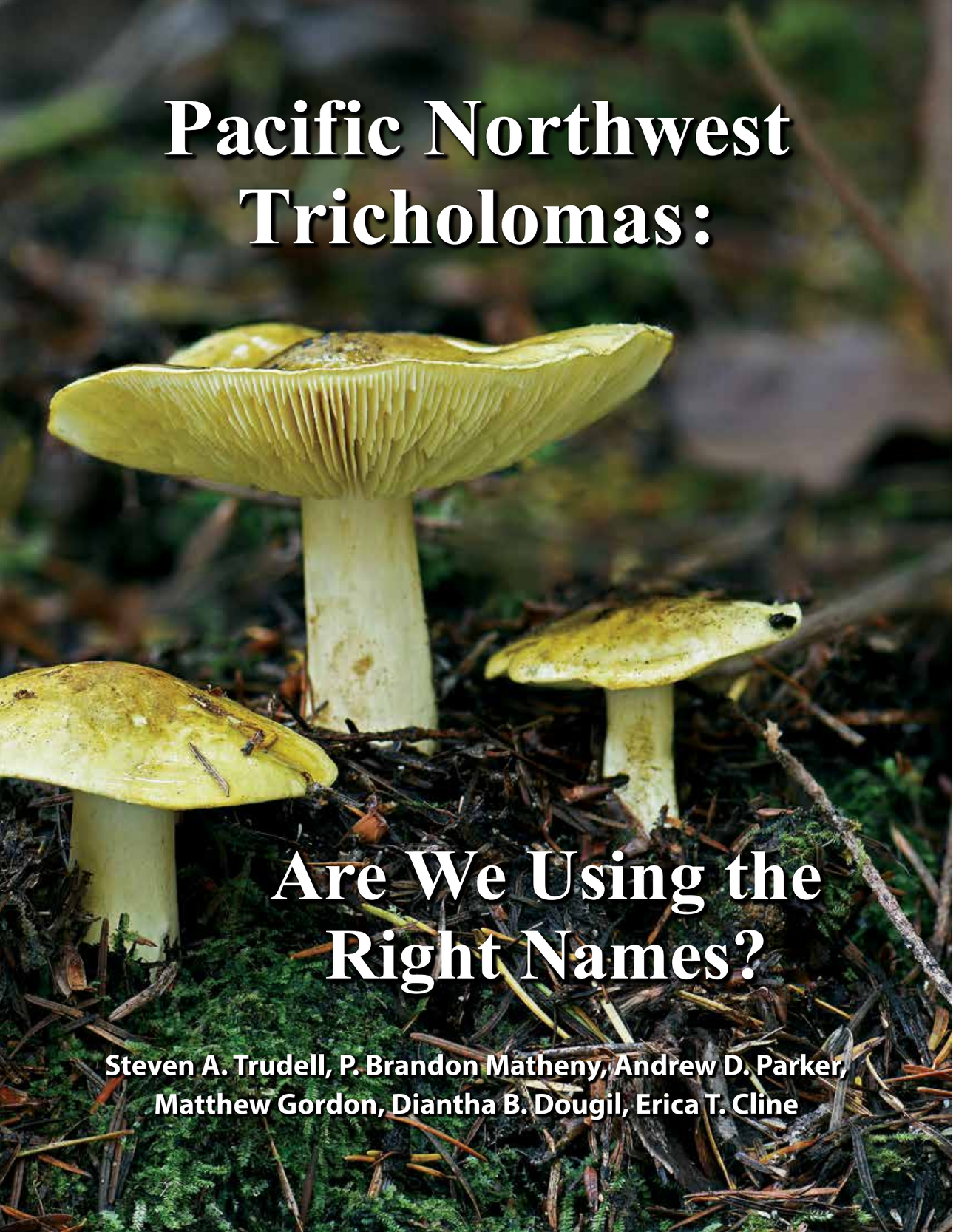

Pacific Northwest Tricholomas: Are We Using the Right Names?

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SUMMARY: Despite the fact that *Tricholoma* includes many large conspicuous woodland fungi, the genus historically has received very little attention in North America and is one of many genera of North American agarics for which identification and other taxonomic resources are largely lacking. More than 130 "*Tricholoma*" species have been reported to occur in the Pacific Northwest region of North America (PNW), including some no longer accepted in the genus and a large number being referred to, often incorrectly, by names based on European fungi. In light of this uncertainty, we made an initial attempt to clarify the application of *Tricholoma* species names in the PNW. This included (i) obtaining ITS barcode sequences from holotypes of *Tricholoma* species described from the PNW, selected other holotypes, and recent, excellent-condition, mostly well-photographed collections; (ii) phylogenetic analysis utilizing 142 sequences generated in this project along with 431 additional sequences obtained from GenBank and other researchers; and (iii) morphological study of selected collections. Our results provide evidence for the existence of at least 50 species of *Tricholoma* in the PNW. As expected, there are many undescribed species here and a number of European names have been misapplied to our fungi. We estimate that the total number of *Tricholoma* species in the PNW could be as high as 75 to 100.

KEY WORDS: Agaricales, Basidiomycota, biodiversity, Fungal Diversity Survey, fungi, ITS barcode, molecular phylogenetics, North American mycota, *Tricholoma*, Tricholomataceae.

NOTE TO READERS REGARDING PEER REVIEW: Although we have chosen to self-publish our study results, they have been reviewed by several knowledgeable peers with expertise in fungal systematics and the genus, *Tricholoma*, in particular. The reviewers are credited and thanked in the Acknowledgments section.

INTRODUCTION

What we know as the genus, *Tricholoma*, originated with Elias Magnus Fries in his 1821–1828 publication, *Systema Mycologicum*. Fries defined *Tricholoma* as including fungi that produce white-spored terrestrial basidiomes that are fleshy and relatively robust. They lack a universal veil and either lack a partial veil or have one that is fibrillose or floccose and disappears early, sometimes leaving remnants on the margin of the pileus. The pileus is hemispherical or somewhat campanulate, often umbonate, and with a thin incurved (at least when young) margin. The lamellae are of unequal length and sinuate or rounded where they approach the stipe. The stipe is fibrillose, scaly, or has coarse longitudinal striations formed by aggregated fibrils, and its flesh is confluent with that of the pileus. The basidiomes exhibit diverse colors, especially in the pileus surface. Subsequent to Fries's initial circumscription of *Tricholoma*, many Friesian "tricholomas" have been transferred to other existing or newly created genera such as *Calocybe*, *Leucopaxillus*, *Lyophyllum*, *Melanoleuca*, and *Tricholomopsis*, most often based on differences in microscopic features. In addition, some Friesian "armillarias," which differed from his tricholomas mainly by having membranous partial veils, have been transferred to *Tricholoma*, resulting in species such as *T. focale* being accepted in the genus. *Tricholoma*, as now generally circumscribed, has been shown to represent a monophyletic group (Sánchez-García et al. 2014).

Despite the fact that *Tricholoma* includes many of the larger and more conspicuous of our woodland fungi, the genus historically has received very little attention in North America. Charles Horton Peck described over 60 *Tricholoma* species in the late 1800s and early 1900s, although many of them subsequently have been transferred to other genera. Between roughly 1910 and 1950, William Alphonso Murrill described slightly more than 100 *Tricholoma* species. Some of these originally were described in other genera, especially *Melanoleuca*, and, similarly to Peck's species, many have since been transferred to other genera. In what still is the only comprehensive treatment of the genus in North America, Murrill prepared the "*Tricholoma*" section of the *North American Flora* (Murrill 1914) under the genus names, *Melanoleuca* and *Cortinellus*.

More recent regional monographic treatments include Clark Ovrebo's (1973) survey of the tricholomas of the Pacific Northwest, his later (Ovrebo 1980) study of the genus in the Great Lakes area, and Kris Shanks's (1994, 1997) survey of the tricholomas of California, which resulted in the description of several new species (Shanks 1996). More recently Ovrebo et al. (2009) produced a preliminary phylogeny of the genus, with emphasis on eastern North American taxa. Bessette et al. (2013) published a popular guidebook to the genus in North America. It drew attention to numerous areas of taxonomic uncertainty and the need for study of nearly all infrageneric groups within *Tricholoma*.

Matheny and Vellinga (2009) called attention to the need for a centralized and updated version of the out-of-date *North American Flora* published by the New York Botanical Garden, an outstanding resource from the early 1900s that provided dichotomous keys and descriptions to mushroom-forming fungi from North America. To illustrate this need, they used the genus, *Melanoleuca*, as an example. In

their words, "*Melanoleuca* is step-motherly treated in guide books where descriptions and illustrations are few. There is no insight into the number of species in North America, nor their identity, and there are no keys to the 17 species recognized for the USA so far. Distribution and ecology of the species are mostly unknown. There are no combined molecular-phylogenetic/morphologic-taxonomic treatments of the genus, nor is its position within the Agaricales sufficiently elucidated." Unfortunately, there are many genera of North American agarics for which resources are similarly sparse to nearly non-existent, and none that can be described as being well provided-for, including *Tricholoma*.

Subsequent to Matheny and Vellinga's plea, the Fungal Diversity Survey ("FunDis," originally known as the North American Mycoflora Project) has gathered momentum and now involves a large number of participants, both individual and organizational, throughout the continent (https://fundis.org/). The growing success of this project has increased the need for resources to assist the participants in identifying collected specimens and understanding their biology and ecology.

More than 130 "*Tricholoma*" species (TABLES 1 and 2) have been reported to occur in the Pacific Northwest region of North America (PNW), here taken to include Oregon, Washington, Idaho, southern and westernmost British Columbia, and southeastern and south-central Alaska. Northernmost California and westernmost Montana share many environmental characteristics of the PNW but, for ease of reference, we have not attempted to formally include them. Many of the epithets that have been applied pertain to species now accepted in other genera or that are so little known that it can't be certain what they are or, in some cases, even if they are tricholomas. Among the remaining ~100 names, many are based on European fungi, or on North American species whose protologues are very brief and usually unillustrated, so that it has been difficult to develop widely accepted concepts of the species involved. Thus, we hypothesized that many of the epithets were being misapplied when used for PNW fungi.

In order to begin to clarify the application of *Tricholoma* species names in the PNW and to contribute to future continent-wide and world-wide understanding of the genus, our main objectives were to (i) obtain ITS barcode sequences from the holotypes of *Tricholoma* species described from the PNW, selected other holotypes, and recent, excellent-condition, mostly well-photographed collections; (ii) provide an initial assessment of the phylogenetic diversity of PNW tricholomas; and (iii) assess the degree to which names based on fungi from outside the PNW can correctly be applied to our species. Although our work was not intended as a systematic or monographic study, in the course of the project we generated evidence for the existence of a number of undescribed species of *Tricholoma*. In most cases, solidification of species concepts and study of additional well-documented collections will be required before their status as new species can be confirmed. However there was sufficient information to allow publication of five new species and two new combinations (Trudell & Parker 2021, Trudell 2022).

MATERIALS AND METHODS

Type specimens for 23 *Armillaria* and *Tricholoma* / *Melanoleuca* species were obtained from the herbaria / fungaria at Cornell University (CUP; herbarium

TABLE 1. Species of *Tricholoma* reported to occur in the Pacific Northwest region of North America.

Epithet	Authority	Ovrebo (1973)	TNA[a]	PNWKC[b]	Myco Match[c]	Herbarium Records[d]
acerbum	(Bulliard) Quélet					OR
acre (-*is*)	Peck		X	X	X	WA
aestuans	(Fries) Gillet			X	X	
albobrunneum	(Persoon) P. Kummer			X	X	OR, WA, ID, BC
album	(Schaeffer) P. Kummer					BC
apium	Jul. Schäffer		X	X	X	WA, BC
arenarium (=*equestre*)	(Léveillé) Gillet					WA
argenteum	Ovrebo		X	X	X	
argyraceum	(Bulliard) Gillet					ID
arvernense	Bon		X		X	OR, WA, ID
atrodiscum (-*us*)	Ovrebo			X		
atrosquamosum	Saccardo		X	X	X	OR, WA, BC
atroviolaceum	A.H. Smith	X	X	X	X	OR, WA, ID, BC
aurantio-olivaceum	A.H. Smith	X	X	X	X	OR, WA, BC
aurantium	(Schaeffer) Ricken	X	X	X	X	OR, WA, ID, BC, AK
bisporigerum (=*terreum*)	J.E. Lange					WA
brunneosquamosa	Beeli					ID
bufonium	(Persoon) Gillet			X	X	WA, BC
californicum (=*subannulatum*)	(Murrill) Murrill					OR
caligatum	(Viviani) Ricken		X	X		OR, WA, BC, AK
cartilagineum	(Bulliard) Quélet					OR
cheilolaminum (=*davisiae*)	Ovrebo & Tylutki	X				OR, WA, ID
chrysites (=*scalpturatum*)	(Junghuhn) Quélet					WA
cingulatum	(Almfelt) Jacobasch	X	X	X	X	OR, WA, BC
columbetta	(Fries) P. Kummer					BC, AK
davisiae	Peck		X	X	X	WA, ID, BC
dryophilum	(Murrill) Murrill		X		X	
dulciolens	Kytövuori				X	
equestre/*flavovirens*	(Linnaeus) P. Kummer/ (Persoon) S. Lundell	X	X	X	X	OR, WA, ID, BC, AK
farinaceum	(Murrill) Murrill	X	X	X	X	OR
flavobrunneum (=*fulvum*)	(Fries) P. Kummer					OR, WA
focale	(Fries) Ricken		X	X	X	OR, WA, ID, BC, AK
fracticum (=*batschii*)	(Britzelmayr) Kreisel		X			
fulvum	(Candolle) Bigeard & H. Guillemin		X	X	X	OR, WA, BC, AK
fumosoluteum	(Peck) Saccardo					ID
gausapatum (=*terreum*)	(Fries) Quélet					BC

Epithet	Authority	Ovrebo (1973)	TNA[a]	PNWKC[b]	Myco Match[c]	Herbarium Records[d]
grande	Peck					WA
griseoviolaceum	Shanks		X			BC
huronense	A.H. Smith			X	X	
imbricatum	(Fries) P. Kummer	X	X	X	X	OR, WA, ID, BC, AK
impolitum (=*acerbum*? *columbetta*?)	(Lasch) P. Kummer					WA, ID
inamoenum	(Fries) Gillet	X	X	X	X	OR, WA, ID, BC, AK
intermedium	Peck		X	X	X	OR, WA, ID, BC
joachimii	Bon & A. Riva					OR
josserandii	Bon					WA
leucophyllum (=*intermedium*)	Ovrebo & Tylutki	X				ID, BC
luteomaculosum	A.H. Smith		X	X	X	BC
manzanitae	Baroni & Ovrebo		X			OR
marquettense	Ovrebo		X			WA
moseri	Singer		X		X	OR, WA
muricatum	Shanks		X	X	X	OR, WA, BC
murrillianum [incl. as *magnivelare*]	Singer	X	X	X	X	OR, WA, ID, BC
mutabile	Shanks		X	X	X	BC
myomyces (=*terreum*)	(Persoon) J.E. Lange	X	X	X	X	OR, WA, ID, BC, AK
nictitans (=*fulvum*)	(Fries) Gillet					WA
nigrocystidium	nom. prov. (Ovrebo 1973)	X		X		
nigrum	Shanks & Ovrebo		X	X	X	OR, WA
odorum	Peck	X	X	X	X	WA
orirubens	Quélet	X		X	X	OR, WA
pardinum	(Persoon) Quélet	X	X	X	X	OR, WA, ID, BC
pessundatum	(Fries) Quélet	X	X	X	X	OR, WA, ID, BC, AK
platyphyllum	(Murrill) Murrill	X		X	X	OR, WA, ID, BC, AK
populinum	J.E. Lange	X	X	X	X	OR, WA, ID, BC, AK
portentosum	(Fries) Quélet	X	X	X	X	OR, WA, ID, BC, AK
portentosum var. avellaneifolium (=*mutabile*)	(Murrill) A.H. Smith	X				WA
psammopus	(Kalchbrenner) Quélet			X		ID, BC
pullum	Ovrebo					BC
resplendens (=*columbetta*)	(Fries) P. Karsten					BC, AK
robustum	(Albertini & Schweinitz) Ricken	X		X	X	OR, WA, BC

Epithet	Authority	Ovrebo (1973)	TNA[a]	PNWKC[b]	Myco Match[c]	Herbarium Records[d]
saponaceum	(Fries) P. Kummer	X	X	X	X	OR, WA, ID, BC, AK
scalpturatum	(Fries) Quélet		X	X	X	WA, BC
sciodes	(Persoon) C. Martín					BC
sejunctum	(Sowerby) Quélet	X	X	X	X	OR, WA, ID, BC, AK
silvaticum	Peck			X		
spermaticum (=*umbonatum*?)	(Fries) Gillet					WA
squarrulosum	Bresadola		X	X		WA, BC
stans	(Fries) Saccardo			X	X	OR, BC, AK
striatum (=*albobrunneum*)	(Schaeffer) Quélet			X		BC
subacutum	Peck					OR, WA
subannulatum	(Peck) Zeller					OR
subluridum	(Murrill) Murrill	X		X	X	
subluteum	Peck			X	X	BC
subsejunctum	Peck					OR, WA, ID, BC
subumbrinum	A.H. Smith	X		X	X	WA
sudum	(Fries) Quélet					ID
sulphurescens	Bresadola		X	X	X	WA, ID, BC, AK
sulphureum	(Bulliard) P. Kummer	X	X	X	X	OR, WA, ID, BC, AK
terreum	(Schaeffer) P. Kummer	X	X	X	X	OR, WA, ID, AK
transmutans	(Peck) Saccardo		X		X	OR, WA
triste	(Scopoli) Quélet			X	X	OR, WA, ID
tumidum	(Persoon) Ricken		X			OR
umbonatum	Clémençon & Bon			X		
ustale	(Fries) P. Kummer		X	X	X	OR, WA, ID, BC, AK
ustaloides	Romagnesi					OR, BC
vaccinum	(Schaeffer) P. Kummer	X	X	X	X	OR, WA, ID, BC, AK
venenatum	G.F. Atkinson		X	X	X	OR, WA, BC
vernaticum	Shanks		X	X	X	OR, WA
virgatum	(Fries) P. Kummer	X	X	X	X	OR, WA, ID, BC, AK
zelleri (=*focale*)	(D.E. Stuntz & A.H. Smith) Ovrebo & Tylutki	X			X	OR, WA, ID, BC, AK
	No. Species:	31	49	58	56	

[a] TNA = *Tricholomas of North America* (Bessette et al. 2013)

[b] Leuthy C. 2019. *A skeleton trial key to* Tricholoma *in the Pacific Northwest*. Prepared for the Pacific Northwest Key Council.

[c] MycoMatch (MatchMaker). Mushrooms of the Pacific Northwest. Version 2.4. Copyright Ian Gibson 1999–2020.

[d] State/province list based on herbarium specimen records accessed via MyCoPortal (15 June 2019).

TABLE 2. Species reported from the PNW as tricholomas that are no longer accepted in *Tricholoma*.

Epithet	Authority[a]	Current name
alboflavidum	(Peck) Saccardo	*Collybia alboflavida* (Peck) Kauffman
amplum	(Persoon) Rea	*Lyophyllum decastes* (Fries) Singer
arcuatum	(Bulliard) Quélet	*Melanoleuca arcuata* (Bulliard) Singer
avellaneifolium	(Murrill) Murrill	*Melanoleuca avellaneifolium* Murrill
bicolor	(Murrill) Murrill	*Melanoleuca bicolor* Murrill
calathus	Never combined in *Tricholoma*?	*Lepista sordida* (Schumacher) Singer? *L. calathus* (Fries) Bon?
chrysenteroides	Peck	*Melanoleuca chrysenteroides* (Peck) Murrill
cinerascens	(Bulliard) Gillet	*Lyophyllum decastes* (Fries) Singer
cognatum	(Fries) Gillet	*Melanoleuca cognata* (Fries) Konrad & Maublanc
crassifolium	Saccardo	*Lyophyllum crassifolium* (Saccardo) Singer
cystidiosum	A.H. Smith	*Inocybe cystidiosa* (A.H. Smith) Singer
decorum	(Fries) Quélet	*Tricholomopsis decora* (Fries) Singer
fallax	Quélet & Schulzer	*Megacollybia fallax* (A.H. Smith) R.H. Petersen & J.L. Mata?
fuligineum	Peck	*Lyophyllum fuligineum* (Peck) Singer
grammopodium	(Bulliard) Quélet	*Melanoleuca grammopodia* (Bulliard) Murrill
ionides	(Bulliard) P. Kummer	*Calocybe ionides* (Bulliard) Donk
irinum	(Fries) P. Kummer	*Lepista irina* (Fries) H.E. Bigelow
laterarium	(Peck) Saccardo	*Leucopaxillus laterarius* (Peck) Singer & A.H. Smith
melaleucum	(Persoon) P. Kummer	*Melanoleuca melaleuca* (Persoon) Murrill
memmingeri	(Murrill) Murrill	*Melanoleuca memmingeri* Murrill
naucoria	(Murrill) Murrill	*Calocybe naucoria* (Murrill) Singer
nudum	(Bulliard) P. Kummer	*Lepista nuda* (Bulliard) Cooke
onychinum	(Fries) Gillet	*Calocybe onychina* (Fries) Donk
panaeolus var. *caespitosum*	Bresadola	*Clitocybe fasciculata* H.E. Bigelow & A.H. Smith
personatum	(Fries) P. Kummer	*Lepista personata* (Fries) Cooke
rhizoideum	A.H. Smith	*Clitocybe ramigena* H.E. Bigelow
roseobrunneum	(Murrill) Murrill	*Leucopaxillus gentianeus* f. *roseobrunneus* sensu Singer & A.H. Smith
russula	(Schaeffer) Gillet	*Hygrophorus russula* (Schaeffer ex Fries) Kauffman
rutilans	(Schaeffer) P. Kummer	*Tricholomopsis rutilans* (Schaeffer) Singer
sclerotoideum	Morse	*Clitocybe sclerotoidea* (Morse) H.E. Bigelow
secedifolium	(Murrill) Murrill	*Tricholomopsis secedifolia* (Murrill) Singer
sordidum	(Schumacher) P. Kummer	*Lepista sordida* (Schumacher) Singer
subpessundatum	(Murrill) Murrill	*Limacella subpessundata* (Murrill) Singer
terriferum	Peck	*Melanoleuca terrifera* (Peck) Murrill

[a] Per *Index Fungorum*. In many reports, the authority has not been included.

abbreviations follow those in *Index Herbariorum* [Thiers, continuously updated]), Field Museum (F), New York Botanical Garden (NY), and San Francisco State University (SFSU), as well as 46 additional specimens of interest from SFSU, University of British Columbia (UBC), University of California, Berkeley (UC), and University of Washington (WTU) (APPENDIX 1), including permission to sample the collections for DNA sequencing. Eighty-eight more recent exsiccates, subsequently deposited at WTU, also were included (APPENDIX 1). Not all of the samples yielded usable DNA despite multiple extraction attempts, so there are gaps in the TR### sample-number sequence. Some specimens were sequenced twice, in separate labs (University of Washington, Tacoma, Washington and Molecular Solutions, LLC, Portland, Oregon) for quality assurance purposes.

In the sequencing, we targeted the two internal transcribed spacers in the nuclear rDNA region (ITS1–5.8S–ITS2 = "ITS"), which is commonly used for fungus species identification and represents the universal fungus barcode (Schoch et al. 2012). Details of the procedures followed for DNA extraction, amplification, and sequencing are provided in APPENDIX 2.

Four hundred thirty-one additional sequences, including many identified during review of previous studies (e.g., Heilmann-Clausen et al. 2017, Ovrebo & Hughes 2018, Ovrebo et al. 2019, Reschke et al. 2018), were obtained from GenBank or other researchers (APPENDIX 3) to assemble a geographically diverse dataset that broadly represents *Tricholoma*, in order to provide a framework within which to assess the PNW species. *Dermoloma magicum* was chosen as outgroup for the analyses.

Sequences were aligned using MAFFT 7 (Katoh and Toh 2008; http://mafft.cbrc.jp/alignment/server/) and edited and manually adjusted in AliView 1.11 (Larsson 2014). Regions of the dataset with ambiguous alignments were excluded. The aligned sequence set was analyzed using two methods: (i) maximum likelihood (ML) analyses using RAxML 8.2.9 (Stamatakis 2014), with 1000 rapid bootstrap replicates; (ii) Bayesian inference (BI) analyses using MrBayes 3.2.6 (Ronquist et al. 2012). Details of the phylogenetics analysis procedures are provided in APPENDIX 2.

We consider ML bootstrap values (MLBS) ≥70% and BI posterior probabilities (BIPP) ≥0.95 to indicate strong support.

RESULTS

Species occurrences supported by our work

We successfully obtained 142 ITS sequences from 134 specimens, including 17 from 14 holotypes. Sequences from specimens that were processed twice, in separate labs, for quality assurance purposes were not always identical but, in all cases, grouped in the same terminal clade.

The ML and BI analyses returned tree topology quite similar to each other and to the ITS trees reported by previous workers (Heilmann-Clausen et al. 2017, Ovrebo et al. 2009, Reschke et al. 2018). The 573 sequences fell within 17 well-defined clades (FIG. 1), 16 of which are well supported (one of those in BI only) and most of which correspond approximately to section rank (cf. Heilmann-Clausen et al. 2017, Reschke et al. 2018): Clade 1 = Sect. *Tricholoma*; Clade 2 = Sect. *Contextocutis* / *Rigida*; Clade 3 = Sect. *Genuina*; Clade 4 = Sect. *Megatricholoma*; Clade 5 = *T. apium*; Clade 6 = Sect. *Caligata*; Clade 7 = Sect. *Sericella*; Clade 8 = Sect. *Lasciva*; Clade 9 = Sect. *Pardinicutis*;

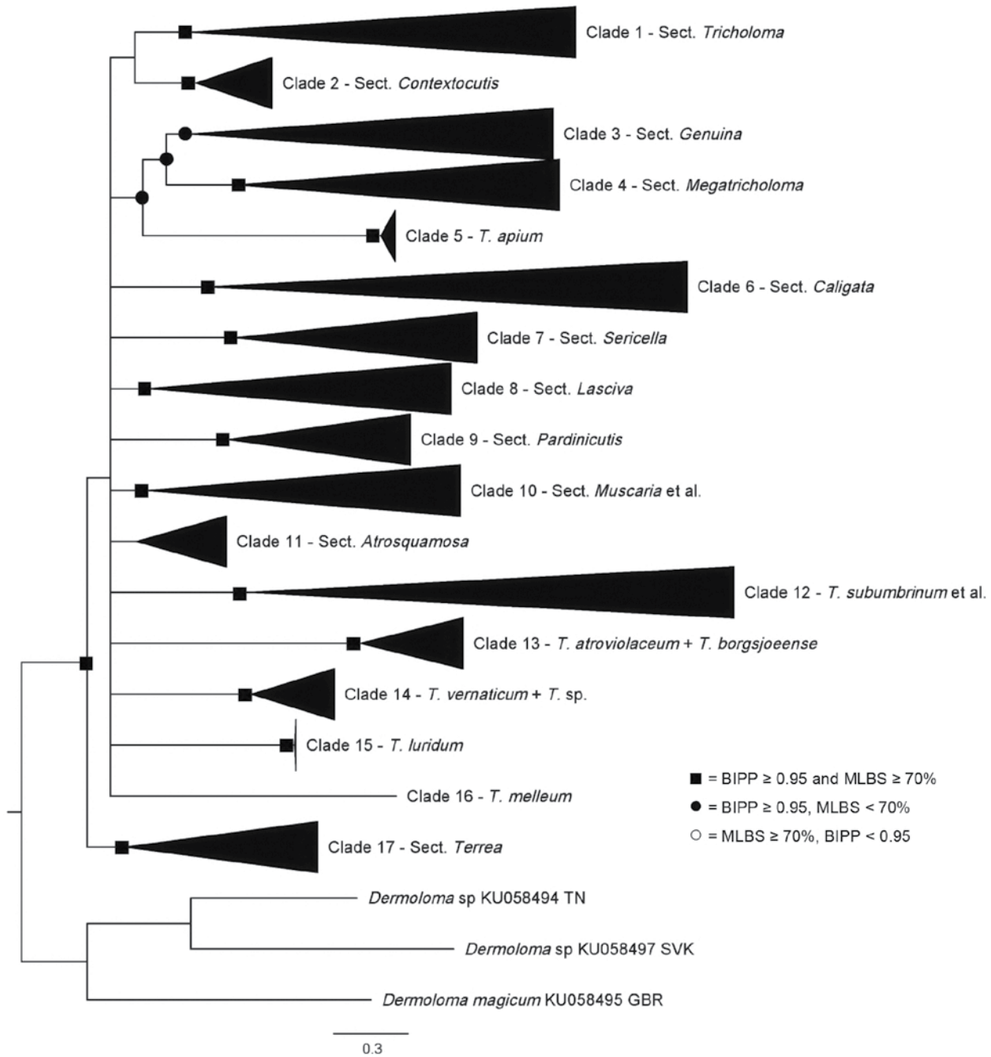

FIG. 1. Fifty percent majority-rule consensus tree from the BI analysis of the ITS dataset. Node symbols: solid squares = BI posterior probability (BIPP) ≥0.95 and ML bootstrap value (MLBS) ≥70%; solid circles = BIPP ≥0.95, MLBS <70%; open circles = MLBS ≥70%, BIPP <0.95. Major clades have been collapsed and root length reduced to facilitate graphical presentation. Details of each of the 17 major clades are provided in subsequent figures.

Clade 10 in part = Sect. *Muscaria*; Clade 11 = Sect. *Atrosquamosa* (relatively weak support, especially in ML); Clade 12 = *T. subumbrinum* – *T. mutabile* group; Clade 13 = *T. borgsjoeënse* + *T. atroviolaceum*; Clade 14 = *T. vernaticum* + "*T. turpescens*"; Clade 15 = *T. luridum*; Clade 16 = *T. melleum*; Clade 17 = Sect. *Terrea*. The PNW species are discussed by clade, below.

***Clade 1: Section* Tricholoma.** Our Clade 1 corresponds to Sect. *Tricholoma* sensu Heilmann-Clausen et al. (2017) and Reschke et al. (2018). The PNW mycota includes representatives of most of the principal groups within the section including (i) *T. subacutum*, sister species to the European *T. virgatum*; (ii) *T. griseoviolaceum* / *T.* "*portentosum*" specimens in a *T. portentosum* complex; (iii) *T. subsejunctum* and *T. atrofibrillosum* in the *T. sejunctum* complex; (iv) *T. intermedium* and a number of probably undescribed *T.* "*equestre*" / "*flavovirens*" and *T.* "*frondosae*" species in the large *T. equestre* complex; and (v) *T. megalophaeum*, a new species, closely related to *T. guldeniae*.

Clade 1a. Sect. *Tricholoma* in part (FIG. 2)

Tricholoma atrofibrillosum S.A. Trudell, A.D. Parker & E.T. Cline and ***T. subsejunctum*** Peck

Tricholoma sejunctum (Sowerby) Quélet is a European species associated with deciduous angiosperm trees such as beech, oak, hazel, and hornbeam. It is most common in southern and central Europe and declines in abundance northward (Christensen & Heilmann-Clausen 2013). Our analyses returned a well-supported broad "*T. sejunctum*" complex, including *T. sejunctum* sensu stricto (Europe), *T. subluteum* (eastern North America), *T. viridilutescens* (Europe, two separate clades), *T. olivaceoluteolum* (China), *T. rufenum* (Europe), *T. sinoportentosum* (China), and two groups of North American "*sejunctum*" / "*subsejunctum*" / "*viridilutescens*" collections. The first of the latter two groups is a well-supported (ML only) clade consisting of specimens from Ontario, North Carolina, and Alaska (TR002). We consider it likely that this represents *T. subsejunctum*. The second well-supported North American clade contains specimens from California, Idaho, and Alaska and represents the new species *T. atrofibrillosum*.

Tricholoma subsejunctum was described from New York, where the holotype was collected in a mixed forest of conifers and deciduous angiosperms. Peck stated that it differs from *T. sejunctum* primarily in the darker more pronounced radial fibrils on the pileus surface and, probably, in the association with conifers. After studying the holotype, Ammirati and Ovrebo (1979) concluded that, with respect to micromorphology, *T. subsejunctum* is almost identical to *T. sejunctum*. Peck considered it a rare species. Although the macromorphology of our collection TR002 closely fits Peck's type description, the spores of TR002 are larger (mean = 7.6 × 5.9 µm, n = 70) than those reported by Peck (5–6 × 4–5 µm) and Ammirati & Ovrebo (5.7–6.7 × 4.8–5.7 µm). Thus, it would be desirable to obtain an ITS sequence from the holotype or a designated epitype collection to confirm the occurrence of *T. subsejunctum* in the PNW.

Tricholoma atrofibrillosum differs from *T. sejunctum* by the much darker radial fibrils on the cap surface, its occurrence with conifers, and by geographic distribution. Based on the samples studied so far, there are no obvious morphological or ecological features to distinguish *T. atrofibrillosum* from *T. subsejunctum*. However, as shown in FIG. 2, the degree of ITS divergence is high among these two species and *T. viridilutescens* Type II.

We are not aware of any evidence that would support the occurrence of *T. sejunctum* sensu stricto in the PNW and consider past reports to be misapplications of the name.

Illustrations and descriptions: FIG. 3A; Baroni 2017; Bessette et al. 2013, p. 141(A–

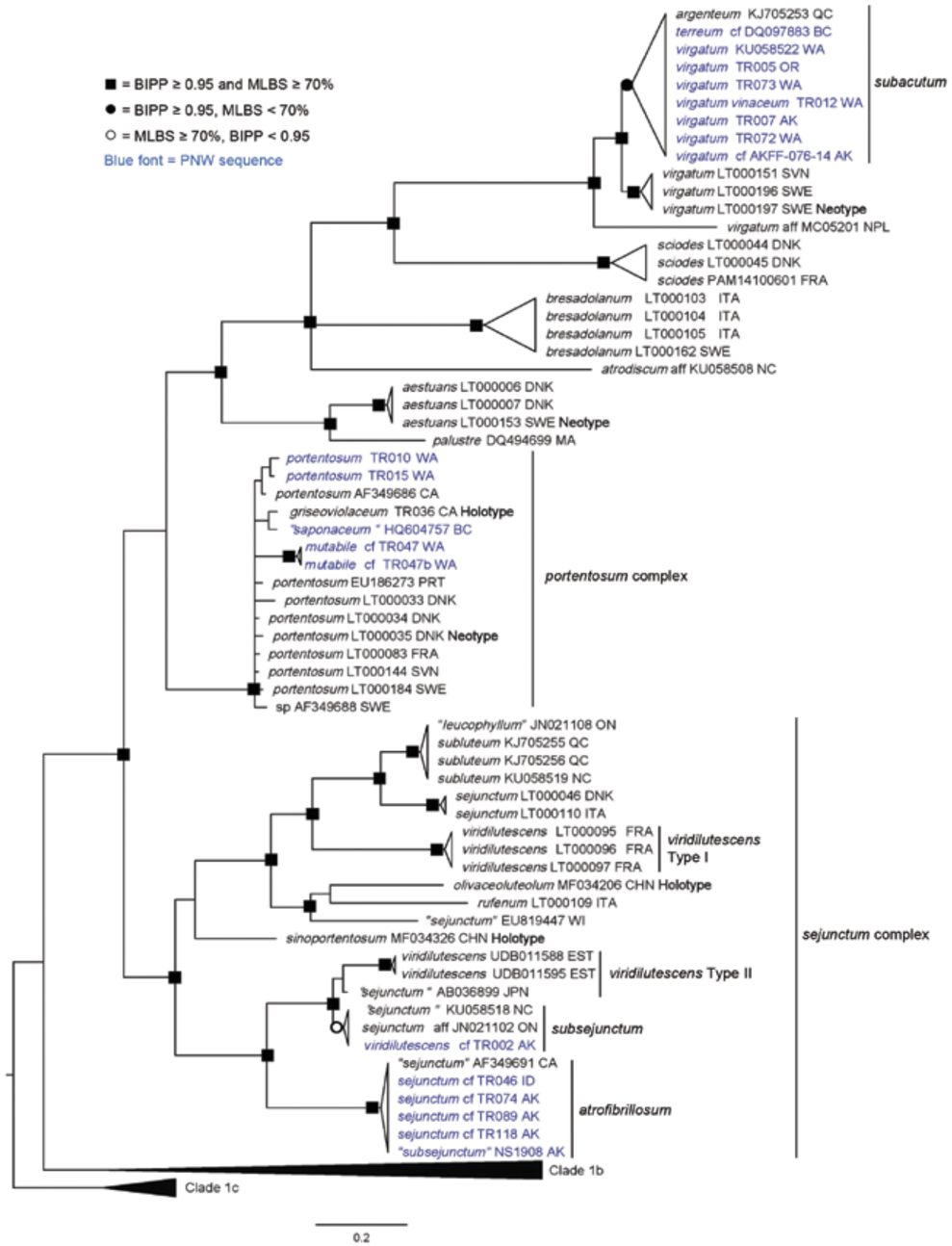

FIG. 2. Detail of Clade 1a, Section *Tricholoma* in part. Symbols as in FIG. 1. PNW sequences shown in blue.

