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Front cover: *Salix alba* L. (1753) with *Coprinellus micaceus* (Bull.) Vigalys, Hopple & Jacq. Johnson (2001).

Faunistic survey of myrmecophilous and other ant-associated beetles and spiders in the Belgian province of Limburg (Araneae, Coleoptera, Hymenoptera: Formicidae)

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Abstract

Many researchers have been fascinated by the social organisation within an ant colony. They have noticed that several other invertebrates are found in or near the ants' nests, notably a variety of Coleoptera and to a lesser extent, some spiders. Many of these observations have been written down, some just as a brief statement but sometimes a detailed report of these interactions as a result of accurate and prolonged monitoring was published. All this information allowed us to make a comparison with the ant species associated with beetles and spiders in the Belgian province of Limburg. We will discuss a large number of species within their respective families and mention in particular a certain connection between the guest and its host, a relationship which cannot necessarily be called myrmecophilous.

Keywords: interaction, relationship, myrmecophily

Samenvatting

Veel onderzoekers zijn gefascineerd door de sociale organisatie binnen een mierenkolonie. Het is hun ook niet ontgaan dat in of nabij de nesten van de mieren meerdere andere ongewervelden worden aangetroffen, met name een verscheidenheid aan kevers en in mindere mate aan spinnen. Veel van deze waarnemingen werden gepubliceerd, soms slechts als korte opmerking, maar soms krijgen we een gedetailleerd verslag als resultaat van nauwkeurige en langdurige monitoring. Al deze informatie laten ons toe een vergelijking te maken met de mierensoorten die geassocieerd worden met kevers en spinnen in de Belgische provincie Limburg. Wij bespreken een groot aantal soorten binnen hun respectieve families en willen in het bijzonder wijzen op een zekere band tussen de gast en zijn gastheer, een relatie die niet noodzakelijk myrmecofiel kan worden genoemd.

Résumé

De nombreux chercheurs sont fascinés par l'organisation sociale qui prévaut au sein d'une colonie de fourmis. Il ne leur a pas échappé que plusieurs autres invertébrés se retrouvent fréquemment au sein ou à proximité directe de la colonie de fourmis, en particulier des coléoptères, et, dans une moindre mesure, quelques araignées. De nombreuses observations

ont été publiées, parfois sous forme de simples mentions, mais aussi sous forme de rapports qui détaillent précisément les interactions, suite à une observation minutieuse et prolongée. Ces publications nous ont permis d'établir une comparaison avec les espèces de fourmis qui sont associées aux coléoptères ou aux araignées dans la province du Limbourg Belge. Nous allons évoquer un grand nombre d'espèces dans leurs familles respectives, en mentionnant en particulier le lien entre l'invité et son hôte, relation qu'on ne pourrait pas toujours qualifier de myrmécophile.

Introduction

In this paper we will offer an overview of the presence of beetles and spiders in Limburg, described in the literature as associated with ants, one way or another. Some relations are just a condition of coming and living together in time and place, while other relations have evolved into a greater or lesser degree of dependence. This is especially the case for a part of the beetles mentioned here.

Due to their social structure with a division of tasks between males, reproductive females and sterile workers, the eusocial ants form a remarkable community within the invertebrate fauna. Of some species such as red wood ants (RWA, *Formica rufa* group), the nest construction is highly ingenious that their shelter can be regarded as the presence of a microhabitat with its own microclimate. It can therefore be expected that arthropods such as insects and spiders have found their way into these environments to stay there temporarily or even permanently. Several researchers, especially myrmecologists have intensively studied the relationship between ants and their guests, e.g. Wasmann (1910), Donisthorpe (1927), Kistner (1982), Parmentier (2019), Parmentier *et al.* (2014, 2022) and Hölldobler & Kwapich (2022). These observations have often revealed complex adaptations both morphological and ethological with interactions in different ways. In this publication, we focus on identical and nearly identical observations in the province of Limburg (Belgium) that are the result of several studies on invertebrates conducted over the last three decades. Most arthropods associated to some extent with ants belong to the Coleoptera.

When we observe the presence of invertebrates in or nearby an ant colony, one can wonder if we can always define it as myrmecophily. The answer is obviously no. If it's a one-time observation, we'll see it as an accidental presence in a shared environment. But if field studies repeatedly show that certain invertebrates are regularly spotted in the vicinity of the same species of ant, more careful investigation may be desirable. Years of research in this field have contributed to several definitions within the concept of myrmecophily. Several invertebrates living in or around the ants' nests do so out of expediency. Many Coleoptera prefer dead wood during some part of their life cycle like certain ant species do, feed on decaying plant material or parts of mould and fungi, while others are scavengers that feed on dead ants and their prey. In search of food, some beetles will have found their way to the brood chambers in the ants' nests to feast on the ants' brood. For many, perhaps the majority of beetles and other invertebrates that are listed as being associated with ants, this is based on observations, while few intensive studies have been set up to further investigate the biological aspects of those observations.

If someone opens an ant's nest during field research, one can only expect chaos to erupt with the workers eager to carry the brood to safety as fast as possible. For beetles that are observed and collected for determination during such a drastic intervention it is hard to estimate what their presence implies. Nor can the researcher conclude on any meaningful interaction between guest and host. In the case of some Coleoptera and other invertebrates, researchers have been able to determine the details of the degree of myrmecophily, but mainly by closely observing the guest and host in an artificial set-up (laboratory conditions). In this way, it was possible to

determine the food preferences of ant hosts, how they are received or rejected in an ant colony, and how their life cycle unfolds in their nest. An important factor in the interaction between ants themselves as well as between ants and their guests, are semiochemicals such as pheromones and allomones (Parmentier, 2020). With the available analysis techniques, it was possible to determine the composition of glandular secretions and which interactions triggered the components of these secretions. There is undoubtedly still much research to be conducted in this field. Especially on species that are now only seen as coincidental inhabitants but might show unexpected connections after close examination. In the study of such relationships between invertebrates, field observations of ants and other invertebrates living together are therefore a first attempt to which we would like to contribute data from the province of Limburg.

Material and methods

The guiding principle throughout this study is the association between ants and beetles or spiders. Päivinen *et al.* (2002) lists 369 ant-associated beetle species along with the associated ants, based on 113 references. From this list we selected beetle species found in the province of Limburg (a total of 2,647 species, stored in an Access database of the Invertebrates Working Group and currently containing 281,830 records (of which 12,230 are ants, 142,300 beetles and 127,300 spiders), a copy of which is present in the Provincial Nature Centre Limburg)) and added additional associated ant species. To represent an idea of the relationship between ants and spiders, we relied on Parmentier *et al*. (2014, Supplemantary Tables) except for the genus *Zodarion*, which is not mentioned by Parmentier (Table 38).

For over thirty years, faunistic invertebrate research has been carried out in the Belgian province of Limburg. All sorts of collecting techniques were used, such as sieving leaf litter, sweeping through plants and grasses, beating trees and bushes, installing malaise traps and light and bait traps. The use of pitfall traps to sample the soil invertebrate fauna over extended periods was the most used approach. However, due to the habitat preference and the relocation strategy of the species covered in this analysis, pitfall traps in the field are not the most appropriate method to obtain an overview of the relationship between ants and beetles or spiders.

The aforementioned various sampling methods gave us only an overview of the diversity of ant, beetle, and spider species in the investigated area. Additional intensive observation in ant nests and their surrounding soil was needed to establish the relationship between the myrmecophilous beetles and their hosts.

This is the first required scientific approach to determine the relationship between ants and their guests, but it is not always possible on a large scale. Here we investigated the presence of the associated guests of ants from a different point of view. From the data of our long-term observations, we will indicate this relationship by evaluating the presence of both groups in a strictly defined microbiotope such as a tree that provides shelter for various species of invertebrates or in a trap. In addition, there are a few records in our database resulting from sieving ants' nests, a method that is avoided as much as possible because of its negative impact on the ant colony.

We would like to highlight three types of field observations that provide a clear relation between ants and beetles. From April to October in 2017, a study was conducted on behalf of the National Orchard Foundation in seventeen locations spread over nine municipalities (to date, no report has been published). During this research, specially designed circle trunk traps were installed at a height of two metres around the trunk of dead fruit trees (Fig. 1), with collecting vials which were emptied every fortnight. The aim of this study was to evaluate the diversity of solitary bees and hoverflies that play an important role in pollinating fruit trees in these traditional orchards.

In 2011 special attention was devoted to the presence of beetles in hollow trees in the municipality of Voeren, in the southeast of the province of Limburg (Fig. 2). In addition to the use of pheromone traps, targeting the presence of two indicator species, the hermit beetle or

Fig. 1. Dead fruit tree with circle trunk trap generating a barrier for upwards climbing insects.

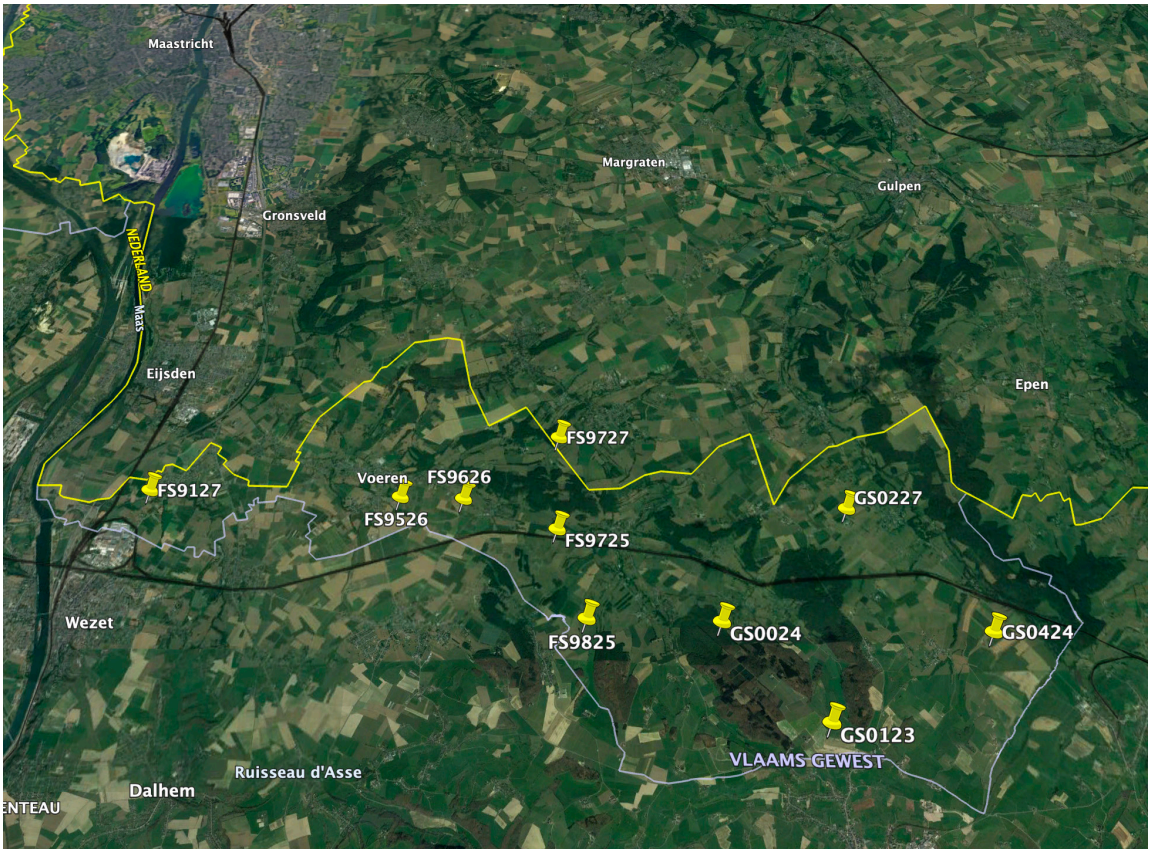

Fig. 2. Community Voeren with indication (yellow symbols) of the locations mentioned in the tables. Toponyms: FS9127 Moelingen; FS9526 Vitchen; FS9626 Altenbroek; FS9725 Schoppem; FS9727 Altenbroek orchard; FS9825 Berg; GS0024 Veurs; GS0123 Kijs; GS0227 Gulp; GS0424 Middelhof.

Osmoderma eremita (Scopoli, 1763) and the rusty click beetle or *Elater ferrugineus* Linnaeus, 1758, pitfall traps were also placed in the cavities of selected trees whenever possible (THOMAES, 2014). From this study, we only retain the data from these pitfall traps in which both the ants and their associated guests were found.

A third survey was spread over two years, 2008 and 2009, and was conducted in the forest reserve Kolmontbos, located northwest of the city of Tongeren. This study focused on the diversity of saproxylic beetles, which were sampled using various collection methods (KÖHLER *et al*., 2011). From these investigations we only report the data of saproxylic beetles collected if an ant nest was also present in the examined tree.

The taxonomy of the Coleoptera is according to Coleoptera Europaea (www.coleoweb.de), ants according to SEIFERT (2018) and spiders according to ROBERTS (1993).

Results

The research resulted in the observation of 24 ant-associated beetle families with 185 ant-associated species on a total of 2,093 specimens (Fig. 3) and six ant-associated spiders. Regarding the beetles, we have grouped the observations by family and included tables with each species, adding the number of specimens found, the UTM 1 x 1 km grid, the respective trees where the specimens were found and the ant species it was found associated to. Often reference is made to a second series of tables (see Annex) with a selected list of all species of beetles that were associated with ants in the consulted literature (PÄIVINEN *et al*., 2002), supplemented by our own observations in Limburg. Of the ants that are native in Belgium, we only include those species that are relevant for this study (Table 1).

All ants discussed in this paper belong to two subfamilies, the Formicinae Latreille, 1809, characterised by an upright scale between the mesosoma and the gaster and the Myrmicinae Lepeletier de Saint-Fargeau, 1835, with two segments, the petiole and the postpetiole between

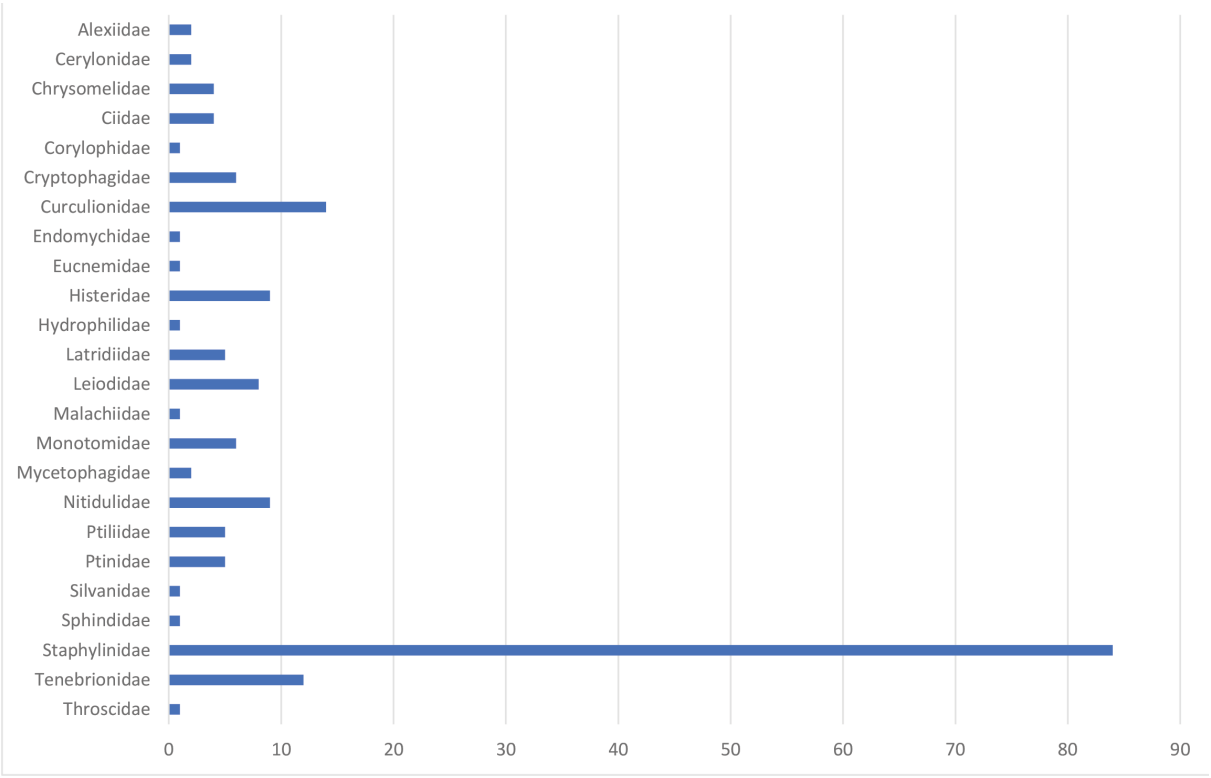

Fig. 3. Observed Coleoptera families with the number of associated species found in Limburg and discussed in this paper as associated with ants (Table 2 – Table 37) according to our own observations.

Table 1. List of the ant species (Formicidae) with the used abbreviation in the tables and the number of 1 x 1 km grids of observation of this species in the province of Limburg (from a total number of 2,644 1 x 1 km grids).

Abbreviations used in the tables	Ant species	Number of 1 x 1 km UTM grid
campfall	*Camponotus fallax* (Nylander, 1856)	1
camp spp.	*Camponotus* spp.	
forc spp.	*Formica* spp.	
forcfusc	*Formica fusca* Linnaeus,1758	148
forcpoly	*Formica polyctena* Förster,1850	24
forcprat	*Formica pratensis* Retzius, 1783	51
forcrufa	*Formica rufa* Linnaeus, 1761	18
forcsang	*Formica sanguinea* Latreille, 1798	63
forctrun	*Formica truncorum* Fabricius, 1804	-
lasi spp.	*Lasius* spp.	
lasialie	*Lasius alienus* (Förster, 1850)	17
lasibico	*Lasius bicornis* (Förster, 1850)	4
lasibrun	*Lasius brunneus* (Latreille, 1798)	114
lasiflav	*Lasius flavus* (Fabricius, 1782)	85
lasifuli	*Lasius fuliginosus* (Latreille, 1798)	156
lasimixt	*Lasius mixtus* (Nylander, 1846)	16
lasinige	*Lasius niger* (Linnaeus, 1758)	117
lasiumbr	*Lasius umbratus* Nylander, 1846	129
leptacer	*Leptothorax acervorum* (Fabricius, 1793)	29
mymi spp.	*Myrmica* spp.	
mymirubr	*Myrmica rubra* (Linnaeus, 1758)	230
mymirugi	*Myrmica ruginodis* Nylander, 1846	180
mymirugu	*Myrmica rugulosa* Nylander, 1849	26
mymisabu	*Myrmica sabuleti* Meinert, 1861	103
mymiscab	*Myrmica scabrinodis* Nylander, 1846	146
mymisulc	*Myrmica sulcinodis* Nylander, 1846	-
temnaffi	*Temnothorax affinis* (Mayr, 1855)	64
temnnyla	*Temnothorax nylanderi* (Förster, 1850)	260
tetrcaes	*Tetramorium caespitum* (Linnaeus, 1758)	119

the gaster and the mesosoma. Due to their nest construction, the greatest diversity of ant guests is associated with the red wood ants (RWA) of the genus *Formica* s. str. (Päivinen *et al.,* 2003). From the genus *Lasius*, two species will be highlighted in this study, *L. brunneus* and *L. fuliginosus* (Fig. 4). The reason for this is not far-fetched as these are xylophilic, a property they share with many beetles. For their nest construction, they rely on trees, both living and dead trees. Considering the association of ants with trees, Bernhard Seifert classifies the species in three groups (Seifert, 2008). The first group is defined as true canopy dwelling ant species. These species are nesting and foraging in tree canopies and three species of this group have been collected in Limburg: *Camponotus fallax* (Nylander, 1856), *Temnothorax affinis* (Mayr, 1855) and *Lasius brunneus* (Latreille, 1798). *Camponotus fallax* is only known from a single location in the municipality Voeren where this species was discovered in 2017 (Vankerkhoven *et al*., 2018). Another species frequently found in combination with xylophylic Coleoptera and by Bernhard Seifert assigned to his second group, is *L. fuliginosus* (Latreille, 1798). The species of this group are defined as foraging in the tree canopies but not nesting there. The third group includes many non-arboricole ants which can only occasionally be found foraging on trees.

If we associate *L. niger* with a beetle species from the somewhat older literature, then we must consider a taxonomic change by SEIFERT (1991). Based on morphological differences and habitat preference, this author splitted this species into two sibling species, *L niger* and *L. platythorax*, with in this context a not unimportant remark that *L. platythorax* preferably builds nests with and between organic material. Except for *Myrmica sulcinodis*, all species within the genera *Myrmica*, *Temnothorax* and *Tetramorium* are well represented in the province of Limburg (Table 1) but are only sparsely selected as hosts by other invertebrates (PÄIVINEN *et al.,* 2003).

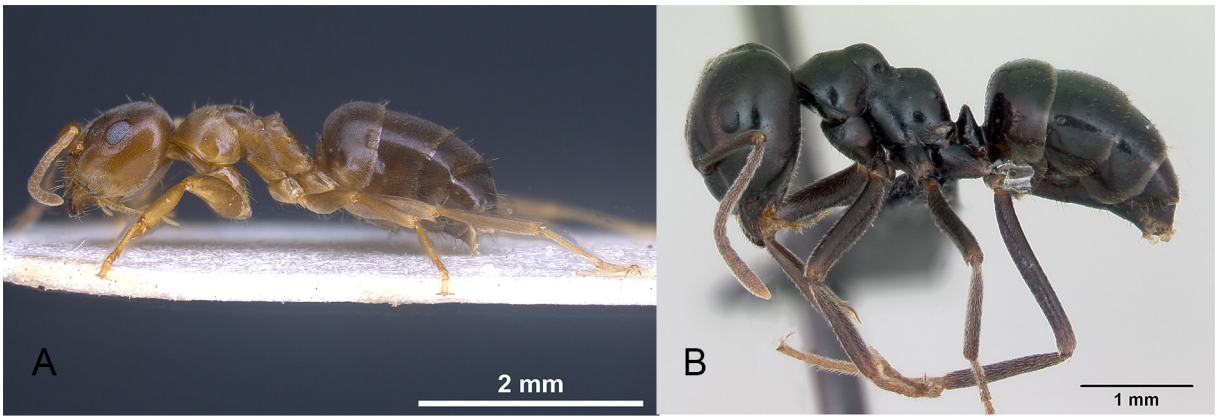

Fig. 4. **A**, *Lasius brunneus* (Latreille, 1798). **B**, *Lasius fuliginosus* (Latreille, 1798). © 2022 California Academy of Sciences. The two most encountered xylobiont ants in a tree where beetles were found when sifting out wood dust.

Alexiidae Imhoff, 1856

Table 2. Observations of alexiid beetles that are mentioned in the literature to be associated with ants, with their correlated ant species on a specific point location in the province of Limburg.

Species	Number	UTM grid	Community	Tree	Host ant
Sphaerosoma globosum (Sturm, 1807)	13	FS7130	Tongeren	*Quercus* sp.	lasifuli
Sphaerosoma pilosum (Panzer, 1793)	1	FS7130	Tongeren	broadleaf tree	lasifuli

This family is represented by a single genus, *Sphaerosoma* Samouelle, 1819 containing some 50 species mostly distributed in Central and Southern Europe, with a few species dispersed in North Africa. The distribution of *S. globosum* (1.8 mm) as well as of *S. pilosum* (1.4-1.6 mm) (Fig. 5) is restricted to Europe while, moreover, they are the most common of the European species (LÖBL & SMETANA, 2007). The alexiidid beetles live in association with mushrooms, feeding on their fruiting bodies and all the specimens mentioned in this study are collected by sieving forest litter, rotten wood and fungi.

Fig. 5. *Sphaerosoma pilosum* (Panzer, 1793) (1.5 mm; range 1.4-1.6 mm) © U. Schmidt..

Cerylonidae Billberg, 1820

Table 3. Observations of cerylonid beetles that are mentioned in the literature to be associated with ants, with their correlated ant species on specific point locations in the province of Limburg.

Species	Number	UTM grid	Community	Tree	Host ant
Cerylon ferrugineum Stephens, 1830	2	FS7130	Tongeren	*Betula* sp.	lasibrun
Cerylon histeroides (Fabricius, 1792)	1	FS4648	Halen	fruit tree	lasibrun, temnaffi
Cerylon histeroides (Fabricius, 1792)	54	FS7130	Tongeren	*Betula* sp.	lasibrun
Cerylon histeroides (Fabricius, 1792)	2	FS7130	Tongeren	*Fagus* sp.	lasifuli
Cerylon histeroides (Fabricius, 1792)	1	FS7130	Tongeren	*Quercus* sp.	lasifuli
Cerylon histeroides (Fabricius, 1792)	2	FS9727	Voeren	*Malus* sp.	lasibrun
Cerylon histeroides (Fabricius, 1792)	1	GS0227	Voeren	*Salix alba*	lasibrun

Cerylon ferrugineum (1.7-2.1 mm) (Fig. 6A) and *C. histeroides* (1.8-2.3 mm) (Fig. 6B) are two common European species, occurring throughout the hole province of Limburg (Annex), associated with both coniferous and deciduous trees. In the debris of ant nests, *C. histeroides* can be found in a concentration of several tens of specimens, as shown when sifting wood dust from a birch in the Kolmontbos in Tongeren (Table 3). Next to the two species presented in Table 3, a third species of the genus *Cerylon* Latreille, 1802 has been found in Limburg, *Cerylon fagi* Brisout, 1867 (2.1-2.6mm), but with only six specimens captured in just four 1 x 1 km grids it has the most restricted distribution. For this species no association with ants was observed.

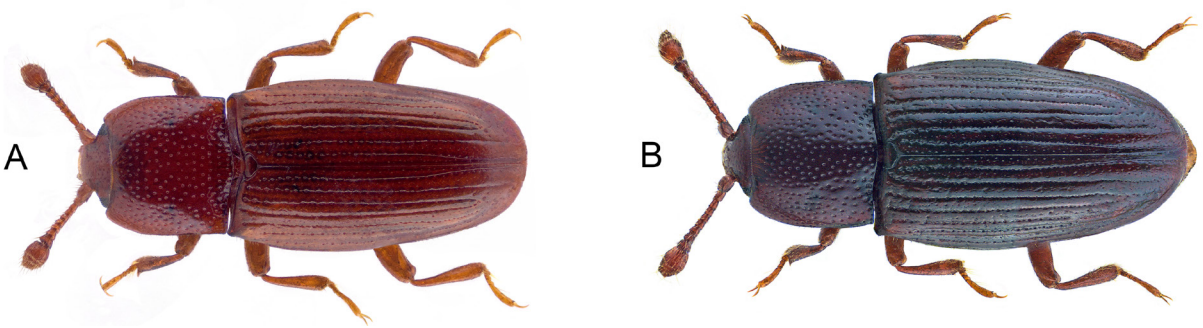

Fig. 6. **A**, *Cerylon ferrugineum* Stephens, 1830 (2 mm; range 1.7-2.1 mm). **B**, *Cerylon histeroides* (Fabricius,1792) (2.1 mm; range 1.8-2.3 mm) © U. Schmidt..

