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Published in:
Journal of Archaeological Science: Reports

DOI:
10.1016/j.jasrep.2020.102299

2020

Document Version:
Publisher's PDF, also known as Version of record

Journal of Archaeological Science: Reports 31 (2020) 102299

Contents lists available at ScienceDirect

Journal of Archaeological Science: Reports

journal homepage: www.elsevier.com/locate/jasrep

Insects and other invertebrate remains from the coffin of a 17th century bishop in Lund Minster, S Sweden

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ARTICLE INFO

Keywords:
Archaeoentomology
17th century burial
Insects
Beetles
Acari (mites)
Forensic entomology

ABSTRACT

An extraordinarily diverse and well-preserved material, including the remains of 47 insect taxa and 12 taxa of other invertebrates, extracted from the 17th century burial of Bishop Peder Winstrup in Lund Minster, is presented and discussed in terms of the treatment of the body, activities connected with the burial and faunal significance. The invertebrate assemblages include species from gardens, insects feeding on living plants as well as dried or decaying plant matter. Many of the species are regarded as closely associated with humans (synanthropic), and a number of these are associated with outbuildings, such as stables and cellars. The absence of species associated with cadavers (necrophilous taxa) in the studied insect material is significant. The most plausible explanation is that the bishop died, and was buried during the winter, when such species are inactive, and thus precluded from colonising the body. A number of species were recorded which are today rare or very rare in southern Sweden. This is a strong indication that they once were more common and widespread, perhaps due to a greater prevalence of their preferred habitats. Sweden's earliest fossil bedbug is also amongst the finds.

1. Introduction

Deposits formed in dry and aerobic conditions do not normally yield fossil insect remains, as the exoskeletons are rapidly broken up by mechanical action, or decay as a result of fungal attacks (Elias, 2010). However, in stable arid conditions, cold climates with permafrost conditions or in sealed containers, such as jars with stored products or coffins with buried bodies, the preservation of biological remains may be excellent. Many lice and their eggs were found on 15th century CE mummies of Inuit women at a site in western Greenland (Hansen, 1989). A Pre-Columbian funerary bundle (11th century CE) found in a cave, in an arid part of northern Mexico, yielded twelve taxa of beetles, flies, wasps and moths (Huchet et al., 2013). Panagiotakopulu (2001) provides an overview of insect finds from ancient Egypt, including pests associated with food offerings in tombs from the 14th and 19th centuries BC. When an Egyptian mummy originally from Karnak was unwrapped, a necrofauna of blowflies and clerid beetles was discovered (Huchet, 2010). Studies of the contents of a lead coffin from a 3rd century CE Roman cemetery at Evreux, France (Pluton-Kliesch et al., 2013) yielded, in addition to coins, textiles, fur and calcite, three species of beetles and a fly pupa. A number of other palaeoentomological studies have presented insect remains from medieval burial contexts in Europe, including burials from London (Stafford, 1971), Canterbury (Girling, 1981), Glasgow (Buckland, 2012), and Hull (Hall et al., 2000; Skidmore, 2000). A recent study by Panagiotakopulu and Buckland (2012) of the burial of the Archbishop Greenfield at York recorded eight taxa of beetles and flies. Huchet (2015) found nine beetle taxa in the royal sarcophagus of Louis XI situated in the church of Notre-Dame de Cléry-Saint-André, Loiret, France. Morrow et al. (2016) presented nine beetle and fly taxa recovered from the Medici embalming jars found in the San Lorenzo Basilica, Florence. All of these studies demonstrate the importance of insect remains for providing a better understanding of burial contexts and practices. As a part of forensic analyses, insects in particular may provide important information concerning the treatment of corpses, exposure conditions and time prior to burial, as well as conditions in the tomb and their significance for the decay process (Panagiotakopulu and Buckland, 2012; Huchet, 2014).

In this paper we present a study of invertebrate remains from the

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https://doi.org/10.1016/j.jasrep.2020.102299
Received 12 December 2019; Received in revised form 16 February 2020; Accepted 19 February 2020

Fig. 1. Image of the bishop Peder Winstrup, when the coffin was opened (left). The bed of dried plants, mainly consisting of stems of *Artemisia*, which was exposed when the body and the mattress were removed (right). Photo by Gunnar Menander.

17th century burial of Bishop Peder Winstrup, in Lund Minster, southern Sweden, and discuss the faunal significance for the archaeological context. The removal of the bishop's coffin in 2014 revealed an extraordinary preservation of the body and textiles, along with a large quantity of plant and invertebrate remains (Fig. 1). This has offered a unique opportunity to open a window into the 17th century world, and especially illuminate aspects which are seldom provided by historical sources or archaeological excavations.

2. Historical background and burial context

Lund, in present day Scania, Sweden, is one of the oldest cities in Scandinavia. It was founded in AD 990, probably as a royal and ecclesiastical seat in connection with the unification of the Danish kingdom (Skansjö, 2012). Around CE 1050, Lund became an episcopal seat and the city expanded considerably, including the foundation of monasteries, a new royal estate, at least nine wooden churches and a commercial centre. Lund was elevated as the Danish archbishop's diocese from CE 1103–1104, and its Romanesque style cathedral was built during the first half of the 12th century.

Peder Winstrup (CE 1605–1679) studied at the universities of Copenhagen, Wittenberg and Jena. He became professor of physics and philosophy at Copenhagen University in CE 1633 and the Danish bishop in Lund AD 1638 (Hansson, 1950, 1952; Karsten and Manhag, 2017). After the Danish-Swedish peace agreement at Roskilde in CE 1658, all East Danish provinces, including Scania, became a part of the Swedish Kingdom and Winstrup changed sides. He became the first Swedish bishop in Lund, and was raised to nobility by the Swedish king Karl X Gustav. Lund University was founded on Winstrup's initiative and inaugurated in 1668. After a prolonged illness, perhaps as long as two years, Winstrup died on December 7th CE 1679, at the age of seventy four. The funeral took place on Janauary 27th 1680, and he was buried

