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RESEARCH ARTICLE

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Towards an understanding of the genus *Glutinoglossum* with emphasis on the *Glutinoglossum glutinosum* species complex (*Geoglossaceae*, *Ascomycota*)

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Key words

earth tongues
key
morphology
new species
systematics
typification

Abstract *Glutinoglossum* is one of the earth tongue genera with viscid or glutinous ascocarps. Based on morphology and ITS1-5.8S-ITS2, nrLSU and *tef1* sequence data, seven new species are described: *G. circinatum*, *G. lumbricale*, *G. orientale*, *G. peregrinans*, *G. proliferatum*, *G. pseudoglutinosum*, and *G. triseptatum*. The lectotypes for *Geoglossum glutinosum* var. *lubricum* and for *Geoglossum glabrum* var. *majus* as well as the epitype for *Glutinoglossum glutinosum* are designated. The comprehensive morphological study of *G. heptaseptatum* resulted in the discovery of ascospores germinating by conidia inside the asci, which is first noted for *Glutinoglossum* species. The status of *Cibalocoryne* is discussed.

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Dedicated to the memory of Professor Richard P. Korf (28 May 1925 – 20 August 2016)

INTRODUCTION

Glutinoglossum is a recently described genus in the family *Geoglossaceae* (Hustad et al. 2013). The genus comprises fungi with orthotropic clavate or cylindrical stipitate dark coloured ascocarps. It differs from the other genera in the family in having viscid or glutinous ascocarps and pale brown, mostly straight paraphyses with enlarged apical cells continuing beyond the hymenium down the stipe and forming a distinct gelatinous layer. Ascospores are slow-maturing with mostly 3 or 7 septa. Though the genus *Geoglossum* also accommodates some species with glutinous ascocarps (*G. affine*, *G. peckianum*, and *G. uliginosum*), *Glutinoglossum* forms a separate clade with *G. glutinosum* as a core according to molecular evidence (Hustad et al. 2013, Hustad & Miller 2015).

Geoglossum glutinosum was described by Persoon (1796). The highly polymorphic nature of the species was observed by early mycologists and resulted in description of several infraspecific taxa – *Geoglossum glutinosum* var. *sylvestre*, *G. glutinosum* var. *lubricum*, *G. glutinosum* forma *minor* (Persoon 1797, 1822, Saccardo 1878). Persoon (1797) described also *Geoglossum viscosum*, one more species with viscid ascocarps. The main differences between those taxa as they were understood at the time consisted in macromorphological characters and ecological preferences.

Hazslinszky (1881) divided the genus *Geoglossum* into four genera based on the characters of hymenium and ascospores: *Eugeoglossum*, *Helote*, *Corynetes*, and *Cibalocoryne* which included the only species with glutinous ascocarps, *C. viscosula*. In the same article Hazslinszky also treated his newly described genera as subgenera of *Geoglossum*. The issue of the rank of *Cibalocoryne* and validity of its publication has been raised in literature repeatedly (Mains 1954, Maas Geesteranus 1964, Hustad et al. 2013, Hustad & Miller 2015); nevertheless, the problem still has not resolved. *Cibalocoryne* as well as *C. viscosula* and *Geoglossum* subg. *Cibalocoryne* currently are forgotten names for the taxa of the family *Geoglossaceae*.

Durand (1908) was the first who paid attention to viscid gelatinous ascocarps and descending paraphyses which form continuous layer to the stipe of some geoglossoid fungi. On this basis he erected the genus *Gloeoglossum* with *G. difforme* as a type species, *G. glutinosum*, and *G. affine* (Durand 1908). Imai (1941) added two more species, *G. barlae* and *G. umbratile*, and proposed inclusion of *Geoglossum bogoriense* in *Gloeoglossum*. However, later he transferred these species into the genus *Cibalocoryne* (Imai 1942). Many subsequent authors dealing with the group recognized neither *Cibalocoryne* nor *Gloeoglossum* and treated mentioned taxa within the *Geoglossum* (Lloyd 1916, Nannfeldt 1942, Mains 1954). Nowadays, the genus *Gloeoglossum* is treated as a synonym of *Geoglossum* since the type species *G. difforme* belongs to *Geoglossum* s.str. clade (Hustad et al. 2013). Nannfeldt (1942) pointed out isolated position of *G. glutinosum* within *Geoglossum* due to its highly viscid ascocarps, peculiarities of paraphyses and asci. Moreover, he focused to ascospore colouring and number of septa at maturity and put *G. glutinosum* into a group with tardily coloured and seven or fewer septated ascospores.

Recent phylogenetic analysis (Hustad et al. 2013) showed that *Geoglossum glutinosum* formed a well-supported clade separate from *Geoglossum* and allowed the establishment of a new genus *Glutinoglossum* for *G. glutinosum* and the closely related *G. heptaseptatum*. Later Hustad & Miller (2015) undertook a comprehensive examination of *Glutinoglossum* based on a statistical analysis of molecular data and morphology and recognized four additional species, namely *G. americanum* from North America, and *G. australasicum*, *G. exiguum*, and *G. methvenii* from Australasia.

All aforementioned *Glutinoglossum* species previously were considered as a single *Geoglossum glutinosum* species which had worldwide distribution. The use of molecular approach pushed to the revision of morphological characters, geographical and ecological data which, as it turned out, are important

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for species delimitation. All this resulted in the description of new species (Hustad et al. 2013, Hustad & Miller 2015) and allowed considering *Geoglossum glutinosum* in the sense of previous authors as a species complex.

Our study focusing foremost on material of *Glutinoglossum* from Europe and Northern Asia resulted in:

i. delimitation of seven new species related to *G. glutinosum* based both on morphological and molecular data;

ii. emendation of description of *G. glutinosum* and designation of the epitype;

iii. increase of knowledge about biogeography and details of ascospore development of *G. heptaseptatum*; and

iv. designation of the lectotypes for *Geoglossum glutinosum* var. *lubricum* and for *Geoglossum glabrum* var. *majus*.

MATERIALS AND METHODS

Specimens and morphological studies

The study is based on recently collected material as well as on specimens preserved in European and Asian herbaria (L, LE, LEP, PAD, SAV, TAAM, and VLA). Herbarium acronyms are used in accordance with Index Herbariorum (Thiers, continuously updated). Species descriptions are based on the studied material while description of the genus was compiled using both literature and studied material. The macro-morphological characters of collections were described according to the observations of fresh and dry material as well as the image analysis of the photos. The micro-morphological structures were examined in dried material. Fragments of ascocarps were mounted in 5 % KOH and tap water for standard light microscopy. To test the amyloid reaction of asci's walls and apical rings Melzer's reagent (MLZ) and Lugol's solution (IKI) without KOH pre-treatment were used. The images of micro-morphological characters were captured with an AxioCam MRc 5 digital camera on an AxioImager A1 microscope (Carl Zeiss, Göttingen, Germany). The measurements of micro-morphological characters and Q value (length / width ratio) were made in KOH and given according to the formula: (min) $\overline{\text{min}}$ – $\overline{\text{max}}$ (max), where min (max) – absolute minimal (maximal) value, $\overline{\text{min}}$ ($\overline{\text{max}}$) – minimal (maximal) arithmetic mean value based on 20 measurements per specimen for ascospores and 10 measurements for other structures. Ascospore septation is described in the following format: e.g., (0–)3(4–6)7, meaning that spores with 3 and 7 septa predominate, but spores with 1, 6 or without septa can also be found. Number of septa for ascospores inside asci was noted. The collected specimens were deposited in the Mycological Herbarium of the Komarov Botanical Institute (LE), Russian Academy of Sciences, and in the Herbarium of the Institute of Botany (SAV), Slovak Academy of Sciences.

DNA extraction, amplification, and sequencing

Total genomic DNA was extracted from a small piece of a single dried ascocarp using an AxyPrep Multisource Genomic DNA Miniprep Kit (Axygen Biosciences, Union City, CA, USA). Three rDNA loci were amplified and sequenced. The internal transcribed spacer region (ITS1-5.8S-ITS2, ITS) was amplified and sequenced using the primer pairs ITS1F-ITS4 (White et al. 1990, Gardes & Bruns 1993) and newly designed GEO-F-GEO-R following the protocol set forth in Wang et al. (2011). The primer pair GEO-F (5'-GCCCAACCTCCAACCCCTTG-3') and GEO-R (5'-AGTCAGTCTGCTACGCTTGAGTCT-3') was designed using an OligoAnalyzer 3.1 web tool (https://eu.idtdna.com/calc/analyzer). The D1-D3 domains at the 5' end of the 28S large subunit (nrLSU, LSU) were amplified and sequenced using the primer pairs JS1-LR5 and LR0R-LR5 (Vilgalys & Hester 1990, Cubeta et al. 1991, Landvik 1996) following Co-David et al. (2009). The fragment of the protein-coding gene, translation elongation factor 1 alpha (*tef1*), was amplified and sequenced using 983F-1567R primers (Rehner 2001). Amplicons were purified using a Thermo Scientific GeneJET PCR Purification Kit (Thermo Scientific, Vilnius, Lithuania) and an AxyPrep™ DNA Gel Extraction Kit (Axygen Biosciences, Union City, CA, USA). For sequencing reaction the BigDye™ Terminator v. 3.1 cycle sequencing Ready Reaction kit (Applied Biosystems, Foster City, CA, USA) was used. Sequences were generated on the ABI model 3130 Genetic Analyzer and initially processed using the Sequencing Analysis 5.3.1 (Applied Biosystems, Foster City, CA, USA). To obtain the consensus sequences of each specimen BioEdit v. 7.2.5 (Hall 1999) and MEGA6 (Tamura et al. 2013) were used. Sequences generated in this study were submitted to NCBI GenBank (Table 1).

Sequence alignment and phylogenetic analysis

Three alignments consisting of individual datasets of ITS, LSU, and *tef1* sequences were created using MAFFT v. 7 web tool (http://mafft.cbrc.jp/alignment/server/) with Q-INS-i strategy and then were corrected manually with MEGA6 (Tamura et al. 2013). To remove ambiguous regions from individual alignment TrimAl v. 1.3 (Capella-Gutiérrez et al. 2009) on the Phylemon2 server (http://phylemon.bioinfo.cipf.es/utilities.html) was used. All alignments were tested by means of PartitionFinder 2 (Lanfear et al. 2017) which includes PhyML program (Guindon et al. 2010), and using greedy algorithm described in Lanfear et al. (2012). The best-fit AICc-selected models of evolution were SYM+I+G for ITS, GTR+I+G for LSU, and SYM+G for *tef1*. Phylogenetic reconstructions were performed with maximum likelihood (ML) and Bayesian (BA) analyses. The ML phylogenetic analysis was run in RAxML Black Box server (http://embnet.vital-it.ch/raxml-bb/) which implements the search protocol of Stamatakis et al. (2008), with Gamma model of rate heterogeneity and estimation of proportion of invariable sites. Clades with a bootstrap support (BS) value > 70 % were considered significant and retained.

Bayesian inference employing a metropolis coupled Markov Chain Monte Carlo algorithm was performed with MrBayes v. 3.2.5 (Ronquist & Huelsenbeck 2003). Four independent chains were run 13 million generations with trees sampled every 100 generations, under the appropriate model parameters. Tracer v. 1.6.0 (Rambaut et al. 2014) was used to evaluate the quality of a sample from the posterior and the continuous parameters, using effective sample size (ESS). The clades with posterior probability (PP) value > 0.95 were considered to be significantly supported.

To obtain combined matrix, individual datasets of ITS, LSU and *tef1* were checked for potential conflict before integration into a single dataset. Conflict of individual gene phylogenies was assumed to be significant if clades with ML BS (> 70 %) or BPP (> 0.95) were conflicting in the individual tree topologies (Lutzoni et al. 2004). Since there were no significant conflicting clades among the individual gene topologies, all regions were combined in this order listed: ITS, LSU, and *tef1*. Further ML and BA phylogenetic analyses were performed on the concatenated dataset as described above. Alignments and phylogenies were deposited in TreeBASE (http://treebase.org) under the submission ID 21085.

RESULTS

Phylogenetic analysis

Ninety new sequences were generated for this study, including 38 ITS, 38 LSU and 14 *tef1* (Table 1). To these were added 6 ITS and 4 LSU sequences from our previous studies (Fedosova & Kovalenko 2015, Kučera et al. 2015), and 68 sequences,

Table 1 Voucher information and NCBI GenBank accession numbers of DNA sequences of the specimens used in the phylogenetic analyses. Some sequences retrieved from GenBank were re-identified and the names originally used in GenBank are given after the taxon names ('as'). The sequences newly generated in this study are marked with *.

Taxon	Locality	Voucher	GenBank accession numbers			Notes
			ITS	LSU	*tef1*	
Geoglossum cookeanum	Czech Republic	ILLS 67347	KC222122	KC222135	–	
	USA	ILLS 61035	JQ256417	JQ256434	–	
G. difforme	USA	ILLS 67348	KC222123	KC222136	–	
	USA	ILLS 67349	KC222124	KC222137	–	
G. nigritum		AFTOL-ID 56	DQ491490	AY544650	DQ471044	isolate
G. simile	USA	ILLS 67350	KC222125	KC222138	–	
	USA	ILLS 61039	JQ256421	JQ256437	–	
Glutinoglossum americanum as *Glutinoglossum glutinosum*	USA	ILLS 67352	KC222128	KC222141	–	holotype
G. americanum	USA	ILLS 64444	KP690086	KP690098	–	
G. australasicum	New Zealand	PDD 103623	KP690088	KP690100	–	holotype
	New Zealand	PDD 103619	KP690087	KP690099	–	
G. australasicum as *Geoglossum glutinosum*	New Zealand	PDD 73996	HQ222869	–	–	
G. circinatum	Russia: Krasnoyarsk Territory	LE 303993	KX694149*	KX694187*	KX898401*	holotype
G. exiguum	New Zealand	PDD 103574	KP690089	KP690101	–	holotype
	New Zealand	PDD 103611	KP690090	KP690102	–	
G. glutinosum	Czech Republic	ILLS 67353	KC222129	KC222142	–	
	Czech Republic	SAV F-10203	KX694150*	KX694188*	–	
	Czech Republic	SAV F-9965	KX694151*	KX694189*	–	
	Czech Republic	SAV F-11268	KX694152*	KX694190*	–	
	Czech Republic	SAV F-11257	KX694153*	KX694191*	–	
	Czech Republic	SAV F-11248	KX694154*	KX694192*	–	
	Denmark	SAV F-11269	–	KX694193*	–	
	Poland	SAV F-11258	KX694155*	KX694194*	–	
	Poland	SAV F-11254	KX694156*	KX694195*	–	
	Russia: Leningrad Region	LE 222165	KX694157*	KX694196*	–	epitype
	Russia: Republic of Tatarstan	LE 303994	KX694158*	KX694197*	KX898402*	
	UK	ILLS 72217	KP690091	KP690103	–	
	UK	ILLS 64446	KP690092	KP690104	–	
	UK	ILLS 64445	KP690093	KP690105	–	
G. heptaseptatum	Czech Republic	ILLS 63754	KC222130	KC222143	–	holotype
	Czech Republic	K(M) 165359	KC222131	KC222144	–	
	Czech Republic	SAV F-11270	KX694159*	KX694198*	–	
	Latvia	LE 303990	KX694160*	KX694199*	–	
	Russia: Leningrad Region	LE 236625	KX694161*	–	–	
	Russia: Leningrad Region	LE 222169	KX694162*	KX694200*	–	
	Russia: Leningrad Region	LE 222479	KX694163*	–	KX898403*	
	Russia: Leningrad Region	LE 222167	KX694164*	KX694201*	–	
	Slovakia	SAV F-10544	KU215768	KU215770	–	
	Slovakia	SAV F-10540	KU215767	KU215769	–	
G. lumbricale as *Geoglossum glutinosum*	China	HMAS 72096	HQ222870	–	–	
G. lumbricale	Russia: Novgorod Region	LE 303987	KX694165*	KX694202*	KX898404*	holotype
G. methvenii	New Zealand	PDD 103629	KP690096	KP690108	–	holotype
	New Zealand	PDD 103597	KP690095	KP690107	–	
	New Zealand	PDD 103604	KP690097	KP690109	–	
G. orientale	Russia: Primorye Territory	LE 222166	KX694166*	KX694203*	KX898405*	holotype
	Vietnam	LE 291818	KX694167*	KX694204*	KX898406*	
G. peregrinans	Finland	SAV F-10789	KX694168*	KX694205*	–	
	Russia: Karachayevo-Circassian Republic	LE 291817	KX694169*	KX694206*	KX898407*	
	Russia: Primorye Territory	LE 303988	KX694170*	KX694207*	KX898408*	holotype
	Russia: Primorye Territory	LE 303989	KX694171*	KX694208*	KX898409*	
	Russia: Pskov Region	LE 222635	KX694172*	KX694209*	KX898410*	
	Russia: Pskov Region	LE 222636	KX694173*	KX694210*	KX898411*	
	Slovakia	SAV F-11246	KX694174*	KX694211*	–	
G. proliferatum	Romania	SAV F-11249	KX694175*	KX694212*	–	holotype
G. pseudoglutinosum	Czech Republic	SAV F-11243	KX694176*	KX694213*	–	
	Czech Republic	SAV F-11255	KX694177*	KX694214*	–	
	Slovakia	SAV F-10903	KX694178*	KX694215*	–	holotype
	Slovakia	SAV F-11196	KX694179*	KX694216*	–	
	Slovakia	SAV F-11264	KX694180*	KX694217*	–	
	Slovakia	SAV F-11265	KX694181*	KX694218*	–	
	Slovakia	SAV F-10406	KX694182*	KX694219*	–	
	Slovakia	SAV F-11267	–	KX694220*	–	
	Slovakia	SAV F-10399	KX694183*	KX694221*	–	
	Slovakia	SAV F-11251	KX694184*	KX694222*	–	
G. pseudoglutinosum as *Glutinoglossum glutinosum*	UK	ILLS 64448	KP690094	KP690106	–	
G. pseudoglutinosum as *Geoglossum glutinosum*		Strain 1100649	–	AY789310	–	strain
G. triseptatum	Slovakia	SAV F-9828	KX694185*	KX694223*	–	holotype
	Slovakia	SAV F-10262	KX694186*	KX694224*	–	
Graddonia coracina	USA	ILLS 60491	JQ256423	JN012009	–	outgroup
Leucoglossum durandii as *Trichoglossum durandii*	China	HMAS 70090	HQ222875	–	–	

Table 1 (cont.)

