

BELGIAN RECORDS OF LABOULBENIALES FROM AQUATIC INSECTS

André DE KESEL¹ & Tom WERBROUCK²

¹National Botanic Garden of Belgium, Domein van Bouchout, B-1860 Meise, Belgium (ADK@BR.FGOV.BE)

²Kievitlaan 176, 1800 Vilvoorde

Summary

This paper presents descriptions and illustrations of eight Laboulbeniales found on aquatic Coleoptera and Heteroptera from old clay-pits and other ponds in Flanders (Belgium). An identification key is provided. Seven species are new for Belgium.

Samenvatting

Dit artikel geeft beschrijvingen en illustraties van acht Laboulbeniales afkomstig van waterkevers en -wantsen, gevonden in oude kleiputten en enkele andere plassen in Vlaanderen. Een determinatiesleutel wordt gegeven. Zeven soorten zijn nieuw voor België.

Keywords: Laboulbeniales, Coleoptera, aquatic, taxonomy, key.

Introduction

The first Belgian specimens of Laboulbeniales from aquatic insects were found by A. Collart (1945). He reported *Laboulbenia gyriticola* Speg., a widespread and frequently found parasite of the whirligig beetles (Coleoptera, Gyridae) (Santamaría 1998). While screening Collart's collection, we could not trace the slides of this species and it is most likely that they are lost.

In an attempt to find new material of *L. gyriticola*, we sampled aquatic beetles in several ponds in the Provinces of Antwerp, Oost- and West-Vlaanderen, as well as part of the insect collections at the Royal Belgian Institute of Natural Sciences. The latter collection did not yield infected material, as the specimens came from rivers, an apparently unsuitable environment for Laboulbeniales. Our own fieldwork, however, brought a number of aquatic Coleoptera with laboulbeniacean parasites from several genera, including the one we were looking for. This paper presents a preliminary report on the available collections of 'aquatic' Laboulbeniales in Belgium.

Material and methods

Most aquatic insects were collected in Niel Waelenhoek (Prov. Antwerp), i.e. a nature reserve around clay-pits, reclaimed by nature since the early seventies. The pits are about 1,5 ha, with semi-stagnant water and a maximum depth of approximately 4 m in the centre. A few ponds were

studied in Bornem (Prov. Antwerp); these are much older and all situated in the alluvial area along the river Schelde. They are separated from the tidal river by dikes and consequently protected from flooding. All sampled ponds are meso- to eutrophic, and partly or entirely surrounded by either poplar plantations or fringed with mainly *Salix*, *Alnus* and/or *Fraxinus*.

The insects were captured with a metal net (mesh 0.2mm) and preserved in 70-80% denaturated ethanol.

All thalli were removed using a dissecting microscope and mounted on permanent slides with Amann's medium and following the protocols of (Benjamin 1971) and (De Kesel 1998). The microscope slide collection and all infected insects are kept at BR (abbr. following Holmgren & Holmgren 1998). Drawings and measurements were made from intact specimens, using an Olympus BX51 light microscope with digital camera and AnalySIS Five imaging software (Soft Imaging System GmbH).

Hosts were identified using the keys of Drost et al. (1992) for Coleoptera and Nieser (1982) for Heteroptera. For specific nomenclature, terminology or extensive iconography of Laboulbeniales we refer to Santamaría (1998, 2003) and Majewski (1994). Cell numberings in *Chitonomyces* and *Hydraeomyces* are indicated and follow Santamaría (2003).