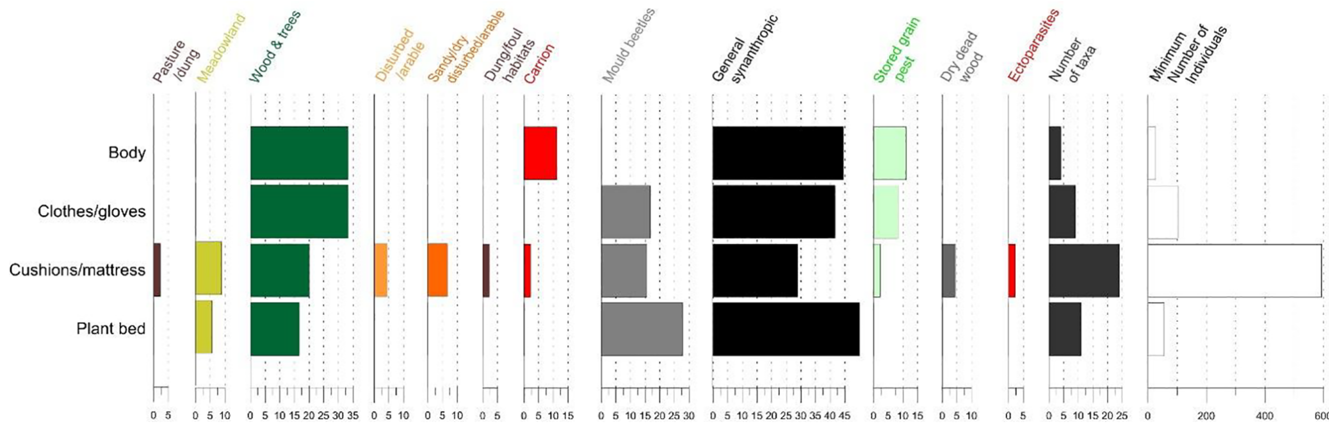

Fig. 2. Quantitative habitat reconstruction based on the beetle fauna, using the BugsCEP database and software (Buckland & Buckland, 2006). The horizontal bars indicate the relative proportion of taxa indicating each habitat category for each sample, irrespective of the number of taxa or individuals per sample (which are shown in the right hand two diagrams). A taxon may be present in more than one habitat category (e.g. carrion and synanthropic). The results show a highly synanthropic and relatively uniform environment between the samples, where the plant material in the pillows/mattress and plant bed is reflected in the beetle assemblage. The body produces a slight carrion signal, but this is a result of the low number of taxa in the sample and the presence of a single individual of the carpet beetle (*Attagenus pellio*), which is attracted to furs and skins. The habitat classifications and methodology are fully described in Buckland (2007).

in the family's vaulted tomb in Lund Cathedral (Möller, 1991; Karsten and Manhag, 2017). During rebuilding works in the cathedral in 1833, a number of coffins, Winstrups included, were opened, inspected and moved to another crypt. Historical records show the coffin has been moved a number of other times, including to the church chapel in 1875. It was also opened and the mummy inspected by Professor Otto Rydbeck in 1923 (Karsten and Manhag, 2017). The implications of these events are considered in the Discussion.

At the time of burial, the body of Winstrup was placed in a relatively plain pinewood coffin. The inside was lined with glued paper, over which silk fabric was nailed, and the bottom board included open slits. This inner coffin was moved into a robust and magnificent coffin of elm wood at the time of the burial. The body was dressed in a ceremonial vestment, including gloves and a cap. It rested on two pillows and a mattress of silk fabric, all stuffed with dried plant material, and placed on a bed of dried plants. Despite the excellent mummification of the body, there were no signs of any embalming treatment, and a CT scan revealed that the internal organs had not been removed before the burial. Mummification was thus most likely achieved through the storage of the body in a cold and relatively airy outbuilding or chamber, in the pine coffin prior to the funeral (Karsten and Manhag, 2017).

Part of the abundant dried plant material has been analysed and presented in Lagerås (2016a,b). The upper, larger pillow was mainly filled with hop cones (*Humulus lupulus*) and numerous grains of oats (*Avena sativa*), some barley (*Hordeum vulgare*) and rye (*Secale cereale*). Smaller quantities of flowers and seeds of lavender (*Lavandula angustifolia*), hyssop (*Hyssopus officinalis*), lemon balm (*Melissa officinalis*) and dill (*Anethum graveolens*), together with berries and needles of juniper (*Juniperus communis*), and a leaf of boxwood (*Buxus sempervirens*) were also present. The smaller, lower pillow was stuffed entirely with aromatic herbs, in particular lavender, hyssop, lemon balm and dwarf everlast (*Helichrysum arenarium*). The filling of the relatively thin mattress was similar to that of the upper pillow, with hop cones, aromatic herbs and cereal grains. It also included small amounts of seeds and nuts of several medicinal and otherwise useful plants, such as henbane (*Hyoscyamus niger*), pot marigold (*Calendula officinalis*), hazel (*Corylus avellana*), sour cherry (*Prunus cerasus*), and buckwheat (*Fagopyrum esculenteum*). Between the pillows and the mattress was a layer of wooden shavings, probably from the construction of the coffin. At the bottom of the coffin was a bed of rather coarse plant material, including stems and leaves of wormwood (*Artemisia absinthium*) and southernwood (*Artemisia abrotanum*).

3. Methods and material

A total of 49 samples were collected for the insect analysis. These were relatively evenly distributed from the entire body of the bishop, plant stuffing and the inner surface of the coffin. Fourteen of the samples were obtained by manual picking from the body and textiles; two were collected from the lower plant bed; two were shaken out from the gloves and the cap; three samples were obtained by dry sieving the pillow and mattress stuffing using a 3 mm sieve. The remaining samples were obtained from a vacuum cleaner used for the initial cleaning of the textiles. The greater part of the animal remains was extracted from the collected material under a binocular microscope at low magnification ($\times 7$). All identifiable specimens and fragments were mounted on cards, and stored at the Biological Museum, Lund University. Mites occurred in such large numbers that only a representative selection was extracted and mounted. The majority of the animal material was relatively well preserved, and consisted mostly of articulated exoskeletal body parts. A few specimens were, however, more or less complete. The numerous remains of mites, protected from fragmentation by their relatively large dorsal plates, were often especially well preserved, to the extent that different developmental stages could even be identified. Diptera were in most cases only represented by single wing fragments.

Habitat data was collated from a variety of sources (see references), including the freely available Bugs Coleopteran Ecology Package (BugsCEP: http://www.bugscep.com; Buckland and Buckland, 2006). An environmental reconstruction was undertaken using the beetle record (Fig. 2), facilitated by BugStats, a palaeoentomological statistics tool in BugsCEP (Buckland, 2007, 2014). BugsCEP uses an internal traits database to calculate and visualize the relative proportion of different habitats represented by the taxa found in each sample. It thus allows for systematic comparison between different samples and sites. See the BugsCEP database and references therein for more details on the ecology and fossil record of individual species. The nomenclature for Coleoptera follows Löbl and Smetana (2003, 2004, 2006, 2007, 2008, 2010, 2011, 2013).

4. Results

The faunal record obtained from the samples taken in the coffin includes mites (Acari), spiders (Araneae), an isopod (Crustacea), a snail (Gastropoda) and taxa of several orders of insects (Table 1). The six taxa of mites outnumber the rest of the animals in terms of numbers of individuals. *Eulaeaps stabularis*, a mite associated with small mammals

Table 1
Taxonomic list of invertebrate remains from the coffin of the bishop Peder Winstrup. Frequencies are calculated either of number of complete specimens or on the most abundant exoskeletal part of the taxon. Samples were analysed from the body of bishop Winstrup (Body), his clothes and gloves (Cloth/glov), the pillows and mattress (Pill/matt), and the plantbed. The mite *Eulaelaps stabularis* (C.L. Koch) was recorded in large quantities in all the samples and the number of individuals were not counted.

