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Kevin P. Smith

Introduction

Island settings are often considered ideal laboratories for studying cultural development in relative isolation from outside influences. As increasing numbers of studies document cultural adaptations to strikingly different island environments, it is also becoming clear that island colonization provides a unique context for understanding the effects of introducing a human presence into pristine ecosystems. It is rarely possible, however, to put the human impact into its proper cultural context, since most regions of the earth were colonized by pre-literate peoples and many of the processes attendant on colonization were initiated too rapidly to be monitored by standard archaeological dating methods. The Norse colonization of Iceland at the end of the first millennium AD established viable colonies on one of the world's last major uninhabited land masses. The relatively late date of this colonization episode, the existence of a voluminous indigenous literature describing it and the presence of dated volcanic tephra layers over much of Iceland bracketing the period of interest would seem to offer, at first glance, prospects for minimizing these problems.

The Icelandic *landnám* (land-taking) is traditionally dated to the period AD 870–930 on the authority of indigenous documentary sources. Although these texts are no older than the twelfth to fourteenth centuries, they have frequently been used as reliable accounts of the island's colonization because of their number and descriptive richness. By relying on these sources, historical and anthropological discussions often make it appear that we have far more direct information about the Norse colonization of Iceland than we actually do. Archaeologists studying this period have also, until recently, devoted more effort to debating the chronology of the settlement than trying to understand the settlement process itself or its impacts on Icelandic society and environment. In recent years, however, multi-disciplinary archaeological research has begun to provide data that extend our understanding of Iceland's settlement. By critically evaluating both historical and archaeological data it may be possible to obtain a better understanding of the role which Iceland's settlement played in the development of Icelandic society and culture.

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Historical perspectives on the settlement of Iceland

The earliest native account of Iceland's settlement is found in the *Book of Icelanders* (*Íslendingabók*), written by Ari hin fróði (the Wise) Þorgilsson in the mid-twelfth century (Hermannsson 1930). The traditions outlined in *Íslendingabók* were elaborated in *Landnámabók*, the Book of Settlements (Pálsson and Edwards 1972). This vast corpus of indigenous traditions about the origins of Icelandic society may have been initially compiled by Ari the Wise; but all extant versions of the manuscript contain extensive modifications from the thirteenth, fourteenth and later centuries (Pálsson and Edwards 1972). *Landnámabók* recounts the family histories of nearly 400 settlers, identifies the farmsteads they founded, outlines the areas of their land claims and describes the settlement of each of Iceland's major districts. These terse accounts were the frameworks for many of the Icelandic Family Sagas written during the thirteenth and fourteenth centuries (Hallberg 1962).

Literary and historical disputes have raged over the degree to which the authors of *Íslendingabók*, *Landnámabók* and the sagas used historically valid local traditions and genealogies to construct their visions of early Icelandic society. Some scholars view these texts as fairly reliable sources of information about early Icelandic society and the process of settlement (Jones 1986; Magnússon 1987). Rafnsson (1974) and Benediktsson (1978), on the other hand, argue that *Landnámabók* manipulates genealogical and historical traditions to legitimate twelfth- and thirteenth-century élite families' claims to property and prerogative. Durrenberger (1992) and others (Hallberg 1962; Hastrup 1985) suggest these texts were written to preserve a sense of cultural unity when Icelandic independence was crumbling or to create a sense of identity when the society was developing. If the agendas behind these documents are disputed, they clearly provide important insights into medieval Icelandic concepts about the settlement.

The medieval texts paint a consistent picture of the country's settlement. According to this tradition, Iceland was discovered around AD 860 by sailors blown off course while sailing to new colonies in the Faeroes. Upon arrival, they found land which was suited to farming, fishing and stock-raising, with forests extending from the shoreline to the mountains (Hermannsson 1930: 48, 60). In contrast to earlier areas where the Norse had settled, the country was uninhabited, although the sources suggest that Irish hermits may have lived on the island prior to the Norse arrival. Several exploratory voyages to obtain information on the island's resources were followed by voyages of colonization from western Norway and from Norse settlement areas in the British Isles.

Iceland's first permanent settler, Ingólfur Arnarson, is said to have established his farm at Reykjavík, c. AD 870–4. Soon after Ingólfur's settlement, colonists began to arrive in waves, many fleeing King Harald Fairhair's efforts to create a unified Norwegian state. Chieftains and land-holders who opposed his efforts packed up their belongings, their families and their retinues to carve out new lives in the wilds of Iceland. The earliest settlers in each of Iceland's major districts are said to have settled on the coastal margin and to have claimed extensive tracts reaching inland to the higher valleys. Family members, slaves, companions and newly arriving colonists were granted holdings within these tracts at the discretion of the original settler or his descendants. According to *Íslendingabók*, all of Iceland had been settled (or at least claimed) by AD 930.

Landnámabók's model of the settlement process is defined more in terms of social actions than fixed chronology. Thus the distribution of settlers across the landscape, the areas of their land claims, their alliances, who gave land and who received it are described in detail. In contrast, information on the sequence of settlers' arrivals or the spread of settlements across the landscape is only sketchily developed and may be contradicted in different versions of the document. Genealogies contained within the texts expand this social construction of time by linking many of the settlement farms (*landnámsbær*) to families who were powerful in Iceland during the thirteenth century.

An example from western Iceland illustrates the literary model of Iceland's settlement and some of the problems inherent in it. According to *Landnámabók* and *Egil's saga*, the Norse chieftain Kveld-Úlf and his son Skallagrím left Norway for Iceland after conflicting with Harald Fairhair (Pálsson and Edwards 1972, 1976). Kveld-Úlf died en route, leaving his son to establish a farmstead at Borg, near the mouth of Borgarfjörður in western Iceland. Skallagrím claimed all of the land between two rivers, from the mountains to the sea, and established farms and outstations at locations suited to exploit the resources of his vast tract. These farms, manned by his slaves and household laborers, provided the resources needed to support his estate. Next, Skallagrím gave portions of this claim to his kinsmen, freed slaves and crew members. New settlers had to purchase or be granted land within his claim. As daughter farms became established around the initial farmsteads, the landscape filled up. Skallagrím's kindred became the nucleus for a regional chiefly dynasty with political authority over the area because of his status as the region's first settler and his high-born Norwegian ancestry.

Figure 1 shows the extent of Skallagrím's land claim, the locations of settlers' farmsteads and the social connections among them, according to *Egil's saga* (Pálsson and Edwards 1976) and the thirteenth-century *Sturlubók* version of *Landnámabók* (Pálsson and Edwards 1972). Farms to the west of the river Norðurá and south of the mountains are said to have been established under Skallagrím's direct authority, but his relationships with the founders of farms east of Norðurá are poorly defined. In this area, the settlement structure consists of many small, independent settlement nuclei.

Both *Sturlubók* and *Egil's saga* maintain that the entire region around Borgarfjörður was within Skallagrím's original land claim. However, another version of *Landnámabók (Melabók)* and the thirteenth-century *Vatnsdæla saga* limit Skallagrím's land claim to areas west of Norðurá (Ashwell and Jackson 1970: 160). When these sources were written, Norðurá and its tributary the Hvítá formed the border between two political districts in western Iceland. Successors to Skallagrim's chieftaincy (the *Mýramannagoðorð*) had no legal claim to political authority east of Norðurá or south of Hvítá, where their authority was challenged by chiefly lineages centered on the estates of Gílsbakki, Reykholt and Stafaholt. However, early in the thirteenth century the chieftain Snorri Sturluson extended Mýramannagoðorð control over all the eastern areas that *Egil's saga* and *Sturlubók* include within Skallagrím's land claim. *Sturlubók* was compiled by Sturla Þórðarson, Snorri's nephew and potential heir, while *Egil's saga* was probably written by Snorri himself (Pálsson and Edwards 1972: 3; Pálsson and Edwards 1976: 7). Skallagrim's land claim, as outlined in these documents, encompasses the entire region over which these chieftains were trying to establish a claim to legitimate political authority. *Melabók* and *Vatnsdæla saga*, which limit Skallagrím's area of control, were written by authors from