Taxon	Locality	Voucher	GenBank accession numbers			Notes
			ITS	LSU	*tef1*	
L. leucosporum	Germany	B 70 0015491	KP272110	–	–	holotype
	Germany	B 70 0015492	KP272111	–	KX898412*	
	Russia	LE 291874	KP272112	KP272113	KX898413*	
	Russia	LE 291891	KP272114	KP272115	KX898414*	
	Spain	ERRO 2012122803	KP144109	–	–	
Sabuloglossum arenarium as *Thuemenidium arenarium*	Finland	OULU-F077201	GU324765	GU324764	–	isolate
S. arenarium	The Netherlands	ILLS 61043	JQ256426	JQ256440	–	
Sarcoleotia globosa		OSC63633	AY789410	AY789409	–	strain
		MBH52476	–	AY789428	–	strain
Trichoglossum hirsutum	Czech Republic	ILLS 61045	JQ256428	JQ256442	–	
	USA	ILLS 67355	KC222132	KC222145	–	
		AFTOL-ID 64	DQ491494	AY544653	DQ471049	isolate

including outgroup taxon (*Graddonia coracina*), were retrieved from NCBI GenBank (Table 1).

Topology of single-gene and three-gene trees in general is congruent. The genus *Glutinoglossum* had a high support in the ITS (BS = 81, PP = 1) and *tef1* (BS = 99, PP = 1) analyses. Despite unsupport in the LSU phylogenetic analyses (BS = 27, PP = 0.61), *Glutinoglossum* represented a separate clade.

The final ITS-LSU-*tef1* combined data matrix included one outgroup taxon and 81 sequences of *Geoglossaceae*, of which 62 belong to *Glutinoglossum*. The final combined ITS-LSU-*tef1* alignment had an aligned 1 816 sites, of which 1 185 were constant and 631 were variable (485 were parsimony-informative and 146 were parsimony-uninformative). A total 205 of the 2 021 characters were removed by TrimAl. To remove the prestationary posterior probability distribution burn-in of 11.5 % was estimated with Tracer v. 1.6.0 to be sufficient, resulting in an ESS value of 3 364. The topology revealed by the ML analysis of the ITS-LSU-*tef1* dataset is illustrated (Fig. 1–2).

The phylogenetic analyses of three combined matrix revealed six well-supported monophyletic clades corresponding to the genera *Geoglossum*, *Glutinoglossum*, *Leucoglossum*, *Sabuloglossum*, *Sarcoleotia*, and *Trichoglossum* (Fig. 1). *Glutinoglossum* was recovered as a well-supported genus (BS = 74, PP = 1). Within the genus *Glutinoglossum* ten clades had a high support (Fig. 2). *Glutinoglossum circinatum* and *G. proliferatum* each are represented by single sequence and form two separate lineages. The combination of the unique morphological characters of respective specimens and statistical support of molecular data allowed us to consider these lineages as distinct species on a par with *G. americanum*, *G. australasicum*, *G. exiguum, G. glutinosum, G. heptaseptatum, G. lumbricale*, *G. methvenii, G. orientale*, *G. peregrinans*, *G. pseudoglutinosum*, and *G. triseptatum*. The clade of *G. pseudoglutinosum* was unsupported in the phylogenetic analyses, but has distinctive morphological and ecological characters. Thus, in this work we recognize thirteen species of *Glutinoglossum*, seven of which

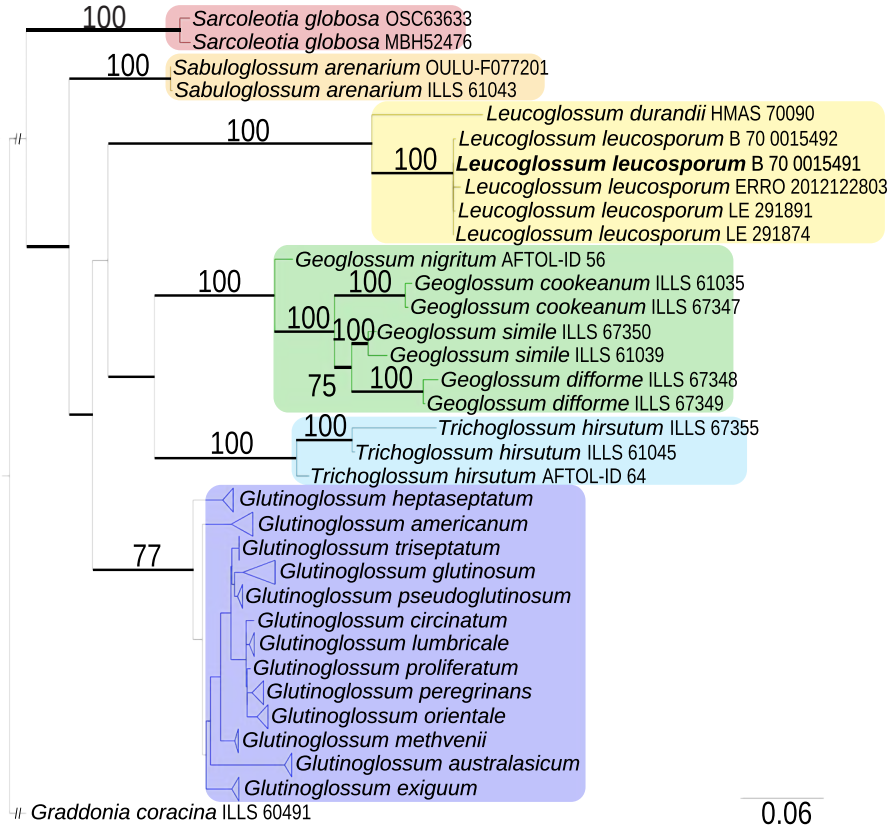

Fig. 1 Phylogenetic tree generated from maximum likelihood analysis based on ITS-LSU-*tef1* sequence data. Branches of *Glutinoglossum* subtree are collapsed. Numbers above branches indicate BS values > 70 %, thickened branches indicate PP value > 0.95. Affiliations to the genera are highlighted. Holotype is in **bold**. Scale bar represents the number of nucleotide changes per site.

are new. Below the description of the genus *Glutinoglossum* and descriptions of nine species distributed in Eurasia are given.

TAXONOMIC PART

Glutinoglossum Hustad et al., Persoonia 31: 104. 2013

Type species. *Glutinoglossum glutinosum* (Pers.) Hustad et al. (≡ *Geoglossum glutinosum* Pers.).

Ascocarps solitary, scattered, gregarious, subcaespitose, clavate, lanceolate, cylindrical-clavate, clavate-capitate, sometimes rudimentary bifurcated, stipitate, 10–75 mm high, dark brown, black, brown, glutinous, viscid. *Ascigerous part* clavate, lanceolate, cylindrical, capitate, 1/2–4/5 the total length of the ascocarp, black, dark brown. *Stipe* dark brown, black, usually slightly lighter than the ascigerous part. *Asci* narrowly clavate, clavate, cylindrical-clavate, 8-spored, arising from croziers, with inamyloid wall and euamyloid apical ring. *Ascospores* subfusiform, cylindrical, clavate, slightly curved, slow-maturing, initially hyaline and aseptate, becoming septate and coloured (pale brown to brown) in maturity, with one or several lipid drops in each cell, germinating by ovoid, subglobose or ellipsoid, pale brown, brown, one-celled conidia inside the asci. *Paraphyses* hyaline below, brown, pale brown to hyaline in the apical part, mostly straight, anastomosing in basal and middle parts, simple or sometimes branching, immersed in light brown or brown amorphous matrix in apical part. *Apical cells of paraphyses* cylindrical, slightly swollen, enlarged up to pyriform, globose, sometimes proliferating, incrusted. *Hyphae of stipe surface* mostly like paraphyses.

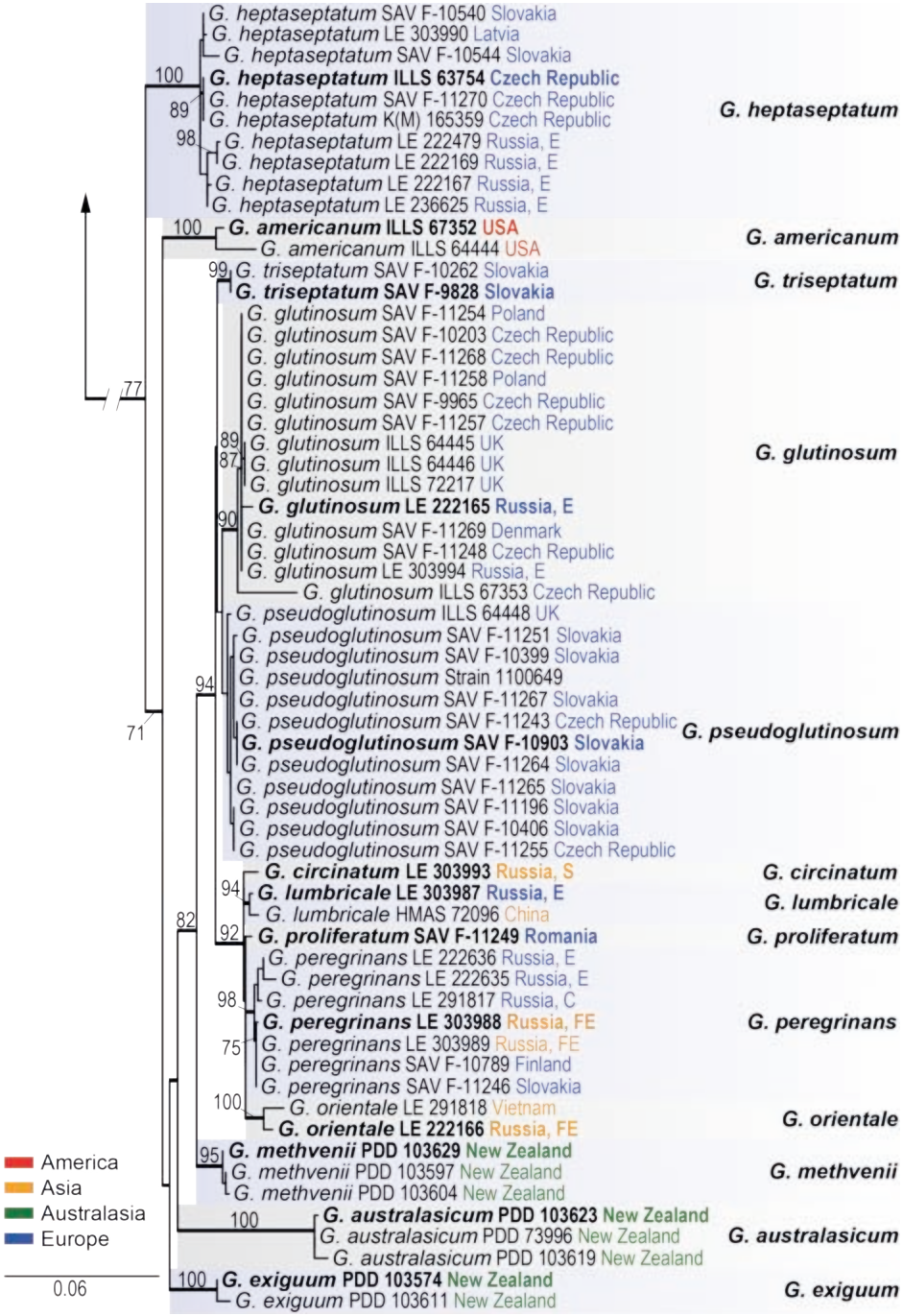

Fig. 2 Phylogenetic tree generated from maximum likelihood analysis based on ITS-LSU-*tef1* sequence data. Main subtree – the genus *Glutinoglossum*. Numbers above branches indicate BS values > 70 %, thickened branches indicate PP value > 0.95. Holotypes and epitype are in **bold**. The parts of Russia are abbreviated: C = the Caucasus Mountains; E = European part; FE = the Far East; S = Southern Siberia. Scale bar represents the number of nucleotide changes per site.

