



sommerfeltia

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E. Bendiksen, K. Bendiksen
& T.E. Brandrud

Cortinarius subgenus *Myxacium* section *Colliniti*
(Agaricales) in Fennoscandia,
with special emphasis on the Arctic-alpine zones

1993



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SOMMERFELTIA appears at irregular intervals, normally one article per volume.

Editor: Rune Halvorsen Økland.

Editorial Board: Scientific staff of the Botanical Garden and Museum.

Address: SOMMERFELTIA, Botanical Garden and Museum, University of Oslo, Trondheimsveien 23B, N-0562 Oslo 5, Norway.

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ISBN 82-7420-021-7

ISSN 0800-6865

Bendiksen, E., Bendiksen, K. & Brandrud, T.E. 1993. *Cortinarius* subgenus *Myxadium* section *Colliniti* (Agaricales) in Fennoscandia, with special emphasis on the Arctic-alpine zones. - *Sommerfeltia* 19: 1–37. Oslo. ISBN 82-7420-021-7. ISSN 0800-6865.

The taxonomy and ecology of *Cortinarius* subgenus *Myxadium* section *Colliniti* in Fennoscandia is treated. Most species of this group have their optima in oligotrophic habitats, and play an important role in upper boreal and Arctic-alpine regions. Variation in spore morphology is subjected to numerical treatment. Relevant nomenclatural types and protologues for classical names are examined.

Presence of clamp connections is stated to be an important diagnostic character towards the most closely related section, *Defibulati*. Also, SEM pictures have revealed a significant difference in the spore ornamentation between the two groups. Spore shape and size provide important diagnostic characters for separation of the different taxa of section *Colliniti*, as shown by scattergrams. The most distinctive species in this respect are found to be *C. mucosus*, with characteristically narrow spores, and *C. collinitus* with larger spores. The species concept within the group is discussed.

Seven Fennoscandian species are recognized and their taxonomy and ecology are discussed. *C. septentrionalis* (type from Norway) and *C. fennoscandicus* (type from Finland) are described as new. Both species are common in upper (northern) boreal mountain birch (*Betula*) woodlands and under the low shrub *Betula nana* in the low alpine and arctic zones. The status of *Agaricus collinitus* Sow: Fries is discussed in more detail.

Keywords: *Cortinarius*, *Myxadium*, taxonomy, ecology, Arctic-alpine, Fennoscandia.

Egil Bendiksen, Norwegian Institute for Nature Research (NINA), P.O. Box 1037 Blindern, N-0315 Oslo, Norway.

Katriina Bendiksen, (formerly K. Metsänheimo), Botanical Garden and Museum, Trondheimsvn. 23 B, N-0562 Oslo, Norway.

Tor Erik Brandrud, Norwegian Institute for Water Research (NIVA), P.O. Box 69 Korsvoll, N-0808 Oslo, Norway.

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INTRODUCTION

Cortinarius (Pers.) S.F. Gray subgenus *Myxadium* (Fr.) Loudon section *Colliniti* (Fr.) Sacc. (= *Myxadium* (Fr.) Nezd.) is characterized by strongly gelatinized fruitbodies, cylindrical stipe turning brown at the base and the presence of clamp connections. Furthermore, section *Colliniti* lacks a sulcate cap margin and the honey-like smell which is typical of section *Defibulati*. Section *Colliniti* has commonly been recognized in the taxonomic literature. Nevertheless, a number of taxonomic and nomenclatural problems have remained unsolved.

Species of section *Colliniti* play an important role in northern boreal and Arctic-alpine regions. Three among the seven Fennoscandian species, viz. *C. favrei*, *C. septentrionalis*, and *C. fennoscandicus*, are more or less restricted to these regions. Most species have their optima in oligotrophic sites and have a wide distribution in Fennoscandia. According to published data and own experience, most of the species apparently have a wide circumboreal distributional pattern.

Detailed ecological data on section *Colliniti* are few, but a systematic ecological synopsis of the upper (northern) boreal and Arctic-alpine macrofungi including *Colliniti* in Finnish Lapland has been presented by Metsänheimo (1982, 1987) and Ohenoja & Metsänheimo (1982).

MATERIAL AND METHODS

The collected material and the ecological as well as macromorphological observations are mainly based on field work carried out at Kilpisjärvi (Enontekiö Lappland, NW. Finland) by K. Bendiksen in 1979-86 (cf. Metsänheimo 1982, 1987), and by K. and E. Bendiksen in 1988, and in Saltdal and Rana (Nordland, N. Norway) by T.E. Brandrud and E. Bendiksen in 1983 (cf. Brandrud & Bendiksen 1984). Scattered collections have also been made in other parts of Fennoscandia.

Type material of *C. absarokensis* Moser & McKnight (MICH), *C. coeruleolutescens* Henry (private herbarium of Dr. R. Henry, France), *C. cylindripes* Kauffm. (MICH), *C. fulvosquamosus* Orton (E), *C. muscigenus* Peck (NYS), *C. splendidus* Peck (NYS), and *C. zosteroides* Orton (E) have been studied. Standard medium for microscopic observations was 2% KOH. Spores were observed through a high power oil immersion lens (100x/1.25). A random selection of 10 mature spores obtained from cortina remnants were measured from each collection. Mean values (MV) of spore length and width (given in square brackets, apiculus and ornamentation excluded), as well as Q-values (length/width ratio; mean values in square brackets), were obtained for 17-30 collections of each taxon. Cap cuticle was studied by mounting in water, then in 2% KOH.

Microscopical drawings were made with the aid of a Leitz Wetzlar tracing device (Leitz Laborlux D-microscope).

Scanning electron microscopy (SEM) preparations of spores were made from dried specimens. The spores were allowed to swell by submerging a gill first in water, then in 45% acetic acid, dehydrated first in glacial acetic acid: 100% ethanol (1:1), then three times in pure 100% ethanol, and critical point dried in CO₂. The preparations were covered with gold-palladium in an argon atmosphere. SEM photographs were taken with a JEOL JSM 35C at the Electron-Microscopical Unit for Biological Sciences at the University of Oslo.

The colour standards used are those given by Kornerup & Wanscher (1978), being indicated as, e.g., brownish orange (6C7), or by Cailleux (1981), indicated as, e.g., M60.

The collections are deposited in the herbaria of the Universities of Oslo (O) and Oulu (OULU).

Ecological data are given as site types in a system based on gradients following Økland & Bendiksen (1985). Studies of the more detailed geographical distribution of each species are beyond the scope of this paper.

References to selected illustrations with abbreviations used in the species descriptions:

- BBB - Bendiksen & al. (1990)
- CFP - Brandrud & al. (1990)
- FAD - J.E. Lange (1938)
- DD - Dähncke & Dähncke (1979)
- GJS - Gulden et al. (1985)
- MJ - Moser & Jülich (1987)
- M - Marchand (1982)
- P - Phillips (1981)
- RH - Ryman & Holmåsén (1984)

Under "Collections examined" for each species, initials (EB, KB, TEB) mean the authors

(KM = K. Metsänheimo). Extra-Fennoscandian type collections are not mentioned here. Symbols given for vegetation zones: UB = upper (northern) boreal, LA = low alpine.

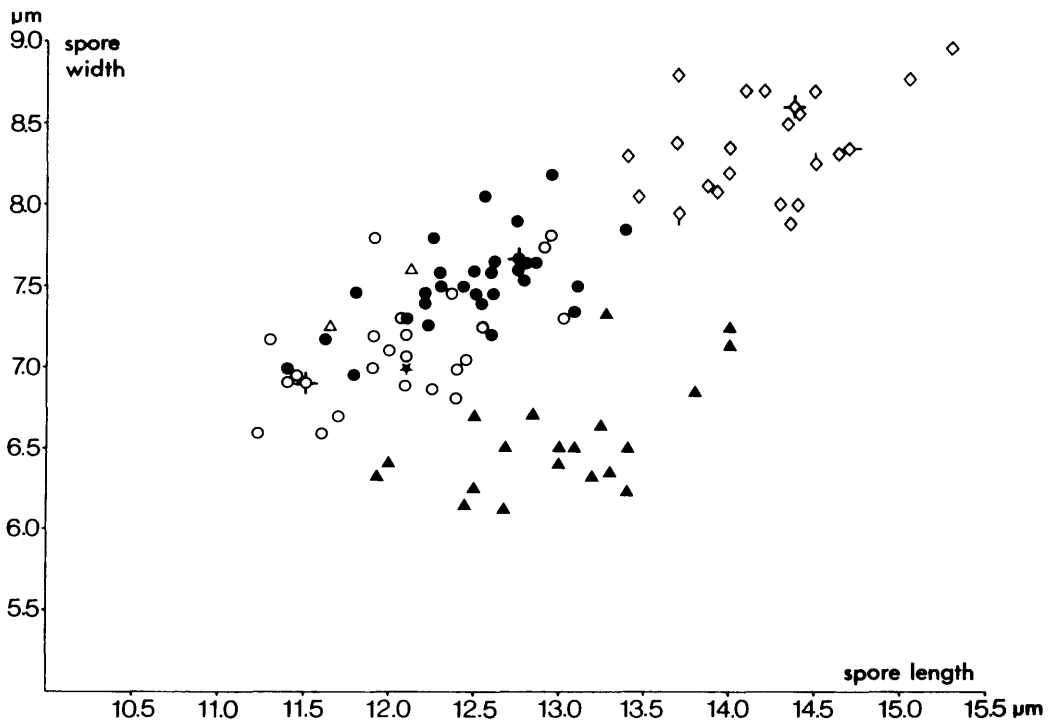


Fig. 1. Scatter diagrams of mature spores from the cortina of the species. Each dot represents the mean value of 10 measured spores from a single collection. - ● = *C. fennoscandicus* (—● holotypus), ○ = *C. septentrionalis* (—○ holotypus), ▲ = *C. mucosus*, ◇ = *C. collinitus* [—◇ = *C. muscigenus*, holotypus (NYS), ◇ = *C. cylindripes*, lectotypus (MICH), ◇ = *C. coeruleolutescens*, holotypus, herb. Henry, ◇ = *C. collinitoparvus*, holotypus, according to Kärcher & Seibt 1987], ★ = *C. grallipes* (TEB 324-79 (O)), △ = *C. absarokensis* (two different fruitbodies of isotypus, Moser 83/352 (MICH)).

RESULTS AND DISCUSSION

MICROMORPHOLOGY

Except for the shape and size of the spores, the section *Colliniti* possesses a very uniform micromorphology. The pileipellis is well differentiated, and two or even three layers can be recognized; a hyaline ixocutis, below which there are some non-gelatinized filamentous hyphae grading into a more or less subcellular hypodermium. The pigmentation is strong, parietal to encrusted; a smooth, thick wall on subcellular elements cracks into zebra stripes or crusts on

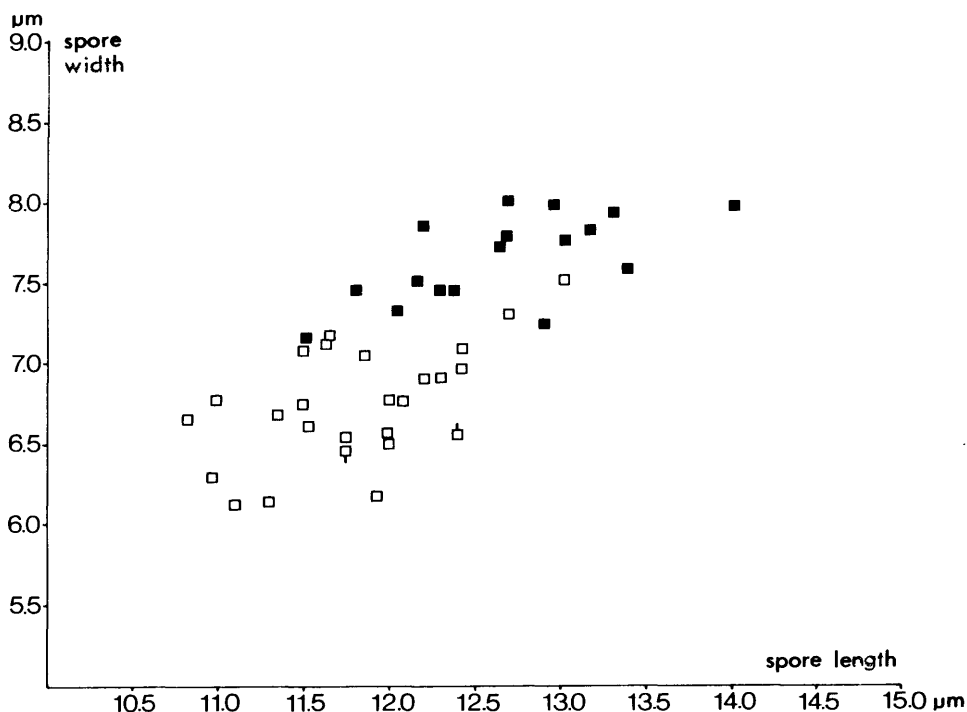


Fig. 2. Scatter diagrams of mature spores from the cortina of the species. Each dot represents the mean value of 10 measured spores from a single collection. - ■ = *C. favrei*, □ = *C. trivialis*, [□ = *C. zosteroides*, holotypus (E), □ = *C. fulvosquamosus*, holotypus (E)].

long and narrow hyphae. The gill edge is always sterile with clavate, basidiform cells, often being somewhat larger than basidia and lacking any light-dispersing content.

