

New records of Laboulbeniales (Ascomycota) from Ukraine

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Abstract: Twenty-four species of Laboulbeniales are reported for the first time from Ukraine. These species are *Cantharomyces robustus*, *Coreomyces* cf. *macropus*, *Euzodiomyces lathrobii*, *Haplomyces texanus*, *Idiomyces peyritschii*, *Laboulbenia argutoris*, *L. asperata*, *L. clivinalis*, *L. coneglianensis*, *L. elaphri*, *L. elaphricola*, *L. inflata*, *L. metableti*, *L. murmanica*, *L. ophoni*, *L. pasquetii*, *L. philonthi*, *L. pseudomasei*, *Mimeomyces zeelandicus*, *Monoicomyces invisibilis*, *Rhachomyces canariensis*, *R. lasiophorus*, *Rhadinomyces pallidus*, *Sphaleromyces lathrobii*. The genera *Coreomyces*, *Euzodiomyces*, *Haplomyces*, *Idiomyces*, *Mimeomyces* and the family *Euceratomycetaceae* are also new to the country.

Keywords: fungi, obligate insect ectoparasites, distribution, taxon occurrences, Europe

INTRODUCTION

The Laboulbeniales Lindau is a key order of the Laboulbeniomycetes Engl. that includes obligate ectobionts on arthropods, mainly insects (Santamaria & Pedersen, 2021). In Ukraine, this group of fungi received little attention, although the first publication (Sorokin, 1871) appeared a few years after the description of *Laboulbenia rougetii* Mont. & C.P. Robin, the first of the Laboulbeniales to be described (Robin, 1853). Recently, we prepared the first synopsis for 37 species of the Laboulbeniomycetes from Ukraine with historical overview of 21 species based on Siemaszko & Siemaszko (1928, 1932, 1934), Wize (1929), Huldén (1985), Majewski (1994, 2008), Haelewaters et al. (2019), Rossi & Christian (2020) and 16 new country records (Mishustin et al., 2022). These are members of the family Laboulbeniaceae G. Winter and Herpomycetaceae I.I. Tav. The present paper is the second contribution towards the knowledge of the diversity of the Laboulbeniales in our country.

MATERIALS AND METHODS

Insects were collected during 2021–2022 mainly in the urbanized and suburbs landscapes Kherson and Zakarpattia regions, 156 specimens in total. One fungus species was found in collections of I.I. Schmalhausen Institute of Zoology, National Academy of Science of Ukraine (SIZK). Host insects were collected using hand collecting and pitfall traps. Insects were kept in Eppendorf

tubes with ethanol (> 90%) accompanied by labels. Specimens were examined by standard microscope techniques using LOMO microscopes Optica and MICROMED-2. Permanent slides were prepared following the techniques described in Huldén (1983), Rossi & Santamaria (2015), and De Kesel et al. (2020). Photographs were taken with a Levenhuk C510 NG camera. Photos of all studied species are deposited in author's databases.

Species identification was carried out using the following key and catalogs: Santamaria et al., 1991, De Kesel et al., 2020, and Santamaria & Pedersen, 2021. Nomenclature of fungi follows Index Fungorum (2022) while insect names follow De Jong et al. (2014). All examined specimens are deposited in the herbarium of Kherson State University (mycological slides as KHER L together with insects as KHER i). The names of the main collectors in the taxon list are abbreviated as follows: RM – Ruslan Mishustin and AK – Alexander Khodosovtsev.

