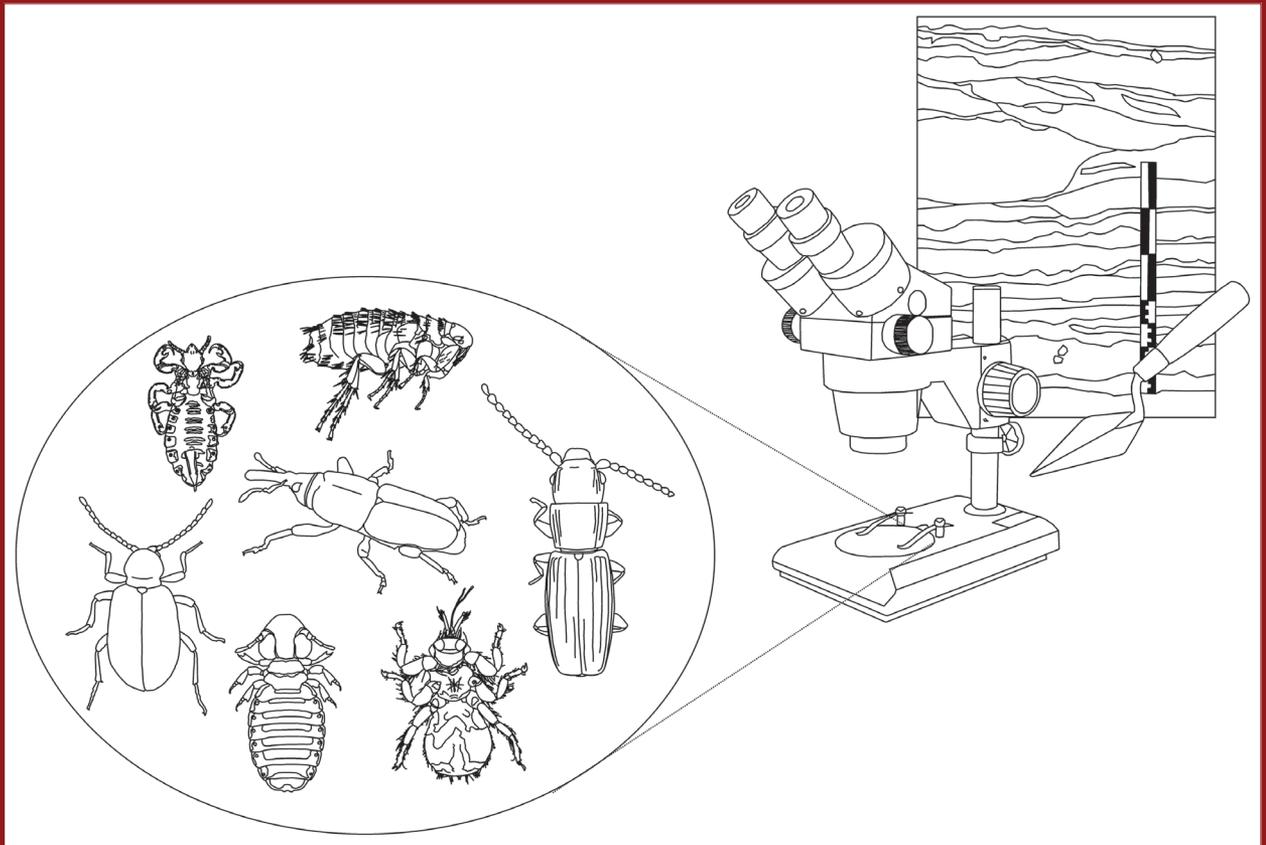




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Archaeoentomological Research in the North Atlantic: Past, Present, and Future

Véronique Forbes, Frédéric Dussault, and Allison Bain



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Archaeoentomological Research in the North Atlantic: Past, Present, and Future

Véronique Forbes^{1,*}, Frédéric Dussault², and Allison Bain³

Abstract - This paper reviews archaeoentomological research in the North Atlantic region, which until relatively recently, was focused mainly on Norse and later farms in Iceland, Greenland, and the Faroes, providing insights into many aspects of daily life on these settlements as well as their impacts on the local environment. Conversely, little research had been undertaken on insect fossils from hunter-gatherer settlements, save a handful of investigations from deposits associated with Saqqaq sites in Western Greenland. Over the past decade, the scope of these studies has extended to encompass new territories, time periods, and research questions. Insect remains from Palaeo- and Neo-Eskimo sites in the eastern Canadian Arctic were examined for the first time, and previously unexamined Norse and later sites have revealed new applications for archaeoentomology. This emerging body of work demonstrates the potential and importance of the continued integration of archaeoentomology in archaeological projects.

Introduction

The lands bordering the North Atlantic region are the homes of distinct cultural groups who have subsisted in these territories through diverse economic adaptations. Palaeo- and Neo-Eskimo hunter-gatherers, who exploited the array of sea mammals and fish provided by the subarctic and arctic waters as well as terrestrial animal and plant resources available in the Tundra, migrated from coastal areas along the North Pacific Ocean to the western North Atlantic region from ca. 2500 B.C. (Grønnow and Sørensen 2006, Labrèche 2001). From the eighth century A.D., seafaring northern European pastoralists (the Norse) sailed westward to establish farming colonies on the North Atlantic islands (Fitzhugh and Ward 2000). This establishment of human settlements in these fragile and “pristine” environments had a profound effect on the local fauna and flora of these regions (Amorosi et al. 1997, Dugmore et al. 2005). Existing ecological niches were expanded, or diminished, while new ecosystems emerged inside the newcomers’ homes. Quaternary entomology, the study of preserved insect remains, has significantly contributed to our understanding of past subsistence and economic strategies and their impacts on North Atlantic landscapes, notably by highlighting the crucial roles human migrations and trade activities have played in reconfiguring the North Atlantic biota over the last millennium (Sadler 1991, Sadler and Skidmore 1995). Until recently, this body of work has largely concentrated on the study of Norse and later agro-pastoral settlements, revealing major ecological changes induced and/or exacerbated by human

activity (Amorosi et al. 1997, Simpson et al. 2001). In contrast, the hunting, fishing, and gathering practices of First Nations peoples and their ancestors, including Palaeo- and Neo-Eskimo cultural groups, have been assumed to have had a limited impact on the environment (e.g., Billington 1981; Dickason 1996, 1997).

This paper provides a review of the contribution of Quaternary entomology to North Atlantic archaeology. All Quaternary-entomological studies use the ecological preferences of identified insects as proxies for past ecological conditions, and the approach can be applied to a diverse set of questions, from the study of natural climatic and environmental changes to the reconstruction of everyday household practices (Elias 2010). Since this paper focuses on studies that contributed to questions of archaeological importance, the term “archaeoentomology” is employed in the text to refer to all studies concerned with the reconstruction of human activities and cultural environments.

For the purposes of this paper, the North Atlantic region includes the islands of Newfoundland, Iceland, Greenland, and the Faroes as well as the eastern Canadian Arctic and extends southwards to where Labrador meets the St. Lawrence River. This review focuses on insect fossil assemblages associated with sites that have been occupied by Palaeo-Eskimos, Neo-Eskimos, Norse people, and their descendants. Research related to European settlements unrelated to the Norse expansion is considered another body of scholarship. Insect assemblages from Norse settlements have previously been reviewed

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elsewhere (Buckland 2000, Buckland and Panagiotakopulu 2005), and although these contributions will also be summarized here, this paper emphasizes work conducted over the past decade.

Four Decades of Archaeoentomological Research in the North Atlantic

The human history of the North Atlantic region

The Palaeo-Eskimos were the first people to settle the lands north of the tree-line in Canada and the coasts of Greenland (McGhee 2001). Similarly, the Norse were the first people to colonize the Faroes and Iceland during the 9th century, although historical (Dicuil 1967) and more recent palaeoecological evidence (Church et al. 2013) suggests an earlier, limited human presence in the Faroes. Figure 1 provides a chronology of cultural developments and major events that took place in the North Atlantic region over the past 4000 years.

