12-2017

Systematics and Biogeography of the *Cortinarius violaceus* group and Sequestrate Evolution in *Cortinarius* (Agaricales)

Emma Harrower
University of Tennessee, Knoxville, eharrowe@vols.utk.edu

To the Graduate Council:

I am submitting herewith a dissertation written by Emma Harrower entitled "Systematics and Biogeography of the *Cortinarius violaceus* group and Sequestrate Evolution in *Cortinarius* (Agaricales)." I have examined the final electronic copy of this dissertation for form and content and recommend that it be accepted in partial fulfillment of the requirements for the degree of Doctor of Philosophy, with a major in Ecology and Evolutionary Biology.

Brandon Matheny, Major Professor

We have read this dissertation and recommend its acceptance:

Randall Small, Jessy Labbe, Sharon Jean-Phillipe, Jen Schweitzer

Accepted for the Council:

Dixie L. Thompson

Vice Provost and Dean of the Graduate School

(Original signatures are on file with official student records.)

Systematics and Biogeography of the *Cortinarius violaceus* group and Sequestrate Evolution in *Cortinarius* (Agaricales)

A Dissertation Presented for the
Doctor of Philosophy
Degree
The University of Tennessee, Knoxville

Emma Harrower
December 2017

ACKNOWLEDGEMENTS

I would like to thank Dr. Brandon Matheny for welcoming me into his lab and teaching me light microscopy and vocabulary pertaining to the Agaricales. He encouraged me to ask questions about biogeography in pushing me to answer questions I had never considered. I would like to thank my lab mates: Brian Looney, Hailee Korotkin, and Rachel Swenie. They made me feel like I was part of a community, showed empathy when I needed it, and helped me destress. Nick Matzke and Brian O’Meara helped me download Unix computer programs and got them up and running for me. Dr. O’Meara provided invaluable input as to which programs and which models I should use to test for the impact of the climate on the evolution of truffle-like fungi. I would also like to thank my committee: Dr. Randall Small, Dr. Jen Schweitzer, Dr. Jessy Labbé, and Dr. Sharon Jean-Philippe.

ABSTRACT

Phylogenetics is a powerful tool used for illuminating the diversity of life on Earth, their evolution and their ecology. I created a multi-gene phylogenetic tree of *Cortinarius* section *Cortinarius* and uncovered five previously overlooked species, increasing the number of species in the section from seven to twelve. All members of the clade possess both cheilocystidia and pleurocystidia and possess a pigment known as (R)-39,49-dihydroxybphenylalanine. Ancestral state reconstruction estimated that the ancestral host was most likely an angiosperm, switching hosts when encountering novel host species in new lands, and only *C. violaceus* associating with the Pinaceae in North America. Biogeographic analysis found it was most likely that the group originated in Australia, dispersed through long-distance dispersal to South America, where it switched hosts to certain members of the Fabaceae, diversified with *Quercus* in Central America, then migrated into North America. The test the 'secotioid' hypothesis, I performed a phylogenetic logistic regression correlating environmental variables with the state of being sequestrate. 'Mean diurnal temperature' and 'mean maximum temperature in the hottest month' were significant in estimating the probability of being sequestrate. None of the precipitation variables were significant. A world map of the distribution of sequestrate specimens included in this study show the sequestrate taxa being present in temperate areas and absent from the tropics, in concordance with the finding that sequestrate taxa are found in habitats variable temperatures. This study brings in doubt that moisture is the sole driving force for the evolution of sequestrate taxa.

TABLE OF CONTENTS

INTRODUCTION 1

CHAPTER I Long-distance dispersal and speciation of Australasian and American species of *Cortinarius* sect. *Cortinarius* 2

Abstract 3
Introduction 3
Materials and Methods 6
Taxon sampling, DNA extraction, amplification and sequencing 6
Alignment and phylogenetic analyses..7
Relaxed molecular clock analysis 7
Haplotype analysis 8
Results 8
Taxonomic and genetic diversity within sect. *Cortinarius*..8
Phylogeographic analyses 11
Discussion..14
References 18
Appendix...24

CHAPTER II New species in *Cortinarius* section *Cortinarius* (Agaricales) from the Americas and Australasia 61

Abstract 62
Introduction 62
Methods 64
Morphological analysis...64
Phylogenetic study 65
Taxonomy 65
Species inquirendae 75
Species excludendae 75
References 77
Appendix...79

CHAPTER III Testing the secotioid syndrome hypothesis across multiple environmental variables: a case study using a global-scale phylogeny of *Cortinarius* 83

Abstract 84
Introduction 84
Methods 87
Taxon sampling and DNA sequencing 87
DNA alignment and Mega-Phylogeny 88
Ancestral state reconstruction..88
Correlation of climate variables with sequestrate state 88
Phylogenetic logistic regression...89
Testing for phylogenetic conservatism...89
Results 90

Discussion 92
References 95
Appendix 98
CONCLUSIONS 148
VITA 149

LIST OF TABLES

Table 1: Number, geography, and DNA sequences of ITS haplotypes in *C. violaceus* auct. mult. 10
Table 2: Herbarium accession numbers, GenBank accession numbers, host association and geography of specimens used in this study. 24
Table 3: Pairwise distances within species in sect. *Cortinarius* in the ITS, 28S and *RPB2* loci using the Kimura 2-parameter distance correction. N/A refers to when one or both sequences are missing. 32
Table 4: Pairwise distances between species in the ITS, 28S and *RPB2* loci using the Kimura 2-parameter distance correction. 59
Table 5: BioClim Variables. A quarter is a period of three months (1/4 of the year). 89
Table 6: Phylogenetic logistic regression models for each of the 19 BioClim variables. 92

LIST OF FIGURES

Figure 1: *Cortinarius violaceus* auct. mult. in Mount Baker-Snoqualmie National Forest, Washington, USA. Bar = 1 cm. Photo by Noah Siegel.................................5

Figure 2: Maximum likelihood (ML) phylogenetic tree of the combined nuclear ITS, 28S and *RPB2* sequences. ML Bootstrap support more than 50% is above nodes and Bayesian posterior probabilities above 0.90 indicated below nodes. Specific epithets are those designated on original collections. Following the specific epithet are collection number, GenBank accession number or UNITE number followed by the country (or state) in which the specimen was found. Forest type is indicated for *Cortinarius violaceus* auct. mult. where known. 8

Figure 3: Chronogram obtained with the uncorrelated log normal relaxed-clock method (implemented in BEAST) with an age constraint (12.1 ± 1.0 mya) at the node indicated by the arrow. Numbers correspond to mean age estimates (in million years), and gray bars represent 95% credibility intervals. 12

Figure 4: Reconstruction of historical ranges produced in BioGeoBEARS is represented on the left. Occurrence in two (or more) locations is represented as a mixture of two or more colors. Ancestral state reconstruction of host association, using maximum likelihood, as implemented in Mesquite, is on the right. 13

Figure 5: Maximum likelihood (ML) phylogenetic tree of *Cortinarius* sect. *Cortinarius* using combined nuclear ITS, 28S and *RPB2* sequences. ML bootstrap support above 50% is shown above nodes. 79

Figure 6: Habit of the following *Cortinarius* species: **a** *C. kioloensis* (TENN 069666, photo I. Dodd) **b** *C. palatinus* (NY 796168, TYPE, photo R.E. Halling) **c** *C. atrotomentosus* (TENN 069922, photo A. Bessette) **d** *C. hallowellensis* (MEL 2300544) **e** *C. neotropicus* (NY 75934, photo R.E. Halling) **f** *C. carneipallidus* (PDD 71219, photo E. Horak) **g** *C. altissimus* (TENN 069829, TYPE photo T. Henkel) **h** C. gayi (ZT 75/82, ISOTYPE, photo E. Horak) **i** *C. austroviolaceus* (MEL 2231689, photo K. Syme). Scale bar = 1 cm. 80

Figure 7: Light micrographs of basidiospores from the following *Cortinarius* species: **a** *C. kioloensis* (PDD 99307) **b** *C. palatinus* (NY 00795933) **c** *C. altissimus* (TENN 069830) **d** *C. hallowellensis* (MEL 2300544) **e** *C. neotropicus* (NY 34729 TYPE) **f** *C. carneipallidus* (PDD95444 TYPE) **g** *C. atrotomentosus* (TENN 065535 TYPE) **h** *C. violaceus* (TENN 062899) *C. austroviolaceus* (MEL 227499). Scale bar = 10 μm. 81

Figure 8: SEM micrographs of basidiospores from the following *Cortinarius* species: **a** *C. kioloensis* (MEL 2351101) **b** *C. palatinus* (NY 796168 TYPE) **c** *C. altissimus* (069830) **d** *C. hallowellensis* (MEL 2300544) **e** *C. neotropicus* (NY 34729 TYPE) **f** *C. carneipallidus* (PDD 71219) **g** *C. atrotomentosus* (TENN 065535 TYPE) **h** *C. violaceus* (TENN 063104) **i** *C. austroviolaceus* (MEL 2121961 PARATYPE). Scale bar = 2 μm. 82

Figure 9: Hypothesized distribution of the probability of being gilled or sequestrate across a climate gradient (eg. dry to wet): **a** Thiers' hypothesis; **b** Bougher and Lebel hypothesis; **c** no selection for a sequestrate state based on climate variables. 86

Figure 10: Basidiome types occurring in the *Cortinarius* clade. **a** Agaricoid basidiomes of *Cortinarius ignotus* (photo Michael Wallace). **b** Sequestrate basidiomes of *Cortinarius magnivelatus* (photo Ron Pastorino). **c** Secotioid basidiome of *Cortinarius pingue* = *Thaxterogaster pinguis* (missing lower part of stipe; photo Jason Hollinger). **d** Basidiome of *Hymenogaster sublilacinus* (photo Noah Siegel). 87
Figure 11: Ancestral state reconstruction of **a** the basidiome morphology **b** the viscidity of the pileus. 90
Figure 12: Geographic location of specimens used to correlate with BioClim variables. Gilled taxa are shown in blue. Sequestrate taxa are shown in red. 91

INTRODUCTION

Phylogenetics is a powerful tool used for illuminating the diversity of life on Earth, their evolution and their ecology. The fungal genus *Cortinarius*, with some 2000 species, is the most taxonomically diverse genus in the Agaricales having diversified as ectomycorrhizal symbionts with numerous plant families across the globe. In this dissertation I make a contribution to studies on taxonomy, biogeography, speciation, and evolution in *Cortinarius*. First, I created a multi-gene phylogenetic tree of *Cortinarius* section *Cortinarius* and uncovered five previously overlooked species-level lineages. All members of the clade share a unique combination of microscopic characters and pigment chemistry. Ancestral plant associations in this group were most likely with angiosperm partners, switching associates when encountering novel ectomycorrhizal plants in new areas. Biogeographic analysis found it was most likely that the group originated in Australasia, dispersed by long-distance to South America, where it switched associations to members of the Fabaceae, diversified with *Quercus* in Central America, then migrated into North America switching to other angiosperm and Pinaceae associates. In my second chapter, I formally described five new species in sect. *Cortinarius* from North America, South America, and Australasia, raising the number of species in the section from seven to twelve. In my third chapter, I test the 'Secotioid Hypothesis' across a large global dataset of *Cortinarius*. In short, this hypothesis predicts that the sequestrate habit evolved as a response to seasonal drought conditions. In *Cortinarius* some 87 sequestrate species can be recognized. To test this hypothesis in *Cortinarius*, I performed a phylogenetic logistic regression analysis in an attempt to correlate environmental variables with the sequestrate state. Of 16 environmental variables, 'mean diurnal temperature' and 'mean maximum temperature in the hottest month' were significant in estimating the probability of being sequestrate. None of the precipitation variables were significant, thus casting doubt that moisture is the sole driving force in the evolution of sequestrate taxa. A world map of the distribution of sequestrate specimens included in this study shows sequestrate taxa present in temperate areas and absent from the tropics, in concordance with the finding that sequestrate taxa are found in habitats with more variable temperatures. When examined across the *Cortinarius* phylogeny, the sequestrate state is clumped indicating that particular clades have more or less sequestrate taxa than other clades.

CHAPTER I
LONG-DISTANCE DISPERSAL AND SPECIATION OF AUSTRALASIAN AND AMERICAN SPECIES OF *CORTINARIUS* SECT. *CORTINARIUS*

A version of this chapter was originally published by Emma Harrower, Neale L. Bougher, Terry W. Henkel, Egon Horak and Patrick Brandon Matheny: "Long-distance dispersal and speciation of Australasian and American species of *Cortinarius* sect. *Cortinarius*." *Mycologia* 107 (2015): 697-709.

Emma Harrower obtained collections, generated DNA sequences, analyzed the data, and wrote the manuscript. Brandon Matheny encouraged me to use BioGeoBEARS and he made edits to the manuscript. Neale Bougher also made edits to the manuscript. Terry Henkel and Egon Horak provided additional collections and made edits the manuscript.

Abstract

We present a multigene phylogeny (partial nuc rDNA and *RPB2*) of *Cortinarius* sect. *Cortinarius* (i.e. the *C. violaceus* group), which reveals eight species distributed in Europe, Australasia, South America, Central America and North America. Relaxed molecular clock analyses suggested that diversification began during the Miocene, thus rejecting more ancient Gondwanan origin scenarios among the taxa currently occurring in the northern and southern hemispheres. There was strong support for an Australasian origin of the *C. violaceus* group with initial dispersal to the Neotropics, followed by migration into North America and Europe. A dispersal-extinction cladogenesis model that includes a parameter for founder effects was the most highly supported biogeographic model in the program BioGeoBEARS. A maximum likelihood analysis showed the most recent common ancestor of sect. *Cortinarius* was an angiosperm ectomycorrhizal associate. Ancestral associations at the plant family level, however, were ambiguous. Of eight recovered species level lineages, *C. violaceus* is the only one that associates with Pinaceae and the only species to associate with both Pinaceae and angiosperms. This analysis showed that long-distance dispersal and founder event speciation have been important factors during evolution of the *C. violaceus* group.

Introduction

Research in genetic diversity and phylogeographic patterns of closely related macrofungal species generally has revealed higher taxonomic and genetic diversity than previously detected and highly structured biogeographic distributions (Chapela and Garbelotto 2004, Zervakis et al. 2004, Geml et al. 2008, Lumbsch et al. 2008, Ryberg et al. 2008, Dentinger et al. 2010, Morgado et al. 2013, Tamm and Po˜ldmaa 2013). Many of these studies suggest allopatric speciation is important for establishing current species distributions. However continental scale disjunct distributions are often best explained by long-distance dispersal (LDD) in studies where fungal taxa are younger than ancient vicariant events (Hibbett 2001, Moncalvo and Buchanan 2008, Matheny et al. 2009, Wilson et al. 2012, Bonito et al. 2013). It is generally assumed that there is tight coevolution of the ectomycorrhizal fungus and its plant host; so much so that it is often hypothesized that host association might affect speciation and distribution

(Chapela and Garbelotto 2004, den Bakker et al. 2007, Kennedy et al. 2011, Rochet et al. 2011, Murata et al. 2013).

In addition a growing number of macroevolutionary studies support host shifts of ectomycorrhizal (ECM) basidiomycetes from ancestral angiosperm partners (e.g. Fagaceae, Myrtaceae, Ericaceae, Betulaceae, Salicaceae) to coniferous (Pinaceae) partners during the Cenozoic (Chapela and Garbelotto 2004; Hosaka et al. 2008; Matheny et al. 2009; Ryberg and Matheny 2011, 2012; Skrede et al. 2011). Ancestral ECM associations with Pinaceae however have been suggested for the agaric genera *Catathelasma* Lovejoy, *Tricholoma* (Fr.) Staude, and *Hygrophorus* Fr., which might have co-diversified with Pinaceae in the northern hemisphere during the late Cretaceous (Ryberg and Matheny 2012), and in the lineage containing *Sebacina* Tul. & C. Tul., which began to diversify during the Paleogene also with conifers (Tedersoo et al. 2014). In this study we examine *Cortinarius* sect. *Cortinarius* (Pers.) Gray, a group of ECM fungi with a known distribution on all continents, except Africa and Antarctica, and associated with a diverse array of ECM plant partners of Fagales, Salicaceae, Myrtaceae, Fabaceae and Pinaceae (Moser 1968, Brandrud 1983). *Cortinarius* sect. *Cortinarius* also contains the type species for the genus *Cortinarius*: *C. violaceus* (L: Fr.) Gray. Gasparini (2001) suggested a Gondwanan origin of the *C. violaceus* group due to the greater number of species found in this clade in the southern hemisphere compared to the northern hemisphere. However such an ancient origin is not likely in that Ryberg and Matheny (2012) calculated a more recent Miocene origin for the group ca. 12 Mya in a relaxed molecular clock analysis. Yet there is a prevailing thought that long-distance dispersal is limited among ECM fungi because soil and climate conditions present barriers to establishment over long distances and because a suitable host may not be found in the new location (Garnica et al. 2009, Peay et al. 2012). Thus we test the hypothesis that species in *Cortinarius* sect. *Cortinarius* are limited by biogeographic barriers and/or plant associates. If correct, then we would expect to see more clades in the group, each clade corresponding to a different geography and/or plant associate.

Figure 1: *Cortinarius violaceus* auct. mult. in Mount Baker-Snoqualmie National Forest, Washington, USA. Bar = 1 cm. Photo by Noah Siegel**.**

Species in sect. *Cortinarius* are characterized by a unique suite of biochemical and morphological features. The dark violet or dark purple fruit body reported for *C. violaceus* is due to a vacuolar and encrusting pigment identified as (R)-39,49-dihydroxybphenylalanine [(R)-β[beta]-dopa] (Gill 2001) (Figure 1). In addition most species in the section share the presence of cheilocystidia and pleurocystidia and a trichodermial pileipellis (Moser 1983). All members have a color change reaction to KOH to red in all parts of the fruit body tissues.
Cortinarius violaceus is regarded as a widely distributed species, occurring in Europe, eastern Asia, southeastern Asia (Malaysia), North America, Central America, South America (Colombia), Papua New Guinea, Australia and New Zealand (Moser 1968, 1986; Bougher and Syme 1998; Watling and Lee 1999; Ridley 2006). Moser (1967, 1976) regarded *C. violaceus* and *C. hercynicus* (Pers.) M.M. Moser as two distinct species, while Brandrud (1983) treated *C. hercynicus* as a variant of *C. violaceus* and then as a subspecies (Brandrud et al. 1990), the former having ellipsoid-subglobose basidiospores and associating with coniferous trees, the latter having amygdaliform-ellipsoid basidiospores and associating with broadleaf trees.

Six additional species in sect. *Cortinarius* have been described from the Neotropics and/or southern hemisphere. *Cortinarius kerrii* Singer & I.J.A. Aguiar was described from the state of Amazonas in Brazil in campinarana-like vegetation (Singer et al. 1983). *Cortinarius subcalyptrosporus* M.M. Moser, *C. paraviolaceus* M.M. Moser and *C. atroviolaceus* M.M. Moser were described from Sabah, Malaysia (Moser 1986). *Cortinarius subcalyptrosporus* is characterized by the presence of a perisporium, a loosening of the outer spore wall (Moser 1986). *Cortinarius atrolazulinus* M.M. Moser was described from New Zealand (Moser1986). In addition to having been found in Sabah, Malaysia, *C. atroviolaceus* and *C. atrolazulinus* also have been reported in New Zealand with *Nothofagus* (Moser 1986).

Cortinarius gayi E. Horak was not placed within a section in the genus *Cortinarius*, but it has the same violet coloration and KOH reaction as other members of sect. *Cortinarius* according to Horak (1980a). It was described from *Nothofagus* forest in Argentina (Horak 1980a). Additional species have been placed within sect. *Cortinarius* solely due to their violet coloration by their respective authors. Moser (1986) cast some doubt about whether *C. paraviolaceus* belongs in sect. *Cortinarius* due to the absence or rarity of cheilocystidia and pleurocystidia. *Cortinarius austroviolaceus* Gasparini was described from Tasmania by Gasparini (2001), who suggested an alliance with species of sect. *Cortinarius*. An RFLP analysis by Chambers et al. (1999) indicated that an Australian collection of *C. violaceus* was not conspecific with the northern hemisphere *C. violaceus*, but no follow-up studies have occurred. In total, eight species have been ascribed to sect. *Cortinarius* worldwide.

Here we document global genetic and taxonomic diversity of *Cortinarius* sect. *Cortinarius* guided by multigene phylogenetic analyses based on three nuclear gene regions: nuc rDNA ITS1-5.8S-ITS2 (ITS), the D1-D2 domains of the 28S region and the second largest subunit of the RNA polymerase II gene (*RPB2*). In addition we reconstruct historical ranges and test the hypothesis that sect. *Cortinarius* has an Australasian origin because the majority of the extant species reside in this region. If so, an ancestral host association might be predicted with the southern hemisphere *Nothofagus* (southern beech) because this genus has been a dominant ECM partner at southern latitudes since its origin in the late Cretaceous (Malloch et al. 1980, Hill 1992, Bougher et al. 1994). An ancestral association with Myrtaceae is a possibility if the group originated some time after the Cretaceous.

Materials and Methods

Taxon sampling, DNA extraction, amplification and sequencing

Collections sequenced in this study are summarized (Table 2 in Appendix). *Cortinarius kerrii* and *C. gayi*, both described from South America and southeastern Asian collections of *C. atroviolaceus*, *C. subcalyptrosporus* and *C. paraviolaceus*, were not included in this study because requests for loans of the types were declined. However we were able to obtain collections identified as the Malaysian species (with the exception of *C. paraviolaceus*) from New Zealand. Multiple collections of an undescribed species from Guyana, in the Guiana Shield region of northeastern South America, also were obtained.

DNA extraction, PCR and sequencing protocols follow Matheny et al. (2010). We used an E.Z.N.A high performance (HP) fungal DNA extraction kit (Omega Bio-Tekfor, Norcross, Georgia) for specimens older than 20 y. Primers ITS1F/ITS4 (White et al. 1990) were used to amplify the ITS region, including the 5.8S rDNA region, except when DNA quality was poor, in which case primer pairs ITS1F/ ITS2 and 5.8SR/ITS4 (White et al. 1990) were used. LR0R/ LR5 (White et al. 1990) was used to amplify the 28S rDNA (28S) region. Primers b6F/b7.1R were used initially to amplify the most variable region of *RPB2* (Liu et al. 1999, Matheny 2005). The *C. violaceus* specific *RPB2* PCR primers CviolF (59–GAA TCC CTG GAA GAR CAC TCC–39) and CviolR (59–CTT ACT TGG TTR TGG TCK GG–39) were designed and used to obtain additional *RPB2* sequences.

Alignment and phylogenetic analyses

Alignments were produced in MAFFT 7.110 using the e-INS-i algorithm (Katoh and Standley 2013) and optimized manually. All nucleotide positions were used for phylogenetic analysis. ITS, 28S and *RPB2* alignments were concatenated after individual alignment and inspection for intergenic conflict following Baroni and Matheny (2011). Two datasets were assembled. One, a supermatrix of 100 ITS, 24 28S and 29 *RPB2* sequences, was generated to assess overall genetic diversity within sect. *Cortinarius* worldwide. This dataset comprises sequences from 100 taxa. *Cortinarius vitiosus* (M. M. Moser) Niskanen, Kyto¨v., Liimat. & S. Laine (JN114094–JN114096), *C. walpolensis* A.A. Francis & Bougher (DQ328131), *C.* cf. *submeleagris* (AY669638), *Cortinarius* sp. (sect. *Dermocybe*) (HQ604652), and uncultured *Cortinarius* sequences (JX316449/JX316363) were used as outgroups based on nearest BLAST hits to *C. austroviolaceus* and Holarctic *C. violaceus* ITS sequences. We created a second dataset to generate a time-calibrated tree to map historical geographic ranges and reconstruct ancestral plant host associations. This dataset consisted of the eight taxa in the *C. violaceus* group and *C. vitiosus* and *C. austroviolaceus* as outgroups based on prior phylogenetic analyses. Alignments are available in TreeBASE under accession number S16049 (http://purl.org/phylo/treebase/ phylows/study/TB2:S16049).

PartitionFinder 1.10 (Lanfear et al. 2012) was used to determine gene partitions and models for the 100 species dataset under the Bayesian information criterion (BIC). The alignment was partitioned into three segments: (ITS)(28S,*RPB2* sites 1+2)(*RPB2* site3). The HKY+G, HKY+I and K80+G models were used in MrBayes 3.2 (Ronquist et al. 2012) for the three partitions respectively. Four chains were run 20 000 000 generations using two independent runs sampling trees from the posterior distribution every 5000 generations. When calculating posterior probabilities, the first 1000 trees were burned from each run. RAxML 7.2.8 (Stamatakis 2006) was used to reconstruct a maximum likelihood (ML) tree with 1000 bootstrap replicates under a GTRGAMMAI model. Mesquite 2.75 (Maddison and Maddison 2011) was used to generate pairwise distance matrices for the ITS, 28S and *RPB2* gene sequences respectively using the Kimura 2-parameter model, which can account for superimposed substitutions (Felsentein 2004).

Relaxed molecular clock analysis

An ultrametric tree was created in BEAST 1.8.0 (Drummond et al. 2012) using an uncorrelated lognormal clock. The alignment was partitioned into ITS, 28S and *RPB2*, each with their own HKY + G substitution models. The tree was calibrated at the node encompassing sect. *Cortinarius*, which is dated at 12.1 6 1.0 MYA following Ryberg and Matheny (2012). A uniform distribution was used as a prior for the uncorrelated lognormal clock. BEAST ran with a chain length of 10 000 000 generations, saving a tree every 1000 generations. This was repeated four times. Tracer 1.5 (Rambaut and Drummond 2009) was used to determine that sufficient ESS values (. 200) were obtained. The burn-in value was determined to be sufficient by examining the ln L trace plot. These four runs were combined in LogCombiner 1.8.0 (Drummond et al. 2012) with a final burn-in of 10 000 trees. Mesquite 2.75 (Maddison and Maddison 2011) was used to reconstruct ancestral plant host associations using the default maximum likelihood algorithm. BioGeoBEARS (Matzke 2012, 2014) was used to reconstruct ancestral geographic ranges under a dispersal extinction cladogenesis + jumping (DEC+J) model.

Haplotype analysis

The SNAP Workbench (Price and Carbone 2005, Aylor et al. 2006) was used to determine the number of ITS haplotypes present in *C. violaceus* auct. mult.

Results

Taxonomic and genetic diversity within sect. Cortinarius

Eight species-level lineages, together forming a monophyletic group, were identified from Australia, New Zealand, Guyana, Costa Rica, Colombia southeastern USA and the holarctic. These lineages were recognized as *C. violaceus* auct. mult., *Cortinarius* sp. CR1, *Cortinarius* sp. CR2, *Cortinarius* sp. NA1, *Cortinarius* sp. SA1, *C. violaceus* sensu Moser 1986, *Cortinarius* sp. AU1, and *Cortinarius* sp. AU2 (Figure 2). Intraspecific variation was 1.0% or less across all loci examined (Table 3 in Appendix). Interspecific variation was 2.0% or greater at the ITS locus (Table 4 in Appendix). *Cortinarius austroviolaceus* was placed with the outgroup taxa outside sect. *Cortinarius*. This placement is consistent with the fact that *C. austroviolaceus* lacks pleurocystidia while members of sect. *Cortinarius* possess them. Attempts to sequence the type specimen of *C. atrolazulinus* (ZT69-276) were unsuccessful.

Figure 2: Maximum likelihood (ML) phylogenetic tree of the combined nuclear ITS, 28S and *RPB2* sequences. ML Bootstrap support more than 50% is above nodes and Bayesian posterior probabilities above 0.90 indicated below nodes. Specific epithets are those designated on original collections. Following the specific epithet are collection number, GenBank accession number or UNITE number followed by the country (or state) in which the specimen was found. Forest type is indicated for *Cortinarius violaceus* auct. mult. where known.

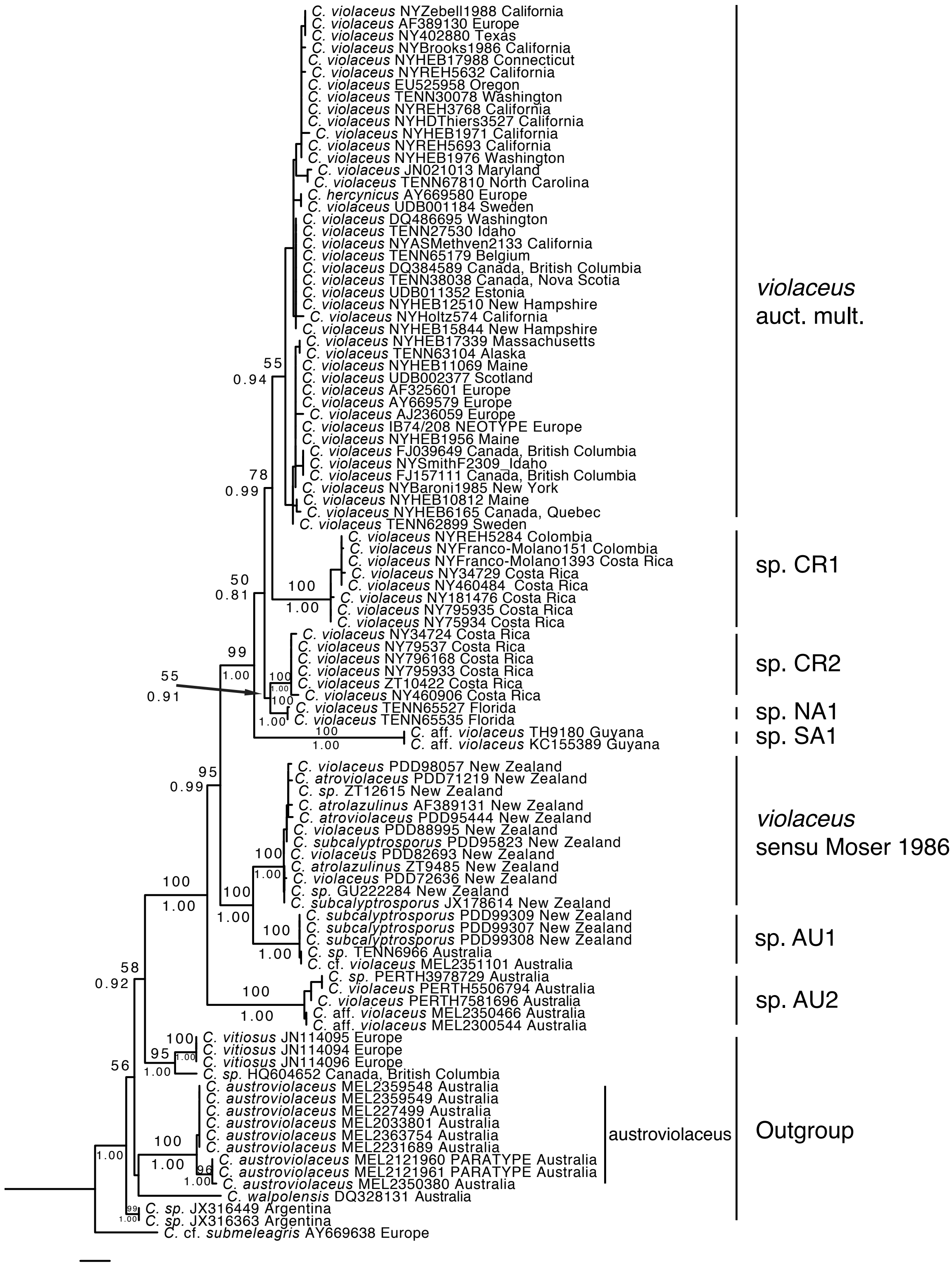

Figure 2 (continued)

Cortinarius violaceus auct. mult. was the most widely distributed species in our dataset, occurring in eastern and western North America and Europe. However the name has historically been broadly applied to what are now known to be different phylogenetic lineages (Bougher and Syme 1998, Halling and Mueller 2005). Minor intraspecific variation was detected within *C. violaceus* auct. mult., but most internal subgroups exhibited little genetic distance and poor branch support (Figure 2). In addition at least two haplotypes appear to be common and widespread, occurring both in North America and Europe (TABLE I). No support was found for genetic differences between individuals associated with coniferous hosts versus those with hardwoods (Figure 2). Within the Americas however four lineages (CR1, CR2, SA1, NA1) were detected that, based on current sampling effort, have been found either in Costa Rica and Colombia, Costa Rica, Guyana or Florida respectively. The name *C. violaceus* has been applied to some of these taxa (e.g. Halling and Mueller 2004), but these lineages represent undescribed species. Morphological data also support their separation. These new taxa will be presented in a forthcoming paper. The two sympatric species in Costa Rica (CR1 & CR2) differed in the size and shape of their basidiospores as well as the presence or absence of caulocystidia. The Guyana species (SA1) had a large stipe length to cap width ratio. The species found in Florida (NA1) did not have caulocystidia in contrast to *C. violaceus* auct. mult., which has abundant caulocystidia.

Table 1: Number, geography, and DNA sequences of ITS haplotypes in *C. violaceus* auct. mult.

Haplotype	# of sequences	Geography	Sequence
H1	17	EU, NA	…CCTATAAACCGGTATT…
H2	3	NA	…TCTATAAACCGGTGTT…
H3	1	NA	…CGTGGAAATCGGTATT…
H4	1	NA	…CCCAGAAGCCGGAACT…
H5	8	EU, NA	…CCTGGAAATCGGTATT…
H6	2	EU	…CCTGTAAACCGGTATC…
H7	1	NA	…CCTAGAAGCCGGAACT…
H8	1	NA	…CCTATTAACCGGTATT…
H9	1	EU	…CCTATATACCGCTATT…
H10	1	NA	…CCTATAAACGAGTATT…
H11	1	NA	…CCTATAAACCAGTATT…

We wanted to test whether the pigment that makes the *C. violaceus* group purple is the same pigment that makes *C. austroviolaceus* purple. We were not able to extract the purple pigment ((R)-β[beta]-dopa) from any dried specimens due to the tendency of the pigment to oxidize quickly to brown. Future attempts to determine the source of the purple pigment in *C. austroviolaceus*, which falls outside the *C. violaceus* group, need to be based on freshly collected, undried specimens.

Collections of sect. *Cortinarius* from New Zealand and Australia sorted into three lineages: the first, *C. violaceus* sensu Moser 1986, best matches Moser's description of *C. violaceus* specimens collected from Sabah, Malaysia, and Papua New Guinea and include the presence of pileocystidia and pale context consistent with Moser's concept (Moser 1986). This species however will require a new name because it obviously is not *C. violaceus* based on our phylogenetic results (Figure 2). The second, *Cortinarius* sp. AU1, is trans-Tasman in distribution having been recorded with the myrtaceous plant genera *Leptospermum* in New Zealand and *Eucalyptus* in southern Australia. This species is remarkably similar to *C. atroviolaceus* originally described from Borneo at high elevation (Moser 1986) but with unknown plant associates. Candidate plant associates from Borneo include members of the Ericaceae, Fagaceae and Myrtaceae based on possible ECM plant groups that occur at this elevation (Beaman et al. 2000, Beaman and Anderson 2004). *Cortinarius atroviolaceus* (from Malaysia with unknown plant associates) and *Cortinarius* sp. AU1 (from Australia and New Zealand with Myrtaceae) are likely ecologically differentiated, hence we treat them as different species. The third, *Cortinarius* sp. AU2, is unique among the *C. violaceus* group in that it has a smooth pileus instead of a squamulose surface that all other members of the group possess. *Cortinarius* sp. AU2 was interpreted as *C. violaceus* by Bougher and Syme (1998). None of the Australasian collections examined here have calyptrate spores indicative of *C. subcalyptrosporus* originally described from Malaysia. Thus we doubt that *C. subcalyptrosporus* is actually present in Australia and New Zealand based on collections examined to date.

We examined a collection (KEP S-S 1419) that was reported as *Cortinarius* cf. *violaceus* found in lowland dipterocarp forest in Semangkok Forest Reserve, Selangor, Malaysia (Watling and Lee 1999). Our examination of this specimen shows an absence of pleurocystidia and cheilocystidia and tissues fail to turn red in KOH. Thus the collection lacks the key diagnostic features of sect. *Cortinarius*. A BLAST query using the ITS region places it 93% similar to the New Zealand species *C. chalybeus* Soop, which belongs to *Cortinarius* section *Purpurascentes* (Soop 2008).

Phylogeographic analyses

Cortinarius sect. *Cortinarius* appears to have initially diversified ca. 14–10 Mya with a mean crown group origin at ca. 12 Mya (Figure 3). Ancestral area analysis (Figure 4) suggested the lineage diversified initially in Australasia in association with an angiosperm host(s), but an ancestral family designation is ambiguous. Fagaceae, Fabaceae, Myrtaceae/ Casuarinaceae and Nothofagaceae are equally probable hosts.

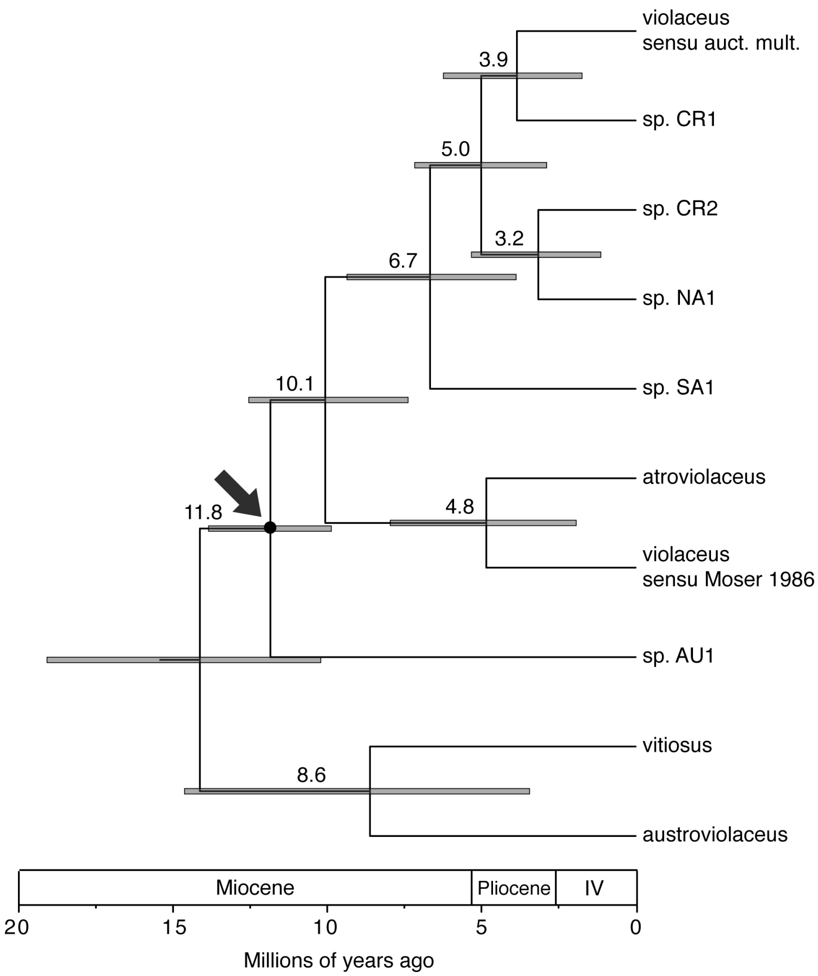

Figure 3: Chronogram obtained with the uncorrelated log normal relaxed-clock method (implemented in BEAST) with an age constraint (12.1 ± 1.0 mya) at the node indicated by the arrow. Numbers correspond to mean age estimates (in million years), and gray bars represent 95% credibility intervals.

Thus these data do not strongly support or reject an ancestral association with Nothofagaceae as proposed by Moser (1986). The split between Australasian and Euro-American groupings is estimated between 13–7 Mya (mean 10 Mya) and favors a long-distance dispersal into the Neotropics perhaps in association with a fagaceous host (*P* = 0.52), but this has a relatively low probability.

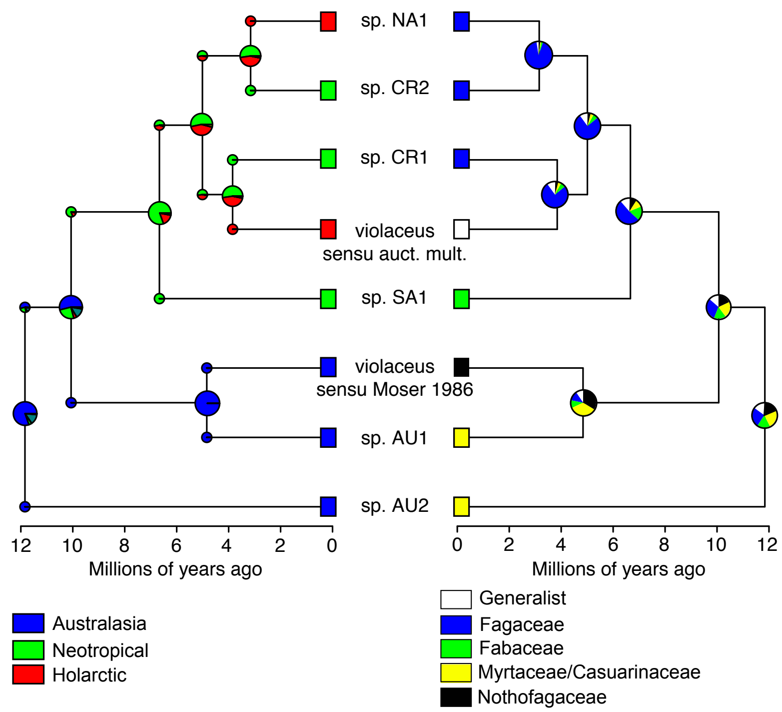

Figure 4: Reconstruction of historical ranges produced in BioGeoBEARS is represented on the left. Occurrence in two (or more) locations is represented as a mixture of two or more colors. Ancestral state reconstruction of host association, using maximum likelihood, as implemented in Mesquite, is on the right.

Cortinarius sp. SA1 and its host (*Dicymbe*) are restricted to the Guiana Shield. This species is sister to a clade containing species currently present in Central America, North America and Europe (*C. violaceus* auct. mult., *Cortinarius* sp. NA1, *Cortinarius* sp. CR1, *Cortinarius* sp. CR2), all of which have been recorded in association with *Quercus*. During the next 10 000 000 y, the closing of the Panamanian land bridge would have facilitated an interchange of species between North and South America. The intercontinental *C. violaceus* appears recently derived from this group of American species and today features what is likely a holarctic distribution. Either sympatric or allopatric speciation ensued in Central America on the same *Quercus* host species, while two other speciation events resulted in one southeastern North American lineage (*Cortinarius* sp. NA1 remaining on *Quercus*) and *C. violaceus* auct. mult. that is found with Fagaceae, Pinaceae and Salicaceae.

To test whether a host association with *Quercus* originated in South America or Central America, we compared the dates for speciation of the *Quercus* associating lineages with the dates of fossilized *Quercus* pollen in Central and South America. The host switch to *Quercus* occurred 9.3–2.9 mya (Figures 3, 4). Quercus is detected in the Gatun Formation on the north side of the Isthmus of Panama 11.4–5.8 mya (Collins et al. 1996) before the land bridge connecting North and South America was formed. *Quercus* is not detected in South America until 330 000 y ago in Colombia (Graham 1999). The late arrival of *Quercus* in South America indicates that the arrival of Cortinarius sp. CR1 in Colombia is likely a recent range expansion. Due to the gap in the fossil record, it cannot be determined whether the association was established before or during the formation of the land bridge connecting North and South America 3.5–2.5 mya (Graham 1999).

BioGeoBEARS gave a higher log likelihood (lnL= -7.3) for the dispersal-extinction-cladogenesis (DEC) model that incorporated a parameter for founder event speciation (DEC+J) when compared to the standard DEC model (lnL= -14.9) as implemented in LAGRANGE (Ree and Smith 2008). When the likelihood of the DEC model was compared to the DEC+J model, which incorporates founder-event speciation (j-parameter), the latter was statistically better than the DEC model ($X^2 = 15.23$, df = 1, P value = 9.5×10^{-5}; AIC weight ratio 746.2:1). Indeed founder event speciation was a dominant process at play (founder-event [j] = 0.349, dispersal [d] = 1.0×10^{-12}, extinction (e) = 1.0×10^{-12}). The number and geographic distribution of ITS haplotypes in C. violaceus auct. mult. is provided (Table 1). Of 43 sequences, 11 haplotypes were found. Two haplotypes were present in both Europe and North America, seven haplotypes were detected only in North American and two different haplotypes were found exclusively in Europe.

Discussion

We have uncovered hidden and novel taxonomic and genetic diversity in *Cortinarius* sect. *Cortinarius*. From the broad areas sampled across the globe, we recovered eight species-level monophyletic groups. While we used a phylogenetic species concept (Taylor et al. 2000), interspecific variation was 2% or more in the ITS region, which is in agreement with other studies that found a 2.0% dissimilarity threshold value optimal to delimit *Cortinarius* species (Stefani et al. 2014). Intraspecific variation was 1% or less. These include putative new species from Costa Rica (two), Guyana (one), Australia (two), New Zealand (two) and another from the Gulf Coast of Florida (Figure 2). *Cortinarius austroviolaceus*, as the specific epithet suggests, originally was thought to share an alliance with sect. *Cortinarius* based on the shared violaceous basidioma colors (Gasparini 2001), but this species lies outside the sectional clade as identified here and also lacks the diagnostic pleurocystidia present in other members of the group. Due to limits of taxon sampling, we are unable to suggest into which *Cortinarius* section or subclade *C. austroviolaceus* should be placed. BLASTN results suggested that *C. austroviolaceus* is related to the secotioid *C. walpolensis* from Australia or a cortinarioid fungus known only as an Argentinian environmental sequence.

In light of the results reported here, the circumscription of *Cortinarius* sect. *Cortinarius* will require emendation. Moser (1983) defined *Cortinarius* sect. *Cortinarius* in part as having a trichodermial pileipellis. However *Cortinarius* sp. AU2 was found to belong to the *C. violaceus* group but possesses a repent cutis. Thus the section should be defined more restrictively by the combination of the universal deep violet coloration and the presence of both cheilocystidia and pleurocystidia with a typical presence of a trichodermial pileipellis.

Cortinarius violaceus auct. mult. is found across North America and Europe with a wide variety of potential ECM host plant genera in the families Pinaceae, Fagaceae, Betulaceae and Salicaceae. While sampling of European *C. violaceus* auct. mult. was limited in this study, we detected no significant genetic difference at the species level between what would be named *C. violaceus* and *C. hercynicus* based on host association. Additional sampling of specimens identified as *C. hercynicus* are necessary to confirm the preliminary results here and the suggestion of Brandrud (1983) that *C. hercynicus* be treated as a variety of *C. violaceus.*

We found one taxon*, C. violaceus* sensu Moser 1986, that best matches the species description for *C. violaceus* described from Malaysia and Papua New Guinea by Moser (1986). It differs from *C. atroviolaceus* and *C. atrolazulinus* by the size and shape of its spores. Moser (1986) documented this taxon as having characteristically smaller basidiomata and possessing pileocystidia, which distinguish it from *C. violaceus* auct. mult. All collections examined by us belonging to *C. violaceus* sensu Moser 1986 occur in New Zealand with *Nothofagus*. Because *C. violaceus* sensu Moser 1986 is not conspecific with *C. violaceus* auct. mult., it requires formal description. Our phylogenetic analyses indicate that the *C. violaceus* group has its origins in Australasia. Three species-level lineages were recovered from this region. *Cortinarius* sp. AU1 is found with *Eucalyptus* and *Allocasuarina* in eastern Australia and with *Leptospermum* in New Zealand. *Cortinarius* sp. AU2 occurs in Western Australia and Tasmania with *Eucalyptus* and *Allocasuarina* in sclerophyll forest. *Cortinarius violaceus* sensu Moser 1986 occurs in New Zealand with *Nothofagus* as mentioned above. However our sampling of the global molecular diversity of the *C. violaceus* group is incomplete. Species are known to occur in Papua New Guinea and southeastern Asia (Malaysia). Additional species in the *C. violaceus* group could be discovered in undersampled locations such as the *Nothofagus* forests of southern South America and the caesalpionioid forests of Africa. Long-distance dispersal and founder event speciation appear to have featured prominently in the historical biogeography of the *C. violaceus* group, which was estimated to have initially diversified during the Miocene (Ryberg and Matheny 2012). Within the clade, three Australasian lineages form a paraphyletic group from which the five Euro-American lineages are derived. By the Miocene, all of the continents were more or less at their present location. Thus, long-distance dispersal is the most likely means by which the species reached the Americas from Australasia, as well as to New Zealand. Counter to previous thinking, long-distance dispersal of ECM fungi may be a relatively frequent phenomenon. Similar to the data presented here, Geml et al. (2012) found that multiple ECM species (including *Cortinarius* spp.) colonized the remote Svalbard Archipelago via long-distance dispersal as recently as 10 000 y ago post glaciation. The nearest land is more than 400 km away.

Masana et al. (2015) modified the Dispersal Extinction Cladogenesis model (DEC*). This modified model performs better than the DEC model and often the DEC+J model (Masana et al. 2015). However, we did not have enough time to test this model on our dataset.

Founder event speciation was an important parameter included in our biogeographic analyses. Founder effect speciation describes a process whereby a small subset of a larger population undergoes a rare dispersal that results in instant genetic isolation (Templeton 2008). This process has been discussed extensively in island biogeography studies and is applicable to our dataset, in that continents may act as islands separating populations by oceanic barriers. Founder effect speciation explains the origin of species of the *C. violaceus* group in South America, Central America and

North America, their ancestors having arrived from Australasia. However migration from Australasia into southeastern Asia and then into the holarctic is a pattern we cannot reject.

Cortinarius sp. SA1 appears to have arrived in the Neotropics 13–7 Mya via long-distance dispersal from Australasia or southeastern Asia, possibly via trade winds and suggests a host shift to Fabaceae. We expect *C. kerrii* from the northern Brazilian Amazon to be closely related to *Cortinarius* sp. SA1 due to their co-occurrence in the greater Guiana Shield region in association with fabaceous hosts. It is possible that the direct ancestor of *Cortinarius* sp. SA1 arrived in Central America and became established with *Quercus* before arriving in Guyana. Regardless, whether *Cortinarius* sp. SA1 arrived in Guyana directly from Australasia or from Central America, it would have had to arrive there via long-distance dispersal because none of the host ranges would have overlapped with that of the Guiana Shield endemic *Dicymbe*.

Our analyses are ambiguous about the phylogeographic origins of the Costa Rican species. It is not clear whether they evolved from holarctic or from Neotropical ancestors. Members of the Boletaceae appear to have originated within North America and migrated south with their plant associates (*Quercus*) as the range of these plants expanded into South America (Halling 1996, Halling et al. 2008, Kennedy et al. 2011). Evidence supporting this hypothesis comes from the observation that species found in Costa Rica and Mexico are morphologically more similar to, and in many cases considered conspecific with, North American species, relative to those of lowland tropical and temperate South America (Mueller and Halling 1995, Halling and Mueller 2002, Montoya et al. 2010). However few phylogenetic studies involving ECM fungi, with complete sampling throughout the Americas, have been completed to corroborate these patterns. In this study the arrival of *Cortinarius* sp. CR1 in Colombia seems to agree with this pattern of southward migration with Quercus. Diversification occurred in the *C. violaceus* group in the Americas during the great American interchange, and it appears that dispersal could have occurred either northward or southward.

Within the genus *Cortinarius* a substantial number of species and clades are shared on different continents in the northern hemisphere (Peintner et al. 2004, Garnica et al. 2009, Harrower et al. 2011). No southern hemisphere species occur naturally in the northern hemisphere. Few clades of *Cortinarius* include both northern and southern hemisphere endemics (Stefani et al. 2014). Representatives of southern hemisphere clades include the Splendidi, known only from Australia, and an unnamed clade known from Australia and South America (Stephani et al. 2014). However multiple dispersals across independent lineages between the northern and southern hemispheres have likely taken place during diversification of *Cortinarius*. Few studies of phylogeography among *Cortinarius* have been completed. Garnica et al. (2011) examined four species complexes in section *Calochroi* that have disjunct distributions between North America and Europe. One species complex, the *C. arcuatorum* group, was interpreted as having a widely distributed ancestral population that diverged into distinctive sympatric populations in North America, including one species in Costa Rica (*C. jardinensis* Garnica, Ammirati & Halling). The authors focused on allopatric populations between Europe and North America and favored the hypothesis that species migrated into Europe by land via the Beringian land bridge (BLB). However long-distance dispersal could not be ruled out.

