

New records of *Pezizaceae* from the Republic of Kazakhstan

Vassilij A. FEDORENKO

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Abstract: The article reports four species of *Pezizaceae*, *Peziza echinospora*, *P. limnaea*, *P. nivalis* and *P. sublaricina*, newly recorded for the Republic of Kazakhstan as a result of field research from 2017 to 2020. The identification of species was carried out based on macro- and microcharacters using appropriate reagents, microscopic techniques and relevant literature. Detailed macro- and micromorphological descriptions of *Peziza* species complemented with illustrations of their fruitbodies and microstructures are provided, as well as a discussion and brief comparison of similar species.

Keywords: Ascomycota, cup-fungi with ornamented ascospores, *Peziza*, taxonomy.

Introduction

The systematic study of Kazakhstan's ascomycetes started in 1962. Field herbarium collections of N.T. Kazhieva obtained over 11 years resulted in a ninth volume of "Flora of spore plants in Kazakhstan", dedicated to discomycetes (SCHWARZMAN & KAZHIEVA, 1976). Just 8 species of *Pezizaceae* were included in this work. In subsequent years, no special studies have been conducted and only one species has been added to the list of *Pezizaceae* of Kazakhstan (RAKHIMOVA *et al.*, 2015).

During my own research since 2017 fungal specimens were obtained and photographed. They included several species that were not previously recorded in the Republic, including four species of *Pezizaceae* which are documented in the present account.

Material and methods

The author's personal collections, collected from 2017 to 2020, served as a basis for this paper. For all the recorded species *in situ* photographs of their fruitbodies as well as photographs of microstructure are given. The species were identified by reference to appropriate literature and web resources (MAAS GEESTERANUS, 1967; DONADINI, 1979; HOHMEYER, 1986; PFISTER, 1992; GAROFOLI & BAIANO, 1995; DOUGOUD, 2001; SPOONER, 2001; RUBIO *et al.*, 2006; VAN VOOREN, 2011; BEUG *et al.*, 2014; FELLMANN, 2014; www.ascofrance.com; www.myc Quebec.org; www.outerbridesfungi.co.uk). Microscopic studies were conducted on fresh or dry samples using a Celestron 44108 optical microscope at the highest possible magnification (100× immersion lens). Microscopic photos were taken with a USB camera Hayear HY-1138, and to capture ascospore ornamentation the DSLR camera Nikon D7100 was used, followed by stacking photos. The following reagents were used: 5% Sodium hydroxide (w/v) for dried material, Melzer's reagent to check the ascus amyloidity and Lactophenol Cotton Blue to observe the ornamentation of the ascospores. Ascospore measurements were obtained using the Piximetre software ver. 5.10 (HENRIOT, 2020), 45–100 measurements for each species. Other microcharacteristics were also measured with a Piximetre. Fungal specimens are deposited in the personal herbarium of the author.

Abbreviations used: Mm – mean measurements of ascospores, Q – ascospores length to width ratio, Qm – mean ascospores length to width ratio, N – number of measured ascospores, NaOH – 5% Sodium hydroxide (w/v).

The systematics of the taxa generally follows Index Fungorum (<http://www.indexfungorum.org/Names/Names.asp>). Species are arranged in alphabetical order. Data on the location, habitat and substrate of the species, date of collection, the names of collectors

and fungarium numbers, as well as macroscopic and microscopic descriptions are provided.

Results and discussion

Detailed macro- and micromorphological descriptions of four species of *Pezizaceae* newly recorded for the Republic of Kazakhstan complemented with illustrations of their fruitbodies and microstructures (fig. 1–5), are provided below.

1. *Peziza echinospora* P. Karst., *Fungi Fenniae Exsiccati*, Fasc. 6: no. 541 (1866).

Material studied: KAZAKHSTAN: Akmola Region, The Burabay National Park, vicinity of Shchuchinsky village, 53°0'34.8"N; 70°13'35.7"E; 435 m a.s.l., pine-birch forest (*Pinus*, *Betula*), on charcoal on fire site, 24-VII-2017, V.A. Fedorenko (FVA-003240717). The description is based on a single specimen.

Apothecium 12 mm broad, sessile, lacking a stalk, cup-shaped, irregularly denticulated margin, slightly wrapped inward. Hymenium smooth, matte, ochre-brown, tan. Outer surface almost smooth, velvety, brownish-white to almost white, with small brown warts at the very margin and along the edge (fig. 1F).