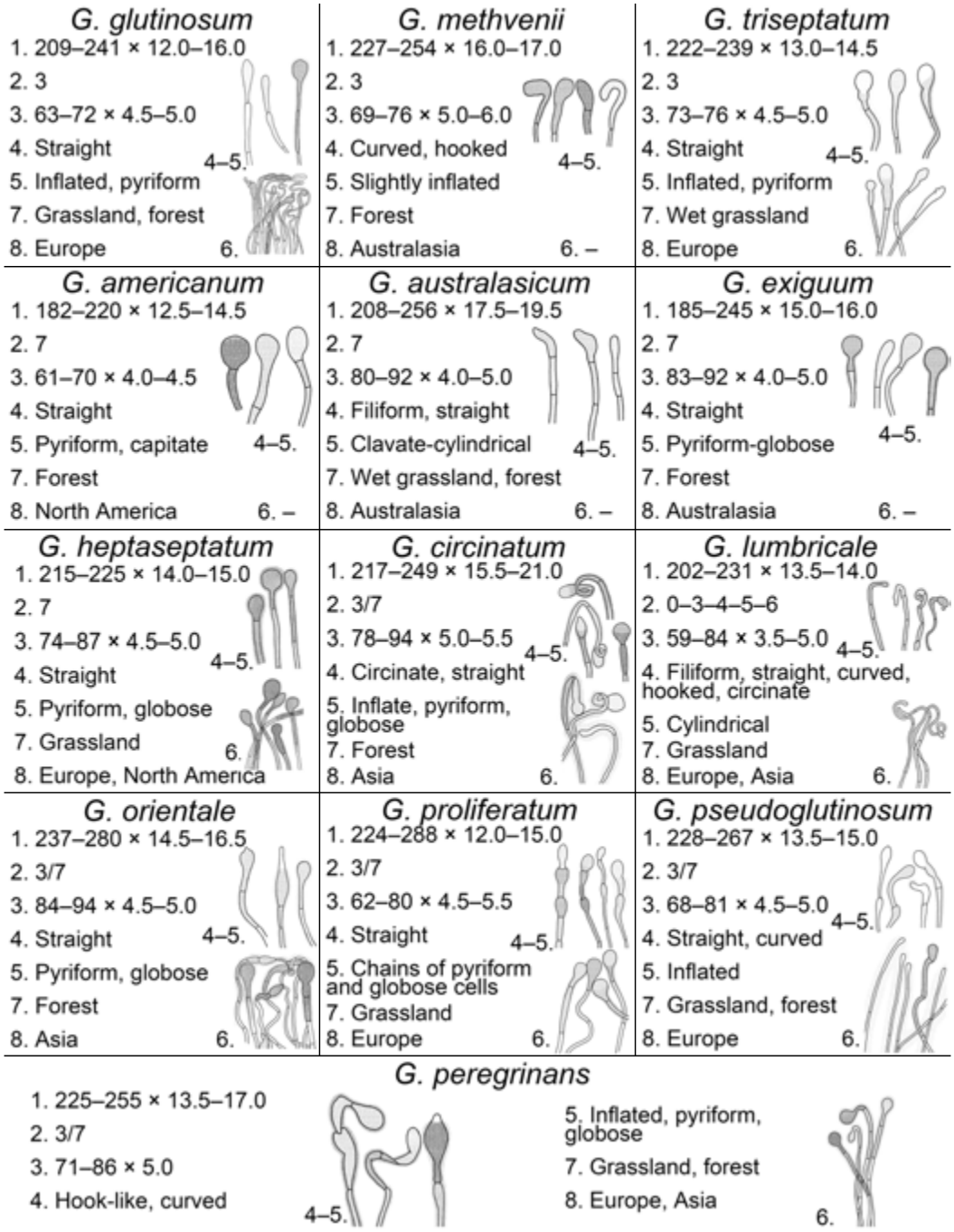

Fig. 3 Comparative table of *Glutinoglossum* species. Sequential numbers indicate main characters: 1 = size of asci (µm); 2 = predominantly number of septa of ascospores; 3 = size of ascospores (µm); 4 = apical part of paraphyses; 5 = apical cells of paraphyses; 6 = hyphae of stipe surface; 7 = habitat; 8 = distribution.

Habitat — On soil or rotten wood, often among mosses in grasslands, mixed or deciduous forests.

Distribution — The Northern and Southern Hemispheres.

Notes — The genus is characterized by dark coloured ascocarps, highly glutinous or viscid when fresh and nitid when dry; it has quite narrow asci and ascospores; ascospores slowly mature remaining pale brown for a long time; paraphyses are immersed in amorphous matrix and stick together, continuing beyond the hymenium down the stipe; apical cells of the paraphyses are mainly swollen, globose or pyriform. The main differences between species consist in form of paraphyses apices (chains of proliferating cells, filiform, circinate); in the number of septa in ascospores which are inside the mature asci; in size of spores and asci; in geography and ecology (Fig. 3).

While studying collections of *Glutinoglossum* formation of anastomoses in the basal and middle parts, branching of the apical part and proliferation of the apical cells of paraphyses by hyaline hyphae was noted (Fig. 4a–b, f–g).

One of the most important characters for delimitation of *Glutinoglossum* species is the number of septa that have ascospores contained inside the mature asci prior the discharge (Fig. 4h–j). Three groups of species based on this character can be distinguished. The first group includes species with only 3-septate ascospores, *G. glutinosum* and *G. triseptatum*. The second group consists of Eurasian species with 3- and 7-septate ascospores, *G. circinatum*, *G. lumbricale*, *G. orientale*, *G. peregrinans*, *G. proliferatum*, and *G. pseudoglutinosum*. The species possessing solely 7-septate ascospores form the third group (only *G. heptaseptatum* was examined morphologically in this study). It should be noted that the number of septa can increase after the ascospore discharge.

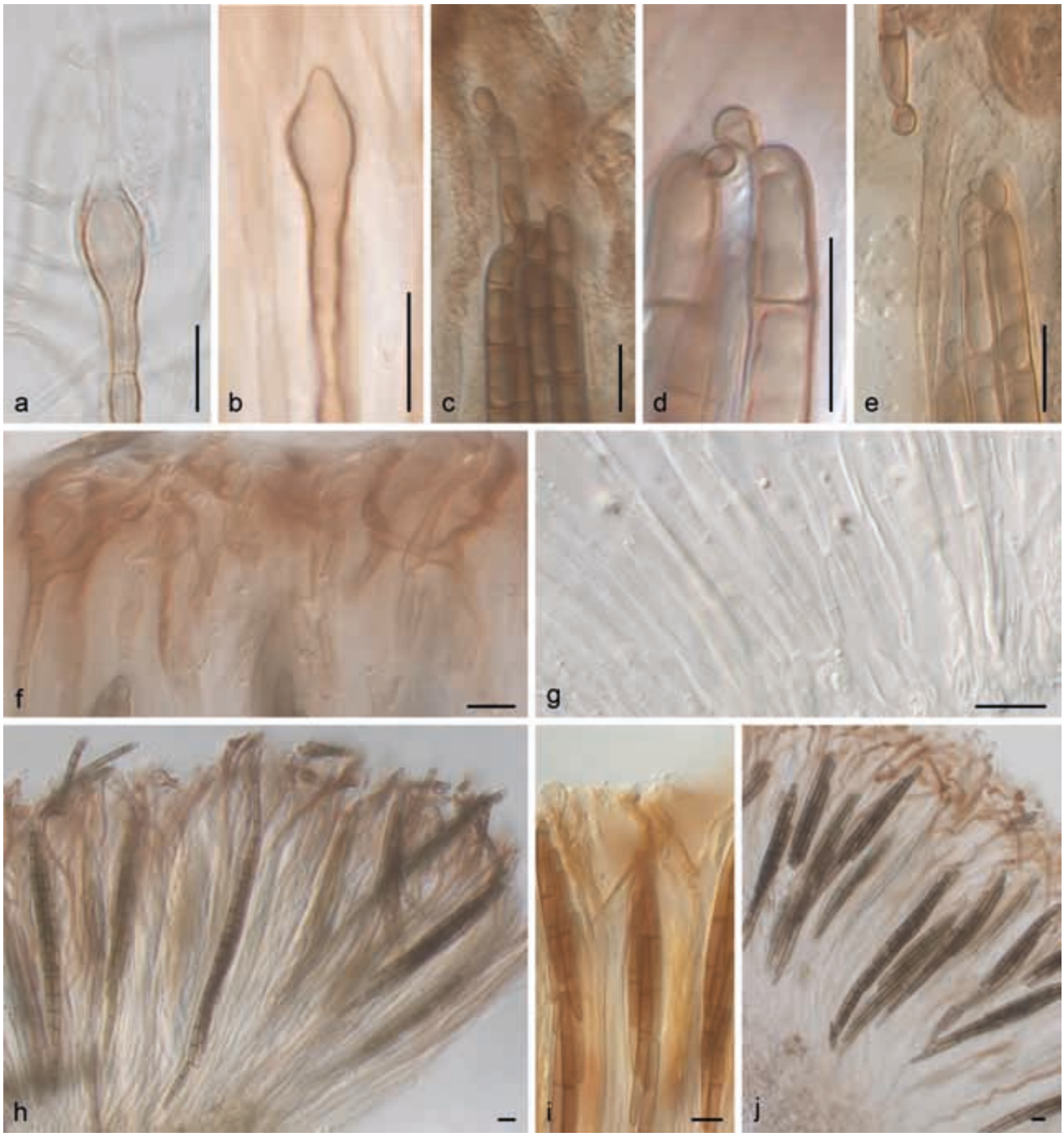

Fig. 4 Microscopic characters in *Glutinoglossum*. a–b. Proliferation of apical cells of paraphyses by hyaline hyphae: a. *G. circinatum* (LE 303993, holotype); b. *G. orientale* (LE 291818); c–e. ascospores germinating by conidia, *G. heptaseptatum* (LE 222167); f. branched apical part of paraphyses, *G. peregrinans* (LE 303988, holotype); g. anastomosis in the basal part of paraphyses, *G. orientale* (LE 222166, holotype); h. hymenium with only 7-septate ascospores inside asci, *G. heptaseptatum* (LE 222167); i. hymenium with only 3-septate ascospores inside asci, *G. glutinosum* (LE 222165, epitype); j. hymenium with 3- and 7-septate ascospores inside asci, *G. circinatum* (LE 303993, holotype). — Scale bars = 10 µm.

Key to species of Glutinoglossum

1. Mature asci contain ascospores predominantly 3-septate 2
1. Mature asci contain ascospores predominantly 3–7-septate 4
2. Paraphyses apically straight, curved and hooked elements present; ascospores 70–80 µm long. — Australasia . . . . . *G. methvenii**
2. Paraphyses apically straight, curved, without hook-like elements; ascospores 60–80 µm long. — Europe 3
3. Ascospores 60–70 µm long . . . . . 2. *G. glutinosum*
3. Ascospores 70–80 µm long . . . . . 9. *G. triseptatum*
4. Mature asci always contain ascospores with more than 3 septa 5
4. Mature asci contain both 3- and 7-septate ascospores . 8
5. Ascospores 60–70 µm long. — Northern Hemisphere (North America) . . . . . *G. americanum**
5. Ascospores longer. — Northern or Southern Hemisphere 6
6. In grasslands; ascospores 70–90 µm long. — Northern Hemisphere (Europe, North America) . . . . 3. *G. heptaseptatum*
6. In forests; ascospores 80–92 µm long. — Southern Hemisphere (Australasia) 7
7. Apical cells of paraphyses cylindrical to clavate-cylindrical . . . . . *G. australasicum**

7. Apical cells of paraphyses swollen, pyriform to globose . . . . . *G. exiguum**
8. Paraphyses apically hooked, curved or circinate. 9
8. Paraphyses apically straight or rarely slightly curved . 11
9. Apical cells of paraphyses mostly cylindrical; ascospores with varying number of septa, 60–84 µm long . . . . . 4. *G. lumbricale*
9. Apical cells of paraphyses mostly swollen, pyriform, globose; ascospores predominantly with 3- or 7-septa, 70–90 µm long 10
10. Paraphyses apically circinate, hooked, curved; ascospores 80–90 µm long . . . . . 1. *G. circinatum*
10. Paraphyses apically hooked, curved, without circinate elements; ascospores 70–85 µm long. . . 6. *G. peregrinans*
11. Paraphyses apically with chains of pyriform and globose cells . . . . . 7. *G. proliferatum*
11. Paraphyses apically with single pyriform, globose, cylindrical or hooked cells. 12
12. Ascospores 68–81 µm long; gelatinous coating covering hyphae of stipe surface conspicuous; stipe with mucilaginous layer in fresh condition. — Europe . . . . . 8. *G. pseudoglutinosum*
12. Ascospores 83–94 µm long; gelatinous coating covering hyphae of stipe surface inconspicuous; stipe without mucilaginous layer in fresh condition. — Asia. . 5. *G. orientale*

The characters of species marked with an asterisk (*) are taken from Hustad & Miller (2015). The distribution of *G. glutinosum* is given according to data confirmed by studied herbarium specimens or available molecular data (see notes on *G. glutinosum*). The distribution of *G. heptaseptatum* in North America is based on molecular data only.

1. *Glutinoglossum circinatum* Fedosova, *sp. nov*. — MycoBank MB818531; Fig. 4a, j, 5, 6f

Etymology. The epithet refers to the apically curved or circinate paraphyses.

Holotype. Russia, Krasnoyarsk Territory, Yermakovsky District, Sayano-Shushensky State Nature Biosphere Reserve, Ranger station Kerema, right side of the River Bolshaya Kerema, N52°07'07.4" E92°13'33.9", mixed forest with fern, moss and herb, on a gentle slope, on soil, 23 Aug. 2015, *A.G. Fedosova* (LE 303993).

Ascocarps solitary, lanceolate, stipitate, 28 mm high, dark brown, glutinous. *Ascigerous part* clavate, 1/4 the total length of the ascocarp, 7 mm long, dark brown up to black, dumbbell-shaped to oval in cross section, transition zone delimited by form and colour, surface in dry material smooth, ceraceous, sometimes tomentose due to prominent paraphyses protruding from the hymenium. *Stipe* dark brown, slightly lighter than the ascigerous part, compressed, oval with ribs in cross section, surface in dry material smooth, nitid. *Asci* narrowly clavate, (217–)232.3(–249) × (15.5–)17.6(–21) µm, Q = (11.8–)13.4(–14.7). *Ascospores* subfusiform, cylindrical, (78–)84.6(–94) × (5–)5.1(–5.5) µm, Q = (14–)16.6(–19.3), pale brown, (0–)3(5–6)7-septate. *Paraphyses* hyaline below, pale brown up to hyaline in the apical part, straight, moderately septate, (2–)2.9(–3.5) µm diam, in apical part straight, hooked, curved, or circinate. *Apical cells of paraphyses* cylindrical, swollen to pyriform, (14–)23.5(–51.5) × (3–)7.9(–10.5) µm, brown, pale brown to hyaline. *Hyphae of stipe surface* hyaline below, brown to hyaline in the apical part, moderately septate, straight, curved to circinate, apical cells cylindrical, swollen, or pyriform.

Habitat — On soil in mixed forest.

Known distribution — Russia (Siberia).

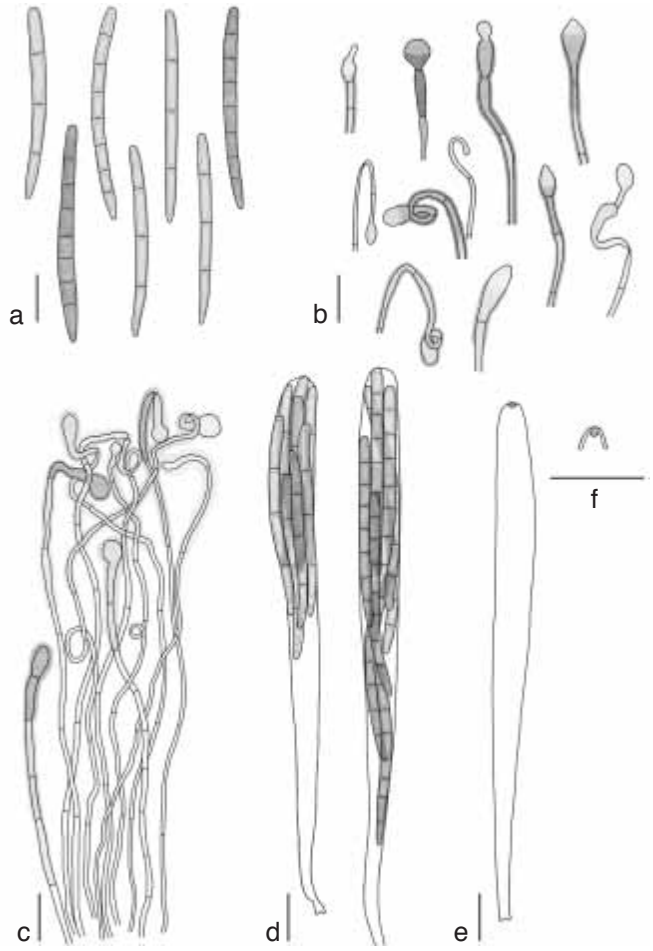

Fig. 5 *Glutinoglossum circinatum* (LE 303993, holotype). a. Ascospores; b. apical part of paraphyses; c. hyphae of stipe surface; d. asci with 3- and 7-septate ascospores inside; e. inamyloid reaction of ascus, with euamyloid apical ring; f. ascus apical ring in IKI. — Scale bars = 20 µm.

Notes — *Glutinoglossum circinatum* belongs to the group of species which has mature asci with 3- and 7-septate ascospores inside. Among the other species of the group *G. circinatum* can be recognized by its relatively long ascospores (78–94 µm), more broad asci (15.5–21 µm), circinate and curved elements in the apical part of paraphyses and hyphae of stipe surface (Fig. 3).

