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THE TAXONOMIC VALUE OF THE ORNAMENTATION OF SPORES IN 'THE XEROCOMUS-GROUP' OF BOLETUS

G.T. OOLBEKKINK

*Amsterdam**

The taxa of the *Xerocomus*-group are considered to belong to the genus *Boletus*. The spore surface of 17 taxa of this group and the related *Phylloporus rhodoxanthus* have been studied with SEM. The taxa of the *B. chrysenteron*-complex can be distinguished from the *B. subtomentosus*-complex and the other taxa examined by their striate spores. *Boletus parasiticus* can be distinguished by its conspicuously pitted spore surface. The spores of the taxa in the *B. subtomentosus*-complex, *B. bubalinus* sp. nov. and *B. armeniacus* show a fibrillose or a floccose to smooth spore surface. Entirely smooth spores have been found in *B. badius*, *B. moravicus*, *B. pulverulentus*, and *B. ichnusanus* comb. nov. The spores of *P. rhodoxanthus* show a fibrillose, a floccose or a pitted-and-floccose ornamentation. One new species is described, *Boletus bubalinus* Oolbekkink & Duin, and one new combination is proposed, *Boletus ichnusanus* (Alessio & al.) Oolbekkink. *Boletus fragilipes* is considered a nomen dubium. It is suggested that '*B. rubellus*' is merely a colour variant of *B. chrysenteron*. To elucidate the author's present points of view, a chapter is added with a discussion on the taxonomic status of *Xerocomus*, a provisional key and descriptions of, and notes on taxa of the *Xerocomus*-group.

1. INTRODUCTION

In a previous study on the characters of taxa in '*Xerocomus*' (Oolbekkink & van Duin, unpublished report, 1985) emphasis was laid on analysing and comparing pileipellis structures in order to come to more clearly defined taxa, especially in the *B. chrysenteron*- and *B. subtomentosus*-complex. Abstracts of that study have been published (Oolbekkink & van Duin, 1988; Bas & al., 1988) and many of its observations are included or referred to in this paper.

These observations made clear that it was impossible to totally delimit *Xerocomus* Quél. from *Boletus* Fr.: Fr., as will be explained in section 3.1 of this paper. *Xerocomus* is thus not separated from the genus *Boletus* and 'the *Xerocomus*-group' in the title only means the group of taxa formerly placed in that genus.

That previous study also included observations on collections received from Czechoslovakia under the name *B. fragilipes* C. Martin with an annotation that their striate spores distinguish them from *B. chrysenteron* Bull., which is supposed to have smooth spores. It

* 1e Helmersstraat 230-1, 1054 EP Amsterdam, The Netherlands.

appeared then that also a Dutch collection with striate spores was available. When spores of these collections were mounted in Cotton blue or Congo red, longtudinal striae were observed with a light microscope at high magnification, but often with great difficulty and only on a small number of the spores. This aroused curiosity to what the spore surface of these and other taxa would look like if observed with a scanning electron microscope (SEM) and whether in this respect taxonomically useful differences between these taxa could be found.

Several *'Xerocomus'* taxa have been reported to have striae or other types of ornamentation on the spore surface (van der Aa, 1979; Pegler & Young, 1971, 1981; Hübsch, 1982). Also on spores of *Phylloporus rhodoxanthus* (Schwein.) Bres., by many mycologists regarded as closely related to *Xerocomus*, a distinct ornamentation has been found (Pegler & Young, 1971, 1981). All these published results of SEM research include only a part of the European taxa of *'Xerocomus'* and hardly more than one collection per taxon was analysed.

In the present study a scanning electron microscope was used to examine the spore surface in 17 taxa of the *'Xerocomus*-group' of *Boletus* and in *P. rhodoxanthus*.

While preparing this paper, another paper on the subject was published by Heinemann & al. (1988), in which several types of ornamentation of spores of *'Xerocomus'* and *Phylloporus* species are shown. As the article by Heinemann & al. covers the greater part of the taxa examined by the present author it is extensively referred to in the discussions in the present paper.

As the genus concept of *'Xerocomus'* as well as species concepts in *'Xerocomus'* are still rather unstable, a chapter has been added with a discussion on the taxonomic status of *Xerocomus*, a provisional key, and descriptions and notes on taxonomy and nomenclature of the species.

2. OBSERVATIONS ON THE SPORE SURFACE WITH SEM

2.1. MATERIALS AND METHODS

Spores obtained from spore prints and fragments of the tubes from fresh or mostly well-annotated herbarium collections were mounted on metal stubs with double-sided adhesive tape. The prepared stubs were coated with gold for 4 minutes at 20 mA in a vacuum of about 0.08 Torr, with argon present, using a SEM Coating Unit model E5100. To examine the surface morphology of the spores, the stubs were observed at 15 kV in a JEOL Scanning Microscope model JSM-35 and photographs were taken with a Mamiya 6 × 7 cm camera on Kodak Panatomic-X Professional film.

In case of the tube-fragments, spores at different stages of their development were examined and mature spores in these mounts were, whenever possible, compared with mature spores taken from spore prints of the same taxon.

The taxa examined are described in section 3.3. Except when stated otherwise, the short characteristics in that section are based on a previous study of these taxa (Oolbekkink & van Duin, 1985, 1988; Bas & al., 1988). As many collections as possible were used to describe the macroscopic and microscopic characters, except for the spore size for which 10 spores per collection were measured with a maximum of 10 collections (n = 100).

The collections in which the spore surface was studied with SEM, are enumerated at the end of the descriptions of the taxa.

The term striate may cause confusion because mycologists use it in two different meanings. Striate is used to describe lines or streaks not raised from the surface as well as ridges raised from the surface. The latter sense is preferred by the present author and is applied in this paper. Difference is made between striate, when the ridges are fine and low, and costate, when the ridges are prominent and high as in for instance in *Boletellus russellii* (Frost) E.J. Gilb.

2.2. RESULTS

The spores of *B. badius* are smooth (Fig. 1). Only very few spores in one collection show a surface with rounded swellings (a 'blistered' surface) (Fig. 2).

The spores of *B. parasiticus* show elongated depressions or pits in one collection (Fig. 3) and a reticulately venose to pitted spore surface in the other four collections (Figs. 4–6).

The spore surface of *B. subtomentosus* is fibrillose (= covered with fibres), resembling a structure described by Pegler & Young (1971) as 'a surface with numerous, rod-like structures', to floccose (= covered with cotton-like tufts) (Figs. 7, 8) or smooth with floccose remnants (Fig. 9) to entirely smooth (Fig. 10). A very few spores in one collection show a 'blistered' surface (Fig. 11, arrow). In spore prints the spores are smooth or with floccose remnants. Young spores appear to be smooth.

Boletus subtomentosus var. *luteolus* with pileipellis-type I as well as with type II (see section 3.3) has smooth spores with floccose remnants to entirely smooth spores (Fig. 12).

In *B. ferrugineus* floccose (Fig. 13) and smooth with floccose remnants (Fig. 14) to smooth spores (Fig. 15) are found.

In the taxa *B. chrysenteron* (Figs. 16, 17), *B. rubellus* (Fig. 18), *B. fraternus* (Figs. 19, 20), *B. pruinatus* (Figs. 21, 22), *B. fragilipes* (Fig. 23), *B. porosporus* (Figs. 24, 25) and *B. truncatus* (Fig. 27) most spores have faint to distinct longitudinal striae, usually anastomosing and often fading at the apex. Frequently the spores of *B. porosporus* have only a faint striation and on a very few spores in one collection a 'blistered' surface has been observed (Fig. 26). A small number of the mature spores of the taxa is smooth. Very young spores are all smooth, but they already develop ridges when still attached to the sterigmata.

There is no difference in spore ornamentation among basidiocarps with the two pileipellis-types (see section 3.3) of *B. chrysenteron* and *B. rubellus*, and among basidiocarps with the three pileipellis-types of *B. fragilipes*.

In *B. armeniacus* floccose (Fig. 28) to smooth spores (Fig. 29) have been found. Sometimes spores in the sample examined were covered with strange structures, perhaps of foreign origin (Fig. 28). *Boletus bubalinus*, sp. nov., has smooth spores with floccose remnants (Fig. 30) to entirely smooth spores (Fig. 31).

The spores of *B. moravicus* (Fig. 32) and *B. pulverulentus* (Fig. 33) are smooth. In *B. ich-nusanus*, comb. nov., the spore surface appears to be smooth, but there were some difficulties in establishing this, because in the sample examined it was covered with a strange substance considered of foreign origin (Fig. 34).

The spores of *Phylloporus rhodoxanthus* show a floccose (Fig. 35) or a pitted-and-floccose ornamentation (Fig. 36). The spores in the sample examined in Fig. 35 show also some strange structures probably of foreign origin. See also footnote in the discussion (2.3).

2.3. DISSCUSION

The sporal layers in *'Xerocomus'* taxa were not studied by the present author, but for a better understanding of the probable origin of the ornamentation of spores of *'Xerocomus'* as described in this paper, it is necessary to take the wall layers of the spore into consideration. The terminology of these layers may cause confusion, as several authors use a different terminology. Since Perreau-Bertrand (1961, 1964, 1965, 1967; Perreau & Heim, 1969) extensively examined the structure of the spore wall of Boletales, her terminology is applied here.

Perreau-Bertrand (1967: 676) demonstrated that five wall layers are present in the spores of Boletales. As the spores mature, the surface ornamentation can be formed (i) by remnants of the distintegrating two outer wall layers, viz. the ectosporium and perisporium, or (ii) by outgrowths of the exosporium. It is difficult to decide on the most probable of these two origins for the various taxa in this study, because it is hardly possible to make a distinction between an ornamentation of perisporial origin (remnants) or an ornamentation of exosporial origin on SEM photographs, as was also noticed by Perreau & Heim (1969: 330).

The spores of *Boletus parasiticus* show an ornamentation that varies from reticulately venose to (elongately) pitted (Figs. 3–6). A somewhat comparable ornamentation has been found in *Phylloporus rhodoxanthus* (Fig. 36), except that the latter is also floccose whereas the edges of the pits of spores of *B. parasiticus* are smooth. Perreau-Bertrand (1967: 676) supposed that the spores of these taxa were smooth, but she studied the spore surface with a light microscope only and therefore was unable to see any of these very fine structures. Pegler & Young (1981: 117) found an ornamentation in *B. parasiticus* with SEM that they described as 'minute rugulose'. After comparing their fig. 60 with Fig. 3 in this paper, it is concluded that the type of ornamentation is similar, but the terminology applied is different. Exactly the same can be said about fig. 27 in Heinemann & al. (1988: 531) and Fig. 3 in this paper. Heinemann & al., however, placed *B. parasiticus* in a group with vroughened to smooth spores,

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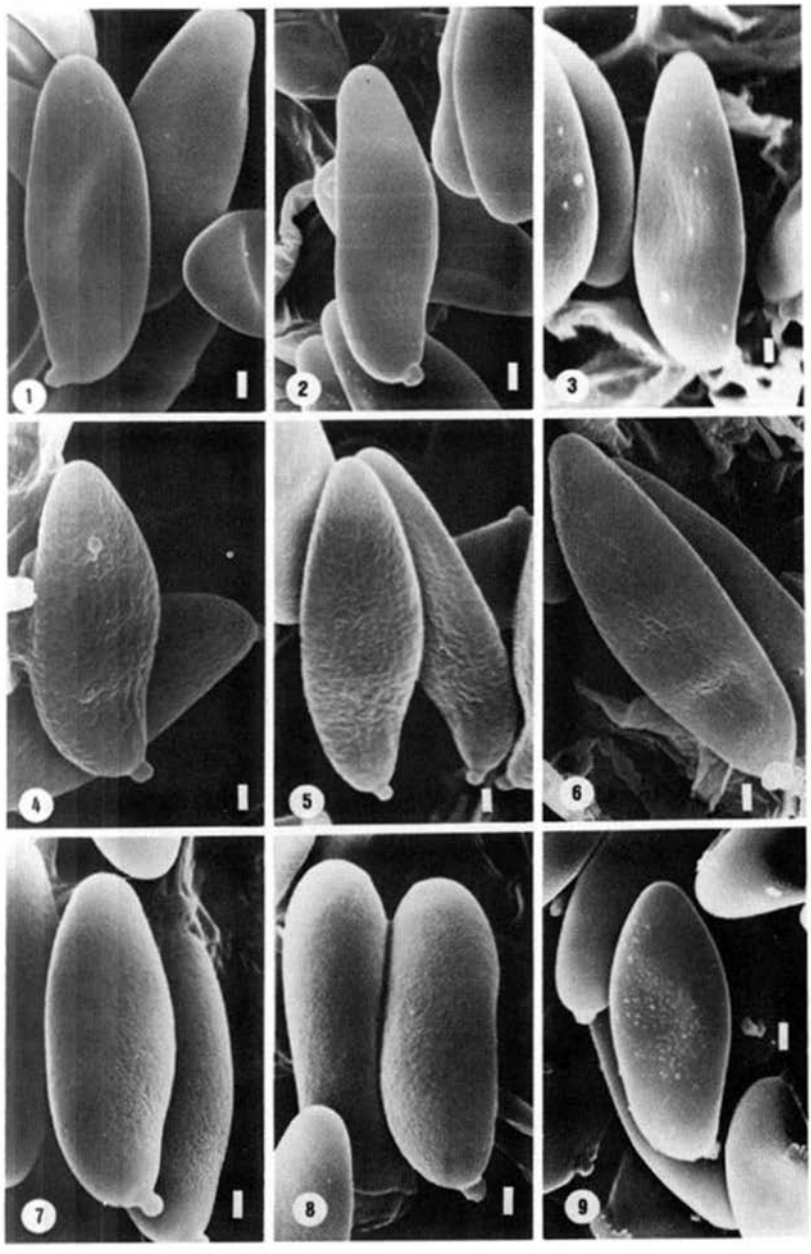
Figs. 1–9. Spores of *Boletus*. — 1–2. *B. badius*. — 3–6. *B. parasiticus*. — 7–9. *B. subtomentosus* (Figs. 1, 2, 4, and 6–9, × 6000; Fig. 3, × 5400; Fig. 5, × 4800. Bar = 1 µm).

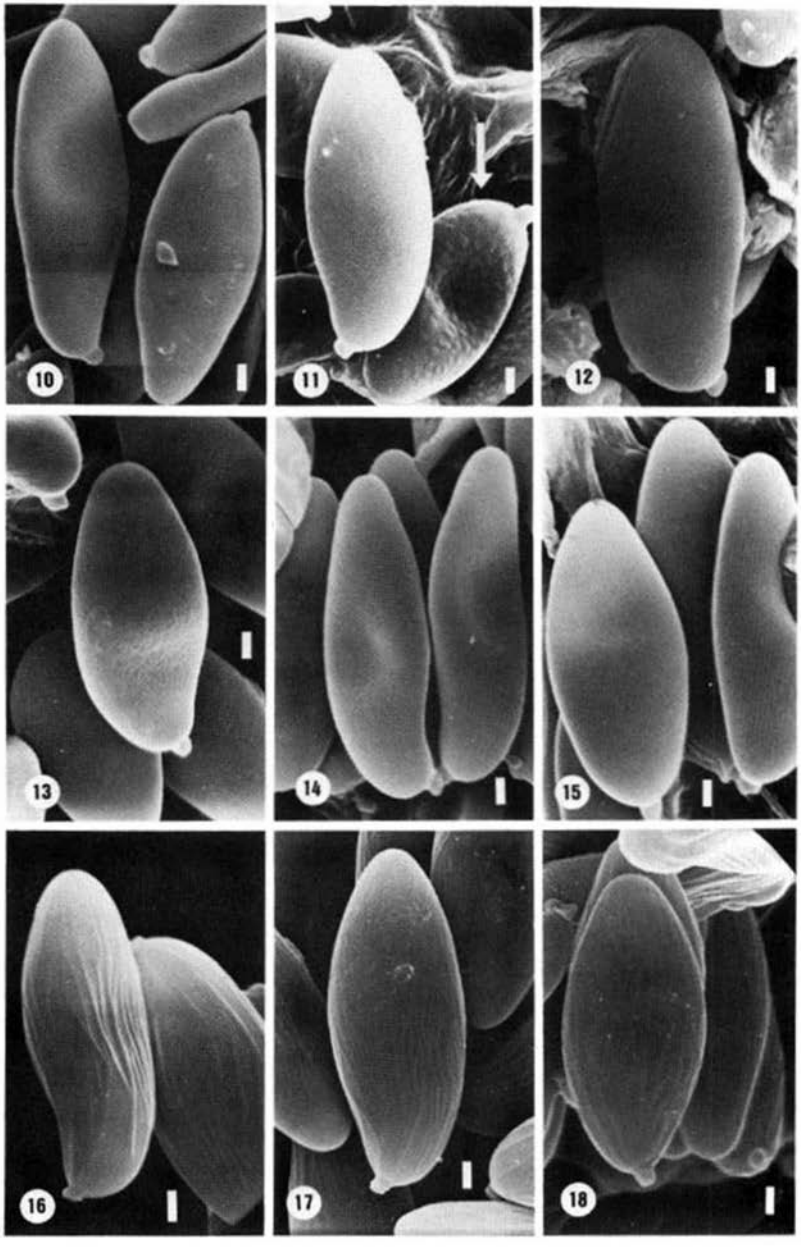
Figs. 10–18. Spores of *Boletus*. — 10–11. *B. subtomentosus*. — 12. *B. subtomentosus* var. *luteolus*. — 13–15. *B. ferrugineus*. — 16–17. *B. chrysenteron*. — 18. *B. rubellus* (Fig. 16, × 6600; Figs. 10–15, 17, and 18, × 6000. Bar = 1 µm).

Figs. 19–27. Spores of *Boletus*. — 19–20. *B. fraternus*. — 21–22. *B. pruinatus*. — 23. *B. fragilipes*. — 24–26. *B. porosporus*. — 27. *B. truncatus* (Figs. 24 and 25, × 6600; Figs. 20–22, 26, and 27, × 6000; Fig. 23, × 5400; Fig. 19, × 4000. Bar = 1 µm).

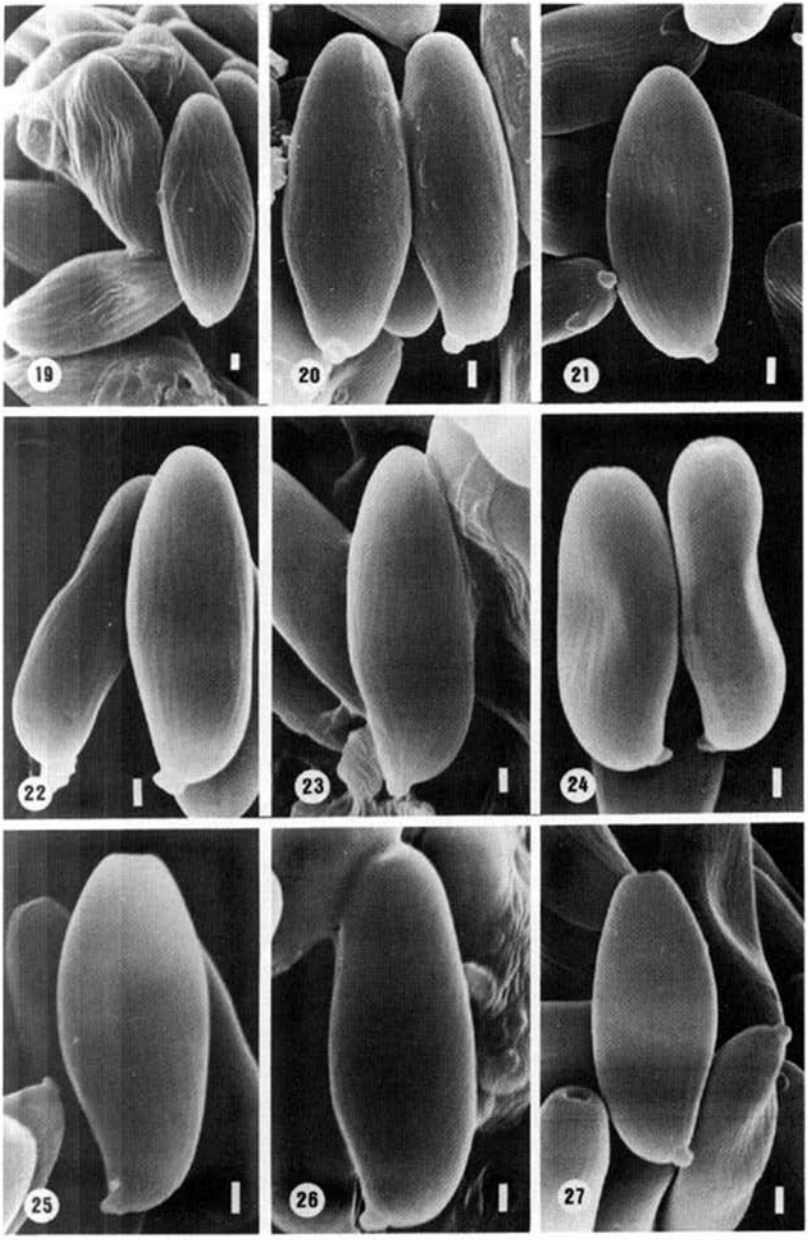
Figs. 28–36. Spores of *Boletus* and *Phylloporus*. — 28–29. *B. armeniacus*. — 30–31. *B. bubalinus*. — 32. *B. moravicus*. — 33. *B. pulverulentus*. — 34. *B. ichnusanus*. — 35–36. *P. rhodoxanthus* (Figs. 28–36, × 6000. Bar = 1 µm).



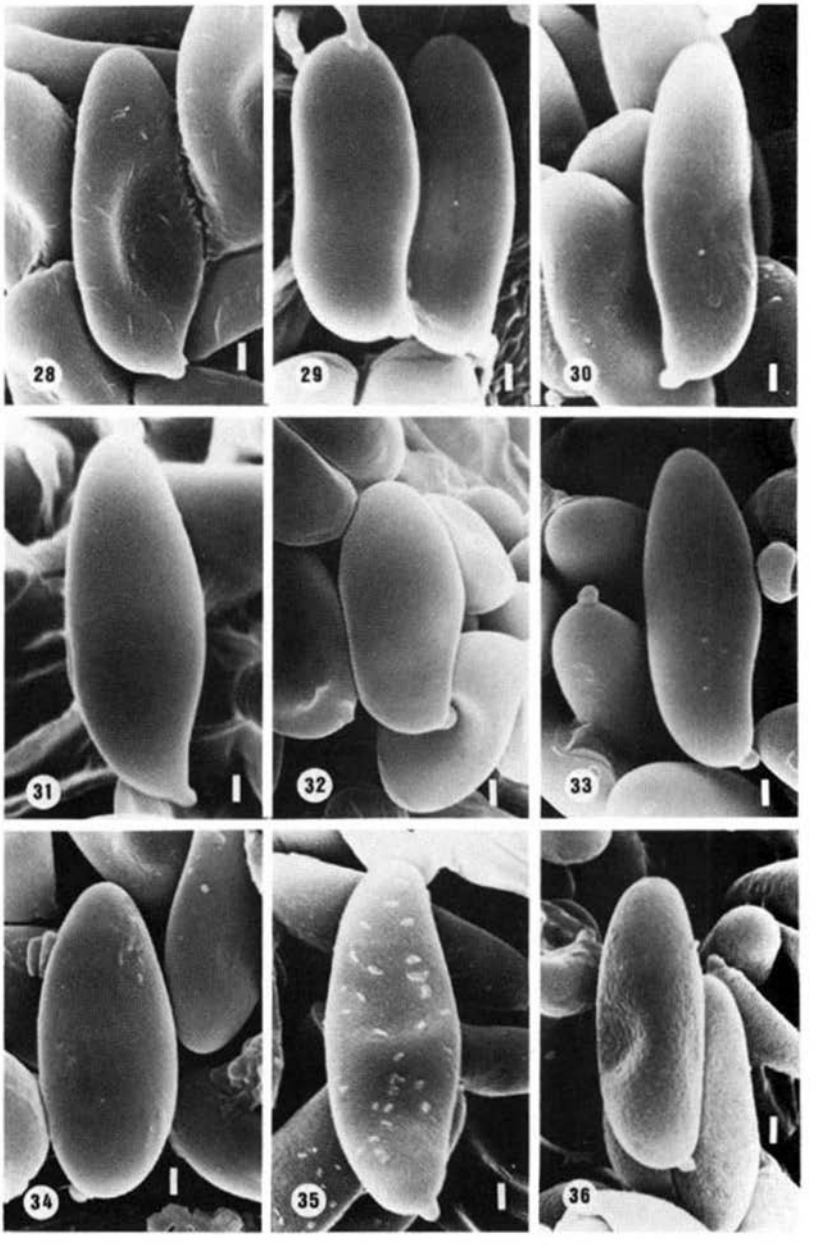
Figs. 1–9



Figs. 10–18



Figs. 19–27



Figs. 28–36

but stated also that it can have certain spores showing a very faint ornamentation resembling the striae of weakly ornamented *Boletellus* spores. The reason why these authors did not also find more pronouncedly pitted spores (see Figs. 4–6) probably lies in the fact that in each case only one or two collections were examined.

The surface structure of spores of *P. rhodoxanthus* (Figs. 35, 36) remains a puzzle. Not only the ornamentation observed in this study (floccose or pitted-and-floccose) is in disagreement with the one found by Pegler & Young, also their observations of 1971 and 1981, of the same collection, disagree with each other. They reported in 1971 (: 158) a spore surface with numerous, rod-like structures comparable to those observed in *Oudemansiella,* but in 1981 (: 119) they reported a fine rugulose ornamentation. Heinemann & al. (1988: 517) found bacillate ('bacillées') spores in *P. rhodoxanthus*. Some confusion is caused by the different terminology. The term bacillate is considered deceptive by the present author, because the spore surface is covered by numerous very fine structures, of which only a part can be described as rod-like. Consequently Heinemann & al. display a rather broad concept of bacillate. One part of the structures covered by their term can be described as rod-like (as Pegler & Young do) or as fibrillose (this paper), but the other part as floccose (this paper). Therefore the spore surface of *P. rhodoxanthus* as described by Heinemann & al. agrees well with the data of Pegler & Young of 1971, but also with the spore surface depicted in Fig. 35 in this paper. The pitted-and-floccose spore surface (Fig. 36) is only reported in this paper.[1]

It is supposed that on the spores depicted in the Figs. 3 and 35 the ecto- and perisporium are beginning to disintegrate. The ornamentation showed in the Figs. 4–6 and 36 may be formed (i) by remnants of a much further disintegrated ecto- and perisporium, (ii) by the exosporium which becomes visible as these two outer layers disappear, or (iii) by both (i) and (ii). As all the spores in the Figs. 3–6, 35, and 36 are probably mature, it seems possible that the degree of ecto- and perisporium disintegration is not always equal in different collections.

An ornamentation almost certainly formed by remnants of the two outer layers, is found in the taxa of the *B. subtomentosus*-complex and *B. bubalinus*, sp. nov. The gradual breakdown of the ecto- and perisporium, which eventually disappears to leave a smooth exosporial surface, can be observed in the Figs. 7 to 10. All degrees of disintegration may be found in mature spores, however, smooth spores and spores with floccose remnants are found in both spore prints and tube-fragments, but fibrillose to floccose spores only in tube-fragments. This strongly supports the supposition that the ornamentation in the *B. subtomentosus*-complex is caused by disintegration of the outer layers.

The ornamentations of the spore surface Heinemann & al. (1988: 524, 532) found in *B. subtomentosus* (bacillate) and *B. ferrugineus* (bacillate or roughened to smooth), are similar to stages found in this study, bearing in mind that their 'bacillate' is comparable to 'fibrillose to floccose', here. Besides smooth spores, Perreau-Bertrand (1965: 4247) and Pegler & Young (1971: 156) also observed striate spores in some collections of *B. subtomentosus*. This is contrary to the observations of Heinemann & al. (1988) and the present author, that indicate that striate spores occur only in taxa of the *B. chrysenteron*-complex.

[1] Photographs, made at a later time and therefore not reproduced here, of one of the collections also examined earlier (coll. *Schreurs 464*) show spores, some still attached to the sterigmata, with a fibrillose surface similar to the rod-like structures found by Pegler & Young (1971: 158).

In all the taxa of the *B. chrysenteron*-complex studied here, a majority of the spores show fine, usually anastomosing, longitudinal striae, distinguishing them from the other taxa of the *Xerocomus*-group studied. Up to the start of the present study only *'B. fragilipes'* (Pouzar, 1981: 8; Hübsch, 1982: 62) and *B. truncatus* (Pegler & Young, 1981: 116) were known to have spores with fine longitudinal striae, and *B. chrysenteron* was suspected to have them (van der Aa, 1979: 207). Recently Heinemann & al. (1988: 522) have observed this type of ornamentation in *B. chrysenteron, B. porosporus* and *B. pruinatus*. They also notice that the ornamentation of spores of *B. porosporus* often is faint. However, they describe *B. versicolor* as having roughened to smooth spores. This is in disagreement with the observation of the present author and could be caused by a different concept of *B. versicolor* (a synonym of *B. rubellus*). That striate spores are typical for the *B. chrysenteron*-complex, is made more plausible by the fact that the spores of the North American *Boletus zelleri* (Murr.) Murr., a taxon with a 'deceptive external similarity' to *B. chrysenteron,* have a similar fine striation (Snell & al., 1960: 575; Perreau & Heim, 1969: 333; Pegler & Young, 1981: 116). Because of this striation, some mycologists consider this taxon to belong to *Boletellus* (*Boletellus zelleri* (Murr.) Sing., Snell & Dick).

Boletus fragilipes is a taxon reinstated by Pouzar to accommodate collections with striate spores and that are close to, but somewhat aberrant from *B. chrysenteron* (see section 3.4). As the taxa examined in the *B. chrysenteron*-complex all show striate spores and as there seem to be no other reliable characters to distinguish *B. fragilipes* from *B. chrysenteron, B. fragilipes* is considered here a nomen dubium.

The ornamentation of the spores in the *B. chrysenteron*-complex is probably of exosporial origin, as was pointed out for *B. zelleri* (Perreau-Bertrand, 1967: 680; Pegler & Young, 1971: 162; 1981: 116). The reason why a number of spores are smooth or only faintly striate, can be explained by an overlying ecto- and perisporium obscuring the exosporial ornamentation (e.g. Figs. 20, 25). Smooth and faintly to distinctly striate spores can all be found in a spore sample of one specimen of the various taxa, except *B. porosporus,* which frequently has only smooth and faintly striate spores.

The spores of *B. armeniacus* (Figs. 28, 29) have a floccose to smooth surface comparable to and probably of the same origin as that of spores in the *B. subtomentosus*-complex and *B. bubalinus*. Heinemann & al. (1988: 526) consider the spore surface to be roughened to smooth, probably similar to what is described in this paper. Therefore *B. armeniacus* seems not to belong to the *B. chrysenteron*-complex, as initially thought (Oolbekkink & van Duin, 1988: 1). It is, however, not easy to place this taxon elsewhere. Although the colour of the cap, the pink zone under the pileipellis and the pileipellis-structure suggest a relationship with *B. chrysenteron,* the surface structure of the spores, the ridges on the stem and the hardly blueing flesh suggest a relationship with *B. subtomentosus*.

Smooth spores without any trace of remnants have been found by the present author in *B. badius, B. pulverulentus, B. moravicus,* and *B. ichnusanus*. This has been confirmed for *B. badius* by both Perreau-Bertrand (1967: 676) and Pegler & Young (1981: 117), and for *B. pulverulentus* only by the former. Pegler & Young (1971: 156) are the only authors reporting occasional faint longitudinal striae on the spores of *B. pulverulentus*. Heinemann & al. (1988: 526, 528) place *B. badius* and *B. moravicus* in a group with roughened to smooth

spores, but also state that *B. badius* shows very faint veins on a small number of spores when enlarged to 20,000 times, and that the spore wall of *B. moravicus* is longitudinally wrinkled (l.c.: 530). As yet no data on the spore surface of *B. ichnusanus* were available in the literature.

On a very few spores in one collection of each *B. badius*, *B. subtomentosus*, and *B. porosporus*, a surface with rounded swellings ('blistered') has been observed. As these species are distinctly different and the number of spores involved is very small, it is considered not characteristic for any of these taxa and possibly externally caused.

This study and the one by Heinemann & al. (1988) show that more *'Xerocomus'* species have ornamented spores than could be expected from the available data in earlier literature. Summarizing the above, the most striking results of this study are that the taxa of the *B. chrysenteron*-complex can be distinguished from the *B. subtomentosus*-complex and the other taxa examined, by their striate spores, and that *B. parasiticus* can be distinguished by its conspicuously pitted spore surface. If the presence of remnants of an outer layer on a large number of spores of *B. bubalinus*, *B. armeniacus*, and the taxa in the *B. subtomentosus*-complex is a constant feature, then they can be distinguished from taxa with only entirely smooth spores. The SEM study of the spores has not altered the author's concept of the taxa discussed in section 3.3, except for *'B. fragilipes'*, which is now considered a nomen dubium, and *B. armeniacus*, which seems better placed outside the *B. chrysenteron*-complex.

3. TAXONOMY AND NOMENCLATURE

3.1. THE TAXONOMIC STATUS OF XEROCOMUS QUÉL.

Although part of the specimens in several taxa of *Xerocomus* can be distinguished from part of the specimens in several taxa of *Boletus* by the characters given by Quélet (1888: 417), it is impossible to totally delimit all the specimens in all of the taxa of the former from those of the latter, because none of the characters used is exclusively reserved for either of them.

Singer and other mycologists consider the structure of the hymenophoral trama the main criterion for separating *Xerocomus* from *Boletus*. This has produced, however, a rather artificial systematic arrangement; e.g. Singer emended *Boletus* sect. *Subpruinosi* (see Singer, 1986: 777) to include species with xerocomoid features of the fruit-body but with a boletoid trama, within *Boletus*. In such a systematic arrangement it is impossible to place closely resembling taxa, such as *B. chrysenteron* and *B. pruinatus*, near to each other.

The present author does not regard the occurrence of a hymenophoral trama of the *Phylloporus*-type or the *Boletus*-type as such a fundamental character, because the distinction between the two is often not sharp and it is often difficult to designate either of them to the various taxa of *Xerocomus*. This view is supported by observations of other authors and by the author's own experience.

In Singer (1986: 58) is stated that towards the end of the sporulation of *Boletus* fruit-bodies, the *Boletus*-type changes into a tramal type similar to the *Phylloporus*-type. The reverse is also possible, as is suggested to occur in some species of *Pulveroboletus* Murr.,

where the *Phylloporus*-type found in young specimens changes through further development into the *Boletus*-type (l.c: 771). A tramal structure intermediate between phylloporoid and boletoid, has been found in *B. badius* and related taxa (l.c.: 764).

Corner (1972: 19) noticed in his study of Malaysian species that in a very young stage all boletes seem to be phylloporoid. Moreover, he observed (l.c.: 9, 18) several species with intermediate trama where a sharp distinction between phylloporoid and boletoid trama could not be made, and he suggested that there may be several, not merely two, variations in tramal structure. In a previous study (Oolbekkink & van Duin, 1985) on the morphology of taxa of the *Xerocomus*-group, the *Phylloporus*-type and the *Boletus*-type, but also intermediate structures were observed. For instance: in *B. badius*, the *Phylloporus*-type and the *Boletus*-type, and an intermediate tramal structure were found; in *B. porosporus* and *B. pruinatus*, the *Phylloporus*-type and an intermediate structure were found, and in *B. fraternus* the *Phylloporus*-type and the *Boletus*-type. As these tramal types were all found in mature fruit-bodies, it seems that there is no obvious relation between the hymenophoral trama-type and the stage of development of the fruit-body.

Earlier also Watling (1968: 304) pointed out irregularities of the hymenophoral trama in several taxa. Smith & Thiers (1971: 11) considered the differences between the tramal types not sufficiently constant to be of aid in distinguishing genera or species in their study of Michigan boletes. The present author agrees with Smith & Thiers, because the hymenophoral trama displays such a variation in structure during the short existence of the fruit-body, that no great value can be attached to it as distinguishing character.

Another difference between the two genera has been mentioned, namely the fact that many taxa of *Xerocomus* are facultatively ectomycorrhizal, whereas *Boletus* taxa are constantly obligatorily ectomycorrhizal (Pegler & Young, 1981: 116, 123; Singer, 1986: 762). Besides the fact that it is very difficult in most cases to establish whether a taxon is obligatorily or facultatively mycorrhizal, the present author wonders if this difference is of any value for the taxonomy. According to Harley & Smith (1983: 114) the variability of many proved mycorrhiza-forming species in culture suggests that the indication 'facultatively mycorrhizal' should be treated with caution.

The discussion above has led to the conclusion that *Xerocomus* should not be separated from *Boletus* at genus level.

3.2. Provisional key to the species and varieties of 'the Xerocomus-group' of Boletus

1a. Basidiocarp growing on *Scleroderma*; cap yellow-brown with olivaceous tinge; spores 11.6–18.0 µm long (mean value 15.7±1.3 µm); pileipellis a strongly intricate trichoderm of branched narrow hyphae, (3.5–) 4.5–9.0 µm broad, with apical cells often curving inwards, often slightly inflated at septa and there up to 11.0 µm broad . . . . . 2. *B. parasiticus*

b. Basidiocarp on the ground 2

2a. Basidiocarps usually growing in tufts; stem covered over two-third from apex downwards by a brownish red to brown net; base usually prolonged into soil by root-like strand of mycelium; spores long and broad, 12–18(–23) × 5–7(–7.5) µm; probably restricted to the Mediterranean . . . . . 16. *B. ichnusanus*

b. Basidiocarp never with a prominent net on the greater part of the stem; base never prolonged; spores smaller 3

3a. Many spores with a truncate apex 4

b. Spores not truncate 5

4a. Cap dark yellowish brown to brown or olive-brown, with surface usually cracking and showing whitish or yellowish flesh underneath; no red on stem, or more rarely a red-brown or deep red zone at apex 10. *B. porosporus*

b. Cap dark olive to olive-brown at first, but very soon red to reddish throughout, with surface cracking and then showing pink to red flesh; stem soon pink to red from base upwards . . . . . 11. *B. truncatus*

5a. Spores short and broad, Q = 1.7–2.4; cap ochraceous or pale brown; pores pale cream-coloured at first, later yellow to yellowish-ochraceous; flesh never changing to blue . . . . . 14. *B. moravicus*

b. Spore size larger, minimum Q value never below 2.0, maximum Q value greater than 2.4 6

6a. Cap and stem bruising dark blue to black on handling; flesh strongly turning blue to dark blue throughout . . . . . 15. *B. pulverulentus*

b. Cap and stem not or not so prominent bruising blue; flesh not or weakly changing, or turning (greenish) blue irregularly and usually more slowly 7

7a. Cap viscid when wet; pileipellis an intricate ixotrichoderm of branched, narrow hyphae, (3.5–)5.5–7.0 (–9.0) µm broad . . . . . 1. *B. badius*

b. Cap never viscid; pileipellis an intricate, irregular or epithelioid trichoderm 8

8a. Pileipellis an intricate to strongly intricate trichoderm of branched narrow hyphae, about 5.5–13.0 µm broad, with age at surface sometimes tending to change into a cutis; terminal cells not or slightly inflated. 9

b. Pileipellis a trichoderm of wider hyphae, about 7.0–18.0 µm broad; terminal and/or subterminal cells often distinctly inflated and broader than 14.5 µm; terminal cells can be cystidioid or globose 11

9a. Cap buff, pale brown, yellow-brown or olive-brown; stem buff or yellow-brown, on the upper half with reddish brown or brownish tinges or yellowish brown, brown or reddish brown, sometimes slightly anastomosing ridges; NH_4OH on cap producing a somewhat orange-brown spot with dark brown to dark purple ring . . . . . 3. *B. subtomentosus*

b. Cap yellow to yellow-ochre or (dark) brown to (dark) reddish brown; stem yellow or brownish 10

10a. Cap yellow to yellow-ochre; stem yellow, sometimes with yellow ridges at apex 4. *B. subtomentosus* var. *luteolus*

b. Cap (dark) brown to (dark) reddish brown; stem on upper part merely (dark) reddish brown to brown dotted, or with concolorous dots and ridges and these hardly anastomosing or forming a coarse net; lower part pale yellow to pale brown; NH_4OH on cap reddish brown to dark brown with a dark ring, or fleeting dark (greenish) blue, leaving a whitish spot (colour disappearing) with a dark reddish brown to black ring . . . . . 5. *B. ferrugineus*

11a. Pileipellis an intricate to irregular trichoderm with remarkably large terminal cells, 25.0–63.0(–81.0) µm long and 8.0–23.5(–30.5) µm broad; cap yellow to yellow-ochre; (see 10 also) 4. *B. subtomentosus* var. *luteolus*

b. Pileipellis an irregular or epithelioid trichoderm with terminal cells usually not longer than 50.0 µm, but when longer, terminal cells usually not broader than 20.0 µm; cap several tints of brown, pink or red, never yellow 12

12a. Pileipellis an epithelioid trichoderm 13

b. Pileipellis an irregular trichoderm 14

13a. Pileipellis an epithelioid trichoderm of many inflated terminal and subterminal cells, respectively (9.0–)14.5–25.0 and (9.0–)13.5–35.0(–45.0) µm broad; hyphae narrowing downwards, (7.0–)9.0–17.0 (–20.5) µm broad; no red line under pileipellis; cap red, with surface often minutely cracking and then showing (deep) yellow flesh; NH_4OH on cap producing an orange-yellow spot (red colour disappearing) 8. *B. fraternus*

b. Pileipellis an epithelioid trichoderm with many chains of almost globose cells on hardly narrower hyphae; terminal cells (5.5–)10.0–25.0(–31.0) µm; subterminal cells (7.0–)11.5–23.5(–31.0) µm broad; cells underneath 10.0–18.0(–22.0) µm broad; red line under pileipellis 17

14a. Pileipellis a thin, 80–110(–145) µm thick, somewhat irregular trichoderm with many rather narrow terminal cells, (5.5–)8.0–14.0(–15.5) µm broad, and often slightly inflated subterminal cells, (7.0–)10.0–16.0(–18.0) µm broad; cap dark brown with a red to purplish red colour shining through, covered with a hoary bloom easily destroyed by handling or by rain ..... 9. *B. pruinatus*

b. Pileipellis thicker, 135–280(–420) µm; terminal cells often broader than 15.5 µm; subterminal cells often broader than 16.0 µm 15

15a. Pileipellis an irregular trichoderm often with branching elements in upper part and usually rather narrow terminal cells, (5.5–)7.0–18.0(–27.0) µm broad; subterminal cells (5.5–)7.0–18.0(–22.0) µm broad; cap buff, (dark) yellow-brown or pale brown, usually with pink flush appearing locally, with age becoming very smooth, often with surface cracking and showing yellowish flesh underneath; pores bright yellow when young, with age becoming dark (greenish) yellow or sometimes brownish and then somewhat orange-brown ..... 13. *B. bubalinus*

b. Pileipellis an irregular trichoderm usually with slightly inflated, but sometimes cystidioid terminal cells, (5.5–)8.0–18.0(–28.5) µm broad; subterminal cells (5.5–)9.0–23.5(–31.0) µm broad; hyphae usually narrowing downwards; with few to many incrustations 16

16a. Cap pink when young, becoming pale ochraceous brown or a mixture of reddish pink and brownish-ochraceous to ochraceous buff; stem bright to golden yellow, paler yellow at base, often with ridges especially near apex and these sometimes reddish orange ..... 12. *B. armeniacus*

b. Cap drab, pale brown, dark yellowish brown, dull to dark red, or variegated dark red and dark yellowish brown 17

17a. Cap drab, pale brown or dark yellowish brown, often with red flush particularly when mature, usually with irregularly cracking surface and showing reddish, sometimes whitish or yellowish flesh underneath 6. *B. chrysenteron*

b. Cap dull red, with age dark red, often variegated dark red and dark yellowish brown, sometimes with surface cracking particularly at margin and then showing pinkish, sometimes whitish flesh (considered a red-coloured variant of *B. chrysenteron*) ..... 7. *'B. rubellus'*

3.3. Descriptions of and notes on taxa of the Xerocomus-group

1. **Boletus badius** (Fr.) Fr.: Fr.

