EDINB. J. BOT. 51(3): 331–353 (1994)

BOLETES FROM SOUTH AND EAST CENTRAL AFRICA – II

R. WATLING* & E. TURNBULL*

Nineteen boletes (Basidiomycotina) are recorded from Zambia. They belong to the tylopiloid and xerocomoid elements. Three of these boletes are described as new: *Tylopilus ochraceosquamosus* Watling, *T. perplexus* Watling & Turnbull and *T. zambianus* Watling. Another four cannot be assigned to formally recognized taxa, and the provisional name *Tylopilus conspicuocystidiata* is adopted for one of them. Two new combinations are made: *Tylopilus brunneirubens* (Corner) Watling & Turnbull and *T. nigropurpureus* (Corner) Watling.

INTRODUCTION

In an earlier part (Watling & Turnbull, 1993) boletes with ornamented basidiospores collected by Dr M. Ivory in the Copperbelt of Zambia were described and discussed, in addition to other exsiccata and fresh collections from Chati, Ndola and Misaka forest areas. The first paper also dealt with members of smaller genera possessing smooth, ellipsoid basidiospores (Gyrodontoideae) and the *Boletus* consortium. The present paper continues these studies on smooth-spored boletes, concentrating on the tylopiloid and xerocomoid elements in the flora. The vegetational types in which the boletes were found are discussed in the previous paper (Watling & Turnbull, 1993).

The specimens forming the basis of this contribution were again collected by G.D. Piearce and M.H. Ivory during 1974 and 1975 in the Copperbelt of Zambia. The collections are supplemented with information from a limited number of fresh specimens and from notes on additional dried material deposited at the Forest Pathology Herbarium, Riverside Laboratories, Kitwe, which was examined when one of us (RW) was in Zambia in 1991. The herbarium and laboratories are part of the former Northern Rhodesia Forestry Department, Ndola (NDO), with collections prefixed by FP (Forest Pathology). Ivory's collections (abbreviated *Ivory*) are in E with duplicate or part collections in NDO. The field notes are from M.H. Ivory.

TAXONOMIC ACCOUNT

TYLOPILUS

1. **Boletus** cf. **brunneirubens** Corner, Boletus in Malaysia, 186 (1972).

Pileus 70mm diam., velvety, convex-plane, brown vinaceous. *Stipe* 35 × 10mm, brown vinaceous, reticulate near apex, solid. *Context* white bruising brown vinaceous. *Tubes* 8mm long, white bruising brown vinaceous; *pores* white. *Spore-print* fawn.

*Royal Botanic Garden Edinburgh, Inverleith Row, Edinburgh EH3 5LR, UK.

Basidiospores subfusiform (boletoid) 12.2–13 × 4.8μm, pale honey-colour in water and ammoniacal solutions, smooth. *Basidia* 4-spored. *Cheilo-* and *pleurocystidia* hyaline, cucurbitiform with ± long, obtuse prolongation.

Habitat: in relic miombo woodland.

Material examined: Riverside, Kitwe, 27 xii 1974, FP 335/11, *Ivory* 20. Also in Forest Pathology Herbarium, Riverside Lab., Kitwe (NDO): FP 176/44 and 335/13.

Boletus brunneirubens was originally described from both Malaya and Singapore (Corner, 1972); several collections were made in the latter locality during the period 1929–44. Our African collections differ in that the basidiospores are slightly longer, and possibly broader (12.2–13 × 4.8μm vs. 9–12.5 × 3.7–4.8μm), although this could come well within the accepted variation once the range found in tropical boletes has been ascertained. Many species of tropical boletes are based on one collection alone and, although distinct and superficially warranting a formal description, such a procedure does not offer a yardstick as to the true variation.

Although Ivory's field notes indicate that the tubes were white changing to brown vinaceous and the pores white, in the exsiccata both have taken on a greyed appearance as one might expect of a member of the *Tylopilus porphyrosporus* group. They are not like those of members of the *T. felleus* group which take on a distinct pink shade. The Malaysian and East African collections possessed fawn spore-masses. The following new combination is proposed.

Tylopilus brunneirubens (Corner) Watling & Turnbull, **comb. nov.**
Basionym: *Boletus brunneirubens* Corner, Boletus in Malaysia, 186 (1972).

Singer et al. (1991), in discussions on *T. cyaneotinctus* Smith & Thiers, considered *B. brunneirubens* to probably be related to *Porphyrellus* (= *Tylopilus*) *atrobrunneus* Vasilyeva. Corner (1972) also draws attention to two species of bolete to which *B. brunneirubens* is probably related, viz. *B. austrofelleus* Cleland and *B. ferrugineus* Frost. As indicated by Watling & Gregory (1989) *B. austrofelleus* is a mixed concept and critical analysis of all Cleland's specimens, and if possible fresh material from the type or neighbouring localities, is essential to formulate a modern concept of this species. What is certain is that the pileipellis is gelatinized in *B. austrofelleus* to some degree, something not seen in *B. brunneirubens*.

Boletus ferrugineus Frost poses quite a different problem. It was originally described from Vermont, USA (Frost, 1874) and transferred by Singer (1947) to *Tylopilus* with an accompanying description, suggesting that the type agrees with material from elsewhere on the east coast of N America. He proposed that *B. decorus* Frost, *B. indecisus* Peck (as *Tylopilus* in Murrill, 1909), *B. subpunctipes* Peck, *B. subdecorus* Snell and *B. pseudodecorus* Snell are all conspecific; however, Smith & Thiers (1971) disagree with this, placing two of the above taxa in *Tylopilus*, e.g. *Tylopilus* stirps *Indecisus* viz. *B. indecisus* and *B. subpunctipes*. *Boletus indecisus* differs from Singer's concept of *B. ferrugineus* in having 'vinaceous spores in deposit' not 'Isabella colour or wood-brown'. *Tylopilus rubrobrunneus* Mazzer & Smith, which one of us (RW) has collected and has had the opportunity to critically examine (*Watling* 2717, 2735, 2794: A1624/C1913 and A501/C1947 all from Michigan), differs in the non-reticulate stipe and much more bulky structure; it is especially common in the Great Lake region, the area from which both *B. indecisus* and *B. subpunctipes* are recorded. Dick & Snell (1965) consider *B. pseudodecorus* to be conspecific with *B. ferrugineus*.

Boletus indecisus Peck as illustrated by Coker & Beers (1943) is similar to our material from Kitwe except for the strongly pink pores and tubes; the basidiospores are also shorter and narrower but the two are very close; the illustration by Snell & Dick (1970) depicts a fungus agreeing in macromorphology. Unfortunately the spore measurements given by Coker & Beers (1943) are different to those of the lectotype of *B. indecisus*, viz. 10–15(–16) × 3–5μm as opposed to 8.5–11.2 × 3.5–4.2μm. Authentic material of *B. ferrugineus* in Pringle Herbarium, University of Vermont (VT), No. 3142, also has small basidiospores (8–11(–14) × 3–4(–5)μm); Halling (1983) has discussed this. Although *B. decorus* has microscopic features in common with *B. indecisus*, the yellow tubes which turn green when cut clearly do not indicate a close relationship. Murrill (1909) referred this fungus to *B. edulis* Fr.; it is certainly not this species judging from the results of Halling's (1983) examination of the lectotype.

Wolfe (1986) has examined *B. pseudodecorus* and Singer's conclusion on its synonymy with *B. ferrugineus* appears correct; he also supports Snell (1936) in considering *B. subdecorus* not a *Tylopilus* at all, but further work is required on the taxon (Wolfe, 1986). Earlier, Wolfe (1981) reduced *T. subpunctipes* to a variety of *T. indecisus*; it also has small basidiospores and probably represents the interpretation adopted by Coker & Beers (1943).

2. **Tylopilus conspicuocystidiata** nom. prov. Fig. 1A & B.

Pileus 55mm, convex, viscid/papery, buff/ochraceous. *Stipe* 50 × 8mm with swollen base, white at apex with raised reticulations, remainder buff/ochraceous. *Context* firm, white. *Tubes* sinuate, 13mm long; *pores* angular, fawn.

Basidiospores fawn in mass, 8.3–10.5(–10.9) × 3.9μm, smooth, honey-coloured, subfusiform, no apical differentiation. *Basidia* shortly clavate, 4-spored, 22–49 × 10μm, cylindric-clavate, hyaline with pale granular material; *sterigmata* 2.2–6μm. *Cheilo-* and *pleurocystidia* similar, numerous, prominent, elongate-rostrate to lageniform, even ampulliform, 24–37–(39) × 7–9(–13)μm, apex 2–4μm, filled with honey-coloured granular, colloidal-coagulated material, sometimes with apical part with clear contents, sometimes expanded into a slight subcapitate apex, thin-walled, not generally deep-seated, commencing with clear yellow contents with many spores attached to the mucilaginous apex, then becoming granular and tawny-coloured, some traceable almost to the mediostratum. *Hymenophoral trama* broad with mediostratum of slightly gelatinized, hyaline hyphae of narrow, flexuous units flanked by a narrow, hardly divergent, lateral strata. *Pileipellis* a gelatinized, collapsed cutis of irregular, smooth, thin-walled, flexuous, hyaline, cylindric hyphae 7.5μm broad, with pale honey-coloured contents or hyaline with a few segments scattered in the outer layers with brown vacuolar material, irregularly seated on hyaline, more compacted hyphae beneath; mediopellis seated on open, anastomosing, hyaline hyphae forming the spongy context; some areas of the suprapellis with concentrations of browner hyphae, end-cells hardly differentiated, rounded or torpedo-shaped.

Habitat: under moderate shade in miombo woodland.

Material examined: on soil, solitary, Chati Forest Reserve, 13 ii 1975, FP 358/4, *Ivory* 10.

