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Study on *Cortinarius* subgenus *Telamonia* section *Hydrocybe* in Europe, with especial emphasis on Mediterranean taxa

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ARTICLE INFO

Article history:

Received 16 January 2009

Received in revised form

5 June 2009

Accepted 11 July 2009

Available online 17 July 2009

Corresponding Editor: Roy Halling

Keywords:

Cortinarius subgenus *Telamonia*

FESEM

ITS sequences

Morphological and spore diversity

Systematics

Taxonomy

ABSTRACT

In this paper we have attempted to clarify the taxonomy and nomenclature of thirteen taxa of the genus *Cortinarius* subgenus *Telamonia* (sections *Hydrocybe*, *Fraternii*) well represented in the southwestern Mediterranean area of Europe (*C. atrocoeruleus*, *C. bombycinus*, *C. casimiri*, *C. contrarius*, *C. decipiens*, *C. fraternus*, *C. gallurae*, *C. hoffmannii*, *C. petroselineus*, *C. sertipes*, *C. subturibulosus*, *C. urdaibaiensis* and *C. vernus*). To this end we have performed a combined study of morphological and molecular data (rDNA ITS sequences). The morphological analysis was carried out on 114 collections and the molecular analysis involved 31 of the 114 collections, including 11 type collections (types for *C. casimiri* and *C. fraternus* were not available). In addition, a study of spores under field emission scanning electron microscopy (FESEM) was conducted. The results of the combined analysis allowed us to assign the studied material to five species (*C. casimiri* s.l., *C. decipiens* s.l., *C. gallurae*, *C. subturibulosus* s.l. and *C. vernus* s.l.). Thus, all collections from more continental areas, which were originally identified as six different taxa (*C. atrocoeruleus*, *C. contrarius*, *C. decipiens*, *C. fraternus*, *C. sertipes*, *C. flexipes* fo. *sertipes*) corresponded to *C. decipiens sensu lato*, a widely distributed, genetically and morphologically variable species. *Cortinarius casimiri* is also found in such habitats, but it is confirmed as distinct taxon. Collections from Mediterranean sclerophyllous communities correspond to *C. gallurae*, *C. vernus sensu lato* and *C. subturibulosus sensu lato*. Due to close phylogenetic relationships we propose the new combinations *C. casimiri* var. *hoffmannii* (= *C. decipiens* var. *hoffmannii* non *C. hoffmannii*) and *C. subturibulosus* var. *bombycinus* (= *C. bombycinus*), and the new variety *C. vernus* var. *nevadavernus* (= *C. vernus* H. Lindstr. & Melot *sensu auct.*).

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Introduction

Due to the high number of taxa, systematics and taxonomy of the genus *Cortinarius* is one of the most difficult within Basidiomycetes. The taxonomic confusion is also caused by the lack of good microscopical characters and the variability of the

widely applied macro-morphological characters. The incorporation of molecular methods to the systematics of this genus now allows addressing the phylogeny of the whole genus with different molecular markers (e.g. Ammirati *et al.* 2007; Frøslev *et al.* 2005; Garnica *et al.* 2003, 2005; Peintner *et al.* 2001, 2002, 2004). Phylogenetic studies focussing on the genus

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doi:10.1016/j.mycres.2009.07.006

Cortinarius generally resulted in phylogenetic hypothesis with low internal support on subgenus level. Nevertheless, many traditional taxonomic groups, for instance the classical major subgenera (Høiland & Holst-Jensen 2000; Peintner et al. 2004) have been shown to be artificial. In contrast to the low support for the internal-nodes, *Cortinarius* phylogenies result in highly supported and well resolved terminal (external) nodes, showing that e.g. internal transcribed spacers of the nuclear ribosomal DNA (rDNA ITS) data are useful for establishing relationships between closely related species. The suitability of rDNA ITS sequences has been demonstrated in many studies (Frøslev et al. 2006, 2007; Kytövuori et al. 2005; Lindström et al. 2008; Liu et al. 1995, 1997; Ortega et al. 2008; Peintner et al. 2003; Seidl 2000), and they have been proposed as species-identifier sequences (barcoding) in *Cortinarius* (Frøslev et al. 2007; Ortega et al. 2008). Resolved phylogenies allow the evaluation of the taxonomic value of morphological characters used in the taxonomy.

In this paper, we have attempted to clarify the taxonomy and nomenclature of 13 taxa of *Cortinarius* subgenus *Telamonia* included, from a morphological point of view, in the sections *Hydrocybe* sensu Brandrud et al. (1992) and Bidaud et al. (1994), or *Fraternii* Reumaux & Moëgne-Loccc. (Moëgne-Loccc & Reumaux 1990). This is a group of taxa well represented in the southwestern Mediterranean area of Europe, where we have focused our study. All 13 taxa are accepted by most Spanish mycologists (Mahiques 2006); however all of them are surrounded by considerably taxonomic confusion, as the morphological characters traditionally used for their delimitation are quite variable. For this reason they were often misidentified, and the taxonomy applied in this group differs vastly in different parts of Europe (Brandrud et al. 1994, 1998; Arnold 1993; Moser 2001; Niskanen et al. 2008). Thus, *C. atroceruleus*, *C. casimiri*, *C. decipiens* and *C. vernus* form a group of well accepted, 'classical' taxa in wide usage in Europe; *C. contrarius* and *C. sertipes* are species with some usage in parts of Europe; *C. bombycinus*, *C. gallurae*, *C. petroselinus*, *C. subturibulosus* and *C. urdaibaiensis* are Mediterranean species with hitherto local usage; and finally, *C. hoffmannii* and *C. fraternus* are regarded as doubtful and/or little known species. Moreover, a consequence of the few knowledge about the taxonomy of this group of taxa is the trend to split the species in many doubtful taxa, increasing the taxonomic confusion within the section *Hydrocybe*. To test the taxonomic relevance of morphological and ecological characters in these 13 taxa we performed a combined study of morphological and molecular data based on rDNA ITS sequences.

Materials and methods

A total of 114 collections of 13 taxa were studied. All analysed specimens belong to *Hydrocybe* taxa, a well represented group in the southwestern Mediterranean area of Europe, and closely related taxa. In order to clarify the taxonomy and nomenclature of the analysed taxa, all available type specimens were included in the study (11 types, no type exist for *C. casimiri* and *C. fraternus*; Table 1). Molecular analysis involved 31 collections, including the type materials (except in the case

of *C. subturibulosus*, from which ITS sequences could not be obtained).

The studied material originates from the public herbaria AH, C, GDA and GDAC, GK, IB, JA-cussta, L, PC, S, TUB and from personal herbaria of A. Bidaud (AB), J. Bouteville (J.B.), G. Chevassut (CHEV), G. Consiglio (CONS), R. Fernández Sasía (R.F.S), Grupo Iberopeninsular de Cortinariólogos (GIC), S. Kizlik (S. Ki.), R. Mahiques (MES), P. Moëgne-Loccc (P.M.L), and F. Palazón (FP). A reference number was assigned to each collection (see Table 1 and material examined).

Because most of the studied material were voucher collections, the macromorphological data were based on: (i) fresh material studied by us, (ii) unpublished notes of the own collector, (iii) descriptions in literature, and/or (iv) our interpretations of plates from literature. All collections studied from fresh material are indicated with an asterisk mark in Table 1.

Basidiospores were studied using a Leo (Zeiss), model 1539 Gemini, Field Emission Scanning Electron Microscope (FESEM) in the "Servicio de Apoyo a la Investigación" of the University of Granada. For each collection we measured 20 spores from 3 basidiomata, each, and calculated the following values: maximum (LM, WM), mean (Lme, Wme) and minimum (Lm, Wm) values for length and width; average of maximum values (Mmax), average of mean values (Mme) and average of minimum values (Mmin); as well as maximum length/width ratio (QM), mean values (Qme) and minimum values (Qm).

A Principal Components Analysis (PCA) for the studied collections was made with the spore, ecological and biogeographical characters using the statistical package CANOCO version 4.55 (Ter Braak & Smilauer 1998). The characters were codified according to Brandrud (1996) (Table 1): (i) spore size (μm) (LM, Lme, Lm, WM, Wme, Wm, QM, Qme, Qm); (ii) spore ornamentation (Or) [light-medium (1), medium-strong (2), strong (3)]; (iii) habitat (Ha) [conifers woodlands (1), riparian or hygrophilous communities (*Alnus*, *Betula*, *Corylus*, *Populus*, *Salix*, etc.) (2), deciduous woodlands (*Fagus sylvatica*, *Quercus* spp.) (3), sclerophyllous woodlands (*Quercus ilex* subsp. *ballota* and *Q. suber*) (4)]; (iv) biogeography (Bi) [Eurosiberian temperate-alpine areas (1), Mediterranean sclerophyllous areas (2)].

The molecular analysis included 57 ITS sequences in total; thirty-eight of the 57 sequences were generated as part of this study and the remainder were taken from GenBank and UNITE databases. The 38 sequences belonged to 31 collections, including 10 types (Table 1). Sequences from morphologically related species [*C. alnetorum* (Velen.) Mos., *C. bibulus* Quél. (as *C. pulchellus* J.E. Lange), *C. parvannulatus* Kühner (as *C. cedriolens* M.M. Moser) and *C. umbrinolens* P. D. Orton; Brandrud et al. 1994] were retrieved from public sequence databases to investigate the phylogenetic relationship. BLAST searches showed a high identity between ITS sequences of *C. vernus* s.l. and *C. helobius* Romagn. (from collection in Flora Photographica, CFP542; sect. *Incrustati*), and then this sequence was also included in the analysis. *Cortinarius torvus* was chosen as out-group species. EMBL and GenBank accession numbers for the sequences of those collections analysed morphologically are shown in Table 1, while the GenBank and UNITE accession numbers for the remainder are shown in the ITS tree.

Total genomic DNA was extracted using the CTAB method (Doyle & Doyle 1987). The entire ITS region (ITS-1, 5.8S and

Table 1 – Morphological, ecological and biogeographical data for the 114 collections studied of *Cortinarius*. Nr. Collection reference number. LM. Maximum length. Lme. Mean length. Lm. Minimum length. WM. Maximum width. Wme. Mean width. Wm. Minimum width. QM. Maximum length/width ratio. Qme. Mean length/width ratio. Qm. Minimum length/width ratio. Or. Spore ornamentation. Ha. Habitat. Bio. Biogeography. Herbaria. Voucher reference for each collection. GenBank/EMBL. Accession numbers for ITS sequences in the GenBank and EMBL databases

Taxa	Collections	Nr ^a	LM	Lme	Lm	WM	Wme	Wm	QM	Qme	Qm	Or ^b	Ha ^c	Bio ^d	Herbaria ^e	GenBank/EMBL
<i>C. casimiri</i>																
var. casimiri	<i>C. casimiri</i>	1	13	12.00	10	8.5	7.1	6.4	2	1.69	1.5	1.5	3	1	MES 4042	
	<i>C. subsertipes</i>	2	12.8	11.8	10.8	7.4	6.9	6.4	1.9	1.68	1.5	1	3	1	PC 0090277	
	<i>C. subsertipes</i>	3	12	11.2	9.6	7.2	6.5	6	1.9	1.72	1.5	1	2	1	PC 0090278	
	<i>C. subsertipes</i>	4	12	11.2	10.4	7.2	6.6	5.6	1.9	1.7	1.6	1	1	1	PC 0090279	
	<i>C. subsertipes</i>	5	11.8	10.5	9.5	7	6.1	5.6	1.9	1.72	1.5	1	3	1	PC 0090280	
	<i>C. subsertipes</i>	6	12	11.1	10.4	7.2	6.5	5.6	2	1.71	1.5	1.5	3	1	PC 0090281	
	<i>C. subsertipes</i>	7	12	11.2	10	6.8	6.5	5.7	1.9	1.72	1.6	1	3	1	PC 0090282	
	<i>C. subsertipes</i>	8	11	10.4	9.6	7.2	6.3	5.6	2	1.69	1.5	1	2	1	PC 0090283	
	<i>C. subsertipes</i>	9	14.5	11.3	9.5	8	6.7	5.6	1.8	1.69	1.5	1.5	3	1	PC 0090284	
	<i>C. subsertipes</i>	10	12.1	10.7	9.5	6.5	6.1	5.6	1.9	1.75	1.6	1.5	3	1	PC 0090285	
	<i>C. subsertipes</i>	11	12	10.9	10	7	6.4	6	1.8	1.7	1.5	1	1	1	CONS 01158	FN429014
	<i>C. casimiri</i>	12	12	10.3	9	7.2	6.1	5.5	1.9	1.7	1.5	1	3	1	C-F84763	AJ889945
	<i>C. casimiri</i>	13	13.1	11.9	10.9	7.2	6.3	5.8	2.1	1.89	1.7	1	2	1	S-F44850	
	<i>C. casimiri</i>	14	11.3	10.4	9.6	6.5	5.9	5.4	2	1.76	1.6	1	3	1	S-F44849	
	<i>C. casimiri</i>	15	12	10.8	10	7.2	6.5	5.6	1.9	1.66	1.4	1	3	2	MES 3370	FN429010, FN429011, FN429012, FN429013
	<i>C. subsertipes</i>	16	12	10.8	9.6	7	6.2	5.6	2	1.74	1.6	1	3	1	TUB 011449	AY669679
	Mean values		12.23	11.03	9.90	7.19	6.42	5.75	1.93	1.72	1.53	1.13				
var. hoffmannii	<i>C. decipiens</i>															
	var. hoffmannii	17-a	11.2	9.6	8.8	6.2	5.7	5.2	1.9	1.68	1.6	2	3	1	P.M.L. 559-T	
	<i>C. decipiens</i>															
	var. hoffmannii	17-b	9.7	9	8.2	5.6	5.3	5	1.8	1.7	1.6	1.5	3	1	P.M.L. 559-T	
	<i>C. decipiens</i>															
	var. hoffmannii	17-c	10.4	9.5	8.8	5.6	5.3	4.8	2	1.78	1.6	1.5	3	1	P.M.L. 559-T	
	<i>C. decipiens</i>															
	var. hoffmannii	17-d	9.6	8.5	8	5.5	5	4.5	1.9	1.7	1.6	1.5	3	1	P.M.L. 559-T	
	<i>C. decipiens</i>															
	var. hoffmannii	17-e	9.6	8.7	7.2	5.6	4.9	4.1	2	1.78	1.6	2	3	1	P.M.L. 559-T	
	Mean values		10.10	9.06	8.20	5.70	5.24	4.72	1.91	1.73	1.58	1.70			P.M.L. 559-T	FN429015
	Total mean values		11.72	10.56	9.50	6.84	6.14	5.50	1.92	1.72	1.54	1.26				
C. decipiens	<i>C. atrocoeruleus</i>	18	9.5	9	8.5	5.5	5.2	5	1.9	1.73	1.5	2	1	1	IB 1951/0161-T	FN428992
	<i>C. atrocoeruleus</i>	19	10	8.9	8.2	5.5	5.2	4.8	1.9	1.72	1.6	2	2	1	IB 86/274	
	<i>C. atrocoeruleus</i>	20	10	8.7	8	5.5	5	4.5	1.8	1.74	1.6	2	2	1	IB 93/225	
	<i>C. atrocoeruleus</i>	21	9.5	9.1	8.5	6	5.4	5.2	1.9	1.68	1.5	2	2	1	IB 66/199	
	<i>C. atrocoeruleus</i>	22	9	8.1	7.8	5.4	5	4.8	1.7	1.62	1.5	2	2	1	AH 30921	
	<i>C. atrocoeruleus</i>	23	9.2	8.5	8	6	5.2	5	1.8	1.63	1.5	2	1	1	CONS 01145	
	<i>C. atrocoeruleus</i>	24*	9	8.2	7.5	5.5	5.2	5	1.7	1.58	1.5	1	2	1	ORTEGA 259	
	<i>C. sertipes</i>	25	9.5	8.9	8	5.5	5.1	4.5	1.9	1.74	1.5	3	3	3	GK 388257-T	FN429001
	<i>C. sertipes?</i>	26	10	9	8.2	6.2	5.6	5.2	1.8	1.61	1.5	2	2	1	GK 52852	
	<i>C. sertipes</i>	27	10	9.1	8.2	6	5.7	5.2	1.7	1.6	1.5	1	2	1	GK 52850	
	<i>C. aff. sertipes</i>	28	9.5	8.8	8	5.8	5.3	5	1.7	1.66	1.5	2	2	1	GK 52851-L1	
	<i>C. aff. sertipes</i>	29	9.2	8.6	8	5.8	5.3	5	1.7	1.62	1.5	2	2	1	GK 52851-L2	