Ascospores are oblong-ellipsoid, hyaline, fairly obtuse at the poles, non-guttulate, with isolated short spines and warts, more elongated at the poles. The spines are clearly distinguishable in water and stained with Lactophenol Cotton Blue (fig. 1G, 1L). Measuring (fresh in water): (13.2) 14.2–15.6 (16.2) × (6.4) 6.7–7.6 (7.9) μm; Q = (1.8) 1.9–2.2 (2.4); N = 45; Mm = 14.8 × 7.2 μm; Qm = 2.1. **Asci** 217–260 × 9.8–12.9 μm, cylindrical, slightly tapering to the base, pleurorhynchous base (fig. 1C), rounded apex, tips amyloid (fig. 1A), operculate (fig. 1B), 8-spored. **Paraphyses** 466–503 μm long, cylindrical-filiform, septate (fig. 1E), 2.7–3.6 μm thick, slightly swollen at apex up to 4.0–6.7 μm (fig. 1D), apex is slightly curved, hyaline, do not contain vacuoles. **Excipulum** differentiated into 5 layers, 520–610 μm thick (rehydrated in NaOH) (fig. 1N). **Subhymenium** 25–35 μm thick, hyaline, is composed of textura angularis-intricata cells, 5–15 μm broad (fig. 1H). **Medullary excipulum** upper 280–370 μm thick, hyaline, predominantly of *textura globulosa-angularis*, with polygonal or globoid cells 20–85 × 20–55 μm, cells thin-walled (fig. 1I). Medullary excipulum middle 60–80 μm thick, brown, of parallel oriented *textura intricata* cylindrical hyaline to yellow-brown hyphoid cells 5–10 μm wide, cells thick-walled (0.5–0.6 μm) (fig. 1J). Medullary excipulum lower 100–130 μm thick, hyaline, is composed of *textura globulosa-angularis* cells, with polygon or globoid cells 30–65 μm broad, cells thin-walled (fig. 1K). **Ectal excipulum** 70–100 μm thick, brown, of *textura globulosa*, with globular brown cells

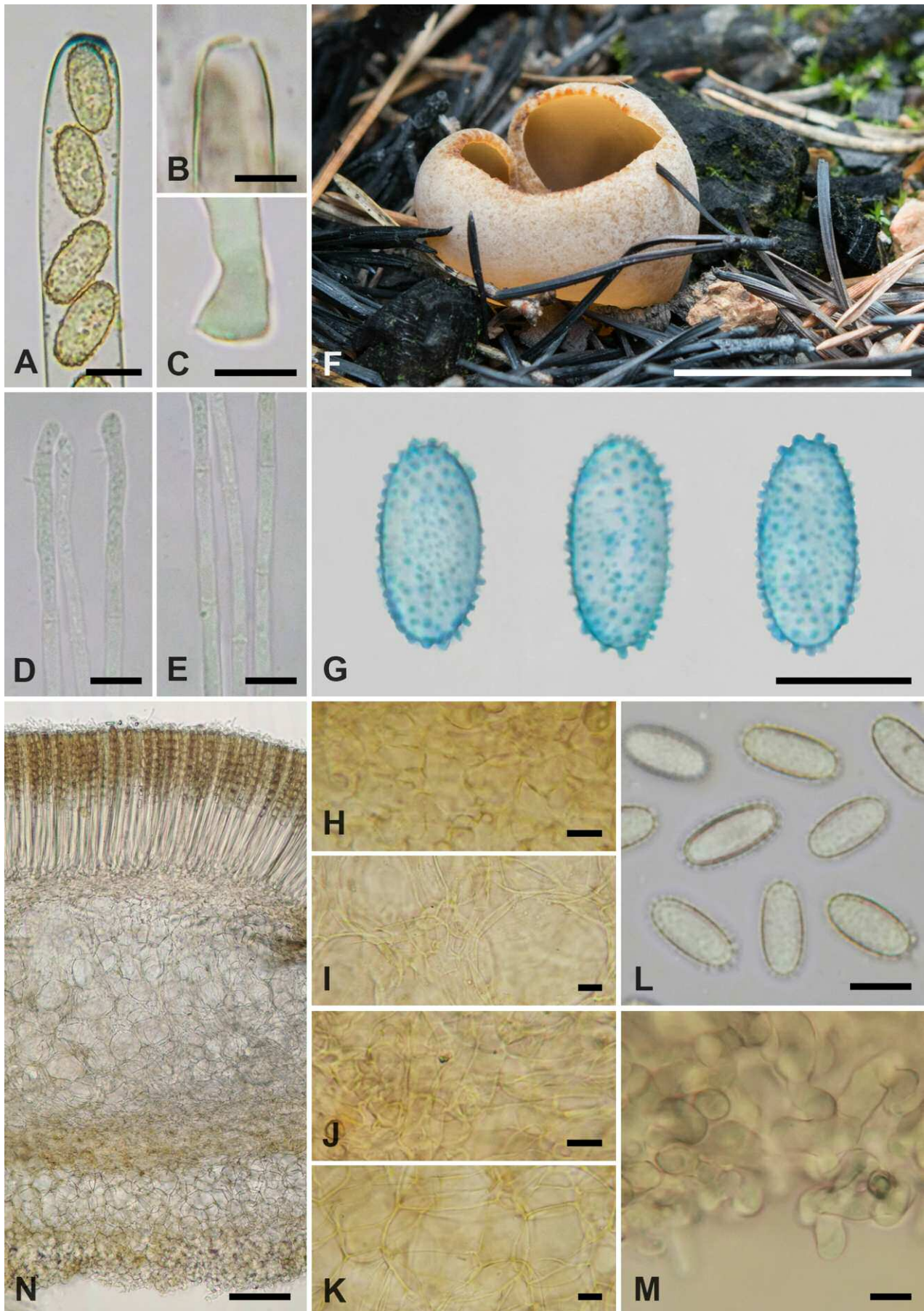


Fig. 1 – *Peziza echinospora*

A. Asci in Melzer's reagent; B. Asci operculate apex in NaOH; C. Asci pleurorhynchous base in NaOH; D. Paraphyses apex in NaOH; E. Paraphyses septate middle part in NaOH; F. Apothecium *in situ*; G. Ascospore ornamentation in Lactophenol Cotton Blue; H. Subhymenium in NaOH; I. Medullary excipulum upper in NaOH; J. Medullary excipulum middle in NaOH; K. Medullary excipulum lower in NaOH; L. Ascospore in NaOH; M. Ectal excipulum in NaOH; N. Median section of an apothecia in NaOH. Scale bars: A-E, G-M = 10 μ m; F = 1 cm; N = 100 μ m. Photos V.A. Fedorenko.