Chrysomelidae Latreille, 1802

Chrysomelidae or leaf beetles are phytophagous and can therefore become agricultural pests, but some species can be used to control invasive crops. A remarkable leaf beetle associated with ants is *Clytra quadripunctata* (7.0-11 mm) (Fig. 7). The known image of *C. quadripunctata* reproduction is that the female wraps an egg in a cocoon above the nest of RWA and drops this cocoon into the ant nest, where the protected larva is incorporated into the ant community. However, during a long-term investigation of the verges along the E314 highway in 1999, five cocoons containing a larva were found in pitfall traps at four different locations (observation by the first author - unpublished). This indicates that it is not self-evident that these cocoons can only be found in the anthills of RWA where the larvae continue their development undisturbed. Wood ants can remain at the same location for years, but changes in the environment in which they are situated can force a wood ant nest to relocate. Moreover, a colony of wood ants may split up due to an increase in population and the incorporation of more queens after the nuptial flight. These conditions are accompanied by a great deal of activity in the environment with nesting

Table 4. Observations of chrysomelid beetles that are mentioned in the literature to be associated with ants, with their correlated ant species on specific point locations in the province of Limburg. * red wood ant not identified to the species.

Species	Number	UTM grid	Community	Tree	Host ant
Clytra quadripunctata (Linnaeus, 1758)	1	FS8144	Zutendaal	nest	*Formica* sp.*
Crepidodera aurata (Marsham, 1802)	2	FS6626	Heers	fruit tree	lasibrun
Crepidodera aurata (Marsham, 1802)	42	FS7338	Hoeselt	fruit tree	lasibrun, temnaffi
Crepidodera aurata (Marsham, 1802)	1	FS7035	Kortessem	fruit tree	lasibrun, temnaffi
Crepidodera aurata (Marsham, 1802)	1	FS9727	Voeren	fruit tree	campfall, lasibrun, temnaffi
Crepidodera aurata (Marsham, 1802)	1	FS9825	Voeren	*Salix alba*	lasibrun
Cryptocephalus pusillus Fabricius, 1777	1	FS7130	Tongeren	*Betula* sp.	lasibrun
Phyllotreta undulata Kutschera, 1860	1	FS4648	Halen	fruit tree	lasibrun, temnaffi
Phyllotreta undulata Kutschera, 1860	1	FS9352	Maasmechelen	*Populus* sp.	lasifuli

material and brood being transferred from one place to another. During these migrations, other invertebrates from the mother nest will also make the transfer, either on their own or carried by the workers of the wood ants (PARMENTIER, 2019).

Phyllotreta undulata (2-2.5 mm) is a plant parasite of cabbage plants (Brassicaceae). The adult beetles lay up to 200 eggs at the base of cabbage plants, after which the larvae feed on the roots. A new generation of beetles feeds on the leaves of the crops in late summer and overwinters as adults. For this purpose, they seek refuge in leaf litter and wood dust under trees. This explains why they are sometimes found in the vicinity of saproxylic ants.

Fig. 7. *Clytra quadripunctata* (Linnaeus, 1758) (range 7.0-11.0 mm). © U. Schmidt.

Ciidae Leach *in* Samouelle, 1819

Of the 18 ciid beetles found in Limburg, we have selected four that are associated with ants in the consulted literature. They are not only fungiphagous but also complete their full life cycle in the fruit bodies of fungi, with a preference for fungi on trees. *Cis castaneus* (1.5-2.1 mm) (Fig. 8 A) and *C. fusciclavis* (1.5-2.2 mm) have an extensive feeding pattern and adults can be found on the fruiting bodies of several species of tree mushrooms. Also, *Ennearthron cornutum* (1.4-2.0 mm) (Fig. 8 B) is not selective about food supply and appreciates just about any tree fungus as a food source. On the other hand, it is just about the only beetle species that is found in the bracket fungus *Laetiporus sulphureus* (Bull.) Murrill (1920) (REIBNITZ, 1999). In addition to the observations in the close vicinity of a nest of *L. fuliginosus* (Table 5), this species was also found sifting two sulphur shelves (*Laetiporus sulphureus* (Bull.) Murrill (1920)) in Kolmontbos

Table 5. Observations of ciid beetles that are mentioned in the literature to be associated with ants, with their correlated ant species on specific point locations in the province of Limburg.

Species	Number	UTM grid	Community	Tree	Host ant
Cis castaneus (Herbst, 1793)	1	FS7130	Tongeren	*Betula* sp.	lasibrun
Cis castaneus (Herbst, 1793)	44	FS7130	Tongeren	*Fagus* sp.	lasifuli
Cis castaneus (Herbst, 1793)	1	FS9626	Voeren	*Malus* sp.	lasibrun
Cis fusciclavis Nyholm, 1953	6	FS7130	Tongeren	*Fagus* sp.	lasibrun
Cis fusciclavis Nyholm, 1953	1	FS7130	Tongeren	*Quercus* sp.	lasifuli
Ennearthron cornutum (Gyllenhal, 1827)	1	FS7130	Tongeren	*Picea* sp.	lasifuli
Ennearthron cornutum (Gyllenhal, 1827)	2	FS7130	Tongeren	*Quercus* sp.	lasifuli
Sulcacis nitidus (Fabricius, 1792)	1	FS7735	Bilzen	fruit tree	lasibrun, temnaffi
Sulcacis nitidus (Fabricius, 1792)	1	FS7130	Tongeren	*Quercus* sp.	lasifuli

(2008 & 2009 - Tongeren - FS7130). The cinnabar polypore, *Pycnoporus cinnabarinus* (Jacq.) P. Karst. (1881) is almost exclusively brooded by *Sulcacis nitidus* (1.2-1.4 mm) (Fig. 8C) (Reibnitz *et al*., 2013) but our own data does not allow us to confirm this finding.

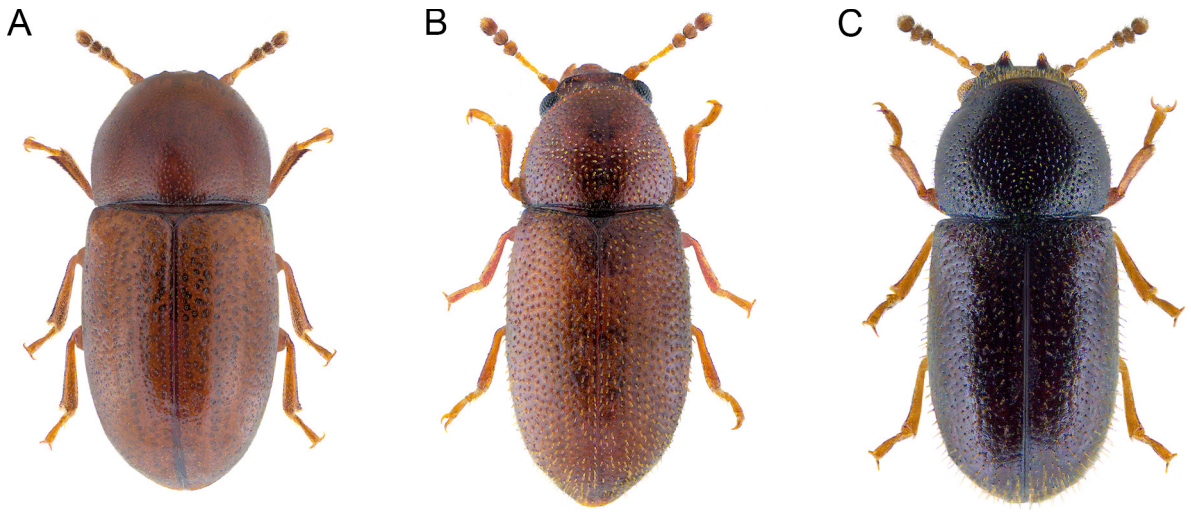

Fig. 8. **A**, *Cis castaneus* (Herbst, 1793) (2.1 mm; range 1.5-2.1 mm). **B**, *Ennearthron cornutum* (Gyllenhal, 1827) (middle) (1.7 mm; range 1.4-2.0 mm). **C**, *Sulcacis nitidus* (Fabricius, 1792) (1.7 mm). © U. Schmidt.

Corylophidae LeConte, 1852

Table 6. Observation of a corylophid beetle that is mentioned in the literature to be associated with ants, with its correlated ant species on specific point locations in the province of Limburg.

Species	Number	UTM grid	Community	Tree	Host ant
Sericoderus lateralis (Gyllenhal, 1827)	1	FS6840	Diepenbeek	fruit tree	temnaffi
Sericoderus lateralis (Gyllenhal, 1827)	1	FS9352	Maasmechelen	*Populus* sp.	lasifuli

Sericoderus lateralis (0.9-2 mm) (Fig. 9) is one of the smallest beetles found in decomposing plant debris, feeding mainly on the spores of Basidiomycetes and others. With the presence of 366 specimens in 77 grids of 1 x 1 km (Annex), we define *Sericoderus lateralis* as a very common species. The large radius of action can be partly attributed to the strong dispersal capacity of this tiny beetle. Of the 366 specimens recorded in our data, no less than 196 of these minute hooded

beetles were trapped with flight-interception traps and only one could be linked to a *L. fuliginosus* nest. *Temnothorax affinis* is an ant that resides in the canopy of trees, inhabits twigs and whose nests are difficult to access for research. In Diepenbeek, it was found foraging on a dead cherry tree, where a single specimen of *S. lateralis* was also collected using a circle trunk trap (Fig. 1).

Fig. 9. *Sericoderus lateralis* (Gyllenhal, 1827) (2.0 mm). © U. Schmidt.

Cryptophagidae Kirby, 1826

Table 7. Observations of cryptophagid beetles that are mentioned in the literature to be associated with ants, with their correlated ant species on specific point locations in the province of Limburg.

Species	Number	UTM grid	Community	Tree	Host ant
Atomaria nigrirostris Stephens, 1830	1	FS8952	Maasmechelen	*Populus* sp.	lasifuli
Cryptophagus dentatus (Herbst, 1793)	1	FS9526	Voeren	*Quercus robur*	temnaffi
Cryptophagus labilis Erichson, 1846	1	FS7130	Tongeren	*Quercus* sp.	lasifuli
Cryptophagus lycoperdi (Scopoli, 1763)	1	FS8952	Maasmechelen	*Populus* sp.	lasifuli
Cryptophagus saginatus Sturm, 1845	2	FS7130	Tongeren	*Fagus* sp.	lasifuli
Cryptophagus saginatus Sturm, 1845	5	FS7130	Tongeren	*Quercus* sp.	lasifuli
Cryptophagus scutellatus Newman, 1834	1	FS5427	Sint-Truiden	broadleaf tree	lasifuli
Cryptophagus scutellatus Newman, 1834	1	FS7130	Tongeren	*Quercus* sp.	lasifuli

The Cryptophagidae or silken-fungus beetles are labelled as saproxylic beetles and therefore can often be found in the same environment as the typical ants of deciduous forests, *L. brunneus* and *Myrmica ruginodis*. But also in the neighbourhood of the ant *L. fuliginosus,* with his carton-like nest construction made of small wood particles glued together with the sugars of the harvested

Fig. 10. *Cryptophagus dentatus* (Herbst, 1793) (1.9 mm; range 1.9-2.9 mm). © U. Schmidt.

honeydew, we regularly found Cryptophagidae. The sugars also provide the breeding ground for ascomycete fungi, which make the nest construction more solid. It cannot be excluded that the small mycetophagous beetle *Atomaria nigrirostris* (1.7-1.9 mm) is attracted by the fungi present in the nest, which may explain its symbiosis with this ant. *Cryptophagus labilis* (2.0–2.5 mm) as well as the other fungivore species of this genus prefer dead trees, a microhabitat they like to share with *L. brunneus* (Annex) who excavate tunnels and galleries for their nest in dead trunks. Several *Cryptophagus* species have been found to live in wasp nests (Köhler, 2000). Through our study, *C. dentatus* (1.9-2.9 mm) (Fig. 10) can be linked to the tree dwelling ant *T. affinis* for the first time. Studying the habitat requirements of saproxylic beetles, researchers evaluated the preference of the beetles for mid-canopy or forest floor branches with flight interception traps. In their results, they indicate that *C. dentatus* is assigned to the canopy assemblages (Bouget *et al*., 2011). This preference is consistent with the choice of microhabitat of *T. affinis* who builds its nests in the crown of the host tree (Seifert, 1994).

Curculionidae Latreille, 1802

From the curculionid beetles or weevils we selected 14 species mentioned in literature and supplemented them with our own observations, as symbiotic with ants (Annex). Some weevils have a reputation for being pests that can cause considerable damage to cereals and trees. One

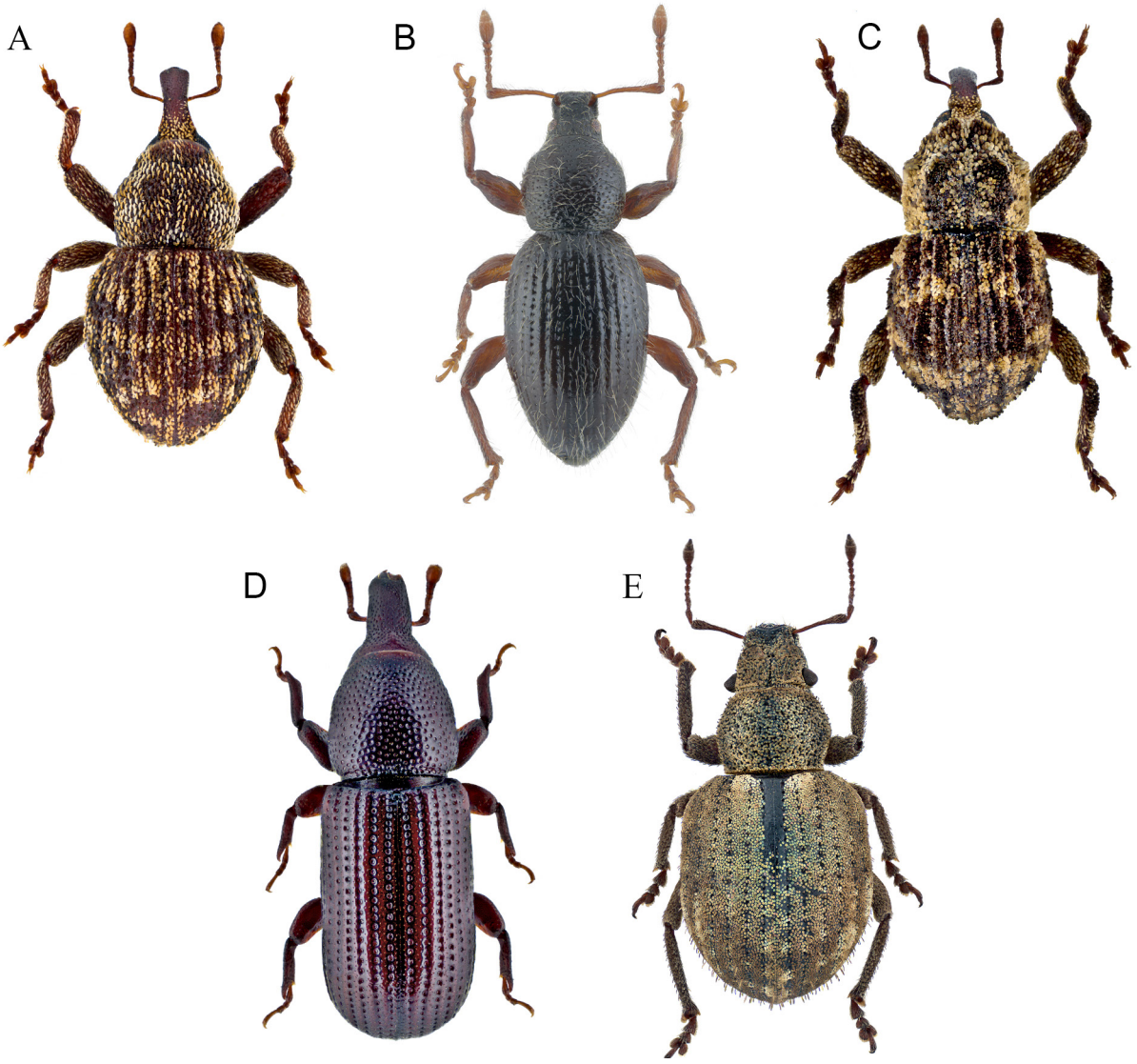

Fig. 11. **A**, *Acalles ptinoides* (Marsham, 1802) (3.0 mm; range 2.0-3.0 mm). **B**, *Exomias pellucidus* (Boheman, 1834) (3.5 mm; range 2.5-3.5 mm). **C**, *Kyklioacalles roboris* (Curtis, 1834) (3.3 mm; range 2.2-3.8 mm). **D**, *Stereocorynes truncorum* (Germar, 1824)) (3.0 mm; range 2.5-3.0 mm). **E**, *Strophosoma melanogrammum* (Forster, 1771) (range 4.0-5.5 mm). © U. Schmidt.

Table 8. Observations of curculionid beetles that are mentioned in the literature to be associated with ants, with their correlated ant species on specific point locations in the province of Limburg. - * sieving nesting material 20 cm below the top layer.

Species	Number	UTM grid	Community	Tree	Host ant
Acalles echinatus (Germar, 1824)	1	FS7130	Tongeren	*Picea* sp.	lasifuli
Acalles echinatus (Germar, 1824)	4	FS7130	Tongeren	*Quercus* sp.	lasifuli
Acalles ptinoides (Marsham, 1802)	2	FS7130	Tongeren	*Betula* sp.	lasibrun
Acalles ptinoides (Marsham, 1802)	8	FS7130	Tongeren	*Quercus* sp.	lasifuli
Acalles ptinoides (Marsham, 1802)	2	GS0123	Voeren	*Fraxinus excelsior*	lasibrun
Acalles ptinoides (Marsham, 1802)	1	FS7754	Zwartberg	nest	forcprat*
Anisandrus dispar (Fabricius, 1792)	1	FS4648	Halen	fruit tree	lasibrun, temnaffi
Anisandrus dispar (Fabricius, 1792)	1	FS9626	Voeren	*Malus* sp.	lasibrun
Anisandrus dispar (Fabricius, 1792)	1	GS0424	Voeren	*Alnus glutinosa*	lasibrun
Anthonomus rectirostris (Linnaeus, 1758)	3	FS7130	Tongeren	*Betula* sp.	lasibrun
Caenopsis fissirostris (Walton, 1847)	2	FS7130	Tongeren	*Betula* sp.	lasibrun
Ceutorhynchus sulcicollis (Paykull, 1800)	1	FS9825	Voeren	*Salix alba*	lasibrun
Cossonus parallelepipedus (Herbst, 1795)	1	GS0227	Voeren	*Salix alba*	lasibrun
Exomias pellucidus (Boheman, 1834)	1	FS7130	Tongeren	*Betula* sp.	lasibrun
Exomias pellucidus (Boheman, 1834)	3	FS7130	Tongeren	*Quercus* sp.	lasibrun
Exomias pellucidus (Boheman, 1834)	24	FS7130	Tongeren	*Quercus* sp.	lasifuli
Exomias pellucidus (Boheman, 1834)	1	FS9825	Voeren	*Salix alba*	lasibrun
Kyklioacalles roboris (Curtis, 1834)	1	FS7130	Tongeren	*Betula* sp.	lasibrun
Kyklioacalles roboris (Curtis, 1834)	1	FS7130	Tongeren	*Quercus* sp.	lasifuli
Scolytus mali (Bechstein, 1805)	1	FS7735	Bilzen	fruit tree	lasibrun, temnaffi
Scolytus mali (Bechstein, 1805)	1	FS7035	Kortessem	fruit tree	lasibrun, temnaffi
Scolytus mali (Bechstein, 1805)	4	FS9727	Voeren	*Malus* sp.	lasibrun
Stereocorynes truncorum (Germar, 1824)	14	FS7130	Tongeren	*Betula* sp.	lasibrun
Stereocorynes truncorum (Germar, 1824)	6	FS7130	Tongeren	*Picea* sp.	lasifuli
Stereocorynes truncorum (Germar, 1824)	1	FS7130	Tongeren	*Quercus* sp.	lasifuli
Stereocorynes truncorum (Germar, 1824)	1	FS9526	Voeren	*Quercus robur*	lasibrun
Stereocorynes truncorum (Germar, 1824)	3	FS9626	Voeren	*Malus* sp.	lasibrun
Stereocorynes truncorum (Germar, 1824)	6	FS9727	Voeren	*Malus* sp.	lasibrun
Stereocorynes truncorum (Germar, 1824)	1	FS9825	Voeren	*Salix alba*	lasibrun
Stereocorynes truncorum (Germar, 1824)	2	GS0024	Voeren	*Malus* sp.	lasibrun
Stereocorynes truncorum (Germar, 1824)	16	GS0123	Voeren	*Fraxinus excelsior*	lasibrun
Stereocorynes truncorum (Germar, 1824)	1	GS0227	Voeren	*Salix alba*	lasibrun, lasifuli
Strophosoma capitatum (De Geer, 1775)	2	FS7130	Tongeren	*Betula* sp.	lasibrun
Strophosoma melanogrammum (Forster, 1771)	1	FS7130	Tongeren	*Betula* sp.	lasibrun
Strophosoma melanogrammum (Forster, 1771)	3	FS7130	Tongeren	*Quercus* sp.	lasifuli
Strophosoma melanogrammum (Forster, 1771)	1	GS0024	Voeren	*Malus* sp.	lasibrun
Taphrorychus villifrons (Dufour, 1843)	2	FS9626	Voeren	*Malus* sp.	lasibrun

weevil, not included in the list but usually mentioned in relation with ants is *Curculio glandium* Marsham, 1802 (4.0-6.7 mm) or acorn weevil, common in Limburg. This weevil drills a hole in fallen acorns and lays its eggs in them. For their development, the larvae eat the acorns inside, with the result that large numbers of acorns can no longer germinate. After hibernation, the adult beetles leave the acorn, leaving it hollowed out. These freed up shelters are gratefully colonised by the minute ant *Temnothorax nylanderi* (Förster, 1850), whereby several acorns lying close to each other can be inhabited by specimens of the same colony (personal observation of the first author). Besides the damage they can do to healthy trees, such as *Strophosoma capitatum* (3.0-5.2 mm) eating the buds of oak trees (Rougon, 1995), many weevils are ubiquitous where dead trees are found, the ideal environment to complete their life cycle. Here they usually share their breeding sites with our xylobiont ants.

Endomychidae Leach, 1815

Table 9. Observations of an endomychid beetle that is mentioned in the literature to be associated with ants, with its correlated ant species on specific point locations in the province of Limburg.

Species	Number	UTM grid	Community	Tree	Host ant
Mycetaea subterranea (Fabricius, 1801)	4	FS7130	Tongeren	*Fagus* sp.	lasifuli
Mycetaea subterranea (Fabricius, 1801)	3	FS9526	Voeren	*Quercus robur*	lasibrun
Mycetaea subterranea (Fabricius, 1801)	1	FS9626	Voeren	*Malus* sp.	lasibrun

The genus *Mycetaea* Stephens, 1829 is represented by five extant species worldwide of which only *M. subterranea* (1.5-1.8 mm) (Fig. 12) is cosmopolitan (Shockley *et al*., 1999). They are all mycophagous with a preference for *Lycoperdina bovistae* (Fabricius, 1792), with only three records for Limburg (Table 9), feeding almost exclusive in puffballs. Consequently, they are found under decomposing bark, in decaying wood and in composting leaf litter, with an indication that *M. subterranea* was also found in birds' nest (Hicks, 1959). In his discussion of the Endomychidae, E. Wasmann (1894) mentions that frequently myrmecophily is attributed to the species of this family such as *Mycetaea hirta* (Marsham, 1802) (syn. of *Mycetaea subterranea*). He remarks that this species is rather accidentally found in the vicinity of ants. Besides *M. subterranea*, three more species of this family occur in Limburg (*Symbiotes gibberosus* (Lucas, 1846), *Lycoperdina bovistae* (Fabricius, 1792) and *Endomychus coccineus* (Linnaeus, 1758)), of which Wasmann only mentions *S. gibberosus* as observed near ants without specification of a genus or species (Wasmann, 1894). Albena Lapeva-Gjonova mentions the presence of *Mycetea subterranea* (sic) in a nest of *F. rufa* (Lapeva-Gjonova & Rücker, 2011).

Fig. 12. *Mycetaea subteranea* (Fabricius, 1801) (1.7 mm; range 1.5-1.8 mm). © U. Schmidt.

Eucnemidae Eschscholtz, 1829

Table 10. Observations of an eucnemid beetle that is mentioned in the literature to be associated with ants, with its correlated ant species on specific point locations in the province of Limburg.

Species	Number	UTM grid	Community	Tree	Host ant
Eucnemis capucina Ahrens, 1812	1	FS9626	Voeren	*Malus* sp.	lasibrun
Eucnemis capucina Ahrens, 1812	1	GS0227	Voeren	*Salix alba*	lasibrun

With only 21 captured specimens in 12 UTM grids of 1 x 1 km (Annex) *Eucnemis capucina* (4.3-6.5 mm) (Fig. 13) is not a very common species in Limburg. This beetle prefers old relic forests with a variety of dead trees such as oak and beech but is also found on fruit trees. Most of the beetles were captured with flight-interception traps and not even one was collected sieving rotten wood. The two specimens observed in Voeren were caught with a pitfall trap set up into the wood mould inside the hollow of the trees with a *Lasius brunneus* nest inside.

Fig. 13. *Eucnemis capucina* Ahrens, 1812 (6.1 mm; range 4.3-6.5 mm). © U. Schmidt.