This same taxon has been found in clusters at the edge of a clearing under light shade in relic, dry, evergreen forest in Ndola Forest Reserve (13 xii 1974; Ivory, pers. comm.). The material available

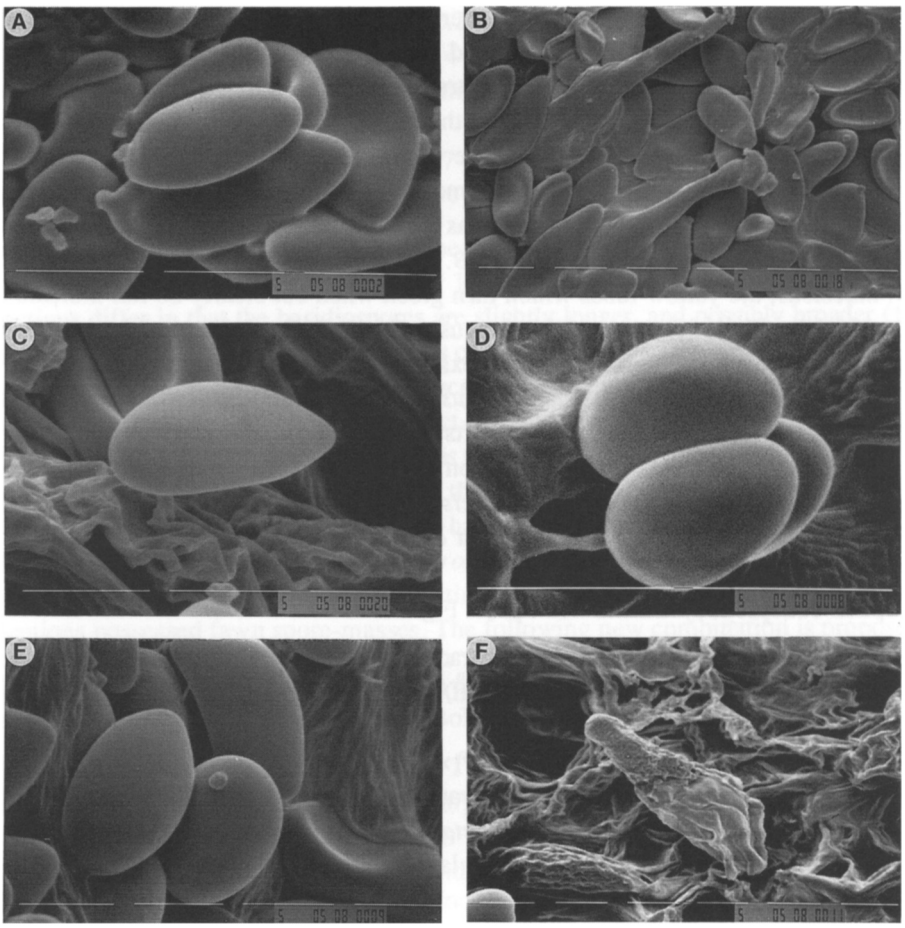

FIG. 1. A & B, *Tylopilus conspicuocystidiata*, FP 358/4; C, *Tylopilus niger*, FP 370/5; D, *Tylopilus niger*, *Watling* 22690; E & F, *Tylopilus ochraceosquamosus*, holotype, FP 338/5. A, C–E, basidiospores; B & F, pleurocystidia.

is not in a good state of preservation but we are confident that this species will in the future be recognized as autonomous, only requiring fresh material to clarify its seemingly distinctive characters.

FP 358/4 is very distinctive in that it possesses both cheilo- and pleurocystidia similar in structure to those of *Boletus spinifer* Pat. & C. F. Baker, which Singer (1944) designated as the type of the genus *Boletochaete*. Corner (1972) pointed out that the cystidia in this fungus were in fact thin-walled and not homologous with those of *Boletochaete brunneoseta* Singer described in the same article (Singer, 1944); the latter was subsequently transferred to *Tubosaeta* Horak (see Watling & Turnbull, 1993). The present collection agrees in some respects with *B. spinifer* although that species is more robust, the pileus velvety and much more pigmented; the basidiospores are also much smaller. In Corner (1972) it would key out close

to *B. brunneinanus* Corner from Sabah, but both the structure of the stipe and the spore size are wrong. The relationship with *B. viridis* (Heinem. & Gooss.-Font.) Corner (= *Pulveroboletus* fide Heinemann, 1954a), with which Corner compares his Malaysian collections of *B. brunneinanus*, seems less possible.

Boletus balloui var. *fuscatus* Corner, which would be placed in *Rubinoboletus* by Heinemann & Rammeloo (1983), has similar cystidial contents but again the basidiospores are quite different. *Tylopilus niveus* McNabb from New Zealand has a lacunose stipe and long basidiospores, although the structure of the pileus is parallel.

3. **Tylopilus niger** (Heinem. & Gooss.-Font.) Wolfe in Biblioth. Mycol. 69: 111 (1979). Fig. 1C & D.

Pileus 70mm diam., plane, velvety, dark mouse-grey. *Stipe* 60 × 20mm, solid, tomentose, fuscous with raised, buff reticulations near apex; *context* firm, white bruising indigo rapidly; *tubes* adnate breaking free, rosy-buff bruising fawn then black; pores angular, compound, white/rosy buff. *Spore-print* fawn.

Habitat: in groups under moderate shade in relic miombo woodland.

Material examined: Riverside, Kitwe, 5 iii 1975, FP 370/5, *Ivory* 21; same locality, i 1974, FP 176/69, *Ivory* 21a.

Additional material examined: Forest Pathology Herbarium, Riverside Lab., Kitwe (NDO): FP 176/72, 336/3, 349/5, 353/1, 358/3 and 622/6.

Reported from December until March in miombo woodland at Chati Forest Reserve in addition to Kitwe, where it has been found under an isolated *Marquesia macroura* Gilg. in a garden; see p. 351. Some specimens identified in the field as *T. niger* were more than 140mm in diameter. Pegler (1982 as *Porphyrellus*) records this species from the Copperbelt based on FP 628/16 in K.

This species is known from Katanga and Binga (Heinemann, 1954a & b), and Wolfe (1979) has examined the holotype reporting in detail on the microscopic characters. However, his basidiospore measurements are indicated as 10.5–13 × 4–5µm (as opposed to 9.6–11.8 × 4.1–5µm (Heinemann, 1954a) and 9.6–11.4(–12.2) × 4.2–4.8µm of the present material). This shows some discrepancy and is exceedingly intriguing, as a violaceous black velvety-capped bolete has recently been collected with *Marquesia* at Chati with similar field characters yet spores even smaller ((5.7–)6(–7) × 3.9–4.4µm) and only slightly boletoid if at all; this collection (*Watling* 22690: Plate 1 fig. D) was colonized by a hyperparasite close to *Dactylium dendroides* Fr. (= *Cladobotryum*: anamorphic *Hypomyces rosellus* (Alb. & Schwein.: Fr.) Tul.) which has caused the hymenium to be retained in an immature condition although the basidiomes had fully expanded.

Tylopilus niger by its general facies is obviously close to *T. alboater* (Schwein.) Murrill, a bolete originally described from N America (Schweinitz, 1822) which Corner (1972) records as common in Malaya and Singapore. This same author (1972) also suggests that *B. nigroviolaceus* Heim, originally described from New Guinea (Heim, 1963), might also be conspecific. *Tylopilus alboater* is obviously a widely distributed taxon but differs markedly from *T. niger* in the non-reticulate stipe and rufescent then blackening but never cyanescent

flesh. In N America, from where one of us (RW) knows *B. alboater* (*Watling* 20864, and 16341 from New Jersey and *Watling* A1598/C1878 from Pennsylvania), it grows solitary or in groups under oaks from New England south to Florida and west to Pennsylvania and Ohio. In Malaya it occurs from lowland to mountain forest (1300m). This species may be related to the recently described *Porphyrellus zaragozae* Singer & Garcia (Singer et al., 1991).

4. **Boletus nigropurpureus** Corner, Boletus in Malaysia, 178 (1972).

Pileus 40–80mm diam., irregular convex, fuscous with dark mouse-grey cracks. *Stipe* 40–50 × 10–18mm, solid, fuscous with narrowed apex. *Context* vinaceous buff bruising fawn then black. *Tubes* adnate breaking free, 8mm long, vinaceous buff bruising fawn then black; pores small angular, rosy buff/fawn bruising rust/brick. Spore-print fawn.

Basidiospores 10.5–10.9 × 5.5–6μm, broadly subfusiform (broadly boletoid drawn out at the apex). *Basidia* 4-spored. *Cheilo-* and *pleurocystidia* ampullaceous sometimes connected to brown laticiferous hyphae or sections of brown hyphae in hymenium and hymenophoral trama.

Habitat: in relic miombo woodland.

Material examined: in cluster beneath large trees under dense shade from undergrowth, Kitwe, 9 xii 1974, FP 281, *Ivory* 19.

Additional material examined in Forest Pathology Herbarium, Riverside Lab., Kitwe (NDO): FP 176/27, 270/8 and 349/3.

Boletus nigropurpureus is reported as occurring at the Kitwe site from December until March (M. Ivory, pers. comm.) but was not found in April 1991.

These collections are very similar to Corner's original description apart from the larger basidiospores. This may only exhibit the regional variation one might expect over a wide geographical range. It was originally described from Singapore (Bukit Timah) and Malaya (Pahang, Fraser's Hill) by Corner (1972), and one of us (RW) has again collected it at Fraser's Hill (23 iii 1992). The hyphae of the pileus of our African collections are very faintly asperulate, the basidiospores possess a distinct snout at the apex, and the pileus and stipe are not as intensely purple; the cystidia have apparently a longer neck. It is undoubtedly a member of the genus *Tylopilus* and the following transfer is proposed:

Tylopilus nigropurpureus (Corner) Watling, **comb. nov.**
Basionym: *Boletus nigropurpureus* Corner, Boletus in Malaysia, 178 (1972).

T. beelii Heinem. & Gooss.-Font. recorded from the Congo (Heinemann, 1954a) is similar but has larger basidiospores, inflated cells in the pileipellis and is of larger stature. The collection from Kitwe (FP 281, *Ivory* 19) comes close to *B. nigerrimus* Heim from New Guinea but this has larger basidiospores and tinges of green. Under this last name Corner (1972) describes material from Singapore and from Sabah; the rufescent-nigrescent flesh and lack of orange at the stipe base, the abundant pleurocystidia and pinkish to cinnamon vinaceous spore-print point to an independent taxon being involved.