RESULTS

New Laboulbeniales occurrence records for Ukraine of 24 species are given hereafter. Five genera *Coreomyces* Thaxt., *Euzodiomyces* Thaxt., *Haplomyces* Thaxt., *Idiomyces* Thaxt. and *Mimeomyces* Thaxt. are new for Ukraine. All genera, except *Euzodiomyces*, are member of Laboulbeniaceae. The genus *Euzodiomyces* belong to the first recorded family Euceratomy-

cetaceae I.I. Tav. from Ukraine. Mainly, studied species of Laboulbeniales are found on Coleoptera Linnaeus, 1758 (24 species), exceptionally one on Hemiptera Linnaeus, 1758. Host species of Coleoptera belong to Carabidae Latreille, 1802 (16 species from 13 genera) and Staphylinidae Lameere 1900 (8 species from 8 genera). All Coleoptera species were found from terrestrial habitats on damp soil, but *Sigara* Fabricius, 1775 (Hemiptera) was collected from fresh water.

CANTHAROMYCES ROBUSTUS T. Majewski

This fungus has been reported from a few European countries (Belgium, The Netherlands, Poland, Spain, and from Ecuador) (Bernardi et al. 2014).

Specimens examined. On the pronotum of *Carpelimus* sp. (Coleoptera, Staphylinidae). – Zakarpattia Reg., Uzhhorod city, 48.619783° N, 22.259492° E, 11 May 2021, RM (KHER L00046, i00041).

COREOMYCES cf. **MACROPUS** Thaxt. (Fig. 1 A)

This species was described from Jamaica and reported from Bulgaria, Denmark, Poland, Romania, Russia, Spain, Sweden and Turkey (Santamaria & Pedersen, 2021). It is new record for the genus *Coreomyces* from Ukraine.

Specimens examined. A single thallus was found on the 5th segments of the anal sternite of male *Sigara longipalis* (J.Sahlberg, 1878) (Corixidae, Hemiptera). – Zakarpattia Reg., Uzhhorod city, 48.606049° N, 22.233151° E, 28 June 2022, RM (KHER L00191, i00149).

Notes – The thallus is more similar to illustration of *Coreomyces macropus* Thaxt. (Sundberg et al., 2021: Fig. 5c). In our material, the upper appendiculate cell is similar in size to IV cell. The species is variable and appearance of thalli depends on its location on the insect. The recently described *C. confusus* (Sundberg et al., 2021) is similar to our specimen as well, but for certain identify need molecular analyses.

EUZODIOMYCES LATHROBII Thaxt. (Fig. 1 B)

Widespread species, reported from various European countries, less common in North and South America, Asia and Africa (Santamaria & Pedersen, 2021). It is new record for the genus *Euzodiomyces* and family Euceratomycetaceae from Ukraine.

Specimens examined. On the elytra *Lathrobium* sp. (Coleoptera, Staphylinidae). – Zakarpattia Reg., Uzhhorod city, 48.619783° N, 22.259492° E, 11 May 2021, RM (KHER L00050, i00043).

HAPLOMYCES TEXANUS Thaxt. (Fig. 1 C)

The species was found in the USA, in various European countries and in Asia (Santamaria & Pedersen, 2021). The genus *Haplomyces* is new for Ukraine.

Specimens examined. On the anal tergite of *Bledius (Hesperophilus) crassicolis* Lacordaire (Coleoptera, Staphylinidae). – Zakarpattia Reg., Uzhhorod city, 48.616506° N, 22.256222° E, 08 June 2021, RM (KHER L00064, i00054).

IDIOMYCES PEYRITSCHII Thaxt.

It is known from the USA, from Japan and from several countries of Europe (Santamaria & Pedersen, 2021). The genus *Idiomyces* is reported for the first time from Ukraine.

Specimens examined. On the anal tergite of *Deleaster dichrous* Gravenhorst (Coleoptera, Staphylinidae). – Ivano-Frankivsk Reg., Verkhovyna Dist., Verkhovinsky National Nature Park, 47.800382° N, 24.953805° E, 11 July 2021, AK (KHER L00115, i00092).

Notes – A single, not fully mature thallus was observed, which however is unmistakable.

LABOULBENIA ARGUTORIS Cépède & F.Picard

This fungus is relatively common in Europe, rare in Asia (Japan) (Santamaria & Pedersen, 2021).

