Polish Botanical Journal 55(2): 353–358, 2010

LABOULBENIALES (ASCOMYCETES) FROM COPROPHILIC COLEOPTERA ON GALLOWAY COW DUNG IN BELGIUM*

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Abstract. This paper presents Belgian records of six Laboulbeniales found on coprophilic Coleoptera. The hosts came from a small forested nature reserve; they were captured exclusively on dung from Galloway cows. *Kainomyces rehmanii* T. Majewski and *Monoicomyces matthiatis* T. Majewski are particularly rare and previously have been reported only from a few localities in Poland. The Belgian records are described and illustrated; they represent a significant extension of the known distribution.

Key words: Laboulbeniales, *Monoicomyces*, *Kainomyces*, coprophilic Coleoptera, Galloway cow

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Introduction

One objective of this paper is to broaden our knowledge of Laboulbeniales with descriptions of rare species from relatively specialized habitats, that is, Coleoptera living on animal feces. Majewski's (2003) extensive ecological survey of Laboulbeniales from Białowieża indicates that Laboulbeniales, collected most often on coprophilic Coleoptera, occasionally occur on hosts collected in forest litter, decaying plant remains and fruitbodies of fungi and Myxomycetes. In that study Majewski reported 13 minuscule for laboulbeniaceous species from almost exclusively coprophilic hosts belonging to the Macrochelidae (Acarina), Staphylinidae (Coleoptera) or Ptiliidae (Coleoptera). In an attempt to find some of these unique taxa in Belgium, I sampled a community of coprophilic beetles from feces of Galloway cows.

Material and methods

In August 2009 I collected Galloway cow dung from a forested part of the Waelenhoek Nature Reserve near Niel (Antwerp Prov., Belgium). The reserve is a complex of abandoned clay pits that were allowed to undergo natural succession in the early 1970s. It is a depression 10–12 m deep and covering 60 ha, with several ponds and a humid deciduous forest covering *ca* 25 ha.

The Galloway cows are kept in a fenced part of the forest all year round. They were introduced to enable more natural/ecological management and improve forest structure.

The dung, weighing *ca* 2 kg and 1–2 weeks old, was taken to the laboratory in a closed container, placed over a sieve (5 mm mesh) and subjected to strong light (100W lamp) from the side. A glass plate separated the lamp from the feces. Insects either falling through the sieve or flying towards the light were captured with tweezers or/and a pooter (mouth-operated aspirator). All insects, mostly Coleoptera, were preserved in 90% denatured ethanol. Screening of the hundreds of insects was done with a stereomicroscope at 50×. Thalli were removed and mounted on permanent slides following the protocol from Benjamin (1971) and De Kesel (1998). The microscope slide collection and all infected insects are kept at the Herbarium of the National Botanic Garden of Belgium (BR). Drawings were made from intact specimens under an Olympus BX51 light microscope, using a drawing tube; measurements were made using the microscope's digital camera and AnalySIS Five imaging software (Soft Imaging System GmbH). For specific nomenclature, terminology or the extensive iconography of Laboulbeniales we refer to Santamaría (1998, 2003) and Majewski (1994).

* This paper is dedicated to Professor Tomasz Majewski on the occasion of his 70th birthday.

RESULTS AND DISCUSSION

The sampled community of Coleoptera was infected with six different species of Laboulbeniales. Although the hosts were living in a very small area (one dropping) I did not find hosts infected with more than one species of Laboulbeniales. The following species were recorded:

1. ***Rhachomyces philonthinus*** Thaxt.

Proc. Amer. Acad. Arts Sci. **35**: 435. 1900.

SELECTED ICONES: Thaxter 1908 (Pl. 44: 3–4); Huldén 1983 (Fig. 56a–b); De Kesel & Haghebaert 1991 (Fig. 2e); Majewski 1994 (Pl. 25: 1–9); Weir & Beakes 1995 (Fig. 3).

This palearctic species is relatively common in Belgium (De Kesel 2002). It occurs on a number of Staphylinidae generally found in rotting organic matter such as feces, fruitbodies of mushrooms, rotting plant debris and carcasses.

SPECIMENS EXAMINED. Niel, on sternite of penultimate abdominal segment of *Philonthus* sp. (Col., Staphylinidae), in dung from Galloway cows, 19 Aug. 2009, *A. De Kesel 4740* (BR).

2. ***Ecteinomyces trichopterophilus*** Thaxt.

Proc. Amer. Acad. Arts Sci. **38**: 26. 1902.
= *Misgomyces trichopterophilus* (Thaxt.) Thaxt., Mem. Amer. Acad. Arts Sci. **16**: 304, 1931.

