

Fungal Systematics and Evolution: FUSE 7

Bálint Dima¹, Tor Erik Brandrud², Gilles Corriol³, Gerrit Maarten Jansen⁴, John Bjarne Jordal⁵, Abdul N. Khalid⁶, Ellen Larsson⁷, Jostein Lorås⁸, Olga V. Morozova⁹, Arooj Naseer⁶, Machiel Evert Noordeloos⁴, Walter Rossi¹⁰, Sergi Santamaria¹¹, Samina Sarwar¹², Ertuğrul Sesli¹³, Muhammad Usman⁶, Najam ul Sehar Afshan⁶, Ishtiaq Ahmad¹⁴, Arghya Banerjee^{15,16}, Koushik Banerjee¹⁷, Egil Bendiksen¹⁸, Débora Rodrigues da Silva Colombo¹⁹, André De Kesel²⁰, Francesco Dovana²¹, Giuliano Ferisin²², Shah Hussain²³, Saidul Islam^{16,24}, Ana Lucia Jesus¹⁹, Oğuzhan Kaygusuz²⁵, Irmgard Krisai-Greilhuber²⁶, Sultan Mahammad²⁷, Dilip Kumar Mishra²⁸, Partha Sarathi Nath¹⁶, Sarah Cristina de Oliveira da Paixão¹⁹, Birendranath Panja¹⁶, Viktor Papp²⁹, Carmen Lidia Amorim Pires-Zottarelli¹⁹, Ágnes Radnóti²⁹, Debashis Rana¹⁶, Raina Saha³⁰, İbrahim Türkekül³¹ & Danny Haelewaters^{32,33}

¹ Department of Plant Anatomy, Institute of Biology, Eötvös Loránd University, 1117 Budapest, Hungary

² Norwegian Institute for Nature Research, 0855 Oslo, Norway

³ Conservatoire botanique national des Pyrénées et de Midi-Pyrénées, 65203 Bagnères-de-Bigorre, France

⁴ Naturalis Biodiversity Center, 2300 RA Leiden, The Netherlands

⁵ Miljøfaglig Utredning, 6630 Tingvoll, Norway

⁶ Department of Botany, University of the Punjab, Quaid-e-Azam Campus, 54590 Lahore, Pakistan

⁷ Gothenburg Global Biodiversity Center, Department of Biological and Environmental Sciences, University of Gothenburg, 405 30 Göteborg, Sweden

⁸ Nord University Nesna, 8700 Nesna, Norway

⁹ Komarov Botanical Institute of the Russian Academy of Sciences, 197376 Saint Petersburg, Russia

¹⁰ Sect. Environmental Sciences, Department of Life, Health and Environmental Sciences (MeSVA), University of L'Aquila, 67100 Coppito, Italy

¹¹ Unitat de Botànica, Departament de Biologia Animal, de Biologia Vegetal i d'Ecologia, Facultat de Biociències, Universitat Autònoma de Barcelona, 08193 Cerdanyola del Vallès (Barcelona), Spain

¹² Department of Botany, Lahore College for Women University, 54000 Lahore, Pakistan

¹³ Department of Biology Education, Fatih Faculty of Education, Trabzon University, 61335 Trabzon, Turkey

¹⁴ Department of Botany, Islamia College Peshawar, 25120 Peshawar, Pakistan

¹⁵ Plant Quarantine Station, Haldia, West Bengal 721604, India

¹⁶ Department of Plant Pathology, Bidhan Chandra Krishi Viswavidyalaya, Mohanpur, West Bengal 741252, India

¹⁷ Division of Agricultural Physics, Indian Agricultural Research Institute (ICAR), New Delhi 110012, India

¹⁸ Norwegian Institute for Nature Research, 0855 Oslo, Norway

¹⁹ Instituto de Botânica, Núcleo de Pesquisa em Micologia, São Paulo, SP CEP 04301-912, Brazil

²⁰ Meise Botanic Garden, 1860 Meise, Belgium

²¹ Department of Life Sciences and Systems Biology, University of Torino, 10125 Torino, Italy

²² Associazione Micologica Bassa Friulana, 33052 Cervignano del Friuli, Italy

²³ Center for Plant Sciences and Biodiversity, University of Swat, 19130 Swat, Pakistan

²⁴ Krishi Vigyan Kendra, Gayeshpur, West Bengal 741234, India

²⁵ Department of Plant and Animal Production, Atabey Vocational School, Isparta University of Applied Sciences, 32670 Isparta, Turkey

²⁶ Department of Botany and Biodiversity Research, University of Vienna, 1030 Wien, Austria

²⁷ Institute for Agriculture Sciences and Forestry, University of Swat, 19130 Swat, Pakistan

²⁸ ICAR-AICRP on Fruits, Directorate of Research, Bidhan Chandra Krishi Viswavidyalaya, Kalyani, West Bengal 741235, India

²⁹ Department of Botany, Institute of Agronomy, Hungarian University of Agriculture and Life Sciences, 1118 Budapest, Hungary

³⁰ Department of Plant Pathology, Uttar Banga Krishi Viswavidyalaya, Cooch Behar, West Bengal 736165, India

³¹ Department of Biology, Faculty of Science and Arts, Tokat Gaziosmanpaşa University, 60010 Tokat, Turkey

³² Research Group Mycology, Department of Biology, Faculty of Sciences, Ghent University, 9000 Ghent, Belgium

³³ Faculty of Science, University of South Bohemia, 370 05 České Budějovice, Czech Republic

* e-mail: ?????????????????????

Dima B., Brandrud T.E., Corriol G., Jansen G.M., Jordal J.B., Khalid A.N., Larsson E., Lorås J., Morozova O.V., Naseer A., Noordeloos M.E., Rossi W., Santamaria S., Sarwar S., Sesli E., Usman M., Afshan N.S., Ahmad I., Banerjee A., Banerjee K., Bendiksen E., Colombo D.R.S., De Kesel A., Dovana F., Ferisin G., Hussain S., Islam S., Jesus A.L., Kaygusuz O., Krisai-Greilhuber I., Mahammad S., Mishra D.K., Nath P.S., da Paixão S.C.O., Panja B., Papp V., Pires-Zottarelli C.L.A., Radnóti Á., Rana D., Saha R., Türkekül İ. & Haelewaters D. (2021) Fungal Systematics and Evolution: FUSE 7. – *Sydowia* 73: 271–339.

In this 7th contribution to the Fungal Systematics and Evolution series published by Sydowia, the authors formally describe 14 species: *Cantharomyces paschalis*, *Cryptandromyces pinguis*, *C. tricornis*, *Laboulbenia amblystomi* (Laboulbeniales); *Cortinariarius squamosus*, *Entoloma brunneicoeruleum*, *E. callipygmaeum*, *E. minutigranulosum*, *E. perasprellum*, *E. pulchripes*, *E. tigrinum*, *E. timidum*, *E. violaceoserrulatum* (Agaricales); and *Suillus quarcinus* (Boletales). The following new country records are reported: *Crepidotus malachiooides* from Italy, *Leucoagaricus mucrocystis* from French Guiana, *Pluteus multiformis* from Turkey (Agaricales); *Herpomyces periplanetae* from Bénin, the D.R. Congo, and Togo (Herpomycetales); *Melanustilospora ari* from Pakistan (Urocystidales); *Neopestalotiopsis clavisporea* causing fruit rot on *Zizyphus mauritiana* from India (Amphisphaeriales); and *Phytophthium chamaehyphon* and *Pp. litorale* from Brazil (Peronosporales). Finally, a new combination is proposed based on morphology, ecology, and phylogenetic analysis: *Rhodocollybia asema* (Agaricales).

Keywords: 14 new species, 8 new records, 1 new combination, Agaricomycetes, Entolomataceae, integrative taxonomy, Laboulbeniomycetes, Oomycota, Sordariomycetes, Ustilaginomycetes.

Materials and methods

Sample collection, isolation, and specimen examination

Most of the host insects bearing thalli of *Cantharomyces* Thaxt., *Cryptandromyces* Thaxt., and *Laboulbenia* Mont. & C.P. Robin were supplied to S. Santamaria and W. Rossi by entomologists. The host insects of *Laboulbenia amblystomi* sp. nov. from Spain and Thailand were collected in the field either by hand or by light trap. Permanent slide mounts were prepared following the method described by Rossi & Santamaria (2015) and were deposited at FI or BCB. Photomicrographs were captured with a ProgRes 10 Plus digital camera (Jenoptik, Jena, Germany) on a Leica DMR microscope (Leica Biosystems, Wetzlar, Germany) with differential interference contrast optics (DIC); images were processed with Photoshop CS5 (San Jose, California) and DpxView Pro (Deltapix, Måløv, Denmark).

Basidiomata of *Cortinariarius* (Pers.) Gray were collected in Çilekli Village, Trabzon, Turkey. Photographs were taken in the laboratory. One of the basidiomata was used for a spore print; other basidiomata were dried for further studies and vouchering purposes. Free-hand sections of pileus and lamellae were treated in 5 % NH₄OH, some of them were stained with 1 % Congo red. and photographed. Microscopic structures were observed and photographed under an Axio Imager A2 trinocular microscope with Axio Imager software (ZEISS, Jena, Germany). The description follows previous literature, including Moser et al. (1995), Bidaud et al. (1997), Høiland & Holst-Jensen (2000), Moser (2002), Bidaud et al. (2006), Niskanen & Kytövuori (2008), and Niskanen et al. (2012). Specimens are deposited in the herbarium of the Fatih Education Faculty at Trabzon University (KATO).

Collections of *Entoloma* spp. were photographed in the field. Macroscopic characters were noted straight after collecting. Color codes in the descriptions follow Kornerup & Wanscher (1978), except

for *Entoloma perasprellum* sp. nov. that follows Munsell Color Company (1954). Microscopic characters were studied with a Leica DMLS microscope, using a drawing tube and a Touptek Phototronics camera ((Zhejiang, China); a ZEISS Axioscope A1 microscope with AxioCam 1Cc 3; and a ZEISS Axiophot microscope with DC controlled Cree XP-G3 R3 CRI 90+ LED illumination, Plan Neofluar objectives 40×/1.30 Oil, 100×/1.30 Oil (ZEISS), differential interference contrast (DIC) optics, a 12MP Touptek video camera with SONY Exmor IMX226 CMOS sensor (Tokyo, Japan), and Touptek video & image processing software (Touptek Photonics). Basidiospores, basidia, and cystidia were observed in squash preparations of small parts of the lamellae in 5 % KOH or 1 % Congo Red in concentrated NH₄OH. Pileipellis was examined on a radial section of the pileus in 5 % KOH. Stipitipellis was examined in 10 % Ammonia solution. Basidiospore dimensions are based on measuring 20 spores, dimensions of cystidia and basidia on observing at least 10 structures per collection. Basidia were measured without sterigmata, and the basidiospores without apiculus. Spore length to width ratios are reported as Q. Collections are deposited at the following herbaria: GB, L, LE, O, WU (sensu Thiers continuously updated).

For the *Suillus* Gray study, specimens were collected from moist temperate forests in Khyber Pakhtunkhwa Province, Pakistan. Basidiocarps were photographed in the field. Fresh morphological characters were recorded in the field; colors follow Munsell Color Company (1954). Field data on basidiocarps (site, habitat, association, etc.) was noted. Specimens were studied microscopically following Bessette et al. (2000). For basidiospore dimensions, the first and last values represent the range of lengths and widths, whereas the values in parentheses represent mean lengths and widths ± standard deviations; Q, length/width ratio of an individual basidiospore; Q_{av}, the mean of Q. Other measurements are given as a range with outlier values in

parentheses. Voucher specimens are deposited at LAH (sensu Thiers continuously updated).

The macroscopic description of *Crepidotus malachoides* is based on observations of fresh material. Photographs were taken with a Canon EOS 80D camera (Tokyo, Japan). The micro-morphological characters are based on the study of both fresh and dried material. Dry specimens were rehydrated in distilled water or 10 % KOH before observation and mounted in aqueous Congo Red. In the notation of basidiospore dimensions, (a-)b-c(-d), 'b-c' is the range including 90 % of the measured values, with 'a' and 'd' being extreme values. Q represents the range of the length/width ratio for all measured spores. For all microscopic structures, 20 elements were measured. Voucher specimens are deposited at GDOR (sensu Thiers continuously updated).

For the *Herpomyces* Thaxt. study, *Periplaneta americana* cockroaches (Blattodea, Blattellidae) were collected by hand and screened for the presence of *Herpomyces* thalli (Ascomycota, Laboulbeniomyces) under 40–50× magnification. Antennae were dislodged from the host and embedded in cotton blue, resulting in clearly colored thalli. Next, thalli were removed from the antenna using a stainless steel No. 000 insect pin (Ento Sphinx, Pardubice, Czech Republic). Thalli were embedded in Amann solution (Benjamin 1971) with the help of a droplet of Hoyer's medium as described by De Kesel et al. (2020). Permanent slides are deposited at BR. Mounted thalli were viewed at 200–1,000× magnification using an Olympus BX51 light microscope (Tokyo, Japan) with drawing tube, digital camera, and AnalySIS software (Soft Imaging System GmbH, Münster, Germany).

For the *Leucoagaricus* Locq. ex Singer study, macromorphological features were studied on fresh collections as well as by analyzing photos taken in the field. Micromorphological data were obtained from dried material and observed under a Zeiss Axio Imager.A2 light microscope, equipped with AxioVision Release 4.8.2. software. Measurements were done with a 100× oil immersion objective (1,000× magnification). Dried basidiomata were sectioned with a razor blade, and the sections were mounted in water, stained with ammoniacal Congo red and Melzer's reagent, separately. The specimens are deposited at the Department of Plant Anatomy, Eötvös Loránd University, Budapest, Hungary (ELTE).

For the *Melanostilospora* Denchev study, infected plants of *Arum jacquemontii* (Alismatales, Araceae) were collected in Kalam, a sub-valley of Swat (Pakistan), situated at 2,085 m a.s.l. Swat val-

ley is an important phytogeographic region in northwestern Pakistan with a very rich flora (Ali & Qaiser 1986, Ahmad et al. 2015). The genus *Arum* is native to Europe, Northern Africa, and Central and Western Asia, with the highest species diversity in the Mediterranean region (Govaerts et al. 2002). In Pakistan, only one species is currently known, *Arum jacquemontii*, found in northern areas of the country, including Swat (Stewart 1972). Spores were studied by light and scanning electron microscopy (SEM). Spores were observed under an Olympus BX40 compound microscope in lactic acid. For SEM, spores were attached to specimen holders using double-sided adhesive tape and coated with a 50-nm film of gold in a Polaron E5300 freeze dryer (Quorum Technologies, Laughton, UK). The gold-coated stubs were photographed in a 3-30BM scanning electron microscope (CamScan Inc., Cranberry Township, PA). Measurements of teliospores are presented as (a-)b-c(-d), with 'b-c' representing 90 % of the measured values, and 'a' and 'd' being extreme values. Studied materials are deposited at LAH.

The *Neopestalotiopsis* Maharachch., K.D. Hyde & Crous study was conducted in November–December 2017, with the detection of symptoms of fruit rot on ripened skins of Ber fruit, *Zizyphus mauritiana* (Rosales, Rhamnaceae). Observations were made in five different orchards in Cooch Behar District, West Bengal, India. Diseased tissue was cut into small pieces and surface-sterilized with 0.1 % HgCl₂ for 30 sec, then plated on potato-dextrose agar (PDA) and incubated for 10 days at 25 °C and photoperiod of 12:12 (L:D) h. To confirm pathogenicity, both mycelial plug inoculation (5 mm diam.) and conidial suspension injection (1×10⁶ conidia/ml) were performed under laboratory condition (20 °C, relative humidity 90 %) on detached Ber fruit; control fruits were treated with PDA plug inoculation (5 mm diam.) and sterile water injection. Diseased plant material and cultures are preserved at the National Herbarium of Cultivated Plants, Indian Agricultural Research Institute, and at the Indian Type Culture Collection (New Delhi, India).

For the study of *Phytophthium* Abad, De Cock, Bala, Robideau, A.M. Lodhi & Lévesque in Brazil, samples of water, soil, submerged leaves, and surface sediments were collected in several areas of the Atlantic Rainforest. Soil, submerged leaves, and surface sediments were diluted in 30 ml of sterile ddH₂O and, along with water samples collected from freshwater bodies and rainbow trout farming tanks, plated and baited using the multiple baiting method (Milanez 1989). Plates were incubated for

4–7 days in an acclimatized room at ~22 °C. After this period, the baits (*Sorghum* spp. seeds, onion-skin, corn leaves, and snakeskin) were observed under a Leica DMLB2 compound microscope. *Phytophthium* isolates were purified onto cornmeal agar (CMA) medium (Fuller & Jaworski 1987), with 0.5g/l streptomycin sulphate and 0.5g/l penicillin G. Species were identified morphologically based on the original descriptions using a Leica MC170 HD camera with Leica Qwin 3.1 software. Specimens were incorporated into the CCIBt culture collection (Coleção de Culturas de Algas, Fungos e Cianobactérias do Instituto de Botânica).

Collections of *Pluteus* Fr. were collected in the province of Muğla, Turkey in 2015. Morphological features were described from young to mature basidiomata. The macro-morphological descriptions and images of basidiomata were based on fresh material. For micro-morphological structures, dried basidiomata were rehydrated in 3 % KOH, and subsequently stained with Congo Red. The following abbreviations are used in the descriptions: L_m for the average length of all measured basidiospores, W_m for the average width, Q for length/width ratio, and Q_m for the average of all calculated Q values. At least thirty basidiospores from spore prints were measured. Microstructures were drawn with the help of Adobe Illustrator CS4 (San Jose, CA). Specimens are deposited in the personal fungarium of O. Kaygusuz at Isparta University of Applied Sciences (Turkey).

Collections of *Rhodocollybia* Singer were made in the framework of the Norwegian Barcode of Life project (NorBOL). Macromorphological observations are based on field notes, fresh or dried basidiomata were photographed by NorBOL staff in the laboratory as part of the standard NorBOL documentation method under a Creative Commons Attribution NonCommercial ShareAlike (CC BY-SA) license. Specimens were dried in a dehydrator at 45 °C and deposited at O (sensu Thiers continuously updated).

DNA extraction, PCR amplification, and sequencing

For the *Cortinarius* study, total DNA was extracted from dried specimens following Murray & Thompson (1980). Primers ITS1F and ITS4 (White et al. 1990, Gardes & Bruns 1993) were used to amplify the internal transcribed spacer (ITS) barcode region, and LR0R and LR5 (Vilgalys & Hester 1990, Hopple 1994) were used for the large subunit (LSU) ribosomal RNA gene. Cycling conditions were as

follows: initial denaturation at 95 °C for 5 min; followed by 35 cycles of denaturation at 94 °C for 45 s, annealing at 54 °C for 30 s, and extension at 72 °C for 45 s; followed by a final extension at 72 °C for 10 min (Mullis & Faloona 1987). PCR products were checked in 1% agarose gels, and positive reactions were sequenced with one or both PCR primers. Chromatograms were checked to search for putative reading errors, which were corrected manually.

For the *Entoloma* study, DNA was extracted from dried herbarium material using the NucleoSpin Plant II kit (Macherey-Nagel, Germany). Forward primers ITS1F and reverse primers ITS4 and ITS4B (White et al. 1990, Gardes & Bruns 1993) were used in both PCR and sequencing reactions for the ITS barcode region. PCR products were purified with the Fermentas Genomic DNA Purification Kit (Thermo Scientific, Pittsburg, PA). Purified PCR products were sequenced on an ABI model 3130 Genetic Analyzer (Applied Biosystems, Foster City, CA) or commercially at LGC Genomics (Berlin, Germany). Alternatively, DNA extraction, PCR, and sequencing procedures were performed through the Norwegian Barcode of Life project (NorBOL) and followed Larsson & Jacobsson (2004) and Larsson et al. (2018). Chromatograms were checked and edited with the CodonCode Aligner package (CodonCode Corporation, Centerville, MA) and MEGA X (Kumar et al. 2018). Sequence comparison with public and personal databases followed Noordeloos et al. (2017). Newly generated sequences were submitted to GenBank (Tab. 1).

Total DNA of *Suillus quercinus* sp. nov. was extracted from dried material following a modified CTAB extraction method (Lee et al. 1988). The extracted genomic DNA was evaluated using gel electrophoresis with 1 % agarose gels and a UViPro Platinum gel documentation system (Uvitec, Cambridge, UK) with default settings. Genomic DNA was suspended in nuclease-free H₂O and stored at 20 °C. The ITS region was amplified using primers ITS1F and ITS4 (White et al. 1990, Gardes & Bruns 1993). Cycling conditions included an initial denaturation step at 94 °C for 1 min; then 35 cycles of denaturation at 94 °C for 1 min, annealing at 53 °C for 1 min, and extension at 72 °C for 1 min; and final extension at 72 °C for 8 min (Saba et al. 2020). Purification and sequencing were outsourced to Macrogen (Seoul, South Korea). Consensus sequences were generated from the obtained sequence reads in BioEdit version 7.0.9 (Hall 1999). Newly generated sequences were submitted to NCBI GenBank with accession numbers MT361744, MT361745, and MT361746.

Tab. 1. Details of sequences and isolates included in the BLAST searches and molecular analyses for the new species and interesting reports.

Species name	ID (isolate, strain ¹ , status ² , voucher)	Country, isolation source	SSU	ITS	LSU	Reference(s)
<i>Agrocybe pediades</i>	CIGYA 003	Mexico		MG817376		A.M. Montiel Gonzalez & R. Ortega Avila, unpubl.
<i>Collybia butyracea</i>	olrim421	Sweden		AY781251		Mata et al. (2004)
<i>Collybia butyracea</i>	olrim426	Sweden		AY805607		Mata et al. (2004)
<i>Cortinarius aavae</i>	VMS8	Canada		FJ717539		Harrower et al. (2011)
<i>Cortinarius aciculisporeus</i>	G: 257	France		MT934844		Liimatainen et al. (2020)
<i>Cortinarius albolens</i>	PC:A. Bidaud 97-10-368	France		MT934855		Liimatainen et al. (2020)
<i>Cortinarius aureifer</i>	G:351	France		MT934893		Liimatainen et al. (2020)
<i>Cortinarius badioflavidus</i>	WTU:J.F. Ammirati 13668, T	USA		NR_153055		Li et al. (2016)
<i>Cortinarius badioflavidus</i>	WTU:M. Beug 11MWB111913	USA		KU041733		Li et al. (2016)
<i>Cortinarius buxiolens</i>	G:3300	France		MT934935		Liimatainen et al. (2020)
<i>Cortinarius carcharias</i>	G:4276	France		MT934948		Liimatainen et al. 2020
<i>Cortinarius conicocombonatus</i>	KATO 3455	Turkey		MF696141		Sesli & Liimat. (2018)
<i>Cortinarius ferrugineifolius</i>	IB:M. Moser 1964-0110	Sweden		MT935277		Liimatainen et al. (2020)
<i>Cortinarius ferrugineifolius</i>	IB:M. Moser 1991-0305	USA		MT935044		Liimatainen et al. (2020)
<i>Cortinarius ferrugineovelatus</i>	UBC:F17141	Canada		GQ159884		Harrower et al. (2011)
<i>Cortinarius fulvoisabellinus</i>	JB-8342/14	Spain		KU953939		Ballarà et al. (2016)
<i>Cortinarius fulvoisabellinus</i>	PC:RH1891	France		KJ206485		Dima et al. (2014)
<i>Cortinarius griseascens</i>	G:4263	France		MT935100		Liimatainen et al. (2020)
<i>Cortinarius helvolus</i>	TUB 011905	France		AY669667		Garnica et al. (2005)
<i>Cortinarius herculinus</i>	G:4195	France		MT935120		Liimatainen et al. (2020)
<i>Cortinarius hinnuleoarmillatus</i>	G: 00052098, T	France		NR_131790		Niskanen et al. (2006)
<i>Cortinarius hinnuleoarmillatus</i>	G:GK16160	France		DQ499464		Niskanen et al. (2006)
<i>Cortinarius hinnuleoarmillatus</i>	H:IK01-021	Finland		DQ499462		Niskanen et al. (2006)
<i>Cortinarius hinnuleoarmillatus</i>	H:TN03-093	Finland		DQ499460		Niskanen et al. (2006)
<i>Cortinarius hinnuleoarmillatus</i>	S:F39953	Sweden		DQ499461		Niskanen et al. (2006)
<i>Cortinarius hinnuleocervinus</i>	Ammirati 13502	USA		MT935133		Liimatainen et al. (2020)
<i>Cortinarius hinnuleocervinus</i>	Niskanen 12-175, T	USA		MG136827		Liimatainen (2017)
<i>Cortinarius hinnuleovelatus</i>	G:4203	France		MT935136		Liimatainen et al. (2020)
<i>Cortinarius hinnuleus</i>	CFP332	Sweden		DQ117926		Kytövuori et al. (2005)
<i>Cortinarius hinnuleus</i>	IB19960139	India		AY083183		Peintner et al. (2003)
<i>Cortinarius cf. hinnuleus var. minutalis</i>	2071876	Canada		MG786239		K. Liimatainen & J. Ammirati, unpubl.
<i>Cortinarius hinnulooides</i>	G:4285	France		MT935139		Liimatainen et al. (2020)
<i>Cortinarius lepidus</i>	G:765	France		MT935194		Liimatainen et al. (2020)
<i>Cortinarius nauseosmus</i>	G:4214	France		MT935240		Liimatainen et al. (2020)
<i>Cortinarius ochraceoplicatus</i>	G:378	France		MT935256		Liimatainen et al. (2020)
<i>Cortinarius paraphaeochrous</i>	IB:M. Moser 1991-0323	USA		MT935282		Liimatainen et al. (2020)
<i>Cortinarius pseudohinnuleus</i>	G:4224	France		MT935343		Liimatainen et al. (2020)
<i>Cortinarius radicosissimus</i>	G:142	France		MT935369		Liimatainen et al. (2020)
<i>Cortinarius roseonudipes</i>	G:37	France		MT935391		Liimatainen et al. (2020)
<i>Cortinarius salicum</i>	G:4479	France		MT935414		Liimatainen et al. (2020)
<i>Cortinarius scabridipileus</i>	H:7000550, T	Sweden		MT112168		Niskanen (2020)
<i>Cortinarius semiodoratus</i>	PC:R. Henry 91.6	France		MT935427		Liimatainen et al. (2020)
<i>Cortinarius solidus</i>	G:4253	France		MT935438		Liimatainen et al. (2020)
<i>Cortinarius sp.</i>	1745193	Spain		MG739379		B. McAdoo, unpubl.
<i>Cortinarius speciosior</i>	G:4280	France		MT935443		Liimatainen et al. (2020)
<i>Cortinarius squamosus</i>	KATO Fungi 3386, T	Turkey		MW314263	MW314262	This study
<i>Cortinarius squamulifer</i>	G:4260	France		MT935451		Liimatainen et al. (2020)
<i>Cortinarius subfilamentosus</i>	G:1196	France		MT935484		Liimatainen et al. (2020)
<i>Cortinarius subhelvolus</i>	G:470	France		MT935491		Liimatainen et al. (2020)
<i>Cortinarius subrigidipes</i>	IB:M. Moser 1991-0309	USA		MT935523		Liimatainen et al. (2020)
<i>Cortinarius subulatus</i>	G:4229	France		MT935536		Liimatainen et al. (2020)
<i>Cortinarius tigris</i>	G:4269	France		MT935553		Liimatainen et al. (2020)
<i>Cortinarius umbrinolens</i>	TUB 011918	Germany		AY669658		Garnica et al. (2005)
<i>Crepidotus albolanatus</i>	PDD:72865 holotype	New Zealand		KY827292		Horak (2018)
<i>Crepidotus luteolus</i>	16834	Italy		JF907963		Osmundson et al. (2013)
<i>Crepidotus malachiooides</i>	303022	USA		MK607561		S.D. Russell & D. Grootmyers, unpubl.