Invertebrate taxa from P. Winstrup					
	Taxon	Body	Cloth/glov	Pill/matt	Plant bed
Insecta					
Dermaptera					
Forficulidae	*Forficula auricularia* L.			1	
Hemiptera					
Cimicidae	*Cimex lectularius* L.			5	
Lygaeidae	Lygaeidae indet.			1	
Cicadellidae	*Eupteryx aurata* (L.)				1
Aphididae	*Macrosiphoniella* cf. *abrotani* (Walker)				1
	Phorodon humuli (Schrank)			9	
	Aphidoidea indet.			7	2
Coleoptera					
Carabidae	*Amara ovata* (F.)			1	
	Ocys quinquestriatus (Gyllh.)				1
Staphylinidae	*Phyllodrepa puberula* Bernh.			2	
Dermestidae	*Dermestes lardarius* L.			2	
	Attagenus pellio (L.)	1			
Anobiidae	*Ernobius mollis* (L.)			1	
	Stegobium paniceum (L.)	1	6	1	
	Anobium punctatum (DeG.)			4	
Ptinidae	*Epauloecus unicolor* (Piller & Mitterpacher)	22	86	520	36
	Ptinus fur (L.)	2	1	19	3
Nitidulidae	*Meligethes* cf. *aeneus* (F.)			1	
Cryptophagidae	*Cryptophagus saginatus* Sturm			3	2
	Cryptophagus dentatus (Herbst)			1	
	Cryptophagus cf. *distinguendus* Sturm				1
	Cryptophagus scutellatus Newman		1	1	
	Cryptophagus cellaris (Scop.)			2	
	Atomaria munda Erich.				2
	Atomaria nigripennis (Kugel.)			4	
Endomychidae	*Mycetaea subterranea* (F.)			3	3
Corylophidae	*Orthoperus* sp.		1	1	1
Latridiidae	*Latridius minutus*-group		4	14	4
	Corticaria fulva (Comolli)			1	1
Mycetophagidae	*Typhaea* sp.			1	
Apionidae	*Protapion* sp.			1	
Curculionidae	*Polydrusus* cf. *flavipes* (DeG.)			1	
Hymenoptera					
Pteromalidae	Pteromalidae indet.			1	
Ichneumonidae	*Picrostigeus/Batakomacrus* sp.			1	
Formicidae	*Lasius niger* (L.)			1	
	Hymenoptera indet.		2	3	1
Diptera					
Anisopodidae	Anisopodidae indet. (pupa)			1	
Chaoboridae	*Mochlonyx* sp.	2	1		
	Chaoboridae indet.		1		
Rhagionidae	Rhagionidae indet. (pupa)		1		
Stratiomyidae	*Chloromyia formosa* (Scop.)				1
Heleomyzidae	Heleomyzidae indet.		1		
Calliphoridae	Calliphoridae indet.			3	
	Diptera indet.		2	11	9
Lepidoptera					
Psychidae	Dahlicini indet.	1	2		
Tineidae	*Tinea pellionella* (L.)	13	9	4	3
Coleophoridae	*Coleophora* sp.			1	
Arachnida					
Acari					
Cheyletidae	*Cheyletus* sp.			2	
Eulohmannidae	*Eulohmannia ribagai* (Berlese)			5	2
Hermanniidae	*Hermannia* sp.			1	
Laelapidae	*Eulaelaps stabularis* (C.L. Koch)	xx	xx	xx	xx
	Hypoaspis sp.		5		
Parasitidae	*Parasitus* sp.			1	
Aranae					
Gnaphosidae	*Scotophaeus* cf. *scutulatus* (L.Koch)		1		
Theridiidae	*Steatoda* cf. *bipunctata* (L.)			1	
Agelenidae	*Tegenaria domestica* (Clerck)	1	1		
	Aranae indet.		3	2	1
Crustacea					
Isopoda	Isopoda indet.			1	
Gastropoda					
Helicidae	*Arianta arbustorum* (L.)			1	

Fig. 3. The spider beetle *Epauloecus unicolor* (left) and the mite *Eulaelaps stabularis* (right). The two most abundant species found in the coffin. Photo by C. Fägerström.

(Brinck et al., 1984; Edler, 1968, 1969, 1972; Lundqvist, 1974), was particularly abundant and found in large numbers in most of the sampled areas (Fig. 3). It is a predator on other mites, as well as eggs and larvae of insects. The other mite taxa found, *Parasitus* sp., *Hypoaspis* sp., *Cheyletus* sp., *Hermannia* sp. and *Eulohmannia ribagai* were much less frequent, and of these, at least *Cheyletus* is a predator on other mites (Boström et al., 1997), while *Hypoaspis* is a general predator, found in bird and animal nests (Evans and Till, 1966; Karg, 1993). Living specimens of *E. ribagai* were found on the inside of the gloves and in the plant bed. A thorax of a tangle-web spider (Theridiidae) was found in the upper pillow, probably belonging to the "false widow" species *Steatoda bipunctata*, which is mainly found in and around houses, but also in rubbish accumulations some distance from buildings (Roberts, 1996). One individual of the copse snail *Arianta arbustorum* was found in the mattress. Normally a forest species, it can also be found in green spaces in urban environments, such as gardens, cemeteries and parks. Wood-lice (Isopoda), terrestrial crustaceans which live in damp places, feeding mainly on plant matter and occasionally carrion, were also found.

Insects dominate the animal record with regards to the number of identified taxa (47) in the coffin and on the body. The majority were found in small numbers, with the exception of a few species of beetles. In the following description, we present the insect finds according to where in the coffin they were collected. The insect assemblages are dominated by "general synanthropic" species, i.e. species favoured by human environments and activities. Taxa associated with wood and trees, carrion, mould and stored grain are also significant, although these groups do share some species with the synanthropes (Fig. 2).

4.1. The body

The insect assemblage from the body of the bishop includes only seven identified taxa.

The carpet beetle, *Attagenus pellio*, is a common household pest, its larvae feeding on textiles, hair, feathers, and other organic matter, usually of animal origin. The adult beetle can also be found in birds' nests, flowers and decaying trees outside of anthropogenic environments (Koch, 1989). The biscuit beetle, *Stegobium paniceum*, is adapted to food containing starch, such as crispbread, cereals, dried vegetables, nuts and spices (Mourier and Winding, 1986). Whilst its origins are most likely in the Mediterranean region (Zahradník, 2013), it is considered almost exclusively as a pest of stored products in northern Europe. Twenty-two individuals of the flightless spider beetle *Eupauloecus unicolor* were found on the body (Fig. 3). *E. unicolor* is presently mainly found in barns and outbuildings, but also occurs in rodent burrows and bumblebee nests. It feeds on decaying organic matter, is normally rather local, and rarely found in large numbers (Harde, 1984). However, numerous finds of insect remains have been recorded from indoor human habitats (e.g. Hall and Kenward, 1990; Buckland et al., 1993; Kenward and Hall, 1995) in relatively clean and dry conditions (see further Discussion). The white-marked spider beetle, *Ptinus fur*, was originally adapted to environments such as bird nests and hollow trees where it was polyphagous on substances of plant or animal origin. Today it is mainly synanthropic and probably now the United Kingdom's most common pest of stored grain (Armitage et al., 1999). Like *E. unicolor*, it avoids very dry conditions (Mourier and Winding, 1986). Ghost midges (Chaoboridae) of the genus *Mochlonyx*, which live in marshes and overgrown small ponds, were also found, as well as bagworms (Psychidae) of the genus *Dahlicia*, which feed on mosses, lichens or algae and are often found on stone walls, on the ground or on vegetation (Bengtsson et al., 2008). The larvae of the case-bearing clothes moth *Tinea pellionella* feed on substances that consist of keratin, such as wool, fur and feathers. They usually also require supplementary foods such as flour, meat or dead insects for their development (Bengtsson et al., 2008; Chauvin et al., 1979).