SELECTED ICONES: Thaxter 1908 (Pl. 51: 15–18); Huldén 1983 (Fig. 14); Tavares 1985 (Pl. 41: b–c); De Kesel & Rammeloo 1992 (Fig. 2b); Majewski 1994 (Pls 31: 9–19, 32: 1–15 & 33: 1–18); Weir & Beakes 1995 (Fig. 4b); Santamaría 2003 (Fig. 71); De Kesel 2010 (Fig. 1: d–h).

Thallus 144 μm long, hyaline. Lower receptacle (cell I – cell II) 66 μm long, straight; composed of a series of 6 slightly flattened cells, broadening slightly upwards. Cell I triangular, twice as high as broad. Primary appendage making a 45° angle with the receptacle, composed of a tapering series of 4 isodiametric cells, distally carrying a branchlet of 4 narrow cells. Antheridia small with a short lateral neck, situated next to some of the larger cells of the primary appendage, some proliferating. Stalk cell of the perithecium (VI) flattened; secondary stalk cell (VII) large and triangular. Perithecium 78 × 35 μm, with ovoid venter and narrow neck; ostiolum rounded, without specific differentiations.

SPECIMENS EXAMINED. Niel, on left elytron of *Acrotrichis* sp. (Col., Ptiliidae), in dung from Galloway cows, 19 Aug. 2009, *A. De Kesel 4734* (BR); ibid. *A. De Kesel* 4769 (BR).

This species was reported in Belgium on representatives of the genus *Acrotrichis* (Coleoptera, Ptiliidae) (De Kesel & Rammeloo 1992). *E. trichopterophilus* is a variable species, and interesting notes on this are given by Majewski (1994). A description of the material found on the host from Galloway dung is given below and illustrated in De Kesel (2010).

The hosts of *E. trichopterophilus* all belong to *Acrotrichis* (Santamaría *et al.* 1991, also *Baeocrara*, Majewski 1994), a group of very mobile and therefore widely distributed insects. The Belgian material originates from various humid habitats including rivulet-associated meadows, forest litter and under bark. My recent find in cow feces corresponds well with observations by Santamaría (2003) and Majewski (1994, 2003, 2008). Extensive distributional data from Poland (Majewski 2008) clearly indicate that *E. trichopterophilus* is expected to be the most common species, also in Belgium. Because of its small size, the host is rarely collected and properly screened.

3. ***Kainomyces rehmanii*** T. Majewski

Fig. 1a–c

Polish Bot. Stud. **1**: 121. 1991.

ICONES: Majewski 1991 (Figs 1–8); Majewski 1994 (Pl. 11: 5–11).

Thallus pale yellowish, 92–108 μm long. Lower receptacle composed of 4–5 superposed cells, 22–27 μm long, gradually becoming broader towards the top, its lower cells elongated, the upper ones flattened; its last cell oblique. Primary appendage 27–54 μm long, distally with a number of thin branchlets, the latter 1–2 times branched, not extending beyond the perithecial apex. Antheridia not differentiated in my material. Perithecial stalk short, 2–3-celled, along the axis of the