The peopling of the eastern Canadian Arctic and Greenland occurred in a series of independent migrations over a period of more than 3000 years. Palaeo-Eskimos were seasonally mobile hunter-gatherer groups able to exploit wild animal and plant resources from the land and the sea, whereas Neo-Eskimos were better adapted to the hunting of marine mammals. They dwelt in sod, ice, or snow houses in winter and in tents or other types of temporary shelters in the warmer seasons (Fagan 2000, McGhee 2001). This mode of living contrasts with

that of the Norse farmers, who lived in turf and stone buildings on farmsteads occupied year-long. Norse subsistence was generally based on pastoral farming and the secondary products of sheep and cattle husbandry supplemented by fishing, hunting, and, in the Faroes and some parts of Iceland, the cultivation of cereals (Arge et al. 2005, Buckland 2000, Sveinbjarnardóttir et al. 2007). The Norse expansion into the North Atlantic began during the 9th century A.D., although Norsemen did not come into contact with Palaeo-Eskimo (Dorset) and Neo-Eskimo (Thule) people in Greenland until approximately four centuries later (Gulløv 2008). The establishment of Norse temporary outposts from ca. A.D. 1000 in eastern North America (e.g., L’Anse-aux-Meadows; Wallace 2000) possibly led to interactions with Palaeo- and Neo-Eskimo groups (Sutherland 2009), while the presence of European whalers and fisherman on the coasts of the St. Lawrence Gulf and the Labrador Sea from the late 15th century (Jordan 1978, Pope 2008) would have created opportunities for further exchanges. Encounters between Neo-Eskimos and Europeans in Arctic Canada certainly occurred with Martin Frobisher’s travels to Labrador and Baffin Island in 1576, but may have remained sporadic until the arrival of Moravian missionaries in the mid-18th century (Pope and Lewis-Simpson 2013). In Greenland, the Norse colonies were extant for ~500 years until abandonment sometime after A.D. 1408 (Seaver 2010), and thereafter, Eskimo groups lived away from further European influences until

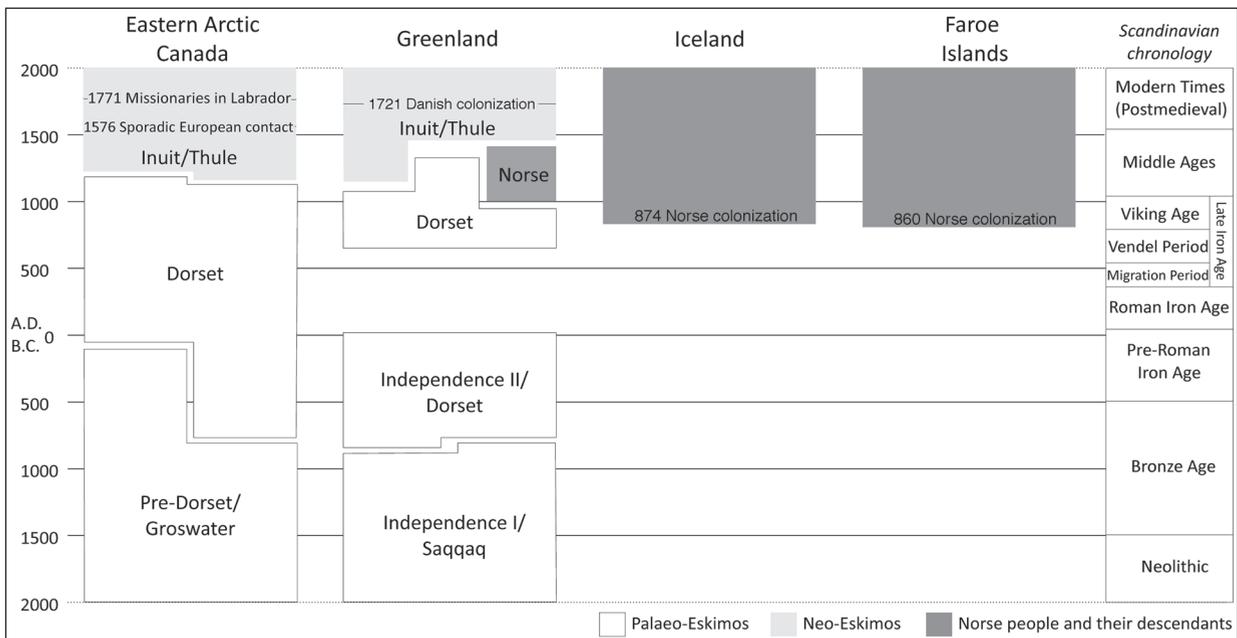


Figure 1. Chronology of Palaeo/Neo-Eskimos cultural groups and Norse and later settlements in the North Atlantic region, modified from the Arctic Chronology of the Avataq Cultural Institute (2011) with added information from Gad (1973), Karlsson (2000), and Pope and Lewis-Simpson (2013). The Scandinavian chronology is based on Hedeager and Kristiansen (1985).

the Danish colonization began in the 18th century (Gad 1973). On Faroese and Icelandic farmsteads, the descendants of the Norse people continued to live in turf buildings off the products of farming until the 19th century (Karlsson 2000).

A brief history of North Atlantic archaeoentomology

Archeoentomological research in the North Atlantic was largely pioneered by Buckland et al. (1983, 1986a) and Skidmore (1996), whose work on beetle (Coleoptera), external parasite (e.g., Phthiraptera and Siphonaptera), and fly (Diptera) fossils preserved in archaeological deposits from Norse Greenland and Iceland established the value of insect remains for reconstructing past activity and living conditions on North Atlantic farmsteads. In Iceland and the Faroe Islands, samples from off-site locations such as peat bogs and mires provided insights into biogeographic changes and the impact of human activity on the native insect fauna (Buckland and Dinnin 1998, Buckland and Dugmore 1991, Buckland et al. 1986b). This early work was underpinned by contemporary revisions and surveys of the modern invertebrate fauna of the region (Bengston 1981, Böcher 1988, Dugmore 1981, Ólafsson 1991), which clarified the status and ecology of many species and thus provided the backbone for archaeoentomological interpretations.

With the development of the BugsCEP database (Buckland and Buckland 2006), which compiles beetle fossil records as well as species' biological and distributional information, it became easier to tackle broad research questions. Concurrent with the generation of new datasets from the Faroes, Iceland, and Greenland (e.g., Forbes et al. 2010, Panagiotakopulu and Buckland 2013, Vickers 2006, Vickers et al. 2005), Quaternary entomologists made progress towards resolving questions regarding the origin and biogeography of the North Atlantic insect fauna (Böcher 2012, Böcher et al. 2012, Buckland and Panagiotakopulu 2010, Panagiotakopulu 2014) and the possibility of a pre-Norse European presence in the region (Buckland and Panagiotakopulu 2008).

One study of insect remains associated with Palaeo-Eskimo occupations pre-dates the first archaeoentomological analyses on Norse sites (Haarløv 1967). However, apart from the identification of lice from Greenlandic mummies (Bresciani et al. 1983, 1989; Hansen et al. 1991), the archaeoentomology of Palaeo- and Neo-Eskimo groups in the North Atlantic halted until the 1990s (Böcher 1998, Böcher and Fredskild 1993). This work developed independently from research on North Atlantic farmsteads until a renewed interest in Norse-indigenous

interactions (Edwards et al. 2009) resulted in new datasets from both Norse and Palaeo/Neo-Eskimo sites in southern Greenland (e.g., Panagiotakopulu et al. 2012, Vickers 2012, Vickers and Panagiotakopulu 2011). Concurrently, research in northern Greenland and Labrador provided opportunities to examine insect fossils from floors and middens on hunter-gatherer sites (e.g., Dussault 2011, Dussault and Bain 2010).

In addition to providing further insights into the timing and nature of human environmental impacts in the North Atlantic (e.g., Panagiotakopulu 2014, Panagiotakopulu and Buckland 2013), recent archaeoentomological research has explored new issues. Assemblages from Norse and later farmsteads have provided evidence about past land-use (Buckland et al. 2009a, Panagiotakopulu and Buckland 2012), transhumance (Vickers and Sveinbjarnadóttir 2013), and eiderdown production (Forbes et al. 2013). Studies on Neo-Eskimo sites have begun to reveal insights into practices and attitudes regarding hygiene and the impacts of hunter-gatherers subsistence activities on their environments (Bain 2000, 2001; Dussault 2011).

Overview of the sites and contexts investigated

North Atlantic archaeoentomology has focused on a diverse array of contexts ranging from archaeological features such as houses or middens to natural deposits such as peat bogs associated with human occupation sites. On farm settlements, anthrosols (soils modified through long-term human activity such as irrigation and manuring) have also been examined for insect remains. Most archaeological research on Palaeo- and Neo-Eskimo sites has focused on occupational, midden, and peat deposits associated with winter dwellings.

Tables 1–3 detail the sites discussed in this paper, the locations of which are shown on Figure 2. These tables and maps provide an overview of archaeoentomological work in the North Atlantic region and facilitate access to the relevant publications and grey literature. For the most up-to-date and exhaustive information on Quaternary-entomological research, readers should refer to the BugsCEP database (Buckland and Buckland 2006) and the Bibliography of Quaternary Entomology (Buckland et al. 2013), both of which are regularly updated.

The Archaeoentomology of Norse and Later Farmsteads

The timing and impacts of *Landnám*

The Norse colonization of the North Atlantic islands, often termed *Landnám* (old Norse for “land-

taking”) led to the establishment of a European farming system based on livestock husbandry in largely pristine landscapes. Norse settlers introduced sheep, horses, cattle, goats, and pigs as well as other resources they would need for their subsistence (Buckland 2000). One of the most striking impacts of the Norse colonization was the accidental introduction of new flora and fauna (Dugmore et al. 2005), including a number of insect pests and “hitch-hikers” that exploited microhabitats provided by shipboard provisions, ballast, and dunnage, but also by the settlers and the animals themselves

(Sadler 1991, Sadler and Skidmore 1995). Indeed, ectoparasites of humans and sheep, including the human louse *Pediculus humanus* L., the sheep lice *Bovicola* (= *Damalinia*) *ovis* (L.), and the sheep ked *Melophagus ovinus* (L.), are common in contexts dated from just after *Landnám* (Buckland 2000). Many predacious and mold-feeding beetles, including *Omalium excavatum* Stephens, *Xylodromus concinnus* (Marsham), *Latridius minutus* (grp) (L.), *Cryptophagus* spp., and *Atomaria* spp., also traveled onboard ships and found ideal habitats in domestic waste, animal manure, and stored hay in the Norse

Table 1. List of North Atlantic sites associated with Palaeo-Eskimo occupations that were investigated for insect remains.