4.2. Clothes and gloves

Twelve insect taxa were found in the clothes and gloves. *Orthoperus* beetle species are found under bark, on mouldy wood, under rotting leaves, in fungi, straw and similar substrates (Freude, 1971). In anthropogenic contexts, the mould and fungus beetles *Cryptophagus scutellatus* and *Latridius minutus* are most often found in haystacks, compost, cellars and stables. Although considered synanthropic species, both can be found in the wild in Europe, including Scandinavia, especially in plant debris and rotten or hollow trees (Hansen, 1950). The beetles *Stegobium paniceum* and *Ptinus fur* were also recorded, together with 86 individuals of *Epauloecus unicolor*. Snipe flies (Rhagionidae) are found in plant debris in wet places or in streams. The larvae of Heleomyzidae flies feed on carrion, dung and fungi (Oosterbroek, 2006). *Mochlonyx* sp., *Dahlicini* sp. and *Tinea pellionella* were also recorded.

4.3. Pillows and mattress

The most diverse and rich insect assemblage was collected and identified from the plant material in the pillows and the mattress, totaling 31 taxa and at least 593 individuals. The ground beetle *Amara ovata* lives on rather dry, gravelly soil with sparse but tall vegetation in environments such as gravel pits and arable fields where it is polyphagous, but commonly feeds on seeds (Lindroth, 1986). It is a typical spring breeder and, although rare, can be found as an adult throughout the year in milder climates. The rove beetle *Phyllodrepa puberula* is found in plant refuse and manure in stables and outbuildings (Palm, 1948). The larder beetle *Dermestes lardarius* was formerly a serious indoor pest, with the carnivorous and zoodetriphagous larvae and adults both attacking all forms of animal products. It appears to have a preference, however, for drier material including smoked or dried meat and fish, which was often kept hanging from the ceiling in pre-modern times (Peacock, 1993). Their larvae may gnaw tunnels in wood or plaster in order to get to the food source. A fragment of one adult and a larva were found in the material within the pillows. The pollen beetle *Meligethes aeneus* is commonly found in the flowers of the cabbage family (Brassicaceae), and can be found in large numbers on many different flowers. *Cryptophagus dentatus* and *C. saginatus* are both associated with dead wood in forested environments or in stables, granaries and outbuildings, whereas *C. cellaris* is found in grain, hay and other types of dried plant material (Hansen, 1950). *Corticaria fulva* and *Mycetaea subterranea* are often found in cellars and stables on mouldy plant debris (Vogt, 1967; von Perez, 1967). *Atomaria nigripennis* feeds on mouldy, old hay mixed with manure and on fungi in cellars (Fig. 4).

The common furniture beetle or woodworm, *Anobium punctatum*, is a common pest of timber and furniture in older houses (Mourier and Winding, 1986). Its optimum development takes place at a temperature of 22–23 °C, but it may also survive outdoors at lower temperatures. The life cycle of *Ernobius mollis* is similar, with the larvae developing in the innermost bark or the outermost sapwood of conifer trees. *Protapion* spp. feed on herbs of the bean family (Fabaceae), and *Trifolium* and *Medicago* species in particular. *Polydrusus flavipes* feeds mainly on the leaves of oak but also on birch and willow, and may be polyphagous on deciduous trees (Koch, 1992; Palm, 1996). *Orthoperus* sp., *Cryptophagus scutellatus*, *Latridius minutus*, *Stegobium paniceum* and *Ptinus fur* were also recorded, along with 520 individuals of *Epauloecus unicolor*. The common earwig, *Forficula auricularia,* feeds on both dead and living plants, carrion and may also prey on smaller insects and mites. It is common in gardens and can occasionally cause damage in plant nurseries. Window gnats, Anisopodidae, often occur in high quantities in old cowpats, but can also be found in decaying plant matter and sewage. Blowflies, Calliphoridae, are an important group in forensic entomology and among the first insects to lay their eggs on animals after their death (Sharma et al., 2015). They also lay eggs in manure or decomposing organic matter. Larval development takes only a few weeks and under favourable conditions, the flies propagate considerably. Only wings of the adult flies were recorded, but the bodies are prone to disarticulate rapidly into small sclerites. During early summer the host plants of the aphid *Phorodon humuli* are sloe (*Prunus spinosa*) and plum (*Prunus domestica*), whereas during June and July it changes food plant to hops (*Humulus lupulus*) (Heie, 1994). Bugs of the family Lygaeidae feed on seeds. The wingless bedbug, *Cimex lectularius*, feeds on human blood throughout its development, is night active and spends the day in suitable hiding-places close to beds. It requires a relatively warm and dry climate and in northern countries breeds in heated houses, where increased travel and insecticide resistance are helping it to regain a foothold as a common domestic pest (Romero et al., 2007). The black garden ant *Lasius niger* often makes its nests inside house walls, stone walls and under pavements (Collingwood,

Fig. 4. The fungus beetle *Atomaria nigripennis*. Photo by C. Fägerström.

1979). The caterpillars of case-bearer moth *Coleophora hemerobiella* develop on leaves of fruit trees or shrubs of the Rosaceae, although identification of this larva is uncertain. Remains of *Tinea pellionella* and ichneumon wasps were also recorded.

4.4. The plant bed

Fifteen insect taxa were identified from the plant bed under the mattress. The ground beetle *Ocys quinquestriatus* is a very rare species in Scandinavia today, being a European southern-temperate species (Lindroth, 1985). It is generally synanthropic, being found in and around cellars, stables, ruins and occasionally under the bark of trees in gardens. It is also probably associated with rodents. *Cryptophagus distinguendus* occurs in cellars and compost, especially decaying grass or straw. *Atomaria munda* is found in similar, but often moldier places. Other beetle taxa identified include *Orthoperus* sp., *Cryptophagus saginatus*, *Latridius minutus*, *Corticaria fulva*, *Mycetaea subterranea*, *Epauloecus unicolor* and *Ptinus fur*, as described earlier. The larvae of the soldier fly *Chloromyia formosa* develop in cow dung but also in decaying plant matter (Stubbs and Drake, 2001). The aphid *Macrosiphoniella* cf. *abrotani* feeds on *Artemisia* species (Fig. 5). *Eupteryx aurata* is primarily confined to nettles (*Urtica dioica*), but may also be found on plants of the Asteraceae family (Ossiannilsson, 1981). Remains of *Tinea pellionella* were also recorded.