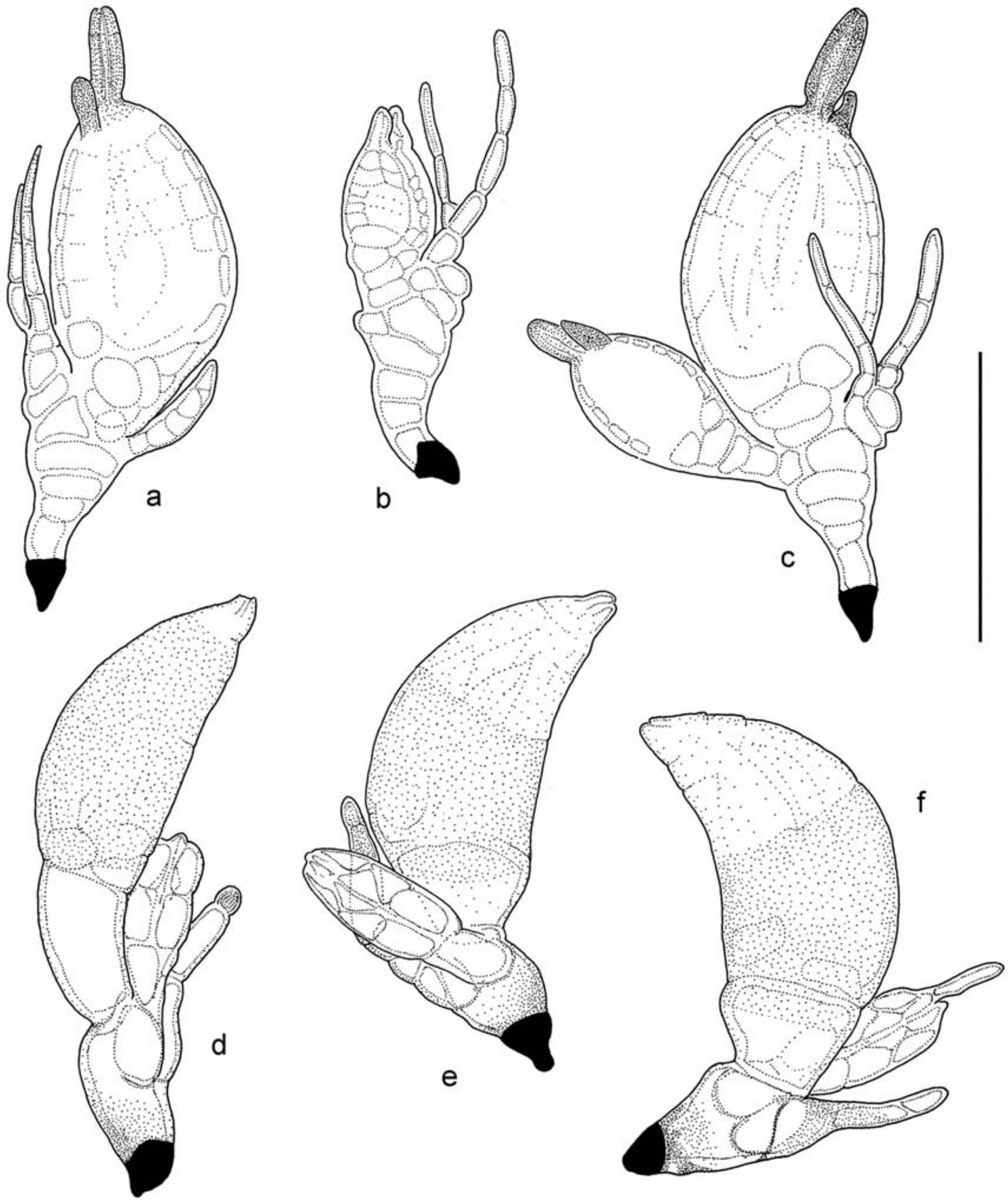

Fig. 1. a–c – *Kainomyces rehmanii* T. Majewski: a – mature thallus from scutellum of *Acrotrichis* sp. (*A. De Kesel 4736*), b – young thallus from upper side of abdomen of *Acrotrichis* sp. (*A. De Kesel 4735a*), c – mature thallus with two perithecia, from left elytron of *Acrotrichis* sp. (*A. De Kesel 4735b*). d–f – *Monoicomyces matthiatis* T. Majewski: d – mature thallus from edge of last abdominal tergite of *Platystethus* cf. *arenarius* (*A. De Kesel 4743*), e–f – mature thalli from last abdominal tergite of *Platystethus* cf. *arenarius* (*A. De Kesel 4741*). Scale bar = 50 µm.

receptaculum (first perithecium) or lateral (second perithecium). Perithecium 62–73 × 22–38 μm, short ellipsoid or ovate (section), with a demarcated darkened and beak-like apex 17–20 μm long (rostrum; Tavares 1985). Remains of the trichogyne occurring near the base of the perithecial apex, darkened, stump-like and 6–8 μm long. One secondary perithecium often formed below the primary perithecium. Secondary appendage similar to the primary, infrequently formed as replacement after damage. Ascospores not seen.

SPECIMENS EXAMINED. Niel, on scutellum, abdominal tergites and elytra of *Acrotrichis* sp. (Col., Ptiliidae), in dung from Galloway cows, 19 Aug. 2009, *A. De Kesel 4735 (a,b)* (BR); ibid. *A. De Kesel* 4736 (BR).

The appendage system of the depicted specimens (Fig. 1a–c) shows only two branches, whereas Majewski (1994, Pl. 11: 5–11) shows and describes a more developed appendage for this taxon. This simpler appendage of my depicted material is certainly not a constant for the entire population. Several thalli indeed show 3 branchlets, some of these branched, thus fitting well with the original description.

