

# Phylogenetic revision of *Camarosporium* (Pleosporineae, Dothideomycetes) and allied genera

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**Abstract:** A concatenated dataset of LSU, SSU, ITS and *tef1* DNA sequence data was analysed to investigate the taxonomic position and phylogenetic relationships of the genus *Camarosporium* in Pleosporineae (Dothideomycetes). Newly generated sequences from *camarosporium*-like taxa collected from Europe (Italy) and Russia form a well-supported monophyletic clade within Pleosporineae. A new genus *Camarosporidiella* and a new family *Camarosporidiellaceae* are established to accommodate these taxa. Four new species, *Neocamarosporium korfii*, *N. lamiacearum*, *N. salicorniicola* and *N. salsolae*, constitute a strongly supported clade with several known taxa for which the new family, *Neocamarosporiaceae*, is introduced. The genus *Staurosphaeria* based on *S. lycii* is resurrected and epitypified, and shown to accommodate the recently introduced genus *Hazlinszkyomyces* in *Coniothyriaceae* with significant statistical support. *Camarosporium quaternatum*, the type species of *Camarosporium* and *Camarosporomyces flavigena* cluster together in a monophyletic clade with significant statistical support and sister to the *Leptosphaeriaceae*. To better resolve interfamilial/intergeneric level relationships and improve taxonomic understanding within Pleosporineae, we validate *Camarosporiaceae* to accommodate *Camarosporium* and *Camarosporomyces*. The latter taxa along with other species are described in this study.

**Key words:** Multigene phylogeny, Muriformly septate, Pleomorphism, Pleosporales, Taxonomy.

**Taxonomic novelties:** **New families:** *Camarosporiaceae* Wanas., K.D. Hyde & Crous, *Camarosporidiellaceae* Wanas., Wijayaw., Crous & K.D. Hyde, *Neocamarosporiaceae* Wanas., Wijayaw., Crous & K.D. Hyde; **New genus:** *Camarosporidiella* Wanas., Wijayaw. & K.D. Hyde; **New species:** *Camarosporidiella elaeagnicola* Wanas., Bulgakov & K.D. Hyde, *Ca. eufemiana* Wanas., Camporesi & K.D. Hyde, *Ca. halimodendri* Wanas., Bulgakov & K.D. Hyde, *Ca. italica* Wanas., Camporesi & K.D. Hyde, *Ca. mackenziei* Wanas., Bulgakov & K.D. Hyde, *Ca. melnikii* Wanas., Bulgakov & K.D. Hyde, *Ca. mirabellensis* Wanas., Camporesi & K.D. Hyde, *Ca. premilcurensis* Wanas., Camporesi & K.D. Hyde, *Ca. schulzeri* Wanas., Bulgakov & K.D. Hyde, *Staurosphaeria rhamnocola* Wanas., Yu. Sh. Gafforov & K.D. Hyde, *Neocamarosporium korfii* Wanas., E.B.G. Jones & K.D. Hyde, *N. lamiacearum* Dayar., E.B.G. Jones & K.D. Hyde, *N. salicorniicola* Dayarathne, E.B.G. Jones & K.D. Hyde, *N. salsolae* Wanas., Gafforov & K.D. Hyde; **New combinations:** *Camarosporidiella caraganicola* (Phukhams. et al.) Phukhams., Wanas. & K.D. Hyde, *Ca. aborescentis* (Phukhams. et al.) Phukhams., Wanas. & K.D. Hyde, *Ca. arezzoensis* (Tibpromma et al.) Wanas. & K.D. Hyde, *Ca. celtidis* (Shear) Thambugala, Wanas. & K.D. Hyde, *Ca. clematidis* (Wijayaw. et al.) Wijayaw., Wanas. & K.D. Hyde, *Ca. elongata* (Fr.) Wanas., Wijayaw. & K.D. Hyde, *Ca. laburni* (Pers.) Wanas., Bulgakov, Camporesi & K.D. Hyde, *Ca. laburnicola* (R.H. Perera et al.) Wanas. & K.D. Hyde, *Ca. moricola* (Chethana et al.) Wanas. & K.D. Hyde, *Ca. robinicola* (Wijayaw. et al.) Wijayaw., Wanas. & K.D. Hyde, *Ca. spartii* (Trail) Wijayaw., Wanas. & K.D. Hyde, *Neocamarosporium chenopodii* (Ellis & Kellerm.) Wanas. & K.D. Hyde, *N. obiones* (Jaap) Wanas. & K.D. Hyde, *Staurosphaeria aloes* (Crous & M.J. Wingf.) Crous, Wanas. & K.D. Hyde; **New name:** *Staurosphaeria lyciicola* (Crous & R.K. Schumach.) Crous, Wanas. & K.D. Hyde; **Epitypification (basonym):** *Staurosphaeria lycii* Rabenh; **Generic abbreviations:** *Camarosporidiella*: Ca., *Camarosporium*: Cm., *Camarosporomyces*: Cs. & *Cucurbitaria*: Cu.

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## INTRODUCTION

Morphological characteristics, cultural studies and host-fungal association have been considered as important aspects in the traditional taxonomy of coelomycetous fungi (Sutton 1980, Sivanesan 1984, Nag Raj 1993, Jeewon et al. 2002, 2003b, 2004, Wijayawardene et al. 2016). However, morphological plasticity of several coelomycetous genera led to poor generic

and species delimitation, often resulting in incorrect taxonomic placement (Jeewon et al. 2003a, Shenoy et al. 2007, Wijayawardene et al. 2016). Proposing new genera (e.g. *Vermisporium/Seimatosporium*, fide Barber et al. 2011) and linking asexual genera with more than one sexual genus (e.g. *Phoma* and *Camarosporium*, fide Crous & Groenewald 2017) have resulted in taxonomic controversies among taxonomists and plant-pathologists (Wijayawardene et al. 2012a, b, Hyde et al.

2013, Crous *et al.* 2015a). DNA-based sequence analyses have so far provided reliable evidence for more precise generic boundaries (e.g. *Pestalotiopsis* fide Jeewon *et al.* 2003b, 2004, Maharachchikumbura *et al.* 2012, 2014a, b, *Phoma* fide de Gruyter *et al.* 2009, 2012, Chen *et al.* 2015, *Camarosporium* fide Crous *et al.* 2013, Wijayawardene *et al.* 2014b, 2015, 2016, *Coniothyrium* fide Verkley *et al.* 2004, 2014, Wijayawardene *et al.* 2016) and resolution of species complexes (e.g. *Diplodia* fide Phillips *et al.* 2008, *Colletotrichum* fide Damm *et al.* 2012, 2014).

The genus *Camarosporium* was introduced by Schulzer (1870) with *Cm. quaternatum* as the type species, and it is one of the largest coelomycetous genera, comprising over 500 epithets in Index Fungorum (2017). Several *Camarosporium* species have been reported as important plant pathogens with a worldwide distribution. *Camarosporium pistaciae* is known as a common pathogen responsible for blight of the shoots and panicles in pistachio production in Greece (Assimakopoulou & Elena 2010). Smith *et al.* (1988) listed *Camarosporium dalmaticum*, *Cm. flaccidum*, *Cm. pistaciae*, and *Cm. strobilinum* as plant pathogens in Europe. *Camarosporium* species are reported as causing damage in the cut-flower industry in the USA. (Taylor *et al.* 2001). *Camarosporium* species are also reported as common pathogens of deciduous trees in Europe and *Cm. pini* induces severe infection that can result in significant growth reduction to pine plantations (Ivanová & Bernadovičová 2010).

Sutton (1980) pointed out the heterogeneity of the genus, citing *Camarosporium propinquum* as an example. Sutton's (1980) prediction was confirmed by Wijayawardene *et al.* (2014c), who reported that *Cm. propinquum* should be accommodated in *Didymosphaeriaceae*. *Camarosporium* has been linked to *Cucurbitaria* (Kirk *et al.* 2008, Wijayawardene *et al.* 2012b, Doilom *et al.* 2013), *Leptosphaeriaceae* (Schoch *et al.* 2009) and *Botryosphaeriales* (Kirk *et al.* 2008, Liu *et al.* 2012, Wijayawardene *et al.* 2012b), although Crous *et al.* (2006) reported that *Cm. quaternatum* (based on CBS 134.97 culture, now described as *Libertasomyces quercus*; Crous & Groenewald 2017) does not belong to the *Botryosphaeriales*. Further evidence was provided that camarosporium-like taxa are polyphyletic within *Pleosporales* (Crous *et al.* 2014a, b, Wanasinghe *et al.* 2014a, Wijayawardene *et al.* 2014a, c, 2016, Crous & Groenewald 2017), leading to more taxonomic confusion of *Camarosporium* and camarosporium-like taxa. In a recent study, Crous & Groenewald (2017) designated an epitype for *Cm. quaternatum* and treated *Camarosporium* s. str. in *Coniothyriaceae*, and reported this complex to have phoma-like synasexual morphs, and pleospora-like sexual morphs. To date there is DNA sequence data for only a small number of species, and the validity of taxonomic concepts and other species remains uncertain. Therefore, it has been necessary to recollect these taxa from type localities, isolate them in axenic culture, and analyse their DNA sequence data to better understand their morpho- and phylotaxonomy. Given the considerable taxonomic confusion among *Camarosporium* and its allies and its familial placement, this study was undertaken to answer the following questions: (i) Do camarosporium-like taxa represent a natural group?; (ii) What are the allied sexual and synasexual morphs of camarosporium-like taxa?; (iii) Where does *Camarosporium quaternatum* position itself within the *Pleosporineae*?

## MATERIALS AND METHODS

### Specimens and isolates

Fresh camarosporium-like specimens were collected in Europe (Russia and Italy) and Asia (Thailand and Uzbekistan) from various host plants. Uzbekistan specimens were loaned from Tashkent Mycological Herbarium (TASM), Tashkent. The specimens were examined following the methods described in Wanasinghe *et al.* (2014a). Axenic strains were established from single spores as described in Chomnunti *et al.* (2014), with a modification of the incubation temperature at 16 °C overnight in the dark. Germinated ascospores and conidia were observed with a Motic SMZ 168 Stereo Zoom microscope and transferred to potato dextrose agar (PDA; 39 g/L distilled water, Difco potato dextrose) for extraction of DNA, determination of growth rates and observation of cultural characteristics. The specimens are deposited at Mae Fah Luang University (MFLU) Herbarium, Chiang Rai, Thailand and the New Zealand Fungal Herbarium (PDD). Living cultures are deposited at the Culture Collection of Mae Fah Luang University (MFLUCC) and the Westerdijk Fungal Biodiversity Institute in Utrecht, the Netherlands (CBS)

### Morphological classification

Digital images of the fruiting structures were captured with a Canon 450D digital camera fitted to a Nikon ECLIPSE 80i compound microscope. Squash mount preparations were prepared to determine micro-morphology, and free hand sections of sporocarps made to observe the shapes of ascomata/conidiomata and peridium structures. Measurements of morphological structures were taken from the widest part of each structure. Whenever possible, more than 30 measurements were made. The lengths and widths were measured using the Tarosoft (R) Image Frame Work program and images used for figures processed with Adobe Photoshop CS3 Extended v. 10.0 (Adobe®, San Jose, CA). Three sets of duplicate cultures of each isolate were measured to determine colony characteristics on PDA at 16 °C in the dark. Colony size was determined, and colour rated according to the colour charts of Rayner (1970) after 3 wk of incubation.

### DNA extraction, PCR and sequencing

Isolates were grown on PDA for 3–4 wk at 16 °C and total genomic DNA was extracted from 50 to 100 mg of mycelium scraped from the edges of the growing cultures (Wu *et al.* 2001). Mycelium was ground to a fine powder in liquid nitrogen and DNA was extracted using the Biospin Fungus Genomic DNA Extraction Kit, BSC14S1 (BioFlux, P.R. China) following the instructions of the manufacturer. When fungi failed to germinate and grow in culture, DNA was extracted directly from ascomata using a DNA extraction kit (E.Z.N.A.® Forensic DNA kit, D3591-01, Omega Bio-Tek) following Telle & Thines (2008). DNA were stored at 4 °C for use in regular work and duplicated at –20 °C for long term storage. DNA sequence data was obtained from the partial sequences of four loci: the internal transcribed spacers (ITS1-5.8S nrDNA-ITS2, ITS), small subunit nrDNA (18S, SSU), large subunit nrDNA (28S, LSU) and translation elongation factor 1-alpha gene (*tef1*). Nuclear ITS regions were amplified using the primers ITS5 and ITS4 (White *et al.* 1990). The LSU was amplified using the primers LROR (Rehner &

Samuels 1994) and LR5 (Vilgalys & Hester 1990), the SSU using the primers NS1 and NS4 (White *et al.* 1990), and *tef1* using primers EF1-983F and EF1-2218R (Rehner & Buckley 2005). The polymerase chain reaction (PCR) was carried out with a final volume of 25  $\mu$ L under the following protocol: 12.5  $\mu$ L of 2  $\times$  Power Taq PCR MasterMix (a premix and ready to use solution, including 0.1 Units/ $\mu$ L Taq DNA Polymerase, 500  $\mu$ M dNTP Mixture each (dATP, dCTP, dGTP, dTTP), 20 mM Tris-HCL pH 8.3, 100 mM KCl, 3 mM MgCl<sub>2</sub>, stabilizer and enhancer), 1  $\mu$ L of each primer (10  $\mu$ M), 1  $\mu$ L genomic DNA extract and 9.5  $\mu$ L deionised water. The reaction was then allowed to run for 35 cycles. The PCR profile was as follows: initial denaturation 95 °C for 5 min, 35 cycles of denaturation at 95 °C for 90 s, annealing for 90 s, elongation at 72 °C for 1 min, and final extension at 72 °C for 10 min. The annealing temperature was 55 °C for ITS, LSU, *tef1* and 48 °C for SSU. The amplified PCR fragments were sequenced by BGI, Ltd., Shenzhen, P.R. China. Sequences were deposited in GenBank (Tables 1 and 2).

## Sequence alignment and phylogenetic analyses

Sequences generated from different primers of the four genes were analysed with other sequences retrieved from GenBank. Sequences with high similarity indices were determined from a BLAST search to find the closest matches with taxa in *Pleosporineae*, and from recently published data (Liu *et al.* 2015, Grum-Grzhimaylo *et al.* 2016, Crous & Groenewald 2017, Tibpromma *et al.* 2017). The sequences were aligned in MAFFT v. 7 with the web server (<http://mafft.cbrc.jp/alignment/server/>), using iterative refinements as E-INS-i method for ITS & *tef1*, and as G-INS-i method for LSU and SSU (Katoch & Standley 2013). The alignment was edited where necessary with BioEdit v. 7.0.5.2 (Hall 1999). The alignment properties for the individual genes are shown in the Table 3. The final alignment and tree were deposited in TreeBASE, submission ID: 21397 (<http://www.treebase.org/>).

The final alignment (combined LSU, SSU, *tef1* and ITS loci) included 212 strains, (representing 16 selected families within the *Pleosporineae*), the new taxa proposed in this study, and *Cyclothyriella rubronotata* (CBS 141486 & CBS 121892) as the outgroup taxon. Phylogenetic analyses of both individual and combined aligned data were based on Maximum Likelihood (ML), Maximum Parsimony (MP) and Bayesian analyses. The sequence alignments were converted to NEXUS file format (.nex) for maximum parsimony and Bayesian analyses using ClustalX2 v. 1.83 (Thompson *et al.* 1997). The NEXUS file was prepared for MrModeltest v. 2.2 after deleting the symbols =“ABCDEFGHIKLMNOPQRSTUVWXYZ” (Nylander 2004) in PAUP (Phylogenetic Analysis Using Parsimony) v. 4.0b10 (Swofford 2003). For the Randomized Accelerated Maximum Likelihood (RAxML) analysis, sequence alignments were converted to PHYLIP file format (.phy) using ALTER (alignment transformation environment: <http://sing.ei.uvigo.es/ALTER/>; 2017).

The MP bootstrap analysis was performed with PAUP, with 1000 bootstrap replicates using 10 rounds of heuristic search replicates with random addition of sequences and subsequent TBR branch swapping (MULTREES option in effect, steepest descent option not in effect) during each bootstrap replicate, with each replicate limited to 1 M rearrangements. All characters were unordered and given equal weight; gaps were treated as missing data; the COLLAPSE command was set to minbrlen. Descriptive tree statistics for parsimony were calculated for trees generated under different optimality criteria: Tree Length (TL), Consistency

Index (CI), Retention Index (RI), Relative Consistency Index (RC) and Homoplasy Index (HI). The Kishino-Hasegawa tests (Kishino & Hasegawa 1989) were performed to determine whether trees were significantly different. Other details are outlined in Jeewon *et al.* (2003b) and Promputtha *et al.* (2007).

The evolutionary models for Bayesian analysis and ML were selected independently for each locus using MrModeltest v. 2.3 (Nylander 2004) under the Akaike Information Criterion (AIC) implemented in PAUP v. 4.0b10. The GTR + I + G model was selected as the best-fit model for each locus in both Bayesian and ML analyses.

The Bayesian analysis was performed in MrBayes v. 3.1.2 (Huelsenbeck & Ronquist 2001) to evaluate Posterior probabilities (PP) (Rannala & Yang 1996, Zhaxybayeva & Gogarten 2002) by Markov Chain Monte Carlo sampling (BMCMC). Six simultaneous Markov chains were run for 5 M generations and trees were sampled every 500<sup>th</sup> generation. The distribution of log-likelihood scores was examined to determine the stationary phase for each search and to decide if extra runs were required to achieve convergence, using the program Tracer v. 1.5 (Rambaut & Drummond 2007). All sampled topologies beneath the asymptote (10 %) were discarded as part of a burn-in procedure; the remaining trees were used for calculating PP in the majority rule consensus tree.

The ML trees were generated using the RAxML-HPC2 on XSEDE (v. 8.2.8) (Stamatakis *et al.* 2008, Stamatakis 2014) in the CIPRES Science Gateway platform (Miller *et al.* 2010) using a GTR + I + G model of evolution. Phylograms were visualised with FigTree v. 1.4.0 (Rambaut 2012) and annotated in Microsoft PowerPoint (2007) or Adobe Illustrator® CS5 (v. 15.0.0, Adobe®, San Jose, CA).

## RESULTS

### Phylogenetic analyses

Topologies of trees (ML, MP and PP) for each gene dataset were compared and the overall tree topology was congruent to those obtained from the combined dataset.

The RAxML analysis of the combined dataset yielded a best scoring tree (Fig. 1) with a final ML optimisation likelihood value of -24419.107973. The matrix had 1 273 distinct alignment patterns, with 24.87 % of undetermined characters or gaps. Parameters for the GTR + I + G model of the combined LSU, SSU, *tef1* and ITS were as follows: Estimated base frequencies; A = 0.24346, C = 0.239263, G = 0.26821, T = 0.249067; substitution rates AC = 1.464074, AG = 3.479937, AT = 2.089279, CG = 0.715575, CT = 7.524749, GT = 1.000; proportion of invariable sites I = 0.630738; gamma distribution shape parameter  $\alpha$  = 0.492847. The maximum parsimonious dataset consisted of 3 461 characters, of which 2 583 were constant, 745 parsimony-informative and 133 parsimony-uninformative. The parsimony analysis of the data matrix resulted in the maximum of 1 000 equally most parsimonious trees with a length of 3 928 steps (CI = 0.341, RI = 0.793, RC = 0.27, HI = 0.659) in the first tree. The Bayesian analysis resulted in 10 000 trees after 5 M generations. The first 1 000 trees, representing the burn-in phase of the analyses, were discarded, while the remaining 9 000 trees were used for calculating posterior probabilities in the majority rule consensus tree.

**Table 1.** Cultures and related GenBank accession numbers of *Pleosporineae* used in the phylogenetic analyses.

Taxon	Culture accession no. <sup>1</sup>	GenBank accession no. <sup>2</sup>				References
		ITS	LSU	SSU	<i>tef1</i>	
<i>Acrocalymma aquatica</i>	MFLUCC 11-0208	NR_121544	JX276952	JX276953	–	Zhang <i>et al.</i> (2012)
<i>A. ficus</i>	CBS 317.76	NR_137953	KP170712	–	KP170663	Trakunyingcharoen <i>et al.</i> (2014)
<i>A. medicaginis</i>	CPC 24340	KP170625	KP170718	–	–	Trakunyingcharoen <i>et al.</i> (2014)
	CPC 24345	KP170620	KP170713	–	–	Trakunyingcharoen <i>et al.</i> (2014)
<i>Alternaria alternata</i>	MFLUCC 14-1184	KP334711	KP334701	KP334721	KP334735	Ariyawansa <i>et al.</i> (2015c)
<i>A. eureka</i>	CBS 193.86	–	KC584331	KC584589	–	Woudenberg <i>et al.</i> (2013)
<i>Alternariaster bidentis</i>	CBS 134021	KC609333	KC609341	–	–	Woudenberg <i>et al.</i> (2013)
<i>A. helianthi</i>	CBS 327.69	KC609335	KC584369	KC584627	–	Woudenberg <i>et al.</i> (2013)
<i>Amarenographium ammophilae</i>	MFLUCC 17-296	KU848196	KU848197	KU848198	–	Wijayawardene <i>et al.</i> (2016)
<i>Ascochyta pisi</i>	CBS 126.54	–	DQ678070	DQ678018	DQ677913	Schoch <i>et al.</i> (2006)
<i>Ascochyliandra marina</i>	MD6011*	–	KT252905	KT252907	–	Ariyawansa <i>et al.</i> (2015a)
	MD6012*	–	KT252906	–	–	Ariyawansa <i>et al.</i> (2015a)
<i>Boeremia exigua</i>	CBS 431.74	FJ427001	EU754183	EU754084	GU349080	De Gruyter <i>et al.</i> (2009)
<i>Camarosporidiella aborescentis</i>	MFLUCC 14-0604	KP711377	KP711378	KP711379	–	Liu <i>et al.</i> (2015)
<i>Ca. arezzoensis</i>	CPC 31420	KY929127	KY929163	–	–	Crous & Groenewald (2017)
	MFLUCC 14-0238	KP120926	KP120927	KP120928	–	Tibpromma <i>et al.</i> (2016)
<i>Ca. caraganicola</i>	MFLUCC 14-0605	KP711380	KP711381	KP711382	–	Liu <i>et al.</i> (2015)
<i>Ca. celtidis</i>	MFLUCC 15-0444	KU697613	KU697614	KU697615	KU697612	Thambugala <i>et al.</i> (2016)
	MFLU 15-3551	–	MF434213	MF434301	–	Wijayawardene <i>et al.</i> (2016)
<i>Ca. clematidis</i>	MFLUCC 13-0336	KJ562213	KJ562188	KJ589414	–	Wijayawardene <i>et al.</i> (2014a)
<i>Ca. elongata</i>	CBS 171.55	–	DQ678061	DQ678009	DQ677904	Schoch <i>et al.</i> (2006)
	MFLUCC 14-0260	–	KJ724249	–	–	Wijayawardene <i>et al.</i> (2014a)
<i>Ca. laburnicola</i>	MFLUCC 14-0565	KY497784	KY497779	KY497781	KY497785	Tibpromma <i>et al.</i> (2017)
<i>Ca. moricola</i>	MFLUCC 16-1396	KY053887	KY053890	KY053893	–	Tibpromma <i>et al.</i> (2017)
	MFLUCC 16-1397	KY053888	KY053891	KY053894	–	Tibpromma <i>et al.</i> (2017)
	MFLUCC 16-1398	KY053889	KY053892	KY053895	–	Tibpromma <i>et al.</i> (2017)
<i>Ca. robinicola</i>	MFLUCC 13-0527	KJ562214	KJ589412	KJ589415	–	Wijayawardene <i>et al.</i> (2014a)
	MFLUCC 14-0620	NR_137970	KP744478	KP753948	–	Liu <i>et al.</i> (2015)
<i>Camarosporidiella</i> sp.	CPC 25960	KY929129	KY929164	–	KY929198	Crous & Groenewald (2017)
	CPC 25962	KY929130	KY929165	–	KY929199	Crous & Groenewald (2017)
	CPC 27667	KY929133	KY929168	–	–	Crous & Groenewald (2017)
	CPC 30379	KY929134	KY929169	–	–	Crous & Groenewald (2017)
	CPC 31031	KY929131	KY929166	–	–	Crous & Groenewald (2017)
	CPC 31632	KY929132	KY929167	–	–	Crous & Groenewald (2017)
	CPC 12441	KY929128	DQ377885	–	–	Crous & Groenewald (2017)
<i>Ca. spartii</i>	MFLUCC 13-0548	KJ562215	KJ589413	KJ589416	–	Wijayawardene <i>et al.</i> (2014a)
<i>Camarosporium quaternatum</i>	CPC 23216	KY929135	KY929170	–	KY929200	Crous & Groenewald (2017)
	CPC 31081	KY929136	KY929171	–	KY929201	Crous & Groenewald (2017)
	CPC 31518	KY929137	KY929172	–	KY929202	Crous & Groenewald (2017)
<i>Camarosporomyces flavigenus</i>	CBS 314.80	KY929138	GU238076	–	–	Crous & Groenewald (2017)
<i>Cochliobolus heterostrophus</i>	CBS 134.39	DQ491489	AY544645	AY544727	DQ497603	Schoch <i>et al.</i> (2006)
<i>Coniothyrium carteri</i>	CBS 105.91	JF740181	GQ387594	GQ387533	–	De Gruyter <i>et al.</i> (2010)
<i>C. dolichi</i>	CBS 124140	JF740183	GQ387611	GQ387550	–	De Gruyter <i>et al.</i> (2010)
	CBS 124140	JF740183	GQ387611	GQ387550	–	De Gruyter <i>et al.</i> (2010)
<i>C. glycines</i>	CBS 124455	JF740184	GQ387597	GQ387536	–	De Gruyter <i>et al.</i> (2010)
<i>C. obiones</i>	CBS 453.68	–	DQ678054	DQ678001	DQ677895	Schoch <i>et al.</i> (2006)
<i>C. palmarum</i>	CBS 400.71	AY720708	EU754153	EU754054	–	De Gruyter <i>et al.</i> (2009)
	CBS 758.73	–	EU040225	EU754055	–	Crous <i>et al.</i> (2007)
<i>C. telephii</i>	CBS 188.71	JF740188	GQ387599	GQ387538	–	De Gruyter <i>et al.</i> (2010)
	CBS 856.97	JF740189	GQ387600	GQ387539	–	De Gruyter <i>et al.</i> (2010)
<i>Cucurbitaria berberidis</i>	CBS 363.93	JF740191	GQ387606	GQ387545	–	De Gruyter <i>et al.</i> (2010)
	MFLUCC 11-0386	–	KC506795	KC506799	–	Doilom <i>et al.</i> (2013)
<i>Cu. ephedricola</i>	HA 42*	–	KT313007	KT313005	–	Ariyawansa <i>et al.</i> (2015a)
<i>Cyclothyriella rubronotata</i>	CBS 121892	KX650541	KX650541	–	KX650516	Jaklitsch & Voglmayr (2016)
	CBS 141486	KX650544	KX650544	KX650507	KX650519	Jaklitsch & Voglmayr (2016)

Table 1. (Continued).

Taxon	Culture accession no. <sup>1</sup>	GenBank accession no. <sup>2</sup>				References
		ITS	LSU	SSU	<i>tef1</i>	
<i>Didymella exigua</i>	CBS 183.55	GU237794	EU754155	EU754056	–	De Gruyter <i>et al.</i> (2009)
<i>Didymellocamarosporium tamaricis</i>	MFLUCC 14-0241	–	KU848183	KU848182	–	Wijayawardene <i>et al.</i> (2016)
<i>Dimorphosporicola tragani</i>	CBS 570.85	KU728497	KU728536	–	–	Crous & Groenewald (2016)
<i>Dothidotthia aspera</i>	CPC 12928	–	EU673272	EU673225	–	Phillips <i>et al.</i> (2008)
	CPC 12930	–	EU673276	EU673228	–	Phillips <i>et al.</i> (2008)
	CPC 12932	–	EU673274	EU673226	–	Phillips <i>et al.</i> (2008)
	CPC 12933	–	EU673275	EU673227	–	Phillips <i>et al.</i> (2008)
<i>D. symphoricarpi</i>	CPC 12929	–	EU673273	EU673224	–	Phillips <i>et al.</i> (2008)
<i>Foliophoma fallens</i>	CBS 161.78	KY929147	GU238074	GU238215	–	Crous & Groenewald (2017)
	CBS 284.70	KY929148	GU238078	GU238218	–	Crous & Groenewald (2017)
<i>Halojulella avicenniae</i>	BCC 20173	–	GU371822	GU371830	GU371815	Schoch <i>et al.</i> (2009)
	BCC 18422	–	GU371823	GU371831	GU371816	Schoch <i>et al.</i> (2009)
	JK 5326A	–	GU479790	GU479756	–	Schoch <i>et al.</i> (2009)
<i>Leptosphaeria maculans</i>	CBS 260.94	JF740235	JF740307	–	–	De Gruyter <i>et al.</i> (2012)
<i>Leptosphaerulina australis</i>	CBS 317.83	GU237829	GU301830	GU296160	GU349070	Schoch <i>et al.</i> (2009)
<i>Libertasomyces myopori</i>	CPC 27354	NR_145200	KX228332	–	–	Crous & Groenewald (2017)
<i>L. platani</i>	CPC 29609	KY173416	KY173507	–	–	Crous & Groenewald (2017)
<i>L. quercus</i>	CBS 134.97	KY929152	DQ377883	–	–	Crous & Groenewald (2017)
<i>Macroventuria anomochaeta</i>	CBS 525.71	GU237881	GU237984	GU238208	GU456262	Aveskamp <i>et al.</i> (2009)
<i>Melnikia anthoxanthii</i>	MFLUCC 14-1010	–	KU848204	KU848205	–	Wijayawardene <i>et al.</i> (2016)
<i>Neocamarosporium betae</i>	CBS 109410	–	EU754179	EU754079	GU349075	De Gruyter <i>et al.</i> (2009)
	CBS 523.66	FJ426981	U43483	U43466	–	Aveskamp <i>et al.</i> (2009)
<i>N. calvescens</i>	CBS 246.79	–	EU754131	EU754032	–	De Gruyter <i>et al.</i> (2009)
<i>N. chenopodii</i>	CBS 344.78	–	EU754132	EU754033	–	De Gruyter <i>et al.</i> (2009)
<i>N. chersinae</i>	CPC 27298	KY929153	KY929182	–	–	Crous & Groenewald (2017)
<i>N. chichastianum</i>	CBS 137502	KP004455	KP004483	–	–	Crous <i>et al.</i> (2014b)
<i>N. goegapense</i>	CPC 23676	KJ869163	KJ869220	–	–	Crous <i>et al.</i> (2014b)
<i>N. obiones</i>	CBS 432.77	GU230752	JF740267	JF740096	–	De Gruyter <i>et al.</i> (2012)
<i>Neocamarosporium</i> sp.	M303*	KJ443253	KJ443123	KJ443078	KJ443210	Grum-Grzhimaylo <i>et al.</i> (2016)
	M305*	KJ443255	KJ443125	KJ443080	KJ443212	Grum-Grzhimaylo <i>et al.</i> (2016)
	M311*	KJ443260	KJ443130	KJ443085	KJ443217	Grum-Grzhimaylo <i>et al.</i> (2016)
<i>Neophaeosphaeria agaves</i>	CPC 21264	KF777174	KF777227	–	–	Crous <i>et al.</i> (2013)
<i>N. filamentosa</i>	CBS 102203	–	JX681104	–	–	Verkley <i>et al.</i> (2014)
	CBS 102202	JF740259	GQ387577	GQ387516	GU349084	De Gruyter <i>et al.</i> (2010)
<i>Neoplatysporoides aloicola</i>	CPC 24435	KR476719	KR476754	–	–	Crous <i>et al.</i> (2015a, b)
<i>Ochrocladosporium elatum</i>	CBS 146.33	EU040233	EU040233	–	–	Crous & Groenewald (2017)
<i>O. frigidarii</i>	CBS 103.81	EU040234	EU040234	–	–	Crous & Groenewald (2017)
<i>Paradendryphiella salina</i>	CBS 142.60	DQ411540	KF156158	KF156098	DQ414251	De Gruyter <i>et al.</i> (2012) & Woudenberg <i>et al.</i> (2013)
<i>Paraleptosphaeria dryadis</i>	CBS 643.86	JF740213	GU301828	KC584632	GU349009	De Gruyter <i>et al.</i> (2012) & Woudenberg <i>et al.</i> (2013)
<i>P. rubi</i>	MFLUCC 14-0211	KT454726	KT454718	KT454733	–	Phookamsak <i>et al.</i> (2014)
<i>Phaeosphaeria chiangraina</i>	MFLUCC 13-0231	KM434270	KM434280	KM434289	KM434298	Phookamsak <i>et al.</i> (2014)
<i>P. musae</i>	MFLUCC 11-0133	KM434267	KM434277	KM434287	KM434296	Phookamsak <i>et al.</i> (2014)
<i>P. thysanolaenicola</i>	MFLUCC 10-0563	KM434266	KM434276	KM434286	KM434295	Phookamsak <i>et al.</i> (2014)
<i>Phaeosphaeriopsis dracaenicola</i>	MFLUCC 11-0193	KM434274	KM434284	KM434293	KM434302	Phookamsak <i>et al.</i> (2014)
	MFLUCC 11-0157	KM434273	KM434283	KM434292	KM434301	Phookamsak <i>et al.</i> (2014)
<i>Phoma herbarum</i>	CBS 276.37	FJ427022	DQ678066	DQ678014	DQ677909	Schoch <i>et al.</i> (2006)
	CBS 615.75	KF251212	KF251715	EU754087	KR184186	Schoch <i>et al.</i> (2006)
<i>Plenodomus guttulatus</i>	MFLUCC 15-1876	KT454721	KT454713	KT454729	–	Ariyawansa <i>et al.</i> (2015b)
<i>P. salviae</i>	MFLUCC 13-0219	KT454725	KT454717	KT454732	–	Ariyawansa <i>et al.</i> (2015b)

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Table 1. (Continued).