Clamp connections of the universal veil and cortina are very numerous, thus contrasting the total absence in section *Defibulati*. We find this to be a constant difference, and thus of considerable diagnostic importance. We therefore disagree with Orton (1983), who does not rely on the presence or absence of clamp connections for identification purposes.

Each species showed more or less its own pattern of variation in spore size and shape (cf. scattergrams, Figs 1, 2). The three upper boreal/alpine species *C. septentrionalis*, *C. fennoscandicus*, and *C. favrei* were most similar, while *C. collinitus* (large spores) and *C. mucosus* (narrow spores) which showed an almost discontinuous variation when compared with the others, were most distinctive. As to the Q-values (length/width ratio, Fig. 3) of the spores, only *C. mucosus* is separated by its narrower spores. Despite considerable variation between individual spores from the same collection, the between-collection (and within-species) variation in parameter means was remarkably restricted, usually within 2-2.5 μm . Spore shape is variable, varying from amygdaliform to slightly citriform or even ellipsoid within each preparation. *C. favrei* deviates slightly from this pattern in its more constantly ellipsoid spores.

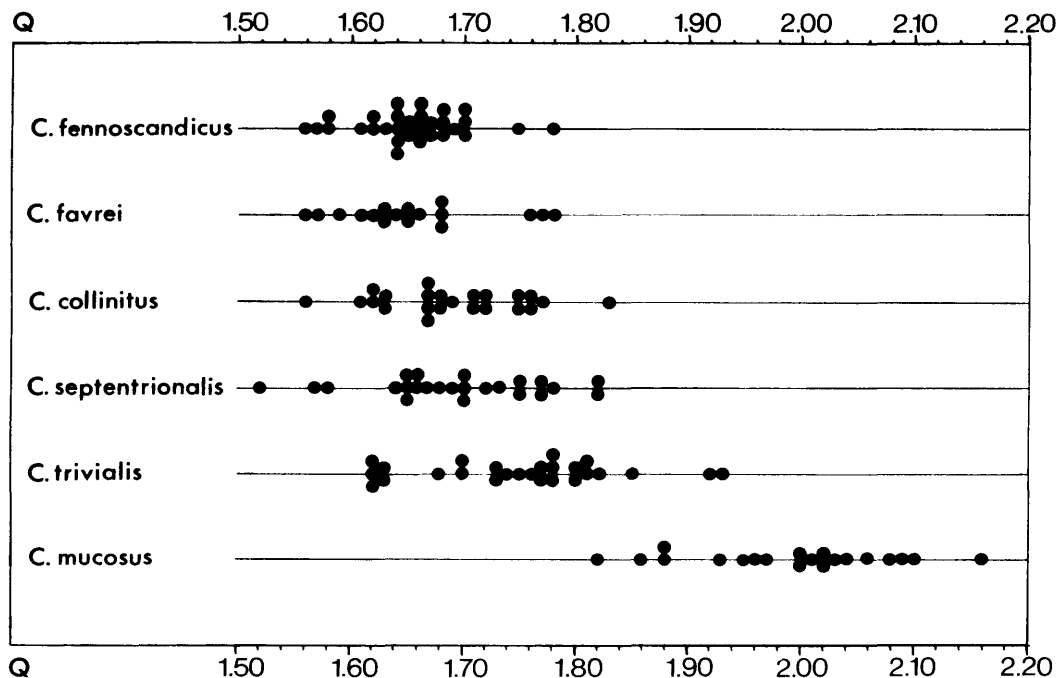
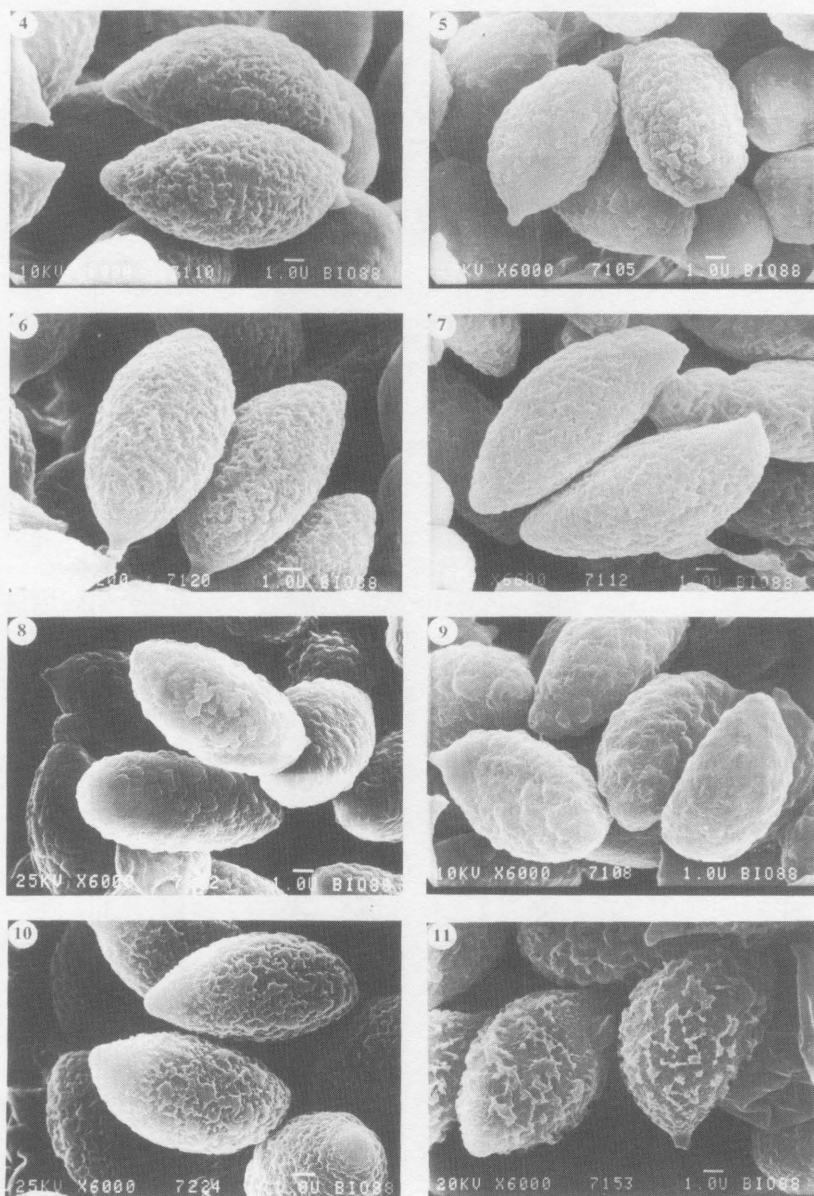


Fig. 3. Q-values of spores for section *Colliniti* species. Each dot represents the mean value of 10 measured spores from a single collection.

SEM revealed fairly characteristic and uniform spore ornamentation within these species (Figs 4-11). The surface layer is composed of low, diffusely delineated crusts, reminding of the ornamentation in some groups of the subgenus *Phlegmacium* and deviating from the typical warty type found in the rest of the subgenus *Myxadium*, and in the subgenera *Telamonia*, *Cortinarius*, and *Dermocybe* (cf. Brandrud 1983, Høiland 1984).

SEM spore pictures of the three common species of section *Defibulati* in Fennoscandia; *C. lividoochraceus* Berk. (= *C. elatior* s. auct.), *C. stillatitius* Fr. (= *C. integerrimus* Kühn.), and *C. mucifluus* Fr., revealed a significant difference from section *Colliniti*. In *Defibulati* the ornamental crust is more sharply delineated and covers a smaller area, leaving space for larger grooves in between (Figs 10, 11). However, the two taxa, *Colliniti* and *Defibulati*, have a much closer relationship to each other than to the two other commonly accepted Holarctic sections of the subgenus (Sects *Delibuti* and *Vibratiles* (= *Ochroleuci*), cf. Moser in Singer 1986). Thus their taxonomic position would probably be better reflected by placing *Defibulati* as a subsection under sect. *Colliniti*.



Figs 4-11. SEM spore pictures. The scales are 1 μ m. - Figs 4-9. Sect. *Colliniti*. Fig. 4. *C. collinitus* (KM & EB 11 Sept. 1984 (O)). Fig. 5. *Cortinarius favrei* (Høiland D9, 9 Aug. 1978 (O)). Fig. 6. *C. fennoscandicus* (EB/TEB 160/83 (O)). Fig. 7. *C. mucosus* (TEB 409-78 (O)). Fig. 8. *C. septentrionalis* (TEB 153-78 (O)). Fig. 9. *C. trivialis* (KM 15 Sept. 1979 (OULU)). Figs 10-11. Sect. *Defibulati*. Fig. 10. *C. lividoochraceus* (TEB 318-79 (O)). Fig. 11. *C. stillatitius* (EB 1112/80 (O)).

ECOLOGY

The seven species of section *Colliniti* can be placed in four different ecological groups based on preference for vegetation zones (Figs 12-13) and mycorrhizal associates:

- (1) alpine dwarf-*Salix* associates: *C. favrei*
- (2) low alpine - upper boreal *Betula* (-*Salix*) associates: *C. septentrionalis*, *C. fennoscandicus*
- (3) low alpine - nemoral (ubiquitose) deciduous tree/shrub-associates: *C. trivialis*
- (4) middle boreal - hemiboreal pine/spruce associates: *C. mucosus*, *C. collinitus*.

C. grallipes is not ecologically classified here due to insufficient material.

The majority of species are quite specialized as to mycorrhizal associates. Five of the species in Fennoscandia seem to be more or less associated with only one host genus; *C. favrei* with *Salix*, *C. septentrionalis* and *C. fennoscandicus* with *Betula* (possibly also with *Salix*), *C. mucosus* with *Pinus*, and *C. collinitus* with *Picea*. In contrast to these species, *C. trivialis* is ubiquitous and apparently able to grow with the majority of mycorrhiza-forming European deciduous trees (or shrubs), particularly with *Populus* spp., *Salix* spp., *Betula* spp., and *Quercus* spp. (pers. obs.), but also with *Castanea sativa* (Kärcher & Seibt 1987).

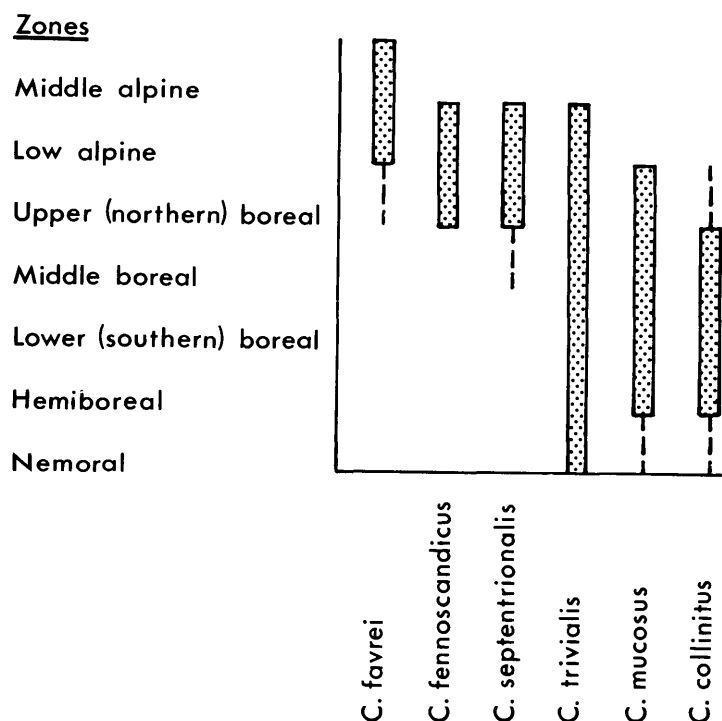


Fig. 12. Distribution of species of section *Colliniti* in the different vegetation zones.