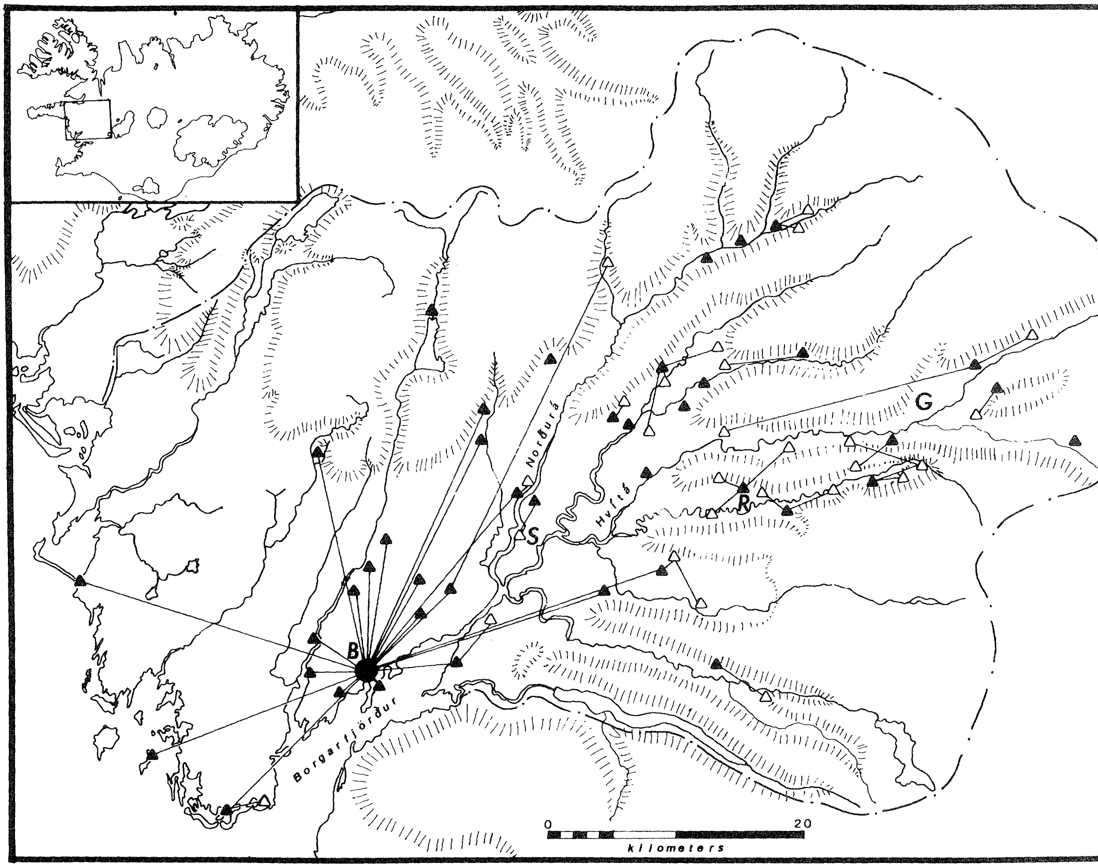

Figure 1 The historical model of *landnám* in Borgarfjörður. The dashed and dotted line encloses the area of Skallagrím's land claim, as described in the *Sturlubók* version of *Landnámabók* and *Egil's saga*. The large closed circle (at B) identifies Borg, Skallagrím's home farm. Filled triangles identify farms said to have been established in the first generation of Norse colonization, while open triangles are those farms said to have been established in the second generation. Solid lines connect parent and daughter farms. The residential compounds of thirteenth-century chieftains in Borgarfjörður are located at Borg (B), Gílsbakki (G), Reykholt (R) and Stafaholt (S).

districts that were not under Mýramannagoðorð control. Rafnsson's (1974) argument that medieval accounts of Iceland's settlement can be read as thirteenth-century political statements appears to be supported by the existence of such factional biases in the manuscripts.

It is likely that these sources contain fragments of reliable local traditions about the settlement period (Benediktsson 1978). However, if these documents also map thirteenth-century political claims onto the regional landscape it is impossible to state which version, if any, represents a more accurate picture of the actual process of settlement in Iceland. Archaeological and paleoecological research provides an alternative perspective from which to understand Iceland's colonization and the impact of the settlement process on Icelandic environment and society.

Pre-*landnám* ecology

Ari the Wise's statement that Iceland was fully forested at the time of settlement suggests a landscape much different from that which greets the visitor today. At present, less than 1 per cent of Iceland is wooded and less than 25 per cent of the country is vegetated (Arnalds 1987). Palynological research, studies of modern Icelandic floral communities, place-name evidence and zooarchaeological analyses make it possible to draw a rough model of the pre-settlement environment (Einarsson 1963; Löve 1983; Hallsdóttir, 1987; Amorosi 1989, 1991; Buckland et al. 1991b).

Prior to the Norse settlement, lowland areas (below 300–400 meters ASL) that are now occupied by heathland, grassland or eroded gravel plains were covered by woodlands of tree- or shrub-sized birch, willow and rowan (Einarsson 1963; Hallsdóttir 1987). The forest floor supported a relatively simple grass- and sedge-dominated community; but towards the coastal regions, on windswept heights, and in other areas where the canopy was more open, the birch woodland would have graded into heathlands dominated by crowberry, blueberries, heather, dwarf birch (*B. nana* L.) and recumbent willows mixed with grasses, sedges and forbs (Hester et al. 1991). Low-lying, waterlogged areas would have been occupied by wetland fens in which grasses, sedges and low-lying forbs such as cottongrass, cinquefoil and bogbeans were dominant. Willows of varying sizes, from the recumbent *Salix herbacea* L. to *S. phylicifolia* L. (which grows to a height of 7m), formed a zone transitional to surrounding heaths and woodlands. At higher elevations the birch woodlands would have thinned, leaving heath communities on higher and drier ground overlooking lower-lying fens. At these altitudes, hardier and more cold-tolerant grasses, sedges and forbs would have replaced some of the taxa found in the lower valleys and coastal lowlands. Botanical, place-name and archaeological research suggests that before AD 850, 65 per cent of the country was vegetated and birch woodlands covered at least 25 per cent of Iceland (Arnalds 1987).

The only land mammal known to have occupied the pre-settlement landscape was the arctic fox (*Alopex lagopus*), which reached Iceland across the arctic ice pack that embraces the northern and eastern coasts in severe winters. Foxes may have survived by raiding the nests of migratory birds or scavenging the carcasses of marine mammals. Place names and zooarchaeological evidence (Amorosi 1991) suggest that walrus and seal colonies were present at scattered locations around Iceland's coasts. Polar bears may also have visited the island periodically, but are not thought to have been permanent residents.

During the short summers, the seas, shoreline cliffs, woodlands, lakes and heaths of Iceland currently become nesting grounds for vast numbers of migratory birds from Europe, North America and Africa. However, only a handful of species, including ptarmigan, falcons, swans and sea eagles, remain through the winter. Atlantic salmon arrive in Icelandic rivers during the summer months to spawn, trout can be found in highland lakes and rivers year-round, and the coastal waters teem with an enormous variety of pelagic fish whose numbers and distribution shift with the seasons. In the absence of evidence to the contrary, it is generally assumed that these resources would also have been available to Iceland's first settlers, although their current distribution, numbers and community associations may not accurately reflect pre-settlement conditions.

These statements provide a rough sketch of the resources which Iceland's first settlers would have found on their arrival. The proportion of woodland to heath and grassland, the location of off-shore fishing grounds and the suitability of the island for different migratory species has certainly varied during the Holocene (Einarsson 1963; Buckland and Dugmore 1991). Throughout this period, long-term survival based on hunting and gathering would have required highly efficient scheduling to generate storable surpluses reliably during the summer or the capability to harvest marine resources year-round. Throughout the Holocene, Iceland's shores would have been ice-free in most winters, except during periods of extreme climatic deterioration (e.g. the Little Ice Age). Relying on marine resources would have required a well-developed, fully maritime adaptation. Without this capability, survival in Iceland would have been difficult, if not impossible. The absence of evidence for successful colonization of the island by hunting and gathering populations may reflect this reality.

The first Icelanders: chronologies in contention

The date of Iceland's earliest settlement phase is a subject of continuing debate. No evidence for a prehistoric, non-European settlement has yet been found, despite the relative proximity of Paleoeskimo settlement areas in eastern Greenland. Similarly, no archaeological evidence has convincingly demonstrated a pre-Norse European presence. Five late Roman *antoniniani* have been found in southern and eastern Iceland. These are currently interpreted as Viking booty, in the absence of other evidence to suggest Roman exploration or settlement of the island (Eldjárn 1956; Magnússon 1973; G. Sveinbjarnardóttir, pers. comm.). Literary references and place names have been used to suggest that Irish hermits were in Iceland at the time of the Norse colonization. No archaeological evidence for such a settlement has yet been found. From 1967 to 1981, Kristján Eldjárn conducted excavations on Papey, a small island off the southeastern coast of Iceland that has been associated with Irish settlement by place-name evidence. Eldjárn's surveys and excavations documented early Norse settlement on the island, but produced no evidence for Irish occupation (Eldjárn 1989).