Cortinarius violaceus auct mult. is the only species in the *C. violaceus* group that could have migrated across the BLB because it is the only species in the group that is known to currently occur in Europe (if we assume no extinction has occurred). We do detect some population substructure within *C. violaceus* auct mult., but its full elucidation is currently limited by the low taxon sampling of Asian and European taxa. A microsatellite analysis might be a better approach for answering questions about the population genetic history in this species. Among the 43 *C. violaceus* auct. mult. ITS sequences analyzed here, we observe some identical sequences shared between North American and European samples, but nine haplotypes are seemingly rare and more geographically restricted. Nevertheless we suspect that frequent long-distance dispersal or migration (gene flow) between Europe and North America is responsible for the low genetic diversity observed in this lineage.

The ancestral plant host of the *C. violaceus* group was most likely an angiosperm associate (Figure 4). Indeed *C. violaceus* auct. mult. was the only species to occur with three or more angiosperm hosts and the only species to occur with Pinaceae. This ability to associate with a wide range of hosts in this species may have contributed to its ability to expand its distribution throughout North America and Europe and likely into Asia.

In some cases sister species can be differentiated based on plant associations and in other cases, on ecology. Based on present data, species of the *C. violaceus* group in New Zealand appear to occupy different niches with either *Leptospermum* or *Nothofagus*. However some species of agarics, like some *Inocybe* spp., may associate with either plant partner in New Zealand (Horak 1979, 1980b). In Australia species occupy different niches depending on the environmental characteristics (e.g. sclerophyll or rainforest). *Cortinarius* sp. SA1 from South America however is unique in that it apparently associates with *Dicymbe* and possibly other ECM plant genera such as *Aldina* and *Pakaraimaea*. This association may contribute to the restriction of *Cortinarius* sp. SA1 to the Guiana Shield. In Costa Rica two different species are sympatric and associate with the same *Quercus* host species. They may have speciated during or after the formation of the Talamanca Mountains 5.5–3.5 Mya (Gräfe et al. 2002). Costa Rica was an archipelago before the formation of the mountains (Coates and Obando 1996). Thus these two Costa Rican lineages could have arisen through allopatric speciation from isolation on two sides of a mountain range or from origination elsewhere with re-colonization of Costa Rica at a later date.

References

Aylor DL, Price EW, Carbone I. 2006. SNAP: combine and map modules for multilocus population genetic analysis. Bioinformatics 22:1399–1401.

Bakker HC den, Zuccarello GC, Kuyper TW, Noordeloos ME. 2007. Phylogeographic patterns in *Leccinum* sect. *Scabra* and the status of the arctic-alpine species *L. rotundifoliae*. Mycol Res 111:663–672.

Baroni TJ, Matheny PB. 2011. A re-evaluation of gasteroid and cyphelloid species of Entolomataceae from eastern North America. Harvard Pap Bot 16:293–310.

Beaman JH, Anderson CE. 2004. The Plants of Mt. Kinabalu 5. Dicotyledon families: Magnoliaceae to Winteraceae. Sabah: Natural History Publications (Borneo).

———, Anderson CE, Beaman RS. 2000. The Plants of Mount Kinabalu 4. Dicotyledon families Acanthaceae to Lythraceae. Sabah: Natural History Publications (Borneo).

Bonito G, Smith ME, Nowak M, Healy RA, Guevara G, Cazares E, Kinoshita A, Nouhra ER, Domı´nguez LS, Tedersoo L, Murat C, Wang Y, Moreno BA, Pfister DH, Nara K, Zambonelli A, Trappe JM, Vilgalys R. 2013. Historical biogeography and diversification of truffles in the Tuberaceae and their newly identified southern hemisphere sister lineage. PLoS One 8:e52765.

Bougher NL, Fuhrer BA, Horak E. 1994. Taxonomy and biogeography of Australian *Rozites* species mycrorrhizal with *Nothofagus* and Myrtaceae. Aust Syst Bot 7:353– 375.

———, Syme K. 1998. Fungi of southern Australia. Nedlands: Univ. Western Australia Press.

Brandrud TE. 1983. *Cortinarius* subgen. *Cortinarius* (Agaricales) in the Nordic countries, taxonomy, ecology and chorology. Nord J Bot 3:577–592.

———, Lindstro¨m H, Marklund H, Melot J, Muskos S. 1990. *Cortinarius*: Flora photographica., Matfors: *Cortinarius* HB.

Chambers S, Sawyer N, Cairney J. 1999. Molecular identification of co-occurring *Cortinarius* and *Dermocybe* species from southeastern Australian sclerophyll forests. Mycorrhiza 9:85–90.

Chapela IH, Garbelotto M. 2004. Phylogeography and evolution in matsutake and close allies inferred by analyses of ITS sequences and AFLPs. Mycologia 96: 730–41.

Coates AG, Obando JA. 1996. The geologic evolution of the Central American isthmus. In: Jackson JBC, Budd AF, Coates AG, eds. Evolution and environment in tropical America. Chicago: Univ. Chicago Press., 21–56.

Collins LS, Coates AG, Berggren WA, Aubry M-P, Zhang J. 1996. The late Miocene Panama isthmian strait. Geology 24:687–690.

Dentinger BTM, Ammirati JF, Both EE, Desjardin DE, Halling RE, Henkel TW, Moreau P-A, Nagasawa E, Soytong K, Taylor AF, Watling R, Moncalvo J-M, McLaughlin DJ. 2010. Molecular phylogenetics of porcini mushrooms (*Boletus* section *Boletus*). Mol Phylogenet Evol 57:1276–1292.

Drummond AJ, Suchard MA, Xie D, Rambaut A. 2012. Bayesian phylogenetics with BEAUti and the BEAST 1.7. Mol Biol Evol 29:1969–1973.

Felsenstein J. 2004. Inferring phylogenies., Sunderland: Massachusetts: Sinauer Associates Inc. Garnica S, Weiss M, Oertel B, Ammirati JF, Oberwinkler F. 2009. Phylogenetic relationships in *Cortinarius*, section *Calochroi*, inferred from nuclear DNA sequences. BMC Evol Biol 9:1.

———, Spahn P, Oertel B, Ammirati J, Oberwinkler F. 2011. Tracking the evolutionary history of *Cortinarius* species in section *Calochroi*, with transoceanic disjunct distributions. BMC Evol Biol 11:213.

Gasparini B. 2001. A contribution to the knowledge of *Cortinarius* and allied genera of southern Tasmania, Australia. Australas Mycol 20:49–54.

Geml J, Timling I, Robinson CH, Lennon N, Nusbaum HC, Brochmann C, Noordeloos ME, Taylor DL. 2012. An arctic community of symbiotic fungi assembled by long-distance dispersers: phylogenetic diversity of ectomycorrhizal basidiomycetes in Svalbard based on soil and sporocarp DNA. J Biogeogr 39:74–88.

———, Tulloss RE, Laursen GA, Sazanova NA, Taylor DL. 2008. Evidence for strong inter- and intracontinental phylogeographic structure in *Amanita muscaria*, a wind-dispersed ectomycorrhizal basidiomycete. Mol Phylogenet Evol 48:694–701.

Gill M. 2001. The biosynthesis of pigments in basidiomycetes. Aust J Chem 54:721–734.

Gräfe K, Frisch W, Villa IM, Meschede M. 2002. Geodynamic evolution of southern Costa Rica related to low-angle subduction of the Cocos Ridge: constraints from thermochronology. Tectonophysics 348:187–204.

Graham A. 1999. The Tertiary history of the northern temperate element in the northern Latin American biota. Am J Bot 86:32–38.

Halling RE. 1996. Boletaceae (Agaricales): Latitudinal biodiversity and biological interactions in Costa Rica and Columbia. Rev Biol Trop 44:111–114.

———, Mueller GM. 2002. Agarics and boletes of Neotropical oak woods. In: Watling R, Frankland JC, Ainsworth AM, Issac S, Robinson CH, eds. Tropical mycology. New York: CAB International. p 1–10.

———. 2004. Common mushrooms of the Talamanca mountains. New York: The New York Botanical Garden.

———, Osmundson TW, Neves M-A. 2008. Pacific boletes: implications for biogeographic relationships. Mycol Res 112:437–447.

Harrower E, Ammirati J, Cappuccino A, Ceska O, Kranabetter J, Kroeger P, Lim S, Taylor T, Berbee M L. 2011. *Cortinarius* species diversity in British Columbia and molecular phylogenetic comparison with European specimen sequences. Botany 89:799–810.

Hibbett DS. 2001. Shiitake mushrooms and molecular clocks: historical biogeography of *Lentinula*. J Biogeogr 28:231–241.

Hill RS. 1992. *Nothofagus*: evolution from a southern perspective. Trends Ecol Evol 7:190–194.
Horak E. 1979. *Astrosporina* (Agaricales) in Indomalaya and Australasia. Persoonia 10:157–205.
———. 1980a. Fungi Basidiomycetes. Agaricales y Gasteromycetes Secotioides. Flora Cryptogámica Tierra del Fuego 11:1–528.
———. 1980b. *Inocybe* (Agaricales) in Indomalaya and Australasia. Persoonia 11:1–37.
Hosaka K, Castellano MA, Spatafora JW. 2008. Biogeography of Hysterangiales (Phallomycetidae, Basidiomycota). Mycol Res 112:448–462.
Katoh K, Standley DM. 2013. MAFFT multiple sequence alignment software 7: improvements in performance and usability. Mol Biol Evol 30:772–780.
Kennedy P, Garibay-Orijel R, Higgins L, Angeles-Arguiz R. 2011. Ectomycorrhizal fungi in Mexican *Alnus* forests support the host co-migration hypothesis and continental-scale patterns in phylogeography. Mycorrhiza 21:559–568.
Lanfear R, Calcott B, Ho SYW, Guindon S. 2012. Partition-Finder: combined selection of partitioning schemes and substitution models for phylogenetic analyses. Mol Biol Evol 29:1695–1701.
Liu YJ, Whelen S, Hall BD. 1999. Phylogenetic relationships among ascomycetes: evidence from an RNA polymerase II subunit. Mol Biol Evol 16:1799–1808.
Lumbsch TH, Buchanan PK, May TW, Mueller GM. 2008. Phylogeography and biogeography of fungi. Mycol Res 112:423–424.
Maddison WP, Maddison DR. 2011. Mesquite: a modular system for evolutionary analysis 2.75, http://mesquiteproject.org
Malloch DW, Pirozynski KA, Raven PH. 1980. Ecological and evolutionary significance of mycorrhizal symbioses in vascular plants (a review). Proc Natl Acad Sci 77: 2113–2118.
Matheny PB. 2005. Improving phylogenetic inference of mushrooms with RPB1 and *RPB2* nucleotide sequences (*Inocybe*; Agaricales). Mol Phylogenet Evol 35:1–20.
———, Aime MC, Bougher NL, Buyck B, Desjardin DE, Horak E, Kropp BR, Lodge DJ, Soytong K, Trappe JM, Hibbett DS. 2009. Out of the Palaeotropics? Historical biogeography and diversification of the cosmopolitan ectomycorrhizal mushroom family Inocybaceae. J Biogeogr 36:577–592.
Matheny PB, Austin EA, Birkebak JM, Wolfenbarger AD. 2010. *Craterellus fallax*, a black trumpet mushroom from eastern North America with a broad host range. Mycorrhiza 20:569–575.
Matzke NJ. 2012. Founder-event speciation in BioGeo-BEARS package dramatically improves likelihoods and alters parameter inference in dispersal-extinction cladogenesis (DEC) analyses. Front Biogeogr 4(suppl. 1):210.
———. 2014. Model selection in historical biogeography reveals that founder-event speciation is a crucial process in island clades. Syst Biol 63:951–970.
Moncalvo J-M, Buchanan PK. 2008. Molecular evidence for long distance

dispersal across the southern hemisphere in the *Ganoderma applanatum-australe* species complex (Basidiomycota). Mycol Res 112:425–436.
Montoya L, Haug I, Bandala VM. 2010. Two *Lactarius* species associated with a relict *Fagus grandifolia* var. mexicana population in a Mexican montane cloud forest. Mycologia 102:153–162.
Morgado LN, Noordeloos ME, Lamoureux Y, Geml J. 2013. Multigene phylogenetic analyses reveal species limits, phylogeographic patterns and evolutionary histories of key morphological traits in *Entoloma* (Agaricales, Basidiomycota). Persoonia 31:159–178, doi:10.3767/ 003158513X673521
Moser M. 1968. Die Verbreitung der Gattung *Cortinarius* Fr. in der Weltflora und ihre Beziehung zu bestimmten Phanerogamen. Acta Mycol 4:199–203.
———. 1967. Basidiomyceten II: Die Ro¨hrlinge und Bla¨tterpilze (Agaricales). In: Gam H, ed. Kleine Kryptogamenflora. Vol. 2 b/2. Stuttgart, Germany. p 443.
———. 1976. Fragen aus dem Leserkreis, Antwort zu Frage 29. Zeitschrift Für Pilzkd 42:210.
———. 1983. Keys to Agarics and Boleti., London: Roger Phillips.
———. 1986. *Cortinarius* Fr. subgen. *Cortinarius* in the SW Pacific area. Sydowia 39:138–147.
Mueller GM, Halling RE. 1995. Evidence for high biodiversity of Agaricales (Fungi) in Neotropical montane Quercus forests. Biodivers Conserv Neotrop Mont For 303–312.
Murata M, Kinoshita A, Nara K. 2013. Revisiting the host effect on ectomycorrhizal fungal communities: implications from host-fungal associations in relict *Pseudotsuga japonica* forests. Mycorrhiza 23:641–653.
Peay KG, Schubert MG, Nguyen NH, Bruns TD. 2012. Measuring ectomycorrhizal fungal dispersal: macroecological patterns driven by microscopic propagules. Mol Ecol 21: 4122– 4136.
Peintner U, Moncalvo J-M, Vilgalys R. 2004. Toward a better understanding of the infrageneric relationships in *Cortinarius* (Agaricales, Basidiomycota). Mycologia 96: 1042–1058.
Price EW, Carbone I. 2005. SNAP: workbench management tool for evolutionary population genetic analysis. Bioinformatics 21:402–404.
Rambaut A, Drummond AJ. 2009. Tracer 1.5, Available from http://beast.bio.ed.ac.uk/Tracer.
Ryberg M, Matheny, PB. 2012. Asynchronous origins of ectomycorrhizal clades of Agaricales. Proceedings of the Royal Society B: Biological Sciences 279: 2003-2011.
Ree RH, Smith SA. 2008. Maximum likelihood inference of geographic range evolution by dispersal, local extinction, and cladogenesis. Syst Biol 57:4–14.
Ridley G. 2006. A photographic guide to mushrooms and other fungi of New Zealand. Aukland, New Zealand: New Holland Publishers.
Rochet J, Moreau P-A, Manzi S, Gardes M. 2011. Comparative phylogenies and host specialization in the alder ectomycorrhizal fungi *Alnicola*, *Alpova* and *Lactarius* (Basidiomycota) in Europe. BMC Evol Biol 11:40.
Ronquist F, Teslenko M, van der Mark P, Ayres DL, Darling A, Ho¨hna S, Larget

B, Liu L, Suchard MA, Huelsenbeck JP. 2012. MrBayes 3.2: Efficient Bayesian phylogenetic inference and model choice across a large model space. Syst Biol 61:539–542, doi:10.1093/sysbio/sys029
Ryberg M, Matheny PB. 2011. Dealing with incomplete taxon sampling and diversification of a large clade of mushroom-forming fungi. Evolution 65:1862–1878, doi:10.1111/evo.2011.65.issue-7
———. 2012. Asynchronous origins of ectomycorrhizal clades of Agaricales. Proc R Soc B Biol Sci 279:2003– 2011, doi:10.1098/rspb.2011.2428
———, Nilsson RH, Kristiansson E, To¨pel M, Jacobsson S, Larsson E. 2008. Mining metadata from unidentified ITS sequences in GenBank: a case study in *Inocybe* (Basidiomycota). BMC Evol Biol 8:50.
Singer R, Araujo IJA, Ivory MH. 1983. The ectotrophically mycorrhizal fungi of the Neotropical lowlands, especially central Amazonia. Beihefte Nova Hedwigia 77: 1–352.
Skrede I, Engh IB, Binder M, Carlsen T, Kauserud H, Bendiksby M. 2011. Evolutionary history of Serpulaceae (Basidiomycota): molecular phylogeny, historical biogeography and evidence for a single transition of nutritional mode. BMC Evol Biol 11:230.
Soop K. 2008. Cortinarioid fungi of New Zealand. Mora: Éditions Scientrix.
Stamatakis A. 2006. RAxML-VI-HPC: maximum likelihood based phylogenetic analyses with thousands of taxa and mixed models. Bioinformatics 22: 2688–2690.
Stefani FOP, Jones RH, May TW. 2014. Concordance of seven gene genealogies compared to phenotypic data reveals multiple cryptic species in Australian dermocyboid *Cortinarius* (Agaricales). Mol Phylogenet Evol 71:249–260.
Tamm H, Põldmaa K. 2013. Diversity, host associations and phylogeography of temperate aurofusarin-producing *Hypomyces*/*Cladobotryum* including causal agents of cobweb disease of cultivated mushrooms. Fungal Biol 117:348–367.
Taylor JW, Jacobson DJ, Kroken S, Kasuga T, Geiser DM, Hibbett DS, Fisher MC. 2000. Phylogenetic species recognition and species concepts in fungi. Fungal Genet Biol 31:21–32.
Tedersoo L, Bahram M, Ryberg M, Otsing E, Kõljalg U, Abarenkov K. 2014. Global biogeography of the ectomycorrhizal/sebacina lineage (Fungi, Sebacinales) as revealed from comparative phylogenetic analyses. Mol Ecol 23:4168–4183.
Templeton AR. 2008. The reality and importance of founder speciation in evolution. Bioessays 30:470–479, doi:10.1002/(ISSN)1521-1878
Watling R, Lee SS. 1999. Some larger fungi of Semangkok Forest Reserve, Selangor. Malayan Nat J 53:315–322.
White TJ, Bruns S, Lee S, Taylor J. 1990. Amplification and direct sequencing of fungal ribosomal RNA genes for phylogenetics. In: PCR protocols: a guide to methods and applications. p 315–322.
Wilson AW, Binder M, Hibbett DS. 2012. Diversity and evolution of ectomycorrhizal host associations in the Sclerodermatineae (Boletales, Basidiomycota). New Phytol 194:1079–1095.

Zervakis GI, Moncalvo J-M, Vilgalys R. 2004. Molecular phylogeny, biogeography and speciation of the mushroom species *Pleurotus cystidiosus* and allied taxa. Microbiology 150:715–726.

Appendix

Table 2: Herbarium accession numbers, GenBank accession numbers, host association and geography of specimens used in this study.

Voucher specimen	Species	Locality	Potential hosts	GenBank accession No.		
				ITS	28S	*RPB2*
UBCF19215	*Cortinarius* sp.	Canada: BC		HQ604652	—	—
PH213-92 (TUR)	*C. vitiosus*		*Picea abies*, *Pinus sylvestris*, *Betula*	JN114094	—	—
TN04-221	*C. vitiosus*		*Picea abies*, *Pinus sylvestris*, *Betula*	JN114095	—	—
TN04-576	*C. vitiosus*		*Picea abies*, *Betula*	JN114096	—	—
PERTH6234623	*C. walpolensis*	Australia: Western Australia	*Eucalyptus marginata, Corymbia calophylla*	DQ328131	—	—
HO990411A1	*C.* cf. *submeleagris*			AY669638	—	—
MEL2350380	*C. austroviolaceus*	Australia: Tasmania	*Eucalyptus obliqua*	KJ920005	—	—
MEL2121961	*C. austroviolaceus*	Australia: Tasmania	*Eucalyptus obliqua, Leptospermum scoparium*	KJ920002	—	—
MEL2121960	*C. austroviolaceus*	Australia: Tasmania	*Eucalyptus obliqua, Leptospermum scoparium*	KJ919998	—	—
MEL2033801	*C. austroviolaceus*	Australia: Victoria	*Eucalyptus radiata*	KJ920004	—	—
MEL227499	*C. austroviolaceus*	Australia: Victoria		KJ920003	—	—
MEL2359548	*C. austroviolaceus*	Australia: Tasmania		KJ920001	—	—
MEL2359549	*C. austroviolaceus*	Australia: Tasmania		KJ920000	—	—
MEL2231689	*C. austroviolaceus*	Australia: Victoria	*Eucalyptus*	KJ919999	KJ919977	KJ920099
MEL2363754	*C. austroviolaceus*	Australia: Tasmania		KJ919997	KJ919976	—
MEL2300544	*Cortinarius* sp. AU2	Australia: Tasmania	*Eucalyptus amygdalina, Allocasuarina monilifera, Leptospermum scoparium*	KJ920010	—	—
MEL2350466	*Cortinarius sp. AU2*	Australia: Tasmania	*Eucalyptus, Allocasuarina verticillata*	KJ920007	KJ919979	KJ920098

Table 2 (continued)

Voucher specimen	Species	Locality	Potential hosts	GenBank accession No.		
PERTH7581696	*Cortinarius sp. AU2*	Australia: Western Australia	*Eucalyptus marginata, E. calophylla, Allocasaurina fraseriana*	KJ920006	KJ919978	—
PERTH5506794	*Cortinarius sp. AU2*	Australia: Western Australia	*Eucalyptus marginata, E. calophylla, Allocasaurina fraseriana*	KJ920009	—	—
PERTH3978729	*Cortinarius sp. AU2*	Australia: Western Australia	*Eucalyptus marginata, Allocasaurina fraseriana*	KJ920008	—	—
MEL2351101	*Cortinarius sp. AU1*	Australia: Tasmania	*Eucalyptus, Allocasuarina*	KJ920015	—	—
PDD99307	*Cortinarius sp. AU1*	New Zealand	*Leptospermum*	KJ920014	KJ919983	KJ920072
PDD99309	*Cortinarius sp. AU1*	New Zealand	*Leptospermum*	KJ920013	KJ919982	KJ920070
PDD99308	*Cortinarius sp. AU1*	New Zealand	*Leptospermum*	KJ920012	KJ919981	KJ920071
TENN69666	*Cortinarius sp. AU1*	Australia: New South Wales	*Eucalyptus*	KJ920011	KJ919980	KJ920073
OTA60199	*C. violaceus sensu Moser 1986*	New Zealand		JX178614	—	—
NZ8517	*C. violaceus sensu Moser 1986*	New Zealand		AF389131	—	—
PDD98057	*C. violaceus sensu Moser 1986*	New Zealand	*Nothofagus*	KJ920017	KJ919985	KJ920074

Table 2 (continued)

Voucher specimen	Species	Locality	Potential hosts	GenBank accession No.		
PDD95823	*C. violaceus sensu Moser 1986*	New Zealand	*Nothofagus solandri var. cliffortioides*	KJ920022	KJ919990	KJ920075
PDD95444	*C. violaceus sensu Moser 1986*	New Zealand	*Nothofagus solandri*	KJ920021	KJ919989	KJ920076
PDD82693	*C. violaceus sensu Moser 1986*	New Zealand	*Nothofagus*	KJ920018	KJ919986	KJ920078
PDD72636	*C. violaceus sensu Moser 1986*	New Zealand		KJ920019	KJ919987	KJ920079
PDD71219	*C. violaceus sensu Moser 1986*	New Zealand		KJ920016	KJ919984	KJ920069
ZT9485	*C. violaceus sensu Moser 1986*	New Zealand		KJ939335	—	—
TENN69831	*Cortinarius sp. SA1*	Guyana	*Dicymbe*	KC155389	—	—
TENN69830	*Cortinarius sp. SA1*	Guyana	*Dicymbe*	KJ920039	KJ919995	—
Halling5284	*Cortinarius sp. CR1*	Colombia	*Quercus humboldtii*	KJ920033	—	KJ920091
NY Franco-Molano151	*Cortinarius sp. CR1*	Colombia	*Trigobalanus*	KJ920034	—	KJ920090
NY75934	*Cortinarius sp. CR1*	Costa Rica	*Quercus costaricensis*	KJ920037	—	KJ920096

Table 2 (continued)

Voucher specimen	Species	Locality	Potential hosts	GenBank accession No.		
NY34729	*Cortinarius sp. CR1*	Costa Rica	*Quercus costaricensis*	KJ920032	—	KJ920094
NY460484	*Cortinarius sp. CR1*	Costa Rica	*Quercus costaricensis*	KJ920036	—	KJ920092
NY795935	*Cortinarius sp. CR1*	Costa Rica	*Quercus copeyensis, Quercus seemannii*	KJ920035	—	KJ920095
NY181476	*Cortinarius sp. CR1*	Costa Rica	*Quercus copeyensis, Quercus seemannii*	KJ920031	KJ919994	KJ920097
NY Franco-Molano1393	*Cortinarius sp. CR1*	Costa Rica	*Quercus copeyensis, Quercus seemannii*	KJ920038	—	KJ920093
NY79537	*Cortinarius sp. CR2*	Costa Rica	*Quercus costaricensis*	KJ920026	—	—
NY34724	*Cortinarius sp. CR2*	Costa Rica	*Quercus copeyensis, Quercus seemannii*	KJ920023	KJ919991	KJ920084
NY795933	*Cortinarius sp. CR2*	Costa Rica	*Quercus costaricensis*	KJ920028	—	—
NY460906	*Cortinarius sp. CR2*	Costa Rica	*Quercus copeyensis, Quercus seemannii*	KJ920025	—	KJ920083
NY796168	*Cortinarius sp. CR2*	Costa Rica	*Quercus costaricensis, possibly with Comarostaphylis arbutoides*	KJ920024	—	—
ZT10422	*Cortinarius sp. CR2*	Costa Rica	*Quercus costaricensis*	KJ920027	—	KJ920082

Table 2 (continued)

Voucher specimen	Species	Locality	Potential hosts	GenBank accession No.		
TENN65527	*Cortinarius sp. NA1*	USA: FL	*Quercus virginiana, and/or Quercus nigra*	KJ920029	KJ919992	KJ920081
TENN65535	*Cortinarius sp. NA1*	USA: FL		KJ920030	KJ919993	KJ920080
IB 74/208	*C. violaceus auct. mult.*	Sweden	*Fagus, Betula*	KM253741	—	—
KH16	*C. violaceus auct. mult.*	Norway		AJ236059	—	—
TU106457	*C. violaceus auct. mult.*	Estonia	*Mixed forest*	UDB011352	—	—
IA06-7	*C. violaceus auct. mult.*	Great Britain	*Betula pubescens*	UDB002377	—	—
IB 19980181	*C. violaceus auct. mult.*	Sweden		AF325601	—	—
TUB 011825	*C. violaceus auct. mult.*	Germany		AY669579	—	—
UBCF15187	*C. violaceus auct. mult.*	Canada: BC	*Tsuga heterophylla*	DQ384589	—	—
MTS 4854	*C. violaceus auct. mult.*	USA: WA		DQ486695	—	—
TUB 011824	*C. violaceus auct. mult.*	Germany		AY669580	—	—

Table 2 (continued)

Voucher specimen	Species	Locality	Potential hosts	GenBank accession No.		
AT2004128	*C. violaceus auct. mult.*	Sweden	*mixed forest*	UDB001184	—	—
TRTC155606	*C. violaceus auct. mult.*	USA: MD		JN021013	—	—
OSC 1064077	*C. violaceus auct. mult.*	USA: OR	*Peusdotsuga menziesii, Tsuga heteropyhlla*	EU525958	—	—
IB19950556	*C. violaceus auct. mult.*			AF389130	—	—
TENN67810	*C. violaceus auct. mult.*	USA: NC	*Tsuga*	KJ920044	—	—
TENN27530	*C. violaceus auct. mult.*	USA: ID	*Tsuga, Picea*	KJ920043	—	KJ920085
TENN30078	*C. violaceus auct. mult.*	Canada	*Picea, Betula*	KJ920058	—	—
TENN38038	*C. violaceus auct. mult.*	Sweden	*Populus*	KJ920053	—	—
TENN62899	*C. violaceus auct. mult.*	USA: WA		KJ920055	—	KJ920089
TENN63104	*C. violaceus auct. mult.*	USA: AK		KJ920048	—	KJ920088
TENN65179	*C. violaceus auct. mult.*	Belgium	*Fagus*	KJ920049	—	—

Table 2 (continued)

Voucher specimen	Species	Locality	Potential hosts	GenBank accession No.		
NY HEB11069	*C. violaceus auct. mult.*	USA: ME		KJ920051	—	—
NY HEB12510	*C. violaceus auct. mult.*	USA: NH		KJ920052	—	—
NY HEB17339	*C. violaceus auct. mult.*	USA: MA	*Mixed conifers*	KJ920040	KJ919996	—
NY Halling5693	*C. violaceus auct. mult.*	USA: CA		KJ920057	—	KJ920086
NY ASMethven2133	*C. violaceus auct. mult.*	USA: CA	*Mixed forest*	KJ920045	—	—
NY Baroni1985	*C. violaceus auct. mult.*	USA: NY	*Pinus resinosa*	KJ920050	—	KJ920087
NY HEB1976	*C. violaceus* auct. mult.	USA: WA		KJ920061	—	—
NY HEB1971	*C. violaceus* auct. mult.	USA: CA		KJ920042	—	—
NY HDThiers35271	*C. violaceus* auct. mult.	USA: CA	mixed conifers	KJ920059	—	—
NY Halling5632	*C. violaceus* auct. mult.	USA: CA		KJ920064	—	—
NY Brooks1986	*C. violaceus* auct. mult.	USA: CA		KJ920063	—	—
NY Zebell1988	*C. violaceus* auct. mult.	USA: CA	*Pinus taeda, Pinus palustris*	KJ920056	—	—
NY401880	*C. violaceus* auct. mult.	USA: TX		KJ920068	—	—
NY Holtz574	*C. violaceus* auct. mult.	USA: CA		KJ920046	—	—

Table 2 (continued)

Voucher specimen	Species	Locality	Potential hosts	GenBank accession No.		
NY HEB6165	*C. violaceus* auct. mult.	Canada: QC		KJ920066	—	—
NY HEB10812	*C. violaceus* auct. mult.	USA: ME		KJ920065	—	—
NY HEB15844	*C. violaceus* auct. mult.	USA: NH		KJ920054	—	—
NY HEB17988	*C. violaceus* auct. mult.	USA: CT		—	—	—
NY Smith F2309	*C. violaceus* auct. mult.	USA: ID		KJ920047	—	—
Halling3768	*C. violaceus* auct. mult.	USA: CA	*Abies*	KJ920060	—	—
Halling6989	*C. violaceus* auct. mult.	USA: CA		KJ920062	—	—
NY HEB1956	*C. violaceus* auct. mult.	USA: ME		KJ920067	—	—
UBCF16428	*C. violaceus* auct. mult.	Canada: BC		FJ039649	—	—
UBCF18503	*C. violaceus* auct. mult.	Canada: BC		FJ157111	—	—
KEP S-S 1419	*Cortinarius* sp.	Malaysia	*Dipterocarpus*	KP091458	—	—

Table 3: Pairwise distances within species in sect. *Cortinarius* in the ITS, 28S and *RPB2* loci using the Kimura 2-parameter distance correction. N/A refers to when one or both sequences are missing.

Cortinarius sp. AU2										
Taxa	Average			ITS			28S			*RPB2*
1-2	0.01	Max:	0.01	0.01	Max:	0.01	N/A	Max:	0.00	N/A
1-3	0.01	Min:	0.00	0.01	Min:	0.00	N/A	Min:	0.00	
1-4	0.00			0.00			0.00		0.00	
1-5	0.00			0.00			N/A		0.00	
2-3	0.00			0.00			N/A		0.00	
2-4	0.00			0.00			N/A		0.00	
2-5	0.01			0.01			N/A		0.00	
3-4	0.00			0.00			N/A		0.00	
3-5	0.01			0.01			N/A		0.00	
4-5	0.00			0.00			N/A		0.00	

Cortinarius sp. AU1												
Taxa	Average			ITS			28S			*RPB2*		
1-2	0.00	Max:	0.00	0.00	Max:	0.0	N/A	Max:	0.00	N/A	Max:	0.0
1-3	0.00	Min:	0.00	0.00	Min:	0.0	N/A	Min:	0.00	N/A	Min:	0.0
1-4	0.00			0.00			N/A			N/A		
1-5	0.00			0.00			N/A			N/A		
2-3	0.00			0.00			0.00			0.00		
2-4	0.00			0.00			0.00			0.00		
2-5	0.00			0.00			0.00			0.00		
3-4	0.00			0.00			0.00			0.00		
3-5	0.00			0.00			0.00			0.00		
4-5	0.00			0.00			0.00			0.00		

Cortinarius sensu Moser 1986												
Taxa	Average			ITS			28S			*RPB2*		
1-2	0.00	Max:	0.00	0.00	Max:	0 0	N/A	Max:	0.00	N/A	Max:	0.0
1-3	0.00	Min:	0.00	0.00	Min:	0.0	N/A	Min:	0.00	N/A	Min:	0.0
1-4	0.00			0.00			N/A			N/A		
1-5	0.00			0.00			N/A			N/A		
1-6	0.00			0.00			N/A			N/A		
1-7	0.00			0.00			N/A			N/A		
1-8	0.00			0.00			N/A			N/A		
1-9	0.00			0.00			N/A			N/A		
1-10	0.00			0.00			N/A			N/A		

Table 3 (continued)

Cortinarius sensu Moser 1986				
Taxa	Average	ITS	28S	*RPB2*
1-11	0.00	0.00	N/A	N/A
1-12	0.00	0.00	N/A	N/A
2-3	0.00	0.00	N/A	N/A
2-4	0.00	0.00	N/A	N/A
2-5	0.00	0.00	N/A	N/A
2-6	0.00	0.00	N/A	N/A
2-7	0.00	0.00	N/A	N/A
2-8	0.00	0.00	N/A	N/A
2-9	0.00	0.00	N/A	N/A
2-10	0.00	0.00	N/A	N/A
2-11	0.00	0.00	N/A	N/A
2-12	0.00	0.00	N/A	N/A
3-4	0.00	0.00	0.00	N/A
3-5	0.00	0.00	0.00	N/A
3-6	0.00	0.00	0.00	N/A
3-7	0.00	0.00	0.00	N/A
3-8	0.00	0.00	0.00	N/A
3-9	0.00	0.00	0.00	N/A
3-10	0.00	0.00	N/A	N/A
3-11	0.00	0.00	N/A	N/A
3-12	0.00	0.00	N/A	N/A
4-5	0.00	0.00	0.00	N/A
4-6	0.00	0.00	0.00	N/A
4-7	0.00	0.00	0.00	N/A
4-8	0.00	0.00	0.00	N/A
4-9	0.00	0.00	0.00	N/A
4-10	0.00	0.00	N/A	N/A
4-11	0.00	0.00	N/A	N/A
4-12	0.00	0.00	N/A	N/A
5-6	0.00	0.00	0.00	0.00
5-7	0.00	0.00	0.00	0.00
5-8	0.00	0.00	0.00	0.00
5-9	0.00	0.00	0.00	0.00
5-10	0.00	0.00	N/A	N/A
5-11	0.00	0.00	N/A	N/A
5-12	0.00	0.00	N/A	N/A
6-7	0.00	0.00	0.00	0.00
6-8	0.00	0.00	0.00	0.00
6-9	0.00	0.00	0.00	0.00
6-10	0.00	0.00	N/A	N/A
6-11	0.00	0.00	N/A	N/A
6-12	0.00	0.00	N/A	N/A

Table 3 (continued)

Cortinarius sensu Moser 1986				
Taxa	Average	ITS	28S	*RPB2*
7-8	0.00	0.00	0.00	0.00
7-9	0.00	0.00	0.00	0.00
7-10	0.00	0.00	N/A	N/A
7-11	0.00	0.00	N/A	N/A
7-12	0.00	0.00	N/A	N/A
8-9	0.00	0.00	0.00	0.00
8-10	0.00	0.00	N/A	N/A
8-11	0.00	0.00	N/A	N/A
8-12	0.00	0.00	N/A	N/A
9-10	0.00	0.00	N/A	N/A
9-11	0.00	0.00	N/A	N/A
9-12	0.00	0.00	N/A	N/A
10-11	0.00	0.00	N/A	N/A
10-12	0.00	0.00	N/A	N/A
11-12	0.00	0.00	N/A	N/A

Cortinarius sp. SA1								
Taxa	Average			ITS			28S	*RPB2*
1-2	0.00	Max:	0.00	0.00	Max:	0.00	N/A	N/A
		Min:	0.00		Min:	0.00		

Cortinarius sp. CR2										
Taxa	Average			ITS			28S	*RPB2*		
1-2	0.00	Max:	0.00	0.00	Max:	0.00	N/A	N/A	Max:	0.01
1-3	0.00	Min:	0.00	0.00	Min:	0.00		N/A	Min:	0.00
1-4	0.00			0.00				0.00		
1-5	0.00			0.00				N/A		
1-6	0.00			0.00				0.00		
2-3	0.00			0.00				N/A		
2-4	0.00			0.00				N/A		
2-5	0.00			0.00				N/A		
2-6	0.00			0.00				N/A		
3-4	0.00			0.00				N/A		
3-5	0.00			0.00				N/A		
3-6	0.00			0.00				N/A		
4-5	0.00			0.00				N/A		
4-6	0.00			0.00				0.01		
5-6	0.00			0.00				N/A		

Table 3 (continued)

Cortinarius sp. NA1

Taxa	Average			ITS			28S			*RPB2*
1-2	0.00	Max:	0.00	0.00	Max:	0.00	0.00	Max:	0.00	N/A
		Min:	0.00		Min:	0.00		Min:		

Cortinarius sp. CR1

Taxa	Average			ITS			28S	*RPB2*		
1-2	0.00	Max:	0.01	0.00	Max:	0.00	N/A	0.00	Max:	0.01
1-3	0.00	Min:	0.00	0.00	Min:	0.00		0.01	Min:	0.00
1-4	0.00			0.00				0.00		
1-5	0.00			0.00				0.01		
1-6	0.00			0.00				0.01		
1-7	0.00			0.00				0.00		
1-8	0.00			0.00				0.00		
2-3	0.00			0.00				0.00		
2-4	0.00			0.00				0.00		
2-5	0.01			0.00				0.01		
2-6	0.01			0.00				0.01		
2-7	0.00			0.00				0.00		
2-8	0.00			0.00				0.00		
3-4	0.00			0.00				0.00		
3-5	0.00			0.00				0.00		
3-6	0.00			0.00				0.00		
3-7	0.00			0.00				0.00		
3-8	0.00			0.00				0.01		
4-5	0.01			0.00				0.01		
4-6	0.01			0.00				0.01		
4-7	0.00			0.00				0.00		
4-8	0.00			0.00				0.00		
5-6	0.00			0.00				0.00		
5-7	0.00			0.00				0.01		
5-8	0.00			0.00				0.01		
6-7	0.00			0.00				0.01		
6-8	0.00			0.00				0.01		
7-8	0.00			0.00				0.00		

C. violaceus sensu auct. mult.

Taxa	Average			ITS			28S			*RPB2*		
1-2	0.00	Max:	0.01	0.00	Max:	0.01	N/A	Max:	0.01	0.01	Max:	0.02
1-3	0.00	Min:	0.00	0.00	Min:	0.00	N/A	Min:	0.01	N/A	Min:	0.00
1-4	0.00			0.00			N/A			0.00		
1-5	0.01			0.01			N/A			N/A		
1-6	0.00			0.00			N/A			N/A		

Table 3 (continued)

C. violaceus sensu auct. mult.				
Taxa	Average	ITS	28S	*RPB2*
1-7	0.01	0.00	N/A	0.01
1-8	0.00	0.00	N/A	N/A
1-9	0.00	0.00	N/A	N/A
1-10	0.01	0.01	N/A	N/A
1-11	0.01	0.01	N/A	N/A
1-12	0.00	0.00	N/A	N/A
1-13	0.00	0.00	N/A	N/A
1-14	0.01	0.01	N/A	N/A
1-15	0.00	0.00	N/A	N/A
1-16	0.00	0.00	N/A	N/A
1-17	0.00	0.00	N/A	N/A
1-18	0.00	0.00	N/A	N/A
1-19	0.01	0.01	N/A	N/A
1-20	0.00	0.00	N/A	N/A
1-21	0.01	0.00	N/A	0.01
1-22	0.00	0.00	N/A	N/A
1-23	0.00	0.00	N/A	N/A
1-24	0.00	0.00	N/A	N/A
1-25	0.00	0.00	N/A	N/A
1-26	0.00	0.00	N/A	N/A
1-27	0.00	0.00	N/A	N/A
1-28	0.00	0.00	N/A	N/A
1-29	0.01	0.01	N/A	N/A
1-30	0.00	0.00	N/A	N/A
1-31	0.00	0.00	N/A	N/A
1-32	0.00	0.00	N/A	N/A
1-33	0.00	0.00	N/A	N/A
1-34	0.00	0.00	N/A	N/A
1-35	0.01	0.01	N/A	N/A
1-36	0.00	0.00	N/A	N/A
1-37	0.00	0.00	N/A	N/A
1-38	0.01	0.01	N/A	N/A
1-39	0.01	0.01	N/A	N/A
1-40	0.00	0.00	N/A	N/A
1-41	0.00	0.00	N/A	N/A
1-42	0.00	0.00	N/A	N/A
1-43	0.00	0.00	N/A	N/A
2-3	0.00	0.00	N/A	N/A

Table 3 (continued)

C. violaceus sensu auct. mult. Taxa	Average	ITS	28S	*RPB2*
2-4	0.00	0.00	N/A	0.00
2-5	0.01	0.01	N/A	N/A
2-6	0.00	0.00	N/A	N/A
2-7	0.01	0.00	N/A	0.02
2-8	0.00	0.00	N/A	N/A
2-9	0.00	0.00	N/A	N/A
2-10	0.01	0.01	N/A	N/A
2-11	0.01	0.01	N/A	N/A
2-12	0.00	0.00	N/A	N/A
2-13	0.00	0.00	N/A	N/A
2-14	0.01	0.01	N/A	N/A
2-15	0.00	0.00	N/A	N/A
2-16	0.00	0.00	N/A	N/A
2-17	0.00	0.00	N/A	N/A
2-18	0.00	0.00	N/A	N/A
2-19	0.01	0.01	N/A	N/A
2-20	0.00	0.00	N/A	N/A
2-21	0.01	0.00	N/A	0.02
2-22	0.00	0.00	N/A	N/A
2-23	0.00	0.00	N/A	N/A
2-24	0.00	0.00	N/A	N/A
2-25	0.00	0.00	N/A	N/A
2-26	0.00	0.00	N/A	N/A
2-27	0.00	0.00	N/A	N/A
2-28	0.00	0.00	N/A	N/A
2-29	0.01	0.01	N/A	N/A
2-30	0.00	0.00	N/A	N/A
2-31	0.00	0.00	N/A	N/A
2-32	0.00	0.00	N/A	N/A
2-33	0.00	0.00	N/A	N/A
2-34	0.00	0.00	N/A	N/A
2-35	0.01	0.01	N/A	N/A
2-36	0.00	0.00	N/A	N/A
2-37	0.00	0.00	N/A	N/A
2-38	0.01	0.01	N/A	N/A
2-39	0.01	0.01	N/A	N/A
2-40	0.00	0.00	N/A	N/A
2-41	0.00	0.00	N/A	N/A

Table 3 (continued)

C. violaceus sensu auct. mult.				
Taxa	Average	ITS	28S	*RPB2*
2-42	0.00	0.00	N/A	N/A
2-43	0.00	0.00	N/A	N/A
3-4	0.00	0.00	N/A	N/A
3-5	0.01	0.01	N/A	N/A
3-6	0.00	0.00	N/A	N/A
3-7	0.00	0.00	N/A	N/A
3-8	0.00	0.00	N/A	N/A
3-9	0.00	0.00	N/A	N/A
3-10	0.01	0.01	N/A	N/A
3-11	0.01	0.01	N/A	N/A
3-12	0.00	0.00	N/A	N/A
3-13	0.00	0.00	N/A	N/A
3-14	0.01	0.01	N/A	N/A
3-15	0.00	0.00	N/A	N/A
3-16	0.00	0.00	N/A	N/A
3-17	0.00	0.00	N/A	N/A
3-18	0.00	0.00	N/A	N/A
3-19	0.01	0.01	N/A	N/A
3-20	0.00	0.00	N/A	N/A
3-21	0.00	0.00	N/A	N/A
3-22	0.00	0.00	N/A	N/A
3-23	0.00	0.00	N/A	N/A
3-24	0.00	0.00	N/A	N/A
3-25	0.00	0.00	N/A	N/A
3-26	0.00	0.00	N/A	N/A
3-27	0.00	0.00	N/A	N/A
3-28	0.00	0.00	N/A	N/A
3-29	0.01	0.01	N/A	N/A
3-30	0.00	0.00	N/A	N/A
3-31	0.00	0.00	N/A	N/A
3-32	0.00	0.00	N/A	N/A
3-33	0.00	0.00	N/A	N/A
3-34	0.00	0.00	N/A	N/A
3-35	0.01	0.01	N/A	N/A
3-36	0.00	0.00	N/A	N/A
3-37	0.00	0.00	N/A	N/A
3-38	0.01	0.01	N/A	N/A
3-39	0.01	0.01	N/A	N/A

Table 3 (continued)

C. violaceus sensu auct. mult.				
Taxa	Average	ITS	28S	*RPB2*
3-40	0.00	0.00	N/A	N/A
3-41	0.00	0.00	N/A	N/A
3-42	0.00	0.00	N/A	N/A
3-43	0.00	0.00	N/A	N/A
4-5	0.01	0.01	N/A	N/A
4-6	0.00	0.00	N/A	N/A
4-7	0.01	0.00	N/A	0.02
4-8	0.00	0.00	N/A	N/A
4-9	0.00	0.00	N/A	N/A
4-10	0.01	0.01	N/A	N/A
4-11	0.01	0.01	N/A	N/A
4-12	0.00	0.00	N/A	N/A
4-13	0.00	0.00	N/A	N/A
4-14	0.01	0.01	N/A	N/A
4-15	0.00	0.00	N/A	N/A
4-16	0.00	0.00	N/A	N/A
4-17	0.00	0.00	N/A	N/A
4-18	0.00	0.00	N/A	N/A
4-19	0.01	0.01	N/A	N/A
4-20	0.00	0.00	N/A	N/A
4-21	0.01	0.00	N/A	0.02
4-22	0.00	0.00	N/A	N/A
4-23	0.00	0.00	N/A	N/A
4-24	0.00	0.00	N/A	N/A
4-25	0.00	0.00	N/A	N/A
4-26	0.00	0.00	N/A	N/A
4-27	0.00	0.00	N/A	N/A
4-28	0.00	0.00	N/A	N/A
4-29	0.01	0.01	N/A	N/A
4-30	0.00	0.00	N/A	N/A
4-31	0.00	0.00	N/A	N/A
4-32	0.00	0.00	N/A	N/A
4-33	0.00	0.00	N/A	N/A
4-34	0.00	0.00	N/A	N/A
4-35	0.01	0.01	N/A	N/A
4-36	0.00	0.00	N/A	N/A
4-37	0.00	0.00	N/A	N/A
4-38	0.01	0.01	N/A	N/A

Table 3 (continued)

C. violaceus sensu auct. mult.				
Taxa	Average	ITS	28S	*RPB2*
4-39	0.01	0.01	N/A	N/A
4-40	0.00	0.00	N/A	N/A
4-41	0.00	0.00	N/A	N/A
4-42	0.00	0.00	N/A	N/A
4-43	0.00	0.00	N/A	N/A
5-6	0.01	0.01	N/A	N/A
5-7	0.00	0.00	N/A	N/A
5-8	0.00	0.00	N/A	N/A
5-9	0.00	0.00	N/A	N/A
5-10	0.00	0.00	N/A	N/A
5-11	0.00	0.00	N/A	N/A
5-12	0.00	0.00	N/A	N/A
5-13	0.01	0.01	N/A	N/A
5-14	0.00	0.00	N/A	N/A
5-15	0.01	0.01	N/A	N/A
5-16	0.01	0.01	N/A	N/A
5-17	0.01	0.01	N/A	N/A
5-18	0.01	0.01	N/A	N/A
5-19	0.00	0.00	N/A	N/A
5-20	0.00	0.00	N/A	N/A
5-21	0.01	0.01	N/A	N/A
5-22	0.01	0.01	N/A	N/A
5-23	0.01	0.01	N/A	N/A
5-24	0.01	0.01	N/A	N/A
5-25	0.01	0.01	N/A	N/A
5-26	0.00	0.00	N/A	N/A
5-27	0.00	0.00	N/A	N/A
5-28	0.01	0.01	N/A	N/A
5-29	0.00	0.00	N/A	N/A
5-30	0.01	0.01	N/A	N/A
5-31	0.01	0.01	N/A	N/A
5-32	0.01	0.01	N/A	N/A
5-33	0.01	0.01	N/A	N/A
5-34	0.00	0.00	N/A	N/A
5-35	0.00	0.00	N/A	N/A
5-36	0.01	0.01	N/A	N/A
5-37	0.01	0.01	N/A	N/A
5-38	0.01	0.01	N/A	N/A

Table 3 (continued)

C. violaceus sensu auct. mult.				
Taxa	Average	ITS	28S	*RPB2*
5-39	0.01	0.01	N/A	N/A
5-40	0.01	0.01	N/A	N/A
5-41	0.01	0.01	N/A	N/A
5-42	0.01	0.01	N/A	N/A
5-43	0.01	0.01	N/A	N/A
6-7	0.00	0.00	N/A	N/A
6-8	0.00	0.00	N/A	N/A
6-9	0.00	0.00	N/A	N/A
6-10	0.01	0.01	N/A	N/A
6-11	0.01	0.01	N/A	N/A
6-12	0.00	0.00	N/A	N/A
6-13	0.00	0.00	N/A	N/A
6-14	0.01	0.01	N/A	N/A
6-15	0.00	0.00	N/A	N/A
6-16	0.00	0.00	N/A	N/A
6-17	0.00	0.00	N/A	N/A
6-18	0.00	0.00	N/A	N/A
6-19	0.01	0.01	N/A	N/A
6-20	0.00	0.00	N/A	N/A
6-21	0.00	0.00	N/A	N/A
6-22	0.00	0.00	N/A	N/A
6-23	0.00	0.00	N/A	N/A
6-24	0.00	0.00	N/A	N/A
6-25	0.00	0.00	N/A	N/A
6-26	0.00	0.00	N/A	N/A
6-27	0.00	0.00	N/A	N/A
6-28	0.00	0.00	N/A	N/A
6-29	0.01	0.01	N/A	N/A
6-30	0.00	0.00	N/A	N/A
6-31	0.00	0.00	N/A	N/A
6-32	0.00	0.00	N/A	N/A
6-33	0.00	0.00	N/A	N/A
6-34	0.00	0.00	0.01	N/A
6-35	0.01	0.01	N/A	N/A
6-36	0.00	0.00	N/A	N/A
6-37	0.00	0.00	N/A	N/A
6-38	0.01	0.01	N/A	N/A
6-39	0.01	0.01	N/A	N/A

Table 3 (continued)

C. violaceus sensu auct. mult.				
Taxa	Average	ITS	28S	*RPB2*
6-40	0.00	0.00	N/A	N/A
6-41	0.00	0.00	N/A	N/A
6-42	0.00	0.00	N/A	N/A
6-43	0.00	0.00	N/A	N/A
7-8	0.00	0.00	N/A	N/A
7-9	0.00	0.00	N/A	N/A
7-10	0.00	0.00	N/A	N/A
7-11	0.00	0.00	N/A	N/A
7-12	0.00	0.00	N/A	N/A
7-13	0.00	0.00	N/A	N/A
7-14	0.00	0.00	N/A	N/A
7-15	0.00	0.00	N/A	N/A
7-16	0.01	0.01	N/A	N/A
7-17	0.00	0.00	N/A	N/A
7-18	0.00	0.00	N/A	N/A
7-19	0.00	0.00	N/A	N/A
7-20	0.00	0.00	N/A	N/A
7-21	0.00	0.00	N/A	0.00
7-22	0.00	0.00	N/A	N/A
7-23	0.01	0.01	N/A	N/A
7-24	0.01	0.01	N/A	N/A
7-25	0.01	0.01	N/A	N/A
7-26	0.00	0.00	N/A	N/A
7-27	0.00	0.00	N/A	N/A
7-28	0.00	0.00	N/A	N/A
7-29	0.00	0.00	N/A	N/A
7-30	0.01	0.01	N/A	N/A
7-31	0.00	0.00	N/A	N/A
7-32	0.00	0.00	N/A	N/A
7-33	0.00	0.00	N/A	N/A
7-34	0.00	0.00	N/A	N/A
7-35	0.00	0.00	N/A	N/A
7-36	0.01	0.01	N/A	N/A
7-37	0.01	0.01	N/A	N/A
7-38	0.01	0.01	N/A	N/A
7-39	0.01	0.01	N/A	N/A
7-40	0.00	0.00	N/A	N/A
7-41	0.00	0.00	N/A	N/A

