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

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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 (symanthropic), 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...
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 January 27th 1680, and he was buried
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 pine wood 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 mumification 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. Mumification 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 esculentum). 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, the pillow and mattress 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 (×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.bugcscep.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.


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. Eulaeopsis 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 plant bed. 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

<table>
<thead>
<tr>
<th>Taxon</th>
<th>Body</th>
<th>Cloth/glov</th>
<th>Pill/matt</th>
<th>Plant bed</th>
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<tr>
<td><strong>Insecta</strong></td>
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<td>Lygaeidae</td>
<td><em>Lygaeus lardarius</em> L.</td>
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<tr>
<td>Ectopryiidae</td>
<td><em>Ectopryia aurata</em> (L.)</td>
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<td><strong>Aphididae</strong></td>
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<td><em>Macrocephalia cf. abrotani</em> (Walker)</td>
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<td><em>Phorodon humuli</em> (Schrank)</td>
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<td><strong>Phytoidea</strong></td>
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<td><em>Cryptophagius scutellatus</em> Newman</td>
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<td><em>Latridius minutus-group</em></td>
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<td><em>Protapion</em> sp.</td>
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<td><em>Lasius niger</em> (L.)</td>
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<td><em>Heliomyza</em> indet.</td>
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<td><em>Calliphora</em> indet.</td>
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<td><em>Lepidoptera</em>*</td>
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<td>Psychidae</td>
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<td>Laelapidae</td>
<td><em>Eulaelaps stabularis</em> (C.L. Koch)</td>
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<td><em>Hypoaspis</em> sp.</td>
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<td><em>Parasitus</em> sp.</td>
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<td>Agelenidae</td>
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<td><strong>Crustacea</strong></td>
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<td>Isopoda</td>
<td><em>Isopoda</em> indet.</td>
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<td>Gastropoda</td>
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<td><strong>Helicidae</strong></td>
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<tr>
<td><em>Arion</em> arbustorum (L.)</td>
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Fig. 3. The spider beetle *Eupauloecus 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, 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 panicum*, 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 (*Chaoformidae*) of the genus *Mochlonyx*, which live in marshes and overgrown small ponds, were also found, as well as bagworms (*Psychidae*) of the genus *Dahlia*, 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 moudly wood, under rotting leaves, in fungi, straw and similar substrates (Freude, 1971). In anthropogenic contexts, the mould and fungus beetles *Cryptophagus scutellatus* and *Latriidius 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 panicum* and *Ptinus fur* were also recorded, together with 86 individuals of *Eupauloecus unicolor*. Snipe flies (Rhiagonidae) are found in plant debris in wet places or in streams. The larvae of Heleomyzidae flies feed on carrion, dung and fungi (Oosterbroek,
Forficula auricularia, also recorded, along with 520 individuals of inside house walls, stone walls and under pavements (Collingwood, et al., 2007). The black garden ant helping it to regain a foothold as a common domestic pest (Romero
spends the day in suitable hiding-places close to beds. It requires a feeds on human blood throughout its development, is night active and
) (Heie, 1994). Bugs of the
Humuluslupulus
), whereas during June and July it
Prunus domestica
) and plum (Prunus spinosa
summer the host plants of the aphid
are prone to disarticulate rapidly into small sclerites. During early
weeks and under favourable conditions, the flies propagate con-
iderably. Only wings of the adult flies were recorded, but the bodies
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 poly-
phagous, 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 Phyllophaga 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 zoobenthic 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 dif-
ferent flowers. Cryptophagus dentatus and C. saginatus are both asso-
ated 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 My-
cetea 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 Ermobius mollis is similar, with the larvae developing in the innermost bark or the outermost sapwood of conifer trees. Protopan
sp. 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 Pityius fur were also recorded, along with 520 individuals of Epaloeus 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 nur-
saries. Window gnats, Anisopodidae, often occur in high quantities in old cowpats, but can also be found in decaying matter in and around cellars, stables, ruins and occasionally under the bark of trees in gardens. It is also probably associated with rodents. Cryptophagus dis-
tinguendus occurs in cellars and compost, especially decaying grass or straw. Atomaria mundus is found in similar, but often molder places. Other beetle taxa identified include Orthoperus sp., Cryptophagus sagi-
natus, Latridius minutus, Corticaria fulva, Mycetea subterranea, Epal-
oeus unicolor and Pityius fur, as described earlier. The larvae of the soldier fly Chloromyia formosana develop in cow dung but also in decaying plant matter (Stubbs and Drake, 2001). The aphid Macrosiphoniellafil.
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 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 Ocyis quinquestrati
da 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 dis-
tinguendus occurs in cellars and compost, especially decaying grass or straw. Atomaria mundus is found in similar, but often molder places. Other beetle taxa identified include Orthoperus sp., Cryptophagus sagi-
natus, Latridius minutus, Corticaria fulva, Mycetea subterranea, Epal-
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5. Discussion

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

Fig. 4. The fungus beetle Atomaria nigripennis. 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 re-
 mains were found in the pillows, the mattress and the plant bed, but
remains were also well represented in the gloves and the clothes. Excep-
for the numerous remains of mites, subfossil beetles dominate the as-
semblages. 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 scarce, the latter most likely
having collapsed into unidentifiable fragments. Apart from fragmenta-
tion, 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 necrophil-
ous 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 parallelo-
collis (Panagiotakopulu and Buckland, 2012). As Winstrup died in De-
cember, 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 pre-
vented 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
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, Myctea subterranea,
and Atomaria nigripennis. Orthoperus species may also have been brought
in with mouldy plant material. 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. Phyllopertha hubneri, Cryptophagus scutellatus, C. saginatus,
C. distinguendus, Aatomaria munda, A. nigripennis, Corticaria fulva,
Lattridius minutus and Myctea 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 re-
idential-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 Artagenuspellio 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 colo-
nised 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 un-
doubtedly 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

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.
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 Epulococcus 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 persisted 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 synchronic, 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. scutatus 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 faunistc 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 less sanitary lifestyle. Ocys quinquestriatus has only been found in a few places in Sweden, in connection with old buildings and rodent's within their walls (Lindroth, 1985). Phylldodropa 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 Phylldodropa 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).

Epulococcus 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 beeheives 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 palaeontological 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 Neferes 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.

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