and spores was generally good between the sub-samples except for M10, where the pollen grains appeared more degraded. Unfortunately, there is no sequence to the bulk sampling of sediments from the barrel, with most described as from the base (Table 1). Therefore, only a general impression of the local vegetation near Kirkjubæjarklautur in the medieval period can be inferred from these pollen assemblages.

Overall, the sub-samples derived from the barrel provided a list of forty-five pollen taxa, nine spore taxa, and three types of CFS, with little differentiation between pollen assemblages (Table 4). All of the pollen assemblages were dominated by Poaceae pollen with the other pollen taxa suggestive of indigenous vegetation communities associated with dry (e.g. *Galium*, Lactuceae, *Plantago lanceolata*, *Ranunculus*-type, *R. acetosa*) and damp (e.g. *Caltha palustris*, *Geum rivale*, *Montia fontana*) grassland habitats (Kristinsson 1986). This interpretation may be skewed slightly as hay (Poaceae) was used to line the pit that the barrel was situated in (Mímisson & Einarsson 2002, pp. 13-16). Nonetheless, said hay was presumably from within the immediate area of the monastery.

Similarly, the occurrence of hybrid *Betula* pollen grains (F, G, H & M10) would suggest that both *B. nana* (dwarf birch) and *B. pubescens* were present in the area, the latter verified somewhat with *Betula* pollen grains of up to 27 µm in size (Karlsdóttir et al. 2007). However, the remains of twigs and branches comprised some of the bulk material in samples A & F, while *Betula* twigs were specifically identified within bulk sample G, all of which might provide a source of *Betula* pollen (Table 1). Speculatively, and drawing upon Mímisson & Einarsson (2002, pp. 13-16), it is possible that *Betula* played a part in whatever process the barrel remains were a part of e.g. tanning (Klokkernes 2008).

Another feature of the pollen assemblage are taxa that can be associated with disturbed soils e.g. *Cerastium*-type, *L. alpina*, *Polygonum aviculare*, *Rumex acetosella*, *Sagina*-type, *Silene uniflora* (Kristinsson 1986). This group might also include *Anthemis*-type which in Iceland is represented by four anthropochores (*Tripleurospermum maritimum*, *Leucanthemum vulgare*, *Achillea millefolium*, *Achillea ptarmica*; Edwards et al. 2021), taxa associated with grasslands, cultivation, gardens, curtilage, spoil heaps etc. (Kristinsson 1986). Such indications of disturbed ground may be derived from domestic animals trampling or poaching ground wherever they routinely walk or gather i.e. a dairy, which has been mooted as another possible use for the building in which the barrel was found (Mímisson & Einarsson 2002, pp. 13-16). The CFS confirm the presence of livestock (Cugny et al. 2010; van Geel et al. 2003).

In further relation to taxa associated with disturbed ground, there are a few *Hordeum*-type and *Avena*-type pollen grains among the Poaceae in assemblage's F and G which might suggest cultivation at Kirkjubæjarklaustur (Table 4 & 5). However, only one of these can definitively be described as *Hordeum*-type while the remainder feature characteristics of both *Hordeum*-type (annulus) and *Avena*-type (grain size). Furthermore, it is difficult to separate these pollen-types from the indigenous grass *Elymus arenarius* which is likely to have always been common in the area due to repeated jökullhlaups (glacial floods) and associated alluvial deposits (Kristinsson 1986; Riddell et al. 2023).

Ericaceous taxa are present in the assemblages (e.g. *Calluna vulgaris*, *Empetrum nigrum* and *Vaccinium*-type), but only nominally, and at times are completely absent (A, M10) implying that heathland-type habitats were not found in the vicinity of the monastery.