B), 142(C); McNeil 2006 (*T. subsejunctum*). FIG. 3B–E, 4; Bessette et al. 2013, p. 142(E); Trudell & Parker 2021 (description) (*T. atrofibrillosum*).

Tricholoma portentosum (Fries) Quélet

Tricholoma portentosum generally is considered a relatively large species with a grayish somewhat viscid pileus, whitish lamellae and stipe that often develop yellowish tones, mildly farinaceous odor and taste, and association with conifers. Our analyses returned a well-supported "*T. portentosum*" clade that includes the *T. portentosum* neotype and the *T. griseoviolaceum* holotype, however, there is little support for *T. griseoviolaceum* (BIPP = 0.81; MLBS = 45%) and for other PNW / California "*T. portentosum*" specimens. For now, we accept *T. portentosum* sensu lato as occurring in the PNW, pending future work to better resolve the relationships in this group.

After study of the holotype, Shanks (1994) concluded that *T. avellaneifolium* (Murrill) Murrill actually represents a species of *Lyophyllum*. Thus, *T. portentosum* var. *avellaneifolium* (Murrill) A.H. Smith, described from Olympic National Park, Washington, required a new name, which Shanks (1996) provided — *T. mutabile*. It appears in our Clade 12 (FIG. 31) with other species that do not fall in one of the traditional sections and was included in Shanks (1994) under the provisional name, *T. smithii*.

Illustrations and descriptions: FIG. 3F–H; Bessette et al. 2013, p. 127(D); Breitenbach & Kränzlin 1991; Christensen & Heilmann-Clausen 2013; Ludwig 2012; Læssøe & Petersen 2019; McKenny et al. 1987; Shanks 1997; Siegel & Schwarz 2016.

Tricholoma subacutum Peck

Misapplied names: Tricholoma virgatum, *T. argenteum*

Tricholoma subacutum was described from New York where it was reported to occur with spruce and fir. Peck (1903) stated that it is easily recognized by its prominent pointed, often darkly colored, umbo, by the radiating brown or blackish lines or fibrils on its dry cap, and by the white color of its flesh and stem. The taste was described as sometimes acrid and sometimes mild (perhaps because the taste can be slow to develop). In both the protologue and the later description (Peck 1903), Peck commented on the close similarity of *T. subacutum* and *T. virgatum*, saying "The species is so closely related to the European virgate tricholoma, *Tricholoma virgatum*, that it is with some hesitation that I have kept it distinct." Both Ovrebo (1989) and Shanks (1994) considered the two species to be synonymous. In our analysis, all North American "*T. virgatum*" specimens and one "*T. argenteum*" specimen formed a well-supported clade sister to the European *T. virgatum* clade, the latter of which includes the neotype. The morphology and ecology of the collections we have examined agree well with the description of *T. subacutum* and we accept that name for our PNW taxon. According to Ovrebo (1989), *T. argenteum* is distinguished by a light gray to silvery gray pileus, innate, radially arranged pileus surface fibrils, and bitter taste, and differs from *T. virgatum* in lacking an acute umbo or at most having a rounded subacute umbo, lighter pileus surface, and by lacking a distinctly virgate pileus surface. ITS or other DNA sequences from the holotype do not appear to be available. For now, we interpret the "*T. argenteum*" specimen in our analyses as a misapplication of the name. However, further work, including DNA sequence analysis of the type collections and recent well-documented material, would be desirable to

FIG. 3. Photographs of Tricholoma collections studied in this project. A. *T. subsejunctum* (TR002). B–E. *T. atrofibrillosum* (B: TR046. C: TR074. D: TR089. E: NS1908). F–H. *T. portentosum* s.l. (F: TR047. G: TR010. H: TR015). Collection details can be found in APPENDIX 1 (TR### collections) and APPENDIX 3 (others). E. Photograph courtesy of Noah Siegel.

FIG. 4. Photograph of holotype collection for *Tricholoma atrofibrillosum* (TR118). Collection details can be found in APPENDIX 1.

clarify the relationship between *T. subacutum* and *T. argenteum*.

Illustrations and descriptions: FIG. 5A–F; Baroni 2017; McNeil 2006; Shanks 1997; Siegel & Schwarz 2016; Trudell & Ammirati 2009 (all as "*T. virgatum*.").

Clade 1b. Sect. *Tricholoma* in part (FIG. 6)
Tricholoma equestre (Linnaeus) P. Kummer

Synonyms: *Tricholoma arenarium* (Léveillé) Gillet, *T. auratum* (Paulet) Gillet, *T. flavovirens* (Persoon) S. Lundell

"*Tricholoma equestre*" represents a complex of many species that will require considerable future work to resolve. For instance, Heilmann-Clausen et al. (2017), Moukha et al. (2013), and Reschke et al. (2018) recognized multiple clades within the complex with little correspondence to the epithets applied to the specimens, which included *auratum*, *equestre*, *flavovirens*, and *frondosae*. We observed a similar pattern, including sequences labeled with those epithets, but also others labeled *ulvinenii*, *intermedium*, *leucophyllum*, and *joachimii*. Consistent with the findings of Horton (2002), it is clear that we have multiple (perhaps as many as six or more) "*equestre*" / "*frondosae*" species in the PNW, but establishing the species boundaries and how the PNW taxa relate to those in Europe and elsewhere will require revision, beginning with solidifying the concepts for the previously described European species. For now, it will probably be best to refer to PNW collections as "*T. equestre* group."

Illustrations and descriptions: FIG. 5G–H, 7A–E; Bessette et al. 2013, (p. 62[C] *T. frondosae* s.l., [D–E] *T. equestre* s.l.); Breitenbach & Kränzlin 1991 (*T. frondosae* s.l., as *T. equestre*); Christensen & Heilmann-Clausen 2013, p. 101, 103 (*T.*

FIG. 5. Photographs of *Tricholoma* collections studied in this project. A–F. *T. subacutum* (A: TR005. B: TR007. C: TR012. D: TR072. E. TR073. F: AKFF-076-14). G–H. *T. equestre* group (G: TR009. H: TR079). Collection details can be found in APPENDIX 1 (TR### collections) and APPENDIX 3 (others).

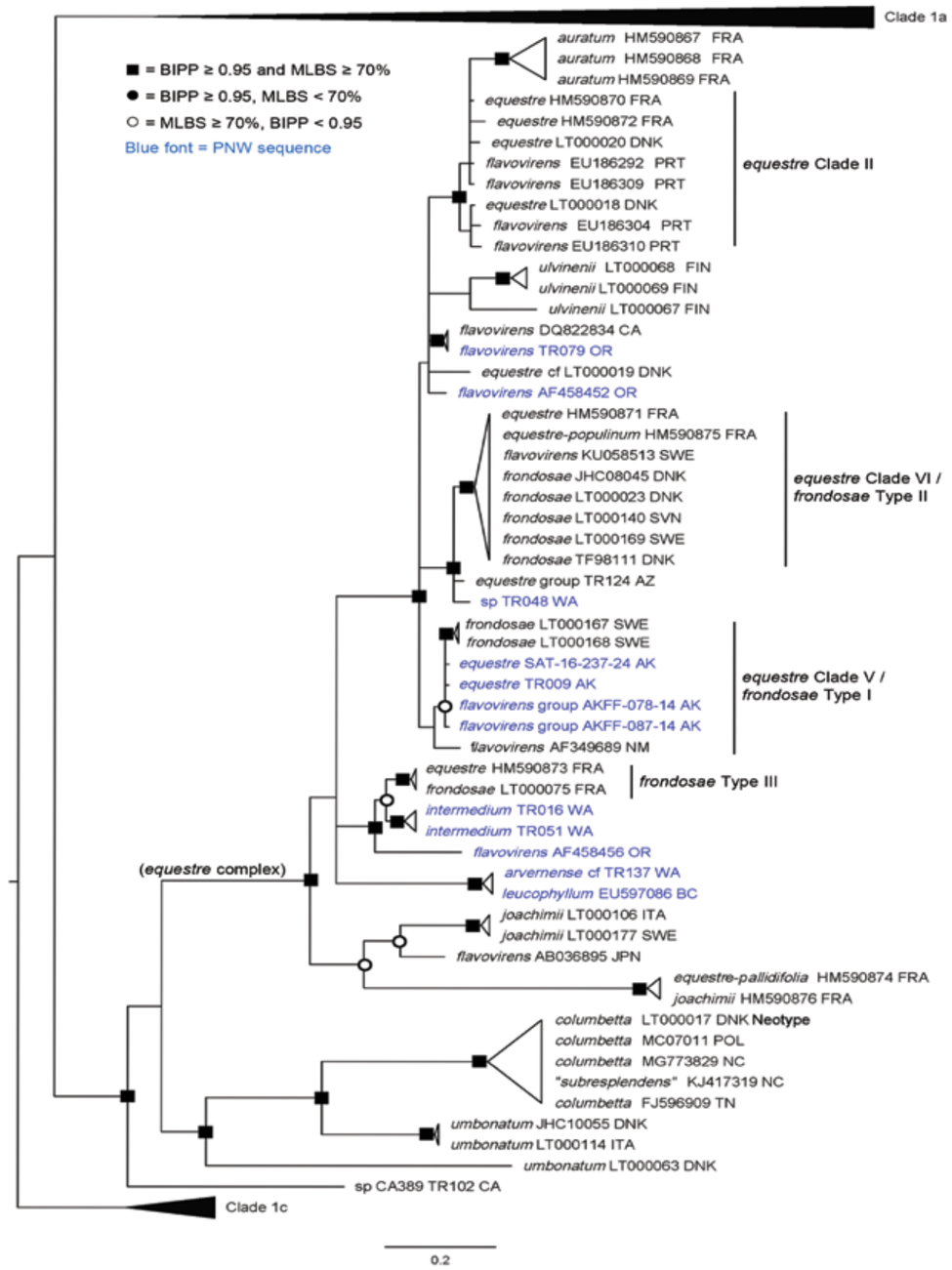

FIG. 6. Detail of Clade 1b, Section *Tricholoma* in part. Symbols as in FIG. 1. PNW sequences shown in blue.

FIG. 7. Photographs of *Tricholoma* collections studied in this project. A–E. *T. equestre* group (A: TR124. B: TR137. C: AKFF-078-14. D: AKFF-087-14. E: SAT-16-237-24). F–G. *T. intermedium* (F: TR016. G: TR051). H. *T. megalophaeum* (TR081). Collection details can be found in APPENDIX 1 (TR### collections) and APPENDIX 3 (others). C–D. Photographs courtesy of Noah Siegel.

equestre s.l.), 102, 105 (*T. frondosae*); Desjardin et al. 2015; Ludwig 2012; Læssøe & Petersen 2019; McKenny et al. 1987 (as *T. flavovirens*); Siegel & Schwarz 2016; Trudell & Ammirati 2009.

Tricholoma intermedium Peck

Synonym: *Tricholoma leucophyllum* Ovrebo & Tylutki

Tricholoma intermedium was described from a "thin woods" of unspecified tree species composition in New York. The epithet reflects Peck's interpretation of the species as intermediate between *T. equestre* and *T. sejunctum*. It resembles some forms of *T. equestre* in its slightly viscid, greenish-yellow cap but differs in having whitish gills. It differs from *T. sejunctum* principally in having a glabrous, rather than fibrillose, cap. Ovrebo (1980) concluded that *T. leucophyllum* was a synonym of *T. intermedium* and we follow his interpretation here (although note in FIG. 6 the GenBank sequence from British Columbia labelled "*leucophyllum*" that clusters with our TR137, labelled "*arvernense* cf."). The morphology of two PNW collections of *T. intermedium* (TR016 and TR051) closely matches descriptions and photographs of eastern North American collections (McNeil 2006; Bessette et al. 2013) as well as Peck's original description, and their occurrence with conifers agrees with that of the recent eastern reports. In our analyses, sequences from those collections grouped with French samples labelled "*equestre*," and "*frondosae*," so *T. intermedium* belongs in the *T. equestre* complex and is more distantly related to the *T. sejunctum* complex.

Illustrations and descriptions: FIG. 7F–G; Bessette et al. 2013; McNeil 2006.

Clade 1c. Sect. *Tricholoma* in part (FIG. 8) In our analyses, this small group was sister to Clades 1a and 1b within Sect. *Tricholoma*. Three European specimens of *T. guldeniae* formed a well-supported clade sister to a well-supported clade consisting of TR081 and TR154, which represents the new species, *T. megalophaeum*.

Tricholoma megalophaeum N. Siegel, S.A. Trudell & A.D. Parker

Tricholoma megalophaeum is medium-sized to large with a dry umbonate cap that is appressed-fibrillose or faintly virgate and very dark olivaceous gray over a yellowish ground color. The gills are pale cream with a grayish cast to dingy grayish yellow and slightly eroded. The stipe is equal or somewhat clavate with an abruptly rounded to bulbous base, dry, fibrillose-scaly, and off-white to pale yellowish. The odor is slightly farinaceous, sometimes somewhat like green corn and the taste is mild to slightly farinaceous. All known collections to date have come from coastal conifer forests that contain abundant Sitka spruce. *Tricholoma guldeniae* is a very similar species described from Norway that also occurs primarily with spruce in near-coastal environments. Based on the illustrations we have seen, its cap is considerably lighter in color, at least at maturity.

Illustrations and descriptions: FIG. 7H, 9A, 10; Trudell & Parker 2021 (description).

Clade 2. Sect. *Contextocutis* / *Rigida* (FIG. 11)**.** Our Clade 2 corresponds to Sect. *Contextocutis* sensu Heilmann-Clausen et al. (2017) and Sect. *Rigida* sensu Reschke et al. (2018). As in the former study, our analyses supported the existence of at least four European taxa, viz. *T. "saponaceum*," *T. sudum*, *T. rapipes*, and *T. boudieri*. European specimens labelled *"T. saponaceum*" were paraphyletic with respect to *T. rapipes* and might represent two different species. Unfortunately, there is no type material

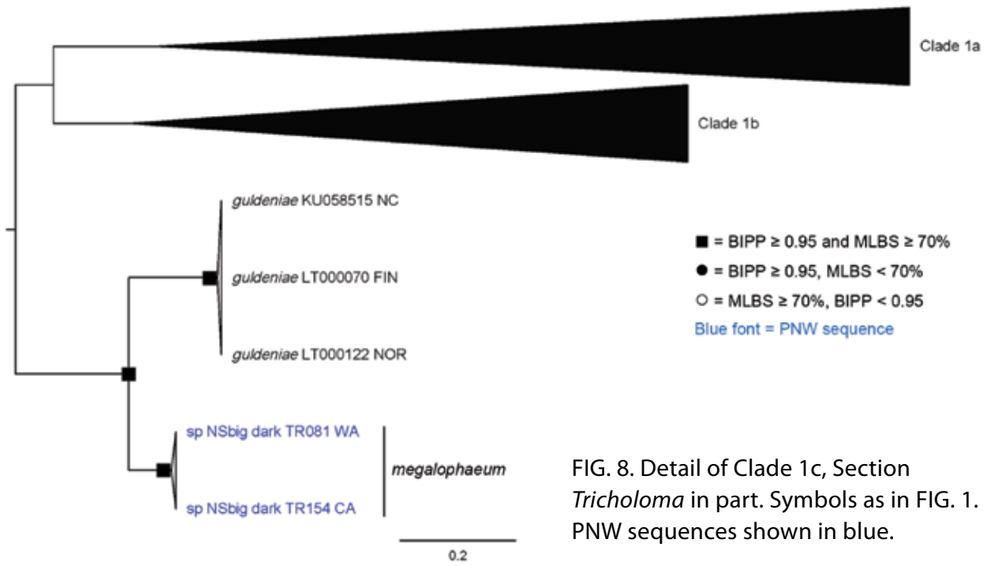

FIG. 8. Detail of Clade 1c, Section *Tricholoma* in part. Symbols as in FIG. 1. PNW sequences shown in blue.

for *T. saponaceum* so it remains unclear just what the "real" *T. saponaceum* is. In addition, specimens of *T. olivaceum* and *T. viridiolivaceum*, from China and New Zealand, respectively, fell within the clade that includes specimens labelled *T. boudieri*, so the latter epithet may encompass more than one species, as was noted by Heilmann-Clausen et al. (2017). All North American specimens, including those from the PNW, clustered separately from specimens from other continents in a paraphyletic assemblage. It appears that several lineages are represented but more work will be needed to resolve the relationships among them and determine appropriate names.

Tricholoma saponaceum (Fries) P. Kummer

Tricholoma saponaceum sensu lato is a highly variable species and many varieties have been described (Christensen & Heilmann-Clausen 2013). However, those authors concluded that many of the varieties were based on characters that are highly variable and have limited taxonomic value. Nonetheless, at least *T. rapipes* and *T. boudieri* are sufficiently distinct to warrant recognition at species rank (Heilmann-Clausen et al. 2017). Our analyses returned a well-supported broad "*T. saponaceum*" clade, with two large groups sister to *T. forteflavescens* (China). The first group consists of European "*T. saponaceum*" specimens that, together, are paraphyletic with respect to *T. rapipes*. The second group consists of a number of North American specimens that, together, are paraphyletic with respect to species from other continents, including *T. sudum* (Europe), *T. boudieri* (Europe, multiple specimens likely representing more than one species), *T. olivaceum* (China), and *T. viridiolivaceum* (New Zealand). It appears that the North American collections could represent a number of distinct lineages, three of which occur in the PNW. Further work, including designation and sequencing of a type specimen for *T. saponaceum* sensu stricto, will be necessary to resolve the relationships within this group. For now, we accept the occurrence of *T.*

FIG. 9. Photographs of *Tricholoma* collections studied in this project. A. *T. megalophaeum* (TR154). B–F. *T. saponaceum* group (B: TR123. C: TR130. D: AKFF-082-14. E: SAT-16-237-07. F: SAT-16-237-14). G–H. *T. ammophilum* (G: TR017. H: TR096). Collection details can be found in APPENDIX 1 (TR### collections) and APPENDIX 3 (others). A, D. Photographs courtesy of Noah Siegel.

saponaceum sensu lato in the PNW.

Illustrations and descriptions: FIG. 9B–F; Bessette et al. 2013, p. 137(H); McKenny et al. 1987; Siegel & Schwarz 2016.

Clade 3: Section *Genuina*. Our Clade 3 corresponds to Sect. *Genuina* sensu Heilmann-Clausen et al. (2017) and Reschke et al. (2018) and, as in those studies, we observed two subclades, both well supported. The first includes the species with reddish brown colors and a usually viscid to glutinous pileus surface such as *T. focale*, *T. fulvum*, and *T. subannulatum*. It includes a clade formed exclusively by a large number of Southern Hemisphere specimens. The second subclade includes species with a dry, often scaly, pileus surface such as *T. vaccinum*. The PNW *T. aurantio-olivaceum* groups with the European *T. imbricatum* and closely related West Coast "*T. imbricatum*" specimens (FIG. 19) and does not appear to be very closely

FIG. 10. Photograph of holotype collection for *Tricholoma megalophaeum* (Noah Siegel NS4666 / WTU-F-073091 / MW597305 [ITS]). Photograph courtesy of Noah Siegel.

related to *T. fucatum* (in our Clade 12, FIG. 31), as conjectured by Heilmann-Clausen et al. (2017). TR159 (FIG. 19) could represent an undescribed species in this group but the specimen was obtained at an exhibition and so important information about it is lacking.

Clade 3a. Sect. *Genuina* in part, viscid-capped species (FIG. 12, 13)

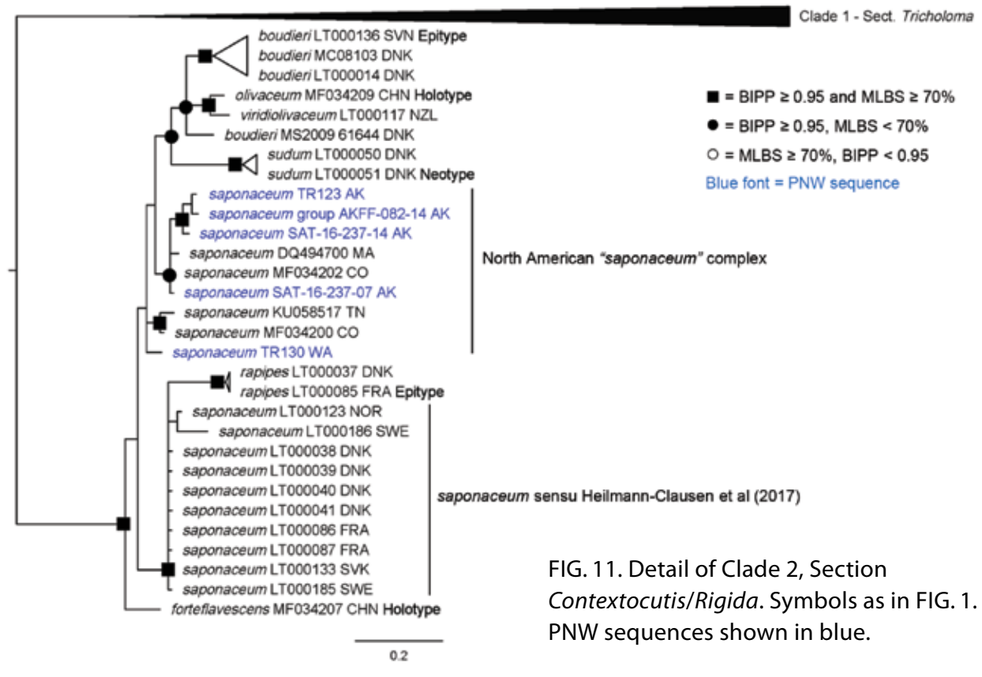

FIG. 11. Detail of Clade 2, Section *Contextocutis*/*Rigida*. Symbols as in FIG. 1. PNW sequences shown in blue.

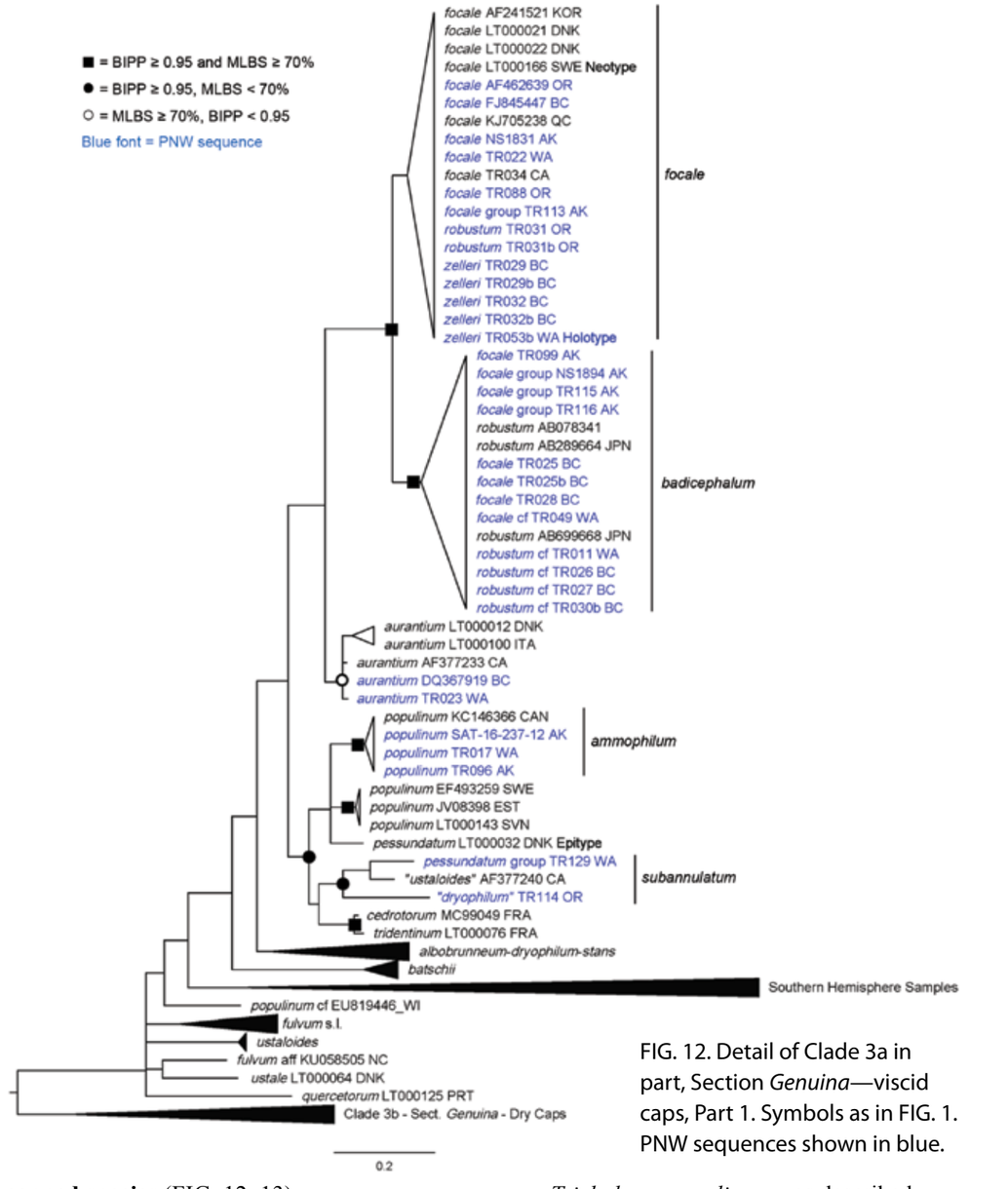

FIG. 12. Detail of Clade 3a in part, Section *Genuina*—viscid caps, Part 1. Symbols as in FIG. 1. PNW sequences shown in blue.

Tricholoma ammophilum A.D. Parker, Grubisha & S.A. Trudell

Misapplied name: *Tricholoma populinum*

Tricholoma populinum was described from Denmark and is generally considered to be ectomycorrhizal exclusively with *Populus* species. In our analyses, "*T. populinum*" specimens formed a moderately supported

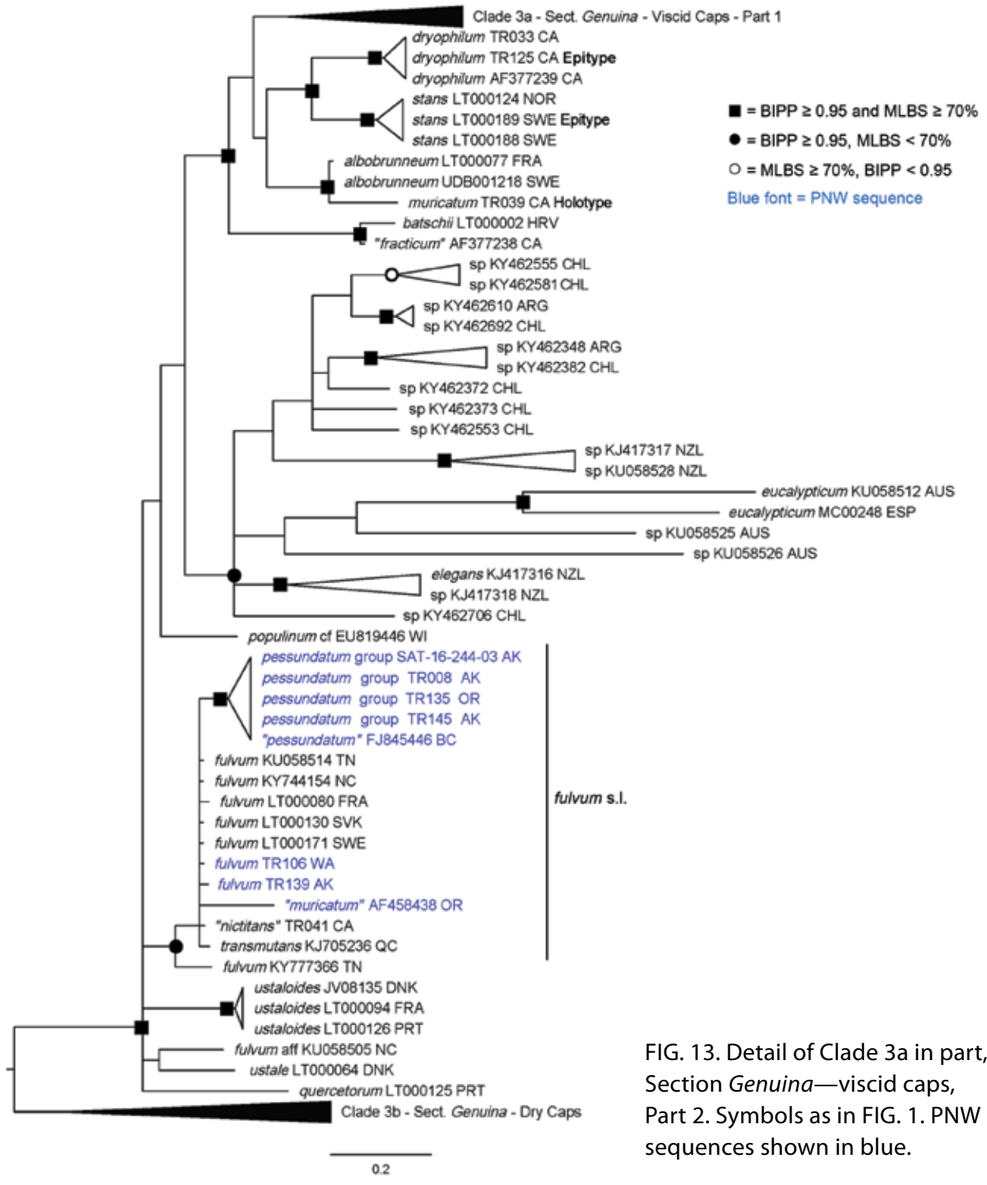

FIG. 13. Detail of Clade 3a in part, Section *Genuina*—viscid caps, Part 2. Symbols as in FIG. 1. PNW sequences shown in blue.

group with the *T. pessundatum* epitype (FIG. 12). Within this group, specimens from Europe and specimens from the PNW formed two well-supported, mutually exclusive clades. This is consistent with the results of Grubisha et al. (2012) who found substantial divergence between North American and Fennoscandian populations of *T. populinum*, and estimated that reproductive isolation began 1–1.7 million years ago. Thus, the PNW

FIG. 14. Photograph of holotype collection for *T. ammophilum* (SAT-16-237-12). Collection details can be found in APPENDIX 3.

"*T. populinum*" represents a separate species, *T. ammophilum* ("sand-loving"), reflecting the taxon's regional common name of "the sandy." It is medium-sized, often occurring in dense groups under black cottonwood. The cap is broadly convex, viscid when moist, pale pinkish brown to reddish brown, darker over the disc, and paler or whitish toward the edge. The flesh is thick and the odor and taste are farinaceous. The whitish gills stain reddish brown in age, especially along the edge. The thick stem is white at first, then colored like the cap at maturity.

Illustrations and descriptions: FIG. 9G–H, 14; Bessette et al. 2013 (as *T. populinum*); McKenny et al. 1987 (as *T. populinum*); Trudell & Parker 2021 (description).

Tricholoma aurantium (Schaeffer) Ricken

Tricholoma aurantium is a European species that occurs with both coniferous and angiosperm trees. In our analyses, sequences from Washington, British Columbia, and California collections of "*T. aurantium*" fell in a well-supported (ML only) clade with sequences from two well-documented European collections (FIG. 12). In addition, the macromorphology of North American specimens closely matches that of European material, so we accept *T. aurantium* sensu lato as occurring in the PNW. However, we are unaware of DNA sequence data from type material (it appears that designation of an epitype would be necessary) and, in our analyses, the North American group is paraphyletic with respect to the European collections, so further work, at least including ITS comparison with type material would be desirable to resolve the group.

Illustrations and descriptions: FIG. 15A; Bessette et al. 2013; Breitenbach & Kränzlin 1991; Christensen & Heilmann-Clausen 2013;

FIG. 15. Photographs of *Tricholoma* collections studied in this project. A. *T. aurantium* (TR023). B–H. *T. badicephalum* (B: TR011. C: TR026. D: TR049. E: TR099. F: TR115. G: TR116. H: NS1894). Collection details can be found in APPENDIX 1 (TR### collections) and APPENDIX 3 (others). C, H. Photographs courtesy of Paul Kroeger and Noah Siegel, respectively.

FIG. 16. Photograph of epitype collection for *Tricholoma badicephalum* (NS1006 / WTU-F-073095 / MW597309 [ITS]). Photograph courtesy of Noah Siegel.

Ludwig 2012; Læssøe & Petersen 2019; Shanks 1997; Siegel & Schwarz 2016.

Tricholoma badicephalum (Zeller) N. Siegel, S.A. Trudell & M.J. Gordon

Misapplied names: *Tricholoma focale*, *T. robustum*

A large number of "*T. focale*," "*T. focale* group," and "*T. robustum*" samples comprise a well-supported clade sister to the *T. focale* clade, which includes the neotype (FIG. 12). It had been recognized that these collections looked different from other *T. focale* and some had been informally referred to as the "other *focale*." Siegel and Schwarz (2016) called attention to *Armillaria badicephala* Zeller, noting that it belongs in *Tricholoma* and that it "is like a brown-colored version of *T. focale*." They considered it to be rare in California, occurring only on the northernmost coast on sand dunes under spruce and pine. *Armillaria badicephala* was described from a small collection made near Newport, Oregon on sand-dune soil under scrubby Sitka spruce trees. Our collections TR049, TR099, TR115, and TR116 fit the macroscopic and microscopic description of *A. badicephala* and ITS sequences (not included in our tree) from two Oregon collections of *A. badicephala* made by Noah Siegel cluster within the "other *focale*" clade (analysis results not shown). Therefore the new combination, *Tricholoma badicephalum*, was made and an epitype collection designated (Trudell & Parker 2021).

Tricholoma badicephalum differs from *T. focale* by the usually dry cap (although it clearly is a member of the "viscid-capped" group), greater tendency of the cap to be squamulose, the duller brown and gray-brown colors, and lack of prominent orange and green tones, although orangish brown fibrils may be present on cap and stipe. The two species share a similar stature, with a tapered

stipe similar to that of *T. murrillianum*, and ecological occurrence with conifers in sandy nutrient-poor soils. We have observed them to fruit near each other at times.

In the PNW, the name *T. robustum* sometimes has been applied to this taxon (e.g., TR011, TR026, TR027, and TR030) and two "*robustum*" sequences from Japan fall in our *badicephalum* clade. Photographs in Japanese publications (e.g., Imazeki and Hongo 1957, Imazeki et al. 1977, Imazeki et al. 1988) are very similar to images of collections from the PNW. However, *T. robustum* is a European species, the concept of which has not been solidified, and is considered a synonym of *T. focale* by many European mycologists (e.g., Christensen & Heilmann-Clausen 2013, Galli 1999, Riva 2003). In addition, Albertini and Schweinitz's image of "*Armillaria robusta*" (as presented by Riva 2003) clearly does not represent the same fungus as our PNW taxon.

Illustrations and descriptions: FIG. 15B–H, 16; Bessette et al. 2013, p. 69; Trudell & Ammirati 2009, p. 102, lower figure (all as *T. focale*).

