

## Some rare and interesting *Cortinarius* species associated with *Salix repens*\*

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Fifteen species of *Cortinarius*, associated with *Salix repens* in coastal dunes in the Netherlands, are described and illustrated. A key to the species of subgenus *Telamonia* associated with *S. repens* in the dunes is also provided. Specificity towards host tree and edaphic conditions is discussed. A comparison is made with the *Cortinarius* flora associated with dwarf willow vegetation in the alpine zone.

Keywords: *Cortinarius*, *Salix repens*, coastal dunes, The Netherlands.

Coastal dune ecosystems, in which *Salix repens* L. occurs, can be rich in ectomycorrhizal fungi. In the coastal dunes of the Netherlands and especially on the Wadden Island of Terschelling, *Salix repens* occurs in a wide variety of habitats, ranging from dry to moist, and from calcareous, humus-poor to acid, humus-rich soils.

The ectomycorrhizal flora in the various vegetation types is quite diverse and an inventory of 16 permanent plots, each measuring 500 m<sup>2</sup> during one year (1992) yielded 50 ectomycorrhizal fungi associated with *Salix repens* (Kuyper & al., 1994). Among the ectomycorrhizal fungi, species of the Cortinariaceae were dominant, with 38 species (76%) belonging to the genera *Cortinarius* (inclusive of *Dermocybe*), *Inocybe*, *Hebeloma*, and *Naucoria*. Especially the genus *Cortinarius* is well represented, as 19 species have been recorded. Similar observations were made in the British coastal dunes, where Watling (1981) and Watling & Rotheroe (1989) also listed a large number of species of the Cortinariaceae.

In this paper we describe fifteen rare and interesting *Cortinarius* species. Twelve species belong to subgenus *Telamonia*, and one each to the subgenera *Myxacium*, *Sericeocybe*, and *Dermocybe*. A key to the species of subgen. *Telamonia* is provided. Six species have not previously been reported from the Netherlands (Arnolds, 1984; Arnolds & al., 1992). We shall discuss the specificity of these

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\* This paper is dedicated to Professor M. Moser on the occasion of his seventieth birthday. Communication 519 of the Biological Station Wijster.

*Cortinarius* species with regard to host trees and soil characteristics. We will also comment on the similarities and differences in species composition between these scrub ecosystems and the dwarf willow vegetation in the alpine zone (Favre, 1955).

Methods follow those of the *Flora agaricina neerlandica* (Bas, 1988). Ornamentation on the spore surface is described as punctate when ornamentation is very fine, verruculose when it is somewhat coarser, and verrucose when it is much coarser.

**Key to the species of *Cortinarius* subgen. *Telamonia* associated with *Salix repens* in the dunes**

- 1a. Sporocarps relatively robust: pileus 25–70 mm broad, not translucent striate; stipe 6–16 mm thick..... 2
- 1b. Sporocarps smaller: pileus 6–40 mm broad, often translucent striate when moist; stipe 1–4 mm thick ..... 3
  
- 2a. Stipe with violaceous tinges, especially in apical part, and with sock-like velar remains in lower part; pileus dark reddish brown .  
*C. cohabitans*
- 2b. Stipe at first whitish, then orange-brown with some fibrils of white veil, without violaceous tinge; pileus orange brown to chestnut-brown ..... *C. cf. privignus*
  
- 3a. Veil on stipe (sometimes also on pileus) yellowish or brownish... 4
- 3b. Veil on stipe white or pinkish ..... 6
  
- 4a. Pileus scaly or with fibrillose velar patches; veil yellow-brown to grey-brown ..... 5
- 4b. Pileus smooth or with some thin velar remains at margin; veil (pale) yellowish ..... 6
  
- 5a. Pileus up to 10 mm broad, acutely conical, with grey-brown fluffy scales; spores (8.0–)8.5–10.5 × 6.0–6.5 μm, Q = 1.3–1.5(–1.6)  
*C. comatus*
- 5b. Pileus larger, convex, umbonate, fibrillose (remining *Inocybe* spp.); spores 9.5–10.5(–11.0) × 4.5–5.0 μm, Q = 1.9–2.2(–2.4) .....  
*C. ammophilus*
  
- 6a. Veil forming a conspicuous white belt or annulus on the stipe.....7
- 6b Veil on stipe as fine fibrils .....10

- 7a. Spores  $10.5\text{--}12.0 \times 6.0\text{--}7.0 \mu\text{m}$ ; pileus dark (reddish) brown .....  
*C. casimiri*
- 7b. Spores  $7.0\text{--}10.5 \times 4.5\text{--}6.0 \mu\text{m}$ ; pileus paler, orange-brown 8
- 8a. Smell very strong of cedar wood; pileus without distinct velar remains .....*C. parvannulatus*
- 8b. Smell not distinct; pileus with distinct, white velar remains, at least at margin.....9
- 9a. Pileus pale reddish brown to flesh-coloured, entirely covered with white, arachnoid veil, not striate (exceptionally obscurely striate in old sporocarps); stipe with distinct woolly annulus.....  
.....*C. dumetorum*
- 9b. Pileus bright orange-brown, near margin with fibrils of white veil, distinctly translucent striate; stipe often with narrow, white-floccose velar belt, not annulate  
*C. pauperculus*
- 10a. Smell of fresh sporocarps as leaves of *Pelargonium*; lamellae initially violaceous or brownish; veil usually yellowish 11
- 10b. Smell of fresh sporocarps not as leaves of *Pelargonium*; lamellae without violaceous tinge; veil white..... 12
- 11a. Lamellae initially violaceous; spores  $(7.5\text{--})8.0\text{--}9.0 \times 4.5\text{--}5.0 \mu\text{m}$ ; smell strong .....*C. tiliaceus*
- 11b. Lamellae yellow-brown to rusty brown; spores  $8.5\text{--}11.5 \times 5.0\text{--}6.0 \mu\text{m}$ ; smell weak ..... *C. cucumisporus*
- 12a. Pileus finely fluffy; spores  $7.0\text{--}8.0\text{--}(8.5) \times 5.0\text{--}6.0 \mu\text{m}$ ,  $Q = 1.3\text{--}1.4\text{--}(1.5)$ ..... *C. comptulus*
- 12b. Pileus not fluffy; spores  $8.0\text{--}11.5 \times 4.5\text{--}6.0 \mu\text{m}$ ,  $Q = 1.6\text{--}2.0\text{--}(2.1)$ .....  
.....13
- 13a. Spores in majority obovoid-oblong to subamygdaliform  
.....*C. cucumisporus*
- 13b. Spores ellipsoid-oblong to weakly obovoid..... 14
- 14a. Pileus blackish brown; stipe brown with distinct pinkish tinge; spores  $(9.0\text{--})9.5\text{--}11.5 \times 5.0\text{--}5.5\text{--}(6.0) \mu\text{m}$ ..... *C. cavipes*
- 14b. Pileus and stipe orange-brown; spores  $8.0\text{--}9.5\text{--}(10.0) \times 4.5\text{--}5.0 \mu\text{m}$   
.....*C. pauperculus*

## Annotated list of species

1. *Cortinarius ammophilus* A. Pears., Trans. Br. mycol. Soc. 29: 198. 1946. – Fig. 1.