Species name	ID (isolate, strain ¹ , status ² , voucher)	Country, isolation source	SSU	ITS	LSU	Reference(s)
<i>Crepidotus malachioides</i>	BD46	China		JQ666669		Zhiguang et al. (2016)
<i>Crepidotus malachioides</i>	FLAS-F-61634	USA		MH212015		B.S. Kaminsky, M.E. Smith, R. Healy & B. Spakes Richter, unpubl.
<i>Crepidotus malachioides</i>	GDOR5069	Italy		MW504470		This study
<i>Crepidotus malachioides</i>	SLO 1250, T	Slovakia		NR_132047		Jančovičová et al. (2014)
<i>Crepidotus malachioides</i>	WU 31421	Austria		KF879616		Jančovičová et al. (2014)
<i>Crepidotus malachioides</i>	WU 32709	Austria		KF879615		Jančovičová et al. (2014)
<i>Crepidotus cf. malachioides</i>	TENN 055381	Argentina		KY559326		P.B. Matheny, H.B. Korotkin & M.E. Smith, unpubl.
<i>Crepidotus nyssicola</i>	S.D. Russell MycoMap # 7399	USA		MN906236		S.D. Russell, unpubl.
<i>Crepidotus nyssicola</i>	S.D. Russell MycoMap # 7426	USA		MN906237		S.D. Russell, unpubl.
<i>Crepidotus</i> sp.	MushroomObserver.org/307011	USA		MH087459		A. Rockefeller, unpubl.
<i>Crepidotus</i> sp.	SDR NAMA 2017-156	USA		MK575449		A. Rockefeller, unpubl.
<i>Crepidotus sphaerosporus</i>	11253	Italy		JF907960		Osmundson et al. (2013)
<i>Crepidotus sphaerosporus</i>	HMAS 255466			MK966515		T.Z. Wei, unpubl.
<i>Crepidotus sphaerosporus</i>	HMAS 290002			MK966514		T.Z. Wei, unpubl.
<i>Crepidotus subverrucisporus</i>	15720	Italy		JF907961		Osmundson et al. (2013)
<i>Entoloma anatinum</i> [as <i>Entoloma longistriatum</i>]	TUF106928	Estonia		UDB015648*		I. Saar, unpubl.
<i>Entoloma asprellum</i> [as <i>Entoloma lividocyanulum</i>]	TUF106064	Estonia		UDB011486*		I. Saar, unpubl.
<i>Entoloma atrocoeruleum</i> [as <i>Entoloma poliopus</i> var. <i>parvisporigerum</i>]	TUF120520	Estonia		UDB031517*		UNITE
<i>Entoloma azureosquamulosum</i>	HKAS53408	China		JQ410334		He et al. (2012)
<i>Entoloma brunneicoeruleum</i>	AKS-E1-15	Norway		MZ145169		This study
<i>Entoloma brunneicoeruleum</i>	JL124-16	Norway		MZ145168		This study
<i>Entoloma brunneicoeruleum</i>	L0608198	The Netherlands		MZ145166		This study
<i>Entoloma brunneicoeruleum</i>	LE 302098, T	Russia		MZ145170		This study
<i>Entoloma brunneicoeruleum</i>	O-F-291139	Norway		MZ145167		This study
<i>Entoloma</i> aff. <i>caesiellum</i>	SAAS1410	China		KP329587		X.-L. He, unpubl.
<i>Entoloma callipygmaeum</i>	LE 253784, T	Russia		MZ145207		This study
<i>Entoloma callipygmaeum</i>	LE 312487	Russia		MZ145206		This study
<i>Entoloma callipygmaeum</i>	LE 312488	Russia		MZ145205		This study
<i>Entoloma cf. catalaunicum</i>	TU106338	Estonia		UDB011680*		I. Saar, unpubl.
<i>Entoloma chalybaeum</i>	TUF105760	Denmark		UDB034191*		I. Saar, unpubl.
<i>Entoloma ekaterinae</i>	LE312053, T	Russia		MK693215		Crous et al. (2019)
<i>Entoloma erhardii</i>	LE312051, T	Russia		MK693218		Crous et al. (2019)
<i>Entoloma exile</i>	K(M)157760	Great Britain		MF977951		J.J. Elsey, unpubl.
<i>Entoloma cf. foliocontusum</i> [as <i>Leptonia cf. foliocontusa</i>]	4954SL	USA		KX574457		M. Gordon, unpubl.
<i>Entoloma fuscocosquamosum</i>	TENN064384	USA		KY777405		P.B. Matheny, S.A. Trudell & M.G. Wood, unpubl.
<i>Entoloma holmvassdalenense</i>	O-F-75311, T	Norway		KM610321		Weholt et al. (2014)
<i>Entoloma incanum</i>	K(M)190322	Great Britain		MF977955		J.J. Elsey, unpubl.
<i>Entoloma kauffmanii</i>	KA13-1202	South Korea		KR673675		Kim et al. (2015)
<i>Entoloma cf. largentii</i> [as <i>Leptonia cf. convexa</i>]	OSC144006	USA		KX574458		M. Gordon, unpubl.
<i>Entoloma longistriatum</i>	TENN070451	USA		KY744164		P.B. Matheny, S.A. Trudell & M.G. Wood, unpubl.
<i>Entoloma minutigranulosum</i>	GB-0204540	Sweden		MZ145209		This study
<i>Entoloma minutigranulosum</i>	JL54-14	Norway		MZ145221		This study
<i>Entoloma minutigranulosum</i>	JL69-17	Norway		MZ145220		This study
<i>Entoloma minutigranulosum</i>	JL99-11	Norway		MZ145216		This study
<i>Entoloma minutigranulosum</i>	JL99-16	Norway		MZ145217		This study
<i>Entoloma minutigranulosum</i>	L0607681	The Netherlands		MZ145215		This study
<i>Entoloma minutigranulosum</i>	L0607941 / MD-2014-7	Germany		MZ145211		This study
<i>Entoloma minutigranulosum</i>	LE 302096, T	Russia		MZ145214		This study
<i>Entoloma minutigranulosum</i>	LE 312483	Russia		MZ145212		This study
<i>Entoloma minutigranulosum</i>	LE 312484	Russia		MZ145210		This study
<i>Entoloma minutigranulosum</i>	LE 312675	Russia		MZ145219		This study
<i>Entoloma minutigranulosum</i>	O-F-175913 / GG 3568	Norway		MZ145218		This study

Species name	ID (isolate, strain ¹ , status ² , voucher)	Country, isolation source	SSU	ITS	LSU	Reference(s)
<i>Entoloma minutigranulosum</i>	O-F-304886 / TEB 121-16	Norway		MZ145208		This study
<i>Entoloma minutigranulosum</i>	WU25057	Austria		MZ145213		This study
<i>Entoloma montanum</i>	GB-0191635, T	Sweden		MW340896		Noordeloos et al. (2021)
<i>Entoloma mougeotii</i>	LE254352	Russia		KC898446		Morozova et al. (2014)
<i>Entoloma nigrovelutinum</i>	LE295077, T	Vietnam		MF898426		Crous et al. (2017)
<i>Entoloma nipponicum</i>	TNS F70747, T	Japan		MK693223		Crous et al. (2019)
<i>Entoloma nordlandicum</i>	O-F-76176, T	Norway		MW340899		Noordeloos et al. (2021)
<i>Entoloma ochromicaceum</i>	TU120040	Estonia		UDB023715*		I. Saar, unpubl.
<i>Entoloma perasprellum</i>	GB-0204546 / EL28-19	Sweden		MZ145182		This study
<i>Entoloma perasprellum</i>	GB-0204547 / JBJ 19-107	Sweden		MZ145179		This study
<i>Entoloma perasprellum</i>	GB-0204548 / JBJ 19-122	Sweden		MZ145180		This study
<i>Entoloma perasprellum</i>	GB-0204549 / JBJ 19-180	Sweden		MZ145183		This study
<i>Entoloma perasprellum</i>	GB-0204550 / JBJ 19-119	Sweden		MZ145181		This study
<i>Entoloma perasprellum</i>	GC01100310, T	France		MZ145177		This study
<i>Entoloma perasprellum</i>	LE 312499	Russia		MZ145186		This study
<i>Entoloma perasprellum</i>	LE 312500	Russia		MZ145185		This study
<i>Entoloma perasprellum</i>	LE 312501	Russia		MZ145178		This study
<i>Entoloma perasprellum</i>	O-F-256732 / JBJ 18-004	Sweden		MZ145184		This study
<i>Entoloma poliopus</i>	G4742	Estonia		UDB0332859*		R. Pau, unpubl.
<i>Entoloma pulchripes</i>	LE 311808, T	Russia		MZ145188		This study
<i>Entoloma pulchripes</i>	LE 311809	Russia		MZ145189		This study
<i>Entoloma pulchripes</i>	LE 312485	Russia		MZ145187		This study
<i>Entoloma querquedula</i>	18.XI.2011 TUR	Finland		LN850627		Kokkonen (2015)
<i>Entoloma</i> aff. <i>rectangulum</i> [as <i>Leptonia rectangula</i>]	SCL8524	USA		KU574744		M. Gordon, unpubl.
<i>Entoloma roseotinctum</i>	WU13070	Austria		LN850611		Kokkonen (2015)
<i>Entoloma sarcitulum</i>	TUR-31-VII-1967	FIN		LN850562		Kokkonen (2015)
<i>Entoloma septentrionale</i>	O-F-254295, T	Norway		MW340904		This study
<i>Entoloma serrulatum</i>	LE254361	Russia		KC898447		Morozova et al. (2014)
<i>Entoloma</i> sp.	CM13-233	New Caledonia		KY774214		Carriconde et al. (2019)
<i>Entoloma</i> sp.	MEL2382758	Australia		KP012941		G. Bonito, M. Barrett, F. Udovicic & T. Lebel, unpubl.
<i>Entoloma</i> sp.	MES-2627	Chile		MH930251		A.B. Mujic & M.E. Smith, unpubl.
<i>Entoloma</i> sp.	MES-534	Chile		KY462681		Truong et al. (2017)
<i>Entoloma</i> sp.	MushroomObserver.org/240552	USA		MG966312		A. Rockefeller, unpubl.
<i>Entoloma</i> sp.	soil sample	USA		EF619690		Parrent & Vilgalys (2007)
<i>Entoloma</i> sp.	soil sample	USA		KP889939		S.H.A. Guichon & S.W. Simard, unpubl.
<i>Entoloma</i> sp.	TRTC156923	Canada		JN021015		Dentinger et al. (2011)
<i>Entoloma</i> sp.	TUF120259	Estonia		UDB024650*		I. Saar, unpubl.
<i>Entoloma</i> sp. [as <i>Entoloma</i> cf. <i>sericeum</i>]	UBC-F14053	Canada		AF335439		M.L. Berbee, P. Inderbitzin & G. Zhang, unpubl.
<i>Entoloma subcaesiellum</i>	LE253776, T	Russia		MK693224		Noordeloos & Morozova (2010)
<i>Entoloma subcaesiocinctum</i>	SAAS2238	China		KY711234		He et al. (2017)
<i>Entoloma subcorvinum</i>	TENN070435	USA		KY744169		P.B. Matheny, S.A. Trudell & M.G. Wood, unpubl.
<i>Entoloma subfarinaceum</i>	TENN070395	USA		KY777374		P.B. Matheny, S.A. Trudell & M.G. Wood, unpubl.
<i>Entoloma tigrinum</i>	GB-0204535 / EL156-18	Sweden		MZ145172		This study
<i>Entoloma tigrinum</i>	GB-0204536 / JBJ 19-128	Sweden		MZ145171		This study
<i>Entoloma tigrinum</i>	GB-0204537 / JBJ 19-109	Sweden		MZ145173		This study
<i>Entoloma tigrinum</i>	GB-0204538	Sweden		MZ145175		This study
<i>Entoloma tigrinum</i>	GB-0204539	Sweden		MZ145174		This study
<i>Entoloma tigrinum</i>	O-F-304580, T	Norway		MZ145176		This study
<i>Entoloma timidum</i>	JL13-16	Norway		MZ145195		This study
<i>Entoloma timidum</i>	JL15-14	Norway		MZ145194		This study
<i>Entoloma timidum</i>	LE 311800	Russia		MZ145191		This study
<i>Entoloma timidum</i>	LE 312382	Russia		MZ145198		This study
<i>Entoloma timidum</i>	LE 312480, T	Russia		MZ145197		This study
<i>Entoloma timidum</i>	LE 312481	Russia		MZ145199		This study
<i>Entoloma timidum</i>	O-F-252355	Norway		MZ145196		This study

Species name	ID (isolate, strain ¹ , status ² , voucher)	Country, isolation source	SSU	ITS	LSU	Reference(s)
<i>Entoloma timidum</i>	O-F-75148	Norway		MZ145190		This study
<i>Entoloma timidum</i>	TEB73-20	Norway		MZ145193		This study
<i>Entoloma timidum</i>	Weholt E16-10	Norway		MZ145192		This study
<i>Entoloma turci</i>	MCVE3882	Italy		JF907993		Osmundson et al. (2013)
<i>Entoloma cf. unicolor</i>	TENN070383	USA		KY777373		P.B. Matheny, S.A. Trudell & M.G. Wood, unpubl.
<i>Entoloma violaceoserrulatum</i>	JV 8329F (TUR), T	Finland		MF476913		Morozova et al. (2018)
<i>Entoloma violaceoserrulatum</i>	L0607704	The Netherlands		MZ145200		This study
<i>Entoloma violaceoserrulatum</i>	LE 312676	Sweden		MZ145204		This study
<i>Entoloma violaceoserrulatum</i>	O-F-260353 / TEB 339-15	Norway		MZ145201		This study
<i>Entoloma violaceoserrulatum</i>	O-F-75151	Norway		MZ145203		This study
<i>Entoloma violaceoserrulatum</i>	TEB128-19	Norway		MZ145202		This study
<i>Entoloma yanacolor</i>	QCAM 6312, T	Ecuador		MG947210		Crous et al. (2018)
<i>Herpomyces chaetophilus</i>	D. Haelew. 1097b	Panama, Periplaneta americana	MG438321	MG438294	MG438352	Haelewaters et al. (2019)
<i>Herpomyces chaetophilus</i>	D. Haelew. 1097c	Panama, Periplaneta americana	MG438322	MG438295	MG438353	Haelewaters et al. (2019)
<i>Herpomyces chaetophilus</i>	D. Haelew. 435b	USA Massachusetts, Periplaneta americana	MG438318	MG438292		Haelewaters et al. (2019)
<i>Herpomyces chaetophilus</i>	D. Haelew. 483b	USA Massachusetts, Periplaneta americana	MG438319	MG438293	MG438350	Haelewaters et al. (2019)
<i>Herpomyces chaetophilus</i>	D. Haelew. 483e	USA Massachusetts, Periplaneta americana	MG438320		MG438351	Haelewaters et al. (2019)
<i>Herpomyces chaetophilus</i>	D. Haelew. 602b	USA Massachusetts, Periplaneta americana	KT800023	KT800039	KT800009	Haelewaters et al. (2015)
<i>Herpomyces ectobiae</i>	MG001	Poland, Blattella germanica	KT800024	KT800040		Haelewaters et al. (2015)
<i>Herpomyces ectobiae</i>	TW793a	USA California, Blattella germanica		MG438296		Haelewaters et al. (2019)
<i>Herpomyces leurolestis</i>	2017/0199	Hungary, Phoetalia pallida		MG438299		Haelewaters et al. (2019)
<i>Herpomyces leurolestis</i>	D. Haelew. 1417b	Hungary, Phoetalia pallida		MG438297		Haelewaters et al. (2019)
<i>Herpomyces leurolestis</i>	Debr_Ppal	Hungary, Phoetalia pallida	MG438323	MG438298	MG438354	Haelewaters et al. (2019)
<i>Herpomyces paranensis</i>	D. Haelew. 1365a	Panama, Blaberus giganteus		MG438300		Haelewaters et al. (2019)
<i>Herpomyces paranensis</i>	D. Haelew. 1365b	Panama, Blaberus giganteus		MG438301		Haelewaters et al. (2019)
<i>Herpomyces periplanetae</i>	ADK6485	Bénin, Periplaneta americana	MZ145233	MZ145234	MZ144000	This study
<i>Herpomyces periplanetae</i>	D. Haelew. 1187d	USA Massachusetts, Periplaneta americana	MG438331	MG438309	MG438359	Haelewaters et al. (2019)
<i>Herpomyces periplanetae</i>	D. Haelew. 602a	USA Massachusetts, Periplaneta americana	MG438326	MG438304		Haelewaters et al. (2019)
<i>Herpomyces periplanetae</i>	D. Haelew. 602c	USA Massachusetts, Periplaneta americana	KT800025	KT800041	KT800010	Haelewaters et al. (2015)
<i>Herpomyces periplanetae</i>	D. Haelew. 602d	USA Massachusetts, Periplaneta americana	MG438327	MG438305	MG438357	Haelewaters et al. (2019)
<i>Herpomyces periplanetae</i>	D. Haelew. 620a	USA New York, Periplaneta americana	MG438328	MG438306	MG438358	Haelewaters et al. (2019)
<i>Herpomyces periplanetae</i>	D. Haelew. 654b	Panama, Periplaneta americana	MG438329	MG438307		Haelewaters et al. (2019)
<i>Herpomyces periplanetae</i>	D. Haelew. 654c	Panama, Periplaneta americana	MG438330	MG438308	MG438308	Haelewaters et al. (2019)
<i>Herpomyces periplanetae</i>	TW437c	USA Massachusetts, Periplaneta americana	MG438324	MG438302	MG438355	Haelewaters et al. (2019)
<i>Herpomyces periplanetae</i>	TW448b	USA Massachusetts, Periplaneta americana	MG438325	MG438303	MG438356	Haelewaters et al. (2019)
<i>Herpomyces shelfordellae</i>	Bud_Slat	Hungary, Shelfordella lateralis	MG438333	MG438312	MG438361	Haelewaters et al. (2019)
<i>Herpomyces shelfordellae</i>	D. Haelew. 1415a	Hungary, Shelfordella lateralis		MG438313		Haelewaters et al. (2019)
<i>Herpomyces shelfordellae</i>	D. Haelew. 1427a	USA Massachusetts, Shelfordella lateralis		MK299847		Haelewaters et al. (2019)
<i>Herpomyces shelfordellae</i>	DE_HerpBL1	Hungary, Shelfordella lateralis	KT800026	KT800042	KT800011	Haelewaters et al. (2015)

Species name	ID (isolate, strain ¹ , status ² , voucher)	Country, isolation source	SSU	ITS	LSU	Reference(s)
<i>Herpomyces shelfordellae</i>	MH202b, T	Poland, Shelfordella lateralis		MK299848		Haelewaters et al. (2019)
<i>Herpomyces</i> sp.	H77-1	USA North Carolina, Parcoblatta cf. lata	KY523239	KY293260	KY350529	Sundberg et al. (2018)
<i>Herpomyces spegazzinii</i>	CEPHe27-1	Argentina, Periplaneta fuliginosa		MN597427		Gutierrez et al. (2020)
<i>Herpomyces spegazzinii</i>	LPS:49123-2, T	Argentina, Periplaneta fuliginosa		NR_169702		Gutierrez et al. (2020)
<i>Herpomyces stylopygae</i>	Bud_Bori	Hungary, Blatta orientalis	MG438332	MG438310	MG438360	Haelewaters et al. (2019)
<i>Herpomyces stylopygae</i>	Bud_Bori_2	Hungary, Blatta orientalis		MG438311		Haelewaters et al. (2019)
<i>Leucoagaricus americanus</i>	BHI-F360a	USA Massachusetts		MF161229		Haelewaters et al. (2018)
<i>Leucoagaricus americanus</i>	S.D. Russell HRL0779	Canada		MH979431		S. Russell & R. Lebeuf, unpubl.
<i>Leucoagaricus americanus</i>	S.D. Russell MO #107715	USA Indiana		MW567919		S.D. Russell, unpubl.
<i>Leucoagaricus americanus</i>	S.J.W.Verduin (L)	USA North Carolina		AF295928		Vellinga (2000)
<i>Leucoagaricus americanus</i>	CCBAS802	Czech Republic		LN714565		Větrovský et al. (2016)
[as <i>Leucoagaricus bresadolae</i>]						
<i>Leucoagaricus americanus</i>	MCVE:756	Italy		GQ329047		Osmundson et al. (2013)
[as <i>Leucoagaricus bresadolae</i>]						
<i>Leucoagaricus americanus</i>	Royan 3	Iran		MT573394		Alimadadi et al. (2019)
[as <i>Leucoagaricus</i> sp.]						
<i>Leucoagaricus</i> cf. <i>majusculus</i>	MFLU 09-0164	Thailand		HM488764		Vellinga et al. (2011)
<i>Leucoagaricus gongylophorus</i>	MyrE002	Panama		KF572016		Kooij et al. (2015)
<i>Leucoagaricus meleagris</i>	AJ 542	USA Massachusetts		MN483027		Justo et al. (2021)
<i>Leucoagaricus meleagris</i>	E.C.Vellinga 1990	The Netherlands		AY176419		Vellinga (2004)
<i>Leucoagaricus meleagris</i>	E.C.Vellinga 2095	The Netherlands		AF482867		Vellinga et al. (2003)
<i>Leucoagaricus meleagris</i>	HAW:JKS90	USA Hawai'i		MK412590		Stallman (2019)
<i>Leucoagaricus meleagris</i>	iNAT:58855005	USA New York		MW031133		S. Jakob, unpubl.
<i>Leucoagaricus meleagris</i>	WA0000072219	Laos		MT252565		Luczaj et al. (2021)
<i>Leucoagaricus mucrocystis</i>	AJ 476	USA US Virgin Islands		MN483025		Justo et al. (2021)
<i>Leucoagaricus mucrocystis</i>	CA 16 (JBSD)	Dominican Republic		MN483026		Justo et al. (2021)
<i>Leucoagaricus mucrocystis</i>	ELTE:DB-FG-167-19	French Guiana		MZ047586	MZ047585	This study
<i>Leucoagaricus mucrocystis</i>	ELTE:DB-FG-168-19	French Guiana		MZ047587		This study
<i>Leucoagaricus mucrocystis</i>	D.E. Hemmes deh1867	USA Hawai'i		HM488763		Vellinga et al. (2011)
[as <i>Lepiota besseyi</i>]						
<i>Leucoagaricus mucrocystis</i>	HAW:JKS109	USA Hawai'i		MK412602		Stallman (2019)
[as <i>Lepiota besseyi</i>]						
<i>Leucocoprinus</i> sp.	RB29	Brazil		MN473907		R. Bizarria Jr. & A. Rodrigues, unpubl.
<i>Neopetalotiopsis clavispora</i>	ncb01	India, Ziziphus mauritiana		MW012901		This study
<i>Phytopythium boreale</i>	CBS:551.88	China		AB725879	HQ665261	Robideau et al. (2011), Baten et al. (2014)
<i>Phytopythium carbonicum</i>	CBS:112544	France		AB725876	AB996605	Baten et al. (2014)
<i>Phytopythium carbonicum</i>	CBS:292.37	The Netherlands		AB690620		M.A. Baten, K. Kageyama & H. Suga, unpubl.
<i>Phytopythium chamaehyphon</i>	CBS:259.30	USA Hawai'i		AB690609	HQ665177	Robideau et al. (2011), Baten et al. (2014)
<i>Phytopythium chamaehyphon</i>	CCIBt 4338	Brazil		MT620968	MT612336	This study
<i>Phytopythium chamaehyphon</i>	CCIBt 4407	Brazil		MT620969	MT612337	This study
<i>Phytopythium chamaehyphon</i>	CPZ68	Brazil		MT620967	MT612335	This study
<i>Phytopythium chamaehyphon</i>	PPRI8625	South Africa		FJ415975		McLeod et al. (2009)
<i>Phytopythium citrinum</i>	CBS:119171	France		AY197328	AB948195	Baten et al. (2014)
<i>Phytopythium curcubitacearum</i>	CBS:748.96	Japan		AB725877	AB690598	Baten et al. (2014)
<i>Phytopythium delawarensis</i>	382B	USA Ohio		AB725875	AB690591	Baten et al. (2014)
<i>Phytopythium dogmae</i>	USTCMS 4101	Philippines		MF353170	MF373431	Bennett et al. (2017)
<i>Phytopythium fagopyri</i>	CBS:293.35	Japan		AB690617	AB690590	Baten et al. (2014)
<i>Phytopythium fagopyri</i>	FP1	Japan		AB690621	AB690599	Baten et al. (2014)
<i>Phytopythium fagopyri</i>	HonMa	Japan		AB690615	AB690588	Baten et al. (2014)
<i>Phytopythium helicoides</i>	CBS:286.31	USA		AB725878	MF375637	Baten et al. (2014), Bennett et al. (2017)
<i>Phytopythium helicoides</i>	CCIBt 4103	Brazil		KR092138		This study

