PERSOONIA
Published by the Rijksherbarium, Leiden
Volume 14, Part 3, pp. 245–273 (1991)

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In a previous study on the characters of taxa in '*Xerocomus*' (Oolbekkink & van Duin, unpublished report, 1985) emphasis was laid on analysing and comparing pileipellis structures in order to come to more clearly defined taxa, especially in the *B.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).

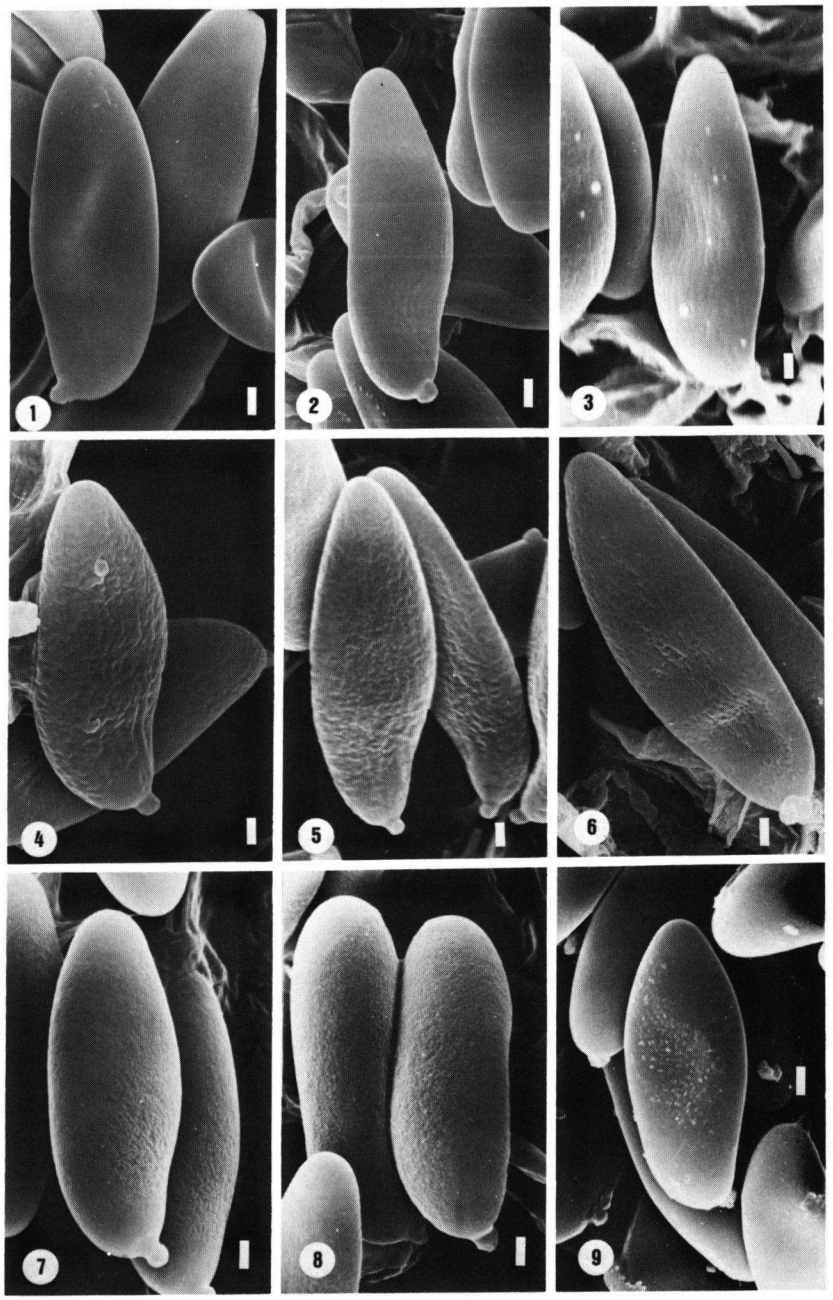
The spores of *Boletus parasiticus* show an ornamentation that varies from reticulately venose to (elongately) pitted (Figs. 3–6). A somewhat comparable ornamentation has been found in *Phylloporus rhodoxanthus* (Fig. 36), except that the latter is also floccose whereas the edges of the pits of spores 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,

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).