Pileus 22 mm, convex, umbonate, hygrophanous, not translucent-striate, in centre dark greyish brown, outwards yellow-brown, with scattered arachnoid velar patches, fibrillose, towards margin radially rimulose, and therefore seemingly white-fibrillose (like some species of *Inocybe*). – Lamellae 32,  $l = 1(-3)$ , thin,  $\pm$  crowded, 3.5 mm broad, subventricose, adnate, rusty brown, with fimbriate paler edge. – Stipe 39  $\times$  3 mm, equal or slightly swollen at base (4 mm), yellow-brown, discolouring from base upwards to brown, with yellow-brown velar patches in lower half and a yellow-brown ring halfway. – Context yellow-brown to brown. – Smell (very) faint, with pelargonoid or saponaceous component. – Spores 9.5–10.5(–11.0)  $\times$  4.5–5.0  $\mu\text{m}$ ,  $Q = 1.9-2.2(-2.4)$ , average  $Q = 2.0$ , punctate to almost smooth. – Basidia 26–34  $\times$  7–9  $\mu\text{m}$ , 4-spored, hyaline or with brown pigment. – Cheilocystidia absent. – Hymenophoral trama made up of 4–10  $\mu\text{m}$  wide cells, with pigment distinctly incrusting.

Habitat – Associated with *Salix repens* on a dry north-exposed slope on humus-rich, acid sand, with *Empetrum nigrum* L.

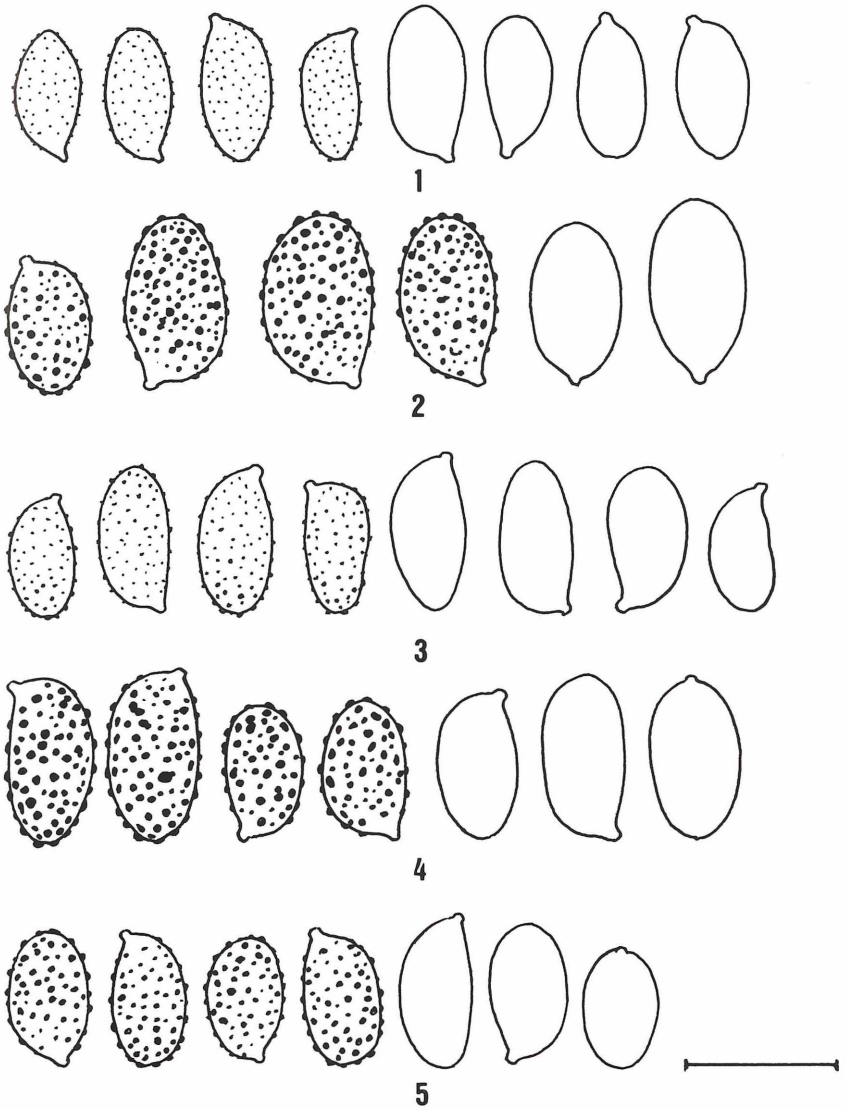
Collection examined – NETHERLANDS: Terschelling, West aan Zee, 2 Oct. 1990, Kuyper 3094 (WBS).

This species can be recognised by a combination of fairly fibrillose to rimulose pileus, which is not unlike that of several *Inocybe* species, brown veil, and fusiform, almost smooth to minutely punctate spores. It is apparently not well-known. After the first description by Pearson (1946), it was only mentioned by Høiland (1975). Both authors found the species associated with *Salix repens*.

Other *Cortinarius* species with slender spores ( $Q > 2.0$ ) are *C. cucumisporus* Mos. (q.v.) and *C. fuisporus* Kühner. The latter species has not been recorded with *Salix repens*. It differs from *C. ammophilus* in having a less fibrillose pileus and in having a whitish to pale yellow veil (sometimes indistinctly so) without a ring-like zone.

2. *Cortinarius casimiri* (Velen.) Huijsman, Fungus 25: 20. 1955. – Fig. 2.

Pileus 15–40 mm, conico-convex, then plano-convex with broad umbo, hygrophanous, not or weakly translucent striate, when



Figs. 1-5. Sporograms. - 1. *C. ammophilus* (Kuyper 3094). - 2. *C. casimiri* (Arnolds 6192). - 3. *C. cavipes* (Arnolds 6105). - 4. *C. cinnamomeoluteus* (Arnolds 6189). - 5. *C. cohabitans* (Arnolds 3931). - Scale bar: 10  $\mu$ m.

moist dark reddish brown, outwards slightly paler, narrow margin with adpressed, silky, white remains of veil, on drying becoming paler brown. - Lamellae 24-40, l = 1-3, thin, crowded, adnate, subventricose, rusty brown. - Stipe 28-45  $\times$  3-5 mm, equal, pale, slightly reddish brown, white-fibrillose striate lengthwise, in addition

with one or two white ring-like patches of veil halfway. – Context slightly paler than surface. – Smell not distinctive. – Spores (10.0–)10.5–12.0(–13.0) × 6.0–7.0(–7.5) μm, Q = 1.6–1.8(–1.9), average Q = 1.7, sometimes slightly flattened above apiculus, rather pale yellow-brown, densely verruculose with dark brown, isolated rounded warts, not coarser near apex. – Basidia 25–36 × 8–10 μm, 4-spored, hyaline or with brown intracellular pigment. – Cheilocystidia not observed, basidioles rather frequent in some specimens. – Hymenophoral trama made up of 3–13 μm wide cells, with pale brown membranal pigment, in addition with pigment minutely incrusting.