Specimens examined. On the pronotum and elytra of *Pterostichus (Phonias) strenuus* Panzer (Coleoptera, Carabidae). – Kherson Reg., Kherson Dist., Antonivka village, 46.674903° N, 32.780847° E, 13 May 2021, RM (KHER L00107, i00086).

Notes – The parasites on *Pterostichus strenuus* can be found together with *Laboulbenia kajaniensis*, but the latter species has shorter cells III and IV and more slender cell II than *L. argutoris*.

LABOULBENIA ASPERATA Thaxt. (Fig. 1 D)

The species was described from Argentina (Thaxter, 1912) and later collected in Belgium, Bulgaria, Ecuador, Spain and Turkey (Barragán et al., 2013; Rossi et al., 2019).

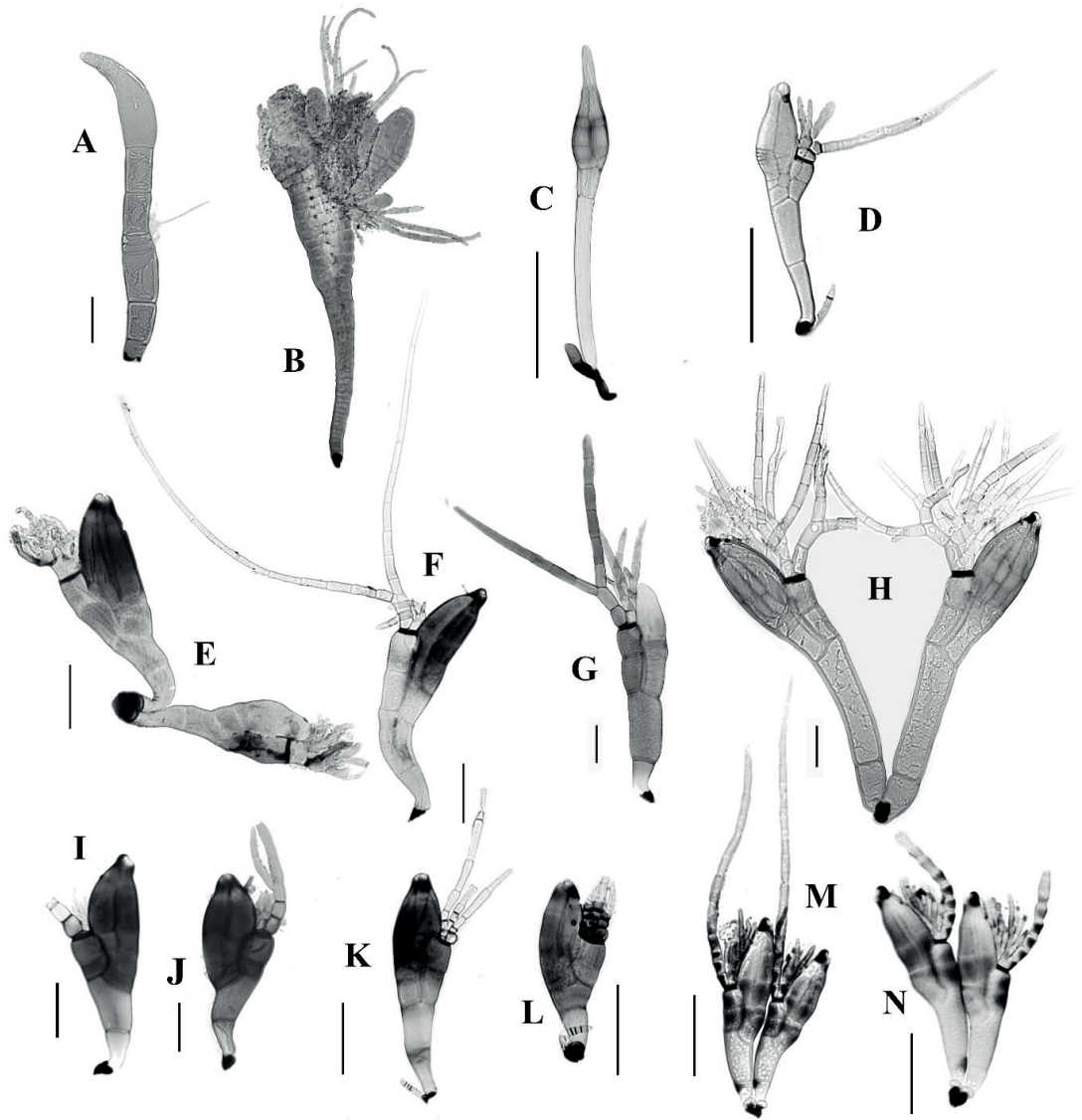


Fig. 1. The morphology of Laboulbeniales specimens. A – *Coreomyces* cf. *macropus* (KHER L00191), B – *Euzodiomyces lathrobii* (KHER L00050), C – *Haplomyces texanus* (KHER L00064), D – *Laboulbenia asperata* (KHER L00128), E – *L. clivinalis* (KHER L00058), F – *L. coneglianensis* (KHER L00108), G – *L. elaphri* (KHER L00193), H – *L. elaphri* (KHER L00198), I – *L. elaphricola* (KHER L00048), J – *L. elaphricola* (KHER L00194), K – *L. inflata* (KHER L00106), L – *L. inflata* (KHER L00121), M – *L. metableti* (KHER L00081), N – *L. metableti* (KHER L00060). Scale bars = 50 μ m.

Specimens examined. On the pronotum and elytra of *Tachys (Paratachys) bistriatus* (Duftschmid) (Coleoptera, Carabidae). – Kherson Reg., Kherson Dist., Antonivka village, 46.674903° N, 32.780847° E, 13.05.2021, RM (KHER L00102, L00103, i00080-1-3); on elytra *Tachys (Paratachys)* sp. – Kherson Dist., Zelenivka village, 46.708162° N, 32.609488° E, 20.08.2021, RM (KHER L00128, i00102).

