



# The enigmatic *Cortinarius magellanicus* complex occurring in Nothofagaceae forests of the Southern Hemisphere

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## ARTICLE INFO

### Article history:

Received 28 February 2018

Received in revised form

24 August 2018

Accepted 29 August 2018

Available online 8 September 2018

Corresponding Editor: Gabor M. Kovacs

### Keywords:

*Cortinarius janthinophaeus*

*Cortinarius lugubris*

*Cortinarius semiamictus*

*Cycnei*

Gondwanian biogeography

Nothofagus-associated *Myxaci*

## ABSTRACT

*Cortinarius magellanicus* Speg. is an edible, ectomycorrhizal fungus, widely distributed in Argentina, Chile and New Zealand. However, earlier studies already indicated that the epithet '*magellanicus*' might have been applied in a wide sense, thus circumscribing several species. A neotype was designated by Moser and Horak (1975) due to Spegazzini's type was lost. Argentinian Nothofagaceae forests' samples, from autumn of 2017, morphologically recognized as *C. magellanicus* were used for a phylogenetic analysis, including sequences from type material and closely related species. Our results showed that *C. magellanicus* represents a complex of species, with at least three phylogenetic lineages, each with strong regionalism and distinct host associations. *Cortinarius magellanicus* s. str. is restricted to Patagonia of Argentina and Chile. The misidentified reports from New Zealand and Australia represent distinct and different lineages. In the present contribution, the re-description of *C. magellanicus* is based on neotype material and two new species are proposed. *Cortinarius vitreopileatus* var. *similissimus* is described as variety from New Zealand resembling *C. magellanicus*, however without close phylogenetic relationship to it. The taxonomic delimitation for *C. magellanicus* species complex is of high relevance due to the abundance of these fungi and their ectomycorrhizal role in Nothofagaceae forests in Gondwanian region.

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## 1. Introduction

*Cortinarius magellanicus* Speg. is one of the most frequent and conspicuous species of *Cortinarius* (Pers.) Gray in the sub-Antarctic Nothofagaceae Kuprian. forests of Argentina, Chile, Australia and New Zealand (Garnica et al., 2003; Moser and Horak, 1975; Soop, 2003). It was originally described by Spegazzini (1887a) and is considered a living fossil in Nothofagaceae forests (Horak and Wood, 1990). In Argentinian Patagonia this species is not only considered an edible fungus of high nutritional quality (Barroetaveña and Rajchenberg, 2008; Gamundí and Horak, 1993;

Toledo et al., 2014) but is also renowned for its antioxidant, antimicrobial and acidifying properties (Toledo et al., 2016). Moreover, *C. magellanicus* is reported as an ectomycorrhizal fungus typical for Nothofagaceae forests in sub-Antarctic South America (Garnica et al., 2003; Garrido, 1988; Valenzuela et al., 1996; Teasdale et al., 2013).

Moser and Horak (1975) were first reluctant to use Spegazzini's epithet *C. magellanicus* (Spegazzini, 1887a), because the type material was lost (Horak, 1967). Accordingly, Horak and Moser proposed the provisional epithet *Cortinarius tyriomyxa* ad int. for this taxon. Subsequently, based on fresh and autochthonous material they changed their mind and decided to adopt and validate the original name *C. magellanicus*, because Spegazzini's description of the habitat and the distinct macroscopical characters of the basidiomes were in accordance with their concept. Thus, Moser and Horak (1975) re-described and validated this taxon with the neotype specimen (IB19630347) from Argentina (Prov. Neuquén, Puerto Manzano). Only the spore sizes given by Spegazzini are slightly smaller as later reported by Moser and Horak (1975). The difference is probably explained best by the fact that Spegazzini

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measured the basidiospores in water, whereas the basidiospores of the neotype were examined in 3 % KOH.

Moser and Horak (1975) described *C. magellanicus* as a slender, lilac-coloured *Myxaciium* associated to *Nothofagus* forests. This species is especially remarkable, because in the same population the cortina can be either typically thread-like or is formed by a well-developed glutinous membranaceous ring. They also emphasized that *C. magellanicus* has macromorphological affinities to the *Cortinarius salor* complex. In addition, the lilac colours of the basidiomes also recall *C. praelatus* M.M. Moser, another representative of *Myxaciium* species reported in association with *Quercus humboldtii* in Colombia (Moser and Horak, 1975).

*C. magellanicus* is strictly associated with Nothofagaceae trees and was reported in late autumn (April–May) from Argentina (neotype), Chile and erroneously from New Zealand. The morpho-taxonomic species concept of *C. magellanicus* was comparatively wide. However, an earlier phylogenetic analysis also including New Zealand voucher material tentatively identified as “*C. magellanicus*” has demonstrated that the New Zealand specimens actually are not conspecific with Argentinian collections of *C. magellanicus* from the neotype locality (Peintner et al., 2004). This observation prompted the question about the taxonomic position of *C. magellanicus* s. str. and its putatively related species. Therefore, the aim of this work is to study the variability of *C. magellanicus* s.l. associated to Nothofagaceae trees in Patagonia (Argentina), using molecular, anatomical and morphological methods. However, these studies are hampered by the fact that the knowledge about the diversity and ecology of Patagonian *Cortinarius* is in general still poor and mainly based on the data presented by Moser and Horak (1975). Therefore, we made an effort to generate rDNA ITS sequences from type material described in this pioneering publication and included species superficially resembling *C. magellanicus* in various macroscopical characters. Thus, this work contributes to a better general knowledge of the diversity and biogeography of *Cortinarius* so far recorded in the Gondwanian region (New Zealand and sub-Arctic region of Argentina and Chile) of the Southern Hemisphere (Horak, 1983).

## 2. Materials and methods

### 2.1. Field work

Samples were collected in Nothofagaceae spp. forests in Argentina (Chubut and Neuquén provinces) during autumn of 2017 (April–May). Study sites were in NW Patagonia, Argentina, in habitats belonging to the deciduous forest district, sub-Antarctic province, sub-Antarctic domain (Cabrera and Willink, 1980) (Table 1).

### 2.2. Morphological study

Macroscopic descriptions are routinely made from fresh basidiomes. Colours of the basidiomes are documented following the Methuen Handbook of Colour (Kornerup and Wanscher, 1961). For UV recordings dried basidiomes were tested using a UV lamp at 254 and 350 nm. Macrochemical KOH reactions were tested on dried basidiomes (KOH 30 %), for abundant voucher collections. Other macrochemical reactions are reported as provided in the original German description by Moser and Horak (1975) for fresh material (e.g. for AgNO<sub>3</sub>, FeSO<sub>4</sub>, Formol, Guaiac, HCl, NH<sub>3</sub>, Phenol). Microscopic data were documented with a Nikon camera DSFi1 in combination with the computer program NIS-Elements D 3.0. Microscopic characters are taken from dried specimens revived in 3 % KOH. The dextrinoid reaction refers to basidiospores placed in Melzer's reagent for 5 min. Measurements ( $n \geq 80$ ) were made in 3 % KOH from basidiospores taken from spore deposits either on the

apex of the stipe and on veil remnants. For statistical evaluation 90 to 120 basidiospores were measured. Spore measurements are based on (min) mean  $\pm$  standard deviation (max): the range of spore length and width have been calculated as follows: mean–standard deviation–mean + standard deviation. Examined voucher material is deposited in the herbaria IB and CIEFAP.

### 2.3. DNA extraction, PCR amplification and sequencing

In order to establish phylogenetic relationships, rDNA ITS sequences were produced as previously described (Peintner et al., 2001) using the primers ITS1 and ITS4. The rDNA LSU region was amplified with the primer combination LR0R and LR05 (White et al., 1990). PCR amplifications of RPB1 domains A–C were made with the primer combination RPB1-A and RPB1-C (Matheny et al., 2002). The same primers were used for sequencing. Sequences were assembled and edited with Sequencher 4.1 (Gene Codes, Ann Arbor, Mich., USA) and BLAST-searches were conducted against UNITE and the International Nucleotide Sequence Databases Collaboration (INSDC) (<http://unite.et.ee>). Sequences of closely related *Cortinarius* species were downloaded from GenBank (<http://ncbi.nlm.nih.gov/>) and UNITE. Sequences from type material were also included in the study (Table 1). A total of 28 ITS, 9 LSU and 3 RPB1 sequences from 11 *Cortinarius* taxa were produced for this study. Newly created sequences were submitted to GenBank and/or UNITE (Table 1).

### 2.4. Data analysis

A total of 75 rDNA ITS sequences were aligned and manually adjusted in MEGA 6 (Tamura et al., 2011). The alignment is composed of 687 nucleotide positions (including gaps) and is available at TreeBASE under TB2:S22370 (<http://www.treebase.org/treebase-web/home.html>). A short sequence (ITS2) generated from *Cortinarius janthinophaeus* E. Horak & M.M. Moser was included in a first analysis, but was excluded from the final dataset, because *C. janthinophaeus* is not closely related to the *C. magellanicus* complex. The phylogeny was reconstructed using a Maximum Likelihood (ML) method. All positions with less than 95 % site coverage were eliminated, and 505 remaining positions were included in the analyses. The ML analysis was based on the Hasegawa-Kishino-Yano model with discrete Gamma distribution (4 categories + G, parameter = 0.2288), as previously estimated in MEGA. The Bootstrap method was inferred using the Maximum Parsimony (MP) method. The MP tree was obtained using the Subtree-Pruning-Regrafting (SPR) algorithm, 1000 replicates, 10 initial trees, search level 4, max. 50 trees retained. Midpoint rooting was applied.

Additionally, branch robustness was tested with Bayesian Inference in MrBayes 3.2.6 (Altekar et al., 2004; Huelsenbeck and Ronquist, 2001; Ronquist and Huelsenbeck, 2003; Ronquist et al., 2012). GTR was used as substitution model, and a gamma distribution of rate variation across sites was chosen. For prior probability settings defaults were kept. For the Markov Chain Monte Carlo (MCMC) analyses, four chains were run for 10 million generations, with trees being sampled every 5000 generations. The analysis was stopped as the convergence diagnostic (average standard deviation of split frequencies) was below 0.05 after 10 million generations. From the 20 000 sampled trees (for each of the 2 runs) 25 % were discarded as burn-in before summary statistics were calculated (using *sump* and *sumt* commands). Diagnostic plots, as well as the convergence diagnostics EES (Estimated Sample Size; min ESS around 10K) and PSRF (Potential Scale Reduction Factor; 1.000 for all parameters), indicated stationarity.

Table 1

Material sequenced for this study with ecological and habitat data and herbarium and GenBank/UNITE numbers.

Species	Site	Associated species	GenBank/UNITE numbers ITS/LSU/RPB1	Voucher number	Type	Sampling date
<i>C. austrorapaceus</i>	Chile, Valdivia, San Antonio	Unknown	AF539723	TUB011486		10.05.1996
<i>C. austrorapaceus</i>	Chile, Valdivia, Jardín Botánico	Unknown	AF539724	TUB011485		16.05.1998
<i>C. capitellinus</i>	Argentina, Ushuaia, Valle del Glaciar Martial,	<i>Nothofagus pumilio</i>		IB19630891	Holotype	02.03.1963
<i>C. capitellinus</i>	Chile, Osorno, Futrono	<i>Lophozonia alpina</i>	UDB034602	ZT 75288	Epitype	11.04.1975
<i>C. capitellinus</i>	Chile, Osorno, Cortillera Pelada	<i>Lophozonia alpina</i>	UDB034603/MH492987	ZT 75390		17.04.1975
<i>C. cinereus</i>	Argentina, Lago Frías, Puerto Frías, Río Negro	<i>Nothofagus dombeyi</i>	UDB023853	IB19630117	Holotype	21.03.1963
<i>C. cinereus</i>	Chile, Coyhaique	<i>Nothofagus dombeyi</i>	MH511098	CONC-F0650		05.03.2007
<i>C. cremeolina</i>	New Zealand Amuri, Boyle's River Track	<i>Nothofagus</i> sp.	JX000351	PDD70506	Holotype	25.04.1999
<i>C. cremeolinus</i> var. <i>subpicoides</i>	New Zealand, Cobb Valley, Ridge Track	<i>Fuscospora cliffortioides</i>	MH101573	PDD105782		15.05.2014
<i>C. cremeorufus</i>	New Zealand, Waipori Falls River	<i>Kunzea</i> sp.	NR_153064	PDD94056	Holotype	15.05.2008
<i>C. cremeorufus</i>	New Zealand, Taupo, TNP <sup>a</sup>	<i>Nothofagus</i> sp.	KT833622	PDD72649		29.04.2001
<i>C. cucumeris</i>	New Zealand, UNP <sup>b</sup> , Lake Ruapani	<i>Fuscospora fusca</i> - <i>L. menziesii</i>	MH492988/MH492988	ZT 8280		22.04.2000
<i>C. cucumeris</i>	New Zealand, Taupo	<i>Nothofagus</i> sp.	MH101610	PDD 96335		13.05.2013
<i>C. cucumeris</i>	New Zealand, Taupo, Turangi, Kiko Rd., Ngapuketuru Track	<i>Nothofagus</i> sp.	MH101553	PDD72687		02.05.2001
<i>C. cucumeris</i>	Australia, Gisborne, UNP	<i>F. fusca</i> , <i>L. menziesii</i>	MH492990/MH492990	ZT 0638		22.05.1981
<i>C. cycneus</i>	New Zealand, Nelson, Lake Rotoiti	<i>F. cliffortioides</i> , <i>F. fusca</i>	UDB034606/MH492986	PDD 27254/ZT 68-330	Holotype	01.05.1968
<i>C. cycneus</i>	New Zealand, N-Canterbury, Craigieburn Range	<i>Fuscospora cliffortioides</i>	UDB034607	ZT 1997		12.03.1983
<i>C. cycneus</i>	New Zealand, Springs Junction, Lake Daniells Track	<i>Lophozonia menziesii</i>	GU222272	PDD88966		09.05.2006
<i>C. cycneus</i>	New Zealand, Springs Junction, Lake Daniells Track	<i>F. fusca</i> , <i>L. menziesii</i>	GU222297	PDD89071		09.05.2006
<i>C. fuligineoviolaceus</i>	Argentina, Tierra del Fuego, Paso Garibaldi	<i>Nothofagus pumilio</i>	UDB034604	ZT 74-102		26.02.1974
<i>C. fuligineoviolaceus</i>	Argentina, Tierra del Fuego, Glaciar Martial	<i>Nothofagus pumilio</i>	UDB034605	ZT 74-075	Epitype	09.03.1974
<i>C. fuligineoviolaceus</i>	Argentina	<i>Nothofagus pumilio</i> , <i>N. betuloides</i>	KY462350	CT 4372		Unknown
<i>C. iringa</i>	New Zealand, Clements Road, Te Iringa Track	<i>Nothofagus</i> sp.	EU660948	PDD73135	Holotype	13.05.2001
<i>C. janthinophaeus</i>	Chile, Osorno, Refugio de Antillanca	<i>Nothofagus dombeyi</i> , <i>N. antarctica</i>	UDB023912	IB19630864	Holotype	21.03.1963
<i>C. lubricanescens</i>	New Zealand, Urewera, Tuai, Lake Waikareiti Track	<i>Nothofagus</i> sp.	MG019347	PDD107508		09.05.2001
<i>C. lubricanescens</i>	New Zealand, Westland, Cascades Rd, 2 km from bridge	<i>Nothofagus</i> sp.	GU233359	PDD75709		07.05.2002
<i>C. lubricanescens</i>	New Zealand	Unknown	JX178611	OTA60291	Unknown	
<i>C. lubricanescens</i>	New Zealand, Flora Saddle	<i>Lophozonia menziesii</i>	KJ421073	PDD78801		10.05.2004
<i>C. lubricanescens</i>	New Zealand, Saint Arnaud Range	<i>Nothofagus</i> sp.	KU885995	PDD94031		03.05.2008
<i>C. lugubris</i>	Argentina, Neuquén, NHNP <sup>c</sup> , Cerro Cortinario,	<i>Nothofagus pumilio</i>	UDB023842	IB19630084	Holotype	19.03.1963
<i>C. lugubris</i> aff.	Chile	<i>Nothofagus pumilio</i>	KY462549	MES 1758		Unknown
<i>C. macolobulga</i>	Australia, New South Wales, Mt Kaputar	<i>Eucalyptus dalrympleana</i> , <i>E. pauciflora</i> , <i>E. viminalis</i>	Q890306	KV532		16.07.2007
<i>C. macolobulga</i>	Australia, New South Wales, Mt Kaputar	<i>Eucalyptus dalrympleana</i> , <i>E. pauciflora</i> , <i>E. viminalis</i>	NR_152994	MEL2331647	Holotype	12.07.2007
<i>C. magellanicoalbus</i>	Argentina, Chubut, UNPSJB <sup>d</sup> , Parcela Huemules	<i>Nothofagus pumilio</i>	MF964301	IB20170100/CIEFAPC46		03.04.2017
<i>C. magellanicoalbus</i>	Argentina, Chubut, LANP <sup>e</sup> , Río Rivadavia	<i>Nothofagus dombeyi</i>	MF964300	IB20170101/CIEFAPC57	Holotype/Isotype	18.04.2017
<i>C. magellanicoalbus</i>	Argentina, Chubut, LANP, Río Rivadavia	<i>Nothofagus dombeyi</i>	MF964302	IB20170102/CIEFAPC92		18.04.2017
<i>C. magellanicoalbus</i>	Argentina, Chubut, LANP, Río Rivadavia	<i>Nothofagus dombeyi</i>	MF964303	IB20170103/CIEFAPC93		18.04.2017
<i>C. magellanicoalbus</i>	Argentina, Chubut, LANP, Río Rivadavia	<i>Nothofagus dombeyi</i>	MF964304	IB20170104/CIEFAPC94		18.04.2017
<i>C. magellanicoalbus</i>	Argentina, Chubut, LANP, Río Rivadavia	<i>Nothofagus dombeyi</i>	MF964305	IB20170105/CIEFAPC95		18.04.2017
<i>C. magellanicoalbus</i>	Argentina, Chubut, LANP, Río Rivadavia	<i>Nothofagus dombeyi</i>	MF964306	IB20170106/CIEFAPC96		18.04.2017
<i>C. magellanicoalbus</i>	Argentina, Chubut, LANP, Río Rivadavia	<i>Nothofagus dombeyi</i>	MF964307	IB20170107/CIEFAPC97		18.04.2017
<i>C. magellanicoalbus</i>	Argentina, Chubut, LPNP <sup>h</sup> , Los Hitos	<i>Nothofagus dombeyi</i>	MF964308/MH492985/MH537070	IB20170108/CIEFAPC140		19.04.2017
<i>C. magellanicoalbus</i>	Argentina, Chubut, LPNP, Los Hitos	<i>Nothofagus dombeyi</i>	MF964309/MH492989	IB20170109/CIEFAPC141		19.04.2017
<i>C. magellanicoalbus</i>	Chile, Coyhaique, National Reserve Río Simpson	<i>Nothofagus dombeyi</i>	MH469160/MH492983/MH537072	CONC-F0237		15.04.2007
<i>C. magellanicus</i>	Argentina, Neuquén, NHNP <sup>c</sup> Puerto Manzano	<i>Nothofagus dombeyi</i>	AF389125/MH492991	IB19630347/ZT70 233	Neotype	14.04.1963
<i>C. magellanicus</i>	Argentina, Tierra del Fuego, Lago Fagnano	<i>Nothofagus antarctica</i>	MG520625	IB19650710		19.02.1965
<i>C. magellanicus</i>	Chile, Ensenada, Yanquihue	<i>Nothofagus dombeyi</i>	MG520626	IB19720420		18.09.1972
<i>C. magellanicus</i>	Argentina, Neuquén, NHNP, Puerto Manzano	<i>Nothofagus dombeyi</i>	MH492991	ZT70 233	Neotype	14.04.1963

