

Dung-inhabiting ascomycetes from the Ukrainian Carpathians

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The paper provides data on dung-inhabiting ascomycetes which were collected in 2015 during a mycological survey in the Carpathian Biosphere Reserve (Rakhiv District, Zakarpattia Region). Twenty-five species belonging to the Pezizomycetes, Sordariomycetes, Dothideomycetes and Leotiomycetes were found, 19 of which were new to the Ukrainian Carpathians. *Schizothecium dakotense* and *Sordaria lappae* were collected in Ukraine for the first time. Substrates, localities, data on general distribution and some taxonomic notes to these species are presented. The species new to Ukraine are described, and interesting finds are illustrated.

Key words: Ascomycota, Carpathian Biosphere Reserve, coprophilous fungi, Pezizomycotina, *Schizothecium dakotense*, *Sordaria lappae*.

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Článek přináší souhrn údajů o výskytu koprofilních askomycetů, sbíraných v roce 2015 během mykologického průzkumu v Karpatské biosférické rezervaci (okres Rachov, Zakarpatská oblast). Celkem bylo nalezeno 25 druhů ze tříd Pezizomycetes, Sordariomycetes, Dothideomycetes a Leotiomycetes, přičemž 19 z nich bylo nových pro Ukrajinské Karpaty. Sběry *Schizothecium dakotense* a *Sordaria lappae* představují první nálezy pro Ukrajinu. U jednotlivých druhů jsou uvedeny jejich substráty a lokality, shrnuto rozšíření ve světě a přičiněny taxonomické poznámky. U druhů nových pro Ukrajinu je zpracován popis a zajímavé nálezy jsou ilustrovány.

INTRODUCTION

The Ukrainian Carpathians have always attracted scientists, including mycologists who have studied fungi from different taxonomic and ecological groups. Despite more than one hundred years of mycological research in the Ukrainian Carpathians, the diversity of some groups of fungi has not been studied well. One of them is dung-inhabiting or coprophilous fungi.

Coprophilous (or dung) fungi are a large specialised group of saprotrophic fungi mostly found on herbivore dung and using the organic matter of excrements as nutrients. They are an integral part of the heterotrophic component of many ecosystems and play an important ecological role in decomposing and recycling nutrients from animal dung (Sarrocco 2016). In addition, dung-inhabiting fungi produce a large array of bioactive secondary metabolites and have a potent enzymatic arsenal able to utilise even complex molecules.

They have been studied in Europe for about 200 years. The contribution of Ukrainian mycologists in the study of these fungi is much more modest. Before 2000, coprophilous ascomycetes were usually only mentioned in general mycofloristic lists of this country, besides a few articles (Korolyova 2000, Hayova 2005, Golubtsova 2009, Golubtsova et al. 2010, Lytvynenko & Kravtsov 2012, Lytvynenko & Stepanovska 2014).

The literature on coprophilous ascomycetes of the Ukrainian Carpathians was until recently limited to 16 species, which does not fully reveal the species richness of dung-inhabiting ascomycetes in this territory.

The first records of these fungi are mentioned in the early 20th century by Namysłowski (1910, 1914). He recorded *Ascobolus immersus* Pers., *Podospora fimiseda* (Ces. & De Not.) Niessl, and *Thelebolus polysporus* (P. Karst.) Otani & Kanzawa from the Ivano-Frankivsk Region.

Wróblewski (1916) collected *Cheilymenia granulata* (Bull.) J. Moravec from a meadow above the Cheremosh River (Zakarpattya Region). The same species, as well as another species of the genus, *C. subhirsuta* (Schumach.) Boud. were recorded during the survey of Mount Pip Ivan (Zakarpattya Region) by Pilát (1940).

In the Handbook of the fungi of Ukraine (Morochkovskyi et al. 1969) only four coprophilous ascomycetes were known for the Ukrainian Carpathians: *Chaetomium elatum* Kunze, *Schizothecium conicum* (Fuckel) N. Lundq., *Sordaria fimicola* (Roberge ex Desm.) Ces. & De Not., and *Sporormiella minima* (Auersw.) S.I. Ahmed & Cain.

In the summarising monograph of Smitska (1980) dealing with discomycetes of Ukraine, only one dung-inhabiting fungus species, *Ascobolus stercorarius* (Bull.) J. Schröt. (recorded near Rakhiv), was mentioned from the Carpathians.

The largest contribution to the knowledge of coprophilous ascomycetes in the Ukrainian Carpathians is the work by Prokhorov (1991). As a result of his research, seven species of dung-inhabiting discomycetes were found on excrements of sheep, horse and dog from the Pozhzhzhevskya Mountain Valley and Dantsyra Mountains (1800 m; now part of the Carpathian National Nature Park). These were *Ascobolus albidus* P. Crouan & H. Crouan, *A. furfuraceus* Pers., *A. immersus* Pers., *A. sacchariferus* Brumm., *Ascodesmis nigricans* Tiegh., *Saccobolus verrucisporus* Brumm. and *Thelebolus stercoreus* Tode.

The present article provides data on dung-inhabiting ascomycetes which were obtained from moist chambers of dung collected in 2015 during our mycological survey in the Svydovetskyi and Chornohirskyi Mountain Ranges of the Carpathian Biosphere Reserve (Rakhiv District, Zakarpattya Region).

MATERIAL AND METHODS

Sampling and isolation. Twenty six samples from three dung types of domestic herbivores, goat (*Capra hircus* L.), horse (*Equus caballus* L.) and sheep (*Ovis aries* L.), were collected in the Svydovetskyi and Chornohirskyi Mountain Ranges of the Carpathian Biosphere Reserve in 22–29 August 2015.

The moist-chamber method of incubation was used to detect and obtain the fruitbodies of coprophilous ascomycetes (Keyworth 1951, Richardson 2001) from samples of dung gathered earlier. Samples of excrement were placed in a Petri dish on filter paper, moistened with water and later watered more, if necessary, to maintain sufficient moisture of the substrate. The day after placement in moist chambers, the samples were carefully examined using a stereomicroscope. This allowed us to detect the fruitbodies which had already formed in nature. Further samples were examined frequently at intervals of a few days. The incubation was carried out at room temperature (18–20 °C) under natural light for 30–50 days, depending on the nature of ascoma development.

Species identification. Macro- and microstructures were observed in fresh material. Identification of species was performed using an MBS-10 stereomicroscope (JSC “LZOS”, Lytkarino, Moscow Region, Russia) and an XSM-40 light microscope (Ningbo Sunny Instruments Co., Ltd., Yuyao, Zhejiang, China). The microstructures such as asci, ascospores and paraphyses were studied in water. A minimum of 20 spores and asci were measured. The quotient of spore length and width (Q), as well as the average quotient (Q_{av}) were calculated. Dimensions of fungus structures were measured using the Tsview7 modular software (Fuzhou Tucsen Imaging Technology Co., Ltd., Fuzhou, Fujian, China). The amyloid reaction of the apical apparatus and the walls of the asci were tested

using Melzer's reagent. Aqueous Cotton Blue was used for staining the hyaline gelatinous sheath and/or appendages.

Digital photomicrographs were made with a 3.0mp Digital Microscope Camera (Fuzhou Tucsen Imaging Technology Co., Ltd., Fuzhou, Fujian, China) with Tsview7 modular software.

Species were identified using various monographs, dichotomous and synoptic keys (van Brummelen 1967, Kimbrough et al. 1969, 1972, Ahmed & Cain 1972, Lundqvist 1972, Prokhorov 2004, Doveri 2004, 2014, Bell 2005).

Analysis of the general distribution of species is based on data from published sources (van Brummelen 1967, Kimbrough 1969, Lundqvist 1972, Ahmed & Cain 1972, Prokhorov & Armenskaya 2003, Doveri 2004, Prokhorov 2004, Bell 2005, Richardson 2007; more recent works predominantly focus on new records in particular countries, adding no new information to the general distribution) and on critically revised open internet resources.

Collected specimens are deposited in the Herbarium of the Taras Shevchenko National University of Kyiv (KWU).

Abbreviations. The following abbreviations were adopted: CMR – Chornohirskiy Mountain Range of the Carpathian Biosphere Reserve; SMR – Svydovetskiy Mountain Range of the Carpathian Biosphere Reserve. Region (province) of Ukraine: Cky – Cherkasy, Cnv – Chernihiv, Cr – Republic of Crimea, Cvi – Chernivtsi, Do – Donetsk, Ivf – Ivano-Frankivsk, Kha – Kharkiv, Khe – Kherson, Ky – Kyiv, Lu – Luhansk, My – Mykolaiv, Po – Poltava, Su – Sumy, Tp – Ternopil, Zk – Zakarpattia.