Notes – The fungus is characterized by transverse wrinkles on ventral side of the perithecium.

LABOULBENIA CLIVINALIS Thaxt. (Fig. 1 E)

It is a widespread species in Europe, Asia, Africa and North America (Santamaria & Pedersen, 2021).

Specimens examined. On pronotum, thoracic segments, elytra, abdominal sternites and legs of *Clivina collaris* Herbst (Coleoptera, Carabidae). – Zakarpattia Reg., Uzhhorod city, 48.619783° N, 22.259492° E, 11 May 2021, RM (KHER L00056, L00057, L00058, i00049-1-3).

LABOULBENIA CONEGLIANENSIS Speg. (Fig. 1 F)

Recently, the distribution of the species in Europe, Asia and Africa was given by Santamaria & Pedersen (2021).

Specimens examined. On pronotum, thoracic segments, elytra, abdominal sternites and legs of *Harpalus affinis* (Schrank) (Coleoptera, Carabidae). – Zakarpattia Reg., Uzhhorod city, 48.610320° N, 22.259786° E, 11 May 2021, RM (KHER L00093, i00073); *idem.*, 48.618630° N, 22.263457° E, 11 May 2021, RM (KHER L00108, L00109, i00088-1-2).

Notes – The species is similar to *Laboulbenia rougetii*, but differs from the latter by the septum II-III clearly shorter than septum II-VI, cell V clearer than surrounding structures, and *Harpalus* spp. as host insects (De Kesel et al., 2020). *Laboulbenia coneglianensis* differs from the similar *L. flagellata* by the full black ring area below the perithecial ostiole whereas both preostiolar spots in *L. flagellata* are separated (Santamaria & Pedersen, 2021).

LABOULBENIA ELAPHRI Speg. (Fig. 1 G, H)

Reported so far only from Europe: it was found in Belgium, Denmark, Czech Republic, Finland, Germany, Hungary, Latvia, Poland, Sweden, Russia and Switzerland (Santamaria & Pedersen, 2021).

