Human Impact at Tjørnuvík in the Faroe Islands

Mannaárin í Tjørnuvík í Føroyum

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Úrtak

Fyrsta búseting í Tjørnuvík er tíðarfest av nýggjum til 1270 ± 60 BP við AMS-mannagongd til at kanna makrosteinrenningar av jarðplantum úr eini 3 mm áløgu. Tey fornplantufrøðiligu prógvini eru hesi: týðulig øking av makrosteinrenning av illgresissløgum, flogsáð av *Hordeum*-kornsløgum varð funnið, flogsáð av kjarri og Cyperacea minkað í nøgd og flogsáð av Gramineae er vaksið í nøgd. Hetta bendir á, at jørðin hevur verið velt, og á stórar broytingar í gróðrinum. Tað ber tó illa til at gera neyva tíðarfesting, tí ein kolevni-14 plateau er frá somu tíð. Kalibreraður aldur er miðskeiðis í 8. øld e.Kr. (aldur millum 675-861 e.Kr. 1 σ frávik), og tí er torført at tíðarfesta við kolevnis-metoduni eina. Fleiri ørsmáir tefrajaðarar vórðu sæddir oman fyri búsetingarjaðaran. Teirra millum minst eitt jarðevnafrøðiliga definerað brot av basaltskiftinum í tí sonevndu »landnáms«tefruni. Fleiri tefrur frá niðursetutíðini eru jarðevnafrøðiliga staðfestar í ískjarnum í Grønland, og tað skuldi økt møguleikarnir fyri at tíðarfesta landnámið neyvari.

Abstract

The first settlement at the village at Tjørnuvík has been re-dated to 1270 ± 60 BP, using AMS techniques on terrestrial plant macrofossils from a 3 mm sediment sample. The palaeobotanical evidence for settlement is a significant increase in macrofossils of weed species, appearance of *Hordeum*-type cereal pollen, decrease in shrubs and Cyperaceae and increase in Gramineae pollen. These indicate crop cultivation as well as a major shift in the local vegetation. The exact dating of this phase however, is hampered by the coincidental occurrence of a radiocarbon plateau. The calibrated age range in calendar years, is in the mid AD 700s (age range AD 675-861, 1 σ variation), making high resolution dating of this event difficult using the radiocarbon method alone. Several microscopic tephra horizons were observed above the settlement horizon. These included at least one geochemically defined shard from the basaltic phase of the so called 'Landnám' tephra. Several tephras occurring around the time of settlement have been geochemically identified in the Greenland Ice Cores and have the potential of increasing the dating precision of this important event.

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Introduction

The divergence between the historical dates for the earliest settlement in the Faroe Islands (AD 825)(Debes, 1990) and radiocarbon dating of the first cereal cultivation (AD 600-700s) (Jóhansen, 1971; 1985; Hannon and Hermanns-Auðardóttir, 1996; Hannon, 1997) has caused intense discussion as to which is the more reliable source of information. Debate has focused on the original palaeobotanical studies (Jóhansen, 1971; 1985) and doubts have been raised about the radiocarbon evidence such as the inherent inaccuracy of bulk dates (Arge, 1991), and the possibility of a local dilution of the atmospheric ^{14}C concentration due to depleted oceanic air masses (Olsson, 1983; 1990). The reliability of cereal pollen grain identification has been questioned (Arge, 1991), and it has been considered surprising that the fossil insect evidence for early settlement is not detected from the horizon in which the first cereals were recorded at recorded at Tjørnuvík, one of Jóhansens (1971; 1985) early settlement sites (Buckland, 1990).

The recognition of human activity on the landscape can be problematic, as these islands may have been predominantly treeless during the Holocene. However, the potential impact is large because of the fragility of the ecosystems. In this paper, we define permanent settlement as meaning pollen evidence for cereal crop cultivation, associated with their characteristic suite of weed species defined by macrofossil remains. As part of a multidisiplinary project called 'Settlement and Chronology in the North Atlantic region' (Hermanns-Auðardóttir, 1993), high resolution pollen and macrofossil sampling has been carried out from a series of sites in order to establish the settlement horizon using a combination of techniques. Having achieved that, the next tasks were (1) to extract sufficient terrestrial plant macrofossil remains to redate the settlement horizon using the high resolution AMS radiocarbon techniques now available, and to compare with previous dating projects (2) to numerically distinguish large wild grass pollen grains from those of cereals and (3) to see if volcanic ash was associated with the pollen inferred, settlement layer.