The Norse settlement of Iceland has been traditionally dated to the ninth century. Recently, however, the site of Herjólfsdalur, on the island of Heimaey off Iceland's south coast, has been interpreted as a sixth- to seventh-century Nordic farmstead by its excavator (Hermannsdóttir 1986; Hermanns-Auðardóttir 1989), who also argues that other sites with similar dates prove that Iceland was extensively settled during this period. These arguments are currently the subject of a vigorous debate concerning the artifactual and chronometric bases for dating these sites (Hermannsdóttir 1986; Hallsdóttir 1987; Nordahl 1988; Hermanns-Auðardóttir 1989; Einarsson 1989; Mahler and Malmros 1991; Rafnsson 1990a; Sveinbjarnardóttir 1990; Vilhjálmsson 1991a, 1991b, 1992).

Few artifacts from Herjólfsdalur can be typologically dated; yet those which can have closer parallels from ninth- to tenth-century Norwegian and North Atlantic Norse settlements than from Scandinavian Migration or Merovingian Period contexts. Architectural remains at the site are also familiar from Viking Period settlements (Kaland 1991; Mahler and Malmros 1991). In the absence of demonstrably early artifacts or architectural styles, Hermanns-Auðardóttir (1989) emphasizes the presence of six seventh- to eighth-century calibrated radiocarbon dates from the site. The site's full suite of radiocarbon samples also contains three dates with calibrated mid-points in the late tenth or early eleventh centuries and one fourteenth-century date (Vilhjálmsson 1991b: Table 1). The presence of charcoal samples dating to both the eighth and the tenth centuries in a single feature at the site (U-2529, U-2531) suggests that the site's residents may have burnt wood of different original ages (Hermanns-Auðardóttir 1989; Mahler and Malmros 1991: 17).

Most of the Herjólfsdalur dates were run on samples of birch charcoal to eliminate driftwood of unknown age or origin. However, since paleobotanical research indicates that birch did not grow on Heimaey at the time the site was occupied, all of the dated samples must be of extra-local origin (Hallsdóttir 1982). Palynological studies suggest that wood from peat beds on the adjacent mainland may have been one source of fuel for Herjólfsdalur's settlers (Påhlsson 1981; Hallsdóttir 1987). The birch stratum in these peat beds dates to the fifth through tenth centuries AD (Haraldsson 1981; Stuiver and Pearson 1993). Currents may also have brought birch from mainland Iceland to Heimaey, along with non-indigenous taxa. The Herjólfsdalur radiocarbon series includes three dates (U-2529, U-2533, U-4403) run on samples incorporating non-indigenous species such as larch and spruce (Kaland 1991; Mahler and Malmros 1991). These dates span the same range as those run on birch alone, suggesting that driftwood accumulations were used as fuel for this island farm. That driftwood could survive for centuries on Icelandic beaches has been demonstrated by excavations at Papey, where samples of non-indigenous fir and pine charcoal dated to the fourth to seventh centuries AD were recovered from floors that were formed during the tenth through thirteenth centuries, according to radiocarbon dates on birch charcoal samples and diagnostic artifact types (Eldjárn 1989).

Radiocarbon dates from an early farm site in downtown Reykjavík suggest that similar processes were at work there (Grímsson and Einarsson 1970; Sigurðardóttir 1987; Nordahl 1988). Radiocarbon dates from these excavations separate into three spatially coherent and statistically distinct series. The first series, of tightly clustered seventh-century dates, appears to represent samples run on birch logs and branches from a storm beach deposit on the shore of a shallow lagoon or tidal lake. The second series, dating to the late eighth century, consists of birch charcoal from a burnt layer sealed beneath the walls and floors of the sites' earliest houses. Neither the birch wood accumulation nor the burning episode can be clearly associated with human activity. Only two of the fourteen samples with seventh or eighth century dates were found in association with sealed features or structure floors. Few of the artifacts incorporated in the wood-chip or burnt layers were chronologically distinctive; those that were are ninth- to eleventh-century types (Nordahl 1988: 49, 75–81).

Calibrated mid-points for the third series of eleven dates range from the late ninth to the eleventh centuries. Nine of these samples were recovered in direct association with structural remains, floor deposits or cultural layers containing typical Viking period artifacts similar to those found on the wood-chip layer. Rather than indicating that this farm was occupied from the seventh century onward, the dates from Reykjavík suggest that early Icelandic settlers here, as at Papey and Herjólfsdalur, used easily accessible driftwood for fuel. Artifactual and typological evidence suggests that the earliest structures in Reykjavík represent a late ninth-century farmstead.

Those sites for which a pre-ninth-century date has been suggested on the basis of radiocarbon dating are located in coastal or insular settings, where the use of driftwood accumulations could be expected. In contrast, potentially early inland sites have not produced calibrated dates earlier than the late ninth century. The single exception is Skeljastaðir, in the interior valley of Þjórsárdalur, where conventional and AMS radiocarbon dates on bones from Christian burials produced dates in the eighth to early ninth centuries AD (Vilhjálmsson 1991b). Since Iceland's conversion is well documented at circa 1000 AD, these dates require comment. One possible explanation for the anomalously early dates may be the presence of significant quantities of fossil carbon from dietary use of marine mammals and fish in Icelandic skeletal bone. Archaeological and historical sources testify to the use of marine resources by interior farms, especially after Christianity imposed restrictions on the use of terrestrial protein during Lent and other fast days (Amorosi 1991; Thomas 1974: 157). Arundale (1981) suggests that the North Atlantic marine reservoir effect produces radiocarbon dates that are too old by an average of 430 ± 50 years. If the dates from Skeljastaðir are re-calibrated taking this reservoir effect into account, they fall into the eleventh century, with the assumption that only 15–20 per cent of the skeletons' carbon was assimilated from marine foods (Stuiver and Braziunas 1993; Stuiver and Pearson 1993).

Archaeologists in Iceland also rely on tephrochronology to date archaeological sites (Þórarinsson 1943, 1967, 1970; Larsen 1984). Several volcanic layers are useful for establishing the relative age of settlements in southern and southwestern Iceland. The so-called 'landnám layer' (Vö-900) has been found just above, or in, several early archaeological sites and in pollen cores at levels where evidence for non-indigenous, weedy annuals and domesticated cereals were first identified (Þórarinsson 1970; Einarsson 1963; Hallsdóttir 1987). Six radiocarbon dates on peat and charcoal recovered below, within and above the Vö-900 layer from three palynological sites in southern Iceland are statistically indistinguishable, giving an average age of cal. AD 875 [886] 892 (Hallsdóttir 1987; Stuiver and Pearson 1993). Twin acid peaks in the Greenland ice cap at AD 897 and 898 may represent the Vö-900 eruption sequence, in agreement with this dating (Hammer et al. 1980; Larsen 1984). Several black tephra layers from eruptions of the sub-glacial volcano Katla were also deposited across southern Iceland between AD 900 and 1000 (Þórarinsson 1967; Hallsdóttir 1987), making it possible to obtain fine-grained chronological sequences in these regions. It is harder to date the spread of human activity across the landscape in northern or eastern Iceland, as fewer tephra sequences have been established there.

The earliest structures at Reykjavík appear to have been constructed before the Vö-900 eruption, and this tephra layer was incorporated into the turf walls of slightly later structures (Nordahl 1988). Vö-900 also occurs in bogs around Reykjavik at the same level as the appearance of pollen types that mark the onset of local attempts at cultivation (Hallsdóttir 1987). At Herjólfsdalur, Vö-900 and a Katla tephra dated to AD 900–34 are present in the lower portion of the cultural layers and in the turf walls of the latest structures at the site. Although a seventh-century occupation has been proposed for both of these sites (Hermannsdóttir 1986), artifact types, architecture, tephra layers and radiocarbon dates suggest instead that these are late ninth-century settlements with occupation continuing into the tenth or eleventh centuries.

