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OBSERVATIONS ON THE BOLETES OF THE COOLOOLA SAND-MASS, QUEENSLAND AND NOTES ON THEIR DISTRIBUTION IN AUSTRALIA: PART 3. LAMELLATE TAXA

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INTRODUCTION

The lamellate boletes found in the Cooloola Sand-mass, Queensland are described and discussed in the light of earlier Australian records of paxilloid fungi. Nine species of *Paxillus* are discussed, two in *Tapinella*, which is maintained as a separate entity, and 11 are assigned to *Phylloporus*. Of the last, eight are new records to Australia and two are new species. Three appendices cover various aspects of studies on Australian boletes which have come to light since the publication of this series, including notes on the host-range of the parasitic hyphomycete *Sepedonium*.

The present paper covers members of the Paxillaceae, which includes in the authors' definition four genera. Of these both *Paxillus* and *Phylloporus* are represented in Australia as is the segregate genus of *Paxillus*, *Tapinella*. *Phylloporus* is included in the Boletaceae by Singer (1986) and in the Xerocomaceae by Pegler & Young (1981). The only other family of lamellate boletes, the Gomphidiaceae, is not represented in Australia, although they might be expected there in the extensive plantings of Coniferae with which they are mycorrhizal. Members of the Gomphidiaceae are known from New Zealand (McNabb, 1969).

Bailey (1913) records four species of *Paxillus* from Queensland, *P. hirtulus* F. Mueller, *P. crassus* Fr., *P. muelleri* (Berk.) Sacc. and *P. paradoxus* (Kalch.) Cooke. Horak (1979) lists nine species of *Paxillus* although little is known on six of them presumably because types or authentic material are not available. These are *P. olivaceoflavidus* (Cooke & Massee) Reid (which Horak suggests is a synonym of *P. aureus* Lloyd), *P. crassus* Fr. sensu Cooke, *P. eucalyptorum* Berk., *P. hirtulus* and *P. psammiphila* Cleland. Horak also includes *P. panuoides* (Fr.: Fr.) Fr. in his listings and *Paxillus involutus* (Batsch: Fr.) Fr. which he believes to be an introduction; *P. muelleri* and *P. veluticeps* (Sacc.) Singer are discussed in full. The only other paxilloid fungus known from Australia is *Phylloporus hyperion* (Cooke & Massee) Singer.

ABBREVIATIONS

Abbreviations for herbaria used in the text follow *Index Herbariorum*, 7th edition (Holmgren, Keuken & Schofield, 1981). JECA refers to the herbarium of Jack Aberdeen now housed in Brisbane (BRIP). *Wat* refers to R. Watling, all material of which is in E, and ADW to Waite Agricultural Research Institute, Adelaide.

MATERIAL

Unless otherwise stated all material, except that of the senior author which is in the Royal Botanic Garden Edinburgh (E), is housed in Brisbane. The material on which the records appearing in F. Manson Bailey's *Comprehensive Catalogue of Queensland Plants* (1913) are based, is deposited in the Royal Botanic Gardens, Kew (K).

PAXILLACEAE

Contrary to many previous classifications *Paxillus* and *Phylloporus* are considered very closely related, as already indicated by Corner (1970); undoubtedly the latter is also related to the xerocomoid boletes. The presence or absence of cystidia and clamp-connections, and the shape of the basidiospores are not definitive. The present authors separate the two genera primarily on the persistently enrolled margin and narrow, closely arranged gills in the former and the thicker more widely spaced gills in the latter, and the colour of the spore-print, i.e. ferrugineous in the former and olivaceous in the latter. The large differences recognized by Singer (1986) only work when the extremes of the two genera are considered and various concepts appear in the literature, e.g Singer (1945 et subseq.), Horak (1979), Pegler & Young (1981) and Singer, Ovrebo & Halling (1990). The genus *Tapinella* is used as outlined by Redhead & Ginns (1985); see Singer et al. (1990) for further discussion.

The Paxillaceae should also be extended to include those boletes with a shallow, irregularly poroid hymenophore as in the N American *Boletinellus meruloides* (Schw.) Murr. formerly placed in *Gyrodon* which has been shown not to be mycorrhizal with *Fraxinus* (Oleaceae) as previously considered but in fact symbiotic with aphids on the tree roots (Brundett & Kendrick, 1987). It only superficially resembles the European *Uloporus lividus* (Opat.) Quél. generally considered typifying the genus *Gyrodon*. The pseudolamellate pores resembling the top of the stipe in many *Paxillus* species and formation of sclerotia in parallel with *Paxillus involutus* Fr. are considered significant and support the present placement.

Basidiospore shape is not a good character in distinguishing the poroid and lamellate boletes, as a whole spectrum of spore outlines are exhibited in the different genera when taken on a world basis. It is true that the subfusiform spore so frequently and erroneously termed boletoid dominates the north temperate flora. Although it is true that the most common members in *Phylloporus* and *Paxillus* are distinct and easily recognized one from the other it is difficult to separate the two genera when dealing with tropical taxa; this is why spore-print colour is given such great significance herein.

Paxillus Fries

This is a characteristic genus of temperate areas of both hemispheres, although it is known in the tropics. Many are mycorrhizal and associated generally with frondose trees, e.g. Betulaceae, Fagaceae, but also Coniferae; some members are both mycorrhizal and lignicolous. Basidiomata are pilangiocarpic where known, with decurrent

hymenophore which shows at least some degree of anastomosis especially at the stipe-apex. Basidiospores in mass are cinnamon brown, ferrugineous or chocolate brown lacking olivaceous tints, and are generally ovoid to ellipsoid, less commonly subfusoid, and often dextrinoid.

1. P. aureus Lloyd in Mycol. Notes 43: 595 (1916).
This species is based on a collection sent to C.G. Lloyd by J.B. Cleland from Australia. It is illustrated (Mycol. Notes 1916: fig. 837), and said to be similar to *Merulius aureus* Fr. (= *Pseudomerulius aureus* (Fr.) Jülich). The gills are said to be similar to *P. panuoides* (=*Tapinella*) q.v. No type material has been found at ADW and therefore further discussion is deferred until considering members of the genus *Tapinella.*

2. P. crassus Fr., Hymenomycetes Europaei, 404 (1874).
No Australian material is available in K for examination. It is recorded from Queensland by Cooke (1892), and is further discussed under *P. muelleri* q.v.

3. P. eucalyptorum Berk. in Hooker's London Journal of Botany 4: 49, 1845.*
Although apparently no type material exists, it is still considered useful to publish the original description of this agaric because of the chance that it may be recognized in the future.

> *31. Paxillus eucalyptorum*, n.sp.; caespitosus pileo convexo carnoso compacto flavo-fusco; stipite deorsum attenuato transversim squamuloso; lamellis distantibus decurrentibus flavis; sporis elongatis. - *Drumm.* n. 111.
> Under the York gum trees.
> Caespitose. Pileus 3–9 inches across, yellow brown, convex, very thick and fleshy, compact, with a very minute, mealy pubescence, especially near the margin. Stem 2 inches high, $^3/_4$ of an inch thick above, attenuated below, marked with flat, minute, transverse scales. Mycelium white, reticulate. Gills of a fine yellow, thick, scarcely at all ventricose, slightly decurrent, sparingly forked, separating from the pileus. Spores large, oblong, colourless, at least when dry. Antheridia conical, giving the gills a pubescent appearance.

Judging from the notes and the placement by Cooke (1892) in *Paxillus* (*Lepista*) it is more likely to be a member of the Tricholomataceae.

4. P. hirtulus F. Mueller in Kalchbrenner, in Proc. Linn. Soc. New South Wales 8: 175 (1884).
This species was described from the Daintree River, north of Cairns, Queensland; it has not been seen since and no material exists in K. The original description is reproduced for completeness:

> *Paxillus hirtulus* F. v. Mueller.
> Pileus e convexo depressus margine involutus luride fuscescens stipes deorsum incrassatus et pallidior ad basim abruptam radicatus hirtulus, lamellae adnate aequaliter decurrentes confertae angustae luridae.
> Daintree River, Pentzke.
> Pluribus notis *P. sordario* convenit sed multo minor, pileus vix 3–4 lineas latus stipes circiter pollicaris et sesquilineam crassus

* Horak (1979) incorrectly cites the place of publication as '*J. Linn. Soc. Bot.* 4:49, 1845'

5. P. infundibuliformis Cleland in Trans. Proc. R. Soc. South Australia 51: 304 (1927). This species was originally described from South Australia and Victoria. Horak (1979, 1983) examined the type and synonymized the name with *P. muelleri* (see below). Discussion on his action appears below, although it must be stated here that the present authors maintain Cleland's name for an agaric which lacks clamp-connections and cystidia.

Cleland's description is reproduced below (colours follow Ridgway, 1912).

> 477. *Paxillus infundibuliformis*, n. sp. Sometimes slender, usually large and stout. Pileus up to 3 ins. (8.7 cm.) in diameter, irregularly infundibuliform (shallow or deep), sometimes irregularly convex or rather flabelliform when the stem is excentric, finely villous, tending to crack into rows of villi near the periphery, sometimes covered with brown to very dark brown (near Russet, pl. xv., to Mars Brown, pl. xv.) warty scales, the edge involute when young, Ochraceous Tawny (pl. xv.), becoming Cinnamon Brown (pl. xv.), or Raw Sienna (pl. iii.) or Light Cadmium (pl. iv.) or under the scales when present near Honey Yellow (pl. xxx.). Gills decurrent, often deeply so, often forking several times from near the stem, moderately close, edges a little thick, when young near Aniline Yellow (pl. iv.), becoming Sudan Brown (pl. iii.), Ochraceous Tawny (pl. xv.) or Clay Colour (pl. xxix.) and later still darker (*e.g.*, Antique Brown, pl. iii.), sometimes becoming spotted with brown. Stem up to 1 ins (3.7 cm.) high, up to in (1.2 cm) thick, relatively slender, attenuated downwards, swollen under the pileus, villous or somewhat mealy or even fibrillosely scaly, stuffed or hollow, central or sometimes excentric, pallid to the colour of the gills (base Mars Brown, pl. xv.), sometimes with a few slightly raised brown lines. Flesh pallid or turning reddish-brown when cut, then darker. Spores mummy-shaped, elongated, yellow-brown to greenish-yellow, usually 12.8 to 16, occasionally 21 x 4 to 7μ. Cystidia not seen. S.A. – Kuitpo, May; Mount Lofty, April to July. Vict. – Sedgwick, near Ararat, July (E.J. Semmens, No. 126), and near Bendigo.

As little microscopic information is given the following data is offered based on a recent collection (*Wat.* 10236).

Basidiospores smooth, subfusoid, rich golden yellow in ammonia, 13–13.6 x 5.4μm, relatively thick-walled with no germ pore or apical differentiation. *Basidia* clavate, hyaline, 4-spored, 59–62 x 11μm, sterigmata > 6.5μm long. *Cheilo-* and *pleurocystidia* absent. *Pileipellis* an irregular trichoderm with suprapellis of cylindric to elongate hyphae adhering in loose flexuous tufts, often Y-branched, with subfusoid or undifferentiated end-cells, orange brown passing into hyaline or pale honey-coloured, smooth or slightly ornamented hyphae below, seated on similarly coloured subpellis; laticiferous hyphae present pushing into pileipellis; clamp-connections absent.

Material examined:

> WESTERN AUSTRALIA, near Perth Diamond State Park, junction of Grand Road and Channybearup, on roadside in dry sclerophyll, 14 vi 1924, *Wat* 10236.

This material agrees with *Agaricus muelleri* from Albert Range *Berkeley* 15444 and 'Victoria-Mueller' cited by Horak (1979). An unlocalized collection of Mueller in K (probably Victoria) should also be referred here as well as a contaminated specimen in K with basidiospores 13–14 x 5μm from Pennant Hill, Parammata, New South Wales (as *P. muelleri* mixed with a *Cortinarius* sp.). A collection of *P. infundibuliformis* under *Phylloporus* from Mansfield, Victoria (12 v 1953, Herb FPSM 3321) was noted by Reid

(1955); no cystidia were found in the material and the spores measured 11–15.6 x 4–5μm. Pegler & Young (1981) have recorded finely rugulose spores in this species.

One of our own collections from Tasmania (Mount Field National Park, Russell Falls, 14 v 1974, *Wat* 10372) macroscopically comes very close. However it differs markedly from *Wat.* 10236 in the smaller and ellipsoid not subfusiform basidiospores (8.5–10.5 x 5.4–5.8μm); highly septate units and hyaline, silvery laticiferous hyphae were also present in the trama. In addition, the cheilocystidia are poorly developed and clamp-connections and pleurocystidia absent. The pileipellis is composed of a suprapellis of short, smooth to encrusted, broad cells 10–12.5μm diam., with or without distinctly yellow contents passing into a thin, radially arranged zone of similar coloured cells seated on similar but hyaline hyphae which form a demarcation to the context. In places the pileipellis forms long chains of cells often adhering into groups to form scales but with end-cells hardly differentiated. In the field it was recognized by the paler gills and the pileus splitting into distinct scales.

6. P. involutus (Fr.) Fr., Epicrisis Systematis Mycologici, 317 (1838).

Material examined:

> ACT, near Canberra, Stromolo Forest, in pine forest with *Pinus radiata* D. Don, 24 iv 1974, legit J. Sheperd, *Wat.* 10597; NEW SOUTH WALES, Gosford Horticultural Institute grounds, under small-leaved *Populus* aff. *trichocarpa* Torrey & Gray ex Hooker.

It is generally accepted that this species has been introduced into Australia (Horak, 1979; comm. auct. pl.), New Zealand (McNabb, 1969) and South America (Singer, 1964). It is common and widespread in Europe and North America although recently it has been shown to be composed of at least three inter-sterility races (Fries, 1985). To date these races have not been linked with specific characters, although gross morphology and certain ecological features are possibly correlated. The Australian collections noted above have slightly shorter and more abundant pleurocystidia than those described by Watling (1970) for British material, although in this character they are still considered to come within the variation of the taxon. Perhaps the speciation noted by Fries (1985) is operating within these introductions and populations with slightly different spore sizes are evolving.

7. P. muelleri (Berk.) Sacc., Sylloge Fungorum 5: 986 (1887).

Three authors have examined material deposited in Kew (K) under this name. Pegler (1965) and Horak (1979) were both unable to find the type (*Mueller* 121) and instead examined two authentic collections (Victoria, *Mueller* s.n. and Albert Range, *Mueller* 113, *Herb Berkeley* 1544), although Singer (1955, 1964) had previously reported on the type. That they were dealing with different fungi is possible as Singer states 'I found many septa without clamps but am not certain whet(h)er the species is really clamp-less .....; cystidia clavate e.gr. 43 ⇌ 10 μ'.