Key to the species

1. Perithecial wall cells short, numerous, equal or subequal in height (fig. 1a) *Rhynchophoromyces anacaenae*
1. Perithecial wall cells usually by 4 or 5 in each vertical row, at least 2 rows of unequal height 2
2. Perithecium borne inside the distal cells of the receptacle, i.e. a true prolongation of the lower receptacle and distal on the thallus axis (fig. 1b) *Coreomyces arcuatus*
2. Perithecium borne lateral on the receptacle - appendage axis 3

3. Antheridia formed below the reduced, two-celled primary appendage 4
 3. Antheridia formed on well developed primary appendage 7
4. Perithecial wall with unequal cell rows, two rows with short cells (up to 7), two rows with taller (less) cells; perithecial or receptacular outgrowths absent (fig. 2d-e) *Hydraeomyces halipli*
 4. Perithecial wall with similar cell rows; perithecial or receptacular outgrowths present 5
5. Perithecial wall with a conspicuous, thorn-like apical outgrowth (fig. 2c, immature) *Chitonomyces paradoxus*
 5. Perithecial wall without such an outgrowth, sometimes with prominent ostiolar lips 6
6. Cell IIIa black, not proliferating, triangular; basal cell of primary appendage dark-brown to black, apically hooked (fig. 2a) *Chitonomyces melanurus*
 6. Cell IIIa darkened, producing an arcuate outgrowth; basal cell of primary appendage hyaline, campanulate, not hooked (fig. 2b) *Chitonomyces italicus*
7. Cell III taller than cell IV; perithecial outgrowths rounded or lobed (fig. 1c) *Laboulbenia fennica*
 7. Cell IV equal or taller than cell III; two apical perithecial outgrowths, one elongated hooked, the other short pointed (fig. 1d) *Laboulbenia gyrinicola*

Description of the species

1. *Rhynchophoromyces anacaenae* Scheloske

Parasitol. Schriftenreihe **19**: 143 (1969)

Syn.: *R. anacaenae* Scheloske subsp. *nasutellus* Sarna & Milewska. Acta Mycol. **13**: 307 (1978)

Select. icones: Majewski 1994 (Pl. 3: 1-9); **Fig. 1a**

Thallus yellow-brown to dark brown, 530-750 µm long. Lower receptacle composed of 7-12 cells of equal width, the basal cell triangular, the other more or less flattened to rounded. Appendage composed of 5-11 cells, with branches turned towards the perithecium. Cell VI and VII flattened. Perithecium 390-600 × 35-85 µm; with a strongly curved elongated neck of 275-450 µm × 18-37 µm; outer wall cells organised in vertical rows of 32-45 cells.

Studied material: On *Anacaena lutescens* Stephens. Ardoie, Koolkamp, eutrophic ditch, February-March 2007, specimen infected on the inside of the epipleura (elytra), *T. Werbrouck* 167.

Specificity and geographical distribution: *Rhynchophoromyces* (Ceratomycetaceae) occurs on Hydrophilidae (Coleoptera) from the genus *Anacaena* Thomson. Eight species are known worldwide; two are reported from Europe, i.e. France, Germany, Italy, Poland and Spain (Santamaría et al. 1991, Majewski 1994).

Remarks

In some thalli the perithecial neck shows a discontinuity in the outer wall cells, usually manifested at some point by a marked change in density and colour of the cells. We think that this abrupt change may be the result of regeneration after

damage. More material is needed, preferably from experimental ex situ populations, to explain/understand the origin of this feature.

2. *Coreomyces arcuatus* Thaxt.

Mem. Amer. Acad. Arts Sci. **16**: 324 (1931)

Select. icones: Majewski 1994 (Pl. 19: 1-10); **Fig. 1b**

Thallus 220 µm long, yellowish-brown except for the amber-brown perithecium and hyaline appendages. Lower receptacle slightly bent; cell I triangular, cell II, III, IV and IVa 2-3 times higher than broad. Intercalary cells (between cell III and IV) flattened, laterally producing thin and minute hyaline appendages of 20-40 µm long, the latter sterile or antheridial. Perithecium 65 × 25 µm, the neck about as long as the venter, bent in the same direction as the lower receptaculum, giving the entire thallus an arched aspect.