(continued on next page)

Table 1 (continued)

Species	Site	Associated species	GenBank/UNITE numbers ITS/LSU/RPB1	Voucher number	Type	Sampling date
<i>C. magellanicus</i>	Chile, Valdivieso	<i>Nothofagus dombeyi</i>	KY462378	CT 4461		Unknown
<i>C. napivelatus</i>	New Zealand, Glentui Loop Track	<i>Fuscospora solandri</i>	KU523945	PDD99567		06.05.2010
<i>C. napivelatus</i>	New Zealand, Lake Rotoiti	<i>Nothofagus</i> sp.	KU523944	PDD72728		07.05.2001
<i>C. napivelatus</i>	New Zealand, Arthurs Pass, Waimakariri Valley Track	<i>Nothofagus</i> sp.	KF727356	PDD103876		09.04.1997
<i>C. rapaceus</i> var. <i>luridus</i>	Argentina, Neuquén, NHNP, Puerto Manzano	<i>Nothofagus pumilio</i> , <i>L. alpina</i>	<sup>g</sup>	IB19630075	Holotype	16.03.1963
<i>C. roblerauli</i>	Chile, Valdivia, Jardín Botánico	Unknown	AF539719	TUB011480		12.05.1998
<i>C. roblerauli</i>	Argentina, Neuquén, LPN <sup>d</sup> , Lago Norquínco,	<i>Lophozonia alpina</i> , <i>L. obliqua</i>	MF964310	IB20170110/CIEFAPC200	Holotype/Isotype	03.05.2017
<i>C. roblerauli</i>	Argentina, Neuquén, LPN, Yuco	<i>Lophozonia alpina</i> , <i>L. obliqua</i>	MF964311	IB20170111/CIEFAPC221		05.05.2017
<i>C. roblerauli</i>	Argentina	<i>Lophozonia alpina</i> , <i>L. obliqua</i>	JX316427/UDB007206			Unknown
<i>ectomycorrhiza</i>						
<i>C. roblerauli</i>	Argentina	<i>L. obliqua</i>	JX316312/UDB007090			Unknown
<i>ectomycorrhiza</i>						
<i>C. roblerauli</i>	Argentina, Neuquén, LNP, Yuco	<i>L. obliqua</i>	KJ701302			Unknown
<i>ectomycorrhiza</i>						
<i>C. rotundisporus</i>	New Zealand	<i>Nothofagus</i> sp.	AF389127	NZ8501		Unknown
<i>C. rotundisporus</i>	Unknown	Unknown	AY669612	PERTH 05255074		Unknown
<i>C. rotundisporus</i> subsp. <i>tessiae</i>	New Zealand, TNP, Mt Ruapehu, Whakapapa	<i>Nothofagus</i> sp.	HM060317	PDD72611		27.04.2001
<i>C. saturniorum</i> cf.	New Zealand	<i>Nothofagus</i> sp.	KF727379	PDD103687		13.05.2013
<i>C. semiamictus</i>	Argentina, Río Negro, Valle Frías	<i>Nothofagus antarctica</i> , <i>N. dombeyi</i>	UDB023828	IB19620161	Holotype	07.04.1962
<i>C. subcastanella</i>	New Zealand	<i>Nothofagus</i> sp.	AY033110	NZ8503		Unknown
<i>C. subcastanella</i>	New Zealand	Unknown	KU523947	OTA65683		Unknown
<i>C. subcastanella</i>	New Zealand	Unknown	KU523946	OTA62394		Unknown
<i>C. vitreopileatus</i>	New Zealand, Gisborne, UNP, Black Beech Track,	<i>Fuscospora fusca</i> , <i>L. menziesii</i>	NR_119788	PDD27271	Holotype	23.05.1981
<i>C. vitreopileatus</i>	New Zealand, Borland Lodge Track	<i>Nothofagus</i> sp.	KF727384	PDD103882		26.04.2003
<i>C. vitreopileatus</i>	New Zealand, Borland Lodge Track	<i>Nothofagus</i> sp.	KJ635225	PDD78778		25.04.2004
<i>C. vitreopileatus</i>	New Zealand	Unknown	AF389123	NZ8644		Unknown
<i>C. vitreopileatus</i> var. <i>similissimus</i>	New Zealand, Gisborne, UNP, Lake Waikareiti,	<i>Nothofagaceae</i> spp.	AF389124	NZ847	Holotype	30.05.1981
<i>C. xenosma</i>	New Zealand, Clements Road, Te Iringa Track	<i>Nothofagus</i> sp.	JX000358	PDD73149	Holotype	29.04.2001
<i>C. xenosma</i>	New Zealand, Te Anau Downs, Motel	<i>Nothofagus</i> , <i>Leptospermum</i>	KJ635229	PDD88274		03.04.2006
<i>C. xenosma</i>	New Zealand	<i>Nothofagus</i>	KJ635207	PDD101822		02.04.2011
<i>Cortinarius</i> sp.	Argentina, Chubut, LANP	<i>Nothofagus antarctica</i>	MH492984/MH492984/ MH537071	IB20170264/CIEFAP 150		25.04.2017

<sup>a</sup> Tongariro National Park.<sup>b</sup> Urewera National Park.<sup>c</sup> Nahuel Huapi National Park.<sup>d</sup> Universidad Nacional de la Patagonia "San Juan Bosco".<sup>e</sup> Los Alerces National Park.<sup>f</sup> Lanin National Park.<sup>g</sup> Submitted to UNITE.<sup>h</sup> Lago Puelo National Park.



For a combined analysis of concatenated gene sequences spanning RPB1 A-C regions, the ITS1, 5.8S and ITS2 regions, and about 600 bases of the 5'-terminal large subunit (LSU) domain (D1/D2) was carried out based on the alignment provided in the Data S2 (supporting information) of Garnica et al. (2016). The RPB1 region could be amplified for three representative species from the *C. magellanicus* complex. Two separate MrBayes runs were run under the generaltime-reversible model with gamma-distributed rate variation. Runs included four incrementally heated chains, they were run for 10 million generations each, sampling every 100 generations and with the first 2.5 million generations discarded as burn-in. RPB1 sequences have been submitted to GenBank under the accession numbers MH511098, MH49298, MH537070, MH469160, MH537072, MH53707.

A combined analysis of ITS and LSU sequences was carried out in MrBayes with the same settings as for the concatenated RPB1, ITS and LSU analysis. rDNA LSU sequences have been submitted to GenBank under the accession numbers MH492983, MH492984, MH492985, MH492986, MH492987, MH492988, MH492989, MH492990, MH492991. Trees from combined analyses were drawn with FigTree 1.4.3 (<http://tree.bio.ed.ac.uk/software/figtree/>).

Statistical analyses were performed with spore width and length. Variables were checked for normal distribution and equal variances using Shapiro-Wilk and Levene tests, respectively (Everitt, 2005). Based on data distributions, differences between species were analysed using non-parametric Kruskal-Wallis tests performed at the 0.05 significance level, using the statistical package InfoStat for Windows version 2017 (Di Rienzo et al., 2017). Plots were constructed in R (R Core Team, 2016) using the packages vegan, dplyr, ggpubr, gridExtra, and ggsci (Auguie and Antonov 2017; Kassambara, 2017; Oksanen et al., 2017; Wickham et al., 2017; Xiao, 2017).

### 3. Results

#### 3.1. Molecular data

The phylogenetic tree with the highest log likelihood (-14120.2490) resulting from the ML analysis of the ITS sequences is shown in Fig. 1. Currently, there are no other sequences with similarities >97 % deposited in public databases.

Our phylogenetic analysis showed that *C. magellanicus* represents a species complex of at least three phylogenetic lineages: the first lineage represents *C. magellanicus* based on the neotype. This lineage is not related to *C. salor* Fr., but the closest BLAST match represents *C. cygneus* E. Horak from New Zealand with 96 % sequence identities. There are 0–1 bases difference within the *C. magellanicus* s. str. clade, 14–17 bases difference to both *C. cygneus* and *Cortinarius magellanicus*, each, and >20 to all other clades.

The second lineage is represented by voucher material of a new species, *C. magellanicoalbus*.

The third lineage is represented by the new Patagonian species, *Cortinarius roblerauli*. It consists of two identical sequences from Argentinian material, and one public sequences of *C. 'magellanicus'* from Chile (AF539719), which differs by 3 substitutions and indel positions from *C. roblerauli*. These typical species of the *C. magellanicus* complex belong to a weakly supported clade (BPP 0.77) representing sect. *Magellanici* (ined.) This clade also includes the Patagonian *C. capitellinus* E. Horak, which is morphologically closely related to *C. magellanicus*. Moreover, the three New Zealand species *C. cucumeris* E. Horak, *C. cygneus*, and *C. lubricanescens* Sooty also belong to this group. *C. cygneus* represents a distinct lineage based on sequences from the isotype (ZT 68-330). *Cortinarius*

'*magellanicus*' from New Zealand (JX1786111) was misidentified and the voucher is identical to *C. lubricanescens*.

Finally, another closely related additional lineage is based on *C. vitreopileatus* E. Horak from New Zealand (99 % sequence identity within the clade). The lilac-blue coloured representatives of this species are described here as a new variety viz. *C. vitreopileatus* var. *similissimus*. This clade differs by 36–42 substitutions and indel positions from all other lineages of the group. *C. vitreopileatus* is sister to *Cortinarius fuligineoviolaceus* E. Horak, and accordingly is not related to *C. magellanicus*.

The sequences generated from holotype material of other morphologically and phylogenetically related species were included in the alignment. Phylogenetic analysis confirmed *C. janthinophaeus* and *C. cinereus* as distinct species and indicated that *Cortinarius semiamictus* and *Cortinarius lugubris* are sister taxa or possibly also synonyms, because their sequences are 100 % identical. No sequences could be generated from type material of *C. capitellinus* and *C. fuligineoviolaceus*, but vouchers from the same area could be amplified, thus allowing the designation of epitypes.

Nine rDNA LSU sequences and three RPB1 sequences were generated for representative species of the *C. magellanicus* complex. We could not obtain RPB1 sequences from old vouchers. Therefore, the RPB1, ITS and LSU sequences generated from a potentially new species of this complex, *Cortinarius magellanicooides* ad int. were included into the analyses to confirm sect. *Magellanici*; Because of incomplete morphological data, this taxon was not included in the ITS phylogeny, and is not further discussed in the paper.

Tree topologies consistently recovered sect. *Magellanici* as distinct clade in both analyses, with BPP of 0.99 in the combined rDNA ITS and LSU analysis, and with BPP of 1.00 in the concatenated RPB1, ITS, LSU analysis (Supplementary Figs 1–2).