Both Pegler and Horak found no clamp-connections, and the latter author could find no cystidia. On this basis Horak, after examining Cleland's type of *P. infundibuliformis* in ADW, decided that it and *P. muelleri* were synonymous. Singer (1955) had already

suggested that *Flammula veluticeps* and *Paxillus infundibuliformis* were synonyms, although at that time no type material had been examined. Paxilloid fungi are common in the Australian flora, and the tradition of accommodating all collections under one or two names has resulted in confusion. As indicated from his material now housed in the Berkeley Herbarium (K) it is possible that when Mueller collected the agaric to be named after him he had in fact two or more species in hand. Certainly the type description (reproduced here for completeness) is very brief and helps very little in solving the problem of the true identity of *P. muelleri*.

> 41. *Paxillus muelleri, B.* Pileo convexo umbonato obscure furvo; stipite fulvo pruinato; lamellis decurrentibus una desinentibus fulvis. Müll, no. 121.
> In meadows near the river Albert, May; Wilson's Promontory. Pileus 1 inch across; stem 1 inch high, nearly ½ inch thick.

Based on Horak's findings on Cleland's type of *P. infundibuliformis* and the difference between Singer's interpretation of *P. muelleri* (presence of cystidia and possible presence of clamp-connections) and that of both Horak and Pegler for the same fungus (absence of cystidia and clamp-connections) it is proposed to maintain the name *P. infundibuliformis* for a widespread *Paxillus* lacking facial cystidia and rare clamp-connections, and *P. muelleri* for an agaric with cystidia, but lacking clamp-connections.

A field description is not available but microscopic characters are as follows:

Basidiospores (12–)13–14.5(–15.5) x (4.8–)5.3(–6.3)µm*, golden yellow, smooth or showing slight rugulosity with phase contrast microscopy, no apical differentiation, elongate ellipsoid to slightly elongate phaseoliform. *Basidia* 4-spored some becoming thick-walled. *Cheilocystidia* poorly differentiated, very thin-walled, narrowly clavate to elongate, hyaline or sometimes with oily yellow contents; *pleurocystidia* similar. *Hymenophoral trama* divergent, with some laticiferous hyphae in the mediostratum. *Pileipellis* a turf of short suberect ± very slightly roughened, ± diverticulate golden yellow cells adhering in small bundles and apparently at maturity collapsing and with end-cells not prominently differentiated, seated on a mixture of hyaline and orange hyphae. *Clamp-connections* not seen.

Material examined:

> ACT: Tidbinbilla Reserve, on roadside, 26 iv 1974, *Wat.* 1068; *ibid.*, on bankside, 26 iv 1974, *Wat.* 10689. TASMANIA: Tatura Park, Haz Mountain area, 20 v 1982, *Wat.* 14951**, 20 v 1982, *Wat.* 15090. VICTORIA: Near Mount Cole, Victoria Mill, Dawson Rock Road, trackside in mixed dry sclerophyll, 29 iv 1982, *Wat.* 14735; near Marysville, Cumberland Falls, Lake Mountain, floor of wet sclerophyll (with *Eucalyuptus regnans* F. Mueller), 7 v 1982, *Wat.* 14653, and in K (all as *P. infundibuliformis)*, north side of Mt Strathbogie, 700m under *Eucalyptus*, 28 v 1977, *L.M. Green & J. Waters*;Mansfield, on gravel, 12 v 1953, *D.W. Paine*; Mt Beckworth, 600m, west of Clunes, on moss gravel under *Eucalyptus*, 12 vi 1977, *K.H. & N.H. Sinnott* 2295. WESTERN AUSTRALIA: Pine Creek Road, near Manjimup, Kari experimental area, track in regrowth, 23 iv 1982, *Wat.* 14549; 2 People's Bay, near Albany, legit G. Smith, 24 v 1974, *Wat.* 10300.

* Two collections *Wat.* 14951 & *Wat.* 15090 with spores 10.5–11 (–12) x 5.8µm

** slightly different in the sparse cheilocystidia and more sulphur to lemon yellow colour of pileus

Apparently the concept of *Paxillus muelleri* has been erratic even in Berkeley's mind (see Bailey, 1913). Thus in two of Bailey's collections in K from Brisbane, Queensland a tricholomataceous agaric (*Clitocybe* with non-amyloid, narrowly ellipsoid basidiospores; *Bailey* 743) and an entolomataceous agaric (*Rhodocybe*, with irregularly rugulose basidiospores, *Bailey* 667; see Horak, 1978) have been located. Indeed in a further collection, from the Challenger Expedition 1874, even two different genera are involved, a *Cortinarius* subg. *Dermocybe*, of the *C. sanguineus* group with coarsely ornamented broadly ellipsoid basidiospores and red pigment in ammoniacal solutions, and a genuine member of the genus *Paxillus*. The latter agrees with the unlocated Mueller material mentioned above in its boletoid but richly tawny coloured basidiospores. It has been redetermined in script on the sheet as *Phylloporus infundibuliformis* (basidiospores 13–14 x 5μm). As outlined above it is not a *Phylloporus* as understood in the present article and we would assign the collection to *Paxillus infundibuliformis*.

This collection again emphasises the problem in separating members of the genus *Paxillus* from those of *Phylloporus*. The colour of the basidiospores, supported by the state of gelatinization of the hymenophoral trama, in our mind is critical. Cheilocystidia, although poorly differentiated, are found on the gill-edge in Bailey's material from Pennant Hills, Paramatta (June 1874) in K and also possesses hardly emergent pleurocystidia, embedded in yellowish material, similar to the laticiferous hyphae.

Cooke (1892) refers to a Queensland collection of *Paxillus* as *P. crassus* Fr. presumably as it had the same characters as the collection he depicted in his *Illustrations of British Fungi* (Plate 870(877), 1886–88) based on material from England (mound of rifle butts, November 1885, Blackheath). It is, however, very doubtful whether Cooke's interpretation of this taxon is the same as that of Fries (1874). The collections in K referring to *P. crassus* are labelled 'Blackheath House' and 'J. Howse Weybridge 1885' and both are probably nothing more than *P. involutus*. The epithet refers to the thick pileus but *P. involutus* frequently exhibits this. There seems to be some discrepancy in the field data between this material and that figured in Cooke's illustrations as reference is made to the Blackheath collection being November 1885. The notes accompanying the material also refer to Battara (1759) but even his description is of little help.

8. P. psammophila Cleland in Trans. R. Soc. South Australia 57: 187 (1933).
Authentic material has been located and examined by Grgurinovic (pers. comm.) but the present authors suggest that it is not a member of the genus *Paxillus* as the basidiospores are white. It was placed in *Paxillus* by Cleland (1933 and as *P. psammophilus* 1934)who followed the trend in Europe (e.g. Rea, 1922) which incorporated species such as *P. giganteus* (Sow.: Fr.) Fr. (= *Leucopaxillus*) and *P. panaeolus* Fr. (= *Ripartites*) in addition to the *P. involutus* group; see W.G. Smith (1908). Indeed Cleland refers to Rea (1922) directly in the circumscription adopted. A large brown, white-spored agaric growing in sand should be looked for in the future to ascertain its true affinities; with its white spores if proving paxilloid would be related to *Hygrophoropsis*.

The type description is given for completeness.

> 593. *Paxillus psammophilus*, n. sp. - Pileus 8.7 cm., flabelliforme-dimidiatus subfibrillosus, deinde rimosus, brunneus. Lamellae decurrentes, confertae, ad stipem reticulatae, sub-brun-

neae. Stipes brevis (2.5 cm.), sublateralis, tenuis, radice longa angusta. Sporae elongatae, albae, 3-13.5 x 4μ. In arena. S.A. Elliston.

9. P. veluticeps (Sacc.) Singer in Sydowia 9: 418 (1955).

Examination of the type material by Horak (1979), Pegler (1965) and Singer (1955) indicates that this species possesses clamp-connections. This is confirmed in the present study of the type in K although interestingly Singer relates this taxon to the South American *P. defibulatus* Singer which lacks clamps. In the same paper Singer indicates that *Crepidotus pactolus* Cooke ex Pilát is a pleurotoid form of *P. veluticeps*; Pilát (1948) indicated a relationship with *Phylloporus* based on the spore shape, not realising that species of *Paxillus* in Australasia also possess so-called boletoid spores. Singer (1955) synonymized *P. veluticeps* with *P. infundibuliformis*, although he did not examine Cleland's type material of the latter in ADW.

Flammula veluticeps Saccardo is based on Cooke & Massee's *Agaricus veluticeps* (Cooke, 1891a) and not *A. veluticeps* (Cooke, 1889) of the same authors; the latter is a member of the Coprinaceae. For clarity Cooke & Massee's description and Pilát's diagnosis of *Crepidotus pactolus* are presented (1950).

Agaricus (Flammula) veluticeps, Cke. & Mass. in Grevillea 19: 89, 1891
Pileus convex, then flattened, depressed in the centre, densely and shortly velvety, bay-brown (3–4cm broad), margin involute. Stem expanded upwards into the pileus, stuffed, rather short (8cm long), smooth, of the same colour as the pileus (5mm thick). Gills rather distant, attenuated behind, and deeply decurrent, orange brown, then umber. Spores orange brown, minutely apiculate at the base (12 x 5 μ).
Amongst grass on the hillsides. Omeo, Victoria. *(Baron F. v. Mueller, H.)*

Crepidotus pactolus Cooke ined. in Herb. Kew.
Specimen typicum in herbario Kewensi: Omeo (Victoria, Australia) leg. J. Stirling. (Tab. II, fig. 26.)
(Solum pars unius carposomatis visum)
Pileus cuneato-flabelliformis, 4.5cm longus et 3cm latus, superficie haud lucidus, sed subglaber, minime tomentosus, obscure ferrugineo-fuscus. Lamellae obscure ferrugineo-fuscae, confertae. Habitu sat carposomata.
C. panuoidis in mentem revocat. Sporae cylindraceo-subfusoideae, laeves, luteo-ferrugineae, 14–15 x 5.6–6μ forma sporas Boletorum in mentem revocantes. Lamellae speciminis originalis pro dolor pressae sunt. Forma sporarum haec species in affinitatem generis *Phylloporus* spectat, quamquam habitus carposomatis alius est et magis *Crepidotum panuoidem in mentem revocat.*

In Pilát's description it should be noted that he considered *Tapinella panuoides* [treated below] as a *Crepidotus*. By doing so he is relating *P. veluticeps* indirectly to this group of paxilloid agarics. Singer et al. (1990) have in the same way associated *Paxillus leptopus* Fr. as 'merely an often pleurotoid non-mycorrhizal from of *P. involutus*'.

Singer (1955) indicates that the cystidia of *Ag. veluticeps* are inconspicuous. This may be an artifact of preservation and it is not considered appropriate at this stage to describe a new species which agrees with *Ag. veluticeps* except in the prominent cystidia; certainly the degree of development of cystidia in this species is slightly variable. Pegler & Young (1981) have indicated the basidiospores of the type are finely rugulose under the scanning electron microscope; this has been confirmed from some of the collections below but it is almost at the limits of resolution.

Basidiospores (12–)13–14.8(–16) x 5.4–5.8 (–6.3)µm, subfusiform (boletoid) bright tawny golden to orange-coloured in ammoniacal solutions, smooth with no apical differentiation. *Basidia* 4-spored, sometimes with golden contents. *Cheilocystidia* and *pleurocystidia*, frequent and prominent, elongate clavate to cylindric, some flexuous and very narrow. *Hymenophoral trama* with some laticiferous hyphae ramifying through mediostratum. *Pileipellis* of narrow, smooth to ornamented honey-coloured to golden yellow, interwoven hyphae with slightly tapered end-cells and some heaped to form small, ± erect piles of hyphae adhering together in groups, although not highly organized. *Clamp-connections* present in trama and cuticular elements.

Material examined:

> ACT: Tidbinbilla Nature Reserve, on bankside, 26 iv 1974, *Watling* 10643; ibid., 27 iv 1974, *Watling* 10628. TASMANIA: Harz mountains, on trackside, 20 v 1982, *Watling* 15088; Turata Park, Harz Mountains, by River Huon, 20 v 1982, *Watling* 15092. WESTERN AUSTRALIA; Anzac Road, Big Brook National Forest, on bankside, under Kari (*Eucalyptus diversicolor* F. Mueller), 22 v 1982, *Watling* 14578. VICTORIA: Cairn Road (2), Wombat State Forest, trackside, 20 iv 1982, *Watling* 14747; Dawson Rock Road, Mt Cole, along track in dry sclerophyll, 29 iv 1982, *Watling* 14789; *ibid.*, 12 v 1982, *Watling* 14859.

Flammula aldridgei Massee, (in Cooke, 1891b) undoubtedly is a paxilloid agaric which may have been introduced into the British Isles. It is pertinent to note that Rea (1922) even suggested that *F. aldridgei* was equivalent to the Australian *Flammula veluticeps* discussed above. *F. aldridgei* was originally described (Massee apud Cooke, 1891b) found on the ground at Petersfield, nr Portsmouth, Hants, and has probably only been seen once. The basidiospores of the type in K are subfusiform-ellipsoid 13–15 x 5.5–6.5µm.

Phylloporus Quélet

A characteristic subtropical to tropical genus of equatorial Africa and Australasia with a few north temperate members. Many are probably mycorrhizal although associated plants are generally difficult to ascertain but in north temperate areas;*P. rhodoxanthus* occurs regularly with Fagaceae. Basidiomata gymnocarpic with thick, decurrent hymenophore, sometimes with an irregular poroid configuration, or lamellate or interveined and intermediate between these extremes. Basidiospores olivaceous brown or bronze in mass, generally subfusoid in outline and sometimes faintly but distinctly ornamented. Connected to the xerocomoid boletes.

Many collections of *Phylloporus* have been made in Australia, eighteen of which are from Queensland. Unlike the rich central African flora, where the genus exhibits a wide range of characters (Heinemann & Rammeloo, 1987), in general the Australian material represents the *P. rhodoxanthus* (Schw.) Bres. consortium, and perhaps by some would all be named that, or refer them to as one of its synonyms, e.g. *Paxillus paradoxus* (Kalchbr.) Cooke: see below. Undoubtedly the genus is native to Australia, and its members share many similarities with those from both Malaysia and North America.