RESULTS AND DISCUSSION

Twenty-six samples of dung from horse (11), goat (8) and sheep (7), providing a total of 79 records (horse dung 23 records, goat dung 28, sheep dung 28) of 25 species of coprophilous ascomycetes. According to Ainsworth & Bisby's Dictionary of the Fungi (Kirk et al. 2008), the identified species belong to nine genera, seven families, four orders and four classes: Pezizomycetes and Sordariomycetes (11 species), Dothideomycetes (2), Leotiomyces (1). Nineteen of the species were new to the Ukrainian Carpathians. For some of them, digital photomicrographs are presented in this article (Figs. 1–2, 4–5). *Schizothecium dakotense* and *Sordaria lappae* were found in Ukraine for the first time. *Ascobolus michaudii* has already been reported by us for Ukraine, but without description or illustrations (Lytvynenko & Stepanovska 2014). Here we present detailed descriptions and illustrations (Figs. 3, 6–7), based on study of the samples collected, and discuss the details of their morphology and ecology.

An annotated list of the species collected and, for each species, citations in published lists and bibliographies, localities, habitat, taxonomic notes, general distribution in Ukraine and worldwide are provided below. Species not previously recorded for the Ukrainian Carpathians are marked with an asterisk (*). For a full list of species synonyms, as well as for higher taxonomic ranks, see the Index Fungorum online database (<http://www.indexfungorum.org/>).

DOTHIDEOMYCETES, *PLEOSPORALES*

***Sporormiaceae* Munk**

Sporormiella minima (Auersw.) S.I. Ahmed & Cain, *Can. J. Bot.* 50(3): 449, 1972

Notes. This species is common in Ukraine and worldwide. Non-obligate coprophilous fungus. In addition to excrements of animals, it was isolated from soil samples (Abdullah et al. 1986), leaf litter (Arenal et al. 2005) and is an endophyte of some species of higher plants (Kumaresan & Suryanarayanan 2001).

The ascospores of this species vary in size from 28–32 × 5–6 μm (Ahmed & Cain 1972) to 27–38 × 4–7 μm (Bell 2005). The size of the ascospores in the samples studied from the Ukrainian Carpathians is 28.8–35.4 × (3.6)4.3–5.8 μm.

Distribution in Ukraine. Cnv, Cr, Do, Khe, Lu, My, Su, Tp, Zk.

General distribution. Worldwide.

Material examined. Five specimens on dung incubated for 8 to 28 days.

CMR. Petros Mountain, spruce forest, alt. 2020 m, 48°10'19.4" N, 24°25'16.8" E, on goat dung, 28 Aug. 2015 (KWU 06918, KWU 38918); *ibid.*, 48°10'18.9" N, 24°25'17.5" E, on sheep dung, 28 Aug. 2015 (KWU 08918, KWU 28918, KWU 39918), both leg. Yu.V. Shcherbakova, det. Yu.I. Lytynyenko & I.V. Topchii.

* ***Sporormiella subtilis*** S.I. Ahmed & Cain, *Can. J. Bot.* 50(3): 459, 1972 Fig. 5 h

Notes. In Ukraine this species was only known from the Chornomorsky Biosphere Reserve (Kherson Region).

According to various authors, the size of its ascospores ranges from 23–29 × 5.5–6.5 μm (Ahmed & Cain 1972) to 27–32 × 6–8 μm (Bell 2005). The size of the ascospores in the samples studied is 25.3–30.7 × 5.7–7.2 μm.

Distribution in Ukraine. Khe, Zk.

General distribution. Australia, Europe, North America.

Material examined. A single specimen on dung incubated for 46 days.

CMR. Petros Mountain, spruce forest, alt. 2020 m, 48°10'19.4" N, 24°25'16.8" E, on goat dung, 28 Aug. 2015, leg. Yu.V. Shcherbakova, det. Yu.I. Lytynyenko (KWU 18918).

LEOTIOMYCETES, *THELEBOLALES*

Thelebolaceae Eckblad

* *Coprotus dextrinoideus* Kimbr., Luck-Allen & Cain, Can. J. Bot. 50(5): 962, 1972 Fig. 1 a, b

Notes. This species is common in Ukraine, but is recorded from the Ukrainian Carpathians for the first time.

This species is very similar to the well-known *C. disculus* from the Luhansk region of Ukraine (Golubtsova 2009), but differs by broader ascospores and longer asci. In addition, *C. disculus* ascomata are always whitish, colourless, while in *C. dextrinoideus* they become eventually pigmented and yellowish. The size of the ascospores ($11.3\text{--}12.2 \times 7.8\text{--}8.5 \mu\text{m}$) and asci ($95\text{--}113 \times 20\text{--}25 \mu\text{m}$) of the *C. dextrinoideus* specimens studied by us are completely consistent with the protologue (Kimbrough et al. 1972).

Distribution in Ukraine. Cky, Cr, Khe, Su, Zk.

General distribution. Asia, Europe, North America.

Material examined. A single specimen on dung incubated for 16 days.

SMR. Bliznitsa Mountain, alt. 1767 m, $48^{\circ}13'25.1''$ N, $24^{\circ}13'50.4''$ E, on horse dung, 22 Aug. 2015, leg. Yu.V. Shcherbakova, det. Yu.I. Lytvynenko & I.V. Topchii (KWU 24918).

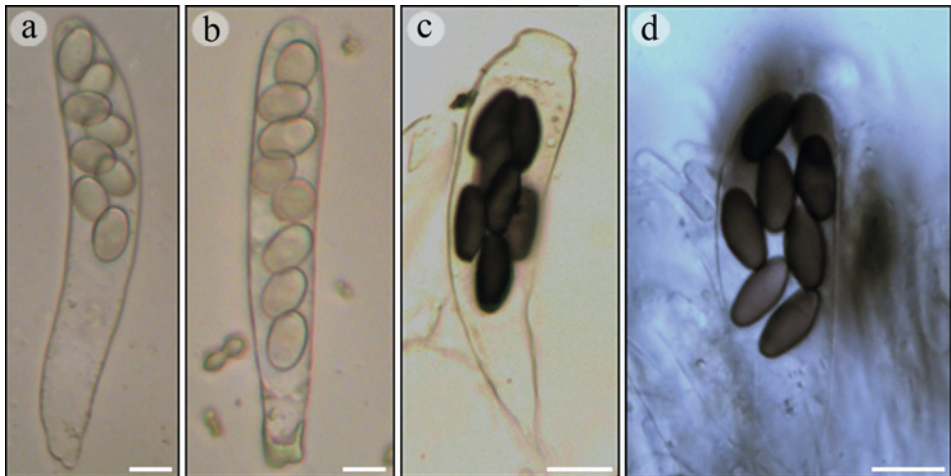


Fig. 1. *Coprotus dextrinoideus* (KWU 24918): **a, b** – asci with ascospores. *Saccobolus saccoboloides* (KWU 40918): **c** – mature ascus with ascospore cluster, **d** – mature ascus with free ascospores. Scale bars = 10 μm (a, b), 20 μm (c, d). Photos by Iryna V. Topchii.

PEZIZOMYCETES, PEZIZALES

Ascobolaceae Boud. ex Sacc.

Ascobolus albidus P. Crouan & H. Crouan, Ann. Sci. Nat. Bot., sér. 4(10): 193, 1858 Fig. 2 a, b, e

Notes. This species is widespread around the world. In Ukraine it is only known from mountainous regions, with two records from the Carpathian National Nature Park (Pozhyzhevskya and Dantsyra Mountains; Prokhorov 1991) and Crimea (mountain plateau of Chatyr-Dag; Golubtsova et al. 2010).

Ascobolus albidus is quite variable in ascospores size which, according to various authors, is (18)20–36(39) × (9)11–14(16) μm (van Brummelen 1967), (19)20–22 × (9)10–11(12) μm (Bell 2005), (20)20.5–21.5(22) × 9.5–10.5(11) μm (Doveri 2004), (19.3)22.5–30.5 × 11.5–12.8 μm (Prokhorov 2004). The size of the spores we examined was 19.5–22.2 × 11.4–12.5 μm. Some authors (van Brummelen 1967, Prokhorov 2004) indicate that biseriate ascospores are characteristic of this species, but we observed both biseriate and uniseriate ascospores.

Distribution in Ukraine. Cr, Ivf, Zk.

General distribution. Africa, Asia, Australia and Oceania, Europe.

Material examined. A single specimen on dung incubated for 12 days.

CMR. Petros Mountain, vicinity of tourist chalet, spruce forest, alt. 1534 m, 48°09'36.8" N, 24°28'09.3" E, on horse dung, 27 Aug. 2015, leg. Yu.V. Shcherbakova, det. Yu.I. Lytvynenko & I.V. Topchii (KWU 46918).