5. Discussion

The insect material collected from the coffin of Peder Winstrup, in comparison with previous archaeoentomological studies from burial

Fig. 5. The aphid *Macrosiphoniella* cf. *abrotani*. The damage shown on the dorsal part of the abdomen is probably an exit hole of a parasitic wasp. Photo by C. Fägerström.

contexts (see introduction), is uniquely diverse both with respect to the number of taxa and individuals. The majority of the invertebrate remains were found in the pillows, the mattress and the plant bed, but remains were also well represented in the gloves and the clothes. Except for the numerous remains of mites, subfossil beetles dominate the assemblages. Less chitinised taxa such as the adults of Diptera, which are prone to fall apart post mortem, are rare. Many empty Lepidoptera pupae were found but adult specimens are absent, the latter most likely having collapsed into unidentifiable fragments. Apart from fragmentation, there are few signs of degradation of the faunal material. This suggests relatively little activity of decomposers after the burial in the crypt. In any burial context, one would expect a number of necrophilous species, including true flies of the families Calliphoridae, Muscidae, Sarcophagidae and beetles of the families Silphidae, Histeridae, Rhizophagidae and Cleridae. However, these taxa are more or less absent in the insect material studied from the burial of Winstrup. This contrasts significantly with the insect assemblage associated with the coffin of the medieval Archbishop Greenfield from York Minster, which was dominated by the graveyard beetle *Rhizophagus parallelocollis* (Panagiotakopulu and Buckland, 2012). As Winstrup died in December, and was buried in January (Möller, 1991; Karsten and Manhag, 2017), the absence of this faunal group may be explained in terms of a lack of activity of these species during the winter. If the body was stored in an unheated outbuilding, the low temperatures may also have prevented any activity of necrophilous species that might have been active at that time of year. Evidently, despite being highly mobile, no such species were able to enter the coffins after the burial in the crypt. In this respect, the entomological evidence supports the historical record, but also supports the sealed context nature of the coffin and the minor entomological implications of later re-opening events (but see below). It is also possible that the abundance of dry hop cones and wormwood had a deterrent effect on necrophilous species, particularly during the first years in the crypt (e.g. Bedini et al., 2015).

The possible origins of the invertebrates found, in terms of their habitat requirements and food preferences, provide insights into the treatments of the body and the activities connected with the burial. A number of species are restricted to more natural habitats, whereas others are normally found indoors today or are favoured by other environments created by humans (synanthropic species). The assemblages include species associated with living plants, including *Artemisia* spp. (*Macrosphoniella* cf. *abrotani*), nettles (*Epteryx aurata*), herbs of Brassicaceae (*Meligethes* cf. *aeneus*) and Fabaceae (*Protapion* sp.). Remains of the aphid *M.* cf. *abrotani* were found with indication of attack from a parasitic wasp of the genus *Aphidius*, indicating that the former was immobile and stuck to the host plant. Finds of the aphid *Phorodon humili*, which was most likely connected to the hops in the upper pillow, may indicate that the harvest of the plant material took place after July, but before November when the plant withers. The presence of invertebrate taxa which favour garden environments, including the copse snail, ghost midges, bagworms, black garden ant and common earwig, supports the suggestion that the plant material probably originated from gardens (Lagerås, 2016a,b). The beetles *Amara ovata* and *Polydrusus flavipes* may also have been brought in with the plants harvested from a garden. Historical documents show that Winstrup was the owner of gardens where plants, including medical herbs were cultivated. These were mainly for household use, and some of the cultivated products were preserved by drying, to enable storage for future use (Karsten and Manhag, 2017). The insect evidence suggests that the plants used in the coffin were probably dried indoors, in ventilated outbuildings, where they attracted insects which feed on dried plant material, such as the biscuit beetle, white-marked spider beetle, and *Cryptophagus cellaris*. However, part of the plant material may have been attacked by fungi, either during drying or later storage, as suggested by the presence of *Corticaria fulva*, *Mycetaea subterranea*, and *Atomaria nigripennis*. *Orthoperus* species may also have been brought in with mouldy plant matter. The fossil record testifies to pests of stored products having been a significant problem since humans began cultivating crops and storing a surplus (Panagiotakopulu and Buckland, 2017). The cereals which were included in the stuffing of the upper pillow may have been infested by the biscuit beetle prior to their usage in this context. Likewise, the wooden material used was most likely bored by the furniture beetles (Anobiidae) before the coffin was made.

A number of insect taxa indicate outbuildings such as stables and cellars, e.g. *Phyllodrepa puberula*, *Cryptophagus scutellatus*, *C. saginatus*, *C. distinguendus*, *Atomaria munda*, *A. nigripennis*, *Corticaria fulva*, *Latridius minutus* and *Mycetaea subterranea*. A possible explanation is that the coffin, perhaps with the plant material, was placed for a shorter period in such a space which enabled these insects to enter the coffins. *Epauloecus unicolor* may also have first entered the coffin at this point, although it is possible that it may have entered from a room in a residential-house. Recent studies from Iceland have shown that the indoor environments of abandoned houses may favour the species. Forbes and Milek (2014) found numerous remains of *E. unicolor* under floorboards in the bedroom of a turf building in NE Iceland. Remains of the species were also recorded inside a workshop for eiderdown production (Forbes, 2015). The large number of specimens could also suggest that the species was reproducing inside Winstrup's coffin after burial, and that its high abundance does not necessarily reflect a high abundance in the environment outside of the coffin. Perhaps more intriguing are the finds of species often associated with the storage of textiles and skins. These species, including *Attagenus pellio* and *Dermestes lardarius* require warm, indoor environments and are most likely to have colonised the bishop's clothing whilst it was in storage prior to his funeral dressing. The case-bearing clothes moth (*Tinea pellionella*) probably also colonised his woollen garments whilst they were stored in a wardrobe during his illness. Bed bugs (*Cimex lectularius*) were probably a frequent pest of relatively well-heated houses during the 17th century (although evidence from the fossil record is limited). A bedbound individual, like Winstrup whilst affected by serious illness in his last years, was undoubtedly an easy target for these ectoparasites, which left him when he died and were incorporated in the plant material of his pillows and mattress.

The only indications of species reproducing in great numbers within the coffin are from *Epauloecus unicolor* and *Eulaelaps stabularis*, which were very frequent in the invertebrate assemblages. The large number of specimens, and in the case of *E. stabularis* in different developmental stages, suggests that these species lived for several generations inside the coffin. *Epauloecus unicolor* probably fed on the plant material and the remains of other insects. However, when the gloves were removed from Winstrup, damage on the skin of his hands was discovered. The damper conditions within the glove may have supported an outbreak of

E. unicolor, as would be consistent with the size pattern of the damage marks. The mite *Eulaelaps stabularis* may have preyed on eggs and larvae of *Epauloecus unicolor*. It is possible that the third most abundant taxon, *Tinea pellionella*, also survived within the coffin, but if so then only for a few generations. No adults were found within the coffin, which suggests that either their bodies were fragmented by *E. unicolor* or they escaped the coffin.

Of particular interest is the fragment of *Dermestes lardarius* larva which was found in the material within the bottom pillow. It has perished in its larval stage, and if it had been alive within the coffin, some unfavourable conditions may have interrupted its development. This could be an indication of the low temperatures and dry conditions that were likely to have occurred within the coffin. The European fossil record of *D. lardarius* is surprisingly sparse and entirely synanthropic, with a few Viking Age and medieval finds from England and Scandinavia complementing the few finds from Late Bronze Age Runnymede and Late Neolithic Willington in England (see species entry in Buckland and Buckland, 2006). Single individuals were also retrieved from the Roman site at Poultry in London (Smith, 2013) and Saxon features at Barton Court Farm in Oxfordshire, England (Robinson et al., 1984).