Boletus badius (Fr.) Fr.: Fr., Elench. fung.: 126. 1828.

Cap orange-brown, (dark) reddish brown or dark brown, tomentose when young, soon becoming smooth, viscid when wet. Pores pale yellow to pale greenish yellow, bruising blue. Stem at apex concolorous with pores, elsewhere concolorous with cap but usually paler. Flesh (yellowish) white to pinkish white in cap, greyish white or brownish white in stem, turning blue particularly over the tubes. NH_4OH on cap producing an orange-brown or reddish brown spot with spreading and fading blackish brown or blackish green ring, on flesh negative, seldom yellowish.

Spores (n = 100) 13.5±1.1 × 4.7±0.4 (10.7–15.8 × 4.3–6.3) µm, Q = 2.9±0.2 (2.4–3.5), smooth with SEM. Pileipellis an intricate ixotrichoderm of branched, narrow hyphae, (3.5–)5.5–7.0(–9.0) µm broad, difficult to observe in older specimens probably because of gelatinizing hyphal walls; pigment incrustations present.

Collections examined.—NETHERLANDS: Lage Vuursche, 29 Sept. 1983, *Oolbekkink & van Duin 113*; Hulshorst, 11 Oct. 1983, *van Duin & Oolbekkink 133 and 134*; Gooisch Natuurreservaat, 18 Oct. 1984, *Oolbekkink & van Duin 171 and 173*.

The taxon *B. badius* was first described by Fries as *B. castaneus* β *Badius* in the Observationes mycologicae (1818: 247) and again in 1821 (: 392) as *B. castaneus* β *B. badius* in the Systema mycologicum. Gams (1984: 227) pointed out that this epithet is of uncertain infraspecific rank. Fortunately Fries described the taxon once more in the Elenchus fungorum (1828: 126), but now as a species with the name *B. badius* and thus this name is sanctioned.

See also the notes under *B. moravicus*.

2. Boletus parasiticus Bull.: Fr.

Boletus parasiticus Bull.: Fr., Syst. mycol. 1: 389. 1821.

Cap pale yellow-brown with olivaceous tinge to dirty yellowish brown, with surface often cracking particularly at centre, dry. Pores yellow, brownish yellow becoming reddish brown (rust-coloured), not blueing. Stem concolorous with cap or paler, often curved. Flesh yellow, unchanging. NH_4OH reaction on cap or flesh not recorded.

Spores (n = 70) 15.7±1.3 × 4.9±0.4 (11.6–18.0 × 4.2–5.4) µm, Q = 3.2±0.3 (2.6–4.0), pitted to reticulately venose with SEM. Pileipellis a strongly intricate trichoderm of branched narrow hyphae, (3.5–)4.5–9.0 µm broad, apical cells often curving inwards, often slightly inflated at septa, then up to 11.0 µm broad; incrustations absent.

Fruit-bodies growing on *Scleroderma citrinum* Pers.

Collections examined.—NETHERLANDS: Het Gooi, 29 July 1956, *Smit*; Breda, 12 Oct. 1958, *Jansen*; Swalmen, Hillenraad, 7 Oct. 1962, *Bas 2844*; Breda, Liesbos, 14 Sept. 1968, *Goos*; Arnhem, Vijverberg, 4 Aug. 1975, *van der Laan*.

3. Boletus subtomentosus L.: Fr.

Boletus subtomentosus L.: Fr., Syst. mycol. 1: 389. 1821.

Cap buff, pale brown, yellow-brown or olive-brown with dark yellowish brown, orange-brown or reddish brown patches where bruised, tomentose, sometimes with surface cracking particularly at margin and then showing (very) pale yellow, never pink or red, flesh. Pores bright yellow, darker with age and sometimes more greenish yellow, seldom slightly blueing on bruising. Stem buff or yellow-brown, on the upper half with brown or reddish brown tinges or yellowish brown, brown or reddish brown, sometimes slightly anastomosing ridges. Flesh yellowish white to pale yellow, with (reddish) brown line under pileipellis, often with pinkish tinge in cap, sometimes turning brownish or slightly bluish green locally. NH_4OH on cap producing a ± orange-brown spot with a dark brown to dark purple ring, on flesh negative.

Spores (n = 100) 12.2±1.2 × 4.4±0.4 (10.0–15.3 × 3.6–5.4) µm, Q = 2.8±0.2 (2.2–3.5), fibrillose to floccose or smooth with or without floccose remnants with SEM. Pileipellis an intricate to strongly intricate trichoderm of branched narrow hyphae, about 5.5–13.0 µm broad, with age at its surface sometimes tending to change into a cutis; terminal cells not or slightly inflated, (5.5–)8.0–14.5(–18.0) µm broad, rarely curving inwards; without inflations at septa; sometimes with a few incrustations.

Collections examined.—NETHERLANDS: Vogelenzang, A.W.-dunes, 9 Oct. 1983, *Bas 131*; Bergen, 15 Oct. 1984, *Ypelaar YP8461B*; Bergen, Zwarte Weg, 21 Oct. 1984, *Ypelaar 174*; Castricum, Noordhollands Duinreservaat, 26 Sept. 1987, *Oolbekkink 203*. — LUXEMBURG: Dillingen, 29 Oct. 1987, *Oolbekkink 209*.

See notes under *B. subtomentosus* var. *luteolus*, *B. ferrugineus*, and *B. chrysenteron*.

4. **Boletus subtomentosus** var. **luteolus** Velen.

Boletus subtomentosus var. *luteolus* Velen., České Houby: 717. 1922.
Xerocomus subtomentosus var. *xanthus* E. J. Gilb., Les Bolets: 142. 1931; ?*Xerocomus flavus* Sing. & Kuthan in Česká Mykol. 30: 153. 1976.

Cap yellow to yellow-ochre, tomentose. Pores bright yellow. Stem at apex concolorous with pores, elsewhere pale yellow, sometimes with yellow ridges at apex. Flesh yellowish white to pale yellow, often with pinkish tinge in cap. NH_4OH reaction on cap or flesh not recorded.

Two pileipellis-types could be distinguished in the collections examined: (I) Pileipellis as in *B. subtomentosus*. Spores (n = 100) 12.3±1.1 × 4.9±0.4 (9.2–14.9 × 4.0–5.7) µm, Q = 2.5±0.2 (2.0–3.2), smooth with or without floccose remnants with SEM. (II) Pileipellis an intricate to irregular trichoderm with remarkably large terminal cells, (16.0–)25.0–63.0 (–81.0) µm long and (6.5–)8.0–23.5(–30.5) µm broad; subterminal cells 7.0–18.0(–29.5) µm broad; incrustations absent. Spores (n = 20) 12.6±1.0×4.9±0.5 (10.7–14.9 × 3.9–5.5) µm, Q = 2.6±0.4 (2.2–3.5), smooth with or without floccose remnants with SEM.

Collections examined.—NETHERLANDS: roadside (Koningsweg) between Utrecht and Bunnik, 31 Aug. 1969, *Arnolds 350*; Hardenberg, 20 Sept. 1969, *Hengstmengel 169* (both type I); Breda, Liesbos, 1 Sept. 1959, *Bas 1742*; Breda, Liesbos, 8 Aug. 1975, *Jansen* (both type II).

Velenovský has given a more extended description of his taxon in Latin in 1939 (: 159). Singer & Kuthan (1976: 154) consider *X. flavus* to be very close to *X. spadicus* and *X. lanatus* and possibly very similar to yellowish forms of *X. subtomentosus*. They describe a striking chemical character for *X. flavus*, viz. NH_4OH on surfaces produces an immediate, very slowly fading blue-green reaction. The NH_4OH reaction is not recorded for the specimens described above. The structure of the pileipellis of *X. flavus* as described by Singer & Kuthan does not fit either of the pileipellis-types described here. Therefore it is doubtful whether *X. flavus* is identical with *B. subtomentosus* var. *luteolus*.

The present author has found two pileipellis-types in otherwise similar collections. This was concluded after comparing the annotations of the collections, as no fresh material was available. More studies are needed to solve this problem. There are three possibilities: (i) the annotations are inaccurate and two taxa are involved; (ii) variation in the pileipellis-structure is caused by genetic variation within one taxon; (iii) variation in the pileipellis-structure is caused by abiotic factors, e.g. the weather conditions during the development of the fruit-bodies.

5. **Boletus ferrugineus** Schaeff.

Boletus ferrugineus Schaeff., Fung. Bavariae 4: 85. 1774 (as *B. decimus nonus* in vol. 2: Tab. 126. 1763).
Boletus spadiceus Fr., Epicr.: 415. 1838; *Boletus lanatus* Rostk. *in* Sturm (ed.), Deutschl. Fl. (Pilze), Abth. III, 5: 77. 1844.

Cap (dark) reddish brown to (dark) brown, (dark) reddish brown patches where bruised, with (pale) yellow, soon collapsing tomentum. Pores bright yellow to deep golden yellow, sometimes with greenish tinge, seldom slightly blueing on bruising. Stem on upper part merely (dark) reddish brown to brown dotted, or with concolorous dots and ridges and these hardly anastomosing or forming a coarse net; lower part pale yellow to pale brown. Flesh whitish

to pale yellowish, often more yellowish in stem, with dark reddish brown to brown line under pileipellis, often with pinkish to pale brownish pink tinges in cap and stem, seldom turning pale bluish locally. NH_4OH on cap reddish brown to dark brown with a dark ring, or fleeting dark (greenish) blue, leaving a whitish spot (colour disappearing) with a dark reddish brown to black ring. NH_4OH on flesh not recorded.

Spores (n = 90) 12.8±1.2 × 4.5±0.5 (10.8–15.8 × 3.6–6.1) µm, Q = 2.8±0.3 (2.0–3.5), floccose or smooth with or without floccose remnants with SEM. Pileipellis as in *B. subtomentosus*.

Collections examined.—NETHERLANDS: Bunnik, 23 Aug. 1967, *Arnolds*; Amersfoort, Pinetum Birkhoven, 11 Oct. 1980, *Wisman*; Amersfoort, Birkhoven, 7 July 1984, *Wisman*. — AUSTRIA: Sattnitzridge, south of Klagenfurth, near Göltschach, 3 Oct. 1978, *Bas 7394*.

The description of *B. spadiceus* by Fries (1838: 415) was based on the species of *Boletus* described by Schaeffer in 1763 (: Pl. 126), because Fries referred to this publication in his description and because he mentioned this taxon as '*B. spadiceus* Schaeff.' in the index of the Hymenomycetes europaei (Fries, 1874: 746). Fries neglected the fact that Schaeffer had already given his nineteenth species of *Boletus* the name *B. ferrugineus* in 1774 (: 85). Therefore *B. ferrugineus* Schaeff. is the correct name for this species.

When the original descriptions are compared, the differences between the taxa of the *B. subtomentosus*-complex can be summarized as follows: *B. subtomentosus* has an olivaceous cap and somewhat ridged, furrowed or grooved stem; *B. ferrugineus* has a (dark) reddish brown cap and no ridges on the stem; *B. lanatus* has a brown cap and reddish brown wrinkled, almost netted stem. Unfortunately these differences are in reality not very useful, as the taxa show an overlap of characters, which was shown in an earlier study of the concerning taxa (Oolbekkink & van Duin, 1985, 1988). During that study specimens were found with yellow-ochre, yellow-brown, olivaceous or reddish brown to (dark) brown cap, without or with yellow, yellowish brown, reddish brown or brown ridges sometimes (slightly) anastomosing or forming a coarse net.

On account of the fortuitous occurrence of, sometimes anastomosing, ridges on the stem of any of the specimens with the above described colours of the cap, the emphasis in grouping them is laid here on the colour of the cap and not on the occurrence of ridges. This implicates that *B. ferrugineus* can have ridges, although they were not described by Schaeffer. Schaeffer and also Rostkovius considered the presence or absence of ridges or anastomosing ridges on the stem a good reason to distinguish several 'different' taxa, many of which are quite similar to *B. subtomentosus* or *B. ferrugineus*.

Fries (1874: 503), who also attached much value to the presence of ridges on the stem, mentioned Rostkovius' *B. lanatus* under *B. subtomentosus* on account of its ridges, but also stated that *B. lanatus* closely resembles *B. spadiceus*. In this paper *B. lanatus* is considered a synonym of *B. ferrugineus*. The differences between these two reported by Watling (1970: 26, 40), viz. the pileipellis-structure and the NH_4OH reaction on the cap, could not be confirmed by Oolbekkink & van Duin (1985). The pileipellis-structure appeared to be similar in all the examined taxa of the *B. subtomentosus*-complex (except in part of the collections of *B. subtomentosus* var. *luteolus*) and the blue NH_4OH reaction can occur in specimens with a reddish brown to (dark) brown cap, both with and without ridges. Singer (1965: 97) and

Watling (1970: 41) disagree on the colour of the NH_4OH reaction of the cap of *B. ferrugineus*, as they also disagree in their concept of *B. lanatus*, probably caused by the above-mentioned overlap of characters. Anyhow, it seems doubtful whether an inconsistently blue NH_4OH reaction alone can be used to separate taxa.

Therefore additional observations on the NH_4OH reaction of the cap, but also on the structure of the caulocystidia in the taxa of the *B. subtomentosus*-complex are still necessary. The latter because Grund & Harrison (1976: 94–96) have found in their studies on Nova Scotian boletes that the caulocystidia of *B. subtomentosus* are often multiseptate, whereas those of *B. ferrugineus* are not. But this does not automatically imply that the same applies to the European taxa.

See also the notes under *B. subtomentosus* var. *luteolus*.

6. **Boletus chrysenteron** Bull.

Boletus chrysenteron Bull., Hist. champ. France: 328. 1791.

Cap drab, pale brown, dark yellowish brown or dingy brown, often with paler margin, often with red flush particularly when mature, usually with irregularly cracking surface and then showing reddish, sometimes whitish or yellowish flesh. Pores pale yellow becoming (dark) greenish yellow with age, often bruising (dark) bluish green. Stem (pale) yellow at apex, often almost totally pink to (dark) red elsewhere, often bluish to bluish green on handling; old bruises becoming brown. Flesh in cap whitish to yellowish white or pale yellow, in stem brownish or yellowish brown with pink, red or purplish red streaks or patches, often with pink to red line under pileipellis, sometimes also under stipitipellis, turning faintly (greenish) blue in cap, blue to dark greenish blue in stem. NH_4OH reaction on cap and flesh negative.

Two pileipellis-types could be distinguished in the collections examined: (I) Pileipellis an irregular trichoderm with not or usually slightly inflated, but sometimes cystidioid terminal cells, (5.5–)8.0–18.0(–28.5) µm broad, subterminal cells (5.5–)9.0–23.5(–31.0) µm broad; hyphae branched, usually narrowing downwards; with few to many incrustations; pileipellis usually rather thick, (70–)135–280(–420) µm. Spores (n = 100) 13.6±1.5 × 4.9±0.5 (10.5–18.1 × 4.0–6.8) µm, Q = 2.8±0.3 (2.2–3.3), with faint to distinct striae with SEM. (II) Pileipellis an epithelioid trichoderm with many chains of almost globose cells on hardly narrower hyphae; terminal cells (5.5–)10.0–25.0(–31.0) µm, subterminal cells (7.0–)11.5–23.5(–31.0) µm broad, cells underneath 10.0–18.0(–22.0) µm broad; hyphae not branched; few to many incrustations; pileipellis usually thin, (50–)80–130(–170) µm.

Spores (n = 20) 12.4±1.3 × 4.7±0.5 (10.5–15.8 × 3.6–5.4) µm, Q = 2.6±0.3 (2.2–3.2), with faint to distinct striae with SEM.

Collections examined.—NETHERLANDS: Lage Vuursche, 29 Sept. 1983, *van Duin & Oolbekkink 114*; Vogelenzang, A.W.-dunes, 2 Oct. 1984, *Oolbekkink & van Duin 153*; Hilversum, near Larense Weg, 18 Oct. 1984, *van Duin & Oolbekkink 168B*; Castricum, Noordhollands Duinreservaat, 26 Sept. 1987, *Oolbekkink 201* (all type I); Hilversum, near Larense Weg, 18 Oct. 1984, *Oolbekkink & van Duin 168A* (type II). — GERMANY: Dillingerbrück, 25 Oct. 1987, *Oolbekkink 208* (type I).

Fries' description of *B. subtomentosus* L. in 1821 (: 389) included *B. chrysenteron* Bull., because Bulliard's (1791: 328) concept of *B. chrysenteron* was very broad and included amongst others *B. subtomentosus*. Later, in 1838 (: 415), Fries separated them and described *B. chrysenteron* as it is interpreted today.

The present author has found two pileipellis-types in otherwise identical collections. As the collections looked identical in fresh condition, the variation in type of structure can be caused by genetic variation within the taxon or by abiotic factors (see also the relevant note under *B. subtomentosus* var. *luteolus*).

See also the notes under *'B. rubellus'*.

7. 'Boletus rubellus Krombh.'

'Boletus rubellus Krombh.', Naturgetr. Abbild. Schwämme 5: 12. 1836.

Boletus versicolor Rostk. *in* Sturm (ed.), Deutschl. Fl. (Pilze), Abth. III, 5: 55. 1844.

Excluded. — *Boletus rubellus* sensu Singer, Röhrl. 2 *in* Pilze Mitteleur. 6: 45. ('1967') 1966 (= *Boletus fraternus* Peck).

Cap dull red, with age dark red, often variegated dark red and dark yellowish brown, or with dark yellowish brown centre and dark red margin, sometimes with surface (minutely) cracking particularly at margin and then showing pinkish, sometimes whitish flesh. Pores pale yellow becoming greenish yellow with age, often blueing on bruising. Stem (pale) yellow at apex, often almost totally red or dark red elsewhere with yellow to yellow-brown base. Flesh whitish to pale yellow in cap, in stem pale yellow with pink to red streaks or patches, with red line under pileipellis, often turning (greenish) blue. NH_4OH reaction on cap negative, on flesh not recorded.

Two pileipellis-types could be distinguished in the collections examined: (I) Pileipellis as in *B. chrysenteron* type I. Spores (n = 100) 12.1±1.0 × 5.1±0.5 (9.5–15.8 × 4.3–6.8) µm, Q = 2.4±0.3 (1.8–3.1). (II) Pileipellis as in *B. chrysenteron* type II. Spores (n = 50) 12.8±1.4 × 4.7±0.4 (10.2–15.0 × 4.0–5.7) µm, Q = 2.7±0.3 (2.2–3.8). In both types spores with faint to distinct striae with SEM.

Collections examined. — NETHERLANDS: Oegstgeest, Oud-Poelgeest, 27 July 1954, *Bas 541a*; roadside (Koningsweg) between Utrecht and Bunnik, 31 Aug. 1969, *Arnolds 351* (both type I); Callantsoog, Zwanewater, 26 Sept. 1981, *Schreurs 643*; Aardenbrug, De Plaôte, near Bakkersdam, 24 Aug. 1982, *de Meijer 602* (both type II).

After careful comparison of the description and plate of *B. rubellus* by Krombholz (1836: 12) with *B. versicolor* by Rostkovius (1844: 55), it is evident that both concern the same fungus. Both taxa are described as having a dull red cap, a red with brownish yellow stem, yellow pores, a red line under the pileipellis and yellowish flesh with red in the centre of the stem. Therefore, if the material described above represents an independent species, *B. rubellus* is the correct name for this fungus, as it is the oldest one. This is fortunate, because the name *B. versicolor* is preoccupied. It was used by several 18th and 19th century mycologists (e.g. Gray, 1821: 642) for various polypores that were included in *Boletus* at the time.

Fries (1874) regarded *B. versicolor* as totally different from *B. rubellus* and placed these taxa widely apart in his systematic arrangement on account of some characters that cannot be found in the original descriptions. As he did not see any material himself, but studied only descriptions and plates, Fries' opinion on this matter can hardly be considered authoritative.

During their observations on *B. chrysenteron* and *B. rubellus*, Oolbekkink & van Duin (1985) found as only difference between these two the dark red cap and usually redder stem of the latter. At the time it led to the conclusion that *B. rubellus* was merely a variety of

B. chrysenteron. This view altered when the present author came across a well-annotated collection in the herbarium of specimens from one locality with dark yellowish brown to red caps and several colour variants in between. As these specimens, all of approximately the same age, exhibited a gradual colour range from dark yellowish brown to red, it seems logical to suppose that *B. rubellus* represents only an extreme colour variant of *B. chrysenteron*, but this possibility needs corroboration.

Oolbekkink & van Duin (1988: 8) thought *B. rubellus* specifically different from *B. versicolor* on account of the description of the former given by Singer (1966: 45) and of the latter given by Watling (1970: 42). This view needs to be corrected. The description by Watling concerns *B. versicolor* of Rostkovius and this is a synonym of *B. rubellus* Krombh., as is demonstrated above. Singer's description of *B. rubellus*, however, does not agree with the one by Krombholz, but quite well with Peck's (1897: 145) original description of *B. fraternus*. A comparison of the description by Peck with those by Krombholz and Rostkovius, makes clear that *B. fraternus* cannot be a synonym of *B. rubellus*, alias *B. versicolor*, as Singer thought. The comprehensive description of *B. fraternus* by Coker & Beers (1943: 60), who compared their material with Peck's type and found it identical, confirms this point of view.

The present author has found two pileipellis-types in otherwise identical collections of '*B. rubellus*'. The collections were not in fresh condition when examined. The variation in pileipellis structure may have been caused by one of the same factors as mentioned for *B. chrysenteron* (see also the note on this subject under *B. subtomentosus* var. *luteolus*).

8. **Boletus fraternus** Peck

Boletus fraternus Peck *in* Bull. Torrey bot. Club 24: 145. 1897.

Misapplied name.—*Boletus rubellus* sensu Singer, Röhrl. 2, *in* Pilze Mitteleur. 6: 45. ('1967') 1966.

Cap red to deep red when young, becoming somewhat paler with age, but only losing much of the red colour on drying (in dried state yellowish brown or reddish brown with almost no red), with surface often minutely cracking and then showing (deep) yellow flesh. Pores bright yellow to deep yellow, later often with greenish flush, finally pale yellow-brown, bruising greenish blue. Stem at upper part concolorous with pores, at lower part or only at base red to dark red (concolorous with cap), dark greenish blue on handling. Flesh pale yellow to (deep) yellow, sometimes red in lower part of stem, turning greenish blue, without red line under pileipellis. NH_4OH on cap producing an orange-yellow spot (red colour disappearing), on flesh greenish brown.

Spores (n = 20) 13.5±1.1 × 4.9±0.5 (11.8–15.8 × 4.5–5.7) µm, Q = 2.8±0.2 (2.2–3.2), with faint to distinct striae with SEM. Pileipellis a rather thick, 135–180 µm, epithelioid trichoderm of many inflated terminal and subterminal cells, respectively (9.0–)14.5–25.0 and (9.0–)13.5–35.0(–45.0) µm broad; hyphae narrowing downwards, (7.0–)9.0–17.0 (–20.5) µm broad; hyphae rarely branched, without or with scarce incrustations.

Collections examined.—NETHERLANDS: Aerdenhout, A.W.-dunes, 'Naaldenbos', 21 Sept. 1983, *van Duin & Oolbekkink 102*; Kortenhoef, 22 Sept. 1983, *Daams 83-28*.

Oolbekkink & van Duin (1985, 1988) have been the first to report the occurrence of *B. fraternus* in the Netherlands. It is easy to distinguish *B. fraternus* from the red coloured

variant of *B. chrysenteron* (= '*B. rubellus*') by the vivid red of the cap, the deep yellow flesh in the cracks of the cap and the absence of a red line under the pileipellis. Observations on specimens collected in the Netherlands show that two important features can be added, viz. the orange-yellow (disappearing of red) NH_4OH reaction on the surface of the cap and the pileipellis being an epipthelioid trichoderm.

See also the notes under *B. rubellus*.

9. Boletus pruinatus Fr.

Boletus pruinatus Fr., Boleti fung. gen.: 9. 1835.

Misapplied name.—*Boletellus fragilipes* sensu Dermek in Fung. rar. Ic. col. 16: 20. 1987.

Cap dark brown with a (dark) red or purplish red colour shining through, giving it the appearance of being dark reddish brown or purplish red-brown, covered with a hoary bloom easily destroyed by rain or by handling (handling causes also intensifying of dark red or purplish red colour), never viscid, surface never cracking. Pores pale to bright yellow, later sometimes with orange flush, slightly blueing on bruising. Stem yellow at apex, deep red elsewhere or variegated yellow and deep red or entirely deep yellow, sometimes with orange flush, covered with fine, not densely distributed, orange, yellowish green or red to reddish brown dots, brownish at base, sometimes blueing on handling; old bruises becoming brown. Flesh in cap pale yellow, in stem yellow but brownish in base, with pinkish to purplish red line under pileipellis, often turning greenish blue over tubes and in stem. NH_4OH reaction on cap and flesh negative.

Spores (n = 60) 12.7±1.2 × 5.0±0.6 (10.2–15.8 × 4.2–6.8) µm, Q = 2.6±0.3 (2.0–3.4), with faint to distinct striae with SEM. Pileipellis a thin, 80–110(–145) µm, somewhat irregular trichoderm with many rather narrow terminal cells, (5.5–)8.0–14.0(–15.5) µm broad, and often slightly inflated subterminal cells, (7.0–)10.0–16.0(–18.0) µm broad; incrustations scarce.

Collections examined.—NETHERLANDS: Bunnik, Amelisweerd, 20 Oct. 1984, *Bas 8335*. — GERMANY: Dillingerbrück, 25 Oct. 1987, *Oolbekkink 207*.

There seems to be some doubt among mycologists whether *B. pruinatus* as described by Rea (1922: 565), Pearson (1952: 122) and Watling (1970: 33) is identical with the one originally described by Fries (1835: 9; 1838: 414; 1874: 504). This doubt is caused by a disagreement on the colour of the flesh, as the other characters agree amazingly well. Fries did not mention the colour of the flesh in the original description of 1835 (which should be attributed to him only and not to Fries & Hök), but later he described it as whitish or white. However, to illustrate *B. pruinatus* Fries (1838) referred to Bulliard's Plate 393 fig. B and C (1791, *B. communis*), in which the flesh is distinctly yellow, although Bulliard described the flesh of his specimens as whitish or yellowish. This *B. communis* has a good resemblance with *B. pruinatus* sensu Rea, Pearson, and Watling.

It happened more often that Fries described the colour of the flesh of a taxon as white or whitish, while it is nowadays known that it can also be yellowish (e.g. in *B. subtomentosus*). Considering all this, it seems logical to attach more value to the other characters that do agree with Fries' description and to use the name *B. pruinatus* for the taxon described by Rea, Pearson, and Watling. Phillips (1981: 204) has excellently illustrated this species. A subject

for discussion could be whether *B. pruinatus* or *B. communis*, which Fries referred to in his description, is the correct name for the taxon. According to Petersen (1977: 159) *B. communis* is a name given by Ventenat to part of Bulliard's *B. chrysenteron*.

See also the notes under *'B. fragilipes'* (section 3.4).

10. **Boletus porosporus** (Imler ex Imler) Watl.

Boletus porosporus (Imler ex Imler) Watl. *in* Notes R. bot. Gdn. Edinb. 28: 305. 1968.
Xerocomus porosporus Imler ex Imler in Watl. *in* Notes R. bot. Gdn. Edinb. 28: 304. 1968.

Cap (dull) dark yellowish brown to (dark) brown or olive-brown, with surface usually cracking sometimes deeply into flesh, and then always showing whitish or yellowish flesh. Pores (pale) yellow becoming greenish yellow with age, bruising greyish blue to greenish blue. Stem at apex bright yellow to deep yellow sometimes with a red-brown or deep red zone, elsewhere pale brown to dark yellowish brown or striped with these colours on a pale brownish yellow ground-colour, brown at base. Flesh in cap pale yellow, in upper half of stem (deep) yellow, towards base yellow-brown to brown sometimes with pinkish to purplish red tinges, never with red line under pileipellis, turning blue or greenish blue particularly over tubes. NH_4OH reaction on cap or flesh negative.

Spores (n = 100) 14.7±1.5 × 5.5±0.6 (11.5–19.8 × 4.3–6.8) µm, Q = 2.7±0.2 (2.1–3.3), many with truncate apex, with faint to distinct striae with SEM. Pileipellis a rather regular and rather thick (140–210(–320) µm) trichoderm with protruding, never cystidioid and usually not inflated terminal cells, 7.0–20.0(–28.5) µm broad; subterminal cells 11.0–20.0 µm broad; all its elements strongly pigment-incrusted.

Collections examined.—NETHERLANDS: Duin en Kruidberg, 27 Sept. 1983, *van Duin & Oolbekkink 110*; Aerdenhout, A.W.-dunes, 'Oranjekom', 14 Oct. 1983, *Oolbekkink & van Duin 147*; Castricum, Noordhollands Duinreservaat, 26 Sept. 1987, *Oolbekkink 202*.

Imler (1958: 97) failed to designate a type as well in his Latin description as in his French description (Imler, 1964: Atlas Pl. 141–142) of *Xerocomus porosporus*. Therefore the name was invalidly published. Watling (1968: 304), while transferring Imler's species to *Boletus*, corrected this by publishing a personal communication by Imler stating that the collection of 10 July 1963, Brasschaat (Belgium) should be considered the type of *X. porosporus*. This collection was described and illustrated with a coloured plate by Imler in 1964. Therefore the most complete author citation would be *Boletus porosporus* (Imler (1958) ex Imler in Watl. (1968)) Watl. (1968), but (Imler ex Imler) Watl. is sufficient.

See also the notes under *B. truncatus*.

11. **Boletus truncatus** (Sing. & al.) Pouzar

Boletus truncatus (Sing., Snell & Dick) Pouzar (non sensu Pouzar) *in* Česká Mykol. 20: 2. 1966.

Macroscopic description (free after Smith & Thiers, 1971: 288): Cap dark olive to olive-brown, very soon red to reddish throughout or along the margin, with surface cracking and then usually showing pink to red flesh. Pores pale yellow when young, later becoming greenish yellow, bruising greenish blue. Stem (pale) yellow at apex, soon pink to red from base

upwards. Flesh whitish to pale yellow, pinkish red under pileipellis, turning blue. NH_4OH reaction on cap or flesh not recorded.

Spores (n = 20) 11.0–14.0 × 4.5–6.0 µm, Q = 2.3–2.7, many with truncate apex, with faint to distinct striae with SEM. Pileipellis not yet thoroughly examined, but probably similar to that of *B. chrysenteron* type I.

Collection examined.—U.S.A.: California, Contra Costa County, Indian Creek Valley, 3 Dec. 1968, *Rademacher*.

The description of *B. truncatus* by Pouzar (1966: 2) includes the characters of *B. porosporus*, because that author supposed that these two taxa were conspecific. This, however, is incorrect. If the original descriptions are compared, one of the differences between the two is the almost total lack of red or pink in *B. porosporus*. This species is never red or pink on the cap, or in the cracks of the cap and rarely on the stem, where there can be a red-brown or deep red zone at the apex. It also has yellower flesh and probably a different pileipellis-structure. *Boletus truncatus* closely resembles *B. chrysenteron*, except for the truncate spores and the usually more slender fruit-bodies.

Pouzar's (1966: 6) records of *B. truncatus* from Czechoslovakia refer to *B. porosporus*. Hübsch (1982: 63) seems to record the true *B. truncatus* for Germany.

12. **Boletus armeniacus** Quél.

Boletus armeniacus Quél. *in* C.r. Ass. fr. Avanç. Sci. 13: 281. ('1884') 1885.

Cap pink when young, becoming pale ochraceous brown or a mixture of reddish pink and brownish-ochraceous to ochraceous buff, granular felted, with surface often (minutely) cracking and showing yellowish flesh. Pores bright yellow to golden yellow, becoming greenish yellow with age, bruising greenish blue. Stem bright to golden yellow, paler yellow at base, often with ridges especially near apex and these sometimes reddish orange. Flesh in cap pale yellow to pale golden yellow, in stem (pale) golden yellow but deep golden yellow in base, sometimes with pink zone under pileipellis, not or hardly blueing in cap, never blueing in stem. NH_4OH reaction on cap or flesh not recorded.

Spores (n = 80) 10.5–17.4 × 3.6–6.3 µm, Q = 2.0–3.3, floccose to smooth with SEM. Pileipellis as in *B. chrysenteron* type I.

Collections examined.—NETHERLANDS: Vogelenzang, A.W.-dunes, 13 Aug. 1970, *Bas 5264*; Wassenaar, Wassenaarseslag, 21 Oct. 1979, *Bas 7472*.

13. **Boletus bubalinus** Oolbekkink & Duin, *sp. nov.*

Boleti species xerocomoidea. Pileus pallide bubalinus vel ochraceo-brunneus, plerumque in parte roseo-tinctus, velutinus, posterius valde glabrescens et rimosus. Pori e clare luteo virido-lutei, tacti virido-caerulescentes. Stipes flavus vel pallide flavo-brunneus, supra roseo-tinctus vel roseo-striatus, infra brunneo-striatus. Caro albida vel pallide lutea, in stipite pallide flavo-brunnea, supra tubulos caerulescens, in pileo roseolescens. Sporae 10.8–16.8 × 4.0–5.8 µm, in cumulo olivaceo-brunneae.

Typus: '*G. Oolbekkink & W. van Duin 145*, 14 Oct. 1983, Netherlands, prov. Noord-Holland, Aerdenhout, A.W.-dunes, near Ezelenvlak' (L).

Cap buff, pale to dark yellow-brown or pale brown, usually with pink flush appearing locally, tomentose when young, later becoming very smooth (in dried state almost shining

smooth, particularly at centre), often with surface cracking and showing yellowish, sometimes locally pinkish flushed flesh. Pores bright yellow when young, with age becoming dark (greenish) yellow or sometimes brownish and then somewhat orange-brown, bruising (dark) greenish blue. Stem at apex concolorous with pores, but also with pink flush or stripes (pink tending to disappear in old specimens), elsewhere striped with dark yellow-brown or (dark) brown on a yellow to pale yellow-brown ground-colour, very dark brown in old specimens. Flesh in cap whitish to very pale yellow, in upper part of stem pale yellow-brown, darkening towards base, turning bluish over tubes and pinkish in rest of cap or sometimes vice versa, sometimes blueing in apex of stem adjacent to tubes, rarely blueing in rest of stem. NH_4OH on cap producing a somewhat orange-brown spot with a fading dark ring, on flesh usually yellowish otherwise negative.

Spores (n = 70) 13.7±1.4 × 5.0±0.4 (10.8–16.8 × 4.0–5.8) µm, Q = 2.7±0.2 (2.2–3.4), smooth with or without floccose remnants with SEM. Pileipellis an irregular trichoderm often with branching elements in upper part and usually rather narrow terminal cells, (5.5–)7.0–18.0(–27.0) µm broad; subterminal cells (5.5–)7.0–18.0(–22.0) µm broad; pileipellis moderately strong pigment-incrusted and rather thick, (100–)150–210(–260) µm.

Habitat.—Preferably with poplar (e.g. *Populus alba*) on sandy soils; up to now only found in coastal regions of the provinces Noord- and Zuid-Holland.

Collections examined.—NETHERLANDS: Voorschoten, Ter Horst, 22 August 1982, *Bas 7892*; Aerdenhout, A.W.-dunes, 'Ezelenvlak', 14 Oct. 1983, *van Duin & Oolbekkink 144, 145* (type) *and 146*.

This new species shows resemblance to *B. chrysenteron* as well as to *B. subtomentosus*. It can be distinguished from *B. chrysenteron* by the paler colour of the fruit-body, pink discolouration of flesh in cap, NH_4OH reaction on cap and the different pileipellis-structure, and from *B. subtomentosus* by the locally appearing pink flush on the cap, the pink flush or stripes on the stem at apex and the different pileipellis-structure. Because of its pale colours *B. bubalinus* could be mistaken for *B. leonis* or *B. moravicus*, but the former has never any pink on cap or stem, an ochraceous citrine spore print and shorter and somewhat broader spores, and the latter has never any pink on cap or stem, an uncracked cap and shorter and somewhat broader spores.

Boletus bubalinus has earlier been described under the provisional name *B. populinum* by Oolbekkink & van Duin (1988: 11).

14. **Boletus moravicus** Vaček

Boletus moravicus Vaček *in* Studia bot. Čech. 7: 36. 1946.

Misapplied name.—*Xerocomus tumidus* sensu Imler *in* Bull. Soc. mycol. Fr. 70: Atlas Pl. C. 1954; *in* Sterbeeckia 14: 17. 1986.

Macroscopic description after Dermek (1984: 3): Cap ochraceous or pale brown, dry, finely tomentose, smooth or wrinkled. Pores pale cream-coloured at first, later yellow to yellowish-ochraceous. Stem pale yellow or ochraceous, here and there reddish brown, irregularly wrinkled. Flesh yellow in cap, brownish under pileipellis, white in stem, pale brown in base, unchanging. NH_4OH reaction on cap or flesh not recorded.

Spores (n = 20) 9.0–12.5 × 5.0–6.0 µm, Q = 1.7–2.4, smooth with SEM. Pileipellis not yet thoroughly examined, but in older specimens seeming to be a cutis.

Collections examined.—CZECHOSLOVAKIA: Moravia, Žarošice, 20 Aug. 1945, *Vaček PRM 203553*.—FRANCE: Touraine, Bois de Montrésor, 24 Sept. 1955, *Imler* (as *X. tumidus*).

Fries described *B. tumidus* in 1874 (: 501) with a red-brown, viscid cap and placed it together with e.g. *B. badius* in *Boletus* sect. *Viscipelles*. The specimens determined as *B. tumidus* by Imler (1954, 1986, as *Xerocomus*) do not agree with Fries' taxon, as they had a brownish and dry cap. It is rather improbable that Fries made a mistake in establishing such a striking character as a viscid cap. The convincing reasoning of Kallenbach (1942: 155) shows that *B. tumidus* Fr. is merely a variant of *B. badius*.

The description and plate of Imler's *B. tumidus* agree with *B. moravicus* described by Vaček (1946). Observations of the present author on the collections of Imler and Vaček cited above confirmed their conspecificity. Therefore *B. moravicus* is the correct name for Imler's specimens.

15. **Boletus pulverulentus** Opat. in Wiegm.

Boletus pulverulentus Opat. in Wiegm. *in* Arch. Naturgesch. Meckl. 2: 27. 1836.