Ascobolus immersus Pers. ex Pers., Mycol. Eur. 1: 341, 1822

Notes. *Ascobolus immersus* is a large and common coprophilous species that sporulates very early on incubated dung. Distributed throughout Ukraine. It was recorded for the Ukrainian Carpathians by Namysłowski (1914) and Prokhorov (1991).

Distribution in Ukraine. Cnv, Cr, Cvi, Do, Ivf, Kha, Khe, Ky, Lu, Po, Su, Tp, Zk.

General distribution. Worldwide.

Material examined. Nine specimens on dung incubated for 4 to 9 days.

CMR. Petros Mountain, vicinity of tourist chalet, spruce forest, alt. 1534 m, 48°09'33.6" N, 24°28'09.5" E, on goat dung, 27 Aug. 2015 (KWU 21918); *ibid.*, 48°09'36.8", N 24°28'09.3" E, on horse dung, 27 Aug. 2015 (KWU 02918, KWU 49918); *ibid.*, 48°09'33.4", N 24°28'15.0" E, on sheep dung, 27 Aug. 2015 (KWU 47918, KWU 50918); *ibid.*, alt. 2020 m, 48°10'19.2", N 24°25'18.3" E, on sheep dung, 28 Aug. 2015 (KWU 08918); *ibid.*, alt. 1534 m, 48°09'35.3" N, 24°28'07.1" E, on horse dung, 29 Aug. 2015 (KWU 48918), all leg. Yu.V. Shcherbakova, det. Yu.I. Lytvynenko & I.V. Topchii. – Menchul Mountain, mountain valley, beech forest, vicinity of camp of Lviv National University, alt. 1366 m, 48°09'19.4" N, 24°20'15.7" E, on horse dung, 25 Aug. 2015, leg. Yu.V. Shcherbakova, det. Yu.I. Lytvynenko & I.V. Topchii (KWU 20918).

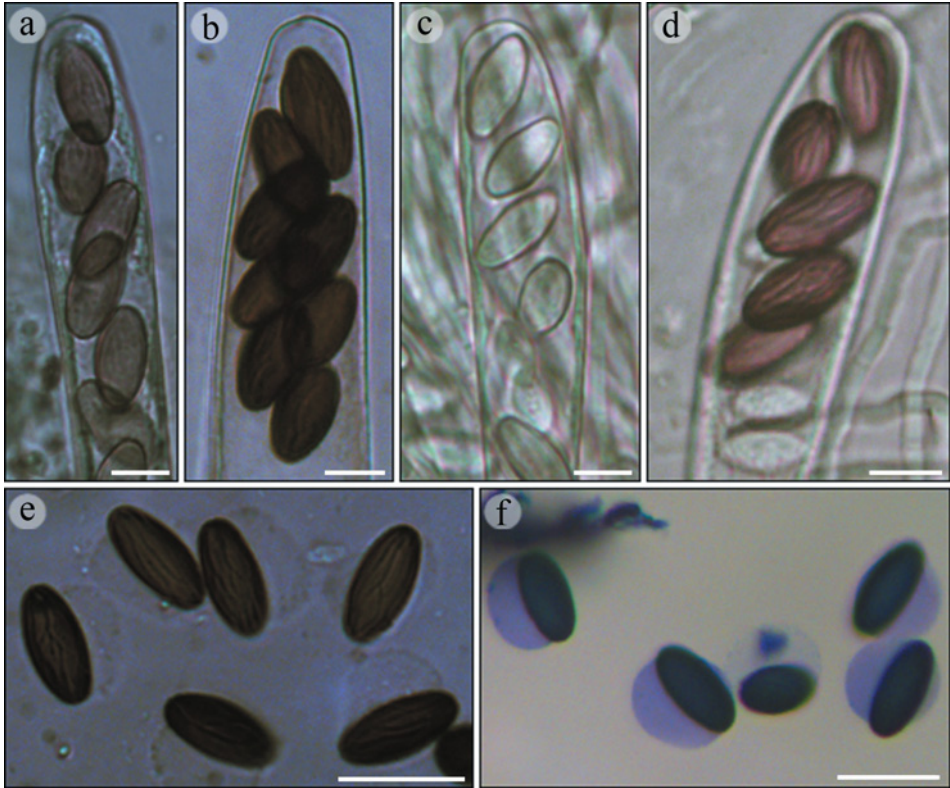


Fig. 2. *Ascobolus albidus* (KWU 46918): **a** – immature ascospores in apical part of the ascus, **b** – mature ascospores in apical part of the ascus, **e** – free mature ascospores with unilateral gelatinous sheath. *Ascobolus sacchariferus* (KWU 23918): **c** – immature ascospores in apical part of the ascus, **d** – mature ascospores in apical part of the ascus, **f** – free mature ascospores with unilateral gelatinous sheath. Scale bars = 10 µm (a–d), 20 µm (e–f). Photos by Iryna V. Topchii.

SMR. Slope of Bliznitsa Mountain, alt. 1767 m, 48°13'25.1" N, 24°13'50.4" E, on horse dung, 22 Aug. 2015, leg. Yu.V. Shcherbakova, det. Yu.I. Lytvynenko & I.V. Topchii (KWU 19918).

* *Ascobolus michaudii* Boud., Hist. Class. Discom. Eur.: 71, 1907 Fig. 3

Description. Ascomata apothecioid, globose at first, later expanded, scattered or gregarious, semi-immersed to superficial, 0.8–2.0 mm diam. Hymenial disc lemon yellow, plane or concave, dark dotted with black protruding tips of asci at maturity; margin distinct, crenulate. Hypothecium thin, made up of polygonal elongated cells. Medullary excipulum a *textura angularis*. Ectal excipulum a *textura globulosa-angularis*, 6.5–15.5 × 7.5–12.5 µm, with hyphoid hairs.

