‘Cort short on a mountaintop’ – Eight new species of sequestrate *Cortinarius* from sub-alpine Australia and affinities to sections within the genus

M. Danks¹, T. Lebel², K. Vernes¹

**INTRODUCTION**

*Cortinarius* is an important ectomycorrhizal genus, widely distributed in both hemispheres. It is one of the larger, taxonomically diverse genera of basidiomycetes, with approximately 2,000 species recognised worldwide (Kirk et al. 2001). *Cortinarius* species are highly variable in colour and form, though may be distinguished from other Agaricales by brown, ornamented spores and an inner cobweb (cortina) veil. Several genera of sequestrate fungi have at various times been shown to share these characters, and are known to have affinities to *Cortinarius* (Dodge & Zeller 1934, Singer 1951, Singer & Smith 1959, Bouger & Castellano 1993). The general characteristics distinguishing sequestrate genera from related agaric taxa are that the hymenophore remains enclosed by the pileus, the spores are not actively discharged, and the sporocarps are hypogaeal or emergent. As with many groups of sequestrate fungi, the taxonomy and nomenclature of the cortinarioid fungi is in a state of flux, with many genera proving to be paraphyletic based upon molecular evidence (Peintner et al. 2002a, Hosaka et al. 2006, Lebel & Tonkin 2008). A number of agaricoid and sequestrate genera have been incorporated into *Cortinarius*, for example the genus *Thaxterogaster* (Peintner et al. 2002b), however the more gastroid taxa such as *Hymenogaster*, *Quadrispora* and *Protoglossum* have as yet to be transferred.

In Australia 11 genera and 39 species of sequestrate cortinarioid fungi have been fully described (Cunningham 1979, Beaton et al. 1984, Castellano & Trappe 1990, Bouger & Castellano 1993, May et al. 2003, Francis & Bouger 2003, 2004), and numerous DNA sequences made available for another 20–30 undescribed taxa (Francis 2007). During an extensive study of sequestrate fungi and mycophagy in the Northern Tablelands of New South Wales, a large number of new sequestrate taxa were discovered representing some 22 genera. The *Cortinariaceae* are a dominant component of the mycota, particularly of the sub-alpine zone. We present descriptions and illustrations of eight new species, and a key to currently described Australian sequestrate *Cortinarius* and *Protoglossum* species.

**MATERIALS AND METHODS**

**Molecular analyses**

**Taxon sampling**

The regions of nuclear ribosomal DNA data used for examination of species included the ITS1-5.8S-ITS2. Preliminary analyses were conducted on a large dataset (285 taxa; 340 sequences) with several different outgroups and exemplars of main clades suggested by analyses of Peintner et al. (2002a) and Garnica et al. (2005), and additional sequences of Australian sequestrate fungi (Francis 2007). Blast searches were conducted to...
check for any sequences that matched or were close matches to sequences of novel taxa. Close matches (97–100 %) were included in all alignments. In a series of successive analyses several sections known to be represented solely by Northern hemisphere taxa, i.e. Caloclori, or taxa showing no affinity to the new taxa described here (including numerous undescribed Australian sequestrate taxa), were removed. The final alignment included 178 sequences, representing 156 species, including a range of species within Cortinarius (98), Descolea (2), Hebeloma (3), and sequestrate taxa known to have affinities with these genera. Agaricus bisporus was selected as outgroup in final analyses, and a further 9 taxa from sister clades (Agrocybe, Anamika, Gymnopilus, Inocybe, Laccaria) also included to confirm placement of some Hymenogaster species. Twenty three novel sequences of Australian Cortinariaceae were included in the alignment and analyses (Table 1 lists all taxa with corresponding herbarium and GenBank accession numbers).

### Nucleic acid preparation, amplification and sequencing

Genomic DNA was isolated with the QIAGEN DNeasy<sup>®</sup> Plant Mini Kit, following the manufacturer’s protocol. The targeted regions were amplified from purified DNA using standard fungal primer pairs: ITS1/ITS4 and ITS5/ITS4 (Gardes & Bruns 1990). Sequencing was carried out by directly sequenced using the ABI Prism BigDye Terminator Cy PCR Purification System (Life Technologies). Purified DNA was and 1 m at 72 °C. These cycles were followed by 5 m of final at 95 °C, followed by 30 cycles of 30 s at 94 °C, 30 s at 58 °C, and 1 m at 72 °C. These cycles were followed by 5 m of final extension at 72 °C, after which the product was held at 4 °C.

Products of amplification were purified using the Concert Rapid PCR PCR Purification System (Life Technologies). Purified DNA was directly sequenced using the ABI Prism BigDye Terminator Cycle Sequencing Kit with primers for the ITS region ITS1, ITS5, and ITS4 (White et al. 1990). Sequencing was carried out by means of an ABI model Automated 377 DNA Sequencer.

### Phylogenetic analysis

Missing and ambiguous regions were removed from the analyses. All transformations were weighted equally. Gaps in the alignment were treated as missing data. All trees were rooted by the outgroup method (Maddison et al. 1984). Maximum parsimony analyses were performed using PAUP* 4.0b10 (Swofford 2002). Heuristic searches of the dataset were conducted with 1 000 replicates of random addition sequence, tree bisection-connection (TBR) branch swapping and MULTREES on. Nodal support was tested by bootstrapping of 200 replicates with the heuristic search option (TBR and MULTREES off), including groups compatible with 50 % majority rule consensus, with 10 random addition sequences.

### Morphology

The loss of gross morphological characters in the evolution of sequestrate sporocarp forms has led to a separate descriptive terminology to develop which we feel is confusing and, in the light of affinities shown by analysis of DNA sequences, unnecessary. In this paper we use the agaricid descriptive terms wherever possible, however determining homology of some tissue types is difficult (i.e. veil and pellis structure). Macroscopic characters were described directly from fresh material. Colours are described in general terms only. Macrochemical tests were not recorded. Fresh material was dried in a food dehydrator at 35 °C for 12 h. Habitat, associated plant communities, and fruiting season are based on field notes.

Hand-cut sections of fresh and dried material were mounted in 5 % aqueous solution of KOH, then stained with Congo Red.