Cap drab to brown, with or without red flush, tomentose then smooth, strongly bruising blue to almost black on handling. Pores (deep) yellow, bruising blue to dark blue. Stem at apex yellow to yellowish orange with fine red dots, elsewhere brownish with red streaks, on handling dark blue and finally black. Flesh in cap (pale) yellow, in stem deep yellow sometimes with red patches, in base red, immediately and strongly turning blue to dark blue throughout when cut. NH_4OH reaction on cap or flesh not recorded.

Spores (n = 20) 10.0–14.0 × 4.0–6.0 µm, smooth with SEM. Pileipellis not yet examined.

Collections examined.—NETHERLANDS: Valburg, Oosterhout, 26 Sept. 1971, *Schreurs 346*; Bunde, Bunderbos, 21 Sept. 1979, *Schreurs 343*.

As the present author does not regard the structure of the hymenophoral trama as a distinguishing character, it seems logical to include *B. pulverulentus* in the *Xerocomus*-group of *Boletus* because of the xerocomoid features of its fruit-bodies. This view is supported by the fact that other taxa with xerocomoid features are arranged together with *B. pulverulentus* in one section by both Singer and Watling. Singer (1986: 777) has placed *B. pulverulentus* together with e.g. *B. rubellus* and *B. fraternus* in genus *Boletus* sect. *Subpruinosi*. Watling (1970: 99) has placed it together with *B. pruinatus* and *B. versicolor* in *Boletus* subgenus *Xerocomus* sect. *Subpruinosi*.

16. **Boletus ichnusanus** (Alessio, Galli & Litt.) Oolbekkink, *comb. nov.*

Xerocomus ichnusanus Alessio, Galli & Litt. in Alessio *in* Boll. Gruppo micol. G. Bresadola, Trento 27: 170. 1984 (basionym).

Macroscopic and microscopic description after Alessio (1984: 170; 1985: 596):

Cap reddish brown (chestnut-coloured) to brown tinged with reddish pink, becoming darker with age, dry, finely tomentose, smooth with age. Pores golden yellow, becoming reddish

brown (rust-coloured), bruising green-blue. Stem at upper part bright yellow to golden yellow, at lower part brownish red, covered over two-third from apex downwards by a brownish red to brown net; base brown, usually prolonged into soil by root-like strand of mycelium. Flesh yellowish white with pink spots in lower part of stem, turning blue. Spore print brown. NH_4OH reaction on cap or flesh not recorded.

Spores 12–18(–23) × 5–7(–7.5) µm. Pileipellis not examined.

Habitat.—With broad-leaved trees and shrubs (*Quercus* and *Cistus*) in the Mediterranean (possibly restricted to Sardinia), usually growing in groups or tufts.

Collection examined.—ITALY: Sardinia, Arzachena, 23 Oct. 1987, *Kuyper*.

3.4. THE INSUFFICIENTLY KNOWN TAXON BOLETUS FRAGILIPES

Boletus fragilipes C. Martin *in* Bull. Soc. bot. Genève 7: 189. 1894. — *Boletus subtomentosus* subsp. *fragilipes* (C. Martin) C. Martin *in* Matér. Fl. cryptog. suisse 2: Pl. 18. 1903. — *Boletellus fragilipes* (C. Martin) Kuthan *in* Přír. Sb. Ostr. Muz. Ostrava 26: 162. 1982.

Macroscopic description after Martin (1894: 189; 1903: Pl. 18): Cap olivaceous brown mixed with purple and green, subtomentose. Pores yellow stained with red. Tubes brownish yellow. Stem thickened at base, narrow at apex with tendency to break there, at upper part with dark red to purple stripes, at lower part yellow with brown and red-brown. Flesh in cap pale yellow, purplish stained with yellow or green in upper part of stem, golden yellow in lower part, turning blue in cap. NH_4OH reaction on cap of flesh not recorded.

In the three collections received under this name there was hardly any difference in spore size, but there were large differences in pileipellis-structure. Spores (n = 30) 12.5–18.0 × 4.0–6.0 µm, Q = 2.2–3.6; with great difficulty a fine striation is visible with a light microscope at highest magnification in a number of spores mounted in Congo red or Cotton blue. According to Pouzar (1981) this character is typical for this taxon. Each collection has its own pileipellis-type: (i) a pileipellis as in *B. chrysenteron* type I was found in a collection from the Netherlands: Apeldoorn, 't Loo, 8 Oct. 1960, *Bas 2268;* (ii) a pileipellis as in *B. chrysenteron* type II was found in a collection from Czechoslovakia: Klačianská Magura, Slovakia, Malá Fatra, 18 Oct. 1984, *Pouzar*; (iii) a pileipellis as in *B. pruinatus* was found in a collection from Czechoslovakia: Bohemia, Karlovy Vary, 11 Nov. 1984, *Valter* (but determined by Pouzar).

Boletus fragilipes is a taxon created by Martin in 1894, later regarded as a subspecies of *B. subtomentosus* in his publication of 1903. Pouzar (1981) came across this forgotten taxon and reinstated it, because he thought its description and plate fitted a taxon with striate spores, considered different from *B. chrysenteron* (see paper of Hübsch, 1982). Attributing a striking but (sub)microscopical character (striate spores) to an old taxon of which no authentic material is available and thereby giving it a new status, is rather risky, as is shown by the discovery of such ornamented spores in all taxa examined of the *B. chrysenteron*-complex.

In recent publications (e.g. Dermek, 1987: 20) the striation of spores is considered the fundamental character of *B. fragilipes*, but the characters given by Martin are ignored. *Boletus fragilipes* sensu Pouzar, or *Boletellus fragilipes* sensu Kuthan (1982: 162), who transferred it on account of its striate spores, have become a mixture of taxa from the *B. chrysenteron*-complex which explains why collections with different characters are found under the name *B. fragilipes*.

For that reason the macroscopic description by Martin is reproduced above. The taxon of Martin is, however, insufficiently known and thus *B. fragilipes* is considered a nomen dubium.

3.5. DESCRIPTION OF PHYLLOPORUS RHODOXANTHUS

Phylloporus rhodoxanthus (Schwein.) Bres., Fungi Trid. 2: 95. 1900.

Cap reddish brown to brown often with olivaceous flush, tomentose then smoother, sometimes with slightly cracking surface. Gills distant, decurrent, golden yellow, often weakly to strongly anastomosing, reddish brown on bruising. Stem reddish brown granular, dotted or streaked on a yellow to golden yellow ground-colour. Flesh yellowish white in cap but flushed reddish brown under pileipellis, brownish red in stem. NH_4OH reaction on cap or flesh not recorded.

Spores (n = 30) 11.0–13.5 × 3.5–5.0 µm, fibrillose, floccose or pitted-and-floccose with SEM. Pileipellis not yet examined.

Collections examined.—NETHERLANDS: Baarn, 1 Aug. 1953, *de Vries;* Apeldoorn, 't Loo, 18 Sept. 1971, *de Kleuver-Schreuters*; Stokkem, 28 Aug. 1980, *Schreurs 464*.

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STUDIES IN COPRINUS–II
Subsection Setulosi of section Pseudocoprinus

C.B. ULJÉ* and C. BAS**

A key is given to the Netherlands' species of subsect. *Setulosi* J. Lange of *Coprinus* sect. *Pseudocoprinus* (Kühn.) P.D. Orton & Watling. Some additional species are also included. All species dealt with are concisely described and fully discussed. A few probably new species are described ad interim. Type-material has been examined of *C. bisporiger*, *C. eurysporus*, *C. fallax*, *C. subpurpureus*, and *C. subimpatiens*.

This paper is the result of our observations on *Coprinus* subsect. *Setulosi* J. Lange (1915) and is a continuation of an earlier paper (Uljé & Bas, 1988), in which subsections *Auricomi* Sing. and *Glabri* J. Lange have been treated. In some species, which in our opinion are typical members of *Setulosi*, cylindrical elements of a universal veil are present on the pileus. As sect. *Pseudocoprinus* (Kühn.) P.D. Orton & Watl. (1979) and subsect. *Setulosi* J. Lange per definition have no species with such veil elements, the diagnoses of this section and subsection have consequently been modified.

As subsect. *Setulosi* perhaps is the most frequently treated and therefore the best known group of the genus *Coprinus*, our study of it has not been very searching. For the sake of completeness, we give a key and a survey of the species of subsect. *Setulosi* found so far in the Netherlands and some species yet to be found. More thorough studies on other less well-known groups of *Coprinus* are in preparation.

The key to the species is given because in recent times a few new species have been described. Some probably undescribed species are included also; these are not yet validly named because the available material and data on these taxa are still insufficient.

It is hoped that others will be inspired by this paper to search for material of critical and possibly undescribed species of subsect. *Setulosi*. Material that cannot be named with the present key would be gratefully received for analysis and identification by the first author. Comments on this paper are welcome.

PRESENTATION

In the descriptions is referred to the colour codes of Munsell (1975) and Kornerup & Wanscher (1978), respectively indicated as Mu. and K. & W. Other abbreviations used are:

* Van Dijkstraat 21, 2405 XE Alphen a/d Rijn, Netherlands.
** Rijksherbarium / Hortus Botanicus, Leiden, Netherlands.

av. – average
B – breadth of the spores in front view
bas. – basidia
c. – circa
cau. – caulocystidia
ch. – cheilocystidia
diam. – diameter
L (relating to the lamellae) – number of lamellae reaching stipe
L (relating to spores) – length
l – number of short lamellae (not reaching the stipe)
l. c. – loco citato
pi. – pileocystidia
pl. – pleurocystidia
pp. – pileipellis
Q – length divided by breadth (not width!)
scl. – sclerocystidia
sp. – spores
sph. – spherocysts
ve. – veil
W – width of the spores in side view

The terminology applied in this paper is in accordance with the glossary in Flora agaricina neerlandica, vol. 1 (Bas & al., 1988).

Unless indicated otherwise, the collections examined are to be found in the Rijksherbarium Leiden. When no collection-number is given the collection is not preserved.

A notation like [80, 4, 2] means: 80 spores from 4 specimens from 2 collections were measured. Spore measurements are based on samples of 20 spores.

The sizes of the spores as given in the key and the descriptions relate to L × B or L × B × W. Although in literature on agarics Q generally relates to the length and the width of the spores in side view (L : W), *in this publication Q relates to the length and the breadth of the spores in front view* (L : B). The reason for this is that in *Coprinus* the breadth of the spores varies much stronger than the width, because many species have spores that are to some degree dorsiventrally flattened. This makes a Q value relating length to breadth a taxonomically very useful character.

The term cheilocystidium refers to all cystidioid sterile elements on the lamella edge. In this publication, however, the pileocystidia that in subsect. *Setulosi* sometimes continue to occur over a short distance on the lamella edge from the pileus margin inwards are excluded from the description of the cheilocystidia (see the discussion on microscopic characters).

As in subsect. *Setulosi* caulocystidia are always present and usually very similar to the pileocystidia, they are not separately mentioned, unless this pattern is broken.

Sclerocystidia also are not described, but simply their presence or absence is recorded. They too are very similar to the pileocystidia but (partly) thick-walled and somewhat more slender.

The enlargements of the drawings are × 2000 for the spores, × 800 for the other microscopical characters, and × 1 for the basidiocarps, unless otherwise indicated.

Synonyms are in general given only when generally accepted. For practical reasons we have refrained from studying other synonyms and their types.

MATERIAL AND METHODS

As much as possible, fresh material was examined. When several fresh collections were available at the same time, first the macroscopical characters were described and then the material was quickly dried; the microscopical characters were studied later. When cylindrical veil elements are present on the pileus, these have to be studied in fresh condition, as in dried material this type of veil is hard to find.

Cylindrical veil elements, spherocysts and sclerocystidia were studied in scalps; pleuro-, cheilo-, and pileocystidia in sections of lamellae or, in very small specimens, on a flattened lamella (inclusive of an attached narrow sector of the pileus). Spores as well as sclerocystidia and spherocysts from fresh material were observed in water. Scalps from exsiccata, on which spherocysts and sclerocystidia were observed, were reinflated in KOH. Before microscopical examination, the other preparations were stained in Congo red. After about a quarter of an hour, the Congo red was sucked away with filter-paper from one side of the cover-glass, while at the other side a 5% solution KOH was added. This method has been used in all collections, fresh or dried.

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Coprinus section **Pseudocoprinus** (Kühn.) P.D. Orton & Watl.

Pseudocoprinus Kühn. *in* Botaniste: 155. 1928. — *Coprinus* sect. *Pseudocoprinus* (Kühn.) P.D. Orton & Watl. *in* Br. Fung. Fl.: 9. 1979.

Very small to medium-sized species; expanded pileus 1 to c. 40 mm in diam., in extreme cases up to 80 mm. Flesh thin, thickness less than 2(–3) mm in centre of pileus. Pileus with setulae and/or setae or glabrous. Lamellae narrow, less than 5 mm wide, free to narrowly adnate. Stipe with setulae or glabrous, hollow, base slightly bulbous or clavate. Pileipellis made up of (sub)globose, ellipsoid or clavate cells with or without pedicels. Pileocystidia present or absent. Besides normal (thin-walled) pileocystidia sometimes sclerocystidia (thick-walled) and/or velar spherocysts or, rarely, velar hyphae present (the last two elements never at the same time). Pleuro- and cheilocystidia present or absent. Spores with central or eccentric germ pore.

Coprinus subsection **Setulosi** J. Lange

Coprinus subsect. *Setulosi* J. Lange *in* Dansk bot. Ark. 2 (3): 38. 1915.

Pileus and stem with setulae. Pileipellis consisting of (sub)globose, ellipsoid to clavate cells with or without pedicels. Pileo- and caulocystidia always present, often in combination with sclerocystidia and/or spherocysts; a few species with sparse veil remnants consisting of hyphae on the pileus.

Macroscopical characters

Species in subsect. *Setulosi* are rather small, with pilei when expanded usually less than 30 mm in diam., but in some species rarely slightly larger. The colour of the pileus is brown or yellow-, ochre-, fox-, red- to purple-brown or cinnamon and is, as normally in ink-caps, very variable. For most species the colour of the pileus is not a very useful character, but it is true that the one species is in general darker or has more red in its colour than the other. *Coprinus pyrrhanthes* Romagn. and *C. dilectus* Fr. sensu Joss. are characterized by a beau-

tiful orange colour, but this bright colour can disappear quickly owing to the weather conditions. Species like *C. plagioporus* Romagn., *C. subpurpureus* A.H. Smith and *C. fallax* M. Lange & A.H. Smith are usually dark purple coloured in young, fresh specimens. Other species, in particular the smaller, membranous ones, can also show purple or pink tinges, especially in moist weather.

At first sight the pilei of species in subsect. *Setulosi* often seem to be smooth. In young, fresh condition, however, they mostly have a velvet appearance, especially at the centre, because of the presence of setulae. Under a hand-lens the setulae or setae are almost always well perceptible at the centre of the pileus. The best way to see them is looking with a hand-lens over the surface of a well-lit pileus against a dark background. When the conditions are moist, very small drops adhere to the setulae; the pilei then look hoary.

The veil deserves special attention. On fresh pilei, veil elements are visible with the naked eye, but they soon disappear. Therefore it is important to look for this character in the field using a hand-lens. Then the spherocysts are visible as small, granular flocks. Remnants of the veil consisting of cylindrical elements are revealed by the presence of small, radial fibrillose flocks. In the literature the last kind of veil is described in only two species, namely *C. heterothrix* Kühn. and *C. velatopruinatus* Bender. The first author of this paper has collected two more unnamed taxa of *'Setulosi'* with such a veil and discovered that it is also present in *C. hiascens* (Fr.: Fr.) Quél.

The lamellae are narrow and thin, just free from the stem or narrowly adnate. The breadth of the lamellae is 0.5–3 mm, with a length/breadth ratio usually more than 5. Sometimes, especially in species with spherocysts (which species generally have more or less rounded pilei when still closed), the lamellae are somewhat broader with regard to the length. In these cases they are always adnate, sometimes up to half the width of the lamellae. The number of lamellae reaching the stipe may vary between 8 and 38. The number of short lamellae is 0–3, seldom 5. The colour of the lamellae is white in very young stages, becomes then grey with or without a slight brownish tinge and turns finally to a dark grey to blackish. In species with lageniform cheilocystidia the edge of the lamellae is weakly dentate to even and concolorous with the rest of the lamellae. In species with globose to vesiculose cheilocystidia the edge usually is white and subflocculose.

The stipe is white to greyish white, somewhat watery brown towards the base. Under a hand-lens caulocystidia are nearly always visible. In fresh specimens with the stipe densely covered with setulae (caulocystidia), the colour is pure white. Very small carpophores have a vitreous stipe and the setulae not so crowded. The stem is equally thick or, in most cases, slightly tapering towards the apex. The base of the stipe is weakly bulbous or clavate. The stipe is usually 0.5–3 mm wide and at the base up to 5 mm. The combination of setulae on the stipe and a relatively thin stipe makes it possible to recognize members of subsect. *Setulosi* in the field immediately. Other species of *Coprinus* with setulae on the stipe have a distinctly thicker stipe (5–10 mm).

Species belonging to subsect. *Setulosi* grow on pure dung, mixtures of straw and dung, decaying hay or straw, vegetable refuse, humus, wood, woody fragments mixed with soil, naked soil (preferably clay), lawns or at other grassy places. Paths covered with wood-chips form an ideal habitat for many species.

Microscopical characters

The pileipellis consists of more or less globose, spheropedunculate or clavate, 10–25 µm wide cells intermixed with setulae (pileocystidia), which are always present, and is sometimes covered by globose, thin- or thick-walled, hyaline to brown velar cells (spherocysts) or still more rarely by cylindrical velar hyphae. Velar hyphae, if present on the pileus, are straight or curved, thin-walled, sometimes slightly thick-walled at centre of pileus and somewhat diverticulate with–mostly–widened, clavate terminal cells; in most cases the walls of these cells are encrusted, but not or only partly coloured.

Sclerocystidia are found in many species. They look like the pileocystidia, but are thick-walled and more slenderly ventricose with thin necks, have usually rather long pedicels and brown walls. Pileocystidia may be slightly coloured and thick-walled, especially at their bases.

Pileocystidia are present on the whole surface of the pileus, but on the margin they are particularly dense. They usually occur also on the lamella edge over a short distance from the cap margin towards the stipe. Therefore, in species which have truly lageniform cheilocystidia (thus looking like the pileocystidia), these have to be searched for on the half of the lamella nearest to the stipe. *Coprinus disseminatus* for example, does not have cheilocystidia in the proper sense of the word, but a few pileocystidia continue to occur on the edge of the lamellae, sometimes even up to half-way. Most authors consider these, in our opinion 'escaped' pileocystidia, as being cheilocystidia and include them as such in their keys (M. Lange, 1952; Kühner & Romagnesi, 1953; M. Lange & A.H. Smith, 1953; Moser, 1978; Orton & Watling, 1979).

All species have caulocystidia which are similar to the pileocystidia, but in general a little larger and broader. In a few cases the shape is somewhat aberrant.

Except *C. disseminatus* all species of the *'Setulosi'* group have true cheilocystidia. Some species have lageniform cheilocystidia; others cheilocystidia which are more or less globose, ellipsoid or vesiculose. A few species have a mixture of these two types of cystidia.

Pleurocystidia are present only in some of the species. If present, they are (sub)globose, ellipsoid, ovoid, vesiculose, or broadly cylindrical. *Coprinus eurysporus* M. Lange & A.H. Smith is the only species, which, according to the original description, has lageniform pleurocystidia. We were unable to detect such pleurocystidia in the type-material; in fact we did not find any pleurocystidia at all.

Clamp-connections may be present or not and their presence is not always easy to detect. Sometimes they seem to be present, but they may be the short side-branches of hyphae near the septa. These short branches sometimes strongly suggest clamp-connections indeed and have usually been named pseudoclamps.

The spores of most species are ellipsoid or ovoid in front view. Only *C. marculentus* Britz., *C. angulatus* Peck, *C. verrucispermus* Joss. & Enderle, and *C. silvaticus* Peck have differently shaped spores. In *C. disseminatus* (Pers.: Fr.) S.F. Gray and *C. hiascens* (Fr.: Fr.) Quél. the spores taper somewhat towards their base into the hilar appendage. The other species have spores with a more rounded base with an abrupt hilar appendage. Ellipsoid and–in particular–ovoid spores can sometimes have a slight apical papilla.

In most species, the germ pore is eccentric, but in some it is central. The degree of eccentricity differs not only between species, but also in different collections of the same species. In species that usually have spores with a slightly eccentric germ pore, it may also be almost central, thus leading to mistakes. The diameter of the germ pore varies between 1.3 and 2.5 µm.

Most of the species have spores which are 10–13 µm long, but some species lie outside this range. In side view the spores are usually slightly narrower than in front view (B–W= 0–1 µm), and in some species up to 2.5 µm as in *C. angulatus*. A warty surface is found in the spores of *C. verrucispermus* and in *C. silvaticus* but all other species have smooth spores. Under the microscope the ripe spores are dark red-brown to almost black. The larger the spores are, the darker their colour.

Basidia may be four- or two-spored. In *C. singularis* Uljé, which has predominantly two-spored basidia, some of the basidia are one-spored in all collections studied. Except in *C. silvaticus*, where the basidia have a length of up to 60 µm, the basidia are never longer than 40 µm. The number of pseudoparaphyses (sterile cells around the basidia) is usually between 3 and 5 or 4 and 6 per basidium, but 7 may be found. These cells are more or less globose and 10–25 µm wide.

KEY TO THE SUBSECTIONS OF COPRINUS SECT. PSEUDOCOPRINUS

1. Stipe and pileus with setulae ..... subsect. *Setulosi*
1. Stipe glabrous; pileus glabrous or with scattered, microscopical, long, brown hairs (see Uljé & Bas, 1988) ..... subsect. *Glabri* and *Auricomi*

KEY TO THE SPECIES OF SUBSECT. SETULOSI[1]

1. Spores smooth.
   2. Basidia 4-spored.
      3. Spores ellipsoid, ovoid or oblong.
         4. Pileocystidia with distinctly tapering neck.
            5. No velar spherocysts on pileipellis.
               6. Germ pore eccentric (sometimes only slightly).
                  7. With pleurocystidia.
                     8. On dung.
                        9. Clamps-connections absent ..... 24. *C. congregatus*
                        9. Clamps-connections present ..... 25. *C. ephemerus*
                     8. Not on dung.
                        10. Av. Q of spores c. 1.25 ..... 23. *C. eurysporus*
                        10. Av. Q of spores c. 1.60 ..... 16. *(Uljé 877)*
                  7. Without pleurocystidia.
                     11. Cheilocystidia predominantly globose, subglobose, ellipsoid, broadly ellipsoid, ovoid or obovoid.
                        12. On dung. Pileus < 8 mm in diameter ..... 28. *C. heterosetulosus*
                        12. Not on dung. Pileus larger.
                           13. Pileocystidia > 100 µm. Sclerocystidia present .. 14. *C. callinus* (compare also 13. *C. sclerocystidiosus*)
                           13. Pileocystidia < 100 µm. Sclerocystidia absent ... 15. *(Uljé 1009)*
                     11. Cheilocystidia predominantly lageniform.
                        14. Av. Q of spores c. 1.25 ..... 23. *C. eurysporus*
                        14. Av. Q of spores c. 1.60 ..... 22. *C. impatiens*

6. Germ pore central.
15. On dung and decaying straw. Base of spores rounded.
16. With pleurocystidia. Breadth of spores 5–6 µm. Pileus c. 20 mm
26. *C. stellatus*
16. Without pleurocystidia. Breadth of spores 4–5 µm. Pileus < 8 mm
27. *C. pellucidus*
15. Not on dung. Base of spores rounded or obconical.
17. With cylindrical elements of veil on pileus. Base of spores obconical
7. *C. hiascens*
17. Without cylindrical elements of veil on pileus. Base of spores rounded
22. *C. impatiens*
5. With velar spherocysts on pileipellis.
18. On dung. Pileus brown, < 10 mm . . . . . 3. *C. heptemerus*
18. Not on dung. Pileus orange, somewhat larger.
19. Cheilocystidia in general ellipsoid to globose . . . . . 5. *C. pyrrhanthes*
19. Cheilocystidia in general lageniform . . . . . 4. *C. dilectus*
4. Pileocystidia (sub)cylindrical, with apex more or less thickened or not, but not tapering.
20. Av. length of spores 10–12 µm.
21. No velar spherocysts on pileipellis. Not on dung.
22. No cylindrical veil on pileus.
23. Cheilocystidia globose
17. *C. plagioporus* (compare 18. *C. subpurpureus* and 19. *C. fallax*).
23. Cheilocystidia at least partly lageniform.
24. Cheilocystidia mixed, ellipsoid to globose and lageniform. Av. Q of spores < 1.80. . . . . 12. *C. subimpatiens*
24. Cheilocystidia lageniform. Av. Q of spores > 1.80
20. *C. subdisseminatus*
22. Cylindrical veil present on pileus.
25. Spores < 6 µm broad. Cheilocystidia lageniform.
26. Av. Q of spores c. 1.70 . . . . . 8. *C. heterothrix*
26. Av. Q of spores c. 2.00 . . . . . 10. *(Uljé 952)*
25. Spores > 6 µm broad. Cheilocystidia ellipsoid to globose
11. *C. velatopruinatus*
21. Velar spherocysts present on pileipellis. On dung . . . . . 2. *C. curtus*
20. Av. length of spores < 10 µm or > 12 µm.
27. Av. length of spores more than 12 µm.
28. Cheilocystidia globose or ellipsoid.
29. Pileus brown. Sclerocystidia numerous
13. *C. sclerocystidiosus* (compare 14. *C. callinus*)
29. Pileus with purple tinges. Sclerocystidia rare
18. *C. subpurpureus* (compare 17. *C. plagioporus* and 19. *C. fallax*)
28. Cheilocystidia lageniform . . . . . 21. *(den Held Jager 1276)*
27. Av. length of spores less than 10 µm.
30. With spherocysts on pileipellis. Pileocystidia up to 200 µm long. Base of spores obconical. Germ pore entral . . . . . 6. *C. disseminatus*
30. Without spherocysts on pileus. Cylindrical elements of veil present. Pileocystidia < 120 µm.
31. Germ pore eccentric. Cheilocystidia lageniform . . . . . 8. *C. heterothrix*
31. Germ pore central. Cheilocystidia ellipsoid to globose . . . . 9. *(Uljé 926)*
3. Spores mitriform or angular, not ellipsoid, ovoid or oblong.
32. Spores mitriform . . . . . 29. *C. angulatus*
32. Spores hexagonal (more or less 6-angled) in front view . . . . . 1. *C. marculentus*
2. Basidia 2-spored.
33. Cheilocystidia globose, subglobose, ellipsoid, broadly ellipsoid, ovoid or obovoid.

34. No sclerocystidia. No clamps-connections. Pleurocystidia absent or present.
35. Pleurocystidia absent. On dung or decaying straw ..... 31. *C. bisporus*
35. Pleurocystidia usually present. On sticks, not on dung ..... 30. *C. bisporiger*
34. Sclerocystidia, pleurocystidia and clamp-connections present. On dung ..... 36. *C. sassii*
33. Cheilocystidia lageniform.
36. Germ pore eccentric. Spores ellipsoid. Av. Q of spores 1.75–1.80 ... 32. *C. amphithallus*
36. Germ pore central. Spores broadly cylindrical to ovoid. Av. Q of spores 1.35–1.50 33. *C. singularis*

1. Spores warty.
37. Basidia 4-spored. Cheilocystidia lageniform. Pleurocystidia absent ..... 34. *C. silvaticus*
37. Basidia 2-spored. Cheilocystidia ellipsoid to globose. Pleurocystidia present .. 35. *C. verrucispermus*

1. **Coprinus marculentus** Britz. — Fig. 1

Coprinus marculentus Britz. *in* Bot. Zbl. 15/17: 13. 1893. — *Coprinus hexagonosporus* Joss. (invalid) *in* Rev. Mycol. 13: 82. 1948.

Closed pileus up to 13 × 10 mm, yellow-brown to date-brown, more frequently dark red-brown at centre (Mu. 7.5 YR 3/3 to 6/6, K. & W. 5E7 to 5D8), paler towards margin, up to 25 mm in diameter when expanded. Granular-flocculose veil present on pileus. Lamellae free to narrowly adnate, white in very young stage, blackish at mature. Stipe 40–80 × 1–2 mm, whitish, pubescent.

Spores [60, 3, 3] 9.7–14.3 × 6.3–8.7 × 6.2–7.3 µm, av. L = 10.7–12 µm, av. B = 7.4–7.7 µm, Q = 1.30–1.70, av. Q = 1.45–1.55, hexagonal in front view; germ pore eccentric, c. 1.8 µm wide. Basidia 16–38 × 9–12 µm, 4-spored. Pseudoparaphyses (3–)4–5(–6) per basidium. Cheilocystidia 20–70 × 17–40 µm, ellipsoid to globose. Pleurocystidia 60–90 × 20–35 µm, oblong, ellipsoid to subglobose. Sclerocystidia absent. Velar spherocysts on pileipellis up to c. 40 µm in diam., globose. Pileocystidia 50–100 × 12–20 µm, lageniform with cylindrical, 6–10 µm wide neck and equal to slightly broader, up to 12 µm wide apex. Clamp-connections present.

Habitat. — On dung, mixtures of straw and dung and decaying grass. Subgregarious. Rather rare.

Collections examined. — NETHERLANDS: prov. Zuid-Holland, Alphen a/d Rijn, 3 Oct. 1984, *Uljé 564b*; Hazerswoude, 15 Aug. 1987, *Uljé 864*; Ter Aar, 22 Sept. 1989, *Uljé 1036*.

This species is easy to recognize by its six-angled spores. In the literature, it is usually named *C. hexagonosporus* Josserand. Enderle & al. (1986: 118), however, discovered that *C. marculentus* Britz. is identical with *C. hexagonosporus*. The description of Britzelmayr and in particular his drawings leave no doubt about the synonymy of these two names, of which *C. marculentus* is the oldest and has to be used for this species.

Josserand (1948: 86) also described *C. hexagonosporus* var. *stephanosporus* and Malençon (Malençon & Bertault, 1970: 241) *C. hexagonosporus* var. *homosetulosus*. Enderle & al (l.c.) introduced new combinations for both of these variants. According to Josserand his variety was distinguished by the presence of small warts around the suprahilar plage, pronounced in NH_4OH or HCl. Enderle & al. attached little value to this character and reduced Josserand's variety to forma, *C. marculentus* f. *stephanosporus* (Joss.) Enderle.

Coprinus marculentus var. *homosetulosus* (Malenç.) Enderle would be recognizable by the probable absence of pleurocystidia and lageniform cheilocystidia.

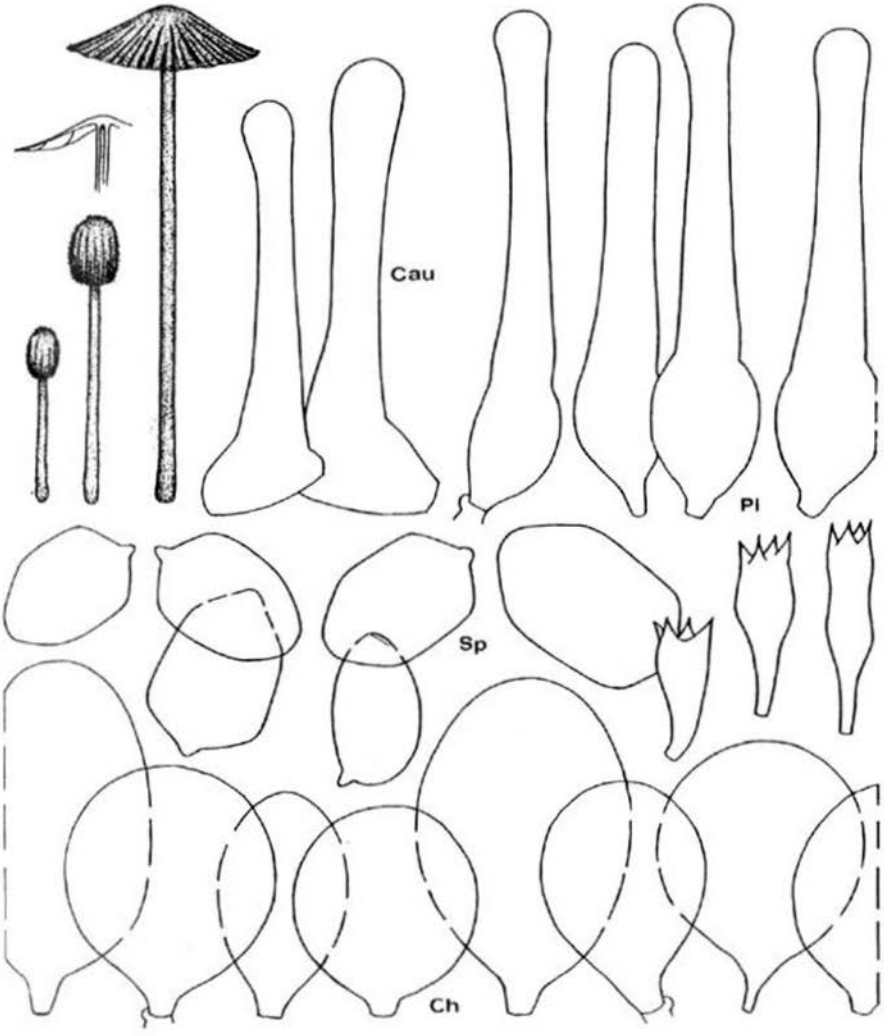

Fig. 1. *Coprinus marculentus* Britz. — All figures from *Uljé 1036*.

2. **Coprinus curtus** Kalchbr.—Fig. 2

Coprinus curtus Kalchbr. *in* Grevillea 9: 133. 1881.

Closed pileus up to 6 × 4 mm, cream coloured, at centre with yellow-brown to ochre-brown granular-flocculose veil; expanded pileus up to 10(–15) mm wide. Lamellae almost free to free, whitish, grey to blackish; L = c. 20, l = 0–1. Stipe 30–60 × 0.5–1 mm, whitish, vitreous, sparsely pubescent from setulae.

Spores [40, 1, 1] 9.7–13.8 × 6.7–8.8 × 5.8–8.2 µm, av. L = 11.0–12.0, av. B = 7.3–8.0 µm, Q = 1.35–1.70, av. Q = 1.50–1.55, ellipsoid to ovoid in front view; germ pore strongly eccentric, c. 2 µm wide. Basidia 11–28 × 8–12 µm, 4-spored. Pseudoparaphyses 5–7 per basidium. Cheilocystidia globose, up to 35 µm in diam. to subglobose, the latter up to 40 × 35 µm. Pleurocystidia absent. Pileocystidia 40–90(–110) × 10–20 µm, lageniform to nettle hair-shaped with cylindrical to slightly tapering, 3–7 µm wide neck and subcapitate to capitate, up to 12(–15) µm wide apex. Sclerocystidia absent. Velar spherocysts on pileipellis up to 40 µm in diam., rather strongly encrusted, often brown. Clamp-connections not seen.

Habitat.—On horse-dung. Subgregarious. Rather rare.

Collection examined.—NETHERLANDS: prov. Zuid-Holland, Hazerswoude, 23 Oct. 1988, *Uljé 997*.

Coprinus curtus is the only species that has both spherocysts and (sub)capitate pileocystidia. Other species with velar spherocysts on the pileus (except *C. marculentus*) have pileocystidia with tapering or cylindrical neck without enlarged apex. *Coprinus marculentus* has differently shaped (hexagonal) spores.

Romagnesi (1941: 126) described *C. curtus* Kalchbr. f. *macrosporus* which has somewhat larger spores (10.7–14.7 × 6.5–8.5 µm). M. Lange & A.H. Smith raised this taxon to the rank of species, naming it *C. heptemerus* (see under that name).

3. **Coprinus heptemerus** M. Lange & A.H. Smith—Fig. 3

Coprinus curtus f. *macrosporus* Romagn. *in* Rev. Myc. 6: 126. 1941. — *Coprinus heptemerus* M. Lange & A.H. Smith *in* Mycologia 45: 751. 1953.

Closed pileus up to 8 × 5 mm, brown, yellow-brown to dark-brown at centre (Mu. 10 YR 3/3 to 6/6, K. & W. 5E7, 5D8), paler towards margin; pileus up to 10 mm in diam. when expanded. Brownish granular-flocculose veil present on pileus. Lamellae free, narrow, rather distant, white to blackish. Stipe 25–50 × 0.5–1 mm, whitish, vitreous, sparsely pubescent from setulae.

Spores [20, 1, 1] 12.7–16.6 × 7.2–8.5 µm, av. L = 14.7, av. B = 7.8 µm, Q = 1.70–2.10, av. Q = 1.90, ellipsoid to oblong in front view; germ pore distinctly eccentric, c. 2.3 µm wide. Basidia 14–38 × 9–11 µm, 4-spored. Pseudoparaphyses not noted. Cheilocystidia 25–55 µm in diam., vesiculose. Pleurocystidia absent. Pileocystidia 50–120 × 8–21 µm, ventricose-lageniform with narrow, tapering neck and 2.5–4 µm wide apex. Sclerocystidia absent. Velar spherocysts on pileipellis 20–35 µm in diam., often with long spine-like projections. Clamp-connections absent.

Habitat.—On dung of different animals. Subgregarious. Rather common.

Collection examined.—NETHERLADS: prov. Zuid-Holland, Alphen a/d Rijn, 19 Sept. 1985, *Uljé 609*.

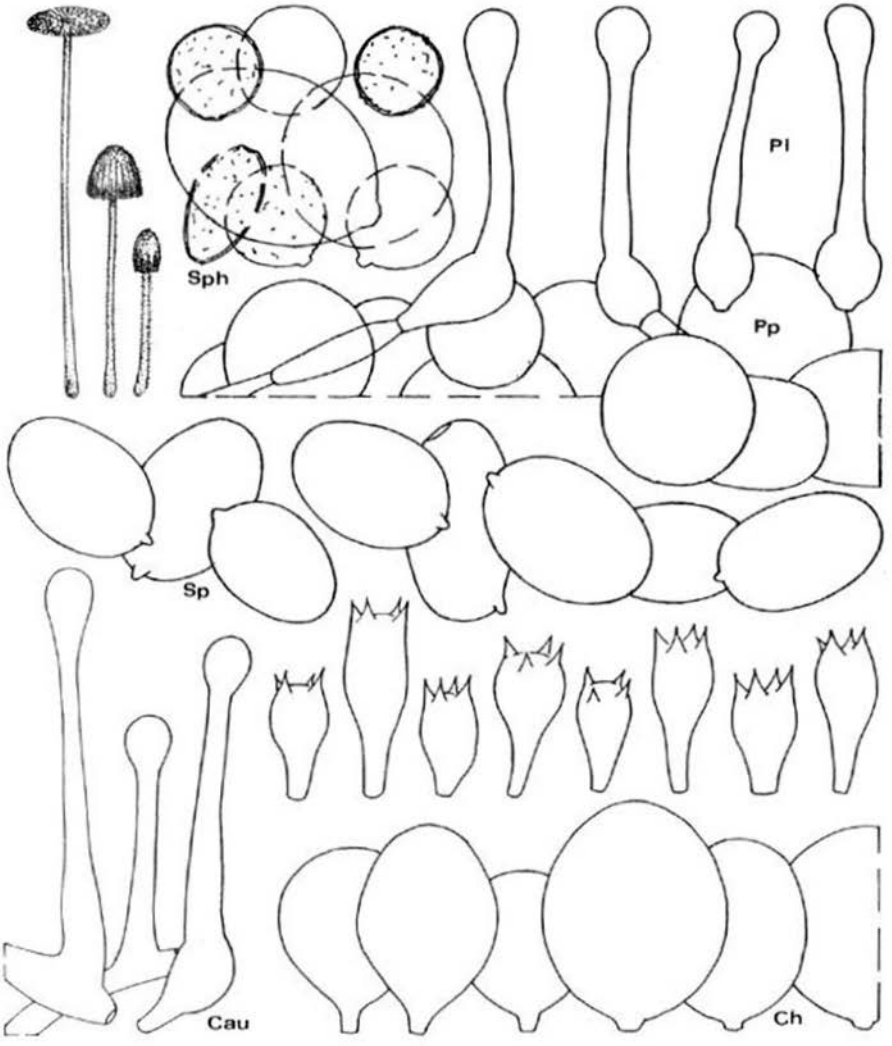

Fig. 2. *Coprinus curtus* Kalchbr. — All figures from *Uljé 997*.

