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RESEARCH ARTICLE

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The largest type study of *Agaricales* species to date: bringing identification and nomenclature of *Phlegmacium* (*Cortinarius*) into the DNA era

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Key words

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Abstract *Cortinarius* is a species-rich and morphologically challenging genus with a cosmopolitan distribution. Many names have not been used consistently and in some instances the same species has been described two or more times under separate names. This study focuses on subg. *Phlegmacium* as traditionally defined and includes species from boreal and temperate areas of the northern hemisphere. Our goals for this project were to: i) study type material to determine which species already have been described; ii) stabilize the use of Friesian and other older names by choosing a neo- or epitype; iii) describe new species that were discovered during the process of studying specimens; and iv) establish an accurate ITS barcoding database for *Phlegmacium* species. A total of 236 types representing 154 species were studied. Of these 114 species are described only once whereas 40 species had one ore more synonyms. Of the names studied only 61 were currently represented in GenBank. Neotypes are proposed for 21 species, and epitypes are designated for three species. In addition, 20 new species are described and six new combinations made. As a consequence ITS barcodes for 175 *Cortinarius* species are released.

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INTRODUCTION

Studies using DNA sequence data have shown that the diversity of fungi far exceeds earlier expectations with many common species of macrofungi still to be described and named (Schmit & Mueller 2007). In addition, it is not always easy to determine which species have been described and which are new to science, unless the type specimens of existing names can be carefully studied, including DNA sequencing.

For many species of macrofungi the names have been difficult or even impossible to interpret. The most difficult ones are the older names with brief descriptions and usually without type material. But even if type material exists it can be very difficult to be certain of the identification based only on morphology, especially in challenging genera like *Cortinarius* where there is considerable convergence in morphology, colouration, and microscopic features. Furthermore, the literature is often difficult to obtain, making it hard to get information on available names and their application by earlier taxonomists. Consequently, many names have not been used consistently and in some cases the same species has been described two or more times under separate names. In instances where there is no type material available, a neotype (or a lectotype if collections of the author are available) is required to stabilize the use of the name. Finally, old type collections that are considered historical materials may not be available for study or DNA sequencing requiring the selection of an epitype.

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The development of molecular techniques has provided a more unambiguous tool to identify species. Currently the most commonly used locus in species level taxonomy is the nuclear ribosomal internal transcribed spacer (ITS), which has been proposed as a universal barcode marker for fungi (Schoch et al. 2012). The region is present in several chromosomes and is arranged in tandem repeats that are thousands of copies long (Burnett 2003). Due to the high copy number the region usually is easy to amplify and sequence, even from very old specimens (Larsson & Jacobsson 2004). In *Cortinarius* the ITS was proposed as a species-identifier sequence already in 2007 by Frøslev et al. and in 2008 by Ortega et al. It has also been shown that in the majority of the cases ITS is suitable for species delimitation in *Cortinarius*. The results of the multi-gene phylogenetic study based on ITS, *rpb1*, and *rpb2* regions by Frøslev et al. (2005) showed that inference from ITS alone is indicative of the species level phylogenetic delimitations of multi-gene analyses. Furthermore, the delimitations inferred from ITS usually correlate with the morphospecies (Frøslev et al. 2007, Ortega et al. 2008, Niskanen et al. 2012b).

Cortinarius is the largest genus of *Agaricales* with a cosmopolitan distribution and over 2 000 described species (Kirk et al. 2008). *Cortinarius* species are important ectomycorrhizal fungi associated with different trees and shrubs, belonging to the order *Fagales*, families *Caesalpiniaceae*, *Cistaceae*, *Dipterocarpaceae*, *Myrtaceae*, *Pinaceae*, *Rhamnaceae*, *Rosaceae* and *Salicaceae* as well as a few herbaceous plants in the *Cyperaceae*. Owing to their often narrow ecological preferences and sensitivity to environmental change, many *Cortinarius* species have been used as indicator species for valuable natural environments, e.g. in Sweden and Denmark (Vesterholt 1991, Hallingbäck & Aronsson 1998, Frøslev & Jeppesen 2011). Lately it also was suggested that they have a key role in the carbon cycling of boreal forests (Bödeker et al. 2011).

Many of the major studies in *Cortinarius* have dealt with North American and especially European species, while the species of southern hemisphere are somewhat less studied (Moser & Horak 1975, Garnica et al. 2002, Cleland 1976 (1935), Gasparini & Soop 2008). In Europe the most extensive studies have been done by Fries (e.g., 1821, 1836–1838, 1851) from Sweden, Henry (e.g., 1951, 1958, 1981, 1986) and Bidaud et al. (e.g., 1992, 2010) from France, Moser (e.g. 1960, 1969–1970, 1983) from Central Europe, Høiland (1984), Brandrud (e.g., 1996, 1998), Brandrud et al. (e.g., 1990, 2012) and Niskanen et al. (e.g., 2009, 2011a, 2013a) mainly from northern Europe, Frøslev et al. (e.g., 2006, 2007) from northern and Central Europe, Orton (1955, 1958) from Great Britain, and Ortega et al. (2008) and Suárez-Santiago et al. (2009) from mediterranean area. Selected papers of some of the major contributors to *Cortinarius* systematics in North America include Peck (1873; also see Gilbertson 1962), Kauffman (1918, 1923, 1932), Smith (1939, 1942, 1944), Ammirati (1972), Ammirati et al. (2013), Garnica et al. (2009), Liu et al. (1997), Moser & Ammirati (1996, 1999), Moser et al. (1995), Bojantchev (2011a, b) and Niskanen et al. (2013b, c).

Very little is known about the distribution of *Cortinarius* species on a larger scale or the differences in the species composition between the continents, although species in the southern hemisphere are distinct from those in the northern hemisphere (Peintner et al. 2004, Garnica et al. 2005). However, recent molecular studies on *Cortinarius* have shed some light on these questions for North America and Europe (Moser & Peintner 2002, Matheny & Ammirati 2006, Garnica et al. 2009, 2011, Harrower et al. 2011, Ammirati et al. 2013, Niskanen et al. 2011b, 2012c, 2013b, c). These studies show several patterns of species distributions. There are species common to North America and Europe, especially those species from more northern and montane conifer forests, i.e. *Cortinarius aureofulvus* M.M. Moser s.auct., *C. napus* Fr. and *C. pinophilus* Soop, but also endemic species occur both in western North America, eastern North America and Europe, i.e. *C. elegantio-occidentalis* Garnica & Ammirati in western North America, *C. hesleri* Ammirati, Niskanen, Liimat. & Matheny in eastern North America and *C. puniceus* P.D. Orton in Europe. *Cortinarius* species composition is somewhat similar between eastern North America and Europe, but there appears to be less similarity between Europe and western North America.

Different infrageneric classification systems have been proposed for *Cortinarius*, i.e. Brandrud et al. (1990) divided the genus in four subgenera: *Cortinarius*, *Myxacium*, *Phlegmacium* and *Telamonia*. Recent molecular analyses have shown that *Cortinarius* is monophyletic, but also that many of the infrageneric groups such as subg. *Phlegmacium* are not monophyletic (Peintner et al. 2004, Garnica et al. 2005). Nonetheless, several authors have treated subg. *Phlegmacium* in similar ways (Moser 1983, Bidaud et al. 1994, Brandrud et al. 2012) including in it species with viscid to glutinous pileus and dry, often bulbous stipe, or dry-capped, stout species with a yellow KOH reaction, i.e. the species of sect. *Phlegmacioides* (Niskanen et al. 2012a).

Molecular techniques have been in use for more than a decade, and the sequencing of ITS regions even from older *Cortinarius* specimens is possible. Furthermore, type studies are essential for a stable and consistent application of names in *Cortinarius* where currently a large percentage of the *Cortinarius* sequences are incorrectly named or without a name in the public sequence databases (e.g., Niskanen et al. 2011a). While several papers present sequences for individuals or groups of species, for example Garnica et al. (2009) and Niskanen et al. (2011a), the only large study is that of Frøslev et al. (2007) where 52 types of *Cortinarius* sect. *Calochroi* were sequenced. The present study focuses on *Cortinarius* subg. *Phlegmacium* as traditionally defined and includes species from boreal and temperate areas of the northern hemisphere. Our goals for this project are to: i) study type material to determine which taxa have already been described; ii) stabilize the use of Friesian and other older names by choosing a neo- or epitype; iii) describe new species that were discovered during the process of studying specimens; and iv) establish an accurate ITS barcoding database for *Phlegmacium* species.

MATERIALS AND METHODS

Taxon sampling

The type specimens of species of subg. *Phlegmacium* published over many years by J.F. Ammirati, A. Bidaud, T.E. Brandrud, G. Chevassut, J. Favre, R. Henry, P.A. Karsten, C.H. Kauffman, R. Kühner, K.H. McKnight, M.M. Moser, P. Moënne-Loccoz, P. Reumaux, A.H. Smith and H.D. Thiers were sampled as well as relevant collections published and illustrated in Brandrud et al. (1990, 1992, 1994, 1998). The species of sections *Calochroi*, *Fulvi* and *Riederi* described from Europe were generally excluded. The first two have been treated by Frøslev et al. (e.g., 2007) and the latter will be treated by Brandrud et al. in the near future. In some instances type material could not be acquired from herbaria, for example, the *Cortinarius* type collections of C.H. Peck were only recently available on loan from the New York State Museum and will be included in a later study.

Our aim was to have at least two sequences per species in our study. Therefore, in addition to sequences from type specimens, either our own unpublished sequences or additional sequences retrieved from the sequence databases GenBank and UNITE were included. Unpublished sequences were also supplied by D. Bojantchev, K. Hughes and A. Taylor. Information on the sequences of type specimens is available in Table 1 and information on other sequences included in the phylogenetic analysis is available in Table 2. Herbarium acronyms follow Index Herbariorum (Thiers 2013).

Molecular analyses

DNA was extracted from a few milligrams of dried material (a piece of lamella) with the NucleoSpin Plant kit (Macherey-Nagel, Düren, Germany), or with various CTAB protocols in Brandrud's and Frøslev's specimens (see Frøslev et al. 2005, 2007). Primers ITS 1F and ITS 4 (White et al. 1990, Gardes & Bruns 1993) were used to amplify ITS regions. The same primer pairs were used in direct sequencing. For problematic material the primer combinations ITS 1F/ITS 2 and ITS 3/ITS 4 were also used. PCR amplifications were performed in a 25 µL reaction mix with about 70 ng extracted DNA, 1 U Phusion High-Fidelity DNA polymerase and 1× HF buffer (Finnzymes), 200 mM of each dNTP and 0.5 µM of each primer. The PCR reactions were run on a MBS 0.2 G Thermal Cycler (Thermo Hybaid) with the following settings: denaturation for 30 s at 98 °C, followed by 35 cycles of denaturation for 10 s at 98 °C, annealing for 30 s at 50 °C and extension for 30 s at 72 °C. The PCR products were purified using an ExoSAP-IT purification kit (Amersham Biosciences). Sequencing was performed on both strands using a BigDye Terminator v. 1.1 Sequencing kit (Applied Biosystems). Reactions were performed in 10 µL with 1 µL of PCR product, 1.3 mM of primer (ITS 1F or ITS 4), 1 µL 5X sequencing buffer, and 1 µL of Terminator Ready Reaction Mix. Reactions were run for 1 min at 96 °C, followed by 30 cycles of 30 s at 96 °C, 15 s at 50 °C and 4 min at 60 °C. Unincorporated dye terminators and primers were removed by Sephadex G-50 DNA Grade Fine (Amersham Biosciences) purification system,

(text continues on p. 117)

Table 1 Type specimens studied. Sequences of the type materials of *C. caesiocinctus*, *C. cobaltinus*, *C. gracilior*, *C. mahiquesii*, *C. norrlandicus* and *C. van-campiae* retrieved from the GenBank or UNITE. Short ITS sequences excluded from the analysis marked with *.

Species	Voucher	Herb.	Locality	Ecology	Current name	Collection date	Collector	GenBank number
C. acidophilus Brandrud 1997 (holotype)	TEB61-79	O	Norway, Oppl, Lunner, Østäsen	In forest of *Picea abies*	*C. pseudonaevosus* Rob. Henry 1957	01.08.1979	T.E. Brandrud	KF732241
C. acystidiosus Thiers 1960 (holotype)*	1902	MICH	USA, Texas, San Jacinto Co., Sam Houston National Forest, Coldspring	In pine-hardwood forest	*C. acystidiosus* Thiers 1960	23.05.1953	H.D. Thiers	KF732242
C. aggregatus Kauffman 1918*	MICH10311	MICH	USA, Michigan, Jackson, Vandercook Park, Jackson	In low woods	*C. aggregatus* Kauffman 1918	09.09.1907	C.H. Kauffman	KF732243
C. albescens A.H. Sm. 1944 (holotype)	17522	MICH	USA, Washington, Olympic National Park, Olympic Hot Springs	Under conifers	*C. albescens* A.H. Sm. 1944	02.10.1941	A.H. Smith	KF732244
C. albofragrans Ammirati & M.M. Moser 1997 (holotype)	95/595	IB	USA, California, Del Norte Co., Highway 199, Danger Point	Under *Quercus*, also evergreen oaks (*Q. vaccinifolia*, *Q. chrysolepis*, *Lithocarpus densiflora*) with some *Pseudotsuga menziesii*	*C. albofragrans* Ammirati & M.M. Moser 1997	20.11.1996	M. Moser	KF732245
C. alnobetulae Kühner 1989 (syntype)	53-6	G	France	Under *Alnus viridis*	*C. alnobetulae* Kühner 1989	Unknown	Unknown	KF732246
C. alticaudus Reumaux 2008 (holotype)	PML1632	PC	France, Lozère, bois de la Sagne	In *Pinus* forest	*C. alticaudus* Reumaux 2008	30.10.1989	P. Reumaux	KF732247
C. amarocaerulescens Bidaud 2009 (holotype)	AB99-11-362	PC	France, Loire, Montbrison	In mixed forest	*C. infractus* (Pers.: Fr.) Fr. 1838	09.11.1999	A. Bidaud	KF732248
C. amnicola A.H. Sm. 1942 (holotype)	15381	MICH	USA, Michigan, Ann Arbor	Under butternut, walnut, and bassword on low ground along streams	*C. amnicola* A.H. Sm. 1942	15.09.1940	A.H. Smith	KF732249
C. anfractoides Rob. Henry & Trescol 1987 (holotype)*	RH1898	PC	France	In frondose forest under *Quercus ilex*	*C. anfractoides* Rob. Henry & Trescol 1987	11.1984	G. Chevassut & F. Trescol	KF732250
C. anfractoides var. *cinereoclarus* Bidaud 2009 (holotype)	AB08-09-155	PC	France, Ain, Cerin	In calcareous deciduous forest	*C. persoonianus* Bidaud 2009	07.09.2008	A. Bidaud	KF732251
C. arenicola A.H. Sm. 1942 (holotype)	15315	MICH	USA, Michigan, Waterloo, Waterloo Project	Under *Sassafras* in dry sandy open woods	*C. arenicola* A.H. Sm. 1942	12.09.1940	A.H. Smith	KF732252
C. areni-silvae (Brandrud) Brandrud 2012 (holotype)	CFP461b	S	Sweden, Ång, Graninge, Viksmon	In boreal coniferous forest with *Pinus* and *Picea* on sandy soil	*C. areni-silvae* (Brandrud) Brandrud 2012	25.08.1986	T.E. Brandrud et al.	KF732253
C. argutipes Bidaud & Reumaux 1996 (holotype)*	713	G	France, Creuse	Under *Fagus* on acid soil	*C. chromataphilus* Rob. Henry 1989	15.10.1987	D. Brion	KF732254
C. atrochalybaeus M.M. Moser & Ammirati 2000 (holotype)	95/630	IB	USA, California, Del Norte Co., Highway 199, Smith River Middle Fork, Danger Point	Under *Lithocarpus densiflora*, *Arbutus menziesii*, *Quercus vacciniifolius* and *Q. chrysolepis* on calcareous soil	*C. atrochalybaeus* M.M. Moser & Ammirati 2000	29.11.1995	J. Ammirati	KF732255
C. *aurantionapus* Bidaud & Reumaux 2006 (holotype)*	PML4893	PC	France, Drôme, Romeyer	Under *Picea* and *Pinus sylvestris* on calcareous soil	*C. talus* Fr. 1838	09.10.1992	J. Garin	KF732256
C. aurantionapus var. *similis* Moënne-Locc. 2006 (holotype)	PML883	PC	France, Haute-Savoie, Avernioz	Under *Picea* on calcareous soil	*C. talimultiformis* Kytöv., Liimat., Niskanen, A.F.S. Taylor & Sesli sp. nov.	06.06.1988	P. Moënne-Loccoz	KF732257
C. aurantiopallidus Bidaud 2006 (holotype)	AB05-11-404	PC	France, Ardèche, Lagorce	Under *Quercus ilex* on calcareous soil	*C. aurantiopallidus* Bidaud 2006	11.11.2005	A. Bidaud	KF732258
C. badiolatus (M.M. Moser) M.M. Moser 1967 (holotype)*	53/10	IB	Germany, Schwenningen	In coniferous forest	*C. badiolatus* (M.M. Moser) M.M. Moser 1967	28.08.1953	H. Haas	KF732259
C. balteatialutaceus Kytöv., Liimat. & Niskanen sp. nov. (holotype)	IK09-751	H	Sweden, Jmt, Frostviken, Jormlien, Säterklumpen	In *Betula* forest with solitary *Picea*	*C. balteatialutaceus* Kytöv., Liimat. & Niskanen sp. nov.	09.07.2009	P. & I. Kytövuori	KF732586
C. balteatibulbosus Kytöv., Niskanen, Liimat., Bojantchev & A.F.S. Taylor sp. nov. (holotype)	IK98-1624 (H6033539)	H	Finland, U, Espoo, Nuuksio, Pirttimäki	In half-open cut meadow	*C. balteatibulbosus* Kytöv., Niskanen, Liimat., Bojantchev & A.F.S. Taylor sp. nov.	04.09.1998	I. Kytövuori	KF732589
C. balteaticlavatus Kytöv., Liimat. & Niskanen sp. nov. (holotype)	IK96-595 (H6032412)	H	Finland, PH, Virrat, Hauhuu, Sikosaari, Salmela	On the grassy roadside with young *Picea*, *Betula*, *Populus tremula*, *Alnus incana* and *Salix* spp.	*C. balteaticlavatus* Kytöv., Liimat. & Niskanen sp. nov.	23.08.1996	I. Kytövuori	KF732596
C. balteatoalbus Rob. Henry 1985 (isotype)*	RH82.98	PC	France	In submontane *Picea* forest	*C. balteatoalbus* Rob. Henry 1985	Unknown	Unknown	KF732260
C. balteatotomentosus Rob. Henry ex Rob. Henry 1985 (holotype)	RH306	PC	France, Doubs, Boujaille	In montane forest (mostly) of *Picea abies*	*C. balteatus* (Fr.) Fr. 1838	Unknown	Unknown	KF732261
C. balteatus (Fr.) Fr. 1838 (neotype)	CFP940	S	Sweden, Ång, Säbrå, Överdal	Under *Picea* in cultivated area	*C. balteatus* (Fr.) Fr. 1838	03.08.1990	T.E. Brandrud et al.	KF732262
C. balteatus var. *praestantoides* Reumaux 1996 (holotype)	760	G	France, Ile-de-France, Forêt de Rambouillet, Etang d'Or	In shrubs in *Quercus* forest	*C. flavescentipes* Reumaux 1996	23.10.1982	P. Reumaux	KF732263
C. barrentium Poirier & Reumaux 1993 (holotype)*	2398	G	France, Loiret, Arboretum des Barres	Under conifers	*C. barrentium* Poirier & Reumaux 1993	13.11.1991	J. Poirier	KF732264

C. bigelowii Thiers & A.H. Sm. 1969 (holotype)	45385	MICH	USA, Idaho, Seven Devils Mts, Heaven's Gate Ridge	Under conifers	*C. bigelowii* Thiers & A.H. Sm. 1969	26.07.1954	H.E. Bigelow	KF732265
C. boreicyanites Kytöv., Liimat., Niskanen & A.F.S. Taylor sp. nov. (holotype)	CFP931	S	Sweden, Jmt, Ragunda, Böle	In birch forest on rich ground (*Betula*, *Picea*)	*C. boreicyanites* Kytöv., Liimat., Niskanen & A.F.S. Taylor sp. nov.	07.24.1990	T.E. Brandrud et al.	KF732296
C. boreidionysae Kytöv., Liimat., Niskanen & Dima sp. nov. (holotype)	IK97-1220	H	Finland, PeP, Tervola, Peura, Raemäki	In grass-herb-spruce forest with spring-fed depressions, on calcareous ground	*C. boreidionysae* Kytöv., Liimat., Niskanen & Dima sp. nov.	11.09.1997	I. Kytövuori	KF732488
C. borgsjoeensis Brandrud 1992 (isotype)	CFP728	S	Sweden, Jmt, Ragunda, Kullstabodarna	In herbaceous spruce forest	*C. borgsjoeensis* Brandrud 1992	31.08.1988	T.E. Brandrud et al.	KF732266
C. brunneiaurantius Kytöv., Liimat. & Niskanen sp. nov. (holotype)	JV17979 (H6032422)	H	Finland, V, Turku, Ruissalo, Kansanpuisto	*Tilia* alley, also *Quercus robur* nearby, on clayey-mull soil	*C. brunneiaurantius* Kytöv., Liimat. & Niskanen sp. nov.	22.09.2001	J. Vauras	KF732600
C. brunneolividus Bidaud 1996 (holotype)	3734	G	France, Isère, Optevoz	In calcareous deciduous forest of *Quercus* and *Carpinus*	*C. brunneolividus* Bidaud 1996	14.09.1993	C. Blanc	KF732268
C. brunneoviolaceus Bidaud 1996 (holotype)	2951	G	France, Isère, Arzay	Under *Castanea* on acid soil	*C. brunneolividus* Bidaud 1996	01.10.1992	A. Bidaud	KF732269
C. cacodes M.M. Moser & Ammirati 2000 (holotype)	91/618	IB	USA, California, Mendocino, Russian Gulch State Park	In mixed coniferous forest with *Tsuga*, *Pseudotsuga*, *Abies*	*C. cacodes* M.M. Moser & Ammirati 2000	30.11.1991	M. Moser	KF732270
C. caerulescens (Schaeff.) Fr. 1838 (epitype)	CFP853	S	Belgium, Brabant, Tervuren	In beech forest on calcareous ground	*C. caerulescens* (Schaeff.) Fr. 1838	23.09.1989	T.E. Brandrud et al.	KF732271
C. caesiocinctus Kühner 1989 (holotype)	57-13	G	France, Haute-Savoie, Le Môle	In mixed forest with *Fagus* and *Picea*	*C. caesiocinctus* Kühner 1989	30.08.1957	R. Kühner	DQ663239
C. caesiocolor Kytöv., Liimat. & Niskanen sp. nov. (holotype)	IK00-029	H	Finland, U, Lohja, Jalassaari, Tamminiemi, by a track	With *Betula*, *Populus tremula*, *Quercus*, *Corylus* and *Salix caprea*, on calcareous ground	*C. caesiocolor* Kytöv., Liimat. & Niskanen sp. nov.	27.08.2000	I. Kytövuori	KF732603
C. caesiophylloides Kytöv., Liimat., Niskanen, Brandrud & Frøslev sp. nov. (holotype)	TN05-016 (H6029792)	H	Finland, ES, Joutsa, Koivuranta	In fairly young, mesic to damp, *Picea abies*-dominated forest with some *Betula* and *Pinus sylvestris*	*C. caesiophylloides* Kytöv., Liimat., Niskanen, Brandrud & Frøslev sp. nov.	30.08.2005	K. Liimatainen & T. Niskanen	KF732572
C. calojanthinus M.M. Moser & Ammirati 1999 (holotype)	97/220	IB	USA, Wyoming, Teton National Forest, Calypso Creek, Flagstaff Road	In subalpine forest under *Picea engelmannii*, *Abies lasiocarpa*	*C. calojanthinus* M.M. Moser & Ammirati 1999	21.08.1997	M. Moser & J. Ammirati	KF732272
C. calyptratus A.H. Sm. 1939 (holotype)	8352	MICH	USA, California, Crescent City	Under mixed spruce and redwood, presumably also *Lithocarpus* and *Quercus*	*C. calyptratus* A.H. Sm. 1939	03.11.1937	A.H. Smith	KF732273
C. calyptrodermus A.H. Sm. 1942 (holotype)	15356	MICH	USA, Michigan, Sharron Hollow	In low woods of second growth oak and basswood (*Tilia*) and various shrubs	*C. calyptrodermus* A.H. Sm. 1942	14.09.1940	A.H. Smith	KF732274
C. castaneicolor A.H. Sm. 1944 (holotype)	17926	MICH	USA, Washington, Olympic National Park, Olympic Hot Springs	Under conifers	*C. castaneicolor* A.H. Sm. 1944	15.10.1941	A.H. Smith	KF732275
C. cephalixoides M.M. Moser & Thiers 1995 (holotype)	87/188	IB	USA, Wyoming, Teton National Forest, Flagstaff Road	In subalpin forest under *Picea engelmannii*	*C. cephalixoides* M.M. Moser & Thiers 1995	09.08.1987	H.D. Thiers	KF732276
C. cephalixolargus Rob. Henry 1977 (holotype)	6048	PC	France, Bois de Dampierre	In mixed frondose forest under *Fagus*, *Quercus*, *Carpinus* and *Betula*	*C. largus* Fr. 1838	Unknown	R. Henry	KF732277
C. chromataphilus Rob. Henry 1989 (holotype)	86.90	PC	France, Luxeuil	In mixed forest	*C. chromataphilus* Rob. Henry 1989	1986	Exposition	KF732278
C. cinctipes Bidaud, Eyssart. & Hermitte 2004 (holotype)	GE 02-100	PC	France, Var, Les Mayons	Under *Quercus suber* and *Erica arborea*	*C. pseudocephalixus* Bidaud & Moënne-Locc. 2000	01.11.2002	J.-C. Hermitte	KF732279
C. citrinifolius A.H. Sm. 1939 (holotype)	3158	MICH	USA, Washington, Olympic National Park, Boulder Creek	Under fir	*C. citrinifolius* A.H. Sm. 1939	15.10.1935	A.H. Smith	KF732280
C. citrinipedes A.H. Sm. 1942 (holotype)	15305	MICH	USA, Michigan, Ann Arbor	On humus in oak woods	*C. citrinipedes* A.H. Sm. 1942	11.09.1940	A.H. Smith	KF732281
C. citriolens Ammirati & M.M. Moser 1999 (holotype)	97/122	IB	USA, Wyoming, Teton National Forest Flagstaff Creek	In subalpine forest under *Picea engelmannii*, *Abies lasiocarpa*	*C. citriolens* Ammirati & M.M. Moser 1999	06.08.1997	M. Moser & J. Ammirati	KF732282
C. claricolor (Fr.) Fr. 1838 (neotype)	CFP691	S	Sweden, Ång, Stigsjö, Uland, Langmyrberget	In spruce forest with blueberry	*C. claricolor* (Fr.) Fr. 1838	09.08.1988	T.E. Brandrud et al.	KF732283
C. clarobaltoides var. *longispermus* Reumaux 1996 (holotype)	833	G	France, Ile-de-France	Under conifers	*C. clarobaltoides* var. *longispermus* Reumaux 1996	15.09.1987	M. Pelerin	KF732284
C. clarus Reumaux 1996 (holotype)	4038	G	France, Yonne, Forêt de Hervaux	In frondose forest	*C. largus* Fr. 1838	04.10.1994	Mlle Maité	KF732285
C. claviceps Reumaux 1996 (holotype)	2932	G	France, Ardennes, Forêt de Belval	Under *Quercus* and *Fagus* on clayey-calcaerous soil	*C. largus* Fr. 1838	19.09.1992	P. Reumaux & F. Reumaux	KF732286
C. cobaltinus Kytöv., Liimat. & Niskanen 2013 (holotype)	TN02-1012 (H6032404)	H	Finland, Ks, Kuusamo, Oulanka National Park	In herb-rich *Picea abies* forest with some *Pinus*, *Betula* and *Populus* on calcareous ground	*C. cobaltinus* Kytöv., Liimat. & Niskanen 2013	22.09.2002	T. Niskanen, I. Kytövuori & K. Liimatainen	KF673470
C. collocandoides Reumaux 2009 (holotype)	PML5087	PC	France, Yvelines, étang d'Or, Rambouillet	In mixed forest	*C. collocandoides* Reumaux 2009	27.10.1996	G. Redeuilh & P. Reumaux	KF732287
C. concrescens Secr. ex Bidaud, Moënne-Locc. & Reumaux 1996 (holotype)	3578	G	France, Haute-Savoie, Le Danay, St-Jean-de-Sixt	Under *Picea abies* and *Alnus viridis*	*C. balteatoalbus* Rob. Henry 1985	10.10.1993	M. Mugnier	KF732288

Table 1 (cont.).

Species	Voucher	Herb.	Locality	Ecology	Current name	Collection date	Collector	GenBank number
C. congeminus Moënne-Locc. & Reumaux 1995 (holotype)	3422	G	France, Ardennes, Forêt de Belval	In deciduous forest on clayey-calcareous soil	*C. largus* Fr. 1838	03.10.1992	P. Reumaux & F. Reumaux	KF732289
C. corrugis A.H. Sm. 1944 (holotype)	16842	MICH	USA, Washington, Baker National Forest, Anderson Lookout, Ermine Creek Trail	Under conifers	*C. turmalis* Fr. 1838	11.09.1941	A.H. Smith	KF732290
C. crassus Fr. 1838 (neotype)	CFP938	S	Sweden, Ång, Säbrä, Hårsta	In wet mixed forest with *Sphagnum* and *Pinus*, *Picea*, *Betula*	C. *crassus* Fr. 1838	28.07.1990	T.E. Brandrud et al.	KF732291
C. cremeiamarescens Kytöv., Liimat. & Niskanen sp. nov. (holotype)	IK11-014	H	Sweden, Gtl, Alskog and När parish	Mesic to damp spruce forest with some *Pinus*, *Quercus* and *Corylus*	*C. cremeiamarescens* Kytöv., Liimat. & Niskanen sp. nov.	27.09.2011	I. Kytövuori	KF732493
C. crenulatus Rob. Henry ex Bidaud & Reumaux 2006 (holotype)	PML4866	PC	France, Allier, Forêt de Tronçais	In deciduous forest	*C. talus* Fr. 1838	17.10.1992	F. Lopez	KF732292
C. cruentipellis Kytöv., Liimat., Niskanen & Dima sp. nov. (holotype)	TN03-1451	H	Sweden, Öl, Långlöt, Åstad, Nitares hägn	Grassy pasture with *Corylus* and *Juniperus*	*C. cruentipellis* Kytöv., Liimat., Niskanen & Dima sp. nov.	13.09.2003	I. Kytövuori, K. Liimatainen & T. Niskanen	KF732539
C. cumatilis Fr. 1838 (neotype)	IK98-2164	H	Sweden, Nrk, Hidinge, Garphyttan	Spruce forest	*C. cumatilis* Fr. 1838	20.09.1998	I. Kytövuori	KF732293
C. cupreorufus Brandrud 1994 (isotype)	CFP1038	S	Sweden, Upl, Älvkarleby, Billudden	In dry spruce forest on rich ground	*C. cupreorufus* Brandrud 1994	03.10.1990	T.E. Brandrud et al.	KF732294
C. cupreoviolaceus Bidaud & Reumaux 1996 (holotype)	3426	G	France, Ardennes, Forêt de Belval	In deciduous forest on clayey-calcareous soil	*C. largus* Fr. 1838	27.09.1992	P. Reumaux & F. Reumaux	KF732295
C. cyanites Fr. 1838 (neotype)	AT2005069	H	Sweden, Upl, Uppsala, Stadsskogen	In mixed forest	*C. cyanites* Fr. 1838	26.08.2005	A. Taylor	KF732355
C. delaportei Rob. Henry 1988 (holotype)	RH8673	PC	France, Paris region	In frondose forest	*C. delaportei* Rob. Henry 1988	Unknown	A. Delaporte	KF732297
C. dionysae var. *avellaneus* Rob. Henry ex Bidaud & Carteret 2008 (holotype)	AB97-10-361	PC	France, Ain, Champdor	In mixed calcareous forest	*C. dionysae* var. *avellaneus* Rob. Henry ex Bidaud & Carteret 2008	21.10.1997	G. Chamonaz	KF732298
C. eliae Bidaud, Moënne-Locc. & Reumaux 1996 (holotype)	1032	G	France, Haute-Savoie, Vieugy	In herbaceous *Quercus* forest	*C. eliae* Bidaud, Moënne-Locc. & Reumaux 1996	27.10.1988	P. Moënne-Loccoz	KF732299
C. elotoides M.M. Moser & McKnight 1995 (holotype)	87/60	IB	USA, Wyoming, Teton National Forest, Turpin Meadow	Under *Picea pungens*, *P. engelmannii*, *Pseudotsuga menziesii* in subalpine forest	*C. elotoides* M.M. Moser & McKnight 1995	23.07.1987	Unknown	KF732300
C. eumarginatus Rob. Henry ex Bidaud, Carteret & Reumaux 2009 (holotype)	AB07-10-175	PC	France, Ain, Chanay, col de Richemont	In coniferous forest	*C. purpurascens* Fr. 1838	16.10.2007	A. Bidaud	KF732301
C. evosmus Joachim ex Bidaud & Reumaux 2006 (holotype)*	PML4837	PC	France, Oise, Coye-la-Forêt	In deciduous forest on calcareous soil	*C. evosmus* Joachim ex Bidaud & Reumaux 2006	20.10.1995	M. Diamond	KF732302
C. flavaurora M.M. Moser & McKnight 1995 (holotype)*	89/187	IB	USA, Wyoming, Teton National Forest, Fourmile meadow	Under *Picea engelmannii* in subalpine forest	*C. elotoides* M.M. Moser & McKnight 1995	07.08.1989	Unknown	KF732303
C. flavescentipes Reumaux 1996 (holotype)	3606	G	France, Loiret, Forêt de Montargis	Under *Quercus*	*C. flavescentipes* Reumaux 1996	27.10.1993	Participants of mycological field trip in Sully-sur-Loire	KF732304
C. flavipallens Kytöv., Liimat. & Niskanen sp. nov. (holotype)	IK08-1729 (H6032745)	H	Finland, Kn, Kajaani, Hietalahti	In fairly damp grass-herb-spruce forest with *Pinus*, *Betula* and *Populus tremula*, on calcareous ground	*C. flavipallens* Kytöv., Liimat. & Niskanen sp. nov.	13.09.2008	I. Kytövuori	KF732554
C. flavivelatus Kytöv., Liimat. & Niskanen sp. nov. (holotype)	IK98-885	H	Sweden, Nb, Pajala, Junosuando	In dryish *Picea abies* heath forest with *Pinus*, *Betula*, and open meadows	*C. flavivelatus* Kytöv., Liimat. & Niskanen sp. nov.	15.08.1998	I. Kytövuori	KF732528
C. flavobulbus Ammirati & M.M. Moser 1997 (holotype)	95/629	IB	USA, California, Del Norte Co., Highway 199, Danger Point	Under *Quercus vacciniifolia* and *Q. garrayana* in rather dry habitats on basic soils	*C. flavobulbus* Ammirati & M.M. Moser 1997	29.11.1995	M. Moser	KF732305
C. foetens (M.M. Moser) M.M. Moser 1967 (holotype)	51/128	IB	Austria, Tyrol, Hötting-Innsbruck, Buchtal	In mixed deciduous forest under *Fagus*	*C. foetens* (M.M. Moser) M.M. Moser 1967	13.09.1951	M. Moser	KF732306
C. fraudulosus Britzelm. 1885 (neotype)	IK95-1852	S	Germany, Baden-Württemberg, Freudenstadt, Heiligenbronn	In gently sloping grass-herb coniferous forest (*Abies alba*, *Picea abies*, *Fagus sylvatica*) on calcareous ground	*C. fraudulosus* Britzelm. 1885	05.10.1995	I. Kytövuori	KF732518
C. fraudulosus var. *patrickensis* M.M. Moser 2000 (holotype)	95/617	IB	USA, California, Humboldt Co., Trinidad, Patrick's Point State Park	Under *Picea sitkensis* and *Pseudotsuga menziesii*	*C. patrickensis* (M.M. Moser) Niskanen, Liimat., Kytöv., Bojantchev & Ammirati comb. nov.	25.11.1995	M. Moser	KF732307
C. frondosophilus Bidaud 2001 (holotype)	PML4817	PC	France, Ain, Cerin	In deciduous forest on calcareous soil	*C. platypus* (M.M. Moser) M.M. Moser 1967	16.11.1997	A. Bidaud	KF732562

C. fuligineofolius (M.M. Moser) M.M. Moser & Peintner 2002 (holotype)	91/682	IB	USA, California, Mendocino, Caspar Little Lake Road	In coniferous forest with *Pseudotsuga*, *Tsuga* and *Sequoia*	*C. fuligineofolius* (M.M. Moser) M.M. Moser & Peintner 2002	06.12.1991	M. Moser	KF732308
C. fulmineus var. *sulphureus* Kauffman 1918 (lectotype)*	MICH10351	MICH	USA, Michigan, Washtenaw, Ann Arbor	On the ground among humus, in frondose or mixed wood	*C. fulmineus* var. *sulphureus* Kauffman 1918	03.10.1910	C.H. Kauffman	KF732309
C. gentianeus Bidaud 1993 (holotype)	2575	G	France, Ain, Lampnas	In calcareous *Fagus* forest with *Betula*	*C. gentianeus* Bidaud 1993	08.10.1991	M. Russi	KF732310
C. genuinus Rob. Henry ex Bidaud & Carteret 2009 (holotype)	XC2005-132	PC	France, Seine-Maritime, Les Petites Dalles, Valmont	In deciduous forest	*C. collocandoides* Reumaux 2009	02.09.2005	X. Carteret	KF732311
C. georgiolens Rob. Henry 1986 (holotype)*	RH3153	PC	France, Languedoc-Roussillon	In forest of *Quercus ilex*	*C. georgiolens* Rob. Henry 1986	Unknown	Unknown	KF732312
C. glaucocephalus M.M. Moser, Ammirati & Halling 2000 (holotype)	95/679	IB	USA, California, Mendocino Co., Caspar Little Lake Rd.	In mixed forests with *Tsuga*, *Pseudotsuga*, *Pinus ponderosa*, *Abies* and *Arctostaphylos manzanita*	*C. glaucocephalus* M.M. Moser, Ammirati & Halling 2000	07.12.1995	J. Ammirati & M. Moser	KF732313
C. glaucopoides Kauffman 1923 (holotype)	MICH10358	MICH	USA, Colorado, Grand, Leal	Under spruce and fir	*C. glaucopus* (Schaeff.: Fr.) Gray 1821	16.08.1917	C.H. Kauffman	KF732314
C. glaucopus (Schaeff.: Fr.) Gray 1821 (neotype)	CFP786	S	Sweden, Mpd, Alnö, Ås brygga	In dry spruce forest on calcareous ground	*C. glaucopus* (Schaeff.: Fr.) Gray 1821	21.09.1988	T.E. Brandrud et al.	KF732315
C. glaucopus var. *olivaceus* f. *ingratus* Moënne-Locc. 2008 (holotype)	PML762	PC	France, Haute-Savoie, forêt de la Semine, Clarafond	In calcareous deciduous forest	*C. scaurocaninus* Chevassut & Rob. Henry 1982	05.11.1987	P. Moënne-Loccoz	KF732316
C. glaucopus var. *subrubrovelatus* Bidaud 2008 (holotype)	AB97-11-431	PC	France, Ain, Farges, in mixed forest with *Populus tremula*, *Corylus sativa*, *Fagus sylvatica*, *Abies alba*	In deciduous forest	*C. subrubrovelatus* (Bidaud) Kytöv., Liimat., Niskanen & Dima comb. nov.	01.11.1997	A. Bidaud	KF732317
C. gracilior (Jul. Schäff. ex M.M. Moser) M.M. Moser 1967 (holotype)	58/73	IB	Germany, Baden-Württemberg, Randengebiet near Zollhaus	In *Fagus* forest on calcareous soil	*C. gracilior* (Jul. Schäff. ex M.M. Moser) M.M. Moser 1967	09.10.1958	M. Moser	UDB001082
C. gratus Reumaux 2008 (holotype)	PML85	PC	France, Haute-Savoie, forêt de la Mandallaz, Choisy	In deciduous forest under *Fagus*	*C. leonicolor* Reumaux 2001	27.09.1986	P. Moënne-Loccoz	KF732318
C. griseocoeruleus Ammirati & M.M. Moser 1997 (holotype)	95/685	IB	USA, California, Mendocino Co., about 8 km east of Mendocino on road 408	Under *Lithocarpus densiflora* Moser 1997	*C. griseocoeruleus* Ammirati & M.M.	08.12.1995	M. Moser	KF732319
C. herculeolens Bidaud 1996 (holotype)*	3700	G	France, Montbrison, Loire	Under *Quercus petraea* on basaltic soil	*C. chromataphilus* Rob. Henry 1989	11.11.1992	A. Bidaud	KF732320
C. herpeticus Fr. 1838 (neotype)	CFP936	S	Sweden, Ång, Säbrå, Hällenyland	Under *Picea* on cultivated area	*C. herpeticus* Fr. 1838	20.07.1990	T.E. Brandrud et al.	KF732321
C. hysginicolor Bidaud 1995 (holotype)*	2955	G	France, Ain, Innimont	In young herbaceus, calcareous *Picea* forest	*C. badiolatus* (M.M. Moser) M.M. Moser 1967	03.10.1992	A. Bidaud	KF732322
C. immixtus Kauffman 1932 (holotype)*	MICH10365	MICH	USA, Washington, Mason, Lake Cushman, Olympic Mountains	Under fir and hemlock	*C. immixtus* Kauffman 1932	20.10.1915	C.H. Kauffman	KF732323
C. inamoenus (J. Favre) Quadr. 1985 (holotype)*	13522	G	Switzerland	In subalpine coniferous forest on calcareous ground	*C. rosargutus* Chevassut & Rob. Henry 1978	Unknown	J. Favre	KF732324
C. infractus (Pers.: Fr.) Fr. 1838 (neotype)	CFP495	S	Sweden, Boh, Tossene, Anneröd	In beech forest, on medium rich ground	*C. infractus* (Pers.: Fr.) Fr. 1838	15.09.1986	T.E. Brandrud et al.	KF732325
C. infractus var. *aeruginosus* Rob. Henry ex Reumaux 2009	XC2006-66	PC	France, Seine-et-Marne, forêt de Villefermoy	In deciduous forest on clayey-calcareous soil	*C. infractus* (Pers.: Fr.) Fr. 1838	11.10.2006	R. Chalange	KF732326
C. infractus var. *flavus* M.M. Moser 1999 (holotype)*	97/169	IB	USA, Wyoming, Shoshone National Forest, Brooks Lodge	In coniferous forest under *Picea engelmannii* and *Abies lasiocarpa*	*C. infractiflavus* (M.M. Moser) Kytöv., Niskanen, Liimat., Bojantchev & Ammirati stat. nov. & nom. nov.	12.08.1997	M. Moser	KF732327
C. josephii Reumaux 2006 (holotype)	PML5193	PC	France, Ardennes, forêt d'Elan	In calcareous deciduous forest	*C. gracilior* (Jul. Schäff. ex M.M. Moser) M.M. Moser 1967	08.10.1999	P. Reumaux	KF732328
C. juxtadibaphus Rob. Henry 1983 (holotype)	RH3880	PC	France, Haut-Doubs, L'Hôpital du Grosbois	In submontane, calcareous *Carpinus* forest	*C. juxtadibaphus* Rob. Henry 1983	1950	Unknown	KF732329
C. kuehneri M.M. Moser 1974 (holotype)	1965/0042	IB	Austria, Tyrol, Oetztal, Untergurgl	Under *Alnus viridis*	*C. kuehneri* M.M. Moser 1974	03.09.1965	M. Moser	KF732330
C. kytoevuorii Niskanen & Liimat. sp. nov. (holotype)	TN05-158, H6029355	H	Finland, Ks, Kuusamo, Oulanka, Ampumavaara	In old, grass-herb *Picea abies* forest with some *Betula*, *Pinus sylvestris* and *Populus tremula*, on calcareous ground	*C. kytoevuorii* Niskanen & Liimat. sp. nov.	17.09.2005	K. Liimatainen & T. Niskanen	KF732529
C. laetargutus Chevassut & Rob. Henry 1978 (holotype)	RH70405	PC	France, Mont Aigoual	In mixed forest of *Picea* and *Fagus*	C. *crassus* Fr. 1838	29.09.1975	Mme Moutet	KF732331
C. largoides Rob. Henry ex Bidaud, Carteret & Reumaux 2009 (holotype)	PML2336	PC	France, Ain, bois de la Morgne, Ordonnaz	In deciduous forest	*C. subpurpurascens* (Batsch) Fr. 1838	06.10.1991	A. Bidaud	KF732332
C. largus Fr. 1838 (neotype)	TN08-060 (H6001957)	H	Finland, V, Turku, Ruissalo	In deciduous forest of *Quercus robur*, *Corylus avellana* and some *Betula* on mull soil	*C. largus* Fr. 1838	03.09.2008	K. Liimatainen & T. Niskanen	AB859985
C. largusiellus Reumaux 1996 (holotype)	3411	G	France, Ardennes, Forêt de Boult	Under deciduous trees (*Betula*, *Carpinus*) on clayey-calcareous soil	*C. largus* Fr. 1838	09.10.1992	P. Reumaux	KF732334
C. latoclaricolor Rob. Henry 1989 (holotype)	RH1199	PC	France	In *Picea* forest	*C. badiolatus* (M.M. Moser) M.M. Moser 1967	Unknown	Unknown	KF732335

Table 1 (cont.).