Histeridae Gyllenhal, 1808

Most of the specimens of *Abraeus granulum* (1.2-1.5 mm) (Fig. 14A), 51 of the 61 collected (Annex), have been found in sieve samples from decaying wood in Kolmontbos, Tongeren. The species is common in deciduous woodland with no specific preference for a typical tree but can be found on any decayed tree, colonized by saproxylic ants (*Lasius* spp.) or not. *Abreus parvulus* (1.2-1.5 mm) is rather rare, at least in Limburg, with only five specimens from two locations (Kolmontbos, Tongeren and Jongenbos, Kortessem). In obvious dissimilarity to the latter species, *Abraeus perpussilus* (1.0-1.5 mm) (Fig. 14B) is widely distributed with 1,551 captured specimens in 62 1 x 1 km grids (Annex). *Aeletes atomarius* (1.0 mm) (Fig. 14C) does not show a general distribution pattern in Limburg, which seems to be contradicted by the high number of individuals in Limburg (Annex). The explanation is that they can be found in a collectively large number of several dozen. On one occasion by sifting the wood of a northern red oak (*Quercus rubra* L. (1753)) and the tinder fungus (*Fomes fomentarius* (L.) Fr., 1849) present, that grew on the edge of a pond, 286 adult beetles were sampled (8 May 2020, Hoefaert, Lanaken, FS8140). Jussi Päivinen (Päivinen *et al.*, 2002) mentions the symbiotic correlation of *A. atomarius* with the ant *Lasius niger* referring to data prior to 1991, the year in which Bernhard Seifert (Seifert, 1991) emphasized the ecological difference between *L. niger* and *L. platythorax*. The latter prefers nest constructions in woodland avoiding urban habitats and it is most probable the species that is found with *A. atomarius*. With 75 1 x 1 km grids, *Paromalus flavicornis* (1.5-2.2 mm) (Fig. 14D) is the most common histeridid species observed in Limburg (Annex) which is in line with the general pattern for Europe where this species is

Table 11. Observations of histerid beetles that are mentioned in the literature to be associated with ants, with their correlated ant species on specific point locations in the province of Limburg.

Species	Number	UTM grid	Community	Tree	Host ant
Abraeus granulum Erichson, 1839	1	FS7130	Tongeren	*Betula* sp.	lasibrun
Abraeus granulum Erichson, 1839	14	FS7130	Tongeren	*Fagus* sp.	lasifuli
Abraeus granulum Erichson, 1839	1	FS7130	Tongeren	*Quercus* sp.	lasibrun
Abraeus parvulus Aubé, 1842	1	FS7130	Tongeren	*Betula* sp.	lasibrun
Abraeus parvulus Aubé, 1842	2	FS7130	Tongeren	*Fagus* sp.	lasifuli
Abraeus perpusillus (Marsham, 1802)	1	FS7130	Tongeren	*Betula* sp.	lasibrun
Abraeus perpusillus (Marsham, 1802)	32	FS7130	Tongeren	*Fagus* sp.	lasifuli
Abraeus perpusillus (Marsham, 1802)	9	FS7130	Tongeren	*Picea* sp.	lasifuli
Abraeus perpusillus (Marsham, 1802)	2	FS7130	Tongeren	*Quercus* sp.	lasifuli
Aeletes atomarius (Aubé, 1842)	4	FS7130	Tongeren	*Betula* sp.	lasibrun
Aeletes atomarius (Aubé, 1842)	10	FS7130	Tongeren	*Fagus* sp.	lasifuli
Dendrophilus punctatus (Herbst, 1791)	1	FS9626	Voeren	*Malus* sp.	lasibrun
Dendrophilus punctatus (Herbst, 1791)	1	GS0227	Voeren	*Salix alba*	lasibrun, lasifuli
Gnathoncus buyssoni Auzat, 1917	1	FS9526	Voeren	*Quercus robur*	temnaffi
Gnathoncus buyssoni Auzat, 1917	12	FS9626	Voeren	*Malus* sp.	lasibrun
Margarinotus striola (Sahlberg, 1819)	3	FS9626	Voeren	*Malus* sp.	lasibrun
Paromalus flavicornis (Herbst, 1791)	1	FS4648	Halen	fruit tree	lasibrun, temnaffi
Paromalus flavicornis (Herbst, 1791)	2	FS7130	Tongeren	*Betula* sp.	lasibrun
Paromalus flavicornis (Herbst, 1791)	1	FS8653	Dilsen-Stokkem	*Fagus* sp.	lasifuli
Paromalus flavicornis (Herbst, 1791)	4	FS7130	Tongeren	*Fagus* sp.	lasifuli
Paromalus flavicornis (Herbst, 1791)	1	FS7130	Tongeren	*Picea* sp.	lasifuli
Paromalus flavicornis (Herbst, 1791)	2	FS7130	Tongeren	*Quercus* sp.	lasifuli
Paromalus flavicornis (Herbst, 1791)	6	FS9626	Voeren	*Malus* sp.	lasibrun
Paromalus flavicornis (Herbst, 1791)	4	FS9727	Voeren	*Malus* sp.	lasibrun
Paromalus flavicornis (Herbst, 1791)	1	FS9924	Voeren	*Malus* sp.	lasibrun
Paromalus flavicornis (Herbst, 1791)	1	GS0024	Voeren	*Malus sp.*	lasibrun
Paromalus flavicornis (Herbst, 1791)	1	GS0227	Voeren	*Salix alba*	lasibrun
Plegaderus dissectus Erichson, 1839	2	FS4648	Halen	fruit tree	lasibrun, temnaffi
Plegaderus dissectus Erichson, 1839	18	FS7130	Tongeren	*Betula* sp.	lasibrun
Plegaderus dissectus Erichson, 1839	1	FS8653	Dilsen-Stokkem	*Fagus* sp.	lasifuli
Plegaderus dissectus Erichson, 1839	22	FS7130	Tongeren	*Fagus* sp.	lasifuli

also widely distributed. Adult specimens can be found throughout the year and feel at home on both conifers and deciduous trees. While many species of saproxylic beetles are usually found with a few trapping techniques such as sifting, this species is caught with just about every set-up used in this study. *Plegaderus dissectus* (1.0-1.5 mm) (Fig. 14 E) is another common histeridid of which many individuals were observed (Annex). Of this beetle, seven specimens have been found in the extraction sample from Hoefaert, Lanaken together with *A. atomarius* (cf. supra). Like several species of this family, *P. dissectus* can be found under tree bark where it preys on bark beetle larvae.

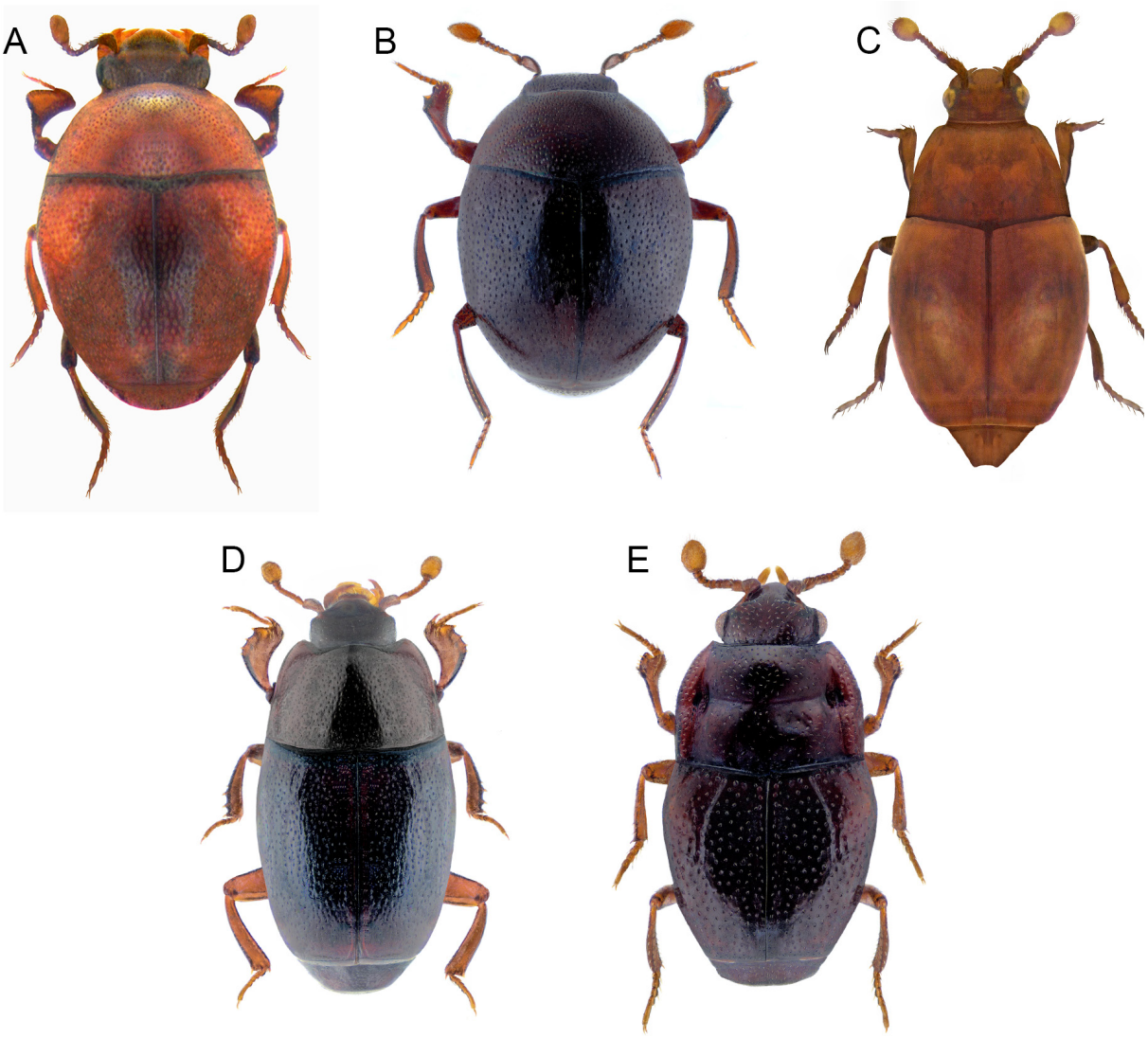

Fig. 14. **A**, *Abraeus granulum* Erichson, 1839 (range 1.2-1.5 mm). **B**, *Abraeus perpusillus* (Marsham, 1802) (1.4 mm; range 1.0-1.5 mm). **C**, *Aeletes atomarius* (Aubé, 1842) (1.0 mm). **D**, *Paromalus flavicornis* (Herbst, 1791) (2.2 mm; range 1.5-2.2 mm). **E**, *Plegaderus dissectus* Erichson, 1839) (1.5 mm; range 1.0-1.5 mm). © U Schmidt.

Hydrophilidae Latreille, 1802

Table 12. Observations of a hydrophilid beetle that is mentioned in the literature to be associated with ants, with its correlated ant species on specific point locations in the province of Limburg.

Species	Number	UTM grid	Community	Tree	Host ant
Megasternum concinnum (Marsham, 1802)	1	FS7130	Tongeren	*Quercus* sp.	lasifuli
Megasternum concinnum (Marsham, 1802)	1	GS0227	Voeren	*Salix alba*	lasibrun

As the family name suggests, majority of the species of this family are wetland species. Along with other members of the subfamily Sphaeridiinae, *Megasternum concinnum* (1.7-2.2 mm) (Fig. 15) is rather terrestrial with a preference for decaying organic matter. Their presence is not limited to decomposing plant material, but this beetle may be very abundant in drier dung, which is why they are often recorded at mammal nests. A single specimen of *M. concinnum* was found in Tongeren by sieving wood dust, and the second specimen observed in Voeren was captured using a trap placed in the wood mold within the tree cavity, near a nest of *L. fuliginosus* and *L. brunneus*, respectively.

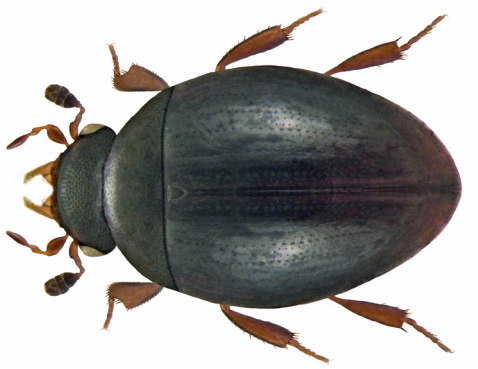

Fig. 15. *Megasternum concinnum* (Marsham, 1802) (range 1.7-2.2 mm). © U. Schmidt.

Latridiidae Erichson, 1842

Table 13. Observations of latridiid beetles that are mentioned in the literature to be associated with ants, with their correlated ant species on specific point locations in the province of Limburg.

Species	Number	UTM grid	Community	Tree	Host ant
Cartodere nodifer (Westwood, 1839)	4	GS0424	Voeren	*Alnus glutinosa*	lasibrun
Dienerella clathrata (Mannerheim, 1844)	2	FS7130	Tongeren	*Betula* sp.	lasibrun
Dienerella vincenti Johnson, 2007	1	FS7130	Tongeren	*Betula* sp.	lasibrun
Enicmus histrio Joy & Tomlin, 1910	1	FS7130	Tongeren	*Quercus* sp.	lasifuli
Enicmus histrio Joy & Tomlin, 1910	1	GS0123	Voeren	*Fraximus excelsior*	lasibrun
Stephostethus rugicollis (Olivier, 1790)	1	GS0424	Voeren	*Alnus glutinosa*	lasibrun

From this family, we have retained nine species that are associated with ants (Annex) and for five of them we could confirm the relationship (Table 13). These small beetles are associated with wood-inhabiting fungi and are mostly found under bark and decaying wood. This makes their presence in the vicinity of the xylobiont ants obvious. Nevertheless, several species have been recorded in association with wood ants (Annex). In Bulgaria, samples of anthills were extracted with Tullgren funnels and the presence of *Dienerella vincenti* (Fig. 16) in the nests of *F. pratensis* was confirmed. In the same study the association between *Corticaria longicollis* (2.3-2.6 mm) (Annex) with *F. pratensis* and *F. rufa* was demonstrated (Lapeva-Gjonova & Rücker, 2011). With 523 records from 80 UTM 1 x 1 km grids, the mould-feeding *Cartodere nodifer* (1.2-2.1 mm) is the most ubiquitous species throughout Limburg from this family. This beetle is native to Australia, but as a cosmopolitan it is now known worldwide as a food pest, attracted by fungi that develop during spoilage. The species is common in the wild on and under moist substrates where it feeds on the fungi. Although this beetle is widespread and does not make high demands on the food supply, until now the only ant-association reported, is in the vicinity of *L. brunneus*.

Fig. 16. *Dienerella vincenti* Johnson, 2007 (1.6 mm). © Ignace David

Leiodidae Fleming, 1821

Table 14. Observations of leiodid beetles that are mentioned in the literature to be associated with ants, with their correlated ant species on specific point locations in the province of Limburg.

Species	Number	UTM grid	Community	Tree	Host ant
Agathidium nigripenne (Fabricius, 1792)	1	FS7035	Kortessem	fruit tree	lasibrun, temnaffi
Agathidium nigripenne (Fabricius, 1792)	1	FS9526	Voeren	*Quercus robur*	temnaffi
Agathidium seminulum (Linnaeus, 1758)	1	FS7130	Tongeren	*Betula* sp.	lasibrun
Agathidium varians Beck, 1817	2	FS7130	Tongeren	*Quercus* sp.	lasifuli
Catops picipes (Fabricius, 1787)	15	FS8653	Dilsen-Stokkem	*Fagus* sp.	lasifuli
Catops picipes (Fabricius, 1787)	8	FS7130	Tongeren	*Quercus* sp.	lasifuli
Catops picipes (Fabricius, 1787)	1	GS0123	Voeren	*Fraxinus excelsior*	lasibrun
Catops picipes (Fabricius, 1787)	4	GS0227	Voeren	*Salix alba*	lasibrun, lasifuli
Nargus velox (Spence, 1813)	1	GS0227	Voeren	*Salix alba*	lasibrun
Nargus wilkini (Spence, 1813)	1	FS7130	Tongeren	*Picea* sp.	lasifuli
Ptomaphagus medius (Rey, 1889)	2	FS9352	Maasmechelen	*Populus* sp.	lasifuli
Sciodrepoides watsoni (Spence, 1813)	1	FS4648	Halen	fruit tree	lasibrun, temnaffi
Sciodrepoides watsoni (Spence, 1813)	1	FS7130	Tongeren	*Picea* sp.	lasifuli
Sciodrepoides watsoni (Spence, 1813)	1	GS0227	Voeren	*Salix alba*	lasibrun

The leiodid beetles are represented in Limburg with 31 species of which eight have been associated with ants according to the consulted literature and confirmed by our own research (Annex). The available sources lead to the conclusion that they are mainly observed in the vicinity of the xylobiont *L. fuliginosus*. *Catops picipes* (5.0-6.5 mm) (Fig. 17A) prefers a subterranean environment such as burrows of various mammals to develop his life cycle. Apparently, this species has a distinctly strong foraging behaviour. Of the 207 specimens captured, 135 were collected with pitfall traps compared to 31 with sifting of rotten wood at the base of a tree.

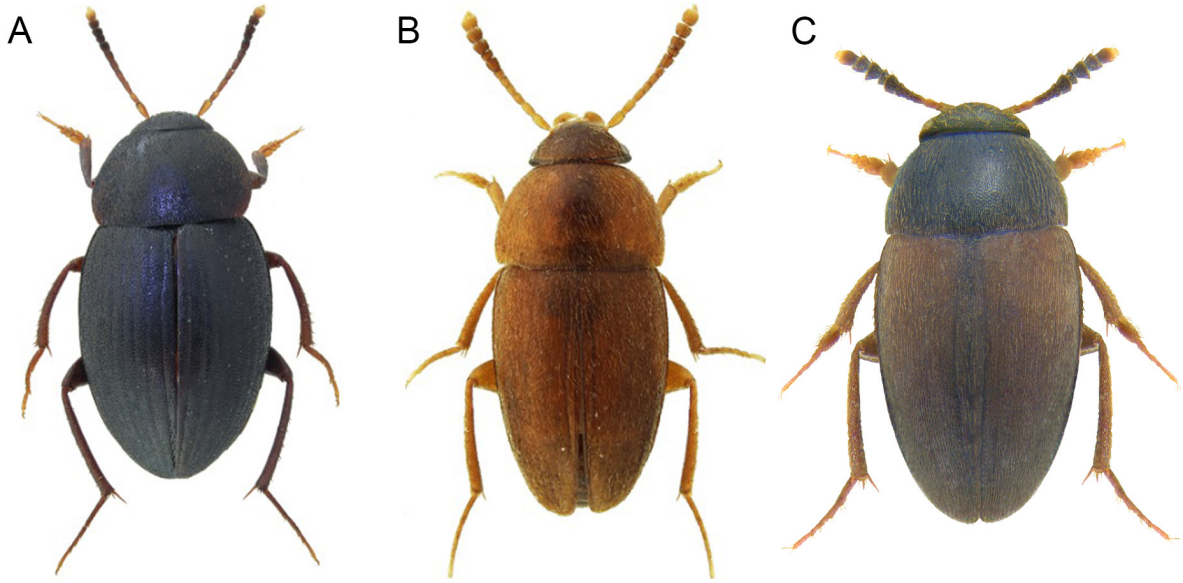

Fig. 17. **A**, *Catops picipes* (Fabricius, 1787) (5.5 mm), © Ignace David. **B**, *Nargus wilkini* (Spence, 1815) (2.3 mm), © Ignace David. **C**, *Sciodrepoides watsoni* (Spence, 1815) (2.6-3.4 mm), © U. Schmidt.

Another 25 specimens have been captured with cavity traps (pitfall trap set up in a hollow tree). *Nargus wilkini* (2.2-2.4 mm) (Fig. 17 B) is certainly not restricted to habitats with an abundance of leaf-litter or organic debris as will be found near a nest of *L. fuliginosus*. Moreover, this species can be observed in large numbers in the same location. With a pitfall, set up in an agricultural field, we collected 41 specimens in 2009 at Neerrepen (FS7231). Among the other species listed here (Table 14), *Ptomaphagus medius* (1.8-3.0 mm) and *Sciodrepoides watsoni* (2.6-3.4 mm) (Fig. 17 C) are found primarily in corridors and burrows of mammals, mainly rodents, and are attracted to carcasses. The ant *Temnothorax affinis* is one of our arboreal species, which creates its nests in bark or parts of dead wood from living trees and was encountered with *Agathidium nigripenne* (2.0-4.0 mm) on an oak tree.

Malachiidae Fleming, 1821

Table 15. Observation of a malachiid beetle that is mentioned in the literature to be associated with ants, with its correlated ant species on a specific point location in the province of Limburg.

Species	Number	UTM grid	Community	Tree	Host ant
Sphinginus lobatus (Olivier, 1790)	1	GS0227	Voeren	*Salix alba*	lasibrun

Only two records in Limburg of *Sphinginus lobatus* (2.2-3.0 mm) (Fig. 18) are available of which one in association with the ant *L. brunneus*.

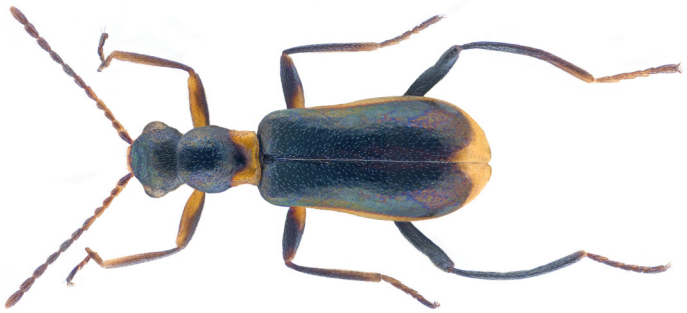

Fig. 18. *Sphinginus lobatus* (Olivier, 1790) (2.9 mm; range 2.2-3.0 mm). © U. Schmidt.

M**onotomidae** Laporte, 1840

Table 16. Observations of monotomid beetles that are mentioned in the literature to be associated with ants, with their correlated ant species on specific point locations in the province of Limburg. - * sieving of nesting material 20 cm below the top layer.

Species	Number	UTM grid	Community	Tree	Host ant
Monotoma angusticollis (Gyllenhal, 1827)	1	FS7754	Zwartberg	nest	forcprat*
Monotoma conicicollis Aubé, 1837	1	FS7349	Genk	nest	farcsang
Monotoma conicicollis Aubé, 1837	1	FS7754	Zwartberg	nest	forcprat*
Monotoma longicollis (Gyllenhal, 1827)	1	FS4648	Halen	fruit tree	lasibrun, temnaffi
Rhizophagus bipustulatus (Fabricius, 1792)	2	GS0227	Voeren	*Salix alba*	lasibrun
Rhizophagus cribratus Gyllenhal, 1827	3	GS0227	Voeren	*Salix alba*	lasibrun
Rhizophagus perforatus Erichson, 1845	1	FS4648	Halen	fruit tree	lasibrun, temnaffi
Rhizophagus perforatus Erichson, 1845	1	FS9825	Voeren	*Salix alba*	lasibrun

We recorded 9,224 specimens of *Rhizophagus depressus* (2.8-4.0 mm) in Limburg (Annex). In Europe this beetle is often found in the nests of the ant *F. rufa*. This wood ant is used as a predator in biological pest control (Akyol & Sarikaya, 2017). However, in addition to this

ant, *R. depressus* also predates on pest species such as the pine shoot beetle *Tomicus piniperda* (Linnaeus, 1758), attracted by the terpenes of the conifers (Mazur, 1979). This common food source creates a microbiotope where the beetle and the ant are observed together and where *R. depressus* finds a shelter in the dome-shaped mounds of the wood ant. In the coniferous forests of Limburg, 9,114 specimens of *R. depressus* were collected with pheromone traps (the results of this study have not yet been published), set up to monitor the presence of the black pine sawyer beetle, *Monochamus galloprovincialis* (Olivier, 1795). Whereas 99.24% of all our observations of *R. depressus* were made in coniferous forests, the ratio with *R. perforatus*, associated with *L. brunneus* is clearly different. Of *R. perforatus,* 57 specimens were collected in deciduous forests and only two specimens in a coniferous forest.

Monotoma conicicollis (2.0-3.0 mm) (Fig. 19) can be found in the brood-chambers of ants of the subgenera *Formica* s. str. and *Raptiformica* were they feed on ant eggs (https://www.ukbeetles.co.uk/monotoma-conicicollis - consulted 2023-05-18).

Fig. 19. *Monotoma conicicollis* Aubé, 1837 (2 mm). © L. Borowiec.

Mycetophagidae Leach, 1815

Table 17. Observations of mycetophagid beetles that are mentioned in the literature to be associated with ants with their correlated ant species on specific point locations in the province of Limburg.

Species	Number	UTM grid	Community	Tree	Host ant
Mycetophagus populi Fabricius,1798	2	FS4648	Halen	fruit tree	lasibrun, temnaffi
Mycetophagus populi Fabricius,1798	1	FS9727	Voeren	*Malus* sp.	lasibrun
Mycetophagus quadriguttatus Müller, 1821	1	FS9626	Voeren	*Malus* sp.	lasibrun
Mycetophagus quadriguttatus Müller, 1821	1	GS0227	Voeren	*Salix alba*	lasibrun

Mycetophagidae feed on fungi and live in decaying, damp wood of deciduous trees. Here they are usually collected by sieving the wood dust of hollow trees. Of the 105 sampled individuals (Annex) 76 were found by sieving with a concentration of 63 specimens in one location (Brullenbos, Hoeselt, FS7233). Only five specimens could be associated with ants, due to the presence of these beetles in the vicinity of a nest of *L. brunneus*.

Nitidulidae Latreille, 1802

This large family of sap or pollen beetles is represented in the province of Limburg by 54 species. The number of specimens in our database amounts to 16,187 beetles belonging to the cosmopolitan genus *Glischrochilus* Reitter, 1873. At only one location (Kolmontbos FS7130 Tongeren) 5,429 individulas of the saproxylic species *G. hortensis* (4.0-7.0 mm) (Fig. 20B)

Table 18. Observations of nitidulid beetles that are mentioned in the literature to be associated with ants, with their correlated ant species on specific point locations in the province of Limburg.