	<i>C. aff. sertipes</i>	30	10	9.2	8.5	6	5.5	5.2	1.8	1.67	1.6	1	2	1	GK 52851-L3	
	<i>C. sertipes</i>	31	10	8.5	8	6	5.1	4.5	1.9	1.67	1.5	2	2	1	AB 01-10-100	FN428989, FN428990
	<i>C. sertipes</i>	32	9.2	8.5	8	5.5	5.2	5	1.8	1.63	1.5	3	2	1	AB 92-10-220	
	<i>C. sertipes</i>	33	9.2	8.8	8.2	5.8	5.3	4.8	1.8	1.66	1.5	3	2	1	AB 96-10-147	
	<i>C. sertipes</i>	34	10	8.6	8.6	5.5	5.1	4.8	1.9	1.69	1.5	2	2	1	AB 91-10-222	
	<i>C. contrarius</i>	35	10.5	9.2	8.5	6	5.5	5	1.9	1.67	1.5	1.5	2	1	L 0053478-T	FN429000
	<i>C. fraternus</i>	36	9	8.7	8.2	6	5.4	5.2	1.7	1.61	1.4	1	2	1	J.B. 08096	FN428999
	<i>C. fraternus</i>	37	9	8.5	7.8	5.5	5.2	5	1.7	1.63	1.5	1	2	1	J.B. 08096-1	FN428991
	<i>C. sertipes</i>	38*	9.5	8.8	8	5.8	5.2	5	1.9	1.69	1.5	2	4	2	GDAC 36772	FN428993
	<i>C. sertipes</i>	39	9.5	8.9	8.2	5.5	5.1	5	1.8	1.74	1.6	2	4	2	R.F.S. 041218-01	
	<i>C. sertipes</i>	40*	9.5	9	8	6	5.5	5	1.8	1.65	1.6	1.5	4	2	GDAC 36737	
	<i>C. sertipes</i>	41*	9.2	8.8	8.2	5.8	5.2	5	1.8	1.69	1.6	2	4	2	GDAC 36744	
	<i>C. sertipes</i>	42*	9.8	9.1	8.5	5.8	5.4	4.8	1.9	1.69	1.6	2	4	2	GDAC 30786	
	<i>C. sertipes</i>	43*	10	9.4	9	6	5.6	5.2	1.9	1.72	1.5	2	4	2	GDAC 36738	
	<i>C. sertipes</i>	44	9.6	8.9	8.5	5.7	5.3	5	1.7	1.67	1.5	2	2	1	AH 26839	FN428998
	<i>C. decipiens</i> var. <i>hoffmannii</i>	45	10.5	9.4	8.8	6.2	5.7	5.1	1.7	1.65	1.5	2	2	2	CONS 05431	FN428995, FN428996, FN428997
	<i>C. sertipes</i> fo. <i>contrarius</i>	46*	9.8	8.9	8.5	5.5	5.2	4.8	1.8	1.73	1.6	2	4	2	GDAC 30788	
	<i>C. decipiens</i> var. <i>atrocoeruleus</i>	47	8.6	8.1	7.2	5	4.7	4.2	1.8	1.72	1.7	1	2	2	S-F44856-a	
	<i>C. decipiens</i> var. <i>atrocoeruleus</i>	48	10	9.3	8.8	6.1	5.6	5.2	1.7	1.66	1.5	2	2	2	S-F44856-b	
	<i>C. decipiens</i>	49	9.6	8.9	8.1	5.6	5.2	4.8	1.9	1.71	1.6	1.5	2	2	S-F44857	
	<i>C. decipiens</i>	50*	9.5	9.1	8.5	5.2	4.9	4.5	2.1	1.86	1.7	1.5	1	2	GDA 54265	FN429002
	<i>C. decipiens</i>	51	9.6	8.6	7.8	5.6	5.1	4.8	2	1.69	1.4	2	1	1	P.M.L. 366-NT	FN428988
	<i>C. decipiens</i>	52	8.8	7.9	7.2	5	4.6	4	1.9	1.72	1.5	1.5	2	1	IB 1974/0451	AY083180
	Mean values		9.57	8.80	8.17	5.71	5.25	4.89	1.83	1.68	1.53	1.84				
<i>C. gallurae</i>	<i>C. sertipes sensu</i> A.Ortega & Mahiques	53*	9.8	9	8	5.5	5.3	5	1.8	1.7	1.5	2	4	2	GDAC 31400	
	<i>C. decipiens</i>	54*	8.5	8	7	5.5	4.8	4.5	1.9	1.67	1.5	2	4	2	JA-Cussta 1601	
	<i>C. sertipes sensu</i> A.Ortega & Mahiques	55*	9.8	9.1	8	6	5.7	5	1.8	1.6	1.5	2	4	2	GDAC 30789	
	<i>C. sertipes sensu</i> A.Ortega & Mahiques	56*	10	8.7	8	6	5.4	5	1.8	1.63	1.5	2	4	2	GDAC 31454	
	<i>C. decipiens</i>	57	9.3	8.7	7.8	5.6	5.2	5	1.9	1.67	1.5	2	3	3	AH 30918	FN428981
	<i>C. gallurensis</i>	58	9	8.3	7.2	6	5.4	5	1.7	1.53	1.4	2	4	2	CONS 00076-T	FN428979
	<i>C. sertipes sensu</i> A.Ortega & Mahiques	59*	10.8	9.5	8.5	6.2	5.9	5.2	1.7	1.62	1.4	2	4	2	GDAC 36743	
	<i>C. gallurae</i>	60*	10	9.5	9	6.2	5.9	5.5	1.7	1.61	1.5	2	4	2	GDA 54264	FN428982
	<i>C. gallurae</i>	61*	10	9.3	8.8	6.5	6.1	5.5	1.7	1.53	1.4	2	4	2	GDA 54263	FN428980
	<i>C. gallurae</i>	62*	9.6	8.9	8	6.4	5.7	4.8	1.8	1.56	1.4	2.5	4	2	GDAC 54272	
	<i>C. gallurae</i>	63*	10.4	9.9	9	6.5	6	5.2	1.8	1.65	1.5	2.5	4	2	GDAC 54271	
	<i>C. gallurae</i>	64*	8.8	8.2	7.2	6	5.5	5	1.6	1.49	1.4	2.5	4	2	GDA 54270	
	<i>C. petroselineus</i>	65	8.8	7.9	7.2	5.8	5.4	4.8	1.7	1.47	1.4	1.5	4	2	MES 3984	
	Mean values		9.60	8.85	7.98	6.02	5.56	5.04	1.76	1.59	1.45	2.08				

(continued on next page)

Table 1 – (continued)

Taxa	Collections	Nr ^a	LM	Lme	Lm	WM	Wme	Wm	QM	Qme	Qm	Or ^b	Ha ^c	Bio ^d	Herbaria ^e	GenBank/EMBL
<i>C. subturibulosus</i>																
var. <i>subturibulosus</i>	<i>C. decipiens</i>															
	var. <i>subturibulosus</i>	66*	10.5	9.2	8.5	6	5.4	5	1.8	1.69	1.5	3	4	2	GDAC 31805	
	<i>C. decipiens</i>															
	var. <i>subturibulosus</i>	67*	9.5	9	8.4	6	5.4	5	1.8	1.67	1.5	3	4	2	GDA 54267	
	<i>C. urdaibaiensis</i>	68	10.2	9.3	8.2	6	5.5	5	1.9	1.68	1.5	3	4	2	R.F.S. 030215-01-T	FN428983
	<i>C. urdaibaiensis</i>	69	11	9.9	9	6	5.4	5	2.1	1.83	1.5	3	4	2	R.F.S. 040225-01-IT	
	<i>C. decipiens</i>															
	var. <i>subturibulosus</i>	70*	10.2	9.8	9.5	6.5	6	5.5	1.7	1.61	1.5	2	4	2	GDAC 10195	
	<i>C. urdaibaiensis</i>	71	9.5	8.8	8	5.5	5.3	5	1.8	1.66	1.4	3	4	2	GDA 54269	
	<i>C. decipiens</i>															
	var. <i>subturibulosus</i>	72*	10	9.1	8.2	5.5	5.1	4.8	2	1.78	1.6	2	4	2	ORTEGA 198	
	<i>C. decipiens</i>															
	var. <i>subturibulosus</i>	73	10	9.3	8.5	6	5.5	5	1.9	1.68	1.5	2	4	2	MES 2185	
	<i>C. decipiens</i>															
	var. <i>subturibulosus</i>	74	9.8	8.9	8.2	5.8	5.4	5	1.8	1.65	1.5	3	4	2	MES 2147	
	<i>C. decipiens</i>															
	var. <i>subturibulosus</i>	75*	10	9.3	8.8	6	5.5	4.8	1.9	1.77	1.6	2	4	2	GDAC 10194	
	<i>C. decipiens</i>															
	var. <i>subturibulosus</i>	76*	10	9.2	8.8	5.5	5.3	5	2	1.74	1.6	2	4	2	GDAC 36736	
	<i>C. subturibulosus</i>	77	11	9.8	9	6.2	5.6	4.8	2	1.75	1.6	2.5	4	2	S.Ki. 8-83-104-T	
	<i>C. decipiens</i>															
	var. <i>subturibulosus</i>	78	9.8	9.3	9	5.8	5.4	4.8	1.9	1.73	1.6	2	4	2	MES 2288	FN428984
	<i>C. decipiens</i>															
	var. <i>subturibulosus</i>	79	10	9.7	9.2	6	5.5	5	1.9	1.78	1.6	2	4	2	MES 2347	FN428985
	<i>C. decipiens</i>															
	var. <i>subturibulosus</i>	80	10.5	9.4	8.8	6	5.5	5.2	1.9	1.7	1.6	2	4	2	MES 2083	
	<i>C. decipiens</i>															
	var. <i>subturibulosus</i>	81	10.5	9.8	9	6	5.5	5	1.9	1.8	1.6	2	4	2	MES 1441	
	<i>C. decipiens</i>															
	var. <i>subturibulosus</i>	82	10.5	9.7	9	6	5.4	5	2	1.79	1.7	2	4	2	MES 2115	
	<i>C. decipiens</i>															
	var. <i>subturibulosus</i>	83	12	10.9	10	6.5	5.7	5	2	1.91	1.7	3	4	2	GDA 54266	
	<i>C. decipiens</i>															
	var. <i>subturibulosus</i>	84*	11.2	9.9	8.8	6	5.6	5	2	1.77	1.7	3	4	2	GDA 42904-a	
	<i>C. decipiens</i>															
	var. <i>subturibulosus</i>	85*	12	10.9	10	6	5.5	5	2.2	1.96	1.8	3	4	2	GDA 42904-b	
	<i>C. decipiens</i>															
	var. <i>subturibulosus</i>	86	10.8	9.9	9.2	5.8	5.5	5	1.9	1.8	1.7	2.5	4	2	GIC 061108-6	
	<i>C. decipiens</i>															
	var. <i>subturibulosus</i>	87*	10.4	9.5	8.8	6	5.5	4.8	2.1	1.73	1.5	2.5	4	2	GDA 54268	
	Mean values		10.43	9.57	8.86	5.96	5.48	4.99	1.93	1.75	1.58	2.48				

var. bombycinus	<i>C. decipiens</i>																
	var. <i>atrocoeruleus</i>	88	12.1	11.3	10	6.5	5.9	5.5	2.2	1.91	1.7	3	4	2	MES 3662	FN428986	
	<i>C. bombycinus</i>	89	11.2	10.4	9.7	6.4	5.8	5.5	2	1.79	1.6	3	4	2	MES 3779-T-a	FN428987	
	<i>C. bombycinus</i>	90	10	9.1	8	5.8	5.1	4.6	2	1.79	1.6	3	4	2	MES 3779-T-b		
	<i>C. bombycinus</i>	91	11	10	9.6	5.7	5.5	5	2	1.82	1.7	3	4	2	MES 3780-IT		
	<i>C. bombycinus</i>	92	12.3	11.2	10	6.5	6.2	5.8	2	1.81	1.5	3	4	2	R.F.S. 041218-05		
	<i>C. bombycinus</i>	93	12	10.5	9.6	6.2	5.7	5.4	2	1.84	1.7	2.5	4	2	GIC 061108-7		
	Mean values		11.43	10.42	9.48	6.18	5.70	5.30	2.03	1.83	1.64	2.92					
Total mean values		10.64	9.75	8.99	6.01	5.53	5.05	1.95	1.77	1.59	2.57						
C. vernus																	
var. vernus	<i>C. petroselineus</i>																
	var. <i>radicipes</i>	94	8.5	7.6	7	5.5	5	4.5	1.6	1.51	1.4	2	4	2	CHEV 3130-T	FN429003	
	<i>C. petroselineus</i>																
	var. <i>radicipes</i>	95	8.5	7.9	7.2	6	5.5	5	1.6	1.44	1.4	3	4	2	MES 1552		
	<i>C. petroselineus</i>																
	var. <i>cedriphila</i>	96	9	8.2	7.5	6	5.4	4.8	1.6	1.51	1.4	2	1	2	CHEV 1954-T		
	<i>C. petroselineus</i>																
	var. <i>conicopurpurata</i>	97	8.5	7.6	6.8	5.5	4.8	4.5	1.7	1.57	1.4	2	1	2	CHEV 2555-T		
	<i>C. petroselineus</i>																
	var. <i>typica</i>	98	9	7.9	7	6	5.3	5	1.7	1.49	1.4	3	4	2	CHEV 2333		
	<i>C. petroselineus</i>																
	var. <i>typica</i>	99	8.2	7.3	7	5	4.7	4.5	1.7	1.55	1.4	2	4	2	CHEV 3362	FN429004	
	<i>C. petroselineus</i>	100*	8	7.4	7	6	5	4.6	1.6	1.48	1.3	3	4	2	GDAC 42721	FN429005	
	<i>C. petroselineus</i>	101	8	7.4	6.8	5.7	5.4	5.2	1.4	1.37	1.2	3	4	2	AH 30917		
	<i>C. erythrinus?</i>	102*	9	8	7.5	6	5.4	5	1.6	1.49	1.3	3	4	2	ORTEGA 90		
	<i>C. erythrinus</i>	103*	8	7.4	7	5.8	5.5	4.8	1.5	1.43	1.3	3	4	2	GDAC 30608		
	<i>C. petroselineus</i>	104	8.5	7.8	7.2	6.8	6	5.5	1.4	1.3	1.2	3	4	2	GIC 061108-3		
<i>C. petroselineus</i>	105	8	7.4	6.5	5.8	5.2	4.8	1.5	1.42	1.3	2.5	4	2	MES 3624			
<i>C. vernus</i>	106	8	7.3	6.5	6	5.5	4.8	1.6	1.38	1.3	2.5	1	1	S-F44879-T	UDB000742		
Mean values		8.40	7.63	7.00	5.85	5.28	4.85	1.58	1.46	1.33	2.62						
var. nevadavernus	<i>C. vernus</i>	107*	8.5	7.6	7	6	5.5	5	1.5	1.37	1.3	3	2	2	GDAC 44731	FN429009	
	<i>C. vernus</i>	108*	7.8	7.3	7	5.8	5.2	4.8	1.5	1.38	1.3	2	2	2	GDAC 41046	FN429007, FN429008	
	<i>C. vernus</i>	109*	9	8.4	7	6	5.5	5	1.8	1.53	1.3	3	2	2	GDA 45876		
	<i>C. vernus</i>	110*	9	8.1	7	6	5.4	5	1.6	1.5	1.4	3	2	2	GDA 45877		
	<i>C. vernus</i>	111	8	7.5	7	5.8	5.4	5	1.6	1.39	1.3	2.5	3	1	FP 20040526009		
	<i>C. vernus</i>	112	8.2	7.7	7.2	5.6	5.3	4.8	1.6	1.45	1.4	2	3	1	FP 20070422006	FN429006	
	<i>C. erythrinus</i>	113	8.8	8	7.2	5.6	5.4	5	1.6	1.48	1.3	2.5	2	1	TUB 011900	AY669690	
	Mean values		8.47	7.80	7.06	5.83	5.39	4.94	1.60	1.44	1.32	2.57					
Total mean values		8.43	7.69	7.02	5.85	5.32	4.88	1.59	1.45	1.33	2.60						
Cortinarius sp.	<i>C. hoffmannii</i>	114	10	9	8	6	5.4	5	1.8	1.67	1.6	2	3	1	P.M.L. 5090	FN429016	

a *: Morphology studied from fresh material.

b 1: Light-medium; 2: medium-strong; 3: strong.

c 1: Conifers woodlands; 2: riparian or hygrophilous communities; 3: deciduous woodlands; 4: sclerophyllous woodlands.

d 1: Eurosiberian hygrophilous-mountain areas; 2: Mediterranean sclerophyllous areas.

e T: type; IT: isotype NT: neotype (after voucher reference).