5. **Tylopilus ochraceosquamosus** Watling, **sp. nov.** Fig. 1E & F.

Pileus 40–80mm convexus vel planus ochraceus vel fulvus subcutifractus vel squamulosus. *Stipes* 60–80 × 10–15mm solidus, albus vel pallido-luteus dein testaceus vel fulvus, basi attenuati. *Tubi* 17mm adnati vel adnexi albi dein pallido-glauci; *poris* concoloribus. *Caro* alba, immutabilis vel modo supra tubos subcyanescens. *Sporae* 10.0–11.4 × 5.7–6.5μm, leves, ellipisoideae vel amygdaliformes.

Typus: Zambia, ad terram in silva, 6 i 1975, *Ivory* 22 (holo. E).

Pileus 40–80mm, convex to plane, humid to dry, ochreous to fulvous, finely cracking or with larger scales separated by paler flesh. *Stipe* 60–80 × 10–15mm, tapered to base, solid, brittle, white to pale luteous becoming dark brick-colour or fulvous. *Tubes* 17mm long, adnate to adnexed separating from stipe apex, white with greenish glaucous tinge: *pores* white also with greenish glaucous tinge. *Flesh* firm, thick, white, becoming spongy, slowly cyanescent near tubes in FP 339/11.

Basidiospores umber in mass, broadly ellipsoid in face view, ellipsoid to slightly amygdaliform in side view, 10.9–11.4 × 5.7–6.5μm, slightly thick-walled, distinctly yellow honey-colour in water and ammoniacal solutions but with 1 or 2 large guttules, smooth, lacking apical differentiation. *Basidia* 4-spored, hyaline, clavate with distinct pedicel, becoming tawny buff in some areas. *Cheilocystidia* elongate clavate to vesiculose, adhering together in loose groups, hyaline to honey-coloured, intermixed with amorphous honey-coloured material; *pleurocystidia* ventricose-lageniform, 40–50μm long with distinct elongate neck and swollen venter (μm broad) and obtuse apex, hyaline or becoming tawny buff in some areas. *Hymenophoral trama* bilateral of broad, septate, hyaline, cylindric cells, divergent from indistinctly regular, similarly coloured mediostratum and supporting in some areas tawny buff hymenial elements (basidia, cystidia and accompanying cells). *Pileipellis* a tangled mass of hyphae showing little orientation at maturity but consisting of a disrupted suprapellis of irregular rounded cells (10.5μm broad) intermixed with short and long cylindric elements that form islands amongst more or less radially arranged hyaline to honey-coloured, smooth, cylindric-flexuous hyphae 8.7–14.2mm broad. *Stipitipellis* of cylindric hyphae supporting ellipsoid to shortened cylindric, tawny cells grouped to make the furfuraceous elements on the stipe.

Habitat: in relic miombo woodland.

Material examined: Misaka Forest Reserve, 3 i 1975, FP 338/5, *Ivory* 22 (holo. E); Kitwe, 6 i 1975, FP 339/11, *Ivory* 22a.

These collections are on spore morphology alone close to a group of boletes centred on *Krombholzia excedens* Heinemann and *K. porphyreus* Heinemann (both from Central Africa), which differ, however, in the purple tints to their pileus, stipe and flesh. FP 339/11 differs from FP 338/5 in that the pleurocystidia are difficult to revive and on so-doing have a reduced neck; the collections agree in every other way. Corner (1972) described *B. cuticulatus* from Mt Kinabalu, Sabah, based on a single collection, and, although close, it differs from *T. ochraceosquamosus* in its narrower basidiospores, phylloporoid tube trama and strongly moniliform cells in the suprapellis; see p. 345. The two are, however, close; indeed they and the two '*Krombholzia*' taxa from Central Africa make a separate group not related to *Leccinum* (= *Krombholzia*) or to *Xerocomus*. They should be placed in *Tylopilus* where Corner himself keys out his taxon.

However, in the text the same author places *B. cuticulatus* Corner in subgenus *Xerocomus* close to the N American *T. cyaneotinctus* Smith & Thiers, which, however, has longer and narrower basidiospores (10–13.5 × 4–5.5μm) and the flesh turns blue or rose and blue-green in the stipe base; the pores turn deep blue-green then deep brownish red when bruised. Singer et al. (1991) describe the last fungus in detail based on material from Mexico.

6. **Tylopilus perplexus** Watling & Turnbull, **sp. nov.** Fig. 2A & B.

Pileus 90mm, planus, siccus, cutifractus, umbrinus marginem versus luteus. *Stipes* 70 × 10mm solidus pallido-luteus haud albus umbrino-fibrillosus basim versus vinaceo-brunneus. *Tubi* 8mm, adnexi albo dein vinaceo-bubalini, tactu pallido-brunnei; *poris* minutis, angularibus, concoloribus. *Caro* alba rubescens dein obscure-cyanea. *Sporae* 10.5–12.7 × 4.4(–4.8)μm leves, subfusiformes vel boletiformes.

Ad terram in silva.

Typus: Zambia, Kitwe, on soil in relic miombo woodland, 19 ii 1975, FP 360/3, *Ivory* 6 (holo. E).

Pileus 90mm, plane, dry, luteous at margin to umber at centre, somewhat cracked. *Stipe* 70 × 10mm, solid, white with umber fibrils at top, mid-portion pale luteous and base brown vinaceous. *Context* white bruising red then indigo. *Tubes* adnexed, 8mm long, white/vinaceous buff bruising fawn; *pores* small, angular, vinaceous buff.

Basidiospores rosy buff/fawn in mass, 10.5–12.7 × 4.4(–4.8)μm, subfusiform to boletoid, smooth, pale honey-coloured, lacking apical differentiation. *Basidia* clavate, hyaline, 4-spored, 22–23 × 8–9μm; *sterigmata* 3μm long. *Cheilo-* and *pleurocystidia* similar, obtusely lanceolate, hyaline or with slight yellowish material at apex, many ampulliform, forming a sterile edge or scattered, 17–33 × 7–9μm, 2–3μm at apex with neck 2–9μm long, and even some vesiculose with conic head 11 × 24μm (where damaged), some filled with tawny, dark honey-coloured coagulated material. *Hymenophoral trama* consisting of broad, hyaline, non-gelatinized hyphae, forming a narrow mediostratum and similar but distinctly divergent lateral strata; sometimes with a few segments of tawny brown hyphae distributed in the hymenium and patches of brown hymenial units with tawny, laticiferous hyphae and basidioles. *Pileipellis* a cutis of open, intermixed, smooth or slightly irregularly roughened hyphae forming a suprapellis of chains of units 9–11μm broad, with or without granular or homogeneous dark honey-coloured or hyaline contents and cylindric obtuse or slightly tapered (torpedo-shaped) end-cells; *mediopellis* strongly demarcated, of hyaline, open, anastomosing, filamentous hyphae with only a few brown units at upper limits, possibly slightly gelatinized and passing into a compacted, hyaline subpellis of apparently radially arranged hyphae with a few sparse, brown, laticiferous hyphae.

Habitat: under light shade, in relic miombo woodland.

Solitary basidiomes of the same species have been found at the same site and in miombo woodland at Misaka Forest Reserve in both December and February; FP 176/25, 335/8 and 338/15 in Riverside Herbarium.

This is one of several boletes which fall into the *Tylopilus alboater* complex. It is so distinct that it is here described as a new species, although it is certain that at least one other very similar taxon

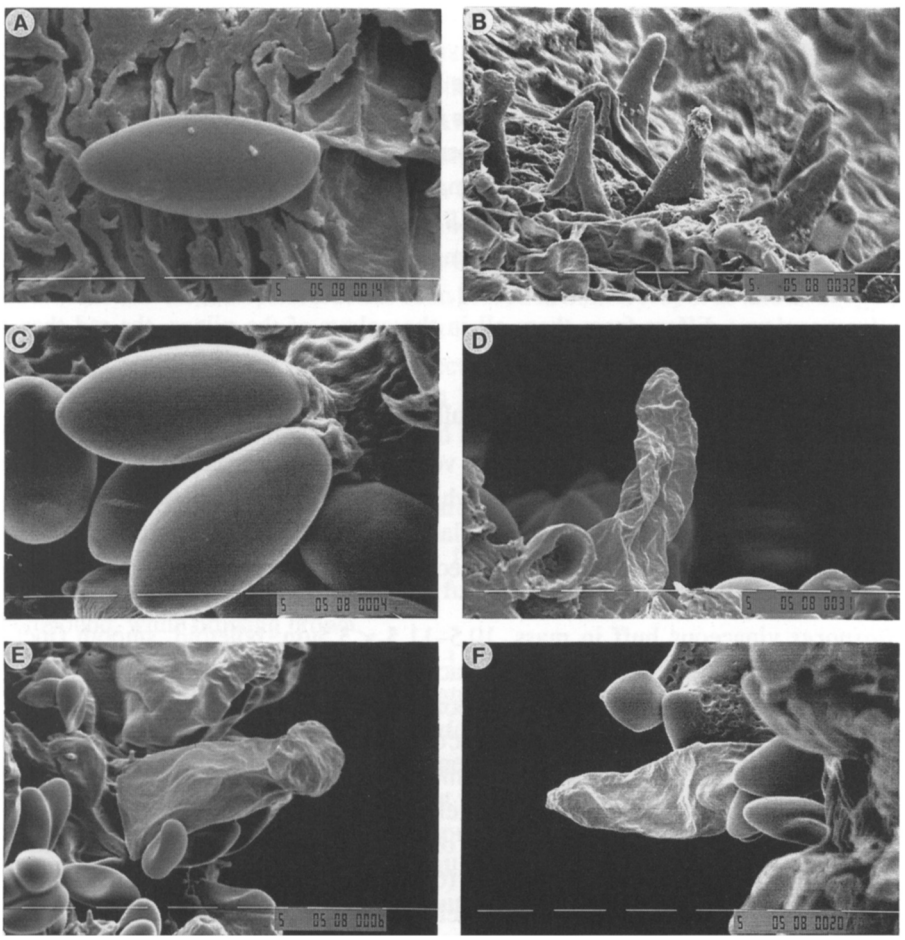

FIG. 2. A & B, *Tylopilus perplexus*, holotype, FP 360/3; C & D, *Tylopilus zambianus*, FP 349/7; E, *Xerocomus boletiformis*, FP 370/7; F, *Xerocomus* sp. 2, FP 348. A & C, basidiospores; B & D, pleurocystidia; E & F, basidiospores and pleurocystidia.

exists in Malaysia, judging from Corner's interpretation of *Boletus alboater* Schweinitz. Corner (1972) has identified his *B. alboater* Schwein. with *Boletus pachycephalus* Massee but this seems unlikely as the flesh of the latter is unchangeable (Massee, 1909), a feature agreeing with neither our present taxon nor the N American *B. alboater* (a conclusion made also by Singer et al. (1991) during the examination of members of this complex). However, examination of Massee's type, based on *Ridley* ser. 2 n. 24 from the Singapore Garden Jungle and Ridley's illustration, led Corner (1972) to believe it was not only the same as Schweinitz's bolete, but that *B. nigricans* Pat. & C. F. Baker is also a synonym. *B. pachycephalus* possesses a velvety brown pileus much the same as *T. perplexus* judging from the exsiccata, although in the fresh condition the latter is noted as having a 'luteous' margin and an umber centre; the dried material is now uniformly brick-colour.