Habitat – Associated with *Salix repens* on north-exposed slope on dry, acid dune sand with *Empetrum nigrum* and *Polypodium vulgare* L.

Collection examined – NETHERLANDS: Terschelling, West aan Zee, 25 Oct. 1991, Arnolds 6192 (WBS).

For differences between *C. casimiri* and *C. cavipes* J. Favre see under that species. We consider *C. casimiri* and *C. subsertipes* Romagn. as synonyms because both species have equally-sized large, verruculose spores. Moser (1983a) separated both taxa on account of stipe colour: violaceous in *C. subsertipes*; only with vague violaceous tinges at the apex in *C. casimiri*. However, the protologue of *C. casimiri* clearly indicated a pale violaceous stipe. Keizer & Arnolds (1994) also suggested that both names might best be regarded as synonyms, and Arnold (1993) noted some variability in stipe colour of *C. subsertipes*, which most likely included *C. casimiri* as well. The name *C. casimiri* has priority.

3. ***Cortinarius cavipes*** J. Favre, *Ergebn. wiss. Unters. Schweiz. Nat. Parks* 5 (NF): 202. 1955. – Fig. 3.

Pileus 9–25 mm, campanulate when young, then convex to plano-convex, with or without umbo, hygrophane, not translucent striate, when moist blackish brown, somewhat paler towards margin because of scattered velar remains, on drying becoming chestnut-brown. – Lamellae to 6 mm broad, fairly distant, narrowly to broadly adnate, yellow-brown when young, with even, concolorous edge. – Stipe 18–40 × 1.5–4 mm, equal to somewhat swollen at base (to 6 mm), fistulose-hollow, somewhat pinkish-tinged brown, covered with pinkish fibrillum, on drying pale pinkish-greyish-brownish. – Context in pileus blackish brown, in stipe dark pinkish brown. – Smell faint, somewhat reminiscent of cedar wood. – Spores

(9.0–)9.5–11.5 × 5.0–5.5(–6.0) μm, Q = 1.8–2.1, average Q = 1.9–2.0, verruculose, with fairly low, isolated to slightly interconnected warts, somewhat more strongly ornamented towards apical part, sometimes punctate. – Basidia 23–37 × 7–10 μm, 4-spored, hyaline or with brown, intracellular pigment. – Cheilocystidia absent. – Hymenophoral trama with distinctly incrusting pigment, incrustations partly crust-like.

**Habitat** – Associated with *Salix repens* in moist, calcareous dune slacks, partly grazed by rabbits.

**Collections examined** – NETHERLANDS: Terschelling, West aan Zee, Lange Vallei, 3 Oct. 1990, Baartmans, Biemans & Verbruggen 173; ibidem, 23 Oct. 1990, Keizer 90038 & 90039; Terschelling, West aan Zee, Schoenus-Vallei, 11 Oct. 1990, Arnolds 6105 (all in WBS).

The combination of dark blackish brown pileus, fairly bright lamellae, and a somewhat pinkish, hollow stipe fits quite well *Cortinarius cavipes* (Favre, 1955). The microscopical characters are also in good agreement with those of the lectotype (Horak, 1987). We do not believe that the hollow stipe itself is a good differentiating character, as many hygrophanous species of *Cortinarius* can get a fistulose stipe with age.

*Cortinarius casimiri* (Velen.) Huijsman (q.v.), which is also associated with *S. repens*, differs in having more copious veil remains on the stipe and in larger and distinctly broader spores, viz. (10.0–)10.5–12.0(–13.0) × 6.0–7.0(–7.5) μm. The group of species around *C. sertipes* Kühner, including *C. flexipes* f. *sertipes sensu* Kühner (1961), and *C. contrarius* Geesink (1976), differ in having smaller and less slender spores, viz. (6.5–)7.0–9.0(–10.0) × 4.5–5.5 μm, and a pileus margin with more conspicuous velar covering.

*Cortinarius cavipes* was not previously reported from the Netherlands.

4. ***Cortinarius cinnamomeoluteus*** P D. Orton, Trans. Br. mycol. Soc. 43: 217 1960. – Fig. 4.

**Pileus** 13–50 mm, at first conico-convex, then plano-convex to applanate, usually with obtuse umbo, not hygrophanous, olivaceous green to ochraceous or orange-brown, somewhat more orange-brown or yellow-brown in centre, especially on ageing [Mu. 5 Y 5/6, 2.5 Y 5/6, 10 YR 5/8, 7.5 YR 4/6], slightly radially fibrillose, when young with some fibrils of yellow veil at margin. – Lamellae 30–35, l = 3, broadly adnate, up to 8(–11) mm broad, ventricose, moderately crowded, when very young mustard-yellow to olive-yellow [5 Y 7/8,

6/6], soon discolouring to brownish orange [10 YR 5/8], then orange-brown [7.5 YR 5/8], with even, slightly paler edge. – *Stipe* 45–80 × 3–6 mm, cylindrical or slightly clavate, stuffed, straw-yellow with some orange-brown fibrils of veil, at first with yellow cortina. – *Context* in pileus up to 2.5 mm thick, rather firm, concolorous with surface, in stipe cortex bright greenish yellow, inside pale yellow. – *Smell* absent to faintly iodine-like, especially on drying. – *Taste* bitterish-raphanoid. – *Spores* (8.0–)8.5–11.5(–12.5) × 5.5–6.0(–6.5) μm, *Q* = (1.5–)1.6–2.0(–2.2), average *Q* = 1.8–1.9, pale yellow-brown with rather coarse rounded warts (0.3–0.6 μm broad), not more coarsely so towards apex. – *Basidia* 28–36 × 6–8 μm, 4-spored, in parts with bright yellow clots. – *Cheilocystidia* absent. – *Hymenophoral trama* made of subcylindric cells, 2–17 μm wide, hyaline, without incrustations.

*Habitat* – Associated with *Salix repens* (and *S. aurita* L.) in high scrub on moist, acid, humus-rich dune-sand.

*Collections examined* NETHERLANDS: Terschelling, Kroonpolders, 10 Sept. 1980, Kuyper 2079; Terschelling, Groene Strand, 25 Oct. 1991, Arnolds 6189; Terschelling, Midsland aan Zee, 2 Sept. 1992, Kuyper 3224 (all in WBS).

As in some of the plots *C. uliginosus* Berk. was also recorded, the possibility that the yellow forma of this species [f. *lutea* (Gabriel & Lamoure) Høiland] is included in this material could not be excluded, as both taxa can not be separated on account of morphological characters, but only on the basis of pigment chemistry (Høiland, 1983). Both species can be quite abundant in some *Salix repens* scrub, with each species forming more than 1000 sporocarps on 500 m<sup>2</sup>. *Cortinarius huronensis* Ammirati & Smith var. *huronensis* differs in having a darker pileus; it has not yet been reported in association with *Salix repens*.

5. *Cortinarius cohabitans* P Karst., Bidr. Känned. Finl. Nat. Folk 32: 388. 1879. – Fig. 5.

