An update on the occurrence of the *Sporormiaceae* (*Pleosporales*) in Ukraine

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The article provides an update on the dung-inhabiting members of the *Sporormiaceae* in Ukraine. Overall, 26 species of *Sporormia* and the *Preussia/Sporormiella* species complex have been recorded in the country to date. Based on examination of specimens collected in 2007–2020, we report one species of *Sporormia* (*S. fimetaria*), two of *Preussia* s. str. (*P. fleischhakii*, *P. funiculata*) and 11 of *Sporormiella* (*S. affinis*, *S. commutata*, *S. grandispora*, *S. heptamera*, *S. kansensis*, *S. leporina*, *S. longisporopsis*, *S. megalospora*, *S. muskokensis*, *S. octomera* and *S. pulchella*). Of these, the genus *Sporormia* and four species of the other genera (*P. fleischhakii*, *S. affinis*, *S. commutata* and *S. longisporopsis*) are newly recorded in Ukraine. For all fourteen species, their morphological characters are described, illustrated and discussed; occurrence records, habitat and distribution data are also provided. This study extends the distribution ranges of these fungi eastwards within Europe and contributes to their substrate list.

**Key words:** coprophilous fungi, distribution, morphology, *Preussia*, *Sporormia*, *Sporormiella*.

**Article history:** received 4 October 2022, revised 17 November 2022, accepted 18 November 2022, published online 12 December 2022.

DOI: [https://doi.org/10.33585/cmy.74206](https://doi.org/10.33585/cmy.74206)


Článek přináší současné údaje o výskytu hub z čeledi *Sporormiaceae* na území Ukrajiny. Celkem zde bylo dosud zaznamenáno 26 druhů z rodu *Sporormia* a komplexe *Preussia/Sporormiella*. Na základě studia sbírů z let 2007–2020 jsou podány souhrnné informace o jednom druhu z rodu *Sporormia* (*S. fimetaria*), dvou z rodu *Preussia* s. str. (*P. fleischhakii*, *P. funiculata*) a 11 z rodu *Sporormiella* (*S. affinis*, *S. commutata*, *S. grandispora*, *S. heptamera*, *S. kansensis*, *S. leporina*, *S. longisporopsis*, *S. megalospora*, *S. muskokensis*, *S. octomera* a *S. pulchella*). Z toho rod *Sporormia* a čtyři druhy z dalších rodů (*P. fleischhakii*, *S. affinis*, *S. commutata* a *S. longisporopsis*) jsou poprvé zaznamenány na území Ukrajiny. U všech čtrnácti zmíněných druhů jsou popsány,
**INTRODUCTION**

Members of the *Sporormiaceae* are widely distributed throughout the world. They occur mainly as saprobic fungi on various organic substrates, such as dung, soil, decaying plant debris, etc. There are also numerous reports on these fungi isolated from different plant species as endophytes (Arenal et al. 2007, Mapperson et al. 2014, Gonzalez-Menendez et al. 2017). The majority of the *Sporormiaceae* are, however, coprophilous [some authors prefer the term ‘fimicolous’ for fungi inhabiting dung only occasionally, see e.g. Calaça et al. (2020), nevertheless we maintain the term ‘coprophilous’ in the wide sense throughout this paper]. The abundance of fossil ascospores of these fungi in ancient sediments was used as a proxy indicator of megaherbivore existence and decline in the past (Davis et Shafer 2006, Johnson et al. 2015).

The *Sporormiaceae* are characterised by pseudothecia with fissitunicate asci (Kruys et Wedin 2009, Hyde et al. 2013). Ascospores are thick-walled, dark brown, usually 4- to multi-celled, constricted at septa and often separating into part-spores at maturity, frequently with germ slits, sometimes surrounded by a mucilaginous sheath (Barr 2000, Hyde et al. 2013).

The number of genera varies from 7 (Lumbsch et Huhndorf 2010) or 8 with ca 100 species (Barr 2000) to 10 genera and 143 species (Kirk et al. 2008) or 9 genera and 199 species (Wijayawardene et al. 2020). *Preussia* Fuckel and *Sporormiella* Ellis et Everh. are particularly species-rich genera. Having studied phylogenetic relationships within the *Sporormiaceae*, Kruys et Wedin (2009) proposed a phylogeny-based generic classification of the family. In particular, the authors argued for merging *Sporormiella* and *Spororminula* Arx et Aa into the genus *Preussia*. However, phylogenetic analysis showed *Preussia* and *Sporormiella* to form non-monophyletic groups, thus the *Preussia/Sporormiella* complex has remained unresolved. Based on morphology and molecular data, Zhang et al. (2012) also accepted *Preussia* s. 1. (inclusive of *Sporormiella* and *Spororminula*) pending further research. The same generic concept was supported by Hyde et al. (2013), who considered within the family five genera, *Chaetopreussia* Locq.-Lin., *Pleophragmia* Fuckel, *Preussia*, *Sporormia* De Not. and *Westerdykella* Stolk. Further phylogenetic analyses have not demonstrated a distinction between *Preussia* and *Sporormiella* (Mapperson et al. 2014, Gonzalez-Menendez et al. 2017). They are, therefore, treated as synonyms in recent classifications (Wijayawardene et al. 2014, 2017, 2018, 2020). Consequently, the above five genera are placed in
the Sporormiaceae, but the family has gradually expanded from five (Wijayawardene et al. 2014) to six (Wijayawardene et al. 2018), seven (Wijayawardene et al. 2017) and finally nine genera (Wijayawardene et al. 2020).

Since Sporormiella, Preussia and Sporormia are morphologically very similar (Kruys et Wedin 2009, Doveri 2011, Zhang et al. 2012), they remain a subject of extensive debate, leading to confusion with regard to a distinction of the genera. There are currently two main concepts resulting from different interpretations of the original diagnoses.

The first concept considers Preussia and Sporormiella as distinct genera, based on morphological and ecological characters (Cain 1961, Ahmed et Cain 1972, Barrasa et Checa 1991, Doveri 2004, 2011, Bell 2005, Kirk et al. 2008, Lumbsch et Huhndorf 2010, Mungai et al. 2012, Doveri et Sarrocco 2013, Melo et al. 2017). In this case, Sporormiella is characterised by semi-immersed or immersed ostiolate pseudothecia, cylindrical to cylindrical-clavate asci, 4- to multicelled spores, and is preferably found on dung. These features are opposite to those observed in Preussia with superficial, globose, cleistothecioid pseudothecia, clavate to broadly clavate asci, 4-celled spores, and main occurrence on soil and plant debris, occasionally on dung.