Species	Voucher	Herb.	Locality	Ecology	Current name	Collection date	Collector	GenBank number
C. lemanicus A. Favre & Vialard 2000 (holotype)	452177	G	France, Savoy, Thonon-les-Bains, Margencel	Under *Pinus* and *Picea* on calcareous soil	*C. delaportei* Rob. Henry 1988	06.11.1999	A. Favre, J. Vialard	KF732336
C. leonicolor Reumaux 2001 (holotype)	4739	PC	France, Ardennes, bois du Vivier	In clayey-calcareous deciduous forest under *Quercus* and *Carpinus*	*C. leonicolor* Reumaux 2001	04.10.1992	P. Reumaux	KF732337
C. lilacinicolor Reumaux 1996 (holotype)	3512	G	France, Ardennes, La Croix-aux-Bois	In deciduous forest on clayey-calcareous soil	*C. largus* Fr. 1838	16.09.1979	P. Reumaux	KF732338
C. lintrisporus Reumaux 1997 (holotype)	2935	G	France, Ardennes, Mont Dieu	In clayey-calcareous deciduous forest (*Carpinus*, *Betula*)	*C. largus* Fr. 1838	23.09.1992	P. Reumaux	KF732339
C. lividoviolaceus Rob. Henry 1987 (paratype)*	RH2932	PC	France	In frondose woodland	*C. largus* Fr. 1838	1969	Unknown	KF732340
C. luteiaureus Kytöv., Liimat. & Niskanen sp. nov. (holotype)	IK07-247b (H6033617)	H	Finland, OP, Kiiminki, Juuvansydänmaa	In grass-herb *Picea abies* forest with some *Betula*, *Populus tremula* and *Pinus*, on calcareous ground	*C. luteiaureus* Kytöv., Liimat. & Niskanen sp. nov.	17.08.2007	I. Kytövuori	KF732568
C. luteoarmillatus A.H. Sm. 1942 (holotype)*	15360	MICH	USA, Michigan, Sharron Hollow	On muck soil in low woods	*C. luteoarmillatus* A.H. Sm. 1942	14.09.1940	A.H. Smith	KF732341
C. luteobrunnescens A.H. Sm. 1944 (holotype)	17785	MICH	USA, Washington, Olympic National Park, Olympic Hot Springs	Under conifers	*C. luteobrunnescens* A.H. Sm. 1944	11.10.1941	D.E. Stunz & A.H. Smith	KF732342
C. luteocingulatus Bidaud & Fillion 1992 (holotype)*	AB91-10-260	G	France, Haute-Savoie, Forêt de la Semine	Under *Quercus* and *Carpinus* on clayey, slightly acid soil	*C. luteocingulatus* Bidaud & Fillion 1992	10.1991	Unknown	KF732343
C. luteovaginans Bidaud & Faurite-Gendron 2006 (holotype)	AB03-11-73	PC	France, Ardèche, Saint-Alban-sur-Sampzon	In deciduous forest under *Quercus ilex* and *Q. humilis*	*C. aurantiopallidus* Bidaud 2006	05.11.2003	A. Faurite-Gendron	KF732344
C. maculatipes Bidaud 1996 (holotype)	2845	G	France, Savoie, Les Arcs	In subalpine zone under *Picea abies* and *Alnus viridis*	*C. pseudonaevosus* Rob. Henry 1957	13.08.1992	P.A. Moreau	KF732345
C. maculatocaespitosus Bidaud 2009 (holotype)	AB08-10-302	PC	France, Ain, Cerin	In calcareous deciduous forest	*C. maculatocaespitosus* Bidaud 2009	11.10.2008	A. Bidaud	KF732346
C. mahiquesii Vila, A. Ortega & Suár.-Sant. 2008 (holotype)	GDA54298	GDA	Spain, Catalonia, Perafita	Under *Cistus monspeliensis*, on acid soil	*C. mahiquesii* Vila, A. Ortega & Suár.-Sant. 2008	18.01.2008	J. Vila, X. Llimona	FM202139
C. melleicarneus Kytöv., Liimat., Niskanen & Brandrud sp. nov. (holotype)	IK01-053	H	Estonia, Hiiumaa, Sarve, Soonlepa	In deciduous forest *(Corylus*, *Quercus*) with some *Pinus* on calcareous ground	*C. melleicarneus* Kytöv., Liimat., Niskanen & Brandrud sp. nov.	16.09.2001	I. Kytövuori	KF732577
C. mendax Bidaud, Mahiques & Reumaux 2011 (holotype)	AB07-10-162	PC	France, Ain, col de Richemont, Chanay	In mixed forest under *Betula* and *Picea*	*C. mendax* Bidaud, Mahiques & Reumaux 2011	12.10.2007	E. Bidaud & R. Fillion	KF732401
C. metarius Kauffman 1921 (holotype)	MICH10374	MICH	USA, Colorado, Grand, Leal	Under spruce and fir	*C. metarius* Kauffman 1921	29.08.1917	C.H. Kauffman	KF732347
C. misermontii Chevassut & Rob. Henry 1986 (holotype)	RH84.134	PC	France, Montpellier	Under *Quercus ilex*	*C. misermontii* Chevassut & Rob. Henry 1986	12.1984	G. Chevassut	KF732348
C. montanus Kauffman 1932 (holotype)	MICH10377	MICH	USA, Oregon, Clackamas, Mt Hood, near Welches Post Office	In hemlock and cedar forest	*C. montanus* Kauffman 1932	03.10.1922	C.H. Kauffman	KF732349
C. multiformis Fr. 1838 (neotype)	CFP445	S	Sweden, Ång, Häggdånger, Sjö	In spruce forest with blueberry	*C. multiformis* Fr. 1838	21.08.1986	T.E. Brandrud et al.	KF732350
C. multiformis var. *caesiophyllus* Moënne-Locc. 2006 (holotype)	PML882	PC	France, Savoie, Arith	Under *Picea* on calcareous soil	*C. caesiolamellatus* (Bidaud) Kytöv., Liimat., Niskanen, Brandrud, Frøslev & A.F.S. Taylor comb. nov.	03.06.1988	P. Moënne-Loccoz	KF732351
C. muricinicolor Moënne-Locc. 1996 (holotype)	3582	G	France, Haute-Savoie, Quintal	Under *Picea* on calcareous soil	*C. variecolor* (Pers.: Fr.) Fr. 1838	11.10.1993	P. Moënne-Loccoz	KF732352
C. mutabilis A.H. Sm. 1944 (holotype)	17451	MICH	USA, Washington, Olympic National Park, Olympic Hot Springs	Under conifers, pine, Douglas fir and mountain hemlock	*C. occidentalis* A.H. Sm. 1939	30.09.1941	A.H. Smith	KF732353
C. myrtilliphilus Kytöv., Liimat., Niskanen & Brandrud sp. nov. (holotype)	IK97-1469 (H6032751)	H	Finland, Kn, Suomussalmi, Suolijärvi	In gently sloping, partly swampy, grass-herb spruce forest with some *Pinus*, *Betula*, *Populus*, *Alnus incana* and *Salix* spp.	*C. myrtilliphilus* Kytöv., Liimat., Niskanen & Brandrud sp. nov.	14.09.1997	I. Kytövuori	KF732605
C. neotriumphans Bidaud, Moënne-Locc. & Reumaux 2000 (holotype)	PML209	G	France, Haute-Savoie, Semnoz	Under *Picea* on calcareous soil	*C. neotriumphans* Bidaud, Moënne-Locc. & Reumaux 2000	18.09.1985	P. Moënne-Loccoz	KF732354
C. norrlandicus Brandrud 1989 (isotype)	CFP526	S	Sweden, Ång, Häggdånger, Torrom	High herbaceous spruce forest on rich ground	*C. norrlandicus* Brandrud	22.09.1986	T.E. Brandrud	DQ117928
C. obsoletus Kühner 1955 (syntype)	Sa-52-66 (G00262069)	G	France, Haute-Savoie, Samoëns	Under *Fagus*	*C. obsoletus* Kühner 1955	22.09.1952	R. Kühner	KF732628
C. obsoletus Kühner 1955 (syntype)	Sa-52-91 (G00262070)	G	France, Haute-Savoie, Samoëns	Under *Fagus* and *Quercus* among moss and grass	*C. obsoletus* Kühner 1955	27.09.1952	R. Kühner	KF732356
C. occidentalis A.H. Sm. 1939 (holotype)	8654	MICH	USA, California, Trinidad	Under redwood	*C. occidentalis* A.H. Sm. 1939	12.11.1937	A.H. Smith	KF732357

C. occultus Moënne-Locc. & Reumaux 1996 (holotype)	3591	G	France, Ile-de-France, région de Versailles	In calcareous deciduous forest	*C. largus* Fr. 1838	14.10.1993	M. Cerutti	KF732358
C. ochraceobrunneus Rob. Henry ex Bidaud, Moënne-Locc. & Reumaux 2000 (holotype)	4027	G	France, Haute-Savoie, Bois de Vorcier	In mixed forest dominated by *Picea*	*C. ochraceobrunneus* Rob. Henry ex Bidaud, Moënne-Locc. & Reumaux 2000	05.11.1995	H. Debauvais	KF732359
C. ochribubalinus Kytöv., Liimat. & Niskanen sp. nov. (holotype)	IK93-641, H6032734	H	Finland, U, Espoo, Nuuksio	In fairly rich grass-herb forest with *Populus tremula*, *Betula*, *Alnus incana*, *Quercus*, *Corylus*, *Prunus padus*, *Salix* spp., and some old pines and young spruces	*C. ochribubalinus* Kytöv., Liimat. & Niskanen sp. nov.	02.09.1993	I. Kytövuori	KF732530
C. ochroclarus Rob. Henry ex Rob. Henry 1996 (holotype)*	2792	G	France, Haute-Savoie, Forêt de la Semine	In deciduous forest mixed with some *Picea* on clayey-calcareous soil	*C. ochroclarus* Rob. Henry ex Rob. Henry 1996	11.07.1992	R. Fillion	KF732360
C. ochropudorinus Rob. Henry ex Bidaud & Reumaux 2006 (holotype)	PML2339	PC	France, Ain, Meyriat	In deciduous forest	*C. talus* Fr. 1838	09.10.1991	A. Bidaud	KF732361
C. olidoamarus var. *valentinus* Mahiques & A. Favre 1999 (holotype)	452173	G	Spain, Valencia	Under *Quercus suber*	*C. olidoamarus* var. *valentinus* Mahiques & A. Favre 1999	26.10.1996	Unknown	KF732362
C. oliveopetasatus M.M. Moser 2000 (holotype)	95/360	IB	USA, Oregon, Wasco Co., Mt Hood, Clear Creek Camp Ground	In mixed coniferous forest (*Abies*, *Picea*, *Pinus*, *Tsuga*, *Pseudotsuga*, *Larix*)	*C. oliveopetasatus* M.M. Moser 2000	25.10.1995	M. Moser	KF732363
C. olympianus A.H. Sm. 1939 (holotype)	3242	MICH	USA, Washington, Olympic Mountains, Olympic Hot Springs, Boulder Creek	Under fir	*C. olympianus* A.H. Sm. 1939	19.10.1935	A.H. Smith	KF732364
C. ophiopus Peck 1878 (part of type)*	s.n.	PC	USA, Maryland	Among fallen leaves in woods	*C. ophiopus* Peck 1878	September	Unknown	KF732365
C. oregonensis A.H. Sm. 1939 (holotype)	3557	MICH	USA, Oregon, Florence, Lake Tahkenitch	Under spruce	*C. oregonensis* A.H. Sm. 1939	19.11.1935	A.H. Smith	KF732366
C. orichalceus var. *olympianus* A.H. Sm. 1944 (holotype)	17513	MICH	USA, Washington, Olympic National Park, Olympic Hot Springs	Under conifers	*C. pseudocupreorufus* (A.H. Sm.) Niskanen, Liimat. & Ammirati stat. nov. & nom. nov.	02.10.1941	A.H. Smith	KF732367
C. orichalceus var. *olympianus* f. *luteifolius* A.H. Sm. 1944 (holotype)	16970	MICH	USA, Washington, Olympic Mts, Lake Angeles	Under conifers	*C. luteicolor* (A.H. Sm.) Ammirati, Bojantchev, Niskanen & Liimat. stat. nov. & nom. nov.	19.09.1941	A.H. Smith	KF732368
C. orichalceus var. *xanthocephalus* A.H. Sm. 1944 (holotype)*	17514	MICH	USA, Washington, Olympic National Park, Olympic Hot Springs	Under conifers	*C. orichalceus* var. *xanthocephalus* A.H. Sm. 1944	02.10.1941	A.H. Smith	KF732369
C. pallidifolius A.H. Sm. 1939 (holotype)	3244	MICH	USA, Washington, Olympic Mountains, Olympic Hot Springs	Under fir	*C. pallidifolius* A.H. Sm. 1939	19.10.1935	A.H. Smith	KF732370
C. pallidirimosus Kytöv., Liimat. & Niskanen sp. nov. (holotype)	IK95-585, H6035694	H	Finland, InL, Utsjoki, Kevo, Tsieskuljohka	In mesic heath forest with *Betula* and *Pinus*, some moist depressions	*C. pallidirimosus* Kytöv., Liimat. & Niskanen sp. nov.	17.08.1995	I. Kytövuori	KF732578
C. pansa (Fr.) Sacc. 1887 (neotype)	IK90-1826	H	Finland, V, Kemiö, Pederså	At small, abandoned limestone quarries, spruce heath forest, roadside	*C. pansa* (Fr.) Sacc. 1887	21.09.1990	I. Kytövuori	KF732522
C. papulosus Fr. 1838 (neotype)*	CFP344	S	Sweden, Mpd, Alnö, Ås	In spruce forest on calcareous ground	*C. papulosus* Fr. 1838	07.09.1985	T.E. Brandrud et al.	KF732371
C. paracrassus Reumaux 1995*	3522	G	France, Ile-de-France, Fontainebleau	In calcareous deciduous forest	*C. largus* Fr. 1838	07.10.1979	N. Martelli	KF732372
C. paracyanopus Moënne-Locc. & Reumaux 1996 (holotype)	3510	G	France, Ardennes, Bois du Mont Dieu	Under *Carpinus* and *Betula*, on clayey-calcareous soil	*C. largus* Fr. 1838	25.09.1980	P. Reumaux	KF732373
C. parafulmineus Rob. Henry 1993	2384	G	France, Drôme, Romeyer	In montane forest of *Fagus* and *Abies*, on calcareous ground	*C. parafulmineus* Rob. Henry 1993	02.11.1991	A. Bidaud & P. Reumaux	KF732552
C. parargutus Bidaud, Moënne-Locc. & Reumaux 1999 (holotype)	1144	G	France, Ile-de-France	In deciduous forest	*C. pardinus* Reumaux 1995	24.08.1987	J. Poirier	KF732374
C. pardinus Reumaux 1995 (holotype)	3432	G	France, Ardennes, Forêt de Belval	In deciduous forest on clayey-calcareous soil	*C. pardinus* Reumaux 1995	27.09.1992	P. Reumaux & F. Reumaux	KF732375
C. parolivascens Moënne-Locc. & Reumaux 2009 (holotype)	PML29	PC	France, Haute-Savoie, plateau des Glières	Under *Pinus* among *Sphagnum*	*C. scaurus* (Fr.: Fr.) Fr. 1838	08.09.1984	R. Baubet	KF732377
C. patibilis Brandrud & Melot 1983 (holotype)*	213-78	O	Norway, Akh, Nannestad, Hornsjøen	In oligotrophic *Picea abies* forest	*C. patibilis* Brandrud & Melot 1983	10.08.1978	T.E. Brandrud	KF732378
C. patibilis var. *scoticus* Brandrud 1997 (holotype)*	TEB161-83	E	Scotland, Perthshire, Calvine, Struan Wood	In subalpine zone under *Betula pubescens*	*C. largus* Fr. 1838	22.09.1983	T.E. Brandrud	KF732379
C. percomis Fr. 1838 (neotype)	TN08-041	H	Finland, V, Karjaa, Kohagen	In herb-rich *Picea abies* forest with some *Corylus avellana*, *Quercus robur*, *Betula* and *Populus tremula*	*C. percomis* Fr. 1838	02.09.2008	K. Liimatainen & T. Niskanen	KF732380
C. perpallens Chevassut & Rob. Henry 1978 (holotype)	RH3928	PC	France, Mont Aigoual	Under *Picea* and *Fagus*	*C. perpallens* Chevassut & Rob. Henry 1978	28.10.1973	Unknown	KF732381
C. persoonianus Bidaud 2009 (holotype)*	AB97-11-496	PC	France, Ain, Cerin	In grassy meadow	*C. persoonianus* Bidaud 2009	16.11.1997	A. Bidaud	KF732382
C. phylladus Rob. Henry 1983 (holotype)*	RH2046	PC	France, Jura, Forêt de Chaux	In frondose forest with *Quercus* and *Fagus*	C. *crassus* Fr. 1838	07.1965	R. Henry	KF732383
C. pini Brandrud 1996 (isotype)	CFP394	S	Norway, Oppl, Østre Toten, Balke	In coniferous forest on calcareous ground	*C. pini* Brandrud 1996	25.09.1985	T.E. Brandrud et al.	KF732384
C. piriodolens Moënne-Locc. 1996 (holotype)	642	G	France, Haute-Savoie, Plateau de Solaison	In young calcareous *Picea* forest	*C. variecolor* (Pers.: Fr.) Fr. 1838	01.09.1987	R. Baubet	KF732385

Table 1 (cont.).

Species	Voucher	Herb.	Locality	Ecology	Current name	Collection date	Collector	GenBank number
C. platypus (M.M. Moser) M.M. Moser 1967 (holotype)	58/64 (19580064)	IB	Germany, Baden-Württemberg, Inzigkofen	In *Fagus* forest on calcareous soil	*C. platypus* (M.M. Moser) M.M. Moser 1967	09.10.1948	M.M. Moser	KF732563
C. ponderosus A.H. Sm. 1939 (holotype)	9273	MICH	USA, Oregon, Cave City	Under *Pinus ponderosa* and *Quercus* spp.	*C. ponderosus* A.H. Sm. 1939	01.12.1937	A.H. Smith	KF732386
C. porphyropus (Alb. & Schwein.) Fr. 1838 (neotype)	CFP717	S	Sweden, Jmt, Ragunda, Ragunda	In birch forest on rich ground	*C. porphyropus* (Alb. & Schwein.) Fr. 1838	20.08.1988	T.E. Brandrud et al.	KF732387
C. porphyropus var. *porphyrophorus* Reumaux 2009 (holotype)	PML5086	PC	France, Ardennes, La Croix-aux-Bois	In deciduous forest	*C. porphyropus* (Alb. & Schwein.) Fr. 1838	06.10.1995	P. Reumaux	KF732388
C. praestans (Cordier) Gillet 1874 (epitype)	IK94-1861	H	France, Ain, communen d'Echallan	In *Fagus* forest with *Picea*	*C. praestans* (Cordier) Gillet 1874	27.10.1994	I. Kytövuori	KF732389
C. psalliotoides Chevassut & Rob. Henry 1978 (holotype)*	RH3154	PC	France, St. Mitre-les-Remparts	Under *Quercus ilex*	*C. psalliotoides* Chevassut & Rob. Henry 1978	22.11.1970	Unknown	KF732390
C. pseudocephalixus Bidaud & Moënne-Locc. 2000 (holotype)*	4446	G	France, Drôme, Forêt de Romeyer	In mixed calcareous forest	*C. pseudocephalixus* Bidaud & Moënne-Locc. 2000	02.11.1991	A. Bidaud	KF732392
C. pseudocyanites var. *paucus* Reumaux 2005 (holotype)	PML5261	PC	France, Val-de-Marne, bois d'Ivry	In deciduous forest	*C. cyanites* Fr. 1838	17.10.1998	A. Bardet & R. Bardet	KF732393
C. pseudogracilior Reumaux 2006 (holotype)	PML4858	PC	France, Dordogne, Tursac	In calcareous deciduous forest	*C. pseudogracilior* Reumaux 2006	26.10.1997	P. Reumaux	KF732394
C. pseudolargus Rob. Henry 1987 (holotype)	RH70218	PC	France, Doubs	In frondose and coniferous forest	*C. pseudonaevosus* Rob. Henry 1957	Unknown	Unknown	KF732395
C. pseudominor Rob. Henry ex Reumaux 2006 (holotype)	PML4750	PC	France, Ardennes, Bois des Alleux	In deciduous forest on clayey-calcareous soil	*C. talus* Fr. 1838	27.09.1997	P. Reumaux	KF732396
C. pseudonaevosus Rob. Henry 1957 (type)	RH162	PC	France	In montane *Picea* forest	*C. pseudonaevosus* Rob. Henry 1957	Unknown	Unknown	KF732397
C. pseudonebularis Moënne-Locc. 1996 (holotype)	42	G	France, Haute-Savoie, Massif du Semnoz	In subalpine *Picea* forest	*C. pseudonebularis* Moënne-Locc. 1996	22.09.1985	P. Moënne-Loccoz	KF732398
C. pseudopansa Bidaud 2000 (holotype)	4401	G	France, Ain, Le Poizat	In coniferous forest on calcareous ground	*C. varius* (Schaeff.: Fr.) Fr. 1838	14.10.1995	P.A. Moreau	KF732399
C. pseudopimus Rob. Henry ex Rob. Henry 2000 (holotype)	4516	G	France, Ain, Innimont	In mixed forest	*C. varius* (Schaeff.: Fr.) Fr. 1838	08.10.1990	D. Mazuir	KF732400
C. pseudotalus Rob. Henry ex Bidaud & Reumaux 2006 (holotype)	PML4859	PC	France, Seine-Maritime, Forêt de la Londe-Rouvray	Under deciduous trees on calcareous soil	*C. talus* Fr. 1838	24.10.1997	J.-C. Malaval	KF732402
C. pseudoturmalis Bidaud & Moënne-Locc. 2010 (holotype)	PML3465	PC	France, Haute-Savoie, Thorens-Glières	In coniferous forest	*C. claricolor* (Fr.) Fr. 1838	29.07.1993	A. Faurite-Gendron	KF732403
C. pseudovariegatus M.M Moser 1999 (holotype)	97/296	IB	USA, Wyoming, Shoshone National Forest, Lake east of Two Ocean Mt	In subalpine forest under *Picea engelmannii*, *Pinus albicaulius*	*C. pseudovariegatus* M.M Moser 1999	31.08.1997	M. Moser	KF732404
C. pseudovarius Moënne-Locc. & Reumaux 2000 (holotype)*	4391	G	France, Ile de France, Bois de Noisiel	In calcareous deciduous forest	*C. luteocingulatus* Bidaud & Fillion 1992	20.10.1996	G. Flantzer	KF732405
C. purpurascens Fr. 1838 (neotype)	IK98-2121	H	Sweden, Nrk, Hidinge, Garphyttans NP	In fairly rich spruce grass-herb forest with *Corylus*, *Populus tremula*, *Betula* and *Quercus*	*C. purpurascens* Fr. 1838	20.09.1998	I. Kytövuori	KF732406
C. rapaceoides Bidaud, G. Riousset & Riousset 2000 (holotype)	AB97-12-527	G	France, St. Rémy de Provence, Bouches du Rhône	In deciduous forest	*C. rapaceoides* Bidaud, G. Riousset & Riousset 2000	03.11.1997	G. Riousset & L. Riousset	KF732407
C. reverendissimus Bidaud, Moënne-Locc. & Reumaux 2000 (holotype)	4667	G	France, Haute-Loire, Forêt de Miaune	In mixed calcareous forest	*C. reverendissimus* Bidaud, Moënne-Locc. & Reumaux 2000	16.10.1997	P. Chapon	KF732408
C. rex-claricolorum Bidaud, Carteret & Reumaux 2010 (holotype)	AB04-09-163	PC	France, Ain, la Vèche, Chanay	In coniferous forest	*C. rex-claricolorum* Bidaud, Carteret & Reumaux 2010	15.09.2004	A. Bidaud & R. Fillion	KF732409
C. rioussetiae Chevassut & Rob. Henry 1986 (holotype)	RH84.70-78	PC	France, Gravesen	Under *Populus alba*	*C. rioussetiae* Chevassut & Rob. Henry 1986	10.1984	Mme. Riousset	KF732410
C. rosargutus Chevassut & Rob. Henry 1978 (holotype)	RH70477	PC	France, Haut-Doubs	Under conifers	*C. rosargutus* Chevassut & Rob. Henry 1978	Unknown	Unknown	KF732411
C. rufior Reumaux 2000 (holotype)	1118	G	France, Haute Ardenne	In coniferous forest, under *Picea*	*C. varius* (Schaeff.: Fr.) Fr. 1838	08.11.1988	G. Flantzer	KF732412
C. rufoallutus Rob. Henry ex Bidaud & Reumaux 2006 (holotype)	PML635	PC	France, Haute-Savoie, Plateau de Glières	Under *Picea*	*C. rufoallutus* Rob. Henry ex Bidaud & Reumaux 2006	26.08.1987	P. Moënne-Loccoz & J. Melot	KF732413
C. rufoallutus var. *caesiolamellatus* Bidaud 2006 (holotype)	PML4905	PC	France, Ain, col des Bérentin	Under *Picea* on calcareous soil	*C. caesiolamellatus* (Bidaud) Kytöv., Liimat., Niskanen, Brandrud, Frøslev & A.F.S. Taylor comb. nov.	03.10.1993	A. Bidaud	KF732414
C. rufolatus Moënne-Locc. 1996 (holotype)	664	G	France, Haute-Savoie, Plateau de Glières	Under *Picea abies*	*C. rufolatus* Moënne-Locc. 1996	26.09.1987	P. Moënne-Loccoz	KF732415

C. russus Fr. 1838 (neotype)	CFP941	S	Sweden, Ång, Säbrä, Överdal	In dry spruce forest on rich ground	*C. russus* Fr. 1838	03.08.1990	T.E. Brandrud et al.	KF732416
C. sabuletorum Redeuilh & Reumaux 1995 (holotype)*	2954	G	France, Ile-de-France, Les Mureaux	On river sand-banks under deciduous trees	*C. chromataphilus* Rob. Henry 1989	01.10.1992	G. Redeuilh	KF732417
C. saginoides Bidaud & Reumaux 2000 (holotype)	1264	G	France, Ain, Forêt de Meyriat	In mixed forest	*C. varius* (Schaeff.: Fr.) Fr. 1838	22.10.1989	A. Bidaud & P. Reumaux	KF732418
C. sannio M.M. Moser 1999 (holotype)	97/352	IB	USA, Wyoming, Teton National Forest, Lost Lake	In subalpine coniferous forest under *Picea engelmannii*, *Abies lasiocarpa* and *Pinus albicaulis*	*C. sannio* M.M. Moser 1999	10.09.1997	M. Moser	KF732420
C. saxamontanus Fogel 1995 (holotype)	F2535	MICH	USA, Nevada, White Pine Co., Whealer Peak Campground	Under *Pinus* spp. and *Abies* spp.	*C. saxamontanus* Fogel 1995	30.06.1981	R. Fogel	KF732421
C. scaurocaninus Chevassut & Rob. Henry 1982 (holotype)*	RH71678	PC	France, Montpellier	Under *Quercus ilex*	*C. scaurocaninus* Chevassut & Rob. Henry 1982	04.11.1979	G. Chevassut	KF732422
C. scaurus (Fr.: Fr.) Fr. 1838 (neotype)	CFP1074	S	Switzerland, Bern, Fribourg, Rechthalten	In the border of a peatbog with *Pinus strobus*	*C. scaurus* (Fr.: Fr.) Fr. 1838	29.09.1991	T.E. Brandrud et al.	KF732423
C. scaurus f. *phaeophyllus* M.M. Moser 2001 (holotype)	94/243	IB	Sweden, Sm, Femsjö, Stora Mosse, Källanäset	On bare peat soil in a mire with *Pinus sylvestris*	*C. scaurus* (Fr.: Fr.) Fr. 1838	13.09.1994	M. Moser	KF732424
C. scaurus subsp. *violaceonitens* Rob. Henry 1976 (holotype)	RH2190	PC	France	In forest with *Fagus*, *Quercus* and *Carpinus*	*C. violaceonitens* (Rob. Henry) Moënne-Locc. 2009	Unknown	Unknown	KF732425
C. scaurus var. *notandus* Bidaud 2009 (holotype)	AB94-08-32	PC	France, Loire, Jeansagnière	In montane coniferous forest	*C. scaurus* (Fr.: Fr.) Fr. 1838	21.08.1994	A. Bidaud	KF732426
C. serariicolor Rob. Henry 1985 (holotype)*	RH1731	PC	France	In montane coniferous forest	*C. papulosus* Fr. 1838	Unknown	Unknown	KF732427
C. serarius Fr. 1838 (neotype)	CFP959	S	Sweden, Ång, Häggdånger, Torrom	In dry spruce forest on rich ground	*C. serarius* Fr. 1838	11.08.1990	Brandrud et al.	KF732428
C. sobrius P. Karst. 1890 (type)	PAK3235	H	Finland, EH, Mustiala, Tammela	In frondose forest	*C. sobrius* P. Karst. 1890	23.09.1890	P.A. Karsten	KF732429
C. sphagnetorum Bidaud 1996 (holotype)	3746	G	France, Savoie, Lac du Clou - Beaufortin	In subalpine zone under *Picea*, among *Sphagnum* and *Vaccinium*	*C. pseudonaevosus* Rob. Henry 1957	31.08.1991	A. Bidaud	KF732430
C. splendens var. *papillatosporus* Bidaud & Moënne-Locc. 2003 (holotype)	960	PC	France, Haute-Savoie, Les Puisots	In mixed forest	*C. splendens* var. *papillatosporus* Bidaud & Moënne-Locc. 2003	25.09.1988	Exposotion of Annecy	KF732431
C. squamosocephalus Bidaud, Moënne-Locc. & Reumaux 1999 (holotype)	99670	PC	France, Ardennes, Bois de la Brouille	Under *Quercus*	*C. squamosocephalus* Bidaud, Moënne-Locc. & Reumaux 1999	02.10.1998	P. Reumaux	KF732432
C. subaccedens Rob. Henry 1989 (holotype)*	RH3170	PC	France, Languedoc-Roussillon-Cévennes region	Under *Quercus ilex*	*C. subaccedens* Rob. Henry 1989	Unknown	Unknown	KF732433
C. subamaricatus Bidaud 2008 (holotype)	AB94-10-313	PC	France, Ain, Meyriat	In calcareous mixed forest of *Fagus* and *Abies*	*C. tirolianus* Bidaud, Moënne-Locc. & Reumaux 2005	16.10.1994	A. Bidaud	KF732434
C. subaustralis A.H. Sm. & Hesler 1944 (holotype)*	14336	MICH	USA, N.C., Great Smoky Mts National Park, Indian Gap	In coniferous forest	*C. crassus* Fr. 1838	14.07.1942	L.R. Hesler	KF732435
C. subbalteatus Kühner 1955 (syntype)*	8-12 (G00262072)	G	France, Savoie, St-Bon, Praz	In *Picea* forest	*C. balteatus* (Fr.) Fr. 1838	10.09.1927	R. Kühner	KF732437
C. subcrassoides Moënne-Locc. & Remaux 1995 (holotype)	363	G	France, Savoie, Col des Saisies	In herbaceous *Picea abies* forest	*C. pseudonaevosus* Rob. Henry 1957	29.09.1986	R. Campia	KF732438
C. subcrassus Rob. Henry 1983 (holotype)*	RH71520	PC	France, Doubs, Seloncourt	Under conifers	C. *crassus* Fr. 1838	30.09.1979	From exhibition of Seloncourt	KF732439
C. subcyanites Bidaud 2005 (holotype)	PML5304	PC	France, Ain, Le Poizat	Under *Picea*	*C. cyanites* Fr. 1838	05.09.1999	A. Bidaud	KF732440
C. subdecolorans M. Langl. & Reumaux 2000 (holotype)	4403	G	France, Marne, Bazancourt	In deciduous forest	*C. subdecolorans* M. Langl. & Reumaux 2000	20.10.1991	M. Langlois	KF732441
C. subdecoloratus Reumaux 2000 (holotype)	3951	G	France, Ardennes, Bois des Alleux	Under *Betula*	*C. ochraceobrunneus* Rob. Henry ex Bidaud, Moënne-Locc. & Reumaux 2000	30.10.1994	G. Laffond & P. Reumaux	KF732442
C. subfoetens M.M. Moser & McKnight 1995 (holotype)	89/307	IB	USA, Wyoming, Teton National Forest, Fourmile meadow	Under *Picea engelmannii*	*C. subfoetens* M.M. Moser & McKnight 1995	21.08.1989	K.H. McKnight	KF732443
C. subfoetidus A.H. Sm. 1944 (holotype)	17778	MICH	USA, Washington, Olympic National Park, Olympic Hot Springs	Under conifers	*C. subfoetidus* A.H. Sm. 1944	11.10.1941	A.H. Smith	KF732444
C. subfraudulosus Kytöv., Liimat. & Niskanen sp. nov. (holotype)	IK11-006	H	Norway, Oppl, Lunner, Skøyenåsen	In *Picea abies* forest with *Corylus* on calcareous ground	*C. subfraudulosus* Kytöv., Liimat. & Niskanen sp. nov.	03.09.2011	I. Kytövuori	KF732564
C. subfuligineus Bidaud 2008 (holotype)	AB97-10-339	PC	France, Ain, Petaray, Aranc	In calcareous coniferous forest	*C. subrugulosus* Bidaud & Armada 2006	21.10.1997	A. Bidaud	KF732445
C. subinops Reumaux 2009 (holotype)	PML5119	PC	France, Ardennes, bois de Toges	In deciduous forest	*C. subpurpurascens* (Batsch) Fr. 1838	06.10.1996	P. Reumaux	KF732446
C. sublilacinopes Bidaud, Moënne-Locc. & Reumaux 2001 (holotype)	PML4819	PC	France, Seine-Maritime, La Londe-Rouvray	In calcareous deciduous forest	*C. sublilacinopes* Bidaud, Moënne-Locc. & Reumaux 2001	24.10.1997	L.C. Malaval	KF732561
C. subolivascens A.H. Sm. 1944 (holotype)	14311	MICH	USA, Washington, Olympic National Park, Deer Lake	Under conifers	*C. subolivascens* A.H. Sm. 1944	13.06.1939	A.H. Smith	KF732447

Table 1 (cont.).