A distinctive two-coloured volcanic ash layer originating from the Vatnaöldur fissure in southern Iceland (Zielinski *et al.*, 1997; Larsen, 1984), which itself is partially located within the Torfajökull central volcano, was first described by Thorarinsson as VIIa+b (Thorarinsson, 1944). It is often used as a stratigraphic marker because of its close association with the time of the first permanent settlements on Iceland (Hallsdóttir, 1987) and thus has been named the 'Landnám' tephra. Tephras are valuable, synchronous time marker horizons, and have distinctive chemical characteristics. If located within a sediment sequence, they can provide an independent dating control to the radiocarbon or historical evidence. The 'Landnám' tephra has been chemically finger-printed in Iceland (Hafliðason *et al.*, 1992; Boygle, 1994) and geochemically identified in the Greenland Ice Cores where it has been dated in calendar years to AD 871 ± 2 (GRIP)(Grönvold *et al.*, 1995) and AD 874 ± 4 (GISP2)

(Zielinski *et al.*, 1997). However, a chemically distinct tephra with a calendar age of AD 860 ± 20 has been described from Irish peat (Pilcher *et al.,* 1995). The geochemical analyses of the glass shards from Ireland, which are based on 25 reference points, show it to be distinct from that of the 'Landnám' tephra layer, and so could not have originated from the Vatnaöldur eruption despite the fact that its calibrated age overlaps the ice core age for that event (Zielinski *et al.*, 1997). Furthermore, Zielinski *et al.* (1994) and Zielinski (1995) report another eruption recorded in the summit ice core which covers a two year period, and gives a calibrated age from AD 822 to 823. The source area of this layer is presently unknown, but is thought to be Icelandic (Zielinski, pers. comm. April, 1998).

Numerous eruptions have been described in the written records since the first settlement on Iceland (Hallsdóttir, 1987; Hafliðason *et al.,* 1992,) and many of these tephra horizons may be present in the Faroe Islands. Volcanic ash layers have been identified by the refractive indices of the glass shards from peat deposits in the Faroe Islands by Persson (1968; 1971). At one of the sites, Mýrarnar on the island of Streymoy, a tephra layer is bulk radiocarbon dated to the calibrated age of AD 850 -1050 (Persson 1968; 1971) and a correlation suggested to the Landnám tephra. A further aim of this work was to see if this could be identified in the sediment sequence examined, in order to increase the dating precision of the settlement horizon. We began by using a new technique for extracting rhyolitic microtephra from minerogenic deposits, developed by Turney (1998).

Methods

Tjørnuvík was chosen as the prime target for investigation, as it was here that Jóhansen (1971; 1985) had described palaeobotanical evidence for early settlement. At the time of his investigations, the total depth of the peat was unknown, as sampling stopped at 250 cm. A series of new probes were made across the peat deposit in the autumn of 1994 to determine the maximum depth. Preliminary pollen samples were taken every 5 cm and counts of *c.* 500 pollen grains were made at each level. The annulus diameter, pore diameter, M+ (largest diameter of a pollen grain), and M- (diameter at a right angle to M+) of all Gramineae pollen grains with an annulus diameter of >8 µm were measured, to separate cereal type pollen taxa from those of large, wild grasses (Andersen, 1979).

Once the area covering the settlement horizon had been identified, a 30 cm section of the core was cut out of the main profile and frozen. This was then sliced while frozen at between 3 and 4 mm intervals using an electric meat slicer. The slices were placed in individual plastic bags and put back in the freezer. Before samples were taken for pollen preparation, the slices were carefully scraped on both sides while frozen, to remove any possible contamination. Pollen samples were prepared for every sample over the settlement horizon, in order to pinpoint for dating purposes, the first instance of cereal pollen.

Plant macrofossils were picked from

each sediment slice after sub-sampling for pollen and washed with distilled water through individual plastic netting (sieve size 180 µm). Determinations were made based on the plant macrofossil collection at the Department of Quaternary Geology in Lund and the first author's own reference collection. After identification, terrestrial plant macrofossils to be used for dating were immediately dried at 50°C overnight in aluminium foil, to eliminate contamination sources arising from being left in distilled water (Wohlfarth *et al.,* 1998). AMS dating was carried out by Steinar Gulliksen at the Laboratory for Radiological Dating, Trondheim, Norway.

Preparation for the density separation technique for concentrating rhyolitic microtephra (25 – 80 µm) from minerogenic deposits followed the procedures as outlined by Turney (1998). The advantage of this new method is that less extensive tephra horizons may be discovered. The study concentrated on invisible tephra horizons from the period before and after the first settlement as identified by pollen analysis. A density of between 2.3 and 2.5 g/cm^3 was chosen, which should pick up most rhyolitic glass shards (Turney *et al.,* 1997).