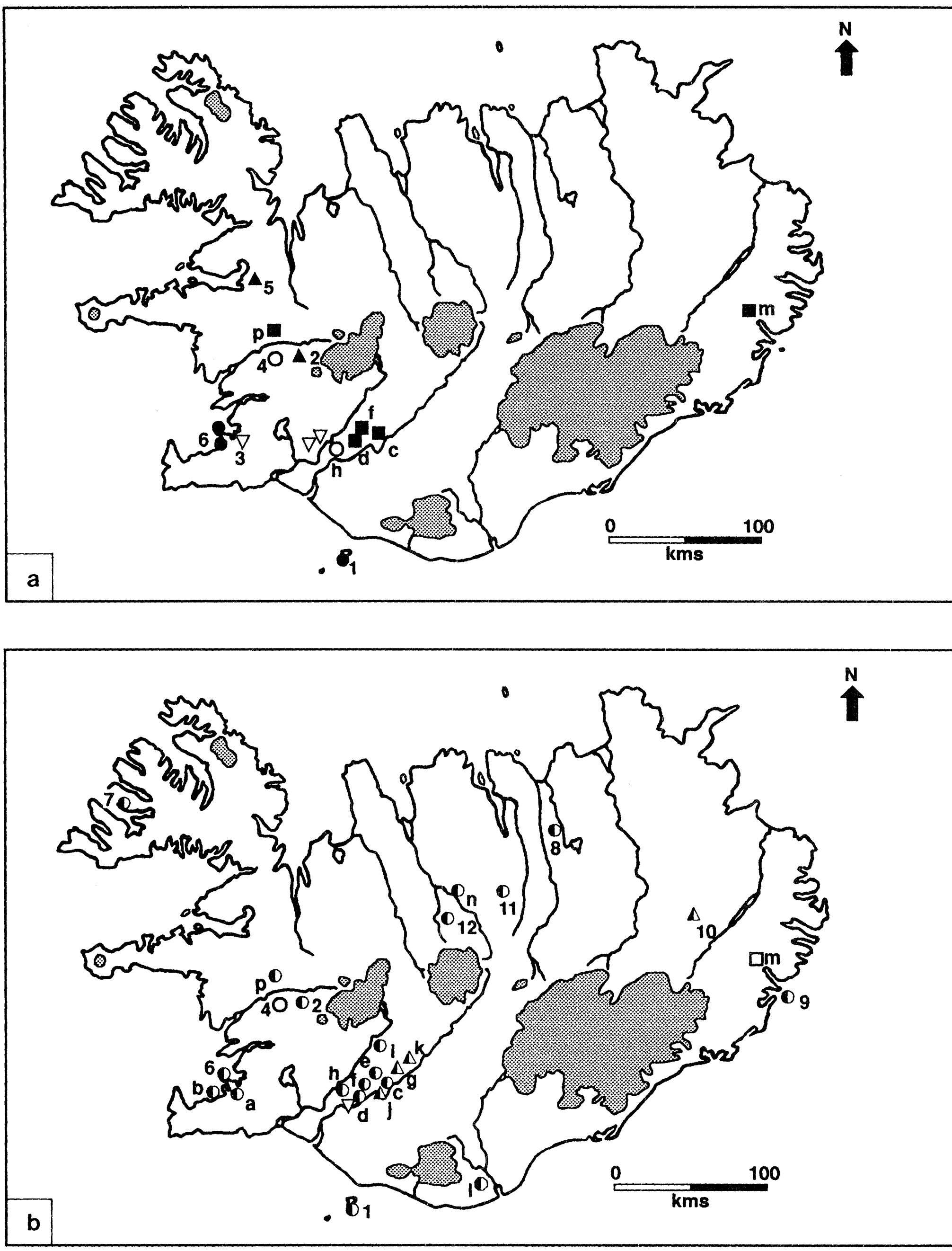

Figure 2 The expansion of human settlements across Iceland, based on archaeological evidence. (a) Ninth-century components. (b) Tenth-century components. Circles indicate farmsteads, triangles identify iron-production sites, squares indicate sites with evidence of burning prior to the establishment of farms, and octagons identify mortuary sites dated by C^{14} or tephrochronology. Fully open symbols indicate sites where the dating or nature of site use are ambiguous. Inverse triangles identify palynological coring stations with evidence for the birch decline or *Cerealia* pollen below the Vö-900 tephra layer. Site names and dating evidence are summarized in Tables 1a–b.

Figures 2a and 2b show the distribution of archaeological sites dated to the ninth and tenth centuries by radiocarbon or tephrochronological analyses. All available and relevant radiocarbon dates have been calibrated for this study using CALIB rev.3.0.3A (Stuiver and Reimer 1993) and are reported with one-sigma ranges (Table 1). Many pagan burials and several residential sites that have been dated only by the presence of artifact types are missing from these maps. These are certainly relevant for understanding the extent of settlement before AD 1000, but current knowledge of local typological sequences and artifact curation rates are insufficiently precise to separate late ninth- from tenth-century assemblages.

Sites with dated ninth-century components are scattered thinly throughout the coastal and interior regions of southern Iceland (Fig. 2a). Documented residential sites are located on the outer coastal margin, while sites in the interior or at inner fjord locations appear to represent areas of iron production or forest clearance. Two sites (Hvítárholt and Reykholt) may represent early interior farmsteads, but their dating remains ambiguous. At Hvítárholt, an early *skáli* sealed beneath a barn with the Vö-900 tephra layer in its turf walls may date to the ninth century (Magnússon 1973). At Reykholt, a large ash-filled trench produced a ninth-century radiocarbon date, but the nature of the site's earliest component remains unclear due to later disturbances (Buckland et al. 1992).

Tenth-century sites, in contrast, are numerous and document the spread of permanent settlements along the coasts and far into Iceland's interior (Fig. 2b). Many inland locations where burning layers suggested late ninth-century clearance or iron production became the sites of farmsteads during this century. At the same time, areas of iron production or clearance by burning appear to have spread on the fringes of tenth-century settlement areas in Þjórsárdalur and possibly into the upland valley of Hrafnkelsdalur in eastern Iceland.

The absence of reported early sites in northern and eastern Iceland may reflect less research effort there or the absence of diagnostic ninth- to eleventh-century tephra layers in this region. Alternatively, it may suggest that southern and western Iceland's broad plains and warmer climate were more attractive to the first settlers than the narrow and snow-blanketed mountain valleys of the north and east.

Elements of early Icelandic culture

The earliest settlements at Herjólfsdalur, Reykjavík and Grelutóttir appear to incorporate a wider range of buildings and building styles than is found on later farm sites. These farms consist of a large number of detached and semi-detached structures, each with a specific function in the total farmstead. The central feature in all of these complexes is, however, a turf-walled residential longhouse (*skáli*) with bowed side- and end-walls and a floor-level, stone-paved hearth (*langeldur*). This structure type is clearly derived from mainland Scandinavian prototypes (Petersen 1933). Other features that occur with some regularity on the earliest sites include pithouses (multi-functional structures for cooking, weaving and bathing), smithies, barns and byres (Ólafsson 1980; Einarsson 1989). Building complexes similar to those at Herjólfsdalur and Reykjavík can be found in ninth-century components at Oma in Rogaland (Petersen 1933), Toftanes in the Faeroes (Stummann Hansen 1989, 1991) and Jarlshof in the Shetlands (Hamilton 1956).

Our knowledge of early Icelandic settlement systems beyond the structure of the farmsteads remains poorly developed. Seasonal harbors, assembly sites, upland fishing and hunting shelters, sheep-shelters and other outlying structures are well-documented components of later Icelandic landscapes that have not been documented for the earliest phases of settlement. Even the upland shieling (*sel*, summer farm), with its implications of seasonal transhumance and efforts to conserve fields and pastures near the main farms, cannot be demonstrated to have been a part of the earliest settlers' agricultural system. Place-name and literary evidence indicates that *sel* were in use in Iceland by the twelfth century and shielings appear to have been present in the Faeroes by the ninth century (Mahler 1989, 1991). However, recent archaeological surveys of shielings in several parts of Iceland produced no evidence to document their use earlier than the fourteenth century (Sveinbjarnardóttir 1991, 1992).

Artifact types found in early Icelandic settlements and burials (Eldjárn 1956) have direct Scandinavian correlates and are often similar enough to those from later centuries to suggest few differences in basic adaptation. However, at the assemblage level, the earliest sites appear to have higher ratios of locally produced to imported objects than are typical of later farmsteads. This may imply that a generation or more was required to integrate the early Icelandic colonies into European long-distance exchange networks, or that the requirements of establishing settlements in a new land forced the settlers to produce and consume more tools made from locally available materials. Whatever the reason, this pattern contrasts with the view that travel and trade between Iceland and Europe were most intense during the first centuries after settlement and dropped off sharply thereafter (Gelsinger 1981).

Faunal assemblages, like architectural remains, incorporate a wider range of exploited species than is found at later sites. The presence of young walrus remains in middens from Reykjavík supports place-name evidence that rookeries once existed in this area (Amorosi 1991: 280). Walrus no longer breed in Iceland and these colonies may have been exterminated by the Norse colonists. Bird bones are much more common in the middens of the earliest settlements than they are in later periods, but until detailed taxonomic analyses are published it will be impossible to assess the impact of Norse settlement on the island's avifauna or to compare it with other cases of island colonization. Compared to later assemblages, the bones of seals, whales and fish are rare in these early sites. However, the use of whalebone for tools implies technological and subsistence roles for marine resources from earliest times (Amorosi 1991; Nordahl 1988).