*Pileus* 25–58 mm, plano-convex to almost applanate with low broad umbo or without umbo, hygrophanous, not translucent striate, when moist dark reddish brown [K. & W 6E6 or slightly darker], upon drying pallescent to flesh-coloured brown [between 6B4 and 6C4], along margin with a few small remains of whitish veil. – *Lamellae* rather broadly adnate, fairly distant, slightly thickish, bright cinnamon-brown [6E7], with even, concolorous edge. – *Stipe* 30–50 × 6–16 mm, somewhat attenuate towards apex, equal, swollen



towards base to subbulbous, solid, pale violaceous all over, but covered with longitudinal white fibrils, discolouring to brown from base upwards, with faint sock-like velar remains in lower part. – **C o n t e x t** in pileus pale brown, in stipe apex pale violaceous. – **S m e l l** fairly distinct, somewhat radish-like or with a sweetish component. – **S p o r e s** (7.5–)8.0–9.5 × 5.0–5.5 μm, Q = 1.6–1.8, average Q = 1.7, verrucose. – **B a s i d i a** 24–30 × 8–9 μm, 4-spored, hyaline. – **C h e i l o c y s t i d i a** absent. – **H y m e n o p h o r a l t r a m a** consisting of 4–12 μm wide hyphae, without incrusting pigment.

**H a b i t a t** – Associated with *Salix repens* in moist calcareous dune slacks and on north-exposed slopes with *Ammophila arenaria* (L.) Link and *Polypodium vulgare*.

**C o l l e c t i o n e x a m i n e d** – NETHERLANDS: Rottumeroog, 26 Oct. 1977, Arnolds 3931 & 3939 (WBS).

This species is probably better known as *Cortinarius saturninus* (Fr.: Fr.) Fr. var. *bresadolae* Mos. (ined.), or *C. saturninus sensu* Brandrud (1983), but according to Melot (1986) the epithet *cohabitans* should have priority on species level because of the doubtful identity of the original *C. saturninus*. The species has also been recorded on the island of Terschelling in association with *Salix repens*, mainly in primary stages of succession on calcareous soils.

6. ***Cortinarius comatus*** J. Favre, *Ergebn. wiss. Unters. Schweiz. Nat. Parks* 5 (NF): 202. 1955. – Fig. 6.

**P i l e u s** 7 mm broad and 7 mm high, acutely conical, hygrophanous, not translucent striate, dark brown, completely covered with grey-brown fluffy scales, somewhat pallescent on drying and becoming brown. – **L a m e l l a e** dark brown, with even, slightly paler edge. – **S t i p e** 18 × 1.5 mm, equal, concolorous with pileus, with grey-brown ring-like zone and appressed grey-brown velar belts below. – **C o n t e x t** concolorous with surface. – **S m e l l** absent. – **S p o r e s** (8.0–)8.5–10.5 × 6.0–6.5 μm, Q = 1.3–1.5(–1.6), average Q = 1.45, ellipsoid to ovoid, minutely warty-punctate, sometimes almost smooth. – **B a s i d i a** 28–34 × 8–10 μm, 4-spored. – **C h e i l o c y s t i d i a** absent. – **H y m e n o p h o r a l t r a m a** with rather heavily incrusting pigment.

**H a b i t a t** – Associated with *Salix repens* in a moist, calcareous dune slack, short-grazed by rabbits.

Collection examined – NETHERLANDS: Terschelling, West aan Zee, 23 Oct. 1990, Keizer 90041 (WBS).

The highly conical pileus and very small stature fit very well *Cortinarius comatus*, as described and illustrated by Favre (1955). However, the lectotype seems to possess somewhat more slender spores according to the description and illustration provided by Horak (1987), viz.  $9.0\text{--}10.0\text{(--}10.5) \times 5.5\text{--}6.5 \mu\text{m}$ ,  $Q = 1.5\text{--}1.75$  (according to drawings).

*Cortinarius comatus* was not previously reported from the Netherlands.

7. *Cortinarius comptulus* Mos., Nova Hedwigia 14: 514. 1967. – Fig. 7.

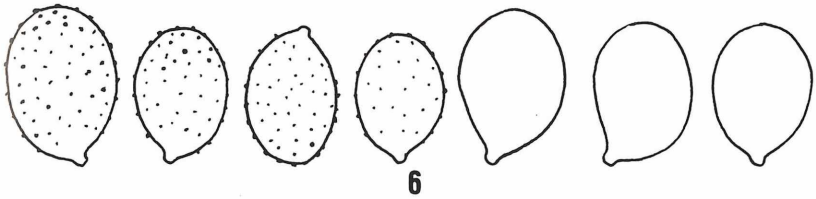
Pileus 19 mm, plano-convex, umbonate, hygrophanous, not translucent striate, very finely fluffy (under lens), especially in outer part, dark greyish brown [Mu. 7.5 YR 4/4–10 YR 4/3]. – Lamellae 25,  $l = 3$ , thin, fairly crowded, broadly adnate, brown, with even, concolorous edge. – Stipe  $31 \times 4$  mm, equal, white when fresh, becoming brown on handling, with white velar sock; when young with very faint violaceous sheen at stipe apex, but violaceous tinge soon disappearing. – Context when moist dark brown. – Smell absent. – Spores  $7.0\text{--}8.0\text{(--}8.5) \times 5.0\text{--}6.0 \mu\text{m}$ ,  $Q = 1.3\text{--}1.4\text{(--}1.5)$ , average  $Q = 1.4$ , verruculose, more strongly so towards apex. – Basidia  $27\text{--}41 \times 7\text{--}10 \mu\text{m}$ , 4-spored, colourless or with pale brown contents. – Cheilocystidia not observed. – Hymenophoral trama mostly with fine granular incrustations, walls partly even smooth.

Habitat – Associated with *Salix repens* in a north-exposed slope on dry, acid dune sand together with *Empetrum nigrum*.

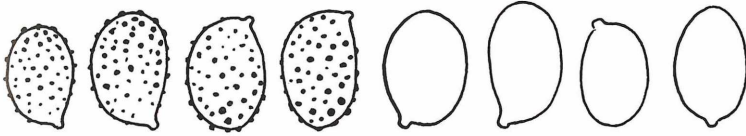
Collection examined – NETHERLANDS: Terschelling, West aan Zee, 4 Nov. 1992, Kuyper 3252 (WBS).

Among the species with a fluffy pileus, only two possess broadly ellipsoid spores, viz. *Cortinarius comptulus* and *C. sublatisporus* Svrcek (1968). The latter species differs in having pronounced violaceous tinges in stipe and lamellae, but the value of this character in the section must probably not be overestimated (Arnold, 1993).

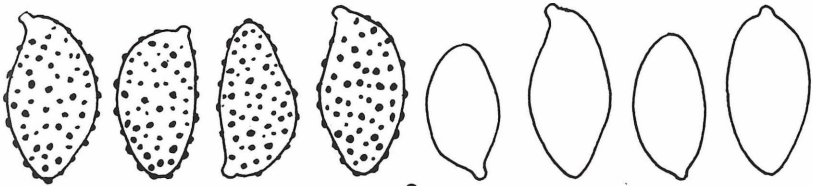
Our material seems to have somewhat larger spores than initially indicated by Moser (1967), viz.  $6.0\text{--}7.0\text{(--}7.5) \times 5.0\text{--}5.5\text{(--}6.0) \mu\text{m}$ , but is in full agreement with the descriptions provided by Arnold (1993) and Keizer & Arnolds (1994).