Zones					
LA	10	2	0	<i>C. fennoscandicus</i>	
UB		18	0		
LA	0	3	1	<i>C. septentrionalis</i>	
UB		38	0		
LA	0	1	0	<i>C. trivialis</i>	
UB		8	1		
	SX	SM	M	Series	

Fig. 13. Number of records of the species growing under *Betula* and *Salix* species in the different moisture series on the forest-alpine transition in Saltdal and Rana, North Norway, Brandrud & Bendiksen 30 July - 8 August 1983 (see Brandrud & Bendiksen 1984). SX = subxeric vegetation dominated by *Empetrum*, SM = submesic vegetation dominated by *Vaccinium myrtillus*/low herbs, M = mesic vegetation dominated by tall ferns/tall herbs, UB = upper (northern) boreal zone; dominated by *Betula pubescens* ssp. *tortuosa*, LA = low alpine zone; recognized by *Betula nana* and *Salix* copses.

Most species show strict preference both for soil nutrient status and moisture. Four of the six species (groups 2, 4) have a distinct optimum in oligotrophic sites. A more detailed discussion of ecology is given under the species.

SPECIES CONCEPT

The taxonomy and nomenclature of species in section *Colliniti* have been much disputed. The rather strong variability within the group has led authors using a narrow species concept to describe a large number of taxa (cf. Henry 1945, 1950, 1976).

The commonly accepted morphological species concept requires discontinuous variation in at least one important morphological "character" in order for taxa to be regarded as separate species (cf. Clemençon 1977). The species concept used here may be considered a fairly narrow one. All seven taxa dealt with in this study are intimately related, and may be difficult to separate when not young and fresh. They can be distinguished mainly by spore size and shape, cap colour, and colour and manner of disruption of the veil. Except for the spore morphology of *C. collinitus* and *C. mucosus* all species apparently overlap the character variation of the other (see discussion under each species). The between-taxa differences with respect to combinations of ecological and geographical patterns, combined with their rather weak morphological distinction, make it reasonable to ask whether the taxa should rather be regarded as subspecies. However, we have chosen here to follow the currently well-established species concept in the group and regard them as species.

TAXONOMY

KEY TO THE SPECIES

- 1 Associated with dwarf-*Salix* species (rarely *Betula*) in the alpine zones; cap 1.5-4.5 cm, dark red-brown to rusty brown *C. favrei*
- 1 Not associated with dwarf-*Salix* species. (If in alpine zones, then with *Betula* or in thickets of larger *Salix* species.) 2
- 2 (1) Stipe with (thick) veil remnants cracking in separate annulate scales or girdles (by stretching), often with vertical connections forming a net-like structure; young gills violet grey to greyish blue, or more rarely pale ochraceous grey; associated with deciduous trees or shrubs *C. trivialis*
- 2 Veil on stipe not cracking into annulate scales or net-like girdles; gills lacking violet or bluish tinges 3
- 3 (2) Spores large (13-16 × 7.5-9.5 µm); cap red-brown, often rather dark; stipe violet; poor subxeric and submesic coniferous forests, under *Picea* *C. collinitus*
- 3 Spore length not exceeding 14 µm 4
- 4 (3) Spores narrowly amygdaliform, Q-value 2.0; cap sienna to ochraceous brown with dark centre; stipe white; under *Pinus*, often in very dry, lichen-dominated sites *C. mucosus*
- 4 Spores wider, Q-value 1.6-1.7; under deciduous trees 5
- 5 (4) Cap vividly orange to golden yellow, centre darker; stipe white or violet; in subarctic and mountain birch woods and under low alpine *Betula nana* (and *Salix*?) shrubs *C. septentrionalis*
- 5 Cap without vividly orange or golden yellowish colours; stipe whitish 6
- 6 (5) In mountain birch woods and under low alpine shrubs, frequently in dry *Betula nana*-heaths; cap dull ochraceous with olivaceous tinge, when moist often fairly dark *C. fennoscandicus*
- 6 Lowland species growing in mixed forests under beech, birch and aspen; cap more brightly coloured *C. grallipes*

DESCRIPTION OF THE SPECIES

Cortinarius collinitus (Sow. : Fr.) S.F. Gray

Nat. Arr. Br. Pl. I: 628, 1821. - *Agaricus collinitus* Sow. : Fr., Syst. mycol. 1: 248, 1821. - *Cortinarius muscigenus* Peck, N.Y. St. Mus. Ann. Rep. 41: 71, 1888. - *Cortinarius cylindripes* Kauffman, Bull. Torr. Bot.

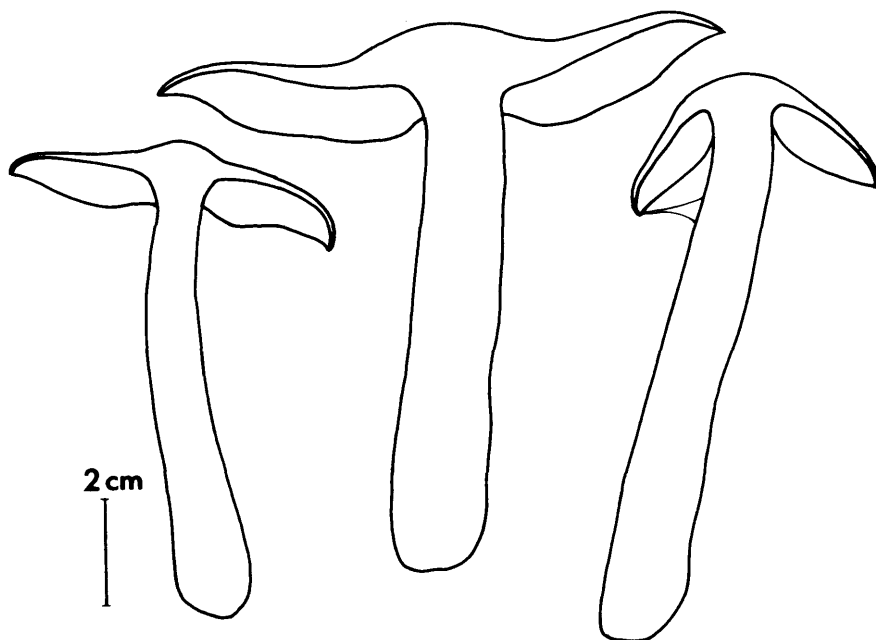


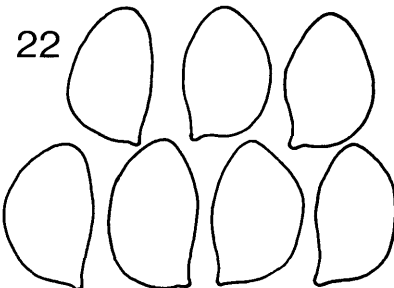
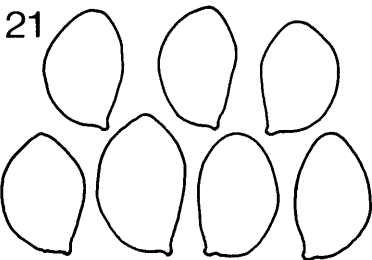
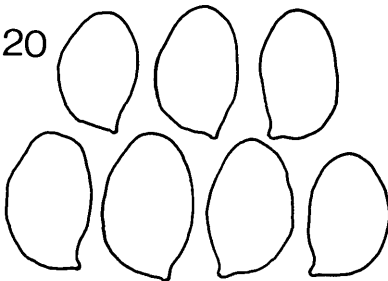
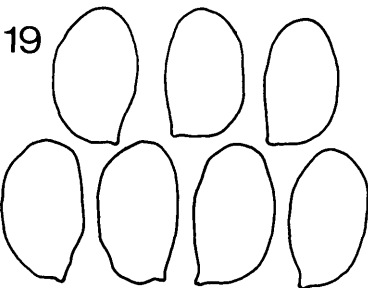
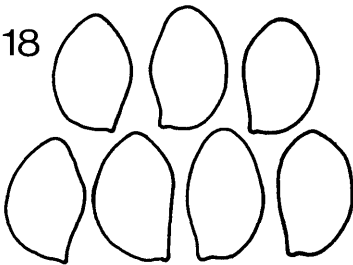
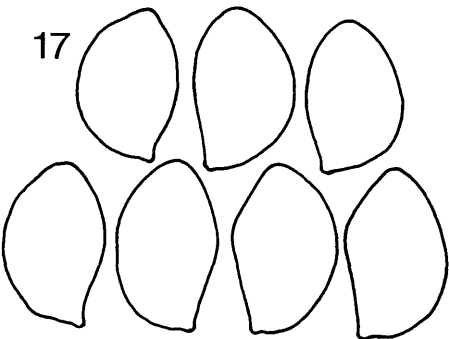
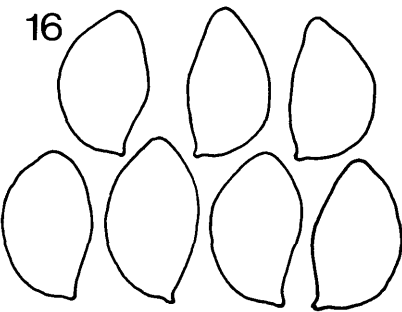
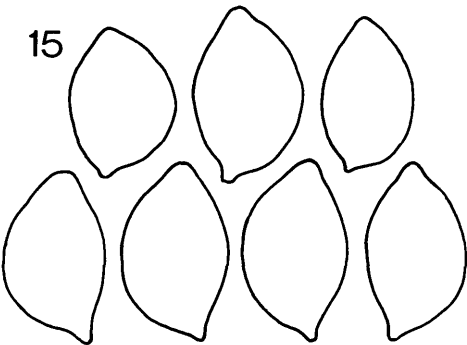
Fig. 14. *Cortinarius collinitus* (EB/TEB 86/83 (O)).

Club 32: 321, 1905. - *Cortinarius collinitus* var. *typicus* f. *caeruliipes* A.H. Smith, Lloydia 7: 175, 1944. - *Cortinarius mucosus* var. *caeruliipes* (A.H. Smith) Favre, Ergebn. Wiss. Untersuch. Schweiz. Nationalparks (N.F.) 6: 499, 1960 (nom. inval.). - *Cortinarius coeruleolutescens* Henry, Bull. Soc. mycol. Fr. 100: 5, 1984.

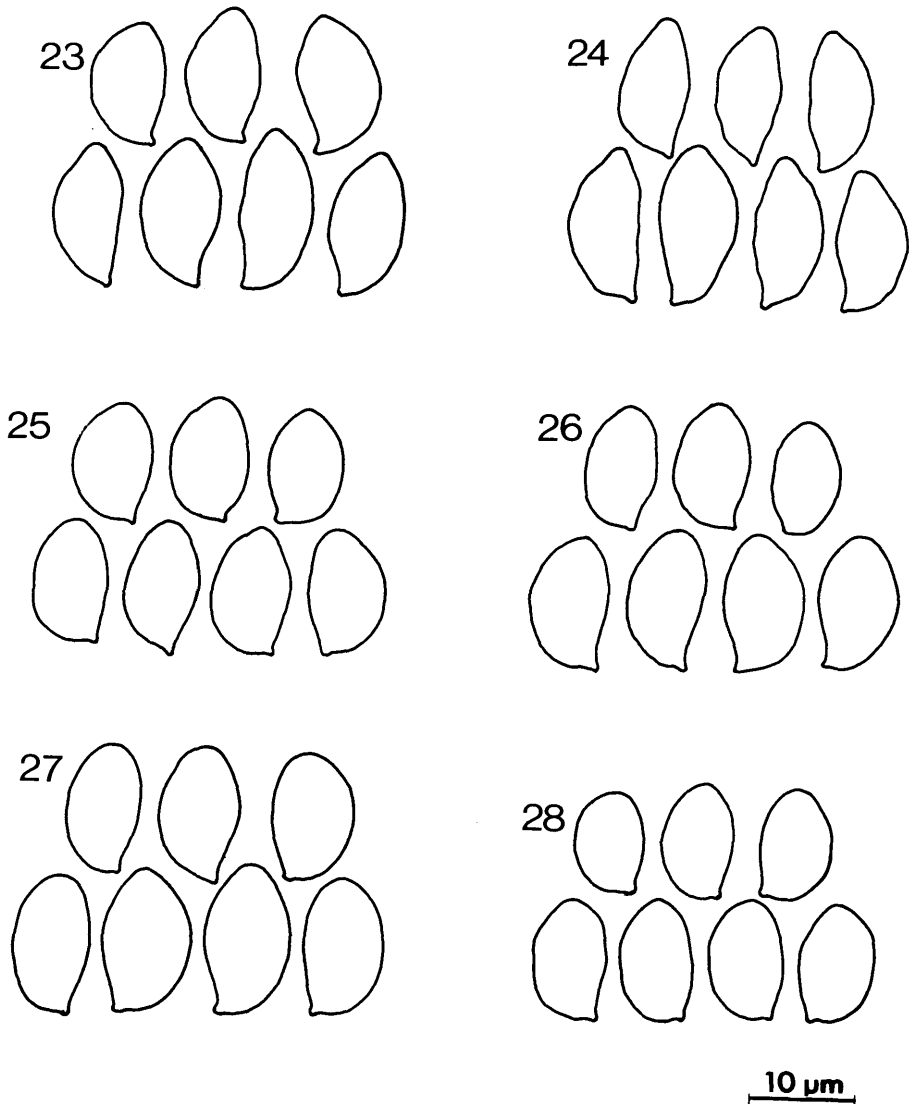
Neotypus (selected here): Unpublished plate in Herb. S, "*Cortinarius* (*Myxaciium*) *collinitus* (Sow.) - Smolandia, Femsjö, 30. VII. 1857 - P. Åkerlund del., E. Fries direx. et approb.". Representative material: *Cortinarius* (*Myxaciium*) *collinitus* in Fungi Exsiccati Suecici, Praesertim Upsaliensis, No 2802, Lundell & Nannfeldt 1979; SWEDEN - Småland: Femsjö parish, N. of the road to Flahult, near "Dröplastigen", 31 Aug. 1943, S. Lundell (n. 3827).

