

Rare, whitish–pale ochre *Cortinarius* species of sect. *Calochroi* from calcareous *Tilia* forests in South East Norway

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NØKKELOD

Cortinarius, ITS-sekvensering, morfologi, *C. albertii*, *C. catharinae*, *C. parasuaveolens*, *C. subgracilis*, *C. insignibulbus*

SAMMENDRAG

Fem slørsopper fra kalklindeskog med hvitaktig – blekoker hatt (“*C. parvus*-komplekset”); seksjon *Calochroi*) er behandlet her. Disse har alle sin verdensnordgrense i Oslofjord–Mjøsa-området, er ekstremt sjeldne og hos

oss bundet til kalklindeskogen. De er hver kun kjent fra 1–3, trolig svært gamle, reliktpregete lokaliteter. Selv om disse artene er svært like, og kan være vanskelig å skille, er denne gruppen ikke monofyletisk, og artene opptrer i forskjellige fylogenetiske greiner/klader innenfor *Calochroi*. Basert på makrokjemiske KOH reaksjoner kan to undergrupper skilles ut; de som reagerer kraftig rosa–blodrødt med KOH både på hatt(kant) og undersiden av knollen (*C. albertii*, *C. catharinae* og *C. parasuaveolens*) og de som reagerer sterkt bare på undersiden av knollen (*C. subgracilis* and *C. insignibulbus*). Den sistnevnte gruppen skilles også på noe større sporer, dog med overlapp til de andre artene. *Cortinarius catharinae* og *C. subgracilis* er bare funnet i vårt sørlige kalklindeskogsområde (Grenland), mens *C. parasuaveolens* og *C. insignibulbus* er funnet i de nordlige områdene (indre Oslofjord–Ringerike–Mjøsa), mens *C. albertii* er registrert både i Grenland og på Ringerike.

ABSTRACT

Five initially whitish-pale ochre *Cortinarius* section *Calochroi* species (“the *C. parvus* complex”) from SE Norwegian calcareous *Tilia* forests are treated. The species have their world’s northernmost localities in the Oslofjord–Mjøsa area, and are all extremely

rare; with 1–3 known localities from our *Tilia* forests, probably very old ones, of relic nature. Although more or less overlapping in morphological features, the group is not monophyletic, and the species belongs to different clades within *Calochroi*. According to their macrochemical KOH-reaction, two subgroups can be distinguished; those with a bright pink-blood red reaction with KOH both on pileus (margin) and bulb underside (*C. albertii*, *C. catharinae*, *C. parasuaveolens*) and those with pink-blood red reaction only at bulb underside (*C. subgracilis* and *C. insignibulbus*). The two species of latter subgroup are also distinguished on slightly larger spores. *Cortinarius catharinae* and *C. subgracilis* are recorded only in the southern calcareous *Tilia* forest region (outer Oslofjord), whereas *C. parasuaveolens* and *C. insignibulbus* are found only in the more northern regions (inner Oslofjord-Ringerike-lake Mjøsa), and *C. albertii* is found both in outer Oslofjord and at Ringerike.

INTRODUCTION

Cortinarius is a remarkably large genus of agarics, with more than 2000 species accepted worldwide, including more than 900 species verified with DNA sequences in Garnica et al. (2016). The number of habitat-specific calciphilous species is also remarkable, and e.g. calcareous *Quercus-Carpinus-Fagus-Tilia-Corylus* forests can be extreme hotspots for specialized species of *Cortinarius* assigned to subgenus *Phlegmacium*, in the traditional sense. Many of these species have been cited as strict indicator species for calcareous forest types in Northern (N) Europe (e.g. Brandrud 1999, Brandrud and Bendiksen 2001, Brandrud et al. 2011, Jeppesen and Frøslev 2011) and Central (C) Europe (e.g. Knoch 1990, Gminder 2010, Brandrud and Schmidt-Stohn 2011). According to recent phylogenetic studies, subgen. *Phlegmacium* is not monophyletic (Stensrud et al. 2014, Garnica et al. 2016),

and in the following, this group is termed phlegmacioid species.

In Norway, calcareous frondose forests occur as small *Tilia-Corylus(-Quercus)* stands on limestone ridges and outcrops (Brandrud 1999, Brandrud et al. 2011, 2016). Calcareous *Tilia cordata* forests are internationally very rare, almost confined to Southeast (SE) Norway (Brandrud 1999, Brandrud et al. 2016). The SE Norwegian calcareous *Tilia* forests are situated outside the natural *Fagus* and *Carpinus* forest range, and where *Quercus* is scarce. It seems that calcareous *Tilia* forests at present are mainly confined to such regions in Europe. These *Tilia* forests of SE Norway are believed to be 6000–7000 years old relics, often with complex, multi-stemmed *Tilia cordata* individuals, which could be as old as their forest stands (Brandrud 1999, Brandrud et al. 2011, 2014, 2016).

A monitoring programme for the habitat-specific calcareous *Tilia* forest fungi was recently initiated, with a base-line monitoring in 2013–2015, including 30 randomly selected localities/sites (Brandrud et al. 2014, 2016). As a result of this monitoring, 89 species of fungi that have their primary habitat in this forest type in Norway are now recognized. More than 60 of these habitat specialists are *Cortinarius* species, including five recently published new taxa (Brandrud et al. 2015, Brandrud et al. 2016, Frøslev et al. 2017). Of the *Cortinarius* species recorded in our calcareous *Tilia* forests, 37 are phlegmacioid taxa, and more than half of these phlegmacioid ones belong to the large monophyletic section *Calochroi* (incl. sect. *Fulvi* sensu Brandrud et al. 1990–2014) (19 taxa; see synoptic tables in Brandrud et al. 2011, 2016).

The majority of the European calochroid species are strictly associated with frondose trees, and could well be said to represent the prototype of calciphilous frondose forest macrofungi. The group is especially speciose in Mediterranean, calcareous *Quercus ilex*

forests–woodlands (e.g. Brandrud 2000, Frøslev et al. 2007, Mahiques 2000, Mahiques et al. 2011). In nemoral-temperate regions they are characteristic for calcareous *Fagus* or *Quercus-Carpinus* forests (e.g. Oertel 1984, Jeppesen and Frøslev 2011, Brandrud and Schmidt-Stohn 2011), and in the boreo-nemoral belt of SE-Norway–SE Sweden they occur in calcareous *Tilia-Corylus* and *Quercus-Corylus* woodlands (Brandrud 1999, Brandrud and Bendiksen 2001). A number of species shows a submediterranean-southern temperate distribution, but many are widely distributed from the Mediterranean Sea to the Oslofjord, having their world’s northernmost occurrences in SE Norway. This group also includes a few more strictly *Tilia*-associated taxa, such as *C. osloensis* Brandrud, T.S. Jeppesen & Frøslev, which is only recorded in the SE Norwegian calcareous *Tilia* forests (Frøslev et al. 2006a).