Table 3 (continued)

C. violaceus sensu auct. mult.				
Taxa	Average	ITS	28S	*RPB2*
7-42	0.00	0.00	N/A	N/A
7-43	0.00	0.00	N/A	N/A
8-9	0.00	0.00	N/A	N/A
8-10	0.00	0.00	N/A	N/A
8-11	0.00	0.00	N/A	N/A
8-12	0.00	0.00	N/A	N/A
8-13	0.00	0.00	N/A	N/A
8-14	0.00	0.00	N/A	N/A
8-15	0.00	0.00	N/A	N/A
8-16	0.01	0.01	N/A	N/A
8-17	0.00	0.00	N/A	N/A
8-18	0.00	0.00	N/A	N/A
8-19	0.00	0.00	N/A	N/A
8-20	0.00	0.00	N/A	N/A
8-21	0.00	0.00	N/A	N/A
8-22	0.00	0.00	N/A	N/A
8-23	0.01	0.01	N/A	N/A
8-24	0.01	0.01	N/A	N/A
8-25	0.01	0.01	N/A	N/A
8-26	0.00	0.00	N/A	N/A
8-27	0.00	0.00	N/A	N/A
8-28	0.00	0.00	N/A	N/A
8-29	0.00	0.00	N/A	N/A
8-30	0.01	0.01	N/A	N/A
8-31	0.00	0.00	N/A	N/A
8-32	0.00	0.00	N/A	N/A
8-33	0.00	0.00	N/A	N/A
8-34	0.00	0.00	N/A	N/A
8-35	0.00	0.00	N/A	N/A
8-36	0.01	0.01	N/A	N/A
8-37	0.01	0.01	N/A	N/A
8-38	0.01	0.01	N/A	N/A
8-39	0.01	0.01	N/A	N/A
8-40	0.00	0.00	N/A	N/A
8-41	0.00	0.00	N/A	N/A
8-42	0.00	0.00	N/A	N/A
8-43	0.00	0.00	N/A	N/A
9-10	0.00	0.00	N/A	N/A

Table 3 (continued)

C. violaceus sensu auct. mult.				
Taxa	Average	ITS	28S	*RPB2*
9-11	0.00	0.00	N/A	N/A
9-12	0.00	0.00	N/A	N/A
9-13	0.00	0.00	N/A	N/A
9-14	0.00	0.00	N/A	N/A
9-15	0.00	0.00	N/A	N/A
9-16	0.01	0.01	N/A	N/A
9-17	0.00	0.00	N/A	N/A
9-18	0.00	0.00	N/A	N/A
9-19	0.00	0.00	N/A	N/A
9-20	0.00	0.00	N/A	N/A
9-21	0.00	0.00	N/A	N/A
9-22	0.00	0.00	N/A	N/A
9-23	0.01	0.01	N/A	N/A
9-24	0.01	0.01	N/A	N/A
9-25	0.01	0.01	N/A	N/A
9-26	0.00	0.00	N/A	N/A
9-27	0.00	0.00	N/A	N/A
9-28	0.00	0.00	N/A	N/A
9-29	0.00	0.00	N/A	N/A
9-30	0.01	0.01	N/A	N/A
9-31	0.00	0.00	N/A	N/A
9-32	0.00	0.00	N/A	N/A
9-33	0.00	0.00	N/A	N/A
9-34	0.00	0.00	N/A	N/A
9-35	0.00	0.00	N/A	N/A
9-36	0.01	0.01	N/A	N/A
9-37	0.01	0.01	N/A	N/A
9-38	0.01	0.01	N/A	N/A
9-39	0.01	0.01	N/A	N/A
9-40	0.00	0.00	N/A	N/A
9-41	0.00	0.00	N/A	N/A
9-42	0.00	0.00	N/A	N/A
9-43	0.00	0.00	N/A	N/A
10-11	0.00	0.00	N/A	N/A
10-12	0.00	0.00	N/A	N/A
10-13	0.01	0.01	N/A	N/A
10-14	0.00	0.00	N/A	N/A
10-15	0.01	0.01	N/A	N/A

Table 3 (continued)

C. violaceus sensu auct. mult.				
Taxa	Average	ITS	28S	*RPB2*
10-16	0.01	0.01	N/A	N/A
10-17	0.01	0.01	N/A	N/A
10-18	0.01	0.01	N/A	N/A
10-19	0.00	0.00	N/A	N/A
10-20	0.00	0.00	N/A	N/A
10-21	0.01	0.01	N/A	N/A
10-22	0.01	0.01	N/A	N/A
10-23	0.01	0.01	N/A	N/A
10-24	0.01	0.01	N/A	N/A
10-25	0.01	0.01	N/A	N/A
10-26	0.00	0.00	N/A	N/A
10-27	0.00	0.00	N/A	N/A
10-28	0.01	0.01	N/A	N/A
10-29	0.00	0.00	N/A	N/A
10-30	0.01	0.01	N/A	N/A
10-31	0.01	0.01	N/A	N/A
10-32	0.01	0.01	N/A	N/A
10-33	0.01	0.01	N/A	N/A
10-34	0.01	0.01	N/A	N/A
10-35	0.00	0.00	N/A	N/A
10-36	0.01	0.01	N/A	N/A
10-37	0.01	0.01	N/A	N/A
10-38	0.01	0.01	N/A	N/A
10-39	0.01	0.01	N/A	N/A
10-40	0.01	0.01	N/A	N/A
10-41	0.01	0.01	N/A	N/A
10-42	0.01	0.01	N/A	N/A
10-43	0.01	0.01	N/A	N/A
11-12	0.00	0.00	N/A	N/A
11-13	0.01	0.01	N/A	N/A
11-14	0.00	0.00	N/A	N/A
11-15	0.01	0.01	N/A	N/A
11-16	0.01	0.01	N/A	N/A
11-17	0.01	0.01	N/A	N/A
11-18	0.01	0.01	N/A	N/A
11-19	0.00	0.00	N/A	N/A
11-20	0.00	0.00	N/A	N/A
11-21	0.01	0.01	N/A	N/A

Table 3 (continued)

C. violaceus sensu auct. mult.				
Taxa	Average	ITS	28S	*RPB2*
11-22	0.01	0.01	N/A	N/A
11-23	0.01	0.01	N/A	N/A
11-24	0.01	0.01	N/A	N/A
11-25	0.01	0.01	N/A	N/A
11-26	0.00	0.00	N/A	N/A
11-27	0.00	0.00	N/A	N/A
11-28	0.01	0.01	N/A	N/A
11-29	0.00	0.00	N/A	N/A
11-30	0.01	0.01	N/A	N/A
11-31	0.01	0.01	N/A	N/A
11-32	0.01	0.01	N/A	N/A
11-33	0.01	0.01	N/A	N/A
11-34	0.00	0.00	N/A	N/A
11-35	0.00	0.00	N/A	N/A
11-36	0.01	0.01	N/A	N/A
11-37	0.01	0.01	N/A	N/A
11-38	0.01	0.01	N/A	N/A
11-39	0.01	0.01	N/A	N/A
11-40	0.01	0.01	N/A	N/A
11-41	0.01	0.01	N/A	N/A
11-42	0.01	0.01	N/A	N/A
11-43	0.01	0.01	N/A	N/A
12-13	0.00	0.00	N/A	N/A
12-14	0.00	0.00	N/A	N/A
12-15	0.00	0.00	N/A	N/A
12-16	0.01	0.01	N/A	N/A
12-17	0.00	0.00	N/A	N/A
12-18	0.00	0.00	N/A	N/A
12-19	0.00	0.00	N/A	N/A
12-20	0.00	0.00	N/A	N/A
12-21	0.00	0.00	N/A	N/A
12-22	0.00	0.00	N/A	N/A
12-23	0.01	0.01	N/A	N/A
12-24	0.01	0.01	N/A	N/A
12-25	0.01	0.01	N/A	N/A
12-26	0.00	0.00	N/A	N/A
12-27	0.00	0.00	N/A	N/A
12-28	0.00	0.00	N/A	N/A

Table 3 (continued)

C. violaceus sensu auct. mult.				
Taxa	Average	ITS	28S	*RPB2*
12-29	0.00	0.00	N/A	N/A
12-30	0.01	0.01	N/A	N/A
12-31	0.00	0.00	N/A	N/A
12-32	0.00	0.00	N/A	N/A
12-33	0.00	0.00	N/A	N/A
12-34	0.00	0.00	N/A	N/A
12-35	0.00	0.00	N/A	N/A
12-36	0.01	0.01	N/A	N/A
12-37	0.01	0.01	N/A	N/A
12-38	0.01	0.01	N/A	N/A
12-39	0.01	0.01	N/A	N/A
12-40	0.00	0.00	N/A	N/A
12-41	0.00	0.00	N/A	N/A
12-42	0.00	0.00	N/A	N/A
12-43	0.00	0.00	N/A	N/A
13-14	0.01	0.01	N/A	N/A
13-15	0.00	0.00	N/A	N/A
13-16	0.00	0.00	N/A	N/A
13-17	0.00	0.00	N/A	N/A
13-18	0.00	0.00	N/A	N/A
13-19	0.01	0.01	N/A	N/A
13-20	0.00	0.00	N/A	N/A
13-21	0.00	0.00	N/A	N/A
13-22	0.00	0.00	N/A	N/A
13-23	0.00	0.00	N/A	N/A
13-24	0.00	0.00	N/A	N/A
13-25	0.00	0.00	N/A	N/A
13-26	0.00	0.00	N/A	N/A
13-27	0.00	0.00	N/A	N/A
13-28	0.00	0.00	N/A	N/A
13-29	0.01	0.01	N/A	N/A
13-30	0.00	0.00	N/A	N/A
13-31	0.00	0.00	N/A	N/A
13-32	0.00	0.00	N/A	N/A
13-33	0.00	0.00	N/A	N/A
13-34	0.00	0.00	N/A	N/A
13-35	0.01	0.01	N/A	N/A
13-36	0.00	0.00	N/A	N/A

Table 3 (continued)

C. violaceus sensu auct. mult.				
Taxa	Average	ITS	28S	*RPB2*
13-37	0.00	0.00	N/A	N/A
13-38	0.01	0.01	N/A	N/A
13-39	0.01	0.01	N/A	N/A
13-40	0.00	0.00	N/A	N/A
13-41	0.00	0.00	N/A	N/A
13-42	0.00	0.00	N/A	N/A
13-43	0.00	0.00	N/A	N/A
14-15	0.01	0.01	N/A	N/A
14-16	0.01	0.01	N/A	N/A
14-17	0.01	0.01	N/A	N/A
14-18	0.01	0.01	N/A	N/A
14-19	0.00	0.00	N/A	N/A
14-20	0.00	0.00	N/A	N/A
14-21	0.01	0.01	N/A	N/A
14-22	0.01	0.01	N/A	N/A
14-23	0.01	0.01	N/A	N/A
14-24	0.01	0.01	N/A	N/A
14-25	0.01	0.01	N/A	N/A
14-26	0.00	0.00	N/A	N/A
14-27	0.00	0.00	N/A	N/A
14-28	0.01	0.01	N/A	N/A
14-29	0.00	0.00	N/A	N/A
14-30	0.01	0.01	N/A	N/A
14-31	0.01	0.01	N/A	N/A
14-32	0.01	0.01	N/A	N/A
14-33	0.01	0.01	N/A	N/A
14-34	0.01	0.01	N/A	N/A
14-35	0.00	0.00	N/A	N/A
14-36	0.01	0.01	N/A	N/A
14-37	0.01	0.01	N/A	N/A
14-38	0.01	0.01	N/A	N/A
14-39	0.01	0.01	N/A	N/A
14-40	0.01	0.01	N/A	N/A
14-41	0.01	0.01	N/A	N/A
14-42	0.01	0.01	N/A	N/A
14-43	0.01	0.01	N/A	N/A
15-16	0.00	0.00	N/A	N/A
15-17	0.00	0.00	N/A	N/A

Table 3 (continued)

C. violaceus sensu auct. mult.				
Taxa	Average	ITS	28S	*RPB2*
15-18	0.00	0.00	N/A	N/A
15-19	0.01	0.01	N/A	N/A
15-20	0.00	0.00	N/A	N/A
15-21	0.00	0.00	N/A	N/A
15-22	0.00	0.00	N/A	N/A
15-23	0.00	0.00	N/A	N/A
15-24	0.00	0.00	N/A	N/A
15-25	0.00	0.00	N/A	N/A
15-26	0.00	0.00	N/A	N/A
15-27	0.00	0.00	N/A	N/A
15-28	0.00	0.00	N/A	N/A
15-29	0.01	0.01	N/A	N/A
15-30	0.00	0.00	N/A	N/A
15-31	0.00	0.00	N/A	N/A
15-32	0.00	0.00	N/A	N/A
15-33	0.00	0.00	N/A	N/A
15-34	0.00	0.00	N/A	N/A
15-35	0.01	0.01	N/A	N/A
15-36	0.00	0.00	N/A	N/A
15-37	0.00	0.00	N/A	N/A
15-38	0.01	0.01	N/A	N/A
15-39	0.01	0.01	N/A	N/A
15-40	0.00	0.00	N/A	N/A
15-41	0.00	0.00	N/A	N/A
15-42	0.00	0.00	N/A	N/A
15-43	0.00	0.00	N/A	N/A
16-17	0.00	0.00	N/A	N/A
16-18	0.00	0.00	N/A	N/A
16-19	0.01	0.01	N/A	N/A
16-20	0.01	0.01	N/A	N/A
16-21	0.00	0.00	N/A	N/A
16-22	0.00	0.00	N/A	N/A
16-23	0.00	0.00	N/A	N/A
16-24	0.00	0.00	N/A	N/A
16-25	0.00	0.00	N/A	N/A
16-26	0.00	0.00	N/A	N/A
16-27	0.01	0.01	N/A	N/A
16-28	0.00	0.00	N/A	N/A

Table 3 (continued)

C. violaceus sensu auct. mult.				
Taxa	Average	ITS	28S	*RPB2*
16-29	0.01	0.01	N/A	N/A
16-30	0.00	0.00	N/A	N/A
16-31	0.00	0.00	N/A	N/A
16-32	0.00	0.00	N/A	N/A
16-33	0.00	0.00	N/A	N/A
16-34	0.00	0.00	N/A	N/A
16-35	0.01	0.01	N/A	N/A
16-36	0.00	0.00	N/A	N/A
16-37	0.01	0.01	N/A	N/A
16-38	0.01	0.01	N/A	N/A
16-39	0.01	0.01	N/A	N/A
16-40	0.00	0.00	N/A	N/A
16-41	0.00	0.00	N/A	N/A
16-42	0.00	0.00	N/A	N/A
16-43	0.00	0.00	N/A	N/A
17-18	0.00	0.00	N/A	N/A
17-19	0.01	0.01	N/A	N/A
17-20	0.00	0.00	N/A	N/A
17-21	0.00	0.00	N/A	N/A
17-22	0.00	0.00	N/A	N/A
17-23	0.00	0.00	N/A	N/A
17-24	0.00	0.00	N/A	N/A
17-25	0.00	0.00	N/A	N/A
17-26	0.00	0.00	N/A	N/A
17-27	0.00	0.00	N/A	N/A
17-28	0.00	0.00	N/A	N/A
17-29	0.01	0.01	N/A	N/A
17-30	0.00	0.00	N/A	N/A
17-31	0.00	0.00	N/A	N/A
17-32	0.00	0.00	N/A	N/A
17-33	0.00	0.00	N/A	N/A
17-34	0.00	0.00	N/A	N/A
17-35	0.01	0.01	N/A	N/A
17-36	0.00	0.00	N/A	N/A
17-37	0.00	0.00	N/A	N/A
17-38	0.01	0.01	N/A	N/A
17-39	0.01	0.01	N/A	N/A
17-40	0.00	0.00	N/A	N/A

Table 3 (continued)

C. violaceus sensu auct. mult.				
Taxa	Average	ITS	28S	*RPB2*
17-41	0.00	0.00	N/A	N/A
17-42	0.00	0.00	N/A	N/A
17-43	0.00	0.00	N/A	N/A
18-19	0.01	0.01	N/A	N/A
18-20	0.00	0.00	N/A	N/A
18-21	0.00	0.00	N/A	N/A
18-22	0.00	0.00	N/A	N/A
18-23	0.00	0.00	N/A	N/A
18-24	0.00	0.00	N/A	N/A
18-25	0.00	0.00	N/A	N/A
18-26	0.00	0.00	N/A	N/A
18-27	0.00	0.00	N/A	N/A
18-28	0.00	0.00	N/A	N/A
18-29	0.01	0.01	N/A	N/A
18-30	0.00	0.00	N/A	N/A
18-31	0.00	0.00	N/A	N/A
18-32	0.00	0.00	N/A	N/A
18-33	0.00	0.00	N/A	N/A
18-34	0.00	0.00	N/A	N/A
18-35	0.01	0.01	N/A	N/A
18-36	0.00	0.00	N/A	N/A
18-37	0.00	0.00	N/A	N/A
18-38	0.01	0.01	N/A	N/A
18-39	0.01	0.01	N/A	N/A
18-40	0.00	0.00	N/A	N/A
18-41	0.00	0.00	N/A	N/A
18-42	0.00	0.00	N/A	N/A
18-43	0.00	0.00	N/A	N/A
19-20	0.00	0.00	N/A	N/A
19-21	0.01	0.01	N/A	N/A
19-22	0.01	0.01	N/A	N/A
19-23	0.01	0.01	N/A	N/A
19-24	0.01	0.01	N/A	N/A
19-25	0.01	0.01	N/A	N/A
19-26	0.01	0.01	N/A	N/A
19-27	0.01	0.01	N/A	N/A
19-28	0.01	0.01	N/A	N/A
19-29	0.00	0.00	N/A	N/A

Table 3 (continued)

C. violaceus sensu auct. mult.				
Taxa	Average	ITS	28S	*RPB2*
19-30	0.01	0.01	N/A	N/A
19-31	0.01	0.01	N/A	N/A
19-32	0.01	0.01	N/A	N/A
19-33	0.01	0.01	N/A	N/A
19-34	0.01	0.01	N/A	N/A
19-35	0.00	0.00	N/A	N/A
19-36	0.01	0.01	N/A	N/A
19-37	0.01	0.01	N/A	N/A
19-38	0.01	0.01	N/A	N/A
19-39	0.01	0.01	N/A	N/A
19-40	0.01	0.01	N/A	N/A
19-41	0.01	0.01	N/A	N/A
19-42	0.01	0.01	N/A	N/A
19-43	0.01	0.01	N/A	N/A
20-21	0.00	0.00	N/A	N/A
20-22	0.00	0.00	N/A	N/A
20-23	0.01	0.01	N/A	N/A
20-24	0.01	0.01	N/A	N/A
20-25	0.01	0.01	N/A	N/A
20-26	0.00	0.00	N/A	N/A
20-27	0.00	0.00	N/A	N/A
20-28	0.00	0.00	N/A	N/A
20-29	0.00	0.00	N/A	N/A
20-30	0.01	0.01	N/A	N/A
20-31	0.00	0.00	N/A	N/A
20-32	0.00	0.00	N/A	N/A
20-33	0.00	0.00	N/A	N/A
20-34	0.00	0.00	N/A	N/A
20-35	0.00	0.00	N/A	N/A
20-36	0.01	0.01	N/A	N/A
20-37	0.01	0.01	N/A	N/A
20-38	0.01	0.01	N/A	N/A
20-39	0.01	0.01	N/A	N/A
20-40	0.00	0.00	N/A	N/A
20-41	0.00	0.00	N/A	N/A
20-42	0.00	0.00	N/A	N/A
20-43	0.00	0.00	N/A	N/A
21-22	0.00	0.00	N/A	N/A

Table 3 (continued)

C. violaceus sensu auct. mult. Taxa	Average	ITS	28S	*RPB2*
21-23	0.00	0.00	N/A	N/A
21-24	0.00	0.00	N/A	N/A
21-25	0.00	0.00	N/A	N/A
21-26	0.00	0.00	N/A	N/A
21-27	0.00	0.00	N/A	N/A
21-28	0.00	0.00	N/A	N/A
21-29	0.01	0.01	N/A	N/A
21-30	0.00	0.00	N/A	N/A
21-31	0.00	0.00	N/A	N/A
21-32	0.00	0.00	N/A	N/A
21-33	0.00	0.00	N/A	N/A
21-34	0.00	0.00	N/A	N/A
21-35	0.01	0.01	N/A	N/A
21-36	0.00	0.00	N/A	N/A
21-37	0.00	0.00	N/A	N/A
21-38	0.01	0.01	N/A	N/A
21-39	0.01	0.01	N/A	N/A
21-40	0.00	0.00	N/A	N/A
21-41	0.00	0.00	N/A	N/A
21-42	0.00	0.00	N/A	N/A
21-43	0.00	0.00	N/A	N/A
22-23	0.00	0.00	N/A	N/A
22-24	0.00	0.00	N/A	N/A
22-25	0.00	0.00	N/A	N/A
22-26	0.00	0.00	N/A	N/A
22-27	0.00	0.00	N/A	N/A
22-28	0.00	0.00	N/A	N/A
22-29	0.01	0.01	N/A	N/A
22-30	0.00	0.00	N/A	N/A
22-31	0.00	0.00	N/A	N/A
22-32	0.00	0.00	N/A	N/A
22-33	0.00	0.00	N/A	N/A
22-34	0.00	0.00	N/A	N/A
22-35	0.01	0.01	N/A	N/A
22-36	0.00	0.00	N/A	N/A
22-37	0.00	0.00	N/A	N/A
22-38	0.01	0.01	N/A	N/A
22-39	0.01	0.01	N/A	N/A

Table 3 (continued)

C. violaceus sensu auct. mult.				
Taxa	Average	ITS	28S	*RPB2*
22-40	0.00	0.00	N/A	N/A
22-41	0.00	0.00	N/A	N/A
22-42	0.00	0.00	N/A	N/A
22-43	0.00	0.00	N/A	N/A
23-24	0.01	0.01	N/A	N/A
23-25	0.01	0.01	N/A	N/A
23-26	0.00	0.00	N/A	N/A
23-27	0.01	0.01	N/A	N/A
23-28	0.00	0.00	N/A	N/A
23-29	0.01	0.01	N/A	N/A
23-30	0.01	0.01	N/A	N/A
23-31	0.00	0.00	N/A	N/A
23-32	0.01	0.01	N/A	N/A
23-33	0.00	0.00	N/A	N/A
23-34	0.00	0.00	N/A	N/A
23-35	0.01	0.01	N/A	N/A
23-36	0.00	0.00	N/A	N/A
23-37	0.00	0.00	N/A	N/A
23-38	0.01	0.01	N/A	N/A
23-39	0.01	0.01	N/A	N/A
23-40	0.01	0.01	N/A	N/A
23-41	0.00	0.00	N/A	N/A
23-42	0.00	0.00	N/A	N/A
23-43	0.00	0.00	N/A	N/A
24-25	0.01	0.01	N/A	N/A
24-26	0.00	0.00	N/A	N/A
24-27	0.01	0.01	N/A	N/A
24-28	0.00	0.00	N/A	N/A
24-29	0.01	0.01	N/A	N/A
24-30	0.01	0.01	N/A	N/A
24-31	0.00	0.00	N/A	N/A
24-32	0.01	0.01	N/A	N/A
24-33	0.00	0.00	N/A	N/A
24-34	0.00	0.00	N/A	N/A
24-35	0.01	0.01	N/A	N/A
24-36	0.01	0.01	N/A	N/A
24-37	0.01	0.01	N/A	N/A
24-38	0.01	0.01	N/A	N/A

Table 3 (continued)

C. violaceus sensu auct. mult.				
Taxa	Average	ITS	28S	*RPB2*
24-39	0.01	0.01	N/A	N/A
24-40	0.01	0.01	N/A	N/A
24-41	0.00	0.00	N/A	N/A
24-42	0.00	0.00	N/A	N/A
24-43	0.00	0.00	N/A	N/A
25-26	0.00	0.00	N/A	N/A
25-27	0.01	0.01	N/A	N/A
25-28	0.00	0.00	N/A	N/A
25-29	0.01	0.01	N/A	N/A
25-30	0.01	0.01	N/A	N/A
25-31	0.00	0.00	N/A	N/A
25-32	0.01	0.01	N/A	N/A
25-33	0.00	0.00	N/A	N/A
25-34	0.00	0.00	N/A	N/A
25-35	0.01	0.01	N/A	N/A
25-36	0.01	0.01	N/A	N/A
25-37	0.01	0.01	N/A	N/A
25-38	0.01	0.01	N/A	N/A
25-39	0.01	0.01	N/A	N/A
25-40	0.01	0.01	N/A	N/A
25-41	0.00	0.00	N/A	N/A
25-42	0.00	0.00	N/A	N/A
25-43	0.00	0.00	N/A	N/A
26-27	0.00	0.00	N/A	N/A
26-28	0.00	0.00	N/A	N/A
26-29	0.00	0.00	N/A	N/A
26-30	0.00	0.00	N/A	N/A
26-31	0.00	0.00	N/A	N/A
26-32	0.00	0.00	N/A	N/A
26-33	0.00	0.00	N/A	N/A
26-34	0.00	0.00	N/A	N/A
26-35	0.00	0.00	N/A	N/A
26-36	0.00	0.00	N/A	N/A
26-37	0.00	0.00	N/A	N/A
26-38	0.00	0.00	N/A	N/A
26-39	0.00	0.00	N/A	N/A
26-40	0.00	0.00	N/A	N/A
26-41	0.00	0.00	N/A	N/A

Table 3 (continued)

C. *violaceus* sensu auct. mult.				
Taxa	Average	ITS	28S	*RPB2*
26-42	0.00	0.00	N/A	N/A
26-43	0.00	0.00	N/A	N/A
27-28	0.00	0.00	N/A	N/A
27-29	0.00	0.00	N/A	N/A
27-30	0.01	0.01	N/A	N/A
27-31	0.00	0.00	N/A	N/A
27-32	0.01	0.01	N/A	N/A
27-33	0.00	0.00	N/A	N/A
27-34	0.00	0.00	N/A	N/A
27-35	0.00	0.00	N/A	N/A
27-36	0.01	0.01	N/A	N/A
27-37	0.01	0.01	N/A	N/A
27-38	0.01	0.01	N/A	N/A
27-39	0.01	0.01	N/A	N/A
27-40	0.01	0.01	N/A	N/A
27-41	0.00	0.00	N/A	N/A
27-42	0.00	0.00	N/A	N/A
27-43	0.00	0.00	N/A	N/A
28-29	0.01	0.01	N/A	N/A
28-30	0.00	0.00	N/A	N/A
28-31	0.00	0.00	N/A	N/A
28-32	0.00	0.00	N/A	N/A
28-33	0.00	0.00	N/A	N/A
28-34	0.00	0.00	N/A	N/A
28-35	0.01	0.01	N/A	N/A
28-36	0.00	0.00	N/A	N/A
28-37	0.00	0.00	N/A	N/A
28-38	0.01	0.01	N/A	N/A
28-39	0.01	0.01	N/A	N/A
28-40	0.00	0.00	N/A	N/A
28-41	0.00	0.00	N/A	N/A
28-42	0.00	0.00	N/A	N/A
28-43	0.00	0.00	N/A	N/A
29-30	0.01	0.01	N/A	N/A
29-31	0.01	0.01	N/A	N/A
29-32	0.01	0.01	N/A	N/A
29-33	0.01	0.01	N/A	N/A
29-34	0.00	0.00	N/A	N/A

Table 3 (continued)

C. violaceus sensu auct. mult.				
Taxa	Average	ITS	28S	*RPB2*
29-35	0.00	0.00	N/A	N/A
29-36	0.01	0.01	N/A	N/A
29-37	0.01	0.01	N/A	N/A
29-38	0.01	0.01	N/A	N/A
29-39	0.01	0.01	N/A	N/A
29-40	0.01	0.01	N/A	N/A
29-41	0.01	0.01	N/A	N/A
29-42	0.01	0.01	N/A	N/A
29-43	0.01	0.01	N/A	N/A
30-31	0.00	0.00	N/A	N/A
30-32	0.01	0.01	N/A	N/A
30-33	0.00	0.00	N/A	N/A
30-34	0.00	0.00	N/A	N/A
30-35	0.01	0.01	N/A	N/A
30-36	0.01	0.01	N/A	N/A
30-37	0.01	0.01	N/A	N/A
30-38	0.01	0.01	N/A	N/A
30-39	0.01	0.01	N/A	N/A
30-40	0.01	0.01	N/A	N/A
30-41	0.00	0.00	N/A	N/A
30-42	0.00	0.00	N/A	N/A
30-43	0.00	0.00	N/A	N/A
31-32	0.00	0.00	N/A	N/A
31-33	0.00	0.00	N/A	N/A
31-34	0.00	0.00	N/A	N/A
31-35	0.01	0.01	N/A	N/A
31-36	0.00	0.00	N/A	N/A
31-37	0.00	0.00	N/A	N/A
31-38	0.01	0.01	N/A	N/A
31-39	0.01	0.01	N/A	N/A
31-40	0.00	0.00	N/A	N/A
31-41	0.00	0.00	N/A	N/A
31-42	0.00	0.00	N/A	N/A
31-43	0.00	0.00	N/A	N/A
32-33	0.00	0.00	N/A	N/A
32-34	0.00	0.00	N/A	N/A
32-35	0.01	0.01	N/A	N/A
32-36	0.01	0.01	N/A	N/A

Table 3 (continued)

C. violaceus sensu auct. mult.				
Taxa	Average	ITS	28S	*RPB2*
32-37	0.01	0.01	N/A	N/A
32-38	0.01	0.01	N/A	N/A
32-39	0.01	0.01	N/A	N/A
32-40	0.00	0.00	N/A	N/A
32-41	0.00	0.00	N/A	N/A
32-42	0.00	0.00	N/A	N/A
32-43	0.00	0.00	N/A	N/A
33-34	0.00	0.00	N/A	N/A
33-35	0.01	0.01	N/A	N/A
33-36	0.00	0.00	N/A	N/A
33-37	0.00	0.00	N/A	N/A
33-38	0.01	0.01	N/A	N/A
33-39	0.01	0.01	N/A	N/A
33-40	0.00	0.00	N/A	N/A
33-41	0.00	0.00	N/A	N/A
33-42	0.00	0.00	N/A	N/A
33-43	0.00	0.00	N/A	N/A
34-35	0.01	0.01	N/A	N/A
34-36	0.00	0.00	N/A	N/A
34-37	0.00	0.00	N/A	N/A
34-38	0.01	0.01	N/A	N/A
34-39	0.01	0.01	N/A	N/A
34-40	0.00	0.00	N/A	N/A
34-41	0.00	0.00	N/A	N/A
34-42	0.00	0.00	N/A	N/A
34-43	0.00	0.00	N/A	N/A
35-36	0.01	0.01	N/A	N/A
35-37	0.01	0.01	N/A	N/A
35-38	0.01	0.01	N/A	N/A
35-39	0.01	0.01	N/A	N/A
35-40	0.01	0.01	N/A	N/A
35-41	0.01	0.01	N/A	N/A
35-42	0.01	0.01	N/A	N/A
35-43	0.01	0.01	N/A	N/A
36-37	0.00	0.00	N/A	N/A
36-38	0.01	0.01	N/A	N/A
36-39	0.01	0.01	N/A	N/A
36-40	0.01	0.01	N/A	N/A

Table 3 (continued)

C. violaceus sensu auct. mult.				
Taxa	Average	ITS	28S	*RPB2*
36-41	0.00	0.00	N/A	N/A
36-42	0.00	0.00	N/A	N/A
36-43	0.00	0.00	N/A	N/A
37-38	0.01	0.01	N/A	N/A
37-39	0.01	0.01	N/A	N/A
37-40	0.01	0.01	N/A	N/A
37-41	0.00	0.00	N/A	N/A
37-42	0.00	0.00	N/A	N/A
37-43	0.00	0.00	N/A	N/A
38-39	0.00	0.00	N/A	N/A
38-40	0.01	0.01	N/A	N/A
38-41	0.01	0.01	N/A	N/A
38-42	0.01	0.01	N/A	N/A
38-43	0.01	0.01	N/A	N/A
39-40	0.01	0.01	N/A	N/A
39-41	0.01	0.01	N/A	N/A
39-42	0.01	0.01	N/A	N/A
39-43	0.01	0.01	N/A	N/A
40-41	0.00	0.00	N/A	N/A
40-42	0.00	0.00	N/A	N/A
40-43	0.00	0.00	N/A	N/A
41-42	0.00	0.00	N/A	N/A
41-43	0.00	0.00	N/A	N/A
42-43	0.00	0.00	N/A	N/A

Table 4: Pairwise distances between species in the ITS, 28S and *RPB2* loci using the Kimura 2-parameter distance correction.

ITS								
	AU1	AU2	*violaceus* sensu Moser 1986	SA1	NA1	CR2	CR1	*violaceus* auct. mult.
AU1	—	—	—	—	—	—	—	—
AU2	0.079	—	—	—	—	—	—	—
violaceus sensu Moser	0.041	0.076	—	—	—	—	—	—
SA1	0.106	0.107	0.102	—	—	—	—	—
NA1	0.068	0.073	0.065	0.067	—	—	—	—

Table 4 (continued)

ITS	AU1	AU2	violaceus sensu Moser 1986	SA1	NA1	CR2	CR1	violaceus auct. mult.
CR2	0.081	0.083	0.078	0.071	0.020	—	—	—
CR1	0.083	0.094	0.091	0.092	0.048	0.057	—	—
violaceus auct. mult.	0.062	0.073	0.060	0.071	0.020	0.023	0.044	—

28S	AU1	AU2	*violaceus* sensu Moser 1986	SA1	NA1	CR2	CR1	*violaceus* auct. mult.
AU1	—	—	—	—	—	—	—	—
AU2	0.022	—	—	—	—	—	—	—
violaceus sensu Moser	0.010	0.019	—	—	—	—	—	—
SA1	0.028	0.035	0.025	—	—	—	—	—
NA1	0.018	0.022	0.010	0.023	—	—	—	—
CR2	0.025	0.029	0.016	0.029	0.008	—	—	—
CR1	0.023	0.026	0.019	0.036	0.015	0.023	—	—
violaceus auct. mult.	0.017	0.026	0.014	0.029	0.010	0.019	0.011	—

RPB2	AU1	AU2	*violaceus* sensu Moser 1986	NA1	CR2	CR1	*violaceus* auct. mult.
AU1	—	—	—	—	—	—	—
AU2	0.069	—	—	—	—	—	—
violaceus sensu Moser	0.031	0.065	—	—	—	—	—
NA1	0.063	0.065	0.059	—	—	—	—
CR2	0.063	0.067	0.057	0.018	—	—	—
CR1	0.073	0.081	0.067	0.034	0.027	—	—
violaceus auct. mult.	0.069	0.073	0.063	0.031	0.025	0.033	—

CHAPTER II
NEW SPECIES IN *CORTINARIUS* SECTION *CORTINARIUS* (AGARICALES) FROM THE AMERICAS AND AUSTRALASIA

A version of this chapter was originally published by: Emma Harrower, Neale L. Bougher, Caitlin Winterbottom, Terry W. Henkel, Egon Horak, and P. Brandon Matheny: “New species in *Cortinarius* section *Cortinarius* (Agaricales) from the Americas and Australasia.” *Mycokeys* 11 (2015): 1-21.

Emma Harrower obtained collections, generated DNA sequences, examined collections under light and SEM microscopes, generated a species phylogeny and wrote the manuscript. Terry Henkel and Egon Horak collected some of the specimens and edited the manuscript. Neale Bougher, Caitlin Winterbottom and Brandon Matheny edited the manuscript.

Abstract

Five new species from *Cortinarius* sect. *Cortinarius* are formally described, four from the Americas (*Cortinarius palatinus* Harrower, sp. nov., *Cortinarius atrotomentosus* Harrower, sp. nov., *Cortinarius altissimus* Harrower & T.W. Henkel, sp. nov., *Cortinarius neotropicus* Harrower, sp. nov.) and one from Australasia (*Cortinarius carneipallidus* Harrower & E. Horak, sp. nov.) based on molecular, morphological, and ecological circumscription. Additional collections of the Australasian species *Cortinarius hallowellensis* Wood and *Cortinarius kioloensis* Wood reveal wider host associations and geographic ranges than previously recorded. Morphological descriptions, photomicrographs and a dichotomous key to all species in *Cortinarius* sect. *Cortinarius* are provided. This work raises the number of species in sect. *Cortinarius* to twelve.

Introduction

Recent phylogenetic analyses by Harrower et al. (2015) have revealed greater species-level diversity in *Cortinarius* (Pers.) Gray sect. *Cortinarius* (also known as the *C. violaceus* group) than previously thought (Bougher and Syme 1998, Halling and Mueller 2005, Gasparini and Soop 2008). Phylogenetically defined species within the section exhibit continental scale disjunct distributions and form ectomycorrhizal associations with different plant partners (Harrower et al. 2015). Taking their morphological differences into consideration, a taxonomic revision of the section is warranted.

Cortinarius subgenus *Cortinarius* sect. *Cortinarius* is an easily identifiable section within the very large genus *Cortinarius*. All basidiomata have a deep violet color, the pigment of which has been identified as (R)-3′,4′-dihydroxy-β[beta]-phenylalanine [(R)-β[beta]- dopa] in *Cortinarius violaceus* (L.) Gray (von Nussbaum et al. 1998). The pigment is vacuolar, encrusting (Brandrud 1983) and oxidizes quickly to brown (von Nussbaum et al. 1998). The following features for the section were noted by Brandrud (1983), the circumscription of which is based on European taxa only at the time. The pileus is tomentose to finely scaly (comprising a trichoderm), neither hygrophanous nor viscid. KOH on any surface of a basidiome produces a red reaction. Pleurocystidia and cheilocystidia are present, none of which differ in size, shape and abundance and caulocystidia are present. The basidiospores of all species are verrucose and bear a plage.

Linnaeus (1753) described the first species in the section as *Agaricus violaceus* L. Persoon (1801) recognized *A. violaceus* ("ad margines sylvarum") and *A. hercynicus* Pers. ("in pinetis"). However, the latter was synonymized with *A. violaceus* by Fries (1821). Moser (1967; 1969) later recognized *Cortinarius hercynicus* (Pers.) M.M. Moser as an autonomous species. Brandrud (1983) treated the two species as varieties and later as a subspecies (Brandrud 1990), but Harrower et al. (2015) did not find a genetic or ecological basis for distinguishing these taxa.

Clements and Shear (1931) designated *C. violaceus* (L.) Gray as the type species of the genus *Cortinarius*. The subgenus *Cortinarius* was circumscribed by Orton (1958) to include *C. violaceus*, *C. orellanus*, *C. cotoneus* and other allied species. Moser (1967,1969) transferred members of the *C. orellanus*-*cotoneus* group into subgenus *Leprocybe* sensu Moser, leaving subgenus *Cortinarius* represented by only *C. violaceus* and *C. hercynicus*. Niskanen et al. (2008) included sections *Cortinarius*, *Dermocybe*, *Veneti*, *Limonii*, *Orellani* and *Humicolae* within subgenus *Cortinarius*.

As many as twelve species have been recognized in sect. *Cortinarius*, but the inclusion of some these species is suspect. Members are known on every continent except for Africa and Antarctica (Moser 1968, Brandrud 1983). *Cortinarius violaceus* occurs throughout North America, Asia and Europe in association with members of the Fagales, Salicaceae and Pinaceae (Brandrud 1983; Nezdoiminogo 1996; Harrower et al. 2015). Horak (1980) described *C. gayi* Horak from *Nothofagus* in Chile for *C. violaceus* Fr. sensu Montagne (Montagne 1989). Singer et al. (1983) described *Cortinarius kerrii* Singer & I.J.A. Aguiar from the Amazon in campinarana vegetation. Moser (1987) documented *C. violaceus* Fr. as occurring in mixed deciduous forests in Malaysia and Papua New Guinea. In the same paper, he described *C. atroviolaceus* M.M. Moser, *C. subcalyptrosporus* M.M. Moser and *C. paraviolaceus* M.M. Moser from Mt. Kinabalu, Sabah, Malaysia. Malaysian plant associates were likely in the plant families Fagaceae and Myrtaceae (Beaman et al. 2000, Beaman and Anderson 2004), and Moser also documented *C. atroviolaceus* and *C. subcalyptrosporus* as occurring with *Nothofagus* in New Zealand (Moser 1987). He was uncertain whether *C. paraviolaceus* belonged in sect. *Cortinarius* due to the lack of cheilocystidia, atypical pleurocystidia, a pileus that is not strongly squarrose-fibrillose-squamulose and basidiomata that are less intensely violet (Moser 1987). Moser also described *C. atrolazulinus* M.M. Moser with *Nothofagus* in New Zealand (Moser 1987). Gasparini (2001) added *C. austroviolaceus* Gasparini from Australia. This species was excluded from the *C. violaceus* group by Harrower et al. (2015) due to a lack of pleurocystidia and phylogenetic placement outside the clade containing *C. violaceus*. Wood (2009) described *C. jenolanensis*, *C. kioloensis* and *C. hallowellensis* from *Eucalyptus* forests in Australia, but the former lacks pleurocystidia suggesting to us an alliance outside the *C. violaceus* group. Assuming *C. hercynicus* is treated as a synonym of *C. violaceus* then twelve species can be recognized in sect. *Cortinarius*.

Harrower et al. (2015) produced a multigene phylogenetic tree that delimited eight different species present in sect. *Cortinarius* in the Americas and Australasia. Species were separated by at least a 2% difference in the ITS region, which conforms to the benchmark in *Cortinarius* established by Stephani et al. (2014). Of the eight species level lineages detected, two new were found in Costa Rica, one in North America, one in New Zealand, and one in Guyana. Here we provide descriptions for all species recognized in this previous study (except for *C. violaceus*). Additional collections of *C. kioloensis* and *C. hallowellensis* (Wood 2009) have been examined extending their known host association and geographic ranges. The purpose of this study is to revise the taxonomy of species in the *C. violaceus* group found in Australasia and the Americas and refine sect. *Cortinarius* based on morphological data previously confirmed by molecular phylogenetic results. A key to twelve species in the section is provided.

Methods

Dried specimens of collections labeled as *C. violaceus*, *C. subcalyptrosporus*, *C. atroviolaceus*, *C. atrolazulinus*, and *C. austroviolaeus* were obtained from the TENN, ZT, HSC, NY, PDD and PERTH herbaria. Additional collections were provided from Ian Dodd (West Kempsey, Australia). Requests for type collections of *C. subcalytrosporus*, *C. atroviolaceus*, *C. atrolazulinus* and *C. paraviolaceus* were denied from the IB herbarium. Previous attempts to sequence *C. subcalyptrosporus* and *C. paraviolaceus* were purportedly unsuccessful (Ursula Peintner, personal communication).

Morphological analysis

Macroscopic descriptions were taken from fresh material as described by collectors where possible. Color documentation of basidiocarps follows the Methuen Handbook of Colour (Kornerup and Wanscher 1967). When no descriptions were made from fresh material, macroscopic descriptions were assembled from dried material and from photographs of fresh material. By measuring the pileus diameter and stipe length of MEL 2351101 (*C. kioloensis*) before and after drying, it was estimated that basidiomata were reduced by a factor of 1.75 upon drying. Macroscopic measurements were taken from dried specimens of *C. atrotomentosus* sp. nov., *C. neotropicus* sp. nov., *C. kioloensis* and *C. carneipallidus* sp. nov. Dry measurements were multiplied by a factor of 1.75.

Microscopic features were observed from sections of dried material rehydrated in 5% KOH on a Nikon Eclipse 80i microscope. Basidiospore measurements were taken from spores trapped in the cortina on the stipe. However, for specimens that did not have any remaining cortina, basidiospore measurements were taken from lamellar tissue, and mature basidiospores (judged by the presence and development of ornamentation) were measured at random. Measurements were taken with a Nikon DS-Fi1 camera and Nikon NIS Elements 3.1 software. Twenty-five basidiospores were measured per collection. Outliers are placed in parentheses. Five basidia, cheilocystidia, and pleurocystidia were measured per specimen. The following abbreviations are used: Q = quotient of length divided by width; Q mean = average value of Q values. Scanning electron microscope images were taken on a Zeiss Auriga scanning electron microscope. Lamellae were placed on double-sided carbon adhesive tape and covered with two layers of a gold sputter coating.

Phylogenetic study

Methods for DNA extraction, PCR amplification, and sequencing are given in Harrower et al. (2015). Figure 2 in Harrower et al. (2015) is summarized here in part as Figure 5[1], showing the phylogenetic relatedness of species within sect. *Cortinarius*.

Taxonomy

Cortinarius* Fr. subgen. *Cortinarius* sect. *Cortinarius

Synonyms: *Agaricus* (ser. *Cortinaria*) trib. *Inoloma* Fr.: Fr. 1821: 217. – *Agaricus* subgen. *Inoloma* (Fr.: Fr.) Loudon 1836: 1000. – *Cortinarius* Fr. 1836 trib. *Inoloma* (Fr.: Fr.) Fr. 1836: 279. – *Inoloma* (Fr.: Fr.) Wünsche 1877: 87. – Type species: *Cortinarius violaceus* (L.:Fr.) Gray.

Type species. *Cortinarius violaceus* (L.:Fr.) Gray

Basidiomata tricholomatoid, deep violet; pileus squamose to tomentose, rarely greasy, then simply innately fibrillose; KOH+ red; basidiospores subglobose, ellipsoid to amygdaliform, weakly to strongly verrucose, with suprahilar plage (may only be visible in SEM); pleurocystidia and cheilocystidia present; caulocystidia present or usually absent; pileipellis a trichoderm of hyphae (6–22 µm wide) or rarely an ixocutis with gelatinized hyphae (2-11µm wide); pigment vacuolar and soluble in water, violet often turning brownish in age.

Key to species of *Cortinarius* sect. *Cortinarius*

1 Pileus smooth, greasy; pileipellis an ixocutis……………………*C. hallowellensis*
– Pileus scaly, dry; pileipellis a trichoderm 2
2 Stipe more than two times longer than the width of the pileus ....*C. altissimus*
– Stipe less than twice as long as the width of the pileus....................................... 3
3 Basidiospores with a visible perisporium ....*C. subcalyptrosporus*
– Basidiospores without a loosening of the perisporium... 4
4 Cheilocystidia 25–30 × 9.5–11.5 µm..*C. kerrii*
– Cheilocystidia larger than above.. 5
5 Basidiospores 9–12.5 × 5.5–6.5 µm; Q=1.86; basidia 32–38 × 7.5–8 µm ....*C. atrolazulinus*
– Basidiospores often longer, less elongate; Q<1.86; basidia width > 8 µm 6
6 Growing on calcareous soil with *Quercus virginiana*……...........*C. atrotomentosus*
– Growing on a variety of soils; not with *Quercus virginiana*.................................. 7
7 Basal mycelium white ....*C. neotropicus*
– Basal mycelium pale violet 8

[1] All figures are located in the Appendix

8 Caulocystidia present ....*C. violaceus*
– Caulocystidia absent 9
9 Occurring with Quercus in Costa Rica ....*C. palatinus*
– Occurring with *Myrtaceae* or *Nothofagus* in Australasia or Fagaceae in Indonesia 10
10 With *Nothofagus* ....*C. carneipallidus*
– Not with *Nothofagus* ……………………………………………………..……….11
11 Occuring with Myrtaceae in Australia and New Zealand ....*C. kioloensis*
– Occuring with Fagaceae in Indonesia...*C. atroviolaceus*

Cortinarius kioloensis Wood 2009
Figures 5, 6a, 7a, 8a

Type. AUSTRALIA. New South Wales: Batemans Bay, Kioloa State Forest, Eucalypt woodland, 19 May 1983, S. Lowry (holotype: UNSW 83/781).

Description. Pileus 45–120 mm wide, convex to plano-convex with a low, broad umbo with age, surface dry, tomentulose-squamulose, dark violet (17F8), lighter concolorous (17E3) near margin, red in KOH; margin entire, split and broadly undulating with age. Lamellae close, sinuate, thick, broad to ventricose, deep blue (19D–E8). Stipe 105–165 mm long, 7–28 mm thick at apex, 9–31 mm thick at base, bulbous, light violet (18A3–5) turning deep blue (18F8) upon touch because of the copious universal veil. Universal veil pale violet (17A3). Basal mycelium pale violet (17A3). Context at apex dark violet to black (18F8).

Basidiospores 10.5–14 µm × 6.5–9 µm, means= 11.5–12.5 µm × 7.5–8 µm, Q = 1.41–1.63, Q means = 1.45–1.60 (125 spores, 5 specimens), ellipsoid to amygdaloid, strongly verrucose, plage present under SEM. Basidia 4-spored, clavate, (27) 35–49 µm × 8–12 µm. Cheilocystidia ventricose to lageniform, sometimes strangulated, brown in KOH, (50–) 60–100 (–127) µm × (10–) 15–30 (–35) µm. Pleurocystidia narrowly conical to lageniform, sometimes strangulated, brown or grey in KOH, (50–) 60–90 (–105) µm × (15–) 20–25 (–30) µm. Caulocystidia absent but brown vacuolar pigment in some hyphae of the caulopellis. Pileipellis a trichoderm composed of fasicles of multiseptate hyphae, 8–20 µm wide, smooth, terminal cells clavate to lanceolate, with brown contents in KOH. Clamp connections present.

Ecology and distribution. With *Eucalyptus* and/or *Allocasuarina* in southeast Australia. With *Leptospermum* in New Zealand. Fruiting April to July.

Other specimens examined. Australia. Tasmania: Florentine River Valley, Pagoda Hut, on soil under *Eucalyptus* and *Allocasuarina*, 23 Apr. 2003, D.A. Ratkowsky (MEL 2351101). New South Wales: Swans Crossing State Forest (Eucalyptus), 21 May 2003, I. Dodd 70845 (TENN 069666). New Zealand. Auckland: Waitakere Ranges, Little Huia, Donald Mclean Track, 10 July 2010, C. Shirley AK375 (PDD 99307). Auckland: Waitakere, Piha Rd, Upper Nihotupu Dam track, (*Leptospermum*), 24 July 2010, C. Shirley AK373 (PDD 99309). Auckland: Waitakere, Mountain Rd, Opanuku Pipeline Track, (*Leptospermum*), 17 July 2010, C. Shirley AK370 (PDD 99308).

Discussion. The collections examined here match the protologue of *C. kioloensis* Wood in all particulars. One collection (TENN 069666) was seen to have dark purple, nearly black flesh at the apex. Flesh color at the base was not observed. We have not studied the type of this species (the collection was not readily available at UNSW) but are confident for now applying the name *C. kioloensis* to our material. As such, the species range has been extended from N. S. W. into Tasmania and New Zealand and a new host association with *Leptospermum* has been revealed. *Cortinarius atroviolaceus* and *C. kioloensis* cannot be distinguished morphologically, but the two are geographically separated and likely ecologically differentiated. *Cortinarius atroviolaceus* is found at 1700 m on Mt. Kinabalu, Malaysia where *Leptospermum* (Myrtaceae), *Trigonobalanus* (Fagales), *Quercus* (Fagales), *Lithocarpus* (Fagales), and Castanopsis (Fagales) may occur (Beaman et al. 2000; Beaman and Anderson 2004). *Cortinarius kioloensis* is found with *Eucalyptus* (Myrtaceae) and/ or *Allocasuarina* (Casuarinaceae) in southeastern Australia and with *Leptospermum* (Myrtaceae) in New Zealand. Herbarium collections of *C. kioloensis* from New Zealand have been misidentified as *C. subcalyptrosporus*. *Cortinarius kioloensis* differs from *C. subcalyptrosporus* by the non-calyptrate basidiospores. It differs from *C. atrolazulinus* by association with Myrtaceae, not Nothofagaceae. *Cortinarius kioloensis* is also similar to *C. carneipallidus*, a *Nothofagus* association, but differs from this latter species by association with Myrtaceae. Phylogenetic results (Figure 5) also support these separations. Unique molecular synapomorphies are present at pos. 11, 35, 203 (ITS1), 475, 554, 577, 578, 623 (ITS2) of our alignment. *Cortinarius kioloensis* was treated as “C. sp. AU1” in Harrower et al. (2015).