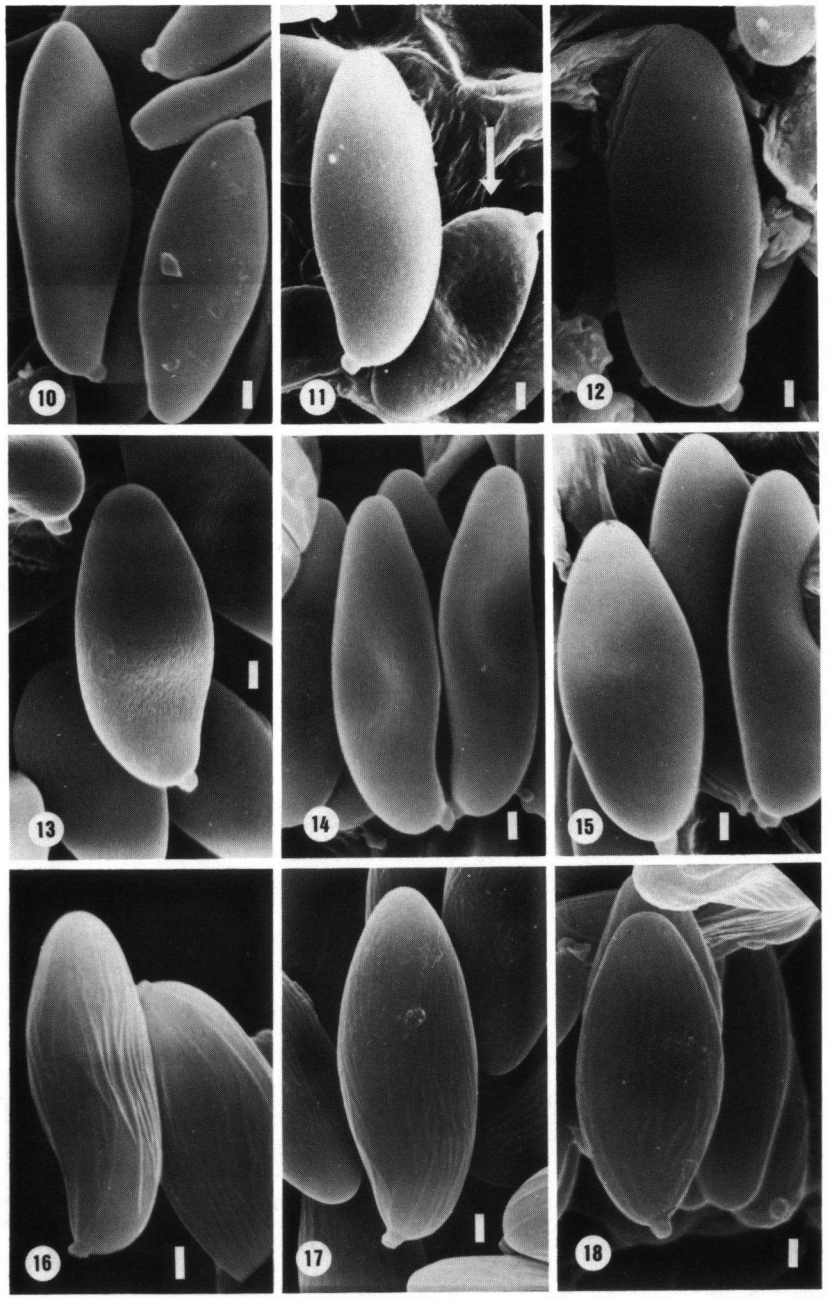
Figs. 10–18. Spores of *Boletus*. — 10–11. *B. subtomentosus*. — 12. *B. subtomentosus* var. *luteolus*. — 13–15. *B. ferrugineus*. — 16–17. *B. chrysenteron*. — 18. *B. rubellus* (Fig. 16, × 6600; Figs. 10–15, 17, and 18, × 6000. Bar = 1 μm).