Many of the calochroid species in calcareous *Tilia* forests appear to be extremely rare. Even after long-term studies and intensive monitoring 2013–2015, five species have only been recorded in one out of the 150 presently known calcareous *Tilia* localities/ sites, and seven species only in two (Brandrud et al. 2011, 2016).

The present paper deals with one of the least known and morphologically most difficult groups of species in *Calochroi* in Norwegian calcareous *Tilia* forests. This group of whitish-pale ochre species has earlier been interpreted more broadly as one taxon – i.e. *C. parvus* Rob. Henry (e.g. Moser 1961, Brandrud and Bendiksen 2001) or *C. calochrous* (Pers.) Gray var. *parvus* (Rob. Henry) Brandrud (Brandrud et al. 1990–2014), but is now recognized as a group of morphologically very similar but phylogenetically distinct species. Morphologically, the species are pale with a whitish to very pale yellow ochre pileus or pileus margin when young and unexposed, lilac (to greyish) lamellae, and a

bright pink KOH-reaction on the bulb underside (bulbipellis/basal mycelium). Phylogenetically, this morphological complex does not form a supported monophyletic lineage (Frøslev et al. 2007, Garnica et al. 2009, 2016).

The “*C. parvus* complex” illustrates well the fluctuating and conflicting taxonomic approaches and stages in the study of genus *Cortinarius*. Three major approaches can be distinguished during the last 30 years:

- (i) *The extreme lumping approach*. In the nordic *Cortinarius Flora Photographica* (Brandrud et al. 1990–2014) the complex was initially treated as *C. calochrous* var. *parvus*, covering all deciduous forest variants with a pale pileus with a whitish margin and whitish universal veil remnants at bulb margin. This lumping was partly based on the continuous nature of morphological characters (such as pileus colours), but also partly a result of lack of information on character variations (due to very little material being available) and an under-emphasis on some taxonomically relevant features such as the KOH-reaction on the bulb underside and pileus (margin).
- (ii) *The extreme splitting approach*. The French *Atlas des Cortinaires* (AdC; cf. e.g. Bidaud et al. 2001) has performed an extensive splitting of the presently accepted taxa. For instance, the most frequent taxon in the *C. parvus* group, *C. catharinae*, was in AdC XI (Bidaud et al. 2001) treated as five or six different species (Frøslev et al. 2007), species which according to our morphological and phylogenetic analyses are identical (see further treatment under Taxonomic part).
- (iii) *The phylogenetic stages*. With phylogenetic methods our “*C. parvus*” can be separated in at least 5 well-supported phylogenetic species (Frøslev et al. 2007,

Garnica et al. 2009, 2016, Bellanger 2015), accompanied by a more or less distinct morphological differentiation. These taxa are further treated and discussed below.

MATERIAL AND METHODS

Norwegian material of the studied, five *Calochroi* species was derived from a monitoring project of 30 sites/localities of calcareous *Tilia* forests in SE Norway 2013–2015, as well as some studies in these *Tilia* forests prior to that. For monitoring results, and data on each site/locality (incl. site GPS-coordinates), see Brandrud et al. (2016). The studied collections are deposited in the herbarium of the University of Oslo, Natural History Museum (O). The descriptions are also based on other European collections made by the authors (for collection lists, see Frøslev et al. 2007, Clericuzio et al. 2017). The colour standard used is that of Cailleux (1981).

Spores and other microscopic features were studied and measured with a 100 × oil immersion lens (achromatic Zeiss and Leiz equipments), with mounts in 2 % KOH. From each basidiocarp, a random selection of ten to twenty mature spores obtained from cortina remnants/stipe surface were measured excluding apiculus and ornamentation. Based on the mean values obtained from these measurement series, the range of spore variation is given in species description (extreme single-spore measurements are thus omitted from the range given). The study of macromorphological features are based on notes on fresh material. For macrochemical reactions 10–40% KOH was applied.

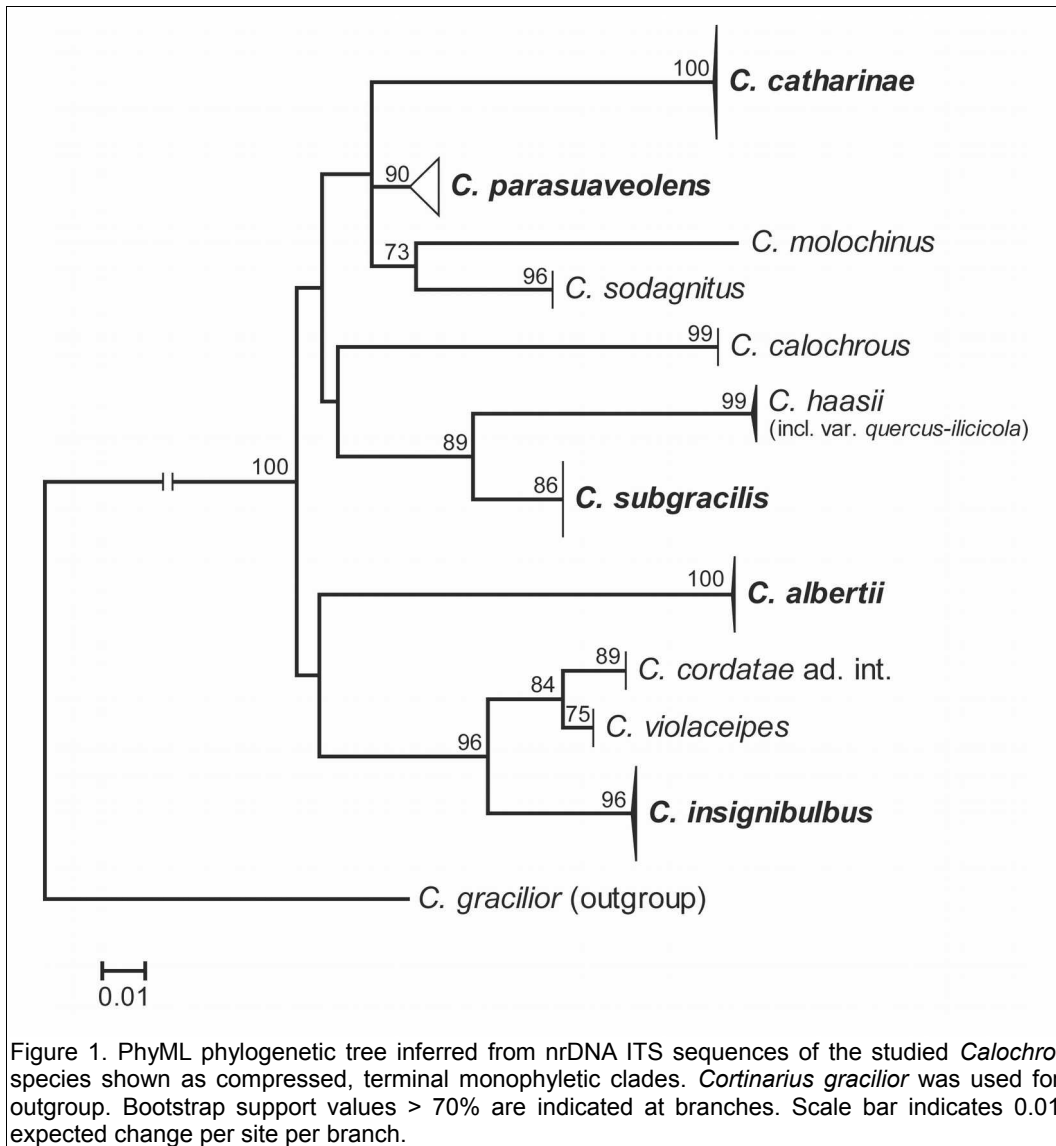
The nrDNA ITS region was sequenced in all studied collections. DNA extraction, PCR and sequencing procedures followed Brandrud et al. (2015). The ITS sequences of the 5 species treated here were supplemented with sequences of morphological similar species mentioned in the Taxonomy part. Alignment