Cortinarius palatinus **Harrower, sp. nov.**
MycoBank MB 811657
Figures 5, 6b, 7b, 8b

Diagnosis. Similar to *Cortinarius neotropicus* sp. nov. but differs in having shorter basidiospores and absence of caulocystidia. Unique molecular synapomorphies at pos. 39 (ITS1), 524, 618, 649, 651, 672 (ITS2) of our alignment.

Type. COSTA RICA. San Jose: Perez Zeledon, Villa Mills, CATIE Experimental Forest, 9°33'03"N; 83°40'56"W, 2880 m alt., (*Quercus costaricensis*), 21 June 2003, R.E. Halling 8411 (holotype: NY 796168).

Etymology. Named for the color palatinate, a shade of violet.

Description. Pileus 30-50 mm wide, convex to plano-convex, surface dry, densely squamulose, appressed toward margin, erect on disc, violet (15C5–8, 15D5–8,15E5–8, 16C5–8, 16D5–8, 16E5–8), red with KOH. Lamellae adnexed, close, violet, concolorous with pileus, soon assuming brown colors, up to 1 cm broad, edges even to uneven. Stipe 80–120 mm long, 10–14 mm broad, equal or subclavate, strict or curved, dry, upper half violet, fibrillose–striate; lower half pale violet, fibrillose, base violet (15C5–8, 15D5–8, 15E5–8, 16C5–8, 16D5–8, 16E5–8). Universal veil pale violet. Context pale violet, unchanging. Smell mild. Taste mild.

Basidiospores 11–15 μm × 7–9.5 μm, means= 12–13 μm × 8–8.5 μm, Q = 1.39–1.59, Q means= 1.40–1.53 (150 spores, 6 specimens). Amygdaloid, strongly verrucose, plage present under SEM. Basidia 2- and 4-spored, clavate, (20–) 30–40 × 10–15 μm. Cheilocystidia present but not abundant in younger specimens, lageniform, brown or grey in KOH, (35–) 60–95 (–100) μm × (11–) 13–25 (–30) μm. Pleurocystidia abundant, lageniform, brown or grey in KOH, (40–) 50–80 (–105) µm × (10–) 15–25 (–40) µm. Pileipellis a trichoderm composed of hyphae up to 20 µm wide, multi-septate, with brown contents in KOH, terminal hyphae blunt-ended, sometimes aciculate. Clamp connections present.

Ecology and distribution. Known from Perez Zeledon and San Gerardo de Dota in Costa Rica. Associated with *Quercus copeyensis*, *Q. seemannii*, and *Q. costaricensis* on acidic soils. Occurring mid-June to mid-July. Elevation 2220–2280 m.

Other specimens examined. Costa Rica, San Jose, Perez Zeledon, Villa Mills, CATIE Experimental Forest, 9°33'03"N; 83°40'55"W, 2880 m, (*Quercus costaricensis*), 22 June 1995, R.E. Halling 7450 (NY 79537). San Jose, San Gerardo de Dota, Albergue de Montana, Savegre, ~5 km SW of Cerro de la Muerte, 9°33'02"N; 83°48'27"W, 2500 m, (*Quercus copeyensis*, *Q. seemannii*), 20 June 1994, R.E. Halling 7307 (NY 34724). San Jose, Perez Zeledon, Villa Mills, CATIE Experimental Forest, 9°41'56"N; 83°56'31"W, 2850 m, (*Quercus costaricensis*), 12 June 2000, R.E. Halling 8184 (NY 795933). San Jose, San Gerardo de Dota, Albergue de Montana, Savegre, ~5 km SW of Cerro de la Muerte, 9°33'02"N; 83°48'27"W, 2220 m, (*Quercus copeyensis*, *Q. seemannii*), 10 July 2001, R.E. Halling 8004 (NY 460906). San Jose, Perez Zeledon, Villa Mills, CATIE Experimental Forest, (*Quercus costaricensis*), 23 June 2001, E.& A. Horak (ZT 10422).

Discussion. *Cortinarius palatinus* sp. nov. is treated as 'C. sp. CR2' in Harrower et al. (2015). It occurs in the same oak forests and at the same elevation as *Cortinarius neotropicus* sp. nov. It can be distinguished from *C. neotropicus* sp. nov. by its larger and more heavily verrucose basidiospores and pale violet context. Caulocystidia were found in *C. violaceus* and *C. neotropicus* sp. nov., but not in *C. palatinus* sp. nov. *Cortinarius atrotomentosus* sp. nov. differs from *C. palatinus* sp. nov. by its wider and olive colored stipe. These two species appear to be most closely related (Figure 5). *Cortinarius atrotomentosus* sp. nov. occurs on limestone soil and *C. palatinus* sp. nov. on acidic soil. This is the same species that was referred to as *C. violaceus* by Halling and Mueller (2005) from the Talamanca Mountains of Costa Rica (NY 795933 illustrated).

***Cortinarius altissimus* Harrower & T.W. Henkel, sp. nov.**
MycoBank MB811658;
Figure 5, 6g, 7c, 8c

Diagnosis. Similar to *Cortinarius kerrii* Singer & I.J.M. Araujo but differs by its larger basidia and less frequent, much larger pleurocystidia. Unique molecular synapomorphies at pos. 46, 108, 156, 212, 216, 259, 260, 261, 262, 264 (ITS1), 440, 503, 506, 532, 545, 554, 583, 617 (ITS2) are present in our alignment.

Type. GUYANA. Region 8 Potaro-Siparuni: Pakaraima Mountains, Upper Potaro River Basin, vicinity of Potaro base camp at 5°18'04"N; 59°54'40"W, 710 m alt., on lateritic soils; 2 km southeast of base camp near Dicymbe plot 1, on humic mat of forest floor under *Dicymbe corymbosa*, May 25 2001, T.W. Henkel 8211 (holotype: BRG 41220; isotype TENN 069829, HSC G1168)

Etymology. Refers to the exceptionally tall basidiomata of the species, due to the long stipe.

Description. Pileus 24–56 (–87) mm wide, 17–29 mm tall, convex to plano-convex with a low, broad umbo with age, surface dry, erect tomentulose-squamulose throughout, especially over disc, under hand lens squamules subpyramidal and subacuminate, 0.5 mm tall, dark violet (16F7–16F8, 17F7–17F8), lighter concolorous (16E8) near margin, red in KOH; margin entire, broadly undulating with age. Lamellae subclose, shallowly adnexed with short decurrent tooth, subthick, 2 mm broad at margin, 8–10 mm centrally, 7 mm at stipe, concolorous (16F5–17F5), browning with basidiospore development; edges concolorous, hispid under hand lens; lamellulae usually 3 (2 short at 1–3 mm, 1 long at 6–21 mm), occasionally 5, rarely 7. Stipe 132–220(–263) mm long, (2–) 5–11 mm thick at apex, (3–) 7–17 mm thick at center, (7–) 12–24 mm thick at base, subequal, tapering gradually from base to apex, concolorous (16F5–16F6) or slightly lighter concolorous (16D7–16E7, 17D7–17E7) over lower 4/5, apex slightly more greyish violet (15D6–15D7), finely longitudinally striate throughout, with appressed longitudinal fibrils visible under hand lens, cartilaginous, snapping easily, red with KOH. Partial veil cortinate, rather scant, concolorous, minimally retained as scattered, rust-brown fibrils on upper stipe and occasionally pileus margin. Basal mycelium a pale purple (16B3–16B4) matted tomentum. Pileus context subsolid, off white to light purple (17A4–17B4), unchanging, 0.5–1 mm thick at margin, 1–1.5 mm centrally, 6 mm above stipe. Stipe context cartilaginous and concolorous in outer rind, core hollow and off-white, reddening instantly with KOH. Smell mild, slightly fruity to musty. Taste minimal, indistinct.

Basidiospores dark orange–brown (7E7–7E8) in heavy deposit, 10–16 × 8–11 (–13) µm, means = 12–14 × 9.5–11 µm, Q = (1.0–) 1.10–1.44 (–1.56), Q means = 1.18–1.33 (70 spores, 5 specimens), ellipsoid to amygdaloid, verrucose, plage present under SEM. Basidia 4-spored, clavate, (40–) 50–60 (–65) × (8–) 9–15 (–16) µm. Cheilocystidia scattered to abundant, ventricose-rostrate to lageniform, opaque greyish or brown in KOH, (60–) 70–90 (–100) µm × (10–) 20–30 (–40) µm. Pleurocystidia infrequent, ventricose to ventricose–rostrate, grey or rarely brown in KOH, (60–) 70–110 (–125) × (10–) 25–40 (–45) µm. Pileipellis a trichoderm, organized into discrete, suberect fascicles; hyphae (10–) 15–30 (–35) µm wide, (225–) 270–500 (–550) µm high, light brown in KOH, multiseptate; terminal cells undifferentiated, rounded at apex, or occasionally subclavate. Clamp connections present.

Ecology and distribution. Solitary to scattered on humic mat of forest floor in forests dominated by *Dicymbe corymbosa* (Caesalpinioideae) on lateritic soils; also occurring in forests dominated by *Dicymbe altsonii*, *Aldina insignis* (Papilionoideae), and *Pakaraimaea dipterocarpacea* (Dipterocarpaceae) and *Dicymbe jenmanii* on white sand soils; known only from the Upper Potaro and Upper Mazaruni River Basins in the Pakaraima Mountains of Guyana, in the central Guiana Shield.

Other specimens examined. Guyana, Region 8 Potaro-Siparuni: Pakaraima Mountains, Upper Potaro River Basin, within a 15 km radius of Potaro base camp at 5°18'04"N; 59°54'40"W, 710 m alt., on lateritic soils; 1 km SE of Potaro base camp on Benny’s Ridge, (*Dicymbe corymbosa*), 7 July 2003, T.W. Henkel 8539 (BRG; HSC G1169; TENN 069831). ~15 km E of Potaro base in vicinity of Tadang base camp, (*Dicymbe altsonii*, *Aldina insignis*), 30 Dec 2009, T.W. Henkel 9180 (BRG; HSC G1170; TENN 069830). 200 m southwest of Tadang base camp (*Dicymbe corymbosa*, *Dicymbe altsonii*, *Aldina insignis*), 6 June 2013, T.W. Henkel 9752 (BRG; HSC G1171). Region 7

Mazaruni-Cuyuni: Pakaraima Mountains, Upper Mazaruni River Basin, within 1 km radius of base camp at 5°26'21"N, 60°04'43"W, ~800 m alt., on white sand soils; 1 km SW of base camp in monodominant stand of *Pakaraimaea dipterocarpacea*, 25 Dec 2010, T.W. Henkel 9543 (BRG; HSC G1172). Pakaraima Mountains, Upper Mazaruni River Basin, within 1 km radius of base camp at 5°26'21"N, 60°04'43"W, ~800 m alt., on white sand soils; 1 km SW of base camp in monodominant stand of *Pakaraimaea dipterocarpacea*, 5 June 2012, T.W. Henkel 9690 (BRG; HSC G1173).

Discussion. *Cortinarius altissimus* was treated as '*Cortinarius* sp. SA1' in Harrower et al. (2015). The species has an exceptionally long stipe compared to the width of its pileus, and overall one of the longest stipe lengths recorded in the genus. The size of its basidiospores overlaps with that of *C. kerrii*, which is known from Amazonia. However, the size of the basidia and cystidia are twice that of *C. kerrii*. Additionally, pleurocystidia are infrequent in *C. altissimus* sp. nov. whereas they are abundant in *C. kerrii*. *Cortinarius altissimus* sp. nov. is a prominent member of the ECM fungal assemblage associated with *Dicymbe* monodominant forests in Guyana. In a long-term *D. corymbosa* plot study of Henkel et al. (2012), basidiomata of *C. altissimus* sp. nov. occurred in 5.2% of 630 quadrats sampled during the May–July rainy seasons over seven years. Phylogenetically (Figure 5), *C. altissimus* sp. nov. is most closely related to other taxa of the *C. violaceus* group that also occur in the Americas.

Cortinarius hallowellensis **Wood 2009**
Figures 5, 6d, 7d, 8d

Type. AUSTRALIA. Western Australia: Mount Hallowell Reserve, (Eucalyptus) 22 May 1993 K. Syme (holotype: PERTH 5506794).

Description. Pileus 34–90 mm wide, not velvety or velvety smooth, not at all squamulose, greasy when wet, radially innately fibrillose when dry, dark violet (18F4), red in 5% KOH. Lamellae broadly adnexed to adnate, 4–9 mm deep, subdistant, dark violet (16F5), edge smooth, entire, lamellulae abundant in 2 tiers. Stipe 37–80 mm long,10–30 mm thick, dry, longitudinally fibrillose, cylindrical to clavate with a swollen base, 16F4 (dark violet). Universal veil deep violaceus. Context firm in pileus, fibrous in mature stipe, pallid, tinged purplish (16A2) especially near outside; purple slate/deep purple in stipe and middle of pileus surrounded by speckled white in pileus; yellow-brown at base of stipe. Basal mycelium whitish. Odor not distinctive. Taste none.

Basidiospores (8.5–) 10–13.5 µm × (5–) 6–7.5 µm, means = 10–12 µm × 6–7 µm, Q = 1.55–1.95, Q means = 1.55–1.94, (150 spores, 6 specimens), ellipsoid to subamygdaliform, moderately verrucose, plage barely noticeable under SEM. Basidia 4-spored, clavate, (25–) 30–50 (–65) µm × 9–12 µm. Cheilocystidia abundant, narrowly fusiform, purple or brown in KOH, (50–) 55–95 (–130) µm × 10–20 µm. Pleurocystidia abundant, narrowly fusiform, purple or brown in KOH, (40–) 50–90 (–105) µm × (5–) 10–15 µm. Caulocystidia not observed. Pileipellis an ixocutis, of even thickness throughout. Hyphae 2.5–11.0 µm wide. Clamp connections present.

Ecology and distribution. With *Eucalyptus*, *Corymbia*, *Melaleuca*, *Allocasuarina*, *Agonis*, and/or *Leptospermum* in Western Australia and Tasmania. Fruiting May and June.

Other specimens examined. Australia. Tasmania: Scamander, Winifred Curtis Scamander Reserve, near Boundary Track (*Allocasuarina verticillata* and *Eucalyptus*), 8 June 2003, D.A. Ratkowsky (MEL 2350466). Hobart, Peter Murrell Nature Reserve. Site HEG. [55G, 524296, 5258469], (*Allocasuarina monilifera*, *Eucalyptus amygdalina*, *Leptospermum scoparium*), 10 July 2001, S. McMullan-Fischer (MEL 2300544). Western Australia: Two Peoples Bay Nature Reserve, Moates Lake access road (*Allocasuarina monilifera*, *Eucalyptus amygdalina*, *Leptospermum scoparium*), 7 May 1991, K. Syme (PERTH 3978729). Cemetery Road near Walpole-Nornalup National Park (*Eucalyptus marginata*, *Corymbia calophylla*, *Agonis flexuosa*, *Agonis parvceps*, *Agonis hypericifolia*, *Allocasaurina fraseriana*, *Melaleuca* sp.), 3 May 1992, K. Syme, N.L. Bougher & M. Hart (PERTH 7581696).

Discussion. *Cortinarius hallowellensis* was treated as '*Cortinarius* sp. AU2' in Harrower et al. (2015). Based on sequencing the type, we have demonstrated that this species occurs in Tasmania as well as Western Australia. *Cortinarius hallowellensis* is unique in the *C. violaceus* group in that it has an ixocutis instead of a trichoderm and is the deepest diverging lineage in the *C. violaceus* clade (Figure1). Macroscopically, the pileus is not at all squamulose. The suprapellis is mucilaginous imparting a greasy appearance when wet. The only other species in the *C. violaceus* group found in Australia – *C. kioloensis* is readily distinguished from *C. hallowellensis* by its dry, tomentulose-squamulose pileus. *Cortinarius jenolanensis*, *C. paraviolaceus* and *C. austroviolaceus* lack a squamulose pileus, but unlike *C. hallowellensis*, they lack pleurocystidia and/or cheilocystidia. *Cortinarius hallowellensis* is also referred to as *C. violaceus* by Bougher and Syme (1998) (PERTH 5506794 illustrated). Unique molecular synapomorphies are found at pos. 63, 100, 101, 123, 132, 148, 163, 164, 180, 228 (ITS1), 462, 532, 540, 546, 577, 602, 611, 614, 643 (ITS2) in our alignment.

***Cortinarius neotropicus* Harrower, sp. nov.**
MycoBank MB 811660
Figures 5, 6e, 7e, 8e

Diagnosis. Similar to *Cortinarius palatinus* Harrower sp. nov. but differs by its longer basidiospores and presence of caulocystidia. Unique molecular synapomorphies are found at pos. 58, 161, 200, 205 (ITS1), 467, 566 (ITS2) in our alignment.

Type. COSTA RICA. San Jose: Perez Zeledon, Villa Mills, CATIE Experimental Forest, 9°33'03"N; 83°40'55"W, 2880 m, (*Quercus costaricensis*), 22 June 1994, R.E.Halling 7330 (holotype: NY 34729).

Etymology. Refers to where it is found: the neotropics.

Description. Pileus 28–88 mm wide, convex to plano-convex, surface dry, not hygrophanous, squamulose to appressed squamulose, (18D3-6, 18E3-6), dull violet to greyish violet, red with KOH. Lamellae subdistant, adnexed to adnate, average thickness, ventricose, dark violet (17F2). Stipe 61–149 mm long, 4–16 mm thick at apex, 7–48 mm thick at base, tapering gradually from base to apex, sometimes clavate, dry, 18(D–E)(3–6), dull violet to grayish violet. Universal veil pale violet. Basal mycelium white. Odor mild. Taste mild.

Basidiospores (11.5–) 13–17 μm × 7–10 μm, means= 13–15 × 8–9 μm, Q = 1.53–1.77, Q means = 1.59–1.78, (200 spores, 8 specimens), ellipsoid to amygdaloid, finely verrucose, plage present under SEM. Basidia 4-spored, clavate, (25–) 30–45 (–55) µm × 10–15 µm. Cheilocystidia abundant, narrowly fusiform to lageniform, brown or grey in KOH, (40–) 50–75 (–95) µm × (10–) 15–20 (–30) µm. Pleurocystidia abundant, narrowly fusiform to lageniform, sometimes subcapitate, brown or grey in KOH, (35–) 50–90 (–120) µm × 10–25 (–40) µm. Caulocystidia present. Pileipellis a trichoderm, composed of interwoven smooth hyphae, these 9–20 µm wide, 265–415 µm high, multiseptate, with brown contents in KOH, terminal hyphae mostly blunt-ended, some lanceolate. Clamp connections present.

Ecology and distribution. Known from Costa Rica and Colombia. With *Quercus copeyensis*, *Q. seemannii*, and *Q. costaricensis* in Costa Rica and with *Q. humboldtii* and *Trigobalanus* in Colombia. 2200–2880 m alt. Fruiting late May to the end of August in Costa Rica and November in Colombia.

Other specimens examined. Colombia. Huila: Finca Merenberg, (*Quercus humboldtii*), 21 May 1987, R.E. Halling 5284 (NY). Valle del Cauca: Municipio de Pance, Parque Nacional Los Farallones, above El Topacio, (*Trigonobalanus*), 17 Nov. 1988, A.E. Franco-Molano 151 (NY). Costa Rica. San Jose: Perez Zeledon, Villa Mills, CATIE Experimental Forest, 9°33'03"N 83°40'60 W (*Quercus costaricensis*), 30 June 1998, R.E. Halling 7787 (NY 75934). Perez Zeledon, Villa Mills, CATIE Experimental Forest, 9°33'03"N; 83°40'60"W, 2840 m, (*Quercus costaricensis*), 27 June 2000, R.E. Halling 7946 (NY 460484). San Gerardo de Dota, Albergue de Montana, Savegre, ~5 km SW of Cerro de la Muerte, 9°33'02"N; 83°48'27"W, 2200 m alt., (*Quercus copeyensis* and *Q. seemannii*), 9 June 2001, R.E. Halling 8154 (NY 795935). San Gerardo de Dota, Albergue de Montana, Savegre, ~5 km SW of Cerro de la Muerte, 9°33'02"N; 83°48'27"W,
2500 m alt., (*Quercus copeyensis* and *Q. seemannii*), 8 June 1997, R.E. Halling 7709 (NY 181476). La Guaria, 9°35'60"N; 83°58'60"W, 2300 m alt., (*Quercus copeyensis* and *Q. seemannii*), 21 Aug. 1995, A.E. Franco-Molano 1393 (NY).

Discussion. *Cortinarius neotropicus* sp. nov. was treated as '*Cortinarius* sp. CR1' in Harrower et al. (2015). This species can be distinguished from *C. palatinus* sp. nov., with which it co-occurs in Costa Rica, by its smaller and finely verrucose basidiospores. In addition, *C. neotropicus* sp. nov. and *C. violaceus* both have caulocystidia, whereas other species in the *C. violaceus* group (such as *C. palatinus* sp. nov. and *C. atrotomentosus* sp. nov.) do not. Colors of the basal mycelium and context have not been recorded. There are no microscopic characters that can be used to distinguish it from *C. violaceus*, and the two species are supported as sister lineages (Figure 5).

Cortinarius carneipallidus Harrower & E. Horak, sp. nov.
MycoBank MB 811661
Figures 5, 6f, 7f, 8f

Diagnosis. Similar to *Cortinarius kioloensis* but differs by its association with *Nothofagus*. Unique molecular synapomorphies at pos. 33, 157, 170, 190, 233, 249 (ITS1), 472, 480, 489, 525, 607, 670 (ITS2).

Type. NEW ZEALAND. Ruapehu: Tongariro National Park, Mt. Ruapehu, Blyth Track, (*Nothofagus solandri*) 21 April 2009, J.A. Cooper (holotype: PDD 95444).

Etymology. Means ‘pale flesh’, referring to the relative lack of purple pigment in the center context of this species compared to *C. violaceus*, *C. atrotomentosus*, *C. atrolazulinus*, *C. atroviolaceus* and *C. subcalyptrosporus*.

Description. Pileus 49–100 mm wide, surface dry, convex then plano-convex, tomentose to fine scaly, dark violet (16D5–8), paler at margin, red in KOH. Lamellae crowded, emarginate-adnexed, average thickness, broad, deep violet. Stipe 96–175 mm long, 5–11 mm thick at apex, 12–30 mm thick at base, subequal, sometimes slightly bulbous, tapering gradually from base to apex, pale violet (17C3–6), covered in copious veil material. Universal veil pale violet (same color as stipe), leaving bands on the stipe. Basal mycelium pale violet. Context white flecked with violet in pileus and lower half of stipe, upper half of stipe violet flecked with white, sometimes white with violet cortex, younger specimens violet flecked with white and only fully white in the base.

Basidiospores (9–) 10–12 (–13) µm × (7–) 8–9 (–9.5) µm, means = 10.5–12 µm × 8–8.5 µm, Q = 1.19–1.64, Q means = 1.30–1.45, (224 spores, 8 specimens). Ellipsoid to amygdaloid, strongly verrucose, plage present. Basidia 4 spored, clavate, (35–) 40–50 (–55) µm × (9–) 10–12 (–13) µm. Cheilocystidia abundant, narrowly fusiform to lageniform, brown in KOH, 60–90 (–100) µm × 15–20 (–25) µm. Pleurocystidia abundant, narrowly fusiform to lageniform, sometimes subcapitate, brown in KOH, (40–) 55–80 (–100) µm × (10–) 15–25 (–30) µm. Caulocystidia not seen. Pileipellis a trichoderm, composed of smooth hyphae 10–25 µm wide, 350–370 µm long, multiseptate, brown content in KOH, terminal cells bottle-shaped, clavate, lanceolate or ending bluntly. Clamp connections present.

Ecology and distribution. Under *Nothofagus* in New Zealand. Fruiting April to June.

Other Specimens Examined. New Zealand. Wellington: Kapiti Coast, Tararua Forest Park (*Nothofagus*), 16 May 2009, K. Hosaka (PDD 98057). Canterbury: Selwyn Klondyke Corner (*Nothofagus cliffortioides*), 5 June 2010, P. White (PDD 95823). Waikato: Taupo, Erua Forest National Park, Erua Forest rest area (*Nothofagus*), 8 Apr. 2005, L. Fischer (PDD 82693). Taupo, Mt. Ruapehu, Tongariro National Park, Whakapapanui Track, Buller 28 Apr. 2001, E. Horak (PDD 72636). West Coast: Buller, Springs Junction, Lake Christabel Track, 14 Apr. 2000, E. Horak (PDD 71219). Buller, Reefton, Victoria Forest Park, Tawhai Walk, (*Nothofagus*) 13 May 2006, E. Horak (PDD 88638). Buller, South Charleston, Tiropahi Track (*Nothofagus*) 8 May 2010, A. Roberts (PDD 88995).

Discussion. *Cortinarius carneipallidus* sp. nov. differs from *C. subcalyptrosporus* by the absence of calyptrate basidiospores. The association with *Nothofagus* distinguishes this species ecologically from *C. atroviolaceus*, which likely associates with members of the Myrtaceae and/or Fagaceae in Malaysia. The context is hygrophanous purple in young specimens. In older specimens, it is hygrophanous grey or white in the pileus and base and only purple at the stipe apex. The only other species described from Indonesia or Australasia to have whitish flesh is *C. kioloensis*. It differs from *C. kioloensis*, with which it forms a sister group relationship (Figure 5), by its association with *Nothofagus*. *C. carneipallidus* has a wider pileus and longer stipe than *C. atrolazulinus*. The width of the basidiospores is wider than those in *C. atrolazulinus* as well. *Cortinarius carneipallidus* sp. nov. has been variously identified as *C. atroviolaceus*, *C. atrolazulinus*, *C. subcalyptrosporus*, *C. violaceus* and *Cortinarius* sp.

The species was treated as '*C. violaceus* sensu Moser 1986' in Harrower et al. (2015) but differs from north temperate *C. violaceus* by the absence of caulocystidia and association with *Nothofagus*. However, the name '*C. violaceus* sensu Moser 1986' was applied based on interpretation of the protologue only, and as no specimens of '*C. violaceus* sensu Moser 1986' were examined, we do not intend to synonymize the former with *C. carneipallidus*.

Cortinarius atrotomentosus Harrower, sp. nov.
MycoBank MB 811662
Figures 5, 6c, 7g, 8g

Diagnosis. Similar to *Cortinarius violaceus* (L.: Fr.) Gray but differs by having smaller spores and shorter basidia as well as an absence of caulocystidia. Unique molecular synapomorphies at pos. 71 (ITS1), and 606 (ITS2) are present in our alignment.

Type. USA, Florida: Wakulla Co., Crawfordville, Apalachicola National Forest (30°12'06"N; 84°26'33"W), on soil under *Quercus virginiana*, 4 Dec. 2010, TFB 13848, (holotype: TENN 065535).

Etymology. Meaning 'dark-tomentose' in reference to the dark coloration of the fruiting body.

Description. Pileus 26–91 mm wide, surface dry, tomentose to fine scaly, dark violet (17F3) to dark brown in age (7F3), red in KOH. Lamellae adnexed, not sinuate, close to subdistant, thin, ventricose, dark violet (17F3). Stipe 75–131 mm long, 8–18 mm thick at apex, 17–26 mm thick at base, ventricose, silky-glabrous, olive brown (4E6) to brownish grey in age (5D2). Basal mycelium lilac (16B4) to greyish magenta (14D3). Context purple grey (13E2) to reddish brown (10D4). Smell mild. Taste none. Basidiospores (9–) 10.5–13 (–14.0) µm × (6–) 7–8 µm, means=10.5–12 µm × 6–8 µm, Q = 1.43–1.67, Q means= 1.50–1.53, (70 spores, three specimens), ellipsoid to amygdaloid, strongly verrucose, plage present under SEM. Basidia 4-spored, clavate, 20–30 × 10–12 µm. Cheilocystidia abundant, narrowly fusiform to lageniform, brown in KOH, 50–70 (–80) µm × 15–25 µm. Pleurocystidia abundant, narrowly fusiform to lageniform, brown in KOH, 43–65 (–70) × 15–20 µm. Caulocystidia not seen. Pileipellis a trichoderm, hyphae 6–20 µm wide, 185–370 µm high, multiseptate, brown content in KOH, terminal hyphae mainly blunt-ended, some lanceolate or aciculate. Clamp connections present.

Ecology and distribution. Under *Quercus virginiana*. Known only from Apalachicola National Forest, Crawfordville, Florida, USA. Fruiting early December.

Other specimens examined. USA. Florida: Wakulla Co., Crawfordville, Apalachicola National Forest (30°12'07"N; 84°26'33"W), (*Quercus virginiana*), 2 Dec. 2010, D.Lewis & B.Petty TFB 13840 (TENN 065527). Florida: Wakulla Co., Crawfordville, Apalachicola National Forest, Leon Sinks Geological Area (30° 18' 52" N; 84° 20' 34"W, mixed forest, 6 Dec. 2014, Bruce Horn EH275 (TENN 069922).

Discussion. *Cortinarius atrotomentosus* sp. nov. was treated as '*Cortinarius* sp. NA1' in Harrower et al. (2015). This species can be differentiated from *C. violaceus* by its dark violet to dark brown pileus and the olive brown to brownish grey stipe. The context of *C. violaceus* is violet to greyish, not mauve as is *C. atrotomentosus* sp. nov. Caulocystidia were not found on this species whereas they are present in *C.*

neotropicus sp. nov. and *C. violaceus*. The current Gulf Coast geographic distribution of *C. atrotomentosus* sp. nov., where it associates with *Quercus*, does not overlap with the more northerly distribution of *C. violaceus*. The species differs from *C. palatinus* sp. nov., with which it appears to be most closely related (Figure 5), by its location (Gulf Coast region) and its dark exterior. The basal mycelium is the only part of the fruiting body that could be described as pale violet.

Species inquirendae

Cortinarius hercynicus (Pers.) M.M.Moser 1967

Cortinarius hercynicus differs from *C. violaceus* s.s. by having smaller and broader basidiospores and occurrence in coniferous forests. Harrower et al. (2015) did not find a molecular difference between *C. hercynicus* and *C. violaceus*, but taxon sampling of *C. hercynicus* was not adequate. Brandrud (1983) treated *C. hercynicus* as a variety of *C. violaceus*. However, in Harrower et al. (2015) samples of *C. violaceus* s.l. recorded from coniferous forests and separately in hardwood forests failed to form monophyletic groups suggesting that host association is of no taxonomic significance. Thus, current data suggest *C. hercynicus* is synonymous with *C. violaceus*.

Species excludendae

Cortinarius austroviolaceus Gasparini 2001
Figure 6i, 7i, 8i

This species is phylogenetically placed outside of *Cortinarius* sect. *Cortinarius* (Harrower et al. 2015). In comparison to species within the section, the basidiospores lack a plage (Figure 3i), the basidiospore ornamentation differs (less coarsely ornamented) at the SEM level, and pleurocystidia are absent.

Cortinarius gayi E. Horak 1980
Figure 6h

The purple color and densely squamulose or fibrillose pileus is consistent with most other species in sect. *Cortinarius*. However, *C. gayi* lacks both pleurocystidia and cheilocystidia, and a plage is reportedly absent from the basidiospores. This species may have closer to affinities to *C. austroviolaceus* than sect. *Cortinarius*.

Cortinarius paraviolaceus M.M.Moser 1987

This species is described as having a pileus that is “rather intensely violaceus…the center becoming dull tawny ochraceus” (Moser 1987). The stipe is described as “violaceus tomentose at the base, otherwise brownish fibrillose with the cortina”. Pleurocystidia are rare and no cheilocystidia were observed (Moser 1987). The pileus is “not strongly squarrose-fibrillose-squamulose”. These characters, taken together, are not consistent with the *C. violaceus* group.

Cortinarius jenolanensis Wood 2009

This species has a smooth pileus and cheilocystidia, but lacks pleurocystidia. This species may have closer to affinities to *C. austroviolaceus* than sect. *Cortinarius*.

Cortinarius atrolazulinus M.M. Moser sensu Soop 2008

Known collections (not examined by the authors): New Zealand. Southland: Southland, Fiordland, Lake Gunn Track, (*Nothofagus*), 5 May 2001, K. Soop KS CO1223 (PDD 103879; GenBank KF727372; KF727328). Taupo: Taupo, Kaimanawa Forest Park, Cascade Hut Track, (*Nothofagus*) 9 May 2009 K. Soop KS CO1917 (PDD 97542).

C. atrolazulinus was described by Moser (1987) from *Nothofagus* forest in New Zealand. These two collections match Moser's description well, which includes the presence of cheilocystidia and pleurocystidia. Phylogenetic analyses (not shown) place it in an unknown clade outside of *Cortinarius* sect. *Cortinarius*. Further morphological and genetic analyses are needed to correctly classify this species. Attempts to sequence the type collection of *C. atrolazulinus* (ZT 69-276) were unsuccessful.

Cortinarius atroviolaceus M.M. Moser sensu Shirley

New Zealand: Auckland, Kauri Point Reserve. (*Leptospermum*) C. Shirley AK 369 (PDD; GenBank KT444633; KT444634).

Pileus fibrillose, not tomentose. Epicutis not a trichoderm, hyphae 6-14 µm wide, blue extracellular pigment clumps. Purple intracellular pigment readily dissolving in KOH. Spores 7.5-8.5 x 4-5 µm. Cheilocystidia and pleurocystidia present. This species shares 90% ITS sequence identity with one member of *Cortinarius* sect. *Cortinarius* (*C. carneipallidus*) at best. It shows higher sequence identity to members outside of the section. Phylogenetic analyses (not shown) could not place it within the section with confidence. *Cortinarius jenolanensis* has wider spores and lacks pleurocystidia, compared to this species. *Cortinarius atroviolaceus* M.M. Moser has much longer and wider spores. As there is only one collection of this species, with inadequate documentation, more work needs to be done to document and classify this species.

References

Beaman JH, Anderson CE (2004) The Plants of Mt. Kinabalu: 5. Dicotyledon families: Magnoliaceae to Winteraceae. Natural History Publications (Borneo), 1–609.

Beaman, JH, Anderson CE, Beaman RS (2000) The Plants of Mount Kinabalu: 4. Dicotyledon families Acanthaceae to Lythraceae. Natural History Publications (Borneo), 1–588.

Bougher NL, Syme K (1998) Fungi of Southern Australia. University of Western Australia Press, 1–391.

Brandrud TE (1983) *Cortinarius* subgen. *Cortinarius* (Agaricales) in the Nordic countries, taxonomy, ecology and chorology. Nordic Journal of Botany 3:577–592.

Brandrud TE, Melot J (1990) Validations and new combinations in *Cortinarius*, with special emphasis on infrageneric taxa of subgenus *Phlegmacium* (Agaricales). Nordic Journal of Botany 10:535–538.

Clements FE, Shear CL (1931) The Genera of Fungi. H.W. Wilson Co., 1–496. Fries EM. (1821) Systema Mycologicum. Ex Officina Berlingiana.

Gasparini B (2001) A Contribution to the Knowledge of *Cortinarius* and Allied Genera of Southern Tasmania, Australia. Australasian Mycologist 20: 49–54.

Halling RE, Mueller GM (2005) Common Mushrooms of the Talamanca Mountains, Costa Rica. The New York Botanical Garden, 1–195.

Harrower E, Bougher NL, Henkel TW, Horak E, Matheny PB (2015) Long- distance dispersal and speciation of Australasian and American species of *Cortinarius* sect. *Cortinarius*. Mycologia. 107(4): 697–709.

Henkel TW, Aime MC, Chin M, Miller SL, Vilgalys R, Smith ME (2012) Ectomycorrhizal fungal sporocarp diversity and discovery of new taxa in *Dicymbe* monodominant forests of the Guiana Shield. Biodiversity and Conservation 21(9): 2195–2220.

Horak E (1980) Fungi Basidiomycetes. Agaricales y Gasteromycetes Secotioides. Flora Cryptogámica Tierra Del Fuego 11(6): 1–528.

Kornerup A, Wanscher JH (1967) Methuen Handbook of Colour. Methuen & Co. Ltd., 1–243.

Linnaeus C von. (1753) Species Plantarum. Stokholm.

Montagne C (1849) In Gay C: Historia Física y Política de Chile. Botanica 7: 344.

Moser M (1969) *Cortinarius* Fr., Untergattung *Leprocybe* subgen. nov, die Rauhköpfe. Vorstudie zu einer Monographie. Zeitschrift für Pilzkunde 35: 213–248.

Moser M (1987) [as 1986] *Cortinarius* Fr. subgen. *Cortinarius* in the SW-Pacific area. Sydowia 39: 138–147.

Moser MM (1967) Basidiomyceten II: Die Röhrlinge und Blätterpilze (Agaricales). In: Gam H (Ed) Kleine Kryptogamenflora vol2 b/2. Stuttgart. 1–443.

Nezdoiminogo EL (1996) Definitorium fungorum Rossiae. Ordo Agaricales 1. Familia Cortinariaceae. Petropolis, Nauka: 1–408.

Niskanen T, Kytövuori I, Høiland K (2008) Subgen. *Cortinarius*. In: Hansen L, Knudsen H,(Eds) Funga Nordica. Nordsvamp, Copenhagen, 662–663.

Nussbaum F von, Spiteller P, Rüth M, Steglich W, Wanner G, Gamblin B, Stievano L, Wagner FE (1998) An Iron(III)-Catechol Complex as a Mushroom Pigment.

Angewandte Chemie International Edition 37(23):3292–3295.
Orton PD (1958) *Cortinarius* II. The Naturalist 7(6):81–149.
Persoon CH (1801) Synopsis Methodica Fungorum. Dieterich.
Singer R, Araujo I de J, Ivory MH (1983) The ectotrophically mycorrhizal fungi of the neotropical lowlands, especially Central Amazonia. Beihefte zur Nova Hedwigia 77:1–352.
Soop K (2008) Cortinarioid Fungi of New Zealand. Éditions Scientrix, Mora, 1–50.
Stefani FOP, Jones RH, May TW (2014) Concordance of seven gene genealogies compared to phenotypic data reveals multiple cryptic species in Australian dermocyboid *Cortinarius* (Agaricales). Molecular Phylogenetics and Evolution 71: 249–260.
Wood AE (2009) *Cortinarius* Fr. Subgenus *Cortinarius* in Australia. Proceedings Of The Linnean Society Of New South Wales 130: 147–155.

Appendix

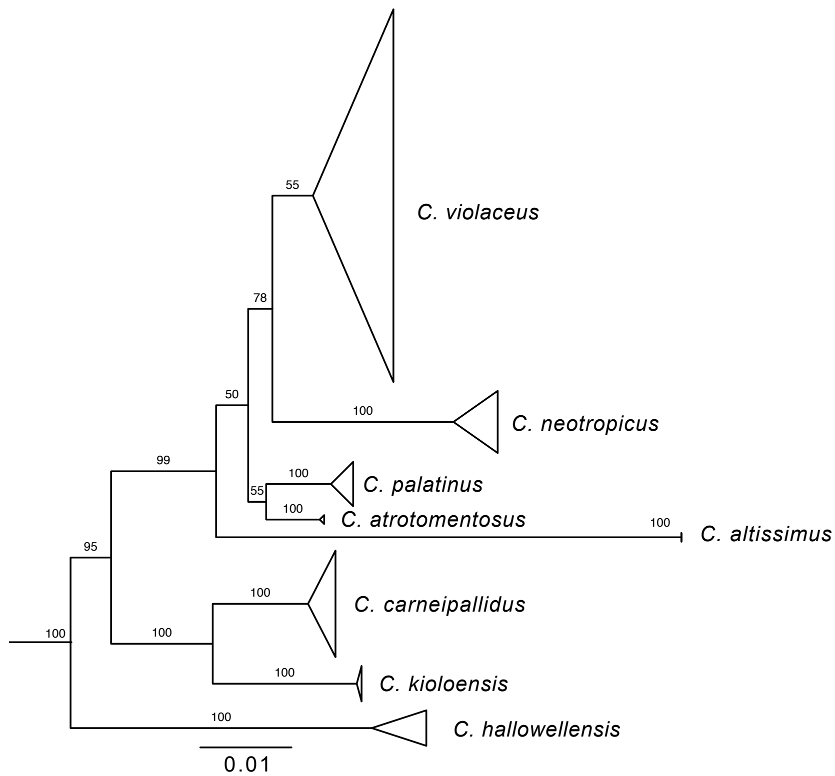

Figure 5: Maximum likelihood (ML) phylogenetic tree of *Cortinarius* sect. *Cortinarius* using combined nuclear ITS, 28S and *RPB2* sequences. ML bootstrap support above 50% is shown above nodes.

Figure 6: Habit of the following *Cortinarius* species: **a** *C. kioloensis* (TENN 069666, photo I. Dodd) **b** *C. palatinus* (NY 796168, TYPE, photo R.E. Halling) **c** *C. atrotomentosus* (TENN 069922, photo A. Bessette) **d** *C. hallowellensis* (MEL 2300544) **e** *C. neotropicus* (NY 75934, photo R.E. Halling) **f** *C. carneipallidus* (PDD 71219, photo E. Horak) **g** *C. altissimus* (TENN 069829, TYPE photo T. Henkel) **h** C. gayi (ZT 75/82, ISOTYPE, photo E. Horak) **i** *C. austroviolaceus* (MEL 2231689, photo K. Syme). Scale bar = 1 cm.

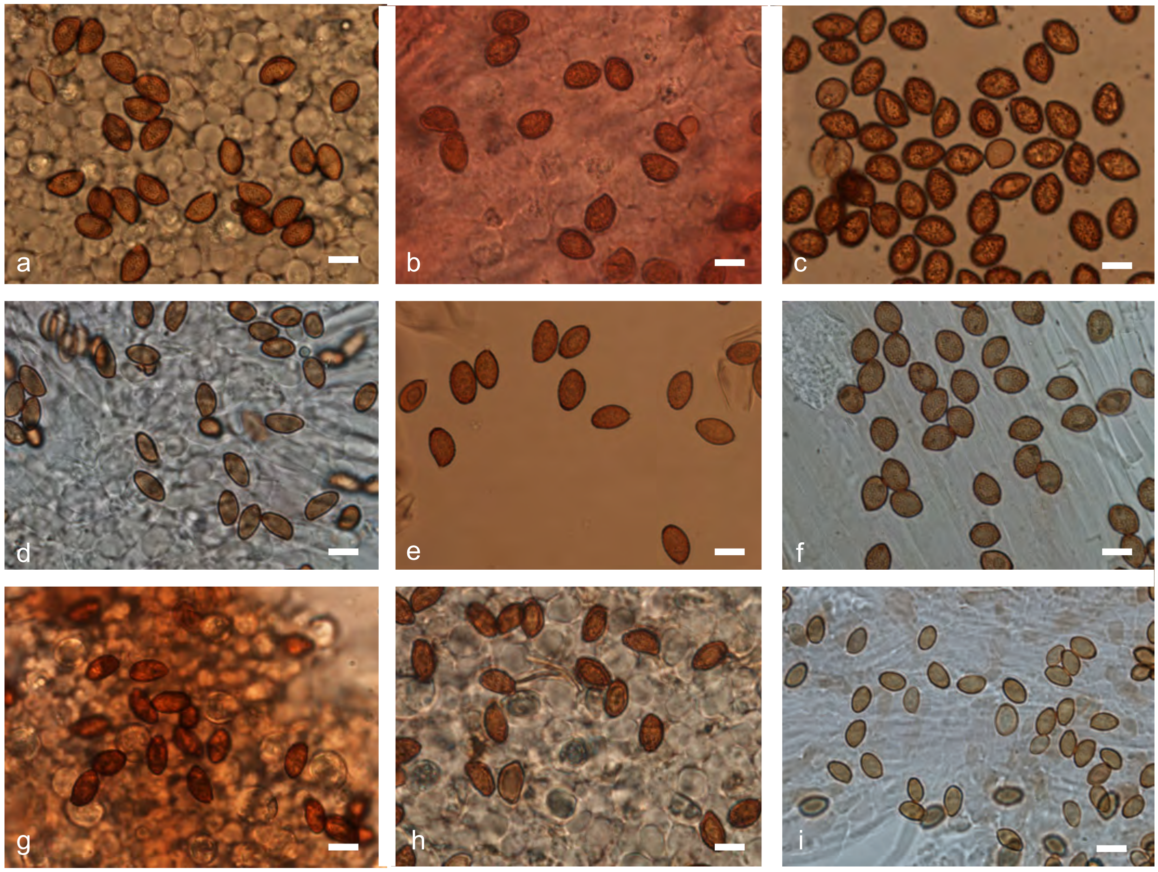

Figure 7: Light micrographs of basidiospores from the following *Cortinarius* species: **a** *C. kioloensis* (PDD 99307) **b** *C. palatinus* (NY 00795933) **c** *C. altissimus* (TENN 069830) **d** *C. hallowellensis* (MEL 2300544) **e** *C. neotropicus* (NY 34729 TYPE) **f** *C. carneipallidus* (PDD95444 TYPE) **g** *C. atrotomentosus* (TENN 065535 TYPE) **h** *C. violaceus* (TENN 062899) *C. austroviolaceus* (MEL 227499). Scale bar = 10 µm.

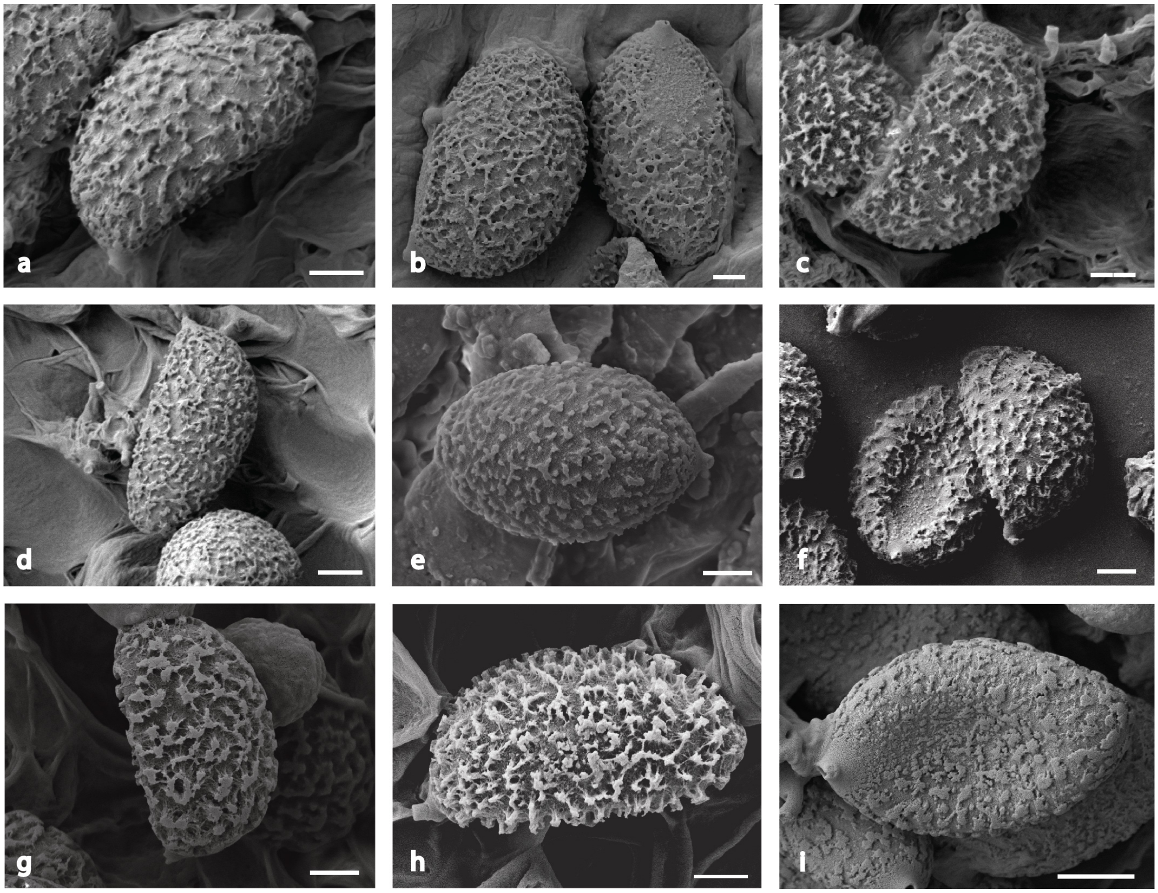

Figure 8: SEM micrographs of basidiospores from the following *Cortinarius* species: **a** *C. kioloensis* (MEL 2351101) **b** *C. palatinus* (NY 796168 TYPE) **c** *C. altissimus* (069830) **d** *C. hallowellensis* (MEL 2300544) **e** *C. neotropicus* (NY 34729 TYPE) **f** *C. carneipallidus* (PDD 71219) **g** *C. atrotomentosus* (TENN 065535 TYPE) **h** *C. violaceus* (TENN 063104) **i** *C. austroviolaceus* (MEL 2121961 PARATYPE). Scale bar = 2 µm.

CHAPTER III
TESTING THE SECOTIOID SYNDROME HYPOTHESIS ACROSS MULTIPLE ENVIRONMENTAL VARIABLES: A CASE STUDY USING A GLOBAL-SCALE PHYLOGENY OF *CORTINARIUS*

Brandon Matheny and Emma Harrower came up with the idea to test Thiers' 'secotioid syndrome' hypothesis. Terry Henkel, M. Catherine Aime and Clark Ovrebo provided loans of *Cortinarius* taxa they collected in Cameroon, Guyana and Colombia. Jean-Marc Moncalvo provided ITS sequences of *Cortinarius* species he collected in Sarawak, Malaysia. Matt Smith and Camille Truong provided ITS sequences to species collected in Chile and Argentina.

Abstract

Cortinarius is the most species-rich genus of Agaricales with some 2000 accepted species, most of which are epigeous and agaricoid in form. Distribution of the genus is largely north and south temperate, although an increasing number of species are known from the tropics. Eighty-four sequestrate species, however, have been described and are now generally accepted as *Cortinarius*. Sequestrate taxa have an enclosed hymenophore and typically statismosporic basidia, thus having lost their ability to disperse their basidiospores through the air. Most rely on vertebrate-based mycophagy for dispersal. Thiers hypothesized that these evolutionary changes in sequestrate taxa have resulted from selection pressures to avoid a loss of moisture in dry environments. However, Bougher and Lebel hypothesized that there may be an equal but opposing selection pressure to protect the hymenophore from excessively moist conditions. Using a global phylogeny of temperate and tropical *Cortinarius* species, we tested whether a correlation exists between the occurrence of sequestrate *Cortinarius* in wet and dry environments and in hot and cold environments. The model including the mean diurnal temperature range had the greatest statistical significance, while none of the precipitation models were statistically significant. The hypothesis of a random distribution of sequestrate taxa within *Cortinarius* could not be rejected but it is noted that some clades (*Dermocybe*, *Leprocybe*, *Orellanii*, *Rozites* and *Cortinarius*), some of which are toxic, lacked sequestrate species. Using sister-group comparisons, there was an equal likelihood for taxa with a dry pileus or with a viscid pileus to evolve a sequestrate state.

Introduction

Climate affects the evolution of species. Grant and Grant (2006) found that some Darwin's finches evolved larger beaks after a significant drought event. Franks et al. (2007) found genetic evidence of a change in flowering time in a *Brassica rapa* population that suffered an extreme drought. In the kingdom Fungi, climate is known to change the phenotype of fruiting bodies under controlled conditions (Kues and Liu 2000). There are theories on how climate could provide a select pressure for the evolution of certain traits in fungi. The theory that we will focus on relates to the evolution of sequestrate taxa from pileate-stiptate taxa.

The term sequestrate has been applied to both ascomycete and basidiomycete taxa that do not forcibly discharge their spores (ballistospory) (Bougher and Lebel 2001). Rather, their basidia or asci develop inside enclosed mostly hypogeous (below ground) fruiting bodies or inside partially exposed fruiting bodies and spores are released through statismospory (no active discharge from the basidium) (Thiers 1984).

Members of the sequestrate ascomycete genus *Tuber* have been referred to as true truffles while sequestrate ascomycetes, zygomycetes and basidiomycetes have been referred to by a number of different names: truffle-like, false truffles, gasteroid (a peridium that encloses a loculate or highly convoluted gleba lacking a stipitate columella), and secotioid (the margin of the pileus remains appressed to the stipe and the lamellae are convoluted and anastomosed). The term sequestrate was proposed by Kendrick (1992) as a neutral term simply referring to any fungi that do not forcibly discharge their spores.