Species	Voucher	Herb.	Locality	Ecology	Current name	Collection date	Collector	GenBank number
C. subopimus Bidaud 1995 (holotype)	3477	G	France, Haute-Savoie, Plateau de Dran, Les Glières	In herbaceous, calcareous *Picea abies* forest near *Alnus viridis*	*C. balteatus* (Fr.) Fr. 1838	05.08.1993	A. Bidaud	KF732448
C. subpurpurascens (Batsch) Fr. 1838 (epitype)	TN08-059	H	Finland, V, Turku	In deciduous forest of *Quercus robur*, *Corylus avellana* and some *Betula* on mull soil	*C. subpurpurascens* (Batsch) Fr. 1838	03.09.2008	K. Liimatainen & T. Niskanen	KF732449
C. subpurpureophyllus A.H. Sm. 1939 (holotype)	8164	MICH	USA, California, Crescent City	Under spruce	*C. subpurpureophyllus* A.H. Sm. 1939	28.10.1937	A.H. Smith	KF732450
C. subrugulosus Bidaud & Armada 2006 (holotype)	AB05-10-263	PC	France, Isère, Treminis	In coniferous forest on calcareous soil	*C. subrugulosus* Bidaud & Armada 2006	06.10.2005	A. Bidaud & F. Armada	KF732451
C. subsolitarius A.H. Sm. 1942 (holotype)	15377	MICH	USA, Michigan, Ann Arbor	On humus in oak-hickory woods	*C. subsolitarius* A.H. Sm. 1942	11.09.1940	A.H. Smith	KF732452
C. subspadiceus Reumaux 1996 (holotype)	2780	G	France, Haute-Vienne, Limousin	Under *Picea abies*	*C. largus* Fr. 1838	15.10.1990	Taupenot	KF732453
C. subtortus (Pers.: Fr.) Fr. 1838 (neotype)	IK87-1510	S	Sweden, Sm, Hylte commune, Femsjö parish	In partly paludified spruce forest with some other tree species	*C. subtortus* (Pers.: Fr.) Fr. 1838	18.09.1987	I. Kytövuori	KF732454
C. subvariiformis Bidaud 2000 (holotype)	4663	G	France, Bouches-du-Rhône, St Rémy de Provence	Under *Quercus ilex* on calcareous soil	*C. luteocingulatus* Bidaud & Fillion 1992	03.12.1997	G Riousset & L. Riousset	KF732455
C. superbus A.H. Sm. 1944 (holotype)	17680	MICH	USA, Washington, Olympic National Park, Olympic Hot Springs	On steep mountain slopes	*C. superbus* A.H. Sm. 1944	08.10.1941	A.H. Smith	KF732456
C. talimultiformis Kytöv., Liimat., Niskanen, A.F.S. Taylor & Sesli sp. nov. (holotype)	AT2004096	UPS	Sweden, Upl, Hässelby Park	In mixed forest	*C. talimultiformis* Kytöv., Liimat., Niskanen, A.F.S. Taylor & Sesli sp. nov.	11.07.2004	A. Taylor	KF732583
C. talus Fr. 1838 (neotype)	CFP832	S	Sweden, Jmt, Ragunda, Ragunda	In birch forest on rich ground (*Betula*, *Populus*, *Pinus*)	*C. talus* Fr. 1838	26.08.1989	T.E. Brandrud et al.	KF732457
C. thalliopurpurascens Rob. Henry 1995 (isotype)	RH458677	PC	France, Jura, Bois Boucot	In deciduous forest mainly of *Carpinus* and *Fagus*	*C. herpeticus* Fr. 1838	10.1986	Unknown	KF732458
C. tiliae Brandrud 1996 (holotype)	TEB141-85	O	Norway, Akh, Bærum, Løkkeåsen	In dry calcareous soil, under *Tilia cordata*	*C. tiliae* Brandrud 1996	28.08.1985	T.E. Brandrud	KF732459
C. tirolianus Bidaud, Moënne-Locc. & Reumaux 2005 (holotype)	PML4341	PC	France, Jura, Moirans-en-Montagne	Under *Picea*	*C. tirolianus* Bidaud, Moënne-Locc. & Reumaux 2005	15.09.1996	A. Dégrange	KF732460
C. triumphalis Bidaud, Moënne-Locc. & Reumaux 2000 (holotype)	3950	G	France, Allier, Forêt des Colettes	In coniferous forest	*C. triumphalis* Bidaud, Moënne-Locc. & Reumaux 2000	23.10.1992	R. Chalange	KF732462
C. turmalis Fr. 1838 (neotype)	CFP716	S	Sweden, Mpd, Borgsjö, Julåsen	In herbaceous spruce forest	*C. turmalis* Fr. 1838	20.08.1988	T.E. Brandrud et al.	KF732464
C. vacciniophilus Brandrud 1997 (holotype)	TEB17-88	O	Norway, Oppl, Lunner, Søndre Oppdalen	In forest of *Picea abies*	*C. pseudonaevosus* Rob. Henry 1957	09.08.1988	T.E. Brandrud	KF732465
C. van-campiae Cons. 2000*	871	MCVE	Italy	In mixed woodland with *Abies alba* and *Fagus sylvatica*	*C. van-campiae* Cons. 2000	04.10.1995	G. Consiglio	JF907867
C. variecolor (Pers.: Fr.) Fr. 1838 (neotype)	CFP1021	S	Sweden, Gtl, Viklau, Tjakule	In spruce forest on calcareous ground	*C. variecolor* (Pers.: Fr.) Fr. 1838	29.09.1990	T.E. Brandrud et al.	KF732466
C. variipes Rob. Henry 1977 (holotype)	RH5026	PC	France, Ardennes	In montane coniferous forest	*C. variipes* Rob. Henry 1977	Unknown	P. Reumaux	KF732467
C. variosimilis M.M. Moser & Ammirati 1999 (holotype)*	89/493	IB	USA, Washington, Skagit Co., Trail to Easy Pass	In subalpine coniferous forest under *Picea engelmannii*, *Abies lasiocarpa*	*C. variosimilis* M.M. Moser & Ammirati 1999	12.09.1989	M. Moser	KF732468
C. varius (Schaeff.: Fr.) Fr. 1838 (neotype)	CFP801	S	Sweden, Ång, Häggdånger, Torrom	In spruce forest on rich ground	*C. varius* (Schaeff.: Fr.) Fr. 1838	23.09.1988	T.E. Brandrud et al.	KF732469
C. velicopius Kauffman 1918 (lectotype)*	MICH10435	MICH	USA, Michigan, Washtenaw, Cascade Glen, Ann Arbor	Among fallen leaves in mixed or frondose woods	*C. velicopius* Kauffman 1918	29.09.1907	C.H. Kauffman	KF732470
C. veneris Bidaud, Moënne-Locc. & Reumaux 1996 (holotype)	2952	G	France, Haute-Loire, Dunières	Under *Abies alba* on granitic soil	*C. flavescentipes* Reumaux 1996	02.10.1992	B. Renon	KF732471
C. violaceomaculatus Brandrud 1997 (holotype)	CFP1449	S	Sweden, Gtl, Bäl	In forest of *Picea abies* and *Pinus sylvestris* on calcareous soil	*C. violaceomaculatus* Brandrud 1997	28.09.1993	T.E. Brandrud et al.	KF732473
C. violaceorubens Moënne-Locc. & Reumaux 1990 (holotype)	PML005	G	France, Haute-Savoie, Pessière plantée d'Avernioz	Under *Picea* in needle litter	*C. violaceorubens* Moënne-Locc. & Reumaux 1990	21.06.1985	P. Moënne-Loccoz	KF732474
C. virentophyllus Kauffman 1918 (holotype)	MICH10439	MICH	USA, Michigan, Washtenaw, German Park Woods, SW of Ann Arbor	On the ground, among grasses in frondose woods of oak, maple, etc.	*C. virentophyllus* Kauffman 1918	11.10.1912	C.H. Kauffman	KF732475
C. viridirubescens M.M. Moser & Ammirati 1997 (holotype)	95/688	IB	USA, California, Mendocino Co., on Forest Road 408 about 8 miles from village	Under *Lithocarpus densiflora* and *Quercus garrayana*	*C. viridirubescens* M.M. Moser & Ammirati 1997	08.12.1995	M. Moser	KF732476
C. vixolivascens Rob. Henry 1992 (holotype)	RH89.123	PC	France, Habsheim, Forêt de la Hardt	In mixed deciduous forest with *Carpinus*, *Acer*, *Crataegus* and *Quercus* on subcalcareous soil	*C. vixolivascens* Rob. Henry 1992	1989	M.V. Rastetter	KF732477
C. volvatus A.H. Sm. 1939 (holotype)	8857	MICH	USA, California, Crescent City	Under spruce	*C. volvatus* A.H. Sm. 1939	18.11.1937	A.H. Smith	KF732478
C. wiebeae Thiers & A.H. Sm. 1969 (holotype)	8051	MICH	USA, Oregon, Mt Hood, Camas Corral	Under fir	*C. wiebeae* Thiers & A.H. Sm. 1969	08.06.1958	E. Wiebe	KF732479

Table 2 *Cortinarius* specimens other than types included in the phylogenetic analysis. Short sequences excluded from the analysis marked with *.

Species	Voucher	Herb.	Locality	GenBank number
C. acystidiosus Thiers 1960	CLO4681	TENN	USA	KF732419
C. aggregatus Kauffman 1918*	TN10-179	H	Canada, QC, Papineauville	KF732512
C. alnobetulae Kühner 1989	JFA12247	WTU	Italy, Passo del Rolle	EU655672
C. alticaudus Reumaux 2008	IK09-1402b	H	Finland, PK, Kesälahti	KF732610
C. areni-silvae (Brandrud) Brandrud 2012	IK95-341	H	Finland, InL, Inari	KF732611
C. argutus Fr. 1838 s. auct	O-60164	O	Norway	AY669535
C. argutus s. auct.	T44	O	Norway	UDB000138
C. badiolatus (M.M. Moser) M.M. Moser 1967	IK98-1029	H	Sweden, Nb, Pajala	KF732612
C. balteatialutaceus Kytöv., Liimat. & Niskanen sp. nov.	JV10452, TUR5282	TUR	Finland, InL, Utsjoki	KF732587
*C. balteatialutaceus**	JR100900	H	Norway, S&F, Sogndal	KF732588
C. balteatibulbosus Kytöv., Niskanen, Liimat., Bojantchev & A.F.S. Taylor sp. nov.	DBB33060	UC	Bulgaria, Saranzi	KF732590
*C. balteatibulbosus**	DBB36892	UC	Sweden, Järfälla	KF732591
C. balteatibulbosus	H6027358	H	Finland, V, Vihti	KF732592
C. balteatibulbosus	IK93-639, H6032755	H	Finland, U, Espoo	KF732593
C. balteatibulbosus	IK04-044	H	Finland, U, Vantaa	KF732594
*C. balteatibulbosus**	H6032413	H	Finland, U, Helsinki	KF732595
C. balteatibulbosus	AT2004091	UPS	Sweden, Upl, Berthåga graveyard	UDB001132
C. balteatibulbosus	AT2004045	UPS	Sweden, Upl, Slottsbacken	UDB000711
C. balteatibulbosus	AT2004088	UPS	Sweden, Upl, Stenhagen	UDB000715
*C. balteatibulbosus**	AT2004127	UPS	Sweden, Upl, Berthåga graveyard	UDB000722
C. balteaticlavatus Kytöv., Liimat. & Niskanen sp. nov.	IK95-382, H6032729	H	Finland, InL, Inari	KF732597
C. balteaticlavatus	IK96-782, H6032415	H	Finland, ES, Mäntyharju	KF732598
C. balteaticlavatus	IK08-584, H6033533	H	Finland, Ks, Taivalkoski Jurmu-Kurtti	KF732599
C. balteatoalbus Rob. Henry 1985*	CFP1083	S	France, Ain, Ordonnaz	KF732613
C. balteatoalbus	IK97-761b	H	Sweden, Jmt, Revsund	KF732614
C. bigelowii Thiers & A.H. Sm. 1969	OSC-81327	OSC	USA, OR, Klamath	EU056976
C. boreicyanites Kytöv., Liimat., Niskanen & A.F.S. Taylor sp. nov.	TN03-112	H	Finland, PS, Kuopio	KF732500
C. boreicyanites	AT2010203	UPS	Great Britain, Scotland, Grampian	KF732501
C. boreidionysae Kytöv., Liimat., Niskanen & Dima sp. nov.	IK07-245	H	Finland, OP, Kiiminki	KF732489
C. borgsjoeensis Brandrud 1992	IK07-1029	H	Finland, Ks, Salla	KF732615
C. brunneiaurantius Kytöv., Liimat. & Niskanen sp. nov.	IK93-644, H6032406	H	Finland, U, Espoo	KF732601
C. brunneiaurantius	JV17979b, H6032422	H	Finland, V, Turku	KF732602
C. caerulescens (Schaeff.) Fr. 1838	UL98-88, TUB012146	TUB	Germany	AY174863
C. caesiocinctus	IK97-1573	H	Finland	DQ663241
C. caesiocolor Kytöv., Liimat. & Niskanen sp. nov.	IK97-207, H6032730	H	Finland, U, Helsinki	KF732604
C. caesiolamellatus (Bidaud) Kytöv., Liimat., Niskanen, Brandrud, Frøslev & A.F.S. Taylor comb. nov.	TN09-201	H	USA, WA, Olympic peninsula	KF732571
C. caesiolamellatus	AT2005085	UPS	Sweden, Upl	UDB002202
C. caesiolamellatus	11841	TUB	Germany	AY669531
C. caesiophylloides Kytöv., Liimat., Niskanen, Brandrud & Frøslev sp. nov.	IK92-3044	H	Finland, SoL, Pelkosenniemi	KF732573
C. caesiophylloides	IK08-1554	H	Finland, Kn, Paltamo	KF732574
C. caesiophylloides	TF28			KF732576
C. caesiophylloides	TF40			KF732575
C. calojanthinus M.M. Moser & Ammirati 1999	TN08-129	H	Finland, V, Västanfjärd	KF732538
C. calojanthinus	TSJ2003-005	C	Sweden, Vg	DQ663281
C. castaneicolor A.H. Sm. 1944	SMI38	UBC	Canada, BC	FJ157126
C. chromataphilus Rob. Henry 1989	TUB 011862	TUB	Germany	AY669550
C. citriolens Ammirati & M.M. Moser 1999	19970154	IB	USA, WY	AF325607
C. claricolor (Fr.) Fr. 1838	TN07-138	H	Finland, Ks, Kuusamo	KF732616
C. claricolor	TUB 011852	TUB	Germany	AY669522
C. cobaltinus Kytöv., Liimat. & Niskanen 2013	TSJ2006068	C	Norway, Oppl, Jevnaker	KF673471
C. cobaltinus	TF2006-103	C	Norway, Oppl, Jevnaker	KF673472
C. cremeiamarescens Kytöv., Liimat. & Niskanen sp. nov.	IK00-027	H	Finland, U, Siuntio	KF732494
C. cremeiamarescens	TN06-273	H	Finland, V, Parainen	KF732495
C. cremeiamarescens	OCS153F	UBC	Canada, BC	EF218754
C. cremeiamarescens	clone AlASOILE08		USA, AK	JN889840
C. cruentipellis Kytöv., Liimat., Niskanen & Dima sp. nov.	IK01-055	H	Estonia, Hiiumaa, Pühalepa	KF732540
C. cruentipellis	IK98-2503	H	Sweden, Öl, Algutsrum	KF732541
C. cruentipellis	IK11-008	H	Norway, Akh, Asker	KF732542
C. cumatilis Fr. 1838	IK92-2927	H	Finland, V, Lohja	KF732517
C. cumatilis	H6016455	H	Finland, U, Espoo	KF732643
C. cupreorufus Brandrud 1994	TN02-700	H	Finland, Ks	KF732548
C. cupreorufus	TN07-378	H	USA, WA, Olympic Peninsula	KF732549
C. cupreorufus	TN11-129	H	USA, AK, Fairbanks	KF732550
C. cyanites Fr. 1838	IK98-1476	H	Finland, U, Espoo	KF732502
C. cyanites	AT2000154	UPS	Sweden, Upl, Uppsala	KF732503
*C. cyanites**	AT2004139	UPS	Sweden, Upl, Uppsala	KF732391
C. cyanites	AT2004089	UPS	Sweden, Upl, Uppsala	UDB001154
C. dionysae Rob. Henry 1933 s. auct	TUB011450	TUB	Germany	AY174813
C. dionysae s. auct	TSJ2000-102	C	Germany, Bayern	DQ083782
C. dionysae var. *avellanus* Rob. Henry ex Bidaud & Carteret 2008	IK94-1745a	H	France, Ain, Oyonnax SE	KF732606
C. eliae Bidaud, Moënne-Locc. & Reumaux 1996	41098	PC	France	KF732617
C. elotoides M.M. Moser & McKnight 1995	CFP503	S	Sweden, Vg	DQ663395
C. evosmus Joachim ex Bidaud & Reumaux 2006	TSJ2004-014	C	Denmark	DQ663368
C. evosmus	TUB011399	TUB	Germany	AY174815
C. flavipallens Kytöv., Liimat. & Niskanen sp. nov.	H6032393	H	Finland, LK, Parikkala	KF732555
C. flavipallens	TK368	H	Finland, PeP, Tervola	KF732556
C. aff. *flavipallens*	SMIA06	UBC	Canada, BC	FJ039640
C. flavobulbus Ammirati & M.M. Moser 1997	JFA11826	WTU	USA, CA, Del Norte	EU057017
C. fraudulosus Britzelm. 1885	TU106876	TU	Estonia, Saare, Kihelkonna	UDB011906
C. fraudulosus	19960696	IB	Italy, Bozen	UDB001036
C. fuligineofolius (M.M. Moser) M.M. Moser & Peintner 2002	19910576	IB		AF478578
C. fuligineofolius	19910682	IB		AF478577
C. gentianeus Bidaud 1993	IK11-015	H	Sweden, Gtl, Alskog and När parish	KF732496
C. gentianeus	IK97-1378	H	Finland, Kn, Suomussalmi	KF732497
C. gentianeus	IK09-1525	H	Finland, ES, Kerimäki	KF732498
C. gentianeus	CFP775	S	Sweden, Dlr, Rättvik	KF732499
C. gentianeus	TUB011845	TUB	Germany	AY669519

Table 2 (cont.)

Species	Voucher	Herb.	Locality	GenBank number
C. georgiolens Rob. Henry 1986	IK98-2504	H	Sweden, Öl, Algutsrum	KF732618
C. glaucocephalus M.M. Moser, Ammirati & Halling 2000	F19524	UBC	Canada, BC	HQ604682
C. glaucopus (Schaeff.: Fr.) Gray 1821	IK92-1105a	H	Finland, SoL, Pelkosenniemi	KF732619
C. glaucopus	SMIA20	UBC	Canada, BC	FJ039616
C. glaucopus	clone NWBRO20		Canada, BC	EU645632
C. glaucopus	SMI293	UBC	Canada, BC	FJ039615
C. gracilior (Jul. Schäff. ex M.M. Moser) M.M. Moser 1967	JV19538	H, TUR	Italy, Veneto, Belluno	KF732492
C. herpeticus Fr. 1838	IK92-593	H	Norway, Troms, Storfjord	KF732507
C. herpeticus	DB2142	BP	Hungary, Vas, Ispánk	KF732508
C. herpeticus	TUB011456	TUB	Germany	AY174808
C. herpeticus	9204		Italy	JF907950
C. immixtus Kauffman 1932	F17145OC73	UBC	Canada, BC	GQ159888
C. infractiflavus (M.M. Moser) Kytöv., Niskanen, Liimat., Bojantchev & Ammirati stat. nov. & nom. nov.	DBB19634	UC	Bulgaria, Pirin Mts	KF732534
C. infractiflavus	IK92-1109	H	Finland, SoL, Pelkosenniemi	KF732535
C. infractiflavus	SMI286	UBC	Canada, BC	FJ039612
C. infractus (Pers.: Fr.) Fr. 1838	TN02-832	H	Finland, Ks, Oulanka	KF732523
C. infractus	IK93-223	H	Finland, EH, Pälkäne	KF732524
C. juxtadibaphus Rob. Henry 1983	CFP1108	S	France, Ain	DQ663286
C. largus Fr. 1838	CFP1085	S	France, Ain, Ordonnaz, Penant	KF732333
C. leonicolor Reumaux 2001	CFP852	S	Belgium, Brabant, Tervuren	KF732490
C. luteicolor (A.H. Sm.) Ammirati, Bojantchev, Niskanen & Liimat. stat. nov. & nom. nov.	DBB46740	UC	USA, CA, Yosemite Nat'l Park	KF732546
C. luteicolor	DBB38211	UC	USA, CA, Yosemite Nat'l Park	KF732547
C. luteicolor	JMB10-06-2007-03		USA	HM068562
C. luteicolor	VMS13		Canada, BC	FJ717511
C. luteicolor	JFA11701	WTU	USA, OR, Clackamus	EU057024
C. luteobrunnescens A.H. Sm. 1944	IK97-2298	H	Finland, V, Lohja	KF732620
C. maculatocaespitosus Bidaud 2009	TUB011396	TUB		AY174780
C. meinhardii Bon 1986 s. auct.	TN05-168	H	Finland, Ks, Kuusamo	KF732551
C. meinhardii s. auct.	TUB011443	TUB	Germany	AY174840
C. melleicarneus Kytöv., Liimat., Niskanen & Brandrud sp. nov.	O-125960	O	Norway, AA, Grimstad	AY669533
C. mendax Bidaud, Mahiques & Reumaux 2011	TN06-291	H	Finland, A, Sund	KF732515
C. mendax	TN06-157	H	Finland, PK, Kitee	KF732516
C. metarius Kauffman 1921	PML5204	PC	France, Ain	DQ663236
C. misermontii Chevassut & Rob. Henry 1986	IK98-2417	H	Sweden, Öl, Högsrum	KF732621
C. misermontii	IK872172	H	Spain, Catalonia, Girona	KF732622
C. montanus Kauffman 1932	OSC1064150	OSC	USA, OR	EU525972
C. montanus	DBB00174	UC	USA, OR	JF795378
C. multiformis Fr. 1838	IK08-1857	H	Finland, PS, Sonkajärvi	KF732623
C. multiformis	TN06-139	H	Finland, PK, Kitee	KF732624
C. multiformis	IK98-1401	H	Finland, EH Vilppula	KF732625
C. multiformis	TN05-247	H	Norway, Hord, Voss	KF732626
C. multiformis	19940224	IB	Sweden, Sm	UDB001004
C. multiformis	TAAM128778	TAAM	Estonia, Tartu	UDB016114
C. multiformis	TU105180	TU	Estonia, Voru	UDB016130
C. multiformis	AT2004187	UPS	Sweden, Jmtl	UDB002163
C. multiformis	PK4471	UBC	Canada, BC	FJ039634
C. multiformis	F16414	UBC	Canada, BC	FJ039635
C. myrtilliphilus Kytöv., Liimat., Niskanen & Brandrud sp. nov.	O-125949	O	Norway, Oppl, Ringebu	AY669518
C. neotriumphans Bidaud, Moënne-Locc. & Reumaux 2000	TN05-232	H	Norway, Hord, Ulvik	KF732607
C. neotriumphans	CFP475	S	Sweden, Ång, Säbrå	KF732608
C. norrlandicus	IK99-711	H	Finland, PK, Juuka	KF732627
C. olivaceodionysae A. Ortega, Vila & Fdez.-Brime	TN06-311	H	Finland, SF, A, Jomala	KF732480
C. olivaceodionysae	IK94-1899	H	France, Ain	KF732481
C. olivaceodionysae	TN06-306	H	Finland, A, Finström	KF732482
C. olivaceodionysae	IK11-013	H	Sweden, Gtl	KF732483
C. olivaceodionysae	MK2540	H	Finland, A, Lemland	KF732484
C. olivaceodionysae	IK12-001	H	Estonia, Hiiumaa, Raplamaa	KF732485
C. olivaceodionysae	IK07-1417	H	Sweden, Gstr	KF732486
C. olivaceodionysae	IK11-012	H	Sweden, Gtl	KF732487
C. olivaceodionysae	TUB011856	TUB	Germany	AY669523
C. oliveopetasatus M.M. Moser 2000	F14280	UBC	Canada, BC	FJ157042
C. olympianus A.H. Sm. 1939	IK94-1225	H	Finland, ES, Kerimäki	KF732553
C. ophiopus Peck 1878	IK01-050	H	Finland, U, Helsinki	KF732609
C. ophiopus	AT2004256	UPS	Sweden, Upl, Norrtälje	UDB000729
C. oregonensis A.H. Sm. 1939	F15822	UBC	Canada, BC	FJ157035
C. orichalceus var. *xanthocephalus* A.H. Sm. 1944	CFP769	S	Sweden, Dlr, Rättvik	KF732543
C. orichalceus var. *xanthocephalus*	TN04-874	H	Finland, V, Lohja	KF732544
C. orichalceus var. *xanthocephalus*	IK08-1482	H	Finland, Kn, Paltamo	KF732545
C. palazonianus Vila, A. Ortega & Fdez.-Brime	TN04-1106 (H7017897)	H	Italy, Sardinia, Nuoro, Gavoi, Lago di Gusana	KF732531
C. palazonianus	clone PS01-02		Spain	FJ946938
C. pallidirimosus Kytöv., Liimat. & Niskanen sp. nov.	IK07-692	H	Finland, PeP, Tervola	KF732579
C. pallidirimosus	TN04-470	H	Finland, PeP, Rovaniemi	KF732580
C. pallidirimosus	IK92-966	H	Finland, SoL, Sodankylä	KF732581
C. pallidirimosus	IK98-711	H	Norway, Troms, Storfjord	KF732582
C. pallidirimosus	19990590	IB	Russia, Sakha	UDB001073
C. pallidirimosus	clone 8-73M8		USA, OR	JQ393042
C. pansa (Fr.) Sacc. 1887	IK97-1914	H	Finland, ES, Mäntyharju	KF732521
C. pansa			UK	AM084701
C. pansa	UP21		Sweden	DQ179120
C. papulosus Fr. 1838	TN06-319	H	Finland, A, Jomala	KF732629
C. papulosus	IK90-1822	H	Finland, V, Kemiö	KF732630
C. parafulmineus Rob. Henry 1993	Arangu-Cort-03101201		Spain, Roncal Navarra	EF014269
C. pardinus Reumaux 1995	RH70356	PC	France	KF732461
C. patibilis Brandrud & Melot 1983	IK97-086	H	Finland, V, Karkkila	KF732631
C. patibilis	IK97-087, H6032748	H	Finland, V, Karkkila	KF732632
C. patrickensis (M.M. Moser) Niskanen, Liimat., Kytöv., Bojantchev & Ammirati comb. nov.*	DBB39406	UC	USA, CA, Humboldt	KF732532
*C. patrickensis**	IK95-1400, H7019584	H	Sweden, Mpd, Borgsjö	KF732533

Table 2 (cont.)

Species	Voucher	Herb.	Locality	GenBank number
C. percomis Fr. 1838	CFP1104	S	France, Ain, Brenod	KF732520
C. percomis	AT2004243	UPS	Sweden, Upl	UDB000726
C. percomis	TU105232	TU	Sweden, Gtl	UDB015914
C. pini Brandrud 1996	IK90-2288	H	Finland, V, Parainen	KF732633
C. porphyropus (Alb. & Schwein.) Fr. 1838	TN10-004	H	Canada, QC, Riviere-á-Pierre	KF732513
C. porphyropus	TN06-151	H	Finland, PK, Kitee	KF732514
C. praestans (Cordier) Gillet 1874	TAAM128528	TAAM	Estonia, Saare	UDB015946
C. praestans	CFP482	S	Sweden, Upl, Börstil, Marieberg	KF732267
C. praestans	TUB011460	TUB	Germany	AY174804
C. pseudocephalixus Bidaud & Moënne-Locc. 2000	IK98-1842	H	Sweden, Ög, V. Tolstad	KF732634
C. pseudocephalixus	TUB011444	TUB	Germany	AY174784
C. pseudonaevosus Rob. Henry 1957	CFP1175	S		KF732635
C. purpurascens Fr. 1838	IK87-1174	H	Finland, ES, Joutseno	KF732511
C. purpurascens	IK09-1510	H	Finland, LK, Parikkala	KF732644
C. purpurascens	TUB011401	TUB	Germany	AY174858
C. purpurascens	TAAM128795	TAAM	Estonia, Lääne-Viru	UDB016117
C. rapaceoides Bidaud, G. Riousset & Riousset 2000	TUB012692	TUB	Italy, Laina	EU057049
C. cf. *rhizophorus* Bidaud & Cons. 2012	IK95-1973	H	Germany, Baden-Württemberg, Freudenstadt	KF732569
C. cf. *rhizophorus*	IK98-2451	H	Sweden, Öl, Borgholm	KF732570
C. cf. *rhizophorus*	TUB011860	TUB	Germany	AY669527
C. cf. *rhizophorus*	JV01-574	C	Denmark, Jylland	DQ083813
C. rosargutus Chevassut & Rob. Henry 1978	IK96-1279	H	Germany, Baden-Württemberg Freiburg, Biederbach	KF732636
C. rosargutus	IK07-242	H	Finland, OP, Kiiminki	KF732637
C. rosargutus	IK08-565	H	Finland, Ks, Taivalkoski	KF732638
C. rufoallutus Rob. Henry ex Bidaud & Reumaux 2006	AV010997		Sweden, Jmt (Borgsjö Congress)	KF732639
C. rufoallutus	DBB00242		USA, OR	JF750423
C. rufolatus Moënne-Locc. 1996	CFP1112	S	France, Ain, Brenod	KF732640
C. russus Fr. 1838	CFP923	S	Sweden, Ång, Säbrå	KF732519
C. sannio M.M. Moser 1999	IK98-891	H	Sweden, Nb, Pajala	KF732536
C. sannio	IK88-1160	H	Finland, KiL, Kittilä	KF732537
C. saxamontanus Fogel 1995	MTS-97-166-11	WTU	USA, WA, Kittitas	EU057026
C. scaurocaninus Chevassut & Rob. Henry 1982	HS031095	H	Germany, Baden-Württemberg Karlsruhe	KF732641
C. scaurus (Fr.: Fr.) Fr. 1838	TN10-053	H	Canada, QC	KF732509
C. scaurus	TN03-1698	H	Slovakia, Liptovská kotlina basin, Važec	KF732510
C. scaurus	19940243	IB	Sweden, Femsjö	UDB001068
C. scaurus	156946	TRTC	Canada, ON	JN021010
C. scaurus	19980175	IB	Sweden	AF325562
C. scaurus	19960092	IB	Italy, Sudtirol	UDB001069
C. scaurus	AF-D35		Great Britain, Scotland, Banffshire	UDB002441
C. serarius Fr. 1838	TN04-923	H	Finland, U, Kirkkonummi	KF732558
C. sobrius P. Karst. 1890	IK04-045	H	Finland, U, Helsinki	KF732559
Cortinarius sp.	IK03-005	H	Sweden	KF732525
Cortinarius sp.	IK03-004	H	Sweden, Öl, Nötbrunnskärret	KF732526
Cortinarius sp.*	IK11-010	H	Norway, Busk, Röyken	KF732527
C. spectabilis M.M. Moser 1952 s. auct.	TEB594-04	O	Norway, Oppl	DQ663425
C. spectabilis s. auct.	TEB595-04	O	Norway, Oppl	DQ663426
C. subdecolorans M. Langl. & Reumaux 2000	IK11-011	H	Norway	KF732491
C. subfoetens M.M. Moser & McKnight 1995	IK08-2010	H	Finland, V, Lohja	KF732560
C. subfoetens	F17229OC157	UBC	Canada, BC	GQ159817
C. subfraudulosus Kytöv., Liimat. & Niskanen sp. nov.	CFP481	S	Sweden, Upl, Börstils sn	KF732565
C. subfraudulosus	IK98-2245	H	Sweden, Srm, Mörkö parish	KF732566
C. subfraudulosus	IK88-2016	H	Sweden, Ög, Väversunda parish	KF732567
C. subfraudulosus	TU106607	TU	Estonia, Saare, Kihelkonna	UDB011261
C. sublilacinopes Bidaud, Moënne-Locc. & Reumaux 2001	TSJ2002-043	C	Czech Republic	DQ663434
C. subolivascens A.H. Sm. 1944	C1-EC172	WTU	USA, WA	AY356323
C. subpurpurascens (Batsch) Fr. 1838	AT2004275	UPS	Sweden, Upl	UDB000736
C. subpurpurascens	14615		Italy	JF907905
C. subpurpureophyllus A.H. Sm. 1939	TN04-855	H	Finland, U, Vantaa	KF732557
C. subpurpureophyllus	AT2005152	UPS	Sweden, Upl	UDB002241
C. subpurpureophyllus	19890242	IB	USA, Wyoming, Yellowstone National Park	GU363492
C. subrubrovelatus (Bidaud) Kytöv., Liimat., Niskanen & Dima comb. nov.	TUB011414	TUB	Germany	AY174787
C. subrubrovelatus	TU106663	TU	Estonia, Saare	UDB011262
C. subrugulosus Bidaud & Armada 2006	IK98-2578	H	Sweden, Öl, Böda	KF732463
C. subtortus (Pers.: Fr.) Fr. 1838	TN05-021	H	Finland, ES, Joutsa	KF732645
C. subtortus	19760289	IB	Sweden, Femsjö	UDB001087
C. subtortus	JMB07-08-2007-05		Canada, BC	FJ717556
C. sulphurinus Quél. 1883 s. auct.	CFP506	S	Sweden, Vg, Medelplana	DQ663437
C. sulphurinus var. *fageticola* Brandrud 1998	CFP783	S	Sweden, Sk, Degeberga	DQ663439
C. superbus A.H. Sm. 1944	SMI45		Canada, BC	FJ157114
C. talimultiformis Kytöv., Liimat., Niskanen, A.F.S. Taylor & Sesli sp. nov.	IK300866 (H6032747)	H	Finland, PH, Virrat	KF732584
C. talimultiformis	SES2741		Turkey, Trabzon, Macka	KF732585
C. talimultiformis	TUB0118410	TUB	Germany	AY669532
C. talimultiformis	TAAM128693	TAAM	Estonia, Tartu	UDB015959
C. tiliae Brandrud 1996	O-63407	O	Norway	AY669556
C. triumphalis Bidaud, Moënne-Locc. & Reumaux 2000	CFP781	S	Sweden, Sk, Degeberga	KF732642
C. turmalis Fr. 1838	IK92-1133	H	Finland, SoL, Pelkosenniemi	KF732436
C. variegatus Bres. 1884 s. auct.	CFP525	S	Sweden, Upl, Vattholma	KF732376
C. variegatus s. auct.	F16442	UBC	Canada, BC	FJ039663
C. variipes Rob. Henry 1977	CFP981	S	Sweden, Ång, Häggdånger	KF732472
C. variosimilis M.M. Moser & Ammirati 1999	VMS26	UBC	Canada, BC	FJ717596
C. violaceonitens (Rob. Henry) Moënne-Locc. 2009	TN06-170	H	Finland, PK, Kitee	KF732505
C. violaceonitens	TN00-661	H	Finland, V, Kisko	KF732506
C. violaceorubens Moënne-Locc. & Reumaux 1990	TN07-062	H	Finland, V, Kisko	KF732504
C. violaceorubens	TUB011885	TUB	Germany	AY669647
C. viridirubescens M.M. Moser & Ammirati 1997	JFA11817	WTU	USA, CA, Mendocino	EU057007
C. wiebeae Thiers & A.H. Sm. 1969	clone NHPY20		USA, OR/CA	FJ440879
Hebeloma fastibile (Pers.) P. Kumm.	19940036	IB		AF325643
H. mesophaeum (Pers.) Quél.	GLM31004			AF126100

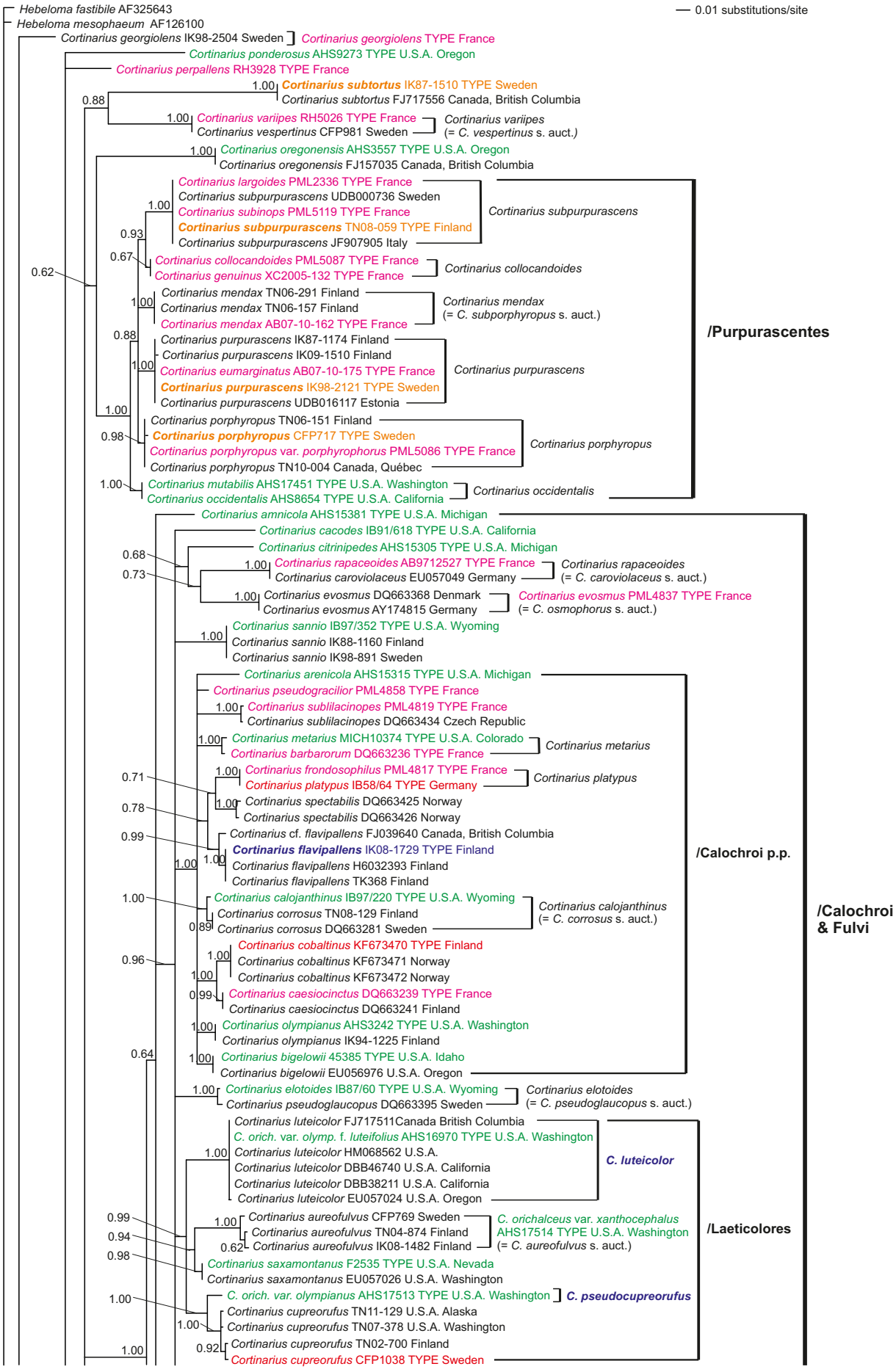
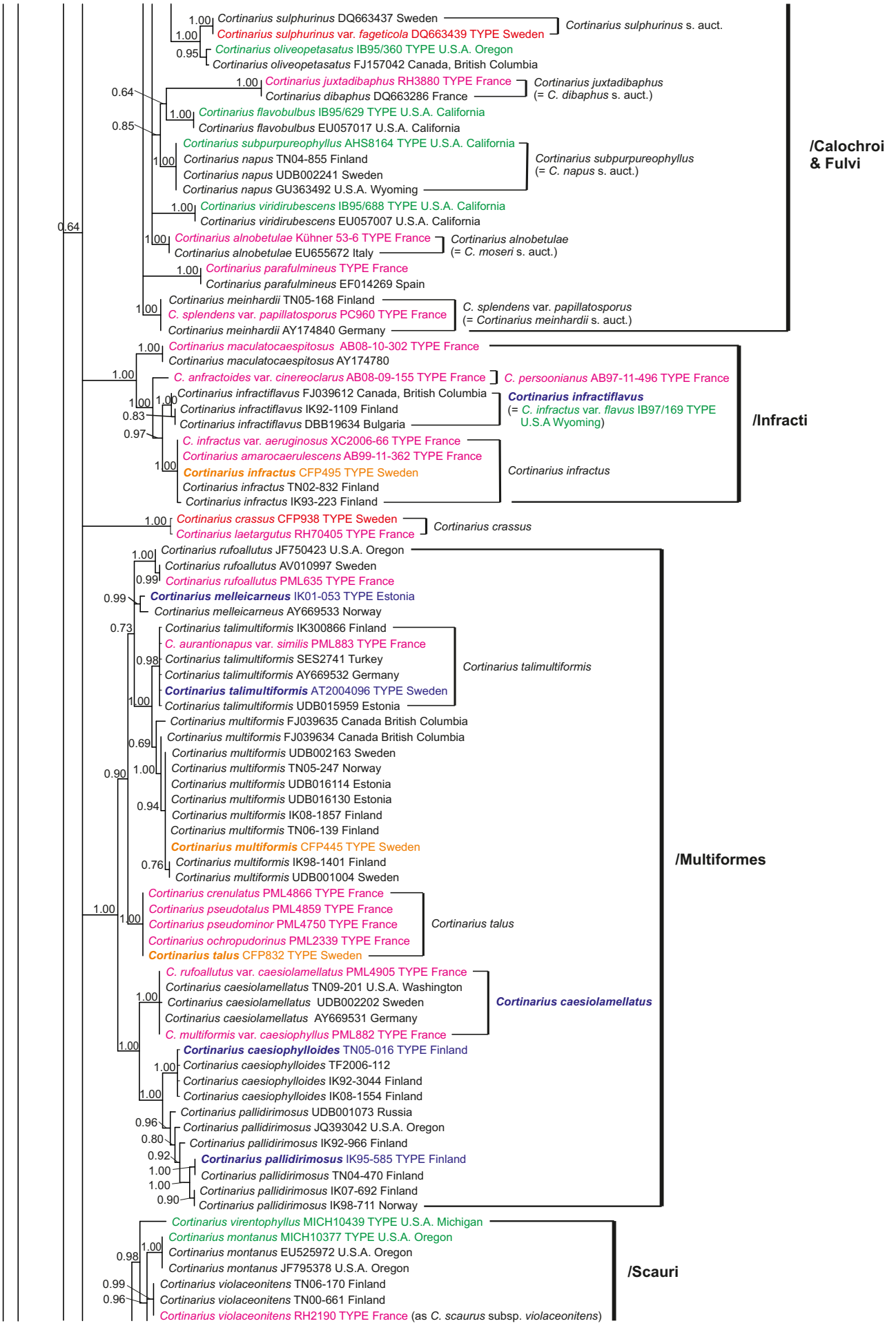