was done by MAFFT online version 7 (<http://mafft.cbrc.jp/alignment/server/>) using the E-INS-I method (Kato and Standley 2013). After manual adjustment in SeaView (Gouy et al. 2010), Maximum Likelihood analysis was performed in PhyML online (Guindon et al. 2010) using the GTR+I+Γ model of evolution. The resulting phylogenetic tree was edited in MEGA 7 (Kumar et al., 2016) and shown in Fig. 1.

RESULTS AND DISCUSSION

All five of the now accepted calochroid species in the “*C. parvus* complex” in Europe (Fig. 1) were recorded and verified with ITS sequences in our calcareous *Tilia* forests during our recent extensive surveying and monitoring studies. The species were among the rarest taxa in our monitoring data, recorded at only one locality/site (*C. parasuaveolens*, *C. subgracilis*), two localities (*C. albertii*, *C. catharinae*) or three localities (*C. insignibulbus*). Apart from one area where *C. albertii* and *C. parasuaveolens* occur close to each other, the species are not co-occurring on the same localities. *Cortinari* *catharinae* and *C. subgracilis* differ from the others by occurrence only in the southern calcareous *Tilia* forest region (outer Oslofjord). Due to sparse material, some collections would have been impossible to identify with certainty without sequencing.

The sequencing of our material confirmed the results of Frøslev et al. (2007) and Garnica et al. (2009, 2016), that the five pale species of the “*C. parvus* complex” are phylogenetically well-separated and the individual clusters are well-supported and monophyletic units, with a clear and constant barcoding gap towards neighbouring clusters/taxa (Fig. 1), and with little intraspecific genetic variation. The “*C. parvus* complex” did not, however, form a monophyletic group, but occurred intermixed with some species with lilac tinged pileus, and some with more yellow tinged pileus



(margin) when young. Only two of our species come close in our phylogenetic tree, namely *C. catharinae* and *C. parasuaveolens* (Fig. 1), but with an unresolved relationship presented as a soft polytomy. With other tree clustering methods applied, the two species fell more distantly from each other (data not shown, but see phylogenetic tree in Clericuzio et al. 2017). Their ITS dissimilarity is rather con-

siderable. *Cortinarius parasuaveolens* differs from *C. catharinae* by >20 basepairs, and from the more bluish tinged *C. molochinus* by >25 basepairs. Whereas *C. albertii* occupies a fairly isolated position in our tree, *C. subgracilis* is a well-supported sister to the *C. haasii*-group (with yellow pileus and basal-mycelium), and *C. insignibulbus* a well-supported sister

to the *C. violaceipes*-*C. cordatae* group (with lilac-violaceous spotted pileus).

Re-examination of our material combined with studies of the descriptions in literature revealed that all five species have differences in morphology, although seemingly with some character overlap. The morphological differentiation is treated in detail in taxonomic part.

Cortinarius albertii Dima, Frøslev & T.S.

Jeppesen

Fig 2.

Misapplied name: Cortinarius calochrous (Pers.) Gray var. *parvus* (Rob. Henry) Brandrud sensu Brandrud et al. (1992); Cortin. Fl. Photogr. 2: B53 p.p.

Illustration: Frøslev et al. (2006), Mycol. Res. 110: 1048.

Pileus 4–8(–10) cm, viscid–glutinous, glabrous; initially usually pure whitish, at least towards margin, but often entire pileus white when covered by leaf litter, soon with ochraceous

brown spots or stripes from centre (N–P 65) due to oxidation, often rendering the pileus bicoloured, marginal zone persistently whitish (where not bruised). Universal veil remnants sparse, sometimes as whitish, soon (dark) brownish patches at centre.

Lamellae initially pale greyish or rarely faintly lilac tinged, lilac tinges especially (or only) towards edge, finally more greyish brown.

Stipe 4–9(–10) × (0.8–)1–1.5 cm; at base with a strongly marginated, broad and flattened bulb up to 4 cm; stipe colour greyish white, often becoming somewhat brownish (spotted) with age. Universal veil at bulb margin initially rather thick, sometimes almost volva-like, but soon more diffuse, whitish, later often turning brownish.

Context white, with (ochre) greyish hygrophanous streaks in stipe apex. *Smell* faint to distinct dust/earth-like, especially the lamellae.

Macrochemical reaction: KOH (10–40%) bright pink on pileus (margin) when young,



Figure 2. *Cortinarius albertii*. One of two verified occurrences in Norway (TEB 224-10, Blekebakken NR, Telemark, outer Oslofjord). Photo: Kristin H. Brandrud.

then blood red, on base of bulb (basal mycelium/bulbipellis) bright pink (–pinkish red).

Spores 9.5–11 × 5.5–6.5(–7) μm, MV = 10.1 × 6.2 μm, amygdaloid, sometimes slightly citriform, strongly and coarsely (crust-like/net-like) verrucose. *Pileipellis* thick, simplex, of narrow hyphae, some filled with yellow pigment lumps (necropigment). Pale hyphae become distinctly pink with KOH, yellow hyphae more diffuse vinaceous.

Habitat: In calcareous *Tilia* forests, with *Tilia cordata* and *Corylus avellana*, on small limestone shelves or among stones in steep scree areas with substantial accumulation of leaf litter/humus (SE Norway; e.g. Brandrud et al. 2018). In S Scandinavia–C Europe mainly in calcareous *Fagus* forest, in the Mediterranean areas mainly in calcareous *Quercus ilex* forests, usually in organic soils (leaf litter).

Localities in SE Norway (Tilia): Telemark, Porsgrunn, Blekebakken NR, T.E. Brandrud, TEB 224-10. Buskerud, Hole, Sønsterudelva east (Ringerike), T.E. Brandrud & B. Dima, TEB 293a,b-17.