Before the advent of molecular analysis, many mycologists had hypothesized that sequestrate taxa were the predecessors from which gilled taxa evolved (Brefeld 1877, Buchholtz 1902, Lohwag 1924, Singer 1932, 1936, 1986). However, morphological analysis (Thiers 1984) and genetic analysis (Peintner et al. 2001, Wilson et al. 2013) have repeatedly shown that sequestrate taxa evolved from gilled ancestors. Sequestrate taxa have evolved independently in many different lineages (Justo et al. 2010, Hibbett 2004, 2007, Hosaka et al. 2007, Miller et al. 2007, Peintner et al. 2001, Wilson et al. 2013). Various theories have been proposed hypothesizing under what conditions sequestrate fungi evolve (Albee-Scott 2007, Bougher and Lebel 2001, Bruns et al. 1989, Thiers 1984).

Thiers (1984) hypothesized that sequestrate fungi evolved under arid climates, especially in localities that had a short growing season such as montane regions. He proposed that natural selection would select for a basidiocarp that can survive the unusually dry, warm fall and summer seasons. He explains how, in velar species, the failure of the pileus to expand would result in pockets or spaces which would maintain higher humidity and enhance spore production. Ascomycetes release their spores through turgor pressure (Kendrick 1992), and basidiomycetes release their spores through the Buller's drop (Webster, Turner and Davie 1989), whereby a droplet of water accumulates on one end of the spore, changing the center of gravity and thus discharging the spore. Thiers refered to this as the 'Secotioid Syndrome', hereby refered to as the 'Secotioid Hypothesis'. Bruns et al. (1989) takes this hypothesis one step further, where there is initially selection for a reduction in water loss, followed by selection for animal dispersal, once ballistospory ceases.

In contrast to the 'arid climate hypothesis', Bougher and Lebel (2001) hypothesized that sequestrate fungi found in tropical climates or cool, temperate forest could be under selection to evolve an enclosed hymenium to protect the spores from excessive moisture, and allow the spores to develop for longer. Under Thiers' hypothesis, one would expect more sequestrate taxa in warm, dry habitats (Figure 9a). Under Bougher and Lebel's hypothesis, one would expect more sequestrate fungi in cool, wet habitats (Figure 9b). An alternative hypothesis is that there is not strong climatic selection for a sequestrate state, in which one would find sequestrate taxa across all climate variables (Figure 9c).

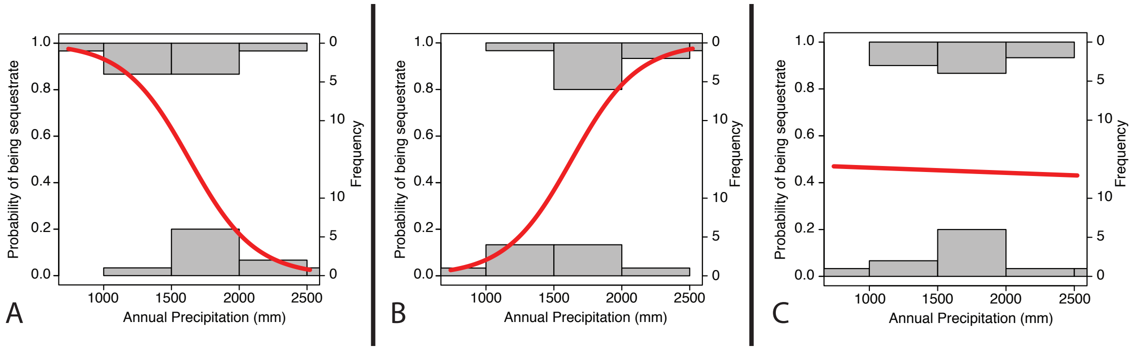

Figure 9: Hypothesized distribution of the probability of being gilled or sequestrate across a climate gradient (eg. dry to wet): **a** Thiers' hypothesis; **b** Bougher and Lebel hypothesis; **c** no selection for a sequestrate state based on climate variables.

The genus *Cortinarius* is a useful genus to look for correlations between climate variables and the evolution of sequestrate taxa because of its large size (over 2000 species have been described) (Kirk et al. 2008) and global distribution. Gilled taxa are found on every continent except for Antarctica. No sequestrate *Cortinarius* species have not been found in the tropics to date. The genus contains multiple morphologies of sequestrate taxa, which could be used to study the evolution of sequestrate taxa: (1) strongly velate and partially hypogeous (emergent) taxa (Figure 10b) (Bougher and Trappe 2002); (2) secotioid *Thaxterogaster* spp. (Figure 10c) (Thiers 1984); (3) gasteroid *Hymenogaster* (Figure 10d) (Thiers 1984), *Quadrispora* (Bougher and Castellano 1993), *Protoglossum* (Massee 1891) and *Gigasperma* (Horak 1971). Many the above taxa have been synonymized with *Cortinarius* based on the phylogenetic species concept (Gasparini 2014, Peintner et al. 2001, 2002). I challenged the Bougher and Lebel and Thiers' hypotheses by correlating climate variables (temperature and precipitation) and the morphology of the fruiting body (gilled or sequestrate) in *Cortinarius* using a phylogenetic logistic regression.

In addition, I examined the distribution of sequestrate taxa within the *Cortinarius* phylogeny. Sequestrate taxa that went extinct won't appear on the phylogeny. Taxa that were selected for may be clumped or over-dispersed on a phylogeny if they have diversified. If there was no selection and sequestrate taxa persisted, they will appear randomly on the phylogeny. Sequestrate taxa are potentially vulnerable to extinction because of the potential for decreased gene flow caused by the reduction in the area of spore dispersal. A large number of sequestrate taxa are dispersed through mycophagy by mammals (Fogel and Trappe 1978). However, some clades in *Cortinarius*, such as the *Orellanii* clade, are deadly poisonous to mammals (Schumacher and Høiland 1983), which may prevent them from evolving successful sequestrate taxa. I tested for phylogenetic conservatism to see if the evolution of the sequestrate state is random, or if there is selection for certain clades to have more or less sequestrate species than other clades.

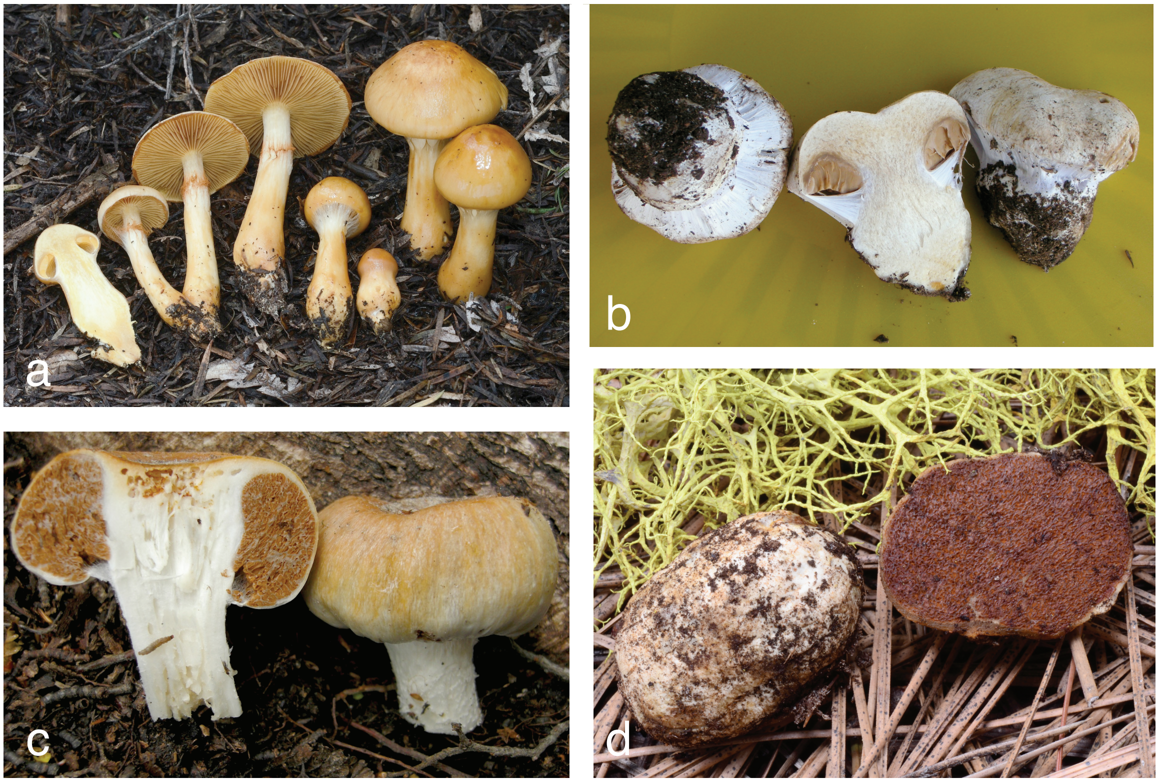

Figure 10: Basidiome types occurring in the *Cortinarius* clade. **a** Agaricoid basidiomes of *Cortinarius ignotus* (photo Michael Wallace). **b** Sequestrate basidiomes of *Cortinarius magnivelatus* (photo Ron Pastorino). **c** Secotioid basidiome of *Cortinarius pingue* = *Thaxterogaster pinguis* (missing lower part of stipe; photo Jason Hollinger). **d** Basidiome of *Hymenogaster sublilacinus* (photo Noah Siegel).

Peintner et al (2001) produced a phylogeny in which there were more sequestrate taxa in *Cortinarius* subgenera which show a viscid pileus compared to subgenera which have a dry cap and stipe. Observing this trend, we hypothesize that there will be a higher probability of evolving a sequestrate state from a *Cortinarius* species that has a viscid pileus, compared to species that have a dry cap. We will compare the number of sequestrate taxa found in dry clades compared with the number of sequestrate taxa found in viscid clades.

Methods

Taxon sampling and DNA sequencing

Dried specimens of collections were loaned from the PUR, HSC and CSU herbaria. DNA extraction and PCR protocols followed that of Matheny et al. (2010). Primers ITS1F-ITS4 (White et al. 1990) were used to amplify the internal transcribed spacer regions (ITS). ITS sequences of undescribed *Cortinarius* species from Borneo, stored by TRTC, were added to the dataset as well as ITS sequences of *Cortinarius* specimens collected in Argentina and Chile and stored in FLAS (see Appendix).

There were 8637 sequences in the ITS FASTA file that contained all the Cortinariaceae species in the UNITE and GenBank databases as of 1 January 2016. We removed: *Descolea spp. Mackintoshia persica, Hemistropharia spp., Cribbea sp., Anamika sp., Ganoderma sp, Mortiella sp., Corticiaceae,* and *Phaeocollybia spp.* because they are not in the Cortinariaceae. We removed all the environmental sequences because it cannot be determined if a DNA sequence comes from a gilled taxon or a sequestrate taxon from a single DNA sequence. We added the 'newly generated' and 'obtained sequences' to this FASTA file. We manually removed sequences that were too short (sequences must be 90% complete) and/or of poor quality (missing 50 or more nucleotides). To delimit species, we used CROP v1.33 (Hao et al. 2011) using an arbitrary cut-off value of 1% sequence dissimilarity, based on the recommendations of Garnica et al. 2016. When CROP was not discriminate enough, we used CD-Hit (Li and Godzik 2006) v4.6.6 using a 99% cut-off value. We added KC581343 *Hypholoma capnoides,* KM390723 *Hebeloma aanenii*, AJ585434 *Galerina stordalii*, and AF325663 *Gymnopilus penetrans* to serve as outgroups because these genera were sister to *Cortinarius* on MycoCosm (http://genome.jgi.doe.gov/mycocosm) on October 24, 2016.

DNA alignment and Mega-Phylogeny

Sequences were aligned using MAFFT v7.305 using the e-INS-i algorithm (Katoh and Standley 2013) with manual optimization. The 100 spp. three gene alignment published by Garnica et al. (2016) was edited so as to remove the *rpb2* and LSU data regions. It was manually aligned to match the larger dataset and used as a guide tree. RAxML 8.2.10 (Stamatakis 2006) was used to reconstruct a maximum likelihood (ML) tree with 200 bootstrap replicates under a GTRGAMMA model. Taxa in the guide-tree were manually removed after the tree was created. The outgroups were also then removed.

Ancestral state reconstruction

Mesquite 3.2 (Maddison and Maddison 2011) was used reconstruct the ancestral state of sequestration and of the viscidity of the pileus using the default parsimony and maximum likelihood algorithms.

Correlation of climate variables with sequestrate state

For the 1211 taxa that had complete ITS sequences, we recorded the location (and GPS coordinates if available) of where the specimen was collected, examined herbarium databases, GenBank records and citations in the recorded literature (see Appendix). Locations for 928 specimens were found, 24 of which were secotioid and 14 of which were gasteroid. Of the specimens that did not have GPS locations, we estimated the GPS location using Google Maps and the written description of the location. Estimates are estimated to be within a ten-kilometer radius. Locations that only gave the country, state or the province were not included as an accurate location could not be surmised.

The GPS locations were uploaded to ArcMap 10.5 (ESRI 2016) as a point layer. WorldClim2 Bioclimatic variables (Table 5; Fick and Hijams 2017) at a resolution of 30 seconds were added as a raster layer. The extract tool was used to extract all 19 separate climate variables for each point location.

Table 5: BioClim Variables. A quarter is a period of three months (1/4 of the year).

BioClim Variable	Explanation
BIO1	Annual Mean Temperature
BIO2	Mean Diurnal Range (Mean of monthly (max temp - min temp))
BIO3	Isothermality (BIO2/BIO7) (* 100)
BIO4	Temperature Seasonality (standard deviation *100)
BIO5	Max Temperature of Warmest Month
BIO6	Min Temperature of Coldest Month
BIO7	Temperature Annual Range (BIO5-BIO6)
BIO8	Mean Temperature of Wettest Quarter
BIO9	Mean Temperature of Driest Quarter
BIO10	Mean Temperature of Warmest Quarter
BIO11	Mean Temperature of Coldest Quarter
BIO12	Annual Precipitation
BIO13	Precipitation of Wettest Month
BIO14	Precipitation of Driest Month
BIO15	Precipitation Seasonality (Coefficient of Variation)
BIO16	Precipitation of Wettest Quarter
BIO17	Precipitation of Driest Quarter
BIO18	Precipitation of Warmest Quarter
BIO19	Precipitation of Coldest Quarter

Phylogenetic logistic regression

A phylogenetic logistic regression (Ives and Garland 2010) was performed on all 19 bioclimatic variables using the ‘phylolm’ package version 2.4 in R. The maximum likelihood method was used. One hundred to five hundred bootstrap replicates were performed on each BioClim variable, until convergence was achieved.

Testing for phylogenetic conservatism

PHYLOCOM 4.2 (Webb et al. 2008) was used to test for phylogenetic conservatism between gilled and sequestrate taxa (1202 taxa), and between taxa with a dry pileus and taxa with a viscid pileus (1202 taxa) (see Appendix). The program ran for 10,000 runs for both the state of the pileus and the state of the fruiting body. The net relatedness index (NRI), nearest taxon index (NTI), mean phylogenetic distance (MPD) and the mean nearest phylogenetic distance (MNTD) were recorded.

Results

The evolution of sequestrate *Cortinarius* species is rare and there is little evidence of speciation within sequestrate lineages. 1211 *Cortinarius* species were assessed for sequestration, and having a viscid pileus and or stipe (Figure 11a). Of these, 38 species are sequestrate. Visual inspection of the phylogenetic tree with its states reveals that there has been little to no diversification of sequestrate taxa in the genus *Cortinarius*. Ancestral state reconstruction reveals that gilled taxa are the ancestral state (Figure 11b). It also shows that taxa with a viscid pileus are the ancestral state. There have been multiple cases of a loss of the viscid pileus and few to no gains.

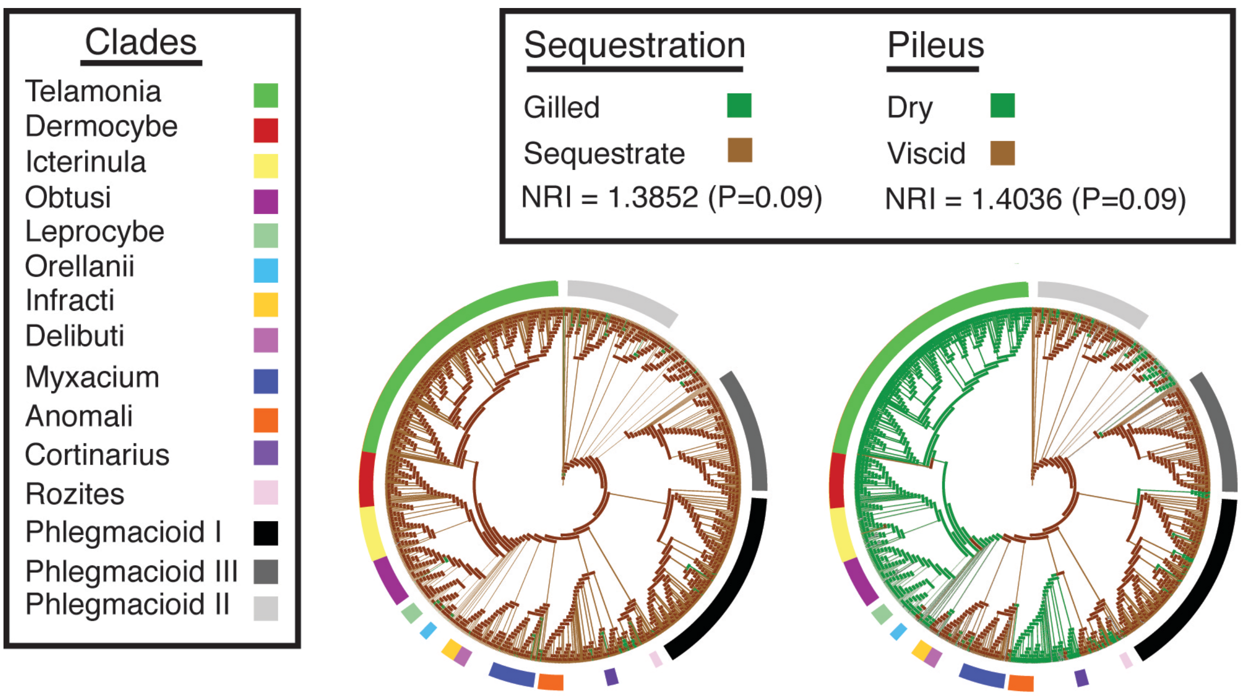

Figure 11: Ancestral state reconstruction of **a** the basidiome morphology **b** the viscidity of the pileus.

An analysis of phylogenetic conservatism of the sequestrate state across the mega-phylogeny could not reject the null hypothesis of a random distribution across the phylogeny with a net relatedness index (NRI) of 1.3852 (P=0.09), but there was a higher probability to be clumped (P=0.09), than even (P=0.91). An analysis looking at the distribution of taxa having a viscid pileus could not reject the null hypothesis of a random distribution (NRI= 1.4036, but there was a higher probability to be clumped (P=0.09), than even (P=0.91). Of sister group comparisons having >75% bootstrap support, there was an equal number of evolution events of a sequestrate state from dry taxa (9) and viscid taxa (8). There were nine events where a dry gilled taxon evolved to be a dry sequestrate taxon, four events where a viscid gilled taxon evolved to be a dry sequestrate taxon and four events where a viscid gilled taxon evolved to be a viscid sequestrate taxon.

Figure 12 shows the location of sequestrate and gilled taxa used to assess the correlation of BioClim variables and the morphological state of sequestration. Sequestrate taxa are found in temperate climates in both the northern and southern hemispheres. They are noticeably absent from the tropics.

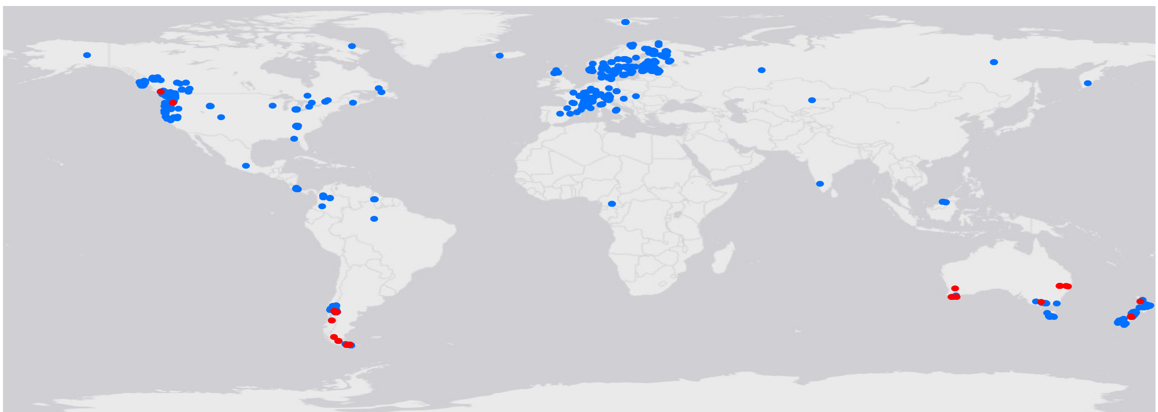

Figure 12: Geographic location of specimens used to correlate with BioClim variables. Gilled taxa are shown in blue. Sequestrate taxa are shown in red.

Of 16 of the 19 BioClim variables, only ‘BIO2: mean diurnal range’ and ‘BIO5: maximum temperature of the warmest month’ were statistically significant, using a p-value of 0.05 (Table 6). These two variables were estimated to have a positive slope, meaning that there were more sequestrate taxa found in the hottest locations, and in locations where the temperature fluctuates. The AIC value for BIO 2 was lower than the AIC value for BIO5, hence the mean diurnal range has a stronger effect, than the maximum temperature of the warmest month. None of the variables for precipitation were significant, suggesting that this is not a strong limiting factor for spore growth and dispersal. The estimates of alpha (the phylogenetic correlation, which varies between -4 and 4) are around zero, suggesting that there is not a strong phylogenetic signal for sequestrate taxa. Convergence was not achieved for BIO12, BIO18 and BIO19.

Table 6: Phylogenetic logistic regression models for each of the 19 BioClim variables.

BioClim Variable	BioClim Name	alpha estimate	slope estimate	Lower CI	Upper CI	Y-Intercept estimate	Slope P-value	AIC
BIO1	Annual Mean Temperature	0.05	0.04	0	0.1	-3.11	0.11	255.9
BIO2	Mean Diurnal Range (Mean of monthly (max temp – min temp))	0.06	0.24	0.17	0.35	-5.12	0	255.4
BIO3	Isothermality (BIO2/BIO7) (* 100)	0.02	0.03	0.03	0.04	-4.23	0.06	278.1
BIO4	Temperature Seasonality (standard deviation *100)	0.02	0	0	0	-2.03	0.07	276.9
BIO5	Max Temperature of Warmest Month	0.02	0.08	0.06	0.1	-3.88	0.05	262.7
BIO6	Min Temperature of Coldest Month	0.02	0.03	0	0.07	-3	0.2	273.7
BIO7	Temperature Annual Range (BIO5-BIO6)	0.02	-0.01	-0.02	0.01	-1.83	0.51	259.2
BIO8	Mean Temperature of Wettest Quarter	0.05	0.01	-0.02	0.05	-2.66	0.6	258.3
BIO9	Mean Temperature of Driest Quarter	0.06	0.02	0	0.08	-2.92	0.27	258.4
BIO10	Mean Temperature of Warmest Quarter	0.02	0.07	0.05	0.09	-3.38	0.06	262.1
BIO11	Mean Temperature of Coldest Quarter	0.04	0.03	-0.01	0.06	-2.65	0.12	255.5
BIO12	Annual Precipitation	N/A	N/A	N/A	N/A	N/A	N/A	N/A
BIO13	Precipitation of Wettest Month	0.02	0	0	0	-3.01	0.58	282.4
BIO14	Precipitation of Driest Month	0.02	0	-0.02	0	-3.22	0.44	287.6
BIO15	Precipitation Seasonality (Coefficient of Variation)	0.02	0.01	0	0.01	-2.82	0.23	272
BIO16	Precipitation of Wettest Quarter	0.02	0	0	0	-2.95	0.27	282
BIO17	Precipitation of Driest Quarter	0.02	0	0	0	-3.22	0.82	289.9
BIO18	Precipitation of Warmest Quarter	N/A	N/A	N/A	N/A	N/A	N/A	N/A
BIO19	Precipitation of Coldest Quarter	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Discussion

Contrary to both the Thiers hypothesis (Thiers 1984), which hypothesized sequestrate fungi evolved under dry conditions, and the Bougher and Lebel hypothesis (Bougher and Lebel 2001), which hypothesized that sequestrate fungi evolved under moist conditions, we found that precipitation was not correlated with the presence of sequestrate *Cortinarius* species. However, there was a significantly higher probability of finding sequestrate *Cortinarius* species in habitats where the temperature fluctuates daily compared to where the temperature stays the same throughout the day. These habitats can be in found on the top of mountains, such as the Sierra Nevada Mountains which Thiers used to develop the 'Secotioid Syndrome' hypothesis. Globally, these habitats are found in temperate areas with mediterranean or oceanic climates as well as deserts. Habitats with variable temperatures throughout the day are absent from the tropics. Corroborating the model for increased probability of sequestrate *Cortinarius* species in habitats with a variable daily temperature, there are no sequestrate

Cortinarius species recorded from the tropics while there are over 87 species (Appendix) from temperate areas. This pattern is not exclusive to *Cortinarius*, as there is a general absence of ectomycorrhizal sequestrate genera from the tropics (Tedersoo et al. 2010). Only one other study has attempted to test Thiers' hypothesis. Sheedy et al. 2016 did a meta-analysis dating the origin of sequestrate taxa in Australia and concluded that while aridification was likely a factor, it was not the sole driver of sequestration in Australia. In addition to the mean diurnal range, maximum temperature of the warmest month was statistically significant. Evidence points towards temperature being an important factor in the evolution of sequestrate taxa.

It is striking that none of the precipitation variables came across as being significant in the distribution of sequestrate *Cortinarius* species, especially as semi-arid fungi such as *Podaxis*, *Montagnea*, *Galeropsis* and *Kalaharituber* are all sequestrate. Future research should look for a correlation between climate variables and the sequestrate state in genera other than *Cortinarius*.

This study used the average monthly climate data for minimum, mean, and maximum temperature and for precipitation between 1970-2000. The origin of *Cortinarius* is estimated to be around 54.6 MYA (Ryberg et al. 2012). The sequestrate fungi in this study were all recently derived. The authors could not find climate data dating back to the last 12 MYA and note that the climate then was similar to the present climate.

To test the 'Secotioid Hypothesis' further, it would be interesting to empirically measure the humidity of the hymenium of a gilled fruiting body, within a veiled fruiting body, within a secotioid fruiting body and within a gasteroid fruiting body. Any differences in humidity would show that there is a variable that could be selected upon and an indication of the strength of selection could be inferred.

In addition to looking for support for the 'Secotioid Hypothesis', we examined patterns in the evolution and diversification of sequestrate *Cortinarius* species. The first thing that we found was that we could not reject the null hypothesis of a random distribution of sequestrate taxa in the phylogeny. However, the mean phylogenetic distance was in favor of sequestrate taxa being clumped within the phylogeny. Thus, the evolution and persistence of sequestrate taxa in *Cortinarius* may not be entirely random and may be affected by selection.

Some indication of why there are more sequestrate species in some clades and not in other may be seen in investigating the clades where sequestrate taxa are absent. Of note are the *Dermocybe*, *Leprocybe*, and *Orellanii* clades which contain toxins. This is important because sequestrate taxa often rely on animal dispersal to disperse their spores as wind dispersal is no longer an option. There are a wide range of mycophagous mammals including mice, rats, squirrels, rabbits and beavers (Fogel and Trappe 1978). While some mammals supplement their diet with fungi, others rely almost exclusively on fungi, such as the bush rat (Tory et al. 1997). All members of *Orellanii* contain the toxin orellanine which is fatal to mammals such as humans, cats, dogs, rabbits, guinea pigs and mice (Schumacher and Høiland 1983). A novel orellanine was found in *Cortinarius armillatus*, a member of subgenus *Telamonia*, albeit at a much lower concentration than members of the *Orellanii* clade (Shao et al. 2016). If a sequestrate fungus were lethal to mammals, it would likely go extinct.

In addition to mammals eating fungi, birds have been observed consuming sequestrate fungi as a staple diet (Alsheikh and Trappe 1983), and opportunistically, perhaps searching for insects (Dickson 1955). While there have not been any sightings of this behavior in *Cortinarius*, it has been hypothesized that birds consume sequestrate fungi in New Zealand, in the absence of mammals (Bougher and Lebel 2001, Beever 1999). Species in the *Dermocybe* and *Icterinula* clades are often brightly colored and high in anthraquinones (Keller and Ammirati 1983). The anthraquinone emodin has been found to be present in *Cortinarius sanguineus* (Keller and Ammirati 1983) and has been shown to be a diarrheagenic toxicant in chickens (Wells et al. 1975). These toxins would deter birds from eating them. Toxicity may be a factor that selects against the evolution of the sequestrate state.

There could be other factors that affect which clades evolve sequestrate taxa and which do not. Peintner et al. 2001 found that there was an abundance of secotioid *Cortinarius* species in the *Myxacium* clade compared to some of the *Phlegmacium* clades, which had emergent *Cortinarius* spp. They commented that this might be an indication that some groups may be more susceptible to evolving some certain sequestrate forms over others. In our larger *Cortinarius* phylogeny, we found that there were emergent *Cortinarius* spp. in both the *Phlegmacium* III and *Icterinula* clades. *Myxacium* still holds a large number of secotioid taxa while the *Phlegmacium* clades hold all three forms of sequestrate taxa. We believe that the climate has a larger impact in selecting which form a sequestrate taxon takes than whether it is in the *Myxacium* clade or in one of the *Phlegmacium* clades. A future study that discriminates between the three different sequestrate forms is in order.

In the phylogeny of Peinter et al. (2001), there were more sequestrate taxa in clades that had a viscid cap, which prompted us to hypothesize that there was a higher probability of evolving a sequestrate state in clades that had a viscid cap. There were an equal number of transitions from a dry gilled taxon to a sequestrate taxon as there were from a viscid gilled taxon to a sequestrate taxon. Thus there is an equal probability of becoming sequestrate from a viscid state as with a dry state. This shows that morphology may not predispose a fruiting body to becoming sequestrate.

This study has produced the largest and most comprehensive phylogeny of *Cortinarius* to date, including multiple species from southern South America, Africa, Malyasia, Colombia and Guyana. Using this global dataset, we tested the ‘Secotioid Hypothesis’ and surprisingly found that precipitation was not as important as temperature. Some clades had more sequestrate fungi than others and the moisture content of the pileus was not a factor. This paves the way to developing new hypotheses for the evolution of sequestrate taxa, including the amount of fungivory and the variability of the climate.

References

Albee-Scott, S. R. (2007). Does secotioid inertia drive the evolution of false-truffles? *Mycological Research*, *111*(9), 1030–1039.

Alsheikh, A. M., & Trappe, J. M. (1983). Taxonomy of *Phaeangium lefebvrei*, a desert truffle eaten by birds. Canadian Journal of Botany, 61(7), 1919–1925.

Beever, R. E. (1999). Dispersal of New Zealand sequestrate fungi. In Proceedings of the IX International Congress of Mycology (p. 190).

Bougher, N. L. & Castellano, M. A. (1993). Delimitation of *Hymenogaster* sensu stricto and Four New Segregate Genera. *Mycologia*, *85*(2), 273–293.

Brefeld, O. (1877). *Untersuchungen aus dem Gesamtgebiete der Mykologie.* Basidiomyceten III, vol. 8. Verlag von Arthur Felix, Leipzig.

Bruns, T. D., Fogel, R., White, T. J., & Palmer, J. D. (1989). Accelerated evolution of a false-truffle from a mushroom ancestor. *Nature*, *339*(6220), 140–142.

Buchholtz, F. (1902). Beitrage zur Morphologie und Systematik der Hypogaeen. *Riga*.

Dickson, V. (1955). The wild flowers of Kuwait and Bahrain. London: George Allen & Unwin, Ltd.

Environmental Systems Research Institute, Inc. [ESRI]. (2016). What is GIS? ESRI. Redlands, California. < http://www.esri.com/what-is-gis>. Accessed June 2017.

Fick, S. E. & R. J. Hijams (2017). Worldclim 2: New 1-km spatial resolution climate surfaces for global land areas. *International Journal of Climatology*.

Fogel, R., & Trappe, J. M. (1978). Fungus Consumption (Mycophagy) by Small Animals. *Northwest Science*, *52*(1), 1–48.

Franks, S. J., Sim, S., & Weis, A. E. (2007). Rapid evolution of flowering time by an annual plant in response to a climate fluctuation. *Proceedings of the National Academy of Sciences of the United States of America*, *104*(4), 1278–1282.

Garnica, S., Schön, M. E., Abarenkov, K., Riess, K., Liimatainen, K., Niskanen, T., Dima, B., Soop, K., Frøslev, T. G., Jeppesen, T. S., Kuhnert-Finkernagel, R., Brandrud, T. E., Saar, G., Oertel, B., Ammirati, J. F. (2016). Determining threshold values for barcoding fungi: lessons from *Cortinarius* (Basidiomycota), a highly diverse and widespread ectomycorrhizal genus. *FEMS Microbiology Ecology*, *92*(4).

Gasparini, B. (2014). *Cortinarius* (Agaricales) revised taxonomy: new species names or combinations. *Mycosphere*, *5*(4), 541–544.

Grant, P. R., & Grant, B. R. (2006). Evolution of Character Displacement in Darwin's Finches. *Science*, *313* (5784), 224-226.

Hao, X., Jiang, R. & Chen, T. (2011). Clustering 16S rRNA for OTU prediction: A method of unsupervised Bayesian clustering. *Bioinformatics*, *27*(5), 611–618.

Hibbett, D. S. (2007). After the gold rush, or before the flood? Evolutionary morphology of mushroom-forming fungi (Agaricomycetes) in the early 21st century. *Mycological Research*, *111*(9), 1001–1018.

Hibbett, D. S., & Lutzoni, F. (2004). Trends in Morphological Evolution in Homobasidiomycetes Inferred Using Maximum Likelihood: A Comparison of Binary and Multistate Approaches. *Systematic Biology*, *53*(6), 889–903.

Horak, E. (1971). Contributions to the knowledge of the Agaricales s.l. (Fungi) of New Zealand. *New Zealand Journal of Botany*, *9*(3), 463–493.
Hosaka, K., Bates, S. T., Beever, R. E., Castellano, M. A., Colgan, W., Domínguez, L. S., Noura, E. R., Geml, J., Giachini, A. J., Kenny, S. R., Simpson, N. B., Spatafora, J. W. & Trappe, J. M. (2006). Molecular phylogenetics of the gomphoid-phalloid fungi with an establishment of the new subclass Phallomycetidae and two new orders. *Mycologia*, *98*(6), 949–959.
Ives, A. R., & Garland, T. (2010). Phylogenetic Logistic Regression for Binary Dependent Variables. *Systematic Biology*, *59*(1), 9–26.
Justo, A., Morgenstern, I., Hallen-Adams, H. E., and Hibbett, D. S. (2010). Convergent evolution of sequestrate forms in *Amanita* under Mediterranean climate conditions. *Mycologia*, *102*(3), 675–688.
Katoh K., and Standley D.M. 2013. MAFFT multiple sequence alignment software 7: improvements in performance and usability. Mol Biol Evol 30: 772–780.
Keller, G. and Ammirati, J. F. (1983). Chemotaxonomic Significance of Anthraquinone Derivatives in North American Species of *Dermocybe*, section Sanguinae. *Mycotaxon*, *18*(2), 357–377.
Kendrick, B. (1992). *The Fifth Kingdom*. Focus Information Group, Newburyport, MA.
Kirk, P. M., Cannon, P. F., Minter, D. W., & Stalpers, J. A. (2008). *Dictionary of the Fungi* (10th ed.). Wallingford: CAB International.
Kües, U., & Liu, Y. (2000). Fruiting body production in basidiomycetes. *Appl Microbiol Biotechnol*, *54*, 141–152.
Li, W., & Godzik, A. (2006). Cd-hit: a fast program for clustering and comparing large sets of protein or nucleotide sequences. *Bioinformatics*, *22*(13), 1658–1659.
Lohwag, H. (1924). Zur Stellung und Systematik der Gastromyceten. *Verhandlungen Der Zoologisch-Botanischen Gesellschaft in Wien*, *74*, 38–55.
Massee, G. (1891). New or imperfectly known gasteromycetes. *Grevillea*, *19*(92), 94–98.
Maddison W. P. & Maddison D. R. 2011. Mesquite: a modular system for evolutionary analysis 2.75, http://mesquiteproject.org
Matheny, P. B., Austin, E. A., Birkebak, J. M. and Wolfenbarger, A. D. (2010). *Craterellus fallax*, a Black Trumpet mushroom from eastern North America with a broad host range. *Mycorrhiza*, *20*(8), 569–575.
Miller, S. L., Larsson, E., Larsson, K.-H., Verbeken, A., & Nuytinck, J. (2006). Perspectives in the new Russulales. *Mycologia*, *98*(6), 960–970.
Peintner, U., Bougher, N. L., Castellano, M. A., Moncalvo, J. M., Moser, M. M., Trappe, J. M., & Vilgalys, R. (2001). Multiple origins of sequestrate fungi related to *Cortinarius* (Cortinariaceae). *American Journal of Botany*, *88*(12), 2168–79.
Peintner, U., Moser, M. M. & Vilgalys, R. (2002). *Thaxterogaster* is a taxonomic synonym of *Cortinarius*: New Combinations and New Names. *Mycotaxon*, *81*, 177–184.
Ryberg, M. & Matheny, P. B. (2012). Asynchronous origins of ectomycorrhizal clades of Agaricales. *Proceedings of the Royal Society B: Biological Sciences*, *279*(1735), 2003–2011.

Shao, D., Tang, S., Healy, R. A., Imerman, P. M., Schrunk, D. E. and Rumbeiha, W. K. (2016). A novel orellanine containing mushroom *Cortinarius armillatus*. *Toxicon*, *114*, 65–74.
Sheedy, E. M., Ryberg, M., Lebel, T., May, T. W., Bougher, N. L. and Matheny, P. B. (2016). Dating the emergence of truffle-like fungi in Australia, by using an augmented meta-analysis. *Australian Systematic Botany*, *29*(5), 284.
Schumacher, T. & Høiland, K. (1983). Mushroom poisoning caused by species of the genus *Cortinarius* Fries. *Archives of Toxicology*, *53*(2), 87–106.
Singer, R. (1932). Monographie der Gattung Russula. *Beihefte Zum Botanischen Centralblatt*, *49*(II), 205–380.
Singer, R. (1936). Studien zursystematik der Basidiomyceten. *Beihefte Zum Botanischen Centralblatt*, *56*(B), 137–174.
Singer, R. (1986). *Agaricales in Modern Taxonomy* (4th ed.). Koeltz Scientific Books.
Thiers, H. D. (1984). The Secotioid Syndrome. *Mycologia*, *76*(1), 1–8.
Tory, M. K., May, T. W., Keane, P. J., & Bennett, A. F. (1997). Mycophagy in small mammals: A comparison of the occurrence and diversity of hypogeal fungi in the diet of the long-nosed potoroo *Potorous tridactylus* and the bush rat *Rattus fuscipes* from southwestern Victoria, Australia. *Austral Ecology*, *22*(4), 460–470.
Wilson, A. W., Binder, M., & Hibbett, D. S. (2012). Diversity and evolution of ectomycorrhizal host associations in the Sclerodermatineae (Boletales, Basidiomycota). *New Phytologist*, *194*(4), 1079–1095.
Webster, J., Davies, R. A., & Turner, J. C. R. (1989). Vapour as the source of water in Buller’s drop. *Mycological Research*, *93*(3), 297–302.
Wells, J. M., Cole, R. J., & Kirksey, J. W. (1975). Emodin, a toxic metabolite of *Aspergillus wentii* isolated from weevil-damaged chestnuts. *Applied Microbiology*, *30*, 26–28.
White, T. J., Bruns, S., Lee, S., & Taylor, J. W. (1990). Amplification and direct sequencing of fungal ribosomal RNA genes for phylogenetics. In *PCR Protocols: A Guide to Methods and Applications* (pp. 315–322).

Appendix

Species sampled, GenBank accession numbers, type of fruiting body, pileus surface viscosity and GPS locations used in this study.

GenBank Number	Taxon Name	Type of Fruiting Body	Pileus surface	Location	Latitude	Longitude
MF599228	CO2476	gilled	dry	Colombia, Municipio Santa Rosa de Osos, near Llanos de Cuiva	6.7500	-75.5000
MF599229	CO2504	gilled	dry	Colombia, Municipio Santa Rosa de Osos, near Llanos de Cuiva	6.7500	-75.5000
MF599231	CO2555	gilled	dry	Along road from San Jose de la Montana to Labnes Mun San Jose, Departmento Antiogenia, Colombia	6.8557	-75.6818
JQ746601	Cortinarius aavae	gilled	dry	Canada, TN10-166; Québec: Montebello	45.6534	-74.9322
GU234040	Cortinarius absarokensis	gilled	dry	Svalbard	78.3060	16.8770
AF182797	Cortinarius absarokensis	gilled	dry	Washington, USA		
GU222306	Cortinarius achrous	gilled	dry	Springs Junction, Lake Daniells Track, Buller, New Zealand	-42.3050	172.2893
UDB001000	Cortinarius acutovelatus	gilled	dry	Schulterberg, Achenkirch, Tirol, Austria	47.5542	11.6410
FJ157001	Cortinarius acutovelatus	gilled	dry	F15818, Canada, BC, #3 Mount Elphinstone Provincial Park Area	49.4167	-122.3500
GQ159881	Cortinarius acutus	gilled	dry	F17138: USA, WA, Cobble Hill	48.6833	-122.3833
GQ159781	Cortinarius acutus	gilled	dry	F17191: Canada, BC, Tofino	49.1167	-124.1167
KC581333	Cortinarius acutus	gilled	dry	F20368: Canada, BC, North Vancouver, Capilano Regional Regional Park	49.3500	-122.9000
FJ157002	Cortinarius acutus	gilled	dry	F16038: Heater Harbour, Kunghit Island, Queen Charlotte Islands, BC, Canada	52.1167	-130.9500
HQ604665	Cortinarius acutus	gilled	dry	F20325: Canada, BC, Burnaby Island, Burnaby Narrows	52.3600	-130.6500
HQ604674	Cortinarius acutus	gilled	dry	F20322: Canada, BC, Bischof Island	52.5667	-130.4500
UDB001002	Cortinarius acutus	gilled	dry	Sweden, Smoland, Femsjö, Moor östl Buchenhügel östl. Löjenäs	56.9015	13.3524
UDB001547	Cortinarius acutus	gilled	dry	Scotland, Invernesshire, Glen Strathfarrar	57.4103	-4.8376
KC842420	Cortinarius acutus	gilled	dry	Norway, OS576; NA		
KF732419	Cortinarius acystidiosus	gilled	dry	USA: TENN: CLO4681	35.6367	-83.7353
GU233333	Cortinarius aegrotus	gilled	dry	Urewera National Park, trail to Lake Waikareiti, Gisborne, New Zealand	-38.7007	177.1886
GU233329	Cortinarius aerugineoconicus	gilled	dry	Takaka Hill, Mt Evans, Nelson, New Zealand	-40.9483	172.9202
UDB002228	Cortinarius agathosmus	gilled	dry	Bispgården, Ragunda, Jämtland, Sweden	63.0284	16.6166
UDB001834	Cortinarius albertii	gilled	dry	Denmark, Østjylland		
KR674106	Cortinarius	gilled	dry	WTU:J.F.Ammirati 13292, USA, Washington, Klickitat County,	45.7180	-121.3320

GenBank Number	Taxon Name	Type of Fruiting Body	Pileus surface	Location	Latitude	Longitude
	albidolilacinus			Syncline Winery		
KJ705122	Cortinarius albidus	gilled	dry	Quebec, 601-HRL 601; NA		
KJ705123	Cortinarius albidus	gilled	dry	Quebec, 4425; NA		
JX648600	Cortinarius alboaggregatus	gilled	dry	Craigieburn, Mid Canterbury, New Zealand	-43.1516	171.7133
KR011137	Cortinarius alboamarescens	gilled	dry	Finland, H:6029887; Finland, Varsinais-Suomi, Vihti, Vihtijärvi	60.5232	24.5481
KC608576	Cortinarius alboambitus	gilled	dry	USA: Washington, TN07-358; USA. Washington: Snohomish County, Barlow Pass, Mount Baker-Snoqualmie national forest	48.9746	-121.8756
JX983156	Cortinarius albocanus	sequestrate	dry	Argentina, EN27 (CORD); Using holotype location: valle Glaciar Martial prope Ushuaia, Tierra del Fuego, Argentina	-54.7986	-68.3716
KF732245	Cortinarius albofragrans	gilled	dry	USA: IB:19950595; USA, California, Del Norte Co., Highway 199, Danger Point	41.8486	-123.9826
UDB017792	Cortinarius albogaudis	gilled	dry	Finland, Tornio, Arpela, Korkiamaa, Runteli	65.1654	25.2312
GU234113	Cortinarius albonigrellus	gilled	dry	Svalbard	78.3060	16.8770
AY033097	Cortinarius alboroseus	gilled	dry	ZT NZ8672		
UDB018297	Cortinarius alborufescens	gilled	dry	Estonia, Võru maakond, Rõuge vald , Roobi village	57.5942	26.8619
JF907914	Cortinarius albovariegatus	gilled	dry	PLoS ONE 8 (4), E62419 (2013); Italy		
FJ039565	Cortinarius alboviolaceus	gilled	dry	East Sooke Park, along the trail to Babington hill (about 1/2 way up)	48.3531	-123.6715
EU821675	Cortinarius alboviolaceus	gilled	dry	DAVFP 27503: Pebble Creek, Riondel, B.C., Canada	49.8098	-116.8471
DQ097877	Cortinarius alboviolaceus	gilled	dry	BC Canada, OUC97234; DAVFP	50.5843	-118.8149
UDB000154	Cortinarius alboviolaceus	gilled	dry	Norway: Rogaland: Eigersund: near Egersund	58.4473	5.9926
AY669657	Cortinarius alboviolaceus	gilled	dry	Germany, TUB 011882		
KJ705146	Cortinarius alboviolaceus	gilled	dry	Quebec, 4682-HRL 1248; NA		
UDB001787	Cortinarius alcalinophilus	gilled	dry	Denmark, Sjælland		
JX407327	Cortinarius aleuriodor	gilled	dry	France, CFP869; France, Jura NA		
KJ421148	Cortinarius aleuriosmus	gilled	dry	MES4263; NA		
UDB002202	Cortinarius allutus	gilled	dry	Nåsten, Uppsala, Uppland, Sweden	59.8200	17.5777
UDB001004	Cortinarius allutus	gilled	dry	Sweden, Femsjö, Slättagärdet (Parish)		
GQ159796	Cortinarius alnetorum	gilled	dry	F17207	48.4833	-122.6167

GenBank Number	Taxon Name	Type of Fruiting Body	Pileus surface	Location	Latitude	Longitude
UDB000069	Cortinarius alnetorum	gilled	dry	Denmark, Sjælland, Lille Bøgeskov	55.4859	11.6437
UDB002798	Cortinarius alnetorum	gilled	dry	Porijõe, Estonia	58.3555	26.7486
AY669695	Cortinarius alnetorum	gilled	dry	Germany, TUB 01192		
EU655672	Cortinarius alnobetulae	gilled	dry	JFA 12247, Italy, Passo del Rolle	46.2951	11.7850
JF907932	Cortinarius alpicola	gilled	dry	PLoS ONE 8 (4), E62419 (2013); Italy		
JX630751	Cortinarius alpinus	gilled	dry	Canada: Baffin Island, 68.45 N 66.83 W	68.4500	-66.8300
GU234036	Cortinarius alpinus	gilled	dry	Svalbard	78.3060	16.8770
DQ295086	Cortinarius alpinus	gilled	dry	Peintner et al. isolate USA_3_9E; Colorado, USA		
KF732247	Cortinarius alticaudus	gilled	dry	France, PC:P. Moenne-Loccoz 1632; France, Lozere, bois de la Sagne	47.0411	6.7828
KJ920039	Cortinarius altissimus	gilled	dry	~15 km E of Potaro base in vicinity of Tadang base camp, Guyana	5.3089	59.9038
AF389129	Cortinarius amazonicus	gilled	dry	Brazil B12139; Estrada Manaus-Caracaraí, km-45. Amazonas, Brasil	-2.6922	-60.0513
UDB021475	Cortinarius ammiratii	gilled	dry	United States, Washington, Olympic Peninsula, Boulder Creek Trail, in the beginning of the trail by the road	47.9779	-123.6935
KF732249	Cortinarius amnicola	gilled	dry	USA: MICH:10315	42.2753	-83.7308
AF539721	Cortinarius amoenus	gilled	dry	San Antonio, Valdivia, Chile	-39.8283	-73.2299
UDB001007	Cortinarius amoenus	gilled	dry	Austria, Tirol, ober Thaur	47.3073	11.4786
GU233350	Cortinarius anauensis	gilled	dry	Te Anau, Totara Rest Area, Southland, New Zealand	-45.4606	167.7884
KR674108	Cortinarius anetholens	gilled	dry	WTU:J.F.Ammirati 13670, USA, Washington, Klickitat County, Syncline Winery	45.7180	-121.3320
KF732250	Cortinarius anfractoides	gilled	dry	France, PC:R. Henry 1898; NA		
UDB000671	Cortinarius angelesianus	gilled	dry	Stadsskogen, Uppsala, Sweden	59.8254	17.5553
KP165562	Cortinarius angustisporus	gilled	dry	Sweden, H:I. Kytovuori 01-056; Sweden, Pajala, by the road on W side of the river Muonioalven, opposite to the church village of Kolari	67.3264	23.7429
UDB001361	Cortinarius anisatus	gilled	dry	Finland, PeP, Tornio	65.8606	24.1442
JX407300	Cortinarius anisochrous	gilled	dry	Germany, 27.9.1996; Germany, Baden-Württenberg, Freiburg	47.9999	7.8072
UDB018358	Cortinarius anomalellus	gilled	dry	Estonia, Lääne maakond , Taebla vald , Hallimägi between Kirimäe and Leediküla	58.9294	23.7894
FJ717605	Cortinarius anomalovelatus	gilled	dry	JFA13109; NA		

GenBank Number	Taxon Name	Type of Fruiting Body	Pileus surface	Location	Latitude	Longitude
FJ039632	Cortinarius anomalus	gilled	dry	Windy Bay, Lyell Island, BC	52.6923	-131.4582
UDB001558	Cortinarius anomalus	gilled	dry	Scotland, Invernesshire, Glen Strathfarrar	57.4103	-4.8376
UDB000151	Cortinarius anomalus	gilled	dry	Norway: Oslo: Oslo: Nordmarka, Vettakollen	59.9680	10.6988
UDB002168	Cortinarius anomalus	gilled	dry	Abisko Research Station, N. Sweden	68.3537	18.8153
UDB018293	Cortinarius anomalus	gilled	dry	Estonia, Võru maakond , Varstu vald, Vorotka kivikalmed	57.5958	26.8577
UDB018296	Cortinarius anomalus	gilled	dry	Estonia, Võru maakond , Varstu vald, near Vorotka kivikalmed	57.5967	26.8569
UDB018347	Cortinarius anomalus	gilled	dry	Estonia, Lääne maakond , Taebla vald , near Kadarpiku village	58.9661	23.6944
KC842425	Cortinarius anomalus	gilled	dry	Norway, CA3; NA		
AY174807	Cortinarius anserinus	gilled	dry	Eßlingen, Germany	48.7414	9.3215
UDB001229	Cortinarius anthracinus	gilled	dry	Sweden, Ångermanland, Säbrå, Hällenyland	62.6103	17.7821
KP087976	Cortinarius appalachiensis	gilled	dry	TENN:061675	35.6075	-83.8086
UDB000072	Cortinarius aprinus	gilled	dry	Farum Nørreskov, North East Sealand, Denmark	55.8074	12.3731
AY669663	Cortinarius aprinus	gilled	dry	Germany, TUB 01191		
KJ420991	Cortinarius aquilanus	gilled	dry	TUB 019752; NA		
KJ421072	Cortinarius aquilanus	gilled	dry	Arangu Cort 02 11; NA		
AF112142	Cortinarius archeri	gilled	dry	no data	N/A	N/A
KJ421010	Cortinarius arcifolius	gilled	dry	TUB 020414; NA		
UDB001009	Cortinarius arcuatorum	gilled	dry	Italy, I, Prov. Parma, Val di Taro. Stabielle Borgotaro	44.4875	9.7470
AY669650	Cortinarius ardesiacus	gilled	dry	Tasmania HO 970419A0		
KF732252	Cortinarius arenicola	gilled	dry	USA: Michigan, Waterloo, Waterloo Project	42.3339	-84.1074
UDB001036	Cortinarius argutus	gilled	dry	Italy, Störer Wald, Armentarola unterhalb Falzarego Pass, Prov. Bozen, Italien	46.5199	12.0202
UDB000138	Cortinarius argutus	gilled	dry	Norway: Østfold: Sarpsborg: Skjeberg, Grimsøy	59.1434	11.2090
KR090549	Cortinarius argutus	gilled	dry	Finland, H:6029426; NA		
GQ890312	Cortinarius argyrionus	sequestrate	dry	Australia, MD163; MEL2331642	-30.4300	151.6500
UDB000160	Cortinarius armeniacus	gilled	dry	Norway: Oslo: Oslo: Nordmarka, Høgås	59.8381	10.3842