Fig. 1 The Bayesian 50 % majority-rule consensus tree inferred from ITS regions. PP > 0.50 are indicated above branches. In blue colour and **bold** are new species described in this study as well as new combinations made and in orange and **bold** neo- and epitypes designated in this study. In pink are species described by French authors, in red species described by other European authors, in green species described by North American authors and in black other specimens included in this study.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Cortinarius sulphurinus s. auct.
0.95 Cortinarius oliveopetasatus IB95/360 TYPE U.S.A. Oregon
Cortinarius oliveopetasatus FJ157042 Canada, British Columbia
1.00 Cortinarius juxtadibaphus RH3880 TYPE France
Cortinarius dibaphus DQ663286 France
Cortinarius juxtadibaphus (= C. dibaphus s. auct.)
0.64
1.00 Cortinarius flavobulbus IB95/629 TYPE U.S.A. California
0.85
Cortinarius flavobulbus EU057017 U.S.A. California
Cortinarius subpurpureophyllus AHS8164 TYPE U.S.A. California
1.00 Cortinarius napus TN04-855 Finland
Cortinarius napus UDB002241 Sweden
Cortinarius napus GU363492 U.S.A. Wyoming
Cortinarius subpurpureophyllus (= C. napus s. auct.)
1.00 Cortinarius viridirubescens IB95/688 TYPE U.S.A. California
Cortinarius viridirubescens EU057007 U.S.A. California
0.64
1.00 Cortinarius alnobetulae Kühner 53-6 TYPE France
Cortinarius alnobetulae EU655672 Italy
Cortinarius alnobetulae (= C. moseri s. auct.)
1.00 Cortinarius parafulmineus TYPE France
Cortinarius parafulmineus EF014269 Spain
1.00 Cortinarius meinhardii TN05-168 Finland
C. splendens var. papillatosporus PC960 TYPE France
Cortinarius meinhardii AY174840 Germany
C. splendens var. papillatosporus (= Cortinarius meinhardii s. auct.)
/Calochroi & Fulvi
1.00 Cortinarius maculatocaespitosus AB08-10-302 TYPE France
Cortinarius maculatocaespitosus AY174780
1.00 C. anfractoides var. cinereoclarus AB08-09-155 TYPE France
C. persoonianus AB97-11-496 TYPE France
1.00 1.00 Cortinarius infractiflavus FJ039612 Canada, British Columbia
1.00 Cortinarius infractiflavus IK92-1109 Finland
0.83
Cortinarius infractiflavus DBB19634 Bulgaria
Cortinarius infractiflavus (= C. infractus var. flavus IB97/169 TYPE U.S.A Wyoming)
0.97
C. infractus var. aeruginosus XC2006-66 TYPE France
Cortinarius amarocaerulescens AB99-11-362 TYPE France
1.00 Cortinarius infractus CFP495 TYPE Sweden
Cortinarius infractus TN02-832 Finland
Cortinarius infractus IK93-223 Finland
Cortinarius infractus
/Infracti
1.00 Cortinarius crassus CFP938 TYPE Sweden
Cortinarius laetargutus RH70405 TYPE France
Cortinarius crassus
1.00 Cortinarius rufoallutus JF750423 U.S.A. Oregon
Cortinarius rufoallutus AV010997 Sweden
0.99 Cortinarius rufoallutus PML635 TYPE France
0.99 Cortinarius melleicarneus IK01-053 TYPE Estonia
Cortinarius melleicarneus AY669533 Norway
0.73 Cortinarius talimultiformis IK300866 Finland
C. aurantionapus var. similis PML883 TYPE France
0.98 Cortinarius talimultiformis SES2741 Turkey
Cortinarius talimultiformis AY669532 Germany
Cortinarius talimultiformis AT2004096 TYPE Sweden
1.00 Cortinarius talimultiformis UDB015959 Estonia
Cortinarius talimultiformis
Cortinarius multiformis FJ039635 Canada British Columbia
0.69 Cortinarius multiformis FJ039634 Canada British Columbia
Cortinarius multiformis UDB002163 Sweden
0.90 1.00 Cortinarius multiformis TN05-247 Norway
Cortinarius multiformis UDB016114 Estonia
Cortinarius multiformis UDB016130 Estonia
0.94 Cortinarius multiformis IK08-1857 Finland
Cortinarius multiformis TN06-139 Finland
Cortinarius multiformis CFP445 TYPE Sweden
0.76 Cortinarius multiformis IK98-1401 Finland
Cortinarius multiformis UDB001004 Sweden
1.00 Cortinarius crenulatus PML4866 TYPE France
1.00 Cortinarius pseudotalus PML4859 TYPE France
Cortinarius pseudominor PML4750 TYPE France
Cortinarius talus
Cortinarius ochropudorinus PML2339 TYPE France
Cortinarius talus CFP832 TYPE Sweden
C. rufoallutus var. caesiolamellatus PML4905 TYPE France
Cortinarius caesiolamellatus TN09-201 U.S.A. Washington
1.00 Cortinarius caesiolamellatus UDB002202 Sweden
Cortinarius caesiolamellatus AY669531 Germany
C. multiformis var. caesiophyllus PML882 TYPE France
Cortinarius caesiolamellatus
1.00 Cortinarius caesiophylloides TN05-016 TYPE Finland
1.00 Cortinarius caesiophylloides TF2006-112
Cortinarius caesiophylloides IK92-3044 Finland
1.00 Cortinarius caesiophylloides IK08-1554 Finland
Cortinarius pallidirimosus UDB001073 Russia
0.96 Cortinarius pallidirimosus JQ393042 U.S.A. Oregon
0.80 Cortinarius pallidirimosus IK92-966 Finland
0.92 Cortinarius pallidirimosus IK95-585 TYPE Finland
1.00 Cortinarius pallidirimosus TN04-470 Finland
1.00 Cortinarius pallidirimosus IK07-692 Finland
0.90 Cortinarius pallidirimosus IK98-711 Norway
/Multiformes
Cortinarius virentophyllus MICH10439 TYPE U.S.A. Michigan
Cortinarius montanus MICH10377 TYPE U.S.A. Oregon
1.00
0.98 Cortinarius montanus EU525972 U.S.A. Oregon
Cortinarius montanus JF795378 U.S.A. Oregon
0.99 Cortinarius violaceonitens TN06-170 Finland
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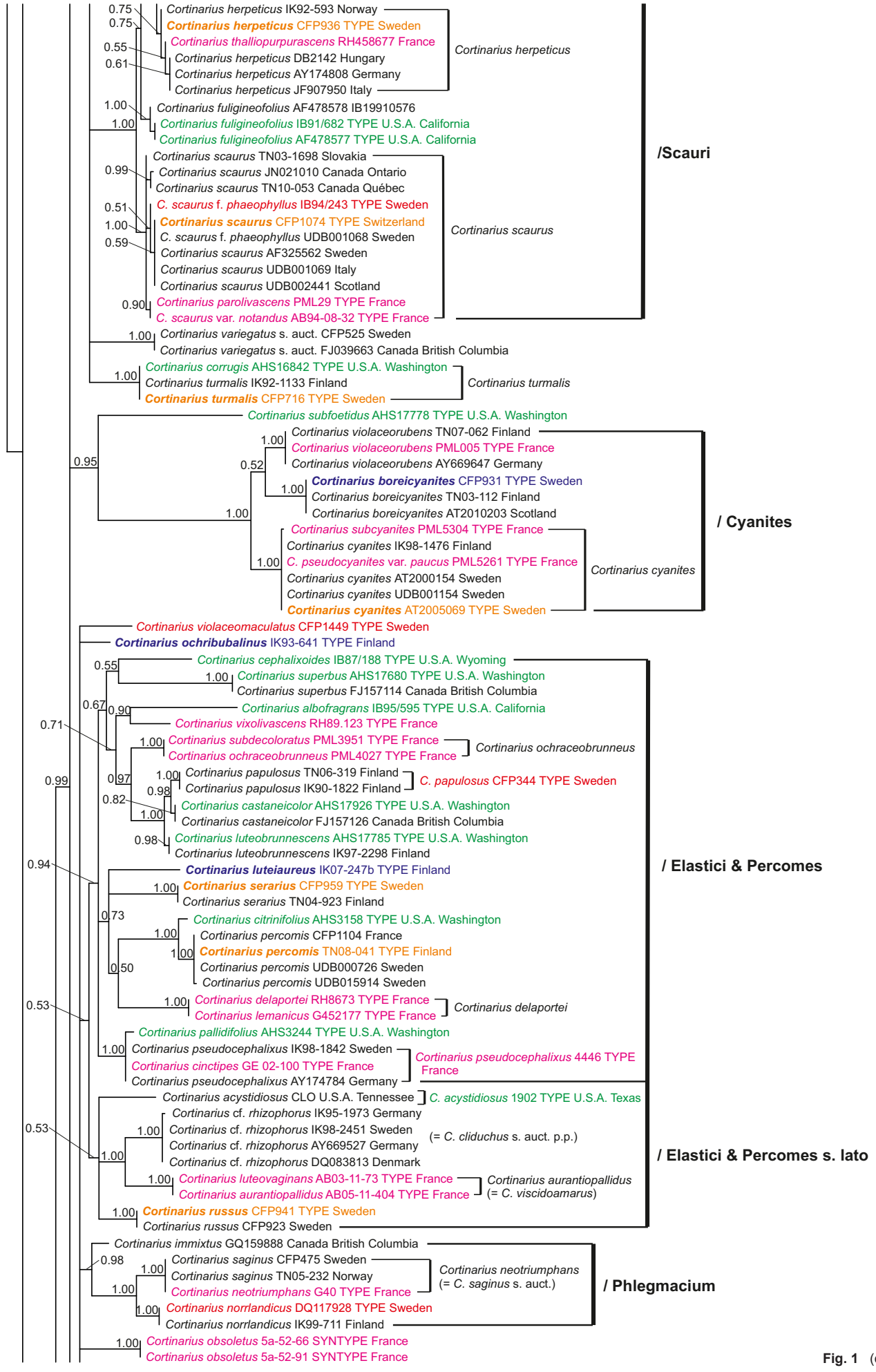
Cortinarius violaceonitens RH2190 TYPE France (as C. scaurus subsp. violaceonitens)
/Scauri

Fig. 1 (cont)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Cortinarius herpeticus IK92-593 Norway
Cortinarius herpeticus CFP936 TYPE Sweden
Cortinarius thalliopurpurascens RH458677 France
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0.61
Cortinarius herpeticus DB2142 Hungary
Cortinarius herpeticus AY174808 Germany
Cortinarius herpeticus JF907950 Italy
Cortinarius herpeticus
1.00
1.00
Cortinarius fuligineofolius AF478578 IB19910576
Cortinarius fuligineofolius IB91/682 TYPE U.S.A. California
Cortinarius fuligineofolius AF478577 TYPE U.S.A. California
Cortinarius scaurus TN03-1698 Slovakia
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Cortinarius scaurus JN021010 Canada Ontario
Cortinarius scaurus TN10-053 Canada Québec
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0.59
C. scaurus f. phaeophyllus IB94/243 TYPE Sweden
Cortinarius scaurus CFP1074 TYPE Switzerland
C. scaurus f. phaeophyllus UDB001068 Sweden
Cortinarius scaurus AF325562 Sweden
Cortinarius scaurus UDB001069 Italy
Cortinarius scaurus UDB002441 Scotland
0.90
Cortinarius parolivascens PML29 TYPE France
C. scaurus var. notandus AB94-08-32 TYPE France
Cortinarius scaurus
/Scauri
1.00
Cortinarius variegatus s. auct. CFP525 Sweden
Cortinarius variegatus s. auct. FJ039663 Canada British Columbia
Cortinarius corrugis AHS16842 TYPE U.S.A. Washington
1.00
Cortinarius turmalis IK92-1133 Finland
Cortinarius turmalis CFP716 TYPE Sweden
Cortinarius turmalis
Cortinarius subfoetidus AHS17778 TYPE U.S.A. Washington
1.00
Cortinarius violaceorubens TN07-062 Finland
Cortinarius violaceorubens PML005 TYPE France
0.95
0.52
Cortinarius violaceorubens AY669647 Germany
1.00
Cortinarius boreicyanites CFP931 TYPE Sweden
Cortinarius boreicyanites TN03-112 Finland
1.00
Cortinarius boreicyanites AT2010203 Scotland
Cortinarius subcyanites PML5304 TYPE France
Cortinarius cyanites IK98-1476 Finland
1.00
C. pseudocyanites var. paucus PML5261 TYPE France
Cortinarius cyanites AT2000154 Sweden
Cortinarius cyanites UDB001154 Sweden
Cortinarius cyanites AT2005069 TYPE Sweden
Cortinarius cyanites
/ Cyanites
Cortinarius violaceomaculatus CFP1449 TYPE Sweden
Cortinarius ochribubalinus IK93-641 TYPE Finland
0.55
Cortinarius cephalixoides IB87/188 TYPE U.S.A. Wyoming
1.00
Cortinarius superbus AHS17680 TYPE U.S.A. Washington
Cortinarius superbus FJ157114 Canada British Columbia
0.67
0.90
Cortinarius albofragrans IB95/595 TYPE U.S.A. California
0.71
Cortinarius vixolivascens RH89.123 TYPE France
1.00
Cortinarius subdecoloratus PML3951 TYPE France
Cortinarius ochraceobrunneus PML4027 TYPE France
Cortinarius ochraceobrunneus
0.99
0.97
1.00
Cortinarius papulosus TN06-319 Finland
0.98
Cortinarius papulosus IK90-1822 Finland
C. papulosus CFP344 TYPE Sweden
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Cortinarius castaneicolor AHS17926 TYPE U.S.A. Washington
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Cortinarius castaneicolor FJ157126 Canada British Columbia
0.98
Cortinarius luteobrunnescens AHS17785 TYPE U.S.A. Washington
Cortinarius luteobrunnescens IK97-2298 Finland
0.94
Cortinarius luteiaureus IK07-247b TYPE Finland
1.00
Cortinarius serarius CFP959 TYPE Sweden
Cortinarius serarius TN04-923 Finland
0.73
Cortinarius citrinifolius AHS3158 TYPE U.S.A. Washington
1.00
Cortinarius percomis CFP1104 France
1.00
Cortinarius percomis TN08-041 TYPE Finland
0.50
Cortinarius percomis UDB000726 Sweden
Cortinarius percomis UDB015914 Sweden
0.53
1.00
Cortinarius delaportei RH8673 TYPE France
Cortinarius lemanicus G452177 TYPE France
Cortinarius delaportei
Cortinarius pallidifolius AHS3244 TYPE U.S.A. Washington
1.00
Cortinarius pseudocephalixus IK98-1842 Sweden
Cortinarius cinctipes GE 02-100 TYPE France
Cortinarius pseudocephalixus AY174784 Germany
Cortinarius pseudocephalixus 4446 TYPE France
/ Elastici & Percomes
Cortinarius acystidiosus CLO U.S.A. Tennessee
C. acystidiosus 1902 TYPE U.S.A. Texas
Cortinarius cf. rhizophorus IK95-1973 Germany
0.53
1.00
Cortinarius cf. rhizophorus IK98-2451 Sweden
Cortinarius cf. rhizophorus AY669527 Germany
(= C. cliduchus s. auct. p.p.)
1.00
Cortinarius cf. rhizophorus DQ083813 Denmark
1.00
Cortinarius luteovaginans AB03-11-73 TYPE France
Cortinarius aurantiopallidus AB05-11-404 TYPE France
Cortinarius aurantiopallidus
(= C. viscidoamarus)
/ Elastici & Percomes s. lato
1.00
Cortinarius russus CFP941 TYPE Sweden
Cortinarius russus CFP923 Sweden
Cortinarius immixtus GQ159888 Canada British Columbia
0.98
1.00
Cortinarius saginus CFP475 Sweden
Cortinarius saginus TN05-232 Norway
1.00
Cortinarius neotriumphans G40 TYPE France
Cortinarius neotriumphans
(= C. saginus s. auct.)
1.00
Cortinarius norrlandicus DQ117928 TYPE Sweden
Cortinarius norrlandicus IK99-711 Finland
/ Phlegmacium
1.00
Cortinarius obsoletus 5a-52-66 SYNTYPE France
Cortinarius obsoletus 5a-52-91 SYNTYPE France

Fig. 1 (cont)


1.00 Cortinarius triumphalis 3950 TYPE France
Cortinarius vulpinus CFP781 Sweden
Cortinarius triumphalis
(= C. vulpinus s. auct., C. ophiopus s. Kühner)
1.00 Cortinarius pseudovariegatus IB97/296 TYPE U.S.A. Wyoming
1.00 Cortinarius cumatilis H6016455 Finland
Cortinarius cumatilis IK98-2164 TYPE Sweden
1.00
0.99
Cortinarius praestans UDB015946 Estonia
1.00 Cortinarius praestans IK94-1861 TYPE France
Cortinarius praestans AY174804 Germany
Cortinarius rex-claricolorum AB04-09-163 TYPE France
1.00 Cortinarius pseudoturmalis PML3465 TYPE France
0.96 Cortinarius claricolor TN07-138 Finland
Cortinarius claricolor CFP691 TYPE Sweden
Cortinarius claricolor AY669522 Germany
Cortinarius claricolor
/Claricolores
1.00 Cortinarius tiliae TEB141-85 TYPE Norway
Cortinarius tiliae AY669556 Norway
Cortinarius kuehneri IB1965-0042 TYPE Austria
0.55
1.00 Cortinarius pardinus 3432 TYPE France
Cortinarius parargutus 1144 TYPE France
Cortinarius pardinus
1.00
Cortinarius patibilis IK97-086 Finland
Cortinarius patibilis IK97-087 Finland
C. patibilis 213-78 TYPE Norway
1.00 Cortinarius borgsjoeensis IK07-1029 Finland
Cortinarius borgsjoeensis CFP728 TYPE Sweden
Cortinarius congeminus 3422 TYPE France
Cortinarius claviceps 2932 TYPE France
Cortinarius clarus 4038 TYPE France
Cortinarius cupreoviolaceus 3426 TYPE France
Cortinarius subspadiceus 2780 TYPE France
1.00 Cortinarius occultus 3591 TYPE France
Cortinarius paracyanopus 3510 TYPE France
Cortinarius lintrisporus 2935 TYPE France
Cortinarius lilacinicolor 3512 TYPE France
0.66
0.97 Cortinarius largus TN08-060 TYPE Finland
Cortinarius cephalixolargus RH6048 TYPE France
Cortinarius largusiellus 3411 TYPE France
Cortinarius largus
0.99 Cortinarius squamosocephalus PC99670 TYPE France
1.00 Cortinarius eliae PML1032 TYPE France
0.68
Cortinarius eliae PC41098 France (as C. cupreoviolaceus)
Cortinarius variecolor CFP1021 TYPE Sweden
1.00 Cortinarius piriodolens 642 TYPE France
Cortinarius muricinicolor PML3582 TYPE France
Cortinarius variecolor
1.00
1.00 Cortinarius rufolatus PML664 TYPE France
Cortinarius spadicellus CFP1112 France
Cortinarius rufolatus
(= C. spadicellus s. auct.)
0.77
Cortinarius balteaticlavatus IK95-382 Finland
1.00 Cortinarius balteaticlavatus IK96-595 TYPE Finland
0.63
Cortinarius balteaticlavatus IK96-782 Finland
0.77
Cortinarius balteaticlavatus IK08-584 Finland
Cortinarius balteatialutaceus JV10452 Finland
0.99
Cortinarius balteatialutaceus IK09-751 TYPE Sweden
1.00 Cortinarius concrescens 3578 TYPE France
Cortinarius balteatoalbus IK97-761 Sweden
C. balteatoalbus RH82.98 TYPE France
/Phlegmacioides
1.00 Cortinarius chromataphilus RH86-90 TYPE France
1.00 Cortinarius chromataphilus AY669550 Germany
several synonyms, see Table 1
e.g. C. sabuletorum
1.00 Cortinarius caesiocolor IK97-207 Finland
1.00
Cortinarius caesiocolor IK00-029 TYPE Finland
1.00
Cortinarius latoclaricolor RH1199 TYPE France
Cortinarius badiolatus IK98-1029 Sweden
C. badiolatus IB53/10 TYPE Germany
(= C. durus s. auct.)
1.00 Cortinarius areni-silvae IK95-341 Finland
0.57
Cortinarius areni-silvae CFP461b TYPE Sweden
1.00
Cortinarius myrtilliphilus IK97-1469 TYPE Finland
Cortinarius myrtilliphilus TEB 4-94/AY669518 Norway
Cortinarius balteatibulbosus DBB33060 Bulgaria
Cortinarius balteatibulbosus H6027358 Finland
Cortinarius balteatibulbosus IK93-639 Finland
1.00 Cortinarius balteatibulbosus IK98-1624 TYPE Finland
Cortinarius balteatibulbosus IK04-044 Finland
Cortinarius balteatibulbosus AT2004091 Sweden
1.00
Cortinarius balteatibulbosus AT2004045 Sweden
Cortinarius balteatibulbosus AT2004088 Sweden
0.75
Cortinarius pseudonebularis G42 TYPE France
0.61
Cortinarius veneris 2952 TYPE France
Cortinarius flavescentipes 3603 TYPE France
0.84
C. balteatus var. praestantoides PML760 TYPE France
Cortinarius flavescentipes
(= C. balteatocumatilis s. auct.)
Cortinarius clarobaltoides var. longispermus 833 TYPE France
1.00 Cortinarius brunneoviolaceus 2951 TYPE France
Cortinarius brunneolividus 3734 TYPE France
Cortinarius brunneolividus
1.00
Cortinarius balteatotomentosus RH306 TYPE France
1.00
0.99 Cortinarius balteatus CFP940 TYPE Sweden
Cortinarius subopimus 3477 TYPE France
Cortinarius balteatus
0.93
Cortinarius brunneiaurantius IK93-644 Finland
1.00 Cortinarius brunneiaurantius JV17979 TYPE Finland
1.00
Cortinarius brunneiaurantius JV17979 Finland
0.59
Cortinarius sobrius PAK3235 TYPE Finland
0.98
Cortinarius sobrius IK04-045 Finland

Fig. 1 (cont)

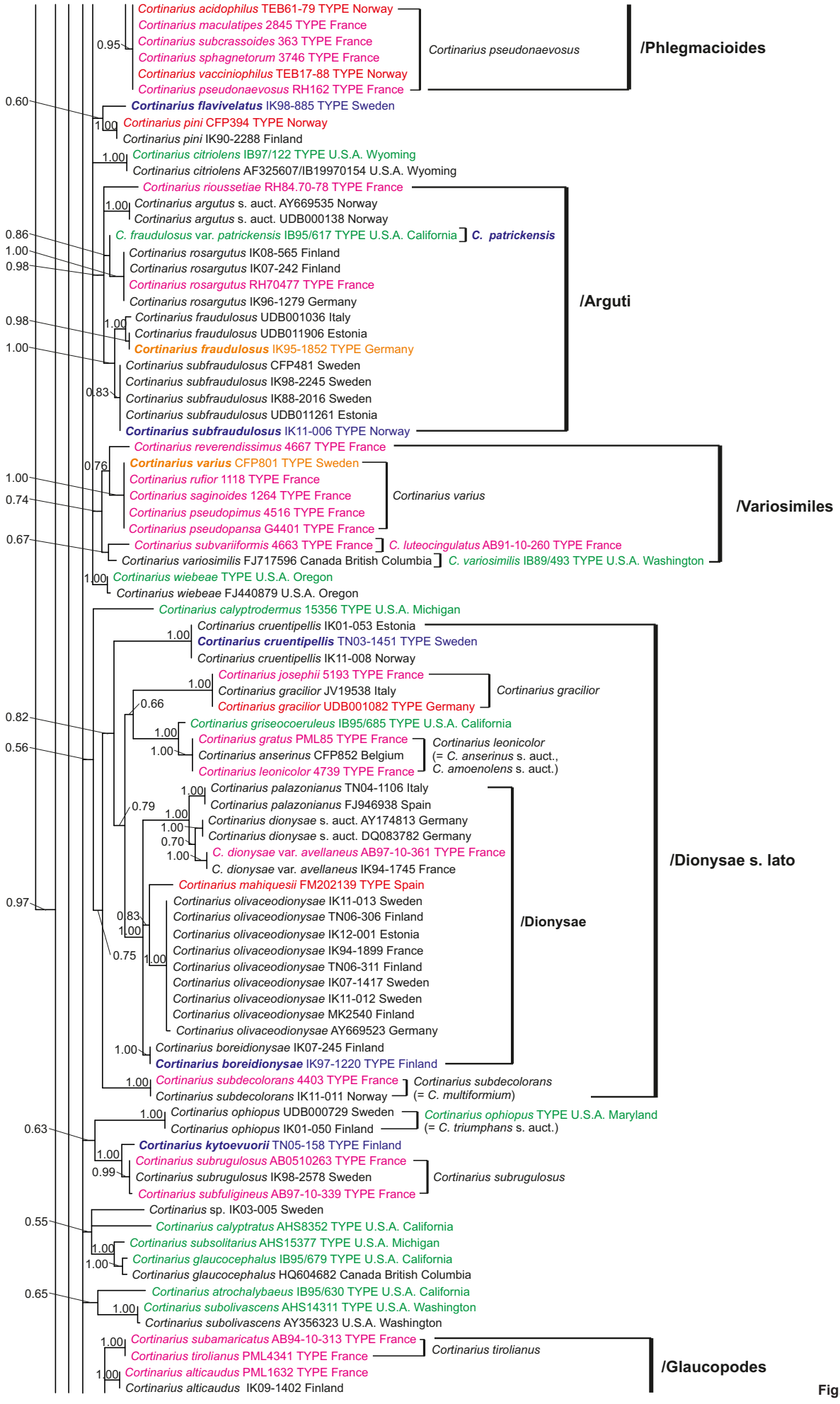
Cortinarius acidophilus TEB61-79 TYPE Norway
Cortinarius maculatipes 2845 TYPE France
Cortinarius subcrassoides 363 TYPE France
Cortinarius sphagnetorum 3746 TYPE France
Cortinarius vacciniophilus TEB17-88 TYPE Norway
Cortinarius pseudonaevosus RH162 TYPE France
Cortinarius pseudonaevosus
/Phlegmacioides
Cortinarius flavivelatus IK98-885 TYPE Sweden
Cortinarius pini CFP394 TYPE Norway
Cortinarius pini IK90-2288 Finland
Cortinarius citriolens IB97/122 TYPE U.S.A. Wyoming
Cortinarius citriolens AF325607/IB19970154 U.S.A. Wyoming
Cortinarius rioussetiae RH84.70-78 TYPE France
Cortinarius argutus s. auct. AY669535 Norway
Cortinarius argutus s. auct. UDB000138 Norway
C. fraudulosus var. patrickensis IB95/617 TYPE U.S.A. California
C. patrickensis
Cortinarius rosargutus IK08-565 Finland
Cortinarius rosargutus IK07-242 Finland
Cortinarius rosargutus RH70477 TYPE France
Cortinarius rosargutus IK96-1279 Germany
Cortinarius fraudulosus UDB001036 Italy
Cortinarius fraudulosus UDB011906 Estonia
Cortinarius fraudulosus IK95-1852 TYPE Germany
Cortinarius subfraudulosus CFP481 Sweden
Cortinarius subfraudulosus IK98-2245 Sweden
Cortinarius subfraudulosus IK88-2016 Sweden
Cortinarius subfraudulosus UDB011261 Estonia
Cortinarius subfraudulosus IK11-006 TYPE Norway
/Arguti
Cortinarius reverendissimus 4667 TYPE France
Cortinarius varius CFP801 TYPE Sweden
Cortinarius rufior 1118 TYPE France
Cortinarius saginoides 1264 TYPE France
Cortinarius pseudopimus 4516 TYPE France
Cortinarius pseudopansa G4401 TYPE France
Cortinarius varius
Cortinarius subvariiformis 4663 TYPE France
C. luteocingulatus AB91-10-260 TYPE France
Cortinarius variosimilis FJ717596 Canada British Columbia
C. variosimilis IB89/493 TYPE U.S.A. Washington
/Variosimiles
Cortinarius wiebeae TYPE U.S.A. Oregon
Cortinarius wiebeae FJ440879 U.S.A. Oregon
Cortinarius calyptrodermus 15356 TYPE U.S.A. Michigan
Cortinarius cruentipellis IK01-053 Estonia
Cortinarius cruentipellis TN03-1451 TYPE Sweden
Cortinarius cruentipellis IK11-008 Norway
Cortinarius josephii 5193 TYPE France
Cortinarius gracilior JV19538 Italy
Cortinarius gracilior UDB001082 TYPE Germany
Cortinarius gracilior
Cortinarius griseocoeruleus IB95/685 TYPE U.S.A. California
Cortinarius gratus PML85 TYPE France
Cortinarius anserinus CFP852 Belgium
Cortinarius leonicolor 4739 TYPE France
Cortinarius leonicolor
(= C. anserinus s. auct.,
C. amoenolens s. auct.)
Cortinarius palazonianus TN04-1106 Italy
Cortinarius palazonianus FJ946938 Spain
Cortinarius dionysae s. auct. AY174813 Germany
Cortinarius dionysae s. auct. DQ083782 Germany
C. dionysae var. avellaneus AB97-10-361 TYPE France
C. dionysae var. avellaneus IK94-1745 France
Cortinarius mahiquesii FM202139 TYPE Spain
Cortinarius olivaceodionysae IK11-013 Sweden
Cortinarius olivaceodionysae TN06-306 Finland
Cortinarius olivaceodionysae IK12-001 Estonia
Cortinarius olivaceodionysae IK94-1899 France
Cortinarius olivaceodionysae TN06-311 Finland
Cortinarius olivaceodionysae IK07-1417 Sweden
Cortinarius olivaceodionysae IK11-012 Sweden
Cortinarius olivaceodionysae MK2540 Finland
Cortinarius olivaceodionysae AY669523 Germany
Cortinarius boreidionysae IK07-245 Finland
Cortinarius boreidionysae IK97-1220 TYPE Finland
/Dionysae
Cortinarius subdecolorans 4403 TYPE France
Cortinarius subdecolorans IK11-011 Norway
Cortinarius subdecolorans
(= C. multiformium)
/Dionysae s. lato
Cortinarius ophiopus UDB000729 Sweden
Cortinarius ophiopus IK01-050 Finland
Cortinarius ophiopus TYPE U.S.A. Maryland
(= C. triumphans s. auct.)
Cortinarius kytoevuorii TN05-158 TYPE Finland
Cortinarius subrugulosus AB0510263 TYPE France
Cortinarius subrugulosus IK98-2578 Sweden
Cortinarius subfuligineus AB97-10-339 TYPE France
Cortinarius subrugulosus
Cortinarius sp. IK03-005 Sweden
Cortinarius calyptratus AHS8352 TYPE U.S.A. California
Cortinarius subsolitarius AHS15377 TYPE U.S.A. Michigan
Cortinarius glaucocephalus IB95/679 TYPE U.S.A. California
Cortinarius glaucocephalus HQ604682 Canada British Columbia
Cortinarius atrochalybaeus IB95/630 TYPE U.S.A. California
Cortinarius subolivascens AHS14311 TYPE U.S.A. Washington
Cortinarius subolivascens AY356323 U.S.A. Washington
Cortinarius subamaricatus AB94-10-313 TYPE France
Cortinarius tirolianus PML4341 TYPE France
Cortinarius tirolianus
Cortinarius alticaudus PML1632 TYPE France
Cortinarius alticaudus IK09-1402 Finland
/Glaucopodes

Fig. 1 (cont)

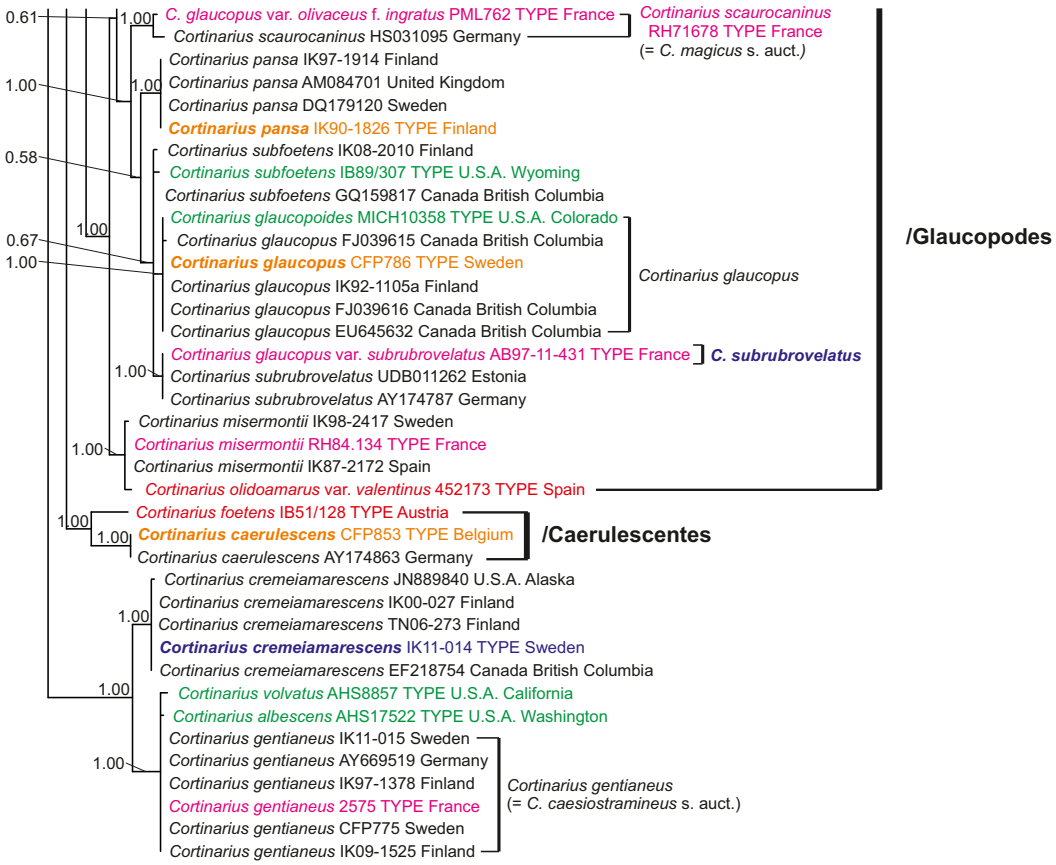

Fig. 1 (cont)

and the reactions were analysed by ABI 3730 DNA Analyzer (Applied Biosystems) automatic sequencer. Sequences were assembled and edited with Sequencer 4.1 (Gene Codes, Ann Arbor, Michigan, USA). A total of 405 new ITS sequences were produced for this study. Collections and GenBank sequences used for the phylogenetic analysis are given in Table 1 and 2. The alignment of 461 ITS sequences was produced with the MUSCLE program (Edgar 2004) under default settings and followed by manual adjustments in BioEdit (www.mbio.ncsu.edu/BioEdit/bioedit.html). The alignment is 812 nucleotides long (including gaps) and is available at TreeBASE under S14832 (http://www.treebase.org/treebase-web/home.html).

Bayesian inference (BI) was performed with MrBayes v. 3.1.1 (Ronquist & Huelsenbeck 2003). The best substitution model for alignment was estimated by both the Akaike information criterion and the Bayesian information criterion with jModelTest 0.1.1 (Posada 2008). GTR model was chosen. Two independent runs with four chains in each were performed 6 000 000 generations with sampling every 100th generation. All trees sampled before stationarity were discarded with a 25 % safety margin (burn-in of 15 000 trees, 1 500 000 generations). Sampled trees from both runs were combined in a 50 % majority rule consensus phylogram with posterior probabilities (PP). The analyses were run with computer clusters of the CSC, IT Center for Science, Espoo, Finland.

Morphological study

Morphological descriptions are based on material collected by the authors and D. Bojantchev, T.E. Brandrud, T.S. Jeppesen, E. Sesli and A.F. Taylor including specimens in all stages of development. Microscopic characteristics were observed from dried material mounted in Melzer's reagent (MLZ). Measurements were made in MLZ with an ocular micrometer using 100× oil-immersion lens. Basidiospores were measured from the veil or top of the stipe, 20 spores from one basidiocarp unless otherwise indicated. The length and width were measured for each spore, and their length/width ratios (Q value) were calculated. The average of all measurements is marked in *italic*. The lamellar trama and basidia also were examined and the pileipellis structure was studied from scalps from the pileus centre.

RESULTS

Phylogenetic analyses

The 50 % majority rule phylogram resulting from the BI analysis is shown in Fig. 1. Most species are supported by 1.00 PP (or slightly less). Six species received support below 0.95 PP: *C. castaneicolor*, *C. collocandoides*, *C. flavescentipes* (= *C. balteatocumatilis* s.auct.), *C. herpeticus*, *C. infractiflavus* and *C. multiformis*. Three species, *C. balteatoalutaceus*, *C. pseudocephalixus* and *C. subfoetens* did not form monophyletic groups in our phylogenetic analysis. Most of these nine species represent species that differ from their closest relatives by less than 10 substitutions and indel positions in ITS regions, but they all, however, have low intraspecific variation.

In a majority of the species, the intraspecific variation is from 0 to 1 substitutions or indel positions. In some species it is 2 substitutions and/or indel positions. Similarly, in a majority of the species, the interspecific difference is more than 10 substitutions and indel positions, but in some species it is only four, i.e. in the species pair *C. claricolor*/*C. rex-claricolorum*. All the species, however, have a clear barcoding gap between intra- and interspecific variation. In the following species the intraspecific variation was more than two substitutions and/or indel positions, but no clear grouping was obtained in the analysis of ITS sequences or the number of specimens was too low for making conclusions: *C. albescens*/*C. gentianeus*/*C. volvatus* complex, *C. aureofulvus* s.auct./*C. orichalceus* var. *xanthocephalus* complex, *C. herpeticus*/*C. violaceonitens* complex, *C. misermontii*/*C. olidoamarus* var. *valentinus*/*C. sub-*

accedens/*C. van-campiae* complex, *C. pallidirimosus*, *C. porphyropus* and *C. scaurus*.

A total of 236 types representing 154 species were successfully sequenced. Of these, 114 species are described only once whereas 40 species had one or more synonyms. The species with the largest number of synonyms are *C. largus* (14 synonyms), *C. pseudonaevosus* (6 synonyms), *C. talus* (5 synonyms), *C. crassus* (4 synonyms) and *C. varius* (4 synonyms). All the names of the types are listed in alphabetical order in Table 1, followed by the current name.

Several infrageneric groups with three or more species were supported by 1.00 PP: /Calochroi & Fulvi, /Claricolores, /Cyanites, /Dionysae (s.lat. 0.56 PP), /Glaucopodes, /Infracti, /Multiformes, /Phlegmacium, /Purpurascentes and /Scauri. In addition, clade /Arguti (0.98 PP) received some support and clades /Elastici & Percomes (0.94 PP, s.l. 0.53 PP), /Phlegmacioides (0.77 PP) and /Variosimiles (0.74 PP) low support.

Taxonomy

Neo- and epitypifications

Neotypes for 15 species described by Fries and six species described by Albertini, Batsch, Britzelmayr, Persoon, Schaeffer and Schweinitz are proposed as well as epitypes for three species described by Batsch, Cordier and Schaeffer in the 19th century. These include names that have been commonly used in Europe during the last 20 years (Brandrud et al. 1990,1992, 1994, 1998, Jeppesen et al. 2012) and where the current use of the names is not in contradiction with the protologue. Citations of illustrations and descriptions of the species are provided. If our observations on the species deviate from those of Brandrud et al. (1990,1992, 1994, 1998) and/or Jeppesen et al. (2012), they are presented in comments under each species. For *C. cyanites* and *C. fraudulosus* full descriptions are provided since the current use of the name included several closely related species. Synonyms are based on DNA studies of the type specimens and the information on the types is presented in Table 1. The reasonings for synonymy are presented in the discussion.