Another viewpoint does not acknowledge the independence of Sporormiella and considers it as a later synonym of Preussia (Ahmad 1978, Valldosera et Guarro 1990, Guarro et al. 1997a, 1997b, Abdullah et al. 1999, Arenal et al. 2004, Chang et Wang 2009, Kruys et Wedin 2009, Asgari et Zare 2010, Mapperson et al. 2014, Kruys 2015, Gonzalez-Menendez et al. 2017). That opinion is based on rather vague distinctions between the two genera with respect to substrate preference (coprophilous vs. non-coprophilous) and morphological features of pseudothecia (ostiolate vs. non-ostiolate) and asci (cylindrical to cylindrical-clavate vs. clavate to broadly clavate).

The latter concept has been supported by extensive phylogenetic studies on the Preussia/Sporormiella complex (Arenal et al. 2005, 2007, Kruys et Wedin 2009, Asgari et Zare 2010, Mapperson et al. 2014, Gonzalez-Menendez et al. 2017), although these do not definitely resolve the question of synonymy. However, this approach has resulted in several recombinations of Sporormiella species into Preussia (Arx 1973, Ahmad 1978, Valldosera et Guarro 1990, Guarro et al. 1997a, 1997b, Abdullah et al. 1999, Arenal et al. 2004, Chang et Wang 2009, Kruys et Wedin 2009). Nevertheless, new species of Sporormiella have later been described (Doveri et Sarrocco 2013, Melo et al. 2017). Some publications reported both Sporormiella species and those transferred to Preussia (Kruys 2015, Gonzalez-Menendez 2017), which may lead to more confusion. In general, a large number of Sporormiella species have not been assigned to Preussia to date. Accordingly, Index Fungorum (http://www.indexfungorum.org/) and Mycobank
online databases also lack clarity regarding the synonymy of *Preussia* and *Sporormiella*.

In this study, we follow a rather conservative generic classification accepting *Preussia* s. str. and *Sporormiella*, despite the latter not being conclusively a well-supported monophyletic group. Given that generic delimitation in the *Sporormiaceae* is still not thoroughly resolved, we treat the two genera here in the sense of Cain (1961), Ahmed et Cain (1972), Doveri (2004), Kirk et al. (2008) and Mungai et al. (2012).

Although species of *Sporormiaceae* have long attracted attention of many mycologists in various countries, little information regarding this group of fungi is available in Ukraine. The first significant inventory of coprophilous fungi in the country (Milovtsova 1937) reported 56 species, including two species of *Sporormiella*, *S. intermedia* (Auersw.) S.I. Ahmed et Cain ex Kobayasi and *S. lageniformis* (Fuckel) S.I. Ahmed et Cain. *Sporormiella minima* (Auersw.) S.I. Ahmed et Cain was subsequently added by Morochkovskyi et al. (1969). *Sporormiella tomitinii* O.V. Korol. was described as a new species from Ukraine (Korolyova 2000). In 2000–2010, we studied the species diversity of the coprophilous *Sporormiaceae* in the country. As a result, we reported eight species of *Sporormiella* for Ukraine in 2008–2014: *S. australis* (Speg.) S.I. Ahmed et Cain, *S. minimoides* S.I. Ahmed et Cain, *S. vexans* (Auersw.) S.I. Ahmed et Cain (Golubtsova 2008), *S. dubia* S.I. Ahmed et Cain (Golubtsova et al. 2010), *S. corynespora* (Niessl) S.I. Ahmed et Cain (Akulov et Ordynets 2011), *S. megalospora* (Auersw.) S.I. Ahmed et Cain (Akulov et Ordynets 2011, Lytvynenko et Stepanovska 2014), *S. inaequalis* S.I. Ahmed et Asad (Lytvynenko et Kravtsov 2012) and *S. grandispora* S.I. Ahmed et Cain ex J.C. Krug (Lytvynenko et Stepanovska 2014). Ten of the above species are also listed in a summarising publication on the genus *Sporormiella* in Ukraine (Korolyova 2015). After that, another nine species of the *Sporormiaceae* have been recorded; out of these, seven species from the north-east of the country (Sunny Region) – *Preussia funiculata* (Preuss) Fuckel, *Sporormiella heptamera* (Auersw.) S.I. Ahmed et Cain, *S. kansiensis* (Griffiths) S.I. Ahmed et Cain, *S. leporina* (Niessl) S.I. Ahmed et Cain, *S. muskokensis* (Cain) S.I. Ahmed et Cain, *S. octomera* (Auersw.) S.I. Ahmed et Cain and *S. pulchella* (E.C. Hansen) S.I. Ahmed et Cain (Lytvynenko et al. 2016, Mironets et Lytvynenko 2017), one species from the Carpathian Mountains, i.e. *Sporormiella subtilis* S.I. Ahmed et Cain (Lytvynenko et al. 2018), and one more species from Oleshkivsky Pisky National Nature Park, i.e. *Sporormiella tetramera* S.I. Ahmed et Cain (Lytvynenko et al. 2021).

In this paper, we provide updated information on the occurrence of coprophilous species of the *Sporormiaceae* in Ukraine, including new records for the country, as well as their descriptions, current distribution data and original illustrations.
MATERIAL AND METHODS

Dung samples were collected during 2007–2020 at 12 locations in five regions in Ukraine (Fig. 1). The moist-chamber method of incubation was used to detect and obtain ascomata in the dung samples. The samples were placed in a Petri dish on filter paper and moistened with distilled water. More water was added when necessary to maintain sufficient moisture of the substrate. The incubation was carried out at room temperature (18–22 °C) under natural light for 30–45 days, depending on the period of ascomata development. The samples were examined at intervals of 1–2 days using a stereomicroscope.

Microcharacters were examined on fresh material. MBS-10 (JSC ‘LZOS’, Lytkarino, Moscow Region, Russia) and SM-6630 ZOOM (MICROmed, China) stereomicroscopes were used to examine the surface of the excrements and to study the morphology of the ascomata. Microstructures were examined with MB-302 40x-1600x LED Trino (Sigeta, Kyiv, Ukraine) and XSM-40 (Ningbo Sunni Instruments Co., Zhejiang, China) compound microscopes. Dimensions of microstructures were measured using the Tsview7 modular software, and photomicrographs were taken with a 3.0mp Digital Microscope Camera (both produced by Fuzhou Tucsen Imaging Technology Co., Fujian, China).

Microstructures mounted in distilled water were examined at magnifications of up to 600×. Aqueous cotton blue was used for staining the hyaline gelatinous sheaths or appendages. Since ascomata and ascospores of the studied fungi are dark coloured (blackish or dark brown and olivaceous brown to dark brown, respectively), no colour charts were used for the descriptions. At least 20–30 mature spores and 10–20 more or less mature asci per specimen were measured. The quotient Q represents the length/width ratio of spores or cells. The mean values of spore dimensions and quotient are provided in square brackets.

![Fig. 1. Map of sampling locations (black dots) in Ukraine.](image)
Analysis of general distribution is based on data from numerous bibliographic sources listed in the References and on critically revised open internet resources. Also the Global Biodiversity Information Facility (GBIF, www.gbif.org) was consulted for records.