Studied material: On *Sigara striata* Linnaeus (Heteroptera). Retie, Witte Nete, 11.x.1983 (leg. Th Vercauteren, PIH), thalli on the central part of the fifth abdominal sternite, *T. Werbrouck* 171. (this material is lost, only digital images from the specimens are left)

Specificity and geographical distribution

Coreomyces Thaxt. (Laboulbeniaceae) parasitizes aquatic Heteroptera (Corixidae) from the genera *Sigara* Fabricius, *Callicorixa* White and *Centrocorisa* Lundblad. The genus counts 20 species (Santamaría 2003), four in Europe (Majewski 1994). *C. arcuatus* is known from Bulgaria, Poland (Majewski 1994).

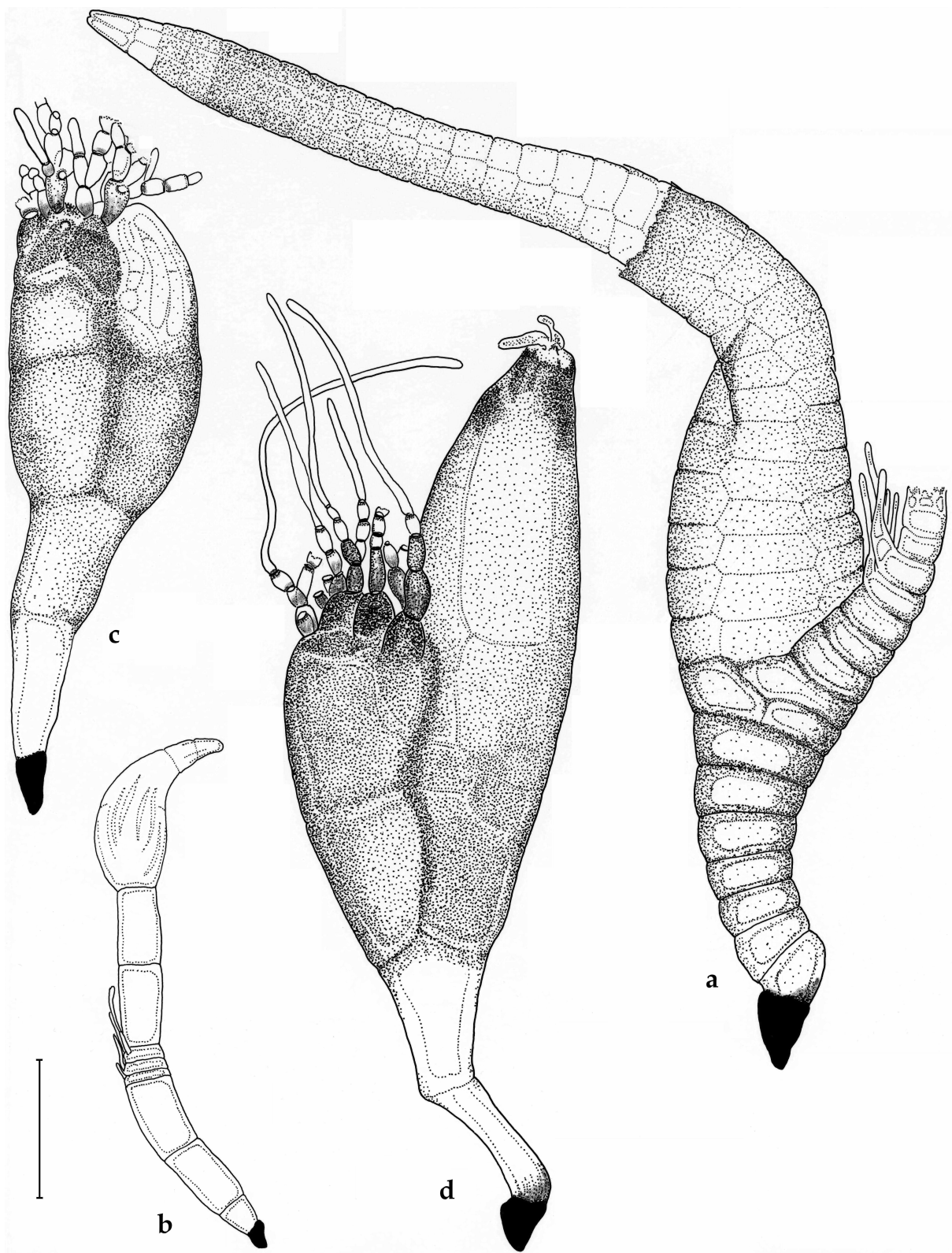


Figure 1. Laboulbeniales. **a.** *Rhynchophoromyces anacaenae* Scheloske, thallus from *Anacaena lutescens* (T. Werbrouck 167); **b.** *Coreomyces arcuatus* Thaxt., thallus from *Sigara striata* (T. Werbrouck 171); **c.** *Laboulbenia fennica* Huldén, immature thallus from *Gyrinus substriatus* (A. De Kesel 4152b); **d.** *Laboulbenia gyrinicola* Speg. from *Gyrinus marinus* (A. De Kesel 4663). Scale bar = 50µm.

Remarks

Our material is smaller compared to the data given in Majewski (1994). The number of intercalary cells can vary between 2 and 4.

The thalli of *Coreomyces* have a peculiar construction and development. In a very early stage the young thallus develops a receptaculum from the basal cells. A perithecium is then derived from the most distal cells, while the central cells stay intercalary to produce appendages and eventually antheridia (Thaxter 1908).

3. *Laboulbenia fennica* Huldén

Karstenia **23**: 54 (1983)

Select. icones: Huldén 1983 (Fig. 97: a-c, Fig. 97: h-i); Majewski 1994 (Pl. 64: 1-11); Santamaría 1998 (Fig. 13: f-i); **Fig. 1c**

