

The polypore genera *Abundisporus* and *Perenniporia* (Basidiomycota) in China, with notes on *Haploporus*

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Received 22 April 2002, accepted 12 June 2002

Dai, Y. C., Niemelä, T. & Kinnunen, J. 2002: The polypore genera *Abundisporus* and *Perenniporia* (Basidiomycota) in China, with notes on *Haploporus*. — *Ann. Bot. Fennici* 39: 169–182.

The species of *Abundisporus* Ryvarden and *Perenniporia* Murrill (Aphyllphorales, Basidiomycota) from China are listed. A key was prepared for the 24 species so far recorded in the two genera from the country, including condensed descriptions and spore dimensions. Two new species are described and illustrated: *Abundisporus quercicola* Y.C.Dai and *Perenniporia piceicola* Y.C.Dai. The genera *Haploporus* Singer and *Pachykytospora* Kotl. & Pouzar are considered as synonymous, being closely related to *Perenniporia* but differing from it by ornamented spores. The following new combinations are proposed: *Haploporus alabamiae* (Berk. & Cooke) Y.C.Dai & Niemelä, *Haploporus papyraceus* (Schwein.) Y.C.Dai & Niemelä, *Haploporus subtrameteus* (Pilát) Y.C.Dai & Niemelä, *Haploporus tuberculosus* (Fr.) Niemelä & Y.C.Dai, and *Perenniporia subadusta* (Z.S.Bi & G.Y.Zheng) Y.C.Dai.

Key words: *Abundisporus*, *Haploporus*, *Perenniporia*, Basidiomycota, China, polypores, taxonomy

Introduction

The genus *Perenniporia* Murrill was typified by *Polyporus medulla-panis* Jacq. : Fr. (Donk 1960). During the past 30 years numerous species have been described in or added to the genus, and at present 77 names are treated under it. According to the modern definition the genus has di- to trimitic hyphal structure with clamps

on generative hyphae; basidiospores are smooth and thick-walled, globose to ellipsoid, hyaline to yellowish, and often truncate. In addition, both vegetative hyphae and spores are dextrinoid to a varying degree, and the species of the genus cause a white rot (Ryvarden & Johansen 1980, Gilbertson & Ryvarden 1986–1987, Ryvarden & Gilbertson 1994). Some further, important characters are given below.

Loweporus Wright was typified by *Polyporus lividus* Kalchbr. which is a synonym of *Polyporus tephroporus* Mont., and the species differs from *Perenniporia* by having brown-coloured basidiocarps. Ryvarden (1998) discussed the relationships between *Loweporus* and *Perenniporia*, and concluded that no critical differences could be found between the two. *Abundisporus* Ryvarden was established (Ryvarden 1998) to include species with coloured and non-dextrinoid spores; such species were earlier listed under either *Perenniporia* or *Loweporus*. Parmasto and Hallenberg (2000) made a detailed discussion on *Abundisporus*, *Loweporus* and *Perenniporia*; they had an opinion that it was difficult to define the three genera because of many overlapping characters. Six species, *Abundisporus fuscopurpureus* (Pers.) Ryvarden, *A. pubertatis* (Lloyd) Parmasto, *A. roseoalbus* (Jungh.) Ryvarden, *A. sclerosetosus* C.Decock & O.Laurence, *A. subflexibilis* (Berk. & M.A.Curtis) Parmasto and *A. violaceus* (Wakef.) Ryvarden, have been combined into or described in *Abundisporus* (Ryvarden 1998, Parmasto & Hallenberg 2000, Decock & Laurence 2000). Among them only *A. pubertatis* is found in the temperate forests of NE China and the Russian Far East, the other five species being tropical.

In this paper, we mostly follow the generic definitions of Ryvarden (1998), but special emphasis is laid on two characters: the pigmentation of spores and the cyanophilous reaction with Cotton Blue. The species with coloured spores are included in *Abundisporus*, and *Perenniporia* is for those having hyaline spores. Although hyphae and spores in most species of *Perenniporia* are dextrinoid, many species do not have that reaction. For instance, *P. medulla-panis* (Jacq. : Fr.) Donk (type species of the genus), *P. tephropora* (Mont.) Ryvarden, *P. narymica* (Pilát) Pouzar and *P. ohiensis* (Berk.) Ryvarden have non-dextrinoid vegetative hyphae. Spores in *P. narymica* and *P. truncatospora* (Lloyd) Ryvarden are non-dextrinoid. While dextrinoid reaction varies according to species, it is the cyanophilous reaction that is more reliable. Spores in all the species of *Perenniporia* are distinctly cyanophilous, and vegetative hyphae of almost all the species (except *P. narymica*) in *Abundisporus* and *Perenniporia* are cyanophil-

ous as well. The shape of the spores may vary within a genus.