Species name	ID (isolate, strain ¹ , status ² , voucher)	Country, isolation source	SSU	ITS	LSU	Reference(s)
<i>Phytophthium helicoides</i>	CCIBt 4104	Brazil		KR092137		This study
<i>Phytophthium iriomotense</i>	GUCC0025			AB690622	AB690600	M.A. Baten, K. Kageyama & H. Suga, unpubl.
<i>Phytophthium iriomotense</i>	GUCC7020			AB690629	AB690607	M.A. Baten, K. Kageyama & H. Suga, unpubl.
<i>Phytophthium kandeliae</i>	CBS:111.91	Taiwan		HQ643134	HQ665065	Robideau et al. (2011)
<i>Phytophthium kandeliae</i>	CCIBt 4023	Brazil		KJ399962	KJ399965	Marano et al. (2014)
<i>Phytophthium leanoi</i>	CBS:113.91	Taiwan		MF355474	KJ399963	Marano et al. (2014), Bennett et al. (2017)
<i>Phytophthium leanoi</i>	USTCMS 4102	Philippines		MF353169	MF373430	Bennett et al. (2017)
<i>Phytophthium litorale</i>	CBS:118360	Germany		HQ643386	HQ665082	Robideau et al. (2011)
<i>Phytophthium litorale</i>	CCIBt 4659	Brazil		MT620970	MT612338	This study
<i>Phytophthium litorale</i>	Dyrbkr01	Turkey		MN203107	MN197634	Derviş et al. (2020)
<i>Phytophthium litorale</i>	Dyrbkr02	Turkey		MN203108	MN197635	Derviş et al. (2020)
<i>Phytophthium litorale</i>	GUCC7167			AB690612	AB690583	Baten et al. (2014)
<i>Phytophthium litorale</i>	SCP82	Brazil		MT620972	MT612340	This study
<i>Phytophthium megacarpum</i>	CBS:112351	France		AB725881	HQ665067	Robideau et al. (2011), Baten et al. (2014)
<i>Phytophthium mercuriale</i>	CBS:112443	South Africa		AB725882	KF853236	de Cock et al. (2015); M.A. Baten, K. Kageyama & H. Suga, unpubl.
<i>Phytophthium mirpurens</i>	CBS:124524	Pakistan		KJ831614		de Cock et al. (2015)
<i>Phytophthium montanum</i>	ADC9762	Germany		HQ643391		Robideau et al. (2011)
<i>Phytophthium montanum</i>	CBS:111349	Germany		AB725883	HQ665064	Robideau et al. (2011), Baten et al. (2014)
<i>Phytophthium nanginjense</i>	Chen216	China		MF459636		Chen et al. (2019a)
<i>Phytophthium nanginjense</i>	Chen218	China		MF459635		Chen et al. (2019a)
<i>Phytophthium oedochilum</i>	CBS:292.37	USA		AB690619	HQ665191	Robideau et al. (2011), Baten et al. (2014)
<i>Phytophthium oedochilum</i>	CBS:738.94	South Africa		HQ643394		Robideau et al. (2011)
<i>Phytophthium ostracodes</i>	CBS:768.73	Spain		AB108022	HQ665295	Robideau et al. (2011); M.A. Baten, K. Kageyama & H. Suga, unpubl.
<i>Phytophthium palingenes</i>	CCIBt 3981	Brazil		KR092139	KR092143	This study
<i>Phytophthium palingenes</i>	CCIBt 4397	Brazil		MT620974	MT612342	This study
<i>Phytophthium palingenes</i>	CCIBt 4428	Brazil		MT620973	MT612341	This study
<i>Phytophthium sindhum</i>	CBS:124518	Pakistan		HM244825		Bala et al. (2010)
<i>Phytophthium sindhum</i>	JKI			KJ755089		König et al. (2015)
<i>Phytophthium</i> sp. 'amazonianum'	WPC:8239B1845	Ecuador		GU258624		M.D. Coffey, A.K. Brar, E. Xu, E.A. Sarhan & I.M. Cunningham, unpubl.
<i>Phytophthium</i> sp. 'amazonianum'	WPC:8243B519	Ecuador		GU258937		M.D. Coffey, A.K. Brar, E. Xu, E.A. Sarhan & I.M. Cunningham, unpubl.
<i>Phytophthium vexans</i>	CBS:119.80	Iran		AY598713	HQ665090	Lévesque & de Cock (2004), Robideau et al. (2011)
<i>Phytophthium vexans</i>	CCIBt 4101	Brazil		KR092141	KR092144	This study
<i>Phytophthium vexans</i>	CCIBt 4383	Brazil		MT620976	MT612344	This study
<i>Phytophthium vexans</i>	CCIBt 4398	Brazil		MT620975	MT612343	This study
<i>Pluteus beniensis</i>	RSPF 0299	Brazil		JQ065029		A. Justo, N. Menolli Jr & A.M. Minnis, unpubl.
<i>Pluteus cinereofuscus</i>	AJ229	Portugal		HM562108		Justo et al. (2011b)
<i>Pluteus</i> aff. <i>cinereofuscus</i>	LE 303665	Russia		KX216324		Malysheva et al. (2016)
<i>Pluteus eludens</i>	MA50497	Portugal		HM562118	HM562240	Justo et al. (2011b)
<i>Pluteus eludens</i>	SF15	USA		HM562185		Justo et al. (2011b)
<i>Pluteus exiguus</i>	O-F-21721	Norway		UDB036730*		A. Molia, unpubl.
<i>Pluteus extremiorientalis</i>	LE 303463	Russia		KM658282		Crous et al. (2014)
<i>Pluteus extremiorientalis</i> , T	LE<RUS>:262872	Russia		NR_153249		Crous et al. (2014)
<i>Pluteus floccipes</i>	BRNM	Czech Republic		LN794642		Ševčíková & Borovička (2015)
<i>Pluteus fluminensis</i>	SP393710	Brazil		FJ816655		Menolli et al. (2010)
<i>Pluteus fluminensis</i>	SP393711	Brazil		FJ816664	FJ816650	Menolli et al. (2010)
<i>Pluteus fuligineovenosus</i>	SP393705	Brazil		FJ816662		Menolli et al. (2010)
<i>Pluteus hubeiensis</i>	HMJAU45199	China		MH167350		W. Fengjian & L. Yu, unpubl.
<i>Pluteus hubeiensis</i>	HMJAU45200	China		MH167353		W. Fengjian & L. Yu, unpubl.
<i>Pluteus jamaicensis</i>	SP393706	Brazil		FJ816657		Menolli et al. (2010)

Species name	ID (isolate, strain ¹ , status ² , voucher)	Country, isolation source	SSU	ITS	LSU	Reference(s)
<i>Pluteus cf. jamaicensis</i>	SP416738	Brazil		KM983709		Menolli et al. (2015)
<i>Pluteus cf. jamaicensis</i>	SP417454	Brazil		KM983711		Menolli et al. (2015)
<i>Pluteus keselakii</i>	BRNM 817402	Slovakia		MN250223	MN250223	Ševčíková et al. (2020)
<i>Pluteus keselakii</i>	LIP Mycologie 0401385	France		MN250224		Ševčíková et al. (2020)
<i>Pluteus keselakii</i> , T	BRNM:817402	Slovakia		NR_169977		Ševčíková et al. (2020)
<i>Pluteus ludwigii</i>	MCVE:30136	Slovenia		MK834525	MK834527	Crous et al. (2019)
<i>Pluteus ludwigii</i> , T	MCVE:30136	Slovenia		NR_164496		Crous et al. (2019)
<i>Pluteus multififormis</i>	AC4249	Spain		HM562201	MK278503	Justo et al. (2011b), Varga et al. (2019)
<i>Pluteus multififormis</i>	AH 40107	Spain		MN250225	MN250225	Ševčíková et al. (2020)
<i>Pluteus multififormis</i>	OKA-TR1750	Turkey		MT982425	MT982429	This study
<i>Pluteus multififormis</i>	OKA-TR1751	Turkey		MT982426	MT982430	This study
<i>Pluteus multififormis</i> , T	AH:40107	Spain		NR_119877		Justo et al. (2011a)
<i>Pluteus nanus</i>	UCI859980	USA		KF306030		N.H. Nguyen, E.C. Vellinga, G.M. Cobian, A.J. Fernandez & T.D. Bruns, unpubl.
<i>Pluteus nanus f. griseopus</i>	NL-2546	Hungary			MK278504	Varga et al. (2019)
<i>Pluteus pallescens</i>	AJ214	Spain		HM562056	HM562231	Justo et al. (2011b)
<i>Pluteus rimosoaffinis</i>	SP394379	Brazil		HM562145		Menolli et al. (2015)
<i>Pluteus rimosoaffinis</i>	SP416740	Brazil		KM983706		Menolli et al. (2015)
<i>Pluteus sapiicola</i>	SP394382	Brazil		HM562148		Justo et al. (2011b)
<i>Pluteus sapiicola</i>	SP394387	Brazil		HM562146		Justo et al. (2011b)
<i>Pluteus sp.</i>	JLF1767	USA		MK634597		J.L. Frank, unpubl.
<i>Pluteus sp.</i>	PDD:106511	New Zealand		MN738653		J.A. Cooper, unpubl.
<i>Pluteus sp.</i>	PDD:110518	New Zealand		MN738674	MN738605	J.A. Cooper, unpubl.
<i>Pluteus tenebromarginatus</i>	GC17102401	France		MT079860		Corriol et al. (2020)
<i>Pluteus terricola</i>	PDD:107339	New Zealand		MN738665	MN738585	J.A. Cooper, unpubl.
<i>Pythium takayamanum</i>	CBS:122.492	Japan		HQ643853	HQ665094	Robideau et al. (2011)
<i>Pythium takayamanum</i>	CCIBt 4040	Brazil		KM058758	KM058755	This study
<i>Pyridiophora arvensensis</i>	CBS 657.82	The Netherlands	FJ176839		FJ176894	Schoch et al. (2009)
<i>Pyridiophora cf. microspora</i>	MG200	Poland	MG438334	MG438314	MG438362	Haelewaters et al. (2019)
<i>Rhodocollybia asema</i>	O-F-248185	Norway		MZ156765		This study
<i>Rhodocollybia asema</i>	O-F-248288	Norway		MZ156764		This study
<i>Rhodocollybia asema</i>	O-F-74975	Norway		MZ156766		This study
<i>Rhodocollybia asema</i>	O-F-75562	Norway		MZ156767		This study
<i>Rhodocollybia butyracea</i>	FB10726 (TENN)	Russia		AF505750		Mata et al. (2004)
<i>Rhodocollybia butyracea</i>	FB11456 (TENN)	Austria		AF505751		Mata et al. (2004)
<i>Rhodocollybia butyracea</i>	O-F-74979	Norway		MZ156768		This study
<i>Rhodocollybia butyracea</i>	O-F-75421	Norway		MZ156769		This study
<i>Rhodocollybia butyracea</i>	TENN53580	Sweden		AY313293		Mata et al. (2004)
<i>Rhodocollybia butyracea</i>	TU106219, UNITE RefSeq	Estonia		UDB011434*		V. Liiv, unpubl.
<i>Rhodocollybia butyracea</i>	TU118269	Estonia		UDB015439*		V. Liiv, unpubl.
<i>Rhodocollybia butyracea f. asema</i>	TU106218	Estonia		UDB015078*		V. Liiv, unpubl.
<i>Rhodocollybia butyracea f. asema</i>	TU106229	Estonia		UDB019799*		V. Liiv, unpubl.
<i>Rhodocollybia butyracea f. asema</i>	TU118574	Estonia		UDB017989*		V. Liiv, unpubl.
<i>Rhodocollybia fodiens</i>	TU106942	Estonia		UDB015266*		V. Liiv, unpubl.
<i>Rhodocollybia maculata</i>	BRNM699408	Italy		GU947370		Antonin & Noordeloos (2010)
<i>Rhodocollybia maculata</i>	BRNM714632	Czech Republic		GU947369		Antonin & Noordeloos (2010)
<i>Rhodocollybia maculata</i>	TU106940	Estonia		UDB015655*		V. Liiv, unpubl.
<i>Rhodocollybia cf. maculata</i>	O-F-75733	Norway		MZ156770		This study
<i>Rhodocollybia prolixa</i>	TU118816	Estonia		UDB019494*		V. Liiv, unpubl.
<i>Rhodocollybia sp.</i>	h43	Czech Republic		LN714597		Větrovský et al. (2016)
<i>Suillus americanus</i>	1008-NC	USA North Carolina		AF166500		Wu et al. (2000)
<i>Suillus americanus</i>	F1185163	USA West Virginia		KU663182		R. Zhang, X. Shi, P. Liu & G.M. Mueller, unpubl.
<i>Suillus americanus</i>	F1185445	USA Indiana		KU663183		R. Zhang, X. Shi, P. Liu & G.M. Mueller, unpubl.
<i>Suillus americanus</i>	MAV-5625	USA Ohio		AF166503		Wu et al. (2000)
<i>Suillus americanus</i>	TDB-581	USA Michigan		L54103		Wu et al. (2000)
<i>Suillus americanus</i>	TJB-7683	USA New York		AF166502		Wu et al. (2000)
<i>Suillus cf. americanus</i>	YNP:2355	USA California		KU663196		R. Zhang, X. Shi, P. Liu & G.M. Mueller, unpubl.

Species name	ID (isolate, strain ¹ , status ² , voucher)	Country, isolation source	SSU	ITS	LSU	Reference(s)
<i>Suillus cothurnatus</i>	MA-Fungi 47683	Spain		AJ419218		Martin & Raidl (2002)
<i>Suillus cothurnatus</i>	MA-Fungi 49403	Spain		AJ419217		Martin & Raidl (2002)
<i>Suillus cothurnatus</i>	NSW-4662	USA Louisiana		L54092		Kretzer et al. (1996)
<i>Suillus decipiens</i>	DG-1451	USA Texas		AF166508		Wu et al. (2000)
<i>Suillus decipiens</i>	DG-1451	USA Texas		L54079		Kretzer et al. (1996)
<i>Suillus decipiens</i>	DPL-5724	USA Texas		AF166510		Wu et al. (2000)
<i>Suillus flavidus</i>	DG66	UK		JQ888208		Jones et al. (2012)
<i>Suillus flavidus</i>	FFP909	Canada		JQ711962		Jones et al. (2012)
<i>Suillus flavidus</i>	FFP962	Canada		JQ711908		Jones et al. (2012)
<i>Suillus granulatus</i>	K-15-1	Russia		MK414509		O.B. Vaishlya, K.S. Karbysheva, I. Bakhtinskaya & E. Murina, unpubl.
<i>Suillus granulatus</i>	KA17-0554	South Korea		MN294845		Cho et al. (2020)
<i>Suillus himalayensis</i>	SNW-03	India		KJ472765		Verma & Reddy (2014a)
<i>Suillus intermedius</i>	ACAD-15271	Canada		L54074		Kretzer et al. (1996)
<i>Suillus placidus</i>	TDB-725	USA Michigan		L54108		Kretzer et al. (1996)
<i>Suillus placidus</i>	VC-1022	Nepal		L54118		Kretzer et al. (1996)
<i>Suillus quercinus</i>	LAH240711	Pakistan		MT361746		This study
<i>Suillus quercinus</i>	LAH36421, T	Pakistan		MT361745		This study
<i>Suillus quercinus</i>	LAH36422	Pakistan		MT361744		This study
<i>Suillus sibiricus</i>	EA24040	Pakistan		JN119750		Sarwar et al. (2011)
<i>Suillus sibiricus</i>	EA24104	Pakistan		JN119751		Sarwar et al. (2011)
<i>Suillus sibiricus</i>	HMAS:66061	China		AF166512		Kretzer et al. (1996)
<i>Suillus sibiricus</i>	QXW-2092	Austria		AF166513		Kretzer et al. (1996)
<i>Suillus sibiricus</i>	UC2023481	Switzerland		KX213817		Kretzer et al. (1996)
<i>Suillus sibiricus</i>	VC-1040	Nepal		L54117		Kretzer et al. (1996)
<i>Suillus spraguei</i>	GMM-5703	China		AF166518		Wu et al. (2000)
<i>Suillus spraguei</i>	QXW-2409	China		AF166520		Wu et al. (2000)
<i>Suillus spraguei</i>	QXW-2435	China		AF166522		Wu et al. (2000)
<i>Suillus spraguei</i>	Tissue_lib TDB-638	USA Michigan		M91617		Wu et al. (2000)
<i>Suillus spraguei</i>	TJB-6228	USA New York		AF166525		Wu et al. (2000)
<i>Suillus subalutaceus</i>	ACAD-15288	Canada		L54075		Kretzer et al. (1996)
<i>Suillus subaureus</i>	TDB-780	USA Massachusetts		L54109		Kretzer et al. (1996)
<i>Suillus subluteus</i>	IB-13-8/19/72	USA Michigan		L54088		Kretzer et al. (1996)
<i>Suillus triacicularis</i>	MSM 0027	Pakistan		KM677929		Sarwar et al. (2015)
<i>Suillus triacicularis</i>	PUN 5534	India		KF977188		Verma & Reddy (2014b)
<i>Suillus triacicularis</i>	PUN 5534, T	India		NR_153233		Verma & Reddy (2014b)
<i>Uncultured Basidiomycota</i>	4S1_A12	USA		EU489965		Hollister et al. (2010)
<i>Uncultured Basidiomycota</i>	A2	Australia		DQ672275		Midgley et al. (2007)
<i>Uncultured fungus</i>	FDBC50	Mexico		JQ247381		Romero-Olivares et al. (2013)
<i>Uncultured fungus</i>	4248_284	Lithuania		MT236490		Marčiulynas et al. 2020
<i>Uncultured fungus</i>	TUN11	UK		KM374523		Johnson et al. (2014)

¹ Herbarium abbreviations follow Index Herbariorum (Thiers continuously updated).

² T: ex-type strain. * from UNITE database (<https://unite.ut.ee>).

DNA was extracted from dried *Crepidotus mal-achiooides* basidiomata with the CTAB protocol from Doyle & Doyle (1987). The ITS region was amplified with primers ITS1F (Gardes & Bruns 1993) and ITS4 (White et al. 1990). Cycling conditions were as in Saba et al. (2020). The generated sequence reads were assembled and edited in Geneious version 11.1.5 (Kearse et al. 2012) and then submitted to NCBI GenBank. Accession numbers are reported in Tab. 1.

Genomic DNA was isolated from 1 female thallus of *Herpomyces periplanetae* using the REPLI-g

Single Cell Kit (Qiagen, Valencia, CA) following the modifications by Haelewaters et al. (2019). Amplification of the internal transcribed spacer (ITS) barcode region and the nuclear ribosomal RNA small and large subunits (SSU and LSU) was done using the following primer sets: NSL1/NSL2 for SSU (Haelewaters et al. 2015), ITS1f/ITS4 for ITS (White et al. 1990, Gardes & Bruns 1993), and LIC24R/LR3 for LSU (Vilgalys & Hester 1990, Miadlikowska & Lutzoni 2000). Amplifications were performed on a pro S Mastercycler (Eppendorf, Hauppauge, NY) in 25- μ l reactions containing 12.5 μ l of 2 \times MyTaq Mix

(Bioline, Swedesboro, NJ), 9.5 µl of ddH₂O, 1.0 µl of each 10 mM primer, and 1.0 µl of DNA extract. Cycling conditions followed Haelewaters et al. (2019) for ITS and Liu et al. (2020) for SSU and LSU. For SSU: initial denaturation at 95 °C for 5 min; then 40 cycles of denaturation at 95 °C for 30 s, annealing at 55 °C for 45 s, and extension at 72 °C for 45 s; and final extension at 72 °C for 1 min. For ITS: initial denaturation at 94 °C for 3 min; then 35 cycles of denaturation at 94 °C for 1 min, annealing at 50 °C for 45 s, and extension at 72 °C for 90 s; and final extension at 72 °C for 10 min. For LSU: initial denaturation at 94 °C for 5 min; then 35 cycles of denaturation at 94 °C for 30 s, annealing at 50 °C for 45 s, and extension at 72 °C for 1 min; and final extension at 72 °C for 7 min. Purification and Sanger sequencing were outsourced to Genewiz (Plainfield, NJ). Raw sequence reads were assembled, trimmed, and edited in Sequencher version 5.2.3 (Gene Codes Corporation, Ann Arbor, MI).

For the *Leucoagaricus* study, the ITS and LSU regions were amplified directly from samples with the Phire Plant Direct PCR Master Mix Kit (Thermo Scientific). Amplification of the regions ITS and LSU was done using primer sets ITS1F/ITS4 (White et al. 1990, Gardes & Bruns 1993) and LR0R/LR5 (Vilgalys & Hester 1990, Hopple 1994), respectively. Sequencing of the amplicons was carried out with the primers used for amplification by LGC Genomics (Berlin, Germany). Chromatograms were checked and edited with CodonCode Aligner version 8.0.1 (CodonCode Corporation). Newly generated sequences were submitted to GenBank (Tab. 1).

Neopestalotiopsis DNA was extracted from conidia, conidiophores, and mycelium using the CTAB method from Doyle & Doyle (1990). DNA was resuspended in 100 µl of MilliQ H₂O and quantified using a Nanodrop 2000c spectrophotometer (Thermo Scientific) at A_{260/280} and A_{230/260}. DNA was then diluted to 20 ng/ml and stored at -20±2 °C. Amplification of the ITS region was performed with primers ITS1 and ITS4 (White et al. 1990). PCR was done in 15-µl reactions consisting of 0.18 µl of each 10 mM primer, 0.18 µl of dNTPs, 0.90 U of GoTaqVR DNA Polymerase (Promega, Madison, WI), and 3 µl of the diluted DNA suspension. Amplified PCR products were checked by electrophoresis on 1.5 % agarose gel and cleaned with ExoSAP-IT PCR Product Cleanup Reagent (Thermo Scientific). Sequencing was done by Macrogen. The generated sequence was submitted to GenBank (accession no. MW012901).

Mycelium biomass from each *Phytophthium* specimen was grown for 3–5 days in falcon tubes

containing 20 ml of MP5 (4 g of maltose, 1 g of peptone, and 1 l of ddH₂O) liquid medium at room temperature (~22 °C). Biomass was transferred to Eppendorf tubes, washed with sterile water, and centrifuged at 13,000 rpm for 15 min to obtain pellets. The DNA extraction was performed according to the protocol described in the PureLink Genomic DNA kit (Invitrogen, Carlsbad, CA). The ITS and LSU regions were amplified using the primers UN-up18S42 and UN-1o28S22 (Robideau et al. 2011) and LR0R/LR6-O, respectively (Hopple 1994, Riethmüller et al. 2002). DNA was amplified with JumpStart™ Taq DNA Polymerase (Sigma-Aldrich, St. Louis, MO) for a final volume of 25 µl using the PCR conditions described by Marano et al. (2014). Amplicons were purified manually according to the protocol of Schmitz & Riesner (2006). Sanger sequencing was performed by Macrogen. Assembly of contigs and correction of ambiguous bases were manually edited using Sequencher version 4.1.4. All sequences were submitted to GenBank (Tab. 1).

Genomic DNA of *Pluteus* basidiomata was extracted using the ZR Fungal/Bacterial DNA Mini-Prep kit (Zymo research, Irvine, CA). PCR amplification was performed with the following primer pairs: ITS1F and ITS4 for ITS (White et al. 1990, Gardes & Bruns 1993), and LR0R and LR5 for LSU (Vilgalys & Hester 1990, Hopple 1994). PCR procedures were after Kaygusuz et al. (2020). Purification of PCR products was done using the UltraClean PCR Clean-Up kit (MoBio Laboratories, Carlsbad, CA) following the manufacturer's instructions. Sanger sequencing of purified PCR products using the PCR primers was outsourced to Source Bioscience (Berlin, Germany). Newly generated sequences were submitted to GenBank (accession numbers in Tab. 1).

Seven *Rhodocollybia* collections from Norway were studied by molecular methods (Tab. 1). Six of them belong to the *R. butyracea* (Bull.) Lennox complex. DNA extraction and PCR amplification of the ITS region as well as Sanger sequencing were done in collaboration with the Norwegian Barcode of Life Network (NorBOL) as part of BOLD (Barcode of Life Data System). For BOLD methods, see Ratnasingham & Hebert (2007, 2013).

Phylogenetic analyses

The newly generated *Cortinari* sequence was subjected to a BLAST search against NCBI GenBank's standard *nr/nt* nucleotide database (<https://blast.ncbi.nlm.nih.gov/Blast.cgi>) to select and download the most closely related sequences in

Cortinarius subg. *Telamonia* sect. *Hinnulei* (Liimatainen et al. 2020). Sequences were aligned in MEGA5 (Tamura et al. 2011) using ClustalW and then corrected manually. The final alignment included 512 characters, of which 65 were parsimony-informative. Bayesian inference (BI) was performed in MrBayes 3.2.6 (Ronquist et al. 2012), under the following parameters: data not partitioned, GTR+G+I as substitution model, two independent runs, four chains, temperature set to 0.2, sampling every 100 generations, until convergence parameters were met after 0.74 million generations. Finally, a maximum likelihood (ML) analysis was run using RAxML version 8.2.12 (Stamatakis 2014) using the GTRGAMMA model. Bootstrapping was done with 2,000 replicates. Trees were visualized in FigTree version 1.4.3 (<http://tree.bio.ed.ac.uk/software/figtree/>) and then edited in Adobe Illustrator 25.1.

Entoloma sequences were aligned with MAFFT version 7 using the E-INS-i option (Katoh et al. 2019). The alignment was checked and edited in SeaView version 4 (Gouy et al. 2010). Maximum likelihood (ML) analysis was performed in PhyML version 3.0 (Guindon et al. 2010) using the non-parametric Shimodaira-Hasegawa version of the approximate likelihood-ratio test (SH-aLRT) and the GTR+I+ Γ model of evolution. The final tree (Fig. 4) was edited in MEGA7 (Kumar et al. 2016) and Adobe Illustrator CS4.

For the *Suillus* study, consensus sequences were subjected to BLAST searches (<https://blast.ncbi.nlm.nih.gov/Blast.cgi>). ITS sequences sharing higher identity with our newly generated sequences were downloaded. All sequences were aligned using the MUSCLE alignment tool (Edgar 2004), which is available online through the European Bioinformatics Institute (<https://www.ebi.ac.uk/Tools/msa/muscle/>). Next, sequences in the aligned ITS dataset were trimmed at the conserved motifs 5'-(...GAT)CATT-3' (3' end of the SSU) and 5'-GACCT(CAAA...)-3' (5' end of the LSU) (Dentinger et al. 2011). A maximum likelihood (ML) tree was inferred using RAxML-HPC2 version 8.1.11 (Stamatakis 2014) with the GTRGAMMA model of nucleotide substitution. Rapid bootstrapping was done with 1,000 replicates. Phylogenetic analysis was performed on the CIPRES Science Gateway version 3.3 (Miller et al. 2010).

Crepidotus sequences that shared >87.5% identity with the newly generated ITS sequence in BLAST were downloaded from NCBI GenBank (<https://www.ncbi.nlm.nih.gov/genbank/>). *Agrocybe pediades* (Fr.) Fayod, GenBank accession no. MG817376, was selected as outgroup. Sequences

were aligned using MAFFT version 7.450 (Katoh & Toh 2008) with default parameters in Geneious version 11.1.5. Maximum likelihood (ML) was inferred with RAxML version 8.2.11 (Stamatakis 2014). The GTR+G model was selected, and a total of 1,000 bootstrap (MLBS) replicates were used. The average distance between clades was estimated with MEGA version 10.0.4 (Kumar et al. 2018).

All existing ribosomal DNA sequences of *Herpomyces* species were downloaded from GenBank. Sequences of two species of *Pyxidiophora* Bref. & Tavel, which served as outgroup, were also downloaded. Sequences were aligned by region (SSU, ITS, LSU) using MUSCLE version 3.7 (Edgar 2004) on the CIPRES Science Gateway (Miller et al. 2020). Aligned ITS sequences were trimmed with the conserved motifs 5'-CATT-3' (3' end of SSU) and 5'-GACCT-3' (5' end of LSU); the alignment portion between these motifs was included in subsequent analysis (Dentinger et al. 2011). Aligned LSU sequences were trimmed with the 5'-GACCT-3' motif; the alignment portion upstream from and including this conserved motif were included in subsequent analysis. Next, aligned sequences were trimmed using TrimAl version 1.3 (Capella-Gutiérrez et al. 2009) with gap threshold (-gt) of 0.6 and minimal coverage (-cons) of 0.5. Appropriate models of nucleotide substitution were selected under the Akaike Information Criterion corrected for small sample size (AICc) using the IQ-TREE built-in ModelFinder (Kalyaanamoorthy et al. 2017). Selected models were GTR+F+R2 (SSU, -lnL=2066.978), TVM+F+G4 (ITS, -lnL=4635.696), and TIM3+F+R2 (LSU, -lnL=2729.742). The data for each region were combined using MEGA version 7.0.26 (Kumar et al. 2016). We used the command-line version of IQ-TREE to perform a maximum likelihood (ML) analysis of the concatenated SSU-ITS-LSU dataset, under multiple partitions (Nguyen et al. 2015, Chernomor et al. 2016) and with branch support calculated from 1,000 ultrafast bootstrap replicates (Hoang et al. 2018). The final tree with ML bootstrap (MLBS) support values was visualized in FigTree version 1.4.3 (<http://tree.bio.ed.ac.uk/software/figtree/>) and edited in Adobe Illustrator version 25.1.

Selected ITS sequences of *Leucoagaricus* spp. were aligned with MAFFT online version 7 using the E-INS-i option (Katoh et al. 2019). The alignment was checked and edited in SeaView version 4 (Gouy et al. 2010). A maximum likelihood (ML) phylogenetic analysis was performed in raxmlGUI version 1.5 (Silvestro & Michalak 2012) using the GTRGAMMA nucleotide substitution model.