Kainomyces rehmanii is new for Belgium, previously reported only from Poland and exclusively on *Acrotrichis dispar* (Matthews) (Majewski 2008). The infected hosts were found in dung from European bison and from cows (exceptionally horse), occurring mainly in and around the Białowieża forest (Majewski 2008). It was suggested that the survival of this species may be uncertain, as it depends on preservation of the Białowieża Forest and its animals in an unchanged state (Majewski 1994). The record in Belgium indicates that *K. rehmanii* can also occur on *Acrotrichis* in small pockets of man-made forest in a largely industrialized and urbanized region. The strong anthropogenic influence in the Belgian locality is not at all comparable to the situation in the Białowieża Forest. This suggests that the occurrence of *K. rehmanii* is governed purely by the presence of dung from Galloways living in wet forests for a number of years. *K. rehmanii* could also be more common than expected, as the use of Galloways for forest management is a common practice throughout Belgium, the Netherlands and neighboring countries.

4. ***Monoicomyces homalotae*** Thaxt.

Proc. Amer. Acad. Arts Sci. **35**: 412. 1900.

= *M. ternatus* Speg., Anales Mus. Nac. Hist. Nat. Buenos Aires **27**: 67. 1915.

= *M. unilateralis* Speg., Anales Mus. Nac. Hist. Nat. Buenos Aires **27**: 68. 1915.

= *M. homalotae* Thaxt. var. *geostibae* Maire, Bull. Soc. Hist. Nat. Afrique Nord **7**: 8. 1916.

SELECTED ICONES: Thaxter 1908 (Pl. 35: 3–4, ut *M. britannicus*, PL. 35: 8–10); Huldén 1983 (Fig. 23, ut *M. britannicus*); De Kesel & Haghebaert 1991 (Fig. 2a, ut *M. britannicus*); Weir & Beakes 1993 (Figs 27 & 28); Santamaría 1994 (Figs 1–4); Majewski 1994 (Pls 112: 1–11, 114: 2 & 133: 1–9); De Kesel 2005 (Fig. 1: d–f).

This species was reported in Belgium on several representatives of the genus *Atheta* Thomson (Aleocharinae, Staphylinidae) originating from a wide variety of humid habitats: hayfield, gardens, salt marshes and compost from plants (De Kesel 2005). It is suggested that *M. homalotae* has a wide ecological amplitude. My record on *Atheta longicornis* (Grav.) from Galloway dung corresponds with the numerous records made in Białowieża forest (Poland, Majewski 2003).

SPECIMENS EXAMINED. Niel, on legs and elytra or entire body of *Atheta longicornis* (Col., Staphylinidae, Aleocharinae), in dung from Galloway cows, 19 Aug. 2009, *A. De Kesel 4737 (a,b,c)* (BR); ibid. *A. De Kesel* 4738 (BR).

5. ***Monoicomyces invisibilis*** Thaxt.

Proc. Amer. Acad. Arts Sci. **35**: 414. 1900.

= *Eumonoicomyces invisibilis* (Thaxt.) Thaxt., Mem. Amer. Acad. Arts Sci. **13**: 275. 1908.

= *Eumonoicomyces argentinensis* Speg., Anales Mus. Nac. Hist. Nat. Buenos Aires **23**: 188. 1912.

= *Monoicomyces affinis* Speg., Anales Mus. Nac. Hist. Nat. Buenos Aires **27**: 65. 1915.

= *Monoicomyces furcatus* Thaxt., Mem. Amer. Acad. Arts Sci. **16**: 41. 1931.

= *Monoicomyces oxyteli* Huldén, Karstenia **23**: 61. 1983 (as *M. oxytelis*).

SELECTED ICONES: Thaxter 1908 (Pl. 37: 7–8, ut *Eumonoicomyces invisibilis*); Huldén 1983 (Fig. 21–20, ut *M. furcatus*; 22, ut *M. oxyteli*); De Kesel & Haghebaert 1991 (Fig. 2c); Majewski 1994 (Pls 115: 1–9 & 116: 1–3); De Kesel 2005 (Fig. 3: c–d).

The first Belgian record of *M. invisibilis* on a dung-inhabiting staphylinid was on *Oxytelus laqueatus* (Marsham) (Staphylinidae, Oxytelinae) (De Kesel 2005). *M. invisibilis* is common in Western Europe, but also known from the Azores, North and South America and Asia (Santamaría *et al*. 1991).

SPECIMENS EXAMINED. Niel, on the abdominal tergites and apical edge of the elytra of *Oxytelus* sp. (Col., Staphylinidae), in dung from Galloway cows, 19 Aug. 2009, *A. De Kesel 4739* (BR).

6. ***Monoicomyces matthiatis*** T. Majewski

Fig. 1d–f

Acta Mycol. **25**: 49. 1990.