Thallus 240-450 µm long (immature specimen), dark olive-brown, except for the almost hyaline lower receptacle, appendages and apex of the perithecium. Cell I and II at least twice higher than wide; cell III higher than wide, always 1,3-1,5 times higher than cell IV, the latter isodiametrical in optical section. Cell V less than half the height of cell IV, obtriangular. Appendages born on small rounded cells above cell V and IV, thin, numerous, ramified near their base, all septa are black. Perithecium (data from Majewski 1994) 125-250 × 50-100µm, 2/3 free, gradually tapering upwards, with subapical darkening and two apical outgrowths; each of these divided in two short unequal lobes; usually with a black spot between the lobes. Spores 75-80 × 5-8 µm.

Studied material: On *Gyrinus substriatus* Stephens. Bornem (B), Branst, in a meso- to eutrophic pond (named 'Beerdonk'), IFBL D4.12.22, 04.iv.2007, specimens infected on the edge of right elytron, *A. De Kesel* 4152 (3 slides, 15 juvenile thalli).

Specificity and geographical distribution:

Laboulbenia is a very important and large genus, with more than 550 species worldwide, 100 in Europe (Tavares 1985, Santamaría et al.1991, Majewski 1994) and 36 in Belgium (De Kesel 1998). Most species parasitize terrestrial coleopteroid hosts. *L. fennica* is reported on *Gyrinus* Linnaeus (Coleoptera, Gyrinidae) from Finland, Spain, United Kingdom and the former USSR (Santamaría et al. 1991, Majewski 1994, Santamaría 1998).

Remarks

Our material is not entirely mature and none of the perithecia have reached their full size. The height of the receptacular cells III and IV, however, enables to identify this material as *L. fennica* because cell III is taller than cell IV. In young and adult thalli of *L. gyrenicola* (see below), cell IV is taller than cell III.

4. *Laboulbenia gyrenicola* Speg.

Redia **10**: 34 (1914)

Select. icones: Huldén 1983 (Fig. 97: d-g); Majewski 1994 (Pl. 63: 2-12); Santamaría 1998 (Fig. 15: c-f); **Fig. 1d**.