Species	Number	UTM grid	Community	Tree	Host ant
Amphotis marginata (Fabricius, 1781)	1	FS5427	Sint-Truiden	broadleaf tee	lasifuli
Amphotis marginata (Fabricius, 1781)	8	FS7130	Tongeren	*Quercus* sp.	lasifuli
Epuraea melanocephala (Marsham, 1802)	1	FS7130	Tongeren	*Betula* sp.	lasibrun
Epuraea ocularis (Fairmaire, 1849)	1	GS0227	Voeren	*Salix alba*	lasibrun
Glischrochilus hortensis (Geoffroy, 1785)	48	FS6732	Borgloon	fruit tree	lasibrun, temnaffi
Glischrochilus hortensis (Geoffroy, 1785)	1	FS7035	Kortessem	fruit tree	lasibrun, temnaffi
Glischrochilus hortensis (Geoffroy, 1785)	1	FS9127	Voeren	*Malus* sp.	lasibrun
Glischrochilus hortensis (Geoffroy, 1785)	3	FS9526	Voeren	*Quercus robur*	lasibrun
Glischrochilus hortensis (Geoffroy, 1785)	7	FS9626	Voeren	*Malus* sp.	lasibrun
Glischrochilus hortensis (Geoffroy, 1785)	5	FS9725	Voeren	*Malus* sp.	lasibrun, lasifuli
Glischrochilus hortensis (Geoffroy, 1785)	1	FS9825	Voeren	*Salix alba*	lasibrun
Glischrochilus hortensis (Geoffroy, 1785)	2	FS9924	Voeren	*Malus* sp.	lasibrun
Glischrochilus hortensis (Geoffroy, 1785)	1	GS0123	Voeren	*Fraxinus excelsior*	lasibrun
Glischrochilus hortensis (Geoffroy, 1785)	42	GS0227	Voeren	*Salix alba*	lasibrun, lasifuli
Glischrochilus quadriguttatus (Fabricius, 1777)	1	FS6732	Borgloon	fruit tree	lasibrun, temnaffi
Glischrochilus quadriguttatus (Fabricius, 1777)	15	FS7035	Kortessem	fruit tree	lasibrun, temnaffi
Glischrochilus quadriguttatus (Fabricius, 1777)	1	FS9626	Voeren	*Malus* sp.	temnaffi
Glischrochilus quadriguttatus (Fabricius, 1777)	1	FS9825	Voeren	*Salix alba*	lasibrun
Glischrochilus quadriguttatus (Fabricius, 1777)	7	GS0227	Voeren	*Salix alba*	lasibrun, lasifuli
Glischrochilus quadriguttatus (Fabricius, 1777)	1	GS0424	Voeren	*Alnus glutinosa*	lasibrun
Glischrochilus quadrisignatus (Say, 1835)	1	FS4648	Halen	fruit tree	lasibrun, temnaffi
Glischrochilus quadrisignatus (Say, 1835)	2	FS6732	Borgloon	fruit tree	lasibrun, temnaffi
Glischrochilus quadrisignatus (Say, 1835)	4	FS7035	Kortessem	fruit tree	lasibrun, temnaffi
Glischrochilus quadrisignatus (Say, 1835)	2	FS9727	Voeren	fruit tree	campfall, lasibrun, temnaffi
Glischrochilus quadrisignatus (Say, 1835)	2	FS9526	Voeren	*Quercus robur*	lasibrun, temnaffi
Glischrochilus quadrisignatus (Say, 1835)	3	FS9725	Voeren	*Malus* sp.	lasibrun, lasifuli
Glischrochilus quadrisignatus (Say, 1835)	1	FS9924	Voeren	*Malus* sp.	lasibrun
Glischrochilus quadrisignatus (Say, 1835)	1	GS0024	Voeren	*Malus* sp.	lasibrun
Glischrochilus quadrisignatus (Say, 1835)	6	GS0227	Voeren	*Salix alba*	lasibrun, lasifuli
Omosita discoidea (Fabricius, 1775)	1	GS0227	Voeren	*Salix alba*	lasibrun
Pityophagus ferrugineus (Linnaeus, 1761)	1	FS9127	Voeren	*Malus* sp.	lasibrun
Soronia punctatissima (Illiger, 1794)	1	GS0227	Voeren	*Salix alba*	lasibrun

were collected using a trap baited with a mixture of water, alcohol, glycerol and acetic acid. The trap was installed in a dead oak tree, and beetles were captured from 21-06-2008 until 03-08-2008. Less abundant in both species numbers and occupancy of UTM grids (Annex) is *Amphotis marginata* (3.8-5.8 mm) (Fig. 20A). Although the niche occupancy of the latter may be significantly lower compared to the occurrence of *G. hortensis*, the attention given

to this beetle in publications on myrmecophily is even greater. In this relationship, the ant *L. fuliginosus* appears to be the exclusive partner.

Once the shining black ant *L. fuliginosus* has found a suitable shelter, the workers start building a carton nest. Usually, the nest is built inside a cavity at the root of a decaying tree, and partly due to the labour-intensive cost of this enterprise, this settlement can be observed in the same location for years. From this permanent residence, hundreds of workers migrate incessantly, day and night, to nearby aphid colonies to feed on the excreted nectar of the aphids. These foraging paths, which can be up to a few dozen meters, will remain in use season after season. The nitidulid beetle *Amphotis marginata* (Fig. 20A) has found an easily accessible food source in the ants that return to the nest with a full social stomach. Hidden in a shelter during the day along the foraging trail, the beetles line up at dusk and during the night to beg the homing ants for food. They approach the food-carrying ants, imitate the food-begging behaviour of their nestmates and obtain the supplied honeydew through trophallaxis. The relationship between these beetles and the ants is mainly attributed to food solicitation and although no adult beetles have been observed in the ant nest, it cannot be ruled out that their larvae hibernate and develop inside the ant nests (Hölldobler *et al*., 2017).

Lasius fuliginosus is a common ant, and the number of grids (156) where the species was recorded in the surveyed province contrasts sharply with the eight grids where *A. marginata* was observed. An explanation may be that the dispersal pattern of this nitidulid beetle is not distinctly large, and they prefer to stay close to an established colony of *L. fuliginosus* with a guaranteed food supply. However, this assumption is not supported by our observations (Annex). Eleven beetles were collected in just two grids when screening rotten wood from a tree (*Quercus* sp.) in which a nest of *L. fuliginosus* was located (Tongeren FS7130 – 2008 and Sint-Truiden FS5427 – 2012). In the other six grids, the beetles were caught in flight - one specimen was caught with a butterfly net, one specimen with a light trap and five specimens (in four grids) with a vehicle-mounted net. Therefore, from our data, we cannot offer an acceptable explanation for the scant presence of this beetle in a region where the host is a common species. Other unknown conditions need to be explored to better understand the ant-beetle association for *A. marginata* (Hölldobler *et al*., 2017).

Based on their observations of *Lasius neglectus* van Loon, Boomsma & Andrasfalvy, 1990 in Barcelona, Espadaler and Bernal (2007) make mention of *Amphotis marginata* as a guest but later this was corrected into the very similar species *Amphotis martini* Brisout, 1878 (Lencina *et al*., 2011). This shows us that the related species within the genus *Amphotis* exhibit a similar behaviour towards a variety of host ants.

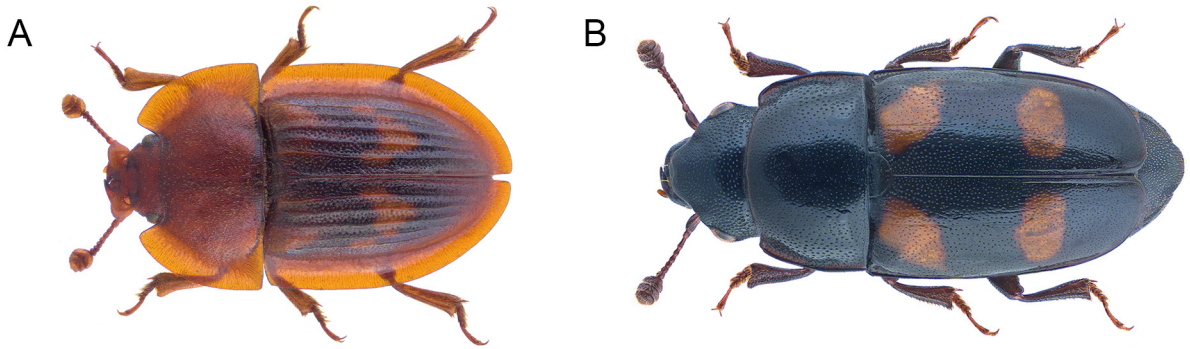

Fig. 20. **A**, *Amphotis marginata* (Fabricius, 1781) (5.7 mm; range 3.8-5.8 mm). **B**, *Glischrochilus hortensis* (Geoffroy, 1785) (6.7 mm; range 4.0-7.0 mm). © U. Schmidt.

Ptiliidae Heer, 1843

Table 19. Observations of ptiliid beetles that are mentioned in the literature to be associated with ants, with their correlated ant species on specific point locations in the province of Limburg. - * sieving top layer of the nest.

Species	Number	UTM grid	Community	Tree	Host ant
Acrotrichis intermedia (Gillmeister, 1845)	1	FS7130	Tongeren	*Betula* sp.	lasibrun
Acrotrichis sitkaensis (Motschulsky, 1845)	2	FS7130	Tongeren	*Quercus* sp.	lasifuli
Pteryx suturalis (Heer, 1841)	28	FS7130	Tongeren	*Betula* sp.	lasibrun
Pteryx suturalis (Heer, 1841)	3	FS7130	Tongeren	*Fagus* sp.	lasifuli
Pteryx suturalis (Heer, 1841)	2	FS7130	Tongeren	*Picea* sp.	lasifuli
Pteryx suturalis (Heer, 1841)	1	FS7130	Tongeren	*Quercus* sp.	lasifuli
Ptilium myrmecophilum (Allibert, 1844)	2	FS7349	Genk	nest	forcsang*
Ptinella errabunda Johnson, 1975	3	FS7130	Tongeren	*Betula* sp.	lasibrun

In the family Ptiliidae we are dealing with the smallest of all coleopterans. Some species are just 300 µm and the measurements of the specimens we collected during this long-term survey (Annex) fall within the following averages: 580–630 µm (*Micridium halidaii)*, 1050–1180 µm (*Ptenidium laevigatum*), 750–850 µm (*Pteryx suturalis*) (Fig. 21B) and 600 – 650 µm (*Ptilium myrmecophilum*) (Fig. 21C) (Freude *et al*., 1971) The minute size of these beetles and the difficulty of identification, contribute to the poor study of this group. It is therefore hardly surprising that little is known about the biological connection between these inconspicuous beetles and the ants, and that there are only sporadic reports of observations in or near an ants' nest.

The observation of *Micridium halidaii*, associated with the ants *L. brunneus* and *L. niger* (or *L. platythorax*) (Annex) on 16 June in 2008 is the first mention of this species in Belgium and even in the Benelux. The specimen was collected in the Kolmont forest reserve in Tongeren by wrapping a glue ring around the trunk of a dead beech tree, on which, however, no ant was found.

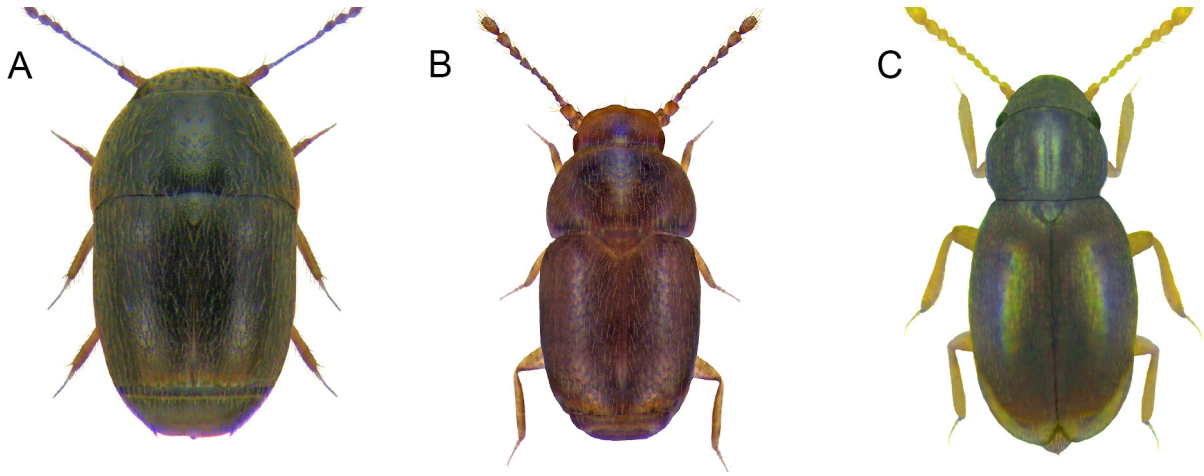

Fig. 21. **A**, *Acrotrichis intermedia* (Gillmeister, 1845) (range 1.0-1.1 mm). **B**, *Pteryx suturalis* (Heer, 1841) (range 0.75-0.85 mm). **C**, *Ptilium myrmecophilum* (Alibert, 1844) (range 0.6-0.65 mm). © U. Schmidt.

Ptinidae Latreille, 1802

The common furniture beetle or *Anobium punctatum* (2.5-5.0 mm) (Fig. 22A) is well known as a synanthropic pest beetle which can cause considerable damage to wooden structures in buildings and furniture. It is the larvae that feed on the wood and build up a corridor structure. This may explain why we mainly noted the connection with the ant *L. brunneus* with a single

Table 20. Observations of ptinid beetles that are mentioned in the literature to be associated with ants, with their correlated ant species on specific point locations in the province of Limburg.

Species	Number	UTM grid	Community	Tree	Host ant
Anobium punctatum (De Geer, 1774)	6	FS4648	Halen	fruit tree	lasibrun, temnaffi
Anobium punctatum (De Geer, 1774)	1	FS6529	Borgloon	fruit tree	lasibrun, lasifuli, temnaffi
Anobium punctatum (De Geer, 1774)	2	FS6732	Borgloon	fruit tree	lasibrun, temnaffi
Anobium punctatum (De Geer, 1774)	1	GS0024	Hoeselt	fruit tree	lasibrun, temnaffi
Anobium punctatum (De Geer, 1774)	2	GS0024	Voeren	*Malus* sp.	lasibrun
Anobium punctatum (De Geer, 1774)	13	GS0424	Voeren	*Alnus glutinosa*	lasibrun
Hemicoelus canaliculatus (Thomson,1863)	1	FS9727	Voeren	*Malus* sp.	lasibrun
Hemicoelus canaliculatus (Thomson,1863)	1	FS9727	Voeren	fruit tree	campfall, lasibrun, temnaffi
Priobium carpini (Herbst, 1793)	2	FS7735	Bilzen	fruit tree	lasibrun, temnaffi
Priobium carpini (Herbst, 1793)	1	FS7933	Bilzen	fruit tree	lasibrun, temnaffi
Priobium carpini (Herbst, 1793)	2	FS6629	Borgloon	fruit tree	lasibrun, temnaffi
Priobium carpini (Herbst, 1793)	3	FS6732	Borgloon	fruit tree	lasibrun, temnaffi
Priobium carpini (Herbst, 1793)	21	FS4648	Halen	fruit tree	lasibrun, temnaffi
Priobium carpini (Herbst, 1793)	18	FS7233	Hoeselt	fruit tree	lasibrun, temnaffi
Priobium carpini (Herbst, 1793)	1	FS7035	Kortessem	fruit tree	lasibrun, temnaffi
Priobium carpini (Herbst, 1793)	23	FS5130	Sint-Truiden	fruit tree	lasibrun, temnaffi
Priobium carpini (Herbst, 1793)	1	FS5528	Sint-Truiden	fruit tree	lasibrun
Priobium carpini (Herbst, 1793)	1	FS7131	Tongeren	fruit tree	lasibrun, temnaffi
Priobium carpini (Herbst, 1793)	1	FS9727	Voeren	fruit tree	campfall, lasibrun, temnaffi
Priobium carpini (Herbst, 1793)	1	FS9626	Voeren	*Malus* sp.	lasibrun
Priobium carpini (Herbst, 1793)	1	GS0227	Voeren	*Salix alba*	lasibrun
Ptilinus pectinicornis (Linnaeus, 1758)	1	FS6529	Borgloon	fruit tree	lasibrun, lasifuli, temnaffi
Ptilinus pectinicornis (Linnaeus, 1758)	6	FS4648	Halen	fruit tree	lasibrun, temnaffi
Ptilinus pectinicornis (Linnaeus, 1758)	4	FS5130	Sint-Truiden	fruit tree	lasibrun, temnaffi
Ptilinus pectinicornis (Linnaeus, 1758)	1	FS7131	Tongeren	fruit tree	lasibrun, temnaffi
Ptilinus pectinicornis (Linnaeus, 1758)	1	FS9725	Voeren	*Malus* sp.	lasibrun
Ptilinus pectinicornis (Linnaeus, 1758)	5	FS9727	Voeren	fruit tree	campfall, lasibrun, temnaffi
Ptilinus pectinicornis (Linnaeus, 1758)	1	GS0024	Voeren	*Malus* sp.	lasibrun
Ptinus fur (Linnaeus, 1758)	1	FS9526	Voeren	*Quercus robur*	lasibrun
Ptinus fur (Linnaeus, 1758)	4	FS9526	Voeren	*Quercus robur*	temnaffi

observation in the vicinity of a *L. fuliginosus* nest. *Lasius fuliginosus* builds a cardboard nest with basic material such as small wood particles, while *L. brunneus* leads a cryptic life in a gnawed-out corridor system in dead trees. There is no consensus as to whether *L. brunneus* gnaws out the tunnel system all by itself, or whether this ant uses existing beetle tunnels, which it may or may not further process. According to Edward Wilson, the ant's jaw structure is not powerful enough to dig burrows (Wilson, 1955), but more recent findings contradict this view, with Bernhard Seifert adding that mining the wood is not preceded by weakening by fungi or xylophagous insects (Seifert, 2018). All the collected *A. punctatum* beetles were trapped on broadleaf trees, a finding that also applies to the other discussed species of this family.

The xylophagous beetle *Ptilinus pectinicornis* (3.5-5.5 mm) (Fig. 22 C) is a general, widespread species, which is also evidenced by the large number of individuals that were caught in general in Limburg. Our observations also show that they can occur in large concentrations (Annex) with collected numbers of 64, 77, 82 and 138 on a single location. The mention of only two specimens found near a nest of *L. brunneus* (Table 20) is therefore an underestimation or lack of targeted research. For the sexually dimorphic *Ptinus fur* (2.6-4.3 mm) (Fig. 22 D and 22 E) we not only designate a connection with the ant *L. brunneus* but also with the arboreal species *T. affinis* (Table 20).

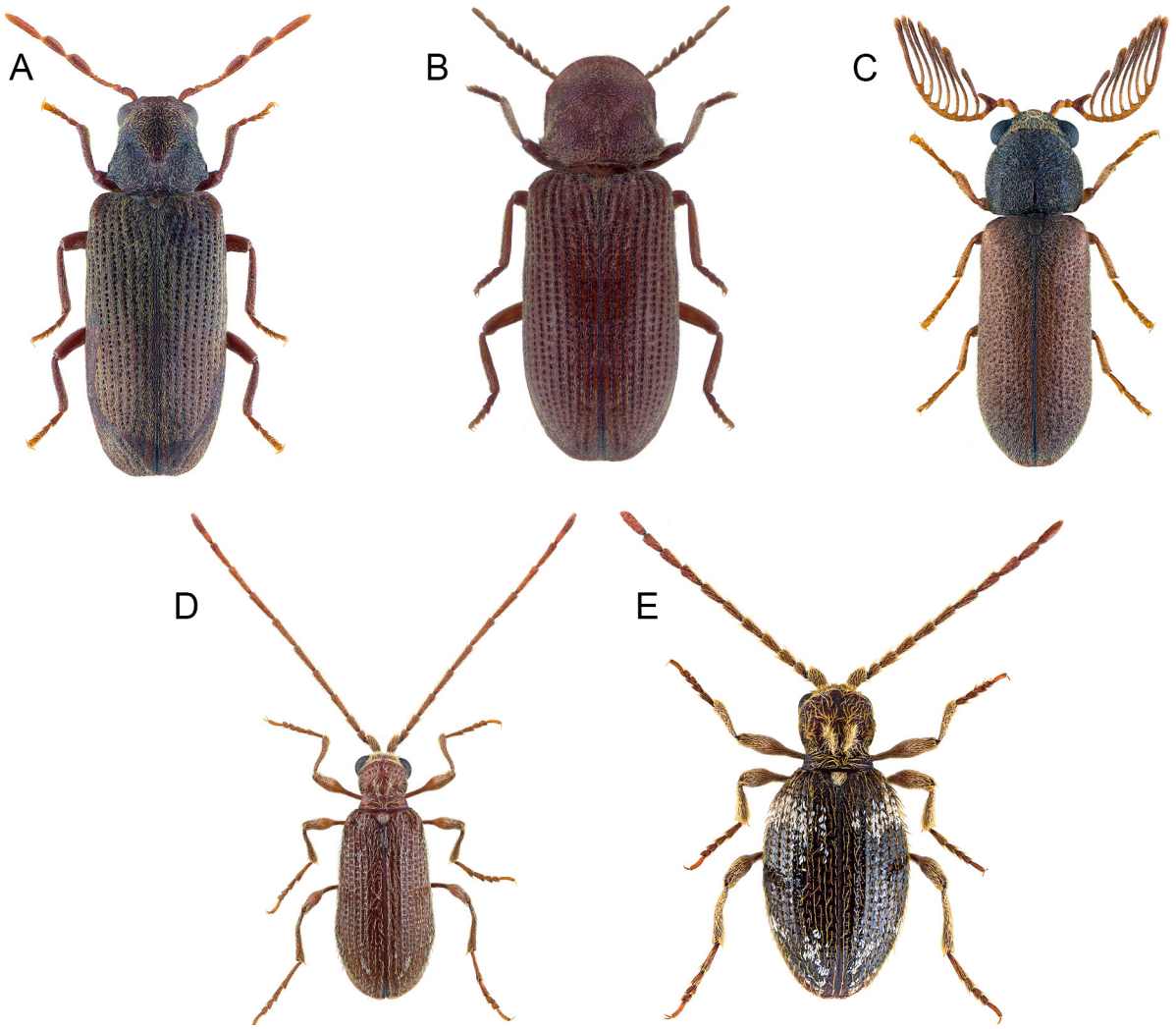

Fig. 22. **A**, *Anobium punctatum* (De Geer, 1774) (range 2.5-5.0 mm). **B**, *Priobium carpini* (Herbst, 1793) (4.8 mm; range 3.0-5.0 mm). **C**, *Ptilinus pectinicornis* (Linnaeus, 1758) (3.6 mm; range 3.5-5.5 mm) . **D**, *Ptinus fur* (Linnaeus, 1758) male) (3.3 mm; range 2.6-4.3 mm). **E**, *Ptinus fur* (Linnaeus, 1758) female (3.8 mm; range 2.6-4.3 mm). © U. Schmidt.

Silvanidae Kirby, 1837

Table 21. Observation of a silvanid beetle that is mentioned in the literature to be associated with ants with its correlated ant species on specific point locations in the province of Limburg.

Species	Number	UTM grid	Community	Tree	Host ant
Uleiota planatus (Linnaeus, 1761)	5	FS7035	Kortessem	fruit tree	lasibrun, temnaffi
Uleiota planatus (Linnaeus, 1761)	1	FS9626	Voeren	*Malus* sp.	lasibrun

Attracted by decaying timber, *Uleiota planatus* (4.5-5.5 mm) (Fig. 23) rather prefers deciduous trees with a ratio of 6:1 for typical deciduous versus coniferous forests according to our observations.

Fig. 23. *Uleiota planatus* (Linnaeus, 1761) (range 4.5-5.5 mm). © U. Schmidt.

Sphindidae Jacquelin du Val, 1858

Table 22. Observations of a sphindid beetle that is mentioned in the literature to be associated with ants with its correlated ant species on specific point locations in the province of Limburg.

Species	Number	UTM grid	Community	Tree	Host ant
Aspidiphorus orbiculatus (Gyllenhal, 1808)	9	FS7130	Tongeren	*Betula* sp.	lasibrun
Aspidiphorus orbiculatus (Gyllenhal, 1808)	1	FS7130	Tongeren	*Fagus* sp.	lasifuli

Of the individuals collected in Limburg so far (Annex), 92 % were caught while migrating to a new suitable location. Only a targeted search by sifting through decayed wood near the ants' nests has shown that *Aspidiphorus orbiculatus* (1.2-1.5 mm) (Fig. 24) inhabits the same microbiotope as the xylobiont ants *L. brunneus* and *L. fuliginosus* (Table 22). This beetle is widespread in Europe and feeds upon spores of slime mould.

Fig. 24. *Aspidiphorus orbiculatus* (Gyllenhal, 1808) (1.4 mm; range 1.2-1.5 mm). © U. Schmidt.

Staphylinidae Latreille, 1802

A total of 19,674 staphylinid specimens discussed in this paper were collected (Annex). Due to the large number of species, we list our observations by subfamily. In the family of rove beetles, we find most of the species defined as true myrmecophiles. Morphologically, physiologically and ethologically, they have adapted to deal with ants. They have learned to appease the host's aggressive behaviour, their permanent presence in ant colonies has been confirmed and they sometimes develop their entire life cycle in this environment. This assured them a shelter from which they could easily access the necessary food, either from the ants' brood or from food supplied by the foraging ants.

Aleocharinae Fleming, 1821

Table 23. Observations of aleocharine beetles that are mentioned in the literature to be associated with ants, with their correlated ant species on specific point locations in the province of Limburg.