Singer has discussed at some length (Singer, 1945 et subseq.) the division of *P. rhodoxanthus* into separate subspecies, emphasizing that the main difference between

the European and N American subspecies is the degree of anastomosis of the gills, being greater in the former. Some of Singer's subspecies have since been given specific rank.

P. rhodoxanthus subsp. *foliiporus* (Murr.) Singer is a cyanescent taxon described from Florida; it too resembles some of the Australian taxa; *P. bogorensis* Höhnel, also considered a subspecies of *P. rhodoxanthus* by Singer, is quite distinct in that the cyanescence is so intense that the fungus becomes black. *P. rhodoxanthus* subsp. *europaeus* Singer is said to differ in its non-cyanescent flesh.

The distinction between the last subspecies and the type subspecies has not been confirmed in an examination of a wide range of herbarium material. In E 25 collections (17 from various States in North America and five from the British Isles) possessed veined gills. Only a single collection from North Amerca (Michigan: *Wat* A1660/C1968) and two from Britain (Blackheath, *Orton* 3375; ibid. *Wat* 236C) exhibited separate gill-plates; none were distinctly poroid. In a similar examination of material in K (22 collections) one showed extensive veining (Oxfordshire, legit Cole) and one was distinctly poroid (Michigan, legit D A Reid). The rest showed only some degree of veining but were never obviously poroid. It might be suggested that the Michigan collection exhibitied some teratological condition. The newly recognized *P. leucomycelinus* Singer is the most frequent member of the complex found in Mid-west N America and will be discussed further in connection with an Australian collection.

The collections of *Phylloporus* below from widely separated areas are discussed in an attempt to understand the *Phylloporus rhodoxanthus* complex in Australia as it is only by so doing the Queensland material can be assigned to particular taxa.

1. P. australensis Wat.

Corner (1970) described an agaric from Malaysia with overall colouring of *P. hyperion* but with cheilo-, pleuro- and caulocystidia distinctly thick-walled, and the pileipellis composed of a compact pile of short, inflated cells. Three collections from the Cooloola Sand-mass (BRIP 16135, 16136 & 16137) come close to this species in the presence of thick-walled cystidia, and to *P. hyperion* in general facies. Judging from the type material in K one of the distinguishing features of *P. tunicatus* is the remarkably delicate nature of the basidiomes (pileus 15–22mm, stipe 12.8 x 1.5–2mm). Therefore we believe the Queensland collections represent a new species.

Phylloporus australiensis Watling, **sp. nov. Fig. 1A–G.**

Basidiomata omnino luteo-brunnea. *Pileus* 58mm latus, luteo-ochraceus, glaber. *Stipes* 70 x 5mm (ad basim 3.5mm), albus, luteo-brunneo tincto, glaber, mycelio basali albo. *Caro* pallide lutea. *Lamellae* subdecurrentes. *Sporae* elliptico-subfusiformes, 12.7–13(–14) x 4.8–5.7μm, laeves. *Cheilocystidia* numerosa, vesiculosa vel lageniformia vel ventricoso-rostrata collo longo cylindrico et apice obtuso; pleurocystidia similia, parietibus hyalinis vitreis incrassatis. Holotypus: Cooloola Sand-mass, Chalimbar landscape (Cooloola 124195), 13 xii 1983, JECA 82/67, BRIP 16135.

Basidiome overall yellow. *Pileus* 58mm, very smooth yellow brown, no fibrils distinguished (under x 10 lens). *Flesh* (exposed after surface eaten) near white but yellowish. *Lamellae* subdecurrent. *Stipe* 70 x 5(–3.5b), smooth near white, yellowish

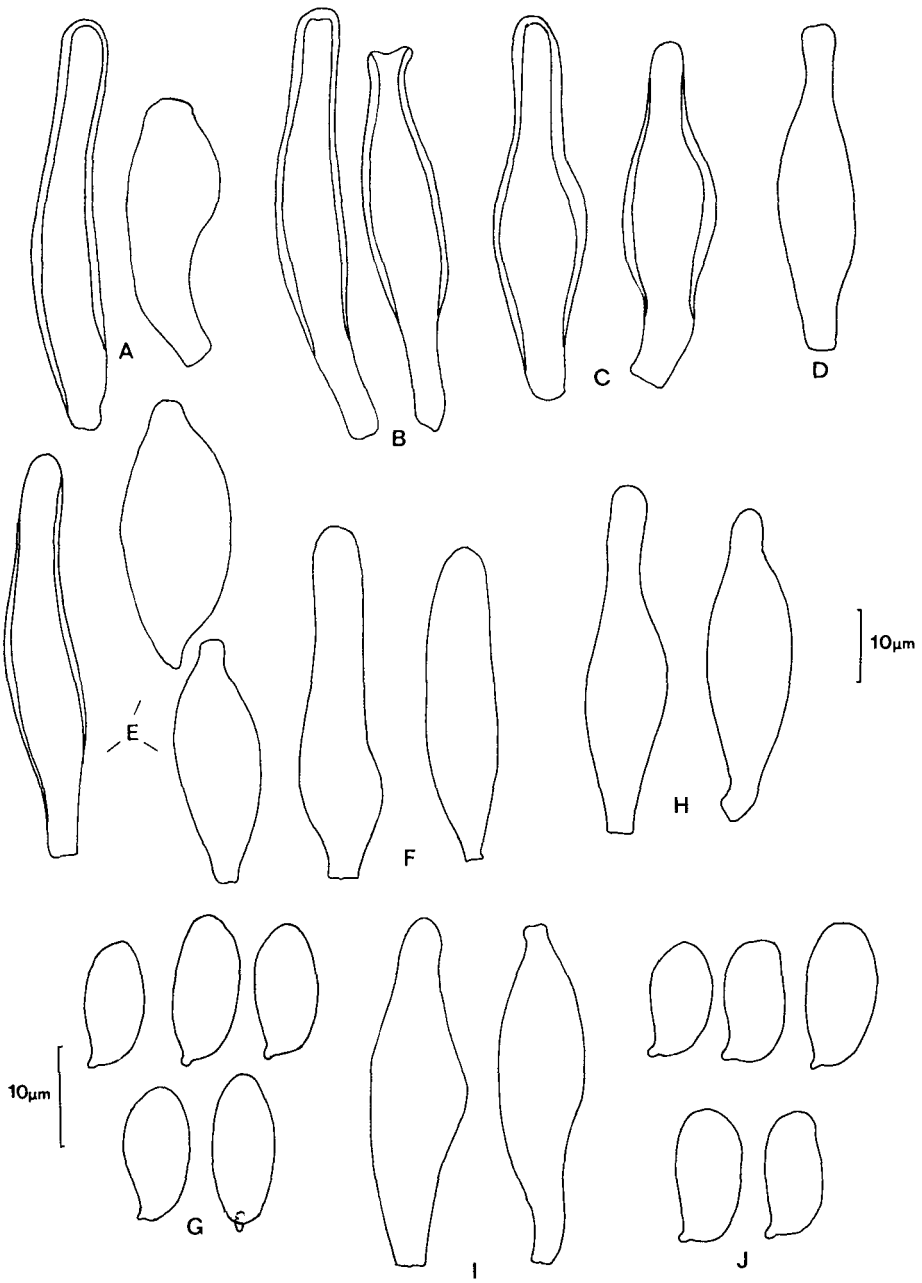

FIG.1. A–G, *Phylloporus australiensis* Wat. A, D & F, cheilocystidia; B, C & E, pleurocystidia (B, broken at apex); G, basidiospores. H–J, *P. clelandii* Wat. H, cheilocystidia; I, pleurocystidia; J, basidiospores. A, B & G from BRIP 16135; C, D from BRIP 16137; E, F from BRIP16136; H–J from *Wat.* 10257.

tinge; basal mycelium in exsiccata white. *Basidiospores* subfusiform (boletoid) 12.2–13(–14) x 4.8–5.2μm, smooth except for very faint rugulosity under SEM, honey-coloured, lacking apical differentiation. *Basidia* 4-spored, 28 x 7.5–9μm ; sterigmata up to 4.5μm. *Cheilocystidia* numerous, forming sterile fringe to lamellae, vesiculose to lageniform to ventricose rostrate but with long, cylindric neck and obtuse apex; *pleurocystidia* similar in shape to cheilocystidia, with distinct hyaline, thick (glassy) wall, 43–54.5 x 9–10μm, neck 6.5–8.5μm, sometimes collapsing to give irregular pointed ends (and so resembling metuloids) often deeply seated. *Pileipellis* a collapsed cutis of smooth, filamentous, non-gelatinized, honey-yellow, intertwined hyphae 6.5–8.7μm broad, disarticulating at septa and with some torpedo-shaped end-cells with obtuse ends, seated on subpellis of similar, hyaline either broader or narrower hyphae and passing into hyaline context. *Hymenophoral trama* contrasting with distinctly orange honey-coloured hymenium, with dark honey-coloured mediostratum and colourless, non-gelatinized divergent lateral strata. *Clamp-connections* not seen. *Imler's reaction* with Melzer's reagent negative.

Habitat: In several clumps dwarf forest (BRIP 16136) and about base of *Cassuarina* (BRIP 16137)

Material examined:

> QUEENSLAND.Cooloola Sand-mass: Kings Bore Sand-dune, Mutyi landscape, (Cooloola 106128) legit C.H. Thompson, JECA 80/336, BRIP 16136; Mutyi landscape (Cooloola 105128), 24 iv 1980, legit C.H. Thompson, JECA 80/335, BRIP 16137.

2. P. bellus (Massee) Corner in Nova Hedw. 20: 798 (1970).

This species is based on *Flammula bella* Mass., from the Singapore Garden's Jungle (*Burkill* 134 in K) although Corner (1970) records it from Malaya and Singapore; he also suggests that the illustration in Imazeki & Hongo (1957: Plate 36, No. 211) represents this species although these authors (Imazeki & Hongo, 1978a) consider it to be *P. rhodoxanthus* subsp. *americanus*. Corner (1970) at the same time introduced var. *cyanescens* of Massee's taxon differing only in the blueing of the gills and flesh and the larger spore size.

Massee's description of *Flammula bella* (Kew Bull. 1914: 74) is reproduced here as there is still some question as to whether the taxon as conceived by Corner is in fact uniform.

> *Pileus* hemispherico-explanatus, margine regulari vel plus minusve undulato, pulchre fulvo-aurantiacus, squamulosus, 3–5cm latus. *Lamellae* confertae, angustae, utrinque acutatae, postice dente decurrentes, flavae. *Stipes* teres, solidus, extus fibrillosus, pallide lutescenti-fulvescentes, 4cm. longus, 0.8–1cm crassus. *Sporae* oblongo-ellipsoideae, basi oblique apiculatae, pallide ferrugineae, 10 x 5μ.
> SINGAPORE. On a path in the jungle, E.M. Burkill 134.
> A very beautiful fungus with a tawny-orange cap and clear yellow gills. Allied to *F. sapinea*, from which it differs in the squamulose cap and narrow, crowded gills.

What we consider *P. bellus*, differing from Massee's type material only in the slightly narrower basidiospores (3.5–4.5μm as opposed to 4.5–5.5μm) has been sent by T.R. Lohmeyer from Montville, Kondabilla Falls National Park, Queensland (on base of

living tree in eucalypt forest). Singer & Gomez (1984) have shown similar discrepancies between material from Central America (Costa Rica & Mexico) and Japan, the material from Japan (*Singer* A4021) possessing narrow basidiospores. The most frequent range indicated by Singer & Gomez was 9–10 x 3.5–4.5μm; our material agreed satisfactorily (8.7–9.6 x 3.9–4.4μm). The type possesses spores 8–10.5 x 5–5.7μm. The short basidiospores, blackish brown pileus with a tinge of purple date-colour contrasting with the deep lemon yellow gills characterize the Queensland material. This differed somewhat from the painting accompanying the type material in K where Miss Smith's copy of Burkhill's original illustration depicts a fungus with deep rust-coloured pileus. Singer (in herb. K) indicated that Burkhill's collection was possibly *P. rhodoxanthus* subsp. *bogorensis* but later accepted the autonomy of the taxon.

One collection (BRIP 10280) from the University Campus, St Lucia agrees with the protologue of Corner's cyanescent variety, both having larger spores than the type variety. Unfortunately as no Cooloola material has been located a description of this St Lucia material is offered:

'*Pileus* 40–140mm irregular in outline, more or less convex with flat to slightly depressed centre, brown with no distinct zones, except where cracking and then showing cream to yellow flesh, (blackening due to damage?) not fibrillose, but cracking leaves reticulate pattern. *Stipe* 85 x 21mm dark brown, attenuated downwards or almost equal, relatively smooth but not very firm fibrillose structure discernable. *Lamellae* adnate to sinuate, yellow brown, cyanescent on bruising, margin dark brown, veined on face and lamellules distinctly wrinkled. *Flesh* near white, pink flush under pileus cuticle, cyanescent adjacent to lamellae; pale or yellow flush in flesh above lamellae'.

Basidiospores (13–)13.5–14 x (4.8–)5.2(–5.7)μm, subfusiform, honey-coloured, lacking apical differentiation. *Basidia* 4-spored, elongate-clavate, slightly honey-coloured, 32 x 8–7μm. *Cheilocystidia* vesiculose, sometimes with an apical broad snout, only slightly protruding (8–9μm broad); *pleurocystidia* very thin-walled, cylindric-clavate, hyaline, 75–85 x 12.5–14μm narrowed to 8.7μm below. *Pileipellis* a turf of cylindric tawny to dark honey-coloured hyphae 8.7–13μm broad adhering together in clumps to form erect columns and with shortened torpedo-shaped end-cells as in *Armillaria*, seated on a very thin layer of filamentous, repent hyphae passing into open context of anastomosing floccose hyphae with filamentous units resembling laticiferous hyphae passing through, compacting near hymenium. *Hymenophoral trama* divergent, with very little differentiation into a medio- and lateral strata, quite open in structure and with some elements with internal plaques of amorphous material. *Clamp-connections* not seen. *Imler's reaction* with Melzer's reagent negative.