GenBank Number	Taxon Name	Type of Fruiting Body	Pileus surface	Location	Latitude	Longitude
KM504515	Cortinarius armenicorius	gilled	dry	France, KS-CO1865; France, Jura, Prénovel	46.5154	5.8356
UDB000155	Cortinarius armillatus	gilled	dry	Norway: Rogaland: Sandnes: Rogaland arboret	58.8130	5.8148
KF732255	Cortinarius atrochalybaeus	gilled	dry	USA: IB:19950630; USA, California, Del Norte Co., Highway 199, Danger Point	41.8486	-123.9826
KJ635241	Cortinarius atrolazulinus	gilled	dry	Cascade Hut Track, Taupo, New Zealand	-44.4938	168.6677
JX679160	Cortinarius atropurpureus	gilled	dry	Australia: Tasmania Maydena - Strathgordon Rd	-42.7357	146.4238
JQ749629	Cortinarius atropusillus	gilled	dry	France, PAM06082610; NA - email M. Roy		
KJ920029	Cortinarius atrotomentosus	gilled	dry	USA: Florida, Wakulla, Crawfordville, Apalachicola National Forest, Aaron Area, 'Boneyard'	30.2017	-84.4425
AF062619	Cortinarius atrovirens	gilled	dry	no data	N/A	N/A
UDB002094	Cortinarius atrovirens	gilled	dry	Sweden, Gotland		
KJ420977	Cortinarius aurantiobasalis	gilled	dry	TUB 019736; NA		
EF420139	Cortinarius aurantiobrunneus	gilled	dry	Costa Rica, JFA 11937	9.5506	-83.4633
KJ547666	Cortinarius aurantioferreus	gilled	dry	Tawanui, Southland, New Zealand	-46.4543	169.5120
JQ287691	Cortinarius aurantioferreus	gilled	dry	New Zealand: Saint Arnaud Lodge, Buller	-41.8021	172.8488
KF732258	Cortinarius aurantiopallidus	gilled	dry	France, PC:A. Bidaud 05-11-404; France, Ardeche, Lagorce	44.4622	4.4275
AF539710	Cortinarius aurantiorufus	gilled	dry	Salto de la Princesa, Temuco, Chile	-38.4747	-71.6734
UDB000601	Cortinarius aureifolius	gilled	dry	Sweden		
UDB001012	Cortinarius aureocalceolatus	gilled	dry	Italy, I, Italien, Region Abruzzo, Parco Naz. della Majella, nahe Opi, Val Fondillo	41.7786	13.8568
KJ421120	Cortinarius aureocistophilus	gilled	dry	SCM B 5145 Holotypus; Location of Isotype: SPAIN. GIRONA: Roses, hillock above Punta Falconera	42.2360	3.2176
UDB001883	Cortinarius aureofulvus	gilled	dry	Sweden, Västra Götaland, Kinnekulle, Gössäter	58.6077	13.4585
UDB001772	Cortinarius aureomarginatus	gilled	dry	Sweden		
UDB001773	Cortinarius aureomarginatus	gilled	dry	Sweden		
EF420140	Cortinarius aureopigmentatus	gilled	dry	Costa Rica, JFA 11940	9.5506	-83.4633
UDB001884	Cortinarius aureopulverulentus	gilled	dry	Sweden, Västergötland,		

GenBank Number	Taxon Name	Type of Fruiting Body	Pileus surface	Location	Latitude	Longitude
UDB001768	Cortinarius aureovelatus	gilled	dry	Norway		
KR674111	Cortinarius aurescens	gilled	dry	WTU:J.F.Ammirati 13662; USA. Washington, Klickitat County, Columbia Gorge; Location of Holotype: Syncline Winery	45.7180	-121.3320
UDB001790	Cortinarius aurilicis	gilled	dry	France, Doubs, Besançon, Grand Desert	47.2360	6.0472
KJ705134	Cortinarius aurilicis	gilled	dry	Quebec, 4407; NA		
EU057018	Cortinarius aurora	gilled	dry	JFA 9938; Wyoming: Teton Co., Fourmile Meadow, USA	43.8196	-110.2664
AF503553	Cortinarius aurora	gilled	dry	IB19890227		
KJ635233	Cortinarius australis	gilled	dry	Lewis Pass, Boyle River, Buller, New Zealand	-42.3801	172.4020
AY669626	Cortinarius austrocyanites	gilled	dry	New Zealand, CO1034; Craigieburn	-43.1516	171.7133
AY669619	Cortinarius austrosaginus	gilled	dry	Tasmania HO 980509A0		
AF539730	Cortinarius austroturmalis	gilled	dry	Lonquimay, Temuco, Chile	-38.7408	-72.6282
JX679098	Cortinarius austrovenetus	gilled	dry	Australia: Victoria Marginal Rd, Glenburn	-37.4441	145.4727
KJ920004	Cortinarius austroviolaceus	gilled	dry	Australia: Victoria, Eastern Highlands, Narbethong, Anderson Street, 350 m W of Maroondah Highway	-37.5470	145.6595
HM017845	Cortinarius badiolaevis	gilled	dry	Sweden, CFP 1251 (S); Sweden, Ångermanland, Säbrå, Hårsta	59.9820	16.7030
KF732612	Cortinarius badiolatus	gilled	dry	Sweden, IK98-1029; Sweden, Nb, Pajala	67.2127	23.3462
UDB001015	Cortinarius badiovinaceus	gilled	dry	USA, Clallam Co., Washington, Olympic National Park, Lake Angeles Trail	48.0383	-123.4392
UDB002221	Cortinarius badiovinaceus	gilled	dry	Bispgården, Ragunda, Jämtland, Sweden	63.0284	16.6166
UDB018299	Cortinarius balaustinus	gilled	dry	Estonia, Võru maakond , Rõuge vald , Saarlase	57.7061	26.8703
KF732597	Cortinarius balteaticlavatus	gilled	dry	Finland, IK95-382; Finland, Inari	68.9063	27.0311
UDB000711	Cortinarius balteatoalbus	gilled	dry	Slottsbacken, Uppsala, Sweden	59.8542	17.6332
KF732253	Cortinarius balteatoalbus	gilled	dry	Sweden, S:CFP461b; Sweden, Ang, Graninge, Viksmon	63.0686	17.0055
UDB016143	Cortinarius balteatocumatilis	gilled	dry	Estonia, Valga maakond , Põdrala vald , Riidaja village	58.1006	25.9022
UDB001134	Cortinarius balteatus	gilled	dry	Northern Sweden, Vindeln, Åheden experimental site	63.6822	20.0533
UDB002113	Cortinarius barbaricus	gilled	dry	Sweden, Västergötland		
UDB001835	Cortinarius barbarorum	gilled	dry	France, Haute-Savoie, Massif de Semnoz	45.8042	6.1097
FJ717554	Cortinarius	gilled	dry	JFA13140; Barlow Pass, WA, USA	48.0255	-121.4435

GenBank Number	Taxon Name	Type of Fruiting Body	Pileus surface	Location	Latitude	Longitude
	barlowensis					
EU837213	Cortinarius barlowensis	gilled	dry	OSC 114595	48.9746	-121.8756
KF732264	Cortinarius barrentium	gilled	dry	France, G:100391/1; France, Loiret, Arboretum des Barres	47.8369	2.7554
AY669607	Cortinarius basipurpureus	sequestrate	viscid	Australia PERTH 04259629	-34.9550	118.1850
GQ890319	Cortinarius basirubescens	gilled	dry	Australia:'Victoria, Kinglake National Park	-37.3498	145.1947
GQ890309	Cortinarius basorapulus	sequestrate	dry	Australia, KV621; MEL2331650	-30.3000	149.7667
JX045666	Cortinarius bataillei	gilled	dry	Switzerland, CFP1078; NA		
AY669685	Cortinarius belleri	gilled	dry	Spain, TUB 011895		
KF727383	Cortinarius bellus	gilled	dry	Lake Waikareiti Track, Gisborne, New Zealand	-38.7007	177.1886
UDB001799	Cortinarius bergeronii	gilled	dry	Denmark. NØS, Arresødal at Frederiksværk	56.0092	12.0181
UDB016133	Cortinarius betuletorum	gilled	dry	Estonia, Võru maakond , Rõuge vald , Saarlase	57.7081	26.8739
UDB001135	Cortinarius betulinus	gilled	dry	Northern Sweden, Abisko Research Station	68.3537	18.8153
KR674113	Cortinarius beugii	gilled	dry	WTU:M.W.Beug 04MWB11510; USA. Washington, Klickitat County, Columbia Gorge		
UDB001061	Cortinarius bibulus	gilled	dry	Austria, Tirol, Gschnitztal, ca. 2 km von Lift,	47.0426	11.3511
GQ159846	Cortinarius biformis	gilled	dry	F17260: Canada, BC, Saanich, Observatiory Hill	48.5167	-122.5833
GQ159851	Cortinarius biformis	gilled	dry	F17265: Canada, BC, Saanich, Observatiory Hill	48.5167	-122.5833
FJ039574	Cortinarius biformis	gilled	dry	Canada, BC, Smithers	54.7742	-127.4113
FJ039592	Cortinarius birkebakii	gilled	dry	Around small cottages, near the admin building, Observatory Hill, Saanich, BC	48.5206	-123.4153
KJ421024	Cortinarius bisporiger	gilled	dry	A202300; NA		
UDB016134	Cortinarius bivelus	gilled	dry	Estonia, Võru maakond , Rõuge vald , near Metstaga (Varstu commune)	57.6511	26.7856
UDB001137	Cortinarius bolaris	gilled	dry	Sweden, Uppsala, Stadsskogen	59.8372	17.6230
UDB011342	Cortinarius boreicyanites	gilled	dry	Estonia, Saare maakond , Lümanda vald , Kiviselja	58.2712	22.1288
KF732488	Cortinarius boreidionysae	gilled	dry	Finland: H:I. Kytovuori 97-1220; FINLAND, Perä-Pohjanmaa, Tervola, Peura, Raemäki	66.1733	25.1374
KF732266	Cortinarius borgsjoeensis	gilled	dry	Sweden, Jmt, Ragunda, Kullstabodama	63.0993	16.3148
UDB001452	Cortinarius boulderensis	gilled	dry	USA, Wash., Clallam Co.		

GenBank Number	Taxon Name	Type of Fruiting Body	Pileus surface	Location	Latitude	Longitude
KC905158	Cortinarius bovarius	gilled	dry	USA: Alaska, TN11-255; U.S.A. Alaska, Fairbanks	64.8592	-147.8247
JX407266	Cortinarius bovinaster	gilled	dry	Sweden, CFP1656; Sweden, Jmt, Froso	63.1762	14.5374
JX407269	Cortinarius bovinatus	gilled	dry	Sweden, CFP640; Sweden, Jg, Medelplana	58.5845	13.3602
UDB015907	Cortinarius bovinus	gilled	dry	Sweden, Väskinde parish, Brucebo Nature Reserve	57.6848	18.3473
UDB001382	Cortinarius bovinus	gilled	dry	Austria, Tirol		
HQ845159	Cortinarius bresadolanus	gilled	dry	France, GK432466; France, Loiret, Montargi	48.0076	2.7515
KF732600	Cortinarius brunneiaurantius	gilled	dry	Finland, H:6032422; FINLAND, Varsinais-Suomi, Turku, Ruissalo, Kansanpuisto	60.4336	22.1803
EU259284	Cortinarius brunneifolius	gilled	dry	Finland, TN06-146 (H) ; Kitee, PK	62.0926	30.1377
KR011128	Cortinarius brunneoalbus	gilled	dry	USA: Washington, H:T. Niskanen 09-075; GenBank ITS: KR011129. Snohomish County, Barlow Pass, Mount Baker-Snoqualmie national forest,	48.9746	-121.8756
JQ746602	Cortinarius brunneocalcarius	gilled	dry	Canada, TN10-150; Québec: Montebello	45.6534	-74.9322
KF732268	Cortinarius brunneolividus	gilled	dry	France, G:286391/1; France, Isere, Optevoz	45.7520	5.3121
UDB018335	Cortinarius brunneotinctus	gilled	dry	Estonia, Jõgeva maakond , Jõgeva, Endla Nature Reserve	58.8797	26.1403
KC608580	Cortinarius brunneovernus	gilled	dry	USA: Washington, DM05-14; USA. Washington: Klickitat County, Jack Creek Road, North Fork Teanaway River	47.3308	-120.8537
UDB016118	Cortinarius brunneus	gilled	dry	Estonia, Põlva maakond , Põlva maakond, Kõlleste vald , Krüüdneri village, forest behind Krüüdneri pub	58.1225	26.6922
UDB018341	Cortinarius brunneus	gilled	dry	Estonia, Jõgeva maakond		
AY669659	Cortinarius bulliardii	gilled	dry	Germany, TUB 011899		
JF907860	Cortinarius bulliardii	gilled	dry	PLoS ONE 8 (4), E62419 (2013); Italy		
JQ746617	Cortinarius bulliardioides	gilled	dry	Finland, IK97-2293; NA		
KP114463	Cortinarius cacaodiscus	gilled	dry	Canada, Alberta, H:T. Niskanen 11-367; Canada, Alberta, Hinton	53.4000	-117.5804
KF732270	Cortinarius cacodes	gilled	dry	USA: IB:19910618; USA, California, Mendocino Co., Russian Gulch State Park	39.3316	-123.7937
AF539715	Cortinarius caelicolor	gilled	dry	San Antonio, Valdivia, Chile	-39.8283	-73.2299
UDB000070	Cortinarius caerulescens	gilled	dry	Farum Nørreskov, North East Sealand, Denmark	55.8074	12.3731
GQ890310	Cortinarius	sequestrate	dry	Australia, KV660; MEL2331651	-30.4811	152.2903

GenBank Number	Taxon Name	Type of Fruiting Body	Pileus surface	Location	Latitude	Longitude
	caesibulga					
FJ717517	Cortinarius caesiifolius	gilled	dry	JMB10-20-2007-15	47.3731	-122.9728
KP137504	Cortinarius caesioarmeniacus	gilled	dry	Canada: Quebec, H:T. Niskanen 10-070; Canada, Quebec, Saint-Donat foray	46.3129	-74.2264
EU266650	Cortinarius caesiobrunneus	gilled	dry	Sweden, IK00-013 (H); Idre; Dlr	61.8550	12.7324
KJ420989	Cortinarius caesiocanescens	gilled	dry	TUB 019749; NA		
UDB011730	Cortinarius caesiocinctus	gilled	dry	Estonia, Hiiu maakond ,Kõrgessaare vald , Kõpu peninsula, E of Hirmuste	58.9331	22.1433
DQ663240	Cortinarius caesiocinctus	gilled	dry	Finland, JR27997 ; SF: 27 Sept. 1997: J. Ruotsalainen; NA		
KF732603	Cortinarius caesiocolor	gilled	dry	Finland, H:I. Kytovuori 00-029; FINLAND, Uusimaa, Lohja, Jalassaari, Tamminiemi	60.2103	23.9031
UDB001792	Cortinarius caesiocortinatus	gilled	dry	Czech republic. Karlstejn	49.9409	14.1896
KF732572	Cortinarius caesiophylloides	gilled	dry	Finland, H:6029792; FINLAND, Etelä-Savo, Joutsa, Koivuranta, W of Rakkolanselkä	61.7425	26.1822
KF727395	Cortinarius calaisopus	gilled	dry	Kaimanawa, Clements Mill Road, Taupo, New Zealand	-38.9841	176.2169
FJ039678	Cortinarius californicus	gilled	dry	Along the North Saanich Road, base of Observatory Hill, Saanich, BC	48.5175	-123.4220
JF742660	Cortinarius callimorphus	gilled	dry	USA, DBB25837		
FJ157127	Cortinarius callisteus	gilled	dry	Date Creek, Hazelton	55.4308	-127.7992
AY669594	Cortinarius callisteus	gilled	dry	Germany TUB 011827		
EU056985	Cortinarius callochrous	gilled	dry	TUB 012715 ; Flözlingen, Germany	48.1587	8.5288
EU056981	Cortinarius calochrous	gilled	dry	JFA 11855; California: Del Norte Co., Danger Point, USA	41.8486	-123.9826
EU056984	Cortinarius calochrous	gilled	dry	JFA 11854 ; California: Del Norte Co., Danger Point, USA	41.8486	-123.9826
EU056962	Cortinarius calochrous	gilled	dry	JFA 11646 ; Oregon: Wasco Co., Clear Creek Campground, USA	45.1464	-121.5859
EU056977	Cortinarius calochrous	gilled	dry	JFA 11649 ; Oregon: Wasco Co., Clear Creek Campground, USA	45.1464	-121.5859
FJ039639	Cortinarius calochrous	gilled	dry	Canada, BC, Smithers, McDonnell Forestry Service Road	54.7742	-127.4113
KF732273	Cortinarius calyptratus	gilled	dry	USA: MICH:10328; USA, California, Del Norte, Crescent City	41.7676	-124.1806
KF732274	Cortinarius calyptrodermus	gilled	dry	USA: MICH:10329	42.1783	-84.0939
KP406561	Cortinarius	gilled	dry	F28430: Canada, BC, Campbell River	50.0667	-124.5833

GenBank Number	Taxon Name	Type of Fruiting Body	Pileus surface	Location	Latitude	Longitude
	camphoratus					
KJ421043	Cortinarius camptoros	gilled	dry	TUB 019788; NA		
EU313201	Cortinarius caninus	gilled	dry	Western Siberia; NA		
U56024	Cortinarius caninus	gilled	dry	N/A		
UDB000152	Cortinarius caperatus	gilled	dry	Norway: Buskerud: Modum: Modum bad	59.9658	9.9373
EU266659	Cortinarius carabus	gilled	dry	IK01-025 (H); Kolari, Kil, Finland	67.3324	23.7896
KJ635222	Cortinarius carbonellus	gilled	dry	Kaimanawa, Te Iringa Track, Taupo, New Zealand	-38.9841	176.2169
AF539712	Cortinarius carneolus	gilled	dry	Jardı´n Bota´ nico, Valdivia, Chile	-39.8047	-73.2516
JX983157	Cortinarius carneoroseus	sequestrate	dry	Argentina, EN76 (CORD); Using holotype location: Monte Alto, Puerto Natales, Magellanes, Chile	-51.5722	-72.3481
EF420149	Cortinarius carranzae	gilled	dry	Costa Rica, JFA 12929a	9.5506	-83.4633
GU233356	Cortinarius caryotis	gilled	dry	Urewera National Park, Lake Waikareiti Track, Gisborne, New Zealand	-38.7007	177.1886
JX045671	Cortinarius cascadensis	gilled	dry	JFA6156	45.0245	-123.9453
EU819499	Cortinarius casimiri	gilled	dry	Cummings-Carlson, Wisconsin Department of Natural Resources, West Salem, WI	43.9109	-91.0763
GQ159838	Cortinarius casimiri	gilled	dry	F17252: Canada, BC, Saanich, Observatory Hill	48.5167	-122.5833
GQ159893	Cortinarius casimiri	gilled	dry	F17150; Canada, BC, Duncan, Elkington Estates	48.8080	-123.6315
GU233332	Cortinarius castaneiceps	gilled	dry	Little Barrier Island, Summit Track, Coromandel, New Zealand	-36.2194	175.0570
KF732275	Cortinarius castaneicolor	gilled	dry	USA: MICH:10331	47.9763	-123.6842
GU222311	Cortinarius castoreus	gilled	dry	Charming Creek Walkway, Nelson, New Zealand	-41.6096	171.8804
UDB001904	Cortinarius catharinae	gilled	dry	Denmark. SS, Broby Vesterskov	55.3851	11.5898
FJ157016	Cortinarius causticus	gilled	dry	F14975: Canada, BC, Cranberry Junction near Kitwanga	55.1000	-127.9333
FJ157135	Cortinarius causticus	gilled	dry	Date Creek Reasearch Forest near Kispiox	55.4308	-127.7992
EU057036	Cortinarius cedretorum	gilled	dry	JFA 11845 ; California: Del Norte Co., Gasquet Flat, USA	41.8486	-123.9826
EU057038	Cortinarius cedretorum	gilled	dry	JFA 11767 ; California: Del Norte Co., Patrick Creek Campground, USA	41.8719	-123.8467
KF732276	Cortinarius cephalixoides	gilled	dry	USA: KF732276; USA, Wyoming, Teton National Forest, Flagstaff Road	43.7989	-110.2519

GenBank Number	Taxon Name	Type of Fruiting Body	Pileus surface	Location	Latitude	Longitude
AY174784	Cortinarius cephalixus	gilled	dry	Eßlingen, Germany	48.7460	9.3224
FJ039693	Cortinarius ceraceus	gilled	dry	Quadra Point, Rose Inlet, Moresby Island, BC	52.2037	-131.1544
HQ604656	Cortinarius ceraceus	gilled	dry	F20336: Canada, BC, Graham Island, Rose Spit Eclogical Reserve	54.1667	-130.3333
AF539711	Cortinarius cervinus	gilled	dry	San Antonio, Valdivia, Chile	-39.8283	-73.2299
FJ039595	Cortinarius ceskae	gilled	dry	Behind the smaller dome, Observatory Hill, Saanich, BC	48.5211	-123.4202
UDB001838	Cortinarius chailluzii	gilled	dry	France. Doubs, Besançon, Forêt du chailluz	47.2959	6.0455
JQ287671	Cortinarius chalybeus	gilled	dry	New Zealand: Te Anau, Te Anau Downs, Lake Gunn Track, Fiordland	-44.8916	168.0816
KJ421096	Cortinarius chlorophanus	gilled	dry	TUB 020419; NA		
GU233339	Cortinarius chrysma	gilled	dry	Craigieburn, Middle Canterbury, New Zealand	-43.1516	171.7133
EU821663	Cortinarius chrysolitus	gilled	dry	DAVFP 28810: Canada, BC, Stillwater	49.9072	-124.3708
JX045672	Cortinarius chrysolitus	gilled	dry	Kauffman 10332, USA, New York; NA		
UDB017797	Cortinarius cicindela	gilled	dry	Norway, Bardu, Setermoen	68.8620	18.3406
GQ890315	Cortinarius cinereoroseolus	sequestrate	dry	Australia, KV529; MEL2331646	-30.3000	149.7667
UDB000161	Cortinarius cinnabarinus	gilled	dry	Norway: Vestfold: Stokke	59.2228	10.2904
JF907925	Cortinarius cinnamomeoluteus	gilled	dry	PLoS ONE 8 (4), E62419 (2013); Italy		
EU525963	Cortinarius cinnamomeus	gilled	dry	USA: Oregon, HJ Andrews Experimental Forest	44.2119	-122.2554
FJ717560	Cortinarius cinnamomeus	gilled	dry	F17075; Canada, BC, Pacific Rim National Park, Tofino, South Beach	48.7833	-124.8000
FJ845396	Cortinarius cinnamomeus	gilled	dry	F16548: Canada, BC, Mcdonnell FSR Smithers	54.7742	-127.4113
UDB000128	Cortinarius cinnamomeus	gilled	dry	Norway: Buskerud: Drammen: Bragernesåsen	59.7500	10.2038
JX436890	Cortinarius cinnamomeus	gilled	dry	Alaska, ME13_B10; NA		
KR019840	Cortinarius cinnamomeus	gilled	dry	Latvia, HA9; NA		
JF795387	Cortinarius cisqhale	gilled	dry	Salt Point State Park, California, USA	38.5702	-123.3187
UDB001839	Cortinarius cisticola	gilled	dry	France. Hérault, Montpellier, Gigean, Mt. du Gardiole	43.4873	3.7275
KF732280	Cortinarius	gilled	dry	USA: MICH:10334	47.9780	-123.7480

GenBank Number	Taxon Name	Type of Fruiting Body	Pileus surface	Location	Latitude	Longitude
	citrinifolius					
KF732281	Cortinarius citrinipedes	gilled	dry	USA: MICH:10335	42.2753	-83.7308
UDB001898	Cortinarius citrinolilacinus	gilled	dry	Italy. Abruzzo		
UDB001918	Cortinarius citrinus	gilled	dry	Denmark, Sjælland, Farum Nørreskov	55.8074	12.3731
AF325607	Cortinarius citriolens	gilled	dry	Wyoming, USA		
GQ159871	Cortinarius clandestinus	gilled	dry	F17128: Canada, BC, Vancouver Island, Mt. Washington	49.7345	-125.3545
UDB011340	Cortinarius claricolor	gilled	dry	Estonia, Saare maakond , Lümanda vald , Kiviselja	58.3025	22.1193
UDB019912	Cortinarius clarobrunneus	gilled	dry	Finland, Rovaniemi, Pisavaara, NE corner of Strict Nature Reserve	66.3133	25.1467
UDB016156	Cortinarius claroplaniusculus	gilled	dry	Estonia, Tartu maakond , Võnnu vald , Järvselja	58.2679	27.3119
JN942296	Cortinarius clelandii	gilled	dry	MEL2300725	-42.9008	147.2603
JN942297	Cortinarius clelandii	gilled	dry	MEL2089675	-37.6667	145.3667
KJ421037	Cortinarius cliduchus	gilled	dry	TUB 019783; NA		
KJ421020	Cortinarius coalescens	gilled	dry	F319; NA		
KF673472	Cortinarius cobaltinus	gilled	dry	TF2006-103; Norway, Oppl, Jevnaker	60.2379	10.3783
JX114945	Cortinarius coccineus	gilled	dry	France 435745 (GK); Holotype; NA		
AY669640	Cortinarius coelopus	gilled	dry	Tasmania, HO 990504A3		
UDB001797	Cortinarius coerulescentium	gilled	dry	No data.		
EU266682	Cortinarius coleoptera	gilled	dry	IK01-024 (H); Kolari, Kil, Finland	67.3324	23.7896
AY033114	Cortinarius collariatus	gilled	dry	IB19630088		
UDB019881	Cortinarius collinitus	gilled	dry	Finland, Rovaniemi, Pohtimolampi, surroundings of Bear's Lodge	66.6606	25.3311
DQ295116	Cortinarius collinitus	gilled	dry	IB19890443 ; California, USA		
KJ421036	Cortinarius collocandoides	gilled	dry	TUB 019782; NA		
GU233346	Cortinarius collybianus	gilled	dry	St Arnaud Range, Nelson, New Zealand	-41.8119	172.8605
AF539735	Cortinarius columbinus	gilled	dry	San Antonio, Valdivia, Chile	-39.8283	-73.2299

GenBank Number	Taxon Name	Type of Fruiting Body	Pileus surface	Location	Latitude	Longitude
UDB002220	Cortinarius colus	gilled	dry	Bispgården, Ragunda, Jämtland, Sweden	63.0284	16.6166
UDB002195	Cortinarius colymbadinus	gilled	dry	Nåsten, Uppsala, Uppland, Sweden	59.8200	17.5777
EF420150	Cortinarius comparioides	gilled	dry	Costa Rica, JFA 11998	9.5506	-83.4633
UDB002198	Cortinarius comptulus	gilled	dry	Nåsten, Uppsala, Uppland, Sweden	59.8200	17.5777
KF732288	Cortinarius concrescens	gilled	dry	France: G:286479/1; France, Haute-Savoie, Le Danay, St-Jean-de-Sixt	45.9197	6.4035
KT591611	Cortinarius conterminus	gilled	dry	No data.		
KJ421019	Cortinarius controversus	gilled	dry	A20523A0; NA		
KJ206499	Cortinarius coracis	gilled	dry	Finland, IK98-195 (H); Finland, PeP, Tornio	65.8458	24.1507
UDB001840	Cortinarius corrosus	gilled	dry	Sweden. Gotland, Klinte, Laxare	57.3780	18.2371
AF325611	Cortinarius corrugatus	gilled	dry	Vermont, USA; IB20000544		
EF420147	Cortinarius costaricensis	gilled	dry	Costa Rica, JFA 11904	9.7678	-83.9553
AY669597	Cortinarius cotoneus	gilled	dry	Germany TUB 011826		
KP165555	Cortinarius crassisporus	gilled	dry	Finland, OULU:F032227; Finland, Kainuu, Suomussalmi, Raate, in the three-year-old forest fire area on the hill between Jannevaara and Pyoriaisenvaara in the frontier zone	64.8166	29.6460
KJ421011	Cortinarius crassus	gilled	dry	TUB 020415; NA		
UDB018303	Cortinarius craticius	gilled	dry	Estonia, Võru maakond , Rõuge vald , Metsataga	57.7058	26.8722
KF732493	Cortinarius cremeiamarescens	gilled	dry	Sweden, H:I. Kytovuori 11-014; SWEDEN, Gotland, Alskog and När parish, Ollajvs Nature Reserve	57.3365	18.6883
AY669622	Cortinarius cretax	gilled	dry	New Zealand, CO1180 ; Taupo; Clements Road, Te Iringa Track	-38.9562	176.2445
FJ039706	Cortinarius croceocoeruleus	gilled	dry	Boschniakia Point, Rose Inlet, Moresby Island, BC	52.1897	-131.1390
UDB000763	Cortinarius croceocoeruleus	gilled	dry	Denmark, NEZ, Farum Nörreskov	55.7954	12.3882
UDB021482	Cortinarius croceosimilis	gilled	dry	Canada, Alberta, Hinton	53.3903	-117.5577
UDB002244	Cortinarius croceus	gilled	dry	Pustnäs Salix plantation, Uppsala, Sweden	59.7985	17.6736
UDB000129	Cortinarius croceus	gilled	dry	Norway: Oslo: Oslo: Nordmarka, Skådalen	59.9652	10.6976
UDB017633	Cortinarius croceus	gilled	dry	Norway, Vest-Agder , Farsund, Lomsesanden	58.0660	6.7920
UDB016056	Cortinarius	gilled	dry	Estonia, Tartu maakond , Võnnu vald , Ca 3 km SW from Kurista	58.2425	26.9647

GenBank Number	Taxon Name	Type of Fruiting Body	Pileus surface	Location	Latitude	Longitude
	croceus					
UDB019892	Cortinarius croceus	gilled	dry	Finland, Rovaniemi, Pohtimolampi, surroundings of Bear's Lodge	66.6700	25.3142
KF732539	Cortinarius cruentipellis	gilled	dry	Sweden, H:T. Niskanen et al. 03-1451; SWEDEN, Öland, Långlöt, Åstad, Nitares hägn	56.7469	16.6922
UDB021562	Cortinarius cruentiphyllus	gilled	dry	Finland, Uusimaa, Espoo, Luukkaa outdoor recreation area, W side of the lake Kaitalampi, nature reserve area	60.3200	24.6619
DQ097879	Cortinarius crystallinus	gilled	dry	BC, Canada, OUC99252; DAVFP	50.5843	-118.8149
AY174812	Cortinarius cumatilis	gilled	dry	Oberjoch, Germany	47.5165	10.4027
JX000350	Cortinarius cupreonatus	gilled	dry	Hawdon, Cass, Craigieburn, Mid Canterbury, New Zealand	-42.9112	171.7329
UDB011345	Cortinarius cupreorufus	gilled	dry	Estonia, Saare maakond , Kärla vald , Jõempa	58.3431	22.2994
UDB001099	Cortinarius cyanites	gilled	dry	Austria, Tirol, Absamer Aichat	47.5083	12.0607
UDB001154	Cortinarius cyanites	gilled	dry	Sweden, Uppsala, Berthåga graveyard	59.8585	17.5761
GU222297	Cortinarius cycneus	gilled	dry	Springs Junction, Lake Daniells Track, Buller, New Zealand	-42.3050	172.2893
JF907859	Cortinarius cypriacus	gilled	dry	PLoS ONE 8 (4), E62419 (2013); Italy		
AY669651	Cortinarius cystidiocatenatus	gilled	dry	Tasmania HO A20518A6		
UDB001927	Cortinarius dalecarlicus	gilled	dry	Italy. Kaltern		
UDB021526	Cortinarius davemallochii	gilled	dry	Canada, New Brunswick, Charlotte County, Lepreau Parish, woods at west end of MacPherson's Beach, 1.4 km southwest of Little Lepreau	45.1336	-66.4597
GQ159776	Cortinarius decipiens	gilled	dry	F17186: Canada, BC, Wikanninish Beach	49.1167	-124.1167
UDB000067	Cortinarius decipiens	gilled	dry	Denmark, Sjælland, Lille Bøgeskov	55.4859	11.6437
UDB000068	Cortinarius decipiens	gilled	dry	Denmark, Sjælland, Lille Bøgeskov	55.4859	11.6437
UDB001145	Cortinarius decipiens	gilled	dry	Sweden, Uppland, Fastarbo, Björklinge, Old spruce site, 40 km N. of Uppsala nr	60.0278	17.5556
FN428988	Cortinarius decipiens	gilled	dry	France:Haute-Savoie		
GQ159815	Cortinarius degratus	gilled	dry	F17227: Canada, BC, Saltspring Island, Mt. Tuam	48.7167	-122.5167
UDB016105	Cortinarius delaportei	gilled	dry	Estonia, Saare maakond , Leisi vald , near Triigi harbour	58.5944	22.7092
UDB001102	Cortinarius delibutus	gilled	dry	Austria, Tirol, Matrei, Maria Waldrast, unterhalb Serles	47.1299	11.4038

GenBank Number	Taxon Name	Type of Fruiting Body	Pileus surface	Location	Latitude	Longitude
UDB000144	Cortinarius delibutus	gilled	dry	Norway: Rogaland: Eigersund: near Egersund	58.4473	5.9926
UDB002173	Cortinarius delibutus	gilled	dry	Abisko Research Station, N. Sweden	68.3537	18.8153
UDB020292	Cortinarius delibutus	gilled	dry	Estonia, Tartu maakond , Tähtvere vald , ca 2 km S of Ilmatsalu	58.3698	26.5560
UDB002234	Cortinarius depressus	gilled	dry	Nåsten, Uppsala, Uppland, Sweden	59.8200	17.5777
JQ724018	Cortinarius diasemospermus	gilled	dry	Sweden: natural/naturalized willow stand NWS1, 59.49 N 17.40 E	59.4900	17.4000
UDB002162	Cortinarius diasemospermus	gilled	dry	Bispgården, Ragunda, Jämtland, Sweden	63.0284	16.6166
KF738092	Cortinarius dionysae	gilled	dry	France, AB_05_09_100; NA		
KF738095	Cortinarius dionysae	gilled	dry	Spain, JVG_1020829_8;NA		
KJ421135	Cortinarius dionysae	gilled	dry	TUB 020423; NA		
GQ159918	Cortinarius diosmus	gilled	dry	F16584, Canada, BC, Smithers	54.7667	-126.8333
JF907895	Cortinarius diosmus	gilled	dry	PLoS ONE 8 (4), E62419 (2013); Italy		
KP013187	Cortinarius disjungendulus	gilled	dry	Finland, H:I. Kytovuori 96-543; Finland, PH Virrat	62.2349	23.7661
KP013191	Cortinarius disjungendus	gilled	dry	Finland, H:I. Kytovuori 01-029; Finland, PH, Virrat	62.2349	23.7661
AF325610	Cortinarius dulciolens	gilled	viscid	New Zealand; ZT NZ8635		
JX178605	Cortinarius dulciolens	gilled	dry	New Zealand, OTA:60170 NA		
JX000364	Cortinarius dulciorum	gilled	dry	Kiko Track, Taupo, New Zealand	-39.0195	175.9945
KP165557	Cortinarius duristipes	gilled	dry	Finland, H:T. Niskanen 02-888; Finland, Koillismaa, Kuusamo, SW of Laajusvaara, Jussinlamminvaara	66.2144	29.6952
GU233340	Cortinarius dysodes	gilled	dry	Craigieburn, Middle Canterbury, New Zealand	-43.1516	171.7133
KP311432	Cortinarius eartoxicus	gilled	dry	MEL:2351137	-43.1333	147.9500
UDB001101	Cortinarius eburneus	gilled	dry	Italy, Parco Naz. di Maielle, Campo di Giove, Fonte Romana	42.0073	14.0471
UDB001293	Cortinarius ectypus	gilled	dry	Finland, Espoo, Luukki	60.3170	24.6881
AY669627	Cortinarius elaiochrous	gilled	dry	New Zealand, CO1335; Taupo; Te Iringa Track	-38.9841	176.2169
AY033099	Cortinarius elaiochrous	gilled	dry	ZT NZ8701		

GenBank Number	Taxon Name	Type of Fruiting Body	Pileus surface	Location	Latitude	Longitude
JX000369	Cortinarius elaiops	gilled	dry	Mackay Creek, Fiordland, New Zealand	-45.0655	167.9911
AF539725	Cortinarius elaphinus	gilled	dry	Conguillı´o, Temuco, Chile	-38.6486	-71.6417
JQ906746	Cortinarius eldoradoensis	gilled	dry	USA: California: El Dorado County, El Dorado National Forest, 0.1 mi. east of Wrights Lake Road	38.8056	-120.2383
GU363473	Cortinarius elegantiomontanus	gilled	dry	IB19890059; Teton County. Turpin Meadow, Wyoming	43.8550	-110.2622
UDB002235	Cortinarius elegantior	gilled	dry	Nåsten, Uppsala, Uppland, Sweden	59.8200	17.5777
UDB001935	Cortinarius elegantissimus	gilled	dry	Denmark. ØJ, Århus skovene, Ørnereden	56.1012	10.2377
UDB018345	Cortinarius eliae	gilled	dry	Estonia, Lääne maakond , Taebla vald , near Kadarpiku village	58.9486	23.6997
EU056948	Cortinarius elotoides	gilled	dry	JFA 9983, Wyoming, USA		
EU056953	Cortinarius elotus	gilled	dry	IB 2001/0090 ; Uagan Unus, Russia		
AY669576	Cortinarius emodensis	gilled	dry	China HKAS 365-41		
UDB018639	Cortinarius erubescens	gilled	dry	Estonia, Lääne maakond , Martna vald , between Kaasiku and Ubasalu	58.9189	23.9453
AY669605	Cortinarius erythraeus	gilled	dry	Austtalia PERTH 05506727	-34.4083	117.9567
AY669690	Cortinarius erythrinus	gilled	dry	Germany, TUB 011900		
JX679121	Cortinarius erythrocephalus	gilled	dry	Australia: Victoria Western Highway, c. 5 km NW Dadswell Bridge	-36.8982	142.4805
GU222267	Cortinarius eutactus	gilled	dry	Springs Junction, Lake Daniells Track, New Zealand	-42.3050	172.2893
UDB000157	Cortinarius evernius	gilled	dry	Norway: Oslo: Oslo: Nordmarka, Høgås	59.8381	10.3842
GU233338	Cortinarius exlugubris	gilled	dry	Hawdon, Middle Canterbury, New Zealand	-42.9112	171.7329
GQ159913	Cortinarius fasciatus	gilled	dry	F17170: Canada, BC, Vancouver Island, Koksilah Ridge	48.7000	-122.2333
UDB001084	Cortinarius fennoscandicus	gilled	dry	Finland, Utsjoki, Kevojärvi, Kevonsuu	69.7585	26.9905
DQ295106	Cortinarius fennoscandicus	gilled	dry	IB19840141 ; Finland		
JX436886	Cortinarius fennoscandicus	gilled	dry	Alaska, ME12_E3; NA		
KP087989	Cortinarius ferruginosus	gilled	dry	USA: Washington, MICH:11058	48.1367	-123.7328
UDB016097	Cortinarius fervidus	gilled	dry	Estonia, Tartu maakond, Vara vals, Alajõe village	58.5208	26.9475
HQ845171	Cortinarius fillionii	gilled	dry	France, GK432471; NA		

GenBank Number	Taxon Name	Type of Fruiting Body	Pileus surface	Location	Latitude	Longitude
JQ272395	Cortinarius firmus	gilled	dry	USA: Nantahala NF, Albert Mt.	35.0525	-83.4800
AF389163	Cortinarius firmus	gilled	dry	Wyoming, USA; IB19990084		
AF539716	Cortinarius flammuloides	gilled	dry	Jardı´n Bota´ nico, Valdivia, Chile	-39.8047	-73.2516
KJ705128	Cortinarius flavifolius	gilled	dry	Quebec, 4461; NA		
KF732528	Cortinarius flavivelatus	gilled	dry	Sweden, H:I. Kytovuori 98-885; SWEDEN, Norrbotten, Pajala, Junosuando, Nature Reserve Area between Sarvikero and Tulemajoki	67.4506	22.8345
JQ928168	Cortinarius flavoaurantians	gilled	dry	Italy: Genoa, Zoagli	44.3454	9.2702
EU057017	Cortinarius flavobulbus	gilled	dry	JFA 11826 ; California: Del Norte Co., Danger Point, USA	41.8486	-123.9826
EU057046	Cortinarius flavobulbus	gilled	dry	JFA 11836 ; California: Del Norte Co., Gasquet Flat, USA	41.8486	-123.9826
UDB001940	Cortinarius flavovirens	gilled	dry	France, Ain		
GQ159767	Cortinarius flexipes	gilled	dry	F17177: Canada, BC, Metchosin, Montreal Hill	48.3592	-123.6331
FJ845398	Cortinarius flexipes	gilled	dry	F16553: Canada, BC, Mcdonnell FSR Smithers	54.7742	-127.4113
UDB000063	Cortinarius flexipes	gilled	dry	Denmark, Sjælland, Rude Skov	55.8412	12.4777
UDB002249	Cortinarius flexipes	gilled	dry	Nåsten, Uppsala, Uppland, Sweden	59.8200	17.5777
UDB015952	Cortinarius flexipes	gilled	dry	Estonia, Jõgeva maakond , Jõgeva, Endla Nature Reserve	58.8733	26.2600
FJ717557	Cortinarius flexipes	gilled	dry	SLB2004-10-24-07; NA		
JQ746616	Cortinarius floccopus	gilled	dry	France, GK432472; NA		
KM273108	Cortinarius fraudulosoides	gilled	dry	USA: Alaska, TN11-096		
KT246172	Cortinarius frondosomultiformi s	gilled	dry	Italy, C:T.G. Froslev; Italy, South Tyrol, Kaltern east, Montigglerwald near Eppan	46.4238	11.2692
UDB001841	Cortinarius frondosophilus	gilled	dry	France. Cerin (Ain)	45.7791	5.5537
KC608581	Cortinarius fructuodorus	gilled	dry	USA: Washington, TN07-467; USA. Washington: Mount Rainier National Park, N of Mount Rainier, Ipsut Creek, Carbon River	46.9775	-121.8312
JX983158	Cortinarius fuegianus	sequestrate	dry	Argentina, EN165 (CORD); Cerro Cortinario, Puerto Manzano, Prov. Neuquen, Argentina	-40.8570	-71.6149
AF478577	Cortinarius fuligineofolius	gilled	dry	Austria; IB		
KF738096	Cortinarius fulminoides	gilled	dry	Germany, SAAR_8848;NA		
EU821662	Cortinarius fulvescens	gilled	dry	DAVFP 28802: Canada, BC, Stillwater	49.9033	-124.3012
HQ604733	Cortinarius fulvescens	gilled	dry	F20328: Canada, BC, Moresby Island, Matheson Inlet	52.4492	-130.5306

GenBank Number	Taxon Name	Type of Fruiting Body	Pileus surface	Location	Latitude	Longitude
HQ604660	Cortinarius fulvescens	gilled	dry	F20307: Canada, BC, Graham Island, Canoe Six	53.5833	-131.7667
UDB018657	Cortinarius fulvescens	gilled	dry	Estonia, Jõgeva maakond , Saare vald , near lake Särgjärv	58.6539	26.8689
EU057004	Cortinarius fulvoarcuatorum	gilled	dry	JFA 11766 ; California: Del Norte Co., Patrick Creek Campground, USA	41.8719	-123.8467
UDB001037	Cortinarius fulvocitrinus	gilled	dry	Italy, I, Südtirol, MgÃ . di Romea, bei Altenburg	46.3796	11.2365
AY669677	Cortinarius fulvoconicus	gilled	dry	Chile, TUB 011525		
KF023073	Cortinarius fulvoconicus	gilled	dry	India, DAKM-009; NA		
KJ206485	Cortinarius fulvoisabellinus	gilled	dry	France, RH1891 (PC); NA		
KP137509	Cortinarius furvoumbrinus	gilled	dry	Sweden, H:7018141; Sweden, Oland, Vickleby	56.5786	16.4554
KP137497	Cortinarius furvus	gilled	dry	Finland, H:T. Niskanen 06-320; Finland, Aland, Jomala commune, Onningby, N of Sodervik	60.1076	20.0040
KP165549	Cortinarius fuscescens	gilled	dry	Finland, H:I. Kytovuori 04-048; Finland, Pohjois-Hame, Laukaa, Hitonhauta SE,	62.4903	25.7450
JX407323	Cortinarius fuscobovinus	gilled	dry	Sweden, TN03-598; Sweden, Mpd, Haverö	60.0410	18.6774
JX407330	Cortinarius fuscoperonatus	gilled	dry	France, CFP1470, France, Ain NA		
KT591587	Cortinarius fuscoumbrinus	gilled	dry	Norway, O:F74959; Agarica 36, 11-42 (2015); Norway, Akershus		
KP165576	Cortinarius fuscovelatus	gilled	dry	Sweden, H:I. Kytovuori 00-036; Sweden, Dalarna, Alvdalen, Karmorasen	61.8802	12.4617
FN428982	Cortinarius gallurae	gilled	dry	Spain:Sevilla		
UDB001253	Cortinarius gentilis	gilled	dry	Finland, Rovaniemi mlk	66.4992	25.7563
UDB011266	Cortinarius gentilis	gilled	dry	Estonia, Võru maakond , Rõuge vald , Metsataga	57.6484	26.7779
U56026	Cortinarius gentilis	gilled	dry	N/A		
KF732618	Cortinarius georgiolens	gilled	dry	Sweden, IK98-2504; Sweden, Öl, Algutsrum	56.6742	16.5476
EU655681	Cortinarius glaucescens	gilled	dry	TUB 011655; Freyburg/Unstrut, Germany	51.2165	11.7762
KF732313	Cortinarius glaucocephalus	gilled	dry	USA: IB:19950679; USA, California, Mendocino Co, Caspar Little Lake Road	39.3405	-123.7632
UDB000139	Cortinarius glaucopus	gilled	dry	Norway: Oslo: Oslo: Bygdøy, Dronningberget	59.9144	10.6830
UDB001039	Cortinarius glaucopus	gilled	dry	Russia, Sakha, Yakutsk, Chuchur_Muran 62Â00'N 129Â35'E	62.0000	129.5833
UDB016284	Cortinarius glaucopus	gilled	dry	Estonia, Lääne maakond , Vormsi vald , near Borby	59.0191	23.2210

GenBank Number	Taxon Name	Type of Fruiting Body	Pileus surface	Location	Latitude	Longitude
KJ421191	Cortinarius glaucopus	gilled	dry	TUB 019732; NA		
JN942291	Cortinarius globuliformis	sequestrate	dry	MEL2317889	-37.0100	144.1033
UDB001082	Cortinarius gracilior	gilled	dry	Austria, Randengebiet bei Zollhaus	47.6650	12.1862
KF732319	Cortinarius griseocoeruleus	gilled	dry	USA: IB:19950685; USA, California, Mendocino Co, 8 Km E of Mendocino on road 408	39.3192	-123.7327
KF040010	Cortinarius griseovioleipes	gilled	dry	Spain, GDA52963; NA		
JQ746596	Cortinarius grosmornensis	gilled	dry	Canada , TN07-227; Newfoundland: Gros Morne National Park, Lomond river hiking trail,	49.4495	-57.7521
JX501775	Cortinarius gualalaensis	gilled	dry	USA: California, Salt Point Lodge, elev. 120 ft.	38.5562	-123.3022
EU057063	Cortinarius guttatus	gilled	dry	JFA 9942 ; Wyoming: Teton Co., Fourmile Meadow, USA	43.8270	-110.2692
JX000376	Cortinarius gymnocephalus	gilled	viscid	Te Iringa Track, Taupo, New Zealand	-38.9841	176.2169
UDB021508	Cortinarius hadrocroceus	gilled	dry	Canada, Quebec, Road 347 between Notre-Dame-de-la-Merci adn Saint-Côme, S side of the road	46.2500	73.9167
KJ920010	Cortinarius hallowellensis	gilled	dry	Australia: Tasmania, Hobart, Peter Murrell Nature Reserve	-43.0016	147.2922
JX045677	Cortinarius harrisonii	gilled	dry	TENN61657	35.7576	-83.2791
UDB001771	Cortinarius helobius	gilled	dry	Sweden		
AY669684	Cortinarius helvelloides	gilled	dry	Germmany, TUB 011904		
GQ159782	Cortinarius helvolus	gilled	dry	F17192: Canada, BC, Tofino, Rainforest trail	49.1167	-124.1167
DQ097870	Cortinarius hemitrichus	gilled	dry	BC, Canada, OUC99106; DAVFP	50.5843	-118.8149
AY669680	Cortinarius hemitrichus	gilled	dry	Germany, TUB 011509		
KF732320	Cortinarius herculeolens	gilled	dry	France, G:287282/1; France, Montbrison, Loire	45.6077	4.0595
UDB001104	Cortinarius herculeus	gilled	dry	France, F, Frankreich, Provence, Massiv du Cedres, Mt. Ventoux	44.1756	5.2715
KJ421098	Cortinarius herculeus	gilled	dry	TUB 019805; NA		
JQ974382	Cortinarius hesleri	gilled	dry	TENN:61122; US, TN, GSMNP	35.4689	-83.8744
AF268894	Cortinarius heterosporus	gilled	dry	Sweden		
UDB002189	Cortinarius hinnuleoarmillatus	gilled	dry	Stenhagen, Uppsala, Uppland, Sweden	59.8634	17.5477
UDB001458	Cortinarius	gilled	dry	France, Région de Semuy		

GenBank Number	Taxon Name	Type of Fruiting Body	Pileus surface	Location	Latitude	Longitude
	hinnuleoarmillatus					
UDB001042	Cortinarius hinnuleus	gilled	dry	Austria, Tirol, ober Thaur, Marstanzboden	47.2970	11.4646
HQ604704	Cortinarius hinnuleus	gilled	dry	UBC:F18967	48.6833	-122.3167
UDB001342	Cortinarius hinnuleus	gilled	dry	Sweden, Mpd, Torp	58.3497	11.8108
UDB001147	Cortinarius hinnuleus	gilled	dry	Sweden, Uppsala, Ultuna, Oak Avenue	59.8133	17.6538
UDB002196	Cortinarius hinnuleus	gilled	dry	Nåsten, Uppsala, Uppland, Sweden	59.8200	17.5777
GQ159904	Cortinarius holophaeus	gilled	dry	F17161: Canada, BC, Koksilah Ridge	48.7000	-122.2333
FJ039597	Cortinarius humboldtensis	gilled	dry	West slope-margin of the forest along the ridge, Observatory Hill, Saanich, BC	48.5204	-123.4205
UDB001093	Cortinarius humicola	gilled	dry	Switzerland, Ch, Schweiz, Kt. Neuchatel, Wald "des Râbles /s' Voëns	47.0295	6.9968
UDB001954	Cortinarius humolens	gilled	dry	France. Notre Dame de Sanilhac	45.1211	0.7135
FJ039640	Cortinarius humolens	gilled	dry	McDonnell FSR Smithers, BC	54.7742	-127.4113
UDB001953	Cortinarius humolens	gilled	dry	France. Provence, Sion Blanc		
AF539720	Cortinarius icterinus	gilled	dry	San Antonio, Valdivia, Chile	-39.8283	-73.2299
KF727365	Cortinarius ignellus	gilled	dry	Matawai Conservation Area, Te Wera Reserve, Gisborne, New Zealand	-38.4269	177.4536
KC152090	Cortinarius illibatus	gilled	dry	Mexico: Morelos, Huitzilac, Volcan Pelado	19.1493	-99.2187
UDB016020	Cortinarius illuminus	gilled	dry	Finland, Ristijärvi, Nature Reserve Koljatinvaaran	64.4945	28.2302
UDB001160	Cortinarius imbutus	gilled	dry	Sweden, Harnosand, Fågelberget		
GQ159832	Cortinarius impennoides	gilled	dry	F17246: Canada, BC, Incomappleux Valley near Revelstoke	50.9867	-116.4136
AY669656	Cortinarius incisus	gilled	dry	Germany, TUB 011906		
KF727396	Cortinarius indolicus	gilled	dry	Lake Waikareiti Track, Gisborne, New Zealand	-38.7007	177.1886
GU222322	Cortinarius indotatus	gilled	dry	Westport, Denniston Walkway, Nelson, New Zealand	-41.7356	171.7962
KJ421110	Cortinarius indotatus	gilled	dry	KS CO1624; NA		
KJ421015	Cortinarius inexspectatus	gilled	dry	S F14264; NA		
HQ604687	Cortinarius infractus	gilled	dry	F18940: Canada, BC, Shawnigan Lake, Koksilah Ridge	48.6833	-122.3167