9–25 µm in diameter, on which more or less tangled cylindrical vermiform hyaline hyphoid hairs (5–10 µm wide) are located, hairs perpendicular oriented (fig. 1M).

Ecology and distribution: Carbotroph – growing solitary or in groups on old burners and bonfires. Nominally widespread in Europe (Austria, Bulgaria, Denmark, Finland, France, Germany, Iceland, Italy, Netherlands, Norway, Poland, Russia, Slovenia, Spain, Sweden, Switzerland, Ukraine, United Kingdom), Asia (Bhutan, Israel, Korea, Russia (Siberia), Turkey), North America (USA) and South America (Argentina, Chile) [GÖTZSCHE, 1987; PRASHER, 1999; HANSEN *et al.*, 2002; KOSHELEVA & KUTAFJEVA, 2008; BARSEGHYAN & WASSER, 2011; DZHAGAN & SCHERBAKOVA, 2012; KAPITONOV, 2013; KUDASHOVA *et al.*, 2013; BEUG *et al.*, 2014; GÜNGÖR *et al.*, 2014; POPOV & ARSLANOV, 2014; SVETASHEVA *et al.*, 2016].

Similar species: several species of the genus *Peziza* are associated with burnt soil:

P. petersii Berk. – with a similar brown coloration, has smaller ascospores, (11.5) 12–13 (14) × 5–6.5 µm, with fine elongated connecting ridges (HOHMEYER, 1986; BEUG *et al.*, 2014; DOUGGOLD, 2001; VIZZINI *et al.*, 2020).

A few other species have purple apothecia, however, with age they fade to brown.

P. moseri Aviz.-Hersh. & Nemlich – distinguished by smooth guttulate ascospores, (11) 13–15 (16) × (6) 7–9 µm (HOHMEYER, 1986; DOUGGOLD, 2001).

P. lobulata (Velen.) Svrček – has smooth non-guttulate ascospores, 13–16 × 7–9 µm (DOUGGOLD, 2001; BEUG *et al.*, 2014).

P. tenacella W. Phillips – has somewhat smaller, (11) 12–14 (15) × 6–8 µm, finely warted, biguttulate ascospores (DOUGGOLD, 2001; BARSEGHYAN & WASSER, 2011).

In Kazakhstan, these species have not been found. Only "*Peziza violacea* Pers." with a violet disk and smooth ascospores, 12–15 × 6–8 µm, growing on soil (SCHWARZMAN & KAZHIEVA, 1976) has been reported. It can be assumed that this refers to the species now known as *P. lobulata*.

2. *Peziza limnaea* Maas Geest., Persoonia 4(4): 422 (1967).

Material studied: KAZAKHSTAN: Akmola Region, The Burabay National Park, vicinity of Shchuchinsky village, 53°0'32.8"N; 70°13'58.7"E; 435 m a.s.l., pine-birch forest (*Pinus*, *Betula*), near the swamps, 27-VII-2017, V.A. Fedorenko (FVA-001270717). The description is based on 4 specimens.

Apothecia 27–77 mm broad, sessile, lacking a stalk, first deep-cupulate, then saucer-shaped, the margin plain, slightly incurved. Hymenium smooth, matte, rugose in the center, colored irregularly from dark yellow-brown, light grey-brown, greyish-olive to light red-brown and light yellow-brown in maturity with darker spots. The outer surface is rough, velvety, lighter than hymenium, pale grey-brown, brown-yellow, beaver, light yellow-grey-brown or golden (fig. 2F).

Ascospores oblong-ellipsoid, hyaline, guttulate, with one or two, equal or unequal, large oil drops, with isolated short irregularly shaped warts, some of which are connected by ridges, but do not form a network, at the poles the warts are higher. The warts are stained with Lactophenol Cotton Blue (fig. 2G, 2J). Measuring (rehydrated in NaOH): (17.3) 18.1–20.3 (20.7) × (8.3) 8.9–9.9 (10.6) µm; Q = (1.8) 1.9–2.18 (2.2); N = 45; Mm = 19.2 × 9.5 µm; Qm = 2. **Asci** 283–390 × 12.6–15.2 µm, cylindrical, slightly tapering to the base, pleurorhynchous base (fig. 2C), tips amyloid (fig. 2A), operculate (fig. 2B), 8-spored. **Paraphyses** 268–296 µm long, cylindrical-filiform, septate (fig. 2E), simple or bifurcated, 3.6–4.9 µm thick, swollen at the apex up to 5.2–7.4 µm (fig. 2D), apex straight, hyaline, do not contain vacuoles. **Excipulum** differentiated into 3 layers, 500–650 µm (rehy-

drated in NaOH) (fig. 2L). **Subhymenium** 100–150 µm thick, hyaline, is composed of *textura intricata* cells, 4–10 µm broad (fig. 2H). **Medullary excipulum** 330–380 µm thick, hyaline, of septate *textura globulosa-angularis* cells, with polygon or globoid cells 25–100 × 20–70 µm, cells thin-walled (fig. 2I). **Etal excipulum** 50–120 µm thick, brown, of *textura globulosa-angularis*, with brownish with polygon or globoid cells 30–70 × 20–55 µm, on which short cylindrical or fusiform septate hyaline tomentum hyphae 30–80 × 8–20 µm are located, hyphae perpendicular oriented (fig. 2K).