Distribution: Widely distributed in Europe, but apparently everywhere rare and restricted to calcareous frondose forest hotspots. Exact distribution is, however, little known due to confusion with similar species (especially the more common *C. catharinae*). Probably with a mainly southern distribution, with a number of verified records from Mediterranean E Spain–S France regions (Frøslev et al. 2006b). Also verified from nemoral–colline areas of Hungary, Germany and north to Denmark–S Sweden, with the here listed boreonemoral outposts in the Oslofjord-Ringerike area of SE Norway (Brandrud et al. 2018).

Comments: When well-developed, *C. albertii* should normally be possible to distinguish from the other species in the “*C. parvus* complex” by the initially non-yellow, often pure white pileus (margin) and pale greyish lamellae, without or with only sparse lilac–

bluish tinges. The KOH-reaction is very strong and immediate: bright pink-red on pileus (margin) and bulbipellis/basal mycelium. *Cortinarius catharinae* has a very similar KOH-reaction, but more blood red than pink on pileus, and on average not so intense. *Cortinarius catharinae* may also initially be very pale on pileus margin, but soon develops a faint yellow ochre tinge, and the lamellae are distinct to bright lilac(–pink). The spores are almost identical. *Cortinarius parasuaveolens* also possesses a strong red/pink KOH-reaction, but has slightly larger spores (10–11.5 × 5.5–6.5 μm versus 9.5–11 × 5.5–6.5 μm). Moreover, the basidiocarps of the latter are hardly pure whitish, and may also have some lilac tinges on bulb margin and/or pileus margin when (very) young. All these three species seem to have more or less the same habitat requirements, and may even be co-occurring in the same sites. *Cortinarius albertii* seems more restricted to soils with a (deep) leaf-litter layer than the others, and substrate remnants attached to base of bulb is always organic soil/litter. The two remaining taxa, *C. insignibulbus* and *C. subgracilis*, show no, or a weak KOH-reaction on pileus margin.

The species is so far recorded and ITS-verified only from two localities in our calcareous *Tilia* forests. One of these was found in 2017 in a large, newly discovered scree *Tilia* forest near the Tyrifjord at the Ringerike region (Sønsterudelva E; Brandrud et al. 2018). The material depicted in Brandrud and Bendiksen (2001, as *C. parvus*) were from an adjacent scree forest at Ringerike, and probably also represent *C. albertii*, although the lamellae appear too much lilac in the picture. This has yet to be verified by sequencing.

Cortinarius catharinae Consiglio

Fig. 3

Syn: *Cortinarius albolutescens* Reumaux; *C. pallens* Eyssart. & Reumaux; *C. pseudoparvus* Bidaud.

Misapplied names: *Cortinarius calochrous* (Pers.) Gray var. *parvus* (Rob. Henry) Brandrud sensu Brandrud et al. (1992); Cortin. Fl. Photogr. 2: B53 p.p. *Cortinarius xanthochrous* P.D. Orton sensu Bidaud et al. (2001).

Illustrations: Consiglio et al. (2003), Gen. Cortin. Ital. 1 A19 (upper; holot.). Brandrud et al. (1992), Cortin. Fl. Photogr. 2: B53. Bidaud et al. (2001), Atl. Cortin. 11: 334 (as *C. pallens*), 335 (lower, as *C. pseudoparvus*), 337 (as *C. albolutescens*)

Pileus 3–8(–10) cm, viscid–glutinous, glabrous; colour variable, initially usually whitish, at least towards margin, then becoming more ochraceous brown from centre (N60–65, P 60–65), and then tinged ochraceous yellow towards margin (K85(–K87)); rarely more (ochraceous) yellow already when young.

Lamellae intensely (to pale) lilac blue, edge sometimes persistently lilac, finally more greyish brown.

Stipe 4–6 × 0.8–1.5 cm; at base with a marginate, broad and flattened bulb up to 4 cm; stipe colour greyish white, sometimes with a faint lilac tinge at apex.

Context (greyish) white. *Smell* faint to distinct dust/earth-like, especially the lamellae.

Macrochemical reaction: KOH (10–40%) strongly blood red on pileus (margin), bright pink (–pinkish red) on base of bulb (bulbipellis/basal mycelium).

Spores 9.5–10.5(–11) × 5.5–6(–6.5) μm, MV = 10.1 × 5.9 μm, amygdaloid to somewhat ellipsoid, sometimes slightly citriform, strongly and coarsely (crust-like/net-like) verrucose.

Pileipellis thick, simplex, of narrow hyphae, many become gradually filled with bright yellow pigment lumps. Pale hyphae (without yellow pigment lumps) become distinctly pink with KOH.



Figure 3. *Cortinarius catharinae*. The most frequent of the pale *Calochroi* in C/S Europe, but only two verified finds in Norway so far (TEB 546-14/DB5518, Åsstranda NR, Telemark, outer Oslofjord). Photo: Bálint Dima.

Habitat: In calcareous *Tilia* forests, with *Tilia cordata* and *Corylus avellana*, on small limestone benches/shelves with some accumulation of leaf litter (SE Norway). In S Scandinavia–C Europe mainly in calcareous *Fagus* and *Quercus-Carpinus* forests, as well as thermophilous *Quercus cerris-Q. pubescens* forests, in the Mediterranean areas mainly in *Quercus ilex* forests, usually in organic soils (leaf litter).

Localities in SE Norway (Tilia): Telemark, Porsgrunn, Åsstranda NR, T.E. Brandrud & B. Dima, TEB 546-14 / DB5518 (O). Skien, Slettevann N, T.E. Brandrud & S. Reiso, TEB 624-14 (O).

Distribution: *Cortinarius catharinae* is widely distributed in Europe, from Mediterranean areas of Spain, S France and Italy, to the northern outposts in SE Norway. The species is one of the more frequent taxa in the *C. calochrous* complex in calcareous *Fagus* and *Quercus* forests of C Europe.

Comments: Among the five pale *Calochroi* species, *C. catharinae* is – together with *C. albertii* and *C. parasuaveolens* – distinguished by the strong, positive KOH-reaction on all surfaces; becoming instantly blood red/pink on pileus (margin) and bright pink on the bulb underside (basal mycelium/bulbipellis). *Cortinarius catharinae* is distinguished from *C. albertii* mainly by the faint ochraceous yellow tinge that develops rapidly when the pileus expands, the bright and often persistent lilac colours on the lamellae, and the slightly different KOH-reaction on pileipellis (blood red vs. strong pink). *Cortinarius parasuaveolens* may be quite similar to *C. catharinae*, but can often be distinguished on some faint lilac tinges on stipe, bulb margin or pileus margin, and then with a more skin coloured tinge on the pileus centre. *C. insignibulbus* is also whitish when young, but is distinguished by the negative KOH-reaction on the pileus (but still pink on the bulb underside), whereas the last taxon – *C. subgracilis* – usually shows

an ‘intermediate’ faint pinkish grey KOH-reaction on the pileus (margin).