Domestic faunal remains indicate that in the first centuries of Norse settlement more reliance was placed on cattle than on sheep or goats. This pattern was reversed in later centuries (Amorosi 1991). Horses and dogs are also well-represented in grave offerings and middens (Eldjárn 1956), while pig bones have been recovered from the earliest levels in Reykjavík (Grímsson and Einarsson 1970). Palynological evidence, place names and ethnobotanical samples (Nordahl 1988: 106) indicate that the early colonists introduced cereal cultivation as well as pastoralism to the Icelandic landscape. Barley, and perhaps flax, continued to be grown in small amounts until the fourteenth century in southern Iceland (Friðriksson 1959, 1960).

Table 1a Radiocarbon dates from early settlements in Iceland

Ref. no.	*Site name (region)**	*Material dated*	*Lab number*	*Date (cal. AD, 1 sigma)*
1.	Herjólfsdalur (S)	birch charcoal	U-2660	627(657)677
		birch charcoal	U-2661	654(671)767
		birch charcoal	U-2663	665(690)783
		mixed charcoal	U-2529	680(776)873
		mixed charcoal	U-2533	689(782)883
		birch charcoal	U-2662	710(782)881
		larch charcoal	U-4403	892(989)1024
		birch charcoal	U-2531	897(997)1024
		birch charcoal	U-4402	972(1012)1032
		birch charcoal	U-2532	1321(1408)1433
2.	Háls	birch charcoal	Beta-34359	719(881)973
3.	Kopavógur (SW)	charcoal	HAR-2155	685(883)1005
4.	Reykholt (W)	charcoal	RCD-47	785(886)962
5.	Ýtri-þorsteinsstaðir	birch charcoal	Lu-2999	880(893)979
	(W)	birch charcoal	Lu-3000	870(891)1006
6.	Reykjavík sites (SW)			
	Group 1			
	Gjótagata	birch charcoal?	K-940	634(671)783
	Aðalstræti 18	birch charcoal	U-2530	651(676)779
	Suðurgata 3–5	birch wood	U-2680	631(661)688
	Suðurgata 3–5	birch wood	U-2719	646(665)692
	Suðurgata 3–5	birch charcoal	U-2672	652(669)761
	Suðurgata 3–5	birch charcoal	U-2741	662(676)756
	Group 2			
	Aðalstræti 18	birch charcoal	U-2617	654(719–766)888
	Suðurgata 3–5	birch charcoal	U-2745	673(723–770)853
	Suðurgata 3–5	birch stake	U-2720	665(728–772)883
	Suðurgata 3–5	birch charcoal	U-2676	682(776)867
	Suðurgata 3–5	birch charcoal	U-2681	680(777)959
	Suðurgata 3–5	birch charcoal	U-2748	682(779)882
	Suðurgata 3–5	birch charcoal	U-2747	678(781)887
	Suðurgata 3–5	birch charcoal	U-2744	686(781)959
	Group 3			
	Tjarnargata 4	birch wood	U-2167	719(881)973
	Tjarnargata 4	larch wood	U-2082	820(893)990
	Aðalstræti 18	birch charcoal	U-2592	789(893)997
	Suðurgata 3–5	birch charcoal	U-2671	827(891)976
	Suðurgata 3–5	birch wood	U-2743	827(893)987
	Suðurgata 3–5	birch wood	U-2682	886(978)1020
	Suðurgata 3–5	birch charcoal	U-2721	894(1005)1035
	Suðurgata 3–5	birch charcoal	U-2534(ave)	1011(1027)1156
	Suðurgata 3–5	birch charcoal	U-2679	893(984)1017
	Suðurgata 3–5	birch charcoal	U-2746	889(978)1015
	Suðurgata 7	birch charcoal	K-4271	884(973)1015
7.	Grelutóttir (NW)	birch charcoal	pithouse 1, ave	895(988)1018
		birch charcoal	pithouse 2, ave	88(896–956)990
8.	Holt (N)	birch charcoal	St-5292	780(901–978)1020

Table 1a Continued

Ref. no.	*Site name (region)**	*Material dated*	*Lab number*	*Date (cal. AD, 1 sigma)*
9.	Papey (SE)			
	Hellisbjargi	larch/birch	U-4014	886(978)1020
	Goðatættur 1	birch charcoal	St-3605	1012(1049–1154)1224
	Goðatættur 2	birch charcoal	St-3604	984(1028)1176
	Áttahringsvogur 2	charcoal	St-8348	1021(1058–1157)1220
	Áttahringsvogur 2	birch charcoal	Birm-1128	1022(1046–1153)1177
10.	Aðalból (E)	birch charcoal	U-4327	884(967)1009
11.	Granastaðir (N)	birch charcoal	Ki-2856	886(902–980)998
		birch charcoal	Ki-2854	900(990)1020
		birch charcoal	Ki-2855	902(1001–1017)1149
12.	Hraunþúfuklaustur (N)	birch charcoal	St-4572	894(997)1150

Sources: Herjólfsdalur (Hermanns-Auðardóttir 1989; Mahler and Malmros 1991; Vilhjálmsson 1991b, 1992); Háls (Smith 1991b); Kopavógur (Sveinbjarnardóttir 1986); Reykholt (Buckland et al. 1992); Ýtri-Þorsteinsstaðir (Ólafsson, pers. comm.; Vilhjálmsson 1991); Reykjavík (Grímsson and Einarsson 1970; Nordahl 1988; Sigurðardóttir 1987); Grelutóttir (Ólafsson 1980); Holt (Þórarinsson 1977); Papey (Eldjárn 1989); Aðalból (Rafnsson 1990b); Granastaðir (Einarsson 1989); and Hraunþúfuklaustur (Þórarinsson 1977). All radiocarbon dates have been calibrated using CALIB, rev. 3.0.3A for the Macintosh, test version 6 (Stuiver and Reimer 1993).

Note

* Locations of all sites listed in Tables 1a and 1b are shown in Figures 2a and 2b.

The variability seen in early Icelandic architectural, artifactual and faunal assemblages suggests that a phase of experimentation and adaptation to new conditions preceded the development of stable adaptive patterns or a common culture in this North Atlantic Scandinavian outpost. The settlers' material culture, coupled with linguistic and physical anthropological data (Berry 1974; Bjarnason et al. 1973), supports medieval assertions that the country was colonized from western Scandinavia and Scandinavian settlement areas in the British Isles. With the introduction of agro-pastoralism, Iceland's Norse settlers found a way to convert the natural productivity of Iceland's summer growth to storable surpluses of dairy products, meal and meat for use over the long winter months. Although cereal cultivation diminished in importance through time, the management of hay crops remained the key to the survival of Icelandic society (Friðriksson 1972). The preferential use of coastal sites during the earliest settlement phase may indicate settlers' needs to use maritime and riverine resources as buffers against the uncertainties of agricultural production in an untried land.

The ecological impacts of *landnám*

Too few early sites have been adequately studied to describe regional variations in the rate at which settlements spread across Iceland or to identify local differences in adaptation. However, paleoecological data record widespread, apparently pene-contemporaneous

Table 1b Archaeological data other than C^{14} for dating early settlements in Iceland

Ref. no.	*Site name**	*Dated by*	*Dated to*	*Dating evidence*
a.	Ellíðavatn (S)	tephra	10th century	Vö-900 in wall turf.
b.	Bessastaðir (S)	tephra	10th century	Vö-900 in wall turf.
c.	Skeljastaðir (S)	tephra	9th century (burning) 10th century (farm)	Vö-900 over charcoal layer and beneath field wall.
d.	Snjáleifartóttir (S)	tephra	9th century (burning) 10th century (farm)	Vö-900 in house walls, charcoal layer under house and in walls.
e.	Stórhólshlið (S)	tephra	10th century	Vö-900 in the turf of earliest field wall.
f.	Skallakot (S)	tephra	9th century? (burning) 10th century (farm)	Vö-900 under walls, Vö-900 and charcoal layers in turfs of earliest house.
g.	Stöng (S)	tephra	10th century (burning) 11th century (farm)	Vö-900 and K-1000 in house walls. Burnt layer over Vö-900. Smithy beneath outhouse with Vö-900 and K-1000 in its walls implies that the smithy is older than either the outhouse or the earliest residence.
h.	Hvítárholt (S)	tephra	9th century farm?	Vö-900 in walls of structures built over earlier houses, suggests late 9th–early 10th century date for first phase of occupation.
i.	Þórarinsstaðir (S)	tephra	10th century (burning) 10th century (farm)	Vö-900 below charcoal and lowest turf wall of farm house abandoned before circa AD 1104.
j.	Sámsstaðir (S)	tephra	10th century (smelting) 11th century (farm)	K-1000 is over a small structure with slag and charcoal, K-1000 is in turf walls of farmhouse built over the slag-filled structure.
k.	Gjáskógur (S)	stratigraphic relationship	10th century? (smelting) 11th century (farm)	Smelters' hut under walls of house built in local 11–12th-century style and abandoned before deposition of H-1104 tephra layer.
l.	Hrífunes (S)	tephra	10th century	Burial pits cut through Vö-900 tephra layer, but are capped by Katla tephra of circa AD 934.
m.	Broddaskáli (E)	tephra	9th century (burning) 10th century (burning) 10th century? (farm)	Charcoal layers above and below Vö-900 tephra, overlain by farmhouse floor.