2. *Glutinoglossum glutinosum* (Pers.) Hustad et al., Persoonia 31: 104. 2013. — Fig. 4i, 6a, 7

Basionym. *Geoglossum glutinosum* Pers., Observ. Mycol. 1: 11. 1796.

Synonyms. *Cibalocoryne* (as '*Cibarocoryne*') *glutinosa* (Pers.) S. Imai, Bot. Mag. (Tokyo) 56: 525. 1942.

Gloeoglossum glutinosum (Pers.) E.J. Durand, Ann. Mycol. 6 (5): 419. 1908.

Neotype. Assumed to be collected in Europe (L 0110938, Herb. Persoon)!, designated by Durand (1908) (first-step) and Hustad et al. (2013) (second-step) (Fig. 8a). *Epitype* designated here: Russia, Leningrad Region, Priozersky District, Otradnoye, forb meadow with moss, on soil, Sept. 1998, *O.V. Morozova* (LE 222165), MycoBank MBT373122.

Geoglossum glutinosum var. *lubricum* Pers., Mycol. Eur. 1: 197. 1822.

Lectotype designated here: 'in Pascuis montosis circa Bruyerium autumnio. Mis. Mougeot in Hb. Pers.' (L 0110962, Herb. Persoon)!, MycoBank MBT378950 (Fig. 8b).

Ascocarps solitary to gregarious, clavate to lanceolate, stipitate, 20–40 mm high (dry material), dark brown up to black, glutinous. *Ascigerous part* clavate, 1/4–1/2 the total length of the ascocarp, 4–14 mm long, black, compressed, dumbbell-shaped to oval in cross section, transition zone delimited by

Fig. 6 *Glutinoglossum* species. a. *G. glutinosum* (SAV F-11248); b. *G. pseudoglutinosum* (LE 304022, SAV F-11289); c. *G. heptaseptatum* (LE 303990); d. *G. orientale* (LE 222166, holotype); e. mucilaginous layer covering stipe of *G. pseudoglutinosum* (LE 304022, SAV F-11289); f. *G. circinatum* (LE 303993, holotype); g. *G. peregrinans* (LE 303988, holotype); h. *G. peregrinans* (LE 303989). — Scale bars = 10 mm. — Photos: a. J. Gaisler; b–c, e–h. A.G. Fedosova; d. E.S. Popov.

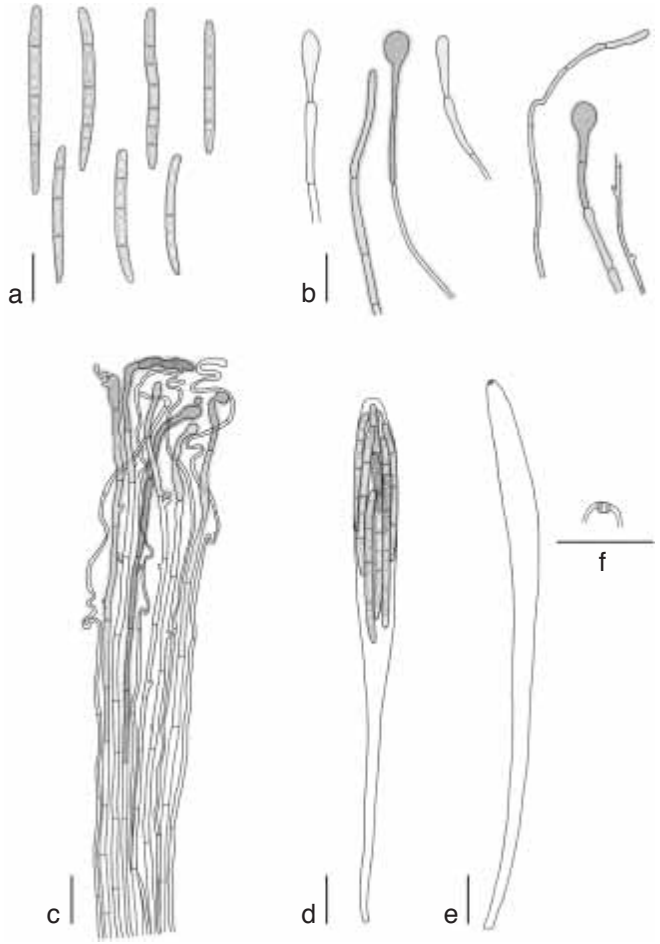

Fig. 7 *Glutinoglossum glutinosum* (LE 222165, epitype). a. Ascospores; b. apical part of paraphyses; c. hyphae of stipe surface; d. ascus with 3-septate ascospores inside; e. inamyloid reaction of ascus, with euamyloid apical ring; f. ascus apical ring in IKI. — Scale bars = 20 µm.

form, colour, and surface, surface in dry material smooth, ceraceous, sometimes alveolate. *Stipe* dark brown, slightly lighter than ascigerous part, terete or compressed, with ribs in cross section, surface in dry material smooth, ceraceous, nitid. *Asci* narrowly clavate, (180–)209.3–241.2(–283.5) × (9–)12.2–15.9(–19) µm, Q = (10.8–)14.6–18.3(–24.5). *Ascospores* subfusiform, elongate-clavate, cylindrical, narrowed to one end, sometimes slightly curved, (47–)63–71.8(–87) × (3.5–)4.6–5.1(–5.5) µm, Q = (9.4–)12.4–14.9(–19.3), pale brown up to brown, (0–)3(–7)-septate. *Paraphyses* hyaline below, brown, pale brown to hyaline in the apical part, straight, rarely, moderately or frequently septate, (2–)2.6–3.4(–5.5) µm diam, in apical part straight, sometimes curved. *Apical cells of paraphyses* cylindrical, slightly swollen up to pyriform and globose, sometimes proliferate, (8–)16.3–24.3(–45) × (4–)5.9–9.8(–13) µm, brown, pale brown to hyaline. *Hyphae of stipe surface* hyaline below, brown to hyaline in the apical part, moderately septate, straight, curved, hooked, apical cells cylindrical or swollen.

Habitat — On soil in deciduous forests and wet meadows with moss, most commonly on acidic bedrock.

Known distribution — Czech Republic, Denmark, France, Germany, Poland, Russia (European part), UK (Hustad et al. 2013, Hustad & Miller 2015, this paper).

Additional specimens examined. Czech Republic, Ještědsko-kozákovský hřbet, Frýdštejn, c. 100 m S of the bus station, Sestroňovice direction, N50°38'59.932" E15°8'38.971", alt. 462 m, E exp. slope, bedrock sandstone, mowed mesophilic meadow with *Agrostis capillaris*, *Festuca rubra*, *Plantago lanceolata*, on soil, 3 Nov. 2013, *J. Gaisler* (SAV F-11257); ibid., 9 Nov. 2013, *J. Gaisler* (SAV F-11248); Ještědsko-kozákovský hřbet, Machnín, 50 m S of Hamrštejn castle ruins, N50°47'10.99" E14°58'14.86", alt. 348 m, S exp. slope, bedrock metamorphic – phyllite, broadleaf forest with *Carpinus betulus*, *Betula pendula*, *Fraxinus* sp., on soil, 10 Sept. 2010, *V. Kučera* (SAV F-9965); ibid., 10 Sept. 2010, *V. Kautman* (SAV F-10203); Šumava Mts, Vimperk-arboretum, alt. 725 m, among grass, on soil, 5 Oct. 2012, *Z. Trojánková* (SAV F-11268); Třeboň region, c. 1.7 km NWW of the centre of Vlkov, shore of Malý Horusický rybník, N49°09'12.4" E14°42'05.6", alt. 421 m, mowed meadow, on soil, 16 Oct. 2016, *V. Kučera* & *A.G. Fedosova* (LE 304024, SAV F-11287). – Denmark, Dragør near Copenhagen, on fen meadow in coastal area, among grass and mosses, 13 Oct. 2007, *I. Kautmanová* (SAV F-11269). – (France, Vosges, Alsace), in herbidis sylvarum, autumno (Mougeot & Nestler, Stirp. Crypt. Vog.-Rhen. VIII, №780, as *Geoglossum glutinosum* b. *lubricum*) (LE 179513). – (Germany, Free State of Saxony), pr. Driesen, in collibus sylvaticis, *Lasch*. (Rabenhorst, Klotzschii Herb. Viv. Mycol. Ed. II, №319, as *Geoglossum glutinosum*) (LE 179511, LE 179515); s.l., in graminosis, Aest. – Auct., *Lasch.* (Rabenhorst, Klotzschii Herb. Viv. Mycol. Ed. I, № 641, as *Geoglossum glutinosum*) (LE 179514). – Poland, Góry Izerskie, Jakuszyce, near bike trail between Jakuszyce and Szklarska Poręba, c. 1.4 km NE of Leśniczówka hut, N50°49'48.7" E15°27'34.8", alt. 825 m, S exp. slope, bedrock granite, mowed mesophilic meadow with *Agrostis capillaris*, *Festuca rubra*, *Prunella vulgaris*, on soil, 9 Oct. 2012, *J. Gaisler* (SAV F-11258); ibid., 10 Nov. 2013, *J. Gaisler* (SAV F-11254). – Russia, Leningrad Region, Priozersky District, Otradnoye, N60°49'9" E30°13'16.8", forb meadow, on soil, 2001, *A.E. Kovalenko* & *O.V. Morozova* (LE 222477); Republic of Tatarstan, Zelenodolsky District, Volzhsko-Kamsky State Nature Biosphere Reserve, arboretum, on soil, 13 Sept. 2015, *K.O. Potapov* (LE 303994).

Notes — *Glutinoglossum glutinosum* is an easily recognizable species characterized by very short (63–72 µm) 3-septate ascospores, straight paraphyses with swollen apical cells, thin hyphae of stipe surface with mainly cylindrical apical cells (Fig. 3).

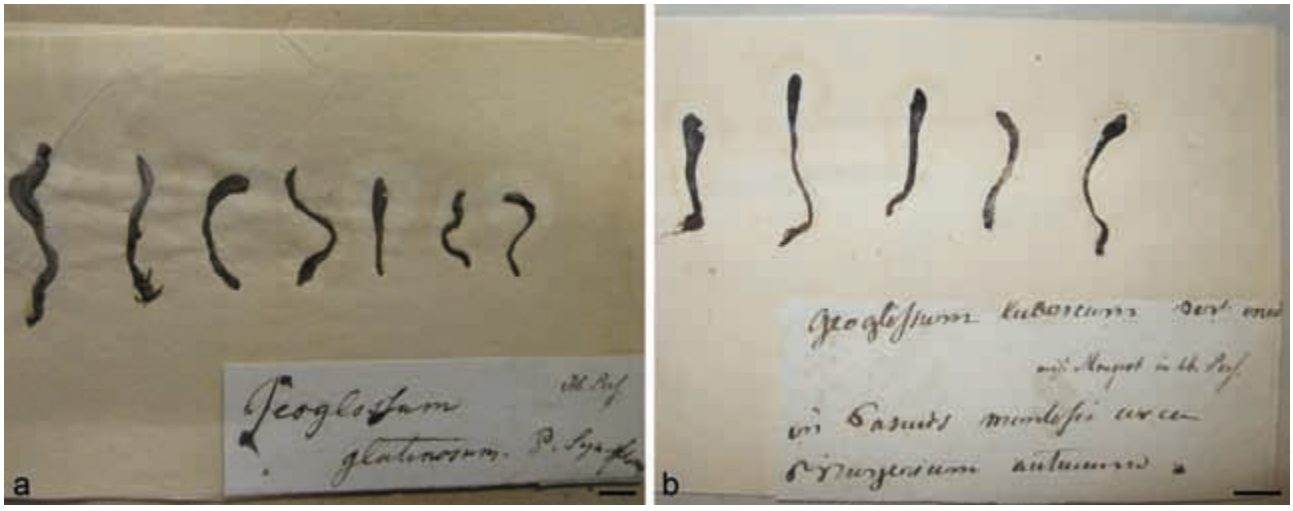

Fig. 8 Lectotypes. a. *Geoglossum glutinosum* (L 0110938); b. *G. glutinosum* var. *lubricum* (L 0110962). — Scale bars = 10 mm.

Glutinoglossum glutinosum prefers acidic bedrock what appears as an important ecological character of this species.

Application of the molecular approach to the genus *Glutinoglossum* resulted in reconsideration of the morphological characters, geographical patterns, and ecological preferences used for delimitation of the species. Worldwide distribution and wide range of quantitative characters such as size of asci or ascospores specified for *G. glutinosum* indicated that the name may be used to refer to several different species. Recently three Australasian and one American species of *Glutinoglossum* were delimited in *G. glutinosum* species complex (Hustad & Miller 2015), and additional Eurasian taxa in this study are described. Thus, in distribution of *G. glutinosum* we mentioned only those countries from which we have examined herbarium specimens or molecular data.

Neotype of *Geoglossum glutinosum* (L 0110938) is represented by seven ascocarps. *Ascocarps* clavate, lanceolate, stipitate, 22–47 mm high, dark brown up to black. *Ascigerous part* clavate, less than 1/2 the total length of the ascocarp, black, transition zone sharply delimited by form and colour in some ascocarps and not delimited in others. *Stipe* dark brown, slightly lighter than ascigerous part. Description and illustrations of microcharacters were given by Durand (1908).

In the protologue of *G. glutinosum* Persoon (1796) did not mention any specimen for this species while locality as 'prope Osterode' was referred. Durand studied Persoon's material kept in L and in his work (1908) cited a specimen of *G. glutinosum* as 'Type: European, in herb. Persoon, at Leiden'. According to the Art. 9.17 of the International Code of Nomenclature for algae, fungi, and plants (ICN) (McNeill et al. 2012), Durand designated the material as (first-step) neotype. The second-step of neotypification was made by Hustad et al. (2013) when number of the specimen was published. The misapplication of the term 'holotype' (Hustad et al. 2013) to denote what is in fact a neotype treated as an error to be corrected (Art. 9.9 of ICN) (McNeill et al. 2012). *Glutinoglossum glutinosum* is a type species of the genus. In order to be applied in the taxonomy of the geoglossoid fungi, the type specimen of *G. glutinosum* should be univocal and be available for critically identification. Since the neotype of *G. glutinosum* is very old and not available for molecular study we designate the epitype. Epitype selection is based on analysis of available good preserved material and its comparison with the photographs, drawings, and notes on microcharacters of neotype preserved at Leiden made by Durand. The epitype specimen has clearer morphological characters as well as ITS and LSU sequenced.

Lectotype of *Geoglossum glutinosum* var. *lubricum* (L 0110962) is represented by five ascocarps. Ascocarps lanceolate, stipitate, 25–35 mm high, black. Ascigerous part clavate, 1/4–1/3 the total length of the ascocarp, black, transition zone sharply delimited by form. Stipe black. For description and illustrations of microcharacters of the specimen see Durand (1908).

Describing *Geoglossum glutinosum* var. *lubricum*, Persoon (1822) mentioned 'in Vogesia' as a habitat of the new variety. The one specimen of this variety (as '*Geoglossum lubricum*') kept in Persoon's Herbarium (L) was collected by Mougeot near 'Bruyerium' (Lorraine, Vosges, Bruyères). We suppose the specimen represents the original material of *Geoglossum glutinosum* var. *lubricum* but it is uncertain if it was the only specimen used by Persoon for the description of the new variety. Therefore, the specimen L 0110962 is selected as a lectotype.

3. *Glutinoglossum heptaseptatum* Hustad et al., Persoonia 31: 105. 2013 — Fig. 4c–e, h, 6c, 9

Holotype. Czech Republic, Hradec Králové, Betlem, moist pasture with moss, 20 Oct. 2010, *J. Gaisler* (ILLS 63754).

Synonym. *Geoglossum glabrum* var. *majus* Weinm., Hymen. Gasteromyc.: 497. 1836.

Lectotype designated here: 'Sylva Gor., 15 Sept. 1820' (LEP)!, MycoBank MBT378955 (Fig. 10).

