A very curious larder – Insects from post-medieval Skálholt, Iceland, and their implications for interpreting activity areas

Citation for published version:
Konráðsdóttir, H, Panagiotakopulu, E & Lucas, G 2021, 'A very curious larder – Insects from post-medieval Skálholt, Iceland, and their implications for interpreting activity areas', *Journal of Archaeological Science*, vol. 126, 105319. https://doi.org/10.1016/j.jas.2020.105319

Digital Object Identifier (DOI):
10.1016/j.jas.2020.105319

Published In:
Journal of Archaeological Science

A very curious larder – Insects from post-medieval Skálholt, Iceland, and their implications for interpreting activity areas

Hrönn Konráðsdóttir[a], Eva Panagiotakopulu[b*], Gavin Lucas[c]

a. National Museum of Iceland, Suðurgötu 41, 101 Reykjavík, Iceland
b. School of GeoSciences, University of Edinburgh, Drummond Street, EH8 9XP, Edinburgh, UK
c. University of Iceland, Nýji Garður, 101 Reykjavík, Iceland

* Corresponding author: eva.p @ed.ac.uk

Abstract

Fossil insect assemblages from post-medieval Skálholt, the oldest episcopal see in Iceland, provide new information about indoor environments and the specific use of a structure which according to historical information was listed as a larder attached to the episcopal school. The assemblages recovered also provide information on the background fauna which comprises of species related to turves, used for building construction and indicating storage of peat. In addition to the introduced *Sitophilus granarius*, the granary weevil, a new pest, *Callosobruchus maculatus* which is a pan-tropical and subtropical field and storage pest of legumes, and a rarely introduced species in Iceland even today, were also recovered from the site. In view of the nature of the assemblages, these were probably accidental introductions into the room, perhaps in faeces. The historical record provides information about the life history and events at Skálholt and data about school supplies including imports of stored products to Iceland during this period. In addition, the high numbers of sheep keds, *Melophagus ovinus*, combined with high numbers of human lice, *Pediculus humanus*, point to the washing of wool and clothing in urine to get rid of ectoparasites. Intra-site comparisons and a review of all Icelandic archaeological sites suggest a clear correlation between the presence of ectoparasites and wool preparation and cleaning. The results from Skálholt clearly show that rooms and specific spaces in post-medieval buildings could have multiple functions, not only the one assigned to them in the historical record.

Keywords

Fossil insects, activity areas, Iceland, post-medieval, wool processing, urine, storage pests

1. Introduction

The North Atlantic islands combine a comparatively short ecological history, since the end of the last glaciation, with an even shorter history of human impact, essentially less than two thousand years. Palaeocological studies from the islands provide detailed information for environmental and climate change and unique details on changes from the beginning of colonisation, Landnám (*c.* 870 AD) onwards (Sveinbjarnardóttir, 2018, Panagiotakopulu and Buckland, 2017). Fossil insects reflect changes in biodiversity from the initial immigration of the biota to local extinctions and samples from archaeological contexts can provide data on activity patterns, materials brought into or disposed of in particular locations, and occasionally evidence for singular events, such as delousing or wool and feather preparation (Buckland et al., 1992; Buckland et al., 2012, Forbes, 2015). Iceland is perhaps the most researched of the North Atlantic islands in terms of its fossil insect faunas, with studies which range from the natural environment to middens and farms. These have refined the understanding of Norse settlement from Landnám and onwards. Research from post-medieval Icelandic sites such as Reykholt, Stóraborg, and Hólar provide an indication of the breadth of information which can be retrieved (*cf.* Buckland et al., 1991; 1992, Hellqvist and Backström, 2002). Excavations at the episcopal see at Skálholt provided the opportunity to study faunas from an area of the site during a specific time period, from 1630 to 1784 AD. The refined time window, the excellent preservation of organic remains and the wealth of the historical and archaeological information available provide a unique opportunity to understanding domestic contexts and activities on site.

In this paper we present new fossil insect data from a structure at Skálholt listed in the historical sources as a larder. Through the interpretation of the insect faunas from this building, in association with palaeoecological, archaeological, historical and ethnographic evidence, we reconstruct the environmental conditions of the surrounding area, infer activities and patterns associated with the structure's use, in comparison with other assemblages from synanthropic contexts from Iceland, and highlight any indicators of biogeographic change during the post-medieval period, as seen from the insect faunas.

2. The Site

The site of the cathedral and bishop's residence at Skálholt in south-west Iceland, about 85 km from Reykjavík (Fig. 1) is located in a favourable location for utilising the surrounding region. The area around the site is characterized by meadows and improved hay fields as well as mires and stony non-arable lands. Three fishing rivers lie close to Skálholt: Tungufljót, Hvítá and Brúará and warm springs run into these rivers. Skálholt was the older and larger one of the two episcopal sees in Iceland, the other being Hólar in the north. Founded in 1056, it was the first bishop's residence from the early days of Christianity in Iceland. The buildings housed a school during the period from mid-16th to 18th century and was the largest estate in Iceland during the early post-medieval period. A large fire in 1630 severely damaged the residential complex at Skálholt, and subsequently an earthquake in 1784 led to further damage at the site; in the aftermath majority of the buildings were abandoned (Grímsdóttir, 2006). Following the earthquake the school and the episcopal see were moved to Reykjavík.

The archaeological remains at Skálholt have always interested researchers and parts of it were previously excavated in the late 19th century as well as a few times the 20th century. The most recent excavation in 2002-2006 focussed specifically on the period between 1650 and 1784 (Lucas, 2003). The buildings consist of a residential complex, school houses, kitchen, dining room and storages. As part of the excavation, sampling for insects took place in an elongated room (XVIII), between room XVII and the main corridor (XIII) (Fig. 2a). A plan from *c.* 1700 AD labelled this room the "Big larder/pantry", *Stórabúr* in Icelandic (Fig. 3). It was 11.8 m long and *c.* 3.2 m wide, with a long central ash floor flanked by flagstones on either side room (Fig. 2b). The excavation of this room revealed three barrel pits, a larger one (1.3 m in diameter) and a smaller one (0.85 m in diameter) which was later replaced with the largest one (1.9 m in diameter).

3. Methodology

Three five litre samples were taken from the central aisle in-between flagstones for examination for insect remains. Sample processing followed the method devised by Coope and Osborne (1968). Insect fossil material extraction was achieved by carefully disaggregating each sample in warm water over a 300 µm sieve to remove silt. The residue was then left to drain and paraffin (kerosene) was mixed with this residue and cold water added to float the insect remains. The float was retained on a 300 µm sieve and washed with detergent to eliminate traces of paraffin. Flotation was repeated at least three times. The residue was stored in ethanol before being sorted under a stereomicroscope and identified using an Icelandic insect collection at the School of GeoSciences, University of Edinburgh, with reference to relevant identification keys. All Coleoptera remains were identified to the lowest taxonomic level possible, preferably to species level. Preservation of remains was generally good, although the beetles recovered were quite fragmented. Ectoparasite preservation was unusually good, e.g. the human lice pronota, which are very fragile and rarely found, were used to count the number of lice in some samples as they were perfectly preserved.

BugsCEP (Buckland and Buckland, 2006) and additional relevant references were used to collate habitat information and ecological diagrams were produced using raw numbers as opposed to percentages as we believe that these represent a more detailed picture of the ecology of the samples. All Icelandic sites which included ectoparasites were listed as part of this research and the samples from the larder were compared to relevant Icelandic assemblages using detrended correspondence analysis in the R computing program, Vegan package (Oksanen et al., 2008).