Boletus nigroviolaceus R. Heim from New Guinea is closely related, although at least one collection identified by Hongo (1975) is believed to be the same as *T. eximius* (Peck) Singer (= *Leccinum eximius* (Peck) Pomerl.), another N American taxon. These placements are not supported by observations based on collections in E (*B. alboater*: New Jersey: Hunterdon Co., viii 1988, legit G. Kibby, *Watling* 20864; Morristown, under *Quercus*, 13 viii 1982, legit S. Hopkins, *Watling* 16341. Pennsylvania: Bourmanstown, Carbon Co., under scrub oak, 23 viii 1965, legit R. Homola, *Watling* A1598/C1878. *B. eximius*: Michigan: Tahquamenon State Park, Lone Tree, Luce Co., 4 ix 1965, legit A.H. Smith, *Watling* A480/C2348. New Jersey: Jenny Jump State Park, 21 viii 1982, *Watling* 16324).

Tylopilus perplexus differs from them all in the colour of the pileus, the red then indigo bruising flesh and microscopic characters.

7. **Tylopilus** cf. **rhoadsiae** (Murrill) Murrill, Bull. Torrey Bot. Club 67: 62 (1940).

Pileus 110mm, irregularly convex then plane, velvety, dry-scaly, vinaceous grey to vinaceous buff. *Stipe* 100 × 27mm, attenuated upwards, white at apex, rosy buff to fawn downwards, with shallow reticulations to halfway down, scurfy black below, solid. *Tubes* free to adnexed, <14mm long vinaceous buff; *pores* small, angular, vinaceous purple becoming vinaceous buff. *Flesh* firm, white; *taste* acrid.

Basidiospores vinaceous buff in mass, 10.5–11.5 × 3.5μm, boletoid, smooth (incl. under SEM), only slightly pigmented in ammoniacal solutions. *Basidia* 4-spored, hyaline but scattered over the tube surface with solitary, spore-bearing basidia becoming filled with tawny, coagulated contents. *Cheilocystidia* not recovered; *pleurocystidia* absent replaced by accumulated amorphous material within hymenial cells. *Hymenophoral trama* divergent, bilateral of two similarly coloured strata, not gelatinized. *Pileipellis* an erect trichoderm, some elements even curling inwards, consisting of adhering hyphae with internal threads of honey-coloured material, either with clavate (6.5–9.8μm broad) or narrower (3.5μm broad) end-cells, but resolvable into an eroded suprapellis of erect, hyaline, smooth hyphae some with coloured contents seated on an irregularly arranged subpellis of strongly pigmented hyphae that form an irregular line of demarcation because of the distribution of tawny pigment; pileus with smooth, wavy outline mirrored by the curved end-elements which delimit the surface.

Habitat: clustered at base of *Bougainvillea* (Nyctaginaceae).

Material examined: Kitwe, 23 i 1975, FP 349/6, *Ivory* 28.

Additional material examined: Forest Pathology Herbarium, Riverside Lab., Kitwe (NDO): FP 370/4.

This bolete is reported as having been seen at the same spot in January and April of the same year, a location which is 4.5m from the edge of a relic miombo woodland. The association with Nyctaginaceae could be significant in that Singer & Araujo (1979) and Singer et al. (1983) have indicated that this family forms cicatrizing ectomycorrhizae; certainly *Neea*, in this same family, has been implicated in ectomycorrhizal formation although illustrations of root sections have not been published (Janos, 1980; Alexander & Höberg, 1986; Alexander, 1989). The present collection, with its combination of velvety, vinaceous tinged pileus, white, bitter-tasting flesh and apically reticulate stipe, is very close to *Boletus rhoadsiae* Murrill which is a southern North American bolete. It differs minutely, but possibly significantly, in the structure of the pileipellis,

although this may come within the circumscription of the taxon. In collections from Florida the pileipellis consists exclusively of filamentous hyphae that are more nearly parallel and horizontally arranged towards the surface, with the terminal members often in strands or as single hyphal ends which are erect or ascendant and have rounded tips sometimes with yellow guttulate contents and sometimes with hyaline incrustations.

Singer (1947) records this bolete from south Florida to Michigan, although Smith & Thiers (1971) consider that it is more a southern species and probably not present in the Great Lake region. Snell & Dick (1970) give an excellent illustration (plate 58 bottom left) and record it as far north-east as New Hampshire. It has been placed in both *Gyroporus* and *Leucogyroporus* but Singer's placement is supported herein; it is not just a white 'form' of *T. felleus* (Fr.) P. Karst., although it undoubtedly agrees with section *Fellei* Singer. It is interesting to note that *T. rhoadsiae* is more common in subtropical North America; *Bougainvillea* is a native of Central and South America and widely planted in gardens in North America, Africa and Asia.

8. **Tylopilus** cf. **striatulus** Heinem. in Bull. Jard. Bot. l'État. Brux. 21: 320 (1951).

Pileus <35mm, smooth/pubescent, ochreous fulvous. *Stipe* 35mm tapered to base, solid, sepia/fuscous. *Context* vinaceous buff bruising fuscous rapidly. *Tubes* adnate, colour as context; *pores* compound, white bruising brown.

Basidiospores fawn in mass, 10.1–10.9 × 3.9–4.4μm, boletoid, smooth, honey-coloured, lacking apical differentiation. *Basidia* elongate-clavate, 4-spored, many filled with smoky brown vacuolar sap, 39 × 10.5μm. *Pleurocystidia* long, cylindric, hyaline or filled with smoky material and deeply seated in trama by long pedicel, brown material sometimes coagulating irregularly; *cheilocystidia* similar, cylindric but without smoky contents. *Hymenophoral trama* composed of a broad, central, pale brownish zone with vascular elements from which diverge slightly gelatinized hyphae, contrasting markedly with the smoky contents of the facial cystidia and the vascular hyphae many of which accumulate in the hymenium. *Context* filled with vermiform, ± long vascular hyphae filled with smoky brown contents. *Pileipellis* a turf of erect or suberect-curved, broad units 13–16μm long, some drawn off into torpedo-shaped ends, adhering in small groups as scales, or separating into denser areas consisting of hyaline-walled cells with or without pale brown contents, but lacking an intermix of vascular elements.

Habitat: in moderate shade in relic miombo woodland.

Material examined: Kitwe, clustered on side of trench in moderate shade in relic miombo woodland, 23 i 1975, FP 349/4, *Ivory* 27.

This is a very distinct bolete with the bright fulvous pileus contrasting with the white pores which brown readily on handling. Under the microscope it exhibits copious smoky to umber brown vascular hyphae and so resembles some *Strobilomyces* species. Although the pileipellis is similar to that of *Tylopilus striatulus*, the distinctive features of the present bolete are the vinaceous buff flesh that becomes rapidly fuscous and the strongly browning tubes and pores.

Tylopilus tenuis Heinem., also from the Congo, has a pileipellis composed of filamentous units but differs in the colour change of the flesh. Several Malaysian species, e.g. *B. brunneirubens* Corner and *B. levitinctus* Corner, come close to the Zambian bolete except for their pileus structure.

9. **Tylopilus** cf. **violaceus** (Beeli) Heinem. in Bull. Jard. Bot. l'État. Brux. 21: 322 (1951).

Pileus 50–60mm, convex, soft, humid, buff with bay scales. *Stipe* 30–60 × 5–10mm, solid, brittle, fulvous/bay with raised striations and reticulations on the upper half. *Context* spongy, white. *Tubes* adnexed, ≤12mm long, vinaceous buff; *pores* angular, vinaceous buff.

Basidiospores fawn in mass, 12.7–14 × 4.8–5.2μm, elongate, boletoid, subfusoid, smooth, honey-coloured without apical differentiation. *Basidia* 4-spored, clavate, hyaline in ammoniacal solutions, 32.7 × 9.5–10μm; *sterigmata* 4.4μm long. *Cheilocystidia* lageniform, 48 × 8.7–10μm with neck 3.3μm broad; *pleurocystidia* apparently absent. *Hymenophoral trama* rather pale-coloured in contrast to the spores which give it an overall pinkish tinge in mass, consisting of a narrow, central line of hyaline, gelatinized hyphae giving rise to slightly divergent, twisted lateral strata with rather broad (6.5μm) honey-coloured, non-septate 'vascular' hyphae scattered throughout. *Pileipellis* rather simple, although disrupted, of hyaline, smooth, disarticulating hyphae 7.6–13.5μm broad, hardly constricted at septa and forming a collapsed cutis which becomes obviously radially arranged downwards; *suprapellis* forming a continuous layer at the disc of non-gelatinized, honey-coloured usually branched hyphae but thrown up in an irregular way to form scales of branched, smooth hyphae (17.5μm broad) similar to those in *Armillaria*, intermixed with many barrel-shaped hyphae (17.5–21.5μm broad) some with thickened end-cells or irregular inner wall from a honey-coloured layer which disperses in ammoniacal solutions to give a pinkish fluid; *mediopellis* radially arranged of more compacted and narrower hyphae.