No.	Site	Types of deposits sampled	Dating of sampled contexts	References
1	Asummiut, Greenland	Occupations layers from Saqqaq houses	2 nd millennium BC	Böcher 1998
2	Qeqertasussuk, Greenland	Midden and occupation layers from Saqqaq houses	2 nd millennium BC	Bennike et al. 2000; Böcher and Fredskild 1993; Buckland et al. 1996; Skidmore 1996; unpubl. data in BugsCEP database (Buckland and Buckland 2006)
3	Nanook, Baffin Island, Canada	Midden and occupation layers from Dorset houses	ca. 12 th –15 th centuries AD	Bain 2003
4	Sermermiut, Greenland	Peat deposits close to Saqqaq occupation sites	2 nd millennium BC	Haarløv 1967
5	Willows Island, Baffin Island, Canada	Midden layers associated with a Dorset occupation site	3 rd century BC – 7 th century AD	Bain 1994

Table 2. List of North Atlantic sites associated with Neo-Eskimo occupations that were investigated for insect remains.

No.	Site	Types of deposits sampled	Dating of sampled context	References
6	Cape Grinnell, Greenland	Occupation layers associated with Inughuit houses	13 th –15 th centuries AD	Dussault 2011
7	Great Caribou Island, Labrador, Canada	Occupation layers from Inuit houses	17 th –18 th centuries AD	Dussault and Bain 2010
8	Iita, Greenland	Occupation layers from Inughuit houses	Early 20 th century AD	Dussault 2011
9	Kamaiyuk, Baffin Island, Canada	Occupation layers from Inuit houses	15–20 th centuries AD	Smith 1992, 1994
10	Kuyait, Baffin Island, Canada	Occupation layers from Inuit houses	Mid-19 th –early 20 th centuries AD	Smith 1992, 1994
11	Mallikjuak Island, Baffin Island, Canada	Occupation layers from Inuit houses	10 th –16 th centuries AD	Bain 1997
12	North Island, Labrador, Canada	Occupation layers from Inuit houses	17 th –18 th centuries AD	Dussault and Bain 2010
13	Peterhead Inlet, Baffin Island, Canada	Fill layer in Inuit house	16 th century AD	Bain 1997
14	Qaqaitut, Greenland	Occupation layers from Inuit houses	14 th –17 th centuries AD	Dussault 2011
15	Qilakitsoq, Greenland	Ectoparasites from Thule mummies	15 th century AD	Bresciani et al. 1983, 1989; Hansen et al. 1991
16	Uivak Point, Labrador, Canada	Midden and occupation layers from Inuit houses	18 th –19 th centuries AD	Bain 2000, 2001

Table 3. List of North Atlantic sites associated with Norse and later occupations that were investigated for insect remains.

No.	Site	Types of deposits sampled	Dating of sampled contexts	References
17	Alþingisreitur, Iceland	Midden and floor layers from houses and workshops	9 th –16 th centuries AD	Konráðsdóttir 2010a
18	Bessastaðir, Iceland	Midden and floor layers from residential and farm buildings	9 th –17 th centuries AD	Amorosi et al. 1992; Skidmore 1996, 2013; unpublished data in BugsCEP database (Buckland and Buckland 2006)
19	Breiðuvík, Iceland	Floor layers from pit houses	10 th –11 th centuries AD	Hellqvist 2001
20	Dettifossvegur, Iceland	Floor layers from residential and farm buildings	11 th century AD	Konráðsdóttir 2010c
21	Engihlið, Iceland	Peat deposits close to a Medieval site, possibly a shieling	14 th century AD	Buckland and Sadler 1991
22	Eiríksstaðir, Iceland	Floor layers from residential and farm buildings	9 th –11 th centuries AD	Analyses by M. Hellqvist
23	Egalugialik, Greenland	Peat deposits close to a Norse farmstead	10 th –14 th centuries AD	Sadler 1987, Skidmore 1996
24	Garðar, Greenland	Drainage ditch section close to a Norse farmstead	10 th –15 th centuries AD	Buckland et al. 2009a, Panagiotakopulu and Buckland 2012, Panagiotakopulu et al. 2012
25	Gården under Sandet (GUS), Greenland	Floor and abandonment layers from a Norse farmstead	10 th –14 th century AD	Buckland et al. 1998a; Buckland P.I. 2000, 2007b; Panagiotakopulu 2004; Panagiotakopulu et al. 2007; unpubl. data in BugsCEP database (Buckland and Buckland 2006)
26	Gásir, Iceland	Occupation and midden layers from a Medieval trading post	12 th –14 th centuries AD	Konráðsdóttir 2009a, 2010b
27	Glaumbær, Iceland	Midden layers from Norse and Medieval farmsteads	9 th –14 th centuries AD	Analyses by M. Hellqvist
28	Grænaborg, Iceland	Floor layers from residential and farm buildings	19 th century AD	Konráðsdóttir 2012b
29	Hofsstaðir, Iceland	Floor layers from Norse residential and farm buildings	9 th –11 th centuries AD	Analyses by M. Hellqvist
30	Hólar, Iceland	Midden and floor layers from buildings from a bishopric/farm complex	10 th century AD to the present	Hellqvist 2002, 2003, 2013
31	Holt, Iceland	Midden layers associated with the occupation of a farmstead	9 th –16 th centuries AD	Buckland et al. 1991a
32	Hornbrekka, Iceland	Floor layers and pit fills from a Postmedieval farmhouse	19 th –20 th centuries AD	Forbes 2013b
33	Hrisbrú, Iceland	Floor layers from a Norse longhouse	9 th –11 th centuries AD	Forbes 2009a, Hellqvist 2005
34	Keldudalur, Iceland	Floor layers from Norse and Medieval farmsteads	9 th –15 th centuries AD	Analyses by M. Hellqvist
35	Keldur, Iceland	Floor layers from a Medieval farmstead	12 th –15 th centuries AD	Analyses by M. Hellqvist
36	Ketilsstaðir, Iceland	Peat deposits close to Norse and Medieval farmsteads	7 th –16 th centuries AD	Buckland et al. 1986a
37	Kolkuós, Iceland	Floor layers from booths used as dwelling and workshops (harbor site)	9 th –15 th centuries AD	Analyses by M. Hellqvist
38	Mjóeyri, Iceland	Floor layers from a Medieval farmstead	12 th –13 th centuries AD	Konráðsdóttir 2008b
39	Möðruvellir, Iceland	Midden layers from a monastic center/farm	13 th –20 th centuries AD	Forbes 2013c
40	Mykines (Lambi and Uldalið), Faroe Islands	Deposits from an erosion face	6 th –9 th centuries AD 1998c	Buckland 1992, Buckland et al.

Table 3, continued.

No.	Site	Types of deposits sampled	Dating of sampled contexts	References
41	Nesstofa, Iceland	Midden layers associated with the occupation of a farmstead	9 th –18 th centuries AD	Amorosi et al. 1994
42	Niaqussat, Greenland	Midden layers associated with the occupation of a Norse farmstead	10 th –14 th centuries AD	McGovern et al. 1983, Panagiotakopulu 2004, Sadler 1987, Skidmore 1996
43	Nipaítsoq, Greenland	Midden layers associated with the occupation of a Norse farmstead	10 th –14 th centuries AD	Barlow et al. 1997, Buckland et al. 1983; McGovern et al. 1983, Panagiotakopulu et al. 2007, Skidmore 1996
44	Pálstóftir, Iceland	Midden layers associated with the occupation of a Medieval shieling	10 th –11 th centuries AD	Buckland P.I. 2007a, Lucas 2008
45	Papey (Undir Hellisbargi and Goðatættur), Iceland	Peat deposits close to a Norse farmstead	8 th –13 th centuries AD	Buckland et al. 1995
46	Reykholt (and Faxadalur), Iceland	Midden and floor layers from residential and farm buildings, peat deposits and enclosed areas	9 th –19 th centuries AD	Buckland et al. 1992, 2009b, 2012; Sveinbjarnadóttir et al. 2007; Vickers and Sveinbjarnadóttir 2013
47	Sandhavn, Greenland	Peat deposits close to a Norse farmstead	14 th –15 th centuries AD	Vickers and Panagiotakopulu 2011
48	Sandnes (Kilaersavik), Greenland	Midden layers associated with the occupation of a Norse farmstead	10 th –14 th centuries AD	Buckland et al. 1994, 1996; Panagiotakopulu 2004; Skidmore 1996; Sveinbjarnadóttir and Buckland 1983
49	Skálholt, Iceland	Floor layers from buildings from a bishopric/farm complex	17 th –18 th centuries AD	Konráðsdóttir 2007
50	Skriðuklaustur, Iceland	Floor layers from buildings from a monastery/hospital complex	15 th –16 th centuries AD	Konráðsdóttir 2008a, 2009b, 2012a
51	Skútústaðir, Iceland	Midden layers associated with the occupation of a farmstead	9 th –19 th centuries AD	King and Forbes 2010
52	Stóraborg, Iceland	Midden, floor layers and drain fills from a Postmedieval farmhouse	17 th century AD	Buckland and Perry 1989, Perry et al. 1985, Sveinbjarnadóttir et al. 1980
53	Svalbarðshreppur (Svalbarð and Hjálmarsvík), Iceland	Midden layers associated with the occupation of farm buildings and shielings	11 th –19 th centuries AD	Forbes 2013a; unpubl. data in BugsCEP database (Buckland and Buckland 2006)
54	Sveigakot, Iceland	Floor layers and hearth fills from residential and farm buildings	9 th –12 th centuries AD	Analyses by H. Konráðsdóttir
55	Tasiusaq, Greenland	Peat deposits close to a Norse farmstead	11 th –14 th centuries AD	Edwards et al. 2008, Panagiotakopulu and Buckland 2013
56	Tatsip Ataa, Greenland	Midden layers associated with a Norse occupation	10 th –12 th centuries AD	Dussault et al. 2014
57	Tjørnuvík, Faroe Islands	Peat deposits close to a Norse farmstead	7 th –11 th centuries AD	Buckland 1992, Buckland and Dinnin 1998
58	Toftanes, Faroe Islands	Floor layers and drain fills from a Norse farmstead and peat deposits	9 th –10 th centuries AD	Edwards et al. 1998, Vickers and Buckland 2013, Vickers et al. 2005
59	Þjótandi, Iceland	Floor layers from a Norse farmstead	10 th century AD	Konráðsdóttir 2008c, 2009c
60	Þverá, Iceland	Floor layers and drain fills from a still-standing farmhouse and associated outbuildings	20 th century AD	Forbes 2013b, Forbes and Milek 2013
61	Vatnsfjörður, Iceland	Floor, midden and abandonments layers from a farmstead	10 th –20 th centuries AD	Forbes 2007, 2008, 2009b, 2009c, 2013b; Forbes et al. 2010, 2013