Cortinarius balteatus (Fr.) Fr., Epicr. Syst. Mycol.: 257. 1838

Basionym. *Agaricus balteatus* Fr., Observ. Mycol. 2: 138. 1818.
= *Cortinarius subbalteatus* Kühner, Bull. Mens. Soc. Linn. Lyon 24, 2: 40. 1955.
= *Cortinarius balteatotomentosus* Rob. Henry ex Rob. Henry, Bull. Soc. Mycol. France 101, 1: 4. 1985.
= *Cortinarius subopimus* Bidaud, Atlas des Cortinaires 7: 231. 1995.

Neotype. Sweden, Ångermanland, Säbrå, Överdal, under *Picea* on cultivated area, 3 Aug. 1990, *Brandrud et al.* CFP940 (S), designated here. MycoBank MBT176298. GenBank KF732262.

Illustrations — Brandrud et al. (1994: pl. C60), Fries (1867–1884: pl. 142).
Descriptions of the species — Brandrud et al. (1994: pl. C60), Jeppesen et al. (2012: 814).

Notes — *Cortinarius balteatotomentosus* was first described in 1958 without indicating a type, nonetheless Index Fungorum and MycoBank report it as valid. The validation has been performed later by Henry (1985) giving the holotype no. 306.

Cortinarius caerulescens (Schaeff.) Fr., Epicr. Syst. Mycol.: 265. 1838

Basionym. *Agaricus caerulescens* Schaeff., Fung. Bavar. Palat. 4: 17. 1774.

Lectotype. J.C. Schaeffer, Fung. Bav. I, t. 34, f. I, II, III (1762) (designated in Cortin. Fl. Photogr. II (Swedish version): 11, 1992).

Epitype. Belgium, Brabant, Tervuren, in beech forest on calcareous soil, 23 Sept. 1989, *Brandrud et al.* CFP853 (S), designated here. MycoBank MBT176395. GenBank KF732271.

Illustrations — Brandrud et al. (1992: pl. B51), also see MycoBank.
Descriptions of the species — Brandrud et al. (1992: pl. B51), Jeppesen et al. (2012: 793).

Cortinarius claricolor (Fr.) Fr., Epicr. Syst. Mycol.: 257. 1838

Basionym. *Agaricus multiformis* ð *claricolor* Fr., Observ. Mycol. 2: 65. 1818.
= *Cortinarius pseudoturmalis* Bidaud & Moënne-Locc., Atlas des Cortinaires 19: 1503. 2010.

Neotype. Sweden, Ångermanland, Stigsjö, Uland, Långmyrberget, in spruce forest with blueberry, 9 Aug. 1988, *Brandrud et al.* CFP691 (S), designated here. MycoBank MBT176396. GenBank KF732283.

Illustrations — Bidaud et al. (2010: pl. 759), Brandrud et al. (1992: pl. B48), Fries (1867–1884: pl. 141).
Descriptions of the species — Brandrud et al. (1992: pl. B48), Jeppesen et al. (2012: 821).

Cortinarius cumatilis Fr., Epicr. Syst. Mycol.: 269. 1838

Neotype. Sweden, Närke, Hidinge, Garphyttans National Park, N of the road, grass-herb forest with *Corylus*, *Populus tremula*, *Ulmus*, *Fagus*, *Quercus* and *Picea*, 150 m asl, 20 Sept. 1998, *I. Kytövuori* 98-2164 (H; NY isoneotype), designated here. MycoBank MBT176397. GenBank KF732293.

Illustrations — Brandrud et al. (1990: pl. A47), Fries (1867–1884: pl. 146).
Descriptions of the species — Brandrud et al. (1990: pl. A47), Jeppesen et al. (2012: 824).

Cortinarius cyanites Fr., Epicr. Syst. Mycol.: 279. 1838

= *Cortinarius pseudocyanites* var. *paucus* Reumaux, Atlas des Cortinaires 15: 1032. 2005.
= *Cortinarius subcyanites* Bidaud, Atlas des Cortinaires 15: 1032. 2005.

Neotype. Sweden, Uppland, Uppsala, Stadsskogen, mixed forest, 26 Aug. 2005, *A. Taylor* 2005069 (S; UPS isoneotype), designated here. MycoBank MBT176398. UNITE No. UDB002193, GenBank KF732355.

Illustrations — Bidaud et al. (2005: pl. 534), Fries (1867–1884: pl. 152).

Pileus 3–9 cm broad, convex with persistently incurved margin, plano-convex when old, innately fibrillose, greyish blue to greyish brown at centre, greyish blue towards the margin, first viscid but soon dry. *Lamellae* emarginate, medium spaced to almost crowded, first dark violet, later brownish violet. *Stipe* 4.5–10 cm long, 1–1.5 cm thick at apex, 1.5–4 cm at base, clavate, blue to greyish blue. *Universal veil* greyish to brownish grey, forming complete and incomplete fibrillose girdles on stipe. *Context* bluish white in pileus, stronger blue adjacent to lamellae, bluish in stipe, becoming vinaceous red on exposure, marbled hygrophanous. *Odour* pleasant, fruity (according to Bidaud et al. 2005). *Exsiccata*: pileus pale bluish grey to lilac grey, when young with the same tint as *C. traganus*, often with a pale brownish tint at the centre, weakly fibrillose, stipe bluish grey, brownish at the base.

Spores 8.8–*9.8*–10.9 × 5.2–*5.7*–6.3 µm, av. = 9.5–10.0 × 5.5–5.8 µm, Q = 1.59–1.72–1.84, Qav. = 1.66–1.77 (6 specimens, 240 spores), amygdaloid, with a fairly narrow apex, moderately verrucose, some with few small golden yellow guttules, fairly faintly dextrinoid. *Basidia* 32–41 × 7–9 µm (80 basidia), 4-spored, narrowly clavate, with blood red guttules, many with yellowish contents. *Lamellar trama hyphae* yellowish, smooth, with abundant small to large to worm-like blood red guttules. *Stipe apex hyphae* almost colourless to yellowish, smooth, with abundant small to large to worm-like, blood red guttules, the

guttulate layer thick. On the surface few bands of entangled, ochraceous hyphae mostly without guttules. *Pileipellis*: epicutis very weakly gelatinous, uppermost hyphae 3–10 µm wide, very pale ochraceous brownish, mostly very sparsely, spot-like incrusted, often with scanty to abundant small blood red guttules, lower down 3–9 µm wide, almost colourless, smooth hyphae with abundant small to large to worm-like, blood red guttules. Hypoderm not developed.

Ecology & Distribution — In mixed forests of coniferous and deciduous trees, host unknown.

Notes — We studied the *C. cyanites* species complex and recognized three different species, *C. cyanites* s.str., *C. boreicyanites* and *C. violaceorubens*. All the species were well supported in our phylogenetic analysis and differ from one another by more than 20 substitutions and indel positions. The most distinct of the species is *C. violaceorubens*. It has a dark, violaceous-brownish pileus, the exsiccata are dirty violaceous grey to violaceous brown, and the spores are largest of the group (av. 9.9–11.0 × 6.3–6.6 µm). It grows in *Picea* dominated forests, often on rich soil and is known from France, Germany, Sweden and Finland. Sister species *C. cyanites* and *C. boreicyanites* both have smaller spores and paler exsiccata. Of these, *C. boreicyanites* is so far only known from the middle boreal zone of Sweden, Finland and Scotland while *C. cyanites* has a more southern distribution extending from South Finland and middle Sweden to France. In the protologue of *C. cyanites* Fries described a species with a "pileo pallide coeruleo". In addition, the picture of *C. cyanites* in Fries (1867–1884: pl. 152) illustrates a species with a bluish grey pileus. Attached at the base of the stipe there are leaves of *Quercus* and *Betula* and spruce needles. Based on the protologue, illustration, and ecology and distribution of the three species we conclude that the species best fitting the description of Fries is the one described here as *C. cyanites* and we here propose collection *A. Taylor 2005069* as neotype for the species.

Cortinarius fraudulosus Britzelm., Ber. Naturhist. Vereins Augsburg 4: 122. 1885

Neotype. Germany, Baden-Württemberg, Freudenstadt, Heiligenbronn, gently sloping grass-herb conifer forest on calcareous soil, *Abies alba*, *Picea abies*, *Fagus sylvatica*, 5 Oct. 1995, *I. Kytövuori* 95-1852, H7019563 (H; NY isoneotype), designated here. MycoBank MBT176399. GenBank KF732518.

Illustration — Abarenkov et al. (2010: photo under the accession no. UDB011906).

Pileus 4–8 cm broad, hemispherical to convex, then planoconvex, fibrillose, white to ochraceous white when young, with age becoming pale brownish. *Lamellae* emarginate, almost distant, first white to very pale brownish grey, later pale brown. *Stipe* 5–10 cm long, 1–2 cm thick at apex, 1.5–3.5 cm wide at base, clavate to almost bulbose, sometimes slightly rooting, whitish, with handling and with age becomes brownish. *Universal veil* white, forming distinct girdles on stipe, sometimes floccose. *Context* white. *Odour* not recorded. *Exsiccata* pale greyish brown.

Spores 12.9–*13.7*–15.0 × 7.3–*8.1*–8.8 µm, Q = 1.60–*1.70*–1.78 (1 specimen, 20 spores), amygdaloid, with a narrow apex, fairly strongly verrucose, warts anastomosing, not high, some with dark intracellular granules, moderately dextrinoid. *Basidia* 42–53 × 10–12 µm (20 basidia), 4-spored, clavate, otherwise colourless but with a few dark granular bodies. *Lamellar trama hyphae* sand brown, full of small dark granules or particles. *Stipe apex hyphae* yellow brown to red brown, entangled, otherwise colourless, but with small to large to long bodies of red brown to red blackish to black granules, uppermost hyphae 5–10 µm wide. *Pileipellis*: epicutis fairly weakly gelatinous, hyphae 5–15 µm wide, ochraceous brownish, finely, densely incrusted, with scanty red brown granules. Hypoderm present. In the overall view red brown and unstructured when seen from above.

Ecology & Distribution — In montane and hemiboreal conifer forests, calcicolous. Known from Germany, Italy and Estonia. Fruiting in autumn.

Notes — The material of *C. fraudulosus* formed two well supported groups in our phylogenetic analysis. One group consisted of specimens collected from Germany, Italy and Estonia while the other group included mainly specimens from northern Europe. Since *C. fraudulosus* Britzelm. is described from Germany, the neotype is chosen among the Central/southern European clade and the other is described below as a new species *C. subfraudulosus*.

Cortinarius glaucopus (Schaeff.: Fr.) Gray, Nat. Arr. Brit. Pl. 1: 629. 1821

Basionym. *Agaricus glaucopus* Schaeff., Fung. Bavar. Palat. 4: 23. 1774: sanctioned in Fr., Syst. Mycol. 1: 224. 1821.

= *Cortinarius glaucopoides* Kauffman, Papers from the Michigan Academy of Science, Arts and Letters 1: 133. 1923.

Neotype. Sweden, Medelpad, Alnö, Ås brygga, in dry spruce forest on calcareous soil, 21 Sept. 1988, *Brandrud et al.* CFP786 (S), designated here. MycoBank MBT176400. GenBank KF732315.

Illustration — Brandrud et al. (1994: pl. C30).
Description of the species — Jeppesen et al. (2012: 802).

Notes — The description of *Agaricus glaucopus* in Fries (1821) is short but fits our species. In addition, an unpublished plate of *C. glaucopus* painted with the supervision of Fries (S, 0318) exists. It represents a species with red brown pileus and bluish lamellae. It is very similar to the photograph of collection CFP786 in Brandrud et al. (1994), which we propose as a neotype for the species. Our observations of *C. glaucopus* are consistent with those of Jeppesen et al. (2012), only the length of the spores is slightly different: our measurements 7.3–*8.1*–9 × 4.5–*5.0*–5.5 µm, Q = 1.54–*1.63*–1.76, Jeppesen et al. (2012): 7–8.5 × 4.5–5.5 µm.

Cortinarius herpeticus Fr., Epicr. Syst. Mycol.: 268. 1838

= *Cortinarius thalliopurpurascens* Rob. Henry, Doc. Mycol. 25 (no. 97): 48. 1995.

Neotype. Sweden, Ångermanland, Säbrå, Hällenyland, under *Picea* on cultivated area, 20 July 1990, *Brandrud et al.* CFP936 (S), designated here. MycoBank MBT176401. GenBank KF732321.

Illustration — Brandrud et al. (1994: pl. C08, as *C. scaurus* var. *herpeticus*).
Descriptions of the species — Brandrud et al. (1994: pl. C08), Jeppesen et al. (2012: 784).

Notes — An unpublished plate of *C. herpeticus* (S, 0324) painted with the supervision of Fries exists. The basidiomes in the illustration are similar to the ones in the photo of collection CFP936 (Brandrud et al. 1994), which we propose as a neotype for the species. *Cortinarius herpeticus* is distinguished from *C. scaurus* by a stouter appearance, paler colours, more strongly ornamented spores and above all the lack of sepia-coloured pigments in the epicutis. *Cortinarius violaceonitens* is fairly similar, but is separated by the spores, which are narrower (9.3–*10.0*–10.7 × 5.4–*5.9*–6.3 µm), amygdaloid-fusoid, with a shallow suprahilar depression, a low ventral humb and blunt apex, and very strongly verrucose surface especially at the apex. The spores of *C. herpeticus* are 9.1–*10.3*–11.6 × 5.7–*6.4*–7.0 µm, narrowly oblong-ellipsoid, and moderately to strongly verrucose.

Cortinarius infractus (Pers.: Fr.) Fr., Epicr. Syst. Mycol.: 261. 1838

Basionym. *Agaricus infractus* Pers., Observ. Mycol. 2: 42. 1800 (1799): sanctioned in Fr., Syst. Mycol. 1: 223. 1821.
= *Cortinarius amarocaerulescens* Bidaud, Atlas des Cortinaires 18: 1376. 2009.
= *Cortinarius infractus* var. *aeruginosus* Reumaux, Atlas des Cortinaires 18: 1376. 2009.

Neotype. Sweden, Bohuslän, Tossene, Anneröd, beech forest, medium rich soil, 15 Sept. 1986, *Brandrud et al.* CFP495 (S), designated here. MycoBank MBT176402. GenBank KF732325.

Illustrations — Bidaud et al. (2009: pl. 739), Brandrud et al. (1990: pl. A09).
Description of the species — Brandrud et al. (1990: pl. A09).

Cortinarius largus Fr., Epicr. Syst. Mycol.: 259. 1838

= *Cortinarius cephalixolargus* Rob. Henry, Bull. Trimestriel Soc. Mycol. France 93, 3: 323. 1977.
= *Cortinarius clarus* Reumaux, Atlas des Cortinaires 8: 291. 1996.
= *Cortinarius claviceps* Reumaux, Atlas des Cortinaires 8: 291. 1996.
= *Cortinarius congeminus* Moënne-Locc. & Reumaux, Atlas des Cortinaires 7: 228. 1995.
= *Cortinarius cupreoviolaceus* Bidaud & Reumaux, Atlas des Cortinaires 8: 292. 1996.
= *Cortinarius largusiellus* Reumaux, Atlas des Cortinaires 8: 293. 1996.
= *Cortinarius lilacinicolor* Reumaux, Atlas des Cortinaires 8: 294. 1996.
= *Cortinarius lintrisporus* Reumaux, Doc. Mycol. 27, no. 106: 53. 1997.
= *Cortinarius lividoviolaceus* Rob. Henry, Doc. Mycol. 17, no. 68: 27. 1987.
= *Cortinarius occultus* Moënne-Locc. & Reumaux, Atlas des Cortinaires 8: 295. 1996.
= *Cortinarius patibilis* var. *scoticus* Brandrud, Edinburgh J. Bot. 54, 1: 114. 1997.
= *Cortinarius paracrassus* Reumaux, Atlas des Cortinaires 7: 230. 1995.
= *Cortinarius paracyanopus* Moënne-Locc. & Reumaux, Atlas des Cortinaires 8: 296. 1996.
= *Cortinarius subspadiceus* Reumaux, Atlas des Cortinaires 8: 298. 1996.

Neotype. Finland, Varsinais-Suomi, Turku, Ruissalo, deciduous forest of *Quercus robur*, *Corylus avellana* and some *Betula* on mull soil, 3 Sept. 2008, *K. Liimatainen & T. Niskanen* 08-060, H6001957 (H; NY isoneotype), designated here. MycoBank MBT176403. GenBank AB859985.

Illustration — Brandrud et al. (1998: pl. D22).
Descriptions of the species — Brandrud (1998), Brandrud et al. (1998: pl. D22), Jeppesen et al. (2012: 815).

Notes — Based on morphological and molecular data *C. largus* seems like a uniform species. The collection CFP1085 (Brandrud et al. 1998), however, is from France and therefore not ideal as a type for a species described from Sweden. We do not have our own, well-documented specimen from Sweden and therefore we propose the collection *K. Liimatainen & T. Niskanen* 08-060 from hemiboreal deciduous forest from south western Finland as a neotype for the species.

Cortinarius multiformis Fr., Epicr. Syst. Mycol.: 263. 1838

Neotype. Sweden, Ångermanland, Häggdånger, Sjö, spruce forest with blueberry, 21 Aug. 1986, *Brandrud et al.* CFP445 (S), designated here. MycoBank MBT176404. GenBank KF732350.

Illustration — Brandrud et al. (1990: pl. A45).
Descriptions of the species — Brandrud et al. (1990: pl. A45), Jeppesen et al. (2012: 808).

Notes — The species as neotypified here fits best the original description of the species and the unpublished plate of *C. multiformis* (S0350). The reminiscent sister species *C. talimultiformis*, which has been mixed with *C. multiformis*, has white fibrils on the pileus, and less dextrinoid spores. Our observations of *C. multiformis* are in concordance with those of Brandrud et al. (1990) and Jeppesen et al. (2012: 808), except that our spore measurements are somewhat larger, 8.6–*9.6*–10.4 × 5.2–*5.7*–6.1 µm, Q = 1.58–*1.70*–1.79 than those of Brandrud et al. (1990) and Jeppesen et al. (2012) 8–9.5 × 5–5.5 µm.

Cortinarius pansa (Fr.) Sacc., Syll. Fung. 5: 901. 1887

Basionym. *Agaricus pansa* Fr., Observ. Mycol. (Havniae) 2: 67. 1818.

Neotype. Finland, Varsinais-Suomi, Kemiö, Pedersåå, at small, abandoned limestone quarries, spruce heath forest, roadside, 35 m asl, 21 Sept. 1990, *I. Kytövuori* 90-1826 (H; isoneotype NY), designated here. MycoBank MBT176405. GenBank KF732522.

Illustration — Fries (1867–1884: pl. 145).
Description of the species — Jeppesen et al. (2012: 803).

Notes — The description and illustration of *C. pansa* published by Fries (1818, 1867–1884) fit well with the species presented in Jeppesen et al. (2012). The spore measurements given in Jeppesen et al. (2012) (6–)6.5–7.5 × 4–5 µm differ somewhat from ours 6.8–*7.5*–8.2 × 4.3–*4.6*–5.0 µm, Q = 1.52–*1.64*–1.82. The species was previously included in *C. glaucopus* but differs from it by more red brown pileus, smaller, less verrucose spores, and habitat often on roadsides, yards, parks and plantations.

Cortinarius percomis Fr., Epicr. Syst. Mycol.: 260. 1838

Neotype. Finland, Varsinais-Suomi, Karjaa, Kohagen, herb-rich *Picea abies* forest with some *Corylus avellana*, *Quercus robur*, *Betula* and *Populus tremula*, 2 Sept. 2008, *K. Liimatainen & T. Niskanen* 08-041 (H; isoneotype NY), designated here. MycoBank MBT176406. GenBank KF732380.

Illustrations — Brandrud et al. (1994: pl. C56), Fries (1867–1884: pl. 143).
Descriptions of the species — Brandrud et al. (1994: pl. C56), Jeppesen et al. (2012: 812).

Notes — Based on morphological and molecular data *C. percomis* seems like a uniform species. The collection CFP1104 (Brandrud et al. 1994), however, is from France and therefore not ideal as a type for a species described from Sweden. We do not have our own, well-documented specimen from Sweden and therefore we propose the collection *K. Liimatainen & T. Niskanen* 08-041 from hemiboreal *Picea abies* dominated forest from south western Finland as a neotype for the species. An identical ITS sequence of the species from a specimen collected from Sweden, however, exists in UNITE (UDB000726).

Cortinarius porphyropus (Alb. & Schwein.) Fr., Epicr. Syst. Mycol.: 271. 1838

Basionym. *Agaricus porphyropus* Alb. & Schwein., Consp. Fungorum Lusat.: 153. 1805.
= *Cortinarius porphyropus* var. *porphyrophorus* Reumaux, Atlas des Cortinaires 18: 1378. 2009.

Neotype. Sweden, Jämtland, Ragunda sn, Ragunda, in birch forest on rich soil, 20 Aug. 1988, *Brandrud et al.* CFP717 (S), designated here. MycoBank MBT176407. GenBank KF732387.

Illustration — Brandrud et al. (1992: pl. B55).
Descriptions of the species — Brandrud et al. (1992: pl. B55), Jeppesen et al. (2012: 819).

Notes — *Cortinarius porphyropus* is described from Germany. Based on our studies it is a uniform and widespread species occurring at least in Europe and North America (Fig. 1). The most representative collection CFP717 from Sweden is here proposed as a neotype for the species.

Cortinarius praestans (Cordier) Gillet, Hyménomycètes: 475. 1874

Basionym. *Agaricus praestans* Cordier, Champ. France, Discom.: 98. 1870.

Holotype. Pl. XXI (Cordier, Champ. France, 1870).

Epitype. France, Ain, Oyonnax SE, Commune d'Echallon, by the road from St-Germain-de-Joux to Echallon, N of the crossing to Plagne, E sloping, rich *Fagus* forest with *Picea abies*, 540 m asl, 27 Oct. 1994, *P. & I. Kytövuori* 94-1861 (H; isoepitype NY). MycoBank MBT176411. GenBank KF732389.

Illustration — Brandrud et al. (1990: pl. A42).
Descriptions of the species — Brandrud et al. (1990: pl. A42), Jeppesen et al. (2012: 823).

Notes — *Cortinarius praestans* is one of the most distinctive *Cortinarius* species and is easy to recognize by its large basidiomata and spores, and habitat with thermophilous deciduous trees. It is described from France, but identical sequences of the species exist from Estonia, Germany, Italy and Sweden (Fig. 1, Table 2).

Cortinarius purpurascens Fr., Epicr. Syst. Mycol.: 265. 1838

= *Cortinarius eumarginatus* Rob. Henry ex Bidaud, Carteret & Reumaux, Atlas des Cortinaires 18, 1, 2: 1378. 2009.

Neotype. Sweden, Närke, Hidinge, Garphyttans National Park, S of the road, fairly rich spruce grass-herb forest with *Corylus*, *Populus tremula*, *Betula* and *Quercus*, 150 m asl, 20 Sept. 1998, *I. Kytövuori* 98-2121 (H; isoneotype NY), designated here. MycoBank MBT176419. GenBank KF732406.

Illustration — Bidaud et al. (2009: pl. 743).
Description of the species — Jeppesen et al. (2012: 802).

Notes — Based on the data we have so far, the species is known from northern to southern Europe (Fig. 1).

Cortinarius russus Fr., Epicr. Syst. Mycol.: 261. 1838

Neotype. Sweden, Ångermanland, Säbrä, Överdal, in dry spruce forest on rich soil, 3 Aug. 1990, *Brandrud et al.* CFP941 (S), designated here. MycoBank MBT176412. GenBank KF732416.

Illustration — Brandrud et al. (1994: pl. C35, C44).
Descriptions of the species — Brandrud et al. (1994: pl. C35), Jeppesen et al. (2012: 817).

Cortinarius scaurus (Fr.: Fr.) Fr., Epicr. Syst. Mycol.: 268. 1838

Basionym. *Agaricus scaurus* Fr., Observ. Mycol. 2: 75. 1818.
= *Cortinarius parolivascens* Moënne-Locc. & Reumaux, Atlas des Cortinaires 18: 1375. 2009.
= *Cortinarius scaurus* var. *notandus* Bidaud, Atlas des Cortinaires 18: 1375. 2009.
= *Cortinarius scaurus* f. *phaeophyllus* M.M. Moser, Fungi non Delineati 15: 18. 2001.

Neotype. Switzerland, Bern, Fribourg, Rechthalten, on the border of a peat-bog with *Pinus strobus*, 29 Sept. 1991, *Brandrud et al.* CFP1074 (S), designated here. MycoBank MBT176413. GenBank KF732423.

Illustrations — Brandrud et al. (1994: pl. C21), Fries (1867–1884: pl. 146).
Descriptions of the species — Brandrud et al. (1994: pl. C21), Jeppesen et al. (2012: 783).

Notes — *Cortinarius scaurus* is a widespread species and to date known from eastern North America and Europe (Fig. 1). The most representative collection CFP1074 from Switzerland is proposed as a neotype and the ITS sequence of the specimen is identical to the UNITE sequence UDB001068 from Femsjö, Sweden.

Cortinarius serarius Fr., Epicr. Syst. Mycol.: 269. 1838

Neotype. Sweden, Ångermanland, Häggdånger, Torrom, in dry spruce forest on rich soil, 11 Aug. 1990, *Brandrud et al.* CFP959 (S), designated here. MycoBank MBT176414. GenBank KF732428.

Illustration — Brandrud et al. (1994: pl. C25).
Descriptions of the species — Brandrud et al. (1994: pl. C25), Jeppesen et al. (2012: 824).

Cortinarius subpurpurascens (Batsch) Fr., Epicr. Syst. Mycol.: 265. 1838

Basionym. *Agaricus subpurpurascens* Batsch, Elench. Fung., cont. prim.: 71. 1786.
= *Cortinarius largoides* Rob. Henry ex Bidaud, Carteret & Reumaux, Atlas des Cortinaires 18: 1378. 2009.
= *Cortinarius subinops* Reumaux, Atlas des Cortinaires 18: 1379. 2009.

Holotype. Batsch, Elench. Fung., cont. prim. tab. 16: 74. 1786.
Epitype. Finland, Varsinais-Suomi, Turku, Ruissalo, deciduous forest of *Quercus robur*, *Corylus avellana* and some *Betula* on mull soil, 3 Sept. 2008, *K. Liimatainen & T. Niskanen* 08-059 (H; isoepitype NY), designated here. MycoBank MBT176420. GenBank KF732449.

Illustrations — Bidaud et al. (2009: pl. 749, 750).
Description of the species — Jeppesen et al. (2012: 819).

Notes — Based on the data we have so far the species is known from northern to southern Europe (Fig. 1). A representative collection *Liimatainen & Niskanen* 08-059 from South Finland is here proposed as an epitype of the species.

Cortinarius subtortus (Pers.) Fr., Epicr. Syst. Mycol. (Upsaliae): 273. 1838

Basionym. *Agaricus subtortus* Pers., Syn. Meth. Fung. (Göttingen) 2: 284. 1801, sanctioned in Fr., Syst. Mycol. 1: 222. 1821.

Neotype. Sweden, Inre Småland, Femsjö, Prästskogen, partly paludified spruce forest with some deciduous tree species, 175 m asl, 18 Sept. 1987, *I. Kytövuori* 87-1510 (H; isoneotype NY), designated here. MycoBank MBT176415. GenBank KF732454.

Description of the species — Jeppesen et al. (2012: 811).

Cortinarius talus Fr., Epicr. Syst. Mycol.: 263. 1838

= *Cortinarius aurantionapus* Bidaud & Reumaux, Atlas des Cortinaires 16: 1096. 2006.
= *Cortinarius crenulatus* Rob. Henry ex Bidaud & Reumaux, Atlas des Cortinaires 16: 1097. 2006.
= *Cortinarius ochropudorinus* Rob. Henry ex Bidaud & Reumaux, Atlas des Cortinaires 16: 1097. 2006.
= *Cortinarius pseudominor* Rob. Henry ex Reumaux, Atlas des Cortinaires 16: 1098. 2006.
= *Cortinarius pseudotalus* Rob. Henry ex Bidaud & Reumaux, Atlas des Cortinaires 16: 1098. 2006.

Neotype. Sweden, Jämtland, Ragunda sn, Ragunda, in birch forest on rich soil (*Betula*, *Populus*, *Pinus*), 26 Aug. 1989, *Brandrud et al.* CFP832 (S), designated here. MycoBank MBT176416. GenBank KF732457.

Illustrations — Brandrud et al. (1992: pl. B47), Fries (1867–1884: pl. 145).
Descriptions of the species — Brandrud et al. (1992: pl. B47), Jeppesen et al. (2012: 811).

Notes — Our observations of the species are in concordance with those of Brandrud et al. (1992) and Jeppesen et al. (2012), except for the length of the spores, which according to our measurements is 7.3–*8.0*–8.8 × 4.5–*5.0*–5.2 µm and in Brandrud et al. (1992) and Jeppesen et al. (2012) 7.5–9.5 × 4.5–5.5 µm.

Cortinarius turmalis Fr., Epicr. Syst. Mycol.: 257. 1838

Neotype. Sweden, Medelpad, Borgsjö, Julåsen, in herbaceous spruce forest, 20 Aug. 1988, *Brandrud et al.* CFP716 (S), designated here. MycoBank MBT176417. GenBank KF732464.

Illustration — Brandrud et al. (1994: pl. C31).
Descriptions of the species — Brandrud et al. (1994: pl. C31), Jeppesen et al. (2012: 821).

Cortinarius variecolor (Pers.: Fr.) Fr., Epicr. Syst. Mycol.: 259. 1838

Basionym. *Agaricus variecolor* Pers., Syn. Meth. Fung. 2: 280. 1801. Sanctioned in Fr., Syst. Mycol. 1: 222. 1821.

= *Cortinarius muricinicolor* Moënne-Locc., Atlas des Cortinaires 8: 295. 1996.

= *Cortinarius piriodolens* Moënne-Locc., Atlas des Cortinaires 8: 296. 1996.

Neotype. Sweden, Gotland, Viklau, Tjaukle, in spruce forest on calcareous soil, 29 Sept. 1990, *Brandrud et al.* CFP1021 (S), designated here. MycoBank MBT176418. GenBank KF732466.

Illustrations — Brandrud et al. (1992: pl. B20), Fries (1867–1884: pl. 144).

Descriptions of the species — Brandrud (1998), Brandrud et al. (1992: pl. B20), Jeppesen et al. (2012: 815).

NEW SPECIES AND COMBINATIONS

Species with an isolated position

Cortinarius cremeiamarescens Kytöv., Liimat. & Niskanen, *sp. nov*. — MycoBank MB805786; Fig. 2a, 3a

Etymology. The name refers to the colour of the basidiomata and bitter taste of pileus cuticle.

= *Cortinarius caesiostramineus* Rob. Henry sensu Brandrud et al. 1990, Jeppesen et al. 2012, p.p.

Type. Sweden, Gotland, Alskog and När parish, Ollajvs Nature Reserve, mesic to damp spruce forest with some *Pinus*, *Quercus* and *Corylus*, 27 Sept. 2011, *I. Kytövuori* 11-014 (holotype H; isotype NY). GenBank KF732493.

Pileus 3.5–5.5 cm broad, hemispherical to convex, then expanded, very finely innately fibrillose, cream-coloured to pale

Fig. 2 Photo of: a. *C. cremeiamarescens* TN06-273; b. *C. flavivelatus* IK98-885; c. *C. kytoevuorii* TN05-158; d. *C. flavipallens* T. Kekki 368; e. *C. boreidionysae* IK97-1220; f. *C. cruentipellis* IK01-053; g. *C. caesiophylloides* TEB277-09. — Photos: a, c. Kare Liimatainen; b, e, f. I. Kytövuori; d. T. Kekki; g. T.E. Brandrud.

ochraceous yellow. *Lamellae* emarginate, almost crowded, pale greyish brown. *Stipe* 6.5–9.5 cm long, 0.7–1.4 cm thick at apex, 1–2.3 cm wide at base, with slightly marginate bulb, at first white, becoming pale brownish yellow with age. *Universal veil* white, sparse, at bulb margin. *Context* white. *Odour* indistinct. *Taste:* pileus cuticle bitter. *Exsiccata*: pileus ochraceous clay-colour to ochraceous yellow to warm ochraceous brown especially at the centre, stipe pale grey to brown.

In MLZ: *Spores* 7.0–*7.8*–8.8 × 4.3–*4.7*–5.0 µm, av. = 7.5–8.3 × 4.6–4.9 µm, Q = 1.54–*1.67*–1.87, Qav. = 1.59–1.74 (9 specimens, 260 spores, Fig. 3a), citriform to narrowly fusoid, beaked, thin-walled, fairly finely, densely, and often sharply verrucose, slightly to moderately dextrinoid. *Basidia* 24–34 × 6.5–8 µm (80 basidia), 4-spored, narrowly clavate, very thin-walled, colourless, more or less filled with blood red drops. *Lamellar trama hyphae* yellow, filled with small blood red drops, larger globose and worm-like guttules fairly scanty (especially more scanty than in *C. gentianeus*). *Stipe apex hyphae* almost colourless to yellow, smooth, full of small golden yellow to blood red drops, larger globose and worm-like guttules fewer. *Pileipellis*: epicutis strongly gelatinous, hyphae 2–6 µm wide, very thin-walled and difficult to define, filled with small to medium-sized blood red guttules, mostly evenly distributed in the hyphae. Hypoderm present, pale yellow. In *C. gentianeus* the epicutis hyphae are full of very long, worm-like, foamy guttules and the blood red layer is much thicker than in *C. cremeiamarescens*.

Ecology & Distribution — In hemiboreal and southern boreal conifer-dominated forests on rich to calcareous soil. Known from southern Europe and western North America, British Columbia and Alaska. Fruits from late August to late October.

Other specimens examined. Finland, Varsinais-Suomi, Parainen, Lemlahdensaari, Fallskogen, *Pinus sylvestris* heath forest with some *Picea abies* on sandy soil, by the calcareous dust road, 20 Oct. 2006, *K. Liimatainen & T. Niskanen* 06-273; Uusimaa, Espoo, Luukkaa outdoor recreation area, N of Haukkalampi, mesic, partly grass-herb-spruce forest with some *Populus tremula*, *Betula* and *Pinus sylvetris*, 9 Sept. 2004, *K. Liimatainen & T. Niskanen* 04-768, H6029461; Kirkkonummi, Dorgarn, Meiko-Trehörningen nature reserve, semi-open spruce forest with some hardwood bushes, 27 Sept. 2007, *I. Kytövuori* 07-1722, H6001575 (H); Siuntio, Lappträsk, grass-herb-spruce forest with some *Pinus*, *Betula*, *Populus* and *Corylus*, 24 Aug. 2000, *I. Kytövuori* 00-027 (H); Etelä-Savo, Mäntyharju, Juolasvesi, Hietaniemi, Sojonkangas, fairly rich spruce-pine forest with abundant *Betula* and *Populus tremula*, 29 Sept. 1994, *I. Kytövuori* 94-1177b, H6035734 (H). – Sweden, Västergötland, Undenäs, c. 1.5 km NNW of Sätra bruk, herb-rich *Picea abies* forest with some *Betula*, *Populus* and *Pinus*, 6 Sept. 2003, *T. Niskanen et al.* 03-1255, H7018363 (H); F03-1163, H7018395 (H); Närke. Hidinge, Garphyttans Nationalpark, herb-rich *Picea abies* forest with *Corylus*, *Populus tremula*, *Betula* and *Quercus*, 26 Sept. 2004, *T. Niskanen et al.* 03-1255, H7017775 (H).

Additional specimens. Canada, British Columbia, Interior Cedar Hemlock Forest, mycorrhizal root tip of *Betula papyrifera*, isolate UBCOCS153F, GenBank EF218754. – USA, Alaska, Delta Junction, source: boreal forest, soil 0–20 cm, GenBank JN889840.

Notes — *Cortinarius cremeiamarescens* was previously confused taxonomically with *C. gentianeus* Rob. Henry (= *C. caesiostramineus* sensu Jeppesen et al. 2012 p.p.). However, the latter species is larger, typically has paler, more whitish or greyish exsiccata and larger (7.7–*8.5*–9.3 × 4.8–*5.2*–5.4 µm, Q = 1.54–*1.65*–1.76), amygdaloid to citriform, less thin-walled, more dextrinoid, and more verrucose spores, and much more abundant large, blood red, foamy, worm-like guttules in the pileipellis and lamellar trama. *Cortinarius cremeiamarescens* formed a well-supported clade in our phylogenetic analysis (1.00 PP). The ITS sequences of the species are identical and it differs from its sister species *C. gentianeus* by 17 substitutions and indel positions. Further relationships with other species of *Cortinarius* were not resolved in our analysis.

Cortinarius flavivelatus Kytöv., Liimat. & Niskanen, *sp. nov.* — MycoBank MB805863; Fig. 2b, 3b

Etymology. The name refers to the yellow universal veil.

Type. Sweden, Norrbotten, Pajala, Junosuando, Nature Reserve Area between Sarvikero and Tulemajoki, dryish *Picea abies* heath forest with *Pinus*, *Betula*, and with open meadows, 15 Aug. 1998, *I. Kytövuori* 98-885 (holotype H; isotype NY). GenBank KF732528.

Pileus 5–8 cm broad, hemispherical to convex, then plano-convex, viscid, finely innately fibrillose, olive brown to ochraceous brown to brown at the centre, lighter at the margin, with hygrophanous streaks. *Lamellae* emarginate, crowded, first distinctly pale bluish, later pale brown with a bluish tint. *Stipe* 6–10 cm long, 1–1.8 cm thick at apex, 1.5–2.5 cm wide at base, clavate to almost cylindrical, whitish, with a bluish tint at the apex. *Universal veil* yellow, forming girdles on stipe, somewhat viscid. *Context* white in pileus and lower part of the stipe, bluish at stipe apex. *Odour* indistinct. *KOH-reaction* negative in all parts. *Exsiccata*: pileus warm yellowish to reddish brown, stipe whitish.

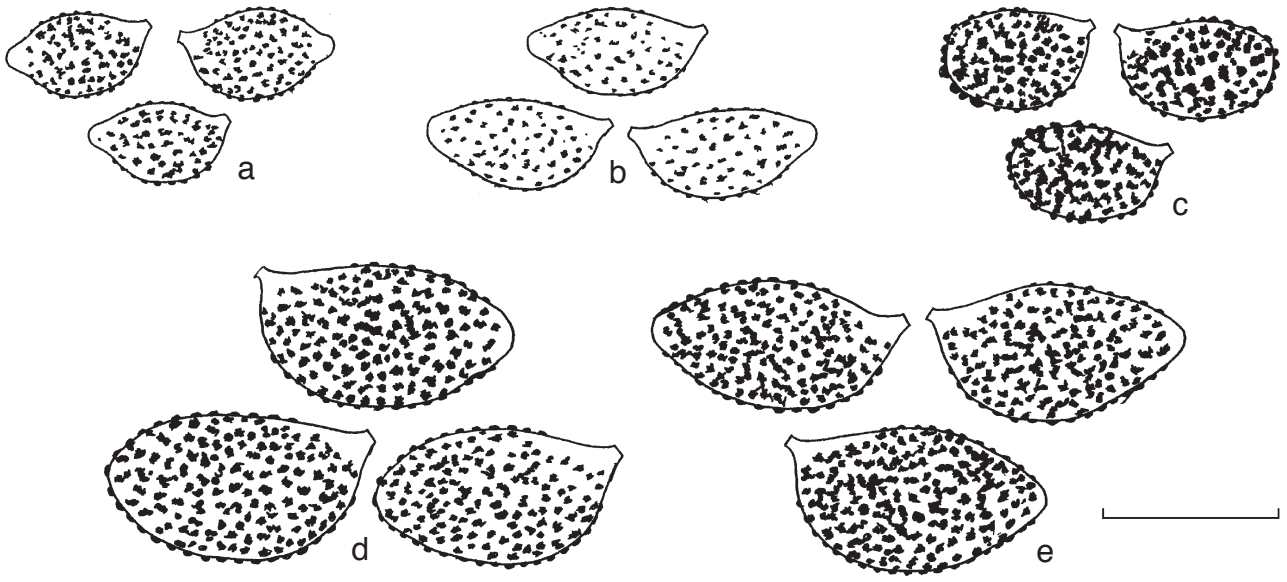

Fig. 3 Spores of: a. *C. cremeiamarescens* TN04-768; b. *C. flavivelatus* IK98-885; c. *C. kytoevuorii* TN05-158; d. *C. ochribubalinus* IK93-641; e. *C. subfraudulosus* IK11-006, in Melzer's reagent. — Drawn by I. Kytövuori and T. Niskanen. — Scale bar = 10 µm.