The percentage weight loss on ignition was carried out at 1 cm intervals at 105°C and 550°C to determine the water and organic content of the sediment. Re-calibration of the bulk radiocarbon dates from Jóhansen (1971; 1985) and Persson (1968;1971) were carried out using the CALIB vers. 3.0.3 (Stuiver and Pearson, 1993). Quantitative microcharcoal counting followed the techniques described by Clark (1982).

Results

Sediments

The maximum sediment depth was 357 cm, and the deepest section beside the flat area where the present village and hayfields now lie. The new sediment profile, taken with a Russian Corer, produced a complete core of 335 cm, of which the section between 165 and 250 cm is shown here. The sediments were mainly peat with much sand. The massive increase of inorganic sediment described in the literature as reflecting Norse Landnám (Buckland, 1990) was not clear in the field in the present study. A layer of almost pure moss, identified as *Calliergon giganteum* and dated to 880±100 BP (AD 1028-1276; 1 σ variation; CALIB vers. 3.0.3; Stuiver and Pearson, 1993) in Jóhansens original study, was visible between 193 and 195 cm, along with a thick, unsorted gravel layer between 233.5 and 245 cm also identified by Jóhansen (1971; 1985). Other thinner layers of sorted material were also visible, and are thought to have been deposited by the small river in the centre of the flat area in times of flood. While slicing the core section between 205 and 235 cm, a change was noticed in the nature of the sediment between 223 and 224.3 cm which again had not been visible in the field. The sediment became much more gritty in texture and the pollen concentration was too low to allow a pollen count. There was a marked increase in organic matter above 217 cm, rising from 11.9% to 20.7%. Microcharcoal was first

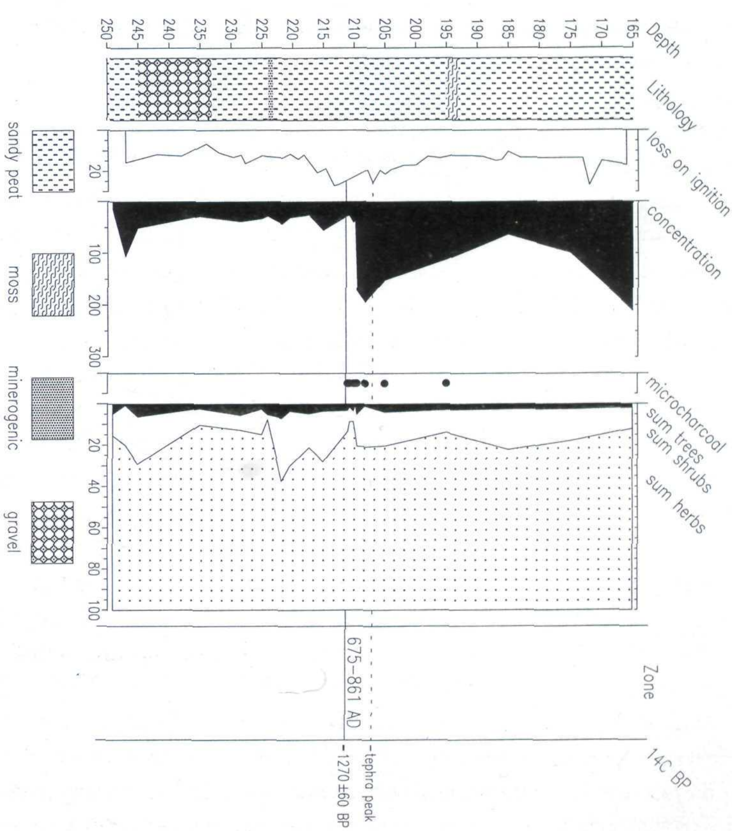

Fig. 1. Summary diagram of the lithology, % weight loss on ignition (organic content), total pollen concentration, microcharcoal area and percentage sums for trees, shrubs and herbaceous taxa at Tjørnuvík. The AMS radiocarbon date is calibrated using CALIB vers. 3.0.3 (1 σ variation; Stuvier and Pearson, 1993). Total pollen concentration is expressed as grains.cm^{-3} and microcharcoal as cm^{2}.cm^{-3}.
Mynd 1. Yvirlitsstrikumynd av steinfrøðini, vektmissi av kveiking í % (lívrunnum innihaldi), heildarkonsentratión av flogsáð, mikrotrækoløki og taxa av viðar- og kjarrvøkstri og plantum í prosentum í Tjørnuvík. AMS kolevni 14-dagfestingin er kalibrerað við CALIB vers. 3.0.3. (1 σ frábrigdi; Stuvier og Pearson, 1993). Heildarkonsentratión av flogsáð er í korn.cm^{-3} og mikrotrækol í cm^{2}.cm^{-3}

recorded at 211.3 cm. The main sedimentary changes, percentage weight loss on ignition, microcharcoal area, summary profiles for pollen concentration, percentage representation of trees, shrubs and herbs are illustrated in Figure 1.