GenBank Number	Taxon Name	Type of Fruiting Body	Pileus surface	Location	Latitude	Longitude
GQ159866	Cortinarius infractus	gilled	dry	F17123: Canada, BC, Mt. Washington, Lower Trail to Rossiter Lake	49.7415	-125.3452
UDB001045	Cortinarius infractus	gilled	dry	Russia, Sakha, Yakutsk, Chuchur_Muran 62"00'N 129"35'E	62.0000	129.5833
KJ421014	Cortinarius infractus	gilled	dry	TUB 019772; NA		
GU234012	Cortinarius inops	gilled	dry	Svalbard	78.3060	16.8770
UDB001804	Cortinarius insignibulbus	gilled	dry	Denmark. NVS, Allindelille	55.5222	11.7634
KJ421121	Cortinarius inusitatus	gilled	dry	GDA 53701; NA		
KF937327	Cortinarius iodes	gilled	dry	Colombia: Boyaca, Villa de Leyva, Vereda Capilla, Vereda Capilla, Entrada Km 5 de la via Villa de Leyva-Gachantiva, a 200 m de entrada Parque de Iguaque	5.6356	-73.5270
KF937326	Cortinarius iodes	gilled	dry	Colombia: Boyaca, Gachantiva, via Moniquira-Gachantiva, Km 15 via Moniquira-Gachantiva, Bosque en el borde de carretera costado oriental	5.8220	-73.5826
KF937328	Cortinarius iodes	gilled	dry	Colombia: Antioquia, Medellin, Corregimiento de Santa Elena, Corregimiento de Santa Elena, vereda el Placer, interseccion entrada Silleteros	6.2197	-75.5024
KF937329	Cortinarius iodes	gilled	dry	Colombia: Santander, Belen, Vereda San Jose de la montana, Vereda San Jose de la montana, Km 16 desde el paramo de la Rusia hacia el bosque	6.2370	-75.5687
KJ705111	Cortinarius iodes	gilled	dry	Quebec, St. Augustin, 3869; NA	51.2307	-58.6520
JX000362	Cortinarius ionomataius	gilled	dry	Te Anau Downs, 3km Sth, Otaga Lakes, New Zealand	-45.1936	167.8281
FJ039677	Cortinarius ionosmus	gilled	dry	McDonnell FSR Smithers, BC, Canada	54.7742	-127.4113
HQ533032	Cortinarius iringa	gilled	dry	Craigieburn, Dracophyllum Flat, Mid Canterbury, New Zealand	-43.1519	171.7086
AY669624	Cortinarius iringa	gilled	dry	New Zealand, CO1255; Taupo; Clements Road, Te Iringa Track	-38.9562	176.2445
EU660948	Cortinarius iringa	gilled	dry	PDD73135; Clements Road, Te Iringa Track, Taupo, New Zealand	-38.9562	176.2445
EU057001	Cortinarius jardinensis	gilled	dry	JFA 1206; Prov. Cartago: Parque Prusia, Costa Rica	9.9775	-83.8458
JF907944	Cortinarius jubarinus	gilled	dry	PLoS ONE 8 (4), E62419 (2013); Italy		
DQ097874	Cortinarius junghuhnii	gilled	dry	BC, Canada, OUC99166; DAVFP	50.5843	-118.8149
HQ604725	Cortinarius junghuhnii	gilled	dry	F20310: Canada, BC, Graham Island	54.0458	-130.1078
KF732329	Cortinarius juxtadibaphus	gilled	dry	France, PC:R. Henry 3880; France, Haut-Doubs, L'Hopital du Grosbois	47.1715	6.2107
KJ635213	Cortinarius kaimanawa	gilled	dry	Boyds Creek, Fiordland, New Zealand	-45.1344	167.9492
GQ890308	Cortinarius kaputarensis	sequestrate	dry	Australia, KV603; MEL2331649	-30.3000	149.7667

GenBank Number	Taxon Name	Type of Fruiting Body	Pileus surface	Location	Latitude	Longitude
AY083188	Cortinarius keralensis	gilled	dry	India: Kerala State: Wayanad District, Ponkuzhy	76.5693	76.5693
KJ920015	Cortinarius kioloensis	gilled	dry	Australia: Tasmania, Florentine River Valley, Pagoda Hut	-42.7048	146.4084
KT222912	Cortinarius koldingensis	gilled	dry	Demark, C:F-100310; Denmark, Østjylland, Kolding Skov (site 1)	55.5057	9.4871
FJ157055	Cortinarius kroegeri	gilled	dry	F15371: Canada, BC, Ellen Island	52.1500	-130.9000
KF732330	Cortinarius kuehneri	gilled	dry	Austria: IB:19650042; Austria, Tyrol; Oetzal, Untergurgl	46.8899	11.0397
KF732529	Cortinarius kytoevuorii	gilled	dry	Finland, H:6029355; FINLAND, Koillismaa, Kuusamo, Oulanka, Ampumavaara	66.3681	29.3164
EU660952	Cortinarius lacteus	gilled	dry	HO 980404A0 Giving directions for HO 522420 (Australia, Tasmania, Tasman Peninsula, Clarks Cliffs Track)	-43.0953	147.8042
GQ159898	Cortinarius laetissimus	gilled	dry	F17155: Canada, BC, Koksilah Ridge	48.7000	-122.2333
UDB001046	Cortinarius laetus	gilled	dry	Russia, Sakha, Yakutsk, Magan, 2 km SE of Magan Airport, 62Â05N, 129Â35E	62.0000	129.5833
JX000363	Cortinarius lamproxanthus	gilled	dry	Te Anau, Kepler Track, Fiordland, New Zealand	-45.4510	167.5746
UDB001814	Cortinarius langeorum	gilled	dry	Denmark. ØJ, Århus skovene, Jens Bæks Vedkast	56.1674	10.2040
HM068559	Cortinarius laniger	gilled	dry	SLB2004-10-10-03; NA		
JQ287674	Cortinarius laquellus	gilled	dry	New Zealand: Wangapeka Valley, Nelson	-41.4060	172.6817
EU057059	Cortinarius largentii	gilled	dry	JFA 11875 ; California: Humboldt Co., Boise Creek Campground, USA	40.9044	-123.7433
UDB016145	Cortinarius largus	gilled	dry	Estonia, Tartu maakond , Vara vald , Alajõe village	58.5208	58.5208
AY669550	Cortinarius latobalteatus	gilled	dry	Germany TUB 011862		
HQ843177	Cortinarius lavandulochlorus	gilled	dry	PS-2011 voucher GE 10.021; Département de la Dordogne (France), commune de Tursac, lieu-dit « La Rastucie »	44.9693	1.0209
AY669631	Cortinarius lavendulensis	gilled	dry	Tasmania, HO 990304A2		
JF907863	Cortinarius lebretonii	gilled	dry	PLoS ONE 8 (4), E62419 (2013); Italy		
EU259289	Cortinarius leiocastaneus	gilled	dry	Finland, TN06-150 (H) ; Kitee, PK	62.0926	30.1377
FJ039662	Cortinarius leucophanes	gilled	dry	McDonnell FSR Smithers, BC	54.7742	-127.4113
UDB019884	Cortinarius leucophanes	gilled	dry	Finland, Rovaniemi, Pohtimolampi, surroundings of Bear's Lodge	66.6442	25.3281
GQ159823	Cortinarius leucopus	gilled	dry	F17236, Canada, BC, Saanich, Observatory Hill	48.5167	-122.5833
GQ159855	Cortinarius leucopus	gilled	dry	F17269, Canada, BC, Saanich, Observatory Hill	48.5167	-122.5833

GenBank Number	Taxon Name	Type of Fruiting Body	Pileus surface	Location	Latitude	Longitude
AF325593	Cortinarius leucopus	gilled	dry	Sweden		
JN133921	Cortinarius leucopus	gilled	dry	Pakistan, MH301689.2; Himilayas; NA		
AF539718	Cortinarius lignyotus	gilled	dry	San Antonio, Valdivia, Chile	-39.8283	-73.2299
UDB001807	Cortinarius lilacinovelatus	gilled	dry	Denmark. NØS, Farum Nørreskov	55.7937	12.3882
KJ705150	Cortinarius lilacinus	gilled	dry	Quebec, 4453; NA		
EU057002	Cortinarius lilaciotinctus	gilled	dry	JFA 11893; California: Mendocino Co., Casper-Little Lake Road, USA	39.3713	-123.7048
FJ157056	Cortinarius limonius	gilled	dry	F15984: Canada, BC, Moresby Island, Kendrick Point	52.2000	-130.8667
FJ157057	Cortinarius limonius	gilled	dry	F16016: Canada, BC, Moresby Island	52.2000	-130.8667
UDB002200	Cortinarius limonius	gilled	dry	Nåsten, Uppsala, Uppland, Sweden	59.8200	17.5777
UDB002419	Cortinarius lividoochraceus	gilled	viscid	Ledmore Oakwood, Spinningdale, Sutherland, Scotland	57.8864	-4.2499
AF539734	Cortinarius lividus	gilled	dry	Arboretum UACH, Valdivia, Chile	-39.8000	-73.2588
KJ421073	Cortinarius lubricanescens	gilled	dry	PDD78801; Flora Saddle, Nelson, New Zealand	-41.1900	172.7469
UDB016052	Cortinarius lucorum	gilled	dry	Estonia, Saare maakond , Kihelkonna vald , Tagamõisa puisniit	58.4560	22.0008
UDB000744	Cortinarius lucorum	gilled	dry	Norway, Vestfold, Moss, Jeløia	59.4820	10.6475
KJ705156	Cortinarius lucorum	gilled	dry	Quebec, 4631-HRL 1195; NA		
UDB001809	Cortinarius luhmannii	gilled	dry	Denmark. NVS, Allindelille	55.5222	11.7634
UDB001448	Cortinarius lustrabilis	gilled	dry	France, Haute-Savoie, Les Pursots		
AY174853	Cortinarius lustratus	gilled	dry	Bu¨cheneck, Germany	50.1983	6.6760
KF732568	Cortinarius luteiaureus	gilled	dry	Finland, H:6033617; FINLAND, Oulun Pohjanmaa, Kiiminki, Juuvansydänmaa, S part of Iso Juuvankangas, W of the lake Iso Juuvanjärvi	65.1066	26.0029
KF732546	Cortinarius luteicolor	gilled	dry	DBB46740; USA, California, Yosemite National Park		
JX000356	Cortinarius luteinus	gilled	dry	Clements Road, Te Iringa Track, Taupo, New Zealand	-38.9562	176.2445
KJ705125	Cortinarius luteoarmillatus	gilled	dry	Quebec, 606-HRL606; NA		
KF732455	Cortinarius luteocingulatus	gilled	dry	France, G:295131/1; France, Bouches-du-Rhone, St Remy de Provence	43.7727	4.8359

GenBank Number	Taxon Name	Type of Fruiting Body	Pileus surface	Location	Latitude	Longitude
KJ421026	Cortinarius luteoimmarginatus	gilled	dry	TUB 019774; NA		
UDB001968	Cortinarius luteolus	gilled	dry	France, Ain		
HQ845141	Cortinarius luteoornatus	gilled	dry	Finland, JV15585; Finland, Etela-Hame, Vilppula, Elamanmaki	62.0725	24.3410
HQ845135	Cortinarius luteoornatus	gilled	dry	Norway, TN06-053; Norway, Troms, Malsev, about 5 km S from the center of Skjold near Road 87	68.9930	19.2221
UDB000676	Cortinarius luxnymphae	gilled	dry	Riddarhyttan Research plots, 59º48'N:15º30'E, Skinnskatteberg, Västmanland, Sweden	59.8000	15.5000
KF732345	Cortinarius maculatipes	gilled	dry	France, G:292695/1; France, Savoie, Les Arcs	45.5722	6.8297
KF732346	Cortinarius maculatocaespitos us	gilled	dry	France, PC:A. Bidaud 08-10-302, France, Ain, Cerin	45.7846	5.5384
KJ421116	Cortinarius maculatocaespitos us	gilled	dry	TUB 019813; NA		
GQ890306	Cortinarius maculobulga	gilled	dry	Australia,KV532; MEL2331647	-30.3000	149.7667
KJ421123	Cortinarius maculosus	gilled	dry	JV991102 5; NA		
AF539719	Cortinarius magellanicus	gilled	dry	Jardı´n Bota´ nico, Valdivia, Chile	-39.8047	-73.2516
UDB001810	Cortinarius magicus	gilled	dry	Denmark, NVS, Allindelille	55.5222	11.7634
EU056976	Cortinarius magnivelatus	gilled	dry	OSC-81327 ; Oregon: Klamath Co., Crater Lake National Park, USA	42.8861	-122.0417
EU846306	Cortinarius magnivelatus	sequestrate	dry	OSC 109198	42.7000	-122.1300
KF738101	Cortinarius mahiquesii	gilled	dry	Spain, JVG_1080229_9; NA		
KJ421208	Cortinarius mairei	gilled	dry	TUB 020435; NA		
KJ421071	Cortinarius majoranae	gilled	dry	KS CO1392; NA		
UDB018306	Cortinarius malachius	gilled	dry	Estonia, Võru maakond , Rõuge vald , Metsataga	57.7058	26.8722
GQ159775	Cortinarius malicorius	gilled	dry	F17185: Canada, BC, Tofino, Wickanninish Beach	49.1167	-124.1167
UDB016170	Cortinarius malicorius	gilled	dry	Estonia, Lääne maakond , Vormsi vald , Fällarna, between Hullo and Borrby	59.0142	23.2008
JX045674	Cortinarius malicorius	gilled	dry	Sweden CFP429 NA		
JX000373	Cortinarius malosinae	gilled	dry	Haast, Blue Pools, Westland, New Zealand	-44.1646	169.2769
AY669611	Cortinarius	gilled	dry	Chile TUB 011836		

GenBank Number	Taxon Name	Type of Fruiting Body	Pileus surface	Location	Latitude	Longitude
	malvaceus					
JX178622	Cortinarius mariae	gilled	dry	New Zealand, OTA:61920 NA		
JX045692	Cortinarius marylandensis	gilled	dry	USA DMS1772, USA, Delaware; WTU; NA		
KF738104	Cortinarius mediterraneensis	gilled	dry	Spain, JA_Cussta_1606; Using location of the type specimen: France, Poquerolles, southern Ferme	42.9852	6.2059
UDB000727	Cortinarius meinhardii	gilled	dry	Nåtham, Island of Väddö, N. of Stockholm	59.9991	18.8340
UDB015948	Cortinarius meinhardii	gilled	dry	Estonia, Järva maakond, Ambla vald , Kurisoo	59.1253	25.7683
GU222276	Cortinarius meleagris	gilled	dry	Springs Junction, Lake Daniells Track, Buller, New Zealand	-42.3050	172.2893
GU222275	Cortinarius meleagris	gilled	dry	Lyell Walkway, Nelson, New Zealand	-41.7980	172.0475
HM060324	Cortinarius meleagris	gilled	dry	Mt Tongariro N.P., Ohakune, Blyth Track, Taupo, New Zealand	-39.3295	175.4961
GU233372	Cortinarius melimyxa	gilled	dry	Te Anau, Kepler Track, Fjordland, New Zealand	-45.4510	167.5746
KF732577	Cortinarius melleicarneus	gilled	dry	Estonia, H:I. Kytovuori 01-053; ESTONIA, Hiiumaa, Pühalepa, Sarve, Soonlepa	58.8545	22.9983
KJ635206	Cortinarius melleomitis	gilled	dry	Kowai Bush, Mid Canterbury, New Zealand	-43.2903	171.9249
UDB001105	Cortinarius mellinus	gilled	dry	Italy, Parma Prov., Val di Ceno, bei Calice		
EU660947	Cortinarius memoriaannae	gilled	dry	KS-CO1482 NA		
UDB013466	Cortinarius metallicus	gilled	dry	Australia, Tasmania, Warra Long-Term Ecological Research Site	-43.1333	146.6833
KF961227	Cortinarius microglobisporus	gilled	dry	Italy: IB20130101	44.4926	9.7833
UDB001090	Cortinarius microspermus	gilled	dry	Sweden, Schweden, Smoland, Femsjö, Gatebäck	56.9000	13.3142
JF795384	Cortinarius mikedavisii	gilled	dry	Caspar Cemetery, California, USA	39.3598	-123.8126
AY669628	Cortinarius minoscaurus	gilled	dry	New Zealand, CO1013; central Otago; Waipori Park	-38.9562	176.2445
KJ421108	Cortinarius minoscaurus	gilled	dry	KS CO1174; NA		
JF907902	Cortinarius minutulus	gilled	dry	PLoS ONE 8 (4), E62419 (2013); Italy		
JQ906753	Cortinarius miwok	gilled	dry	USA: California, El Dorado National Forest; California: El Dorado County, El Dorado National Forest, 0.1 mi. SE of Icehouse Road	38.8567	-120.3756
KJ421139	Cortinarius moenneloccozii	gilled	dry	TUB 019711; NA		
UDB001811	Cortinarius molochinus	gilled	dry	Switzerland. Neuchâtel	46.9916	6.9389

GenBank Number	Taxon Name	Type of Fruiting Body	Pileus surface	Location	Latitude	Longitude
KF732349	Cortinarius montanus	gilled	dry	USA: MICH:10377	45.3283	-121.9597
KP114460	Cortinarius montebelloensis	gilled	dry	Canada: Quebec, H:T. Niskanen 10-147; Canada, Quebec, Montebello	45.6534	-74.9322
EU655666	Cortinarius montensis	gilled	dry	TUB PC0090399; NA		
JF907862	Cortinarius moserianus	gilled	dry	PLoS ONE 8 (4), E62419 (2013); Italy		
UDB015965	Cortinarius mucifluus	gilled	dry	Estonia, Hiiu maakond , Pühalepa vald , Salinõmme, near Tamme farmhouse	58.8462	22.9319
DQ295114	Cortinarius mucosus	gilled	dry	IB19910694 ; California, USA		
KP241016	Cortinarius mucosus	gilled	dry	Great Hinggan mountains of Inner Mongolia in China; NA		
KP165571	Cortinarius murinascens	gilled	dry	Finland, H:I. Kytovuori 01-058; Finland, Uusimaa, Helsinki, Vuosaari N, at the beginning of the hiking road	60.2047	25.1156
UDB001064	Cortinarius mussivus	gilled	dry	Austria, A, Tirol, Gschnitztal, ca. 2 km von Lift,	47.0426	11.3511
JX000374	Cortinarius myxenosma	gilled	dry	Waimakariri Valley Track, Mid Canterbury, New Zealand	-42.9416	171.5613
AF539733	Cortinarius myxoclaricolor	gilled	dry	Conguillı´o, Temuco, Chile	-38.6486	-71.6417
UDB011367	Cortinarius nanceiensis	gilled	dry	Estonia, Saare maakond , Lümanda vald	58.3074	22.0716
GU233344	Cortinarius naphthalinus	gilled	dry	Springfield, Kowai Bush, Mid Canterbury, New Zealand	-43.2903	171.9249
KF727356	Cortinarius napivelatus	sequestrate	dry	Arthurs Pass, Waimakariri Valley Track, North Canterbury, New Zealand	-42.9416	171.5613
UDB000137	Cortinarius napus	gilled	dry	Norway: Oppland: Lunner	60.2223	10.6686
UDB001794	Cortinarius natalis	gilled	dry	France. Hérault, Montpellier, Gigean, Mt. du Gardiole	43.4810	3.7288
KC608586	Cortinarius nauseosouraceus	gilled	dry	USA: Washington, TN09-161; USA. Washington: Clallam Co., Olympic National Park, road to the Deer Park camp ground	47.9493	-123.2598
GQ890307	Cortinarius nebulobrunneus	sequestrate	dry	Australia, KV588; MEL2331648	-30.3000	149.7667
KF048129	Cortinarius neofallax	gilled	dry	France, PC:PML1158; NA		
UDB001267	Cortinarius neofurvolaesus	gilled	dry	Finland, U, Tammisaari	59.9747	23.4356
JX045680	Cortinarius neosanguineus	gilled	dry	JFA11655; USA, Oregon	45.0946	-123.9777
KJ920033	Cortinarius neotropicus	gilled	dry	Colombia: Huila, near Parque Nacional Purace, Finca Merenberg	2.3805	-75.8891
KT591603	Cortinarius niveotraganus	gilled	dry	Norway, O:T.E. Brandrud TEB 77-07; Norway, Oppland		
KP137493	Cortinarius nodosisporus	gilled	dry	Norway, H:I.Kytovuori 00-032; Norway, Sogn og Fjordane, Leikanger commune, Hermansverk	61.1856	6.8222

GenBank Number	Taxon Name	Type of Fruiting Body	Pileus surface	Location	Latitude	Longitude
KJ206487	Cortinarius nolaneiformis	gilled	dry	Hungary, DB886 (BP); Hungary, Vas, Szalafő	46.8644	16.3588
UDB001276	Cortinarius norrlandicus	gilled	dry	Sweden, Ång, Häggdånger	62.5455	17.8152
KP137510	Cortinarius nucicolor	gilled	dry	Sweden, H:7018310; Sweden, Oland, Vickleby, Natur reserve area N of Hagapark	56.5860	16.4157
UDB001849	Cortinarius nymphicolor	gilled	dry	France. Provence, Sion Blanc		
AF539708	Cortinarius obscurooliveus	gilled	dry	Salto de la Princesa, Temuco, Chile	-38.4747	-71.6734
KJ421046	Cortinarius obsoletus	gilled	dry	TUB 019791; NA		
AJ438981	Cortinarius obtusus	gilled	dry	Germany:Freising, Bavaria	48.4066	11.7425
EU821665	Cortinarius obtusus	gilled	dry	DAVFP 28814: Canada, BC, Stillwater	49.9053	-124.3208
HQ604671	Cortinarius obtusus	gilled	dry	F20304: Canada, BC, Graham Island, Anvil Trail	53.5333	-130.0667
HQ604670	Cortinarius obtusus	gilled	dry	F20306: Canada, BC, Graham Island, Canoe Six	53.5833	-131.7667
HQ604676	Cortinarius obtusus	gilled	dry	F20316: Canada, BC, Graham Island, Tow Hill Provincial Park	54.0833	-130.2000
UDB002204	Cortinarius obtusus	gilled	dry	Nåsten, Uppsala, Uppland, Sweden	59.8200	17.5777
UDB000127	Cortinarius obtusus	gilled	dry	Norway: Oslo: Oslo: Nordmarka, by Bjordammen	60.0068	10.6701
UDB017606	Cortinarius obtusus	gilled	dry	Norway, Vest-Agder , Farsund, Havika	58.0670	6.7300
UDB017643	Cortinarius obtusus	gilled	dry	Norway, Vest-Agder , Farsund, Havika	58.0670	6.7310
UDB018669	Cortinarius obtusus	gilled	dry	Estonia, Tartu maakond , Vara vald , Alajõe village	58.5217	26.9444
FJ717549	Cortinarius obtusus	gilled	dry	SLB2004-10-31-13; NA		
KC842421	Cortinarius obtusus	gilled	dry	Norway, OS577; NA		
KF732357	Cortinarius occidentalis	gilled	dry	USA: MICH:10382	41.0595	-124.1419
KF732359	Cortinarius ochraceobrunneus	gilled	dry	France, G:292932/1; France, Haute-Savoie, Bois de Vorcier	45.9748	5.8968
UDB001817	Cortinarius ochraceopallescen s	gilled	dry	Switzerland. Neuchâtel, Les Cadolles	46.9993	6.9245
KF732530	Cortinarius ochribubalinus	gilled	dry	Finland, H:6032734; FINLAND, Uusimaa, Espoo, Nuuksio	60.3265	24.4926
KR011133	Cortinarius	gilled	dry	Finland, H:6001939; Finland, Varsinais-Suomi, Karjaa, Mustio,	60.1455	23.8727

GenBank Number	Taxon Name	Type of Fruiting Body	Pileus surface	Location	Latitude	Longitude
	ochroamarus			Kohagen		
KF732360	Cortinarius ochroclarus	gilled	dry	France: G:292943/1; France, Haute-Savoie, Foret de la Semine	46.0438	5.8462
KF700241	Cortinarius ochropallens	gilled	dry	USA: Washington, TN11-471; U.S.A. Washington: Kittitas County. Table Mountain	45.6895	-121.9781
FJ039617	Cortinarius ochrophyllus	gilled	dry	Below the paved road, Observatory Hill, Saanich, BC	48.5196	-123.4133
UDB000675	Cortinarius ochrophyllus	gilled	dry	Fastarbo, Old spruce site, 40 km N. of Uppsala nr, Björklinge, Uppland, Sweden	60.0315	17.5562
UDB001987	Cortinarius odoratus	gilled	dry	Denmark. ØJ, Vosnæs Havskov,		
KJ705136	Cortinarius odorifer	gilled	dry	Quebec, 4758-HRL 1325; NA		
KP191888	Cortinarius ohauensis	sequestrate	dry	Arthurs Pass, Waimakariri Valley Track, North Canterbury, New Zealand	-42.9416	171.5613
JQ906757	Cortinarius ohlone	gilled	dry	USA: California, Contra Costa County, Kennedy Grove	37.9464	-122.2661
EU057032	Cortinarius olearioides	gilled	dry	SRC-608 ; , California: Yuba Co.: UC Sierra Foothill Research & Extension Center, USA	39.2499	-121.3128
EU057021	Cortinarius olearioides	gilled	dry	JFA 11846 ; California: Del Norte Co., Gasquet Flat, USA	41.8486	-123.9826
UDB001168	Cortinarius olearioides	gilled	dry	Sweden, North of Stockholm, Isle of Väddo, Almsta Oak Reserve	59.9757	18.8150
KM273091	Cortinarius olididisjungendus	gilled	dry	Ontario, TN07-191; Canada, Ontario, Muskoka, Lake of Bays	45.2551	-79.0523
KJ421075	Cortinarius olidoamarus	gilled	dry	GDA 44813; NA		
UDB016166	Cortinarius olidoamethysteus	gilled	dry	Estonia, Lääne maakond , Vormsi vald , between Hullo and Borby	59.01194	23.2250
AF539736	Cortinarius olivaceobubalinus	gilled	dry	San Antonio, Valdivia, Chile	-39.8283	-73.2299
KF738105	Cortinarius olivaceodionysae	gilled	dry	France, AB_98_10_373; Using location of the type specimen: France, Doubs, Cour-Saint-Maurice	47.2586	6.6969
UDB015963	Cortinarius olivaceofuscus	gilled	dry	Estonia, Hiiu maakond , Hiiumaa, Hanikatsi, Rootsi kuninga mets	58.7808	23.0472
KC842417	Cortinarius olivaceofuscus	gilled	dry	Norway, KH23x; NA		
JX679106	Cortinarius olivaceopictus	gilled	dry	Australia: Victoria Kinglake	-37.5229	145.3530
FJ039601	Cortinarius olivaceopictus	gilled	dry	McDonnell FSR Smithers, BC, Canada	54.7742	-127.4113
KF732363	Cortinarius oliveopetasatus	gilled	dry	USA: IB:19950360; USA, Oregon, Wasco Co., Mt Hood, Clear Creek Campground	45.1464	-121.5859
HM060330	Cortinarius olorinatus	gilled	dry	Mt Tongariro National Park, Whakapapa, Whakapapanui Track, Taupo, New Zealand	-39.3295	175.4961
FJ717510	Cortinarius olympianus	gilled	dry	SAT00-312-38	47.9489	-123.2581

GenBank Number	Taxon Name	Type of Fruiting Body	Pileus surface	Location	Latitude	Longitude
AF389149	Cortinarius ombrophilus	gilled	dry	Argentina; IB19630228		
KJ547667	Cortinarius ophryx	gilled	dry	Kepler Track, Fiordland, New Zealand	-45.4510	167.5746
KP013200	Cortinarius orasericeus	gilled	dry	Canada, Quebec, H:T. Niskanen TN10-029; NA		
KF732366	Cortinarius oregonensis	gilled	dry	USA: MICH:10387	43.8075	-124.1512
KC842419	Cortinarius orellanus	gilled	dry	Norway, Cor2; NA		
UDB000718	Cortinarius orichalceus	gilled	dry	Old spruce plantation behind Stenhagen, Uppsala, Sweden	59.8634	17.5477
KJ635244	Cortinarius orixanthus	gilled	dry	Cascade Hut Track, Taupo, New Zealand	-44.4938	168.6677
UDB002071	Cortinarius osloensis	gilled	dry	Norway, Oslo, Norge		
UDB001847	Cortinarius osmophorus	gilled	dry	Denmark. NVS, Allindelille	55.5222	11.7634
JX407292	Cortinarius oulankansis	gilled	dry	Finland, TN05-169; Finland, Koillismaa, Kuusamo, Oulanka, Puukkorrinne	66.4096	29.1535
EF420154	Cortinarius ovreboi	gilled	dry	Costa Rica, JFA 13000	9.5506	-83.4633
KJ920027	Cortinarius palatinus	gilled	dry	Costa Rica: Perez Zeledon, Villa Mills	9.5645	-83.7079
KF738107	Cortinarius palazonianus	gilled	dry	Spain, JVG_1001029_2; Spain, Barcelona, Gava, Ca n'Espinos	41.3087	1.9770
FJ039709	Cortinarius paleaceus	gilled	dry	Raspberry Cove, Moresby Island, BC	*52.1663*	*-131.0866*
KF732579	Cortinarius pallidirimosus	gilled	dry	Finland, IK07-692; Finland, Tervola	66.0772	24.8178
UDB018361	Cortinarius panellus	gilled	dry	Estonia, Lääne maakond , Taebla vald , Hallimägi between Kirimäe and Leediküla	58.9294	23.7894
GU233375	Cortinarius papaver	gilled	dry	Hunua, Workman Road, Workman Track, Auckland, New Zealand	-37.1196	175.2095
KR080708	Cortinarius paracephalixus	gilled	dry	Hungary, BP:50169; NA		
AY033108	Cortinarius paradoxus	gilled	dry	IB19650506		
EF014269	Cortinarius parafulmineus	gilled	dry	Garnica et al 2006 Arangu-Cort-03101201; Spain, Roncal Nevarra	42.8108	-0.9526
UDB001170	Cortinarius paragaudis	gilled	dry	Bispgården, Central Sweden	63.0281	16.6333
AF539731	Cortinarius parahumilis	gilled	dry	San Antonio, Valdivia, Chile	-39.8283	-73.2299
JX000361	Cortinarius paraonui	gilled	dry	Te Anau, Kepler Track, Fiordland, New Zealand	-45.4510	167.5746
JX000365	Cortinarius paraxanthus	gilled	dry	Eves Bush, Brightwater, Nelson, New Zealand	-41.3352	173.0592

GenBank Number	Taxon Name	Type of Fruiting Body	Pileus surface	Location	Latitude	Longitude
KJ206496	Cortinarius pardinipes	gilled	dry	Finland, TN04-534 (H); Finland, PeP, Tornio	65.8458	24.1507
FJ039585	Cortinarius parkeri	gilled	dry	SW slope, just above the main gate, Observatory Hill, Saanich, BC	48.5177	-123.4210
FJ039554	Cortinarius parvannulatus	gilled	dry	Texada Island, BC	49.5261	-124.1439
KF732631	Cortinarius patibilis	gilled	dry	Finland, IK97-086; Finland, V, Karkkila	60.5335	24.1977
GU234055	Cortinarius pauperculus	gilled	dry	Svalbard	78.3060	16.8770
JX000372	Cortinarius pectochelis	gilled	dry	Haast, Blue Pools, Westland, New Zealand	-44.1646	169.2769
KC520543	Cortinarius peraurantiacus	sequestrate	dry	Waitakere Ranges, Goldies Bush, Mokoroa Falls Track, Auckland, New Zealand	-36.8424	174.4480
JX000349	Cortinarius peraureus	gilled	dry	Craigieburn, Mid Canterbury, New Zealand	-43.1516	171.7133
GU222287	Cortinarius peraureus	gilled	dry	Karamea, Adams Track, Nelson, New Zealand	-41.1988	172.1916
JX178607	Cortinarius peraureus	gilled	dry	New Zealand, OTA:60292 NA		
UDB001821	Cortinarius percomis	gilled	dry	France. Hérault, Montpellier, Gigean, Mt. du Gardiole	43.4873	3.7275
KJ421090	Cortinarius percomis	gilled	dry	TUB 019799; NA		
GU233341	Cortinarius perelegans	gilled	dry	Hawdon, Middle Canterbury, New Zealand	-42.9112	171.7329
JX178615	Cortinarius perelegans	gilled	dry	New Zealand, OTA:60285 NA		
GU233351	Cortinarius periclymenus	gilled	dry	Amuri, Boyle River, North Canterbury, New Zealand	-42.5224	172.4062
KF732381	Cortinarius perpallens	gilled	dry	France: PC:R. Henry 3928; France, Mont Aigoual	44.1192	3.5868
JF907864	Cortinarius perrugatus	gilled	dry	PLoS ONE 8 (4), E62419 (2013); Italy		
GU233345	Cortinarius persicanus	gilled	dry	St Arnaud Range, Nelson, New Zealand	-41.8119	172.8605
KJ421118	Cortinarius persoonianus	gilled	dry	TUB 019815; NA		
GU234038	Cortinarius phaeochrous	gilled	dry	Svalbard	78.3060	16.8770
FJ157064	Cortinarius pholideus	gilled	dry	F14962	55.6333	-126.2500
KJ421031	Cortinarius phrygianus	gilled	dry	KS CO584; NA		
UDB001791	Cortinarius piceae	gilled	dry	Italy, Kaltern, Mendelpass	46.4165	11.2002
KP013206	Cortinarius piceidisjungendus	gilled	dry	Finland, H:I. Kytovuori 97-1491; Finland, Kn, Puolanka	64.6776	27.9692

GenBank Number	Taxon Name	Type of Fruiting Body	Pileus surface	Location	Latitude	Longitude
GU233371	Cortinarius picoides	gilled	dry	Milford, Boyd Creek, Fjordland, New Zealand	-44.6760	167.9228
GQ159874	Cortinarius pingue	sequestrate	dry	F17131: Canada, BC, Vancouver Island, Mt. Washington	49.7345	-125.3545
KF732633	Cortinarius pini	gilled	dry	Finland, IK90-2288; Finland, V, Parainen	60.2942	22.2928
FJ039637	Cortinarius pinophilus	gilled	dry	Smithers, BC	54.7855	-127.1518
UDB021469	Cortinarius pitkinensis	gilled	dry	United States, Colorado, Pitkin County, Elk Camp	39.2045	-106.8940
DQ663381	Cortinarius platypus	gilled	dry	Denmark, TF2000-010		
UDB001085	Cortinarius pluviorum	gilled	dry	Sweden, Smoland, Femsjö, östlich Trollgröll	56.8833	13.3214
KP406541	Cortinarius pluvius	gilled	dry	UBC F28444: Canada, BC, Campbell River	50.0667	-124.5833
UDB001058	Cortinarius pluvius	gilled	dry	Russia, Kamchatka, Avacha River Valley, bridge over Avacha River by Razdolny, 5312'E, 15820''	53.2000	158.3333
KC608588	Cortinarius politus	gilled	dry	USA: Washington, JFA13416; USA. Washington: Chelan County. Rd. 62, road to Trinity, end of pavement	48.0804	-120.8443
KJ421052	Cortinarius ponderosus	gilled	dry	BW 2004 10 24; NA		
UDB015886	Cortinarius populinus	gilled	dry	Estonia, Tartu maakond , Vara vald , Alajõe village	58.5208	26.9492
KP191900	Cortinarius porphyroideus	sequestrate	dry	New Zealand, OTA61893; NA		
GU233331	Cortinarius porphyrophaeus	gilled	dry	Little Barrier Island, Tirikawa Stream, Coromandel, New Zealand	-36.2194	175.0570
UDB000145	Cortinarius porphyropus	gilled	dry	Norway: Rogaland: Suldal: Røssdal	59.5091	6.5228
AY174804	Cortinarius praestans	gilled	dry	Weyer, Germany	50.1992	7.7162
UDB000086	Cortinarius praestigiosus	gilled	dry	Denmark, Sjælland, Rude Skov	55.8412	12.4777
EU684535	Cortinarius praetermissus	gilled	dry	MES-4312; Castelló, Morella, Mas d'Arrufat, Spain	40.6196	-0.1037
UDB001822	Cortinarius prasinocyaneus	gilled	dry	Sweden. Öland, Åstad	56.7452	16.6899
UDB002013	Cortinarius prasinus	gilled	dry	France. Haute-Savoie		
KP165569	Cortinarius privignipallens	gilled	dry	Sweden, H:7018125; Sweden, Jamtland, Froso, Fillsta, Fillstabacken	63.1435	14.5485
JF907956	Cortinarius privignoides	gilled	dry	PLoS ONE 8 (4), E62419 (2013); Italy		
LN823977	Cortinarius prodigiosus	gilled	dry	No data		
AY669672	Cortinarius psammocephalus	gilled	dry	Germany, TUB 011910		

GenBank Number	Taxon Name	Type of Fruiting Body	Pileus surface	Location	Latitude	Longitude
JX000371	Cortinarius pselioticton	gilled	dry	Borland , Fiordland, New Zealand	-45.7768	167.5370
UDB001463	Cortinarius pseudobovinus	gilled	dry	USA, Wyoming, Teton Natl. Forest		
GQ159908	Cortinarius pseudocandelaris	gilled	dry	F17165	48.7000	-122.2333
KF732392	Cortinarius pseudocephalixus	gilled	dry	France: G:293291/1; France, Drôme, Foret de Romeyer	44.8151	5.4597
KF732367	Cortinarius pseudocupreorufu s	gilled	dry	USA: MICH:10390	47.9763	-123.6842
GQ159899	Cortinarius pseudoduracinus	gilled	dry	F17156: Canada, BC, Koksilah Ridge	48.7000	-122.2333
KT591592	Cortinarius pseudofallax	gilled	dry	Norway, O:T.E. Brandrud TEB 424-14; Norway, Akershus		
KF732394	Cortinarius pseudogracilior	gilled	dry	France: PC:P. Moenne-Loccoz 4858; France, Dordogne, Tursac	44.9693	1.0209
KF732635	Cortinarius pseudonaevosus	gilled	dry	CFP1175; NA		
KF732398	Cortinarius pseudonebularis	gilled	dry	France: G:293321/1 France, Haute-Savoie, Massif du Semnoz	45.8000	6.1075
UDB017791	Cortinarius pseudorubricosus	gilled	dry	France, Fôret de Belval	49.4838	5.0334
AF182792	Cortinarius pseudosalor	gilled	viscid	California, USA		
AY669600	Cortinarius pseudotriumphans	gilled	dry	Chile, TUB 011873		
KF732404	Cortinarius pseudovariegatus	gilled	dry	USA: IB:19970296 USA, Wyoming, Shoshone National Forest, Lake east of Two Ocean Mountain	43.7480	-110.0031
UDB001106	Cortinarius psittacinus	gilled	dry	Italy, Parco Naz. di Maielle, Gamberale, San Antonio	42.1947	14.2169
KJ705155	Cortinarius pulchrifolius	gilled	dry	Quebec, 4450; NA		
AF539714	Cortinarius punctatisporus	gilled	dry	San Antonio, Valdivia, Chile	-39.8283	-73.2299
FJ039660	Cortinarius purpurascens	gilled	dry	McDonnell FSR Smithers, BC	54.7742	-127.4113
UDB000736	Cortinarius purpurascens	gilled	dry	Rosenberg Farm, nr. Vänge, Uppsala, Sweden	59.8557	17.4208
UDB016117	Cortinarius purpurascens	gilled	dry	Estonia, Lääne-Viru maakond , Vihula vald , Käsmu	59.6164	25.9069
KJ705124	Cortinarius purpurascens	gilled	dry	Quebec, 4464; NA		
AY033121	Cortinarius purpurellus	gilled	dry	Chile, RA412		
UDB018316	Cortinarius	gilled	dry	Estonia, Võru maakond , Antsla vald, near Ähijärv	57.6853	26.5472

GenBank Number	Taxon Name	Type of Fruiting Body	Pileus surface	Location	Latitude	Longitude
	purpureus					
UDB001174	Cortinarius quarciticus	gilled	dry	Sweden, Västmanland, Skinnskatteberg, Riddarhyttan Research plots	59.8000	15.5000
AY669616	Cortinarius quaresimalis	gilled	dry	Tasmania HO A20606A5		
UDB001825	Cortinarius quercilicis	gilled	dry	Sweden. Öland, Åstad	56.7452	16.6899
AF112143	Cortinarius radicatus	gilled	dry	no data	N/A	N/A
DQ663417	Cortinarius rapaceoides	gilled	dry	Vernot, France	47.4928	4.9789
UDB002026	Cortinarius rapaceotomentosu s	gilled	dry	France, Seine-Maritime		
JX000375	Cortinarius rattinoides	gilled	dry	W. Klondyke, Rest Area, Mid Canterbury, New Zealand	-43.0020	171.5892
GU233352	Cortinarius rattinus	gilled	dry	Amuri, Boyle River, North Canterbury, New Zealand	-42.5224	172.4062
UDB002178	Cortinarius renidens	gilled	dry	Nåsten, Uppsala, Uppland, Sweden	59.8200	17.5777
KF732408	Cortinarius reverendissimus	gilled	dry	France, G:293709/1; France, Haute-Loire, Foret de Miaune	45.2261	3.9696
KF732409	Cortinarius rex	gilled	dry	France, PC:A. Bidaud 04-09-163; France, Ain, la Vèche, Chanay	46.0014	5.7798
JX000368	Cortinarius rhipiduranus	gilled	dry	Kepler Track, Fiordland, New Zealand	-45.4510	167.5746
KJ421051	Cortinarius rhodophyllus	gilled	dry	TUB 020416; NA		
KJ421008	Cortinarius riederi	gilled	dry	TUB 019769; NA		
KJ421204	Cortinarius riederi	gilled	dry	TUB 020433; NA		
UDB001033	Cortinarius rigens	gilled	dry	Italy, Bozen Province, Armentarola unterhalb Falzarego Pass, Prov. Bozen, Italien	46.5199	12.0202
GQ159763	Cortinarius rigens	gilled	dry	F17173: Canada, BC, Royal Roads, Across from Tennis Court	48.4333	-122.5167
GQ159903	Cortinarius rigens	gilled	dry	F17160: Canada, BC, Koksilah Ridge	48.7000	-122.2333
GQ159809	Cortinarius rigens	gilled	dry	F17221, Canada, BC, Forest off Echo Lane Farm	48.9181	-123.7330
AY669674	Cortinarius rigens	gilled	dry	Germany, TUB 011517		
AY669675	Cortinarius rigens	gilled	dry	Germany, TUB 011518		
KJ206505	Cortinarius rigidipes	gilled	dry	France, IK94-1830 (H); France, Ain, Oyonnax	46.2512	5.6837
KR080707	Cortinarius rioussetiae	gilled	dry	Hungary, BP:B. Dima DB3769 NA		
KF732636	Cortinarius rosargutus	gilled	dry	Germany, IK96-1279; Germany, Baden-Württemberg, Freiburg, Biederbach	48.1906	8.0356
KP114464	Cortinarius roseivelatus	gilled	dry	Finland, H:T. Niskanen 01-2001; Finland, Kainuu, Sotkamo, Hiidenportti	63.8960	29.0729
HQ845119	Cortinarius	gilled	dry	Finland, Satakunta, Vammala, Perkojarvi	61.3416	22.9154

GenBank Number	Taxon Name	Type of Fruiting Body	Pileus surface	Location	Latitude	Longitude
	roseoarmillatus					
EU056982	Cortinarius roseobulbus	gilled	dry	JFA 11850; , California: Del Norte Co., Gasquet Flat, USA	41.8502	-123.9730
KP114461	Cortinarius roseocastaneus	gilled	dry	Finland, H:6001997; Finland, Varsinais-Suomi, Turku, Ruissalo, Honkapirtti	60.4284	22.1480
AF112144	Cortinarius rotundisporus	gilled	dry	no data	N/A	N/A
AF389127	Cortinarius rotundisporus	gilled	dry	New Zealand; ZT NZ8501		
AY669612	Cortinarius rotundisporus	gilled	dry	Austrailia PERTH 05255074		
UDB001055	Cortinarius rubellus	gilled	dry	Sweden, Smoland, Femsjö, Pellatorpet	56.9000	13.3145
AY669599	Cortinarius rubicundulus	gilled	dry	Germany TUB 011829		
AY669673	Cortinarius rubricosus	gilled	dry	Germany, TUB 011911		
AF539732	Cortinarius rubrivelatus	gilled	dry	San Antonio, Valdivia, Chile	-39.8283	-73.2299
AF539726	Cortinarius rubrobasalis	gilled	dry	Salto de la Princesa, Temuco, Chile	-38.4747	-71.6734
UDB021539	Cortinarius rubrobrunneus	gilled	dry	Canada, Ontario, Campbellville Road, Halton Forest	43.5066	-79.9641
JQ287668	Cortinarius rubrocastaneus	gilled	dry	New Zealand: Arthurs Pass, North Canterbury	-42.9416	171.5613
KF732413	Cortinarius rufoallutus	gilled	dry	France, PC:P. Moenne-Loccoz 635; France, Haute-Savoie, Plateau de Glières	45.9604	6.3420
UDB002028	Cortinarius rufoolivaceus	gilled	dry	Sweden. Västra Götaland, Kinnekulle, Österplana Hed	58.5742	13.4279
GU234032	Cortinarius rufostriatus	gilled	dry	Svalbard	78.3060	16.8770
JX407334	Cortinarius rusticus	gilled	dry	Finland, TN02-228, Finland, Ks, Kuusamo	65.9696	29.1860
UDB016148	Cortinarius safranopes	gilled	dry	Estonia, Valga maakond , Põdrala vald , Salu, near lake Veisjärv	58.0703	25.7933
UDB016116	Cortinarius safranopes	gilled	dry	Estonia, Tartu maakond , Vara vald , Kõrveküla, near lake Vasula	58.4387	26.7119
UDB011344	Cortinarius saginus	gilled	dry	Estonia, Saare maakond , Lümanda vald , Viidu	58.2832	22.1358
KT591590	Cortinarius salicticolus	gilled	dry	Norway, O:E. Bendiksen EB 255-07; Norway, Akershus		
AY669618	Cortinarius salmaster	gilled	dry	Tasmania HO A20528A3		
DQ097886	Cortinarius salor	gilled	viscid	BC, Canada, OUC99394; DAVFP	50.5843	-118.8149
EU821686	Cortinarius salor	gilled	viscid	DAVFP 26194	53.3327	-120.3140

GenBank Number	Taxon Name	Type of Fruiting Body	Pileus surface	Location	Latitude	Longitude
FJ039600	Cortinarius salor	gilled	viscid	McDonnell FSR Smithers, BC	54.7742	-127.4113
UDB015945	Cortinarius salor	gilled	viscid	Estonia, Harju maakond , Kose vald , Tammiku	59.2058	24.9311
AY669592	Cortinarius salor	gilled	viscid	Germany TUB 011838		
UDB002029	Cortinarius sanctifelicis	gilled	dry	Spain, Catalunya		
JN114091	Cortinarius sanguineus	gilled	dry	France, G00110215 (G); France, Saone-et-Loire, near Charolles	46.4420	4.2596
UDB001176	Cortinarius sanguineus	gilled	dry	Fastarbo, Old spruce site, 40 km N. of Uppsala nr, Björklinge, Uppland, Sweden	60.0315	17.5562
FJ717541	Cortinarius saniosus	gilled	dry	JMB10-15-2007-05; United States, Washington, Highland Park Way	47.5389	-122.3468
UDB002181	Cortinarius saniosus	gilled	dry	Fredrikslund, Uppsala, Uppland, Sweden	59.7571	17.6547
KF732420	Cortinarius sannio	gilled	dry	USA: IB:19970352; USA, Wyoming, Teton National Forest, Lost Lake	43.7808	-110.0980
UDB001827	Cortinarius saporatus	gilled	dry	Denmark. LFM, Møns Klinteskov, Maglevandsfald	54.9788	12.5213
AY033123	Cortinarius sarmienti	gilled	dry	Chile,RA7413		
JF907949	Cortinarius saturatus	gilled	dry	PLoS ONE 8 (4), E62419 (2013); Italy		
GU233337	Cortinarius saturniorum	gilled	dry	Hawdon, Middle Canterbury, New Zealand	-42.9112	171.7329
EF420145	Cortinarius savegrensis	gilled	dry	Costa Rica, JFA 11950	9.5506	-83.4633
EU057028	Cortinarius saxamontanus	gilled	dry	Ben Woo 5-31-04-1 ; Washington: Kittitas Co., Peoh Point, USA	47.1518	-120.9487
KF732422	Cortinarius scaurocaninus	gilled	dry	France: PC:R. Henry 71678; Montpellier , France	43.6419	3.8830
GQ159877	Cortinarius scaurus	gilled	dry	F17134: Canada, BC, Jordan Ridge	48.4833	-123.9167
FJ039704	Cortinarius scaurus	gilled	dry	Rose Inlet Estuary, BC, Canada	52.2036	-131.1577
FJ039621	Cortinarius scaurus	gilled	dry	McDonnell FSR Smithers, BC	54.7742	-127.4113
FJ039622	Cortinarius scaurus	gilled	dry	McCabe Trail, Smithers, BC	54.8850	-126.9780
UDB000146	Cortinarius scaurus	gilled	dry	Norway: Rogaland: Sandnes: Rogaland arboret	58.8130	5.8148
UDB001568	Cortinarius scaurus	gilled	dry	Scotland, Aberdeenshire,		
KJ635210	Cortinarius sclerophyllarum	gilled	dry	Haast, Blue Pools, Otago Lakes, New Zealand	-44.1646	169.2769
GU234069	Cortinarius scotoides	gilled	dry	Svalbard	78.3060	16.8770

GenBank Number	Taxon Name	Type of Fruiting Body	Pileus surface	Location	Latitude	Longitude
KC842394	Cortinarius scotoides	gilled	dry	Norway, G8; NA		
DQ328133	Cortinarius sebosus	sequestrate	dry	Australia AF92 ; H7265; PERTH 06234631	-31.4911	117.7264
UDB001853	Cortinarius selandicus	gilled	dry	Denmark. NVS, Allindelille	55.5222	11.7634
FJ157068	Cortinarius semisanguineus	gilled	dry	F15880, Canada, BC, #2 Mount Elphinstone Provincial Park Area	49.4167	-122.3500
FJ157071	Cortinarius semisanguineus	gilled	dry	F15825, Canada, BC, #3 Mount Elphinstone Provincial Park Area	49.4167	-122.3500
UDB001548	Cortinarius semisanguineus	gilled	dry	Scotland, Moray, Culbin Forest	57.6313	-3.6808
UDB001178	Cortinarius semisanguineus	gilled	dry	Fastarbo, Old spruce site, 40 km N. of Uppsala nr, Björklinge, Uppland, Sweden	60.0315	17.5562
FJ717529	Cortinarius semisanguineus	gilled	dry	SAT05-302-05; NA		
JN114090	Cortinarius semisanguineus	gilled	dry	Sweden, CFP333 (S) NA		
AY669541	Cortinarius serarius	gilled	dry	Norway O-65724		
EF420146	Cortinarius sericeolazulinus	gilled	dry	Costa Rica, JFA 12053	9.5506	-83.4633
JX045688	Cortinarius sierraensis	gilled	dry	USA DBB03415; USA, California; D.Bojantchev's personal collection NA		
AY669577	Cortinarius similis	gilled	dry	China HKAS 26154		
HM060328	Cortinarius sinapicolor	gilled	dry	Lake Okataina, Eastern Track, Bay of Plenty, New Zealand	-38.0988	176.4278
AY669604	Cortinarius sinapicolor	gilled	dry	Australia PERTH 05506778	-34.9564	117.3567
GQ890305	Cortinarius sinapivelus	sequestrate	dry	Australia, KV518; MEL2331645	-30.3000	149.7667
JQ287672	Cortinarius singularis	gilled	dry	New Zealand: Te Anau, Kepler Track, Fiordland	-45.4510	167.5746
GU222321	Cortinarius singularis	gilled	dry	Westport, Denniston Walkway, Nelson, New Zealand	-41.7356	171.7962
JX045689	Cortinarius smithii	gilled	dry	USA AHS3485	43.9828	-124.0987
KF732559	Cortinarius sobrius	gilled	dry	IK04-045; Finland, Helsinki	60.1814	24.9139
UDB001828	Cortinarius sodagnitus	gilled	dry	Denmark. LFM, Møns Klinteskov, Sandskredsfald	54.9788	12.5213
JN114083	Cortinarius sommerfeltii	gilled	dry	Sweden, CFP594 (S) NA		
UDB001360	Cortinarius sordidemaculatus	gilled	dry	Finland, U, Kirkkonummi	60.1231	24.4337
KJ421145	Cortinarius sphagnophilus	gilled	dry	TUB 019717; NA		