### Table 1 Taxa included in DNA analyses. Current nomenclature is given as well as names used in GenBank.

| Current name                  | Genbank name | voucher | locale | Moser (1986) sections | Garnica et al. (2005) sections | Genbank #   |
|-------------------------------|--------------|---------|--------|-----------------------|-------------------------------|-------------|
| Agaricus bisporus             | HAI0235      |         | UK     |                       |                               | AJ84644     |
| Agaricus arvensis             | ARV1         |         | USA    |                       |                               | AY48491     |
| Agrocybe praecox              | PMB2310      |         | USA    |                       |                               | AY81348     |
| Anamika indica                | HK10998      |         | Canada |                       |                               | AY948189    |
| Crepidotus mollis             | ubc116579    |         | Canada |                       |                               | FJ627025    |
| Gymnopilus eucalyptorum       | BRV 99/10    | AU      |         |                       |                               | AF501546    |
| Gymnopilus penetrans          | IB 19980105  | AU      |         |                       |                               | AF325663    |
| Inocybe geophylla             | OUC97144     | Canada  |         |                       |                               | DQ093854    |
| Inocybe rufusfusca            | 82           | Austria |         |                       |                               | EU26156     |
| Descolea junii                | NZ2042       | NZ      |         |                       |                               | AF325653    |
| Descolea maculata             | E4986        | AU      |         |                       |                               | AF325651    |
| Descomyces albus              | H5339        | AU      |         |                       |                               | DG285157    |
| Descomyces albus              | H5372        | AU      |         |                       |                               | DG285168    |
| Descomyces angustisporus      | H7216        | AU      |         |                       |                               | DG285058    |
| Descomyces sp.                | TL1608       | AU      |         |                       |                               | DG285188    |
| Hebeloma amorphillum          | NP122        | Austria |         |                       |                               | AY948190    |
| Hebeloma cavipes              | NP121        | Austria |         |                       |                               | AY948193    |
| Hebeloma circinans            | dkad638      |         | Netherlands |               |                               | AF124699    |
| Laccaria ochropurpurea         | JMP0038      | USA     |         |                       |                               | EU819479    |
| Sethellogaster australisensis | Claridge 2621|         | AU      |                       |                               | AF325628    |
| Sethellogaster tenuepis       | Trappe 24776 | AU      |         |                       |                               | AF325624    |
| Timgrovea ferruginea          | H5803        | AU      |         |                       |                               | DG282128    |
| Timgrovea sp.                 | H4167        | AU      |         |                       |                               | DG282109    |
| Timgrovea sp.                 | H6171        | AU      |         |                       |                               | DG282195    |
| Cortinarius alboaggregatus    | PDD 77472    | NZ      |         |                       | Phlegmacium                   | AY669620    |
| Cortinarius albivolaceus       | IB 19740181  |         |         |                       | Sericeocybe                    | AF325596    |
| Cortinarius allusus            | IB 19940224  |         |         |                       | Phlegmacium                   | AF325585    |
| Current name | Genbank name | voucher | locale | Moser (1986) sections | Gamica et al. (2005) sections | Genbank # |
|--------------|--------------|---------|--------|----------------------|-------------------------------|----------|
| Cortinarius anomalus | IB 19950138 | Sericeocybe | AU | M. Anamolus | | AF325581 |
| Cortinarius archeri | PERTH 05506395 | AU | Myxaciun | | | AY666910 |
| Cortinarius ardesiacus | HO 970419A0 | AU | Telamonia | | | AY666950 |
| Cortinarius argyrinus sp. nov. | MEL2331641; MD158 | AU | M. Anamolus | | | AG989311 |
| Cortinarius argyrinus sp. nov. | MEL2331642, MD163 | AU | M. Anamolus | | | AG989312 |
| Cortinarius argyrinus sp. nov. | NE94635; MD162 | AU | M. Anamolus | | | AG989313 |
| Cortinarius austriensis | ZT ACT72567 | AU | Phlegmacium | | | AF389126 |
| Cortinarius australis | HO A20420A0 | AU | Phlegmacium | | | AY666515 |
| Cortinarius austrocinnaabarius | MEL2089674 | AU | Dermocybe | | | GQ990321 |
| Cortinarius austrocanites | PD 70498, CO1034 | NZ | Phlegmacium | | | AY666628 |
| Cortinarius austrodelucenssp. nov. | TUB 011522 | Chile | Phlegmacium | | | AY669563 |
| Cortinarius austrosaginus | HO 980509A0 | AU | Phlegmacium | | | AY669519 |
| Cortinarius austroturmalis | TUB 01449 | Chile | Phlegmacium | | | AFS93730 |
| Cortinarius austroviolatus | HO 990125A1 | AU | Phlegmacium | | | AY666935 |
| Cortinarius austrovenetus | MEL2089666 | AU | Dermocybe | | | GQ990318 |
| Cortinarius balteatus | TUB 011844 | GER | Phlegmacium | | | AY669528 |
| Cortinarius basipurpureus | MEL2089698 | AU | Dermocybe | | | GQ990324 |
| Cortinarius basirubescens | MEL2089702 | AU | Dermocybe | | | GQ990319 |
| Cortinarius basirubescens sp. nov. | MEL2331650; KV621 | AU | M. Anamolus | | | AY66966 |
| Cortinarius caesibulgarum sp. nov. | MEL2331651; KV666 | AU | M. Anamolus | | | AY669668 |
| Cortinarius caesibulgarum | TUL052A | AU | | | | DQ328070 |
| Cortinarius caesibulgarum | Trappe 18313 | AU | Purpurascens | | | AFS325559 |
| Cortinarius caesibulgarum | Trappe 9127 | AU | | | | DQ325155 |
| Cortinarius cagei | H9094 | AU | | | | DQ325146 |
| Cortinarius campbelliae | TUB 011514 | GER | Telamonia | | | AY669676 |
| ‘Cortinarius campbelliae/levisporus’ | Trappe 19821 | AU | Phlegmacium | | | AY669558 |
| Cortinarius campbelliae | Trappe 9127 | AU | Phlegmacium | | | AY669519 |
| Cortinarius campbelliae | TUL053 | AU | | | | DQ328071 |
| Cortinarius campionarius | TUB 011848 | GER | Phlegmacium | | | AY669640 |
| Cortinarius canarius | HO 980511C4 | AU | Dermocybe | | | AY669633 |
| Cortinarius canarius | MEL2089669 | AU | Dermocybe | | | GQ990320 |
| Cortinarius caperatus | TUB 011913 | GER | Rozites | | | AY669575 |
| Cortinarius chalybaeus | PDD77482 | NZ | Phlegmacium | | | AY669613 |
| Cortinarius cinereobrunneus | IB 19630258 | AU | M. Telamonia | | | AFS325600 |
| Cortinarius cinereoroseus sp. nov. | MEL2331646; KV529 | AU | | | | AY669635 |
| Cortinarius clementi | MEL2089677 | AU | Dermocybe | | | GQ990322 |
| Cortinarius coelopus | HO 990504A3 | AU | Phlegmacium | | | AY669640 |
| Cortinarius collinitis | IB 19960601 | AU | Myxaciun | | | AFS32573 |
| Cortinarius columnarius | TUB 011473 | Chile | Phlegmacium | | | AFS325736 |
| Cortinarius cretaceus | PDD 73148 | NZ | Phlegmacium | | | AY669622 |
| Cortinarius croceus | JFA9732 | Austria | | | | U56038 |
| Cortinarius cystidocatenatus | HO 9021518A6 | AU | Telamonia | | | AFS93725 |
| Cortinarius delaportei | TUB 011853 | GER | Percomes | | | AY669534 |
| Cortinarius delibutus | IB 19860263 | AU | M. Telamonia | | | DQ325172 |
| Cortinarius deminutus | TUB 011474 | Chile | Telamonia | | | AFS93725 |
| Cortinarius elaphinus | H9726 | AU | | | | AY669576 |
| Cortinarius emodensis | HKA9365-41 | China | Rozites | | | AY669576 |
| Cortinarius erythraeus | PERTH 05506727 | AU | Myxaciun | | | AY669605 |
| Cortinarius erythrocephalus | MEL2089681 | AU | Dermocybe | | | GQ990323 |
| Cortinarius favrei | IB 19990927 | AU | Myxaciun | | | AFS32573 |
| Cortinarius flavofusatus | TUB 011476 | Chile | Iceniula | | | AFS93709 |
| Cortinarius globuliformis | Claridge 2351 | AU | Dermocybe | | | AFS325765 |
| Cortinarius gracilior | TUB 011857 | GER | Phlegmacium | | | AY669525 |
| Cortinarius haryanaensis | TUB011824 | GER | Phlegmacium | | | AY669650 |
| Cortinarius holoprasellus | Halling 5733 | Argentina | | | | AFS325557 |
| Cortinarius humidiola | IB 19970396 | Argentina | | | | France |
| Cortinarius iringa | PDD 73135 | NZ | Phlegmacium | | | AY669624 |
| Cortinarius kapturiensis sp. nov. | MEL2331649 KV603 | AU | | | | AFS325581 |
| Dermocybe kula | HO 980515A0 | AU | Dermocybe | | | AFS325316 |
| Dermocybe kula | MEL2089692 | AU | Dermocybe | | | AFS325316 |
| Dermocybe luteus | HO 90250A42 | AU | Myxaciun | | | AY669642 |
| Dermocybe langei | TUB 011861 | GER | Phlegmacium | | | AY669527 |
| Dermocybe langier | IB 19740251 | AU | Telamonia | | | AY669519 |
| Dermocybe lavendulensis | MEL2089702 | AU | Phlegmacium | | | AY669527 |
| Dermocybe lavendulensis | HO 990304A2 | AU | Phlegmacium | | | AY669527 |
| Dermocybe leucosperosus | MEL2057558 | AU | | | | AFS325732 |
| Dermocybe leucosperosus | MEL2057558 | AU | | | | AFS325732 |
| Dermocybe ligrigus | TUB 011478 | Chile | Telamonia | | | AY669519 |
| Dermocybe lividochraszensis | IB 19960258 | AU | M. Telamonia | | | AFS325665 |
| Dermocybe lividus | TUB 011479 | Chile | Telamonia | | | AFS325743 |
| Dermocybe maculebulga sp. nov. | MEL2331647 KV532 | AU | M. Telamonia | | | AY669548 |
| Dermocybe major | IB 93619 | Chile | Phlegmacium | | | AY669548 |
| Dermocybe memoria-annae | HO A205020A0 | AU | Phlegmacium | | | EU660945 |
| Genbank name | Current name | Genbank # | Habitat | Host | Genbank # |
|--------------|--------------|-----------|--------|------|-----------|
| PDD 71005 | Cortinarius minoscaurus | NZ | Phlegmacium | NZ | Ay669628 |
| TUB 011422 | Cortinarius nanceiensis | GER | Percomes | NZ | Ay174856 |
| MEL233168 KV588 | Cortinarius nebulonbrunneus sp. nov. | AU | Telamonia | NZ | GQ890307 |
| TUB 18741 | Cortinarius nebulonbrunneus | Trappe | Thaxterogaster sp. | NZ | Af325857 |
| ZR AT6743 | Cortinarius ochraceoaezures | Argentina | Telamonia | NZ | Ay03122 |
| JFA1110 | Cortinarius olivaceoaezures | USA | Dermomyce | NZ | DQ566050 |
| MEL2120743 | Cortinarius olivaceoaezures | AU | Dermomyce | NZ | GQ890316 |
| AH 13475 | Cortinarius pachylophorus | Chile | Telamonia | NZ | Af539722 |
| TUB 011867 | Cortinarius papulosus | GER | Telamonia | NZ | Y669555 |
| TUB 011293 | Cortinarius paraulis | USA | Myxacin | NZ | Af539731 |
| TUB 7982 | Cortinarius pavilekii | USA | Myxacin | NZ | Af325654 |
| TUB 011868 | Cortinarius pericumis | GER | Myxacin | NZ | Y669529 |
| AH 19524 | Cortinarius permagnificus | Chile | Myxacin | NZ | Af539722 |
| TUB 011485 | Cortinarius persplendidus | NZ | Dermomyce | NZ | Af325853 |
| MEL2089694 | Cortinarius persplendidus | AU | Dermomyce | NZ | Y669602 |
| IB 19951102 | Cortinarius pingue | Myxacin | Thaxterogaster pingue | NZ | Af325571 |
| TUB 20116 | Cortinarius piniforme | AU | Dermomyce | NZ | Af325659 |
| MEL2079347 | Cortinarius 'porphyroides' | NZ | Myxacin | NZ | DQ328106 |
| NZ8468 | Cortinarius 'porphyroides' | NZ | Myxacin | NZ | Af325577 |
| IB 19990515 | Cortinarius porphyropus | Phylmacrium | Thaxterogaster porphyreus | NZ | Af325650 |
| TUB 011873 | Cortinarius pseudodotriumphans | Chile | Phylmacrium | NZ | Y669690 |
| TUB 011401 | Cortinarius purpurascens | GER | Phylmacrium | NZ | Y174858 |
| TUB011871 | Cortinarius purpurascens | GER | Phylmacrium | NZ | Y174858 |
| HO A20606A5 | Cortinarius quaresimalis | Myxacin | Phylmacrium |NZ | Y669616 |
| TUB 011485 | Cortinarius rapaeus var. luridus | Chile | Pseudotriumphans | NZ | Af325724 |
| TUB 011516 | Cortinarius rindens | GER | Pseudotriumphans | NZ | Af325652 |
| NZ8501 | Cortinarius rotundisporus | NZ | Myxacin | NZ | Af389127 |
| HO 19940297 | Cortinarius saltor | Phylmacrium | Thaxterogaster albocanus | NZ | Af325579 |
| HO 19940243 | Cortinarius sarsiocnirous | Phylmacrium | Halling 5632 | NZ | Af325563 |
| HO A203403A | Cortinarius sclerophyllarium | AU | Phylmacrium | NZ | Ay669637 |
| H7265 | Cortinarius sebusos | AU | Phylmacrium | NZ | DQ328060 |
| HO 990125A | Cortinarius sejunctus | AU | Phylmacrium | NZ | Y669636 |
| HKA 26154 | Cortinarius similis | China | Rozites | NZ | Y669657 |
| PERTH 0556778 | Cortinarius sinapicolar | AU | Rozites | NZ | Y669604 |
| TUB 336145 | Cortinarius sinapivulus sp. nov. | AU | Rozites | NZ | Y669638 |
| O-65723 | Cortinarius spadiceus | Norway | Phlegmacium | NZ | Y669639 |
| NZ800 | Cortinarius subcastaneolus | NZ | Rozites | NZ | Ay033112 |
| PDD 77482 | Cortinarius subcastaneolus | NZ | Rozites | NZ | Ay669623 |
| HO A20518B4 | Cortinarius submagellanicus | AU | Myxacin | NZ | Y669614 |
| HO 990411A | Cortinarius submelangis | AU | Rozites | NZ | Y669638 |
| IB 19990590 | Cortinarius talus | Phylmacrium | Alli | NZ | Af325586 |
| TUB 011489 | Cortinarius tenellus | Chile | Telamonia | NZ | Af359728 |
| HO A20526A0 | Cortinarius walkeri | AU | Dermomyce | NZ | Y669632 |
| PERTH 0566786 | Cortinarius vinaceoceleolatus | AU | Dermomyce | NZ | Y669632 |
| PERTH 0556794 | Cortinarius violaceus | AU | Dermomyce | NZ | Y669638 |
| TUB 011490 | Cortinarius virdibasilis | Chile | Telamonia | NZ | Af539717 |
| MEL2089665 | Cortinarius sp. | AU | Dermomyce | NZ | Y669638 |
| MEL2120747 | Cortinarius sp. | AU | Dermomyce | NZ | Y669638 |
| MEL2098705 | Cortinarius sp. | AU | Dermomyce | NZ | Y669638 |
| PDD 77446 | Cortinarius sp. | NZ | Myxacin | NZ | Y669644 |
| H5362 | Cortinarius sp. | AU | Myxacin | NZ | DQ328077 |
| H6558 | Cortinarius sp. | AU | Myxacin | NZ | DQ328080 |
| H6558 | Cortinarius sp. | AU | Myxacin | NZ | DQ328090 |
| H9202 | Cortinarius sp. | AU | Myxacin | NZ | DQ328107 |
| MEL2059057 | Cortinarius sp. | AU | Myxacin | NZ | DQ328117 |
| H1194 | Cortinarius sp. | AU | Myxacin | NZ | DQ328122 |
| H1120 | Cortinarius sp. | AU | Myxacin | NZ | DQ328122 |
| H1013 | Cortinarius sp. | AU | Myxacin | NZ | DQ328124 |
| H6558 | Cortinarius sp. | AU | Myxacin | NZ | DQ328149 |
| H4770 | Cortinarius sp. | AU | Myxacin | NZ | DQ328151 |
| H6913 | Cortinarius sp. | AU | Myxacin | NZ | DQ328175 |
| H1146 | Cortinarius sp. | AU | Myxacin | NZ | DQ328216 |
| H0790 | Hymenogaster arenarius | AU | Myxacin | NZ | DQ328124 |
| H0791 | Hymenogaster australis | AU | Myxacin | NZ | DQ328132 |
| AHS 68806 | Hymenogaster brunnescens | AU | Myxacin | NZ | EU84967 |
| OSC Trappe 12842 | Hymenogaster buillardi | Spain | Myxacin | NZ | Af325641 |
| KiM136970 ?Europe | Hymenogaster citrus | AU | Myxacin | NZ | EU784360 |
| Trappe 22752 | Hymenogaster subalpinus | USA | Myxacin | NZ | Af325640 |
| AHS 34677 | Hymenogaster subalpinae | AU | Myxacin | NZ | EU84961 |
| VIDAL 990620-6 | Protoglossum aromaticum | AU | Myxacin | NZ | DQ328081 |
| H6358 | Protoglossum violaceum | AU | Myxacin | NZ | EU84962 |
| Trappe 1272a | Protoglossum violaceum | AU | Myxacin | NZ | DQ328081 |
| Trappe 18111 | Quadrispora oblongispora | AU | Myxacin | NZ | Af325566 |
| PERTH00960403 | Quadrispora tuberculare | AU | Myxacin | NZ | DQ328113 |
Fig. 1 Heuristic analysis of ITS sequence data; one of 4,298 trees of length 3,716. Bootstrap support shown above lines. 'oval' = sequestrate taxa.
To determine the amyloid reaction, dried material was stained with Melzer’s reagent. Measurements were made at × 400 or × 1 000 with a calibrated ocular micrometer. Spore dimensions are given as length range × width range, mean length × width (n = 10 unless specified). The length : width ratio (Q) is presented as the range of Q values and the mean Q. Measurements do not include the apiculus or ornamentation. Basidia and cystidia dimensions are given as length range × width range (n = 10). Material for scanning electron microscopy (SEM) was sputter-coated with gold and photomicrographs taken using a JEOL JSM-5600 machine. Scanning electron microscope photographs were referred to wherever possible to aid interpretation of spore ornamentation patterns, however descriptions are in terms of structures visible by light microscopy and are based on type material (except where noted).