Although most specimens found within the coffin are likely to have originated from the time of the burial, there are some species of uncertain origin. The coffin was opened on at least two occasions, with events in 1833 and 1923 well documented, and there is a possibility that some of the fossil material originates from these events. Some Diptera, including the Chaoboridae, may occur in great numbers and are often encountered indoors, potentially seeking shelter in the crevices under a coffin lid. The spider *Scotophaeus* cf. *scutulatus* was found as a nearly undamaged exoskeleton shed, strongly suggesting that it is of recent origin, and a modern contaminant. Some specimens of the mite *Eulohmannia ribagai* were found alive at the time of sampling. They occurred in three different samples, but these very small mites were hard to spot and could potentially have occurred in greater numbers. Their presence is hard to explain, and the most likely scenario is that they were introduced into the coffin recently. The overall robustness of the interpretation based on the other species, however, suggests that the vast majority of other specimens entered the coffin around the time of the original burial.

The occurrences of some species are of great interest from a faunistic perspective, when compared to what could be expected in similar environments today. A few of the species found in the coffin are now very rare, only to be found in old buildings and related to a less sanitary lifestyle. *Ocys quinquestriatus* has only been found in a few places in Sweden, in connection with old buildings and rodents within their walls (Lindroth, 1985). *Phyllodrepa puberula*, *Corticaria fulva*, *Atomaria nigripennis* and *A. munda* are all rare species today, connected to old agricultural practices and buildings with low sanitary standards. Both *O. quinquestriatus* and the two *Atomaria* species are classified as vulnerable on the Swedish Red-List (ArtDatabanken, 2015). The occurrence of these species in the environment, in which the coffin of Winstrup was assembled or stored, is a strong indication that they once were more common and widespread, even within small cities. The single previous fossil record of *Phyllodrepa puberula* comes from a Roman well at Ashby Folville in Leicestershire, England (Rackham, 2009). *Atomaria nigripennis* is a reasonably common fossil find in the post-Roman north European record, but *A. munda*, perhaps due to the difficulty of identifying some *Atomaria* species from fossil parts, is only previously known from Roman and Anglo-Scandinavian York (Hall and Kenward, 1990).

Epauloecus unicolor is associated with human structures, presently mainly found in barns and outbuildings, where it feeds on decaying organic matter. Today it is a widespread but rare species in the Nordic countries, although its abundance may be underestimated due to limited collecting in its habitat (Forbes et al., 2016). In the mid-19th century, it was recognised as “rather rare in beehives and old wood” by the renowned entomologist Thomson (1863), who lived in the city of Lund. The high concentration of specimens found in the coffin could indicate that this species was more frequent in the time of Winstrup than it is today or even in the 19th century. A number of palaeoentomological studies from England and Iceland suggest that *E. unicolor* was more frequent during medieval time and at least until the 18th century, particularly in indoor environments (e.g. Hall and Kenward, 1990; Buckland et al., 1993; Kenward and Hall, 1995; Kenward et al., 1995; Smith, 2013; Forbes and Milek, 2014; Forbes et al., 2016).

The bedbug, *Cimex lectularius*, is confined to indoor environments in the temperate zone, and was brought to the north of Europe by humans. The earliest north European find is from the 4th century CE in Lincoln, UK (Dobney et al., 1998), but it is known as fossil from Ra Nefers House at el Amarna, Minya (Egypt) and dated to ca. 1350 BCE (Panagiotakopulu et al., 2010). Medieval accounts of infestation are known from southern Germany, France and the British Isles (Andrews, 1976; Usinger, 1966). *Cimex* species require exceptional conditions to be preserved as fossils, and they were undoubtedly more common in the past than the fossil record belies. *Cimex lectularius* was probably introduced to the UK by the Romans, but may have arrived later in Scandinavia. The bedbug has not previously been found in archaeological contexts in Sweden and this represents its earliest Scandinavian find.

6. Conclusions

The uniquely diverse insect material collected from the coffin of Peder Winstrup, mainly found in the pillows, the mattress and the plant bed, provides insights into the treatment of the body, activities connected with the burial and faunal implications. Necrophilous taxa are more or less absent from the material, which most likely is due to Winstrup having died and being buried during the winter, which precluded any activity of such species. The abundance of insect repelling plants in the coffin may also have had a deterrent effect on necrophilous species. The invertebrate taxa support the suggestion from the previous plant macrofossil analysis that the plant material in the coffin probably originated from gardens. A number of insect taxa also indicate outbuildings, such as stables and cellars. A possible explanation is that the coffin was placed in such a place during the seven weeks before the funeral, which enabled these insects to enter the coffin. There are indications that a few species reproduced within the coffin, since they were very frequent in the assemblages. Finds of living mites and a few very well preserved insect and spider specimens are regarded as modern contaminants. A number of species included in the insect assemblages are today rare or very rare, which is a strong indication that they once were more common and widespread, probably reflecting a greater abundance of their required habitats.

Author contributions

Christoffer Fägerström identified the collected material and contributed to the text. Philip I. Buckland contributed to the text and undertook the quantitative analysis of the data. Geoffrey Lemdahl drafted the original text, contributed to revisions and managed the article production. Per Karsten, Per Lagerås and Andreas Manhag provided background information and contributed to the text equally.

Acknowledgements

We would like to express our gratitude to the following colleagues for their help in the identification of specimens: Bengt-Åke Bengtsson, Torslunda; Rune Bygebjerg, Lund; Roy Danielsson, Dalby; Jens Esser, Berlin; Lars Jonsson, Kristianstad; Jette Knudsen, Lund; Lars Lundkvist, Lund; Ted von Proschwitz, Göteborg. We are also thankful for the assistance and sampling undertaken by Lovisa Dal, conservator at the Historical Museum in Lund. This study was supported by funds from the

Crafoord Foundation. We would also like to thank the editor and an anonymous reviewer for their comments on the manuscript and the addition of several valuable references.

References

Andrews, M., 1976. In: The Life that Lives on Man. Faber & Faber, London, pp. 183.

Armitage, D.M., Kelly, M.P., Amos, K., Schaanning, S., Spagnoli, W., 1999. The white-marked spider beetle, Ptinus fur (L.) in stored grain – biology, seasonal occurrence and control using a surface insecticidal admixture. Proceedings of the 7th International Working Conference on Stored-product Protection, 1, Beijing, pp. 51–57.

ArtDatabanken, 2015. Rödlistade arter i Sverige 2015. ArtDatabanken SLU, Uppsala.

Bedini, S., Flamini, G., Girardi, J., Cosci, F., Conti, B., 2015. Not just for beer: evaluation of spent hops (Humulus lupulus L.) as a source of eco-friendly repellents for insect pests of stored foods. J. Pest Sci. 88, 583–592.