ITS-2) was amplified by PCR, using primers ITS-5 (White *et al.* 1990) and C26A (Wen & Zimmer 1996). PCR reactions were performed in a volume of 50 µl under standard conditions (Innis *et al.* 1990). For several taxa (*Cortinarius decipiens*, *C. casimiri* var. *casimiri* and *C. vernus* var. *nevadavernus*) intraindividual variability was explored by cloning the PCR products [using the TOPO TA Cloning® Kit for Sequencing with One Shot® TOP10 Chemically Competent *E. coli* following the manufacturer's recommendations (Invitrogen)], and also by sequencing different PCR products from the same specimen (for *C. decipiens*). Ten clones for one collection of each taxa were obtained and only those sequences which showed variation were used in the phylogenetic tree.

Automated sequencing of the purified PCR products and plasmid clones was performed in both directions using the ITS-5/C26A and T7/SP6 primer pairs (respectively) on a 3100-Avant Genetic Analyzer. Nucleotide sequences were edited with the SEQMAN II v. 3.61 program from the DNASTAR software package (LASERGEN).

The 57 ITS sequences were aligned using the CLUSTAL option of the MEGALIN program from the DNASTAR software package (LASERGEN), followed by a visual inspection. The data matrix is available from TreeBASE (study accession number S2430). Three regions were ambiguously aligned in the whole matrix data. Because of the ambiguously aligned regions were invariable (except for few cases) at intraspecific level and unambiguously aligned among closely related species, we considered them to calculate the intraspecific distance values and the divergence values between closely related species. In the phylogenetic analysis the ambiguously aligned regions were treated following the method of Lutzoni *et al.* (2000) to account for the phylogenetic information that these regions give. We calculated the divergence (*p*-distance) between the sequences using MEGA version 4 (Tamura *et al.* 2007). Phylogenetic analysis was performed using the maximum-parsimony criterion (MP), as implemented in PAUP* version 4.0b10 (Swofford 2003), and it involved heuristic searches. The data matrix was subjected to 1000 replicates of random sequence additions using tree bisection-reconnection (TBR) branch-swapping under the Fitch criterion (unordered states and equal weights), and MaxTrees setting set to 10000. Gaps were treated as missing data. Only ten trees were allowed to be held at each step, in order to minimize the time the algorithms spent searching for trees on sub-optimal islands. The starting tree was obtained by stepwise addition. The characters were optimized by delayed transformation. Finally, 1000 bootstrap replicates (BS: Felsenstein 1985) with 10 heuristic searches were performed to assess internal support for nodes. Phylogenetic analysis reached the maximum number of trees permitted in memory (10000). Fig 1 shows one of the most parsimonious trees.

Species identification of the collections studied was based on the analysis of the ITS sequences in combination with the morphological characters. Collections were assigned to a species when their ITS sequences formed a strongly supported monophyletic group with the sequences of that species, with low internal genetic variation and good correlation with the morphological characters. The mean genetic variation (treating the gaps as missing data in pairwise comparisons) within the clades considered as the same species was

between 0.000 and 0.0076, corresponding the greatest value to *C. vernus* s.l. (including the two varieties) while this value was between 0.0174 and 0.0328 for the comparisons between most closely related species according to the tree shown in Fig 1. Thus, collections with the same ITS sequences or with very low variation between the sequences were considered as the same species.

Taxonomy

Our results show that the traditionally used morphological characters (colour of the pileus, stipe and lamellae; spore size, *Q*: *L/w*; and spore ornamentation; Table 1) are quite variable, explaining the different author interpretations. According our own data and the literature (i) the colour of the pileus varies from blackish-brown to purplish-brown, dark greyish-brown or reddish-brown; (ii) the quantity of whitish universal veil on cap surface depends on environmental factors and basidiomata age; (iii) lilac, pinkish-brown, reddish-brown or purplish-brown hues on the stipe are sometimes inconstant; (iv) lamellae colour varies even within the same collection, being ochre cream, lilac, violet or purplish; (v) the spore size also varies, sometimes even within the same collection, but is, nevertheless, a good character to define some taxa (e.g. *C. casimiri* s.str.). Spore shape and spore ornamentation are the most stable characters within collections and species, and therefore they are always among the most useful characters for differentiation of taxa (Fig 2).

We have been able to assign the studied material to five species (*C. casimiri* s.l., *C. decipiens* s.l., *C. gallurae*, *C. subturibulosus* s.l. and *C. vernus* s.l.) on the base of the results of the combined (morphological and ITS data) analysis. Our results are in accordance with the concept of species applied by Arnold (1993) and other authors (see Knudsen & Vesterholt 2008), lumping the doubtful taxa in appropriate consistent species. Thus, all collections from Mediterranean mountain and temperate-alpine areas, which were originally identified as six different taxa (*C. atrocoeruleus*, *C. contrarius*, *C. decipiens*, *C. fraternus*, *C. sertipes*, *C. flexipes* fo. *sertipes*) corresponded to *C. decipiens sensu lato*, a widely distributed, genetically and morphologically variable species. Also *C. casimiri* is found in this kind of habitat. All collections from Mediterranean sclerophyllous communities corresponded to *C. gallurae*, *C. vernus sensu lato* and *C. subturibulosus sensu lato*. The lineage formed by *C. decipiens*, *C. subturibulosus* and *C. gallurae* (Fig 1) involved species of both habitats.

We propose the new combinations *C. casimiri* var. *hoffmannii* (= *C. decipiens* var. *hoffmannii* non *C. hoffmannii*) and *C. subturibulosus* var. *bombycinus* (= *C. bombycinus*), and a new variety *C. vernus* var. *nevadavernus* (= *C. vernus* H. Lindstr. & Melot *sensu auct.*).

Cortinarius casimiri* var. *casimiri (Velen.) Huijsman, *Fungus, Wageningen* 25: 20 (1955). (Figs 1, 2A)

C. subsertipes Romagn., *Bull. Soc. Naturalistes Oyonnax* 7: 61 (1952).

Icon. Sel.: Brandrud *et al.* *Cortinarius Flora Photographica*, 4: D28, D32 (1998).

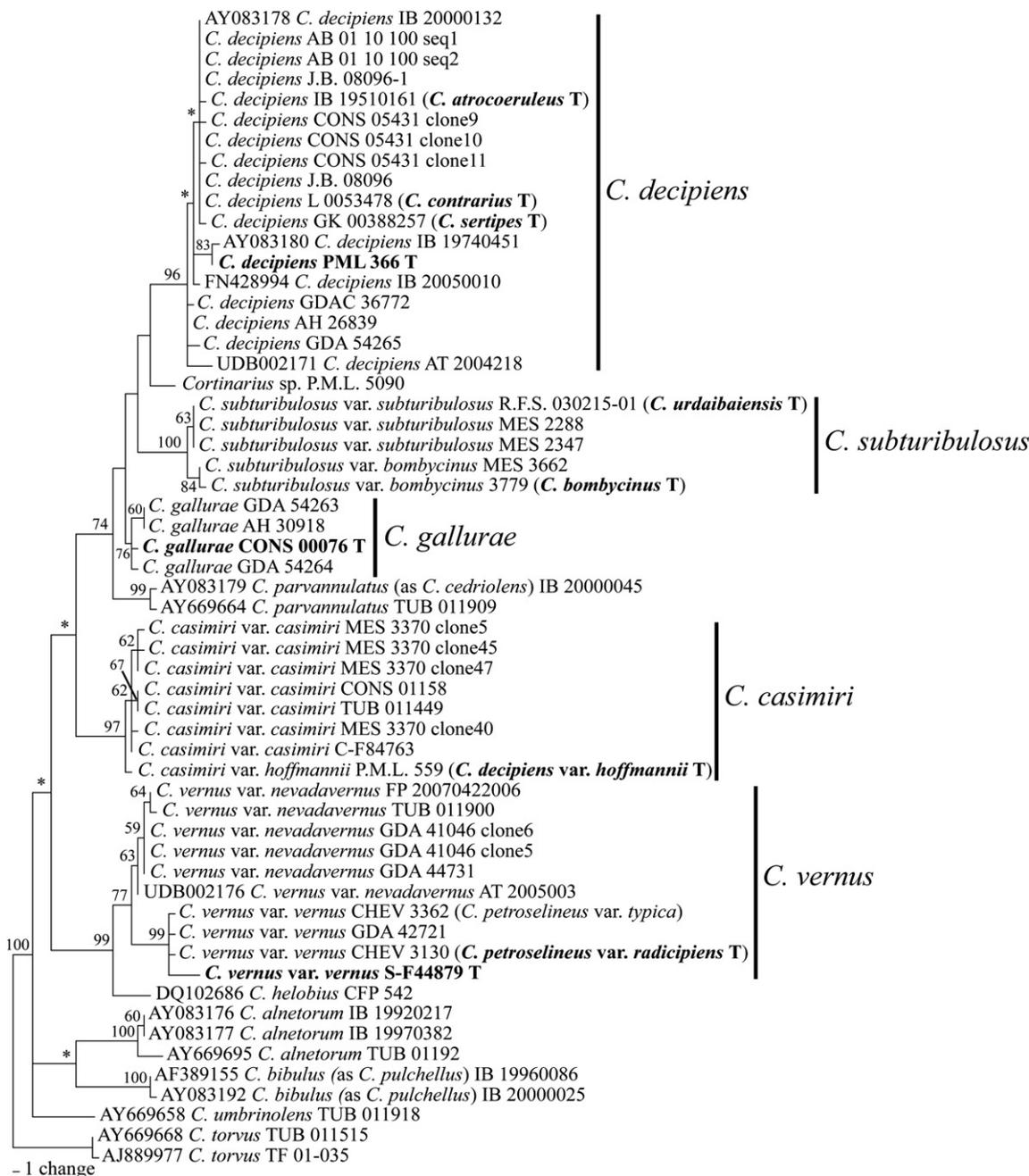


Fig 1 – Phylogenetic relationships of species of *Cortinarius* sect. *Hydrocybe* (subg. *Telamonia*) sensu Brandrud et al. (1992) and Bidaud et al. (1994). Phylogram of one of the most parsimonious trees (length: 173; CI: 0.775; RI: 0.937) obtained from the parsimony analysis. Bootstrap values $\geq 50\%$ are shown above branches. Branches collapsing in the strict consensus tree are marked with an asterisk. The herbarium references (for all sequences) and accession number (for the sequences taken from GenBank database and which specimens were not included in the morphological analysis) are shown after and before each taxon name, respectively. The bolded names followed by ‘T’ represent sequences obtained from type specimens. Species studied are indicated at right.

Pileus 15–45 mm, conical, conico-campanulate, campanulate, later convex or plano-convex, with an acute or subacute umbo, hygrophanous, dark reddish-brown; surface \pm furrowed and covered by whitish-silvery fibrils, \pm woolly when dried. Context reddish-brown in the cap, grayish-brown, pinkish-brown, violet-brown or purplish-brown in the stipe; smell pleasant or no distinct. Lamellae intermediate to subdistant, adnate or

decurrent by a tooth, reddish-brown with grayish hues. Stipe 30–75 \times 3–7 mm, cylindrical, with broader or clavate base; surface whitish, becoming brownish when mature, with lilac or violet tinge at uppermost part and reddish- or pinkish-brown tinge at lower part, covered with white sericeous veil remnants.

Spores 9–13.1(–14.5) \times 5.4–7.4(–8.5) μm , mv: 10.3–12 \times 5.9–7.1 μm , (Mmin: 9.9 \times 5.8 μm ; Mme: 11 \times 6.4 μm ; Mmax:

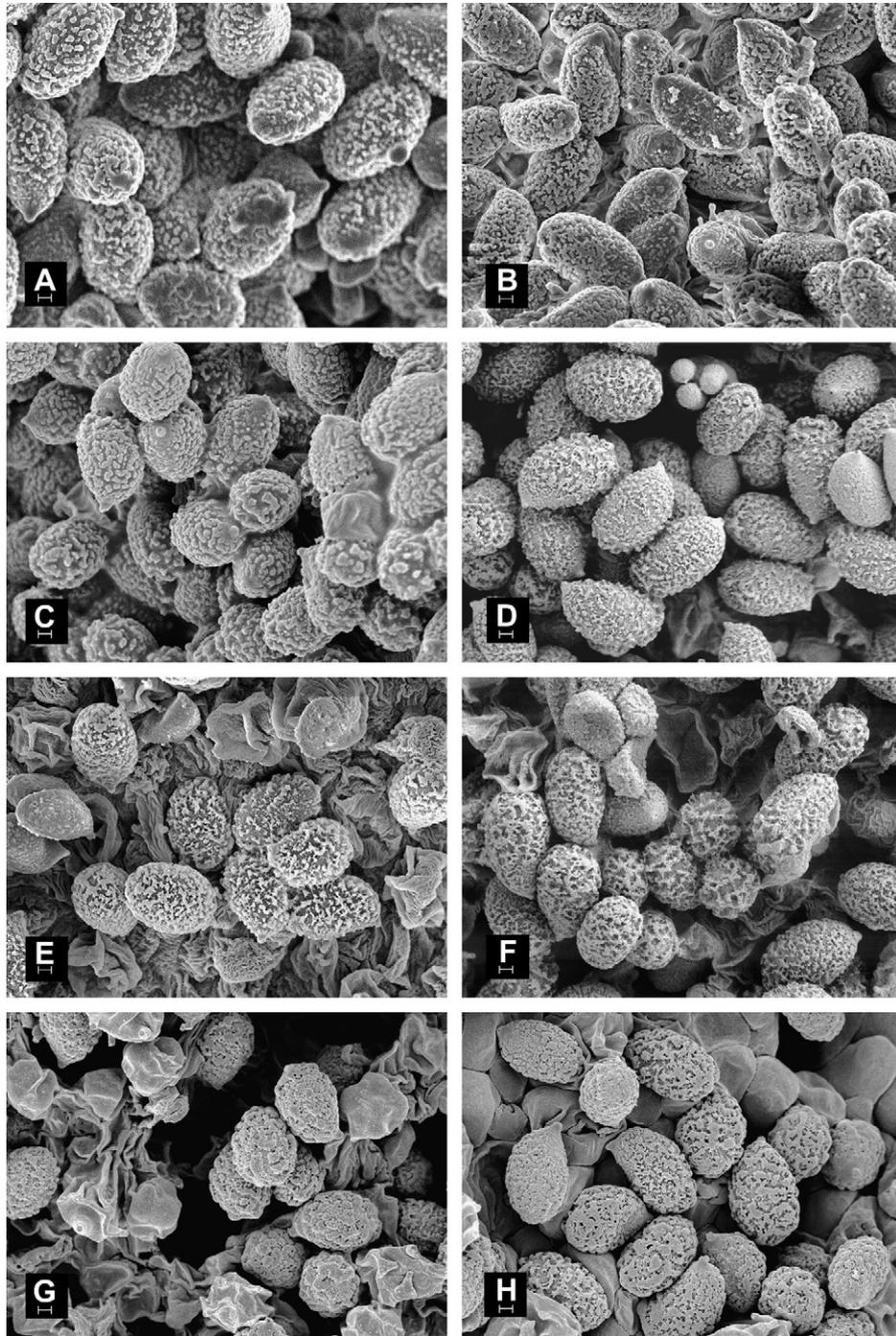


Fig 2 – Field emission scanning electron microscopy (FESEM) of spores. (A) *Cortinarius casimiri* var. *casimiri* (PC 0090284). (B) *C. casimiri* var. *hoffmannii* (holotype). (C) *C. decipiens* (coll. *C. atrocoeruleus*, holotype). (D) *C. decipiens* (coll. *C. contrarius*, holotype). (E) *C. decipiens* (neotype). (F) *C. decipiens* (coll. *C. sertipes*, type material). (G) *C. gallurae* (holotype). (H) *C. gallurae* (GDA 54263). (I) *C. subturibulosus* var. *bombycinus* (coll. *C. bombycinus*, holotype). (J) *C. subturibulosus* var. *subturibulosus* (holotype). (K) *C. subturibulosus* var. *bombycinus* (coll. *C. decipiens* var. *atrocoeruleus*, MES 3662). (L) *C. subturibulosus* var. *subturibulosus* (coll. *C. urdaibaiensis*, holotype). (M) *C. vernus* var. *vernus* (CHEV 3130). (N) *C. vernus* var. *nevadavernus* (holotype). Bars = 1.2 μm .