Taxon	Culture accession no. <sup>1</sup>	GenBank accession no. <sup>2</sup>				References
		ITS	LSU	SSU	<i>tef1</i>	
<i>Pleospora tarda</i>	CBS 714.68	KC584238	KC584345	KC584603	JQ672391	Woudenberg <i>et al.</i> (2013)
<i>Pyrenochaeta cava</i>	CBS 257.68	JF740260	EU754199	EU754100	–	De Gruyter <i>et al.</i> (2009)
<i>P. nobilis</i>	CBS 407.76	EU930011	DQ678096	EU754107	DQ677936	Schoch <i>et al.</i> (2006)
<i>P. phaeocomes</i>	DAOM 222769	DQ491507	DQ499596	DQ499595	DQ497607	Schoch <i>et al.</i> (2006)
<i>Shiraia bambusicola</i>	NBRC 30772	AB354991	AB354972	–	–	Morakotkarn <i>et al.</i> (2008)
	NBRC 30771	AB354990	AB354971	–	–	Morakotkarn <i>et al.</i> (2008)
	NBRC 30754	AB354988	AB354969	–	–	Morakotkarn <i>et al.</i> (2008)
	NBRC 30753	AB354987	AB354968	–	–	Morakotkarn <i>et al.</i> (2008)
<i>Staurophaeria aloes</i>	CPC 21572	KF777142	KF777198	–	–	Crous & Groenewald (2017)
<i>S. aptrootii</i>	CBS 483.95	KY929149	DQ377884	GU296141	GU349044	Crous & Groenewald (2017)
<i>S. lycicola</i>	CPC 30998	KY929150	KY929180	–	–	Crous & Groenewald (2017)
	CPC 31014	KY929151	KY929181	–	–	Crous & Groenewald (2017)
<i>Stemphylium vesicarium</i>	CBS 191.86	KC584239	GU238160	GU238232	DQ471090	Woudenberg <i>et al.</i> (2017), Aveskamp <i>et al.</i> (2010) & Spatafora <i>et al.</i> (2006)
<i>Subplenodomus valerianae</i>	CBS 630.68	JF740251	GU238150	GU238229	–	Aveskamp <i>et al.</i> (2009)
<i>S. violicola</i>	CBS 306.68	FJ427083	GU238156	GU238231	–	Aveskamp <i>et al.</i> (2009)

<sup>1</sup> BCC: Belgian Coordinated Collections of Microorganisms; CBS: Culture Collection of the Westerdijk Fungal Biodiversity Institute, Utrecht, the Netherlands; CPC: Personal collection of P.W. Crous, Utrecht, the Netherlands; DAOM: Canadian Collection of Fungal Cultures, Ottawa, Canada; E.G.S.: Personal collection of Dr. E.G. Simmons; IBRC: Iranian Biological Resources Center, Academic Center for Education Culture and Research (ACECR), Tehran, Iran; JK: J. Kohlmeyer; MFLUCC/MFLU: Mae Fah Luang University Culture Collection, Chiang Rai, Thailand; NBRC: NITE Biological Resource Center, Department of Biotechnology, National Institute of Technology and Evaluation, Kisarazu, Chiba, Japan. \*Strain designation from GenBank.

<sup>2</sup> ITS: Internal transcribed spacers; LSU: partial 28S nrDNA; SSU: partial 18S nrDNA; *tef1*: translation elongation factor 1-alpha gene.

Newly generated sequences from 75 isolates of camarosporium-like taxa grouped with *Camarosporium aborescentis*,  *Cm. arezzoensis*,  *Cm. aureum*,  *Cm. caraganicola*,  *Cm. clematidis*,  *Cm. elaeagnellum*,  *Cm. elongata*,  *Cm. laburnicola*,  *Cm. moricola*,  *Cm. robinicola*,  *Cm. spartii*,  *Cm. uniseriatum* and  *Cucurbitaria elongata* (fide Wijayawardene *et al.* 2014a, b, 2016, Tibpromma *et al.* 2015, 2017, Thambugala *et al.* 2016, Crous & Groenewald 2017). These taxa formed an isolated, well-supported clade (97 % ML, 97 % MP and 1.00 PP, Clade A, Fig. 1) within *Pleosporineae* which we formally introduce as *Camarosporidiellaceae*.

Six newly generated sequences, *Staurophaeria lycii* (MFLUCC 17-0210, MFLUCC 17-0211, MFLUCC 17-0720 and MFLUCC 17-0721), *S. rhamnicola* (MFLUCC 17-0813 and MFLUCC 17-0814) grouped with *Hazslinszkyomyces lycii* (CPC 31014 and CPC 30998), the type species of *Hazslinszkyomyces*, *H. aptrootii* (CBS 483.95) and *H. aloes* (CPC 21572). These taxa form a monophyletic clade (Clade B) in *Coniothyriaceae* with significant statistical support (92 % ML, 83 % MP and 1.00 PP, Fig. 1) and hereby being referred to as the genus *Staurophaeria*.

*Camarosporium quaternatum* and *Camarosporomyces flavigenus* always grouped together in a separate clade with high statistical support (86 % ML, 70 % MP and 1.00 PP, Clade C, Fig. 1). In different analyses, the placement of this clade is unstable and in this concatenated analysis, these taxa are basal to the *Leptosphaeriaceae*. We herein validate *Camarosporiaceae* to accommodate *Camarosporium* and *Camarosporomyces*.

*Neocamarosporium korfii* (MFLUCC 17-0745), *N. lamiaeum* (MFLUCC 17-560 and MFLUCC 17-0750), *N. salicornicola* (MFLUCC 15-0957) and *N. salsolae* (MFLUCC 17-0826 and MFLUCC 17-0827) grouped with *Coniothyrium obiones* (CBS 453.68), *Dimorphosporicola tragani* (CBS 570.85), *Neocamarosporium betae* (CBS 109410 and CBS 523.66), *N. calvescens* (CBS 246.79), *N. chenopodii* (CBS 344.78), *N.*

*chersinae* (CPC 27298), *N. chichastianum* (CBS 137502), *N. goegapense* (CPC 23676), *N. obiones* (CBS 432.77) and *Neocamarosporium* sp. (IBRC M 30134, IBRC M 30264, IBRC M 30177, IBRC M 30257, IBRC M 30243, IBRC M 30263, M303, M305 and M311) from a distinct clade (Clade D) with high bootstrap values (95 % and 79 % in ML and MP analyses respectively) and high PP value (1.00). Multi-gene phylogenetic analyses herein support the establishment of a new family, *Neocamarosporiaceae* fam. nov. for Clade D (Fig. 1).

Apart from establishing three new families, our multi-gene phylogeny, with relatively good support, this study also clarifies interfamilial relationships. In particular, we note that all the families herein are well supported monophyletic lineages. The *Cucurbitariaceae* was previously considered as a close ally to *Coniothyriaceae* (Hyde *et al.* 2013), *Phaeosphaeriaceae* (Wijayawardene *et al.* 2014a), *Pleosporaceae* (Doilom *et al.* 2013, Wanasinghe *et al.* 2014b), but this study demonstrates a sister relationship to *Neophaeosphaeriaceae*. It is also interesting to note that *Neocamarosporiaceae* shares close affinities to *Pleosporaceae* and *Libertasomycetaceae*. The affinities of *Foliophoma*, which is characterized by eustromatic conidiomata, uni- to multi-loculate with 1–3 ostioles and conidiogenous cells with periclinal thickening or percurrent proliferation at apex (Crous & Groenewald 2017), warrants further investigations as only one species has been described so far. *Phaeosphaeriaceae* and *Shiraiaceae* are closely related while *Didymellaceae* is sister family to *Dothidotthiaceae*. In other analyses (results not shown) the *Microsphaeropsidaceae* (introduced by Chen *et al.* 2015) clusters basal to the *Didymellaceae*. The other families viz. *Acrocallymmaceae*, *Ascocylindricaceae* and *Halojulellaceae*, with relatively few taxa are basal families of the *Pleosporineae*.

***Camarosporiaceae*** Wanas., Wijayaw., K.D. Hyde & Crous, fam. nov. MycoBank MB821938; Facesoffung number: FoF 03527.

**Table 2.** Cultures and related GenBank accession numbers of *Pleosporineae* obtained in this study.

Taxon	Original no.	Culture no. <sup>1</sup>	Specimen no. <sup>2</sup>	Host or substrate	Country	GenBank accession no. <sup>3</sup>				
						ITS	LSU	SSU	<i>tef1</i>	
<i>Camarosporidiella aborescentis</i>	T-0477	–	MFLU 15-2181	<i>Colutea orientalis</i>	Russia	MF434115	MF434202	MF434290	MF434378	
	IT2674	MFLUCC 17-0660	MFLU 15-3630	<i>Colutea arborescens</i>	Italy	MF434116	MF434203	MF434291	MF434379	
	NK076	MFLUCC 17-0738	MFLU 16-2387	<i>Amorpha</i> sp.	Russia	MF434117	MF434204	MF434292	MF434380	
<i>Ca. arezzoensis</i>	T-0009	MFLUCC 14-0891	MFLU 17-0455	<i>Amorpha fruticosa</i>	Russia	MF434118	MF434205	MF434293	MF434381	
	T-0016	MFLUCC 14-0899 = CBS 143102	MFLU 17-0462	<i>Cytisus austriacus</i>	Russia	MF434119	MF434206	MF434294	MF434382	
	T-0064	MFLUCC 14-0913 = CBS 143103	MFLU 17-0475	<i>Cytisus borysthenticus</i>	Russia	MF434120	MF434207	MF434295	MF434383	
	T-0072	MFLUCC 14-0916 = CBS 143104	MFLU 17-0478	<i>Cytisus austriacus</i>	Russia	MF434121	MF434208	MF434296	MF434384	
<i>Ca. caraganicola</i>	T-0005	MFLUCC 14-0887 = CBS 143105	MFLU 17-0453	<i>Caragana frutex</i>	Russia	MF434122	MF434209	MF434297	MF434385	
	T-0013	MFLUCC 14-0896 = CBS 143106	MFLU 17-0459	<i>Caragana frutex</i>	Russia	MF434123	MF434210	MF434298	MF434386	
	T-0538	MFLUCC 17-0697 = CBS 143107	MFLU 15-2242	<i>Caragana frutex</i>	Russia	MF434124	MF434211	MF434299	MF434387	
	T-1488	MFLUCC 17-0726 = CBS 143108	MFLU 16-1782	<i>Caragana frutex</i>	Russia	MF434125	MF434212	MF434300	MF434388	
<i>Ca. celtidis</i>	T-0193	–	MFLU 15-1897	<i>Spiraea</i> sp.	Russia	MF434126	MF434214	MF434302	MF434389	
	T-0332	–	MFLU 15-2036	<i>Elymus repens</i>	Russia	MF434127	MF434215	MF434303	MF434390	
	T-0002	MFLUCC 14-0884 = CBS 143109	MFLU 17-0450	<i>Maclura pomifera</i>	Russia	MF434128	MF434216	MF434304	MF434391	
	T-0040	MFLUCC 14-0904 = CBS 143110	MFLU 17-0466	<i>Gleditsia triacanthos</i>	Russia	MF434129	MF434217	MF434305	MF434392	
	T-0358	MFLUCC 17-556	MFLU 15-2062	<i>Betula pendula</i>	Russia	MF434130	MF434218	MF434306	MF434393	
	T-0224	MFLUCC 17-0676 = CBS 143111	MFLU 15-1928	<i>Prunus padus</i>	Russia	MF434131	MF434219	MF434307	MF434394	
	T-0239	MFLUCC 17-0679	MFLU 15-1943	<i>Morus alba</i>	Russia	MF434132	MF434220	MF434308	MF434395	
	T-0767	MFLUCC 17-0701 = CBS 143112	MFLU 15-2912	<i>Ailanthus altissima</i>	Russia	MF434133	MF434221	MF434309	MF434396	
	NK041	MFLUCC 17-0735	MFLU 16-2358	<i>Robinia</i> sp.	Russia	MF434134	MF434222	MF434310	MF434397	
	<i>Ca. elaeagnicola</i>	T-0220	–	MFLU 15-1924	<i>Artemisia santonicum</i>	Russia	MF434135	MF434223	MF434311	MF434398
T-0511		–	MFLU 15-2215	<i>Elaeagnus angustifolia</i>	Russia	MF434136	MF434224	MF434312	MF434399	
T-0051		MFLUCC 14-0908 = CBS 143113	MFLU 17-0470	<i>Elaeagnus angustifolia</i>	Russia	MF434137	MF434225	MF434313	MF434400	
T-0055		MFLUCC 14-0911 = CBS 143114	MFLU 17-0473	<i>Elaeagnus angustifolia</i>	Russia	MF434138	MF434226	MF434314	MF434401	
T-0061		MFLUCC 14-0912 = CBS 143115	MFLU 17-0474	<i>Elaeagnus angustifolia</i>	Russia	MF434139	MF434227	MF434315	MF434402	
T-0813		MFLUCC 17-0705	MFLU 15-2956	<i>Elaeagnus angustifolia</i>	Russia	MF434140	MF434228	MF434316	MF434403	
T-0815		MFLUCC 17-0706	MFLU 15-2958	<i>Elaeagnus angustifolia</i>	Russia	MF434141	MF434229	MF434317	MF434404	
T-0819		MFLUCC 17-0707	MFLU 15-2962	<i>Elaeagnus angustifolia</i>	Russia	MF434142	MF434230	MF434318	MF434405	
T-1186		MFLUCC 17-0712	MFLU 16-1481	<i>Elaeagnus angustifolia</i>	Russia	MF434143	MF434231	MF434319	MF434406	
NK067		MFLUCC 17-0737	MFLU 16-2382	<i>Elaeagnus angustifolia</i>	Russia	MF434144	MF434232	MF434320	MF434407	
<i>Ca. eufemiana</i>		IT1621	MFLUCC 17-0207 = CBS 143116	MFLU 16-0182	<i>Cytisus</i> sp.	Italy	MF434145	MF434233	MF434321	MF434408
<i>Ca. halimodendri</i>		T-0018	MFLUCC 14-0901 = CBS 143117	MFLU 17-0463	<i>Halimodendron halodendron</i>	Russia	MF434146	MF434234	MF434322	MF434409
	T-0041	MFLUCC 14-0905	MFLU 17-0467	<i>Halimodendron halodendron</i>	Russia	MF434147	MF434235	MF434323	MF434410	
	T-0050	MFLUCC 14-0907 = CBS 143118	MFLU 17-0469	<i>Caragana frutex</i>	Russia	MF434148	MF434236	MF434324	MF434411	
	T-0066	MFLUCC 14-0914	MFLU 17-0476	<i>Cytisus podolicus</i>	Russia	MF434149	MF434237	MF434325	MF434412	
	T-0419	MFLUCC 17-0212 = CBS 143119	MFLU 15-2123	<i>Lycium barbarum</i>	Russia	MF434150	MF434238	MF434326	MF434413	
	T-0468	MFLUCC 17-0691	MFLU 15-2172	<i>Halimodendron halodendron</i>	Russia	MF434151	MF434239	MF434327	MF434414	
<i>Ca. italica</i>	IT1283	MFLUCC 13-0547	MFLU 17-0139	<i>Coronilla emerus</i>	Italy	MF434152	MF434240	MF434328	MF434415	
<i>Ca. laburni</i>	T-0003	MFLUCC 14-0885	MFLU 17-0451	<i>Laburnum anagyroides</i>	Russia	MF434153	MF434241	MF434329	MF434416	
	IT83	MFLUCC 14-0919 = CBS 143121	MFLU 16-0094	<i>Laburnum anagyroides</i>	Italy	MF434154	MF434242	MF434330	MF434417	

(continued on next page)

Table 2. (Continued).

Taxon	Original no.	Culture no. <sup>1</sup>	Specimen no. <sup>2</sup>	Host or substrate	Country	GenBank accession no. <sup>3</sup>			
						ITS	LSU	SSU	<i>tef1</i>
	T-0811	MFLUCC 17-0704 = CBS 143122	MFLU 15-2954	<i>Laburnum anagyroides</i>	Russia	MF434155	MF434243	MF434331	MF434418
	T-0838	MFLUCC 17-0709	MFLU 15-2981	<i>Laburnum</i> sp.	Russia	MF434156	MF434244	MF434332	MF434419
	CR029	MFLUCC 17-0751 = CBS 143120	MFLU 17-1434	<i>Laburnum anagyroides</i>	Russia	MF434157	MF434245	MF434333	MF434420
	CR032	MFLUCC 17-0752	MFLU 17-1435	<i>Laburnum anagyroides</i>	Russia	MF434158	MF434246	MF434334	MF434421
<i>Ca. mackenziei</i>	T-0001	MFLUCC 14-0883 = CBS 143123	MFLU 17-0449	<i>Caragana arborescens</i>	Russia	MF434159	MF434247	MF434335	MF434422
	T-0011	MFLUCC 14-0893 = CBS 143124	MFLU 17-0457	<i>Caragana arborescens</i>	Russia	MF434160	MF434248	MF434336	MF434423
	T-0810	MFLUCC 17-0703	MFLU 15-2953	<i>Caragana</i> sp.	Russia	MF434161	MF434249	MF434337	MF434424
<i>Ca. melnikii</i>	T-0318	MFLUCC 17-0684	MFLU 15-2022	<i>Caragana frutex</i>	Russia	MF434162	MF434250	MF434338	MF434425
<i>Ca. mirabellensis</i>	IT2139	–	MFLU 17-228	<i>Robinia pseudoacacia</i>	Russia	MF434163	MF434251	MF434339	MF434426
<i>Ca. moricola</i>	T-0232	–	MFLU 15-1936	<i>Morus alba</i>	Russia	MF434164	MF434252	MF434340	MF434427
	T-0519	–	MFLU 15-2223	<i>Morus alba</i>	Russia	MF434165	MF434253	MF434341	MF434428
	T-0004	MFLUCC 14-0886	MFLU 17-0452	<i>Morus alba</i>	Russia	MF434166	MF434254	MF434342	MF434429
	T-0015	MFLUCC 14-0898	MFLU 17-0461	<i>Morus alba</i>	Russia	MF434167	MF434255	MF434343	MF434430
	T-0265	MFLUCC 17-0680	MFLU 15-1969	<i>Morus alba</i>	Russia	MF434168	MF434256	MF434344	MF434431
	T-0371	MFLUCC 17-0687	MFLU 15-2075	<i>Morus alba</i>	Russia	MF434169	MF434257	MF434345	MF434432
	T-0518	MFLUCC 17-0694	MFLU 15-2222	<i>Morus alba</i>	Russia	MF434170	MF434258	MF434346	MF434433
	T-0856	MFLUCC 17-0711	MFLU 15-2999	<i>Morus alba</i>	Russia	MF434171	MF434259	MF434347	MF434434
	T-01233	MFLUCC 17-0714 = CBS 143125	MFLU 16-1527	<i>Morus alba</i>	Russia	MF434172	MF434260	MF434348	MF434435
	T-01332	MFLUCC 17-0718 = CBS 143126	MFLU 16-1626	<i>Morus alba</i>	Russia	MF434173	MF434261	MF434349	MF434436
	T-01345	MFLUCC 17-0719	MFLU 16-1639	<i>Morus alba</i>	Russia	MF434174	MF434262	MF434350	MF434437
	T-01476	MFLUCC 17-0725	MFLU 16-1770	<i>Morus alba</i>	Russia	MF434175	MF434263	MF434351	MF434438
	<i>Ca. premilcurensis</i>	IT1681	MFLUCC 17-0208 = CBS 143127	MFLU 16-0185	<i>Cytisus</i> sp.	Italy	MF434176	MF434264	MF434352
<i>Ca. robinicola</i>	T-0010	MFLUCC 14-0892 = CBS 143128	MFLU 17-0456	<i>Gleditsia triacanthos</i>	Russia	MF434177	MF434265	MF434353	MF434440
	T-0012	MFLUCC 14-0894 = CBS 143129	MFLU 17-0458	<i>Robinia neomexicana</i>	Russia	MF434178	MF434266	MF434354	MF434441
	T-0042	MFLUCC 14-0906 = CBS 143130	MFLU 17-0468	<i>Gleditsia triacanthos</i>	Russia	MF434179	MF434267	MF434355	MF434442
	T-0053	MFLUCC 14-0909 = CBS 143131	MFLU 17-0471	<i>Robinia pseudoacacia</i>	Russia	MF434180	MF434268	MF434356	MF434443
	T-0403	MFLUCC 17-0688	MFLU 15-2104	<i>Robinia pseudoacacia</i>	Russia	MF434181	MF434269	MF434357	MF434444
	T-1303	MFLUCC 17-0716 = CBS 143132	MFLU 16-1597	<i>Robinia</i> sp.	Russia	MF434182	MF434270	MF434358	MF434445
	DL0004	MFLUCC 17-0733	MFLU 16-2300	<i>Robinia</i> sp.	Russia	MF434183	MF434271	MF434359	MF434446
<i>Ca. schulzeri</i>	T-0205	–	MFLU 15-1909	<i>Gleditsia triacanthos</i>	Russia	MF434184	MF434272	MF434360	MF434447
	T-0014	MFLUCC 14-0897 = CBS 143133	MFLU 17-0460	<i>Elaeagnus angustifolia</i>	Russia	MF434185	MF434273	MF434361	MF434448
	T-1305	MFLUCC 17-0717	MFLU 16-1599	<i>Robinia</i> sp.	Russia	MF434186	MF434274	MF434362	MF434449
	T-1370	MFLUCC 17-0722	MFLU 16-1664	<i>Robinia</i> sp.	Russia	MF434187	MF434275	MF434363	MF434450
<i>Ca. spartii</i>	T-0070	MFLUCC 14-0915	MFLU 17-0477	<i>Cytisus ruthenicus</i>	Russia	MF434188	MF434276	MF434364	MF434451
	T-1189	MFLUCC 17-0713 = CBS 143134	MFLU 16-1484	<i>Bassia</i> sp.	Russia	MF434189	MF434277	MF434365	MF434452
<i>Neocamarosporium korffii</i>	CR006	MFLUCC 17-0745 = CBS 143135	MFLU 17-1436	<i>Bassia prostrata</i>	Russia	MF434190	MF434278	MF434366	MF434453
<i>N. lamiacearum</i>	T-0846	MFLUCC 17-0560 = CBS 143136	MFLU 15-2989	<i>Lamiaceae</i> sp.	Russia	MF434191	MF434279	MF434367	MF434454
	CR-026	MFLUCC 17-0750 = CBS 143137	MFLU 17-1437	<i>Bassia sedoides</i>	Russia	MF434192	MF434280	MF434368	MF434455
<i>N. salicorniicola</i>	CHAM025	MFLUCC 15-0957	MFLU 15-0957	<i>Salicornia</i> sp.	Thailand	MF434193	MF434281	MF434369	–



Table 2. (Continued).

Taxon	Original no.	Culture no. <sup>1</sup>	Specimen no. <sup>2</sup>	Host or substrate	Country	GenBank accession no. <sup>3</sup>			
						ITS	LSU	SSU	tef1
<i>N. salsolae</i>	YG-S6-1	MFLUCC 17-0826	TASM 6099	Salsola sp.	Uzbekistan	MF434194	MF434282	MF434370	MF434456
	YG-S6-2	MFLUCC 17-0827	TASM 6100	Salsola sp.	Uzbekistan	MF434195	MF434283	MF434371	MF434457
<i>Staurosphaeria lycii</i>	T-0289	MFLUCC 17-0210 = CBS 143140	MFLU 15-1993	<i>Lycium barbarum</i>	Russia	MF434196	MF434284	MF434372	MF434458
	T-0418	MFLUCC 17-0211 = CBS 143141	MFLU 15-2122	<i>Lycium barbarum</i>	Russia	MF434197	MF434285	MF434373	MF434459
	T-1346	MFLUCC 17-0720 = CBS 143158	MFLU 16-1640	<i>Lycium barbarum</i>	Russia	MF434198	MF434286	MF434374	MF434460
	T-1347	MFLUCC 17-0721	MFLU 16-1641	<i>Lycium barbarum</i>	Russia	MF434199	MF434287	MF434375	MF434461
<i>S. rhamnicola</i>	YG-S4-5	MFLUCC 17-0813	TASM 6101	<i>Rhamnus</i> sp.	Uzbekistan	MF434200	MF434288	MF434376	MF434462
	YG-S4-4D	MFLUCC 17-0814	TASM 6102	<i>Rhamnus</i> sp.	Uzbekistan	MF434201	MF434289	MF434377	MF434463

<sup>1</sup> Culture Collection of the Westerdijk Fungal Biodiversity Institute, Utrecht, the Netherlands; MFLUCC: Mae Fah Luang University Culture Collection, Chiang Rai, Thailand.

<sup>2</sup> MFLU: Mae Fah Luang University (MFLU) Herbarium, Chiang Rai, Thailand; TASM: Tashkent Mycological Herbarium, Institute of Botany and Zoology, Academy of Sciences of Uzbekistan, Tashkent, Uzbekistan.

<sup>3</sup> ITS: Internal transcribed spacers; LSU: partial 28S nrDNA; SSU: partial 18S nrDNA; tef1: translation elongation factor 1-alpha gene.

*Synonym: Camarosporiaceae* Locq., Mycol. gén. struct. (Paris): 210 (1984); nom. inval., Art. 39.1 (Melbourne).

*Saprobit*, endophytic, pathogenic on leaves and wood in terrestrial habitats. *Asexual morph: Conidiomata* dimorphic, pycnidial, subcorticolous, single to gregarious, partly caespitose, globose, ostiole central, terete, short papillate. *Conidiomata wall* few-layered, consisting of a *textura globulosa-angularis* with red brown, thick-walled, and smooth cells. *Conidiogenous cells* formed from the inner cells of the pycnidial wall, doliiform, hyaline, thin-walled, annellidic. *Conidia* multicelled, muriformly septate, with one longitudinal or diagonal septum per cell and 1–2 per conidium, ellipsoidal, pyriform, clavate, straight to slightly curved, yellowish not brown, basal cell often paler or hyaline, wall golden. *Synasexual morph: conidiomata* separate, pycnidial, immersed to superficial, brown, globose, with 1–2 papillate ostioles, exuding a crystalline conidial mass. *Conidiophores* reduced to conidiogenous cells. *Conidiogenous cells* lining the inner cavity, hyaline, smooth, ampulliform. *Conidia* solitary, hyaline, smooth, subcylindrical, straight, rarely curved, apex obtuse, base truncate. *Sexual morph: Ascomata* gregarious to solitary, immersed to erumpent, globose to subglobose, black, unilocular, ostiolate. *Ostiole* black, papillate. *Peridium* with several cell layers of *textura angularis*, with outer layer brown to reddish brown, inner layer hyaline to sub hyaline. *Asci* stipitate, cylindrical, bitunicate, (2–)4–8-spored. *Ascospores* uniseriate, ellipsoidal, medium brown, mostly with obtuse ends, muriform, 3–8 transverse septa, with 1–2 longitudinal septa, constricted at septa.

*Type genus: Camarosporium* Schulzer.

*Notes:* To better resolve interfamilial/intergeneric level relationships and improve taxonomic issues within *Pleosporineae*, we validate *Camarosporiaceae* (*Camarosporiaceae* Locq. 1984 was not validly published, Art. 39.1) to accommodate *Camarosporium* and *Camarosporomyces*. [Wijayawardene et al. \(2014b\)](#) also proposed *Camarosporiaceae* to accommodate *Camarosporium* s. str. but it was not formerly introduced.

***Camarosporium*** Schulzer, Verh. K.K. Zool.-Bot. Ges. Wien 17: 717. 1870.

*Description and illustration:* [Crous & Groenewald \(2017\)](#).

*Type species: Camarosporium quaternatum* (Hanzl.) Schulzer.

*Notes:* *Camarosporium* morphologically resembles genera such as *Camarographium*, *Camarosporiopsis*, *Camarosporula*, *Dichomera*, *Didymellocomarosporium*, *Hazslinszkyomyces*, *Libertasomyces*, *Magnicamarosporium*, *Melanocamarosporium*, *Melnikia*, *Murilenthescium*, *Neocamarosporium*, *Paracamarosporium*, *Phragmocamarosporium*, *Pseudocamarosporium*, *Pseudohendersonia*, *Suttonomyces* and *Xenocamarosporium* in conidial shape and septation. However, these taxa are phylogenetically distinct and have subtle but specific morphological differences ([Sutton 1980](#), [Butin 1993](#), [Crous et al. 2011, 2013, 2014b, 2015a, b](#), [Wijayawardene et al. 2014a, 2014b, 2014c, 2015, 2016](#), [Tanaka et al. 2015](#), [Tian et al. 2015](#), [Crous & Groenewald 2017](#)).

*Camarosporium quaternatum* was introduced by [Schulzer \(1870\)](#) as the type species of *Camarosporium*. [Schulzer \(1870\)](#) did not provide any illustrations for *Camarosporium*

**Table 3.** Comparison of alignment properties of genes and nucleotide substitution models used in *Pleosporineae* phylogenetic analyses.

	LSU <sup>1</sup>	SSU <sup>2</sup>	ITS <sup>3</sup>	<i>tef1</i> <sup>4</sup>	Combined LSU, SSU, ITS and <i>tef1</i>
Alignment strategy (MAFFT v. 7)	L-INS-i + manually	L-INS-i	E-INS-i	E-INS-i + manually	–
Number of characters included in analysis (including gaps)	857	982	667	955	3461
Number of constant characters	671	877	358	677	2583
Number of parsimony informative characters (%)	158 (18%)	75 (8%)	286 (43%)	226 (24%)	745 (22%)
Number of uninformative and variable characters	28	30	23	52	133
Nucleotide substitution model	GTR + I + G	GTR + I + G	GTR + I + G	GTR + I + G	GTR + I + G

<sup>1</sup> LSU: partial 28S nrDNA.

<sup>2</sup> SSU: partial 18S nrDNA.

<sup>3</sup> ITS: Internal transcribed spacers.

<sup>4</sup> *tef1*: translation elongation factor 1-alpha gene.

*quaternatum* in his article and mentioned it is completely similar to *Clinterium lycii*, described in Hazslinszky (1865). The micro-fungal collections of F.A. Hazslinszky von Hazslin are preserved in the Hungarian Natural History Museum (BP), but the type of *Cm. quaternatum* has been lost. Therefore, in a recent study Crous & Groenewald (2017) designated the original illustrations as lectotypes, to facilitate epitypification.

***Camarosporomyces*** Crous, IMA Fungus 8: 141. 2017.

*Description and illustration:* Crous & Groenewald (2017).

*Type species:* *Camarosporomyces flavigenus* (Constant. & Aa) Crous.

*Notes:* *Camarosporomyces* was introduced by Crous & Groenewald (2017) to accommodate *Camarosporomyces flavigenus*, a phoma-like fungus which was originally described as *Phoma flavigena*. In our molecular analyses, *Camarosporomyces flavigenus* is basal to other strains of *Camarosporium quaternatum* strains with good statistical support (Clade C, Fig. 1).

***Camarosporidiellaceae*** Wanas., Wijayaw., Crous & K.D. Hyde, **fam. nov.** MycoBank MB821939; Facesoffungi number: FoF 03528.

*Etymology:* Referring to the name of the type genus.

*Saprobic* or *endophytic* or *pathogenic* on leaves and wood (Fig. 2). *Asexual morph:* Coelomycetous. *Conidiomata* pycnidial, immersed to sub-peridermal, globose, dark brown to black, unilocular. *Conidiomata wall* thick-walled, dark brown, composed of cells of *textura angularis*, inner layer with hyaline cells. *Ostiole* single, circular, central, papillate. *Conidiogenous cells* enteroblastic, annellidic, integrated to discrete, doliiform, lageniform or cylindrical, smooth, hyaline, formed from the inner cells of the pycnidial wall. *Conidia* medium brown to dark brown, phragmosporous to muriform, variable in shape, mostly ellipsoidal, curved to straight, truncate at the base, obtuse at the apex, continuous or constricted at the septa. *Sexual morph:* *Ascomata* gregarious to solitary, immersed to erumpent, globose to

subglobose, black, unilocular, ostiolate. *Ostiole* black, papillate. *Peridium* with several cell layers of *textura angularis*, with outer layer brown to reddish-brown, inner layer hyaline to sub hyaline. *Asci* stipitate, cylindrical, bitunicate, (2–)4–8-spored. *Ascospores* uniseriate, ellipsoidal, medium brown, mostly with obtuse ends, muriform, 3–8 transverse septa, with 1–2 longitudinal septa, constricted at septa.

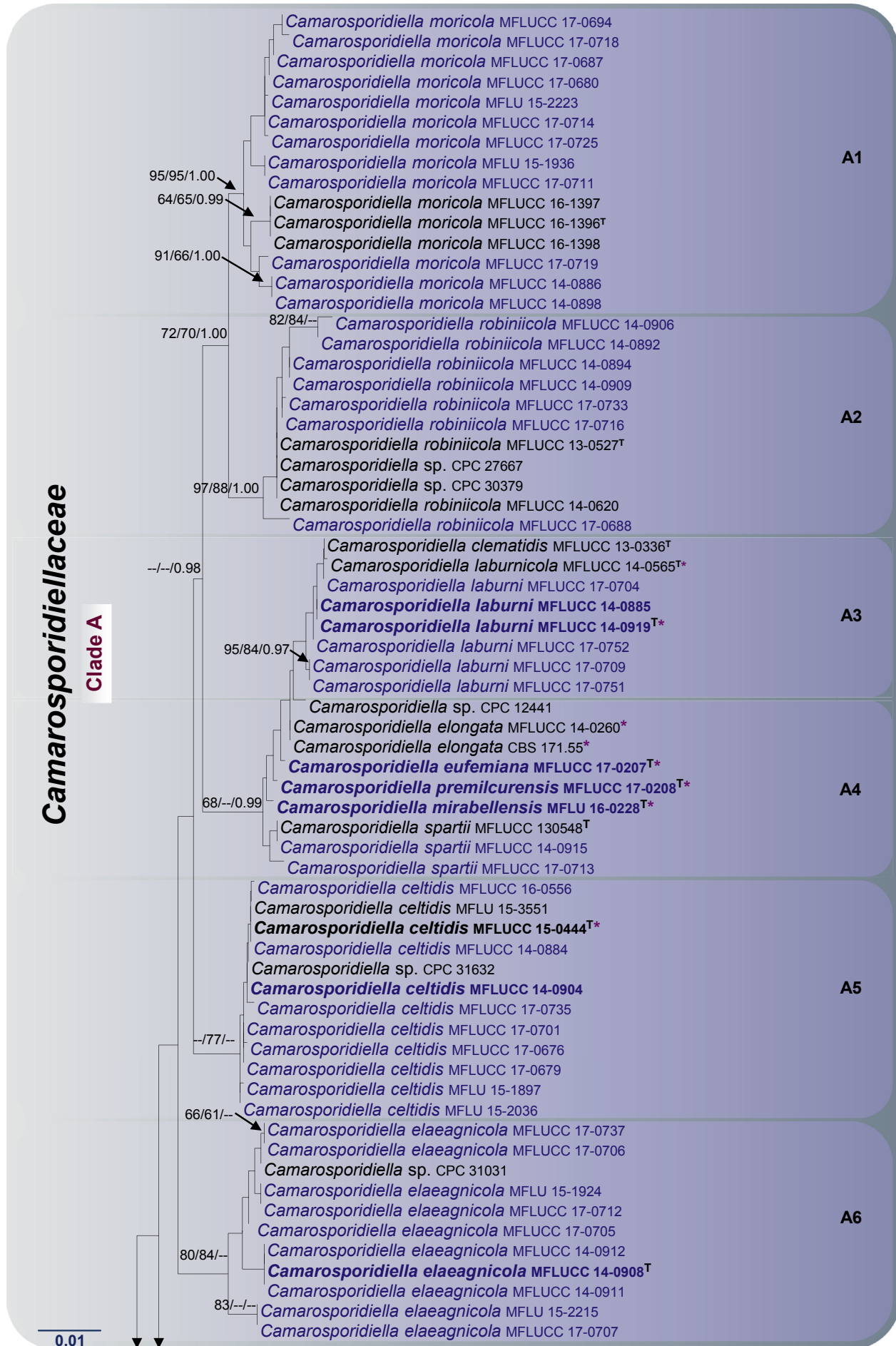
*Type genus:* *Camarosporidiella* Wanas., Wijayaw. & K.D. Hyde.