Bengtsson, B.Å., Johansson, R., Palmqvist, G., 2008. Nationalnyckeln till Sveriges flora och fauna. Fjärilar: Käkmalar-säckspinnare. Lepidoptera: Micropterigidae – Psychidae. ArtDatabanken, SLU, Uppsala, 646 pp.

Boström, S., Johansson, E., Härfast, B., Lundqvist, L., Bäckman, I., von Rosen, E., van Hage-Hamsten, M., 1997. Characterization of the mite fauna (Acari) in Swedish barn dust. Int. J. Acarol. 23, 127–132.

Brinck, P., Brinck-Lindroth, G., Edler, A., Lundqvist, L., Nilsson, A., 1984. Ectoparasites (insecta: anoplura and siphonaptera, acari: mesostigmata, ixodoidea) on small mammals in draved forest, Denmark. Entomol. Meddelelser 51, 103–111.

Buckland, P.C., Sadler, J.P., Smith, D., 1993. An insect's eye-view of the Norse farm. In: Batey, C.E., Jesch, J., Morris, C.D. (Eds.), The Viking Age in Caithness, Orkey and the North Atlantic. Edinburgh University Press, Edinburgh, pp. 518–528.

Buckland, P.C., 2012. Insect fauna from within the cranium of skeleton 570. In: Discroll, S.T. (Ed.), Excavations at Glasgow Cathedral 1988–1997. Society for Medieval Archaeology Monograph, pp. 157.

Buckland, P.I., Buckland, P.C., 2006. BugsCEP Coleopteran Ecology Package. NOAA/NCDC Paleoclimatology Program, Boulder CO, USA. URL: http://www.bugscep.com. Downloaded: 9th Nov 2018.

Buckland, P.I., 2007. The development and implementation of software for palaeoenvironmental and palaeoclimatological research: the Bugs Coleopteran Ecology Package (BugsCEP). Archaeol. Environ. 23, 1–220.

Buckland, P.I., 2014. The Bugs Coleopteran Ecology Package (BugsCEP) database: 1000 sites and half a million fossils later. Quat. Int. 341, 272–282.

Chauvin, G., Vannier, G., Gueguen, A., 1979. Larval case and water balance in Tinea pellionella. J. Insect Physiol. 25 (7), 615–619.

Collingwood, C.A., 1979. The Formicidae (Hymenoptera) of Fennoscandia and Denmark. Fauna Entomol. Scand. 8, 1–174.

Dobney, K., Kenward, H.K., Ottaway, P., Donel, L., 1998. Down, but not out: biological evidence for complex economic organization in Lincoln in the late 4th century. Antiquity 72, 417–424.

Edler, A., 1968. Ectoparasitic mites (Acarina: Parasitiformes) from small mammals from the Tärnasjö and Ammarnäs areas in Swedish Lapland. Entomol. Tidskr. 89, 269–277.

Edler, A., 1969. Ectoparasitic mites (Acarina) from small mammals in Central Sweden. Entomol. Tidskr. 90, 272–284.

Edler, A., 1972. Ectoparasitic mites (Acarina) from small mammals in southern Sweden. Entomol. Tidskr. 93, 100–112.

Elias, S.A., 2010. Advances in quaternary entomology. Dev. Quat. Sci. 12, 1–288.

Evans, G.O., Till, W.M., 1966. Studies on the British Dermanyssidae (Acari: Mesostigmata). Part II, classification. Bull. Br. Museum (Nat. History) Zool. 14, 1–370.

Forbes, V., 2015. Duck fleas as evidence for eiderdown production on archaeological sites. J. Archaeol. Sci. 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.

Forbes, V., Dugmore, A.J., Ólafsson, E., 2016. The life and death of barn beetles: faunas from manure and stored hay inside farm buildings in northern Iceland. Ecol. Entomol. 41, 480–499.

Freude, H., 1971. Familie: Orthoperidae. In Freude, H., Harde, K.W., Lohse, G.A. (Eds.), Die Käfer Mitteleuropas 3, 303–310.

Girling, M.A., 1981. Beetle remains. In: Thorn, J.C. (Ed.), The burial of John Dygon, Abbot of St. Augustine's. Collectanea historica: Essays in memory of Stuart Rigold. Archaeological Society, Maidstone, UK, Kent, pp. 82–84.

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., Carrott, J., Jaques, D., Johnstone, C., Kenward, H., Usain R., 2000. Technical report: studies on biological remains and sediments from medieval deposits at the Magistrates' Courts site, Kingston-upon-Hull (site codes HMC 94 and MCH99). Reports from the Environmental Archaeology Unit, York 2000/25.

Hansen, V., 1950. Biller. XIII. Clavicornia. 1 del. Danmarks Fauna 55, 1–278.

Hansen, J.P.H., 1989. The mummies from Qilakitsoq – paleopathological aspects. Meddelelser om Grønland, Man and Society 12, 69–82.

Hansson, K.F., 1950. Lundabiskopen Peder Winstrup före 1658. Skånsk senmedeltid och renässans 3, Lund.

Hansson, K.F., 1952. Biskop Peder Winstrup 1605-1679. Föreningen det gamla Lunds årsskrift 34, Lund.

Harde, K.W., 1984. A field guide in colour to beetles. Octopuss Books, London, 334 pp.

Heie, O.E., 1994. The Aphidoidea (Hemiptera) of Fennoscandia and Denmark. V. Fauna Entomologica Scandinavica 28, 1–42.

Huchet, J.-B., 2010. Archaeoentomological study of the insect remains found within the mummy of Namenkhet Amun (San Lazzaro Armenian Monastery, Venice/Italy). Adv. Egyptol. 1, 59–80.

Huchet, J.-B., 2014. Insect remains and their traces: Relevant fossil witnesses in the reconstruction of past funerary practices. Anthropologie 52 (3), 329–346.

Huchet, J.-B., 2015. Étude archaéoentomologique du sarcophagi royal. In: Georges-Zimmermann, P. (Ed.), Les sépultures prestiqieuses de l'église Notre-Dame de Cléry-Saint-André (Loiret). Étude pluridisciplinaire du caveau de Louis XI. L'Harmattan, Paris, pp. 172–181.

Huchet, J.-B., Pereira, G., Gomy, Y., Philips, T.K., Alatorre-Bracamontes, C.E., Vásquez-Bolaños, M., Mansilla, J., 2013. Archaeoentomological study of a pre-Columbian funary bundle (mortuary cave of Candelaria, Coahuila, Mexico). Ann. Soc. Entomol. France 49, 277–290.

Karg, W., 1993. Raubmilben. Die Tierwelt Deutschlands 59 (2), 1–523.

Karsten, P., Manhag, A., 2017. In: Peder Winstrup – historier kring en 1600-talsmumie. Lunds universitet, Lund, pp. 153.

Kenward, H.K., Large, F., Skidmore, P., 1995. Insect remains from excavations at Drum Castle, Aberdeenshire. Reports from the Environmental Archaeology Unit, York, 95/46, 24 pp.

Kenward, H.K., Hall, A.R., 1995. Biological Evidence from 16-22 Coppergate. In: Archaeology of York, 14/7. Council for British Archaeology for York Archaeologica Trust, York.

Koch, K., 1989. Die Käfer Mitteleuropas, Ökologie 2. Goecke & Evers, Krefeld.