4. Results and Discussion

The archaeological information from the contexts which produced the samples studied allowed refined chronology and relevant details are currently under preparation for publication by G. Lucas. Two of the samples, S274 and S262 were dated *c.* 1710-40 AD, and the third, S236 *c.* 1740-1760 AD. The assemblages analysed contained 1,203 specimens (Table S1), of which 541 were Coleoptera and 662 ectoparasites (Fig. 4). Coleopteran taxonomy follows Böhme (2005) and other groups (Ólafsson, 1991). There were few differences in terms of species composition in the three samples studied and the results are presented and discussed as a whole below. Although in some cases it is difficult to draw strong divisions, for the purposes of the discussion, the assemblage has been divided to the natural element of the fauna and the synanthropic taxa, which include the hay fauna and pests as well as ectoparasites.

4.1. The natural fauna and species associated with dung

The large carabid *Nebria rufescens* (Ström.), common in Iceland today and called blacksmith, *járnsmiður*, in Icelandic, was recovered from all three samples. It is fairly eurytopic in Iceland (Larsson and Gígja, 1959). *Patrobus septentionis* Dej. lives near water and in damp areas, in particular wet meadow biotopes (Larsson and Gígja, 1959) and although not synanthropic (dependent on humans)), it is frequently recovered from homefields (Lindroth, 1945). The small ground beetle *Bembidion bipunctatum* (L.) is known to hunt its prey around water (Halldórsson, et al., 2002), and is quite common around hot springs and pools (Larsson and Gígja, 1959). It has been recorded from hayfields and pastures as also has another carabid, *Notiophilus biguttatus* (F.) (Gudleifsson, 2005). The latter is often associated with stony, dry areas and occasionally with birch scrub (Larsson and Gígja, 1959). Although older sources record *Pterostichus nigrita* (Payk.) from Iceland, recent research indicates that only the recently defined *P. rhaeticus* Heer occurs. It is found in peat bogs and marshes (Lindroth et al., 1973) and in Iceland has been frequently recovered from damp grasslands (Larsson and Gígja, 1959), while its congener *P. adstrictus* Esch. has been collected from boggy environments (Bengtson, 1981) and tends to be more common in open grassland (Lindroth, 1986). *Amara quenseli* (Schön.) is found on sandy biotopes also associated with sparse vegetation (Larsson and Gígja, 1959).

The small carabid *Trechus rubens* (F.) is primarily subterranean, found near rivers and in moist vegetation (Eyre et al., 1998), but is more commonly found in grasslands, often in improved grassland in Iceland (Larsson and Gígja, 1959) and may be synanthropic. It is often found in association with tall weeds, e.g. *Rumex* sp. (Lindroth, 1945; Lindroth et al., 1973).

The dytiscid *Hydroporus nigrita* (F.) is found in a range of aquatic environments including warm water at hot springs, as well among vegetation by water bodies, although it avoids swiftly flowing water (Larsson and Gígja, 1959; Lindroth et al., 1973). *Agabus* sp. has been also been recovered from Skálholt but it was not possible to identify to species level as the particular specimen was too fragmented. However, all three species of *Agabus* recorded from Iceland are found in both pools and bogs (Halldórsson et al., 2002).

Several staphylinids *Lathrobium brunnipes* (F.), *Othius angustus* Steph, *Bisnius sordidus* (Grav.), *Gabrius trossulus* (Nord.) frequent grassfields and pastures (Koch, 1989; Larsson and Gígja, 1959; Gudleifsson, 2005) and may be found in meadows and cultivated areas suggesting that they came from the Skálholt homefields. Other species, such as *Acidota crenata* (F.) prefers moisture and tends to be near the sea or lakes, although in Iceland it has been recorded in somewhat drier biotopes, in grass, under stones (Larsson and Gígja, 1959). Active in the litter layer, it could have been brought in with turves and other material used for construction and flooring.

Similarly the small click beetle *Hypnoidus riparius* (F.) which frequents a range of biotopes from dry to wet and from grass to birch scrub (Larsson and Gígja, 1959) could have inhabited nearby bogs prior to becoming incorporated into peat.

Most of the weevils of the assemblage are polyphagous, *Otiorhynchus nodosus* (Müll), *Tropiphorus obtusus* Bonsd. and *Barynotus squamosus* Germ., feeding on a range of plants The small weevil *Ceutorhynchus contractus* is fairly eurytopic (Larsson and Gígja, 1959; Lindroth et al., 1973) but is largely restricted to Brassicaceae and *Rhinoncus pericarpius* (L.) is oligophagous on various species of dock, *Rumex* spp. (Koch, 1992). All could have entered the room either in peat, with flooring material or with fodder. *R. pericarpius* has only been found previously in two excavations in Iceland, at medieval Bessastaðir (Amorosi et al., 1992) and post-medieval Reykholt (Buckland et al., 1992). *Rumex acetosa* L., the common sorrel, is its most frequent food plant in Iceland and collection and use of sorrels at Skálholt could be the reason behind the presence of the beetle in the assemblage. The plant is a rich source of vitamin C, which prevents scurvy and another *Rumex* species, *R. longifolius* is also known as a herbal medicine for a variety of ailments (Bjarnason, 1994).

Aphodius lapponum Gyll. is common in the dung of the larger mammals (Larsson and Gígja 1959) introduced by the settlers (Buckland and Panagiotakopulu, 2008; Buckland and Panagiotakopulu 2010, Panagiotakopulu, 2014). The now rare catopid, *Catops fuliginosus* Er. probably fed on fly maggots and is also known from carrion and fungi (Lindroth et al., 1973), as well as the dung of mammals (Larsson and Gígja, 1959). These taxa suggest the presence of animals nearby, perhaps domestic animals, although the last is also recorded from bird cliffs. The low numbers of dung associated species, point to accidental introduction of *Catops* in this context with other materials brought in, or incorporated into peat.

4.2. The hay fauna, pests and ectoparasites

In the beetle assemblages, the highest numbers belong to the hay fauna, which in Iceland is essentially composed of eusynanthropic species. The rove beetle *Quedius mesomelinus* (Marsham) is eurytopic, a generalised predator, often associated with habitats with a large number of maggots and it is synanthropic, in the north, recorded largely from barns, outhouses, cellars and similar structures (Böcher, 1988). *Tachinus corticinus* Grav. is found under stones, in grassland, birch scrub etc. (Koch, 1989), and is also frequently found in synanthropic situations in Iceland, in particular in mouldy hay and straw (Larsson and Gígja, 1959) and similar habitats are exploited by both the species of *Omalium* present, *Omalium rivulare* (Payk.) and *O. excavatum* Steph. (Larsson and Gígja, 1959; Buckland et al., 1991). *Xylodromus concinnus* (Marsham), with 58 specimens in the three samples examined, recorded from stables, cellars and bakeries and also from hay refuse and mammal dung (Larsson and Gígja, 1959; Donisthorpe, 1939), is strongly synanthropic and a key species associated with mouldy hay and indoor environments. All of these species were introduced to Iceland by the Norse and provide a signature insect group for their activities (Panagiotakopulu, 2014; Buckland and Panagiotakopulu, 2010; Buckland and Panagiotakopulu, 2008).