Vegetation history

The vegetational changes inferred from the pollen and macrofossil analysis are summarised in Table 1. The settlement horizon was recognised by the occurrence of cereal pollen grains of *Hordeum*-type and complemented by identification of macrofossil seeds of weed species that are often associated with cultivation and disturbance. In addition to this, Gramineae soon became the most abundant pollen type. The most common pre-settlement plant groups were wet meadow taxa, mainly Cyperaceae and shrubs. The preliminary pollen diagram indicated that pollen grains >3 μm occurred above 210 cm, but not below 215 cm. When individual 3-4 mm slices of sediment were pollen analysed between 205 and 230 cm, the first occurrence of *Hordeum*-type grains was pinpointed to between 211.3 and 211.6 cm. This was prior to the in-

Depth (cm) below surface	pollen concentration grains.cm^{-3}	Vegetation
165	209,904.6	Dry meadow with abundant Gramineae, *Sagina procumbens Filipendula ulmaria, Montia fontana, Stellaria media, Caltha palustris. Hordeum*-type cereal pollen.
205	151,475.3	Pollen and macrofossil remains of large *Rumex* sp. and Gramineae. Microcharcoal, *Sagina procumbens, Montia fontana, Stellaria media* seeds, *Hordeum*-type cereal pollen with low values of *Calluna.*
209	170,958.0	Marked increase in total pollen concentration. Microcharcoal, increase in *Rumex acetosa, Plantago lanceolata* and *Hordeum*- type cereal pollen along with abundant Gramineae. *Sagina procumbens, Montia fontana,* and *Stellaria media* seeds.
211.3	27,499.4	First instance of *Hordeum*-type pollen and increase in grassland herbs. First records for macrofossil weed species associated with clearance. *Sagina procumbens, Montia fontana, Stellaria media,* large, wild grass pollen and microcharcoal. Decrease in pollen of Cyperaceae and minimum of *Juniperus* and *Calluna.*
220-250	14,216.1	Abundant *Juniperus* pollen (30%) with *Calluna vulgaris* (15%) and Cyperaceae. Wet meadow and herb community includes *Ranunculus, flammula, Hypericum pulchrum, Equisetum palustre, Menyanthes trifoliata, Alchemilla, Filipendula, Succisa, Epilobium, Potentilla* and *Armeria.*

Table 1. *Summary descriptions of the pre- and post-settlement vegetation changes inferred from pollen and plant macrofossils in the present study at Tjørnuvík.*
Talva 1. Yvirlitsfrágreiðingar av plantusamansetingini áðrenn og eftir landnám vístar í hesi grein við plantusáð og -leivdum úr Tjørnuvík

crease in total pollen concentration recorded at 209 cm but after the increase in organic content of the sediments at 217 cm. Large, wild grass pollen types were also first recorded in the same sample, numerical details of which will be published separately. This again confirms the results from the earlier work at this site, where the variation in the large grass pollen grains recorded at settlement were stated to probably include *Leymus arenarius* (Jóhansen, 1971; 1985).

The results of the macrofossil analysis (Table 1), revealed that species associated with clearance and cultivation occurred above 211.3 cm. These included *Montia fontana* and *Stellaria media*, both widespread and common today, and troublesome weeds in newly cultivated fields: *Sagina procumbens*, a species which is abundant on beaten paths and by roadsides and abundant flowers of a large *Rumex* sp. (*R. obtusifolius* or *R. longifolius)*, common near dwellings (Bloch, 1980) together with