#### 3.2. Morphological data

All the species included in the morphological study differ significantly in at least one spore parameter ( $p < 0.0001$ , Fig. 2). Statistical analysis of basidiospore measurements confirmed that the basidiospores of *C. magellanicus* are significantly larger (both width and length) as compared to those of *C. magellanicoalbus* and *C. roblerauli* ( $p < 0.0001$ , Fig. 2). On the other hand, basidiospores of *C. magellanicoalbus* and *C. roblerauli* differ significantly in length ( $p < 0.0001$ , Fig. 2).

### 4. Taxonomy

#### 4.1. Key to species resembling *C. magellanicus* in the Southern Hemisphere

Pileus and stipe distinctly blue, lilac violaceous, fading to brown or grey, usually viscid all over.

1 Species associated with Nothofagaceae (*Nothofagus*, *Lophozonia*) in Argentina and Chile.....2

Species associated with Nothofagaceae (*Nothofagus*) or *Eucalyptus* in New Zealand or Australia.....13

2 (1) Pileus and stipe distinctly blue, lilac, violaceous.....3

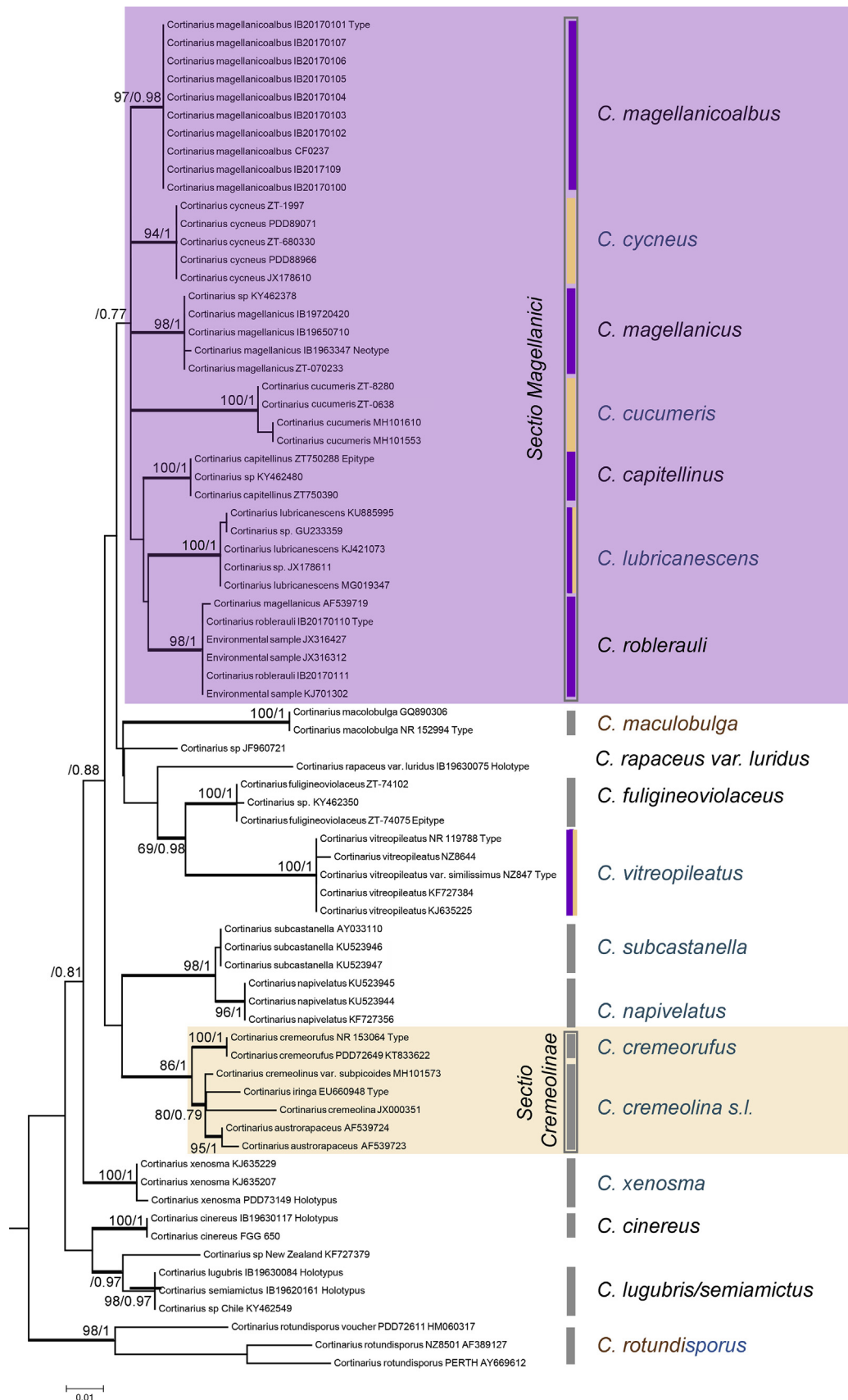
Pileus only pale bluish, grey or reddish colours predominating.....11

3 (2) Pileus surface dry. Basidiomes blue-lilac. Basidiospores slender amygdaliform, minutely verrucose, 8–9.5 × 4–4.5 µm.....*janthinophaeus*

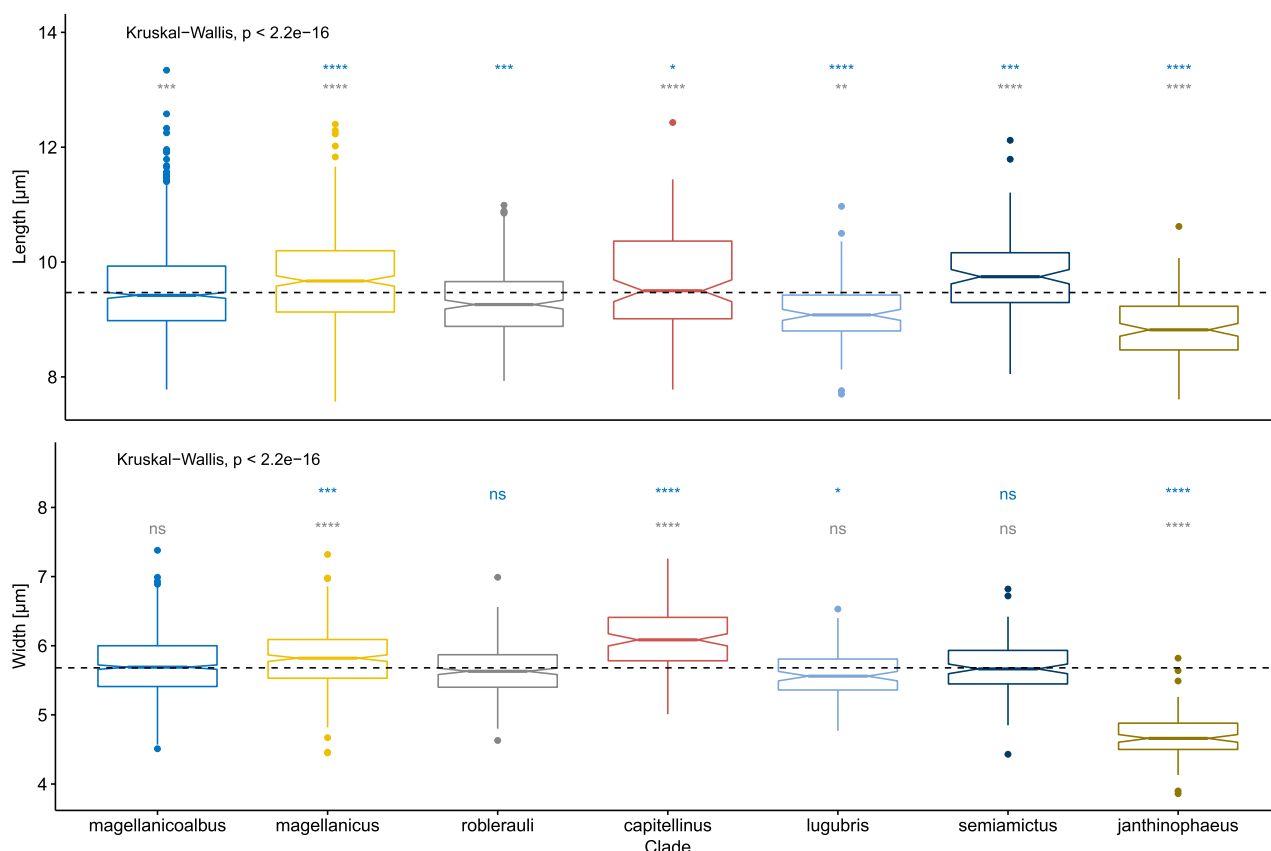
Pileus surface viscid or glutinous.....4

4 (3) Colour of lamella white when young, sometimes with violet tinge.....5

Colour of lamella clearly argillaceous or lilac, not white when young.....6



**Fig. 1.** Phylogenetic maximum likelihood tree (-ln 14120.2490) of *C. magellanicus* s.l. and most closely related taxa. The predominating basidiome colours are coded on the side bar. Species names typical for the Nothofagaceae area from South America are written in black letters, from New Zealand in blue letters and from Australia in brown letters. The species of the *C. magellanicus* complex belong to a weakly supported clade representing sect. *Magellanici* (ined.). Maximum Parsimony bootstrap values > 70 % and clade credibility values of Bayesian inference (BPP values > 0.70) are shown beside branches. (For interpretation of the references to color in this figure legend, the reader is referred to the Web version of this article.)



**Fig. 2.** Boxplots with spore width and length of seven *Cortinarius* species morphologically resembling *C. magellanicus*. Asterisks above bars indicate significant differences separating *C. magellanicoalbus* (blue) and *C. roblerauli* (grey). Significance code: ns = not significant, \*p < 0.05, \*\*p < 0.01, \*\*\*p < 0.001, \*\*\*\*p < 0.0001. (For interpretation of the references to color in this figure legend, the reader is referred to the Web version of this article.)

5 (4) Associated with *Nothofagus dombeyi*. Basidiospores 9.5–10.5 × 5.5–6 µm. **magellanicoalbus**  
 Associated with *Lophozonia alpina* and *Lophozonia obliqua*. Basidiospores 9–10 × 5.5–6 µm. **roblerauli**  
 6 (4) Colour of lamella argillaceous when young, sometimes lilac but not whitish. 7  
 Colour of lamella violet or blue when young. 9  
 7 (6) Basidiospores ovoid to ellipsoid, minutely verrucose 9–11 × 6–7 µm. **capitellinus**  
 Basidiospores subamygdaliform to ellipsoid, distinctly verrucose. 8  
 8 (7) Basidiospores 10–12 × 5–6 µm. **aiacapiiae**  
 Basidiospores 8.5–10 × 5.5–6.5 µm. **magellanicus**  
 9 (6) Basidiomes slender. Pileus up to 15–40 mm diam., pileus and stipe viscid, purple. Basidiospores subglobose 8–9 × 6–7.5 µm. Associated with *Quercus*, Colombia. **praelatus**  
 Basidiomes robust. Pileus 40–100 mm diam. 10  
 10 (9) Basidiospores limoniform, conspicuously verrucose, with plage, 12–14 × 7–8 µm. **opulentus**  
 Basidiospores ellipsoid 9–10.5 × 5–6 µm. **austrosalor**  
 11 (2) Pileus fuliginous (reddish) brown, glutinous or viscid. Lamellae lilac. Basidiospores amygdaliform (to sublimoniform) 13.5–15 × 7–8 µm. **fuligineoviolaceus**  
 Pileus greyish violet or greyish brown. Basidiospores minutely verrucose. 12  
 12 (9) Pileus dry, very dark violet-brown. Lamellae brown, not lilac. Basidiospores ellipsoid 8–10.5 × 5.5–6 µm. **lugubris**  
 Pileus viscid, greyish-brown. Lamellae lilac. Basidiospores 8.5–10 × 4.5–5 µm. **semiamictus**

13 (1) Species associated with Nothofagaceae in New Zealand or Australia. 14  
 Species associated with *Eucalyptus* (Australia) or *Nothofagus/Leptospermum* (New Zealand). 22  
 14 (13) Pileus and stipe distinctly violaceous, lilac, blue. 15  
 Pileus only slightly bluish when young, usually whitish, pale brown. 20  
 15 (14) Basidiospores globose, 7–8.5 × 6–7 µm. Associated with *Nothofagus*. Papua New Guinea (compare *C. salor*). **indigoverus**  
 Basidiospores ellipsoid or amygdaliform. 16  
 16 (15) Basidiospores ellipsoid. 17  
 Basidiospores amygdaliform. 19  
 17 (16) Basidiomes dry. Basidiospores slender amygdaliform, minutely verrucose 8.5–10 × 4.5–5 µm. **rozites**  
 Basidiomes distinctly glutinous. Lamellae lilac. 18  
 18 (17) Basidiospores 8.5–10.5 × 5–6.5 µm. Australia, Tasmania. **submagellanicus**  
 Basidiospores 9.5–12 × 5.5–6 µm. New Zealand. **cucumeris**  
 19 (16) Basidiospores amygdaliform, 10.5–13 × 5.5–7 µm. Lamellae argillaceous. **vitreopileatus var. similissimus**  
 Basidiospores amygdaliform to subfusoid 10.5–14 × 6–7.5 µm. Lamellae lilac. Basidiomes blue, lilac or purple when young, fading to pale brown in age. Associated with *Nothofagus*. New Zealand. **taylorianus**  
 20 (14) Pileus brownish with pale violet hue. Lamellae lilac, soon fading to argillaceous. Odour strong of cucumber. Basidiospores ellipsoid 9.5–12 × 5.5–6 µm. New Zealand. **cucumeris**  
 Pileus whitish. 21

- 21 (20) Pileus ochraceous white to greyish-white. Basidiospores slender amygdaliform to subcylindrical,  $10\text{--}12 \times 5.5\text{--}6 \mu\text{m}$ .....**lubricanescens**  
 Pileus pure white, sometimes with faint violaceous hue. Basidiospores ellipsoid to subamygdaliform  $9.5\text{--}12 \times 5.5\text{--}7 \mu\text{m}$ .....**cycneus**  
 22 (13) Habit secotioid, basidiomes whitish with brown patches. Basidiospores  $12.5\text{--}14 \times 6.5\text{--}8 \mu\text{m}$ .....**maculobulga**  
 Habit agaricoid.....23  
 23 (22) Basidiospores globose to subglobose, verrucose  $6\text{--}8.5 \mu\text{m}$  diam., with *Eucalyptus* (Australia), *Kunzea* and *Nothofagus* (New Zealand).....**rotundisporus**  
 Basidiospores ovoid or amygdaliform.....24  
 24 (23) Basidiospores slender amygdaliform, minutely verrucose  $11.5\text{--}13 \times 5.5\text{--}6.5 \mu\text{m}$ . Basidiomes robust, up to 90 mm diam, distinctly lilac. Associated with *Eucalyptus* (Australia).....**archeri**  
 Basidiospores ovoid or subamygdaliform, Australia.....25  
 25 (24) Basidiospores  $6\text{--}7.5 \times 4.5\text{--}5 \mu\text{m}$ , ovoid. Basidiomes blue, lilac or purple, fading to ochraceous brown.....**microarcheri**  
 Basidiospores  $9.5\text{--}10.5 \times 5\text{--}6.5 \mu\text{m}$  ovoid to subamygdaliform.....**subarcheri**

#### 4.2. The *Cortinarius magellanicus* complex in Argentina and Chile

***Cortinarius aiacapiiae*** Speg. Fungi Fuegiani, Boletín de la Academia Nacional de Ciencias de Córdoba 11 (1): 152 (1887b). MycoBank MB 155158.