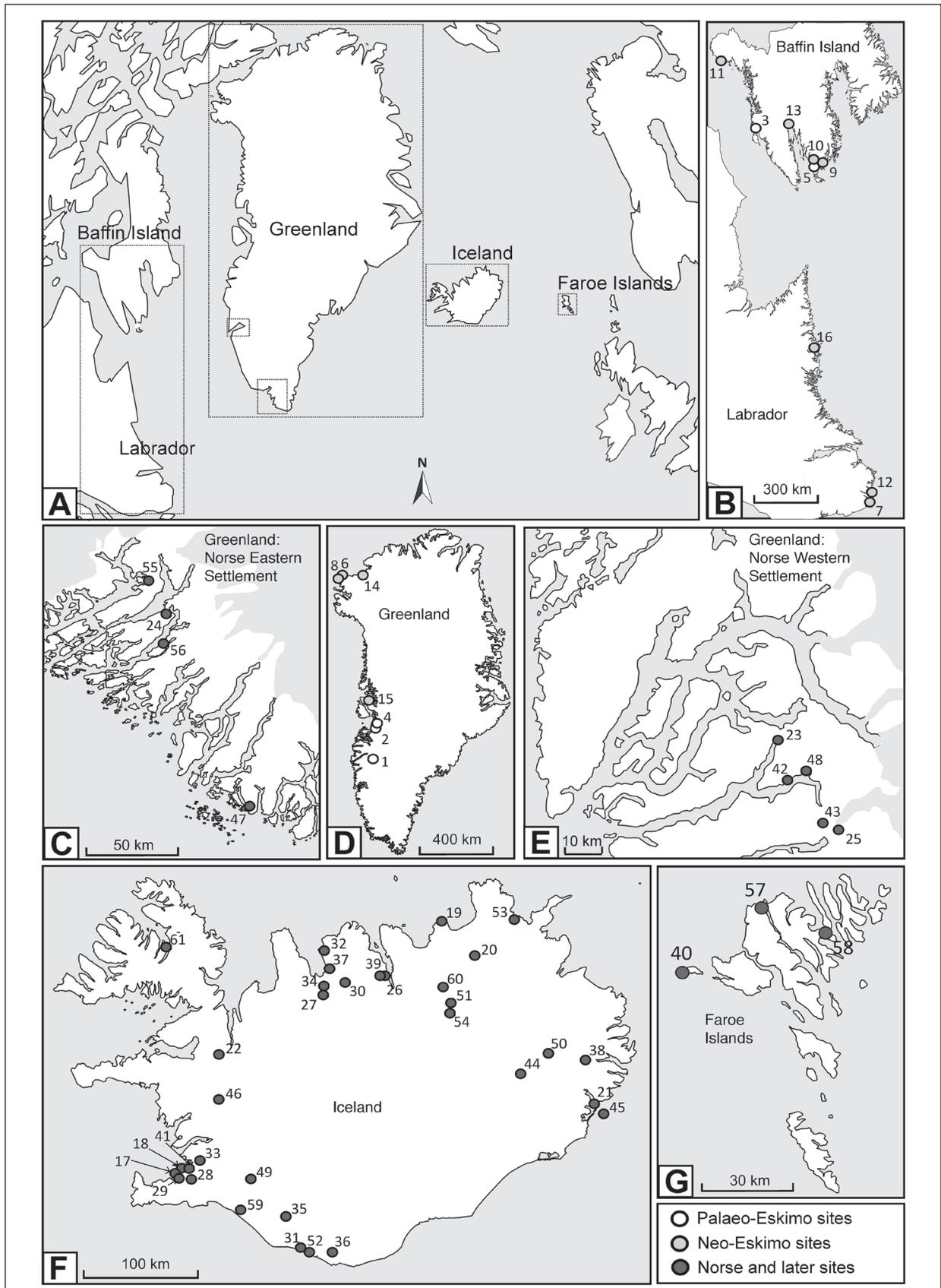


Figure 2. Location of the sites listed in Tables 1–3.

homes (Dugmore et al. 2005, Sadler and Skidmore 1995). The scarabaeid *Aphodius lapponum* Gyll., associated with the dung of large herbivores, has been identified as another Norse introduction to the faunas of Iceland and the Faroes (op. cit.). The species has not been recovered from the Norse Greenlandic settlements despite the introduction of livestock and the presence of native caribou herds, and it was recently suggested that the length of the journey and the harsher climate of Greenland may account for its absence (Panagiotakopulu 2014, Panagiotakopulu and Buckland 2013).

While the continuity of settlement in Iceland and the Faroes ensured the long-term establishment of many introduced species, the eventual abandonment of the Greenlandic colonies led to a few hundred years interruption in the availability of suitable habitats for many synanthropic beetles (Sadler 1991, Sadler and Skidmore 1995). Indeed, Vickers and Panagiotakopulu (2011) did not identify a single anthropochorous species in post-abandonment peat layers at the former Norse settlement of Sandhavn in Greenland. Böcher (1997) has suggested that *Quedius mesomelinus* (Marsham) and *Xylodromus coninnus* (Marsham) may have survived in Thule or Dorset sod houses, as these are the only Norse introductions that were frequently recorded in the early 20th century. Nevertheless, this hypothesis has yet to be substantiated through archaeoentomological data.

The introduction of beetle species strongly dependent on the artificially heated habitats available in houses and ancillary buildings to North Atlantic faunas was a direct consequence of the Norse colonization. There is little doubt that the arrival of the Norse settlers also played a role in modifying the distribution and frequency of some native species, as settlement sites provided a mosaic of microhabitats that “mimicked” particularly nutrient-rich natural settings. The beetles *Corticaria linearis* (Payk.) and *Catops borealis* Krog., respectively found in moss and luxuriant vegetation in Greenland (*C. linearis*) and in bird’s nests and burrows in the Faroes (*C. borealis*) (Bengston 1981, Böcher 1988), expanded from their original niches to colonize accumulations of rotten hay and domestic waste on farms (Buckland et al. 1998c, Sadler and Skidmore 1995), whereas the range of other indigenous insects declined as woodland and scrub was cleared to make room for pastures and hayfields. For example, the willow-associated weevils *Dorytomus imbecillus* Faust and *Rutidosoma globulus* (Hbst.), as well as the psyllid bug *Cacopsylla groenlandica* (Sulc.), seem to disappear from certain areas of southwest Greenland after *Landnám* as a consequence of vegetation clearance and the stripping off turf for

building construction (Panagiotakopulu and Buckland 2013). In Iceland, the aquatic beetle *Hydraena britteni* Joy, recorded in pre- and post- *Landnám* layers at Holt and Ketilsstaðir, became locally extinct sometime in the 14th or 15th century (Buckland et al. 1991a). Whether this extirpation is to be ascribed to the introduction of pastoral agriculture or to climate change is unclear; a combination of those factors is more likely (Erlendsson et al. 2009). Cooling related to the Little Ice Age and agricultural impacts may have influenced not only the fate of *H. britteni* in Iceland, but also that of other native North Atlantic insects including: *Euasthetus laeviusculus* Mann. in Greenland (Buckland and Wagner 2001); *Calathus micropterus* (Duft.), *Coelostoma orbiculare* (F.), and *Ochtheophilus omalinus* (Er.) in the Faroes (Buckland and Dinnin 1998, Buckland et al. 1998b, Vickers and Buckland 2013); and the rove beetle *Lathrobium brunnipes* (F.) in both Iceland and the Faroes (Buckland et al. 1991b, 1998b).