Material examined:

QUEENSLAND, St Lucia, University Campus, ridge between Kings and open air theatre adjacent to trees, legit R. Jones, 14: 1966*, BRIP 10280, JECA 62/2 & 3: Burleigh Head (National Park) growing out of ground on old washed out road near Tallebudgera CK. entrance, 6 ii 1973, legit I. Bevege, BRIP 10281, JECA 73/21

* Probably a typing error in that the JECA number and the field notes refer to 1962

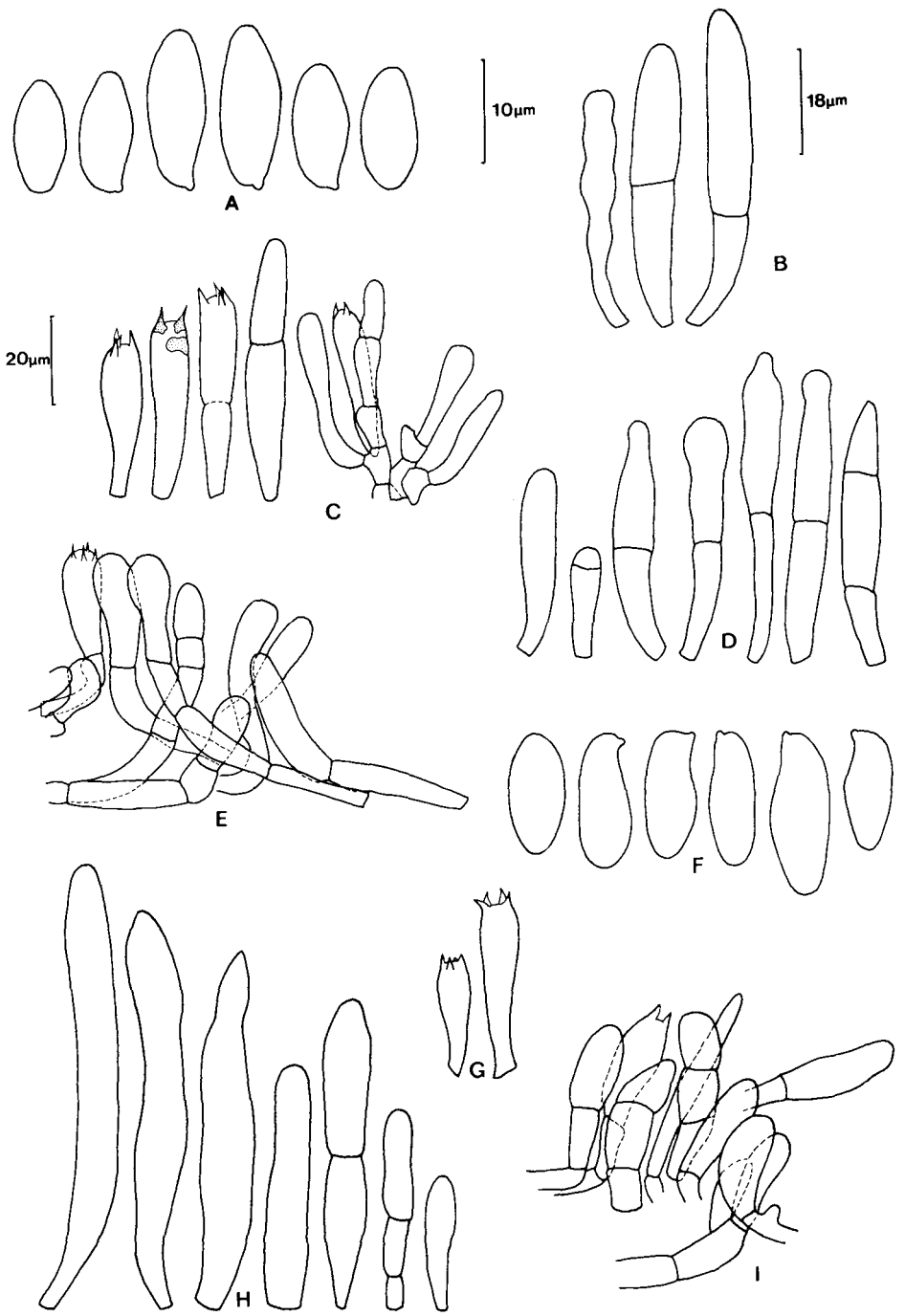

FIG. 2. *Phylloporus bogoriensis* (Henn.) Singer. A & F, basidiospores; B, pleurocystidia; C, hymenial elements; D & H, cheilocystidia; E & I, stipitipellis; G, basidia. A–E from *Wat.* 10939, F–I from *Wat.* 10978.

Corner (1970) indicates that var. *cyanescens* is intermediate between *P. bellus* (spores 8.5–10 x 4.5–5.5(–)6)µm and *P. orientalis* var. *brevisporus* Corner (spores 9–13.5 x 4.5–5(–5.5)µm. However, the latter taxon differs in its thinner stipe and the redder colours to the stipe-cortex and flesh. Although the material was collected over a period the spore-print, pickled material (2 collections) and exsiccata all agree. Singer (1978) has suggested that *P. bellus* var. *cyanescens* is in fact *P. rhodoxanthus* subsp. *foliiporus*. Corner considers that a figure by Imazeki & Hongo (1957) of *P. rhodoxanthus* possibly depicts *P. bellus*, and this might be so especially as the illustration does not resemble a *Gomphidius* to which Murrill (1943) originally assigned *P. foliiporus*.

3. P. aff. **bogoriensis** Höhnel in Sitzker. Kaisel. Acad. Wiss. Math.-Naturw. K1., 123 89 (1914). **Fig. 2.**

One collection (BRIP 16129) from the Cooloola Sandmass approaches Höhnel's species in that the flesh and gills are strongely cyanescent becoming blackened with age. However, the basidiospores are slightly larger than *P. bogoriensis* (9–12 x 4–5µm) and all of the other blackening species, viz. *P. manausensis* Singer from the New World (8.5–11.2 x 4.2–5.5µm), *P. nigresecens* Heinemann & Rammeloo from Central Africa (9.5–12 x (4.7–)6.1µm) and *P. rufescens* Corner from S E Asia (8–9 x 4–5µm). This suggests that a distinct taxon might be recognized.

Details available from the field notes 'Pileus golden brown. Lamellae yellow becoming dark blackish green, to brown, staining black to greenish on touching'.

Microscopic details are:

Basidiospores 13.1–14.3 x (4.8–)5.2–5.7µm subfusiform to elongate ellipsoid in face-view, slightly flattened on lower surface in side view (boletoid), smooth, pale honey-coloured. *Basidia* 35–38 x 8.5–9µm, 4-spored. *Cheilocystidia* clavate or elongate cylindric with obtuse apex 64–90 x 10–15µm, deeply seated and many with honey-coloured contents in ammoniacal solutions; *pleurocystidia* scattered, but very prominent, bluntly lanceolate, hyaline to distinctly coloured or pigmentation restricted to apices, sometimes contents forming colloidal strands. *Hymenium* honey-tawny coloured, strongly demarcated from a hymenophoral trama poorly differentiated into lateral and medio-strata, pale honey-coloured, non-gelatinized or lateral strata slightly coloured towards gill-base. *Pileipellis* probably weathered, of dark honey-coloured to pale tawny, irregular hyphae 8.7–13(–17)µm broad, apparently not differentiated into distinct layers and seated on open, floccose, pale honey-coloured context; probably a collapsed cutis with end-cells obliterated. *Clamp-connections* not seen. *Imler's reaction* with Melzer's reagent negative.

Material examined:

QUEENSLAND: Cooloola Sand-mass, walking track onto King's Bore. Sand blow (reworked Warrawonga landscape), Cooloola 105129; 5 ii 1980, legit D.J. Ross, BRIP 16129, JECA 80/31.NEW SOUTH WALES. Royal National Park, near Loftus, Sydney, under *Cassurina*, 10 iv 1974, *Wat.* 10939 and 10978.

Singer (1945) relegated *P. bogoriensis* to a subspecies of *P. rhodoxanthus* (Schw.) Bres. Corner (1970), with whom we agree maintained it as an autonomous species, but incidentally misquoted Singer's plate; it should be Plate 1, 11–12 (not 3).

4. P. aff. **cingulatus** Corner in Nova Hedw. 20: 803 (1970)

An undocumented collection from Burleigh Heads (BRIP 10282), except for the distinctly lamellate hymenophore, comes close to *P. cingulatus* Corner described from Singapore Garden's Jungle (Corner, 1970). It has the same obturbinate pileus but no information is available for the colours of the fresh basidioma; the exsiccata is tawny orange throughout with pileus 70mm broad and slightly concentrically cracked at margin, flesh very pale (clay buff), gills deeply decurrent anastomosing at their bases and pale pinkish buff tinge to the stipe-base; the basal mycelium is very pale.

The character which joins this collection and *P. cingulatus* is the unusually shaped basidiospores, i.e. ellipsoid obtuse and therefore hardly boletoid. *P. cingulatus* has distinctly but widely poroid gills and a lurid blue-green zone at the stipe-apex; the blue colouration generally fades as the basidioma dry out to leave no traces. The basidiospores are considerably smaller, 7.5–9 x 5–5.5μm, as opposed to 10.5–11.4 (–11.8) x 6–6.5(–7)μm in the present collection. There is no doubt this member of the genus should be looked out for again in Eastern Australia and to facilitate this microscopic details are offered.

Basidiospores 10.5–11.4(–11.8) x 6.1–6.5(–7)μm, ovoid to ellipsoid obtuse, flattish in side-view, pale honey-colour, slightly cyanophilic. *Basidia* 30–31 x 8.5–9μm, colourless in ammoniacal solution, 4-spored. *Cheilocystidia* vesiculose to utriform, hyaline, relatively thin-walled, easily collapsing, 32–33 x up to 15μm occasionally with deep honey-coloured contents in alkali; *pleurocystidia* 8.5–10.5μm broad, cylindric to narrowly clavate with swollen obtuse apices up to 32μm long, or more rarely elongate utriform and then 28–54 x 11μm. *Hymenophoral trama* divergent although little differentiation between medio- and lateral strata, pale honey-coloured. *Pileipellis* an openly arranged cutis of honey-coloured to hyaline, smooth, cylindric hyphae, with slightly tapered or torpedo-shaped end-cells with obtuse apex, 30.5–44 x 8.7–11μm, some slightly disarticulating; *subpellis* more compacted, slightly darker but otherwise little differentiated from open floccose context. *Clamp-connections* not seen. *Imler's reaction* with Melzer's reagent negative.

Material examined:

> QUEENSLAND, Burleigh Heads (National Park 41), 6 ii 1973, legit I. Bevege, BRIP 10282, JECA 73/23.

One of us (RW) has collected material of the African *Phylloporus carmineus* Heinem., also characterized by non-boletoid, ellipsoid basidiospores, but whereas this fungus in colour and stature is rather distinctive, *P. cingulatus* and BRIP 10282 are clearly of the *P. rhodaxanthus* complex.

5. P. clelandii Watling

There is a possibility judging from Cleland's notes for *Paxillus paradoxus* (q.v.) that he had one or more taxa for he writes '.... Cystidia *usually present* 47 x 16μ. On the ground usually under trees. South Australia - Mount Lofty (*no cystidia seen*), Momalta, Morphett Vale, New South Wales ....' (Cleland, 1934: 178) – our italics indicating discrepancies. Grgurinovic (pers. comm.) in a manuscript covering Cleland's herbarium material has not solved the discrepancies.

Material which we believe fits in part Cleland's description has been found in Western Australia and the following new species is proposed to recognize Cleland's great contribution to Australian mycology.

Phylloporus clelandii Watling, **sp. nov. Fig. 1H–J.**

Pileus plano-convexus vel centraliter depressus, 280mm latus, siccus, subtiliter velutinus. *Stipes* 180 x 70mm (ad basim 50mm), basaliter subradicans, fulvus ad apicem luteo-fibrillosus. *Caro* cyanescens. *Lamellae* sinuato-subdecurrentes, cyanescentes. *Sporae* subfusiformes, 12.6–15.2 x 5.4–5.8μm. *Cheilocystidia* lageniformia vel vesiculosa apice obtuso; *pleurocystidia* elongato-vesiculoso vel ventricos-rostrata, papilla apicali saepe provisa. Holo. *Watling* 10257 (E).

> WESTERN AUSTRALIA, Kings Park, Perth 22 v 1974 under *Eucalyptus camaldudensis* Dehnh. in avenue, legit Barley, *Wat.* 10257 (E).

Pileus 280mm, plano-convex or becoming slightly depressed, hazel at margin passing into ochraceous to fulvous zone, dry, minutely tomentose then becoming smooth staining red-brown then date-brown, margin wavy and undulate. *Stipe* 180 x 70 (–50 base)mm, swollen about $^{2}/_{3}$ down, subradicate buried in the soil, sienna to fulvous in the upper part, ochre to luteous and fibrillose at very apex, bay-brown to rusty tawny where handled, fibrillose streaky throughout and becoming dark date-brown to cigar-brown towards base. *Gills* decurrent ochre becoming blue-green on bruising finally reddish brown, darkening with age, becoming spotted rust-colour and brown, not anastomosing or pore-like at apex, not thick and interveined. *Flesh* lemon-yellow above the gills whitish, in the pileus but pale chestnut in wide zone under disc centre faintly blueing, clay buff streaky in stipe-apex downwards and tinged more ochraceous at base, in radicate base dark brick or chestnut, blueing only in yellow areas and only faintly in the white central area of pileus, retaining white area around yellow flesh, after some time paler areas more or less becoming tinged uniformly watery chestnut. *Taste* none. *Ammonia reaction* dark purplish date. *Basidiospores*, subfusiform (boletoid), 12.6–15.2 x 5.4–5.8μm, pale honey-coloured, smooth although with slight rugulosity under SEM; lacking apical differentiation. *Basidia* 4-spored, elongate-cylindric, 40–53 (–65) x 8.5–9.5μm, with prominent sterigmata up to 4μm long. *Cheilocystidia* lageniform or ventricose with obtuse apex, pale honey-coloured from internal contents, wall slightly thickened but not distinctly so, 45–75 x (5.5–) 7.5–11μm; *pleurocystidia* scattered, similar in colour, either inflated, elongate vesiculose or ventricose-rostrate but with apical papilla or elongate cylindric with tapered neck up to 94μm long. *Pileipellis* a collapsed trichoderm forming a dull brown layer of smooth, filamentous hyphae 10–

13μm broad with end-cells obtuse to slightly subcapitate, seated on a more tawny brown layer of interwoven, generally smooth, hyaline or pale honey-coloured hyphae 10–13μm broad, not swollen at septa, intermixed with possible laticiferous elements 5–7.8μm broad. *Hymenophoral trama* with honey-coloured, filamentous, non-gelatinized mediostratum; lateral strata slightly divergent, hardly more coloured. *Clamp-connections* absent. *Imler's reaction* with Melzer's reaction negative.