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).

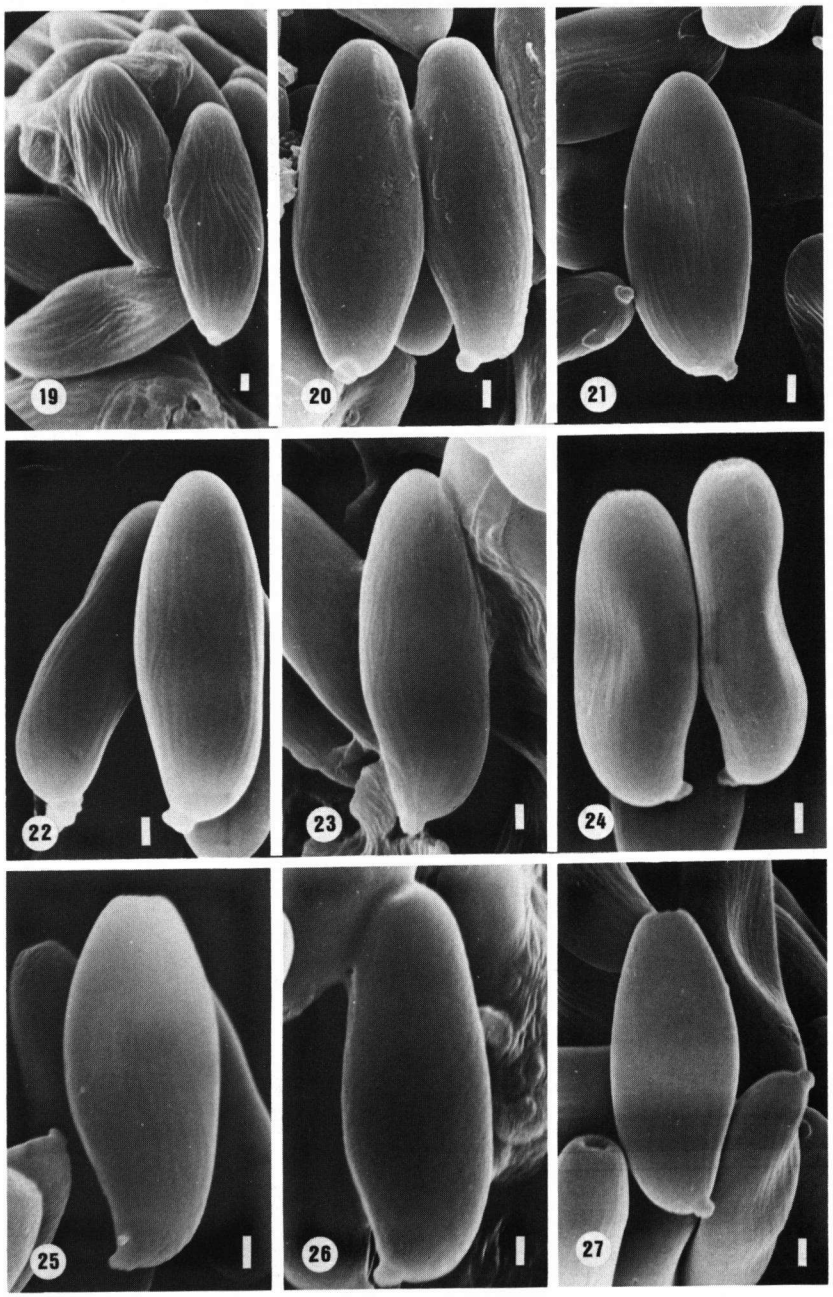
Figs. 28–36. Spores of *Boletus* and *Phylloporus*. — 28–29. *B. armeniacus*. — 30–31. *B. bubalinus*. — 32. *B. moravicus*. — 33. *B. pulverulentus*. — 34. *B. ichnusanus*. — 35–36. *P. rhodoxanthus* (Figs. 28–36, × 6000. Bar = 1 μm).