12.2 \times 7.2 μm), yellowish-ochre, oblong, oblong-ellipsoid, ellipsoid to broadly ellipsoid, Q = 1.4–2.1, Q_{me} = 1.66–1.72–1.89, with light-medium to medium warty (mv: 1.13). Epicutis made up by 3–10 μm wide hyphae. Hypocutis well

differentiated made up by 14–30 μm wide hyphae; with ochre or brownish-ochre parietal-pigment. Universal veil of hyaline, 3–5 μm wide hyphae. Clamp connections present in all tissues. Basidia four-spored, cylindrical to clavate. Lamellar edge

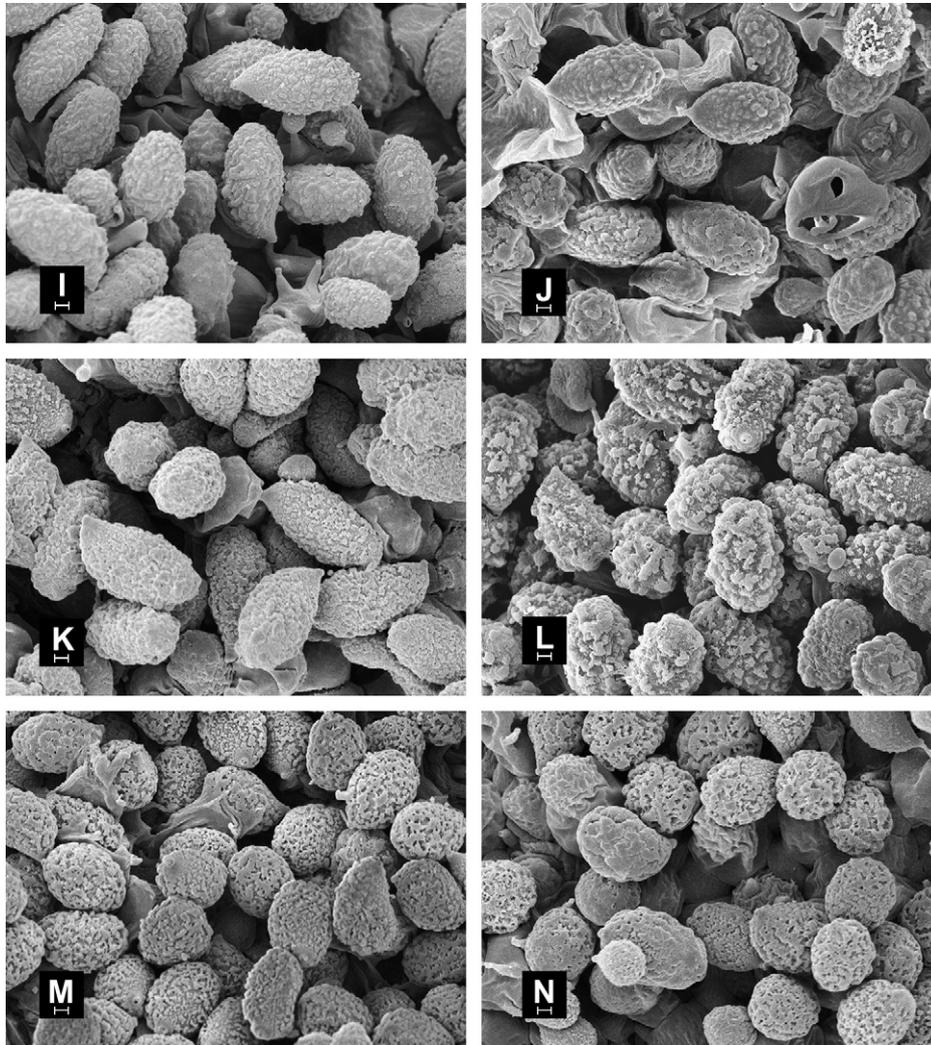


Fig 2 – (continued)

fertile, with poorly differentiated, \pm cylindrical to clavate, (6–8 μm wide) sterile cells.

Habitat and distribution: *Cortinarius casimiri* has Eurosiberian distribution; it is frequent in North and Central Europe under deciduous trees and conifers (Brandrud *et al.* 1998; Niskanen *et al.* 2008). It also occurs in mountain areas of the Mediterranean region in association with broad-leaf trees and/or conifers (MES 4042). In Mediterranean sclerophyllous areas it is replaced by *C. galluræ* and *C. subturibulosus*.

Material examined: **BELGIUM:** Olloy (pt. de Namur): dans les feuilles mortes (*Carpinus*) sur sol acide (schistes, grès), 9 Oct. 1987, H. Romagnesi, n° 87.130 (PC0090283; as *C. subsertipes*) (8). **DENMARK:** Nez: Rude Skov, under *Fagus sylvatica*, 1 Oct. 2001, M. Christensen (C-F84763, coll. no.: MC01-553; as *C. casimiri*) (12). **FRANCE:** Artois: XII journals of JEC, under *Fagus sylvatica* and *Q. robur*, 27 Sept. 1998, R. Mahiques & C. Gutiérrez (MES 3370; as *C. casimiri*) (15). Finistère: Pont L'Abbé, bois feuillu sur sol lourd, 10 Sep. 1979, H. Romagnesi, n° 79.145 bis (PC0090280; as *C. subsertipes*) (5). Manche: Fôret de St. Sauveur-le-Viconte, bois feuillu, 15 Aug. 1982, H. Romagnesi, n° 82.52 (PC0090282; as *C. subsertipes*) (7). Oise: Coye-la-Forêt,

chêne siliceuse, 8 Sept. 1957, H. Romagnesi, n° 63.266 (PC0090277; as *C. subsertipes*) (2); *idem* 22 Oct. 1980, H. Romagnesi, n° 80.186 (PC0090281; as *C. subsertipes*) (6); *idem*, Orry-la-Ville, bois feuillu, 1 Sept. 1951, M.J. Ostoya, n° 51.239 (PC0090284; as *C. subsertipes*) (9); *idem*, Thiers, Forêt d'Ermenonville, bois de *Pinus sylvestris* et *Betula*, 13 Oct. 1966, H. Romagnesi, n° 66.227 (PC0090278; as *C. subsertipes*) (3); *idem*, dans une pinède parmi les mousses, 23 Sept. 1967, H. Romagnesi, n° 67.203 (PC0090279; as *C. subsertipes* f. *major*) (4). Val d'Oise: Luzarches, bois feuillu, 8 Sept. 1957, H. Romagnesi, n° 57.181 (PC0090285; as *C. subsertipes*) (10). **GERMANY:** Thüringen: Uhl städtes Heide, kiefernforst (*Pinus sylvestris*) and *Fagus sylvatica*, 18 Sept. 1996, G. Walther (TUB 011449; as *C. subsertipes*) (16). **ITALY:** Trentino: Diga de Paneveggio, near to Bellamonte, 1500 m, under *Picea abies*, 28 Sept. 2001, G. Consiglio *et al.* (CONS 01158; as *C. casimiri*) (11). **SPAIN:** Valencia: Pina de Montalgrao, *Pinus sylvestris*, *P. pinaster* and *Q. faginea* woodlands, 13 Nov. 2004, F. Tejedor (MES 4042; as *C. casimiri*) (1). **SWEDEN:** Småland: Femsjö sn, Löjenäs, in mixed forests on cultivated field (*Picea*, *Betula*, *Salix*), 18 Sept. 1987, T.E. Brandrud *et al.* (S-F44850; as *C. casimiri*) (13). Jämtland: Ragunda sn,

Bölestrand, in birch forest, 21 July 1990, T.E. Brandrud *et al.* (S-F44849; as *C. casimiri*) (14).

Notes: *Cortinarius casimiri* is morphologically close to the *C. decipiens* complex, however it is easily distinguishable by its larger spores (Table 1, Fig 2). From a molecular point of view, *C. casimiri* is not sister group to *C. decipiens* (Fig 1), and the mean distance value of rDNA ITS sequences is 3.4 % (14 differential nucleotide changes and 1 indel; another indel of 4 bp in length was variable between *C. casimiri* sequences, but it never appeared in the sequences of *C. decipiens*). *Cortinarius casimiri* typically occurs in association with broad-leaves trees in temperate to subalpine (sub-)mountain areas. This taxon rarely occurs also in eastern areas of the Iberian Peninsula (one record only by Mahiques, MES 4042).

We could not study the type material for *C. casimiri* because it is not preserved. However, we studied morphologically (ITS could not be obtained) eight Romagnesi's collections of *C. casimiri* (as *C. subsertipes*), what allowed us to know the typical characters (and their variability) for this species. All other collections we have studied fit very well to the characters showed by the Romagnesi's collections, including those specimens used in the molecular analysis.

Variability between ITS sequences of *C. casimiri* var. *casimiri* was relatively high, with 4 nucleotide changes between sequences and 2 gaps (one of them of 4 bp in length) (*p*-distance: 0.000–0.0059; mean value: 0.0035). This intrataxon variability did not show any clear distribution between specimens, but the most variation happened at intraindividual level (the highest *p*-distance, 0.0059, was for comparisons between clones 39 and 40, and 40 and 41 of collection MES 3370). Mean genetic distance between clones was 0.0039. Our results agree with those reported by Niskanen *et al.* (2009). These authors, studying *Cortinarius* sect. *Brunnei* in North Europe, found that most of species they analysed were genetically polymorphic, and in all cases infraspecific polymorphisms were only or also observed intragenomically.

Cortinarius casimiri* var. *hoffmannii (Reumaux) Suár.–Sant. & A. Ortega, **comb. nov.** (Figs 1, 2B)

Mycobank no: MB 515203

Basionym: *C. decipiens* var. *hoffmannii* Reumaux in Reumaux & Moëgne-Locoz, *Bull. trim. Féd. Mycol. Dauphiné-Savoie* 28 (111): 24 (1988).

Non *C. hoffmannii* (Reumaux) Reumaux in Bidaud, Moëgne-Locoz, Reumaux, Carteret & Eyssartier, *Atlas des Cortinaires*, XI: 573 (2001).

Icon. Sel.: Moëgne-Locoz & Reumaux, *Atlas des Cortinaires*, II: pl. 28 (1990).

According to Moëgne-Locoz & Reumaux (1990) the more significant macro-morphological features of this taxon are: (i) Pileo with dark brown reddish tinges, (ii) stipe with broader or clavate base, which turning pinkish-brown coloured (iii) lamellae subdistant, (iv) context brown reddish.

Spores (7.2–)8–11.2 × 4.1–6.2 μm, mv: 8.5–9.6 × 4.9–5.7 μm (Mmin: 8.2 × 4.7 μm; Mme: 9.1 × 5.2 μm; Mmax: 10.1 × 5.7 μm), brownish-ochre, ellipsoid Q = 1.56–1.98, Qme = 1.68–1.73–1.78, medium-broadly warted (mv: 1.7), stronger at apical part. These spore values correspond to five carpophores from the type collection.

Habitat and distribution: According to Moëgne-Locoz & Reumaux (1990) *Cortinarius casimiri* var. *hoffmannii* has an

Euro Siberian distribution and grows in temperate sub-mountain or mountain areas, under diverse deciduous trees. However, taking into account the high confusion grade between mycologists for identification of *C. casimiri* var. *hoffmannii* (all studied collections as belonging to this taxon were mis-identified, including that used to illustrate *C. hoffmannii* in the Atlas des Cortinaires XI, Bidaud *et al.* 2001), the distribution of this taxon could be smaller or not very well known.

Material examined: FRANCE: Ardennes françaises: Forêt de Belval, sous feuilles humides (chênes, charmes, bouleaux), 20 Sept. 1986, P. Reumaux (P.M.L. 559, as *C. decipiens* var. *hoffmannii*, holotype) (17a–e).

Notes: In this study we propose the new combination *C. casimiri* var. *hoffmannii* on the base of morphological and ITS sequences data. At the beginning, *C. casimiri* var. *hoffmannii* was considered as variety of *C. decipiens* (Reumaux & Moëgne-Locoz, 1988), and then it was recombined on species level (Bidaud *et al.* 2001). Our results from the ITS sequence analysis reject its relationship to *C. decipiens* (mean distance value: 0.0356, 16 diagnostic nucleotide changes and 2 indels, of 4 bp and 2 bp respectively) and support its close relationships with *C. casimiri* (mean distance value: 0.0056, 2 nucleotide changes and 1 indel of 1 bp in length) (Fig 1). We have studied the type material for this taxon and two more collections identified as *C. hoffmannii*, CONS 05431 and P.M.L. 5090. The latter collection was used by Bidaud *et al.* (2001) for illustrating the species in their Atlas des Cortinaires XI. Neither of these two collections could be assigned to *C. casimiri* var. *hoffmannii*, because their ITS sequences were not related to the ITS sequence of the type material (Fig 1). Collection CONS 05431 belongs to *C. decipiens* (see taxonomy for *C. decipiens* below), and the collection P.M.L. 5090 could not be assigned to any of the studied species (also it could not be assigned to any collection with ITS sequence in the GenBank database) because its sequence did not show significant identity with anyone of the analysed sequences (*p*-distance with *C. casimiri* var. *hoffmannii*: 0.0356, 18 nucleotide changes and 2 gaps of 2 bp and 1 bp in length respectively; it was included in the subclade formed by *C. decipiens*, *C. galluræ* and *C. subturibulosus*; Fig 1). Our results suggest that some of the taxonomic confusion surrounding *C. casimiri* var. *hoffmannii* could be due to the use of mis-identified collections by the authors of the taxon, as happened with the collection used for illustrating *C. hoffmannii* in Bidaud *et al.* (2001). *Cortinarius casimiri* var. *hoffmannii* differs from *C. decipiens* by its reddish hues on the cap and the absence of lilac hues on the lamellae and on the apex of the stipe.