Names of herbaria are abbreviated according to Holmgren et al. (1990).

RESULTS

The alignment of ITS sequences consisted of 774 characters, of which 672 were included in analyses (222 were constant and 450 were parsimony informative). Analyses produced 4 298 trees of 3 716 steps, CI = 0.873, RI = 0.881 (Fig. 1).

A number of clades representative of sections sensu Peintner et al. (2002a) and Gamica et al. (2005) were recovered, though bootstrap support was not strong in the deeper branches (Table 1: Fig. 2). However, there is strong support (100 % bootstrap) for a distinct Cortinarius clade separate from a Descolea/Hebeloma clade. The Hymenogaster A clade, appears to have strong affinities to Descolea/Hebeloma rather than within Cortinarius with Hymenogaster B, including Protoglossum viscidum and P. aromaticum (Fig. 2). Although preliminary results only, some microscopic features such as spore size (generally considerably larger in Hymenogaster A), and ornamentation (more robust in Hymenogaster A), provide some support for distinguishing the two Hymenogaster clades.

The eight newly described taxa are scattered in different lineages within Cortinarius: C. argyronius, C. caesibulga and C. cinereoroseolus are in section Purpurascentes, C. maculobulga in section Rozites, C. sinapivelus in section Splendidi, C. kapatrensis in a mixed section Phlegmacium/Myxacium within a broader section Dermocybe. C. basorapulus in section Percomes and C. nebulobrunneus in section Pseudotriumphantes. Macroscopic and microscopic characters of the new species provide further support for placement in these various sections (discussed further in notes under each taxon). Historically these taxa would have been ascribed, based on morphology, to the genera Thaxterogaster, Hymenogaster or Protoglossum. However, Thaxterogaster has been synonymised with Cortinarius, and species of Hymenogaster and Protoglossum are scattered in several different clades thus the genera can no longer be considered monophyletic nor distinct from Cortinarius or Descolea/Hebeloma. Nomenclatural changes in the genus Protoglossum will be dealt with in a separate paper (May & Lebel in prep).

Very few clades contain solely sequestrate taxa. This may be partially a consequence of taxon sampling, as relatively few sequences have been available until recently, and also to the great diversity of sequestrate fungi currently undescribed from Australasia. Several sequestrate taxa will require further investigation of type material, for example C. porphyroideus, as sequences appear in radically different clades (Purpurascentes and Myxacium).

Taxonomy

Key to genera of the Bolbitiaceae and Cortinariaceae containing sequestrate taxa

1. Spores with a smooth, rostrate apex, and distinct utricle
2. Basidiomes with distinct stipe; spores prominently asymmetrical
3. Basidiomes lacking stipe-columella; spores more or less symmetrical

Key to Australian sequestrate species of Cortinarius and Protoglossum

1. Stipe-columella lacking, much reduced or as a truncate basal pad
2. Stipe-columella distinct, prominent
3. Basidiomes white, yellow, orange or brown
4. Basidiomes with lilac/violet tints
5. Peridium gelatinous, viscid or with a thick layer of slime
6. Peridium not as above
7. Basidiomes initially pale tan becoming reddish/purple brown or grey/violet; stipe-columella white to cream, dry, with a gelatinous purple collar at junction of peridium and stipe
8. Basidiomes lacking reddish/brown tones; stipe-columella absent or truncate, white to violet, dry or viscid, lacking a gelatinised purple collar
9. Spores ellipsoid, 12.5–14.5(–16) × 6–8 µm; peridium silvery white with violet tints to violet/lilac overall
10. Spores retained in tetrads after release
11. Basidiomes brown, warm brown to apricot yellow, drying brown or greyish yellow
12. Basidiomes brown; spores subovoid, coarsely ornamented with irregular tubercules and ridges to 2 µm high

P. niphophilum
P. violaceum
P. purpurescens
C. caesibulga
C. argyronius
C. caesibulga
C. argyronius
C. caesibulga
C. argyronius
C. argyronius
C. argyronius
C. argyronius
C. argyronius
C. argyronius
C. argyronius
C. argyronius

Quadrispora musispora
Quadrispora tuberculatis
Fig. 2  Sporocarps of new species. a. Cortinarius argyrionus; b. C. basorapulus; c. C. caesibulga; d. C. cinereoroseolus; e. C. kaputarensis; f. C. maculobulga; g. C. nebulobrunneus; h. C. sinapivelus. — Scale bars = 10 mm.
12. Basidiomes brown warm to apricot yellow; spores ellipsoidal to oblong, ornamented with crowded, irregular tubercules and ridges to 1 µm high. C. deminutus

13. Spores 15–18 × 8.5–12 µm, ornamented with crowded fine verrucae; basidiomes dark brown overall. C. levisporus

14. Spores almost all < 15 µm in length, ornamented with crowded fine verrucae or short ridges; basidiomes may have brown tints but not dark brown overall. C. cunninghamii

15. Spores almost all < 15 µm in length, ornamented with crowded fine verrucae or short ridges; basidiomes may have brown tints but not dark brown overall. C. sebosus

16. Basidiomes brownish orange to brown; stipe-columella variable; spores mostly ± 8 µm wide. C. maculoulboga

17. Spores 11–13 × 8.5–11 µm; ornamentation to 1.5 µm tall, of irregular rods and short ridges, perisporium conspicuous, closely adhering. P. luteum

18. Spores 11–15.5 × 7.5–9 µm, more ellipsoid; ornamentation to 0.8 µm tall, finely verrucose, perisporium conspicuous, appearing reticulately wrinkled. P. viscidum

19. Spores ≤ 10 × 6 µm. C. orphinus

20. Spores > 10 × 6 µm. C. walpolensis

21. Basidiomes whitish, sometimes with cinnamon fibrils; spores golden brown, ellipsoid, ornamented with small warts or warts, 7–10 × 3–5.5 µm. C. scabrosus

22. Basidiomes brown warm to apricot yellow; spores ellipsoidal to oblong, ornamented with crowded, irregular tubercules and ridges to 1 µm high. C. deminutus

23. Spores 15–18 × 8.5–12 µm, ornamented with crowded fine verrucae; basidiomes dark brown overall. C. levisporus

24. Spores almost all < 15 µm in length, ornamented with crowded fine verrucae or short ridges; basidiomes may have brown tints but not dark brown overall. C. cunninghamii

25. Basidiomes pigmented with distinct dark brown, purple, orange or green tints; stipe generally lacking marginate base. C. sebosus

26. Spores 14–21 µm long; basidiomes of variable colour cream, greenish grey. C. sebosus

27. Basidiomes off-white to greyish, viscid; spores 12.5–14.5 × 8–11 µm. C. leucocoephalus

28. Spore ornamentation to 1.5 µm tall, of irregular rods and short ridges, perisporium conspicuous, closely adhering. P. luteum

29. Basidiomes pigmented with distinct dark brown, purple, orange or green tints; stipe generally lacking marginate base. C. sebosus

30. Spores 7.7–9(–11) × 5–6.5 µm; basidiomes with a silvery sheen. C. argyrionus

31. Basidiomes parachute-shaped; stipe-columella short, base marginate; with thick white partial veil. C. debbiae

32. Stipe-columella white slightly translucent, robust, extending > 30 mm beyond pileus; spores 9–11.9 × 5.5–6.5 µm. C. nebulobrunneus

33. Spores 8.5–10.5 × 4.7–6.6 µm. C. orphinus

### DESCRIPTIONS

1. **Cortinarius argyrionus**

   Danks, T. Lebel & Vernes, sp. nov. — MycoBank MB515235; Fig 2a, 3, 4

   Sporocarpia hypogaea vel emergentia, caespitosa, 6–20 mm lata, subglobosa vel turbinata, grossa rugosa, pileus argentinocereus vel pallidoviolaceus, non violidus. Velum violaceum, crassum, persistens. Hymenophorum loculos, tuminitio sordido brunneum vel cinnamomeum, maturitate fusco brunneum; trama violascens sussuga retinens. Stipes 9–30 × 2–7 mm, percurrones, solidus, albus vel argentiviolaceus, contextus albus dein centrum luteolum et margine violaceo. Pleipellis bistrata, extus hyphis tenuibus hyalinis gelatinosis. Basidiosporae asymmetriceae, late ovatae, 7.7–9(–11) × (4.5–)5–6.5 µm, in KOH pallide luteobrunneae, nodulosis irregularibus inconspicuis vel robustis, < 1.5 µm altis. — Typus: M. Danks K. Vernes T. Cooper & S. Steinhart MD163 (MEL2331842) (holotypus hic designatus), Australia, New South Wales, Armidale, Newholm Field Station, Plot PA4, 1 July 2008.

