# New records of Laboulbeniales (Fungi, Ascomycota) for The Netherlands

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**Laboulbeniales are obligate ectoparasitic ascomycetes occurring on Arthropoda, mostly insects. Since the 1950s almost no research on Laboulbeniales has been done in The Netherlands. This study presents a preliminary list of Laboulbeniales found on insects collected in De Kaaistoep. Thirteen species of Laboulbeniales were found on fourteen different insect hosts, nine of which are new to The Netherlands. One dipteran host is new to the entomofauna of The Netherlands.**

## Introduction

The order Laboulbeniales (Ascomycota) consists of obligate ectoparasitic fungi, which live associated with arthropods, mostly insects. The order presently comprises about 2,050 species in about 140 genera (146 according to Kirk *et al.* 2008). Systematic and taxonomic contributions are available for several countries in Western Europe and Northern America.

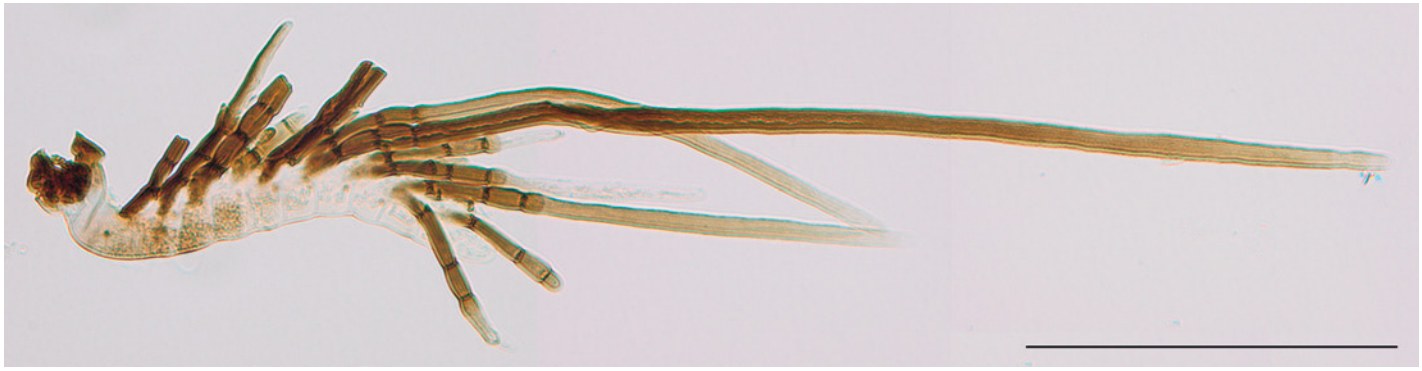
Laboulbeniales do not form a mycelium, instead they produce thalli directly from sticky ascospores that glue to the exterior of the host's integument. Thalli can develop on virtually any site, i.e. elytra, abdomen, but also on tarsi, antenna and eyes. In spite of their parasitic nature, most Laboulbeniales, including the ones forming a haustorium inside the host's body, seem to have little or no effect on the reproduction and survival of their host.

The entire life cycle of Laboulbeniales takes place on the outside of the host, and free-living asexual stages are unknown. Depending on the species and the size of the host, the thalli measure 0.15-1 mm, rarely more. They are somewhat robust, firmly attached, thick-walled and of determinate growth, bearing antheridia and perithecia on a receptacle with appendages (Tavares 1985).

Laboulbeniales occur almost exclusively on adult hosts, infections of pre-imaginal stages are excessively rare and only observed on particular hosts (cockroaches, termites and ants; Benjamin 1971). Amongst the Hexapoda, representatives of ten orders are known as hosts (table 1; Weir & Hammond 1997). About 80% of the described species of Laboulbeniales parasitize Coleoptera (Weir & Blackwell 2005). It is interesting to see that the diversification of laboulbenialean genera within Coleoptera is greatest within Staphylinidae, i.e. 49 genera, with relatively few species per genus. In contrast, Carabidae host only 15 genera, sometimes with hundreds of species in a single genus (*Laboulbenia*) (Tavares 1979).