Arnold (1993) and other authors (cf. www.speciesfungorum) noticed the relationships between *C. decipiens* var. *hoffmannii* and *C. casimiri*, considering them as synonyms. We agree with these authors on the base of our results. The habit of both taxa is quite similar, and also the spore shape and ornamentation type are very close (Table 1, Fig 2). Moreover, the low intraspecific distance values for ITS sequences support the inclusion of *C. decipiens* var. *hoffmannii* in *C. casimiri* (mean value for *C. casimiri* s.l. = 0.0035). However, we have considered it as a variety of *C. casimiri* on the base of the differences in the spore size; the spores of *C. casimiri* var. *hoffmannii* are smaller than those of *C. casimiri* var. *casimiri* (mv: 8.5–9.6 × 4.9–5.7 μm vs. 10.3–12 × 5.9–7.1 μm, respectively). Furthermore, ITS sequences supported their recognition as

different varieties. Despite the variability presented by the ITS sequences of the variety *casimiri*, the sequences analysed from both taxa (var. *casimiri* and var. *hoffmannii*) differ in three positions (2 changes and 1 indel). Sequences of var. *casimiri* in these positions were always unchanged. BLAST searches allowed us to identify 15 ITS sequences assignable (on the base of sequence identity) to *C. casimiri* in GenBank database (accession numbers: FJ717538, FJ039552, FJ039551, FJ039550, FJ039549, FJ039548, EU563920, EU563919, EF411089, AY702771, FJ717537, FJ039547, FJ039545, EF101775). All these sequences were within the range of variability found for the sequences of var. *casimiri* (*p*-distance: 0.000–0.0059), and all of them were homogeneous (in the same way that var. *casimiri*) for the three positions distinguishing both varieties.

Cortinarius decipiens (Pers.) Fr., *Syst. Mycol.* 1: 236 (1821) *sensu lato*. (Figs 1, 2C–F, 3)

C. decipiens var. *atrocoeruleus* (M.M. Moser) H. Lindstr. in Brandrud, Lindström, Marklund, Melot & Muskos, *Cortinarius Flora Photographica*, 4: 20 (1998). Non *C. decipiens* var. *atrocoeruleus* (M.M. Moser) H. Lindstr. *sensu* Mahiques, *Buttl. Soc. Micol. Valenciana* 6: 62 (2001).

C. atrocoeruleus M.M. Moser ex M.M. Moser, *Kleine Kryptogamenflora*, 3^a ed. (Stuttgart): 336 (1967) [=Hydrocybe *atrocaerulea* M.M. Moser (1953) and *C. atrocaeruleus* M.M. Moser (1953) (*nom. inval.*)].

C. atrocoeruleus M.M. Moser ex Kuhnert & Peintner, *Mycotaxon* 87: 114 (2003) (*nom. superfluo*).

C. contrarius J. Geesink, *Persoonia* 8: 443 (1976).

C. flexipes fo. *sertipes* (Kühner) Kühner, *Bull. mens. Soc. Linn. Lyon* 30: 60 (1961).

C. fraternus (Lasch) Reumaux, *Atlas des Cortinaires I*: 21 (1990).

C. sertipes Kühner, *Bull. mens. Soc. Linn. Lyon* 24 (2): 40 (1955).

C. sertipes fo. *contrarius* (J. Geesink) A. Ortega & Mahiques, *Cryptogamie, Mycol.* 16: 267 (1995) *pro parte*.

C. sertipes fo. *sertipes sensu* Ortega & Mahiques, *Cryptogamie, Mycol.* 16: 266 (1995) *pro parte*.

C. decipiens var. *hoffmannii sensu* Consiglio (CONS 05431).

C. albonigrellus Favre (IB 20050010).

Icon. Sel.: Moëne-Loccoz & Reumaux *Atlas des Cortinaires II*: pl. 29 (1990) and Bidaud et al. *Atlas des Cortinaires XI*: pl. 329 (2001).

Pileus 10–50 mm, conico-campanulate, campanulate, convex or plano-convex, umbo obtuse, acute or sometimes sharp-pointed (Kühner 1955), hygrophanous, dark grey-brown, dark brownish (umber), dark purplish-brown or blackish-brown, sometimes with bluish-violet or lilac hues; surface covered by whitish-silvery or grayish fibrils, which remain towards the margin, it is entire to appendiculate. Context brownish-ochre or grayish-brown in the cap, lilac-brown, violet-brown or purplish-brown in the stipe; smell no distinct. Lamellae of variable colour in the younger specimens: lilac or violet (Brandrud et al. 1998; Kühner 1955; Lasch 1828; Soop 1988, etc.), more frequently ochre cream coloured (white coffee) or light grayish-brown (Consiglio 2002; Geesink 1976; Kühner 1955; Moser 2001). Stipe 30–80 × 2–9 mm, cylindrical or enlarged at base; surface whitish, becoming brownish when mature, with pinkish, lilac, violet or bluish tinges more evidents towards upper part (younger specimens), covered with whitish sericeous veil remnants which can form some ± defined

annular zones. Sometimes, beginning purplish-brown or dark reddish-brown when it is handled.

Spores 7.2–10.5 × 4–6.2 μm, mean values (mv): 7.9–9.4 × 4.6–5.7 μm, (Mmin: 8.2 × 4.9 μm, Mme: 8.8 × 5.3 μm, Mmax: 9.6 × 5.7 μm), ellipsoid, broadly ellipsoid or ± lacrymoid, Q = 1.4–2.1, Qme: 1.58–1.68–1.86, ornamentation medium to medium-strong (mv: 1.84). Epicutis made up by 4.5–10.5 μm wide hyphae. Hypocutis well differentiated made up by 15–30 μm wide hyphae, pigment brownish-ochre or brownish-olive intraparietal and epiparietal-encrusted. Universal veil formed by hyaline 3.5–6 μm wide hyphae. Clamp connections presents in all tissues. Basidia four-spored, cylindrical to clavate. Lamellar edge fertile, with ± pyriform or clavate (7–10 μm) sterile cells.

Habitat and distribution: *Cortinarius decipiens* s.l. represents a widely distributed species. It is present in Central and North Europe (Brandrud et al. 1994; Niskanen et al. 2008), where it prefers the (sub-)montane zones, in deciduous woodlands under *Betula*, *Populus*, *Quercus*, *Salix*, but also under *Pinus* and *Picea*. In South Europe it grows on similar ecosystems under *Populus* and *Salix*, but also in Mediterranean sclerophyllous communities under *Pinus halepensis*, *Quercus ilex* subsp. *ballota* and *Q. suber*. Basidiomes occur during summer and autumn–winter, rarely in springtime (JA-cussta, Ortega-259).

Material examined: **AUSTRIA**: Tirol: Gnadental, hinter Gunkel, neben Moor, Nadelwald, 30 Oct. 1951, M.M. Moser (IB 1951/0161; as *C. atrocoeruleus*, holotype) (18). Göltzschach: Sattnitz, Kärnten, bei *Carpinus*, *Populus*, *Betula* an Wieserand, 23 Sept. 1986, M.M. Moser (IB 86/274; as *C. atrocoeruleus*) (19). Opferholz ober Viktring: Kärnten, Waldrand bei Buchen und Birken (Fichte), in Moos, 20 Sept. 1966, M.M. Moser (IB 66/199; as *C. atrocoeruleus*) (21). **FRANCE**: Haute-Savoie: Pessière d'Arith, 1 Oct. 1986, P. Moëne-Loccoz (P.M.L. 366, neotype) (51). Hérault: sous *Alnus* et *Populus*, 8 Oct. 1996, J. Bouteville (Herb. J. B. 08096-1; as *C. fraternus*) (36); *idem* (Herb. J. B. 08096; as *C. fraternus*) (37). Lompnaz (Ain): 850 m.a.s.l., sous *Populus tremula* and *Betula*, 2 Oct. 1992, A. Bidaud (AB 92-10-220; as *C. sertipes*) (32). Lyon: Ain (?), rote Montlued-St. Croix, sur les peupliers mêlés d'aulnes, a gauche de la route, 3 lots, 13 Oct. 1954, Kühner (det. coll. n. 54–119, lot 1,2,3) (GK 52851; as *C. sertipes*) (28, 29, 30); *idem*, aux alentours «elargis» de Lyon, au fond d'un ravin, 27 Oct. 1955, R. Kühner (det. coll. n. Ly 55–126), (GK 52850; as *C. sertipes*) (27); *idem*, vers Isère Venerieu-Floreilles, dans une pelouse enlavée de grandes peupliers, 23 Oct. 1955, leg. R. Kühner (det. coll. n. Ly 55–115) (GK 52852; as *C. sertipes*) (26). Paris: Bois de Vicennes, pelouse, à la lisière d'un bois de chênes, 27 Sept. 1933, R. Kühner (det. coll. n. 4–33 bis), (GK 388257; as *C. sertipes*, type material) (25). Thezillieu (Ain): 800 m.a.s.l., sous *Populus tremula*, 2 Oct. 2001, A. Bidaud (AB 01-10-100; as *C. sertipes*) (31). Trouet (Savoie): alt. 600 m.a.s.l., sous *P. tremula* and *Betula*, 17 Oct. 1996, A. Bidaud (AB 96-10-147; as *C. sertipes*) (33); *idem*, sous *P. tremula*, 8 Oct. 1991, A. Bidaud (AB 91-10-222; as *C. sertipes*) (34). **ITALY**: Ferrara: Pomposa, Bosco Spada, 50 m, on mixed forests of *Salix*, *Populus*, *Quercus ilex* and *Pinus*, G. Consiglio (CONS 05431; as *C. decipiens* var. *hoffmannii*) (45). Trentino: Val di Sella, Weisenrand, bei *Betula*, *Populus*, *Picea*, 23 Sept. 1993, M.M. Moser (IB 93/225; as *C. atrocoeruleus*) (20); *idem*, Bellamonte, alt. 1500 m, under *Picea abies*, G. Consiglio (CONS 01145; as *C. atrocoeruleus*) (23). **NETHERLANDS**: Wieringermeer: Robbenoorch, at roadside under

Populus on calcareous clay, 18 Nov. 1972, J. Geesink, (L 0053478; as *C. contrarius*, holotype) (35). **SPAIN**: Álava: Fontetxa, under *Q. ilex*, 18 Oct. 2004, R. Fernández Sasía (R.F.S. 041218-01; as *C. urdaibaiensis*) (39). Cádiz: road from Ubrique to puerto de Galis, cork oak woodlands, 16 Nov. 1987, A. Ortega (GDAC 30786; as *C. sertipes*) (42). Granada: Sierra de Baza, Arroyo de Gor, bajo *Populus*, 1 May 2003, F.B. Navarro, (JA-cussta, Ortega-259) (24); *idem*, Sierra de Huétor, forestal house of the Peñoncillos, under *Pinus halepensis*, 15 Nov. 2000, A. Ortega (GDA 54265) (50). Huelva: near to Alájar, cork oak forest, 20 Nov. 1991, A. Ortega et al. (GDAC 36744; as *C. sertipes* fo. *contrarius*) (41); *idem*, road from Puerto Moral to Corteconcepción, under holm oak and cork oak, 22 Nov. 1990, A. Ortega (GDAC 36738; as *C. sertipes*) (43). Jaén: Mata Bejid, holm oak woodlands, 27 Nov. 1990, A. Ortega (GDAC 36737; as *C. sertipes*) (40); *idem*, pantano del Quiebrajano, los Pitillos, holm oak forest, 2 Nov. 1990, A. Ortega & M.T. Vizoso (GDAC 36772; as *C. sertipes*) (38). Madrid: Alcalá de Henares, under *Populus alba*, 13 Oct. 1994, F. Esteve-Raventós (AH 30921; as *C. atrocoeruleus*) (22). Málaga: Ronda, Natural Park of the sierra de las Nieves, nava de S. Luis, holm oak forest, 30 Nov. 1988, A. Ortega et al. (GDAC 30788; as *C. sertipes* fo. *contrarius*) (46). Segovia: Riofrío de Riaza, under *Salix atrocinerea*, 20 Oct. 2000, J.M. Barrasa et al. (AH 26839; as *C. atrocoeruleus*) (44). **SWEDEN**: Jämtland: Ragunda sn, Halån at bridge, in deciduous forest at the stream (*Betula*, *Salix*, *Alnus*), 23 Aug. 1987, T.E. Brandrud et al. (S F44857; as *C. decipiens* var. *decipiens*) (49); Sørtrøndelag: Oppdal Kn, Kongsvold, lowalpine zone on calcareous ground (*Betula*, *Salix*), 16 Aug. 1987, T.E. Brandrud et al. (S-F44856; as *C. decipiens* var. *atrocoeruleus*) (47, 48). Småland: Femsjö, Södra Bökeberg, rand einer Waldwiese bei *Betula*, 18 Sept. 1974, M.M. Moser (IB 1974/0451; as *C. decipiens*) (52).

Notes: As we noted at the beginning of the TAXONOMY part, one of the most important conclusions of this study is the synonymization of *C. atrocoeruleus*, *C. contrarius*, *C. decipiens*, *C. fraternus*, *C. sertipes*, *C. flexipes* fo. *sertipes* to *C. decipiens* s.l. Aiming to clarify earlier taxonomic controversies, below we summarize the taxonomic history and the different interpretations for each taxon we have synonymized.

The concept of *C. atrocoeruleus* (M.M. Moser) M.M. Moser (Kuhnert-Finkernagel & Peintner 2003) included *Telamonias* growing under *Betula*, *Corylus*, *Picea*, *Populus*, *Quercus*, *Tilia*, etc. in montane temperate to subalpine areas (Brandrud et al. 1998; Consiglio 2002; Moser 2001; Soop 1988) with the following morphological characteristics: (i) pileus 10–40 mm, (ii) lilac or purplish hues present on pileus and stipe, but absent on lamellae (Consiglio et al. 2003; Moser 2001), (iii) whitish veil abundant on stipe and cap margin. Brandrud et al. (1998) already asserted the variability of lamellae colour of this taxon (e.g. lilac or ochre cream coloured) and that *C. decipiens* var. *atrocoeruleus* and *C. sertipes* could be the same species. Arnolds et al. (1995) considered *C. sertipes* a collective species including *C. atrocoeruleus*, *C. contrarius*, *C. decipiens* sensu Lange, *C. flexipes* sensu Kühner (1961) and *C. pulchripes*. On the other hand, Moser (2001) considered *C. atrocoeruleus* as an independent species.

The concept of *C. sertipes* Kühner was interpreted in different ways by different authors. According to the original description of Kühner (1955) *C. sertipes* has: (i) pileus with a diameter of 15–50 mm, (ii) lilac or purplish hues on the pileus, lamellae and stipe, (iii) an abundant silvery veil covering the

pileus and especially the stipe surface. The original material was collected from deciduous woodlands, but the French mycologist did not describe the forest type, and he missed to design a holotype. Later, Kühner (1961) studied new specimens which he combined as *C. flexipes* fo. *sertipes* (Kühner) Kühner; however, these collections do not fit completely to the original description of *C. sertipes* (Kühner 1955), since the lamellae are not lilac or violet. According to Kühner (1961) this taxon is very similar to *C. decipiens* (Pers.) Fr. sensu Lange, and it differs from *C. flexipes* (Pers.) Fr. fo. *typica* by its bigger basidiomata and its growth under *Populus* spp. Both *C. sertipes* and *C. flexipes* have an undefined smell. Nowadays, *C. flexipes* is well delimited from the *C. sertipes* concept, since the former has a more pronounced veil development on the pileus surface in combination with an evident and typical *Pelargonium* smell (Brandrud et al. 1998; Ortega & Mahiques 1995a). However, *C. sertipes* is only recognized as a separate taxon in some parts of Europe (Bon & Bouteville 2000; Ortega & Mahiques, loc. cit.).