References: Spegazzini (1887b: 152), Horak (1967: 364), Moser and Horak (1975: Pl. 51: Fig 269)

The macroscopical description of *C. aiacapiiae* Speg. (1887b), originally described from Chile (Tierra del Fuego), could also refer to a taxon belonging to the *C. magellanicus* complex. The re-examination (Horak, 1967) of the poorly preserved type material (LPS, consisting of lamellar fragments only) revealed that both the size and the shape of the basidiospores ( $10\text{--}12 \times 5\text{--}6 \mu\text{m}$ ) are correctly reported in the protologue. According to the rather large size of the basidiospores, however, *C. aiacapiiae* cannot be considered a synonym of the sympatric *C. magellanicus*. Thus, *C. aiacapiiae* could possibly represent a distinct species of this *C. magellanicus* complex, which is characterised by whitish-argillaceous lamellae and comparatively large basidiospores. Additional collections might help to elucidate the identity of this obscure species.

##### Material examined:

Chile: Prov. Magallanes, Punt Arenas, Brunswick Peninsula, Voces Bay, on soil in forest, May 1882, leg. C. Spegazzini (LPS, holotype, fragments of lamellae only).

***Cortinarius capitellinus*** E. Horak, Beih. Nova Hedwigia 52: 260 (1975) (Figs. 3 and 4)  
 MycoBank: MB 311912.

Iconography: Moser and Horak (1975: Pl. 1: Fig. 5, Pl. 44: Fig 227 and 228)

**Etymology:** from Latin, *capitellinus* like a capital of a roman pillar (with regard to the prominent glutinous ring-like partial veil).

Pileus 25–70 mm, at first hemispherical becoming conical or conico-umbonate with incurved margin, glutinous, lubricous-viscid in dry condition, dark to dirty violet (46E11–12), gradually discolouring from centre to beige or pale brownish (14B8, Tanbark), interspersed with purple spots, not hygrophanous, membranous pileipellis can be peeled off from margin to the



Fig. 3. Basidiomes of *Cortinarius capitellinus* (ZT75-288, epitype). Bar = 2 cm. Photo by E. Horak.

centre. Lamellae 50–60 reaching stipe, 2–3 lamellulae, emarginate, argillaceous fawn (not purple) already in young specimens, turning pale coffee-brown in mature specimens, concolourous edges serrulate. Stipe 30–100  $\times$  6–18 mm, sub-clavate to short spindle-shaped, above the glutinous ring pale purple, at first dirty violet (45D10) then pale brownish towards base, glutinous. In dry weather conditions the stipe can look like a snake-skin because the viscid coat of gluten is disrupting and then exposing the white background. Ring glutinous to membranous, persistent, whitish-purple, longitudinal fibrillose-silky, not striate, protruding, below with bulky, violaceous strand-like or wire-like structures. These structures are simple or bifurcated and can still be observed as ribs even in old specimens. Context whitish to violaceous in apex and in outer parts of the stipe context. Odour of fresh bread or unpleasant. Taste of context and slime mild. Chemical reactions on pileipellis: KOH, HCl and Formol: negative.



Fig. 4. *Cortinarius capitellinus* (IB19630891, holotype). 1. Basidiomes, Bar = 2 cm. 2. Basidiospores, Bar = 10  $\mu\text{m}$ . 3. Basidia, Bar = 20  $\mu\text{m}$ . 4. Cheilocystidia, Bar = 20  $\mu\text{m}$ .





**Fig. 5.** *Cortinarius magellanicoalbus*. (A) Basidiomes, (B) detail of whitish lamellae, (C) detail of cespitose basidiomes (holotype IB20170101). Bar 1 cm. Photos by M. E. Salgado Salomón.

Basidiospores (7.8) 8.8–10.5 (12.4)  $\times$  (5) 5.6–6.6 (7.3)  $\mu\text{m}$ , ovoid to ellipsoid, verrucose, especially at apex. Basidia 28–34  $\times$  8–9  $\mu\text{m}$ , clavate to fusiform-cylindrical, 4-spored, hyaline, thin-walled, clamped. Basidioles 20–26  $\times$  7–9  $\mu\text{m}$ , clavate, hyaline. Lamellar trama regular, composed of cylindrical hyaline hyphae, 5–10  $\mu\text{m}$  diam. Pileipellis and stipitipellis composed of strongly gelatinized interwoven hyphae, 2–5  $\mu\text{m}$  diam., with plasmatic pigment. Oleiferous hyphae scarce. Clamp connections present.

#### Material examined:

Argentina: Prov. Tierra del Fuego, Ushuaia, Valle del Glaciar Martial, on soil under *Nothofagus pumilio*, about 360 m elev., 2 Mar. 1963, leg. E. Horak (IB19630891, **holotype**; ZT 70-227, isotype). Chile: Prov. Osorno, Futrono, on soil in Selva Valdiviana, 11 Apr. 1975, leg. E. Horak (ZT75-288, **epitypus hic designatus**); Prov. Osorno, Cordillera Pelada, Angol, Chivería, on soil under *L. alpina*, 17 Apr. 1975, leg. E. Horak (ZT 75-390).

**Ecology and distribution:** On soil under *N. pumilio* (Argentina, type) and *L. alpina* (Chile).

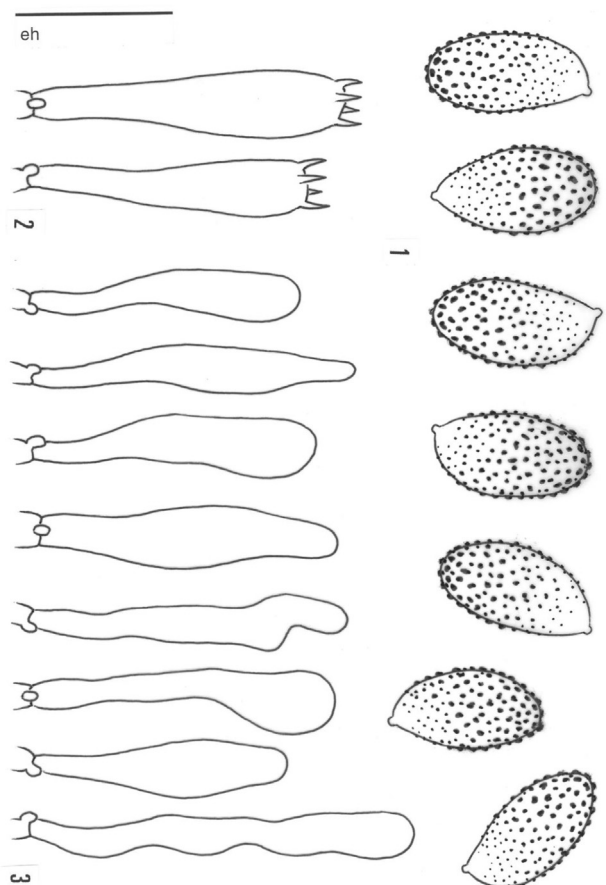
**Notes:** The macroscopical characters of *Cortinarius capitellinus* are very similar to several other species accommodated in the *C. magellanicus* complex. But, based in our own measurements, the basidiospores of *C. capitellinus* are larger as compared to *C. magellanicus* s. str., *C. magellanicoalbus* or *C. roblerauli*. In addition, the ornamentation of the spore wall is less pronounced compared to *C. magellanicus*.

***C. magellanicoalbus*** Salgado Salomón & Peintner **sp. nov.** (Figs. 5 and 6).

Mycobank: MB 823762.

**Etymology:** The species epithet refers to the principal morphological difference between *C. magellanicus* and *C. magellanicoalbus*, namely the lilac lamellae vs. the whitish lamellae in young specimens.

**Diagnosis.** *C. magellanicoalbus* is characterized by the violaceous, glutinous pileus and stipe, and by the off-white lamellae lacking lilaceous colour in young specimens. The basidiospores measure



**Fig. 6.** *Cortinarius magellanicoalbus* (holotype IB20170101). 1. Basidiospores, Bar = 10  $\mu\text{m}$ . 2. Basidia, Bar = 20  $\mu\text{m}$ . Cheilocystidia, Bar = 20  $\mu\text{m}$ .

9.8 ( $\pm 0.5$ )  $\times$  5.9 ( $\pm 0.4$ )  $\mu\text{m}$ , are amygdaliform and minutely verrucose. In Argentina and Chile usually growing in (sub)cespitose groups and in association with *N. dombeyi*.

Pileus 17–50 mm diam., convex to hemispherical, occasionally subconical in young specimens, becoming low convex in age, margin incurved in young specimens, becoming innately fibrillose, not hygrophanous, colour varies between purple (15B7) to lilac (16B4–16C4) when young, at apex changing from pale violet (16A3) to golden brown (5D7–5D6), greyish yellow (4B4) and also greyish rose (12B4) in age. Lamellae about 12–15 per cm at the pileus margin, emarginate, young whitish (7A1), becoming pale cinnamon (6C6–6D6), edges entire. Stipe 50–80 × 5–11 mm, cylindrical to subclavate, glutinous, whitish (16A1) above the cortina zone, violet to lilac below cortina (16B4–16C4) from universal veil, in dry condition glutinous coat often cracking into scales, girdles or net-like structures (snake skin-like in appearance), cortina white, silky in young specimens. Usually growing (sub)cespitate in groups. Context soft, whitish (2A1) in pileus. Odour not distinct. Taste mild, with a metallic after-taste. Macrochemical reactions on context: KOH 30 % pale brownish (11C3–11D3). UV-Fluorescence of exsiccata: veil violet-blue at 350 nm, none at 254 nm.

Basidiospores (8) 9.5–10.5 (13.5) × (5) 5.5–6.0 (7.5)  $\mu\text{m}$  (mean  $\pm$  sd:  $9.8 \pm 0.5 \times 5.7 \pm 0.4 \mu\text{m}$ , Q: (1.3)  $1.7 \pm 0.1$  (2.3); (n = 80), subamygdaliform to amygdaliform, with a low suprahilar depression, minutely verrucose, often prominently stronger verrucose towards and at apex, yellow-brown (5D8–5D7), not dextrinoid. Spore print brownish-cinnamon (6C6). Basidia (12) 15–22 (26) × 8–10 (11)  $\mu\text{m}$ , clavate, 4-spored, sterigmata 3–4 (5)  $\mu\text{m}$  long (n = 20), clamped. Cheilocystidia not observed, but irregularly shaped basidioles sometimes present. Pileipellis an ixocutis composed of gelatinized cylindrical hyphae, 2–3 (4)  $\mu\text{m}$  diam. Subpellis about 500  $\mu\text{m}$  thick, composed of interwoven short-celled hyphae, (22) 24–36 (40)  $\mu\text{m}$ , staining brownish with KOH 3 %, embedded in an ochre-ferrugineous-brownish (5C6) transparent matter. Context of inflated hyphae, (20) 22–29 (30)  $\mu\text{m}$  (n = 10) diam., hyaline, thin-walled hyphae not incrustated. Lamellar trama consisting of parallel hyaline hyphae, (11) 13–21 (24)  $\mu\text{m}$  (n = 20), thin-walled. Clamp connections present.

#### Ecology and distribution.

On soil in association with *N. dombeyi*, less often with *N. pumilio*. April. The monthly average temperature in the area is 8.9 °C (max/min 13/7 °C), with a total of 82 mm precipitation per month (April, weather station at Lago Cholila, data from 2017). Soil pH = 5.8.

#### Material examined:

Argentina: Prov. Chubut, Futaleufú, Los Alerces National Park, Río Rivadavia (Lat.: 42.4002; Long.: 71.4081), about 500 m elev., on soil under *N. dombeyi*, 18 Apr. 2017, leg. M.E. Salgado Salomón (IB20170101, **holotype**; CIEFAP C57, isotype). Genbank acc. No. MF964300. Prov. Chubut, Futaleufú, Parcela Huemules (Lat.: 42.8644; Long.: 71.2681), about 1260 m elev., on soil under *N. pumilio*, 3 Apr. 2017, leg. M.E. Eugenia Salgado Salomón, IB20170100/CIEFAP C 46, Genbank acc. No. MF964301. Prov. Chubut, Futaleufú, Los Alerces National Park, Río Rivadavia (Lat.: 42.4002; Long.: 71.4081), about 500 m elev., on soil under *N. dombeyi*, leg. M.E. Eugenia Salgado Salomón (IB20170102/CIEFAP C92, IB20170103/CIEFAP C93, IB20170104/CIEFAP C94, IB20170105 CIEFAP C95, IB20170106/CIEFAP C96, IB20170107/CIEFAP C97, 18 Apr. 2017, Genbank acc. No. MF964302, MF964303, MF964304, MF964305, MF964306, MF964307. Prov. Chubut, Futaleufú, Lago Puelo National Park, Los Hitos (Lat.: 42.0608; Long.: 71.4335), about 250 m elev., on soil under *N. dombeyi*, 19 Apr. 2017, leg. M.E. Salgado Salomón (IB20170108/

CIEFAP C140, IB20170109/CIEFAP C141); Genbank acc. No. MF964308, MF964309.

Chile: Prov. Coyhaique, Camino Coyhaique, National Reserve Rio Simpson (Lat: 45.2905; Long: 72.1502), about 240 m elev., on soil under *N. dombeyi*, 15 Apr. 2007, leg. G. Palfner (Herbarium Universidad of Concepcion, CONC–F: 0237). Genbank acc. No. MH469160, MH492983.

Notes: *C. magellanicoalbus* differs from *C. magellanicus* by the colour of the lamellae in young specimens, by the smaller basidiospores, and by the ecology of the habitat. See also diagnosis of *C. roblerauli*. Probably edible.

**C. magellanicus** Speg. Boletín de la Academia Nacional de Ciencias de Córdoba 11 (1): 15 (1887a) (Figs. 7 and 8) MycoBank: MB 223217.

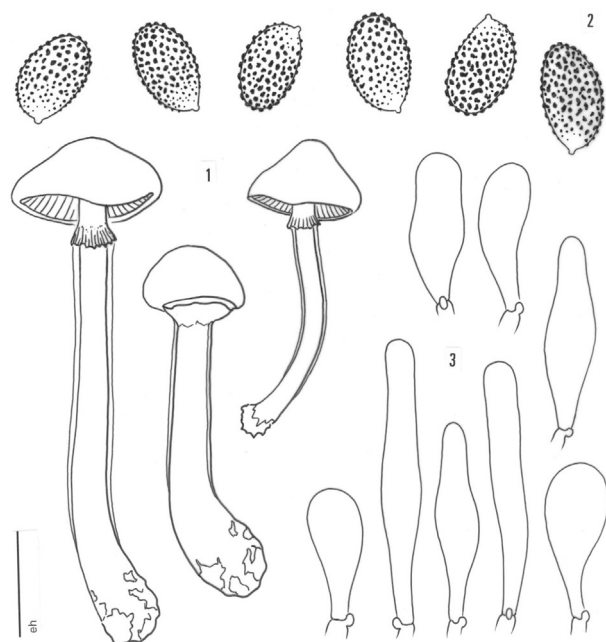
Iconography: Horak (1979: Pl. 63, Fig 225); Gamundí and Horak (1993: p. 102)

Description based on protologue and on data referring to the neotype, including additional records.