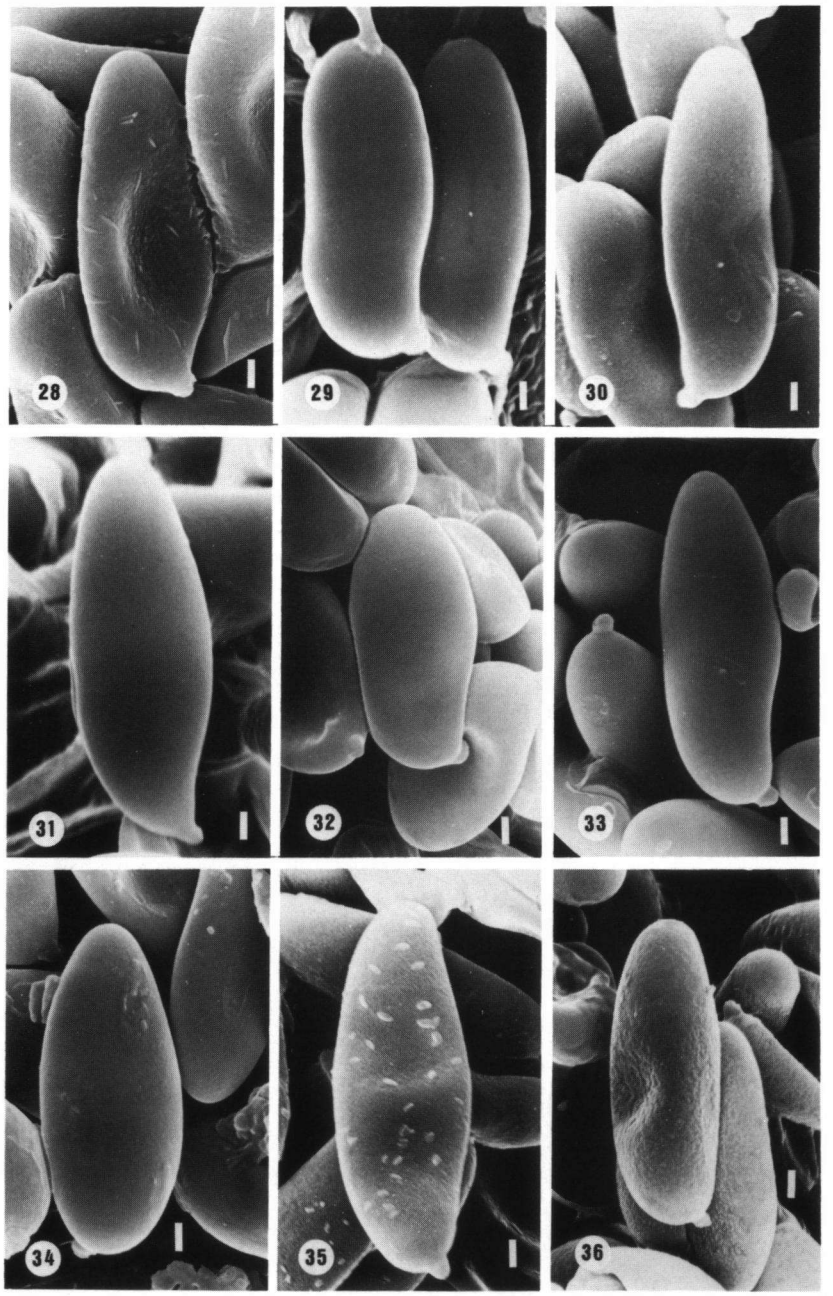
Figs. 1–9



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* fruitbodies, 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: Sattnitz-ridge, 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*.

ACKNOWLEDGEMENTS

The author wishes to thank Mrs. M. Hoek and Dr. C. Bas for their constructive comments on the manuscript, the latter and Dr. R.A. Maas Geesteranus for correcting the Latin description and Mrs. B.J. van Heuven for technical assistance.