Branch support was evaluated using 1,000 bootstrap replicates. The best scoring tree was edited with MEGA7 (Kumar et al. 2016).

ITS and LSU datasets with sequences for 51 *Phytopythium* isolates were used for the phylogenetic analyses, with two isolates of *Pythium takayamanum* Senda & Kageyama as outgroup. The dataset was aligned using MAFFT 7 with default settings (Kato et al. 2019) and adjusted manually in BioEdit (Hall 1999). The best-fitting model of evolution was selected using the Akaike Information Criterion in jModelTest version 0.1.1 (Posada 2008). The aligned sequences were concatenated using SequenceMatrix 1.8 (Vaidya et al. 2010), resulting in a final length of 2,140 characters. Maximum likelihood (ML) and Bayesian inference (BI) analyses were performed using RAxML 8.2.10 (Stamatakis 2014) and MrBayes 3.2.2 (Ronquist et al. 2012) in the CIPRES Science Gateway. The ML analysis was performed with 1,000 bootstraps (MLBS) replicates using the GTRGAMMAI model. The BI used the Markov Chain Monte Carlo (MCMC) methodology to calculate posterior probabilities (BIPP). Four MCMC chains were run for five million generations, with sampling every 1,000 generations, and a burn-in of 10 %. Phylogenetic trees were viewed in FigTree version 1.4.2 (<http://tree.bio.ed.ac.uk/software/figtree/>) and edited in Inkscape version 0.92 (<https://inkscape.org/>).

For the *Pluteus* study, two ITS and two LSU sequences were newly generated. Another 51 related sequences—31 ITS and 12 LSU—were downloaded from GenBank and UNITE. *Pluteus seticeps* (G.F. Atk.) Singer, GenBank accession number HM562192, was selected as the outgroup. All sequences were aligned by MAFFT version 7.110 (Kato et al. 2019). Phylogenetic analyses were performed for the concatenated ITS–LSU dataset with both maximum likelihood (ML) and Bayesian inference (BI) methods. The ML analysis was run through the CIPRES Science Gateway online interface (Miller et al. 2010) using RAxML version 8.2.10 (Stamatakis 2014) under the GTRGAMMA model and with 1,000 bootstrap replicates. BI was performed using MrBayes version 3.2.5 (Ronquist et al. 2012). Four Markov chain Monte Carlo (MCMC) chains were run for 1 million generations, sampling trees every 100 generations. The first 25% of sampled trees were discarded as burn-in.

The newly generated *Rhodocollybia* sequences were compared with those deposited in public databases (GenBank, UNITE) using the BLAST search tool (Altschul et al. 1990). Identical or most similar sequences were downloaded. Sequences belonging

to the *R. maculata* (Alb. & Schwein.) Singer complex were selected as outgroup. Altogether 24 sequences were included in our final dataset. Multiple sequence alignment was done by PRANK (Löytynoja & Goldman 2005) as implemented in its graphical interface (PRANKSTER) with default settings. After manual adjustment in SeaView version 4 (Gouy et al. 2010), the alignment included 783 characters. The phylogenetically informative indels were coded following the simple indel coding algorithm (Simmons et al. 2001) with the program FastGap 1.2 (Borchsenius 2009). Adding indel characters to the nucleotide alignment of ITS sequences increases the robustness of phylogenetic analyses (Nagy et al. 2012). The final matrix including nucleotide + binary data was 829 characters in length. Bayesian inference (BI) analyses were performed with MrBayes version 3.1.2 (Ronquist and Huelsenbeck 2003). The nucleotide and indel characters were split into two partitions to which the GTR+G and two-state Markov model, respectively, were applied. Four Markov chains were run each for 5,000,000 generations, sampling every 100 generations. A burn-in of 12,500 trees was established. Sampled trees from both runs were combined in a 50 % majority rule consensus phylogram and posterior probabilities (BIPP) were calculated (Fig. 34). In addition, maximum likelihood (ML) analysis was carried out using RAxML version 7 (Stamatakis 2008) in raxmlGUI (Silvestro & Michalak 2012) with 1,000 bootstrap replicates under the GTRGAMMA substitution model for DNA and the default set for binary (indel) characters. The final tree was edited in MEGA7 (Kumar et al. 2016) and Adobe Illustrator CS4.

Taxonomy

Ascomycota, Laboulbeniomycetes, Laboulbeniales, Laboulbeniaceae

Cantharomyces paschalis W. Rossi & Santam., sp. nov. – Fig. 1

Mycobank no.: MB 839553

Holotypus. – CHILE. Rapa Nui Island, Maugaoa, on *Mimopaederus insularis* Cameron, 1936 (Coleoptera, Staphylinidae, Oxytelinae), 11 December 1963, leg. J.F.G. & T.M. Clarke, slide WR4370 (4 mature and 11 immature or incomplete thalli; holotype at FI).

Description. – Cells I and VI almost hyaline; the rest of the thallus yellowish brown, with a large, contrasting, dark spot on the upper, inner side of cell III and a second spot, lighter and smaller than the previous, on the ventral, lower angle of cell II. – Cell I obtrapezoidal in section, slightly longer

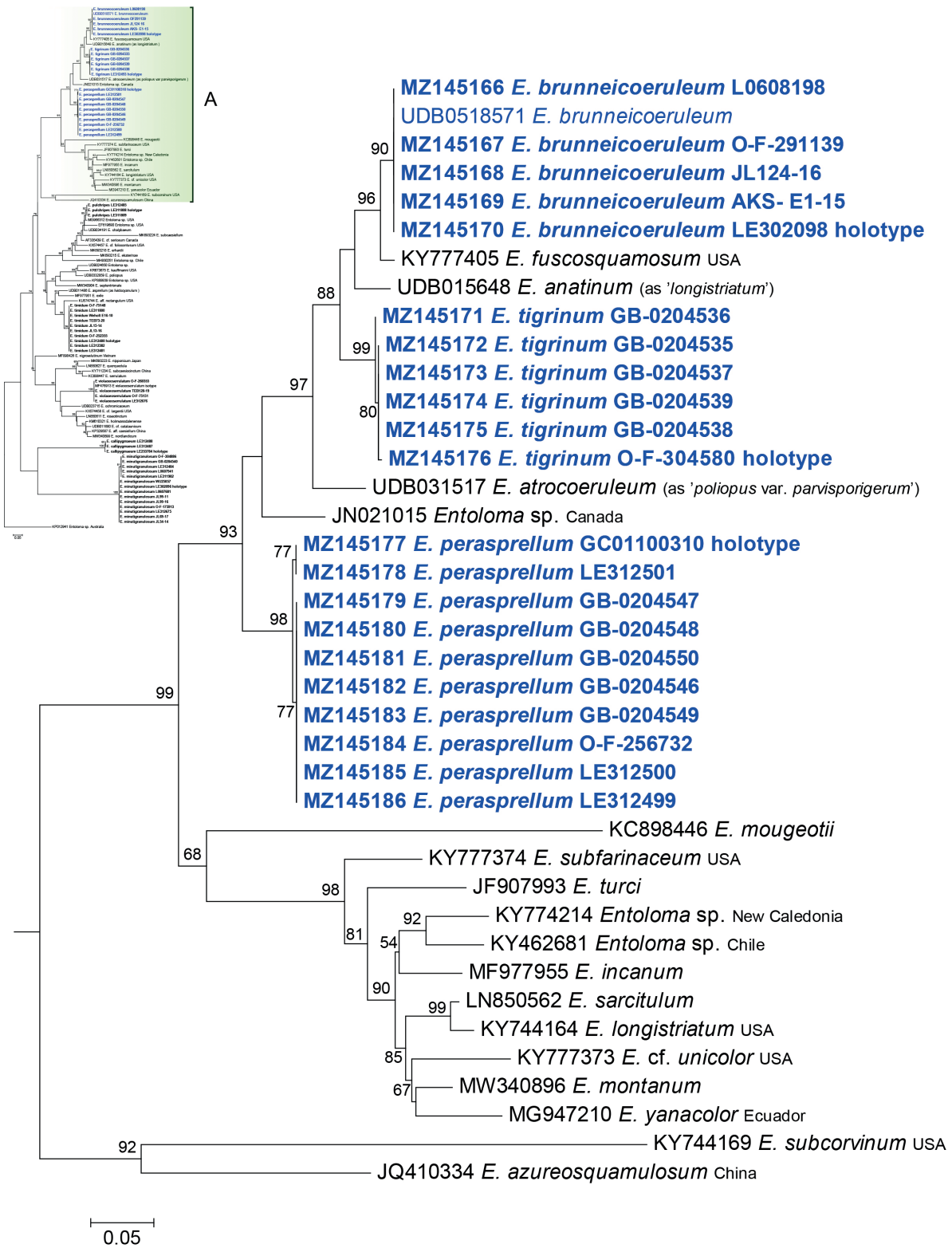


Fig. 4. Phylogeny of *Entoloma* subgen. *Cyanula*, reconstructed from an ITS dataset. The topology is the result of ML inference performed in PhyML 3.0. For each node, the SH-aLRT support value (if >50) is presented on the branch leading to that node. New species are marked in blue; newly generated sequences are highlighted in boldface; labels in smaller font size represent geographic origin except Europe. Bar indicates 0.05 expected changes per site per branch. Part A.

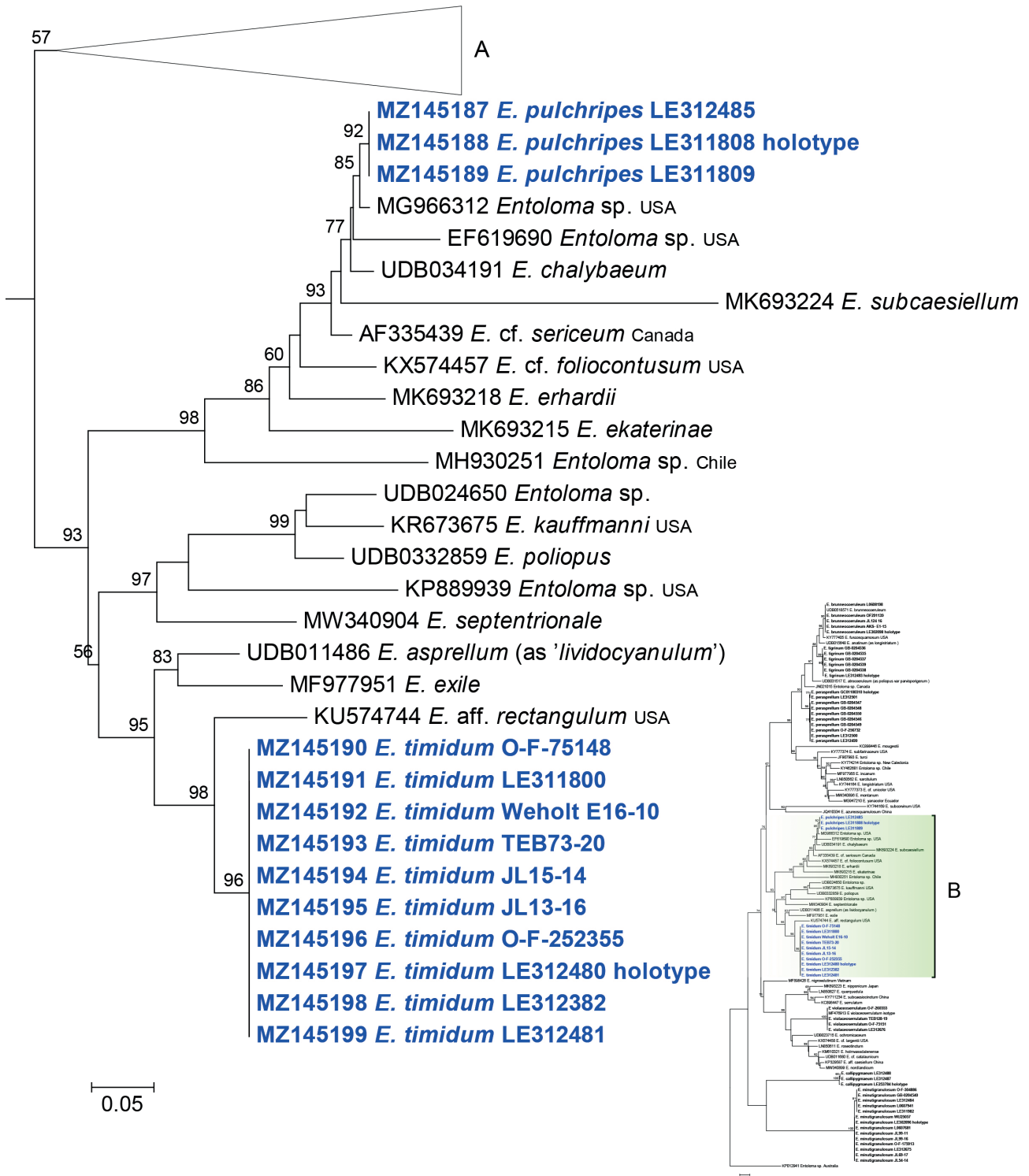


Fig. 4. Continued. Part B.

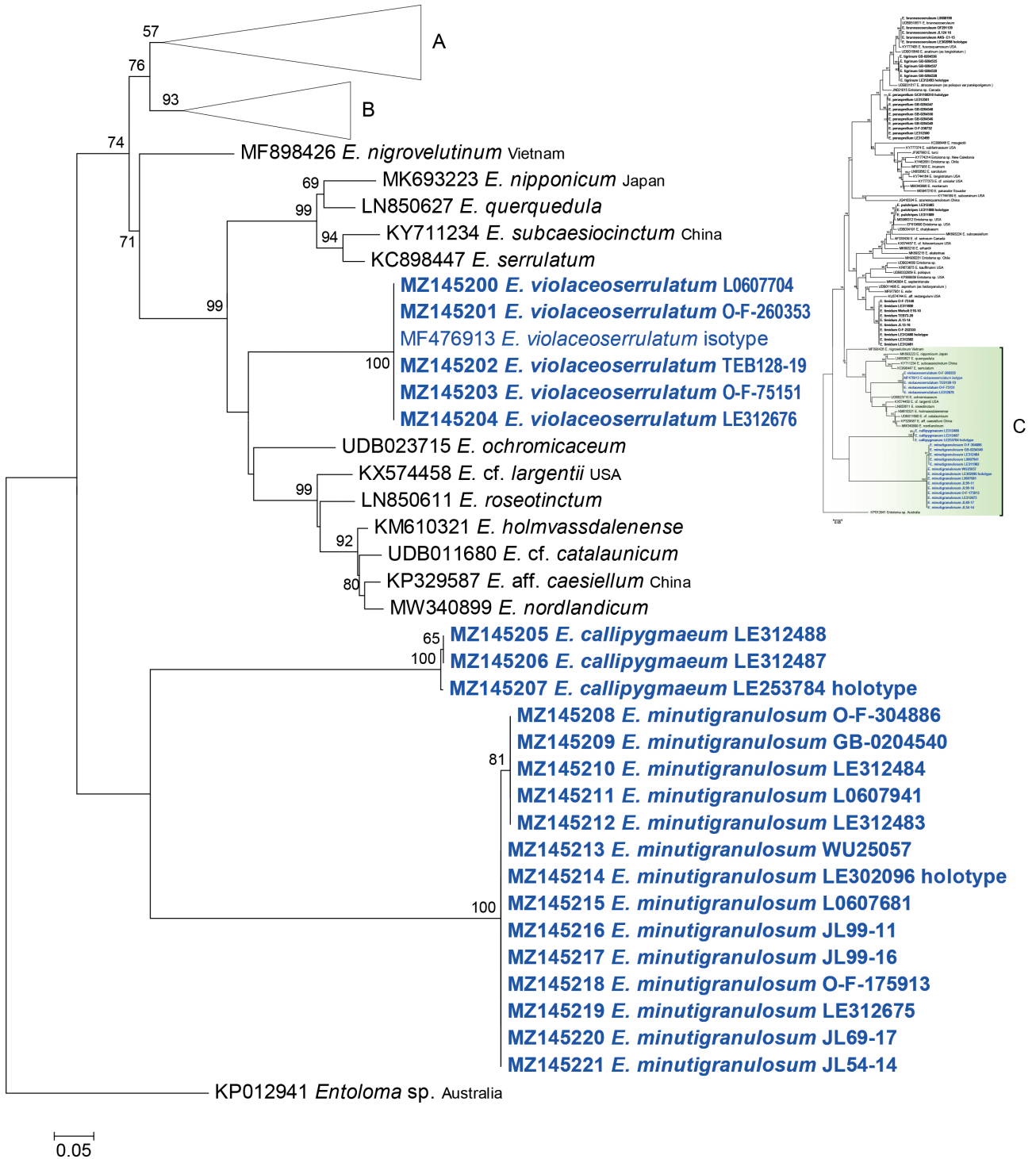


Fig. 4. Continued. Part C.



Fig. 5. *In situ* photos of the new *Entoloma* species. **A.** *Entoloma brunneicoeruleum*, collection LE302098 (holotype). **B.** *Entoloma callipygmaeum*, collection LE253784 (holotype). **C.** *Entoloma minutigranulosum*, collection LE 302096 (holotype). **D.** *Entoloma perasprellum*, collection GC01100310 (holotype). **E.** *Entoloma pulchripes*, collection LE311808 (holotype). **F.** *Entoloma tigrinum*, collection LE312493 (holotype). **G.** *Entoloma timidum*, collection LE312480 (holotype). **H.** *Entoloma violaceoserrulatum*, collection TEB 128-19. Photos O.V. Morozova (A–G), B. Dima (H).

pinguis is quite different from any other *Cryptandromyces*. It may only be compared to *C. geniculatus* Thaxt., described on *Euconnus* sp. [as *Connophron*] from Argentina (Thaxter 1931) and subse-

quently reported from China on *Euconnus* sp. (Shen & Ye 2006), which however has a laterally bent perithecium and a much longer, slender appendage.

Authors: S. Santamaria & W. Rossi

Ascomycota, Laboulbeniomyces, Laboulbeniales, Laboulbeniaceae

***Cryptandromyces tricornis* Santam. & W. Rossi, sp. nov.** – Fig. 1

MycoBank no.: MB 839566

Holotypus. – NICARAGUA. Departamento de Estelí, Mesas de Moropotente, on elytra of *Euconnus (Napochus)* sp. (Coleoptera, Staphylinidae, Scydmaeninae), pitfall trap, 23–30 August 2007, leg. P. Andrés, slide SS-E482a (holotype at BCB).

Description. – Thallus short and hyaline. – Receptacle with the basal cell broadly trapezoidal, about one and a half times longer than broad; suprabasal cell triangular or pentagonal, distinctly shorter than the previous cell. – Appendage consisting of up to ten subequal cells including the basal, slightly tapering only near the apex. – Stalk cell of the perithecium about twice longer than broad, narrower in the middle. – Perithecium asymmetrical, with the dorsal side almost straight and the ventral distinctly convex, about twice longer than maximum width, bearing apically three elongate, straight, unequal projections, the median of which is distinctly longer than the two others. – Length from foot to the tip of the longest projection 94–114 μm ; length from foot to the tip of the longest appendage 92 μm ; perithecium, including basal cells but not the apical projections 42–48 \times 20–25 μm ; longest outgrowth 26–29 μm .

Etymology. – From Latin *tria* (= three) and *cornua* (= horns), referring to the three, long, horn-like perithecial projections.

Hosts and distribution. – Only known from *Euconnus (Napochus)* sp. (Coleoptera, Staphylinidae, Scydmaeninae) in Nicaragua.

Additional material examined. – *Ibid.*, SSE475 (paratype at BCB).

Notes. – The three long and erect projections of *C. tricornis* are unique among the species of the same genus and make it possible to distinguish this new species at first glance.

Authors: S. Santamaria & W. Rossi

Basidiomycota, Agaricomycetes, Agaricales, Entolomataceae

***Entoloma brunneicoeruleum* O.V. Morozova, Noordel., Brandrud, J.B. Jordal & Dima, sp. nov.** – Figs. 5a, 6

MycoBank no.: MB 839631

Holotypus. – RUSSIA. Pskov region, Pechorsky district, eastern shore of Lake Velje, 57°38'16"N, 27°47'35"E, 90 m a.s.l., on soil in wet *Alnus-Betula* forest, 19 July 2007, leg. O. Morozova (LE 302098; holotype). Sequences ex-holotype: MZ145170 (ITS).

Description. – Basidiomata medium-sized, collybioid. – Pileus 13–30 mm in diam., conico-convex or hemispherical with more or less depressed center, soon expanding to plano-convex and appanate with slightly umbilicate center, with deflexed and then straight margin, hygrophanous, translucently striate almost up to the center, minutely radially fibrillose-squamulose all over, more densely in the center, initially greyish brown with

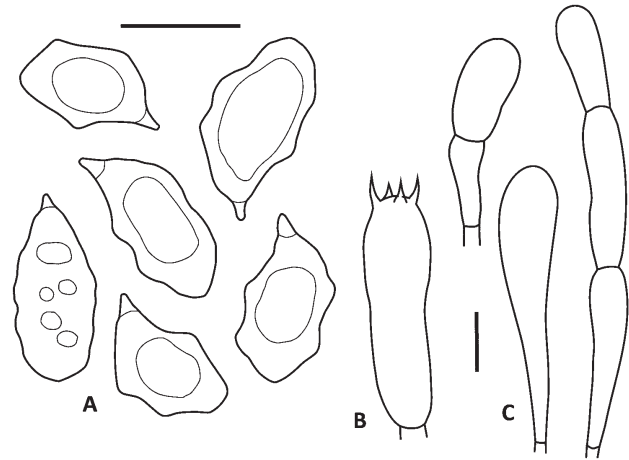


Fig. 6. *Entoloma brunneicoeruleum*, micromorphological features drawn from the holotype (LE302098). **A.** Basidiospores. **B.** Basidium. **C.** Cheilocystidia. Scale bars 10 μm , del. O.V. Morozova.

bluish or purplish tinge (17E4, 19E4–5) and only slightly darker center, then greyish-brown or yellow-brown with a darker, almost black central spot (umbilicus). – Lamellae moderately distant, emarginate or adnexed with short tooth, whitish or pale, becoming pinkish, with irregular to serrulate, concolorous edge. – Stipe 30–80 \times 1.5–3 mm, cylindrical or slightly broadened towards the base, sometimes compressed with longitudinal groove, dark blue, greyish blue, steel-blue or purplish grey (20D4–5, 20E4–6, 19D3–5), initially minutely longitudinally striate(–fibrillose), but soon smooth and polished, white tomentose at base. – Context greyish. Smell indistinct, sweetish on drying, taste not reported. – Basidiospores 10.5–16 \times 6.8–9.5 μm , average 12.0–13.0 \times 7.5–8.7, $Q=1.3$ –2.0 μm , $Q_{av}=1.4$ –1.7, heterodiametrical, of two types, (i) with 5–8 angles in side-view, (ii) or almost nodulose in some collections. – Basidia 30–45 \times 10.5–13.5 μm , 4-spored, narrowly clavate to clavate, clampless. – Lamella edge sterile or heterogeneous. – Cheilocystidia 20–30(–64) \times 8.5–11.5

µm, cylindrical or narrowly clavate, often septate, usually intermixed with basidia. – Caulocystidia absent. – Pileipellis a cutis with transition to a trichoderm of 4–16 µm wide cylindrical hyphae, with ascending, cylindrical to fusiform terminal elements 23–80 × 11–25 µm. Pigment intracellular, sometimes agglutinate, brownish in KOH. – Clamp connections absent.

Etymology. – From ‘*brunneus*’ (Latin, meaning brown), and ‘*coeruleus*’ (Latin, meaning blue), referring to the brown pileus and blue stipe.

Habitat and distribution. – In small groups on soil in damp grasslands (hayfield, pasture), *Sphagnum* bog, and damp forests with *Betula* and *Alnus*, on richer to calcareous soil. Known from Russia (European part), the Netherlands, Norway, and Estonia (from soil sample).

Additional material examined. – NORWAY. More og Romsdal, Fjord, Valldal, Heimsetra, 62°21'00.00"N, 7°20'51.72"E semi-natural grassland (pasture), 3 September 2008, leg. J.B. Jordal, O-F-291139; Nordland, Grane, Holmvassdalen Nature Reserve, 65°17'07.44"N, 13°18'48.58"E, in *Sphagnum* in old calcareous pine forest, leg. J. Lorås & M. Eidissen, JL 124-16; Rogaland, Strand, Strandalia, 59°02'33.36"N, 5°55'51.96"E, old wooded pasture with *Betula*, in *Sphagnum*, 26 July 2015, leg. A.K. Svensen, AKS E1-15. – THE NETHERLANDS. Gelderland province, Ratum, Willinks Weust, 51°57'52.93"N, 6°46'45.94"E, 19 August 2016, leg. G.M. Jansen (L-0608198).

Notes. – *Entoloma brunneicoeruleum* is characterized by the brown pileus, initially with a slight bluish or purplish tinge, dark blue to steel blue stipe, usually heterogeneous lamellae edge with undifferentiated, cylindrical or almost cylindrical cheilocystidia, and spores of two types, (i) medium sized with 5–7 normally developed angles and $Q=1.5-1.7$; (ii) large, almost nodulose with $Q=1.8-2.0$. *Entoloma brunneicoeruleum* belongs to a group of closely related, but phylogenetically well-separated species around *E. atrocoeruleum* Noordel., and may be considered an *E. atrocoeruleum* with more brownish pileus, hence the name. They also differ in basidiospore size. From the other species in this group, *E. anatinum* (Lasch) Donk and *E. perasprellum* and *E. tigrinum* (both described below), it differs by having by far the largest basidiospores. *Entoloma anatinum* differs additionally by the absence of cheilocystidia, a more distinctly fibrillose stipe, and a stouter habit. *Entoloma tigrinum* has ochre-tinged basidiocarps, and a very different pileus surface with small, granulose squamules, whereas *E. perasprellum* differs among other things by a completely sterile lamella edge of the serrulatum type. The poorly known *E. nigroviolaceum* (P.D. Orton) Hesler, with similar large basidiospores, has

more pronounced violaceous tinges, and a strongly fibrillose stipe.

Authors: B. Dima, O.V. Morozova, M.E. Noordeloos, T.E. Brandrud, J.B. Jordal, G. Corriol, G.M. Jansen, E. Larsson & J. Lorås

Basidiomycota, Agaricomycetes, Agaricales, Entolomataceae

Entoloma callipygmaeum O.V. Morozova, Noordel. & Dima, **sp. nov.** – Figs. 5b, 7

= *Entoloma gomerense* sensu Noordeloos & Morozova in Mycotaxon 112: 249 (2010).

Mycobank no.: MB 839632

Holotypus. – RUSSIA. Primorsky Territory, Kedrovaya Pad Nature Reserve, right bank of Kedrovaya River, 43°05'56"N, 131°33'21"E, on soil in flood-plain forest with *Quercus mongolica*, *Tilia amurensis*, *Acer* spp., 17 August 2005, leg. O. Morozova (LE 253784; holotype). Sequences ex-holotype: MZ145207 (ITS).