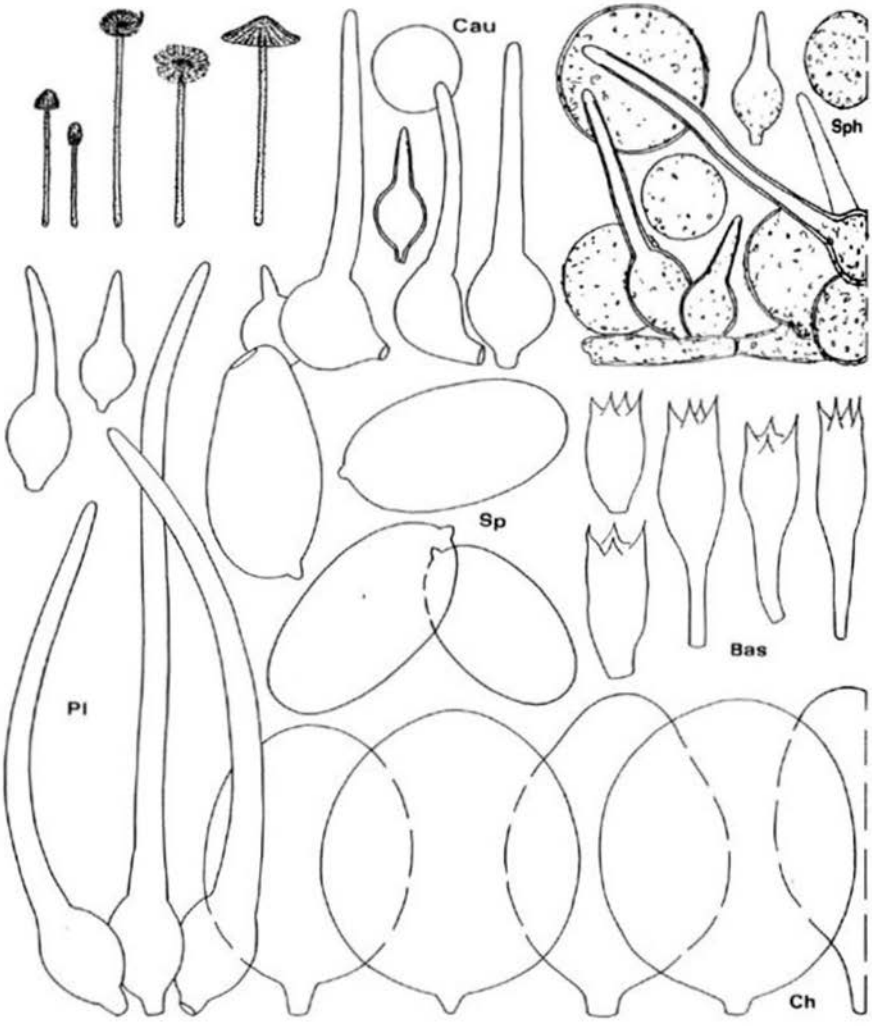

Fig. 3. *Coprinus heptemerus* M. Lange & A.H. Smith. — All figures from *Uljé 609*.

Coprinus heptemerus is recognizable by the combination of spherocysts, tapering pileocystidia, a brown pileus and a preference for dung. The spine-like projections of the velar spherocysts are typical for *C. heptemerus*, which species is based on *C. curtus* f. *macrosporus* Romagn. The description of Romagnesi is, however, not very clear about the important characters of this species. M. Lange & A.H. Smith (1953) checked their material with the authentic culture of *C. curtus* f. *macrosporus* in the C.B.S. at Baarn (Netherlands) and found all details identical.

4. **Coprinus dilectus** Fr. sensu Joss.—Fig. 4

Coprinus dilectus Fr. sensu Joss. *in* Bull. trimest. Soc. myc. Fr. 57: 46. 1941.

Excluded.—*Coprinus dilectus* sensu J. Lange *in* Dansk bot. Ark. 2 (3): 40. 1915 (= *C. erythrocephalus*).

Closed pileus up to 7 × 4 mm, beautifully 'vermillon fauve en naissant', orange-brown, up to 13 mm wide when expanded. Lamellae narrowly adnate, first pale, later grey; L = ?, l = 1-3. Stipe 15–27 × 1–1.5 mm, whitish, pubescent, at base somewhat orange (from spherocysts).

Spores 13.3–14.5 × 6.8–7.2 µm, ellipsoid; germ pore present, very distinct, probably central. Basidia 25–40 × 10–11 µm, 4-spored. Cheilocystidia numerous, lageniform, 50–60 × 18–22 µm, neck 7–9 µm wide. Pleurocystidia not mentioned. Spherocysts on pileipellis

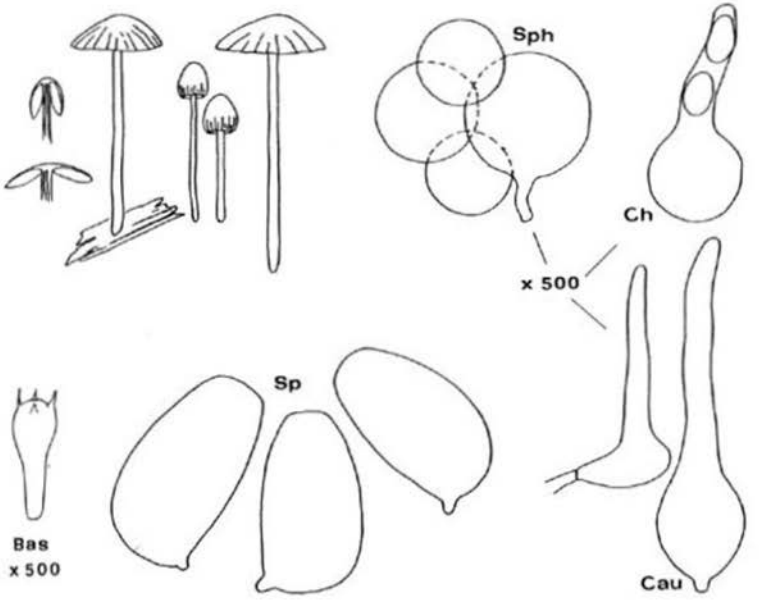

Fig. 4. *Coprinus dilectus* Fr. sensu Joss. — Figures copied from Josserand, in Bull. trimest. Soc. mycol. Fr. 57: 47. 1941).

globose to ovoid, 12–40 µm wide. Pileocystidia not described. Sclerocystidia not noted. Caulocystidia lageniform, 70–90 × 16–20 µm with 8–10 µm wide neck. Velar spherocysts on pileipellis 12–40 µm in diam., globose. Clamp-connections present.

Habitat.—On muddy soil. Not known from the Netherlands. Very rare.

Coprinus dilectus is accepted here in the sense of Josserand. Because of its brief diagnosis *C. dilectus* sensu Fries (1838: 250) may be almost every species of the *'Setulosi'*.

By the combination of the orange colour of the pileus, the presence of spherocysts on the pileipellis and particularly the size of the spores, this species is easy to recognize. In subsect. *Setulosi* only *C. pyrrhanthes* has the same pileus colour, but has much smaller spores (less than 12 µm in length) and vesiculose cheilocystidia. *Coprinus dilectus* seems to be a very rare species. A good collection was not available; therefore Josserand's description is reproduced here. Orton & Watling (1979: 84) described *C. dilectus* from only one location. Krieglsteiner & al. (1982: 82) described this species for the first time from West Germany.

The position of the germ pore is not clear. Josserand (1941) describes it as very distinct but does not show it in his drawings and does not indicate its position. Orton & Watling (l.c.) say: 'germ pore central, sometimes indistinct'. Krieglsteiner & al. (l.c.) found it to be ± eccentric.

Because Josserand does not mention the presence of pileocystidia, it is possible the *C. dilectus* sensu Joss. does not belong to the subsection *Setulosi*, although its other characters indicate that it does.

5. **Coprinus pyrrhanthes** Romagn.—Fig. 5

Coprinus pyrrhanthes Romagn. *in* Rev. Mycol. 16: 128. 1951.

Closed pileus up to 12 × 8 mm, orange-brown, granular-flocculose (from spherocysts), up to 20 mm in diam. when mature. Lamellae narrowly adnate, rather broad, white to blackish; L = c. 16, l = 1–3. Stipe 20–50 × 0.5–1.5 mm, white, pubescent.

Spores [40, 1, 1] 7.1–9.3 × 4.7–6.2 µm, av. L = 8.4, av. B = 5.5, Q = 1.40–1.60, av. Q = 1.50, ovoid to ellipsoid; germ pore eccentric, c. 1.5 µm wide. Basidia 15–32 × 8–10 µm, 4-spored. Pseudoparaphyses (3–)4–6(–7) per basidium. Cheilocystidia 20–40 × 15–30 µm, vesiculose. Pleurocystidia absent. Pileocystidia 40–150 × 14–24 µm, lageniform to nettle hair-shaped with 4–7 µm wide neck. Sclerocystidia absent. Velar spherocysts on pileipellis up to 40 µm in diam., the largest usually hyaline, the smaller ones more yellow-brown and thick-walled. Clamp-connections absent.

Habitat.—Gregarious. The description given here is based on the collection from Germany found on old saw-dust. Very rare.

Collections examined. — NETHERLANDS: prov. Flevoland, Zuid-Flevoland, May 1970, *G.A. de Vries*. — GERMANY: Westfalen, Mönchengladbach, Volksgarten, 15 Aug. 1988, *H. Bender* (*Uljé 1059*).

Macroscopically this species is close to *C. dilectus*, but it differs in microscopical characters (see discussion under *C. dilectus*). The size of the spores is very variable. *Coprinus pyrrhanthes* is a distinct species because of its numerous velar spherocysts, vesiculose cheilocystidia, ovoid spores with eccentric germ pore and its habitat not on dung. The description

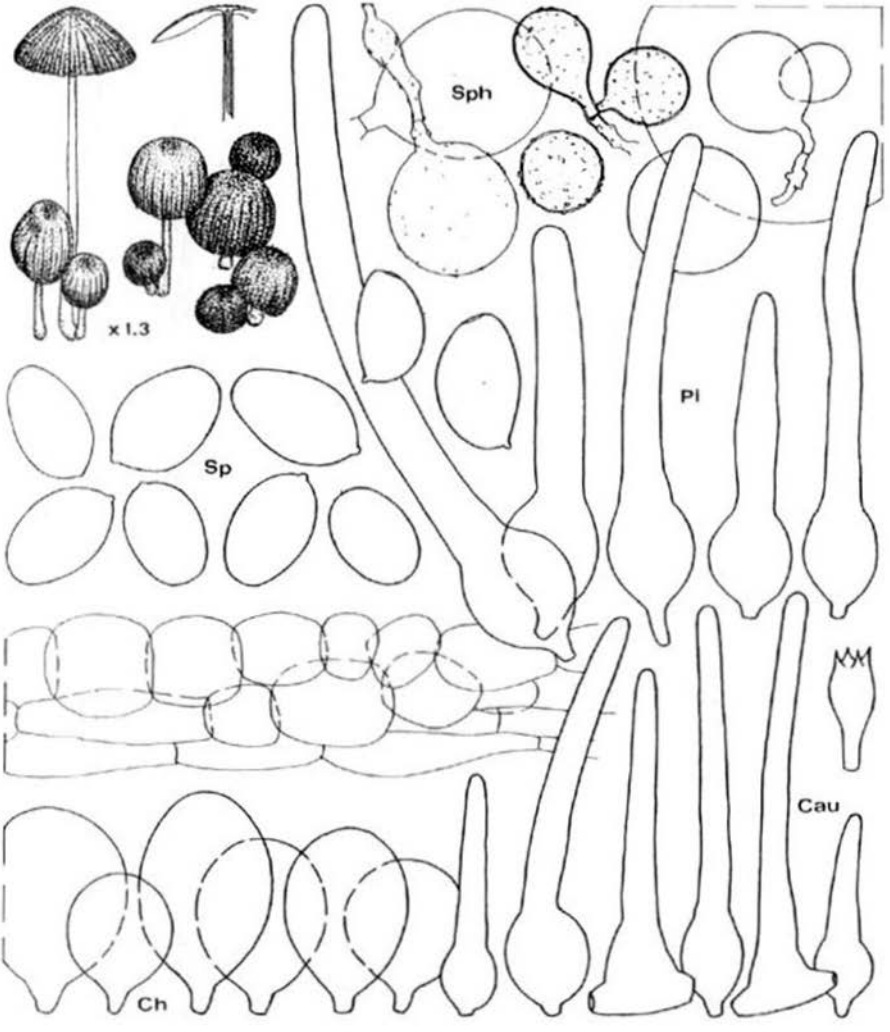

Fig. 5. *Coprinus pyrrhanthes* Romagn. — All figures from *Uljé 1059*.

above is based on the collection of H. Bender from Mönchengladbach. According his information (pers. comm.), he finds *C. pyrrhanthes* almost every year near his home.

The collection from Zuid-Flevoland recorded above represents the only one known from the Netherlands. It has larger spores (9.3–11.8 × 6.3–7.4 × 5.8-6.5 µm), which is closer to the size of the spores given in the original description (10.7–11.5 × 5.2–5.7 µm (L × W)), but we are not quite sure about the identity of this collection. Velar spherocysts are available in great profusion, but we did not find any caulocystidia at all and only a few pileocystidia. Unfortunately, this collection is in a very poor condition. Macroscopically, however, the specimens closely resemble those of the German collection.

6. **Coprinus disseminatus** (Pers.: Fr.) S.F. Gray — Fig. 6

Coprinus disseminatus (Pers.: Fr.) S.F. Gray, Nat. Arr. Brit. Pl. 1: 634. 1821.

Closed pileus up to 8 × 7 mm, usually pale brown, yellow-brown, ochre (Mu. 10 YR 4–6/6, 7/4, K. & W. 5C3–4, 5C/D5, 5D8) at centre, paler towards margin (Mu. 10 YR 6/4 to 8/2), sometimes almost entirely white; expanding pileus up to 15(–20) mm wide. Whitish to brown granular-flocculose veil present on pileus. Lamellae narrowly to rather broadly adnate, c. 3 mm wide, length divided by breadth < 3; L = 16–32, l = 0–3, white to blackish. Stipe 20–40(–60) × 1–1.5 mm, white to greyish-white, often somewhat vitreous, pubescent.

Spores [100, 5, 5] 6.6–9.7 × 4.1–5.8 µm, av. L = 7.7–9.2, av. B = 4.7–5.5 µm, Q = 1.45–1.90, av. Q = 1.55–1.75, ovoid, obconical at base, truncate; germ pore central, c. 1.5 µm wide. Basidia 16–40 × 5–8 µm, 4-spored. Pseudoparaphyses 4–6 per basidium. Cheilocystidia absent (pileocystidia continuing along edge of lamellae over short distance). Pleurocystidia absent. Pileocystidia 50–200 × 15–24 µm, lageniform with cylindrical, 6–15(–17) µm wide neck and rounded apex. Sclerocystidia absent. Velar spherocysts on pileipellis up to 40 µm in diam., usually numerous. Clamp-connections not found (short side-branches of hyphae near septa, resembling clamp-connections, often observed).

Habitat. — On and near wood, gregarious and fasciculate, often in large quantities. Very common.

Collections examined. — NETHERLANDS: prov. Zuid-Holland, Ter Aar, Langeraar, 30 May 1981, *Uljé 168*, 17 May 1985, 20 May 1986, 25 July 1986; Alphen a/d Rijn, 10 Aug. 1987, *Uljé 859*.

Coprinus disseminatus is one of the best known ink-caps. It generally grows with numerous basidiocarps on and around stumps of trees or on soil mixed with wood fragments. The velar spherocysts and typical spore-shape together with the long pileocystidia with cylindrical neck and rounded apex, make this species easily recognizable. Macroscopically, *C. disseminatus* may be mistaken for *Psathyrella pygmaea* (Quél.) Sing., which has a similar habit (fasciculate) and more or less the same appearance. *Coprinus hiascens* too resembles *C. disseminatus* somewhat in habit and in the shape of the spores (see discussion under *C. hiascens*).

Lanconelli & Lanzoni (1988: 236) report the presence of a small number of ellipsoid and fusiform cheilocystidia in one of the four collections of *C. disseminatus* analyzed by them.

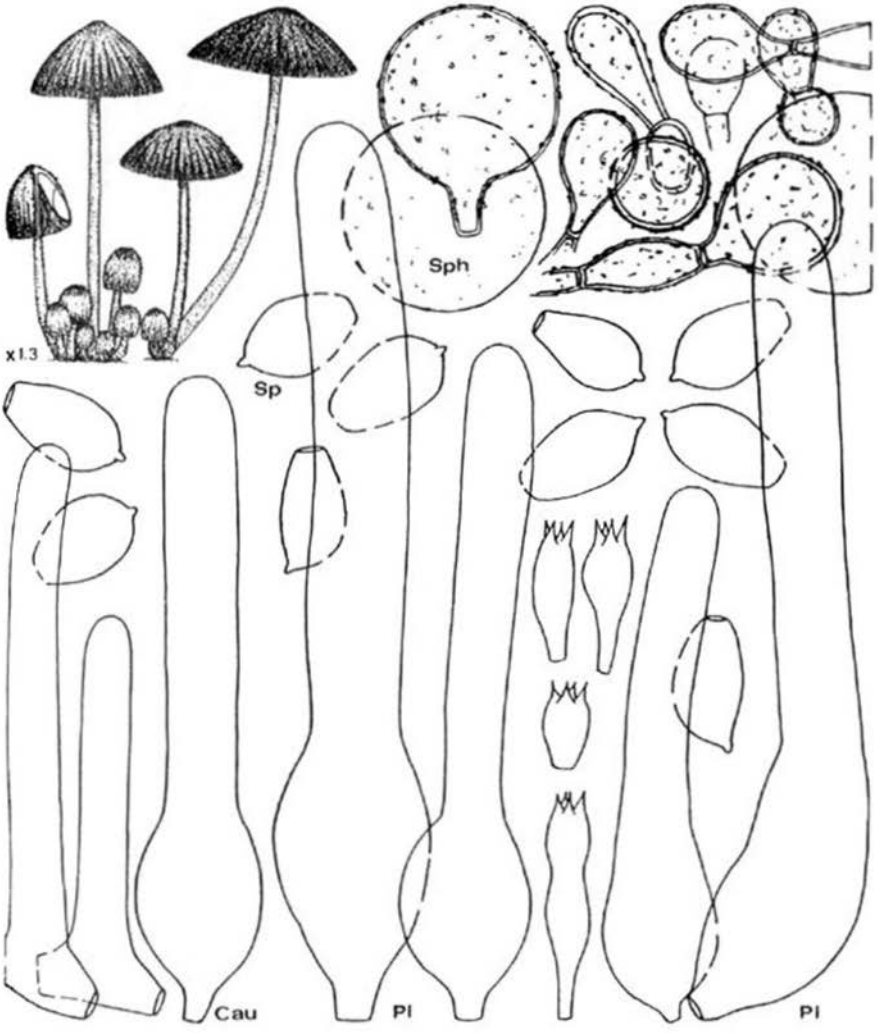

Fig. 6. *Coprinus disseminatus* (Pers.: Fr.) S.F. Gray. — All figures from *Uljé*, 25 July 1986.

7. **Coprinus hiascens** (Fr.: Fr.) Quél.—Fig. 7

Coprinus hiascens (Fr.: Fr.) Quél., Flore mycol. France: 42. 1888.

Closed pileus up to 15 × 12 mm, usually ochre-brown (Mu. 7.5 YR 4/6, 10 YR 3–4/3, 4/4, 4–5/6, K. & W. 6E5, 5D7) at centre, paler (Mu. 10 YR 5/3–6, 6/4, 8/5, 2.5 Y 5/2, K. & W. 5D6, 5C/D3) towards margin, up to c. 40 mm in diam. when expanded, only rarely entirely flattened. Veil present, visible as small, whitish, radially fibrillose flocks. Lamellae narrowly adnate, white to blackish; L = 24–36, l = 1–3. Stipe 40–100 × 1–3(–4) mm, white to greyish-white, pubescent, with slightly clavate, up to 5 mm wide base.

Spores [160, 8, 8] 7.5–11.5 × 4.3–5.9 µm, av. L = 8.8–9.7, av. B = 4.8–5.5 µm, Q = 1.60–2.10, av. Q = 1.70–1.90, ovoid to ellipsoid, obconical at base, truncate; germ pore central, c. 1.8 µm wide. Basidia 14–38 × 7–8 µm, 4-spored. Pseudoparaphyses 3–5 per basidium. Cheilocystidia 30–50(–75) × 10–18 µm, lageniform with 3.5–7 µm wide, tapering neck. Pleurocystidia absent. Pileocystidia slender, 50–200(–250) × 13–24 µm, lageniform, with 4–10 µm wide, tapering neck. Sclerocystidia absent. Veil on pileus consisting of cylindrical or somewhat inflated hyphae, with terminal cells 2–15 µm wide (somewhat wider than in *C. heterothrix*). Clamp-connections present.

Habitat.—On naked soil or grassy places. Gregarious and fasciculate, usually in bundles of more than ten specimens. Rather common.

Collections examined.—NETHERLANDS: prov. Utrecht, Breukelen, Over-Holland, 27 Aug. 1986, *Uljé*; Haarzuilens, 8 Aug. 1987, *Uljé 889*; Breukelen, Sterreschans, 21 June 1988, *Uljé 914*; Linschoten, 6 Aug. 1989, *Uljé 1015, 1016, 1017*; prov. Zuid-Holland, Leiden, 5 Sept. 1985, *Uljé 618*; Leiden, Leidse Hout, 19 Oct. 1985, *Uljé 719*; Ter Aar, de Put, 25 Oct. 1985, *Uljé 681*; Ridderkerk, Huys ten Donck, 9 Aug. 1986, *J. v. Luypen*.

Coprinus hiascens is easily recognizable by the tapering, long pileocystidia in combination with the spore-shape, which is more or less similar to that of *C. disseminatus*, but in that species the spores are slightly smaller and cylindrical veil elements are lacking from the pileus. Moreover, *C. disseminatus* has pileocystidia with a broad, cylindrical, not tapering neck and velar spherocysts on the pileus.

The obconical base of the spores distinguishes this species from other species with cylindrical veil elements on the pileus, which have spores with rounded bases. So far the presence of cylindrical veil has never been mentioned for *C. hiascens*. The basidiocarps and their habit remind of *C. disseminatus*, but those of *C. hiascens* are in general distinctly larger and smaller in number.

8. **Coprinus heterothrix** Kühner—Fig. 8

Coprinus heterothrix Kühner *in* Bull. Soc. Nat. Oyonnax 10–11 (Suppl.): 3. 1957.

Closed pileus up to 10 × 8 mm, first red-brown (Mu. 5 YR 2.5/2, 3/4, K. & W. 6E6), than somewhat more dull brown (Mu. 7.5 YR 4/6 to 5–6/4, K. & W. 6D/E6), finally more greyish brown (Mu. 10 YR 5–6/3–4) to greyish; expanded pileus up to 20 mm wide. Veil present on pileus visible as small, whitish, radial fibrillose flocks. Lamellae narrowly adnate, relative distant, first white, soon dark brown to blackish; L = 9–18, l = 0–3. Stipe 20–50 × 0.5–1.5 mm, at base up to 2 mm wide, whitish, pubescent from setulae.

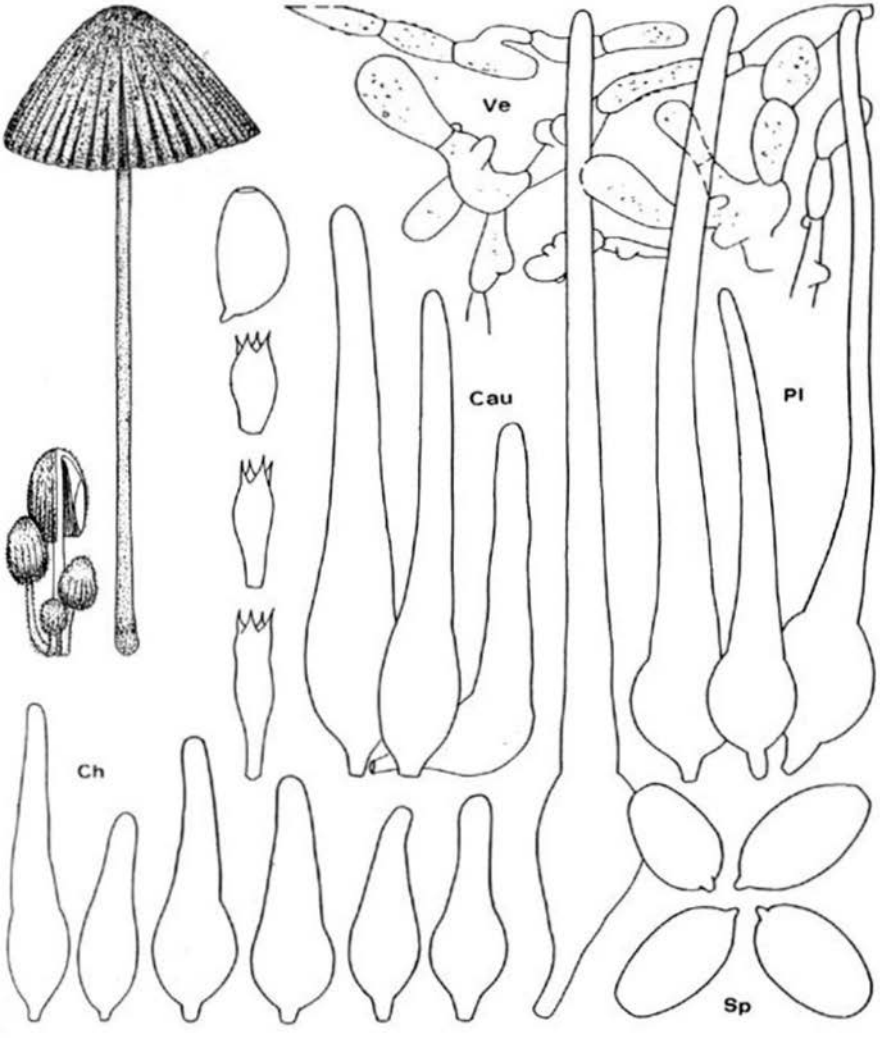

Fig. 7. *Coprinus hiascens* (Fr.: Fr.) Quél. — All figures from *Uljé 1015*.

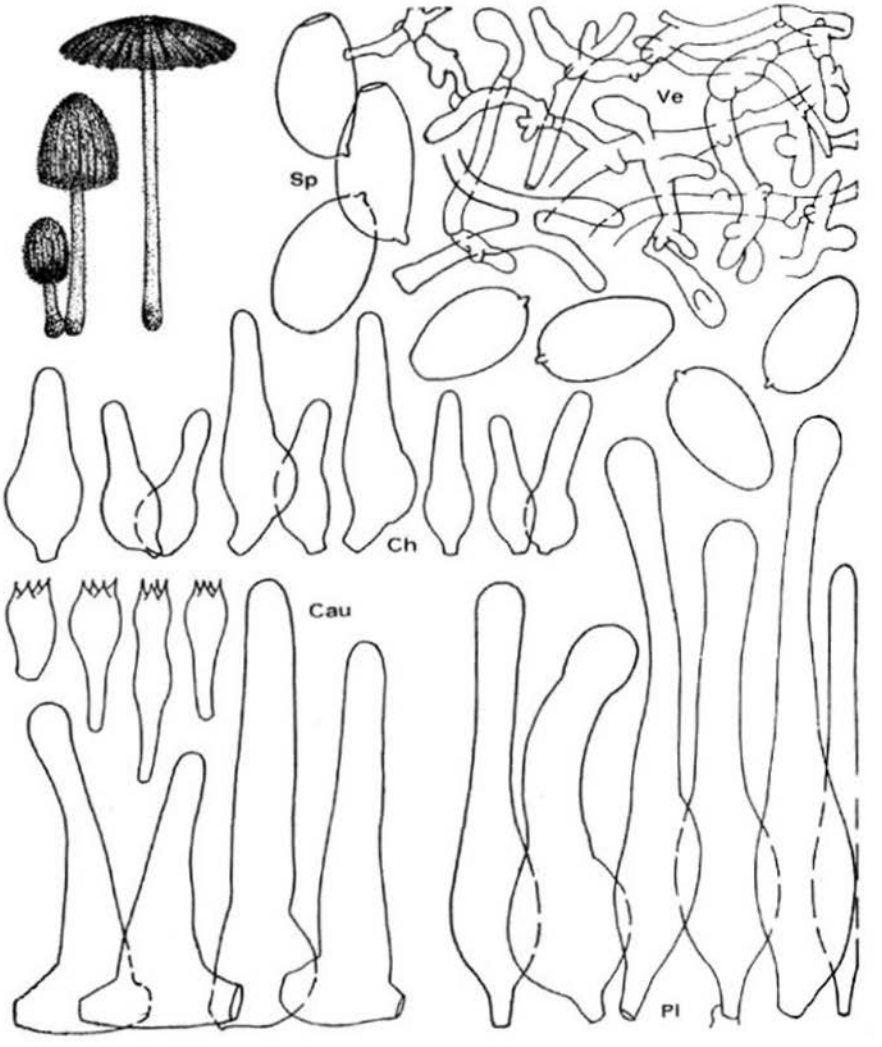

Fig. 8. *Coprinus heterothrix* Kühn. — All figures from *Uljé 1028*.

Spores [180, 9, 9] 8.5–10(–12) × 5–6 µm, av. L = 8.8–9.6, av. B = 5.3–5.6 µm, Q = 1.55–1.80, av. Q = 1.65–1.70, ovoid; germ pore slightly eccentric to almost central, c. 1.5 µm wide. Basidia 16–30 × 6–9 µm, 4-spored. Number of pseudoparaphyses 3–5 per basidium. Cheilocystidia 20–45 × 9–13 µm, lageniform with rather thick, tapering to cylindrical neck and in part somewhat enlarged apex, 3–6 µm wide. Pleurocystidia absent. Pileocystidia lageniform, 50–110 × 11–20 µm, usually with slightly enlarged, subclavate, 6–11 µm wide apex. Sclerocystidia absent. Veil on pileus consisting of cylindrical, somewhat diverticulate, thin-walled, in part slightly thick-walled (< 1 µm, seldom up to 1.5 µm thick) hyphae with often clavate, up to 7 µm thick terminal cells, usually with granular incrustations. Clamp-connections present.

Habitat.—On naked, often mossy soil and on mossy branches. Subgregarious. Rather common.

Collections examined.—NETHERLANDS: prov. Utrecht, Breukelen, Over-Holland, 23 Aug. 1986, *G.J. Keizer*, 3 Oct. 1986, *Uljé*; prov. Zuid-Holland, Leiden, 10 Aug. 1987, *Uljé*; Ter Aar, de Put, 6 Oct. 1986, *Uljé 911*; 15 May 1989, *Uljé 1009*; 18 May 1989, *Uljé 911*; 29 July 1989, *Uljé 1012*; Alphen a/d Rijn, 29 Aug. 1988, *Uljé 965*; 4 Sept. 1989, *Uljé 1028*.

This species can be distinguished from *C. hiascens* and *Coprinus* spec. *Uljé 926* by its spores with a slightly eccentric germ pore. *Coprinus hiascens* has tapering pileocystidia whereas *C. heterotrix* has not and *Uljé 926* posseses vesiculose cheilocystidia, by which character also *C. velatopruinatus* deviates from *C. heterothrix*. *Coprinus* spec. *Uljé 952*, another species with cylindrical velar elements differs in subcylindrical, more slender spores and differently shaped velar elements. The lamellae are rather distant in *C. heterothrix*; this is probably a useful taxonomic character.

9. **Coprinus** species (*Uljé 926*)—Fig. 9

Closed pileus up to 4 × 3 mm, at centre cinnamon, towards margin paler, soon grey, up to c. 7 mm wide when expanded. Veil present on pileus, visible as small, whitish, radial fibrillose flocks. Lamellae narrowly adnate; L = 8–13, l = 0–1. Stipe 8–20 × 0.1–0.5 mm, whitish, vitreous, with widely dispersed setulae.

Spores [40, 2, 1] 7.0–8.5 × 5.1–6.2 µm, av. L = 7.4–8.1, av. B = 5.5–5.7 µm, Q = 1.25–1.60, av. Q = 1.35–1.40, broadly ellipsoid, ellipsoid to ovoid; germ pore central, 1.6 µm wide. Basidia 16–40 × 8–11 µm, 4-spored. Pseudoparaphyses not noted. Cheilocystidia 20–50 × 20–30 µm, vesiculose. Pleurocystidia absent. Pileocystidia 50–100 × 14–22 µm, (broadly) lageniform with 7–12 µm wide, equal to slightly subcapitate apex. Sclerocystidia absent. Veil on pileus of somewhat diverculate 2–8(–10) µm broad hyphae. Clamp-connections present.

Habitat.—On sandy-clayey soil, among or on wood-chips. Solitary or a few together.

Collection examined.—NETHERLANDS: prov. Zuid-Holland, Alphen a/d Rijn, 17 July 1988, *Uljé 926*.

In this species particularly the shape and the size of the spores are characteristic. None of the other species with cylindrical veil elements has spores as small as *Uljé 926*. The central germ pore is the most important difference with other species (except *C. hiascens*) which possess cylindrical veil elements. *Coprinus hiascens*, however, has spores with a conical apex, lageniform cheilocystidia and tapering pileocystidia, whereas *Uljé 926* has spores with

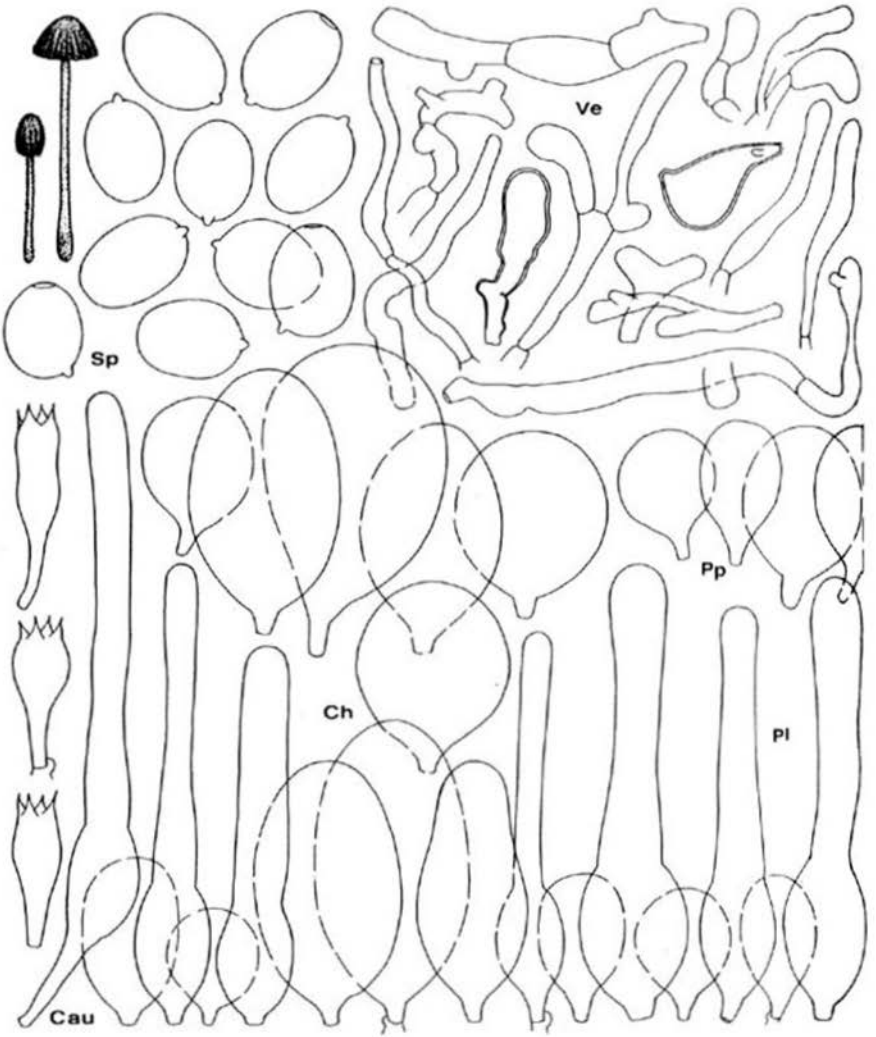

Fig. 9. *Coprinus* species (*Uljé 926*).

a rounded apex, vesiculose cheilocystidia and pileocystidia that are broadened at the apex. Because of the very small size of the fruit-bodies and the greyish colour of the pileus this species is very inconspicuous and difficult to find.

10. **Coprinus** species (*Uljé 952*)—Fig. 10

Closed pileus up to 6 × 4 mm, ochre-brown at centre, somewhat paler towards margin, up to c. 12 mm in diam. when expanded. Veil present, visible as small, whitish, radially fibrillose flocks on pileus. Lamellae narrowly adnate; L ≤ 18, l = 0–1(–3). Stipe 15–30 × 0.5–1 mm, whitish, vitreous, pubescent.

Spores [20, 1, 1] 8.8–11.6 × 5.0–5.7 µm, av. L = 10.4, av. B = 5.3 µm, Q = 1.70–2.15, av. Q = 1.95, subcylindric to narrowly ovoid; germ pore distinctly eccentric, c. 1.6 µm wide. Basidia 17–36 × 7–9 µm, 4-spored. Pseudoparaphyses (3–)4–5(–6) per basidium. Cheilocystidia 30–50 × 8–10 µm, lageniform with 3–5 µm wide neck often slightly enlarged towards (up to 6.5 µm wide) apex. Pleurocystidia absent. Pileocystidia 70–120 × 13–18 µm, broadly lageniform with 7–11 µm wide neck and equal to subclavate, 9–13(–15) µm wide apex. Sclerocystidia absent. Veil consisting of inflated, fusiform, 6–16 µm thick hyphae present on pileus. Clamp-connections present.

Habitat.—On bare, rich river-clay; a few together.

Collection examined.—NETHERLANDS: prov. Utrecht, Linschoten, 13 Aug. 1988, *Uljé 952*.

The single collection of this taxon available consists of only a few fruit-bodies. The veil on the pileus consists of hyphae made up of elongate cells and fusiform to clavate terminal cells. The cells of this veil are larger and broader than in other species of the *Setulosi* with velar hyphae on the pileus. Moreover, this taxon can be distinguished from those species by its slender, (sub)cylindrical spores.

11. **Coprinus velatopruinatus** Bender—Fig. 11

Coprinus velatopruinatus Bender *in* Beitr. Kenntn. Pilze Mitteleur. 5: 80. 1989.

Closed pileus 10 × 20 mm high, cinnamon-brown to ochre, up to 35 mm wide when expanded. Veil present on pileus, visible as small, whitish, radially fibrillose flocks. Lamellae narrowly adnate, crowded, white to blackish. Stipe 35–65 × 1.2–2 mm, whitish, pubescent, somewhat white-felted at base when young.

Spores [20, 1, 1] 11–13.4 × 6.8–7.7 × 6.2–7.1 µm (according to the original description 10.5–12.9 × 6.5–7.5(–8) × 5.8–6.5 µm), av. L = 12.1, av. B = 7.2 µm, Q = 1.55–1.85, av. Q = 1.70, ovoid, in part with slightly apical papilla; germ pore eccentric, c. 1.8 µm wide. Basidia 18–36 × 8–10 µm, 4-spored. Pseudoparaphyses 4–6 per basidium. Cheilocystidia first globose, 15–40 µm broad, later ellipsoid to broadly (sub)cylindrical, up to 70 µm in length. Pleurocystidia absent. Pileocystidia 65–115(–140) × 10–30 µm, lageniform with cylindrical neck and equal to slightly broadened, 5–10 µm wide apex. Sclerocystidia absent. Veil on pileus consisting of 2.5 to 5.5 µm wide, somewhat diverticulate, encrusted hyphae. Clamp-connections present.

Habitat.—Usually gregarious on old saw-dust and small pieces of wood mixed with soil. Not known from the Netherlands.

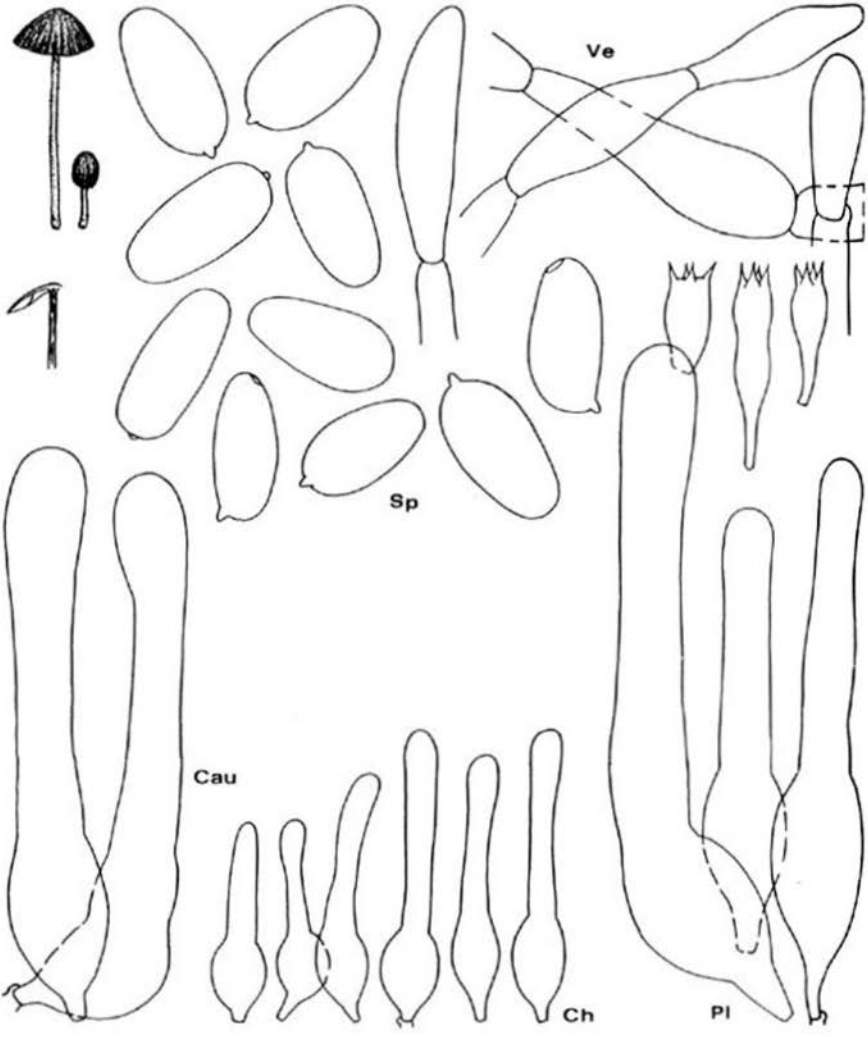

Fig. 10. *Coprinus* species (*Uljé 952*).