This new species is distinctive in its enormous size, subradicate stipe deeply buried in the soil, browning of the cortical layers which immediately turn dark purplish date on application of ammonical solutions. A further possible collection has been located in K (track above Snobb's Fall, near Eildon, Victoria, 3 iv 1976, *K. & G. Beaton*).

6. P. foliiporus (Murr.) Singer in Persoonia 9: 424: (1978). **Figs 3 & 4.**
Although originally described in *Gomphidius* this is a true *Phylloporus*; indeed Singer (1945) made this a subspecies of *P. rhodoxanthus* (Schw.) Bres. (q.v.). After examination of at least five collections from Australia of material attributable to Murrill's agaric we prefer to maintain it as an autonomous species.

The following details of a Queensland collection (BRIP 10283) are offered.
'*Pileus* on cutting some bluish green fleets of colour in flesh and later a pink flush on cut surface of trama with area adjacent to lamellae clear lemon ?; surface brown to slightly darker in centre (umber to dark ?) dry, some cracking of surface tissues, ± smooth to slightly rough especially towards centre but not in form of scales; margin barely incurved, no distinctive veil fragments. *Lamellae* face greenish yellow (amber) en masse slightly darker due to distinctly darker (brown) lamella edge; face suggestion of veins near junction with trama, decurrent; lamellules 3–5 occasionally 1. *Stipe* central, tapered to base surface smooth, no pattern, very fine long striations solid. *Spore-print* greenish brown.'
Microscopic details:

Basidiospores 10.5–11.4 x 4.4–4.8μm, typically boletoid, very pale honey-colour, smooth although very faintly rugulose under SEM. *Basidia* 4-spored, 45–47.5 x 8.5–9μm. *Cheilocystidia* elongate clavate, 56–64 x 13–15μm, similar in structure to those on face; *pleurocystidia* very thin-walled, elongate with slightly tapered apex, 42–45 x 10–15μm, rather sparse, poorly differentiated, hyaline. *Hymenophoral trama* fairly uniform, medio-and lateral strata not highly differentiated, honey-coloured, not gelatinized, not distinctly divergent. *Pileipellis* a trichoderm, turf of smooth, honey-coloured hyphae with chains of shortened units adhering together in groups, constricted at septa and with some cells almost subglobose or at least ellipsoid (17–34 x 15–24μm), with end-cells possibly disarticulating, obtuse and hardly swollen at apex; not strongly differentiated into layers although the subpellis more compacted and seated on a similarly coloured context of floccose, thin-walled hyphae. *Clamp-connections* not seen. *Imler's reaction* with Melzer's reagent negative.
Material examined:

QUEENSLAND. Goodna, soil in *Acacia* and regrowth lantana, 19 iii 1975, J.E.C. Aberdeen, BRIP 10283, JECA 75/30; Cooloola Sand-mass, Burwilla (Cooloola 085199), 13–14 ii 1980, legit R. Pitt, BRIP 16134, JECA 80/55.

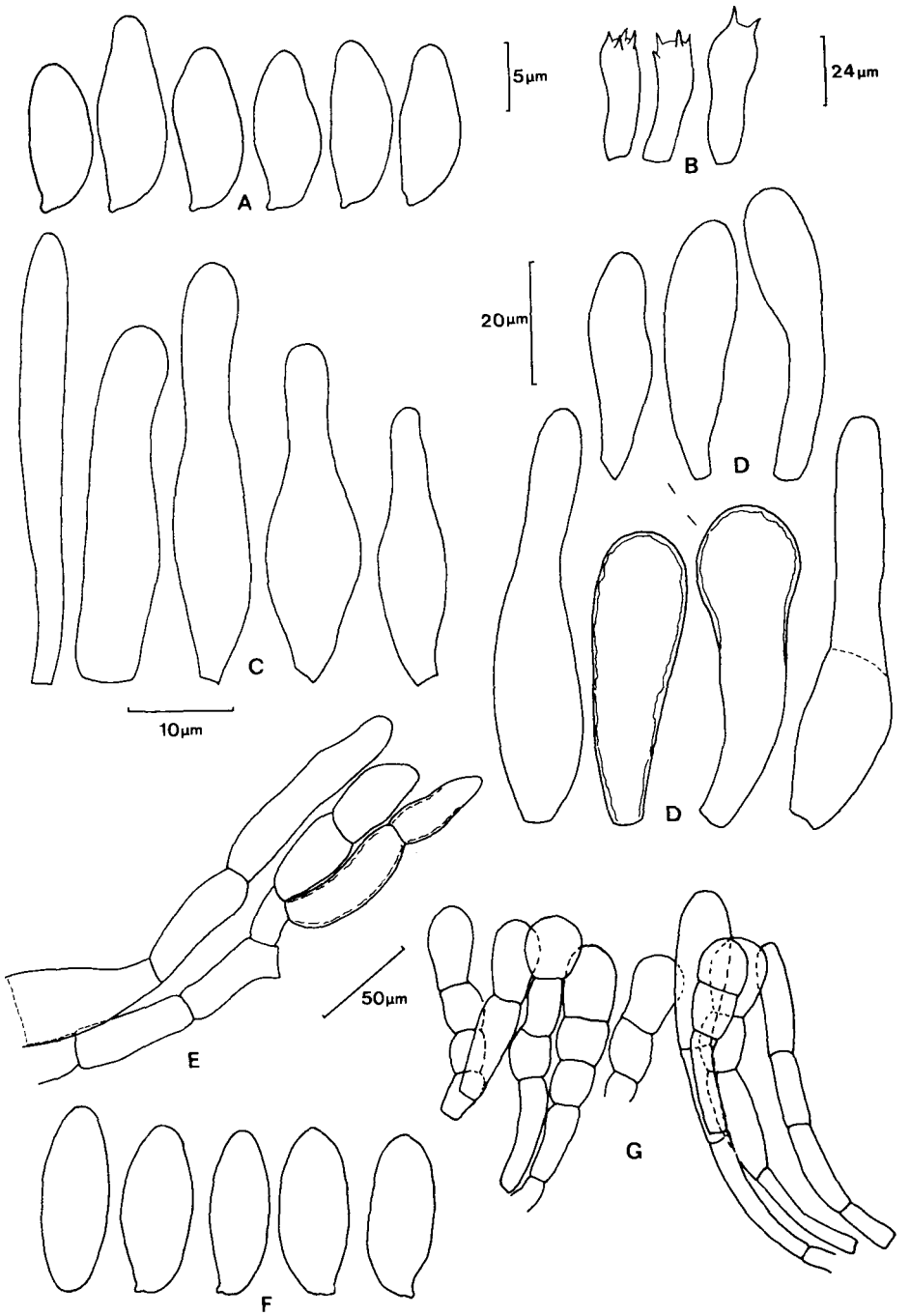

FIG. 3. *Phylloporus foliiporus* (Murr.) Singer. A & E, basidiospores; B, basidia; C, pleurocystidia; D, cheilocystidia; F, pileipellis; G, stipitipellis. All from *Wat.* 11063 except E and G from *Wat.* 10272.

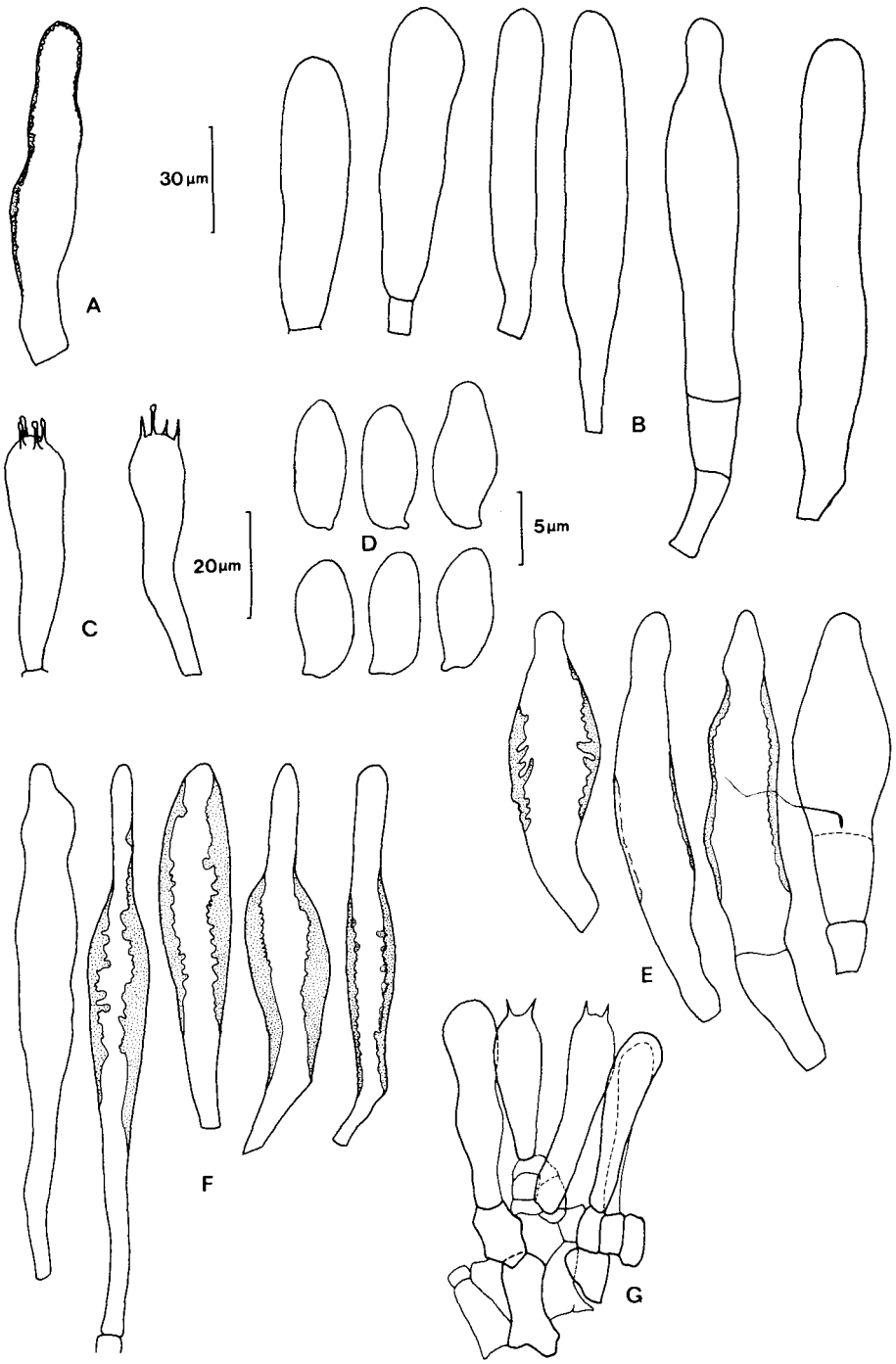

FIG. 4. *Phylloporus foliiporus* (Murr.) Singer. A, pileocystidia; B, pleurocystidia; C, basidia; D, basidiospores; E, hymenial layer; F & G, cheilocystidia. A–C from *Wat.* 10272, D–G from *Wat.* 10407.

Three cyanescent collections of *Phylloporus* (*Wat.* 11063, 10272 and 10407) from New South Wales, Western Australia and South Australia respectively agree with *P. foliiporus* and all come close to parts of Cleland's interpretation of *Paxillus paradoxus* (Kalchb.) Cooke (as *Phylloporus;* Cleland, 1934). *Wat.* 10407 has slightly smaller basidiospores than *Wat.*11063 and the Queensland material. Singer (1945) considers Cleland's taxon to be a suspected new subspecies of *P. rhodoxanthus*. It differs from the present fungus in its enormous size (3–5½ inch; Cleland 1934) and dark olivaceous gills when dry. This large, bulky fungus is formally described earlier as *P. clelandii* q.v.

A collection of Mueller's from Daylesford, Victoria, seen by Kalchbrenner and now in K as *Phylloporus hyperion* is in fact a member of the Cortinariaceae, and very probably a species of *Cortinarius*. Bailey (1913) records under *Paxillus* a *Tapinia paraxodus* Kalchb. This is said by Cooke to be the same as his illustrations of *Paxillus* (*Lepista*) *paradoxus* from Scarborough. Indeed the figure in Cooke (1892: Plate 6, 38) for the Australian fungus is, we believe, simply copied from the Yorkshire material depicted in Plate 866 (884) some years earlier (Cooke 1886–88); it therefore does not necessarily represent the Australian fungus. A further specimen in K labelled *Paxillus paradoxus* K var., Brisbane, Bailey 720 (*Gomphidius)* is indeed a member of the *Phylloporus rhodoxanthus* complex but is badly contaminated and lacks documentation (spores 11–13 x 45–52µm). It could well represent *P.foliiporus* but it is impossible to place it more critically. Imazeki & Hongo (1978b) record this species as subsp.*foliiporus* (Plate 28, No. 178) from Japan, but see comments under *P. bellus* above.

7. P. hyperion (Cooke & Massee in Cooke) Singer in Sydowia 9: 420: (1955); superfluous combination in Sydowia 15: 82 1962. **Fig. 5 A–C.**

There is some confusion over various interpretations of this name, and differences between authors have been registered (Cooke, 1888; Singer, 1955); incidentally Singer (1955) referred incorrectly to this species as *hypericon* (Singer, 1955, 1965).

As we believe material which agrees with *Reader* 34, (the type material, from near Melbourne, Victoria, now in K), has been found at Cooloola we offer an expanded microscopic description.

Basidiospores 13–15.8 (–17) x (4.7)5.2–5.6(–6)µm, boletoid (subfusoid), thin-walled, hyaline to very pale yellow in aqueous alkali solutions, smooth, although very faintly rugulose under SEM. *Basidia* 4-spored clavate, hyaline in aqueous alkali solutions, 39–48 x 10–12µm (sterigmata 5–7µm long). *Cheilocystidia* abundant, although intermixed with fertile basidia, variable, cylindric with obtuse, sometimes slightly swollen apex to ventricose-lageniform, mostly thin-walled, although not infrequently thick-walled and then either smooth or rugose on inner surface, with hyaline to granular yellowish contents; *pleurocystidia* abundant, 66–149 x 9–21µm, similar to cheilocystidia. *Hymenophoral trama* poorly differentiated into medio-and lateral strata, of non-gelatinized, hyphae 7–17µm broad, some divergent with inner wall rugulose in more or less annular fashion; *subhymenium* of broad short cells, 4–5 deep. *Pileipellis* a collapsed cutis of tightly tangled, repent, branched hyphae 6.5–10µm broad, elongate, septate with simple end-cells, pale brown, non-gelatinized although embedded in an amorphous matrix; seated on a similar, collapsed subpellis, overlying open, pale-coloured context.