Habitat: in miombo woodland.

Material examined: Misaka Forest Reserve, on soil under moderate shade in groups in miombo woodland, 3 i 1975, FP 338/14, *Ivory* 14.

The collection comes very close to a whole series of Central African boletes, especially *Tylopilus violaceus* (Beeli) Heinem., which also possesses a cuticle resembling an irregular hymenium but differs in its much narrower basidiospores. The pileus in *T. violaceus* is finely velvety cracked etc., with a violaceous then grey-brown coloration; the stipe is not reticulate but longitudinally striate and velvety. *T. beelii* Heinem. & Gooss.-Font. equally has a finely squamulose pileus but again the basidiospores are narrower and the pileus elements are infused with a violet then blue pigment in ammoniacal solutions. *Krombholzia porphyreus* Heinem. (= *Leccinum*) exhibits similar pileus colours and structure but the basidiospores are shorter and the flesh becomes blue and reddish on exposure to the air.

10. **Tylopilus zambianus** Watling, **sp. nov.** Fig. 2C & D.

Pileus 40–65mm convexus dein planus, siccus, vinaceo-brunneus vel fuscus. *Stipes* 50–80 × 8–10mm, viscidus solidus vinaceo-brunneus, apice reticulato, basim versus flavus floccoso-tomentosus. *Tubi* <5mm subdecurrentes, griseo-flavi dein cyaneo-olivacei; *poris* griseo-flavis, cyanescentibus. *Caro* flava fractu intense cyanescens. *Sporae* 13.5–15 × 7–7.5μm leves boletiformes.

Ad terram in silva.

Pileus 40–65mm diam., convex/plane, dry, papery, brown vinaceous/fuscous. *Stipe* 50–80 × 8–10mm, viscid, brown vinaceous, paler reticulate near apex with a fluffy yellow base, solid,

centre yellow bruising indigo with a bay/vinaceous base. *Tubes* subdecurrent, ≤5mm long, yellow/sepia bruising indigo/blue; *pores* angular, yellow/sepia. *Flesh* straw/sulphur yellow bruising indigo/blue very rapidly. *Spore-print* olivaceous, although with cinnamon hint when dry.

Basidiospores 13.5–15 × 7–7.5μm, broadly boletoid, rather thick-walled, tinged dull golden yellow in ammoniacal solutions, dextrinoid in Melzer's, smooth with a slight apical pale spot. *Basidia* 4-spored, prominent, broadly clavate, pedicellate, 15–10 × 32–40μm, hyaline then tawny; *sterigmata* 4–5μm long. *Cheilocystidia* tapered upwards to obtuse apex, some irregularly inflated about the middle, 40–45 × 10–13μm with apex 3–5μm broad; *pleurocystidia* similar, rare, scattered. *Hymenophoral trama* bathed in dirty yellow fluid in ammoniacal solutions, composed of hyaline to tawny, non-gelatinized, filamentous, adhering hyphae neither divergent nor strongly bilateral and often without a coloured mediostratum, the latter similar in all other ways to lateral strata which support a tawny hymenium. *Pileipellis* differentiated into suprapellis of yellow-brown to dark brown, intertwined hyphae 6.5–11μm broad, not or poorly constricted at the septa, with slightly rounded end-cells, apparently clothed in a pigmented sheath which in places splits to give irregular surface features; *mediopellis* similarly coloured but more compacted than suprapellis and seated on radially arranged, hyaline hyphae of the subpellis and then passing into context. *Clamp-connections* absent; sections blueing in some areas in Melzer's reagent.

Habitat: in relic miombo woodland.

Material examined: Riverside, Kitwe, in clusters under light to moderate shade, 23 i 1975, FP 349/7, *Ivory* 29 (holo. E).

The basidiospores of this collection are very distinctive in shape, colour and wall thickness, and in these characters are in agreement with *Boletus loosii* Heinem. from Central Africa, i.e. Boletoideae, whereas the encrusted hyphae are a feature of members of the *Boletus porosporus/chrysenteron* complex, i.e. Xerocomoideae. However, the stature and coloration of the basidiomes, particularly the sepia-coloured pores (especially in dried material), resemble neither. It is more in keeping with *Porphyrellus amylosporus* Smith from Idaho, N America (Smith, 1965), a species now referable to *Tylopilus* (Wolfe, 1979); the basidiospores are, however, dextrinoid not amyloid. Some similarities of the basidiomes and basidiospores are also found between *T. zambianus* and some provisionally recognized Australian taxa (see Watling & Gregory, 1989).

FP 349/7 resembles the North American *T. sordidus* (Frost) Smith & Thiers in basidiospore shape and dimensions even to the small apical spot, and the unusual spore coloration, although in *T. zambianus* it is even more yellow. Smith & Thiers (1971) have speculated that Frost's species might be a hybrid between their *T. pseudoscaber* (Secr.) Smith & Thiers and *T. umbrosus* (Atkinson) Smith & Thiers. However, Wolfe (1979) considers *T. sordidus* purely a diminutive form of the latter, and there is really no practical basis for Smith & Thiers' view. This would be quite an important concept in the boletes if proven; obviously fresh, well-documented collections supported by cultures are required. Little has changed in fact since Singer (1945) wrote 'it has to remain among the dubious species of *Porphyrellus* Sect. *Tristis* until further evidence shows the correct position'; Snell & Dick (1970) were of similar views.

Corner (1972) described *Boletus incertus* from Malaysia with some features in parallel with the Zambian bolete. He also drew attention to *T. sordidus*, in addition to *T. suavissimus* Heinem.

& Gooss.-Font. from Zaire, and *Porphyrellus brunneus* McNabb from New Zealand. The coloration of all these taxa is quite different, leaving the only conclusion that FP 349/7 represents a new, albeit anomalous, species.

It is interesting to note that Corner (1972) recognized a relationship between his *B. incertus* and *B. longipes* Massee, a synonym of which is considered to be *Porphyrellus tristis* (Pat. & C. F. Baker) Singer, again reflecting the common features.

11. **Tylopilus** sp. 1.

Pileus 20–60mm, plane, smooth, hazel/fawn. *Stipe* 20–25 × 5–8mm, greenish glaucous near apex.

Basidiospores dark brick-colour in mass, very pale honey-colour in ammoniacal solutions, 7.4–7.9 × 3.9–4.4μm, ellipsoid, hardly or not boletoid. *Basidia* 4-spored. *Hymenium* dark honey-colour with numerous, prominent pleuro- and cheilocystidia, c.26 × 6.5μm, apex 3μm. *Hymenophoral trama* of non-gelatinized mediostratum flanked by similar, reduced lateral strata. *Pileipellis* a cutis of thin, smooth, collapsed, slightly pigmented hyphae adhering together to form a compacted zone over an extremely loose layer of similar, stretched, very open hyphae often leaving a gap between cortex and compacted layer above the tubes but bridged by twisted, collapsed, hyaline hyphae straggling from suprapellis.

Habitat: on relic miombo woodland.

Material examined: Riverside, Kitwe, solitary in clearing with very light shade, 10 xii 1973, FP 176/23, *Ivory* 18.

The dried material possesses cinnamon-coloured pores but we have no information on their fresh condition. The dark brick spore-print certainly places this species in *Tylopilus* but the lack of any further details makes it difficult to place. It has some affinities with *T. tenuis* Heinem. from the Congo, but this differs, especially in the size of the basidiospores.

XEROCOMUS

1. **Xerocomus** cf. **boletiformis** (Beeli) Heinem. in Bull. Jard. Bot. l'État. Brux. 21: 274 (1951). Fig. 2E.

Pileus 30mm convex with flattened centre, pubescent, amber/honey with slightly darker centre. *Stipe* 50 × 8mm solid, yellow/ochraceous/amber, punctate, centre yellow bruising green. *Context* white bruising green rapidly, spongy. *Tubes* 6mm long, straw/sulphur-yellow bruising green; *pores* bruising black rapidly.

Basidiospores olivaceous in mass, 7.9–9.2(–9.6) × (3.9–)4.4(–4.8)μm, smooth, lacking apical differentiation, pale honey-coloured in ammoniacal solutions. *Basidia* 4-spored, elongate, clavate 18 × 7.6μm; *sterigmata* 3μm long. *Cheilocystidia* forming a dense band at orifice of tubes, either elongate cylindric or slightly swollen towards upper part or elongate ellipsoid, drawn out to an obtuse apex, smooth, filled with bright tawny to fulvous vacuolar sap, 34–56 × 7.6–11μm (cylindric), 26–48 × 8.7–16.4μm (ellipsoid) including neck, interspersed with free, yellow globules; *pleurocystidia* numerous, hyaline but more generally filled with yellow vacuolar sap, lageniform with short or elongated neck, swollen at base, 33 × 11μm, 6.5μm at neck. *Hymenophoral trama* bilateral, consisting of pale honey-coloured, central strand, slightly

gelatinized from which diverge hyaline, gelatinized lateral strata of similar hyphae supporting a honey-coloured hymenium containing yellow hymenial cystidia, bathed in yellow fluid. *Pileipellis* composed of an open, loosely tangled suprapellis of narrow, long hyphae 3.3μm broad intermixed with elongate-cylindric to elongate-ellipsoid, non-erect cells 7.6–10.9μm broad with distinctly thickened honey-coloured walls which may be slightly ornamented (but if so, neither consistently nor prominently), disarticulating with some units filled with fulvous vacuolar contents and end-cells with or without yellowish contents, sometimes torpedo-shaped and occasionally adhering in groups; *mediopellis* of similar filamentous, radially arranged, hyaline hyphae compacted in the uppermost areas.

Habitat: in relic miombo woodland.

Material examined: Riverside, Kitwe, solitary on soil under moderate shade in miombo woodland, 5 iii 1975, FP 370/7, *Ivory* 15.

The material is in poor condition, but the closest taxon would appear to be *X. boletiformis* described from the Congo (Heinemann, 1951). It differs, however, in several characters, especially the tawny to fulvous filled cystidia and narrower basidiospores.

2. **Boletus (Xerocomus)** cf. **cuticulatus** Corner, Boletus in Malaysia, 217 (1972).