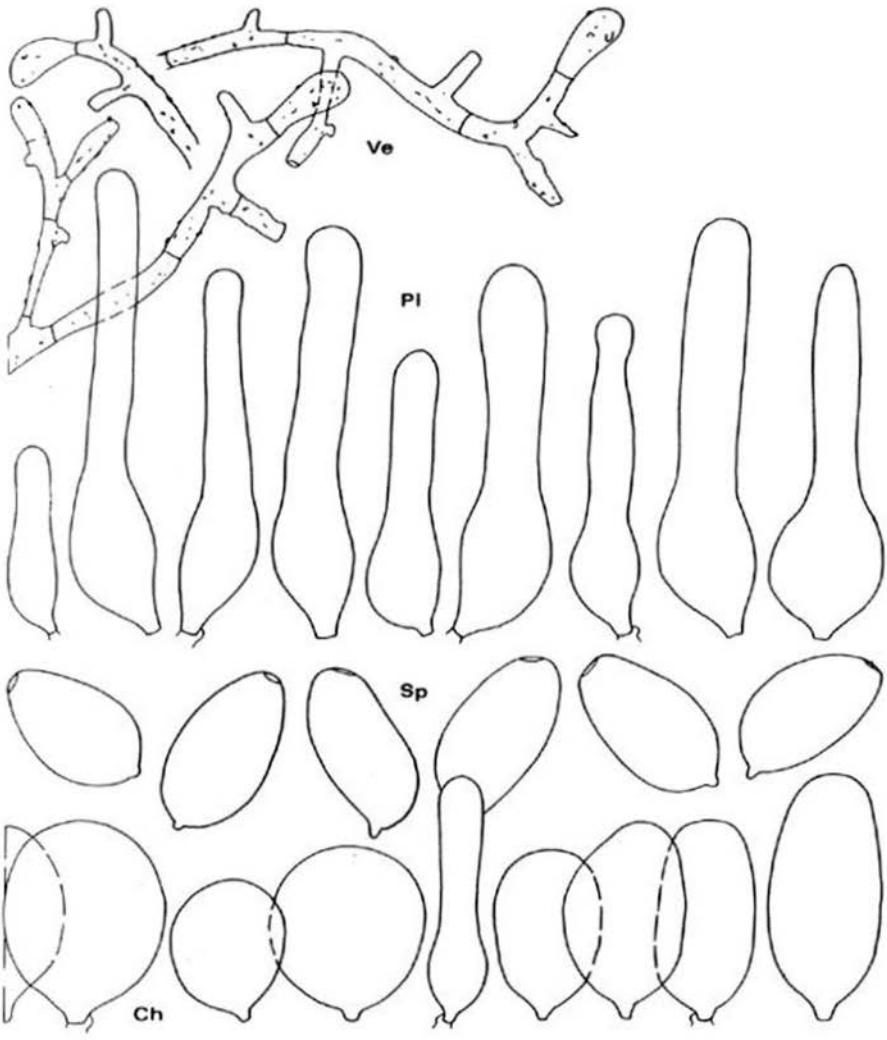

Fig. 11. *Coprinus velatopruinatus* Bender. — All figures copied from Bender (1989: 79).

Collection examined.—GERMANY: Westfalen, Mönchengladbach, MTB 4804, 31 Aug. 1988, *H. Bender* (herb. Bender, topotype).

Coprinus velatopruinatus is one of the species of subsect. *Setulosi* with a veil on the pileus that consists of cylindrical hyphae and seems closely related to *C. heterothrix*. The microscopical differences are the shape of the cheilocystidia which are mainly globose to ellipsoid and rarely lageniform to subcylindrical in *C. velatopruinatus*, but always lageniform in *C. heterothrix* and the smaller spores in last named species. Bender (l.c.) did not compare his new species with *C. heterothrix*, but with *C. subimpatiens*, *C. callinus*, and *C. sclerocystidiosus*.

12. **Coprinus subimpatiens** M. Lange & A.H. Smith—Fig. 12

Coprinus subimpatiens M. Lange & A.H. Smith *in* Mycologia 45: 772. 1953.

Closed pileus up to 23 × 18 mm, dark reddish brown to yellow-brown or leather- to cinnamon-coloured at centre (Mu. 2.5 YR 2.5/4, 5 YR 3/2–3, 5/8, 7.5 YR 4–5/6, 10 YR 5–6/5–6), paler towards margin (7.5 YR 4–5/6, 10 YR 6/7, 7/6, 5–7/4, 5–6/2, 5/1), up to c. 40 mm in diam. when expanded. Lamellae narrowly adnate to free, white to blackish; L = c. 26–28, l = 1–3. Stipe 40–100 × 1–3 mm, white to greyish-white, pubescent.

Spores [160, 7, 7] 9.3–14.1 × 6.2–8.2 µm, av. L = 10.3–12.3, av. B = 6.3–7.6 µm, Q = 1.40–1.85, av. Q = 1.50–1.65, ellipsoid to ovoid; germ pore eccentric, c. 1.8 µm wide. Basidia 18–43 × 9–10 µm, 4-spored. Pseudoparaphyses (4–)5–6(–7) per basidium. Cheilocystidia from globose and up to c. 50 µm in diam. to lageniform and 40–70(–100) × 13–17 µm with somewhat tapering neck and 4–8 µm wide apex. Pleurocystidia 50–75 × 20–40 µm, vesiculose to utriform, not always present. Pileocystidia 60–120 × 13–24 µm, lageniform with cylindrical to somewhat tapering neck and 5–10 µm wide, equal to slightly broader apex. Sclerocystidia in most collections present (not found in type material). Clamp-connections present.

Habitat.—Gregarious on often clayey soil. Rather common.

Collections examined.—U.S.A.: Michigan, Gratiot Co., Ithaca, Schovence's Woods, 22 Aug. 1948, *v. Potter* (holotype MICH). — NETHERLANDS: prov. Utrecht, Breukelen, Over-Holland, 27 Aug. 1986, *Uljé 747*; 19 Sept. 1986, *Uljé 640*; prov. Zuid-Holland, Alphen a/d Rijn, 27 Nov. 1984, *Uljé 503*; Leiden, 16 Oct. 1985, *Uljé 697*; 24 Aug. 1986, *Uljé*; Ter Aar, de Put, 15 Aug. 1986, *Uljé 746*.

Coprinus subimpatiens is close to *C. callinus*. The most important difference between these two species is the shape of the cheilocystidia: in *C. callinus* exclusively globose, in *C. subimpatiens* intermixed lageniform and globose.

In species with predominantly globose cheilocystidia, like *C. callinus*, a few lageniform ones are sometimes present. In some species with mixed globose and lageniform cheilocystidia, the latter are not always abundant. Therefore identification is not easy. Fortunately there are other characters that may help.

In the case of *C. subimpatiens* and *C. callinus* such characters are: (1) the spores of *C. subimpatiens* are somewhat broader (6.2–8.2 µm versus 5.7–7.4 µm); (2) the neck of the pileocystidia is more (sub)cylindrical in *C. subimpatiens* and tapering towards the apex in *C. callinus*; (3) in *C. subimpatiens* sclerocystidia usually are rare or even absent, in *C. callinus* almost always present, sometimes abundant.

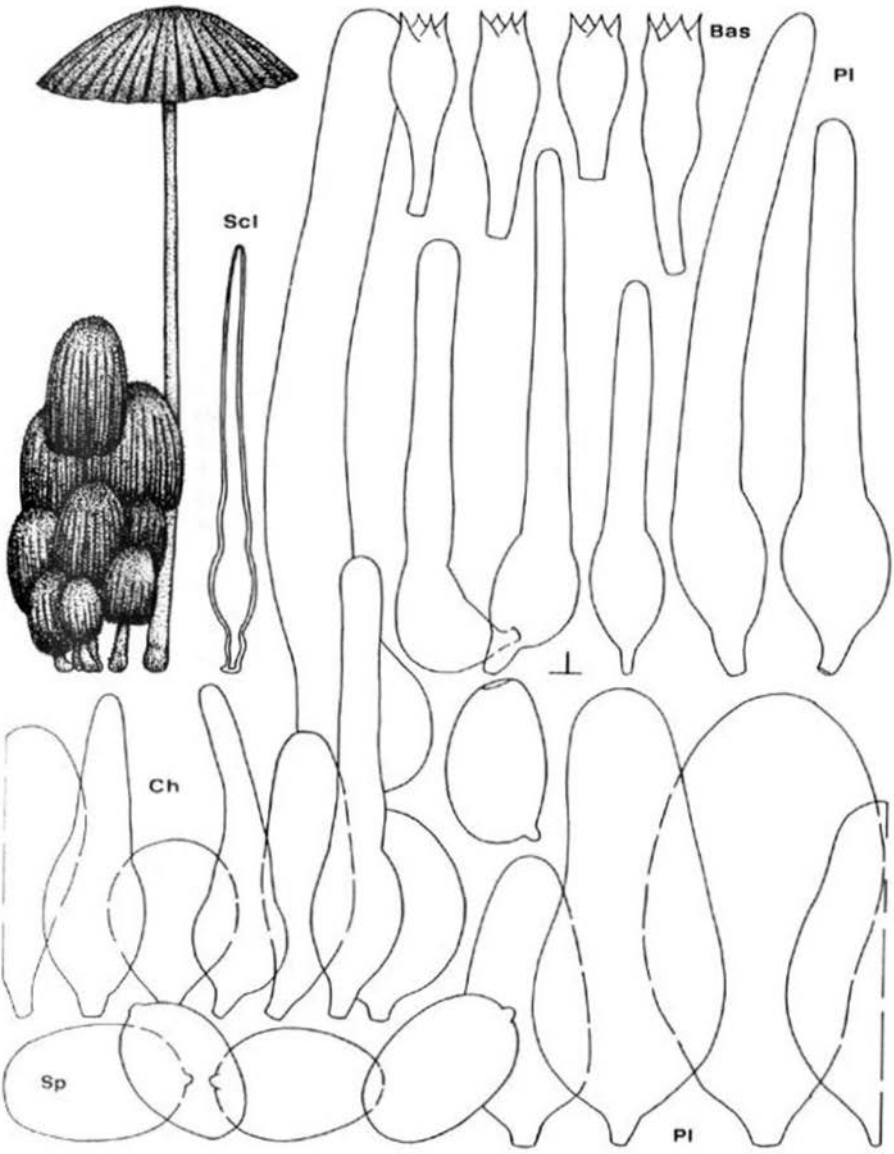

Fig. 12. *Coprinus subimpatiens* M. Lange & A.H. Smith. — All figures from type.

In the original description of *C. subimpatiens* pleurocystidia are mentioned, but according to its authors they are absent in some specimens. The first author (Uljé) found pleurocystidia to be present in the type collection, but not in other collections. Judging from the literature on this species pleurocystidia may not be always present.

13. **Coprinus sclerocystidiosus** M. Lange & A.H. Smith—Fig. 13

Coprinus sclerocystidiosus M. Lange & A.H. Smith *in* Mycologia 45: 769. 1953.

Closed pileus up to 22 × 16 mm, yellow-brown to ochre-brown at centre (Mu. 10 YR 4/6, 2.5 Y 6/8, K. & W. 5D5 to 4A/B7), paler towards margin, up to c. 35 mm in diam. when expanded. Lamellae free, narrow, white to blackish; L = c. 36, l = 1–3 (–5). Stipe 40–100 × 1–3(–4) mm, white to greyish-white, pubescent.

Spores [60, 2, 2] 10.6–14.2 × 6.7–8.4 µm, av. L = 12.1–12.6, av. B = 7.4–7.9 µm, Q = 1.35–1.80, av. Q = 1.55–1.70, ellipsoid to ovoid; germ pore eccentric, c. 2 µm wide. Basidia 18–38 × 8–10 µm, 4-spored. Pseudoparaphyses 4–6(–7) per basidium. Cheilocystidia 20–60 × 20–50 µm, globose, ellipsoid, ovoid to obovoid. Pleurocystidia absent. Pileocystidia 40–120 × 8–16, lageniform with cylindrical to sometimes slightly tapering neck and equal, 3–8 µm wide apex. Sclerocystidia present, usually numerous. Clamp-connections present.

Habitat.—Terrestrial on lawns, but also on wood-chips, usually fasciculate. Rather rare.

Collections examined.—NETHERLANDS: prov. Zuid-Holland, Leiden, Wandelpark Noord, 9 June 1984, *Uljé 543*; Alphen a/d Rijn, 11 Sept. 1984, *Uljé 555*.

The species most closely related to *C. sclerocystidiosus* are *C. callinus* and *C. subpurpureus*.

Coprinus callinus can be distinguished by its tapering pileocystidia and its somewhat smaller spores (9.3–13.1 × 5.7–7.4 µm versus 10.6–14.2 × 6.7–8.4 µm).

The density of the sclerocystidia is not always the same in each species which has them. In *C. sclerocystidiosus* they are usually abundant, but in *C. callinus* they can sometimes be abundant.

The main differences between *C. sclerocystidiosus* and *C. subpurpureus* are the colour of the pileus (yellow-brown to ochre-brown versus red-brown to purple-brown) and the abundant versus scarce sclerocystidia. In addition the pileocystidia of *C. sclerocystidiosus* are not or very rarely enlarged at the apex as they often are in *C. subpurpureus*.

14. **Coprinus callinus** M. Lange & A.H. Smith—Fig. 14

Coprinus callinus M. Lange & A.H. Smith *in* Mycologia 45: 770. 1953.

Closed pileus up to 18 × 12 mm, dirty red-brown, cinnamon, ochre to rather pale (yellow-) brown (Mu. 7.5 YR 3/2, 4/6, 10 YR 5/3, 5/6, 6–8/6 to 2.5 Y 5/4, K. & W. 6D6, 5D5, 4A4) at centre, paler towards margin (Mu. 7.5 YR 6/5, 10 YR 5/5, 6/2–3, 7/3, 5/2, 2.5 Y 7–8/4, 6/2, K. & W. 6C4–5, 5D6–7 to 3–4, 5B3, 4B4, 4A3); up to 35 mm wide when expanded. Lamellae free, white to blackish; L = 18–36, l = 0–3. Stipe 50–120 × 1–3, white to greyish-white, with base up to c. 4 mm wide, pubescent.

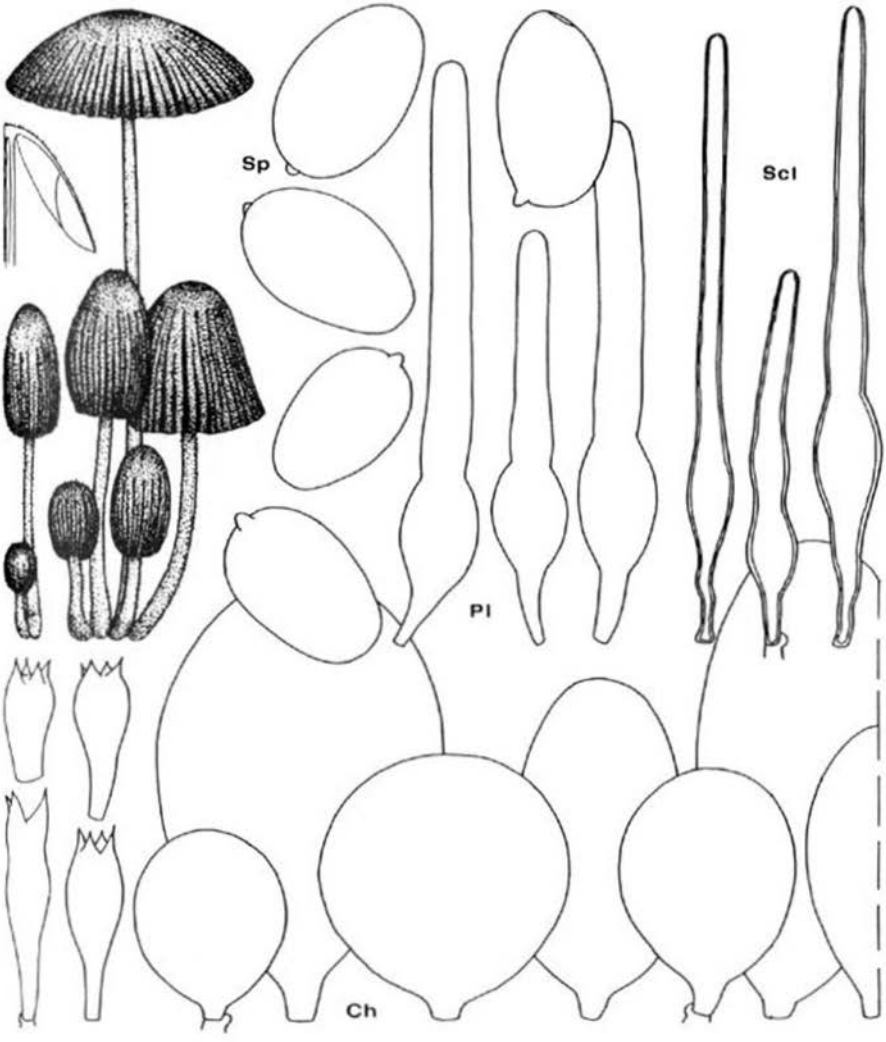

Fig. 13. *Coprinus sclerocystidiosus* M. Lange & A.H. Smith. — All figures from *Uljé 543*.

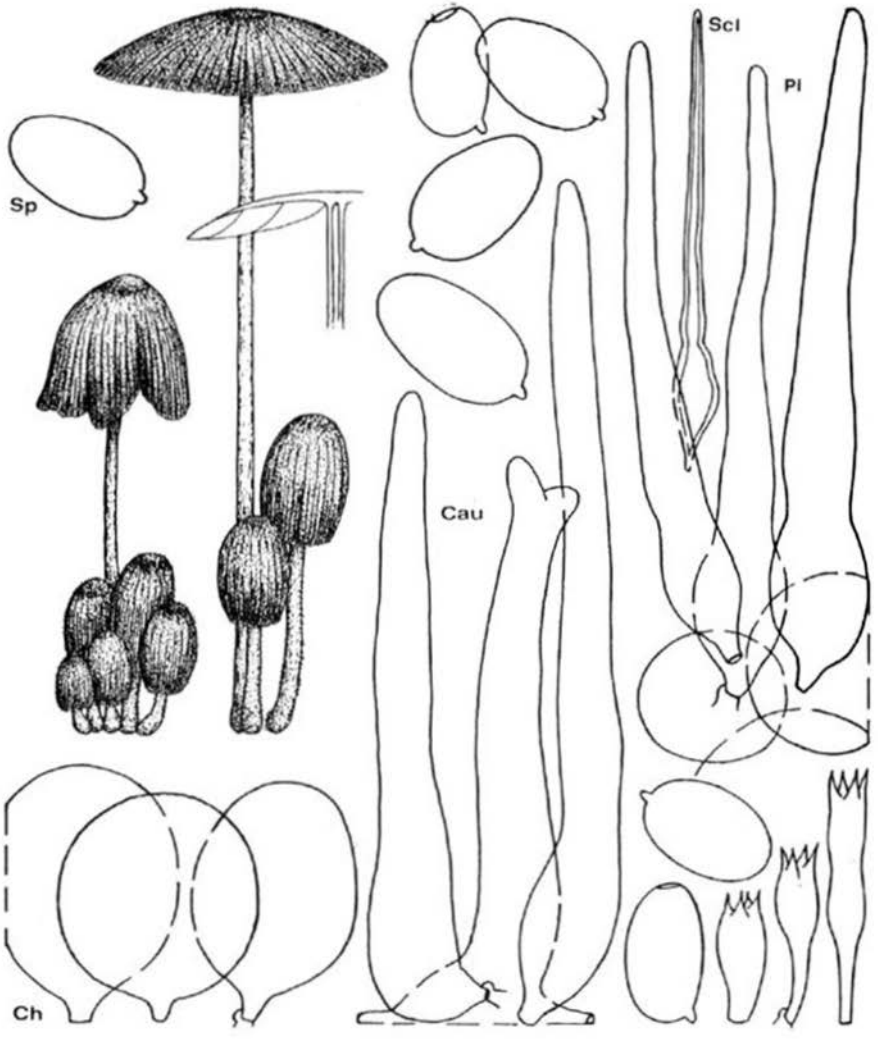

Fig. 14. *Coprinus callinus* M. Lange & A.H. Smith. — All figures from *Uljé 1011*.

Spores [220, 11, 11] 9.3–13.1 × 5.7–7.4 µm, av. L = 10.3–12.1, av. B = 6.1–6.9 µm, Q = 1.50–1.95, av. Q = 1.65–1.90, ellipsoid to ovoid; germ pore weakly to rather strongly eccentric, c. 1.8 µm wide. Basidia 14–38 × 8–10 µm, 4-spored. Pseudoparaphyses 4–6 per basidium. Cheilocystidia globose and 20–50 µm in diam., to ellipsoid and 20–60 × 15–40 µm. Pleurocystidia absent. Pileocystidia 60–150(–200) × 6–25 µm, lageniform with 4–8 (–10) µm wide, tapering neck. Sclerocystidia usually present. Clamp-connections present.

Habitat.—Terrestrial, usually at or near wood fragments, particularly on paths covered with wood chips. (Sub)fasciculate. Common.

Collections examined.—NETHERLANDS: prov. Noord-Holland, Amsterdam, Amsterdamse Bos, 23 July 1985, *Uljé 705*; prov. Zuid-Holland: Alphen a/d Rijn, 21 July 1984, *Uljé 526b*; 23 July 1984, *Uljé 564*; 11 Sept. 1984, *Uljé 511*; 12 Oct. 1984, *Uljé 539b*; 10 Aug. 1987, *Uljé 885*; 12 July 1988, *Uljé*; 8 Sept. 1988, *Uljé 970*; Ter Aar, 11 Sept. 1984, *Uljé 520*; 21 Apr. 1989, *Uljé 1011*; Leiden, 6 June 1987, *Uljé 875*.

In the Netherlands *C. callinus* is a common species, especially on paths covered with wood-chips. In this habitat the species is often abundant and grows in distinct fascicles.

The colour of the pileus is in general not very dark and does not have much red in it. Usually the colour is yellow-brown to ochre-brown or cinnamon. The tapering pileocystidia together with the sclerocystidia, which are usually present, sometimes even numerous, and the spores with a length between 10 and 13 µm, are the most important characters of this species.

15. **Coprinus** species (*Uljé 1009*)—Fig. 15

Closed pileus up to 10 × 9 mm, dark red-brown to ochre-brown at centre (Mu. 7.5 YR 3–4/4, 4/6, 10 YR 4/4, 5/3–4, 6/5, K. & W. 6E/F8, 6E7, 5C4), paler towards margin (7.5 YR 4/4, 10 YR 4–5/3, 6/4–6, 7/2–4, 2.5 Y 7.5/4 to 5 Y 6/1, K. & W. 5C/D4, 4A3); up to c. 22 mm wide when expanded. Lamellae free, up to 2 mm broad, white to blackish; L = 16–21, l = 1–3. Stipe 20–50 × 1.5–2.5 mm, whitish, pubescent.

Spores [60, 3, 1] 9.4–12.8 × 6.0–7.6 µm, av. L = 11.1, av. B = 6.7 µm, Q = 1.55–1.80, av. Q = 1.65, ellipsoid to ovoid; germ pore eccentric, c. 1.8 µm wide. Basidia 18–40 × 8.5–10.5 µm, 4-spored. Pseudoparaphyses 3–6 per basidium. Cheilocystidia mostly globose, up to 40 µm in diam., but also broadly ellipsoid, up to 40 × 25 µm. Pleurocystidia absent. Pileocystidia 50–90 × 13–20 µm, lageniform with tapering neck, 5–7 µm wide at apex. Sclerocystidia absent. Caulocystidia somewhat shorter and broader, 40–80 × 16–25 µm, lageniform with tapering to cylindrical neck and equal, sometimes slightly enlarged, 5–8.5 µm wide apex. Clamp-connections present.

Habitat.—Solitary or gregarious in dry ditch, on humus and fallen branches.

Collection examined.—NETHERLANDS: prov. Zuid-Holland, Ter Aar, de Put, 20 Aug. 1986, *Uljé 1009*.

Macroscopically this taxon resembles *C. callinus*, but the fruit-bodies are smaller than in *C. callinus* and they grow (sub)solitary. Microscopically this species deviates in the absence of sclerocystidia, which are almost always present in *C. callinus*. The other microscopical characters are practically the same, with exception of the length of the pileo- and caulocystidia, which is greater in *C. callinus*.

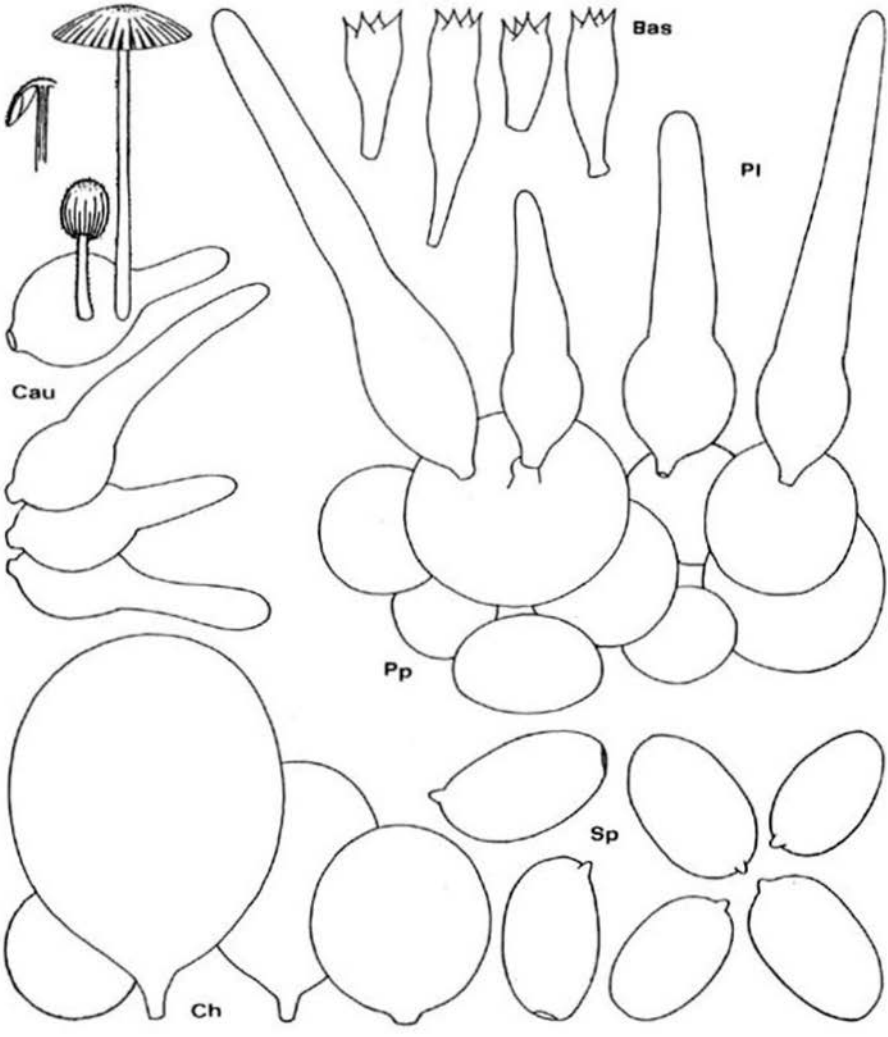

Fig. 15. *Coprinus* species (*Uljé 1009*).

16. **Coprinus** species (*Uljé 877*)—Fig. 16

Closed pileus up to 6 × 5 mm, ochre-brown at centre (Mu. 7.5 YR 4/6, 10 YR 4–5/4, 6/5), paler towards margin (10 YR 4–5/3, 6/6, 7/2), up to 16 mm in diam. when expanded. Lamellae narrowly adnate, white to blackish; L = 16–24, l = 1–3. Stipe 20–30 × 1–1.5 mm, whitish, pubescent from setulae.

Spores [40, 2, 1] 10.3–13.1 × 5.8–7.1 µm, av. L = 11.8, av. B = 6.5 µm, Q = 1.60–1.75, av. Q = 1.65, ellipsoid to ovoid; germ pore eccentric, c. 1.8 µm wide. Basidia 16–34 × 9–10 µm, 4-spored. Pseudoparaphyses 4–6(–7) per basidium. Cheilocystidia vesiculose, 30–55 × 17–35 µm. Pleurocystidia 50–110 × 27–45 µm, ellipsoid, oblong to slightly utriform. Pileocystidia 60–100 × 11–17 µm, lageniform with tapering neck, 4–6 µm wide at apex. Sclerocystidia absent. Clamp-connections present.

Habitat.—Under shrubs, on branches embedded in mud taken from ditch. Fasciculate.

Collection examined.—NETHERLANDS: prov. Zuid-Holland, Oegstgeest, Laan van Poelgeest, 26 July 1987, *Uljé 877*.

Although this species does not grow on dung, it agrees rather well with *C. ephemerus* in its microscopical characters. The spores, however, are somewhat smaller. Not only this character, but also the smaller fruit-bodies and the different habitat make it probable that this collection represents another species. *Coprinus congregatus* is rather similar also, but is fimicolous, has no clamps and has somewhat larger pleuro-, cheilo- and pileocystidia.

17. **Coprinus plagioporus** Romagn.—Fig. 17

Coprinus plagioporus Romagn. *in* Rev. Mycol. 6: 127. 1941.

Closed pileus up to c. 16 × 12 mm, red-brown to purple-brown, in young specimens often very dark (Mu. 5 YR 2.5/2, K. & W. 9F4) at centre, paler towards margin (Mu. 7.5 YR 4/2, K. & W. 7D/E4), up to c. 30 mm in diam. when expanded. Lamellae narrowly adnate. Stipe 40–80 × 1–3 mm, white to greyish white, pubescent from setulae.

Spores [140, 7, 7] 10.4–13.8 × 5.8–7.4 µm, av. L = 11.7–12.6, av. B = 6.3–7.0 µm, Q = 1.70–1.90, av. Q = 1.75–1.85, ellipsoid to ovoid; germ pore eccentric, c. 1.8 µm wide. Basidia 18–38 × 8–9 µm, 4-spored. Pseudoparaphyses (3–)4–6 per basidium. Cheilocystidia globose, up to c. 40 µm wide. Pleurocystidia absent. Pileocystidia 60–150 × 10–18 µm, lageniform with cylindrical neck and clavate to (sub)capitate 7–12 µm wide apex. Sclerocystidia absent. Clamp-connections present.

Habitat.—Terrestrial, often on clayey soil, also on paths covered with wood-chips, fasciculate. Common.

Collections examined.—NETHERLANDS: prov. Zuid-Holland: Ter Aar, Langeraar, 29 May 1984, *Uljé 478*; 17 Sept. 1984, *Uljé 540b*; Alphen a/d Rijn, 28 July 1984, *Uljé 529*; 17 Sept. 1984, *Uljé 546a*; 11 Aug. 1985, *Uljé 621*; 7 Aug. 1987, *Uljé 870*; 1 Dec. 1987, *Uljé 873*.

In young and fresh stages *C. plagioporus* has a dark purple pileus. Microscopically the combination of subcapitate to capitate pileo- and caulocystidia and globose cheilocystidia is usually characteristic for this species. But unfortunately the tips of the pileocystidia and caulo-

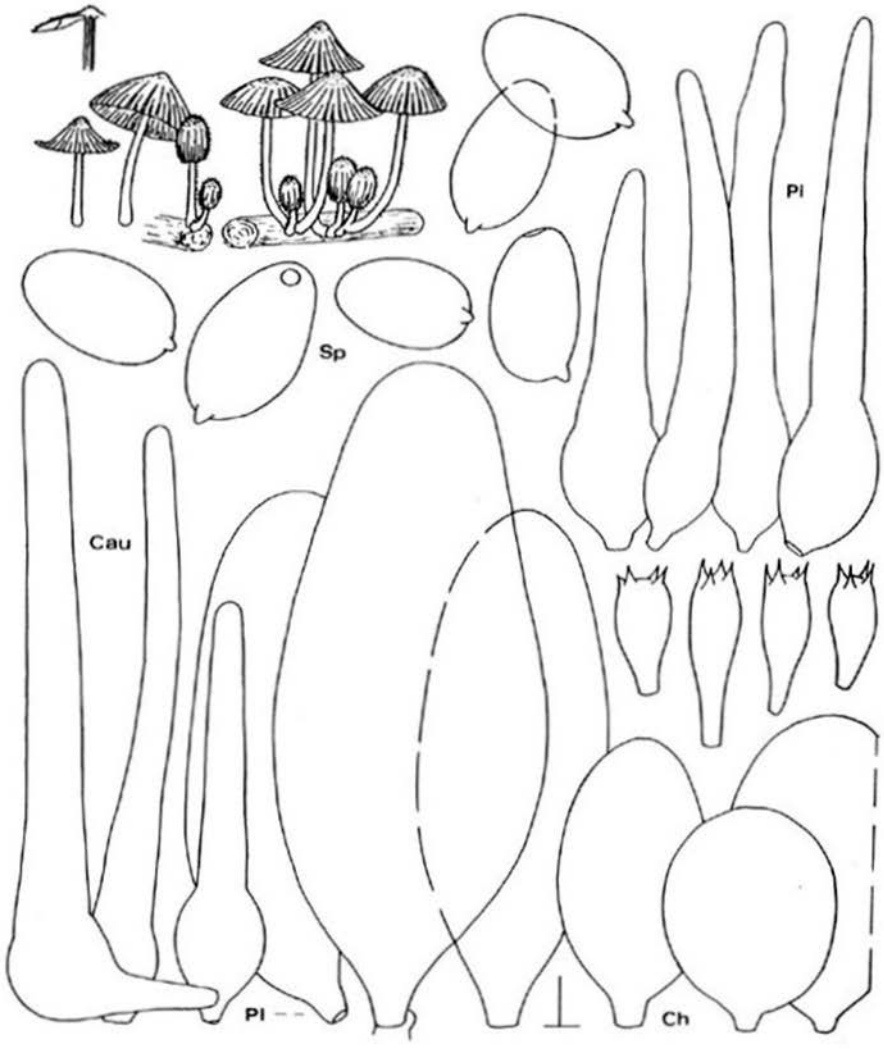

Fig. 16. *Coprinus* species (*Uljé 877*).

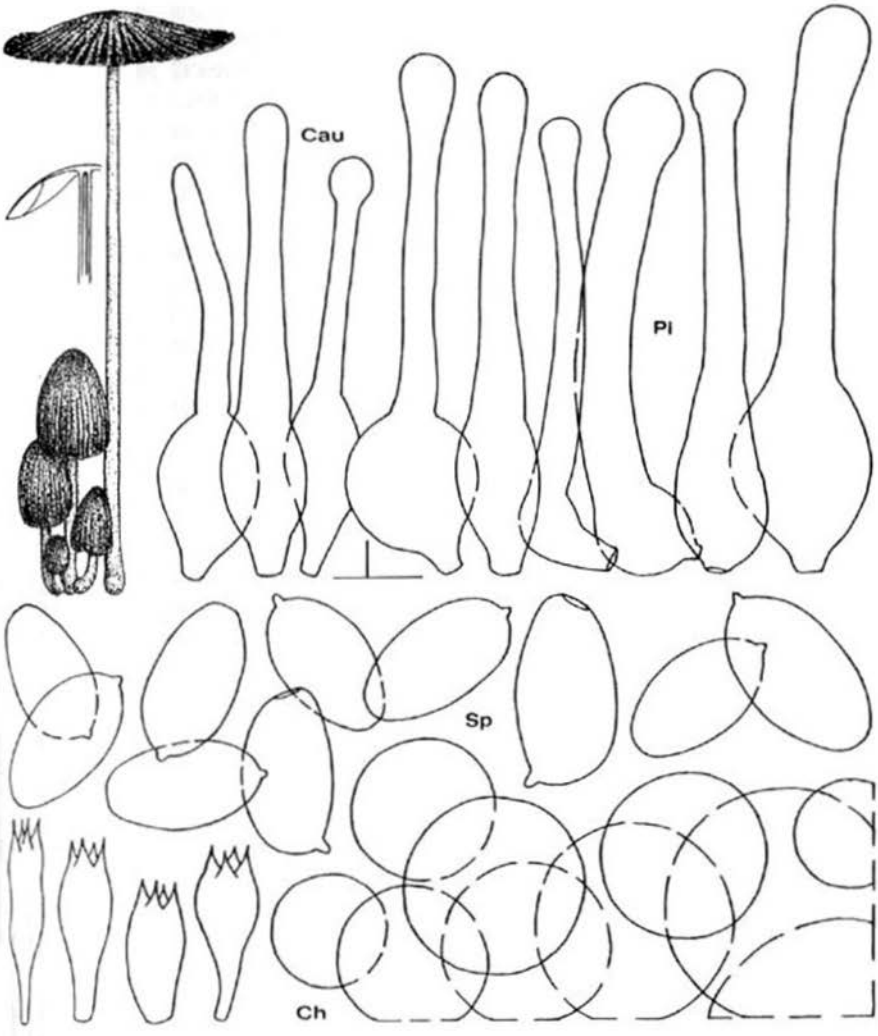

Fig. 17. *Coprinus plagioporus* Rom. — All figures from *Uljé 870*.

cystidia are sometimes only slightly enlarged and in these cases confusion with *C. subpurpureus* and *C. fallax* is possible (see also the discussions under these two species).

From a morphological point of view it is tempting to consider *C. plagioporus*, *C. subpurpureus*, and *C. fallax* as variants of one and the same species. M. Lange (1952: 44), however, found *C. plagioporus* and *C. subpurpureus* completely intersterile. One year later M. Lange & A.H. Smith (1953: 765) described the probably closely related *C. fallax* as a new species, mainly on account of its aberrant spore print colour ('reddish'), but without testing it against *C. plagioporus* and *C. subpurpureus*.

M. Lange & A.H. Smith (l.c.: 766–768) stated that because of the moderately eccentric germ pore and the dark spores measuring 11.75 × 6.05 µm on the av., *C. ephemerus* f. *saturatus* J. Lange (1939: 117) is identical with *C. plagioporus*. But many species of section *Setulosi* have such spores and J. Lange's forma may belong to any of them. J. Lange's coloured illustration (1939: pl. 160 D) does not help either, as macroscopically many species of subsect. *Setulosi* look very similar and this illustration could refer to several of them.

18. **Coprinus subpurpureus** A.H. Smith—Fig. 18

Coprinus subpurpureus A.H. Smith *in* Mycologia 40: 684. 1948.

Closed pileus up to 15 mm high, up to 35 mm in diam. when expanded, dark vinaceous brown at centre, paler towards margin. In age 'dark purple drab' over disk and dark grey to blackish over margin. Lamellae narrowly adnate, whitish to black. Stipe 40–100 × 1–3 mm, dull lilac umber when young, rarely pallid, becoming paler in age, densely pubescent to pubescent but soon glabrescent; base white-strigose (macroscopic description after A.H. Smith, l.c.).

Spores (from type) [20, 1, 1] 9.0–11.5 × 5.6–7.0 µm, av. L = 10.2, av. B = 6.5 µm, Q = 1.45–1.65, av. Q = 1.60, ellipsoid to ovoid; germ pore eccentric, c. 1.8 µm wide. Basidia 16–40 × 8–10 µm, 4-spored. Pseudoparaphyses 3–6 per basidium. Cheilocystidia vesiculose, 40–85 × 25–45 µm. Pleurocystidia absent. Pileocystidia 45–100 × 7–14 µm, lageniform with (sub)cylindrical neck and even to clavate, 4.5–9 µm wide apex. Sclerocystidia absent. Clamp-connections present.

H a b i t a t.— In moist leaves or on wet black muck. Gregarious or solitary.

C o l l e c t i o n e x a m i n e d.—U.S.A.: Michigan, Cheboygan Co., Burt Lake, Colonial point, 31 July 1947, *M. Feigly* (A.H. Smith 26158, holotype MICH).

Coprinus subpurpureus should be distinguishable from *C. plagioporus* by its pileocystidia with a cylindrical neck and not or weakly enlarged but not capitate apex and its more purple colour. Collections that have pileocystidia with a subcapitate apex have to be named *C. plagioporus* because the apex of the pileocystidia in *C. plagioporus* is not always distinctly capitate.

It should be mentioned that there is a great difference between the size of the spores given in the original description and that in our own measurements on the type material (12–14 × 7–8 µm versus 9.0–11.5 × 5.6–7.0 µm).

Coprinus fallax is another probably closely related species, but should have a more reddish spore print (see also the discussion under *C. plagioporus* and *C. fallax*).