In MLZ: *Spores* 9.1–*9.8*–10.9 × 5.0–*5.4*–5.9 µm, Q = 1.67–*1.82*–1.98 (1 specimen, 60 spores, Fig. 3b), amygdaloid-fusoid to slightly, narrowly citriform, with a shallow suprahilar depression and somewhat beaked apex, fairly finely, separately verrucose, slightly dextrinoid. *Basidia* 27–38 × 7.5–8 µm (40 basidia), 4-spored, clavate, pale sand brown, with few dark red brown granules, almost hyaline when mature. *Lamellar trama hyphae*: with abundant dark granules and chips, sometimes in small mounds. *Stipe apex hyphae* pale yellowish sand brown with small brown granules, outermost hyphae entangled, narrow, with more or less abundant blackish red granules. *Pileipellis*: epicutis strongly gelatinous, uppermost hyphae 5–10 µm wide, ochre brown, finely to strongly spirally incrusted, mostly not granulose, lower down dark-granulose. Hypoderm well developed, red brown. The upper part of the hypoderm and the transition hyphae towards the epicutis strongly incrusted and with mounds of blackish brown granules. Evenly distributed small granules present (sometimes absent) between the mounds.

Ecology & Distribution — In northern boreal coniferous forests. Known from Sweden, Norrbotten. No sequences of this species exist in public databases.

Notes — Based on morphology and molecular data *C. flavivelatus* is a sister species of *C. pini* Brandrud. *Cortinarius pini*, however, has white, sometimes ochraceous white universal veil and much larger spores (10.7–*11.7*–12.9 × 6.3–*6.8*–7.3 µm). In ITS regions the difference between the species is 17 substitutions and indel positions.

Cortinarius kytoevuorii Niskanen & Liimat., *sp. nov*. — MycoBank MB805865; Fig. 2c, 3c

Etymology. The species is named in honour of Ilkka Kytövuori, a mycologist from Finland.

Type. Finland, Koillismaa, Kuusamo, Oulanka, Ampumavaara, S slope, old, grass-herb *Picea abies* forest with some *Betula*, *Pinus sylvestris* and *Populus tremula*, on calcareous soil, 17 Sept. 2005, *T. Niskanen & K. Liimatainen* 05-158, H6029355 (holotype H; isotype NY). GenBank KF732529.

Pileus 6–9 cm broad, hemispherical to convex, then expanded, finely innately fibrillose, yellow brown to brown, with hygrophanous streaks. *Lamellae* emarginate, almost crowded to medium spaced, at first pale brownish grey, becoming more brown with age. *Stipe* 6–9 cm long, 1.2–1.5 cm thick at apex, 2–2.5 cm wide at base, with fairly narrow, marginate bulb, at first white, becoming pale brownish yellow with age. *Context* whitish to pale yellow. *Odour* indistinct. *KOH reactions*: in pileipellis brown (no reddish tints); in context, mycelium and bulb margin negative. *Exsiccata*: pileus dull, dark red brown overall, stipe almost concolorous with pileus.

In MLZ: *Spores*: 7.5–*8.5*–9.5 × 5.0–*5.3*–5.4 µm, Q = 1.54–*1.61*–1.72 (1 specimen, 60 spores, Fig. 3c), amygdaloid-ellipsoid, very strongly, separately, ± sharply verrucose (*C. porphyropus* like but more dextrinoid), slightly to moderately dextrinoid. *Basidia*: 24–32 × 7.5–9 µm (20 basidia), 4-spored, clavate. *Lamellar trama hyphae*: pale pellucid yellowish, guttulate, smooth. *Stipe apex hyphae* colourless to pale straw-coloured, smooth, guttulate. *Pileipellis*: epicutis in overall view orange, (very) weakly gelatinous, hyphae 5–10 µm wide, finely to strongly spirally incrusted, many of the uppermost ones abundantly with intercellular, unevenly distributed, orange red granules, granule mounds and concretions. Large-celled hypoderm present, yellowish and with scanty small orange granules in the upper part, lower down colourless.

Ecology & Distribution — In coniferous forests, on calcareous soil. Fruits in autumn.

Notes — *Cortinarius kytoevuorii* is reminiscent of *C. glaucopus* but is more slender, has a yellow brown to brown pileus, and lacks bluish tints in basidiomata. It is most easily recognised by the orange red granules and concretions in the uppermost hyphae of the pileipellis when mounted in MLZ. The sister species *C. subrugulosus* Bidaud & Armada has a more southern distribution. The northernmost known collection is from Sweden, Öland under *Fagus* (*Kytövuori* 98-2578 (H)). Furthermore, the spores are shorter (7.3–*7.9*–8.6 × 5.0–*5.3*–5.7 µm), relatively broader (Qav. = 1.5), less verrucose, and more strongly dextrinoid, and in the pileipellis small yellow to blood-red guttules are seen in MLZ. In our phylogenetic analysis *C. kytoevuorii* formed a well-supported clade (1.00 PP) with *C. subrugulosus*, but further relationships were not solved. The difference in ITS regions between the two sister species is 11 substitutions and indel positions.

Cortinarius ochribubalinus Kytöv., Liimat. & Niskanen, *sp. nov.* — MycoBank MB805866; Fig. 3d

Etymology. The name refers to the colour of the basidiomata.

Type. Finland, Uusimaa, Espoo, Nuuksio, the open-air territory of Pirttimäki, between the main road and the lake, opposite the parking area, fairly rich grass-herb forest with *Populus tremula*, *Betula*, *Alnus incana*, *Quercus*, *Corylus*, *Prunus padus*, *Salix* spp., and some old pines and young spruce, 2 Sept. 1993, *I. Kytövuori* 93-641, H6032734 (holotype H; isotype NY). GenBank KF732530.

Pileus 5–8 cm broad, convex, soon plano-convex, sometimes with a broad umbo, very finely fibrillose, centre ochraceous, whitish towards margin. *Lamellae* emarginate, medium spaced, at first very pale brownish grey, later pale brown. *Stipe* 6–10 cm long, 0.8–1.3 cm thick at apex, 1.5–2 cm at base, clavate, at first white, becoming pale brownish yellow with age. *Universal veil* white, on pileus margin thin, forming thin belts on the stipe. *Context* white. *Odour* pleasant. *Exsiccata*: pileus warm yellowish brownish at centre, pale leather-coloured to almost whitish at margin, stipe concolorous with the pileus margin.

In MLZ: *Spores* 12.5–*13.4*–14.3 × 7.5–*7.9*–8.2 µm, Q = 1.57–*1.69*–1.84 (1 specimen, 60 spores, Fig. 3d), amygdaloid, strongly verrucose, most strongly so at the apex, very much like those in *C. riederi* group or *C. violaceus*, moderately dextrinoid. *Basidia* 39–48 × 9–12 µm (20 basidia), light sand brown, with large to small blood black granules. *Lamellar trama hyphae* with blood black substance and/or same-coloured granules, dark chips almost lacking. *Stipe apex hyphae* yellow, with colourless guttules, coloured granules lacking, but outermost hyphae sand brown to somewhat redder, with few to abundant blood red, small granules. *Velum/Cortina hyphae* sand brown to somewhat redder, with few to abundant blood red, small granules. *Pileipellis*: epicutis somewhat gelatinous, hyphae 3–10 µm wide, near the surface ochraceous brown, finely, densely incrusted, mostly not granulose, lower down strongly granulose with small to large blackish brown granules in mounds and long, sausage-shaped clusters and concretions. Hypoderm well developed, red brown, hyphae mostly granulose in the upper part.

Ecology & Distribution — With deciduous trees, possible hosts *Populus*, *Corylus* or *Quercus*. Known from South Finland. No sequences of this species exist in public databases.

Notes — Based on our molecular studies *C. ochribubalinus* does not have any known, close relatives. It holds an isolated position in the phylogenetic tree and differs in ITS regions by more than 20 substitutions and indel positions from the closest species *C. patrickensis* (M.M. Moser) Niskanen, Liimat., Kytöv., Bojantchev & Ammirati. Morphologically, it is reminiscent of species in /Arguti. The spores are large and similar to those of *C. fraudulosus* and *C. subfraudulosus*, but more strongly verrucose. The smell of the lamellae is also different, pleasant in *C. ochrobubalinus* and often earthy-raphanoid in *C. fraudulosus* and *C. subfraudulosus*. In addition, the universal veil is sparse

where as *C. fraudulosus* and *C. subfraudulosus* have more abundant sometimes even floccose universal veil remnants on stipe.

/ARGUTI

Cortinarius patrickensis (M.M. Moser) Niskanen, Liimat., Kytöv., Bojantchev & Ammirati, *comb. nov.* — MycoBank MB805883

Basionym. *Cortinarius fraudulosus* var. *patrickensis* M.M. Moser, Mycotaxon 74, 1: 10. 2000.

Type. USA, California, Humboldt Co., Patrick's Point State Park prope Trinidad, in coniferous forest (*Picea sitchensis*, *Pseudotsuga menziesii*), 25 Nov. 1995, *M. Moser* 95/617 (holotype IB). GenBank KF732307.

Other specimens examined. Sweden, Medelpad, Borgsjö, Julåsen, SE sloping, partly paludified, rich grass-herb-spruce forest with some pines and birches, 15 Sept. 1995, *I. Kytövuori* 95-1400, H7019584 (H). – USA, Six Rivers Nat'l forest, off Hwy 299, 1004 m asl, mixed forest (*Notholithocarpus densiflorus*, *Quercus kelloggii*, *Pinus* spp., *Pseudotsuga menziesii*, etc.), 20 Nov. 2010, *D. Bojantchev* DBB39406 (UC).

Notes — *Cortinarius patrickensis* is a typical member of /Arguti, it has a whitish to pale brown basidiomata and large spores, and the placement is also supported by molecular data. It was first described as a variety of *C. fraudulosus* but based on our genetic and morphological data it should be treated as a species. In our phylogenetic analysis *C. patrickensis* grouped together with *C. rosargutus* Chevassut & Rob. Henry (0.86 PP). Also with the pairwise comparison the closest species is *C. rosargutus* from which it differs by 5 substitutions and indel positions in ITS regions. Both taxa, *C. patrickensis* and *C. rosargutus*, include several identical or almost identical sequences and have a clear barcoding gap (no overlap between intra- and interspecific variation). A description of the species is provided in Moser & Ammirati (2000). Typical for the species are amygdaloid, large spores 12.2–*13.3*–14.7 × 7.0–*7.7*–8.4 µm, Q = 1.62–*1.73*–1.84, and green apple-like to strong green corn-like odour. The spores are narrower than those of *C. rosargutus* (Qav. = 1.60). *Cortinarius patrickensis* grows in coniferous forests, often on calcareous soil. It was previously only known from California, USA but is here reported for the first time from Europe in Sweden. Species might be occasional in suitable habitats, at least in Europe and North America, but has most likely been misidentified as either *C. fraudulosus* or *C. rosargutus*.

Cortinarius subfraudulosus Kytöv., Liimat. & Niskanen, *sp. nov*. — MycoBank MB805867; Fig. 3e

Etymology. The name refers to the affinity of *C. fraudulosus*.

Type. Norway, Oppland, Lunner, Skøyenåsen, *Picea abies* forest with *Corylus* on calcareous soil, 3 Sept. 2011, *I. Kytövuori* 11-006 (holotype H; isotype NY). GenBank KF732564.

Illustrations — Brandrud et al. (1990: pl. A07 as *C. argutus* subsp. *fraudulosus*), Abarenkov et al. (2010: photo under the accession no. UDB011261).

Pileus 4–10 cm broad, hemispherical to convex, then planoconvex, finely fibrillose, white to ochraceous white when young, with age becoming pale brownish. *Lamellae* emarginate, medium spaced to almost distant, first white to very pale brownish grey, later pale brown. *Stipe* 5–10 cm long, 1–2 cm thick at apex, 1.5–3 cm wide at base, clavate to slightly bulbous, sometimes slightly rooting, whitish, becoming brownish with handling and with age. *Universal veil* white, forming distinct girdles on stipe, sometimes floccose. *Context* white, but becomes very slowly black when bruised. *Odour* weak, a combination of earthy and raphanoid. *Exsiccata*: pileus dirty greyish to yellow brown at the centre, whitish to yellowish brown towards the margin, stipe greyish white to pale brown.

In MLZ: *Spores* 12.0–*13.6*–15.0 × 7.0–*7.8*–8.4 µm, av. = 12.5–14.4 × 7.6–8.2 µm, Q = 1.57–*1.72*–1.88, Qav. = 1.64–1.75 (4 specimens, 100 spores, Fig. 3e), amygdaloid (to weakly citriform), with a narrow apex, moderately to fairly strongly verrucose, warts anastomosing, not high, moderately dextrinoid. *Basidia* 38–55 × 10–12 µm (2 specimens, 60 basidia), almost colourless to pale sand brownish, clear or with few small, brown granules. *Lamellar trama hyphae* full of dark granules or chips or blood black particles. *Stipe apex hyphae* yellow to reddish brown, outermost ones with abundant large red brown to blood blackish granule masses or opaque particles. *Velum/Cortina hyphae* with abundant large red brown to blood blackish granule masses or opaque particles. *Pileipellis*: epicutis fairly weakly gelatinous, hyphae at the surface 3–10 µm wide, finely incrusted, ochraceous brownish, mostly not granulose, lower down somewhat granulose or not. In the transition between epicutis and hypoderm up to 15 µm wide, dark red brown, strongly incrusted hyphae with large, blackish granula mounds, intracellular concretions and/or red brown, 3–15 µm wide extracellular pigment mounds on the hyphae, with few evenly distributed small granules. Hypoderm well developed, red brownish to very dark red brown, somewhat granulose or not.

Ecology & Distribution — In hemiboreal and southern boreal coniferous forests, calcicolous. Known from Fennoscandia and Estonia. Fruiting in autumn, in September.

Other specimens examined. Estonia, Hiiumaa, Kõrgessaare, Kõpu, old spruce forest with *Pinus*, *Betula*, *Quercus*, *Populus tremula* and *Corylus*, on calcareous soil, 15 Sept. 2001, *T. Niskanen & I. Kytövuori* (H); Pühalepa, Kallaste pank, spruce forest with *Pinus*, *Betula*, *Populus tremula* and *Corylus*, on calcareous soil, 23 Sept. 2008, *J. Vesterholt & J. Vauras* 26655F (TURA). – Sweden, Östergötland, Väversunda parish, E sloping, very rich spruce grass-herb forest with hardwood bushes, 26 Sept. 1988, *I. Kytövuori* 88-2016 (H); Uppland, Börstils sn, Marieberg, Täpporna, in rich spruce forest, 11 Sept. 1986, *T.E. Brandrud et al.* CFP481, F44801 (S); Södermanland, Mörkö parish, Oaxen, dryish spruce grass-herb forest with *Pinus*, *Betula*, *Populus tremula* and *Salix* spp., on calcareous soil, 27 Sept. 1998, *I. Kytövuori* 98-2244 (H), 98-2245 (H).

Additional specimen. Estonia, Saare, Kihelkonna, Mäebe, in coniferous forest, 21 Sept. 2009, *V. Liiv* TU106607, UNITE No. UDB011261 as *C. fraudulosus* (TU(M)).

Notes — The species has earlier been called *C. fraudulosus* in northern Europe. *Cortinarius fraudulosus*, however, has been described by Britzelmayr (1885) from Siebentischwald, Bavaria, Germany. In our phylogenetic tree the northern material and the more southern European material formed two separate, well-supported clades which differ from one another by 9 substitutions and indel positions in their ITS regions. The sequences of *C. subfraudulosus* have one base polymorphisms and the maximum pairwise distance is zero. Therefore, we here describe the northern species as new.

/CALOCHROI & FULVI

Cortinarius flavipallens Kytöv., Liimat. & Niskanen, *sp. nov.* — MycoBank MB805868; Fig. 2d, 4a

Etymology. The name refers to the colour of the pileus.

Type. Finland, Kainuu, Kajaani, Hietalahti, Torakangas NNW of Korpitaipale, by the power line, fairly damp grass-herb-spruce forest with *Pinus*, *Betula* and *Populus tremula*, on calcareous soil, 13 Sept. 2008, *I. Kytövuori* 08-1729, H6032745 (holotype H; isotype NY). GenBank KF732554.

Pileus 4–8 cm broad, hemispherical to convex, soon expanded, pale ochraceous to pale brown. *Lamellae* emarginate, crowded, pale grey to pale greyish brown. *Stipe* 4–6 cm long, 1–1.5 cm thick at apex, 2–2.5 cm wide at base, with a marginate bulb, white. *Universal veil* whitish to pale brown at bulb margin.

Context white. *Odour* indistinct. *KOH reactions* on pileus and bulb margin red, on basal tomentum and rhizomorphs slowly and/or weakly vinaceous pink. *Exsiccata*: pileus pale ochre to ochre brown, darkest at the centre, paler towards the margin, stipe greyish white to pale brown.

In MLZ: *Spores* 9.5–*10.7*–11.6 × 5.4–*6.0*–6.3 µm, av. = 10.3–11.0 × 5.9–6.1, Q = 1.65–*1.77*–1.85, Qav. = 1.73–1.80 (3 specimens, 120 spores, Fig. 4a), amygdaloid-fusoid to weakly citriform, with a shallow suprahilar depression and mostly a somewhat blunt apex, moderately verrucose, warts anastomosing or not, slightly to moderately dextrinoid. *Basidia* 26–38 × 8–10 µm (60 basidia), 4-spored, clavate, very pale yellowish, clear, few slightly granulose-guttulate. *Lamellar trama hyphae* pale yellowish, smooth, sometimes guttulate, some colourless crystals solitary or in roundish masses, not in branch-like fascicles. *Pileipellis*: epicutis strongly gelatinous, hyphae on the surface 3–5 µm wide, very pale ochre, smooth to very finely, densely, spirally incrusted, walls distinctly visible, also some hyphae with yellow, foamy contents. Lower down equally wide to slightly wider, strongly incrusted hyphae, often in bundles. Hypoderm absent. In KOH the gelatinized hyphae pale vinaceous pink.

Ecology & Distribution — In boreal *Picea abies* dominated forests on calcareous soil. So far only known from Finland but might be widely distributed, since an ITS sequence (FJ039640) from a specimen collected in British Columbia in western Canada differed only by 4 substitutions and indel positions from Finnish material and might be conspecific.

Other specimens examined. Finland, Laatokan Karjala, Parikkala, Vaaranperä, Soininmäki, S part, Soininjoki, fairly old, SE sloping spruce forest with some *Pinus*, *Betula* and *Populus tremula*, 17 Sept. 2009, *A. Ahola* H6032393 (H); Perä-Pohjanmaa, Tervola, Peura, Raemäki, in *Picea* dominated forest on calcareous soil, 5 Sept. 2011, *T. Kekki* 368 (H).

Notes — *Cortinarius flavipallens* with its pale ochraceous colours is in appearance between *C. metarius* Kauffman (= *C. barbarorum* Bidaud, Moënne-Locc. & Reumaux) and *C. caesiocinctus* Kühner, without the bright yellow pileus of the former or the bluish grey one of the latter. In addition, the KOH reaction in the mycelium is slower and weaker than in the former two species. *Cortinarius piceae* Frøslev, T.S. Jeppesen & Brandrud and *C. corrosus* Fr. differ from *C. flavipallens* by their negative KOH reaction in the basal mycelium. The ITS sequences of *C. flavipallens* were identical and it formed a well-supported clade in our phylogenetic analysis. However, the relationships with other species of /Calochroi p.p. were not resolved.

Cortinarius luteicolor (A.H. Sm.) Ammirati, Bojantchev, Niskanen & Liimat., *stat. nov. & nom. nov.* — MycoBank MB805896

Etymology. The name refers to the yellowish colours of the pileus and lamellae.

Basionym. *Cortinarius orichalceus* var. *olympianus* f. *luteifolius* A.H. Sm., Lloydia 7: 185. 1944.

Type. USA, Washington, Olympic Mts, near Lake Angeles, 19 Sept. 1941, *A.H. Smith* 16970, barcode 10389 (holotype MICH). GenBank KF732368.

Other specimens examined. USA, California, Sierra Nevada, Yosemite Nat'l Park, Hwy 120, 2433 m asl, *Pinus contorta*, *Pseudotsuga menziesii*, *Abies concolor*, *A. magnifica*, etc., 16 Nov. 2011, *D. Bojantchev* DBB46740 (UC), 14 Nov. 2010, *D. Bojantchev* DBB38211 (UC).

Additional specimens. Canada, British Columbia, VMS13, GenBank FJ-717511 as '*Cortinarius* sp.' (UBC). – USA, Oregon, Clackamas Co., Bull Run Watershed, *Tsuga heterophylla*, *Pseudotsuga menziesii*, 11 Nov. 1995, M.M. 95/500/ *J.F. Ammirati* 11701, GenBank EU057024 as 'sp.'; Washington, Chelan Co., Chatter Creek, *Tsuga heterophylla*, *Pseudotsuga menziesii*, 6 Oct. 2007, *J. Birkebak* JMB10-06-2007-03 (UBC), GenBank HM068562 as '*C. cupreorufus*'.

Notes — ITS sequence analysis shows *C. luteicolor* as a well-delimited species within clade /Laeticolores. Morphologically, it is not similar to any of the species we have studied. Initially, the species was described as a form of *C. orichalceus* var. *olympianus* (= *C. pseudocupreorufus* (A.H. Sm.) Niskanen, Liimat. & Ammirati). In the ITS regions it, however, differs from *C. pseudocupreorufus* by more than 25 substitutions and indel positions. Furthermore, Smith (1944) noticed several differences among these taxa: "This form (= *C. luteicolor*) differs from the typical form (= *C. pseudocupreorufus*) in lacking the faint lilac tint in the apex of stipe, in the pileus not becoming dark vinaceous red but instead merely dull cinnamon brown when fresh, and in the brighter yellow lamellae. The pilei of the herbarium specimens are also paler, but the bulb is deep purplish as in typical material of the variety (= *C. pseudocupreorufus*)". Based on morphology and molecular data we conclude that *C. luteicolor* should be treated as a species. Description of the species is presented in Smith (1944). Typical for the species are at first rich dull yellow or yellow tinged pileus gradually becoming dull cinnamon, pale yellow gills, and subalmond-shaped spores (9–11.5 × 6–7 µm). *Cortinarius luteicolor* grows in coniferous forests (*Pseudotsuga*, *Tsuga*) and is currently known from Pacific northwest of North America, from California and Washington, USA, and British Columbia, Canada.

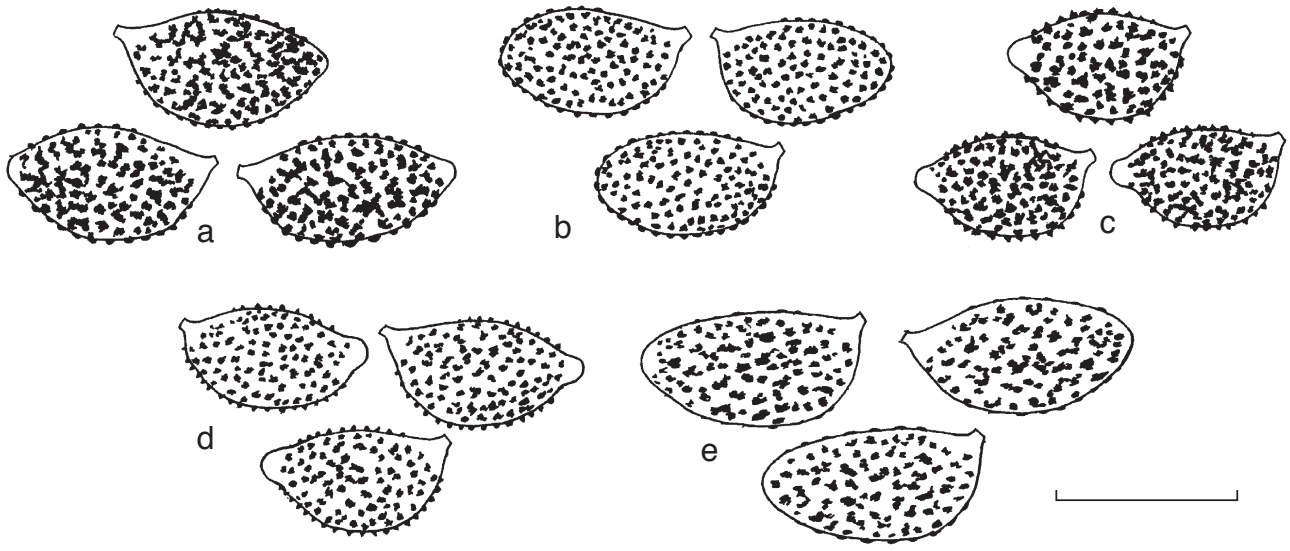

Fig. 4 Spores of: a. *C. flavipallens* IK08-1729; b. *C. boreicyanites* CFP931; c. *C. boreidionysae* IK97-1220; d. *C. cruentipellis* IK98-2503; e. *C. luteiaureus* IK07-247a, in Melzer's reagent. — Drawn by I. Kytövuori and T. Niskanen. — Scale bar = 10 µm.

Cortinarius pseudocupreorufus (A.H. Sm.) Niskanen, Liimat. & Ammirati, *stat. nov. & nom. nov.* — MycoBank MB805886

Etymology. The name refers to the affinity to *C. cupreorufus*.

Basionym. *Cortinarius orichalceus* var. *olympianus* A.H. Sm., Lloydia 7, 3: 184. 1944.

Type. USA, Washington, Olympic National Park, Olympic Hot Springs, under conifers, 2 Oct. 1941, *A.H. Smith* 17513, barcode 10390 (holotype MICH). GenBank KF732367.

Notes — In our phylogenetic analysis *C. pseudocupreorufus* is placed as a sister species of *C. cupreorufus* Brandrud from which it differs by 10 substitutions and indel positions in ITS regions. The spores of *C. pseudocupreorufus* are 9–11 × 5–6.5 µm and somewhat amygdaloid, while the spores of *C. cupreorufus* are broader, 10–11.5 × 6.5–7.5 µm, and amygdaloid-citriform. Based on morphology and molecular data we conclude that *C. pseudocupreorufus* should be treated as a species. Description of the species is presented in Smith (1944). The species is so far only known from the type locality.

/CYANITES

Cortinarius boreicyanites Kytöv., Liimat., Niskanen & A.F.S. Taylor, *sp. nov*. — MycoBank MB805870; Fig. 4b

Etymology. The name refers to the affinity with *C. cyanites* and distribution in boreal zone.

Holotype. Sweden, Jämtland, Ragunda sn, Ragunda, Böle, at the riverside, in birch forest on rich soil (*Betula*, *Picea*), 24 July 1990, *Brandrud et al.* CFP931 (S). GenBank KF732296.

Pileus 4–10 cm broad, hemispherical to convex, then expanded, distinctly innately fibrillose, bluish grey when young, later pale greyish brown. *Lamellae* emarginate, almost crowded, greyish blue when young, later brownish violet. *Stipe* 5–10 cm long, 1–2 cm thick at apex, 2.5–4 cm wide at base, clavate to bulbose, greyish blue. *Universal veil* pale greyish brown, abundant, forming girdles on stipe. *Context* violet when young, later in pileus and bulb white to brownish white, marbled hygrophanous, turning vinaceous red on exposure. *Odour* indistinct. *Exsiccata*: pileus reddish brown at the centre, greyish brown at the margin, stipe pale bluish greyish, brown at the base.

In MLZ: *Spores* 9.1–*9.8*–10.4 × 5.4–*5.8*–6.3 µm, av. = 9.7–9.9 × 5.6–5.9 µm, Q = 1.58–*1.69*–1.80, Qav. = 1.66–1.73 (3 specimens, 120 spores, Fig. 4b), amygdaloid, with a blunt apex, fairly finely to moderately verrucose, many with few small golden yellow guttules, slightly dextrinoid. *Basidia* 36–45 × 7–9 µm (60 basidia), 4-spored, narrowly clavate, with a long, narrow pedicel, with blood red guttules, commonly with yellow foamy contents. *Lamellar trama hyphae* 4–10 µm wide, colourless to yellowish brown, smooth, with abundant small to large worm-like blood red guttules. *Stipe apex hyphae* 3–8 µm wide, pale yellowish, smooth, with small to large blood red guttules, the outermost ones c. 3 µm wide, ochraceous brown, mostly not guttulate. *Pileipellis*: epicutis very weakly gelatinous, uppermost hyphae 4–8(–13) µm wide, ochraceous brown, very thinly spot-like incrusted, not or weakly guttulate with small, golden yellow guttules, lower hyphae up to 10 µm wide, brown, smooth, with abundant small to large worm-like, blood red guttules. Hypoderm not developed.

Ecology & Distribution — In boreal mixed forests of *Picea*, *Betula* and *Populus* in northern Europe. In Scotland also collected with *Helianthemum*. Fruiting in autumn.

Other specimens examined. Finland, Pohjois-Savo, Kuopio, Vehmersalmi, submesic, mixed forest (*Betula*, *Picea*, *Pinus*), in grassy places, 1 Aug. 2003, *T. Niskanen et al.* 03-112 (H). – Great Britain, Scotland, Grampian, Braemar, Morrone Wood, with *Helianthemum* on rich calcareous soil, 8 Aug. 2010, *A. Taylor* 2010203 (UPS).

Notes — ITS sequence analysis shows *C. boreicyanites* as a well-delimited species within clade /Cyanites (Fig. 1). The ITS sequences of the species are identical and differ by more than 30 substitutions and indel positions from those of *C. cyanites* Fr. and *C. violaceorubens* Moënne-Locc. & Reumaux. Typical for *C. boreicyanites* are a pale greyish brown pileus, exsiccata with reddish brown pileus at the centre, greyish brown at the margin, and spores on average 9.7–9.9 × 5.6–5.9 µm. The species is so far only known from the middle boreal zone of Sweden, Finland and Scotland. *Cortinarius cyanites* has a more southern distribution extending from the hemiboreal zone of Finland and Sweden to France. In addition, the pileus is more bluish. *Cortinarius violaceorubens* has a more brownish pileus, dark dirty violaceous brown exsiccata, and larger spores (av. 9.9–11.0 × 6.3–6.6 µm). It grows in *Picea* dominated forests, often on rich soil.

/DIONYSAE s.l.

Cortinarius boreidionysae Kytöv., Liimat., Niskanen & Dima, *sp. nov*. — MycoBank MB805894; Fig. 2e, 4c

Etymology. The name refers to the affinity with *C. dionysae* and the northern distribution.

Type. Finland, Perä-Pohjanmaa, Tervola, Peura, Raemäki, grass-herb-spruce forest with spring-fed depressions, calcareous soil, 11 Sept. 1997, *I. Kytövuori* 97-1220 (holotype H; isotype NY). GenBank KF732488.

Pileus 5–10 cm broad, hemispherical to convex, then expanded, glutinous, innately fibrillose, mustard brown to cocoa brown with a somewhat silky shining centre and olive yellowish tint on the margin when young. *Lamellae* emarginate, crowded, violaceous when young, later violet grey to pale brownish grey. *Stipe* 3–9 cm long, 1–1.8 cm thick at apex, 2–2.5 cm wide at base, with a marginate bulb, when young pale violaceous, becoming yellowish. *Universal veil* yellow at bulb margin. *Context* in pileus white, in stipe violaceous, in bulb at first whitish, later brownish yellowish. *Odour* faintly farinaceous. *Exsiccata*: pileus uniformly orange brown, sometimes with a faint greyish tint, stipe somewhat paler.

In MLZ: *Spores* 8.4–*9.3*–10.2 × 5.2–*5.8*–6.1 µm, av. = 8.9–9.5 × 5.3–5.8 µm, Q = 1.54–*1.67*–1.80, Qav. = 1.63–1.67 (5 specimens, 160 spores, Fig. 4c), strongly citriform, strongly beaked, moderately, sharply verrucose, often with small coloured guttules, faintly to moderately dextrinoid. *Basidia* 23–32 × 7–9 µm (60 basidia), 4-spored, clavate, some with brownish yellow, foamy contents. *Lamellar trama hyphae* yellow, granulose-guttulate, blood red guttules absent. *Stipe apex hyphae* yellowish to yellow, smooth, with golden yellow small drops and large, blood red, worm-like guttules abundant in the outermost hyphae. *Pileipellis*: epicutis strongly gelatinous, uppermost hyphae 3–11 µm wide, mostly densely, spirally incrusted with small to large blood red guttules, lower down with a thick layer of somewhat wider hyphae filled with small to large or very large, worm-like, foamy, blood red guttules. Hypoderm well developed, yellow to red brownish.

Ecology & Distribution — In northern boreal *Picea abies* dominated forests on calcareous soil, rare. Fruiting in autumn.

Other specimens examined. Finland, Oulun Pohjanmaa, Kiiminki, Juuvansydänmaa, S part of Iso Juuvankangas, W of the lake Iso Juuvanjärvi, grass-herb-spruce forest with some *Betula*, *Populus tremula* and *Pinus*, on calcareous soil, 17 Aug. 2007, *M. Toivonen & I. Kytövuori* 07-245, H6000476 (H); Perä-Pohjanmaa, Tervola, Peura, Raemäki, grass-herb-spruce forest with spring-fed depressions, calcareous soil, 21 Aug. 1998, *I. Kytövuori* 98-1316, H6035751 (H), 21 Aug. 2007, *M. Toivonen & I. Kytövuori* 07-491, H6000724 (H); church village, Ala-Kirvesmaa, rich grass-herb-spruce forest with some *Betula*, *Populus* and *Pinus*, on calcareous soil, 24 Aug. 2007, *I. Kytövuori* 07-768, H6001001 (H); Petäjämaa, Kivimaa, 6 Sept. 2012, *I. Kytövuori* (H); Tornio, Korkiamaa, Runteli, rich grass-herb-spruce forest

with hardwood bushes and some pines, slightly paludified depressions, calcareous soil, 12 Aug. 1995, *I. Kytövuori* 95-210, H6035732 (H), 10 Sept. 1997, *I. Kytövuori* 97-1170 (H), 20 Aug. 1998, *I. Kytövuori* 98-1279, H6035740 (H), 22 Aug. 2007, *I. Kytövuori* 07-626, H6000859 (H); Kuusamo, Oulanka National Park, Ampumavaara, mesic to damp, herb-rich *Picea abies* forest, with some *Pinus*, *Populus* and *Betula*, 19 Sept. 2002, *T. Niskanen et al.* 02-876, H6033134 (H).

Notes — *Cortinarius boreidionysae* reminds one of *C. olivaceodionysae* A. Ortega, Vila & Fdez.-Brime, but the latter has paler, olive brown to yellowish brown pileus, somewhat larger, less distinctly and less regularly citriform spores, and a more southern distribution (up to the hemiboreal zone). The ITS sequences of *C. boreidionysae* are identical and it formed a well-supported clade in our phylogenetic analysis. It belongs to /Dionysae but further relationships were not solved. Based on ITS sequence comparison the closest species is *C. olivaceodionysae* from which it differs in ITS regions by 9 substitutions and indel positions, although two of them include intragenomic base polymorphisms.

Cortinarius olivaceodionysae has been called *C. dionysae* Rob. Henry in northern Europe. *Cortinarius dionysae*, however, has been described from France (Henry 1933) as a species with a distinctly farinaceous smell and collected under *Fagus* – both characters in contradiction with our material of *C. olivaceodionysae*. To confirm the identity of *C. dionysae* we tried to sequence the type material but unfortunately we did not succeed. In our phylogenetic analysis all the taxa with a strong farinaceous smell, *C. dionysae* sensu Frøslev & Garnica, *C. dionysae* var. *avellanus* Rob. Henry ex Bidaud & Carteret and *C. palazonianus* Vila, A. Ortega & Fdez.-Brime, formed a well-supported subclade (1.00 PP) inside the clade /Dionysae. Of these, *C. dionysae* sensu Frøslev & Garnica and *C. dionysae* var. *avellanus* are potential candidates for the real *C. dionysae*. The former is collected under *Fagus*, but is so far only recorded from Germany and the spores are smaller than given in the original description. The latter is found in mixed forest in France but the spores fit well to the description. Further studies with French material are needed to confirm the identity of *C. dionysae*.

Cortinarius cruentipellis Kytöv., Liimat., Niskanen & Dima, *sp. nov*. — MycoBank MB805872; Fig. 2f, 4d

Etymology. The name refers to the large and abundant blood red drops/guttules in the pileipellis.

= *Cortinarius luteoimmarginatus* Rob. Henry sensu Jeppesen et al. (2012).
= *Cortinarius polymorphus* Rob. Henry s.auct. p.p.

Type. Sweden, Öland, Långlöt, Åstad, Nitares hägn, grassy pasture with *Corylus* and *Juniperus*, 13 Sept. 2003, *I. Kytövuori*, *K. Liimatainen & T. Niskanen* 03-1451 (holotype H; isotype NY). GenBank KF732539.

Pileus 3–7.5 cm broad, hemispherical to convex, then expanded, unevenly wavy, olivaceous yellowish brown at centre, olivaceous to ochraceous yellow towards margin. *Lamellae* emarginate, almost crowded, pale grey when young, later pale greyish brown. *Stipe* 3–5 cm long, 0.5–1.4 cm thick at apex, 1.5–2.5 cm wide at base, with a marginate bulb, when young whitish, becoming slightly yellow with age. *Universal veil* ochraceous yellow at bulb margin. *Context* whitish. *Odour* indistinct. *Exsiccata*: pileus orange brown to dirty red brown at the centre, yellowish brown at the margin, stipe concolorous with the centre.

In MLZ: *Spores* 9.5–*10.4*–11.6 × 5.7–*6.1*–6.6 µm, av. = 10.3–10.5 × 6.0–6.2 µm, Q= 1.59–*1.71*–1.85, Qav. = 1.69–1.73 (5 specimens, 160 spores, Fig. 4d), often strongly citriform, beaked, moderately, sharply verrucose, fairly faintly to moderately dextrinoid. *Basidia* 23–34 × 7.5–9.5 µm (50 basidia), 4-spored, clavate, some with yellow foamy contents. *Lamellar trama hyphae* yellowish, many with greenish yellowish, oily guttules. Blood red guttules absent. *Stipe apex hyphae* pale yellowish to greyish brownish to reddish brownish, smooth to finely or more strongly incrusted, somewhat granulose-guttulate, large blood red and smaller golden yellow guttules present in the outermost hyphae. *Pileipellis*: epicutis distinctly gelatinous, uppermost hyphae 4–10 µm wide, thin-walled, finely densely, spirally incrusted, mostly not guttulate, below these a thick layer of smooth to somewhat incrusted hyphae with abundant very long sausage-like guttules with blood red foamy contents. Hypoderm present, yellow brownish.

Ecology & Distribution — Very rare in temperate to hemiboreal grass-herb forests with deciduous trees, mostly *Corylus* and *Quercus*, on calcareous soil. In addition, it occurs in half-open deciduous vegetation in wooded pastures and parks. In Northwest Europe it is known in Denmark, Norway, Sweden and Estonia. Fruits in autumn.

Other specimens examined. Estonia, Hiiumaa, Pühalepa, Sarve, dryish *Corylus* forest with *Juniperus*, *Quercus* and *Populus*, stony calcareous soil, 16 Sept. 2001, *I. Kytövuori & T. Niskanen* (Kytövuori 01-055, H). – Norway. Oslo, Bygdøy, Dronginberget south, deciduous forest, 26 Sept. 2004, *T.E. Brandrud* (Niskanen F04-983) (H7017763); Akershus, Asker, Spirodden, rich calcareous forest, *Corylus*, 8 Sept. 2011, *I. Kytövuori* 11-008 (H). – Sweden, Öland, Algutsrum, Gråbor Fornborg, rich grass-herb forest with *Corylus*, *Quercus*, *Populus tremula* and *Picea*, on sedimentary limestone, 30 Sept. 1988, *I. Kytövuori* 98-2503 (H); Öland, Torslunda, 1.5 km S from Borg, *Corylus* forest with some *Picea*, *Betula* and *Quercus*, 12 Sept. 2003, *T. Niskanen* D03-1393 & *I. Kytövuori & K. Liimatainen*, H7018687 (H).

Notes — *Cortinarius cruentipellis* is a rather small, olivaceous tinted *Phlegmacium* of deciduous forests with citriform spores and strongly blood red pileipellis in MLZ. Of the other deciduous forest species with red MLZ reaction in pileus cuticle, *C. gracilior* (M.M. Moser) M.M. Moser is small and yellowish and has exsiccata with pale stramineous pileus and whitish stipe, *C. leonicolor* Reumaux (= *C. anserinus* (Velen.) Rob. Henry s.auct.) has much larger spores, and *C. subdecolorans* Langl. & Reumaux (= *C. multiformium* Cons. & Moënne-Locc.) pileipellis hyphae filled by mostly small guttules. Based on the ITS sequence analysis *C. cruentipellis* is a well-supported species (1.00 PP) belonging to the clade /Dionysae (0.82 PP). It has no close known relatives, and in the ITS regions it differs by more than 30 substitutions and indel positions from the closest species.