*Notes:* *Camarosporidiellaceae* forms a highly-supported monophyletic lineage (97 %/97 %/1.00; Fig. 1, clade A) but lacks internal support. Morphological features are not informative for generic distinction within Clade A. The taxa studied here are treated below according to the phylogenetic clades (Subclades A1–A12, Fig. 1) as follows:

***Camarosporidiella*** Wanas., Wijayaw. & K.D. Hyde, **gen. nov.** MycoBank MB821940; Facesoffungi number: FoF 03529.

*Etymology:* Resembling the genus *Camarosporium*.

*Saprobic* or *endophytic* or *pathogenic* on leaves and wood in terrestrial habitats. *Asexual morph:* *Conidiomata* pycnidial, immersed to sub-peridermal, globose, dark brown to black, unilocular. *Conidiomata wall* thick-walled, dark brown, composed of cells of *textura angularis*, inner layer with hyaline cells. *Ostiole* single, circular, centrally papillate. *Macroconidiogenous cells* enteroblastic, annellidic, integrated, indeterminate, doliiform, lageniform or cylindrical, smooth-walled, hyaline, formed from the inner cells of the pycnidial wall. *Macroconidia* medium brown to dark brown, phragmosporous to muriform, variable in shape, mostly ellipsoidal, curved to straight, truncate at base, obtuse at apex, continuous or constricted at the septa. *Microconidiogenous cells* present or absent in cultures, when present; intermingled with macroconidiogenous cells, hyaline, integrated, enteroblastic, percurrent annellidic, ampulliform to subcylindrical. *Microconidia* present or absent, when present; hyaline, round to oblong or ellipsoidal, with small guttules. *Sexual morph:* *Ascomata* black, superficial to semi-immersed, gregarious, confluent, sometimes scattered beneath the host periderm or on decorticated wood, fully or partly erumpent, globose, black,



**Fig. 1.** RAxML tree based on a combined dataset of LSU, SSU, *tef1* and ITS partial sequences. Bootstrap support values for ML and MP equal to or greater than 60 %, Bayesian posterior probabilities (PP) equal to or greater than 0.95 are defined as ML/MP/PP above the nodes. Species used for morphological observation in this study are indicated in **bold**. Families, where known, and selected genera are indicated with coloured blocks. The tree is rooted to *Cyclothyriella rubronotata* (CBS 141486 & CBS 121892). The new isolates are in blue. Asterisk marks origin of isolates from single ascospore. The ex-type strains are noted with superscripted T. The scale bar represents the expected number of nucleotide substitutions per site.

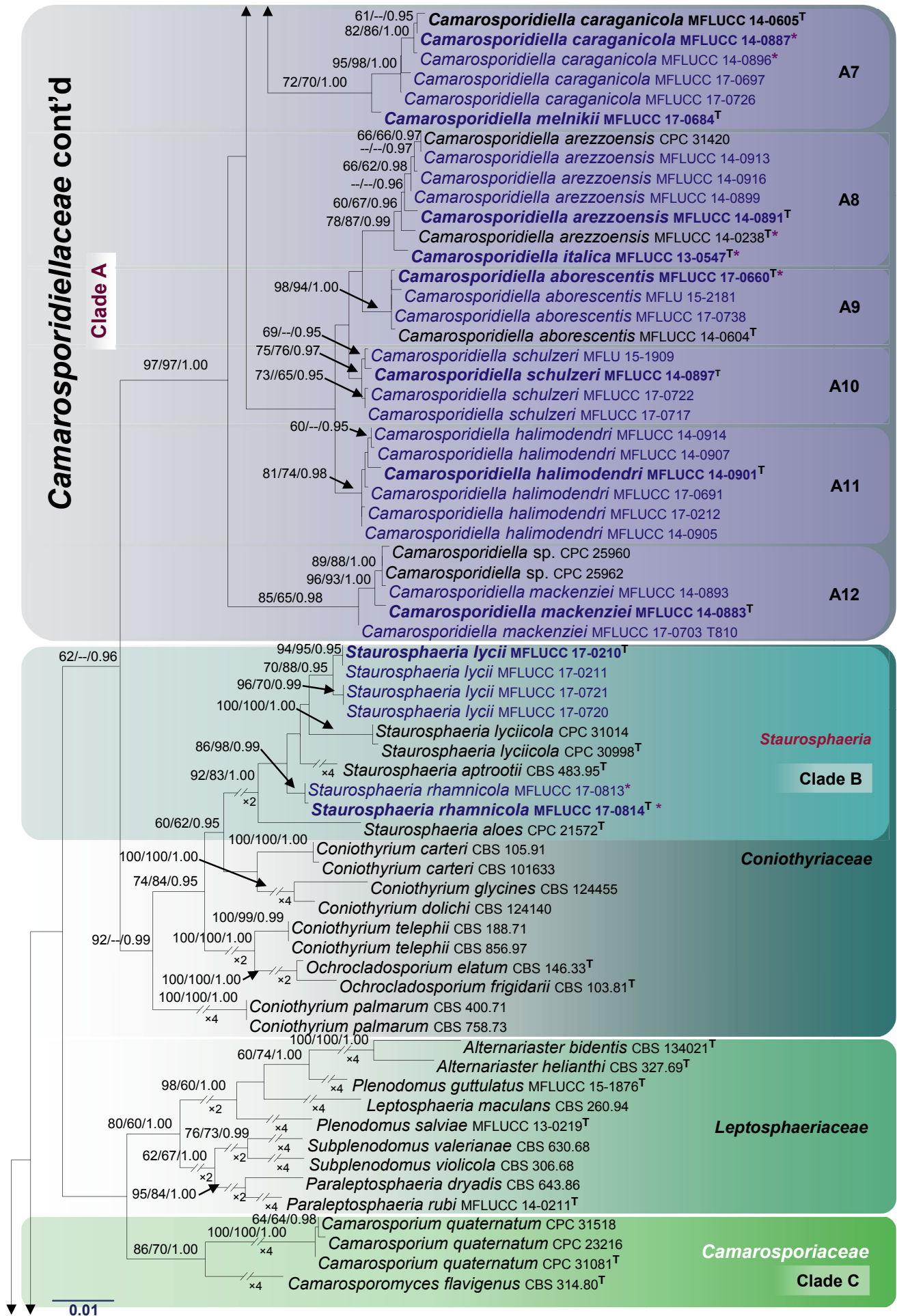


Fig. 1. (Continued).

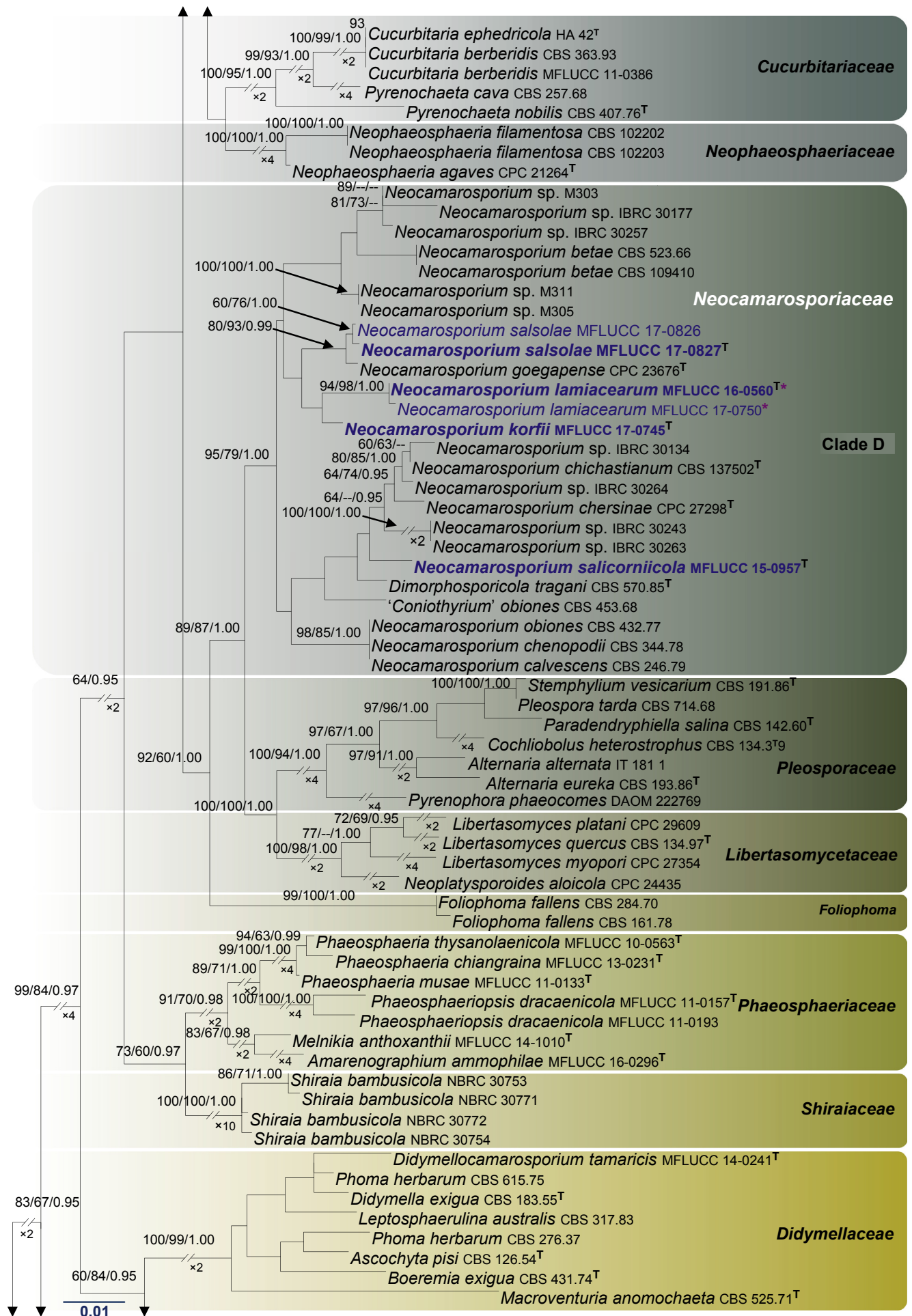


Fig. 1. (Continued).

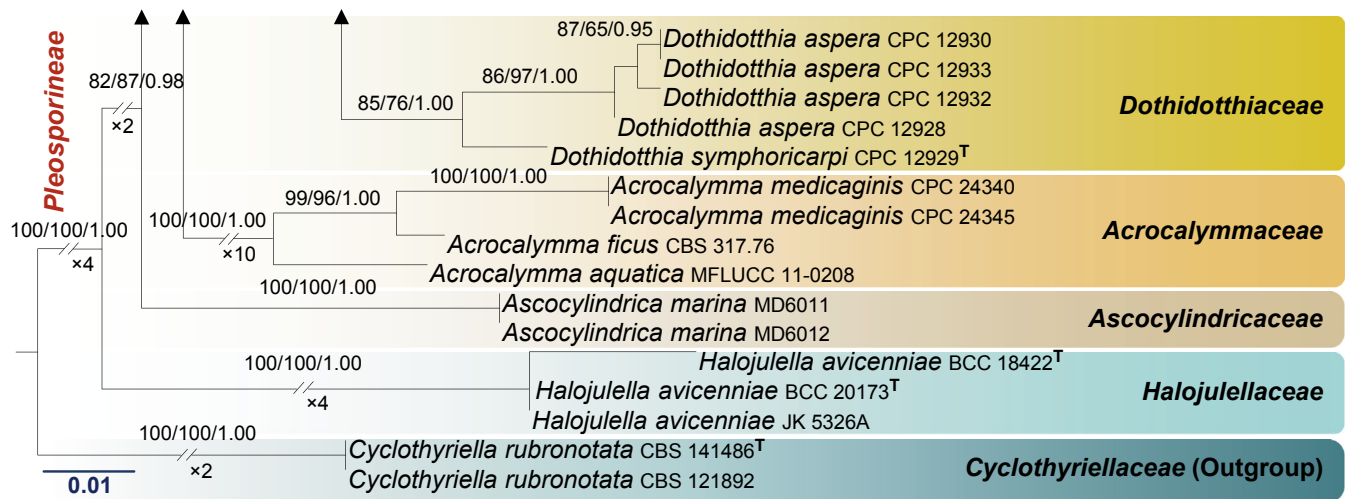


Fig. 1. (Continued).

ostiolate. *Ostirole* central, short. *Peridium* composed of blackish to dark brown cells of *textura angularis*, cells towards the inside lighter, composed of thin-walled cells of *textura angularis*. *Hamathecium* comprising numerous, branched septate, *pseudoparaphyses*. *Asci* 8-spored, bitunicate, fissitunicate, cylindrical, short-pedicellate. *Ascospores* overlapping uniseriate, muriform, mostly ellipsoidal, 3–8-transversely septate, with 2–4 vertical septa, constricted at middle septum, initially hyaline, becoming brown at maturity, slightly paler, conical and narrow at the ends, not surrounded by a mucilaginous sheath.

*Type species: Camarosporidiella caraganicola* (Phukhams. *et al.*) Phukhams., Wanas. & K.D. Hyde.

***Camarosporidiella caraganicola*** (Phukhams. *et al.*) Phukhams., Wanas. & K.D. Hyde, **comb. nov.** MycoBank MB821941; Facesoffungi number: FoF 03530. Figs 3, 4.

*Basionym: Camarosporium caraganicola* Phukhams. *et al.*, Fungal Diversity 72: 156. 2015.

*Saprobic* on dead branches of *Caragana frutex*. *Asexual morph*: See Liu *et al.* (2015). *Sexual morph*: *Ascomata* 400–550 µm high, 450–500 µm diam ( $\bar{x}$  = 436.2 × 457.8 µm,  $n$  = 10), black, superficial to semi-immersed, confluent, gregarious, sometimes scattered beneath the host periderm or on decorticated wood, fully or partly erumpent, globose, rough or hairy, ostiolate. *Ostirole* central, short, slightly sunken, minute, inconspicuous on surface, smooth, with ostiolar canal filled with hyaline cells. *Peridium* 60–80 µm wide at the base, 50–70 µm wide in sides, comprising 8–10 layers, with outer layer heavily pigmented, thick-walled, comprising blackish to dark brown cells of *textura angularis*, cells towards inside lighter, with inner layer composed 3–4 layers, hyaline, flattened, thin-walled cells of *textura angularis*. *Hamathecium* comprising numerous, 2.5–3 µm ( $n$  = 40) wide, filamentous, branched, septate, *pseudoparaphyses*. *Asci* 150–190 × 10–15 µm ( $\bar{x}$  = 170.8 × 13.1 µm,  $n$  = 40), 8-spored, bitunicate, fissitunicate, cylindrical, short-pedicellate, rounded at apex with a minute ocular chamber. *Ascospores* 20–30 × 7–10 µm ( $\bar{x}$  = 24.9 × 8.7 µm,  $n$  = 50), overlapping uniseriate, muriform, mostly ellipsoidal, 3–5-transversely septate, with 2–4 vertical septa, constricted at middle septum, initially hyaline, becoming brown at maturity, slightly paler, conical and narrow at the ends, not surrounded by a mucilaginous sheath.

*Colonies on PDA*: Slow growing, reaching 2 cm diam after 4 wk at 16 °C, later with dense mycelium, circular, rough margin white at first, greenish grey after 6 wk, reverse greenish grey, flat on the surface, without aerial mycelium.

*Materials examined*: **Russia**, Rostov region, Rostovna-Donu, BadiaTega, Botanical Garden of Southern Federal University, Systematic Arboretum, on dead twigs of *Caragana frutex* (*Fabaceae*), 26 Apr. 2014, T.S. Bulgakov T-046 (MFLU 14-0794, **holotype**; ex-type culture MFLUCC 14-0605; Rostov region, Rostov-na-Don city, Botanical garden of Southern Federal University, 47, 234635° N, 39, 656986° E, 3 Mar. 2014, T.S. Bulgakov T-005 (MFLU 17-0453, **paratype**, ex-paratype culture MFLUCC 14-0887 = CBS 143105); Rostov region, Oktyabrsky district, natural monument, 47, 5049392° N, 40, 1539564° E, 26 Apr. 2014, T.S. Bulgakov T-013, MFLU 17-0459, living culture MFLUCC 14-0896 = CBS 143106; Rostov region, Krasnosulinsky district, Donskoye forestry, Kabanya Balka, 47, 8643133° N, 40, 2421045° E, 28 Jun. 2015, T.S. Bulgakov T-538, MFLU 15-2242, living culture MFLUCC 17-0697 = CBS 143107, *ibid.* 18 Feb. 2016, T.S. Bulgakov T-1488, MFLU 16-1782, living culture MFLUCC 17-0726 = CBS 143108.

*Notes: Camarosporidiella caraganicola* (MFLUCC 14E-0605) is based on a strain derived from the asexual morph that was described by Liu *et al.* (2015). In this study, we have examined two specimens of the sexual morph of *Camarosporidiella caraganicola* (T-005 and T-013). These two taxa were collected from the same host (*Caragana frutex*) in the Rostov Region, Russia. By considering the identical host and statistical support, we conclude that these two taxa represent the holomorph of *Camarosporidiella caraganicola*. Also, we have observed another three specimens of the asexual morph of *Ca. caraganicola* (T-538 and T-1488). All strains of this species cluster together with significant statistical support of 95 % for ML, 98 % for MP and 1.00 for PP (Clade A7, Fig. 1).

## Other accepted species

***Camarosporidiella aborescentis*** (Phukhams. *et al.*) Phukhams., Wanas. & K.D. Hyde, **comb. nov.** MycoBank MB821942; Facesoffungi number: FoF 03531. Fig. 5.

*Basionym: Camarosporium aborescentis* Phukhams. *et al.*, in Liu *et al.*, Fungal Diversity 72: 151. 2015.

*Saprobic* on woody branches. *Asexual morph*: See Liu *et al.* (2015) for illustrations. *Sexual morph*: *Ascomata* 350–450 µm high, 500–600 µm diam ( $\bar{x}$  = 406.4 × 529.7 µm,  $n$  = 10), black, superficial to semi-immersed, confluent, gregarious, sometimes

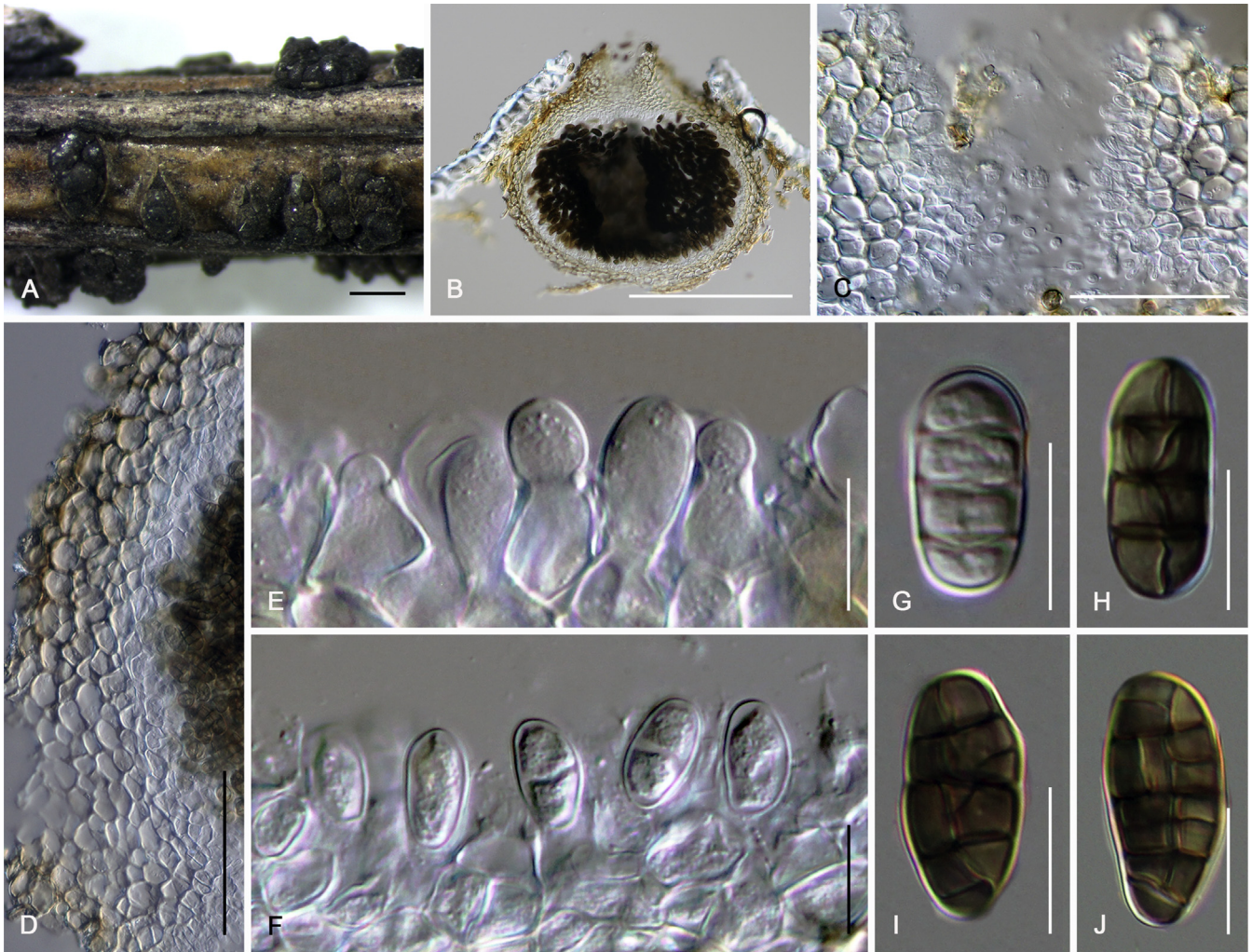


Fig. 2. *Camarosporidiella* spp. on different hosts. A, B. *Elaeagnus angustifolia*. C. *Caragana arborescens*. D. *Laburnum anagyroides*. E, F. *Morus alba*.

scattered beneath the host periderm or on decorticated wood, fully or partly erumpent, globose, rough or hairy, ostiolate. *Ostiole* central, short, slightly sunken, minute, inconspicuous on surface, smooth, with ostiolar canal filled with hyaline cells. *Peridium* 15–25  $\mu\text{m}$  wide at the base, 25–50  $\mu\text{m}$  wide in sides, comprising 6–10 layers, with outer layer heavily pigmented, thick-walled, comprising blackish to dark brown cells of *textura angularis*, cells towards inside lighter, with inner layer composed of 3–4 layers, hyaline, flattened, thin-walled cells of *textura angularis*. *Hamathecium* comprising numerous, 2–3  $\mu\text{m}$  ( $n = 40$ ) wide, filamentous, branched, septate, pseudoparaphyses. *Asci* 170–210  $\times$  15–18  $\mu\text{m}$  ( $\bar{x} = 186.2 \times 16.1 \mu\text{m}$ ,  $n = 40$ ), 8-spored,

bitunicate, fissitunicate, cylindrical, short-pedicellate, rounded at apex with a minute ocular chamber. *Ascospores* 28–32  $\times$  12–13  $\mu\text{m}$  ( $\bar{x} = 29.9 \times 12.4 \mu\text{m}$ ,  $n = 50$ ), overlapping uniseriate, muriform, mostly ellipsoidal, 5–7-transversely septate, with 1–2 vertical septa, constricted at middle septum, initially hyaline, becoming brown at maturity, slightly paler, conical and narrow at the ends, not surrounded by a mucilaginous sheath.

*Colonies on PDA*: Slow growing, reaching 2 cm diam after 4 wk at 16 °C, later with dense mycelium, circular, rough margin, greenish-grey after 6 wk, reverse greenish-grey, flat on the



**Fig. 3.** Asexual morph of *Camarosporidiella caraganicola* (MFLU 14-0794, holotype) **A.** Conidiomata on host surface. **B.** Vertical section through ostiole. **C.** Conidioma wall. **D.** Part of pycnidium wall. **E, F.** Conidiogenous cells and developing conidia. **G–J.** Conidia. Scale bars: A = 500  $\mu\text{m}$ ; B = 200  $\mu\text{m}$ ; C, D = 50  $\mu\text{m}$ ; E–J = 10  $\mu\text{m}$ .

surface, without aerial mycelium. Hyphae septate, branched, hyaline, thin-walled.

**Materials examined:** **Italy**, Forlì-Cesena Province, near Predappio, on dead branches of *Colutea arborescens* (*Fabaceae*), 25 Oct. 2015, E. Camporesi IT2674, MFLU 15–3630, living culture MFLUCC 17-0660. **Russia**, Rostov region, Rostov-on-Don city, Botanical Garden of Southern Federal University, Systematic Arboretum, parkland, 47.2350724° N, 39.6541643° E, on *Colutea orientalis*, 30 May 2015, T.S. Bulgakov T-477, MFLU 15-2181; on *Amorpha* sp., 14 Jun. 2016, T.S. Bulgakov NK076, MFLU 16-2387, living culture MFLUCC 17-0738.

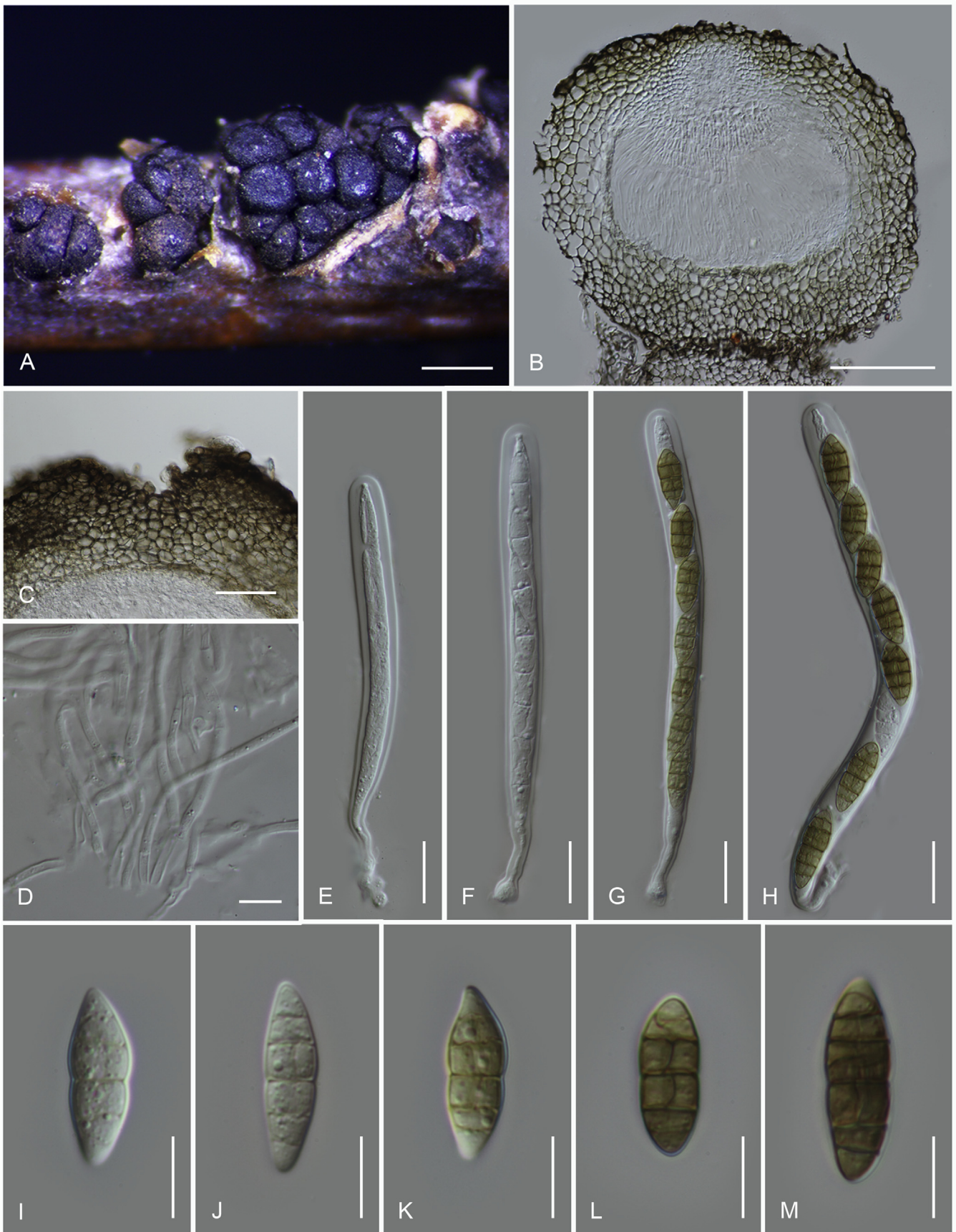
**Notes:** *Camarosporidiella aborescentis* is morphologically similar to *Camarosporium feurichii* in having black conidiomata and brown, smooth-walled, oblong, 3-transversely septate conidia and usually with one longitudinal septum (Liu et al. 2015). In this study, we add another three strains to *Camarosporidiella aborescentis* from Italy and Russia. Altogether strains of this taxon cluster together with high statistical support of 98 % for ML, 94 % for MP and 1.00 for PP (Clade A9, Fig. 1).

***Camarosporidiella arezzoensis*** (Tibpromma et al.) Wanas. & K.D. Hyde, **comb. nov.** MycoBank MB821943; Facesoffungi number: FoF 03532. Fig. 6.

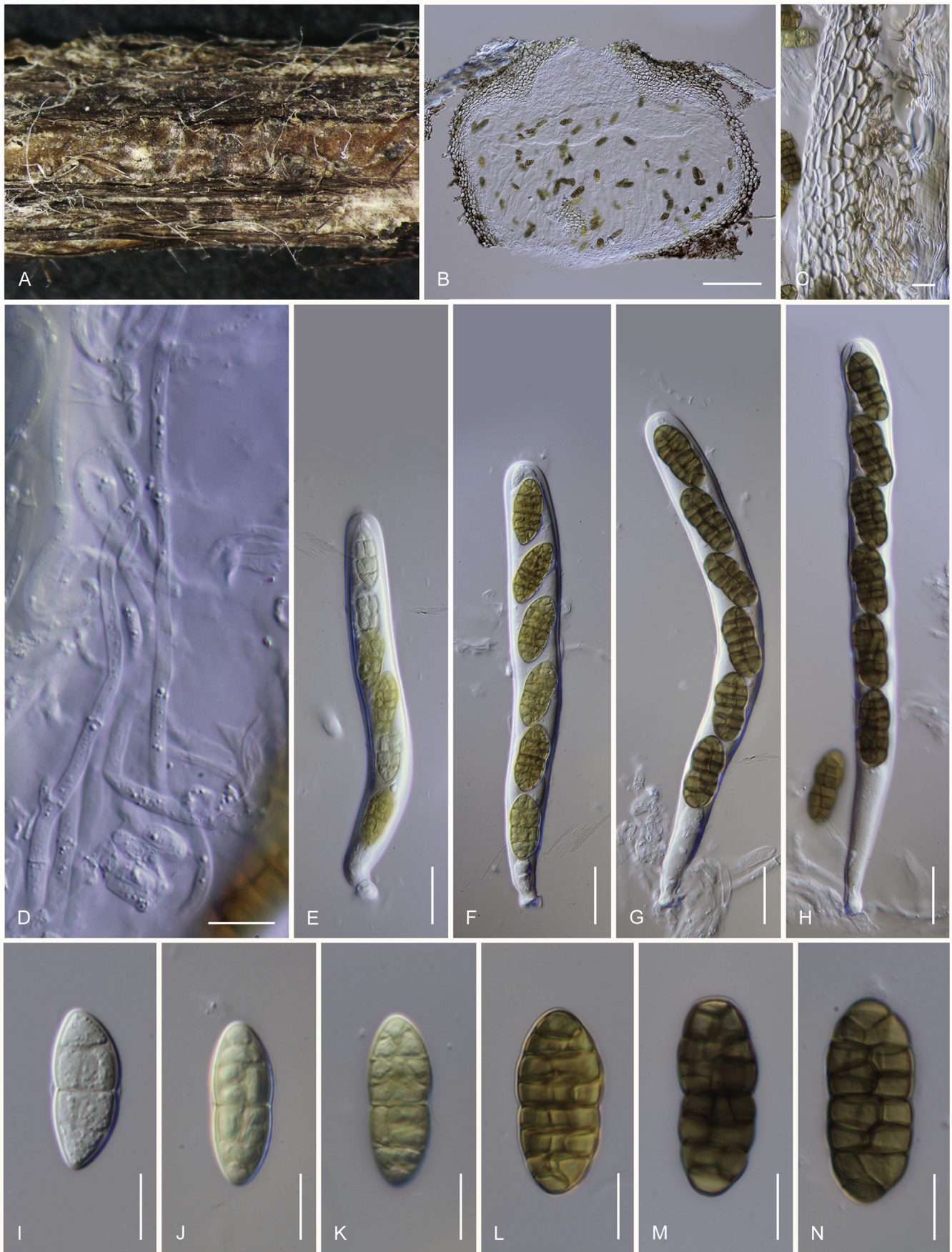
**Basionym:** *Camarosporium arezzoensis* Tibpromma et al., Saudi Journal of Biological Sciences 23: 2. 2016.