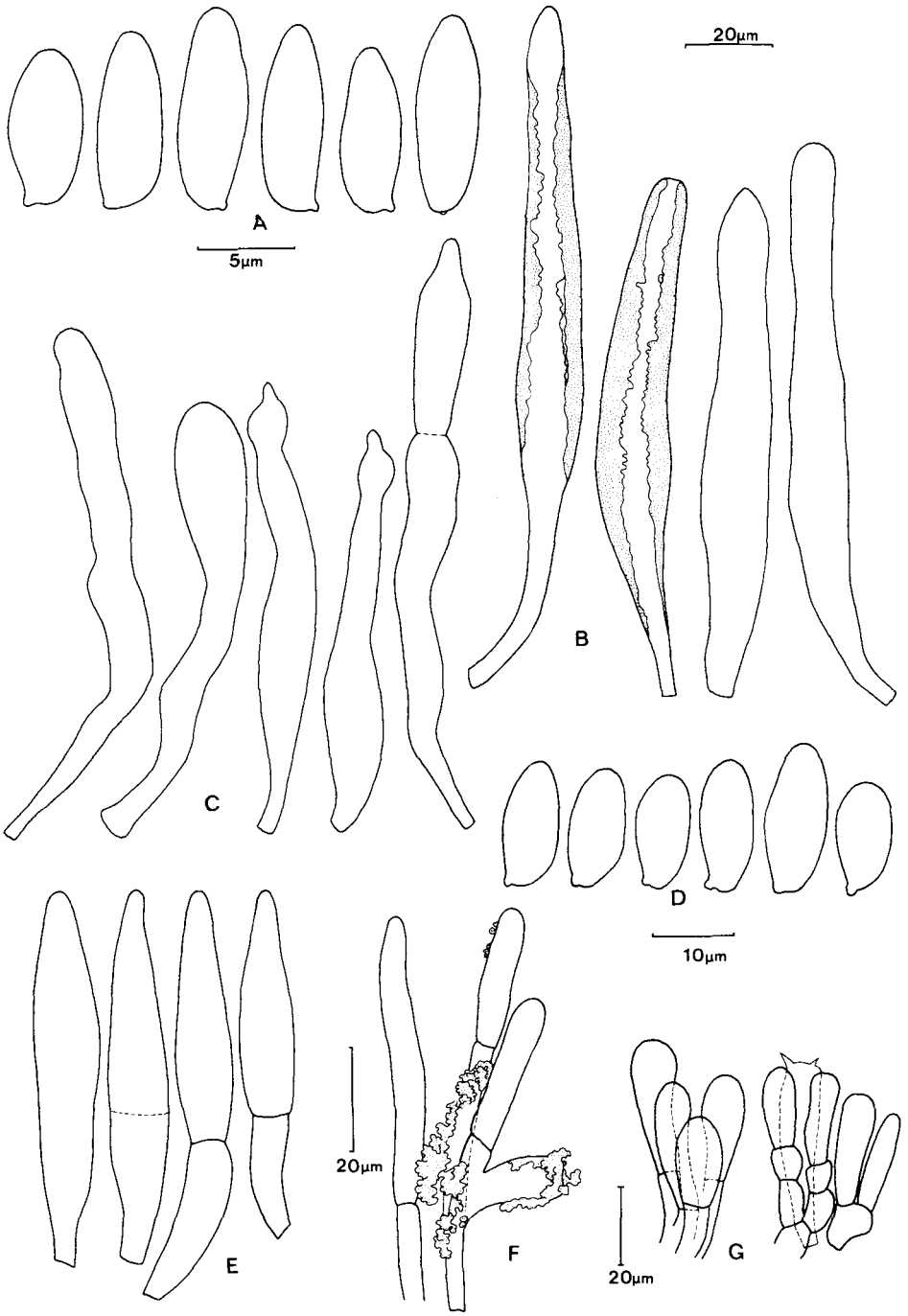

FIG. 5. A–C, *Phylloporus hyperion* (Cke. & Mass.) Singer . A, basidiospores; B, pleurocystidia; C, cheilocystidia. D–G, *P. leucomycelinus* Singer. D, basidiospores; E, pleurocystidia; F, pileipellis; G, stipitipellis. A–C from *Wat.* 10899, D–G from *Wat.* 11013.

Stipitipellis varying from a complex erect hymenial layer of tightly packed cystidioid cells supported on a loosely woven layer of hyaline hyphae at apex to a simple layer of cystidioid end-cells with thickened walls towards base; the loosely woven hyphae lie on a layer of parallel hyphae with brownish walls. *Clamp-connections* not seen. *Imler's reaction* with Melzer's reagent negative, although orange in context and blueing in ammoniacal solutions.

Material examined:

> QUEENSLAND, Cooloola Sand-mass (Cooloola 086208), Warrawonga landscape, on trunk of *Casuarina torulosa* Ait., 9 i 1981, legit C. H. Thompson, BRIP 16132, JECA 81/56. NEW SOUTH WALES, Wallamgambie, near Bell, wilderness area, 15 iv 1974, legit W. Greenfield, *Wat.* 10899.

Although in poor condition, especially the gills, a collection from the Cooloola Sand-Mass (Warrawonga landscape Cooloola 090210, legit D.J. Ross, 4 iii 1980, BRIP 16131, JECA 80/215) resembles material determined herein as *P. hyperion* and agrees microscopically with the type (see Singer, 1955; Pegler, 1965; unpubl. data). However, according to the field notes, accompanying the original description the lamellae become blue. Singer (1955) also mentions the blueing of the gills in this species based on his opinion that Cleland's interpretation of *Paxillus paradoxus* is *P. hyperion* (Cleland, 1934). Could this perhaps be the new subspecies Singer (1945) suggests? Unfortunately discrepancies arise as blueing is neither mentioned by Cooke & Massee (apud Cooke, 1888) nor by Cooke (1892) as can be seen from the original description reproduced below.

> *Agaricus (Flammula) hyperion*, Cke. & Mass. apud Cke. in Grevillea 16: 72, 1888
> Pileo plano-convexo, demum explanato (3 unc. lat.) carnoso, aureo-fulvo, dein obscuriore, laevi, glabro, margine incurvo, carne flavido, stipite deorsum attenuato, subconcolori, striato-sulcato, fibrilloso, subsquamuloso (2 unc. long, $^{1}/_{2}$-$^{3}/_{4}$ unc. crass), lamellis subdistantibus, ochraceo-flavidis, arcuatis, decurrentibus. Sporis 16–18 x 6–8μ.
> On stumps (?). Melbourne. (Reader, 34.)

In colouring this fungus resembles a *Paxillus* sp. more than a *Phylloporus*. Indeed BRIP 16131 had been annotated as such, and Singer (1955) himself had been struck by the resemblance. The basidiospores, however, are typical not of the former but of the latter genus. Cleland's *P. paradoxus* is considered an autonomous taxon; see below

P. hyperion was originally described as occurring possibly on a stump and certainly collections examined during the present study were on wood, e.g. BRIP 16132 & 16128. It must not be assumed, however, because it is on wood that this species is necessarily lignicolous; *Paxillus involutus* for instance is often found fruiting on wood. Indeed many mycorrhizal species fruit on rotten wood in the forest situation whether tropical rain-forest, N W American mist forest or dense hemlock or redwood forests. Christy, Sollens & Trappe (1982) have even suggested that seedling/mycorrhizal associations are often established in the rotten wood of fallen logs.

Nevertheless the association with woody material may mean that two undocumented collections from Toowoomba, Queensland (23 v 1952, BRIP 16132, JECA 52/21) and (23–25 v 1952, BRIP 10279, JECA 52/21), although in poor condition, may also be

referred here. *Basidiospores* (11.8–) 12.7–13.5(–14) x 4.8–5.2μm. *Cheilocystidia* cylindric, tapered towards obtuse apex, with granular contents, 62–83 x 19.5–23μm (apex 15–15.5μm broad); *pleurocystidia* similar.

One further collection, on wood from the sand hills of the Noosa River Basin (BRIP 16128, 16 ii 1901, legit D.J. Ross, *Woha* 965124, JECA 81/105), despite its somewhat smaller basidiospores (11–12 x 4.8–5.2μm) is also referred here. The small spores are probably because the collection is rather immature, but the concolorous pileus, stipe and gills are typical.

Paxillus hyperion has been recorded for New Zealand (Massee, 1898) but Singer showed (1955) that this report was based on a member of the genus *Gymnopilus*.

8. P. aff. **leucomycelinus** Singer in Persoonia 9: 426 (1978) as 'Singer ex Singer'. **Fig. 5D–G.**

One collection from Cooloola, except for the larger basidiospores and distinctly scurfy stipe-apex, closely resembled *P. leucomycelinus*. Confirmation of the position of this N American taxon in the Australian flora is required and a description is therefore offered:

'*Pileus* 31 x 25mm, brownish grey with purplish area, smooth, glabrous. *Lamellae* lemon-yellow; *lamellulae* present 1–3, some joined to appear bifurcate, adnate; slight tooth. *Stipe* pale upper half with yellow tinge, minute scales pinpoint size, concolorous pale brown, lower half ± smooth'

Basidiospores 14–15.6 x 5.5–6.5μm honey-coloured, smooth although very faintly rugulose under SEM, subfusiform (boletoid) with no apical differentiation. *Basidia* 4(–2)-spored, hyaline, elongate clavate, 40–45 x 10–11μm; *sterigmata* up to 6mm . *Cheilocystidia* forming very prominent sterile margin of clavate-elongate, pale honey-coloured, fusiform cylindric to pedicellate or clavate cells, 40–75 x 12–17.5μm, pedicel up to 32μm long.; *pleurocystidia* numerous, clustered towards marginal fringe, many collapsing to give pointed appearance, similar in shape and size to those on margin. *Hymenophoral trama* divided into medio- and lateral strata but with little differentiation, slightly divergent from main strand; *hymenium* honey-coloured, not distinctly gelatinized. *Pileipellis* hardly differentiated into distinct zones; *suprapellis* a trichoderm of elongate end-cells 85–90 x 7.5–12μm some hyphae bunched together irregularly and projecting from mediopellis of intertwined filamentous, smooth, honey-coloured hyphae some contracted at septa, passing into very slightly denser layer of similar hyphae which lack pigmentation downwards, seated on context of floccose, non-gelatinized, intertwined, filamentous hyphae. *Clamp-connections* not seen.

Material examined:

> QUEENSLAND: Cooloola Sand-mass, Warrawonga Research Site, Warrawonga landscape (Cooloola 086208), 11 i 1982, legit P. Sequin, BRIP 16133, JECA 82/9. NEW SOUTH WALES: Pennant Hills, near Sidney, on trackside under mixed eucalypts, 8 iv 1974, *Wat.* 11013.

The purplish pink tinge to the pileus, which darkens with ammoniacal solutions, and the non-cyanescent, whitish lemon-coloured flesh and white basal mycelium are distinctive. The species is well represented in E based on several collections from the Great Lake

area, e.g. *Wat.* A1876/C2300 & A348/C2240 both from Michigan, but in this material the reaction with ammonia is to a strong greenish blue colouration. Singer (1945) mentions that *P. rhodoxanthus* subsp. *foliiporus* (Murr.) Singer also occurs in two possibly hereditary forms, one with yellow and the other white mycelium; in subsp. *foliiporus* the flesh is cyanescent.

Phylloporus novae-zelandiae McNabb is obviously closely related, differing in the yellow basal mycelium and the narrower basidiospores 9–13 x 3.8–4.5µm as opposed to 14–15.6 x 5.5–6.5µm; the gills of *P. novae-zelandiae* are cyanescent (McNabb, 1971).

The history of *P. leucomycelinus* is somewhat confused and a summary of the details is offered:

> *Phylloporus leucomycelinus* Singer, Araujo, & Ivory in Beih. Nova Hedw. 77, 58, 1983 superfluous name in Key without latin diagnosis based on *Singer* N7674.
>
> *P. leucomycelinus* Singer & Gomez in Brenesia 22, 175, 1984 superfluous authorship based on *Singer* N7674.
>
> *P. rhodoxanthus* subsp. *albomycelinus* Singer ined. in The Boleti of Northeastern North America, W.H. Snell & E.A. Dick, 47, 1970. Without latin diagnosis but erroneously quoted as *P. rhodoxanthus* subsp. *leucomycelinus* Singer, apud Snell & Dick in Brenesia 22: 176, 1984 (the combination as subsp. *leucomycelinus* was attempted in Die Röhrlinge I (Boletaceae ohne Boletoideae, 91 & 119, 1965 but with no latin description).

9. P. orientalis Corner in Nova Hedw. 20: 809, 1970

This species was introduced with two varieties, the type variety with basidiospores 13–16.5 x 5–5.5 (–6)µm and var. *brevisporus* Corner with smaller basidiospores (9–13.5 x 4.4–5(–5.5µm). Type material of both is in K and there is a strong possibility that basidiomes of the latter have probably been collected in the Cooloola Sandmass (BRIP 16130). Unfortunately the field data is so sparse it is difficult to offer a definitive determination.

'*Pileus* smooth, brown, ? velvety. *Lamellae* decurrent yellow staining blue. *Stipe* brownish. *Flesh* blue on cutting in pileus, brownish in stipe'.

The following microscopic data applies to the collection.

Basidiospores subfusiform (boletoid) 11.5–13.5–13.1 x 4–5µm honey-coloured, smooth with no apical differentiation. *Basidia* 4-spored; narrowly clavate 31.6–39.5 x 8–8.7µm, sterigmata prominent up to 4.5µm. *Cheilocystidia* elongate-vesiculose, hyaline or pale honey-coloured with slightly thickened wall, 45–48 x 15–13µm; *pleurocystidia* similar, very prominent, (54–)62–72.5 x 12–13µm. *Pileipellis* a collapsed cutis with suprapellis of narrow, pale honey-coloured to distinctly pigmented honey- or tawny honey-coloured, smooth to slightly asperulate hyphae 6.5–11µm broad with some end-cells cystidioid, forming groups of suberect to upwardly curved (reflexed) clavate cells, 21–22 x 8.7–11µm, slightly constricted at septa; *subpellis* of similar hyphae to base of suprapellis but irregularly arranged and darker, seated on floccose context of

intertwined and anastomosing hyaline hyphae of similar or slightly broader units. *Hymenophoral trama* not well differentiated into medio- and lateral strata, pale honey-coloured and only slightly divergent.