Jeppesen et al. (2012) used the name *C. luteoimmarginatus* Rob. Henry for this species. In the original description of *C. luteoimmarginatus* (Henry 1939, as *C. multiformis* var. *luteoimmarginatus*) the species is mentioned to have a clavate stipe, like the one of *C. cliduchus*, and this is also illustrated by Henry in Bidaud et al. (2012) whereas our species has a marginate bulb (Jeppesen et al. 2012). In addition, the spores are 11–11.5 × 5.5–6.5 µm, generally longer than those of our species and not overlapping with the average size of the spores (10.4 × 6.1 µm) or with the measurements of Jeppesen et al. (2012) (10–11 × 5.5–6.5 µm). In the original description no type has been designated but later Henry (1985) suggested a type (no. 1006) and a heterotype (no. 1014) for the species. The type of *C. luteoimmarginatus*, however, was not located in Paris (PC). A collection numbered as 1014 was found, but it was labelled as *C. privignofulvus* and represented a species of subg. *Telamonia*. Since the original description of *C. luteoimmarginatus* does not fit to our species we here describe it as new.

/GLAUCOPODES

Cortinarius subrubrovelatus (Bidaud) Kytöv., Liimat., Niskanen & Dima, *comb. nov*. — MycoBank MB805884

Basionym. *Cortinarius glaucopus* var. *subrubrovelatus* Bidaud, Atlas des Cortinaires 17, 2: 1237. 2008.

Holotype. France, Ain, Farges, in mixed forest of *Populus*, *Corylus*, *Fagus* and *Abies*, 1 Nov. 1997, *A. Bidaud* 97-11-431 (PC). GenBank KF732317.

Other specimens examined. Finland, Varsinais-Suomi, Lohja, Jalassaari, herb-rich *Picea abies* forest with some *Corylus avellana*, 19 Sept. 2004, *I. Kytövuori & T. Niskanen* 04-881, H6031330 (H); Paimio, Huso, Kalkkimäki, below the old limestone quarries, moist spruce grass-herb forest with hardwood bushes, 6 Oct. 1985, *I. Kytövuori* 85-1553 (H). – Germany, Bayern, Oberjoch, conifer forest with *Picea abies*, 4 Oct. 2001, *S. Garnica* 4498 (TUB 011414), GenBank AY174787.

Additional specimens. Estonia, Saare, Lümanda, in garden, with spruce and pine, *V. Liiv* 2009-10-29 (as '*C. pini*' TU106663/UDB011262).

Notes — ITS sequence analysis shows *C. subrubrovelatus* as a well-defined species (1.00 PP) in /Glaucopodes. Typical for *C. subrubrovelatus* is pale brown to red brown pileus, bluish lamellae, and small, relatively broad spores (7.0–*7.9*–8.8 × 4.5–*5.0*–5.4 µm, av. = 7.7–8.0 × 4.8–5.2 µm, Q = 1.44–*1.56*–1.70, Qav. = 1.52–1.61 (3 specimens, 180 spores)). From its closest relatives *C. subfoetens* and *C. glaucopus* it differs by 2 and 4 substitutions and/or indel positions. *Cortinarius subfoetens* has larger, more fusoid and narrower, and less dextrinoid (8.2–*8.9*–9.7 × 5.0–*5.3*–5.4 µm, Q = 1.58–*1.69*–1.82) spores, and the spores of *C. glaucopus* are relatively narrower as seen in the Q-values (7.3–*8.1*–9.1 × 4.5–*5.0*–5.4 µm, Q = 1.54–*1.64*–1.82). The latter also has somewhat more reddish brown colours deep in the pileipellis and less incrusted upper hyphae than those of *C. subrubrovelatus*. The differences in the ITS region between the three species are not large but since all three groups are represented by several collections and also have morphological differences we conclude that *C. subrubrovelatus* should be treated as a species. *Cortinarius subrubrovelatus* grows in coniferous forests on calcareous soil and is known from Central Europe and hemiboreal zone of northern Europe.

/ELASTICI & PERCOMES

Cortinarius luteiaureus Kytöv., Liimat. & Niskanen, *sp. nov*. — MycoBank MB805895; Fig. 4e

Etymology. The name refers to the colour of the pileus.

Type. Finland, Oulun Pohjanmaa, Kiiminki, Juuvansydänmaa, S part of Iso Juuvankangas, W of the lake Iso Juuvanjärvi, grass-herb *Picea abies* forest with some *Betula*, *Populus tremula* and *Pinus*, on calcareous soil, 17 Aug. 2007, *M. Toivonen & I. Kytövuori* 07-247b, H6033617 (holotype H; isotype NY). GenBank KF732568.

Pileus 4–7 cm broad, convex, then plano-convex, with a low and broad umbo, viscid to glutinous, not fibrillose, yellow to brownish yellow. *Lamellae* emarginate, almost crowded, greyish white, later very pale greyish brown. *Stipe* 5–10 cm long, 1–1.5 cm thick at apex, 1.5–2 cm wide at base, almost cylindrical with clavate to subbulbous base, white. *Universal veil* yellow, forming girdles on stipe. *Context* white. *Odour* not recorded. *Exsiccata*: pileus yellow brownish, stipe whitish.

In MLZ: *Spores* 9.7–*10.6*–11.6 × 5.7–*6.1*–6.6 µm, Q = 1.62–*1.74*–1.92 (1 specimen, 60 spores, Fig. 4e), narrowly amygdaloid, with rounded apex, moderate to fairly strongly verrucose, moderately dextrinoid, often with dark red brown angular granules in the spore. *Basidia* 32–44 × 8–10 µm (20 basidia), 4-spored, clavate, sand brown, with fairly small granules and chips. *Lamellar trama hyphae* with moderate to very large sand brown to red brown granules. *Stipe apex hyphae* sand brown, densely granulose, outermost ones more orange or reddish, not granulose. *Pileipellis*: epicutis strongly gelatinous, uppermost hyphae 2–4 µm wide, ochraceous yellow to ochraceous brown, mostly not granulose, lower down 4–10 µm wide, full of small to very large dark red brown granules. Hypoderm absent.

Ecology & Distribution — In coniferous forest (*Picea*) on calcareous soil. Known from northern Finland, Oulun Pohjanmaa. No sequences of this species exist in public databases.

Notes — *Cortinarius luteiaureus* resembles somewhat a species which we assume could be called *C. rhizophorus* Bidaud & Cons. but we have not studied the type material of the species yet. *Cortinarius* cf. *rhizophorus* is larger, somewhat paler, has larger spores (10.2–*11.3*–12.5 × 6.1–*6.5*–7.0 µm) and occurs in temperate to hemiboreal broad-leaved and coniferous forests. *Cortinarius varius* (Schaeff.: Fr.) Fr. is also somewhat similar but has blue lamellae, stout, clavate stipe, wider spores, and hypoderm in the pileipellis. *Cortinarius luteiaureus* differs in ITS regions by more than 30 substitutions and indel positions from the closest species found with the BLAST. Based on our phylogenetic analysis it belongs to the large /Elastici & Percomes clade.

/INFRACTI

Cortinarius infractiflavus (M.M. Moser) Kytöv., Niskanen, Liimat., Bojantchev & Ammirati, *stat. nov. & nom. nov.* — MycoBank MB805887

Etymology. The name refers to the affinity to *C. infractus* and the yellowish pileus.

Basionym. *Cortinarius infractus* var. *flavus* M.M. Moser, Mycotaxon 72: 313. 1999.

Type. USA, Wyoming, Shoshone Natl. Forest, prope Brooks Lake Lodge, in subalpine coniferous forest (*Picea engelmanii*, *Abies lasiocarpa*), 12 Aug. 1997, *M. Moser* 97/169 (holotype IB). GenBank KF732327.

Other specimens examined. Bulgaria, Pirin Mt, Bansko locality, 1600 m asl, under *Picea abies*, 7 Oct. 2009, *D. Bojantchev*, DBB19634 (UC). – Finland, Sompion Lappi, Pelkosenniemi, Suvanto, Kalkkivaara, half-open dry *Pinus sylvestris* forest with *Picea*, *Juniperus*, *Betula*, *Populus* and *Alnus*, dolomite rock, 26 Aug. 1992, *I. Kytövuori* 92-1109 (H).

Additional specimen. Canada, British Columbia SMI286, GenBank FJ039612 (UBC).

Notes — *Cortinarius infractiflavus* formed a well-supported clade (1.00 PP) in our phylogenetic analysis. It belongs to sect. *Infracti* and differs from the sister species *C. infractus* by 9 substitutions and indel positions in ITS regions. Morphologically, it can be distinguished from *C. infractus* by the yellowish colours of the pileus, paler gills, a nearly mild taste and larger spores (7.5–*8.2*–9.1 × 6.3–*6.7*–7.0 µm, Q = 1.16–*1.23*–1.30; *C. infractus* 7.3–*8.0*–8.8 × 5.7–*6.1*–6.6 µm, Q= 1.23–*1.30*–1.38). *Cortinarius infractiflavus* grows in boreal and mountainous conifer forests (*Picea*, *Abies*) and is widespread occurring from Wyoming, western USA to Finland and Bulgaria. Full description of the species can be found from Moser & Ammirati (1999).

/MULTIFORMES

Cortinarius caesiolamellatus (Bidaud) Kytöv., Liimat., Niskanen, Brandrud, Frøslev & A.F.S. Taylor, *comb. nov*. — MycoBank MB805885

Basionym. *Cortinarius rufoallutus* var. *caesiolamellatus* Bidaud, Atlas des Cortinaires 16: 1095. 2006.

Type. France, Ain, Bugey, col de Bérentin, in young *Picea abies* plantation, on calcareous soil, 3 Oct. 1993, *A. Bidaud* PML4905 (holotype PC). GenBank KF732414.

= *Cortinarius multiformis* var. *caesiophyllus* Moënne-Locc., Atlas des Cortinaires 16: 1095. 2006. — *Type*. *P. Moënne-Loccoz* PML882 (holotype PC), France, Savoie, Arith, under *Picea* on calcareous soil, 3 June 1988. GenBank KF732351.

Illustrations — Bidaud et al. (2006: pl. 581, 587).

Pileus 4–8 cm broad, hemispherical to plano-convex, sometimes radially rugulose towards the margin, viscid, red brown to ochraceous brown, rarely bluish brown, becoming paler ochra-

ceous brown with age, often bi-coloured, outer part hygrophanous and darker (grey) brown. *Lamellae* emarginate, almost crowded, pale grey with a bluish tint when young, later pale brown. *Stipe* 4–8 cm long, 0.7–1.7 cm thick at apex, cylindrical, slender, 1.5–2.5 cm wide at base, mostly bulbous but the bulb often fairly small, fibrillose (not glossy like *C. multiformis*), whitish but often with a bluish tint at apex when very young, often becoming pale brown with age. *Universal veil* white, sparse, sometimes viscid (at bulb margin). *Context* in the pileus fairly thin, whitish, brownish below the pileus cuticle, in the stipe with a bluish tint or not when young. *Odour* faint to distinct of honey in the context of the stipe base. *Exsiccata*: pileus greyish to reddish brown, stipe very pale.

In MLZ: *Spores* 8.2–*9.3*–10.7 × 5.0–*5.6*–6.3 µm, av. = 8.5–9.9 × 5.2–5.9 µm, Q = 1.51–*1.65*–1.85, Qav. = 1.57–1.74 (7 specimens, 240 spores), ovoid-amygdaloid to narrowly ovoid-ellipsoid, with a fairly long, blunt, tapering apex, moderately to strongly verrucose, warts wide, anastomosing, slightly to fairly strongly dextrinoid. *Basidia* 25–34 × 7.5–9 µm (100 basidia), 4-spored, clavate, mostly with fairly wide base. Many basidia and subhymenium with yellowish, granulose/guttulate contents. *Pileipellis*: epicutis with a fairly thick, gelatinous layer with some 2–3 µm wide, erect-entangled, smooth, obscure, colourless hyphae. Hypoderm present, fairly thin-walled, with pale brownish parietal pigment, some small brown spots present, large yellow to yellow brown spots absent, few spirally incrusted hyphae present deep in the pileipellis.

Ecology & Distribution — In montane to middle boreal, mesic coniferous forests, often on rich soil. In Europe apparently mainly/only under *Picea*, but in USA also found under *Pinus*. Known from Central and northern Europe, and Washington, USA, and considered occasional. The fruiting period is very long, once collected in June (France) and once in November (USA).

Other specimens examined. Estonia, Saaremaa, Mustjala, Võhma, dryish pine heath forest with some spruce, on calcareous soil, 16 Sept. 1993, *I. Kytövuori* 93-1336 (H). – Finland, Uusimaa, Kunnarla, Myllyoja, grass-herb forest with some pines and hardwood trees, 22 Sept. 1994, *I. Kytövuori* 94-852 (H); Pohjois-Savo, Kuopio, Vehmersalmi, Putroniemi, Roikanselän ranta-Mäkijärvi E, under *Picea*, 30 years old forest, 26 Sept. 2009, *J. Ruotsalainen* 8103F, H6011464 (H). – France, Oyonnax SE, Giron, Forêt de Champfromier, rich conifer forest with *Abies alba*, *Picea abies* and *Fagus*, 27 Oct. 1994, *P. & I. Kytövuori* 94-1897 (H); Savoie, Arith, under *Picea* on calcareous soil, 3 June 1988, *P. Moënne-Loccoz* PML882 (PC). – Germany, Baden-Württemberg, Thölendorf, *Picea*, 11 Oct. 1998, UL 98/122 (TUB 011841), GenBank AY669531 as '*C. allutus*'; Schwaben, Ehingen a.d. Donau, Kohlhau, *Picea* plantation on calcareous soil, 28 Sept. 2010, *G. Schmidt-Stohn & T.E. Brandrud*, TEB 428-10 (O, TUB). – Norway, Oslo, Steinbruvannet-Røverkollen, *Picea* forest of somewhat richer, low-herb type, 4 Sept. 2011, *T.E. Brandrud* 687-11 (O). – Sweden, Uppland, Uppsala, Nåsten, mixed forest, 27 Aug. 2005, *A. Taylor* 2005085, UNITE No. UDB002202 as '*C. allutus*' (UPS); Vänge, Fiby urskog, virgin spruce forest with *Pinus*, *Betula*, *Populus tremula*, *Colylus*, *Alnus glutinosa*, etc., with fairly rich depressions, decaying logs very abundant, 8 Sept. 1994, *P. & I. Kytövuori* 94-309 (H). – USA, Washington, Grays Harbor Co., Ocean Shore State Park, under *Pinus* on sandy soil, 11 Nov. 2009, *J.F. Ammirati & T. Niskanen* 09-201 (H).

Notes — *Cortinarius caesiolamellatus* and *C. caesiophylloides* are easily distinguished from the related species in /Multiformes by their initially bluish tinged lamellae and often also stipe apex. Based on material seen so far and available descriptions, these two blue-gilled species are hardly distinguishable macromorphologically, but *C. caesiolamellatus* differs in slightly larger and more strongly verrucose spores. Furthermore, there seems to be a geographical differentiation in Europe; *C. caesiolamellatus* apparently being mainly a Central European species, whereas *C. caesiophylloides* is hitherto found only in northern Europe. If bluish tints have gone, *C. caesiolamellatus* can also be confused with conifer associated *C. rufoallutus* Rob. Henry ex Bidaud & Reumaux, *C. multiformis* Fr. and *C. talimultiformis* Kytöv., Liimat., Niskanen, A.F.S Taylor & Sesli. The latter two, however, have less strongly ornamented spores and lack the yellow to yellow brown large spots deep in the pileipellis. *Cortinarius rufoallutus* differs from *C. caesiolamellatus* by stouter appearance, small amygdaloid-fusoid, finely verrucose spores and abundant strongly spirally incrusted red brown hyphae deep in the pileipellis.

In our phylogenetic analysis *C. caesiolamellatus* forms a well-supported group (1.00 PP) and belongs together with *C. caesiophylloides* and *C. pallidirimosus* in a strongly supported (1.00 PP) subclade in clade /Multiformes (1.00 PP). The species was originally described twice in Bidaud et al. (2006), as a variety of both *C. rufoallutus* (var. *caesiolamellatus*) and *C. multiformis* (var. *caesiophyllus*). Based on the molecular and morphological data neither of those relationships is supported. *Cortinarius caesiolamellatus* clearly represents a distinct species and is here combined at species level.

Cortinarius caesiophylloides Kytöv., Liimat., Niskanen, Brandrud & Frøslev, *sp. nov*. — MycoBank MB805873; Fig. 2g, 5a

Etymology. The name refers to the bluish tints in lamellae and affinity with *C. caesiolamellatus* (= *Cortinarius multiformis* var. *caesiophyllus*).

Type. Finland, Etelä-Savo, Joutsa, Koivuranta, W of Rakkolanselkä, fairly young, mesic to damp, *Picea abies*-dominated forest with some *Betula* and *Pinus sylvestris*, 30 Aug. 2005, *T. Niskanen et al.* 05-016, H6029792 (holotype H; isotype NY). GenBank KF732572.

Pileus 4–8 cm broad, hemispherical to plano-convex, viscid, apricot to redbrown-coloured, with hygrophanous streaks or outer zone, hygrophanous areas somewhat darker umber to less vivid (grey) brown, becoming paler ochraceous brown to ochraceous yellow with age, sometimes almost whitish ochre at centre. *Lamellae* emarginate, almost crowded, pale grey with a bluish tint when young, later pale brown. *Stipe* 5–11 cm long, 1–1.5 cm thick at apex, 1.5–3.5 cm wide at base, with a more or less distinct marginate bulb, whitish but usually with a bluish tint at apex when very young, often becoming pale brown with age, but not as pronounced as with *C. multiformis*. *Universal veil* white, sparse to hardly visible, at bulb margin. *Context* white, slightly bluish at the apex of the stipe when young. *Odour* faint to distinct of honey in the context of the stipe base. *Exsiccata*: pileus pale dirty brown, stipe somewhat lighter.

In MLZ: *Spores* 8.6–*9.7*–10.9 × 5.2–*5.8*–6.3 µm, av. = 9.0–10.2 × 5.5–6.0 µm, Q = 1.54–*1.68*–1.85, Qav. = 1.63–1.73 (4 specimens, 240 spores, Fig. 5a), amygdaloid, with fairly narrow apex, sometimes almost ellipsoid, finely to moderately verrucose, warts often rounded-confluent, slightly to fairly strongly dextrinoid; with a bit narrower apex, thinner wall and finer verrucosity than in *C. multiformis*. *Basidia* 24–37 × 7–9 µm (60 basidia), 4-spored, clavate, almost colourless. *Lamellar trama hyphae* very pale yellowish, smooth, concolorous guttulate. *Stipe apex hyphae* very pale yellow, smooth, somewhat concolorous guttulate. *Pileipellis*: epicutis with a clear gelatinous layer with sparse, erect-entangled, 2–3 µm wide, smooth, colourless and very obscurely seen hyphae. Hypoderm present, hyphae fairly thin-walled, with pale yellowish brown amber-like parietal pigment, small brown encrust-spots present, large yellow brown spots absent, a few spirally incrusted (zebra-striped) hyphae seen deep in the cuticle.

Ecology & Distribution — In mesic coniferous forests, presumably with *Picea*, mainly in richer low-herb types, sometimes on calcareous soil. Known only from Fennoscandia and considered occasional. Fruits from August to September.

Other specimens examined. Finland, Kainuu, Paltamo, Oikarilankylä, Kivesvaara, old mesic spruce forest with some *Betula*, *Pinus* and *Populus tremula*, 11 Sept. 2008, *I. Kytövuori* 08-1554, H6032621 (H); Sompion Lappi, Pelkosenniemi, Suvanto, Kalkkivaara, steep SW slope, dry pine forest with *Juniperus*, *Betula*, *Populus*, *Alnus incana*, 26 Aug. 1992, *I. Kytövuori* 92-3044, H6032620 (H). – Norway, Nord-Trøndelag, Stjørdal, Beistadvollen, calcareous spruce forest (on karst surfaces), 13 Aug. 2009, *T.E. Brandrud* 277-09 (O).

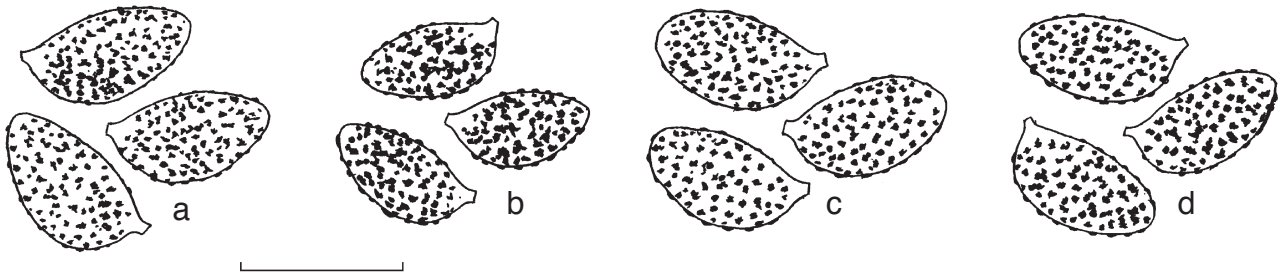

Fig. 5 Spores of: a. *C. caesiophylloides* TN05-016; b. *C. melleicarneus* IK01-053; c. *C. pallidirimosus* IK95-585; d. *C. talimultiformis* AT2004096, in Melzer's reagent. — Drawn by I. Kytövuori and T. Niskanen. — Scale bar = 10 µm.

Notes — *Cortinarius caesiophylloides* is a typical member of sect. *Multiformes*. Together with *C. caesiolamellatus* they are the only known species of the section with bluish tinted lamellae when young. *Cortinarius caesiolamellatus* differs from *C. caesiophylloides* by more strongly ornamented spores. When bluish tints are absent they can be confused with *C. multiformis* and *C. talimultiformis*, but in the latter two there are abundant, yellow to yellow-brown, large spots deep in the pileipellis. Those are practically lacking from *C. caesiophylloides* and *C. caesiolamellatus*. In *C. multiformis* the honey smell is either lacking or is very weak, and the stipe becomes strong brass brown with age.

Cortinarius caesiophylloides is strongly supported (1.00 PP) in our phylogenetic analysis. It belongs to /Multiformes (1.00 PP) and further, in a well-supported (1.00 PP) subclade with *C. caesiolamellatus* and *C. pallidirimosus*. The ITS sequences of *C. caesiophylloides* have one base polymorphism and the maximum pairwise distance is zero. The difference to *C. pallidirimosus* is 11 substitutions and indel positions.

Cortinarius melleicarneus Kytöv., Liimat., Niskanen & Brandrud, *sp. nov.* — MycoBank MB805874; Fig. 5b, 6a

Etymology. The name refers to the colour of the pileus.

Type. Estonia, Hiiumaa, Pühalepa, Sarve, Soonlepa, deciduous forest (*Corylus*, *Quercus*) with some *Pinus* on calcareous soil, 16 Sept. 2001, *I. Kytövuori* 01-053 (holotype H; isotype NY). GenBank KF732577.

Pileus 4–10 cm broad, hemispherical to convex, with rather persistently incurved margin, then expanded, sometimes somewhat silvery-silky from fine veil remnants, cream-coloured, pale yellow brown, honey brown to more grey brown, with hygrophanous streaks or patches/zones near margin; hygrophanous zones somewhat darker grey brown, almost with an olivaceous brown tinge. *Lamellae* emarginate, crowded, first pale greyish white, later pale greyish brown. *Stipe* 5–7(–9) cm long, 1.2–2 cm thick at apex, 2–3 cm wide at base, clavate or with a somewhat marginate bulb, short and robust, white. *Universal veil* very sparse at bulb margin, white. *Context* in pileus pale yellow brown, marbled hygrophanous flesh-coloured, in stipe white. *Odour* not recorded.

In MLZ: *Spores* 7.9–*8.7*–9.5 × 4.3–*4.7*–5.2 µm, av. = 8.6–8.9 × 4.7–4.8 µm, Q = 1.67–*1.86*–2.00, Qav. = 1.85–1.89 (2 specimens, 120 spores, Fig. 5b), amygdaloid to fusoid, with a low suprahilar depression and blunt apex, moderately to fairly strongly, densely and coarsely, somewhat unevenly, not sharply verrucose, slightly to moderately dextrinoid. *Basidia* 25–31 × 7–8 µm (40 basidia), 4-spored, clavate, many granulose-guttulate. *Lamellar trama hyphae* pale yellow, smooth. *Stipe apex hyphae* very pale yellowish, smooth, coloured guttules absent. *Pileipellis*: epicutis gelatinous, with 3–8 µm wide, thin-walled, smooth to very finely incrusted, colourless and very obscure hyphae. Hypoderm present, with pale yellowish brown walls, few incrusted hyphae and small brown spots deep in the pileipellis.

Ecology & Distribution — With thermophilous deciduous trees (*Corylus*, *Quercus*) on calcareous soil, including near-shore sandy shell-beds. Known from Estonia and Norway.

Other specimens examined. Norway, Aust-Agder, Grimstad, Fevik, under *Quercus*, *Fagus* and (planted) *Larix* also present, on sandy soil, rather rich, probably with shell-bed deposits, 21 Sept. 1994, leg. *I-L. Fonneland*, det. *T.E. Brandrud* 86-94, O 125960 (O, sub nom. *C. areni-silvae*).

Notes — *Cortinarius melleicarneus* belongs to /Multiformes. It differs from the other species of the group by honey-coloured pileus, fusoid spores, and habitat with deciduous trees on calcareous soil. No honey-smell was noted in the two collections, and the lack of this smell might be a diagnostic character towards the usually strongly honey-smelling *C. talus*. *Cortinarius talus* has furthermore usually an innately fibrillose pileus structure and rarely possess short-stemmed, compact carpophores. *Cortinarius cruentipellis* grows in similar habitats, but it has ochraceous yellow universal veil on bulb margin, larger spores, and red-colouring pileipellis in MLZ. In dry conditions, *C. melleicarneus* might resemble *C. areni-silvae* (Brandrud) Brandrud which also occurs in sandy soils, and the Norwegian collection was originally determined as *C. areni-silvae* (based on dry material and collectors notes). ITS sequences of the two *C. melleicarneus* specimens are identical and it forms a clade in our analysis. It differs by 11 substitutions and indel positions from *C. talimultiformis*, 14 from *C. talus*, 15 from *C. multiformis*, and 17 from *C. rufoallutus* Rob. Henry ex Bidaud & Reumaux.

Cortinarius pallidirimosus Kytöv., Liimat. & Niskanen, *sp. nov*. — MycoBank MB805875; Fig. 5c, 6b

Etymology. The name refers to the pale pileus with streaks.

Type. Finland, Inarin Lappi, Utsjoki, Kevo, Tsieskuljohka, mesic heath forest with *Betula* and *Pinus*, with some moist depressions, 17 Aug. 1995, *I. Kytövuori* 95-585, H6035694 (holotype H; isotype NY). GenBank KF732578.

Pileus 3–9 cm broad, hemispherical to convex, then expanded, viscid, very finely innately fibrillose, whitish to cream-coloured, centre brownish yellow, becoming ochraceus with age, with hygrophanous streaks. *Lamellae* emarginate, crowded, pale greyish brown when young, later pale brown. *Stipe* 6–13 cm long, 0.7–1.5 cm thick at apex, 1.5–2.5 cm wide at base, clavate to almost cylindrical, whitish, becoming very pale brown with age. *Universal veil* white, sparse. *Context* white. *Odour* in context honey-like. *Exsiccata*: pileus cream-coloured to ochre brownish, somewhat darker at the centre, lighter towards the margin, stipe somewhat lighter than pileus.

In MLZ: *Spores* 8.6–*9.6*–10.7 × 5.2–*5.7*–6.1 µm, av. = 9.0–10.1 × 5.5–5.9, Q = 1.54–*1.70*–1.85, Qav. = 1.60–1.76 (12 specimens, 320 spores, Fig. 5c), amygdaloid to amygdaloid-ellipsoid, moderately to fairly strongly, unevenly, sometimes coarsely verrucose, warts fairly wide but not high, slightly (to moderately) dextrinoid. *Basidia* 24–36 × 7.5–9 µm (100 basidia), 4-spored, clavate, almost colourless. *Lamellar trama hyphae* pale pellucid yellowish, smooth, somewhat concolorous granulose-guttulate.

Fig. 6 Photo of: a. *C. melleicarneus* IK01-053; b. *C. pallidirimosus* IK95-585; c. *C. talimultiformis* AT2004096; d. *C. balteatialutaceus* IK09-751; e. *C. balteatibulbosus* IK98-1624; f. *C. balteaticlavatus* IK95-382; g. *C. brunneiaurantius* JV17979; h. *C. caesiocolor* IK00-029. — Photos: a, b, d–f, h. I. Kytövuori; c. A. Taylor; g. J. Vauras.

Few small mounds of colourless crystals sometimes present in the lamellar trama. *Stipe apex hyphae* pale yellowish, smooth. *Pileipellis*: epicutis with a clear slime layer with 1.5–3 µm wide, smooth, colourless and very obscure hyphae. Hypoderm present, very pale brownish to almost colourless.

Ecology & Distribution — In the middle to northern boreal, mesic, mixed forests with *Betula*, among mosses, on oligotrophic to eutrophic soil. Often solitarily or in small groups. Known from Fennoscandia, Sakha, Russia, and Oregon, USA, and considered occasional. Fruiting in late summer to autumn.

Other specimens examined. Finland, Kainuu, Puolanka, Väyrylä, Körölä, grass-herb-spruce forest with some pines and hardwood bushes, 15 Sept. 1997, *I. Kytövuori* 97-1523, H6035715 (H); Perä-Pohjanmaa, Rovaniemi, Louevaara, Tuohilaki nature reserve area (west), eutrophic, submesic to mesic *Picea abies* forest with *Betula*, *Populus tremula* and some *Pinus sylvestris*, 29 Aug. 2004, *T. Niskanen & K. Liimatainen* 04-470, H6029374 (H); Tervola, Louepalo, Kätkävaaran marmorilouhos, E of the western quarry, S of the track, gently E sloping forest of young *Betula* and *Picea*, with some *Populus tremula*, *Alnus incana* and *Salix* spp., 23 Aug. 2007, *I. Kytövuori* 07-692, H6000925 (H); Peura, Kaitalampi, Kaitaharju, half-open, eutrophic grass-herb-spruce forest with some pines, calcareous soil, 5 Sept. 1992, *I. Kytövuori* 92-1779, H6035693 (H); Koillismaa, Kuusamo, Oulanka National Park, Ampumavaara, mesic to damp, herb-rich *Picea abies* forest with some *Pinus*, *Populus* and *Betula*, 19 Sept. 2002, *T. Niskanen et al.* 02-859, H6033129 (H); Kittilän Lappi, Kolari, Teuravuoma-Lappea (Korkealehdontie), Tappikumpu, mesic spruce-birch forest, 18 Aug. 1998, *I. Kytövuori* 98-1078, H6035705 (H); Sompion Lappi, Sodankylä, Tähtelä, Hassikankaannokka, mesic spruce forest with some pines and hardwood trees, 24 Aug. 1992, *I. Kytövuori* 92-966 (H); Inarin Lappi, Utsjoki, Kevo, Tsieskuljohka, mesic heath forest with *Betula* and *Pinus*, some moist depressions, 17 Aug. 1995, *I. Kytövuori* 92-540, H6035704 (H). – Norway, Troms, Storfjord, Skibotndalen, Lullesletta, dry pine forest with *Betula* and *Salix*, 13 Aug. 1998, *I. Kytövuori* 98-711 (H). – Sweden, Jämtland, Bodsjö, Sidsjö, Stuguberget, dryish, fairly young spruce-pine forest with some hardwood trees and bushes, some moist depressions, 4 Sept. 1997, *I. Kytövuori* 97-699, H7019576 (H); Frösö, Böle, Fillstabäcken, damp to mesic coniferous forest (*Picea*, *Pinus*) on calcareous soil, 2 Sept. 2003, *Niskanen et al.* 03-1058, H7018404 (H).

Additional specimens. Russia, Sakha, Khangalasskiy Ulus, Myachei-Sise Mts, *Larix gmelinii* forest with *Betula platyphylla*, 8 Aug. 1999, *U. Peintner* IB19990590 (IB), UNITE No. UDB001073. – USA, Oregon, source: mycorrhizal root tip, clone="8_73M8, GenBank JQ393042.

Notes — *Cortinarius pallidirimosus* can easily be identified by the cream-coloured, hygrophanous streaked pileus, honey-like smell in context, large, amygdaloid to amygdaloid-ellipsoid spores, and habitat with *Betula* in the boreal zone. The other *Betula* associated species in sect. *Multiformes*, *C. talus* Fr., has relatively wider, ochraceous yellow pileus and smaller spores (7.3–*8.0*–8.8 × 4.5–*5.0*–5.2 µm). *Cortinarius gentianeus* Bidaud and *C. cremeiamarescens* Kytöv., Liimat. & Niskanen are reminiscent of *C. pallidirimosus*, but the former two have a bitter tasting pileus, indistinct odour, and smaller, citriform to narrowly fusoid spores. In addition, the lamellae and pileipellis of both species are strongly red in MLZ.

The placement of *C. pallidirimosus* in /Multiformes is well supported (1.00 PP) and it forms a strongly supported subclade with *C. caesiolamellatus* and *C. caesiophylloides*. From its sister species *C. caesiophylloides* it differs by 11 substitutions and indel positions in ITS regions. The sequences of *C. pallidirimosus* have one base polymorphism and six intraspecific variation sites and the maximum pairwise distance is six. The amount of variation is highly compared to many other species in the genus *Cortinarius* in which the variation typically is 0–2 substitutions and/or indel positions. Most likely the data includes a close sister species, but more specimens would be needed to study this complex more in detail.

Cortinarius talimultiformis Kytöv., Liimat., Niskanen, A.F.S. Taylor & Sesli, *sp. nov*. — MycoBank MB805876; Fig. 5d, 6c

Etymology. The name refers to the appearance of the species, which has features from both *C. multiformis* and *C. talus*.

Type. Sweden, Uppsala, Hässelby Park, mixed forest, 11 July 2004, *A. Taylor* AT2004096 (holotype UPS; isotype S) UNITE No. UDB001167. GenBank KF732583.

= *Cortinarius aurantionapus* var. *similis* Moënne-Locc., Atlas des Cortinaires 16: 1096. 2006. — *Type*. *P. Moënne-Loccoz*, PML883 (holotype PC), France, Haute-Savoie, Aviernoz, under *Picea abies*, on calcareous soil, 6 June 1988, .

Illustration — Bidaud et al. (2006: pl. 596).

Pileus 4–12 cm broad, hemispherical to plano-convex, viscid, whitish fibrillose, especially near the margin, ochraceous yellow to red brown, with strongly hygrophanous streaks. *Lamellae* emarginate, crowded, pale grey when young, later pale greyish brown. *Stipe* 4–10 cm long, 1–2 cm thick at apex, 2–3.5 cm wide at base, clavate or with a somewhat marginate bulb, white. *Universal veil* white, sparse, sometimes fairly abundant at pileus margin. *Context* white. *Odour* slightly honey-like at the context of the base of the stipe. *Exsiccata*: pileus leather brown to yellow brown to mahogany brown, sometimes whitish variegate at the centre, stipe whitish to pale brownish.

In MLZ: *Spores* 8.4–*9.5*–10.7 × 5.0–*5.5*–6.1 µm, av. = 8.9–9.9 × 5.3–5.8 µm, Q = 1.58–*1.73*–1.87, Qav. = 1.68–1.78 (9 specimens, 320 spores, Fig. 5d), amygdaloid to narrowly amygdaloid to amygdaloid-fusoid, with a long, narrowish apex, rather weakly to fairly strongly, lowly verrucose, slightly to moderately dextrinoid. *Basidia* 27–36 × 7–9 µm (80 basidia), 4-spored, clavate. *Lamellar trama hyphae* very pale yellowish, smooth. *Stipe apex hyphae* 4–8 µm wide, pale yellowish, smooth, some outermost ones 2–3 µm wide, in entangled bundles. *Pileipellis*: epicutis with fairly thick, clear slime layer with 1.5–2.5 µm wide, colourless, hardly visible hyphae. Hypoderm present, in its upper part large, brownish yellow pigment spots abundant.

Ecology & Distribution — In hemiboreal to boreal, mesic coniferous forests with *Picea* and *Abies*. Known from North and Central Europe, and East Black Sea Region's mountains in Turkey, considered common. Basidiocarps occur from June to late August.

Other specimens examined. Finland, Pohjois-Häme, Virrat, Killinkoski, *Abies sibirica* forest, 30 Aug. 1966, *I. Kytövuori*, H6032747 (H); Oulun Pohjanmaa, Kiiminki, Keskikylä, Pikkuhalmeenmaa, grass-herb-spruce forest with some *Betula*, *Populus tremula* and *Pinus*, on calcareous soil, 15 Aug. 2007, *M. Toivonen & I. Kytövuori* 07-131, H6000360 (H); Perä-Pohjanmaa, Tornio, Kalkkimaa, Kalkkimaan lehto (NW), mainly grass-herb forest with *Picea*, *Betula*, *Populus tremula*, *Juniperus* and *Pinus*, on calcareous soil, 22 Aug. 2007, *I. Kytövuori* 07-605, H6000838 (H). – France, Haute-Savoie, Aviernoz, under *Picea abies*, on calcareous soil, 6 June 1988, *P. Moënne-Loccoz*, PML883 (PC, holotype of *C. aurantionapus* var. *similis*). – Germany, Baden-Württemberg, Titisee, saurer Boden unter Fichten, 10 Sept. 2002, Saar 4855, TUB 011864 (TUB), GenBank AY669532 as '*C. allutus*' (TUB). – Norway, Oppland, Gran, Lygna, mesic spruce forest with some *Betula* and *Pinus*, 13 Sept. 2010, *E. Bendiksen & I. Kytövuori* (H). – Turkey, East Black Sea Region, Trabzon, Macka, Gurgenagac village, *Picea orientalis* forest, 7 July 2010, *E. Sesli*, SES 2741.

Notes — The appearance of *C. talimultiformis* is rather variable, but most often it is fairly low, wide and stout. The colour of the pileus varies from ochraceous yellow to mahogany brown and the form of the stipe from clavate to bulbous. Typical for the species, however, are the white fibrils on the pileus margin, narrow, prominently verrucose spores, abundant large yellow spots in the pileipellis, and habitat with *Picea* or *Abies*. The fruiting period of this species starts early and it can be found in early June. The sister species *C. multiformis* Fr. grows in similar habitats but has no fibrils on the pileus, the spores are moderately to strongly dextrinoid, fairly finely verrucose, and abundant large brownish yellow spots are present deep in the pileipellis. The colour of the pileus in the exsiccata is uniformly red brown. The other common species, *C. talus* Fr., is associated with deciduous trees, is pale ochraceous yellow, and the spores are smaller (7.3–*8.0*–8.8 × 4.5–*5.0*–5.2 µm).

Cortinarius talimultiformis formed a well-supported group in our phylogenetic analysis. It is a sister species of *C. multiformis* from which it differs by 6 substitutions and indel positions in ITS regions.

/PHLEGMACIOIDES

Cortinarius balteatialutaceus Kytöv., Liimat. & Niskanen, *sp. nov*. — MycoBank MB805877; Fig. 6d, 7a

Etymology. The name refers to the colour of the pileus.

Type. Sweden, Jämtland, Frostviken, Jormlien, Säterklumpen, *Betula* forest with solitary *Picea*, 7 Sept. 2009, *P. & I. Kytövuori* 09-751 (holotype H; isotype NY). GenBank KF732586.

Pileus 6–12 cm broad, hemispherical to plano-convex, with a fairly persistently involute margin, first very slightly viscid, dry with age, pale brown with a whitish to very pale brown margin, becoming darker brown from centre. *Lamellae* emarginate, crowded, pale brownish grey when young, later pale brown. *Stipe* 5–7 cm long, 1.3–2.5 cm thick at apex, 1.8–3.5 cm wide at base, clavate, sometimes with an almost marginate bulb, whitish. *Universal veil* white, sparse. *Context* white. *Odour* indistinct. *KOH-reaction* in context yellow. *Exsiccata*: pileus leather brown at centre, paler at margin, stipe very pale brownish.