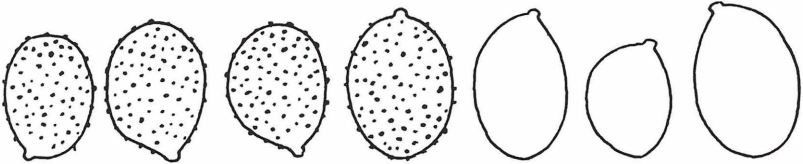
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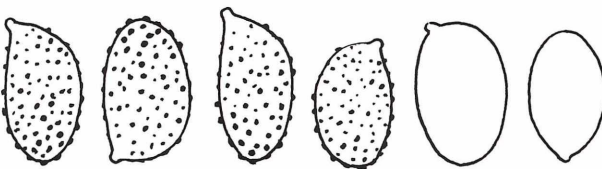
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10



Figs. 6–10. – Sporograms. 6. *C. comatus* (Keizer 90041). – 7. *C. comptulus* (Kuyper 3252). – 8. *C. cucumisporus* (Arnolds 6151). – 9. *C. decoloratus* (Kuyper 1365). – 10. *C. dumetorum* (Arnolds 6147). – Scale bar: 10  $\mu$ m.

8. *Cortinarius cucumisporus* Mos., Nova Hedwigia 14: 514. 1967. – Fig. 8.

Pileus 10–25 mm, at first conical, then conico-convex to plano-convex, mostly (but not constantly) with obtuse to slightly

pointed umbo, finally appanate to slightly depressed with obtuse umbo, strongly hygrophanous, not translucent striate to short striate (to 2 mm), when moist (very) dark reddish brown [K. & W. 8E6, F6, Mu. 5–7.5 YR 3/2–3/4], on ageing with less distinct reddish tinges, more medium-brown [7E7], with distinctly paler ochraceous brown margin [10 YR 4/4–5/6] because of appressed fibrils of ochraceous to whitish (not pure white) veil, surface shiny, on drying dull brownish orange [6D7] to orange-brown [7D7]. – Lamellae 20–30, l = 1–3, broadly adnate to slightly emarginate, thin, moderately crowded, not or slightly ventricose, dark yellow-brown to rusty brown [5–7.5 YR 4/6] from the beginning, in some young carpophores with traces of violet that are soon disappearing. – Stipe 17–30 × 2–4 mm, cylindrical to slightly swollen below, stuffed, orange-tinged yellow-brown or reddish brown [5 YR 4/6, 7.5 YR 5/6], in older specimens with blackish brown base, minutely longitudinally pale fibrillose-striate, lower half to 1/4 covered with very thin appressed fibrils of pale ochraceous to whitish veil, sometimes forming a distinct sock, but sometimes veil remnants only indistinct. – Context concolorous with surface, with yellowish tinge on drying. – Smell weak, but distinct, as of leaves of *Pelargonium*. – Spores 8.5–11.5 × (4.5–)5.0–6.0 μm, Q = 1.6–2.0(–2.1), average Q = 1.85–1.95, ellipsoid-oblong or mostly obovoid-oblong to subamygdaliform, (minutely) verruculose, not more coarsely so towards apex. – Cheilocystidia absent. – Basidia 26–32 × 7–9 μm, 4-spored, hyaline or with brown intracellular pigment. – Hymenophoral trama coarsely incrusted, with granular to crust-like incrustations.

**Habitat** – Associated with *Salix repens* in regularly mown, grazed (by rabbits) or ungrazed moist dune slacks on calcareous to acid, humus-rich sand.

**Collections examined** NETHERLANDS: Terschelling, Boschplaat, at base of Jan Thijsensduin, 4 Oct. 1991, Arnolds 6151; Terschelling, West aan Zee, 29 Oct. 1992, Mekenkamp & Verbeek 002; ibidem, different plot, 3 Oct. 1990, Kuyper s.n. (all in WBS).

The somewhat yellow veil points towards the group *Semivestiti* in Moser (1983a), and in this group *Cortinarius cucumisporus* and *C. gausapatius* J. Favre (1955) seem to fit reasonably well. However, according to Horak (1987), the lectotype of the latter species has less slender spores, described as not different from *C. comatus* J. Favre in dimensions and shape. On the other hand, the descriptions and illustration of *C. cucumisporus* by Moser (1967, 1983b) are

satisfactory in almost all respects, except for the smell of leaves of *Pelargonium* in our material.

*Cortinarius ammophilus* A. Pears. differs in having a more fibrillose pileus, more developed veil remains on the stipe, and narrower and more slender spores. *Cortinarius fusisporus* Kühner differs in having a less developed veil and somewhat narrower and more slender spores.

*Cortinarius cucumisporus* was not previously reported from the Netherlands.

9. *Cortinarius decoloratus* (Fr.: Fr.) Fr., Epicr.: 270. 1838. – Fig. 9.

Pileus up to 41 mm, convex to plano-convex, not or indistinctly umbonate, not hygrophanous, in centre brown [Mu. 10 YR 4–5/4–5], towards margin more yellow-brown [10 YR 6/6], sericeous-smooth, when moist slightly greasy to distinctly viscid. – Lamellae 60,  $l = 3$ , thin, (very) crowded, to 6 mm wide, broadly adnate, yellow-brown, somewhat more clay-coloured when young, with minutely serrulate, concolorous edge. – Stipe to  $75 \times 6$  mm, bulbous (at base 11 mm), becoming fistulose, when young whitish, discolouring to yellowish brown on handling, at apex with faint gray (not violaceous) tinge, sericeous-smooth, in lower part with yellow velar remains. – Context pale yellowish brown in pileus, but pale greyish in apex of stipe. – Smell indistinct. – Spores  $(7.0\text{--})7.5\text{--}8.5\text{(--}9.0) \times (5.5\text{--})6.0\text{--}7.0 \mu\text{m}$ ,  $Q = 1.2\text{--}1.4$ , average  $Q = 1.2\text{--}1.3$ , broadly ellipsoid, with small isolated warts, more distinctly verruculose towards apex. – Basidia  $28\text{--}34 \times 7\text{--}8 \mu\text{m}$ , 4-spored, colourless. – Cheilocystidia absent. – Hymenophoral trama consisting of colourless hyphae. – Pileipellis a slightly gelatinized cutis to well-developed ixocutis, to  $150 \mu\text{m}$  thick, with ascending, colourless hyphae,  $2\text{--}3 \mu\text{m}$  wide.

Habitat – Associated with *Salix repens* in dry to moist, grazed or mown dune grassland on acid soil.

Collections examined NETHERLANDS: Terschelling, Boschplaat, Paardenwei, 25 Oct. 1990, Baartmans, Biemans & Verbruggen 209; ibidem, 7 Oct. 1990, Baartmans, Biemans & Verbruggen 241; Callantsoog, Zwanenwater, Oct. 1979, Kuyper 1365 (all in WBS).