   **Etymology.** Name refers to the metallic sheen and silvery-violet colour of the sporocarp (Gk.: argyrion = silvery violet).

   Sporocarpia hypogoeae vel emergentiae, in large clusters, often caespitose (multi-bodied). Pileus 7–38 × 6–20 mm diam, irregularly subglobose to pyriform or turbinate, coarsely wrinkled with plicate margin, attached to stipe by a persistent, cottony violet partial veil becoming paler with age. *Pellis* pale violet to silvery-grey with a metallic sheen, radiate-fibrillose, dry to moist when fresh but not viscid, sometimes with adhering debris, not hygrophanous, not bruising, with overlying remnant silvery-grey, fibrillose-silky veil, easily rubbed off with handling. Context 0.5–1.5 mm thick, white to cream, generally thicker at apex. *Hymenophore* dull brown to cinnamon brown initially becoming rich dark brown, trama initially pale violet, becoming white to grey retaining some violet tints in older speci-
mens; loculate, chambers empty, regular, rounded to elongate
and radially arranged. *Stipe-columella* generally percurrent in
immature sporocarps and occasionally percurrent, more often
truncate, in mature sporocarps, 9–30 × 2–7 mm diam, white
to silvery violet, context white gradually becoming pale yellow
tinted in centre and violet at margins, solid, central, slender,
convoluted and equal or slightly bulbous to base or tapering
to somewhat inserted base; *partial veil* inconspicuous but
present between inrolled margin and stipe-columella, cortinoid
to cottony, concolorous silvery-grey to violet (more obvious in
younger specimens). *Basal mycelium* inconspicuous. *Odour*
strong earthy fungoid, not unpleasant; *taste* not distinctive.

*Spores* 7.7–9(–11) × (4.5–)5–6.5 µm, mean (30 spores) =
8.8 × 5.6 µm, Q = 1.2–2.0, mean Q = 1.62, cinnamon brown
(KOH), broadly ovoid, slightly asymmetrical, ornamented with
irregular crowded nodules, nodules inconspicuous or robust to
1.5 µm tall, usually angular, often taller and more robust towards
apex; hilar appendage to 1 µm, hyaline, conspicuous, taper-
truncating, entire; spores inamyloid non-dextrinoid. *Basidia*
20–40 × 5–7 µm, hyaline, clavate to cylindrical, thin-walled,
with 4 sterigmata. *Cystidia* 12–32 × 3–9 µm, hyaline, clavate,
thin-walled, scattered and never protruding beyond hymenium. *Hymenophoral trama* 65–140 µm wide, of interwoven, hya-
line, gelatinised, thin-walled, narrow hyphae, 3–6 × 20–50 µm;
subhymenium 20–35 µm undifferentiated from trama. *Pileipellis*
duplex. Outer gelatinised layer 35–50 µm wide, of
loosely interwoven, hyaline, partially gelatinised, thin-walled,
narrow hyphae, 4–6 µm diam; *epicutis* 30–65 µm wide, of
more densely compacted, hyaline to pale yellowish in KOH,
narrow filamentous hyphae, 3–6 µm diam; *hypocutis* 65–110
µm wide, of densely packed, yellow-brown tinted, non-gelati-
nised, thick-walled (to 1 µm), ovoid, ellipsoid to subglobose or
rectangular inflated hyphae 8–18 × 8–22 µm long; *context*
250–300 µm wide, of parallel to somewhat interwoven, hyaline,
non-gelatinised, hyphae 8–12 µm diam. *Partial veil* of
subparallel to somewhat interwoven, thin-walled, hyaline hy-
phae 2–5 µm broad. *Clamp connections* present in the pileus
and hymenial tissues.

*Habitat & Distribution* — In New South Wales, found in low
hills and plains near Mt Duval on the New England Tableland,
among paddock shelterbelt plantings of *Acacia filicifolia*, *Euca-
lyptus nova-anglica*, *E. stellulata*, *E. viminalis*, *Hakea micro-

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**Fig. 3** *Cortinarius argyrionus*. a. Pileipellis; b. spores (GEL = outer layer; EPI = epicutis; HYP = hypocutis; C = context). — Scale bars: a = 50 µm; b = 5 µm.

**Fig. 4** Scanning electron micrographs of *Cortinarius argyrionus* spores. — Scale bars = 10 µm.
carpa, H. salicifolia and Leptospermum flavescens. Fruiting: June and July.

Specimens examined. AUSTRALIA, New South Wales, Armidale, Newholme Field Station, Plot PA4, 1 July 2008, M. Danks K. Vernes T. Cooper & S. Steinhart MD158 (MEL2331641); Armidale, Newholme Field Station, Plot PA4, 1 July 2008, M. Danks K. Vernes T. Cooper & S. Steinhart MD 162 (NE94635); Armidale, Newholme Field Station, Plot PA6, 2 June 2009, M. Danks & S. Steinhart MD 213 (MEL2331643 & NE94636); Armidale, Newholme Field Station, Plot PA4, 2 June 2009, S. Steinhart MD222 (MEL2331644).

Notes — Numerous violet-lilac tinted species of Cortinarius occur in Australia, including several that lack a thick gelatinous pileipellis. Cortinarius argyrionus differs macroscopically in the often caespitose sporocarps, with loculate hymenophore, and the initially white stipe context which gradually becomes pale yellow tinted in the centre and violet at the margins. Microscopically, the robust nodulose spore ornamentation (to 1.5 µm), and structure of the pileus are distinct from other violet-lilac tinted sequestrate Cortinarius species.

Based on analyses of ITS sequence data, Cortinarius argyrionus belongs in a well-supported (bootstrap 64 %) section Purpurascents, with two other new species C. caesibulga and C. cine-reoroseus (Fig. 1). Section Purpurascents also includes a strongly supported subclade with northern hemisphere species C. porphyropus, C. purpurascens and C. purpurascens var. largusoides (bootstrap 77 %). The southern hemisphere species C. australis, C. chalybaeus, C. submagellanicus and C. campbellae, and several undescribed Australian sequestrate taxa. Section Scauri is a strongly supported sister clade (bootstrap 96 %). All taxa within section Purpurascents have lilac/purple-tinted sporocarps with varying degrees of gelatinisation of pellic hyphae, minute to robust spore ornamentation, and a pileipellis duplex.

Cortinarius argyrionus is strongly supported (bootstrap 96 %) in a subclade as distinct from two undescribed sequestrate taxa C. sp. H1120 and C. sp. H0910 & H1013 (bootstrap 80 %). Both of these undescribed taxa have a pileus that is pale matt brownish purple rather than pale violet to silvery-grey with metallic sheen, and a stipe that lacks the violet margin staining reaction of C. argyrionus. The structure of the pileus, and spore size and ornamentation also differ from C. argyrionus.

The Australian sequestrate fungus, Cortinarius campbellae (bootstrap 82 %), may have some purple tints to the sporocarp, however it is much darker ‘brownish violet or madera’ than either C. argyrionus or C. caesibulga, has slightly smaller spores with less robust ornamentation, and hypocutis hyphae that are broader (Beaton et al. 1984). A third sequence labelled ‘C. campbellae’ (MEL2032790) appears distant in a well-supported subclade (bootstrap 79 %) with C. levisporus, and sister to a section Obtusi subclade (62 %). On examination, this collection matches reasonably with C. campbellae with a very pale tan pileus with concolorous veil rather than brownish violet or madera, the hymenophore is loculate rather than lamellate, the stipe reduced, the pileipellis hyphae predominantly ellipsoid, and the spores slightly narrower (Beaton et al. 1984). Further investigation, including examination of type material is required in order to determine the appropriate name for other sequestrate taxa in the section Purpurascents clade.

2. Cortinarius basorapulus Danks, T. Lebel & Vernes, sp. nov. — MycoBank MB515236; Fig. 2b, 5, 6

Sporocarps hypogaea vel emergentia, 11–29 mm lata, convexa vel sub-globulosa; pileus eburneus vel pallidobrunneolus, non viscidus. Vulum crassum, persistens. Hymenophorum subimmaculatum contortum et plicatum vel loculatum labyrinthiforme, juventute pallidobrunneolum, maturitate leviter fuscum. Stipes 14–36 × 5–8 mm, percurres, solidus, robustus, basi bulbosus marginatus angustus ad apicem, albus vel eburneus, non-viscidus; contextus albus maculatus, basi brunneus. Pileipellis monostrata, hyphis tenue tenuibus lutibus non-gelatinosas, Basidiosporae asymmetriae, late ellip- soideae, 9.6–11.6 (–12.1) × 7–9.4 µm, in KOH auranteobrunneum, verrucis irregularibus tenuibus 0.3–0.5 µm altis. — Typus: M. Danks, J.M. Trappe, T. Lebel & K. Vernes KV621 (holo MEL2331650 (holotypus hic designatus); iso NE94642), Australia, New South Wales, Mt Kaputar, Kaputar Rd, Plot DS3, 18 July 2007.

Etymology. Name refers to the turnip-like shape of the bulbous base of the sporocarps (L.: rapulum = a little turnip; baso = base).

Sporocarps hypogeous to emergent under leaf litter, in a small group. Pileus 8–24 × 11–29 mm diam, convex to subglobose, occasionally with a flattened apex, and slightly plicate margin attached to stipe by a persistent white, cottony partial veil. Pellis off-white to pale tan brown, finely fibrillose to fealty, dry, not hygrophanous, not bruising, with overlying remnant pale

Fig. 5 Cortinarius basorapulus. a. Pileipellis; b. spores. — Scale bars: a = 50 µm; b = 5 µm.
Habitat & Distribution — In New South Wales, occurring in
distinctively marginate bulbous base that tapers slightly, and
by the combination of sporocarps with pale tan brown pileus,
E. laevopinea among
dry sclerophyll forest on the high slopes of the Kaputar Plateau
connections
more inflated towards the hymenium, 18–24 µm diam.
scattered inflated elements 6–14 µm diam, becoming slightly
(KOH), septate hyphae, mostly 2–5 µm diam, intermixed with
with scattered ellipsoid to elongate elements 6–13 µm diam,
hyphae 2–4 µm diam; epiculis well developed, 40–75 µm
diameter of interwoven light golden yellow hyphae, 2–6 µm diam
with scattered ellipsoid to elongate elements 6–13 × 4–9 µm;
context 220–450 µm wide, of interwoven, light golden yellow
(KOH), septate hyphae, mostly 2–5 µm diam, intermixed with
scattered inflated elements 6–14 µm diam, becoming slightly
more inflated towards the hymenium, 18–24 µm diam. Clamp
connections present in the pileus.