Thallus 270-340 µm long, dark-brown to blackish-brown, except for the lower cells I and II. Cell I bent, slender, pale, at least twice higher than wide; cell II pale, broadened towards the septum with cell III and cell VI; cell III higher than wide, shorter than cell IV; cell V about half the height of cell IV, obtriangular, located in the upper inner corner of cell IV. Branchlets of the appendages thin, fragile, hyaline, up to 30-80 µm long, formed on densely packed, small rounded and dark septate cells that are born on top of the cell V and IV. Insertion cell not clear. Perithecium 133-150 × 50-66µm, at least half-free, gradually tapering upwards, subapically darkened, bearing two apical outgrowths, the posterior outgrowth straight, hyaline, apically hooked, 18-20µm long; the anterior shorter and bent. Spores 65-75 × 5-6 µm.

Studied material: (on 2 hosts, all Gyrinidae)

On *Gyrinus marinus* Gyllenhal. Niel, 18.viii.2008, Walenhoek, meso- to eutrophic pond (reclaimed clay-pit), thalli on the outer margin of left and right elytron of a female, *A. De Kesel* 4662; *ibid.*, 18.viii.2008, on the left elytral margin of a male, *A. De Kesel* 4663.

On *Gyrinus natator* (L.). Rijmenam, without date or specimen, was reported by Collart (1945). This material is untraceable, probably lost.

Specificity and geographical distribution

L. gyrenicola parasitizes *Gyrinus* Linnaeus and *Aulonogyrus* Régimbart (Coleoptera, Gyrinidae) (Santamaría et al. 1991) and *Orectochilus* Dejean (Majewski 1994). Europe and North Africa (Santamaría et al. 1991).

5. *Chitonomyces melanurus* Peyr.

Sitzungsber. Kaiserl. Akad. Wiss. (Wien), Math.-Naturwiss. Cl. **68**: 250 (1873)

Select. icones: Huldén 1983 (Fig. 46); Majewski 1994 (Pl. 70: Fig. 5-11); Santamaría 2001 (Fig. 33); Santamaría 2003 (Fig. 33); **Fig. 2a**.

Thallus 115-135 µm long, 25-40 µm wide, blackish-brown to amber-brown. Cell I and cell Ia approximately 1,5 higher than broad; cell III much longer than broad; cell IIIa the same width as cell III, but shorter and pigmented black, supporting an apically hooked dark-brown to blackish cell (i.e. the basal cell of primary appendage), up to 45 - 105 µm long. Perithecium fusiform, 80-110 × 15-30 µm, assymetrical, with a broad apex and two large lobed lips of 10-30 × 5-15 µm each.