Pileus 10–40 mm, glutinous, convex, obtuse or acute conical, deep purple-lilac to pale blue violet (12D7–12C4), margin of pileus sometimes translucently striate. Lamellae adnate to adnexed, at first violaceous, lilac, argillaceous to pale argillaceous, lamellar edges entire. Stipe 50–120 × 1–6 mm diam. at apex, 3–10 mm diam. at base, glutinous, clavate, base whitish (16A4–16A1), in fresh specimens with delicate membranaceous glutinous ring. Context in pileus and stipe pale yellow. Chemical reactions: KOH, NH<sub>3</sub>, AgNO<sub>3</sub> all negative. KOH (30 %) on gluten of pileus of fresh basidiomata red, as reported by Moser and Horak (1975) for the neotype.



Fig. 7. Painting of *Cortinarius magellanicus* neotype (IB19630347) by Meinhard Moser. Bar = 1 cm.



**Fig. 8.** *Cortinarius magellanicus* neotype (IB19630347). 1. Basidiomes, Bar = 2 cm. 2. Basidiospores, Bar = 10 µm. Cheilocystidia, Bar = 20 µm.

Basidiospores (7.6) 8.5–9.7 (12.4) × (4.5) 5.7–6.4 (7.3) (n = 112), subamygdaliform to ellipsoid, minutely verrucose especially at apex, cinnamon to brown (6D6–6E4). Basidia (20.2) 21.9–25.8 (27.3) × (7.8) 8.6–10 (10.8) µm (n = 16), slender claviform, 4-spored sterigmata (4)5–6 (7) µm long (n = 42), thin walled, hyaline, clamped. Cheilocystidia (27) 24–29 (31) × (6) 7–10 (11) µm (n = 14), ±filiform, cylindrical or slender clavate, hyaline, thin walled, clamped. Pileipellis a gelatinous layer composed of cylindrical hyphae 8–10 × (2–) 2.5–4 (–5) µm (n = 30), wall gelatinized, clamp connections present.

Lamellar trama consisting of parallel hyphae (8) 10–15 (16) µm (n = 20), slightly constricted at septa, with a diam. of thin walled, hyaline hyphae. Hyphae of the stipe 4–6 µm diam. Hyphae of cortina-annulus 3.5–4 µm diam. Clamp connections present. UV-Fluorescence reactions of exsiccata: veil pale blue at 350 nm, none at 254 nm.

#### Material examined:

Argentina: Prov. Neuquén, Quetrichue, Laguna Patagua, on soil under *N. dombeyi* and *Nothofagus antarctica*, 14 Apr. 1963, leg. M.M. Moser (IB19630347, **neotype**; voucher of neotype in Horak ZT 70-233); Genbank acc. No. AF388758; Prov. Tierra del Fuego: Lago Fagnano, 19 Feb. 1965, leg. R. Singer M3354, IB19650710; Genbank acc. No. MG520625; Ushuaia, Puerto Harberton, on soil under *N. antarctica*, 24 Feb. 1970, leg. I. Gamundí and A. Arambarri LPS 35384 in Horak (ZT 74-241); Ushuaia, Tierra Mayor, on soil under *N. pumilio*, 25 Feb. 1974, leg. E. Horak (ZT 74-091); Ushuaia, Valle Río Triste, on soil under *N. pumilio* and *Nothofagus betuloides*, 13 Mar. 1974, leg. E. Horak (ZT 74-191); Ushuaia, Valle del Glaciar Martial, on soil under *N. pumilio* and *N. betuloides*, 11 Mar. 1975, leg. E. Horak (ZT 75-060); Prov. Patagonia, Lago Argentino, Puerto Magallanes, on soil under *N. pumilio*, 19 Mar. 1980, leg. E. Horak (ZT 144). Prov. Chubut, Lago Menendez, Los Alerces N.P., 590 m elev., on soil (and rotten wood) under *N. dombeyi*, 28 Mar. 1992, leg. E. Horak (ZT 6742); Prov. Río Negro: Lago Nahuel Huapi, Laguna Frías, Puerto Blest: trail to Los Cántaros, on soil under *Nothofagus* sp., 14 Mar. 1959, leg. R. Singer M1801 (IB); trail to Paso de las Nubes, 850 m elev., under

*N. dombeyi*, 12 Apr. 1962, leg. E. Horak (ZT 70-226); Puerto Blest, near HQ P.N., on soil under *N. dombeyi*, 9 Apr. 1980, H. Spinedi in Horak (ZT 432); Bariloche, Llao-Llao, Lago Escondido, on soil under *N. dombeyi*, 22 Mar. 1992, leg. E. Horak (ZT 6836). Prov. Neuquén, Lago Nahuel Huapi, Puerto Manzano, 900 m elev., on soil under *N. dombeyi*, 29 Mar. 1962, leg. E. Horak (ZT 70-225).

Chile: Prov. Llanquihue, between Ensenada and Ralun, on soil under *N. dombeyi*, 18 Sep. 1972, leg. R. Singer M7610 (IB19720420); Genbank acc. No. MG520626. Prov. 11 Región, Puerto Aysén, R.F. Río Simpson, on soil under *N. dombeyi*, 15 Apr. 2007, leg. E. Horak (ZT 12338); Quéulat N.P., Río Cascada, 500 elev., on soil under *N. dombeyi*, *Nothofagus nitida* and *N. betuloides*, 14 Apr. 1999, leg. E. Horak (ZT 7264).

**Ecology and distribution:** Most frequently associated with *N. dombeyi* and but also under *N. pumilio* and *N. antarctica*. February to April. Widely distributed in Argentina from Prov. Tierra del Fuego in the South to Prov. Neuquén in the North (type); rarely encountered in Chile.

**Notes:** Based on relatively few collections (Moser and Horak, 1975), the original species concept of *C. magellanicus* was circumscribed in a rather wide definition because in the protologue collections both with white, argillaceous and lilac lamellae (in young specimens) were referred in the re-description. Based on our results, the biogeography, the habitat and mycorrhizal associations appear to be also important for species determination. In Patagonia *C. magellanicus* is considered as a valuable edible mushroom.

#### *C. roblerauli* Salgado Salomón & Peintner **sp. nov.** (Figs. 9 and 10).

Mycobank MB 823763.

**Etymology.** The species epithet refers to the typical habitat, i.e. the association with the two endemic ectomycorrhizal host trees *L. obliqua* (locally called *roble*) and *L. alpina* (locally called *raulí*).

**Diagnosis.** *C. roblerauli* is characterized by the violaceous, glutinous pileus and stipe, the subclavate to clavate stipe, whitish lamellae in young specimens, spore size  $9.4 \pm 0.6 \times 5.7 \pm 0.3$  µm, and the typical habitat both under *L. alpina* and *L. obliqua*. Usually growing (sub)cespitate in groups.

Pileus 20–26 mm diam., convex to hemispherical with incurved margin, occasionally conical in young specimens, strongly glutinous, not hygrophanous, smooth, pileus surface appears finely fibrillose beneath the mucilaginous layer, at first heliotrope violet (17B7) changing to greyish violet (18B5–18B4) in age. Lamellae 15–19 per cm at pileus margin, emarginate, at first violet whitish (19A2), becoming pale cinnamon (5B5–5C5) with age, concolourous margin entire. Stipe 60–72 × 7–14 mm, subclavate to clavate, smooth, glutinous, concolourous with pileus, covered with violet-lilac (16B4–16C4) remnants of the universal veil, base of stipe yellowish white, above silky cortina whitish, subcespitate in groups. Context soft, whitish (2A1) in the pileus, unchanging on exposure. Odour not distinct. Taste mild. Macrochemical reactions on exsiccata KOH 30 %, Guaiac, Phenol, Formol, FeSO<sub>4</sub> and Ammonia (20 %) all negative. Fluorescence: veil strongly and distinctly blue at 350 nm, but no fluorescence at 254 nm. Spore print cinnamon-brown (5B5–5C5).

Basidiospores (8) 9–10 (11) × (4.5) 5.5–6.0 (7.0) µm (mean ± sd:  $9.4 \pm 0.6 \times 5.7 \pm 0.3$  µm, Q: (0.6)  $1.6 \pm 0.3$  (2.1); (n = 122), subamygdaliform to amygdaliform, with low suprahilar depression, minutely to distinctly verrucose, not dextrinoid,





Fig. 9. *Cortinarius roblerauli* (IB20170110, holotype), (A) Basidiomes, (B) Detail of lamellae. Bar = 1 cm. Photo by M.E. Salgado Salomón.

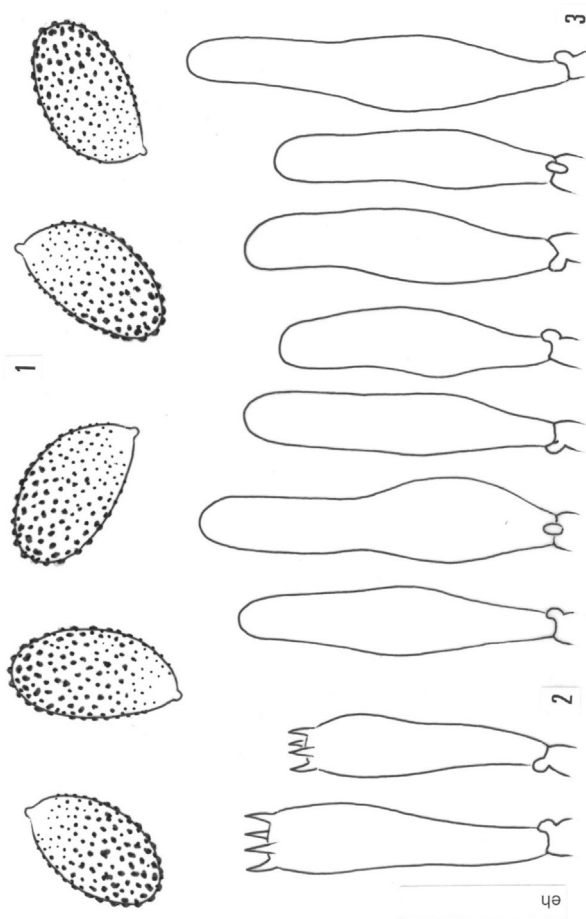


Fig. 10. *Cortinarius roblerauli* (IB20170110, holotype). 1. Basidiospores, Bar = 10 µm. 2. Basidia, Bar = 20 µm. 3. Cheilocystidia, Bar = 20 µm.

bronze brown (5E6–5E7). Basidia (19) 21–25 × (9) 10–11 µm, clavate, 4-spored, sterigmata (3) 4–5 (6) µm long, clamped. Cheilocystidia not observed but irregularly shaped basidioles

are sometimes present at lamellar edges. Pileipellis an ixocutis about 200 µm thick, composed of strongly gelatinized cylindrical hyphae, 3–4 (5) µm diam. Subpellis irregularly subcellular, consisting of by more or less regular, short hyphae with diam. of (8) 10–16 (18) µm ( $n = 23$ ). Hyphal walls brownish in KOH 3 %, and appearing to be embedded in a ferrugineous brown (6E8) transparent matter.

Pileus context consisting of inflated hyphal elements, hyaline, colourless, irregular, thin-walled, hyphal walls not incrustated, with a diam. of (13) 15–24 (29) µm ( $n = 13$ ).

Lamellar trama consisting of parallel, hyaline, thin-walled hyphae, (7) 8–11 (12) µm. Clamp connections present.

#### Material examined:

Argentina: Prov. Neuquén, Aluminé, Lanín National Park, Lago Norquínco (Lat.: 39.0877; Long.: 71.1546), about 1060 m elev., on soil under *L. alpina* and *L. obliqua*, 3 May 2017, leg. M.E. Salgado Salomón (IB20170110, holotype; CIEFAP C200, isotype); Genbank acc. No. MF964310. Neuquén, Lago Lácar, Lanín National Park, Yuco (Lat.: 40.0997; Long.: 71.3153), about 660 m elev., on soil under *L. alpina* and *L. obliqua*, 5 May 2017, leg. M.E. Salgado Salomón (IB20170111, CIEFAP C221); Genbank acc. No. MF964311.

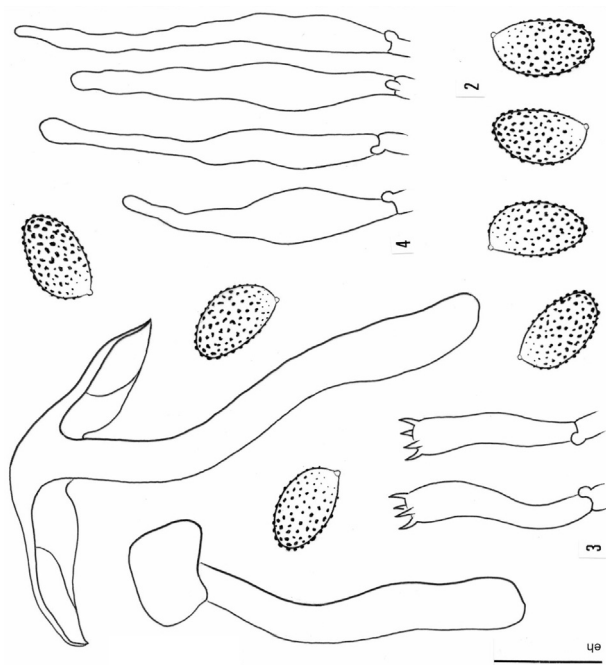
**Ecology and distribution:** On soil under *L. alpina* and *L. obliqua*. May. The monthly average temperature in the area is about 9 °C (max/min 14/6 °C), with a total of 88 mm precipitation per month (May, weather station Lago Norquínco, data from 2017). Soil pH = 6.1.

**Notes:** *C. roblerauli* differs from *C. magellanicocalbus* by more robust basidiomes, persistently clavate stipe, shorter basidiospores, and the typical habitat under the two Nothofagaceae tree species of *Lophozonia*. It differs from *C. magellanicus* by the whitish colour of lamellae in young specimens, by the smaller basidiospores, and by the habitat. Probably edible.

#### 4.3. The *Cortinarius magellanicus* allies in Argentina and Chile

***Cortinarius cinereus*** M. Moser, Beih. Nova Hedwigia 52: 260 (1975) (Fig. 11)  
MycoBank MB 311915.





**Fig. 11.** *Cortinarius cinereus* (IB19630171, holotype). Basidiomes, Bar = 2 cm. 2. Basidiospores, Bar = 10  $\mu$ m. 3. Basidia, Bar = 20  $\mu$ m. 4. Cheilocystidia, Bar = 20  $\mu$ m.

Iconography: Moser and Horak (1975: Pl. 67: Figs 345, 346.; Pl. 68: Fig 347)

Etymology: from Latin, *cinereus*- grey (like ash).