Recent palaeoecological work in the region has shown that the impacts of *Landnám* on North Atlantic environments were neither simultaneous nor spatially homogeneous. At Stóra-Mörk in southern Iceland, evidence for large-scale environmental change only becomes apparent in layers deposited after the eruption of the volcano Katla in A.D. 920, which was 50 years after the area was colonized by the Norse (Vickers et al. 2011). Insect remains and other proxies are indicative of an intensification of land-use, which is likely to have involved drainage and the fertilization of fields with animal manure and domestic waste. Such activities are also apparent in a profile from the former farm and ecclesiastical center of Garðar (modern-day Igaliku) in the Norse Eastern Settlement in Greenland (Buckland et al. 2009a, Panagiotakopulu and Buckland 2012). Insect specimens such as the spider beetle *Tipnus unicolor* (Pill. and Mitt.), sheep keds, and human lice, all of which ought to have originated within built structures, likely ended up in the hayfield as a result of their transport in material used as fertilizer (Buckland et al. 2009a, Panagiotakopulu et al. 2012). A contrasting reconstruction of land-use practices comes from the nearby farm of Tasiusaq, where no synanthropes were recovered (Panagiotakopulu and Buckland 2013). In this instance, the sampled peats were ≈500 m away from the main farm’s ruins, and it is therefore likely that strongly synanthropic insects were present in farm buildings but were not able to reach the sampled area of the hayfield by their own locomotive means (op. cit.). The contrasting nature of these findings stresses the variability of land-use practices and associated environmental change in Greenland. The latest palaeoecological work in the

Eastern Settlement (e.g., Ledger et al. 2013, 2014) also depicts a more heterogeneous cultural landscape than illustrated in earlier studies (e.g., Fredskild 1973).

Insects and the North Atlantic farm

One of archaeoentomology's most important contributions to North Atlantic archaeology was the formulation of a conceptual model for the provenance and origin of insect remains on Norse farms (Buckland et al. 1993). Subsequent research (e.g., Forbes and Milek 2013; Smith 1996a, b) has confirmed many aspects of the initial model while also highlighting potential pitfalls. We summarize below various aspects of past subsistence and economies on North Atlantic farms as examined through the study of insect remains.

Local resource exploitation. Building with turf was once widespread in the North Atlantic region (Ólafsson and Ágústsson 2000). Turf, the active growing layer of grass which was collected in blocks from meadows or wetlands for building purposes, contains fossils of outdoor insects generally representative of these environments (Kenward et al. 2012). Its role as a transport agent for outdoor beetles and bugs into North Atlantic houses, byres, and barns has long been recognized (e.g., Buckland et al. 1992, Forbes et al. 2010, Vickers et al. 2005). Peat is another similar resource that was once commonly used, although in this instance for fuel and litter. Separating the insect component of peat and turf is often difficult, due to the similar ground beetles and phytophagous insects found in both substrates (e.g., Amorosi et al. 1992, 1994; Buckland et al. 1992). Use of peat is likely to introduce aquatic taxa such as water beetles (Dysticidae), larval caddis flies (Trichoptera), and non-biting midges (Chironomidae) as well as mosses and plants common in wetland environments into archaeological deposits. Early records of aquatic insects and moss-dwelling beetles, such as *Byrrhus fasciatus* (Forst.) and *Simplocaria metallica/elongate* Sturm/Sahl, from archaeological floors on Norse farms were interpreted as having resulted from the transport and use of peat as litter (e.g., Buckland et al. 1994). Nevertheless, more recent work has shown that turf collected from wetlands can also contain these insects (Forbes and Milek 2013), stressing the need for caution when interpreting the provenance of remains of aquatic and wetland taxa.

As Norse subsistence was largely based on the products of livestock husbandry, the most important task of farmers was the cultivation of enough fodder to overwinter domestic animals (Amorosi et al. 1998). Cattle were normally fed and housed for the

whole winter, but sheep would have been kept outside, weather permitting (Ogilvie 2000). The buildings and rooms which served to house them would have provided ideal ecological conditions for beetle species feeding on spores, molds, and fungi growing on decaying plant matter, as well as for species thriving in foul conditions such as in stable manure. Most insect assemblages recovered from farm sites are dominated by species which fall into these ecological groups and are commonly referred to as the "barn beetles" (e.g., Buckland et al. 1991a, 1992; Vickers et al. 2005). In Iceland, the insect record from Norse and later farms commonly include *Cryptophagus* spp., *Atomaria* spp., *Latridius minutus* (grp.), *Corticaria elongata* (Gyll.), and *Xylodromus concinnus* (e.g., Buckland et al. 1991a, Forbes et al. 2010, Konráðsdóttir 2007). In Greenland, assemblages are typically less diverse, and *C. elongata* seems to be replaced by *C. linearis* (Payk.) (Buckland et al. 1996, McGovern et al. 1983). Today the "barn beetles" tend to be confined to barns and byres in the region (Larsson 1959). Yet, this would not have been the case in the past, when people used materials such as hay, straw, turf, and peat for a variety of purposes, from bedding to insulation and littering in human and animal dwellings (Annandale 1905, Ólafsson and Pálsson 1805). This caveat is borne out in comparative work on modern faunas from hay and leaf fodder, thatch roofs, and abandoned floor deposits in the UK (Smith 1996a, 1996b, 1998, 2000) and in Iceland (Forbes 2013b), which highlighted the possible flaws in the interpretation of faunas commonly associated with molding hay. Insect assemblages from vegetal material used for flooring and roofing were found to contain species that might also find suitable ecological conditions in stored hay.

Terrestrial plants were not the only vegetal matter to find their way into Norse buildings. Ethnographic records suggest that seaweed was also utilized on North Atlantic farms as a source of salt, animal fodder, bedding, fuel, and fertilizer (Annandale 1905, Fenton 1978, Hallsson 1964, Ólafsson and Pálsson 1805). Seaweed does not preserve easily, but charred remains and small mussel shells associated with marine environments have been recovered from a number of sites (e.g., Mooney 2008, Vickers et al. 2005, Zutter 2000). Furthermore, numerous rove beetles, such as *Omalium laeviusculum* Gyll. and *O. riparium* Thoms., and fragments of the epizootic hydroid *Dynamena pumila* (L.) have been recovered from Icelandic and Greenlandic sites and imply resource exploitation in the littoral zone (Amorosi et al. 1992, 1994; Buckland et al. 1996; Skidmore 1996). While it may be difficult to identify the purpose for which

seaweed was used, the presence of insects associated with beached algae may indicate the collection, use, and possible storage of this material.

Eiderdown was once an important source of wealth in Scandinavia and northern Europe, but this natural resource has largely been overlooked in archaeology (Berglund 2009). Recent examination of insects from modern eiderdown stores in Iceland has revealed that this production can be detectable in the archaeoentomological record through the identification of bird fleas, including the duck flea *Ceratophyllus garei* Rothschild (Forbes 2013b, Forbes et al. 2013). This species infests ground-nesting birds including plovers and Eider ducks in Iceland (Brinck-Lindroth and Smit 2007, Henriksen 1939), and like all other *Ceratophyllus* species, it spends the largest part of its lifecycle in nests rather than on the body of its host (Brinck-Lindroth and Smit 2007). Birds other than Eider ducks are known to have been exploited for their feathers and down on Icelandic farms, but these were obtained through the collection of flight feathers fallen to the ground or by plucking birds (Beck 2013), which are unlikely to introduce large numbers of bird fleas in the archaeological record. The recovery of more than a hundred *Ceratophyllus* fleas alongside egg shell fragments, feathers, and plant debris likely to have originated from nests in a floor layer at 19th-century Vatnsfjörður in northwest Iceland allowed the first archaeological identification of eiderdown production activities (Forbes 2013b, Forbes et al. 2013).

Foodstuff imports and trade. The subarctic climate, which limits the growing season in much of the North Atlantic region, was a severe impediment to the cultivation of cereals. Nevertheless, grain was successfully grown in the Faroes and in Iceland (Church et al. 2005, Guðmundsson et al. 2012) and perhaps even in the early years of settlement in Greenland (Henriksen 2012), but production was never large scale. To complement their largely meat- and dairy-based diets, the Norse and their descendants imported grain from abroad. This fact is evidenced in archaeoentomological studies by finds of grain pests, the most common including the grain weevil *Sitophilus granarius* (L.) and the saw-toothed grain beetle *Oryzaephilus surinamensis* (L.) (e.g., Amorosi et al. 1992, 1994; Buckland et al. 1991a, 1992; Vickers and Buckland 2013). In modern situations, *S. granarius* has been recorded from wheat, rye, barley, maize, oats, buckwheat, millet, and chick peas, and *O. surinamensis* is known to attack damaged grain and processed cereals (Bousquet 1990, Buckland 1990). The former requires temperatures above 15 °C to complete its

developmental cycle, but as the latter requires at least 21 °C (Howe 1965), it is unlikely that intermittent and small stores of locally grown barley would have provided suitable ecological conditions to support breeding populations. Therefore, it has been assumed that most specimens recovered from archaeological sites arrived along with food cargoes. Buckland et al. (2009b) recovered 80 specimens of *Aglenus brunneus* (Gyll.), a blind and flightless beetle able to exploit moldy cereals, compost, hay, and manure (Fogliazza and Pagani 1993, Koch 1989), in one sample dating from the Medieval Period at Reykholt in western Iceland. They suggested that such a large number was indicative of a breeding population, but that, like *S. granarius* and *O. surinamensis*, the species had no doubt been introduced with imported grain or other products (Buckland et al. 2009b, Sveinbjarnardóttir et al. 2007). *A. brunneus* is extremely rare today in Iceland (Larsson and Gígja 1959), which indicates that the species failed to establish permanent populations in the country (Buckland et al. 2009b). The analyses of samples from Postmedieval and Modern phases of occupation on Icelandic farms yielded additional records of obligate pest species, some of which were not recovered from older sites. These finds include the cowpea weevil *Callosobruchus maculatus* (F.) from Skálholt (Konráðsdóttir 2007), the flat grain beetle *Cryptolestes* sp. from Þverá (Forbes and Milek 2013), and the rice/maize weevil *Sitophilus oryzae/zeamais* (L.)/Mots. from Vatnsfjörður (Forbes 2013b, Forbes et al. 2010). The recovery of the non-indigenous ant species *Hypoponera punctatissima* and *Leptothorax* sp. from Postmedieval Reykholt were also suggested as indicative of products imported from Europe (Buckland et al. 2012).