Figs 4, 14-17. Colour ills: CFP A34, P 121, M 752, RH 513.

Description. *Cap* 3-10 cm, convex to plano-convex, sometimes with a broad umbo, strongly glutinous, margin often hygrophanous with sharp border towards inner part which is rusty brown to dark red-brown or even almost black (6C8, 7D8, 8E8, 8F7, R-T37, T11, P-R39), often with darker spots, rarely ochraceous without the red-brownish tinge, margin pale, fleshy-ochraceous (5B4, M60), primordia grey-brown with greyish blue margin. *Gills* 3-11 mm wide, moderately crowded, broadly adnate to slightly emarginate, often with a decurrent tooth, edge even to faintly fimbriate, sometimes very faintly wrinkled, pale greyish (5B3) with a paler edge. *Stipe* 50-100 × 6-23 mm, cylindrical, glutinous, universal veil peronate when young, later typically cracking in irregular adpressed girdles; veil colour distinctly violet at least when young (17A2-B3, 18A2), sometimes paler (very seldom it is pure white), stipe surface turning distinctly brownish, especially towards the base (6D7-8). *Flesh* pale, stipe apex pale violet or bluish grey when very young (strongest close to the surface), brownish below cap cuticle, base turning brownish (5C7-8), blackish brown when damaged by insect larvae, no taste or smell.



10 µm



Figs 15-28. Outlines of spores of the species. - Figs 15-17. *C. collinitus* (TEB 231-80 (O); Lusikkakoski 28 Aug. 1973 (OULU); Peck Sept. 1887, *C. muscigenus* (holotypus NYS)). Fig. 18. *C. grallipes* (TEB 324-79 (O)). Figs. 19-20. *Cortinarius favrei* (Nilsson 2 Sept. 1975 (OULU); K.M. 7 Aug. 1981 (OULU)). Figs 21-22. *C. fennoscandicus* (EB/TEB 161/83 (O); KB/EB 216/88 (holotypus OULU)). Figs 23-24. *C. mucosus* (EB 18 Aug. 1987 (O); KM 31 Aug. 1977 (OULU)). Figs 25-26. *C. septentrionalis* (EB/TEB 156/83 (holotypus O)); KM 4 Aug. 1983 (OULU)). Figs 27-28. *C. trivialis* (TEB 225-85 (O); KM 10 Sept. 1977 (OULU)).

Spores 13-[14.2]-16(-17.5) \times 7.5-[8.5]-9.5 μm , L/W (Q) = 1.56-[1.68]-1.83, mostly amygdaliform, but also with variation towards elliptical or limoniform, strongly verrucose, *Basidia* 38-46 \times 11-14(-15) μm , 4-spored, with basal clamp connections, distinct intracellular granular pigments. *Gill edge* sterile with basidium-like sterile cells. *Cap cuticle* with a fairly thin epicutis (ixocutis) of strongly gelatinized, loosely and irregularly entangled, hyaline hyphae 2-5(-6) μm wide, with clamp connections; basally with a few layers of parallel, slightly wider, brown, zebra-striped, encrusted hyphae, grading evenly into a more or less subcellular hypodermium with brown, inflated hyphae up to 35 μm wide, pigment smooth, parietal to encrusted on wider elements, also with dark brown extracellular pigment clumps. *Hyphae of glutinous veil from stipe* 2.5-6(-7.5) μm wide, hyaline, with numerous clamp connections.

Ecology: Coniferous boreal forest under *Picea*, subxeric and submesic site types on poor soil.

Taxonomic discussion. *C. collinitus* is usually distinct both morphologically and ecologically in its dark red-brown cap, violet stipe, and occurrence typically in moss-rich spruce forests. In addition, it has significantly larger spores than all the other Fennoscandian species of the section. It may be mistaken for a *C. septentrionalis* with violet stipe (cf. discussion under that species). White-stiped specimens of *C. collinitus*, which are very rare, may recall *C. mucosus* or white-stiped *C. septentrionalis*, but are distinguished by spore characters. Fruit bodies with stipes grading from pure white to distinct violet have been found from the same mycelium (Norway, Oppland: Lunner, EB 4 Oct. 1987, (O)).

We have not observed, even in very young specimens, any bluish colour on the gills, as mentioned in several descriptions obviously concerning the present species (e.g. Orton 1955, Phillips 1981, Ryman & Holmåsén 1984).

The Sowerbyan name *C. collinitus* has been widely used for this species for at least 40 years. According to Article 7.20 of the Nomenclatural Code (Greuter et al. 1988) the sanctioned name *A. collinitus* can be typified on any element in the protologue of Fries (1821), but unfortunately *A. collinitus* in *Systema* included several species, as discussed by Kühner (1959) and Melot (1989). The main part of the protologue describes the species which now for several decennia has been called *C. trivialis* (cf. Henry 1938). Important features of *C. trivialis*, such as the characteristic way of veil cracking, and the ecology "in silvaticis mixtis vulgaris" are here mentioned by Fries. Most descriptions and illustrations referred to in Fries' text probably represent *C. trivialis*. The Friesian description, however, also contains elements of species belonging to section *Defibulati*. This is shown by the comparison with *Rozites caperatus*: "*A. caperato* certe affinis" and by the reference to the plate of Sowerby (1797) which illustrates *C. lividoochraceus* (= *C. elatior* s. auct., cf. partly sulcate cap margin, violet, attenuated stipe, also see Henry 1963 and Petersen 1983). Further, *A. mucosus* is included as an infraspecific taxon in *A. collinitus* in the protologue.

The crucial question remains: Is it possible to recognize any element of the actual species, *C. collinitus* s. J.E. Lange in the protologue? There are in fact two characters in the protologue which could point in the direction of that species. The first is the colour of the cap ("aurantio-fulvo") which fits with *C. trivialis*, but even better with *C. collinitus* s. J.E. Lange. The other is the colour of the stipe ("squamas coerulescentes"). This colour certainly fits better with *C. collinitus* s. J.E. Lange (or a *Defibulati* species) than with *C. trivialis*. Since Fries (1821) only included two *Myxadium* species of sections *Colliniti* and *Defibulati* in *Systema*, *A. elatus* (= *C. lividoochraceus*) and *A. collinitus*, it is very probable that Fries included all frequent species of section *Colliniti* in his concept of *A. collinitus*. Later descriptions may in fact throw some light on this: In *Epicrisis* (Fries 1838), when all *Defibulati* elements are removed (all included in other species), the stipe is characterized: "nunc coerulescens, nunc

albus", of which the former must refer to *C. collinitus* s. J.E. Lange, the latter to *C. trivialis* (which still represents the main element). In the collection of unpublished Fries plates at Naturhistoriska Riksmuseet, University of Stockholm, a plate showing a very typical *C. collinitus* s. J.E. Lange is designated *C. collinitus*, and a plate showing *C. trivialis* is designated *C. collinitus* var.! Both plates are from 1857 and accepted by Fries. In his Monographia, Fries (1857) mentioned both coniferous and deciduous forests as habitats, and white as well as violet stipe. On the other hand it is also possible that *C. collinitus* s. J.E. Lange in Epicrisis and Monographia is included within the concept of *C. mucosus*, which in these books is described with white or violet stipe. The latter case is very rarely encountered in *C. mucosus* (cf. Bendiksen & Bendiksen 1992).

Based on the above analysis of protologue, later descriptions and illustrations of Fries, and extensive discussions with several mycologists (including members of the nomenclatural committee for fungi and lichens), we have eventually decided to amend the widely and persistently used name *C. collinitus*.

C. muscigenus Peck 1888 seems to be the oldest synonym for *C. collinitus*, and the present authors have earlier used this name for the taxon discussed here (Bendiksen et al. 1990, Brandrud et al. 1990). According to the protologue it is "closely related to *C. collinitus* from which it is separated by its more highly coloured pileus, striate margin and even, not diffracted-squamose stipe". This characterization of the stipe shows that Peck used the name *C. collinitus* for *C. trivialis* J.E. Lange. Comparing further details, small and thin-fleshed fruit bodies of *C. collinitus* with striate margin are not uncommon. More deviating is the stipe colour given as "white or whitish" which is a rare feature in *C. collinitus*. The strongest argument for *C. muscigenus* to be synonymous is, however, the spore characters of its well-preserved holotype, fitting very well to the spores of *C. collinitus*. This species has larger spores than all of the other species of the section (cf. description and Figs 15-17). The ecology given for *C. muscigenus* is "mossy ground under balsam trees". This refers to *Abies balsamifera* which frequently forms mixed forests with *Picea glauca*. Attached to the stipe base of the holotype are also *Picea* needles, and the habitat of the holotype is thus in well accordance with the habitat of our species in Europe. According to more recent literature, a separate species with white stipe, apparently otherwise very similar to *C. collinitus*, does not seem to occur in North America. Information from O. Miller (pers. comm.) also seems to confirm our interpretation of *C. muscigenus*.

C. splendidus Peck (N.Y. St. Mus. Ann. Rep. 29: 42, 1878) has affinities to our species when its macroscopical characters are concerned. The spores of the holotype are, however, different (more of the *C. mucosus* type).

C. cylindripes Kauffman 1905 is a synonym, demonstrated by studies of a syntype and earlier studies done by Smith (1944). Details are discussed by Bendiksen et al. (1992).

C. collinitoparvus Henry (Bull. Soc. mycol. Fr. 79: 292, 1963 (nom. inval.), Bull. Soc. mycol. Fr. 101: 5, 1985) was described to have large spores exactly like those of *C. collinitus*. They seem to be closely related or may possibly even be conspecific. *C. collinitoparvus* is usually discussed in connection with *C. trivialis* (e.g. Kärcher & Seibt 1987).

Ecological discussion. The species is common in boreal coniferous forest, typically growing in deep moss (*Dicranum* spp., *Hylocomium splendens* and *Pleurozium schreberi*). It seems exclusively associated with *Picea* in Fennoscandia, having its optimum in submesic bilberry spruce forest. It may also occur in moist spruce forests with *Sphagnum* or in drier, mixed *Picea* and *Pinus* forests. Furthermore, the species has been found abundantly in *Picea* plantations outside the natural range of Norway spruce. From the Alps it is recorded from pure

pine forests (Favre 1960). *C. collinitus* and *C. mucosus* are the only species in section *Colliniti* not found in upper boreal birch woods. In the Alps, where no mountain birch woods are present, it grows in coniferous forests up to the tree line, reaching 2200 m (Favre 1960). It is also found in the highest, as well as in the northernmost, spruce forests in Fennoscandia. Consequently, its upper limit is set by the distribution limits of its assumed mycorrhizal hosts rather than by climatic conditions. In Moser (1983) and some other floras *C. collinitus* is also recorded from deciduous forests. This is probably due to a wider concept of this taxon, at least including blue-stiped forms of *C. septentrionalis*.

Collections examined: 19 from a wide geographical area in Norway, Sweden and Finland (O, OULU).

Cortinarius favrei Moser ex Henderson

Notes Roy. Bot. Garden Edinburgh 22: 593, 1958. - *Myxaciium favrei* Moser in Gams, H., Kleine Kryptogamenflora, 2b/2: 195, 1955 (nom. inval.).

Figs 5, 19-20, 29. Colour ills: GJS 33, RH 512.