Specimens examined. On *Elaphrus cupreus* Duftschmid (Carabidae, Coleoptera). – Kharkiv Reg., Izyumsky Dist., Savintsy village, bank of the river Seversky Donets, 49.383236° N, 37.052024° E, 24.06.1988, A. Puchkov (KHER L00136, i00111, SIZK-K70); Zakarpattia Reg., Uzhhorod city, 48.620573° N, 22.270840° E, 10 June 2022, RM (KHER L00193, L00197, L00198, i00150-1-3 together with *Laboulbenia elaphricola*); *idem.*, 20 July 2022, RM (KHER L00204, i00155).

Notes – The species is difficult to identify. Thalli from surface of the pronotum and elytra have the most typical shape (Fig. 1 G) with outer appendage bifurcates into two subequal branches. Thalli from the thoracic segments and limbs of the beetle have much more numerous and branched appendages (Rossi et al., 2010). Similar dimorphism was described in other *Laboulbeniales* for example in *Laboulbenia biformis* W. Rossi and *Rhachomyces dimorphus* W. Rossi occurring on *Diploharpus rossii* Moret from Ecuador (Rossi & Proano Castro, 2009; Rossi, 2011). *Laboulbenia elaphri* from lower part of *Elaphrus* (Fig. 1 H) can be confused with *L. flagellata*. However, in *L. elaphri*, the upper part of perithecium is wider and flattened shape in contrast with *L. flagellata* which bears a narrow upper part of perithecium (Santamaria & Pedersen, 2021). The presence of several thalli at different ages of the fungus from different parts of the insect are the key to successful species identification.

LABOULBENIA ELAPHRICOLA J.Siemaszko & W.Siemaszko (Fig. 1 I, J)

It is a rare species described from Poland (Siemaszko & Siemaszko, 1928), rediscovered in Latvia almost 80 years later (De Kesel & Krastina-De Kesel, 2006) and more recently found in Austria (Rossi & Christian, 2020).

Specimens examined. On the head, antennae, pronotum, thoracic segments, legs, elytra, abdominal sternites of *Elaphrus (Elaphroterus) aureus* P. Muller (Coleoptera, Carabidae). – Zakarpattia Reg., Uzhhorod city, 48.619783° N, 22.259492° E, 11 May 2021, RM (KHER L00047, i00042-1-48). On *Elaphrus cupreus* Duftschmid (Carabidae, Coleoptera). – Uzhhorod city, 48.620573° N, 22.270840° E, 10 June 2022, RM (KHER L00194, L00199, i00150-2-3. Together with *Laboulbenia elaphri*).

Notes – This fungus is completely different from the abovementioned *L. elaphri* and it is similar to *L. vulgaris*. *Laboulbenia elaphricola* differs mainly from *L. vulgaris* in the wider and shorter III cell.

LABOULBENIA INFLATA Thaxt. (Fig. 1 K, L)

This species was collected mainly in European countries, less commonly in North and South America (USA, Brazil), Asia (South Korea) (Santamaria & Pedersen, 2021).

Specimens examined. On pronotum and elytra of *Acupalpus flavicollis* (Sturm) (Coleoptera, Carabidae). – Zakarpattia Reg., Uzhhorod city, 48.610306° N, 22.286554° E, 13 May 2021, RM (KHER L00094, i00074); – Kherson Reg., Kherson Dist., Antonivka village, RM (KHER L00106, i00083). On thoracic segments and abdominal sternites of *Acupalpus luteatus* (Duftschmid) (Coleoptera, Carabidae). – Kherson Dist., Zelenivka village, 46.708162° N, 32.609488° E, 20 Aug. 2021, RM (KHER L00121, i00098).

LABOULBENIA METABLETI Scheloske (Fig. 1 M, N)

It is known in Europe and North-East Africa (Morocco) (Santamaria & Pedersen, 2021).