Description. – Basidiomata small, collybioid. – Pileus 7–10 mm in diam., plano-convex with depressed center, slightly hygrophanous, deeply translucently striate, ground color rather pale bluish, blue-grey or violaceous-grey, but covered with darker squamules, more dense at center, more spread towards margin; squamules and striae greyish blue, greyish purple, or greyish brown (18E5–7, 18F5–7, 20E5–7). – Lamellae adnate-emarginate with a small decurrent tooth, whitish to greyish pink with more or less serrulate blackish purple edge. – Stipe 22–35 × 1–2 mm, cylindrical, dark greyish blue (19D4–5, 19E4–5, 20D4–5), polished, glabrous, base with white tomentum. – Context concolorous with the surface, whitish in the inner part. – Smell indistinct, taste indistinct. – Basidiospores 8.5–11 × 6.5–9.0 µm, average 10.0 × 7.5 µm, $Q=1.3-1.5$, $Q_{av}=1.4$, heterodiametrical, with 5–6 angles in side view. – Basidia 22–32 × 8–13 µm, clavate to elongate, clampless. – Lamella edge sterile. – Cheilocystidia 20–85 × 11–22 µm, broadly clavate or lageniform, including those with a rather long neck, but in some specimens, only clavate cystidia present, with dark intracellular pigment. – Pileipellis a cutis with transition to a trichoderm with inflated, narrowly clavate or elongated terminal cells 45–70 × 12–20 µm, with intracellular pigment. – Clamp connections absent.

Etymology. – From Greek ‘*κάλλος*’ (beauty) and ‘*πυγμαίος*’ (dwarfish), referring to the nice color and small size of basidiomata.

Habitat and distribution. – Saprotrophic on soil, among living mosses and on decayed

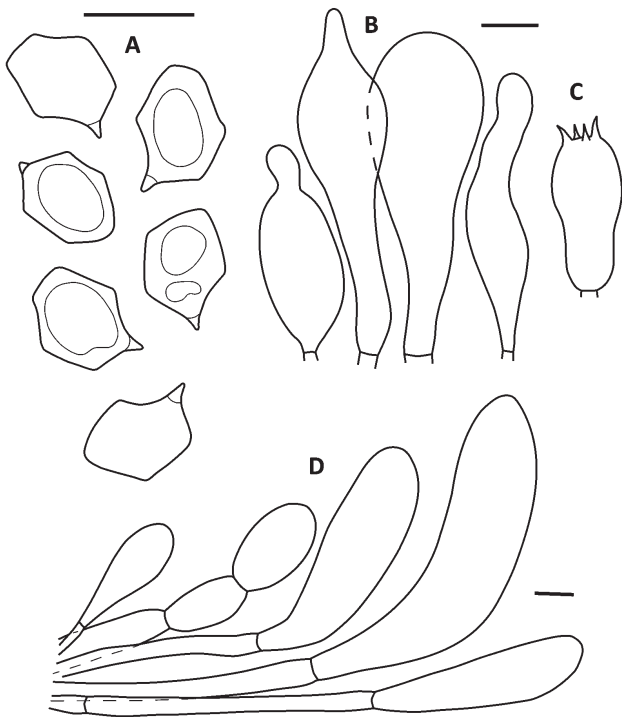


Fig. 7. *Entoloma callipygmaeum*, micromorphological features drawn from the holotype (LE253784). **A.** Basidiospores. **B.** Cheilocystidia. **C.** Basidium. **D.** Pileipellis. Scale bars 10 μm , *del.* O.V. Morozova.

wood in floodplain forests. Thus far only been recorded from the Russian Far East (Primorski Territory).

Additional material examined.—RUSSIA. Primorski Territory, Sikhote-Alin Nature Reserve, vicinities of Maisa, on living mosses in the road in mixed forest of *Quercus mongolica*, *Acer mono*, *Tilia amurensis*, *Pinus koreana*, 45°14'19.80"N, 136°30'40.02"E, 22 August 2013, *leg.* O. Morozova (LE 312487); *Ibid.*, along stream, in flood-plain forest of *Quercus mongolica*, *Acer mono*, *Tilia amurensis*, *Pinus koreana*, 27 August 2013, *leg.* O. Morozova (LE 312488).

Notes.—The tiny violaceous or blue basidiocarps with deeply striate pileus and purplish serrulate lamella edge are reminiscent of *E. gomerense* Wölfel & Noordel., a Mediterranean species with a slightly different pileus surface, and smaller, simple basidiospores. It is also similar to *E. cyanulum* (Lasch) Noordel., which, however, never has a blue-purple serrulate lamella edge. Phylogenetically the closest species is *E. carneogriseum* (Berk. & Broome) Noordel., another species with serrulatum-type lamellae edge, which, however, has predominantly yellow-brown colored basidiomata with only traces of blue tinge near the pileus margin and in the stipe.

Authors: B. Dima, O.V. Morozova, M.E. Noordeloos, T.E. Brandrud, J.B. Jordal, G. Corriol, G.M. Jansen, E. Larsson & J. Lorås

Basidiomycota, Agaricomycetes, Agaricales, Entolomataceae

Entoloma minutigranulosum O.V. Morozova, Noordel., Brandrud & Dima, **sp. nov.** – Figs. 5c, 8 = *Entoloma ochromicaceum* sensu Morozova et al. in *Novosti Sist. Nizsh. Rast.* 49: 196 (2015). MycoBank no.: MB 839633

Holotypus.—RUSSIA. Pskov region, Pechorsky district, Izborsk village, Zmeinaya ravine, on calcareous grassland, 57°43'N, 27°51'E, 23 August 2011, *leg.* O. Morozova (LE 302096; holotype). Sequences ex-holotype: MZ145214 (ITS).

Description.—Basidiomata small, collybioid. —Pileus 10–20 mm in diam., hemispherical to convex, expanding to plano-convex, with blunt, slightly umbonate, or umbilicate center, with deflexed margin, not distinctly hygrophanous, dark yellow-brown to warm ochre-brown (5B4–6, 5C4–6), with darker center (up to 6D4), entirely minutely granulate or finely squamulose, sometimes glabrescent with age, initially not striate but becoming translucently striate with age. —Lamellae moderately distant, emarginate or adnate with a decurrent tooth, subventricose, white then pale

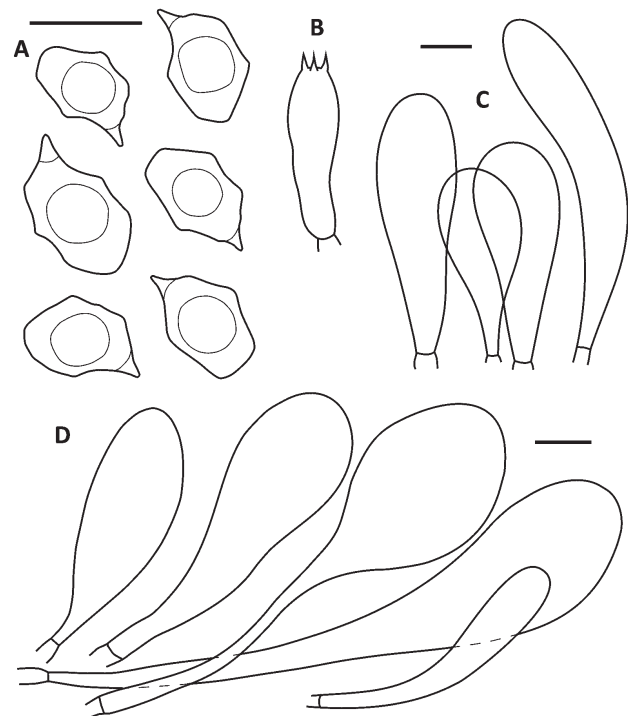


Fig. 8. *Entoloma minutigranulosum*, micromorphological features drawn from the holotype (LE 302096). **A.** Basidiospores. **B.** Basidium. **C.** Cheilocystidia. **D.** Pileipellis. Scale bars 10 μm , *del.* O.V. Morozova.

pink, with minutely serrulate, (in part) brown edge. – **Stipe** 20–50 × 2–3 mm, cylindrical or slightly broadened towards base, pale brown with distinct metallic-grey to bluish grey tinge, particularly in the lower half, which fades with age, when very young often with distinct greyish blue tinge on the entire stipe, smooth, polished, base with some white tomentum. – **Context** very thin, brittle. – **Smell and taste** inconspicuous. – **Basidiospores** 7–12 × 5.5–7.5 µm, average 10.0 × 6.5 µm, Q=1.3–1.7, Q_{av}=1.5, heterodiametrical, with 5–7 distinct angles in side-view. – **Basidia** 31–37 × 9.5–11.5 µm, 4-spored, clavate, clampless. – **Lamella edge** sterile. – **Cheilocystidia** 35–75 × 8–14 µm, clavate or narrowly clavate, sometimes septate, sometimes with brownish intracellular pigment in KOH. – **Hymenophoral trama** regular, made up of cylindrical elements, 50–160 × 5–22 µm. – **Pileipellis** a cutis with transition to a trichoderm made up of 5–12 µm wide cylindrical hyphae, and clavate, broadly clavate or sphaeropedunculate terminal elements, 40–100 × 14–45 µm, with brown granular intracellular pigment. – **Caulocystidia** absent. – **Clamp connections** absent.

Etymology. – From Latin, ‘*minutum*’ (very small) and ‘*granulosum*’, referring to the finely granulate pileus.

Habitat and distribution. – In small groups on soil on calcareous semi-natural grasslands (pastures), once also recorded from alpine heath. Known from Austria, Denmark, France, Germany, the Netherlands, Norway, Sweden, and Russia (European part and Siberia).

Additional material examined. – RUSSIA. Altay Republic, Altaiskiy Nature Reserve, cordon Chelyush, 46°07′07.97″N, 11°06′56.76″E, grassland near farm, 28 August 2018, *leg.* O. Morozova, LE 312483; *Ibid.*, LE 312484. – AUSTRIA. Vorarlberg, Lechtal, Dalaas, Tannlägeralpe, 47°09′20.91″N, 9°54′16.98″E, August 2004, *leg.* A. Hausknecht (WU25057, as *E. glaucobasis*). – GERMANY. Bayern, Lenggries, Hohenwiesen, Hohenwiesener Berg, Hochalm, 47°36′32.29″N, 11°35′11.49″E, 2 August 2014, *leg.* M. Dondl, MD-2014-7 (L0607941). – THE NETHERLANDS. Gelderland Province, Staverden, Leemputten, 52°02′40.74″N, 6°40′12.70″E, October 2019, *leg.* Finy Salzman, L0607681. – NORWAY. Finnmark, Porsanger, Kolvik N, 70°17′33.00″N, 22°06′52.20″E, calcareous seminatural pasture, 12 August 2015, *leg.* G. Gaarder, GG 7142; Nordland, Grane, Ner-Laksfors, 65°37′47.64″N, 13°16′11.64″E, calcareous meadow along the river, 14 August 2003, *leg.* G. Gaarder, GG 3568 (O-F-175913); Nordland, Grane, Holmvassdalen Nature Reserve, 65°18′52.32″N, 13°18′08.49″E, low herb vegetation in calcareous spruce forest, *leg.* J. Lorås & S. Eidissen, JL 99-11; *Ibid.*, 65°33′19.43″N, 13°45′52.18″E, JL 54-14; *Ibid.*, 65°18′57.08″N, 13°19′12.87″E, JL 99-16; Nordland, Grane, Danielåsen Nature Reserve, 65°33′11.42″N, 13°38′26.33″E, tall herb vegetation in calcareous spruce forest, *leg.* J. Lorås & S. Eidissen, JL 67-17; Oppland, Nord-Aurdal, Øystre Slidre, Skrautvål, Jordet (Bun-

dli Ø), 61°02′22.92″N, 9°12′25.92″E, calcareous pasture (shallow soil), 6 August 2016, *leg.* T.E. Brandrud & G. Gulden, TEB 121-16 (O-F-304886). – SWEDEN. Lule lappmark, Jokkmokk, Padjelanta, Ajajaure, 67°24′28.72″N, 16°44′40.94″E, alpine heath with *Betula nana* and *Salix* spp., 16 August 2016, *leg.* G. Gulden (GB-0204540).

Notes. – Typically the stipe of this species appears to be bicolored: ochre-brown at the apex, and steel-grey with a glaucous-bluish tinge at the base. This is reminiscent of *E. glaucobasis* Huijsman ex Noordel., which, however, has a distinctly fibrillose-striate stipe surface, and larger basidiospores. When very young the entire stipe can be bluish, and in such stages this species may be misidentified as *E. poliopus* var. *parvisporigerum* Noordel., but this species has a more bluish, darker pileus, and is a member of the /chalybeum clade. *Entoloma perasprellum* may appear similar, but has larger, nodulose-angled basidiospores. *Entoloma minutigranulosum* was erroneously referred to as *E. ochromicaceum* Noordel. & Liiv by Morozova et al. (2015), but the latter species lacks grey-bluish-metallic tinges in the stipe, and has larger spores (Noordeloos 1992). We note that *E. minutigranulosum* was also present in an environmental soil sample from calcareous grassland in the province of Limburg, the Netherlands (data not shown).

Authors: B. Dima, O.V. Morozova, M.E. Noordeloos, T.E. Brandrud, J.B. Jordal, G. Corriol, G.M. Jansen, E. Larsson & J. Lorås

Basidiomycota, Agaricomycetes, Agaricales, Entolomataceae

Entoloma perasprellum Corriol, Dima, Morozova, J.B. Jordal & Noordel., **sp. nov.** – Figs. 5d, 9
Mycobank no.: MB 839634

Holotypus. – FRANCE. Seine-et-Marne, Fontainebleau, near the Hippodrome de la Solle, 3 October 2001, about thirty basidiomata, *leg.* G. Corriol (GC01100310; holotype in BFF). Sequences ex-holotype: MZ145177 (ITS).

Description. – **Basidiomata** medium-sized, collybioid. – **Pileus** 10–40 mm in diam., campanulate then expanding to convex or plano-convex, usually distinctly umbilicate, with deflexed margin, which is often crenulate, and sometimes undulating-lobed, opaque, not hygrophanous, indistinctly translucently striate at first, soon clearly translucently striate, grey-blue at first, but blue tinge quickly disappearing (Mu 10YR 5/4), entirely fibrillose to squamulose, then with neat, small, grey-brown (10YR 3/3) squamules on a paler yellow-brown (10YR 3/3) background. – **Lamellae** rather distant, adnate-emarginate, white to greyish, with an irregular edge which is often brown pig-

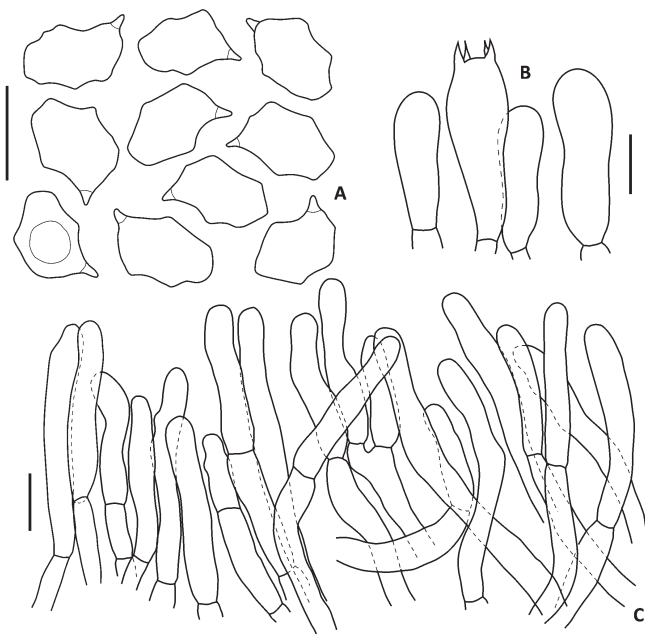


Fig. 9. *Entoloma perasprellum*, micromorphological features drawn from the holotype (GC01100310). **A.** Basidiospores. **B.** Basidium and basidioles. **C.** Lamella edge. Scale bars 10 μm , *del.* M.E. Noordeloos.

mented, but non-pigmented forms occur frequently. – **Stipe** 25–50 \times 2–5 mm, cylindrical to compressed, glabrous, polished, or with fine pruinose-fibrillose covering, when fresh often bright blue or blue-grey, quickly pallescent to pale grey or pale greyish brown, paler than pileus, with white mycelium at base. – **Context** white. – **Smell** indistinct or somewhat sweet, like flowers. – **Basidiospores** (8.9–)9.4–11.0(–12.4) \times (6.0–)6.4–7.6(–8.3) μm , average 10.0 \times 7.0 μm ; $Q = (1.25\text{--})1.30\text{--}1.60(–1.81)$, $Q_{av}=1.45$, heterodiametrical, with 6–7(–8) fairly pronounced angles, but with a tendency to be nodulose. – **Basidia** 28–40 \times 11–12 μm , cylindrical-clavate, 4-spored, clampless. – **Lamella edge** sterile. – **Cheilocystidia** 19–38 \times 3–6 μm , well-developed, subcylindrical to narrowly clavate, with brown, intracellular pigment. – **Caulocystidia** not observed. – **Pileipellis** a transition between a cutis and a trichoderm, made up of inflated-clavate terminal elements, up to 25 μm . – **Pigment** brown, intracellular. – **Clamp connections** absent.

Etymology. – Referring to the resemblance to *E. asprellum*.

Habitat and distribution. – Found mainly in calcareous alpine heaths and subalpine grasslands (pastures), but also in temperate/nemoral xerophytic grassland on base-rich sandy soil, with

Clitocybe collina (Velen.) Klán, *C. costata* Kühner & Romagn., *Lycoperdon lividum* Pers., *Marasmius oreades* (Bolton) Fr., *Hebeloma cistophilum* Maire (holotype site). Known from France, Norway, Sweden, and Russia (Caucasus and Kamchatka).

Additional material examined. – *Ibid.* (L, isotype). – NORWAY. Trøndelag, Rennebu, Joldalen, Bortstugusestra, 62°52'15.96"N, 9°32'52.80"E, seminatural pasture, 23 August 2018, *leg.* J.B. Jordal, JBJ 18–004 (O-F-256732). – RUSSIA. Karachaevo-Cherkesia Republic, Teberda Biosphere Reserve, Klukhor pass, 43°21'06.97"N, 41°41'46.22"E, ~2700 m a.s.l., on alpine grassland, 23 August 2012, *leg.* O. Morozova (LE 312501); Kamchatka Region, vicinities of Esso, near the village, 55°55'37.12"N, 158°41'04.81"E, 470 m a.s.l., in grassland, 5 August 2005, *leg.* O. Morozova (LE 312499); *Ibid.*, on hill, ~800 m a.s.l., in subalpine grassland, 5 August 2005, *leg.* O. Morozova (LE 312500). – SWEDEN. Åsele lappmark, Vilhelmina, Lasterfjället, Tjårnunjes, 65°15'27.40"N, 14°37'38.24"E, on alpine meadow on calcareous ground, 19 August 2019, *leg.* E. Larsson, EL-28-19 (GB-0204546); *Ibid.*, 65°15'27.39"N, 14°37'40.86"E, on alpine meadow on calcareous ground, 19 August 2019, *leg.* J.B. Jordal, JBJ 19-107 (GB-0204547); Åsele lappmark, Vilhelmina, Murfjället, 65°10'20.15"N, 15°08'03.97"E, on alpine heath on calcareous ground, 20 August 2019, *leg.* J.B. Jordal, JBJ 19-119 (GB-0204550); *Ibid.*, JBJ 19-122 (GB-0204548); Jämtland, Frostviken, NW slope of Raavre, 64°09'55.35"N, 17°21'17.57"E, in low alpine calcareous heath, 23 August 2019, *leg.* J.B. Jordal, JBJ 19-180 (GB-0204549).

Notes. – *Entoloma perasprellum* resembles *E. asprellum* (Fr.) Fayod, with its usually entirely finely squamulose pileus and blue-grey polished stipe. The new species differs by the almost nodulose basidiospores, and having a distinctly sterile lamella edge of the serrulatum-type. Initially, Corriol (2016) gave it the provisional name *E. cyaneoturci*, as the type specimens did have some resemblance to *E. turci* (Bres.) M.M. Moser, differing from it by the basidiospore shape and blue tinges in the basidiomata. However, now we have more collections from a rather wide geographic area, the variability appears much bigger, and the resemblance with *E. turci* is less striking. On the contrary, this new species is much more morphologically similar to *E. asprellum*, hence the name.

Authors: B. Dima, O.V. Morozova, M.E. Noordeloos, T.E. Brandrud, J.B. Jordal, G. Corriol, G.M. Jansen, E. Larsson & J. Lorås

Basidiomycota, Agaricomycetes, Agaricales, Entolomataceae

Entoloma pulchripes O.V. Morozova, Noordel., Brandrud & Dima, **sp. nov.** – Figs. 5e, 10
MycoBank no.: MB 839635

Holotypus. – RUSSIA. Tver region, Zubtsov district, 2 km SE from Mozgovo village, open place in calcareous pine forest, right bank of Derzha river, 56°12'49.90"N,

034°48'09.00"E, 11 September 2015, *leg.* O. Morozova (LE 311808; holotype). Sequences ex-holotype: MZ145188 (ITS).

Description. – Basidiomata small to medium-sized, collybioid. – Pileus 10–25 mm in diam., obtuse-conical, conico-convex or hemispherical with slightly depressed center, soon expanding to plano-convex with convex or slightly umbilicate center, with deflexed then straight margin, hygrophanous, translucently striate up to the center, minutely radially fibrillose-squamulose all over, more densely in the center, initially greyish brown (8D3, 8E3–4) with blackish-purple center, changing color with age to greyish-brown or yellowish-brown with contrasting brownish-black center, sometimes radially cracked when drying out, showing white context. – Lamellae moderately distant, adnate-emarginate, segmentiform to decurrent with short tooth, whitish, pale or greyish, becoming pinkish-grey, with irregular, more or less serrulate brown edge (sometimes almost concolor, hard to see). – Stipe 30–80 × 1.5–3 mm, cylindrical or slightly broadened towards the base, sometimes compressed with longitudinal groove, smooth, polished or minutely longitudinally striate, dark blue, greyish blue or steel-blue (20D4–5, 20E4–6), white tomentose at the base. – Context white, greyish under the surface. – Smell indistinct, sweetish on drying, taste not reported. – Basidiospores 7–11.5 × 5–7.5 μm, average 9.0 × 6.5 μm, $Q=1.3–1.6$, $Q_{av} = 1.45$, heterodiametrical, with 5–7 angles in side-view, relatively simple. – Basidia 27–34 × 10.5–11.5 μm, 4-spored, narrowly clavate to clavate, clampless. – Lamella edge sterile. – Cheilocystidia 40–90 × 16–31.5 μm, broadly clavate, vesiculose or spheropedunculate, consisting of cylindrical basal and spherical to oblong apical cells, 14–90 × 9–32 μm, often septate, with or without brown intracellular pigment in KOH. – Pileipellis a cutis with transition to a trichoderm of cylindrical 8–13 μm wide hyphae, with ascending terminal elements, 40–85 × 16–26 μm, and brownish intracellular pigment in KOH. – Caulocystidia absent. – Clamp connections absent.

Etymology. – From Latin, '*pulchrum*' (= beauty), referring to the beautifully colored stipe.

Habitat and distribution. – In small groups on soil in grasslands and calcareous pine forest. Known from Russia (European part).

Additional material examined. – RUSSIA. Tver region, Zubtsov district, 2 km SE from Mozgovo village, 56°12'49.90"N, 34°48'09.00"E, open place in calcareous pine forest, right bank of the Derzha river, 11 September 2015, *leg.* O. Morozova (LE 311809); Novgorod region, Valgay district, Valdaisky National Park, bank of Msta river, 58°16'49.19"N,

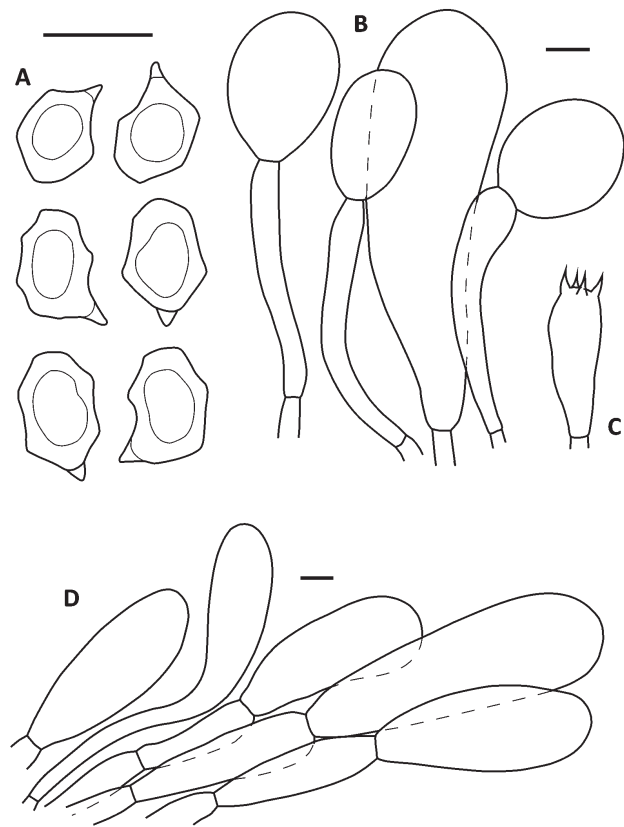


Fig. 10. *Entoloma pulchripes*, micromorphological features drawn from the holotype (LE311808). **A.** Basidiospores. **B.** Cheilocystidia. **C.** Basidium. **D.** Pileipellis. Scale bars 10 μm, *del.* O.V. Morozova.

31°03'55.39"E, calcareous grassland, 23 September 2011, *leg.* O. Morozova (LE 312485).

Notes. – *Entoloma pulchripes* is characterized by the brown pileus, sometimes having a minute purplish tinge; dark blue to steel blue stipe; small basidiospores; and distinctive vesiculose or spheropedunculate cheilocystidia. It resembles *E. poliopus* (Romagn.) Noordel., from which it differs by the smaller basidiospores and the shape of cheilocystidia. Due to the brown lamella edge, *E. pulchripes* could be mistaken for *E. brunneiserrulatum* Eyssart. & Noordel., which, however, is distinguished by the brown stipe, large basidiospores, and elongate terminal cells of cheilocystidia. *Entoloma sodale* Kühner & Romagn. ex Noordel., a species with subglobose and spheropedunculate cheilocystidia, differs by the warm brown color of the pileus and larger basidiospores. According to our phylogenetic analysis (Fig. 4), the closest related species is *E. chalybaeum* (Pers.) Noordel. However, this species differs by its dark blue pileus (vs. brown pileus

in *E. pulchripes*). One sequence from California, USA (GenBank accession no. MG966312, MushroomObserver.org/240552) is very close to *E. pulchripes*, sharing 99% identity. This potential conspecificity needs to be studied further.

Authors: B. Dima, O.V. Morozova, M.E. Noordeloos, T.E. Brandrud, J.B. Jordal, G. Corriol, G.M. Jansen, E. Larsson & J. Lorås

Basidiomycota, Agaricomycetes, Agaricales, Entolomataceae

Entoloma tigrinum Noordel., O.V. Morozova, Brandrud, J.B. Jordal & Dima, **sp. nov.** – Figs. 5f, 11
MycoBank no.: MB 839636

Holotypus. – NORWAY. Nordland, Steinkjer, Kvamsfjellet north of Lystjørna (Vesterolsenget), 64°12'46.08"N, 11°49'03.72"E, edge of rich fen, 20 August 2016, *leg.* M.E. Noordeloos, O. Morozova & J.B. Jordal (O-F-304580; holotype). Sequences ex-holotype: MZ145176 (ITS).