The specimens are deposited at the Fungarium of the M.G. Kholodny Institute of Botany, National Academy of Sciences of Ukraine, Kyiv (KW-M) and Mycological Herbarium (Fungarium) of the V.N. Karazin Kharkiv National University (CWU-MY).

RESULTS

As a result of our research, the species diversity of the Sporormiaceae in Ukraine has increased to 26 species of the Sporormia and Preussia/Sporormiella species complex: one species of Sporormia, two of Preussia s. str., and 23 of Sporormiella. The Sporormia species was recorded for the first time in the country. Five of the currently distinguished species (Preussia fleischhakii, Sporormia fimetaria, Sporormiella affinis, S. commutata and S. longisporopsis) were new records for Ukraine. This study, therefore, extends the distribution ranges of these species within Europe, now including Ukraine as one more country in Eastern Europe. For some species, their substrate list has been extended.

Below we provide descriptions, photomicrographs, habitats, distribution data and taxonomic notes for 14 species of Sporormiaceae in Ukraine, five of them new to Ukraine, and nine listed in previous publications without any additional data.

Preussia fleischhakii (Auersw.) Cain, Can. J. Bot. 39: 1640, 1961 Figs 2A–C

Basionym: Sporormia fleischhakii Auersw. in Rabenhorst, Fungi Europaei exsiccati, Klotzschii herbarii vivi mycologici continuatio. Edito nova, Series secunda, Cent. 10: no. 921, 1866

= Gnomonia fleischhakii (Auersw.) Auersw., Mycologia europaea. Abbildungen sammlicher Schwämme Europas 5–6: 26, 1869

= Perisporium fleischhakii (Auersw.) Auersw. in Rabenhorst, Fungi Europaei exsiccati, Klotzschii herbarii vivi mycologici continuatio. Edito nova, Series secunda, Cent. 14: no. 1338, 1870

= Diaporthe fleischhakii (Auersw.) M. Monod, Beihefte zur Sydowia 9: 219, 1983

= Fleischhakia laevis Auersw., Hedwigia 8: 2, 1869

= Perisporium laeve (Auersw.) Auersw., Hedwigia 8: 179, 1869

Description. Pseudothecia scattered, semi-immersed, subglobose, glabrous, blackish, non-ostiolate, 132–175 μm diam. Peridium layered, pseudo-parenchymatous, consisting of angular cells 5–9 μm diam. Asci 8-spored, broadly clavate to saccate, short stipitate, 51–60 × 20–26 μm (spore-bearing part 40–49 × 20–26 μm), broadly rounded at the apex, narrowing from the broadest part near the middle into a short, lobate stipe, 11–13 μm long. Ascospores crowded and fasciculate inside the asci, arranged parallel to the longitudinal axis and forming cylindrical bundles 40–55 μm long (sometimes one or two lower mature spores may enter the upper part of the stipe, hence the size of the bundle exceeds that of the spore-bearing part of the ascus), 4-celled, 26.4–[27.7]–28.7 × 5.2–[5.9]–6.6 μm,
Q = 4.15–[4.75]–5.41, cylindrical, straight or slightly curved, olivaceous brown when young, turning dark brown with age; septa transverse, constrictions at septa broad and deep, segments easily separable; end cells slightly narrower and longer, 7.5–9.2 × 5.2–5.6 μm, ovoid to conical, with a roundish apex, mid-cells cylindrical to subglobose, 7.3–7.6 × 5.2–6.6 μm; germ slits oblique; gelatinous sheath not observed. *Pseudoparaphyses* numerous, filiform, septate, slightly exceeding the asci, 3–5 μm diam.

**Distribution.** Europe: Belgium, Cyprus, Czech Republic, Germany, Hungary, Italy, the Netherlands, Poland, Spain, Sweden, Ukraine, UK; Asia: Japan; Australasia: New Zealand; North America: Canada, USA (Cain 1961, Barrasa et Checa 1991, Doveri 2004, Kruys et Ericson 2008, Kruys et Wedin 2009, Asgari et Zare 2010, this study).


**Specimen examined**


**Notes.** This species is widespread in the world. Our record of *P. fleischhakii* is the first for Ukraine and rabbit dung represents a new substrate.

*Preussia funiculata* (Preuss) Fückel, Fungi rhenani exsic. Suppl. Fasc. 3, No. 1750, 1866

**Basionym:** *Perisporium funiculatum* Preuss, Linnaea 24: 143, 1851

= *Verrucaria pulposa* Leight., Lich.-Fl. Great Brit.: 427, 1871

**Description.** Pseudothecia scattered, semi-immersed, subglobose, glabrous, blackish, 325–455 × 295–425 μm; neck papilliform, bare, black. Peridium layered, pseudoparenchymatous, consisting of angular cells measuring 8–14 μm diam. Asci 8-spored, broadly-clavate, long stipitate, 95–128 × 14–18.5 μm (spore-bearing part 64–76 × 14–18.5 μm), narrowing from the broadest part above the middle into a very long, slender, nearly cylindrical stipe, 32–55 μm long. Ascospores crowded and fasciculate inside the asci, arranged parallel to the longitudinal axis and forming cylindrical bundles 60–66 μm long; 4-celled, young spores visible in asci measuring 24.7–[25.5]–26.6 × 6.3–[6.8]–7.7 μm, Q = 3.53–3.76–4.40, olivaceous brown; mature spores 26.4–[28.3]–29.7 × 5.3–[6.1]–7.3 μm, Q = 4.23–[4.51]–4.72, cylindrical, straight or slightly curved, dark brown; septa oblique, constrictions at septa broad and deep, segments easily separable; end cells slightly narrower and longer, 7.9–9.9 × 5.8–7.0 μm, more or less conical, with a roundish apex; mid-cells ovoid or barrel-shaped when young, 5.8–7.7 × 6.3–7.7 μm,
becoming cylindrical with age, 6.8–8.5 × 5.3–7.3 μm; germ slits oblique; gelatinous sheath not observed. *Pseudoparaphyses* numerous, filiform, septate, slightly exceeding the asci, 3–5 μm diam.

**Distribution.** Europe: Austria, Denmark, Estonia, France, Germany, Hungary, Lithuania, Norway, Russian Federation, Spain, Sweden, Switzerland, Ukraine, UK; Africa: Morocco, Senegal; Asia: Iran; Australasia: Australia; North America: Canada, USA (Munk 1957, Cain 1961, Valldosera et Guarro 1990, Treigienè 2004, Richardson 2004b, Bell 2005, Kruys et Ericson 2008, this study).

**Habitat.** On dung of dog, goat, horse, moose, porcupine, rabbit, roe deer, sheep and wild boar, on decaying wood of *Quercus* sp., on straw and rotting stems of *Brassica oleracea*, *Festuca* spp., *Poa* spp., on an old beehive, old wooden boards, rotten cloth, sacking, seeds (Munk 1957, Cain 1961, Doveri 2004, Richardson 2004b, Treigienè 2004, Kruys et Ericson 2008).