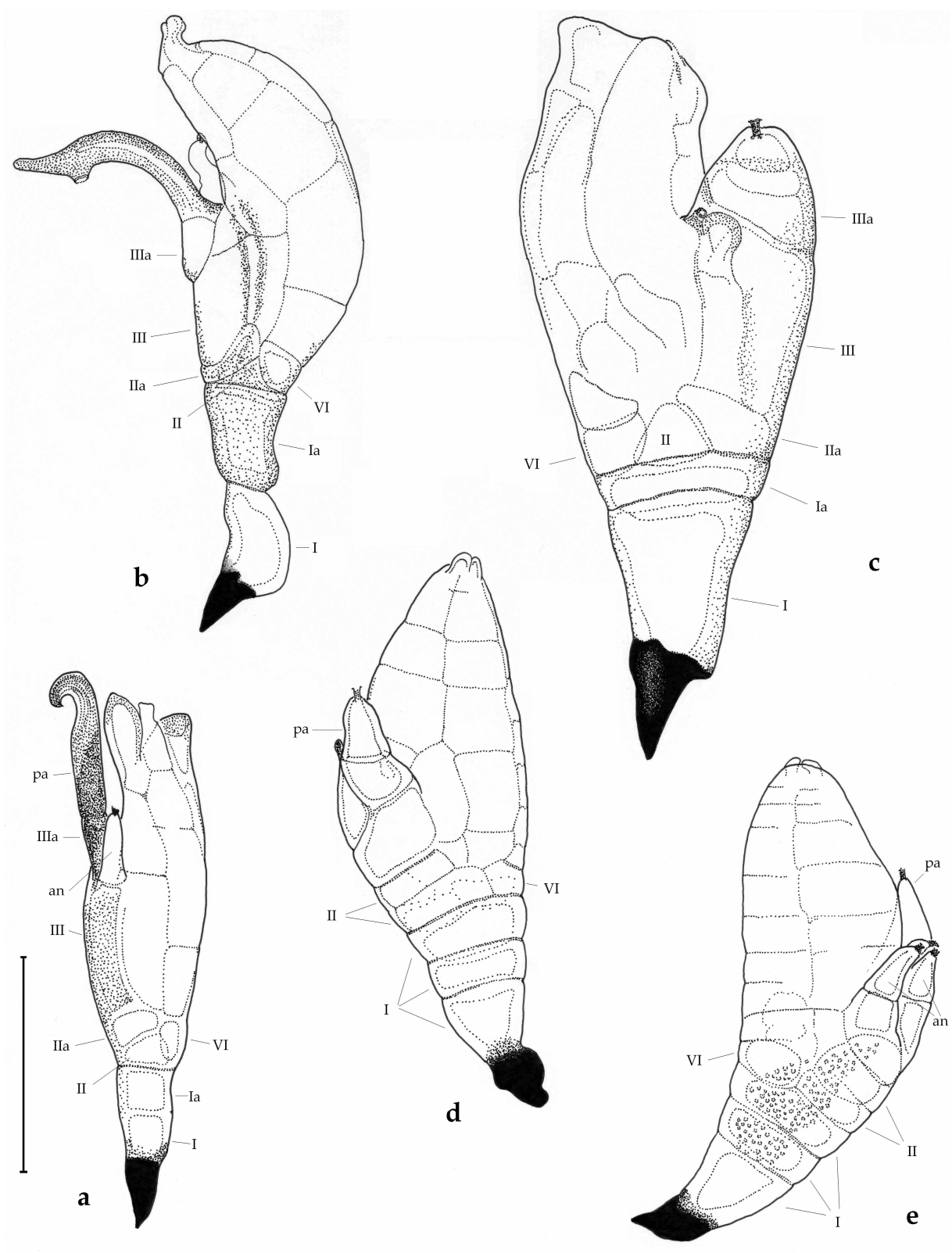


Figure 2. Laboulbeniales. **a.** *Chitonomyces melanurus* Peyr. thallus from *Laccophilus hyalinus* (A. De Kesel 4149b); **b.** *Chitonomyces italicus* Speg. thallus from *Laccophilus hyalinus* (A. De Kesel 4149c); **c.** *Chitonomyces paradoxus* (Peyr.) Thaxt., immature thallus from *Laccophilus hyalinus* (A. De Kesel 4149a); **d-e.** *Hydraemyces halipli* (Thaxt.) Thaxt. thallus from *Haliplus lineolatus*, **d.** right side, **e.** left side (both thalli in A. De Kesel 4147). Abbr.: pa = primary appendage, an = antheridium. Scale bar = 50 μm.

Studied material: On *Laccophilus hyalinus* Degeer. Niel(B), 30.x.2006, Walenhoek, pond (reclaimed clay-pit), A.D e Kesel 4149b.

Specificity and geographical distribution

Chitonomyces Peyr. (Laboulbeniaceae) is a large genus with 97 species worldwide, nine species in Europe (Tavares 1985, Santamaría et al. 1991, Majewski 1994, Santamaría 2003).