Species	Number	UTM grid	Community	Tree	Host ant
Aleochara lanuginosa Gravenhorst, 1802	1	FS7338	Hoeselt	fruit tree	lasibrun, temnaffi
Aleochara sparsa Heer, 1835	1	FS6529	Borgloon	fruit tree	lasibrun, lasifuli, temnaffi
Aleochara sparsa Heer, 1835	22	FS6732	Borgloon	fruit tree	lasibrun, temnaffi
Aleochara sparsa Heer, 1836	195	FS4648	Halen	fruit tree	lasibrun, temnaffi
Aleochara sparsa Heer, 1837	1	FS6626	Heers	fruit tree	lasibrun
Aleochara sparsa Heer, 1838	1	FS7338	Hoeselt	fruit tree	lasibrun, temnaffi
Aleochara sparsa Heer, 1839	21	FS9526	Voeren	*Quercus robur*	temnaffi
Aleochara sparsa Heer, 1840	56	FS9727	Voeren	fruit tree	campfall, lasibrun, temnaffi
Aleochara sparsa Heer, 1839	13	FS9526	Voeren	*Quercus robur*	lasibrun
Aleochara sparsa Heer, 1839	4	FS9626	Voeren	*Malus* sp.	lasibrun
Aleochara sparsa Heer, 1839	16	FS9725	Voeren	*Malus* sp.	lasibrun, lasifuli
Aleochara sparsa Heer, 1839	16	FS9825	Voeren	*Salix alba*	lasibrun
Aleochara sparsa Heer, 1839	20	FS9924	Voeren	*Malus* sp.	lasibrun
Aleochara sparsa Heer, 1839	13	GS0123	Voeren	*Fraxinus excelsior*	lasibrun
Aleochara sparsa Heer, 1839	20	GS0227	Voeren	*Salix alba*	lasibrun, lasifuli
Aleochara sparsa Heer, 1839	25	GS0424	Voeren	*Alnus glutinosa*	lasibrun
Aloconota gregaria (Erichson, 1839)	1	FS7130	Tongeren	*Quercus* sp.	lasifuli
Dinaraea linearis (Gravenhorst, 1802)	1	FS7130	Tongeren	*Quercus* sp.	lasifuli
Dinarda dentata (Gravenhorst, 1806)	4	FS4257	Engsbergen	nest	forcsang
Dinarda dentata (Gravenhorst, 1806)	2	FS6458	Houthalen-Helchteren	nest	forc sp.
Dinarda dentata (Gravenhorst, 1806)	1	FS5881	Lommel	nest	forcsang
Drusilla canaliculata (Fabricius, 1787)	1	FS8549	Maasmechelen	nest	mymirubr
Euryusa optabilis Heer, 1839	1	FS7130	Tongeren	*Betula* sp.	lasibrun
Gyrophaena minima Erichson, 1837	1	FS7130	Tongeren	*Fagus* sp.	lasifuli
Gyrophaena strictula Erichson, 1839	1	FS7130	Tongeren	*Quercus* sp.	lasifuli
Haploglossa gentilis (Märkel, 1844)	264	FS7130	Tongeren	*Quercus* sp.	lasifuli
Leptusa pulchella (Mannerheim, 1830)	3	FS7130	Tongeren	*Betula* sp.	lasibrun
Lomechusa emarginata (Paykull, 1789)	1	FS6648	Hasselt	foraging ant	forcfusc
Lomechusa emarginata (Paykull, 1789)	1	FS5749	Lummen	nest	forcfusc
Lomechusa emarginata (Paykull, 1789)	1	FS8044	Zutendaal	nest	mymirugi
Oxypoda annularis (Mannerheim, 1830)	1	FS7130	Tongeren	*Fagus* sp.	lasifuli

Species	Number	UTM grid	Community	Tree	Host ant
Oxypoda opaca (Gravenhorst, 1802)	1	FS7130	Tongeren	*Quercus* sp.	lasifuli
Oxypoda vittata Märkel, 1842	3	FS7130	Tongeren	*Quercus* sp.	lasifuli
Pella cognata (Märkel, 1842)	3	FS8653	Dilsen-Stokkem	*Fagus* sp.	lasifuli
Pella cognata (Märkel, 1842)	7	FS9352	Maasmechelen	*Populus* sp.	lasifuli
Pella funesta (Gravenhorst, 1806)	1	FS6673	Pelt	*Castanea sativa*	lasifuli
Pella funesta (Gravenhorst, 1806)	4	FS7130	Tongeren	*Quercus* sp.	lasifuli
Pella laticollis (Märkel, 1844)	1	FS6072	Lommel	*Quercus* sp.	lasifuli
Pella laticollis (Märkel, 1844)	9	FS7130	Tongeren	*Quercus* sp.	lasifuli
Pella lugens (Gravenhorst, 1802)	1	FS7130	Tongeren	*Quercus* sp.	lasifuli
Placusa tachyporoides (Waltl, 1838)	1	FS7735	Bilzen	fruit tree	lasibrun, temnaffi
Placusa tachyporoides (Waltl, 1838)	1	FS9526	Voeren	*Quercus robur*	temnaffi
Thamiaraea cinnamomea (Gravenhorst, 1802)	1	FS4648	Halen	fruit tree	lasibrun, temnaffi
Thamiaraea cinnamomea (Gravenhorst, 1802)	1	FS5130	Sint-Truiden	fruit tree	lasibrun, temnaffi
Thamiaraea cinnamomea (Gravenhorst, 1802)	1	FS9727	Voeren	*Malus* sp.	lasibrun
Thamiaraea cinnamomea (Gravenhorst, 1802)	1	GS0024	Voeren	*Malus* sp.	lasibrun
Zyras haworthi (Stephens, 1832)	1	GS0123	Voeren	*Fraxinus excelsior*	lasibrun

With thirteen species within the genus *Aleochara* Gravenhorst, 1802 observed in Limburg, one would expect several of them to be found together with ants. However, it is clear that *A. sparsa* (2.0-5.0 mm) is the most common species with 3,710 specimens spread over 69 1 x 1 km grids (Annex), and apart from an occasional observation of *A. lanuginos*a (3.0-5.5 mm), the only species of this genus frequently observed in the vicinity of ants. The use of proper sampling techniques appears to be a determining factor for the detection of this species as well. In Voeren, a total of 880 individuals were collected with pitfall traps in hollow trees, but across the whole study area, 1,404 individuals were caught with flight-interception traps (air eclectors). We emphasize that only the pitfall traps in hollow trees used in Voeren can demonstrate a connection between beetle and ant.

With 63 species, the genus *Atheta* Thomson, 1858 is well represented in Limburg. Many species are associated with decaying sporocarps and accordingly we collected 29% of the specimens screening decomposing mushrooms. We selected seven species that have been reported in literature in relation with ants (Annex). In Germany Frank Köhler found *Atheta paracrassicornis* Brundin, 1954 in a nest of *L. brunneus*, excavated in a hollow ash (*Fraxinus excelsior*) (Köhler, 2000) but neither during the study in Tongeren nor in Voeren could we confirm these observations.

The genus *Dinarda* Leach, 1819 includes only species that coexist with ants. Erich Wasmann (1889, 1894), who may be regarded as the pioneer in the study of the life cycle of *Dinarda*, closely observed these beetles in artificial nests and concluded that the *Dinarda* species are indifferently tolerated by the host ants. He distinguished four species: *D. dentata* Gravenhorst, 1806, *D. märkelii* Kiesenwetter, 1843, *D. hagensi* Wasmann, 1889, and *D. pygmaea* Wasmann, 1894. In the classification, he not only paid attention to the morphological differences, but

also considered the different host ants with which they were found. From his observations the following combinations have been noted:

D. märkelii associated with *F. rufa*, *F. polyctena* and *F. pratensis*
D. dentata associated with *F. sanguinea*
D. hagensi associated with *F. exsecta*
D. pygmaea associated with *F. fusca*

It is noteworthy that the first three *Dinarda'*s which are coloured red to dark brown are found with *Formica* species which show a similar colour pattern, while *D. pygmaea* is more uniformly dark gray, just like the host ant *F. fusca*. This conclusion may be premature, as *D. pygmaea* was also found with *F. rufibarbis* (Hölldobler, 2019). On the other hand, the other species were until now not found with *F. fusca*.

In 74 grids of 1 x 1 km, we recorded 490 specimens of *Drusilla canaliculata* (4.0-4.8 mm) (Annex)**.** This staphylinid beetle is ubiquitous present in nests of several genera of ants, *Formica*, *Lasius*, *Leptothorax*, *Myrmica*, *Ponera* and *Tetramorium* (Donisthorpe, 1915). Many species of ants associated with this beetle build a ground nest, which may explain why 97% of the individuals collected were caught with pitfall traps in the field and only a single specimen with a light trap. Whether *D. canaliculata* develops in ants' nests is not very clear, but larvae were also found in nests in addition to the adult beetles (Donisthorpe, 1927). It is certain that the beetle predates the ants, but it has also been observed that beetles are brought to the ant nests by the ants themselves.

Haploglossa gentilis (3.0-4.0 mm) and to a lesser extent *Haploglossa marginalis* (3.0-3.5 mm), was observed in several nest boxes of the common kestrel (*Falco tinnunculus* Linnaeus, 1758) (Struyve, 2006). Data obtained here can link these rove beetles to the colonies of the tree-dwelling ant species *L. fuliginosus.* An observation in the southeast of Limburg shows that

Fig. 25. *Dinarda dentata* (range 3.5-4.5 mm) with *Formica* sp. © Pavel Krásenský.

Haploglossa gentilis can be present in a large concentration in or near the nest of *L. fuliginosus*. From a hollow oak tree (*Quercus robur* L.), about 10 litres of pulverized wood was collected above a nest, from which 264 beetles were taken.

The rove beetle *Lomechusa emarginata* (3.5-4.5 mm) (Fig. 26D) uses the hospitality of two different species of ants during its development. From autumn to spring, as an adult beetle, it seeks shelter in a colony of Myrmicine ants while in early summer it searches for a red wood ant nest to lay eggs that will develop in this environment into a new generation of adult beetles. However, the beetles were not only found in red wood ant nests but were also observed with *F. fusca.* Donisthorpe (1927) repeatedly reported the presence of *F. fusca* as a host. He recorded several observations of this ant species in the months of April and May and found larvae in the months of June and July. In the same months, the beetles were also found in the nests of *F. rufa* and in April he observed workers of *F. fusca* carrying ten beetles into their nest during an hour and a half. During the winter months he noticed beetles in the nests of *Myrmica scabrinodis*, *M. ruginodis, M. rubra* and *M. sulcinodis*. It is suspected that the adult beetles stay near the Myrmicine ants during the winter months because of the presence of brood on which they can feed. In the lab, Donisthorpe (1927) found that when the beetles moved from the nest of a *Myrmica* sp. to that of a *Formica* sp., they remained in seclusion for twenty-four hours before entering the new nest. Apparently, the beetle first wants to get rid of a hostile *Myrmica* smell before confronting the new host. (Donisthorpe, 1927)

On May 24, 2007, we found a specimen of *L. emarginata* in Zutendaal (Lieteberg) in the nest of *M. ruginodis* built in a shady place under the moss. In this nest only eggs and larvae, but no nymphs of the host ant were present. Sietske and Sieger Verbeeck (two grandchildren of the first author) found a worker of *F. fusca* with this rove beetle between its jaws on 15 April 2009 at Hasselt Kiewit, which only confirms Donisthorpe's observations.

The genus *Pella* Stephens, 1835 contains 30 species distributed in the Palaearctic region (Maruyama, 2006) and six of these species have been observed in the province of Limburg: *P. funesta* (Gravenhorst, 1806) (Fig. 26E), *P. humeralis* (Gravenhorst, 1802), *P. cognata* (Märkel, 1842), *P. limbata* (Paykull, 1789), *P. lugens* (Gravenhorst, 1802) and *P. laticollis* (Märkel, 1845). The *Pella* beetles, included in this study are all associated with the dendrobiont ant *L. fuliginosus* as the main host. *P. humeralis* is also noticed with *F. rufa* and *F. pratensis* and in a few observations *P. lugens* is recorded in a nest of *L. brunneus*.

From observations both in the lab and in the field, Hölldobler *et al.,* (1981) gives us a description of the life cycle of *Pella funesta* and notes that this rove beetle deposits eggs, larvae and pupae on the garbage dumps of the ant, a nesting chamber where the attention of the ants is probably less vigilant. Foraging around the nest usually takes place at night. During the day these beetles take shelter. Most observers assume that they feed exclusively on dead ants and their waste, but nocturnal observations indicate that they are also present on the foraging trails of *L. fuliginosus* and that they attack, kill and eat living ants. In their feeding behaviour, the beetles are obviously opportunistic. As long as corpses are available, they will opt for the easy meal but during periods of scarcity they will switch more quickly to predatory behaviour by attacking ants. Accurate observation and biochemical research have revealed that in aggressive contact by the ants, the beetles can repel the attacks both by adapted behaviour, such as feigning death, and by releasing chemical compounds from abdominal glands. In the typical characteristics of these rove beetles, Hölldobler supposes preadaptations in the evolution towards a higher degree of myrmecophily (Hölldobler *et al*., 1981). A more recent study of three species of the genus *Pella*, *P. cognata*, *P. funesta* and *P. laticollis* reveals few specific differences both in behaviour and in chemical interaction between these beetles and ants with emphasis on the different reactions of *L. fuliginosus* in response to the dispersion of glandular secretions (Stoeffler *et al*., 2011).

The presence of the six species from the genus *Pella* in the locations where *L. fuliginosus* is observed, is clearly demonstrated in our long-term research. In the forest complex, Jagersborg, situated in Maaseik, the presence of a colony of *L. fuliginosus* was confirmed by the observation of a nest in a hollow birch. Sampling of invertebrates around this tree was performed from mid-April until mid-July by means of pitfalls and a window trap. *Pella cognata, P. humeralis, P. limbata* and *P. lugens* were captured in the same period and in the same vicinity. The presence of different species in the same neighbourhood is probably not uncommon. In another deciduous forest, Kolmontbos in Tongeren, we found three different rove beetles*: P. funesta, P. lugens* and *P. laticollis* by sieving the nesting material of *L. fuliginosus* from a hollow oak.

Two rove beetles closely related to *Pella* were also added to the list: *Zyras collaris* (Paykull, 1800) (4.0-5.0 mm), with thirteen specimens and *Z. haworthi* (Stephens, 1832) (5.5-7.0 mm) with three specimens (Annex). In a recent study only one for each of the two species was captured in Baden-Württemberg (Germany) and due to the observation of only 18 (*Z. collaris*) and ten (*Z. haworthi*) individuals between 1950 and 2000, the authors label them as 'two rare myrmecophilous species'. Their research was carried out on the chemicals from the tergal glands of this rove beetles with a remarkable conclusion. Analysis of the secretions (α-pinene, β-pinene, myrcene and limonene) of these glands and the reaction when confronted with the

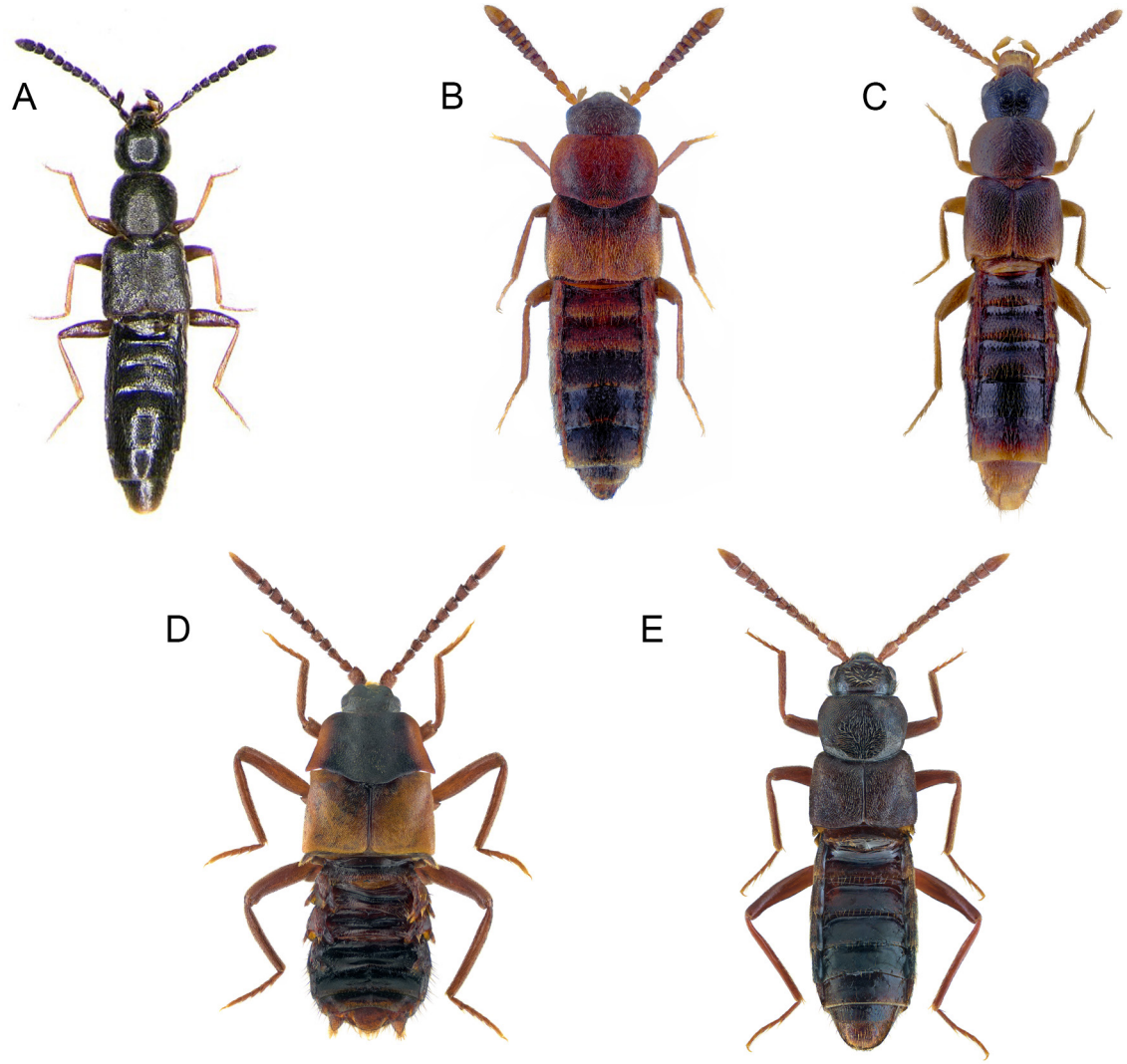

Fig. 26. **A**, *Aloconota gregaria* (Erichson, 1839) (range 2.7-3.8 mm). **B**, *Euryusa optabilis* Heer, 1839 (2.7 mm; range 2.5-3.0 mm). **C**, *Leptusa pulchella* (Mannerheim, 1830) (3.2 mm; range 2.7-3.2 mm). **D**, *Lomechusa emarginata* (Paykull, 1789) (4.5 mm; range 3.5-4.5 mm). **E**, *Pella funesta* (Gravenhorst, 1806) (5.2 mm; range 5.0-5.5 mm). © U. Schmidt.

presence of *L. fuliginosus* indicates that this is a unique composition. The researchers found no flight response or aggressive reaction in the ants when confronted with this secretion. The ants, on the contrary, showed a behaviour that they also exhibit when interacting with aphids. Since the identified terpenes are known to be present in some aphids as well as in their honeydew, it is assumed that these *Zyras* beetles mimic this composition in the pursuit of peaceful contact with the ants (Stoeffler *et al*., 2013). From literature we know that *Z. collaris* is associated with ants but not exclusively, while *Z. haworthi* is associated with *Lasius* and *Formica* species (Hastir & Haubruge, 2002).

Dasycerinae Reitter, 1887

Table 24. Observation of a dasycerine beetle that is mentioned in the literature to be associated with ants, with its correlated ant species on a specific point location in the province of Limburg.

Species	Number	UTM grid	Community	Tree	Host ant
Dasycerus sulcatus Brongniart, 1800	1	FS7130	Tongeren	*Quercus* sp.	lasibrun

Within the subfamily of Dasycerinae the only genus *Dasycerus* is represented by 17 mycophagous beetles. Besides four species from USA, the remaining species cover a wide range in the Palaearctic and Oriental region, with, as far as we know only *Dasycerus sulcatus* (1.9-2.3 mm) (Fig. 27) occurring in Belgium with expansion across Central Europe, France, and Italy (Löbl & Calame, 1996). The first notification were observations nearby the frontier with France (Coulon, 1987), supplemented with one recent mention from Buzenol in 2020 (Luxembourg – www.waarnemingen.be) and ever since no other publications have added new data. *D. sulcatus* is a litter-dwelling species, found on fruiting bodies of fungi. Only two specimens have been collected (Annex); Voeren (GS0227) in 2007 and one specimen observed by sifting the decayed wood of an old oak tree in Tongeren (2009) colonised by the ant *L. brunneus*.

Fig. 27. *Dasycerus sulcatus* Brongniart, 1800 (2.1 mm; range 1.9-2.3 mm). © U. Schmidt.

Habrocerinae Mulsant & Rey, 1877

Table 25. Observations of a habrocerine beetle that is mentioned in the literature to be associated with ants, with its correlated ant species on specific point locations in the province of Limburg.

Species	Number	UTM grid	Community	Tree	Host ant
Habrocerus capillaricornis (Gravenhorst, 1806)	10	FS8653	Dilsen-Stokkem	*Fagus* sp.	lasifuli
Habrocerus capillaricornis (Gravenhorst, 1806)	1	FS7130	Tongeren	*Fagus* sp.	lasifuli
Habrocerus capillaricornis (Gravenhorst, 1806)	1	FS7130	Tongeren	*Quercus* sp.	lasifuli

Of the 171 specimens of Habrocerinae in our database (Annex), 151 were collected sieving all types of vegetable refuse, and adults of *Habrocerus capillaricornis* (3.4-4.2 mm) (Fig. 28) were found throughout the year. Only the specimens collected from dead wood of trees (beech and oak) in Dilsen-Stokkem and Tongeren (Table 25) can be associated with *L. fuliginosus*.

Fig. 28. *Habrocerus capillaricornis* (Gravenhorst, 1806) (3.8 mm; range 3.4-4.2 mm). © U. Schmidt

Omaliinae MacLeay, 1825

Table 26. Observations of omaliine beetles that are mentioned in the literature to be associated with ants, with their correlated ant species on specific point locations in the province of Limburg.

Species	Number	UTM grid	Community	Tree	Host ant
Anthobium unicolor (Marsham, 1802)	1	FS8653	Dilsen-Stokkem	*Fagus* sp.	lasifuli
Anthobium unicolor (Marsham, 1802)	1	FS9352	Maasmechelen	*Populus* sp.	lasifuli
Anthobium unicolor (Marsham, 1802)	1	FS7130	Tongeren	*Quercus* sp.	lasibrun
Coryphium angusticolle Stephens, 1834	1	FS9352	Maasmechelen	*Populus* sp.	lasifuli
Dropephylla ioptera (Stephens, 1834)	1	FS7130	Tongeren	*Quercus* sp.	lasibrun
Dropephylla ioptera (Stephens, 1834)	1	FS7130	Tongeren	*Quercus* sp.	lasifuli
Omalium rivulare (Paykull, 1789)	5	FS7130	Tongeren	*Fagus* sp.	lasifuli
Phloeonomus punctipennis Thomson, 1867	1	FS7130	Tongeren	*Betula* sp.	lasibrun
Phloeostiba plana (Paykull, 1792)	2	GS0424	Voeren	*Alnus glutinosa*	lasibrun
Xylodromus affinis Gerhardt, 1877	1	FS7130	Tongeren	*Quercus* sp.	lasifuli

Omalium rivulare (3.0-4.0 mm) (Fig. 29 C) is described as the most common species of the genus and prefers warm summer evenings to disperse by flying. Consequently, this rove beetle has been captured in large numbers with flight-interception traps. But concentrations from ten to 39 individuals were also observed when sieving decaying mushrooms. The genus *Phloeonomus* Heer, 1839 is represented by three species in the province of Limburg: *P. minimus* (Erichson, 1839) (1.3-1.6 mm), *P. punctipennis* Thomson, 1867 (1.7-2.0 mm) (Fig. 29 D) and *P. pusillus* (Gravenhorst, 1806) (1.7-2.0 mm). We were only able to demonstrate the relationship with *L. brunneus* for *P. punctipennis*. *Phloeonomus minimus* is not as common as *P. punctipennis* but since both these species share the same biotope preference, namely deciduous forests, it is plausible that *P. minimus* could also be noticed in the vicinity of a nest of *L. brunneus*. *Phloeonomus pussilus*, on the other hand, is mainly bound to coniferous forests, which makes an association with *L. brunneus* less likely. The ant *L. brunneus* is common in deciduous forests but avoids dense coniferous forests (Siefert, 1992). *Xylodromus affinis* (3.2-3.7 mm) (Fig. 29 F) has been reported as a beetle living in the nests of the mole and the hamster (Sainte-Claire Deville, 1912). This may explain the fact that this rove beetle is only encountered sporadically

and is reported as rather rare. In Rullen (FS9922), a hamlet in the municipality of Voeren (Figure 2) one single specimen was captured with a subterranean pitfall trap (i.e., an 80 cm long PVC-tube with several perforations and a recipient at the bottom with a storage liquid, sunk directly into the soil) set up under a hornbeam (*Carpinus betulus* L. (1753)). The single observation near a nest of *L. fuliginosus* (Tongeren – Table 26) should therefore be assessed from this perspective.

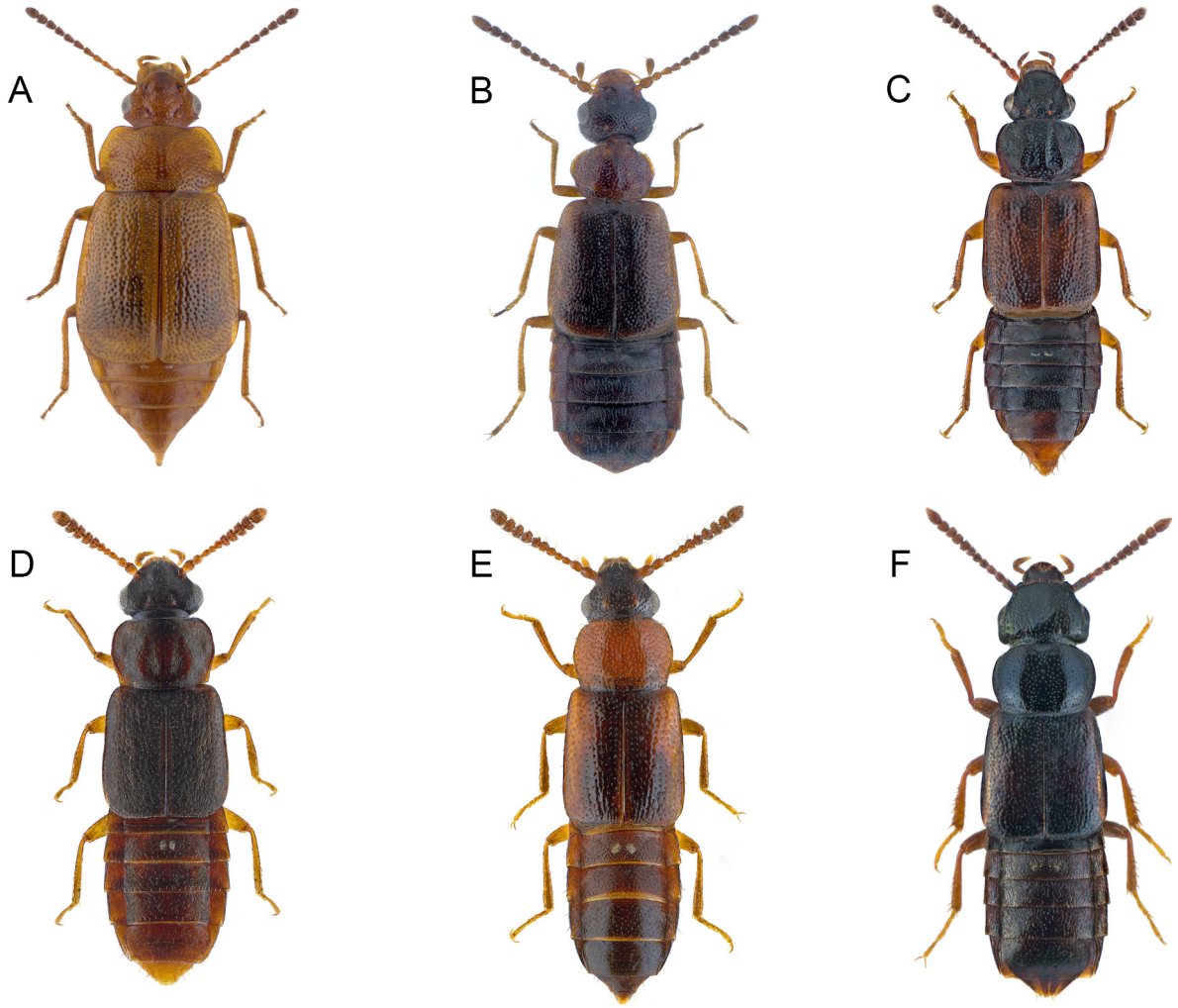

Fig. 29. **A**, *Anthobium unicolor* (Marsham, 1802) (3.5 mm; range 3.0-3.5 mm). **B**, *Coryphium angusticolle* Stephens, 1834 (3.0 mm; range 2.5-3.0 mm). **C**, *Omalium rivulare* (Paykull, 1789) (3.8 mm; range 3.0-4.0 mm). **D**, *Phloeonomus punctipennis* Thomson, 1867 (1.9 mm; range 1.7-2.0 mm). **E**, *Phyllodrepa ioptera* (Stephens, 1834)) (2.6 mm; range 2.5-3.0 mm). **F**, *Xylodromus affinis* (Gerhardt, 1877) (range 3.2-3.7 mm). © U. Schmidt.