Ascocarps solitary to gregarious, caespitose, clavate, lanceolate, sometimes rudimentary bifurcated, stipitate, 20–40 mm high, black up to dark brown, glutinous. *Ascigerous part* clavate to capitate, 1/7–1/2 the total length of the ascocarp, 2–13 mm long, black, compressed, dumbbell-shaped, or oval in cross section, transition zone delimited by form and surface, surface in dry material smooth, ceraceous, nitid. *Stipe* black, dark brown at the top up to brown below, terete, compressed, or dumbbell-shaped in cross section, surface in dry material smooth, ceraceous, nitid, sometimes with papillae and ribs. *Asci* narrowly clavate, (195–)215.3–225.3(–260) × (12–)14–15(–16) µm, Q = (13–)14.9–15.9(–19.6). *Ascospores* subfusiform, elongate-subclavate, cylindrical, sometimes curved, (65–)74.3–86.6(–105) × (4–)4.6–5(–6) µm, Q = (13.6–)15.3–17.1(–21), pale brown up to brown, (0–)7(–11)-septate, germinating by ovoid, subglobose or ellipsoid, pale brown up to brown, one-celled conidia (3.5–)4.6(–7) × (2.5–)3(–3.5) µm, Q = (1.2–)1.6(–2.4) inside the asci. *Paraphyses* hyaline below, brown, pale brown to hyaline in the apical part, straight, frequently or moderately septate, (1.5–)2.9–3.3(–5) µm diam, in apical part straight, seldom curved. *Apical cells of paraphyses*

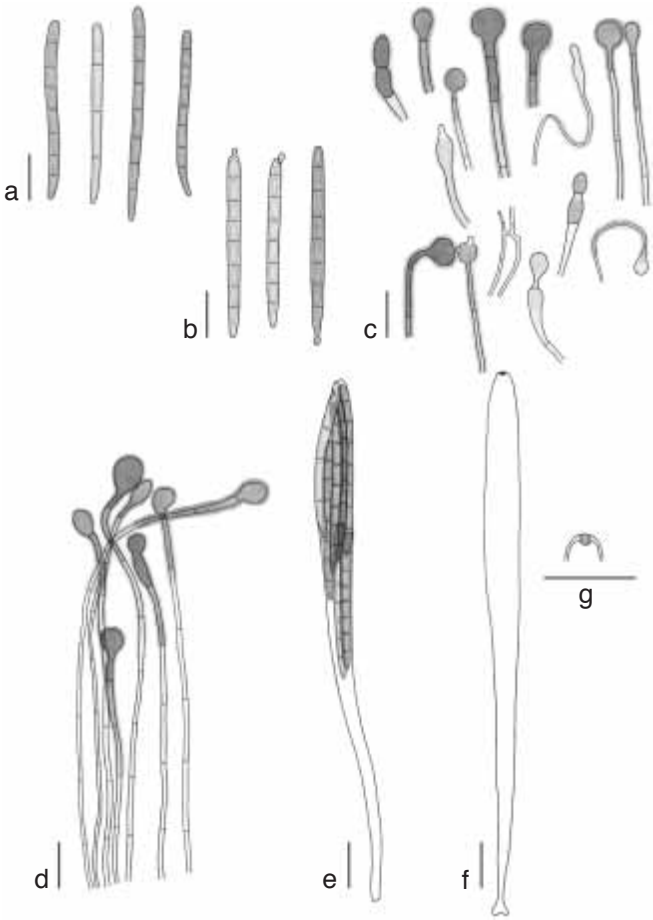

Fig. 9 *Glutinoglossum heptaseptatum* (LE 222167). a. Ascospores; b. ascospores germinating by conidia; c. apical part of paraphyses; d. hyphae of stipe surface; e. ascus with 7-septate ascospores inside; f. inamyloid reaction of ascus, with euamyloid apical ring; g. ascus apical ring in IKI. — Scale bars = 20 µm.

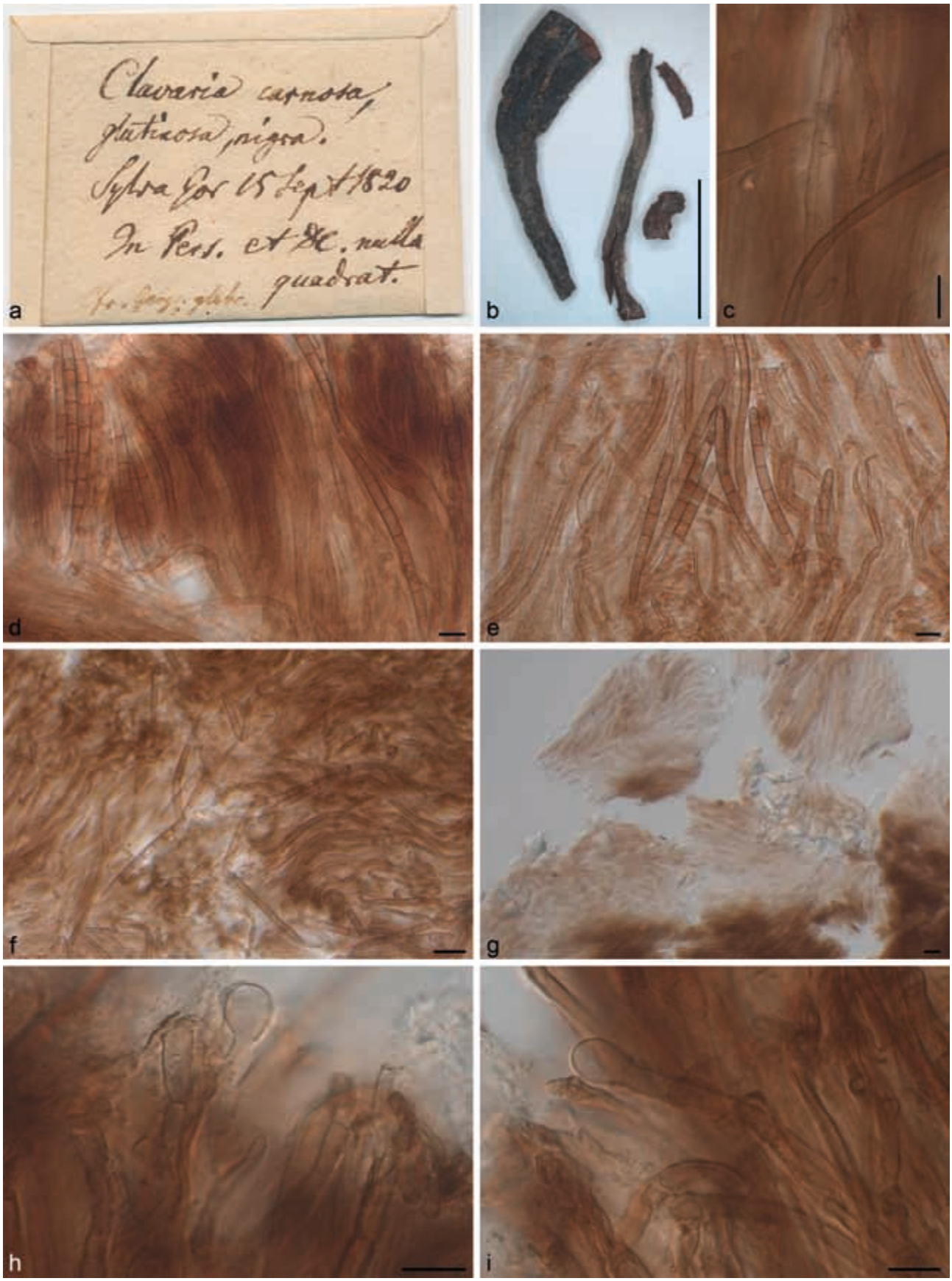

Fig. 10 Lectotype of *Geoglossum glabrum* var. *majus* (LEP). a. Envelope with label; b. ascocarp; c. anastomosis in the middle part of paraphyses; d–f. ascospores; g. hyphae of stipe surface; h–i. apical cells of paraphyses. — Scale bars: b = 10 mm; c–i = 10 µm.

swollen, pyriform up to globose, sometimes with rostrate projection, cylindrical in immature material, sometimes proliferate, (8.5–)15.8–26.8(–51.5) × (3.5–)6.7–10.5(–15.5) µm, brown, pale brown up to hyaline. *Hyphae of stipe surface* hyaline below, brown to hyaline in the apical part, frequently or moderately septate, straight, sometimes curved, apical cells swollen, globose, or pyriform.

Habitat — On soil in various types of meadows.

Known distribution — Czech Republic, Latvia, Russia (European part), Slovakia, USA (Hustad et al. 2013, Hustad & Miller 2015, Kučera et al. 2015, this paper).

Additional specimens examined. Czech Republic, Český les Mts, Lesná, c. 5 km NW of the village centre, Pavlova Huť nature reserve, N49°46'51.85" E12°28'20.73", alt. 759 m, 19 Oct. 2012, *V. Kučera* (SAV F-11270); Třeboň region, c. 1.7 km NWW of the centre of Vlkov, shore of Malý Horusický rybník, N49°09'12.4" E14°42'05.6", alt. 421 m, mowed meadow, on soil, 16 Oct. 2016, *A.G. Fedosova* & *V. Kučera* (LE 304023, SAV F-11288). – Latvia, Talsi District, Medze parish, Šķēde, Mežmāja, in a ditch by the roadside, N57°14'55.35" E22°41'29.74", in short grass, on soil, 23 Sept. 2014, *A.G. Fedosova* (LE 303990). – Russia, Karelia, Kivach, inter *Marchantias*, Aug. 1936, *R. Singer* & *M.V. Freindling* (LE 179529); Leningrad Region, Vyborg District, Berezovye Islands Zakaznik, Bolshoi Berezovyi Island (Koivistonsaari), Peschanomysskaya bay, maritime *Calamagrostis* meadows, on soil, 2 Oct. 2005, *O.V. Morozova* (LE 236625); ibid., Kirovsky District, near Muya, road to Turyshkino station, N59°38'20.4" E31°14'23.9", meadow, on soil, 2 Sept. 2004, *E.S. Popov* (LE 222167); ibid., Turyshkino station, N59°41'23.3" E31°14'31", meadow, on soil, 2 Sept. 2004, *E.S. Popov* (LE 222169); ibid., Priozersky District, Otradnoye, near cemetery, N60°49'15" E30°13'28", pasture, on soil, 7 Oct. 1995, *E.A. Fomina* (LE 222479); Pskov Region, Loknyansky District, near Bashovo, Kozlovka, N56°39'21.5" E30°09'20.2", *Calamagrostis* meadow, on soil, 13 Oct. 2003, *E.S. Popov* (LE 303991). – Slovakia, Stolické vrchy Mts, Muránska Zdychava, c. 2.6 km N of the village, Karafová, N48°45'40.13" E20°08'26.38", alt. 649 m, fen meadow with *Eriophorum* sp., *Salix* sp. and mosses, 21 Sept. 2012, *V. Kučera* (SAV F-10540, SAV F-10544); Veľká Fatra Mts, c. 500 m NWW of the centre of Rojkov, Rojkovské rašelinisko National reserve, N49°08'54.7" E19°09'17.4", alt. 438 m, peat bog, on soil, 2 Oct. 2016, *V. Kučera* & *A.G. Fedosova* (LE 304021).

Notes — *Glutinoglossum heptaseptatum* belongs to the group of species with predominantly 7-septate ascospores. This is the only species with such character known in Eurasia at the moment. Moreover, *G. heptaseptatum* is characterized by stout, straight paraphyses, with apical cells usually broad (6.7–10.5 µm), mainly pyriform or globose, immersed in well-developed brown amorphous matrix. Among other *Glutinoglossum* species with 7-septate ascospores *G. heptaseptatum* stands out by habitat. All known finds of this species (ascocarps) originate from different types of grasslands in Europe excepting ITS sequences obtained from soil in a restored grassland-savanna in the Cedar Creek Natural History Area, Minnesota, USA (Hustad & Miller 2015).

While studying one of the specimens of *G. heptaseptatum* (LE 222167) pale brown 7-septate ascospores germinating by ascoconidia were observed inside the asci (Fig. 4c–e, 9b). It was not reported for *Glutinoglossum* before, however, this phenomenon was observed earlier in other genera of the family *Geoglossaceae*, namely *Geoglossum fallax* (Arauzo & Iglesias 2014), *Hemileucoglossum alveolatum* (Prasher & Sharma 1997, Arauzo & Iglesias 2014), *H. littorale* (Arauzo & Iglesias 2014), *Leucoglossum leucosporum* (Arauzo & Iglesias 2014, Fedosova & Kovalenko 2015) and *Nothomitra sinensis* (Zhuang & Wang 1997). It seems the phenomenon is common across the family.

Lectotype of *G. glabrum* var. *majus* (LEP) (Fig. 10) is represented by one broken ascocarp. *Ascocarp* lanceolate, stipitate, black. *Ascigerous part* clavate, black, oval in cross section, transition zone sharply delimited by form, surface in dry material ceraceous, smooth. *Stipe* black, compressed in cross section, surface in dry material ceraceous. *Asci* 8-spored, collapsed. *Ascospores* subfusiform, elongate-subclavate, cylindrical, sometimes curved, (63–)73.4(–85) × (4–)4.8(–5.5) µm, Q = (13.2–)15.5(–18), pale brown to brown, (5–)7-septate. *Paraphyses* brown, straight, frequently or moderately septate, (2.5–)4.1(–6) µm diam, in apical part straight, immersed in brown amorphous matrix. *Apical cells of paraphyses* swollen, pyriform, globose, many are collapsed, (9–)12.2(–17) × (7.5–)8.4(–10) µm, brown to pale brown, incrusted. *Hyphae of stipe surface* hyaline below, brown to hyaline in the apical part.

We consider the specimen kept in LEP represents *G. heptaseptatum* due to certain microscopic characters and brief information about vital characters ('glutinosa, nigra') on the label. The ascospores of the specimen are predominantly 7-septate, the range of ascospore size corresponds to *G. heptaseptatum*, paraphyses are stout and robust with globose or pyriform apical cells, stipe surface contains more or less long brown and hyaline hyphae. The species of the *G. glabrum* group have the apical part of paraphyses and hyphae of stipe surface formed by chains of several inflated cells (up to 5) unlike *G. heptaseptatum* with only apical cells of paraphyses inflated. All aforementioned characters of the lectotype of *G. glabrum* var. *majus* fit very well with *G. heptaseptatum*.

Weinmann (1836) in his description of *G. glabrum* var. *majus* pointed out with reference to a letter of Dr. Goldbach that the fungus occurs in autumn in dry mossy meadows near Moscow, but he did not cite any specimen. In the Mycological Herbarium of LEP we found a specimen labelled 'Clavaria carnosa, glutinosa, nigra. Sylva Gor 15 Sept. 1820. In Pers. et DC. nulla quadrat.' in Goldbach's handwriting and annotated in another hand 'Cfr. Geogl. glabr.' (Fig. 10a). We consider that 'sylva Gor' means 'sylva Gorenkiensis', a part of Count Alexei Razumovsky's Gorenki estate (now within the city of Balashikha near Moscow) where Goldbach worked on his dissertation (Fischer 1855). One more fact confirming affinity of this specimen with Goldbach is its mention in the revision of fungi from the vicinity of Moscow by Bucholtz (1897). Bucholtz treated the specimen as *Geoglossum ophioglossoides* citing 'Goldb. exs. Silva Gorenki 15 Nov. 1820' and adding 'Exs. Goldb. 46, Praep. № 42'. We suppose wrong designation of month is a misspelling. We also assume that Goldbach's material could be divided into parts: the one was sent to Weinmann in Pavlovsk (now part of Saint Petersburg), and the other was left by Goldbach in his own herbarium in Moscow. Bucholtz is known to be graduated from Moscow University (Parmasto 2010, Pfister 2010) where the main part of Goldbach's herbarium is kept (Bucholtz 1897, Sokoloff et al. 2002). Moreover, Bucholz unequivocally indicated the place of work as 'Moskau, Bot. Garten der Universitat'. We tried to find this part of Goldbach's collection in the department of Mycology and Algology of the Moscow State University (MW) but had not been succeeded yet. Another part of Goldbach's material which was used by Weinmann for variety description probably belonged to the part of fungi which was deposed to the Herbarium of the Imperial Academy of Sciences (in Saint Petersburg, now LE) (Weinmann 1836). We suppose the lectotype of *Geoglossum glabrum* var. *majus* could be deposed in LEP by Jaczewski who worked in the Imperial Botanical Garden (now part of LE). In 1897 he established phytopathological laboratory, however, in 1905 he left the Botanical Garden and during 1905–1907 worked at home with a personal library and herbarium (Berestetskaja 2013) which could contain some specimens from the herbarium of the Imperial Botanical Garden. In 1907 Jaczewski founded the Bureau of Mycology and Phytopathology (now LEP) which included the mycological herbarium based on the personal Jaczewski's collection (Berestetskaja 2013). We suppose that the specimen kept in LEP belongs to the original material of *G. glabrum* var. *majus*, and here we designate this specimen as lectotype of *G. glabrum* var. *majus* to stabilize the name.