Description. *Cap* 1.5-4.5 cm, convex to plano-convex, rarely obtusely conical, glutinous when fresh, soon drying, more or less hygrophanous; at least towards disc, dark golden red-brown (6C7-6D8-7D8-7E8), disc often more olivaceous sootbrown (5F5) or olivaceous black, cap colour sometimes grading into more ochraceous (then reminding of *C. fennoscandicus*), margin paler golden yellow (5B7) with a faint olivaceous tinge, the disc becomes slightly paler red-brown to orange when dry. *Gills* 3-8 mm wide, moderately crowded, adnate with a short tooth or slightly emarginate, pale greyish (ochre), sometimes with a slight violet tinge when young, edge paler, even. *Stipe* 22-55 × 3-10(-12) mm, cylindric, sometimes wider towards base, rarely with a faint bulb, glutinous when young, but often soon drying (and veil often cracked) in the windy alpine climate; white, sometimes with a faint reflex of violet, base turning yellowish brown, above the cortina pale with a golden tinge. *Flesh* pale, later with an ochre tinge, dingy brownish on stipe base, no taste or smell.

Spores 11.5-[12.8]-14(-14.5) × 7-[7.7]-8.5 µm, L/W (Q) = 1.56-[1.66]-1.78, elliptical to faintly amygdaliform, strongly and coarsely verrucose. *Basidia* 40-44 × 11-15 µm, 4-spored, with basal clamp connections. *Gill edge* sterile, with basidium-like, clavate sterile cells. *Cap cuticle* with a fairly thin epicutis (ixocutis) of strongly gelatinized, loosely and irregularly entangled hyphae, with clamp connections, hyaline hyphae 2-4.5(-6.5) µm wide; basally with a few layers of parallel, slightly wider, brown, zebra-striped, encrusted hyphae, grading evenly into a more or less subcellular hypodermium with brown, inflated hyphae up to 30 µm wide, pigment smooth, parietal to encrusted on wider elements. *Hyphae of glutinous veil from stipe* 2.5-6(-7.5) µm wide, hyaline, with numerous clamp connections.

Ecology: Alpine zones with dwarf-*Salix* spp.; subxeric sites to late snow-beds, poor and rich soils.

Taxonomic discussion. *C. favrei* is normally easily separated from closely related species. However, difficult transitional collections occur, especially towards *C. fennoscandicus*. Moreover, the fruitbodies often become very dry and atypical because of extreme climatic conditions.

An alpine *Myxaciium* was first recognized by Boudier & Fischer (1894) under the name *C. alpinus* Boud. The name was applied by Favre (1949, 1955) to the present species. Henry (1950) and Kühner & Romagnesi (1953) argued that this was a misapplication, but *C. favrei* was first named (as *Myxaciium favrei*) by Moser (1955) and nomenclaturally validated by

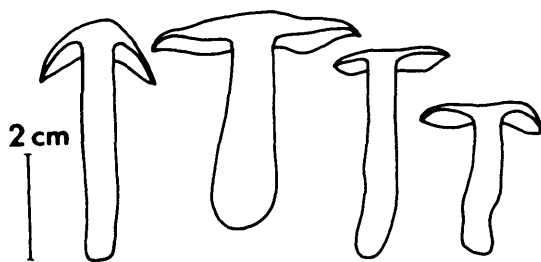


Fig. 29. *Cortinarius favrei* (EB/TEB 236/83 (O)).

Henderson (1958).

The arguments for maintaining two species were strongly contradicted by Favre (1955), and there is still much disagreement about this matter. The separating character of *C. favrei* is said to be the much smaller spores as compared with the spores of *C. alpinus*, which, according to Moser (1983), measure $16\text{--}20 \times 7\text{--}9 \mu\text{m}$ (*C. favrei*: $11\text{--}14\text{--}(16) \times 6.5\text{--}8.5 \mu\text{m}$). Maintaining two taxa was also strongly supported by Trimbach (1978) and Moser (in discussion at Arctic and Alpine Symposium 1980; see Laursen & Ammirati 1982: 311), after rediscovery of what was thought to be Boudier's *C. alpinus* with a more robust habit and spores up to $22 \mu\text{m}$.

When measuring spores from cortina, we found a limited variation in spore length, usually ranging from 11.5 to $14 \mu\text{m}$ with exceptional values of up to $15 \mu\text{m}$ (cf. Fig. 2). This agrees well with earlier measurements of Nordic material (see Gulden & Lange 1971 and references quoted therein). Thus, our taxon is certainly identical with *C. favrei*. However, when measuring spores from gills a much larger heterogeneity may be found, with spores sometimes reaching at least $18 \mu\text{m}$. A statistical examination of a more extensive material, including *C. alpinus* s. Moser, is needed. Hitherto, our results strongly support the existence of only one species in this complex in Fennoscandia.

At the Arctic and Alpine Symposium in Alaska in 1980, the significance of the violet tinge which sometimes occurs on the gills (cf. Laursen & Ammirati 1982: 309), was discussed. Violet tinges are also observed in Fennoscandian material and such fruitbodies often seem to have more greyish cap colour than normal. The inconstancy of bluish pigments in many species of *Cortinarius*, also stated by Melot (1982, 1986), is well demonstrated by most of the other species of section *Colliniti* as well; for instance the colour of gills and/or stipes of *C. trivialis*, *C. collinitus* and *C. septentrionalis*. There are transitions between bluish and non-bluish forms, and this character hardly has any taxonomic value.

Ecological discussion. *C. favrei* is the sole purely alpine species of subgenus *Myxaciium* in Fennoscandia, sharing ecology with a number of small species of subgenus *Telamonina*. *C. favrei* is very common in late *Salix herbacea* and *S. polaris* snow beds. It is also frequent in moderate snow beds and with dwarf-*Salix* species in *Dryas* heath (subxeric-submesic series). It is recorded along the whole nutrient gradient, but we have the impression that it occurs in the largest numbers in eutrophic habitats. The species is one of the most common in alpine zones, where it reaches high into the middle alpine zone, being recorded up to about 1600 m in Jotunheimen, Norway. One exceptional find was made on the middle - upper boreal transition with only *Betula pubescens* subsp. *tortuosa* (Norway: Nordland, Narvik, Skjomen, EB 5 Sept. 1987, (O)). The species seems to have a wide circumpolar distribution (Ohenoja 1971).

Collections examined: 17 from a wide geographical area in the mountains of Norway and North Finland (O, OULU).

***Cortinarius fennoscandicus* E. Bendiksen, K. Bendiksen & Brandrud, sp. nov.**

Pileus 2.5-7.5 (-10) cm *latus*, *planoconvexus*, *interdum umbone inconspicuo praeditus*, *valde glutinosus leviter striatus*, *hygrophanus*, *madidus ochraceus*, *interdum satis atro-ochraceobrunneus plerumque olivaceo suffusus*, *media parte atrobrunnea*, *sicca lutea vel pallide ochracea*. *Lamellae* 3-12 (-16) mm *latae*, *modice confertae vel subdistantes*, *adnatae vel tenuiter emarginatae acie aequata vel leviter fimbriata*, *pallide griseo-brunneola vel griseolo-ochracea*. *Stipes* 4-10 cm *longus*, 6-15 mm *crassus*, *cylindricus*, *glutinosus*. *Velum interdum in zonas angustas adpressas ruptum*, *album*, *rarissime autem violaceum*, *in statu vetere magis olivaceo-ochraceum*, *basin versus brunnescens*. *Caro alba basin versus leviter brunnescens*. *Sapor mitis*. *Odor nullus*. *Sporae* 11-13(-13.5) × 6.5-8.5 µm, *late amygdaliformes vel leviter limoniformes*, *raro ellipticae*, *valde verrucosae*. *Cheilocystidiis nullis*. *Sub Betula pubescenti ssp. tortuosa et Betula nana*, *zonis subalpinis et alpinis*. *Typus: K. Bendiksen and E. Bendiksen 216/88 (OULU)*.

Typus: Finland. Enontekiö Lapland. Enontekiö: Kilpisjärvi, Skirhasjohka, ca. 1/2 km NE of Custom Station, few metres from track road, oligotrophic woodland dominated by *Betula pubescens* ssp. *tortuosa*, 525 m a.s.l., UTM DB 91 62, 5 Aug. 1988, K. Bendiksen and E. Bendiksen 216/88 (OULU, holotypus; O, isotypus).

Figs 6, 21-22, 30. Colour ill.: BBB.

Description. *Cap* 2.5-7.5(-10) cm, hemispherical to obtusely conical, later plano-convex, sometimes with a faint umbo, strongly glutinous, thin-fleshy fruitbodies faintly but distinctly translucently striate, hygrophanous; when moist dull ochraceous (5D6-8, P60, 65, 67, N77), commonly with an olivaceous tinge, especially at disc which is dark red-brown or dark-brown (T35, S27, R67, 76, 77); when drying with more of a vividly coloured zone (6C8-5B8) around a temporarily persisting dark centre, at the same time being paler in stripes in the outer parts, finally whole cap vivid yellow to olivaceous yellow or pale ochraceous (4A,B4-4A,B6, M79, N65, M60), the colour is often pale even when moist, extreme margin sometimes whitish (4A3), primordia olivaceous greyish. *Gills* 3-12(-16) mm wide, moderately crowded to somewhat distant, broadly adnate to slightly emarginate, often with a decurrent tooth, edge even to faintly fimbriate, when old with some low interconnections, greyish beige to pale greyish ochraceous (5C5, K90), whitish towards edge. *Stipe* 40-100 × (4-)-6-15(-20) mm, cylindrical, sometimes with a faintly narrower apex and/or expanded base, glutinous, veil peronate, but sometimes cracking in narrow adpressed girdles reminding somewhat of *C. stillatitius*; very rarely violet (tinge of 17A2), in age more olivaceous ochre, becoming faintly brownish at the base. *Flesh* faintly hollow in upper part of stipe, white when young, greyish in upper part of stipe, turning brownish in stipe base, but not strongly, no taste or smell.

Spores 11-[12.5]-13(-13.5) × 6.5-[7.6]-8.5 µm, L/W (Q) = 1.56-[1.65]-1.78, mostly amygdaliform, but also with variation towards elliptical or limoniform, strongly verrucose. *Basidia* 34-45 × 10-13 µm, 4-spored, with basal clamp connections. *Gill edge* sterile, with basidium-like sterile cells. *Cap cuticle* with a fairly thin epicutis (ixocutis) of strongly gelatinized, loosely and irregularly entangled, hyaline hyphae 2-5(-6.5) µm wide, with clamp connections; basally with a few layers of parallel, slightly wider, brown, zebra-striped, encrusted hyphae, grading evenly into a more or less subcellular hypodermium with brown, inflated hyphae up to 35 µm wide, pigment smooth, parietal to encrusted on wider elements. *Hyphae of glutinous veil from stipe* 2-5(-7.5) µm wide, hyaline, with numerous clamp connections.

Ecology: Upper boreal and low alpine zones with *Betula* spp.; subxeric and submesic site types, preferably on poor soils, in low alpine zone also in mesic sites (here also with *Salix* spp.?).

Taxonomic discussion. *C. fennoscandicus* is separated from the closely related *C. septentrionalis* by its more dull, never vivid orange colour. The cap is strongly hygrophanous,

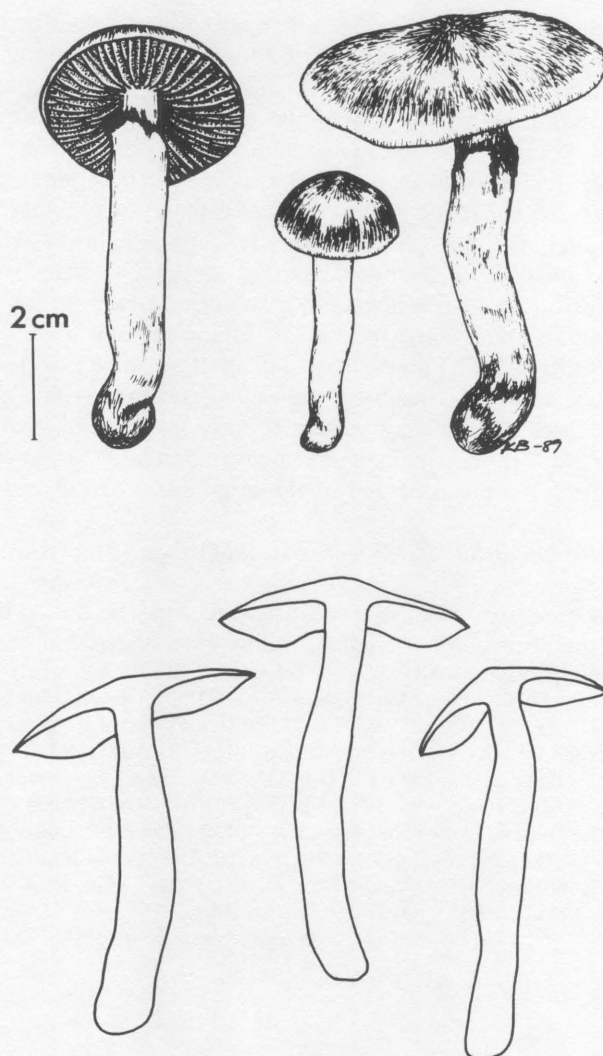


Fig. 30. *Cortinarius fennoscandicus* (KB/EB 452/88 (OULU)).

ranging from dark ochraceous brown to pale yellowish. The two species may, however, be difficult to separate when old, especially in dry weather. At least when young, the cap colour of *C. fennoscandicus* has a tinge of olive. For differences towards *C. favrei*, see the discussion under that species.