Osoriinae Erichson, 1839

Table 27. Observation of an osoriine beetle that is mentioned in the literature to be associated with ants, with its correlated ant species on a specific point location in the province of Limburg.

Species	Number	UTM grid	Community	Tree	Host ant
Thoracophorus corticinus Motschulsky, 1837	5	FS9126	Voeren	*Malus* sp.	lasibrun

In Germany, *Thoracophorus corticinus* (2.8 mm) is designated as an Urwald relict species D category 2, which means that this beetle has high environmental requirements (MÜLLER, 2005). With two observations (Voeren – FS9126 and Voeren GS0227), both in an orchard, we cannot endorse this status. Nevertheless, sifting out of five specimens in a dead apple tree, inhabited by the ant *L. brunneus,* confirms the link between these two invertebrates as mentioned in the literature.

Oxytelinae Fleming, 1821

Table 28. Observations of oxyteline beetles that are mentioned in the literature to be associated with ants, with their correlated ant species on specific point locations in the province of Limburg.

Species	Number	UTM grid	Community	Tree	Host ant
Anotylus tetracarinatus (Block, 1799)	1	FS9626	Voeren	*Malus* sp.	lasibrun
Carpelimus pusillus (Gravenhorst, 1802)	1	FS7130	Tongeren	*Quercus* sp.	lasifuli
Coprophilus striatulus (Fabricius, 1792)	1	FS9727	Voeren	fruit tree	campfall, lasibrun, temnaffi
Coprophilus striatulus (Fabricius, 1792)	1	GS0227	Voeren	*Salix alba*	lasibrun, lasifuli

During our research, seven species of the genus *Anotylus* Thomson, 1859 were noted, of which two are recorded as being associated with ants (Annex). *Anotylus tetracarinatus* (1.7-2.2 mm) is described as the most common species of this genus and, moreover, is even considered the most common staphylinid beetle (Freude *et al.*, 1964). It is therefore noteworthy that in addition to the 2,680 specimens captured (Annex), only a single individual was noticed near an ant's nest, in this case *L. brunneus* which, on the other hand, may indicate that this combination is highly coincidental.

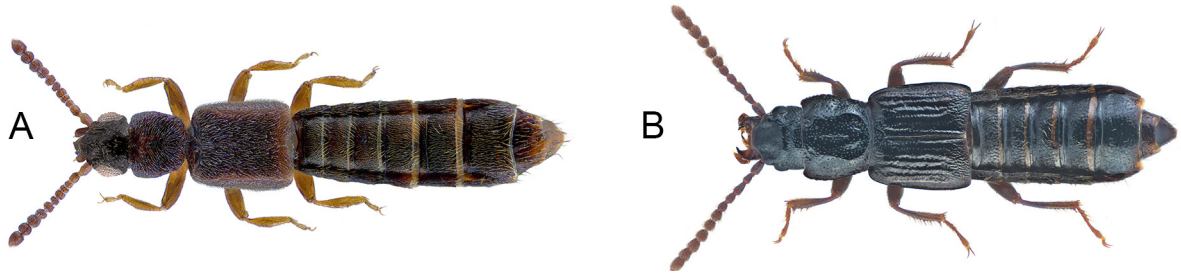

Fig. 30. **A**, Carpelimus pusillus (Gravenhorst, 1802) (1.8 mm; range 1.4-1.9 mm). **B**, Coprophilus striatulus (Fabricius, 1792) (7.2 mm; range 5.3-7.2 mm). © U. Schmidt.

Paederinae Fleming, 1821

Table 29. Observations of paederine beetles that are mentioned in the literature to be associated with ants, with their correlated ant species on specific point locations in the province of Limburg.

Species	Number	UTM grid	Community	Tree	Host ant
Medon brunneus (Erichson, 1839)	1	FS7130	Tongeren	*Fagus* sp.	lasifuli
Rugilus rufipes Germar, 1836	1	FS7130	Tongeren	*Betula* sp.	lasibrun

Medon brunneus (3.8-4.7 mm), like the other species within this genus, is often found in mouse burrows between the roots of old trees (Freude *et al.*, 1964), the same location where the ant *L. fuliginosus* builds its nest. In contrast, *Rugilus rufipes* (5.5-7.5 mm) (Fig. 31) is eurytopic and can be found among decaying vegetation and mushrooms, with no preference for dry or wet habitats.

Fig. 31. *Rugilus rufipes* Germar, 1836 (6.3 mm; range 5.5-7.5 mm). © U. Schmidt.

Proteininae Erichson, 1839

Table 30. Observations of a proteinine beetle that is mentioned in the literature to be associated with ants, with its correlated ant species on specific point locations in the province of Limburg.

Species	Number	UTM grid	Community	Tree	Host ant
Proteinus brachypterus (Fabricius, 1792)	1	FS7130	Tongeren	*Picea* sp.	lasifuli
Proteinus brachypterus (Fabricius, 1792)	1	FS7130	Tongeren	*Fagus* sp.	lasifuli

Proteinus brachypterus (1.5-1.9 mm) is a common beetle with a wide range in the western Palaearctic region which will be searched in any moist decaying organic matter. We noted 2,447 specimens in only 21 1 x 1 km grids (Annex) with the comment that this beetle can be locally very numerous. On 30 March 2017, the seventh author captured 1,958 individuals within an hour, using a vehicle-mounted car-net, in a mixed forest in Lanaken (FS8345).

Pselaphinae Latreille, 1802

Table 31. Observations of pselaphine beetles that are mentioned in the literature to be associated with ants, with their correlated ant species on specific point locations in the province of Limburg.

Species	Number	UTM grid	Community	Tree	Host ant
Amauronix maerkelii (Aubé, 1844)	1	FS7931	Genoelselderen	*Betula* sp.	temnnyla
Batrisodes buqueti (Aubé, 1833)	1	FS7338	Hoeselt	fruit tree	lasibrun, temnaffi
Batrisodes buqueti (Aubé, 1833)	1	FS7130	Tongeren	*Fagus* sp.	lasifuli
Batrisodes delaporti (Aubé, 1833)	1	FS7130	Tongeren	*Betula* sp.	lasibrun
Batrisodes delaporti (Aubé, 1833)	1	FS7130	Tongeren	*Fagus* sp.	lasifuli
Batrisodes delaporti (Aubé, 1833)	1	FS7130	Tongeren	*Quercus* sp.	lasibrun
Batrisodes delaporti (Aubé, 1833)	1	GS0227	Voeren	*Salix alba*	lasibrun
Batrisodes venustus (Reichenbach, 1816)	1	FS7130	Tongeren	*Betula* sp.	lasibrun
Batrisodes venustus (Reichenbach, 1816)	3	FS7130	Tongeren	*Fagus* sp.	lasifuli
Batrisodes venustus (Reichenbach, 1816)	1	FS7130	Tongeren	*Quercus* sp.	lasibrun
Batrisodes venustus (Reichenbach, 1816)	2	FS7130	Tongeren	*Quercus* sp.	lasifuli
Batrisus formicarius Aubé, 1833	9	FS9354	Dilsen-Stokkem	*Populus* sp.	lasibrun
Batrisus formicarius Aubé, 1833	2	FS7139	Kortessem	*Fagus* sp.	lasibrun
Batrisus formicarius Aubé, 1833	3	FS9253	Leut	*Quercus* sp.	lasibrun
Batrisus formicarius Aubé, 1833	2	FS7130	Tongeren	*Betula* sp.	lasibrun
Batrisus formicarius Aubé, 1833	3	FS7130	Tongeren	*Fagus* sp.	lasifuli
Batrisus formicarius Aubé, 1833	2	FS7130	Tongeren	*Quercus* sp.	lasibrun
Bibloporus bicolor (Denny, 1825)	1	FS7130	Tongeren	*Quercus* sp.	lasifuli
Bibloporus minutus Raffray,1914	2	FS7130	Tongeren	*Betula* sp.	lasibrun
Bryaxis curtisii curtisii (Leach, 1817)	3	FS7130	Tongeren	*Fagus* sp.	lasifuli
Bryaxis puncticollis (Denny, 1825)	2	FS7130	Tongeren	*Fagus* sp.	lasifuli
Claviger longicornis Müller, 1818	3	FS9354	Dilsen-Stokkem	*Fagus* sp.	lasibrun
Claviger longicornis Müller, 1818	21	FS9253	Leut	*Quercus* sp.	lasibrun
Claviger longicornis Müller, 1818	7	FS7130	Tongeren	*Quercus* sp.	lasifuli
Euplectus karstenii (Reichenbach, 1816)	1	FS7130	Tongeren	*Betula* sp.	lasibrun
Euplectus karstenii (Reichenbach, 1816)	1	FS7130	Tongeren	*Quercus* sp.	lasifuli
Euplectus nanus (Reichenbach, 1816)	5	FS7130	Tongeren	*Betula* sp.	lasibrun

Species	Number	UTM grid	Community	Tree	Host ant
Euplectus nanus (Reichenbach, 1816)	1	FS9626	Voeren	*Malus* sp.	lasibrun
Euplectus piceus Motschulsky, 1835	20	FS7130	Tongeren	*Betula* sp.	lasibrun
Euplectus piceus Motschulsky, 1835	30	FS7130	Tongeren	*Quercus* sp.	lasifuli
Euplectus punctatus Mulsant & Rey, 1861	1	FS7130	Tongeren	*Picea* sp.	lasifuli
Trichonyx sulcicollis (Reichenbach, 1816)	1	FS7130	Tongeren	*Quercus* sp.	lasifuli

The five species of the genus *Batrisodes* Reitter, 1882 present in the province of Limburg, are all related to ants (Annex) and will rarely be found outside their nests. None of these beetles are very common in our research area and usually a single specimen was collected at a visited location. With only nine individuals found in our flight-interception traps their dispersion seems rather limited. *Batrisodes venustus* (2.0-2.2 mm) (Fig. 32 A) is probably the most eurytopic species within this genus in choosing shelter in ant nests (Annex). *Batrisus formicarius* (3.0-3.5 mm) is rather rare and 93% of all these rove beetles were collected sieving decayed wood from dead trees (Crêvecoeur *et al*., 2004). *Claviger longicornis* (2.4-2.7 mm) would occur mainly in the nests of *L. umbratus* (Donisthorpe, 1927; Freude *et al*., 1974). This could explain the few locations where this beetle was found throughout the province of Limburg because this guest ant has a subterranean way of life, sometimes nesting 'under deeply embedded heavy stones' (Donisthorpe, 1927), and the nests are not easily found. However, recently, in August 2022, we collected 21 specimens sieving the wood dust from an old oak tree in a historic castle park in Leut (Table 31). Another pselaphine beetle which is exclusively associated with ants, is *Amauronix maerkelii* (Aubé, 1844) (1.9-2.2 mm), connected with a wide range of guest ants (Annex). Our data contains only a single record, a specimen collected sieving dead wood from a birch in the Grootbos in the municipality Genoelselderen.

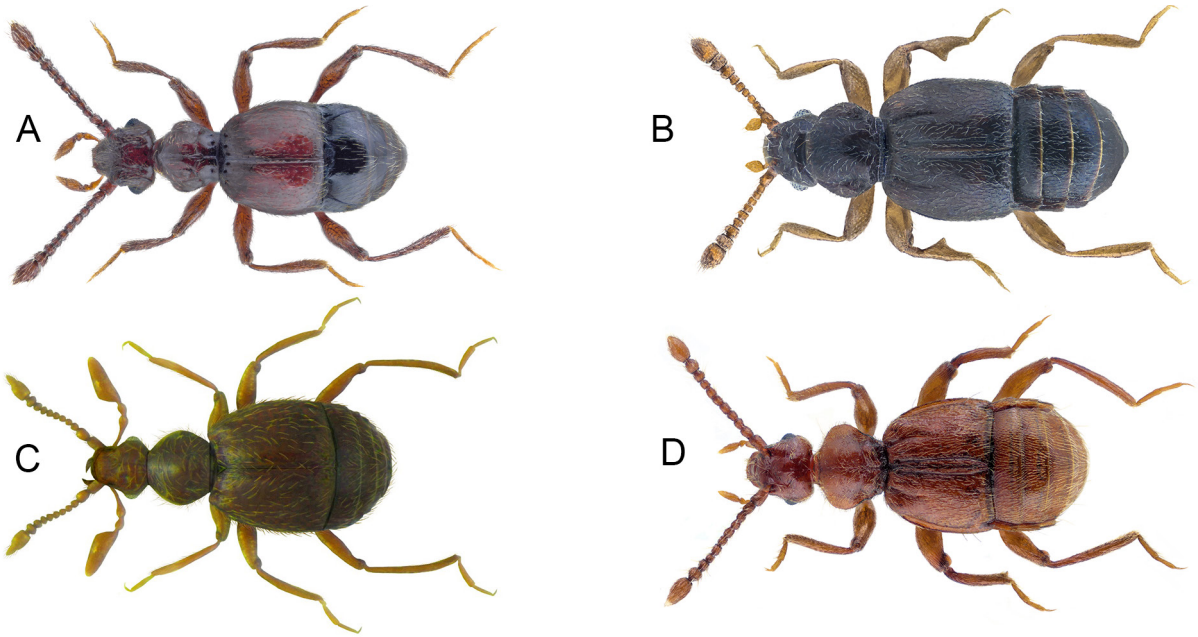

Fig. 32. **A**, *Batrisodes venustus* (Reichenbach, 1816) (2.0 mm; range 2.0-2.2 mm). **B**, *Bibloporus bicolor* (Denny, 1825) (1.2 mm; range 1.2-1.4 mm). **C**, *Bryaxis curtisii* (Leach, 1817) (range 1.45-1.65 mm). **D**, *Trichonyx sulcicollis* (Reichenbach, 1816) (2.9 mm; range 2.5-3.0 mm). © U. Schmidt.

Scaphidiinae Latreille, 1807

Table 32. Observations of a scaphidiine beetle that is mentioned in the literature to be associated with ants, with its correlated ant species on a specific point location in the province of Limburg.

Species	Number	UTM grid	Community	Tree	Host ant
Scaphisoma boleti (Panzer, 1793)	1	GS0424	Voeren	*Alnus glutinosa*	lasibrun

As fungivore, *Scaphisoma boleti* (1.7-2.1 mm) (Fig. 33) will be found in moist decaying wood with a preference for deciduous trees and could occasionally be observed with ants on the same tree.

Fig. 33. *Scaphisoma boleti* (Panzer, 1793) (1.9 mm). © U. Schmidt.

Scydmaeninae Leach, 1815

Table 33. Observations of scydmaenine beetles that are mentioned in the literature to be associated with ants, with their correlated ant species on specific point locations in the province of Limburg.

Species	Number	UTM grid	Community	Tree	Host ant
Cephennium gallicum Ganglbauer, 1899	10	FS7130	Tongeren	*Betula* sp.	lasibrun
Cephennium gallicum Ganglbauer, 1899	3	FS7130	Tongeren	*Fagus* sp.	lasifuli
Cephennium gallicum Ganglbauer, 1899	4	FS7130	Tongeren	*Picea* sp.	lasifuli
Cephennium gallicum Ganglbauer, 1899	1	FS7130	Tongeren	*Quercus* sp.	lasibrun
Cephennium gallicum Ganglbauer, 1899	9	FS7130	Tongeren	*Quercus* sp.	lasifuli
Neuraphes carinatus Mulsant & Rey, 1861	2	FS7130	Tongeren	*Quercus* sp.	lasibrun
Neuraphes elongatulus (Müller & Kunz, 1822)	4	FS7130	Tongeren	*Quercus* sp.	lasifuli
Neuraphes praeteritus (Rye, 1872)	1	FS7130	Tongeren	*Fagus* sp.	lasifuli
Scydmaenus perrisi (Reitter, 1879)	7	FS9354	Dilsen-Stokkem	*Populus* sp.	lasibrun
Scydmaenus perrisi (Reitter, 1879)	30	FS9253	Leut	*Quercus* sp.	lasibrun
Scydmaenus perrisi (Reitter, 1879)	8	FS7130	Tongeren	*Betula* sp.	lasibrun
Scydmaenus perrisi (Reitter, 1879)	29	FS7130	Tongeren	*Fagus* sp.	lasifuli
Stenichnus godarti (Latreille, 1806)	7	FS7130	Tongeren	*Betula* sp.	lasibrun
Stenichnus godarti (Latreille, 1806)	2	FS7130	Tongeren	*Quercus* sp.	lasifuli
Stenichnus scutellaris (Müller & Kunz, 1822)	1	FS7130	Tongeren	*Fagus* sp.	lasifuli

All specimens of *Cephennium gallicum* (1.3-1.5 mm) (Fig. 34A) were sampled in deciduous forests and 89% by sieving mushrooms and decaying plant material. In the entire province, not a single individual was captured with a flight-interception trap. The three species of the genus *Neuraphes* Thomson, 1859 also prefer the presence of broadleaf trees and none of these beetles

was found near coniferous trees. Only *Stenichnus scutellaris* (1.4-1.5 mm) was noted in flight interception samples.

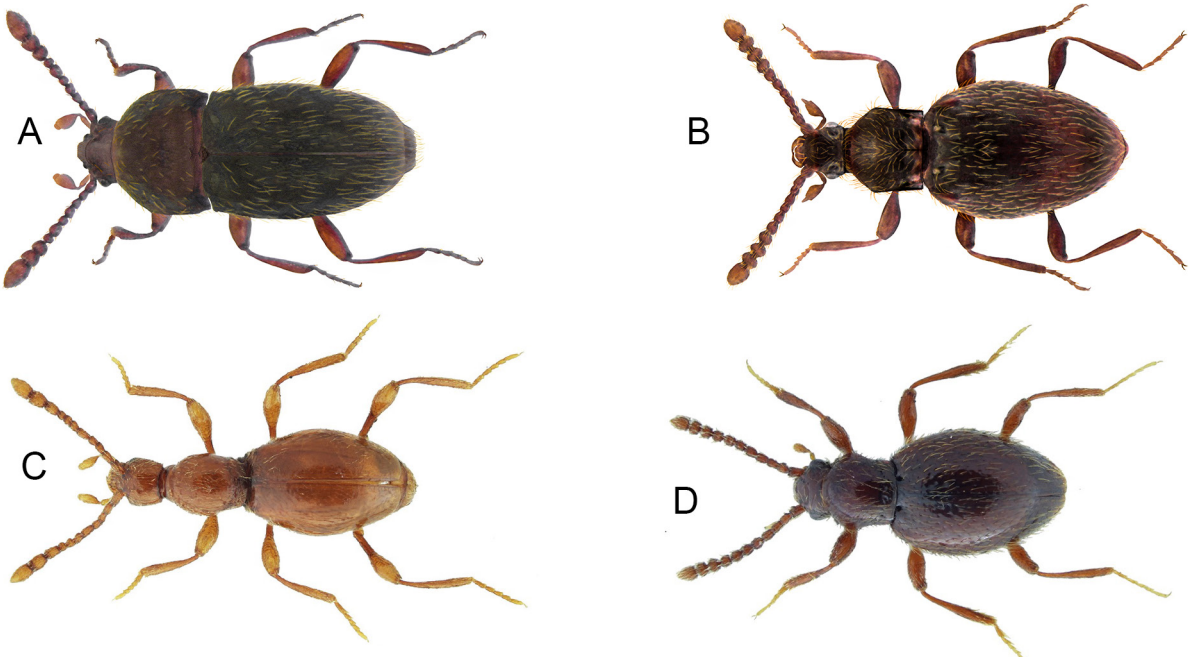

Fig. 34. **A**, *Cephennium gallicum* Ganglbauer, 1899 (range 1.3-1.5 mm). © U. Schmidt. **B**, *Neuraphes elongatulus* (P.J.W. Müller & Kunze, 1822) (range 1.4-1.5 mm). © U. Schmidt**. C**, *Scydmaenus perrisi* (Reitter, 1879) (1.8 mm), © Ignace David. **D**, *Stenichnus godarti* (Latreille, 1806) (1.7 mm), © Ignace David.

Staphylininae Latreille, 1802

Table 34. Observations of staphylinine beetles that are mentioned in the literature to be associated with ants with their correlated ant species on specific point locations in the province of Limburg.

Species	Number	UTM grid	Community	Tree	Host ant
Atrecus affinis (Paykull, 1789)	1	FS7130	Tongeren	*Betula* sp.	lasibrun
Atrecus affinis (Paykull, 1789)	1	FS7130	Tongeren	*Picea* sp.	lasifuli
Atrecus affinis (Paykull, 1789)	2	FS9526	Voeren	*Quercus robur*	temnaffi
Bisnius subuliformis (Gravenhorst, 1802)	1	FS7035	Kortessem	fruit tree	lasibrun, temnaffi
Bisnius subuliformis (Gravenhorst, 1802)	1	FS9626	Voeren	*Malus* sp.	lasibrun
Gyrohypnus angustatus Stephens, 1833	1	FS9352	Maasmechelen	*Populus* sp.	lasifuli
Hypnogyra angularis (Ganglbauer, 1895)	2	FS4648	Halen	fruit tree	lasibrun, temnaffi
Hypnogyra angularis (Ganglbauer, 1895)	4	FS5528	Sint-Truiden	fruit tree	lasibrun
Hypnogyra angularis (Ganglbauer, 1895)	2	FS7130	Tongeren	*Betula* sp.	lasibrun
Hypnogyra angularis (Ganglbauer, 1895)	2	FS7130	Tongeren	*Fagus* sp.	lasifuli
Hypnogyra angularis (Ganglbauer, 1895)	1	FS9626	Voeren	*Malus* sp.	lasibrun
Othius subuliformis Stephens, 1833	8	FS7130	Tongeren	*Quercus* sp.	lasifuli
Quedius cruentus (Olivier, 1795)	1	FS7735	Bilzen	fruit tree	lasibrun, temnaffi
Quedius cruentus (Olivier, 1795)	1	FS6840	Diepenbeek	fruit tree	temnaffi
Quedius cruentus (Olivier, 1795)	1	FS6626	Heers	fruit tree	lasibrun

Species	Number	UTM grid	Community	Tree	Host ant
Quedius cruentus (Olivier, 1795)	1	FS5130	Sint-Truiden	fruit tree	lasibrun, temnaffi
Quedius cruentus (Olivier, 1795)	1	FS5528	Sint-Truiden	fruit tree	lasibrun
Quedius cruentus (Olivier, 1795)	1	FS9526	Voeren	*Quercus robur*	temnaffi
Quedius dilatatus (Fabricius, 1787)	2	FS9526	Voeren	*Quercus robur*	temnaffi
Quedius fumatus (Stephens, 1833)	1	FS7130	Tongeren	*Picea* sp.	lasifuli
Quedius mesomelinus (Marsham, 1802)	1	FS5528	Sint-Truiden	fruit tree	lasibrun
Quedius mesomelinus (Marsham, 1802)	2	FS9526	Voeren	*Quercus robur*	temnaffi
Quedius mesomelinus (Marsham, 1802)	1	FS9825	Voeren	*Salix alba*	lasibrun
Quedius nigrocauruleus Fauvel, 1876	1	FS6732	Borgloon	fruit tree	lasibrun, temnaffi
Quedius ochripennis (Ménétriés, 1832)	1	FS6732	Borgloon	fruit tree	lasibrun, temnaffi
Quedius scitus (Gravenhorst, 1806)	1	FS4648	Halen	fruit tree	lasibrun, temnaffi
Quedius scitus (Gravenhorst, 1806)	3	FS9526	Voeren	*Quercus robur*	temnaffi
Tasgius ater (Gravenhorst, 1802)	1	FS6629	Borgloon	fruit tree	lasibrun, temnaffi
Tasgius ater (Gravenhorst, 1802)	1	FS7131	Tongeren	fruit tree	lasibrun, temnaffi
Tasgius ater (Gravenhorst, 1802)	1	FS9727	Voeren	*Malus* sp.	lasibrun

The genus *Quedius* Stephens, 1829 is strongly represented in the surveyed area with 36 species. *Quedius cruentus* (8.0-10.0 mm) is the dominant species with 608 individuals dispersed over 66 grids, while *Q. invreae* (8.0-11.0 mm) and *Q. maurus* (6.0-9.0 mm) both with a single specimen

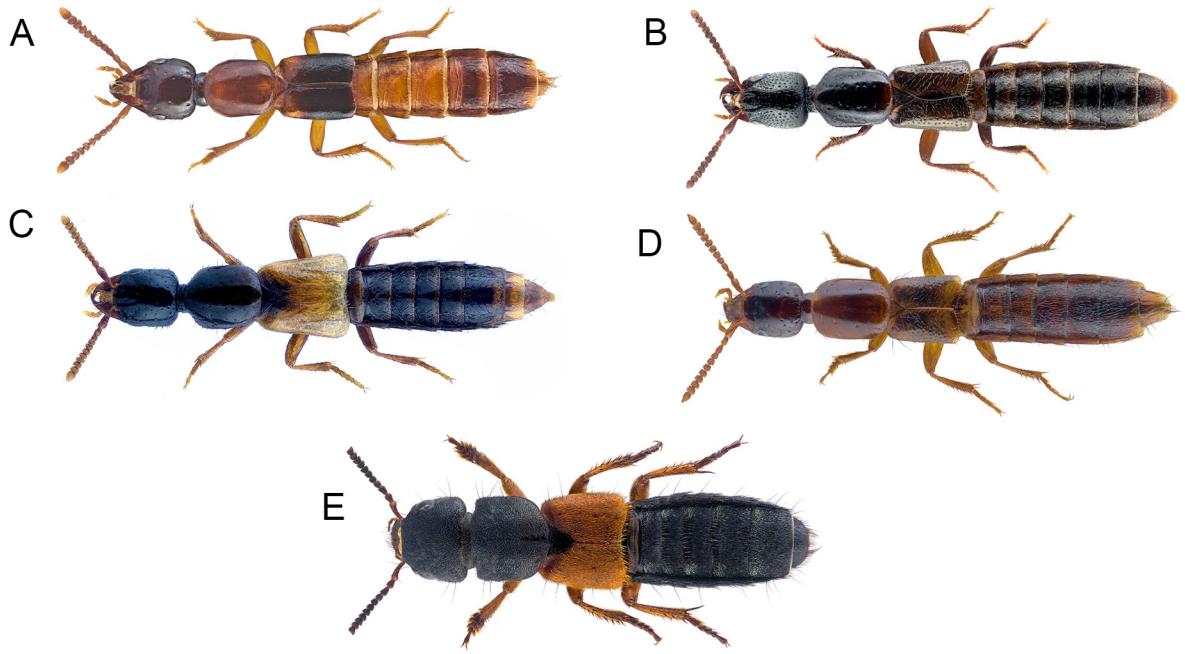

Fig. 35. **A**, *Atrecus affinis* (Paykull, 1789) (range 6.0-7.5 mm). **B**, *Gyrohypnus angustatus* Stephens, 1833 (7.2 mm; range 6.0-8.5 mm). **C**, *Hypnogyra angularis* (Ganglbauer, 1895) (7.0 mm; range 7.0-9.0 mm). **D**, *Othius subuliformis* Stephens, 1833 (6.1 mm; range 4.5-7.2 mm). **E**, *Platydracus stercorarius* (Olivier, 1795) (15.3 mm; range 13.0-18.0 mm). © U. Schmidt.

in a single location are both reported as rare (Annex). They all are predators that seek easy prey in nests of both mammals and hymenoptera.