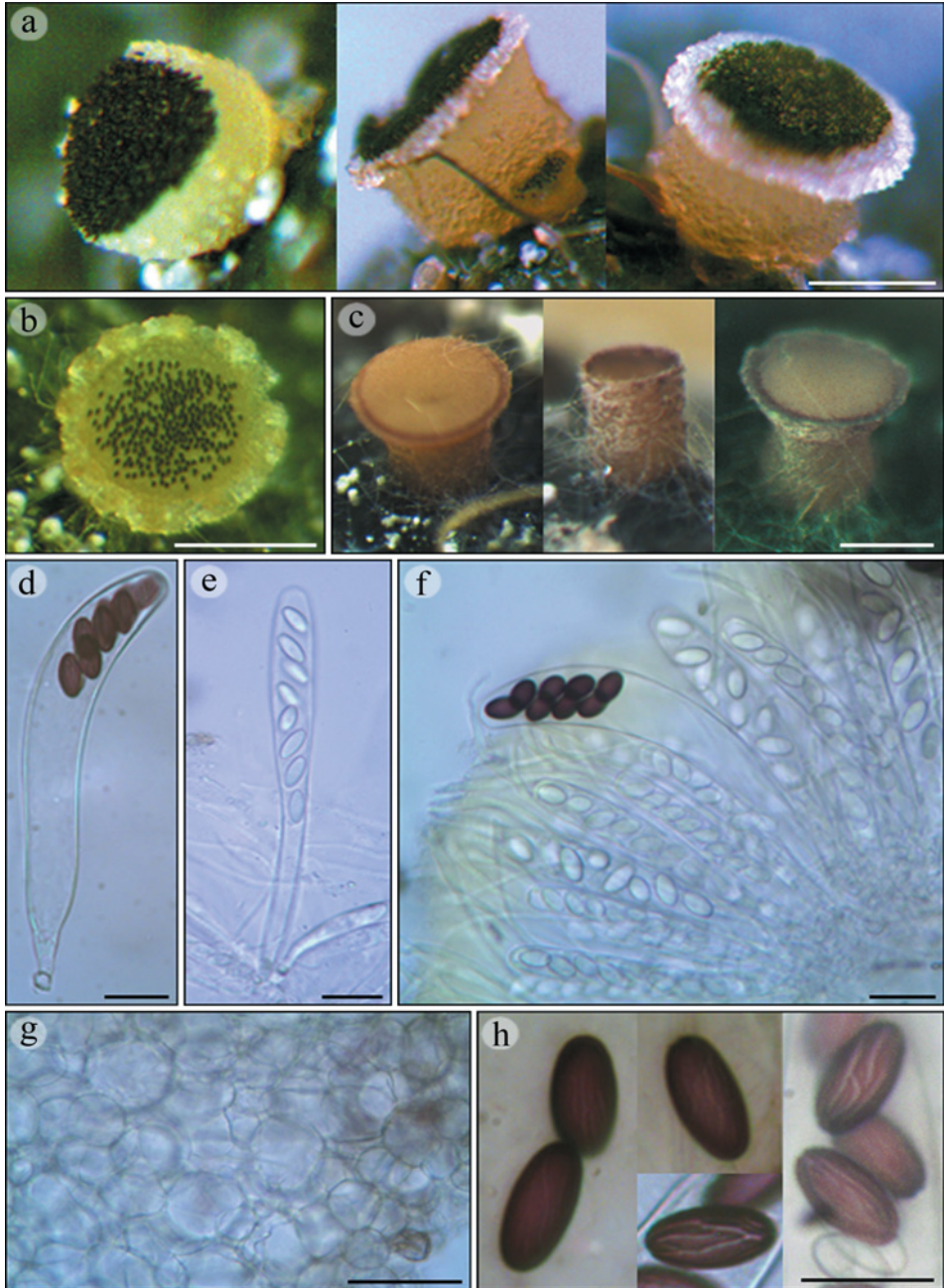


Fig. 3. *Ascobolus michaudii* (KWU 22918): **a, b, c** – ascomata on substrate, **d** – mature ascus and ascospores, **e** – immature ascus, **f** – details of the hymenium with 8-spored mature and immature asci, **g** – details of ectal excipulum, **h** – mature ascospores. Scale bars = 1 mm (a–c), 20 μ m (d–h). Photos by Iryna V. Topchii.

Asci 8-spored, broadly cylindrical, operculate with dome-shaped apex, short-stalked, $159\text{--}224 \times 20.5\text{--}23.7 \mu\text{m}$, weakly amyloid. Ascospores uni- or irregularly biseriate, $20.1\text{--}21.4 \times 9.7\text{--}11.0 \mu\text{m}$, $Q = 1.85\text{--}2.22$, $Q_{av} = 1.94$; ellipsoidal, roundish at the ends, equilateral, smooth, hyaline at first, purplish at maturity, turning brown with age; episorium with (1)2–5 longitudinal or oblique, rarely anastomosed crevices on each side, with unilateral gelatinous sheath. Paraphyses numerous, exceeding the asci, cylindrical, $2.5\text{--}4.0 \mu\text{m}$ diam., simple or sometimes branched, septate, sometimes inflated at the tips, containing yellowish vacuoles.

Notes. In Ukraine it is known from the valley of the Sula River (Belopolsky District, Sumy Region) on rabbit droppings (Lytvynenko & Stepanovska 2014). This record from the Carpathian Biosphere Reserve is the second in Ukraine, and includes the first description and illustration.

This species is very similar to *A. furfuraceus* Pers. (Doveri 2014), which is common in Ukraine, but differs by its smaller ascospores as well as less branched, oblique, often curved and mostly non-anastomosing crevices on the spore surface.

Ascobolus michaudii develops mainly on excrements of domestic herbivores (van Brummelen 1967, Doveri 2004), but has also been isolated from soil in a mixed conifer-*Arbutus* stand (Paden & Stanlake 1973).

Distribution in Ukraine. Su, Zk.

General distribution. Africa, Asia, Australia, Europe, North America.

Material examined. A single specimen on dung incubated for 35 days.

CMR. Petros Mountain, vicinity of tourist chalet, spruce forest, alt. 1534 m, $48^{\circ}09'33.4''$ N, $24^{\circ}28'15.0''$ E, on sheep dung, 27 Aug. 2015, leg. Yu.V. Shcherbakova, det. Yu.I. Lytvynenko & I.V. Topchii (KWU 22918).

Ascobolus sacchariferus Brumm., Persoonia, Suppl. 1: 122, 1967 Fig. 2 c, d, f

Notes. This species was known from only two localities in Ukraine. It was first recorded in the Carpathian Mountains from the Carpathian National Nature Reserve on sheep dung (Prokhorov 1991). Subsequently, it was recorded in the valley of the Oleshna River (Sumy District, Sumy Region) on hare droppings (Lytvynenko & Kravtsov 2012).

Ascobolus sacchariferus is similar to *A. albidus* (Doveri 2014) but differs by finer spores, ascomata with a well-differentiated and granulose margin. It occurs on excrements of wild herbivores (especially deer), domestic herbivores and birds (Doveri 2014). *Ascobolus albidus* colonises dung of both wild and domestic herbivores with the same frequency, less often of carnivores (Richardson 2007, Doveri 2014).

Distribution in Ukraine. Ivf, Su, Zk.

General distribution. Asia, Europe.

Material examined. Four specimens on dung incubated for 10 to 13 days.

CMR. Petros Mountain, vicinity of tourist chalet, spruce forest, alt. 1534 m, 48°09'33.6" N, 24°28'09.5" E, on goat dung, 27 Aug. 2015 (KWU 11918); *ibid.*, 48°09'33.4" N, 24°28'15.0" E, on sheep dung, 27 Aug. 2015 (KWU 03918, KWU 07918, KWU 23918), all leg. Yu.V. Shcherbakova, det. Yu.I. Lytvynenko & I.V. Topchii.

* ***Saccobolus depauperatus*** (Berk. & Broome) E.C. Hansen, Vidensk. Meddel. Dansk Naturhist. Foren. Kjøbenhavn: 293, 1876

Notes. This species is cosmopolitan, and widely distributed in Ukraine. It grows on excrements of various herbivores, without showing any particular preference (Doveri 2004, Prokhorov 2004).

Saccobolus depauperatus is similar to *S. versicolor* Brumm. (van Brummelen 1967, Doveri 2004), which is quite common in Ukraine and in the Ukrainian Carpathians, but differs from it by the smaller fruitbodies, asci, ascospores and spore clusters. In addition, intercellular pigment is often present in the apices of paraphyses and excipular cells of *S. versicolor*, so its ascomata gradually obtain a yellowish tinge.

Distribution in Ukraine. Cky, Cr, Kha, Khe, Ky, Su, Zk.

General distribution. Africa, Asia, Europe, North and South America.

Material examined. Seven specimens on dung incubated for 14 to 36 days.

CMR. Petros Mountain, vicinity of tourist chalet, spruce forest, alt. 1534 m, 48°09'33.6" N, 24°28'09.5" E, on goat dung, 27 Aug. 2015 (KWU 45918); *ibid.*, 48°09'36.8" N, 24°28'09.3" E, on horse dung, 27 Aug. 2015 (KWU 01918, KWU 15918); *ibid.*, 48°09'33.4" N, 24°28'15.0" E, on sheep dung, 27 Aug. 2015 (KWU 07918, KWU 10918); *ibid.*, alt. 2020 m, 48°10'18.8" N, 24°25'16.2" E, on horse dung, 28 Aug. 2015 (KWU 44918), all leg. Yu.V. Shcherbakova, det. Yu.I. Lytvynenko & I.V. Topchii; *ibid.*, alt. 1534 m, 48°09'35.3" N, 24°28'07.1" E, on horse dung, 29 Aug. 2015, leg. Yu.V. Shcherbakova, det. Yu.I. Lytvynenko (KWU 17918).

* ***Saccobolus saccoboloides*** (Seaver) Brumm., Persoonia, Suppl. 1: 168, 1967
Fig. 1 c, d

Notes. *Saccobolus saccoboloides* can be easily identified due to the morphology of its spore clusters. They are rather loose, so ascospores become free at maturity. The size of the ascospores varies: 16–19.5 × 7.5–9 μm (van Brummelen 1967), 14.1–16.1 × 7.4 μm (Prokhorov 2004), 17–18.5 × 9.5–10.5 μm (Doveri 2014). The size of the ascospores from our samples was 15.1–18.8 × 6.0–9.8 μm.

Distribution in Ukraine. Do, Ivf, Khe, Lu, Su.

General distribution. Asia, Oceania, Europe, South America.

Material examined. Four specimens on dung incubated for 23 to 30 days.

CMR. Petros Mountain, vicinity of tourist chalet, spruce forest, alt. 1534 m, 48°09'33.6" N, 24°28'09.5" E, on goat dung, 27 Aug. 2015 (KWU 11918, KWU 13918); *ibid.*, 48°09'33.4" N, 24°28'15.0" E, on sheep dung, 27 Aug. 2015 (KWU 07918); *ibid.*, alt. 2020 m, 48°10'18.8" N, 24°25'17.0" E, on goat dung, 28 Aug. 2015 (KWU 40918), all leg. Yu.V. Shcherbakova, det. Yu.I. Lytvynenko & I.V. Topchii.