Table 1b Continued

Ref. no.	*Site name**	*Dated by*	*Dated to*	*Dating evidence*
n.	Kolgrímastaðir	tephra	10th–11th century (farm)	Tephra layer '3', dated to the 10–11th centuries is in the farms's turf field wall, which is capped by H-1104 tephra.
p.	Ísleifsstaðir (W)	stratigraphic relationship	9th century? (burning) 10th century? (farm)	Charcoal beneath walls of the lowest of three stratigraphically superimposed typical Viking period longhouses.

Sources: Elliðavatn (Ólafsson 1987); Bessastaðir (Smith, pers. obs; Ólafsson, pers. comm.); Skeljastaðir (Þórarinsson 1943; Þórðarson 1943); Snjáleifartóttir (Stenberger 1943; Þórarinsson 1943); Stórhólshlið (Þórarinsson 1943; Voionmaa 1943); Skallakot (Þórarinsson 1943; Roussell 1943); Stöng (Þórarinsson 1943; Nordahl 1988; Vilhjálmsson 1989); Hvítárholt (Magnússon 1973); Þórarinsstaðir (Eldjárn 1949; Þórarinsson 1949); Sámsstaðir (Rafnsson 1977); Gjáskógur (Eldjárn 1961); Hrífunes (Larsen and Þórarinsson 1984); Broddaskáli (Sveinbjarnardóttir 1992); Kolgrímastaðir (Sveinbjarnardóttir 1992); and Ísleifsstaðir (Stenberger 1943b; Nordahl 1988).

Note

* Locations of all sites listed in Tables 1a and 1b are shown in Figures 2a and 2b.

changes in the Icelandic environment that can only be attributed to the impact of human settlement. In southern and southwestern Iceland these changes appear just under or above the Landnám tephra, implying that widespread ecological transformations were under way by the end of the ninth century (Hallsdóttir 1987). Similar changes took place in northern Iceland, but the absence of good tephrochronological sequences for that region makes it difficult to determine whether changes there were contemporary with those under way in the south (Einarsson 1963).

The Norse introduction of cereals, sheep, cattle and other domesticated animals to Iceland by the end of the ninth century has been documented archaeologically and palynologically. In addition to these intentional introductions, the spread of weeds associated with pastures, fields, middens and other anthropogenic habitats can be traced in pollen assemblages and macrofossil samples across Iceland (Einarsson 1963; Hallsdóttir 1987; Zutter 1992). The diversity of insect species in Iceland also increased rapidly in the first century after settlement, most notably around early farmsteads, but also in locations distant from known settlements. This increased diversity reflects the spread of indigenous species that had restricted distributions prior to *landnám* as well as the introduction of a diverse synanthropic fauna adapted to the specialized habitats of barns, byres, dung heaps and dwellings (Buckland et al. 1991a, 1991b). Several species of earthworms may also have been introduced to Iceland after Norse colonization, where they occupied restricted anthropogenic habitats (Bengtson et al. 1975; Enckell and Rundgren 1988). It has recently been proposed that many of these invertebrate species arrived as stowaways in the ballast and dunnage of Norse ships (Enckell and Rundgren 1988; Sadler 1991).

While domesticated plants and animals, weeds and invertebrates show evidence of rapid diversification and population radiation soon after human settlement, the indigenous flora experienced different and complex responses. Palynological records show abrupt rises in the pollen of grasses and sedges, accompanied by a catastrophic decline in birch pollen, suggesting rapid assaults on the native woodlands (Einarsson 1963; Hallsdóttir 1987). At several locations, the birch decline appears to be accompanied by a rise in pollen from indigenous forbs and heathland species before the dominant grass, sedge and weed communities indicative of pastures and fields became established. This suggests that, in some areas, destruction of the birch forests preceded the establishment of farmsteads or intensive grazing and must relate to a different suite of activities.

What could have caused such a dramatic decline in the apparent extent of forest cover over most of Iceland? Archaeological evidence indicates that many early farms in Iceland's interior were built over charcoal-enriched soil layers (Fig. 2a–b). These burning levels have generally been interpreted as evidence for the intentional clearance of Icelandic woodlands prior to the establishment of farms (Þórarinsson 1943, 1970). The palynological evidence of settlement in Iceland was sufficiently accepted to serve as a '*landnám*' profile for interpreting the establishment of swidden cultivation in the European Neolithic (Iversen 1941). Recent work at the site of Háls, in western Iceland, supports suggestions that intentional agricultural clearances may only have been partially responsible for deforestation in Iceland (cf. Þórarinsson 1974).

Háls, located 40 km inland in western Iceland, is the site of a small farmstead established in the mid-tenth century and abandoned by the late thirteenth century (Smith 1989, 1991a, 1991b). Test excavations, systematic coring and soil phosphate testing conducted at the site between 1987 and 1991 mapped subsurface features and cultural strata across the 2.1ha area of the medieval farm's core. Soil horizons containing abundant large fragments of charcoal were found immediately beneath the western gable wall of a tenth-century *skáli* and under the phosphate-enriched stratum representing the medieval farm's homefield. In 1989, an iron-production complex covering 0.2 ha was identified at the southeastern corner of the site, adjacent to a bog-iron-producing marsh. Preliminary analyses suggest that the complex consists of two (possibly three) slag heaps, one or more furnaces, a charcoal production or storage pit and a small turf-framed structure. Birch and willow charcoal from the slag heaps and the charcoal pit indicate that the ridge and bog edges were forested when iron production began. Birch charcoal from the uppermost stratum in one of these slag heaps has been radiocarbon dated to the late ninth century (Beta-34359, cal. AD 719 [881] 973; one sigma range).

Hammer scales, slag spatter, scattered burnt bone fragments and a Norwegian schist whetstone were recovered from the floor of a small structure in the southern half of the complex. This structure was excavated shallowly into the ridge and had a narrow, non-load-bearing turf wall enclosing its downhill side. No debris from the collapse of substantial turf walls or roof was found. Available artifactual and structural data suggest that this was probably a small booth or tent where both domestic and smithing activities took place. Two slag heaps have been exposed by erosion in the northern part of the complex. The best documented of these covers 41 sq m and is stratified to a depth of 0.25 m. Tap slag runnels and blocks, plus aggregated furnace slags (Bachmann 1982; McDonnell 1983), comprise 97.7 per cent, by weight, of the slag samples from this deposit. Together with abundant bog-iron ore, these indicate that smelting was the primary activity at the site. Hammer scales, spheroids, two probable smithing hearth bottoms and smithing slags comprise the remaining 2.3 per cent of the sample, suggesting that blooms were also refined here.

Based on ethnographic, experimental and archaeological data relevant to Viking-period bloomery iron production, the volume of slag in this deposit has been conservatively estimated at 1650–3000 kg, representing the production of 300–650 kgs of iron (Evenstad 1790; Jóhannesson 1943; Jakobsen et al. 1988; Larsen 1989). A highly magnetic anomaly, 90 cm in diameter, at the slag heap's western edge probably represents an as yet unexcavated furnace. No substantial structures were identified in this part of the complex, suggesting that iron production was done in the open air or under an impermanent shelter.

The earliest recognized permanent structure at Háls is a Viking period *skáli*, whose walls were built above the burning horizon and the Vö-900 tephra layer (G. Larsen, pers. comm.). The burnt layers beneath the field strata and farmhouse walls thus appear to document a brief phase of iron production predating the establishment of the tenth-century farmstead at Háls. The extent of the charcoal spread may bear witness to heavy traffic between the iron-production complex and outlying charcoal pits. Alternatively, it may indicate that charcoal and iron production here gave rise to one of the forest fires that were recognized as hazards of these industries by medieval Icelanders (Pálsson 1970).