The most numerous taxon in the assemblages is *Latridius minutus* (L.)/*pseudominutu*s (Strand). As fossils, these can only be separated on ventral characters (Tozer, 1973), and only a fraction of this assemblage was confirmed as *L. minutus*. In Iceland, it is synanthropic, found in haystacks, barns and hay stores (Sadler, 1993). A range of other species can also be found in all sorts of mouldering organic material, feeding on moulds in stored grain (Kingsolver, 1991) and other stored material. *Typhaea stercorea* (L.), *Corticaria elongata* Gyll. and the flightless *Mycetaea subterranea* (Marsham) are reported to be found in haybarns in Iceland (Lindroth et al., 1973). *Tipnus unicolor* (Pill. and Mitt.) is also flightless, anthropochorous and an additional indoors species found in animal stalls, barns and cellars (Larsson and Gígja 1959; Lindroth et al., 1973). Although also found outdoors in open vegetation (Lindroth et al., 1973), *Cryptophagus scanicus* (L.) in Iceland is most frequently found in high numbers in hay (Larsson and Gígja, 1959; Buckland et al., 1991), while *Atomaria apicalis* Er. has been recorded on all kinds of decaying organic materials especially plant waste and manure. In Iceland it is strongly synanthropic, primarily found in old hay (Larsson and Gígja, 1959).

Of particular interest, not previously recorded from Iceland, is the bruchid *Callosobruchus maculatus* (F.), a cosmopolitan field to store pest, with a probable African origin (Cox, 2001, Kébé et al., 2016). In Africa, the beetle infests pulses in the field and can have multiple generations in the storeroom (Cox, 2001). Its optimal temperature for egg-laying and development is 35°C (Lale and Vidal, 2003), which is far above what the temperature inside the houses at Skálholt would have been, although it can develop in temperatures down to 18°C (Rees, 2004). The record from Skálholt is the first archaeological record for this important pest worldwide. It is unlikely that the temperature in unheated turf houses would produce a favourable breeding environment for the species. Probably the specimen derives from infested pulses imported from either southern Europe or Africa and provides evidence for extensive trading networks and accidental imports of exotic pests in post medieval Iceland. The pest remains rare in Iceland during the modern era, with only six records noted by the Icelandic Institute of Natural History in recent years (E. Ólafsson pers. com.).

The grain weevil *Sitophilus granarius* L. is a flightless pest of cereals, recorded from rye, barley, oats, millet, corn, maize, etc., which needs temperatures of at least 15°C to maintain breeding populations (Hoffman, 1954) and is strongly synanthropic, occurring only in stored cereals. In Iceland, until cultivation of barley and use of cereals as a dietary staple, *S. granarius* would have been incapable of maintaining populations and was therefore restricted to sporadic introductions with infested cereals. Information from the historical sources indicates that any attempts at barley cultivation during Landnám were marginal and small scale (Ólsen, 1910 and Sveinbjarnardóttir, 1992). In a manuscript from around 1590, a description of Iceland, Oddur Einarsson (bishop of Skálholt) noted that barley was imported and that no cereals were being produced in the country at that point in time (Einarsson, 1970). During the medieval period, *S. granarius* is recorded from Bessastaðir and Gásir (Konráðsdóttir, 2010) while the species was also recorded in the post-medieval period from Reykholt (Buckland et al., 1992; Buckland et al., 2012) and Stóraborg (Sveinbjarnardóttir et al., 1981) indicating relatively wide use of imported cereals for food in Iceland.

It is possible that the single individuals of *S. granarius* and *C. maculatus* derive from dung of animals fed mildly infested import residues rather than from infested stored products in this room.

Pediculus humanus L., the human louse, is the most common human ectoparasite, on the heads and bodies of people (Clay, 1973), where it feeds on the blood of its host. It is known to cause anaemia and be linked with a range of diseases, including typhus (Harden, 1993). It has co-evolved with humans (Boutellis et al., 2014) and the earliest fossil record is from Brazil *c.* 10.000 years ago (Araujo et al., 2000) and there are numerous pre-Columbian records from mummies (e.g. Ariaza et al., 2012, Ewing 1924). There are also additional records from North American indigenous groups in Alaska (e.g. Horne, 1979, Dussault et al., 2017). The earliest record of human nits, the eggs of lice, come from the Old World, from Nahal Hemar cave near the Dead Sea *c.* 9000 BP (Mumcuoglu and Zias, 1991), while additional early records of lice and nits have been recovered from hair of pharaonic mummies (Ruffer, 1921) *c.* 5500 BP onwards (Fletcher, 1994; 1998), Roman mummies and a comb (Essing, 1924, Pettigrew, 1834, Palma, 1991).

There are various Roman records of human lice from sites from northern Europe (e.g. Castellum Fectio in the Netherlands (van den Bos et al., 2014)) including the British Isles (e.g. Roman York (Hall and Kenward, 1990)), and assemblages from Anglo-Scandinavian, medieval and post-medieval sites from the British Isles (e.g. various sites in York (Hall et al., 2000, Hall and Kenward, 1990). Medieval assemblages extend to Langenes in northern Norway (Buckland et al., 2006), whilst during the post-medieval period, lice reach Novaya Zemlya with shipwrecked sailors (Hakbijl and De Groot, 1997).

In addition to medieval and post-medieval Icelandic sites (Table S2) there are various records from Greenland, which range from key Norse medieval sites (e.g. Gården under Sandet (Panagiotakopulu et al., 2007), Gardar (Buckland et al., 2009); Nipaatsoq (Buckland et al., 1983)) to evidence from Saqqaq (Qeqertasussuk (Panagiotakopulu, unpublished), and the Thule culture (Dussault et al., 2014) including the Qilaqitsoq mummies (Bresciani et al., 1989). Before the advent of cheap coal tar based soaps in the late 19th century, it is probable that most people and their clothing were infested with lice (Sveinbjarnardóttir and Buckland, 1983).

The presence of imagines and puparia of the ked, *Melophagus ovinus* (L.), *færilús* in Icelandic, in large numbers is usually associated with the presence of fleeces removed from the sheep and cleaned (Buckland and Perry, 1989). The fly is viviparous and the larvae cement themselves on the wool of the animals; high levels of infestations may be associated with malnutrition (Cheyne et al., 1974). In terms of records, sheep keds are also recorded from Late Iron Age and Roman assemblages (e.g. Claydon Pike (Robinson, 2007), Lincoln (Carrot et al., 1995), York (Hall and Kenward, 1990)) in the British Isles, from Anglo-Scandinavian and medieval York (e.g. Hall et al., 2000, Hall and Kenward, 1990), and Viking Orkney (Tuquoy (Sadler, 1991)). Sheep keds have been recovered from other Icelandic archaeological sites: medieval (i.e. Bessastadir (Amorosi et al., 1992), Godataettur (Buckland et al., 1995) Nesstofa (Amorosi et al., 1994), Skriduklaustur (Konráðsdóttir, 2009; 2012), post-medieval Reykholt (i.e. Buckland et al., 1992) (for a full list of medieval and post medieval sites see Table S2) and early modern Vatnsfjörður (Forbes and Milek, 2014). In addition to the Icelandic records, it was also recovered from several sites in Greenland together with human lice and other ectoparasites (e.g. Panagiotakopulu et al., 2007, Buckland et al., 2009, etc.).