The context colours of *Perenniporia* are cream, yellowish, ochraceous and brownish. Variations in context colour within a genus are rather common in polypores, e.g., in the species of *Fomitopsis* P.Karst. (cream colour in *F. rhodophaea* (Lév.) Imazeki, ochraceous in *F. pinicola* (Sw. : Fr.) P.Karst. and pink in *F. rosea* (Alb. & Schwein. : Fr.) P.Karst.) and *Ganoderma* P.Karst. (brown in *G. lipsiense* (Batsch) G.F.Atk. and cream coloured in *G. lucidum* (M.A.Curtis : Fr.) P.Karst.).

Perenniporia sensu lato (including *Abundisporus* and *Loweporus*) has been inadequately known in China. Fifteen species were recorded in the country by Zhao and Zhang (1992) and Dai (2000). Núñez and Ryvarden (2001) increased the number to 17 in their remarkable new book on East Asian polypores. Mostly based on collections from North China (provinces Heilongjiang, Jilin and Liaoning) and South China (Hunan, Guizhou, Yunnan), 24 species including two new ones are here acknowledged. In this paper we summarize the present knowledge of the genus in the area.

The genera *Haploporus* Singer and *Pachykytospora* Kotl. & Pouzar are closely related to *Perenniporia*, and differ from the latter by their ornamented spores. For that reason we include them in our key, and discuss the species briefly at the end.

Materials and methods

This study is mainly based on the following materials: the first author's collections from northern China, and the Hunan, Guizhou and Yunnan provinces in the south; Marja Härkönen's collections from Hunan; Reijo Penttilä's collections from Fenlin Natural Reserve of northeastern China; and specimens deposited in the Chinese herbaria HMAS, HMIGD, HBNU. Specimens deposited in H from Europe and North America were examined for comparison. The collections by Dai, Härkönen and Penttilä are deposited at the Botanical Museum of the University of Helsinki (H) and the Herbarium of the Institute of Applied Ecology, Chinese Academy of Sciences (IFP).

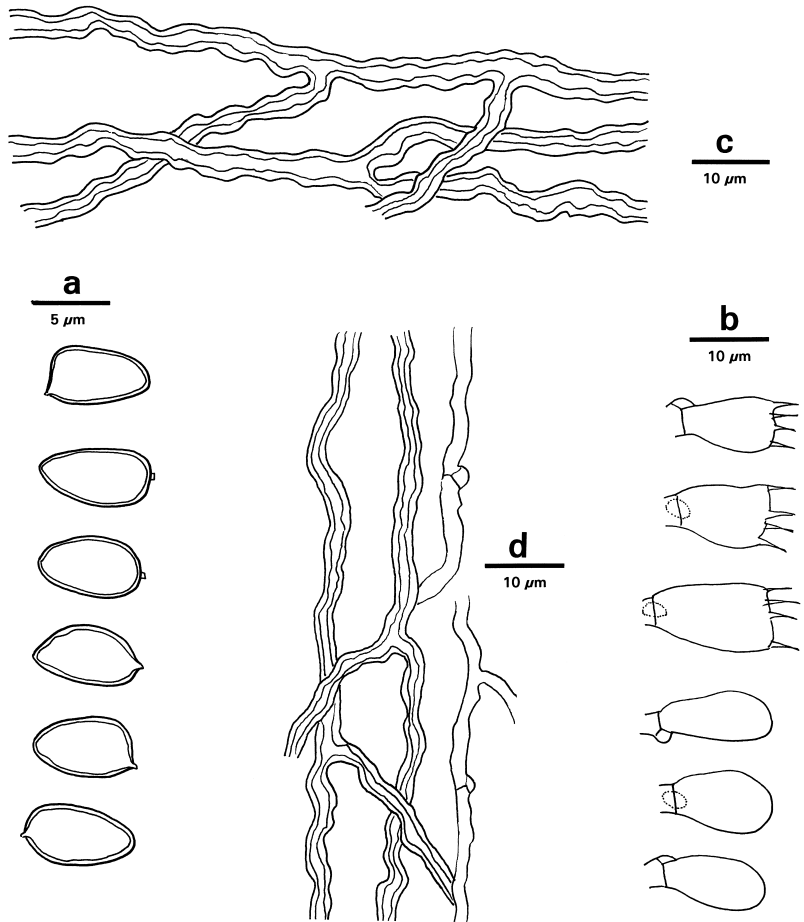


Fig. 1. Microscopical structures of *Abundisporus quercicola* Y.C.Dai (drawn from the holotype). — **a:** Basidiospores. — **b:** Basidia and basidioles. — **c:** Hyphae from context. — **d:** Hyphae from trama.