Material examined:

> Cooloola Sandmass, Chalimbar Research Station (Cooloola 125 194), 17 ii 1981, legit D.J. Ross, JECA 81/194, BRIP 16130.

P. foliiporus discussed earlier comes very close to this species in the yellowish white, pale yellow or yellow cyanescent flesh. The pileus is also tinged purplish a colour not noted by Aberdeen for BRIP 16130.

BRIP 10278 (in litter underneath *Casuarina suberosa* Ott. & Dietr, Mainroad into Southport, 5 vi 1954, legit A.B. Cribb, JECA 54/89) may represent a further collection but no information is given on the flesh colour-changes. On the strength of the species being initially identified as a *Gomphidius* by the collector, a placement Saccardo adopted for *Phylloporus rhodoxanthus* and Murrill (1943) for his *P. foliiporus* (Murrill) Singer, a relationship with *P. orientalis* might be warranted. However, the flesh does not darken in Melzer's reagent (Imler's reaction) a colour change which often indicates the flesh is cyanescent, nor does blueing feature in the field notes, except gills 'greenish yellow'!

10. P. paradoxus (Kalch.) Cleland, Toadstools and Mushrooms of South Australia 1:178 (1934) as (Kalch.) Bres.

Phylloporus paradoxus is based on *Agaricus paradoxus* Kalch. (Icon. Fung. p 27, 1873) which was transferred to *Paxillus* by Cooke (1876) and in the latter author's Australian fungi (Cooke, 1882) it was recorded from both Victoria and Queensland; Cooke placed this fungus in his section *Tapinia* - see below. Singer (1945 et subseq.) has always considered *Ag. paradoxus* Kalch. equivalent to *Phylloporus rhodoxanthus* subspecies *europaeus* but already (Singer, 1945) indicated that Cleland's interpretation was 'probably an undescribed one, or close to subsp. *americanus* or subsp. *bogorensis*'. Ten years later (Singer, 1955) this same author considered Cleland's fungus to be a synonym of *P. hyperion* (Cooke & Mass.) Singer, q.v.

Examination of the type by both Singer (1955; as hyperioon) and Pegler (1965), and confirmed by us would suggest that the basidiospores are considerably smaller than indicated by Cooke and Massee (in Cooke, 1888); unfortunately Cooke's measurements were taken at face value by Corner (1970) and are in fact incorrect. Reference is made by Pegler (1965) to Cooke's illustration (t.4/24 1892) but with its more uniform colouration this neither looks like Cleland's fungus, nor indeed *Phylloporus rhodoxanthus*. It also looks very much as if in illustrating *Paxillus paradoxus* from Australia (t. 6/38, 1892) Cooke used material from Scarborough (top right-hand figure of t. 866(884); Cooke, 1886–88); and subsequently is very misleading.

11. P. rhodoxanthus (Schw.) Bres., Fungi Tridentini 2: 95 (1900).

Singer (1945) has extensively discussed *P. rhodoxanthus* and divided it into four subspecies, viz. *bogoriensis* (v. Hoehn.) Singer now considered an independent species

q.v.; *foliiporus* (Murr.) Singer also independent q.v.; and two non-cyanescent races, a European *europaeus* Singer and N American *americanus* Sing. respectively. As the species is based on Schweinitz's fungus *Agaricus rhodoxanthus*, subsp. *americanus* is superfluous; it is subsp. *rhodoxanthus*. It differs from subsp. *europaeus* in the degree of development of ribs at the stipe-apex and in the configuration of the hymenophore. Singer (1945) defines the type subspecies thus 'anastomosis of the lamellae mostly vein-like, rarely higher and then only toward the margin of the pileus, or near the stipe and even then not surpassing half the breadth of the lamellae, sometimes entirely lacking'. This is in contrast to subsp. *europaeus with* 'anastomosis of the lamellae constant and broad (high) reaching half the breadth of the lamellae or more, or more rarely less'. Under subsp. *americanus* Singer hints at the presence of collections with yellow and with white basal mycelium; the latter has been separated as *P. leucomycelinus* Singer, a taxa which has now been found in Australia q.v.

Although all the *Phylloporus* species so far recorded from Australia belong to the *P. rhodoxanthus* group, the European and N American forms have not so far been recognized, nor have the distinctly poroid taxa described from Africa been found. Electron microscopic studies indicate that all Australian collections examined possess a fainty to slightly, although distinctly rugulose surface to the basidiospore and therefore fall into Heinemann & Rammeloo's sect. *Phylloporus* (1987).

Imazeki & Hongo (1957) illustrate this agaric (Plate 36, No. 211) from Japan and refer to it as *P. rhodoxanthus* although the same outline appears in their later works (Imazeki & Hongo, 1969, 1978a) but the colouration of the basidiome, especially the hymenophore is different.

12. P. sulcatus (Pat.) Gilbert, Les Bolets 88 (1931).

This was originally described from SE Asia (Vallée du Da-Pouman, Indochina as *Paxillus sulcatus*; Patouillard, 1909). Singer (1945) synonymized this taxon with *Phylloporus rhodoxanthus*, and referred it with some hesitation to subspecies *americanus* Singer. Although it is undoubtedly close to *P. rhodoxanthus* it differs in its smaller basidiospores and prominently striate stipe-apex; Perreau & Joly (1964) have supplied a colour photograph. Corner (1970) maintains the species based on the description of Perreau & Joly, and with this we concur.

Wat. 14802 from Victoria (Sherbrooke Forest, near Fern Tree Gully, 10 v 1982) agrees with Patouillard's taxon, and is in full agreement with Perreau & Joly (1964) except for the slightly smaller basidiospores; the spores, however, agree with Patouillard (1909), viz. 10–12 x 4.5μm: *Wat.* 14802 = 10–12.6 x 5.4μm.

Unidentified taxa

Phylloporus sp. 1

One collection (BRIP 10284) with brightly coloured sienna pileus (17mm in diam.) ochre stipe and concolorous lamellae except for an ochraceous tinge has been examined. The basidispores measured 10.5–13.1 x 4.4–4.8(–5.2)μm, and because the material

shows distinctive characters it has been keyed out in the hope that further material will ultimately be found.

Material examined:

QUEENSLAND.Capolaba, Brisbane, 25 ii 1973, legit Mrs Smith, JECA 73/31, BRIP 10284.

Tapinella Gilbert

This genus is here accepted for the widely known *Paxillus panuoides* Fr.: Fr. It is a characteristic genus of temperate areas in both northern and southern hemispheres and has been known to cause damage to worked timber.

P. panuoides is saprophytic producing a brown-rot. The basidiomata are gymnocarpic with decurrent lamellate hymenophore and reduced stipe. It is closely related to a range of merulioid fungi. The basidiospores are cinnamon-brown, to ferruginous, ovoid to ellipsoid, dextrinoid.

1. Paxillus olivaceoflavidus (Cooke & Massee) Reid in Kew Bulletin 1955: 644.

Originally described from Bunyip, New South Wales (Cooke & Massee, 1887; as *Panus*) *P. olivaceoflavidus* has been redescribed based on a more recent collection (Reid, 1955) from a fallen stump of *Pinus radiata* Don. (Victoria, Kilsyth, 7 iv 1953, *N.E.M. Walters*). Reid pointed out that the hymenium was merulioid and suggested that there might be a connection with *Paxillus aureus* Lloyd. In the discussion accompanying the original description of the latter species Lloyd (1916) suggested, because of the merulioid nature of his *Paxillus* that it was a variant of *Merulius aureus*. Horak (1979) also believed that *P. olivaceoflavidus* was probably synonymous with *P. aureus* although no type material of the former exists at K to confirm the suspicion.

Reid (1955) also suggested a connection to *Paxillus curtisii* Berk. from North America, by virtue of the similarity of basidiospores, 1.5–2μm broad in *P. curtisii* and 1–1.5μm in *P. olivaceoflavidus*, indicating that the once thought disjunct distribution was no longer the case as *P. curtisii* had been found in India and Japan (Singer et al., 1990).

Ginns (1976) considered *M. aureus* to be related to *P. panuoides* and *P. curtisii*, and later (Ginns, 1978) compared it with the S.E. Asian *Leucogyraphona luridochracea* (Corner) Ginns. Indeed *M. aureus* var *laeticolor* (Berk & Br.) Quél has been identified with *L. mollusca* (Fr.) Pouzar, and var. *hydnoides* P. Henn. is probably only *L. pinastri* (Fr.) Ginns & Weresub. Redhead & Ginns (1985) later recognized a morphological series with *Paxillus panuoides* (*Tapinella*) at one end and *Leucogyrophana* at the other, with *Pseudomerulius* Jülich including *P. curtisii* (Berk.) Redhead & Ginns in an intermediate position. Singer et al. (1990) transferred *P. curtisii* to the newly erected section *Pseudopaxillus* of *Meiorganum* Heim, a genus based on *M. neocaledonicum* Heim from the S Pacific. *Merulius baileyii* Berk. & Br. is close to *P. curtisii* (Ginns, 1976) and Corner (1966) considers *Merulius olivaceus* (Schw.) Kuntze a synonym. *Paxillus olivaceoflavidus* and *P. aureus* join a group of fungi for which more recent collections and facilities to study the development of their basidiomata are urgently required.

The closeness of this group of merulioid fungi and the boletes, was foreseen by Donk (1964) when he reintroduced the family Coniophoraceae Ulbr.

2. T. panuoides (Fr.) Gilbert, Les Bolets, 67 (1931).
This is a common widespread agaric in both northern and southern hemispheres.
Material examined:

> NEW SOUTH WALES: Blue Block Range, near Cotter Dam, on old conifer stump, 25 iv 1974, *Wat.* 10616. TASMANIA: University of Hobart campus, v 1982, on sawdust mulch. VICTORIA: on *Eucalyptus regnans* F Muell., 26 vii 1954, *D. Ashton* 3742. Fernsham Reserve, Healsville, on living *Eucalyptus* trunks, 6 ix 1981, *D. N. Pegler* A55 (K); *ibid.*, *D. N. Pegler* A56 (K); Burnley Horticultural College, Burnley, Richmond, on sawdust, 11 iv 1978, *I Nesbitt*, ex Herb. VPRI 10267 (K); Mount Macedoa Forest Park, on underside of *Eucalyptus* section, 11 iv 1976, *N. H. Sinnott* 1969 (K); Walhalla, in mines.

Analysis of these eight collections from Australia has shown the existence of a wide range of spore-size, and we can sympathise with Reid (1955) when he even considered separating out another taxon with smaller spores (3–4 x 2.5μm as opposed to 4–5 x 4.5μm). His judgement has been vindicated in that the spore range which he demonstrated, and with which we agree, is only part of a cline ranging through to measurements characteristic of European material. In mounts in ammoniacal solutions the production of soluble yellow or orange-tawny pigment varies with the collection and no correlation could be made between host, pigmentation production or specific microscopic characters. Such variation is not found in Europe and if, as might be suspected, *T. panuoides* has been introduced into Australia we may well be experiencing the stabilization of isolated introductions. Thus populations with slightly different characters reflect the limited amount of genetic variation available in these introductions. A very interesting cultural study might be undertaken with freshly documented material of this taxon. This may be an example of speciation in progress. The same explanation may be offered to explain the differences found between populations of *Paxillus involutus* q.v.

T. panuoides may be expected under suitable conditions throughout Australia either on building materials or in disturbed woodland on discarded timber. As suggested above it is very probably introduced from Europe and N America where it is widespread and common, and if this is the case it has ably taken up colonization of myrtaceous substrates. Interestingly several fungi found on Coniferae or fagaceous trees in Europe are found on eucalypts in Australasia, e.g. *Fistulina hepatica* Huds.: Fr. *T. panuoides* is considered characteristic of *Paxillus* (see Singer, 1986) but the pleurotoid nature of the basidiome, small, dextrinoid basidiospores, insignificant cystidia and lignicolous nature suggests otherwise. Watling (1970) placed the fungus in *Paxillus* as subgenus *Tapinella*. Redhead & Ginns (1985) gave full generic status as indeed Gilbert (1931) had done even 50 years earlier. Redhead & Ginns (1985) also pointed out that *Paxillus panuoides*, despite being placed near to *P. curtisii* Berk. by Singer (1986), was not closely related. This was confirmed by examination of authentic material in E (*Curtis* 2880). However, this collection is labelled 'California U.S.A. Herb. Berk. 1897'; it is really Car. Inf. which as Ginns has pointed out is South Carolina; this fungus does not occur in southwest N America.

Redhead & Ginns (1985) have seen pendant pseudo-stipitate forms of *P. panuoides* with a cyphelloid hymenophore resembling some of those collections from Australia in K examined in the present study. Such collections and the similarities between *P. aureus* and *M. aureus* give credence to Saccardo's suggestion (1887) that *Merulius crispus* Turpin is a synonym of *T. panuoides*.

It is noted on page 360 above that *P. veluticeps* may have a reduced stem and look like a *Crepidotus* and indeed was called *C. pactolus* by Pilát (1950) so relating it to his *C. panuoides*, i.e. *Tapinella panuoides*. Singer at al. (1990) have also indicated that *P. leptopus* is a pleurotoid form of *P. involutus*.