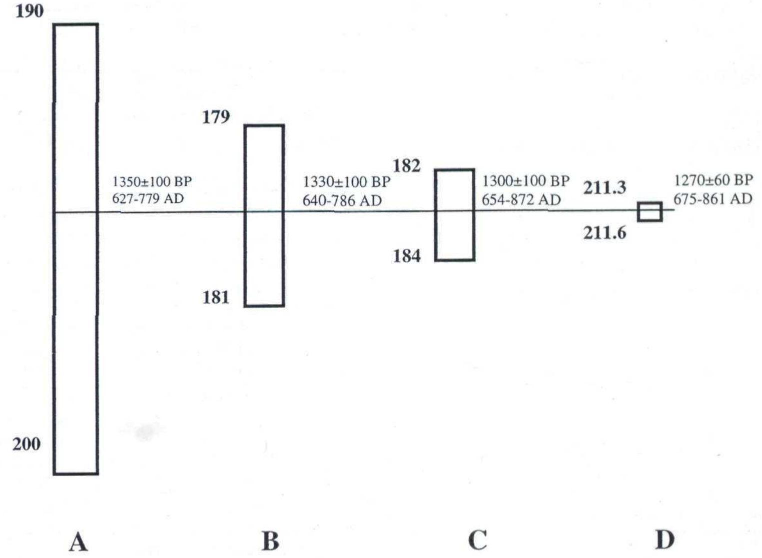

Fig. 2. Recalibrated bulk radiocarbon dates from Tjørnuvík (Profiles A, B and C) (Jóhansen, 1971; 1985) and AMS radiocarbon date of terrestrial plant macrofossils from the present study (Profile D). The central line indicates the settlement horizon as identified by pollen analysis in each profile. Numbers on the left hand side of each profile indicate depth below surface in each bulk sediment section. Profile D indicates sample size from which plant macrofossils were extracted although the sediment itself was not dated.
Mynd 2. Endurkalibreraðar kolevni 14-dagfestingar í Tjørnuvík (Umhvarv A, B og C) (Jóhansen, 1971; 1985) og AMS kolevni 14-dagfesting av makrosteinrenningum av jarðplantum úr hesi rannsókn (Umhvarv D). Miðlinjan vísir búsetingarjaðaran, soleiðis sum hann er ásettur við flogsáðgreiningum í hvørjum umhvarvi. Tøl vinstrumegin hvørt umhvarv vísa dýpd undir yvirflatuni í hvørji áløgudeild í útryðjuni. Umhvarv D vísir støðd á royndum, sum makrosteinrenningar av plantum vórðu tiknar úr, hóast áløgan sjálv ikki varð dagfest.

abundant calyces of Gramineae and seeds of *Caltha palustris*. These species do not occur below the settlement horizon where macroremains of *Menyanthes trifoliata, Ranunculus flammula, Sedum villosum, Hypericum pulchrum* and *Equisetum palustre* predominate.

Dating

Macrofossil material picked for dating the settlement horizon were seeds of *Montia fontana, Sedum villosum, Stellaria media, Silene dioica* and sporangial cones of *Equisetum palustre.* This revealed that the first crop cultivation was at 1270 ± 60 years BP, which when calibrated covers the time period from AD 675-861 (1 σ variation; CALIB vers. 3.0.3; Stuiver and Pearson, 1993), confirming the earlier results at this site; the first permanent settlement, as represented by crop cultivation was earlier than that suggested by the written, secondary sources (Figure 2, Table 2).

Lab no.	Site	Material dated	Author	Depth(cm) below surface	Age BP	Old calibration cal. Years	New calibration 1 sigma	New calibration mid-point
St-2135	Mýrarnar	bulk sediment	Persson 1968;1971	21-23	900±120	1050 AD	1017-1276	1165 AD
K-1699	Tjørnuvík	*Calliergon* moss	Jóhansen 1971;1985	170-175	880±100	1070 AD	1028-1276	1176 AD
K-1700	Tjørnuvík	bulk sediment	Jóhansen 1971;1985	190-200	1350±100	600 AD	627-779	668 AD
K-1787	Tjørnuvík	bulk sediment	Jóhansen 1971;1985	179-181	1330±100	620 AD	640-786	676 AD
K-1788	Tjørnuvík	bulk sediment	Jóhansen 1971;1985	182-184	1300±100	650 AD	654-872	690 AD
TUa-1412	Tjørnuvík	seeds	Hannon 1996;1997	211.3 211.6	1270±60		675-823 838-861	732 AD

Table 2. *Recalibrated bulk radiocarbon dates from Tjørnuvík (Jóhansen 1971; 1985) and from Mýrarnar (Persson, 1968; 1971) together with the AMS date from the present study.*
Talva 2. Endurkalibreraðar kolevni 14-dagfestingar í Tjørnuvík (Jóhansen, 1971; 1985) og á Mýrunum (Persson, 1968; 1971) saman við AMS-dagfestingunum úr hesi rannsókn.

Microtephra

Tephra shards were identified in all samples with a distinct peak in concentration at 207.4 cm, *c.* 3.5 cm above the first settlement as inferred from palaeobotanical data. Most shards are colourless or weak brown, but dark brown basaltic shards were also retrieved. A sample from this level was chosen for microprobe analysis, as the concentration of tephra was too low in samples taken closer to the settlement horizon to allow geochemical analysis. Two rhyolitic populations dominate the sample: The larger consists of glass with SiO_2 content between 65 and 75 %, and exhibits a low TiO content (0.09 – 0.47 %) and a low MgO content (0.03 – 0.58 %) (Table 3). The geochemistry of this tephra shows affinities to the Hekla volcanic system (cf. Dugmore *et al.,* 1995). A second subordinate population is only defined by three analyses so far. It has a SiO_2 content of *c.* 63 %, and distinctly higher TiO and MgO contents than the main population (Table 3). This probably rules out the Hekla volcanic system as source area. A single basaltic shard was analysed which compares well with the geochemical data in the literature for the basaltic phase of the Landnám tephra (Table 4). As we are unable yet, to correlate the rhyolitic tephra results to known horizons on Iceland, or in Ireland or Scotland, we propose that the main population found at Tjørnuvík is called the ***Tjørnuvík A***