There are few exceptions, but most Laboulbeniales are fairly to extremely host-specific (Thaxter 1896, Scheloske 1969, Tavares 1985, Majewski 1994, De Kesel 1996, 1997). Each species seems to have its own host range, i.e. infecting either one host species (stenotopic) or several species (eurytopic). Most Laboulbeniales with a wider host spectrum often infect related or congeneric hosts. When one species infects totally unrelated hosts, they always occupy the same micro-habitat (ants nest, termite mound), suggesting that the parasite's success is affected by this specific environment. This is where the nature of the relationship between host, habitat and parasite is not yet fully understood. In some Laboulbeniales from Carabidae it was shown experimentally that habitat choice and life cycle of the host, environmental preferences of the parasite, characteristics of the host integument, and the availability of nutrients from the host play an important role. Successful establishment of the parasite requires not only a suitable host, but also favorable environmental conditions for fungus development (De Kesel 1996).

The spread and transmission of spores from Laboulbeniales is largely influenced by the activities of the host (Scheloske 1969, De Kesel 1993, 1996, 1997). Direct transmission is caused by contact or copulation with infected hosts and by grooming (auto-infection), the latter often resulting in excessively high fungal densities in older hosts. Direct transmission by copulation is however the most important type of transmission (De Kesel 1995a), as it enables an efficient spread of the fungus in the host population, often resulting in gender dependent infection patterns. Direct transmission at the overwintering site is of utmost importance for the perennity of the fungus population because it allows the parasite to infect the new cohorts. Most, if not all, infected host species from the temperate areas have overwintering adults. Soil-borne infections with Laboulbeniales, i.e. indirect transmission, are quantitatively far less important



**1.** Thallus of *Rhachomyces lasiophorus* (from *Anthracus consputus*). Scale bar = 100 µm. Photo: National Botanic Garden of Belgium
**1.** Thallus van *Rhachomyces lasiophorus* (op *Anthracus consputus*). Maatstreep = 100 µm.

**2.** *Bradycellus harpalinus* (Carabidae) covered with Laboulbeniales (*Laboulbenia eubradycelli*). Photo: Bart Horvers
**2.** *Bradycellus harpalinus* (Carabidae) geparasiteerd door Laboulbeniales (*Laboulbenia eubradycelli*).

than direct transmission. This is due to the nature and short life-span of the spore (De Kesel 1995b) and the fact that they cannot spread through air over long distances (Huldén 1983).

## Historic background

In the 1840s, two French entomologists, Joseph Alexandre Laboulbène and Auguste Rouget, made the first observations on Laboulbeniales. At first these organisms were considered hair-like structures, i.e. outgrowths of the insect's integument, or even parasitic worms. The systematic study of Laboulbeniales began with Roland Thaxter, who published an extensive monograph (1890 to 1931). Thaxter described 103 genera and approximately 1260 species (Benjamin 1971).

In The Netherlands the very first possible presence of Laboulbeniales was mentioned by Lafontijn (1877), although never identified. The first observations were made in 1904 by Prof. Dr. De Meijere (Everts 1906, Boelens 1947) and Boedijn (1923). In the 40s and 50s of the previous century, Middelhoek studied and described 26 species of Laboulbeniales new to The Netherlands (Middelhoek 1941, 1942, 1943a, 1943b, 1943c, 1945, 1947a, 1947b, 1949, 1951, 1957). The last contribution of Laboulbeniales in The Netherlands to date was from Meijer (1975). In comparison with the neighboring countries Germany and Belgium, relatively few data are available from The Netherlands.