Koch, K., 1992. Die Käfer Mitteleuropas. Ökologie 3. Goecke & Evers, Krefeld.

Lagerås, P., 2016a. A fragrant grave. Revealing the mummified remains of a 17th-century bishop. Curr. World Archaeol. 76, 12–13.

Lagerås, P., 2016b. Från trädgård till grav: växterna i biskop Winstrups kista. Ale 4, 15–28.

Lindroth, C.H., 1985. The Carabidae (Coleoptera) of Fennoscandia and Denmark. Fauna Entomol. Scand. 15, 1–225.

Lindroth, C.H., 1986. The Carabidae (Coleoptera) of Fennoscandia and Denmark. Fauna Entomol. Scand. 15, 226–497.

Catalogue of Palaearctic Coleoptera, vol. 1, 819.

Catalogue of Palaearctic Coleoptera, vol. 2, 942.

Catalogue of Palaearctic Coleoptera, vol. 3, 690.

Catalogue of Palaearctic Coleoptera, vol. 4, 935.

Catalogue of Palaearctic Coleoptera, vol. 5, 670.

Catalogue of Palaearctic Coleoptera, vol. 6, 924.

Catalogue of Palaearctic Coleoptera, vol. 7, 373.

Catalogue of Palaearctic Coleoptera, vol. 8, 700.

Lundqvist, L., 1974. Gamasina Mites (Acari, Parasitiformes) from Nests of the Mole Talpa europaea L. Entomol. Scand. 5, 39–48.

Möller, P., 1991. Ätten Winstrups sista suck. Släkt och hävd 1991, 1, Lund.

Morrow, J.J., Myhra, A., Piombino-Mascali, D., Lippi, D., Roe, A., Higley, L., Reinhard, K.J., 2016. Archaeoentomological and archaeoacarological investigations of embalming jar contents from the San Lorenzo Basilica in Florence, Italy. J. Archaeol. Sci. Rep. 10, 166–171.

Mourier, H., Winding, O., 1986. In: Collins Guide to Wild Life in House and Home. Collins, London, pp. 224.

Oosterbroek, P., 2006. In: The European Families of the Diptera. KNNV Publishing, Utrecht, pp. 206.

Ossiannilsson, F., 1981. The Auchenorrhyncha (Homoptera) of Fennoscandia and Denmark. Part 2. The families Cicadidae, Cerocopidae, Membracidae, and Cicadellidae (excl. Deltocephalinae). Fauna Entomol. Scand. 7 (2), 223–593.

Palm, E., 1996. Nordeuropas Snudebiller 1. De kortsnudede arter (Coleoptera: Curculionidae) – med saerligt henblik på den danske fauna. Danmarks Dyreliv Bind 7, 356 pp.

Palm, T., 1948. Skalbaggar. Coleoptera. Kortvingar: Fam. Staphylinidae. Underfam. Micropeplinae, Phloeocarinae, Olisthaerinae, Proteininae, Omaliinae. Svensk Insektfauna 9 (38), 1–133.

Panagiotakopulu, E., 2001. New records for ancient pests: archaeoentomology in Egypt. J. Archaeol. Sci. 28, 1235–1246.

Panagiotakopulu, E., Buckland, P.C., 2012. Forensic archaeoentomology – an insect fauna from a burial in York Minster. Forensic Sci. Int. 221, 125–130.

Panagiotakopulu, E., Buckland, P.C., 2017. A thousand bites–insect introductions and late Holocene environments. Quat. Sci. Rev. 156, 23–35.

Panagiotakopulu, E., Buckland, P.C., Kemp, B.J., 2010. Underneath Ranefer's floors–urban environments on the desert edge. J. Archaeol. Sci. 37, 474–481.

Peacock, E.R., 1993. Adults and larvae of hide, larder and carpet beetles and their relatives (Coleoptera: Dermestidae) and of Derodontid Beetles (Coleoptera: Derodontidae). Handbooks for the Identification of British Insects 5,3. Royal Entomological Society of London, London.

Perez, A. von, 1967. Familie: Lathridiidae. In Freude, H., Harde, K.W., Lohse, G.A. (Eds.), Die Käfer Mitteleuropas 7, 169–190.

Pluton-Kliesch, S., Devièse, T., Kliesch, F., Leconte, L., Moulherat, C., Pilon, F., Yvinec, J.-H., 2013. Un cecueil antique en plombe découvert à Évreux (27): étude pluridisciplinaire. Gallia 70, 323–340.

Rackham, J., 2009. Environmental archaeology. In: Moore, R. (Ed.), Ashby Folville to Thurcaston: The Archaeology of a Leicestershire Pipeline Part 2: Iron Age and Roman Sites. Transactions of the Leicestershire Archaeological & Historical Society, 83, 53–55.

Roberts, M.J., 1996. Collins field guide spiders of Britain and northern Europe. Collins, London, 383 pp.

Robinson, M., Dickson, J.H., Greig, J.R.A., 1984. Waterlogged plant and invertebrate

evidence. In: Miles, D. (Ed.), Archaeology at Barton Court Farm, Abingdon, Oxon., microfiche chapters VIII & IX. Council for British Archaeology Research Report 50.
Romero, A., Potter, M.F., Potter, D.A., Haynes, K.F., 2007. Insecticide resistance in the bed bug: a factor in the pest's sudden resurgence? J. Med. Entomol. 44 (2), 175–178.
Sharma, R., Garg, R.K., Gaur, J.R., 2015. Various methods for the estimation of the post mortem interval from Calliphoridae: a review. Egypt. J. Forensic Sci. 5, 1–12.
Skansjö, S., 2012. Lunds historia – Staden och omlandet 2. Tidigmodern tid, Lund.
Skidmore, P., 2000. Appendix 1: report on selected remains of immatureDiptera from the Magistrates' Courts site, Kingston-upon-Hull. In: Hall, A., Carrott, J., Jaques, D., Johnstone, C., Kenward, H., Usain R. (Eds.), Technical report: studies on biological remains and sediments from medieval deposits at the Magistrates' Courts site, Kingston-upon-Hull (site codes HMC 94 and MCH99). Reports from the Environmental Archaeology Unit, York 2000/25.
Smith, D., 2013. Defining an indicator package to allow identification of 'cesspits' in the archaeological record. J. Archaeol. Sci. 40, 526–543.
Stafford, F., 1971. Insects of a medieval burial. Sci. Archaeol. 7, 6–10.
Stubbs, A., Drake, M., 2001. British Soldierflies and their allies. Br. Entomol. Nat. History Soc. 515.
Thomson, C.G., 1863. Skandinaviens Coleoptera, synoptiskt bearbetade. Tom. V. Lundbergska Boktryckeriet, Lund, 340 pp.
Usinger, R.L., 1966. Monograph of Cimicidae (Hemiptera, Heteroptera). Thomas Say Foundation, 585 pp.
Vogt, H., 1967. Familie: Endomychidae. In: Freude, H., Harde, K.W., Lohse, G.A. (Eds.), Die Käfer Mitteleuropas 7, 216–227.
Zahradník, J., 2013. Beetles of the family Ptinidae of Central Europe. Academia, Prague.