Insect as indicators for specific activities and room functions. Insects preserved in floors or from materials derived from floors may provide insights into specific activities. Human ectoparasites such as *Pediculus humanus* L., the human louse, are common to both Icelandic and Greenlandic farms (Amorosi et al. 1992, 1994; Buckland et al. 1992; Forbes et al. 2010; Sveinbjarnardóttir and Buckland 1983); the latter also yielded records of *Pulex irritans* L., the human flea (Buckland et al. 1998a). Sometimes, such insect remains are charred, suggesting that the parasites were discarded into the hearth following their removal (e.g., Buckland et al. 1992, 1998a). In some cases, the high quantity of human ectoparasites has been used to make inferences about the hygiene of former inhabitants (e.g., Buckland et al. 1992). However, it must be stressed that poor preservation conditions may have “sanitized” the archaeoentomological record, and any interpretation of past

hygiene levels undoubtedly reflects our modern-day prejudices (cf. Buckland et al. 1992, 1993).

Sheep ectoparasites, including sheep keds *Melophagus ovinus* (L.) and lice *Bovicola ovis* (L.), are also prevalent on Icelandic and Greenlandic farms, sometimes in large numbers. One example comes from Stóraborg in Iceland where over 200 sheep ectoparasites were recovered from a drain, raising the question of how these insects were deposited in a closed conduit. Both the mature and immature stages of these insects tend to remain on the fleece of the animal during its life (Marshall 1981), and thus casual losses from stalled animals are unlikely to have resulted in such an accumulation. By integrating archaeological, ethnographical, and entomological evidence, Buckland and Perry (1989) proposed that high concentrations of sheep ectoparasites were deposited with the stale urine used as a cleansing agent in wool processing. When found in small numbers and scattered throughout samples, sheep keds and lice have been interpreted as either resulting from the final preparation of wool or to casual losses from the animals (e.g., Buckland et al. 1992, Forbes et al. 2010, Panagiotakopulu et al. 2007).

Buckland et al. (1993) suggested that the entomological record can be used to discriminate rooms and buildings used by the human occupants from those employed to house animals. At Postmedieval Reykholt, ectoparasites from sheep and humans were found together and interpreted as evidence for delousing and wool spinning and/or combing. Since such activities traditionally occurred in the *stofa* (main living room), the combination of sheep and human ectoparasites was interpreted as fingerprinting such an activity area (Buckland et al. 1992:163). At Nipáitsoq in the Western Settlement in Greenland, insect remains have also been used to attempt to identify sleeping quarters. Here, in a sample matrix containing feathers and down, marine littoral and moss-dwelling insects were recovered (Buckland et al. 1983:93–94, McGovern et al. 1983:104), suggesting that down, mosses, and perhaps seaweed were used in this room. Henderson (1818), a British visitor to Iceland during the years 1814–1815, noted these materials being employed for bedding, and therefore this assemblage was interpreted as an indicator of sleeping quarters (Buckland et al. 1983, McGovern et al. 1983). Whether this approach can always be defended is debatable. Down, feathers, seaweed, and moss were used not only as bedding but also as trade products (down and feathers), fuel (seaweed), and litter (moss and/or peat) (e.g., Annandale 1905, Beck 2013, Boucher 1989, Hallsson 1964). They could therefore have been incorporated into occupation deposits through a wide variety of

means. In recent studies from northwest Iceland, archaeoentomological and archaeobotanical evidence for down and seaweed were identified in deposits from storage rooms (e.g., Forbes et al. 2013; Mooney 2008, 2009).

To test some of the assumptions of the aforementioned “insect indicator for specific activities” approach, Forbes and Milek (2013) investigated insect assemblages from the extant 19th- and early 20th-century turf buildings at Þverá in northeast Iceland. At this site, the function of each room/building and the cultural practices that took place inside them are well documented (Milek 2012) and used to assist the interpretation of insect remains. Although all the samples were dominated by mold-feeders and their predators (the “barn beetles”), statistical analyses revealed differences in the synanthropic component of beetle assemblages from the different rooms and outbuildings. Animal houses were dominated by mold-feeders more or less tolerant to damp and unsavory materials and conditions, while the near-absence of beetles preferring rotting manure was reminiscent of results obtained from modern stable manure on British farms (Smith 1998, 2000). Whether this is attributable to the practice of removing stable manure from animal buildings for use as fertilizer, or to other taphonomic factors (see Smith 1998, 2000) is unclear. Pantry floors contained species preferring drier conditions and facultative pests in stored products, including *Cryptophagus* spp. and *Mycetaea subterranea* (Marshall), while the bedroom, kitchen, corridors, and fuel store comprised a more mixed component, incorporating outdoor species, synanthropes, and eurytopic taxa. The results from Þverá identified varying ecological conditions prevalent in the different rooms, but suggested that elucidating room functions on archaeoentomological evidence alone is perhaps unfeasible. Nevertheless, it may be achieved where entomological data is well-integrated with other archaeological and proxy data.

Sanitation and living conditions. The advent of better cleaning and building technologies and of a better awareness of the role of insects in the transmission of plant and animal diseases had the effect of reducing the overall number of insect pests in homes, especially in the past 50–60 years (Busvine 1976, Kenward and Allison 1994). Despite this, insects are still common in houses today, and when recovered from old houses, they can be used as proxies to evaluate past living conditions. A classic example comes from Norse Greenland, where the retrieval of many human lice and fleas from floors believed to have formed in animals stalls have been used to suggest that farmers lived

in close proximity with animals (Buckland et al. 1998a, Panagiotakopulu et al. 2007). Indeed Buckland et al. (1998a) advanced the theory that this was a necessity if people had to force-feed the animals with hardly palatable fodder when hay crops had failed. The presence of the fly *Telomarina flavipes* (Meig.), whose puparia feed on protein-rich material, in an alcove containing sheep dung at Gården under Sandet (GUS), supports the interpretation of sheep having had a diverse diet that may have included pounded fish (Panagiotakopulu et al. 2007). There are several other cases where insect assemblages were interpreted as evidence for squalid conditions in human dwellings. The species *Catops borealis* Krog. and *Quedius mesomelinus* (Marsham) have been used to suggest the presence of foul residues on floors at Stóraborg (Perry et al. 1985), where the presence of fish bones, mammal bones fragments, and wood chips also suggested the deposition of waste and rotting plant materials on dwelling floors (Sveinbjarnadóttir et al. 1980). At Nipaítsoq in Greenland, high numbers of *Heleomyza serrata* (L.), a fly which breeds mainly in feces, were recovered in some of the living rooms and have been used to argue for unsanitary, squalid conditions (Buckland et al. 1983). The predominance of decomposer species in the 18th-century floors of the Faroese farm at Toftanes was interpreted as evidence for unsavory indoor conditions as well (Vickers and Buckland 2013). These archaeoentomological reconstructions of living conditions paint a picture of life on North Atlantic farms which concurs with contemporary descriptions (e.g., Henderson 1818, Mackenzie 1811). Yet, such interpretations conflict with studies that recovered clear evidence for cleaning and floor-maintenance practices and rather salubrious living environments (Forbes 2013b, Forbes and Milek 2013, Milek 2012). Certainly there is a need for additional data from across time periods and geographical areas before we can really start appreciating how living conditions in turf buildings varied across time, space, and social classes in the North Atlantic region.

Transhumance and the identification of shieling sites. Transhumance, a system whereby animals are moved for the summer to remote pastures to reduce pressure on infield pastures, has long been assumed in the Norse world (Sveinbjarnadóttir 1991). Nevertheless, the temporary nature of shieling sites makes them difficult to identify. A variety of methods have been employed for this purpose, including the study of written sources and place-names, landscape archaeology, and pollen analysis (e.g., Albrethsen and Keller 1986, Ledger et al. 2013, Sveinbjarnadóttir 1991).