Ecology and distribution: apothecia solitary or in groups in moist areas of forests, in particular in swamps, on gravelly soil. Reported from Europe (Austria, Denmark, Estonia, Finland, France, Germany, Iceland, Russia, Netherlands, Norway, Spain, Sweden, United Kingdom), Asia (Russia (Siberia)) and North America (Canada, Mexico, USA) [MAAS GEESTERANUS, 1967; HANSEN *et al.*, 2001; AYEL & VAN VOOREN, 2004; RUBIO *et al.*, 2006; BOGACHEVA, 2012; RAYMUNDO *et al.*, 2012; SVETASHEVA *et al.*, 2016; eol.org].

Similar species: among the large brown species of *Peziza* are several which also have an olive tones in the hymenium:

P. badia Pers. – ascospores of similar size, (15) 17–22 × 8–10 (11) µm, but with an ornamentation in the form of a delicate irregular reticulum (BEUG *et al.*, 2014).

P. phyllogena Cooke – occurs in spring and early summer, has ascospores 16–21 × 8–10 µm with copious irregular small warts (MARTINELLI, 1998; BEUG *et al.*, 2014).

P. depressa Pers. – also grows on moist soil, but the ascospores, (16) 17–19 × (9.5) 10.5–11 µm, are covered with small, isolated, fairly regular, prickly rounded warts up to 1 µm high (LE GAL, 1937; HOHMEYER, 1986; VAN VOOREN, 2011).

P. badioides Donadini – has narrower ascospores, (16.5) 17–19 (20) × 7–8 µm, with an ornamentation of small isolated warts and caps at the poles (VAN VOOREN, 2013).

For Kazakhstan, *Peziza depressa* and *P. badia* are noted in the literature. For *Peziza badia*, the ascospore ornamentation is not specified, it is given only to: "spores with a slightly tuberous-rough membrane, hyaline, with 1–2 large oil drops" (SCHWARZMAN & KAZHIEVA, 1976). *Peziza depressa* is specified only in the list of Kazakhstan Altai fungi without description (RAKHIMOVA *et al.*, 2015).

3. *Peziza nivalis* (R. Heim & L. Rémy) M.M. Moser, *in* Avizohar-Hershenson & Nemlich, *Israel J. Bot.*, 23: 162 (1974).

Material studied: KAZAKHSTAN: Almaty Region, Tian-Shan, Ile Alatau, Kok-Zhailau Plateau, 43°07'13.7"N; 76°58'5.4"E; 2040 m a.s.l., spruce forest (*Picea*), in a clearing in the woods on soil among dry grass a few meters from melting snow, 05-IV-2019, V.A. Fedorenko (FVA-001050419). The description is based on a 14 specimens.

Apothecia 15–53 mm broad, sessile, lacking a stalk, at first cupulate, then expanding with margin plain, often ragged, slightly incurved or recurved in some places. Hymenium smooth, chocolate brown, pale brown, chestnut brown, when dried – light yellow brown. The outer surface is rough, shaggy, concolorous with the hymenium or slightly lighter – light grey-brown (fig. 3F).

Ascospores ellipsoid, hyaline, smooth, with a weakly visible central vacuole (fig. 3G, 3L). Measuring (fresh in water): (16.2) 17–19.1 (19.9) × (9.6) 10.2–11.2 (12) µm; Q = (1.5) 1.54–1.86 (1.9); N = 50; Mm = 18.1 × 10.7 µm; Qm = 1.7. **Asci** 290–380 × 16.3–17.9 µm, cylindrical, slightly tapering to the base, pleurorhynchous base (fig. 3C), tips amyloid (fig. 3A), operculate (fig. 3B), 8-spored. **Paraphyses** 275–360 µm long, septate, the upper section cylindrical, 3.9–5.5 µm thick with extension at the apex to 6.1–8.3 µm (fig. 3D), the lower part cylindrical, the cells of the upper section either weakly or obviously moniliform (fortoulism) (fig. 3E), 13.6–33.2 µm wide; some paraphyses branched above, hyaline, with transparent vacuolar bodies. **Excipulum** differentiated into 5 layers, 700–1100 µm (rehy-