Habitat & Distribution — In New South Wales, occurring in
dry sclerophyll forest on the high slopes of the Kaputar Plateau
among Brachychiton populneus, Eucalyptus albens, E. elliptica,
E. laevopinea and Exocarpus cupressiformis. Fruiting: July.

Specimens examined. Known only from type collection.
Notes — Cortinarius basorapulus may be distinguished by the
combination of sporocarps with pale tan brown pileus,
distinctly marginate bulbous base that tapers slightly, and
pileipellis simplex. Macroscopically this species resembles
descriptions of the sequestrate New Zealand taxon C. leuco-
cephalus and sequestrate Australian taxon C. cunninghamii,
with pale pileus and loculate hymenophore with elongate cells.
However, few collections have been made of either species
and the notes available for macroscopic characters are limited
(Horak 1973, Beaton et al. 1984, Grgrurinovic 1997). Examina-
tion of type and other material of C. cunninghamii in the State
Herbarium Adelaide (AD) confirmed the presence of a slender
attenuated stipe, subgelatinised hyphae forming the cutis, and
spores in the range 9–11 × 5–6.5 µm. Cortinarius basorapulus
sporocarps appear to be slightly darker brown, with a strongly
marginate rather than slender attenuated stipe base, and the
spores are more broadly ellipsoid than either C. cunninghamii
or C. leucocephalus.

Analyses of ITS sequences places C. basorapulus in a poorly
supported section Percomes (bootstrap 61 %), in a subclade
(bootstrap 58 %) with the European taxa C. langei, C. nanci-
encis and C. percomis. A sister subclade with strong support
(bootstrap 93 %) includes the Australian taxon C. coelopus,
European taxon C. papulosus, and the New Zealand taxon
C. sp PDD77486 (Fig. 1). Cortinarius delaportei is nearby but
not included in the Percomes clade in this analysis.
All species in this clade have a basic pileus colour of a ‘variation
on brown’, a pileipellis simplex, and ellipsoid to elongate spores.
However, this group of species does vary in the stipe shape and
degree of violet coloration present. The stipe shape is cylindri-
cal in C. nanciencis and C. percomis, and bulbous in all other
taxa; and in C. coelopus violet blue coloration is restricted to
the pileus margin, in C. delaportei and C. sp PDD77486 violet
blue is exclusively in the lamellae and stipe apex, in C. nanci-
encis violet-blue occurs only in the veil at the stipe base, and
C. basorapulus, C. langei, C. papulosus and C. percomis lack
any violet-blue coloration.

3. Cortinarius caesibulga Vernes, Danks & T. Lebel, sp. nov.
— MycoBank MB515237; Fig. 2c, 7, 8
Sporocarpia hypogaea vel emergentia, 4–27 mm lata, subglobosa vel ir-
regulariter turbinita, margine plicata; pileus griseoaequis decoloratus ad
brunneocaeuis, non-viscidus. Velum argenteis, tenue, sericeum,
persistens. Hymenophorum sublamellatum vel lamellatum contortum et
plicatum, initio pallidocinnamomeum, maturitate leviter fuscum. Stipes
9–25 × 2–3 mm, percurrent, solidus, protrudens argentaecuis, sericeus.
Pileipellis bistrata, extus hyphis tenuibus hyalinis vel pallide luteo-brunneis
gelatinosis, interne hyphis hyalinis inflatis non-gelatinosis. Basidiosporae

Fig. 6 Scanning electron micrographs of Cortinarius basorapulus spores. — Scale bars = 10 µm.

Note — Cortinarius basorapulus may be distinguished by the
combination of sporocarps with pale tan brown pileus,
distinctly marginate bulbous base that tapers slightly, and
asymmetricae, ovatae, 8.7–11 × 4.8–6.2 µm, in KOH pallidocinnamomeae, nodulosis tenuibus 0.5(–0.8) µm altis. — Typus: M. Danks, J.M. Trappe, T. Lebel & K. Vernes KV660 (MEL2331651) (holotypus hic designatus), Australia, New South Wales, off Waterfall Way, near junction with Point Lookout Rd, Plot DS5, 19 July 2007.

Etymology. Name refers to the appearance of the sporocarps as ‘little bags or dumplings’ (L.: caesius = lavender pale blue with grey tinge; bulga = purse or bag).

Sporocarps hypogeous to emergent under leaf litter, singly or in small groups. Pileus 2–18 × 4–27 mm diam, irregularly subglobose to turbinate with a flattened apex, and irregularly folded margin which may be lacerate and seceding slightly in mature specimens, attached to stipe by a persistent cobweb veil. Pellis lavender fading to tan-lavender with a silky, silvery sheen, finely fibrillose, dry to moist when fresh but not viscid, not hygrophanous, not bruising, with overlying remnant of a silvery-grey, fibrillose-silky universal veil, easily rubbed off with handling. Context 0.3–0.8 mm thick, white to cream. Hymenophore pale cinnamon brown initially darkening slightly as spores mature, trama, if noticeable, white to translucent grey; subhymenium undifferentiated from trama. Pileipellis duplex. Overlying partially gelatinised layer, 9–38 µm wide, of narrow parallel, hyaline to pale yellow hyphae, 2–4 µm diam; epicutis narrow, 18–30 µm wide, integrating with overlying gelatinised layer in parts, of subparallel, hyaline to pale yellow hyphae, 2–6 µm diam; hypocutis 25–60 µm wide, of interwoven, hyaline, inflated hyphae, 4–12 µm diam intermixed with irregular, hyaline, inflated isodiametric elements, 14–39 × 6–22 µm; context 65–225 µm wide, of loosely interwoven to subparallel, inflated, septate, elongate, hyaline hyphae 30–80 × 4–11 µm diam. Clamp connections present in the pileus.

Habitat & Distribution — In northern New South Wales, occurring in dry sclerophyll forest on the high eastern slopes of the New England Plateau among Allocasuarina littoralis, Eucalyptus calignosa, E. dalrympleana subsp. heptantha and E. radiata subsp. sejuncta; and in southern New South Wales, occurring in mixed forest of E. cypellocarpa and E. sieberii near Mt Imlay. In Victoria, occurring in wet sclerophyll forest among E. regnans. Fruiting: May–July.

Specimens examined. Australia, New South Wales, off Waterfall Way, near Serpentine Nature Reserve, Plot DS6, 20 July 2007, M. Danks, J.M. Trappe, T. Lebel & K. Vernes KV715 (NE94638); Off Nungatta Rd, 3.35 km from junction with Imlay Rd, on western side of rd, 31 May 2001, T. Lebel & S. Lewis TL502A (MEL2310527); Off Laings Rd west, near corner with Reef Rd west, 3 June 2001, T. Lebel & J. Zdravevski TL621 (MEL2310487); Off Laings Rd west, 1.2 km from junction with Imlay Rd, on eastern side of rd.

Sporocarps ovoid to ellipsoid, slightly asymmetrical, densely ornamented with isolated nodules to 0.5(–0.8) µm; hilar appendage to 1 µm, conspicuous, tapering, truncate; spores inamyloid non-dextrinoid; apex ornamented. Basidia 26–39 × 5–8 µm, hyaline, clavate to cylindrical, thin-walled, with 4 stigmata. Cystidia 23–57 × 6–11 µm, hyaline, narrowly clavate, thin-walled, scattered and never protruding beyond hymenium. Hymenophoral trama 20–45 µm wide, of loosely interwoven to subparallel, hyaline inflated hyphae, 4–11 µm diam; subhymenium undifferentiated from trama. Pileipellis duplex. Overlying partially gelatinised layer, 9–38 µm wide, of narrow parallel, hyaline to pale yellow hyphae, 2–4 µm diam; epicutis narrow, 18–30 µm wide, integrating with overlying gelatinised layer in parts, of subparallel, hyaline to pale yellow hyphae, 2–6 µm diam; hypocutis 25–60 µm wide, of interwoven, hyaline, inflated hyphae, 4–12 µm diam intermixed with irregular, hyaline, inflated isodiametric elements, 14–39 × 6–22 µm; context 65–225 µm wide, of loosely interwoven to subparallel, inflated, septate, elongate, hyaline hyphae 30–80 × 4–11 µm diam. Clamp connections present in the pileus.

Specimens examined. Australia, New South Wales, off Waterfall Way, near Serpentine Nature Reserve, Plot DS6, 20 July 2007, M. Danks, J.M. Trappe, T. Lebel & K. Vernes KV715 (NE94638); Off Nungatta Rd, 3.35 km from junction with Imlay Rd, on western side of rd, 31 May 2001, T. Lebel & S. Lewis TL502A (MEL2310527); Off Laings Rd west, near corner with Reef Rd west, 3 June 2001, T. Lebel & J. Zdravevski TL621 (MEL2310487); Off Laings Rd west, 1.2 km from junction with Imlay Rd, on eastern side of rd.

Fig. 7 Cortinarius caesibulga. a. Pileipellis; b. spores. — Scale bars: a = 50 µm; b = 5 µm.
3 June 2001, J. Zdravevski TL661 (MEL2314440); Off Imlay Rd to south, 1.05 km west of junction with Brushtail Rd, 30 May 2001, J. Zdravevski TL430 (MEL2310509). **Victoria**, Acheron Way, Acheron Gap between Narbethong and Warburton, 29 June 2005, G.M. Mueller 7232 (MEL2293662); Dom Dom Saddle, Maroondah Hwy, 23 May 2004, K. Syme 1303/04 (MEL2293212); Mt Baw Baw National Park, Mt Erica, Mt Monarch Walk, 80 m from trailhead, 17 May 2003, A. Francis & T. Lebel H9094 (PERTH); Nunniong State Forest, Bentley Plains Rd, Claridge site 104, 26 May 1996, A. Jumpponen T18313 (MEL, CANB, OSC130729); Yambulla State Forest, Falkner Rd 3.1 km west of Kallack Rd, 9 July 1996. A.W. Claridge HT127 (PERTH).

Notes — **Cortinarius caesibulga** is distinguished by the silvery-lavender sporocarps with slender stipe-columella, which has a white context, contorted sublamellate to lamellate hymenophore, and the fine spore ornamentation. Based on analyses of ITS sequence data, **C. caesibulga** belongs in section **Purpurascenses** (Fig. 1). This species is in a well-supported clade (bootstrap 84 %) with the agaric **C. submagellanicus** clade (bootstrap 92 %) with the **Agaricomycetes**. The two Victorian collections of lilac pellis vs deep purple or purple-brown pellis. **C. submagellanicus** caesibulga (**Myxacium**) has not been examined by the authors. As such we suggest that this sequence (DQ328106) should not be included in analyses for this taxon. The NZ collection of this taxon in 2004 was misidentified as **Cortinarius sp.**. All of these taxa have some lilac-purple tints to the pileus, stipe and stipe-columella. These taxa have some lilac-purple tints to the pileus, stipe and stipe-columella.