Ninety-two individuals of *Platydracus stercorarius* (Olivier, 1795) (Fig. 35E) have been found in 30 1 x 1 km squares, with 83 collected with pitfall traps (Annex). *Platydracus stercorarius* is an impressive rove beetle reaching 20 mm and is associated with *Tetramorium caespitum, F. rufa* and several species of the genus *Myrmica* and *Lasius* (Päivinen, 2002). According to Donisthorpe (1927) this beetle penetrates the ant nests to feed on the ants and their brood. It is worth mentioning the fact that it is the only myrmecophilous beetle ever found in the nests of our rare slave-making Amazon ant *Polyergus rufescens* (Latreille, 1798) (André, 1874, p. 213). Two locations where this rove beetle has been observed, Hageven in Pelt and De Teut in Zonhoven, are two of the five areas in Belgium where likewise the rare Amazon ant is found (Dekoninck *et al*., 2001; Vankerkhoven *et al*., 2021).

Tachyporinae MacLeay, 1825

Table 35. Observations of tachyporine beetles that are mentioned in the literature to be associated with ants, with their correlated ant species on specific point locations in the province of Limburg.

Species	Number	UTM grid	Community	Tree	Host ant
Lordithon trinotatus (Erichson, 1839)	1	FS7130	Tongeren	*Quercus* sp.	lasifuli
Sepedophilus bipunctatus (Gravenhorst, 1802)	4	FS9626	Voeren	*Malus* sp.	lasibrun
Sepedophilus testaceus (Fabricius, 1792)	1	FS7130	Tongeren	*Betula* sp.	lasibrun
Sepedophilus testaceus (Fabricius, 1792)	1	FS7130	Tongeren	*Fagus* sp.	lasifuli
Tachinus rufipes (Linnaeus, 1758)	1	FS7130	Tongeren	*Quercus* sp.	lasifuli
Tachyporus hypnorum (Fabricius, 1775)	1	FS7130	Tongeren	*Quercus* sp.	lasibrun
Tachyporus nitidulus (Fabricius, 1781)	1	FS9127	Voeren	*Malus* sp.	lasibrun
Tachyporus pusillus Gravenhorst, 1806	14	FS7130	Tongeren	*Quercus* sp.	lasifuli
Tachyporus solutus Erichson, 1839	1	FS7130	Tongeren	*Picea* sp.	lasifuli

Sepedophilus bipunctatus (2.0-2.8 mm) and *S. testaceus* (3.5-5.0 mm) (Fig. 36A) are not very common in Limburg (Annex) and most specimens are collected sieving decomposing plant material. Only 25% of the sampled individuals of *S. bipunctatus* and 7.5% of *S. testaceus* have been captured with flight-interception traps with, in addition, a single or just a few specimens per set-up. All the species we selected from the genus *Tachyporus* Gravenhorst, 1802 are common in the province of Limburg (Annex). *Tachyporus hypnorum* (3.1-4.0 mm) (Fig. 36B) is a predator that, during nocturnal foraging, feeds on aphids, a common food source shared with the xylobiont ant *L. brunneus*.

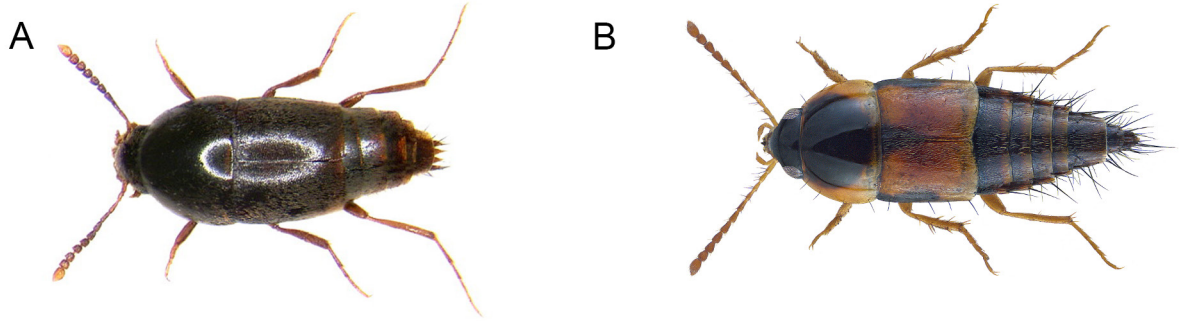

Fig. 36. **A**, *Sepedophilus testaceus* (Fabricius, 1793) (range 3.5-5.0 mm). **B**, *Tachyporus hypnorum* (Fabricius, (1775) (3.8 mm; range 3.1-4.0 mm). © U. Schmidt.

Tenebrionidae Latreille, 1802

Table 36. Observation of tenebrionidid beetles that are mentioned in the literature to be associated with ants, with their correlated ant species on specific point locations in the province of Limburg. - * sieving top layer of the nest- ** sieving nesting material 20 cm under top layer of the nest.

Species	Number	UTM grid	Community	Tree	Host ant
Corticeus unicolor Piller & Mitterpacher, 1783	1	FS9626	Voeren	*Malus* sp.	lasibrun
Diaclina fagi (Panzer, 1799)	6	FS9626	Voeren	*Malus* sp.	lasibrun
Diaperis boleti (Linnaeus, 1758)	1	FS5130	Sint-Truiden	fruit tree	lasibrun, temnaffi
Diaperis boleti (Linnaeus, 1758)	1	FS9725	Voeren	*Malus* sp.	lasibrun, lasifuli
Diaperis boleti (Linnaeus, 1758)	1	FS9727	Voeren	fruit tree	campfall, lasibrun, temnaffi
Eledona agricola (Herbst, 1783)	14	FS9725	Voeren	*Malus* sp.	lasibrun, lasifuli
Mycetochara maura (Fabricius, 1792)	2	FS7338	Hoeselt	fruit tree	lasibrun, temnaffi
Mycetochara maura (Fabricius, 1792)	1	FS7035	Kortessem	fruit tree	lasibrun, temnaffi
Mycetochara maura (Fabricius, 1792)	1	FS9626	Voeren	*Malus* sp.	lasibrun
Myrmechixenus subterraneus Chevrolat, 1835	1	FS7349	Genk	nest	forcsang*
Myrmechixenus subterraneus Chevrolat, 1835	1	FS7754	Zwartberg	nest	forcprat**
Nalassus laevioctostriatus (Goeze, 1777)	4	FS8653	Dilsen-Stokkem	*Fagus* sp.	lasifuli
Palorus ratzeburgii (Wissmann, 1848)	1	FS9626	Voeren	*Malus* sp.	lasibrun
Pentaphyllus testaceus (Hellwig, 1792)	8	FS6732	Borgloon	fruit tree	lasibrun, temnaffi
Pentaphyllus testaceus (Hellwig, 1792)	1	FS5427	Sint-Truiden	broadleaf tree	lasifuli
Pentaphyllus testaceus (Hellwig, 1792)	1	FS9626	Voeren	*Malus* sp.	lasibrun
Prionychus ater (Fabricius, 1775)	1	FS7735	Bilzen	fruit tree	lasibrun, temnaffi
Prionychus ater (Fabricius, 1775)	1	FS6529	Borgloon	fruit tree	lasibrun, lasifuli, temnaffi
Prionychus ater (Fabricius, 1775)	1	FS9127	Voeren	*Malus* sp.	lasibrun
Pseudocistela ceramboides (Linnaeus, 1758)	1	FS9127	Voeren	*Malus* sp.	lasibrun
Pseudocistela ceramboides (Linnaeus, 1758)	1	GS0024	Voeren	*Malus* sp.	lasibrun
Pseudocistela ceramboides (Linnaeus, 1758)	1	GS0424	Voeren	*Alnus glutinosa*	lasibrun
Scaphidema metallica (Fabricius, 1792)	1	FS7130	Tongeren	*Quercus* sp.	lasifuli

The darkling beetles we collected in the vicinity of ants, vary widely in size. *Myrmechixenus subterraneus* (1.3-1.6 mm) is the smallest compared to the largest *Prionychus ater* (12.0-14.0 mm). *Myrmechixenus subterraneus* appears not to be strictly tied to a single guest ant but has been associated with several species of the genera *Formica* and *Lasius*. One might then expect it to be the most common beetle because it has few demands on the microbiotope, but with only three 1 x 1 km grids the opposite is true (Annex). From *Pseudocistela ceramboides*

(10.0-12.0 mm) it is claimed that this darkling beetle prefers oak forests (Freude, 1969), but in addition to pedunculate oak, we have found this species on a wide variety of trees: alder, apple, ash, beech, cherry, elder, hornbeam, linden, pear, Scots pine and poplar. *Diaperis boleti* (6.0-8.0 mm) and *Eledona agricola* (2.2-2.5 mm) are both often observed sieving old mushrooms.

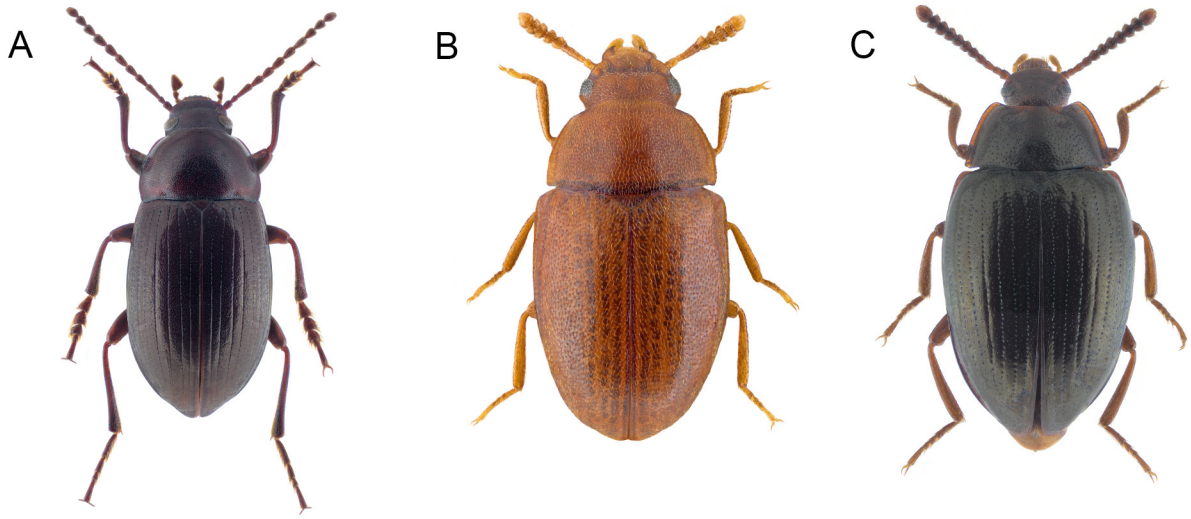

Fig. 37. **A**, *Nalassus laevioctostriatus* (Goeze, 1777) (9.9 mm; range 7.0-11.0 mm). **B**, *Pentaphyllus testaceus* (Hellwig, 1792) (2.0 mm; range 1.5-2.0 mm). **C**, *Scaphidema metallicum* (Fabricius, 1793) (5.0 mm; range 4.0-5.0 mm). © U. Schmidt.

Throscidae Laporte, 1840

Table 37. Observation of a throscidid beetle that is mentioned in the literature to be associated with ants, with its correlated ant species on specific point locations in the province of Limburg.

Species	Number	UTM grid	Community	Tree	Host ant
Aulonothroscus brevicollis (de Bonvouloir, 1859)	2	FS5130	Sint-Truiden	fruit tree	lasibrun, temnaffi
Aulonothroscus brevicollis (de Bonvouloir, 1859)	1	FS7130	Tongeren	*Fagus* sp.	lasifuli

Aulonothroscus brevicollis (2.5-3.3 mm) (Fig. 38) is a common species in deciduous forests with older trees and can be locally very abundant. In the Kolmontbos, where one specimen was found near a nest of *L. fuliginosus* (Table 37), we collected 26% of all individuals from our database using adhesive tapes wrapped around the trunk of dead trees (beech and oak).

Fig. 38. *Aulonothroscus brevicollis* (de Bonvouloir, 1859) (2.9 mm; range 2.5-3.3 mm). © U. Schmidt.

Araneae

Table 38. Overview of the species of the Araneae that are mentioned in the literature to be associated with ants, with the number of the collected specimens, the number of 1 x 1 km grids of observation in the province of Limburg and the encrypted name of the host ant according to the consulted literature.

Species	Number	Number of UTM grid	Host ant
Acartauchenius scurrilis (O.P. -Cambridge, 1872)	13	9	forcrufa, lasiflav, tetrcaes
Mastigusa arietina (Thorell, 1871)	2	2	forcfusc, forcpoly, forcrufa, lasibrun, lasinige, lasifuli, lasiumbr, temnnyla, tetrcaes
Myrmarachne formicaria (De Geer, 1778)	343	72	forccuni, forcrufi, forcrufa, mymirubr, mymiscab
Thyreosthenius biovatus (O.P. -Cambridge, 1875)	2	2	forcfusc, forcpoly, forcprat, forcrufa
Zodarion italicum (Canestrini, 1868)	10	3	Formicidae
Zodarion rubidum Simon, 1914	786	22	Formicidae

Despite their ubiquity, ants are not the main prey of spiders due to the aggressive behaviour these social insects generally display towards other arthropods. From our large-scale survey we selected six myrmecophagous spiders, described in the literature in association with ants. Of these six spiders *Acartauchenius scurilis* and *Mastigusa arietina* received the status endangered in Belgium, *Thyreosthenius biovatus* is labeled critical and *Zodarium rubidum* is noticed as a species with rare geographically restrictions (Maelfait *et al*., 1998). With only sporadic reports of *T. biovatus* (Table 38), the status of this species is considered critical to which Thomas Parmentier countered that a close monitoring of the mounds of the red wood ants, shows that this spider has probably a much wider distribution (Parmentier *et al*., 2015).

To indicate the possible relationship between the spiders and ants, we selected from our field observations these data where both groups were found in the same trap, emphasising that 88% were pitfall traps (Table 39). Within the range of action of the foraging spiders and ants, this shows occupancy of both groups within the same restricted circumference. In our table (Table 39), we have marked the winged females and males in red because their dispersal behaviour during the nuptial flight may fall outside the action radius of the workers. These observations also teach us that the ant-mimicking spider *Myrmarachne formicaria* is not only the most common species of this selection but also a generalist in terms of its association with ants (Table 38 & 39).

The preference for ants as prey has been experimentally demonstrated in the zodariid spider *Zodarion rubidium*, of which the female is 3.5–4.5 mm in size and with a light orange cephalothorax and legs, contrasting with a dark sepia abdomen resembles the myrmicid ants such a*s M. sabuleti*. In an experimental setup, ants from the genera *Camponotus* Mayr, 1861, *Formica* Linnaeus, 1758, *Lasius* Fabricius, 1804, *Monomorium* Mayr, 1855, *Myrmica* Latreille, 1804, *Plagiolepis* Mayr, 1861, *Solenopsis* Westwood, 1840, *Tapinoma* Foerster, 1850 and *Tetramorium* Mayr, 1855, were offered as food. In addition, the spiders also gained access to other invertebrates such as termites, beetles, aphids, silverfish, flies, crickets, and grasshoppers. Except for the termites, only ants were consumed, a preference that the researcher was also able to establish in the field (Pekár, 2004). All *Zodarion* spp. are defined as obligate myrmecophages

and the researchers go so far as to state that without the food supply of ants, these species would not survive (Cushing, 2012).

In the 22 investigated UTM grids where *Z. rubidum* was collected with pitfall traps, the two ant species that are the main food source (Pekár & Křál, 2002), *L. platythorax* (sampled in 17 joined grids) and *T. caespitum* (sampled in 16 joined grids) were also present. In their discussion of *Z. rubidium*, Pekár and Král strongly emphasize the morphological similarity with *M. sabuleti* and argue that the range of this spider matches that of *M. sabuleti* (Pekár & Křál, 2002). During our survey, *M. sabuleti* was found in 20 of the 34 pitfall traps in which *Z. rubidum* was caught but this number was exceeded by *T. caespitum* with 22 observations. In aggressive contact with the ants, *Z. rubidum* will avoid confrontation by tapping the ant's antennae with its first pair of legs and protruding an already captured prey in front of it (Pekár & Křál, 2002). Probably all *Zodarion* spp. have a femoral organ, an external structure of modified hairs situated at the distal tip of the femora combined with an exocrine gland. The researchers are speculating about the role of the secretion of the gland, but it might be a volatile substance to subdue attacking ants (Pekár & Šobotník, 2007).

Together with *L. brunneus* and *T. nylanderi*, we collected the endangered *Mastigusa arietina* in the municipality Houthalen (FS7353) by sieving wood dust from a hollow beech (Table 39). Moreover, this spider was also observed in the nests of *L. flavus* and *L. niger* (Bonte *et al*., 2000) and during surveys in northwest Belgium, the species was collected in two nests of *L. fuliginosus* and in one nest of *T. caespitum* (Parmentier *et al.,* 2022).

Fig. 39. *Myrmarachne formicaria* (De Geer, 1778) (range 5.0-6.5 mm). Public domain https://www.inaturalist.org/photos/76645906

Table 39. List of ants captured in the same traps as the spiders discussed in this paper. The species marked in red were only collected as alate females or males together with the spiders. Abbreviations: acarscur, *Acartauchenius scurrilis;* mastarie, *Mastigusa arietina;* myrmform, *Myrmarachne formicaria;* thyrbiov, *Thyreostenius biovatus;* zodaital, *Zodarion italicum;* zodarubi, *Zodarion rubidium*.

	acarscur	mastarie	myrmform	thyrbiov	zodaital	zodarubi
Anergates atratulus (Schenck, 1852) *	x		x			
Formica cunicularia Latreille, 1798	x		x	x	x	x
Formica fusca Linnaeus, 1758			x		x	x
Formica picea Nylander, 1846			x			
Formica polyctena Förster, 1850			x			
Formica pratensis Retzius, 1783	x		x	x		x
Formica rufa Linnaeus, 1761			x			
Formica rufibarbis Fabricius, 1793	x		x	x	x	x
Formica sanguinea Latreille, 1798	x		x			x
Hypoponera punctatissima (Roger, 1859)			x			
Lasius alienus (Förster, 1850)			x			
Lasius brunneus (Latreille, 1798)		x	x			x
Lasius flavus (Fabricius, 1782)			x		x	x
Lasius fuliginosus (Latreille, 1798)			x	x	x	x
Lasius meridionalis (Bondroit, 1920)	x		x		x	x
Lasius mixtus (Nylander, 1846)			x			x
Lasius niger (Linnaeus, 1758)			x			x
Lasius platythorax Seifert, 1991	x		x	x		x
Lasius psammophilus Seifert, 1992	x		x			
Lasius sabularum (Bondroit, 1918)	x		x			
Lasius umbratus (Nylander, 1846)	x		x		x	x
Leptothorax acervorum (Fabricius, 1793)			x	x		
Myrmecina graminicola (Latreille, 1802)	x		x		x	x
Myrmica gallienii Bondroit, 1920			x			
Myrmica lonae Finzi, 1926			x			x
Myrmica rubra (Linnaeus, 1758)	x		x	x		x
Myrmica ruginodis Nylander, 1846	x		x	x		x
Myrmica rugulosa Nylander, 1849			x			x
Myrmica sabuleti Meinert, 1861	x		x	x	x	x
Myrmica scabrinodis Nylander, 1846	x		x	x	x	x
Myrmica schencki Viereck, 1903	x		x	x		x
Ponera coarctata (Latreille, 1802)			x			x
Solenopsis fugax (Latreille, 1798)	x		x			
Stenamma debile (Förster, 1850)			x			x
Strongylognathus testaceus (Schenck, 1852)	x		x			x
Tapinoma subboreale Seifert, 2012	x		x			
Temnothorax affinis (Mayr, 1855)			x			x
Temnothorax nylanderi (Förster, 1850)	x	x	x			x
Tetramorium caespitum (Linnaeus, 1758)	x		x		x	x

Conclusion

Without a species-specific, intense study, it is not an easy task to define an invertebrate, found in or near the nest of any ant species, as a myrmecophile. Most of the observations reported in the literature, and the observations we ourselves made during our study, are therefore merely a mention of ants and beetles or spiders occupying the same microbiotope.

Most of the invertebrates found in the vicinity of ant nests just share the same appropriate environment for feeding and reproduction. Zealous as they are, ants are constantly on the road searching for food for their brood and, in building their nests, provide the ideal living conditions adapting the temperature and humidity of the environment. Other invertebrates are only too happy to make use of this infrastructure and the constant food supply, either the prey brought in by the ants or their own brood. Some beetles and spiders position themselves along the ants' foraging path to cheat them of the prey they are bringing in, while others have managed to penetrate the nests to feed there and sometimes develop their entire life cycle inside these nests.

The more such associations between the same species are mentioned, the more likely it becomes that a certain biotic or abiotic connection can be suspected as obligate. Only further research under artificial conditions, observing ants and their occasional guests and carefully evaluating their interactions, can reveal the correct degree of myrmecophily.

In the study of 2017 conducted on behalf of the National Orchard Foundation seventeen dead fruit trees were monitored. Fifteen of the seventeen fruit trees were colonised by *L. brunneus* and, in addition, it is noteworthy that twelve trees contained nests of both *L. brunneus* and *Temnothorax affinis*. According to the literature *L. brunneus* is very often associated with saproxylic beetles but never in combination with *T. affinis*. With the data obtained from our large-scale survey we want to contribute to the references concerning the association between ants and beetles or spiders without drawing any definitive conclusion of the degree of myrmecophily.

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Annex - Checklist in alphabetic order of the Coleoptera families.

Checklist of the beetles associated with ants according to the consulted literature (Päivinen *et al*., 2002) and observed in the province of Limburg. The ants that are not listed in the publication by Päivinen *et al.,* (2002) but were found during the research in Limburg near the beetles they are associated with, are indicated in red in the tables.

