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Geoglossaceous fungi in Slovakia III. The genus *Geoglossum*

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Abstract: Recent field research on grassland fungi in Slovakia resulted in collection of rare geoglossaceous fungi. Previously published data on the distribution of the genus *Geoglossum* in Slovakia have been extended: *G. glutinosum* (11 sites), *G. glabrum* (3 sites), *G. cookeanum* (1 site), *G. umbratile* (9 sites) and *G. fallax* (3 sites). The last three species are new for the territory. Each treated species is described and ecological preferences and threat categories are discussed. A field identification key of accepted species is included.

Key words: Geoglossaceae; biodiversity; threatened fungi; key

Members of the genus *Geoglossum* are quite rare in Slovakia but from time to time factors influencing the production of fruitbodies meet at an optimum and the season is uncommonly rich in geoglossaceous fungi as in 2008 and 2010. A large number of collected fruitbodies during these years enabled us to study and analyze the variability of macro- and microcharacters. In situ monitoring also brought valuable data on changes of particular characters during the development of fruitbodies. We would like to emphasise readers that incidental collections of geoglossaceous fungi may posess random values of discriminative characters and therefore their taxonomic position may not be easily interpreted.

Only a few geoglossaceous fungi were listed in the checklist of Slovak fungi (Lizoň & Bacigálová 1998) and in the consecutive red lists (last edition: Lizoň 2001) before 2000 when we started our research on this fungi (Kučera et al. 2008; Kučera et al. 2010). Until now data on *Trichoglossum hirsutum* (Endlicher 1830; Mráz 1997; Adamčík & Hagara 2003), *Microglossum viride* (Bäumler 1897; Ripková & Kučera 2006), *Geoglossum glutinosum, G. glabrum* and *Trichoglossum walteri* (Ripková et al. 2007), *G. glabrum* (Deckerová 2006) and *Thuemenidium atropurpureum, Microglossum olivaceum* and *Trichoglossum variabile* (Kučera et al. 2008) were published. It should be mentioned that these fungi have been used in studies evaluating grasslands that are based on records of various groups of fungi (Rald 1985; Nitare 1988; Jordal 1997; McHugh et al. 2001; Adamčík & Kautmanová 2005) and are of conservation interest.

Material and methods

The macromorphological characters were observed in fresh material. The micromorphological structures were studied in dried material using a light microscope with oil immersion lens. Fragments of material were examined in 5% KOH, Melzer's reagent and a solution of Congo Red in ammonia. Values of micromorphological characters were estimated as average plus and minus a standard deviation of 30 measurements for each taxon (in parenthesis are 10 and 90 percentiles of measurements). For identification, monographs and keys by Dennis (1978), Spooner (1987), Ohenoja (1995, 2000), Durand (1908), Nannfeldt (1942) and Mains (1954) were used. Acronyms for herbaria follow Index herbariorum (Holmgren et al. 1990). The localities are georeferenced and the coordinates are in WGS 84 system. All descriptions are based on studied specimens. Nomenclature follows Index fungorum (Kirk 2011). This study was focused on those clearly distinguishable species which are, when interpreted in a wide sense, well identifiable.

Results

Geoglossum glutinosum Pers.

Apothecia (25)48–82 mm high, solitary or clustered, stipitate, clavate, smooth, with viscid stipe, flexuous. Fertile part lanceolate, terete, more or less compressed,(8)15–50(65) mm long, 4–7(8) mm thick, apex obtuse, black, sometimes with a tinge of olive or brown, not sharply differentiated from the sterile part. Sterile part cylindrical, slender, viscid, often with glued–on particles of debris, brownish-black, (20)42–54(66) mm long, 2–4 mm thick [44 fruitbodies examined]. Asci (182)204–221(253) × (11)12–14(15) µm, 8–spored, subcylindric to narrowly clavate towards the apex, the pore bluing in Melzer's reagent. Spores (55)72–94(102) × 4–5(6) µm, usually irregularly 2–3 seriate, sometimes arranged in parallel fascicules, first non–septate, than 1–3 septate, finally in several cases 5–7–septate, translucent, fuliginous, almost cylindrical, straight, ends obtuse.