The Australian sequence labelled ‘**C. fragilis** T18313’ (AF325559) is unlikely to be the same as the taxon originally described from Chile, instead is here included in the new species **C. caesibulga**. **Cortinarius caesibulga** may be differentiated from **C. fragilis** (Type) by the smaller spores, and sublamellate to lamellate hymenophore, and lilac pellis vs whitish with scant lilac tints. The two **C. porphyroideus** collections (NZ8468 and MEL2079347) included in our analyses, require further examination as the sequences appear in quite different clades, in sections **Myxacium** and **Purpurascenses** respectively. The MEL collection appears to conform to the published description of **C. porphyroideus** (Cunningham 1979), however pileus texture and structure and spore ornamentation make placement of this taxon in **Myxacium** rather than **Purpurascenses** more likely. As such we suggest that this sequence (DQ328106) should not be included in analyses for this taxon. The NZ collection (Myxacium) has not been examined by the authors. **Cortinarius caesibulga** may be differentiated from **C. porphyroideus** and **C. submagellanicus** by the much less robust stipe, and silvery lilac pellis vs deep purple or purple-brown pellis.

The two Victorian collections of **C. caesibulga**, MEL2293662 and MEL2292312, both have slightly more robust spore ornamentation than the New South Wales collections, however are similar in all other characters.

4. **Cortinarius cinereoroseolus** Danks, T. Lebel & Vernes, sp. nov. — **MycoBank** MB515238; Fig. 2d, 9, 10

Sporocarps hypogaea, 11–24 mm lata, subglobosa vel irregulariter pyriformia, marginae plicata; pileus eburneus vel leviter nittens pallide roselilacinus-cineraceus, non visidicus. Velum pallidocineraceum tenue, sericeum. Hymenophorum loculatum, initio pallidobrunneum, maturitate fusco cinnamonomeum. Stipes 5–11 × 3–6 mm, truncatus vel percurrents, basi bulbosa protrudens, albus, sericeus. Pleipellis tenuissimus, hypphis latis hyalinis non-gelatinosis. Basidioporaie asymmetriceae, late ovatae, 7–9.0 × 5.1–6.4 µm, in KOH cinnamonae, nodulosus irregularibus et lineis brevis robustus, < 1.5 µm atis. — Typus: M. Danks, J.M. Trappe, T. Lebel & K. Vernes KV529 (MEL2331646) (holotypus hic designatus), Australia, New South Wales, Mt Kaputar, Kaputar Rd, Plot GW2, 17 July 2007.

**Etymology.** Name refers to the shiny-pale pink colour of the sporocarps (L.: cinereo = greyish; roseolus = pale pink).

**Sporocarps** hypogeous under leaf litter, fruiting in large groups. **Pileus** 11–27 × 11–24 mm diam, irregularly subglobose to pyriform, slightly plicate margin, attached to stipe by a persistent, inconspicuous, white to silvery-grey veil. **Pelli** cream with pale pink-lilac-grey, slightly shiny, finely fibrillose, smooth, dry to moist when fresh but not viscid, not hygrophanous, not bruising, with overlying remnant pale grey, silky universal veil, easily rubbed off with handling. **Context** yellowish to yellow brown; **Hymenophore** pale brown initially, becoming dark cinnamon brown, trama, if noticeable, pale brown to dark grey-brown; **hymenium** yellowish to yellow brown, attached to stipe by a persistent, partially veil, white to silvery-grey veil. **Stipe** -columella a truncate to percurrent columella tapering slightly from a bulbous inserted base towards the apex, 5–11 × 3–6 mm diam, white to translucent in section, central, more or less terete, white, dry, silky, solid, fibrous, base bulbous protruding up to 3 mm below pileus; **partial veil** inconspicuous but present between inrolled pileus margin and bulbous base, cortinoid, concolorous pale grey. **Basal mycelium** inconspicuous, white. **Odour** faintly floral or of chlorine; **taste** not distinctive.

**Spores** 7–9.0 × 5.1–6.4 µm, mean (20 spores) = 8.0 × 5.7 µm, Q = 1.3–1.6, mean Q = 1.45, cinnamon brown (KOH), broadly ovoid, slightly asymmetrical, ornamented with irregular nodules pegs and some short broad lines, nodules robust to 1.5 µm tall, usually angular; hilar appendage to 1 µm, inconspicuous, tapering, truncate; spores inamyloid non-dextrinoid; apex ornamented. **Basidiospores** 28–40 × 7–9 µm, hyaline, clavate to cylindrical, thin-walled, with 4 sterigmata. **Cystidia** 20–26 × 7–11 µm, hyaline, clavate, thin-walled, scattered and never protruding.
beyond hymenium. Hymenophoral trama 30–110 µm wide, of scattered inflated round and elongated, hyaline, gelatinised, thick-walled hyphae, 8–22 × 55–70 µm; subhymenium 20–35 µm undifferentiated from trama. Pileipellis duplex. Epicutis a very thin layer, 5–11 µm wide, of gelatinised, parallel, hyaline to pale yellow narrow hyphae, 3–5 µm diam; hypocutis 30–90 µm, difficult to distinguish from the underlying context, of non-gelatinised, subglobose to ellipsoid, hyaline hyphae, 8–26 µm diam × 6–30 µm long; context up to 350 µm wide, of non-gelatinised, subparallel, inflated hyaline hyphae, 10–30 µm wide. Clamp connections present in the pileus and hymenial tissues.

Habitat & Distribution — In New South Wales, found in the sub-alpine and high slopes areas of the Kaputar Plateau, in a grassy woodland community dominated by *Eucalyptus dalrympleana*, *Poa sieberiana* with scattered *Acacia melanoxylon*, *Acacia* sp., *Hibbertia obtusifolia*, *Lomatia arborescens*, *Monotoca scaparia*, *Olearia rosemanifolia* and *Pultanea satulosa*. Also found in wet sclerophyll forest dominated by *E. dalrympleana*, *E. laevoptima* and *E. viminalis* with an understorey dominated by *Acacia melanoxylon*, *Blechnum cartilagineum*, *Coprosma quadrifida*, *Cyathea australis*, *Lo mandra multiflora*, *Lomatia arborescens* and *Poa sieberiana*. Fruiting: July.

Specimen examined: Australia, New South Wales, Mt Kaputar, Kaputar Rd, Plant WS3, 17 July 2007, M. Danks, J.M. Trappe, T. Lebel & K. Vernes KV610 (NE94637).

Notes — *Cortinarius cinereoroseolus* may be differentiated from other Australian sequestrate *Cortinarius* species by the definite pinkish tint to the sporocarp when fresh (note lilac tones are present) and slightly more robust and irregular spore ornamentation. This species also belongs in section *Purpurascens*.

Analysis of ITS data places *C. cinereoroseolus* in a subclade (bootstrap 69 %) with two undescribed sequestrate taxa, sister to a well-supported subclade including *C. caesibulga* and *C. submagellanicus* (bootstrap 84 %) and an unsupported subclade with *C. australis*, *C. chalybaeus*, *C. porphyropus*, *C. purpurascens* and *C. purpurascens* var. *largusoides* (Fig. 1). While the colour, texture and form of the sporocarps vary, all of the taxa in the *C. cinereoroseolus* subclade share a similar pileus structure, of a thin epicutis of subgelatinised, narrow hyaline to pale yellow hyphae overlying a hypocutis and context of inflated hyphae, and robust spore ornamentation. *Cortinarius* sp. H0920 & H4770 and *Cortinarius* sp. H1114 share a smooth silky pileus, labyrinthine loculate and yellowish to cinnamon hymenophore, and ellipsoid spores with robust warts and nodules up to 0.8–1
µm high. They differ in the colour of the pileus and form of the stipe-columella: pale greyish silky violet to purplish brown and narrow percurrent in Cortinarius sp. H0920 & H4770, and dull, pale greyish brown and narrow percurrent with bulbous base in Cortinarius sp. H1194.

5. Cortinarius kaputarensis Danks, T. Lebel & Vernes, sp. nov.
   — MycoBank MB515239; Fig. 2e, 11, 12, 13

Sporocarpia hypogaea vel emergentia, 15–25 mm lata, conica vel sub-globulosa, margine involuta; pileus luteobrunneus vel aurantobrunneus subviscidus. Velum parietale luteum, crassum, persistentis et veli universalis vestigium fuscobrunneum fibrillosum persistens. Hymenophorum sublamellatum vel lignicolumellatum loculatum contorum, juveni vivide cinnaeomoseus, maturitate cinnaeomoseus. Stipes 15–50 × 3–8 mm, percurrent, protrudens, solidus, gracilis, equalis, pallide luteus, glabrus, non-viscidus; contextus eburneus vel pallide luteus, centro fibrillosus. Pilepellis bistrata, externe hyphis auranteobrunneis, interne hyphis fusco-auranteobrunneis. Basidiosporae asymmetricae, ovatae vel amygdalina, 9.9–12.1 × 5.4–7.4 µm, in KOH cinnaeomoseae, nodulosis irregularibus robustis < 1.5 µm altis. — Typus: M. Danks, J.M. Trappe, T. Lebel & K. Vernes, Kaputar Rd, Plot WS3, 17 July 2007.

Etymology. Name refers to the type locality, Mt Kaputar.

Sporocarps hypogeous to emergent under leaf litter, in a small group. Pileus 12–30 × 15–25 mm diam, conical to subglobose, occasionally with a slightly flattened apex, and inrolled margin. Pellis yellow-brown to orange-brown, smooth, subviscid when fresh, not hygrophanous, not bruising, with scattered universal veil remnants of darker brown fibrils overlying most of the surface, not easily rubbed off with handling. Contextus 0.3–2.0 mm thick, rapidly thinning from disc to margin, translucent cream. Hymenophore bright cinnaeomoseus brown initially, darkening slightly as spores mature to drab cinnaeomoseus brown, sublamellate to loculate, compact, forming irregular, contorted lignicolumellar chambers 0.5–1 mm diam, remaining completely enclosed. Stipe-columella percurrent, 15–50 × 3–8 mm diam, pale yellow, smooth, moist but not viscid when fresh, cream to pale yellow in section, with central core of translucent less fibrillose tissue, central, slender, equal; partial veil cottony, yellow, persistent; universal veil remnants present as scattered dark brown fibrils at base and lower half of stipe. Basal mycelium yellow. Odour mild, not distinctive; taste not distinctive.