**Table 1.** Distribution of arthropod hosts parasitized by Laboulbeniales (based on Weir & Hammond 1997). About 80% of the described species of Laboulbeniales parasitize Coleoptera (beetles) (Weir & Blackwell 2005).
**Tabel 1.** Overzicht van de door Laboulbeniales geparasiteerde Arthropoda-gastheren (gebaseerd op Weir & Hammond 1997). Ongeveer 80% van de beschreven soorten Laboulbeniales parasiteert op Coleoptera (kevers) (Weir & blackwell 2005).

| **Phylum Arthropoda** | **Common name** |
|---|---|
| Subphylum Cheliceriformes | |
| Class Chelicerata | |
| Subclass Arachnida | |
| Order Acari | Mites |
| Subphylum Myriapoda | |
| Class Diplopoda | Millipedes |
| Subclass Chilognatha | |
| Order Callipodida | |
| Order Julida | |
| Order Sphaerotheriida | |
| Order Spirostriptida | |
| Subphylum Hexapoda | |
| Class Pterygota | |
| Subclass Exopterygota | |
| Order Hemiptera | True bugs |
| Order Mallophaga | Bird lice |
| Order Blattodea | Cockroaches and allies |
| Order Thysanoptera | Thrips |
| Order Orthoptera | Crickets and allies |
| Order Dermaptera | Earwigs |
| Order Isoptera | Termites |
| Subclass Endopterygota | |
| Order Hymenoptera | Bees, wasps and ants |
| Order Diptera | True flies |
| Order Coleoptera | Beetles |

**3.** *Laboulbenia eubradycelli* (from *Bradycellus harpalinus*); foot cell (left) and appendages (lower right) broken. Scale bar = 100 µm. Photo: National Botanic Garden of Belgium
**3.** *Laboulbenia eubradycelli* (op *Bradycellus harpalinus*); voetcel (links) en aanhangsels (rechtsonder) afgebroken. Maatstreep = 100 µm.

**4.** *Hesperomyces virescens* upon left elytron of *Harmonia axyridis*. Photo: Hans Henderickx
**4.** *Hesperomyces virescens* op linker dekschild van *Harmonia axyridis*.

## Study area

The natural landscape De Kaaistoep is situated immediately west of the urban area of Tilburg, province Noord-Brabant, in the south of The Netherlands. It belongs to the TWM-Gronden BV (Tilburgsche Waterleiding Maatschappij). Since 1994, this agricultural area has been transformed into a more varied natural landscape. The section Tilburg of the Koninklijke Nederlandse Natuurhistorische Vereniging (KNNV) is inventorying the flora and fauna of the area since 1995 (Van Wielink 1999).

A detailed description of the western part of De Kaaistoep, i.e. the site where the presented arthropods with Laboulbeniales were collected, was published in Felix & Van Wielink (2008).

**Box 1**

# *Spelobia talparum* (Richards) new for the fauna of The Netherlands

In a pitfall trap sample of 28.x-5.xi.2010 one male specimen of the family Sphaeroceridae infected with Laboulbeniales was found. After finding this first infected sphaerocerid, all 1276 other sphaerocerids found in the pitfall trap samples were checked, but no other infected specimens were encountered. Similar observations were made in a Belgian study, where 5700 sphaerocerid flies were screened (representing 84 species) from which only 43 specimens (14 species) carried Laboulbeniales (De Kesel & Hanssens 2007). The prevalence of Laboulbeniales on Sphaeroceridae seems to be extremely low. Usually, however, infected specimens carry a lot of thalli enabling a thorough morphological study of the parasite.

*Stigmatomyces limosinae* is a widely distributed species, known from Europe (Poland, Italy, Portugal, Spain, England and Belgium) but also from the USA, Jamaica, Mexico and New Zealand. In Belgium it is reported on *Spelobia clunipes* (Meigen) (De Kesel & Hanssens 2007), in Poland on *Leptocera breviceps* Stenhammar, *Leptocera limosa* (Fallen), *Leptocera lutosa* (Stenhammar) and in southern Europe on *Leptocera lutosoidea* (Duda) (Majewski 2008). In all cases infected hosts were collected from wet forests or exposed, eutrophized and muddy banks of ponds and rivulets.