**Specimens examined**


**Notes.** *Preussia funiculata* is facultatively coprophilous and is also reported to occur on other organic substrates, such as decaying textile or woody material, plant stems and seeds; it forms numerous fertile perithecia in vitro (Ahmed et Cain 1972).

This species is widespread throughout the world. In Ukraine, *P. funiculata* has been previously reported briefly from two localities, on dung of cow (Lytvynenko et al. 2016) and hare (Lytvynenko et al. 2022), both representing new substrates. Here we provide a description and original illustrations of its microstructures for the first time.


*Basionym: Hormospora fimetaria* De Not., G. Bot. Ital. 1, 2: 47, 1844 (nom. illeg.)

= *Sphaeria fimetaria* (De Not.) Rabenh., Herb. Mycol.: 1733, 1853

= *Brochospora fimetaria* (De Not.) Kirschst., Hedwigia 81: 204, 1944

**Description.** *Pseudothecia* scattered, immersed, globose, glabrous, dark brown, 100–130 × 95–125 μm, without neck. *Peridium* thin, pseudo-parenchymatous, consisting of dark brown, thick-walled, angular cells measuring 9–13 μm diam. *Asci* 8-spored, cylindrical, short stipitate, 52–68 × 11–12.5 μm,
broadly rounded at the apex, contracted below into a very short, persistent, lobate stipe, measuring 5–6 μm in length. Ascospores crowded and fasciculate inside the asci, arranged parallel to the longitudinal axis and forming cylindrical bundles in the middle of the ascus, 37–48 μm long; 16-celled, 37.6–40.9 × 3.2–3.4 × 3.7 μm, Q = 11.1–12.42‒13.9, olivaceous when young, turning dark brown with age; cylindrical, straight or slightly curved; septa transverse, constrictions at septa broad and deep, segments easily separable; end cells slightly narrower and longer, subconical, with a roundish apex; mid-cells cylindrical or barrel-shaped, wider than long; germ slits absent; gelatinous appendages observed at both spore ends. Pseudoparaphyses filiform, septate, slightly exceeding the asci, ephemeral, hardly observable.


Specimen examined

Notes. This is a cosmopolitan but infrequently encountered species. This is the first report for Ukraine.

Figs 3A–E


Description. Pseudothecia ostiolate, scattered, immersed, subglobose, smooth, dark brown, 530–650 μm diam.; neck small, papilliform, bare, black. Peridium thick, membranaceous, layered. Asci 8-spored, cylindrical-clavate, gradually tapered into a short stipe, 190–285 × 30–37 μm. Ascospores triseriate above, uni- or biseriate below, 8-celled, 82.9–87.7 × 13.1–14.0 × 14.9 μm,
Q = 5.97–6.25–6.59, fusiform-cylindrical, straight or slightly curved, olivaceous when young, turning dark brown with age; septa transverse, constrictions at septa broad and deep, segments easily separable; terminal cells ovoid-conical, rounded at the ends, longer than wide; mid-cells cylindrical or ellipsoidal, almost equal in length, wider than long, third cell from the upper end the broadest; germ slit diagonal; gelatinous sheath hyaline, broad, 9.8–11.1 μm wide. Pseudo-paraphyses filiform, septate, equaling the asci.

**Distribution. Europe:** Austria, Belgium, Bulgaria, Denmark, Hungary, Italy, Luxemburg, Spain, Sweden, Switzerland, Ukraine; **North America:** Canada, Mexico, USA (Bommer et Rousseau 1886, Tóth 1963, Fakirova 1969, Ahmed et Cain 1972, Valldosera et Guarro 1990, Kruys et Wedin 2009, Doveri 2011, this study).

**Habitat.** On dung of hare and rabbit (Bommer et Rousseau 1886, Ahmed et Cain 1972).

**Specimens examined**


**Notes.** The species is currently only known from the Northern Hemisphere, where it has been reported exclusively on lagomorph droppings. All Ukrainian specimens were recorded on hare dung. This record is the first for Ukraine.


**Basionym:** Sporormia commutata Niessl, Österr. Bot. Zeit. 28: 164, 1878


**Description.** Pseudothecia scattered, immersed, subglobose, smooth, blackish, 255–273 × 235–248 μm diam.; neck small, papilliform, bare. Peridium thick, membranaceous, layered. Ascii 8-spored, cylindrical-clavate, gradually tapered into a short stipe, 155–198 × 20.5–22.5 μm. Ascospores bi- or triseriate, usually 8-celled, occasionally 7- and 9-celled, 55.5–[61.1]–64.6 × 8.4–[9.9]–10.5 (11.5) μm, Q = 5.85–[6.42]–7.25, cylindrical-clavate, straight or slightly curved, olivaceous brown when young, turning dark brown with age; septa transverse, constrictions at septa deep; segments easily separable, mid-cells broader than long, third cell from the upper end the broadest, terminal cells ovoid, longer than
broad; germ slits strongly oblique to diagonal; gelatinous sheath present, hyaline. *Pseudoparaphyses* filiform, septate, longer than the asci.


**Habitat.** On dung of cattle, donkey, hare, rabbit and sheep (Niessl 1878b, Ahmed et Cain 1972, Treigiene 2004).

**Specimen examined**

**Notes.** This is a rather uncommon and probably rare species globally. This record is the first for Ukraine.


**Basionym:** *Sporormia intermedia* subsp. *grandispora* Speg., Michelia 2: 230, 1878

= *Sporormia grandispora* (Speg.) Speg., Syll. fung. (Abellini) 2: 128, 1883

= *Preussia grandispora* (Speg.) Barrasa et Arenal, in Arenal, Platas et Peláez, Mycotaxon 89(1): 139, 2004

**Description.** Pseudothecia scattered, immersed, becoming almost superficial, subglobose, smooth, dark brown to black, 310–330 μm diam.; neck small, bare, black. Peridium thin, membranaceous. Ascii 8-spored, cylindrical-clavate, gradually narrowing from the broadest part near the apex into a short stipe, 154–187 × 22–27 μm. Ascospores bi- or triseriate, 4-celled, (44.2)46.4–[48.4]–50.7 × 10.9–[11.9]–12.6 μm, Q = 3.53–[3.89]–4.47, fusiform-cylindrical, yellowish brown when young, turning blackish brown with age; septa transverse, constrictions at septa broad and deep; segments not easily separable, cells about equal in length, terminal cells ovoid-conical; germ slits parallel; gelatinous sheath hyaline, broad. *Pseudoparaphyses* filiform, septate, longer than asci.


**Specimens examined**


**Notes.** In Ukraine, apart from these specimens, *S. grandispora* is also known from two localities in the Bilopillya District, Sumy Region (Lytvynenko et Stepanovska 2014).