In MLZ: *Spores* 9.1–*10.0*–10.9 × 5.0–*5.4*–5.9 µm, av. = 9.8–10.4 × 5.3–5.5 µm, Q = 1.75–*1.85*–1.98, Qav. = 1.78–1.87 (5 specimens, 140 spores, Fig. 7a), amygdaloid-fusoid, sometimes with a low suprahilar depression, moderately to fairly strongly verrucose, warts mostly not anastomosing, weakly dextrinoid, yellowish brown. Although narrow, the spores are quite different in appearance than in *C. balteaticlavatus*. *Basidia* 30–39 × 7–8.5 µm (50 basidia), clavate, pale brownish, very finely granulose at the base. *Lamellar trama hyphae* with moderate to large, dark rice-like granules on yellowish green ground colour. *Stipe apex hyphae* pale yellow to pale brown, outermost hyphae with reddish brown, granulose contents. *Pileipellis*: epicutis very weakly gelatinous, uppermost hyphae 3–8 µm wide, pale ochraceous to reddish brown, very finely, densely incrusted, with some small, red brown granules. Deep in the pileipellis some hyphae with fairly large, red brown to blackish brown granules and chips. The thin-walled upper hyphae lost with age and are mostly not seen in older basidiomes. Hypoderm absent.

Ecology & Distribution — Presumably with *Betula*, in subalpine birch forests but also in middle and northern boreal forests at least in oceanic areas. Produces fruitbodies from mid-August to mid-September. Known from Fennoscandia. No sequences of this species exist in public databases.

Other specimens examined. Finland, Inarin Lappi, Utsjoki, Kevo, shore of the river Tsarsjoki, W of the cascade, herb-rich, temporarily flooded site on a small island, with *Betula* and *Salix* bushes, 16 Aug. 1995, *J. Vauras* 10452 (TUR5282). – Norway, Sogn og Fjordane, Sogndal, on the E side of the main road vis-vis the Kaupanger centre, deciduous forest (*Populus*, *Betula*) with some *Pinus*, 10 Sept. 2000, *J. Ruotsalainen* 100900 (H); Sør-Trøndelag, Oppdal, Ålbu, Ålbusbakkan, sloping dryish forest with *Pinus*, *Corylus* and *Betula*, 5 Sept. 2010, *I. Kytövuori* (H); Nordland, Grane, Fagerli, rich spruce forest with few young *Betula*, calcareous soil, 3 Sept. 2010, *I. Kytövuori* (H).

Notes — *Cortinarius balteatialutaceus* belongs to /Balteatoalbi together with *C. balteatoalbus* Rob. Henry and *C. balteaticlavatus* Kytöv., Liimat. & Niskanen. In the ITS regions it differs by 5 substitutions and indel positions from *C. balteatoalbus* and 7 substitutions and indel positions from *C. balteaticlavatus*. The sequences of *C. balteatialutaceus* have one base difference and the maximum pairwise distance is one. Typical for the species of the clade, compared to many other species of /Phlegmacioides, are basidiomata totally without bluish tints even when young and narrow, rather small spores. *Cortinarius balteatialutaceus* is a stout, *C. balteatus*-like species and grows in subalpine birch forests but also in middle and northern boreal forests at least in oceanic areas. The sister species *C. balteatoalbus* has less verrucose spores and lamellar trama hyphae are densely small-granulose in MLZ. In addition, *C. balteatoalbus* has a more southern, hemiboreal to montane distribution although it also rarely occurs in the middle boreal zone. *Cortinarius balteaticlavatus* has a relatively longer stipe, brown pileus margin, on average smaller spores (av. = 8.5–9.3 × 4.9–5.1 µm) and it grows in mixed forests in boreal zone. *Cortinarius balteatus* (Fr.) Fr. and *C. badiolatus* (M.M. Moser) M.M. Moser occur in subalpine forests but have larger spores, *C. balteatus* 10–12 × 5.5–6.5 µm and *C. badiolatus* 10.5–12.5 × 5.5–7.5 µm. In addition, the pileus margin of *C. balteatus* is usually blue, at least when young. *Cortinarius areni-silvae* (Brandrud) Brandrud is reminiscent of *C. balteatialutaceus* but the former grows in dry, sandy pine heaths and has smaller spores (7.7–9.5 × 4.3–5.2 µm).

Cortinarius balteatibulbosus Kytöv., Niskanen, Liimat., Bojantchev & A.F.S. Taylor, *sp. nov*. — MycoBank MB805878; Fig. 6e, 7b

Etymology. The name refers to the confusion of this species with *C. balteatoalbus* and to the marginate bulb.

Type. Finland, Uusimaa, Espoo, Nuuksio, Pirttimäki, half-open cut meadow, 4 Sept. 1998, *I. Kytövuori* 98-1624, H6033539 (holotype H; isotype NY). GenBank KF732589.

Pileus 6–13 cm broad, hemispherical to plano-convex, slightly viscid in moist weather, otherwise dry, coarsely innately fibrillose, pale brown with a whitish to very pale brown margin, rarely completely white, becoming brown with age. *Lamellae* emarginate, crowded, pale grey when young, later pale brown. *Stipe* 4–7 cm long, 1.5–2.5 cm thick at apex, 2.5–4 cm wide at base, with a more or less marginate bulb, whitish. *Universal veil* white, later ochraceous brown at bulb margin, sparse. *Context* white. *Odour* indistinct in lamellae, in flesh mild and pleasant. *KOH-reaction* in context yellow. *Exsiccata*: pileus brown to brownish to leather-coloured, stipe at the top whitish, at the base concolorous with the pileus.

In MLZ: *Spores* 9.1–*9.9*–10.9 × 5.2–*5.7*–6.1 µm, av. = 9.6–10.2 × 5.6–5.8 µm, Q = 1.58–*1.74*–1.89, Qav. = 1.66–1.82 (6 specimens, 120 spores, Fig. 7b), broadly amygdaloid to citriform, fairly strongly, darkly verrucose, fairly dark-coloured, somewhat dextrinoid. *Basidia* 30–42 × 7–10 µm (60 basidia), clavate, brownish, finely granulose and with few larger granules at the base. *Lamellar trama hyphae* with moderate to large, dark rice-like granules on brownish to yellowish ground colour. *Stipe apex hyphae* orange brown, in outermost hyphae with abundant dark red brown, partly blackish brown contents. *Pileipellis*: gelatinous layer practically absent, uppermost hyphae 4–8 µm wide, thin-walled, ochraceous brown to reddish brown, mostly finely, densely, spirally incrusted, with few red brown granules. Lower hyphae somewhat wider with slightly thicker, smooth to incrusted, brown walls and dark sepia brown granular contents, granules small to large. The thin-walled upper hyphae lost with age and are mostly not seen in older basidiomata.

Ecology & Distribution — In rich mixed forests, in parks, and on yard lawns with different deciduous trees (*Tilia*, *Quercus*, *Fagus*, *Populus*, *Corylus*, *Betula*). Until now all the collections known to us are from the hemiboreal zone. Widespread in Europe, from Bulgaria to Finland. Can fruit very early in the season, in July, but also in September.

Other specimens examined. Bulgaria, Saranzi, 700 m asl, *Quercus cerris*, *Q. petraea* and *Q. frainetto*, 10 June 2010, *D. Bojantchev* DBB33060 (UC). – Finland, Varsinais-Suomi, Vihti, Lintumäki, Ruohoisnummentie, fairly old, fairly rich *Picea abies* dominated forest, 19 July 2004, *H. Tuovila*, H6027358 (H); Uusimaa, Espoo, Nuuksio, Pirttimäki fairly rich grass-herb forest with *Populus tremula*, *Betula*, *Alnus incana*, *Quercus*, *Corylus*, *Prunus padus*, *Salix* spp., and some old pines and young spruces, 2 Sept. 1993, *I. Kytövuori* 93-639,

H6032755 (H), 4 Sept. 2004, Ukkola (H); Helsinki, Tamminiemi, on yard, under *Tilia*, on lawn, 3 July 2000, *T. Niskanen* H6032413 (H); cut lawn, under *Tilia*, 18 Sept. 2000, *I. Kytövuori* (H); Vantaa, Tikkurila, at the river, on a cut lawn under *Tilia*, 22 July 2004, *I. Kytövuori* 04-044 (H). – Sweden, Uppsala, Berthåga graveyard, mixed forest, 21 July 2004, *A. Taylor* 2004091, UNITE No. UDB001132 as '*C. balteatoalbus*' (UPS); *A. Taylor* 2004127, UNITE No. UDB000722 as '*C. balteatoalbus*' (UPS); Järfälla, Järfälla Naturreservat, mixed forest of *Picea abies*, *Quercus robur*, *Betula*, *Corylus*, 7 Sept. 2010, *D. Bojantchev* DBB36892 (UC); Slottsbacken, under *Fagus sylvatica*, 2 July 2004, *A. Taylor* 2004045, UNITE No. UDB000711 as '*C. balteatoalbus*' (UPS); Stenhagen, mixed forest, 10 July 2004, *A. Taylor* 2004088, UNITE No. UDB000715 as '*C. balteatoalbus*' (UPS).

Notes — Typical for *C. balteatibulbosus* are low and stout basidiomata without bluish tints, coarsely innately fibrillose pileus, marginate bulb, broadly amygdaloid to citriform, fairly strongly verrucose spores, and habitat with deciduous trees. The species of /Balteatoalbi have smooth to only finely fibrillose pileus and clavate to almost cylindrical stipe. In addition, the spores of *C. balteaticlavatus* Kytöv., Niskanen & Liimat. are smaller, especially shorter. *Cortinarius balteatialutaceus* is almost whitish and has narrower spores and a much more northern distribution. *Cortinarius balteatoalbus* is paler, the spores are narrower, pileipellis is more incrusted, and in MLZ the red brown small granules (large, dark ones in *C. balteatibulbosus*) are abundant in lamellar trama hyphae.

In our phylogenetic analysis *C. balteatibulbosus* forms a well supported clade in /Phlegmacioides. It groups together with *C. flavescentipes* Reumaux (= *C. balteatocumatilis* Rob. Henry ex P.D. Orton s.auct.) and *C. pseudonebularis* Moënne-Locc. (1.00 PP). The sequences of *C. balteatibulbosus* have one length polymorphism and the maximum pairwise distance is zero. In ITS regions it differs by 19 substitutions and indel positions from *C. flavescentipes*. The species was previously called *C. balteatoalbus* in northern Europe but our studies revealed that *C. balteatoalbus* is a completely different species and therefore this one is described as new.

Cortinarius balteaticlavatus Kytöv., Liimat. & Niskanen, *sp. nov*. — MycoBank MB805879; Fig. 6f, 7c

Etymology. The name refers to the affinity of *C. balteatus* and clavate stipe.

Type. Finland, Pohjois-Häme, Virrat, Hauhuu, Sikosaari, Salmela, on the grassy roadside with young *Picea*, *Betula*, *Populus tremula*, *Alnus incana* and *Salix* spp., 23 Aug. 1996, *I. Kytövuori* 96-595, H6032412 (holotype H; isotype NY). GenBank KF732596.

Pileus 5–9 cm broad, hemispherical to plano-convex, with an involute margin when young, dry, sand brown to brown, completely without bluish tints. *Lamellae* emarginate, crowded, pale brownish grey when young, later brown. *Stipe* 6–11 cm long, 1.2–2 cm thick at apex, 1.5–2.5 cm wide at base, clavate, whitish. *Universal veil* whitish to ochraceous, fairly sparse. *Context* thick, white to very pale marbled brownish. *Odour* indistinct. *KOH-reaction* in context yellow. *Exsiccata*: pileus uniformly pale brown to brown, stipe whitish at the top, pale brown at the base.

In MLZ: *Spores* 8.2–*8.9*–10.0 × 4.5–*5.0*–5.4 µm, av. = 8.5–9.3 × 4.9–5.1 µm, Q = 1.60–*1.78*–1.94, Qav. = 1.72–1.85 (5 specimens, 160 spores, Fig. 7c), narrowly amygdaloid to fusoid, with blunt apex, finely, densely verrucose, warts not anastomosing, fairly light-coloured, very faintly dextrinoid. *Basidia* 27–39 × 6.5–8.5 µm (40 basidia), clavate, 4-spored, pale brownish, finely granulose at the base, sometimes with a few dark granules. *Lamellar trama hyphae* with small to moderate, dark rice-shaped granules. *Stipe apex hyphae* yellowish brownish, outermost ones with yellow brown to red brown substance and some dark granules. *Pileipellis*: gelatinous layer absent, uppermost hyphae 4–10 µm wide, thin-walled, ochraceous brown, finely, densely, spirally to spot-like incrusted, with many large, dark red brown, angular particles. Lower hyphae with slightly thicker, smooth to incrusted, brown walls and red brown to sepia brown granular contents, granules small to large. The thin-walled upper hyphae lost with age and are mostly not seen in older basidiomata.

Ecology & Distribution — In mixed forests (*Betula*, *Populus*, *Salix*, *Picea*, *Pinus*) but the tree host is unknown, most of the collections from grassy roadsides. Occurs in the southern boreal to the northern boreal zones, known from South Finland to Lapland. Fruits from mid-August to mid-September.

Other specimens examined. Finland, Etelä-Savo, Mäntyharju, Juolasvesi, mesic spruce heath forest with swampy depressions, *Pinus*, *Betula* and *Populus tremula*, road ditch, 2 Sept. 1996, *I. Kytövuori* 96-782, H6032415 (H); Salmela, half-open forest of *Betula* and *Populus tremula* and some pines and spruces, 22 Aug. 1998, *I. Kytövuori* 98-1337 (H); Koillismaa, Taivalkoski Jurmu-Kurtti, Koivuoja, pine dominated forest with some *Picea* and *Betula*, by a forest track, 31 Aug. 2008, *I. Kytövuori* 08-584, H6033533 (H); Inarin Lappi, Inari, N side of the river Lutto, N side of the road to Rajajooseppi, Keskikompsio (Hätäpuhelin), above the river bank, mesic heath forest with swamp depressions, *Pinus*, *Betula* and *Salix* spp., 14 Aug. 1995, *I. Kytövuori* 95-382, H6032729 (H).

Notes — *Cortinarius balteaticlavatus* belongs to /Balteatoalbi together with *C. balteatoalbus* Rob. Henry and *C. balteatialutaceus*. In ITS regions it differs by 10 substitutions and indel positions from *C. balteatoalbus* and 7 substitutions and indel positions from *C. balteatialutaceus*. The sequences of *C. balteaticlavatus* are identical. Typical for the species of the

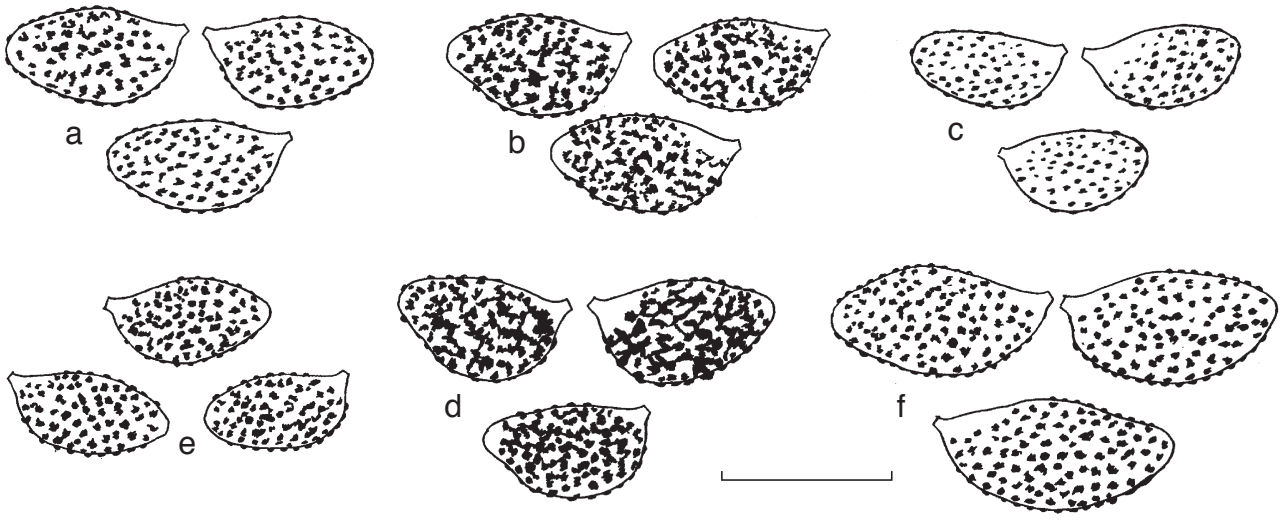

Fig. 7 Spores of: a. *C. balteatialutaceus* IK09-751; b. *C. balteatibulbosus* IK98-1624; c. *C. balteaticlavatus* IK96-595; d. *C. brunneiaurantius* JV17979; e. *C. caesiocolor* IK00-029; f. *C. myrtilliphilus* IK 97-1469, in Melzer's reagent. — Drawn by I. Kytövuori and T. Niskanen. — Scale bar = 10 µm.

clade, compared to many other species of /Phlegmacioides, are basidiomata without bluish tints and narrow, rather small spores. *Cortinarius balteaticlavatus* grows in mixed forests in boreal zones. It is a stout species that resembles *C. crassus* Fr. The latter, however, has narrower spores (7–9 × 3.5–4.5 µm), abundant cylindrical to clavate cystidia especially at the lamellar edge, and no *KOH-reaction* in context. *Cortinarius balteatoalbus* differs from *C. balteaticlavatus* by its lower and wider appearance, larger spores, and more incrusted pileipellis hyphae. *Cortinarius balteatialutaceus* has a relatively shorter stipe, whitish to very pale brown pileus margin, and larger, moderately to fairly strongly verrucose spores.

Cortinarius brunneiaurantius Kytöv., Liimat. & Niskanen, *sp. nov*. — MycoBank MB805880; Fig. 6g, 7d

Etymology. The name refers to the colour of the pileus.

Type. Finland, Varsinais-Suomi, Turku, Ruissalo, Kansanpuisto, *Tilia* alley, also *Quercus robur* nearby, on clayey-mull soil, 22 Sept. 2001, *J. Vauras* 17979 (holotype H6032422; isotype TUR171972). GenBank KF732600.

Pileus 4–9 cm broad, hemispherical to plano-convex, at first viscid but soon dry, centre with small, appressed scales, innately fibrillose toward margin, pale ochraceous brown. *Lamellae* emarginate, crowded, bluish to pale grey when young, later pale brown. *Stipe* 4–9 cm long, 0.8–1.5 cm thick at apex, 1.2–2 cm wide at base, clavate, first whitish, later pale brown. *Universal veil* white, soon brownish, rather sparse. *Context* white in the pileus, bluish at least in the upper part of the stipe. *Odour* not recorded. *KOH-reaction* in context yellow. *Exsiccata*: pileus orange brown to brown at the centre, paler yellowish brown at the margin, stipe pale brown.

In MLZ: *Spores* 8.2–*8.9*–9.7 × 4.8–*5.2*–5.4 µm, av. = 8.9 × 5.2 µm, Q = 1.58–*1.71*–1.83, Qav. = 1.70–1.71 (2 specimens, 100 spores, Fig. 7d), amygdaloid to citriform, with a shallow suprahilar depression, moderately to fairly strongly verrusose, warts dark, moderately dextrinoid, often very dark. *Basidia* 30–38 × 7–8 µm, 4-spored, clavate, sand brown, with very small granules. *Lamellar trama hyphae* with dark small granules and blood red substance or large granules and chips on greenish greyish ground colour. *Stipe apex hyphae* bright yellow, some with granules and chips, outermost ones yellow to reddish brown with blood blackish contents. *Pileipellis* simplex, in overall view orange red, uppermost hyphae 4–8 µm wide, with clearly discernible spirally incrusted wall and some dark granule mounds inside. Lower hyphae wider, more yellow, almost smooth, with abundant dark granular substance. Hypoderm absent.

Ecology & Distribution — In deciduous forests, presumably with *Quercus*, *Corylus* and *Populus*. To date only known from South Finland. Fruits in autumn. No sequences of the species exist in the public databases.

Other specimens examined. Finland, Uusimaa, Espoo, Nuuksio, Pirttimäki, fairly rich grass-herb forest with *Populus tremula*, *Betula*, *Alnus incana*, *Quercus*, *Corylus*, *Prunus padus*, *Salix* spp., and some old pines and young spruces, 2 Sept. 1993, *I. Kytövuori* 93-644, H6032406 (H).

Notes — *Cortinarius brunneiaurantius* belongs to /Phlegmacioides and forms a well supported group (0.99 PP) with *C. sobrius* P. Karst., *C. balteatus* (Fr.) Fr., *C. brunneoviolaceus* Bidaud, *C. pseudonaeovosus* Rob. Henry and *C. clarobaltoides* var. *longispermus* Reumaux. The ITS sequences of *C. brunneiaurantius* are identical and differ from the ones of the sister species *C. sobrius* by 9 substitutions and indel positions. Morphologically, it does not resemble any of its closest relatives. Typical for the species are pale ochraceous brown pileus, rather small, amygdaloid spores, positive granular MLZ reaction, and habitat with deciduous trees.

Cortinarius caesiocolor Kytöv., Liimat. & Niskanen, *sp. nov*. — MycoBank MB805881; Fig. 6h, 7e

Etymology. The name refers to the colour of the pileus.

Type. Finland, Uusimaa, Lohja, Jalassaari, Tamminiemi, by a track with *Betula*, *Populus tremula*, *Quercus*, *Corylus* and *Salix caprea*, on calcareous soil, 27 Aug. 2000, *I. Kytövuori* 00-029 (holotype H; isotype NY). GenBank KF732603.

Pileus 5–9 cm broad, hemispherical to convex, then plano-convex, slightly viscid, innately fibrillose, more so toward margin, bluish violet to violet brown. *Lamellae* emarginate, crowded, first pale greyish brown with a bluish tint, later pale brown to brown. *Stipe* 6–10 cm long, 1–2 cm thick at apex, 2–3.5 cm wide at base, clavate, whitish, with a bluish tint at the apex. *Universal veil* first pale blue, later becoming brown, sparse. *Context* blue in all parts or partially whitish but blue at least close to lamellae. *Odour* indistinct. *KOH-reaction* in context yellow. *Exsiccata*: pileus pale greyish brown to violet brown, stipe pale greyish brown, brown at base.

In MLZ: *Spores* 9.1–*9.9*–10.9 × 5.4–*5.8*–6.3 µm, av. = 9.8–9.9 × 5.7–5.9 µm, Q = 1.59–*1.70*–1.84, Qav. = 1.67–1.72 (2 specimens, 120 spores, Fig. 7e), weakly citriform, sometimes with a low suprahilar depression, dark-coloured, moderately dextrinoid, fairly strongly verrucose, warts anastomosing, dark. *Basidia* 30–41 × 7.5–9.0 µm (40 basidia), 4-spored, clavate, reddish sand brown, mostly with some blood red particles. *Lamellar trama hyphae* yellow to orange yellowish, with small granules. *Stipe apex hyphae* yellow to orange yellow, with small granules, the outermost ones fairly red, with very small blood red granules. *Velum/cortina hyphae* fairly red, with very small blood red granules. *Pileipellis*: epicutis weakly gelatinous, uppermost hyphae narrow, 2–4 µm wide, ochraceous brown, spirally incrusted, mostly not granulose, mostly without large redbrown particles, lower hyphae up to 8 µm wide, mostly incrusted, somewhat granulose with small, brown granules. Hypoderm absent.

Ecology & Distribution — Under *Quercus*, *Populus* and *Corylus* on mull soil in parks, roadsides and deciduous forests. Known from southern Finland. No sequences of this species exist in public databases.

Other specimen examined. Finland, Uusimaa, Helsinki, the cemetery of Malmi, *Quercus robur* alley, on cut meadow, 17 Aug. 1997, *I. Kytövuori* 97-207, H6032730 (H).

Notes — *Cortinarius caesiocolor* is a typical member of /Phlegmacioides. Typical for the species are bluish to violet pileus and upper part of the stipe (appearance somewhat like *C. porphyropus*), small spores, and habitat with deciduous trees. The sister species *C. chromataphilus* Rob. Henry and more distantly related *C. largus* Fr., which also grow in deciduous forests, are at pileus centre greyish brown, towards margin greyish blue, and have larger spores (spores of *C. chromataphilus* 10.5–13 × 6–6.5 µm, of *C. largus* 10.0–11.8 × 6.1–8.8 µm). Another small-spored species with bluish colours is *C. violaceomaculatus* Brandrud, but it has smaller (8.8–10.2 × 5.2–5.7 µm), more weakly verrucose spores, and grows with conifers. *Cortinarius caesiocolor* formed a well-supported clade in our phylogenetic analysis and differs in ITS regions from *C. chromataphilus* by 16 substitutions and indel positions. The sequences of *C. caesiocolor* have three base and one length polymorphisms and the maximum pairwise distance is zero.

Cortinarius myrtilliphilus Kytöv., Liimat., Niskanen & Brandrud, *sp. nov*. — MycoBank MB805882; Fig. 7f

Etymology. The name refers to the habitat with *Vaccinium myrtillus*.

= *Cortinarius vacciniophilus* Brandrud, Edinburgh J. Bot. 54, 1: 114. 1997. p.p.

Type. Finland, Kainuu, Suomussalmi, Suolijärvi, Siikajärvi, NW foot of Siikavaara (Rönninvaara), Pöksäkorpi, gently sloping, partly swampy, grass-herb-spruce forest with some *Pinus*, *Betula*, *Populus*, *Alnus incana* and *Salix* spp., 14 Sept. 1997, *I. Kytövuori* 97-1469, H6032751 (holotype H; isotype NY). GenBank KF732605.

Pileus 4.5–9(–11) cm broad, hemispherical to plano-convex, with slightly incurved margin, weakly to distinctly viscid when young, soon dry, with appressed veil scales, especially at centre, pale yellowish brown to darker ochraceous brown to leather brown (like *C. balteatus*), young margin paler, almost whitish; sometimes with hygrophanous streaks. *Lamellae* emarginate, crowded, greyish white when young, later pale brown. *Stipe* 5.5–11 cm long, 1–2(–2.5) cm thick at apex, 1.5–3 cm wide at base, clavate, at first white, later becoming pale brown from base. *Universal veil* white, sparse. *Context* white, faintly greyish hygrophanous at stipe apex. *Odour* indistinct to weak, pleasant, resembling corn. *KOH-reaction* in context strongly yellow when young, later weakly yellow or with yellow margin. *Exsiccata*: pileus uniformly pale warm yellowish brown to brown or somewhat darker at the middle, stipe with the same tint as pileus but lighter.

In MLZ: *Spores* 10.9–*12.1*–13.4 × 6.3–*6.9*–7.5 µm, Q = 1.63–*1.79*–1.91 (2 specimens, 100 spores, Fig. 7f), amygdaloid-fusoid with a distinct suprahilar depression and a long apical part (in form very much like those in *C. collinitus*), (finely to) moderately verrucose, somewhat dextrinoid. *Basidia* 33–45 × 8.5–11 µm (40 basidia), sand brown, dark granules very few. *Lamellar trama hyphae* with small granules. *Stipe apex hyphae*: pale brown, outermost hyphae more reddish, dark granules few. *Pileipellis*: gelatinous layer present, erect-sinuose gelatinous hyphae 4–6(–8) µm wide, repent subsurface hyphae 5–10 µm wide, fairly thin-walled, finely to fairly strongly spirally incrusted, with some dark red brown, angular particles. Lower hyphae with slightly thicker, smooth to strongly and coarsely incrusted hyphae with dark red brown, farinose to granulose contents.

Ecology & Distribution — In mesic *Picea* dominated forests, from richer to poor *Vaccinium myrtillus* type. So far only known from middle boreal zone from Finland and Norway and might be rare. Produces fruitbodies in autumn.

Other specimens examined. Norway, Oppland, Ringebu, Venabygd, c. 700 m asl, *Picea abies* forest, ± poor raw humus, mossy *Vaccinium myrtillus* type, 30 Aug. 1994, *E. Bendiksen & T.E. Brandrud*, TEB 4-94, O 125949 (O, sub nom. *C. vacciniophilus*).

Notes — *Cortinarius myrtilliphilus* belongs to /Phlegmacioides. It has an ochraceous brown pileus and pale greyish white lamellae, both without bluish tints, large spores, and it grows in mesic *Picea* dominated forests. It has previously been confused with *C. pseudonaevosus* Rob. Henry (= *C. acidophilus* Brandrud) which is a common spruce forest species in northern Europe and also occurs in mountain areas of Central Europe. Typically, *C. pseudonaevosus* has bluish pileus margin, bluish tints in context of the pileus and stipe apex, and smaller spores. However, *C. myrtilliphilus* strongly resembles the large-spored and non-bluish specimens of *C. pseudonaevosus*. Previously, these variants were called *C. vacciniophilus* Brandrud (Brandrud 1998). These large-spored *C. vacciniophilus* specimens are in some regions as frequent as the smaller spored *C. acidophilus* specimens (Gjerde et al. 2012). Our molecular studies showed that a majority of the large-spored specimens are in fact *C. pseudonaevosus*, leaving *C. pseudonaevosus* as an apparently genetic uniform but morphologically heterogeneous species. On the other hand, analysis of ITS sequences also showed that *C. myrtilliphilus* represents an autonomous species and *C. myrtilliphilus* and *C. pseudonaevosus* are not closely related. *Cortinarius pseudonaevosus* belongs to a strongly supported clade (0.99 PP) with *C. balteatus* (Fr.) Fr., *C. brunneiaurantius* Kytöv., Liimat. & Niskanen, *C. brunneoviolaceus* Bidaud, *C. sobrius* and *C. clarobaltoides* var. *longispermus* Reumaux, while *C. myrtilliphilus* is placed elsewhere in /Phlegmacioides, but further relationships with the other members of the clade were not fully resolved. Based on the pairwise comparison of the ITS sequences the closest species is *C. badiolatus* (M.M. Moser) M.M. Moser (= *C. durus* s.auct.) from which it differs by 11 substitutions and indel positions. *Cortinarius badiolatus* differs from *C. myrtilliphilus* by paler, initially almost whitish colours of the pileus, and habitat mainly in subalpine *Betula* forests. Based on molecular and morphological data we conclude that *C. myrtilliphilus* represent an autonomous species and describe it here as new to science. *Cortinarius myrtilliphilus* must be a very rare species, by us only found twice during many years of study. Due to limited material, we do not fully know the morphological variation of *C. myrtilliphilus*, and the morphological overlap with the similar, but genetically quite distant, large-spored variants of *C. pseudonaevosus* (= *C. vacciniophilus* p.p.) needs further study.

DISCUSSION

Type studies

The majority of names published in the genus *Cortinarius* have been by French taxonomists, representing over half of the types we studied, 132 names representing 77 species, but for 17 of these an earlier name by other taxonomists exist, so in reality the number of truly new species they described is 60. They represent species from both broadleaf hardwood (about 60 %) and conifer forests. Thus, the *Cortinarii* of France are among the most extensively studied in the world. Although Friesian names often dominate the nomenclatural discussions in *Cortinarius*, the number of species he described is significantly less than the numbers for French authors. In Fries (1836–1838) there are about 50 names belonging to the groups we studied and of these 32 are currently included in Funga Nordica (Jeppesen et al. 2012). This demonstrates how difficult it is to interpret old names with vague descriptions and no type material. The Friesian names currently in use include mainly species for which either published or unpublished illustrations exists making them easier to interpret. Species with Friesian names represent about 20 % of the species recognized in this study. A similar trend occurs in subg. *Telamonia*. For example, in sections *Armillati* and *Brunnei* 30 % of the total known species were described by Fries, and in the morphologically challenging sect. *Bovini* only 8 % (Niskanen et al. 2009, 2011a, 2013a).

From North America we studied 60 types, representing 59 species. Of these, 52 species (88 %) have apparently not been described from anywhere else in the world, while one of them is the older synonym for a European name (*C. metarius* Kauffman = *C. barbarorum* Bidaud, Moënne-Locc. & Reumaux). Thirty-five of these species were described from the mountains and coastal areas of western North America, 13 species are from the Rocky Mountains and 12 species were collected from eastern North America, mainly Michigan. Almost all the names that are synonyms of European species are associated with conifers, i.e., *C. crassus* Fr. (= *C. subaustralis* A.H. Sm. & Hesler, described from North Carolina), *C. glaucopus* (Schaeff.) Fr. (= *C. glaucopoides* Kauffman, described from Colorado) and *C. metarius*; the only exception is *C. triumphans* Fr. s.auct. (= *C. ophiopus* Peck from Maryland). Species described from North America and reported here for the first time from Europe, include *C. olympianus* (USA, Washington state and Finland), *C. patrickensis* (USA, California and Sweden) and *C. sannio* (USA, Wyoming, Finland and Sweden), all are conifer-associated species. These findings correlate well with previous studies by Garnica et al. (2011), Harrower et al. (2011) and Niskanen et al. (2013a, b). Interestingly, many names described from Europe

have been used in North America, whereas few names from North America have been applied to taxa in Europe.

Of the 154 species recognised in this study 114 of them have no synonyms, however, the remaining 40 species each have one or more synonyms. The species with a significant number of synonyms include *C. largus* (14), *C. pseudonaevosus* (6), *C. talus* (5), *C. crassus* (4) and *C. varius* (4), all represent rather common species. The authors whose names we studied have all described synonyms. This is in part due to the difficulty in determining which species already have been described, especially based only on morphology and ecology. The narrow species concept of Bidaud, Henry, Moënne-Loccoz and Remaux was not supported by our study nor were the broad species concepts of Fries, Brandrud and Jeppesen et al. (2012) as supported by the results of Frøslev et al. (2007) and Niskanen et al. (2009, 2011a).

In this paper, species names have been synonymised when both molecular and morphological data have supported it. Of course there is some risk that morphological differences have been overlooked by studying too few specimens. Based on the overall data we have on *Cortinarius* it would seem logical, however, that in the majority of cases the synonymization is correct. In doubtful cases, when the variation in ITS regions of a group of specimens has been more than 2 substitutions and/or indel positions and we have not had enough specimens to make further comparisons, we have left names unchanged, i.e. *C. albescens/C. gentianeus/C. volvatus*, *C. herpeticus/C. violaceonitens*, and *C. misermontii/C. olidoamarus* var. *valentinus/C. subaccedens/C. van-campiae.* Also, the following species with higher intraspecific variation may in reality represent two to several species: *C. aureofulvus* s.auct. / *C. orichalceus* var. *xanthocephalus*, *C. pallidirimosus*, *C. porphyropus* and *C. scaurus.*

Our study includes the majority of names described in subg. *Phlegmacium*, excluding sect. *Riederi* and parts of sections *Calochroi* and *Fulvi* already treated or to be treated by other taxonomists (e.g. Frøslev et al. 2007). In some instances, type material could not be acquired or found in herbaria, i.e. the material of C.H. Peck (NYSM) and some of the material of R. Henry (PC). In other cases they were not possible to study within the time frame of this study, i.e. the early names described by M. Moser (M). Peck published from 1870 to 1912 about 80 names in the genus *Cortinarius* and the names represent at least twenty species of subg. *Phlegmacium* s.lato based on morphological and microscopical features. The material deposited in München includes about 30 *Phlegmacium* species. For about 55 *Phlegmacium* species described by Henry the type material was not found and over 20 additional ones remain to be studied. Therefore, it is possible that some of these names have priority over currently applied *Cortinarius* names, including some of those in this paper. Our plan is to acquire Peck's, the remaining materials of Moser's and Henry's, and perhaps others that we have overlooked in the near future and attempt to sequence them for comparison.

New species

The majority of new species described here represent boreal taxa, i.e. *C. pallidirimosus*, *C. balteaticlavatus* and *C. myrtilliphilus*, and/or are species that previously have been included within the morphological limits of other, 'well-known' taxa, these include *C. boreicyanites* and *C. subfraudulosus*. The large number of unknown, boreal species is not surprising, since the majority of existing names are described from hemiboreal and temperate zones or from the mountains of Central and southern Europe. Even though the *Cortinarius* species of Europe have been extensively studied, there undoubtedly remain a lot of taxa to be discovered, not to mention in other areas of the world, which are less explored.

Factors affecting on the success of molecular work

The success of the molecular studies was significantly influenced by the condition of type specimens, including the age of the specimen, how it was dried and/or preserved, and whether or not it was mouldy. Also, the length polymorphism of the ITS region caused some problems with direct sequencing. In general, *Cortinarius* is one of the easiest genera of *Agaricales* for molecular work. Often DNA can be extracted with regular methods even from old specimens. For example, we obtained a complete ITS region from the type material fo *C. sobrius* P. Karst. (collected in 1890) and *C. virentophyllus* Kauffman (collected in 1912). The success rate usually decreases with older specimens, however, there is some difference between the specimens collected by different authors. For example, we were not able to successfully sequence any of the specimens collected by T. Hongo during 1960–1968 (Niskanen et al. 2011a, and unpublished data of *C. cinnamomeoides* Hongo, *C. neoarmillatus* Hongo and *C. nigrosquamosus* Hongo) whereas the success rate for the specimens collected by A.H. Smith mainly during 1935–1941 was much better. This could be due to the drying process itself, for example, drying temperature, length of drying time, which is related to air circulation, and the condition of fresh specimens when placed on the dryer. In particular, the type collections of R. Henry proved challenging, since often the material was sparse and poorly labelled, and many were mouldy. In some instances types were missing, could not be located at the time they were requested, or were not available for study.

Several things can improve the success rate of problematic specimens. For example, methods that provided high quality DNA extraction, and PCR and sequencing machines improved the results. If the DNA is fragmented, amplifying and sequencing ITS1 and ITS2 regions separately was often helpful.

Recommendations for stabilizing the nomenclature

For achieving a stable and unambiguous use of names, the following requirements should be fulfilled whenever possible. Types of existing names should be studied. Even easily identifiable species like *C. balteatoalbus* can be misinterpreted, or a species may turn out to be a group of cryptic species, for example, *C. dionysae* and *C. elegantior* (Garnica et al. 2011). Taxonomists should not use names in barcoding databases unless they have been verified by molecular type studies. For old names that do not have type specimens or where the type specimen is in poor condition or not available because of historical preservation, a neotype, lectotype or epitype should be chosen. Names rejected due to the problems of interpretation should be excluded from consideration. If the name is not verified with a sequence from a type specimen its application will be uncertain and a source of confusion. A significant problem with neo-, lecto- and epitypes is the lack of a database for them. It is difficult to find out if a type already has been designated thus hindering nomenclatorial work.

New names should not be accepted for publication without the support of molecular data in genera where the amplification of the ITS or other sequences is easily done, thus preventing the description of synonyms and creating a sound reference database for further taxonomical and ecological studies. Finally, when studying types it is essential to mark the basidiomata from which the DNA has been extracted. Some collection might turn out to be mixed, and thus, knowing exactly which basidiocarp has been studied, will be necessary.

These recommendations may seem self-evident, but have been neglected in many cases. Often the reason is a lack of resources and/or knowledge. At least in *Cortinarius* the amount of already existing names is overwhelming and we need to proceed carefully from this point forward.

Infrageneric classification

The classification of *Cortinarius* is not yet stabilised and many traditional infrageneric groups have shown to be at least partly artificial. Therefore, when studying a certain group of species, it might be difficult to find all the relevant species described from literature. The aim of the phylogenetic estimates in this study was not to solve the infrageneric classification of *Cortinarius* but to show the preliminary placement of the studied species, which then could be used for guidance in further taxonomical studies.

In our phylogenetic analysis ten of the twelve clades representing phlegmacioid species sensu Garnica et al. (2005) were recovered: /Alluti (= Multiformes), /Amarescentes (= Infracti), /Arguti/Calochroi, /Percomes, /Phlegmacium, /Phlegmacioides, /Praestantes (= Claricolores), and /Scauri. In addition, /Glaucopodes was well supported in our analysis. Clades /Caerulescentes and /Vulpini were split.

Barcoding Cortinarius

This study provides ITS barcodes for 175 *Cortinarius* species. This data enables the identification of a majority of boreal and temperate species of *Phlegmacia*, except for sections *Calochroi*, *Fulvi*, for which part of the ITS sequences already are published (e.g. Frøslev et al. 2007) and *Riederi*, from Europe and parts of North America.

Of the 236 names we studied, only 61 were currently represented in GenBank. It is noteworthy that almost half of these names are Friesian names and a third of them are names published from North America. Only 4 % of the names described by French authors have made their way into general use in GenBank. This emphasizes the importance of type studies and the role of taxonomists in the creation of an identification database. If we do not produce sound basic data on *Cortinarius* species, it is difficult or impossible in many cases for non-taxonomists to identify specimens or environmental samples.

A barcoding database based on type studies is essential for ecological, environmental or further taxonomic research. Once completed, it will create a solid base for future studies. Barcoding is a powerful tool, which enables us to identify and compare species from different regions in a completely new way. This is especially true and important for fungi like *Cortinarius*, which are morphologically challenging and difficult to identify. Finally, we are able to reliably compare our knowledge on species from different areas. A base for *Phlegmacia* is created here and provides a beginning and direction for future studies in *Cortinarius*.

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