Pileus 20–60 mm diam., at first hemispherical becoming broadly campanulate, applanate in age, with incurved margin, ash-grey to lead-grey (48A1 to 39A4), apex umber brownish, changing to brown (16A10), with grey margin, dry. Lamellae 60–70 reaching stipe, ~7 lamellulae, emarginate, up to 7 mm wide, lead-grey, rust brown or umber brown in age, edges minutely fimbriate. Stipe 50–70  $\times$  4–6 mm, cylindrical, equal or slightly enlarged towards base (7 mm diam.), grey becoming pale brown, silky-fibrillose, dry, cortina inconspicuous. Context watery brown, darker in pileus and stipe, unchanging on exposure. Odour not distinct. Taste mild. Chemical reactions on pileipellis and context: KOH, pale black-brown.

Basidiospores 7.5–8.5 (9)  $\times$  4.5–5  $\mu$ m, ovoid to subamygdaliform, minutely verrucose, coarser at apex, pale rust brown. Basidia 24–30  $\times$  6–8  $\mu$ m, slender clavate, 4-spored, clamped, sterigmata 2–2.5  $\mu$ m long. Cheilocystidia 40–65  $\times$  5–9  $\mu$ m, slender fusoid with gradually elongating with obtuse apex, occasionally constricted, thin-walled, hyaline or with pale yellow-brown plasmatic pigment. Pileipellis a cutis composed of cylindrical hyphae, 8–10  $\mu$ m diam., with pale yellow-brown pigment. Subpellis composed of subglobose cells, 20–40  $\times$  25–60 (70)  $\mu$ m. Hyphae of stipe 7–14  $\mu$ m diam., wall in KOH yellowish. Clamp connections present.

Material examined:

Argentina: Prov. Río Negro, Lago Frías, 0.5 km S of Puerto Frías, under *N. dombeyi* 21 Mar. 1963, M.M. Moser (IB1963117, holotype; ZT 70–149, isotype); UNITE number acc. UDB023853. Chile: Coyhaique, *N. dombeyi*, 5 May 2017, G. Palfner (CONC–F0650).

**Ecology and distribution:** On soil under *N. dombeyi* (intermixed with *Saxegothea conspicua*). Argentina and Chile.

**Notes:** The basidiomes of *Cortinarius cinereus* rather resemble grey-coloured species traditionally referred to *Telamonia*. It is noteworthy, however, that according to BLAST hits, *C. cinereus* is one of the closest Patagonian relatives of *C. magellanicus*.

***C. fulgineoviolaceus*** E. Horak, Beih. Nova Hedwigia 52: 233 (1975) (Fig. 12)

MycoBank MB 311963.

Iconography: Moser and Horak (1975: Pl. 2, Fig. 11; Pl. 45, Fig 234, 235), Horak and Wood (1990: Pl. 63, Fig 226)

**Etymology:** from Latin *fuliginus* sooty brown and *violaceus* violet.

Pileus 15–50 mm, hemispherical, later becoming obtusely conical or conico-umbonate, applanate in age, glutinous, viscid when dry, centre of pileus fuliginous (16A2–12), brown towards non-striate margin with fibrillose lilac remnants of veil, beneath gluten with innate radial texture, not hygrophanous. Lamellae 35–45 reaching stipe, 3–5 lamellulae, adnate to emarginate, ventricose, ~8 mm wide, at first brilliant lilac, becoming rust brown in age, lilac lamellar edges serrulate. Stipe 35–55  $\times$  6–12 mm, polymorphic, fusoid or gradually attenuating towards base, glutinous from non-persisting, fibrillose (also agglutinated) cortina to base, at first concolourous with lamellae, whitish towards base, fistulose, solitary. Context in pileus and in apex of stipe lilac, but yellowish towards base of stipe, unchanging on exposure. Odour not distinct or weakly of radish. Taste of gluten mild. Chemical reactions on pileus: KOH, NH<sub>3</sub>, HCl negative. Spore print rust brown.

Basidiospores (13.1) 13.6–15.0 (15.8)  $\times$  (6.4) 7.1–7.6 (8.2)  $\mu$ m, Q = (1.9) 1.6–1.8 (2.2) (n = 32), amygdaliform to sublimoniform, with low supraapical depression, distinctly verrucose, basal part more strongly ornamented, rust brown. Basidia 30–40  $\times$  10–12  $\mu$ m, slender clavate to cylindrical, 4-spored, hyaline, clamped. Cheilocystidia 30–65  $\times$  12–18 (20)  $\mu$ m, prominent, ventricose-fusoid, with elongate neck and obtuse apex, thin-walled, with or without pale lilac plasmatic pigment, clamped. Pleurocystidia absent. Lamellar trama regular, composed of subparallel thin-walled hyphae, 6–10  $\mu$ m diam. Pileipellis an ixocutis composed of strongly gelatinized hyphae, 2–5  $\mu$ m diam. Subpellis composed of cylindrical hyphae, 10–20  $\mu$ m diam., hyaline wall minutely incrustated by brown pigment. Hyphae of stipe 5–10  $\mu$ m diam., sometimes incrustated with pigment. Clamp connections present.



**Fig. 12.** Basidiomes of *Cortinarius fulgineoviolaceus* (ZT 74–75, epitype). Bar = 2 cm. Photo by E. Horak.

## Material examined:

Argentina: Prov. Tierra del Fuego, Ushuaia, Valle del Glaciar Martial, on soil under *N. pumilio* and *N. antarctica*, 2 Mar. 1963, leg. E. Horak (IB1963861, **holotype**; ZT 70-231, isotype). Prov. Tierra del Fuego: Ushuaia, Valle Glaciar Martial, on soil under *N. pumilio*, near timberline, 9 Mar. 1974, leg. E. Horak (ZT 74-075, **epitypus hic designatus**, UNITE Accession number UDB034605); Ushuaia, Paso Garibaldi, on soil under *N. pumilio*, 26 Feb. 1974, leg. E. Horak (ZT 74-102, UDB034604).

**Ecology and distribution:** On soil (rarely on decaying wood) among moss under *N. pumilio*, also under *N. antarctica*, from sea level to timber line. Argentina (so far recorded only in Prov. Tierra del Fuego).

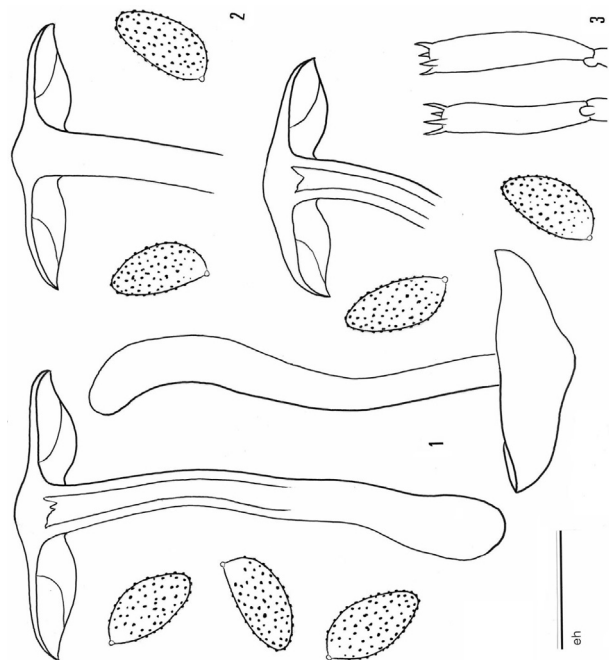
**Notes:** The basidiomes of *C. fuligineoviolaceus* are characterized by the deep lilac colours both of pileus and lamellae. Microscopically, this taxon is readily distinguished by the large and amygdaliform-sublimoniform basidiospores and the prominent ventricose-fusoid cheilocystidia.

***C. janthinophaeus*** E. Horak & M.M. Moser, Beih. Nova Hedwigia 52: 365 (1975) (Fig. 13)  
Mycobank MB 311992.

**Iconography:** Moser and Horak (1975: Pl. 14, Fig 86; Pl. 77, Figs 394 a, b, 395 a, b)

**Etymology:** from Greek *janthinos*, violet coloured, *phaeus* – black-brown, dark brown.

Pileus 20–60 mm diam., at first convex, becoming applanate with obtuse umbo, campanulate, at first lilaceous-grey (48L12), then violaceous-brown (56H1), umbo also pale umbra (15A9), hygrophanous, transparently striate, innate fibrillose, margin with persisting fibrillose veil remnants, dry. Lamellae 40–56 reaching stipe, 3–7 lamellulae, adnate to emarginate, up to 6 mm wide, at first lilac, becoming brownish-lilaceous to greyish-brown in age, concolourous edges entire or subserrate.



**Fig. 13.** *Cortinarius janthinophaeus* (holotype IB19630864). 1. Basidiomes, Bar = 2 cm. 2. Basidiospores, Bar = 10 µm. 3. Basidia, Bar = 20 µm.

Stipe 35–70 × 3–6 mm diam., cylindrical, equal or subclavate towards base, 5–10 mm diam., at first deep lilac, occasionally with reddish tint towards base, silky-fibrillose, dry, solid, solitary. Cortina violaceous-grey, fibrillose, fugacious, towards base with several appressed velar zones. Context lilac in pileus and in upper portion of stipe, pale violet-brown in base of stipe, unchanging on exposure. Odour pleasant, fruity. Taste mild. Chemical reactions on pileipellis: KOH, brown. Spore print (rust) brown.

Basidiospores (7.6) 8.3–9.4 (10.6) × (3.9) 4.4–5 (5.8) µm, slender amygdaliform, roughened to minutely punctately-verrucose, pale brown. Basidia 22–30 × 5–6 µm, slender clavate to subcylindrical, 4-spored, clamped. Cheilocystidia and pleurocystidia absent. Pileipellis a cutis composed of cylindrical hyphae, 4–6 µm diam., non-gelatinized wall thin, smooth. Subpellis composed of short-celled hyphae, 10–12 µm diam., wall incrustated with brownish, in KOH soluble pigment. Hyphae of stipe 4–8 µm diam. Clamp connections present.

## Material examined:

Chile: Prov. Osorno, Lago Puyehue, Volcán Antillanca, near Refugio at timber-line, about 1050 m elev., 11 Apr. 1963, leg. E. Horak (IB19630864, holotype; ZT 70-173, isotype); UNITE acc. UDB023912.

**Ecology and distribution:** On soil under *N. pumilio*, *N. antarctica* and *N. betuloides*. Chile (type).

**Notes:** *Cortinarius janthinophaeus* is recognized by the blue-lilac coloured basidiomes, dry pileipellis and thus this species rather resembles a taxon of *Telamonia*. In addition, *C. janthinophaeus* is readily identified by its exceptionally small and inconspicuously verrucose basidiospores. The morphotaxonomic characters for *C. janthinophaeus* and our preliminary phylogenetic analysis (data not shown) clearly indicate that this species does not belong to the *C. magellanicus* complex, although BLAST hits indicated a possible relationship.

***Cortinarius lugubris*** M.M. Moser, Beih. Nova Hedwigia 52: 357 (1975) (Fig. 14)

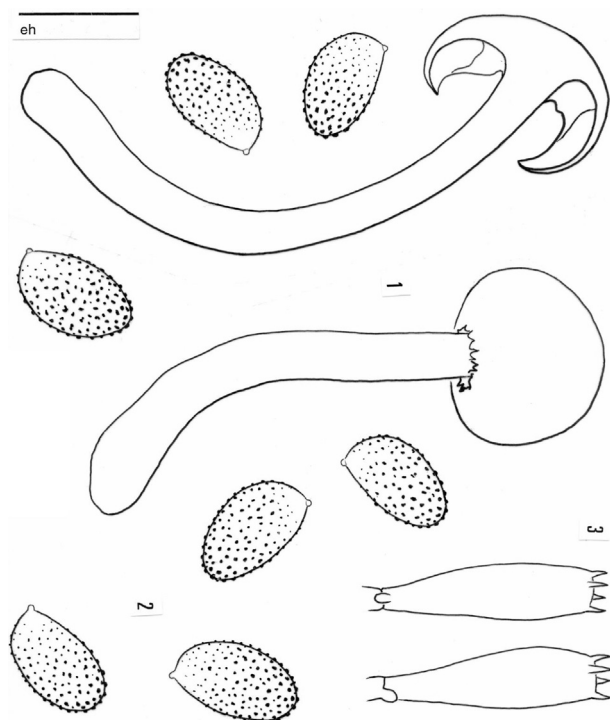
Mycobank MB 312009.

**Iconography:** Moser and Horak (1975: Pl. 14: Fig 84; Pl. 76, Fig 390. 391)

**Etymology:** from Latin *lugubris*, gloomy, sinister.

Pileus 40–60 mm diam., at first subglobose with strongly incurved margin (habit similar to *Thaxterogaster*), gradually expanding with incurved margin and becoming convex in age, very dark violet-brown (48 L1–L9), chocolate brown in centre, hygrophanous, dry, margin with persistent white fibrillose veil remnants. Lamellae emarginate, 5–6 mm wide, already young brown (not violet), concolourous lamellar edges entire. Stipe 50–110 × 6–8 mm, cylindrical, equal or slightly enlarged towards base, concolourous with pileus, (46 E 7), below spurious cortina with 1–3 appressed, silky zones of veil, fibrillose, dry, solid. Context violaceous, in the centre of pileus whitish, unchanging on exposure. Odour not distinct. Taste mild.

Basidiospores (7.7) 8.6–9.6 (11) × (4.8) 5.3–6.0 (6.5) µm, ellipsoid to pip-shaped, yellow-brown, minutely verrucose, coarser towards apex. Basidia 28–30 × 8.5–9 µm, clavate, 4-spored, clamped. Cheilocystidia absent. Pileipellis composed of cylindrical hyphae, 5–9 µm diam., weakly gelatinized wall with pale yellow-brown membranous pigment. Hyphae of lamellar trama 8–17 µm diam., hyphae of stipe hyaline, 8–10 µm diam. Clamp connections present.



**Fig. 14.** *Cortinarius lugubris* (IB19630084, holotype). 1. Basidiomes, Bar = 2 cm. 2. Basidiospores, Bar = 10 µm. Basidia, Bar = 20 µm.

#### Material examined:

Argentina: Prov. Neuquén, Puerto Manzano, Cerro Cortinario, about 1300 m elev., 19 Mar. 1963, M.M. Moser (IB19630084, holotype; ZT 70-158, isotype); UNITE number acc. UDB023842.

**Ecology and distribution:** On soil under *N. pumilio* near timberline. Argentina.

**Notes:** Macroscopically, *Cortinarius lugubris* is characterized by the thaxterogasteroid habit of the 3. basidiomes with very dark violet (brown) colours of the pileus and the broadly ovoid basidiospores with minute warts, coarser at apex. Accordingly, this taxon recalls a species of *Telamonia*. Moser and Horak (1975) pointed out that the basidiomes (colour and shape) of *C. lugubris* are superficially similar to *C. ochraceoazureus*. Based on our phylogenetic analysis *C. lugubris* could be contaxic with *C. semiamictus*.

***Cortinarius opulentus*** M.M. Moser, Beih. Nova Hedwigia 52: 256 (1975)

Mycobank: MB 312056.

**Iconography:** Moser and Horak (1975: Pl. 44: Fig 229; Pl. 94: Fig 539)

**Etymology:** from Latin *opulentus*, conspicuous.

Pileus 50–100 (120) mm diam., at first hemispherical becoming convex with incurved, margin, glutinous, at first brilliant blue becoming grey-blue in age. Lamellae emarginate, rather distant, wide, at first blue turning to rust brown in age. Stipe 60–100 × 10–25 mm, cylindrical, equal or subclavate, blue, glutinous below submembranaceous ring, towards base with several appressed concolourous zones of veil. Odour and taste not recorded.