Tricholoma focale (Fries) Ricken

Synonyms: *Armillaria zelleri* D.E. Stuntz & A.H. Smith, *Tricholoma zelleri* (D.E. Stuntz & A.H. Smith) Ovrebo & Tylutki

Tricholoma focale was described from Europe, where it commonly occurs with pines on sandy soils. ITS sequences from several PNW specimens, including the holotype of *T. zelleri* and Shanks's (1994) voucher collection for *T. focale* (TR034), fall in a group with sequences from several European specimens, including the neotype of *T. focale*. Morphology of the PNW specimens and their occurrence with conifers, often including pine, on nutrient-poor, often sandy, soils is consistent with the European concept of the species. Therefore, we currently accept *T. focale* as occurring in the PNW. However, support for the group (BIPP = 0.78; MLBS = 63%) was not high.

Illustrations and descriptions: FIG. 17A–D; Bessette et al. 2013, pp. 67(B)–68(C-D); Christensen & Heilmann-Clausen 2013; Desjardin et al. 2015; Ludwig 2012; Læssøe & Petersen 2019; McKenny et al. 1987 (as *T. zelleri*); Shanks 1997; Siegel & Schwarz 2016; Trudell & Ammirati 2009, p. 102 upper figure.

Tricholoma fulvum (DC.) Bigeard & H. Guillemin

Synonyms: *Tricholoma flavobrunneum* (Fries) P. Kummer, *T. nictitans* (Fries) Gillet, *T. pseudonictitans* Bon, *T. transmutans* (Peck) Saccardo?

Tricholoma fulvum is a European species that has been subject to different interpretations. We follow the concept presented by Christensen and Heilmann-Clausen (2013), which includes gill colors from cream to yellow and occurrence with conifers as well as birch. Our BI analysis returned a well-supported "*T. fulvum*" group, including PNW, eastern North American, and European sequences labeled "*pessundatum* (group)," "*fulvum*," "*muricatum*," "*nictitans*" (Shanks [1994] voucher collection), and "*transmutans*." A number of PNW "*pessundatum* group" sequences from conifer forests that include spruce and lack birch form a well-supported clade that appears to represent a distinct species, derived within *T. fulvum* s.l. However the collections do not differ obviously in macromorphology or micromorphology from the others in the broad *T. fulvum* group. Further work will be required to resolve the taxonomy of this group, including *T. transmutans*, and clarify the name(s). Until such time, we accept that *T. fulvum* sensu lato occurs, probably

FIG. 17. Photographs of *Tricholoma* collections studied in this project. A–D. T. focale (A: TR022. B: TR088. C: TR113. D: NS1831). E–H. T. fulvum s.l. (E: TR008. F: TR135. G: TR145. H: SAT-16-244-03). Collection details can be found in APPENDIX 1 (TR### collections) and APPENDIX 3 (others).

representing more than one taxon, and is fairly widespread and common, in the PNW.

Illustrations and descriptions: FIG. 17E–H, 18A–B; Bessette et al. 2013, pp. 73–75, 162 (as *T. transmutans*); Breitenbach & Kränzlin 1991; Christensen & Heilmann-Clausen 2013; Ludwig 2012; Læssøe & Petersen 2019; Shanks 1997 (as *T. nictitans*); Siegel & Schwarz 2016 (as *T. nictitans* sensu California).

Tricholoma subannulatum (Peck) Zeller

Synonyms: *Armillaria subannulata* Peck, *Melanoleuca subannulata* (Peck) Murrill, *M. californica* Murrill, *Tricholoma californicum* (Murrill) Murrill

non *Tricholoma subannulatum* (Batsch) Bresadola (=*T. batschii* Gulden ex Mort. Christensen & Noordeloos)

Misapplied names: *Tricholoma dryophilum*, *T. ustale*, *T. ustaloides*

Charles Peck's description of *A. subannulata* in general reflects a typical member of the "*T. pessundatum* group," with a viscid reddish brown cap and farinaceous odor and taste. However, unlike most of the species in that group, he cited it as having "veil thick, soft, white, evanescent; spores elliptic, 10–12 × 8–9 µm" (large for the group). The type collection originated from southern California under oaks so, as noted by Zeller (1922), Peck saw only dried material.

Shortly thereafter, Murrill (1913) described *Melanoleuca californica* / *T. californicum* from the vicinity of Stanford University in California, where it was found under oaks. In his description, which is similar to that of Peck's species, Murrill commented that "This large and handsome species resembles specimens determined as *Armillaria subannulata* Peck" and, indeed, in the *North American Flora* (Murrill 1914), he combined Peck's species in *Melanoleuca* (using his description of *M. californica* rather than Peck's original) and synonymized *M. californica* with it, despite apparent differences in the presence of a partial veil and spore size (Murrill reported 5–7 × 4–5 µm for his species). Subsequently Zeller (1922) combined Peck's species in *Tricholoma*.

Shanks (1994) studied the type collections for both Peck's and Murrill's species although without acknowledging Murrill's considering them to be one species. With respect to *subannulatum*, she commented "there is no evidence of a veil on the holotype material, and notes included with the holotype by the collector do not describe the annulus in any detail." Further, she reported the spore size as 5.3–6. 7 × 3.8–4.8 µm, much smaller than Peck's measurements. As for *californicum*, she stated that "inamyloid spores, absence of clamp connections and parallel lamellar trama hyphae indicate the holotype is a *Tricholoma.* The status of *T. californicum* is difficult to assess. The stature of the preserved specimens is similar to *T. dryophilum,* with very long stipes relative to the pileus diameter, but *T. californicum* has smaller spores, lacks cheilocystidia, and is reported to have a slightly bitter taste. It is possible that *T. californicum* is a synonym of *T. ustale* (which Shanks accepted as occurring in California), although the spores are slightly smaller than common for *T. ustale.*" Singer (1942) also studied the holotype of *T. californicum* and suggested that it represents a species close to *T. ustale*.

Given Shanks's observations on the *A. subannulata* holotype, we believe that Peck erred in his description, both with respect to the presence of a well-developed partial veil and spore size. Thus we accept Murrill's synonymy of *M. subannulata* (*T.*

FIG. 18. Photographs of *Tricholoma* collections studied in this project. A–B. *T. fulvum* s.l. (A: TR106. B: TR139). C–D. *T. subannulatum* (C: TR114. D: TR129). E–F. *T. aurantio-olivaceum* (E: TR108. F: TR133). G–H. *T.* cf. *imbricatum* (G: TR021. H: TR080). Collection details can be found in APPENDIX 1. D. Photograph courtesy of Michael Beug.

subannulatum) and *M. californica* (*T. californicum*), with the former having priority, although the latter would appear to be a more fitting epithet.

Our BI analysis returned a small well-supported clade that included two oak-associated collections from Oregon and Washington (TR114 and TR129) labelled "*dryophilum*" and "*pessundatum* group," respectively, along with Shanks's voucher specimen for *T. ustale* (cited in her 1997 publication and labelled "*T. ustaloides*" in GenBank and FIG. 12). Habitat, macromorphology, and micromorphology of our two collections, plus an additional Oregon collection with matching ITS sequence not included in our analyses are consistent with *T. subannulatum*, as is Shanks's (1994, 1997) description of "*T. ustale*." Therefore we accept the former as the correct name for this oak-associated "*pessundatum* group" species. However, we have not been able to study the holotype of *T. subannulatum* and, despite several attempts, we were unable to obtain an ITS sequence from the holotype of *T. californicum*. Therefore an attempt should be made to obtain at least an ITS sequence from the *T. subannulatum* holotype to confirm a match with the recent samples.

Illustrations and descriptions: FIG. 18C–D; Shanks 1997. Review of numerous online images at sites such as *Mushroom Observer* suggest that many of the "*T. dryophilum*" collections represent this species.

Clade 3b. Sect. *Genuina* in part, dry-capped species (FIG. 19)

Tricholoma aurantio-olivaceum A.H. Smith

Tricholoma aurantio-olivaceum was described from mixed conifer forest on the Olympic Peninsula of Washington and appears to occur widely in the PNW. However, it is not common or at least not frequently reported. Sequences from two recent PNW collections formed a well-supported clade with the holotype sequence.

Illustrations and descriptions: FIG. 18E–F; Bessette et al. 2013; Shanks 1997; Siegel & Schwarz 2016.

Tricholoma imbricatum (Fries) P. Kummer

Tricholoma imbricatum is a European species that typically occurs with pines on sandy soil. In our analyses, one "*T. intermedium*" and three "*T. imbricatum*" sequences are closely related to a well-supported *T. aurantio-olivaceum*. This group of western North American sequences is sister to well-supported European *T. imbricatum*, including the neotype. However the entire "*T. imbricatum*" group is not strongly supported, especially in the ML analysis. These results suggest that western North American "*T. imbricatum*" collections do not belong to that species and that future study will be required to resolve the relationships in this group. For now we refer to the PNW collections as *T.* cf. *imbricatum*.

Illustrations and descriptions: FIG. 18G–H; Bessette et al. 2013; Desjardin et al. 2015; Siegel & Schwarz 2016 (as *T. imbricatum* sensu California); Trudell & Ammirati 2009.

Tricholoma vaccinum (Schaeffer) P. Kummer

Tricholoma vaccinum is a widely distributed species that is associated with conifers, especially spruce. In our analyses, a number of Washington and Alaska specimens fell in a well-supported clade with *T. vaccinum* specimens from Sweden and Slovenia. Thus, we accept the occurrence of *T. vaccinum* in the PNW.

Illustrations and descriptions: FIG. 20A–F; Bessette et al. 2013; Breitenbach & Kränzlin 1991; Christensen & Heilmann-Clausen 2013; Ludwig 2012; Læssøe &

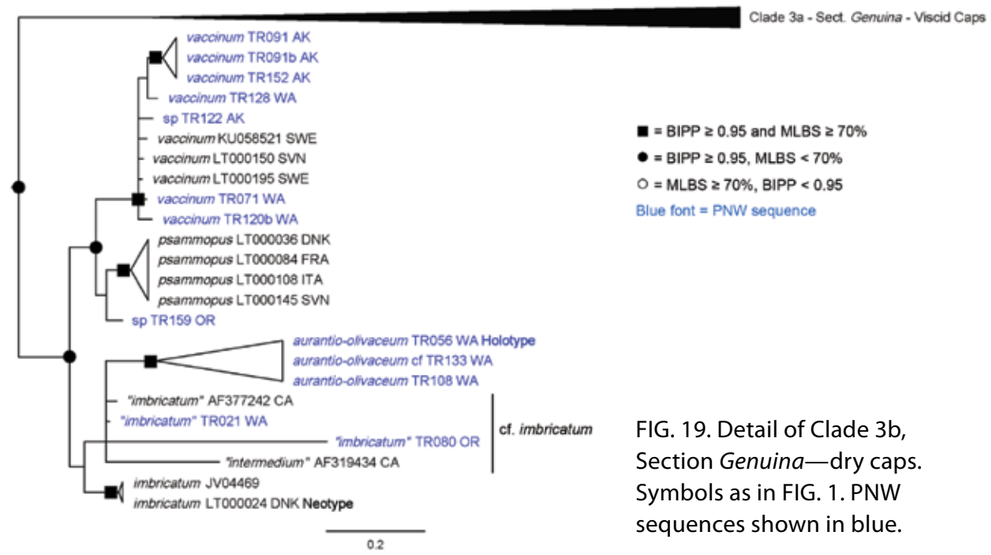

FIG. 19. Detail of Clade 3b, Section *Genuina*—dry caps. Symbols as in FIG. 1. PNW sequences shown in blue.

Petersen 2019; McKenny et al. 1987; Shanks 1997; Siegel & Schwarz 2016; Trudell & Ammirati 2009.

***Tricholoma* sp.**

Our specimen TR159 was found on the drop-off tables at the Mt. Pisgah Arboretum's annual Mushroom Festival in Springfield, Oregon. The name of the collector and the location where the collection was found are unknown. In our analyses it appeared by itself sister to a well supported *T. psammopus* clade consisting only of European samples. Based on inspection of a number of illustrations of *T. psammopus*, TR159 appears much darker in color, exhibits much greater color contrast between cap and gills, and has a more scaly stipe than *T. psammopus*. It also is unlikely that TR159 was collected in an area with larch (*T. psammopus* is primarily a larch associate). Thus TR159 could represent an undescribed species. However, study of additional well-documented collections will be necessary to determine whether description as a new species is warranted.

Illustration: FIG. 20G.

Clade 4. Sect. *Megatricholoma* (FIG. 21)**.** Our Clade 4 corresponds to Sect. *Megatricholoma* sensu Heilmann-Clausen et al. (2017), which, in their analysis, comprised *T. colossus*, *T. acerbum*, and *T. roseoacerbum / japonicum*. Although Reschke et al. (2018) could not confirm inclusion of the *T. acerbum* clade (sensu Heilmann-Clausen et al. 2017, = *T. acerbum* + *T. roseoacerbum* + *T. japonicum*), it is well supported in our analyses. Specimens from the PNW and California all fall within the *T. acerbum* group, including *T. manzanitae* and TR147, which we assign to *T. japonicum*, pending better resolution of *T. roseoacerbum* / *japonicum*.

Tricholoma japonicum Kawamura

Tricholoma japonicum was described from Japan where it occurs most commonly with pine. Heilmann-Clausen et al. (2017) noted its close relationship to the European *T. roseoacerbum* (as well as to specimens from North America) and commented that, if a single species is involved, the epithet,

FIG. 20. Photographs of *Tricholoma* collections studied in this project. A–F. *T. vaccinum* (A: TR071. B: TR091. C: TR120. D: TR122. E: TR128. F: TR152). G. *Tricholoma* sp. (TR159). H. *T. japonicum* (TR147). Collection details can be found in APPENDIX 1.

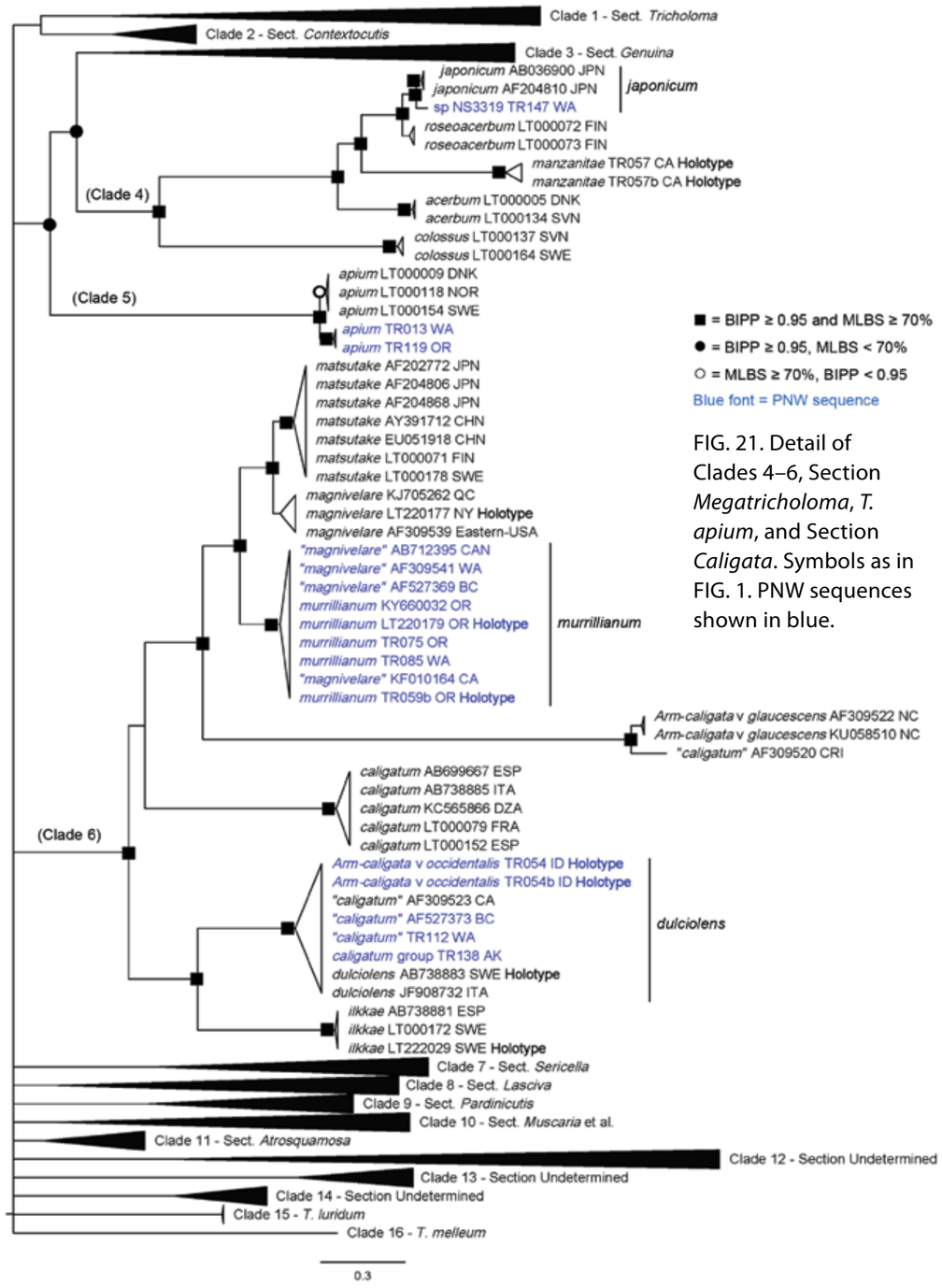

FIG. 21. Detail of Clades 4–6, Section *Megatricholoma*, *T. apium*, and Section *Caligata*. Symbols as in FIG. 1. PNW sequences shown in blue.

japonicum (from 1954), would have priority over *roseoacerbum* (from 1984). Our analyses returned a well-supported clade including *T. roseoacerbum*, TR147, and two *T. japonicum* specimens. In addition, the separation of TR147 and *T. japonicum* also is well supported, so it is possible that there are three species represented in the group. However, given the short branch lengths involved and the fact that we have only two PNW collections (a sequence from a second collection, obtained subsequent to the phylogenetic analyses, matches that of TR147), for now we use *T. japonicum* for the PNW specimens, pending possible future work to clarify the relationships in this group, including sequencing of type material of *T. roseoacerbum* and *T. japonicum*.

Illustrations and descriptions: FIG. 20H, 22A; Imazeki & Hongo 1957; Imazeki et al. 1970; Imazeki et al. 1988.

Tricholoma manzanitae T.J. Baroni & Ovrebo

Tricholoma manzanitae was described from northern California where it is associated with manzanita shrubs, which form arbutoid mycorrhizas. We are aware of three reports of *T. manzanitae* occurring in Oregon made by Dr. James Trappe. Although we have not studied the collections, habitat notes from two of them indicate that madrone, a close relative of manzanita and also an arbutoid mycorrhiza-former, was present. Thus, it appears likely that *T. manzanitae* occurs in at least the southern portion of the PNW and possibly beyond as madrone occurs north as far as southern British Columbia.

Illustrations and descriptions: Bessette et al. 2013; Shanks 1997; Siegel & Schwarz 2016 (collection associated with madrone).

Clade 5. *Tricholoma apium* (FIG. 21)**.** Our Clade 5 comprises a single species, *T. apium*.

Tricholoma apium Jul. Schäffer

Tricholoma apium is a European species that is typically associated with pine on sandy soil. Although it is a relatively distinctive species, it appears that no type material has been designated to help solidify the species concept. Our analyses returned a well-supported "*T. apium*" clade, which did not fall into any of the traditional sections. Within that clade are two well-supported lineages — one from the PNW and the other (well-supported only in ML) from well-documented European collections. Based on the short branch lengths and close morphological and ecological similarity of PNW and European specimens, we accept *T. apium* as occurring in the PNW pending designation of, and critical comparison with, type material.

Illustrations and descriptions: FIG. 22B–C; Bessette et al. 2013; Breitenbach & Kränzlin 1991; Christensen & Heilmann-Clausen 2013; Ludwig 2012; Læssøe & Petersen 2019.

Clade 6. Sect. *Caligata* (FIG. 21)**.** Our Clade 6 corresponds to Sect. *Caligata* sensu Heilmann-Clausen et al. (2017) and Reschke et al. (2018). PNW species include *T. murrillianum*, described from coastal Oregon, and *T. dulciolens*, which has usually been referred to as *T. caligatum* in western North America.

Tricholoma dulciolens Kytövuori

Synonym: *Armillaria caligata* var. *occidentalis* A.H. Smith

Tricholoma dulciolens is a close relative of the matsutake group. It was described from Fennoscandia where it occurs with spruce. Two sequences from the holotype of *Armillaria caligata* var. *occidentalis*, described from Idaho, fall in a well-supported clade that includes several PNW "*T. caligatum*" specimens as well as the

FIG. 22. Photographs of *Tricholoma* collections studied in this project. A. *T. japonicum* (SAT-05-287-01 / WTU-F-073069 / MW597302 [ITS]). B–C. *T. apium* (B: TR013. C: TR119). D–E. *T. dulciolens* (D: TR112. E: TR138). F–G. *T. murrillianum* (F: TR075. G: TR085). H. *T.* aff. *bryogenum* (TR001). Collection details can be found in APPENDIX 1 (TR### collections). D, E. Photographs courtesy of Chris Herrera and Noah Siegel, respectively.

holotype of *T. dulciolens*. Thus, we accept *T. dulciolens* as the correct name for the PNW "*T. caligatum*."

Illustrations and descriptions: FIG. 22D–E; Christensen & Heilmann-Clausen 2013; Ludwig 2012; Shanks 1997 (as *T. caligatum*); Trudell & Ammirati 2009 (as *T. caligatum*).

Tricholoma murrillianum Singer

Misapplied names: Armillaria ponderosa, *Tricholoma ponderosum*, *T. magnivelare*

Tricholoma murrillianum is the common, well-known, PNW matsutake species, originally described as *Armillaria arenicola* by Murrill. *Tricholoma magnivelare* is its eastern North American counterpart.

Illustrations and descriptions: FIG. 22F–G; Bessette et al. 2013; Desjardin et al. 2015; Shanks 1997; Siegel & Schwarz 2016; Trudell & Ammirati 2009 (all as *T. magnivelare*).

Clade 7. Sect. *Sericella* (FIG. 23)**.** Our Clade 7 corresponds to Sect. *Sericella* sensu Heilmann-Clausen et al. (2017) and Reschke et al. (2018). In Europe, this section includes *T. bryogenum*, *T. hemisulphureum*, *T. inamoenum*, and a complex of "*T. sulphureum*" species. Several PNW specimens appear to be closely related to *T. bryogenum* and could represent a separate species. A number of specimens can be assigned to *T. inamoenum* and *T. platyphyllum*. Representatives of the *T. sulphureum* complex also occur in the PNW. All of these are characterized by a strong "coal tar" odor.

Tricholoma* aff. *bryogenum

Tricholoma bryogenum Mort. Christensen, Heilmann-Clausen & Vauras is a member of the *T. sulphureum* complex, small to medium in size with yellowish coloration, white basal mycelium, and strong coal tar odor. It is known from a small number of locations in Fennoscandia where it is, possibly exclusively, a spruce associate. Given the uncertainty in species concepts within the *T. sulphureum* complex and the fact that it has only recently been described, *T. bryogenum* could well be more widely distributed. In our analyses, a well-supported group of specimens from Washington, British Columbia, and Alaska labeled "*sulphureum*" and "cf. *inamoenum*" appears to represent one, or possibly two, distinct species, closely related to *T. bryogenum*. Until sufficient well-documented collections have been made to study the matter closely, we refer the PNW collections to *T.* aff. *bryogenum*.

Illustrations and descriptions: FIG. 22H, 24A; Christensen & Heilmann-Clausen 2013 (holotype).

Tricholoma inamoenum (Fries) Gillet

Tricholoma inamoenum is a creamy whitish European species that typically occurs with spruce and has relatively wide-spaced gills, large spores, and a strong coal tar odor like that of *T. sulphureum*. Our analyses returned a well-supported "*T. inamoenum*" clade that, in turn comprises two well-supported subclades, each containing a mix of "*T. inamoenum*" and "*T. platyphyllum*" sequences. One clade contains northern specimens from Alaska, British Columbia, Ontario, and Sweden and includes the European neotype. Therefore, it can be taken to represent *T. inamoenum* sensu stricto. The second contains specimens from Washington, Oregon, and California, including Shanks's (1994) voucher collection for *T. inamoenum*, and we accept these as representing *T. platyphyllum* (below).

Illustrations and descriptions: FIG. 24B; Breitenbach & Kränzlin 1991; Christensen & Heilmann-Clausen 2013; Ludwig 2012; Læssøe & Petersen 2019.

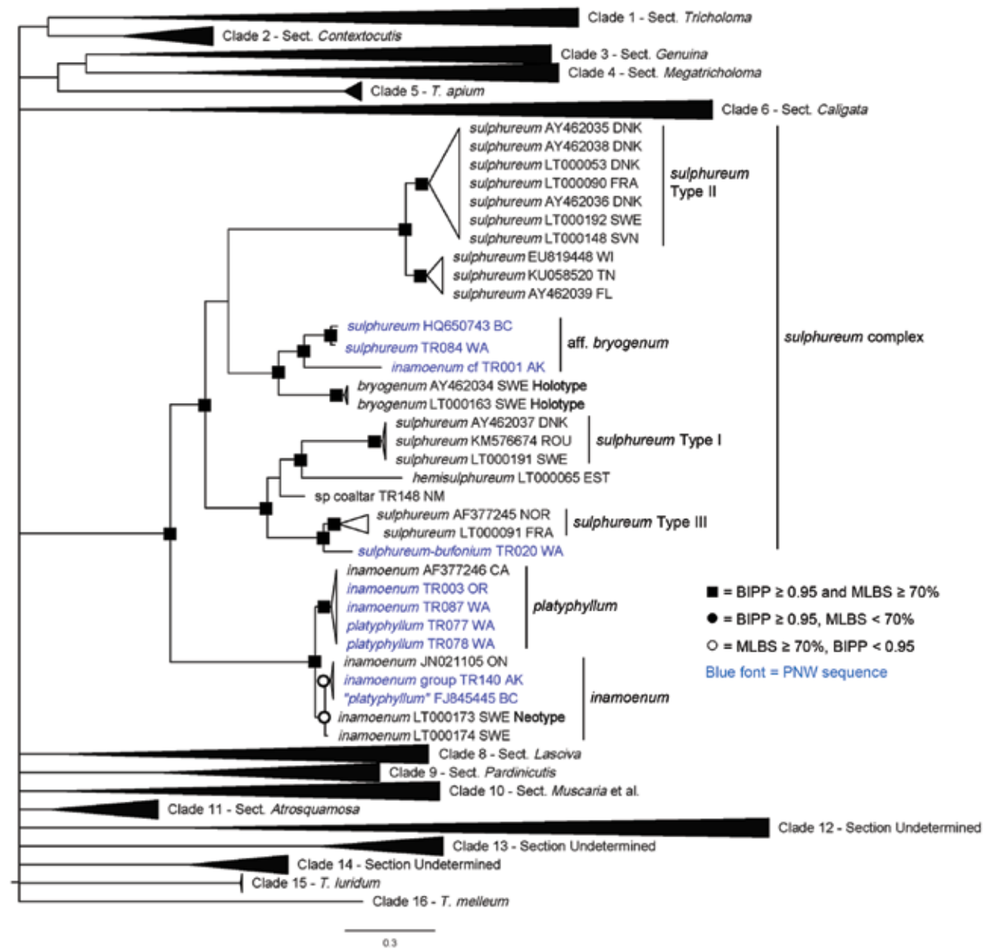

FIG. 23. Detail of Clade 7, Section *Sericella*. Symbols as in FIG. 1. PNW sequences shown in blue.

Tricholoma platyphyllum (Murrill) Murrill

Tricholoma platyphyllum was described from the vicinity of Seattle, Washington. From Murrill's description of the type specimen (a single fruitbody) it is clear that his species is very similar to *T. inamoenum*. However, his specimen was rather small, he made no mention of odor (*T. inamoenum* has a very strong coal tar odor that is difficult to ignore), and he reported the spore size as 8.5 × 6 µm, which would be at the low end of the range for *T. inamoenum*. Ovrebo (1973) noted the similarity of *T. platyphyllum* to *T inamoenum*. Although he reported spore size for the *T. platyphyllum* holotype as 11.3–12 (–12.8) × 6–7.5 (–9) µm, consistent with *T. inamoenum*, he chose to recognize *T. platyphyllum* as a separate species, emphasizing its smaller fruitbodies, pending future study. As part of her study of the *T. platyphyllum* holotype, Shanks (1994) measured the spores as 9.6–12 ×

FIG. 24. Photographs of *Tricholoma* collections studied in this project. A. *T.* aff. *bryogenum* (TR084). B. *T. inamoenum* (TR140). C–F. *T. platyphyllum* (C: TR003. D: TR077. E: TR078. F: TR087). G–H. *T. sulphureum* s.l. (G: TR020. H: TR148). Collection details can be found in APPENDIX 1.

4.8–6.7 µm and noted the existence of European *T. inamoenum* specimens similar in size to Murrill's specimen. Consequently, she considered *T. platyphyllum* to be a later synonym of *T. inamoenum*.

Our analyses returned a well-supported "*T. inamoenum*" clade that includes two groups, one of which consists of northern specimens and includes the neotype of *T. inamoenum*. This group thus represents *T. inamoenum* sensu stricto. The second group contains specimens from California, Oregon, and Washington and likely represents *T. platyphyllum*. Repeated attempts to obtain an ITS sequence from the holotype were unsuccessful. Based on a small number of observations, consistent differences in macromorphology are not immediately obvious. Ecologically, *T. inamoenum* is generally considered to associate primarily with spruce, whereas it is likely that the holotype of *T. platyphyllum* came from a forest dominated by Douglas-fir and western hemlock. Four of the five samples in our *T. platyphyllum* clade came from forests that lack spruce, however the California specimen came from an area where spruce is present. Thus, habitat might provide a useful, but not fool-proof, differentiator. Limited observations suggest that spore size differs between *T. platyphyllum* and *T. inamoenum* — the four *T. platyphyllum* collections we studied (TR003, TR077, TR078, and TR087) had mean spore size 11.4 × 6.5 µm whereas those from two *T. inamoenum* sensu stricto collections (TR140 and an additional collection sequenced after completion of the phylogenetic analyses) had mean spore size 10.0 × 5.8 µm (n = 20 for each collection). Mean Q-values were 1.78 and 1.75, respectively. Observations on additional collections would be highly desirable but, for now, we accept that the specimens in our *T. platyphyllum* clade represent that species. For a possible additional consideration, see the discussion of *T. silvaticum* below under *Other reported species, not confirmed from PNW but considered possible to occur here*.

Illustrations and descriptions: FIG. 24C–F; Bessette et al. 2013, p. 87(A); Trudell & Ammirati 2009 (both as *T. inamoenum*).

Tricholoma sulphureum (Bulliard) P. Kummer

"*Tricholoma sulphureum*" represents a species complex within Sect. *Sericella*. Heilmann-Clausen et al. (2017) recognized three "types" within the complex. Type I is sister to *T. hemisulphureum* (Kühner) A. Riva, Type II is sister to *T. bryogenum* sensu lato, and Type III is sister to the Type I + *T. hemisulphureum* + TR148 clade. "*Tricholoma sulphureum*" from the PNW was not well represented in our analyses. One Washington specimen appears to be closely related to Type III, and a well-supported group from Washington, British Columbia, and Alaska appears to represent a distinct species, closely related to *T. bryogenum* (see above). Until such time as the taxonomy of this complex is worked out, we accept *T.* aff. *bryogenum* and *T. sulphureum* sensu lato as occurring in the PNW.

Illustrations and descriptions: FIG. 24G–H; Christensen & Heilmann-Clausen 2013; Ludwig 2012; Læssøe & Petersen 2019.

Clade 8. Sect. *Lasciva* (FIG. 25)**.** Our Clade 8 corresponds to Sect. *Lasciva* sensu Heilmann-Clausen et al. (2017). Consistent with that study, in our tree, the section is split in two well-supported subclades. The first includes the European species *T. album*, *T. lascivum*, and *T. stiparophyllum*, and the second includes the European species *T. boreosulphurescens* (including two samples labelled "*T. sulphurescens*") and *T. sulphurescens* (the

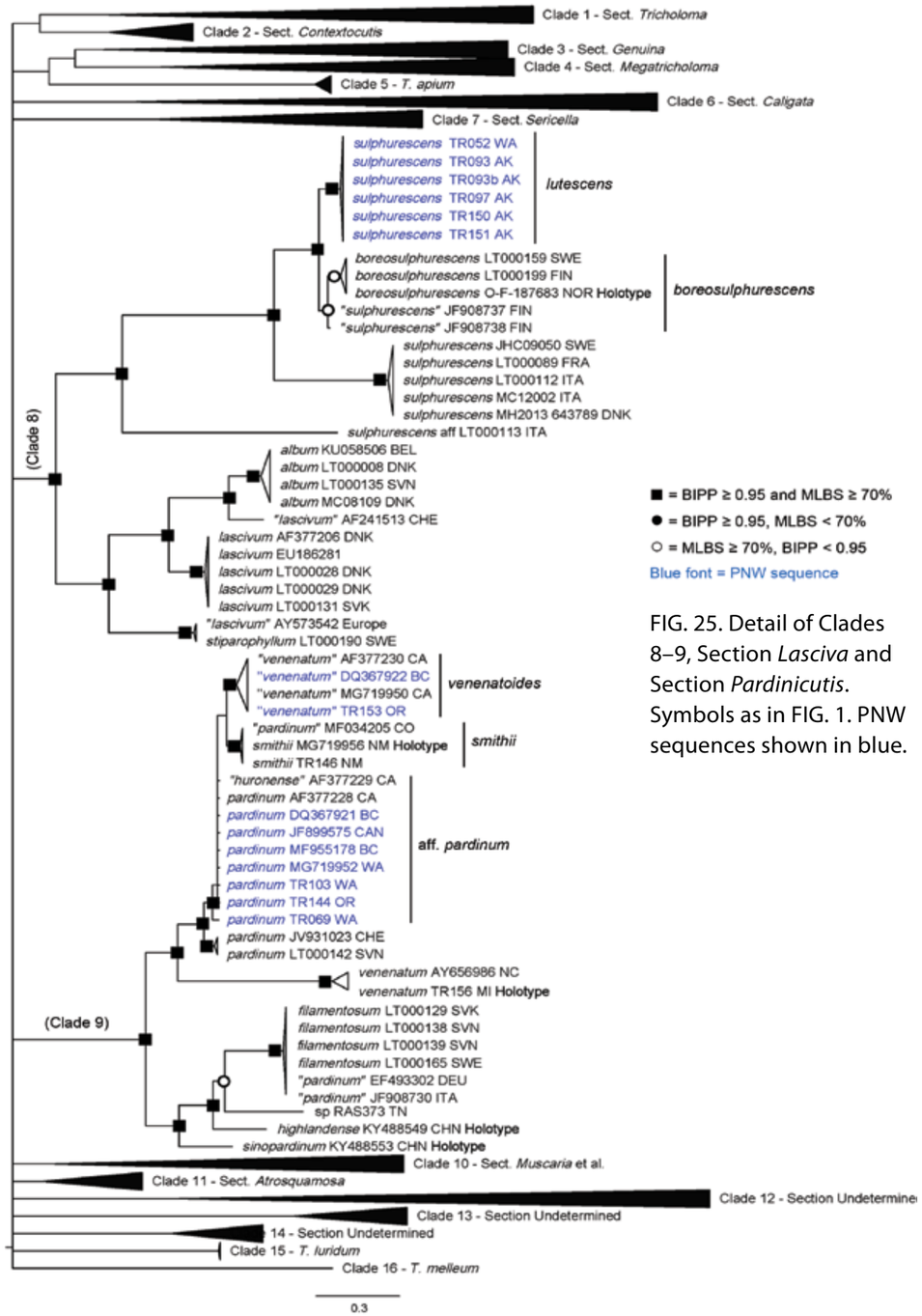

FIG. 25. Detail of Clades 8–9, Section *Lasciva* and Section *Pardinicutis*. Symbols as in FIG. 1. PNW sequences shown in blue.

latter apparently representing two species). All of the PNW specimens in our analyses form a well-supported clade, sister to *T. boreosulphurescens*, and representing a new species, *Tricholoma lutescens*.