The infected specimen from De Kaaistoep was identified as *Spelobia* sp. and sent to Dr. Walter Rossi (University of L'Aquila, Italy) for identification of the fungus. The fungus turned out to be *Stigmatomyces limosinae* Thaxt., not recorded from The Netherlands before. The host specimen was forwarded to Dr. Jindřich Roháček (Silesian Museum, Czech Republic) for further identification. It was identified as *Spelobia talparum*, also not recorded from The Netherlands before.

*Spelobia talparum* is a species commonly occurring in burrows and nests of various small mammals. Imagines occur during the whole year because of their continuous development in subterranean habitats (Roháček 1983). It is widespread in Europe and known from all countries surrounding The Netherlands (Roháček 2004). The fact that this species has not been recorded from The Netherlands before is probably due to the relatively little attention this family has received here.

The specimen is deposited at the collection of Natuurmuseum Brabant.

**Table 2.** Host-parasite list of species from De Kaaistoep. Laboulbenialean and host species marked with an asterisk (*) are new for The Netherlands. The nomenclature of Coleoptera follows Vorst *et al.* (2010), the one of Diptera follows Beuk (2002).
**Tabel 2.** Gastheer-parasietlijst van soorten uit De Kaaistoep. Parasiet- en gastheersoorten aangeduid met een asterisk (*) zijn nieuw voor Nederland. De naamgeving van Coleoptera gebeurt volgens Vorst *et al.* (2010), die van Diptera volgens Beuk (2002).

| Host | Parasite | Collecting method |
|---|---|---|
| COLEOPTERA | | |
| Carabidae | | |
| *Anthracus consputus* (Duftschmid) | *Rhachomyces lasiophorus* (Thaxt.) Thaxt.* | Light |
| *Bembidion guttula* (Fabricius) | *Laboulbenia pedicellata* Thaxt. | Light |
| *Bembidion properans* (Stephens) | *Laboulbenia vulgaris* Peyr. | Pitfall trap |
| *Bradycellus harpalinus* (Serville) | *Laboulbenia eubradycelli* Huldén* | Light |
| *Bradycellus verbasci* (Duftschmid) | *Laboulbenia eubradycelli* Huldén* | Light |
| *Calathus melanocephalus* (Linnaeus) | *Laboulbenia calathi* T. Majewski* | Pitfall trap |
| *Clivina fossor* (Linnaeus) | *Laboulbenia clivinalis* Thaxt. | Light |
| *Stenolophus mixtus* (Herbst) | *Laboulbenia anoplogenii* Thaxt.* | Light |
| Coccinellidae | | |
| *Harmonia axyridis* (Pallas) | *Hesperomyces virescens* Thaxt.* | Light |
| Gyrinidae | | |
| *Gyrinus substriatus* Stephens | *Laboulbenia gyrinicola* Speg.* | Light |
| Staphylinidae | | |
| *Bledius gallicus* (Gravenhorst) | *Haplomyces texanus* Thaxt. | Light |
| *Sepedophilus nigripennis* (Stephens) | *Stichomyces conosomatis* Thaxt.* | Pitfall trap |
| DIPTERA | | |
| Drosophilidae | | |
| *Drosophila subobscura* Collin | *Stigmatomyces majewskii* H.L. Dainat, Manier & Balazuc* | Beer trap |
| Sphaeroceridae | | |
| *Spelobia talparum* (Richards)* | *Stigmatomyces limosinae* Thaxt.* | Pitfall trap |

## Materials & Methods

### Hosts

Insects were collected from fall 1995 until November 2010 by the insect research group of the KNNV, section Tilburg. All collecting sites were situated in De Kaaistoep (Tilburg, The Netherlands, N 51° 33' E 5° 01'). Several sampling methods were used, i.e. pitfall traps, window traps, bands and rings on trees, malaise traps, light traps (Higler *et al.* 2008), beer traps and by hand.