Buckland and Sadler (1991) were the first to explore the potential of archaeoentomology as a means of distinguishing shielings from permanent farms. They argued that the small-sized, remote, and seasonally occupied buildings could not sustain breeding populations of mold-feeders and their predators commonly encountered on permanent farms. For example, Engihlíð, in eastern Iceland, was interpreted as a shieling due to the absence of “barn beetle” fauna and the presence of the dung beetle *Aphodius lapponum* Gyll., indicative of the presence of livestock dung (Buckland and Sadler 1991). Lucas (2008) also used the absence of synanthropic insects associated with decaying vegetal matter in samples from Pálstóftir to support his interpretation of the site as a shieling. In both these cases, differential preservation was evident (Buckland 2007a, Buckland and Sadler 1991), implying that the absence of thermophilous synanthropes was perhaps an artifact of taphonomical processes rather than an evidence for the activities conducted on the sites. Moreover, a recent study at the known shieling site of Faxadalur, associated with the larger farm of Reykholt, did recover taxa commonly associated with organic waste such as *Latridius minutus* (grp.), *Cryptophagus* spp., *Omalium excavatum* Steph. and *Aleochara sparsa* Heer (Vickers and Sveinbjarnadóttir 2013). Contrary to the assumptions of Buckland and Sadler (1991), the presence of anthropochorous insects at Faxadalur indicates that synanthropic decomposers can be transported to shieling sites. As pointed out by Vickers and Sveinbjarnadóttir (2013), a more careful consideration of the taphonomy and mechanisms of dispersal of synanthropes is needed if archaeoentomology is to help in distinguishing shielings from permanent farms.

Fossil insect faunas and farm-abandonment scenarios. An important contribution of archaeoentomology to North Atlantic archaeology has been in reconstructing events preceding the abandonment of Norse Greenland. For example, results of the analysis of preserved fly remains from the farm of GUS in the Western Settlement suggested intermittent phases of temporal abandonments and re-occupation (Buckland et al. 1998a, Panagiotakopulu 2004, Panagiotakopulu et al. 2007). Occupation layers at the site are dominated by remains of the primarily necrophagous species *Heleomyza borealis* Bohé and *T. flavipes*, a thermophilous synanthrope associated with protein-rich decaying organic matter. Samples from abandonment phases were largely devoid of synanthropic species, and one of these, collected from the remains of the collapsed roof, contained many sheep lice and caddis fly larvae. This find was interpreted as evidence for the formation of a

temporary pool and perhaps the return of stray sheep to the farm. A mummified goat found under the collapsed roof did not contain any synanthropic flies, suggesting that the goat died in the ruins post-abandonment, when the farm was no longer an island of warmth able to support *T. flavipes*. Archaeological evidence indicates that the room was later rebuilt on top of the animal's body as the farm was subsequently re-occupied, prior to final abandonment. According to the archaeoentomological data, the inhabitants of GUS may have left the farm during particularly harsh years (op. cit.).

A different abandonment scenario is suggested for the farm of Nipaitsoq. Samples interpreted as the penultimate occupation layers in the presumed bedroom and living room were strongly dominated by *T. flavipes* (Meig.), which was interpreted as indicative of exceptionally squalid conditions in the living rooms, "more similar to a latrine than living quarters" (Panagiotakopulu et al. 2007:304). In the larder, where there were abundant faunal remains, the carrion-associated fly species, *H. borealis* and *Scoliocentra fraterna* Loew were also present. A sharp decrease in *T. flavipes* and their replacement by more cold-tolerant species was considered indicative of an acute temperature change in the rooms, reflecting the rapid abandonment of the farm (Panagiotakopulu et al. 2007). In conjunction with zooarchaeological and palaeoecological evidence, it was suggested that these fly faunas indicated that the occupants of Nipaitsoq were clearly under stress during the last phase of occupation and that, following a long and harsh winter, they slaughtered all their cattle and even consumed their dogs in an attempt for survival (Buckland et al. 1983, McGovern et al. 1983, Panagiotakopulu et al. 2007). The presence of two sarcophagid fly species in post-abandonment layers is also suggested as evidence for the death of the farm's inhabitants *in situ* (Panagiotakopulu et al. 2007:304). This rather dramatic scenario relies heavily on the exceptional character of the fossil fly data recovered from the site, especially the abundance of *T. flavipes* in the living rooms, but there is limited comparative data from other North Atlantic farms (Panagiotakopulu 2004, Skidmore 1996).

The archaeoentomological record has certainly clarified the processes by which two of the farms came to be abandoned; nevertheless, whether the demise of the Norse Greenlandic Settlements happened as a result of its occupants having moved back to Iceland, or having died *in situ* following conflicts and harsh living conditions, still remains a mystery.

The Archaeoentomology of Palaeo- and Neo-Eskimo Sites

Hunter-gatherer subsistence activities and their ecological impacts

Early Quaternary-entomological investigations in Greenland tended to focus on environmental changes and the biogeography of insect faunas (e.g., Böcher 1995, 1997). Some of these studies were conducted on samples collected from Palaeo-Eskimo occupation sites or in peat deposits adjacent to such settlements (e.g., Böcher 1998, Böcher and Fredskild 1993, Haarløv 1967) and therefore helped contextualize these sites in contemporary environments. In peat deposits close to Saqqaq occupation layers at Sermermiut in Western Greenland, Haarlov (1967) noted fly puparia and mites (Acarina) associated with natural habitats ranging from moist or semi-dry heathlands and beaches to wet meadows. More than 30 years later, Böcher and Fredskild (1993) examined insect fossils from midden and occupation layers at the nearby site of Qeqertasussuk, also attributed to the Saqqaq culture. They remarked that several of the identified species were well north of their present-day geographical ranges, suggesting that climate was warmer at the time of the Palaeo-Eskimo occupation than at present (Ibid.).

In addition to providing an environmental context to archaeological studies, analyses of entomological fossils from Palaeo-Eskimo and Neo-Eskimo sites in Greenland and the eastern Canadian Arctic have begun to illustrate how insects can help reconstruct certain aspects of hunter-gatherers' life-ways and how these may have affected local environments.

Resource exploitation. Material culture and zooarchaeological studies testify to the utmost importance of wild terrestrial and marine animal resources in the subsistence of hunter-gatherer cultures (e.g., Betts 2008, Sørensen 2012, Woollett 1999). Archaeoentomology has also contributed to the understanding of these practices. Insects from cultural layers associated with Palaeo- and Neo-Eskimo occupations have demonstrated the presence of carrion on some sites—for example through the identification of blowfly (Calliphoridae) puparia at Qeqertasussuk (Böcher and Fredskild 1993) and of the carrion beetle *Thanatophilus lapponicus* (Hbst.) at the 18th-century Thule site of Uivak Point in Labrador (Bain 2000). Finds of ectoparasites have also contributed to a better understanding of how these animals were exploited, processed, and used. Bird fleas of the genus *Ceratophyllus* have been recovered from Qeqertasussuk and were suggested to be evidence of seabird hunting by Saqqaq people (Böcher and Fredskild 1993). However, since bird

fleas live in nests rather than on their hosts (Brinck-Lindroth and Smit 2007, Marshall 1981), these fleas could equally have ended up in the archaeological record as a result of down or feather collection (see Forbes et al. 2013).

Plant resources were also integral to Palaeo- and Neo-Eskimo life, used as food, fuel, flooring, and bedding (e.g., Böcher and Fredskild 1993, Zutter 2009). Similar to the Norse, many of these cultural groups also used turf for construction. The influence of these materials is clearly evident in insect faunas from occupation deposits and from midden layers on Eskimo sites. Outdoor insect taxa, including ground beetles (fam. Carabidae), water beetles (fam. Dysticidae), moss-feeding pill beetles (fam. Byrrhidae), and phytophagous weevils (fam. Curculionidae), likely originated from sods, limbs, grass, or other vegetation brought into houses by the Palaeo/Neo-Eskimos (Bain 2000, 2001; Böcher 1998; Böcher and Fredskild 1993; Dussault and Bain 2010). Indeed, insect faunas at Uivak Point are in agreement with botanical analyses (Zutter 2009) that suggest spruce boughs were used as bedding for the sleeping platform or floor covering. Numerous bark beetles (family Scolytidae) including the species *Polygraphus rufipennis* (Kirby), which attacks recently broken, cut, or fallen spruce and pine trees (Wood 1982), were also identified. Their presence, combined with evidence for wood having been used in house construction, suggest that the Inuit were actively harvesting rather than collecting this local resource (Bain 2000, 2001). The site today is an open, deforested area similar to many contemporaneous coastal locations in Labrador, and these analyses suggest this lack of trees may be the result of human agency. These findings contradict the idea of Inuit people as passively reacting to their environmental settings; instead, insect analyses suggest they created cultural landscapes. Further work on such preconceptions is needed to properly confirm or refute them for North Atlantic hunter-gatherer cultures.

The insect faunas from hunter-gatherers' homes. Archaeoentomological faunas also evidenced the environmental impact of hunter-gatherer settlements at the micro-scale. Cultural layers from the Palaeo-Eskimo site of Qeqertasussuk are dominated by fly puparia and the rove beetle *Micralymma brevilingue* Schoïdte, a salt-tolerant decomposer species often found on beaches (Böcher 1988, Böcher and Fredskild 1993). These findings are remarkable given that *M. brevilingue* is rather scarce in Greenland nowadays even though widely distributed (Ibid.). Similarly, studies in Nunavut suggest greater concentrations of mold-related species in house and midden samples than in natural environments (Bain

1994, 1997, 2003; Smith 1992, 1994). These results imply that hunter-gatherer settlements, with their accumulations of domestic organic waste and decaying vegetation from structural sods and flooring material, undoubtedly created ideal living conditions for rove beetles normally associated with the upper tidal zone or other damp settings. Thus, even though true synanthropic beetles have so far been absent from such contexts (see below), it is possible to envisage the house floors and middens of Palaeo- and Neo-Eskimos settlements as having been similar to those of Norse and later farmsteads, at least from an insect's perspective.