This common taxon may earlier have been included in *C. mucosus*, or it may also have been confused with *C. trivialis*. Its closest relatives seem to be *C. grallipes* Fr. and *C. absarokensis* Moser & McKnight. According to Moser, who has seen fresh material of our *C. fennoscandicus*, *C. grallipes* has brighter cap colours and characteristic olivaceous tinged gills, apart from having quite different ecology. According to Moser, *C. absarokensis* differs distinctly by being much larger and more stout, and by its pale colours (cf. Moser & Jülich

1987). The latter species apparently occupies a habitat similar to that of *C. fennoscandicus*, being recorded from Arctic-alpine environments in Montana, North America and the European Alps (Moser & McKnight 1987).

Ecological discussion. We have chosen the name *C. fennoscandicus* for this species because it is a frequent species in the mountain chain and the subarctic areas of Fennoscandia. The species seems to be restricted to the upper boreal and Arctic-alpine zones. Its ecology is quite similar to *C. septentrionalis*, and the two species often grow together. They are often the most abundant macrofungi in oligotrophic site-types (cf. Metsänheimo 1987: 67). Both of them thrive well in sites dominated by *Vaccinium myrtillus* and/or *Empetrum*, with a tendency for a subxeric optimum for *C. fennoscandicus* and a submesic optimum for *C. septentrionalis*. This was especially well demonstrated by the low alpine records from Saltdal/Rana, North Norway (Fig. 13). At Kilpisjärvi, Finnish Lapland, in 1988, both species were common in subxeric and submesic *Betula nana* heaths of the low alpine zone with a predominance of *C. fennoscandicus* in the drier series. They were also very frequent in subxeric and submesic birch woods. At Junkerdalen, our main study area at Saltdal, the species were generally common, but none of them were recorded in the large areas of mesic tall herb vegetation existing there.

In contrast to *C. septentrionalis*, *C. fennoscandicus* very rarely grows in mesotrophic sites.

The species is apparently absent in the Alps, which may be due to the same reasons as those responsible for the absence of *C. septentrionalis* (see discussion of the latter species).

Selected collections (paratypes): NORWAY - Telemark: Fyresdal, SW of Bjørntjørn [LA], 20 Aug. 1987, EB (O); Hedmark: Storelvdal, Solli, Muen [LA], EB 222/83 (O); Oppland: Ringebu, Kyrkjegardsfjellet [UB], 15 Aug. 1983, EB 216/83 (O), 16 Aug. 1984, EB 247/84 (O), Flåtjørnet [LA], 16 Aug. 1983, EB 217/83 (O), 18 Aug. 1984, EB 255/84 (O); Sel, Høvringen, Anaripigg [LA], 21 Aug. 1984, EB 256/84 (O); Nordland: Rana, NW of Bjøllåvasshytta [LA], 5 Aug. 1983, EB/TEB 235/83(O); Saltdal, Sollemntind NE of Storjord [UB], 2 Aug. 1983, EB/TEB 160, 161/83 (O), 3 Aug. 1983, EB/TEB 203/83 (O); SWEDEN - Härjedalen, Storsjö sn, Flatruet, 16. Aug. 1986, *Cortinarius*, Flora Photographica 434; Lule Lappmark, Gällivarre, Dunderet [LA], 15 Aug. 1981, TEB 102, 103-81 (O); FINLAND - Enontekiö Lapland: Enontekiö, Karesuvanto [UB], 7 Aug. 1988, KB/EB 284/88 (OULU); Kilpisjärvi, NE of Custom Station [UB], 5 Aug. 1988, KB/EB 214, 215/88 (OULU); Pikku-Malla [UB], 5 Aug. 1985, EB 86/85 (O); Saana [UB], 13 Aug. 1977; [LA], 8 Aug. 1983, KM (OULU); 3 Aug. 1988, KB/EB 187/88 (OULU). (A total of 30 collections were studied.)

C. grallipes Fr.

Epier. Syst. mycol.: 275, 1838.

Figs 18, 31. Colour ill.: MJ III 27.

Description. *Cap* 3-4.5 cm, hemispherical to umbonate, strongly glutinous, somewhat hygrophanous; fulvous brown with a faint olivaceous tinge when moist, or slightly more sienna brown. *Gills* 3-5 mm wide, moderately crowded, edge even, pale ochre when young. *Stipe* 80 x 10 mm, slender and cylindrical with pointed base, peronate of purely white veil, becomes dark brownish at the base with age. *Flesh* whitish, smell none.

Spores 11-13 x 6.5-7 µm, amygdaliform to faintly citriform, verrucose. *Gill edge* sterile with basidium-like sterile cells. *Hyphae of glutinous veil from stipe* with numerous clamp connections.

Ecology: Oligotrophic, open, secondary forest with *Betula* (possibly *Populus*).

Discussion. *C. grallipes* is hitherto only found in Småland, Sweden and seems to be

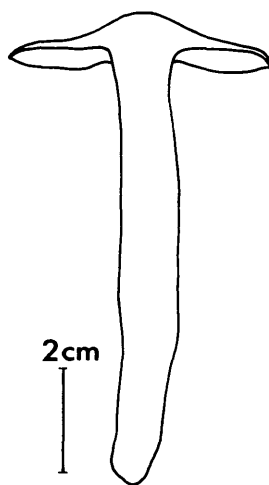


Fig. 31. *Cortinarius grillipes* (TEB 324-79 (O)).

restricted to deciduous forest, especially forests of beech and birch (Moser, pers. comm.). For characters separating it from *C. fennoscandicus*, see the discussion under the latter. The Friesian descriptions (e.g. Fries 1838, 1874) of *C. grillipes* are slightly curious, but no character (cap hygrophanous, fulvous brown to ochre, stipe slender and cylindrical, in mixed frondose forest) clearly contradicts the interpretation introduced by Moser (cf. Moser 1983, Moser & Jülich 1987).

Collections examined: Brief description based on a single collection; SWEDEN - Småland: Femsjö, TEB 324-79 (O).

Cortinarius mucosus (Bull.) Kickx

Fl. crypt. Flandres II: 191, 1867. - *Agaricus mucosus* Bull., Herb. France: pl. 549 D-F, 1792. - *Agaricus collinitus* B. A. *mucosus* (Bull. : Fr.) Fr., Syst. mycol. 1: 248, 1821. - *Cortinarius collinitus* * *C. mucosus* (Bull. : Fr.) Fr., Epicr. Syst. mycol.: 274, 1838.

Figs 7, 23-24, 32. Colour ills: P 122, M 753, RH 512.

Description. *Cap* 4-10 cm, hemispherical to plano-convex, glutinous when young; yellow-brown, sienna (N59, M60, 5B6), soon darker ochraceous brown (P59, 6C8) towards the centre which often becomes dark red-brown (T37) and sometimes has an olivaceous tinge, margin often very pale. *Gills* 5-13 mm wide, moderately crowded, broadly adnate or slightly emarginate, often with a decurrent tooth, edge even to faintly fimbriate, pale greyish to flesh coloured. *Stipe* 55-140 × 12-25 mm, cylindrical, glutinous with a pure white, thick universal veil (very seldom violet), peronate or cracking in adpressed scales or girdles, the base only turning faintly brownish. *Flesh* white, grey to flesh-coloured in the upper part of stipe, in the base turning brownish, no taste or smell.

Spores 11.5-[13.3]-14 × 5.8-[6.6]-7(-7.5) µm, L/W (Q) = 1.82-[2.01]-2.16, narrowly amygdaliform to citriform, strongly verrucose. *Basidia* 35-45 × 9-12(-13) µm, 4-spored, with basal clamp connections. *Gill edge* sterile, with basidium-like sterile cells. *Cap cuticle* with

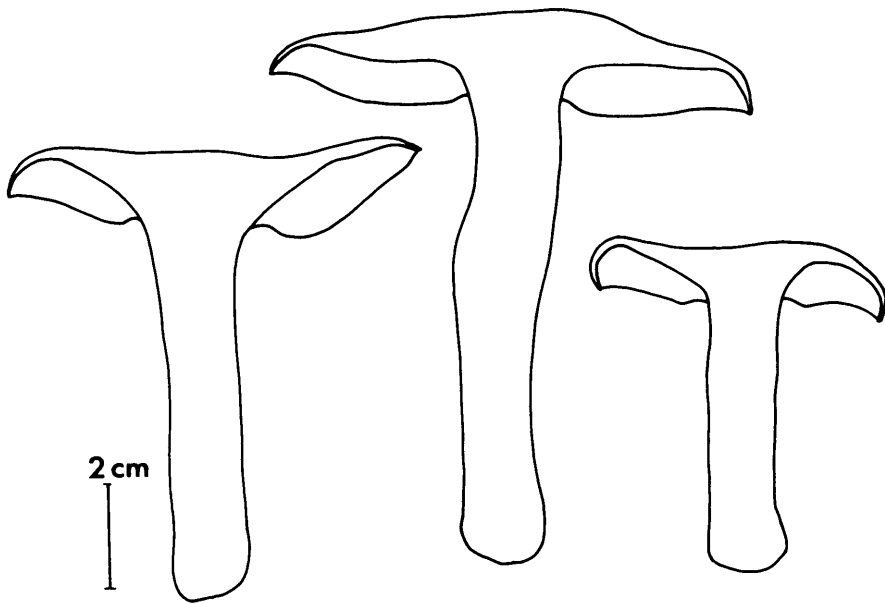


Fig. 32. *Cortinarius mucosus* (TEB 55/83 (O)).

a fairly thin epicutis (ixocutis) of strongly gelatinized, loosely and irregularly entangled, hyaline hyphae 2-4(-6) μm wide, with clamp connections; basally with a few layers of parallel, slightly wider, brown, zebra-striped, encrusted hyphae, grading evenly into a more or less subcellular hypodermium with brown, inflated hyphae up to 27 μm wide, pigment smooth, parietal to encrusted on wider elements. *Hyphae of glutinous veil from stipe* 2-5(-6) μm wide, hyaline, with numerous clamp connections.

Ecology: Boreal forest under *Pinus sylvestris*; xeric and subxeric site-types on poor soil.

Taxonomic discussion. The species is recognized by its yellow-brown to orange-brown cap with darker centre, the white and often short and firm stipe (very seldom violet, cf. Bendiksen & Bendiksen 1992), and the narrow spores (Figs 23, 24). Macroscopically it may be superficially similar to the pure white-stiped forms of *C. septentrionalis* (see discussion under the latter).

Agaricus mucosus of Bulliard (1798) is a collective species, possibly including all the modern species of section *Colliniti* (and *Defibulati*?) known by that author. The original plates of *A. mucosus* illustrate three different species, *C. trivialis* (549 A-C)(cf. Henry 1934), a *Phlegmacium* species (596), and a *Myxacium* species more difficult to interpret (549 D-F). The latter has a dull ochraceous cap colour and a white stipe. *Agaricus mucosus* in *Systema* (Fries 1821) is an infraspecific taxon. The species thus should be lectotypified based on one of the depicted elements of Bulliard (cf. Article 7.4, footnote, of the Nomenclatural Code; Greuter et al. 1988).

Several alternatives may be taken into consideration. The name could be lectotypified based on the elements showing *C. trivialis* J.E. Lange thus using it in contradiction to the current usage; alternatively the name could be proposed rejected, or finally the name could be lectotypified based on the more anonymous element in plate 549 D-F emending the broad concept of Bulliard to cover the pine forest species bearing the name today.

The first alternative would involve great confusion changing a name from one well-

known species to another (cf. also Article 69.4), and is no good solution to the problem.

The second alternative would have to be used if there were clear contradictions in the Code against the use of the name *C. mucosus*.

Concerning the third possibility, it is uncertain whether the species associated with the name today is included. However, when emending *A. mucosus* for the pine forest species in question, it is possible to retain the well-established name *C. mucosus*.

Fries (1821) was the first author who used the name in a stricter sense (but not at the same level). In other words, he was the first to emend the concept of Bulliard. By selecting to retain the name as used now, maximal stability is preserved.

A. mucosus Bull. apud Ventenat (Hist. Champ.: 661, 1812) was listed as a superfluous name by Petersen (1977) because two earlier names from Schaeffer were given as synonyms in the description. The plates were, however, published twenty years before, but without description. Only plate 549 (published 1792) is supplied with a latin name. The plate is to be considered as an illustration with analysis, because of details aiding identification (cf. Articles 44.1 and 44.2). Consequently, *A. mucosus* Bull. is validly published.