Tricholoma lutescens S.A Trudell, A.D. Parker & E.T. Cline

Misapplied name: Tricholoma sulphurescens

Tricholoma sulphurescens is a whitish, yellow-staining, strongly odorous European species that typically is associated with beech and oak. It is much more common in southern Europe than in more northerly areas (Christensen & Heilmann-Clausen 2013). *Tricholoma boreosulphurescens* Mort. Christensen & Heilmann-Clausen is a macroscopically and microscopically very similar species described from Fennoscandia. It differs from *T. sulphurescens* in its boreal and high-mountain occurrence in birch and birch-spruce forests. In our analyses, all of the PNW "*T. sulphurescens*" specimens fell in a well-supported group, sister to *T. boreosulphurescens*, and representing *T. lutescens*. Our collections all came from forests with abundant spruce, often accompanied by birch. In addition to the geographic separation, the PNW collections have smaller basidiospores (mean 5.4 × 4.0 µm [n = 130, from five collections] versus average 5.6–6.4 × 4.2–5.1 µm [Christensen & Heilmann-Clausen 2013]), although the difference may be too small to apply in determining individual collections. Otherwise, we have found no obvious correlated morphological or ecological differences between *T. lutescens* and *T. boreosulphurescens*.

Illustrations and descriptions: FIG. 26A–D, 27; Christensen & Heilmann-Clausen 2013 (*T. boreosulphurescens*); Trudell & Parker 2021 (description, as *T. leucoxanthum* sp. nov., an illegitimate name).

Clade 9. Sect. *Pardinicutis* (FIG. 25)**.** Our Clade 9 corresponds to Sect. *Pardinicutis* sensu Heilmann-Clausen et al. (2017) and Reschke et al. (2018) and the "*Pardinicutis* complex" of Ovrebo and Hughes (2018). As noted in the previous studies, western North American (including PNW) "*T. pardinum*" specimens appear to represent an undescribed species closely related to *T. pardinum* and from which *T. smithii* and a clade of West Coast "*T. venenatum*" specimens (*T. venenatoides*) are derived.

Tricholoma* aff. *pardinum

Tricholoma pardinum (Persoon) Quélet was described from France. In Europe, it is considered a widespread, but not common, usually montane species associated principally with beech and fir (Bon 1991; Galli 1999; Christensen & Heilmann-Clausen 2013). In our analyses, two well-documented European specimens of *T. pardinum* formed a well-supported clade. "*Tricholoma pardinum*" specimens from California, Oregon, Washington, and British Columbia and a "*T. huronense*" specimen from California (*T. huronense* is an apparently rare, or at least rarely reported, species described from a single collection from Michigan in association with oak), formed a group that is paraphyletic with respect to well-supported clades of Rocky Mountain *T. smithii* and West Coast "*T. venenatum*" specimens (=*T. venenatoides*, see below). Ovrebo and Hughes (2018) reported essentially the same result. Although the paraphyletic West Coast "*T. pardinum*" samples appear to represent at least one undescribed species, the relationships within the overall *T. pardinum* group need to be better resolved before describing new taxa involving those specimens. Therefore, until

FIG. 26. Photographs of *Tricholoma* collections studied in this project. A–D. *T. lutescens* (A: TR052. B: TR093. C: TR097. D: TR150). E–F. *T.* aff. *pardinum* (E: TR069. F: TR144). G. *T. smithii* (TR146). H. *T. arvernense* (TR004). Collection details can be found in APPENDIX 1.

FIG. 27. Photograph of the holotype collection for *T. lutescens* (TR151). Collection details can be found in APPENDIX 1.

future studies, including sequencing of *T. pardinum* type material, are conducted, we refer to PNW "*T. pardinum*" specimens as *T.* aff. *pardinum*.

Illustrations and descriptions: FIG. 26E–F; Desjardin et al. 2015; Shanks 1997; Siegel & Schwarz 2016; Trudell & Ammirati 2009 (all as *T. pardinum*).

Tricholoma venenatoides S.A. Trudell, A.D. Parker & M.J. Gordon

Misapplied name: Tricholoma venenatum

Tricholoma venenatum was described in 1908 from Michigan where it was collected under deciduous angiosperm trees. We were able to obtain a partial ITS sequence from the holotype and, in our analyses, it was matched at 141 of 142 positions by an oak ectomycorrhiza from North Carolina. These two samples formed a well-supported clade, sister to a well-supported broad "*T. pardinum*" clade. Within the latter clade, Rocky Mountain collections of "*T. venenatum*" are now assigned to *T. smithii* (Ovrebo & Hughes 2018, TR146—our FIG. 26G). West Coast collections of "*T. venenatum*" represent a new species, *T. venenatoide*s. It is very similar to *T. smithii*—medium to large in size, whitish with tan to brownish scales on the pileus,

FIG. 28. Photograph of the holotype collection for *T. venenatoides* (SAT-19-298-14 / WTU-F-073089 / MW597303 [ITS]).

farinaceous odor and taste, relatively large spores, abundant clamp connections, and occurrence in montane forests.

Illustrations and descriptions: FIG. 28. Trudell & Parker 2021 (description).

Clade 10. Sect. *Muscaria* plus additional species (FIG. 29)**.** Our Clade 10 includes Sect. *Muscaria*, which was recently described by Reschke et al. (2018) and, in their circumscription, comprised the Asian species *T. aurantiipes*, *T. muscarium*, and *T. muscarioides*, plus the North American species *T. davisiae*. Our analyses, which included the latter two species, strongly support the placement of *T. luteomaculosum* in the section in a narrow sense and also suggest that expanding the section to include *T. nigrum* and *T. arvernense* should be considered.

Tricholoma arvernense Bon

Tricholoma arvernense is a European species, which, on that continent, is primarily associated with pine on sandy soil. In our analyses, sequences from several PNW and European collections fell in a well-supported, but paraphyletic (with respect to a group of species including *T. davisiae* and *T. luteomaculosum*), "*T. arvernense*"

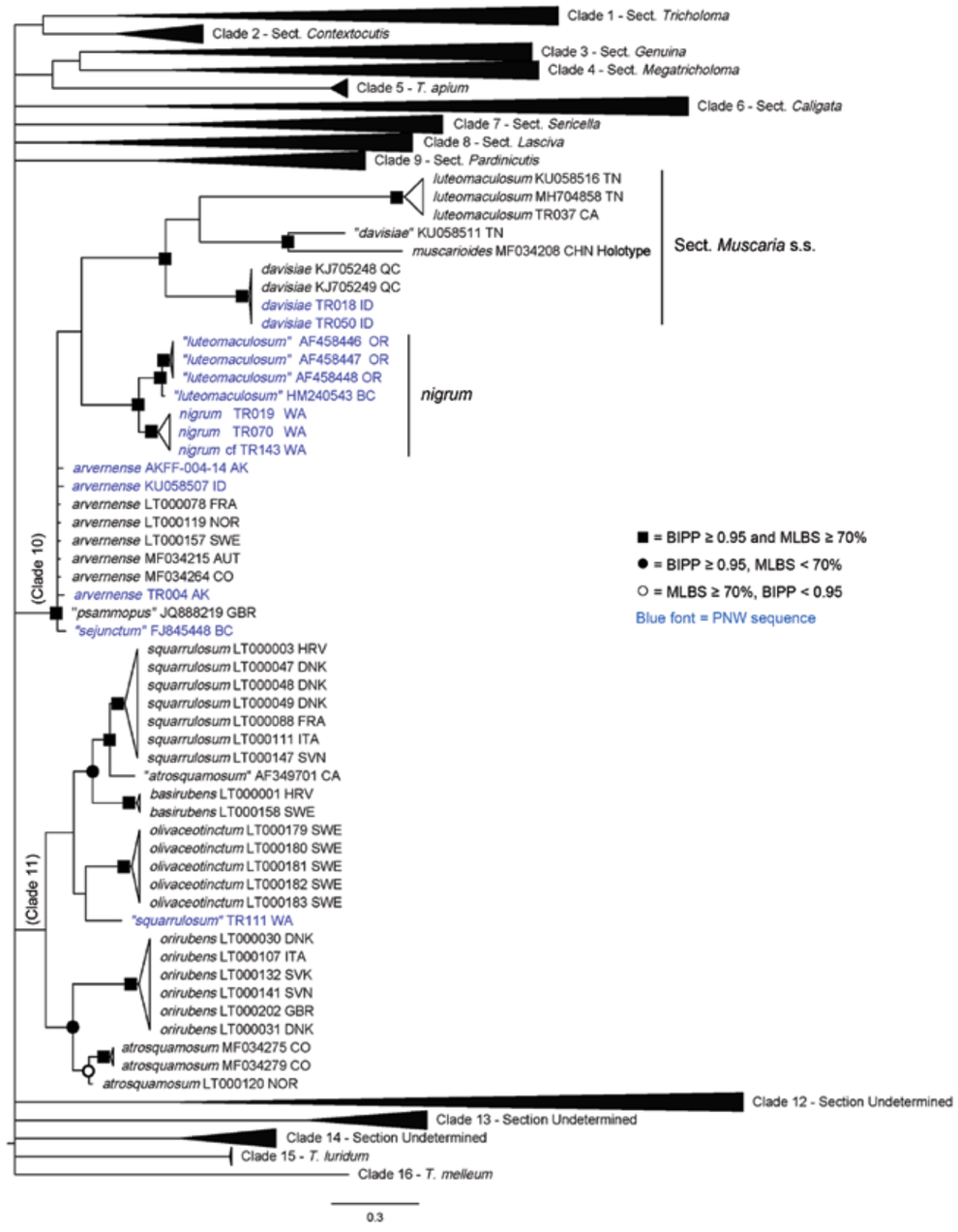

FIG. 29. Detail of Clades 10–11, Section *Muscaria*, additional species, and Section *Atrosquamosa*. Symbols as in FIG. 1. PNW sequences shown in blue.

FIG. 30. Photographs of *Tricholoma* collections studied in this project. A *T. arvernense* (AKFF-004-14). B–C. *T. davisiae* (B: TR018. C: TR050). D–F. *T. nigrum* (D: TR019. E: TR070. F: TR143). G. *T.* aff. *olivaceotinctum* (TR111). H. *T. mutabile* (TR109). Collection details can be found in APPENDIX 1 (TR### collections) and APPENDIX 3 (others). A. Photograph courtesy of Noah Siegel.

group. Although the PNW collections were associated with a variety of conifers, including spruce and hemlock, and were not restricted to sandy soils, we accept *T. arvernense* as occurring in the PNW, pending better resolution of the group.

Illustrations and descriptions: FIG. 26H, 30A; Bessette et al. 2013; Breitenbach & Kränzlin 1991; Christensen & Heilmann-Clausen 2013; Ludwig 2012; Læssøe & Petersen 2019; Siegel & Schwarz 2016.

Tricholoma davisiae Peck

Synonym: *Tricholoma cheilolaminum* Ovrebo & Tylutki

Tricholoma davisiae was described from a collection made under conifers in Maine. In our analyses, ITS sequences from two Idaho collections form a well-supported clade with sequences from two Québec specimens and morphology of the Idaho specimens closely matches the current concept of the species (that of Ovrebo 1980). We are unaware of any molecular data from the holotype but, for now, we accept *T. davisiae* as occurring in the PNW. *Tricholoma cheilolaminum* was described from Oregon by Ovrebo and Tylutki in 1975 and noted to occur in Idaho. However, subsequently Ovrebo (1980) concluded that this name is a later synonym of *T. davisiae*.

Illustrations and descriptions: FIG. 30B–C; Bessette et al. 2013; McNeil 2006.

Tricholoma nigrum Shanks & Ovrebo

Tricholoma nigrum was described from Oregon and, in our analyses, sequences from three collections (TR019, TR070, and TR143) that match the holotype (the latter sequence not shown) formed a well-supported clade sister, with very short branch lengths, to a clade comprising four "*T. luteomaculosum*" sequences from coastal Oregon and Vancouver, British Columbia. Although detailed information concerning the latter four specimens was not readily available, they do not cluster with other *T. luteomaculosum* sequences, and it is likely that they represent misdeterminations of *T. nigrum*.

Illustrations and descriptions: FIG. 30D–F; Shanks 1996.

Clade 11. Sect. *Atrosquamosa* (FIG. 29)**.** Although only weakly supported in both BI and ML, our Clade 11 corresponds closely to Sect. *Atrosquamosa* as presented by Heilmann-Clausen et al. (2017). It includes five well-circumscribed European species, viz. *T. atrosquamosum*, *T. orirubens*, *T. basirubens*, *T. squarrulosum* and *T. olivaceotinctum*, and these species fall in two distinct subclades. The single PNW specimen, TR111 labelled "*T. squarrulosum*," occurs as sister to a well-supported *T. olivaceotinctum*. For now, we refer to it as *T.* aff. *olivaceotinctum*. Two Colorado collections of *T. atrosquamosum* appear to be closely related to European material of that species (sensu Heilmann-Clausen et al. 2017) and a California collection labelled "*T.* cf. *atrosquamosum*" could represent a new species, closely related to *T. squarrulosum*.

Illustration: FIG. 30G.

Clade 12. *Tricholoma subumbrinum – T. mutabile* group (FIG. 31)**.** Our Clade 12 comprises a well-supported group of species that, at least in terms of ITS barcodes, do not fit within any of the currently recognized sections of *Tricholoma*. Included are the European taxa, *T. fucatum* and *T. josserandii* and the American *T. felschii*, *T. marquettense*, *T. mutabile*, and *T. subumbrinum*. The PNW report of *T. josserandii* likely represents a misdetermination of either *T. mutabile* or *T. marquettense*.

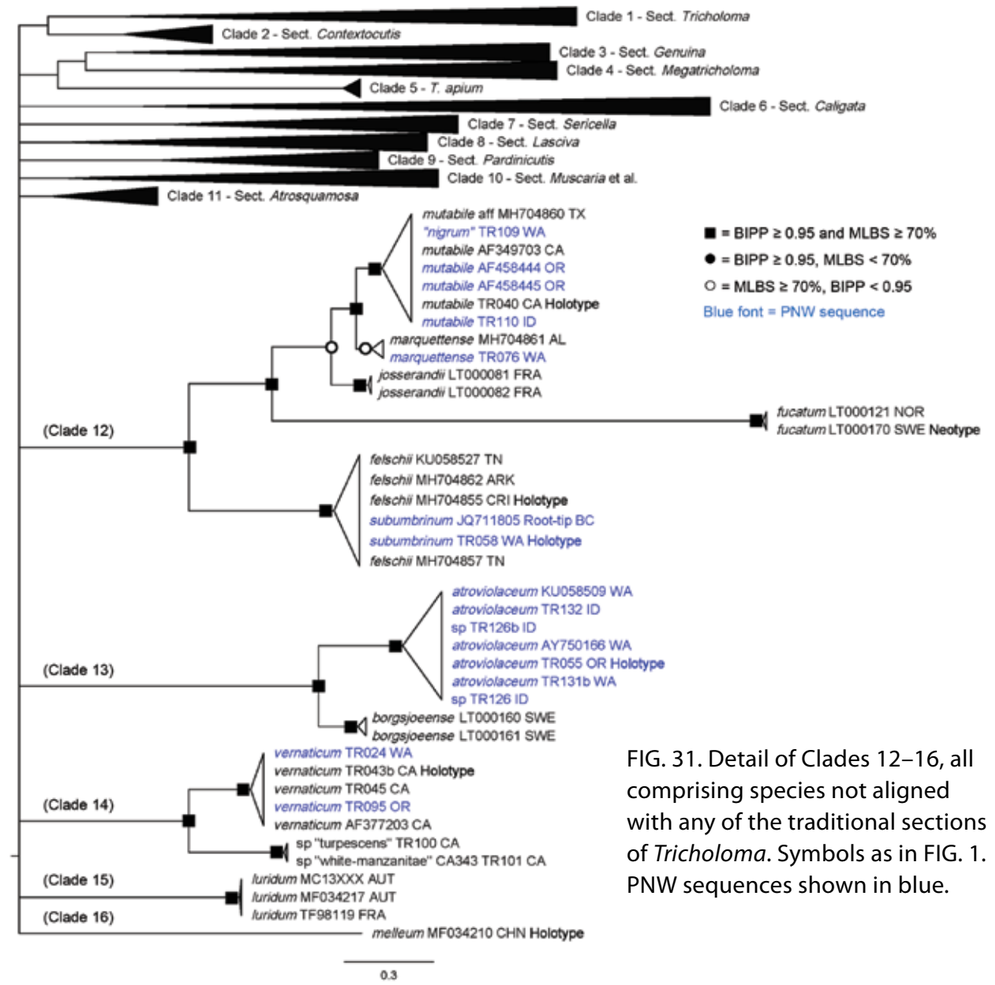

FIG. 31. Detail of Clades 12–16, all comprising species not aligned with any of the traditional sections of *Tricholoma*. Symbols as in FIG. 1. PNW sequences shown in blue.

Tricholoma marquettense Ovrebo

Tricholoma marquettense was described from jack pine forests in Michigan. In our analyses, a sequence from an Olympic Peninsula, Washington collection clustered (well supported in ML) with a collection from Alabama that Ovrebo et al. (2019) accepted as representing *T. marquettense*. Consequently, we accept the occurrence of *T. marquettense* in the PNW, although additional study would seem desirable in light of the unusual apparent distribution.

Illustration and description: Ovrebo 1986.

Tricholoma mutabile Shanks

Synonym: *Tricholoma portentosum* var. *avellaneifolium* (Murrill) A.H. Smith

Tricholoma mutabile was described from California with reference to multiple specimens from Washington. It was earlier proposed as *T. smithii* (Shanks 1994) but never validly published under that name. Shanks (1994, 1996) determined that her California collections represented the same taxon as

Smith's *T. portentosum* var. *avellaneifolium*, a PNW taxon based on collections from Olympic National Park, Washington. However, the latter taxon required a new name ("*T. mutabile*") as Shanks (1994) had determined that the holotype of *M. avellaneifolia* / *T. avellaneifolium* was not a tricholoma and more properly belonged in ("probably") *Lyophyllum* based on the presence of siderophilous granules in the basidia. In our analyses, sequences from Oregon and Idaho *T. mutabile* specimens and a Washington "*T. nigrum*" specimen fell in a well-supported clade that includes the *T. mutabile* holotype sequence.

Illustrations and descriptions: FIG. 30H, 32A; Shanks 1996.

Tricholoma subumbrinum A.H. Smith

Tricholoma subumbrinum is a poorly known species described from Olympic National Park, Washington, where it was collected in a mixed conifer forest. Our analyses returned a well-supported clade that includes the *T. subumbrinum* holotype, the *T. felschii* Ovrebo, Hughes & Halling holotype, and other "*subumbrinum*" and "*felschii*" specimens from British Columbia, Arkansas, and Tennessee. This suggests that *T. felschii* is a later synonym of *T. subumbrinum*. Although there are many similarities in the type descriptions for the two species, there also are points of difference. If they do represent a single species, it would be one with a particularly wide distribution (Washington and British Columbia to eastern North America to Costa Rica) and broad ecological amplitude (with conifers in the PNW, in mixed forests in eastern North America, and with oaks in Costa Rica). Additional study is necessary before accepting the putative synonymy.

Clade 13. *Tricholoma borgsjoeënse* + *T. atroviolaceum* (FIG. 31)**.** Our Clade 13 comprises a well-supported group of species that, at least in terms of ITS barcodes, do not fit within any of the currently recognized sections of *Tricholoma*. Included are the European species, *T. borgsjoeënse* and the very similar North American *T. atroviolaceum*.

Tricholoma atroviolaceum A.H. Smith

Tricholoma atroviolaceum was described from southern Oregon. It is a distinctive, fairly common, species that occurs in conifer forests in many parts of the PNW and appears to be relatively easy to identify, as all "*T. atroviolaceum*" specimens we obtained yielded sequences that fell in a well-supported clade with the holotype sequence. It is closely related, and rather similar in appearance, to the European species, *T. borgsjoeënse*.

Illustrations and descriptions: FIG. 32B–E; Bessette et al. 2013; Siegel & Schwarz 2016; Shanks 1997; Trudell & Ammirati 2009.

Clade 14. *Tricholoma vernaticum* + "*T. turpescens*" (FIG. 31)**.** Our Clade 14 comprises a well-supported group of species that, at least in terms of ITS barcodes, do not fit within any of the currently recognized sections of *Tricholoma*. Included are *T. vernaticum* and an apparently undescribed whitish species from California, given the informal field name, "*T. turpescens*."

Tricholoma vernaticum Shanks

Synonym: *Armillaria olida* Thiers & Sundberg

Tricholoma vernaticum is a spring to early summer montane species described from California as *Armillaria olida*. In our analyses, specimens from California, Oregon, and Washington formed a well-supported clade with the holotype. The results of our analyses are consistent with the observation of

FIG. 32. Photographs of *Tricholoma* collections studied in this project. A. *T. mutabile* (TR110). B–E. *T. atroviolaceum* (B: TR131. C–D: TR126. E: TR132). F–G. *T. vernaticum* (F: TR024. G: TR095). H. *T. argyraceum* s.l. (TR107). Collection details can be found in APPENDIX 1.

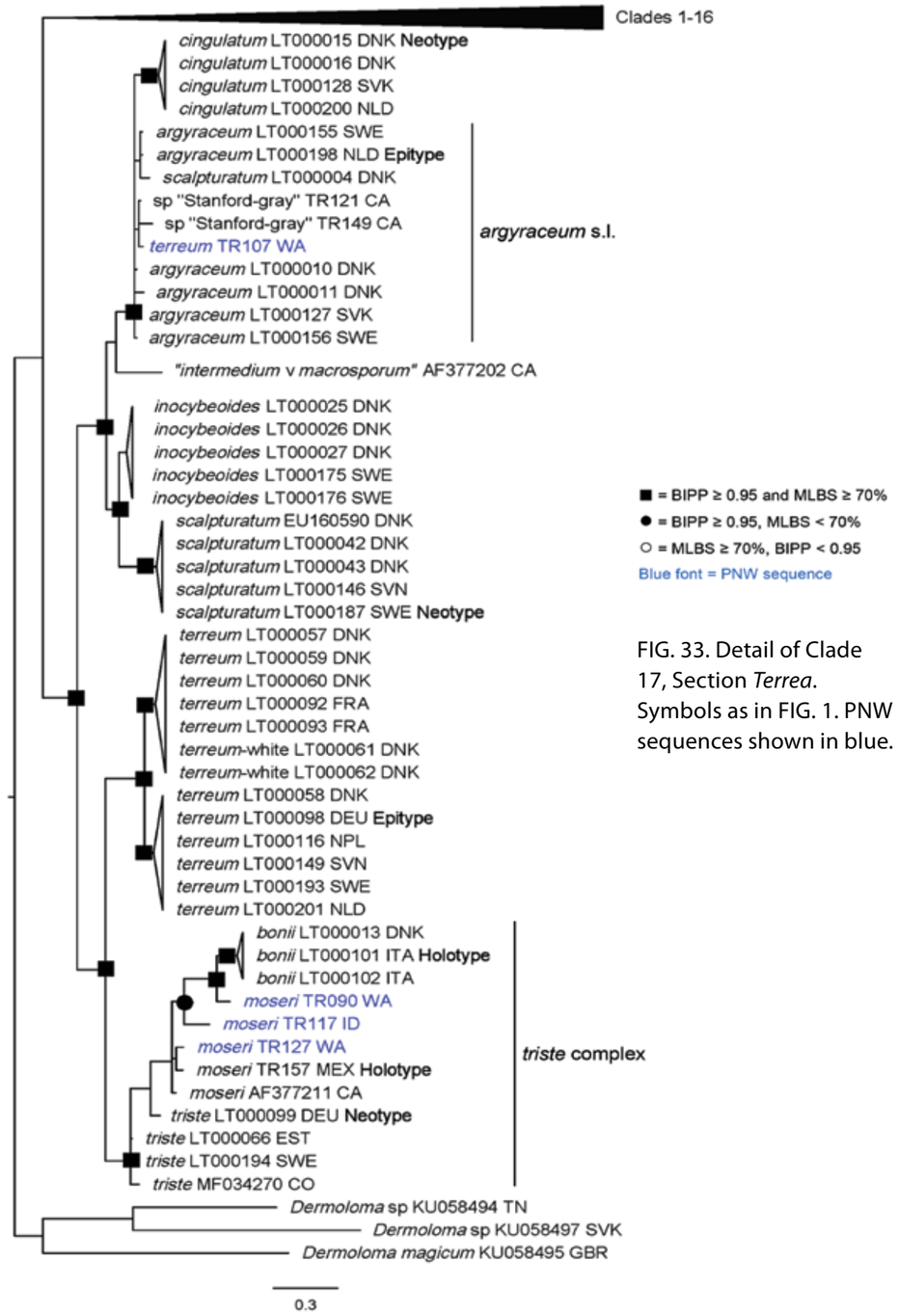

FIG. 33. Detail of Clade 17, Section *Terrea*. Symbols as in FIG. 1. PNW sequences shown in blue.

FIG. 34. Photographs of *Tricholoma* collections studied in this project. A–B. *T. argyraceum* s.l. (A: TR121. B: TR149). C–E. *T. moseri* (C: TR090. D: TR117. E: TR127). Collection details can be found in APPENDIX 1.

Reschke et al. (2018) that *T. vernaticum* does not fit within any of the traditional sections of *Tricholoma*. The closest relative to it in our analyses (TR100 and TR101) is an apparently undescribed whitish species from California.

Illustrations and descriptions: FIG. 32F–G; Bessette et al. 2013; Desjardin et al. 2015; Shanks 1997.

Clade 15—*Tricholoma luridum* and Clade 16—*T. melleum* (FIG. 31)**.** Our Clade 15 consists of three European specimens of *T. luridum* (Schaeffer) P. Kummer, which is a montane species that occurs in mixed forests with beech, fir, and spruce. Our Clade 16 consists of the holotype of *T. melleum* K. Reschke, F. Popa, Z.L. Yang & G. Kost, which was described from a spruce-oak forest in China and seems to be an oak associate. The relationships of these two species to the rest of the genus are unresolved and we have no evidence for the occurrence of either in

FIG. 35. Photograph of epitype collection for *Tricholoma dryophilum* (TR125). Collection details can be found in APPENDIX 1.

the PNW.

Clade 17. Sect. *Terrea* (FIG. 33)**.** Our Clade 17 corresponds to Sect. *Terrea* sensu Heilmann-Clausen et al. (2017) and Reschke et al. (2018). Our analyses returned two well-supported subclades. The first includes the European species *T. argyraceum*, *T. cingulatum*, *T. inocybeoides*, and *T. scalpturatum*. Three specimens in our study formed part of a *T. argyraceum* group that is paraphyletic with respect to *T. cingulatum*. The second subclade included the European species *T. bonii*, *T. terreum*, and *T. triste*. PNW specimens labelled "*T. moseri*," along with the holotype of that species, formed a paraphyletic group with respect to a well-supported *T. bonii* within a larger *T. triste* complex.

Tricholoma argyraceum (Bulliard) Gillet

Tricholoma argyraceum is a European species that is ectomycorrhizal with both deciduous angiosperm and coniferous trees (Jargeat et al. 2010). In our analyses, sequences from "*T. terreum*" and "Stanford gray" (Siegel & Schwarz 2016) collections from Washington and California, respectively, fell in a well-supported, but paraphyletic (with respect to *T. cingulatum*) "*T. argyraceum*" group. Morphology of the North American specimens is a close match to that of *T. argyraceum*. Thus, until further studies can be done to resolve the relationships within this group, we accept *T. argyraceum* sensu lato as occurring in the PNW.

Illustrations and descriptions: FIG. 32H, 34 A–B; Bessette et al. 2013 ("Stanford Gray" as "NAT-11"); Christensen & Heilmann-Clausen 2013; Ludwig 2012; Læssøe & Petersen 2019; Siegel & Schwarz 2016 (as "Stanford Gray").

Tricholoma moseri Singer

Misapplied names: Tricholoma myomyces, *T. terreum*

Tricholoma moseri was described from montane pine forests in Mexico. In our analyses, all *T. moseri* sequences fell within a well-supported "*T. triste*" complex. *Tricholoma triste* specimens, mostly from Europe and including the neotype, but also one Colorado collection, formed a group that is paraphyletic with respect to *T. moseri* and *T. bonii*. In turn, *T. moseri* specimens, including the holotype, formed a group that is paraphyletic with respect to a well-supported *T. bonii* clade, which includes the holotype. A clade consisting of *T. bonii* plus *T. moseri* sample TR090 also is well supported, as is a clade consisting of *T. bonii* plus *T. moseri* samples TR090 and TR117 (BI only). Christensen and Heilmann-Clausen (2013) discussed the difficulty in separating *T. triste* and *T. bonii* using morphological characteristics and also noted the similarity of *T. moseri* to the two European species. Clearly more work is needed to resolve the relationships within the *T. triste* complex. For now, we accept the existence of *T. moseri* in the PNW.

Illustrations and descriptions: FIG. 34C–E; Bessette et al. 2013; Desjardin et al. 2015; Shanks 1997.

Poorly known species of uncertain status, described from the PNW

The following three species were described, one provisionally, from the PNW. However, their current status is unknown.

Tricholoma farinaceum (Murrill) Murrill

Synonym: Melanoleuca farinacea Murrill

Tricholoma farinaceum is a little-known white, strongly farinaceous-smelling species described from the vicinity of Seattle, Washington. Singer (1942) studied the type collection and concluded that *T. farinaceum* is closely related to *T. mongolicum* in Sect. *Leucorigida* of Subg. *Contextocutis*. Shanks (1994) accepted that section placement after her examination of the type collection and suggested a possible relationship to *T. album*. However, Singer characterized the species in *Leucorigida* as not occurring with forest trees, which is the norm for species of *Tricholoma*. Rather the former species occur in grassland and semi-desert habitats and so, presumably, would not be ectomycorrhizal. In part because of this difference, *T. mongolicum*, the type species of Sect. *Leucorigida*, has been transferred to *Leucocalocybe* (Yu et al. 2011) and, earlier, other species in the section were transferred to *Macrocybe* (Pegler et al. 1998). If Singer's placement of *T. farinaceum* was justified, then it is likely that it does not belong in *Tricholoma*. However, despite multiple attempts, we were unable to obtain an ITS sequence from the holotype. For now, it seems best to consider *T. farinaceum* as a nomen ambiguum.

Tricholoma nigrocystidium **nom. prov.** Ovrebo 1973

This putative species was based on study of three collections from Idaho. It was never validly published and we have no new information to add here.

Tricholoma subluridum (Murrill) Murrill

Synonym: *Melanoleuca sublurida* Murrill

The type collection (a single fruitbody) originated from the Oregon Coast Range. Based on his study of the type specimen, Singer (1942) suggested that it was close to, or the same as, *T. sudum* sensu Lange, which would suggest it is a member of the broad *T. saponaceum* complex. The type collection includes an annotation label from Howard Bigelow that refers to the specimen

as *Melanoleuca sublurida* and provides no indication that he disagreed with that name. We have found no well-documented reports of this species since Murrill's original publication.

Species that occur in California and are likely to extend into the PNW

These four species include three that were described from California plus a European species that appears to occur there. Although we did not confirm their occurrence in the PNW, it is likely that they occur here based on their typical habitats.

Tricholoma batschii Gulden ex Mort. Christensen & Noordeloos

Misapplied name: *Tricholoma fracticum*

Tricholoma batschii is a European species that is usually associated with pine. It has a slight annulus and the sharply defined stipe apex is whitish. An ITS sequence from Shanks's (1994) California voucher specimen of *T. fracticum* formed a well-supported clade with that from a Croatian specimen of *T. batschii* studied by Heilmann-Clausen et al. (2017). Macromorphology of the California collection is consistent with the European concept (Shanks 1994, Christensen & Heilmann-Clausen 2013) and ecology also appears consistent. Shanks's (1997) photograph (not of the voucher collection, which was obtained at an exhibition) includes needles of pine. Consequently, we accept the occurrence of *T. batschii* in California but its possible occurrence in the PNW remains to be confirmed.

Illustrations and descriptions: Bessette et al. 2013 (as *T. fracticum*); Breitenbach & Kränzlin 1991 (as *T. fracticum*); Christensen & Heilmann-Clausen 2013; Desjardin et al. 2015 (as *T. fracticum*); Shanks 1997 (as *T. fracticum*); Ludwig 2012; Siegel & Schwarz 2016 (as *T. fracticum*).

Tricholoma dryophilum (Murrill) Murrill

Synonym: *Melanoleuca dryophila* Murrill

Tricholoma dryophilum was described from a collection occurring under coast live oak in the San Francisco Bay Area of California. In our study, multiple attempts to obtain an ITS sequence from the holotype were unsuccessful. However, a sequence from California specimens we collected formed a well-supported clade with two collections made by Shanks (1994), including her designated voucher for the species. The species appears to be sister to *T. stans* (Fries) Saccardo, a European species that most often occurs with pines. Oregon and Washington collections made under Garry oak during our study (TR114 and TR129, respectively) and originally thought to be *T. dryophilum* instead represent *T. subannulatum* (see above), as do many online observations from outside California. Thus, the occurrence of *T. dryophilum* in the PNW remains to be confirmed.

Illustrations and descriptions: FIG. 35; Shanks 1997; Siegel & Schwarz 2016.

Tricholoma griseoviolaceum Shanks

Tricholoma griseoviolaceum was described from California where it associates with coast live oak and tanoak. Our ITS sequence from the holotype, along with a British Columbia "*T. saponaceum*" sequence, formed one of four minimally diverged groupings (but without strong support) within a well-supported "*T. portentosum*" clade, along with European *T. portentosum* specimens, including the neotype, and western North American "*T. portentosum*" specimens. The common occurrence with oak, typically stocky fruitbody stature, violet tones in the cap, and lack of yellow in the gills and stipe have been used to

distinguish *T. griseoviolaceum* from the other members of the "*T. portentosum*" clade and we recognize the species pending future resolution of the relationships within the group. Because the grouping of a British Columbia collection with the *T. griseoviolaceum* holotype was not supported we feel the occurrence of *T. griseoviolaceum* in the PNW remains to be confirmed.

Illustrations and descriptions: Bessette et al. 2013; Desjardin et al. 2015; Shanks 1997; Siegel & Schwarz 2016.

Tricholoma muricatum Shanks

Tricholoma muricatum was described from California. Its species epithet reflects its typical association with *Pinus muricata* (Bishop pine). In our analyses, the holotype sequence fell in a well-supported clade with two *T. albobrunneum* (Persoon) P. Kummer (=*Tricholoma striatum* [Schaeffer] Quélet) sequences from Europe. Shanks's type description is very similar to Christensen and Heilmann-Clausen's (2013) description of *T. albobrunneum*, which also is ectomycorrhizal with pines. However, we are unaware of an ITS sequence from type material of the latter species (it appears that designation of an epitype would be necessary). Thus, we are hesitant to accept *T. muricatum* as synonymous with *T. albobrunneum* until confirmed by critical comparison with type material of the latter species. No PNW sequences grouped with the *T. muricatum* / *T. albobrunneum* sequences, so the occurrence of *T. muricatum* (or *T. albobrunneum*) in the PNW remains to be confirmed, although it appears likely.

Illustrations and descriptions: Desjardin et al. 2015; Shanks 1997 (however, the photograph, made by Ms. Catherine Ardrey, likely shows a collection from Oregon and there is no indication in Shanks's publications (1994, 1996, 1997) that she studied the material).

Other reported species, not confirmed from the PNW but considered possible to occur here

These 12 species include 4 that were described from eastern North America and 8 from Europe. Although we did not confirm their occurrence in the PNW, it is possible that they occur here based on their typical habitats.

Tricholoma aestuans (Fries) Gillet

Tricholoma aestuans is a European species with a conical to umbonate yellowish brown cap, yellowish gills, and an association with spruce and pine. *Tricholoma palustre* is a very similar northeastern North American species that is typically associated with beech and oak. After completion of our phylogenetic analyses, we became aware of a collection from shore pine woodland near Sand Lake, Oregon determined as "*T. aestuans*," with ITS sequence very close to that of European specimens that were included in our analyses (LT000007 and LT000153 [neotype], FIG. 2). Study of the morphological features of the Oregon collection will be required before the existence of *T. aestuans* in the PNW can be confirmed.