Among *Calochroi* species not treated here, *C. catharinae* could in the calcareous *Tilia* forests chiefly be mixed with *C. sublilacinopes*. However, the latter possess a more distinctly ochraceous yellow pileus margin, and has a negative reaction with KOH. Furthermore, these are apparently occurring in different regions; *C. sublilacinopes* is only found in inner Oslofjord-Ringerike. *Cortinarius catharinae* is so far verified only from two localities in outer Oslofjord (Åsstranda, Porsgrunn, Slettevann, Skien). However, also three old collections from Blekebakken nature reserve, Porsgrunn, probably belong here (TEB 99-92, 43-93, 55-94; cf. Brandrud and Bendiksen 2001, as *C. parvus*), but we have not been able to verify this by sequences.

In general, *C. catharinae* seems to be the most common taxon of the ‘*C. parvus* complex’ in Europe, and it is one of the most frequently recorded *Calochroi* species in calcareous *Quercus-Fagus* forests (pers. obs.; see also Bidaud et al. 2001 as *C. albolutescens*, *C. cremeus*, *C. pallens*, *C. pseudoparvus*, *C. xanthochrous*, Consiglio et al 2003–2007, Frøslev et al. 2007, Clericuzio et al. 2017). The “classical name” *C. parvus* Rob. Henry (Henry 1935) has often been used for this species. However, this name is apparently not applicable, as the KOH reaction is indicated as negative, a feature also confirmed by Henry in later publications (Henry 1990). A “heterotype” designated by Henry was found in the Henry herbarium in herb. PC, but was contaminated and did not yield any relevant sequence.

Cortinarius parasuaveolens (Bon & Trescol)
Bidaud, Moëgne-Locc. & Reumaux
Fig. 4

Basionym: *Cortinarius sodagnitus* var.
parasuaveolens Bon & Trescol (1988),
Docum. Mycol. 19(73): 36.

Syn.: *Cortinarius pseudogracilior* Reumaux
in Bidaud et al. (2006) *Atlas des Cortinaires*
16: 1099.

Illustrations: Clericuzio et al. (2017), *Syd-*
owia 69: 221–222.

Pileus 4–7 cm, viscid–glutinous, glabrous,
some with white, appressed veil remnants at
centre; initially usually whitish to greyish
white (–ochraceous white) towards margin,
with an ochraceous (grey) brown tinge towards
centre (N65), later somewhat more ochraceous
brown spotted, sometimes initially with a
faint lilac tinge towards margin (from veil?)

and then with a more skin-coloured-incarnate
tinge towards centre (K70–71).

Lamellae initially pale greyish lilac(–pink),
lilac tinge mainly in the lamellae edge, dis-
colouring to greyish brown with pale edge.

Stipe 4–6(–8) × 0.7–1.5 cm; bulb marginated,
broad and flattened or not, up to 3 cm broad,
veil remnants on bulb margin abundant or not,
initially whitish to pale lilac; stipe initially
greyish or with a lilac blue tinge, also lilac
spots on the bulb margin, soon greyish white.

Context (greyish) white, initially lilac in cortex
of stipe and bulb. *Smell* indistinct.

Macrochemical reaction: KOH (10–40 %)
blood red to vinaceous grey on pileus margin,
on the bulb underside bright pink, on bulb
margin pinkish red.

Spores 10–11(–11.5) × 5.5–6.5 μm, MV =
10.5 × 6.0 μm, amygdaloid(–ellipsoid), mode-
rately strongly to strongly and coarsely ver-



Figure 4. *Cortinarius parasuaveolens*. Here depicted from *Quercus-Corylus* forest at Öland, Sweden (TF 2013-111) Photo: Tobias G. Frøslev.

rucose. *Pileipellis* thick, simplex, of narrow hyphae, entangled-erect at surface, a number with yellowish pigment, hyphae (especially the non-yellow pigmented) become pink when KOH is added.

Habitat: In calcareous *Tilia* forest with *Tilia cordata*, in stony, steep scree slope with gravel and accumulation of leaf litter between the stones (SE Norway). Otherwise recorded mainly in southern, thermophilous oak forests with *Quercus pubescens*, *Q. cerris* or *Q. ilex*, as well as *Carpinus betulus* forests and northern outposts in *Quercus robur-Corylus avellana* woodland (Öland, SE Sweden).

Locality in SE Norway (Tilia): Buskerud, Hole, Bråtåfjellet (near the Tyrifjord, Ringerike NW of Oslo), T.E. Brandrud, TEB 724-11.

Distribution: Apparently widespread in Europe, but very little known, due to confusion with *C. catharinae* and other species. Up to quite recently only published from France, but according to new, sequenced records presented in Clericuzio et al. (2017) it is now also known from E and W Italy, Hungary and SE Sweden. Most records are from southern mediterranean-submediterranean regions, with only few outposts in the boreonemoral Northern Europe region (see distributional map in Clericuzio et al. 2017).

Comments: In SE Norway, *Cortinarius parasuaveolens* is only known from one small, unripe basidiocarp from Bråtåfjellet near the Tyrifjord, which was verified with ITS sequencing. The species has been very little known up to now, and new data on the taxonomy and nomenclature is presented in Clericuzio et al. (2017). The above description is based mainly on data from this publication. The species is very similar to *C. catharinae*, with a pale pileus and bright pink–lilac lamellae, and they may co-occur. However, a (very) faint greyish-lilac tinge in young pilei sometimes gives *C. parasuaveolens* a skin-coloured tinge that is not seen in *C. catharinae*, but gives a superficial resemblance to e.g. *C. molo-*

chinus Bidaud & Ramm, which is also phylogenetically rather close (Fig. 1). Furthermore, *C. parasuaveolens* is sometimes distinctly lilac on the stipe and/or bulb margin. More material is, however, needed to evaluate the variation and significance of these lilac tinges for species delimitations. The spores of *C. parasuaveolens* are on average slightly larger than those of *C. catharinae* (mean value $10.5 \times 6.0 \mu\text{m}$ versus $10.1 \times 5.9 \mu\text{m}$), but still not enough to separate these. The shape of the spores is quite similar. With present knowledge, the two species should be regarded as semi-cryptic, and sequencing is needed for critical identifications.

The species was first described as *C. sodagnitus* var. *parasuaveolens* by Bon and Trescol (1988) from France. They described a *C. suaveolens* look-a-like with pronounced lilac colours on the pileus margin, and yet the ITS sequence of the type matches the present taxon (Bellanger et al. 2017, Clericuzio et al. 2017). The lilac colours emphasized in the protologue either indicates that our species may have pronounced lilac colours at pileus margin, or that Bon and Trescol (1988) included another element in their description of the species.