REFERENCES

AA, H.A. VAN DER (1979). Het Centraalbureau voor Schimmelcultures bestaat 75 jaar. *In* Natura 76: 205–210.
ALESSIO, C.L. (1984). *Xerocomus ichnusanus* Alessio, Galli et Littini sp. nov. *In* Boll. Gruppo micol. G. Bresadola, Trento 27: 166–170.
— (1985). *Boletus* Dill. ex L. Fungi europaei 2. Saronno.
BAS, C., OOLBEKKINK, G. & DUIN, W. VAN (1988). Un rapporto preliminare sul valore tassonomico della struttura della cuticola nel gruppo *Xerocomus* del genere *Boletus*. *In* Fungo 7 (6, suppl.): 41–46.
BULLIARD, J.B.F. (1791). Histoire des champignons de la France 1.
COKER, W.C. & BEERS, A.H. (1943). The Boletaceae of North Carolina. Chapel Hill. (Reprinted by Dover, New York in 1974 as: The Boleti of North Carolina.)
CORNER, E.J.H. (1972). *Boletus* in Malaysia. Botanic Gardens, Singapore.
DERMEK, A. (1984). Fungorum rariorum Icones coloratae 13. Vaduz.
— (1987). Fungorum rariorum Icones coloratae 16. Berlin.
FRIES, E.M. (1818). Observationes mycologicae 2. Hafniae.
— (1821). Systema mycologicum 1. Lundae.
— (1828). Elenchus fungorum 1. Gryphiswaldiae.
— (1835). Boleti, fungorum generis, illustratio. Upsaliae.
— (1838). Epicrisis systematis mycologici. Upsaliae.
— (1874). Hymenomycetes europaei. Upsaliae.
GAMS, W. (1984). An index to fungal names and epithets sanctioned by Persoon and Fries. *In* Mycotaxon 19: 219–270.
GRAY, S.F. (1821). Natural arrangement of British plants 1. London.