*Saprobic or weakly necrotrophic* on dead twigs and branches of *Amorpha fruticosa*. **Asexual morph:** *Conidiomata* pycnidial, 300–400  $\mu\text{m}$  high, 300–350  $\mu\text{m}$  diam ( $\bar{x}$  = 347.9  $\times$  324.5  $\mu\text{m}$ ,  $n$  = 10), solitary or gregarious, black, immersed, sometimes scattered beneath the host periderm or on decorticated wood, fully or partly erumpent, unilocular, with a papillate ostiole. *Ostiole* 60–100  $\mu\text{m}$  long, 100–150  $\mu\text{m}$  diam ( $\bar{x}$  = 82.2  $\times$  115.4  $\mu\text{m}$ ,  $n$  = 6), central, long, smooth, ostiolar canal filled with hyaline or pale brown cells. *Pycnidial wall* multi-layered, 25–45  $\mu\text{m}$  wide at the base, 25–35  $\mu\text{m}$  wide in sides, thick, comprising 5–6 layers, outer layer heavily pigmented, thick-walled, comprising blackish or to dark reddish-brown cells of *textura angularis*, cells towards the inside lighter, inner layer composed of 1–2 layers, hyaline, thin-walled cells of *textura angularis*. *Conidiophores* reduced to conidiogenous cells. *Macroconidiogenous cells* enteroblastic, annellidic, doliiform, integrated, solitary, hyaline, smooth-walled, and formed from the inner layer of pycnidium wall. *Macroconidia* 20–28  $\times$  6–9  $\mu\text{m}$  ( $\bar{x}$  = 24  $\times$  7.8  $\mu\text{m}$ ;  $n$  = 40), cylindrical, straight to slightly curved, rounded at both ends, 4–7-transverse septate, with 1–2-longitudinal septa, muriform, smooth, brown to blackish-brown. *Microconidiogenous cells* intermingled with macroconidiogenous cells, hyaline, discrete, enteroblastic with per-current annellidic, ampulliform to subcylindrical. *Microconidia* 5–7.5  $\times$  3.5–4.5  $\mu\text{m}$  ( $\bar{x}$  = 6.3  $\times$  4  $\mu\text{m}$ ;  $n$  = 25), hyaline, round to

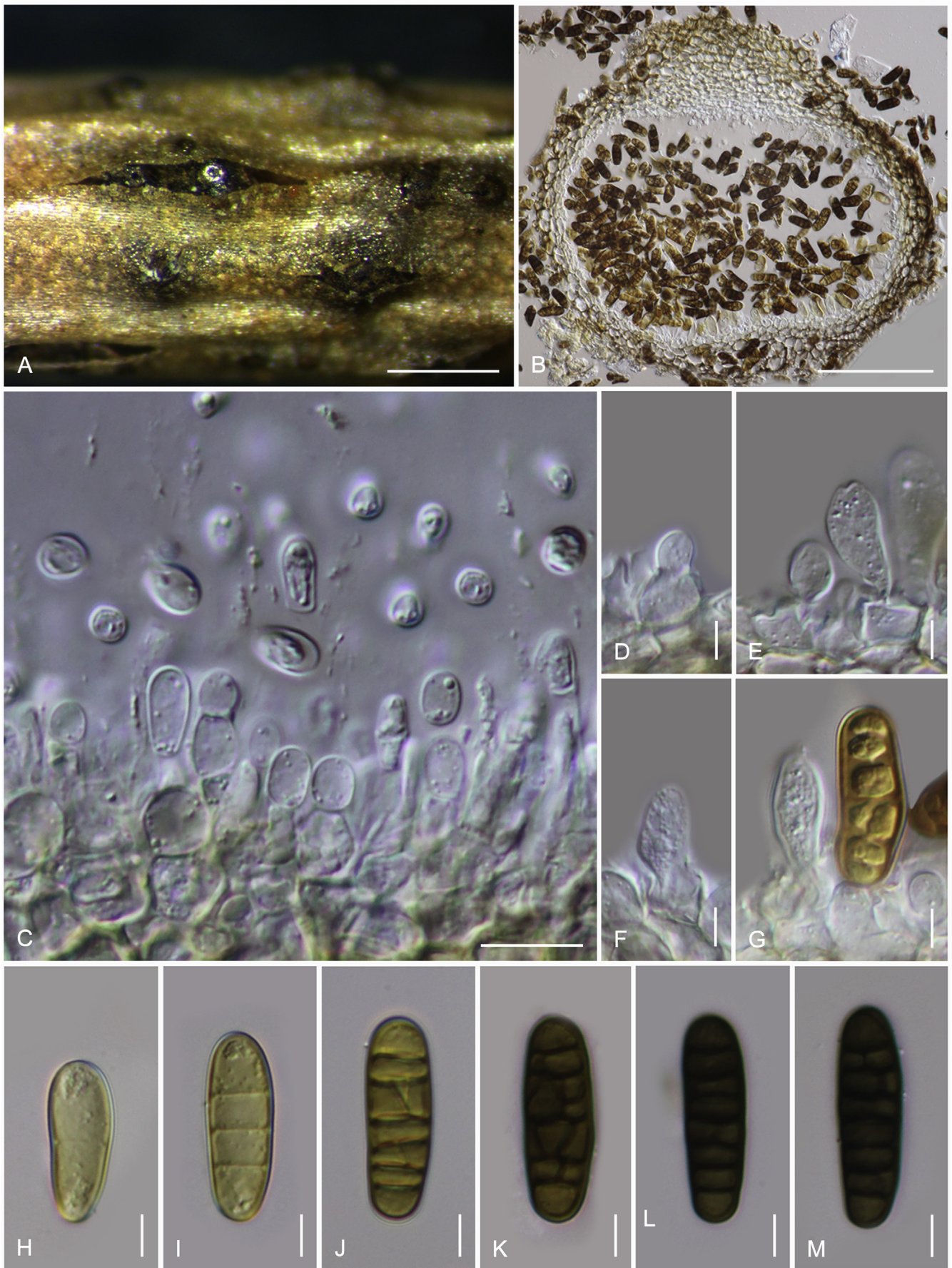




**Fig. 4.** Sexual morph of *Camarosporidiella caraganicola* (MFLU 17-0453). **A.** Appearance of ascomata on host substrate. **B.** Section of ascoma. **C.** Close-up of ostiole. **D.** Pseudoparaphyses. **E–H.** Asci. **I–M.** Ascospores. Scale bars: A = 500  $\mu\text{m}$ ; B = 100  $\mu\text{m}$ ; C = 50  $\mu\text{m}$ ; D, I–M = 10  $\mu\text{m}$ ; E–H = 20  $\mu\text{m}$ .



**Fig. 5.** Sexual morph of *Camarosporidiella aborescentis* (MFLU 15-3630). **A.** Appearance of ascomata on host substrate. **B.** Section of ascoma. **C.** Peridium. **D.** Pseudo-paraphyses. **E–H.** Asci. **I–N.** Ascospores. Scale bars: B = 100  $\mu$ m; C, D = 10  $\mu$ m; E–H = 20  $\mu$ m; I–N = 10  $\mu$ m.



**Fig. 6.** Asexual morph of *Camarosporidiella arezzoensis* (MFLU 17-0455). **A.** Conidiomata on host surface. **B.** Vertical section through conidioma. **C.** Microconidia. **D–G.** Conidiogenous cells and developing conidia. **H–M.** Macroconidia. Scale bars: A = 500  $\mu\text{m}$ ; B = 100  $\mu\text{m}$ ; C = 10  $\mu\text{m}$ ; D–M = 5  $\mu\text{m}$ .

oblong or ellipsoidal, with a few small guttules. *Sexual morph*: See Tibpromma *et al.* (2015).

*Colonies on PDA*: Slow growing, reaching 2 cm diam after 4 wk at 16 °C, later with dense mycelium, circular, rough margin, dirty white, reverse creamy grey, flat on the surface, without aerial mycelium. Hyphae septate, branched, hyaline, thin-walled.

*Materials examined*: **Russia**, Rostov Region, Rostov-on-Don city, Botanical garden of Southern Federal University, Lower Park, 47,2313935° N, 39,6648932° E, on *Amorpha fruticosa* (*Fabaceae*), 14 Apr. 2013, T.S. Bulgakov T-009 (MFLU 17-0455, living culture MFLUCC 14-0891); Azov district, Delta of Don river, sand dunes near Polushkin village, 47,1981111° N, 39,4148684° E, on *Cytisus borysthenicus* (*Fabaceae*), 8 May 2014, T.S. Bulgakov T-064, MFLU 17-0475, living culture MFLUCC 14-0913 = CBS 143103; Rostov-on-Don city, Botanical garden of Southern Federal University, Systematic Arboretum, 47,2360559° N, 39,6555591° E, on *Cytisus austriacus* (*Fabaceae*), 8 May 2014, T.S. Bulgakov T-072, MFLU 17-0478, living culture MFLUCC 14-0916 = CBS 143103; Rostov-on-Don city, Botanical garden of Southern Federal University, Systematic Arboretum, 47,2360559° N, 39,6555591° E, on *Cytisus austriacus*, 5 Mar. 2014, T.S. Bulgakov T-016, MFLU 17-0462, living culture MFLUCC 14-0899 = CBS 143102.

*Notes*: *Camarosporidiella arezzoensis* was reported as a sexual morph and is similar to *Cucurbitaria* species in having long cylindrical asci and narrowly fusiform, muriform ascospores, being 5–7-transversely septate, with 4–6 vertical septa (Tibpromma *et al.* 2015). An asexual morph was undetermined. In this study, we introduce the asexual morph of *Ca. arezzoensis* with four new collections from Russia on *Amorpha fruticosa* and *Cytisus austriacus*. Strains of *Camarosporidiella arezzoensis* cluster together with 60 % for ML, 67 % for MP and 0.96 for PP support (Clade A8, Fig. 1). *Camarosporium amorphae* (= *Cucurbitaria amorphae*) and *Cm. amorphicola* are also found on *Amorpha fruticosa* in Canada and Central Asia (Farr & Rossman 2017), but *Cm. amorphae* (20–24 × 9 µm, 4–5 transverse septa) has fewer transverse septa (Saccardo 1883) compared to the asexual morph of *Camarosporidiella arezzoensis* (20–28 × 6–9 µm, and 4–7 transverse septa). Records are lacking for comparison of *Camarosporium amorphicola* with our new taxon. Our collection differs from known other members in *Camarosporidiella* in having cylindrical conidia.

***Camarosporidiella celtidis*** (Shear) Thambug., Wanas. & K.D. Hyde, **comb. nov.** MycoBank MB821945; Facesoffungi number: FoF 03533. Figs 7, 8.

*Basionym*: *Cucurbitaria celtidis* Shear, Bull. Torrey bot. Club 29: 451. 1902.

*Synonym*: *Camarosporium uniseriatum* Thambug. *et al.*, Stud. Fung. 1: 94. 2016.

*Necrotrophic* or *saprobic* on dead twigs and thin branches. *Asexual morph*: *Conidiomata* pycnidial, 300–350 µm high, 350–450 µm diam ( $\bar{x}$  = 337.1 × 392.7 µm, n = 10), solitary or gregarious, black, immersed to semi-erumpent, unilocular. *Pycnidial wall* multi-layered, 20–25 µm wide at the base, 25–30 µm wide in sides, thick, comprising 3–4 layers, outer layer heavily pigmented, thick-walled, comprising blackish or to dark reddish-brown cells of *textura angularis*, cells towards the inside lighter, inner layer composed of 3–4 layers, hyaline, thick-walled cells of *textura angularis*. *Conidiophores* reduced to conidiogenous cells. *Conidiogenous cells* enteroblastic, annellidic, doliiform, integrated, solitary, hyaline, smooth-

walled, and formed from the inner layer of pycnidium wall. *Conidia* 15–20 × 6–8 µm ( $\bar{x}$  = 16.8 × 6.9 µm; n = 40), oblong, straight, rounded at both ends, sometimes narrowly rounded ends, 2–3-transversely septate, without longitudinal septa, smooth-walled, initially hyaline, becoming brown to dark brown at maturity. *Sexual morph*: *Ascomata* black, semi-immersed, becoming erumpent, scattered, solitary to gregarious, globose to subglobose, coriaceous, rough or hairy, ostiolate. *Ostiole* central, short, ostiolar canal filled with hyaline to lightly pigmented pseudoparenchymatous cells. *Peridium* comprising several layers, outer layers heavily pigmented, thick-walled, comprising blackish to dark brown cells of *textura angularis*, inner layers composed of hyaline, thin-walled cells of *textura angularis*. *Hamathecium* comprising 1–3 µm wide, numerous, filamentous, septate, pseudoparaphyses. *Asci* 8-spored, bitunicate, fissitunicate, cylindrical, short-pedicellate, apex rounded, with an ocular chamber. *Ascospores* uniseriate, slightly overlapping, initially hyaline, becoming dark brown at maturity, ellipsoid, oblong to fusoid, straight, muriform, with 3–5 transverse septa, and 1–2(–3) longitudinal septa, deeply constricted at the central septum, with rounded or acute ends, smooth-walled, without a mucilaginous sheath (Thambugala *et al.* 2016).

*Materials examined*: **Russia**, Rostov Region, Rostov-on-Don city, Botanical Garden of Southern Federal University, Higher Park, on twigs and branches of *Celtis occidentalis* (*Cannabaceae*), 5 Mar. 2014, T.S. Bulgakov T-037, MFLU 16-0469, reference specimen, living culture MFLUCC 15-0444 = ICMP 21250. *ibid.* on *Gleditsia tracanthos* (*Fabaceae*), 26 Mar. 2014, T.S. Bulgakov T-040, MFLU 17-0466, living culture MFLUCC 14-0904 = CBS 1431010; Shakhty city, Central Park, 47,7055886° N, 40,2059913° E, on *Maclura pomifera* (*Moraceae*), 12 Mar. 2013, T.S. Bulgakov T-002, MFLU 17-0450, living culture MFLUCC 14-0884 = CBS 143109; Rostov-on-Don city, Botanical Garden of Southern Federal University, 47, 2306722° N, 39, 6602583° E, on *Spiraea* sp. (*Rosaceae*), 15 Apr. 2015, T.S. Bulgakov T-193, MFLU 15-1897; Shakhty city, Central urban micro-district, Central Park, 47, 7058052° N, 40,2065706° E, on *Prunus padus*, 9 Jul. 2015, T.S. Bulgakov T-224, MFLU 15-1928, living culture MFLUCC 17-0676 = CBS 143111; Shakhty city, At'yukhta River valley, Volchya Balka, 47,7122088° N, 40,1836753° E, on *Morus alba*, 5 Jul. 2015, T.S. Bulgakov T-239, MFLU 15-1943, living culture MFLUCC 17-0679; Shakhty city, Cotton Fabric urban microdistrict, Grushevka steppe slopes near Grushevsky pond, 47,7261179° N, 40,2587664° E, on *Elymus repens*, 12 May 2015, T.S. Bulgakov T-332, MFLU 15-2036; Shakhty city, Cotton Fabric urban microdistrict, Block park, 47,7122088° N, 40,1836753° E, on *Betula pendula*, 14 May 2015, T.S. Bulgakov T-358, MFLU 15-2062, living culture MFLUCC 16-0556; Shakhty city, Cotton Fabric urban microdistrict, Block park, 47,6922302° N, 40,0925446° E, on *Ailanthus altissima*, 21 Jul. 2015, T.S. Bulgakov T-767, MFLU 15-2912, living culture MFLUCC 17-0701 = CBS 143112.

*Notes*: *Cucurbitaria celtidis* was introduced by Shear (1902) from *Celtis occidentalis*. Thambugala *et al.* (2016) placed this species in the genus *Camarosporium* based on DNA sequence data from a fresh collection and introduced *Cm. uniseriatum*. However, in the present study, we accommodate *Cucurbitaria celtidis* in the new genus *Camarosporidiella* and the asexual morph of the species is described and illustrated (Fig. 7). Nine new isolates cluster in the *Ca. celtidis* clade (Subclade A5, Fig. 1), and they are differing from known other members in *Camarosporidiella* in having conidia without longitudinal septa. However, this subclade is only moderately supported  $\leq$  60 % ML & 77 % MP and  $\leq$  0.95 PP.

***Camarosporidiella clematidis*** (Wijayaw. *et al.*) Wijayaw., Wanas. & K.D. Hyde, **comb. nov.** MycoBank MB821946; Facesoffungi number: FoF 03534.

*Basionym*: *Camarosporium clematidis* Wijayaw. *et al.*, Phytotaxa 183: 19. 2014.



**Fig. 7.** Sexual morph of *Camarosporidiella celtidis* (MFLU 17-469). **A.** Appearance of ascomata on host substrate. **B.** Section of ascoma. **C.** Pseudoparaphyses. **D–E.** Asci. **F–I.** Ascospores. Scale bars: B = 100  $\mu\text{m}$ ; C = 10  $\mu\text{m}$ ; D, E = 20  $\mu\text{m}$ ; F–I = 10  $\mu\text{m}$ .

*Illustrations:* See [Wijayawardene et al. \(2014a\)](#).

*Notes:* [Wijayawardene et al. \(2014a\)](#) introduced this species from *Clematis vitalba* in Italy. The sexual morph has not been reported. In this study *Camarosporidiella clematidis* groups with *Ca. laburnicola* ([Tibpromma et al. 2017](#)), which was reported as the sexual morph. This subclade (Subclade A3, [Fig. 1](#)) is not supported and therefore the lifecycle link between these two taxa is ambiguous.

***Camarosporidiella elaeagnicola*** Wanas., Bulgakov & K.D. Hyde **sp. nov.** MycoBank MB821947; Facesoffungi number: FoF 03535. [Fig. 9](#).

*Etymology:* Named after the host genus from which it was collected, *Elaeagnus*.

*Necrotrophic* on dying branches of *Elaeagnus angustifolia*. *Asexual morph:* *Conidiomata* pycnidial, 300–500  $\mu\text{m}$  high, 300–550  $\mu\text{m}$  diam ( $\bar{x}$  = 384.2  $\times$  410.8  $\mu\text{m}$ ,  $n$  = 10), solitary or gregarious, black, immersed, uni- to multi-locular, with a papillate ostiole. *Pycnidial wall* multi-layered, 15–20  $\mu\text{m}$  wide at the base, 30–40  $\mu\text{m}$  wide in sides, comprising 5–8 layers, with heavily pigmented outer layer, thick-walled, comprising blackish to dark brown cells of *textura angularis*, with lighter cells towards the inside, with inner layer composed of 2–4 layers, hyaline, thin-walled cells of *textura angularis*. *Macroconidiophores* reduced to conidiogenous cells. *Macroconidiogenous cells* enteroblastic with percurrent annellations, doliiform, integrated, solitary, hyaline, smooth-walled, and formed from the inner layer of pycnidium wall. *Macroconidia* 18–25  $\times$  9–13  $\mu\text{m}$  ( $\bar{x}$  = 19.5  $\times$  10.8  $\mu\text{m}$ ;  $n$  = 30), oblong, straight to slightly curved, rounded at both ends, 2–3-transversely septate, with one longitudinal septum,

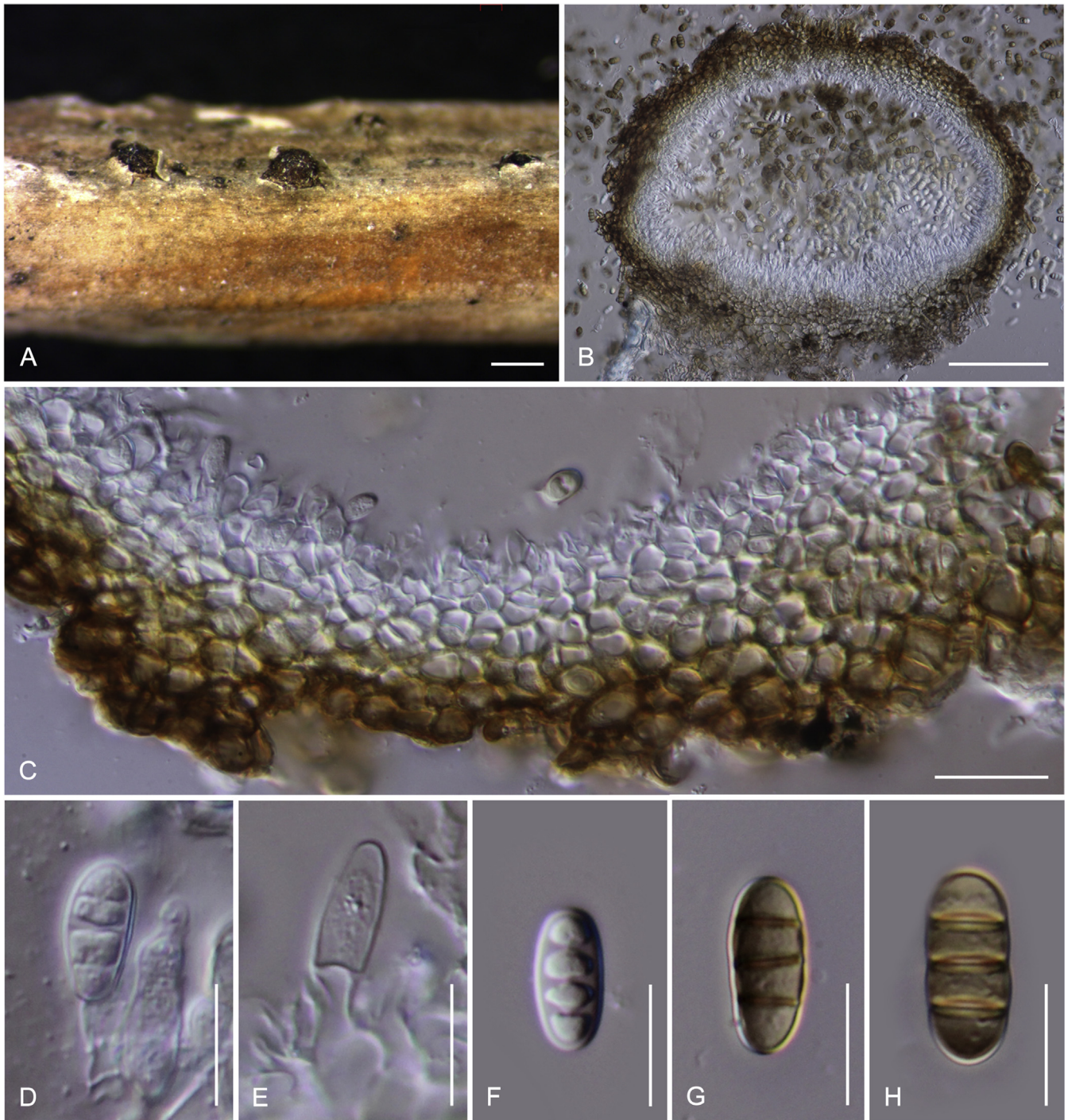


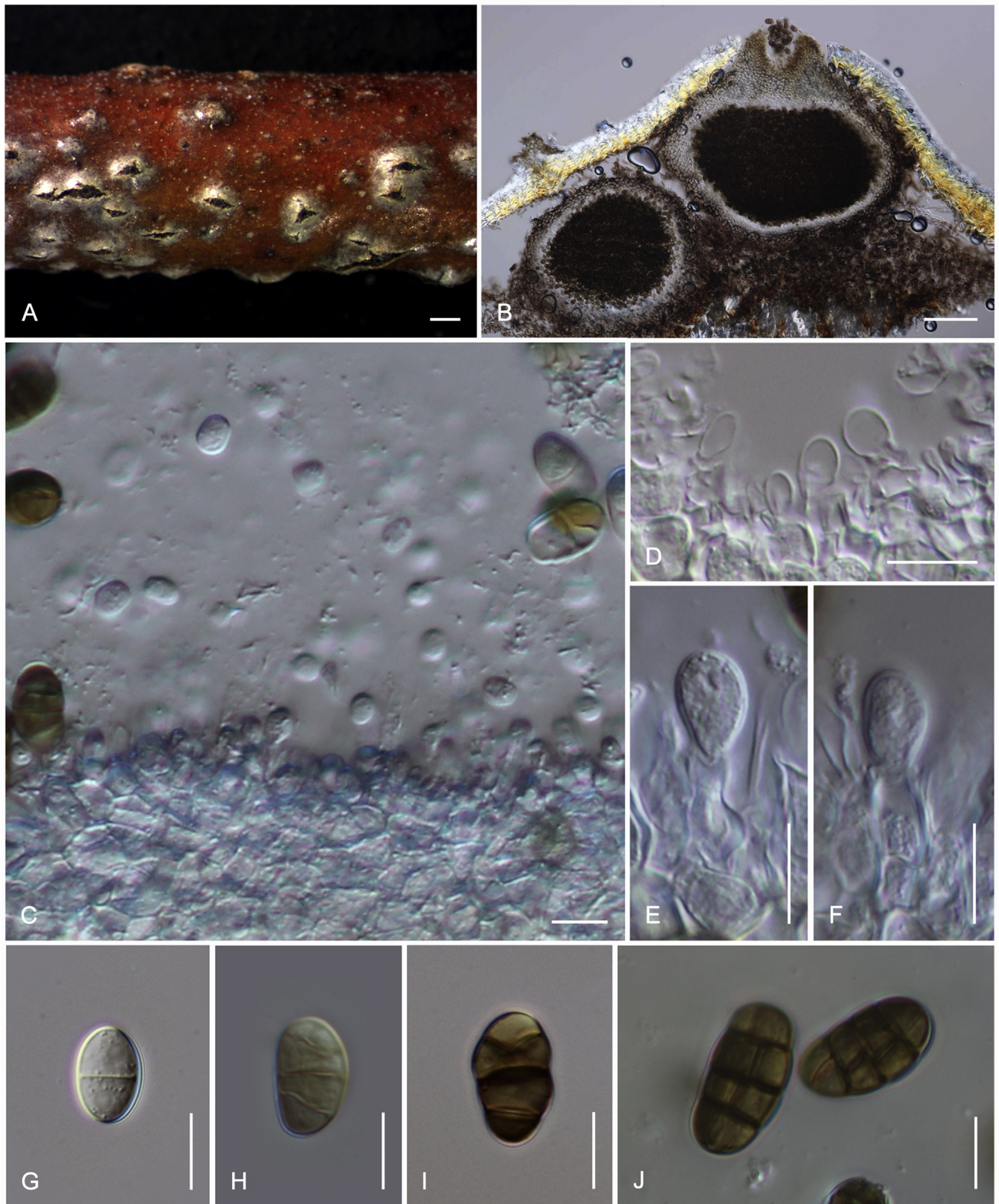
Fig. 8. Asexual morph of *Camarosporidiella celtidis* (MFLU 17-0466). **A.** Conidiomata on host surface. **B.** Vertical section through conidioma. **C.** Conidiomata wall. **D, E.** Conidiogenous cells producing conidia. **F–H.** Conidia. Scale bars: A = 500  $\mu\text{m}$ ; B = 100  $\mu\text{m}$ ; C = 20  $\mu\text{m}$ ; D–H = 10  $\mu\text{m}$ .

muriform, smooth, pale to dark brown. *Microconidiogenous cells* intermingled with macroconidiogenous cells, hyaline, discrete, enteroblastic with percurrently annellidic, ampulliform to sub-cylindrical. *Microconidia* 5–6.5  $\times$  3.5–4.5  $\mu\text{m}$  ( $\bar{x}$  = 5.9  $\times$  4.1  $\mu\text{m}$ ; n = 25), hyaline, round to oblong or ellipsoidal, with a few small guttules. *Sexual morph*: Undetermined.

*Colonies on PDA*: Slow growing, reaching 2 cm diam after 4 wk at 16  $^{\circ}\text{C}$ , later with dense mycelium, circular, rough margin, white at the centre, greenish grey towards margin, reverse greenish-grey, flat on the surface, without aerial mycelium.

*Materials examined*: **Russia**, Rostov Region, Oktyabrsky District, Shakhty city, near Grushevsky pond, shelterbelt artificial forest, 47,7250642 $^{\circ}$  N, 40,2564812 $^{\circ}$  E, on *Elaeagnus angustifolia* (*Elaeagnaceae*), 18 May 2014, T.S.

Bulgakov T-051 (MFLU 17-0470, **holotype**, ex-type culture MFLUCC 14-0908 = CBS 143113); Rostov-on-Don city, Botanical garden of Southern Federal University, Higher Park, 47,2360559 $^{\circ}$  N, 39, 6555591 $^{\circ}$  E, on *Elaeagnus angustifolia*, 26 Mar. 2014, T.S. Bulgakov T-055, MFLU 17-0473, living culture MFLUCC 14-0911 = CBS 143114; Azov district, Delta of Don river, riverside bushes of channel near Obukhovka village, 47,60741 $^{\circ}$  N, 39,4726807 $^{\circ}$  E, on *Elaeagnus angustifolia*, 8 May 2014, T.S. Bulgakov T-061, MFLU 17-0474, living culture MFLUCC 14-0912 = CBS 143115; Rostov region, Shakhty city, 20<sup>th</sup> anniversary of Red Army microdistrict, Balka Solenaya, 47,7089819 $^{\circ}$  N, 40,2637768 $^{\circ}$  E, on *Elaeagnus angustifolia*, 1 May 2015, T.S. Bulgakov T-220, MFLU 15-1924; Krasnosulinsky district, Donskoye forestry, Kabanya Balka, 47,8672211 $^{\circ}$  N, 40,247426 $^{\circ}$  E, on *Elaeagnus angustifolia*, 18 Jun. 2015, T.S. Bulgakov T-511, MFLU 15-2215; Rostov-on-Don city, Botanical Garden of Southern Federal University, Systematic Arboretum, parkland (47,2350724 $^{\circ}$  N, 39,6541643 $^{\circ}$  E), on *Elaeagnus angustifolia*, 28 May 2015, T.S. Bulgakov T-813, MFLU 15-2956, living culture MFLUCC 17-0705; *ibid.* 30 May 2015 T-819, MFLU 15-2962, living culture MFLUCC 17-0707; *ibid.* 18 Feb. 2016 T-1186, MFLU 16-



**Fig. 9.** *Camarosporidiella elaeagnicola* (MFLU 17-0470, holotype). **A.** Conidiomata on host surface. **B.** Vertical section through conidioma. **C.** Microconidia. **D–F.** Conidiogenous cells and developing conidia. **G–J.** Macroconidia. Scale bars: A = 500  $\mu\text{m}$ ; B = 100  $\mu\text{m}$ ; C–J = 10  $\mu\text{m}$ .

2382, living culture MFLUCC 17-0712; *ibid.* 14 Jun. 2016, T-NK067, MFLU 15-2962, living culture MFLUCC 17-0707.

**Notes:** In our phylogenetic analyses, 11 strains of *Camarosporidiella elaeagnicola* cluster together with 80 % ML and 84 % MP support (Subclade A6, Fig. 1). Ten of these isolations were collected on *Elaeagnus angustifolia* from Russia and one from *Elaeagnus rhamnoides* in Germany. *Camarosporium*

*elaegnellum* and *Cm. elaeagni* have also been found on *Elaeagnus angustifolia* from California, Canada and Ukraine (Farr & Rossman 2017). The relationship between these *Camarosporium* spp. with *Camarosporidiella elaeagnicola* cannot be investigated due to lack of morphological and molecular data for *Camarosporium elaeagnellum* and *Cm. elaeagni*. Thus, we introduce *Camarosporidiella elaeagnicola* as a new species.

***Camarosporidiella elongata*** (Fr.) Wanas., Wijayaw. & K.D. Hyde, **comb. nov.** MycoBank MB821948; Facesoffungi number: FoF 03536.

*Basionym:* *Sphaeria elongata* Fr., *Observationes mycologicae* 1: 175. 1815.

*Synonyms:* *Cucurbitaria elongata* (Fr.) Grev., *Scott. crypt. fl.*: pl. 195. 1826.

*Gibberidea elongata* (Fr.) Kuntze, *Revisio generum plantarum* 3: 481. 1898.

*Note:* See Mirza (1968) for further details on *Camarosporidiella elongata* (= *Cucurbitaria elongata*).

***Camarosporidiella eufemiana*** Wanas., Camporesi & K.D. Hyde, **sp. nov.** MycoBank MB821949; Facesoffungi number: FoF 03537. Fig. 10.

*Etymology:* *eufemiana*, due to its occurrence in Santa Eufemia, Italy.

*Saprobic* on dead branches of *Cytisus* sp. *Asexual morph:* Undetermined. *Sexual morph:* *Ascomata* 350–400 µm high, 450–550 µm diam ( $\bar{x}$  = 376.8 × 496.4 µm, *n* = 10), black, semi-erumpent to superficial, solitary or gregarious, globose, ostiolate. *Ostiole* short papillate central, slightly sunken, minute and inconspicuous at the surface, smooth, with ostiolar canal filled with hyaline to brown cells. *Peridium* 40–50 µm wide at the base, 40–70 µm wide in sides, thick, comprising 6–8 layers, with heavily pigmented outer layer, thick-walled, comprising blackish to dark brown elongated cells of *textura angularis*, cells towards the inside lighter, with inner layer composed 2–3 layers, hyaline, flattened, thin-walled cells of *textura angularis*. *Hamathecium* comprising numerous, 2.5–3.5 µm (*n* = 30) wide, filamentous, branched, septate, pseudoparaphyses. *Asci* 130–150 × 14–15 µm ( $\bar{x}$  = 142.4 × 14.5 µm, *n* = 20), 8-spored, bitunicate, fissitunicate, cylindrical, short-pedicellate, rounded at apex with a minute ocular chamber. *Ascospores* 20–25 × 10–12 µm ( $\bar{x}$  = 21.9 × 10.3 µm, *n* = 30), overlapping uniseriate or sometimes biseriate, muriform, mostly ellipsoidal, 3–5-transversely septate, with one longitudinal septum, deeply constricted at the middle septum, slightly constricted at remaining septa, initially hyaline, becoming brown at maturity, asymmetrical, upper part wider than lower part, conical and narrowly rounded at the ends, not surrounded by a mucilaginous sheath.

*Colonies on PDA:* Slow growing, reaching 3 cm diam after 4 wk at 16 °C, later with dense mycelium, circular, rough margin creamy to pale brown centre and dirty white towards the margin after 6 wk, reverse iron, flat on the surface, without aerial mycelium. Hyphae septate, branched, hyaline, thin-walled.

*Material examined:* Italy, Forlì-Cesena [FC], Premilcuore, Santa Eufemia, on dead aerial branches of *Cytisus* sp. (*Fabaceae*), 3 Jan. 2014, E. Camporesi IT1621 (MFLU 16-0182, **holotype**, ex-type culture MFLUCC 17-0207 = CBS 143116).

*Notes:* *Camarosporidiella eufemiana* morphologically resembles other sexual members in this genus in having similar asci and ascospore shapes. In the phylogenetic analyses, *Ca. eufemiana* groups as a sister taxon to *Ca. elongata* but with no statistical support (Subclade A4, Fig. 1). However, *Ca.*

*eufemiana* is different from *Ca. elongata* in having longer asci (140–225 µm, Mirza 1968) with a long pedicel, while *Ca. eufemiana* has comparatively shorter asci (130–150 µm) with a short pedicel. *Camarosporidiella laburni* (= *Cucurbitaria laburni*) and *Cucurbitaria spartii* are also reported from *Cytisus* sp. (Mirza 1968). *Camarosporidiella laburni* (Subclade A3, Fig. 1) is phylogenetically distinct from *Ca. eufemiana* in this study. There is no molecular data available for *Cucurbitaria spartii* and its relationship to *Camarosporidiella eufemiana* cannot be resolved. However, *Ca. eufemiana* has shorter asci (130–150 µm) than *Cucurbitaria spartii* (150–240 µm, Mirza 1968).

***Camarosporidiella halimodendri*** Wanas., Bulgakov & K.D. Hyde, **sp. nov.** MycoBank MB821950; Facesoffungi number: FoF 03538. Fig. 11.