ICONES: Majewski 1990 (Fig. 4); Majewski 1994 (Pl. 111: 12–17).

Thallus 81–109 μm long, pale yellowish throughout, except for the darker amber-yellowish lower wall cells of the perithecium. Basal cell of the receptacle large, obtriangular to obovoid, suprabasal cell isodiametric. Primary appendage up to 42 μm long, very fragile and often damaged, consisting of a basal cell carrying a laterally bent simple branch, the latter composed of two narrow and elongate cells, the distal one up to 3 times longer than the basal one. Secondary receptaculum one-celled, carrying a single perithecium and antheridium. Stalk cell of the perithecium isodiametric, distally broadened, 11–27 μm high. Perithecium 52–60 × 25–30 μm, asymmetrical and bent, broadest near the base, gradually tapering towards the apex, with minute teeth near the ostiolum (concave side); ostiolum simple, without differentiated lips. Antheridial appendage broadly clavate, 30–42 × 10–14 μm, composed of an isodiametric to slightly constricted stalk cell, followed by three subequal tiers of paired cells, the upper ones each giving rise to a minute apical outgrowth (1–4 μm); ascospores not seen.

SPECIMENS EXAMINED. Niel, on abdominal tergite of female *Platystethus* cf. *arenarius* (Fourcroy) (Col., Staphylinidae, Oxytelinae), in dung from Galloway cows, 19 Aug. 2009, *A. De Kesel 4741, 4743, 4744* (BR); ibid., next to the thorn of the last abdominal sternite of a male *Platystethus* cf. *arenarius* (Col., Staphylinidae, Oxytelinae), *A. De Kesel 4742* (BR).

Majewski (1990, 1994) describes the primary appendage of *Monoicomyces matthiatis* as an elongate basal cell carrying a distal branch which is unicellular (?), 3–4 times longer than the subtending cell, and directed laterally. Majewski (1994) mentions that both cells are separated by a subterminal dark septum. In his drawings the darkening of this septum appears to be weak. My material shows only very weak suffusion at this septum, usually when the distal cell is damaged. Despite the difference I consider this material conspecific with *Monoicomyces matthiatis*. The most important common characters are the slender thallus with hyaline primary appendage, perithecial stalk, receptacle and secondary axes. The presence of a one-celled secondary receptacle bearing a stout, typically bent and short-necked perithecium, makes this taxon easy to separate from other *Monoicomyces*.

Monoicomyces matthiatis is new for Belgium. Previously it was reported only from Poland on *Platystethus arenarius* (Fourcroy) (Majewski 2008). It is a rare species and since its description it was reported from few localities. Infected hosts were found in dung from sheep (type) and cows (Majewski 1994, 2008).

A different infection pattern was observed for male (2) and female (4) hosts. Males have their thalli only next to the two small thorns of the abdominal sternite (10 and 4 thalli). Females are infected exclusively on the very edge of the last abdominal tergite (7, 1, 4 and 3 thalli). More material is needed to determine whether this gender-related distribution of thalli is common and due to direct infection between mating hosts.

CONCLUSIONS

The whole of Professor Tomasz Majewski's contribution to the Laboulbeniales is of great systematic and taxonomic importance to many laboulbeniologists in and outside Europe. His work is also an important reference from an ecological point of view. By publishing very accessible and excellent taxonomic, ecological and distributional data, his work enables one to proceed into specific and more ecologically delimited subjects. Based on his most recent work (Majewski 2003, 2008), we chose to investigate Laboulbeniales from hosts living in dung, a subject largely unexplored in Belgium. Finding *Monoicomyces matthiatis* and *Kainomyces rehmanii* in a man-made environment in Belgium was unexpected, because both parasites are rare and the latter is known mostly from more natural habitats in Poland. For local nature conservation (Belgium) this result is very interesting, because it indicates that nature management with Galloway cows does more than increase structure in the forest; it also brings a range of coprophilic insects together with a relatively rich community of six ectoparasitic fungi.

It is interesting to know that Majewski's work treats many more such ecologically delimited communities of hosts and Laboulbeniales, and that they are almost unexplored in many parts of Europe. With his oeuvre (especially Majewski 1994, 2003, 2008), Professor Majewski has given us excellent basic tools to initiate and conduct this type of research. The ecological data available from his work will serve us as an outstanding reference for comparison, and it will lead us to disclose other rare and new taxa in Europe.

ACKNOWLEDGEMENTS. Special thanks to the referees for reviewing the manuscript and to Erik De Keersmaecker (conservator of the Waelenhoek Reserve).

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Received 2 March 2010