Paraphyses cylindrical, slender up to 3 μm thick, septate, protruding above the asci, apical cells abruptly piriform to globose, (6)8–10 μm thick, pale brown, immersed in amorphous mater. The measurements of the asci and spores of different authors are presented by Imai (Imai 1941).

Habitat. On soil, grasslands and grass–heath communities on sub–neutral to calcareous, sandy and also loamy soils, in pastures as well as mowed grasslands. According to our field research the species grows, besides grassland biotopes, also in bushes and field balks, orchards, ecotones and peat-bogs. We have not yet recorded it in coniferous stands.

Distribution. Europe – distributed widely, North America, Asia (China, India, Japan), Australia, Africa (Macaronesia) (Massee 1897; Nannfeldt 1942; Imai 1941; Durand 1908; Maas Geesteranus 1965; Ohenoja 2000; Spooner 1987).

Specimens studied. Vihorlatske vrchy Mts, peat-bog Hypkania, ca 3 km S from Zemplínske Hámre village, 48°54′51″ N, 22°09′29″ E, Q 7098c, alt. 820 m., 20. 9. 2001, J. Terray, S. Adamčík (Ripková et al. 2007, SAV); Javorie Mts., Červený medokýš spring, ca 3.5 km SW from the centre of Zvolen town, 48°33′21″ N, 19°05′31″ E, Q 7480b, alt. ca 300 m, 8. 10. 2009, M. Zajac (SAV); Považský Inovec Mts., ski slope, ca 1.5 km from the church in Banka village, on pastured ski slope, 48°34′26″ N, 17°51′47″ E, Q 7473a, alt. ca 260 m, 27. 10. 2007, V. Kautman (SAV), Ibidem in bushes around ski slope, 29. 9. 2010, V. Kučera (SAV), Ibidem 8. 10. 2010, V. Kučera, N. Rybáriková (SAV); Poľana Mts., Arboretum Borová Hora, ca 2.5 km N from the centre of Zvolen town, wet mowed meadow, 48°35′43″ N, 19°08′10″ E, Q 7480b, alt. ca 340 m, 30. 9. 2009, V. Kučera (SAV); Biele Karpaty Mts. settlement Grúň, ca 1.8 km N from the church in Nová Bošáca village, in an orchard, 48°35′41″ N, 17°47′36″ E, Q 7172b, alt. ca 510 m, 14. 10. 2010, K. Devánová (SAV); Západné Beskydy Mts., Vysoká nad Kysucou village, submontane meadow, 15. 9. 2009, M. Zajac (SAV); Slovenské rudohorie Mts., peat-bog near Karafová bus-stop, ca 2.5 km N from the church in Muránska Zdychava village, 48°45′40″ N, 20°08′25″ E, Q 7286b, alt. ca 650 m, 7. 10. 2008, V. Kučera (SAV), Muránska Huta village, Predná Hora recreation area, 48°46′04″ N, 20°06′37″ E, Q 7286b, alt. ca 800 m, 10. 10. 2008, V. Kautman (SAV); Javorníky Mts. settlement Grúnik, ca 7.5 km NW from the church in Papradno village, 49°16′27″ N, 18°20′02″ E, Q 6776a, alt. ca 775 m, 18. 9. 2010, V. Kučera (SAV); Malá Fatra Mts. Nezbudská lúčka, Starý hrad (ruins of the castle), Q 6879a, 3. 10. 2009, L. Jánošík (SAV); Štiavnické vrchy Mts., Prenčov, Bardínová, 27. 8. 1896, A. Kmeť (BRA), ibidem 20. 9. 1888 A. Kmeť (BRA) both under name *Geoglossum glabrum*.