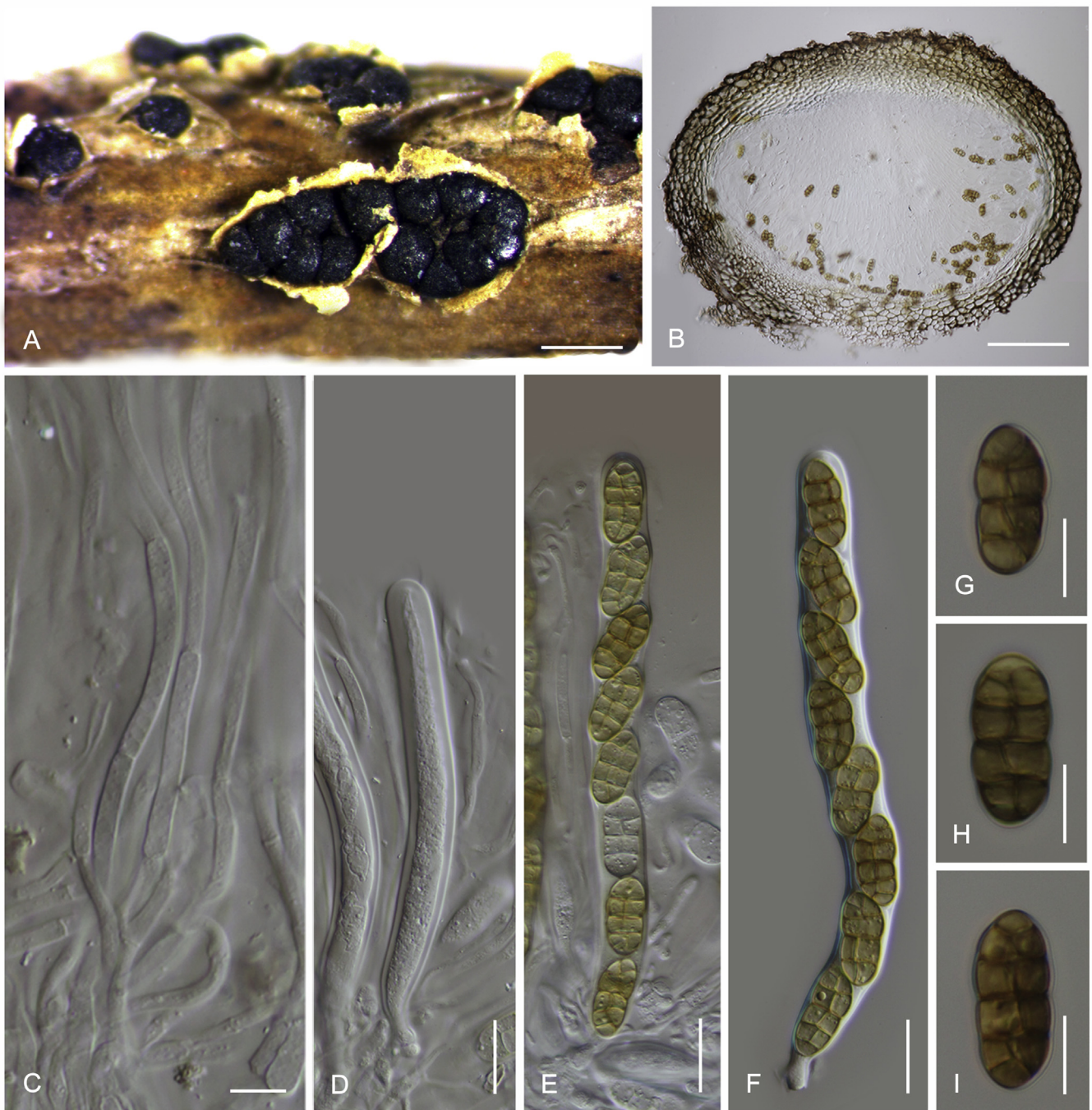
*Etymology:* Named after the host genus from which it was collected, *Halimodendron*.

*Saprobic* or *weakly pathogenic* on dead branches of *Halimodendron halodendron*. *Asexual morph:* *Conidiomata* pycnidial, 500–600 µm high, 350–600 µm diam ( $\bar{x}$  = 480.4 × 496.7 µm, *n* = 10), solitary or gregarious, black, immersed, sometimes scattered beneath the host periderm or on decorticated wood, fully or partly erumpent, unilocular, with a papillate ostiolate. *Ostiole* 100–200 µm long, 80–120 µm diam ( $\bar{x}$  = 169.2 × 93.4 µm, *n* = 6), central, long, smooth, sometimes ostiolar canal filled with hyaline or pale brown cells. *Pycnidial wall* multi-layered, 25–35 µm wide at the base, 35–45 µm wide in sides, thick, comprising 5–6 layers, outer layer heavily pigmented, thick-walled, comprising blackish to dark reddish-brown cells of *textura angularis*, cells towards the inside lighter, inner layer composed of 1–2 layers, hyaline, thin-walled cells of *textura angularis*. *Conidiophores* reduced to conidiogenous cells. *Macroconidiogenous cells* enteroblastic, annellidic, doliform, integrated, solitary, hyaline, smooth-walled, and formed from the inner layer of pycnidium wall. *Macroconidia* 18–25 × 8–12 µm ( $\bar{x}$  = 21.5 × 10.7 µm; *n* = 40), oblong, straight to slightly curved, rounded at both ends, sometimes narrowly rounded ends, 4–6-transverse septate, with 1–2 longitudinal septa, with 2–4 oblique septa, muriform, smooth-walled, brown to dark brown. *Microconidiogenous cells* intermingled with macroconidiogenous cells, hyaline, discrete, enteroblastic with percurrent annellidic, ampulliform to subcylindrical. *Microconidia* 4.5–7.5 × 3.5–4.5 µm ( $\bar{x}$  = 6.5 × 3.9 µm; *n* = 25), hyaline, round to oblong or ellipsoidal, with a few small guttules. *Sexual morph:* Undetermined.

*Colonies on PDA:* Slow growing, reaching 2 cm diam after 4 wk at 16 °C, later with dense mycelium, circular, rough margin, white, reverse cream-grey, flat on the surface, without aerial mycelium. Hyphae septate, branched, hyaline, thin-walled.

*Materials examined:* Russia, Rostov Region, Rostov-on-Don city, Botanical garden of Southern Federal University, Systematic Arboretum, 47,2360559° N, 39,6555591° E, on dying twigs and shrubs *Halimodendron halodendron* (*Fabaceae*), 8 May 2013, T.S. Bulgakov T-018 (MFLU 17-0463, **holotype**, ex-type culture, MFLUCC 14-0901 = CBS 143117); *ibid.* 26 Mar. 2014, T-041 (MFLU 17-0467, **paratype**, ex-paratype culture, MFLUCC 14-0905); Rostov Region, Shakhty city, near Grushevsky pond, stony steppe, 47,7237362° N, 39,2551937° E, on dead twigs of *Caragana frutex* (*Fabaceae*), 18 May 2014, T.S. Bulgakov T-050, MFLU 17-0469, living culture MFLUCC 14-0907 = CBS 143118;





**Fig. 10.** *Camarosporidiella eufemiana* (MFLU 16-0182, holotype) **A.** Appearance of ascomata on host substrate. **B.** Section of ascoma. **C.** Pseudoparaphyses. **D–F.** Asci. **G–I.** Ascospores. Scale bars: A = 500  $\mu$ m; B = 100  $\mu$ m; C = 5  $\mu$ m; D–F = 20  $\mu$ m; G–I = 10  $\mu$ m.

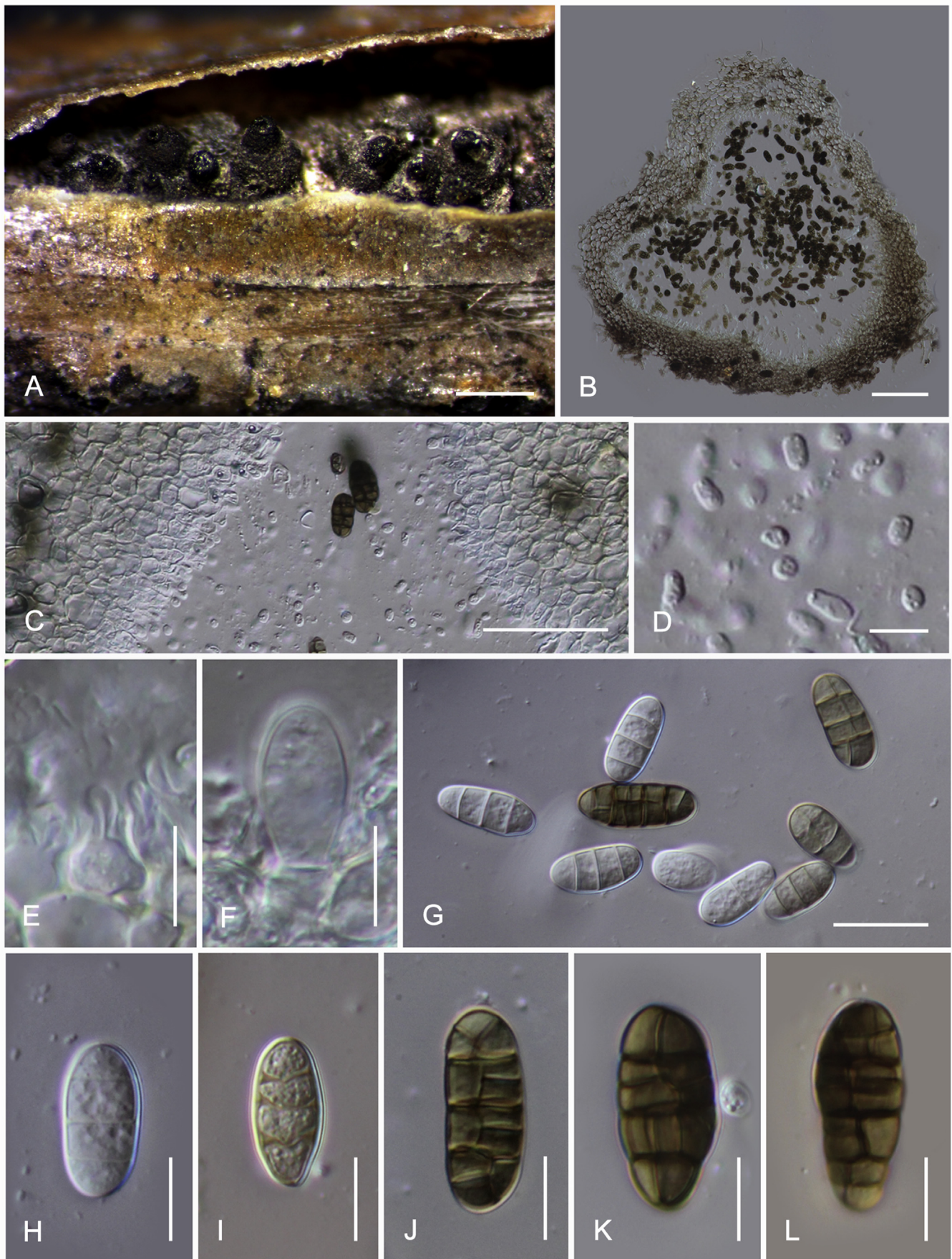
Rostov Region, Rostov-on-Don city, Botanical garden of Southern Federal University, Systematic Arboretum, 47,2360559° N, 39,6555591° E, on dead twigs of *Cytisus podolicus* (Fabaceae), 8 May 2014, T.S. Bulgakov T-066, MFLU 17-0476, living culture MFLUCC 14-0914; Rostov Region, Shakhty city, coal heap of former coal mine 'Proletarian dictature', 47,7104110° N, 40,2627254° E, on dead twigs of *Lycium barbarum* (Solanaceae), 21 May 2015, T.S. Bulgakov T-419, MFLU 15-2123, living culture MFLUCC 17-0212 = CBS 143119.

**Notes:** *Camarosporium halimi* (12–16  $\times$  9–13  $\mu$ m, 2–3 transverse septa) has also been found on *Halimodendron halodendron* from Iran (Farr & Rossman 2017), but it has smaller conidia with fewer transverse septa (Saccardo 1906) compared to *Camarosporidiella halimodendri* (8–25  $\times$  8–12  $\mu$ m, 4–6 transverse septa). In this study, we refer six strains to *Ca. halimodendri* (Subclade A11, Fig. 1), which group together with 81 % ML, 74 % MP, 0.98 PP statistical support and share similar morphologies.

***Camarosporidiella italica*** Wanas., Camporesi & K.D. Hyde, **sp. nov.** MycoBank MB821951; Facesoffungi number: FoF 03539. Fig. 12.

**Etymology:** *italica*, due to its occurrence in Italy.

**Saprobic** on dead branches of *Coronilla emerus*. **Asexual morph:** Undetermined. **Sexual morph:** **Ascromata** 400–450  $\mu$ m high, 550–600  $\mu$ m diam ( $\bar{x}$  = 436.2  $\times$  457.8  $\mu$ m, n = 10), black, immersed to semi-erumpent, solitary or gregarious, globose, with an ostiole comprising greenish grey setae. **Ostiole** 60–90  $\mu$ m long, 30–45  $\mu$ m diam ( $\bar{x}$  = 76.2  $\times$  36.4  $\mu$ m, n = 6) central, short, slightly sunken, minute and inconspicuous on the surface, smooth, ostiolar canal filled with hyaline to brown cells. **Peridium** 20–30  $\mu$ m wide at the base, 40–50  $\mu$ m wide in sides, thick, comprising 5–8 layers, outer layer heavily pigmented, thick-



**Fig. 11.** *Camarosporidiella halimodendri* (MFLU 17-0463, holotype). **A.** Conidiomata on host surface. **B.** Vertical section through conidioma. **C, D.** Microconidia. **E, F.** Conidiogenous cells. **G–L.** Macroconidia. Scale bars: A = 500  $\mu$ m; B = 100  $\mu$ m; C = 50  $\mu$ m; D–F = 10  $\mu$ m; G = 20  $\mu$ m; H–L = 10  $\mu$ m.

walled, comprising blackish to dark brown elongated cells of *textura angularis*, cells towards the inside lighter, inner layer composed of 2–3 layers, hyaline, flattened, thin-walled cells of *textura angularis*. *Hamathecium* comprising numerous, 3.5–4.5  $\mu\text{m}$  ( $n = 40$ ) wide, filamentous, branched, septate, pseudoparaphyses. *Asci* 150–180  $\times$  15–20  $\mu\text{m}$  ( $\bar{x} = 164.7 \times 18.4 \mu\text{m}$ ,  $n = 30$ ), 8-spored, bitunicate, fissitunicate, cylindrical, short-pedicellate, apex rounded with a minute ocular chamber. *Ascospores* 30–35  $\times$  12–14  $\mu\text{m}$  ( $\bar{x} = 32.9 \times 12.8 \mu\text{m}$ ,  $n = 50$ ), overlapping uniseriate or sometimes overlapping biseriate, muriform, mostly ellipsoidal, 6–8-transversely septate, with 2–3 longitudinal septa, deeply constricted at the middle septum, slightly constricted at remaining septa, initially hyaline, becoming brown at maturity, asymmetrical, upper part wider than lower part, slightly paler ends, conical and narrowly rounded at the ends, not surrounded by a mucilaginous sheath.

*Colonies on PDA*: Slow growing, reaching 3 cm diam after 4 wk at 16 °C, later with dense mycelium, circular, rough margin greenish grey after 6 wk, reverse greenish grey, flat on the surface, without aerial mycelium. Hyphae septate, branched, hyaline, thin.

*Material examined*: Italy, Forlì-Cesena [FC], Bagno di Romagna, Valgianna, on dead aerial twigs of *Coronilla emeris* (*Fabaceae*), 19 May 2013, E. Camporesi IT1283 (MFLU 16-0139, **holotype**, ex-type culture MFLUCC 13-0547).

*Notes*: *Cucurbitaria coronillae*, *Cu. elongata* and *Cu. emeris* are also recorded on *Coronilla emeris* (Munk 1957, Mirza 1968). These three species morphologically resemble *Camarosporidiella italica* with respect to their ascomata, peridium, asci and ascospore characters. *Cucurbitaria emeris* is different from *Ca. italica* in having diplodia-like uniseptate conidia. *Cucurbitaria coronillae* differs from *Ca. italica* in having much longer ascospores (> 30  $\mu\text{m}$ ) with 2–3 longitudinal septa while *Cu. coronillae* has comparatively shorter ascospores (< 27  $\mu\text{m}$ ) with one longitudinal septum. *Cucurbitaria elongata* differs from *Ca. italica* in having a prominently thicker peridium (100–180  $\mu\text{m}$ ) while *Ca. italica* has a peridium up to 50  $\mu\text{m}$  wide.

***Camarosporidiella laburni*** (Pers.) Wanas., Bulgakov, Camporesi & K.D. Hyde **comb. nov.** MycoBank MB821952; Facesoffungi number: FoF 03540. Figs 13, 14.

*Basionym*: *Sphaeria laburni* Pers., *Observ. mycol.* 1: 68. 1796. *Synonyms*: *Cucurbitaria laburni* (Pers.) De Not., *Erb. critt. Ital.*, Ser. 1, fasc. 16: 875. 1862.

*Gibberidea laburni* (Pers.) Kuntze, *Revisio generum plantarum* 3: 481. 1898.

*Camarosporium laburni* Sacc. & Roum., *Michelia* 2: 630. 1882.

*Saprobic* on woody branches. *Asexual morph*: *Conidiomata* pycnidial, 300–350  $\mu\text{m}$  high, 300–400  $\mu\text{m}$  diam ( $\bar{x} = 338.2 \times 326.1 \mu\text{m}$ ,  $n = 10$ ), solitary to gregarious, black, immersed, unilocular, with an apiculate ostiole. *Pycnidial wall* multi-layered, 20–30  $\mu\text{m}$  wide at the base, 40–50  $\mu\text{m}$  wide in sides, thick, comprising 4–7 layers, outer layer heavily pigmented, thick-walled, comprising blackish to dark brown cells of *textura angularis*, cells towards the inside lighter, inner layer composed of 2–3 layers, hyaline, thin-walled cells of *textura angularis*. *Conidiophores* reduced to conidiogenous cells. *Conidiogenous cells* enteroblastic, annellidic, doliform, integrated, solitary, hyaline, smooth-walled, and formed from the inner layer of pycnidium wall. *Conidia* 20–30  $\times$  8–11  $\mu\text{m}$  ( $\bar{x} = 26.1 \times 9.7 \mu\text{m}$ ;  $n = 30$ ), oblong, straight to slightly curved,

rounded at both ends, 4–5-transversely septate, with 1–2 longitudinal septa, muriform, smooth-walled, initially hyaline, becoming blackish brown at maturity. *Sexual morph*: *Ascomata* 400–550  $\mu\text{m}$  high, 500–600  $\mu\text{m}$  diam ( $\bar{x} = 462.4 \times 559.9 \mu\text{m}$ ,  $n = 10$ ), black, superficial to semi-immersed, confluent, gregarious, sometimes scattered beneath the host periderm or on decorticated wood, fully or partly erumpent, globose, uniloculate, with an ostiole. *Ostiole* central, short, slightly sunken, minute and inconspicuous at the surface, smooth, ostiolar canal filled with hyaline cells. *Peridium* 40–60  $\mu\text{m}$  wide at the base, 90–120  $\mu\text{m}$  wide in sides, thick, comprising 10–12 layers, outermost layer heavily pigmented, thin-walled, comprising blackish to dark brown amorphous layer, middle layer heavily pigmented, thick-walled, comprising blackish to dark brown loosely packed cells of *textura angularis*, inner layer composed of 3–4 layers, reddish brown to hyaline, cells towards the inside lighter, flattened, thick-walled cells of *textura angularis*. *Hamathecium* comprising numerous, 2.5–3  $\mu\text{m}$  ( $n = 40$ ) wide, filamentous, branched septate, pseudoparaphyses. *Asci* 160–190  $\times$  12–16  $\mu\text{m}$  ( $\bar{x} = 176.3 \times 14.8 \mu\text{m}$ ,  $n = 40$ ), 8-spored, bitunicate, fissitunicate, cylindrical, short-pedicellate, apex rounded with a minute ocular chamber. *Ascospores* 27–32  $\times$  10–12  $\mu\text{m}$  ( $\bar{x} = 30.4 \times 11.1 \mu\text{m}$ ,  $n = 50$ ), overlapping uniseriate, muriform, mostly ellipsoidal, 6–7-transversely septate, with 1–2 longitudinal septa, deeply constricted at the middle septum, slightly constricted at remaining septa, initially hyaline, becoming pale brown at maturity, asymmetrical, slightly paler ends, conical and narrowly rounded at the ends, not surrounded by a mucilaginous sheath.

*Colonies on PDA*: Slow growing, reaching 2 cm diam after 4 wk at 16 °C, later with dense mycelium, circular, rough margin, greenish grey after 6 wk, reverse greenish grey, flat on the surface, without aerial mycelium.

*Materials examined*: Italy, Forlì-Cesena, Fiumicello di Premilcuore, on dead aerial branches of *Laburnum anagyroides*, 1 Jan. 2012, E. Camporesi, IT83, MFLU 16-0094, living culture MFLUCC 14-0919 = CBS 143121. **Russia**, Rostov Region, Rostov-on-Don city, Botanical garden of Southern Federal University, Systematic Arboretum, 47,2360559° N, 39,6555591° E, on dead twigs of *Laburnum anagyroides* (*Fabaceae*), 5 Mar. 2014, T.S. Bulgakov T-003, MFLU 17-0451, living culture MFLUCC 14-0885; Rostov-on-Don city, Botanical Garden of Southern Federal University, Systematic Arboretum, 47,2350733° N, 39,6541689° E, on *Laburnum anagyroides*, 30 May 2015, T.S. Bulgakov T-811, MFLU 15-2954, living culture MFLUCC 17-0704 = CBS 143122; on *Laburnum* sp., 28 May 2015, T.S. Bulgakov T-838, MFLU 15-2981, living culture MFLUCC 17-0709; Republic of Crimea, Feodosia city Municipality, Tepe-Oba ridge, artificial forest, 44,0108725° N, 35,3541327° E, on dead branches of *Laburnum anagyroides*, 23 Jun. 2016, T.S. Bulgakov CR029 (MFLU 17-1434, living culture MFLUCC 17-0751 = CBS 143120) *ibid.* CR032 (MFLU 17-1435, living culture MFLUCC 17-0752)

*Notes*: *Camarosporidiella laburni* (= *Cucurbitaria laburni*) was introduced by De Notaris (1862) for a collection from Italy. Our collection is also from Italy, which fits with the original description of *Cm. laburni* (De Notaris 1862) and the description of Mirza (1968). A comprehensive comparison of *Cm. laburni* with other species is given by Green (1931) and Mirza (1968), which is clearly different from the remaining described species in *Cucurbitaria*. By considering the continent, host and morphological evidence, we introduce DNA-based molecular data for *Cm. laburni* as *Ca. laburni*. Furthermore, in this study the strains (MFLUCC 14-0885, 17-0704, 17-0752, 17-0709, 17-0751, from conidia) cluster together with *C. laburni* (Subclade A3, Fig. 1) and we consider them belong to this species as the asexual

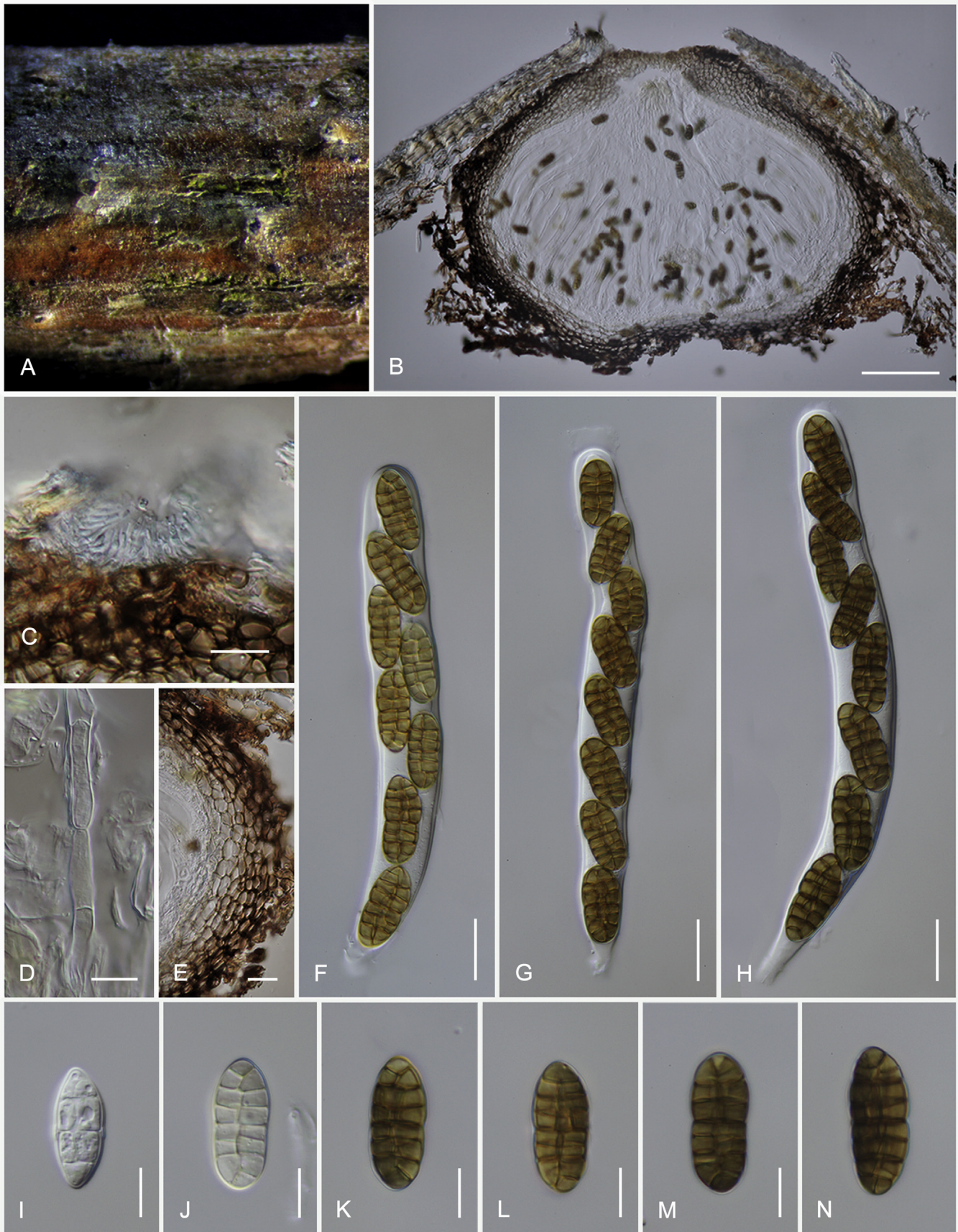


Fig. 12. *Camarosporidiella italica* (MFLU 16-0139, holotype). A. Appearance of ascomata on host substrate. B. Section of ascoma. C. Closeup of ostiole. D. Pseudoparaphyses. E. Peridium. F–H. Asci. I–N. Ascospores. Scale bars: B = 100  $\mu$ m; C, E, F–H = 20  $\mu$ m; D, I–N = 10  $\mu$ m.

morph. *Camarosporidiella clematidis* clusters in a subclade sister to *Ca. laburni*, but morphologically differs from *Ca. laburni* in having smaller conidia (10–17  $\times$  7–9  $\mu$ m) while *Ca. laburni* has comparatively larger conidia (20–30  $\times$  8–11  $\mu$ m).

***Camarosporidiella laburnicola*** (R.H. Perera et al.) Wanas. & K.D. Hyde, **comb. nov.** MycoBank MB821953; Facesoffungi number: FoF 03541.

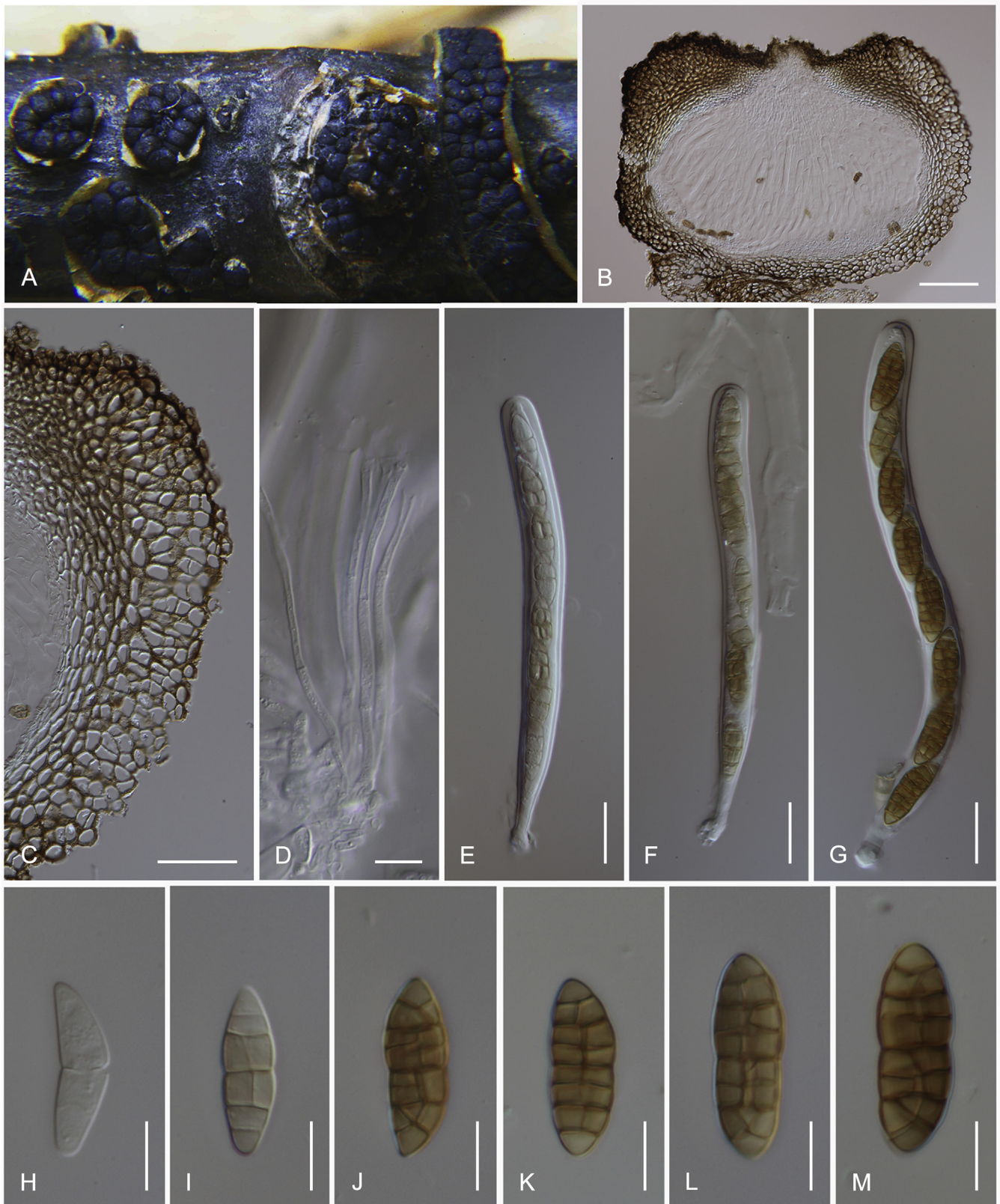


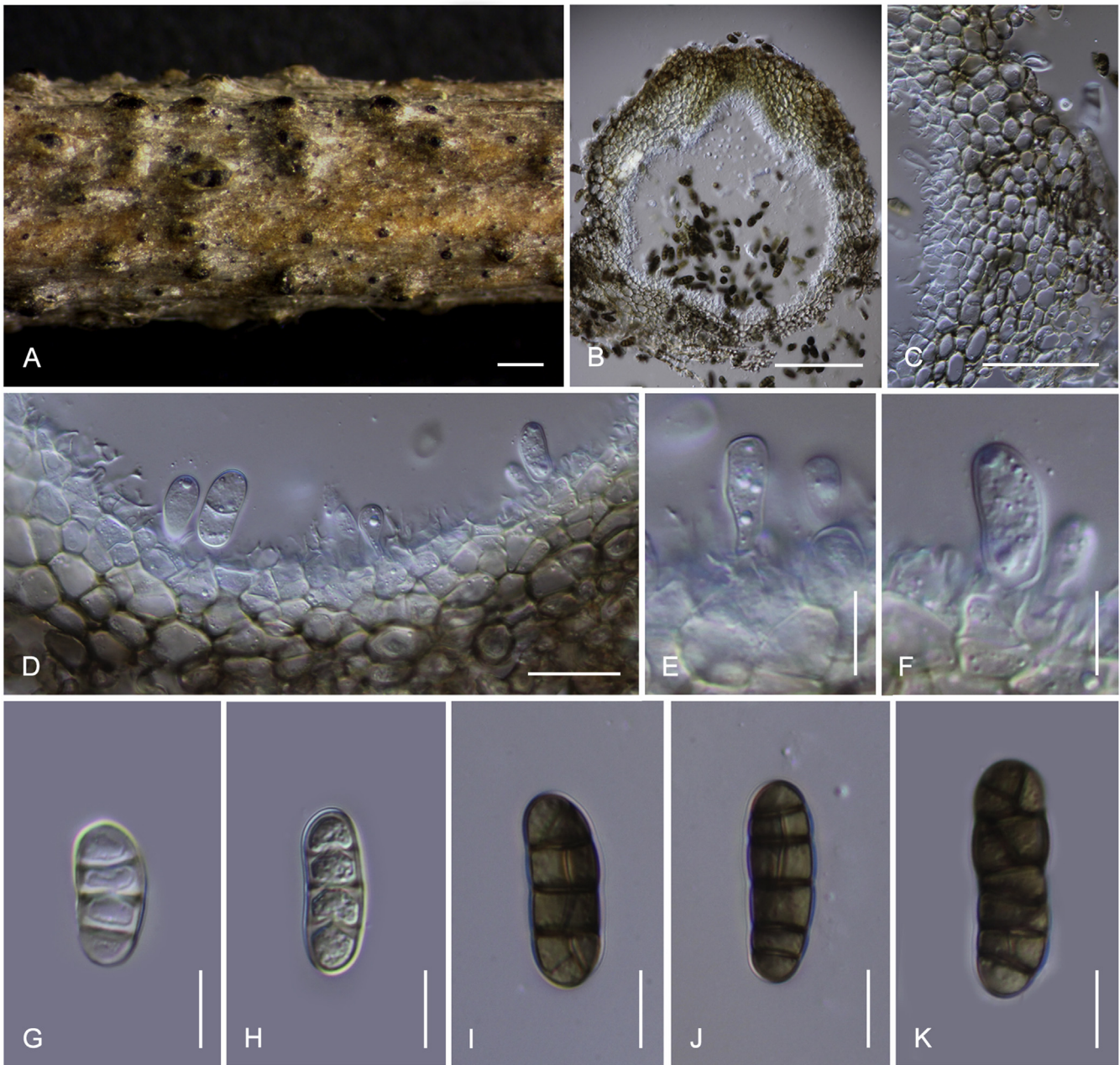
Fig. 13. Sexual morph of *Camarosporidiella laburni* (MFLU 16-0094). A. Appearance of ascomata on host substrate. B. Section of ascoma. C. Peridium. D. Pseudoparaphyses. E–G. Asci. H–M. Ascospores. Scale bars: B = 100  $\mu$ m; C = 50  $\mu$ m; D, H–M = 10  $\mu$ m; E–G = 20  $\mu$ m.