Liimatainen et al. (2014) found that the type of *C. pseudogracilior* also conforms with our species, based in ITS sequencing. In the protologue (Bidaud et al. 2006), *C. pseudogracilior* was described as a slender, pale species, almost without any bluish–lilac tinges, and it was compared with the small *C. gracilior* and placed in sect. *Multiformes* s. lat. (and not in sect. *Calochroi*). This does not fit very well with our species. However, the micro characters (investigated later by Bidaud; Bidaud et al. 2006) correspond much better (including a pink KOH reaction of pileipellis hyphae), and it is possible that there has been a mix of collections, and that the macro description is based on something else (Clericuzio et al. 2017).

Cortinarius subgracilis Moëgne-Loec.

Fig 5.

Misapplied name: ?*Cortinarius subarquatus* (M.M. Moser) M.M. Moser, in Moser (1952) *Sydowia* 6(1–4): 59.

Illustration: Bidaud et al (2001), *Atl. Cortin.* 11: 330

Cap 4–6 cm, viscid–glutinous, glabrous, sometimes with diffuse whitish (later brownish) patches of veil remnants at centre; initially ochraceous white with whitish–greyish white margin (K91–92), centre becoming more ochraceous brown (N65), with age often distinctly bicoloured (brown centre, pale margin; entire pileus might be whitish if covered by leaves).

Lamellae pale greyish lilac, lilac tinges mainly towards the edge, rather fugacious.

Stipe 4–5 cm × 0.8–1.2 cm; at base with a marginate, broad and flattened bulb up to 2.5 cm; bulb margin often with distinct, volva-

like, whitish veil remnants; stipe colour white to ochraceous white.

Context (greyish) white.

Smell weak to distinct earth/dust-like.

Macrochemical reaction: KOH (10–40 %) pale/indistinct pinkish–vinaceous grey to more red brown on pileus margin, bulb underside (basal mycelium) deep pink to pinkish red, distinct reddish tinge also on veil remnants at bulb margin.

Spores 10–11.5 × 6–7 μm, MV = 10.7 × 6.5 μm, amygdaloid to faintly citriform, strongly and coarsely (crust-like/net-like) verrucose.

Pileipellis thick, simplex of narrow hyphae, some filled with yellow brown content.

Habitat: In calcareous *Tilia* forest with *Tilia cordata* and *Quercus robur*, on small limestone shelves with some leaf litter (SE Norway). In C Europe the species occur in strongly calcareous *Abies alba* (mixed) forests, in Sweden (Gotland) in calcareous *Pinus* forests. In S Europe in calcareous *Quercus ilex* forests.



Figure 5. *Cortinarius subgracilis*. One verified occurrence in Norway (TEB 298-10, Kongkleivåsen N, Telemark, outer Oslofjord). Photo Kristin H. Brandrud.

Locality in SE Norway (Tilia): Telemark, Porsgrunn, Kongkleivåsen N (Hitterødbekken S; N of Frierflogene nature reserve), T.E. Brandrud, TEB 297-10.

Distribution: *Cortinarius subgracilis* is known from one locality in Norway; along the limestone plateau edge of Frierflogene-Kongkleivåsen in Porsgrunn, Grenland. Elsewhere in Europe, the species has a core area in the most calcareous, montane *Abies alba* forests (or mixed forests with *Abies*) in the Prealps in Austria-Switzerland and the French Jura north to Black forest. Recently found also in *Abies nordmanniana* dominated forests in W Caucasus (Brandrud et al., in prep.). Then the species re-appear in the far south, in the Mediterranean parts of Spain and France in evergreen oak forests.

Comments: *Cortinarius subgracilis* is a pale species with a broad, flattened bulb, and comparatively large spores. The species' often bicoloured appearance (pileus with ochre brown centre and whitish margin) is typical, although somewhat dependent on age and weather conditions. The species is according to own finds locally rather frequent in calcareous *Abies*-dominated forests in C Europe. However, it has been remarkably overlooked, probably due to confusion with a series of similar (although more yellow or lilac-tinged) *Calochroi* species in this kind of habitat (Brandrud et al., in prep.). In frondose forests, *Cortinarius subgracilis* can be distinguished from the other pale taxa by the KOH-reaction on the pileus: *C. albertii*, *C. catharinae* and *C. parasuaveolens* have a stronger pinkish red reaction, and *C. insignibulbus* has a negative KOH reaction. Furthermore, the spores of *C. subgracilis* are somewhat larger than those of *C. albertii* and *C. catharinae* ($10\text{--}11.5 \times 6\text{--}7 \mu\text{m}$, versus $9.5\text{--}11 \times 5.5\text{--}6.5 \mu\text{m}$).

The species is in SE Norway found in only one locality, along the Frierflaugene limestone plateau edge. Here it was in 2010 collected from three different spots (TEB 252-10, 297-

10, TEB 298-10), but only one of them verified by sequencing. This Norwegian locality is the only known occurrence of *C. subgracilis* north of the Alps in thermophilous deciduous forests (with *Quercus*, *Tilia*). This kind of habitat for the species is otherwise only known from the Mediterranean areas. The description above is based solely on our Norwegian material from *Tilia-Quercus* forests (cfr. Fig. 5), but this seems to be morphologically quite similar to the variant in *Abies*-(*Pinus-Picea*) forests. The southern *Quercus ilex* populations seem to differ by the presence of lilac tinges (sub nom. *C. malvaceopileatus* Bidaud & Raffini; J.-M. Bellanger pers. comm.), and thus it is possible that these may be morphologically distinguishable from other variants. Some of the Mediterranean collections apparently differ by one nucleotide from typical *C. subgracilis*, but other collections appear identical to the type (unpublished data), and this differentiation needs more study. It is possible that this differentiation reflect the eco-geographical variation. A small genetic differentiation is also seen in related taxa, such as *C. haasii* (M.M. Moser) M.M. Moser, with the main populations in *Abies* forests, and with southern frondose forest populations (*C. haasii* var. *quercus-ilicicola* A. Ortega, Suár.-Sant. & J.D. Reyes = *C. aurantiorufus* Bidaud), differing in spore-morphology and a couple of differences also in ITS sequences (Schmidt-Stohn et al. 2016).

According to data available so far, the Norwegian *Tilia-Quercus* forest population seems to be more similar to the *Abies* forest populations in C Europe than to the southern *Quercus* populations, but this needs further study. Our Oslofjord population should anyhow be regarded as a remarkable isolated, ecologically deviating outpost – probably of relic nature.

Cortinarius insignibulbus Bidaud & Moënne-Locc.

Fig 6.

Syn: *Cortinarius calochrous* (Pers.) Gray f. *violascens* Rob. Henry ex. Bidaud, Moënne-Locc. & Reumaux

Misapplied names: *Cortinarius calochrous* (Pers.) Gray var. *parvus* (Rob. Henry) Brandrud sensu Brandrud et al. 1992 Cortin. Fl. Photogr. 2: B53 p.p. *C. subamethystinus* Rob. Henry sensu Bidaud et al. 2001 Atl. Cortin 11.