Spores 9.9–12.1 × 5.4–7.4 µm, mean = 11.2 × 6.1 µm, Q = 1.5–2.2, mean Q = 1.91, cinnaeomoseus brown (KOH), ovoid to almond-shaped, asymmetrical, ornamented with isolated, irregular, rounded nodules, to 1.5 µm tall; hilar appendage to 1.5 µm, conspicuous, tapering, truncate; spores inamyloid non-dextrinoid; apex rostrate, apex ornamentation less conspicuous. Basidia 19–37(–40) × 6–9 µm, cylindrical to clavate, hyaline, mostly 4-, rarely 2-spored. Cystidia 18.5–26.5 × (7–)10–11 µm, clavate, hyaline, abundant. Hymenophoral trama 26–57 µm wide, of interwoven, hyaline, irregularly inflated hyphae, 4–9 µm diam, with scattered to abundant inflated elements, to 12–21 µm diam. Subhymenium undifferentiated from trama. Pileipellis simplex. Veil 110–220 µm wide, of orange-brown pigmented (KOH), finely to zebra encrusted hyphae, 4–11 µm diam, appearing undulating in outline; overlaying a gelatinised layer 30–70 µm wide, of darker orange-brown hyphae, 2–7 µm diam; epicutis 40–85 µm wide, of interwoven to parallel, hyaline to pale yellow hyphae, 3–5 µm diam; context 140–370 µm wide, of densely compacted interwoven to sub-parallel, hyaline hyphae, 3–7 µm diam with rare sinuous dark orange-brown hyphae 2–3.5 µm diam, and scattered inflated elements, 9–17 µm diam becoming more common towards the hymenium. Clamp connections present and obvious in the pileus.

Habitat & Distribution. — In New South Wales, occurring in wet sclerophyll forest on the high slopes of the Kaputar Plateau among Eucalyptus dalrympleana, E. laevoipina and E. viminalis. Fruiting: July.

Specimens examined. Known only from type.

Notes. — No other species of Australian sequestrate Cortinarius has the combination of yellow-brown to orange-brown sub-viscid pileus, persistent bright yellow cottony cortina, pale yellow stipe, and bright cinnamon brown sublamellate to loculate hymenophore. The yellowish brown pigmented veil hyphae, with striped to crustose encrustations are also distinctive, though they do occur in other Cortinarius species. The bright pigments of sporocarp, veil and basal mycelium are characteristic of section Dermocybe. However, analyses of ITS sequences suggests placement in a poorly supported (bootstrap 62 %) section Phlegmacium subclade, with the Australian species C. austrovaginatus and C. sinapicolor and a sister taxon of the European C. croceus, in a poorly supported (bootstrap
50 %) broader section Dermocybe clade (Fig. 1). *Cortinarius austrovaginatus* and *C. sinapicolor* share a glutinous pileus which *C. kaputarensis* and *C. croceus* lack, but all species vary considerably in pileus colour and stipe shape. *Cortinarius austrovaginatus* has a vinaceous-brown pileus, marginate bulbous stipe base, and thick white universal veil, *C. sinapicolor* has a bright yellow pileus and veil and marginate bulbous stipe base, and *C. croceus* has a yellowish brown pileus, and a yellowish with olive brown barely bulbous stipe (Moser & Horak 1975, Garnica et al. 2003). *Cortinarius croceus* is a pine associate and *C. austrovaginatus* a *Nothofagus* associate whilst *C. kaputarensis* and *C. sinapicolor* are wet *Eucalyptus* associates.

In all preliminary analyses with larger datasets and the analysis presented here, *C. sinapicolor* remained one of the closest taxa to *C. kaputarensis*. *Cortinarius kaputarensis* differs from *C. sinapicolor* in the yellow-brown to orange-brown instead of bright yellow pileus, and lacks the thick glutinous epicutis over both pileus and stipe of the latter species.

6. *Cortinarius maculobulga* Danks, T. Lebel & Vernes, sp. nov. — MycoBank MB515240; Fig. 2f, 14, 15

*Sporocarpia hypogaea*, 10–42 mm lata, subglobosa vel irregulariter turbinate; pileus albus vel eburneus maculatus brunneolus, variabilis viscidus. Velum album vel pallidocineraceum, tenue, persistens. Hymenophorum loculatum, juvente pallidocinnamomeum, maturitate fusco-cinnamomeum. Stipes 8–35 × 2–6 mm, truncatus vel percurrente, solidus, basi bulbosus, albus vel eburneus, viscidus; contextus albus vel flavescens. Pileipellis monostrata, hyphis tenuibus hyalinis gelatinosis. Basidiospora asymmetricae, ovatae, 12.6–14 × 6.3–7.8 µm, in KOH cinnamomeae, virencis tenuibus 0.3–0.5 µm altis. — Typus: M. Danks, J.M. Trappe, T. Lebel & K. Vernes KV532 (MEL2331647) (holotypus hic designatus), Australia, New South Wales, Mt Kaputar, Kaputar Rd, Plot GW2, 16 July 2007.

**Etymology.** Name refers to mottled white-brown colour of the sporocarps (L: *maculata* = mottled; *bulga* = purse or bag).

*Sporocarps* hypogeous under leaf litter, fruiting singly or in large groups. *Pileus* 10–23 × 10–42 mm diam, irregularly subglobose to pyriform or turbinate with flattened or convex apex, completely enclosing hymenophore. *Pellis* white to cream mottled with brown patches, smooth, moist to viscid overall or in patches near base, not hygrophanous, not bruising, with patchy overlying remnant veil, white to pale grey, easily rubbed off with handling. *Context* 0.5–1.5 mm thick, translucent white to cream. *Hymenophore* pale cinnamon brown initially becoming dark cinnamon brown, trama, if noticeable, pale brown to dark brown; loculate, chambers empty, irregular, slightly elongate to labyrinthine. *Stipe-columella* a truncate to percurrent columnella tapering slightly from a bulbous exserted base towards the apex, 8–35 × 2–6 mm diam, white to translucent yellow in section, central or slightly eccentric, white to cream, viscid, solid, base bulbous, somewhat marginate, 5–11 mm diam, protruding up to 4 mm below pileus; *universal veil* remnants apparent as patchy white to pale grey, viscid fibrils; *partial veil* inconspicuous, thin membranous, connecting inrolled margin and stipe base, white to cream coloured, dry. *Basal mycelium* inconspicuous, white. *Odour* faintly spicy-sweet; *taste* not distinctive.

*Spores* 12.6–14 × 6.3–7.8 µm, mean = 13.5 × 7.2 µm, Q = 1.8–2.0, mean Q = 1.94, cinnamon brown (KOH), ovoid, ornamented with fine, rounded, isolated warts, 0.3–0.5 × 0.2–0.3 µm; hilar appendage to 1 µm, conspicuous, tapering, truncate; spores inamyloid non-dextrinoid; apex ornamented. *Basidia* 37–40 × 9–12 µm, hyaline, clavate to cylindrical, thin-walled, with 4 sterigmata. *Cystidia* 15–38 × 4–8 µm, hyaline, clavate, thin-walled, scattered and never protruding beyond hymenium.

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**Fig. 12** *Cortinarius kaputarensis* spores. — Scale bar = 5 µm.

**Fig. 13** Scanning electron micrographs of *Cortinarius kaputarensis* spores. — Scale bars = 10 µm.
Hymenophoral trama 45–195 µm wide, of interwoven, hyaline, somewhat gelatinised hyphae 2–5(–8) µm diam, with inflated elements 4–16 × 5–18 µm. Subhymenium undifferentiated from trama. Pileipellis simplex. Epicutis narrow, 15–45 µm wide, of patchy upright hyphal tips, becoming interwoven and subparallel below, hyphae 3–6 µm diam; context, 70–320 µm broad, of gelatinised, hyaline hyphae, 2–8 µm diam. Clamp connections present in the pileus.

Habitat & Distribution — In New South Wales, occurring in sub-alpine grassy woodland on the Kaputar Plateau among Eucalyptus dalrympleana, E. pauciflora and E. viminalis. Fruit-ting: July.

Specimens examined: AUSTRALIA, New South Wales, Mt Kaputar, Kaputar Rd, Plot GW1, 16 July 2007, M. Danks, J.M. Trappe, T. Lebel & K. Vernes KV510 (NE94640); Mt Kaputar, Kaputar Rd, Plot GW1, 16 July 2007, M. Danks, J.M. Trappe, T. Lebel & K. Vernes KV511 (NE94641).

Notes — Cortinarius maculobulga may be distinguished from other Australian sequestrate Cortinarius species by the subglobose to pyriform white to cream sporocarps mottled with brown patches, and largish spores with minute warts. Analyses of ITS sequences places this species in a poorly supported (bootstrap 52 %) Rozites ‘A’ clade with three other southern hemisphere species, Australian C. vinaceolamellatus, New Zealand C. subcastanellus and sequestrate Argentinean taxon C. holochinthus. The Australian species C. submeleagris is not included in this clade in the analysis presented, however in earlier analyses it did group with these taxa. A second clade of Rozites ‘B’ with strong support (bootstrap 97 %), including the European and Asian species C. caperatus, C. emodensis and C. similis is apparently distinct to this first group (Fig. 1).

Species of Rozites have velar remnants or scales on the pileus (which may disappear in older specimens), a slightly viscid to glutinous pileus, and a membranous partial veil. Cortinarius maculobulga appears to lack the distinct velar remnants apparent on the pileus of many other Rozites taxa, though the veil is somewhat membranous. This species also differs from other Rozites taxa in having a pileipellis simplex rather than duplex. Species in the Rozites ‘A’ clade have either glutinous to viscid brownish (C. subcastanellus, C. submeleagris, C. maculobulga) or silver-greyish purple (C. holochinthus and C. vinaceolamellatus) pilei. Cortinarius maculobulga and C. subcastanellus

![Fig. 14](image14.jpg) **Fig. 14** Cortinarius maculobulga. a. Pileipellis; b. spores. — Scale bars: a = 50 µm; b = 5 µm.

![Fig. 15](image15.jpg) **Fig. 15** Scanning electron micrographs of Cortinarius maculobulga spores. — Scale bars = 10 µm.
appear to lack any purple tints to the lamellae/hymenophore, whereas C. holojanthinus, C. submeleagris and C. vinaceolamellatus all have at least some purple tints when young. There is no apparent pattern in plant associates, as C. holojanthinus, C. subcastanellus and C. submeleagris are all Nothofagus associates, and C. maculobulga and C. vinaceolamellatus are eucalypt associates.

7. Cortinarius nebulobrunneus Danks, T. Lebel & Vernes, sp. nov. — MycoBank MB515241; Fig. 2g, 16, 17

Sporocarpia hypogaea vel emergentia, 22–45 mm lata, convexa apicibus complanata, margine laevia; pileus ferrugineus vel brunneus non-viscidis. Velum album, crassum, persistens. Hymenophorum sublamellatum vel labyrinthiforme loculatum contortum, vivide cinnamomeum. Stipes 40–55 × 5–12 mm, percurrens, protrudens, solidus, robustus, basi leviter bulbosus, albus, glaber, non-viscidus; contextus albus. Pileipellis bistrata, extus hyphis tenuibus hyalinis, interne hyphis luteobrunneis non gelatinosis. — Typus: M. Danks, J.M. Trappe, T. Lebel & K. Vernes KV588 (holo MEL2331648 (holotypus hic designatus); iso NE94643), Australia, New South Wales, Mt Kaputar, Kaputar Rd, Plot GW3, 17 July 2007.