Description. – Basidiomata small, collybioid. – Pileus 14–20 mm, convex, expanding, umbilicate, with deflexed to straight margin, hygrophanous, background colour rather vivid ochre-brown (“golden”) to brown, covered with fine, darker sepia to blackish brown dots and radially arranged squamules, densest at the center, obscurely translucently striate up to half the radius or to umbilicus, – Lamellae L=34–40, l=1–5, moderately distant, adnate, slightly emarginate with a decurrent tooth, whitish, turning pale pink, with an entire, concolorous edge. – Stipe 30–50 × 2–4 mm, cylindrical, pale ochre brown or greyish brown, much paler than the pileus, polished or innately fibrillose, with white basal mycelium, rarely slowly staining reddish at the base. – Context pale. – Smell indistinct, taste not reported. – Basidiospores 10–13 × 7.0–8.5 µm, average 11.0 × 7.8 µm, Q=1.3–1.7, Q_{av}=1.5; heterodiametrical, 5–8-angled in side-view. – Basidia 35–52 × 10–13 µm, clavate, 4-spored, clampless. – Lamella edge fertile. – Cheilocystidia absent. – Hymenophoral trama regular, made up of cylindrical to inflated elements, up to 25 µm wide. – Pileipellis a hymeniderm of broadly clavate, broadly fusiform or ellipsoid terminal elements, 50–130 × 10–28(–50) µm. – Pigment brown, intracellular, diluted and in the form of golden brown granules. – Pileitrama of cylindrical to inflated hyphae, up to 23 µm wide with abundant brilliant granules. – Stipitipellis a cutis of cylindrical 4–8 µm wide hyphae, with a few sub-clavate terminal 7–12 µm wide endings, with brown, hyaline, intracellular pigment. – Clamp connections absent.

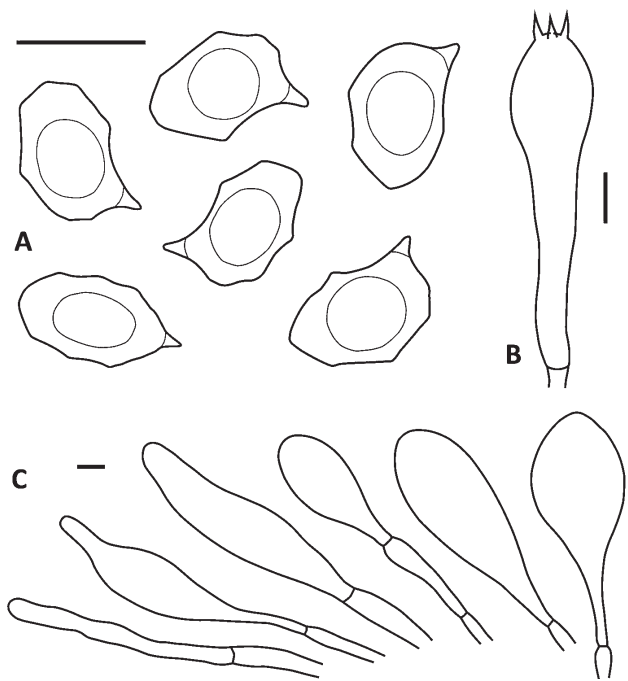


Fig. 11. *Entoloma tigrinum*, micromorphological features drawn from the holotype (LE312493). **A.** Basidiospores. **B.** Basidium. **C.** Pileipellis. Scale bars 10 µm, *del.* O.V. Morozova.

Etymology. – Referring to the resemblance of the pileal surface to that of *Lentinus tigrinus*.

Habitat and distribution. – Calciphilous, terrestrial in alpine meadows and heaths, but also in calcareous fen in a rather open *Picea* forest. Thus far only reported from northern Norway and Swedish Lapland.

Additional material examined. – *Ibid.* (LE 312493; isotype). – SWEDEN. Lule lappmark, Jokkmokk, Padjelanta, Arranoaijvve, 66°36'19.46"N, 19°49'46.78"E, on alpine heath on calcareous ground, 11 August 2016, *leg.* J. Olsson (GB-0204539); *Ibid.*, Vielggisbakke, 66°36'19.46"N, 19°49'46.78"E, on alpine meadow on calcareous soil, 12 August 2016, *leg.* J. Olsson (GB-0204538); Åsele lappmark, Vilhelmina, Lasterfjället, Tjårnunjes, 64°09'55.47"N, 17°19'11.50"E, on alpine heath on calcareous ground, 19 August 2019, *leg.* J.B. Jordal, JBJ 19-109 (GB-0204537); *Ibid.*, Murfjället, 65°10'20.15"N, 15°08'03.97"E, on alpine heath on calcareous ground, 20 August 2019, *leg.* J.B. Jordal, JBJ 19-128 (GB-0204536); Pite lappmark, Arjeplog, NE side of Mt. Ákháris, 66°02'45.45"N, 17°50'23.73"E, on alpine heath calcareous soil, 14 August 2018, *leg.* E. Larsson, EL156-18 (GB-0204535).

Notes. – *Entoloma tigrinum* is distinctive because of the warm ochre-brown pileus with darker greyish brown center, which often has a granulose-squamulose surface alternating with lighter patches—resembling a bit the pileal surface of *Lentinus tigrinus* (Bull.) Fr., and the fertile lamella edge. It is reminiscent of *E. leochromus* Noordel. & Liiv, a

more or less similarly colored species with fertile lamella edge. However, this species is phylogenetically distant. *Entoloma minutigranulosum* has a similarly colored pileus, but differs in having glaucous to blue tinges in the stipe and a sterile lamella edge.

Authors: B. Dima, O.V. Morozova, M.E. Noordeloos, T.E. Brandrud, J.B. Jordal, G. Corriol, G.M. Jansen, E. Larsson & J. Lorås

Basidiomycota, Agaricomycetes, Agaricales, Entolomataceae

Entoloma timidum O.V. Morozova, Noordel., Brandrud, J.B. Jordal & Dima, *sp. nov.* – Figs. 5g, 12
MycoBank no.: MB 839637

Holotypus. – RUSSIA. Karachaevo-Cherkesia Republic, Teberda Nature Reserve, near Teberda town, on grassland in broad-leaved forest, 43°26'19.92"N, 41°43'52.20"E, 1350 m a.s.l., 21 August 2012, *leg.* O. Morozova (LE 312480; holotype). Sequences ex-holotype: MZ145197 (ITS).

Description. – Basidiomata small, collybioid. – Pileus 15–35 mm in diam., abruptly conical or hemispherical, then expanding to conico-convex, convex, and plano-convex with slightly depressed center, with deflexed then straight margin, hygrophanous, translucently striate up to the center, minutely squamulose, more densely in center, typically pallid; pale beige, yellowish brown, or pale grey with a darker central spot (4A2–3, 5B3–4, 5C3–4), initially often almost whitish towards margin. – Lamellae moderately distant, adnate-emarginate, decurrent with a tooth or arcuate, white, becoming pale or pinkish, with a concolorous entire edge. – Stipe 20–70 × 1.5–3 mm, cylindrical or slightly broadened towards the base, sometimes compressed with longitudinal groove, smooth, polished, either entirely pale beige or greyish, or with distinct greyish blue tinge, then often discoloring to beige with age, especially in upper part, white tomentose at the base. – Context white, under the surface beige. – Smell indistinct, taste not reported. – Basidiospores 8–11 × 5.5–8 µm, average 9.5 × 6.5 µm, Q=1.2–1.6, Q_{av}=1.4, heterodiametrical, with 5–7 angles in side-view. – Basidia 30–39 × 9–10.5 µm, 4-spored, narrowly clavate to clavate, clampless. – Lamella edge fertile. – Cheilocystidia absent. – Hymenophoral trama regular, made up of 4–15 µm wide, cylindrical hyphae. – Pileipellis a cutis of cylindrical 5–10 µm wide hyphae, with transition in the center to a trichoderm of chains of inflated cells with cylindrical, inflated or clavate terminal elements, 30–75 × 10–17 µm, and yellow-brown intracellular pigment

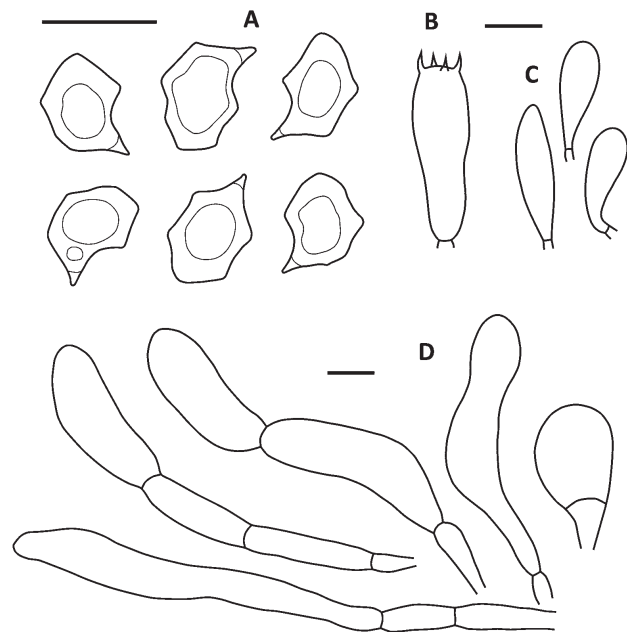


Fig. 12. *Entoloma timidum*, micromorphological features drawn from the holotype (LE312480). **A.** Basidiospores. **B.** Basidium. **C.** Cheilocystidia. **D.** Pileipellis. Scale bars 10 µm, *del.* O.V. Morozova.

in KOH. – Caulocystidia as ascending bundled cylindrical to slightly inflated cells, 23–28 × 5–7 µm. – Clamp connections absent.

Etymology. – From Latin, ‘*timidus*’ meaning modesty, referring to the tender habitus and expressionless colors of basidiomata, especially the greyish-beige stem.

Habitat and distribution. – In small groups in semi-natural grasslands and margins of rich to calcareous *Tilia-Fraxinus-Corylus* and *Picea* forests. Known from Norway and Russia (European part and Caucasus).

Additional material examined. – RUSSIA. Tver region, Staritsa district, vicinities of the Krutitsy village, bank of Volga River, 56°34'22.49"N, 33°36'25.48"E, in grassland, 10 September 2015, *leg.* O. Morozova (LE 311800); Karachaevo-Cherkesia Republic, Teberda Nature Reserve, near Teberda town, 43°26'19.92"N, 41°43'52.20"E, in grassland in broad-leaved forest, 1350 m a.s.l., 6 August 2009, *leg.* O. Morozova (LE 312481); *Ibid.*, foot of a waterfall on the western slope of Mount Kelbashi, 56°52'03.71"N, 35°54'56.47"E, in grassland, 1450 m a.s.l., 25 August 2012, *leg.* O. Morozova (LE 312482). – NORWAY. Nordland, Grane, Holmvassdalen Nature Reserve, 65°31'57.59"N, 13°43'33.64"E, tall herb vegetation in calcareous spruce forest, *leg.* J. Lorås, JL 15-14; Nordland, Grane, Danielåsen Nature Reserve, 65°33'11.42"N, 13°38'26.33"E, tall herb vegetation in calcareous spruce forest, *leg.* J. Erlandsen & M. Eidissen, JL 13-16; Oppland, Lunner, S. Oppdalen, Amundrud, 60°17'39.84"N, 10°40'48.72"E, ~450 m a.s.l., on calcareous, semi-natural (mown) meadow, 19 August 2014, *leg.* T.E. Brandrud (O-F-75148); Troms, Senja,

Lenvik, Senja familiepark, Gressmyrbotn, 69°17'07.08"N, 17°53'43.44"E, 80 m a.s.l., in base rich semi-natural pasture, 31 August 2011, *leg.* J.B. Jordal (O-F-252355); Telemark, Kragerø, Grønnåsliane, 58°52'19.39"N, 9°19'48.47"E, 8 August 2020, rich *Tilia-Fraxinus* forest, near ditch, *leg.* T.E. Brandrud, TEB 73-20; Trøndelag, Steinkjer, Egge church, 64°01'26.04"N, 11°28'26.76"E, rich lawn of churchyard, 23 August 2016, *leg.* Ø. Weholt, OW E10-16.

Notes. – *Entoloma timidum* is characterized by the rather anonymous pale yellowish-brown to beige pileus, greyish-beige polished stipe, rather small basidiospores with 5–7 distinct angles, and the lack of cheilocystidia. Some collections have a bluish-grey tinge in the stipe, particularly when young, at which time the species can be confused with the phylogenetically distant *E. lividocyanulum* (Kühner) Noordel. It is very likely that this species has been described by Ludwig (2007) as *E. mutabilipes* f. *acystidiatum* E. Ludw. *Entoloma mutabilipes* Noordel. & Liiv differs by the (partly) sterile lamella edge and slightly smaller basidiospores (Noordeloos 1992). *Entoloma timidum* might also in certain stages resemble *E. ochromicaceum* Noordel. & Liiv, but this species has a sterile lamellar edge with well-developed cheilocystidia.

Authors: B. Dima, O.V. Morozova, M.E. Noordeloos, T.E. Brandrud, J.B. Jordal, G. Corriol, G.M. Jansen, E. Larsson & J. Lorås

Basidiomycota, Agaricomycetes, Agaricales, Entolomataceae

Entoloma violaceoserrulatum Noordel., Brandrud, Morozova & Dima, *sp. nov.* – Figs. 5h, 13
MycoBank no.: MB 839638

= *Entoloma violaceoserrulatum* Noordel. in *Entoloma* s.l., *Fungi Europaei* vol. 5a: 1038 (2004), *nom. inval.*, Art. 40.7 (Melbourne).

Holotypus. – FINLAND. Varsinais-Suomi, Archipelago National Park, Berghamn, Island of Böskar, Lönöholmen, 60°03'00.07"N, 21°46'56.97"E, 25 August 1993, *leg.* J. Vauras, JV 8329F (L; holotype).

Description. – Basidiomata medium-sized, collybioid. – Pileus 12–50 mm in diam., convex to plano-convex with slightly depressed center, with subinvolute then deflexed margin, not hygrophanous, not translucently striate, entirely velutinous or tomentose, then minutely squamulose, initially dark violet to almost violaceous black, the bluish tinges very soon fades, and then almost blackish and soon discoloring to grey-brown. – Lamellae $L = 30\text{--}40$, $l = 3\text{--}5$, moderately crowded, adnate-emarginate with decurrent tooth, ventricose, initially pure white, then pink, lamellae edge fimbriate to serrulate, usually concolorous, but

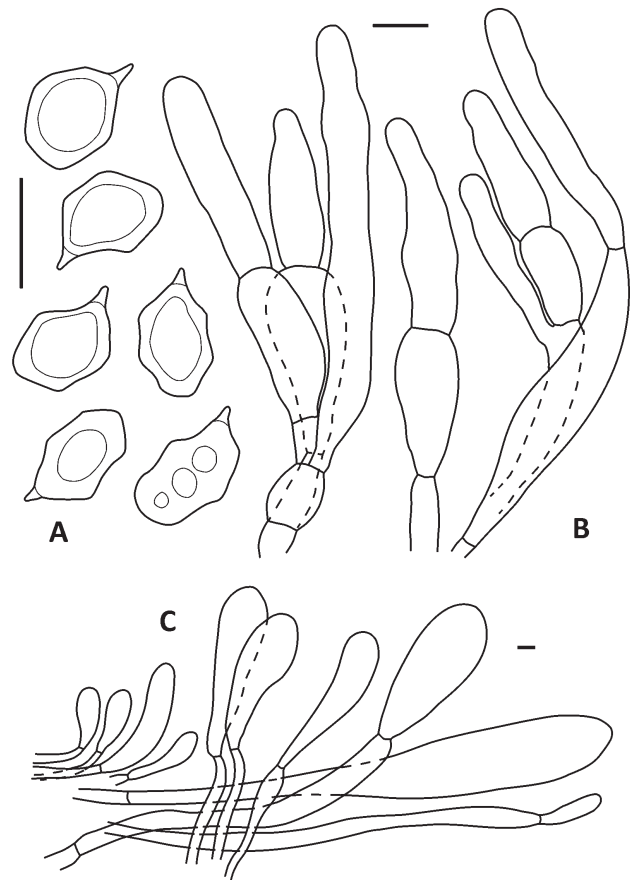


Fig. 13. *Entoloma violaceoserrulatum*, micromorphological features drawn from collection LE312676. **A.** Basidiospores. **B.** Cheilocystidia. **C.** Pileipellis. Scale bars 10 μm , *del.* O.V. Morozova.

sometimes developing bluish black, spots. – Stipe 20–45 \times 2–5 mm, cylindrical, initially silvery violaceous-grey, then discoloring more brownish grey, strongly fibrillose striate lengthwise with darker fibrils and often also minute squamules towards the apex, base with abundant white mycelium. – Context whitish to pale grey. – Smell indistinct (“leptonioid”), taste not recorded. – Basidiospores 8.5–11 \times 6.0–7.5 μm , average 8.7 \times 7.2 μm , $Q = 1.25\text{--}1.45$, $Q_{av} = 1.35$, 5–6-angled in side-view, rather regularly, relatively thin-walled. – Basidia 28–40 \times 4.0–10 μm , 4-spored, clampless. – Lamella edge sterile, of serrulatum-type, with dense clusters of cylindrical cheilocystidia (pseudocystidia), 20–50 \times 2.5–7.0 μm , thin-walled, filled with brilliant, diffractive-hyaline granules, very rarely with bluish pigment. – Hymenophoral trama regular, made up of cylindrical elements; brilliant granules very abundant in trama and in the lamellar edge. – Pileipellis a trichoderm of very

broadly clavate to vesiculose elements, 40–100 × 10–30 µm, with brown, intracellular pigment. – *Stipitipellis* a cutis of loosely arranged, cylindrical hyphae, 3.0–10 µm wide, without caulocystidia. – Clamp connections not seen with certainty.

Etymology – The name refers to the violaceous, serrulate lamellar edge, seen in the type material. Based on study of more material, this, however, appears to be a rare feature of the species.

Habitat and distribution. – Mainly recorded in calcareous grasslands, both natural and semi-natural (grazed or mown), but sometimes also in rather open, calcareous *Picea–Pinus–Betula* forests. This species seems to be northern, widely distributed in calcareous districts of Norway (north to Troms), and recorded also in Finland and Sweden. One recent record from the Netherlands was from a semi-natural grassland on calcareous, loamy-sandy soil.

Additional material examined. – *Ibid.* (TUR; isotype). Sequences ex-isotype: MF476913 (ITS). – NORWAY, Telemark, Porsgrunn, Åsstranda brygge, 59°05'36.96"N, 9°38'49.56"E, near-shore, open, dry, calcareous grassland, 10 September, *leg.* T.E. Brandrud & B. Dima, TEB 339-15 (O-F-260353); Oppland, Lunner, S. Oppdalen, Amundrud nordre, 60°17'39.84"N, 10°40'48.72"E, calcareous hayfield, 19 August 2014, *leg.* T.E. Brandrud (O-F-75151); *Ibid.*, 9 August 2019, *leg.* T.E. Brandrud & B. Dima, TEB 128-19 (O). – SWEDEN. Jämtland, Östersund, Torvalla, Ångsmoen västra, 63°08'45.24"N, 14°45'19.08"E, calcareous semi-natural formerly grazed/mown grassland, 28 August 2016, *leg.* T.E. Brandrud, LE312676. – THE NETHERLANDS. Gelderland Province, Staverden, Leemputten, 52°02'40.74"N, 6°40'12.70"E, 22 October 2019, *leg.* F. & R. Salzman (L0607704).

Notes. – Noordeloos (2004) indicated a holotype specimen for this species in both L and TUR. This is against the rules of the International Code of Nomenclature for algae, fungi, and plants (Turland et al. 2018). Therefore this *nomen invalidum* is here corrected, with a holotype specimen in L, an isotype specimen in TUR, and an emended description. *Entoloma violaceoserrulatum* phylogenetically belongs to the /serrulatum clade. Within this group, it has some aberrant characters that make it quite different from related taxa; the very dark violaceous pileus when young, which is entirely tomentose-squamulose, not translucently striate; the initially pure white lamellae; and the stipe with the same shade of color as the pileus but lighter, and distinctly fibrillose striate. Other *E. corvinum* (Kühner) Noordel. lookalikes have a completely different structure of the lamellar edge, without brilliant granules. *Entoloma mougeotii* (Fr.) Hesler has some resemblance, but it differs by the tender, grey-violaceous color, the often brown lamellar edge, with-

out brilliant granules, and slightly larger basidiospores.

Authors: B. Dima, O.V. Morozova, M.E. Noordeloos, T.E. Brandrud, J.B. Jordal, G. Corriol, G.M. Jansen, E. Larsson & J. Lorås

Ascomycota, Laboulbeniomycetes, Laboulbeniales, Laboulbeniaceae

Laboulbenia amblystomi W. Rossi & Santam., **sp. nov.** – Fig. 14

Mycobank no.: MB 839568

Holotypus. – THAILAND. Lamphun Province, Ban San Ka Yom, on elytra of *Amblystomus femoralis* (Motschulsky, 1858) (Coleoptera, Carabidae, Harpalinae), light trap, 30 October 2016, *leg.* W. Rossi, slide WR4185 (holotype at FI).

Description. – Thallus brownish gray, with paler cell V and lower portion of cell I, and with the surface of the cells of the receptacle finely dotted. – Cell I about twice longer than broad, gradually enlarging upwards. – Cell II slightly longer and distinctly broader than cell I, divided from cell III and cell VI by oblique septa, the latter of which is usually longer and more concave. – Cell III slightly broader than long. – Cell IV similar to cell III. – Cell V small and wedge-shaped. – Outer appendage simple and very long when unbroken, consisting of a basal cell isodiametric in outline, followed by gradually longer cells which start tapering from the fourth cell, and with the third and fourth cells usually darker; the upper, outer portion of the third cell shows a very small spinous process, the remnant of the ascospore apex; additional branches can be produced if the main branch has been broken (Fig. 14C). – Inner appendage with the basal cell much smaller than the outer one, bearing two short cells, each apically producing a short, simple branch and two grayish antheridia, the latter replaced by short branchlets in older thalli. – Cell VI from isodiametric to distinctly broader than long. – Perithecium oblong, about twice longer than broad, with a broad, blackish tip not well distinguished except by its color, the hyaline apex obliquely directed outwards consisting of rounded, hardly protruding, hyaline lips. – Length from foot to perithecial apex 115–120 µm; length from foot to tip of longest appendage 295 µm; perithecium 49–50 × 22–24 µm.

Etymology. – Referring to the host genus, *Amblystomus*.

Hosts and distribution. – On species of *Amblystomus* (Coleoptera, Carabidae, Harpalinae) in Italy, Spain, and Thailand.

coding to pairwise comparison of the ITS region of *R. asema* and *R. butyracea* sequences, they differ from each other by 12 nucleotide positions. Furthermore, there are two remarkable gap regions (deletions of 14 and 11 positions) observed in the ITS1 of *R. asema* where *R. butyracea* has an insertion in these parts. Thus, the difference between the two species in terms of nucleotide and indel positions is 5.5 %. Both our BI and ML analyses indicate that the sequences of *R. butyracea* and *R. asema* form two distinct and phylogenetically strongly supported clades (BIPP=1.00, MLBS=100). Based on these morphological, ecological, and molecular phylogenetic data, we propose to elevate the variety “*asema*” to species level in the genus *Rhodocollybia*.

Authors: B. Dima & E. Bendiksen

Acknowledgements

The work of B. Dima was supported by the ÚNKP-20-4 New National Excellence Program of the Ministry for Innovation and Technology from the source of the National Research, Development and Innovation Fund, and by the ELTE Thematic Excellence Programme 2020 supported by the National Research, Development and Innovation Office of Hungary (TKP2020-IKA-05). The *Cantharomyces*, *Cryptandromyces*, and *Laboulbenia* authors are grateful to the following entomologists for supplying and/or identifying insects bearing Laboulbeniales: P. Andrés, M. Baehr[†], G. Franzini, P. Magrini, G. Makranczy, and C. Okeefe. The Nicaraguan insects hosting *Cryptandromyces pinguis* and *C. tricornis* were collected during the project “Evaluación social multicriterios para la gestión sostenible y la conservación del Paisaje Protegido Miraflores-Moropotente” (2006–2010) funded by the Agencia Catalana para la Cooperación al Desarrollo (ACCD) and the Fundació Autònoma Solidaria (FAS) of the Universitat Autònoma de Barcelona. The *Cortinari* study received support from Trabzon University (TAP: 20TAP00123). E. Sesli is grateful to Serkan Örtücü (ECOTECH Biotechnology Research Development Company, Erzurum, Turkey) for the molecular work, to Pablo Alvarado (ALVALAB, Santander, Spain) for performing phylogenetic analyses, and Kare Liimatainen (Jodrell Laboratory, Royal Botanic Gardens, Kew, UK) for comments about the sequences. The *Entoloma* authors acknowledge the Kits van Waveren Foundation, Leiden, Netherlands for travel grants to M. Noordeloos and substantially supporting the sequencing of types and critical taxa. The Norwegian *Entoloma* and *Rhodocollybia* studies received funding from the Norwegian Biodiversity Information Center (NBIC), and the material was sequenced through NorBOL (<https://www.norbol.org/>) and ALVALAB. Thanks are due to Katriina Bendiksen, Gunhild Marthinsen (Natural History Museum, University of Oslo, Norway), and Pablo Alvarado (ALVALAB) for the barcoding work. The study of O.V. Morozova was conducted in the framework of a research project of the Komarov Botanical Institute of the Russian Academy of Sciences (no. AAAA-A19-119020890079-6) using equipment of its Core Facility of Cell and Molecular Technologies in Plant Science. The *Suillus* authors are grateful to the Higher Education Commission of Pakistan for financial support. The *Melanostilospora* authors are thankful to Cvetomir M. Denchev (Institute of Biodiversity

and Ecosystem Research, Bulgarian Academy of Sciences, Sofia, Bulgaria) for providing a specimen of *M. ari* for morphological comparison and for critically reviewing a draft manuscript. The *Neopestalotiopsis* authors would like to thank Abhijit Roy (University Science Instrumentation Center, Burdwan University, India) for technical assistance. The *Phytophythium* authors are indebted to “Instituto Florestal” for the collecting permit; “Fundação de Amparo à Pesquisa do Estado de São Paulo (FAPESP) for financial support to S.C.O. da Paixão (process no. 2016/18787-5), D.R.S. Colombo (process no. 2018/05602-2), and C.L.A. Pires-Zotarelli (process no. 2016/11146-4); and Conselho Nacional de Desenvolvimento Científico e Tecnológico (CNPq) for the grant given to C.L.A. Pires-Zotarelli (process no. 304091/2018-9). The *Pluteus* authors would like to acknowledge the financial support of Isparta University of Applied Sciences and Tokat Gaziosmanpaşa University Scientific Research Projects Coordination Unit (project no. 2020/56). D. Haelewaters receives support from the Research Foundation – Flanders (junior postdoctoral fellowship 1206620N).