*Fig. 3K–O*

**Basionym:** *Sporormia heptamera* Auersw., Hedwigia 7: 71, 1868


**Description.** Pseudothecia scattered, immersed, subglobose, smooth, dark brown, 420–490 × 385–460 μm; neck small, cylindrical, bare, black. Peridium layered, pseudoparenchymatous. Ascii 8-spored, cylindrical-clavate, 266–348 × 43–50 μm, gradually tapered into a slender stipe, 18–28 μm long. Ascospores biseriate above, uniseriate below, 7-celled, (64.9)70.8–[75.3]–86.7 × (15.7)16.5–[17.8]–19.8 μm, Q = 3.63–[4.26]–5.10, cylindrical, straight or slightly curved, olivaceous brown when young, turning dark brown with age; septa transverse, constrictions at septa deep, segments easily separable; five mid-cells wider than long, third cell from the upper end the broadest, terminal cells slightly longer than the mid-cells, ovoid-conical to almost hemispherical, the basal cell hardly longer than the apical one; germ slits oblique to transverse; gelatinous sheath hyaline, broad. Pseudoparaphyses numerous, filiform, septate, containing many hyaline vacuoles, slightly exceeding the asci.

**Distribution.** Europe: Austria, Belgium, Bulgaria, Czech Republic, Denmark, France, Germany, Hungary, Iceland, Italy, Lithuania, Luxemburg, the Netherlands, Norway, Spain, Sweden, Switzerland, Ukraine; Asia: Japan; Australasia: New Zealand; North America: Canada, USA; South America: Argentina, Chile (Niessl 1878a, Munk 1957, Tóth 1963, Fakirova 1969, Ahmed et Cain 1972, Furuya et Udagawa 1972, Valldosera et Guarro 1990, Doveri 2004, Treigienë 2004, Kruys et Wedin 2009, Richardson 2011, this study).

Specimen examined

Notes. Despite its rather wide distribution range, *S. heptamera* is infrequent. Previously, it was reported as quite rare (Doveri et al. 1999) or apparently uncommon (Richardson 2011). In Ukraine, this is the second record of the species, after another one in the Sumy Region (Lytvynenko et al. 2016). The description and illustrations given here are of the latter collection.


Fig. 4F–J


= *Preussia kansensis* (Griffiths) Guarro, in Guarro, Al-Saadoon et Abdullah, Nova Hedwigia 64(1–2): 182, 1997

Description. Pseudothecia scattered, immersed, pyriform or sub-globose, slightly tomentose, dark brown, 450–475 × 375–425 μm; neck subcylindrical, bare, black. Peridium layered, pseudoparenchymatous, consisting of sub-globose to angular cells. Asci 8-spored, cylindrical-clavate, 225–342 × 31–34 μm, gradually narrowing from the broadest part above the middle into a stout, persistent stipe, 38–45 μm long. Ascospores triseriate above, uni- or biseriate below, 4-celled, (65.9)70.2–[71.8]–74.4 × 9.9–[11.5]–12.9(13.9) μm, Q = 5.33–[6.25]–6.69, cylindrical, straight or slightly curved, olivaceous brown when young, turning dark brown with age; septa transverse, constrictions at septa broad and deep, segments easily separable; all cells about equal in length, end cells hardly narrower; mid-cells cylindrical, the terminal ones more or less conical, with a roundish apex; germ slits parallel, less slightly oblique in terminal cells; gelatinous sheath hyaline, broad. Pseudoparaphyses numerous, filiform, septate, slightly exceeding the asci.


Specimen examined
Notes. *Sporormiella kansensis* is most probably a rare species known from single finds in several countries. In Ukraine, this is the second record of the species, after an earlier brief report of it on cow dung in the same Park (Lytvynenko et al. 2016).


Figs 5A–E

**Basionym:** *Sporormia leporina* Niessl, Österr. Bot. Z. 28: 44, 1878


**Description.** Pseudothecia scattered, immersed, becoming almost superficial, subglobose, smooth, dark brown, 210–280 μm diam.; neck short, papilliform, bare, black. *Peridium* thin, membranaceous. *Ascii* 8-spored, cylindrical-clavate, broadest near the apex, gradually tapered into a stipe, 136–146 × 14.2–17.0 μm. *Ascospores* bi- or triseriate above, uni- or biseriate below, 4-celled, (34.0)34.8–[35.1]–35.5 × 5.8–[6.3]–6.5(7.0) μm, Q = 5.38–[5.62]–5.85, fusiform-cylindrical, straight or slightly curved, olivaceous brown when young, turning dark brown with age; septa transverse, constrictions at septa deep, segments not easily separable; cells more or less equal in length, terminal cells ovoid-conical, mid-cells cylindrical, end cells sometimes slightly longer than the middle ones, and the second upper cell slightly wider than the others, barrel-shaped; germ slits nearly parallel to strongly oblique; gelatinous sheath hyaline, broad. *Pseudoparaphyses* filiform, septate, longer than the asci, 2.5–3.0 μm diam.


**Specimens examined**

Notes. Sporormiella leporina is widely distributed throughout the world. The epithet of this fungus refers to its preference for lagomorph excrements but it also occurs on excrements of many other herbivores and carnivores.

Figs 4Q–W


Description. Pseudothecia scattered or aggregated, immersed, becoming almost superficial, subglobose, smooth, dark brown, 400–450 μm diam.; neck short, bare, black. Peridium thin, membranaceous. Ascii 8-spored, cylindrical-clavate, gradually tapered into a stout, persistent stipe, 289–296 × 36–39 μm. Ascospores bi- or triseriate, 4-celled, 80.6–[84.7]–98.0 × 14.5–[16.7]–17.6 μm, Q = 4.64–[5.03]–5.88, cylindrical, straight or slightly curved, yellowish brown when young to dark brown when mature; septa transverse, constrictions at septa broad and deep; segments easily separable, all cells almost equal in length, roundish at the apex; germ slits parallel or oblique; gelatinous sheath hyaline, broad. Pseudoparaphyses filiform, septate, exceeding the asci.


Specimens examined

Notes. Sporormiella longisporopsis is probably a rare fungus worldwide (Doveri 2004, Mungai et al. 2012). This is the first record for Ukraine and horse dung represents a new substrate.

Figs 4K–P

Basionym: Sporormia megalospora Auersw., Hedwigia 7: 68, 1868
Description. Pseudothecia scattered or aggregated, immersed, becoming almost superficial, pyriform, smooth, dark brown, 487–555 × 325–366 μm; necks short, bare, black. Peridium thin, coriaceous. Ascii 8-spored, cylindrical-clavate, gradually tapered into a stout, persistent short stipe, 194–217 × 28–35 μm. Ascospores bi- or triseriate, 4-celled, 62.6–[71.5]–77.5(81.2) × (13.7)14.8–[15.5]–17.4 μm, Q = 4.23–[4.78]–5.41, fusiform-cylindrical, straight or slightly curved, yellowish brown when young to dark brown when mature; septa transverse, constrictions at septa broad and deep; segments easily separable, terminal cells slightly longer than the mid-cells, ovoid; germ slits diagonal or oblique; gelatinous sheath hyaline, broad. Pseudoparaphyses filiform, septate, exceeding the ascii.