## 6b. The Midden (KBKL-C)

The KBKL-C samples were harvested from immediately below and above the Ö 1362 tephra layer (between 212-218 cm), placing them in or around the 14$^{th}$ century (subject to geochemical analysis). In total, thirty-three pollen taxa, six spore taxa and two CFS taxa were identified in the KBKL-C core pollen assemblages (Fig. 3). That there is less diversity in the midden pollen assemblages compared with those of the barrel (Table 4) is because the different methodologies applied results in a greater number of palynomorphs being examined for the barrel samples. The bulk of the pollen is most likely local and/or regional in origin, with pollen from far flung quarters limited (Hättestrand et al. 2008); there are no exotic taxa in any of the six pollen assemblages (Fig. 3). The condition of the pollen is generally good, with indeterminate pollen grain values lower than 5% below 214.5 cm, and no greater than 8% at 212.5 cm (Fig. 3). Increasing values in this instance are probably a consequence of increased TLP (Fig. 3).

With reference to Fig. 3, it can be said that the landscape in the vicinity of the monastery was dominated by Poaceae (55-78%) i.e. grassland, during the time period under investigation. Tree and shrub taxa i.e. woodland and heathland, are virtually absent from the pollen record while Cyperaceae values (indicative of wetland) only latterly rise to 30% (212.5 cm). Lactuceae are the next well-represented pollen taxa (up to 21%), in Iceland a tribe of plants comprised of *Taraxacum* and *Hieracium* genera that are all associated with grassland. Other grassland taxa present in the KBKL-C pollen assemblages include *Alchemilla*, *Botrychium*, *Gentianella* *campestris*, *P. lanceolata*, *Plantago maritima*, *R. acetosa* and *Selaginella selaginoides*, while *Angelica archangelica*, *Angelica sylvestris*, *Filipendula ulmaria*, *G. rivale* and *M. fontana* suggesting grassland where ground conditions might be damp. It might also be inferred from the presence of Lactuceae, *Alchemilla*, *A. archangelica*, *A. sylvestris*, *F. ulmaria*, *G. rivale* and *Ranunculus*-type that there is an absence of grazing i.e. a hayfield. This inference is supported by very low CFS values of <1.5% (*Sordaria*-type HdV-55a and *Podospora*-type HdV-368) values (Davies 2019).

Taxa particularly associated with disturbed ground are also present in the pollen assemblages (*Anthemis*-type, *L. alpina*, *P. aviculare, R. acetosella* and *Sagina*-type). The most likely reason is the archaeological context i.e. the KBKL-C core is derived from a midden. The repeated deposition of domestic waste over the years will have provided a nutrient rich, exposed soil surface, free of competitors, into which plants adapted to such conditions could establish themselves.

While it is difficult to extrapolate any long term patterns from only six samples (Fig. 3), it is perhaps of note that Cyperaceae does increase (30%) at the expense of Poaceae (55%) in the most recent KBKL-C sample (212.5 cm). This suggests a shift toward wetter ground conditions in the vicinity of the midden, perhaps related to changes in land management or tenuously, a cooler, wetter, climate regime.

## 8. Conclusion

There is a strong degree of parity between the barrel and the midden pollen assemblages in relation to grassland and disturbed ground in the immediate vicinity of Kirkjubæjarklaustur (Table 4 and Fig. 3). This is almost definitive with regard to the interpretation of the midden pollen assemblages, which also suggest that said grassland was managed as a hayfield (arguably upheld by the archaeological context of the barrel and its association with hay). Based upon two pollen assemblages from the barrel (Table 5), there is a very slight possibility that cereals were cultivated at Kirkjubæjarklaustur, but there are difficulties in separating the cereal-type pollen from indigenous grass species (Riddell et al. 2023). Pollen taxa characteristic of disturbed ground in the barrel are probably derived from farm curtilage, while those derived from the midden are probably derived from plants establishing themselves on the midden itself. No exotic taxa that harbour human utility were discovered in any of the assemblages although there are indigenous taxa that might e.g. the angelica's and *F. ulmaria* (Kristjánsdóttir et al. 2014; Åsen 2021; Riddell et al. 2023). Finally, there is scope to build upon this pollen analysis by extracting more samples from the KBKL-C core, but only if a more rigorous chronology can be established.

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