References

- Abdelzaher H.M.A., Mostafa S.M.N., Al-Sheikh H. (2020) The genus *Pythium* from three different continents. In: *Pythium: Diagnosis, Diseases and Management* (eds. Rai M., Abd-El Salam K.A., Ingle A.P.). Taylor & Francis, Boca Raton, FL: 15–29.
- Adedokun O.M., Kyalo M., Gnonlonfin B., Wainaina J.G., Skilton R., Harvey J. (2016) Mushroom: molecular characterization of indigenous species in the Niger Delta Region of Nigeria. *European Journal of Horticultural Science* **81**: 273–280.
- Ahmad H., Öztürk M., Ahmad W., Khan S.M. (2015) Status of natural resources in the uplands of the Swat Valley, Pakistan. In: *Climate change impacts on high altitude ecosystems* (eds. Öztürk M., Hakeem K.R., Faridah-Hanum I., Efe R.), Springer International Publishing, Cham: 49–98.
- Ali S. I., Qaiser M. (1986) A phytogeographical analysis of the phanerogams of Pakistan and Kashmir. *Proceedings of the Royal Society of Edinburgh B* **89**: 89–101.
- Alimadadi N., Pourianfar H.R., Amoozegar M.A., Zabihi S.S., Mahdizadeh V., Shahzadeh Fazeli S.A. (2019) Molecular identification of some wild medicinal macrofungi from Northern Iran. *Studies in Fungi* **4**(1): 26–36.
- Altschul, SF, Gish W, Miller, W, Myers EW, Lipman DJ, 1990. Basic local alignment search tool. *Journal of Molecular Biology* **215**(3): 403–410.
- Antonín V., Noordeloos M.E. (1997) A monograph of *Marasmius*, *Collybia* and related genera in Europe. Part 2: *Collybia*, *Gymnopus*, *Rhodocollybia*, *Crinipellis*, *Chaetocalathus*, and additions to *Marasmiellus*. *Libri Botanici* **17**: 1–256.
- Bala K., Robideau G.P., Lévesque C.A., de Cock A.W.A.M., Abad Z.G., Lodhi A.M., et al. (2010) Fungal Planet 49. *Phytophythium* Abad, de Cock, Bala, Robideau & Lévesque, gen. nov. and *Phytophythium sindhum* Lodhi, Shahzad & Lévesque, sp. nov. *Persoonia* **24**: 136–137.
- Ballarà J., Mahiques, R., Garrido-Benavent I. (2016) Study of Cortinariaceae of the Cadi-Moixero Natural Park (III). *Moixero* **8**: 20–52.
- Banerjee A., Rana D. (2019) Leaf spot disease of *Syzygium cumini* caused by *Neopestalotiopsis clavisporea* newly reported in India. *Plant Disease* **104**(4): 1255.

- Baptista F.R., Pires-Zottarelli C.L.A., Rocha M., Milanez A.I. (2004) The genus *Pythium* Pringsheim from Brazilian cerrado areas, in the state of São Paulo, Brazil. *Revista Brasileira de Botânica* **27**(2): 281–290.
- Baten M.A., Asano T., Motohashi K., Ishiguro Y., Rahman M.Z., Inaba S., et al. (2014) Phylogenetic relationships among *Phytopythium* species, and re-evaluation of *Phytopythium fagopyri* comb. nov., recovered from damped-off buckwheat seedlings in Japan. *Mycological Progress* **13**(4): 1145–1156.
- Baten M.A., Mingzhu L., Motohashi K., Ishiguro Y., Rahman M.Z., Suga H., Kageyama K. (2015) Two new species, *Phytopythium iriomotense* sp. nov. and *P. aichiense* sp. nov., isolated from river water and water purification sludge in Japan. *Mycological Progress* **14**: 2.
- Bauer R., Lutz M., Piątek M., Vánky K., Oberwinkler F. (2007) *Flamingomyces* and *Parvulago*, new genera of marine smut fungi (Ustilaginomycotina). *Mycological Research* **111**(10): 1199–1206.
- Benfradj, N., Migliorini D., Lucchi N., Santini A., Boughalleb-M'Hamdi N. (2017) Occurrence of *Pythium* and *Phytopythium* species isolated from Citrus trees infected with gummosis disease in Tunisia. *Archives of Phytopathology and Plant Protection* **50**(5–6): 286–302.
- Benjamin R.K. (1971) Introduction and supplement to Roland Thaxter's contribution towards a monograph of the Laboulbeniaceae. *Bibliotheca Mycologica* **30**: 1–155.
- Bennett R.M., Nam B., Dedeles G.R., Thines M. (2017) *Phytopythium leanoi* sp. nov. and *Phytopythium dogmae* sp. nov., *Phytopythium* species associated with mangrove leaf litter from the Philippines. *Acta Mycologica* **52**(2): 1103.
- Bessette A., Roody W.C., Bessette A.R. (2000) *North American boletes: a color guide to the fleshy pored mushrooms*. Syracuse University Press, New York, NY.
- Bidaud A., Moëgne-Loccoz P., Reumaux P. (1997) *Atlas des Cortinaires, Les Cortinaires Hinnuloides*. Fédération Mycologique Dauphiné-Savoie, La Roche-sur-Foron.
- Bidaud A., Moëgne-Loccoz P., Reumaux P., Carteret X. (2006) *Atlas des Cortinaires*. Fédération Mycologique Dauphiné-Savoie, La Roche-sur-Foron.
- Blackwell M., Haelewaters D., Pfister D.H. (2020) Laboulbeniomyces: Evolution, natural history, and Thaxter's final word. *Mycologia* **112**(6): 1048–1059.
- Borchsenius F. (2009) FastGap 1.2. Department of Bio-sciences, Aarhus University, Denmark. http://www.aubot.dk/FastGap_home.htm (accessed 21 April 2021).
- Borrero C., Castaño R., Avilés M. (2018) First report of *Pestalotiopsis clavispota* (*Neopestalotiopsis clavispota*) causing canker and twig dieback on blueberry bushes in Spain. *Plant Disease* **102**(6): 1178.
- Bouket A.C., Babai-Ahari A., Arzanlou M., Tojo M. (2016) Morphological and molecular characterization of *Phytopythium litorale* and *Pp. oedochilum* from Iran. *Nova Hedwigia* **102**(1–2): 257–270.
- Breitenbach J., Kränzlin F. (2000) *Fungi of Switzerland Vol. 5, Agarics Part 3*. Verlag Mykologia, Luzern.
- Capella-Gutiérrez S., Silla-Martínez J.M., Gabaldón T. (2009) TrimAl: a tool for automated alignment trimming in large-scale phylogenetic analyses. *Bioinformatics* **25**: 1972–1973.
- Carriconde F., Gardes M., Bellanger J.-M., Letellier K., Gigante S., Gourmelon V., et al. (2019) Host effects in high ectomycorrhizal diversity tropical rainforests on ultramafic soils in New Caledonia. *Fungal Ecology* **39**: 201–212.
- Carvalho P.C.T. (1965) Microorganismos do solo associados as podridões dos toletes de cana-de-açúcar. *Revista Agrícolas* **40**(2): 83–94.
- Chen J.J., Feng H., Wang Y.C., Zheng X.B. (2019) *Phytopythium nanjingense* sp. nov. (Pythiaceae, Peronosporales) from southern China based on morphological and molecular characters. *Phytotaxa* **403**(3): 239–247.
- Chernomor O., von Haeseler A., Minh B.Q. (2016) Terrace aware data structure for phylogenomic inference from supermatrices. *Systematic Biology* **65**(6): 997–1008.
- Cho S.E., Kwag Y.N., Jo J.W., Han S.K., Oh S.H., Kim C.S. (2020) Macrofungal diversity of urbanized areas in southern part of Korea. *Journal of Asia-Pacific Biodiversity* **13**(2): 189–197.
- Consiglio G., Setti L. (2008) *Il Genere Crepidotus in Europa*. A.M.B. Fondazione Centro Studi Micologici, Vicenza.
- Corriol G. (2016) Algunos *Entoloma* inédits del subgenero *Leptonia*. *Errotari* **13**: 33–56.
- Corriol G., Chaduli D., Lavoise C. (2020) *Pluteus tenebromarginatus* sp. nov., une nouvelle espèce à lames bordées et épicutis hétérogène, découverte dans le sud de la France. *Bulletin de la Fédération des Associations Mycologiques Méditerranéennes* **57**: 3–13.
- Courtecuisse R., Samuels G.J., Hoff M., Rossmann A.Y., Cremers G., Huhndorf S.M., Stephenson S.L. (1996) Check-list of Fungi from French Guiana. *Mycotaxon* **57**: 1–86.
- Crous P.W., Carnegie A.J., Wingfield M.J., Sharma R., Mughini G., Noordeloos M.E., et al. (2019) Fungal Planet description sheets: 868–950. *Persoonia* **42**: 291–473.
- Crous P.W., Wingfield M.J., Burgess T.I., Hardy G.E.St.J., Gené J., Guarro J., et al. (2018) Fungal Planet description sheets: 716–784. *Persoonia* **40**: 240–393.
- Crous P.W., Wingfield M.J., Burgess T.I., Carnegie A.J., Hardy G.E.St.J., Smith D., et al. (2017) Fungal Planet description sheets: 625–715. *Persoonia* **39**: 270–467.
- Crous P.W., Wingfield M.J., Schumacher R.K., Summerell B.A., Giraldo A., Gen J., et al. (2014) Fungal plant description sheets: 281–319. *Persoonia* **33**: 212–289.
- Cunningham G.H. (1965) Polyporaceae of New Zealand. *New Zealand Department of Scientific and Industrial Research Bulletin* **164**: 1–304.
- de Cock A.W.A.M., Bala K., Rintoul T.L., Robideau G.P., Abad Z.G., Lodhi A.M., et al. (2015) Molecular phylogeny and new combinations for the genus *Phytopythium*. *Persoonia* **34**: 25–39.
- De Kesel A. (1989) Ontogeny of *Laboulbenia slackensis* Picard & Cépède (Ascomycetes). *Bulletin de la Société royale de botanique de Belgique* **122**: 37–46.
- De Kesel A., Gerstmann C., Haelewaters D. (2020) Catalogue of the Laboulbeniomyces of Belgium. *Sterbeekia* **36**: 3–143.
- De Kesel A., Guelly A.K., Abalo-Loko S. (2011) Laboulbeniales (Ascomycetes) from Togo. *Mycotaxa* **4**(3): 1–5.
- Denchev C.M. (2003) *Melanostilospora*, a new genus in the Urocystales (smut fungi). *Mycotaxon* **87**: 475–477.
- Dennis R.W.G. (1952) *Lepiota* and allied genera in Trinidad, British West Indies. *Kew Bulletin* **7**: 459–499.
- Dentinger B.T., Didukh M.Y., Moncalvo J.M. (2011) Comparing COI and ITS as DNA barcode markers for mushrooms and allies (Agaricomycotina). *Plos One* **6**(9): e25081.
- Derviş S., Türkölmez Ş., Çiftçi O., Özer G., Ulubaş Serçe Ç., Dikilitas M. (2020) *Phytopythium litorale*: A novel killer pathogen of plane (*Platanus orientalis*) causing canker stain and root and collar rot. *Plant Disease* **104**(10): 2642–2648.

- Dima B., Liimatainen K., Niskanen T., Kytovuori I., Bojantchev D. (2014) Two new species of *Cortinarius*, subgenus *Telamonia*, sections *Colymbadini* and *Uracei*, from Europe. *Mycological Progress* **13**(3): 867–879.
- Doyle J.J., Doyle J.L. (1987) A rapid DNA isolation procedure for small quantities of fresh leaf tissue. *Phytochemistry Bulletin* **19**: 11–15.
- Doyle J.J., Doyle J.L. (1990) Isolation of plant DNA from fresh tissue. *Focus* **12**(13): 39–40.
- Drechsler C. (1930) Some new species of *Pythium*. *Journal of the Washington Academy of Sciences* **20**: 398–418.
- Drechsler C. (1941). Three species of *Pythium* with proliferous sporangia. *Phytopathology* **31**: 478–507.
- Edgar R.C. (2004) MUSCLE: multiple sequence alignment with high accuracy and high throughput. *Nucleic Acids Research* **32**(5): 1792–1797.
- Ellis M.B. (1959) *Clasterosporium* and some allied dematiaceae-phragmosporae. II. *Mycological Papers* **72**: 1–75.
- Ellis W.N. (2019) *Melanostilospora ari* (Cooke) Denchev, 2003. Plant parasites of Europe. <https://bladmineerders.nl/parasites/fungi/basidiomycota/ustilaginomycotina/ustilaginomycetes/urocystidales/urocystidaceae/melanostilospora/melanostilospora-ari/> (accessed 22 April 2021).
- Fuller M.S., Jaworski A. (1987) *Zoosporic fungi in teaching and research*. Athens, GA.
- Gardes M., Bruns T.D. (1993) ITS primers with enhanced specificity for Basidiomycetes – application to the identification of mycorrhizae and rusts. *Molecular Ecology* **2**(2): 113–118.
- Garnica S., Schön M.E., Abarenkov K., Riess K., Liimatainen K., Niskanen T., et al. (2016) Determining threshold values for barcoding fungi: lessons from *Cortinarius* (Basidiomycota), a highly diverse and widespread ectomycorrhizal genus. *FEMS Microbiology Ecology* **92**(4): fw045.
- Garnica S., Weiß M., Oertel B., Oberwinkler F. (2005) A framework for a phylogenetic classification in the genus *Cortinarius* (Basidiomycota, Agaricales) derived from morphological and molecular data. *Canadian Journal of Botany* **83**(11): 1457–1477.
- Gilardi G., Bergeretti F., Gullino M.L., Garibaldi A. (2019) First report of *Neopestalotiopsis clavisporea* causing root and crown rot on strawberry in Italy. *Plant Disease* **103**(11): 2959.
- Gillet C.C. (1876) *Les hyménomycètes ou description de tous les champignons (fungi) qui croissent en France avec l'indication de leurs propriétés utiles ou vénéneuses*. Ch. Thomas, Alençon.
- Gonçalves D.R., Jesus A.L., Pires-Zottarelli C.L.A. (2017) *Pythium* and *Phytophythium* species associated with hydroponically grown crops around the city of São Paulo, Brazil. *Tropical Plant Pathology* **41**(6): 397–405.
- González P., Alaniz S., Montelongo M.J., Rauduviniče L., Rebellato J., Silvera-Pérez E., Mondino P. (2012) First report of *Pestalotiopsis clavisporea* causing dieback on blueberry in Uruguay. *Plant Disease* **96**(6): 914–914.
- González Frago R. (1916) Micromicetos varios de España y de Cerdeña. *Trabajos del Museo Nacional de Ciencias Naturales, Serie Botánica* **9**: 1–115.
- Gouy M., Guindon S., Gascuel O. (2010) SeaView version 4: a multiplatform graphical user interface for sequence alignment and phylogenetic tree building. *Molecular Biology and Evolution* **27**(2): 221–224.
- Govaerts R., Frodin D.G., Bogner J. (2002) *World checklist and bibliography of Araceae (and Acoraceae)*. Royal Botanic Gardens, Kew.
- Guindon S., Gascuel O. (2003) A simple, fast and accurate algorithm to estimate large phylogenies by maximum likelihood. *Systematic Biology* **52**(5): 696–704.
- Günther A., Böhning T., Wiesner J., Vesper A., Stacke A., Theiss M., Gminder A. (2019) *Die Großpilze Jenas*. Funga-Jena Verlag, Jena.
- Gupta D., Razdan V.K. (2010) First report of *Pestalotia funera* causing leaf spot disease on *Ziziphus mauritiana* from India. *Indian Phytopathology* **63**(2): 238–239.
- Gutierrez A.C., Ordoqui E., Leclercque A., López Lastra C. (2020) A new species of *Herpomycetes* (Laboulbeniomycetes: Herpomycetales) on *Periplaneta fuliginosa* (Blattodea: Blattellidae) from Argentina. *Mycologia* **112**(6): 1184–1191.
- Haelewaters D., Blackwell M., Pfister D.H. (2021) Laboulbeniomycetes: intimate fungal associates of arthropods. *Annual Review of Entomology* **66**: 257–276.
- Haelewaters D., De Kesel A. (2013) A new species of *Cantharomyces* (Laboulbeniales, Ascomycota) from the Netherlands. *Mycotaxon* **123**: 467–472.
- Haelewaters D., De Kesel A. (2020) Checklist of thallus-forming Laboulbeniomycetes from Belgium and the Netherlands, including *Hesperomyces halyziae* and *Laboulbenia quarantena* spp. nov. *Mycologia* **71**: 23–86.
- Haelewaters D., Dima B., Abdel-Hafiz B.I.I., Abdel-Wahab M.A., Abul-Ezz S.R., Acar I., et al. (2020) Fungal Systematics and Evolution: FUSE 6. *Sydowia* **72**: 231–356.
- Haelewaters D., Dirks A.C., Kappler L.A., Mitchell J.K., Quijada L., Vandegriff R., et al. (2018) A preliminary checklist of Fungi at the Boston Harbor Islands. *Northeastern Naturalist* **25**(Special Issue 9): 45–76.
- Haelewaters D., Gorczak M., Pfiögler W.P., Tartally A., Tischer M., Wrzosek M., Pfister D.H. (2015) Bringing Laboulbeniales into the 21st century: enhanced techniques for extraction and PCR amplification of DNA from minute ectoparasitic fungi. *IMA Fungus* **6**(2): 363–372.
- Haelewaters D., Pfiögler W.P., Gorczak M., Pfister D.H. (2019) Birth of an order: comprehensive molecular phylogenetic study excludes *Herpomycetes* (Fungi, Laboulbeniomycetes) from Laboulbeniales. *Molecular Phylogenetics and Evolution* **133**: 286–301.
- Hall T.A. (1999) BioEdit: a user-friendly biological sequence alignment editor and analysis program for windows 95/98/NT. *Nucleic Acids Symposium Series* **41**: 95–98.
- Harrower E., Ammirati J., Cappuccino A., Ceska O., Kranabetter J.M., Kroeger P. et al. (2011) *Cortinarius* species diversity in British Columbia and molecular phylogenetic comparison with European specimen sequences. *Botany* **89**(11): 799–810.
- He X.-L., Li T.-H., Jiang Z.-D., Shen Y.-H. (2012) Four new species of *Entoloma* s.l. (Agaricales) from southern China. *Mycological Progress* **11**(4): 915–925.
- He X.-L., Wang D., Peng W.-H., Gan B.-C. (2017) Two new *Entoloma* s.l. species with *serrulatum*-type lamellar edge from Changbai Mountains, Northeast China. *Mycological Progress* **16**(8): 761–768.
- Hesler L.R., Smith A.H. (1965) *North American species of Crepidotus*. Hafner Publishing Company, New York.
- Hoang D.T., Chernomor O., von Haeseler A., Minh B.Q., Vinh L.S. (2017) UFBboot2: Improving the ultrafast bootstrap approximation. *Molecular Biology and Evolution* **35**: 518–522.
- Høiland K., Holst-Jensen A. (2000) *Cortinarius* phylogeny and possible taxonomic implications of ITS rDNA sequences. *Mycologia* **92**(4): 694–710.
- Hollister E.B., Schadt C.W., Palumbo A.V., Ansley R.J., Boutton T.W. (2010) Structural and functional diversity of soil

- bacterial and fungal communities following woody plant encroachment in the southern Great Plains. *Soil Biology and Biochemistry* **42**(10): 1816–1824.
- Hopple J.S. Jr. (1994) *Phylogenetic investigations in the genus Coprinus based on morphological and molecular characters*. PhD thesis, Duke University, Durham, NC.
- Horak E. (2018) *Fungi of New Zealand Volume 6: Agaricales (Basidiomycota) of New Zealand 2 Brown spored genera. Westerdijk Biodiversity Series* **16**: 1–255.
- Hunter G.C., Wingfield B.D., Crous P.W., Wingfield M.J. (2006) A multi-gene phylogeny for species of *Mycosphaerella* occurring on *Eucalyptus* leaves. *Studies in Mycology* **55**: 147–161.
- Jančovičová S., Tomšovský M., Urban, A., Krisai-Greilhuber I. (2014) New records and epitypification of *Crepidotus malachioides* (Crepidotaceae, Agaricales). *Sydowia* **66**(1): 79–97.
- Jaouen G., Sagne A., Buyck B., Decock C., Louisanna E., Manzi S., Baraloto C., Roy M., Schimann H. (2019) Fungi of French Guiana gathered in a taxonomic, environmental and molecular dataset. *Scientific Data* **6**: 206.
- Jesus A.L., Gonçalves D.R., Rocha S.C.O., Marano A.V., Jerônimo G.H., De Souza J.I., et al. (2016) Morphological and phylogenetic analyses of three *Phytopythium* species (Peronosporales, Oomycota) from Brazil. *Cryptogamie Mycologie* **37**(1): 117–128.
- Johnson J., Evans C., Brown N., Skeates S., Watkinson S., Bass D. (2014) Molecular analysis shows that soil fungi from ancient semi-natural woodland exist in sites converted to non-native conifer plantations. *Forestry* **87**(5): 705–717.
- Jones M.D., Phillips L.A., Treu R., Ward V., Berch S.M. (2012) Functional responses of ectomycorrhizal fungal communities to long-term fertilization of lodgepole pine (*Pinus contorta* Dougl. ex Loud. var. *latifolia* Engelm.) stands in central British Columbia. *Applied Soil Ecology* **60**: 29–40.
- Justo A., Angelini C., Bizzi A. (2021) The genera *Leucoagaricus* and *Leucocoprinus* in the Dominican Republic. *Mycologia* **113**(2): 348–389.
- Justo A., Caballero A., Muñoz G., Minnis A.M., Malysheva E. (2011a) Taxonomy of *Pluteus eugraptus* and morphologically similar taxa. *Mycologia* **103**(3): 646–655.
- Justo A., Vizzini A., Minnis A.M., Menolli N. Jr., Capelari M., Rodríguez O., et al. (2011b) Phylogeny of Pluteaceae (Agaricales, Basidiomycota): taxonomy and character evolution. *Fungal Biology* **115**(1): 1–20.
- Kalyaanamoorthy S., Minh B.Q., Wong T.K., von Haeseler A., Jermini L.S. (2017) ModelFinder: fast model selection for accurate phylogenetic estimates. *Nature Methods* **14**(6): 587–589.
- Katoh K., Toh H. (2008) Recent developments in the MAFFT multiple sequence alignment program. *Briefings in Bioinformatics* **9**: 286–298.
- Katoh K., Rozewicki J., Yamada K.D. (2019) MAFFT online service: multiple sequence alignment, interactive sequence choice and visualization. *Briefings in Bioinformatics* **20**: 1160–1166.
- Kaygusuz O., Knudsen H., Türkekel İ., Çolak Ö.F. (2020) *Volvariella turcica*, a new species from Turkey, and a multi-gene phylogeny of *Volvariella*. *Mycologia* **112**(3): 577–587.
- Kearse M., Moir R., Wilson A., Stones-Havas S., Cheung M., Sturrock S., et al. (2012) Geneious Basic: an integrated and extendable desktop software platform for the organization and analysis of sequence data. *Bioinformatics* **28**(12): 1647–1649.
- Kim C.S., Jo J.W., Kwag Y.N., Sung G.H., Lee S.G., Kim S.Y., et al. (2015) Mushroom flora of Ulleung-gun and a newly recorded *Bovista* species in the Republic of Korea. *Mycobiology* **43**(3): 239–257.
- Kirk P.M. (2019) Catalogue of Life. <http://www.catalogueof-life.org> (accessed 21 April 2021).
- Kirk P.M., Cannon P.F., Minter D.W., Stappers J.A. (2008) *Ainsworth & Bisby's Dictionary of Fungi*, 10th ed. CABI, Wallingford.
- Kokkonen K. (2015) A survey of boreal *Entoloma* with emphasis on the subgenus *Rhodopolia*. *Mycological Progress* **14**(12): 1–116.
- König S., Schwenkbier L., Pollok S., Riedel M., Wagner S., Popp J., et al. (2015) Potential of *Ypt1* and ITS gene regions for the detection of *Phytophthora* species in a lab-on-a-chip DNA hybridization array. *Plant Pathology* **64**(5): 1176–1189.
- Kooij P.W., Aanen D.K., Schiott M., Boomsma J.J. (2015) Evolutionarily advanced ant farmers rear polyploid fungal crops. *Journal of Evolutionary Biology* **28**(11): 1911–1924.
- Kornerup A., Wanscher J.H. (1978) *Methuen handbook of colours*, 3rd ed. Eyre Methuen, London.
- Knudsen H., Vesterholt J. (2012) *Funga Nordica: agaricoid, boletoid, clavarioid, cyphelloid and gastroid genera*. Nordsvamp, Copenhagen.
- Kretzer A.M., Li Y., Szaro T., Bruns T.D. (1996) Internal transcribed spacer sequences from 38 recognized species of *Suillus* sensu lato: phylogenetic and taxonomic implications. *Mycologia* **88**(5): 776–785.
- Kumar S., Stecher G., Li M., Nknyaz C., Tamura K. (2018) MEGA X: Molecular Evolutionary Genetics Analysis across computing platforms. *Molecular Biology and Evolution* **35**: 1547–1549.
- Kumar S., Stecher G., Tamura K. (2016) MEGA7: Molecular Evolutionary Genetics Analysis version 7.0 for bigger datasets. *Molecular Biology and Evolution* **33**(7): 1870–1874.
- Kuo M. (2004) The genus *Suillus*. <http://www.mushroomexpert.com/suillus.html> (accessed 19 April 2021).
- Kytovuori I., Niskanen T., Liimatainen K., Lindstrom H.K. (2005) *Cortinarius sordidumaculatus* and two new related species, *C. anisatus* and *C. neofurvolaeus*, in Fennoscandia (Basidiomycota, Agaricales). *Karstenia* **45**(1): 33–50.
- Larsson E., Jacobsson S. (2004) The controversy over *Hygrophorus cossus* settled using ITS sequence data from 200-year-old type material. *Mycological Research* **108**(7): 781–786.
- Larsson E., Vauras J., Cripps C. (2018) *Inocybe praetervisa* group: A clade of four closely related species with partly different geographical distribution ranges in Europe. *Mycoscience* **59**(4): 277–287.
- Lee S.B., Milgroom M.G., Taylor J.W. (1988) A rapid, high yield mini-prep method for isolation of total genomic DNA from fungi. *Fungal Genetics Reports* **35**(1): 23.
- Lee Y., Kim G.H., Kim Y., Park S.Y., Koh Y.J. (2019) First report of twig dieback caused by *Neopestalotiopsis clavisporea* on blueberry in Korea. *Plant Disease* **103**(5): 1022.
- Lévesque C.A., de Cock A.W.A.M. (2004) Molecular phylogeny and taxonomy of the genus *Pythium*. *Mycological Research* **108**(12): 1363–1383.
- Li G.J., Hyde K.D., Zhao R.L., Hongsanan S., Abdel-Aziz F.A., Abdel-Wahab M.A., et al. (2016) Fungal diversity notes 253–366: taxonomic and phylogenetic contributions to fungal taxa. *Fungal Diversity* **78**: 1–237.
- Liu J., Haelewaters D., Pfiiegler W.P., Page R.A., Dick C.W., Aime M.C. (2020) A new species of *Gloeandromyces* from Ecuador and Panama revealed by morphology and phylo-