Bovicola ovis L., the sheep louse, *fellilús*, in severe infestations, may be present on all parts of the animal (Noble and Noble, 1976) and its presence may indicate stalled animals, sheep or goat, or more probably, an area where wool was stored, cleaned and processed.). It was recovered from an Iron Age midden at Delfand in the Netherlands (Schelvis and Koot 1995), from medieval combs from Ypres in Flanders (Schelvis, 1999) indicating its association with wool processing, from Anglo-Scandinavian and medieval York (e.g. Hall et al. 2000, Hall and Kenward, 1990), and from medieval Glenarm in Ireland (Kenward et al., 2011)). In addition to the Icelandic records (see Table S2), it is frequently found on Norse sites in Greenland (e.g. Panagiotakopulu et al., 2007, Buckland et al., 2009, etc.).

4.3. The use of the room

The wetland species recovered from the Skálholt assemblages, associated with bogs and peat, could have entered the premises with turves. The houses at Skálholt were mainly made of stone and turf and much of this element of the fauna probably arrived with turves and peat, used as building material or flooring. In addition, peat was commonly used as fuel and harvested in the summer, or at least when the ground was not frozen (Þorsteinsson, 1990). One of the uses for Room XVIII may have been for storing peat, and its vicinity to the dining room on the 1700 AD plan (Fig. 3), and the need for turves for the fire would perhaps support this.

In the absence of synthetic materials, large amounts of urine would be needed for wool cleaning, other washing and dyeing (Stead 1981;1982). This would be collected in barrels over the winter. Its principal use would be for the removal of dirt, sheep lice and keds from fleeces, with combing following the wash in urine. Their recovery from the room could perhaps indicate some sort of wool processing e.g. separating long wool hair from the finer or felting, where the wool would be felted either hanging or in barrels which would incidentally extract the keds from the wool (Jónasson, 1961). Washing of wool was hypothesised on the basis of insect assemblages from post-medieval deposits at Stóraborg (Buckland and Perry, 1989). In the 19th and early 20th century wool was almost exclusively washed outside in running water in Iceland, (Jónasson, ibid), presumably after being immersed in urine vats.

In 1762, a sheep plague perhaps spread by the sheep scrab mite, *Prosoptes ovis* L. accidentally imported with an English ram intended to improve wool quality of Icelandic sheep (Olavius, 1964) was introduced to Iceland. As a result there were hardly any sheep or wool in the south of the country between 1762 and 1784. The number of sheep ectoparasites from this room at Skálholt indicates that they probably belonged to the period before the disease, as according to literary sources, after the disease, the school at Skálholt provided schoolboys with money instead of clothing as wool became scarce (Helgason, 1936). If the disease had put a temporary halt on wool processing at Skálholt, it is possible that general storage of turves, hay and other materials took place in that area. This would provide an explanation for the listing of the room as a larder on the 1784 plan, although the term could have been used loosely for any type of storage, urine included.

According to historical sources, people also washed themselves in diluted urine to get rid of lice (Pálsson, 1945). The few mentions of lice in the literature (Sveinbjarnadóttir and Buckland, 1983) indicate that they were considered a minor irritation (Jónasson, 1961). The remedies for getting rid of them were in some cases more of a quackery nature, involving tying a cat onto the back of infested individuals overnight (Jónasson, 1961, p. 35); they would perhaps have been used as a last resort in severe infestations.

Using urine to wash clothes and bedding and for personal hygiene might have reduced lice infestations and could have been part of the personal hygiene routine of the Skálholt residents. According to the ethnographic record, urine was collected at every farm in Iceland at least until the 19th century, as soap was unknown among the public until after 1750 (Jónasson, 1961) and then only used by the rich until prices fell. Urine was used to wash wool as well as clothing and bedding, as well as washing oneself, although it would be diluted for that use (Jónasson, 1961). This would possibly reduce the number of the ectoparasites which would be left in the urine, *keyta* in Icelandic. The *keyta* would be collected into big barrels at the farms, from the night pots. Jónasson (ibid) notes that felting would commonly take place in doorways, where the material would be hung up and worked hanging and this process would also lead to the extraction of any ectoparasites.

Room XVIII (Fig. 2a), *Stórabúr,* would be a convenient place to collect urine, since the schoolboys' dormitory (Room XX in Fig. 2a) was down the corridor (noted as XIII in Fig. 2a) and the two barrels recovered during the excavation from *Stórabúr* may provide further evidence for this. This would make the room an ideal area for delousing wool, clothing and the students themselves. Large barrels which may have been associated with urine used for cleaning wool were also recovered from Stöng ((Buckland and Perry, 1989).

It is possible that hay, with its associated insect fauna, would have been used periodically to cover the putrid smell of the urine. Perhaps the alkaline peat ash recovered from the room was used for similar purposes, to cover and neutralise the odours (Johnson, 1866, Soper and Obson, 1922), although this interpretation risks putting modern sensibilities on the past.

Alternatively, the different insect signals recorded could indicate seasonal use of the room, perhaps storing hay and fodder during winter, in addition to collecting urine in large vats.

4.4. Comparison with other Icelandic sites

The high occurrence of ectoparasites from the samples from Room XVIII, is notable. After listing all assemblages from medieval and post medieval Icelandic sites, it became apparent that although there are several sites which include evidence for *P. humanus, B. ovis* and *M. ovinus* (Table S1), the abundances observed from this particular room at Skálholt are higher than from most Icelandic sites, including midden material. The numbers from XVIII show similarities with the overall counts from the adjacent room, XVII (Fig. 2a and Fig. 3), from Skálholt (Lucas, 2018) and from other post-medieval Icelandic assemblages (Tables S3 and S4); samples from Stóraborg and Reykholt also produced a large number of ectoparasites. Hús 17 from Stóraborg, included a sample (H17F) from the drain with 177 *M. ovinus,* and produced evidence for a process dedicated to cleaning wool after soaking it in urine (Buckland and Perry, 1989). The lowest number of sheep keds from Hús 17, was 16 individuals (from H17C). From post-medieval Reykholt on the other hand, there are high numbers of both sheep keds and human lice (Buckland et al., 1992), which perhaps indicate washing clothing using urine, in addition to wool processing. Reykholt also includes a church and a school, and the samples in question come from three different areas of the post-

medieval house to the north of the original school, the passage, Hús 5 and Hús 2 (Buckland et al., ibid).
As the data from room XVIII at Skálholt provide evidence for wool processing and cleaning, the hypothesis set was that the overall faunas from these samples would show similarities with faunas from Reykholt and Stóraborg, from areas where similar activities were identified. Based on the results for wool cleaning from Stóraborg (see above) and since the lowest number of sheep keds recovered from a wool cleaning area, Hús 17, was 16 individuals, samples with >15 individuals of sheep keds from Skálholt, Reykholt and Stóraborg, were selected for this comparison using detrended correspondence analysis (DCA) in R. The thirteen samples compared include additional material from room XVII from Skálholt, which according to information from the 1700 AD map of the site was thought to be a tapestry store, *Reflaskemma* (Fig. 3) and a 1784 map notes it as a meat store, *Kjötskemma* (Lucas 2003; 2005). Sample 285 from XVII, was dated *c.* 1720-1750 AD, while sample 269, *c.* 1770-1790 AD.
The DCA results indicate that all of the Skálholt samples, in particular S36 (*c.* 1740-1760 AD) show close affinities to sample H17F from Stóraborg. The Reykholt assemblages from the passage (S7) and Hús 2 (S21, S22) which were interpreted to include occasional material resulting from wool processing showed affinities with sample H17C from Stóraborg, whilst samples from the floor of Hús 5 in Reykholt, (S9S6, S9S9, S9S26) which have been associated with wool processing activities (Buckland et al., 2012, p. 236) are grouped in the middle of the diagram. What is evident is that the area discussed from XVIII from Skálholt, was not a larder but more probably an area dedicated for at least part of the time to wool cleaning. Interestingly the same seems to apply for the adjacent room where the faunas produced little evidence for meat storage. This is a cautionary tale in terms of the need for palaeoecological and other data to verify literary information on activity areas.