* ***Saccobolus truncatus*** Velen., Monogr. Discom. Bohem. 1: 370, 1934

Notes. The size of the ascospores of this species according to various authors is: 14.0–17.5 × 7.5–8.5 µm (van Brummelen 1967), 13.9–14.7 × 7.8–8.3 µm (Prokhorov 2004), 15.0–15.5 × 7.0–7.5 µm (Doveri 2014). Our samples are characterised by somewhat larger ascospores (15.3–18.3 × 6.9–8.7 µm). For all other features, our samples are fully consistent with the description of *S. truncatus* by van Brummelen (1967).

Distribution in Ukraine. Cr, Kha, Khe, Su, Tp, Zk.

General distribution. Africa, Asia, Europe, North and South America.

Material examined. Four specimens on dung incubated for 22 to 48 days.

CMR. Petros Mountain, vicinity of tourist chalet, spruce forest, alt. 1534 m, 48°09'33.6" N, 24°28'09.5" E, on goat dung, 27 Aug. 2015 (KWU 13918); *ibid.*, 48°09'36.8" N, 24°28'09.3" E, on horse dung, 27 Aug. 2015 (KWU 01918); *ibid.*, 48°09'33.4" N, 24°28'15.0" E, on sheep dung, 27 Aug. 2015 (KWU 14918), all leg. Yu.V. Shcherbakova, det. Yu.I. Lytvynenko & I.V. Topchii.

SMR. Slopes of Bliznitsa Mountain, alt. 1767 m, 48°13'25.1" N, 24°13'50.4" E, on horse dung, 22 Aug. 2015, leg. Yu.V. Shcherbakova, det. Yu.I. Lytvynenko & I.V. Topchii (KWU 28918).

***Ascodesmidaceae* J. Schröt.**

* ***Lasiobolus intermedius*** J.L. Bezerra & Kimbr., Can. J. Bot. 53(12): 1218, 1975
Fig. 4 b, c, e, f

Notes. The size of the asci and ascospores in our sample are slightly larger than in the protologue (Bezerra & Kimbrough 1975): 16–18.7 × 9.5–11.2 µm (ascospores) and 155–192 × 17–25 µm (asci).

Distribution in Ukraine. Cr, Do, Khe, Su, Tp, Zk.

General distribution. Asia, Oceania, Europe, North and South America.

Material examined. A single specimen on dung incubated for 10 days.

CMR. Petros Mountain, vicinity of tourist chalet, spruce forest, alt. 1534 m, 48°09'36.8" N, 24°28'09.3" E, on horse dung, 27 Aug. 2015, leg. Yu.V. Shcherbakova, det. Yu.I. Lytvynenko (KWU 54918).

* ***Lasiobolus lasioboloides*** Marchal, Bull. Soc. R. Bot. Belg. 24(1): 68, 1885
Fig. 4 a, d, g, h

Notes. This species is cosmopolitan. There are only two other records from Ukraine: Kaniv Nature Reserve (Cherkassy Region; Prokhorov 1991) and valleys of the Oleshna River (Sumy Region; Lytvynenko & Kravtsov 2012).

Distribution in Ukraine. Cky, Su, Zk.

General distribution. Africa, Asia, Europe, North America.

Material examined. A single specimen on dung incubated for 30 days.

CMR. Petros Mountain, vicinity of tourist chalet, spruce forest, alt. 1534 m, 48°09'33.4" N, 24°28'15.0" E, on sheep dung, 27 Aug. 2015, leg. Yu.V. Shcherbakova, det. Yu.I. Lytvynenko (KWU 55918).

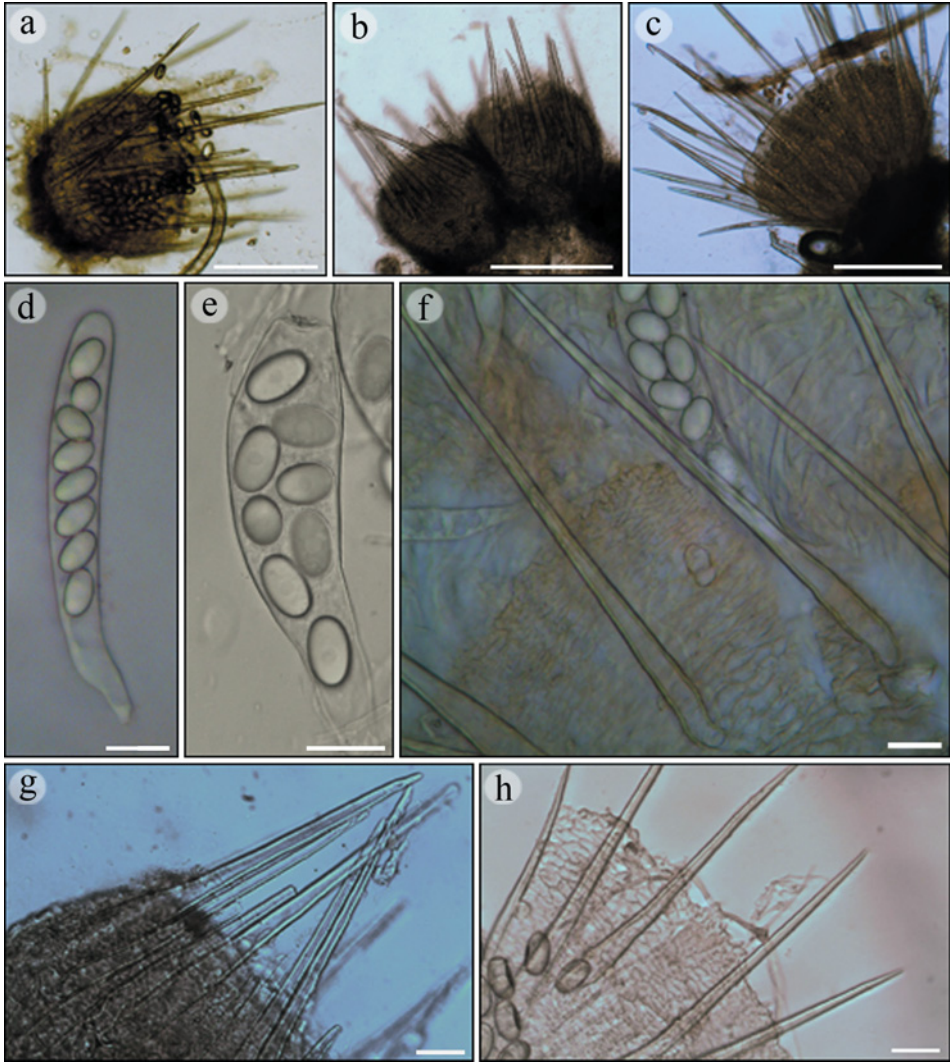


Fig. 4. *Lasiobolus lasioboloides* (KWU 55918): **a** – squashed ascoma, **d** – ascus with uniseriate ascospores, **g**, **h** – setae attached to ectal cells. *Lasiobolus intermedius* (KWU 54918): **b**, **c** – squashed ascomata, **e** – ascus with biseriate ascospores, **f** – bases of setae. Scale bars = 200 μm (a–c), 20 μm (d–h). Photos by Iryna V. Topchii.

***Pezizaceae* Dumort.**

- * ***Iodophanus carneus*** (Pers.) Korf, in Kimbrough & Korf, *Am. J. Bot.* 54(1): 19, 1967

Notes. One of the most widespread and frequent coprophilous discomycetes, widely distributed in Ukraine and the world. In moist-chambers it is characterised by abundant and prolonged fruiting. It is a non-obligate coprophilous fungus. In addition to excrements, it is also known to occur on decaying vegetable matter and soil (Kimbrough et al. 1969).

Distribution in Ukraine. Cr, Cvi, Kha, Khe, Ky, Lu, Po, Su, Zk.
General distribution. Worldwide.

Material examined. Ten specimens on dung incubated for 9 to 27 days.

CMR. Petros Mountain, vicinity of tourist chalet, spruce forest, alt. 1534 m, 48°09'33.6" N, 24°28'09.5" E, on goat dung, 27 Aug. 2015 (KWU 11918, KWU 13918); *ibid.*, 48°09'33.4" N, 24°28'15.0" E, on sheep dung, 27 Aug. 2015 (KWU 04918, KWU 07918, KWU 26918, KWU 27918); *ibid.*, alt. 2020 m, 48°10'18.8" N, 24°25'17.0" E, on goat dung, 28 Aug. 2015 (KWU 12918), all leg. Yu.V. Shcherbakova, det. Yu.I. Lytvynenko & I.V. Topchii; *ibid.*, 48°10'19.2" N, 24°25'18.3" E, on sheep dung, 28 Aug. 2015, leg. Yu.V. Shcherbakova, det. Yu.I. Lytvynenko (KWU 08918, KWU 16918, KWU 25918).