**Basionym:** *Camarosporium laburnicola* R.H. Perera *et al.*, Fungal Diversity 83: 97. 2017.

**Illustrations:** See Tibpromma *et al.* (2017).

**Notes:** *Camarosporidiella laburnicola* (Subclade A3, Fig. 1) was isolated from *Laburnum anagyroides* and is morphologically similar to *Ca. arezzoensis*, *Ca. elongatum* and *Ca. uniseriatum*.

However, *Ca. laburnicola* differs from these taxa in having smaller asci and ascospores with different numbers of longitudinal and transverse septa (Tibpromma *et al.* 2017). *Camarosporidiella laburnicola* is nested in between *Ca. laburni* and *Ca. clematidis*, but this relationship is not supported ( $\geq 60$  ML & MP and  $\geq 0.95$  PP, Clade A3, Fig. 1). *Camarosporidiella laburnicola* is morphologically similar to *Ca. laburni* in ascomata, asci and ascospore characters. However, *Camarosporidiella laburni*



**Fig. 14.** Asexual morph of *Camarosporidiella laburni* (MFLU 17-0451). **A.** Conidiomata on host surface. **B.** Vertical section through conidioma. **C, D.** Conidiomatal wall. **E, F.** Conidiogenous cells. **G–K.** Conidia. Scale bars: A = 500  $\mu\text{m}$ ; B = 100  $\mu\text{m}$ ; C = 50  $\mu\text{m}$ ; D = 20  $\mu\text{m}$ ; E–K = 10  $\mu\text{m}$ .

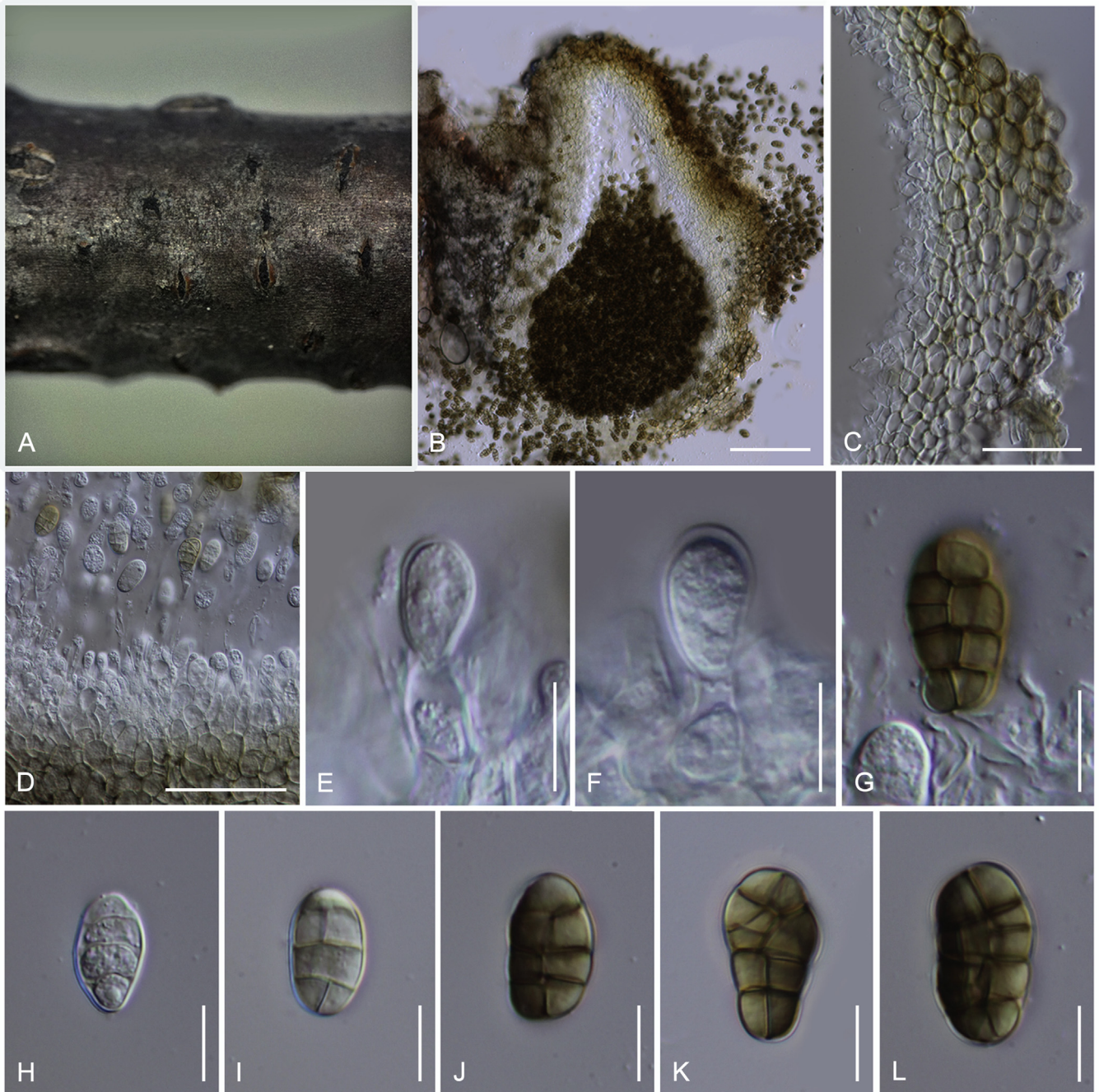
differs from *Ca. laburnicola* in having much larger asci (160–190  $\times$  12–16  $\mu\text{m}$ ) and ascospores (27–32  $\times$  10–12  $\mu\text{m}$ ) while *Ca. laburnicola* has comparatively smaller asci (125–150  $\times$  9–11  $\mu\text{m}$ ) and ascospores (15–21  $\times$  6–8  $\mu\text{m}$ ).

***Camarosporidiella mackenziei*** Wanas., Bulgakov & K.D. Hyde **sp. nov.** MycoBank MB821954; Facesoffungi number: FoF 03542. **Fig. 15.**

**Etymology:** In honour of Dr. Eric Hugh Charles Mckenzie for his immense contribution to mycology.

**Necrotrophic** on dying branches of *Caragana arborescens*. **Asexual morph:** Conidiomata pycnidial, 450–550  $\mu\text{m}$  high, 500–600  $\mu\text{m}$  diam ( $\bar{x}$  = 408.4  $\times$  569.5  $\mu\text{m}$ , n = 10), solitary or gregarious, black, immersed to semi-erumpent, unilocular, with a papillate ostiole. **Ostiole** 120–160  $\mu\text{m}$  long, 80–90  $\mu\text{m}$  diam

( $\bar{x}$  = 140.1  $\times$  66.7  $\mu\text{m}$ , n = 10), central, long, smooth, sometimes ostiolar canal filled with hyaline or pale brown cells. **Pycnidial wall** multi-layered, 40–50  $\mu\text{m}$  wide at the base, 40–55  $\mu\text{m}$  wide in sides, thick, comprising 4–6 layers, outer layer heavily pigmented, thick-walled, comprising blackish to dark reddish-brown cells of *textura angularis*, cells towards the inside lighter, inner layer composed of 1–2 layers, hyaline, thin-walled cells of *textura angularis*. **Conidiophores** reduced to conidiogenous cells. **Macroconidiogenous cells** enteroblastic, annellidic, doliiform, integrated, solitary, hyaline, smooth-walled, and formed from the inner layer of pycnidium wall. **Macroconidia** 17–25  $\times$  9–13  $\mu\text{m}$  ( $\bar{x}$  = 19.6  $\times$  11.1  $\mu\text{m}$ ; n = 50), oblong, straight to slightly curved, rounded at both ends, sometimes narrowly rounded ends, 3–4 transversely septate, with 1–2 longitudinal septa, muriform, smooth-walled, brown to dark brown. **Microconidiogenous cells** intermingled with macroconidiogenous cells, hyaline, integrated, enteroblastic with percurrent annellidic, ampulliform to



**Fig. 15.** *Camarosporidiella mackenziei* (MFLU 17-0449, holotype). **A.** Conidiomata on host surface. **B.** Vertical section through conidioma. **C.** Conidiomatal wall. **D.** Microconidia. **E–G.** Conidiogenous cells forming conidia. **H–L.** Macroconidia. Scale bars: B = 100  $\mu$ m; C, D = 50  $\mu$ m; E–L = 10  $\mu$ m.

subcylindrical. *Microconidia* 6.5–8  $\times$  4–6  $\mu$ m ( $\bar{x}$  = 7.6  $\times$  4.5  $\mu$ m; n = 20), hyaline, round to oblong or ellipsoidal, with small guttules. *Sexual morph*: Undetermined.

*Colonies on PDA*: Slow growing, reaching 2 cm diam after 4 wk at 16  $^{\circ}$ C, later with dense mycelium, circular, rough margin, greenish grey, reverse greenish grey, flat on the surface, without aerial mycelium. Hyphae septate, branched, hyaline, thin-walled.

*Materials examined*: **Russia**, Rostov Region, Oktyabrsky district, natural sanctuary (Persianovskaya preserved steppe), shelterbelt artificial forest, 47,5036056 $^{\circ}$  N, 40,1545572 $^{\circ}$  E, on dying twigs and shrubs of *Caragana arborescens* (Fabaceae), 26 Apr. 2014, T.S. Bulgakov T-001 (MFLU 17-0449, **holotype**, ex-type culture, MFLUCC 14-0883 = CBS 143123); *ibid.* T-011 (MFLU 17-0457, **paratype**, ex-paratype culture, MFLUCC 14-0893 = CBS 143124). *ibid.* 47,2350724 $^{\circ}$  N, 39,6541643 $^{\circ}$  E, 28 May 2015, T-810, MFLU 15-2953, **paratype**, ex-paratype living culture MFLUCC 17-0703.

*Notes*: *Camarosporidiella caraganicola* has also been collected from *Caragana* spp. and resembles *Ca. mackenziei* in conidial dimensions (13–26  $\times$  6–13  $\mu$ m; Liu *et al.* 2015) and shape. However, they are phylogenetically apart (Subclades A7 and A12 respectively, Fig. 1).

The affiliation of *Ca. mackenziei* with *Camarosporidiella* sp. (CPC 25960, CPC 25962) cannot be compared as no details are available for these isolations (Subclade A12, Fig. 1). All the three strains of *C. mackenziei* in Subclade A12 (Fig. 1) are from the same locality and host. There are slight differences in their DNA sequence data and there could be a probability that they constitute a species complex. Perhaps more collections from different regions/hosts can further clarify their taxonomy in future studies. We reiterate, however, that morphologically they are similar and hence we consider them as one species.

***Camarosporidiella melnikii*** Wanas., Bulgakov & K.D. Hyde, **sp. nov.** MycoBank MB821955; Facesoffungi number: FoF 03543. Fig. 16.

**Etymology:** In honour of Vadim Alexandrovich Mel'nik (March 16, 1937 – April 10, 2017) for his immense contribution to mycology.

**Necrotrophic** on dying branches of *Caragana frutex*. **Asexual morph:** *Conidiomata* pycnidial, 350–550 µm high, 300–500 µm diam ( $\bar{x} = 457.7 \times 393.1$  µm,  $n = 10$ ), black, superficial to semi-immersed, confluent, gregarious, sometimes scattered beneath the host periderm or on decorticated wood, fully or partly erumpent, globose, ostiolate. *Ostirole* central, short, slightly sunken, minute, inconspicuous on surface, smooth, with ostiolar canal filled with hyaline cells. *Ostirole* 120–180 µm long, 70–90 µm diam ( $\bar{x} = 150.1 \times 82.7$  µm,  $n = 10$ ), central, long, smooth, sometimes ostiolar canal filled with hyaline or pale brown cells. *Pycnidial wall* multi-layered, 40–50 µm wide at the base, 40–75 µm wide in sides, thick, comprising 4–8 layers, outer layer heavily pigmented, thick-walled, comprising blackish to dark reddish-brown cells of *textura angularis*, cells towards the inside lighter, inner layer composed of 2–4 layers, hyaline, thin-walled cells of *textura angularis*. *Conidiophores* reduced to conidiogenous cells. *Macroconidiogenous cells* enteroblastic, annellidic, doliiform, integrated, solitary, hyaline, smooth-walled, and formed from the inner layer of pycnidium wall. *Macroconidia* 11–16 × 5–6 µm ( $\bar{x} = 13.3 \times 5.5$  µm;  $n = 50$ ), oblong, straight, rounded at both ends, sometimes narrowly rounded ends, 2–3-transversely septate, without longitudinal septa, smooth-walled, initially hyaline, becoming brown to dark brown at maturity. *Microconidiogenous cells* intermingled with macroconidiogenous cells, hyaline, integrated, enteroblastic with percurrent annellidic, ampulliform to subcylindrical. *Microconidia* 7–12 × 4–7 µm ( $\bar{x} = 9.6 \times$  µm;  $n = 20$ ), hyaline, round to oblong or ellipsoidal, with small guttules. **Sexual morph:** Undetermined.

**Colonies on PDA:** Slow growing, reaching 2 cm diam after 4 wk at 16 °C, later with dense mycelium, circular, rough margin, creamy, reverse pale brown, flat on the surface, without aerial mycelium. Hyphae septate, branched, hyaline, thin-walled.

**Material examined:** **Russia**, Rostov region, Shakhty city, Cotton Fabric urban microdistrict, Grushevka steppe slopes near Grushevsky Pond, 47, 7234186° N, 40, 255065° E, on dead aerial branches of *Caragana frutex* (Fabaceae), 12 May 2015, T.S. Bulgakov T-318, MFLU 15-2022, **holotype**, ex-type living culture MFLUCC 17-0684).

**Notes:** *Camarosporidiella melnikii* is an independent taxon (sister to *Ca. caraganicola* isolates) and segregates from others with high statistical support (Subclade A7, Fig. 1). *Ca. melnikii* has smaller conidia (11–16 × 5–6 µm) without longitudinal septa, while *Camarosporidiella caraganicola* has comparatively larger conidia (13–26 × 6–13 µm; Liu et al. 2015) with longitudinal septa. *Camarosporidiella melnikii* also resembles *Ca. celtidis* in having 2–3-transversely septate conidia, without longitudinal septa, but phylogeny herein supports their distinction (Subclades A7 and A5 respectively, Fig. 1).

***Camarosporidiella mirabellensis*** Wanas., Camporesi & K.D. Hyde, **sp. nov.** MycoBank MB821956; Facesoffungi number: FoF 03544. Fig. 17.

**Etymology:** *mirabellensis*, due to its occurrence in Monte Mirabello, Italy.

**Saprobic** on woody branches. **Asexual morph:** Undetermined. **Sexual morph:** *Ascomata* 300–350 µm high, 500–550 µm diam ( $\bar{x} = 323.9 \times 523.3$  µm,  $n = 10$ ), black, immersed to semi-erumpent, solitary or gregarious, broadly oblong, cupulate when dry. *Peridium* 50–80 µm wide at the base, 60–90 µm wide in sides, thick, comprising 8–10 layers, outer layer heavily pigmented, thick-walled, comprising blackish to dark brown elongated cells of *textura angularis*, cells towards the inside lighter, inner layer composed of 2–3 layers, hyaline, flattened, thin-walled cells of *textura angularis*. *Hamathecium* comprising numerous, 1.5–2 µm ( $n = 30$ ) wide, filamentous, branched, septate, pseudoparaphyses. *Asci* 140–170 × 12–16 µm ( $\bar{x} = 158.8 \times 13.7$  µm,  $n = 30$ ), 8-spored, bitunicate, fissitunicate, cylindrical, short-pedicellate, apex rounded with a minute ocular chamber. *Ascospores* 22–27 × 9–11 µm ( $\bar{x} = 24.8 \times 9.9$  µm,  $n = 40$ ), overlapping uniseriate or sometimes overlapping biseriata, muriform, mostly ellipsoidal, 3–5-transversely septate, with 1–2 longitudinal septa, deeply constricted at the middle septum, slightly constricted at remaining septa, initially hyaline, becoming brown at maturity, asymmetrical, slightly paler ends, conical and narrowed at the ends, not surrounded by a mucilaginous sheath.

**Colonies on PDA:** Slow growing, reaching 3 cm diam after 4 wk at 16 °C, later with dense mycelium, circular, rough margin dirty white after 6 wk, reverse creamy, flat on the surface, without aerial mycelium.

**Material examined:** **Italy**, Forlì-Cesena [FC], Predappio, Monte Mirabello, on dead aerial branches of *Robinia pseudoacacia* (Fabaceae), 3 Oct. 2014, E. Camporesi IT 2139 (MFLU 16-0228, **holotype**).

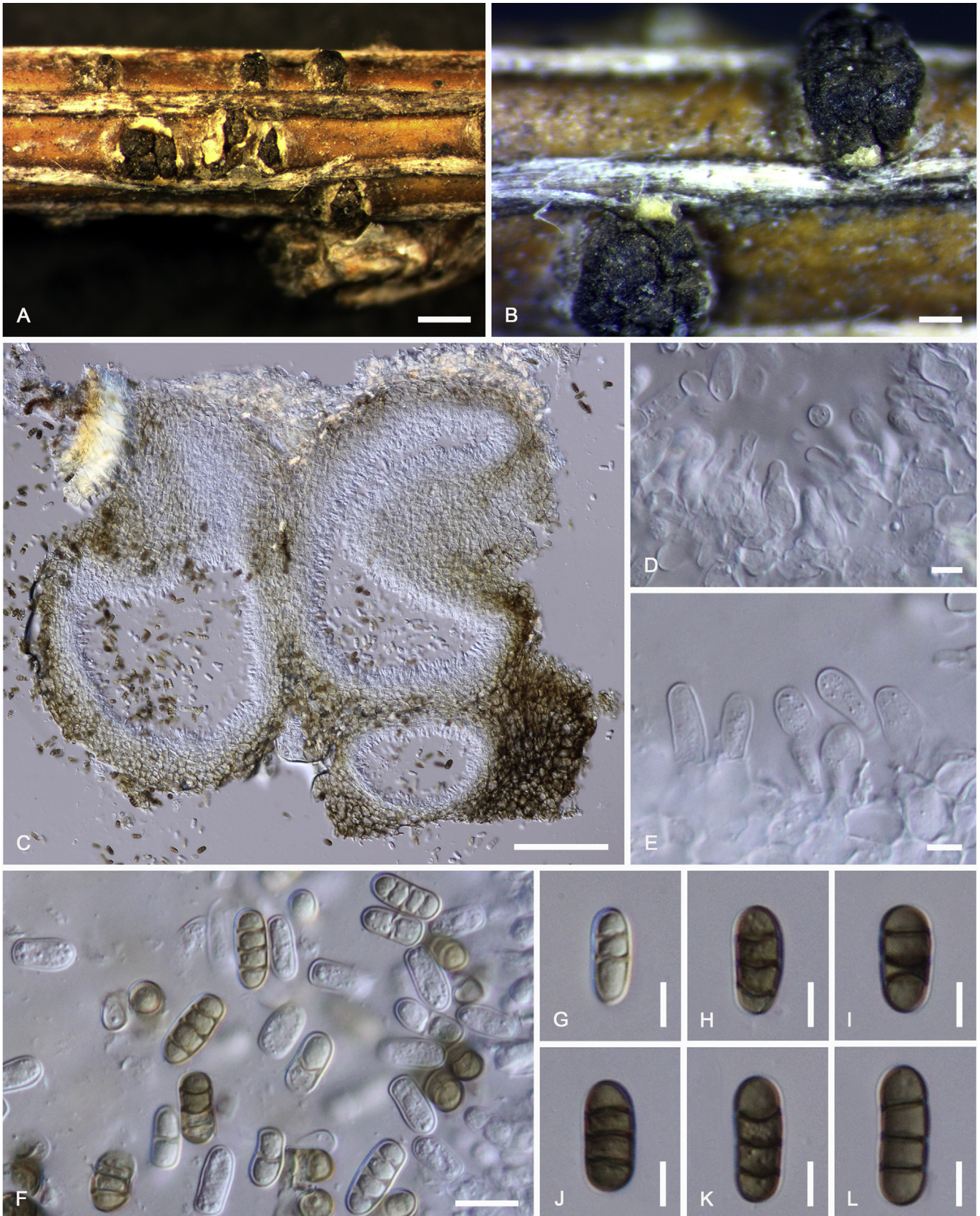
**Notes:** Unfortunately, we could not manage to maintain a living culture as subsequent attempts to subculture failed, and hence a living culture is unavailable. *Camarosporidiella elongata* and *Ca. spartii* have also been reported on *Robinia pseudoacacia* and morphologically resemble our new collection of *Ca. mirabellensis* in their ascomata, peridium, asci and ascospore characteristics (Mirza 1968). However, *Ca. mirabellensis* differs from *Ca. elongata* and *Ca. spartii* in having ascospores with fewer transverse septa (< 5). In multi-gene phylogenetic analyses, *Ca. mirabellensis*, *Ca. eufemiana* and *Ca. premilcurensis* are more closely related (Subclade A4, Fig. 1). We must point out that despite not having sufficient phylogenetic differences, we consider them morphologically different in terms of spore shape, structure and septation. While *Ca. mirabellensis* has pointed ends and more than one longitudinal septum, *Ca. eufemiana* has much more rounded ends with one longitudinal septum. *Camarosporidiella premilcurensis*, on the other hand, has larger asci, and more transverse septa. Therefore, we introduce *Ca. mirabellensis* as a novel species in order to minimize taxonomic ambiguity of *Camarosporidiella*.

***Camarosporidiella moricola*** (Chethana et al.) Wanas. & K.D. Hyde, **comb. nov.** MycoBank MB821957; Facesoffungi number: FoF 03545.

**Basionym:** *Camarosporium moricola* Chethana et al., Fungal Diversity 83: 101. 2017.

**Illustrations:** See Tibpromma et al. (2017).





**Fig. 16.** *Camarosporidiella melnikii* (MFLU 17-2022, holotype). **A, B.** Conidiomata on host surface. **C.** Vertical section through conidiomata. **D, E.** Conidiogenous cells forming conidia. **F.** Macro- and micro-conidia. **G–L.** Macroconidia. Scale bars: A = 500  $\mu$ m; B = 200  $\mu$ m; C = 100  $\mu$ m; D–E = 5  $\mu$ m; F = 10  $\mu$ m; G–L = 5  $\mu$ m.

**Materials examined:** **Russia**, Rostov Region, Shakhty city, railroad artificial forest near Kazyonny pond, 47,7532324° N, 40,208931° E, on *Morus alba* (*Moraceae*), 26 Feb. 2014, T.S. Bulgakov T-004, MFLU 17-0452, living culture MFLUCC 14-0886; *ibid.* Rostov-on-Don city, Botanical garden of Southern Federal University, Higher Park, underwood, 47,2336592° N, 39,6593893° E, 26 Mar. 2014, T.S. Bulgakov T-015, MFLU 17-0461, living culture MFLUCC

14-0898; *ibid.* Shakhty city, At yukhta River valley, Volchya Balka, 47,7122088° N, 40,1836753° E, 5 Jul. 2015, T.S. Bulgakov T-232, MFLU 15-1936; *ibid.* Shakhty city, Cotton Fabric urban microdistrict, Grushevka steppe slopes near Grushevsky Pond, 47,7234186° N, 40,255065° E, 30 Apr. 2015, T.S. Bulgakov T-265, MFLU 15-1969, living culture MFLUCC 17-0680; *ibid.* 14 May 2015, T.S. Bulgakov T-371, MFLU 15-2075, living culture MFLUCC 17-



**Fig. 17.** *Camarosporidiella mirabellensis* (MFLU 16-0228, holotype). **A.** Appearance of ascomata on host substrate. **B.** Section of ascoma. **C.** Peridium. **D.** Pseudoparaphyses. **E–G.** Asci. **H–L.** Ascospores. Scale bars: B = 100 µm; C = 50 µm; D = 5 µm; E–G = 20 µm; H–L = 10 µm.

0687; *ibid.* Krasnosulinsky district, Donskoye forestry, Kabanya Balka, 47,8672211° N, 40,247426° E, 18 Jun. 2015, T.S. Bulgakov T-518, MFLU 15-2222, living culture MFLUCC 17-0694; *ibid.* Krasnosulinsky district, Donskoye forestry, artificial forest plantation, 47,8547249° N, 40,2318907° E, 18 Jun. 2015, T.S. Bulgakov T-856, MFLU 15-2999, living culture MFLUCC 17-0711; *ibid.*, 1 Mar. 2016, T.S. Bulgakov T-1233, MFLU 16-1527, living culture MFLUCC 17-0714 = CBS 143125; *ibid.* 1 Mar. 2016, T.S. Bulgakov T-1332, MFLU 16-1626, living culture MFLUCC 17-0718 = CBS 143126; *ibid.* 24 Mar. 2016, T.S. Bulgakov T-1345, MFLU 16-1639, living culture MFLUCC 17-0719;

*ibid.* 14 Mar. 2016, T.S. Bulgakov T-1476, MFLU 16-1770, living culture MFLUCC 17-0725.

**Notes:** Tibpromma *et al.* (2017) introduced *Camarosporidiella moricola* (= *Camarosporium moricola*) with three isolates, which were collected from *Morus alba* in Russia. In this study, we add another 12 strains to *Camarosporidiella moricola* (Subclade A1, Fig. 1) which were also collected from *Morus alba* in Russia. See more details in Tibpromma *et al.* (2017).

***Camarosporidiella premilcurensis*** Wanas., Camporesi & K.D. Hyde, **sp. nov.** MycoBank MB821958; Facesoffungi number: FoF 03546. Fig. 18.

**Etymology:** *premilcurensis*, due to its occurrence in Premilcuore, Italy.

**Saprobic** on *Cytisus* sp. **Asexual morph:** Undetermined. **Sexual morph:** **Ascomata** 400–450 µm high, 500–600 µm diam ( $\bar{x}$  = 442.1 × 531.7 µm,  $n$  = 10), black, superficial to semi-immersed, confluent, gregarious, sometimes scattered beneath the host periderm or on decorticated wood, fully or partly erumpent, globose, uniloculate, with an apiculate ostiole. **Ostiole** central, short, slightly sunken, minute and inconspicuous at the surface, smooth, ostiolar canal filled with hyaline cells. **Peridium** 30–50 µm wide at the base, 60–90 µm wide in sides, thick, comprising 8–15 layers, outermost layer heavily pigmented, thin-walled, comprising blackish to dark brown amorphous layer, middle layer heavily pigmented, thick-walled, comprising blackish to dark brown loosely packed cells of *textura angularis*, inner layer composed of 3–4 layers, reddish brown to hyaline, cells towards the inside lighter, flattened, thick-walled cells of *textura angularis*. **Hamathecium** comprising numerous, 2.5–3.5 µm ( $n$  = 40) wide, filamentous, branched septate, pseudoparaphyses. **Asci** 160–210 × 14–16 µm ( $\bar{x}$  = 181.1 × 15 µm,  $n$  = 40), 8-spored, bitunicate, fissitunicate, cylindrical, short-pedicellate, apex rounded with a minute ocular chamber. **Ascospores** 22–27 × 10–12 µm ( $\bar{x}$  = 24.7 × 10.9 µm,  $n$  = 50), overlapping uniseriate, muriform, mostly ellipsoidal, 5–7-transversely septate, with 1–2 longitudinal septa, deeply constricted at the middle septum, slightly constricted at remaining septa, initially hyaline, becoming pale brown at maturity, asymmetrical, slightly paler, conical and narrowly rounded at the ends, not surrounded by a mucilaginous sheath.

**Colonies on PDA:** Slow growing, reaching 2 cm diam after 4 wk at 16 °C, later with dense mycelium, circular, rough margin, creamy after 6 wk, reverse greenish grey, flat on the surface, without aerial mycelium. Hyphae septate, branched, hyaline, thin-walled.

**Material examined:** Italy, Forlì-Cesena [FC], Premilcuore, Fantella, on dead aerial twigs of *Cytisus* sp. (*Fabaceae*), 28 Jan. 2014, E. Camporesi, IT1681 (MFLU 16-0185, **holotype**, ex-type culture MFLUCC 14-0939 = CBS 143127).

**Notes:** *Camarosporidiella laburni* has also been collected from the same host genus, *Cytisus* (Farr & Rossman 2017) and morphologically resembles *Ca. premilcurensis* in having similar ascomata, peridium, asci and ascospore characters. However, *Ca. laburni* has longer ascospores (> 27 µm) and a thicker peridium (> 100 µm), while *Ca. premilcurensis* has comparatively shorter ascospores (< 27 µm) and thinner peridium (> 90 µm). *Camarosporidiella premilcurensis* (Subclade A4, Fig. 1) is also phylogenetically distant from *Ca. laburni* and the latter appears to be more closely related to *Ca. laburnicola* and *Ca. clematidis* (Subclade A3, Fig. 1).

***Camarosporidiella robiniicola*** (Wijayaw. et al.) Wijayaw., Wanas. & K.D. Hyde, **comb. nov.** MycoBank MB821959; Facesoffungi number: FoF 03547.

**Basionym:** *Camarosporium robiniicola* Wijayaw. et al., Phytotaxa 183: 21. 2014.

**Synonym:** *Camarosporium aureum* Norphanphoun et al., Fungal Diversity 72: 153. 2015.

**Illustrations:** See Wijayawardane et al. (2014a) and Liu et al. (2015).

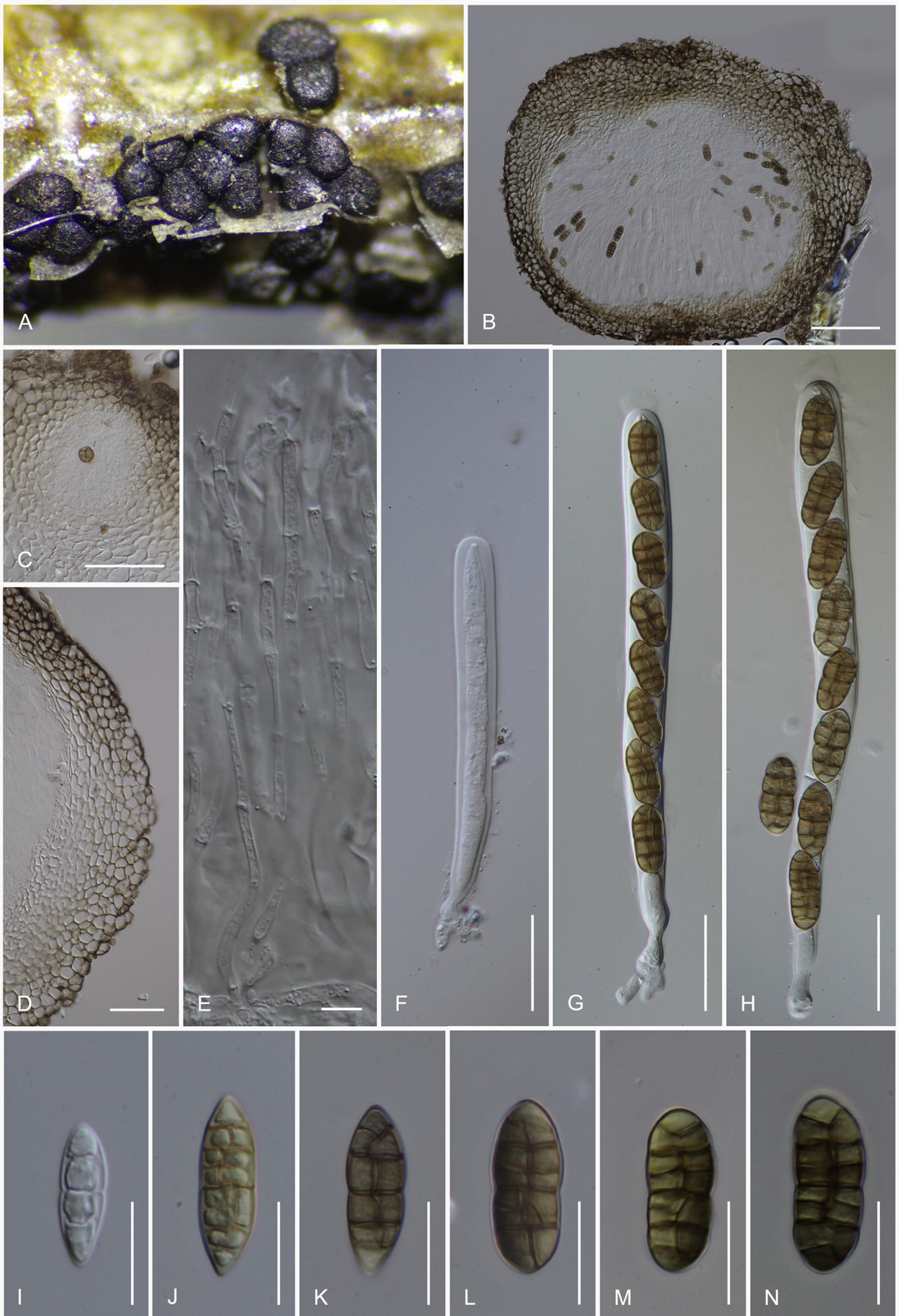
**Additional material examined:** **Russia**, Rostov Region, Krasnosulinsky District, Donskoye forestry, artificial forest, 47,8621251° N, 40,2313757° E, on dead twigs of *Gleditsia triacanthos* (*Fabaceae*), 21 May 2013, T.S. Bulgakov T-042, MFLU 17-0468, living culture MFLUCC 14-0906 = CBS 143130; Rostov Region, Rostov-on-Don city, Botanical garden of Southern Federal University, Higher Park, 47, 2352837° N, 39, 6490788° E, on dead twigs of *Gleditsia triacanthos*, 14 May 2013, T.S. Bulgakov T-010, MFLU 17-0456, living culture MFLUCC 14-0892 = CBS 143128; Rostov region, Shakhty city, Atyukhta river valley, railroad artificial forest, 47,7113209° N, 40,1831603° E, on *Robinia neomexicana* (*Fabaceae*), 14 Mar. 2014, T.S. Bulgakov T-012, MFLU 17-0458, living culture MFLUCC 14-0894 = CBS 143129; Rostov-on-Don city, Botanical garden of Southern Federal University, Higher Park, 47,2389405° N, 39,6484137° E, on *Robinia pseudoacacia* (*Fabaceae*), 8 May 2014, T.S. Bulgakov T-053, MFLU 17-0471, living culture MFLUCC 14-0909 = CBS 143131; Shakhty city, 20<sup>th</sup> anniversary of Red Army microdistrict, Solyonaya Balka, 47,7104113° N, 340,2627254° E, on *Robinia pseudoacacia*, 21 May 2015, T.S. Bulgakov T-403, MFLU 15-2104, living culture MFLUCC 17-0688; *ibid.*, on *Robinia* sp., 21 May 2016, T.S. Bulgakov T-1303, MFLU 16-1597, living culture MFLUCC 17-0688 = CBS 143132; *ibid.*, on *Robinia* sp., 5 Jun. 2016, T.S. Bulgakov DL004, MFLU 16-2300, living culture MFLUCC 17-0733.