- genetic reconstruction, with a discussion of secondary barcodes in Laboulbeniomycetes taxonomy. *Mycologia* **112**(6): 1192–1202.
- Liimatainen K. (2017) Nomenclatural novelties. *Index Fungorum* **344**: 1–5.
- Liimatainen K., Niskanen T., Dima B., Kytövuori I., Ammirati J.F., Kirk P.M., Kytövuori I. (2020) Mission impossible completed: unlocking the nomenclature of the largest and most complicated subgenus of *Cortinarius*, *Telamonia*. *Fungal Diversity* **104**(1): 291–331.
- Lindström H. (2012) Key P: Subgen. *Telamonia* sect. *Hydrocybe* (Fr.) Nezdójm. In: *Funga Nordica. Agaricoid, boletoid and cyphelloid genera* (eds. Knudsen H., Vesterholt J.) Nordsvamp Press, Copenhagen: 878–882.
- Löytynoja A., Goldman N. (2005) An algorithm for progressive multiple alignment of sequences with insertions. *Proceedings of the National Academy of Sciences USA* **102**(30): 10557–10562.
- Luczaj Ł., Lamxay V., Tongchan K., Xayphakatsa K., Phimmakong K., Radavanh S., Kanyasone V., Pietras M., Karbarz M. (2021) Wild food plants and fungi sold in the markets of Luang Prabang, Lao PDR. *Journal of Ethnobiology and Ethnomedicine* **17**(1): 6.
- Ludwig E. (2007) *Pilzkompendium 2*. Fungicon Verlag, Berlin.
- Machado J.L., Rocha J.R.S. (2019) Oomicetos (Oomycota) no Complexo Açude Joana, Pedro II, Piauí, Brasil. *Rodriguésia* **70**: e00222017.
- Mahapatra S., Banerjee J., Kumar K., Pramanik S., Pramanik K., Islam S., Das S. (2018) Leaf spot and fruit rot of strawberry caused by *Neopestalotiopsis clavispora* in Indo-Gangetic plains of India. *Indian Phytopathology* **71**(2): 279–283.
- Maharachchikumbura S.S.N., Hyde K.D., Groenewald J.Z., Xu J., Crous P.W. (2014) *Pestalotiopsis* revisited. *Studies in Mycology* **79**: 121–186.
- Maharachchikumbura S.S.N., Guo L.D., Cai L., Chukeatirote E., Wu W.P., Sun X., et al. (2012) A multi-locus backbone tree for *Pestalotiopsis*, with a polyphasic characterization of 14 new species. *Fungal Diversity* **56**(1):95–129.
- Maire R. (1916) Deuxième contribution à l'étude des Laboulbeniales de l'Afrique du Nord. *Bulletin de la Société d'histoire naturelle de l'Afrique du Nord* **7**: 6–39.
- Malysheva E.F., Malysheva V.F., Justo A. (2016) Observations on *Pluteus* (Pluteaceae) diversity in South Siberia, Russia: morphological and molecular data. *Mycological Progress* **15**(8): 861–882.
- Marano A.V., Jesus A.L., De Souza J.I., Leão E.M., James T.Y., Jerônimo G.H., et al. (2014) A new combination in *Phytophythium*: *P. kandeliae* (Oomycetes, Straminipila). *Mycosphere* **5**(4): 510–522.
- Marčiulynas A., Marčiulynienė D., Lynikienė J., Gedminas A., Vaičiukynė M., Menkis A. (2020) Fungi and oomycetes in the irrigation water of forest nurseries. *Forests* **11**(4): 459.
- Martin M.P., Raidl S. (2002) The taxonomic position of *Rhizopogon melanogastroides* (Boletales). *Mycotaxon* **84**: 221–228.
- Mata J.L., Halling R.E., Hughes K.W., Petersen R.H. (2004) *Rhodocollybia* in neotropical montane forests. *Mycological Progress* **3**(4): 337–352.
- McLeod A., Botha W.J., Meitz J.C., Spies C.F., Tewoldemedhin Y.T., Mostert L. (2009) Morphological and phylogenetic analyses of *Pythium* species in South Africa. *Mycological Research* **113**(9): 933–951.
- Menolli Jr. N., Asai T., Capelari M. (2010) Records and new species of *Pluteus* from Brazil based on morphological and molecular data. *Mycology* **1**(2): 130–153.
- Menolli Jr. N., Justo A., Capelari M. (2015) Phylogeny of *Pluteus* section *Celluloderma* including eight new species from Brazil. *Mycologia* **107**(6): 1205–1220.
- Mert F., Türkölmez S., Ozer G., Derviş S., Çiftçi O. (2020) First report of *Phytophythium litorale* causing root rot of apple in Turkey. *Journal of Plant Pathology* **102**(4): 1361–1362.
- Miadlikowska J., Lutzoni F. (2000) Phylogenetic revision of the genus *Peltigera* (lichen-forming Ascomycota) based on morphological, chemical, and large subunit nuclear ribosomal DNA data. *International Journal of Plant Sciences* **161**: 925–958.
- Midgley D.J., Saleeba J.A., Stewart M.I., Simpson A.E., McGee P.A. (2007) Molecular diversity of soil basidiomycete communities in northern-central New South Wales, Australia. *Mycological Research* **111**(3): 370–378.
- Milanez A.I. (1989) Fungos de águas continentais. In: *Técnicas de coleta, preservação e herborização de material botânico* (eds. Fidalgo O., Bononi V.L.), Instituto de Botânica, São Paulo: 17–20.
- Milanez A.I., Pires-Zottarelli C.L.A., Gomes A.L. (2007) *Brazilian zoospore fungi*. Instituto de Botânica, São Paulo.
- Miller M.A., Pfeiffer W., Schwartz T. (2010) Creating the CIPRES Science Gateway for inference of large phylogenetic trees. In: *2010 Proceedings of the Gateway Computing Environments Workshop (GCE)*, New Orleans, LA: 1–8.
- Morozova O.V., Malysheva E.V., Popov E.S., Psurtseva N.V., Fedosova A.G., Kovalenko A.E. (2015) Macromycetes of the Izborsk-Maly Valley, rare and new to the Pskov Region. *Novosti Sist. Nizsh. Rast.* **49**: 186–203.
- Morozova O.V., Noordeloos M.E., Popov E.S., Alexandrova A.V. (2018) Three new species within the genus *Entoloma* (Basidiomycota, Agaricales) with clamped basidia and a *serulatum*-type lamellae edge, and their phylogenetic position. *Mycological Progress* **17**(3): 381–392.
- Morozova O.V., Noordeloos M.E., Vila J. (2014) *Entoloma* subgenus *Leptonia* in boreal-temperate Eurasia: towards a phylogenetic species concept. *Persoonia* **32**: 141–169.
- Moser M.M. (2002) Studies in the North American *Cortinarii* 7. New and interesting species of *Cortinarius* subgen. *Telamonia* (Agaricales, Basidiomycotina) from the Rocky Mountains. *Feddes Repertorium* **113**: 48–62.
- Moser M.M., McKnight K.H., Ammirati J.F. (1995) Studies on North American *Cortinarii* 1. New and interesting taxa from the greater Yellowstone area. *Mycotaxon* **55**: 301–346.
- Mullis K., Faloona F.A. (1987) Specific synthesis of DNA in vitro via a polymerase-catalyzed chain reaction. *Methods in Enzymology* **155**: 335–350.
- Munsell Color Company. (1954) Munsell Soil Color Charts. Baltimore, MD.
- Murray M.G., Thompson W.F. (1980) Rapid isolation of high molecular weight plant DNA. *Nucleic Acids Research* **8**(19): 4321–4325.
- Nagy L.G., Kocsubé S., Csanádi Z., Kovács G.M., Petkovits T., Vágvolgyi Cs., Papp T. (2012) Re-mind the gap! Insertion – deletion data reveal neglected phylogenetic potential of the nuclear ribosomal internal transcribed spacer (ITS) of fungi. *Plos One* **7**: e49794.
- Nam B., Choi Y.J. (2019) *Phytophythium* and *Pythium* species (Oomycota) isolated from freshwater environments of Korea. *Mycobiology* **47**(3): 261–272.
- Nechwatal J., Mengden K. (2006) *Pythium litorale* sp. nov., a new species from the littoral of Lake Constance, Germany. *FEMS Microbiology Letters* **255**(1): 96–101.
- Nguyen L., Schmidt H.A., von Haeseler A., Minh B.Q. (2015) IQ-TREE: A fast and effective stochastic algorithm for es-

- timating maximum likelihood phylogenies. *Molecular Biology and Evolution* **32**(1): 268–274.
- Niskanen T. (2020) Nomenclatural novelties. *Index Fungorum* **438**: 1–8.
- Niskanen T., Kytövuori I. (2008) Key N: Subgen. *Telamonia* sects. *Hinnulei* Melot and *Safranopedes* Liimat., Kytöv. & Niskanen. In: *Funga Nordica. Agaricoid, boletoid and cyphelloid genera* (eds. Knudsen H., Vesterholt J.). Nordsvamp Press, Copenhagen: 762–764.
- Niskanen T., Liimatainen, K., Kytövuori I. (2006) Taxonomy, ecology and distribution of *Cortinarius rubrovioleipes* and *C. hinnuleoarmillatus* Reumaux (Basidiomycota, Agaricales) in Fennoscandia. *Karstenia* **46**(1): 1–12.
- Niskanen T., Liimatainen K., Kytövuori I., Ammirati J.F. (2012) New *Cortinarius* species from conifer-dominated forests of North America and Europe. *Botany* **90**(8): 743–754.
- Noordeloos, M.E. (1992) *Entoloma* s.l. *Fungi Europaei* **5**: 1–760.
- Noordeloos, M.E. (2004) *Entoloma* s.l. Supplement. *Fungi Europaei* **5A**: 761–1377.
- Noordeloos M.E., Dima B., Weholt Ø., Eidissen S.E., Lorås J., Brandrud T.E. (2017) *Entoloma chamaemori* (Entolomataceae, Basidiomycota) – a new boreal species, with isolated phylogenetic position. *Phytotaxa* **298**(3): 289–295.
- Noordeloos M.E., Lorås J., Eidissen S.E., Brandrud T.E., Bendiksen E., Morozova O., et al. (2021) Three new *Entoloma* species of the *Cyanula* clade (Entolomataceae, Agaricales) from (sub)alpine habitats in Northern Norway and Sweden. *Sydowia* **73**: 185–196.
- Noordeloos M.E., Morozova O. (2010) New and noteworthy *Entoloma* species from the Primorsky Territory, Russian Far East. *Mycotaxon* **112**(1): 231–255.
- Obregón V.G., Meneguzzi N.G., Ibañez J.M., Lattar T.E., Kirschbaum D.S. (2018) First report of *Neopestalotiopsis clavispora* causing root and crown rot on strawberry plants in Argentina. *Plant Disease* **102**(9): 1856.
- Ochoa Y.M., Hernandez A., Delgado J.C., Beltran M., Tapia L.M., Hernandez O., Cerna E. (2018) First report of avocado tree wilt by *Pythium* sp. *amazonianum* in Mexico. *International Journal of Agriculture and Natural Resources* **45**(3): 301–305.
- Orton P.D. (1986) *British Fungus Flora. Agarics and Boleti 4: Pluteaceae: Pluteus and Volvariella*. Royal Botanic Garden, Edinburgh.
- Osmundson T.W., Robert V.A., Schoch C.L., Baker L.J., Smith A., Robich G., et al. (2013) Filling gaps in biodiversity knowledge for macrofungi: Contributions and assessment of an herbarium collection DNA barcode sequencing project. *Plos One* **8**(4): e62419.
- Parrent J.L., Vilgalys R. (2007) Biomass and compositional responses of ectomycorrhizal fungal hyphae to elevated CO₂ and nitrogen fertilization. *New Phytologist* **176**(1): 164–174.
- Pegler D.N. (1983) Agaric flora of the Lesser Antilles. *Kew Bulletin Additional Series* **9**: 1–668.
- Peintner U., Moser M.M., Thomas K.A., Manimohan P. (2003) First records of ectomycorrhizal *Cortinarius* species (Agaricales, Basidiomycetes) from tropical India and their phylogenetic position based on rDNA ITS sequences. *Mycological Research* **107**(4): 485–494.
- Picard F. (1912) Description de deux Laboulbéniciacées nouvelles, parasites de Coléoptères. *Bulletin de la Société Entomologique de France* **8**: 178–181.
- Pires-Zottarelli C.L.A. (1999). *Fungos zoospóricos dos Vales dos Rios Moji e Pilões, Região de Cubatão, SP*. PhD thesis, Universidade Estadual Paulista, Rio Claro.
- Posada D. (2008) jModelTest: phylogenetic model averaging. *Molecular Biology and Evolution* **25**(7): 1253–1256.
- Pradeep C.K., Vrinda K.B. (2006) New and noteworthy species of *Pluteus* (Pluteaceae, Agaricales) from Kerala state, India. *Persoonia* **19**: 95–99.
- Prasannath K., Galea V.J., Akinsanmi O.A. (2020) Characterisation of leaf spots caused by *Neopestalotiopsis clavispora* and *Colletotrichum siamense* in macadamia in Australia. *European Journal of Plant Pathology* **156**(4): 1219–1225.
- Quélet L. (1888) *Flore mycologique de la France et des pays limitrophes*. Octave Doin, Paris.
- Rambaut A., Suchard M.A., Xie D., Drummond A.J. (2014) Tracer v1.6. <http://beast.bio.ed.ac.uk/Tracer> (accessed 15 April 2021).
- Ratnasingham S., Hebert P.D.N. (2007) BOLD: The Barcode of Life Data System (www.barcodinglife.org). *Molecular Ecology Notes* **7**(3): 355–364.
- Ratnasingham S., Hebert P.D.N. (2013) A DNA-based registry for all animal species: the Barcode Index Number (BIN) system. *Plos One* **8**(8): e66213.
- Redekar N.R., Bourret T.B., Eberhart J.L., Johnson G.E., Pitton B.J., Haver D.L., et al. (2020) The population of oomycetes in a recycled irrigation water system at a horticultural nursery in southern California. *Water Research* **183**: 116050.
- Rezaei S., Abrinbana M., Ghosta Y. (2021) Taxonomic and pathogenic characterization of *Phytophthora vexans* species from West Azarbaijan, Iran, and description of two new species. *Mycologia*, in press. doi: 10.1080/00275514.2020.1853986
- Riethmüller A., Voglmayr H., Göker M., Weiß M., Oberwinkler F. (2002) Phylogenetic relationships of the downy mildews (Peronosporales) and related groups based on nuclear large subunit ribosomal DNA sequences. *Mycologia* **94**(5): 834–849.
- Robideau G.P., de Cock A.W.A.M., Coffey M.D., Voglmayr H., Brouwer H., Bala K., et al. (2011). DNA barcoding of oomycetes with cytochrome c oxidase subunit I and internal transcribed spacer. *Molecular Ecology Resources* **11**: 1002–1011.
- Rodríguez-Padrón C., Siverio F., Pérez-Sierra A., Rodríguez A. (2018) Isolation and pathogenicity of *Phytophthora* species and *Phytophthora vexans* recovered from avocado orchards in the Canary Islands, including *Phytophthora niederhauserii* as a new pathogen of avocado. *Phytopathologia Mediterranea* **57**(1): 89–106.
- Romero-Olivares A.L., Baptista-Rosas R.C., Escalante A.E., Bullock E. (2013) Distribution patterns of *Dikarya* in arid and semiarid soils of Baja California, Mexico. *Fungal Ecology* **6**(1): 92–101.
- Ronquist F., Huelsenbeck J.P. (2003) MrBayes 3: Bayesian phylogenetic inference under mixed models. *Bioinformatics* **19**: 1572–1574.
- Ronquist F., Teslenko M., van der Mark P., Ayres D., Darling A., Höhna S., et al. (2012) MrBayes 3.2: Efficient Bayesian phylogenetic inference and model choice across a large model space. *Systematic Biology* **61**(3): 539–542.
- Rossi W., Santamaria S. (2015) New species of *Aporomyces*. *Turkish Journal of Botany* **39**: 354–358.
- Saba M., Haelewaters D., Pfister D.H., Khalid A.N. (2020) New species of *Pseudosperma* (Agaricales, Inocybaceae) from Pakistan revealed by morphology and multi-locus phylogenetic reconstruction. *MycKeys* **69**: 1–31.
- Salmaninezhad F., Mostowfizadeh-Ghalefarsa R. (2019) Oomyceteous flora of ornamental trees of Shiraz County (Iran). *Rostaniha* **57**: 29–43.

- Sarwar S., Hanif M., Khalid A.N., Guinberteau J. (2011) Diversity of boletes in Pakistan; focus on *Suillus brevipes* and *Suillus sibiricus*. *Proceedings of the 7th International Conference on Mushroom Biology and Mushroom Products*: 123–133.
- Sarwar S., Khalid A.N. (2012) Preliminary checklist of the Boletales in Pakistan. *Mycotaxon* **121**. <https://www.mycotaxon.com/resources/checklists/Sarwar-v121-checklist.pdf> (accessed 19 April 2021).
- Sarwar S., Khalid A.N. (2014) Diversity and phylogeny of genus *Suillus* (Suillaceae, Boletales) from coniferous forests of Pakistan (Asia). *International Journal of Agriculture and Biology* **16**(3): 489–497.
- Sarwar S., Khalid A.N., Hanif M., Niazi A.R. (2012) *Suillus flavidus* and its ectomycorrhizae with *Pinus wallichiana* in Pakistan. *Mycotaxon* **12**: 225–232.
- Sarwar S., Saba M., Khalid A.N., Dentinger B.M. (2015) *Suillus marginielevatus*, a new species and *S. triacicularis*, a new record from Western Himalaya, Pakistan. *Phytotaxa* **203** (2): 169–177.
- Sarwar S., Saba M., Khalid A.N., Dentinger B.M. (2018) *Suillus himalayensis* (Boletales: Basidiomycota: fungi) and its symbiotic association with roots of *Pinus wallichiana*, first report from coniferous forests of Pakistan. *Journal of Animal and Plant Sciences* **28**(2): 576–583.
- Savchenko K.G., Dzyumenko O.O., Heluta V.P. (2010) *Melanostilospora ari* (Cooke) Denchev on Arum L. in Ukraine. *Ukrainian Botanical Journal* **67**(6): 916–919.
- Savchenko K.G., Wasser S.P., Heluta V.P., Nevo E. (2015) *Smut fungi of Israel*. Koeltz Scientific Books, Königstein.
- Savian F., Prencipe F., Fillipini N., Nari L., Martini M., Ermacora P., Spadaro D. (2021). Pathogeneticity of *Phytophthium chamehyphon*: a new player in kiwifruit vine decline syndrome of *Actinidia chinensis* var. *deliciosa* (A. Chev) A. Chev. Hayward in Italy. *Plant Disease*, in press. doi: 10.1094/pdis-01-21-0143-sc
- Schmitz A., Riesner D. (2006) Purification of nucleic acids by selective precipitation with polyethylene glycol 6000. *Analytical Biochemistry* **354**(2): 311–313.
- Schoch C.L., Sung G.H., López-Giráldez F., Townsend J.P., Miadlikowska J., Hofstetter V., et al. (2009) The Ascomycota tree of life: a phylum-wide phylogeny clarifies the origin and evolution of fundamental reproductive and ecological traits. *Systematic Biology* **58**(2): 224–239.
- Sesli E., Liimatainen K. (2018) *Cortinarius conicoumbonatus* (*Cortinarius* subgen. *Telamonia* sect. *Hinnulei*): a new species from spruce-beech forests of the East Black Sea Region of Turkey. *Turkish Journal of Botany* **42**(3): 327–334.
- Sesli E., Asan A., Selçuk F. (2020) *Türkiye mantarları listesi*. Ali Nihat Gökyiğit Vakfı Yayını, İstanbul.
- Ševčíková H., Borovička J. (2015) *Pluteus floccipes*, a new species from the Czech Republic. *Sydowia* **67**: 157–165.
- Ševčíková H., Moreau P.-A., Borovička J. (2020) *Pluteus kesselakii* (Pluteaceae, Agaricales), a new species in section *Celuloderma*. *Phytotaxa* **432**(2): 181–189.
- Shen Y.H., Ye D.H. (2006) Laboulbeniales. *Flora Fungorum Sinicorum* **28**: 1–294, Pl. I–II.
- Sideris C.P. (1932) Taxonomic studies in the family Pythiaceae. II. *Pythium*. *Mycologia* **24**(1): 14–61.
- Silvestro D., Michalak I. (2012) raxmlGUI: a graphical front-end for RAxML. *Organisms Diversity & Evolution* **12**(4): 335–337.
- Simmons M.P., Ochoterena H., Carr T.G. (2001) Incorporation, relative homoplasy, and effect of gap characters in sequence-based phylogenetic analysis. *Systematic Biology* **50**(3): 454–462.
- Singer R. (1951) The Agaricales in modern taxonomy. *Lilloa* **22**: 1–832.
- Smith H.V., Weber N.S. (1987) Observations on *Lepiota americana* and some related species. *Contributions from the University of Michigan Herbarium* **16**: 211–221.
- Soop K. (2018) *Cortinarius in Sweden*. Sixteenth revised edition. Éditions Scientrix, Stockholm.
- Spegazzini C. (1915) Laboulbeniales ritrovate nelle collezioni di alcuni musei italiani. *Anales del Museo Nacional de Historia Natural de Buenos Aires* **26**: 451–511.
- Spies C.F.J., Mazzola M., Botha W.J., Van Der Rijst M., Mostert L., Mcleod A. (2011) Oogonial biometry and phylogenetic analyses of the *Pythium vexans* species group from woody agricultural hosts in South Africa reveal distinct groups within this taxon. *Fungal Biology* **115**(2): 157–168.
- Stallman J.K. (2019) Taxonomy of Hawai'i Island's lepiota-ceous (Agaricaceae) fungi: *Chlorophyllum*, *Cystolepiota*, *Lepiota*, *Leucoagaricus*, *Leucocoprinus*. MS thesis, University of Hawai'i at Hilo, Hilo, HI.
- Stamatakis A. (2014) RAxML version 8: a tool for phylogenetic analysis and post-analysis of large phylogenies. *Bioinformatics* **30**: 1312–1313.
- Stewart R.R. (1972) *Flora of West Pakistan: an annotated catalogue of the vascular plants of West Pakistan and Kashmir*. Rawalpindi, Pakistan.
- Sugiyama K., Majewski T. (1985) Notes on the Laboulbeniomycetes of Bali Island (Indonesia) II. *Transactions of the Mycological Society of Japan* **26**: 125–144.
- Sundberg H., Ekman S., Krusys Å. (2018) A crush on small fungi: An efficient and quick method for obtaining DNA from minute ascomycetes. *Methods in Ecology and Evolution* **9**(1): 148–158.
- Tamura K., Peterson D., Peterson N., Stecher G., Nei M., Kumar S. (2011) MEGA5: Molecular evolutionary genetics analysis using maximum likelihood, evolutionary distance, and maximum parsimony methods. *Molecular Biology and Evolution* **28**(10): 2731–2739.
- Tavares I.I. (1985) Laboulbeniales (Fungi, Ascomycetes). *Mycologia Memoir* **9**: 1–627.
- Thaxter R. (1931) Contribution towards a monograph of the Laboulbeniaceae. Part V. *Memoirs of the American Academy of Arts and Sciences* **16**: 1–435.
- Thiers B. (continuously updated) Index Herbariorum: A global directory of public herbaria and associated staff. New York Botanic Garden's Virtual Herbarium. <http://sweetgum.nybg.org/ih/> (accessed 15 April 2021).
- Tkaczyk M. (2020) *Phytophthium*: origin, differences and meaning in modern plant pathology. *Folia Forestalia Polonica A* **62**(3): 227–232.
- Thao L.D., Hien L.T., Liem N.V., Thanh H.M., Khanh T.N., Binh V.T.P., et al. (2020) First report of *Phytophthium vexans* causing root rot disease on durian in Vietnam. *New Disease Reports* **41**(1): 2.
- Truong C., Mujic A.B., Healy R., Kuhar F., Furci G., Torres D., et al. (2017) How to know the fungi: combining field inventories and DNA-barcoding to document fungal diversity. *New Phytologist* **214**(3): 913–919.
- Turland N.J., Wiersema J.H., Barrie F.R., Greuter W., Hawksworth D.L., Herendeen P.S., et al. (2018) International Code of Nomenclature for algae, fungi, and plants (Shenzhen Code) adopted by the Nineteenth International Botanical Congress Shenzhen, China, July 2017. *Regnum Vegetabile* **159**. Koeltz Botanical Books, Oberreifenberg.

- Vaidya G., Lohman D.J., Meier R. (2010) SequenceMatrix: concatenation software for the fast assembly of multigene datasets with character set and codon information. *Cladistics* **27**(2): 171–180.
- van der Plaats-Niterink A.J. (1981) Monograph of the genus *Pythium*. *Studies in Mycology* **1**: 1–242.
- Vánky K. (1994) *European smut fungi*. Gustav Fischer Verlag, Jena.
- Vánky K. (2012) *Smut fungi of the world*. APS Press, St. Paul, MN.
- Varga T., Krizsán K., Földi C., Dima B., Sánchez-García M., Sánchez-Ramírez S., et al. (2019) Megaphylogeny resolves global patterns of mushroom evolution. *Nature Ecology & Evolution* **3**(4): 668–678.
- Vellinga E.C. (1990) *Pluteus* Fr. In: *Flora Agaricina Neerlandica, Vol 2*. (eds. Bas C., Kuyper Th.W., Noordeloos M.E., Vellinga E.C.), A.A. Balkema, Rotterdam: 31–55.
- Vellinga E.C. (2000) Notes on *Lepiota* and *Leucoagaricus*. Type studies on *Lepiota magnispora*, *Lepiota barssii*, and *Agaricus americanus*. *Mycotaxon* **76**: 429–438.
- Vellinga E.C. (2004) Genera in the family Agaricaceae: evidence from nrITS and nrLSU sequences. *Mycological Research* **108**(4): 354–377.
- Vellinga E.C., de Kok R.P., Bruns T.D. (2003) Phylogeny and taxonomy of *Macrolepiota* (Agaricaceae). *Mycologia* **95**(3): 442–456.
- Vellinga E.C., Sysouphanthong P., Hyde K.D. (2011) The family Agaricaceae: phylogenies and two new white-spored genera. *Mycologia* **103**(3): 494–509.
- Verma B., Reddy M.S. (2014) *Suillus himalayensis* (Basidiomycota, Agaricomycetes, Boletales), a new species associated with *Pinus wallichiana* from the northwestern Himalayas, India. *Nova Hedwigia* **99**(3–4): 541–550.
- Verma B., Reddy M.S. (2014b) *Suillus triacicularis* sp. nov., a new species associated with *Pinus roxburghii* from northwestern Himalayas, India. *Phytotaxa* **162**(3): 157–164.
- Vtrovský T., Kolařík M., Žifáková L., Zelenka T., Baldrian P. (2016) The *rpb2* gene represents a viable alternative molecular marker for the analysis of environmental fungal communities. *Molecular Ecology Resources* **16**(2): 388–401.
- Vilgalys R., Hester M. (1990) Rapid genetic identification and mapping of enzymatically amplified ribosomal DNA from several *Cryptococcus* species. *Journal of Bacteriology* **172**: 4238–4246.
- Weholt Ø., Lorås J., Eidissen S.E. (2014) One new and one rare species of *Entoloma* from the Norwegian nature reserve Holmvassdalen. *Österreichische Zeitschrift für Pilzkunde* **23**: 55–60.
- White T.J., Bruns T., Lee S., Taylor J. (1990) Amplification and direct sequencing of fungal ribosomal RNA genes for phylogenetics. In: *PCR protocols: a guide to methods and applications* (eds. Innis M.A., Gelfand D.H., Sninsky J.J., White T.J.), Academic Press, New York, NY: 315–322.
- Wijayawardene N.N., Hyde K.D., Al-Ani L.K.T., Tedersoo L., Haelewaters D., Rajeshkumar K.C., et al. (2020) Outline of Fungi and fungus-like taxa. *Mycosphere* **11**(1): 1060–1456.
- Wu Q.X., Mueller G.M., Lutzoni F.M., Huang Y.Q., Guo S.Y. (2000) Phylogenetic and biogeographic relationships of eastern Asian and eastern North American disjunct *Suillus* species (Fungi) as inferred from nuclear ribosomal RNA ITS sequences. *Molecular Phylogenetics and Evolution* **17**: 37–47.
- Zhiguang H., Xin S., Mengsha L. (2016) Effects of forest age on soil fungal community in a northern temperate ecosystem. *Indian Journal of Microbiology* **56**(3): 328–334.