Ecological discussion. In Fennoscandia, *C. mucosus* is strictly associated with *Pinus sylvestris*. Judging from Central European and North American literature it seems to have obligate mycorrhiza with two-needled *Pinus* species on a world-wide scale (cf. Ammirati & Laursen 1982, Moser 1983). The species is strongly drought resistant being one of the typical species of *Cladonia* (subgen. *Cladina*)-dominated pine forest (xeric series), together with, e.g., *Cortinarius croceus* (Schaeff.) S.F. Gray, *C. semisanguineus* (Fr.) Gill., *C. leucophanes* Karst., *Lactarius rufus* (Scop. : Fr.) Fr., *Russula decolorans* (Fr. : Fr.) Fr., *R. paludosa* Britz., *Suillus bovinus* (L. : Fr.) Roussel, *S. luteus* (L. : Fr.) Roussel, and *S. variegatus* (Sw. : Fr.) O. Kunze. The caps are often expanded while still in the soil and are, therefore, often covered with soil and lichen remnants.

C. mucosus also grows in mossy *Pinus* and *Picea* mixed forests (subxeric series). The species is frequent in Fennoscandia. Favre (1960) recorded it from the tree line above 2300 m under *Pinus mugo* in the Alps. This indicates that its distribution is limited to that of two needled *Pinus* spp. and not by climatic factors, quite equivalent to the pattern observed for *C. collinitus* (in relation to *Picea*). It is apparently also widely distributed in North America (cf. Kauffman 1932, Smith 1939, Ammirati & Laursen 1982).

Collections examined: 20 from a wide geographical range in Norway and Finland (O, OULU).

***Cortinarius septentrionalis* E. Bendiksen, K. Bendiksen & Brandrud, sp. nov.**

Pileus 3.5-10 cm *latus*, *convexus*, *interdum umbone lato praeditus*, *valde glutinosus*, *aurantiacus*, *aureus*, *brunneo-aurantiacus*, *media parte saepe fuscior*, *marginē flava*, *hygrophana*. *Lamellae* 3-13(-16) mm *latae*, *modice confertae*, *adnatae vel tenuiter emarginatae acie aequata vel leviter fimbriata*, *pallide griseo-brunneola vel griseolo-ochracea*. *Stipes* 6-12.5 cm *longus*, 7-25 mm *crassus*, *cylindricus*, *glutinosus*. *Velum interdum ut in C. collinito in zonis adpressas irregulares ruptum*, *saepissime virgineum*, *vel pallide violaceum*, *basin versus brunnescens*. *Caro alba basin versus brunnescens*. *Sapor mitis*. *Odor nullus*. *Sporae* 11-13(-13.5) × 6.5-8.5 μm, *late amygdaliformes vel leviter limoniformes*, *raro ellipticae*, *valde verrucosae*. *Cheilocystidiis nullis*. *Sub Betula pubescenti ssp. tortuosa et Betula nana, zonis subalpinis et alpinis*. *Typus: E. Bendiksen and Brandrud 156/83 (O)*.

Typus: Norway. Nordland: Saltdal, Sollemntind, NE of Storjord, oligotrophic woodland of *Betula pubescens* ssp. *tortuosa* with dominance by *Vaccinium myrtillus*, ca. 600 m a.s.l., UTM WQ 18-19 11-12, 2 Aug 1983, E. Bendiksen and Brandrud 156/83 (O, holotypus; OULU, isotypus).

Misapplied names: *C. aff. mucosus* s. Ammirati & Laursen, Arctic and alpine mycology: 287, 1982. - *C. collinitus* p.p. s. Moser in Gams, H., Kleine Kryptogamenflora 2b/2: 389, 1983.

Figs 8, 25-26, 33-35. Colour ill.: BBB.

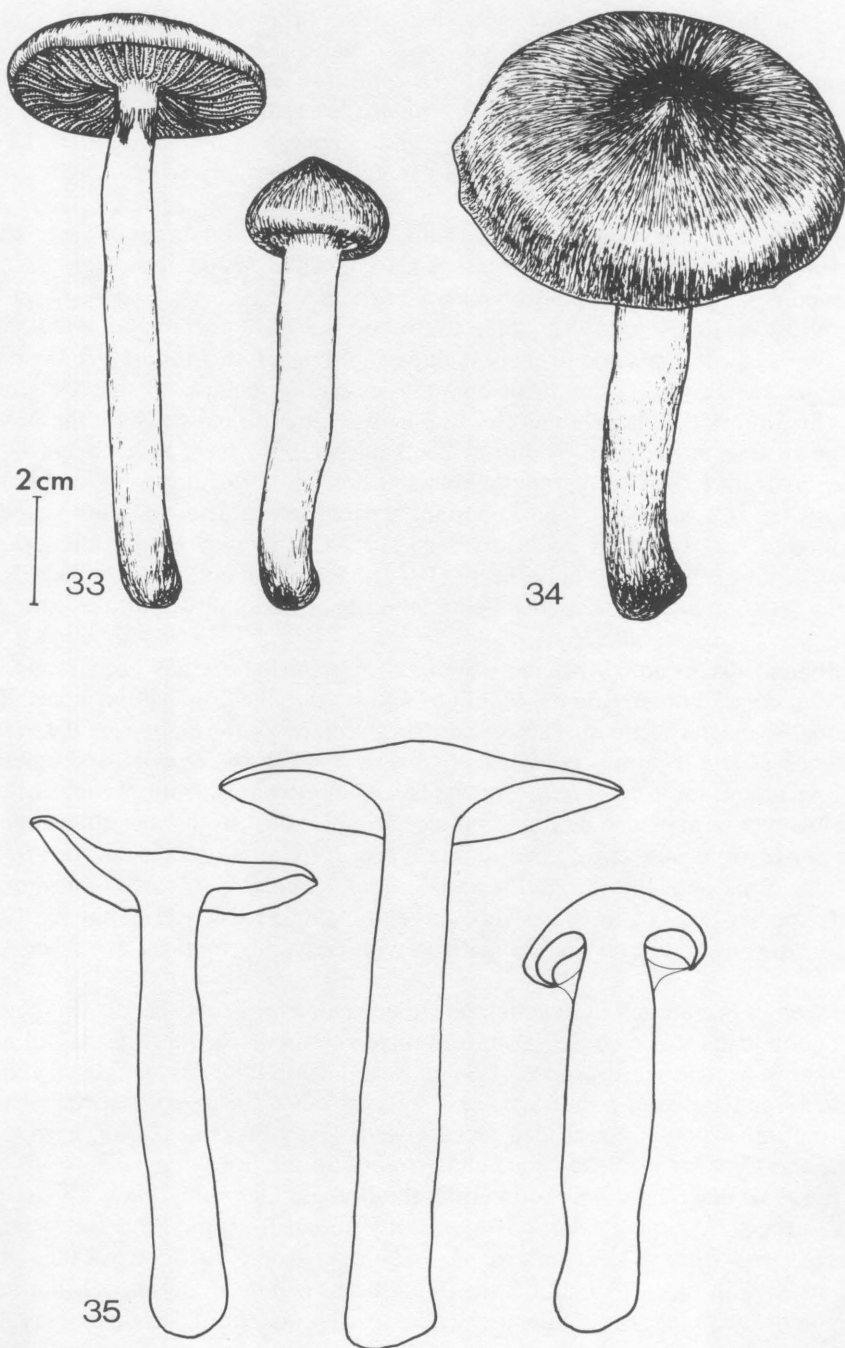
Description. *Cap* 3.5-10 cm, hemispherical to convex when young, later plano-convex, typically with a broad umbo, disc often somewhat pseudohygrophanous (with minute, darker patches), outer part hygrophanous and brownish orange (6C8-6D7), and during the first phase of drying with a sharp border between outer and inner part (as *C. collinitus*), otherwise vividly, warm orange, golden yellow (5B8-5A7,8, 6A8, 6B8) to more red-brownish (6C8, P39), concolorous, or disc commonly darker brown (7C8, 7E8, 7F8, 8E8), or sometimes with darker, red-brown spots, outermost margin sometimes paler, more yellow (4A3,5), faintly translucently striate when old, and then often discolouring to more dull ochraceous, primordia brownish (R47, R49) with an olivaceous tinge. *Gills* 3-13(-16) mm wide, moderately crowded, broadly adnate to shallowly emarginate, often with a tooth, edge even to slightly fimbriate, greyish beige to pale greyish ochraceous (K90, 5C4, 5C5). *Stipe* 60-125(-180) × 7-25 mm, cylindrical, glutinous, universal veil peronate or cracking in irregular adpressed girdles at least towards the base; the veil colour varies from pure white to pale violet (17A2, but paler), younger specimens, however, often with bright violet colours (17A2-B3, 18A2), stipe surface turning brownish (5C7) towards the base. *Flesh* white, often watery greyish in upper part of stipe, especially close to the surface, not violet, brownish (5C7, 5C8, 6D8) towards the base, extreme base and parts damaged by insect larvae sometimes blackish brown, no taste or smell.

Spores 11-[12.0]-13(-13.5) × 6.5-[7.1]-8.5 µm, L/W (Q) = 1.52-[1.69]-1.82, mostly amygdaliform, but also with variations towards elliptical or limoniform, strongly verrucose. *Basidia* 37-50 × 11-13 µm, 4-spored, base with clamp connections, gill edge sterile, with basidium-like sterile cells. *Cap cuticle* with a fairly thin epicutis (ixocutis) of strongly gelatinized, loosely and irregularly entangled, hyaline hyphae 2-5.5 µm wide, with clamp connections; basally with a few layers of parallel, slightly wider, brown, zebra-striped, encrusted hyphae, grading evenly into a more or less subcellular hypodermium with brown, inflated hyphae up to 30 µm wide, pigment smooth, parietal to encrusted on wider elements. *Hyphae of glutinous veil from stipe* 2-4.5 µm wide, hyaline, with numerous clamp connections.

Ecology: Upper boreal and low alpine zones with *Betula* spp.; subxeric and submesic site-types on poor and mesotrophic soils, in the low alpine zone also in mesic sites (here also with *Salix* spp.?), one find under *Betula pubescens* in the southern boreal zone.

Taxonomic discussion. *C. septentrionalis* is a northern species, associated with *Betula* (-*Salix*), and characterized by the combination of vivid cap colours and white to pale violet stipe. Mycologists who have collected in northern Arctic-alpine environments have mostly included the taxon in *C. mucosus*, some apparently also partly in *C. collinitus* (cf. Moser 1983). The cap colour is dominated by vivid orange to red-brown colours reminding one of *C. mucosus*, but there are several characters which separate the two taxa. *C. mucosus* is not umbonate, which is typical for *C. septentrionalis*. Further, *C. mucosus* has a cap colour which is not as vivid as in *C. septentrionalis*. Specific characteristics of *C. mucosus* are also an often spotty surface and a pale cap margin. *C. mucosus* is a much stouter species, and even when growing in deep moss the stipe does not become long and slender as in *C. septentrionalis*. Finally, the stipe of *C. mucosus* has a tendency to widen toward the apex, and it is pure white (veil colour). Only in very rare cases *C. mucosus* has been observed with a violet colour on the stipe, cf. Bendiksen & Bendiksen (1992). The stipe of *C. septentrionalis* is white or pale violet; in young fruit bodies, the colour is sometimes as strong as that of *C. collinitus*.

Besides having a stronger violet colour in later stages, *C. collinitus* has a stronger brown



Figs 33-35. *Cortinarius septentrionalis*. Fig. 33. KB/EB 218/88 (OULU). Fig. 34. KB/EB 190/88 (OULU). Fig. 35. EB/TEB 156/83, holotypus (O)).

discolouring of the stipe base. The wide and more or less amygdaliform spores of *C. septentrionalis* are different both from the typical narrow spores of *C. mucosus* (different Q-values) and the distinctly larger spores of *C. collinitus*. Both *C. mucosus* and *C. collinitus* are coniferous forest species, while *C. septentrionalis* is exclusively associated with deciduous trees or shrubs, mostly in the upper boreal - alpine zones. *C. fennoscandicus*, having very similar ecology, is separated by a more dull cap colour, normally with a distinct olivaceous tinge.

Judged by its ecology, the first records of *C. septentrionalis* can probably be traced back to Blytt (1905) from Norway though part of his collective *Myxarium mucosum* apparently included even *C. collinitus* and possibly also *C. favrei*.