Specimens examined. On head, antennae, pronotum, thoracic segments, elytra and abdominal sternites and tergites of *Syntomus pallipes* (Dejean) (Coleoptera, Carabidae). – Kherson Reg., Kherson city, 46.653453° N, 32.559225° E, 6 Feb. 2022, RM (KHER L00060, i00051-1-11); *idem.*, in park, 46.641492° N, 32.619295° E, 15 May 2021, RM and M. Klymovska (KHER L00096, i00076-1-33); Antonivka village, 46.674903° N, 32.780847° E, 13 May 2021, RM (KHER i00084-1-10); on the thoracic segments, elytra and legs of *Syntomus obscuroguttatus* (Duftschmid) (Coleoptera, Carabidae). – Antonivka village, 46.674903° N, 32.781180° E, 13 Feb. 2022, RM (KHER L00081, i00065-1-2, i00085-1-2).

Notes – The deeply pigmented lower 4-5 cells of outer appendage are a distinguishing character for this species.

LABOULBENIA MURMANICA Huldén (Fig. 2 A)

The species was described from Russia (Huldén, 1983) and later found in few European countries: Belgium, Denmark, Lithuania, Poland and United Kingdom (Santamaria & Pedersen, 2021).

Specimens examined. On pronotum and elytra of *Bembidion assimile* Gyllenhal (Coleoptera, Carabidae). – Kherson Reg., Kherson Dist., Zelenivka village, 46.708162° N, 32.609488° E, 20 Aug. 2021, RM (KHER L00123, L00124, i00100-1-4).

Notes – The fungus is characterized by a constriction between upper part of II cell and lower parts of III and VI cells.

LABOULBENIA OPHONI Thaxt.

It is widespread fungus in Europe, rarely collected also in North Africa (Algeria) (Santamaria & Pedersen, 2021).

Specimens examined. On *Parophonus (Ophonomimus) hirsutululus* (Coleoptera, Carabidae). – Kherson Reg., Kherson city, 46.653453° N, 32.559225° E, 6 Feb. 2022, RM (KHER L00061, i00052).

LABOULBENIA PASQUETHI Picard (Fig. 2 B)

It is a rare fungus known so far only from Europe (France, Spain), Africa (Algeria, Madagascar) and Asia (Japan) (Santamaria 1998).

Specimens examined. On elytra of *Chlaenius kindermanni* Chaudoir (Coleoptera, Carabidae). – Zakarpattia Reg., Uzhhorod city, 48.619783° N, 22.259492° E, 11 May 2021, RM (L00055, i00048-1).

Notes – The distinguishing characters of the species are the small size of the thallus, cells III and IV adhering to the dorsal side of the perithecium up to the tip.

LABOULBENIA PHILONTHI Thaxt. (Fig. 2 C)

Widespread species known from Asia, Europe, North and South America (Santamaria & Pedersen, 2021).

Specimens examined. On antennae, pronotum, elytra, abdominal sternites and tergites of *Philonthus rubripennis* (Stephens) (Coleoptera, Staphylinidae). – Zakarpattia Reg., Uzhhorod city, 48.619783° N, 22.259492° E, 11 May 2021, RM (KHER L00035, L00036, i00034-1-3). On elytra of *Philonthus* sp. (Coleoptera, Staphylinidae). – Kherson Reg., Kherson Dist., Zelenivka village, 46.708162° N, 32.609488° E, 20 Aug. 2021 RM (KHER L00120, i00097).