Geesink (1976) described *C. contrarius* J. Geesink (= *C. flexipes* fo. *sertipes*) to include those *C. sertipes* with different colour of lamellae. After studying Mediterranean specimens, Ortega & Mahiques (1995a) concluded that the lamellae colour is not a good, constant taxonomic character allowing to keep *C. sertipes* and *C. contrarius* as separate species, and they combined this taxon as *C. sertipes* fo. *contrarius*. Arnolds et al. (1995) synonymized *C. sertipes* and *C. contrarius*.

Some reference can be found about *C. fraternus* (Lasch) Reumaux in the literature, but no type material exists. Lasch's (1828) description coincides well with the descriptions of *C. atrocoeruleus* and *C. sertipes*, including the lack of the odour and the habitat (swamped or very damp soils). Saccardo (1887) synonymized *C. fraternus* to *C. flexipes*; however this author did not allude to the typical *Pelargonium*-like smell of *C. flexipes*, and therefore we believe that Saccardo's *C. flexipes* was really *C. sertipes*. Moënné-Locoz & Reumaux (1990) synonymized *C. fraternus* and *C. sertipes*. Bon & Bouteville (2000) studied some collections of *C. sertipes* and proposed that they could correspond to *C. fraternus*. Two collections of Bon & Bouteville were included in our study: macroscopical- and spore characters as well as the habitat coincide well with the concept of *C. sertipes* (Bon & Bouteville 2000).

These different interpretations explained above make easy to understand the big taxonomic and nomenclature controversy surrounding *C. decipiens* s.l. This controversy has its origin in the high variability of this taxon, and it has been fomented by the recently split of *C. decipiens* s.l. in many different taxa (Bidaud et al. 2001), which are difficult to distinguish from this species (Ortega & Vila 2008) and which we have not considered in this study. Principal Components Analysis (PCA) (Fig 3A) shows that micro-morphological characters alone do not separate groups within *C. decipiens* s.l., therefore supporting the inclusion of all *a priori* considered taxa in *C. decipiens* s.l. Only when the habitat and biogeographical data are included in the analysis, PCA discriminates two groups (Fig 3B). The first group includes collections (18–37, 44, 47–49, 51–52) from the Eurosiberian or Mediterranean area in montane deciduous forests under *Populus*, *Alnus*, *Betula*, *Quercus* (except IB 1951/0161 under conifers). The second group includes collections (38–43, 45–46, 50) growing in Mediterranean sclerophyllous *Quercus* or *Pinus* woodlands. However, beside of

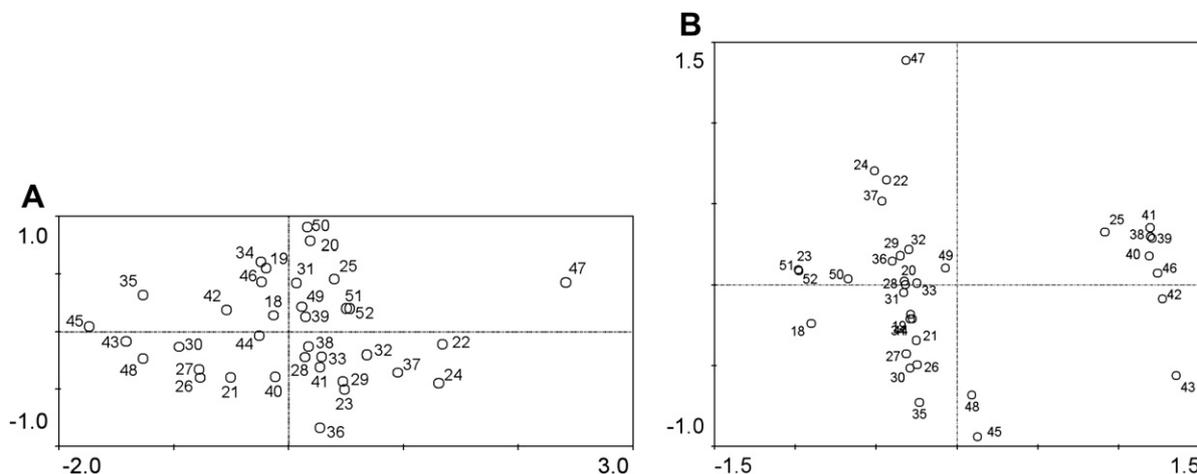


Fig 3 – PCA plots of the studied collections of *C. decipiens* made with the characters shown in Table 1. (A) Habitat and biogeographical data not considered; 67.9 % and 16.4 % of the variance was explained by the X-axis and Y-axis respectively. (B) Habitat and biogeographical data considered; 49.6 % and 20.2 % of the variance was explained by the X-axis and Y-axis respectively. See Material examined and Table 1 for numerical collection codes.

habitat there are no diagnostic morphological features to distinguish both groups, but some little and inconstant differences: (i) pileus blackish brown-grey = 100 % (first group) vs. 20 % (second group), pileus reddish-brown (0 % vs. 80 %), (ii) lamellae lilac or violet (8 % vs. 40 %) or ochre cream coloured (92 % vs. 60 %), (iii) the deciduous forests collections have wider ($Q = 1.58\text{--}1.74$ vs. $1.65\text{--}1.86$) and smaller spores (mv: $7.9\text{--}9.3 \times 4.6\text{--}5.7 \mu\text{m}$ vs. $8.8\text{--}9.4 \times 4.9\text{--}5.7 \mu\text{m}$), but the spore measurements overlap between groups, (iv) spore ornamentation (warts) are medium to medium-strong (mv: 1.73 vs. 2).

Molecular data also support the conclusions from the analysis of morphological data: Sequences of *C. decipiens* s.l. form a strongly supported clade (BS: 95 %; Fig 1), without supported internal clades (except the sequences of the neotype material, P.M.L. 366, and one collection from the original locality, AY083180). *Cortinarius decipiens* s.l. has a relatively high intra-specific variability in ITS sequences ($p = 0.000\text{--}0.014$, mean value: 0.0052), but this intraspecific variability is always significantly lower than the interspecific divergence to other closely related groups [mean values: 0.019 (13 diagnostic positions, 8 changes and 5 indels) to *C. gallurae*, and 0.033 (18 diagnostic positions, 14 changes and 4 indels) to *C. subturibulosus*. Moreover, the intraspecific variability detected in *C. decipiens* s.l. does not coincide with the distribution pattern according to *a priori* considered morpho-taxa, but it is a random variability among sequences. The two groups separated by habitat and biogeographical data (Fig 3) also showed a considerable intra-group genetic variability (0.000–0.007 in the first, and 0.004–0.008 in the second group). Even when considering clones of the same specimen, p -distance values up to 0.004 were detected.

Summarizing the above mentioned considerations, both molecular and morphological data clearly support *C. decipiens* s.l. as a distinct species including *C. atrocoeruleus*, *C. contrarius*, *C. decipiens*, *C. fraternus*, *C. sertipes*, *C. flexipes* fo. *sertipes*. Due to the impossibility to unambiguously define infraspecific taxa in *C. decipiens* s.l. (e.g. subspecies, varieties), all above mentioned included taxa have to be considered synonyms of *C. decipiens* s.l.

Cortinarius decipiens s.l. has a very variable ecology, growing on arctic-alpine *Salix-Dryas* heaths, low-alpine *Salix* shrubs, conifers, deciduous and sclerophyllous woodlands. From a biogeographical point of view, it is a widely distributed species growing in Mediterranean, temperate, boreal, alpine and arctic zones from South, Central and North Europe (Brandrud et al. 1998; Niskanen et al. 2008).

We would like to note that the neotype for *C. decipiens* (Pers.) Fr. proposed by Moënne-Loccoz & Reumaux (1990) fits well into the concept of *C. decipiens*, both from a morphological as well as from a molecular point of view. However, we have noted a mistake, since the correct voucher number is P.M.L. 366, not P.M.L. 336. Arnold (1993) synonymized this collection (as PML 336) to *C. subsertipes* and *C. decipiens* var. *hoffmannii* on the base of the macro- and microscopic characters, but our molecular study showed that these conclusions were wrong.

According to Brandrud et al. (1994) *C. alnetorum* and *C. bibulus* (= *C. pulchellus*) could be closely related to *C. decipiens*, but they can be distinguished because *C. decipiens* have more sparse veil remnants (Brandrud et al., loc. cit.) and because *C. alnetorum* and *C. bibulus* exclusively grow in swamp forest under *Alnus incana* and *A. glutinosa* (Niskanen et al. 2008). Results from the molecular analysis rejected a close relationships between *C. alnetorum* and *C. bibulus* with regard to *C. decipiens*. Both the phylogenetic analysis (Fig 1) as well as the genetic distance values supported this conclusion. Genetic distance between ITS sequences of *C. decipiens* and those of *C. alnetorum* (taken from GenBank, two of them from collections identified by the author of the species) was 0.0495 in average (29 differential positions exist between both species, 23 nucleotide changes and 6 indels, one of 6 bp in length and another of 7 bp in length); while the mean genetic distance between *C. decipiens* and *C. bibulus* was 0.041 (23 differential positions, 19 nucleotide changes and 4 indels, one of 4 bp in length).

According to Niskanen et al. (2008) *C. albonigrellus* J. Favre is a morphologically close species to *C. decipiens*. It is an alpine species growing with *Salix herbacea* in Switzerland (Horak 1995) or with *Salix* bushes and shrubs in Scandinavian

countries (Niskanen et al., loc. cit.). Following these authors, *C. albonigrellus* can be distinguished from *C. decipiens* by its abundant white cortina which constitutes a differentiated ring on the stipe. We included one specimen identified as *C. albonigrellus* (IB2005/0010) in the molecular analysis, which grouped together the rest of *C. decipiens* sequences. More studies (including the type of *C. albonigrellus*) are needed to clarify the relationship between *C. albonigrellus* and *C. decipiens*.

Cortinarius gallurae D.A. Antonini, M. Antonini & Consiglio, *Rivista di Micologia* XLVIII (2): 144 (2005). (Figs 1, 2G–H)

C. gallurensis D.A. Antonini, M. Antonini & Consiglio, *Il genere Cortinarius in Italia*, 3: C101 (2005), *nom. nud.* (non *C. galluraensis* Contu).

C. sertipes fo. *contrarius* (J. Geesink) A. Ortega & Mahiques, *Cryptogamie, Mycol.* 16: 267 (1995) *pro parte*.

Icon. Sel.: D.A. Antonini, M. Antonini & Consiglio, *Il genere Cortinarius in Italia*, 3: C103 (2005) (as *C. gallurensis*).

Pileus 20–60 mm, conico-campanulate, campanulate or (hemi-)sphaerical, later convex or plano-convex, umbo (sub-)acute or obtuse-rounded, hygrophanous, dark chestnut, purplish wine-brown, dark reddish-brown or reddish-brown; surface covered by numerous whitish-silvery or grayish fibrils, which remain towards the margin, which can be appendiculate. Context brownish-ochre or reddish-brown in the cap, lilac, violet, reddish or purplish coloured in the stipe; smell pleasant aromatic, similar to the *Pelargonium* leaves (Consiglio et al. 2005) or no distinct. Lamellae distant, lilac-violet or ochre-cream coloured (milky coffee), with whitish and fimbriate edge. Stipe 30–90 × 4–10 mm, cylindrical or enlarged to (sub-)bulbose at base; surface whitish, becoming brownish when mature, with lilac, violet hues more evident towards upper part, covered with whitish sericeous veil remnants, which sometimes can form an ± evident and ± defined ascendent ring.

Spores 7–10.8 × 4.5–6.5 μm, mv: 7.9–9.9 × 4.8–6.1 μm, (Mmin: 8 × 5 μm, Mme: 8.9 × 5.6 μm, Mmax: 9.6 × 6 μm), broadly ellipsoid, ovoid to ± lacrymoid or pyriform, Q = 1.36–1.89, Qme = 1.47–1.59–1.7, ornamentation medium-strong (mv: 2.08). Epicutis made up by 4–10 μm wide hyphae. Hypocutis well differentiated made up by 15–25 μm wide hyphae, pigment brownish-ochre or brownish-olive intraparietal and epiparietal-encrusted. Universal veil formed by hyaline 3.5–5.5 μm wide hyphae. Clamp connections presents in all tissues. Basidia four-spored, cylindrical to clavate. Lamellar edge almost sterile heterogeneous, with sterile cells abundant, sometimes articulate, apical cells pyriform or clavate (7–12 μm wide).

Habitat and distribution: *Cortinarius gallurae* frequently occurs in typical Mediterranean sclerophyllous ecosystems (Italy and Spain), but was often confused with *C. decipiens*, *C. subturibulosus* and other similar taxa.

Material examined: ITALY: Sassari: Baldo, cerca de Tempio Pausania, under *Quercus suber*, 20 Oct. 2002, D. Antonini et al. (CONS 00076; as *C. gallurensis*, holotype) (58). SPAIN: Cádiz: road from Jimena de la Frontera to the puerto de Galis, cork oak woodlands, 11 Nov. 1989, A. Ortega et al. (GDAC 31454; as *C. sertipes sensu* Ortega & Mahiques) (56). Granada: La Alcaicería, under *Q. ilex* subsp. *ballota* and *Cistus laurifolius*, 14 Dec. 2005, A. Ortega (GDA 54263) (61); *idem*, Natural Park of the Sierra de Huétor, forestal track of the Pajareras, Km 0.5, under holm oak, 16 Dec. 2006, A. Ortega (GDA 54271) (63); *idem*, 5

Jan. 2007 (GDA 54272) (62); *idem*, Arroyo de Fardes, 28 Nov. 1989, A. Ortega & M.T. Vizoso (GDA 54270) (64); *idem*, 1 Nov. 2002, A. Ortega & A. Capilla (JA-cusstta 1601; as *C. decipiens*) (54). Huelva: Navahermosa, under *Castanea sativa*, 5 Nov. 2003, F. Esteve-Raventós (AH 30918; as *C. decipiens*) (57); *idem*, near to Galaroza, mixed forest of holm oak and *Pinus halepensis*, 20 Nov. 1991, A. Ortega (GDAC 36743; as *C. sertipes sensu* Ortega & Mahiques) (59). Jaén: Natural Park of the Sierras de Cazorla, Segura y las Villas, Fuente de la Teja, holm oak woodlands, 25 Nov. 1988, A. Ortega (GDAC 30789; as *C. sertipes sensu* Ortega & Mahiques) (55); *idem*, Los Villares, same habitat, 1 Dec. 1989, F. Jiménez (GDAC 31400; as *C. sertipes sensu* Ortega & Mahiques) (53). Sevilla: road to Madroño, Km 5, under *Q. ilex* subsp. *ballota* and *Cistus laurifolius*, 29 Nov. 2002, L. Alcoba & A. Ortega (GDA 54264) (60). Valencia: La Vall d'Albaida, Bocairent Serra de Mariola, Mas de Seratina, under *Q. ilex* subsp. *ballota*, T. Conca (MES 3984; as *C. petroselinus*) (65).

Notes: *Cortinarius gallurae* grows in Mediterranean sclerophyllous woodlands (*Q. suber*, *Q. ilex* subsp. *ballota*, *Cistus laurifolius* and *C. monspeliensis*). It is a morphologically well defined species characterized by (i) reddish-brown or red purplish-brown pileus, (ii) lilac-violet lamellae with whitish edge, (iii) violet hues on the top stipe, (iv) abundant silvery cortina, and (v) ellipsoid spores with a medium to strong ornamentation (2.08). Sometimes it looks like a small *C. assiduus* Mahiques, A. Ortega & Bidaud, but they differ by smaller basidiomata and different spores (Mahiques et al. 2001). From an ecological and morphological point of view, *C. gallurae* resembles *C. vernus* (= *C. petroselinus*), but it can be distinguished by bigger (mv: 7.9–8.9–9.9 × 4.8–5.6–6.1 μm vs. 7.3–7.7–8.4 × 4.7–5.3–6 μm), ellipsoid (Qme = 1.47–1.59–1.7 vs. 1.3–1.45–1.57) spores with less pronounced ornamentation (2.08 vs. 2.60). Phylogenetic analysis places *C. gallurae* in a subclade together with *C. subturibulosus* and *C. decipiens* (Fig 1). However, spore characters enable to distinguish these three taxa very well (Fig 2, Table 1).