Pileus 70mm, convex, humid, sepia with wide, pale cracks. *Stipe* 70 × 10mm, solid, pale luteous, centre white the upper half of which bruises blue. *Context* white bruising rapidly blue then indigo. *Tubes* adnexed to 11mm, dark-brick; *pores* angular, fawn.

Basidiospores brown-vinaceous in mass, 10.5–10.9(–11.4) × 4.8–5.2μm, boletoid, slightly flattened in side view, smooth, honey-coloured in water and ammoniacal solutions, lacking apical differentiation. *Basidia* 4-spored, elongate-clavate, hyaline to slightly honey-coloured in ammoniacal solution, 13–24μm long; *sterigmata* to 8.7μm long. *Cheilocystidia* lageniform, swollen below and with short neck and obtuse apex, or simply tapered towards obtuse apex (torpedo shape), 39 × 15.3μm, apex 6.5μm usually with clear, honey-coloured or granular contents at apex; *pleurocystidia* similar but lacking honey-colour and granulation. *Hymenophoral trama* hyaline, non-gelatinized, composed of relatively broad mediostratum slightly divergent from similar but reduced lateral strata supporting pale, honey-coloured hymenium, some cells of which contain irregular granular material. *Pileipellis* a collapsed cutis of narrow, honey-coloured hyphae, possibly slightly gelatinized and thrown up into turf-like units of broad, ellipsoid hyphae 22–26 × 15–16μm with torpedo-shaped end-cells resembling those in the scales of *Armillaria*, smooth, deep honey-colour and intermixed with granular material, collapsing towards the margin of the group; *mediopellis* passing into hyaline, open arrangement of flexuous, intertwined, disorganized hyphae of context.

Habitat: in miombo woodland.

Material examined: Misaka Forest Reserve, solitary in miombo woodland, 30 i 1975, FP 338/13, *Ivory* 25.

The colour of the spore-print and the blueing of paper when it comes into contact with the basidiomes is reminiscent of members of the genus *Porphyrellus* (= *Tylopilus*). The structure of the pileus cuticle composed of moniliform or ellipsoid to short torpedo-shaped cells parallels *Boletus cuticulatus* Corner, but this differs in the greyish tubes and pores and much darker (bay

brown) pileus; the basidiospores are broader although of similar shape. The pileus of *Krombholzia porphyreus* Heinem. has a similar structure but this has overall lilaceous purple colours. Corner (1972) compares his taxon to *B. semitarius* Corner and *B. satisfactus* Corner because of similarities in the structure of the pileipellis, but both lack the rapidly blueing flesh; in *B. cuticulatus* the flesh changes slowly greenish blue. *Tylopilus cyaneotinctus* Smith & Thiers differs dramatically in its overall darker basidiome colours and size of the basidiospores.

The sepia pileus in the field is distinctive which in the exsiccata is dull fulvous ochre with reddish brown flecks.

A collection from the Chati Forest Reserve, FP 377/2 (*Ivory* 30), is worthy of description as the material parallels *B. cuticulatus* Corner except for the pale pores and tubes and pileipellis not being composed of short cells.

Pileus 35–50mm, convex with flattened top, dry, soft, straw-colour with umber scales. *Stipe* 30–40 × 4–6mm, stuffed, pale luteous, smooth, centre white bruising green or blue near apex (fading). *Context* spongy <6mm thick, white bruising bluish/mauve (fading rapidly). *Tubes* <7mm long, adnexed, fawn; *pores* angular, compound, fawn.

Basidiospores fawn in mass, 10.1–10.9 × 4.8μm, shortly boletoid to almost amygdaliform, smooth, distinctly honey-coloured in ammoniacal solutions, lacking apical differentiation. *Basidia* 4-spored, clavate, hyaline, 24–26 × 11–13μm; *sterigmata* 2μm long. *Pleurocystidia* narrowly ventricose, rostrate with a broad, obtuse apex and narrow venter, 28 × 11μm, apex 5μm, hyaline to pale honey-colour, smooth, thin-walled, scattered (not common); *cheilocystidia* not recovered. *Hymenophoral trama* a central strand of narrow, pale honey-coloured hyphae, poorly differentiated from the very slightly divergent lateral strata, non-gelatinized. *Pileipellis* an irregular cutis collapsed in tangled mass and consisting of a suprapellis of a mixture of hyaline, smooth, almost disarticulating, cylindric hyphae of shortened units, 9.8–13.1μm broad and narrower, more flexuous, branched units 5.5μm broad, both types occasionally with slightly thickened glassy walls, rarely asperulate, 32–83μm long, non-gelatinized. *Pileus scales* consisting purely of darkened, pale tawny-coloured hyphae similar in all respects to the suprapellis; *subpellis* of radially arranged cells, loose in the upper areas, more compacted towards context.

3. **Boletus (Xerocomus)** cf. **intentus** Corner, Boletus in Malaysia, 234 (1972).

Pileus 70mm plane, smooth, dry, ochreous. *Stipe* 30 × 8mm, fulvous. *Context* fleshy, white, bruising glaucous blue-green rapidly. *Tubes* citrine bruising glaucous blue-green; *pores* small, ochreous.

Basidiospores (8.7–)9.6–10.1(–10.5) × 3.9–4.8μm, shortly subfusiform, dull honey-coloured with olivaceous tinge in Melzer's reagent, lacking apical differentiation, apparently smooth. *Basidia* 4-spored, hyaline, shortly clavate, c.24 × 11μm. *Cheilo-* and *pleurocystidia* utriform to clavate vesiculose, scattered throughout hymenium or forming a very distinct, dense edge, 26–39 × 16–22μm with hyaline or slightly granular contents on margin, thin-walled or with yellowish tawny vacuolar pigment on gill-face, some also slightly spathulate. *Hymenophoral trama* taking on dull greenish colour in Melzer's reagent, consisting of filamentous, non-gelatinized, hyaline mediostratum of narrow units, flanked by tawny yellow,

non-gelatinized lateral strata showing little divergence and supporting similarly pigmented hymenium in which are embedded ventricose rostrate cells, 34–39 × 11 × 4–6μm (neck 15–24μm long) filled with yellowish tawny material and with similar mucilaginous coloured material about apex, possibly the origin of the yellowish green discharge in ammoniacal solutions. *Pileipellis* composed of a uniform cutis of slightly gelatinized, intertwined, collapsed, smooth, hyaline or slightly but uniformly honey-tawny hyphae 11μm broad, with end-cells poorly differentiated, producing bright apricot-orange discharge in ammoniacal solutions, not differentiated into zones and easily tearing from the hymenium where the hyphae are floccose and more openly arranged.

Habitat: under moderate shade in relic miombo woodland.

Material examined: Riverside, Kitwe, solitary on soil, 10 xii 1973, FP 176/24, *Ivory* 5.

This collection comes closest to *Boletus intentus* Corner described from the Singapore Reservoir Jungle, Bukit Timah but unfortunately the Zambian exsiccata is in poor condition, thus hindering a critical study; an *Acremonium*-like hyphomycete is colonizing parts of the hymenium and the pileipellis has collapsed on drying. Nevertheless, the impressive rostrate pleurocystidia with rich tawny, fairly homogeneous contents are very distinctive and again emphasize Corner's point when discussing the so-called 'setae' in boletes (Corner, 1972: 14–17). In FP 176/24 these cystidia are thin-walled and accompanied towards the margin by hyaline, vesicular cheilocystidia which are quite unique amongst the boletes.

It is undoubtedly a distinct species not related to either the New Zealand *X. leptospermus* McNabb, which is a much darker and robust fungus resembling members of the *Boletus fragrans* group (McNabb, 1968), or to *X. lenticolor* Snell & Dick, which occurs in conifer forests in California, the two species which Corner (1972) considered when describing *B. intentus*. *Xerocomus lenticolor* has been synonymized with *Suillus tomentosus* (Kauffm.) Singer, Snell & Dick, with which one of us (RW) is very familiar (see Thiers, 1975); it is characterized by the clustered non-vesiculose cheilo- and pleurocystidia and fibrillose scaly pileus.

4. **Xerocomus latisporus** Heinem. in Bull. Jard. Bot. l'État. Brux. 34: 438 (1964).

Pileus 80mm convex, dry tomentose, hazel. *Tubes* greenish glaucous sepia, adnate-sinuate; *pores* white (hazel), white inside. *Flesh* white, ≤ 6mm thick. *Spore-print* salmon rosy-buff.

Habitat: indigenous miombo woodland. November–February.

Material examined: Forest Pathology Herbarium, Riverside Lab., Kitwe: FP 6/5, FP 176/2 and FP 335/10.

The first collection (FP 6/5) now in K has been examined by Pegler & Young (1981). In basidiospore characters this fungus clearly approaches the material herein designated as *Tylopilus zambianus* q.v. The salmon rosy-buff spore-print would also suggest a placement outside *Xerocomus*, and further field data are required.

5. **Xerocomus** cf. **njalaensis** (Beeli) Heinem. in Bull. Jard. Bot. l'État. Brux. 24: 119 (1954).

Pileus 20–60mm somewhat irregular, convex/plane, dry, umber to sepia/hazel, with a few to many straw-coloured cracks. *Stipe* 15–30 × 3–6mm, solid, white/umber. *Context* fleshy, 2–6mm thick,

white. *Tubes* decurrent, 3–12mm long, white/straw; *pores* angular, straw to pale luteous. (Basidiome becoming very 'watery' and rotting quickly during wet weather.)

Basidiospores ochreous/fulvous in mass, 8.3–8.7(–9.6) × 3.9(–4.4)μm, shortly ellipsoid, lacking apical differentiation, honey-coloured in ammoniacal solutions with distinctly, although only slightly, thickened wall, some slightly amygdaliform in side view, smooth. *Basidia* 4-spored, hyaline, clavate. *Cystidia* apparently absent (not recovered). *Hymenium* yellow tawny and demarcated from the rather silvery often broad, sparsely septate hyphae running into it. *Hymenophoral trama* bilateral, non-gelatinized, hardly pigmented lateral strata composed of relatively narrow hyphae, diverging from a poorly differentiated, similarly coloured mediostratum. *Pileipellis* a very open, tangled mass of hyaline, smooth hyphae, intermixed with groups of tawny hyphae, piled into small fascicles and intermixed with silvery, broad, sparsely septate, clearly differentiated hyphae resembling laticifers (4.4μm broad), seated on a hyaline or pale honey-coloured, compacted zone which runs without demarcation into the hymenophoral trama; 'scalp' sections, resembling a disorganized mesh barrier with concentrations of pigment, interlinked with laticifer-like hyphae; end-cells poorly differentiated and intertwined in the main structure, ellipsoid or collapsing and resembling barbed-wire in places.