4.5. Cereal imports and a new pest in Iceland

The presence of *S. granarius,* primarily a stored cereal pest, at Skálholt, comes as no surprise, given the status of the inhabitants, the Bishop, his household and occupants of the school. Indeed, the literary evidence for the post-medieval period perhaps attests to more frequent cereal imports and provides context for the presence of cereal pests in Iceland. In the rule collection, *Lovsamling for Island* (Sigurðsson and Stephensen, 1853), the rules dating from 10th of June 1746 for the schools at Skálholt and Hólar give a day to day account of the food intended for the schoolboys, which included barley porridge on Sundays and milled grain porridge on Mondays and Fridays (or wheat porridge if available) (Sigurðsson and Stephensen ibid). The students would also be provided with bread with every meal as well as fish liver oil, and the teachers were allocated the same food, although they, along with the wealthier students probably had other means of supplementing their diet (Sigurðsson and Stephensen ibid).
The import of rye, primarily milled, is well recorded from 1624-1839 in various documents (Jónsson and Magnússon, 1997), especially from the 18th C, although there is a gap from 1655-1733 (Fig. 6). Milled grain was imported but not always in good condition as a testimony from 1647 by Þórður Hendriksson attests to:
"We do not accept to pay for the ants [could be any small insect], that the merchants bring to us within the milled rye, when it is so loose that the ant crawls out of the barrels and eats the little that is eatable in the rye, and we do not wish the merchants to dilute the rye in this way, because we have enough ants in Iceland, both in size and build very similar to these that the merchant wants to sell to us with the milled rye." (Anon., 1912, p. 124).

Unfortunately we do not know the species of which he is referring to, but they are likely to be the beetles, *S. granarius* and *O. surinamensis*.

The data from *Hagskinna* (Icelandic historical statistics) indicate a trend towards import of products which were not milled towards the end of the period, including rye and barley, as well as a decrease in the import of milled rye (Jónsson and Magnússon 1997). Perhaps the reduction of milled imports was associated with the fact that they were more vulnerable to mould and pests and needed consumption within a shorter timeframe.

Historical records of bean imports (Jónsson and Magnússon, 1997 and Fig. 6) indicate imported materials from 1743 onwards, increasing in 1778-1784. In contemporary rulebooks (see above) there are statements regarding the schoolboys' provisions, where beans were in the menu twice or thrice a week, on Tuesdays and Thursdays, as well as sometimes on Sundays (Sigurðsson and Stephensen, 1853). The bishops would also have purchased supplies for the Church, although the orders differed with every bishop. According to the literary evidence, there must have been a large amount of supplies imported to Skálholt every year, mainly in the form of beans and grain. *C. maculatus* was recovered from S236 dated to *c.* 1740-60 AD (see Table S1). Beans were reported to be imported on two occasions before 1758 and after this date there was an increase in imports which continued in large quantities providing a pathway for the introduction of a new stored product pest, *C. maculatu*s. The first archaeological record of this pest marks an expansion of biological invasions accompanying the trading networks of the post-medieval period. These also lead to the introduction of the mediterranean ant species *Hypoponera punctatissima* (Forel) during the 17th century, probably in straw around wine bottles (Buckland et al., 1992), and of another hitchhiker during the 18th century *Rattus norvegicus* (Berkenhout), the brown rat (Amorosi et al., 1992, Harrison and Snæsdóttir, 2012). Ecological change, with a variety of novel infestations and disease outbreaks were part of these changes.

5. Conclusions

The fossil insect results from a relatively well documented post-medieval context from Skálholt, provide detailed information about the use of a room in the building, which in comparison with results from other Icelandic farms also gives refined information about the palaeoecology of post-medieval Iceland. Our results can be summarised as below:

- The data from the beetles, flies and ectoparasites indicate that the room, listed as larder on the 1700 plan of Skálholt, had probably multiple functions during the 17th and the 18th century, although it is difficult to ascertain whether these were contemporaneous, seasonal or there was change of use over time.
- The large numbers of sheep keds and human and sheep lice, in the context of the archaeological record, indicate that the area could have been used for processing wool, and cleaning wool and clothing from ectoparasites and perhaps delousing the students and inhabitants of the school at Skálholt.
- Taking into account finds from archaeological excavations and the ethnographic record the evidence points to the use of urine for these activities and the extraction of ectoparasites.
- Similar patterns have been recorded from fossil insect assemblages from other Icelandic farms during the post-medieval period, namely Stóraborg and Reykholt.
- The beetle faunas point to the presence of hay, perhaps used to neutralise odours in addition to absorbing spills, although seasonal use of the room for hay storage is also a possibility.

- The presence of pests of stored products, indicates infested cereals and pulses, although it remains possible that these entered the room in herbivore dung and that storage did not take place in this area.
- The first archaeological record of an important currently cosmopolitan pest from Iceland, the bruchid *Callosobruchus maculatus*, is a direct consequence of imports of infested pulses to Iceland, recorded in the historical literature, and indicates the extent of trading networks during the post-medieval period.

Further research from Skálholt and other medieval and post-medieval sites may provide detail which is often omitted in the historical record and give a more complete understanding of the past, through distinct insect faunas associated with particular activities.

Acknowledgements

We would like to thank the Institute of Archaeology in Reykjavík for their support. A special thanks to Mjöll Snæsdóttir for assistance with written sources and to Orri Vésteinsson, Guðmundur Ólafsson, Hildur Gestsdóttir, Lilja Björk Pálsdóttir and Paul Buckland for discussions and their helpful comments. Many thanks are due to Erling Ólafsson, for providing information on the modern records of *Callosobruchus maculatus* from the Icelandic Institute of Natural History database. Anastasios Panayiotakopoulos is thanked for his help with maps and diagrams. We would also like to thank Lilja Árnardóttir and Margrét Hallgrímsdóttir at the National Museum of Iceland. Thanks to the editor Marcos Martinón-Torres for his constructive comments during the reviewing process.

List of Figures

Figure 1. Location map of Skálholt, southwest Iceland including other post-medieval sites mentioned in the paper.
Figure 2. (a). Plan of the excavation noting in red Room XVIII, the room sampled, *Stórabúr* Room XVII, listed as *Reflaskemma* (=tapestry store) in a 1700 map and Kjötskemma (=meat store) in a 1784 map, and the schoolboys' dormitory, Room XX, mentioned in the paper. (b). photograph of Room XVIII during excavation.
Figure 3. Map of Skálholt *c.* 1700 AD (courtesy of the National Archives of Iceland).The relevant room sampled for insects, Room XVIII, is indicated as *Stórabúr* (= big larder/ pantry). The adjacent room, XVII, mentioned in this paper, is listed as *Reflaskemma* (=tapestry store) in this map. XVII was listed as *Kjötskemma* (=meat store) in a 1784 map.
Figure 4. Ecological diagram from the samples from Skálholt, using BugsCEP (Buckland and Buckland 2006).
Figure 5. Comparison of species lists of Icelandic samples from synanthropic contexts with >15 MNIS of *Melophagus ovinus* (L.) using detrended correspondence analysis (DCA) in the computing program R. Samples from Skálholt are colour coded in orange, from Reykholt in red and from Stóraborg in purple. Sample H17F (=13) shows closest similarity with the Sample S236 (=3). Samples S262 (=1) and S269 (=5) from Skálholt also show strong similarities with H17F. For full information on the samples used for the comparison, their numbering for the DCA and detailed species lists, see information in this paper and Supplementary material, Table S4.
Figure 6. Import of rye products, barley and beans to Iceland from 1655-1784, based on data from *Hagskinna* (Jónsson and Magnússon, 1997).