Notes. The species has an almost worldwide distribution but it was not reported from Slovakia before 2001 (Ripková et al. 2007). We propose to include *G. glutinosum* in the red list of Slovak fungi as a vulnerable (VU) taxon. The species is well characterised by having viscid fruitbody at least on the stipe and by fertile part not sharply separated from the sterile one. *Geoglossum peckianum* Cooke and *G. uliginosum* Hakelier, which might be collected in Slovakia in the future, have also viscid stipe.

***Geoglossum glabrum* Pers.**

Apothecia (29)48–92(108) mm high, solitary or clustered, gregarious, stipitate, clavate, smooth, fragile. Fertile part lanceolate, terete, more or less compressed, sometimes grooved, (20)42–88 mm long, 5–7(8) mm thick, apex rounded, black, dark-brown, differentiated from the sterile part. Sterile part cylindrical or slightly compressed, densely scabrous, slender, brownish-black to black, (20)42–54(86) mm long, 1–3 mm thick [49 fruitbodies examined]. Asci (163)175–189(198) × (15)18–20(22) μm, 8-spored, clavate to lanceolate, apex narrowed and rounded, the pore bluing in Melzer's reagent. Spores (62)66–82(85) × 7(8) μm, in parallel fascicles, 7-septate, dark fuliginous, almost cylindrical, slightly curved. Paraphyses cylindrical, slender, up to 3 μm thick, septate, slightly protruding above the asci, adhering in clusters, the apical part of short chains of broadly ellipsoidal or globose septatecells up to 8–10(15) μm thick, brown above.

Habitat. In peat-bog, among mosses. According to the literature also on soil in *Cedrus* or *Quercus* forests or among mosses on exposed slopes at an altitude of about 2000 m (Maas Geesteranus 1965), on soil (Zhuang & Wang 1998), in Nordic countries in swampy forests and pastures (Ohenoja 2000). In Slovakia the species grows in wet meadows and peat-bogs, often in association with *Hygrocybe coccineocrenata* and *H. turunda*. The species is well characterized by black fragile fruitbody and by occurrence in peat–bogs. *Geoglossum simile* Peck, which might be collected in Slovakia in the future, have simillar characters but differs in spore size and paraphyses shape.

Distribution. Asia (India, Japan, China), North Amerika, Europe (Bille-Hansen 1954; Zhuang & Wang 1997; Maas Geesteranus 1965; Ohenoja 2000; Nannfeldt 1942).

Specimens studied. Vihorlatské vrchy Mts., peat-bog Postávka, ca 3 km S from Zemplínske Hámre village, 48°55′24″ N, 22°09′25″ E, Q 7098d, alt. 763 m, 20. 9. 2001, V. Kučera, S. Adamčík, S. Ripková, SAV (Ripková et al. 2007); Ibidem 11. 8. 2009, J. Pavlík (SAV); Západné Beskydy Mts. peat-bog Klinské rašelinisko, ca 1 km SSE from Klin village, 49°25′44″ N, 19°30′01″ E, Q 6582d, alt. 613 m, 28. 9. 2002, M. Vašutová (SAV). Nízke Tatry Mts., peat-bog pod Soľankou, ca 3.5 km NW from Liptovská Teplička village, 48°58′44″ N, 20°02′52″ E, Q 7086a, alt. 1210 m, 9. 9. 2006, I. Kautmanová (SAV).

Notes. The fruitbodies are fragile and easily break up. The species was not reported from Slovakia before 2001 (Ripková et al. 2007). For data on variability of young vs. old and fresh vs. dry material from Czechia and Slovakia see Deckerová (2006). We propose to include this species in the red list of Slovak fungi as an endangered (EN) taxon.