The taxonomy of *Cortinarius* sect. Anomali is extremely difficult, as species recognition is almost exclusively based on macroscopical characters and all species have the same subglobose to broadly ellipsoid spores. Colour of pileus, stipe apex and young lamellae are the characters that determine to what taxon a certain collection must

be assigned. However, in our opinion variability of these characters has been insufficiently assessed. The absence of violaceous tinges in the lamellae and the somewhat viscid pileus (not well-developed in all collections) point to *C. decoloratus* on the basis of the keys provided by Moser (1983a) and Kühner & Romagnesi (1953). However, the differences with *C. tabularis* (Bull.) Fr. are quite small and rather unconvincing. Orton (1958) treated both taxa as conspecific but preferred to use the name *C. tabularis* for this taxon. However, the name *C. decoloratus*, being based on a sanctioned name, has priority.

10. *Cortinarius dumetorum* J. Favre, *Ergebn. wiss. Unters. Schweiz. Nat.Parks* 6 (NF): 588. 1960. – Fig. 10.

**Pileus** 12–30 mm, at first rather acutely conical, then plano-convex to applanate or depressed, always with distinct, subacute umbo, often lacerate, indistinctly hygrophanous, not striate, only in one older specimen at margin obscurely striate; when moist giving a very dull, pale flesh-coloured brown impression by covering of entire surface by appressed fibrils of white veil, below veil in centre rather pale reddish brown [Mu. 5 YR 4/6, 3/6], towards margin dirty flesh-coloured [7.5 YR 7/4] or entirely flesh-coloured. – **Lamellae** 22–26, l = 1–3, broadly adnate to slightly adnexed or emarginate, up to 3 mm broad, subdistant, sometimes interveined, at first flesh-coloured brownish orange [7.5 YR 6/6] with pale flesh-coloured margin, then slightly more brownish orange [10 YR 6/6], but remaining remarkably pale. – **Stipe** 23–52 × 2–5 mm, somewhat thickened at base, narrowly fistulose, pale flesh-coloured brown at apex, longitudinally white striate, then with distinct, white woolly annulus, below annulus entirely covered with white fibrils. – **Context** in pileus up to 2 mm thick, concolorous with surface, brittle. – **Smell** weak, fungoid. – **Spores** (7.5–)8.0–10.5 × 5.0–6.0 μm, Q = 1.6–2.0, average Q = 1.7–1.8, ellipsoid- to ovoid-oblong, moderately coarsely punctate. – **Basidia** 25–28 × 7–9 μm, 4-spored, hyaline. – **Cheilocystidia** absent. – **Hymenophoral trama** consisting of cylindrical to inflated elements, hyaline or pale yellow, not incrustated.

**Habitat** – In tall dense and open, mown scrub of *Salix repens* in dune slacks on moist, acid, humus-rich sand.

**Collections examined** – NETHERLANDS: Terschelling, Groene Strand, 9 Oct. 1990, Arnolds 6103; ibidem, 5 Oct. 1991, Arnolds 6157; Terschelling, Boschplaat, Jan Thijssensduin, 4 Oct. 1991, Arnolds 6147 (all in WBS).

*Cortinarius dumetorum* was described by Favre (1960) from *Salix* scrub in the subalpine zone in Switzerland, but also recorded from a lowland site near Geneva. It is similar to our collections in the striking white fibrillum on the pileus and the white ring at the stipe. The dimensions of the basidiomata in Favre's collection are somewhat smaller (pileus up to 17 mm, stipe up to 53 × 2.5 mm) and the pileus colour was described as dark greyish brown, but the illustration by Favre (pl. 4, f. 2) shows much paler colours and fits our material satisfactorily.

*Cortinarius dumetorum* was not previously reported from the Netherlands.

11. *Cortinarius eburneus* (Velen.) M. Bon, Doc. mycol. 15(60): 38. 1985. – Fig. 11.

Pileus 15–20 mm, hemispherical, soon convex with flattened centre, without umbo, not hygrophanous, at first white, then centre cream-coloured, later pale ochraceous yellow [K. & W 5A2–3] at centre, slightly viscid when moist. – Lamellae 38–52, l = 1(–3), slightly adnexed, crowded, up to 2 mm broad, pale brownish orange [6B4(–5)]. – Stipe 18–25 × 6–10 mm, fusiform, white, at apex pale isabella, with a few fibrils of veil, dry. – Context in pileus 2 mm broad, cream-coloured, in upper half of stipe also, downwards white. – Smell not distinct. – Taste of pellis and context bitter. – Spores 5.0–6.0(–6.5) × 3.5–4.5 μm, Q = 1.3–1.5, average Q = 1.4, ellipsoid, pale brownish orange, (minutely) punctate, warts 0.1 μm broad. – Basidia 24–29 × 6–8 μm, 4-spored. – Cheilocystidia absent. – Hymenophoral trama consisting of cylindrical, thin-walled hyphae, 3–14 μm wide, pigment not incrusting.

Habitat – Associated with *Salix repens* in primary moist dune slack on nitrogen-poor calcareous soil, short-grazed by rabbits.

Collection examined – NETHERLANDS: Terschelling, West aan Zee, 5 Oct. 1991, Arnolds 6155 (WBS).

It has been difficult to find a reliable name for this taxon. The fairly dry pileus and stipe would fit well for *C. ochroleucus* (Schaeff.: Fr.) Fr., but this species is reported to have larger spores. Small, broadly ellipsoid spores are only noted for *C. eburneus* (syn. *C. crystallinus sensu* Kühner & Romagnesi, 1953), of which the authors also remarked that differences in spore sizes and form in the group of

pale-coloured species of sect. *Ochroleuci* have not been mentioned by any other author.

12. *Cortinarius parvannulatus* Kühner, Bull. mens. Soc. linn. Lyon 24: 40. 1955. – Fig. 12.