Habitat: in relic miombo woodland and under introduced trees.

Material examined: Riverside, Kitwe in clusters on soil, pine plantation (*Pinus kesiya* Royale ex Gord.), 19 xii 1973, FP 166/7, *Ivory* 4; Riverside, Kitwe in relic miombo woodland, 27 xii 1974, FP 335/9, *Ivory* 4a.

Additional material examined: Forest Pathology Herbarium, Riverside Lab., Kitwe (NDO): FP 5/6, 339/9, 342/3, 353/2, 355/2, 370/6 and 371/3.

This taxon occurs from December until March at both the sites listed and has also been collected under *Cupressus lusitanica* Mill. at Itimpi Forest Station, Kitwe (FP 335/9).

Cupressus lusitanica is a native of Mexico and the high mountains of Guatemala. It has obviously been planted in Kitwe, as has *Pinus kesiya*. The latter is a native of North Burma and the Philippines but is grown widely elsewhere as a timber tree. FP 166/7 was found as a cluster approximately 1m from the base of a single *P. kesiya* in a corner of a small plantation.

The short, rather brightly coloured basidiospores are very distinctive and would be a key character. Indeed, the combination of the spores and a loose, tangled pileipellis with oleiferous hyphae, lack of prominent cystidia (or absence of), and unchanging flesh make this bolete quite distinctive. It comes close to *B. njalaensis* Beeli from Sierra Leone (Beeli, 1938; Heinemann, 1954b) especially in the oleiferous-like hyphae in the pileipellis, but in Beeli's taxon the hymenophore is brown-yellow.

6. **Xerocomus schmitzii** Heinem. in Bull. Jard. Bot. l'État. Brux. 34: 440 (1964).

Pileus 8–17mm conical/convex, smooth, humid, ochreous/umber/ black. *Stipe* 20 × 2mm, hollow, umber. *Context* thin, buff (vinaceous just under cuticle) unchanging. *Tubes* adnate, 3mm long, citrine; *pores* citrine.

Basidiospores isabelline/umber in mass, 10.9 × 4.4μm, smooth, subfusiform lacking apical differentiation, distinctly honey-coloured in ammoniacal solutions, olivaceous in Melzer's

reagent. *Basidia* 4-spored, hyaline, clavate, 19.6 × 7.6μm; *sterigmata* 2.2μm long. *Cheilocystidia* elongate, clavate, 43–48 × 7.6–10.9μm, hyaline, thin-walled, forming clusters at orifices of tubes, some slightly torpedo-shaped; *pleurocystidia* hyaline, thin-walled, sometimes with basidiospores clustered around top, lageniform, obclavate with fairly broad neck and obtuse apex, scattered but numerous, fairly thin-walled and collapsed onto surface, rarely with slightly yellowish contents and perhaps even with a slightly thicker wall. *Hymenophoral trama* with hyaline, flexuous, apparently non-gelatinized mediostratum with a few vascular hyphae penetrating the centre, flanked by deep honey-coloured, slightly divergent lateral strata supporting similarly coloured hymenium with pleurocystidia issuing from top of the lateral strata. *Pileipellis* a collapsed cutis of poorly formed hyphae, 8.7–10.9μm broad ending in clusters of rounded, smooth cells probably from a former palisade, masked with slight surface detritus, thin-walled or slightly thick-walled as in cystidia, either pedicellate as in Bolbitiaceae or in short chains 26–30 × 8–11μm, with more rounded cells 14.2μm in loose palisade, seated on compacted, filamentous hyphae which pass gradually down into context with little demarcation.

Habitat: in relic miombo woodland.

Material examined: Riverside, Kitwe, grouped under light shade on soil, 6 i 1975, FP 339/14, *Ivory* 9.

This species, originally described from Haut-Katanga, is very characteristic with its small stature, hollow stipe and microscopic features including rather small basidiospores. It is a member of a group of xerocomoid boletes with the pileipellis composed of an open palisadoderm of swollen, pedicellate and catenulate, rounded cells, e.g. *X. albobrunneus* Heinem. & Gooss.-Font. and *X. pallidoporus* Heinem. & Gooss.-Font., both from the Congo; the former has 2-spored basidia and narrower basidiospores and the latter, in addition to narrower spores, possesses coloured cystidia; the colours in both taxa are also rather different to *X. schmitzii*.

Heinemann (1964) places his species in close proximity to *B. pernanus* Pat. & C. F. Baker which Corner (1972) places in synonymy with *Boletus nanus* Massee, a species both of the authors are very familiar with from fresh collections from Peninsular Malaya (*Watling* 24386, 24871, 24488–90 in E). However, there are some discrepancies between Corner's notes, the original description by Massee (1909) and von Höhnel's two collections from Java redescribed by Singer (1947). Corner has the pores and tubes 'pallid white then pinkish', i.e. *Tylopilus*, whereas the other two authors state 'greenish yellow', i.e. *Xerocomus* or *Boletus*. *Xerocomus schmitzii* and *Boletus nanus* are not congeneric.

Boletus pernanus has a yellow mycelial tomentum (Singer, 1947) absent in our collection (FP 339/14), but the pileipellis of ascendant cylindric hyphae with the last members erect and forming an epithelium of ovoid to globose bodies is in good agreement. It is yellowish brown in colour. *B. patouillardii* Singer from Cambodia is close to *B. pernanus* but has less mycelial development at the stipe base and the pileus is a beautiful red; the basidiospores are <10 × 4.5–5.5μm. The basidiospores of *B. pernanus* are in keeping with our collections but our material differs in the shades of the pileus (see above). Singer (1947), after examining von Höhnel's material of *B. nanus* Massee, concluded that this is in a different group to *B. pernanus* as it possesses a filamentous cutis.

7. **Xerocomus** sp. 1.

Pileus 50–120mm, convex slightly depressed, pubescent-rough, fulvous/bay. *Stipe* 50–80 × 10–15mm, solid, ochreous with dark line near apex. *Context* thick, spongy, white/straw bruising bluish near stipe. *Tubes* adnexed to 15mm long, sulphur yellow/amber/fulvous bruising green/blue, fading slowly.

Basidiospores sepia in mass, 8.7–11.4 × 4.4–4.8μm, very pale honey-colour in ammoniacal solutions, smooth, lacking apical differentiation. *Basidia* hyaline, pedicellate, clavate, 4-spored, 19 × 10μm. *Cheilocystidia* elongate-vesiculose resembling enlarged basidioles, scattered, hyaline; *pleurocystidia* similar, numerous. *Hymenophoral trama* consisting of cinnamon-coloured central zone with closely packed lateral elements exhibiting only slight divergence. *Pileipellis* a deep trichoderm forming a turf ≤400μm in depth, of thin, long chains of flexuous, cinnamon-brown, erect hyphae <30μm long easily separating from the context in dried material.

Habitat: in shade in miombo woodland.

Material examined: Misaka Forest Reserve, in group under light to moderate shade, 3 i 1975, FP 338/7, *Ivory* 24.

Additional material examined in Forest Pathology Herbarium, Riverside Lab., Kitwe (NDO): FP 339/10 and FP 355/1.

This bolete has also been found from January to February in miombo woodland at Riverside, Kitwe.

In the dried material the pileus in the young specimen is suede-like arising from the snuff-brown tomentosity, the elements of which separate in the older specimens to expose the lower ochraceous yellow layer, finally collapsing and forming fibrillose patches. In this character it resembles some interpretations of the North American *Boletus olivaceobrunneus* Zeller & Bailey, but Thiers (1975) has demonstrated that the type of Zeller & Bailey's bolete is in fact *Tylopilus pseudoscaber* (Secr.) Smith & Thiers; other interpretations are of a fungus in the *Boletus edulis* group. Corner (1972) considers *B. olivaceobrunneus* the same as *B. phaeocephalus* Pat. & C. F. Baker described from Singapore; Singer (1947) places *B. phaeocephalus* in the genus *Pulveroboletus. Boletus umbrinellus* Pat. & C. F. Baker is also a member of this complex.

Xerocomus spinulosus Heinem. is probably the closest taxon known in Africa; it was described from the Congo (Heinemann, 1951).

8. **Xerocomus** sp. 2. Fig. 2F.

Pileus 110mm, plane, dry, with tiny cracks, pale luteous/ochreous. *Stipe* 45 × 12mm, ochreous. *Context* straw with vinaceous tinge under cuticle and in stipe, unchanging on bruising. *Tubes* 10mm long, sulphur yellow/citrine; *pores* citrine with fulvous tinge.

Basidiospores isabelline in mass, 10.5–13.1 × 5.2(–6.1)μm, smooth, honey-coloured, slightly thick-walled, lacking apical differentiation, boletoid. *Basidia* hyaline, clavate, pedicellate, 24–28 × 9–11μm, 4-spored. *Cheilocystidia* hyaline, bunched at tube orifices as extensions of the hymenophoral trama, elongate-clavate, smooth or slightly roughened, sometimes with honey-coloured contents, intermixed with shorter clavate (9–11μm broad) to vesiculose cells (11–15μm broad); *pleurocystidia* hyaline, prominent, thin-walled, elongate-lanceolate, drawn

out into an obtuse apex, 46–54 × 8–11μm with neck 22–24 × 3–4μm long. *Hymenophoral trama* a distinct mediostratum of broad, prominently septate hyphae becoming narrower downwards, hyaline, slightly gelatinized with similarly coloured or slightly honey-coloured, divergent lateral strata of similar elements, sometimes accompanied in broader tubes with silvery laticiferous hyphae; *hymenium* accentuated by production of acicular crystals in ammoniacal solution but evidence of prominent cellular subhymenium absent. *Pileipellis* a palisadoderm of vesiculose cells 15–17μm broad and broad or torpedo-shaped, ± long pedicellate units; end-cells collapsing onto more filamentous units which include laticiferous hyphae 6.5–7.5μm broad; *suprapellis* loosely arranged with or without pale tawny brown contents and intermixed in places with external debris, resembling in many ways those at tube margin; *subpellis* of loosely arranged, tangled, filamentous hyphae passing into context with little demarcation except for more compaction in zone above hymenophoral trama although gelatinized zone separates flesh from tubes.