Tricholoma atrosquamosum Saccardo

Tricholoma atrosquamosum belongs to a taxonomically difficult group (Sect. *Atrosquamosa*) and Christensen and Heilmann-Clausen (2013) consider it to be most closely related to *T. orirubens* and to occur with a variety of tree species, including birch, hazel, linden, and spruce. Its occurrence in the PNW remains to be confirmed, although it (sensu Christensen & Heilmann-Clausen 2013), or a very close relative, occurs in the Colorado Rocky Mountains (FIG. 29).

Tricholoma bufonium (Persoon) Gillet

Tricholoma bufonium is a member of the *T. sulphureum* complex, traditionally considered to differ by its vinaceous brown pileus and association with conifers. However, Comandini et al. (2004) concluded that *T. bufonium* should be considered an intraspecific variant of *T. sulphureum* based on fruitbody morphology, ecological data, and analysis of ITS sequences from fruitbodies of different ecological and geographic origin. Christensen and Heilmann-Clausen (2013) and Heilmann-Clausen et al. (2017) agreed that cap color was not a reliable character for differentiating species in the complex but concluded that multiple species exist within *T. sulphureum* sensu lato that will require further work to sort out. Our study included a "*T. sulphureum*" specimen with reddish pileus (TR020, FIG. 24G) that fell within the broad *T. sulphureum* complex (FIG. 23). The possible occurrence of *T. bufonium* in the PNW cannot be assessed until the taxonomy of the complex is worked out and the status of the species is resolved.

Tricholoma cingulatum (Almfelt ex Fries) Jacobasch

Tricholoma cingulatum is an annulate species that, in Europe, occurs with willow (Bon 1991, Kibby 2012, Christensen & Heilmann-Clausen 2013). After completion of our phylogenetic analyses, we learned that the photograph of *T. cingulatum* in Shanks (1997) shows a collection made at Fort Casey State Park in Washington. It matches European material in macromorphology. The few other herbarium specimens of PNW "*T. cingulatum*" of which we are aware all appear to have been made under conifers and none include photographs of the fresh material. Siegel & Schwarz (2016) describe and illustrate a California collection that matches European material in macromorphology and host association. However, we are unaware of ITS sequence data from either the PNW or California collections. Therefore we consider that the occurrence of *T. cingulatum* in the PNW, although likely, remains to be confirmed.

Tricholoma fumosoluteum (Peck) Saccardo

Tricholoma fumosoluteum is an eastern North American species associated with conifers. Although we are aware of only one PNW report (from Idaho), the conifer habitat (we have seen it in a mixed forest with spruce, fir, and larch in eastern Canada) suggests it might occur here.

Tricholoma joachimii Bon & A. Riva

Tricholoma joachimii was described from France and, although most common in southern Europe, it also extends into Fennoscandia. It is mycorrhizal with pines, often on sandy soils. We are aware of a single report of *T. joachimii* from coastal Oregon where pines and sandy soils are common. However, we have not studied that collection and, in our analyses, no PNW or other North American sequences appeared near the clade that includes two well-documented European *T. joachimii* sequences, so the report of that species remains to be confirmed.

Tricholoma odorum Peck

Tricholoma odorum is a member of the *T. sulphureum* complex, described from Washington D.C. under broad-leaved trees. Ovrebo et al. (2009) obtained ITS sequences from several "*T. odorum*" collections from eastern North America. All fell within the bounds of the *T. sulphureum* complex but they did not form a monophyletic group. ITS data apparently are not available for the holotype. Much work remains to be done to resolve the relationships within the *T. sulphureum* complex, including clarifying the concept of *T. odorum*. Thus, the possible occurrence of *T. odorum* in the PNW cannot be reliably assessed until the species concept is solidified.

Tricholoma psammopus (Kalchbrenner) Quélet

Tricholoma psammopus is a conifer-associated species (mostly with larch) described from Europe. Its occurrence in the PNW remains to be confirmed.

Tricholoma silvaticum Peck

Tricholoma silvaticum is a little-known, small, white species with broad subdistant gills and large elliptical spores described from North Elba, New York. Peck compared it with *T. inamoenum* and *T. leucocephalum* (now *Tricholomella constricta*), differing from both of them primarily in lacking a strong odor. The overall description is very similar to that of *T. platyphyllum*. Should Peck's *T. silvaticum* and Murrill's *T. platyphyllum* prove to be the same, the former name would have priority. We have not studied the holotype and there appear to be no subsequent well-documented records so, pending future work, the occurrence of *T. silvaticum* in the PNW remains to be confirmed.

Tricholoma subluteum Peck

Tricholoma subluteum, a close relative of *T. sejunctum*, was described from New York and occurs widely in northeastern North America under conifers. Its occurrence in the PNW remains to be confirmed.

Tricholoma terreum (Schaeffer) P. Kummer

Synonyms: *Tricholoma gausapatum* (Fries) Quélet, *T. myomyces* (Persoon) J.E. Lange

Tricholoma terreum is a European species that has been interpreted in various ways by different authors. In order to solidify the species concept, Christensen and Noordeloos (1999) designated an epitype from Germany. During their study of more than 100 collections of *T. terreum* sensu lato, Christensen and Heilmann-Clausen (2013) observed gradational variation in characters such as cap color and presence of a partial veil, and little correlation among the characters. Thus, they interpret *T. terreum* as a variable species that includes *T. gausapatum*, *T. myomyces*, and *T. leucoterreum*. Our analyses returned a well-supported *T. terreum* clade, consisting entirely of European specimens (FIG. 33). Within it are two well-supported clades, one containing the epitype. The most closely related PNW samples in our analyses are *T. moseri* collections that are more closely related to *T. triste* and *T. bonii*. Neither of the two PNW "*T. terreum* (cf.)" samples clustered with the European *T. terreum* samples. One (a British Columbia sequence from GenBank) fell in the North American *T. subacutum* clade and the other (TR107, from Washington) in *T. argyraceum* sensu lato. Consequently, the occurrence of *T. terreum* in the PNW remains to be confirmed.

Tricholoma triste (Scopoli) Quélet

Tricholoma triste is a European species that is associated with conifers and, perhaps, deciduous angiosperm trees. It is very similar in both macro- and micromorphology to *T. bonii* (Christensen & Heilmann-Clausen 2013). Christensen and Noordeloos (1999) stabilized the species concept and designated a neotype from southern Germany. In our analyses, *T. triste* specimens from Europe (including the neotype) and Colorado formed a paraphyletic group from which a paraphyletic group of *T. moseri* was derived and that from which, in turn, a well-supported *T. bonii* was derived (FIG. 33). Until further studies are conducted to resolve the taxonomy and application of names in the *T. triste* complex, we accept the occurrence of *T. moseri* in the PNW and that there could be

other closely related species here as well. The occurrence of *T. triste* sensu stricto remains to be confirmed.

Other reported species, not confirmed from the PNW and considered unlikely to occur here

Most of the following species were described from Europe or eastern North America, usually in association with beech, oak, or other deciduous angiosperm tree species that do not occur naturally or are rare in the PNW. Heilmann-Clausen et al. (2017) noted that at least 12 species in their analyses appeared to occur in North America and/or Asia as well as in northern Europe and that all of them were associated with widely distributed boreal host tree genera, especially *Picea*, *Populus*, and *Salix*. None of the intercontinental species associated exclusively with lower-latitude deciduous angiosperm trees such as beech and oak. The results of our analyses are consistent with those observations. Therefore we consider the following species unlikely to occur in the PNW.

Tricholoma acerbum (Bulliard) Quélet

Tricholoma acris (acre) Peck

Tricholoma album (Schaeffer) P. Kummer

Tricholoma atrodiscus (atrodiscum) Ovrebo

Tricholoma bisporigerum J.E. Lange

Tricholoma brunneosquamosa Beeli

Tricholoma caligatum (Viviani) Ricken

Tricholoma cartilagineum (Bulliard) Quélet

Tricholoma columbetta (Fries) P. Kummer (Synonyms: *T. resplendens* [Fries] P. Karsten, *T. subresplendens* [Murrill] Murrill)

Tricholoma grande Peck

Tricholoma huronense A.H. Smith

Tricholoma impolitum (Lasch) P. Kummer

Tricholoma josserandii Bon

Tricholoma luteomaculosum A.H. Smith

Tricholoma orirubens Quélet

Tricholoma pessundatum (Fries) Quélet. *Tricholoma pessundatum* is a European species that occurs with spruce, pine, and fir, often on sandy soil. Christensen and Heilmann-Clausen (2013) designated an epitype and solidified the species concept. In our analyses, sequences from PNW and European "*T. populinum*" collections were the closest relatives to the epitype of *T. pessundatum* (FIG. 12). Other variously labeled PNW *T. pessundatum* group collections all appear to represent different taxa.

Tricholoma pullum Ovrebo

Tricholoma scalpturatum (Fries) Quélet

Tricholoma sciodes (Persoon) C. Martín

Tricholoma spermaticum (Fries) Gillet

Tricholoma squarrulosum Bresadola

Tricholoma sudum (Fries) Quélet

Tricholoma sulphurescens Bresadola

Tricholoma tumidum (Persoon) P. Karsten. *Tricholoma tumidum* is a little-known European species. The epithet was applied by Shanks (1994, 1997) to specimens from California, however her description differs considerably from European descriptions (e.g., Bon 1984, 1991, Riva 1988, 2003), being a better fit for *T. arvernense*. Notes accompanying the single PNW record of "*T. tumidum*" of which we are aware also are a much better fit for *T. arvernense*.

Tricholoma umbonatum Clémençon & Bon

Tricholoma ustale (Fries) P. Kummer

Tricholoma ustaloides Romagnesi

Tricholoma venenatum G.F. Atkinson

DISCUSSION

Tricholoma diversity in the PNW

The results of our work provide evidence for the existence of at least 50 species of *Tricholoma* in the PNW; undoubtedly, there are more. Unambiguous or highly probable names can be assigned to 30 of the 50. Another 16 are closely related to, but appear to differ somewhat from, existing species or can be tentatively accommodated within broadly circumscribed, mostly European, species. Nearly all of these likely represent undescribed species or ones whose names have been forgotten and there are at least 2 additional putatively undescribed species. Many epithets clearly have been misapplied, mostly ones based on European or eastern North American fungi.

In a number of cases, considerable work will be needed before names can be assigned to PNW species, especially in the *T. equestre*, *T. saponaceum*, and *T. sulphureum* complexes. In most cases this will require solidifying the existing species concepts, often including designation and sequencing of type material, study of new well-documented collections, and sequencing DNA loci beyond the ITS barcode region.

Association of PNW species with traditional sections

As would be expected from analyses using the same marker (ITS), our ML and BI analyses returned overall tree topology that, for most species, closely reflects existing infrageneric classifications as interpreted by Heilmann-Clausen et al. (2017) and Reschke et al. (2018). Nonetheless, we did observe some differences in placement of particular species within those groups. In addition, similar to their results, we found that several species do not fit comfortably in the existing section-level taxa. Consistent with the results of Heilmann-Clausen et al. (2017) and Reschke et al. (2018), the species in the following clades cannot be readily assigned to an existing section based on ITS data: Clade 5 (*T. apium*), Clade 12 (*T. mutabile*, *T. marquettense*, *T. josserandii*, *T. fucatum*, and *T. subumbrinum / T. felschii*), Clade 13 (*T. borgsjoeënse* and *T. atroviolaceum*), Clade 14 (*T. vernaticum* plus an apparently undescribed California species), Clade 15 (*T. luridum*), and Clade 16 (*T. melleum*). In addition, *T. arvernense* and *T. nigrum* appeared in a well-supported Clade 10 with Sect. *Muscaria* sensu stricto and possible expansion of the section to include them should be investigated.

Observations on species distributions

Both Heilmann-Clausen et al. (2017) and Reschke et al. (2018) reported that a number of *Tricholoma* species occur in northern Europe as well as in North America and/or Asia. These include *T. albobrunneum*, *T. argyraceum*, *T. aurantium*, *T. batschii*, *T. bonii*, *T. cingulatum*, *T. dulciolens*, *T. focale*, *T. frondosae*, *T. imbricatum*, *T. inamoenum*, *T. japonicum* / *roseoacerbum*, *T. matsutake*, *T. portentosum*, *T. stans*, *T. triste,* and *T. vaccinum*. Among these, our analyses suggest that all except *T. stans* are represented in the PNW either as the same or a very closely related species. Additional examples will probably be found when the taxonomy of groups such as the *T. equestre*, *T. saponaceum*, and *T. sulphureum* complexes are worked out. As pointed out by Heilmann-Clausen et al. (2017), all of the widespread species are associated with widely distributed boreal tree genera such as *Betula*, *Picea*, *Pinus*, *Populus*, and *Salix*. So far, it appears that no species associated exclusively with lower-latitude, broad-leaved angiosperm trees, particularly *Fagus* and *Quercus*,

occurs in northern Europe, as well as in the PNW and/or Asia. Heilmann-Clausen et al. (2017) noted that *T. roseoacerbum* appeared to be remarkably widely distributed, with almost perfect ITS sequence matches among collections and environmental samples from Finland, Japan, Canada, and Mexico. Our analyses returned a well-supported clade comprising three well-supported subclades: European *T. roseoacerbum* specimens, Japanese *T. japonicum* specimens, and TR147 (plus an additional sample [FIG. 22A] not included in our tree), which we provisionally recognize as *T. japonicum*. Further study will be required before it can be determined whether the lineage should be considered a single species or not.

Need for well-documented field collections

Progress in furthering our taxonomic and ecological understanding of *Tricholoma* will depend to a large extent on obtaining well-documented field collections of high-quality material. Ideally these will include photographs or color illustrations, a list of associated trees, and notes on ephemeral characters such as odor and taste. In some cases, ITS barcode sequences will have to be augmented with sampling of additional DNA loci to help resolve taxonomic issues and allow us to obtain a fuller understanding of the genus, *Tricholoma*, as it occurs in the PNW.

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APPENDIX 1. *Tricholoma* specimens from which ITS sequences were obtained in this study, plus type collections for which sequencing was not successful.

Sample #	Species Epithet / Name	Collector's / Herbarium #	Location / Origin	Habitat / Tree Associates	GenBank/ UNITE # (ITS)
TR001	aff. *bryogenum* (as *inamoenum* cf.)	SAT-13-272-06 / WTU-F-073001	Chugach National Forest, Kenai Peninsula, Alaska (AK)	In deep moss, mixed forest - mostly *Picea* and *Populus*.	MW597185 / ---
TR002	*subsejunctum* (as *viridilutescens* cf.)	SAT-13-273-05 / WTU-F-073002	Girdwood, Alaska (AK)	*Picea sitchensis* - *Tsuga* forest, with occasional *Alnus* and *Populus trichocarpa*.	MW597186 / ---
TR003	*platyphyllum* (as *inamoenum*)	SAT-13-313-16 / WTU-F-073003	H.J. Andrews Experimental Forest, Willamette National Forest, Lane Co., Oregon (OR)	Mixed conifer forest with *Pseudotsuga menziesii*, *Tsuga heterophylla*, and *Thuja plicata*.	MW597187 / ---
TR004	*arvernense*	SAT-12-247-03 / WTU F-073004	Chugach National Forest, Kenai Peninsula, Alaska (AK)	On moss-covered soil with *Picea* and *Tsuga*.	MW597188 / ---
TR005	*subacutum* (as *virgatum*)	SAT-13-313-14 / WTU-F-073005	H.J. Andrews Experimental Forest, Willamette National Forest, Lane Co., Oregon (OR)	Mixed conifer forest with *Pseudotsuga menziesii*, *Tsuga heterophylla*, and *Thuja plicata*.	MW597189 / ---
TR007	*subacutum* (as *virgatum*)	SAT-13-274-15 / WTU-F-073006	Girdwood, Alaska (AK)	*Picea sitchensis* -*Tsuga* forest, with occasional *Alnus* and *Populus trichocarpa*.	MW597190 / ---
TR008	*fulvum* s.l. (as *pessundatum* group)	SAT-13-273-13 / WTU-F-073007	Girdwood, Alaska (AK)	*Picea sitchensis* -*Tsuga* forest, with occasional *Alnus* and *Populus trichocarpa*.	MW597191 / ---
TR009	*equestre* (group)	SAT-13-272-01 / WTU-F-073008	Chugach National Forest, Kenai Peninsula, Alaska (AK)	Mixed forest - mostly *Picea* and *Populus*.	MW597192 / ---
TR010	*portentosum* s.l.	SAT-10-309-05 / WTU-F-073009	Deception Pass State Park, Island Co., Washington (WA)	Mixed conifer forest with *Pseudotsuga menziesii*, *Tsuga heterophylla*, *Thuja plicata*, *Abies grandis*, *Alnus rubra*, and *Acer macrophyllum*.	MW597193 / ---
TR011	*badicephalum* (as *robustum* cf.)	ADP 131005-1 / WTU-F-073010	Olympic National Forest, Clallam Co., Washington (WA)	Mature mixed conifer forest.	MW597194 / ---
TR012	*subacutum* (as *virgatum* var. *vinaceum*)	ADP 090903-5 / WTU-F-073011	Colville National Forest, Pend Oreille Co., Washington (WA)	Mixed conifer forest, mostly *Picea engelmannii* and *Abies*.	MW597195 / ---
TR013	*apium*	ADP 101106-1 / WTU-F-073012	Cornet Bay area, Island Co., Washington (WA)	Conifer forest, with *Pseudotsuga menziesii*, *Tsuga heterophylla*, *Abies grandis*, *Thuja plicata*, *Alnus rubra*, and *Acer macrophyllum*.	MW597196 / ---
TR015	*portentosum* s.l.	ADP 031026-2 / WTU-F-073013	Colville National Forest, Pend Oreille Co., Washington (WA)	Mixed conifer forest.	MW597197 / ---
TR016	*intermedium*	ADP 040905-1 / WTU-F-073014	Colville National Forest, Pend Oreille Co., Washington (WA)	Under *Picea engelmannii* in mixed woods.	MW597198 / ---
TR017	*ammophilum* (as *populinum*)	ADP 051013-1 / WTU-F-073015	Colville National Forest, Pend Oreille Co., Washington (WA)	In gravelly soil under *Populus trichocarpa* in mixed woods.	MW597199 / ---
TR018	*davisiae*	ADP 040923-1 / WTU-F-073016	Idaho Panhandle National Forests, Bonner Co., Idaho (ID)	Conifer forest, in moss under *Tsuga*.	MW597200 / ---
TR019	*nigrum*	ADP 131005-2 / WTU-F-073017	Upper Dungeness Trail, Olympic National Forest, Clallam Co., Washington (WA)	Mature mixed conifer forest with *Pseudotsuga menziesii*, *Tsuga heterophylla*, and *Thuja plicata*.	MW597201 / ---
TR020	*sulphureum* s.l. (as *sulphureum* / *bufonium*)	ADP 041005-1 / WTU-F-073018	Colville National Forest, Pend Oreille Co., Washington (WA)	Under *Pseudotsuga menziesii*.	MZ054352 / ---
TR021	aff. *imbricatum* (as *imbricatum*)	ADP 101023-1 / WTU-F-073019	Road FR 172 south of Slate Creek, Pend Oreille Co., Washington (WA)	Mixed conifer forest under *Pinus* and *Abies grandis*.	MW597202 / ---
TR022	*focale*	ADP 131008-2 / WTU-F-073020	Halliday Fen Research Natural Area, Colville National Forest, Pend Oreille Co., Washington (WA)	Mixed forest with *Pseudotsuga menziesii*, *Tsuga*, *Abies grandis*, *Larix occidentalis*, *Pinus*, *Thuja plicata*, and *Betula papyrifera*.	MW597203 / ---
TR023	*aurantium*	ADP 100619-1 / WTU-F-073021	Road FR 325 west of Crescent Lake, Colville National Forest, Pend Oreille Co., Washington (WA)	With *Tsuga*.	MW597204 / ---
TR024	*vernaticum*	ADP 140523-1 / WTU-F-073022	Road FR 175 off SR 31 N, Pend Oreille Co., Washington (WA)	In needle litter under mixed conifers - *Tsuga heterophylla*, *Abies grandis*, *Pinus monticola*, *Thuja plicata*.	MW597205 / ---
TR025	*badicephalum* (as *focale*)	PK4037 / UBC-F-16235	Mount Elphinstone, British Columbia, Canada (BC)	Mature mixed conifer forest with *Pseudotsuga menziesii*, *Tsuga heterophylla*, and *Thuja plicata*.	MW597206 / ---
TR025b	*badicephalum* (as *focale*)	PK4037 / UBC-F-16235	Mount Elphinstone, British Columbia, Canada (BC)	Mature mixed conifer forest with *Pseudotsuga menziesii*, *Tsuga heterophylla*, and *Thuja plicata*.	MW597207 / ---
TR026	*badicephalum* (as *robustum* cf.)	PK3121 / UBC-F-17552	Manning Provincial Park, British Columbia, Canada (BC)	Under *Pseudotsuga menziesii*, *Tsuga heterophylla* and *Thuja plicata* with *Rhododendron macrophyllum* understory.	MW597208 / ---

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TR027	*badicephalum* (as *robustum* cf.)	PK3153 / UBC-17553	Emerald Forest Trails, Whistler, British Columbia, Canada (BC)	Old-growth conifer forest with *Pseudotsuga menziesii*, *Tsuga heterophylla*, *Abies amabilis* and *Thuja plicata*.	MW597209 / ---
TR028	*badicephalum* (as *focale*)	PK3154 / UBC-F-17554	Emerald Forest Trails, Whistler, British Columbia, Canada (BC)	Old-growth conifer forest with *Pseudotsuga menziesii*, *Tsuga heterophylla*, *Abies amabilis* and *Thuja plicata*.	MW597210 / ---
TR029	*focale* (as *zelleri*)	PK3155 / UBC-F-17555	Emerald Forest Trails, Whistler, British Columbia, Canada (BC)	Old-growth conifer forest with *Pseudotsuga menziesii*, *Tsuga heterophylla*, *Abies amabilis* and *Thuja plicata*.	MW597211 / ---
TR029b	*focale* (as *zelleri*)	PK3155 / UBC-F-17555	Emerald Forest Trails, Whistler, British Columbia, Canada (BC)	Old-growth conifer forest with *Pseudotsuga menziesii*, *Tsuga heterophylla*, *Abies amabilis* and *Thuja plicata*.	MW597212 / ---
TR030b	*badicephalum* (as *robustum* cf.)	PK3171 / UBC-F-17556	Mount Elphinstone, British Columbia, Canada (BC)	Mature mixed conifer forest with *Pseudotsuga menziesii*, *Tsuga heterophylla*, and *Thuja plicata*.	MW597213 / ---
TR031	*focale* (as *robustum*)	PK5305 / UBC-F-18390	Willamette National Forest, Oregon (OR)	Mixed conifer forest with *Pseudotsuga menziesii*, *Tsuga heterophylla*, and *Thuja plicata*.	MW597214 / ---
TR031b	*focale* (as *robustum*)	PK5305 / UBC-F-18390	Willamette National Forest, Oregon (OR)	Mixed conifer forest with *Pseudotsuga menziesii*, *Tsuga heterophylla*, and *Thuja plicata*.	MW597215 / ---
TR032	*focale* (as *zelleri*)	PK6734 / UBC-F-21190	Emerald Forest Trails, Whistler, British Columbia, Canada (BC)	Old-growth conifer forest with *Pseudotsuga menziesii*, *Tsuga heterophylla*, *Abies amabilis* and *Thuja plicata*.	MW597216 / ---
TR032b	*focale* (as *zelleri*)	PK6734 / UBC-F-21190	Emerald Forest Trails, Whistler, British Columbia, Canada (BC)	Old-growth conifer forest with *Pseudotsuga menziesii*, *Tsuga heterophylla*, *Abies amabilis* and *Thuja plicata*.	MW597217 / ---
TR033	*dryophilum*	KMS360 / SFSU	Marin Co., California (CA)	With *Quercus agrifolia*.	MW597218 / ---
TR034	*focale*	KMS390 / SFSU	Sierra Co., California (CA)	Not reported.	MW597219 / ---
TR035	*batschii* (as *fracticum*)	KMS436 / SFSU	Location unknown (Fungus Federation Fair), Santa Cruz Co., California (CA)	Unknown.	MW597220 / ---
TR036	*griseoviolaceum* Holotype	KMS352 / SFSU-F-000786	Portola State Park, San Mateo Co., California (CA)	With *Quercus* and *Lithocarpus* (*Neolithocarpus*).	MN809562 / ---
TR037	*luteomaculosum*	KMS292 / SFSU	Mendocino Co., California (CA)	Not reported.	MW597221 / ---
TR039	*muricatum* Holotype	KMS368 / SFSU-F-000785	San Francisco State University Campus, San Francisco Co., California (CA)	With *Pinus muricatum*.	MN809563 / ---
TR040	*mutabile* Holotype	KMS424 / SFSU-F-000788	Yuba Co., California (CA)	Mixed evergreen forest.	MN809564 / ---
TR041	*fulvum* s.l. (as *nictitans*)	KMS267 / SFSU	Mendocino Co., California (CA)	With conifers, including *Pinus*.	MW597222 / ---
TR042	*nigrum* Holotype	CLO-1758 / SFSU-F-000790	Tillamook Co., Oregon (OR)	On sandy soil under *Pinus contorta*.	MN809565 / ---
TR043b	*vernaticum* Holotype	HDT28816 / SFSU-F-000420	El Dorado National Forest, El Dorado Co., California (CA)	On soil under montane conifers.	MN809561 / ---
TR045	*vernaticum*	KMS378 / SFSU	Sierra Co., California (CA)	Montane conifer forest with *Pseudotsuga menziesii*, *Pinus*, and *Abies*.	MW597223 / ---
TR046	*atrofibrillosum* (as *sejunctum* cf.)	ADP 140920-2 / WTU-F-073023	Trapper Creek Trail, Idaho Panhandle National Forests, Priest Lake, Bonner Co., Idaho (ID)	Mature mixed conifer forest with *Abies grandis*, *Tsuga heterophylla*, *Picea engelmannii*, and *Thuja plicata*.	MW597224 / ---
TR047	*portentosum* s.l. (as *mutabile* cf.)	E. Cline 11-X-2014 / WTU-F-073024	Mt. Rainier National Park, Washington (WA)	On soil in mixed conifer forest with *Tsuga mertensiana*, *Abies amabilis*, and *Callitropsis nootkatensis*.	MW597225 / ---
TR048	*equestre* group (as sp.)	ew-11-X-2014 / WTU-F-073025	NAMA Foray Eatonville, Pierce Co., Washington (WA)	Conifer forest with *Alnus rubra*, *Populus trichocarpa*, *Tsuga heterophylla*, and *Pseudotsuga menziesii*.	MW597226 / ---
TR049	*badicephalum* (as *focale* cf.)	ADP-140927-3 / WTU-F-073026	Near mouth of Kinyon Creek, Colville National Forest, Pend Oreille Co., Washington (WA)	In mossy soil under *Tsuga heterophylla*.	MW597227 / ---
TR050	*davisiae*	ADP 141001-1 / WTU-F-073027	Road FR 638 near jct. FR 302, Idaho Panhandle National Forests, Bonner Co., Idaho (ID)	In moss under mixed conifers.	MW597228 / ---
TR051	*intermedium*	ADP 141006-1 / WTU-F-073028	Slate Creek Trail, Colville National Forest, Pend Oreille Co., Washington (WA)	With mixed conifers.	MZ054353 / ---
TR052	*lutescens* (as *sulphurescens*)	ADP-141006-2 / WTU-F-073029	Slate Creek Trail, Colville National Forest, Pend Oreille Co., Washington (WA)	Mixed forest with *Picea engelmannii*, *Populus*.	MW597229 / ---
TR053b	*focale* (as *zelleri*, Holotype)	AHS-17999 / MICH-4973	Olympic National Park, Clallam Co., Washington (WA)	Old-growth conifer forest with *Tsuga heterophylla*, *Pseudotsuga menziesii*, and *Thuja plicata*.	MN809567 / ---
TR054	*dulciolens* (as *Armillaria caligata* var. *occidentalis*, Holotype)	AHS 60431 / MICH-5578	Valley Co., Idaho (ID)	Conifer forest.	--- / UDB024113
TR054b	*dulciolens* (as *Armillaria caligata* var. *occidentalis*, Holotype)	AHS 60431 / MICH-5578	Valley Co., Idaho (ID)	Conifer forest.	MN809566 / ---

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TR055	*atroviolaceum* Holotype	AHS-8195 / MICH 12312	Josephine Co., Oregon (OR)	Under conifers.	MN809568 / ---
TR056	*aurantio-olivaceum* Holotype	AHS-17666 / MICH-12313	Olympic National Park, Clallam Co., Washington (WA)	Old-growth conifer forest with *Tsuga heterophylla*, *Pseudotsuga menziesii*, and *Thuja plicata*.	MN809569 / ---
TR057	*manzanitae* Holotype	TJB-4084 / MICH 12322	Sonoma Co., California (CA)	On soil under *Arctostaphylos manzanita*, or under *Arbutus menziesii*, *Pseudotsuga menziesii*, and evergreen *Quercus*.	MW597230 / ---
TR057b	*manzanitae* Holotype	TJB-4084 / MICH 12322	Sonoma Co., California (CA)	On soil under *Arctostaphylos manzanita*, or under *Arbutus menziesii*, *Pseudotsuga menziesii*, and evergreen *Quercus*.	MN809570 / ---
TR058	*subumbrinum* Holotype	AHS-17671 / MICH 12330	Olympic National Park, Clallam Co., Washington (WA)	Old-growth conifer forest with *Tsuga heterophylla*, *Pseudotsuga menziesii*, and *Thuja plicata*.	MN809571 / ---
TR059	*murrillianum* Holotype	WAM 1044 / NY 586560	Newport, Lincoln Co., Oregon (OR)	Coastal sand dune woodland with *Pinus contorta* and *Picea sitchensis*.	LT220179 / UDB024112
TR059b	*murrillianum* Holotype	WAM 1044 / NY 586560	Newport, Lincoln Co., Oregon (OR)	Coastal sand dune woodland with *Pinus contorta* and *Picea sitchensis*.	MN809572 / ---
TR062	*dryophilum* Holotype	JM27 / NY 774992	Stanford University, Santa Clara Co., California (CA)	Under live oaks (*Quercus agrifolia*?).	Sequencing unsuccessful.
TR063	*platyphyllum* Holotype	WAM419 / NY 775009	Near Seattle, King Co., Washington (WA)	"in woods."	Sequencing unsuccessful.
TR064	*subcinereiforme* Holotype	WAM901 / NY 775031	Corvallis, Benton Co., Oregon (OR)	In mixed woods.	Sequencing unsuccessful.
TR065	*californicum* Holotype	JM125 / NY 775048	Jasper Ridge, near Stanford University, Santa Clara Co., California (CA)	Under oaks (*Quercus agrifolia*?).	Sequencing unsuccessful.
TR066	*pinicola* Holotype	WAM730 / NY 775056	Tacoma, Pierce Co., Washington (WA)	"on much decayed, coniferous wood."	Sequencing unsuccessful.
TR067	*farinaceum* Holotype	WAM644 / NY 775058	Near Seattle, King Co., Washington (WA)	"in humus in woods."	Sequencing unsuccessful.
TR069	aff. *pardinum* (as *pardinum*)	SAT-01-292-13 / WTU-F-000504	Olympic National Park, Clallam Co., Washington (WA)	Mixed conifer forest with *Pseudotsuga menziesii*, *Tsuga heterophylla*, and *Thuja plicata*.	OM506546 / ---
TR070	*nigrum*	SAT-00-314-38 / WTU-F-000660	Olympic National Park, Clallam Co., Washington (WA)	Mixed conifer forest with *Pseudotsuga menziesii*, *Tsuga heterophylla*, and *Thuja plicata*.	MW597231 / ---
TR071	*vaccinum*	SAT-00-264-25 / WTU-F-000661	Olympic National Park, Clallam Co., Washington (WA)	Mixed conifer forest with *Pseudotsuga menziesii*, *Abies amabilis*, and *A. lasiocarpa*.	MW597232 / ---
TR072	*subacutum* (as *virgatum*)	SAT-00-298-26 / WTU-F-000662	Olympic National Park, Clallam Co., Washington (WA)	Mixed conifer forest with *Pseudotsuga menziesii* and *Tsuga heterophylla*.	MW597233 / ---
TR073	*subacutum* (as *virgatum*)	SAT-00-263-26 / WTU-F-000665	Olympic National Park, Clallam Co., Washington (WA)	Montane mixed conifer forest with *Pseudotsuga menziesii* and *Abies lasiocarpa*.	MZ054354 / ---
TR074	*atrofibrillosum* (as *sejunctum* cf.)	SAT-09-254-08 / WTU-F-010258	Mitkof Island, Alaska (AK)	*Picea sitchensis* -*Tsuga* forest.	OM506547 / ---
TR075	*murrillianum*	SAT-09-304-01 / WTU-F-010474	Camp Magruder, Tillamook Co., Oregon (OR)	Coastal sand dune woodland with *Pinus contorta* and *Picea sitchensis*.	MW597234 / ---
TR076	*marquettense*	PBM2052 / WTU-F-012690	Olympic National Forest, Grays Harbor Co., Washington (WA)	Old-growth conifer forest with *Picea sitchensis*, *Tsuga heterophylla*, *Pseudotsuga menziesii*, and *Thuja plicata*.	MZ054355 / ---
TR077	*platyphyllum*	PBM814 / WTU-F-012695	Mason Co., Washington (WA)	On soil with *Pseudotsuga menziesii* and *Tsuga heterophylla*.	OM506548 / ---
TR078	*platyphyllum*	PBM2013 / WTU-F-012704	Mt. Rainier National Park, Pierce Co., Washington (WA)	On soil with *Pseudotsuga menziesii*, *Tsuga heterophylla*, and *Abies grandis*.	OM506549 / ---
TR079	*equestre group* (as *flavovirens*)	SAT-03-308-05 / WTU-F-012824	Camp Westwind, Lincoln Co., Oregon (OR)	Coastal sand dune woodland with *Pinus contorta* and *Picea sitchensis*.	MW597235 / ---
TR080	*aff. imbricatum* (as *imbricatum*)	SAT-03-308-03 / WTU-F-012825	Camp Westwind, Lincoln Co., Oregon (OR)	Coastal sand dune woodland with *Pinus contorta* and *Picea sitchensis*.	MW597236 / ---
TR081	*megalophaeum* (as sp. NS "big dark")	SAT-00-297-38a / WTU-F-047868	Olympic National Park, Jefferson Co., Washington (WA)	Old-growth conifer forest with *Picea sitchensis*, *Tsuga heterophylla*, and *Pseudotsuga menziesii*.	MW597237 / ---
TR084	aff. *bryogenum* (as *sulphureum*)	SAT-00-324-03 / WTU-F-049202	Olympic National Park, Clallam Co., Washington (WA)	Mixed conifer forest with *Pseudotsuga menziesii*, *Tsuga heterophylla*, and *Thuja plicata*.	MW597238 / ---
TR085	*murrillianum*	SAT-00-283-55 / WTU-F-049207	Olympic National Park, Clallam Co., Washington (WA)	Mixed conifer forest with *Pseudotsuga menziesii*, *Tsuga heterophylla*, and *Thuja plicata*.	MW597239 / ---
TR087	*platyphyllum* (as *inamoenum*)	SAT-00-283-16 / WTU-F-049228	Olympic National Park, Clallam Co., Washington (WA)	Mixed conifer forest with *Pseudotsuga menziesii*, *Tsuga heterophylla*, and *Thuja plicata*.	MW597240 / ---
TR088	*focale*	SAT-13-313-18 / WTU-F-063944	H.J. Andrews Experimental Forest, Willamette National Forest, Lane Co., Oregon (OR)	Mixed conifer forest with *Pseudotsuga menziesii*, *Tsuga heterophylla*, and *Thuja plicata*.	MW597241 / ---