	LT	Tjørnuvík A Tephra								Tjørnuvík B Tephra			
Sample	1	2	3	4	5	6	7	8	9	10	11	12	13
SiO_2	48.78	74.60	73.50	73.45	72.16	68.21	67.20	65.57	65.26	65.15	63.63	63.52	63.09
TiO_2	1.83	0.09	0.13	0.14	0.09	0.26	0.45	0.47	0.39	0.38	1.52	1.44	1.42
Al_2O_3	13.32	13.04	13.09	12.99	12.86	14.31	15.00	14.66	14.47	13.85	13.86	13.66	13.89
FeO_{tot}	12.46	2.10	2.07	1.93	2.03	4.25	5.62	5.35	5.48	6.50	6.13	5.99	6.37
MnO	0.24	0.10	0.10	0.10	0.09	0.15	0.20	0.15	0.21	0.21	0.19	0.22	0.22
MgO	7.32	0.09	0.08	0.08	0.03	0.24	0.58	0.52	0.56	0.24	1.51	1.52	1.45
CaO	11.02	1.31	1.34	1.36	1.14	2.73	3.26	3.09	2.97	3.58	3.56	3.42	3.49
Na_2O	2.66	4.00	3.97	4.26	4.21	4.25	4.41	4.10	4.11	3.51	4.28	3.80	4.53
K_2O	0.21	2.80	2.82	2.92	2.74	2.29	2.01	1.90	2.07	1.99	2.65	2.56	2.55
Total (%)	97.84	98.13	97.10	97.23	95.35	96.69	98.73	95.81	95.52	95.41	97.33	96.13	97.01

Table 3. *The chemical composition of individual glass shards from Tjørnuvík, 207.4 cm, determined by electron microprobe. Only analyses with totals above 95% are shown. The preparation for microprobe analysis and subsequent analytical procedures follow Dugmore et al. (1995).*

Talva 3. Tann evnafrøðiliga samansetingin av einstøkum glasbrotum í Tjørnuvík, 207,4 cm, fastsett við elektroniskari mikrosondu. Einans greiningar við heildarúrsliti oman fyri 95% verða vístar. Fyrireikingin til mikrosondugreiningina og eftirfylgjandi arbeiðsháttur fylgja Dugmore *et al.* (1995).

Tephra and the subordinate population the ***Tjørnuvík B Tephra.*** None of the tephra horizons were visible to the naked eye, and were concentrated by the new technique for extracting rhyolitic microtephra from minerogenic sediments (Turney, 1998).

Re-calibration of bulk radiocarbon dates

The re-calibrated bulk radiocarbon dates from Tjørnuvík which are illustrated on Figure 2 and tabulated on Table 2, came from three separate profiles, A, B and C, together with the AMS date from the present study. The purpose of this figure is to illustrate the consistency in the dating results to the late AD 600s, early 700s. The initial date taken from Profile A, was a 10 cm bulk sediment sample. The results were of such significance, that at a later stage, two further profiles were dated: the first of which (Profile B) consisted of a 4 cm, and the second (Profile C), a 2 cm bulk sediment sample. In each case, the settlement horizon had been identified in the middle of the section and the dating results of Profile A were repeated. The AMS radiocarbon date carried out in the present study of terrestrial plant macrofossils extracted from a 3 mm sample, is the most stratigraphically precise. It confirmed the consistent results from the original work (Jóhansen, 1971; 1985).

The result for the re-calibration of the tephra layer to cover this time period from the peat deposit at Mýrarnar on Streymoy (Persson,1968; 1971), reveals that the calendar age of this layer is from AD 1020 –