4. *Glutinoglossum lumbricale* Fedosova, *sp. nov*. — MycoBank MB818536; Fig. 11

Etymology. The epithet comes from the Latin name of earthworms and refers to the thin interwoven paraphyses reminding of earthworms.

Holotype. Russia, Novgorod Region, Batetsky District, near Peredolskaya station, Novoe Ovsino, near railway, N58°29'57.7" E30°17'4.4", alt. 46 m, unfertilized grassland (*Calamagrostis epigeios*, *Taraxacum officinale*, *Alchemilla vulgaris* s.lat., *Fragaria viridis*), on a gentle slope, on soil, 19 Oct. 2013, *A.G. Fedosova* (LE 303987).

Ascocarps solitary, clavate, rudimentary bifurcated, stipitate, 17 mm high, black, glutinous. *Ascigerous part* cylindrical, 1/3 the total length of the ascocarp, 6 mm long, black, compressed in cross section, transition zone poorly delimited, surface in dry material smooth, ceraceous. *Stipe* black, compressed in cross section, surface in dry material smooth, ceraceous, nitid. *Asci* narrowly clavate, (201.5–)217.2(–230.5) × (13.5–)13.8(–14) µm, Q = (14.4–)15.8(–16.9). *Ascospores* subfusiform, cylindrical, slightly curved, (58.5–)73.9(–84) × (3.5–)4(–5) µm, Q = (14.1–)18.5(–24.2), pale brown, seldom brown, 0–6-septate. *Paraphyses* hyaline below, pale brown to hyaline in the apical part, straight, moderately or frequently septate, (2–)2.8(–4) µm diam, in apical part filiform, straight, hooked, curved, or circinate, interwoven. *Apical cells of paraphyses* cylindrical, narrow, seldom slightly swollen, (16–)20.4(–29.5) × (2–)3.7(–6.5) µm, pale brown to hyaline. *Hyphae of stipe surface* hyaline below, brown to hyaline in the apical part, moderately septate, straight, hooked, curved, or circinate, interwoven, sometimes branched in the apical part, apical cells narrow, sometimes swollen.

Habitat — On soil in unfertilized grassland.

Known distribution — China (Wang et al. 2011, as *G. glutinosum*), Russia (European part).

Notes — *Glutinoglossum lumbricale* is characterized by small asci (202–231 × 13.5–14 µm), rather narrow ascospores (3.5–5 µm), very thin paraphyses and by hyphae of stipe surface which are curved, circinate, interwoven in the apical part, with mainly narrowly cylindrical apical cells (Fig. 3). This species belong to species with 3- and 7-septate ascospores inside asci.

The sequence obtained from the holotype has high identities (1 011/1 025 – 99 %) with the sequence of the nrITS region of *G. glutinosum* from China (HQ222870), obtained in the study of soil fungal diversity by Wang et al. (2011).

5. *Glutinoglossum orientale* Fedosova, E.S. Popov & A.V. Alexandrova, *sp. nov*. — MycoBank MB818540; Fig. 4b, g, 6d, 12

Etymology. The epithet refers to the oriental distribution of the species.

Holotype. Russia, Primorye Territory, Khasansky District, Kedrovaya Pad State Nature Biosphere Reserve, valley of the River Kedrovaya, N43°05'53" E131°33'23", broadleaf forest, on soil, 20 Aug. 2005, *E.S. Popov* (LE 222166).

Ascocarps gregarious, caespitose, clavate to lanceolate, sometimes rudimentary bifurcate, stipitate, 30–65 mm high (dry material), black to dark brown, glutinous. *Ascigerous part* cylindrical, clavate, up to lanceolate, 1/4–1/2 the total length of the ascocarp, 9–20 mm long, black up to dark brown, compressed, dumbbell-shaped, oval in cross section, transition zone delimited by form, surface in dry material smooth, ceraceous,

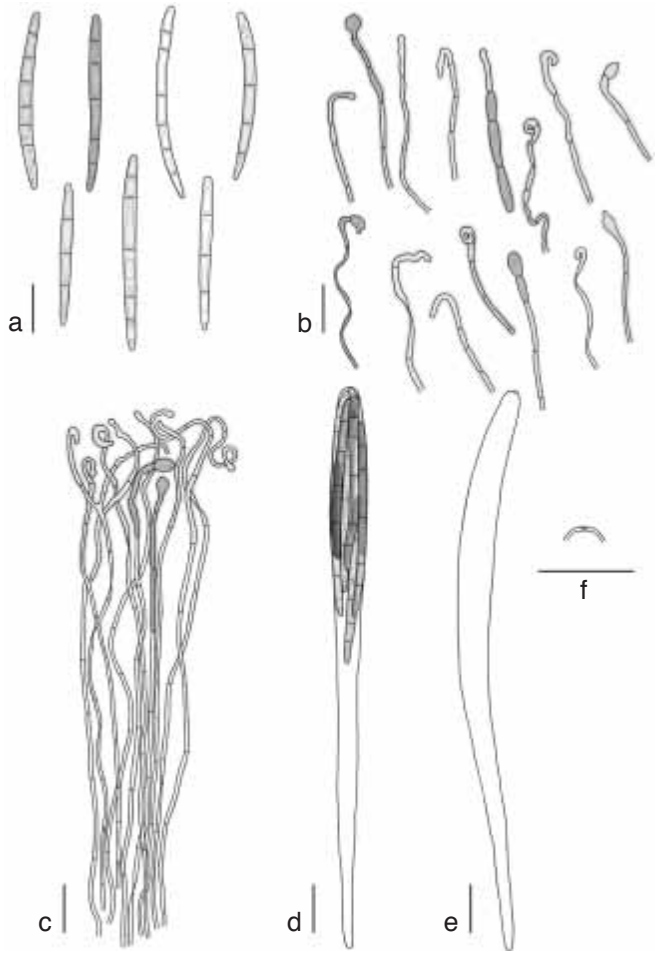

Fig. 11 *Glutinoglossum lumbricale* (LE 303987, holotype). a. Ascospores; b. apical part of paraphyses; c. hyphae of stipe surface; d. ascus with ascospores inside; e. inamyloid reaction of ascus, with euamyloid apical ring; f. ascus apical ring in IKI. — Scale bars = 20 µm.

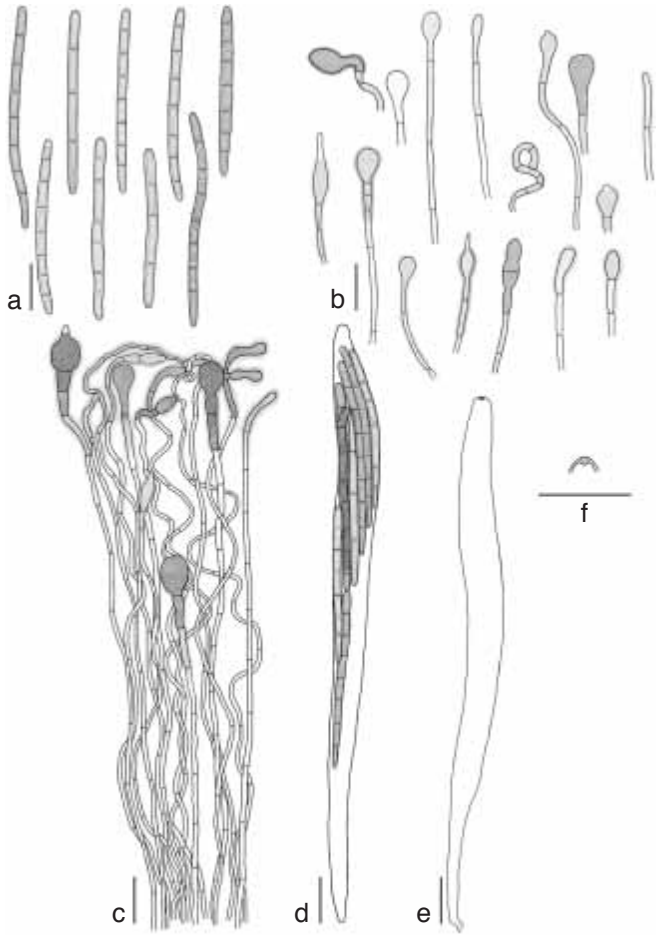

Fig. 12 *Glutinoglossum orientale* (LE 222166, holotype). a. Ascospores; b. apical part of paraphyses; c. hyphae of stipe surface; d. ascus with 7-septate ascospores inside; e. inamyloid reaction of ascus, with euamyloid apical ring; f. ascus apical ring in IKI. — Scale bars = 20 µm.

sometimes tomentose due to prominent paraphyses protruding from the hymenium, nitid. *Stipe* dark brown, lighter than ascigerous part, compressed, dumbbell-shaped, terete with ribs, or oval in cross section, surface in dry material smooth, nitid. *Asci* narrowly clavate, (220–)237.4–279.5(–297) × (12.5–)14.5–16.3(–19) µm, Q = (12.1–)14.7–20.8(–23.3). *Ascospores* cylindrical, subfusiform, slightly curved, narrowed to one end, (72.5–)83.6–94.2(–103.5) × (3.5–)4.6–4.7(–5.5) µm, Q = (14.7–)17.7–20.7(–24.9), pale brown up to brown, (0–)3(4–6)7-septate. *Paraphyses* hyaline below, brown, pale brown to hyaline in the apical part, straight, moderately septate, (2–)2.5–2.8(–5) µm diam, in apical part straight, seldom curved or circinate. *Apical cells of paraphyses* globose, pyriform, cylindrical, or slightly swollen, sometimes with rostrate projection and proliferate, (12–)17.1–18.7(–28.5) × (3–)6.4–7.2(–12) µm, brown, pale brown to hyaline. *Hyphae of stipe surface* hyaline below, brown to hyaline in the apical part, frequently or moderately septate, straight, hooked, apical cells swollen, globose, pyriform, or cylindrical.

Habitat — On soil in valley broadleaf and montane evergreen tropical forests.

Known distribution — Russia (the Far East), Vietnam.

Additional specimen examined. Vietnam, Lam Dong Province, Lac Duong District, Bidoup Nui Ba National Park, Long Lanh, montane evergreen tropical forest dominated by *Fagaceae*, *Lauraceae*, *Theaceae*, and *Magnoliaceae*, on soil, 12 July 2011, *A.V. Alexandrova* (LE 291818).

Notes — *Glutinoglossum orientale* is an easily recognizable species due to the combination of long asci (237–280 µm) and very long ascospores (84–94 µm); paraphyses are straight, only seldom curved and circinate in apical part (Fig. 3). It is one of six species which have 3- and 7- septate ascospores inside asci.

6. *Glutinoglossum peregrinans* Fedosova & V. Kučera, *sp. nov*. — MycoBank MB818547; Fig. 4f, 6g–h, 13

Etymology. The epithet means 'wandering' and refers also to the wide distribution of this species across Eurasia and to some of its habitats near forest huts.

Holotype. Russia, Primorye Territory, Dalnegorsky Urban Okrug, near Dalnegorsk, Partizanskaya Pad, upper reaches of the Mramorny Spring, N44°35'49.3" E135°33'21", mixed forest (*Abies nephrolepis*, *Pinus koraiensis*, *Acer tegmentosum*, *A. mono*, *Philadelphus* sp., *Sorbus* sp., *Aralia elata*), 2 Sept. 2013, *A.G. Fedosova* (LE 303988).

Ascocarps solitary to gregarious, caespitose, clavate, cylindrical, rudimentary bifurcate, stipitate, 35–55 mm high, dark brown up to black, glutinous. *Ascigerous part* clavate, lanceolate, cylindrical, 1/7–4/5 the total length of the ascocarp, 5–23 mm long, black up to dark brown, compressed, dumbbell-shaped, oval in cross section, transition zone poorly delimited by form and surface, surface in dry material smooth, ceraceous, nitid, slightly tomentose due to prominent paraphyses protruding from the hymenium. *Stipe* dark brown, lighter than ascigerous part, terete, compressed, oval, sometimes with ribs in cross section, surface in dry material smooth, nitid, ceraceous, sometimes tomentose due to prominent hyphae of stipe surface. *Asci* narrowly clavate, (200–)224.8–255.1(–280) × (12–)13.6–17.1(–18.5) µm, Q = (12.4–)13.1–17.6(–21.5). *Ascospores* subfusiform, cylindrical, (63–)71.4–85.9(–95) × (4–)4.9–5.2(–5.5) µm, Q = (12–)14.6–17.3(–19), pale brown up to brown, (0–)3(4–6)7-septate. *Paraphyses* hyaline below, brown, pale brown to hyaline in the apical part, straight, moderately or frequently septate, (1.5–)2.5–5.5(–8) µm diam, in apical part straight, slightly curved up to hooked, sometimes branched. *Apical cells of paraphyses* swollen, pyriform, or globose, sometimes cylindrical, sometimes proliferate, (9.5–)16–26(–49.5) × (3.5–)5.2–10(–11.5) µm, pale brown. *Hyphae of stipe surface* hyaline below, brown to hyaline in the apical part, moderately septate, straight, curved, sometimes proliferate, apical cells swollen or pyriform.

Habitat — On soil, rarely on wood, in forests and meadows.

Known distribution — Finland, France, Russia (the Caucasus, European part, the Far East), Slovakia.

Additional specimens examined. Finland, Perä-Pohjanmaa Prov., Rovaniemi, Pisavaara, NE corner of the Strict Nature Reserve, next to the abandoned house, N66°18'44.0" E25°09'13.8", on soil among *Calamagrostis* sp., 4 Sept. 2013, *V. Kučera* (SAV F-10789). – France, dans les bois humides, sur ta terre, en automne (Desmazières, Pl. Crypt. N. France, Ed. 1, № 422, as *Geoglossum glutinosum*) (LE 179508). – Russia, (Amur Region), Obluchye, Yadrino, mixed forest with *Tilia* and *Abies*, on soil, 10 Aug. 1961, *A. Raitviir* (TAAM042223); Karachayevo-Circassian Republic, Karachayevsky District, Teberda State Nature Biosphere Reserve, near Teberda, left side of the Teberda River, N43°26'23.4" E41°43'54", alt. 1360 m, forb meadow, on soil, 7 Aug. 2009, *E.S. Popov* (LE 291817); Khabarovsk Territory, (Khabarovsky District), Khekhtsirsky forestry, on buried wood, 14 Sept. 1946, *Lj.N. Vassiljeva* (VLA D-3557); ibid., (Komsomolsky District), Selikhino, Kabansopka, mixed forest with *Tilia* and *Abies*, 18 Aug. 1961, *A. Raitviir* (TAAM042325); Leningrad Region, Luzhsky District, Krasnye Gory, road to the cemetery, N58°57'21.0" E29°39'37.4", meadow, on soil, 17 Sept. 2016, *A.G. Fedosova* (LE 304020); (Primorye Territory, Chuguyevsky District), Verkhne-Ussuriysky forest station, at the base of *Taxus*, 22 Aug. 1974, *E.M. Bulakh* (VLA D); Primorye Territory, Terneysky District, Sikhote-Alin Nature Reserve, Ranger station Sukhaya, N44°59'47.2" E136°30'8.8", herb meadow, on soil, 3 Sept. 2013, *A.G. Fedosova* (LE 303989); Pskov Region, Kunyinsky District, between Lastovka and Begunovo, W shore of Zhizhitskoye Lake, N56°15'18" E31°10'09", stand of *Calamagrostis canescens*, on soil, 24 July 2003, *E.S. Popov* (LE 303905, LE 222636, LE 222635). – Slovakia, Malá Fatra Mts, Martinské hole, turistic path near the hut, N49°05'43.476" E18°49'58.224", alt. 1256 m, on soil, 19 Sept. 2014, *M. Krivuš* (SAV F-11246).