Basidiospores (11.5) 12.2–13.4 (14.3) × (6.5) 7.0–7.8 (8.5) µm,  $Q = (1.6) 1.8–2.0 (2.2)$  ( $n = 32$ ), sublimoniform to distinctly

limoniform, coarse warts embedded in perisporium, very strongly ornamented, warts partly conrescent, smooth at subpraapicular plage, rust brown. Basidia 38–46 × 8–9 µm, subcylindrical, 4-spored, clamped. Cheilocystidia (30) 35–45 × 5–8 µm, polymorphic, slender fusoid with obtuse apex, thin-walled, with yellowish plasmatic pigment. Pileipellis an ixocutis composed of gelatinized cylindrical hyphae, 3–4 µm diam., hyaline wall thin. Tramal hyphae cylindrical or subcellular, 8–10 µm diam., wall encrusted with orange-brown (KOH) pigment. Velar hyphae cylindrical, 3–5 µm diam., gelatinized wall thin, with pale yellow plasmatic pigment. Clamp connections present.

**Ecology and distribution:** On soil under *N. dombeyi* (intermixed with *Austrocedrus chilensis*). Argentina.

#### Material examined:

Argentina, Prov. Neuquén, Lago Nahuel Huapi: Pto Manzano, 1965, leg. R. Singer M 4097 in Moser (IB19650505, holotype; ZT 79-099, isotype). Neuquén, Lago Nahuel Huapi, Pto Blest, trail to Los Cántaros, 28 Apr. 1965, R. Singer M 409 (IB).

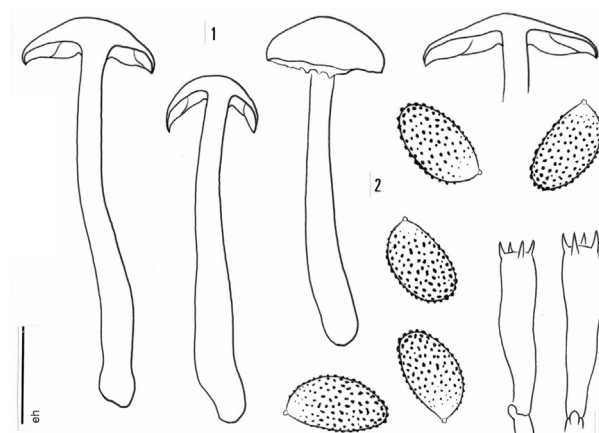
**Notes:** The basidiomes of this conspicuous species were originally collected and annotated by Singer and subsequently described by Moser (Moser and Horak, 1975). In the field, *C. opulentus* could be mistaken for a species belonging to the *C. magellanicus* complex. It was possible to generate a short sequence from the type material (IB19650505), which confirms that *C. opulentus* is clearly not related to the *C. magellanicus* complex (<90 % similarity). The conspicuously limoniform and large basidiospores rather indicate that this taxon is closely related to *Stephanopus*, viz. *S. azureus* M.M. Moser & E. Horak (1975) or *S. vilchensis* Garrido & E. Horak (Garrido, 1988), which were also described from Nothofagaceae forests in Chile. The re-examination of type material demonstrated that the Australian *C. archeri* Berk. (1859) should be considered as closely related to *C. opulentus*, and thus indicating the Gondwanian relationships of cortinarioid species occurring on either side of the Pacific Ocean.

***C. semiamictus*** E. Horak, Beih. Nova Hedwigia 52: 272 (1975) (Fig. 15)

Mycobank MB 312133.

**Iconography:** Moser and Horak (1975: Pl. 15: Fig 90; Pl. 50: Figs 263, 264)

**Etymology:** from Greek *semi*, half, Latin *amictus*, cloaked.



**Fig. 15.** *Cortinarius semiamictus* (IB19620161, holotype). 1. Basidiomes, Bar = 2 cm. 2. Basidiospores, Bar = 10 µm. 3. Basidia, Bar = 20 µm.



*C. semiamictus* is characterized by grey-brown viscid pileus and lilac stipe, lilac lamellae and ellipsoid or subamygdaliform, minutely verrucose basidiospores  $8.5\text{--}10.0 \times 4.5\text{--}5.5 \mu\text{m}$ . It is typically associated to *Nothofagus* forests of Argentina.

Pileus 25–40 mm diam., at first hemispherical with incurved margin, later becoming applanate-expanded, viscid, hygrophanous, greyish-brown (16C7), with persisting fibrillose veil remnants on the transparent-striate margin. Lamellae 36–44 reaching stipe, 3 lamellulae, at first adnate later becoming emarginate, up to 4 mm wide, lilac turning tan in age, con-colourous edges entire or subserrate. Stipe 60–80  $\times$  4–10 mm, equal or gradually enlarging into subclavate or fusoid base, lilac (45A8), paler towards base, dry, innate-fibrillose, below non-persistent fibrillose or submembranaceous cortina with several appressed velar zones, at first sold becoming fistulose, solitary. Context lilac in cortex, at apex of stipe pale lilac, brownish elsewhere, unchanging on exposure. Odour not distinct. Taste mild.

Basidiospores (8)  $9.1\text{--}10.4$  (12)  $\times$  (4.4)  $5.1\text{--}6.1$  (6.8)  $\mu\text{m}$ , ovoid, ellipsoid or subamygdaliform, minutely verrucose. Basidia 27–35  $\times$  7–8  $\mu\text{m}$ , subclavate, 4-spored, hyaline, clamped. Cheilocystidia absent. Lamellar trama regular, hyaline hyphae 5–10  $\mu\text{m}$  diam. Pileipellis a thin ixocutis composed of cylindrical hyaline gelatinized hyphae, 2–3.5  $\mu\text{m}$  diam. Subpellis composed of short cylindrical hyphae and subglobose cells, with pale brown both incrusting and plasmatic pigment. Hyphae of stipe hyaline, 4–8  $\mu\text{m}$  diam. Clamp connections present.

#### Material examined:

Argentina: Prov. Río Negro, Lago Nahuel Huapi, Valle Frías, along trail to Paso de las Nubes, 7 Apr. 1962, leg. E. Horak (IB19620161, **holotype**; ZT 70–217, isotype), UNITE number acc. UDB023828.

**Ecology and distribution:** On soil under *N. antarctica* and *N. dombeyi*. Argentina.

**Notes:** *C. semiamictus* is a sister species or maybe contaxic to *C. lugubris*. Originally, this species with grey-brown viscid pileus and lilac stipe was accommodated in subgenus *Paramyxium* (Moser and Horak, 1975).

#### 4.4. The *Cortinarius magellanicus* complex in New Zealand

***Cortinarius lubrificans*** Soop, Bull. Soc. mycol. Fr. 117: 112 (2001)

Mycobank MB 484896.

Iconography: Soop (2002: Pl 28) (2017: Pl. 111–112)

This myxacioid *Cortinarius* species is reported from New Zealand. The slender amygdaliform to ellipsoid basidiospores measure  $10\text{--}12 \times 5.5\text{--}6 \mu\text{m}$ . Referring to the white to greyish white colours of the glutinous pileus and stipe (Soop, 2001) this taxon is morphologically similar to *C. vitreopileatus* E. Horak (Horak and Wood, 1990). The species is reported to occur in New Zealand in mixed broadleaf forests in association with *Leptospermum* and various *Nothofagus* trees. One sequence was generated from voucher material, which originally was identified as *C. magellanicus* (JX178611). Blue-coloured variants of *C. lubrificans* were also reported by Soop (2017).

#### Material examined:

New Zealand: Prov. Mid-Canterbury, Kowai Bush, on soil under *Leptospermum* and *Nothofagaceae* trees, 22 Apr. 1997, K. Soop (PDD 71006, **holotype**).

***Cortinarius cucumeris*** E. Horak, Sydowia 42: 129 (1990)  
Mycobank MB 127367.

Iconography: Horak and Wood (1990: Pl. 17). Soop (2017: Pl. 110)

*Cortinarius cucumeris* is a myxacioid *Cortinarius* with brown colours of the pileus and lilac lamellae. The verrucose elliptical to subamygdaliform basidiospores measure  $9.5\text{--}12 \times 5.5\text{--}6 \mu\text{m}$ . This species is associated to *Fuscospora fusca* and *Lophozia menziesii* in New Zealand.

#### Material examined:

New Zealand: Gisborne, Urewera N.P., trail to Lake Waikareiti, on soil among litter under *F. fusca*, *L. menziesii* (ass. with *Dicksonia* sp., *Fuchsia excorticata*), 25 Jun. 1968, leg. E. Horak (PDD 27261, **holotype**; ZT 68–603, isotype). Gisborne, Urewera N.P., Lake Ruapani Track, 730 m elev., on soil under *F. fusca*, *L. menziesii*, *Dacrydium cupressinum*, *Metrosideros robusta*, 22 Apr. 2000, leg. E. Horak (PDD 71208, ZT 8280). Gisborne, Urewera N.P., Ngamoko Track, on soil under *F. fusca*, *L. menziesii*, 22 May 1981, leg. E. Horak (ZT 0638).

***Cortinarius cycneus*** E. Horak, Sydowia 42: 94 (1990) (Fig. 16)  
Mycobank MB 127359.

Iconography: Horak and Wood (1990: Pl. 2). Soop (2017: Pl. 109)

*Cortinarius cycneus* is a myxacioid *Cortinarius* with off-white to pale greyish colours of the pileus and whitish to pale argillaceous lamellae. The basidiospores measure  $8\text{--}11 \times 5\text{--}6$  (6.5)  $\mu\text{m}$ , are verrucose and ovoid to subelliptical. Basidiomes of this distinct taxon are frequently encountered in New Zealand



**Fig. 16.** Basidiomes of *Cortinarius cycneus* (ZT 68–330, holotype). Bar = 2 cm. Foto by E. Horak.



Nothofagaceae forests where this species is reported to grow in association both with *Leptospermum scoparium* (type) and various other broadleaf trees, e.g. *Fuscospora solandri*, *F. cliffortioides* and *F. fusca*.

#### Material examined:

New Zealand: Prov. Nelson, Lake Rotoiti, St. Arnaud, Tophouse Saddle, on soil under *Leptospermum scoparium* associated with *F. cliffortioides* and *F. fusca*, 1 May 1968, leg. E. Horak (PDD 27254, **holotype**; ZT 68–330). Prov. N-Canterbury, Craigieburn Range, Cave Stream, on soil under *F. cliffortioides*, 12 Mar. 1983, leg. E. Horak (ZT, 1997).

#### 4.5. The *Cortinarius magellanicus* alikes in Australia

The epithet *C. magellanicus* was applied by Horak and Wood (1990) to New Zealand collections with similar-looking lilac-coloured myxacioid basidiomes occurring in Nothofagaceae forests. Molecular data demonstrated that these collections have 100 % identical ITS sequences as compared to *C. vitreopileatus* (Horak and Wood, 1990), also described from New Zealand. However, by comparison the colours of the basidiomes of both taxa are distinctly different and therefore they are separated and described herewith as a new variety.

***Cortinarius archeri*** Berk., in Hooker. Bot. Antarct. Voy. III, Fl. Tasm. 2: 247 (1859)  
Mycobank MB 207464.

References: Berkeley (1959: 181, Fig. 7a–d). Horak and Wood (1990: 121). Bougher and Syme (1998: 242). Fuhrer (2005: 48)

Based on the macroscopical data published in the protologue *C. archeri* Berk. is characterized by rather robust lilac-violet basidiomes with viscid pileus and stipe. The re-examination of the fragmentary type material (Horak and Wood, 1990) demonstrated that slender amygdaliform (to sublimeriform) and minutely verrucose basidiospores ( $11.5\text{--}13 \times 5.5\text{--}6.5 \mu\text{m}$ ) are typical for this taxon. According to the excellent pictures and descriptions in Bougher and Syme (1998: 242), Fuhrer (2005: 48) and Gasparini (2007) this conspicuous and predominantly with *Eucalyptus* spp. associated species resembles taxa of the *C. magellanicus* complex. Based on the available ITS sequences of *C. archeri*, there is no close phylogenetic relationship to *C. magellanicus*. As already pointed out by Grgurinovic (1989) and Bougher and Syme (1998) two other Australian myxacioid species viz. *C. microarcheri* Cleland and *C. subarcheri* Cleland also resemble taxa of the *C. magellanicus* complex.

#### Material examined:

Australia: Tasmania, Cheshunt, on poor soil, 16 Apr. 1856, leg. W. Archer (K, **holotype** of *C. archeri* Berk., in poor condition). South Australia, Adelaide, Mt. Lofty, 16 Jul. 1917, leg. J.B. Cleland (AD 4231, **lectotype** of *C. microarcheri* Cleland South Australia, Mt Burr Forest Reserve, 30 May 1928, leg. J.B. Cleland (AD 4316, **lectotype** of *C. subarcheri* Cleland).

***Cortinarius submagellanicus*** Gasparini. New Zealand Journal of Botany 45: 207 (2007).  
Mycobank MB 533005.

Iconography: Gasparini (2007: Fig 25)

As the name of the epithet already indicates, *C. submagellanicus* Gasparini is another taxon which undoubtedly also resembles *C. magellanicus*. The species was collected in the Tasmanian rain

forest (Nothofagaceae area). Pileus and stipe of this species with predominantly lilac colours are reported to be viscid. The lamellae are also lilac at least in young specimens. The odour is aromatic. The ovoid to ellipsoid verrucose basidiospores measure  $8.5\text{--}10.5 \times 5.0\text{--}6.5 \mu\text{m}$  and polymorphic cheilocystidia were observed at the lamellar edges.

*Cortinarius rozites* Gasparini (Gasparini and Soop, 2008) from Nothofagaceae forests in Tasmania resembles *C. submagellanicus*, but the lilac or vinaceous pileus is reported to be dry and the lamellae concolourous. Basidiospores are ellipsoid ( $5.6\text{--}7.1\text{--}9.0\text{--}11.2 \times 3.8\text{--}4.8\text{--}5.7\text{--}7.2 \mu\text{m}$ ).

***Cortinarius vitreopileatus* var. *vitreopileatus*** E. Horak, Sydowia 42: 160 (1990).  
Mycobank MB 127379.

Iconography: Horak and Wood (1990). Soop (2003: Pl. 10 Fig 39).

#### Material examined:

New Zealand: Prov. Gisborne, Urewera N.P., Black Beech Track, on soil under *F. fusca* and *L. menziesii*, 23 May 1981, leg. E. Horak (PDD 27271, **holotype**; ZT 0756, isotype).

Notes: *Cortinarius vitreopileatus* var. *vitreopileatus* a paramyxacioid *Cortinarius* with glutinous and caramel to pale honey brown pileus. Lamellae are emarginate and pale argillaceous without lilac tinges in young basidiomes. The distinctly slender-amygdaliform and densely verrucose basidiospores measure  $10.5\text{--}13 \times 5.5\text{--}7 \mu\text{m}$ . On soil under *L. menziesii*, *F. fusca* and *F. cliffortioides*.

***Cortinarius vitreopileatus* var. *similissimus*** E. Horak & Peintner **var. nov.** (Fig. 17)  
Index Fungorum IF 554096.