Chitonomyces melanurus is position specific and develops almost exclusively on the upper margin of the left elytron of beetles belonging to the genus *Laccophilus* Leach (Coleoptera, Dytiscidae). Information on variability and exceptions on the infection site are given by Santamaría (2003). It is a relatively common species, usually found together with *Chitonomyces paradoxus* (see below). It is reported from Austria, Finland, France, Germany, Hungary, Italy, Poland, Spain, United Kingdom, former Yugoslavia and former U.S.S.R (Santamaría et al. 1991, Majewski 1994, Santamaría 2003).

6. *Chitonomyces italicus* Speg.

Anales Mus. Nac. Hist. Nat. Buenos Aires **27**: 46 (1915)

Lectotype designated in Santamaría (2001b)

Select. icones: Majewski 1994 (Pl. 70: 12-17); Santamaría 2001 (Fig. 24-25, 30-31, 42); Santamaría 2003 (Fig. 32); **Fig. 2b**.

Thallus yellowish to amber-brown, paler at the tip of the perithecium, 135-175 µm long. Cell I elongate, sigmoid or arcuate. Cell Ia shorter than cell III, tapering downwards, slightly darker than cell I. Cell III 1.5-3 times longer than wide. Cell IIIa forms an outwardly directed, straight, arcuate to sigmoid, darkened, sometimes lobate, distal outgrowth of up to 50 µm long. Perithecium 70-110 × 25-20 µm, assymetrical, fusiform (widest in the middle), with almost straight posterior side (with cell III) and convex anterior side; apex tapering, papillate and blunt.

Studied material: On *Laccophilus hyalinus* Degeer. Niel(B), 30.x.2006, Walenhoek, pond (reclaimed clay-pit), thalli on tarsal processus, A. De Kesel 4149c.

Specificity and geographical distribution

Only reported on *Laccophilus* Leach (Coleoptera, Dytiscidae) and known from Italy, Germany, Poland and Spain (Majewski 1994, Santamaría 2003).

Remarks

This species is extremely position-specific as the thalli exclusively grow on the tarsal processus of the left hind leg. The species is also very cryptic because it is small, hidden and concolorous with the tarsal cuticula.

This host specimen was also infected with *Ch. melanurus* and *Ch. paradoxus*. Questions may rise whether these 3 taxa are growth forms of the same

species or three genuine species. Molecular analysis is needed to resolve this issue.

7. *Chitonomyces paradoxus* (Peyr.) Thaxt.

Proc. Amer. Acad. Arts Sci. **12** : 287 (1896)

Basionym: *Heimatomyces paradoxus* Peyr. Sitzungsber. Kaiserl. Akad. Wiss. (Wien), Math.-Naturwiss. Cl. **68**: 251 (1873)

Syn.: *C. truncatus* Speg., Anales Mus. Nac. Hist. Buenos Aires **27**: 47 (1915)

Select. icones: Huldén 1983 (Fig. 48); Majewski 1994 (Pl. 68: 4-9, Pl. 69: 1-11); Santamaría 2001 (Fig. 21-23, Fig. 27-29, Fig. 37); Santamaría 2003 (Fig. 34); **Fig. 2c**.

Thallus amber-brown 170 µm long (without the horn or outgrowth). Cell I obtriangular, slightly darker on one side (posterior). Cell Ia flattened, approximately five times wider than high. Cell III twice as high than wide; cell IIIa flattened, about twice as wide as high. Perithecium 100 × 30 µm, large, assymetrical; ostiolum lateral, directed posteriorly; apex of the anterior row of outer wall cells bearing a thorn-like outgrowth of 20µm long (up to 100µm in mature specimens Majewski 1994).

Studied material: On *Laccophilus hyalinus* Degeer, Niel(B), 30.x.2006, Walenhoek, reclaimed clay-pit, thalli exclusively on the lower margin of the left elytron, A. De Kesel 4149a.

Specificity and geographical distribution

On *Laccophilus* Leach (Coleoptera, Dytiscidae), in Germany, Italy, Poland and Spain (Majewski 1994, Santamaría 2003).