Supplementary material

Table S1. Fossil insects from Skálholt, southwest Iceland. The list represents minimum numbers of individuals, MNIs.
Table S2. Table listing presence of *Melophagus ovinus* L., *Bovicola ovis* L. and *Pediculus humanus* L. recovered from medieval and post-medieval Icelandic sites.
Table S3. List of 5 ltr samples from Icelandic sites (Reykholt, Stóraborg, Skálholt) with high abundances (>15) of *M. ovinus*. All the relevant sites are post-medieval.
Table S4. Table with species lists of samples from post-medieval farms, Reykholt, Stóraborg, Skálholt with high abundances (>15) of *Melophagus ovinus* L., which were used in the detrended correspondence analysis (DCA) in the computing program R, see Fig. 5.The list represents minimum numbers of individuals, MNIs.

References

Amorosi, T.A., Buckland, P.C., Olafsson, G., Sadler, J., Skidmore, P., 1992. Site Status and the Palaeoecological Record: A Discussion of the Results from Bessastaðir, Iceland, in: Morris, C.D., Rackham, D.J. (Eds.) Norse and Later Settlement and Subsistence in the North Atlantic. Dept. of Archaeology, University of Glasgow, pp. 169-192.

Amorosi, T., Buckland, P.C., Magnússon, K., McGovern, T.H., Sadler, J.P., 1994. An Archaeozoological Investigation of the Midden at Nesstofa, Reykjavík, Iceland, in: R. Luff, R., Rowley-Conwy, P. (Eds.) Whither Environmental Archaeolog. Oxbow Monograph 38, Oxford, pp. 69-80.

Anon., 1912. Frá einokunartíðinni, Kæra Þórðar sýslumanns Hinrikssonar 1647 fyrir hönd Borgfirðinga yfir verzlaninni. Andvari. 37, 124-125.

Anon., 1948. Hungrvaka, Biskupa sögur I, in Jónsson, G. (Ed.). Snorraprent h.f. Reykjavík. Bengtson, S.A., 1981. Terrestrial invertebrates of the Faroe Islands: III, Beetles (Coleoptera): Checklist, distribution, and habitats. Fauna Norvegica B28, 52-82.

Araujo, A., Ferreira, L.F., Guidon, N., Maues de Serra Freire, N., Reinhard, K.J., Dittmar, K., 2000. Ten thousand years of head lice infection. Parasitol. Today 16, 269.

Arriaza, B., Orellana, N.C., Barbosa, H.S., Menna-Barreto, R.F., Araújo, A., Standen, V., 2012. Severe head lice infestation in an Andean mummy of Arica, Chile. J Parasitol. 98, 433–6.

Bjarnason, Á.H., 1994. Íslensk flóra með litmyndum. Ísafoldarprentsmiðjan, Reykjavík.

Boutellis A., Abi-Rached L., Raoult D., 2014. The origin and distribution of human lice in the world. Infect. Genet. Evol. 23, 209–217.

Böcher, J.,1988. The Coleoptera of Greenland. MoG, Bioscience 26, 1-100.

Böhme, J., 2005. Die Käfer Mitteleuropas. K. Katalog (Faunistiche Übersicht) (2nd ed.). Spektrum Academic, Munich.

Bresciani J., Haarløv N., Nansen P., Moller G., 1989. Head lice in mummified Greenlanders from AD 1475, in: Hart Hansen, J.P., Gullov, H.C. (Eds) The Mummies from Qilakitsoq— Eskimos in the 15th Century. Meddelelser om Grønland, Man & Society, vol 12. Museum Tuscalanum Press, Copenhagen, Denmark, pp. 89–92.

Buckland, P.C., Sveinbjarnardóttir, G., Savory, D., McGovern, T.H., Skidmore, P., Andreasen, C., 1983. Norsemen at Nipáitsoq, Greenland: A palaeoecological investigation. Nor. Archaeol. Rev. 16, 86-98.

Buckland, P.C., Perry, D.W., 1989. Ectoparasites of Sheep from Stóraborg, Iceland and their interpretation: Piss, parasites and people, a palaeoecological perspective. hikuin 15, 37-46.

Buckland, P.C., Dugmore, A. ,Sadler, J.P., 1991. Faunal Change or taphonomic problem? A Comparison of modern and fossil insect faunas from south-east Iceland, in*:* Maizels, J.K., Caseldine, C. (Eds.) Environmental Change in Iceland Past and Present. Kluwer, Dordrecht.
Buckland, P.C., Sadler, J.P., Sveinbjarnardóttir, G., 1992. Palaeoecological Investigations at Reykholt, Western Iceland, in: Morris, C.J D., Rackman, J. (Eds.) Norse and Later Settlement and Subsistence in the North Atlantic. Dept. of Archaeology, University of Glasgow, Glasgow, pp. 149-168.
Buckland, P.C., Edwards, K.J., Blackford, J., Dugmore, A.J., Sadler, J. P., Sveinbjarnardóttir, G., 1995. A question of Landnám: pollen, charcoal and insect studies on Papey, eastern Iceland, in: Butlin, R., Roberts, N. (Eds.) Ecological Relations in Historical Times. Institute of British Geographers, Blackwell, Oxford, pp. 245-264.
Buckland, P.C., Panagiotakopulu, E., Buckland, P.I., Perdikaris, S., Skidmore, P., 2006. Insect faunas from medieval Langenes in Arctic Norway. Proceedings from the 8th Nordic conference on the application of scientific methods in archaeology, Umeå 2001. Engelmark, R., Linderholm, J. Umeå, Dept. of Archaeology & Sami Studies, University of Umeå: 17-32.
Buckland, P.C., Panagiotakopulu, E., 2008. A palaeoecologist’s view of Landnám: a case still not proven? in: Paulsen, C. Michelsen, H.D. (Eds.) Símunarbók. Heiðursrittil Símun V. Arge á 60 áradegnum.Fróðskapur, Faroe University Press, pp. 31-41.
Buckland, P.C., Edwards, K.J., Panagiotakopulu, E., Schofield, E.J., 2009. Palaeoecological and historical evidence for manuring and irrigation at Garðar (Igaliku), Norse Eastern Settlement, Greenland. The Holocene 19, 105-116.
Buckland, P.C., Panagiotakopulu, E., 2010. Reflections on North Atlantic Island Biogeography: a Quaternary entomological view, in: Bengtson, S.-A., Buckland, P. Enckell, P.H., Fosaa, A.M. (Eds.) Dorete – her book:– being a tribute to Dorete Bloch and to Faroese nature. Annales Societatis Scientiarum Færoensis Suppl.52. Faroe University Press, pp. 187-215.
Buckland, P.C., 2012. (with K. Vickers, E. Panagiotakopulu, J. P. Sadler and P. I. Buckland) Insect remains, in: Sveinbjarnardóttir, G., Reykholt. Archaeological investigations at a high status farm in western Iceland. Snorrastofa and National Museum of Iceland, Reykjavík, pp. 218-241.
Buckland, P.I., Buckland, P.C., 2006. Bugs Coleopteran Ecology Package (Versions: BugsCEP v7; Bugsdata v7.11; BugsMCR v2.02; BugStats v1.22) downloaded on 25/10/2019.
Carrott, J., Issitt, M., Kenward, H., Large, F., McKenna, B. & Skidmore, P. (1995). Insect and other invertebrate remains from excavations at four sites in Lincoln (site codes WN87, WNW88, WF89 and WO89). Reports from the Environmental Archaeology Unit, York, 95/10.
Cheyne, I.A., Foster, W.M., Spence, J.B., 1974. The incidence of disease and parasites in the Soay sheep population of Hirta, in: Jewell, P.A., Milner, C., Boyd, J.M. (Eds.) Island Survivor. The ecology of the Soay sheep of St. Kilda. Athlone Press, London, pp. 338-359.
Clay, T., 1973. Pthiraptera (lice). Insects and other arthropods of medical importance. K. G. V. Smith. British Museum (NH), London, pp. 395-397
Coope, G.R., Osborne, P.J., 1968. Report on the Coleopterous Fauna of the Roman Well at Barnsley Park, Gaucestershire. Trans. B.G.A.S. 86, 84-87.
Cox, M.L., 2001. Notes on the natural history, distribution and identification of seed beetles (Bruchidae) of Britain and Ireland. Coleopterist 3, 9, 113-147.