**Notes:** All strains of *Camarosporidiella robiniicola* (including the strain of *Ca. aureum*, MFLUCC 14-0620) cluster together with significant statistical support of 97 % for ML, 88 % for MP and 1.00 for PP (Clade A2, Fig. 1). Morphological comparison reveals identical morphs and our phylogeny strongly supports an association of *Ca. aureum* with other strains of *Ca. robiniicola*. Therefore, it would be taxonomically correct to treat them as conspecific. We herein synonymise *Camarosporium aureum* under *Ca. robiniicola*. See Liu et al. (2015) for more details on *Camarosporium aureum*.

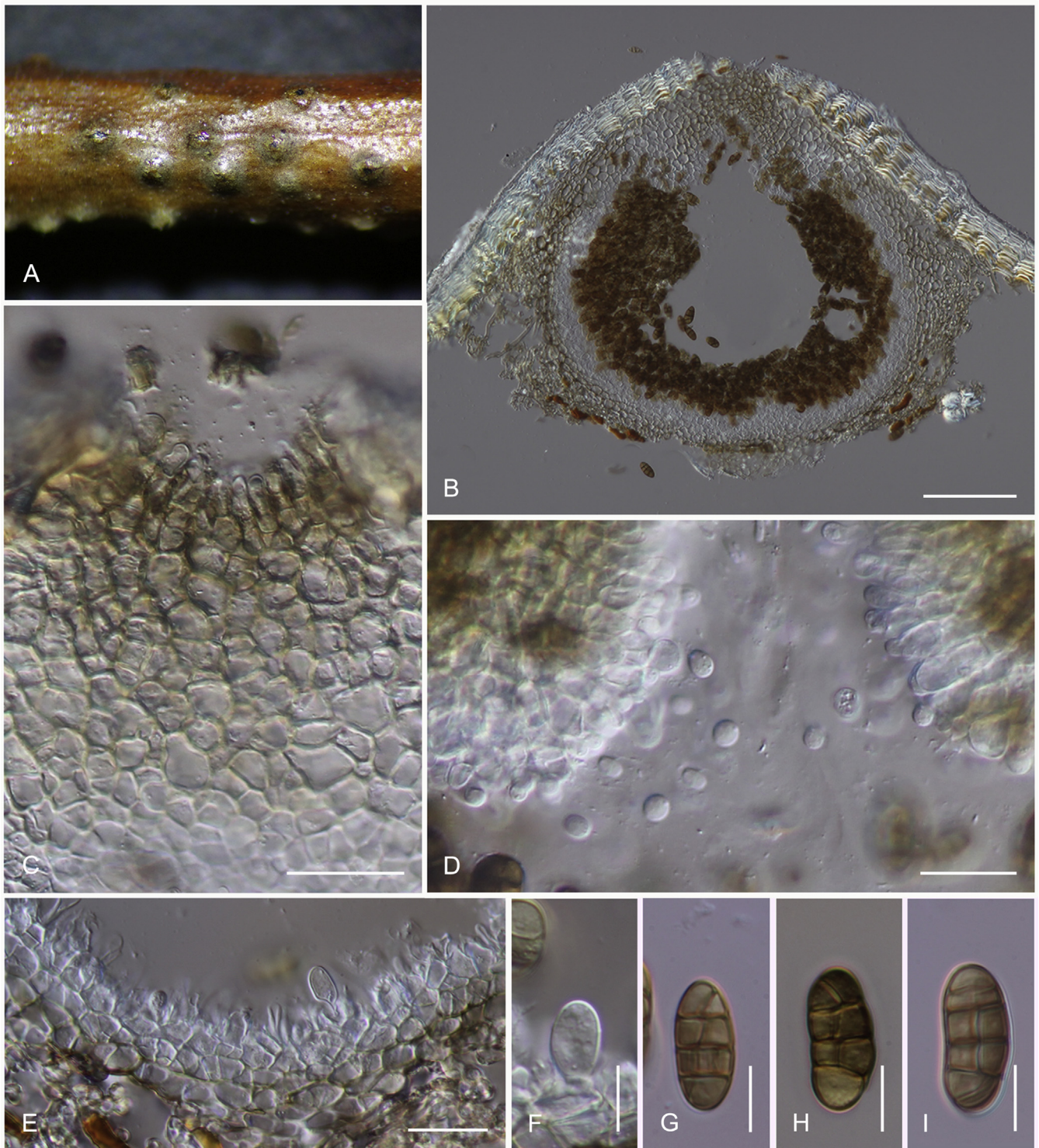
***Camarosporidiella schulzeri*** Wanas., Bulgakov & K.D. Hyde, **sp. nov.** MycoBank MB821960; Facesoffungi number: FoF 03548. Fig. 19.

**Etymology:** Named after Stephan V.M. Schulzer, who introduced the genus *Camarosporium*.

**Necrotrophic** on dying branches of *Elaeagnus angustifolia*. **Asexual morph:** **Conidiomata** pycnidial, 370–420 µm high, 380–460 µm diam ( $\bar{x}$  = 366.4 × 420.7 µm,  $n$  = 10), solitary or gregarious, black, immersed or partly erumpent, unilocular, ostiolate. **Ostiole** 50–80 µm long, 50–70 µm diam ( $\bar{x}$  = 67.2 × 60.4 µm,  $n$  = 6), central, long, smooth, sometimes ostiolar canal filled with hyaline or pale brown cells. **Pycnidial wall** multi-layered, 15–25 µm wide at the base, 25–35 µm wide in sides, thick, comprising 4–5 layers, with heavily pigmented outer layer, thick-walled, comprising blackish to dark reddish-brown cells of *textura angularis*, with lighter cells towards the inside, with inner layer composed of 1–2 layers, hyaline, thin-walled cells of *textura angularis*. **Conidiophores** reduced to conidiogenous cells. **Macroconidiogenous cells** enteroblastic, annellidic, doliiform, integrated, solitary, hyaline, smooth-walled, and formed from the inner layer of pycnidium wall. **Macroconidia** 15–21 × 8–12 µm ( $\bar{x}$  = 18.9 × 10.1 µm;  $n$  = 40), oblong, straight to slightly curved, rounded at both ends, 2–3-transversely septate, with one longitudinal septum, muriform, smooth-walled, brown to dark brown. **Microconidiogenous cells** intermingled with macroconidiogenous cells, hyaline, integrated,



**Fig. 18.** *Camarosporidiella premilcurensis* (MFLU 16-0185, holotype). **A.** Appearance of ascomata on host substrate. **B.** Section of ascoma. **C.** Close-up of ostiole. **D.** Peridium. **E.** Pseudoparaphyses. **F–H.** Asci. **I–N.** Ascospores. Scale bars: B = 100  $\mu$ m; C, D = 50  $\mu$ m; E = 5  $\mu$ m; F–H = 20  $\mu$ m; I–N = 10  $\mu$ m.



**Fig. 19.** *Camarosporidiella schulzeri* (MFLU 17-0460, holotype). **A.** Conidiomata on host surface. **B.** Vertical section through conidioma. **C.** Close-up of ostiole. **D.** Microconidia. **E.** Conidiogenous cells. **F–I.** Conidia. Scale bars: B = 100 µm; C = 50 µm; D, E = 20 µm; F–I = 10 µm.

enteroblastic, annellidic, ampulliform to subcylindrical. *Microconidia*  $4.5\text{--}6.5 \times 4.5\text{--}5.5 \mu\text{m}$  ( $\bar{x} = 5.9 \times 4.9 \mu\text{m}$ ;  $n = 25$ ), hyaline, round to oblong or ellipsoidal, with a few small guttules. *Sexual morph*: Undetermined.

*Colonies on PDA*: Slow growing, reaching 2 cm diam after 4 wk at 16 °C, later with dense mycelium, circular, rough margin, white, reverse cream-grey, flat on the surface, without aerial mycelium. Hyphae septate, branched, hyaline, thin-walled.

*Materials examined*: **Russia**, Rostov Region, Rostov-on-Don city, Botanical garden of Southern Federal University, Higher Park, underwood, 47,2360559° N, 39,6555591° E, on *Elaeagnus angustifolia* (*Fabaceae*), 26 Mar. 2014, T.S. Bulgakov

T-014 (MFLU 17-0460, **holotype**, ex-type culture, MFLUCC 14-0897 = CBS 143133); Oktyabrsky district, south of Persianovsky settlement, Balka Khoruli (Khoruli gully), 47,5036926° N, 40,1241732° E, on *Gleditsia triacanthos*, 28 Apr. 2015, T.S. Bulgakov T-205, MFLU 15-1909; *ibid.*, on *Robinia* sp., 14 Mar. 2016, T.S. Bulgakov T-1305, MFLU 16-1599, living culture MFLUCC 17-0722; *ibid.*, on *Robinia* sp., 24 Mar. 2016, T.S. Bulgakov T-1370, MFLU 16-1664, living culture MFLUCC 17-0722.

*Notes*: The holotype of *Camarosporidiella schulzeri* was collected from *Elaeagnus angustifolia*, and *Camarosporium caraganae* (conidia  $14\text{--}22 \times 9\text{--}12 \mu\text{m}$ ), *Ca. elaeagnicola* ( $21\text{--}23 \times 8\text{--}10 \mu\text{m}$ ), *Camarosporidiella elaeagnicola* ( $18\text{--}25 \times 9\text{--}13 \mu\text{m}$ ) and *Ca. arezzoensis* ( $22\text{--}30 \times 8\text{--}10 \mu\text{m}$ )

have also been reported from *Elaeagnus* (Farr & Rossman 2017, this study). *Camarosporidiella elaeagnicola* and *Ca. arezzoensis* are also positioned in different subclades (Subclades A6 and A8 respectively, Fig. 1) and this provides additional support to justify their species status. The relationship between *Camarosporium caraganae* and *Ca. elaeagnicola* with *Camarosporidiella schulzeri* cannot be investigated due to lack of molecular data for *Camarosporium caraganae* and *Ca. elaeagnicola*.

***Camarosporidiella spartii*** (Trail) Wijayaw., Wanas. & K.D. Hyde, **comb. nov.** MycoBank MB821961; Facesoffungi number: FoF 03549.

**Basionym:** *Camarosporium spartii* Trail, Scott. Natural., N.S. 3 ("9"): 222. 1888.

**Illustrations:** See Wijayawardane et al. (2014a).

**Note:** This species is located basal in Subclade A4 (Fig. 1).

**Coniothyriaceae** W.B. Cooke, Revista de Biol. 12: 289. 1983 ("1980–1983").

**Type genus:** *Coniothyrium* Corda.

***Staurosphaeria*** Rabenh., Bot. Ztg. 16(40): 303. 1858. MycoBank MB5186; Facesoffungi number: FoF 03550.

**Synonym:** *Hazslinszkyomyces* Crous & R.K. Schumach, IMA Fungus 8: 143. 2017.

**Necrotrophic** or saprobic on dead branches. **Asexual morph:** *Conidiomata* solitary, globose, dark brown, immersed, erumpent, globose, with central ostiole; ostiolar canal filled with hyaline cells; conidiomatal wall of 6–8 layers of dark brown *textura angularis*. *Conidiophores* reduced to conidiogenous cells lining the inner cavity. *Macroconidiogenous cells* hyaline, smooth, doliiform, proliferating percurrently at apex. *Macroconidia* solitary, ellipsoid, smooth, red-brown, with central transverse septum, becoming muriformly septate. *Microconidial cells* intermingled with macroconidial cells, hyaline, integrated, proliferating percurrently at apex, subcylindrical. *Microconidia* hyaline, globose to ellipsoid, smooth, aseptate. **Sexual morph:** cucurbitaria-like. *Ascomata* black, superficial to semi-immersed, gregarious, confluent, sometimes scattered beneath the host periderm or on decorticated wood, fully or partly erumpent, globose, black, ostiolate. *Ostiole* central, short. *Peridium* composed of blackish to dark brown cells of *textura angularis*, cells towards the inside lighter, composed of thin-walled cells of *textura angularis*. *Hamathecium* comprising numerous, branched septate, *pseudoparaphyses*. *Asci* 8-spored, bitunicate, fissitunicate, cylindrical, short-pedicellate. *Ascospores* overlapping uniseriate, muriform, mostly ellipsoidal, 4–6-transversely septate, with 1–2 vertical septa, constricted at middle septum, initially hyaline, becoming brown at maturity, slightly paler, conical and narrow at the ends.

**Type species:** *Staurosphaeria lycii* Rabenh.

***Staurosphaeria lycii*** Rabenh., Bot. Ztg. 16(40): 303. 1858. Facesoffungi number: FoF 03551. Figs 20, 21.

**Necrotrophic** on dead branches of *Lycium barbarum*. **Asexual morph:** *Conidiomata* pycnidial, 500–600 µm high, 500–650 µm diam ( $\bar{x}$  = 570.4 × 567.5 µm, n = 10), solitary, black, immersed or partly erumpent, unilocular, ostiolate. *Ostiole* 150–200 µm long,

200–250 µm diam ( $\bar{x}$  = 170.2 × 235.4 µm, n = 6), central, long, smooth, ostiolar canal filled with hyaline cells. *Pycnidial wall* multi-layered, 20–25 µm wide at the base, 25–30 µm wide in sides, thick, comprising 4–5 layers, with heavily pigmented outer layer, thick-walled, comprising blackish to dark reddish-brown cells of *textura angularis*, with lighter cells towards the inside, with inner layer composed of 1–2 layers, hyaline, thin-walled cells of *textura angularis*. *Conidiophores* reduced to conidiogenous cells. *Macroconidiogenous cells* enteroblastic, annellidic, doliiform, integrated, solitary, hyaline, smooth-walled, and formed from the inner layer of pycnidium wall. *Macroconidia* 11–16 × 9–11 µm ( $\bar{x}$  = 13.1 × 10.1 µm; n = 40), globose to oblong, rounded at both ends, 1–2-transversely septate, with one longitudinal septum, muriform, smooth-walled, brown to dark brown. *Microconidiogenous cells* intermingled with macroconidiogenous cells, hyaline, integrated, enteroblastic, annellidic, ampulliform to subcylindrical. *Microconidia* 3.5–6.5 × 3.5–4.5 µm ( $\bar{x}$  = 5.1 × 4 µm; n = 25), hyaline, round to oblong or ellipsoidal, with a few small guttules. **Sexual morph:** Undetermined.

**Colonies on PDA:** Slow growing, reaching 2 cm diam after 4 wk at 16 °C, later with dense mycelium, circular, rough margin, white, reverse creamy grey, flat on the surface, without aerial mycelium. Hyphae septate, branched, hyaline, thin-walled.

**Material examined:** **Germany**, Dresden, on dry branches of *Lycium barbarum* (**lectotype designated here**, Rabenh., Klotzschii Herb. Viv. Mycol., Ed. nov., Ser. Prima, Cent. VIII, No. 736, in HAL). **Russia**, Rostov Region, Shakhty city, coal heap of former coal mine "Proletarian dictatorship", 47,7104113° N, 40,2627254° E, on dying and dead twigs of *Lycium barbarum* (*Solanaceae*), 21 May 2015, T.S. Bulgakov T-289 (MFLU 15-1993, **epitype** designated here, MBT377706, ex-type culture, MFLUCC 17-0210 = CBS 143140); *ibid.*, T-418 (MFLU 15-2122, living culture MFLUCC 17-0211 = CBS 143141).

**Notes:** The type species has very characteristic red-brown conidia, developing a transverse septum, and later vertical septa, dividing the conidium into four compartments. It is distinct from *Camarosporium* s. str. in that conidia in the latter are unevenly pigmented (pale brown at ends), and multi-septate, lacking a microconidial morph as observed in conidiomata of *Staurosphaeria*. It was in the past assumed that *Staurosphaeria* and *Karstenula* (*Didymosphaeriaceae*) are congeneric. However, the type species, *K. rhodostoma*, has been linked to the asexual morph *Microdiplodia frangulae* (Constantinescu 1993), so the generic synonymy with *Staurosphaeria* seems rather unlikely.

## Other accepted species

***Staurosphaeria aloes*** (Crous & M.J. Wingf.) Crous, Wanas. & K.D. Hyde, **comb. nov.** MycoBank MB821962; Facesoffungi number: FoF 03552.

**Basionym:** *Camarosporium aloes* Crous & M.J. Wingf., Persoonia 31: 247. 2013.

**Synonym:** *Hazslinszkyomyces aloes* (Crous & M.J. Wingf.) Crous, IMA Fungus 8: 143. 2017.

**Illustrations and material examined:** See Crous et al. (2013).

***Staurosphaeria aptrootii*** (Crous & M.J. Wingf.) Crous, Wanas. & K.D. Hyde, **comb. nov.** MycoBank MB821963; Facesoffungi number: FoF 03553.

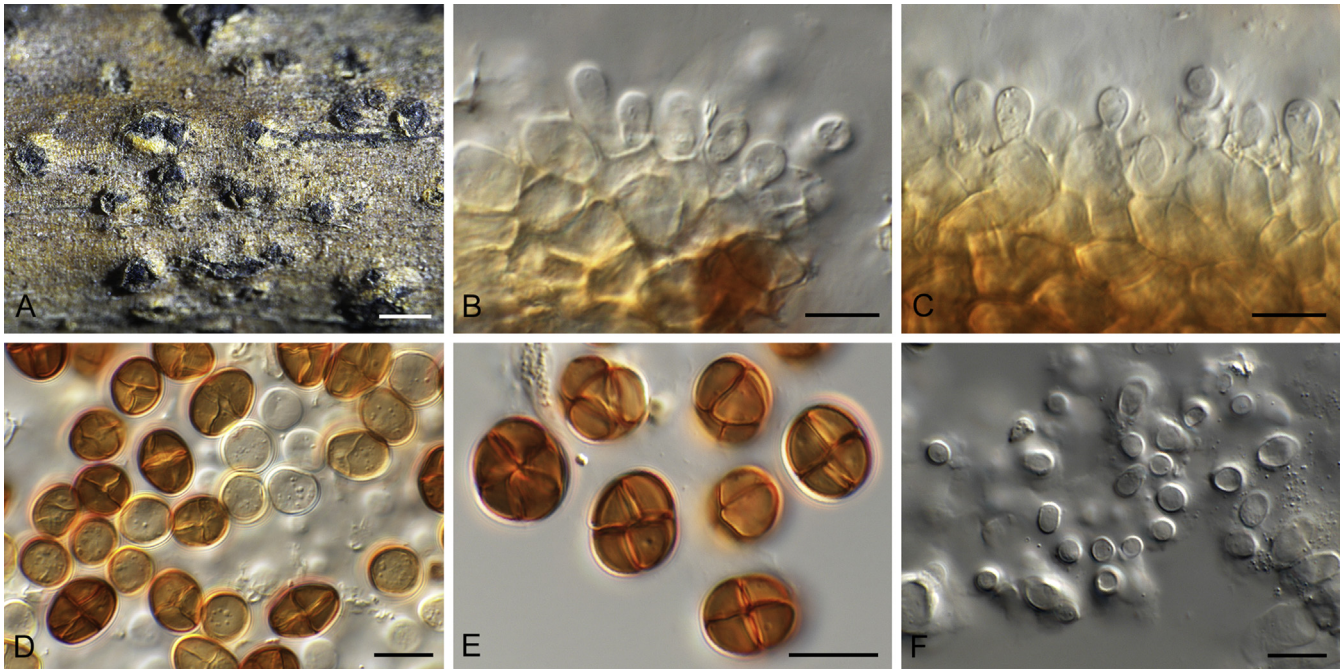


Fig. 20. *Staurosphaeria lycii* (HAL, lectotype). A. Conidiomata on host surface. B, C. Conidiogenous cells. D, E. Macroconidia. F. Microconidia. Scale bars: A = 500  $\mu$ m, E–F = 10  $\mu$ m.

*Basionym:* *Hazslinszkyomyces aptrootii* Crous, IMA Fungus 8: 143. 2017.

*Illustrations and material examined:* See Crous & Groenewald (2017).

*Staurosphaeria lyciicola* (Crous & R.K. Schumach.) Crous, Wanas. & K.D. Hyde, **nom. nov.** MycoBank MB821964; Facesoffungi number: FoF 03554.

*Basionym:* *Hazslinszkyomyces lycii* Crous & R.K. Schumach., IMA Fungus 8: 144. 2017.

*Illustrations and material examined:* See Crous & Groenewald (2017).

*Staurosphaeria rhamnicola* Wanas., Gafforov & K.D. Hyde, **sp. nov.** MycoBank MB821965; Facesoffungi number: FoF 03555. Fig. 22.

*Etymology:* Named after the host genus from which it was collected, *Rhamnus*.

*Saprobic* on dead branches of *Rhamnus* sp. *Asexual morph:* Undetermined. *Sexual morph:* Ascumata 200–400  $\mu$ m high, 250–350  $\mu$ m diam ( $\bar{x}$  = 320.4  $\times$  296.8  $\mu$ m,  $n$  = 10), black, superficial to semi-immersed, confluent, gregarious, sometimes scattered beneath the host periderm or on decorticated wood, fully or partly erumpent, globose, uniloculate, with an ostiole. *Ostiole* central, short, slightly sunken, minute and inconspicuous at the surface, smooth, ostiolar canal filled with hyaline cells. *Peridium* 25–40  $\mu$ m wide at the base, 30–50  $\mu$ m wide in sides, thick, comprising 8–12 layers, outermost layer heavily pigmented, thin-walled, comprising blackish to dark brown amorphous layer, middle layer heavily pigmented, thick-walled, comprising blackish to dark brown loosely packed cells of *textura angularis*, inner layer composed of 3–4 layers, reddish brown to hyaline, cells towards the inside lighter, flattened, thick-walled cells of *textura angularis*. *Hamathecium* comprising numerous,

2.5–3  $\mu$ m ( $n$  = 40) wide, filamentous, branched septate, pseudoparaphyses. *Asci* 170–200  $\times$  16–22  $\mu$ m ( $\bar{x}$  = 186.2  $\times$  18.4  $\mu$ m,  $n$  = 40), 8-spored, bitunicate, fissitunicate, cylindrical, short-pedicellate, apex rounded with a minute ocular chamber. *Ascospores* 26–32  $\times$  12–14  $\mu$ m ( $\bar{x}$  = 30.4  $\times$  13.1  $\mu$ m,  $n$  = 50), overlapping uniseriate, muriform, mostly ellipsoidal, 5–6-transversely septate, with 1–2 longitudinal septa, deeply constricted at the middle septum, slightly constricted at remaining septa, initially hyaline, becoming pale brown at maturity, asymmetrical, slightly paler ends, conical and narrowly rounded at the ends, not surrounded by a mucilaginous sheath.

*Colonies on PDA:* Slow growing, reaching 2 cm diam after 4 wk at 16  $^{\circ}$ C, later with dense mycelium, circular, rough margin, creamy after 6 wk, reverse iron, flat on the surface, with aerial mycelium. Hyphae septate, branched, hyaline, thin-walled.

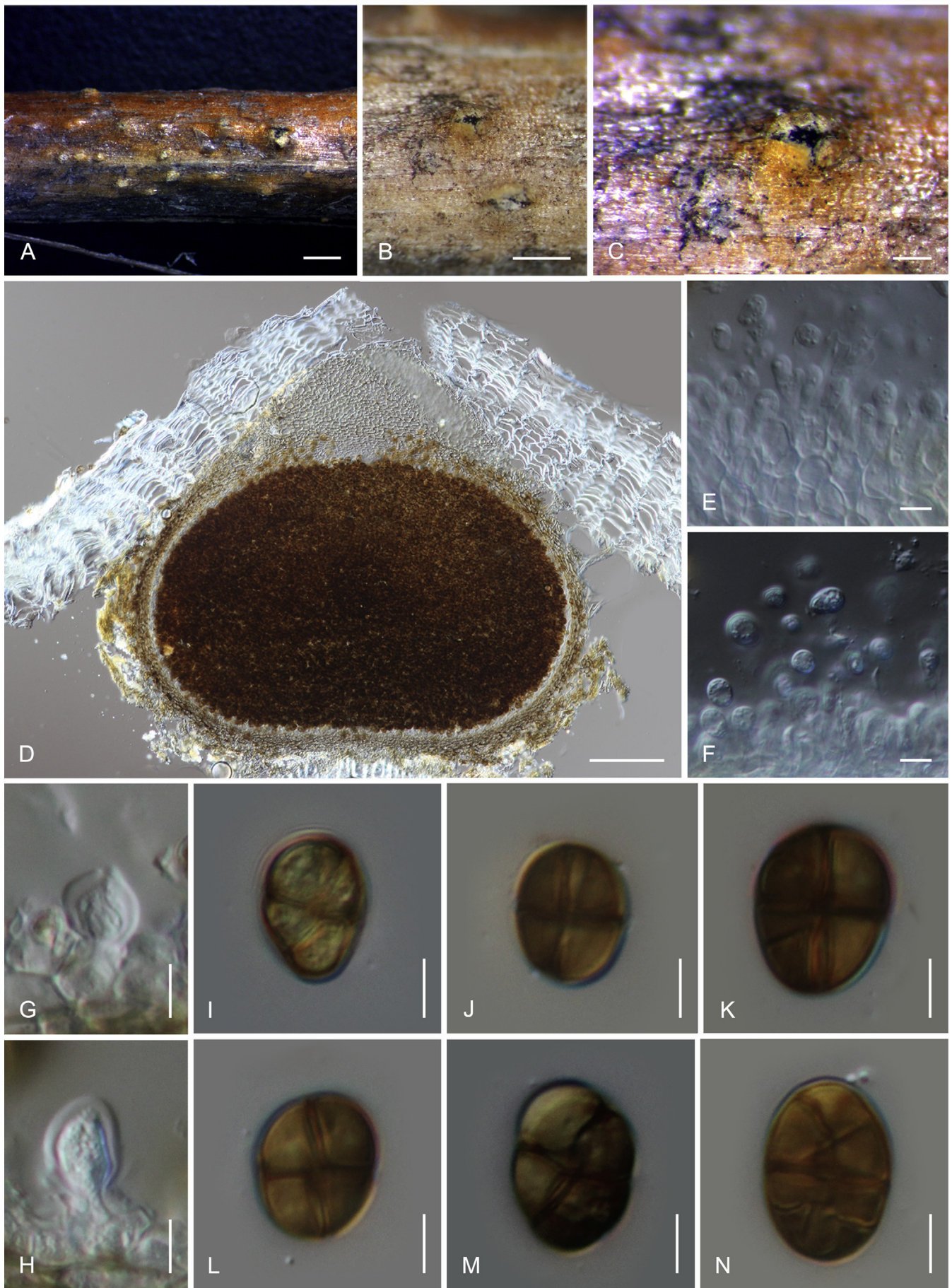
*Material examined:* **Uzbekistan**, Surxondaryo Province, Sherobod District, Oqtosh village on dead twigs of *Rhamnus* sp. (*Rhamnaceae*), 12 May 2016, Y. Gafforov, YG-S4-4D (TASM 6102, **holotype**); *ibid.*, (MFLU 17-0183, **isotype**, ex-isotype culture MFLUCC 17-0814) *ibid.*, YG-S4-5 (TASM 6101 = MFLU 17-0182, **paratype**, ex-paratype culture, MFLUCC 17-0813).

*Notes:* *Staurosphaeria rhamnicola* morphologically resembles *Camarosporidiella arezzoensis*, *Ca. eufemiana*, *Ca. italica*, *Ca. laburni*, *Ca. mirabellensis*, *Ca. premilcurensis* and *Neocucurbitaria acerina* in having similar ascumata, peridium, asci and ascospore characters. However, they are phylogenetically distant from *Staurosphaeria rhamnicola* (Clade B, Fig. 1).

**Neocamarosporiaceae** Wanas., Wijayaw., Crous & K.D. Hyde, **fam. nov.** MycoBank MB821966; Facesoffungi number: FoF 03556.

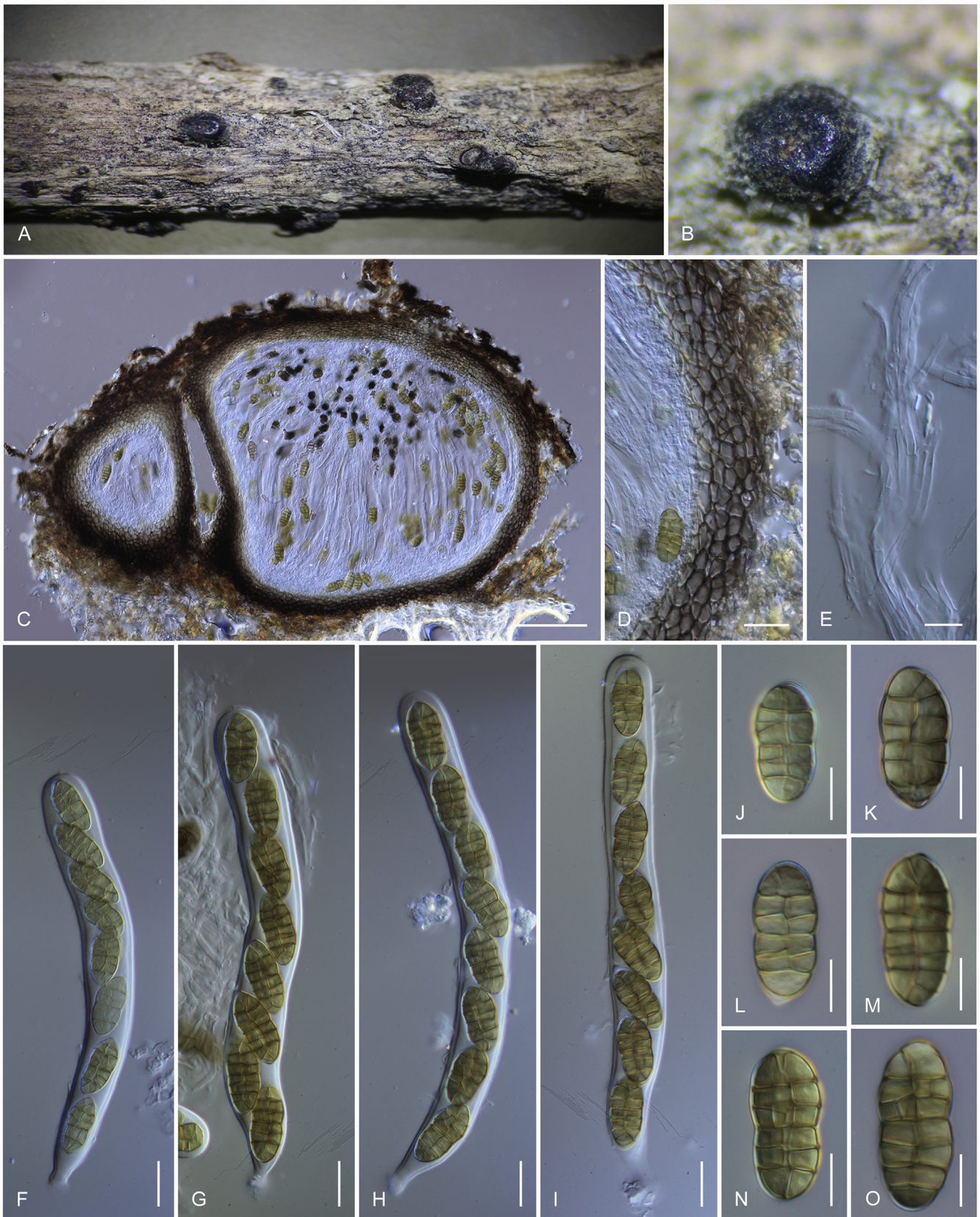
*Etymology:* Referring to the name of the type genus.

*Saprobic* on leaves and wood. *Asexual morph:* Conidiomata immersed, becoming erumpent, globose, brown to black,



**Fig. 21.** *Staurosphaeria lycii* (MFLU 15-1993, epitype). **A–C.** Conidiomata on host surface. **D.** Vertical section through conidioma. **E, F.** Microconidiogenous cells and microconidia. **G, H.** Macroconidiogenous cells. **I–N.** Macroconidia. Scale bars: A = 1 mm; B = 500  $\mu$ m; C, D = 100  $\mu$ m; E–N = 5  $\mu$ m.





**Fig. 22.** *Staurosphaeria rhamnicola* (TASM 6102, holotype). **A, B.** Appearance of ascomata on host substrate. **C.** Section of ascoma. **D.** Peridium. **E.** Pseudoparaphyses. **F–I.** Asci. **J–O.** Ascospores. Scale bars: C = 100  $\mu$ m; D, F–I = 20  $\mu$ m, E, J–O = 10  $\mu$ m.

ostiolate. Ostiole papillate, central. *Conidiomata* wall composed of thin-walled, brown cells of *textura angularis*. *Conidiophores* reduced to conidiogenous cells. *Conidiogenous cells* proliferating several times percurrently near apex, ampulliform to doliiform, separate, hyaline, smooth-walled. *Conidia* solitary, initially

hyaline, aseptate, developing initially a central septum and then becoming muriform, variable from globose to obovoid to ellipsoid, golden brown, finely roughened, thick-walled. *Sexual morph:* *Ascomata* superficial to semi-immersed, confluent, gregarious, fully or partly erumpent, globose, with an apapillate ostiole.

*Ostirole* central, short, erect or slightly sunken, smooth, ostiolar canal filled with hyaline cells. *Peridium* thin, comprising blackish to brown loosely packed cells of *textura angularis*. *Hamathecium* comprising numerous, filamentous, branched septate, pseudoparaphyses. *Asci* 8-spored, bitunicate, fissitunicate, cylindrical-clavate to cylindrical, pedicellate, rounded at apex, with a minute ocular chamber. *Ascospores* uniseriately overlapping, muriform, mostly ellipsoidal, 5–7-transversely septate, with 1–2 longitudinal septa, deeply constricted at middle septum, slightly constricted at remaining septa, initially hyaline, becoming pale brown at maturity, rounded at both ends, surrounded by a mucilaginous sheath.

*Type genus*: *Neocamarosporium* Crous & M.J. Wingf.

*Notes*: Ariyawansa *et al.* (2015c) and Wijayawardene *et al.* (2016) treated *Neocamarosporium* as a genus in *Pleosporaceae*, but in our analyses four *Neocamarosporium* species, three new camarosporium-like taxa and a pleospora-like taxon also group with *Coniothyrium obiones*, *Dimorphosporicola tragani*, *N. chersinae*, *N. chichastianum*, *N. goegapense*, *Pleospora chenopodii*, *P. halimiones*, *P. calvescens*, *P. betae* and *Phoma betae* (which represent phoma-like and ascochyta-like asexual morphs *fide de Gruyter et al.* 2012) and reside in a distinct clade (Clade D, Fig. 1) in *Pleosporineae* with high bootstrap support (95 % and 79 % in ML and MP analyses respectively) and high PP value (1.00). This clade (Clade D) is distinct from *Pleosporaceae sensu stricto* which comprises *Pleospora sensu stricto* (= *Stemphylium*, see Woudenberg *et al.* 2017), the type genus. Therefore, *Neocamarosporiaceae* fam. nov. is introduced for Clade D based on morphology and multi-gene phylogeny.

The family *Neocamarosporiaceae* is somewhat similar to the *Pleosporaceae*, but differs in several respects. The characteristics of the ascomatal wall are distinctly different from each other. *Pleosporaceae* species have a thick peridium with several hyaline and pigmented cell layers, while *Neocamarosporiaceae* species have a thin peridium with only 2–3 pigmented cell layers and lack hyaline cell layers.