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TR089	*atrofibrillosum* (as *sejunctum* cf.)	SAT-11-244-03 / WTU-F-065669	Chugach National Forest, near Cordova, Alaska (AK)	*Picea sitchensis* - *Tsuga* forest.	MW597242 / ---
TR090	*moseri*	SAT-11-154-01 / WTU-F-065670	Mt. Baker-Snoqualmie National Forest, Kittitas Co., Washington (WA)	Mixed conifer forest with *Pinus ponderosa*, *Pseudotsuga menziesii*, *Larix occidentalis*, and *Abies grandis*.	MW597243 / ---
TR091	*vaccinum*	SAT-11-235-10 / WTU-F-065673	Girdwood, Alaska (AK)	*Picea sitchensis* -*Tsuga* forest, with occasional *Alnus* and *Populus trichocarpa*.	MZ054356 / ---
TR091b	*vaccinum*	SAT-11-235-10 / WTU-F-065673	Girdwood, Alaska (AK)	*Picea sitchensis* -*Tsuga* forest, with occasional *Alnus* and *Populus trichocarpa*.	MW597244 / ---
TR093	*lutescens* (as *sulphurescens*)	SAT-11-241-08 / WTU-F-065768	Chugach National Forest, Kenai Peninsula, Alaska (AK)	Mixed forest - mostly *Picea glauca/sitchensis*, *Tsuga*, *Populus tremuloides*, and *Betula papyrifera*, with *Populus trichocarpa* and occasional *Alnus*.	MW597245 / ---
TR093b	*lutescens* (as *sulphurescens*)	SAT-11-241-08 / WTU-F-065768	Chugach National Forest, Kenai Peninsula, Alaska (AK)	Mixed forest - mostly *Picea glauca/sitchensis*, *Tsuga*, *Populus tremuloides*, and *Betula papyrifera*, with *Populus trichocarpa* and occasional *Alnus*.	MW597246 / ---
TR095	*vernaticum*	SAT-11-133-03 / WTU-F-065848	Deschutes National Forest, Jefferson Co., Oregon (OR)	Montane mixed conifer forest with *Pinus ponderosa*, *Pseudotsuga menziesii*, and *Abies concolor*.	MW597247 / ---
TR096	*ammophilum* (as *populinum*)	SAT-10-241-07 / WTU-F-065863	Girdwood, Alaska (AK)	*Picea sitchensis* -*Tsuga* forest, with occasional *Alnus* and *Populus trichocarpa*.	MW597248 / ---
TR097	*lutescens* (as *sulphurescens*)	SAT-11-217-10 / WTU-F-065905	Chena Lakes Recreation Area, near Fairbanks, Alaska (AK)	*Picea glauca* - *Betula papyrifera* forest.	MW597249 / ---
TR099	*badicephalum* (as *focale*)	SAT-10-236-14 / WTU-F-066121	Chugach National Forest, Kenai Peninsula, Alaska (AK)	Mixed forest - mostly *Picea glauca/sitchensis*, *Populus tremuloides*, and *Betula papyrifera*, with *Populus trichocarpa* and occasional *Alnus*.	MW597250 / ---
TR100	sp. "turpescens"	NS-22-IV-2014 / UC-2023282	Mt. Shasta, Siskiyou Co., California (CA)	*Pinus ponderosa*, *P. lambertiana*, and *Abies concolor*.	MW597251 / ---
TR101	sp. "white manzanitae" CA343	CA343 / UC-2023277	Yuba Co., California (CA)	Not reported.	MW597252 / ---
TR102	sp CA389	CA389 / UC-2023278	Not reported.	Mixed forest with *Neolithocarpus densiflorus*.	MW597253 / ---
TR103	aff. *pardinum* (as *pardinum*)	E.Cline 03-X-2015 / WTU-F-073035	Washington (WA)	Not reported.	MW597254 / ---
TR106	*fulvum* s.l.	ADP 151003-1 / WTU-F-073036	Heart of the Hills, Olympic National Park, Clallam Co., Washington (WA)	Mixed forest with *Pseudotsuga menziesii*, *Tsuga heterophylla*, *Abies grandis*, *Alnus rubra*.	MW597255 / ---
TR107	*argyraceum* s.l. (as *terreum*)	ADP 150918-3 / WTU-F-073037	Slate Creek Trail, Colville National Forest, Pend Oreille Co., Washington (WA)	Mixed conifer forest with *Abies*, *Thuja plicata*, P*icea engelmannii*, *Larix occidentalis*, and *Tsuga*.	MW597256 / ---
TR108	*aurantio-olivaceum*	ADP 141028-1 / WTU-F-073038	Road FR 190 south of Hwy 31, Colville National Forest, Pend Oreille Co., Washington (WA)	Mixed forest with *Pseudotsuga menziesii*, *Abies grandis*, *Tsuga heterophylla*, *Pinus*, and *Thuja plicata*.	MW597257 / ---
TR109	*mutabile* (as *nigrum*)	ADP 151002-1 / WTU-F-073039	Olympic National Park, Clallam Co., Washington (WA)	Old-growth mixed conifer forest with *Pseudotsuga menziesii*, *Tsuga heterophylla*, *Picea sitchensis*, and *Thuja plicata*.	MW597258 / ---
TR110	*mutabile*	ADP 141014-1 / WTU-F-073040	Idaho Panhandle National Forests,, Bonner Co., Idaho (ID)	Under *Tsuga*.	MW597259 / ---
TR111	aff. *olivaceotinctum* (as *squarrulosum*)	ADP 151103-1 / WTU-F-073041	Colville National Forest, Pend Oreille Co., Washington (WA)	Mixed conifer forest.	MW597260 / ---
TR112	*dulciolens* (as *caligatum*)	CH-16-285-01 / WTU-F-073042	Mt. Baker-Snoqualmie National Forest, Pierce Co., Washington (WA)	Mixed conifer forest with *Pseudotsuga menziesii*, *Tsuga heterophylla*, *Abies grandis*, and *Thuja plicata*.	MW597261 / ---
TR113	*focale* (as *focale* group)	SAT-16-237-22 / WTU-F-073043	Chugach National Forest, Kenai Peninsula, Alaska (AK)	Mixed forest - mostly *Picea glauca/sitchensis*, *Populus tremuloides*, and *Betula papyrifera*, with *Populus trichocarpa* and occasional *Alnus*.	MW597262 / ---
TR114	*subannulatum* (as *dryophilum*)	SAT-16-318-01 / WTU-F-073044	Ashland, Jackson Co., Oregon (OR)	Under *Quercus garryana*.	MW597263 / ---
TR115	*badicephalum* (as *focale* group)	SAT-16-238-15 / WTU-F-073045	Chugach National Forest, Kenai Peninsula, Alaska (AK)	Mixed forest - mostly *Picea glauca/sitchensis*, *Tsuga*, and *Betula papyrifera*, with *Populus trichocarpa* and occasional *Alnus*.	MW597264 / ---
TR116	*badicephalum* (as *focale* group)	SAT-16-237-23 / WTU-F-073046	Chugach National Forest, Kenai Peninsula, Alaska (AK)	Mixed forest - mostly *Picea glauca/sitchensis*, *Populus tremuloides*, and *Betula papyrifera*, with *Populus trichocarpa* and occasional *Alnus*.	MW597265 / ---
TR117	*moseri*	SAT-13-151-03 / WTU-F-073047	Valley Co., Idaho (ID)	Mixed conifer forest with *Pinus ponderosa*, *Pseudotsuga menziesii*, *Larix occidentalis*, *Populus tremuloides*, and *Abies grandis*.	MW597266 / ---
TR118	*atrofibrillosum* Holotype (as *sejunctum* cf.)	SAT-16-244-15 / WTU-F-073048	Girdwood, Alaska (AK)	*Picea sitchensis* -*Tsuga* forest, with occasional *Alnus* and *Populus trichocarpa*.	MW597267 / ---
TR119	*apium*	SAT-16-319-05 / WTU-F-073049	Honeyman State Park, Lane Co., Oregon (OR)	On sandy soil with *Pseudotsuga menziesii*, *Tsuga heterophylla*, *Picea sitchensis*, *Pinus contorta*, and *Alnus rubra*.	MW597268 / ---
TR120b	*vaccinum*	SAT-10-309-01 / WTU-F-073050	Deception Pass State Park, Island Co., Washington (WA)	Mixed conifer forest with *Pseudotsuga menziesii*, *Tsuga heterophylla*, *Thuja plicata*, *Abies grandis*, *Alnus rubra*, and *Acer macrophyllum*.	MW597269 / ---

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TR121	*argyraceum* s.l. (as sp. "Stanford gray")	SAT-17-040-02 / WTU-F-073051	Nojoqui County Park, Santa Barbara Co., California (CA)	With *Quercus agrifolia*.	MW597270 / ---
TR122	*vaccinum* (as sp.)	SAT-16-238-16 / WTU-F-073052	Chugach National Forest, Kenai Peninsula, Alaska (AK)	Mixed forest - mostly *Picea glauca/sitchensis*, *Tsuga*, and *Betula papyrifera*, with *Populus trichocarpa* and occasional *Alnus*.	MW597271 / ---
TR123	*saponaceum* s.l. (as *saponaceum*)	SAT-16-237-20 / WTU-F-073053	Chugach National Forest, Kenai Peninsula, Alaska (AK)	Mixed forest - mostly *Picea glauca/sitchensis*, *Populus tremuloides*, and *Betula papyrifera*, with *Populus trichocarpa* and occasional *Alnus*.	MW597272 / ---
TR124	*equestre* group	SAT-15-217-05 / WTU-F-073054	Coconino National Forest, north of Flagstaff, Arizona (AZ)	Mixed forest with *Populus tremuloides*, *Pinus ponderosa*, *Pinus strobiformis*, *Abies concolor*, *Picea engelmannii*, and *Pseudotsuga menziesii*.	MW597273 / ---
TR125	*dryophilum* Epitype	SAT-17-041-02 / WTU-F-073055	Near San Marcos Pass, Santa Barbara Co., California (CA)	With *Quercus agrifolia*.	MW597274 / ---
TR126b	*atroviolaceum* (as sp.)	ADP 071006-2 / WTU-F-073056	Idaho Panhandle National Forests, Priest Lake, Bonner Co., Idaho (ID)	Mixed conifers.	MW597275 / ---
TR127	*moseri*	ADP 160430-3 / WTU-F-073057	Colville National Forest, Pend Oreille Co., Washington (WA)	Mixed conifer forest with *Pinus contorta*, *Abies grandis*, *Pinus monticola*, and *Pseudotsuga menziesii*.	MW597276 / ---
TR128	*vaccinum*	ADP 161011-1 / WTU-F-073058	Colville National Forest, Pend Oreille Co., Washington (WA)	Mixed conifer forest, mostly *Tsuga*.	MW597277 / ---
TR129	*subannulatum* (as *pessundatum* group)	04MWB111008 / WTU-F-073059	Klickitat Co., Washington (WA)	With *Quercus garryana*.	MW597278 / ---
TR130	*saponaceum* s.l. (as *saponaceum*)	ADP 130521-2 / WTU-F-073060	Colville National Forest, Pend Oreille Co., Washington (WA)	With *Tsuga*, *Abies*, and *Pinus*.	MW597279 / ---
TR131b	*atroviolaceum*	ADP 121018-1 / WTU-F-073061	Colville National Forest, Pend Oreille Co., Washington (WA)	Mixed conifer forest with *Picea engelmannii*, *Abies grandis*, *Tsuga heterophylla*, and *Thuja plicata*.	MW597280 / ---
TR132	*atroviolaceum*	ADP 081006-1 / WTU-F-073062	Idaho Panhandle National Forests, Priest Lake, Bonner Co.,Idaho (ID)	With *Tsuga*.	MW597281 / ---
TR133	*aurantio-olivaceum* (as *aurantio-olivaceum* cf.)	ADP 161109-2 / WTU-F-073063	Colville National Forest, Pend Oreille Co., Washington (WA)	Mixed forest with *Pseudotsuga menziesii*, *Abies grandis*, *Tsuga heterophylla*, *Pinus*, and *Thuja plicata*.	MW597282 / ---
TR135	*fulvum* s.l. (as *pessundatum* group)	SAT-17-300-01 / WTU-F-073064	Oregon Dunes National Recreation Area, Oregon (OR)	Coastal sand dune woodland with *Pinus contorta* and *Picea sitchensis*.	MW597283 / ---
TR137	*equestre* group (as *arvernense* cf.)	SAT-06-291-02 / WTU-F-073065	Gifford Pinchot National Forest, Washington (WA)	Mixed conifer forest with *Pseudotsuga menziesii* and *Tsuga heterophylla*.	MW597284 / ---
TR138	*dulciolens* (as *caligatum* group)	NS-3162 / WTU-F-073066	Chugach National Forest near Sterling, Kenai Peninsula, Alaska (AK)	In moss, under *Picea*.	MW597285 / ---
TR139	*fulvum* s.l.	SAT-14-239-11 / WTU-F-073067	Chugach National Forest, Kenai Peninsula, Alaska (AK)	Mixed forest - mostly *Picea glauca/sitchensis*, *Populus tremuloides*, and *Betula papyrifera*, with *Populus trichocarpa* and occasional *Alnus*.	MW597286 / ---
TR140	*inamoenum* (as *inamoenum* group)	SAT-14-238-15 / WTU-F-073068	Chugach National Forest, Kenai Peninsula, Alaska (AK)	In mixed forest with *Picea*, *Betula*, *Populus tremuloides*, and shrub *Alnus*.	MW597287 / ---
TR143	*nigrum* (as *nigrum* cf.)	SAT-15-289-11 / WTU-F-073070	Southwestern Olympic Peninsula, Washington (WA)	Mixed conifer forest with *Pseudotsuga menziesii*, *Tsuga heterophylla*, and *Thuja plicata*.	MW597288 / ---
TR144	aff. *pardinum* (as *pardinum*)	SAT-13-314-01 / WTU-F-073071	H.J. Andrews Experimental Forest, Willamette National Forest, Lane Co., Oregon (OR)	Mixed conifer forest with *Pseudotsuga menziesii*, *Tsuga heterophylla*, and *Thuja plicata*, plus occasional *Abies grandis/concolor*, *Acer macrophyllum*, and *Alnus rubra*.	MW597289 / ---
TR145	*fulvum* s.l. (as *pessundatum* group)	SAT-08-242-10 / WTU-F-073072	Chugach National Forest, near Cordova, Alaska (AK)	*Picea sitchensis -Tsuga* forest.	MW597290 / ---
TR146	*smithii*	SAT-18-234-15 / WTU-F-073073	Cibola National Forest, New Mexico (NM)	With *Picea engelmannii*, *Populus tremuloides*, *Abies concolor*, and *Pseudotsuga menziesii*.	MW597291 / ---
TR147	*japonicum* (as sp. NS3319)	NS-3319 / WTU-F-073074	Near Tonga Ridge Trailhead, Skykomish, King Co., Washington (WA)	Mixed conifer forest with *Tsuga menziesii*, *T. heterophylla*, and *Abies amabilis*.	MW597292 / ---
TR148	aff. *hemisulphureum* (as sp. "coaltar")	SAT-15-229-06 / WTU-F-073075	Cibola National Forest, New Mexico (NM)	With *Picea engelmannii*, *Populus tremuloides*, *Abies concolor*, and *Pseudotsuga menziesii*.	MW597293 / ---
TR149	*argyraceum* s.l. (as sp. "Stanford gray")	NS-3518 / WTU-F-073076	Stanford University, Santa Clara Co., California (CA)	With *Quercus agrifolia*.	MW597294 / ---
TR150	*lutescens* (as *sulphurescens*)	SAT-14-238-14 / WTU-F-073077	Chugach National Forest, Kenai Peninsula, Alaska (AK)	In mixed forest with *Picea*, *Betula*, *Populus tremuloides*, and shrub *Alnus*.	MW597295 / ---
TR151	*lutescens* Holotype (as *sulphurescens*)	SAT-14-239-16 / WTU-F-073078	Chugach National Forest, Kenai Peninsula, Alaska (AK)	Mixed forest - mostly *Picea glauca/sitchensis*, *Tsuga*, *Populus tremuloides*, and *Betula papyrifera*, with *Populus trichocarpa* and occasional *Alnus*.	MW597296 / ---

Sample #	Species Epithet / Name	Collector's / Herbarium #	Location / Origin	Habitat / Tree Associates	GenBank/ UNITE # (ITS)
TR152	*vaccinum*	SAT-13-275-05 / WTU-F-073079	Along Seward Highway about 10 miles west of Girdwood, Alaska (AK)	*Picea sitchensis-Tsuga heterophylla* forest with *Betula*, *Populus tremuloides*, and *Alnus*.	MW597297 / ---
TR153	*venenatoides* (as *venenatum*)	RH18-1009 / ---	Diamond Lake Ranger District, Umpqua National Forest, Douglas Co., Oregon (OR).	Mixed conifer forest.	MW597298 / ---
TR154	*megalophaeum* (as sp. NS "big dark")	NS-18-XI-2016 / WTU-F-073080	Spruce Grove, Davison Rd., Redwood National Park, Humboldt Co., California (CA)	Mixed conifer forest with *Picea sitchensis*.	MW597299 / ---
TR156	*venenatum* Holotype	--- / CUP-A-022573	Near Detroit, Michigan (MI)	With hardwoods.	(a) / ---
TR157	*moseri* Holotype	M-8521 / F-C0002152F	D.F.: Paseo de Cortés, Mexico (MEX)	Sparse woodland with *Pinus hartwegii*.	MW597300 / ---
TR158	*Amillaria badicephala* Holotype	--- / NY 00657605, 00657606	Newport, Lincoln Co., Oregon (OR)	Coastal sand dune woodland under *Picea sitchensis*.	Sequencing unsuccessful.
TR159	sp.	SAT-19-299-08 / WTU-F-073081	From display, Mt. Pisgah Arboretum Mushroom Festival, Springfield, Lane Co., Oregon (OR)	Mixed conifer forest.	MW597301 / ---

[a] Sequence <200 bp in length so not eligible for submission to GenBank.

APPENDIX 2. Details of materials and methods.

DNA extraction and ITS sequencing (UW, Tacoma).—The genomic DNA was initially extracted from dried basidiome tissue using the cetyltrimethylammonium bromide (CTAB) protocol described by Gardes and Bruns (1993) with the following modifications: the volume of CTAB lysis buffer was reduced from 300 µL to 100 µL, autoclaved plastic micropestles were used (Sigma, St. Louis, Missouri, USA), and the DNA extract was re-suspended in TE (10 mM Tris, 1 mM ethylenediaminetetraacetic acid (EDTA), pH 8.0). Extracted DNA samples were stored at −40 C for future analysis.

To obtain ITS sequences from these samples, we utilized various approaches depending on the condition of the sample. For samples less than 5 yr old, we used the primers ITS-1 (forward sequence: TCCGTAGGTGAACCTGCGG) and ITS-4 (reverse sequence: TCCTCCGCTTATTGATATGC) (White et al. 1990). For samples more than 5 yr old, the ITS was sequenced in two portions to minimize the impact of DNA degradation due to age. This made it possible to obtain partial sequence data in some cases when the entire template region was no longer intact. The first half was amplified using primers ITS-1 (forward) and 5.8S (reverse sequence: CGCTGCGTTCTTCATCG), while the latter half was amplified using primers 5.8SR (forward sequence: TCGATGAAGAACGCAGCG) and ITS-4 (reverse), using primer sequences from https://sites.duke.edu/vilgalyslab/rdna_primers_for_fungi/.

PCR was performed in a total volume of 25 µL, containing a 1:1000 dilution of the DNA extract, 200 µM each of dATP, dTTP, dCTP, dGTP, 200 nM of each primer, 2.5 mM $MgCl_2$, 0.05 unit µL−1 of GoTaq® DNA Polymerase (ProMega), and Green GoTaq® Reaction Buffer (ProMega). Each run of PCR included a positive control and a sterile water negative control. PCR was carried out using an Eppendorf Flexlid Mastercycler® Nexus Gradient Thermal Cycler. Reaction conditions were as follows: an initial 2 min at 95 C, 40 1-min cycles at 95 C, 1 min at 55 C, 2 min at 72 C, followed by a final extension of 5 min at 72 C. Success of the PCR was measured via gel electrophoresis, using 1% agarose gels prepared with a 0.5x Sodium Bromide buffer and SYBR® Safe DNA Gel Stain (Thermo Fisher Scientific).

DNA extraction and ITS sequencing (Molecular Solutions LLC).—The genomic DNA was extracted using a buffer containing Chelex resin (Di Bonito et al. 1995, Liu et al. 2015). Fungal tissue was placed in a microcentrifuge tube with 400 µL of Chelex buffer (100 mM Tris pH = 8.5, 4% Chelex 100 [Bio-Rad Laboratories, Hercules, California], and 1% Triton X-100). The tubes were heated to 95–99 C for 20 min, vortexed briefly, then frozen. After thawing, the tubes were centrifuged and the supernatant was used in PCR.

PCR was performed in 25-µL reactions with 1 µL basidiome extract, 0.4 mM each primer, 0.2mM dNTP mixture, 5 µg bovine serum albumin, and 0.5 U OneTaq Hot Start DNA polymerase (New England Biolabs, Ipswich, Massachusetts) in 1X OneTaq standard buffer with 2.1 mM $MgCl_2$. PCR conditions were 94 C for 30 s, followed by 36 cycles of 94 C for 15 s, 57 C for 30 s, and 68 C for 60 s, followed by a final extension at 68 C for 5 min.

Generally, the primers ITS1f (Gardes and Bruns 1993) and ITS4 were used. Some specimens, particularly the older ones, were contaminated with mycotrophic fungi, leading to the generation of contaminant sequences or unreadable chromatograms. We designed a *Tricholoma*-specific forward primer, tri1 (CATTATTGAATAAGCTTGGTTRGGTT), that targeted the 5′ end of the *Tricholoma* ITS1 region. The primer tri1, used with ITS4, proved to be helpful in retrieving sequences from specimens where the universal primers failed. Seventeen of the sequences generated in this study were from tri1 amplicons.

For each ITS fragment, the forward and reverse sequences were inspected and assembled using Sequencher 5 (Gene Codes, Ann Arbor, Michigan). All sequences were deposited in GenBank.

Phylogenetic analysis.—Sequences were aligned using MAFFT 7 (Katoh and Toh 2008; http://mafft.cbrc.jp/alignment/server/) using the Q-INS-i strategy and edited and manually adjusted in AliView 1.11 (Larsson 2014). Regions of the dataset with ambiguous alignments were excluded.

The aligned sequence set was analyzed using two methods: (i) maximum likelihood analyses (ML) using RAxML 8.2.9 (Stamatakis 2014), with GTRCAT

approximation across different gene partitions, and executing 1000 rapid bootstrap replicates; (ii) Bayesian inference (BI) analyses using MrBayes 3.2.6, implementing the GTR + GAMMA + I model (Ronquist et al. 2012). Two independent runs were executed. The default number of chains (four) and heating parameters were used. To ensure convergence of the two independent runs, we examined the standard deviation of split frequencies and potential scale reduction factors (PSRFs) for all model parameters following recommendations in the MrBayes user manual. Posterior probabilities were calculated after burning the first 25% of the posterior sample and ensuring that this threshold met the convergence factors described above.

Initially we ran the analysis for 25 million generations sampling trees every 2500 steps.

APPENDIX 3. ITS sequences obtained from GenBank and other sources and included in the phylogenetic analyses.

Epithet or Name	Label	Collector's/Herbarium #	Location/Origin
acerbum	LT000005	JV99-638 / C-F-41483	Denmark (DNK)
acerbum	LT000134	MC00-204 / C-F-96223	Slovenia (SVN)
aestuans	LT000006	JV02-540 / C-F-40955	Denmark (DNK)
aestuans	LT000007	MC94-008 / C-F-59265	Denmark (DNK)
aestuans Neotype	LT000153	MC97-072 / C-F-58885 CFT-0401	Sweden (SWE)
albobrunneum	LT000077	MC99-060 / C-F-96268	France (FRA)
albobrunneum	UDB001218	JV04-471 / ---	Sweden (SWE)
album	KU058506	TFB13753 / TENN-F-065130	Belgium (BEL)
album	LT000008	MC95-159 / C-F-96254	Denmark (DNK)
album	LT000135	MC01-201 / C-F-96234	Slovenia (SVN)
album	MC08109	MC08-109 / ---	Denmark (DNK)
ammophilum (as *populinum*)	KC146366	ATCC 64509 / DAVFP 23587	British Columbia, CAN (BC)
ammophilum (as *populinum*)	SAT-16-237-12	SAT-16-237-12 / WTU-F-073083	Chugach National Forest, Kenai Peninsula, Alaska (AK)
apium	LT000009	JV00-215 / C-F-41884	Denmark (DNK)
apium	LT000118	MC98-034 / C-F-59207	Norway (NOR)
apium	LT000154	JHC95-049 / C-F-35189	Sweden (SWE)
argyraceum (as *scalpturatum*)	LT000004	JHC93-243 / C-F-96206	Denmark (DNK)
argyraceum	LT000010	JHC95-112 / C-F-35092	Denmark (DNK)
argyraceum	LT000011	JHC96-244 / C-F-96212	Denmark (DNK)
argyraceum	LT000127	MC03-251 / C-F-96245	Slovakia (SVK)
argyraceum	LT000155	JHC97-092 / C-F-96213	Sweden (SWE)
argyraceum	LT000156	JHC97-174 / C-F-96215	Sweden (SWE)
argyraceum Epitype	LT000198	MEN94-91 / L0374886	Netherlands (NLD)
argyraceum aff. (as *intermedium* var. *macrosporum*)	AF377202	KMS397 / SFSU	Sierra Co., California, USA (CA)

However, the average standard deviation of split frequencies did not reach <0.01 until 15 million samples had been generated. Thus, we continued the analysis for an additional 10 million steps (so 35 million total) and set the sumt burnin to 15 000 001 after these had concluded. PRSFs were 1.000 to 1.002 for all parameters by this stage. Twenty-eight thousand two trees were read after this burnin, and PPs were calculated from 21 002 total trees (75% of the trees read) from the two runs.

Dermoloma magicum was chosen as outgroup for the analyses based on Sánchez-García and Matheny (2017). We consider bootstrap values (BS) ≥70% and Bayesian posterior probabilities (PP) ≥0.95 to indicate strong support.

Habitat/Tree Associates	GenBank/UNITE # (ITS)	Source
Under *Fagus* and *Quercus*.	LT000005 / UDB001474	Heilmann-Clausen et al 2017
On calcareous soils with *Quercus*.	LT000134 / UDB002361	Heilmann-Clausen et al 2017
Under *Picea*.	LT000006 / UDB000779	Heilmann-Clausen et al 2017
Under *Pinus sylvestris*.	LT000007 / ---	Heilmann-Clausen et al 2017
Conifer forest on nutrient-poor sandy soils with *Pinus* and *Picea*.	LT000153 / UDB001434	Heilmann-Clausen et al 2017
On nutrient-poor soil with *Pinus*.	LT000077 / UDB001444	Heilmann-Clausen et al 2017
On nutrient-poor soil with *Pinus*.	--- / UDB001218	Morten Christensen, unpublished.
In deciduous angiosperm forest with *Quercus*.	KU058506 / ---	Sánchez-García & Matheny 2017
Under *Quercus* and *Corylus* on clay soil.	LT000008 / ---	Heilmann-Clausen et al 2017
Under *Quercus*.	LT000135 / UDB001413	Heilmann-Clausen et al 2017
Under *Quercus* and *Corylus* on clay soil.	--- / ---	Morten Christensen, unpublished.
Populus trichocarpa rhizosphere.	KC146366 / ---	P. Gujjari et al, unpublished.
Mixed forest - mostly *Picea glauca/sitchensis*, P*opulus tremuloides*, and *Betula papyrifera*, with *Populus trichocarpa* and occasional *Alnus*.	MW597140 / ---	N. Siegel & K. Mohatt, The mycota of Alaska, unpublished.
On nitrogen-poor sandy soil with *Pinus mugo*.	LT000009 / UDB001685	Heilmann-Clausen et al 2017
Under *Pinus sylvestris*.	LT000118 / ---	Heilmann-Clausen et al 2017
On nitrogen-poor sandy soil with *Pinus*.	LT000154 / UDB001467	Heilmann-Clausen et al 2017
Under *Fagus sylvatica* on clayish soil.	LT000004 / UDB000784	Heilmann-Clausen et al 2017
Under *Betula*.	LT000010 / UDB000780	Heilmann-Clausen et al 2017
Under *Betula*.	LT000011 / UDB000781	Heilmann-Clausen et al 2017
Under *Fagus*.	LT000127 / UDB001419	Heilmann-Clausen et al 2017
On nutrient-rich soil in mixed woodland.	LT000155 / UDB000782	Heilmann-Clausen et al 2017
On nutrient-rich soil in mixed woodland.	LT000156 / UDB001692	Heilmann-Clausen et al 2017
On nutrient-rich soil in mixed woodland.	LT000198 / UDB000785	Heilmann-Clausen et al 2017
Mixed conifer forest with *Pseudotsuga menziesii*, *Pinus*, and *Abies*.	AF377202 / ---	Bidartondo & Bruns 2002

Epithet or Name	Label	Collector's/Herbarium #	Location/Origin	Habitat/Tree Associates	GenBank/UNITE # (ITS)	Source
Armillaria caligata var. *glaucescens*	AF309522	HN2633 / DUKE 0350245	Buncombe Co., North Carolina, USA (NC)	Not reported.	AF309522 / ---	Chapela & Garbelotto 2004
Armillaria caligata var. *glaucescens*	KU058510	PBM3899 / TENN-F-067754	Transylvania Co., North Carolina, USA (NC)	Mixed *Quercus* forest under *Q. prinus*.	KU058510 / ---	Sánchez-García & Matheny 2017
arvernense	AKFF-004-14	AKFF-004-14 / Pending	Chugach National Forest, Kenai Peninsula, Alaska (AK)	Mixed forest - mostly *Picea glauca/sitchensis*, *Populus tremuloides*, and *Betula papyrifera*, with *Populus trichocarpa* and occasional *Alnus*.	OM506539 / ---	N. Siegel & K. Mohatt, The mycota of Alaska, unpublished.
arvernense	KU058507	ADP-081004-1 / ---	Near Tango Creek and shore of Priest Lake, Idaho, USA (ID)	Scattered under *Tsuga heterophylla*.	KU058507 / ---	This study.
arvernense	LT000078	MC98-120 / C-F-59255	France (FRA)	Unknown; specimen acquired at an exhibition.	LT000078 / UDB001438	Heilmann-Clausen et al 2017
arvernense	LT000119	MC98-020/C-F-59200	Norway (NOR)	On nutrient-poor soil with *Pinus*.	LT000119 / UDB002362	Heilmann-Clausen et al 2017
arvernense	LT000157	MC95-102 / C-F-59014	Sweden (SWE)	On sandy soil with *Pinus sylvestris*.	LT000157 / ---	Heilmann-Clausen et al 2017
arvernense	MF034215	--- / MB-002876	Austria (AUT)	Montane forest with *Fagus*, *Picea abies*, and *Abies alba*.	MF034215 / ---	Reschke et al 2018
arvernense	MF034264	--- / DBG-18239	Mary Jane Ski Lift , Grand Co., Colorado (CO)	Montane forest with *Picea engelmannii* and *Abies lasiocarpa*.	MF034264 / ---	Reschke et al 2018
arvernense (as *psammopus*)	JQ888219	DG-30 / ---	Scotland, United Kingdom (GBR)	*Pinus sylvestris* plantation forest.	JQ888219 / UDB001669	Pickles et al 2012
arvernense (as *sejunctum*)	FJ845448	SMI291 / ---	British Columbia, CAN (BC)	Southern boreal forest on relatively nutrient-poor soils with *Pinus*, *Abies*, and *Picea*.	FJ845448 / ---	Kranabetter et al 2009
atrodiscum cf.	KU058508	MSG132 / TENN-F-070702	Great Smoky Mountains National Park, North Carolina, USA (NC)	Montane forest with *Picea*, *Abies*, and *Betula*.	KU058508 / ---	Sánchez-García & Matheny 2017
atrofibrillosum (as *sejunctum*)	AF349691	KMS285 / SFSU-F-034071	California, USA (CA)	Not reported.	AF349691 / ---	Bidartondo & Bruns 2001
atrofibrillosum (as *subsejunctum*)	NS1908	NS1908 / Pending	Girdwood, Alaska (AK)	*Picea sitchensis-Tsuga* forest with heavy moss groundcover	OM506545 / ---	N. Siegel & K. Mohatt, The mycota of Alaska, unpublished.
atrosquamosum	LT000120	--- / O-F-64018	Norway (NOR)	On calcareous soil in mixed woodland.	LT000120 / ---	Heilmann-Clausen et al 2017
atrosquamosum	MF034275	--- / DBG-24009	Fraser Experimental Forest, Arapaho National Forest, Grand Co., Colorado (CO)	Montane forest with *Picea engelmannii* and *Abies lasiocarpa*.	MF034275 / ---	Reschke et al 2018
atrosquamosum	MF034279	--- / DBG-27983	Fraser Experimental Forest, Arapaho National Forest, Grand Co., Colorado (CO)	Montane forest with *Pinus contorta*, *Pseudotsuga menziesii*, *Picea engelmannii*, and *Populus tremuloides*.	MF034279 / ---	Reschke et al 2018
atroviolaceum	AY750166	C44 EC253 / WTU-F-056406	Washington, USA (WA)	Harvested area in foothill conifer forest dominated by *Pseudotsuga menziesii*.	AY750166 / ---	Cline et al 2005.
atroviolaceum	KU058509	MSG167 / TENN-F-070701	Pierce Co., Washington, USA (WA)	Mixed conifer forest with *Abies procera*, *Pseudotsuga menziesii*, and *Tsuga*.	KU058509 / ---	Sánchez-García & Matheny 2017
aurantium	AF377233	HDT-54945 / SFSU-F-032915	California, USA (CA)	Not reported.	AF377233 / ---	Bidartondo & Bruns 2002
aurantium	DQ367919	OUC-99349 / ---	Southern Interior Forest Region, British Columbia, CAN (BC)	Mature montane forest with *Pseudotsuga menziesii* and *Betula papyrifera*.	DQ367919 / ---	Durall et al 2006
aurantium	LT000012	MC97-227 / C-F-59330	Denmark (DNK)	On calcareous soil under *Fagus*.	LT000012 / UDB001471	Heilmann-Clausen et al 2017
aurantium	LT000100	MC96-303 / C-F-59329	Italy (ITA)	Under *Quercus ilex* and *Q. cerris*.	LT000100 / UDB001470	Heilmann-Clausen et al 2017
auratum	HM590867	AuFr1 / ---	France (FRA)	Sand dunes under *Pinus pinaster*.	HM590867 / ---	Moukha et al 2013
auratum	HM590868	AuFr2 / ---	France (FRA)	Sand dunes under *Pinus pinaster*.	HM590868 / ---	Moukha et al 2013
auratum	HM590869	AuFr3 / ---	France (FRA)	Sand dunes under *Pinus pinaster*.	HM590869 / ---	Moukha et al 2013
badicephalum (as *focale group*)	NS1894	NS1894 / Pending	Hope, Kenai Peninsula, Alaska (AK)	Mixed forest with *Betula*, *Picea*, *Tsuga*, and *Populus*.	OM506544 / ---	N. Siegel & K. Mohatt, The mycota of Alaska, unpublished.
badicephalum (as *robustum*)	AB078341	Not reported.	Not reported.	Not reported.	AB078341 / ---	H. Murata, unpublished.
badicephalum (as *robustum*)	AB289664	TR 1 / ---	Nagano, Japan (JPN)	Not reported.	AB289664 / ---	Kikuchi et al 2007
badicephalum (as *robustum*)	AB699668	KB1 / ---	Nagano, Japan (JPN)	*Pinus densiflora* forest.	AB699668 / ---	Ota et al 2012