Specimens examined

Notes. Sporormiella megalospora is one of the most common and widespread species preferably growing on dung of wild herbivores (Doveri 2004). In Ukraine, it has been previously listed in a few species inventories (Akulov et Ordynets 2011, Lytvynenko et Stepanovska 2014, Akulov et al. 2016, Lytvynenko et al. 2021). Here we provide descriptions and original micrographs of Ukrainian specimens for the first time.
Figs 5F–H

**Basionym:** Sporormia muskokensis Cain, Univ. Toronto Stud., Biol. Ser. No. 38: 96, 1934

**Description.** Pseudothecia scattered, immersed, subglobose, smooth, dark brown, 210–235 μm diam.; neck papilliform to cylindrical, bare, black. Peridium thin, membranaceous. Ascii 8-spored, 144–175 × 14.0–16.5 μm, cylindro-clavate, broadest near the apex, gradually tapered into a relatively long stipe, measuring about 24–32 μm. Ascospores bi- or triseriate, 4-celled, (24.5)27.5–[29.6]–32.4(35.7) × 5.3–[6.2]–6.7(7.2) μm, Q = 4.11–[4.63]–5.16, fusiform-cylindrical, straight or slightly curved, olivaceous brown and guttulate when young, turning dark brown with age; septa oblique, constrictions at septa broad and deep; segments separable, cells about equal in width, terminal cells narrowing toward the ends, conical, mid-cells oblong; germ slits oblique to diagonal; gelatinous sheath hyaline, narrow. Pseudoparaphyses filiform, septate, exceeding the asci.


**Specimens examined**

Ukraine. Sumy Region, Seredyna-Buda District, Desniansko-Starohutsky National Nature Park, Quarter 92, near the village of Vasylivka, pine forest, 52°19’28.8” N, 33°43’48.9” E, roe deer dung, 20 Sept. 2016 (KW-M70965); ibid., Quarter 126, 52°19’01.0” N, 33°43’51.6” E, roe deer dung, 20 Sept. 2016 (KW-M70966), both leg. A. Mironets, det. Yu. Lytvynenko.

**Notes.** This fungus occurs on dung of predominantly wild herbivores (Ahmed et Cain 1972, Prokhorov et Armenskaya 2003, Mungai et al. 2012). In Ukraine, it has so far only been recorded on roe deer pellets. Previously, we reported *S. muskokensis* from two sites in the Sumy Region (Lytvynenko et al. 2016). In this article, we add two more locations, description and illustrations of the species.

Figs 3P–R

**Basionym:** Sporormia octomera Auersw., Hedwigia 7: 70, 1868


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Description. Pseudothecia scattered, immersed, pyriform, smooth, dark brown, 350–375 × 235–265 μm; neck small, papilliform, bare, black. Peridium thin, membranaceous. Asci 8-spored, clavate, 178–196 × 21–24 μm, gradually tapered into a long stipe, measuring 28–37 μm. Ascospores triseriate above, uni- or biseriate below, 8-celled, (35.5)38.4–[39.8]–46.9 × (5.4)6.4–[6.9]–8.3 μm, Q = 5.74–[5.92]–6.81, fusiform-cylindrical, straight or slightly curved, olivaceous brown when young, turning dark brown with age; septa transverse, constrictions at septa deep; segments easily separable, third cell from the upper end the broadest, terminal cells slightly longer than the mid-cells, ovoid-conical; germ slits oblique to diagonal; gelatinous sheath hyaline, broad. Pseudoparaphyses filiform, septate, slightly exceeding the asci.


Specimens examined

Notes. Ahmed et Cain (1972) reported S. octomera on dung of various domestic and wild herbivores. In Europe, it appears to prefer lagomorph droppings (Doveri 2004). Our specimens were collected on hare dung.

Figs 51–N


Description. Pseudothecia scattered, immersed, subglobose, smooth, dark brown, 200–280 μm in diameter; neck short, papilliform, bare, black. Peridium thin, membranaceous. Asci 8-spored, clavate, 178–196 × 21–24 μm, gradually tapered into a long stipe, measuring 28–37 μm. Ascospores triseriate above, uni- or biseriate below, 8-celled, (35.5)38.4–[39.8]–46.9 × (5.4)6.4–[6.9]–8.3 μm, Q = 5.74–[5.92]–6.81, fusiform-cylindrical, straight or slightly curved, olivaceous brown when young, turning dark brown with age; septa transverse, constrictions at septa deep; segments easily separable, third cell from the upper end the broadest, terminal cells slightly longer than the mid-cells, ovoid-conical; germ slits oblique to diagonal; gelatinous sheath hyaline, broad. Pseudoparaphyses filiform, septate, slightly exceeding the asci.


Specimens examined

Notes. Ahmed et Cain (1972) reported S. octomera on dung of various domestic and wild herbivores. In Europe, it appears to prefer lagomorph droppings (Doveri 2004). Our specimens were collected on hare dung.
dium thin, membranaceous. Asci 8-spored, cylindrical, broadest near the apex, gradually tapered into a short stipe, 127–145 × 9.5–10.5 μm. Ascospores uniseriate, 4-celled, 15.2–18.7–23.5(24.3) × 4.5–5.5–6.8 μm, Q = 2.90–3.41–3.88, fusiform, straight or slightly curved, olivaceous brown when young, turning dark brown with age; septa transverse, constrictions at septa broad and deep; segments separable, cells about equal in width, terminal cells longer than the mid-cells, conical, mid-cells oblong to oval; germ slits oblique; gelatinous sheath hyaline, narrow. Pseudoparaphyses filiform, septate, longer than the asci.


Specimens examined

Notes. Prior to this study, we reported S. pulchella twice from the Sumy Region in Ukraine (Lytvynenko et al. 2016). Here it is described from two more locations and illustrated.

Discussion
Despite rather wide geographical distribution ranges, most of the coprophilous species in the Sporormiaceae are encountered infrequently. In addition, the morphological traits of these fungi are often highly variable. For example, ascospores of many species greatly vary in shape and size. For the 14 Ukrainian species of Sporormiaceae reported here we compared ascospore morphology with that of other specimens from various geographical regions.