Ammirati & Laursen (1982) refer to recent literature records of Arctic-alpine "*C. mucosus*". We suspect that some of them include *C. favrei*. Both Ammirati & Laursen (1982) and Gulden & Lange (1971) comment on some deviating features of the Arctic-alpine "*C. mucosus*" (in Ammirati & Laursen as *C. aff. mucosus*), but do not consider the possibility of regarding it as a separate taxon. Kallio & Kankainen (1966) have also obviously found *C. septentrionalis* from Kevo, northernmost Finnish Lapland, correcting some earlier records of "*C. collinitus*" to "*C. mucosus*". The important separating character of spore shape has only been mentioned by Ammirati & Laursen (1982). Concerning the differences in spore morphology from *C. collinitus*, only Smith (1944) has paid attention to the large size of the *C. collinitus* (as *C. cylindripes*) spores, being larger than the spores of all the other species in the section.

Ecological discussion. In Fennoscandia *C. septentrionalis* has been found, with one exception, in upper boreal (montane) birch woods and the low alpine zone. The name "septentrionalis" means northern. The species has a preference for *Empetrum hermaphroditum* and *Vaccinium myrtillus*-dominated woods (subxeric and submesic-poor), and functions as an ecological vicariant for *C. collinitus* upwards and northwards from the climatic limit of conifers. However, it may also be found on mesotrophic soils. In the low alpine zone it spans the whole range from subxeric to mesic site-types. Here it is associated with *Betula nana* (possibly also *Salix* spp. like *S. glauca* and *S. lapponum*). Records of "*C. mucosus*" under dwarf-*Salix* species (M. Lange 1957, Kobayasi et. al. 1967, 1968, 1971) may partly represent misidentifications of *C. favrei*. For comparison with *C. fennoscandicus*, see discussion under that taxon.

The species is common in mountainous regions all over Fennoscandia. In more northern parts of Fennoscandia it is recorded also from mixed conifer - *Betula* forest. Until now, it has been found only once in the lowlands of South Scandinavia (Norway, Oppland: Lunner, TEB 13 Aug. 1992 under *Betula pubescens* (O)). Several other *Cortinarius* species having their optima in the upper boreal zone, such as *C. bivelus* (Fr. : Fr.) Fr., *C. porphyropus* (Alb. & Schw.) Fr., and *C. talus* Fr., also occur under *Betula* in the lowlands.

As far as we have been able to interpret the floristic literature, this is a strictly northern species in Europe. *C. septentrionalis* is apparently absent from the Alps (or at least it must be rare there), and from the oceanic *Betula pubescens* woods of Scotland (cf. Orton 1955, 1986). Its absence in the Alps may be due to the lack of *Betula* spp. on well-drained soils in the alpine and subalpine environments, while its absence from Scotland may be due to restriction to colder climates. The species is probably circumpolar, as it has also been recorded from Alaska (Ammirati & Laursen 1982, as *C. aff. mucosus*) and from Greenland (leg. T. Borgen).

Selected collections (paratypes): NORWAY - Oppland: Dovre, Grimsdalen, Sjøberget [UB], 19 July 1983, EB 157/83 (O); Sel, Høvringen [UB], 21 Aug. 1984, EB 258/84 (O); Buskerud, Hol, Flatåker,

Skurdalsvatnet [UB], 12 Aug. 1984, TEB 28-84 (O); Nordland: Saltdal, Sollemntind NE of Storjord [UB], 2 Aug. 1983, EB/TEB 155, 157, 158/83 (O); SWEDEN - Härjedalen, Storsjö sn, Flatruet, 16. Aug. 1986, *Cortinarius*, Flora Photographica 431; Lule Lappmark: Gällivarre, Dunderet [LA], 15 Aug. 1981, TEB 107, 108-81 (O); FINLAND - Enontekiö Lapland: Enontekiö, Kilpisjärvi, Saana [UB], 3 Aug. 1988, KB/EB 190/88 (OULU); [UB], 4 Aug. 1983 (plot 15), 4 Aug. 1983 (by plot 12), KM (OULU); [LA], 3 Aug. 1988, KB/EB 191/88 (OULU); Pikku-Malla [UB], 7 Aug. 1985 (by plot 4), KM, EB, Skifte (OULU); NE of Custom Station [UB], 5 Aug. 1988, KB/EB 218, 219/88 (OULU). (A total of 24 collections were studied.)

Cortinarius trivialis J.E. Lange

Fl. agaric. Danica 1:III, 1935. - *Agaricus collinitus* Sow. : Fr., Syst. mycol.: 248, 1821. - *Cortinarius collinitus* (Sow. : Fr.) Fr., Epicr. Syst. mycol.: 274, 1838. - *Cortinarius collinitus* var. *trivialis* (J.E. Lange) A. H. Smith, Lloydia 7: 175, 1944. - *Cortinarius fulvosquamosus* Orton, Kew Bull. 31: 709, 1977. - *Cortinarius zosteroides* Orton, Sydowia 36: 215, 1983. (Only selected synonyms are listed.)

Figs 9, 27-28, 36. Colour ills: FAD 89C, CFP, DD 450, 451, P 121, M 751, R 513.

Description. *Cap* 4-7 cm, convex to plano-convex, sometimes with a broad umbo, strongly glutinous, slightly to distinctly hygrophanous; colour variable, pale to dull ochraceous, olivaceous brown to vividly red-brown (5CD6-5CD8, M60, N60, N65, M79, P79), sometimes darkest at the disc (e.g. P77), margin pale greyish (L90-T85) when young (several colour forms are described, but variation is apparently continuous). In Arctic-alpine zones the cap is commonly bicoloured; in the outer part vivid ochraceous with an orange tinge, centre pale honey yellow which expands to the whole surface when drying. *Gills* 4-9 mm wide, crowded to subdistant, broadly adnate or somewhat emarginate, often with a decurrent tooth, edge even to faintly fimbriate, violet grey (17C2) to greyish blue, mostly bluish close to the edge, or more rarely pale ochraceous grey without any bluish tinge. *Stipe* 60-135 × 6-20 mm, cylindrical, or with attenuated base, sometimes narrower also toward the apex, glutinous universal veil cracking in separate annulate scales or girdles (by stretching), often with vertical connections forming a net-like structure; apex pale greyish white, exposed stipe surface between veil remnants early becoming ochraceous (5B-C6), dark brown (6F6) at the base after some time, veil pale ochraceous at first, sometimes olivaceous (N85). *Flesh* pale, greyish in stipe apex, turning brownish in lower part of stipe with a very dark base, no taste or smell.

Spores 10.5-[11.6]-12.5(-13) × 6-[6.8]-7.5 μm, L/W (Q) = 1.62-[1.71]-1.93, amygdaliform to elliptical or citriform, strongly and coarsely verrucose. *Basidia* 37-48 × 10-14 μm, 4-spored, with basal clamp connections. *Gill edge* sterile, sterile cells clavate, basidium-like. *Cap cuticle* with a fairly thin epicutis (ixocutis) of strongly gelatinized, loosely, and irregularly entangled, hyaline hyphae 2-4.5 μm wide, with clamp connections; basally with a few layers of parallel, slightly wider, brown, zebra-striped, encrusted hyphae, grading evenly into a more or less subcellular hypodermium with brown, inflated hyphae up to 35 μm wide, pigment smooth, parietal to encrusted on wider elements. *Hyphae of glutinous veil from stipe* 2-6(-7) μm wide, with numerous clamp connections.

Ecology: Found in all zones up to low alpine, and under a wide range of deciduous tree species; submesic and mesic site-types, poor and rich soils.

Taxonomic discussion. When typically developed the species is very characteristic with its thick universal veil breaking up into strongly disrupted bands on the stipe. It is also the only species in the section which may have distinctly bluish gills and not only bluish tinge. The cap colour is very variable.

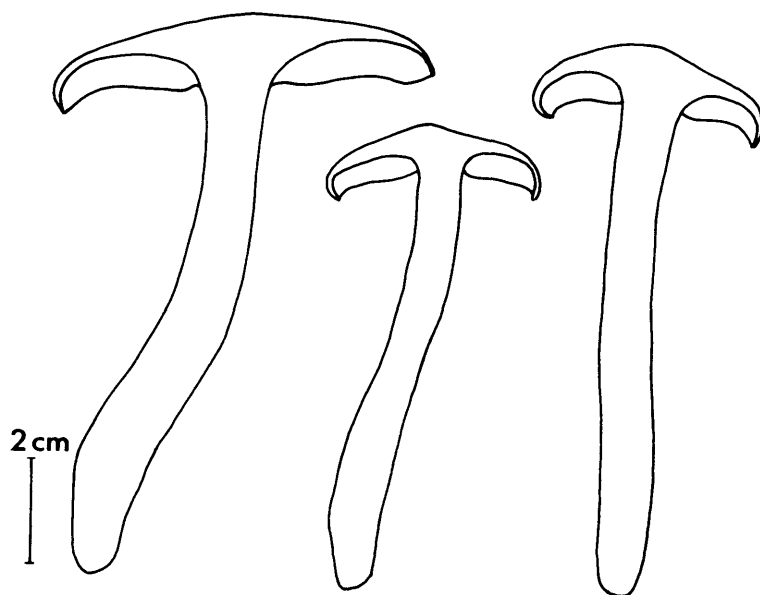


Fig. 36. *Cortinarius trivialis* (EB/TEB 262/83 (O)).

The significant variation has led to the description of several species and varieties in this complex (cf. Henry 1976), none of which in our opinion deserving the rank of species.

The more northern taxa, *C. fulvosquamosus* and *C. zosteroides*, described from Scotland by Orton (1977, 1983), are apparently synonyms of *C. trivialis*. According to Orton (1983) *C. zosteroides* is separated from *C. trivialis* by its wide spores, pale gills (not bluish - vinaceous), pale stipe and habitat under oak. However, as stated earlier, the colour of the gills of *C. trivialis* may vary considerably, and the darkening of the stipe due to the development of necropigment is also variable (as it is throughout the entire group). Furthermore, mycorrhizal associations with *Quercus* spp. are normal for *C. trivialis*, at least in South Europe (pers. obs.). Spores of the typus of *C. zosteroides* appeared to be of the typical size and shape as those of *C. trivialis* (cf. Fig. 2). The type collection of *C. fulvosquamosus* has slightly deviating, narrower spores, but lies within the range of normal variation. Otherwise the species seems to be a typical *C. trivialis*. *C. fulvosquamosus* is recorded under *Salix* spp., a typical habitat for *C. trivialis* in North Europe.

The frequent and characteristic species *C. trivialis* was described by Fries (1821) as a major element of his collective species *Agaricus collinitus*. See also discussion under that species.

Ecological discussion. *C. trivialis* seems to be strictly associated with deciduous trees. In other respects the ecological amplitude is extremely wide compared with other specialized species in this section. It is furthermore apparently distributed all over Europe, occurring in *Quercus ilex* forests of the Mediterranean zone (cf. Malençon & Bertault 1970, Brandrud & Bendiksen 1984) as well as *Salix* copses in Greenland (M. Lange 1957) and *Betula nana* shrubs in the low alpine zone in North Fennoscandia. In the lowlands of South Fennoscandia it seems to be most common in moist sites under *Salix caprea* or *Populus tremula*, while in Central Europe it prefers broad-leaved forests (cf. e.g. Kärcher & Seibt 1987). In Scandinavia *C. trivialis* is also common in mountain birch woods, where it is associated with *Populus tremula*, *Salix* spp., or with *Betula pubescens* ssp. *tortuosa* of submesic and mesic sites. In the

low alpine zone it seems less frequent than *C. septentrionalis* and *C. fennoscandicus* (cf. Fig. 13). *C. trivialis* grows in nutrient-poor as well as on richer soils.

Collections examined: 24 from a wide geographical area in Norway, Sweden, and Finland (O, OULU).

ACKNOWLEDGEMENTS

We wish to thank Fridtjof Nansen's Fund for the Advancement for Science and the Humanities, Academy of Finland and Emil Aaltonen's Foundation for financial support; Tove Bakar at The Electron-Microscopical Unit for Biological Sciences, University of Oslo, for making the SEM photographs; Bjørg Tosterud Danielsen, University of Oslo, for the latin diagnoses; Sverre Løkken and the staff at the Biological Library, University of Oslo, for making available a large amount of old literature; Jacques Melot, Reykjavik, for good advice, valuable communication concerning nomenclature, and loan of slides of Fries' plates; Meinhard Moser, University of Innsbruck, for several fruitful discussions; Vincent Demoulin, University of Liège, Lennart Holm, University of Uppsala, Per Magnus Jørgensen, University of Bergen, Thomas W. Kuyper, Biological Station, Wijster, Orson Miller jr., Virginia Polytechnic Institute and State University, Svengunnar Ryman, University of Uppsala, and Leif Ryvarden and Trond Schumacher, University of Oslo, for advice concerning nomenclature. We also thank Robert Henry, Vesoul, and the curators of the herbaria of the Royal Botanic Garden, Edinburgh, New York State Museum and the University of Michigan for the loan of type material.

We wish to address special thanks to Teuvo Ahti, University of Helsinki, for his critical comments on all aspects of the manuscript.

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