Illustrations: Bidaud et al (2001), Atl. Cortin. 11: 342, 341 (as *C. subamethystinus*), 330 (as *C. calochrous* f. *violascens*)

Pileus 4–10 cm, viscid–glutinous, glabrous to somewhat tomentose when dry, incurved margin young with drop-like spots; initially greyish white to beige white («pearl white»; K92), pale colour usually rather persistent, but can discolour somewhat ochraceous brown (K90–91, M69–65) from centre with age, sometimes with a faint lilac tinge towards margin, and then with more skin-coloured-pinkish brown tinges in the centre.

Lamellae rather persistent pale to bright lilac blue, lilac colour sometimes more pronounced towards edge.

Stipe 5–7 × 1–1.5 cm; at base with a marginated, broad and flattened bulb up to 3.5 cm; stipe colour pale to strong and persistent lilac, especially at apex, sometimes with a lilac tinge also at bulb margin and on basal mycelium when (very) young.

Context (greyish) white, lilac in stipe cortex, sometimes also in the margin of bulb (when very young).

Smell faint to distinctly earth/dust-like.

Macrochemical reaction: KOH (10–40 %) negative (greyish brown, rarely faintly pinkish brown at white margin) on pileus, on the underside of bulb (basal mycelium) bright pink, a faint pinkish tinge also on the bulb margin when young.

Spores 10–12 × 6–7 μm, MV = 11.2 × 6.5 μm, amygdaloid to faintly citriform, strongly and coarsely (crust/net-like) verrucose.

Pileipellis thick, simplex, of narrow hyphae, with age some filled with strongly yellow pigment lumps, no pink colour tinge when KOH is added.

Habitat: In calcareous *Tilia* forest with *Tilia cordata*, in scree areas with limestone gravel and some leaf litter (SE Norway). Elsewhere mainly in calcareous *Fagus* forests, in France also in *Carpinus* forests.

Localities in SE Norway (Tilia): Oppland, Gjøvik, Biri, Eriksrud NR, T.E. Brandrud & B. Dima, TEB 256-14 (O) / DB5370 (BP), TEB 362b-14 (O) / DB5428 (BP). Akershus, Asker, Ormodden, T.E. Brandrud & B. Dima, TEB 398-14 (O). Buskerud, Røyken, Lillelien W, T.E. Brandrud & B. Dima, TEB 326-17 (O).

Distribution: *Cortinarius insignibulbus* is known from three localities in SE Norway (one along Lake Mjøsa and two in inner Oslofjord). Apart from these records, the species has in N Europe only been recorded from a couple of sites in Denmark (Frøslev et al. 2007). The species appears to be very rare everywhere, with confirmed records outside Scandinavia only from nemoral (temperate) France, Germany, Italy (Bidaud et al. 2001, Frøslev et al. 2007), and Hungary (unpublished).

Comments: *Cortinarius insignibulbus* is little known and rarely treated in literature (but see Bidaud et al. 2001, Frøslev et al. 2007). In *Atlas des Cortinaires* (Bidaud et al. 2001) the species is described threefold, under the names *C. insignibulbus*, *C. subamethystinus* sensu Bidaud et al. and *C. calochrous* f. *violascens*. The conspecificity of all three taxa was confirmed by ITS sequencing (Frøslev 2007 et al.). The species is clearly distinguished from the other pale *Calochroi* species by the KOH reaction, which is strikingly different on bulb underside (bright pink) versus pileus surface (negative) (Fig. 6b), a feature not mentioned in the descriptions in Bidaud et al.



Figure 6a,b. *Cortinarius insignibulbus*. From one of the three localities in Norway (TEB 256-14 & 362b-14/DB5370 & DB5428, Eriksrud NR, Biri, Oppland, lake Mjøsa W). See the difference in KOH reaction on bulb and pileus margin in fig. 6b. Photo: Bálint Dima.

(2001). The rather persistently pale, pearl white pileus contrasting the beautiful lilac lamellae and stipe apex is also a characteristic feature. Sometimes the entire stipe is deep and persistently lilac-purplish (see Bidaud et al 2001 as *C. subamethystinus*). Furthermore, the species also has slightly larger spores than those of *C. albertii*, *C. catharinae* and *C. parasuaveolens*, but hardly different from those of *C. subgracilis*. In contrast to the other taxa treated here, *C. insignibulbus* seems to be lacking from Mediterranean *Quercus ilex* forests.

Phylogenetic analyses (based on ITS sequence data) indicate that *C. insignibulbus* is most closely related to species with lilac pileus colours, such as *C. violaceipes* and *C. molochinus*. With age these species can lose their lilac tinges, and may then be difficult to distinguish from *C. insignibulbus*. This applies especially to pale variants of *C. violaceipes*, which also have the same KOH reaction. *Cortinarius violaceipes* is recently confirmed from SE Norwegian *Tilia* forests, but from another region than *C. insignibulbus* (outermost Oslofjord).

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REFERENCES

- Bellanger J-M, 2015. Les cortinaires calochroïdes: une mise au point taxinomique. Documents mycologiques 36: 3–34.
- Bellanger J-M, Bidaud A, Moreau P-A, 2017. Qu'est-ce que *Cortinarius parasuaveolens*? Documents Mycologiques (in press).
- Bidaud A, Moëgne-Loccoz P, Reumaux P, 2001. Atlas des Cortinaires. Pars X. S.A.R.L. Editions fédérations mycologique Dauphiné-Savoie. Marlioz.
- Bidaud A, Carteret X, Eyssartier G, Moëgne-Loccoz P, Reumaux P, 2006. Atlas des Cortinaires. Pars XVI. S.A.R.L. Editions fédérations mycologique Dauphiné-Savoie. Marlioz.
- Bon M, Trescol F, 1988. Quelques taxons nouveaux des chênaies vertes, pubescentes ou thermophiles. Documents Mycologiques 19(73): 36.
- Brandrud TE, 1999. *Cortinarius* subgenus *Phlegmacium* species associated with *Tilia cordata* (and *Corylus avellana*) in SE Norway: A relictual element? J. Journées Européennes Cortinaire 1: 83–88.
- Brandrud TE, 2000. Some distribution patterns of *Cortinarius* subgenus *Phlegmacium* species in Europe. J. Journées Européennes Cortinaire 2: 49–55[Engl. version].
- Brandrud TE, Bendiksen E, 2001. The *Cortinarius* species of calciphilous *Tilia-Corylus* and *Quercus-Corylus* woodlands of Fennoscandia, outposts of the temperate *Fagus* and *Quercus-Carpinus* forest types of C. Europe. J. Journées Européennes Cortinaire 3: 105–113. [Engl. version].
- Brandrud TE, Bendiksen E, Dima B, 2015. Some new and little known telamonioid *Cortinarius* species from Norway. Agarica 36: 11–42.
- Brandrud TE, Bendiksen E, Dima B, 2018. Kartlegging av kalklindeskogsopper i Oslo og Akershus, Buskerud og Telemark i 2017. NINA Rapport (in print.).