Remarks

This specimen was found on a specimen of *L. hyalinus* also infected with *Ch. italicus* and *Ch. melanurus* (see above).

8. *Hydraeomyces halipli* (Thaxt.) Thaxt.

Mem. Amer. Acad. Arts Sci. **12**: 294 (1896)

Basionym.: *Heimatomyces halipli* Thaxt., Proc. Amer. Acad. Arts Sci. **27**: 32 (1892)

Syn.: *H. cnemidoti* Thaxt., Mem. Amer. Acad. Arts Sci. **13**: 267 (1908); nom. nud.

Syn.: *H. venetus* Speg., Anales Mus. Nac. Hist. Buenos Aires **27**: 52 (1915)

Syn.: *Parahydraeomyces italicus* Speg. var. *neopolitanus* Speg., Anales Mus. Nac. Hist. Buenos Aires **27**: 70 (1915)

Select. icones: Huldén 1983 (Fig. 30); Tavares 1985 (Pl. 34: a-f); Majewski 1994 (Pl. 71: 1-8); Santamaría 2003 (Fig. 88); **Fig. 2d-e**.

Thallus yellow-brown, 90-150 µm long, 25-60 µm wide. Cell I obtriangular supporting 2 superposed flattened cells (cell Ia) with rough walls (left side only), the most distal one supporting cell VI and cell II, the latter double (with cell IIa superposed and also with roughened left side walls) and carrying cell III which is also double. The upper cell III carries two

antheridia, these tapering upwards with darkened tips. The remains of the trichogyne, originating from the dorsal side of the perithecium, usually adnate or at the same level of the antheridia (sometimes creating the illusion of a third antheridium). Basal cell of the primary appendage present, situated on the right of the thallus and well above the antheridia, bell shaped or tapering upwards, with an apical dark septum. Perithecium $35\text{--}75 \times 15\text{--}45 \mu\text{m}$, assymetrical, ovate to elongate, relatively voluminous, slightly paler than the rest of the thallus, with two ostiolar lobes; left and right rows of outer wall cells different, the ones on the right side of the perithecium (side of the primary appendage, fig. 2d) tall and bearing simple rounded ostiolar lobes, the ones on the left (antheridial side, fig. 2e) shorter, more numerous (6-7), and without ostiolar lobes.

Studied material: (on 4 hosts, all Haliplidae, Coleoptera)
 On *Haliplus lineatocollis* (Marsham), Niel (B), 30.x.2006, Walenhoek, reclaimed clay-pit, A. De Kesel 4145; *ibid.*, 19.viii.2008, A. De Kesel 4664, 4665;
 On *Haliplus immaculatus* Gerhardt, Niel (B), 30.x.2006, *ibid.*, A. De Kesel 4146;
 On *Haliplus lineolatus* Mannerheim, Niel (B), 30.x.2006, *ibid.*, A. De Kesel 4147;
 On *Haliplus ruficollis* (Degeer), Niel (B), 30.x.2006, *ibid.*, A. De Kesel 4148.

Specificity and geographical distribution

Hydraeomyces Thaxt. (Laboulbeniaceae) is a monospecific genus, close to *Chitonomyces*. It parasitizes the genera *Haliplus* Latreille and also *Peltodytes* Régimbart (*Cnemydotus*) (Coleoptera, Haliplidae) and is known from Albany, Finland, France, Germany, Italy, Poland, Spain, former USSR, but also North Africa, America and East-Asia (Santamaría et al. 1991, Majewski 1994, Santamaría 2003).

Remarks

The four infected *Haliplus*-hosts live in algae-rich and sun-exposed parts of a meso- to eutrophic pond. The populations are important and all host taxa are thought to have frequent contacts as they innately occupy the same habitat. The prevalence of *Hydraeomyces* on these four co-habiting host taxa is different (unpublished data) and needs further investigation.

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