GenBank Number	Taxon Name	Type of Fruiting Body	Pileus surface	Location	Latitude	Longitude
DQ093855	Cortinarius spilomeus	gilled	dry	BC, Canada, OUC97199; DAVFP	50.5843	-118.8149
UDB015906	Cortinarius spilomeus	gilled	dry	Sweden, Fleringe parish, near lake Bästerträsk	57.9140	18.9249
UDB011790	Cortinarius spilomeus	gilled	dry	Estonia, Saare maakond , Lümanda vald , Viidu	58.2842	22.1348
UDB001829	Cortinarius splendens	gilled	dry	Denmark. NVS, Allindelille	55.5222	11.7634
UDB001850	Cortinarius splendidior	gilled	dry	France. Massif des Alpilles, Saint-Rémy de Provence (Vaucluse)	43.7584	4.8526
DQ663432	Cortinarius splendificus	gilled	dry	Hérault, France; This is too vague		
JX219776	Cortinarius splendificus	gilled	dry	JB-7613/11 NA		
KJ421181	Cortinarius squameoradicans	gilled	dry	TUB 019726; NA		
AF539729	Cortinarius squamiger	gilled	dry	San Antonio, Valdivia, Chile	-39.8283	-73.2299
KP114458	Cortinarius squamivenetus	gilled	dry	Finland, H:T. Niskanen 07-119; Finland, Koillismaa, Kuusamo, Oulanka National Park, Camping pale - Puukkorinne	66.3722	29.2935
KF732432	Cortinarius squamosocephalu s	gilled	dry	France: PC:99670; France, Ardennes, Bois de la Brouille		
AY669603	Cortinarius stephanopus	gilled	dry	Chile, TUB 011875		
UDB001569	Cortinarius stillatitius	gilled	viscid	Scotland, Invernesshire, Glen Strathfarrar	57.4103	-4.8376
UDB011254	Cortinarius stillatitius	gilled	viscid	Estonia, Saare maakond , Kihelkonna vald , Lagenõmme	58.3156	22.1850
UDB020290	Cortinarius stillatitius	gilled	viscid	Finland, Rovaniemi, Kiimamaa Nature Protection Area	66.7392	25.2025
UDB001831	Cortinarius suaveolens	gilled	dry	Denmark. ØJ, Vosnæs Havskov,		
UDB001826	Cortinarius subalbescens	gilled	dry	Denmark. ØJ, Århus skovene	56.1674	10.2040
KP137494	Cortinarius subargyronotus	gilled	dry	Sweden, H:7018127; Sweden, Oland, Hogsrum, Haltorp Nature reserve area, at the golf course	56.7005	16.4943
EU821691	Cortinarius subarquatus	gilled	dry	DAVFP 26627: Canada, BC, McBride	53.4089	-120.2997
AY669563	Cortinarius subarquatus	gilled	dry	Germany TUB 01189		
AY669692	Cortinarius subbalaustinus	gilled	dry	Germany, TUB 011915		
KP165550	Cortinarius subbrunneoideus	gilled	dry	Finland, H:6001085; Finland, Koillismaa, Kuusamo commune, Oulanka National Park, W end of Ampumavaara, N of the Biological station	66.3722	29.2904

GenBank Number	Taxon Name	Type of Fruiting Body	Pileus surface	Location	Latitude	Longitude
JX178614	Cortinarius subcalyptrosporus	gilled	dry	New Zealand, OTA:60199 NA		
AY033112	Cortinarius subcastanellus	sequestrate	dry	NZ800		
KF732441	Cortinarius subdecolorans	gilled	dry	France: G:294832/1; France, Marne, Bazancourt	49.3642	4.1676
UDB020271	Cortinarius suberi	gilled	dry	Finland, Rovaniemi, Kaidanharju Protection Area	66.1967	25.1622
KP165575	Cortinarius subexitiosus	gilled	dry	Finland, H:6029589; Finland, Pera-Pohjanmaa, Tornio, Kalkkimaa, Tuppivaara, nature reserve area (west),	62.4880	30.6036
KF732444	Cortinarius subfoetidus	gilled	dry	USA: MICH:10416	47.9763	-123.6842
JX000354	Cortinarius subgemmeus	gilled	dry	Te Anau, Te Anau Downs, Lake Gunn Track, Fiordland, New Zealand	-44.8916	168.0816
UDB001851	Cortinarius subgracilis	gilled	dry	France. Forêt de Saint-François de Sales (Savoie)	45.6836	6.0499
UDB001852	Cortinarius sublilacinopes	gilled	dry	France. Forêt de la Londe-Rouvray (Seine-Maritime)	49.3275	0.9564
AY669614	Cortinarius submagellanicus	gilled	dry	Tasmania HO A20518A1		
HQ845127	Cortinarius suboenochelis	gilled	dry	Finland, TN05-126; Finland, Kainuu, Suomussalmi, Huurunvaaran lehto	65.1944	29.0177
KF732447	Cortinarius subolivascens	gilled	dry	USA: MICH:10418	47.9372	-123.8200
KT159227	Cortinarius subporphyropus	gilled	dry	Norway, M:0275857; Norwegen, Telemark, Porsgrunn	59.1284	9.6572
UDB021486	Cortinarius subrufulus	gilled	dry	United States, Washington, Olympic Peninsula, Boulder Creek Trail, in the beginning of the trail by the road	47.9779	-123.6935
KF732451	Cortinarius subrugulosus	gilled	dry	France, PC:A. Bidaud 05-10-263; France, Isere, Treminis	44.7509	5.7673
KP165553	Cortinarius subserratissimus	gilled	dry	Sweden, H:I. Kytovuori 11-018; Sweden, Gotland, Brucebo	57.6882	18.3509
KF732452	Cortinarius subsolitarius	gilled	dry	USA: MICH:10426 USA, Michigan, Ann Arbor	42.2784	-83.7983
HQ845173	Cortinarius subtestaceus	gilled	dry	USA, AHS15458; USA, Michigan, Oakland, La Badie Lake		
FJ717555	Cortinarius subtortus	gilled	dry	JFA13117	48.0267	-121.4428
KF732645	Cortinarius subtortus	gilled	dry	Finland, TN05-021; Finland, ES, Joutsa	61.7486	26.1049
UDB002400	Cortinarius subtorvus	gilled	dry	Druim Chuibhe, Invernaver, Sutherland, Scotland	58.5196	-4.2506
GU234013	Cortinarius subtorvus	gilled	dry	Svalbard	78.3060	16.8770
GU234058	Cortinarius subtorvus	gilled	dry	Svalbard	78.3060	16.8770
FN428986	Cortinarius	gilled	dry	Spain:Valencia		

GenBank Number	Taxon Name	Type of Fruiting Body	Pileus surface	Location	Latitude	Longitude
	subturibulosus					
JX000360	Cortinarius suecicolor	gilled	dry	Te Iringa Track, Taupo, New Zealand	-38.9841	176.2169
UDB000586	Cortinarius sulphurinus	gilled	dry	Sweden		
FJ157094	Cortinarius superbus	gilled	dry	F14965: Canada, BC, Helen Lake Rd, 8km Mature Forest near Kispiox	54.5000	-125.3167
KJ705108	Cortinarius tabularis	gilled	dry	Quebec, 614-HRL 614; NA		
UDB001167	Cortinarius talimultiformis	gilled	dry	Sweden, Uppsala, Hässelby Park	59.8748	17.5715
UDB019786	Cortinarius talus	gilled	dry	Estonia, Saare maakond , Lümanda vald , Viidu, Audaku	58.2923	22.1099
UDB016004	Cortinarius talus	gilled	dry	Estonia, Tartu maakond , Vara vald , Alajõe village	58.5278	26.9639
AY669633	Cortinarius tasmacamphoratus	gilled	dry	Tasmania, HO A20606A0		
AY033106	Cortinarius taylorianus	gilled	dry	ZT NZ858		
JX178616	Cortinarius taylorianus	gilled	dry	New Zealand, OTA:60233 NA		
GU234060	Cortinarius tenebricus	gilled	dry	Svalbard	78.3060	16.8770
AF539728	Cortinarius tenellus	gilled	dry	San Antonio, Valdivia, Chile	-39.8283	-73.2299
AF389151	Cortinarius teraturgus	gilled	dry	Argentina; IB19630218		
UDB001832	Cortinarius terpsichores	gilled	dry	Czech republic. Karlstejn	49.9409	14.1896
JQ287698	Cortinarius tessiae	gilled	dry	New Zealand: Waipori Falls River, Dunedin	-45.9045	169.9921
UDB000741	Cortinarius testaceofolius	gilled	dry	Sweden, Jämtland, Håsjö, Lövsjön	60.3083	14.6752
JQ287673	Cortinarius thaumastus	gilled	dry	New Zealand: Eves Bush, Brightwater, Nelson	-41.3352	173.0592
JQ287670	Cortinarius tigrellus	gilled	dry	New Zealand: Clements Road, Cascade Hut Track, Taupo	-38.9562	176.2445
AY669556	Cortinarius tiliae	gilled	dry	Norway O-63407		
UDB015917	Cortinarius tillamookensis	gilled	dry	Estonia, Pärnu maakond , Saarde vald , Kilingi-Nõmme	58.1475	24.9516
KP087974	Cortinarius timiskamingensis	gilled	dry	Canada: Ontario, NBM:D. Malloch 3-9-81/2; Canada, Ontario, Timiskaming District, Burt Township, 1.2 km SW of Burt Lake along Burt Creek,	48.0650	-80.3856
KJ421203	Cortinarius tirolianus	gilled	dry	TUB 011526; NA		
UDB001074	Cortinarius tofaceus	gilled	dry	Sweden, Schweden, Smoland, Femsjö, östlich Trollgöl	56.8833	13.3214
UDB017021	Cortinarius	gilled	dry	Estonia, Saare maakond , Kihelkonna vald , near Odalätsi springs	58.3503	22.0000

GenBank Number	Taxon Name	Type of Fruiting Body	Pileus surface	Location	Latitude	Longitude
	tofaceus					
UDB002164	Cortinarius tortuosus	gilled	dry	Bispgården, Ragunda, Jämtland, Sweden	63.0284	16.6166
JX407337	Cortinarius torvus	gilled	dry	Denmark, IK98-1973, Denmark, Nordyllands amt, Fjerritslev og Brovst	57.0878	9.4019
KC842400	Cortinarius torvus	gilled	dry	Norway, T35; NA		
AF389145	Cortinarius trachycystis	gilled	dry	Argentina; IB19630143		
EU821692	Cortinarius traganus	gilled	dry	DAVFP 26156: Canada, BC, McBride	53.2921	-120.2882
UDB000153	Cortinarius traganus	gilled	dry	Norway: Oslo: Oslo: Nordmarka, Høgås	59.8381	10.3842
UDB019887	Cortinarius traganus	gilled	dry	Finland, Rovaniemi, Pohtimolampi, surroundings of Bear's Lodge	66.6606	25.3281
U56042	Cortinarius trappei	gilled	dry	N/A		
UDB000729	Cortinarius triumphans	gilled	dry	Fyringen, 4km NW of Lohärad, beside Lake Erken, Norrtälje, Uppland, Sweden	59.8299	18.5640
AJ296300	Cortinarius trivialis	gilled	dry	Guadalajara, Spain	40.6320	-3.1594
UDB019889	Cortinarius trivialis	gilled	dry	Finland, Rovaniemi, Pohtimolampi, surroundings of Bear's Lodge	66.6675	25.3225
AF182796	Cortinarius trivialis	gilled	dry	Washington, USA		
DQ295110	Cortinarius trivialis	gilled	dry	IB19920268 ; NA		
DQ295112	Cortinarius trivialis	gilled	dry	Peintner et al. Antonini2001111301; NA		
KJ421159	Cortinarius trivialis	gilled	dry	JFA 11917; NA		
JQ937284	Cortinarius truckeensis	gilled	dry	USA: California: Nevada County, North of Truckee, off Hwy. 89	39.4014	-120.1886
GQ159891	Cortinarius tubarius	gilled	dry	F17148: Canada, BC, Jordan Ridge	48.4833	-123.9167
KJ421099	Cortinarius turbinatorum	gilled	dry	TUB 019806; NA		
GQ159774	Cortinarius turibulosus	gilled	dry	F17184: Canada, BC, Tofino	49.1167	-124.1167
UDB002191	Cortinarius turmalis	gilled	dry	Stadsskogen, Uppsala, Uppland, Sweden	59.8401	17.6210
AY669687	Cortinarius umbilicatus	gilled	dry	Germany, TUB 011922		
KP137507	Cortinarius umbrinobellus	gilled	dry	Sweden, H:7018158; Sweden, Oland, Algutsrum, Notbrunnskarret	56.6827	16.5315
AY669658	Cortinarius umbrinolens	gilled	dry	Germany, TUB 011918		
KP165545	Cortinarius uraceisporus	gilled	dry	Finland, H:T. Niskanen 00-270; Finland, Varsinais-Suomi, Kisko commune, Leila, S side of the dust road to Orjanpera	60.2110	23.5898
KJ206508	Cortinarius uraceomajalis	gilled	dry	Hungary, DB1623 (BP); Hungary, Heves, Recsk	47.9166	20.1056
KJ206518	Cortinarius	gilled	dry	Sweden, IK98-1838 (H); Sweden, Ög, Ödenshög	58.2081	14.6881

GenBank Number	Taxon Name	Type of Fruiting Body	Pileus surface	Location	Latitude	Longitude
	uraceonemoralis					
KJ206524	Cortinarius uraceus	gilled	dry	Finland, IK97-1519 (H); Finland, Kn, Puolanka	64.8670	27.6758
UDB001094	Cortinarius urbicus	gilled	dry	Italy, Bozen Province, Armentarola unterhalb Falzarego Pass	46.5599	11.9551
UDB000743	Cortinarius urbicus	gilled	dry	Sweden, Uppland, Uppsala, Botaniska trädgården	59.8503	17.6291
JX000352	Cortinarius ursus	gilled	dry	St Arnaud Range, Nelson, New Zealand	-41.8119	172.8605
AY669518	Cortinarius vacciniophilus	gilled	dry	O-125949 ; Ringebu, Norway	61.5307	10.1323
KJ421095	Cortinarius vaginatus	gilled	dry	TUB 020418; NA		
UDB001108	Cortinarius valgus	gilled	dry	Sweden, S, Smoland, Femsjö, östl. Älmas	57.2774	13.7754
KR011130	Cortinarius vanduzerensis	gilled	viscid	USA: oregon, MICH:10434	45.0245	-123.9410
AF182794	Cortinarius vanduzerensis	gilled	viscid	Oregon, USA		
UDB011729	Cortinarius variecolor	gilled	dry	Estonia, Hiiu maakond ,Kõrgessaare vald , Kõpu peninsula, E of Hirmuste	58.9331	22.1433
FJ039663	Cortinarius variegatus	gilled	dry	McCabe Trail, Smithers, BC	54.8850	-126.9780
KC581330	Cortinarius variicolor	gilled	dry	F20349: Canada, BC, Capilano Regional Park	49.3500	-122.9000
AY174791	Cortinarius variiformis	gilled	dry	Eschweiler, Germany	50.8166	6.2577
KJ421164	Cortinarius variiformis	gilled	dry	1021015 3; NA		
KF732467	Cortinarius variipes	gilled	dry	France, PC:R. Henry 5026; France, Ardennes		
FJ717599	Cortinarius variosimilis	gilled	dry	F17107: Canada, BC, Manning Provincial Park, Lightening Lakes, Strawberry Flats	49.0664	-120.8929
GQ159915	Cortinarius variosimilis	gilled	dry	F16580: Canada, BC, Community Forest Nature Trail, Smithers	54.7667	-126.8333
AY174792	Cortinarius varius	gilled	dry	Oberjoch, Germany	47.5165	10.4027
UDB018643	Cortinarius varius	gilled	dry	Estonia, Lääne maakond , Martna vald , Marimetsa hoiuala, between Kaasiku and Ubasalu	58.9189	23.9119
GQ159907	Cortinarius velenovskyi	gilled	dry	F17164: Canada, BC, Koksilah Ridge	48.7000	-122.2333
GQ159860	Cortinarius velenovskyi	gilled	dry	F17117: Canada, BC, Mt. Washington, Lowertrail to Rossiter Lake	49.7415	-125.3452
UDB018218	Cortinarius venetus	gilled	dry	Sweden, Fleringe parish, near lake Bästerträsk	57.9140	18.9249
UDB011272	Cortinarius venetus	gilled	dry	Estonia, Saare maakond , Lümanda vald , Viidu	58.2887	22.1255
UDB002212	Cortinarius venustus	gilled	dry	Bispgården, Ragunda, Jämtland, Sweden	59.8200	17.5777

GenBank Number	Taxon Name	Type of Fruiting Body	Pileus surface	Location	Latitude	Longitude
UDB019898	Cortinarius venustus	gilled	dry	Finland, Rovaniemi, Louevaara-Tuohilaki, Nature Protection Area SE of Tuohilaki, Loue 3	66.4072	25.2008
HQ845174	Cortinarius veregregius	gilled	dry	France, PC0090322; NA		
JX000370	Cortinarius vernicifer	gilled	dry	Te Anau Downs, Otago Lakes, New Zealand	-45.1936	167.8281
AF182799	Cortinarius vernicosus	gilled	dry	Washington, USA		
FJ039541	Cortinarius vernus	gilled	dry	Camosun College Property at the end of Barrow Road, Metchosin, BC	48.3770	-123.6011
HQ604728	Cortinarius vernus	gilled	dry	UBC:F19638 Canada, BC, Victoria, Highlands, Jocelyn Hill	48.5333	-122.4833
GQ159811	Cortinarius vernus	gilled	dry	F17223: Canada, BC, Heals Rifle Range, Dnd, Saanich, Victoria	48.5500	-122.6333
FJ717497	Cortinarius vernus	gilled	dry	USA, JFA13107; [No locality given on label.]	N/A	N/A
FN429004	Cortinarius vernus	gilled	dry	France:Pezenes		
UDB000742	Cortinarius vernus	gilled	dry	Sweden, Ångermanland Province		
KJ635239	Cortinarius veronicae	gilled	dry	Te Iringa Track, Taupo, New Zealand	-38.9841	176.2169
KC017362	Cortinarius veronicoides	gilled	dry	Australia: TAS, Mt Field National Park	-42.6858	146.5937
EU057042	Cortinarius verrucisporus	gilled	dry	OSC-74303 ; Oregon: Klamath Co., north of Pearce Point, USA	42.4097	-122.1551
EU669367	Cortinarius verrucisporus	gilled	dry	OSC 115194	42.6800	-119.8400
UDB001854	Cortinarius vesterholtii	gilled	dry	Denmark. ØJ, Århus skovene, Jens Bæks Vedkast	56.1674	10.2040
EU821694	Cortinarius vibratilis	gilled	dry	DAVFP 26530	52.9319	-119.3781
UDB000123	Cortinarius vibratilis	gilled	dry	Norway: Rogaland: Bjerkreim: Hetlandsskogen	58.6332	6.1000
UDB000926	Cortinarius vibratilis	gilled	dry	Skorradalur, Iceland	64.5202	-21.5428
FJ717578	Cortinarius vibratilis	gilled	dry	SLB2003-10-12-09; NA		
U56033	Cortinarius vibratilis	gilled	dry	N/A		
AY669608	Cortinarius vinaceolamellatus	gilled	dry	Australia PERTH 05506786	-34.9833	116.6667
UDB001820	Cortinarius violaceipes	gilled	dry	Czech Republic. Karlstejn	49.9409	14.1896
UDB018647	Cortinarius violaceomaculatus	gilled	dry	Estonia, Rapla maakond , Märjamaa vald	59.0142	24.4431
KF732474	Cortinarius violaceorubens	gilled	dry	France, G:295756/1; France, Haute-Savoie, Pessière plantée d'Aviernoz	45.9814	6.2125
AF112146	Cortinarius violaceus	gilled	dry	no data	N/A	N/A

GenBank Number	Taxon Name	Type of Fruiting Body	Pileus surface	Location	Latitude	Longitude
AY669578	Cortinarius violaceus	gilled	dry	Australia PERTH 05506794		
KF732475	Cortinarius virentophyllus	gilled	dry	USA: MICH:10439; USA, Michigan, Washtenaw, Ann Arbor; German Park Woods.	42.3574	-83.6757
AF539717	Cortinarius viridibasalis	gilled	dry	Lonquimay, Temuco, Chile	-38.7408	-72.6282
UDB021473	Cortinarius viridiflavus	gilled	dry	United States, Oregon, Cascade Head Experimental Forest	45.0680	-123.9734
EU057009	Cortinarius viridirubescens	gilled	dry	JFA 11876 ; California: Humboldt Co., Boise Creek Campground, USA	40.9044	-123.7433
GU233353	Cortinarius viscilaetus	gilled	dry	Te Anau, Kepler Track, Southland, New Zealand	-45.4510	167.5746
JX648596	Cortinarius viscincisus	gilled	dry	Cascade Hut Track, Taupo, New Zealand	-38.9893	176.1400
GU233335	Cortinarius viscostriatus	gilled	dry	Lake Rotoiti, track to St Arnaud Range, Nelson, New Zealand	-41.8064	172.8427
JQ282167	Cortinarius viscoviridis	gilled	dry	Lake Rotoiti, track to St Arnaud Range, Nelson, New Zealand	-41.8064	172.8427
JN114097	Cortinarius vitiosus	gilled	dry	Finland, IK02-025 (H); Finland, Kainuu, Puolanka, Paljakka	64.6776	27.9692
GU233357	Cortinarius vitreopileatus	gilled	dry	Takaka Hill Track, Nelson, New Zealand	-41.0312	172.8659
KF732478	Cortinarius volvatus	gilled	viscid	USA: MICH:87; USA, California, Del Norte, Crescent City	41.7620	-124.2187
AY174811	Cortinarius vulpinus	gilled	dry	Gerolstein-Gees, Germany	50.2197	6.6937
KJ421048	Cortinarius vulpinus	gilled	dry	TUB 019793; NA		
DQ328131	Cortinarius walpolensis	sequestrate	dry	Australia AF88 ; H6646; PERTH 06234623	-34.8667	116.7000
KF732479	Cortinarius wiebeae	sequestrate	dry	USA: MICH:8051; USA, Oregon, Clackamas, Camas Corral, Mt Hood	45.1397	-121.5589
KM085408	Cortinarius xanthocephalus	gilled	dry	Poland, ID PAN 734; NA		
UDB001833	Cortinarius xanthochlorus	gilled	dry	Sweden. Öland, Halltorp	56.5030	16.0956
GQ159771	Cortinarius xanthodryophilus	gilled	dry	F17181, Canada, BC, Elkington Property near Duncan	48.8080	-123.6315
UDB001806	Cortinarius xanthoochraceus	gilled	dry	Denmark. ØJ, Århus skovene, SO Blommehaven	56.1102	10.2318
UDB002062	Cortinarius xanthophyllus	gilled	dry	France, Oise		
KJ420986	Cortinarius xanthosuavis	gilled	dry	TUB 019746; NA		
JX000358	Cortinarius xenosma	gilled	dry	Clements Road, Te Iringa Track, Taupo, New Zealand	-38.9562	176.2445
JX178619	Cortinarius	gilled	dry	New Zealand, OTA:60162 NA		

GenBank Number	Taxon Name	Type of Fruiting Body	Pileus surface	Location	Latitude	Longitude
	xenosma					
KF727359	cramesinus	gilled	dry	St Arnaud Range, Buller, New Zealand	-41.8119	172.8605
TBD	CT 4214	gilled	dry	Paso Garibaldi, transecto LG2, Tierra del Fuego, Argentina	-54.7333	-67.8336
KY462290	CT 4215	gilled	dry	Paso Garibaldi, transecto LG2, Tierra del Fuego, Argentina	-54.7333	-67.8336
KY462292	CT 4221	gilled	dry	Valle Andorra, Tierra del Fuego, Argentina	-54.7524	-68.3249
TBD	CT 4223	gilled	dry	Valle Andorra, Tierra del Fuego, Argentina	-54.7524	-68.3249
KY462294	CT 4226	gilled	dry	Valle Andorra, Tierra del Fuego, Argentina	-54.7524	-68.3249
TBD	CT 4227	gilled	dry	Valle Andorra, Tierra del Fuego, Argentina	-54.7524	-68.3249
KY462296	CT 4229	sequestrate	dry	Valle Andorra, Tierra del Fuego, Argentina	-54.7524	-68.3249
KY462298	CT 4233	gilled	dry	Valle Andorra, Tierra del Fuego, Argentina	-54.7524	-68.3249
KY462300	CT 4239	sequestrate	dry	Valle Andorra, transecto LT2, Tierra del Fuego, Argentina	-54.7660	-68.3273
TBD	CT 4246	gilled	dry	Parque Karukinka, valle La Paciencia, Tierra del Fuego, Argentina	-54.3637	-68.8128
KY462305	CT 4248	gilled	dry	Parque Karukinka, valle La Paciencia, Tierra del Fuego, Argentina	-54.3637	-68.8128
KY462311	CT 4261	gilled	dry	Sierra Lucas Bridges, Tierra del Fuego, Argentina	-54.6749	-67.2634
KY462313	CT 4266	gilled	dry	Sierra Lucas Bridges, valle del Lago Lem, Tierra del Fuego, Argentina	-54.7250	-67.1786
KY462318	CT 4276	sequestrate	dry	Estancia Ushuaia, cerca de la entrada a Corazon de la Isla	-54.4689	-67.4456
KY462322	CT 4283	gilled	dry	Estancia Moat, Tierra del Fuego, Argentina	-54.9047	-67.0958
KY462323	CT 4285	gilled	dry	Estancia Moat, Tierra del Fuego, Argentina	-54.9047	-67.0958
TBD	CT 4286	gilled	dry	Estancia Moat, Tierra del Fuego, Argentina	-54.9047	-67.0958
KY462324	CT 4287	gilled	dry	Estancia Moat, Tierra del Fuego, Argentina	-54.9047	-67.0958
KY462325	CT 4288	gilled	dry	Estancia Moat, Tierra del Fuego, Argentina	-54.9047	-67.0958
KY462326	CT 4290	gilled	dry	Estancia Moat, Tierra del Fuego, Argentina	-54.9047	-67.0958
TBD	CT 4292	gilled	dry	Estancia Moat, Tierra del Fuego, Argentina	-54.9047	-67.0958
HQ533027	Dermocybe alienata	gilled	dry	Klondyke Corner, Mid Canterbury, New Zealand	-43.0020	171.5892
JX679151	Dermocybe canaria	gilled	dry	Australia: Tasmania Cradle Mt - Lake St Clair, National Park	-41.5955	145.9287
JX178609	Dermocybe cardinalis	gilled	dry	New Zealand, OTA:61428 NA		
GU233322	Dermocybe egmontiana	gilled	dry	Mt Egmont National Park, near Dawson Falls, Taranaki, New Zealand	-39.3082	174.1000
GU233326	Dermocybe icterinoides	gilled	dry	Uerwera National Park, Lake Waikareiti, Gisborne, New Zealand	-38.7007	177.1886
JN942280	Dermocybe kula	gilled	dry	MEL2320683	-37.4794	144.2914
JX178621	Dermocybe kula	gilled	dry	New Zealand, OTA:60156 NA		
KF727360	Dermocybe purpurata	gilled	dry	Arthurs Pass, Coral Track, North Canterbury, New Zealand	-42.9416	171.5613
JN942288	Dermocybe splendida	gilled	dry	MEL2300745	-37.5167	148.8169
GU233319	Dermocybe	gilled	dry	Waitakere Ranges, Piha Valley, Auckland, New Zealand	-36.9334	174.5561

GenBank Number	Taxon Name	Type of Fruiting Body	Pileus surface	Location	Latitude	Longitude
	splendida					
HQ020415	Gigasperma cryptica	sequestrate	dry	New Zealand, South Island, Canterbury, Craigieburn Forest	-43.1519	171.7086
MF599233	MCA 1838	gilled	dry	Guyana	5.3012	-59.9111
MF599234	MCA 1925	gilled	dry	Guyana	5.2744	-59.9122
MF599237	MCA 2356	gilled	dry	Guyana	5.3012	-59.9111
MF599238	MCA 2412	gilled	dry	Guyana	5.3011	-59.9068
MF599239	MCA 2473	gilled	dry	Guyana	5.3026	-59.8771
MF599240	MCA 3899	gilled	dry	Guyana	5.3046	-59.8930
MF599242	MCA 3951	gilled	dry	Guyana	5.2744	-59.9122
MF599244	MCA 3963	gilled	dry	Guyana	5.3012	-59.9111
MF599245	MCA 3969	gilled	dry	Guyana	5.2744	-59.9122
MF599246	MCA 3973	gilled	dry	Guyana	5.2744	-59.9122
MF599248	MCA 4855	gilled	dry	Guyana	5.3089	-59.9038
MF599249	MCA 4857	gilled	dry	Guyana	5.3089	-59.9038
MF599250	MCA 5721	gilled	dry	Guyana	5.3012	-59.9111
N/A	MES 1060	gilled	N/A	Argentina, (site 3) Puyehue National Park, below Antillanca on the edge of the road,	-40.8740	-72.1765
N/A	MES 1098	gilled	dry	Argentina, (site 2, day 1) Nahuel Huapi National Park, Los Rapidos, Bariloche, Argentina	-41.0965	-71.4551
N/A	MES 1112	sequestrate	dry	Argentina, (site 2, day 1) Nahuel Huapi National Park, Los Rapidos, Bariloche, Argentina	-41.0965	-71.4551
N/A	MES 1138	gilled	dry	Argentina, (day 2, stop 2) Nahuel Huapi National Park, Bariloche, Argentina - along road halfway to Tronador	-41.1126	-71.4162
N/A	MES 1205	gilled	dry	Argentina, (day 4) Nahuel Huapi National Park, Los Rapidos	-41.0965	-71.4551
KY462446	MES 1247	gilled	dry	Argentina, (day 5) Nahuel Huapi National Park, Ultima Esperanza/Lago Espejo Trail, near Villa La Angostura	-40.7218	-71.6931
N/A	MES 1250	gilled	dry	Argentina, (day 5) side of the road south of Villa La Angostura outside Muelle de Piedra	-40.8239	-71.5741
N/A	MES 1257	gilled	dry	Argentina, (day 6) side of the road (lunch spot) near Lago Escondido, Nahuel Huapi National Park	-41.0943	-71.4510
N/A	MES 1276	gilled	dry	Argentina, (day 7) lago Queni area, Lanin National Park	-40.1524	-71.7177
KY462455	MES 1285	gilled	dry	Argentina, (day 7) just outside Hua Hum, Lanin National Park	-40.1111	-71.6664
N/A	MES 135	sequestrate	dry	west of Punta Arenas Chile (at a private site called Casa Escondida, between the airport and the town in a small patch of woods)	-53.0522	-70.8841
N/A	MES 145	sequestrate	dry	Chile, Las Minas, Picnic Area, Reserva Nationale Magallanes	-53.1455	-71.0040
N/A	MES 1497	gilled	dry	Chile, Puyehue National Park, directly below Antillanca ski area nearby the park guard house	-40.7751	-72.2089
KY462470	MES 1498	gilled	dry	Chile, Puyehue National Park, directly below Antillanca ski area nearby the park guard house	-40.7751	-72.2089
KY462473	MES 1527	gilled	dry	Chile, Puyehue National Park, below Antillanca on the edge of the	-40.7811	-72.2118

GenBank Number	Taxon Name	Type of Fruiting Body	Pileus surface	Location	Latitude	Longitude
				road, near the stop with the big flat wash area		
KY462476	MES 1536	gilled	dry	Chile, Puyehue National Park, Sendero Chile area below Antillanca	-40.6611	-72.1775
N/A	MES 1537	gilled	dry	Chile, Puyehue National Park, Sendero Chile area below Antillanca	-40.6611	-72.1775
KY462477	MES 1539	gilled	dry	Chile, Puyehue National Park, Sendero Chile area below Antillanca	-40.6611	-72.1775
KY462479	MES 1550	gilled	dry	Chile, Puyehue National Park, Sendero Chile area below Antillanca	-40.6611	-72.1775
KY462480	MES 1553	gilled	dry	Chile, Puyehue National Park, Unplanned last stop near aguas calientes inside the national park	-40.7339	-72.3098
KY462481	MES 1554	gilled	dry	Chile, Puyehue National Park, Sendero Chile area below Antillanca	-40.6611	-72.1775
KY462483	MES 157	sequestrate	N/A	Chile, Las Minas, Summit Area, Reserva Nationale Magallanes	-53.1455	-71.0040
N/A	MES 1572	N/A	N/A	Chile		
N/A	MES 1574	gilled	dry	Chile, Puyehue National Park, Sendero Chile area below Antillanca	-40.6611	-72.1775
N/A	MES 1593	sequestrate	dry	Chile, Puyehue National Park, foothills of Volcan Puyehue, up the road past El Caulle north of Rio Golgol	-40.6583	-72.2098
KY462490	MES 1600	gilled	dry	Chile, Puyehue National Park, foothills of Volcan Puyehue, up the road past El Caulle north of Rio Golgol	-40.6583	-72.2098
KY462491	MES 1601	gilled	dry	Chile, Puyehue National Park, foothills of Volcan Puyehue, up the road past El Caulle north of Rio Golgol	-40.6583	-72.2098
KY462492	MES 1602	gilled	dry	Chile, Puyehue National Park, foothills of Volcan Puyehue, up the road past El Caulle north of Rio Golgol	-40.6583	-72.2098
KY462493	MES 1603	gilled	dry	Chile, Puyehue National Park, foothills of Volcan Puyehue, up the road past El Caulle north of Rio Golgol	-40.6583	-72.2098
KY462494	MES 1604	gilled	dry	Chile, Puyehue National Park, foothills of Volcan Puyehue, up the road past El Caulle north of Rio Golgol	-40.6583	-72.2098
KY462495	MES 1605	gilled	dry	Chile, Puyehue National Park, foothills of Volcan Puyehue, up the road past El Caulle north of Rio Golgol	-40.6583	-72.2098
N/A	MES 1609	gilled	dry	Chile, Puyehue National Park, foothills of Volcan Puyehue, up the road past El Caulle north of Rio Golgol	-40.6583	-72.2098
KY462499	MES 1611	gilled	dry	Chile, Puyehue National Park, foothills of Volcan Puyehue, up the road past El Caulle north of Rio Golgol	-40.6583	-72.2098
KY462503	MES 1618	sequestrate	dry	Chile, Puyehue National Park, foothills of Volcan Puyehue, up the road past El Caulle north of Rio Golgol	-40.6583	-72.2098
N/A	MES 1634	gilled	dry	Chile, Puyehue National Park, foothills of Volcan Puyehue, up the road past El Caulle north of Rio Golgol	-40.6583	-72.2098
N/A	MES 1636	gilled	dry	Chile, Puyehue National Park, foothills of Volcan Puyehue, up the road past El Caulle north of Rio Golgol	-40.6583	-72.2098
KY462511	MES 1644	gilled	dry	Chile, Puyehue National Park, foothills of Volcan Puyehue, up the road past El Caulle north of Rio Golgol	-40.6583	-72.2098
N/A	MES 1680	gilled	dry	Chile, Puyehue National Park, Anticura, Sendero La Princesa	-40.6637	-72.1752
N/A	MES 1681	gilled	dry	Chile, Puyehue National Park, Anticura, Sendero Pudu	-40.6713	-72.1687

GenBank Number	Taxon Name	Type of Fruiting Body	Pileus surface	Location	Latitude	Longitude
N/A	MES 1722	sequestrate	dry	Chile, Puyehue National Park, second stop from crater area	-40.7754	-72.2072
KY462535	MES 1733	gilled	dry	Chile, Puyehue National Park, Antillanca ski area	-40.7769	-72.2028
KY462537	MES 1737	gilled	dry	Chile, Puyehue National Park, Antillanca ski area	-40.7769	-72.2028
KY462538	MES 1738	gilled	dry	Chile, Puyehue National Park, Antillanca ski area	-40.7769	-72.2028
KY462539	MES 1740	gilled	dry	Chile, Puyehue National Park, Antillanca ski area	-40.7769	-72.2028
N/A	MES 1741	gilled	dry	Chile, Puyehue National Park, Antillanca ski area	-40.7769	-72.2028
KY462540	MES 1742	gilled	dry	Chile, Puyehue National Park, Antillanca ski area	-40.7769	-72.2028
KY462541	MES 1743	gilled	dry	Chile, Puyehue National Park, Antillanca ski area	-40.7769	-72.2028
KY462545	MES 1751	gilled	dry	Chile, Puyehue National Park, Antillanca ski area	-40.7769	-72.2028
KY462546	MES 1752	gilled	dry	Chile, Puyehue National Park, Antillanca ski area	-40.7769	-72.2028
KY462547	MES 1753	gilled	dry	Chile, Puyehue National Park, Antillanca ski area	-40.7769	-72.2028
N/A	MES 1754	gilled	dry	Chile, Puyehue National Park, Antillanca ski area	-40.7769	-72.2028
KY462548	MES 1756	gilled	dry	Chile, Puyehue National Park, Antillanca ski area	-40.7769	-72.2028
N/A	MES 1757	gilled	dry	Chile, Puyehue National Park, Antillanca ski area	-40.7769	-72.2028
KY462549	MES 1758	gilled	dry	Chile, Puyehue National Park, Antillanca ski area	-40.7769	-72.2028
KY462550	MES 1759	gilled	dry	Chile, Puyehue National Park, Antillanca ski area	-40.7769	-72.2028
KY462563	MES 1790	gilled	dry	Chile, Puyehue National Park, foothills of Volcan Puyehue, up the road past El Caulle north of Rio Golgol	-40.6583	-72.2098
KY462564	MES 1793	gilled	dry	Chile, Puyehue National Park, foothills of Volcan Puyehue, up the road past El Caulle north of Rio Golgol	-40.6583	-72.2098
KY462566	MES 1797	gilled	dry	Chile, Puyehue National Park, foothills of Volcan Puyehue, up the road past El Caulle north of Rio Golgol	-40.6583	-72.2098
KY462567	MES 1801	gilled	dry	Chile, Puyehue National Park, foothills of Volcan Puyehue, up the road past El Caulle north of Rio Golgol	-40.6583	-72.2098
KY462568	MES 1803	gilled	dry	Chile, Puyehue National Park, foothills of Volcan Puyehue, up the road past El Caulle north of Rio Golgol	-40.6583	-72.2098
KY462570	MES 1810	gilled	dry	Chile, Puyehue National Park, foothills of Volcan Puyehue, up the road past El Caulle north of Rio Golgol	-40.6583	-72.2098
KY462573	MES 1817	gilled	dry	Chile, Puyehue National Park, foothills of Volcan Puyehue, up the road past El Caulle north of Rio Golgol	-40.6583	-72.2098
KY462578	MES 1830	gilled	dry	Chile, Puyehue National Park, foothills of Volcan Puyehue, up the road past El Caulle north of Rio Golgol	-40.6583	-72.2098
KY462579	MES 1832	gilled	dry	Chile, Puyehue National Park, Unplanned last stop near aguas calientes inside the national park	-40.7339	-72.3098
KY462580	MES 1833	gilled	dry	Chile, Puyehue National Park, Sendero Chile area below Antillanca	-40.6611	-72.1775
KY462582	MES 1835	gilled	dry	Chile, Puyehue National Park, Unplanned last stop near aguas calientes inside the national park	-40.7339	-72.3098
KY462583	MES 1836	gilled	dry	Chile, Puyehue National Park, Unplanned last stop near aguas calientes inside the national park	-40.7339	-72.3098
KY462589	MES 1846	gilled	dry	Chile, Puyehue National Park, Unplanned last stop near aguas calientes inside the national park	-40.7339	-72.3098

GenBank Number	Taxon Name	Type of Fruiting Body	Pileus surface	Location	Latitude	Longitude
KY462594	MES 1855	gilled	dry	Argentina, Nahuel Huapi National Park, Arroyo Goye near colonia suiza, Argentina	-41.0959	-71.5079
KY462596	MES 1857	gilled	dry	Argentina, Nahuel Huapi National Park, Arroyo Goye near colonia suiza, Argentina	-41.0959	-71.5079
KY462597	MES 1858	gilled	dry	Argentina, Nahuel Huapi National Park, Arroyo Goye near colonia suiza, Argentina	-41.0959	-71.5079
KY462598	MES 1859	gilled	dry	Argentina, Nahuel Huapi National Park, Arroyo Goye near colonia suiza, Argentina	-41.0959	-71.5079
KY462599	MES 1860	gilled	dry	Argentina, Nahuel Huapi National Park, Los Rapidos, Argentina	-41.0965	-71.4551
KY462600	MES 1864	gilled	dry	Argentina, Nahuel Huapi National Park, Arroyo Goye near colonia suiza, Argentina	-41.0959	-71.5079
KY462604	MES 1877	gilled	dry	Argentina, Nahuel Huapi National Park, Arroyo Goye near colonia suiza, Argentina	-41.0959	-71.5079
KY462607	MES 1887	gilled	dry	Argentina, Nahuel Huapi National Park, Arroyo Goye near colonia suiza, Argentina	-41.0959	-71.5079
KY462620	MES 1925	gilled	dry	Argentina, Nahuel Huapi National Park, Los Rapidos,	-41.0965	-71.4551
N/A	MES 1926	gilled	dry	Argentina, Nahuel Huapi National Park, Los Rapidos,	-41.0965	-71.4551
KY462621	MES 1928	gilled	dry	Argentina, Nahuel Huapi National Park, Los Rapidos,	-41.0965	-71.4551
N/A	MES 1946	gilled	dry	Argentina, Nahuel Huapi National Park, Los Rapidos,	-41.0965	-71.4551
KY462623	MES 1948	gilled	dry	Argentina, Nahuel Huapi National Park, Los Rapidos,	-41.0965	-71.4551
N/A	MES 1952	gilled	dry	Argentina, Nahuel Huapi National Park, Los Rapidos,	-41.0965	-71.4551
N/A	MES 1955	gilled	dry	Argentina, Nahuel Huapi National Park, Los Rapidos,	-41.0965	-71.4551
N/A	MES 1957	gilled	dry	Argentina, Nahuel Huapi National Park, Los Rapidos,	-41.0965	-71.4551
KY462632	MES 1991	gilled	dry	Argentina, Nahuel Huapi National Park, Road to Tronador, just before the mountain base	-41.0772	-71.8417
N/A	MES 1992	gilled	dry	Argentina, Nahuel Huapi National Park, Road to Tronador, just before the mountain base	-41.0772	-71.8417
KY462633	MES 1993	gilled	dry	Argentina, Nahuel Huapi National Park, Road to Tronador, just before the mountain base	-41.0772	-71.8417
KY462634	MES 1994	gilled	dry	Argentina, Nahuel Huapi National Park, Road to Tronador, just before the mountain base	-41.0772	-71.8417
KY462637	MES 2004	gilled	dry	Argentina, Nahuel Huapi National Park, Road to Tronador, just before the mountain base	-41.0772	-71.8417
N/A	MES 2007	gilled	dry	Argentina, Nahuel Huapi National Park, Road to Tronador, just before the mountain base	-41.0772	-71.8417
N/A	MES 2008	gilled	dry	Argentina, Nahuel Huapi National Park, Road to Tronador, just before the mountain base	-41.0772	-71.8417
N/A	MES 2018	gilled	dry	Argentina, Nahuel Huapi National Park, Road to Tronador, just before the mountain base	-41.0772	-71.8417
KY462639	MES 2019	gilled	dry	Argentina, Nahuel Huapi National Park, Road to Tronador, just before the mountain base	-41.0772	-71.8417
N/A	MES 2020	gilled	dry	Argentina, Nahuel Huapi National Park, Road to Tronador, just before the mountain base	-41.0772	-71.8417
KY462640	MES 2022	gilled	dry	Argentina, Nahuel Huapi National Park, Road to Tronador, just	-41.0772	-71.8417

GenBank Number	Taxon Name	Type of Fruiting Body	Pileus surface	Location	Latitude	Longitude
				before the mountain base		
KY462644	MES 2028	gilled	dry	Argentina, Nahuel Huapi National Park, Road to Tronador, after Pampa Linda, after N. antarctica forest, at the base of the hill	-41.2219	-71.7952
KY462645	MES 2031	gilled	dry	Argentina, Nahuel Huapi National Park, Road to Tronador, after Pampa Linda, after N. antarctica forest, at the base of the hill	-41.2219	-71.7952
N/A	MES 2032	gilled	dry	Argentina, Nahuel Huapi National Park, Road to Tronador, after Pampa Linda, after N. antarctica forest, at the base of the hill	-41.2219	-71.7952
KY462646	MES 2041	gilled	dry	Argentina, Nahuel Huapi National Park, Road to Tronador, creek by hotel Tronador restaurant	-41.2699	-71.6495
KY462647	MES 2042	gilled	dry	Argentina, Nahuel Huapi National Park, Road to Tronador, creek by hotel Tronador restaurant	-41.2699	-71.6495
N/A	MES 2044	gilled	dry	Argentina, Nahuel Huapi National Park, Road to Tronador, creek by hotel Tronador restaurant	-41.2699	-71.6495
KY462648	MES 2047	gilled	dry	Argentina, Nahuel Huapi National Park, Road to Tronador, before Pampa Linda by the river, lunch spot	-41.2318	-71.7720
N/A	MES 2050	gilled	dry	Argentina, Nahuel Huapi National Park, Arroyo Goye near colonia suiza, Argentina	-41.0959	-71.5079
N/A	MES 2060	sequestrate	dry	Argentina, Nahuel Huapi National Park, Los Rapidos, Argentina	-41.0965	-71.4551
KY462651	MES 2068	gilled	dry	Argentina, Nahuel Huapi National Park, Los Rapidos, Argentina	-41.0965	-71.4551
KY462652	MES 2074	gilled	dry	Argentina, Nahuel Huapi National Park, Los Rapidos,	-41.0965	-71.4551
N/A	MES 2076	gilled	dry	Argentina, Nahuel Huapi National Park, Lago Hess	-41.3580	-71.7458
N/A	MES 2086	sequestrate	dry	Argentina, Nahuel Huapi National Park, 1 km after Lago Hess	-41.3732	-71.7449
N/A	MES 2096	gilled	dry	Argentina, Nahuel Huapi National Park, Lago Hess	-41.3580	-71.7458
KY462664	MES 2120	gilled	dry	Argentina, Nahuel Huapi National Park, Lago Hess	-41.3580	-71.7458
KY462679	MES 525	gilled	dry	Chile, Aves del Sotobosque, Melimoyu Patagonia Sur Reserve, Chile	-44.6293	-72.9427
KY462498	MES 527	sequestrate	dry	Chile, Aves del Sotobosque, Melimoyu Patagonia Sur Reserve	-44.6293	-72.9427
N/A	MES 563	sequestrate	dry	Chile, Palena Province, Valle California Patagonia Sur Reserve	-44.6293	-72.9427
N/A	MES 955	gilled	dry	Chile, site 1: just before entrance to Parque Nacional Alerce Costero	-40.2027	-73.4179
N/A	MES 973	gilled	dry	Chile, site 1: just before entrance to Parque Nacional Alerce Costero	-40.2027	-73.4179
KY462698	MES 976	gilled	dry	Chile, site 1: just before entrance to Parque Nacional Alerce Costero	-40.2027	-73.4179
KY462699	MES 977	gilled	dry	Chile, site 1: just before entrance to Parque Nacional Alerce Costero	-40.2027	-73.4179
KY462703	MES 988	gilled	dry	Chile, site 2: Inside Parque Nacional Alerce Costero	-40.1943	-73.4347
EU084983	Protoglossum luteum	sequestrate	dry	Massee 270; NA		
MF599254	TH 9893	gilled	dry	Cameroon. East Province. Dja Biosphere Reserve, Northwest Sector near Somalomo village, Upper Dja River Basin, within 2 km	3.3923	12.7254
MF599256	TH 9959	gilled	dry	Cameroon. East Province. Dja Biosphere Reserve, Northwest Sector near Somalomo village, Upper Dja River Basin, within 2 km	3.3923	12.7254

GenBank Number	Taxon Name	Type of Fruiting Body	Pileus surface	Location	Latitude	Longitude
TBA	TRTC163481	gilled	dry	Gunung Mulu National Park, Borneo	4.0584	114.9014
TBA	TRTC163521	gilled	dry	Gunung Mulu National Park, Borneo	4.0584	114.9014
TBA	TRTC163528	gilled	dry	Gunung Mulu National Park, Borneo	4.0584	114.9014
N/A	TRTC168244	gilled	dry	Sarawak, Borneo	4.1981	114.0436
N/A	TRTC168289	gilled	dry	Sarawak, Borneo	4.1981	114.0436
N/A	TRTC168344	gilled	dry	Sarawak, Borneo	4.1981	114.0436
N/A	TRTC168355	gilled	dry	Sarawak, Borneo	4.1981	114.0436
N/A	TRTC168398	gilled	dry	Sarawak, Borneo	4.1981	114.0436
N/A	TRTC168400	gilled	dry	Sarawak, Borneo	4.1981	114.0436
N/A	TRTC168412	gilled	dry	Sarawak, Borneo	4.1981	114.0436
N/A	TRTC168424	gilled	dry	Sarawak, Borneo	4.1981	114.0436
N/A	TRTC168427	gilled	dry	Sarawak, Borneo	4.1981	114.0436
N/A	TRTC168440	gilled	dry	Sarawak, Borneo	4.1981	114.0436
N/A	TRTC168444	gilled	dry	Sarawak, Borneo	4.1981	114.0436
N/A	TRTC168555	gilled	N/A	Sarawak, Borneo	4.1981	114.0436
N/A	TRTC168582	gilled	N/A	Sarawak, Borneo	4.1981	114.0436

CONCLUSIONS

This dissertation provides important contributions to the processes of evolution and diversification of ectomycorrhizal fungi, using the genus *Cortinarius* as a model. I uncover hidden diversity in *Cortinarius* sect. *Cortinarius* and describe five new species: *Cortinarius carneipallus*, *C. altissimus*, *C. neotropicus*, *C. palatinus* and *C. atrotomentosus*. I demonstrate how the origin of this clade originated in Australasia, then arrived and speciated in the Americas via long-distance dispersal. I challenge the 'Secotioid Hypothesis' and find that precipitation is not correlated with the presence of sequestrate fungi, but temperature does affect their current distribution, especially the magnitude of changes in daily temperatures. I speculate on additional factors that may influence the evolution of sequestrate fungi, such as fungivory. By integrating phylogenetics and biogeography with climate data and morphological data, we can better understand the processes of diversification in ectomycorrhizal fungi.

VITA

Emma Harrower was born in Vancouver, British Columbia, Canada. She attended Carnarvon Community School and continued to Prince of Wales Secondary School. After graduation, she was awarded with a scholarship from the Vancouver Natural History Society. After attending some hikes, she realized that she really did enjoy identifying native plants. While attending the University of British Columbia, Emma was introduced to the fields of phylogenetics and systematics. It is here where she became interested in ectomycorrhizal fungi diversity. She obtained a Bachelor of Science in Biology, specializing in Plant Biology in 2008. She went on to study at the University of Toronto where she worked on a method to automatically classify fungi using a DNA barcode. She received her Master of Science in Ecology and Evolutionary Biology in 2010. Emma graduated with a Doctor of Philosophy in Ecology and Evolutionary Biology at the University of Tennessee, Knoxville in 2017.