- * ***Iodophanus testaceus*** (Moug.) Korf, *Am. J. Bot.* 54(1): 19, 1967

Notes. This species is widespread around the world but less well-known from Ukraine. A non-obligate coprophilous fungus. In addition to excrements, it can colonise other organic and inorganic substrates: paper, compost, sackcloth, leather, plant debris and plastics (Kimbrough et al. 1969).

Distribution in Ukraine. Cnv, Khe, Lu, Su, Zk.
General distribution. Asia, Oceania, Europe, North and South America.

Material examined. A single specimen on dung incubated for 24 days.

SMR. Slope of Bliznitsa Mountain, alt. 1767 m, 48°13'25.1" N, 24°13'50.4" E, on horse dung, 22 Aug. 2015, leg. Yu.V. Shcherbakova, det. Yu.I. Lytvynenko & I.V. Topchii (KWU 03918).

SORDARIOMYCETES, *SORDARIALES*

***Lasiosphaeriaceae* Nannf.**

- * ***Podospora decipiens*** (G. Winter ex Fuckel) Niessl, *Hedwigia* 22: 156, 1883

Notes. *Podospora decipiens* is one of the commonest coprophilous pyrenomycetes, and is widespread in Ukraine and around the world.

Distribution in Ukraine. Cr, Do, Khe, Su, Tp, Zk.
General distribution. Worldwide.

Material examined. Three specimens on dung incubated for 10, 25 and 37 days.

CMR. Petros Mountain, vicinity of tourist chalet, spruce forest, alt. 1534 m, 48°09'33.6" N, 24°28'09.5" E, on goat dung, 27 Aug. 2015 (KWU 35918); *ibid.*, 48°09'33.4" N, 24°28'15.0" E, on sheep dung, 27 Aug. 2015 (KWU 29918); *ibid.*, alt. 2020 m, 48°10'18.8" N, 24°25'17.0" E, on goat dung, 28 Aug. 2015 (KWU 34918), all leg. Yu.V. Shcherbakova, det. Yu.I. Lytvynenko & I.V. Topchii.

* ***Podospora pleiospora*** (G. Winter) Niessl, *Hedwigia* 22: 156, 1883 Fig. 5 a–c

Notes. *Podospora pleiospora* is one of commonest and most widely distributed coprophilous pyrenomycetes in the world (Doveri 2004, 2014).

Variations with 16 and 32-spored asci had been described (Lundqvist 1972, Doveri 2004), but our specimens only had 32-spored asci.

Distribution in Ukraine. Do, Su, Zk.

General distribution. Worldwide.

Material examined. A single specimen on dung incubated for 43 days.

CMR. Petros Mountain, spruce forest, alt. 2020 m, 48°10'18.8" N, 24°25'17.0" E, on goat dung, 28 Aug. 2015, leg. Yu.V. Shcherbakova, det. Yu.I. Lytvynenko (KWU 55918).

* ***Podospora setosa*** (G. Winter) Niessl, *Hedwigia* 22: 156, 1883

Notes. This species is widespread in Ukraine and worldwide, but this is the first record for the Ukrainian Carpathians.

Distribution in Ukraine. Cnv, Kha, Su, Tp, Zk.

General distribution. Africa, Asia, Australia and Oceania, Europe, North America.

Material examined. Nine specimens on dung incubated for 9 to 27 days.

CMR. Petros Mountain, vicinity of tourist chalet, spruce forest, alt. 1534 m, 48°09'33.6" N, 24°28'09.5" E, on goat dung, 27 Aug. 2015 (KWU 05918, KWU 11918, KWU 31918); *ibid.*, 48°09'33.4" N, 24°28'15.0" E, on sheep dung, 27 Aug. 2015 (KWU 14918); *ibid.*, alt. 2020 m, 48°10'18.8" N, 24°25'17.0" E, on goat dung, 28 Aug. 2015 (KWU 12918, KWU 30918), all leg. Yu.V. Shcherbakova, det. Yu.I. Lytvynenko & I.V. Topchii; *ibid.*, 48°10'19.2" N, 24°25'18.3" E, on sheep dung, 28 Aug. 2015, leg. Yu.V. Shcherbakova, det. Yu.I. Lytvynenko (KWU 16918, KWU 32918, KWU 33918).

Schizothecium conicum (Fuckel) N. Lundq., *Symb. Bot. Upsal.* 20(1): 253, 1972

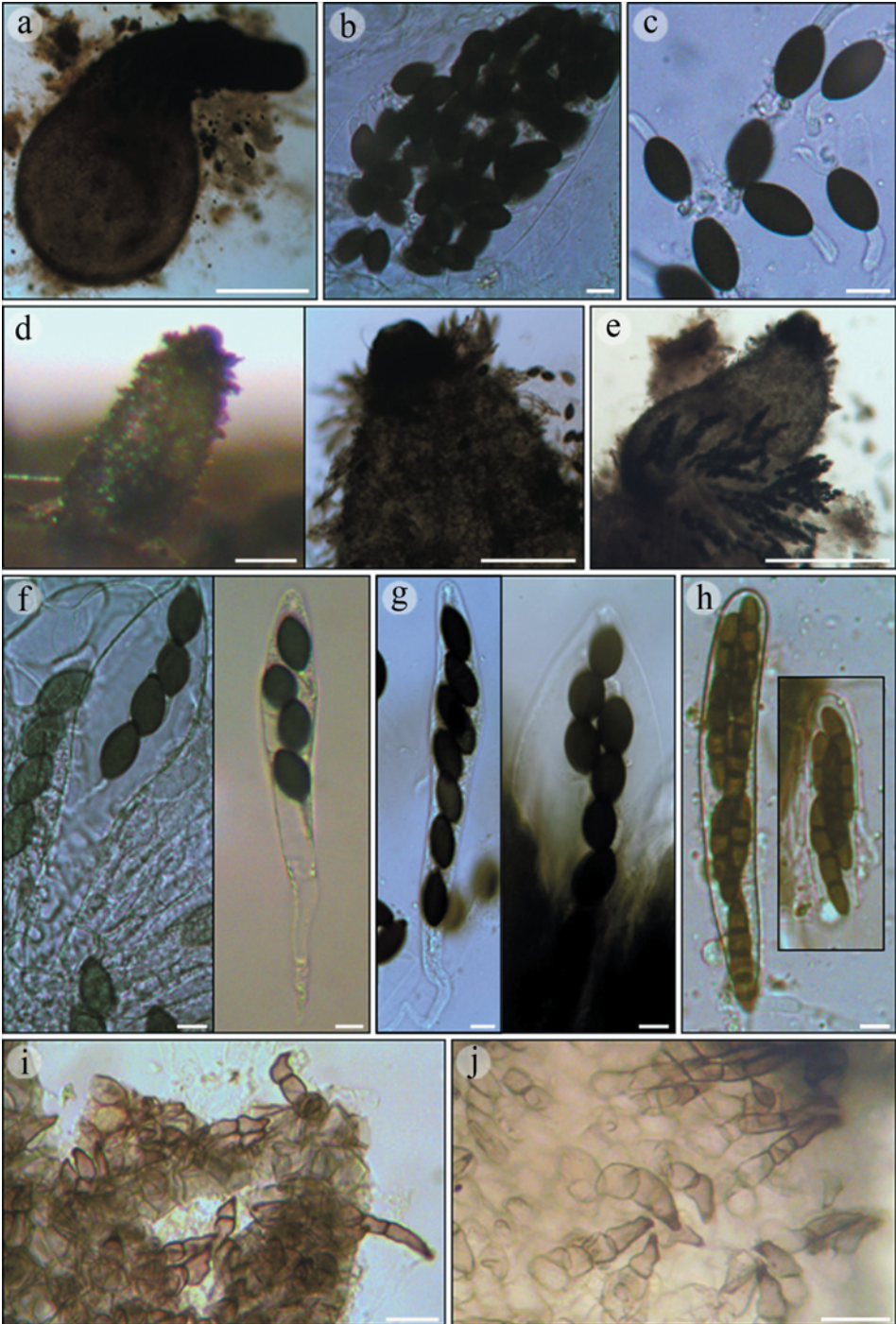
Notes. This species is widespread in Ukraine and worldwide. It has been recorded from the Ukrainian Carpathians, but without specified locality (Morochkovskiy et al. 1969).

Distribution in Ukraine. Cr, Ivf, Kha, Su, Tp, Zk.

General distribution. Asia, Australia and Oceania, Europe, North and South America.