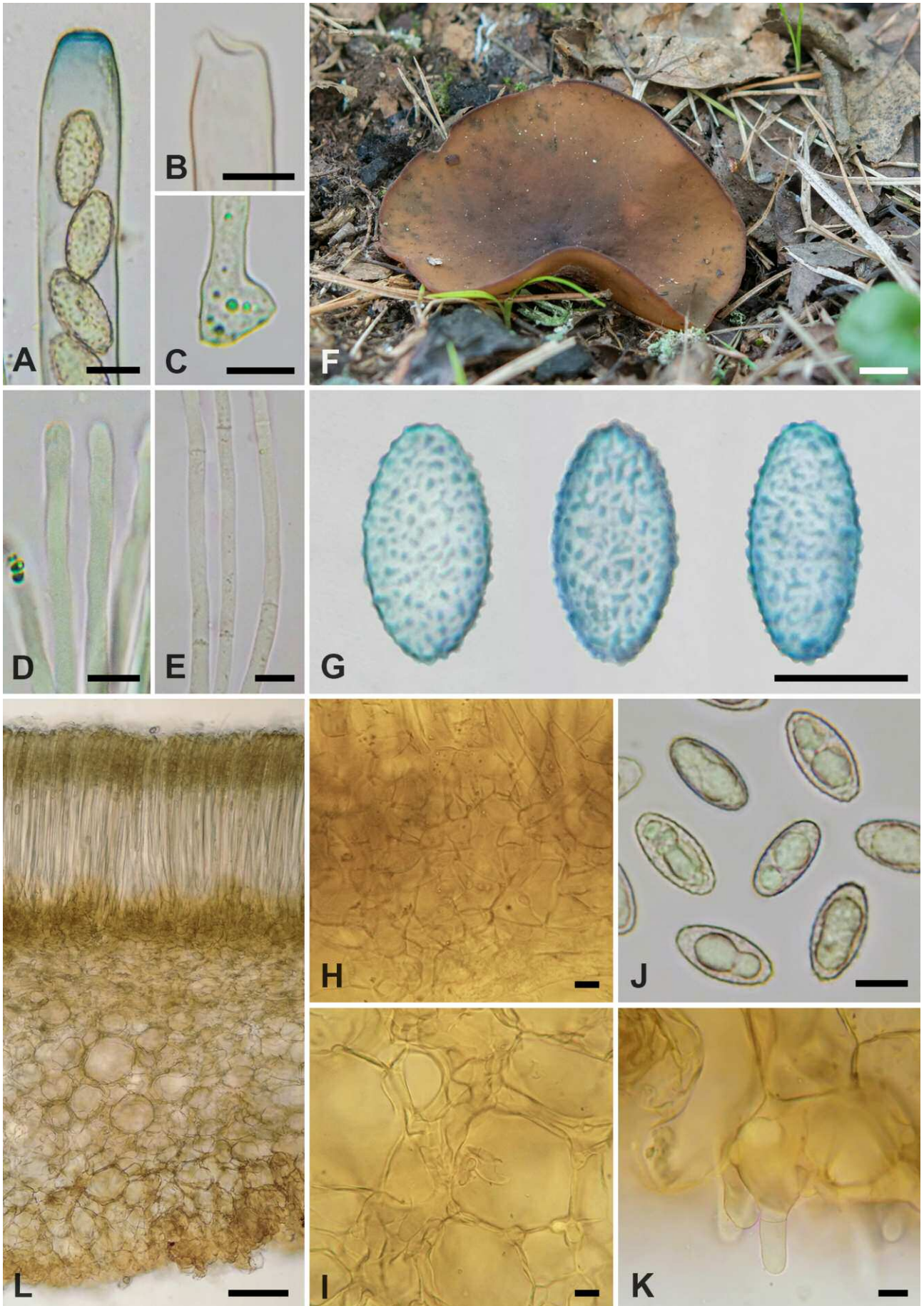


Fig. 2 – *Peziza limnaea*

A. Asci in Melzer's reagent; B. Asci operculate apex in NaOH; C. Asci pleurorhynchous base in NaOH; D. Paraphyses apex in NaOH; E. Paraphyses septate middle part in NaOH; F. Apothecium *in situ*; G. Ascospore ornamentation in Lactophenol Cotton Blue; H. Subhymenium in NaOH; I. Medullary excipulum in NaOH; J. Ascospores in NaOH; K. Ectal excipulum in NaOH; L. Median section of an apothecium in NaOH. Scale bars: A-E, G-K = 10 µm; F = 1 cm; L = 100 µm. Photos V.A. Fedorenko.