Donisthorpe, H.S.J., 1939. A preliminary list of the Coleoptera of Windsor Forest. Nathanial Lloyd & Co, London.
Dussault, F., Bain, A., Lemoine, G., 2014. Early Thule winter houses: an archaeoentomological analysis. Arctic Anthropol. 51, 101-117.
Dussault, F., Bell, T. J., Grimes, V., 2017. Archaeoentomological perspectives on Dorset occupations in Newfoundland: A case study from the site of Phillip's Garden (EeBi-1). Arctic 69, Suppl. 1, 1-15.
Einarsson. O. (1970) Íslandslýsing. Reykjavík.
Ewing, H.E., 1924. Lice from human mummies. Science 60, 389–390.
Eyre, M.D., Luff, M.L., Lott, D.A., 1998. Rare and notable beetle species records from Scotland from survey work with pitfall traps, 1992-1996. Coleopterist 7, 81-90.
Fletcher, I., 1994. A tale of hair, wigs and lice. Egypt Archaeol 5, 31–33.
Fletcher, J., 1998. The secrets of the locks unraveled. Nekhen News (Milwaukee) 10, 7–9. Ewing, H.E., 1924. Lice from human mummies. Science 60, 389–390.
Forbes, V., 2015. Duck fleas as evidence for eiderdown production on archaeological sites. JAS 61, 105–111.
Forbes, V., Milek, K. 2014. Insects, activity areas and turf buildings' interiors: an ethno-archaeoentomological case study from 19th to early 20th-century Þverá, northeast Iceland. Quat. Int. 341, 195-215.
Friðriksson, A., Gestsdóttir, H., Vésteinsson, O. 1998. Fornleifarannsóknir í Skálholti. Greinargerð og tillögur, Reykjavík.
Grímsdóttir, G.Á, 2006. Biskupsstóll í Skálholti Saga Biskupsstólanna, Skálholt 950 ára - Hólar 900 ára. Bókaútgáfan Hólar, Reykjavík.
Haines, C.P., 1991. Insects and Arachnids of Tropical Stored Products: their Biology and IdentificationVol., 2nd edition). Natural Resources Institute, Chatham, Ken.
Hakbijl, T., De Groot, M., 1997. Insect Remains from Willem Barents' 1596 Arctic Exploration preserved in "Het Behouden Huys", Novaya Zemlya - with notes on the medicinal use of Cantharides, in Ashworth, A.C., Buckland, P.C., Sadler, J.P. (Eds.) Studies in Quaternary Entomology - An Inordinate Fondness for Insects. Quatern. Proc. 5, 129-134.
Hall, A.R., Kenward, H.K., 1990. Environmental evidence from the Colonia. Archaeology of York, The Environment, 14/6. Council for British Archaeology for York Archaeological Trust, London.
Hall, A.R., Kenward, H.K., 2000. Technical report: Plant and invertebrate remains from Anglo-Scandinavian deposits at 4-7 Parliament Street (Littlewoods Store), York (site code 99.946). Reports from the Environmental Archaeology Unit, York, 2000/22. York.
Halldórsson, G., Sigurðsson, O., Ólafsson, E., 2002. Dulin veröld, Smádýr á Íslandi. Mál og mynd, Reykjavík.
Hansen, M., 1987. The Hydrophilodea (Coleoptera) of Fennoscandia and Denmark. Fauna Entomologica Scandinavica, 18. Scandinavian Science Press, Leiden.
Harden V.A., 1993. Typhus, Scrub (Tsutsugamushi), in: Kiple K.F. (ed.) The Cambridge World History of Human Disease, 153. Cambridge University Press pp. 355-356.
Harrison, R., Snæsdóttir, M., 2012. Urbanization in Reykjavík: Post-Medieval Archaeofauna from the Downtown Area. JONA 19, 1-17.
Helgason, J., 1936. *Hannes Finnson biskup í Skálholti*. Ísafoldarprentsmiðja hf., Reykjavík.
Hellqvist, M., Backström, Y., 2002. Rapport över fynd av fossila insekter och djurben från Hólar i Hjaltadalur på norra Island 2002. Retrieved from Dalarna: http://uu.diva-portal.org/smash/get/diva2:547149/FULLTEXT01.pdf