Slag and charcoal concentrations, or the remains of small structures with slag-enriched floors, have been found beneath the walls and field layers of tenth-century farms across southern, eastern and northern Iceland. Iron production was critical to the success of the Icelandic colony (Þórarinsson 1974) and some evidence for iron production or smithing has been identified at most of the early sites, whether these are located on the coastal margin or in the interior. However, there may be significant differences in the types of iron-working sites found in these two settings. Excavated iron-working facilities at early coastal sites, such as Reykjavík, Herjólfsdalur and Grelutóttir, are small in scale, occupy small turf-walled houses, are characterized by small quantities of slag ($\leq$ 150 kg) and were clearly integrated into working farmsteads. Artifactual evidence for the production and repair of tools, and even non-ferrous metal working, are found at these facilities, suggesting that their main function was tool manufacture and repair rather than the production and initial refinement of iron blooms (Ólafsson 1980; Hermannsdóttir 1986: 141; Nordahl 1988: 112).

Inland, the range of sites with evidence for iron-working appears to include larger open-air complexes, like Háls, that are located at a distance from contemporary farmsteads. The quantity of iron slag at these sites may be greater by an order of magnitude than at the coastal sites and primarily represents the by-products from iron smelting and initial refinement of blooms. It is tempting to propose that these interior iron-extraction sites produced the raw material for coastal farms' smithies. Data on iron-consumption rates from later Icelandic farms suggest that one of Háls' slag heaps represents the production of enough iron (300–650 kg) to have satisfied the needs of a single farm for thirty to fifty years (Jóhannesson 1943). Until further investigations are undertaken, it is impossible to say whether small amounts of iron were produced repeatedly at Háls over many years or whether a large amount was produced in one or a few seasons. Limited stratigraphic evidence suggests the latter scenario may be more likely. If so, sites like Háls may be evidence for specialized production in a relatively complex economic and settlement system, rather than production geared to meet self-sufficient household needs.

Iron production, with attendant charcoal burning, represents one of a range of activities that probably contributed to the initial assault on Iceland's forests. The iron production episode represented by a single slag heap at Háls represents the destruction of at least 5–10 ha of woodland (Þórarinsson 1974; Tylecote and Clough 1983). This is a conservative estimate of the local impact of iron production, since at least two slag heaps are present at the site and others are known from the immediately surrounding region. If charcoal-burning or iron production generated unintentional forest fires, as has been suggested, their impact would have affected a far wider area over a very short span of time.

The destruction of Iceland's woodlands by iron production, intentional burning, fuel collection, grazing, building and unintentional fires had long-lasting effects on Icelandic society and environment. Evidence that woodlands were burnt prior to the establishment of farms has been reported for two-thirds of the sites known to have been permanently settled in the tenth century. Residues from iron production are present at 40 per cent of those locations. Clearings produced by iron production or other intentional burning would have been attractive locations for establishing farms, since the back-breaking business of field clearance would have already been completed. Thus, resource decisions made in the earliest land-use phases may have directly influenced the development of later settlement patterns.

Clearances, especially when followed by livestock browsing, would also have dramatically affected the structure and economic utility of Icelandic forests. The dominant tree in Icelandic woodlands, the hairy whitebirch (*Betula pubescens* ssp. *tortuosa*), grows as a straight-trunked tree to heights of 8–12 m when protected from predation (Blöndal 1987). However, fire, felling, livestock browsing and soil acidification cause the tree to regenerate from basal buds as a low and shrubby, multi-branched form that rarely reaches heights greater than 3 m (Davy and Gill 1984; Kauppi et al. 1987; Verwijst 1988). At these heights, most of the trees' branches, leaves and buds would have been accessible to browsing sheep, goats and horses, leading to stunted growth and death. Further, progressive deforestation reduces the extent of sub-canopy snow beds which provide optimum conditions for the survival of birch saplings through the winter (Kullman 1984). As pressure from humans and livestock increased, therefore, it would have been harder to regenerate forests, even in their shrubby form. The low, multi-branched Icelandic birch woodlands could be managed for rafter and charcoal production, but loss of the higher canopy forests eliminated the potential for using indigenous wood resources in construction or ship-building. By the twelfth century, driftwood beaches and birch coppices were economically valuable resources, but voyages were made to Norway for house timber and ships were no longer built in Iceland. Deforestation therefore contributed to the eventual isolation of Iceland, its increasing reliance on foreign shipping and the development of economic inequalities based on access to, and control of, fuel and construction materials.

Farms that were partially deforested prior to their settlement may also have experienced fuel shortages before those that were established in pristine woodlands. We have found no smithies or evidence for iron smelting in the tenth- through thirteenth-century components at Háls, although abundant ore can still be found in bogs surrounding the site. The limiting factor here may have been the ability to obtain adequate fuel for both household use and iron production. The late twelfth-century author of *Heiðarvíga saga* noted that in his time the hillsides within sight of Háls were no longer forested and farmers had to travel 5–12 km

Figure 3 Archaeologists walk through over-grazed waist-high birches (*Betula pubescens* ssp. *tortuosa*) in Hvítársíða, western Iceland. The twelfth-century author of *Heiðarvíga saga* wrote of this same area: 'At that time [the early eleventh century] there was a great forest in Hvítársíða, as there were widely in this land then', implying that most of the local woodlands had already disappeared by his time. A modern Icelandic joke runs, Q: What do you do if you get lost in an Icelandic forest? A: Stand up.

to visit farms that could operate smithies (Fig. 3) (Nordal and Jónsson 1938: 294). Hearths and floor deposits in the thirteenth-century farmstead at Háls are filled with ash from burning peat, rather than charcoal, and willow seems to disappear from the charcoal assemblage after the eleventh century. Here, archaeological and historical evidence suggests that early deforestation helped to create later conditions of economic dependency that were antithetical to the ethos of household self-sufficiency which pervades the sagas and medieval Icelandic scholarship.

The long-term effects of deforestation on local environments and farm productivity may have been equally dramatic. Figure 4 indicates how the inter-related processes initiated by human activities (including deforestation, intentional and accidental fires, grazing and field agriculture) may have led to the expansion of heathlands, blanket bogs and erosion fields. Erosion is one of the most severe problems facing Icelandic farmers today (Arnalds et al. 1987), yet paleobotanical and geological evidence indicates that erosion on a massive scale began within a century of initial settlement and land clearance. Þórarinsson (1970), Einarsson (1963) and Hallsdóttir (1987) have documented rapidly changing rates of aeolian sedimentation in lowland settings by the tenth and eleventh centuries, which implies increasing erosion in surrounding areas and uplands. Dugmore and Buckland (1991) have shown that in southern Iceland the effects of erosion were felt at relatively

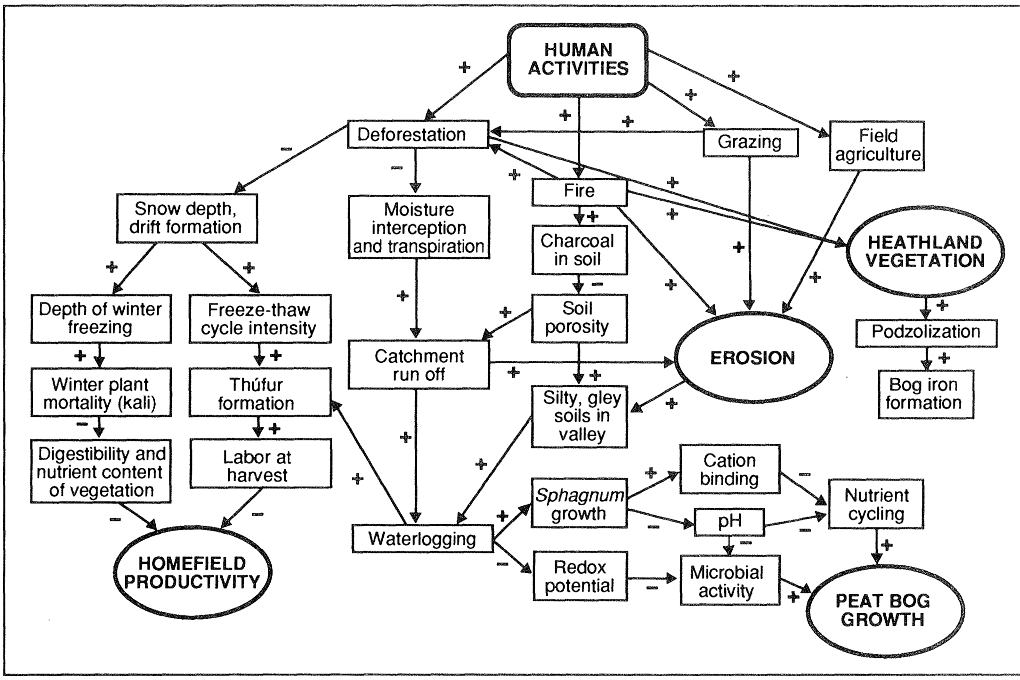

Figure 4 Flowchart showing the impact of human activities on heathland and peat bog expansion, the formation and extension of erosion fields, and agricultural productivity. After Friðriksson (1972), Wheeler (1984), Buckland et al. (1991b) and Moore (1993).

high elevations soon after the *landnám*, with erosion fronts moving downslope through time. Use of these upland areas for iron production, fuel gathering and sheep pasturage could well have contributed to the early spread of erosion.