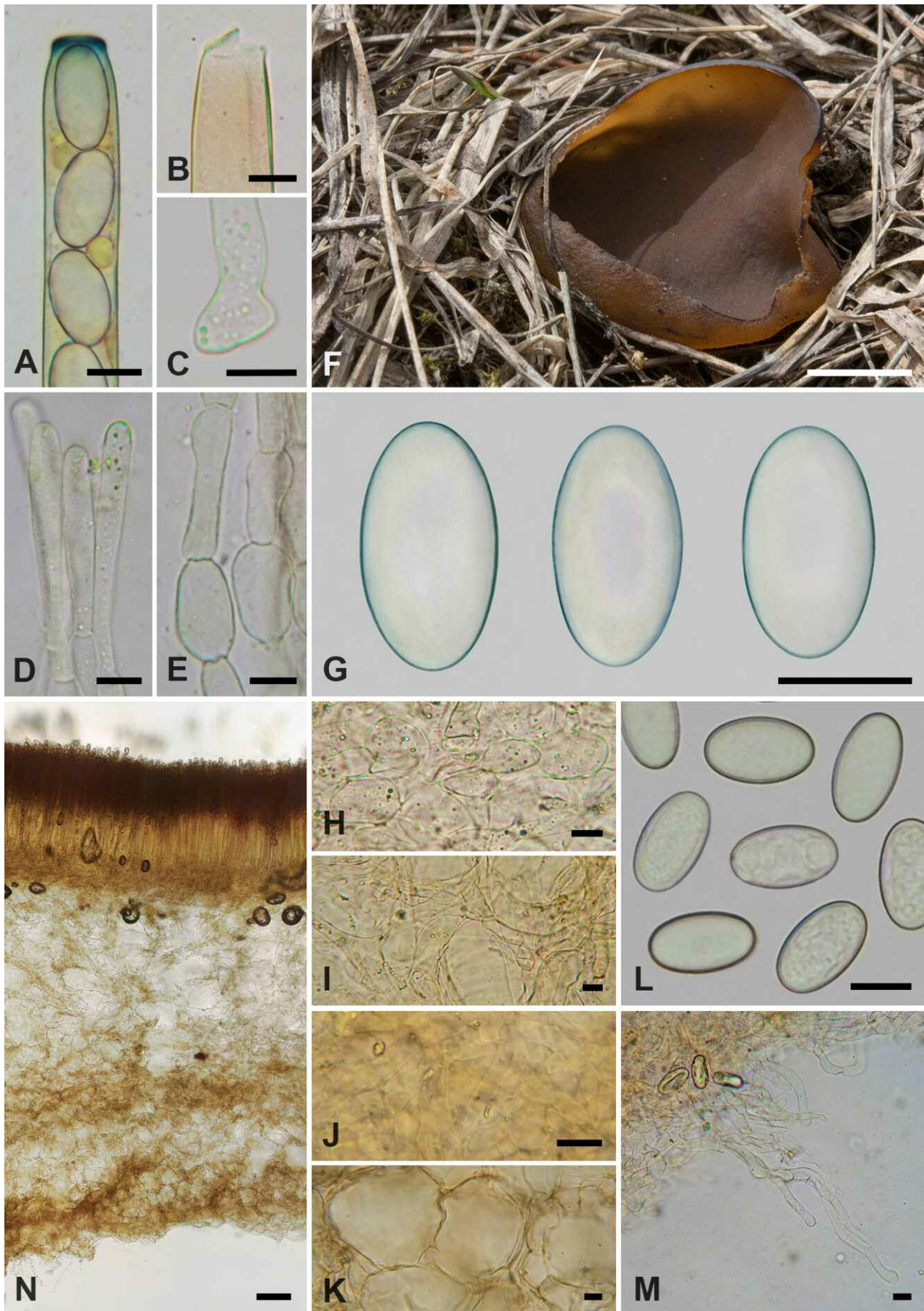


Fig. 3 – *Peziza nivalis*

A. Asci in Melzer's reagent; B. Asci operculate apex in NaOH; C. Asci pleurorhynchous base in NaOH; D. Paraphyses apex in NaOH; E. Paraphyses septate middle part in NaOH; F. Apothecium *in situ*; G. Ascospore in Lactophenol Cotton Blue; H. Subhymenium in NaOH; I. Medullary excipulum upper in NaOH; J. Medullary excipulum middle in NaOH; K. Medullary excipulum lower in NaOH; L. Ascospores in NaOH; M. Hyphoid hairs of ectal excipulum in NaOH; N. Median section of an apothecium in NaOH. Scale bars: A-E, G-M = 10 µm; F = 1 cm; N = 100 µm. Photos V.A. Fedorenko.

drated in NaOH) (fig. 3N). **Subhymenium** 65–110 μm thick, hyaline, is composed of *textura globulosa* cells, 13.9–33.2 \times 8.7–25.4 μm (fig. 3H). **Medullary excipulum** upper 260–520 μm thick, hyaline, predominantly of *textura globulosa-angularis*, with polygonal or globose cells 47.4–123.7 \times 32.9–75.2 μm , cells thin-walled (fig. 3I). Medullary excipulum middle 100–270 μm thick, brown, of parallel oriented *textura intricata* cylindrical hyaline to yellow-brown hyphoid cells 5–15 μm wide (fig. 3J). Medullary excipulum lower 130–260 μm thick, hyaline, is composed of *textura globulosa-angularis* cells, with polygon or globose cells 17.7–81.9 \times 14.4–60.0 μm , cells thin-walled (fig. 3K). **Ectal excipulum** 120–300 μm thick, brown, of *textura globulosa*, with globular brown cells 19.6–66.7 \times 15.8–48.8 μm and cylindrical septate hyaline more or less sinuous hyphoid hairs up to 150 μm in length and 4–7 μm wide, hairs perpendicular oriented (fig. 3M).

Ecology and distribution: an early spring fungus, apothecia solitary or in sparse groups on soil immediately after snowmelt. Reported from Europe (Bulgaria, France, Italy, Switzerland, United Kingdom), Asia (Israel), North America (Canada, USA) and Australasia (New Zealand) [HEIM & RÉMY, 1932; GAROFOLI & BAIANO, 1995; SPOONER, 2001; HANSEN *et al.*, 2002; BARSEGHYAN & WASSER, 2011; Mycoquebec.org].