***Geoglossum cookeanum* Nannf.**
Apothecia (25)48–63 mm high, solitary, scattered, stipitate, clavate, smooth, robust. Fertile part lanceolate, terete, compressed, (12)20–48(54) mm long, 8–12(15) mm thick, apex tapering, brownish black to almost black, sharply differentiated from the sterile part. Sterile part short, cylindrical, brownish black to black, (9)18–33(41) mm long, 2–6 mm thick [38 fruitbodies examined]. Asci (163)170–182(185) × 14–17(22) μm, 8–spored, cylindrical-clavate with narrowed obtuse apex, the pore bluing in Melzer's reagent. Spores (55)62–77(83) × 5.5–6(7) μm, usually irregularly 2–3 seriate, 7-septate, dark fuliginous, almost cylindrical, slightly curved, tapering towards one end. Paraphyses cylindrical, slender up to 2.5 μm thick, septate, protruding above the asci, adherent in clusters, the apical cells barrel-shaped to globose, 6–8–10 μm thick, often in chains of alternating thicker and slender cells, straight to somewhat curved, pale brown in upper part.
Habitat. On soil, collected only one time in Slovakia in a brush habitat.
Distribution. Europe, China (India), North America (Mains 1954; Durand 1908; Nannfeldt 1942; Ohenoja 2000; Maas-Geesteranus 1965).
Specimens studied. Malé Karpaty Mts., locality ca 2.5 km NW from Chtelnica village, 48°34′26, 1″ N, 17°35, 5′31, 1″ E, Q 7471b, alt. 334 m., 29. 9. 2010, V. Kučera, V. Kautman (SAV).
Notes. The species was not reported from Slovakia before. We propose to include *G. cookeanum* in the red list of Slovak fungi as a vulnerable (VU) taxon. The species is well characterised by the "elegant" smooth fruitbody, with the fertile part lanceolate and compressed.

***Geoglossum umbratile* Sacc.**
Syn. (according to Ohenoja 2000) *G. nigritum* (Pers.) Cooke ss. auct.
Apothecia (63)71–80(88) mm high, mostly solitary, stipitate, clavate, slender. Fertile part lanceolate to ligulate or cylindrical, more or less compressed, (27)35–40(48) mm long, 2–5(7) mm thick, subacute to obtuse apex, black or brownish-black, sharply differentiated from the sterile part. Sterile part cylindrical, terete, slender, upper part squamulous to glabrous (36)42–54(60) mm long, 1–2 mm thick [examined 57 fruitbodies]. Asci (146)150–175(182) × (14)16–18(20) μm, 8-spored, cylindrical-clavate, apex rounded, the pore blued in Melzer's reagent. Spores (56)67–82(87) × 5–6(7) μm, in a parallel fascicle, 7-septate, fuliginous, clavate, slightly curved, tapering towards one end. Paraphyses cylindrical, septate, not constricted on the septa, slightly protruding above the asci, the apical cells more or less curved, slightly thickened to 7–8 μm, pale brown above.
Habitat. Hay meadows, mesophilous pastures, humid meadows, sometimes forest margins. According to Durand (1908) also on rotten wood.
Distribution. Europe, Asia (China, Japan, India), North America, Australia (Zhuang & Wang 1998; Mains 1954; Durand 1908; Nannfeldt 1942; Ohenoja 2000; Maas-Geesteranus 1965; Imai 1941).
Specimens studied. Považský Inovec Mts., ski slope, ca 1.5 km from the church in Banka village, on pastured ski slope, 48°34′26″ N, 17°51′47″ E, Q 7473a, alt. ca 260 m, 27. 10. 2007, V. Kautman (SAV), Ibidem 25. 10. 2008 (SAV); Javorie Mts., Červený medokýš spring, ca 3.5 km SW from the centre of the Zvolen town, 48°33′21″ N, 19°05′31″ E, Q 7480b, alt. ca 300 m, 8. 10. 2009, M. Zajac (SAV); Malé Karpaty Mts., locality ca 2.5 km NW from Chtelnica village, 48°34′26, 1″ N, 17°35, 5′31, 1″ E, Q 7471b, alt. 334 m., 5. 10. 2010, V. Kučera (SAV); Biele Karpaty Mts. Lysá meadow, Vršatské Podhradie, ca 1.2 km NW from the ruins of the castle Vršatec, 49°04′19, 2″ N, 18°08′37, 5″ E,Q 6974b, alt. 683 m, 26. 9. 2005, V. Kučera (SAV); Zahorská nížina lowland: Abrod National Nature Reserve near Závod vilage, 48°32′01, 6″ N, 17°00′26, 1″ E, Q 7468c, alt. 151 m, 20. 8. 2002, V. Kučera (SAV); Liptovská kotlina Basin., orchard with apple trees, ca 1 km NE from Hybe village, 49°03′10, 48″ N, 19°50′16, 14″ E, Q 6985a, alt. 705 m, 2. 9. 2010, V. Kučera (SAV); Malé Karpaty Mts., mown meadow, ca. 1.5 km SE of Sološnica village, 48°27′25″ N, 17°14′42″ E, Q 7569a, 250 m in grass, 26. 8. 2008, leg. V. Kučera (SAV); Slovenské Rudohorie Mts., Muránska Huta village, Predná Hora recreation area, 48°46′05″ N, 20°06′36″ E, Q 7286b, alt. ca 810 m, 10. 10. 2008, V. Kučera (SAV); Chočské vrchy Mts., Dolný Kubín, Brezovec hill, ca 500 m NNW from the TV transmiter, moist meadow, Q 6781d, alt. ca 640 m, 15. 9. 2010, M. Švidroň (SAV).
Notes. First record in Slovakia. In hay meadows, also in open forests and brushes, according to Durand (1908) also on rotten wood. A variable species, to be included to red list as a vulnerable (VU) taxon.