Epithet or Name	Label	Collector's/Herbarium #	Location/Origin	Habitat/Tree Associates	GenBank/UNITE # (ITS)	Source
basirubens	LT000001	MC01-209 / C-F-96240	Croatia (HRV)	On calcareous soil with *Quercus*.	LT000001 / ---	Heilmann-Clausen et al 2017
basirubens	LT000158	TL5303 / C-F-38408	Sweden (SWE)	On calcareous soil with *Quercus* and *Fagus*.	LT000158 / ---	Heilmann-Clausen et al 2017
batschii	LT000002	MC01-200 / C-F-96233	Croatia (HRV)	On calcareous soil with *Pinus*.	LT000002 / UDB001412	Heilmann-Clausen et al 2017
bonii	LT000013	JHC91-721 / C-F-96201	Denmark (DNK)	Under *Pinus*, next to road.	LT000013 / UDB000811	Heilmann-Clausen et al 2017
bonii	LT000102	MEN96-112 / L0354472	Italy (ITA)	Not reported.	LT000102 / UDB000791	Heilmann-Clausen et al 2017
bonii Holotype	LT000101	--- / LUG-F-8450	Italy (ITA)	Not reported.	LT000101 / UDB000790	Heilmann-Clausen et al 2017
boreosulphurescens	LT000159	SAE95-07 / C-F-59441	Sweden (SWE)	On calcareous soil in boreal forest with *Betula*.	LT000159 / UDB001475	Heilmann-Clausen et al 2017
boreosulphurescens	LT000199	IK97-1187 / H6002040	Finland (FIN)	On calcareous soil in boreal forest with *Betula*.	LT000199 / ---	Heilmann-Clausen et al 2017
boreosulphurescens (as *sulphurescens*)	JF908737	JV05-IX-04 / MCVE-17159(1)	Finland (FIN)	Not reported.	JF908737 / ---	Osmundson et al 2013
boreosulphurescens (as *sulphurescens*)	JF908738	JV05-IX-04 / MCVE-17159(2)	Finland (FIN)	Not reported.	JF908738 / ---	Osmundson et al 2013
boreosulphurescens Holotype	O-F-187683	--- / O-F-187683	Norway (NOR)	In boreal forest with *Betula*.	--- / ---	Heilmann-Clausen et al 2017
borgsjoeënse	LT000160	JHC95-067 / C-F-96211	Sweden (SWE)	On nutrient-rich soil with *Picea*.	LT000160 / ---	Heilmann-Clausen et al 2017
borgsjoeënse	LT000161	JHC95-307 / C-F-96219	Sweden (SWE)	On nutrient-rich soil with *Picea*.	LT000161 / UDB000807	Heilmann-Clausen et al 2017
boudieri	LT000014	MC95-317 / C-F-59305	Denmark (DNK)	Under *Fagus* and *Quercus* on calcareous soil.	LT000014 / UDB001428	Heilmann-Clausen et al 2017
boudieri	MC08103	MC08-103 / ---	Denmark (DNK)	Under *Fagus* on calcareous soil.	--- / ---	Morten Christensen, unpublished.
boudieri	MS2009_61644	MS2009-61644	Denmark (DNK)	Under *Fagus* and *Quercus*.	--- / ---	Morten Christensen, unpublished.
boudieri (Epitype)	LT000136	MC01-600 / C-F-90092	Slovenia (SVN)	In mixed woodland on calcareous soil.	LT000136 / ---	Heilmann-Clausen et al 2017
bresadolanum	LT000103	MC96-264 / C-F-59341	Italy (ITA)	Under *Quercus*.	LT000103 / UDB000549	Heilmann-Clausen et al 2017
bresadolanum	LT000104	MC96-265 / C-F-59342	Italy (ITA)	Mixed deciduous woodland.	LT000104 / UDB000550	Heilmann-Clausen et al 2017
bresadolanum	LT000105	--- / TRgmb00652	Italy (ITA)	In Mediterranean forest under *Quercus*.	LT000105 / ---	Heilmann-Clausen et al 2017
bresadolanum	LT000162	CL94-166 / C-F-59442	Sweden (SWE)	In Mediterranean forest under *Quercus*.	LT000162 / UDB000792	Heilmann-Clausen et al 2017
bryogenum Holotype (as *sulphureum*)	AY462034	MC97-101 / C-F-59167	Sweden (SWE)	In mixed forests with *Picea*.	AY462034 / ---	Comandini et al 2004
bryogenum Holotype	LT000163	MC97-101 / C-F-59167	Sweden (SWE)	On calcareous soil under *Picea*.	LT000163 / ---	Heilmann-Clausen et al 2017
caligatum	AB699667	--- / SCM-B-5116	Spain (ESP)	On sand dune soil with *Pinus*.	AB699667 / ---	Murata et al 2013
caligatum	AB738885	NBRC 109036 / TFM-M-R107	Italy (ITA)	*Pinus pinea* forest.	AB738885 / ---	Murata et al 2013
caligatum	AF309520	REH7321 / NY	Costa Rica (CRI)	Not reported.	AF309520 / ---	Chapela & Garbelotto 2004
caligatum	KC565866	CM030 / MPU028328	Algeria (DZA)	*Quercus suber* and *Pinus halepensis* forest.	KC565866 / ---	Benazza-Bouregba et al 2016
caligatum	LT000079	PH99-519 / C-F-96274	France (FRA)	In Mediterranean forest with *Pinus*.	LT000079 / UDB000793	Heilmann-Clausen et al 2017
caligatum	LT000152	JV07-451 / C-F-76630	Spain (ESP)	In Mediterranean forest with *Pinus*.	LT000152 / ---	Heilmann-Clausen et al 2017
cedrotorum	MC99049	MC99-049 / ---	France (FRA)	Under *Cedrus atlanticus*.	--- / ---	Morten Christensen, unpublished.
cingulatum	LT000016	MC96-170 / C-F-59068	Denmark (DNK)	Roadside under *Salix*.	LT000016 / UDB000544	Heilmann-Clausen et al 2017
cingulatum	LT000128	MC03-252 / C-F-96246	Slovakia (SVK)	Under *Salix*.	LT000128 / UDB001420	Heilmann-Clausen et al 2017
cingulatum	LT000200	MEN95-210 / L-MEN95210	Netherlands (NLD)	Under *Salix*.	LT000200 / ---	Heilmann-Clausen et al 2017
cingulatum Neotype	LT000015	MC96-134 / C-F-59057	Denmark (DNK)	On sandy soil under *Salix*.	LT000015 / UDB000543	Heilmann-Clausen et al 2017
colossus	LT000137	MC01-205 / C-F-96238	Slovenia (SVN)	Under *Pinus*.	LT000137 / UDB001417	Heilmann-Clausen et al 2017
colossus	LT000164	MC97-047 / C-F-59154	Sweden (SWE)	Under *Pinus* in dry forest.	LT000164 / UDB001433	Heilmann-Clausen et al 2017
columbetta	FJ596909	CLO4550 / TENN-F-60893	Great Smoky Mountains National Park, Tennessee, USA (TN)	Not reported.	FJ596909 / ---	Hughes et al 2009

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columbetta	MC07011	MC07-011 / ---	Poland (POL)	In rich forest of *Quercus* and *Picea*.	--- / ---	Morten Christensen, unpublished.
columbetta	MG773829	RAS212 / TENN-F-071792	Great Smoky Mountains National Park, North Carolina, USA (NC)	Under *Tsuga canadensis* and *Betula*.	MG773829 / ---	This study.
columbetta (as *subresplendens*)	KJ417319	SAT-10-279-01 / TENN-F-065679	Great Smoky Mountains National Park, North Carolina, USA (NC)	Mixed woods with *Quercus*, *Tsuga*, etc.	KJ417319 / ---	Sánchez-García et al 2014
columbetta Neotype	LT000017	MC95-181 / C-F-58898	Denmark (DNK)	Under *Quercus*.	LT000017 / UDB001468	Heilmann-Clausen et al 2017
davisiae	KJ705248	--- / 2346-QFB-25632	Quebec, CAN (QC)	Not reported.	KJ705248 / ---	Bérubé et al unpublished: The Quebec Mushroom Project
davisiae	KJ705249	4689-HRL 1256	Amos, Quebec, CAN (QC)	Under *Pinus banksiana*.	KJ705249 / ---	Bérubé et al unpublished: The Quebec Mushroom Project
davisiae cf.	KU058511	TFB13409 / TENN-F-061672	Great Smoky Mountains National Park, Tennessee, USA (TN)	Under *Tsuga* and *Quercus*.	KU058511 / ---	Sánchez-García & Matheny 2017
Dermoloma magicum	KU058495	GG220904 / TENN-F-063736	Wales, United Kingdom (GBR)	Not reported.	KU058495 / ---	Sánchez-García & Matheny 2017
Dermoloma sp.	KU058494	ECV4208 / TENN-F-065324	Great Smoky Mountains National Park, Tennessee, USA (TN)	Mixed woods - *Tsuga*, *Quercus*, *Fagus*, *Pinus*, etc.	KU058494 / ---	Sánchez-García & Matheny 2017
Dermoloma sp.	KU058497	--- / SAV4102	Slovakia (SVK)	Not reported.	KU058497 / ---	Sánchez-García & Matheny 2017
dryophilum	AF377239	KMS362 / SFSU-F-032952	Marin Co., California, USA (CA)	With *Quercus agrifolia*.	AF377239 / ---	Bidartondo & Bruns 2002
dulciolens	JF908732	--- / MCVE-14633	Italy (ITA)	Not reported.	JF908732 / ---	Osmundson et al 2013
dulciolens (as *caligatum*)	AF309523	HDT48319 / SFSU	Yuba Co., California, USA (CA)	Not reported.	AF309523 / ---	Chapela & Garbelotto 2004
dulciolens (as *caligatum*)	AF527373	--- / DAVFP 26219	British Columbia, CAN (BC)	Not reported.	AF527373 / ---	Lim et al 2003
dulciolens Holotype	AB738883	--- / H-7002022	Sweden (SWE)	*Picea* and *Vaccinium myrtillus* forest.	AB738883 / ---	Murata et al 2013
elegans	KJ417316	PBM3142 / TENN-F-063711	New Zealand (NZL)	Under *Nothofagus*.	KJ417316 / ---	Sánchez-García et al 2014
equestre	HM590870	EqFr1 / ---	France (FRA)	Hill forest under *Pinus sylvestris*.	HM590870 / ---	Moukha et al 2013
equestre	HM590871	EqFr2 / ---	France (FRA)	Hill forest under *Abies alba* and *Quercus pubescens*.	HM590871 / ---	Moukha et al 2013
equestre	HM590872	EqFr3 / ---	France (FRA)	Hill forest under conifers.	HM590872 / ---	Moukha et al 2013
equestre	HM590873	EqFrPa / ---	France (FRA)	Not reported.	HM590873 / ---	Moukha et al, unpublished.
equestre	LT000018	MC94-027 / C-F-58886	Denmark (DNK)	Under *Pinus*, *Picea*, and *Tsuga*.	LT000018 / UDB001508	Heilmann-Clausen et al 2017
equestre	LT000020	MC96-155 / ---	Denmark (DNK)	On sandy soil under *Pinus sylvestris* and *P. mugo*.	LT000020 / UDB001469	Heilmann-Clausen et al 2017
equestre cf.	LT000019	MC95-187 / C-F-96256	Denmark (DNK)	On sandy soil under *Pinus*.	LT000019 / ---	Heilmann-Clausen et al 2017
equestre group (as *flavovirens* group)	AKFF-078-14	AKFF-078-14 / Pending	Chugach National Forest, Kenai Peninsula, Alaska (AK)	Mixed forest - mostly Picea glauca/sitchensis, Populus tremuloides, and Betula papyrifera, with Populus trichocarpa and occasional Alnus.	OM506540 / ---	N. Siegel & K. Mohatt, The mycota of Alaska, unpublished.
equestre group (as *flavovirens* group)	AKFF-087-14	AKFF-087-14 / Pending	Chugach National Forest, Kenai Peninsula, Alaska (AK)	Mixed forest - mostly *Picea glauca/sitchensis*, *Populus tremuloides*, and *Betula papyrifera*, with *Populus trichocarpa* and occasional *Alnus*.	OM506542 / ---	N. Siegel & K. Mohatt, The mycota of Alaska, unpublished.
equestre group (as *flavovirens*)	AB036895	613 / NBRC 33142	Japan (JPN)	*Pinus densiflora* forest.	AB036895 / ---	Murata et al 2013
equestre group (as *flavovirens*)	AF349689	HDT-54614 / SFSU	New Mexico, USA (NM)	Not reported.	AF349689 / ---	Bidartondo & Bruns 2001
equestre group (as *flavovirens*)	AF458452	trh546 / ---	Oregon Dunes National Recreation Area, Oregon, USA (OR)	Coastal sand dune woodland with *Pinus contorta* and *Picea sitchensis*.	AF458452 / ---	Thomas R. Horton, unpublished.
equestre group (as *flavovirens*)	AF458456	trh652 / ---	Oregon Dunes National Recreation Area, Oregon, USA (OR)	Coastal sand dune woodland with *Pinus contorta* and *Picea sitchensis*.	AF458456 / ---	Thomas R. Horton, unpublished.
equestre group (as *flavovirens*)	DQ822834	KGP52 / ---	Marin Co., California, USA (CA)	With *Pinus muricata*.	DQ822834 / ---	Peay et al 2007
equestre group (as *flavovirens*)	EU186292	AP19 / ---	Portugal (PRT)	Not reported.	EU186292 / ---	A. Portugal et al, unpublished.
equestre group (as *flavovirens*)	EU186304	FlPo4 (AP33) / ---	Portugal (PRT)	With conifers.	EU186304 / ---	Moukha et al 2013
equestre group (as *flavovirens*)	EU186309	AP39 / ---	Portugal (PRT)	Not reported.	EU186309 / ---	A. Portugal et al, unpublished.

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equestre group (as *flavovirens*)	EU186310	AP40 / ---	Portugal (PRT)	Not reported.	EU186310 / ---	A. Portugal et al, unpublished.
equestre group (as *flavovirens*)	KU058513	TFB13553 / TENN-F-062900	Sweden (SWE)	Under *Populus* and *Betula*.	KU058513 / ---	Sánchez-García & Matheny 2017
equestre var. *pallidifolia*	HM590874	EqFrW / ---	France (FRA)	Hill forest under *Quercus pubescens*.	HM590874 / ---	Moukha et al 2013
equestre var. *populinum*	HM590875	EqFrPop / ---	France (FRA)	Hill forest under *Betula pendula* and *Populus* sp.	HM590875 / ---	Moukha et al 2013
eucalypticum	KU058512	PBM3154 / TENN-F-066413	New South Wales, Australia (AUS)	Under *Eucalyptus*.	KU058512 / ---	Sánchez-García & Matheny 2017
eucalypticum	MC00248	MC00-248 / ---	Spain (ESP)	Under *Eucalyptus* in plantation on sandy soil.	--- / ---	Morten Christensen, unpublished.
felschii	KU058527	MSG160 / TENN-F-070700	Cherokee National Forest, Tennessee, USA (TN)	On soil with *Betula*, *Quercus*, and *Rhododendron*.	KU058527 / ---	Sánchez-García & Matheny 2017
felschii	MH704857	CLO-4562 / ---	Great Smoky Mountains National Park, Tennessee, USA (TN)	Not reported.	MH704857 / ---	Ovrebo et al 2019
felschii	MH704862	CLO-5177 / ---	Ozark-St. Francis National Forest, Arkansas, USA (AR)	Not reported.	MH704862 / ---	Ovrebo et al 2019
felschii Holotype	MH704855	AGF21 / ---	Costa Rica (CRI)		MH704855 / ---	Ovrebo et al 2019
filamentosum	LT000129	MC03-242 / C-F-96243	Slovakia (SVK)	Under *Fagus sylvatica*.	LT000129 / UDB000803	Heilmann-Clausen et al 2017
filamentosum	LT000138	JHC01-202 / C-F-96191	Slovenia (SVN)	Under deciduous angiosperm trees.	LT000138 / UDB000804	Heilmann-Clausen et al 2017
filamentosum	LT000139	MC00-218 / C-F-96226	Slovenia (SVN)	Under *Fagus sylvatica*.	LT000139 / ---	Heilmann-Clausen et al 2017
filamentosum	LT000165	--- / C-F-35924	Sweden (SWE)	On calcareous soil under *Fagus*.	LT000165 / UDB001506	Heilmann-Clausen et al 2017
filamentosum (as *pardinum*)	EF493302	UP177 / ---	Munich, Germany (DEU)	Mixed forest.	EF493302 / ---	Nygren et al 2008
filamentosum (as *pardinum*)	JF908730	--- / MCVE-14072	Italy (ITA)	Not reported.	JF908730 / ---	Osmundson et al 2013
filamentosum aff. (as sp. RAS373)	MT197008	RAS373 / TENN-F-074697	William Hastie Natural Area, Tennessee, USA (TN)	On ground in hardwood forest under *Quercus*, *Fagus*.	MT197008 / ---	This study.
focale	AF241521	CBS 575.96	Not reported (Korea?)	Not reported.	AF241521 / ---	S.J. Suh & J.G. Kim, unpublished.
focale	AF462639	trh597 / ---	Oregon Dunes National Recreation Area, Oregon, USA (OR)	Coastal sand dune woodland with *Pinus contorta* and *Picea sitchensis*.	AF462639 / ---	Thomas R. Horton, unpublished.
focale	FJ845447	SMI260 / ---	British Columbia, CAN (BC)	Southern boreal forest on relatively nutrient-poor soils with *Pinus*, *Abies*, and *Picea*.	FJ845447 / ---	Kranabetter et al 2009
focale	KJ705238	4502 / ---	Quebec, CAN (QC)	Not reported.	KJ705238 / ---	Bérubé et al unpublished: The Quebec Mushroom Project
focale	LT000021	JV99-603 / C-F-41444	Denmark (DNK)	On nutrient-poor sandy soil with *Pinus*.	LT000021 / UDB001500	Heilmann-Clausen et al 2017
focale	LT000022	MC98-600 / C-F-96260	Denmark (DNK)	On nutrient-poor sandy soil with *Pinus*.	LT000022 / UDB002364	Heilmann-Clausen et al 2017
focale (as *focale* group)	NS1831	NS1831 / Pending	Chugach National Forest, Kenai Peninsula, Alaska (AK)	Mixed forest - mostly *Picea glauca/sitchensis*, *Populus tremuloides*, and *Betula papyrifera*, with *Populus trichocarpa* and occasional *Alnus*.	OM506543 / ---	N. Siegel & K. Mohatt, The mycota of Alaska, unpublished.
focale Neotype	LT000166	JV97-239 / C-F-27500 CFT-0398	Sweden (SWE)	On nutrient-poor sandy soil with *Pinus*.	LT000166 / UDB001501	Heilmann-Clausen et al 2017
forteflavescens Holotype	MF034207	--- / KUN-HKAS-93511	China (CHN)	With *Quercus*.	MF034207 / ---	Reschke et al 2018
fracticum	AF377238	KMS436 / SFSU	California, USA (CA)	Not reported.	AF377238 / ---	Bidartondo & Bruns 2002
frondosae	JHC08045	JHC08-045 / ---	Denmark (DNK)	On clay soil under *Populus*.	--- / ---	Morten Christensen, unpublished.
frondosae	LT000023	MC96-235 / C-F-59084	Denmark (DNK)	Under *Populus tremula*.	LT000023 / UDB001509	Heilmann-Clausen et al 2017
frondosae	LT000075	MC98-086 / C-F-59243	France (FRA)	In mixed forest with *Abies*, *Picea*, and deciduous angiosperm trees.	LT000075 / UDB001504	Heilmann-Clausen et al 2017
frondosae	LT000140	MC00-225 / C-F-96227	Slovenia (SVN)	On nutrient-rich soil with *Populus* and *Picea*.	LT000140 / ---	Heilmann-Clausen et al 2017
frondosae	LT000167	MC95-130 / C-F-59031	Sweden (SWE)	Under *Picea*, *Pinus*, and *Populus*.	LT000167 / ---	Heilmann-Clausen et al 2017
frondosae	LT000168	MC97-151 / C-F-59188	Sweden (SWE)	On nutrient-rich soil with *Populus* and *Picea*.	LT000168 / ---	Heilmann-Clausen et al 2017
frondosae	LT000169	MC97-158 / C-F-59395	Sweden (SWE)	On nutrient-rich soil under *Populus tremula*.	LT000169 / UDB002363	Heilmann-Clausen et al 2017

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frondosae	TF98111	TF98-111 / ---	Denmark (DNK)	On nutrient-rich soil with *Populus* and *Picea*.	--- / ---	Morten Christensen, unpublished.
fucatum	LT000121	MC98-023 / C-F-59201	Norway (NOR)	Under *Picea*.	LT000121 / ---	Heilmann-Clausen et al 2017
fucatum Neotype	LT000170	MC97-149 / C-F-58980 CFT-0403	Sweden (SWE)	On calcareous soil under *Picea*.	LT000170 / ---	Heilmann-Clausen et al 2017
fulvum	KU058514	BPL304 / TENN-F-068348	Great Smoky Mountains National Park, Tennessee, USA (TN)	On soil near *Tsuga canadensis* in mixed forest with *Betula*, *Fagus*, and *Rhododendron*.	KU058514 / ---	Sánchez-García & Matheny 2017
fulvum	KY744154	PBM3988 / TENN-F-068436	Mt. Mitchell State Park, North Carolina, USA (NC)	Montane forest under *Abies*.	KY744154 / ---	This study.
fulvum	KY777366	PBM3970 / TENN-F-068956	Great Smoky Mountains National Park, Tennessee, USA (TN)	On soil and hardwood leaf litter in mixed forest of *Quercus*, *Pinus rigida*, *Betula*, and *Tsuga canadensis*.	KY777366 / ---	This study.
fulvum	LT000080	MC98-078 / C-F-96259	France (FRA)	Mixed woods with *Betula*, *Abies*, and *Picea*.	LT000080 / UDB002365	Heilmann-Clausen et al 2017
fulvum	LT000130	JHC03-019 / C-F-96193	Slovakia (SVK)	Under *Betula*.	LT000130 / UDB001695	Heilmann-Clausen et al 2017
fulvum	LT000171	JHC04-251 / C-F-96195	Sweden (SWE)	Mixed forest with *Betula* and *Picea*.	LT000171 / UDB001700	Heilmann-Clausen et al 2017
fulvum aff.	KU058505	TFB14052 / TENN-F-065997	Macon Co., North Carolina, USA (NC)	Not reported.	KU058505 / ---	Sánchez-García & Matheny 2017
fulvum s.l. (*as muricatum*)	AF458438	trh610 / ---	Not reported (probably Oregon)	Not reported.	AF458438 / ---	Thomas R. Horton, unpublished.
fulvum s.l. (as *pessundatum* group)	SAT-16-244-03	SAT-16-244-03 / WTU-F-073082	Girdwood, Alaska (AK)	*Picea sitchensis* - *Tsuga* forest with heavy moss groundcover	MW597179 / ---	N. Siegel & K. Mohatt, The mycota of Alaska, unpublished.
fulvum s.l. (as *pessundatum*)	FJ845446	SMI303 / ---	British Columbia, CAN (BC)	Southern boreal forest on medium to relatively nutrient-rich soils with *Pinus*, *Abies*, and *Picea*.	FJ845446 / ---	Kranabetter et al 2009
fulvum s.l. (as *transmutans*)	KJ705236	4499 / ---	Quebec, CAN (QC)	Not reported.	KJ705236 / ---	Bérubé et al unpublished: The Quebec Mushroom Project
griseoviolaceum aff. (as *saponaceum* cf.)	HQ604757	BD 39 / UBC-F-09755	CAN (BC?)	Not reported.	HQ604757 / ---	M. Berbee et al, unpublished.
guldeniae	KU058515	MSG131 / TENN-F-070705	Great Smoky Mountains National Park, North Carolina, USA (NC)	Montane forest with *Picea*, *Abies*, and *Betula*.	KU058515 / ---	Sánchez-García & Matheny 2017
guldeniae	LT000070	JuV16997 / TUR-JuV16997	Finland (FIN)	In moist *Picea* forest.	LT000070 / UDB001701	Heilmann-Clausen et al 2017
guldeniae	LT000122	MC95-103 / C-F-96251	Norway (NOR)	In moist *Picea* forest.	LT000122 / ---	Heilmann-Clausen et al 2017
hemisulphureum	LT000065	JV08-364 / C-F-96217	Estonia (EST)	In alvar with *Helianthemum*.	LT000065 / ---	Heilmann-Clausen et al 2017
highlandense Holotype	KY488549	HKAS-70192	China (CHN)	Highland forest dominated by *Pinus yunnanensis*.	KY488549 / ---	Yang et al 2017
ilkkae	AB738881	--- / SCM B-4205	Spain (ESP)	*Abies alba* forest.	AB738881 / ---	Murata et al 2013
ilkkae	LT000172	MC98-602 / C-F-96261	Sweden (SWE)	Mixed conifer forest with *Pinus* and *Picea*.	LT000172 / ---	Heilmann-Clausen et al 2017
ilkkae Holotype	LT222029	S-F513823 / UPS-F-513823	Sweden (SWE)	Conifer forest with *Pinus sylvestris* and scattered *Picea*.	LT222029 / ---	Heilmann-Clausen et al 2017
imbricatum	JV04469	JV04-469 / ---	Denmark (DNK)	Roadside under *Pinus*.	--- / ---	Morten Christensen, unpublished.
imbricatum Neotype	LT000024	MC94-046 / C-F-59268 CFT-0394	Denmark (DNK)	Under *Prunus* and *Pinus sylvestris*.	LT000024 / UDB001421	Heilmann-Clausen et al 2017
imbricatum aff.	AF377242	KMS296 / SFSU-F-033251	California, USA (CA)	Not reported.	AF377242 / ---	Bidartondo & Bruns 2002
imbricatum aff. (as *intermedium*)	AF319434	KMS593 / SFSU-F-033249	California, USA (CA)	Not reported.	AF319434 / ---	K.M. Shanks, unpublished.
inamoenum	JN021105	--- / TRTC156828	Algonquin Provincial Park, Ontario, CAN (ON)	Not reported.	JN021105 / ---	Dentinger et al 2011
inamoenum	LT000174	MC95-115 / C-F-59020	Sweden (SWE)	In deep moss with *Picea*.	LT000174 / UDB001424	Heilmann-Clausen et al 2017
inamoenum (as *platyphyllum*)	FJ845445	SMI309 / ---	British Columbia, CAN (BC)	Southern boreal forest on medium to relatively nutrient-rich soils with *Pinus*, *Abies*, and *Picea*.	FJ845445 / ---	Kranabetter et al 2009
inamoenum Neotype	LT000173	JHC95-042 / C-F-35182 CFT-0399	Sweden (SWE)	In deep moss with *Picea*.	LT000173 / UDB001688	Heilmann-Clausen et al 2017
inocybeoides	LT000025	MC03-229 / C-F-96242	Denmark (DNK)	On nutrient-rich soil with *Betula*.	LT000025 / UDB000783	Heilmann-Clausen et al 2017
inocybeoides	LT000026	MC95-152 / C-F-59272	Denmark (DNK)	On nutrient-rich soil with *Betula*.	LT000026 / UDB000537	Heilmann-Clausen et al 2017
inocybeoides	LT000027	MC96-172 / C-F-59094	Denmark (DNK)	Roadside with *Populus canescens*.	LT000027 / UDB000538	Heilmann-Clausen et al 2017

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inocybeoides	LT000175	JHC95-072 / C-F-35211	Sweden (SWE)	On nutrient-rich soil with *Betula* and *Populus*.	LT000175 / UDB000796	Heilmann-Clausen et al 2017
inocybeoides	LT000176	MC97-060 / C-F-59159	Sweden (SWE)	In park under *Betula*.	LT000176 / UDB000539	Heilmann-Clausen et al 2017
japonicum	AB036900	MR27 / ---	Japan (JPN)	Not reported.	AB036900 / ---	Reschke et al 2018
japonicum	AF204810	Tj 3 / ---	Japan (JPN)	Not reported.	AF204810 / ---	Kikuchi et al 2000
joachimii	HM590876	JoFr / HM590876	France (FRA)	Hill forest under *Quercus pubescens*.	HM590876 / ---	Moukha et al 2013
joachimii	LT000106	--- / TRgmb00060	Italy (ITA)	In dry *Pinus* forest on sandy soil.	LT000106 / ---	Heilmann-Clausen et al 2017
joachimii	LT000177	MC98-603 / C-F-96262	Sweden (SWE)	In dry *Pinus* forest on sandy soil.	LT000177 / ---	Heilmann-Clausen et al 2017
josserandii	LT000081	MC99-053 / C-F-96266	France (FRA)	Under *Cedrus* and *Pinus*.	LT000081 / UDB000797	Heilmann-Clausen et al 2017
josserandii	LT000082	MC99-056 / C-F-96267	France (FRA)	Under *Cedrus* and *Pinus*.	LT000082 / UDB000798	Heilmann-Clausen et al 2017
lascivum	AF241513	--- / CBS 100136	Switzerland (CHE)	Not reported.	AF241513 / ---	S.J. Suh & J.G. Kim, unpublished.
lascivum	AF377206	MC99-197 / C-F-59446	Denmark (DNK)	Under *Fagus*.	AF377206 / ---	Bidartondo & Bruns 2002
lascivum	EU186281	AP61 / K(M) 125042	Not reported (Portugal?)	Not reported.	EU186281 / ---	A. Portugal et al, unpublished.
lascivum	LT000028	MC00-519 / C-F-96230	Denmark (DNK)	On mull soil with *Fagus*.	LT000028 / UDB000005	Heilmann-Clausen et al 2017
lascivum	LT000029	MC99-197 / C-F-59446	Denmark (DNK)	Under *Fagus*.	LT000029 / ---	Heilmann-Clausen et al 2017
lascivum	LT000131	JHC03-020 / C-F-96194	Slovakia (SVK)	On mull soil with *Fagus*.	LT000131 / UDB001696	Heilmann-Clausen et al 2017
leucophyllum	EU597086	UBCOGTR0475s	British Columbia, CAN (BC)	Not reported.	EU597086 / ---	Jones et al 2008
luridum	MC13XXX	MC13-XXX / ---	Austria (AUT)	Mixed *Fagus* and *Abies* forest on calcareous bedrock.	--- / ---	Morten Christensen, unpublished.
luridum	MF034217	--- / MB-002901	Austria (AUT)	Montane *Fagus-Picea-Abies* forest.	MF034217 / ---	Reschke et al 2018
luridum	TF98119	TF98-119 / ---	France (FRA)	Unknown; specimen acquired at an exhibition.	--- / ---	Morten Christensen, unpublished.
luteomaculosum	KU058516	CLO-4632 / TENN-F-061807	Great Smoky Mountains National Park, Tennessee, USA (TN)	Scattered under *Quercus*, *Tsuga*, and *Pinus strobus*.	KU058516 / ---	Sánchez-García & Matheny 2017
luteomaculosum	MH704858	CLO-4623 / ---	Tennessee, USA (TN)	Not reported.	MH704858 / ---	Ovrebo et al 2019
luteomaculosum aff.	AF458446	trh-914 / ---	Oregon, USA (OR)	Not reported.	AF458446 / ---	Ovrebo et al 2019
luteomaculosum aff.	AF458447	trh-1033 / ---	Oregon, USA (OR)	Not reported.	AF458447 / ---	Ovrebo et al 2019
luteomaculosum aff.	AF458448	trh-1187 / ---	Oregon, USA (OR)	Not reported.	AF458448 / ---	Thomas R. Horton, unpublished.
luteomaculosum aff.	HM240543	--- / UBC-F-19693	Capilano River Regional Park, North Vancouver, British Columbia, CAN (BC)	Caespitose on very rotten log covered with soil. Western redcedar (*Thuja plicata*) and western Hemlock (*Tsuga heterophylla*) nearby.	HM240543 / ---	Reschke et al 2018
magnivelare	AF309539	ICh-AF309539	New England, USA	Not reported.	AF309539 / ---	Chapela & Garbelotto 2004
magnivelare	KJ705262	--- / 2150-QFB-25947	Quebec, CAN (QC)	Not reported.	KJ705262 / ---	Bérubé et al unpublished: The Quebec Mushroom Project
magnivelare Holotype	LT220177	--- / NYS f2421	New York, USA (NY)	Not reported.	LT220177 / UDB024110	Trudell et al 2017
marquettense	MH704861	CLO-4912 / ---	Alabama, USA (AL)	Not reported.	MH704861 / ---	Ovrebo et al 2019
matsutake	AF202772	Tm A-5 / ---	Japan (JPN)	Not reported.	AF202772 / ---	Kikuchi et al 2000
matsutake	AF204806	Tm 33 / ---	Japan (JPN)	Not reported.	AF204806 / ---	Kikuchi et al 2000
matsutake	AF204868	Tm 1 / ---	Japan (JPN)	Not reported.	AF204868 / ---	Kikuchi et al 2000
matsutake	AY391712	TM25112.2 / ---	China (CHN)	Not reported.	AY391712 / ---	T. Sha et al, unpublished.
matsutake	EU051918	Not reported	Not reported (China?)	Not reported.	EU051918 / ---	H-M Tang et al, unpublished.
matsutake	LT000071	JuV23362F / TUR-JuV23362F	Finland (FIN)	On nutrient-poor sandy soil with *Pinus sylvestris*.	LT000071 / ---	Heilmann-Clausen et al 2017
matsutake	LT000178	MC03-600 / C-F-96247	Sweden (SWE)	On nutrient-poor sandy soil with *Pinus sylvestris*.	LT000178 / ---	Heilmann-Clausen et al 2017