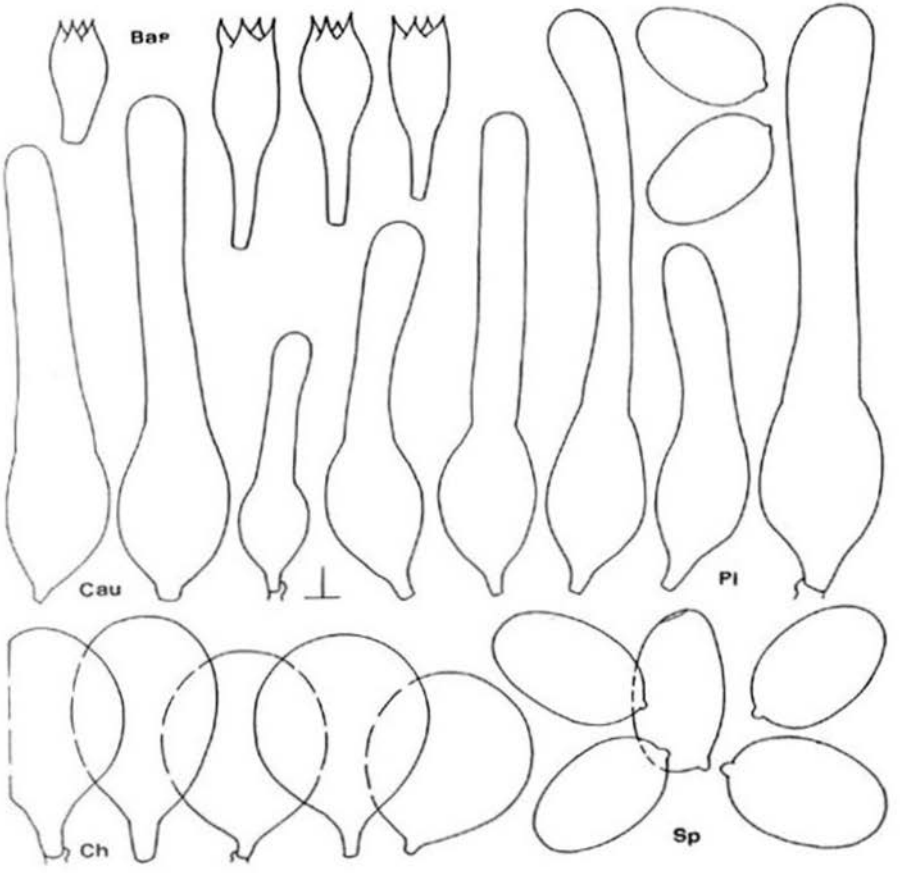

Fig. 18. *Coprinus subpurpureus* A.H. Smith. — All figures from type.

19. **Coprinus fallax** M. Lange & A.H. Smith—Fig. 19

Coprinus fallax M. Lange & A.H. Smith *in* Mycologia 45: 765. 1953.

Closed pileus up to 10 × 7 mm, walnut-brown to 'Rood's brown' on disk, margin about dark to pale vinaceous brown; expanded pileus up to 20 mm wide. Lamellae narrowly adnate, (sub)distant, the faces about concolorous with pileus. Stipe 20–35 × c. 1 mm, white or at base slightly discoloured (macroscopical description after M. Lange & A.H. Smith, l.c.).

Spores (from type) [40, 1, 1] 9.4–12.0 × 6.3–7.5 µm, av. L = 11.1, av. B = 7.2 µm, Q = 1.50–1.65, av. Q 1.60, ellipsoid to ovoid; germ pore eccentric, c. 1.8 µm wide. Basidia 16–32 × 8–11 µm, 4-spored. Pseudoparaphyses (3–)4–5(–6) per basidium. Cheilocystidia vesiculose, 40–70 × 25–35 µm. Pleurocystidia absent. Pileocystidia 60–110 × 16–27 µm, lage-

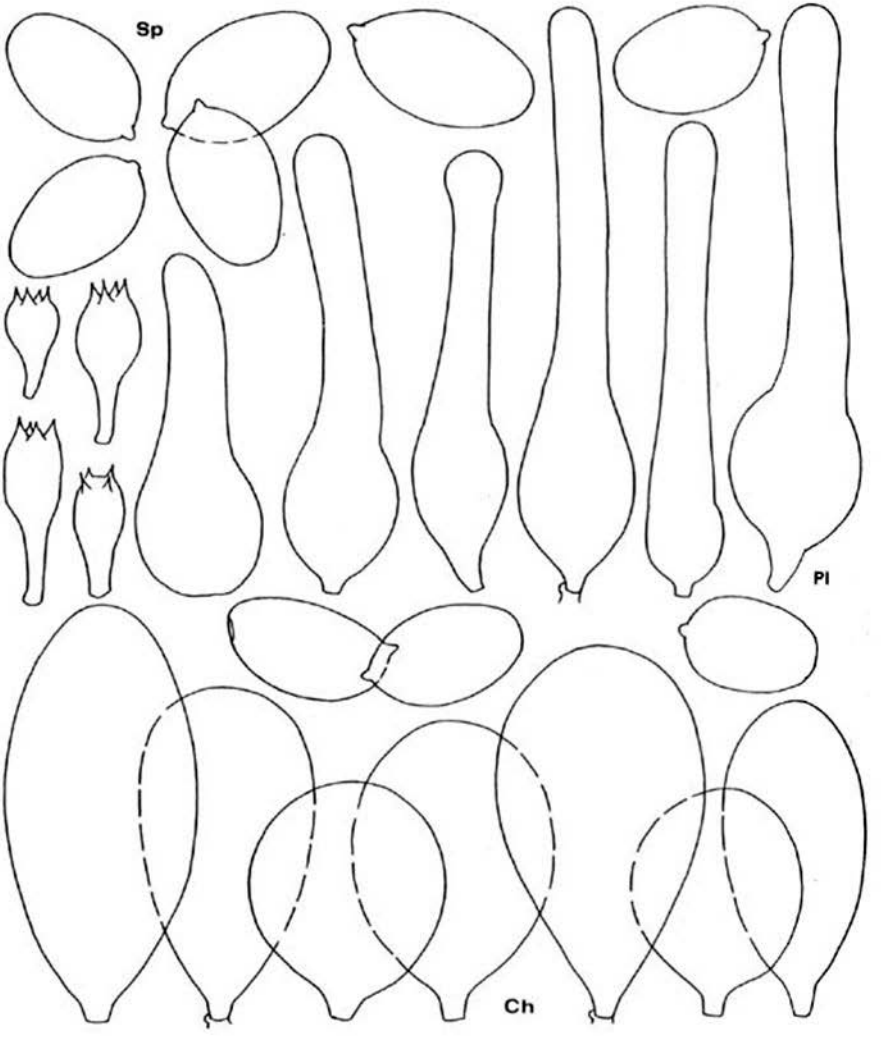

Fig. 19. *Coprinus fallax* M. Lange & A.H. Smith. — All figures from type.

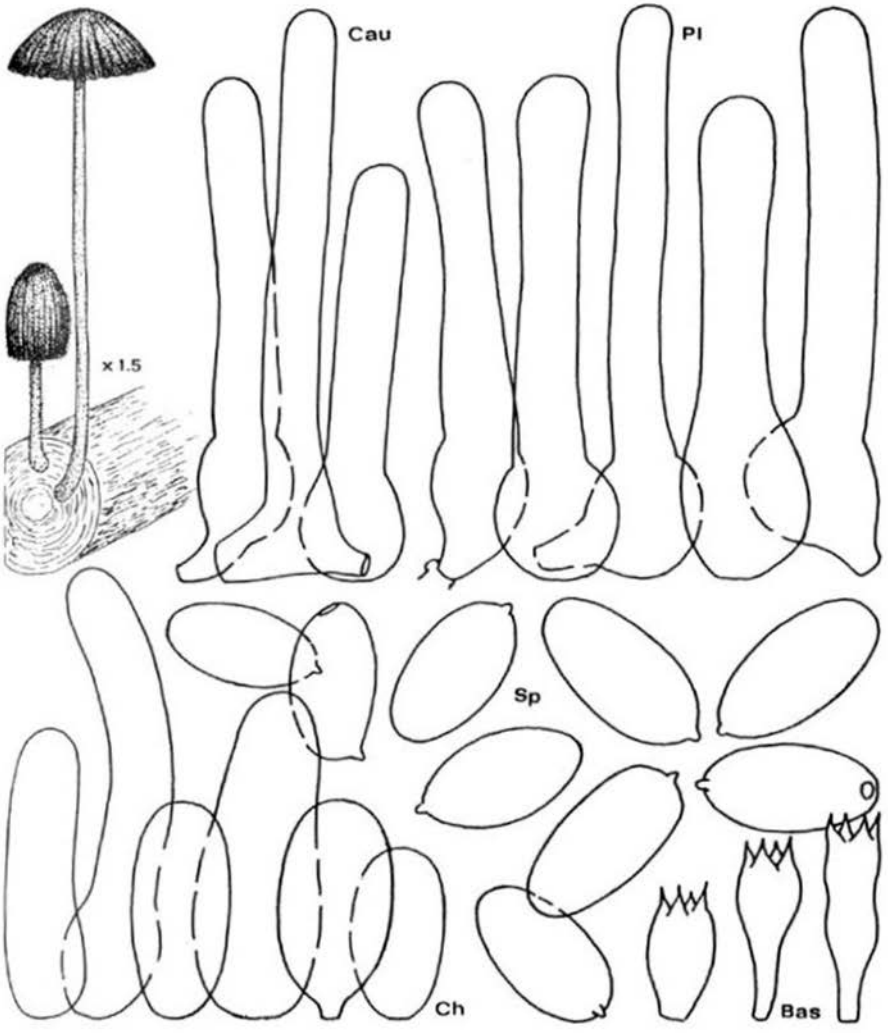

Fig. 20. *Coprinus subdisseminatus* M. Lange. — All figures from *Uljé*, 23 Sept. 1989.

niform with (sub)cylindrical neck and equal to somewhat enlarged, 8–12 µm wide apex. Sclerocystidia very rare or absent. Clamp-connections present.

Habitat.—Caespitose on soil in a lumber yard. Known only from the type location.

Collection examined.—U.S.A.: Michigan, Washtenaw Co., Dexter, 24 May 1949, *A.H. Smith 32096* (holotype MICH).

According to the original description *C. fallax* should have a reddish spore-print. In KOH the spores should become first pale and then purplish grey-brown.

Under the microscope we did not observe anything unusual in the colour of the spores of the type in comparison to other species of subsect. *Setulosi*. The spores became paler in KOH but not darker afterwards. The sizes of the spores of the type material in our own measurements differ from those in the original description (9.4–12 × 6.3–7.5 µm versus 11–14 × 6.0–7.5 µm). The breadth of the spores in the original description relates to the breadth in side view (W)! (See also the discussion under *C. plagioporus*).

20. **Coprinus subdisseminatus** M. Lange—Fig. 20

Coprinus subdisseminatus M. Lange *in* Mycologia 45: 777. 1953.

Closed pileus up to 8 × 6 mm, pale brown, at centre somewhat darker, up to 15 mm in diam. when expanded. Lamellae narrowly adnate, white to blackish; L = 16–24, l = 0–1. Stipe 20–40 × 0.5–1 mm, whitish, vitreous, sparsely pubescent.

Spores [60, 2, 2] 9.2–13.3 × 5.3–6.7 µm, av. L = 10.8–11.7, av. B = 5.8–6.3 µm, Q = 1.70–2.05, av. Q = 1.85–1.95, oblong to elongate ellipsoid or ovoid; germ pore eccentric, c. 1.5 µm wide. Basidia 18–36 × 8.5–11 µm, 4-spored. Pseudoparaphyses not noted. Cheilocystidia ellipsoid to oblong, some of them (sub)cylindrical or slightly utriform, 30–55 × 15–23 µm, but also pileocystidia-like cheilocystidia sparsely present on the edge of the lamellae. Pleurocystidia absent. Pileocystidia 60–90(–120) × 10–22 µm, lageniform with (sub) cylindrical neck and equal, sometimes somewhat broadened, 8–14 µm wide apex. Sclerocystidia absent. Clamp-connections probably present.

Habitat.—On or near branches, in very wet places. Rare.

Collections examined.—NETHERLANDS: prov. Zuid-Holland: Leiden, 16 Oct. 1985, *Uljé*; Alphen a/d Rijn, 23 Sept. 1989, *Uljé*.

The main character of this species is the rather broad, cylindrical neck of the pileocystidia. They resemble the pileocystidia of *C. disseminatus* very much, but are distinctly shorter.

Coprinus subdisseminatus has been found only twice in the Netherlands, both times on sticks. According to the original description the species also grows on wet, black mull and other vegetable matter in wet places.

21. **Coprinus** species (*C.M. den Held-Jager 1276*)—Fig. 21

Closed pileus up to 4 × 3 mm, at centre brown (K. & W. 7E2, 7D3). Lamellae narrowly adnate, thin, brownish grey (K. & W. 7F2); L = rather few. Stipe 16–18 × 0.5 mm, whitish, somewhat tomentose at base (descr. den Held-Jager).

Spores [20, 1, 1] 12.6–16.0 × 8.2–9.4 µm, av. L = 13.8, av. B = 8.8 µm, Q = 1.50–

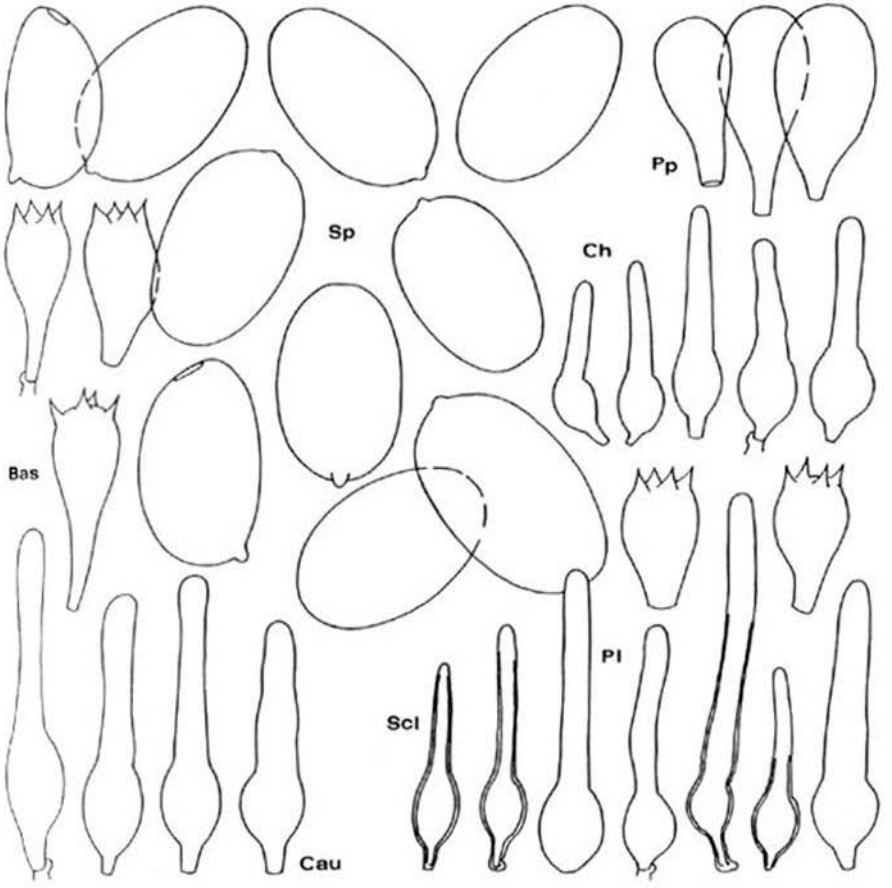

Fig. 21. *Coprinus* species (*den Held-Jager 1276*).

1.70, av. Q = 1.60, ellipsoid to ovoid; germ pore distinctly eccentric, c. 2 µm wide. Basidia 4-spored. Pseudoparaphyses not noted. Cheilocystidia 25–40(–50) × 7–11 µm, lageniform with (sub)cylindrical to slightly tapering neck and 2–4 µm wide apex. Pleurocystidia absent. Pileocystidia 30–70 × 7–12 µm, lageniform with cylindrical to slightly tapering neck and 2–5 µm wide apex. Sclerocystidia sparse. Clamp-connections present.

Habitat.—On wood-chip at stony road-side with many pieces of wood and stems of flowering plants. Among *Campanula, Rhinanthus, Gentiana lutea,* and *Rhododendron*. Till now only known from Andorra.

Collection examined.—ANDORRA: Val d'Incles, 21 July 1981, *C.M. den Held-Jager 1276* (herb. den Held-Jager).

This species is characterized by large, broad spores in combination with lageniform cheilocystidia and four-spored basidia. Other species that have large spores in combination with lageniform cheilocystidia are *C. amphithallus* and *C. singularis*.

Both species have 2-spored basidia and in *C. amphithallus* the spores are distinctly smaller and the pileo- and cheilocystidia are more tapering towards the apex. In *C. singularis* the germ pore is central and the shape of the spores is different.

The closest species is probably *C. subimpatiens*, which also has pileocystidia with a more or less cylindrical neck, but in that species the lageniform cheilocystidia are intermixed with globose ones and the smaller spores have a germ pore that is not so strongly eccentric.

22. **Coprinus impatiens** (Fr.) Quél. — Fig. 22

Coprinus impatiens (Fr.) Quél. *in* Fl. mycol. France: 42. 1888.

Closed pileus up to 16 × 12 mm, dark red-brown to ochre-brown at centre, paler towards margin, up to c. 30 mm wide when expanded. Lamellae narrowly adnate, rather distant; L = 14–21, l = 0–3. Stipe 30–80 × 0.5–2 mm, whitish, pubescent.

Spores [100, 5, 5] 10.6–11.3 × 6.2–7.6 µm, av. L = 10.7–10.9, av. B = 6.7–6.9 µm, Q = 1.45–1.75, av. Q = 1.55–1.65, ellipsoid to ovoid; germ pore weakly eccentric to almost central, c. 1.5 µm wide. Basidia 20–40 × 9–10 µm, 4-spored. Pseudoparaphyses 4–6(–7) per basidium. Cheilocystidia 25–50 × 8–15 µm, lageniform with distinctly tapering neck and 2–6 µm wide apex. Pleurocystidia absent. Pileocystidia 50–100(–125) × 12–22 µm, lageniform with tapering neck, 3–6 µm wide at apex. Sclerocystidia absent. Clamp-connections present.

Habitat.—Terrestrial, often at grassy places. Solitary to gregarious. Rather common.

Collections examined.—NETHERLANDS: prov. Utrecht, Breukelen, 27 Aug. 1986, *Uljé 622*; 21 June 1988, *Uljé 912*; prov. Noord-Holland, Vogelenzang, 3 May 1981, *Uljé 160*; prov. Zuid-Holland: Leiden, 21 Sept. 1984, *Uljé 566*; Alphen a/d Rijn, 21 Aug. 1988, *Uljé 958*.

Microscopically *C. impatiens* closely resembles *C. heterothrix*. The differences are the presence of veil remnants consisting of hyphae at the centre of the pileus in *C. heterothrix* and the more ovoid spores of that species. Moreover, the germ pore is often somewhat projecting in *C. heterothrix* and not at all in *C. impatiens*. Macroscopically *C. impatiens* has more crowded lamellae.

23. **Coprinus eurysporus** M. Lange & A.H. Smith — Fig. 23

Coprinus eurysporus M. Lange & A.H. Smith *in* Mycologia 45: 773. 1953.

Pileus 10–25(–30) mm broad, subcylindric when young, becoming obtusely conic to convex, deer-brown, cinnamon, paler towards margin. Lamellae narrowly adnate, whitish to blackish. Stipe 50–90 × 0.25–1 mm, white, somewhat thickened towards base (macroscopical description after M. Lange & A.H. Smith, l.c.).

Spores (from type) [60, 1, 1] 8.3–10.3 × 6.7–8.4 µm, av. L = 9.1–9.8, av. B = 7.3–7.9 µm, Q = 1.10–1.40, av. Q = 1.25, broadly ovoid; germ pore weakly eccentric, c. 2 µm wide. Basidia 18–40 × 8–11 µm, 4-spored. Pseudoparaphyses (3–)4–6(–7) per basidium. Cheilocystidia 20–40 × 8–14 µm, lageniform with tapering neck and 2.5–3.5 µm wide apex. Pleurocystidia not found (present and lageniform according to original description).

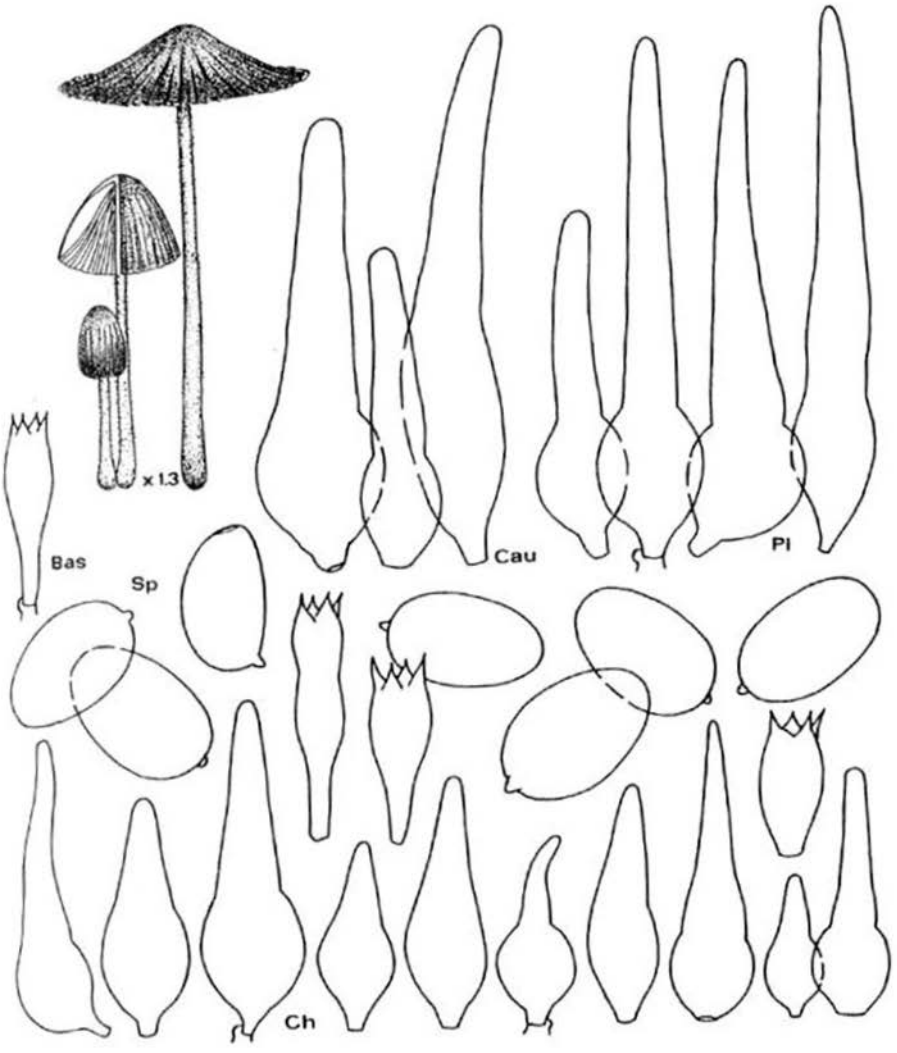

Fig. 22. *Coprinus impatiens* (Fr.) Quél. — All figures from *Uljé 912*.

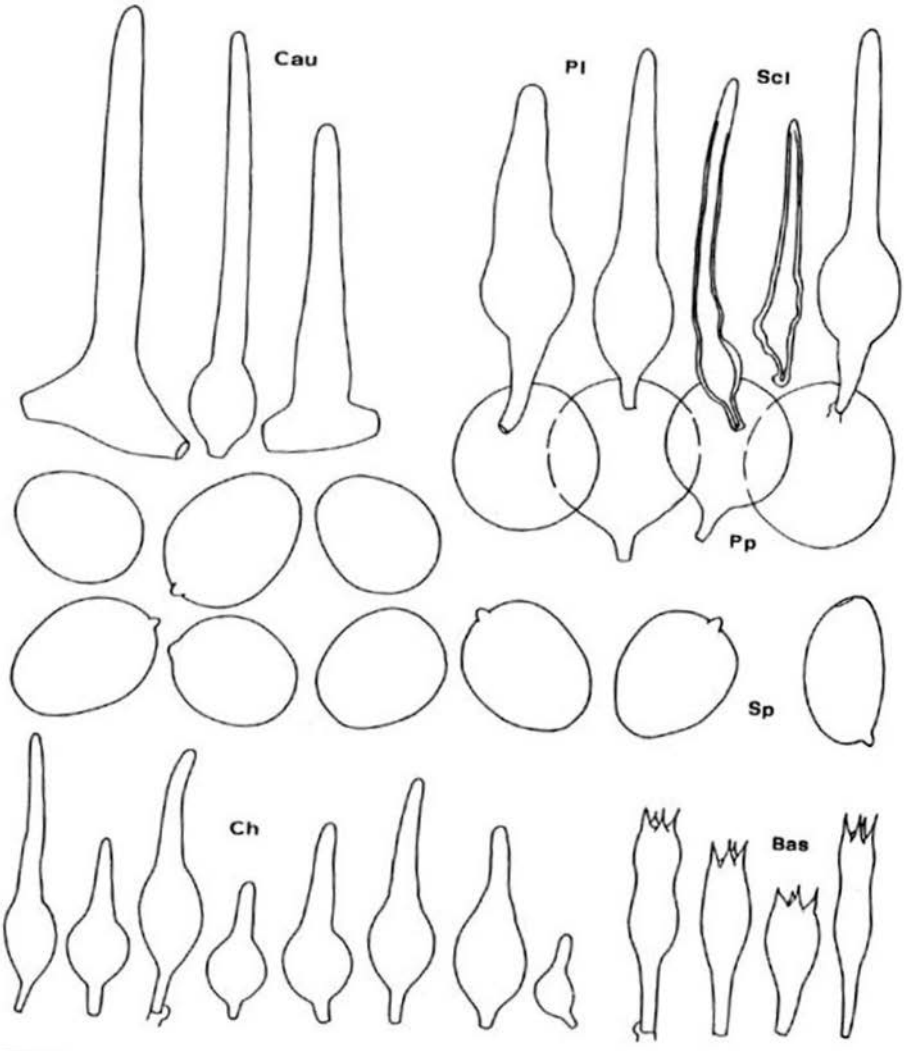

Fig. 23. *Coprinus eurysporus* M. Lange & A.H. Smith. — All figures from type.

Pileocystidia 40–70(–90) × 9–16 µm, lageniform with tapering neck, 2.5–5(–7) µm wide at apex. Sclerocystidia up to 100 µm long, rather scanty. Clamp-connections present.

Habitat.—Gregarious on fallen branches. Not known from the Netherlands.

Collection examined.—U.S.A.: Oregon, Hood River Co., Mt. Hood National Forest, Beaver Creek, 21 Oct. 1947, *A.H. Smith 28033* (holotype MICH).

Coprinus eurysporus is close to *C. impatiens* but has spores that are broader than in the latter species. The spores are not ellipsoid as normally in subsect. *Setulosi* but are broadly rounded subtruncate-ovoid. According to its authors *C. eurysporus* should have lageniform pleurocystidia. The first author of this paper was unable to find pleurocystidia in the type-material. *Coprinus eurysporus* would be the only species with lageniform pleurocystidia in subsect. *Setulosi*. In the other species with pleurocystidia in this subsection, they are inflated, globose to broadly subutriform.

24. **Coprinus congregatus** Bull.: Fr.—Fig. 24

Coprinus congregatus Bull.: Fr., Epicr.: 249. 1838.

Closed pileus up to 18 × 14 mm, cream-coloured with ochre-brown to cinnamon-coloured centre (Mu. 7.5 YR 4/6, K. & W. 6E6) when young, at mature greyish-yellow (Mu. 10 YR 7/6, K. & W. 4A/B4), c. 25 mm in diam. when expanded. Lamellae narrowly adnate to almost free, narrow, white to blackish; L = 18–34, l = 0–3. Stipe 30–80 × 0.5–2.5 mm, whitish, pubescent.

Spores [40, 2, 2] 9.8–14.2 × 5.6–7.5 µm, av. L = 11.1–12.4, av. B = 6.1–7.0 µm, Q = 1.55–1.95, av. Q = 1.75–1.85, ellipsoid to ovoid; germ pore strongly eccentric, c. 1.8 µm wide. Basidia 16–36 × 9–12 µm, 4-spored. Pseudoparaphyses (3–)4–5(–6) per basidium. Cheilocystidia 30–90 × 20–45 µm, ellipsoid to broadly utriform. Pleurocystidia 30–140 × 20–50 µm, ellipsoid, oblong to slightly utriform. Pileocystidia 30–120 × 8–18 µm, lageniform with tapering neck and 3–8 µm wide apex. Sclerocystidia absent. Clamp-connections absent.

Habitat.—Gregarious on dung, especially dung mixed with straw. Common.

Collection examined.—NETHERLANDS: prov. Zuid-Holland, Alphen a/d Rijn, 10 Aug. 1987, *Uljé 862*.

Coprinus congregatus is very similar to *C. ephemerus*. It seems to differ from that species practically only in the absence of clamps and the somewhat smaller spores (9.8–14.2 × 5.6–7.5 µm versus 11.6–15.8 × 6.1–7.9 µm).

25. **Coprinus ephemerus** (Bull.: Fr.) Fr.—Fig. 25

Coprinus ephemerus (Bull.: Fr.) Fr., Epicr.: 252. 1838.

Closed pileus up to 16 × 12 mm, ochre-brown to cinnamon-brown at centre (Mu. 10 YR 6-7/6, K. & W. 5B5) paler towards margin, up to c. 20(–25) mm wide when expanded. Lamellae narrowly adnate, almost free, white to blackish; L. 26–38, l = 0–3. Stipe 30–80 × 1-3 mm, whitish, pubescent.

Spores [20, 1, 1] 11.6–15.8 × 6.1–7.9 µm, av. L = 13.8, av. B = 6.9 µm, Q = 1.80–2.00, av. Q = 1.90, ellipsoid to ovoid; germ pore eccentric, c. 1.8 µm wide. Basidia 18–40 ×

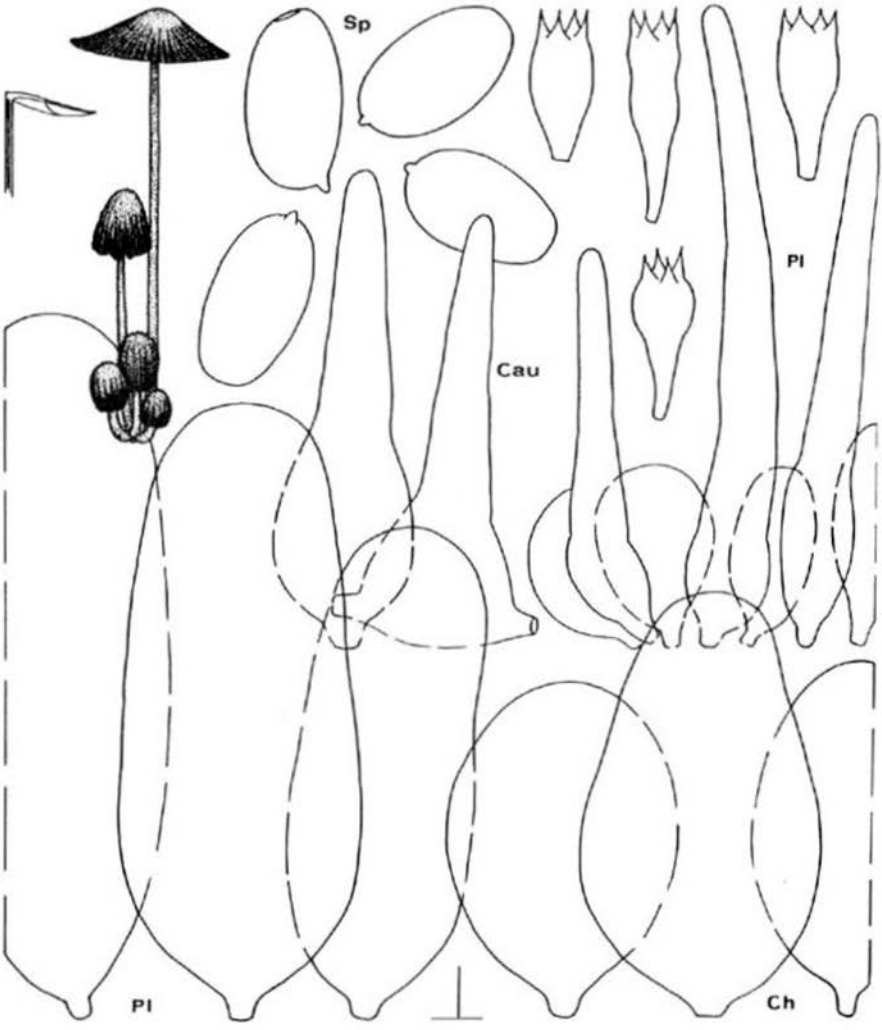

Fig. 24. *Coprinus congregatus* Bull.: Fr. — All figures from *Uljé 862*.

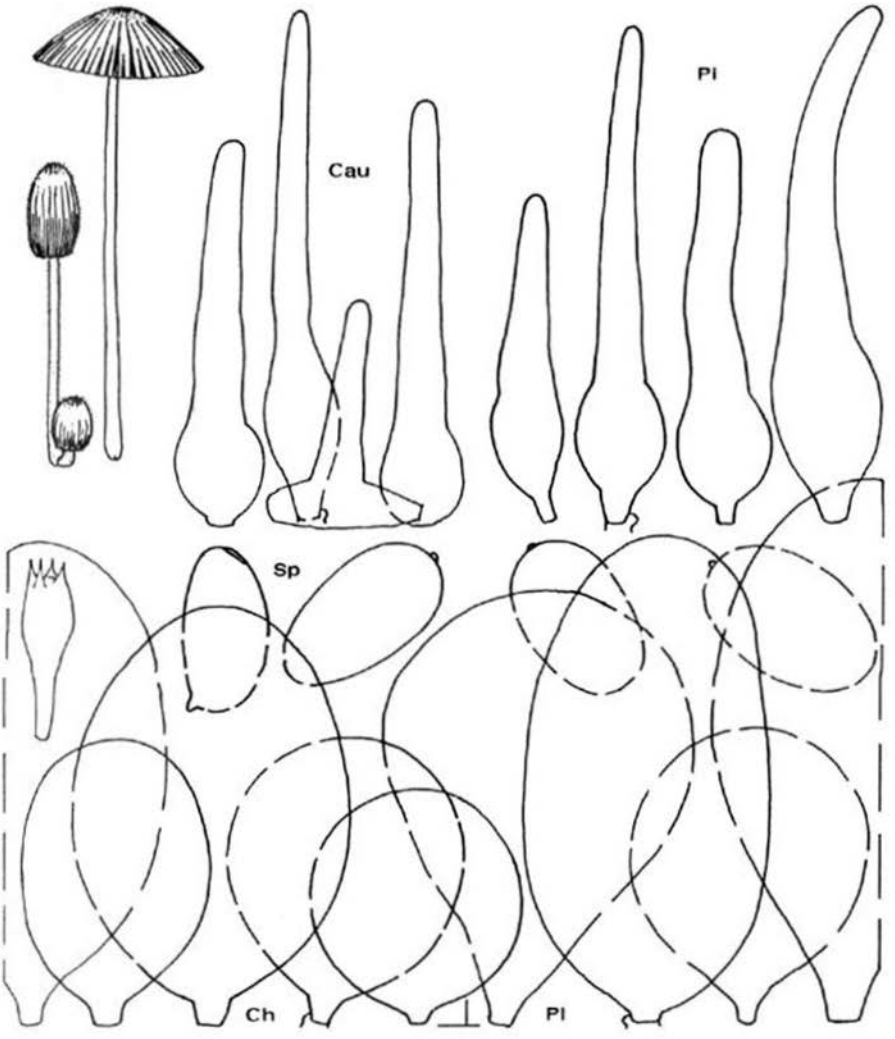

Fig. 25. *Coprinus ephemerus* (Fr.: Bull.) Fr. — All figures from *Daams 72-200*.

9–13 µm, 4-spored. Pseudoparaphyses 4–6 per basidium. Cheilocystidia 20–60 × 20–30 µm, (sub)globose, (broadly) ellipsoid, obovoid, but some lageniform cheilocystidia are present as well. Pleurocystidia 60–120 × 20–45 µm, subglobose, broadly ellipsoid, obovoid to broadly cylindrical. Pileocystidia 30–110 × 10–21 µm, lageniform with tapering neck and 4–8 µm wide apex. Sclerocystidia absent. Clamp-connections present.

Habitat.—On cow-dung, but also on decaying straw. Gregarious or more or less fasciculate. Rare.

Collection examined.—NETHERLANDS: prov. Noord-Holland, 's-Graveland, 19 June 1972, *J. Daams 72-200*.

This species is characterized by the combination of pleurocystidia, four-spored basidia, spores with an eccentric germ pore, clamp-connections and its preference for dung. *Coprinus congregatus* is probably the closest relative. It differs from *C. ephemerus* in the absence of clamps and the slightly smaller spores.

26. **Coprinus stellatus** Buller—Fig. 26

Coprinus stellatus Buller, Fungi Manitoba: 119. 1929.
Coprinus brevisetulosus Arnolds, Ecol. Coenol. Macrofungi Grassl. Heathl. Drenthe Netherl.: 309. 1982.

Closed pileus up to 10 × 7 mm, ochre-coloured at centre, paler towards margin, up to c. 18 mm in diam. when expanded. Lamellae free, narrowly, white to blackish; L = c. 12–20, l = 0–1(–3). Stipe 30–70 × 0.5–2 mm, whitish, pubescent.

Spores [40, 2, 2] 7.9–11.4 × 5.2–6.7 µm, av. L = 8.7–9.2, av. B = 5.3–5.4 µm, Q = 1.50–1.90, av. Q = 1.65–1.70, ovoid, somewhat truncate; germ pore central, c. 1.4 µm wide. Basidia 16–30 × 8–11 µm, 4-spored. Pseudoparaphyses (3–)4–5(–6) per basidium. Cheilocystidia 40–60 × 20–30 µm, globose to ellipsoid, ovoid or oblong. Pleurocystidia 60–120 × 15–35 µm, ellipsoid, ovoid, obovoid, oblong, (sub)cylindrical or slightly utriform. Pileocystidia 20–65 × 7–14 µm, lageniform with tapering neck, 2.5–5 µm wide at apex. Sclerocystidia absent. Clamp-connections absent.

Habitat.—Gregarious, on dung.

Collections examined.—NETHERLANDS: prov. Drente, de Wijk, Reestdal, 15 Oct. 1976, *E. Arnolds 3666* (as *C. brevisetulosus*, holotype WBS); Westerbork: Mantinge, 14 Jan. 1975, *Arnolds 3381* (WBS); Elp, 9 Oct. 1975, *Arnolds 3440* (WBS); prov. Overijssel, Staphorst, Reestdal, 7 Oct. 1975, *Arnolds 3437* (WBS); 10 Sept. 1976, *Arnolds 3579* (WBS); prov. Zuid-Holland, Alphen a/d Rijn, 23 Sept. 1986, *Uljé*.

The main characters, separating this species from others in the *'Setulosi'*, are the roundish apex of the spores and the central germ pore. The other species with this character is *C. pellucidus*, but that has no pleurocystidia and its cheilocystidia are more globose and smaller. Moreover, *C. pellucidus* has very small fruit-bodies.

M. Lange (1952: 115) described *C. stellatus* with spores measuring 8.8–12.1 × 4.9–5.9 µm (averages per sample); Buller (original description) found them to measure 8–10 × 4–5 µm. In view of the narrow species concept in the *Setulosi*, Arnolds preferred to describe *C. stellatus* sensu M. Lange as a new species on account of the different spore sizes and the somewhat deviating colour of the pileus (slightly more reddish) with the name *C. brevisetulosus*.