***Geoglossum fallax* E. J. Durand**
Apothecia (22)52–84 mm high, solitary, stipitate, clavate slightly compressed. Fertile part lanceolate, compressed, (6)8–15(17) mm long, 3–5(7) mm thick, apex obtuse, tawny black to almost black, sometimes with umber tint, sharply differentiated from the sterile part. Sterile part cylindrical, slender, squamulose on upper part, brownish black, (19)39–48(56) mm long, 1–2 mm thick [examined 19 fruitbodies]. Asci (146)153–169(182) × (16)18–20 μm, 8–spored, subcylindric to clavate towards the apex, the pore bluing in Melzer's reagent. Spores (55)68–92(106) × 4–5(6) μm, biseriate to multiseriate, at first non–septate, then 3 septate, finally up to 12 septate, hyaline than fuliginous, almost straight or curved with obtuse ends. Paraphyses cylindrical, slender up to 2 μm thick, not closely septate, the apical cells abruptly elliptical to circinate, 5–7–8 μm thick, hyaline.
Habitat. In hay, mesophilous and humid meadows, sometimes in forest margins. Often in the same stands as *Geoglossum umbratile*.
Distribution. Europe – distributed widely, North America, Asia (China, India, Japan) (Nannfeldt 1942; Imai 1941; Durand 1908; Maas Geesteranus 1965;

Ohenoja 2000; Bille-Hansen 1954).

Specimens studied. Západné Beskydy Mts., Korňa village, mowed meadow, 19. 9. 2010, V. Kautman (SAV); Štiavnické vrchy Mts., locality N from the Banská Štiavnica town, *Corylus avellana*, *Fagus sylvatica*, *Cerasus avium*, forest margin, 23. 9. 2010, V. Beňadik (SAV); Ibidem *Picea abies*, 24. 9. 2010, V. Beňadik (SAV); Malá Fatra Mts., Dubový diel, 1.65 km, SWW from Bystrička village, in mosses, on the pasture, with *Picea abies*, Q6979a, alt. 540 m, 31. 10. 1981, L. Hagara as *Geoglossum glabrum*? (BRA).