Source	Thingvallavatn[a] (n = 5)		GISP2[b] (n = 6)		Litlidalur[c] (n = 10)		Tjørnuvík (n = 1)
	Mean	1 σ	Mean	1.σ	Mean	1 σ	
SiO_2	49.94	0.87	52.0	1.4	49.89	0.75	48.78
TiO_2	1.86	0.29	1.5	0.4	2.00	0.33	1.83
Al_2O_3	13.15	0.44	13.8	0.4	13.20	0.25	13.32
FeO_{tot}	12.79	0.49	14.0	1.3	12.54	0.39	12.46
MnO	0.24	0.04	-	-	0.21	0.04	0.24
MgO	6.53	0.24	6.1	0.4	6.40	0.38	7.32
CaO	11.59	0.24	11.0	0.6	10.65	0.53	11.02
Na_2O	2.38	0.16	1.1	0.3	2.63	0.16	2.66
K_2O	0.17	0.15	0.4	0.1	0.31	0.05	0.21
Total (%)	98.87		99.9		97.84		97.84

[a] Hafliðason *et al.* (1992, Table 2)
[b] Zielinski *et al.* (1997).
[c] Boygle (1994, data from Tephrabase, http://www.geo.ed.ac.uk/tephra/tbasehom.html)

Table 4. *The chemical composition of the basaltic phase of the Landnám Tephra from Iceland and Tjørnuvík, determined by electron microprobe. All analyses are expressed as wt%.*
Talva 4. Tann evnafrøðiliga samansetingin av basaltskiftinum í Landnámstefrúni úr Íslandi og Tjørnuvík, fastsett við elektroniskari mikrosondu. Allar greiningar eru endurgivnar sum wt%.

1240 and therefore does not include the tephras in the AD 800s, geochemically defined by Hafliðason *et al.*, (1992), Grönvold *et al.*, (1995), Pilcher *et al.*, (1995) or Zielinski *et al.*, (1997). Table 2 gives the details of sample size, original (published) radiocarbon years BP, the original calibrated estimation and the re-calibration using CALIB vers. 3.0.3 (Stuiver and Pearson, 1993).

Discussion

The palaeobotanical investigations at the site of Tjørnuvík are now complete, and the settlement layer identified by a series of techniques and dated (Table 1; Figure 1). This horizon had to be pinpointed microscopically, as the sediment changes associated with settlement were not clear in the field. The evidence is threefold: (1) There is a significant increase in macrofossils of weed species such as *Montia fontana, Sagina procumbens* and *Stellaria media* that rarely set seed in their native habitats unless repeatedly disturbed (Bloch, 1980) (2) Palaeobotanical analyses revealed a shift in local vegetation conditions from a wet meadow community with tall herbs including Cyperaceae, *Succisa, Potentilla, Alchemilla, Epilobium, Filipendula, Ranunculus flammula, Menyanthes trifoliata, Hypericum pulchrum and Equisetum palustre* together with shrubs such as *Juniperus, Calluna* and *Salix,* to a dry grassland with associated macrofossil weed species including *Stellaria media, Montia fontana,* *Sagina procumbens*, a large *Rumex* sp. (*R. obtusifolius* or *R. longifolius*) and Gramineae which is likely to be as a consequence of the laying out of hay fields in addition to crop cultivation, as suggested by Jóhansen (1971; 1985) (3) Recovery of *Hordeum*-type pollen at the same time as large wild grass pollen grains, and associated with microcharcoal (<30 µm). Together these results indicate permanent settlement, introduction of anthropogenic plants, clearance and crop cultivation. In addition, the increase in pollen concentration at 209 cm is likely to also be an indirect consequence of human impact. This may be as a result of depleted vegetation on the slopes surrounding the valley, with the effect of increasing the catchment area for pollen recruitment to the site, leading to a steep increase in pollen concentration.

The level from which the sample for AMS radiocarbon dating was taken was stratigraphically very precise, and the terrestrial plant macrofossils that were dated had been dried immediately after sorting. The result confirmed the earlier findings at this site. However, the precise dating of this important horizon, is hampered by the radiocarbon plateau. The pilot microtephra analysis at Tjørnuvík shows that several tephra horizons including the basaltic phase of the 'Landnám' tephra occur around the time of settlement. The two different populations of rhyolitic tephra may indicate two ash-fall events, or a geochemical evolution during the same eruption (Table 3). As yet, the number of analyses is insufficient to allow a secure correlation with tephra horizons on Iceland or in the British Isles but it is likely that the ***Tjørnuvík A Tephra*** represents an eruption from the Hekla Volcanic system. A more precise chronology for the first permanent settlement can be achieved at a better site in which the tephra layers are well separated stratigraphically, as many dated tephra horizons reported in the literature occur during this time interval (Hafliðason *et al.*, 1992; Grönvold *et al.*, 1995; Pilcher *et al.*, 1995; Zielinski *et al.*, 1997).