From a molecular point of view, *C. gallurae* is also a well defined species. The ITS sequences of *C. gallurae* were very homogeneous ($p = 0.000–0.002$, mean value: 0.001). Only one nucleotide change exist between its ITS sequences. Sequences from collections GDA 54263 and AH 30918 share a 'G' in this position, while the type collection (CONS 00076) and GDA 54264 share an 'A'. The distribution of this polymorphic position between *C. gallurae* sequences is not related with the distribution of any morphological character. Thus, a comparatively high variation of the spore size was found among collections of *C. gallurae*, [mv: 7.9–9.1 × 4.8–5.5 μm (CONS-00076, AH-30918, GDA 54270, GDAC 31400, 31454, MES 3984) vs. 9.1–9.9 × 5.5–6.1 μm (GDA 54263, 54264, 54271, GDAC 36743); see Table 1], but these differences were not related to the molecular data, since the collections with the same nucleotide in the polymorphic position showed different spore sizes. Therefore, we consider these different spore sizes as the spore variability range of this species.

Cortinarius subturibulosus

Cortinarius subturibulosus var. **subturibulosus** Kizlik & Trescol, *Doc. Mycol.* XXI (83): 41 (1991). (Figs 1, 2J,L)

C. decipiens var. *subturibulosus* (Kizlik & Trescol) A. Ortega & Mahiques, *Doc. Mycol.* **XXV** (98–100): 301 (1995).

C. urdaibaiensis Fernández Sas., *Butll. Soc. Micol. Valenciana* **8**: 100–101 (2003).

Icon. Sel.: Ortega et al. *Setas: Identificación, toxicidad, gastromicología*: 263, fig 117 (1996) (as *C. decipiens* var. *subturibulosus*); Aparici Izquierdo et al. *Bolets de la Vall d'Albaida*: 64 (1995) (as *C. subturibulosus*); Fernández Sasía, *Butll. Soc. Micol. Valenciana* **8**: 161 (2003) (as *C. urdaibaiensis*).

Habitat and distribution: *Cortinarius subturibulosus* var. *subturibulosus* is frequent in Mediterranean sclerophyllous ecosystems, especially in association with *Quercus ilex* and *Pinus halepensis*, but occurs also, under other *Quercus* spp.: *Q. faginea*, *Q. ilex* subsp. *ballota*, *Q. pyrenaica*, *Q. suber*; *Erica arborea*, *Pistacia lentiscus* or *Cistus ladanifer*, *C. laurifolius*, etc.

Material examined: **FRANCE:** Les Dèvès: Lezon (Gard), forêt de feuilles et de conifères (principalement *Quercus ilex* et *Pinus halepensis*), 4 Dec. 1983, S. Kizlik (S. Ki. n° 8-83-104; as *C. subturibulosus*, holotype) (77). **SPAIN:** Biskaia: Sukarrieta, réserve de la biosphère de Urdaibai, under *Q. ilex* subsp. *ilex* with *Laurus nobilis*, *Pistacia lentiscus* and *Phyllirea latifolia*, 15 Feb. 2003, R. Fernández Sasía (R.F.S. 030215-01; as *C. urdaibaiensis*, holotype) (68); *idem*, 25 Feb. 2004 (R.F.S. 040225-01; as *C. urdaibaiensis*, isotype) (69). Castelló: Vallibona, under *Q. ilex* subsp. *ballota*, 26 Oct. 1994, R. Mahiques (MES 2288; as *C. decipiens* var. *subturibulosus*) (78). Córdoba: Priego de Córdoba, same habitat, 10 Nov. 1993, J. Gómez (GDAC 42904; as *C. decipiens* var. *subturibulosus*) (84, 85). Granada: Alhama de Granada, puerto del Navazo, holm oak forests, 27 Nov. 1980, A. Ortega (GDAC 10194; as *C. decipiens* var. *subturibulosus*) (75); *idem*, 29 Nov. 1979, R. Galán (GDAC 10195; as *C. decipiens* var. *subturibulosus*) (70); *idem*, Natural Park of the sierra de Huétor, Arroyo de Fardes, same habitat, 28 Nov. 1989, A. Ortega & M. Zea (GDAC 31805; as *C. decipiens* var. *subturibulosus*) (66); *idem*, forestal track of the Pajareras, km 0.5, same habitat, 31 Dec. 2005, A. Ortega (GDA 54267; as *C. decipiens* var. *subturibulosus*) (67); *idem*, 4 Nov. 2007, A. Ortega (GDA 54268; as *C. decipiens* var. *subturibulosus*) (87); *idem*, Sierra Nevada, Soportújar, Fuente de Palo, under *Q. ilex* subsp. *ballota* and *Q. pyrenaica*, 3 Nov. 2001, A. Ortega, (JA-cusstá, Ortega 198; as *C. decipiens* var. *subturibulosus*) (72). Jaén: Linares, Los Cerrillos, holm oak woodlands, 2 March 2003, J.D. Reyes (GDA 54266; as *C. decipiens* var. *subturibulosus*) (83); *idem*, pantano del Quebrajano, same habitat, 27 Nov. 1990, A. Ortega (GDA 36736; as *C. decipiens* var. *subturibulosus*) (76); *idem*, Santa Elena, Miranda del Rey, under *Q. suber*, *Erica arborea* and *Cistus ladanifer*, 22 Dec. 2002, J.D. Reyes (GDA 54269; as *C. urdaibaiensis*) (71). Valencia: Barx, carrascar de Barx, under *Q. ilex* subsp. *ballota*, 27 Nov. 1993, R. Mahiques (MES 2147; as *C. decipiens* var. *subturibulosus*) (74); *idem*, Bocairant, sierra de Mariola, mixed forests of holm oak and pines, 6 Dec. 1993, R. Mahiques (MES 2185; as *C. decipiens* var. *subturibulosus*) (73); *idem*, la Vall d'Albaida, Pinet, Els Surars, cork oak forest, 13 Nov. 1993, R. Mahiques (MES 2083; as *C. decipiens* var. *subturibulosus*) (80); *idem*, Mariola, "Mas del carrascar", under *Q. ilex* subsp. *ballota*, 24 Nov. 1994, R. Mahiques (MES 2347; as *C. decipiens* var. *subturibulosus*) (79); *idem*, Ontinyent, mixed forests of holm oak and pines, 22 Nov. 1990, R. Mahiques (MES 1441; as *C. decipiens* var. *subturibulosus*) (81); *idem*, holm oak forest, 18 Nov. 1993, R. Mahiques (MES 2115; as *C. decipiens* var. *subturibulosus*) (82). Zamora: Camarzana de Tera, 780 m, under *Q. ilex* and *C. ladanifer*, 8 Nov. 2006, J. Campos et al. (GIC 061108-6; as *C. decipiens* var. *subturibulosus*) (86).

Cortinarius subturibulosus var. **bombycinus** (Mahiques & Burguete) Suár.-Sant. & A. Ortega, **comb. nov.** (Figs 1, 2I,K) MycoBank no: MB 515204

Basionym: *C. bombycinus* Mahiques & Burguete, *Butll. Soc. Micol. Valenciana* **6**: 246 (2001).

C. decipiens var. *atrocoeruleus* (M.M. Moser) H. Lindstr. *sensu* Mahiques, *Butll. Soc. Micol. Valenciana* **6**: 62 (2001).

Icon. Sel.: Mahiques & Burguete, *Butll. Soc. Micol. Valenciana* **6**: 134 (2001) (as *C. bombycinus*); Fernández Sasía, *Journal des Journées Européennes du Cortinaire* **8**: 70 (2004) (as *C. bombycinus*).

Habitat and distribution: *Cortinarius subturibulosus* var. *bombycinus* is frequent in Mediterranean sclerophyllous communities, especially in association with *Quercus ilex*, *Q. ilex* subsp. *ballota*, *Q. faginea*, and *Q. suber* or *Cistus albidus*, *C. crispus*, *C. salviifolius*, etc.

Material examined: **SPAIN:** Álava: Fontetxa, under *Q. ilex* and *Cistus albidus*, 18 Dec. 2004, R. Fernández Sasía (R.F.S. 041218-05; as *C. bombycinus*) (92). Teruel: San Agustín, Mas de Andrés, 900 m, under *C. laurifolius* and *C. salviifolius* on *Q. ilex* subsp. *ballota* and *Q. faginea* forest 26 Oct. 2001, A. Burguete (MES 3779; as *C. bombycinus*, holotype) (89, 90); *idem*, (MES 3780; as *C. bombycinus*, isotype) (91). Valencia: La Vall d'Albaida, Pinet, Els Surars, under *Pinus pinaster*, *Q. suber*, *C. salviifolius* and *C. crispus*, 20 Oct. 2000, R. Mahiques (MES 3662; as *C. decipiens* var. *atrocoeruleus*) (88). Zamora: Camarzana de Tera, 780 m, under *Q. ilex* and *C. ladanifer*, 8 Nov. 2006, J. Campos et al. (GIC 061108-7; as *C. bombycinus*) (93).

Cortinarius subturibulosus s.l. is characterized by: Pileus 15–40 mm, conical, conico-campanulate, (hemi-)sphaerical, convex or plano-convex, umbo acute or obtuse, hygrophanous, dark brownish (umber), dark reddish-brown, blackish-brown or reddish-brown; surface covered by the universal veil (very abundant in *C. subturibulosus* var. *bombycinus*), it is formed by numerous whitish-silvery or grayish fibrils, which remain towards the margin. Context brownish-ochre in the cap, brownish-lilac, brownish-violet or brownish-red (red wine) in the stipe; smell pleasant aromatic (orange blossom, in *C. subturibulosus* var. *subturibulosus*) or no distinct (*C. subturibulosus* var. *bombycinus*). Lamellae ochre or lilac-violet coloured. Stipe 30–55 × 2.5–6 mm, cylindrical or enlarged at base; surface whitish, becoming brownish when mature, with pinkish, lilac or violet hues more evident towards upper part (younger specimens), later brownning (mature specimens), covered with a variable development whitish sericeous veil remnants.

Spores 8–12.3 × 4.6–6.5 µm, mv: 8.8–11.3 × 5.1–6.2 µm, (Mmin: 9 × 5.1 µm, Mme: 9.7 × 5.5 µm, Mmax: 10.6 × 6 µm), very variable, (sub-)cylindrical, ellipsoid, or ± lacrymoid, $Q = 1.47\text{--}2.2$ $Q_{me} = 1.61\text{--}1.77\text{--}1.96$; ornamentation formed by strong (mv: 2.57), isolated or ± interconnected irregular and heterogeneous warts. Epicutis made up by 5–12 µm wide hyphae. Hypocutis well differentiated made up by 15–35 µm wide hyphae, pigment brownish-ochre or brownish-olive intraparietal and epiparietal-encrusted. Universal veil formed by hyaline 3.5–5 µm wide hyphae. Clamp connections present in all tissues. Basidia four-spored, cylindrical to clavate. Lamellar edge fertile, with ± clavate (7–10 µm) sterile cells.

Notes: *Cortinarius subturibulosus* collections are highly variable in pileus shape and size, lamellae, stipe colour, smell, and universal veil development. This phenotypic variability caused considerable taxonomic confusion among mycologists: *C. subturibulosus* was treated as *C. decipiens* var. *subturibulosus* (Ortega & Mahiques 1995b) or considered as separate species

(*C. bombycinus*, Mahiques & Burguete 2001; *C. urdaibaiensis*, Fernández Sasía 2003). *Cortinarius bombycinus* was described to include those specimens growing under *Cistus* spp. and/or sclerophyllous *Quercus* species in acid soils with: (i) silvery veil very abundant on pileus and stipe surface, (ii) lilac or violet hues presents on stipe and lamellae, (iii) spores with a strong ornamentation (Fernández Sasía, 2005; Mahiques & Burguete 2001); the *C. urdaibaiensis* concept included specimens growing on Mediterranean *Quercus ilex* and *Q. suber* woodlands characterized by: (i) spores with a strong ornamentation, (ii) pleasant aromatic smell, (iii) lilac hues presents in the stipe and lamellae, (iv) silvery cortina abundant in the stipe. Our results clearly show that both *C. bombycinus* and *C. urdaibaiensis* are synonyms of *C. subturibulosus* s.l., since ITS sequences generated from holotype materials form a strongly supported clade together with sequences generated from *C. subturibulosus* collections (Fig 1). The low intraspecific distances among its sequences support this conclusion (mean value: 0.004). This result agrees with the spore data, since all studied collections showed the typical spore for *C. subturibulosus*, which it is a good character for identification of this species. However, the ITS phylogeny resulted in two subclades within the *C. subturibulosus* clade corresponding to the morphological concept of *C. bombycinus* (MES 3662, MES 3779; intragroup distance = 0.002), and with the morphological concept of *C. subturibulosus*-*C. urdaibaiensis* (R.F.S. 030215-01, MES 2288, MES 2347; intragroup mean distance = 0.000). The ITS sequences of these two groups differ in six diagnostic positions, three nucleotide changes and three indels (1 bp in length), being the mean intergroup genetic distance of 0.007. From a morphological point of view the only differences between the two groups are the veil development (more abundant in var. *bombycinus*) and the smell of the basidiomata (pleasant aromatic in var. *subturibulosus*, non distinct in var. *bombycinus*). Due to the fact that these morphological characters could be variable, as it has been observed in other *Cortinarius* groups (veil development can be determined by the influence of bioclimatic factors, Ortega et al. 2006), together with the relatively low genetic distances (in general the mean genetic variation within the clades considered as the same species was between 0.000 and 0.0076, while this value was between 0.0174 and 0.0328 for the comparisons between most closely related species according to the tree shown in Fig 1), we define the two subgroups as varieties of *C. subturibulosus*.

The subordination of *C. subturibulosus* as a variety of *C. decipiens* is clearly rejected by both, molecular and morphological data. Phylogenetic tree shows *C. subturibulosus* related to *C. decipiens* (Fig 1), but the bootstrap support was low. Moreover, the genetic distance between *C. subturibulosus* and *C. decipiens* is high (mean value: 0.033), since 19 diagnostic positions distinguish their sequences (14 nucleotide changes and 5 indels, one of 4 bp in length); while the intraspecific mean distances were low (0.005 for *C. decipiens* and 0.004 for *C. subturibulosus*). *Cortinarius subturibulosus* and *C. decipiens* share a similar habit, but *C. subturibulosus* differs from *C. decipiens* in: (i) bigger (mv: $8.8\text{--}9.7\text{--}11.3 \times 5.1\text{--}5.5\text{--}6.2 \mu\text{m}$ vs. $8.1\text{--}8.9\text{--}9.4 \times 4.9\text{--}5.3\text{--}5.7 \mu\text{m}$) and variable spores, (ii) stronger spore ornamentation (2.57 vs. 1.84).

Cortinarius subturibulosus and *C. gallurae* are also related (Fig 1), but *C. gallurae* can be separated by a larger, more fleshy basidiomata (pileus 10–40 mm vs 20–60 mm; stipe 30–55 × 2.5–6 mm vs 30–90 × 4–10 mm), the white almost sterile lamellae edge, broader ellipsoids spores ($Q = L/w$: 1.61–1.77–1.96 vs.