Species	Number	Nb of UTM grid	Host ant
Alexiidae			
Sphaerosoma globosum (J. Sturm, 1807)	38	2	lasifuli
Sphaerosoma pilosum (Panzer, 1793)	1	1	lasifuli
Cerilonidae			
Cerylon ferrugineum Stephens, 1830	238	32	forc s.str., lasibrun
Cerylon histeroides (Fabricius, 1792)	549	56	forcrufa, lasibrun, lasifuli, temnaffi
Chrysomelidae			
Clytra quadripunctata (Linnaeus, 1758)	12	10	forc spp.
Crepidodera aurata (Marsham, 1802)	220	47	campfall, lasibrun, temnaffi
Cryptocephalus pusillus Fabricius, 1777	18	15	lasibrun
Phyllotreta undulata (Kutschera, 1860)	23	10	lasibrun, lasifuli, temnaffi
Ciidae			
Cis castaneus (Herbst, 1793)	226	29	lasibrun, lasifuli
Cis fusciclavis Nyholm, 1953	141	17	lasibrun, lasifuli
Ennearthron cornutum (Gyllenhal, 1827)	68	21	lasifuli
Sulcacis nitidus (Fabricius, 1792)	35	12	lasibrun, lasifuli, temnaffi
Corylophidae			
Sericoderus lateralis (Gyllenhal, 1827)	366	77	lasifuli, temnaffi
Cryptophagidae			
Atomaria nigrirostris Stephens, 1830	117	20	lasifuli
Atomaria nigriventris Stephens, 1830	1	1	lasifuli
Caenoscelis ferruginea (Sahlberg, 1820)	2	1	forcrufa
Cryptophagus dentatus (Herbst, 1793)	67	9	temnaffi
Cryptophagus distinguendus Sturm, 1845	3	2	forcrufa
Cryptophagus labilis Erichson, 1846	7	3	lasibrun, lasifuli, mymirugi
Cryptophagus lycoperdi (Scopoli, 1763)	133	24	lasifuli
Cryptophagus saginatus Sturm, 1845	10	3	lasifuli
Cryptophagus scutellatus Newman, 1834	5	2	lasifuli, forc spp.
Curculionidae			
Acalles echinatus (Germar, 1824)	37	1	lasifuli
Acalles ptinoides (Marsham, 1802)	117	49	lasibrun, lasifuli, forcprat
Anisandrus dispar (Fabricius, 1792)	1351	52	lasibrun, temnaffi
Anthonomus rectirostris (Linnaeus, 1758)	53	28	lasibrun
Caenopsis fissirostris (Walton, 1847)	15	6	lasibrun
Ceutorhynchus sulcicollis (Paykull, 1800)	1	1	lasibrun
Cossonus parallelepipedus (Herbst, 1795)	3	3	lasibrun
Exomias pellucidus (Boheman, 1834)	230	20	lasibrun, lasifuli
Kyklioacalles roboris (Curtis, 1834)	100	19	lasibrun, lasifuli
Scolytus mali (Bechstein, 1805)	6	2	lasibrun, temnaffi

Species	Number	Nb of UTM grid	Host ant
Stereocorynes truncorum (Germar, 1824)	151	26	lasibrun, lasifuli
Strophosoma capitatum (De Geer, 1775)	131	51	lasibrun
Strophosoma melanogrammum (Forster, 1771)	474	66	lasibrun, lasifuli
Taphrorychus villifrons (Dufour, 1843)	9	3	lasibrun
Endomychidae			
Mycetaea subterranea (Fabricius, 1801)	94	22	lasibrun, lasifuli
Eucnemidae			
Eucnemis capucina (Ahrens, 1812)	21	12	lasibrun
Histeridae			
Abraeus granulum Erichson, 1839	61	8	lasibrun, lasifuli, lasi spp.
Abraeus parvulus Aubé, 1842	5	2	lasibrun, lasifuli, lasi spp.
Abraeus perpusillus (Marsham, 1802)	1551	62	forcrufa, lasibrun, lasifuli
Acritus minutus (Herbst, 1792)	1	1	lasi spp.
Aeletes atomarius (Aubé, 1842)	771	13	forc spp., lasibrun, lasifuli, lasinige
Dendrophilus punctatus (Herbst, 1791)	27	15	lasibrun, lasifuli
Dendrophilus pygmaeus (Linnaeus, 1758)	4	2	forcpoly, forcprat, forcrufa, lasifuli
Gnathoncus buyssoni Auzat, 1917	41	14	lasibrun, temnaffi
Hister unicolor Linnaeus, 1758	4	3	lasifuli
Margarinotus merdarius (Hoffmann, 1803)	1	1	lasifuli, lasinige
Margarinotus striola (Sahlberg, 1819)	42	13	lasibrun
Myrmetes paykulli Kanaar, 1979	1	1	forcpoly, forcprat, forcrufa, lasi spp.
Paromalus flavicornis (Herbst, 1791)	876	75	lasibrun, lasifuli, temnaffi
Plegaderus caesus (Herbst, 1791)	8	4	lasifuli
Plegaderus dissectus Erichson, 1839	422	39	Formicidae, lasibrun, lasifuli, temnaffi
Hydrophilidae			
Megasternum concinnum (Marsham, 1802)	260	45	lasibrun, lasifuli
Latridiidae			
Cartodere nodifer (Westwood, 1839)	523	80	lasibrun
Corticaria inconspicua Wollaston, 1860	1	1	forcprat, forcrufa
Corticaria longicollis (Zetterstedt., 1838)	2	2	forcprat, forcpoly, forcrufa, lasinige
Dienerella clathrata (Mannherheim, 1844)	70	6	forcrufa, lasibrun
Dienerella ruficollis (Marsham, 1802)	3	1	forcrufa
Dienerella vincenti Johnson, 2007	33	9	lasibrun, lasifuli
Enicmus histrio Joy & Tomlin, 1910	10	6	lasibrun, lasifuli
Enicmus transversus (A.G. Olivier, 1790)	12	7	forcrufa
Stephostethus rugicollis (A.G. Olivier, 1790)	5	4	lasibrun, forcrufa
Leiodidae			
Agathidium nigripenne (Fabricius, 1792)	18	14	lasibrun, temnaffi
Agathidium seminulum (Linnaeus, 1758)	1	1	lasibrun
Agathidium varians Beck, 1817	20	4	lasifuli
Catops picipes (Fabricius, 1787)	207	47	lasibrun, lasifuli
Nargus velox (Spence,1813)	94	20	lasibrun
Nargus wilkini (Spence, 1813)	118	24	lasifuli

Species	Number	Nb of UTM grid	Host ant
Ptomaphagus medius (Rey, 1889)	3	1	lasifuli
Sciodrepoides watsoni (Spence, 1813)	274	54	lasibrun, lasifuli, temnaffi
Malachiidae			
Sphinginus lobatus (Olivier, 1790)	2	2	lasibrun
Monotomidae			
Monotoma angusticollis (Gyllenhal, 1827)	2	2	forcpoly, forcprat, forcrufa
Monotoma conicicollis Aubé, 1837	7	3	forcpoly, forcprat, forcrufa, forcsang
Monotoma longicollis (Gyllenhal, 1827)	15	11	Formicidae, lasibrun, temnaffi
Monotoma picipes Herbst, 1793	11	6	Formicidae
Rhizophagus depressus (Fabricius, 1792)	9224	36	forcrufa
Rhizophagus perforatus Erichson,1845	126	30	lasibrun, temnaffi
Mycetophagidae			
Mycetophagus populi Fabricius, 1798	5	4	lasibrun, temnaffi
Mycetophagus quadriguttatus Müller, 1821	100	19	lasibrun, lasifuli
Nitidulidae			
Amphotis marginata (Fabricius, 1781)	19	8	lasifuli
Epuraea melanocephala (Marsham, 1802)	39	5	lasibrun
Epuraea ocularis (Fairmaire, 1849)	14	9	lasibrun
Glischrochilus hortensis (Geoffroy, 1785)	14826	96	lasibrun, lasifuli, temnaffi
Glischrochilus quadriguttatus (Fabricius, 1777)	1029	64	lasibrun, lasifuli, temnaffi
Glischrochilus quadrisignatus (Say, 1835)	157	50	campfall, lasibrun, lasifuli, temnaffi
Omosita discoidea (Fabricius, 1775)	20	15	lasibrun
Pityophagus ferrugineus (Linnaeus, 1761)	192	29	lasibrun
Soronia punctatissima (Illiger, 1794)	16	12	lasibrun
Ptiliidae			
Acrotrichis atomaria (De Geer, 1774)	6	4	forcrufa
Acrotrichis dispar (A. Matthews, 1865)	84	1	forcrufa
Acrotrichis fascicularis (Herbst, 1793)	280	2	forcrufa
Acrotrichis intermedia (Gillmeister, 1845)	458	8	forcrufa, lasibrun
Acrotrichis montandonii (Allibert, 1844)	17	2	forcpoly, forcprat, forcrufa, lasibrun, lasifuli, lasiumbr
Acrotrichis sitkaensis (Motschulsky, 1845)	273	5	lasifuli
Micridium halidaii (A. Matthews, 1868)	1	1	lasibrun, lasinige
Ptenidium laevigatum Erichson, 1845	2	2	forcrufa, lasifuli
Ptenidium pusillum (Gyllenhal, 1808)	12	5	forcrufa
Pteryx suturalis (Heer, 1841)	295	13	lasibrun, lasifuli
Ptilium myrmecophilum (Alibert, 1844)	2	1	forcprat, forcrufa, forcsang, lasi spp.
Ptinella aptera (Guérin-Méneville, 1839)	359	6	forcrufa
Ptinella errabunda C. Johnson, 1975	50	5	lasibrun
Ptinidae			
Anobium punctatum (De Geer, 1774)	62	16	lasibrun, lasifuli, temnaffi
Hemicoelus canaliculatus (Thomson,1863)	11	7	campfall, lasibrun, temnaffi
Priobium carpini (Herbst, 1793)	129	30	campfall, lasibrun, temnaffi
Ptilinus pectinicornis (Linnaeus, 1758)	1424	51	campfall, lasibrun, lasifuli, temnaffi

Species	Number	Nb of UTM grid	Host ant
Ptinus fur (Linnaeus, 1758)	27	6	lasibrun, temnaffi
Silvanidae			
Uleiota planatus (Linnaeus, 1761)	360	89	lasibrun, temnaffi
Sphindidae			
Aspidiphorus orbiculatus (Gyllenhal, 1808)	92	25	lasibrun, lasifuli
Staphylinidae			
Acrotona aterrima (Gravenhorst, 1802)	7	7	Formicidae
Acrotona parvula Mannerheim, 1830	1	1	forcrufa, lasifuli
Aleochara lanuginosa Gravenhorst, 1802	7	7	forcrufa, lasibrun, temnaffi
Aleochara ruficornis Gravenhorst, 1802	3	3	forcfusc, forcrufa, lasifuli
Aleochara sanguinea (Linnaeus, 1758)	13	4	lasibrun, lasifuli
Aleochara spadicea (Erichson, 1837)	1	1	lasifuli
Aleochara sparsa Heer, 1839	3710	69	campfall, lasibrun, lasifuli, temnaffi
Aloconota gregaria (Erichson, 1839)	18	10	lasifuli
Aloconota sulcifrons (Stephens, 1832)	8	3	Formicidae
Amarochara forticornis (Lacordaire, 1835)	1	1	lasifuli
Amauronyx maerkelii (Aubé, 1844)	1	1	forcfusc, lasibrun, lasiflav, lasifuli, mymi spp., temnnyla, tetrcaes
Amischa analis (Gravenhorst, 1802)	90	22	forcrufa, lasibrun, lasiflav, lasifuli, mymirubr, mymiscab
Amischa bifoveolata (Mannerheim, 1830)	3	3	forcrufa, lasifuli
Amischa nigrofusca (Stephens, 1832)	18	2	lasifuli
Anotylus rugosus (Fabricius, 1775)	817	83	forc spp.
Anotylus tetracarinatus (Block, 1799)	2680	44	lasibrun
Anthobium unicolor (Marsham, 1802)	532	53	lasibrun, lasifuli
Astenus gracilis (Paykull, 1789)	3	3	forc spp.
Atheta castanoptera (Mannerheim, 1830)	2	1	forcrufa, lasifuli
Atheta fungi (Gravenhorst, 1806)	365	41	Formicidae
Atheta longicornis (Gravenhorst, 1802)	10	8	Formicidae
Atheta nigra (Kraatz, 1856)	6	4	forcrufa
Atheta paracrassicornis Brundin, 1954	33	6	lasibrun
Atheta sodalis (Erichson, 1837)	24	5	forcrufa, lasibrun, lasifuli
Atheta trinotata (Kraatz, 1856)	2	2	forcrufa, lasifuli
Atrecus affinis (Paykull, 1789)	30	13	lasibrun, lasifuli
Batrisodes buqueti (Aubé, 1833)	7	6	lasibrun, lasifuli, temnaffi
Batrisodes delaporti (Aubé, 1833)	12	7	lasibrun, lasifuli
Batrisodes oculatus (Aubé, 1833)	11	7	lasi spp.
Batrisodes unisexualis Besuchet, 1988	3	1	lasi spp.
Batrisodes venustus (Reichenbach, 1816)	17	5	forcfusc, forcrufa, lasibrun, lasifuli, lasinige, mymiscab
Batrisus formicarius Aubé, 1833	54	7	lasibrun, lasifuli
Bibloporus bicolor (Denny, 1825)	20	7	lasifuli
Bibloporus minutus Raffray,1914	22	12	lasibrun
Bisnius subuliformis (Gravenhorst, 1802)	10	8	lasibrun, lasifuli, temnaffi

Species	Number	Nb of UTM grid	Host ant
Bolitobius cingulatus Mannerheim, 1830	40	25	mymi spp.
Brachygluta fossulata (Reichenbach, 1816)	32	20	forcrufa
Bryaxis curtisii (Leach, 1817)	20	11	lasifuli
Bryaxis puncticollis (Denny, 1825)	17	5	lasifuli
Callicerus rigidicornis (Erichson, 1839)	3	2	forcrufa, lasifuli, lasinige
Carpelimus pusillus (Gravenhorst, 1802)	42	7	lasifuli
Cephennium gallicum Ganglbauer, 1899	231	22	lasibrun, lasifuli
Claviger longicornis Müller, 1818	38	5	lasibrun, lasiflav, lasifuli, lasimixt, lasinige, lasiumbr
Coprophilus striatulus (Fabricius, 1792)	75	34	campfall, lasibrun, lasifuli, temnaffi
Coryphium angusticolle Stephens, 1834	23	14	lasifuli
Crataraea suturalis (Mannerheim, 1830)	12	3	forcrufa, lasifuli
Cypha pulicaria (Erichson, 1839)	1	1	Formicidae
Dasycerus sulcatus Brongniart, 1800	2	2	lasibrun
Dinaraea linearis (Gravenhorst, 1802)	5	3	lasifuli
Dinarda dentata (Gravenhorst, 1806)	7	4	forcfusc, forcrufi, forcsang
Dropephylla ioptera (Stephens, 1834)	60	26	lasibrun, lasifuli
Drusilla canaliculata (Fabricius, 1787)	490	74	forcfusc, forcrufa, forcsang, lasialie, lasibrun, lasiflav, lasifuli, lasinige, leptacer, mymirubr, mymirugi, mymiscab, mymisulc, tetrcaes
Euplectus karstenii Reichenbach, 1816	46	1	forcrufa, lasibrun, lasifuli
Euplectus nanus (Reichenbach, 1816)	84	10	forcpoly, forcrufa, lasibrun, lasinige
Euplectus piceus Motschulsky, 1835	65	4	forcrufa, lasibrun, lasifuli
Euplectus punctatus Mulsant & Rey, 1861	3	1	forcrufa, lasifuli
Euplectus signatus (Reichenbach, 1816)	1	1	forcrufa, lasius spp.
Euryusa castanoptera Kraatz, 1856	10	4	lasibrun, lasifuli
Euryusa optabilis Heer, 1839	9	3	forcrufa, lasibrun, lasifuli, lasinige
Gabrius nigritulus (Gravenhorst, 1802)	16	5	forc spp.
Gabrius osseticus (Kolenati, 1846)	2	1	forcrufa, lasifuli
Gabrius splendidulus (Gravenhorst, 1802)	167	26	forcrufa
Geostiba circellaris (Gravenhorst, 1806)	91	33	forcrufa, lasifuli
Gyrohypnus angustatus Stephens, 1833	9	9	forcrufa, lasifuli
Gyrohypnus atratus (Heer, 1839)	1	1	forcpoly, forcprat, forcrufa, lasifuli
Gyrophaena minima Erichson, 1837	638	8	lasifuli
Gyrophaena strictula Erichson, 1839	5	3	lasifuli
Habrocerus capillaricornis (Gravenhorst, 1806)	171	52	lasifuli
Haploglossa gentilis (Märkel, 1844)	273	2	lasibrun, lasifuli
Haploglossa marginalis (Gravenhorst, 1806)	3	3	lasibrun, lasifuli
Haploglossa villosula (Stephens, 1832)	7	4	forcrufa, lasibrun, lasifuli, mymi spp.
Heterothops dissimilis (Gravenhorst, 1802)	5	3	forcrufa
Heterothops niger Kraatz, 1868	1	1	forcrufa, lasifuli
Heterothops praevius Erichson, 1839	1	1	forcrufa
Hypnogyra angularis (Ganglbauer, 1895)	74	17	lasibrun, lasifuli, temnaffi

Species	Number	Nb of UTM grid	Host ant
Ilyobates nigricollis (Paykull, 1800)	29	16	lasifuli, mymi spp.
Lamprinodes saginatus (Gravenhorst, 1806)	4	3	forcfusc, forcrufa, forcsang, lasiflav, lasifuli, mymirubr, mymirugi, mymisabu, mymiscab
Leptacinus formicetorum Märkel, 1841	5	4	forcpoly, forcprat, forcrufa, forcrufi, lasibrun
Leptusa pulchella (Mannerheim, 1830)	56	9	lasibrun
Leptusa ruficollis (Erichson, 1839)	5	4	forc spp.
Liogluta longiuscula (Gravenhorst, 1802)	3	3	forcrufa, lasibrun, lasifuli
Lomechusa emarginata (Paykull, 1789)	12	12	forcfusc, forcrufa, forcsang, lasi spp., mymirubr, mymirugi, mymirugu, mymisabu, mymiscab, mymisulc
Lomechusoides strumosus (Fabricius, 1792)	5	4	forcpoly, forcprat, forcrufa, forcsang
Lordithon trinotatus (Erichson, 1839)	99	18	lasifuli
Lyprocorrhe anceps (Erichson, 1837)	1	1	forcprat, forcrufa, forctrun, lasifuli
Medon apicalis (Kraatz, 1857)	4	4	forcrufa
Medon brunneus (Erichson, 1839)	10	3	lasifuli
Medon castaneus (Gravenhorst, 1802)	1	1	Formicidae
Medon fusculus (Mannerheim, 1830)	1	1	Formicidae
Meotica exilis (Gravenhorst, 1806)	3	2	forc spp.
Mycetoporus lepidus (Gravenhorst, 1806)	37	23	forcrufa, lasifuli
Neuraphes carinatus Mulsant & Rey, 1861	3	1	lasibrun
Neuraphes elongatulus (Müller & Kunz, 1822)	43	12	lasifuli
Neuraphes praeteritus (Rye, 1872)	9	1	lasifuli
Nudobius lentus (Gravenhorst, 1806)	4	4	forcpoly
Ocalaea badia Erichson, 1837	2	2	forcrufa, lasifuli
Oligota pusillima (Gravenhorst, 1806)	12	3	forcrufa, lasifuli
Omalium caesum Gravenhorst, 1806	40	15	forcrufa, lasifuli
Omalium rivulare (Paykull, 1789)	1372	80	lasifuli
Othius angustus Stephens, 1833	2	2	lasifuli
Othius punctulatus (Goeze, 1777)	95	32	Formicidae
Othius subuliformis Stephens, 1833	80	19	lasifuli
Ousipalia caesula (Erichson, 1839)	3	2	forcrufa, lasifuli
Oxypoda acuminata (Stephens, 1832)	35	12	lasifuli, lasinige
Oxypoda annularis (Mannerheim, 1830)	44	5	lasifuli, forcrufa
Oxypoda brachyptera (Stephens, 1832)	7	5	forcrufa, tetrcaes
Oxypoda formiceticola Märkel, 1841	1	1	forcfusc, forcpoly, forcrufa, lasi spp.
Oxypoda haemorrhoa (Mannerheim, 1830)	1	1	forcpoly, forcprat, forcrufa, forcsang, forctrun, lasifuli
Oxypoda opaca (Gravenhorst, 1802)	19	11	lasifuli
Oxypoda spectabilis (Märkel, 1844)	4	4	lasifuli
Oxypoda vittata Märkel, 1842	20	4	forcrufa, lasibrun, lasifuli
Pella cognata (Märkel, 1842)	56	11	forcfusc, lasibrun, lasifuli, lasinige
Pella funesta (Gravenhorst, 1806)	10	5	lasifuli

Species	Number	Nb of UTM grid	Host ant
Pella humeralis (Gravenhorst, 1802)	156	6	forcpoly, forcprat, forcrufa, lasibrun, lasifuli, lasiumbr
Pella laticollis (Märkel, 1844)	11	3	lasifuli
Pella limbata (Paykull, 1789)	119	19	forcfusc, forcsang, lasibrun, lasiflav, lasifuli, lasinige, mymirubr, mymiscab
Pella lugens (Gravenhorst, 1802)	10	5	lasibrun, lasifuli
Philonthus ventralis (Gravenhorst, 1802)	1	1	forcrufa
Phloeonomus punctipennis Thomson, 1867	89	28	lasibrun
Phloeostiba plana (Paykull, 1792)	383	48	lasibrun
Placusa tachyporoides (Waltl, 1838)	72	12	lasibrun, temnaffi
Platydracus fulvipes (Scopoli, 1763)	11	5	mymirugi
Platydracus latebricola (Gravenhorst, 1806)	6	5	forcrufa, lasifuli, lasiumbr, mymirubr, mymirugi
Platydracus stercorarius (Olivier, 1795)	92	30	forcrufa, lasialie, lasiflav, mymirubr, mymirugi, mymiscab, polyrufe, tetrcaes
Platystethus arenarius (Geoffroy, 1785)	21	9	forcrufa
Plectophloeus nitidus (Fairmaire, 1858)	2	1	lasibrun, lasifuli
Proteinus brachypterus (Fabricius, 1792)	2447	21	lasifuli
Quedius boops (Gravenhorst, 1802)	10	8	lasifuli
Quedius brevicornis (Thomson, 1860)	5	5	lasi spp.
Quedius brevis Erichson, 1840	5	5	forcrufa, forcsang, lasibrun, lasifuli
Quedius cruentus (Olivier, 1795)	608	66	lasibrun, temnaffi
Quedius dilatatus (Fabricius, 1787)	113	33	temnaffi
Quedius fuliginosus (Gravenhorst, 1802)	46	27	lasifuli
Quedius fumatus (Stephens, 1833)	32	18	lasifuli
Quedius invreae Gridelli, 1924	1	1	lasifuli
Quedius maurus (Sahlberg, 1830)	1	1	lasifuli
Quedius mesomelinus (Marsham, 1802)	227	38	forcrufa, lasibrun, lasifuli, temnaffi
Quedius nigrocauruleus Fauvel, 1876	3	3	lasibrun, temnaffi
Quedius ochripennis (Ménétriés, 1832)	7	7	lasibrun, lasifuli, temnaffi
Quedius scitus (Gravenhorst, 1806)	26	13	forcrufa, lasibrun, temnaffi
Quedius truncicola Fairmaire & Laboulbène, 1856	13	8	lasifuli
Rugilus rufipes (Germar, 1836)	61	25	lasibrun
Scaphisoma boleti (Panzer, 1793)	30	18	lasibrun
Scopaeus laevigatus (Gyllenhal, 1827)	44	19	forcrufa
Scopaeus pusillus Kiesenwetter, 1843	2	1	forcrufa
Scydmaenus perrisi (Reitter, 1879)	84	7	lasibrun, lasifuli
Sepedophilus bipunctatus (Gravenhorst, 1802)	36	10	lasibrun
Sepedophilus immaculatus (Stephens, 1832)	10	7	forcrufa, lasifuli
Sepedophilus marshami (Stephens, 1832)	30	16	lasi spp.
Sepedophilus testaceus (Fabricius, 1792)	40	17	forcrufa, lasibrun, lasifuli
Staphylinus erythropterus Linnaeus, 1758	7	6	mymi spp.
Stenichnus godarti (Latreille, 1806)	28	3	forcrufa, lasibrun, lasifuli, lasinige
Stenichnus scutellaris (Müller & Kunz, 1822)	41	22	forcrufa, lasifuli
Stenus crassus Stephens, 1833	1	1	forcrufa

Species	Number	Nb of UTM grid	Host ant
Sunius bicolor (Olivier, 1795)	3	3	lasiflav, mymirugi
Sunius melanocephalus (Fabricius, 1792)	1	1	lasifuli
Tachinus fimetarius Gravenhorst, 1802	3	3	forcrufa, lasifuli
Tachinus marginellus (Fabricius, 1781)	20	14	forcrufa, lasifuli
Tachinus rufipes (Linnaeus, 1758)	136	30	forcrufa, lasifuli
Tachyporus chrysomelinus (Linnaeus, 1758)	21	13	forcpoly
Tachyporus hypnorum (Fabricius, 1775)	44	15	forcpoly, lasibrun
Tachyporus nitidulus (Fabricius, 1781)	69	25	forcpoly, lasibrun
Tachyporus obtusus (Linnaeus, 1767)	69	39	forcrufa
Tachyporus pusillus Gravenhorst, 1806	50	9	lasifuli
Tachyporus solutus Erichson, 1839	22	18	lasifuli
Tasgius ater (Gravenhorst, 1802)	44	17	lasibrun, temnaffi
Thamiaraea cinnamomea (Gravenhorst, 1802)	626	36	lasibrun, temnaffi
Thamiaraea hospita (Märkel, 1844)	2	1	lasifuli
Thiasophila angulata (Erichson, 1837)	1	1	forcpoly, forcprat, forcrufa, forcsang, lasibrun, lasifuli
Thoracophorus corticinus Motschulsky, 1837	6	2	lasibrun
Trichonyx sulcicollis (Reichenbach, 1816)	11	5	lasibrun, lasifuli, mymi spp.
Tychus niger (Paykull, 1800)	77	13	lasifuli
Tyrus mucronatus (Panzer, 1803)	1	1	forcfusc, forcrufa, forcsang, lasibrun, lasinige
Xantholinus linearis (Olivier, 1795)	61	27	forcrufa, lasifuli
Xylodromus affinis Gerhardt, 1877	2	2	lasifuli
Zyras collaris (Paykull, 1800)	13	12	forcrufa, lasifuli, mymirubr, mymirugi
Zyras haworthi (Stephens, 1832)	3	3	lasibrun
Thenebrionidae			
Corticeus unicolor (Piller & Mitterpache, 1783)	125	33	lasibrun
Diaclina fagi (Panzer, 1799)	11	5	lasibrun
Diaperis boleti (Linnaeus,1758)	274	68	campfall, lasibrun, lasifuli, temnaffi
Eledona agricola (Herbst, 1783)	105	13	lasibrun, lasifuli
Mycetochara maura (Fabricius,1792)	64	28	lasibrun, temnaffi
Myrmechixenus subterraneus Chevrolat, 1835	4	3	forcfusc, forcpoly, forcprat, forcrufa, lasifuli, lasinige
Nalassus laevioctostriatus (Goeze, 1777)	300	73	lasifuli
Opatrum sabulosum (Linnaeus, 1760)	19	2	forcfusc, lasinige
Palorus depressus (Fabricius, 1790)	12	10	forcpoly, forcrufa
Palorus ratzeburgi (Wissmann, 1848)	5	2	lasibrun
Pentaphyllus testaceus (Hellwig, 1792)	99	21	lasibrun, lasifuli, temnaffi
Prionychus ater (Fabricius, 1775)	45	26	lasibrun, lasifuli, temnaffi
Pseudocistela ceramboides (Linnaeus, 1858)	56	25	lasibrun
Scaphidema metallica (Fabricius, 1792)	36	24	lasifuli
Throscidae			
Aulonothroscus brevicollis (de Bonvouloir, 1859)	217	24	lasibrun, lasifuli, temnaffi