Hoffmann, A. 1954. Coleoptérès Curculionides 2. Faune de France, 59, 487-1208. Lechevalier, Paris.
Horne, P., 1979. Head lice from an Aleutian mummy. Paleopathol News 25,7–8.
Johnson, S.W., 1866. Peat and its uses: as fertilizer and fuel. Orange Judd and Company, New York City.
Jónasson, J., 1961. Íslenzkir Þjóðhættir. Ísafoldarprentsmiðja, Reykjavík.
Jónsson, G., Magnússon, M.S. (Eds.), 1997. Hagskinna: sögulegar hagtölur um Ísland. Hagstofa Íslands, Reykjavík.
Kébé, K., Alvares, N., Espíndola, A., Justy, F., Olivieri I., Sembène, M. 2016. Insights into the genetic structure of the cowpea pest *Callosobruchus maculatus* in Africa. J Pest Sci 89, 449–458.
Kenward, H. K., Hall, A. R., Allison, E. P. & Carrott, J. (2011). Environment, activity and living conditions at Deer Park Farms: evidence from plant and invertebrate remains. In, C. J. Lynn, J. A. McDowell, Deer Park Farms: the excavation of a raised rath in the Glenarm valley, Co. Antrim, 497-548. North Ireland Archaeological Monograph 9. Stationery Office for Northern Ireland Environment Agency, Belfast.
Kingsolver, J.M. (Ed.), 1991). Adult beetles (Coleoptera*)* (Vol. Agriculture Handbook 655). US Dept. of Agriculture, Washington.
Koch, K., 1989. Die Käfer Mitteleuropa, Vol. 1. Goecke and Evers, Krefeld.
Konráðsdóttir, H., 2009. Archaeoentomological analysis of samples from the 2008 season of Skriðuklaustur excavation. Skýrslur Skriðuklaustursrannsókna XXI, Reykjavík.
Konráðsdóttir, H., 2010. Archaeoentomological analysis from Gásir in Eyjafjörður, in: O. Vésteinsson, O., Guðmundsdottir Beck, S., Mould, Q., Konráðsdóttir, H., Juel Hansen, S. C. (H. M. Roberts (Ed.)). Gásir Post Excavation Reports 2. Fornleifastofnun Íslands, Reykjavík, pp. 51-72.
Konráðsdóttir, H., 2012. Archaeoentomological analysis of samples from the 2011 season of Skriðuklaustur excavation. Skýrslur Skriðuklaustursrannsókna XXXIII, Reykjavík.
Lale, N.E.S., Vidal, S., 2003. Effect of constant temperature and humidity on oviposition and development of Callosobruchus maculatus (F.) and Callosobruchus subinnotatus (Pic) on bambara groundnut, Vigna Subterranea (L.). J. Stored Prod. Res.*39*, 5, 459-470.
Larsson, S.J. Gígja, G., 1959. Coleoptera (Vol. 43). Munksgaard, Copenhagen.
Lindroth, C.H.,1945. Die Fennoskandischen Carabidae I-II. Goteborgs K. Vetensk. o VitterhSamh. Handl.(6) B, 4. Goteborg. (reprinted as English translation (1992) Intercept, Andover.
Lindroth, C.H. 1986. The Carabidae (Coleoptera) of Fennoscandia and Denmark (Vol. 15). E.J.Brill/Scandinavian Science Press Ltd. Leiden/Copenhagen.
Lindroth, C.H., Andersson, H., Bodvarsson, H., Richter, S.H., 1973. Surtsey, Iceland. The Development of a New Fauna, 1963-1970. Terrestrial Invertebrates. Entomol. Scandinavica, Suppl.5.
Lucas, G., 2003. Skálholt 2002, Framvindunarskýrslur/Interim Report no. 1, Reykjavík.
Lucas, G., 2005. Skálholt 2005, Framvinduskýslur/Interim Report No.4, Reykjavík.
Lucas, G., 2018. Symbiotic architectures. In, S. Pilaar Birch (ed.) Multispecies archaeology, 105-117. Routledge, Abingdon.
Mumcuoglu, K.Y., Zias, J., 1991. Pre-pottery neolithic B head lice found in Nahal Hemar Cave and dated 6,900–6,300 B.C.E. (uncalibrated). Atikot 20, 167–168.
Mumcuoglu, K.Y., Zias, J., Tarshis, M., Lavi, M., Stiebel, G.D., 2003. Body louse remains in textiles excavated at Massada, Israel. J Med Entomol 40, 585–587.
Noble, E.R., Noble, G.A., 1976. Parasitology. The biology of animal parasites. Lea and Febiger, Philadelphia.

Olavius, Ó., 1964. Rejsebog, Copenhagen, Translated to Icelandic and published from the 1780 manuscript. Reykjavik.
Ólafsson E., 1991. A checklist of Icelandic insects. Fjolrit Natturufraedistofnunar 17, 1–69.
Ólsen, B.M., 1910. Um kornyrkju á Íslandi. Búnaðarrit 24: 81-167. Búnaðarfélag Íslands. Reykjavík.
Pálsson, S., 1945. Ferðabók. Dagbækur og ritgerðir 1791-1897. Reykjavík.
Palma, R.L., 1991. Ancient head lice on a wooden comb from Antinoe, Egypt. J Egypt Archaeol 77, 194.
Panagiotakopulu, E., 2014. Hitchhiking across the North Atlantic – Insect immigrants, origins, introductions and extinctions. Quat. Int. 341, 59-68.
Panagiotakopulu, E, Buckland, P.C., 2017. A thousand bites: Insect introductions and late Holocene environments. Quat. Sci. Rev. 156, 23-35.
Panagiotakopulu, E., Skidmore, P., Buckland, P.C., 2007. Fossil insect evidence for the end of the Western Settlement in Norse Greenland. Naturwissenschaften 94, 300-306.
Pettigrew, T.J., 1834. History of Egyptian Mummies and an Account of the Worship and Embalming of the Sacred Animals. Longman, Rees, Orme, Brown, Green & Longman, London.
Robinson, M.A., 2007. The environmental archaeology of the Cotswold Water Park, in: Miles, D. Palmer, S. Smith, A. Jones, G.P. Iron Age and Roman settlement in the Upper Thames Valley: excavations at Claydon Pike and other sites within the Cotswold Water Park, 355-363. Thames Valley Landscapes Monograph 26, Oxford.
Rees, D., 2004. Insects of stored products. Manson publishing Ltd, London.
Ruffer, M.A., 1921. Studies in the paleopathology of Egypt. University of Chicago Press, Chicago.
Sadler, J.P., 1991. Archaeological and palaeoecological implications of palaeoentomological studies in Orkney and Iceland. Unpubl. Ph.D. thesis, University of Sheffield.
Sadler, J.P., 1993. Records of modern and subfossil species of Coleoptera from Westray, Orkney. Entomol.'s Mon. Mag. 129, 201-203.
Schelvis, J., 1991. Lice and nits (*Pediculus humanus capitis*) from medieval combs excavated in the Netherlands. Experimental and Applied Entomology, Proceedings of the Netherlands Entomological Society, 2, 14-15.
Schelvis, J., Koot, C. 1995. Sheep or goat? Damalinia deals with the dilemma. Experimental & Applied Entomology. Proceedings of the Netherlands Entomological Society, 6, 161-162.
Sigurðsson, J., Stephensen, O. (Eds.). (1853-1870). *Lovsamling for Island*. Volume II. Höst og sön. Köbenhavn.
Soper, E.K., Obson, C.C., 1922. The occurrence and uses of peat in the United States. U.S.G.S. Bulletin 728, 1-207.
Stead, J., 1981. Uses of urine, part 1 (with assistance from Arthur Saul). Old West Riding 1**,** 12-17.
Stead, J., 1982. The uses of urine, part II. Old West Riding 2, 1-9.
Sveinbjarnardóttir, G., 1992. Farm abandonment in medieveal and post -medieval Iceland: an interdiciplenary study. Oxbow Monograph 17, Oxbow books.
Sveinbjarnardóttir, G., 2018. Archaeological, Written, and Palaeoecological Evidence for Environmental Change in the Wake of Settlement in Iceland: Two Case Studies. *JONA* 11, 1-12.
Sveinbjarnardóttir, G., Buckland, P. C. 1983. An uninvited guest. *Antiquity* 58, 127-130.
Sveinbjarnardóttir, G., Buckland, P.C., Gerrard, A.J., Greig, J.R.A., Perry, D., Savory, D. Snæsdóttir, M., 1981. Excavations at Stóraborg: a palaeoecological approach. Arbók hins Islenzka Fornleifarfélags 1980, 113-129.

Tozer, E.R., 1973. On the British species of Latridius Herbst (Col., Latridiidae). Entomol.'s Mon. Mag. 108, 193-199.
Þorsteinsson, G., 1990. Horfnir starfshættir og leiftur frá liðnum öldum (Second edition ed.). Örn og Örlygur hf. Reykjavík.
van den Bos, V., Brinkkemper, O., Bull, I.D., Eengels S., Hakbijl, T., Schepers, M., van Dinter, M., van Reenen, G., van Geel, B., 2014. Roman impact on the landscape near castellum Fectio, The Netherlands. Vegetation History and Archaeobotany 23, 277-298.
Wen, T., Zhaoyong, X., Zhijie, G., Yehua, X., Jianghua, S., Zhiyi, G., 1987. Observation on the ancient lice from Loulan. Investigatio et Studium Naturae, Museum Historiae Naturae, Shanghaiense.