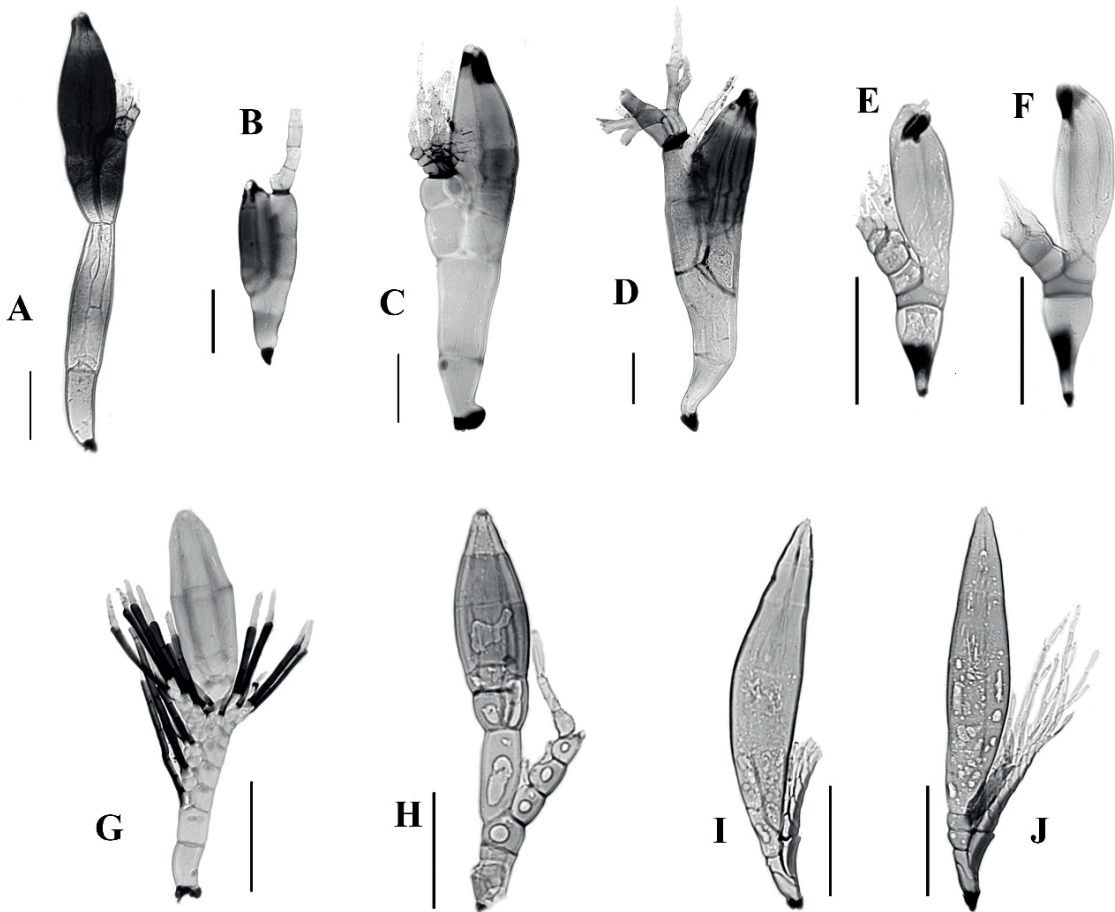


Fig 2. The morphology of Laboulbeniales specimens. A – *Laboulbenia murmanica* (KHER L00124), B – *L. pasquetii* (KHER L00055), C – *L. philonthi* (KHER L00035), D – *L. pseudomasei* (KHER L00069), E – *Mimeomyces zeelandicus* (KHER L00066), F – *M. zeelandicus* (KHER L00101), G – *Rhachomyces canariensis* (KHER L00097), H – *Rhadinomyces pallidus* (KHER L00098), I – *Sphaleromyces lathrobii* (KHER L00099-1), J – *S. lathrobii* (KHER L00099-2). Scale bars = 50 μ m.

LABOULBENIA PSEUDOMASEI Thaxt. (Fig. 2 D)
This fungus is reported by Santamaria & Peder-
sen (2021) from Asia, Europe, North and South
America.

Specimens examined. On the elytra of *Stomis pumicatus* Panz (Coleoptera, Carabidae). – Za-
karpattia Reg., Uzhhorod city, 48.617528° N,
22.255198° E, 8 June 2021, RM (KHER L00069,
i00058).