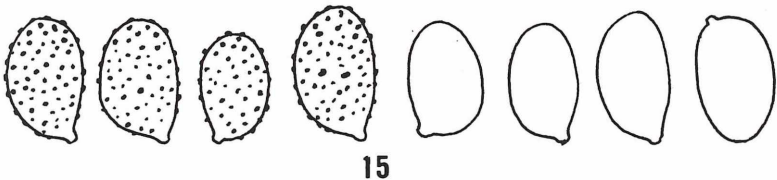
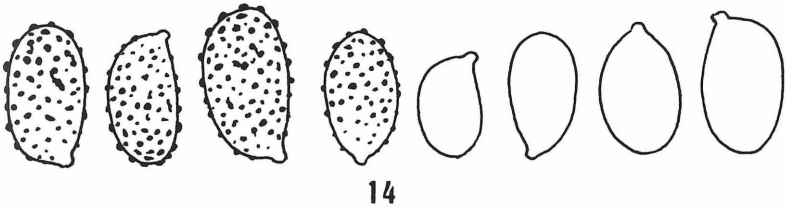
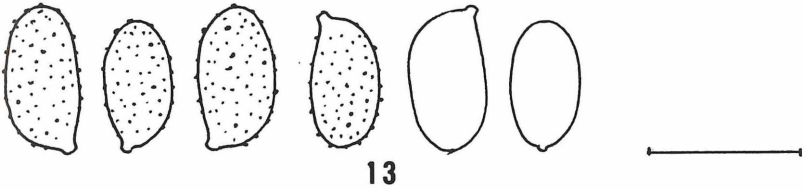
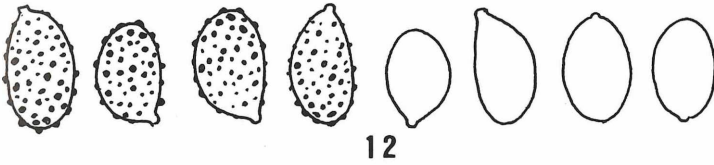
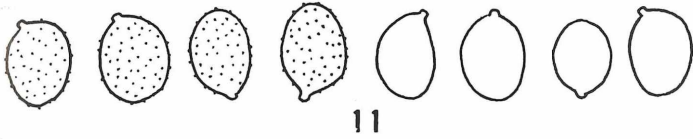
Pileus 20 mm, convex, without umbo, hygrophanous, not translucent-striate, when moist orange-brown to reddish brown, pallescent on drying to brownish orange, without distinct velar remnants. – Lamellae thin, crowded, broadly adnate, cinnamon brown to rusty brown, with even, concolorous edge. – Stipe 48 × 4 mm, with clear, white, ring-like zone, above ring violaceous grey, below reddish-brownish. – Context brownish orange. – Smell very strong, as cedar wood. – Spores 7.0–8.0 × 4.5–5.0 μm, Q = 1.5–1.6, average Q = 1.6, moderately coarsely verruculose, especially in apical part. – Basidia 25–32 × 8–10 μm, 4-spored, usually hyaline, but a minority with yellow-brown contents. – Cheilocystidia absent. – Hymenophoral trama consisting of 4–10 μm wide, hyphae with membranous or finely incrusting pigment.

Habitat – Associated with *Salix repens* on north slope on dry, acid sand, together with *Empetrum nigrum*.

Collection examined – NETHERLANDS: Terschelling, West aan Zee, 2 Oct. 1990, Kuyper 3096 (WBS).

This collection fits the diagnosis by Kühner (1956) and the description by Arnold (1993) very well. The relationship between *Cortinarius parvannulatus* and *C. cedriolens* (Mos.) Mos. has been repeatedly discussed. Moser (1983b) thought that the available data were insufficient to resolve this question. Lindström & Brandrud (1987) suggested that these two species are synonyms, and stated that transitions between these taxa have been found within one collection. Arnold (1993) denied the synonymy and pointed out that these species do not only differ in the characteristics of the veil on the stipe, but also in spore shape and ornamentation. The taxonomy of this complex has been complicated by the description of a new species with an orange-brown pileus and a strong smell of cedar wood, viz. *C. croceocingulatus* N. Arnold with a whitish to yellowish veil that forms a ring-like zone on the stipe. This species has been recorded from willows (Grünert, 1989, as *C. parvannulatus*), and might be expected to occur in *Salix repens* scrub in Terschelling.





Figs. 11–15. – Sporangia. 11. *C. eburneus* (Arnolds 6155). – 12. *C. parvannulatus* (Kuyper 3096). – 13. *C. pauperculus* (Arnolds 6153). – 14. *C. cf. privignus* (Kuyper 3095). – 15. *C. cf. tiliaceus* (Kuyper 3250). – Scale bar: 10  $\mu\text{m}$ .

13. *Cortinarius pauperculus* J. Favre, *Ergebn. wiss. Unters. Schweiz. Nat.Parks* 5 (NF): 203. 1955. – Fig. 13.

Pileus 6–13 mm, at first rather acutely conical, then conico-convex to plano-convex with acute to obtuse umbo, finally applanate, umbonate, distinctly hygrophanous, long translucent striate (to 0.75 R),

when moist rather bright orange-brown [K. & W. 6D7-E7, Mu. 5 YR 4/8], at centre more reddish brown [7D6-E6, 2.5 YR 3/4], with margin rather sharply delimited, much paler,  $\pm$  ochraceous brown due to dense appressed fibrils of white veil, also often some scattered fibrils at centre (and then appearing sl. arachnoid). - *L a m e l l a e* 12-17, l = 1-3, broadly adnate to slightly adnexed, subdistant to distant, at first brownish orange [7.5 YR 5/6, 6D6], then orange-brown, concolorous with pileus, without trace of violet, with even, concolorous edge. - *S t i p e* 14-33  $\times$  0.7-2 mm, cylindrical, slightly swollen towards base, at first brownish orange [7.5 YR 5/6, 6D6], from base upwards becoming slightly darker orange-brown, without trace of violet; veil white, often leaving a narrow, distinct white-floccose belt at the stipe, but also visible as scattered fibrils (even in young carpophores). - *C o n t e x t* hygrophanous, concolorous with surface. - *S m e l l* absent. - *S p o r e s* 8.0-9.5(-10.0)  $\times$  4.5-5.0  $\mu$ m, Q = 1.7-2.0, average Q = 1.85, ellipsoid-oblong, rather pale brownish orange, minutely punctate. - *B a s i d i a* 26-35  $\times$  7-9  $\mu$ m, 4-spored, hyaline, a few with brown pigment. - *C h e i l o c y s t i d i a* absent. - *H y m e n o p h o r a l* trama consisting of 4-13  $\mu$ m wide hyphae with pigment distinctly incrusting.

*H a b i t a t* - In dense tall scrub of *Salix repens* in deep, secondary dune slack on moist, acid, humus-rich sand.

*C o l l e c t i o n* e x a m i n e d - NETHERLANDS: Terschelling, Groene Strand, 5 Oct. 1991, Arnolds 6153 (WBS).

The bright colours of the pileus and the presence of veil at the stipe would place this species in the complex of *Cortinarius incisus* (Pers.: Fr.) Fr. *sensu* Moser (1983a). The bright orange reddish colours of pileus and stipe agree quite well with *C. pauperculus*, so far known from the alpine zone with *Salix* only on siliceous soil (Horak, 1987), although the long translucent-striate pileus is rather deviating. That latter character conforms better with *C. striaepilus* J. Favre, originally described from peatbogs but probably occurring in a wide variety of habitats (Keizer & Arnolds, 1994). However, this species has less warm, more yellow-brown tinges.

*Cortinarius pauperculus* was not previously recorded from the Netherlands.