**Etymology:** from Latin similis similar.

#### Diagnosis.

In many macro-morphological aspects, size and colours of *C. vitreopileatus* var. *similissimus* basidiomes recall both *C. magellanicus* and *C. submagellanicus*. The New Zealand taxon, however, is characterized by rather slender basidiomes and persistently blue-lilac colours of pileus and stipe, amygdaliform and verrucose basidiospores measuring  $10.5\text{--}13 \times 5.5\text{--}7 \mu\text{m}$ , and conspicuous clavate to vesiculose cheilocystidia with lilac plasmatic pigment.

Molecular data indicate that this New Zealand variety is closely related to sympatric and pale yellow-brown coloured *C. vitreopileatus* var. *vitreopileatus*. Both taxa are frequently encountered in New Zealand Nothofagaceae forests.

Pileus 15–30 mm, at first hemispherical with incurved margin, in age becoming expanded-convex or subumbonate, brilliant lilac-purple, glutinous, substrate towards margin. Lamellae 12–20, up to 5 lamellulae, broadly adnate to emarginate, at first deep purple-lilac, turning rust brown with age, lamellar edges lilac. Stipe 30–75  $\times$  4–5 mm, polymorphic, shape ranging from slender terete-cylindrical to swollen (7 mm diam.) or fusoid at base, at first concolourous with pileus, lower half turning yellowish in age, glutinous, solitary and cespitose. Odour and taste not distinct. Chemical reaction on pileus and context – negative.

Spore print rust brown. Basidiospores  $10.5\text{--}13 \times 5.5\text{--}7 \mu\text{m}$ , amygdaliform, distinctly verrucose, stronger towards apex. Basidia 25–35  $\times$  8–9  $\mu\text{m}$ , slender clavate, 4-spored, clamped. Cheilocystidia (25) 30–60  $\times$  (10) 12–20 (23) broadly clavate to vesiculose, thin-walled, with lilac plasmatic pigment.



**Fig. 17.** Basidiomes of *Cortinarius vitreopileatus* (A, B) *C. vitreopileatus* var. *vitreopileatus* (holotype ZT 0756, ZT 69-263) and (C, D) *C. vitreopileatus* var. *similissimus* (ZT 0811, ZT 69-252).

Pleurocystidia absent. Pileipellis a distinct ixocutis composed of strongly gelatinized, cylindrical hyphae, 3–5  $\mu\text{m}$  diam., with lilac plasmatic pigment. Subpellis of isodiametric cells with pigment-incrusted wall. Clamp connections present. Ecology and distribution: On soil under Nothofagaceae trees belonging to the genera *Fuscospora*, *Lophozonia* and *Nothofagus*. New Zealand.

#### Material examined:

New Zealand: Prov. Gisborne, Urewera N.P., Lake Waikareiti, on soil under Nothofagaceae trees (mixed with *Leptopermum scoparium*), 30 May 1981, leg. E. Horak (ZT 847, **holotype**). Fiordland: Lake Te Anau, North Fiord, Luga Burn, on soil under *Fuscospora cliffortioides* and *L. menziesii*, 10 Apr. 1969, leg. E. Horak (ZT 69-252). Prov. Nelson, Lake Rotoiti, trail to Mt. Robert, on soil under *L. menziesii* and *F. fusca*, 1 May 1969, leg. E. Horak (ZT 69-273). Prov. Gisborne: Urewera N.P., Lake Waikareiti, on soil under *L. menziesii* and *F. fusca*, 27 May 1981, leg. E. Horak (ZT 811); same locality, on soil under *L. menziesii* and *F. fusca*, 11 May 2001, leg. E. Horak (ZT 9703). Prov. N-Canterbury, Lewis Pass, on soil under *F. cliffortioides*, *F. fusca* and *L. menziesii*, 15 Mar. 1983, leg. E. Horak (ZT, 2001).

## 5. Discussion

The clear definition of taxa in the *C. magellanicus* species complex is of high relevance, given the abundance of these fungi and their ectomycorrhizal role in Nothofagaceae forests in the Gondwanian region of the Southern Hemisphere. *C. magellanicus* s.l. has been repeatedly reported from Nothofagaceae forests in Argentina, Chile and New Zealand (Garnica et al., 2003; Horak and Wood, 1990; Palfner, 2001; Segedin and Pennycook, 2001; Toledo et al., 2014). The data of molecular analysis, however, clearly demonstrate, that *C. magellanicus* encompasses a species complex including at least three phylogenetic lineages representing distinct species. The taxonomic position of these species is further

corroborated by morpho-anatomical features, and the analysis of a representative number of *C. magellanicus*-like samples. We re-define and describe *C. magellanicus* based on neotype material. In addition, *C. magellanicoalbus* and *C. roblerauli* are proposed as new species based on consistent sequences, morpho-anatomical characters of the basidiomes and the ecology of the habitat.

Our study also clearly demonstrates that the area of distribution of *C. magellanicus* s. str. is exclusively restricted to Argentina and Chile. Voucher material previously identified as *C. 'magellanicus'* from New Zealand is not conspecific. Soop (2016) already proposed that New Zealand's *C. 'magellanicus'* could be a violet version of *C. lubricanescens*. In our interpretation we also observe a similar phenomenon for *C. vitreopileatus*. Because of the distinct morphological differences of typical *C. vitreopileatus*, we describe this taxon here as the new variety *C. vitreopileatus* var. *similissimus*.

Giving the fact that *Cortinarius* is an ectomycorrhizal (EM) genus (Valenzuela et al., 1998), also *C. magellanicus* s. str., *C. roblerauli* and *C. magellanicoalbus* can be considered as EM species. Host specificities could explain the observed high regionalism and habitat relationship. In this study, *C. roblerauli* was only found in mixed forests of *L. obliqua* (roble) and *L. alpina* (raulí), while *C. magellanicoalbus* and *C. magellanicus* s. str. were associated with *N. dombeyi*, with few records also in mixed stands together with *N. pumilio* and/or *N. betuloides*. Moreover, *C. magellanicus* s. str. was found in sites with 500–600 mm of annual precipitation (Servicio Meteorológico Nacional, 2017), while *C. magellanicoalbus* appears to be more hydrophilic because it was found in sites with 1200–2000 mm of annual precipitation (Servicio Meteorológico Nacional, 2017). Factors like mean precipitation can influence the occurrence of EM fungi (Brundrett, 1991). More profound ecological studies are needed to define the ecological range of the species referred to in the present contribution.

The infrageneric positions and relationships are not clearly defined for the species of *Cortinarius* recorded in the Southern Hemisphere (Peintner et al., 2004), and the delimitation and actual taxonomic value between different morphogroups (e.g. myxacioid

or rozitoid) is still under discussion. Originally, Spegazzini (1887a) described *C. magellanicus* as *Phlegmacium*, and this was accepted for later publications (Horak, 1964, 1979), until Moser and Horak (1975) accommodated this species in subgenus *Myxadium*. The subgenus *Myxadium* is recognized as polyphyletic (Høiland and Holst-Jensen, 2000; Peintner et al., 2001; Seidl, 2000) and is represented by at least three distinct lineages (Peintner et al., 2004). However, the actual taxonomic value (and the ecological relevance) of the viscid-glutinous universal veil in *Cortinarius* is still unexplored and unexplained yet (Peintner et al., 2004).

Recently, *Cortinarius* sect. *Cycnei* Soop (Mycobank 814857) was described based on voucher material from New Zealand (Soop, 2016). Our phylogenetic analyses confirmed this section based on tree topologies and Bayesian posterior probabilities. It includes species from the *Nothofagus* area of both, New Zealand and South America: species from New Zealand are *C. lubricanescens*, *C. cucumeris*, *C. cygneus*, and species from South America are *C. capitellinus*, *C. magellanicus* s. str., *C. magellanicoalbus*, and *C. roblerauli*. The sequestrate species *Cortinarius maculobulga* Danks et al. (2010) from Australia is not a member of this section, as earlier assumed (Soop, 2016). All currently known species of this section share the following morphologically characters: Pileus and stipe are viscid to glutinous, distinctly blue, lilac or purple colours are usually present, but whitish, ochraceous, to brownish pileus colours mixed with violet shades are also present. The lamellae are whitish, argillaceous or violaceous, stipes are cylindrical to slightly clavate, and the hyaline universal veil has often a pale violet tinge. The basidiospores are ovoid, elliptic to (sub)amygdaloid, moderately to coarsely verrucose. Interestingly, intensely blue colours of basidiomes are more pronounced in South American species than in species from New Zealand. All species are mostly associated with Nothofagaceae and have a Southern Hemisphere distribution. However, species of sect. *Magellanici* represent disjunct South American or Australasian (New Zealand) lineages. The current disjunct distribution of this group can best be explained by Gondwanan vicariance.

The typification of this section with *C. cygneus* is not correct, because *C. magellanicus* is an older, valid epithet. Thus, this section should be typified with *C. magellanicus* Speg. and consequently, also named sect. *Magellanici*. This section name was already correctly applied in the figure, but not in the text of Soop's publication (2016).

Soop (2016) also described the sect. *Cremerolinae* and included *Cortinarius austrorapaceus* Soop. The basionym for this new name and new status is *Cortinarius rapaceus* var. *luridus* M.M. Moser (Moser and Horak, 1975). A new name for this taxon is necessary, because (when this taxon is accepted at species level), the epithet 'luridus' is already in occupied (Henry, 1969). The type was not included in this study, but sequences from recent voucher collections from Chile (Garnica et al., 2003) identified as *C. rapaceus* var. *luridus* were published. We generated an ITS2 sequence from type material of *C. rapaceus* var. *luridus*, clearly demonstrating that the type and vouchers from Chile are not conspecific. The phylogenetic relationship of *C. rapaceus* var. *luridus* could not be further resolved, but it is clearly not a member of Section *Cremerolinae*. It is not clear yet whether *C. austrorapaceus* applies to the type of *C. rapaceus* var. *luridus*, or to a new species belonging to sect. *Cremerolinae*. *C. austrorapaceus* is based on misidentified voucher material and a wrong interpretation of *C. rapaceus* var. *luridus* and is therefore is invalid.

Both, *C. aiacapiiae* and *C. capitellinus* were first considered as *C. magellanicus* s. str. synonyms by Horak (1979). Now, phylogenetic evidence confirms spore size and ornamentation as important characters for species distinction in this group of the

genus *Cortinarius*. Our spore size analysis showed that *C. capitellinus* basidiospores are larger, in width and length, and with smaller ornamentation as observed in *C. magellanicus* s. str. Unfortunately, no good quality sequence data could be obtained from the type of *C. capitellinus*, therefore an epitype was designated here for this taxon (Ariyawansa et al., 2014). *C. aiacapiiae* has clearly larger basidiospores, but it is still obscure what this epithet really represents. Also *C. opulentus* is a similar species with conspicuously blue, robust basidiomes but, as already indicated by spore morphology, this taxon is clearly not related to the *C. magellanicus* s. str.

*C. semiamictus* and *C. lugubris* have ITS sequences with 100 % identity. However, the colour of the lamellae in young specimens is reported to be lilac in *C. semiamictus*, but tan in *C. lugubris*. Moreover, our spore measurements showed that the basidiospores of *C. lugubris* are significantly shorter as observed in *C. semiamictus*. Based on spore morphology, these two epithets could represent different taxa. It must be emphasized, however, that both descriptions were based on single collections only. Accordingly, it is likely that the whole range of variability was not recognized examining the fresh specimens. More vouchers are needed for unambiguous clarification of this question. In the original descriptions, these two species were placed in completely different groups: *C. lugubris* was placed in Stirps *Obscurus* of sect. *Hydrocybe*, *C. semiamictus* in Stirps *Myxacioides* of subgenus *Paramyxadium*. This subgenus was created for species with the habitus and pigmentation resembling *Myxadia*, but with strongly translucent-striate, hygrophanous pilei and a dry stipe. *C. semiamictus* has a slightly gelatinous viscid pileus and ring-like zone and was therefore placed in this group (Moser and Horak, 1975). However, the tendency to become slimy appears to be variable in South American species (Peintner et al., 2004). Also, the tendency to form a velar ring, as described for *C. semiamictus*, could rather be interpreted as a quantitative but not as a qualitative character. Thus, these differences seem to be due to character variability and we are reluctant to give them any taxonomic value.

Morphologically, the basidiomes of several other species of *Cortinarius* subgenus *Myxadium* resemble *C. magellanicus* s.l.: *C. salor* Fr., *Cortinarius austrosalor* M.M. Moser, *C. archeri* Berk., *Cortinarius microarcheri* Cleland, *Cortinarius subarcheri* Cleland, *Cortinarius taylorianus* E. Horak, *Cortinarius iodes* Berk. & M.A. Curtis, *C. praelatus* M.M. Moser, *C. opulentus*, *Cortinarius indigoverus* E. Horak, *Cortinarius rotundisporus* Cleland & Cheel. The sequences generated from *C. magellanicus* s.l. vouchers have very low sequence similarities (<95 %) compared to sequences from these afore-mentioned taxa, thus indicating that they are not closely related. Moreover, they also differ regarding ecology of the habitats and in various macro-morphological characters. Moreover, with the exception of *C. austrosalor* and *C. opulentus*, all other species are from New Zealand, Australia, Europe or North America and have not been reported yet from the Patagonian Nothofagaceae forests (Horak, 1983).

The ITS region is frequently used for fungal species identification (Bruns et al., 1991; Gardes and Bruns, 1993; Peintner et al., 2003; Tedersoo et al., 2003; Schoch et al., 2012). Anyway the 5.8S region has only little variation across the genus *Cortinarius*, and the use of the ITS region probably underestimates the true diversity of *Cortinarius* species in natural ecosystems by at most 20 % (Garnica et al., 2016). On the other hand, rDNA regions have been found to be useful to infer relationships on genus level in fungi (e.g. Hibbett and Binder, 2002) and to delimit the species (e.g. Peintner et al., 2001, 2003). Therefore, rDNA regions are now widely used and accepted as barcoding regions at genus and species level (Schoch et al., 2012). Barcoding is a powerful tool for ecological,



environmental or further taxonomic research (Liimatainen et al., 2014). However, fungi occurring in the Southern Hemisphere are still largely under-represented in public databases, and data concerning their diversity and distribution are far from being complete. This is especially true and important for fungal groups with immense species richness like *Cortinarius*, a widespread and important ectomycorrhizal genus of the Nothofagaceae forests of the Southern Hemisphere.

## Acknowledgements

We thank the Österreichische Akademie der Wissenschaften (JESH program or the ÖAW), the Tiroler Wissenschaftsfonds and Universidad Nacional de la Patagonia San Juan Bosco, Argentina (FL005/15 Project) for financial support. We are grateful to Asociación de Parques Nacionales, Patagonian Delegation, for allowing us work in Los Alerces, Lago Puelo and Lanín National Parks. Valeria Silva and Juan Monges for their kind help in field trips. Regina Kuhnert is warmly thanked for her help in the mycological collection IB, and Johannes Falbesoner for his help in the lab in Innsbruck. MESS and CB are researchers for the National Research Council of Argentina (CONICET).

## Appendix A. Supplementary data

Supplementary data related to this article can be found at <https://doi.org/10.1016/j.funbio.2018.08.009>.

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