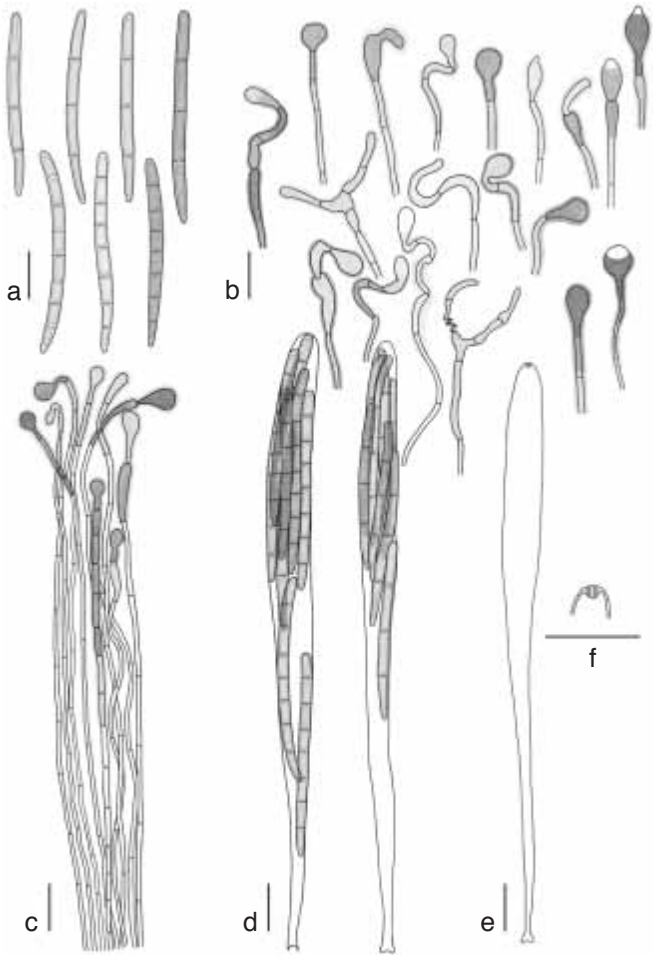

Fig. 13 *Glutinoglossum peregrinans* (LE 303988, holotype). a. Ascospores; b. apical part of paraphyses; c. hyphae of stipe surface; d. asci with 3- and 7-septate ascospores inside; e. inamyloid reaction of ascus, with euamyloid apical ring; f. ascus apical ring in IKI. — Scale bars = 20 µm.

Notes — Among other species which have 3- and 7-septate ascospores inside asci *G. peregrinans* possesses the widest range of morphological variation. However, it can be distinguished due to curved or hooked apical part of paraphyses without circinate elements (Fig. 3).

7. *Glutinoglossum proliferatum* V. Kučera, *sp. nov*. — MycoBank MB818553; Fig. 14

Etymology. The epithet refers to the shape of paraphyses which apical cells proliferate to form chains of pyriform and globose cells.

Holotype. Romania, Făgăraș Mts, Transfăgărășan route, blue marked tourist path, near the tunnel, N45°36'07.52" E24°37'10.05", alt. 2099 m, among grass next to the path, 22 Sept. 2015, *M. Caboň* (SAV F-11249).

Ascocarps solitary, lanceolate to clavate, short stipitate, 13–24 mm high, black, with glutinous stipe. *Ascigerous part* clavate, 1/2–4/5 the total length of the ascocarp, 7–18 mm long, black, dumbbell-shaped, compressed in cross section, transition zone delimited by form, surface in dry material smooth, sometimes tomentose due to prominent paraphyses protruding from the hymenium. *Stipe* black, short, compressed in cross section, surface in dry material smooth, nitid. *Asci* narrowly clavate, (223.5–)244.8(–287.5) × (12–)13.7(–15) µm, Q = (16.1–)18(–22.7). *Ascospores* subfusiform, cylindrical, elongate-clavate, slightly curved, (62–)74(–79.5) × (4.5–)5(–5.5) µm, Q = (12.5–)14.9(–17.1), pale brown, (0–)3(4–6)7-septate. *Paraphyses* hyaline below, brown to pale brown in the apical part, straight, frequently or moderately septate, (2.5–)4.7(–8) µm diam, in apical part straight or slightly curved. *Apical cells of paraphyses* pyriform, globose, or swollen, frequently proliferate, sometimes with rostrate projection, (11–)11.6(–13) × (5–)8.7(–10) µm, brown up to pale brown. *Hyphae of stipe surface* hyaline below, brown to hyaline in the apical part, frequently or moderately septate, straight, curved, apical cells pyriform, globose, or swollen, sometimes proliferate.

Habitat — On soil among grass.

Known distribution — Romania.

Notes — From other species with 3- and 7-septate ascospores *G. proliferatum* is easily distinguishable morphologically by straight paraphyses formed by chains of proliferating pyriform and globose cells (Fig. 3). The only specimen of this species was collected in a mountain meadow (alt. 2099 m).

8. *Glutinoglossum pseudoglutinosum* V. Kučera, *sp. nov*. — MycoBank MB818555; Fig. 6b, e, 15

Etymology. The epithet derived from 'pseudo-' (false, in Greek) and the species epithet '*glutinosum*'.

Holotype. Slovakia, Malé Karpaty Mts, Sološnica, 1.5 km SE of the village church, N48°27'22.88" E17°14'37.96", alt. 318 m, mowed meadow, on soil, 1 Oct. 2013, *V. Kučera* (SAV F-10903).

Ascocarps solitary to gregarious and scattered, lanceolate, stipitate, 10–65 mm high, dark brown, glutinous, with mucilaginous layer on the stipe. *Ascigerous part* truncate or cylindrical with rounded apex when young, later in development lanceolate, 1/3 the total length of the ascocarp, 3–21 mm long, dark brown up to black, when young oval later compressed in cross section, when fresh transition zone delimited by form and colour, surface in dry material smooth. *Stipe* dark brown, slightly lighter than the ascigerous part, oval in cross section, surface in dry material smooth. *Asci* narrowly clavate, (195–)227.5–266.6(–320)

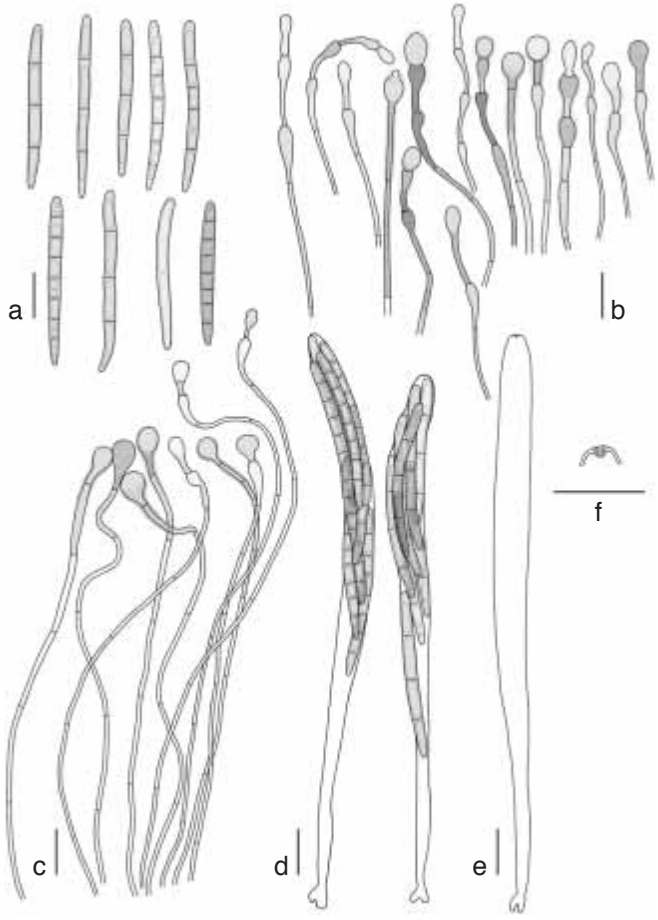

Fig. 14 *Glutinoglossum proliferatum* (SAV F-11249, holotype). a. Ascospores; b. apical part of paraphyses; c. hyphae of stipe surface; d. asci with 3- and 7-septate ascospores inside; e. inamyloid reaction of ascus, with euamyloid apical ring; f. ascus apical ring in IKI. — Scale bars = 20 µm.

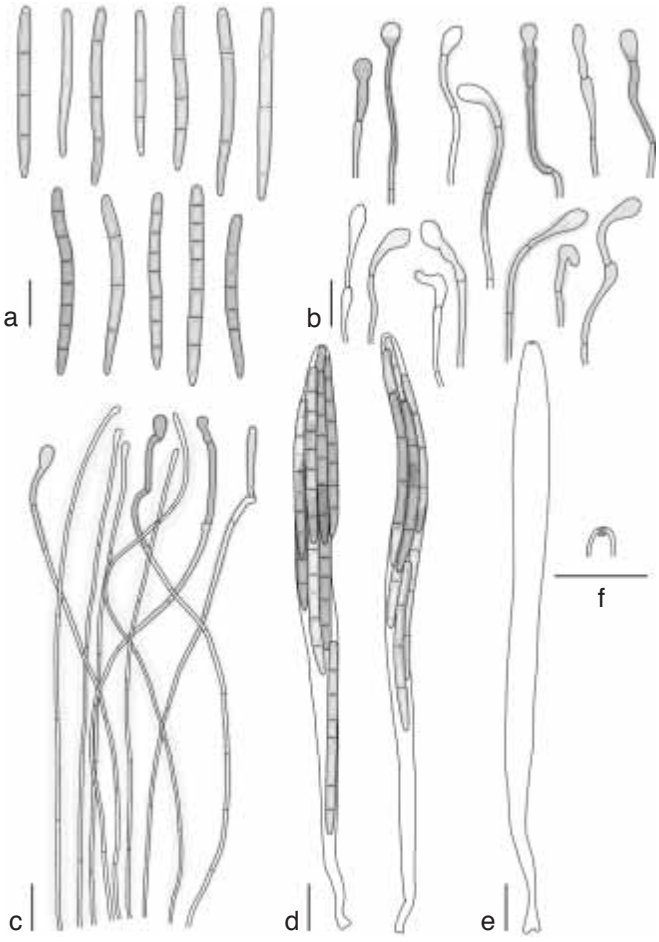

Fig. 15 *Glutinoglossum pseudoglutinosum* (SAV F-10903, holotype). a. Ascospores; b. apical part of paraphyses; c. hyphae of stipe surface; d. asci with 3- and 7-septate ascospores inside; e. inamyloid reaction of ascus, with euamyloid apical ring; f. ascus apical ring in IKI. — Scale bars = 20 µm.

× (11–)13.7–14.8(–18) µm, Q = (11.9–)15.5–19.5(–24.6). *Ascospores* cylindrical, elongate-clavate, slightly curved, narrowed to one end, (53–)68.4–81.2(–91) × (4–)4.6–5.1(–6) µm, Q = (8.8–)13.5–16.4(–22.5), pale brown, (0–)3(4–6)7-septate. *Paraphyses* hyaline below, brown, pale brown to hyaline in the apical part, straight, frequently or moderately septate, (1.5–)2.1–3.8(–5) µm diam, in apical part straight, sometimes slightly curved or hooked. *Apical cells of paraphyses* swollen, globose, or pyriform, (8.5–)17.3–28.7(–60) × (3–)5.5–10.2(–14) µm, brown, pale brown to hyaline. *Hyphae of stipe surface* hyaline below, brown to hyaline in the apical part, moderately or rarely septate, straight, curved, covered by conspicuous gelatinous coat, apical cells cylindrical, sometimes swollen only coloured cells.

Habitat — On soil in mowed meadows or pastures, in broadleaf forests, preferably on calcareous bedrock.

Known distribution — Czech Republic, Germany, Slovakia, United Kingdom (Hustad & Miller 2015, as *G. glutinosum*).

Additional specimens examined. Czech Republic, Posázaví region, Benešov District, Čtyřkoly, c. 750 m W of the village centre, 50 m of the chalet colony, N49°52'21.201" E14°42'47.251", alt. 317 m, irregulary mowed meadow, on soil among grass, 11 Nov. 2013, *J. Matouš* (SAV F-11243); Ralská pahorkatina upland, Zákupy, park around the castle, 160 m SWW of the main entrance, N50°41'8.668" E14°38'29.546", alt. 265 m, marlstone bedrock, mowed grassland with *Festuca rubra*, *Agrostis capillaris*, *Hieracium pilosella*, on soil, 11 Sept. 2013, *J. Gaisler* (SAV F-11255). – (Germany, Free State of Saxony), bei Schandau, an einem grasigen Abhange im Zahnsgrunde, 6 Oct. 1906, *W. Krieger* (Krieger, Fungi Saxon. Exs., №2026, as *Geoglossum glutinosum*) (LEP). – Slovakia, Javorníky Mts Papradno, Podjavorník, Dolný Grúnik, N49°16'27.08" E18°20'2.84", alt. 775 m, broadleaf forest, on soil, 11 Oct. 2014, *V. Kučera* (SAV F-11196); ibid., N49°16'27.3" E18°20'05.9", alt. 759 m, on soil, 9 Oct. 2016, *V. Kučera* & *A.G. Fedosova* (LE 304022, SAV F-11289); ibid., Vysoká nad Kysucou, c. 1.3 km NW of the centre of Vrchrieka, N49°22'10.82" E18°32'03.26", alt. 604 m, grazed meadow, on soil, 12 Oct. 2012, *N. Rybáriková* (SAV F-11264); ibid., Korňa, U Žilov, under *Corylus avellana* and other shrubs, on soil, 26 Sept. 2014, *V. Kautman* (SAV F-11251); Biele Karpaty Mts, Vršatské Podhradie, c. 1.1 km NW of the centre of the village, 'Lysá', N49°04'21.39" E18°08'42.06", alt. 737 m, meadow, on soil among grass, 20 Oct. 2014, *V. Kučera* (SAV F-11265); Považský Inovec Mts, Banka, c. 1.5 km of the church, N48°34'25.82" E17°51'49.48", alt. 260 m, on pastured ski slope, under *Corylus avellana*, *Crataegus* sp., *Rosa canina* shrubs, on soil, 8 Oct. 2010, *V. Kučera* & *N. Rybáriková* (SAV F-10399); ibid., 29 Sept. 2014, *V. Kučera* (SAV F-10406); Stolické vrchy Mts, Muránska Huta, Predná Hora, N48°46'04" E20°06'37", alt. 802 m, on irregulary mowed meadow, among *Hieracium pilosella* plants, on soil, 10 Oct. 2008, *V. Kučera* (SAV F-11267).

Notes — *Glutinoglossum pseudoglutinosum* is easily recognised in fresh condition in the field due to the thick mucilaginous layer covering the stipe (Fig. 6e). Consequently, the stipe is so viscous that it is almost impossible to collect the ascocarps without a knife. Micromorphologically, this feature appears in a distinctive conspicuous gelatinous coat covering very thin hyphae of stipe surface. *Glutinoglossum pseudoglutinosum* occurs preferably on calcareous bedrock and this probably plays a limiting role for the species distribution. Apart from the thick mucilaginous layer, *G. pseudoglutinosum* also differs from other species which have 3–7-septate ascospores (*G. circinatum*, *G. lumbricale*, *G. orientale*, *G. peregrinans*, and *G. proliferatum*) by characters of ascospores, asci, apical cells and apical part of paraphyses (Fig. 3). The ascospores of *G. pseudoglutinosum* are shorter than those of *G. orientale* (68–81 µm long vs 84–94 µm); they are narrower than those of *G. circinatum* (4.5–5 µm wide vs 5–5.5 µm). Moreover, *G. circinatum* has broader asci (15.5–21 µm wide vs 13.5–15 µm in *G. pseudoglutinosum*). Paraphyses of *G. pseudoglutinosum* apically are straight or sometimes slightly curved or hooked, formed by single pyriform, globose or swollen cells. *Glutinoglossum proliferatum* also has apically straight paraphyses but formed by chains of proliferating pyriform and globose cells. Paraphyses of *G. lumbricale* and *G. peregrinans* apically often are hooked or curved; besides, *G. lumbricale* has very thin paraphyses with cylindrical apical cells. Although *G. pseudoglutinosum* has 3- and 7-septate ascospores inside asci, according to the phylogenetic analyses, *G. pseudoglutinosum* does not cluster with other species of this group but it is closer to *G. glutinosum* which has predominantly 3-septate ascospores. Though *G. pseudoglutinosum* has no support in the phylogenetic analyses, morphological and ecological characters allow us to consider this species as a separate one.