So far, the only synanthropic beetle species to have been identified from a hunter-gatherer site in the region is the minute brown fungus beetle *Latridius minutus* (grp.), which was recovered from 16th- and 17th-century deposits in Labrador and is therefore likely to have been introduced through direct or indirect contact with Europeans (Dussault and Bain 2010). As discussed by Kenward (1997), the ability of synanthropic species to colonize and establish populations in habitats provided by buildings in northern latitudes is dependent on the size, permanency, and proximity of such habitats and on the frequency and/or volume of trade and contact between settlements. Given the isolation of Palaeo- and Neo-Eskimo settlements and their short-lived nature, the low diversity of anthropochorous insects on such sites is unsurprising. The only truly synanthropic insects recovered from Palaeo/Neo-Eskimo sites are human ectoparasites. The oldest record of the human louse *Pediculus humanus* L. in the region came from Qeqertasussuk in western Greenland, in deposits dated from the 2nd millennium B.C. (E. Panagiotakopulu, unpubl. data in BugsCEP), long before the arrival of the Norse.

Ectoparasites and hygiene studies in Greenland

The hygiene practices of Palaeo and Neo-Eskimo groups have long been a focus of interest in the North Atlantic. Ever since the publication of travelers and explorers' accounts of the Polar Inuit, the perception has been of a dirty, filthy, and unmannerly people (Henson and Peary 1912, Peary and Peary 1893). This view contrasts with those expressed by anthropologists and ethnologists who observed and described daily hygienic practices (Birket-Smith 1976, Rasmussen and Ostermann 1976, Rasmussen et al. 1994).

The first opportunity to scrutinize such prejudices came with the discovery of eight Neo-Eskimo mummies in western Greenland. Adult specimens and nits (eggs) of human lice were recovered from the hair and stomachs of these mummies, suggesting

the consumption of lice as part of delousing practices (Bresciani et al. 1983, 1989; Hansen et al. 1991). Furthermore, recent research in northwest Greenland examined insect remains recovered from four different houses and allowed the recovery of numerous body and head lice *P. humanus* and of a single specimen of pubic lice *Phthirus pubis* (L.) from the site of Cape Grinnell (Dussault 2011). Higher concentrations of human lice were recovered in entrance tunnels than in the living areas and sleeping platforms, and Dussault (2011) argued that these ectoparasite concentrations were the result of human activity, with spatial distribution of parasites influenced by delousing practices. The presence of bird lice of the genus *Ricinus* (= *Nirmus*) sp., which spend their whole lifecycle on the body of their host (Séguy 1944), in the main living area and the entrance tunnel, was interpreted as an indication that birds had been prepared for consumption in these areas. Dog lice of the species *Linognathus setosus* Von Olfers were also identified from the entrance tunnels and living areas, suggesting that dogs may, at times, have been permitted in houses. As these records are from the 13th to 17th century and pre-date European contact, they rule out the possibility of the dog louse having been introduced to Greenland through interactions with Europeans, but it is possible that Palaeo- and Neo-Eskimo groups played a role in its dispersal. These results indicate that ectoparasites were a part of the daily lives of the Polar Inuits and that hygienic practices were known and undertaken by these people. These findings are consistent with the Inughuit oral tradition but contradict 19th-century western prejudices (Dussault 2011, Forbes et al. 2013).

The Future of Archaeoentomology in the North Atlantic

Archaeoentomologists' work in the North Atlantic region has contributed new insights into a wide range of questions, from the reconstruction of site-scale economic and domestic activities to the assessment of the nature, timing, and impacts of the complex interactions between humans and their environment. Despite the growing numbers of studies, the archaeoentomological record remains patchy for many reasons, including variable preservation conditions, a lack of adequate funding and trained specialists, limited awareness of the potential of the methods, and logistical difficulties with working on sites of remote locations. However, new and ongoing archaeoentomological projects have started to explore innovative and promising pathways for future research.

Latest trends

The discovery by Bain (2000, 2001) of entomological evidence for Neo-Eskimos' having exploited fresh wood for sod house construction challenges the view of native North American cultures as living in harmony with nature and therefore having a limited, perhaps invisible, impact on the environment (e.g., Billington 1981; Dickason 1996, 1997; Wenzel 2004). Similarly, the analyses of lake sediments at the Port au Choix National Historic Site in Newfoundland documented vegetation, salinity, and water pH changes that were interpreted as impacts of Dorset activities, including the processing of seal skins near Bass Pond (Bell et al. 2005, Renouf 2011, Renouf and Bell 2008, Renouf et al. 2009). A forthcoming doctoral project by F. Dussault will further explore the idea that hunter-gatherers' exploitation of animal and vegetal resources available in their environment may have left a "footprint" in the landscape of Newfoundland. Archaeoentomological data associated with Dorset Palaeo-Eskimo occupations at Phillip's Garden will be used to reconstruct the living conditions in winter sod houses and identify the natural resources locally available for exploitation at Port au Choix. As such, the project will complement lake-sediment proxies studied by Renouf et al. (2009) with finer-scale reconstructions of living conditions and activities inside Dorset houses and in their immediate surroundings. New data from Neo-Eskimo settlements in southwest Greenland (Vickers 2012) and ongoing analyses on Inuit sites in Labrador by Bain also promise to reveal new insights into the nature and scale of the impact of hunter-gatherers' activities on North Atlantic environments.

Since Buckland and Panagiotakopulu's (2005) review of archaeological and palaeoecological research in the North Atlantic, new insect data from regions that had been largely ignored in Iceland have been studied (e.g., Forbes 2013a, b, c; Forbes et al. 2010; Hellqvist 2013). The analysis of insect remains from 19th-century Vatnsfjörður has established a link between the presence of duck fleas *Ceratophyllus garei* and eiderdown production, providing a unique means to identify such activities in the archaeological record (Forbes et al. 2013). Furthermore, Forbes' (2013b) doctoral thesis has revealed the potential for the processes of modernization to be traced using the archaeoentomological approach. The recovery of the earliest Icelandic records of species of subtropical and tropical origin—*Ptinus tectus* Boield., *Cryptolestes* sp., and *Sitophilus oryzae/zaemais* (L.) Mots—from samples collected at Vatnsfjörður and Þverá indicated that the occupants of these sites were engaged in worldwide

trade networks at least from the late 19th century. Additionally, the earliest Icelandic records of the cattle-biting louse *Bovicola bovis* (L.) were found at Hornbrekka and Þverá and are contemporary with documentary evidence for the import of foreign cattle as part of efforts to improve Icelandic agriculture (Thoroddsen 1919). These results suggest the pursuit of further archaeoentomological analyses on Postmedieval and Modern sites can not only enhance our understanding of the history of human migrations, trade and their role in the dispersal of pests around the world (e.g., Buckland 1981, King et al. 2014), but also reveal how globalization and the implementation of ideas for improvement impacted people's lives in the recent past.

Future challenges

The recognition of the value of archaeoentomological research in the North Atlantic region is unfortunately not sufficient to ensure its perennity. Obviously, the possibility of conducting any type of research is dependent on the availability of funding, resources, and suitable facilities. Archaeological excavations are inherently destructive, and only detailed and robust post-excavation analyses on finds, sediments, and biological remains can allow highly detailed reconstructions of past human activity and living conditions. Ideally, provision for such analyses should be conditional to undertaking excavations, but in reality, with limited funding and the "salvage" nature of many excavations, this ideal is difficult to achieve. These problems are exacerbated when undertaking research in remote areas such as Greenland and Northern Canada, where funding needs to cover equipment, transport, and shipping costs, leaving little for post-excavation research. Even though it is clear that the numerous archaeoentomological datasets published since the 1960s have contributed to the awareness and potential of this method, it is still not uncommon for insect remains to be extracted from subsamples of sediment collected for archaeobotanical analysis or from samples that have already been processed. This approach is not ideal, since plant and insect remains do not necessarily preserve in similar conditions and the best extraction procedures for insect remains (paraffin floatation; see Kenward et al. 1980) differ from those used for plant macrofossils. It is fortunate that sampling for archaeoentomological analysis is much less uncommon in the North Atlantic region than it once had been, but we also need to ensure these samples are duly stored, processed, and analyzed.

The time, resources, and methods needed for archaeoentomological analyses vary depending on the

questions that are being asked and the nature of the sediment sampled. Thus, one way to ensure the best use of archaeoentomology is to include, or at least consult, specialists early in the planning process. This approach requires archaeological project managers to be well aware of the potential applications of insect analyses and to be able to identify whether information derived from entomological remains could help them attain their research objectives. In providing an overview of the types of questions that can be addressed with archaeoentomology in the North Atlantic region, it is hoped that this paper will raise awareness concerning an important but under-exploited methodology and stimulate new ventures for archaeoentomological research in the North Atlantic region and beyond.

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