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melleum Holotype	MF034210	--- / KUN-HKAS-93514	China (CHN)	Mixed forest with *Quercus*.	MF034210 / ---	Reschke et al 2018
moseri	AF377211	KMS447 / SFSU	California, USA (CA)	Not reported.	AF377211 / ---	Bidartondo & Bruns 2002
murrillianum Epitype	KY660032	SAT-16-319-01 / WTU-F-068823	Oregon Dunes National Recreation Area, Oregon, USA (OR)	Mixed woodland with abundant shore pine (*Pinus contorta* var. *bolanderi*) on dune sand.	KY660032 / ---	Trudell et al 2017
murrillianum (as *magnivelare*)	AB712395	CA1 / TFM M-L903	Canada (CAN)	Not reported.	AB712395 / ---	Ota et al 2012
murrillianum (as *magnivelare*)	AF309541	DED5372 / SFSU	Washington, USA (WA)	Not reported.	AF309541 / ---	Chapela & Garbelotto 2004
murrillianum (as *magnivelare*)	AF527369	--- / DAVFP 26221	British Columbia, CAN (BC)	Not reported.	AF527369 / ---	Lim et al 2003
murrillianum (as *magnivelare*)	KF010164	JLF2815 / ---	Mendocino Co., California, USA (CA)	Not reported.	KF010164 / ---	J.L. Frank, unpublished.
murrillianum Holotype	LT220179	WA Murrill 1044 / NY586560	Newport, Lincoln Co., Oregon (OR)	Mixed woodland with abundant shore pine (*Pinus contorta* var. *bolanderi*) on dune sand.	LT220179 / UDB024112	Trudell et al 2017
muscarioides Holotype	MF034208	--- / KUN-HKAS-93512	China (CHN)	Broad-leaved forests with *Quercus* and *Lithocarpus* spp.	MF034208 / ---	Reschke et al 2018
mutabile	AF349703	KMS428 / SFSU	Yuba Co., California, USA (CA)	Not reported.	AF349703 / ---	Bidartondo & Bruns 2001
mutabile	AF458444	trh-916 / ---	Oregon Dunes National Recreation Area, Oregon, USA (OR)	Coastal sand dune woodland with *Pinus contorta* and *Picea sitchensis*.	AF458444 / ---	Ovrebo et al 2019
mutabile	AF458445	trh-1184 / ---	Oregon Dunes National Recreation Area, Oregon, USA (OR)	Coastal sand dune woodland with *Pinus contorta* and *Picea sitchensis*.	AF458445 / ---	Ovrebo et al 2019
mutabile aff.	MH704860	CLO-4711 / ---	Texas, USA (TX)	Not reported.	MH704860 / ---	Ovrebo et al 2019
olivaceoluteolum Holotype	MF034206	--- / KUN-HKAS-93510	China (CHN)	Broad-leaved forests with *Quercus* and *Lithocarpus* spp.	MF034206 / ---	Reschke et al 2018
olivaceoluteolum aff. (as *sejunctum*)	EU819447	JMP0091 / ---	Wisconsin, USA (WI)	*Castanea*-dominated forest.	EU819447 / ---	Palmer et al 2008
olivaceotinctum	LT000179	JHC95-070 / C-F-35209	Sweden (SWE)	Under *Picea*.	LT000179 / UDB000526	Heilmann-Clausen et al 2017
olivaceotinctum	LT000180	KJ1993 / S-KJ1993	Sweden (SWE)	Under *Picea*.	LT000180 / UDB000799	Heilmann-Clausen et al 2017
olivaceotinctum	LT000181	MC95-135 / C-F-59036	Sweden (SWE)	Under *Picea*.	LT000181 / UDB000527	Heilmann-Clausen et al 2017
olivaceotinctum	LT000182	MC97-103 / C-F-59168	Sweden (SWE)	Under Picea.	LT000182 / UDB000525	Heilmann-Clausen et al 2017
olivaceotinctum	LT000183	OP1981 / UPS-OP1981	Sweden (SWE)	Under Picea.	LT000183 / UDB000800	Heilmann-Clausen et al 2017
olivaceum Holotype	MF034209	--- / KUN-HKAS-93513	China (CHN)	In *Pinus* forests or mixed forests with *Pinus*.	MF034209 / ---	Reschke et al 2018
orirubens	LT000030	JHC93-261 / C-F-96208	Denmark (DNK)	On base-rich soil with *Fagus sylvaticus*.	LT000030 / UDB000523	Heilmann-Clausen et al 2017
orirubens	LT000031	MC97-258 / C-F-59427	Denmark (DNK)	Under *Fagus* and *Quercus*.	LT000031 / UDB000521	Heilmann-Clausen et al 2017
orirubens	LT000107	MC96-301 / C-F-59365	Italy (ITA)	Under *Quercus ilex*, *Q. cerris*, and *Cupressus sempervirens*.	LT000107 / UDB000522	Heilmann-Clausen et al 2017
orirubens	LT000132	MC03-243 / C-F-96244	Slovakia (SVK)	Under *Fagus sylvatica*.	LT000132 / UDB000801	Heilmann-Clausen et al 2017
orirubens	LT000141	JHC01-200 / C-F-96189	Slovenia (SVN)	Under *Fagus*.	LT000141 / UDB000524	Heilmann-Clausen et al 2017
orirubens	LT000202	MC98-214 / C-F-59315	England (GBR)	Under *Fagus* on calcareous soil.	LT000202 / UDB000520	Heilmann-Clausen et al 2017
palustre	DQ494699	PBM2494 (AFTOL-ID 497) /	Massachusetts, USA (MA)	Not reported.	DQ494699 / ---	Matheny et al 2006 (as aestuans).
pardinum	AF377228	KMS197 / SFSU-F-033715	Salt Point State Park, Sonoma Co., California, USA (CA)	Mixed forest with (among others) *Pseudotsuga menziesii* and *Notholithocarpus densiflorus*.	AF377228 / ---	Bidartondo & Bruns 2002
pardinum	DQ367921	--- / OUC99350	British Columbia, CAN (BC)	Not reported.	DQ367921 / ---	Durall et al 2006
pardinum	JF899575	--- / DAVFP 28035	Western Canada (CAN)	With *Tsuga heterophylla*.	JF899575 / ---	S.H.A. Guichon, unpublished.
pardinum	JV931023	JV93-1023 / ---	Switzerland (CHE)	Mixed *Fagus* and *Abies* forest on calcareous bedrock.	--- / ---	Morten Christensen, unpublished.
pardinum	LT000142	JHC01-201 / C-F-96190	Slovenia (SVN)	In mixed forest on calcareous soil.	LT000142 / UDB000802	Heilmann-Clausen et al 2017
pardinum	MF955178	--- / UBC-F-32191	Whistler, British Columbia, CAN (BC)	Montane mixed conifer forest.	MF955178 / ---	M. Berbee et al, unpublished.
pardinum	MG719952	PBM828 / WTU-F-012756	Yakima Co., Washington, USA (WA)	Under *Abies*, *Thuja*, *Populus*, *Picea*, *Larix*.	MG719952 / ---	Ovrebo & Hughes 2018

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pardinum aff. (as *huronense*)	AF377229	KMS248 / SFSU-F-033187	California, USA (CA)	Not reported.	AF377229 / ---	Bidartondo & Bruns 2002
pessundatum Epitype	LT000032	JV04-482 / C-F-43780 CFT-0400	Denmark (DNK)	On nutrient-poor sandy soil with *Pinus*.	LT000032 / UDB001502	Heilmann-Clausen et al 2017
platyphyllum (as *inamoenum*)	AF377246	KMS249 / SFSU-F-033184	Patrick's Point State Park, Humboldt Co., California, USA (CA)	Coastal conifer forest including *Picea*.	AF377246 / ---	Bidartondo & Bruns 2001
populinum	EF493259	UP603 / ---	Uppsala, Sweden (SWE)	Mixed forest.	EF493259 / ---	Nygren et al 2008
populinum	JV08398	JV08-398 / C-F-76788	Estonia (EST)	Under *Populus tremula*.	--- / ---	Morten Christensen, unpublished.
populinum	LT000143	MC00-236 / C-F-96229	Slovenia (SVN)	On nutrient-rich soil under *Populus*.	LT000143 / UDB001410	Heilmann-Clausen et al 2017
populinum cf.	EU819446	JMP0090 / ---	Wisconsin, USA (WI)	Castanea-dominated forest with *Populus* present in low abundance.	EU819446 / ---	Palmer et al 2008
portentosum	AF349686	KMS304 / SFSU-F-033823	California, USA (CA)	Not reported.	AF349686 / ---	Bidartondo & Bruns 2001
portentosum	EU186273	AP50 / K(M) 121539	Not reported.	Not reported.	EU186273 / ---	A. Portugal et al, unpublished.
portentosum	LT000033	JHC92-277 / C-F-96202	Denmark (DNK)	Under *Tilia* on clayish soil.	LT000033 / UDB001686	Heilmann-Clausen et al 2017
portentosum	LT000034	MC94-082 / C-F-58959	Denmark (DNK)	Under *Pinus*.	LT000034 / ---	Heilmann-Clausen et al 2017
portentosum	LT000083	MC98-116 / C-F-59262	France (FRA)	Unknown; specimen acquired at an exhibition.	LT000083 / ---	Heilmann-Clausen et al 2017
portentosum	LT000144	MC00-206 / C-F-96224	Slovenia (SVN)	Under *Fagus sylvatica*.	LT000144 / UDB001409	Heilmann-Clausen et al 2017
portentosum	LT000184	JHC04-431 / C-F-96197	Sweden (SWE)	Under *Fagus* on rich soil.	LT000184 / UDB001698	Heilmann-Clausen et al 2017
portentosum Neotype	LT000035	MC96-156 / C-F-59053 CFT-0404	Denmark (DNK)	Under *Pinus sylvestris* and *P. mugo* on sandy soil.	LT000035 / UDB001429	Heilmann-Clausen et al 2017
portentosum s.l. (as sp.)	AF349688	Ork2058 / ---	Sweden (SWE)	Not reported.	AF349688 / ---	Bidartondo & Bruns 2001
psammopus	LT000036	MC98-048 / C-F-59212	Denmark (DNK)	Under *Larix* on clayish soil.	LT000036 / UDB001472	Heilmann-Clausen et al 2017
psammopus	LT000084	MC99-089 / C-F-96273	France (FRA)	Under *Pinus*.	LT000084 / UDB001503	Heilmann-Clausen et al 2017
psammopus	LT000108	MC96-345 / C-F-59324	Italy (ITA)	Under *Cupressus sempervirens*.	LT000108 / ---	Heilmann-Clausen et al 2017
psammopus	LT000145	MC04-600 / C-F-96248	Slovenia (SVN)	Under *Larix*.	LT000145 / ---	Heilmann-Clausen et al 2017
quercetorum	LT000125	MC99-044 / C-F-96263	Portugal (PRT)	Under *Quercus suber*.	LT000125 / UDB000795	Heilmann-Clausen et al 2017
rapipes	LT000037	MC03-228 / C-F-96241	Denmark (DNK)	Under *Fagus* on calcareous soil.	LT000037 / UDB001418	Heilmann-Clausen et al 2017
rapipes Epitype	LT000085	MC98-106 / C-F-59258 CFT-0406	France (FRA)	Under *Abies* and *Picea*.	LT000085 / UDB001439	Heilmann-Clausen et al 2017
roseoacerbum	LT000072	IK88-1120 / H6002032	Finland (FIN)	Under *Pinus*.	LT000072 / ---	Heilmann-Clausen et al 2017
roseoacerbum	LT000073	IK92-2945 / H6002034	Finland (FIN)	Under *Pinus*.	LT000073 / ---	Heilmann-Clausen et al 2017
rufenum	LT000109	MC96-376 / C-F-59393	Italy (ITA)	In Mediterranean woodland with *Pinus* and *Quercus*.	LT000109 / UDB001432	Heilmann-Clausen et al 2017
saponaceum	DQ494700	PBM2514 (AFTOL 672) /	Massachusetts, USA (MA)	Not reported.	DQ494700 / ---	Matheny et al 2006
saponaceum	KU058517	TFB12328 / TENN-F-060376	Great Smoky Mountains National Park, Tennessee, USA (TN)	Under *Pinus rigida*, *P. strobus*, *P. pungens*, and *Tsuga*, plus occasional *Quercus* and *Carya*.	KU058517 / ---	Sánchez-García & Matheny 2017
saponaceum	LT000038	--- / C-F-23337	Denmark (DNK)	Under *Tilia* on clayish soil.	LT000038 / UDB001499	Heilmann-Clausen et al 2017
saponaceum	LT000039	JHC95-165 / C-F-35147	Denmark (DNK)	Under *Fagus sylvatica*.	LT000039 / UDB001505	Heilmann-Clausen et al 2017
saponaceum	LT000040	JHC97-237 / C-F-96216	Denmark (DNK)	On rich soil under *Fagus*.	LT000040 / UDB001689	Heilmann-Clausen et al 2017
saponaceum	LT000041	JV87-682 / C-F-96218	Denmark (DNK)	Under *Fagus sylvatica*.	LT000041/ UDB001507	Heilmann-Clausen et al 2017
saponaceum	LT000086	MC98-059 / C-F-59217	France (FRA)	Under *Fagus* on non-calcareous soil.	LT000086 / ---	Heilmann-Clausen et al 2017
saponaceum	LT000087	TF98-098 / C-F-96276	France (FRA)	Not reported.	LT000087 / UDB001498	Heilmann-Clausen et al 2017
saponaceum	LT000123	JHC00-049 / C-F-96188	Norway (NOR)	Under *Betula* and *Corylus* on rich soil.	LT000123 / UDB001693	Heilmann-Clausen et al 2017
saponaceum	LT000133	JHC03-015 / C-F-96192	Slovakia (SVK)	Under *Fagus*.	LT000133 / UDB001694	Heilmann-Clausen et al 2017
saponaceum	LT000185	JHC04-429 / C-F-96196	Sweden (SWE)	Under *Fagus* and *Quercus* on poor soil.	LT000185 / UDB001697	Heilmann-Clausen et al 2017

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saponaceum	LT000186	JHC04-439 / C-F-96198	Sweden (SWE)	Under *Fagus* on rich soil.	LT000186 / UDB001699	Heilmann-Clausen et al 2017
saponaceum	MF034200	--- / DBG-23531	Roosevelt National Forest, Boulder Co.,Colorado, USA (CO)	Montane conifer forest with *Picea engelmannii* and *Abies concolor*.	MF034200 / ---	Reschke et al 2018
saponaceum	MF034202	--- / DBG-23751	Roosevelt National Forest, Boulder Co.,Colorado, USA (CO)	Montane conifer forest including *Pseudotsuga menziesii*.	MF034202 / ---	Reschke et al 2018
saponaceum	SAT-16-237-07	SAT-16-237-07 / WTU-F-073084	Chugach National Forest, Kenai Peninsula, Alaska (AK)	Mixed forest - mostly *Picea glauca/sitchensis*, *Populus tremuloides*,and *Betula papyrifera*, with *Populus trichocarpa* and occasional *Alnus*.	MW597135 / ---	N. Siegel & K. Mohatt, The mycota of Alaska, unpublished.
saponaceum	SAT-16-237-14	SAT-16-237-14 / WTU-F-073085	Chugach National Forest, Kenai Peninsula, Alaska (AK)	Mixed forest - mostly *Picea glauca/sitchensis*, *Populus tremuloides*, and *Betula papyrifera*, with *Populus trichocarpa* and occasional *Alnus*.	MW597142 / ---	N. Siegel & K. Mohatt, The mycota of Alaska, unpublished.
saponaceum group	AKFF-082-14	AKFF-082-14 / Pending	Chugach National Forest, Kenai Peninsula, Alaska (AK)	Mixed forest - mostly *Picea glauca/sitchensis*, *Populus tremuloides*, and *Betula papyrifera*, with *Populus trichocarpa* and occasional *Alnus*.	OM506541 / ---	N. Siegel & K. Mohatt, The mycota of Alaska, unpublished.
scalpturatum	EU160590	JHC96-249 / ---	Denmark (DNK)	Under *Fagus sylvatica*.	EU160590 / ---	Jargeat et al 2010
scalpturatum	LT000042	JHC93-263 / C-F-96210	Denmark (DNK)	Under *Fagus sylvatica* on clayish soil.	LT000042 / UDB000541	Heilmann-Clausen et al 2017
scalpturatum	LT000043	JHC94-231 / C-F-35309	Denmark (DNK)	Under *Fagus sylvatica*.	LT000043 / UDB000542	Heilmann-Clausen et al 2017
scalpturatum	LT000146	MC00-207 / C-F-96225	Slovenia (SVN)	Under *Carpinus*.	LT000146 / ---	Heilmann-Clausen et al 2017
scalpturatum (Neotype)	LT000187	MC95-165 / C-F-59399	Sweden (SWE)	In park under *Betula*.	LT000187 / ---	Heilmann-Clausen et al 2017
sciodes	LT000044	MC94-007 / C-F-58902	Denmark (DNK)	Under *Fagus sylvatica*.	LT000044 / UDB000547	Heilmann-Clausen et al 2017
sciodes	LT000045	MC95-182 / C-F-96255	Denmark (DNK)	Under *Fagus sylvatica* on clayish soil.	LT000045 / UDB000548	Heilmann-Clausen et al 2017
sciodes	PAM14100601	PAM14100601	France (FRA)	Under *Fagus*.	--- / ---	Morten Christensen, unpublished.
sejunctum	LT000046	MC95-187 / C-F-58998	Denmark (DNK)	Under *Fagus sylvatica* on clayish soil.	LT000046 / ---	Heilmann-Clausen et al 2017
sejunctum	LT000110	MC96-314 / C-F-58979	Italy (ITA)	In decidous woodland dominated by *Quercus*.	LT000110 / UDB001431	Heilmann-Clausen et al 2017
sinopardinum Holotype	KY488553	HKAS-58001	China (CHN)	Not reported.	KY488553 / ---	Yang et al 2017
sinoportentosum Holotype	MF034326	KUN-HKAS-46084	China (CHN)	Conifer forest with *Picea* and *Pinus*.	MF034326 / ---	Reschke et al 2018
smithii (as *pardinum*)	MF034205	--- / DBG-25191	Roosevelt National Forest, Gilpin Co., Colorado, USA (CO)	Montane forest with *Pinus contorta* and *Pseudotsuga menziesii*.	MF034205 / ---	Reschke et al 2018
smithii Holotype	MG719956	CLO-4510 / ---	New Mexico, USA (NM)	Not reported.	MG719956 / ---	Ovrebo & Hughes 2018
sp.	KJ417317	PBM3141 / TENN-F-063710	New Zealand (NZL)	*Nothofagus* forest.	KJ417317 / ---	Sánchez-García et al 2014
sp.	KJ417318	PBM3085 / TENN-F-063664	New Zealand (NZL)	*Nothofagus* forest.	KJ417318 / ---	Sánchez-García et al 2014
sp.	KU058525	PBM3168 / TENN-F-066438	Australia (AUS)	Under *Eucalyptus*.	KU058525 / ---	Sánchez-García & Matheny 2017
sp.	KU058526	PBM3170 / TENN-F-066434	Australia (AUS)	Under *Eucalyptus*.	KU058526 / ---	Sánchez-García & Matheny 2017
sp.	KU058528	PBM3144 / TENN-F-063713	New Zealand (NZL)	*Nothofagus* forest.	KU058528 / ---	Sánchez-García & Matheny 2017
sp.	KY462348	CT-4370 / ---	Argentina (ARG)	*Nothofagus pumilio* (bosque de lenga).	KY462348 / ---	Truong et al 2017
sp.	KY462372	CT-4439 / ---	Chile (CHL)	Bosque Valdevieso with *Nothofagus dombeyi*.	KY462372 / ---	Truong et al 2017
sp.	KY462373	CT-4441 / ---	Chile (CHL)	Bosque Valdevieso with *Nothofagus dombeyi*.	KY462373 / ---	Truong et al 2017
sp.	KY462382	CT-4474 / ---	Chile (CHL)	Bosque Valdevieso with *Nothofagus dombeyi*.	KY462382 / ---	Truong et al 2017
sp.	KY462553	MES-1766 / ---	Chile (CHL)	Under *Nothofagus pumilio* (lenga)	KY462553 / ---	Truong et al 2017
sp.	KY462555	MES-1769 / ---	Chile (CHL)	Under *Nothofagus pumilio* (lenga)	KY462555 / ---	Truong et al 2017
sp.	KY462581	MES-1834 / ---	Chile (CHL)	Mixed *Nothofagus dombeyi* and *N. obliqua* forest.	KY462581 / ---	Truong et al 2017
sp.	KY462610	MES-1890 / ---	Argentina (ARG)	Mixed *Nothofagus dombeyi* and *N. pumilio* forest.	KY462610 / ---	Truong et al 2017
sp.	KY462692	MES-928 / ---	Chile (CHL)	Mixed forest with *Nothofagus dombeyi*, *N. alpina*, and mixed *Myrtaceae*.	KY462692 / ---	Truong et al 2017

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sp.	KY462706	MES-997 / ---	Chile (CHL)	Under *Nothofagus alpina*	KY462706 / ---	Truong et al 2017
squarrulosum	LT000003	MC01-202 / C-F-96235	Croatia (HRV)	Under *Quercus ilex*.	LT000003 / UDB001414	Heilmann-Clausen et al 2017
squarrulosum	LT000047	JHC93-224 / C-F-96205	Denmark (DNK)	Under *Fagus sylvatica* on clayish soil.	LT000047 / UDB000532	Heilmann-Clausen et al 2017
squarrulosum	LT000048	JHC93-262 / C-F-96209	Denmark (DNK)	Under *Fagus sylvatica* on clayish soil.	LT000048 / UDB000530	Heilmann-Clausen et al 2017
squarrulosum	LT000049	JHC95-169 / C-F-35151	Denmark (DNK)	Under *Fagus sylvatica*.	LT000049 / UDB000786	Heilmann-Clausen et al 2017
squarrulosum	LT000088	MC98-081 / C-F-59238	France (FRA)	Under *Picea* and *Abies* on calcareous soil.	LT000088 / UDB000529	Heilmann-Clausen et al 2017
squarrulosum	LT000111	MC96-269 / C-F-59343	Italy (ITA)	Under *Quercus*.	LT000111 / UDB000531	Heilmann-Clausen et al 2017
squarrulosum	LT000147	MC01-700 / C-F-96239	Slovenia (SVN)	Under *Fagus* and *Quercus*.	LT000147 / UDB000528	Heilmann-Clausen et al 2017
squarrulosum aff. (as *atrosquamosum* cf.)	AF349701	KMS435 / SFSU-F-032886	Santa Cruz Co., California, USA (CA)	Not reported.	AF349701 / ---	Bidartondo & Bruns 2001
stans	LT000124	MC98-018 / C-F-96258	Norway (NOR)	On nutrient-poor soil with *Pinus.*	LT000124 / ---	Heilmann-Clausen et al 2017
stans	LT000188	MC95-131 / C-F-59032	Sweden (SWE)	Under *Pinus* and *Picea*.	LT000188 / UDB001426	Heilmann-Clausen et al 2017
stans Epitype	LT000189	MC95-145 / C-F-59042 CFT-0396	Sweden (SWE)	Under *Pinus* and *Betula*.	LT000189 / UDB001427	Heilmann-Clausen et al 2017
stiparophyllum	LT000190	MC95-117 / C-F-96252	Sweden (SWE)	Under *Betula*.	LT000190 / ---	Heilmann-Clausen et al 2017
stiparophyllum (as *lascivum*)	AY573542	Trilas2IV / ---	Europe (Germany?)	Not reported.	AY573542 / ---	K. Krause & E. Kothe, unpublished.
subacutum (as *argenteum*)	KJ705253	4770-HRL 1337	Saint-Chrysostome, Quebec, CAN (QC)	Under *Pinus rigida*.	KJ705253 / ---	Bérubé et al unpublished: The Quebec Mushroom Project
subacutum (as t*erreum* cf.)	DQ097883	OUC-99342 / ---	British Columbia, CAN (BC)	Not reported.	DQ097883 / ---	Durall et al, unpublished.
subacutum (as *virgatum* cf.)	AKFF-076-14	SAT-14-239-18 / WTU-F-073086	Chugach National Forest, Kenai Peninsula, Alaska (AK)	Mixed forest - mostly *Picea glauca/sitchensis*, *Populus tremuloides*, and *Betula papyrifera*, with *Populus trichocarpa* and occasional *Alnus*.	MW597129 / ---	N. Siegel & K. Mohatt, The mycota of Alaska, unpublished.
subacutum (as *virgatum*)	KU058522	MSG165 / TENN-F-070703	Pack Forest, Pierce Co., Washington, USA (WA)	In moss in mixed conifer forest with *Pseudotsuga menziesii* and *Tsuga heterophylla*.	KU058522 / ---	Sánchez-García & Matheny 2017
subannulatum (as *ustaloides*)	AF377240	KMS324 / SFSU-F-034213	California, USA (CA)	Not reported.	AF377240 / ---	Bidartondo & Bruns 2002
subluteum	KJ705255	--- / 2139-QFB-25830	Quebec, CAN (QC)	Not reported.	KJ705255 / ---	Bérubé et al unpublished: The Quebec Mushroom Project
subluteum	KJ705256	3793 / ---	Quebec, CAN (QC)	Not reported.	KJ705256 / ---	Bérubé et al unpublished: The Quebec Mushroom Project
subluteum	KU058519	MSG134 / TENN-F-070707	Great Smoky Mountains National Park, North Carolina, USA (NC)	Montane forest with *Picea*, *Abies*, and *Betula*.	KU058519 / ---	Sánchez-García & Matheny 2017
subluteum (as *leucophyllum*)	JN021108	ALG-06-42 / TRTC-150955	Ontario, CAN (ON)	Not reported.	JN021108 / ---	Dentinger et al 2011
subsejunctum (as *sejunctum* aff.)	JN021102	--- / TRTC156944	Algonquin Provincial Park, Ontario, CAN (ON)	Not reported.	JN021102 / ---	Dentinger et al 2011
subsejunctum (as *sejunctum*)	KU058518	MSG133 / TENN-F-070704	Great Smoky Mountains National Park, North Carolina, USA (NC)	Montane forest with *Picea*, *Abies*, and *Betula*.	KU058518 / ---	Sánchez-García & Matheny 2017
subumbrinum	JQ711805	FFP509 / ---	British Columbia, CAN (BC)	Pinus contorta forest.	JQ711805 / ---	Ovrebo et al 2019; Jones et al 2012
sudum	LT000050	JV96-306 / C-F-96221	Denmark (DNK)	On nutrient-poor sandy soil with *Pinus*.	LT000050 / UDB001684	Heilmann-Clausen et al 2017
sudum Neotype	LT000051	MC98-601 / C-F-90094 CFT-0403	Denmark (DNK)	On nutrient-poor sandy soil with *Pinus*.	LT000051 / UDB002366	Heilmann-Clausen et al 2017
sulphurescens	JHC09050	JHC09-050 / ---	Sweden (SWE)	Not reported.	--- / ---	Morten Christensen, unpublished.
sulphurescens	LT000089	MC99-063 / C-F-96269	France (FRA)	Under *Fagus* and *Quercus*.	LT000089 / UDB002367	Heilmann-Clausen et al 2017
sulphurescens	LT000112	MC96-296 / C-F-59362	Italy (ITA)	Under *Quercus ilex*.	LT000112 / UDB000809	Heilmann-Clausen et al 2017
sulphurescens	MC12002	MC12-002 / ---	Italy (ITA)	Under *Fagus* on calcareous soil.	--- / ---	Morten Christensen, unpublished.
sulphurescens	MH2013_643789	MH2013_643789 / ---	Denmark (DNK)	Under *Fagus* and *Quercus* on calcareous soil.	--- / ---	Morten Christensen, unpublished.
sulphurescens aff.	LT000113	TRgmb00062 / C-F-101489	Italy (ITA)	Not reported.	LT000113 / ---	Heilmann-Clausen et al 2017

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sulphureum	AF377245	HO70098 / O	Norway (NOR)	Not reported.	AF377245 / ---	Bidartondo & Bruns 2002
sulphureum	AY462035	MC96-162 / C-F-59062	Denmark (DNK)	Under *Fagus sylvaticus*.	AY462035 / ---	Comandini et al 2004
sulphureum	AY462036	MC94-023 / C-F-58914	Denmark (DNK)	Under *Populus tremula* and *Quercus*.	AY462036 / ---	Comandini et al 2004
sulphureum	AY462037	MC96-245 / C-F-59115	Denmark (DNK)	Under *Quercus*.	AY462037 / ---	Comandini et al 2004
sulphureum	AY462038	MC95-188 / C-F-59292	Denmark (DNK)	Under *Fagus sylvaticus*.	AY462038 / ---	Comandini et al 2004
sulphureum	AY462039	DED4539 / SFSU-F-034076	Florida, USA (FL)	Under *Quercus* and *Pinus*.	AY462039 / ---	Comandini et al 2004
sulphureum	EU819448	JMP0092 / ---	Wisconsin, USA (WI)	*Castanea*-dominated forest.	EU819448 / ---	Palmer et al 2008
sulphureum	HQ650743	Not reported.	British Columbia, CAN (BC)	Southern boreal forest on relatively nutrient-rich soils with *Pinus*, *Abies*, and *Picea*.	HQ650743 / ---	Kranabetter et al 2009
sulphureum	KM576674	LM2344 / ---	Romania (ROU)	Root of *Quercus petraea*.	KM576674 / ---	Suz et al 2014
sulphureum	KU058520	PBM3959 / TENN-F-068897	Great Smoky Mountains National Park, Tennessee, USA (TN)	Under *Tsuga*, *Betula*, *Carya*.	KU058520 / ---	Sánchez-García & Matheny 2017
sulphureum	LT000053	JHC07-236 / C-F-96199	Denmark (DNK)	Under *Fagus* on rich soil.	LT000053 / ---	Heilmann-Clausen et al 2017
sulphureum	LT000090	MC98-109 / C-F-59260	France (FRA)	Under *Abies*.	LT000090 / UDB001440	Heilmann-Clausen et al 2017
sulphureum	LT000091	TF06-045 / C-F-96275	France (FRA)	Not reported.	LT000091 / ---	Heilmann-Clausen et al 2017
sulphureum	LT000148	MC01-204 / C-F-96237	Slovenia (SVN)	Under *Picea*, *Abies* and *Fagus*.	LT000148/ UDB001416	Heilmann-Clausen et al 2017
sulphureum	LT000191	JHC08-049 / C-F-96200	Sweden (SWE)	Under *Fagus* on rich soil.	LT000191 / ---	Heilmann-Clausen et al 2017
sulphureum	LT000192	MC07-001 / C-F-101488	Sweden (SWE)	Under *Fagus sylvatica*.	LT000192 / ---	Heilmann-Clausen et al 2017
terreum	LT000057	JHC93-260 / C-F-96207	Denmark (DNK)	Under *Fagus* and *Corylus* on clay soil.	LT000057 / UDB000536	Heilmann-Clausen et al 2017
terreum	LT000058	JHC95-118 / C-F-35098	Denmark (DNK)	Under *Picea*, *Pinus*, and *Quercus*.	LT000058 / ---	Heilmann-Clausen et al 2017
terreum	LT000059	JHC95-172 / C-F-35154	Denmark (DNK)	Under *Pinus*.	LT000059 / UDB000812	Heilmann-Clausen et al 2017
terreum	LT000060	TL11-317 / C-F-96277	Denmark (DNK)	Under *Abies* and *Picea* on calcareous soil.	LT000060 / UDB000808	Heilmann-Clausen et al 2017
terreum	LT000061	JHC93-222 / C-F-96204	Denmark (DNK)	Under *Fagus sylvatica* on clayish soil.	LT000061 / UDB000534	Heilmann-Clausen et al 2017
terreum	LT000062	JV95-519 / C-F-96220	Denmark (DNK)	Under *Fagus sylvatica* on rich soil.	LT000062 / UDB000535	Heilmann-Clausen et al 2017
terreum	LT000092	MC99-071 / C-F-96271	France (FRA)	Under *Pinus*.	LT000092 / UDB001445	Heilmann-Clausen et al 2017
terreum	LT000093	MC99-074 / C-F-96272	France (FRA)	Under *Pinus*.	LT000093 / UDB001446	Heilmann-Clausen et al 2017
terreum	LT000116	MC05-200 / C-F-96249	Nepal (NPL)	Under *Pinus wallichiana*.	LT000116 / UDB002368	Heilmann-Clausen et al 2017
terreum	LT000149	MC01-020 / C-F-96232	Slovenia (SVN)	Under *Pinus*.	LT000149 / UDB001411	Heilmann-Clausen et al 2017
terreum	LT000193	MC95-119 / C-F-96253	Sweden (SWE)	Under *Populus* and *Pinus*.	LT000193 / UDB001425	Heilmann-Clausen et al 2017
terreum	LT000201	MC98-209 / C-F-59313	Netherlands (NLD)	Under *Pinus nigra* on dune sands.	LT000201 / UDB000533	Heilmann-Clausen et al 2017
terreum Epitype	LT000098	MEN95-192 / L0374887	Germany (DEU)	Under *Pinus*.	LT000098 / UDB000813	Heilmann-Clausen et al 2017
tridentinum	LT000076	JV99-700 / C-F-96222	France (FRA)	Under *Cedrus* and *Pinus*.	LT000076 / UDB000805	Heilmann-Clausen et al 2017
triste	LT000066	JuV5271F / TUR-JuV5271F	Estonia (EST)	Not reported.	LT000066 / ---	Heilmann-Clausen et al 2017
triste	LT000194	JHC97-169 / C-F-96214	Sweden (SWE)	Under *Picea* on rich soil.	LT000194 / UDB001691	Heilmann-Clausen et al 2017
triste	MF034270	--- / DBG-22631	Pike National Forest, Teller Co., Colorado, USA (CO)	Montane conifer forest with *Salix*, *Populus tremuloides*, *Picea engelmannii*, and *Pinus flexilis*.	MF034270 / ---	Reschke et al 2018
triste Neotype	LT000099	E3754 / L-E3754	Germany (DEU)	Under *Pinus*.	LT000099 / UDB000814	Heilmann-Clausen et al 2017
ulvinenii	LT000067	IK93-1613 / H6002036	Finland (FIN)	Not reported.	LT000067 / ---	Heilmann-Clausen et al 2017
ulvinenii	LT000068	JuV13229F / TUR-JuV13229F	Finland (FIN)	Not reported.	LT000068 / ---	Heilmann-Clausen et al 2017
ulvinenii	LT000069	JuV26740F / TUR-JuV26740F	Finland (FIN)	Not reported.	LT000069 / ---	Heilmann-Clausen et al 2017

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umbonatum	JHC10055	JHC10-055 / ---	Denmark (DNK)	On calcareous soil under *Fagus sylvatica*.	--- / ---	Morten Christensen, unpublished.
umbonatum	LT000063	MC00-A01 / C-F-96231	Denmark (DNK)	On calcareous soil under *Fagus sylvatica*.	LT000063 / UDB002369	Heilmann-Clausen et al 2017
umbonatum	LT000114	TRgmb00651 / C-F-101490	Italy (ITA)	On calcareous soil under *Fagus sylvatica*.	LT000114 / ---	Heilmann-Clausen et al 2017
ustale	LT000064	JHC92-299 / C-F-96203	Denmark (DNK)	On mineral-rich soil under *Fagus sylvatica*.	LT000064 / UDB000551	Heilmann-Clausen et al 2017
ustaloides	JV08135	JV08-135 / ---	Denmark (DNK)	Under *Fagus* and *Quercus* near the coast.	--- / ---	Morten Christensen, unpublished.
ustaloides	LT000094	MC99-067 / C-F-96270	France (FRA)	Under *Quercus* and *Fagus*.	LT000094 / UDB000815	Heilmann-Clausen et al 2017
ustaloides	LT000126	MC99-047 / C-F-96264	Portugal (PRT)	Under *Quercus suber*.	LT000126 / UDB000816	Heilmann-Clausen et al 2017
vaccinum	KU058521	TFB13554 / TENN-F-062901	Sweden (SWE)	Under *Populus* and *Betula*.	KU058521 / ---	Sánchez-García & Matheny 2017
vaccinum	LT000150	MC00-229 / C-F-96228	Slovenia (SVN)	On sandy nutrient-poor soil under *Picea*.	LT000150 / UDB001511	Heilmann-Clausen et al 2017
vaccinum	LT000195	MC95-109 / C-F-59017	Sweden (SWE)	Roadside under *Picea*.	LT000195 / UDB001423	Heilmann-Clausen et al 2017
venenatoides (as *venenatum*)	AF377230	KMS396 / SFSU-F-031292	California, USA (CA)	Not reported.	AF377230 / ---	Bidartondo & Bruns 2002
venenatoides (as *venenatum*)	DQ367922	OUC99352 / ---	British Columbia, CAN (BC)	Not reported.	DQ367922 / ---	Durall et al 2006
venenatoides (as *venenatum*)	MG719950	MK01140602 / ---	California, USA (CA)	Not reported.	MG719950 / ---	Ovrebo & Hughes 2018
venenatum	AY656986	Tricholoma #01 / ---	Coweeta Hydrologic Laboratory, Macon Co., North Carolina (NC)	On root of *Quercus rubra* seedling in mixed mesic woodland.	AY656986 / ---	Walker et al 2005
vernaticum	AF377203	KMS246 / SFSU-F-034307	Not reported (probably CA)	Not reported.	AF377203 / ---	Bidartondo & Bruns 2002
virgatum	LT000151	MC01-203 / C-F-96236	Slovenia (SVN)	Under *Picea*, *Abies*, and *Fagus*.	LT000151 / UDB001415	Heilmann-Clausen et al 2017
virgatum	LT000196	JHC95-063 / C-F-35203	Sweden (SWE)	Under *Picea*.	LT000196 / UDB000546	Heilmann-Clausen et al 2017
virgatum Neotype	LT000197	MC97-164 / C-F-59398 CFT-0408	Sweden (SWE)	Under Picea in moss-rich forest on calceous soil.	LT000197 / UDB000545	Heilmann-Clausen et al 2017
virgatum aff.	MC05201	MC05-201 / ---	Nepal (NPL)	Under Tsuga and Abies in high montane forest.	--- / ---	Morten Christensen, unpublished.
viridilutescens (Type I)	LT000095	MC98-061 / C-F-59219	France (FRA)	Under *Picea*, *Populus*, *Betula*, and *Quercus*.	LT000095 / UDB001436	Heilmann-Clausen et al 2017
viridilutescens (Type I)	LT000096	MC98-080 / C-F-59237	France (FRA)	Under *Picea*, *Abies* and *Fagus*.	LT000096 / UDB001473	Heilmann-Clausen et al 2017
viridilutescens (Type I)	LT000097	MC98-093 / C-F-59249	France (FRA)	In mixed forest with *Pinus* and deciduous angiosperm trees.	LT000097 / UDB001437	Heilmann-Clausen et al 2017
viridilutescens (Type II)	UDB011588	VL-25.08.2009 / TU106550	Estonia (EST)	Not reported.	--- / UDB011588	Heilmann-Clausen et al 2017
viridilutescens (Type II)	UDB011595	VL-10.09.2010 / TU106841	Estonia (EST)	Not reported.	--- / UDB011595	Heilmann-Clausen et al 2017
viridilutescens (Type II) aff. (as *sejunctum*)	AB036899	NA12 / ---	Japan (JPN)?	Not reported.	AB036899 / ---	H. Murata, unpublished.
viridiolivaceum	LT000117	MC96-002 / C-F-96257	New Zealand (NZL)	Under *Nothofagus solandri*.	LT000117 / ---	Heilmann-Clausen et al 2017