9. *Glutinoglossum triseptatum* V. Kučera, *sp. nov*. — MycoBank MB818557; Fig. 16

Etymology. The epithet refers to the predominantly 3-septate ascospores.

Holotype. Slovakia, Zvolenská Kotlina basin, Zvolen, c. 2.5 km NNW of the city centre, arboretum Borová hora, N48°35'54.37" E19°08'00.05", alt. 316 m, wet meadow, on soil, 30 Sept. 2009, *V. Kučera* (SAV F-9828).

Ascocarps solitary to gregarious, lanceolate, stipitate, 15–30 mm high, brown, glutinous. *Ascigerous part* lanceolate, 1/4 the total length of the ascocarp, 10 mm long, dark brown, oval in cross section, transition zone poorly delimited by form and colour, surface in dry material smooth, ceraceous. *Stipe* dark brown, slightly darker than the ascigerous part, oval in cross section, surface in dry material smooth, nitid. *Asci* narrowly clavate, (200–)221.8–238.5(–270) × (12–)13–14.4(–16) µm, Q = (13.1–)15.5–18.4(–21.3). *Ascospores* cylindrical, subfusiform, elongate-clavate, slightly curved, (58–)72.5–76.4(–90) × (3.5–)4.7–4.8(–6) µm, Q = (11.1–)15.1–16.3(–20.8), pale brown up to brown, (1–)3(4–5)-septate. *Paraphyses* hyaline

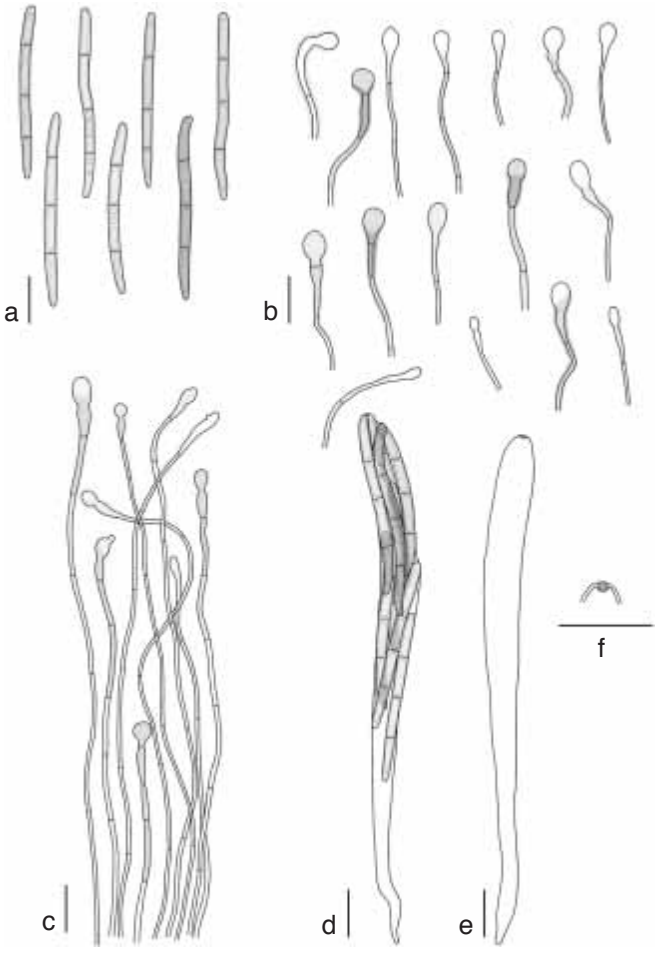

Fig. 16 *Glutinoglossum triseptatum* (SAV F-9828, holotype). a. Ascospores; b. apical part of paraphyses; c. hyphae of stipe surface; d. ascus with 3-septate ascospores inside; e. inamyloid reaction of ascus, with euamyloid apical ring; f. ascus apical ring in IKI. — Scale bars = 20 µm.

below, pale brown to hyaline in the apical part, straight, frequently or moderately septate, (1.5–)2.1–3.8(–5) µm diam, in apical part straight, slightly curved. *Apical cells of paraphyses* swollen, globose, or pyriform, (8–)17.2–21.1(–35) × (5–)7.9–9(–19) µm, brown, pale brown to hyaline. *Hyphae of stipe surface* hyaline below, brown to hyaline in the apical part, moderately septate, straight or curved, apical cells swollen, pyriform or globose, sometimes with rostrate projection.

Habitat — On soil in meadows near broadleaf forests.

Known distribution — Slovakia.

Additional specimen examined. Slovakia, Malé Karpaty Mts, Pezinok, Kejda, 15 Sept. 2010, *V. Kautman* (SAV F-10262).

Notes — *Glutinoglossum triseptatum* is one of the three species characterized by 3-septated ascospores inside mature asci. *Glutinoglossum triseptatum* and *G. glutinosum* occur in Europe and have straight or sometimes curved paraphyses at the apical part and differ from each other by the length of ascospores which are 73–76 µm long in *G. triseptatum* vs 63–72 µm in *G. glutinosum*. In contrast to these species *G. methvenii* belongs to Australasian fungal biota and is characterized by broader ascospores (5–6 µm wide vs 4.5–5 µm in *G. glutinosum* and *G. triseptatum*) and curved to hooked apical part of paraphyses (Fig. 3).

DUBIOUS NAMES AND IMPERFECTLY KNOWN TAXA

Cibalocoryne Hazsl., Értek. Természettud. Köréb. Magyar Tud. Akad. 11 (19): 7. 1881

Type species. *Cibalocoryne viscosula* Hazsl.

Geoglossum Pers. subg. ***Cibalocoryne*** Hazsl., Értek. Természettud. Köréb. Magyar Tud. Akad. 11 (19): 7. 1881

Type species. *Cibalocoryne viscosula* Hazsl.

Cibalocoryne viscosula Hazsl., Értek. Természettud. Köréb. Magyar Tud. Akad. 11 (19): 8. 1881

Synonym. *Geoglossum viscosulum* (Hazsl.) Sacc., Syll. Fung. 8: 43. 1889.

Type. Missing (destroyed during World War II). According to the protologue 'Nő mohos lejtőkön, mohokon, a m. Tátra Rothbaumgrund nevű völgyében' (Grows on mossy slopes, on mosses, in the valley of Rothbaumgrund in Tatra Mountains (now Belianske Tatry Mts, Suchá dolina valley)).

Notes — Hazslinszky (1881) in his treatment divided the genus *Geoglossum* in four distinct genera, according to the characters of hymenium and spores. However, few lines below, he subordinated new genera *Eugeoglossum*, *Cibalocoryne*, *Helote* and *Corynetes* as subgenera to *Geoglossum* in the sense of Persoon. The name *Cibalocoryne* was introduced by him for the only species *C. viscosula*. Although the rank of *Cibalocoryne* was not stated unambiguously in the original publication one year later Hazslinszky (1882) referred to his new species as *Cibalocoryne viscosula*. A serious question we have to deal with is whether Hazslinszky fully accepted the new taxa as he completely misspelled it later as '*Cephalocoryne viscosulat'* (Hazslinszky 1886) or '*Cephalocoryna*' (Hazslinszky 1887).

Cibalocoryne and *C. viscosula* were treated as distinct taxa only by Hazslinszky (1881, 1882, 1886, 1887) and Imai (1942). After the work of Saccardo (1889) *C. viscosula* is accepted within the genus *Geoglossum* (Massee 1897, Durand 1908). According to the description and drawings of original material of *C. viscosula* forwarded by Moesz (curator of the Hungarian Natural History Museum (BP) fungi at that time who refused to send specimens because of war instability) Nannfeldt (1942) stated that this name represents only a synonym of *Geoglossum* (*Glutinoglossum*) *glutinosum*. After this work, *C. viscosula* was considered by mycologists as a synonym of *G. glutinosum* (Mains 1954, Maas Geesteranus 1965, Hustad & Miller 2015).

Our attempt to get more information on *Cibalocoryne viscosula*, besides the protologue, failed. Original material of *Cibalocoryne viscosula* was transferred to BP as a part of Hazslinszky's collections after his death (presumably by the family). During World War II Herbarium BP at first remained in Budapest. In 1942 the management of the museum decided to move the most important collections in a castle in the village of Váchartyán to protect those (Gizella Vasas, pers. comm. 2016). Unfortunately, the castle was destroyed in 1945, and all collections kept there were lost (Rajczy & Buczkó 1995). At present the original material of *C. viscosula* is absent in BP. Moesz's letter to Nannfeldt with data on specimens is not located in the Uppsala University Library archives nor in the Museum of Evolution (UPS) (Håkan Hallberg, pers. comm. 2016, Stefan Ekman, pers. comm. to Anders Dahlberg 2016, Johan Nitare, pers. comm. to Anders Dahlberg 2016, Anders Dahlberg, pers. comm. 2017, Svengunnar Ryman, pers. comm. 2017) and even figure no. 10 depicting the species mentioned in the protologue is missing in the plate (and was not a supplement either in errata or in following issues of the journal). Moreover, attempts to get some data on another specimen of *C. viscosula* collected near Prešov (Hazslinszky 1886) were also unsuccessful. There were two collections of Hazslinszky's material (Lizoň 1997). After the death of Hazslinszky one of the collections was moved to Budapest and the second was kept in the museum of Prešov (before World War II) and then (in the beginning of the 1950s) was transferred to Bratislava (Botany Department of Comenius University, SLO) (Lizoň 1997). Nowadays, a few Hazslinszky's specimens are present at SLO and several more in the Slovak National Museum (BRA) but none of them have geoglossoid fungi collected by Hazslinszky. So, Hazslinszky and Moesz were the only ones who have seen the fungus. And only Nannfeldt received data taken from the type specimen by Gusztav Moesz.

Mains (1954) raised the issue of the validity of *Cibalocoryne* as a generic name "since Hazslinszky (1881) appears to have proposed it as a subgenus and only suggested a future generic status" that is not a validly published name according to the Art. 36.1(b) (McNeill et al. 2012). Maas Geesteranus (1964) pointed out that Hazslinszky's use of the term 'genus' for his taxa is improper but agreed that formally taxa were published both with the generic and subgeneric ranks that is a validly published name before 1 January 1953 (Art. 36.2 of ICN) (McNeill et al. 2012). Hustad et al. (2013) also have concluded that *Cibalocoryne* was not a validly published name. Nevertheless, all these publications recognized the complexity of the situation.

If *Cibalocoryne* was validly published and *C. viscosula* is a synonym of *G. glutinosum*, the name *Cibalocoryne* would have a priority before *Glutinoglossum*. What complicates the situation is whether *Cibalocoryne* was validly published and whether *C. viscosula* is a synonym of *G. glutinosum*. Since there exists no original material of *G. glutinosum* it cannot be reliable affirmed that *C. viscosula* and *G. glutinosum* are synonyms or not. Next complexity is that the name *Cibalocoryne* was published as a provisional name (Art. 36.1(b)) or generic and subgeneric names are alternative (Art. 36.2). If the name *Cibalocoryne* was not validly published in 1881, it is then important to know whether it was validated later. None of the publications (Hazslinszky 1882, 1886, 1887, Imai 1942) validate the generic name. Moreover, new combinations made by Imai (1942) would also not be validly published (Art. 53.1). Since later the name *Cibalocoryne* considered to be a synonym of *Geoglossum* (Massee 1897), it could not have been validly published (Art. 36.1(c)).

Fig. 17 Lectotype of *Geoglossum glutinosum* forma *minor* (PAD). a. Envelope with label; b. ascocarps; c. ascus apical ring in MLZ; d–g. ascospores; h–i. apical cells of hyphae of stipe surface. — Scale bars: b = 10 mm; c–i = 10 µm. — Photos: E. Campo.

Despite complexity of the problem, from the formal point of view the name *Cibalocoryne* can not be rejected until additional information on this problem would appear.

Geoglossum glutinosum forma ***minor*** Sacc., Michelia 1 (4): 444. 1878

Lectotype. '1 Oct. 78, Bell.' (PAD, H.B. Patavinus, Herbarium Mycol. P.A. Saccardo)!, designated by Durand (1908) (Fig. 17).

Description of the type specimen (based on the observations and photographs made by Emanuele Campo).

Lectotype of *Geoglossum glutinosum* forma *minor* (PAD) is represented by three ascocarps, one of which is broken. *Ascocarps* clavate, cylindrical, stipitate, up to 1 cm high, black, entirely covered by clay. *Ascigerous part* clavate, 1/4–1/3 the total length of the ascocarp, black, terete, transition zone delimited by form, covered by clay. *Stipe* black, terete, covered by clay. *Asci* clavate, 15–20 µm wide, 8-spored, with inamyloid wall and amyloid apical ring, many collapsed. *Ascospores* elongate-clavate, subfusiform, cylindrical, sometimes curved, narrowed towards one end, 54–77 × 5–6 µm, brown, (3–6)7-septate. *Paraphyses* collapsed. *Apical cells of paraphyses* collapsed. *Hyphae of stipe surface* mainly collapsed, apical cells brown, globose or ovoid, sometimes forming chains of 2–3 cells.

Notes — Describing this forma, Saccardo (1878) wrote the 'Hab. in udis inter Marchantias a Belluno, Oct. 1878 (Spegazzini)', thereby indicating the gathering. Durand (1908) mentioned 'a specimen' and 'a plant' concerning the Saccardo's specimen from Italy which was cited as 'type' among examined types and figure legend. Moreover, in PAD the only one specimen fits well with the locality mentioned in the protologue. So, Durand's action could be treated as lectotypification of the name.

Ascocarps in the lectotype are covered by clay, therefore the colour and surface characters of ascocarps are difficult to observe; many microstructures are collapsed. Neither amorphous matrix nor any gelatinous structures covering hyphae were found in hymenium and on the stipe surface. Apart from *Geoglossum glutinosum* forma *minor*, the name under which it was published (though on the label it is written 'β minus' and Durand (1908) cited it as 'var. minus'), there are other names on the label such as '*Geoglossum americanum*', '*Geoglossum* cf. *hirs. americanum*' and '*Geoglossum glabrum*'. Durand (1908) considered this taxon as a dwarf form of *Geoglossum nigritum*. In spite of the fact that the protologue mentions predominantly 3-septate ascospores for this forma the most of the ascospores of the studied lectotype are 7-septate. Having examined both the ascocarps and the drawing of the spores, asci and the paraphyses on the label we conclude the specimen belongs to the *Geoglossum umbratile* species group. This group at present includes several species (Arauzo & Iglesias 2014) of which

Geoglossum scabripes seems the most appropriate. Thus we consider the name *Geoglossum glutinosum* forma *minor* as a presumptive synonym of *Geoglossum scabripes*.

Geoglossum glutinosum var. ***sylvestre*** Pers., Comm. Fung. Clav.: 38. 1797

Notes — The name has not been mentioned after the publication in 1797. The type is missing in Persoon's Herbarium of the Naturalis Biodiversity Center (L) and probably no other specimens exist; moreover, the original description is ambiguous. Therefore, the name should be omitted.

Geoglossum viscosum Pers., Comm. Fung. Clav.: 39. 1797

Notes — Persoon (1797) described under the name *G. viscosum* a species with sticky black ascocarps related to *G. glutinosum*, while 'pratis montosis apricis' was pointed out as a habitat. Since the end of the 19th century this name has been considered as a synonym of *Geoglossum glutinosum* (Massee 1897, Durand 1908, Nannfeldt 1942, Mains 1954). The type is not present in Persoon's Herbarium of the Naturalis Biodiversity Center (L). Presently, the name should be omitted because the type is lost, and the original description is ambiguous.

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