Carabidae were identified using Boeken (1987), Staphylinidae with Freude *et al.* (1964, 1974); any name changes and updates on taxonomy correspond with Vorst (2010). Identification of Diptera was done using Baechli *et al.* (2004) and Roháček (1983).

Insects were screened for Laboulbeniales using a stereomicroscope at 50x. Infected hosts were transferred to separate vials (Eppendorf tubes or similar), with 70% ethanol. Only Coleoptera collected by light in the period 2007 till June 2010 were screened for the presence of Laboulbeniales. All the other infected specimens were noticed rather incidentally.

### Laboulbeniales

Thalli were removed from the host using an entomological pin (size 2 or 3) and immediately embedded in Amann's solution (Benjamin 1971) or in a medium based on arabic gum and glycerine (De Kesel 1998). Cover slips were ringed with nail varnish.

Microscopic photographs of Laboulbeniales were taken at the National Botanic Garden of Belgium using an Olympus BX51 light microscope with digital camera and AnalySIS Five imaging software (Soft Imaging System GmbH).

Identification of thalli was done up to species level, using Thaxter (1896), Dainat *et al.* (1974), Majewski (1994), De Kesel (1998, 2002) and Santamaría (1998, 2003).

The microscope slide collection is deposited at the Herbarium of the National Botanic Garden of Belgium, the collection of Natuurmuseum Brabant (Tilburg, The Netherlands), the private collection of the first author (Chantemerle-lès-Grignan, France), and the collection of Walter Rossi (*Stigmatomyces majewskii*, *S. limosinae*). In appendix 1 the full details of the specimens are given.

## Results: host-parasite list

Thirteen species of Laboulbeniales were found on fourteen different hosts. Twelve hosts are Coleoptera, two Diptera. Nine laboulbenialean species and one dipteran host species are new for The Netherlands (see box 1).

The new records of Laboulbeniales constitute a significant addition of the known distribution, bringing the number of species for The Netherlands from 31 to 40. Their hosts represent five families, 35 genera and 81 species. A revised parasite-host list of all Laboulbeniales in The Netherlands based on Everts (1906, 1907), Kossen (1936, 1938), Zaneveld (1938), Middelhoek (1941, 1942, 1943a, 1943b, 1943c, 1945, 1947a, 1947b, 1949, 1951, 1957), Boelens (1947), Meijer (1975), Haelewaters & De Kesel (2011) and the current research is in preparation.

In table 2 the hosts and parasites are presented, together with the collecting method. Hosts are ordered alphabetically. Laboulbeniales and hosts marked with an asterisk (*) are new for The Netherlands. Below only a few aspects of some of the observed Laboulbeniales and their hosts are discussed.

### *Rhachomyces lasiophorus* (Thaxt.) Thaxt.

According to Majewski (1994) and De Kesel (1997, as *Acupalpus consputus*), *Anthracus consputus* is host to both *Rhachomyces lasiophorus* and *Laboulbenia inflata* Thaxt. The latter species is small and easy to identify; it has not yet been recorded in The Netherlands, but is expected to be present.

**5.** *Hesperomyces virescens* (from *Harmonia axyridis*). Scale bar = 50 µm. Photo: National Botanic Garden of Belgium
**5.** *Hesperomyces virescens* (op *Harmonia axyridis*). Maatstreep = 50 µm.

**6.** *Stigmatomyces majewskii* upon leg of *Drosophila subobscura*. Photo: Luciën Rommelaars
**6.** *Stigmatomyces majewskii* op poot van *Drosophila subobscura*.

**7.** *Stigmatomyces majewskii* upon mouth part of *Drosophila subobscura*. Scale bar = 50 µm. Photo: National Botanic Garden of Belgium
**7.** *Stigmatomyces majewskii* op monddeel van *Drosophila subobscura*. Maatstreep = 50 µm.