Since snowdrifts form less frequently during the winters in areas where forest cover has been removed, soil and ground-level plants are exposed to deeper freezing and winterkill. The principal effect of winterkill on Icelandic plant communities is to favor frost-hardy species with low nutrient content and limited digestibility (Friðriksson 1954). More intense freeze–thaw cycles also promote the formation of the frost hummocks (*þúfur*) which blister Icelandic heaths and fields (Sveinbjarnardóttir et al. 1982; Wheeler 1984: 13). The development of these hummocks in homefields and pastures would have dramatically increased the amount of labor needed to harvest the hay on which household livestock depended.

In the short term, forest clearance provided colonists with easily settled farm-sites and also increased the amount of available field and pasture. However, in the long run, winterkill and *þúfur* formation greatly decreased the productivity of homefields and the efficiency of traditional agricultural practices. Erosion gradually reduced the areas available for settlement, while the expansion of heaths and blanket bogs at the expense of tree-sheltered grassland favored sheep, rather than cattle, raising. The loss of the forests themselves may have stimulated the growth of intra-regional economic dependencies and inequalities while reducing the ability of Icelanders to shelter themselves adequately without access to driftwood or imported timber.

The ideological significance of the settlement

Beyond economic practicality, the settlement of Iceland has provided Icelanders with an important ideological charter for eight centuries. *Íslendingabók* formalized the identity of the Icelanders as a distinct people with a unique, known history (Hastrup 1985). By the thirteenth century, when the earliest extant version of *Landnámabók* was written, the tales of Iceland's settlement retained this function. However, different versions of the book manipulated common traditions about the past to legitimate power relationships, in a fashion similar to Tiv use of genealogical relationships (Bohannan 1952). In the Family Sagas, these traditions were elaborated and used to comment allegorically on thirteenth-century political and social conflicts (Sveinsson 1953).

These medieval documents also rationalized social inequalities by reference to the priority of settlers' arrival in Iceland, the social acts of giving or receiving land, and the achievements or fates of different families. Early Icelandic social structure is presented as a network of negotiated alliances between land-owning farmers and chieftains (*goðar*), who were local leaders rather than regional autocrats. This system contrasts sharply with the stratified and regionally centralized polities of thirteenth-century Iceland. Many evolutionary models have been advanced to explain the transition from ranked to stratified pre-state social formations in medieval Iceland (Hermannsson 1930: 13; Sveinsson 1953; Karlsson 1975, 1977; Hastrup 1985; Sigurðsson 1989; Durrenberger 1992). However, early Icelandic society may have been more hierarchically organized than these medieval sources would suggest (Benediktsson 1978). Burial assemblages from ninth- and tenth-century graves suggest three or possibly four social strata, defined by the number of objects accompanying the burials and the presence of recurrent, class-specific artifact sets. This contemporary representation of social structure is similar to the archaeological record of highly stratified social systems in Viking Norway (Solberg 1985), but diverges sharply from the sagas' representation of early Icelandic social structure.

Iceland's colonization provided a powerful ideological framework for legitimizing thirteenth-century élites' claims to power. Traditions about settler-ancestors were used to legitimate and debate claims to authority over regions. At the same time, these traditions were molded in sagas and histories to create a vision of relatively egalitarian conditions from which hierarchical relationships had developed naturally, by common consent and in opposition to the tyranny of Norwegian state founders. From this perspective, *Landnámabók*'s emphasis on the social, rather than chronological, relationships between settlers becomes intelligible. These documents are the ideological foundations for a political system, not descriptions of cultural or ecological processes.

Conclusion

The archaeological record of Iceland's settlement in some ways supports, in other ways refutes and generally extends our historically-based understanding of this case of island colonization. Currently available archaeological data do not refute the medieval texts' chronology for the country's discovery or initial settlement, but it is clear that the frontier of settlement was still expanding into the interior of Iceland long after the AD 930 date by which Iceland was said to have been fully settled (Þórarinsson 1977). While early sites have been found in places such as Reykjavík, where tradition places early settlers, activity was also under way before AD 930 at sites like Háls, Reykholt, Kopavógur and Bessastaðir that are not identified in those sources. At a very general level, medieval descriptions of the settlement process are in accord with current archaeological data. Both suggest initial settlement on the coast, initial use of the interior for non-residential activities and a late spread of settlements out from the coastal cells. However, the historical sources suggest that this entire process took place within the lifetime of single individuals, like Skallagrím, who directed much of the process. Archaeological data, in contrast, suggest that the process took at least a century and was characterized by local diversity and experimentation, rather than planning.

Multi-disciplinary archaeological research in Iceland is still at an early stage, yet work over the past decade has demonstrated that the Norse colonization of the island was characterized by far more complex ecological and social processes than are hinted at in the medieval texts. It is also clear that the medieval texts were products of a later Icelandic political and literary culture that was removed in time and outlook from the society of the earliest Icelanders. Consequently, it is legitimate to question whether the medieval texts help us to understand Iceland's settlement or should be used primarily as sources of information on the ideological foundations of thirteenth-century Icelandic society.

Most archaeologists and historians now working in Iceland refrain from using the medieval texts as accurate sources of information about earliest Icelandic society. Nevertheless, images of Iceland's settlement that were penned by Ari the Wise in the twelfth century still form the basis of North Atlantic culture-historical systematics and in some ways color most attempts to interpret early Icelandic society. North Atlantic archaeologists use the 'settlement period' as a valid culture-historical division and many discussions about Iceland's settlement hinge on whether sites can be dated to the period AD 870–930. Our continued reliance on this twelfth-century construct means that most efforts to 'revolutionize' our understanding of Iceland's settlement have really limited themselves to considering whether this bracket can legitimately be shifted farther back in time.

The duration and character of the 'settlement period' should be defined by archaeological research, rather than being parameters borrowed *in toto* from the medieval literature. I suspect that we would be better served if we abandoned the concept of a *settlement period* altogether and focused our efforts on understanding the settlement of Iceland as a time-transgressive process which spanned different periods of time in different regions as the colonists expanded their areas of settlement and adapted North Sea lifestyles to the challenges of Iceland's North Atlantic environment. Perhaps this process will be better understood when it is possible suitably to define its most significant archaeological correlates.

Several of these correlates can be suggested from data now at hand. The initial Icelandic settlers appear to have relied on a broad-based subsistence strategy, in which primary reliance was placed on resources that had been favored in the original homeland, but with the use of highly visible, energy-intensive resources such as birds as survival foods. In contrast to later periods, limited use was made of resources such as fish and marine mammals that might have provided higher or more sustainable yields, but whose potential could have been less immediately apparent.

Architectural styles and settlement layouts exhibit initially high variability, which may reflect individualized attempts to cope with new conditions or the introduction of building and adaptive traditions from different home areas. This sense of local autonomy is supported by initially high ratios of locally produced to imported objects in site assemblages. This may suggest that the colonists were poorly integrated into foreign exchange networks or that there was an inadequate economic infrastructure to distribute foreign objects within Iceland.

The initial utilization of easily accessible fuel sources, including driftwood accumulations, was accompanied by a rapid expansion of resource extraction zones outward from the initial cells of colonization. Later, this facilitated rapid infilling of the landscape, as settlements were inserted into zones of ecological disturbance that had been created during the first phase of resource exploitation. The result of these activities was a rapid transformation of indigenous ecosystems, with effects that spread out in advance of actual settlement and affected the development of the society for centuries afterward.

Finally, it should be noted that the process of colonization itself left indelible marks on the society and affected the course of its later development. The ecological effects of the *landnám* guided site location choices, initiated processes of environmental change and established enduring patterns of unequal access to critical resources within regions. The settlement process itself also became an important ideological resource that was mined for meaning and political legitimacy over succeeding centuries.

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Abstract

Smith, K. P.

Landnám: the settlement of Iceland in archaeological and historical perspective

The Norse settlement of Iceland established a viable colony on one of the world's last major uninhabited land masses. The vast corpus of indigenous Icelandic traditions about the country's settlement makes it tempting to view this as one of the best case studies of island colonization by a pre-state society. Archaeological research in some ways supports, but in other ways refutes the historical model. Comparison of archaeological data and historical sources provides insights into the process of island colonization and the role of the settlement process in the formation of a culture's identity and ideology.