Material examined. Five specimens on dung incubated for 7 to 46 days.

CMR. Petros Mountain, vicinity of tourist chalet, spruce forest, alt. 1534 m, 48°09'36.8" N, 24°28'09.3" E, on horse dung, 27 Aug. 2015 (KWU 15918, KWU 52918); *ibid.*, 48°09'33.4" N, 24°28'15.0" E,



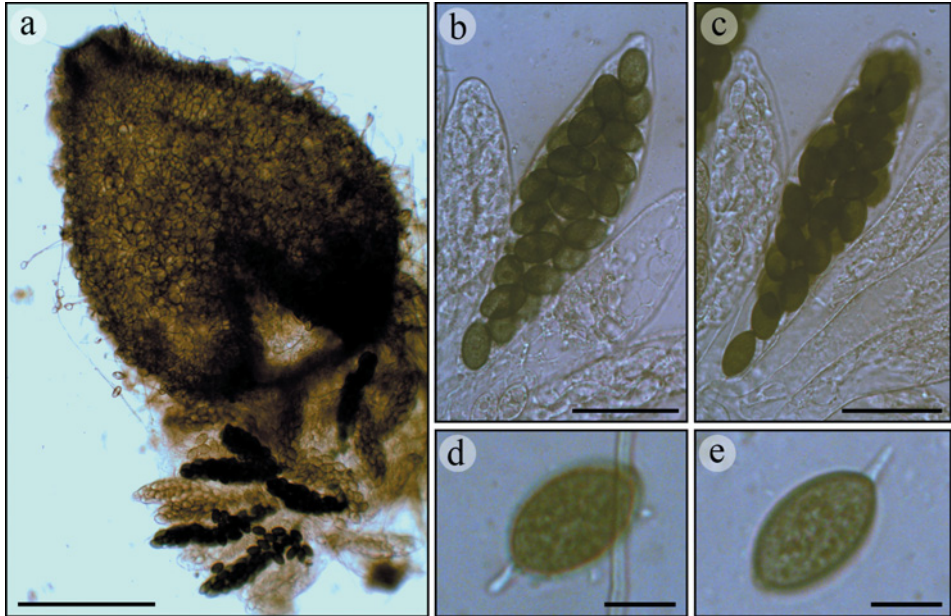


Fig. 6. *Schizothecium dakotense* (KWU 10918): **a** – squashed ascoma, **b, c** – details of the hymenium with 32-spored mature and immature asci, **d, e** – free mature ascospores. Scale bars = 100 μ m (**a**), 50 μ m (**b, c**), 10 μ m (**d, e**). Photos by Iryna V. Topchii.

on sheep dung, 27 Aug. 2015 (KWU 37918); *ibid.*, alt. 2020 m, 48°10'18.8" N, 24°25'16.2" E, on horse dung, 28 Aug. 2015 (KWU 51918), all leg. Yu.V. Shcherbakova, det. Yu.I. Lytvynenko & I.V. Topchii.

SMR. Slope of Bliznitsa Mountain, alt. 1767 m, 48°13'25.1" N, 24°13'50.4" E, on horse dung, 22 Aug. 2015, leg. Yu.V. Shcherbakova, det. Yu.I. Lytvynenko & I.V. Topchii (KWU 36918).

* *Schizothecium dakotense* (Griffiths) N. Lundq., *Symb. Bot. Upsal.* 20(1): 254, 1972 Fig. 6

Description. Ascomata perithecioid, scattered, semi-immersed to superficial, dark above and olivaceous brown below, broadly pyriform-conical, completely hairy, 470–620 \times 150–230 μ m; neck papilliform, conical, blackish, 90–120 \times 85–135 μ m, covered at the base with a collar of subtriangular, agglutinated hairs, consisting of swollen cells. Peridium thin, membranaceous, semi-transparent,

◀ **Fig. 5.** *Podospora pleiospora* (KWU 55918): **a** – squashed ascoma, **b** – 32-spored mature ascus, **c** – free mature ascospores. *Schizothecium tetrasporum* (KWU 37918): **d** – ascomata, **f** – asci with ascospores, **i** – details of exoperidial wall. *Schizothecium miniglutinans* (KWU 54918): **e** – squashed ascoma, **g** – asci with ascospores, **j** – details of exoperidial wall. *Sporormiella subtilis* (KWU 18918): **h** – mature ascus and ascospores. Scale bars = 200 μ m (**a, d**), 20 μ m (**b, c, i, j**), 100 μ m (**e**), 10 μ m (**f, g, h**). Photos by Iryna V. Topchii.

layered, with an exostratum made up of thin-walled, pale brown, roundish or polygonal cells (*textura globulosa-angularis*). Neck hairs short, swollen, 14–22 × 6–7 µm, two- or three-celled, with the end cells bluntly pointed, forming a collar of agglutinated triangular scales at the neck base; some scattered swollen hairs also present on the remaining part of the perithecium, mixed with long, septate, brown hairs measuring 135–155 × 1.5–2.0 µm.

Asci 32-spored, cylindrical-clavate, tending to swell in water, slightly pointed at the apex, with an indistinct apical ring, long-stalked, 223–267 × 40–47 µm, non-amyloid. Ascospores irregularly multiseriate, more or less spoon-shaped in early stages, soon transversely septate; apical dark cell (head) 20.1–21.3 × 12.2–13.7 µm, $Q = 1.47\text{--}1.72$, $Q_{av} = 1.64$; olivaceous to dark brown, ellipsoidal, with an apical germ pore, somewhat flattened at the base and slightly umbonate at the apex; pedicel 6.3–7.7 × 1.3–2.2 µm, hyaline, straight or slightly curved, cylindrical; upper cauda lash-like, gelatinous, eccentric and not covering the germ pore, about 20–30 µm long and about 2–3 µm wide at the base; the lower one similar but narrower and shorter, attached to distal end of the pedicel. Paraphyses hyaline, reduced to a shapeless substance surrounding the asci.

Notes. *Schizothecium dakotense* is morphologically similar to other members of this genus with 32-spored asci, but *S. alloechoaetum* (Mirza & Cain) L. Cai and *S. simile* (E.C. Hansen) N. Lundq. are not known from Ukraine. *Schizothecium dakotense* differs from *S. alloechoaetum* by its larger spores and the absence of long wavy, septate, and pigmented hairs at the neck base, whereas *S. simile* has both 16- and 32-spored asci, but can easily be identified by its larger spores and the presence of rigid hairs at the perithecium neck.

Distribution in Ukraine. Zk.

General distribution. Asia, Oceania, Europe, North America.

Material examined. Three specimens on dung incubated for 15, 21 and 49 days.

CMR. Petros Mountain, vicinity of tourist chalet, spruce forest, alt. 1534 m, 48°09'36.8" N, 24°28'09.3" E, on horse dung, 27 Aug. 2015 (KWU 02918); *ibid.*, 48°09'33.4" N, 24°28'15.0" E, on sheep dung, 27 Aug. 2015 (KWU 10918); *ibid.*, alt. 2020 m, 48°10'18.8" N, 24°25'16.2" E, on horse dung, 28 Aug. 2015 (KWU 53918), all leg. Yu.V. Shcherbakova, det. Yu.I. Lytvynenko & I.V. Topchii.

* *Schizothecium miniglutinans* (J.H. Mirza & Cain) N. Lundq., Symb. Bot. Upsal. 20(1): 254, 1972 Fig. 5 e, g, j

Notes. This species is widespread around the world but less well-known in the Ukraine.

Schizothecium miniglutinans is morphologically similar to *S. conicum* and differs from the latter by the smaller spores and shorter hair tufts.

Distribution in Ukraine. Do, Su, Zk.

General distribution. Asia, Australia and Oceania, Europe, North America.

Material examined. A single specimen on dung incubated for 28 days.

CMR. Petros Mountain, spruce forest, alt. 2020 m, 48°10'18.8" N, 24°25'16.2" E, on horse dung, 28 Aug. 2015, leg. Yu.V. Shcherbakova, det. Yu.I. Lytvynenko (KWU 54918).

- * *Schizothecium tetrasporum* (G. Winter) N. Lundq., Symb. Bot. Upsal. 20(1): 256, 1972 Fig. 5 d, f, i

Notes. This species is widespread around the world but less well-known in the Ukraine. It predominantly occurs on herbivore dung, but has been isolated from soil, wood and culms (Doveri 2004).

Distribution in Ukraine. Kha, Khe, Su, Zk.

General distribution. Africa, Australia and Oceania, Europe, North and South America.

Material examined. A single specimen on dung incubated for 11 days.