#### 14. *Cortinarius* cf. *privignus* (Fr.) Fr., Epicr.: 304. 1838. - Fig. 14.

*P i l e u s* 21-68 mm, convex, then applanate, without umbo or with low broad umbo, hygrophanous, not translucent striate, when moist reddish chestnut-brown [Mu. 5 YR 5/8], more orange on drying

[5 YR 7/8], at outermost margin whitish because of appressed veil, elsewhere smooth and even somewhat greasy. – Lamellae 40–60,  $l = 3$ , thin, crowded, to 11 mm broad, brownish buff [10 YR 6/4, 7/4], then rusty brown, with even, concolorous edge. – Stipe 29–60 × 6–9 mm, equal to somewhat attenuate (6 mm), when young whitish because of longitudinal fibrillose covering, soon orange-brown because of underlying context (more or less concolorous with pileus), with indistinct appressed velar belt in lower half. – Context hygrophanous, orange-coloured. – Smell very faint, indistinct or slightly disagreeable. – Spores 7.5–9.0 × 4.5–5.5  $\mu\text{m}$ ,  $Q = (1.5)–1.6–1.8$ , average  $Q = 1.6–1.7$ , rather pale brown, rather coarsely verruculose, especially in apical part, with small to rather large rounded warts, some interconnected by narrow ridges. – Basidia 24–35 × 7–9(–10)  $\mu\text{m}$ , 4-spored, usually hyaline, but partly with brown granular contents. – Cheilocystidia absent. – Hymenophoral trama consisting of 3–15  $\mu\text{m}$  wide hyphae, not or very indistinctly incrustated.

Habitat – Associated with *Salix repens* on north-exposed, dry acid dunes with *Empetrum nigrum*.

Collections examined – NETHERLANDS: Terschelling, West aan Zee, 2 Oct. 1990, Kuyper 3095; ibidem, 26 Oct. 1990, Baartmans, Biemans & Verbruggen 217; ibidem, 25 Oct. 1991, Arnolds 6191 (all in WBS).

The taxonomy of the species belonging to the *Cortinarius privignus*-complex is extremely complicated and we are by no means certain of our identification. The rather conspicuously hygrophanous pileus would lead to either *C. privignus* or *C. privignofulvus* R. Henry. A comparison of the description of both species, as given by Henry (1948) would suggest that the latter species is somewhat paler when moist and has less distinct veil remains on the stipe. The non-striate pileus, however, seems to fit better for *C. privignofulvus* than for *C. privignus*.

A related taxon from this complex was found at the Isle of Schiermonnikoog in a vegetation with both *Salix repens* and *Betula pubescens* Ehrh. It differs from *C. privignus* in being less hygrophanous (and hence more slowly pallescent), in having a subbulbous stipe with somewhat more developed veil remains and slightly larger spores, viz. 8.5–10.0 × 5.0–6.0  $\mu\text{m}$ . This seems to agree quite well with the description of *C. pseudoprivignus* R. Henry.

15. *Cortinarius* cf. *tiliaceus* N. Arnold, Libri botanici 7: 160. 1993. – Fig. 15.

Pileus up to 35 mm, almost applanate, without umbo, not translucent-striate, yellow-brown, more yellow towards margin because of veil,  $\pm$  smooth. – Lamellae red-brown with conspicuous violaceous tinge. – Stipe yellow-brown with some yellow velar threads. – Context yellowish. – Smell (very) strong of leaves of *Pelargonium*. – Spores  $(7.5\text{--}8.0\text{--}9.0 \times 4.5\text{--}5.0 \mu\text{m})$ ,  $Q = (1.6\text{--}1.7\text{--}1.8)$ , average  $Q = 1.8$ , verruculose, somewhat less so towards apex. – Basidia  $27\text{--}40 \times 8\text{--}10 \mu\text{m}$ , 4-spored, hyaline or with brown necropigment. – Cheilocystidia absent. – Hymenophoral trama (very) strongly incrustated with granular to crust-like incrustations.

Habitat – Associated with *Salix repens* in dune grassland, grazed by horses.

Collection examined – NETHERLANDS: Terschelling, Boschplaat, Paardenwei, 4 Nov. 1992, Kuyper 3250 (WBS).

The conspicuous violaceous-purplish tinge of the mature lamellae combined with the strong smell of leaves of *Pelargonium* would suggest *C. tiliaceus*, which is known to occur with willow. The description by Arnold (1993) suggests a more strongly developed veil on the pileus and whitish, not yellowish veil. The same colour of the lamellae is noted in *C. violilamellatus* P. D. Orton, but this species has decidedly more slender spores, viz.  $(8.0\text{--}9.0\text{--}10.5\text{--}11.0) \times (4.0\text{--}4.5\text{--}5.0 \mu\text{m})$ ,  $Q = (1.8\text{--}1.9\text{--}2.3\text{--}2.5)$ , average  $Q = 1.8\text{--}2.2$  (Keizer & Arnolds, 1994).

*Cortinarius tiliaceus* was not previously reported from the Netherlands.

## Discussion

The species described in this paper show a wide variety in both host range and preference with regard to soil conditions. On the basis of field work in the Netherlands and data reported from the literature we can assign the species to six categories with regard to their host range. *C. anomalus* (Fr.: Fr.) Fr., *C. uliginosus* Berk., and *C. trivialis* J. Lange, not described in this paper, are also treated here. The place of each individual species in this scheme might alter in future when more ecological data become available on this underrecorded taxonomic group.

1. Species only associated with *Salix repens*: *C. ammophilus*.
2. Species associated with *S. repens* and dwarf willows (subgenus *Chamaetia*, e.g. *S. herbacea* L., *S. reticulata* L., *S. retusa* L.) in the arctic and alpine zone: *C. cavipes*, *C. comatus*, *C. cucumisporus*, *C. pauperculus*.
3. Species associated with *S. repens* and other species of shrubby *Salix* (subgenus *Caprisalix*, e.g. *S. aurita* L., *S. cinerea* L.) in the lowlands: *C. cinnamomeoluteus*, *C. dumetorum*, *C. uliginosus*.
4. Species associated with Salicaceae, incl. *Salix* subgenus *Salix* (e.g. *S. alba* L., *S. triandra* L.) and *Populus*: *C. cohabitans*.
5. Species associated with Salicaceae and at least one other genus of trees: *C. anomalus*, *C. decoloratus* (both with *Betula*), *C. trivialis* (with *Quercus*), *C. eburneus* (with *Quercus*), *C. tiliaceus* (with *Tilia*).
6. Species with a wide host range, more often found with other trees than with Salicaceae: *C. casimiri*, *C. comptulus*, *C. parvannulatus*, *C. privignus*?

It is striking that the species of groups 1–3 are apparently lacking under tree-forming willows of subgenus *Salix*.

The host range does not seem to be correlated with edaphic specialisation. Most species show a clear preference for either calcareous soils poor in organic matter or acidic soils richer in organic matter. The number of species on acidic sites (11) is much higher than the number of species on calcareous sites (5); only *C. cohabitans* seems indifferent towards soil acidity. The data in Favre (1955) also suggest that differences in soil pH (with its associated differences in organic matter, phosphate solubility, and mineral form in which nitrogen is available) are very important with regard to the ectomycorrhizal flora.

The similarity between the mycoflora of coastal *Salix repens* scrubs and alpine snowbeds with dwarf willows is evident. This similarity can neither be explained by climatological or soil-ecological factors, nor by taxonomic relationships between *Salix* species, since *S. repens* belongs to subgenus *Caprisalix* and the alpine species to subgenus *Chamaetia*. Possibly physiological resemblance between the dwarfish *Salix* species may result in similarities in ectomycorrhizal symbionts.

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