Similar species: from other brown *Peziza*, this one differs in early spring fruiting even in the presence of snow. Another species related to melting snow *Peziza nivis* Donadini has smaller apothecia, 1–8 mm diam., orange-ochre to red-brown hymenium and fine, irregular verrucose ascospore ornamentation, 17–19 \times 11–13 μm (PFISTER, 1992; GAROFOLI & BAIANO, 1995). *Peziza nivis* has not been found in Kazakhstan.

4. *Peziza sublaricina* Donadini, *Doc. Mycol.*, 14 (53): 57 (1984).

Material studied: Kazakhstan: Almaty Region, Tian-Shan, Ile Alatau, Big Almaty gorge, 43°7'43.7"N; 76°54'28"E; 1315 m a.s.l., poplar grove (*Populus*), on gravelly soil, 06-V-2017, V.A. Fedorenko; *Ibid.*, 29-IV-2020, V.A. Fedorenko (FVA-001290420). The description is based on 8 specimens.

Apothecia 10–25 mm broad, sessile, without stipe or with a short underground stipe up to 6 mm, deeply cup-shaped, with a slightly inverted, irregularly serrated margin. Hymenium smooth, matte, darker in young fruitbodies – olive-brown, greyish-brown or clay-brown, becoming paler with age – buffy-brown, yellowish-brown. The outer surface is rough, with a whitish grit, grey-brown, chestnut-brown to pale grey-brown when wet and whitish when dry, with small dark brown or blackish warts closer to the edge and along the extreme margin (fig. 4A-4D, 5F).

Ascospores oblong-ellipsoidal, with rather blunt poles, hyaline, weakly granulose in water, with a weakly visible vacuole, central or displaced to one of the poles (clearly visible in Melzer's reagent), ornamented with small irregular warts on the sides and at the poles with larger warts which sometimes merge into a solid cap. Warts are poorly distinguishable in water (only along the contour), giving a rough look, and are clearly stained with Lactophenol Cotton Blue (fig. 5G, 5L). Measuring (fresh in water): (16.9) 18–20.2 (21.3) \times (8.4) 8.7–9.4 (10.0) μm ; Q = (1.9) 2–2.3 (2.5); N = 100; Mm = 19 \times 9 μm ; Qm=2.1. **Asci** 255–340 \times 10.2–15.8 μm , cylindrical, slightly tapering to the base, pleurorhynchous base (fig. 5C), tips amyloid (fig. 5A), operculate (fig. 5B), 8-spored. **Paraphyses** 225–290 μm long, septate (fig. 5E), straight, upper sections cylindrical, 3.4–4.8 μm thick, swollen at the apex to 5.8–9.2 μm (fig. 5D), lower sections cylindrical, weakly or moderately moniliform (fortoulism), 5.1–11.2 μm wide,



Fig. 4 – *Peziza sublaricina*. Apothecia *in situ*.

A, B. Apothecium on 06-V-2017; C. The outer surface of apothecium on 06-V-2017; D. The outer surface of apothecium on 29-IV-2020. Scale bars: A-D = 1 cm. Photos V.A. Fedorenko.