- Brandrud TE, Dima B, Liimatainen K, Niskanen T, 2016. Telamonioid *Cortinarius* of the *C. puellaris* group from calcareous *Tilia* forests. *Sydowia* 69: 37–45.
- Brandrud TE, Evju M, Skarpaas O, 2014. Nasjonal overvåking av kalklindeskog og kalklindeskogsopper. Beskrivelse av overvåkingsopplegg fra ARKO-prosjektet. NINA Rapport 1057, 37 p.
- Brandrud TE, Evju M, Blaalid R, Skarpaas O, 2016. Nasjonal overvåking av kalklindeskog og kalklindeskogsopper. Resultat fra første overvåkingsomløp 2013–2015. NINA Rapport 1297. 128 p.
- Brandrud TE, Hanssen O, Sverdrup-Thygeson A, Ødegaard F, 2011. Kalklindeskog – et hotspot-habitat. Sluttrapport under ARKO-prosjektets periode II. NINA Rapport 711. 41 p.
- Brandrud TE, Lindström H, Marklund H, Melot J, Muskos S, 1990–2014. *Cortinarius*, *Flora Photographica*. Vol. 1–5. Härnösand.
- Brandrud TE, Schmidt-Stohn G, 2011. Der Huy – ein artenreicher Cortinarien-Standort mit Kalklaubwäldern in Sachsen-Anhalt. *J. Journées Européennes Cortinaire* 13: 63–78.
- Cailleux A, 1981. Code des couleurs des sols. Paris: Boubée.
- Clericuzio M, Dovana F, Bellanger J-M, Brandrud TE, Dima B, Frøslev TG, Boccardo F, Jeppesen TS, Vizzini A, 2017. *Cortinarius parasuaveolens* (= *C. pseudogracilior*): new data and a synonym of a very poorly known species of section *Calochroi*. *Sydowia* 69: 215–228.
- Consiglio G, Antonini D, Antonini M, 2003–2007. Il genere *Cortinarius* in Italia. Vol 1–5. AMB Trento, Italy.
- Frøslev TG, Brandrud TE, Jeppesen TS, 2006a. New species and combinations in *Cortinarius* subgenus *Phlegmacium* section *Calochroi*. *Mycotaxon* 97: 367–377.
- Frøslev TG, Jeppesen TS, Læssøe T, 2006b. Seven new calochroid and fulvoid species of *Cortinarius*. *Mycological Research* 110: 1148–1160.
- Frøslev TG, Jeppesen TS, Læssøe T, Kjølner R, 2007. Molecular phylogenetics and delimitations of species in *Cortinarius* section *Calochroi* (Basidiomycota, Agaricales) in Europe. *Molecular Phylogenetics and Evolution* 44: 217–227.
- Frøslev TG, Brandrud TE, Dima B, 2017. *Cortinarius stjernegaardii* and *C. kristinae* (Basidiomycota, Agaricales), two new European species with a mainly northern distribution. *Mycological Progress* 16: 145–153.
- Garnica S, Weiß M, Oertel B, Ammirati J, Oberwinkler F, 2009. Phylogenetic relationships in *Cortinarius*, section *Calochroi*, inferred from nuclear DNA sequences. *BMC Evolutionary Biology* 9(1): 1.
- Garnica S, Schön ME, Abarenkov K, Riess K, Liimatainen K, Niskanen T, Dima B, Soop K, Frøslev TG, Jeppesen TS, Peintner U, Kuhnert-Finkernagel R, Brandrud TE, Saar G, Oertel B, Ammirati JF, 2016. Determining threshold values for barcoding fungi: lessons from *Cortinarius* (Basidiomycota), a highly diverse and widespread ectomycorrhizal genus. *FEMS Microbiology Ecology* 92(4): fiw045.
- Gminder A, 2010. Die Großpilze Baden-Württembergs. Band 5: Ständerpilze: Blätterpilze III. Ulmer, Stuttgart.
- Gouy M, Guindon S, Gascuel O, 2010. SeaView version 4: a multiplatform graphical user interface for sequence alignment and phylogenetic tree building. *Molecular Biology & Evolution* 27(2): 221–224.
- Guindon S, Lethiec F, Duroux P, Gascuel O, 2010. PHYML Online – a web server for fast maximum likelihood-based phylogenetic inference. *Nucl Acids Res* 33(Web Server issue):W557–559.
- Henry R, 1935. Etude de quelques Cortinaires du groupe des *Scauri*. Deux espèces nouvelles. *Bulletin Société mycologique de France* 51: 35–101.
- Henry R, 1990. Observations et remarques de R. Henry. [VIIèmes Journées européennes du Cortinaire (Dole 1989)]. *Docum. Mycol.* 80.

- Jeppesen TS, Frøslev TG, 2011. Knoldslørhatte som indikatorarter gennem 20 år (1991 – 2011). *Svampe* 64: 34–45.
- Katoh K, Standley DM, 2013. MAFFT multiple sequence alignment software version 7: improvements in performance and usability. *Molecular Biology and Evolution* 30: 772–780.
- Knoch D, 1990. Pilzschutz und Waldbau am Beispiel des Schönbergs bei Freiburg (Breisgau). *Beitr. Kenntn. Pilze Mitteleuropas* 7: 11–15.
- Liimatainen K, Niskanen T, Dima B, Kytövuori I, Ammirati JF, Frøslev TG, 2014. The largest type study of Agaricales species to date: bringing identification and nomenclature of *Phlegmacium* (*Cortinarius*) into the DNA era. *Persoonia* 33: 98–140.
- Mahiques R, 2000. Flora chorological i bibliogràfica dels Cortinaris Iberoinsulars. I. *Boletín de la Sociedad Micológica de Valenciana* 4–5: 147–364.
- Mahiques R, Ballara J, Cadinanos-Aguirre JA, 2011. Clave d los Cortinarios secc. Fulvi ss. lato de ambiente Mediterraneo. *Errotari* 8:199-239.
- Moser MM, 1961 ("1960"). Die Gattung *Phlegmacium* (Sleimköpfe). Die Pilze Mitteleuropas, Band IV. Julius Klinkhardt, Bad Heilbrunn.
- Oertel B, 1984. Untersuchungen zur Konstitution von Dihydroanthracenonen und Angaben zu ihrer Verbreitung in Pilzen. Univ. Bonn (doctoral thesis).
- Schmidt-Stohn G, Saar G, Brandrud TE, Dima B, 2016. Interessante *Phlegmacium*-Funde um Urbino. *J. Journées Européennes Cortinaire* 18: 86-105.
- Stensrud Ø, Orr RJS, Reier-Røberg K, Schumacher T, Høiland K, 2014. Phylogenetic relationships in *Cortinarius* with focus on North European species. *Karstenia* 54: 57–71.