GRUND, D.W. & HARRISON, A.K. (1976). Nova Scotian Boletes. Vaduz.
HARLEY, J.L. & SMITH, S.E. (1983). Mycorrhizal symbiosis. London.
HEINEMANN, P., RAMMELOO, J. & RULLIER, E. (1988). L'ornementation sporale des Xerocomaceae à spores dites lisses. *In* Bull. Jard. bot. natn. Belg. 58: 513–534.
HÜBSCH, P. (1982). Über Rotfüßchen mit abweichenden Sporen. *In* Boletus 6: 61–66.
IMLER, L. (1954). *Xerocomus tumidus* (Fr.) sensu Peltereau et Gilbert. *In* Bull. Soc. mycol. Fr. 70: Atlas Pl. C.
— (1955). Notes critiques. *In* Bull. Soc. mycol. Fr. 71: 19–25.
— (1958). Notes critiques. *In* Bull. Soc. mycol. Fr. 74: 94–98.
— (1964). *Xerocomus porosporus*. *In* Bull. Soc. mycol. Fr. 80: Atlas Pl. 141 and 142.
— (1986). *Xerocomus tumidus* (Fr.) Gilb. *In* Sterbeeckia 14: 17–19.
KALLENBACH, F. (1942). Die Röhrlinge. Die Pilze Mitteleuropas 1. Leipzig.
KROMBHOLZ, J.V. (1836). Naturgetreue Abbildungen und Beschreibungen der essbaren, schädlichen und verdächtigen Schwämme 5. (Text and atlas.) Prag.
KUTHAN, J. (1982). Einige Bemerkungen zu Funde von seltenen und interessanten Grosspilzen im Stadtgelände von Ostrava. *In* Přír. Sb. Ostr. Muz. Ostrava 26: 153–166.
MARTIN, C.E. (1894). Contribution à la flore mycologique genovois. *In* Bull. Soc. bot. Genève 7: 189–192.
— (1903). Le '*Boletus subtomentosus*' de la région genevoise. Matériaux pour la flore cryptogamique Suisse 2(1). Berne.
OOLBEKKINK, G.T. & DUIN, W.E. VAN (1985). De taxonomische betekenis van de hoedhuidtypen in het genus *Xerocomus*. Rijksherbarium, Leiden. Unpublished report.
— & — (1988). De taxonomische betekenis van de hoedhuidtypen in *Xerocomus*. *In* Coolia 31: 1–11, 48 (errata).
PEARSON, A.A. (1952). New records and observations 5. *In* Trans Br. mycol. Soc. 35: 97–122.
PECK, C.H. (1897). *Boletus fraternus*. *In* Bull. Torrey bot. Club 24: 145.
PEGLER, D.N. & YOUNG, T.W.K. (1971). Basidiospore morphology in the Agaricales. *In* Beih. Nova Hedwigia 35.
— & — (1981). A natural arrangement of the Boletales, with reference to spore morphology. *In* Trans. Br. mycol. Soc. 76: 103–146.
PERREAU-BERTRAND, J. (1961). Recherches sur les ornementations sporales et la sporogenèse chez quelques espèces des genres *Boletellus* et *Strobilomyces* (Basidiomycètes). *In* Annls Sci. nat. (Bot.) 2: 399–489.
PERREAU, J. (1964). Complément à l'étude des ornementations sporales dans le genre *Boletellus*. *In* Annls Sci. nat. (Bot.) 5: 753–766.
PERREAU-BERTRAND, J. (1965). Structure membranaire et différenciations apicales chez les spores des genres *Xerocomus*, *Boletellus*, *Heimiella* et *Strobilomyces*. *In* C. r. hebd. Séanc. Acad. Sci., Paris 260: 4245–4248.
— (1967). Recherches sur la différenciation et la structure de la paroi sporale chez les Homobasidiomycètes a spores ornées. *In* Annls Sci. nat. (Bot.) 8: 639–745.
PERREAU, J. & HEIM, R. (1969). L'ornementation des basidiospores au microscope électronique à balayage. *In* Rev. Mycol. 33: 329–340.
PETERSEN, R.H. (1977). An annotated index for Bulliard's 'Histoire des Champignons'. *In* Mycotaxon 6: 127–166.
PHILLIPS, R. (1981). Mushrooms and other fungi of Great Britain and Europe. London.
POUZAR, Z. (1966). Two interesting species of the family Boletaceae: *Boletus truncatus* and *Boletus subtomentosus* var. *leguei*. *In* Česká Mykol. 20: 1–7.
— (1981). Co jsou podzimni 'babky'? In Mykol. listy 3: 8–14.
QUÉLET, L. (1888). Flore mycologique de la France et des pays limitrophes. Paris.
REA, C. (1922). British Basidiomycetae. (A handbook to the larger British fungi.) Cambridge.
ROSTKOVIUS, F.W.T. (1844). Die Pilze Deutschlands 5. *In* Deutschlands Flora, Abth. 3. J. Sturm (ed.). Nürnberg.
SCHAEFFER, J.C. (1763). Fungorum qui in Bavaria et Palatinatu circa Ratisbonam nascuntur icones nativis coloribus expressae 2. Ratisbonae.
— (1774). Fung. Bavaria 4. Ratisbonae.

SINGER, R. (1965). Die Röhrlinge 1. *In* Pilze Mitteleuropas 5. Bad Heilbrunn.
— (1966). Die Röhrlinge 2. *In* Pilze Mitteleuropas 6. Bad Heilbrunn. '1967'.
— (1986). The Agaricales in modern taxonomy. Koenigstein.
SINGER, R. & KUTHAN, J. (1976). Notes on Boletes. *In* Česká Mykol. 30: 143–155.
SMITH, A.H. & THIERS, H.D. (1971). The Boletes of Michigan. Ann Arbor.
SNELL, W.H., SINGER, R. & DICK, E.A. (1960). Notes on Boletes 11. *In* Mycologia 51: 564–577. '1959'.
VAČEK, V. (1946). *Boletus moravicus*, species nova Cechoslovaca. *In* Studia bot. Čech. 7: 36–37.
VELENOVSKÝ, J. (1939). Novitates mycologicae. Pragae.
WATLING, R. (1968). Records of Boleti and notes on their taxonomic position. *In* Notes R. bot. Gdn. Edinb. 28: 301–315.
— (1970). British fungus flora: Agarics and Boleti. 1. Boletaceae; Gomphidiaceae; Paxillaceae. Royal Botanic Garden, Edinburgh.