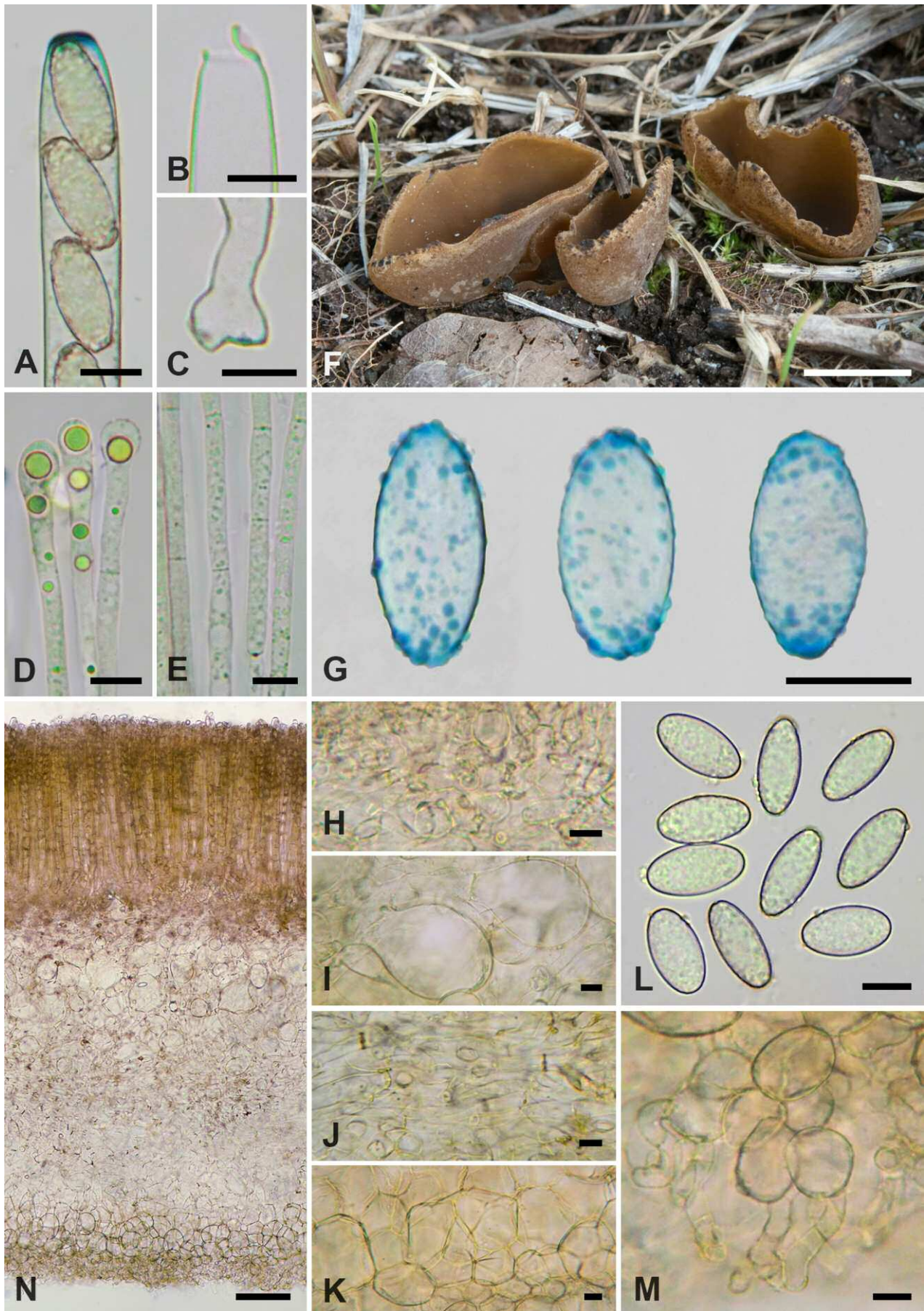


Fig. 5 – *Peziza sublaricina*

A. Asci in Melzer's reagent; B. Asci operculate apex in water; C. Asci pleurorhynchous base in water; D. Paraphyses apex in water; E. Paraphyses septate middle part in water; F. Apothecia *in situ*; G. Ascospore ornamentation in Lactophenol Cotton Blue; H. Subhymenium in water; I. Medullary excipulum upper in water; J. Medullary excipulum lower in water; K. Ectal excipulum in water; L. Ascospore in water; M. Furfuration globular cells with hyphoid hairs in water; N. Median section of an apothecia in water. Scale bars: A-E, G-M = 10 μ m; F = 1 cm; N = 100 μ m. Photos V.A. Fedorenko.

simple, hyaline, containing greenish-yellow vacuolar bodies (disappear in NaOH). **Excipulum** differentiated into 4 layers, 690–970 µm (fresh in water) (fig. 5N). **Subhymenium** 30–60 µm thick, hyaline, is composed of *textura intricata* cells, 3.5–10 µm broad, with brownish septal rings (fig. 5H). **Medullary excipulum** upper 180–260 µm thick, is composed of various globoid, piriform or claviform hyaline hyphae 15–100 µm broad, intertwined with elongated connecting hyphae, cells thin-walled (fig. 5I). Medullary excipulum lower 215–260 µm thick, hyaline, of parallel oriented *textura intricata* cylindrical hyaline hyphoid cells 1.6–5 µm wide, with brownish septal rings, cells thin-walled (fig. 5J). **Ectal excipulum** 85–160 µm thick, brownish, is composed of *textura globulosa-angularis* cells, with polygon or globoid cells 10–65 µm broad, cells thin-walled (fig. 5K). The furcation layer 60–130 µm thick, brown, of *textura globulosa*, with globular cells 13.3–31.1 × 7.6–26.1 µm, on which cylindrical vermiform septate hyaline hyphoid hairs (4–8 µm wide) are located, hairs perpendicular oriented (fig. 5M).

Ecology and distribution: fruiting in spring, solitary or in sparse groups on sandy soil. Several locations of this species are known but only from France and Germany (HEIM & RÉMY, 1932, under *Aleuria granulosa* f. *laricina*; DONADINI, 1979, 1982, 1984; VAN VOOREN, 2011, under *P. dissingii*; FELLMANN, 2014, under *P. dissingii*).

Similar species: according to macro morphology, this species can be confused with many brown *Peziza*, therefore, microscopy is required for its identification. Only *Peziza acroornata* Dougoud & J. Moravec and *P. acropapulata* Dougoud has a similar ascospore pattern. *Peziza acroornata* characterised by smaller apothecia sizes (not more than 15 mm), larger ascospores, 21.3–25.1 × 11.6–13.1 µm, and fewer warts on the lateral surfaces of the ascospores, which makes them look smoother in water (DOUGOUD & MORAVEC, 1995; VAN VOOREN, 2011). *Peziza acropapulata* has smaller ascospores, 16–18.4 × 8.5–9.5 µm, with an ornamentation of more numerous regular warts on the lateral surfaces and pronounced solid caps at the poles (DOUGOUD, 2012). *Peziza acroornata* and *P. acropapulata* have not been found in Kazakhstan.

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1: V.A. Fedorenko – Institute of Zoology, Ministry of Education and Sciences, Al-farabi ave., 93, 050060 Almaty, Kazakhstan – arthey@mail.ru