The basaltic shard analysed shows a geochemistry which matches well with the basaltic phase of the 'Landnám' tephra in Iceland (Table 4) where slightly elevated MgO concentrations have also been reported (up to 7.4 %; Boygle, 1994). While reworking cannot be ruled out when dealing with a single shard, the biostratigraphic evidence does not support this theory. Furthermore, as basaltic tephra shards are more likely to be retrieved if sodium polytungstate with a density of between 2.75 and 3.00 g/cm^3 is used (Turney, 1998), it is significant that this shard was found. The geochemical identification of this shard and correlation to the basaltic phase of the 'Landnám' tephra is also noteworthy, as basaltic tephra is related to less explosive volcanism than rhyolitic tephra, and is normally not carried as far as the British Isles and Scandinavia (Dugmore *et al.*, 1995).

Despite the fact that Buckland (1990) regards early settlement unproved at Tjørnuvík due to the absence of the dung beetle *Aphodius lapponum*, at the settlement horizon, an AMS radiocarbon date (I-16,535) on collagen from sheep/goat bones from a house foundation in the village of Gøtu on the island of Eysturoy, revealed that domestic animals were present at least 1370 ± 80 BP (Jóhansen, pers.comm. August, 1993). This calibrates to a calendar year of AD 640-810 (1 σ variation; CALIB vers. 3.0.3; Stuiver and Pearson, 1993) giving further support for an early colonisation date on these islands. An alternative explanation for the lack of entomological evidence indicating introduced herbivores at Tjørnuvík, in what is called inorganic sediment (Buckland,1990), may simply be unsuitable preservation conditions during the earliest phase of settlement, as identified in that study.

Our work shows that an early settlement date must again be considered at this site, and it is relevant to examine the palaeobotanical record on other Atlantic islands during this time period. In Ireland, an upsurge in farming activity at the beginning of the Christian Period has long been recorded in many places (Mitchell, 1986). The early timing of the first settlement at Tjørnuvík, corresponds to sharp rise in agricultural activity in western Ireland (Molloy and O'Connell, 1993; Ní Ghráinne, 1993; O'Connell and Ní Ghráinne, 1994). At Church Lough on the island of Inishbofin, off the coast of Connemara, a pollen profile with 8 bulk radiocarbon dates recorded the start of this increase at the calibrated age of AD 575. It was defined by a maximum in cereal-type pollen, together with a suite of weed taxa and high charcoal levels, indicating arable farming (Ní Ghráinne, 1993; O'Connell and Ní Ghráinne, 1994). Furthermore, according to historical records (Neary, 1920), St. Colman founded his monastery at this site in AD 665. Molloy and O'Connell (1993) also provided good palynological evidence at Derryinver Hill, on the Renvyle penninsula, for an increase in farming *c.* AD 680. Four radiocarbon dated profiles have allowed the reconstruction of the land use history on the peninsula in considerable detail during the late prehistorical and the early historical period. A notable feature of the well-dated pollen profiles, is increased farming activity after a short phase of woodland regeneration, named the late Iron age lull (Molloy and O'Connell, 1993). In Connemara National Park, renewed farming activity is dated to *c.* AD 653 (Molloy and O'Connell, 1993).

Human activity also increased in the Shetland Islands, prior to the first Norse settlements. Bennett *et al.,* (1992) reported an increase in *Hordeum*-type cereals and decrease in *Betula* woodland at Catta Ness, associated with microcharcoal and sediment changes thought to be as the result of erosion, dated to *c.* AD 500. There are no such changes when the Norse are reputed to have arrived at about AD 800, and so Bennett *et al.,* (1992) conclude that their agricultural practices were probably similar to those of the previous occupants. This widespread evidence of increased cultural activity prior to the written records of cultural expansion gives further credence to the early dates of settlement on the Faroe Islands presented here.

Conclusion

The results up to now give support to Jóhansen's (1971; 1985) claims about settlement chronology. The precise dating of the settlement horizon is hampered by a radiocarbon plateau, despite the stratigraphic precision with which the material for dating was taken. However, the four dates from the settlement horizon at this site are shown to be consistent, and the recovery of the 'Landnám' tephra above the cereal cultivation supports the early radiocarbon dates. A series of AMS dates on terrestrial plant macrofossils, in combination with geochemically defined microtephra horizons for comparison with the ice cores to establish calendar age in ice core years BP, will lead to a more precise chronology. The Tjørnuvík site is unsuitable for such a series as it has a rather uneven sedimentation rate and possibly mixed microtephra horizons. During the course of field work, several other, potentially more promising sites were discovered and sampled. An infilled lake site at the village of Eiði on the northern island of Eysturoy, and a mire fringing a lake close to the village of Sandur on the island of Sandoy show the best potential to achieve these aims, as they have more stable sedimentation conditions while capturing the details of first settlement. At these sites, the multidisiplinary approach should help resolve the question of the timing of the first settlements on the Faroe Islands.

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