The only representative of Sporormia in Ukraine, S. fimetaria (Figs 2J–N), is the type species of the genus. One of its distinguishing morphological features is the presence of pointed gelatinous appendages at both spore ends, first described by Dissing (1992). In our observations, the appendages can be seen after
The ascospores are released from the asci (Fig. 2K arrows). The ascis and ascospores of this species are highly variable in size. In New Zealand collections, ascospores measured 37–40 × 3.5–4.0 μm (Bell 1983). For European specimens, asci of *S. fimetaria* were reported to fall within the range of 50–70 × 10–13 μm (Dissing 1992) or 55–65 × 11–12 μm (Richardson 1998); ascospores are reported to be 40–55 × 3.0–3.5 μm (Dissing 1992) or 37–45 × 3.0 μm (Richardson 1998) in size. According to Ahmed et Cain (1972), North American collections demonstrated much larger asci (70–80 × 12–16 μm) and ascospores (50–57 × 3.5–4.5 μm). Richardson (1998) therefore concluded that “the European and New Zealand collections represent *S. fimetaria* sensu De Notaris, and that *S. fimetaria* sensu Ahmed et Cain, with markedly longer spores and asci, is a different species”. However, Doveri (2004) reported an intermediate size of both asci (63–78 × 11.5–13 μm) and ascospores (47.2–53.6 × 4.0–4.5 μm) for Italian collections. In the Ukrainian specimens, the measurements correspond to those in *S. fimetaria* sensu Dissing (1992) and Richardson (1998), which is currently treated as *S. fimetaria* sensu De Notaris or *S. fimetaria* s. str.

Two species of *Preussia* s. str. are reported here from Ukraine. One of them, *P. funiculata* (Figs 2D–I), the type species of the genus, is the most similar to *P. typharum* (Sacc.) Cain, but differs in having oblique septa and narrower spores with cells more or less equal in size and shape. According to Cain (1961), an important diagnostic feature of *P. typharum* is that the middle ascospore cells are broader than long and distinctly shorter than the end-cells. In *P. funiculata*, the middle cells are cylindrical (Cain 1961). However, in the Ukrainian specimens, the middle cells of ascospores, when first visible in asci, are barrel-shaped as in KW-M71464 (Figs 2D, G), or ovoid as in KW-M71455 (Figs 2H, I); their length is almost equal to the width. The quotient for young middle cells equals 0.89 (KW-M71464) and 1.02 (KW-M71455), respectively. With age, ascospores become narrower and the central cells are extended to become cylindrical (Fig. 2I). The quotient for mature middle cells equals 1.25 (KW-M71464) and 1.18 (KW-M71455), respectively.

Another species, *P. fleischhakii* (Figs 2A–C), is easily recognisable by its uniloculate pseudothecia, transversely septate ascospores and clavate-sacciform
asci with very short stalks (Cain 1961). *Preussia terricola* Cain, resembling *P. fleischhakii* in spore shape and size, is distinguishable by its long stipitate asci and parallel rather than oblique germ slits.

The most species-rich genus in this study is *Sporormiella* with eleven species. *Sporormiella heptamera* (Figs 3K–O) is one of a group of species of the *Preussia/Sporormiella* complex characterised by 7-celled ascospores. Another member of this group, *S. vexans*, also occurs in Ukraine, but *S. heptamera* can be easily distinguished from the other 7-celled species by having the largest spores. In addition, the five central cells of its spores are wider than longer and the third one from the upper end is the largest. Ahmed et Cain (1972) described oblique to diagonal germ slits for this species. Doveri (2004) remarked that the germ slits are diagonal or almost transverse in the middle cells but oblique in the end cells. In our samples, germ slits are predominantly diagonal or almost transverse, with transverse septa occurring in the terminal cells as well (Fig. 3M, arrows).

*Sporormiella affinis* (Figs 3A–E) and *S. octomera* (Figs 3P–R) belong to a group of *Sporormiella* species with 8-celled spores, middle cells being unequal in width and the third cell being the broadest. Two more species of this group, *S. corynespora* and *S. tomilinii*, are also known from Ukraine. In our specimens of *S. affinis* (KW-M71460, KW-M71462), the spores are longer than those in collections from Spain (75–77 μm – Valldosera et Guarro 1990), Italy (70–75 μm – Doveri 2011) and North America (65–80 μm – Ahmed et Cain 1972), thus approaching the upper limit of its spore length (71–90 μm) as provided in the protologue (Bommer et Rousseau 1886).

At the same time, the Ukrainian material of *S. octomera* has ascospores measuring 35–47 × 6.4–8.3 μm (mean width is 6.9 μm, occasionally 5.4–5.8 μm in width), which is narrower than previously reported for this species: (37)40–48(50) × 7–8 μm (Ahmed et Cain 1972), 38–43.7(45.6) × 8–9 μm (Doveri 2004). Our measurements better fit those from Japanese collections of *S. octomera*, 35–40(45) × 6.5–7.5 μm (Furuya et Udagawa 1972), and comply with the protologue data, mentioning a size of 40 × 5–6 μm (Auerswald 1868).
Sporormiella commutata (Figs 3F–J) is a member of a small group of species with a variable number of cells in the ascospores. According to the protologue (Niessl 1878b) and Ahmed et Cain (1972), the cell number in spores mostly equals 9, although 7- and 8-celled spores occur as well. In our specimens, ascospores are mostly 7- (Figs 3G, H) and 8-celled (Figs 3H, I), while 9-celled spores (Fig. 3J) are rarely observed.

The largest group within the genus Sporormiella is represented by species with 4-celled ascospores. In this group, S. grandispora, S. megalospora, S. kansensis and S. longisporopsis are relatively large-spored species. They form a morphological series of species with asci gradually narrowing in a stipe and ascospores usually not conspicuously tapered toward the ends.

Sporormiella grandispora (Figs 4A–E) is quite similar to S. lageniformis and S. dubia, both also recorded in Ukraine. These, however, differ from S. grandispora by their smaller ascospores and different septa. Sporormiella lageniformis has strongly oblique septa, whereas S. dubia has constantly transverse ones. As can be seen in Figs 4D and E, the spore septa in S. grandispora are mostly transverse, but occasionally slightly oblique septa are visible (Fig. 4C). Further, S. grandispora can be confused with another species reported in this article, S. megalospora (Figs 4K–P). Nonetheless, S. megalospora has larger asci and ascospores which are deeply constricted at the transverse septa, with diagonal (Fig. 4O, arrows) or oblique (Fig. 4M, arrows) rather than parallel (Fig. 4N, arrows) germ slits. Moreover, mature spores of S. grandispora do not easily separate into segments, while the segments in the other three species are easily separable. On the whole, the Ukrainian specimens of S. grandispora demonstrate considerable variation in spore size, as well as in septa and germ slit orientation, as observed by Richardson (2011).