1.49–1.59–1.7) with homogeneous smaller spores warts (2.57 vs. 2.08), and by a high interspecific genetic distance (0.025; 12 diagnostic positions, 10 nucleotide changes and 2 indels of 1 bp in length) in combination with a low intraspecific variability (0.001 for *C. gallurae*, 0.004 for *C. subturibulosus*).

Cortinarius vernus

Cortinarius vernus var. **vernus** H. Lindstr. & Melot in Brandrud, Lindström, Marklund, Melot & Muskos, *Cortinarius Flora Photographica* [English translation by J. Melot] (Matfors) 3: 27 (1994). (Figs 1, 2M)

C. petroselineus Chevassut & Rob. Henry, *Doc. Mycol.* XII (47): 59 (1982) (*nom. inv.*).

C. petroselineus var. *typica* Chevassut & Rob. Henry, *Doc. Mycol.* XII (47): 59 (1982) (*nom. inv.*).

C. petroselineus var. *cedriphila* Chevassut & Rob. Henry, *Doc. Mycol.* XII (47): 60 (1982) (*nom. inv.*).

C. petroselineus var. *conicopurpurata* Chevassut & Rob. Henry, *Doc. Mycol.* XII (47): 60 (1982) (*nom. inv.*).

C. petroselineus var. *radicipes* Chevassut & Rob. Henry, *Doc. Mycol.* XII (47): 60 (1982) (*nom. inv.*).

C. erythrinus var. *petroselineus* (Chevassut & Rob. Henry) A. Ortega & Mahiques, *Doc. Mycol.* XXV (98–100): 298 (1995) (*nom. inv.*).

Icon. Sel.: Brandrud et al. *Cortinarius Flora Photographica* 3: C51 (1994).

Habitat and distribution: *Cortinarius vernus* var. *vernus* is a taxon with wide distribution in Europe: it frequently grows in Mediterranean sclerophyllous communities, although according to literature (see Brandrud et al. 1994; Niskanen et al. 2008) it is also frequent in temperate and boreal montane areas of Central and North Europe. It fruits in summer, autumn or winter.

Material examined: **FRANCE:** Espinouze (Hérault): sous hêtres et épicéas, 3 Nov. 1980, G. Chevassut (CHEV 3130; as *C. petroselineus* var. *radicipes*, part of the holotype) (94); Exposition of Avignon: 21 Oct. 1973, G. Chevassut (CHEV 2333; as *C. petroselineus* var. *typica*) (98). Exposition of Vesoul: sous chênes vertes en 1973 et 1974 (10 sp.), G. Chevassut (CHEV 2555; as *C. petroselineus* var. *conicopurpurata*, part of the holotype) (97). Pezenes: chênes sur silice, 18 Nov. 1984, G. Chevassut (CHEV 3362; as *C. petroselineus* var. *typica*) (99). Région de Lamalou: Caroux, Cédrais des Ecrivains anciens Combattants, sous arbres mêles hêtres et épicéas ou cédres, Oct.–Nov. 1973, G. Chevassut (CHEV 1954; as *C. petroselineus* var. *cedriphila*, part of the holotype) (96). **SPAIN:** Granada: Natural Park of the Sierra de Huétor, arroyo de Fardes, holm oak forest, 19 Oct. 1996, A. Ortega (GDAC 42721; as *C. petroselineus*) (100); *idem*, 1 Nov. 2002, A. Ortega & A. Capilla (JA-cussta Ortega-90; as *C. erythrinus*?) (102). Huelva: Navahermosa, under *Castanea sativa*, *Quercus ilex* subsp. *ballota* and *Q. suber*, 5 Nov. 2003, F. Esteve-Raventós (AH 30917; as *C. petroselineus*) (101). Jaén: El Centenillo, under *Cistus laurifolius* shrubs, 23 Nov. 1988, A. Ortega et al. (GDAC 30608; as *C. erythrinus*) (103). Valencia: Els Surars, Pinet, mixed forests of *Pinus* sp. and *Q. suber*, 1 Nov. 1991, R. Mahiques (MES 1552; as *C. petroselineus* var. *radicipes*) (95); *idem*, mixed forests of *Pinus pinaster* and *Q. suber* under *Q. suber*, 3 Nov. 2000, R. Mahiques (MES 3624; as *C. petroselineus*) (105). Zamora: San Pedro de Ceque, 784 m, under *Q. pyrenaica* and *Q. ilex* subsp.

ballota, 8 Nov. 2006, J. Campos et al. (GIC 061108-3; as *C. petroselineus*) (104). **SWEDEN**: Årgermanland: Hemsö Sn, Drafle, in cultivated park with *Abies sibirica*, 19 Aug. 1986, T.E. Brandrud et al. (S-F44879; as *C. vernus*, holotype) (106).

Cortinarius vernus var. **nevadavernus** Suár.-Sant. & A. Ortega, var. nov. (Figs 1, 2N)

Mycobank no: MB 515205

C. vernus H. Lindstr. & Melot *sensu auct.*, non *sensu orig.*

Icon. Sel.: Ortega et al. *Boll. Soc. Micol. Madrid* 28: 202 (2004); Ballarà et al. *Cortinarius Ibero-insularis* -1-: 263–265 (2007) (as *C. vernus*).

Etymology: *nevada*: Related to Sierra Nevada (Granada, Spain), *vernus*: collected in spring time.

Hoc taxon congruit cum C. verno sensu auctorum plurimorum non sensu originali. Differt a C. verno var. verno (=C. petroselineo) carne inodora, fructificatione verno tempore et in hygrophilis montibus vel in submontanis ripariis consortiis. Holotypus Hispaniae (Granada), in naturalibus hortis loci "Sierra Nevada" dicti, 1300 m supra mare alti, prope Huéneja fluminem, sub Juglande regia et Populo nigra, 12/V/1996, lectus, leg. A. Capilla, in GDA sub n. 44731 conservatur.

Habitat and distribution: Cortinarius vernus var. *nevadavernus* grows in temperate (sub-)montane areas from Central (coll. TUB 011900), North (coll. AT 2005003, ITS sequences UDB002176) and South Europe, in riparian communities and mixed forests; in South Europa it also grows in sclerophyllous communities (Ballarà et al. 2007). It fruits exclusively in spring.

Material examined: GERMANY: Altenburg, under *Populus* and *Betula* sp., 24 Apr. 1998, Löffler (TUB 011900; as *C. erythrinus*) (113). **SPAIN**: Granada: Natural Park of Sierra Nevada, Huéneja, Huéneja river, under *Populus nigra*, 19 May 1996, A. Capilla (GDAC 41046; as *C. vernus*) (108); *idem*, under *Juglans regia* and *P. nigra*, 12 May 1996, A. Capilla (GDAC 44731; **holotype**) (107); *idem*, Aldeire, Aldeire river, under *P. nigra*, 4 April 1999, A. Capilla (GDA 45876; as *C. vernus*) (109); *idem*, 17 April 2000 (GDA 45877; as *C. vernus*) (110); Huesca: Aragües del Puerto, Tremuito 1150 m, mixed forests of *Pinus sylvestris*, *Fagus sylvatica* and other deciduous trees, 26 May 2004, F. Palazón (FP 20040526009) (111); *idem*, 22 April 2007 (FP 20070422006) (112).

Cortinarius vernus s.l. is characterized by: *Pileus* 15–60 mm, conico-campanulate, campanulate or (hemi-)spherical, later convex or plano-convex, rounded-obtuse or (sub-)acute umbo, hygrophphanous, blackish-brown, dark purplish-brown or dark reddish-brown (umber) coloured; surface sericeous, covered by whitish-silvery or grayish fibrils which keep towards the margin, which remain whitish coloured. Context brownish-ochre or reddish-brown, with a more evident purplish- or reddish-pink tinges in the stipe cortex; smell no distinct (*C. vernus* var. *nevadavernus*) or pleasant aromatic (persil) (some collections of *C. vernus* var. *vernus*) (according Chevasut & Henry 1982; Consiglio 2004). *Lamellae* distant, cream coloured, ochre-cream coloured, pale cinnamon to brownish, sometimes with violet hues (Consiglio, loc. cit.), edge fimbriate, whitish or concoloured. *Stipe* 30–75 × 3–9 mm, cylindrical or enlarged at base; surface whitish, becoming brownish when mature, with a lilac or violet tinge in upper part (in the younger specimens) and red wine or reddish-pink in the rest, covered with grayish-white sericeous veil remnants.

Spores 6.5–9 × 4.5–6.8 µm, mv: 7.3–8.4 × 4.7–6 µm, (Mmin: 7 × 4.9 µm; Mme: 7.7 × 5.3 µm; Mmax: 8.4 × 5.9 µm), (sub-)globose or pyriform, Q = 1.2–1.78, Q_{me} = 1.3–1.45–1.57; with a strong

ornamentation (mv: 2.6), made up isolate or ± interconnected warts which can form a (sub-)reticulum. *Basidia* four-spored cylindrical to clavate. *Lamellar edge fertile* heterogeneous with frequent, claviform or pyriform, sometimes articulate (8–12 µm wide) sterile cells. *Epicutis* made up by 4–11 µm wide hyphae. *Hypocutis* differentiated made up 15–30 µm wide hyphae, pigment brownish-ochre or brownish-olive intraparietal or epiparietal-encrusted. *Universal veil* formed by hyaline 3.5–5 µm wide hyphae. *Clamp connections* present in all tissues.

Notes: Among the studied collections of *C. vernus* we were able to distinguish two groups, which we now consider on variety level: *C. vernus* var. *vernus* includes collections occurring in sclerophyllous and temperate deciduous woodlands during autumn–winter, while *C. vernus* var. *nevadavernus* includes collections occurring in sclerophyllous, deciduous and riparian forests during spring time. These two varieties can hardly be distinguished based on morphological characters, but the fruiting period and context smell are diagnostic criteria. These two varieties form distinct sistergroups (Fig 1), with an intragroup mean genetic distance of 0.1% for var. *vernus* and 0.05% for var. *nevadavernus* (none intraindividual variability was found), and an intergroup mean genetic distance of 1.3% (9 positions distinguish the two groups, 7 nucleotide changes and 2 indels of 2 and 1 bp in length). In spite of the relatively high genetic distances between the two groups of *C. vernus*, we do not consider them at specific level because of there are not diagnostic morphological features to distinguish them. The fact of both varieties fruit in different periods suggest a reproductive isolation between them, what could explain the intervarieties genetic distance between their ITS sequences. The reproductive isolation is one of the causes of the absence or incomplete concerted evolution in the repetitive DNA families (e.g. ribosomal DNA) between populations (Dover 2002). Therefore, different variants in the polymorphic positions of the ITS sequences could be fixed by molecular drive in each variety of *C. vernus*.

We have synonymized *C. petroselineus* to *C. vernus* because both taxa share the same morphological features and especially because they share the same ITS sequences. The ITS sequence of the type collection of *C. vernus* (S-F44879) showed no variation or very low ($p = 0.000–0.002$, mean value: 0.001) with regard to the ITS sequences of *C. petroselineus*. From a nomenclatural point of view, the name *C. petroselineus* (although it is the oldest name) must be rejected according to the International Code of Botanical Nomenclature (art. 37.1 and 43.1).

According to the literature (Campo 2006; Horak 1995; Niskanen et al. 2008) *C. inops* J. Favre is morphologically related to *C. vernus*, because they have a similar habit and spore morphology and size. However, clear ecological and morphological differences exist between both species (Niskanen et al. 2008). Thus, *C. inops* is an alpine taxon growing with dwarf *Salix*, *Dryas* and in *Salix* shrubs, which shows smaller basidiomata than *C. vernus* (pileus up to 25 mm diam vs 60 mm, stipe up to 3 mm broad vs 9 mm).

The ITS tree showed *C. helobius* as the closer taxon to *C. vernus*. The genetic distance between both taxa was 1.9%, and 10 diagnostic positions distinguish them (7 nucleotide changes and 3 indels, one of 4 bp in length). *Cortinarius helobius* belongs to the section *Incrustati* Melot (Brandrud 1996; Niskanen et al. 2008), and its relationship with *C. vernus* shows the taxonomic difficulty of this group of *Cortinarius* and evidences the necessity of a deeper revision of the section *Hydrocybe* and related sections.

Key to the species of *Cortinarius* studied

- 1 Basidiospores broadly-ellipsoid to pyriform, $Q_{me} = 1.3\text{--}1.57$; very strongly warted ($Or = 2.57\text{--}2.62$)... 2
Basidiospores different, $Q_{me} = 1.47\text{--}1.96$; with variable ornamentation ($Or = 1.3\text{--}2.57$)... 3
- 2 (1) Fruiting in springtime... *C. vernus* var. *nevadavernus*
Fruiting in autumn and/or winter... *C. vernus* var. *vernus*
- 3 (1) Species exclusively collected from Mediterranean sclerophyllous communities... 4
Species exclusively or frequently collected from deciduous communities... 6
- 4 (3) Pileo 20–60 mm in diam.; stipe 30–90 × 4–10 mm; lamellar edge whitish and denticulate-fimbriate. Basidiospores broadly ellipsoids ($Q_{me} = 1.47\text{--}1.7$); strongly warted ($Or = 2.08$); sterile cells abundant... *C. galluriae*
Pileo 10–40 mm; stipe 30–55 × 2.5–6 mm; lamellar edge concolour and entire-smooth. Basidiospores variable shaped ($Q_{me} = 1.61\text{--}1.96$); very strong warted ($Or = 2.57$); sterile cells poorly differentiated... 5
- 5 (4) Smell aromatic-pleasant, veil development variable but not very important in younger specimens (pileus)... *C. subturibulosus* var. *subturibulosus*
Smell non distinct, veil development very important in younger specimens (pileus)... *C. subturibulosus* var. *bombycinus*
- 6 (3) Basidiospores $9.9\text{--}12.2 \times 5.8\text{--}7.2 \mu\text{m}$... *C. casimiri* var. *casimiri*
Basidiospores up to $10.1 \times 5.7 \mu\text{m}$... 7
- 7 (6) Stipe apex without bluish tinge, with broader or clavate base. Context in the lower part of stipe pinkish-brown coloured... *C. casimiri* var. *hoffmannii*
Stipe apex with bluish tinge (when very young), without broader base. Context in the lower part of stipe differently coloured... *C. decipiens*

Acknowledgements

We are grateful to Dr. G. Consiglio (Casalecchio di Reno, Italy) for the latin diagnosis of *C. vernus* var. *nevadavernus*. To Dr. S. Pennycook (Auckland, New Zealand) and Dr. Stegehuis (Centraalbureau voor Schimmelcultures, Utrecht, The Netherlands) for their nomenclatural comments in relation to *Cortinarius petroselineus*. To Dr. J. Lorite (University of Granada, Spain) for statistical assistance. To directors-curators of the herbaria of the University of Granada, Spain (GDA and GDAC); University of Alcalá de Henares, Alcalá de Henares, Madrid, Spain (AH); University of Innsbruck, Austria (IB); Museum National de Histoire Naturelle, Paris, France (PC); University of Leiden, Netherlands (L); Botanic Garden of Gêneve, Switzerland (GK); Sweden Museum of Natural History, Stockholm, Sweden (S); Natural History Museum, University of Copenhagen, Denmark (C); Herbarium Tubigense, University Tübingen, Germany (TUB); CUSSTA, Córdoba, Spain (JA-cussta); and the personal herbaria of the Grupo Iberopeninsular de Cortinariólogos (GIC), R. Mahiques (MES), G. Chevassut (CHEV), P. Moëgne-Loccoz (P.M.L), S. Kizlik (S. Ki.), R. Fernández Sasía (R.F.S), G. Consiglio (CONS), A. Bidaud (AB), F. Palazón (FP), and J. Bouteville (J.B.). To the Drs. A. González and J.D. Bueno (Servicio Técnico de Apoyo a la Investigación, University of Granada) for their collaboration in the spore FESEM study.

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