Habitat: in relic miombo woodland and in gardens.

Material examined: Riverside, Kitwe, solitary under moderate shade, 16 i 1975, FP 348, *Ivory* 12.

This taxon was also collected under a solitary *Marquesia macroura* in a Kitwe garden. It occurs in clusters and often has vinaceous/blood red areas on the pileus. According to Verdcourt (1989) *M. macroura* (Dipterocarpaceae) is native to Zaire, Angola and more rarely eastwards to Tanzania where it is associated with *Brachystegia* spp. in mixed woodland. Dipterocarpaceae is a predominantly Asiatic group of trees many of which are proven ectomycorrhizal-forming phytobionts.

The collector indicates that in old basidiomes the margins of the tubes of this bolete are fringed with red, clavate cheilocystidia with papillate apices. These have not been found in FP 348 during the present study, although pleurocystidia with long necks and tawny tinged cheilocystidia are present (Fig. 2F); the latter are often seen in the darkened edge of the dried tubes.

However, another collection from Kitwe (FP 360/6; NDO) assigned to the same taxon by the collector did have broad cheilocystidia with rich red brown apical inclusions. The stipe in this basidiome is furfuraceous punctate and possesses pale ochraceous yellow basal mycelium; the tubes are dull cinnamon almost concolorous with the finely velvety pileus. The microscopic characters confirm this is not conspecific with FP 348 described above and probably is a *Tylopilus* in which case it might find a place in the *B. spinifer* group discussed earlier (p. 334).

Similarly, a third collection (FP 176/67 in NDO) from the same general locality possesses bright golden yellow basal mycelium and an orange ochraceous punctate stipe; the pileus, especially in the young basidiome, is of a similar colour and texture to *Boletus luridiformis* (Rostk.) O. Kuntze (= *erythropus* Fr.: Fr. auct. europ.). Examination of the older basidiome emphasizes that this is only a superficial resemblance. On studying a manuscript description located in the Riverside Herbarium with which FP 348, FP 360/6 and FP 176/67 were associated, it became apparent that at least three different taxa were used in its compilation. Unfortunately, field notes are not available for FP 360/6 and FP 176/67. The above forcibly demonstrates that several, often superficially similar boletes are still to be critically studied in the Copperbelt of Zambia.

FP 348 cannot be matched with any taxon known from the tropics. It has features in common with many from the Congo but in detail there are always discrepancies. The numerous well-differentiated cheilocystidia, lanceolate to obtuse pleurocystidia and epithelial pileipellis places it close to *Xercomous albotesselatus* Heinem., which has been assigned to the *X. subtomentosus* group (Heinemann, 1954a). Piearce (pers. comm.) has deposited other collections from Kitwe which he believes agree with FP 348 (FP 336/2, 363 and 374/17) in the Forest Pathology Herbarium, Riverside Lab. (NDO). These collections extend the fruiting season from December until March but a critical re-examination of the exsiccata is imperative.

ACKNOWLEDGEMENTS

The authors wish to thank M.H. Ivory, Oxford Forestry Institute, for making available the boletes discussed in this paper, and, with G.D. Piearce (now at the Forestry Research Centre, Harare), for supplying valuable field information and personal observations.

One of us (RW) is also grateful to Hudson Muthali and his colleagues at the Forest Pathology Laboratory, Riverside for the assistance he received there, especially in making it possible for him to visit the Chati and Misaka Forest Reserves. Andrew Angus, formerly of St Andrews University, has been extremely helpful in supplying records and field data of Zambian fungi. Thanks are also extended to Stephen Thomas who assisted in the preparation of the SEM photographs.

REFERENCES

ALEXANDER, I. (1989). Mycorrhizas in tropical forests. In: PROCTOR, J. (ed.) *Mineral nutrients in tropical forest and savanna ecosystems*, pp. 169–188. British Ecological Society Special Publication 9.

ALEXANDER, I. & HÖGBERG, P. (1986). Ectomycorrhizas of tropical angiosperm trees. *New Phytol.* 102: 541–549.

BEELI, M. (1938). Étude de la Flore Mycologique africaine. Note sur des Basidiomycètes récoltés á Sierra Leone par F.C. Deighton. *Bull. Jard. Bot. l'État. Brux.* 15: 25–53.

COKER, W.H. & BEERS, A.N. (1943). *The Boletaceae of North Carolina.* University of North Carolina Press, Chapel Hill.

CORNER, E.J.N. (1972). *Boletus in Malaysia.* Singapore.

DICK, E.A. & SNELL, W.H. (1965). Notes on Boletes XV. *Mycologia* 57: 448–458.

FROST, C.C. (1874). Catalogue of boleti of New England, with descriptions of new species. *Bull. Buffalo Soc. Nat. Sci.* 2: 100–105.

HALLING, R. (1983). Boletes described by Charles C. Frost. *Mycologia* 75: 70–92.

HEIM, R. (1963). Diagnoses latines des espèces de Champignons, ou nonda, associés à la folie du komugl tai et du ndaadl. *Rev. Mycol. Paris* 28: 277–283.

HEINEMANN, P. (1951). Champignons récoltés au Congo Belge par Madame M. Goossens-Fontana 1. Boletineae. *Bull. Jard. Bot. l'État. Brux.* 21: 223–346.

HEINEMANN, P. (1954a). *Flore Iconographie des Champignons du Congo*, Fasc. 3. Boletineae: 49–80.

HEINEMANN, P. (1954b). Notes sur les Boletineae Africaines. *Bull. Jard. Bot. l'État .Brux.* 21: 306.

HEINEMANN, P. (1964). Boletineae du Katanga. *Bull. Jard. Bot. l'Etat. Brux.* 34: 425–477.

HEINEMANN, P. & RAMMELOO, J. (1983). *Flore Illustrée des Champignons d'Afrique Centrale*, Fasc. 10. Gyrodontaceae pp Boletineae: 173–198.

HONGO, T. (1975). Notulae mycologicae (13). *Mem. Shiga Univ. Nat. Sci.* 24: 44–51.

JANOS, D.P. (1980). Mycorrhizae influence tropical succession. *Biotropica* 12 (Suppl.): 56–64.

MASSEE, G. (1909). Fungi Exotici: IX. *Kew Bull.* (1909): 204–209.

MCNABB, R.F.C. (1968). The Boletaceae of New Zealand. *New Zealand J. Bot.* 5: 532–547.

MURRILL, W.A. (1909). The Boletaceae of North America — I. *Mycologia* 1: 4–18.

PEGLER, D.N. (1982). Agaricoid and boletoid fungi (Basidiomycota) from Malâwi and Zambia. *Kew Bull.* 37: 255–271.

PEGLER, D.N. & YOUNG, T.W.K. (1981). A natural arrangement of the Boletales with reference to spore morphology. *Trans. Brit. Mycol. Soc.* 76: 103–146.

SCHWEINITZ, L.D. (1822). *Synopsis Fungorum Carolinae Superioris.* Leipzig.

SINGER, R. (1944). New genera of fungi. *Mycologia* 36: 358–368.

SINGER, R. (1945). The Boletineae of Florida with notes on extralimital species. 1. The Strobilomycetaceae. *Farlowia* 2: 97–141.

SINGER, R. (1947). *Ibid.* 2. The Boletoideae of Florida. *Am. Midl. Nat.* 37: 1–126.

SINGER, R. & ARAUJO, I. (1979). Litter decomposition and ectomycorrhiza in Amazonian forests. *Acta Amazonica* 9: 25–41.

SINGER, R., ARAUJO, I. & IVORY, M.H. (1983). The ectotrophically mycorrhizal fungi of the neotropical lowlands, especially Central Amazonia. *Beih. Nova Hedwigia* 77: 1–352.

SINGER, R., GARCIA, J. & GOMEZ, L.D. (1991). The Boletineae of Mexico and Central America 3. *Beih. Nova Hedwigia* 102: 1–99.

SMITH, A.H. (1965). New and unusual Basidiomycetes with comments on hyphal and spore wall reactions with Melzer's solution. *Mycopath. Mycol. Appl.* 26: 385–402.

SMITH, A.H. & THIERS, H.D. (1971). *The Boletes of Michigan.* University of Michigan Press.

SNELL, W.H. (1936). Notes on Boletes V. *Mycologia* 28: 463–475.

SNELL, W.H. & DICK, E. (1970). *The Boleti of northeastern North America.* J. Cramer, Lehre.

THIERS, H.D. (1975). *California mushrooms. A field guide to the boletes.* Hafner Press, New York.

VERDCOURT, B. (1989). *Flora of Tropical East Africa: Dipterocarpaceae.* Balkema, Rotterdam.

WATLING, R. & GREGORY, N.M. (1989). Observations on the Boletes of the Cooloola sandmass Queensland and notes on their distribution in Australia Part 2C. *Proc. Roy. Soc. Queensland* 100: 13–30.

WATLING, R. & TURNBULL, E. (1993) ['1992']. Boletes from South and East Central Africa Part 1. *Edinb. J. Bot.* 49: 343–361.

WOLFE, C.B. JR (1979). *Austroboletus* and *Tylopilus* subg. *Porphyrellus. Biblioth. Mycol.* 69: 1–148.

WOLFE, C.B. JR (1981). Type studies in *Tylopilus* I. Taxa described by Charles H. Peck. *Sydowia, Annales Mycologici*, series II, 34: 199–213.

WOLFE, C.B. JR (1986). Type studies in *Tylopilus* III. Taxa described by Walter H. Snell, Esther A. Dick and co-workers. *Mycologia* 78: 22–31.