The hosts of *R. lasiophorus* are typical for banks of stagnant water, swamps and marshes (Desender *et al.* 1995, as *Acupalpus consputus*, Turin 2000), a common habitat in De Kaaistoep.

### *Laboulbenia eubradycelli* Huldén

This species shows considerable morphological variation. Especially thallus length varies with the host species. Thalli on *Bradycellus harpalinus* and *B. verbasci* (180-420 µm) differ significantly from those on *B. ruficollis* and *Trichocellus placidus* (160-200 µm) (De Kesel 1997).

Parasite prevalence on light-collected specimens of both *Bradycellus* species differs with each sample collected on light. From April 2007 till August 2010 one specific site was sampled using light. It resulted in a series of 110 day-samples of which 23 with *Bradycellus* sp. The highest parasite prevalence occurred on August 1, 2009. i.e. with 58 *B. verbasci* and 143 *B. harpalinus* showing infection rates of 17.2 and 23.8%, respectively. Considering the fact that *Bradycellus harpalinus* is an autumn-breeding Carabid (Desender 1986), and that such taxa often show highest parasite prevalence just before and during their reproduction period (Scheloske 1969, Huldén 1983, De Kesel 1997), it seems normal to observe higher infection frequencies in August or later.

### *Hesperomyces virescens* Thaxt.

*Hesperomyces* is one of the few taxa penetrating the host's integument with a haustorium. Haustoria make contact with the host's haemocoel and draw nutrient material from it.

Two species of the genus *Hesperomyces* occur in Europe, i.e. *H. virescens* and the much less common *H. coccinelloides* (Santamaría 2003, De Kesel 2011). The specimens found in De Kaaistoep belong to *H. virescens*. They were found on *Harmonia axyridis*, an invasive coccinelid beetle. *H. axyridis* is native to northeastern Asia, including Taiwan, China, Korea, Japan, southern Siberia, Ryukyu Islands and Bonin Islands, and Australia (Mannix 2001). It was identified as an effective biocontrol agent against aphids and scale insects, and has been introduced in the United States since 1916 and in Western Europe since the 1980s (Adriaens *et al.* 2008).

Parasite prevalence is often used to measure dynamics of Laboulbeniales. In a monitored locality in Belgium, parasite prevalence on *Harmonia axyridis* differs significantly from one year to another, i.e. less than 0.5% in winter 2007-2008 and more than 96% in winter 2010-2011 (De Kesel 2011). In De Kaaistoep a considerable increase was noted: 0% in 2007 (n=117), 0.4% in 2008 (n=1130), 3.9% in 2009 (n=700) and 7.2% in 2010 (n=249) on light-collected specimens.

**8.** *Stigmatomyces majewskii* (from *Drosophila subobscura*). Scale bar = 100 µm. Photo: National Botanic Garden of Belgium
**8.** *Stigmatomyces majewskii* (op *Drosophila subobscura*). Maatstreep = 100 µm.

*Stigmatomyces majewskii* H.L. Dainat, Manier & Balazuc

*Stigmatomyces majewskii* has been reported just three times, i.e. from France (type, Dainat *et al*. 1974), Austria (Christian 2001) and the Czech Republic (Rossi *et al*. 2010). In De Kaaistoep *S. majewskii* was found several times on *Drosophila subobscura*.

*Stigmatomyces majewskii* was distinguished from closely related *S. entomophilus* based on the following features: (1) perithecia of *S. entomophilus* have a neck much longer than the rest of the perithecium and (2) appendages of *S. entomophilus* are brown and composed of six cells.

## Conclusion and suggestions

In 1995 an All Taxa Biodiversity Inventory (ATBI) was initiated in De Kaaistoep, resulting in about 7,300 species to date. Our short prospection has resulted in thirteen species of Laboulbeniales, nine of which are new for The Netherlands: *Laboulbenia anoplogenii*, *L. calathi*, *L. eubradycelli*, *L. gyrinicola*, *Hesperomyces virescens*, *Rhachomyces lasiophorus*, *Stichomyces conosomatis*, *Stigmatomyces limosinae* and *S. majewskii*. One parasitized dipteran host, *Spelobia talparum*, is new for the entomofauna of The Netherlands.