MIMEOMYCES ZEELANDICUS Middelh. & Boelens
(Fig. 2 E, F)
This species is reported so far only from The
Netherlands, Poland, Spain and United Kingdom

(Majewski, 1989; Santamaria, 1995). It is new
record of the genus from Ukraine.

Specimens examined. On the anal tergite and
sternites of *Heterothops dissimilis* (Gravenhorst)
(Coleoptera, Staphylinidae). – Kherson Reg.,
Kherson city, 46.724155° N, 32.665642° E, 9
Feb. 2022, RM (KHER L00066, L00067, L00068,
i00056 i00057); Antonivka village, 46.674903°
N, 32.780847° E, 13 May 2021, RM (KHER
L00101, i00079-1-2).

Notes – In this species, the position of the
darkened cell at the perithecial ostiolum may
be variable. In freshly prepared slide mounts,

the darkened area of the ostiolum is directed away from the appendages and at 45 ° as to the longitudinal axis of the perithecium (Fig. 2 E). The darkened area is parallel to the longitudinal axis of the perithecium when the thalli are left in Hoyer's solution for several days (Fig. 2 F).

MONOICOMYCES INVISIBILIS Thaxt.

This fungus is widely distributed in Asia, Europe, North and South America (Santamaria & Pedersen, 2021).

Specimens examined. On tergites of *Oxytelus piceus* (Linnaeus) (Coleoptera, Staphylinidae). – Kherson Reg., Kherson Dist., Zelenivka village, 46.708162° N, 32.609488° E, 20 Aug. 2021, RM (KHER L00112, i00090).

RHACHOMYCES CANARIENSIS Thaxt. (Fig. 2 G)

This species is found in Europe, Asia (Turkey), North Africa (Morocco) and Macaronesia (Canary Islands, Madeira) (Santamaria & Pedersen, 2021).

Specimens examined. On the pronotum and elytra of *Trechus quadristriatus* (Schrank) (Coleoptera, Carabidae). – Kherson Reg., Kherson Dist., Antonivka village, 46.674903° N, 32.780847° E, 13 May 2021, RM (KHER L00097, i00077; L00105 i00082-1-3).

RHACHOMYCES LASIOPHORUS (Thaxt.) Thaxt.

It is found in several European countries, in Asia (Turkey and South Korea) and in the USA (Santamaria & Pedersen, 2021).

Specimens examined. On elytra of *Anthracus consputus* (Duftschmid) (Coleoptera, Carabidae). – Zakarpattia Reg., Uzhhorod, 48.619783° N, 22.259492° E, 11 May 2021, RM (KHER L00043, i00039).

RHADINOMYCES PALLIDUS Thaxt. (Fig. 2 H)

This species was described from the USA (Thaxter, 1908) and subsequently reported from various European countries and from Japan (Santamaria & Pedersen, 2021).

Specimens examined. On elytra of *Tetartopeus terminatus* (Gravenhorst) (Coleoptera, Staphylinidae). – Kherson Reg., Kherson Dist., Antonivka village, 46.674903° N, 32.780847° E, 13 May 2021, RM (KHER L00098 with *Sphaleromyces lathrobii* Thaxt, i00078).

SPHALEROMYCES LATHROBI Thaxt. (Fig. 2 I, J)

The fungus was described from the USA, and was later reported only from Europe (Denmark, France, Poland, Spain, Sweden, UK) (Santamaria & Pedersen, 2021).

Specimens examined. On pronotum, elytra, legs, sternites and tergites of *Tetartopeus terminatus* (Gravenhorst) (Coleoptera, Staphylinidae). – Kherson Reg., Kherson Dist., Antonivka village, 46.674903° N, 32.780847° E, 13 May 2021, RM (KHER L00098 with *Rhadinomyces pallidus*, i00078; L00099, L00100, i00078).

Notes – Among several typical thalli, we observed a single thallus with two additional cells under the perithecium and with an additional appendage (Fig. 2 J).

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