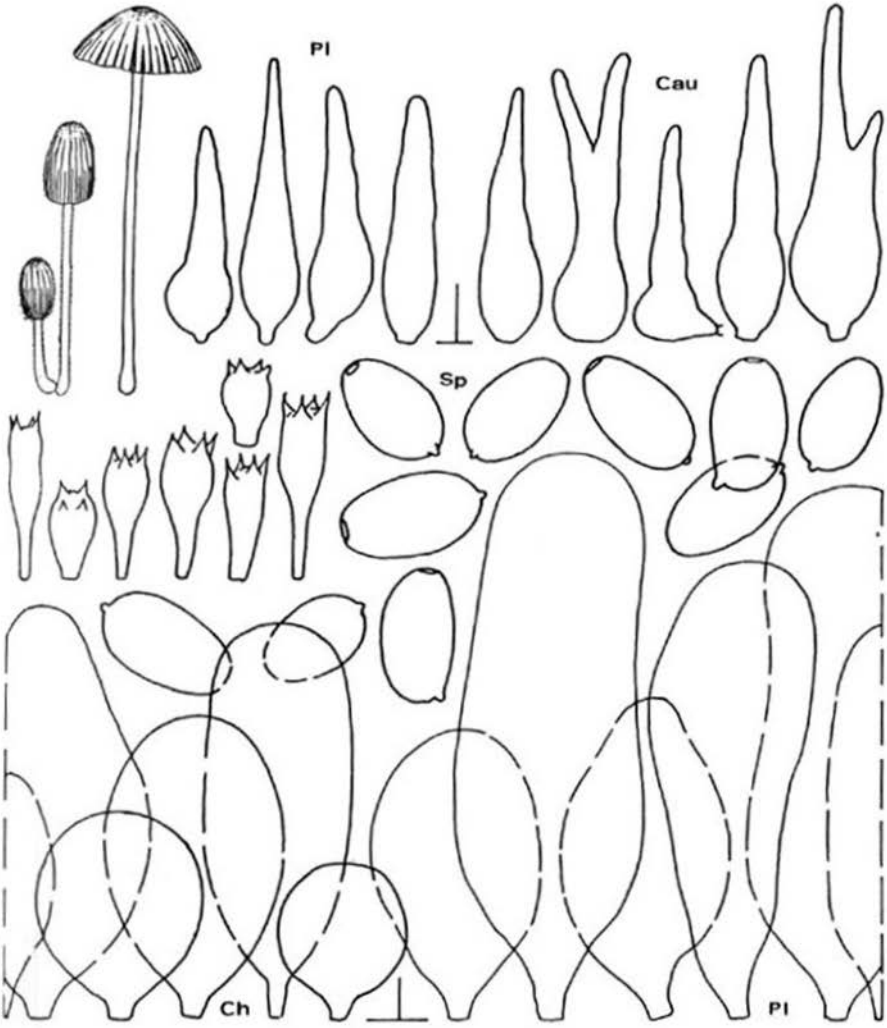

Fig. 26. *Coprinus stellatus* Buller — All figures from *Uljé*, 23 Sept. 1986.

The first author (Uljé) studied the type of *C. brevisetulosus* and found the difference in size of the spores in comparison to those of *C. stellatus* sensu Buller somewhat smaller. Two times a sample of 20 spores was measured and the sizes found are: 7.9–9.9 × 4.9–5.8 µm and 8.0–10.2 × 5.0–6.0 µm. Arnolds found them to be 9.0–10.6 × 5.2–5.6 µm.

The diagnosis of *C. brevisetulosis* Arnolds gave the following spore sizes: (7.7–)8.9–11.4(–12.0) × 4.6–6.7(–7.0) µm, probably compiled from those of the type and the four paratypes (*Arnolds 3381, 3437, 3440 en 3579*). In Arnold's notes with these collections the measurements are:

(*3381*) 8.6–10.8 × 4.8–5.7 µm
(*3437*) 8.7– 9.8 × 5.2–6.0 µm
(*3440*) 9.5–11.4 × 6.0–6.7 µm
(*3579*) 8.6–10.2 × 4.6–5.4 µm

From these data it appears that the length of the spores of the type of *C. brevisetulosus* and the collections *Arnolds 3437, 3579*, and to a lesser degree also of *3381* agrees fairly well with the length of the spores of *C. stellatus* given by Buller. The breadth of the spores of these collections, however, agrees better with that given by M. Lange; the same applies to the length of the spores of *Arnolds 3440*.

The differences in spore size between *C. stellatus* and *C. brevisetulosus* is then mainly restricted to the breadth of the spores: values of about 0.5–1 µm.

We think that these differences are too insignificant to justify the maintenance of *C. brevisetulosus* as a separate species. Moreover, it is possible that Buller measured the spores in side view, whereas we and perhaps also other authors did that in front view. Because of the great variation in the colours of the pileus in subsection *Setulosi* the possible slight difference in pileus colour mentioned by Arnolds is even less convincing.

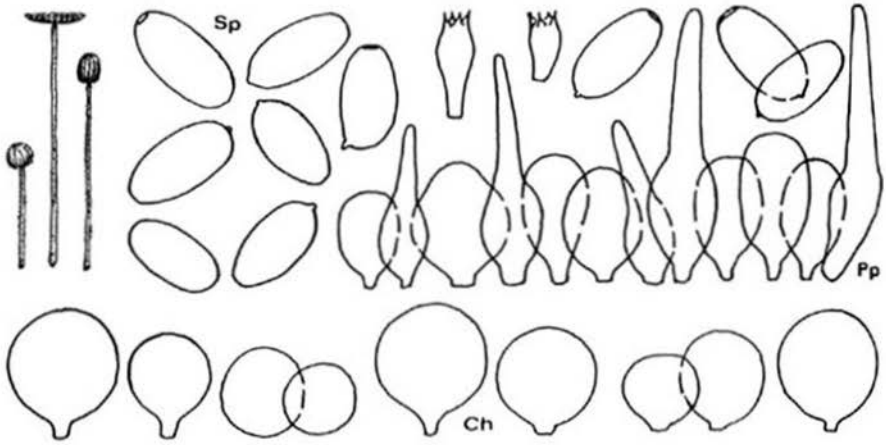

Fig. 27. *Coprinus pellucidus* Karst. — All figures from *Uljé 1006*.

27. **Coprinus pellucidus** P. Karst.—Fig. 27

Coprinus pellucidus P. Karst. *in* Meddn Soc. Fauna Fl. fenn. 9: 61. 1882.

Closed pileus up to 5 × 3 mm, but usually much smaller, whitish with pale yellow-brown, ochre-brown to grey-brown centre (Mu. 10 YR 6/4, K. & W. 5D5), up to c. 7 mm in diam. when expanded. Lamellae free, whitish to blackish; L = 12–20, l = 0–1. Stipe 15–70 × 0.1–0.5 mm, whitish, vitreous, sparsely pubescent.

Spores [60, 3, 3] 6.3–9.4 × 3.2–4.2 µm, av. L = 7.3–7.9, av. B = 3.6–3.9 µm, Q = 1.80–2.20, av. Q = 1.95–2.10, oblong to ovoid, often somewhat cylindrical, slightly truncate; germ pore central, c. 1.3 µm wide. Basidia 10–26 × 5–7 µm, 4-spored. Pseudoparaphyses not noted. Cheilocystidia c. 20–30 × 15–23 µm, (sub)globose. Pleurocystidia absent. Pileocystidia 25–50 × 7–12 µm, lageniform with tapering neck, 3–4 µm wide at apex. Sclerocystidia absent. Clamp-connections absent.

Habitat.—On cow dung. Common.

Collections examined.—NETHERLANDS: prov. Noord-Holland, 1 June 1986, *E.C. Vellinga*; prov. Zuid-Holland, Leiden, 20 Sept. 1985, *Uljé 660*; Alphen a/d Rijn, Hazerswoude, 31 Oct. 1988, *Uljé 1006*.

The spores of *C. pellucidus* are slightly smaller and somewhat more (sub)cylindrical than in *C. stellatus* and that species has pleurocystidia, which *C. pellucidus* has not. In addition the fruit-bodies of *C. pellucidus* are very small and usually cream-coloured whereas those of *C. stellatus* are larger and more ochraceous brown.

28. **Coprinus heterosetulosus** Locq. ex Watl.—Fig. 28

Coprinus heterosetulosus Locq. *in* Bull. trimest. Soc. mycol. Fr. 63: 78. 1947 (invalid) — *Coprinus heterosetulosus* Locq. ex Watl. *in* Notes R. bot. Gdn Edinb. 35: 153. 1976.

Closed pileus up to 5 × 4 mm, sometimes up to 7 mm high, date-brown, umbra-brown (Mu. 7.5 YR 3/6, K. & W. 5E5), paler towards margin, up to c. 7(–10) mm in diam. when expanded. Lamellae free, narrow, white to blackish; L = 8–13, l = 0–1. Stipe 15–50 × 0.25–0.75 mm, whitish, vitreous, sparsely pubescent.

Spores [60, 3, 3] 8.0–11.0 × 5.0–6.4 µm, av. L = 9.1–9.7, av. B = 5.5–5.8 µm, Q = 1.50–1.80, av. Q = 1.65–1.70, ellipsoid to ovoid; germ pore eccentric, c. 1.6 µm wide. Basidia 16–32 × 8.5–10 µm, 4-spored. Pseudoparaphyses 4–6 per basidium. Cheilocystidia 13–25 × 12–18 µm, (sub)globose to ovoid. Pleurocystidia absent. Pileocystidia 30–95 × 8–21, lageniform with tapering neck, 2–5 µm wide at apex. Sclerocystidia present. Clamp-connections present.

Habitat.—Solitary or subgregarious on horse dung. Common.

Collections examined.—NETHERLANDS: prov. Zuid-Holland, Hazerswoude, 30 Nov. 1987, *Uljé*; 12 Dec. 1987, *Uljé 884*; 7 March 1988, *Uljé*; Alphen a/d Rijn, 1 March 1988, *Uljé 986*; 25 Oct. 1988, *Uljé 1002*.

Coprinus heterosetulosus is easily recognizable because of its usually numerous sclerocystidia, its habitat on dung and its spores with an eccentric germ pore. It has very small fruit-bodies, like *C. pellucidus*, but that species has no sclerocystidia and has spores with a central germ pore. The colour of *C. heterosetulosus* is a rather dark brown in fresh, young specimens.

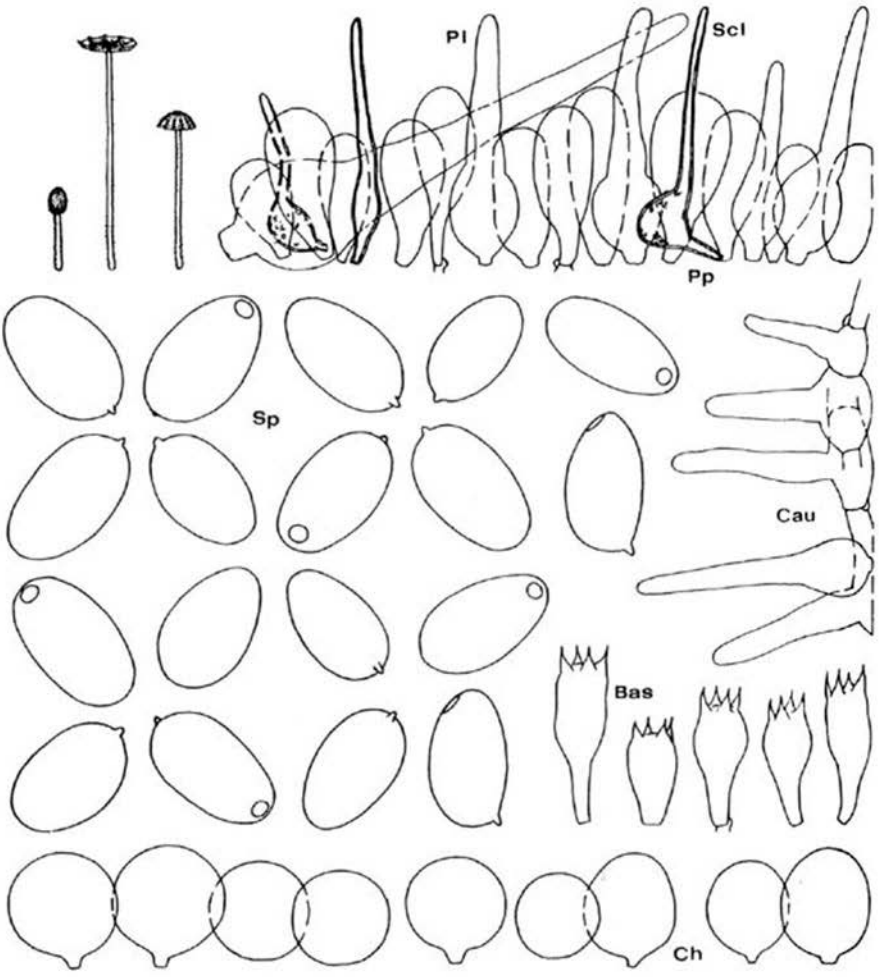

Fig. 28. *Coprinus heterosetulosus* (Locq.) Watl. — All figures from *Uljé 986*.

29. **Coprinus angulatus** Peck—Fig. 29

Coprinus angulatus Peck *in* Rep. N.Y. St. Mus. nat. Hist. 26: 60. 1874.
Coprinus boudieri Quél. *in* Bull. Soc. bot. France 24: 321. 1877.

Closed pileus up to 20 × 15 mm, dark rust-brown to ochre-brown (Mu. 7.5 YR 3/6 to 6/6, K. & W. 6E7 to 5C/D7), remaining campanulate rather long, up to 30 mm in diam. when expanded. Lamellae narrowly adnate, rather broad and distant, white to blackish. Stipe 30–60 × 1–3 mm, usually relatively short, whitish, pubescent.

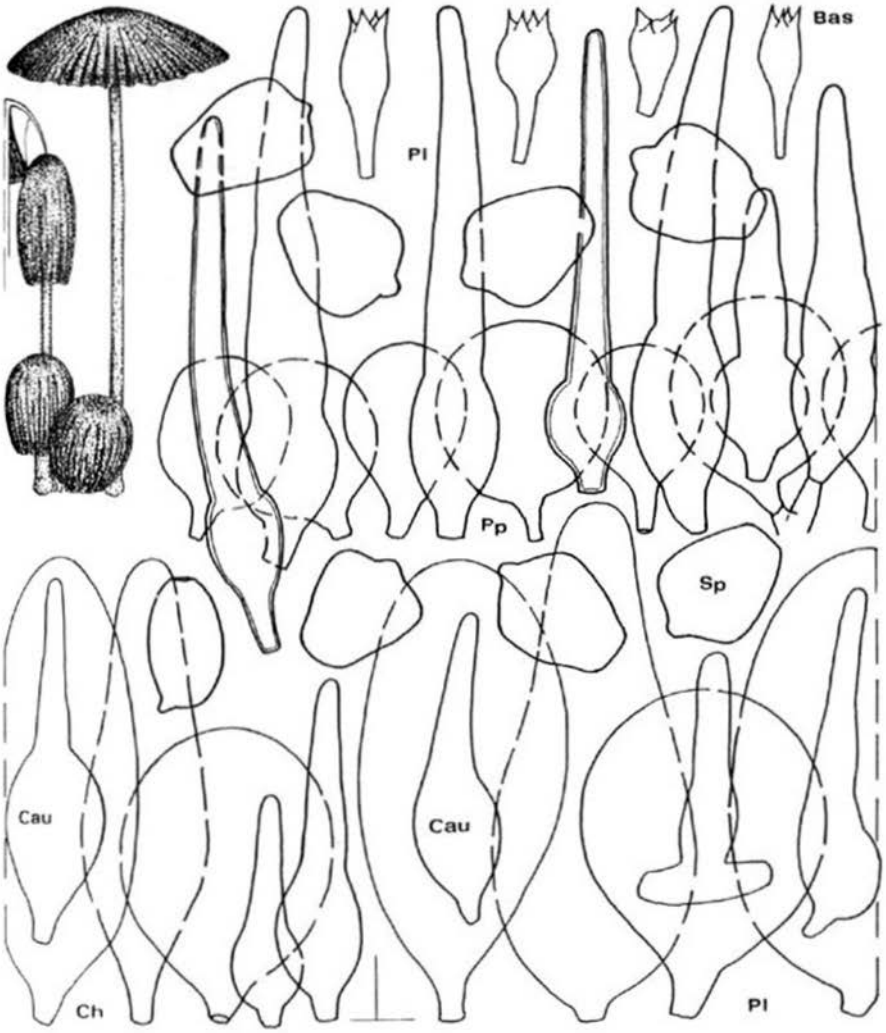

Fig. 29. *Coprinus angulatus* Peck. — All figures from *Daams*, 27 July 1974.

Spores [40, 2, 2] 7.7–10.5 × 6.0–7.8 × c. 5.5 µm, av. L = 8.7–9.6, av. B = 6.8–7.2 µm, Q = 1.15–1.60, av. Q = 1.25–1.35, mitriform in front view, truncate; germ pore central, c. 1.8 µm wide. Basidia 15–36 × 8–10 µm, 4-spored. Pseudoparaphyses 4–6 per basidium. Cheilocystidia 30–80 × 25–40, (sub)globose to narrowly ellipsoid, sometimes slightly utriform intermixed with lageniform ones, 30–60 × 8–20 µm, with tapering neck and 2–5 µm wide at apex. Pleurocystidia 60–100(–120) × 25–60 µm, (sub)globose to ellipsoid or utriform. Pileocystidia 50–100 × 12–15 µm, lageniform with tapering neck, 3.5–6 µm wide at apex. Sclerocystidia present. Clamp-connections present.

Habitat.—Gregarious, on burnt ground. Rather common.

Collections examined.—NETHERLANDS: prov. Noord-Holland, 's-Graveland, Boekesteyn, 27 July 1974, *J. Daams*; prov. Gelderland, Winterswijk, Buskusbos, 29 Sept. 1973, *W. Gams*.

The peculiar shape of the spores makes this species easy to recognize. Macroscopically, the roundish shape of the young fruit-bodies, usually rather dark brown, and the habitat on burned places, are indications that one is dealing with this species.

A.H. Smith (1948: 670) studied the type material and recorded the size of the spores as being 8.5–10(–11) × 7–8.8 × 5.7–6.3 µm. The breadth of the spores is somewhat larger than we found in the two collections analyzed.

30. **Coprinus bisporiger** Buller ex P.D. Orton—Fig. 30

Coprinus bisporiger Buller (*'bisporigera'*) *in* Trans. Brit. mycol. Soc. 3: 350. 1911 (invalid) — *Coprinus bisporiger* Buller ex P.D. Orton in Notes R. bot. Gdn Edinb. 35: 147. 1976.

Misapplied.—*Coprinus bisporus* sensu Buller non J. Lange *in* Trans. Brit. mycol. Soc. 6: 363. 1920.

Closed pileus up to 12 × 9 mm, ochre-brown to cinnamon-brown (Mu. 10 YR 5/6 to 6/8, K. & W. 5C5 to 5A6, 5B5), up to 25 mm in diam. when expanded. Lamellae narrowly adnate, up to 2 mm broad; L = c. 32, l = 1–3, white to blackish. Stipe 40–80 × 1–3 mm, whitish, pubescent.

Spores [80, 4, 3] 10.3–13.7 × 6.3–8.3 µm, av. L = 11.4–12.2, av. B = 7.0–7.9 µm, Q = 1.45–1.70, av. Q = 1.55–1.60, ellipsoid to ovoid; germ pore eccentric, c. 1.8 µm wide. Basidia 16–32 × 7–9 µm, 2-spored. Pseudoparaphyses 4–6 per basidium. Cheilocystidia 25–55 × 20–35 µm, globose to ellipsoid. Pleurocystidia 40–65 × 28–37 µm, subglobose to ellipsoid. Pileocystidia 50–110 × 12–25 µm, lageniform with tapering neck, 5–8 µm wide at apex. Sclerocystidia absent. Clamp-connections absent.

Habitat.—Growing in woods, among leaves and on fallen branches. Rare.

Collections examined.—NETHERLANDS: prov. Noord-Holland, Kudelstaart, 21 July 1988, *K.J. Eigenhuis* (*Uljé 921*). — GERMANY: Westfalen, Mönchengladbach, 1 June 1982, *H. Bender* (herb. Bender). — GREAT BRITAIN: England, Surrey, Richmond, Kew, Oct. 1911, *R. Buller* (holotype, K).

Coprinus bisporiger is very similar to *C. bisporus* but grows on fallen branches and among leaves, whereas *C. bisporus* is fimicolous. Orton & Watling (1979: 88) suggest that *C. bisporiger* also differs in the presence of thick-walled setulae. Bender (1987: 219) stated that *C. bisporiger* has pleurocystidia. The first author of this paper indeed found these in Bender's collection cited above, but only in the half of the lamellae closest to the edge. In the Netherlands' collection pleurocystidia were lacking.

The first author was unable to find more than spores and pileocystidia in Buller's type collection of *C. bisporiger*.

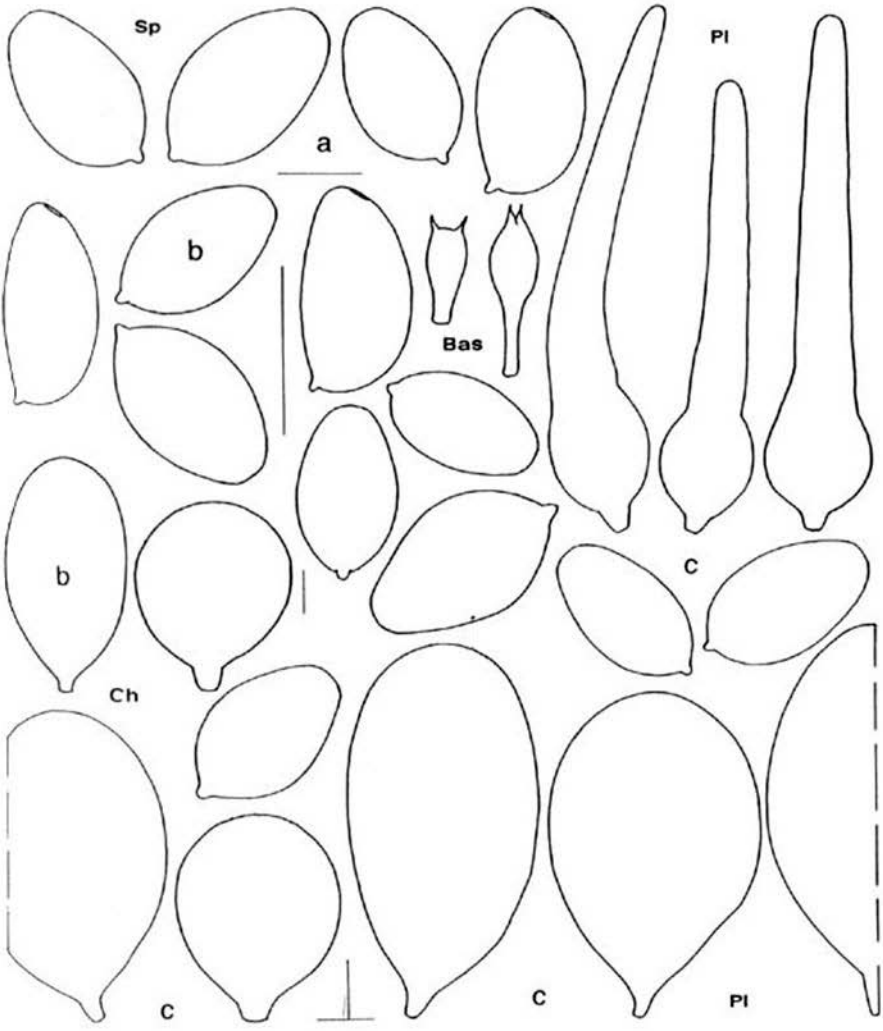

Fig. 30. *Coprinus bisporiger* Buller ex P.D. Orton. — a. From type. — b. From *Uljé 921*. — c. From *Bender*, 1 June 1982.

31. **Coprinus bisporus** J.E. Lange—Fig. 31

Coprinus bisporus J.E. Lange *in* Dansk bot. Ark. 2 (3): 50. 1915.

Closed pileus up to 16 × 12 mm, ochre to cinnamon at centre (Mu. 10 YR 6–7/6, 2.5 Y 5.5/4, K. & W. 5D5, 4A5), paler towards margin (Mu. 2.5 Y 5/5–7/3), up to 20 mm wide when expanded. Lamellae narrowly adnate to free, white to blackish. Stipe 40–80 × 1–2 mm, whitish, pubescent.

Spores [80, 4, 4] 9.7–13.7 × 6.1–8.4 µm, av. L = 10.9–12.2, av. B = 6.5–7.4 µm, Q = 1.40–2.10, av. Q = 1.55–1.80, ellipsoid to ovoid; germ pore eccentric, c. 1.8 µm wide. Basidia 15–28 × 6–8 µm, 2-spored. Pseudoparaphyses (3–)4–5(–6) per basidium. Cheilocystidia 20–55 × 15–32 µm, vesiculose. Pleurocystidia absent. Pileocystidia 60–120 × 10–22 µm, lageniform with tapering neck, 5–10 µm wide at apex. Sclerocystidia absent. Clamp-connections absent.

Habitat.—Fasciculate on dung, mixtures of straw and dung and also on decaying straw. Common.

Collections examined.—NETHERLANDS: prov. Zuid-Holland, Alphen a/d Rijn, 3 Oct. 1984, *Uljé 551*; 19 Apr. 1985, *Uljé 632*; 29 Aug. 1987, *Uljé 894*; Hazerswoude, 15 Oct. 1988, *Uljé 995*.

Coprinus bisporus is easily recognizable by its two-spored basidia, and its globose to ellipsoid cheilocystidia, by the absence of sclerocystidia and clamp-connections and by its preference for dung or straw dung-mixtures. Only *C. bisporiger* is close, but that species grows on sticks and among leaves and perhaps has also some morphological differences (see the discussion under that species).

Kemp (pers. comm.) received *C. bisporiger* from Hohmeyer in Germany (Westfalen) and found it to mate with *C. bisporus*.

32. **Coprinus amphithallus** M. Lange & A.H. Smith—Fig. 32

Coprinus amphithallus M. Lange & A.H. Smith *in* Mycologia 45: 774. 1953.

Closed pileus up to 8 × 5 mm, expanding to 18 mm in diam., cream with dark brown to cinnamon-coloured centre (Mu. 7.5 YR 3–4/4 to 4–5/6, K. & W. c. 6D6), later more grey (Mu. 10 YR 5–6/1, K. & W. 5C/D2), disk and radial stripes staying brown for a rather long time. Lamellae narrowly adnate, up to 1.5 mm broad, whitish, then grey to blackish; L = c. 20, l = 0–1. Stipe 30–80 × 1–1.5 mm, whitish, somewhat vitreous, sparsely pubescent.

Spores [60, 3, 3] 12.3–15.6(–19) × 6.7–8.7(–9.5) µm, av. L = 13.2–14.2, av. B = 7.4–7.9 µm, Q = 1.65–1.90, av. Q = 1.75–1.80, ellipsoid to ovoid; germ pore eccentric, c. 1.8 µm wide. Basidia 21–34 × 8–11 µm, 2-spored. Pseudoparaphyses not noted. Cheilocystidia 25–40(–50) × 10–16 µm, lageniform with tapering neck, 2–3(–5) µm wide at apex. Pleurocystidia absent. Pileocystidia 40–85 × 10–16 µm, lageniform with tapering neck, 4–7 µm wide at apex. Clamp-connections present.

Habitat.—At clayey-sandy roadsides, often among grasses. Solitary or subgregarious. Rather rare.

Collections examined.—NETHERLANDS: prov. Noord-Holland, 19 June 1984, *Uljé 562*; prov. Zuid-Holland, Alphen a/d Rijn, 19 July 1984, *Uljé 525*. — GERMANY: Eifel, Berlinger Bach, 21 Sept. 1980, *F. & G. Tjallingii* (herb. Tjallingii).

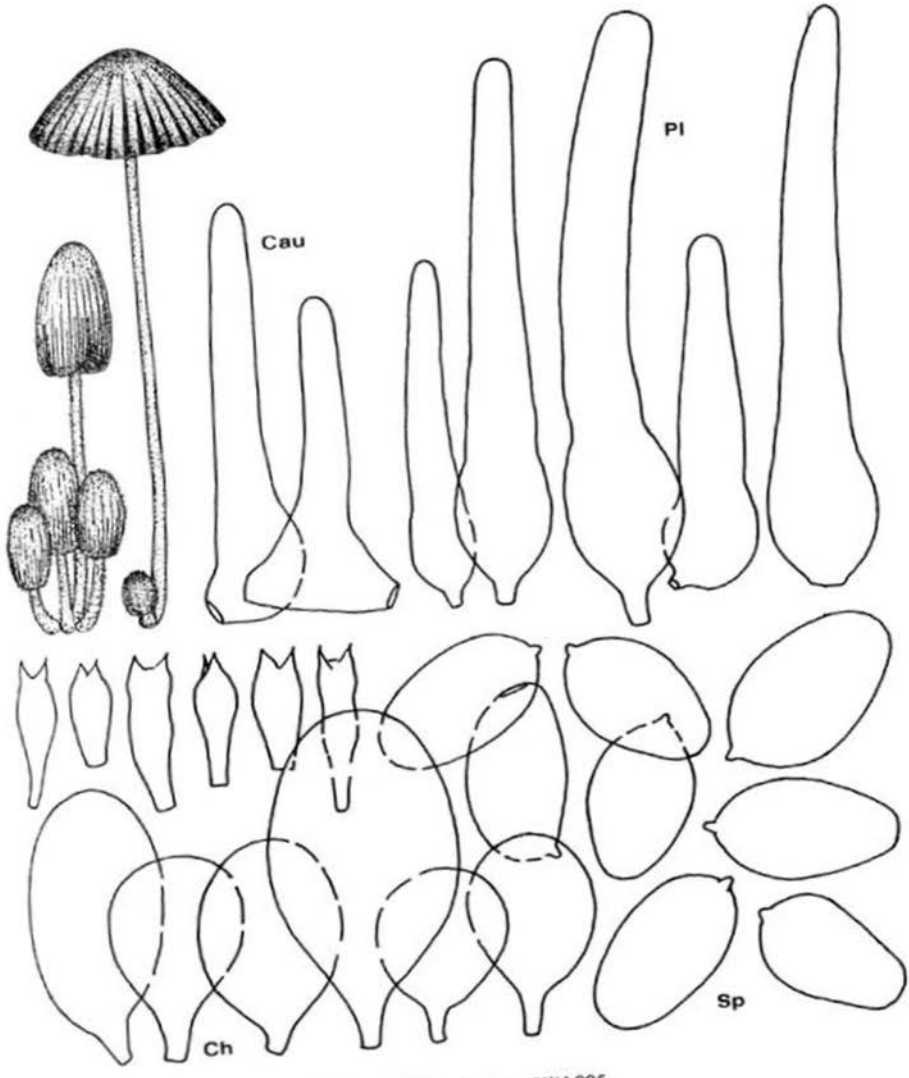

Fig. 31. *Coprinus bisporus* J.E. Lange. — All figures from *Uljé 995*.

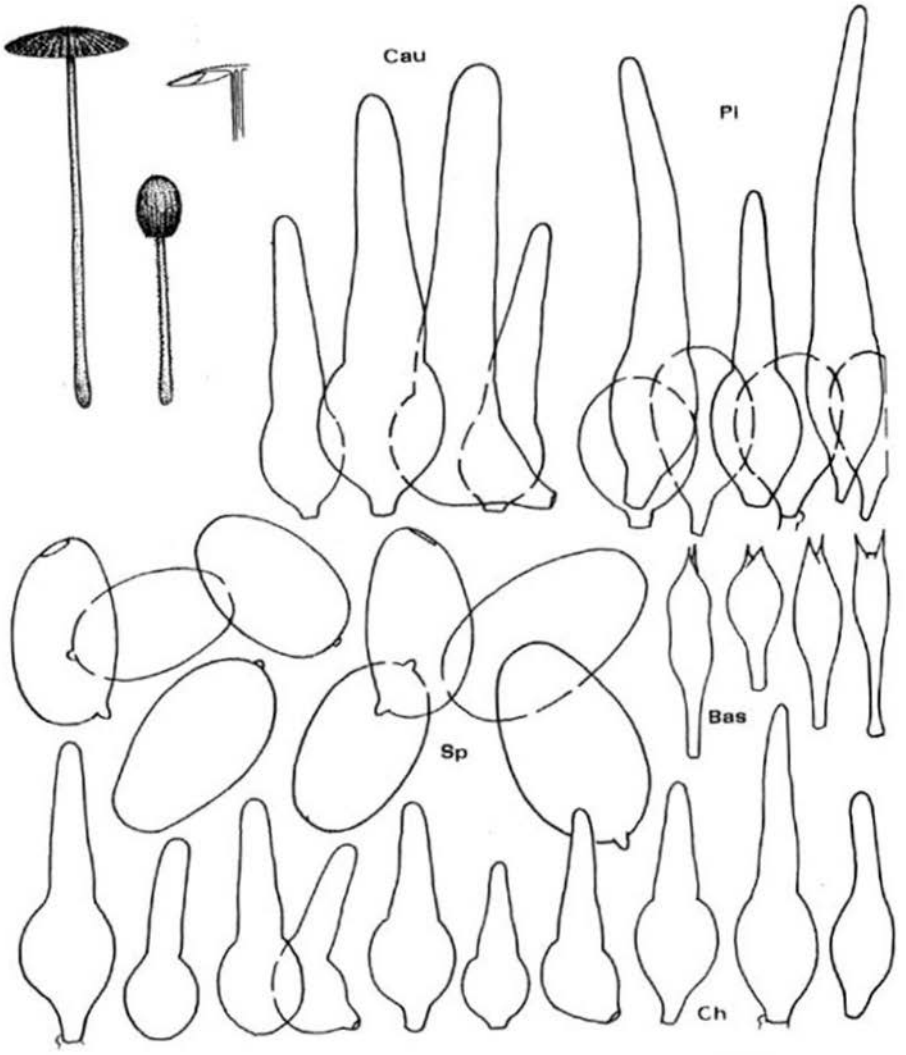

Fig. 32. *Coprinus amphithallus* M. Lange & A.H. Smith. — All figures from *Uljé 562*.

Coprinus amphithallus is a terrestrial, two-spored species with lageniform cheilocystidia. Microscopically the closest species is *C. singularis*, which has smaller fruit-bodies and broader spores with a central germ pore. The shape of the spores is different also in these two species. The other two-spored species in subsect. *Setulosi* grow on dung (except *C. verrucispermus*) and have globose cheilocystidia. *Coprinus verrucispermus* has warty, differently shaped spores.

More or less at the same time that Lange & Smith described *C. amphithallus*, Kühner & Romagnesi (1953: 391) gave a description of a species provisionally named *C. disseminatoides*. That species seems to be identical with *C. amphithallus*, a fact recognized by Kühner (1957: 61) when he gave a description of *C. amphithallus* and placed *C. disseminatoides* in its synonymy (see also Bender & Enderle, 1988: 45–48).

33. **Coprinus singularis** Uljé—Fig. 33

Coprinus singularis Uljé *in* Persoonia 13: 486. 1988.

Closed pileus up to 3 × 2 mm, pale brown to ochre-brown (Mu. 10 YR 7/3 to 7.5 YR 5/6, K. & W. 4A3), with somewhat darker radial striation; expanded pileus greyish and up to 8(–11) mm wide. Lamellae narrowly adnate, white, grey to blackish; L = 8–16, l = 0–3. Stipe 20–35 × 0.5–1 mm, whitish, vitreous, sparsely pubescent.

Spores [120, 6, 3] 9.7–17 × 6.8–10.9 µm, av. L = 11.4–14.4, av. B = 8.5–9.1 µm, Q = 1.20–1.70, av. Q = 1.35–1.50, broadly cylindrical, rounded truncate; germ pore central, difficult to see, because of very dark colour of spores, c. 2 µm wide. Basidia 15–34 × 8–10 µm, 2-spored, but often also 1-spored. Pseudoparaphyses 4–6 per basidium. Cheilocystidia 30–50 × 12–17 µm, lageniform with tapering to (sub)cylindrical neck and 3–5 µm wide apex. Pleurocystidia absent. Pileocystidia 50–85 × 11–18 µm, lageniform with tapering, sometimes (sub)cylindrical neck, 3.5–8 µm wide at apex. Clamp-connections present.

Habitat.—Solitary or subgregarious. On lawns and grassy roadsides. Rather common.

Collections examined.—NETHERLANDS: prov. Zuid-Holland, Alphen a/d Rijn, 21 Aug. 1987, *Uljé 850* (holotype, L); 22 Sept. 1987, *Uljé 853*; 4 Sept. 1987, *Uljé*.

This species differs from *C. amphithallus* in broader, rounded truncate, subcylindrical spores with a central germ pore. The fruit-bodies are distinctly smaller. In all of the several collections found at different localities one-spored as well as two-spored basidia were present.

34. **Coprinus silvaticus** Peck—Fig. 34

Coprinus silvaticus Peck *in* Rep. N.Y. St. Mus. nat. Hist. 24: 71. 1870.
Coprinus tardus (Karst.) Karst. *in* Meddn Soc. Fauna Fl. fenn. 5: 34. 1880.
Misapplied.—*Coprinus tergiversans* Fr. sensu Rick. Blätterpilze: 63. 1915.

Closed pileus up to 35 × 25 mm, ochre-brown (Mu. 7.5 YR 4.5/4 to 10 YR 6/4, K. & W. 6D4.5 to 5D4) with dark reddish brown centre (Mu. 5 YR 3/4, K. & W. 7E5), usually campanulate to convex, up to 40 mm in diam. when mature, seldom entirely flat, with ochre-brown, granular-flocculose veil. Lamellae narrowly adnate, whitish, dark brown to blackish; L and l not noted. Stipe 40–80 × 2–5 mm, whitish, pubescent.

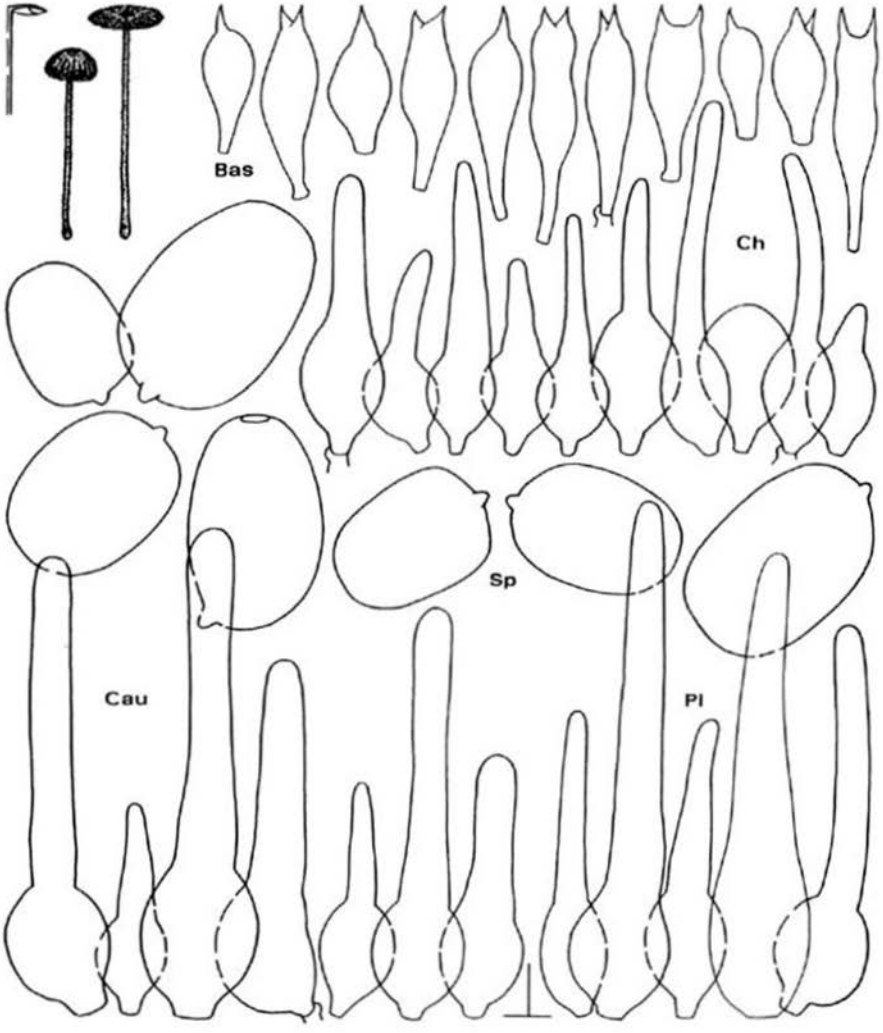

Fig. 33. *Coprinus singularis* Uljé. — All figures from type.

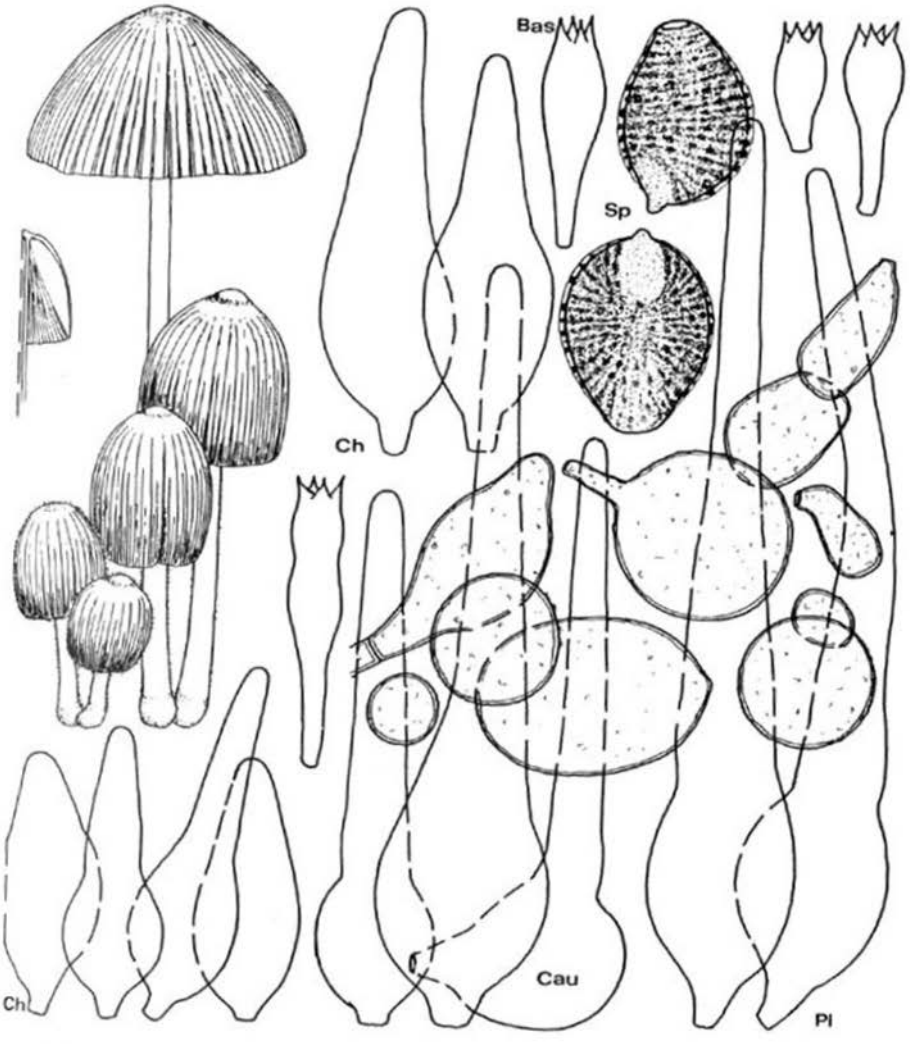

Fig. 34. *Coprinus silvaticus* Peck. — All figures from *Maas Geesteranus 3230*.