Until now, no Dutch insect collections have been screened by mycologists in search for Laboulbeniales, except (partly) the insect collection at Natuurmuseum Brabant (Tilburg). There is no doubt that a systematic study of insect collections of The Netherlands will result in a considerable increase of the number of Laboulbeniales. Simple extrapolations, using the insect diversity in The Netherlands and the target host groups for the 105 Laboulbeniales recorded so far in Belgium (De Kesel 1997, 1998, 2010, 2011, unpublished records, De Kesel & Hanssens 2007, De Kesel & Werbrouck 2008), leave little doubt that at least 150 to 175 Laboulbeniales are expected to occur in The Netherlands.

In order to find these taxa and further elaborate the inventory of the Laboulbeniales and their hosts in The Netherlands, the participation of entomologists is more than welcome.

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## Samenvatting

**Nieuwe vondsten van Laboulbeniales (Fungi, Ascomycota) voor Nederland**
Laboulbeniales zijn obligaat ectoparasitaire ascomyceten die voorkomen op Arthropoda, meestal kevers. In Nederland is er sinds de jaren 1940 nagenoeg geen onderzoek meer gedaan naar Laboulbeniales. De Kaaistoep wordt beschouwd als een hotspot van biodiversiteit in Nederland en leent zich dan ook uitstekend voor gericht onderzoek naar Laboulbeniales. In deze studie werden insecten uit de collectie van Natuurmuseum Brabant (Tilburg, Nederland), verzameld in De Kaaistoep, gescreend op de aanwezigheid van Laboulbeniales. Deze bijdrage resulteerde in dertien soorten Laboulbeniales, waarvan negen nieuw zijn voor Nederland. Het gaat om *Laboulbenia anoplogenii* Thaxt., *L. calathi* T. Majewski, *L. eubradycelli* Huldén, *L. gyrinicola* Speg., *Hesperomyces virescens* Thaxt., *Rhachomyces lasiophorus* (Thaxt.) Thaxt., *Stichomyces conosomatis* Thaxt., *Stigmatomyces limosinae* Thaxt. en *S. majewskii* H.L. Dainat, Manier & Balazuc. Deze laatste soort werd tot dusver slechts drie keer vermeld, in Frankrijk, Oostenrijk en Tsjechië. Ook *Spelobia talparum* (Richards) (Diptera, Sphaeroceridae), gastheer van *S. limosinae*, is nieuw voor Nederland.

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**Appendix 1.** Storage details of the specimens discussed in this paper.
**Bijlage 1.** Details van de collectie-exemplaren die in dit artikel worden beschreven.