In the group of species with 4-celled ascospores, S. kansensis and S. megalospora have ascospores which are often over 60 μm long. However, S. kansensis differs in having narrower spores (10–13 μm vs. 14–18 μm) and parallel germ slits.
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(Figs 4F–J, red arrows). Earlier ascospore measurements revealed some variability in American and Italian collections with ascospores, measuring (68)72–77 × 10–12 μm (Ahmed et Cain 1972) and 69–75(77) × 10.4–13.3 μm (Doveri 2004), respectively. In Taiwanese specimens, Chang et Wang (2009) recorded smaller ascospores, 57–69 × 9–12.5 μm. Our collections have somewhat broader ascospores, but otherwise agree well with the earlier data. An issue under discussion is the ascoma morphology of *S. kansensis*. According to Doveri (2004), “this species can be easily identified by pseudothecia with a long, cylindric neck and covered with wavy, hyphoid hairs”. In the protologue (Griffiths 1901), ascomata are described as having long flexuous septate hairs and papilliform to cylindrical necks. Ahmed et Cain (1972), who examined Griffiths’ slides of *S. kansensis*, but not Griffiths’ collections, suggested that those slides were not in a very good condition and “evidently not the ones used by him in writing his description”. Other authors (Khan et Cain 1979, Chang et Wang 2009) reported glabrous pseudothecia for *S. kansensis*. In our collection, the ascomata are slightly tomentose with bare cylindrical necks.

Another long-spored species, with ascospores of more than 70 μm long, is *S. longisporopsis* (Figs 4Q–W). This epithet refers to the resemblance to *S. longispora* (Cain) Ahmed et Cain, and the two species can be hardly distinguished apart from the different arrangement of the ascospores (Ahmed et Cain 1972). In *S. longisporopsis*, ascospores have a bi- or triseriate arrangement (Figs 4S, T), whereas in *S. longispora*, the uppermost four ascospores are arranged in a parallel manner, more or less at the same level in the ascus. In addition, septa in ascospores of *S. longisporopsis* are strictly transverse, while those of *S. longispora* may occasionally be almost oblique. Furthermore, *S. longisporopsis* has wider ascospores, 14–17 μm vs. 12–14 μm according to Ahmed et Cain (1972), and more rounded cells (vs. rectangular cells in *S. longispora*). Richardson (2011), however, remarked that due to the overlapping ascospore size and variable shape of ascospore cells, these two species may well be synonymous. In our specimens of *S. longisporopsis*, ascospores are slightly wider than in the collections from Australia (Bell 2005), Italy (Doveri 2004) and Kenya (Mungai et al. 2012) and better match those from Japan (Furuya et Udagawa 1972) as well as the protologue data (Ahmed et Cain 1972). The terminal cells of ascospores are slightly narrower and longer than the middle ones in the specimens of *S. longisporopsis* described by Ahmed et Cain (1972) and those reported by Furuya et Udagawa (1972) and Doveri (2004), while in the Ukrainian specimens, these cells are almost equal in size (Figs 4Q, R, V).

Two other species reported here, *S. muskokensis* and *S. leporina*, belong to a group with 4-celled ascospores of approx. 25–35 μm long with strongly oblique or occasionally oblique septa and asci gently narrowing towards the base. These morphological traits, in particular the cylindrical-claviform asci gradually
narrowed towards the base and spore cells nearly equal in length and with oblique septa, are demonstrated for *S. muskokensis* in Figs 5F–H. *Sporormiella lageniformis* and *S. leporina*, also recorded in Ukraine, are similar but the former differs from *S. muskokensis* in larger spores, 37–42 × 7.5–8.5 μm (Ahmed et Cain 1972) as well as unequal spore cells, i.e. terminal cells longer than middle cells. The latter species has somewhat longer spores, 30–35(37) μm (Ahmed et Cain 1972) and only occasionally oblique septa. The spore size ranges in the Ukrainian specimens of *S. muskokensis* fit those described for collections from North America (Ahmed et Cain 1972) and Lithuania (Treigienė 2004), but the

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spores are much wider than reported for the European part of Russia (Prokhorov et Armenskaya 2003).

*Sporormiella leporina* (Figs 5A–E) also comes very close to *S. isomera* Ahmed et Cain. According to Mungai et al. (2012) and Doveri (2004) relying on Lundqvist’s personal comments, these two species differ in the morphology of the germ slits and ascospore cells. In *S. leporina*, the upper cell is mostly conical, while the second cell is a little shorter, broader and rounder than the cylindrical third cell (Fig. 5D). The germ slits in *S. leporina* are mostly oblique (Fig. 5E, arrows) or subparallel, in contrast to parallel to oblique germ slits with a kink near the middle in *S. isomera* (Ahmed et Cain 1972). Mungai et al. (2012), Doveri (2004) and Melo et al. (2017) commented that ascospores of *S. leporina* in water are easily separable at any septum. Ahmed et Cain (1972) and Ahmad (1978), on the contrary, stated that the segments did not separate easily. In our specimens, ascospore cells do not easily separate from each other, except at the central septum (Fig. 5D).

*Sporormiella pulchella* (Figs 5I–N) is a rather exceptional species which can be easily recognised by its small 4-celled fusiform ascospores (Fig. 5J) arranged uniseriately in cylindrical asci (Figs 5K–N). Due to the small size of mature ascospores, germ slits are quite difficult to observe, as noted by Doveri (2004). In the Ukrainian specimens, we observed oblique to parallel germ slits in young, immature spores only. Other authors regarded them as oblique to diagonal (Ahmed et Cain 1972, Valldosera et Guarro 1990). In our examination, spore size varied between the specimens. The ascospores measuring 17.4–23.5(24.3) × 5.8–6.8 μm in KW-M50628 (Figs 5I, L) comply with the protologue data (Hansen 1877) and data given by other authors (Ahmed et al. 1971, Ahmad 1978, Valldosera et Guarro 1990, Doveri 2004), while the ascospores in KW-M70968 (Figs 5J, M, N) are slightly smaller (15.2–16.8 × 4.5–6.2 μm). In both specimens, the spores are at the lower end of the size range described by Ahmed et Cain (1972).

Finally, in addition to the morphological characteristics of the spores described, other anomalies have occasionally been recorded (Cain 1961, Doveri et al. 1999, Doveri 2004). Within the *Sporormiaceae*, spores with underdeveloped cells or spores devoid of one or more septa often occur. We have also observed anomalous ascospores with undeveloped cells in *S. kansensis* (Fig. 4F, blue arrow), *S. longisporopsis* (Fig. 4T, arrows) and *S. pulchella* (Fig. 5L, arrow). In *S. megalospora*, anomalous 3-celled spores were detected (Fig. 4P). In the spores of *S. longisporopsis* we noticed one or two additional septa (Figs 4U, V), which had not been reported before.
ACKNOWLEDGEMENTS

The authors are grateful to A.S. Butsyk, A.E. Mironets, T.V. Khandiuk and K.S. Orlova-Hudim for collecting material in various regions of Ukraine and providing part of the herbivore dung specimens used in this study. The anonymous reviewers are greatly acknowledged for their helpful comments and suggestions.

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