Notes. The species is associated with mesophilous meadows and is almost worldwide in distribution. But it is quite rare almost everywhere and it was not reported from Slovakia before. We propose to include it in the red list of Slovak fungi as a vulnerable (VU) taxon. According to Mains (1954) the species may have also non-septate, hyaline spores. Brown spores have 0–12 septa.

Preliminary key to species of *Geoglossum* in Slovakia

1 Fruitbodies viscid, at least on the stipe 2
– Fruitbodies not viscid 4
2 Brown to dark brown, fertile part not sharply separated from the sterile part, apical cell of the paraphyses pyriform, spore size 72–94 × 4–5 µm . . . . . ***G. glutinosum***
– Dark brown to black, fertile part sharply separated from the sterile part, apical cells of the paraphyses various shaped or curved 3
3 Robust, up to 6 cm high, spores 7-septate, 60–80 × 4.5–6 µm . . . . . ***G. uliginosum****
– Slender, up to 3 cm high, spores 14–septate, 90–120 × 6–7 µm . . . . . ***G peckianum****
4 Growing in peat-bogs among *Sphagnum* sp., or very wet meadows 5
– Growing in different habitats 6
5 The apical cells of the paraphyses swolen up to 10 µm, spores 66–82 × 7 µm . . . . . ***G. glabrum***
– The apical cells of the paraphyses up to 8 µm, spores 65–90 × 6.5–7.5 µm . . . . . ***G. simile****
6 Stem smooth, fertile part compressed, lanceolate, fruitbodies black, paraphyses moniliform, spores 62–77 × 5–6 µm . . . . . ***G. cookeanum***
– Stem slightly rugose to squamulose, fertile part diverse shapes often with obtuse apex, fruitbodies brown to black, paraphyses not moniliform 7
7 Fruitbodies brown, silver brown, blackish brown, fertile part darker than the sterile, stem squamulose mainly at upper part, spores up to 12 septate 68–92 × 4–5 µm . . . . . ***G. fallax***
– Fruitbodies dark brown to black, stem slightly rugose, spores 7 septate 67–82 × 5–6 µm . . . . ***G. umbratile***

(**Geoglossum uliginosum* Hakelier, *G. peckianum* Cooke, *G. simile* Peck are not reported from Slovakia yet. Is likely that these species will be found in the future. Data are taken from Ohenoja 2000.)

Discussion

It is almost impossible to assess the abundance of geoglossaceous fungi because they are in general rare and their fruitbodies appear infrequently and sporadically. So any new collection should be valuated because it could contribute to a better understanding of their taxonomy, ecology and distribution.

Manuals and keys usually present as typical habitats for geoglossaceous fungi peat-bogs, wetlands and shady stands. But these fungi occur also in semi-natural pastures that are recently grazed or were grazed in the past. Usually peat-bogs and wetlands were presented as most endangered habitats because of their reclamation. But unimproved grasslands are also critically threatened all over Europe: their number is decreasing mainly due to the fertilization, lack of grazing animals, and industrial or other pollution (Newton et al. 2003).

This study is based on all available collections in BRA, SLO and SAV and only specimens that were identified without doubt are cited. Because of inconsistent published species concepts we are favouring "wide" circumscription of species avoiding infraspecific taxa. It is almost impossible to distinguish numerous "narrow" species and infraspecific taxa because of lack of collections and thereof insufficient knowledge of discrimination characters. They should be better circumscribed using not only molecular methodologies but also long-term monitoring of variability on known collecting sites where they produce fruitbodies repeatedly and appear for some subsequent years.

Our actual field research indicates that members of the genus *Geoglossum* are rarer than other taxa of the Geoglossaceae s. l. Page: 1

Possibly all of them should be included to the next edition of the red list of Slovak fungi.

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