KEY TO AUSTRALIAN SPECIES OF *Paxillus* (P.), *Phylloporus* (Ph.) & *Tapinella*

1. Basidiome pleurotoid (*Tapinella*) _____ 2
   (see also *P. veluticeps* below)
   x Basidiome with central stipe; basidiospores greater than 6µm long (*Paxillus/Phylloporus*) _____ 3

2. Basidiospores 4–5.5(–6) x 3-4µm _____ **T. panuoides**
   (See also *P. veluticeps*)
   If spores shorter see discussion under *T. panuoides*
   x Basidiospores narrower 3–4 x 1–1.5µm _____ **P. olivaceoflavidus**

3. Basidiospores subfusiform (boletoid), elongate _____ 4
   x Basidiospores ellipsoid/ovoid _____ 18

4. Basidiospores white in mass, hyaline s.m.
   P. psammophila - rejected
   x Basidiospores distinctly pigmented in mass and s.m. _____ 5

5. Spore-print sienna to rust-colour, fulvous, bright and distinctly coloured s.m. _____ 6
   x Spore-print olivaceous isabelline or bronze colour, dull honey-colour in ammoniacal solutions s.m. _____ 8

6. Clamp-connections present; basidiospores 13–16 x 4.5–5.2µm
   P. veluticeps
   x Clamp-connections absent or sparse and only at base of basidia __ 7

7. Clamp-connections absent; basidiospores 12–14 x 4.5–5.7µm
   P. muelleri
   x Clamp-connections rare, if present only at base of basidia; basidiospores 10.5–15 x 5–6µm; lacking pleurocystidia
   P. infundibuliformis

8. Basidiome with rust-brown pileus, gills and stipe; not blueing ____ 9

x Basidiome with gills and pileus contrasting in colour the latter darker often tinged with purple, rose etc and the former lemon or chrome-yellow, blueing or not _____ 10

9. Basidiospores 11.5–14.5 x 6.5–7µm cheilo- and pleurocystidia thin-walled _____ **Ph. hyperion**
(if spores 10.5–13.1 x 4.4–4.8 (–5.2)µm see *Phylloporus* sp. 1)
x Basidiospores 12.7–14.8 x 4.8–52(–6)µm: pleurocystidia distinctly thick-walled _____ **Ph. australiensis**

10. Basidiome enormous over 150mm, cyanescent, subradicate stipe below basal swelling _____ **Ph. clelandii**
x Basidiome smaller, not cyanescent or if flesh or gills blueing then lacking distinct subradicate stipe _____ 11

11. Pileus almost black, snuff to umber tinged dark purple date with spots of ochraceous; flesh becoming rufescent and then blackish, sometimes tinged indigo _____ **Ph. bogoriensis**
x Pileus paler, wine-coloured, pale purplish brown, pinkish buff etc. or with distinct olivaceous colours _____ 12

12. Stipe with distinct white ribs in upper half, pileus brown, flesh non-cyanescent _____ **Ph. sulcatus**
x Stipe not ornamented with ribs to ½-way, punctate at most at apex; flesh cyanescent or not _____ 13

13. Spores 8–10–12.5µm long; pileus with pinkish or wine-coloured tints _____ 14
x Spores larger or if of same range then pileus dark and more olivaceous _____ 15

14. Basal mycelium white; flesh non-cyanescent; spores 10–12.5 x 3.5–4.5µm _____ **Ph. leucomycelinus**
(If spores 9–13 x 3.8–4.5µm and basal mycelium yellow see *Ph. novae-zelandiae* McNabb)
x Basal mycelium, when present, not obviously white; flesh cyanescent; spores 8–10 x 3.5–4.5 (–6)µm _____ **Ph. bellus**

15. Flesh cyanescent _____ 16
x Flesh unchanging _____ 17

16. Basidiospores 11–15 x 4.5–5.8µm _____ **Ph. foliiporus**
x Basidiospores 13.5–14 x (4.8) 5.2(–5.7)µm **Ph. bellus** var. **cyanescens**
(see also *P. orientalis* var. *brevisporus* which differs in narrow stipe)

17. Basidiospores (10–) 11–15 x 3.5–5µm _____ **Ph. rhodoxanthus**

x Basidiospores 14–15.6 x 5.5–6.5μm pileus brownish grey with purple areas _____ **BRIP 16133** (see page 376)

18. Spore-print ochraceous rust to sienna; gills relatively close, distinct, bruising rust-colour _____ **P. involutus**

x Spore-print olivaceous, dull honey-colour in ammoniacal solutions s.m.; gills wide, coarsely anastomosing _ **Ph. cingulatus**

APPENDIX I

PARASITIC FUNGI

In a previous part of this study (Watling & Gregory, 1986) the teleomorph of *Sepedonium ampullosporum* Damon was noted on a member of the *Boletellus emodensis* (Berk.) Singer group. The closely related *S. chrysospermum* (Bull.) Link was located in the present study on a species of *Phylloporus* from Lamington Plateau, Queensland (Binna Burra, 28 iii 1974, *Watling & Aberdeen*, JECA 74/104, BRIP 10285). The basidioma was so heavily infected that hymenial production was suppressed and the specific identity masked. This is an interesting record as Gill & Watling (1986) have already discussed the interesting parallel between the presence of hydroxylated pulvinic acids in boletes and their allies and the susceptibility of these fungi to attacks by *Sepedonium*. This Queensland record on *Phylloporus* and one on *Hygrophoropsis aurantiaca* (Wulf.: Fr.) Schroeter from Canada (Richmond, British Columbia, in birch wood, 6 xi 1986, *Wat.* 19581 in E.) expands the host's range and reinforces the suggestion that *Phylloporus* is very close to *Xerocomus* (Singer 1986; Pegler & Young, 1981) and *Hygrophoropsis* is close to *Paxillus* (Singer, 1986). The senior author has also made collections in N America on *Strobilomyces floccopus* (Vahl: Fr.) Berk. (*Wat.* 16434) and *Porphyrellus porphyrosporus* (Fr.)Gilbert (*Wat.* 19503).

In Europe *Sepedonium chrysospermum* has been located in the type collection of *Gyroporus castaneus* var. *ammophilus* Castro & Freire found under pines in sand-dunes (Pontevedra, Spain, *Wat.* 21615 in E).

APPENDIX II

ADDITIONS TO THE POROID BOLETES OF QUEENSLAND OR FURTHER RECORDS.

Since the first part of this series (Watling & Gregory, 1986) appeared, two further collections have been located in BRIP, and a series of specimens sent by T.R. Lohmeyer and Tony Young from Queensland have been received and are now in E. An analysis of this material is as follows:

a. Plant Pathology Herbarium: Department of Primary Industries

i. *Rubinoboletus* cf. *ballouii* (Peck) Heinem. & Rammeloo. See Watling & Gregory, 1988a: 68.

Habitat: Cooloola Sandmass (Cooloola 088211), Warrawonga Landscape, 25 ii 1980, legit. D. J. Ross, BRIP 9154, JECA 80/97a.

ii. *Boletellus* sp.

Habitat: Cooloola Sand Mass (Cooloola 128191), Chalambar Landscape, rainforest (microphyll scrub), 4 ii 1980, legit. D. J. Ross & P. Sequin, BRIP 9157, JECA 80/12.

This is an interesting find as it is one of the few boletes in the Queensland rainforest community.

Pileus coarse, very pale greenish yellow, surface with scales slightly darker than background. *Pores* depressed, more or less equidimensional, approximately 1mm diam. *Tubes and pores* concolorous, pale olive green. *Stipe* very smooth, upper half very pale yellow and lower half more or less white. *Flesh* very pale yellow. *Basidiospores* 14.5–195(–20) x 4.4–6(–6.7)µm, very pale honey-coloured to almost hyaline, elongate-cylindric to elongate boletoid, very faintly striate, perhaps with slight paling at apex. *Basidia* 4-spored, 21–22 x 7–8µm. *Cheilocystidia* hardly emergent, c.44mm long. *Hymenophoral trama* narrow, very little differentiation between medio- and lateral strata, honey-coloured, gelatinized, of very narrow, filamentous hyphae, some divergence from the very narrow mediostratum. *Pileipellis* apparently composed of smooth, hyaline, filamentous hyphae 5–7µm broad forming an irregular cutis, intermixed with probably slightly gelatinized units 11µm broad not constricted at septa in addition with apparently amorphous, irregularly shaped 'plaques' of material. *Context* beneath pileipellis of honey-coloured, filamentous, floccose, anastomosing hyphae darkening slightly towards tubes. *Clamp-connections* absent.

The collectors thought the darker 'scales' were of volval origin; this is not the case. The darker areas contain a preponderance of the broader pileipellis elements.

This is a very elegant bolete with a long, rather narrow stipe, resembling members of the genus *Fistulinella*. The dark cinnamon buff tubes in the exsiccata also resemble that of *Fistulinella* and *Tylopilus* but the ornamented basidiospores place it in *Boletellus* as presently defined. In Part I of this series (Watling & Gregory, 1986) it would key out at couplet 17 differing from *Boletellus* sp. 3 in the colour of the flesh, ornamented pileus and longer paler basidiospores.

This collection questions the methodology by which all longitudinally striate boletes are placed in a single genus. On other characters the present bolete is a *Fistullinella*.

b. Lohmeyer

i. - no collection

ii. *Boletellus floriformis* Imazeki in Nagoa 2:42 (1952): Palmwoods (Nambour) property of W. Fritz, Landershute Road, under *Casuarina*, 30 xii 1988, legit T. R. Lohmeyer.

iii. *Boletellus ananiceps* (Berk.) Singer. See Watling & Gregory, 1986: 106: Montville, (Nambour) road to Palmwoods, c.250m from Montville intersection, near base of eucalypt (?), 30 xii 1988, legit T.R. Lohmeyer. Record also from under *Casuarina* and *Xanthorrhoea*, Kondabella Falls National Park, (Witta), 1 i 1989.

This collection agrees with the protologue of *Strobilomyces pallescens* Cooke & Massee.

iv. *Strobilomyces mollis* Corner. See Watling & Gregory, 1986: 118: Montville, (Witta) Kondabella Falls National Park, in wet eucalypt forest, 1 i 1989, legit T.R. Lohmeyer.

v. *Boletellus rufescens* (Cke. & Mass.) Singer see Watling & Gregory, 1986: 108: Montville, (Witta) Kondabella Falls National Park, subtropical rainforest, widespread in the area, 1 i 1989, T.R. Lohmeyer.

c. Young

i. *Rubinoboletus balloui* var. *fuscatus* (Corner) Heinem. & Rammeloo. See Watling & Gregory, 1988b: Bunya Mts National Park, in eucalypt forest on soil amongst grass iv 1989, legit Young, *Wat.* 21595.

ii. *Tylopilus* aff. *fuscescens* Watling. See Watling & Gregory, 1989: Mount Glorious, 1 iv 1972, *Young* MH186.

iii. *Boletus* aff. *hibiscus* Corner in Gardens' Bulletin Singapore 27:3 (1974). On soil in eucalypt forest, 21 iv 1989, legit A.J. Whalley & J. Tierney.

As this last collection introduces yet another, probably tropical to subtropical element into the Queensland Flora a full description with discussion is given.

'*Pileus* 150mm convex, smooth, dry, very finely velvety s.l. brown (5F8–518)* at the centre but paler at the margins and approaching olivaceous (4E8). *Flesh* very thick white slowly yellowish (3A6–3A)7, where insect attacked flesh near saffron (5A)7. *Tubes* adnexed brown (6C8); pores similarly coloured, polygonal in the mid-region usually a double structure of up to 3 or 4 pores outwith a larger polygon, 1–2mm diam. *Stipe* 70 x 45mm (65mm base) solid, dry, squat, yellowish to reddish brown at the top (4A8–9C7) then brown (8F6–5E7) at the base, browns predominate with a blend of colour. *Spore-print* pinkish .'

Microscopic details are as follows:

Basidiospores 9.2–9.6(–10.5) x (6.1)6.5–7μm, broadly ellipsoid to almost subglobose, smooth, distinctly thick-walled, rich golden yellow in alkali and water, although perhaps slightly paler in latter, no apical differentiation but with prominent apiculus. *Basidia* 4-spored, hyaline, clavate, although some infused with a golden yellow pigment in dried material. *Cheilocystidia* hyaline, poorly differentiated, irregularly lageniform or simply cylindrical, hyaline or infused with a golden yellow colour as the hymenium, little differentiated; *pleurocystidia* similar, scattered, projecting little above hymenium. *Hymenophoral trama* of gelatinized, slightly but distinctly bilateral hyphae with lateral strata of hyaline hyphae divergent from a narrow, less or non-gelatinized, central, yellowish zone, linked to a gelatinized compact zone at the base of the cap-context, contrasting markedly with the brightly coloured hymenium and basidiospores. *Pileipellis* with little or no differentiation into distinct zones, upper surface of intertwined, filamentous, slightly thick-walled, smooth, hyaline units 5–7.5μm broad with end-cells only slightly swollen, elongate-clavate (8.5–10μm broad), erect to suberect, many collapsing, glassy walled and fracturing and resembling 'barbed wire', a few emergent hyphae with opalescent or milky contents resembling shortened oleiferous hyphae

* Notes accompanying collection - colours from Kornerup & Wanscher

which are connected to similar, more obvious broader, flexuous-twisted, swollen hyphae (8.5–12µm in pileus-trama. *Clamp-connections* present.

The Queensland collection sits uneasy in the classification of the boletes with the unusual combination of small, purplish ferrugineous spore-print, orange-tawny rounded basidiospores and clamp-connections; in these characters it agrees with *B. hibiscus* described from Sarawak (Corner, 1974). The Queensland material differs mainly in the colour of the pileus but until more collections are found it would be unwise to describe a new taxon.

It differs from *Phlebopus marginatus* (Berk.) Watling & Gregory, also known as *Phaeogyroporus portentosus* (Berk. & Br.) McNabb (see Watling & Gregory, 1986) in the lack of any hint of olivaceous in the spore-print and the much more strongly pigmented spores under the microscope. Corner (1974) has suggested because of the spore-colour a relationship with *Gyrodon* and with *Phaeogyroporus tropicus* (Rick) Singer recorded from S America (Brazil south to Argentina). Although Singer (1945) described the spores of the latter as light brown, Corner in fact found in a collection of *P. tropicus* he had from Brazil that the spores were yellow-brown not olivaceous and the hymenophoral trama was phylloporoid as in *B. hibiscus* and the Taromeo, Queensland material; it is boletoid in *P. marginatus*. Singer also (1945) records *P. tropicus* from Liberia but on reinvestigation Heinemann & Rammeloo (1982) believe this to be *Phlebopus beniensis* (Singer & Digillio) Heinem. & Rammeloo.

APPENDIX III

Readers' attention should be drawn to the recently described *Boletus tasmanicus* (Hongo & Mills, 1988) which is characterized by the elongate basidiospores (13.5–19(20.5) x 4–5.5µm and reddish pores, minutely punctate reddish stipe with obscure reticulation. In size the spores resemble *Fistulinella* but are elongate-boletoid. Although apparently close to *B. subvelutipes* Peck from N America, and therefore *B. erythropus* (Pers.) Krombh. and *B. luridus* Fr. it would not key out in Watling & Gregory (1988a) at couplet 44 but as a new entry at couplet 4. After having used this same key to identify boletes from other parts of Australia the key would be improved at couplet 28 by removing the inability to move to some of the other taxa. It is suggested that couplet 28 should read as follows:

28(22x) Basidiospores 45µm broad or exceeding mm and average length over 13.5µm _____ 29

28(x) Basidiospores 3–3.5µm broad or if up to 4.5µm then spores rarely over 13.5µm in any one mount and average spore length always 13.5µm or less _____ 50

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