| HOST | | | | | PARASITE | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Species** | **Date** | **Place[1]** | **RD coor-dinates** | **Collecting method** | | **Num-ber** | **♂** | **♀** | **Permanent slides[2, 3]** |
| Coleoptera - Carabidae | | | | | | | | | |
| *Anthracus consputus* | 6.viii.08 | T.-K. | 128.8-394.6 | Light | *Rhachomyces lasiophorus* | 1 | 0 | 1 | DH 2c,d NMB 2b |
| *Bradycellus harpalinus* | 24.vii.08 | T.-K. | 128.8-394.6 | Light | *Laboulbenia eubradycelli* | 2 | 0 | 2 | DH 13a,b,c |
| | 31.viii.08 | T.-K. | 128.8-394.6 | Light | | 11 | 7 | 4 | DH 8c NMB 8b |
| *Bradycellus verbasci* | 6.viii.08 | T.-K. | 128.8-394.6 | Light | *Laboulbenia eubradycelli* | 2 | ? | ? | DH 7c NMB 7b |
| | 19.viii.2009 | T.-K. | 128.8-394.6 | Light | | 18 | 2 | 16 | DH 22a,b DH 23a,b,c |
| *Calathus melanocephalus* | 7-14.x.2010 | T.-K. | 129-394 | Pitfall trap | *Laboulbenia calathi* | 1 | 1 | 0 | DH 3c NMB 3b |
| *Stenolophus mixtus* | 1.viii.2009 | T.-K. | 128.8-394.6 | Light | *Laboulbenia anoplogenii* | 1 | 0 | 1 | DH17a,b,c,d,e |
| *Clivina fossor* | 2.vii.2010 | T.-K. | 128.8-394.6 | Light | *Laboulbenia clivinalis* | 1 | 0 | 1 | DH 14a |
| *Bembidion guttula* | 4.vii.09 | T.-K. | 128.8-394.6 | Light | *Laboulbenia pedicellata* | 1 | ? | ? | NMB 12b |
| | 9.vii.2010 | T.-K. | 128.8-394.6 | Light | | 1 | 1 | 0 | DH 21a |
| *Bembidion properans* | 8-15.iv.2010 | T.-K. | 129-394 | Pitfall trap | *Laboulbenia vulgaris* | 1 | 0 | 1 | DH 4c NMB 4b |
| Coleoptera - Coccinellidae | | | | | | | | | |
| *Harmonia axyridis* | 6.viii.08 | T.-K. | 128.8-394.6 | Light | *Hesperomyces virescens* | 1 | 1 | 0 | DH 1c NMB 1b |
| | 31.viii.08 | T.-K. | 128.8-394.6 | Light | | 2 | 1 | 1 | DH 11c NMB 11b |
| | 5.viii.2009 | T.-K. | 128.8-394.6 | Light | | 1 | 1 | 0 | DH 26a,b (picture 4) |
| | 8.ix.2009 | T.-K. | 128.8-394.6 | Light | | 2 | 1 | 1 | DH 20a,b |
| Coleoptera - Gyrinidae | | | | | | | | | |
| *Gyrinus substriatus* | 3.vii.2009 | T.-K. | 128.8-394.6 | Light | *Laboulbenia gyrinicola* | 1 | 1 | 0 | DH 15a,b |
| Coleoptera - Staphylinidae | | | | | | | | | |
| *Sepedophilus nigripennis* | 13-27.i.2001 | T.-K. | 129-394 | Pitfall trap | *Stichomyces conosomatis* | 1 | 1 | 0 | NMB 5b |
| | 13.i-10.ii.2001 | T.-K. | 129.1-394.7 | Pitfall trap | | 1 | 0 | 1 | DH 19a,b |
| *Bledius gallicus* | 24.vii.08 | T.-K. | 128.8-394.6 | Light | *Haplomyces texanus* | 1 | 0 | 1 | DH 6c NMB 6b |
| | 26.vii.2009 | T.-K. | 128.8-394.6 | Light | | 1 | 1 | 0 | DH 24a,b,c,d |
| Diptera - Drosophilidae | | | | | | | | | |
| *Drosophila subobscura* | 19-26.viii.2008 | T.-K. | 128-394 | Beer trap | *Stigmatomyces majewskii* | 1 | 0 | 1 | DH 9c NMB 9b |
| | 19-26.viii.2008 | T.-K. | 128-394 | Beer trap | | 1 | 1 | 0 | DH 10c NMB 10b |
| | 19-26.viii.2008 | T.-K. | 128-394 | Beer trap | | 4 | 4 | 0 | DH 18a DH25a,b |
| Diptera - Sphaeroceridae | | | | | | | | | |
| *Spelobia talparum* | 28.x-5.xi.2010 | T.-K. | 128/129-394 | Pitfall trap | *Stigmatomyces limosinae* | 1 | 1 | 0 | collection Walter Rossi (University of L'Aquila, Italy) |

[1] T.-K. = Tilburg-De Kaaistoep
[2] DH = collection Danny Haelewaters
[3] NMB = collection Natuurmuseum Brabant