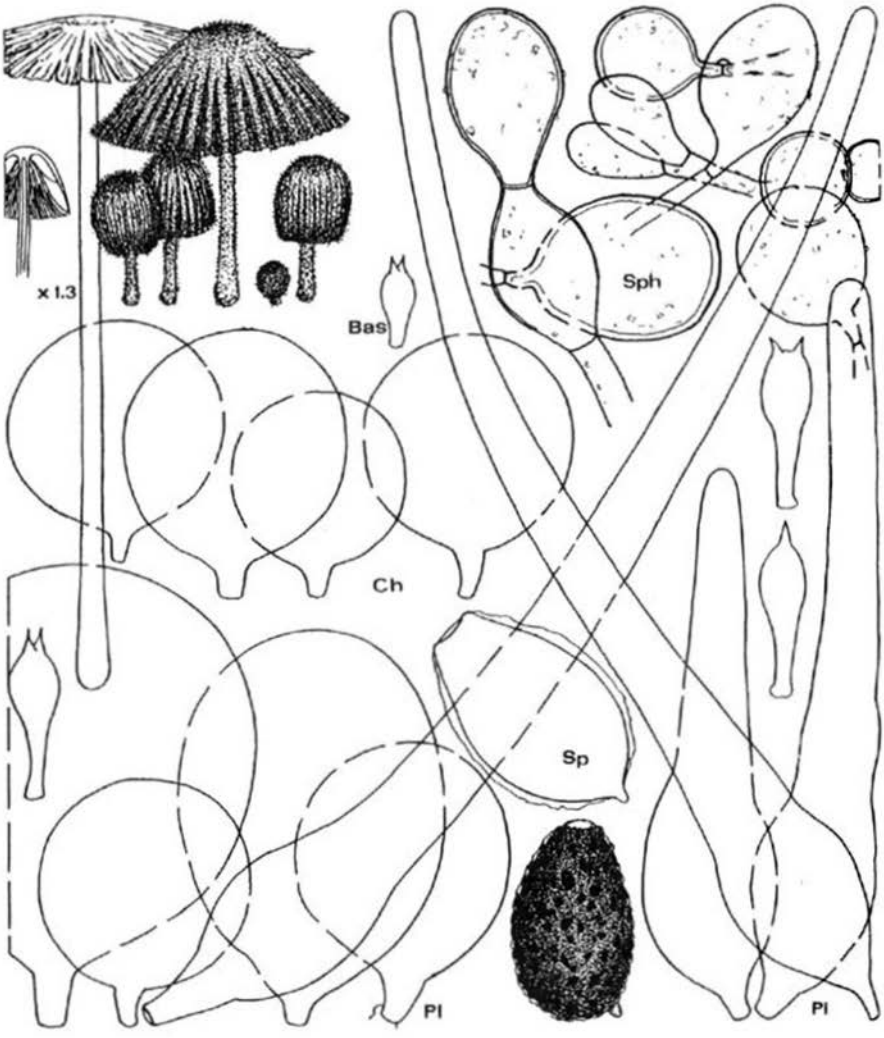

Fig. 35. *Coprinus verrucispermus* Joss. & Enderle. — All figures from *Uljé 1014*.

Spores [80, 4, 4] 10.2–15.0 × 7.2–10.0 µm, av. L = 12.1–12.9, av B = 7.3–8.4 µm, Q = 1.40–1.70(–1.90), av. Q = 1.50–1.65, ovoid in front view, amygdaliform in side view, ornamented with rows of small warts or with larger, more isolate warts, truncate; germ pore central, c. 2.2 µm wide. Basidia 20–60 × 8–11, 4-spored. Pseudoparaphyses (4–)5–6 per basidium. Cheilocystidia 45–90 × 16–30 µm, lageniform or conical to fusiform with tapering neck and 5–8 µm wide apex. Pleurocystidia absent. Pileocystidia 60–150 × 20–35 µm, lageniform with tapering neck, 6–8.5 µm wide at apex. Velar spherocysts on pileipellis globose to ovoid, up to 45 µm long. Clamp-connections not found. (M. Lange (1952: 127) does mention clamps).

Habitat.—On rich, clayey soil, usually fasciculate. Rather rare.

Collections examined.—NETHERLANDS: prov. Utrecht, Breukelen, Sterreschans, 23 Aug. 1986, *Uljé 632*; prov. Zuid-Holland, Wassenaar, 6 Oct. 1945, *R.A. Maas Geesteranus 3230*; prov. Noord-Holland, Vogelenzang, 28 Nov. 1967, *J. Klarenberg*; prov. Friesland, Tjalleberd, 22 Oct. 1982, *J. Wisman*.

Coprinus silvaticus is easily recognized by the verrucose, amygdaliform spores in combination with the four-spored basidia. It has comparatively large fruit-bodies. *Coprinus verrucispermus*, the other species in the *Setulosi* with verrucose spores, has distinctly smaller fruit-bodies and two-spored basidia. Moreover, the spores in that species are more ellipsoid to only slightly amygdaliform. The warty appearance of the spores of *C. verrucispermus* disappears in KOH, that of *C. silvaticus* not.

35. **Coprinus verrucispermus** Joss. & Enderle—Fig. 35

Coprinus verrucispermus Joss. & Enderle *in* Z. Mykol. 54: 67. 1988.

Closed pileus up to 15 × 12 mm, first dark (red-)brown (Mu. 7.5 YR 4/4–5/6, K. & W. 6C4–6D6), soon paler, especially outside centre (Mu. 7.5 YR 5/6–5/8 to 10 YR 7/4, K. & W. 5C4–5, 5D4, 6C6), entirely covered with brown, flocculose-granular remnants of veil, up to 30(–47) mm in diam. when expanded. Lamellae narrowly adnate, white, dark sepia to blackish; L = 22–38, l = 0–3. Stipe 30–70 × 1–3 mm, usually short in proportion to pileus, whitish, pubescent.

Spores [80, 4, 2] 11.2–16.8 × 7.1–9.4 µm, av. L = 13.4–14.5, av. B = 7.9–8.9 µm, Q = 1.40–1.80, av. Q = 1.50–1.70, ovoid in front view, ellipsoid to slightly amygdaliform in side view, ornamented, with wrinkled-folded perisporium giving spores a warty appearance, but after some hours in KOH becoming smooth because of swelling of perisporium, truncate; germ pore central, c. 2 µm wide. Basidia 18–35 × 8–10 µm, 2-spored. Pseudoparaphyses 4–6 per basidium. Cheilocystidia 20–50 µm in diam., (sub)globose to ellipsoid. Pleurocystidia 30–65 µm broad, vesiculose. Velar spherocysts on pileipellis globose, 10–25 µm in diam. to ellipsoid, up to 15–35 × 8–25 µm. Pileocystidia 80–210 × 18–25 µm, lageniform with tapering neck, 5–8 µm wide at apex. Clamp-connections small and difficult to find.

Habitat.—Gregarious on naked, clayey soil. Rare.

Collections examined.—NETHERLANDS: prov. Utrecht, Linschoten, 13 Aug. 1988, *Uljé 951*; 6 Aug. 1989, *Uljé 1014*.

This species is characterized by its warty spores in combination with two-spored basidia. The closest related species is *C. silvaticus*, which has four-spored basidia, no pleurocystidia, lageniform cheilocystidia and usually much larger fruit-bodies.

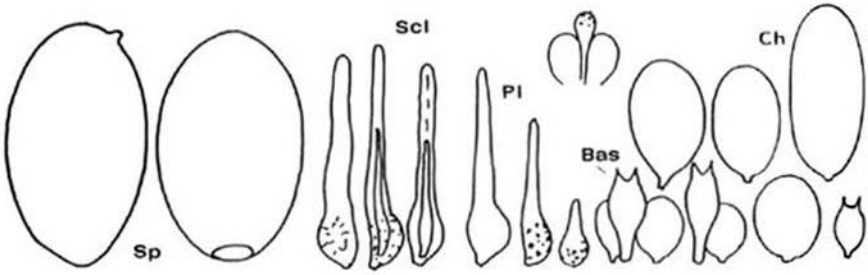

Fig. 36. *Coprinus sassii* M. Lange & A.H. Smith. — Figures copied from M. Lange 1952: 76 (sp.) and 91 (other figs.).

36. **Coprinus sassii** M. Lange & A. H. Smith — Fig. 36

Coprinus ephemerus f. *bisporus* Sass *in* Amer. J. Bot. 16: 669. 1929. — *Coprinus sassii* M. Lange & A.H. Smith *in* Mycologia 45: 755. 1953 (name change).

Closed pileus up to 20 mm high, narrowly conical, up to 35 mm in diam. when expanded, cinnamon-brown, red-brown, young specimens with somewhat purple tinge at centre. Lamellae free or almost free, whitish, finally black; L = c. 28, l = 0–1. Stipe up to 80 × 2–3 mm, white or weakly tinged with colour of pileus at base, pubescent.

Spores 12.8–20.0 × 7.9–11.0 µm, av. L = 15.2–17.3, av. B = 8.7–9.8 µm, av. Q = 1.70–1.75, ellipsoid; germ pore eccentric, c. 2.5 µm wide. Basidia 18–38 × 9–12.5 µm, 2-spored. Pseudoparaphyses not mentioned. Cheilocystidia 20–60 × 20–30 µm, globose to ovoid. Pleurocystidia 50–90 × 25–55 µm, mostly vesiculose. Pileocystidia 30–100 × 5–16 µm, with tapering neck, 2–5 µm wide at apex. Sclerocystidia present. Clamp-connections present (single-spore mycelia with and without clamps, according to Lange & Smith, l.c.).

H a b i t a t.—Gregarious on horse-dung and decaying straw. Not known from the Netherlands (the record mentioned by Arnolds & al., 1984: 67, concerns another species).

This species is unknown to us and we did not study the type. Therefore, the description above is based on that given by Lange & Smith, l.c. On account of the very large spores formed on two-spored basidia, the presence of pleurocystidia and clamp-connections and its habitat on dung *C. sassii* seems to be a well-defined species. *Coprinus bisporus* has no pleurocystidia, no clamps and much smaller spores. *Coprinus bisporiger* has pleurocystidia, but no clamp-connections, smaller spores too and its habitat is not on dung. The other two-spored species in subsect. *Setulosi* have lageniform cheilocystidia. Comparing *C. sassii* with four-spored species, *C. ephemerus* seems to be close to it, but in that species the absence of sclerocystidia and the smaller spores are differentiating characters.

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UBIQUINONES IN SELECTED SPECIES OF PENICILLIUM AND RELATED TELEOMORPH GENERA

M. SCHUBERT and H. KREISEL*

The ubiquinone type of 38 species (41 strains) of *Penicillium* sensu lato and related teleomorphic genera (*Eupenicillium, Talaromyces, Thermoascus*) was determined by RPPC or RPHPLC. In eight of the ten sections of *Penicillium* ubiquinone Q-9 was found as the main type. In sect. *Geosmithia* Q-10 and traces of Q-9 were demonstrated. In sect. *Biverticillium* (= sect. *Simplicium*) and its teleomorph *Talaromyces* Q-10(H_2) was demonstrated; in one species an additional unidentified ubiquinone was found. *Thermoascus* has ubiquinone Q-9. The results and those of earlier authors support the idea that the genus *Penicillium* in the actually accepted broad concept is heterogeneous.

The main components of ubiquinone (coenzyme Q) systems have been shown to be interesting tools in the taxonomy of microscopic fungi, in particular of yeasts and yeast-like fungi (de Hoog & al., 1987). Relatively few information is available concerning ubiquinone types in filamentous fungi. Concerning *Penicillium* sensu lato, the scarce data published by Raman & al. (1965), Lavate & al. (1965), Law & al. (1971), Kuraishi & al. (1985, 1990) and Kreisel & Schubert (1990) show that different ubiquinone types occur in this genus and correlated teleomorphs. Therefore a number of additional strains and species has been analyzed.

MATERIALS AND METHODS

Forty-one strains of *Penicillium* and related teleomorphs, representing 38 species, have been taken from the culture collection of Biology Section, Ernst Moritz Arndt University of Greifswald (SBUG). Origin of these strains is mentioned below together with the results. Determination of all analyzed strains has been done or verified by H. Kreisel.

The ubiquinone analyses have been carried out by M. Schubert with the methods applied by Yamada & Kondo (1973) and Kreisel & Schubert (1990) respectively. The fungi have been cultured in surface cultures on liquid medium. The mycelia were saporified with pyrogallol and methanol, extracted with petrolether, the ubiquinones isolated and cleaned on silicagel plates and extracted with acetone.

In most cases the ubiquinone type was identified by reverse phase paper chromatography (RPPC) and by comparison with reference substances extracted from mycelia of *Galactomyces geotrichum* (Q-9), *Aspergillus fumigatus* (Q-10), *Aspergillus flavus* (Q-10(H_2)) and with ubiquinone Q-10 from Merck.

In some cases, the ubiquinone types were identified by high performance liquid chromatography (RPHPLC), using an HPLC equipment LC 1084 B (Hewlett-Packard) and ap-

* Fachrichtung Biologie, E. M. Arndt-Universität, Ludwig-Jahn-Straße 15, 2200 Greifswald, Germany.

plying 65 vol-% methanol and 35 vol-% n-butanol as motile phase. This combination has been found useful for this purpose by Th. Jira who carried out the determination by RPHPLC and revealed superior to 65 vol-% methanol and 35 vol-% iso-propanol as recommended by Nakase & Suzuki (1986).

RESULTS

The following survey presents name, number, and origin of the investigated strains in alphabetical order, followed by the ubiquinone type determined by RPPC (PC) and/or RPHPLC (LC).

Strain	Ubiquinone type
Eupenicillium euglaucum (van Beyma) Stolk & Samson, Anam. *Penicillium citreonigrum* Dierckx, SBUG M-915, isolated 1988 by F. Schauer from soil contaminated with butyl caoutchouk, Berlin	Q-9 PC
Eupenicillium limoneum Gochenaur & Zlattner, Anam. *Penicillium lagena* (Delitsch) Stolk & Samson, SBUG M-997, ex CBS 382.64, isolated by M. Christenen from soil, USA (type strain of *Monocillium humicola* var. *brunneum*)	Q-9 PC
Penicillium arenicola Chalabuda, SBUG M-994, ex CBS 220.66, type strain from pine forest soil, Soviet Union	Q-9 PC
Penicillium aurantiogriseum Dierckx, SBUG M-275, isolated 1943 by Müller from lemon, Karslruhe	Q-9 PC
Penicillium brasiliense Batista (= *P. simplicissimum* sensu Pitt), SBUG M-564, isolated 1979 by J. Sandoval from grassland soil near Greifswald	Q-9 PC
Penicillium brevicompactum Dierckx, SBUG M-881, ex CBS 257.29 = IMI 40225 = ATCC 10418, isolated by P. Biourge	Q-9 LC
Penicillium camemberti Thom, SBUG M-414, commercial strain ex VEB Ostra, Dresden	Q-9 PC
Penicillium canescens Sopp, SBUG M-537, isolated 1978 by J. Sandoval from grassland soil near Greifswald	Q-9 PC
Penicillium citrinum Thom, SBUG M-260, isolated 1965 by H. Kreisel from ascoma of *Gyromitra gigas*, Stralsund	Q-9 PC
Penicillium clavigerum Demelius, SBUG M-970, ex MW Weimar	Q-9 LC, PC
Penicillium crustosum Thom, SBUG M-823, isolated 1987 by V. Ernst from deciduous forest soil near Greifswald	Q-9 PC
Penicillium cylindrosporum G. Smith (= *Geosmithia cylindrospora* (G. Smith) Pitt), SBUG M-900, ex CCM F-439, isolated by L. Marvanová from technical oil	Q-9 + Q-10 LC
Penicillium digitatum (Pers.: Fr.) Sacc., SBUG M-937, isolated 1988 by H. Marko from air in hospital, Rostock	Q-9 LC, PC
Penicillium glabrum (Wehmer) Westling, SBUG M-1000, isolated 1989 by M. Schubert from *Crassula arborescens*, Greifswald	Q-9 PC
Penicillium glandicola (Oudem.) Seifert & Samson, SBUG M-973, ex MW i 488 (as *P. granulatum*)	Q-9 PC
Penicillium inflatum Stolk & Malla, SBUG M-1018, ex CCM 8036	Q-9 LC
Penicillium islandicum Sopp, SBUG M-108, ex CCM F-473 = ATCC 26535, isolated by K. Ishii from wheat flour	Q-10(H_2) LC, PC

Strain	Ubiquinone type
Penicillium italicum Wehmer, SBUG M-928, isolated 1988 by M. Schubert from Uruguayan orange, Greifswald	Q-9 PC
Penicillium janczewskii Zaleski, SBUG M-413, isolated 1973 by G. Salzsieder from deciduous forest soil, Niederhof near Stralsund	Q-9 PC
Penicillium janczewskii Zaleski, SBUG M-594, isolated 1981 by A. Klement from wheat phylloplane, Greifswald	Q-9 PC
Penicillium lanosum Westling (= *P. puberulum* sensu Pitt), SBUG M-287, ex E.A.N. Sacavem (as *P. expansum*)	Q-9 PC
Penicillium cf. *lividum* Westling, SBUG M-588, isolated 1979 by J. Sandoval from grassland soil near Greifswald	Q-9 PC
Penicillium olsonii Bain. & Sart., SBUG M-991, ex CBS 232.60, isolated from *Picea abies* root, Austria	Q-9 PC
Penicillium oxalicum Currie & Thom, SBUG M-828, isolated 1987 by P. Neubauer from Elbe river water, Pirna	Q-9 PC
Penicillium piceum Raper & Fennell, SBUG M-905, isolated 1988 by H. Böhm in plant cell culture, Halle	Q-10(H_2) PC
Penicillium pinophilum Hedgcock, SBUG M-899, ex CBS 303.67, type strain of *P. proteolyticum* Kamyschko[1]	Q-10(H_2) PC
Penicillium purpurogenum Stoll, SBUG M-67, ex CCM F-709 = CP 187, isolated by R.A. Hill from corn	Q-10(H_2) LC
Penicillium purpurogenum Stoll, SBUG M-370, ex CCM F-199, isolated by M. Polster	Q-10(H_2) LC
Penicillium restrictum Gilman & Abbott, SBUG M-429, isolated 1973 by G. Salzsieder from deciduous forest soil, Niederhof near Stralsund	Q-9 PC
Penicillium roqueforti Thom, SBUG M-982, isolated 1989 by E. Retzlaff from Roquefort cheese, Greifswald	Q-9 LC, PC
Penicillium rugulosum Thom, SBUG M-955, isolated 1988 by H. Marko from air in hospital, Rostock	Q-10(H_2) PC
Penicillium sacculum Dale (= *Eladia saccula* (Dale) G. Smith), SBUG M-582, isolated 1979 by J. Sandoval from meadow soil near Greifswald	Q-9 LC, PC
Penicillium variabile Sopp, SBUG M-818, isolated 1986 by E.D. Erdenetschimeg from soil at filling station, Greifswald	Q-10(H_2) PC
Penicillium variabile Sopp, SBUG M-1009, isolated 1989 by M. Schubert from alpine soil, 2000 m s.m. near Mürren, Switzerland	Q-10(H_2) PC
Penicillium cf. *variabile* Sopp, SBUG M-985, isolated 1989 by M. Schubert from mouldy sausage, Greifswald	Q-10(H_2) and Q-x LC, PC
Penicillium vulpinum (Cooke & Massee) Seifert & Samson, SBUG M-967, ex MW i 490, isolated by G.R.W. Arnold from *Nymphaea* leaves (as *P. claviforme*)	Q-9 PC
Talaromyces byssochlamydoides Stolk & Samson, Anam. *Paecilomyces byssochlamydoides* Stolk & Samson, SBUG M-855 (det. R.A. Samson), isolated 1987 by K. Zimmermann from glasshouse soil, Oberlausitz, Saxonia	Q-10(H_2) PC

[1] *Penicillium proteolyticum* Kamyschko was treated as a synonym of *P. verruculosum* Peyronel by Pitt (1979b), but as a synonym of *P. funiculosum* Thom by Samson (in CBS List of Cultures, 30th ed., 1983). The type culture received from CBS shows colonies on MEA exceeding 22 mm diam. after 7 d, on CzA exceeding 12 mm diam., aerial mycelium white to yellow, stipes 90–120 µm long, conidia smooth walled, grey green in mass; therefore it keys out as *P. pinophilum* Hedgcock.

Strain	Ubiquinone type
Talaromyces flavus (Klöcker) Stolk & Samson, Anam. *Penicillium dangeardii* Pitt, SBUG M-941, ex WM (as *P. spiculisporum*)	Q-10(H_2) PC
Talaromyces stipitatus (Thom) C.R. Benjamin, Anam. *Penicillium emmonsii* Pitt, SBUG M-271 ex CCM Brno F-174 = CBS 375.48 = ATCC 10500 (type strain of *P. stipitatum* Thom), isolated by K.B. Raper from wood, U.S.A.	Q-10(H_2) PC
Talaromyces wortmannii Klöcker, Anam. *Penicillium kloeckeri* Pitt, SBUG M-410, isolated 1972 by G. Salzsieder from deciduous forest soil, Niederhof near Stralsund	Q-10(H_2) LC
Thermoascus thermophilus (Sopp) v. Arx, Anam. *Polypaecilum* spec., SBUG M-859, isolated 1987 by K. Zimmermann from glasshouse soil, Oberlausitz, Saxonia	Q-9 PC

DISCUSSION

Von Arx (1987: 282 and 289) regarded the genus *Penicillium* in the classic circumscription (Raper & Thom, 1949; Pitt 1979b) as polyphyletic, stressing the particular position of the section *Biverticillium* 'which should be transferred to *Paecilomyces*', but he avoided to make any new combinations with *Paecilomyces*.

In the system of Stolk & Samson (1985), *Penicillium* appears again in a very broad concept, divided in 10 sections, whereas Pitt (1979b) had arranged it in four subgenera with nine sections, excluding *Geosmithia* and *Merimbla* (= *Raperia*) as separate anamorphic genera. The analysis of ubiquinone types provides new suggestions for the taxonomic treatment of the mentioned genera.

It should be noted that results obtained by RPPC and by RPHPLC from the same strain were identical, as well as results from different strains of the same species, even if obtained independently by different authors.

Ubiquinone Q-9 was found in the great majority of the investigated strains, i.e. in 27 of the 38 species. Including the results of previous authors, Q-9 has been demonstrated in all investigated species of the teleomorphic genus *Eupenicillium* (Eurotiaceae, teste von Arx, 1987) and – with one exception – of *Penicillium* sect. *Torulomyces, Aspergilloides, Eladia, Divaricatum, Inornata, Ramosum, Penicillium,* and *Coremigenum* in the system of Stolk & Samson (1985). The one exception is *P. megasporum* (sect. *Eladia*), in which ubiquinone Q-10 was found by Kuraishi & al. (1985).

Ubiquinone Q-10(H_2) was found in all investigated species of the teleomorphic genus *Talaromyces* (Onygenaceae) and of *Penicillium* sect. *Biverticillium (P. islandicum, P. piceum, P. pinophilum, P. purpurogenum, P. rugulosum, P. variabile).* This is coincident with results of previous authors (Lavate & al., 1965 for *T. stipitatus*, Kuraishi & al., 1985 for *T. flavus* and *P. islandicum*). Consequently, section *Biverticillium* with its teleomorph *Talaromyces* occupies from the chemotaxonomic point of view a rather separate position within the genus *Penicillium* and deserves a higher taxonomic rank than most of the other sections. Pitt (1979b) recognized a subgenus *Biverticillium*, including the sections *Coremigenum* and *Simplicium*

(= *Biverticillium* s. str.), but our analysis of two representative species of sect. *Coremigenum* (*P. clavigerum*, *P. vulpinum*), both with Q-9, does not support such an arrangement.

An interesting exception in section *Biverticillium* is one doubtfully determined strain of *P.* cf. *variabile*, which has Q-10(H_2) and in somewhat minor quantity another, unidentified ubiquinone, possibly Q-10(H_4), but no reference substance was available.

Ubiquinone Q-10 (main component) and Q-9 (minor component) were found in *P. cylindrosporum*, hitherto the only investigated species of section *Geosmithia* resp. of the genus *Geosmithia*, segregated from *Penicillium* by Pitt (1979a).

Hamigera (Onygenaceae) with its anamorph *Raperia (Merimbla)* is a small genus. The ubiquinone of *H. avellanea*, Anam. *Raparia ingelheimensis* (= *Penicillium ingelheimense*), was determined as Q-10 by Kuraishi & al. (1985). This supports a generic separation of *Hamigera* from both *Eupenicillium* and *Talaromyces*.

Finally, the investigated representant of the genus *Thermoascus* (Onygenaceae), *Th. thermophilus*, has coenzyme Q-9. The same type was found in another species, *Th. auranthiacus*, by Kuraishi & al. (1985).

The results obtained in this paper and by previous authors support the concept that *Geosmithia* and *Biverticillium* s. str. should be separated from *Penicillium* s. str. (which contains the majority of the species) on generic level. But definite taxonomic decisions (new combinations) should be made only after determination of ubiquinone types in more species and strains of *Penicillium* s. l.

The authors of this paper could not consider the oral communication by Pitt & Samson on ubiquinone types in *Penicillium*, during the Fourth International Mycological Congress in Regensburg, 1990.

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R. Agerer (Editor). *Colour atlas of ectomycorrhizae [Fasc. 4].* (Einhorn-Verlag, Eduard Dietenberger GmbH, Schwäbish Gmünd. 1990.) Pp. 40, 48 Pls. with black-and-white photographs, 16 Col. Pls. Price: DM 56.80.

The fourth issue of this loose-leaf colour atlas of ectomycorrhizae comprises an extended key to the 83 species of mycorrhizae treated thus far. An extra key is provided for the identification of boreal and temperate European forest trees by the anatomy of their roots. This key is elucidated by 16 pages of good half-tone photographs. In this issue 16 ectomycorrhizae are described and amply and nicely illustrated in colour and black-and-white photographs. In the end in this atlas a total of 200–300 plates are envisaged.

T.E. Brandrud, H. Lindström, H. Marklund, J. Melot & S. Muskos. *Cortinarius, Flora Photographica. Vol. 1.* (Cortinarius HB, Svamp Konsult, Matfors, Sweden. 1990.) Pp. 44, 60 Col. Pls., in ring binder. Price: £ 35.50 excluding postage.

This is the English edition of the first volume of an atlas, published in Swedish in 1989, presenting colour photographs and descriptions of European species of *Cortinarius*. The work is planned in 5 volumes, each with about 60 plates to be kept in 3 solid and nice ring binders.

The genus *Cortinarius* is subdivided into the subgenera *Cortinarius, Telomonia, Myxacium*, and *Phlegmacium*, each divided in a number of sections, 44 sections in total, in the atlas separated by coloured sheets. *Dermocybe* is considered a section of subgenus *Cortinarius*. The loose-leaf system makes it possible to publish coloured plates in the order in which they become available and to change the arrangement later on if that would become desirable. One of the major aims of the project is to attain the greatest possible agreement on taxonomy and nomenclature among scientists working on *Cortinarius*. On each plate are figured a number of basidiocarps in different stages of development, including views of an underside and an upperside of a pileus and a longitudinal section of a young basidiocarp. Below each plate a terse description is given, followed by habitat indications and commentary notes. The photographs, taken indoors in diffuse artificial light are of an extremely good quality and render this publication now already indispensable for anybody seriously interested in *Cortinarius*.

H. Dörfelt & H. Görner. *Die Welt der Pilze.* (Urania-Verlag, Leipzig/Jena/Berlin. 1989.) Pp. 264, including 163 Col. Photogr. Price unknown.

Although this work comprises a large set of attractive colour photographs of more than 150 species of mainly macromycetes, more important is the textual part which forms an up to date introduction into mycology. There are five chapters in which are discussed respectively the history of mycology, structures and functioning of structures, life-strategies, useful and harmful fungi, the systematic arrangement, and the protection of fungi. Many adequate draw-

ings occur scattered throughout the book. On the final 16 pages, following the colour plates, not only an extensive index is given, but also quite a number of tables giving the reader clear surveys of several subjects treated, e.g. fertilization-types, developmental types of basidiocarps, etc.

This is an instructive, modern introduction into mycology for amateurs who want to know more than just names.

M. Moser & W. Jülich. *Farbatlas der Basidiomyceten. Colour atlas of Basidiomycetes. Lief. 8.* (Gustav Fischer Verlag, Stuttgart, New York. 1990.) Pp. VIII, 30, 80 Pls. with 147 Col. Figs. Price: DM 98.-.

The eighth issue of this loose-leaf colour atlas of Basidiomycetes starts with an advice of the printer for the arrangement of the plates. A new index of the first eight issues is included. Also generic descriptions in four languages are provided for *Cystolepiota, Hohenbuehelia, Lepiota, Leucocoprinus, Leucocortinarius, Limacella, Byssocorticium,* and *Cystostereum.* The plates in this issue contain colour photographs of varying quality, illustrating 68 species of agarics and 41 species of Aphyllophorales and Gasteromycetes. Only for the agarics a direct reference is made to herbarium vouchers.

A. Nograsek. *Ascomyceten auf Gefäßpflanzen der Polsterseggenrasen in den Ostalpen.* (Bibliotheca mycologica 133, J. Cramer in der Gebrüder Borntraeger Verlagsbuchhandlung, Berlin, Stuttgart. 1990.) Pp. 271, 149 Text-figs., 9 black-and-white Photogr. Price: DM 120.-.

This thesis is an ascomycete flora of the *Caricetum firmae,* a plant association of calcareous soils in alpine and (sub)arctic regions. On 34 species of vascular plants typical of this cushion forming plant assocation 52 genera of Ascomycetes with 128 species are found and documented. The inoperculate discomycetes are excluded. Especially *Carex firma, Dryas octopetala, Poa alpina, Sesleria varia, Salix reticulata,* and *Silene acaulis* proved to be a rich substratum for pyrenomycetes. On cushion plants more Ascomycetes develop than on other plants in the same area, because of the favourable microclimate in cushions. Material for this study was collected from Austria, Switzerland, and the northern parts of Sweden and Norway. Each species is fully described and often also depicted. A complete set of keys for the determination of genera and species is provided.

F. Pando, M. Dueñas, C. Lado & M.T. Tellería. *Cuadernos de Trabajo de Flora Micológica Ibérica 1. Información bibliográfica. I. España Peninsular e Islas Baleares.* (Consejo superior de investigaciones científicas. Real Jardín Botánico. 1990.) Pp. 154. Price unknown.

The 'Cuardernos de Trabajo de Flora Micológica Ibérica' is intended to be a series of publications supporting the project 'Flora Micológica Ibérica' (started in 1988) by making available to every student of the myco-flora of Spain the bibliographical and other data being compiled during the work on this flora project. The first volume contains 2281 references to literature on the fungi of Spain and the Baleares. The next volume will contain a similar list for Portugal.

G.J. Samuels and collaborators. *Contributions toward a Mycobiota of Indonesia: Hypocreales, synnematous Hyphomycetes, Aphyllophorales, Phragmobasidiomycetes, and Myxomycetes*. (Memoirs of the New York botanical Garden 59, Bronx, N.Y., U.S.A. 1990.) Pp. 180. Price: US $ 40.65 (US $ 39.30 in the U.S.A.) including postage.

This is the scientific report of the mycobiota (fungi) collected by Dr. G.J. Samuels in a period of six weeks in 1985 during an expedition ('Project Wallace') to the equatorial rain forests of the Dumoga-Bone National Park in Minahassa, North Sulawesi (Celebes), Indonesia. Approximately 500 specimens of fungi were collected. In this volume, after an introduction (by G.J. Samuels), we find contributions on Hypocreales (by G.J. Samuels, Y. Doi & C.T. Rogerson), synnematous hyphomycetes (by K.A. Seifert), polypores (by L. Ryvarden), Phragmobasiodiomycetes (by B. Lowy), and Mycomycetes (by M.L. Farr). In the first two contributions, which form the main part of this volume, also the study of many herbarium specimens, especially from the O. Penzig herbaria at Bogor and Padua, is included. Several keys to included genera and species are provided. It is to be hoped, that more of such excellent contributions toward the little known mycoflora of Indonesia will follow.

B. Senn-Irlet, K.M. Jenssen & G. Gulden. *Arctic and alpine fungi – 3*. (Soppkonsulenten A/S, Oslo. 1990.) Pp. 58, 25 Text-figs., 25 Col. Pls. Price: NOK 200.-.

This is the third of an illustrated, loose-leaf series dedicated to the arctic and alpine mycoflora. Each volume contains descriptions, drawings of microscopical characters, and very good colour photographs of 25 species of agarics. While in the first two volumes species were treated from southern Norway and Spitsbergen, this volume contains species collected in the alpine zone in Switzerland. Several species were not depicted in colour before. The series is rather expensive, but one of the best of its kind.

N. Smith Weber. *A morel hunter's companion. A guide to the true and false morels of Michigan*. (Two Peninsula Press, Lansing, Michigan. 1988.) Pp. 209, 12 Text-figs., 72 Col. Pls. Price: US $ 14.95 (excl. shipping).

This guide gives help and inspiration to all those who are interested in morels (*Morchella* species) and false morels or lorchels (*Gyromitra* species). Both the amateur and the professional mycologist will find all kinds of information on these popular spring fungi, which otherwise will be difficult to find. Things worth knowing about can be found in 13 chapters on subjects like: tips for successful morel hunting, mycophagy, toxicology, cooking and preserving morels, growth, cultivation, classification, and descriptions of genera and species (with identification keys). Although mainly based on situations in Michigan, the booklet will also be useful in other areas and countries. The good colour photographs were made by Mr. J.A. Weber.

M. T. Tellería. *Annotated list of the Corticiaceae, sensu lato (Aphyllophorales, Basidiomycotina), for Peninsular Spain and Balearic Islands.* (Bibliotheca mycologica 135, J. Cramer in der Gebrüder Borntraeger Verlagsbuchhandlung, Berlin, Stuttgart. 1990.) Pp. 152, 1 Text-fig. Price: DM 70.-.

This list compiles the accepted taxa of the corticiaceous fungi s.l. recorded for Spain and offers a base for automatic data processing in this group of fungi. The structure of the database is described. The list is a precursor of 'the Iberian Mycological Flora'. The definition of the corticiaceous fungi s.l. in this book agrees rather close with the resupinate non-poroid Aphyllophorales in Jülich & Stalpers (1980). In the alphabetic catalogue all the generic, specific, and infraspecific taxa recorded for peninsular Spain and the Baleares are listed. For each taxon nomenclature, type, distribution in Spain, substratum, herbaria with specimens, and sometimes observations are given. Some 217 publications were consulted for this project.

R. Treu. *Charakterisierung und Identifizierung von Ektomykorrhizen aus dem Nationalpark Berchtesgaden.* (Bibliotheca mycologica 134, J. Cramer in der Gebrüder Borntraeger Verlagsbuchhandlung, Berlin, Stuttgart. 1990.) Pp. 196, 38 black-and-white Pls. Price: DM 120.-.

In this thesis 19 ectomycorrhizae from the subalpine zone near Berchtesgaden (Germany) are described and illustrated in detail. Sixteen of them could be identified by finding mycelial connections between fruit-bodies and mycorrhizae. Of the morphological, structural, and chemical characters studied, the structure of the mycorrhizal mantle and of the rhizomorphs proved to deliver the most valuable criteria for the distinction of mycorrhizae. A key to the mycorrhizae described is provided. Generic characters are given for the mycorrhizae of the genera *Suillus, Lactarius,* and *Russula.*

R. Tröger & P. Hübsch. *Einheimische Großpilze. Bestimmungstafeln für Pilzfreunde.* (VEB Gustav Fischer Verlag, Jena. 1990.) Pp. 247. Price: DM 34.-.

This is an illustrated key, based on macroscopic characters, for the determination of species of central European macro fungi. In 109 double-page tables an enormous dichotomous key is constructed with text and 814 schematic drawings. The key leads to about 700 species. For each species beside the German and scientific names, the edibility is given. For corresponding illustrations in colour reference is made to plates in five well-known books on central European mushrooms.

A. Ulken. *Marine thraustochytrids and Chytridiomycetes in the North Sea area and in selected other regions.* (Bibliotheca mycologica 137, J. Cramer in der Gebrüder Borntraeger Verlagsbuchhandlung, Berlin, Stuttgart. 1990.) Pp. 93, 55 black-and-white Pls. Price: DM 90.-.

This book is meant to provide a guide to the identification of the exclusively marine Thraustochytridiales and the Chytridiomycetes of brackish environments. The geographical area covered in this book is mainly restricted to the North Sea with its estuaries and intertidal regions of the Wadden Sea. Also some samples from very remote areas, like tropical mangrove swamps and the Antarctic Ocean, are treated. The taxonomy of marine fungi is difficult because of the small number of characters, which also show a rather wide range of variation. It has not been possible to designate the position of these fungi within a phylogenetic tree of microbes. The 34 species studied are listed with annotations on occurrence in nature, physiology, growth in culture, and life cycle. Of each species a complete series of photomicrographs, representing its life cycle, is given. A peculiar way of listing complete literature references under each taxon treated causes long lists with many repetitions in the main part of the text.

R. Watling & N.M. Gregory. *Crepidotaceae, Pleurotaceae and other pleurotoid agarics.* (British Fungus Flora part 6, Royal Botanic Garden Edinburgh. 1989.) Pp. 187, including 9 pp. of line-drawings. Price: £ 10.- (+ £ 1.- postage overseas).

Another fascicle of this well-known flora. Its contents deviate strongly from those of the ones published already, as not a systematic entity is treated but a rather diverse assemblage of agarics with pleurotoid basidiocarps including such agaricoid genera of the Aphyllophorales as *Plicaturopsis, Schizophyllum,* and *Lentinellus*. In total 32 genera belonging to 9 families are keyed out and treated completely or as far as they contain pleurotoid species. This somewhat odd set-up conflicts with the concept of a modern flora but the result may be of considerable value for amateur mycologists.

B. Wittmann-Meixner. *Polyploidie bei Pilzen unter besonderer Berücksichtigung der Boletales. Möglichkeiten eines cytofluorometrische Nachweises.* (Bibliotheca mycologica 131, J. Cramer in der Gebrüder Borntraeger Verlagsbuchhandlung, Berlin, Stuttgart. 1989.) Pp. 163, 23 Figs., 33 Tables. Price: DM 80.-.

The author reports on a cytofluorometric method making it possible to establish the degree of polypoidy in fungi as, within certain limits, the intensity of fluorescence is proportional to the DNA contents of nuclei. First it is shown that in *Pythium, Puccinia, Coprinus,* and *Pleurotus* there is a relation between the chromosome numbers found in literature and the relative nucleus-DNA quantities found by cytofluorometry. Then the number of nuclei per cell and the polyploidy level of 128 species of the Boletales are registered. All levels of ploidy between 1 × and 10 × have been found, but most polyploids are even-numbered. A connection between ploidy and environment is indicated. Finally the degree of the mean relative nucleus-DNA contents within the frequent ploidy level 2 × is shown to be, to a certain degree, correlated with the supposed level of evolution in the Boletales.

Zhao Ji-Ding. *The Ganodermataceae in China*. (Bibliotheca mycologica 132, J. Cramer in der Gebrüder Borntraeger Verlagsbuchhandlung, Berlin, Stuttgart. 1989.) Pp. 176, 84 Text-figs. Price: DM 70.-.

'Lingzhi', the Chinese for *Ganoderma lucidum*, is a very popular fungus in China, since it brings prosperity and good fortune.

The author has studied the Ganodermataceae of China for about 20 years and has summarized the results in this book. Many species are wood-rotting, some are pathogenic, others are valuable in medicine. In this taxonomic study, after a short introductory part, 86 species of *Ganoderma, Amauroderma, Haddowia,* and *Humphreya* are treated. Keys to genera and species are provided. Each species is fully described and of most species the essential microscopical structures are depicted.