Etymology. Name refers to the white ‘bloom’ universal veil overlying the brown pileus (L.: nebulosus = foggy or misty; brunnea = brown).

Sporocarps hypogeous to emergent under leaf litter, in a small group. Pileus 13–27 × 22–45 mm diam, strongly convex, occasionally with a flattened apex, and smooth margin. Pileus light brown-orange to brown, finely fibrillose, viscid, not hygrophanous, not bruising, sometimes with a white remnant of veil on the disc appearing as a white ‘bloom’, easily rubbed off with handling. Context 0.8–3.0 mm thick, rapidly thinning from disc to margin, translucent yellow-brown, slightly waxy texture. Hymenophore bright cinnamon brown at all stages, sublamellate to loculate, compact, forming irregular, contorted labyrinthine chambers 0.3–1 mm diam. Stipe-columella percurrent, 40–55 × 5–12 mm, white slightly translucent, somewhat waxy texture, smooth, moist but not viscid when fresh, white in section, central, solid, robust, equal or sometimes expanding into slightly bulbous base; partial veil remnants inconspicuous, as fine white cottony cortina between pellis margin and stipe. Basal mycelium not conspicuous. Odour mild, not distinctive; taste not distinctive.

Spores 9.0–11.9 × 5.5–6.5 µm, mean (15 spores) = 9.9 × 5.9 µm, Q = 1.6–1.8, mean Q = 1.74, pale yellow (KOH), elongate ellipsoid, asymmetric, ornamented with fine, scattered, irregular, flat-topped or rounded warts, 0.3–0.5 µm high; hilar appendage to 1 µm, inconspicuous, tapering; spores inamyloid non-dextrinoid; apex ornamented. Basidia 25–28(–30) × 5–8 µm.

Fig. 16 Cortinarius nebulobrunneus. a. Pileipellis; b. spores. — Scale bars: a = 50 µm; b = 5 µm.

Fig. 17 Scanning electron micrographs of Cortinarius nebulobrunneus spores. — Scale bars = 10 µm.
µm, elongate cylindrical to narrowly clavate, hyaline, 4-spored. Cystidia not observed. Hymenophoral trama 20–45 µm wide, of interwoven hyaline hyphae 2–3 µm diam, with occasional inflated elements 10–17 µm diam; subhymenium undifferentiated from trama. Pileipellis duplex. Epicutis narrow, 15–25 µm wide, of interwoven, gelatinised hyaline hyphae 2–3 µm diam; hypocutis 25–75 µm wide, of light golden brown, subglobose to ellipsoid inflated hyphae mostly 6–13 µm diam x 8–48 µm long; context 100–300 µm wide, of mostly hyaline hyphae 4–6 µm diam, subparallel with patches of inflated elements up to 12 µm diam x 30–45 µm long. Clamp connections present in the pileus and hymenophoral trama.

Habitat & Distribution — In New South Wales, occurring in sub-alpine grassy woodland among Eucalyptus dafrympleana, E. pauciflora and E. viminalis. Fruiting: June – July.

Specimen examined: AUSTRALIA, New South Wales, Coolangubra NP, Waratah Rd 2.1 km NE of junction with Coolangubra Forest Way, A.W. Claridge Trappe 18741, 2 June 1996 (CANB, MEL, OSC130731).

Notes — Cortinarius nebulobrunneus is distinguished by the combination of brown pellis with white bloom of universal veil, sublamellate to loculate hymenophore and robust stipe—support, other section taxa, and an undescribed sequestrate (Fig. 1). In this current analysis, although lacking bootstrap, other section taxa, especially Neocortinarius and Phlegmacium, are associates of Cortinarius sinapivelus.

Spores hypogeous to emergent under leaf litter, in a small group. Pileus 6–15 × 12–21 mm diam, convex to subglobose with a flattened apex, and slightly plicate margin attached to stipe by a thick cobweb yellow veil, which pulls away in patches to expose the hymenophore. Pellis pale tan brown, finely fibrillose, dry to moist when fresh but not viscid, not hygrophanous, not bruising, with overlying remnant yellow, fibrillose universal veil, easily rubbed off with handling. Context 0.5–3.0 mm thick, translucent yellow-tan. Hymenophore pale cinnamon brown initially, darkening slightly as spores mature, elongated labyrinthine to sublamellate, compressed, contorted/wrinkled and intervenose, especially near the apex and stipe, locules 0.5–2 mm diam. Stipe-columella percurrent, 18–35 × 6–8 mm diam, bright yellow, fibrillose, in section with yellow edges and bright orange centre, central to slightly asymmetric, solid, slender, equal or slightly contorted, dry; universal veil remnants apparent as scattered slightly darker yellow-orange fibrils on pileus surface and stipe; partial veil a thick mustard yellow cortina between pileus margin and stipe. Basal mycelium yellow bright yellow. Odour mild, not distinctive; taste not distinctive.

Spores 8.9–10.2 × 6.5–7.4 µm, mean (13 spores) = 9.4 ± 0.7 µm, Q = 1.2–1.4, mean Q = 1.40, cinnamon brown (KOH), broadly ovoid, slightly asymmetric, ornamented with nodules, irregular, flat topped or rounded, < 0.5 µm tall; hilar appendage to 1 µm, conspicuous, tapering, truncate; spores inamylodiverticinoid; apex ornamented. Basidia 26–29 × 7–8 µm, hyaline, clavate to cylindrical, thin-walled, with 4 sterigmata. Cystidia (13.5–)16.5–26.5 × (5.5–)8–12.5(–17) µm, hyaline, clavate, thin-walled, abundant, never protruding beyond hymenium. Hymenophoral trama 15–30 µm wide, of interwoven hyaline hyphae

**Fig. 18** Cortinarius sinapivelus. a. Pilepellis; b. spores. — Scale bars: a = 100 µm; b = 5 µm.
Notes — Although our preference is to not describe taxa from single collections, there were multiple sporocarps, all with varying degrees of elongate labyrinthe to sublaminellate hymenophore, and a thick partial veil that remained attached to the stipe and pileus margin, even in mature sporocarps. Cortinarius sinapivelus also has a brownish pileus and yellow veil, however does resemble a patchy outer thin layer, 12–17 µm wide, of hyaline subgelatinised hyphae 2.5–3 µm diam; epicutis narrow, 26–55 µm wide, of pale brown pigmented inflated ± isodiametric cells 10–22 × 8–19 µm, merging with the context, 570–1250 µm wide, of subparallel, irregularly inflated, hyaline hyphae, mostly 7.5–12.5 µm diam, with scattered elements 25–30 µm diam. Clamp connections present in the pileus.

Habitat & Distribution — In New South Wales, occurring in sub-alpine grassy woodland on the Kaputar Plateau among Eucalyptus dalrympleana and E. pauciflora. Fruiting: July.

Specimens examined. Known only from type.

Analyses of ITS sequences confirms placement of C. sinapivelus in a well supported section Splendidi (bootstrap 76 %), close to a New Zealand sequence of C. persplendidus in a clade (bootstrap 52 %) with the Australian species C. basirubscens and C. erythrocephalus (Fig. 1). Cortinarius basirubscens, C. erythrocephalus and C. persplendidus have rich red or red and yellow sporocarps with bright yellow basal mycelium. Another Australian red-pigmented species, Dermocybe kula, is also in this broader Splendidi clade, though it has been shown to have unique red pigments. Cortinarius sinapivelus lacks bright red pigments, having a brown pileus, however does resemble C. persplendidus in the bright yellow stipe, bright yellow cortina, and bright basal mycelium. Cortinarius clelandii, which is in a well supported (bootstrap 94 %) subclade with the sequestrate taxa C. globuliformis and C. sejunctus, has duller sporocarps and the spore ornamentation is less robust and more citriniform than C. sinapivelus (Jones 2007).

**DISCUSSION**

Several clades representing sections within Cortinarius sensu Peintner et al. (2002a) and Garnica et al. (2005) were recovered in our analyses of ITS sequences, with varying support (Fig. 1). Not all subgenera were included, such as solely northern hemisphere section Calochroi (Garnica et al. 2009) in final analyses. Poor bootstrap support for the deeper branches is typical for such a large dataset, based upon a single region. Inclusion of nLSU data could perhaps help to clarify some of these deeper relationships, however in this paper we were more concerned in placing our new taxa in a general sectional framework. As has been shown by several workers, the separation of a large and diverse genus Cortinarius from Hebeloma and Gymnopilus is strongly supported (Peintner et al. 2002a, 2004, Garnica et al. 2005, Francis 2007). Sequestrate sporocarp forms are scattered throughout many different lineages within Cortinarius, Descolea and Hebeloma, thus sequestrate cortinarioid genera (based on historical morphological characters) are non-mono phylectic. The sequestrate genus Hymenogaster is again shown to be paraphyletic, with Hymenogaster A (including species from Spain of H. buillardii) having affinities to Hebeloma (73 % bootstrap, Fig. 1) and Hymenogaster B (bootstrap 85 %), along with two species of Protoglossum, within Cortinarius. The related sequestrate genera Descomyces and Timgrovea, with affinities to Descolea, are diverse in Australia, with some 35 undescribed species (Francis 2007, Trappe pers. comm.). Further investigation of the affinities of Hymenogaster should include type studies as well as greater incorporation of these southern taxa.

Broader geographic patterns, of subclades of southern hemisphere taxa within larger sectional clades are apparent (Fig. 2). However this is partly due to taxon selection, with an emphasis on southern hemisphere taxa for the present analyses. Host tree association has been considered a driving force in the evolution of the genus Cortinarius (Horak 1973, Garnica et al. 2009). In Australia species in the genera Nothofagus and Eucalyptus are the main tree associates of native ectomycorrhizal fungi. Although we currently lack extensive geographic data for most...
cortinaroid species, the broader pattern for Australian ectomy-
corrhizal fungi appears to be a lack of host tree species fidelity, i.e. "any eucalypt will do" (May 2002). In several clades in our analyses, *Pseudotriumphantes, Rozites A*’, a mixture of closely related taxa with associations with *Nothofagus* and *Eucalyptus* occur (Fig. 2). A host-shift from *Nothofagus* to *Eucalyptus* has occurred at least once in the Western Australian species *C. symea* (Bougher et al. 1994). However, at this early stage in species delimitation it is not possible to evaluate radiation of taxa or centres of origin for particular sections within *Corti-
narius* in Australia.

The loss of gross morphological characters in sequestrate sporocarp forms can make placement of taxa within broader sectional groupings difficult. The use of molecular data as additional characters, has helped considerably in this goal. However, for most of the novel species presented here, morphological characters were also found to support their placement with agaric taxa in the same clades. Although no totally sequestrate fungi clades occur in our analyses, the great diversification of the sequestrate form in Australia in many agaric families, means that some of these groupings may become apparent in future analyses. The appearance of sequences from a single ‘species’ in different several lineages, (i.e. *C. campbelliae*), highlights the need for type studies and clarification of cryptic taxa within Australian sequestrate *Cortinarius* species, particularly section *Purpurascentes*.

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