Ariyawansa *et al.* (2015c) mentioned that the asexual morphs of *Pleosporaceae* can be coelomycetous or hyphomycetous. Apart from *Neocamarosporium* (ascochyta-like, camarosporium-like and phoma-like) no other *Pleosporaceae* species produce a coelomycetous asexual morph. Therefore, it would appear that hyphomycetous asexual morphs are specific to *Pleosporaceae*. Therefore, by considering the sexual morph and asexual morph differences together with molecular support obtained herein with *Neocamarosporiaceae* in clade D, we believe that it would taxonomically be more appropriate to establish a new family to accommodate these species in *Pleosporineae*.

It is interesting to note that the species which were collected from marine to saline habitats, and produce muriform conidia, i.e. *Neocamarosporium chersinae*, *N. chichastianum* and *N. salicorniicola* cluster together as a subclade in clade D (Fig. 1), but could not be segregated from *Dimorphosporicola tragani* and *Coniothyrium obiones* based on our phylogenetic analyses. However, DNA sequence data of *Coniothyrium obiones* (CBS 453.68) analysed herein is an unverified sequence as it is not from the type material. Given that the relationship between the

*Coniothyrium obiones* and other taxa is undetermined, we keep CBS 453.68 as “*Coniothyrium*” *obiones* for now. *Dimorphosporicola tragani* is different to other taxa in *Neocamarosporium* in conidial morphology and habitat. Consequently, it would be appropriate to retain *Dimorphosporicola* as a separate genus in *Neocamarosporiaceae*. Furthermore, some of the *Neocamarosporium* spp. (e.g. *N. chichastianum*) have only ITS sequence data and it would be wise to consider or evaluate the utility of several other genes such as large subunit nrDNA (28S, LSU), small subunit nrDNA (18S, SSU), or translation elongation factor alpha 1 (*tef1-α*) to further elucidate phylogenetic relationships among this clade of fungi with more fresh collections.

***Neocamarosporium*** Crous & M.J. Wingf., *Persoonia* 32: 273. 2014. **emend.**

*Saprobic* on leaves and wood. *Asexual morph*: See Crous *et al.* (2014b). *Sexual morph*: *Ascomata* superficial to semi-immersed, confluent, gregarious, fully or partly erumpent, globose, with an apiculate ostiolar canal. *Ostiolar canal* filled with hyaline cells. *Peridium* thin, comprising blackish to brown loosely packed cells of *textura angularis*. *Hamathecium* comprising numerous, filamentous, branched septate, pseudoparaphyses. *Asci* 8-spored, bitunicate, fissitunicate, cylindrical-clavate to cylindrical, pedicellate, apex rounded with a minute ocular chamber. *Ascospores* overlapping uniseriate, muriform, mostly ellipsoidal, 5–7-transversely septate, with 1–2-longitudinal septa, deeply constricted at the middle septum, slightly constricted at remaining septa, initially hyaline, becoming pale brown at maturity, rounded at both ends, surrounded by a mucilaginous sheath.

*Type species*: *Neocamarosporium goegapense* Crous & M.J. Wingf.

*Notes*: The genus *Neocamarosporium* was introduced by Crous *et al.* (2014b) based on *Neocamarosporium goegapense* from South Africa, which is morphologically similar to the genus *Camarosporium* with its pycnidial conidiomata, hyaline, percurrently proliferating conidiogenous cells, and brown, muriform conidia (Crous *et al.* 2014b). Currently there are 25 strains that cluster in *Neocamarosporium*, representing 11 species (in this study). Also, a further three strains which was introduced by Grum-Grzhimaylo *et al.* (2016) and six strains which were collected from marine to saline habitats in Iran, group here as *Neocamarosporium* sp. In this study, we introduce *Neocamarosporium korfii*, *N. lamiacearum* (first sexual record), *N. salicorniicola* and *N. salsolae* as new species in *Neocamarosporium*.

## Accepted species in *Neocamarosporium*

***Neocamarosporium betae*** (Berl.) Ariyawansa & K.D. Hyde, *Fungal Diversity* 71: 119. 2015.

*Basionym*: *Pyrenophora echinella* var. *betae* Berl.: 208. 1888.  
*Synonyms*: *Phoma betae* A.B. Frank, *Z. Rübenzucker-Ind.*: 905. 1892.

*Pleospora betae* Björl., *Botaniska Notiser* 1944: 218. 1944.

***Neocamarosporium calvescens*** (Fr. ex Desm.) Ariyaw. & K.D. Hyde, *Fungal Diversity* 71: 120. 2015.

*Basionym:* *Sphaeria calvescens* Fr., Sclerom. Suec.: no. 401. 1822.

*Synonyms:* *Pleospora calvescens* (Fr. ex Desm.) Tul. & C. Tul., Selecta Fungorum Carpologia, Tomus Secundus. Xylariei - Valsei - Sphaeriei 2: 266. 1863.

***Neocamarosporium chenopodii*** (Ellis & Kellerm.) Wanas. & K.D. Hyde, **comb. nov.** MycoBank MB821967; Facesoffungi number: FoF 03557.

*Basionym:* *Phloeospora chenopodii* Ellis & Kellerm., Journal of Mycology 4 (2–3): 26. 1888.

*Synonyms:* *Pleospora chenopodii* (Ellis & Kellerm.) Gruyter & Redhead, Index Fungorum 205: 1. 2014.

***Neocamarosporium chersinae*** Crous, IMA Fungus 8: 146. 2017.

*Illustrations and material examined:* See Crous & Groenewald (2017).

***Neocamarosporium goegapense*** Crous & M.J. Wingf., Per-sonia 32: 273. 2014.

*Illustrations and material examined:* See Crous et al. (2014b).

***Neocamarosporium obiones*** (Jaap) Wanas. & K.D. Hyde, **comb. nov.** MycoBank MB821968; Facesoffungi number: FoF 03558.

*Basionym:* *Diplodina obiones* Jaap, Verh. bot. Ver. Prov. Brandenb. 47: 96. 1905.

*Synonyms:* *Ascochyta obiones* (Jaap) P.K. Buchanan, Mycol. Pap. 156: 28. 1987.

*Pleospora halimiones* Gruyter & Verkley, Stud. Mycol. 75: 25. 2012.

***Neocamarosporium korfii*** Wanas., E.B.G. Jones & K.D. Hyde, **sp. nov.** MycoBank MB821969; Facesoffungi number: FoF 03559. Fig. 23.

*Etymology:* In honour of Prof. Richard Paul “Dick” Korf (May 28, 1925 – August 20, 2016) for his immense contribution to mycology.

*Saprobic* on dead stems. *Asexual morph:* *Conidiomata* pycnidial, 130–200 µm high, 160–220 µm diam ( $\bar{x}$  = 161.7 × 178.9 µm, n = 10), solitary or gregarious, black, superficial, unilocular. *Ostiole* inconspicuous. *Pycnidial wall* 12–20 µm wide, comprising 3–5 layers, outer layer heavily pigmented, thick-walled, comprising dark brown cells of *textura angularis*, cells towards the inside lighter, inner layer comprising 2–3 layers, hyaline, thin-walled cells of *textura angularis*. *Conidiophores* reduced to conidiogenous cells. *Conidiogenous cells* enteroblastic, annellidic, doliiform, integrated, solitary, hyaline, smooth-walled, and originated from the inner layer of pycnidium wall. *Conidia* 12–18 × 8–10 µm ( $\bar{x}$  = 14.3 × 9.4 µm; n = 30), oblong, straight to slightly curved, rounded at both ends, 1–3-transversely septate, with 1–2 longitudinal septa, muriform, smooth-walled, dark brown, guttulated. *Sexual morph:* Undetermined.

*Colonies on PDA:* Slow growing, reaching 3 cm diam after 3 wk at 16 °C, powdery, circular, smooth margin, greenish brown, reverse dark brown.

*Material examined:* **Russia**, Republic of Crimea, Feodosia city Municipality, Karadag State Nature Reserve, 44,9145837°N, 35, 2025127°E, on dead branches of *Bassia prostrata* (*Amaranthaceae*), 23 Jun. 2016, T.S. Bulgakov CR006 (MFLU 17-1436 **holotype**, ex-type culture MFLUCC 17-0745 = CBS 143135).

*Notes:* Based on the multi-gene phylogenetic analyses (Fig. 1), our strain of *Neocamarosporium korfii* segregates from *N. lamiacearum*, but this subclade is not supported in the phylogenetic analyses (Clade D, Fig. 1). *Neocamarosporium korfii* is morphologically similar to *N. salsae* and *N. salicornicola* in conidiomatal characteristics and conidial shape. However, these species are phylogenetically distinct (Clade D, Fig. 1). Thus, in this paper we introduce *N. korfii* as a new species in *Neocamarosporium*.

***Neocamarosporium lamiacearum*** Dayar., E.B.G. Jones & K.D. Hyde, **sp. nov.** MycoBank MB821970; Facesoffungi number: FoF 03560. Fig. 24.

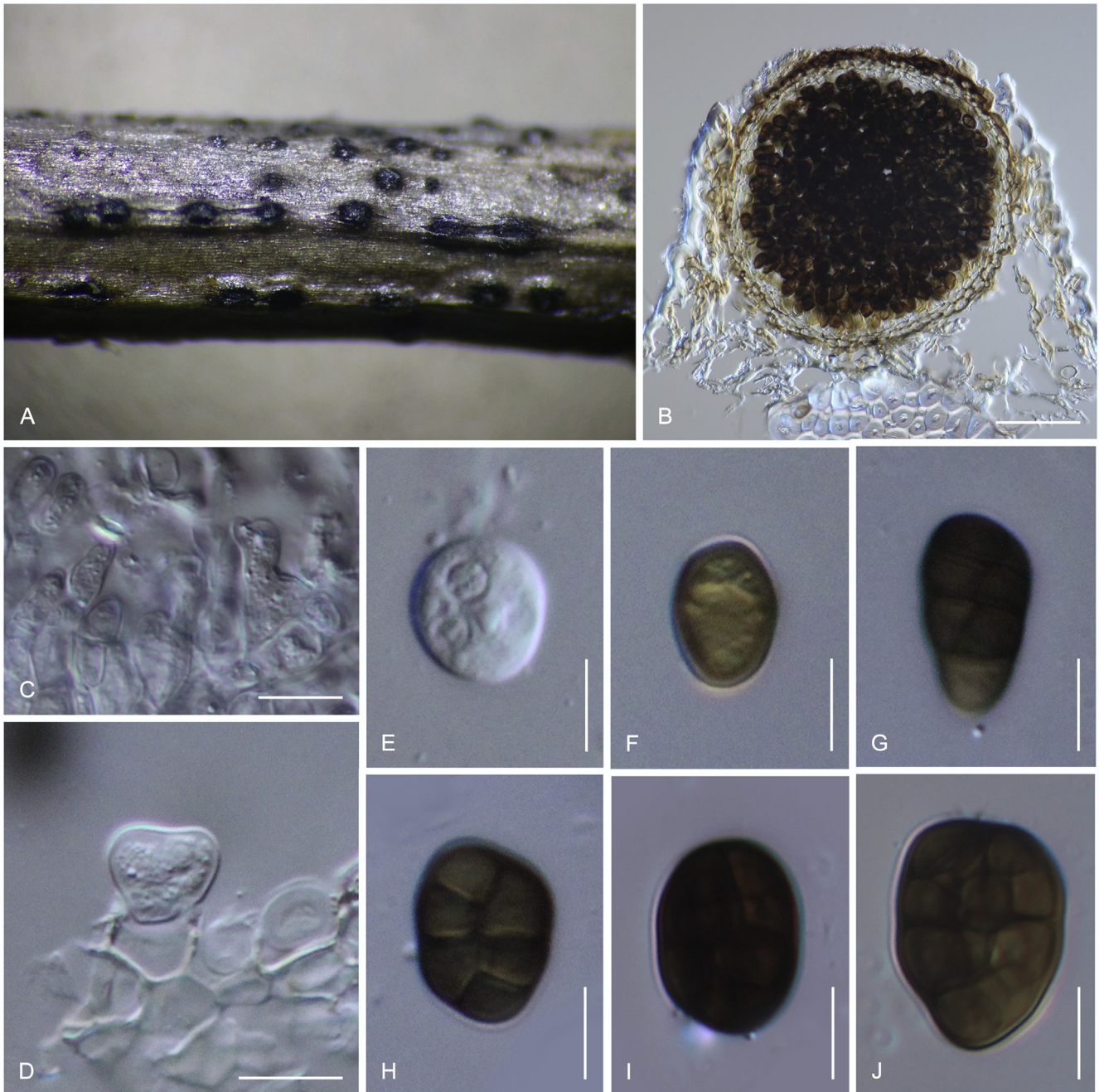
*Etymology:* Named after the host family from which it was collected, *Lamiaceae*.

*Saprobic* on dead stems of *Lamiaceae* sp. *Asexual morph:* Undetermined. *Sexual morph:* *Ascomata* 200–250 µm high, 180–250 µm diam ( $\bar{x}$  = 232.1 × 217.4 µm, n = 10), black, superficial to semi-immersed, confluent, gregarious, cupulate when dry, globose, uniloculate, with an apapillate ostiole. *Ostiole*, 40–60 µm long, 40–60 µm diam, central, short, slightly sunken, minute and inconspicuous at the surface, smooth, ostiolar canal filled with hyaline cells. *Peridium* 10–15 µm wide at the base, 10–20 µm wide in sides, thin, comprising 2–3 layers, reddish brown to brown, cells towards the inside lighter, flattened, thin-walled cells of *textura angularis*. *Hamathecium* comprising numerous, 2.5–3 µm (n = 40) wide, filamentous, branched, septate, pseudoparaphyses. *Asci* 100–120 × 14–17 µm ( $\bar{x}$  = 105.5 × 15 µm, n = 40), 8-spored, bitunicate, fissitunicate, cylindrical-clavate to cylindrical, pedicellate (10–20 µm long), apex rounded with a minute ocular chamber. *Ascospores* 14–20 × 8–11 µm ( $\bar{x}$  = 15.9 × 9.4 µm, n = 50), overlapping uniseriate, muriform, mostly ellipsoidal, with 3–4-transversely septate, with one longitudinal septum, deeply constricted at the middle septum, slightly constricted at remaining septa, initially hyaline, becoming pale brown at maturity, upper part wider than lower part, slightly paler, rounded at both ends, conical at lower end, surrounded by a mucilaginous sheath.

*Colonies on PDA:* Slow growing, reaching 2 cm diam after 4 wk at 16 °C, later with dense mycelium, circular, rough margin, white, reverse cream-grey, flat on the surface, without aerial mycelium. Hyphae septate, branched, hyaline, thin-walled.

*Materials examined:* **Russia**, Rostov Region, Krasnosulinsky district, Donskoye forestry, 47,8547249°N, 40,2318907°E, steppe in gully, on dead stems of *Lamiaceae* plant (perhaps, *Marrubium peregrinum* or *Phlomis herba-venti* ssp. *pungens*), 28 Jun. 2015, T.S. Bulgakov T-846 (MFLU 15–2989, **holotype**, ex-type culture MFLUCC 16-0560 = CBS 143136); **Russia**, Republic of Crimea, Feodosia city Municipality, salt-march near Baraqol salty lake, 44, 9963682°N, 35, 2431965°E, on dead branches of *Bassia sedoides* (*Amaranthaceae*), 23 Jun. 2016, T.S. Bulgakov CR026 (MFLU 17-1437, **paratype**, ex-paratype culture, MFLUCC 17-0750 = CBS 143137).

*Notes:* *Neocamarosporium lamiacearum* is morphologically somewhat similar to taxa in *Pleosporaceae* in having cylindrical-clavate to cylindrical asci and muriform ascospores. However, the characteristics of the ascomatal wall in *Neocamarosporium*



**Fig. 23.** *Neocamarosporium korfii* (MFLU 17-1436, holotype). **A.** Appearance of conidiomata. **B.** Vertical section of conidioma. **C, D.** Conidiogenous cells. **E–J.** Conidia. Scale bars: B = 50  $\mu\text{m}$ ; C, D = 10  $\mu\text{m}$ ; E–J = 5  $\mu\text{m}$ .

*lamiacearum* are noticeably different from *Pleosporaceae* taxa. *Pleosporaceae* species have a thick peridium with several hyaline and pigmented cell layers, while *Neocamarosporiaceae lamiacearum* has a thin peridium with only 2–3 pigmented cell layers and lack hyaline cell layers.

***Neocamarosporium salicornicola*** Dayarathne, E.B.G. Jones & K.D. Hyde, **sp. nov.** MycoBank MB821971; Facesoffungi number: FoF 03561. **Fig. 25.**

**Etymology:** Named after the host genus from which it was collected, *Salicornia*.

**Saprobic** on dead stems of *Salicornia* sp. **Asexual morph:** *Conidiomata* pycnidial, 75–110  $\mu\text{m}$  high, 80–96  $\mu\text{m}$  diam ( $\bar{x}$  = 94.4  $\times$  88  $\mu\text{m}$ , n = 10), solitary or gregarious, black, superficial, unilocular. *Ostiole* inconspicuous. *Pycnidial wall* 7–11  $\mu\text{m}$  wide, comprising 3–4 layers, outer layer heavily pigmented, thick-

walled, comprising dark brown cells of *textura angularis*, cells towards the inside lighter, inner layer comprising 2–3 layers, hyaline, thin-walled cells of *textura angularis*. *Conidiophores* reduced to conidiogenous cells. *Conidiogenous cells* enteroblastic, annellidic, doliiform, integrated, solitary, hyaline, smooth-walled, and originated from the inner layer of pycnidium wall. *Conidia* 8–12  $\times$  4–6  $\mu\text{m}$  ( $\bar{x}$  = 10.5  $\times$  4.8  $\mu\text{m}$ ; n = 30), oblong, straight to slightly curved, rounded at both ends, 1–3-transversely septate, with one longitudinal septum, muriform, smooth-walled, dark brown, guttulated. **Sexual morph:** Undetermined.

**Colonies on PDA:** Slow growing, reaching 3 cm diam after 3 wk at 16  $^{\circ}\text{C}$ , powdery, circular, smooth margin, ash, reverse yellowish at margins and black at the middle.

**Material examined:** Thailand, Phetchaburi Province, Cha-Am, Chao Samran, on dead stem of *Salicornia* sp. (*Amaranthaceae*), 28 Jul. 2015, M. Dayarathne CHAM025 (MFLU 15-0957, **holotype**, ex-type culture MFLUCC 15-0957).



**Fig. 24.** *Neocamarosporium lamiacearum* (MFLU 15-2989, holotype). **A, B.** Appearance of ascomata on host substrate. **C.** Section of ascoma. **D.** Peridium. **E.** Pseudo-paraphyses. **F–H.** Asci. **I–L.** Ascospores. Scale bars: A, B = 200  $\mu\text{m}$ ; C = 100  $\mu\text{m}$ ; D, E = 10  $\mu\text{m}$ ; F–H = 20  $\mu\text{m}$ ; I–L = 10  $\mu\text{m}$ .

Notes: Based on the multi-gene phylogenetic analyses (Fig. 1), our strain of *N. salicorniicola* shares a sister relationship to *N. jorjanensis* and to *Dimorphosporicola tragani* but with no support (Clade D, Fig. 1). In this paper, we introduce *Neocamarosporium salicorniicola* as a new species in *Neocamarosporium*, based on its comparatively smaller and distinct dark, guttulate conidia, and its phylogenetic position.

***Neocamarosporium salsolae*** Wanas., Gafforov & K.D. Hyde, sp. nov. MycoBank MB821972; Facesoffungi number: FoF 03562. Fig. 26.

**Etymology:** Named after the host genus from which it was collected, *Salsola*.

**Saprobic** on dead stems of *Salsola* sp. **Asexual morph:** *Conidiomata* pycnidial, 120–150 µm high, 80–110 µm diam ( $\bar{x}$  = 137.5 × 99.5 µm, n = 10), solitary or gregarious, black, superficial, unilocular. *Ostiole* inconspicuous. *Pycnidial wall* 6–10 µm wide, comprising 3–4 layers, outer layer heavily pigmented, thick-walled, comprising dark brown cells of *textura angularis*, cells towards the inside lighter, inner layer comprising 2–3 layers, hyaline, thin-walled cells of *textura angularis*. *Conidiophores* reduced to conidiogenous cells. *Conidiogenous cells* enteroblastic, annellidic, doliiform, integrated, solitary, hyaline, smooth-walled, and originated from the inner layer of pycnidium wall. *Conidia* 18–25 × 12–20 µm ( $\bar{x}$  = 21.9 × 16.9 µm; n = 30), oblong, straight to slightly curved, rounded at both ends, 1–3-transversely septate, with 1–3 longitudinal septa, muriform, smooth-walled, dark brown. **Sexual morph:** Undetermined.

**Colonies on PDA:** Slow growing, reaching 3 cm diam after 3 wk at 16 °C, circular, smooth margin, dark green, reverse blackish green.

**Materials examined:** Uzbekistan, Surxondaryo Province, Sherobod District, Oqtosh village on dead stem of *Salsola* sp. (*Amaranthaceae*), 12 May 2016, Y. Gafforov YG-S6-(TASM 6100, **holotype**); *ibid.*, (MFLU 17-0192, **isotype**, ex-isotype culture MFLUCC 17-0827) *ibid.*, YG-S6-1 (TASM 6099 = MFLU 17-0191, **paratype**, ex-paratype culture, MFLUCC 17-0826).

Notes: Based on the multi-gene phylogenetic analyses (Fig. 1), our strains of *Neocamarosporium salsolae* cluster in a subclade sister to *N. goegapense* with significant statistical support (Clade D, Fig. 1).

## Another accepted genus

***Dimorphosporicola*** Crous, Fungal Biology 120: 1412.

**Type species:** *Dimorphosporicola tragani* Crous.

***Dimorphosporicola tragani*** Crous, Fungal Biology 120: 1413.

**Illustrations and material examined:** See Crous & Groenewald (2016).

Notes: *Dimorphosporicola* was described by Crous & Groenewald (2017) to accommodate *D. tragani*, which is morphologically similar to *Coleophoma* species. But *D. tragani* is distinct from *Coleophoma* by having percurrently proliferate conidiogenous cells, and having dimorphic conidia.

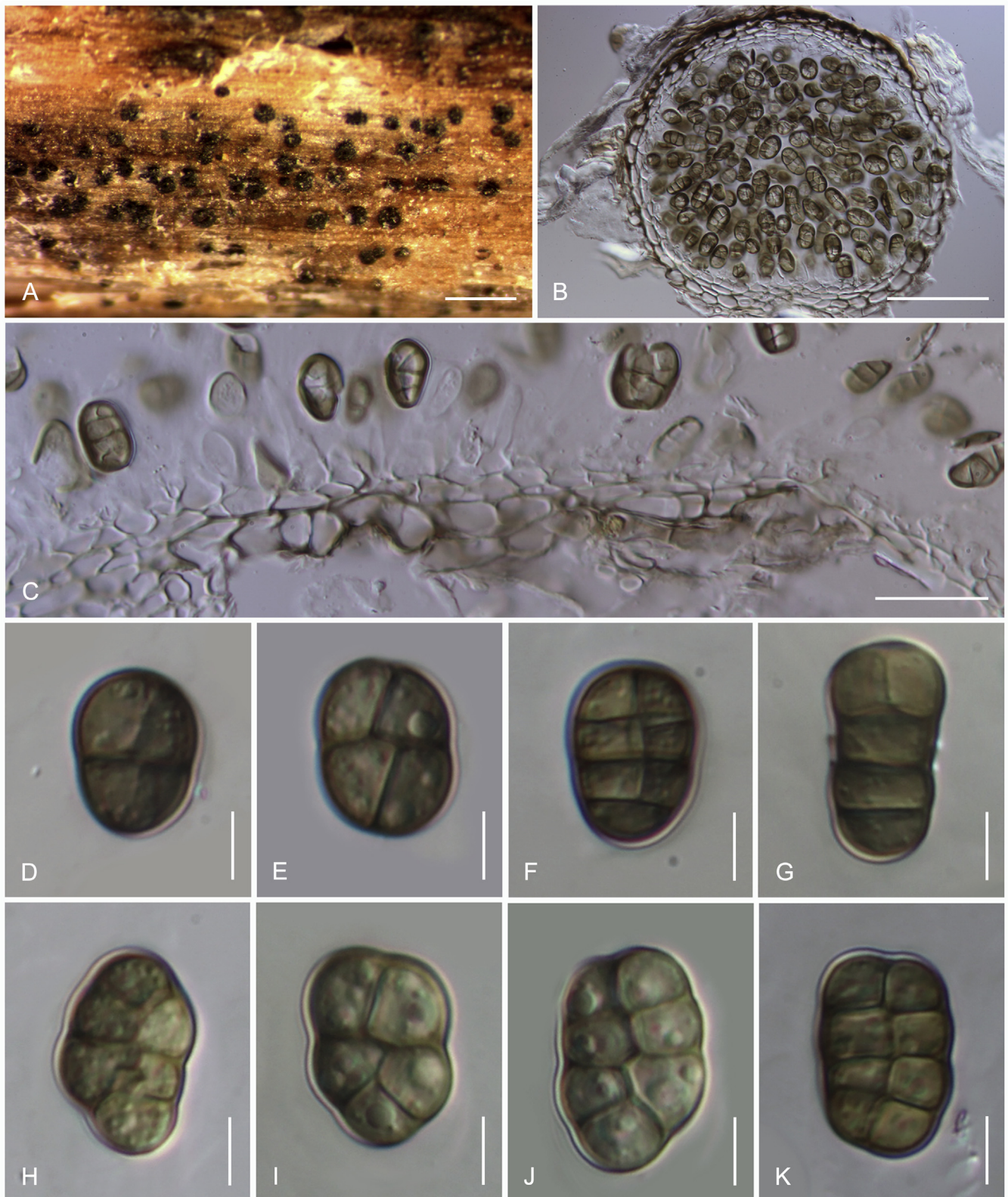
*Dimorphosporicola* and *Neocamarosporium* are different to each other in macro-conidial morphology.

## DISCUSSION

Our phylogenetic results indicate that camarosporium-like species which were treated as *Camarosporium* in previous papers (*viz.* *Camarosporium arezzoensis*, *Ca. aborescentis*, *Ca. caraganicola*, *Ca. elaeagnellum*, *Ca. elongata*, *Ca. clematidis*, *Ca. spartii*, *Ca. robinicola* and *Ca. aureum fide Wijayawardene et al. 2014a, c*, Liu et al. 2015, Tibpromma et al. 2016, Thambugala et al. 2016) are well positioned within the *Pleosporineae* and phylogenetically distinct from other genera. These species, which has been our focal group, constitute a strongly supported monophyletic lineage with 75 newly collected strains (Clade A). In contrast, *Ca. quaternatum* (CPC 23216, CPC 31081 & CPC 31518), the type species of *Camarosporium*, and other camarosporium-like taxa group in separate clades (Clade A, B, C and D, Fig. 1).

To discuss tree output (Fig. 1), we divided the taxa in the phylogram into 4 clades (A–D), and ingroup taxa in Clade A into 12 subclades (A1–A12). Generally, *Camarosporidiella* clustered separately from the rest with high support (Clade A, Fig. 1). All species in Clade A are distinct from other camarosporium-like taxa in *Pleosporineae*. Clade A comprises new strains and several other species were transferred to the new genus, *Camarosporidiella* (Fig. 1). With regards to conidial morphology, *Camarosporidiella* resembles *Camarosporium sensu stricto* and other camarosporium-like genera (Crous et al. 2014b, 2015a, b, Wijayawardene et al. 2014c, 2015, 2016) but is phylogenetically distinct. *Camarosporidiella arezzoensis*, *Ca. aborescentis*, *Ca. caraganicola*, *Ca. celtidis*, *Ca. eufemiana*, *Ca. elongata*, *Ca. italica*, *Ca. laburni*, *Ca. mirabellensis* and *Ca. premilcurensis* represent the sexual morph of the genus. Thus, the holomorph of the genus comprises a camarosporium-like asexual morph and cucurbitaria-like sexual morph. With the addition of new specimens and species, updated morphological characterisation, DNA sequence data analyses with strong support, and the monophyletic status of *Camarosporidiella* species, a new family, *Camarosporidiellaceae* is established herein to circumscribe *Camarosporidiella*.

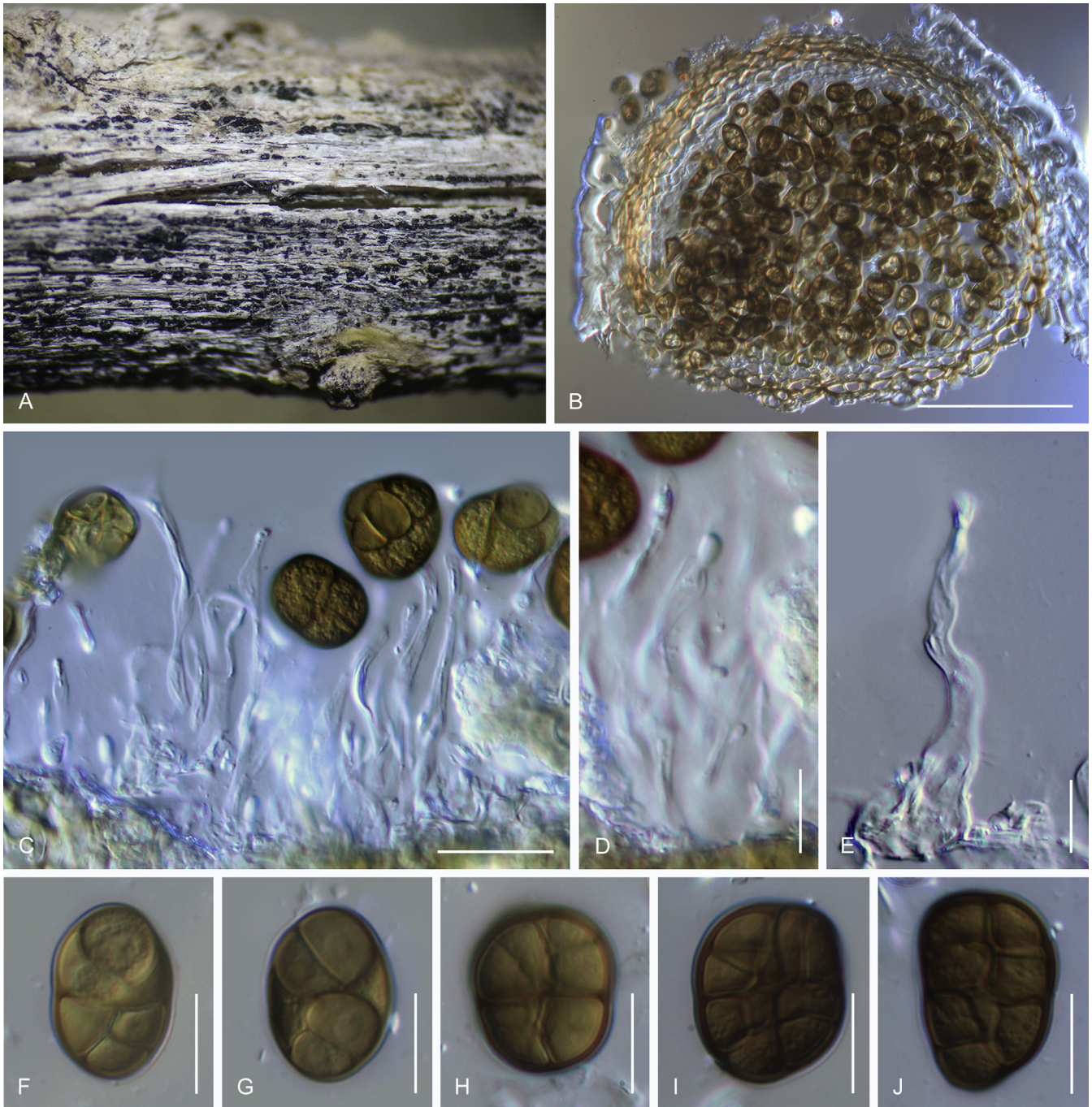
Clade B comprises two new collections which are morphologically similar to *Staurosphaeria lycii* and three other species i.e. *Hazslinszkyomyces lycii*, *H. aptrootii* and *H. aloes* in *Coniothyriaceae* with significant statistical support. By giving precedence to the oldest name, the genus *Staurosphaeria* is resurrected to accommodate this group. Clade C (Fig. 1), which comprises the type species of *Camarosporium*, is retained as *Camarosporium sensu stricto* and *Camarosporomyces flavigenus*. As in Wijayawardene et al. (2014b) and Crous & Groenewald (2017), *Camarosporium sensu stricto* groups with *Coniothyriaceae*, which comprises *Coniothyrium sensu stricto* and phoma-like species (de Gruyter et al. 2012). Recent studies reported that some camarosporium-like genera (such as *Pseudocamarosporium* and *Paracamarosporium*) have broader generic concepts (Crous et al. 2015a, b). Wijayawardene et al. (2014c) introduced *Pseudocamarosporium* and *Paracamarosporium* to accommodate camarosporium-like taxa that reside in *Didymosphaeriaceae*. Crous et al. (2015b) showed that several coniothyrium-like species group with *Pseudocamarosporium* and



**Fig. 25.** *Neocamarosporium salicornicola* (MFLU 15-0957, holotype). **A.** Appearance of conidiomata on *Salicornia* sp. **B.** Vertical section of conidioma. **C.** Developing stages of conidia on conidiogenous cells. **D–K.** Conidia. Scale bars: B = 50  $\mu$ m; C = 20  $\mu$ m; D–K = 5  $\mu$ m.

*Paracamarosporium* in their phylogenetic study. Hence, both *Pseudocamarosporium* and *Paracamarosporium* exhibit camarosporium-like or coniothyrium-like conidial morphologies. Further phylogenetic investigations with broader taxon sampling of *Camarosporium sensu stricto* and *Coniothyrium sensu stricto* are warranted to better understand both the *Camarosporium* and *Coniothyrium* generic concepts.

*Neocamarosporium goegapense* and 10 other *Neocamarosporium* species cluster in a strongly supported clade (Clade D, Fig. 1). Based on morphology of the sexual and asexual morphs and multi-gene phylogeny, *Neocamarosporiaceae* was introduced. Previous studies and our results in this study demonstrate that naming of camarosporium-like taxa based only on morphology is inaccurate and hence there is a need to carry



**Fig. 26.** *Neocamarosporium salsolae* (TASM 6100, holotype). **A.** Appearance of conidiomata on *Salsola* sp. **B.** Vertical section of conidioma. **C–E.** Conidiogenous cells and developing conidia. **F–J.** Conidia. Scale bars: B = 50  $\mu$ m; C = 20  $\mu$ m; D–J = 10  $\mu$ m.

out DNA sequence-based studies. [Wijayawardene et al. \(2016\)](#) discussed the importance of re-collecting, and epitypifying of camarosporium-like taxa as currently it has more than 500 epithets in Index Fungorum (2017), and very few of these taxa are presently known from culture.

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