CMR. Petros Mountain, spruce forest, alt. 2020 m, 48°10'19.4" N, 24°25'16.8" E, on goat dung, 27 Aug. 2015, leg. Yu.V. Shcherbakova, det. Yu.I. Lytvynenko & I.V. Topchii (KWU 37918).

***Sordariaceae* G. Winter**

- * *Sordaria alcina* N. Lundq., Symb. Bot. Upsal. 20(1): 326, 1972

Notes. This species is cosmopolitan and widespread, and occurs on excrements of many herbivore species (Lundqvist 1972, Prokhorov & Armenskaya 2003, Doveri 2004).

Due to a number of micromorphological features, in particular the sizes of asci and ascospores, *S. alcina* is similar to *S. fimicola*, another common species in Ukraine and also found in the Carpathian Biosphere Reserve. These two species can be distinguished by their quotient value (Q). For spores of *S. fimicola* Q is 1.4–1.7, whereas for *S. alcina* it is always more than 1.8 (Lundqvist 1972, Doveri 2004).

Distribution in Ukraine. Khe, Su, Zk.

General distribution. Africa, Australia, Europe, North America.

Material examined. Five specimens on dung incubated for 5 to 15 days.

CMR. Petros Mountain, spruce forest, alt. 2020 m, 48°10'18.8" N, 24°25'16.2" E, on horse dung, 28 Aug. 2015 (KWU 58918); *ibid.*, 48°10'18.8" N, 24°25'17.0" E, on goat dung, 28 Aug. 2015 (KWU 57918, KWU 59918); *ibid.*, 48°10'19.2" N, 24°25'18.3" E, on sheep dung, 28 Aug. 2015 (KWU 62918), all leg. Yu.V. Shcherbakova, det. Yu.I. Lytvynenko & I.V. Topchii.

Sordaria fimicola (Roberge ex Desm.) Ces. & De Not., Comm. Soc. Crittog. Ital. 1(4): 226, 1863

Notes. One of the most widespread and commonest coprophilous pyrenomyces. This species is very common in Russia (Prokhorov & Armenskaya 2003) and has been recorded from the Ukrainian Carpathians (Morochkovskiy et al. 1969).

Distribution in Ukraine. Ivf, Khe, Ky, Su, Zk.

General distribution. Worldwide.

Material examined. Eight specimens on dung incubated for 5 to 15 days.

CMR. Petros Mountain, vicinity of tourist chalet, spruce forest, alt. 1534 m, 48°09'33.6" N, 24°28'09.5" E, on goat dung, 27 Aug. 2015 (KWU 43918); *ibid.*, 48°09'33.4" N, 24°28'15.0" E, on sheep dung, 27 Aug. 2015 (KWU 14918, KWU 42918, KWU 61918); *ibid.*, alt. 2020 m, 48°10'18.8" N, 24°25'17.0" E, on goat dung, 28 Aug. 2015 (KWU 12918, KWU 45918), all leg. Yu.V. Shcherbakova, det. Yu.I. Lytvynenko & I.V. Topchii; *ibid.*, 48°10'19.2" N, 24°25'18.3" E, on sheep dung, 28 Aug. 2015, leg. Yu.V. Shcherbakova, det. Yu.I. Lytvynenko (KWU 44918, KWU 60918).

* ***Sordaria humana*** (Fuckel) G. Winter, Bot. Zeit. 30: 835, 1872

Notes. A cosmopolitan species, and one of the commonest coprophilous pyrenomycetes in Russia (Prokhorov & Armenskaya 2003).

Sordaria humana has a wide substrate preference, occurring on omnivore, carnivore, herbivore and human dung, and also on other substrates: seeds, soil, old paper, and various decaying vegetable material (Lundqvist 1972, Doveri 2004).

Distribution in Ukraine. Su, Zk.

General distribution. Worldwide.

Material examined. A single specimen on dung incubated for 12 days.

CMR. Petros Mountain, spruce forest, alt. 2020 m, 48°10'19.2" N, 24°25'18.3" E, on sheep dung, 28 Aug. 2015, leg. Yu.V. Shcherbakova, det. Yu.I. Lytvynenko & I.V. Topchii (KWU 41918).

* ***Sordaria lappae*** Potebnia, Ann. Mycol. 5(1): 13, 1907

Fig. 7

Description. Ascomata perithecioid, aggregated, immersed or semi-immersed, dark brown to blackish, broadly ovoid to pyriform, 320–435 × 290–395 µm, glabrous or soft-haired; neck blackish, short, conical or subcylindrical. Peridium membranaceous, thick, layered, with an exostratum made up of thick-walled, brown, angular to rounded cells.

Asci eight-spored, cylindrical, with a short stipe measuring 167–239 × 15.8–19.7 µm; unitunicate, slightly narrowed and flattened at the apex, with thickened apical ring, non-amyloid. Ascospores uniseriate, one-celled, smooth, thick-walled, olivaceous brown when young, dark brown when mature, broadly ovoid (sometimes broadly ellipsoidal) to subglobose, pointed at the base, roundish at the apex, with a basal germ pore; 19.2–22.8 × 14.7–16.5 µm, $Q = 1.24–1.51$, $Q_{av} = 1.34$; gelatinous sheath narrow. Paraphyses hyaline, cylindrical-moniliform, septate, soon reduced to a shapeless substance.

Notes. Its distribution is worldwide, although mainly in temperate regions (Lundqvist 1972). It is very common in Russia (Prokhorov & Armenskaya 2003).

This taxon has a dubious taxonomic status (Lundqvist 1972, Khan & Krug 1989). *Sordaria lappae* is similar to *S. fimicola*, which is common in Ukraine,

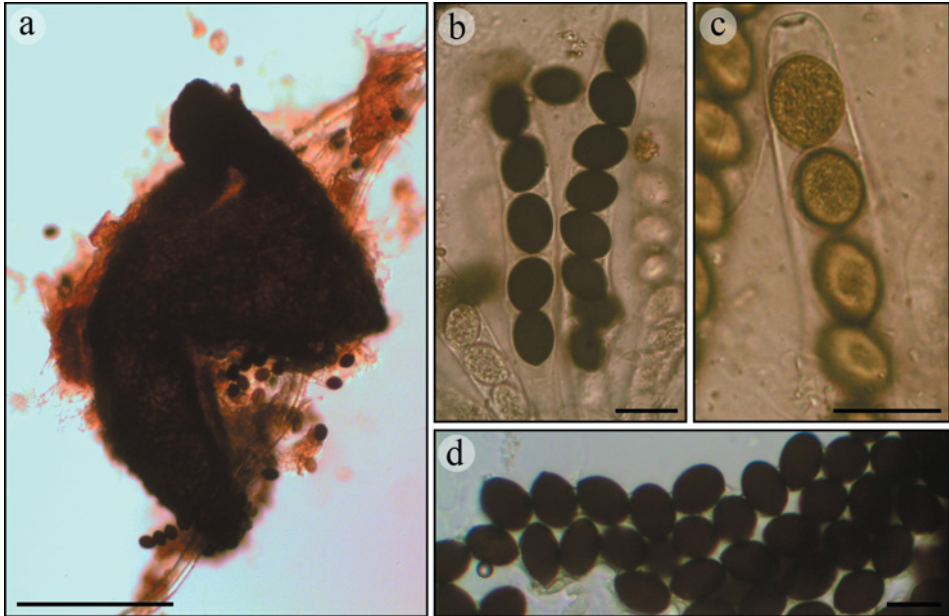


Fig. 7. *Sordaria lappae* (KWU 09918): **a** – squashed ascoma, **b** – mature asci and ascospores showing uniseriate spore arrangement, **c** – immature ascus with flattened apex, **d** – free mature ascospores. Scale bars = 200 µm (a), 20 µm (b–d). Photos by Iryna V. Topchii.

and with which it is easily confused. They have similarly sized asci and ascospores, the values of which may overlap (Lundqvist 1972, Khan & Krug 1989, Prokhorov & Armenskaya 2003, Doveri 2004). A reliable diagnostic feature which can separate these two species is the width of the spore (12–16 µm in *S. lappae* and 11–13 µm in *S. fimicola*; Lundqvist 1972, Doveri 2004) and the Q value: 1.5–2 in *S. fimicola*, 1.27–1.66 in *S. lappae* (Doveri 2004).

Distribution in Ukraine. Zk.

General distribution. Africa, Europe, North and South America.

Material examined. A single specimen on dung incubated for 6 days.

CMR. Petros Mountain, spruce forest, alt. 2020 m, 48°10'18.8" N, 24°25'17.0" E, on goat dung, 28 Aug. 2015, leg. Yu.V. Shcherbakova, det. Yu.I. Lytvynenko & I.V. Topchii (KWU 09918).

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