The microscopic routine used in the study was explained in Dai and Niemelä (1997). In the text the following abbreviations are used: *L* = mean spore length (arithmetical mean of all spores), *W* = mean spore width (arithmetical mean of all spores), *Q* = quotient of the mean spore length and the mean spore width (*L/W* ratio), *n* = the number of spores measured from given number of specimens. In presenting the variation in spore size, 5% of the measurements were excluded from each end of the range, and are given in parentheses; IKI stands for Melzer's reagent and KOH for 5% potassium hydroxide, and CB is the abbreviation of Cotton Blue. CB+ means cyanophilous and CB– acyanophilous; IKI+ means amyloid and IKI– means both inamyloid and indextrinoid. The authors of scientific names were abbreviated mostly according to Brummitt and Powell (1992).

Taxonomy

Abundisporus quercicola Y.C.Dai, *sp. nova* (Figs. 1–2)

Carpophorum perenne, solitarium, ungulatum; pileus cinerascens vel niger; facies pororum albida, pori 5–7 per mm. Systema hypharum dimiticum vel trimiticum, hyphae generatoriae fibulatae, hyphae skeletales 3–6 µm in diam. Sporae ovoideae, 6.8–8.8 × 4.2–5 µm.

HOLOTYPE: China. Yunnan Prov., Lijiang County, Sandaowan, on living *Quercus*, 18.VI.1999 Y.C. Dai 3084 & K. Korhonen (H, isotype IFP).

ETYMOLOGY. — *quercicola* (Lat.), living on oak.

Basidiocarps perennial, solitary, pileate. Pileus unguulate, projecting up to 5 cm, 7 cm wide, and 5 cm thick. Pileal surface dark grey



Fig. 2. *Abundisporus quercicola* Y.C.Dai. A fresh pileate basidiocarp, specimen Dai 3084. Photograph Y.C.D., *in situ*, $\times 0.6$.

to almost black, smooth, concentrically zonate, margin blunt, greyish black. Pore surface white when fresh, becoming ochraceous when dry; pores round, 5–7 per mm, tube mouths entire. Context dark brown, corky, up to 3 cm thick. Tubes dull brown, paler than context, corky, up to 2 cm long, a thin layer of context present between each annual tube layer.

Hyphal system dimitic or trimitic; generative hyphae with clamp connections; skeletal hyphae dominant, dextrinoid, strongly CB+, tissue darkening but otherwise unchanged in KOH.

Context. — Generative hyphae scanty, hyaline, thin-walled, bearing clamp connections, occasionally branched, 2–4 μm in diam.; skeletal hyphae yellowish brown to rust brown, thick-walled with a narrow lumen, occasionally branched, flexuous, interwoven, 3–6 μm in diam.

Tube trama. — Generative hyphae infrequent, hyaline, thin-walled, frequently clamped and branched, 2–3.5 μm in diam. Skeletal hyphae golden brown, thick-walled with a narrow lumen, frequently branched, 3–5 μm in diam., binding hyphae strongly flexuous, 2–4 μm in

diam. All hyphae interwoven. Secondary mycelium present in old tubes, composed of hyaline, thin-walled, frequently clamped and branched hyphae, 2–4.5 μm in diam. Subhymenium indistinct; cystidia not seen; basidia barrel-shaped, with four sterigmata and a basal clamp, 14–19 \times 9–12 μm ; basidioles in shape similar to basidia, but slightly smaller.

Spores. — Basidiospores narrow ovoid, not truncate, yellowish, thick-walled, smooth, non-dextrinoid, juvenile ones CB+, (6.2–)6.8–8.8(–9) \times (4–)4.2–5(–5.2) μm , $L = 7.62 \mu\text{m}$, $W = 4.69 \mu\text{m}$, $Q = 1.63$ ($n = 30/1$).

Abundisporus quercicola is characterized by perennial and ungulate basidiocarps, when fresh white pore surface, thick-walled, yellowish, narrowly ovoid and not truncate spores, and by its growth on living oak in a temperate forest of the foothills of the Himalayas.

The genus *Abundisporus* was originally defined as follows: basidiocarps are annual to perennial, resupinate to pileate, and context is greyish to umber brown; hyphal system is dimitic, and generative hyphae bear clamps; basidiospores are ellipsoid, slightly thick-

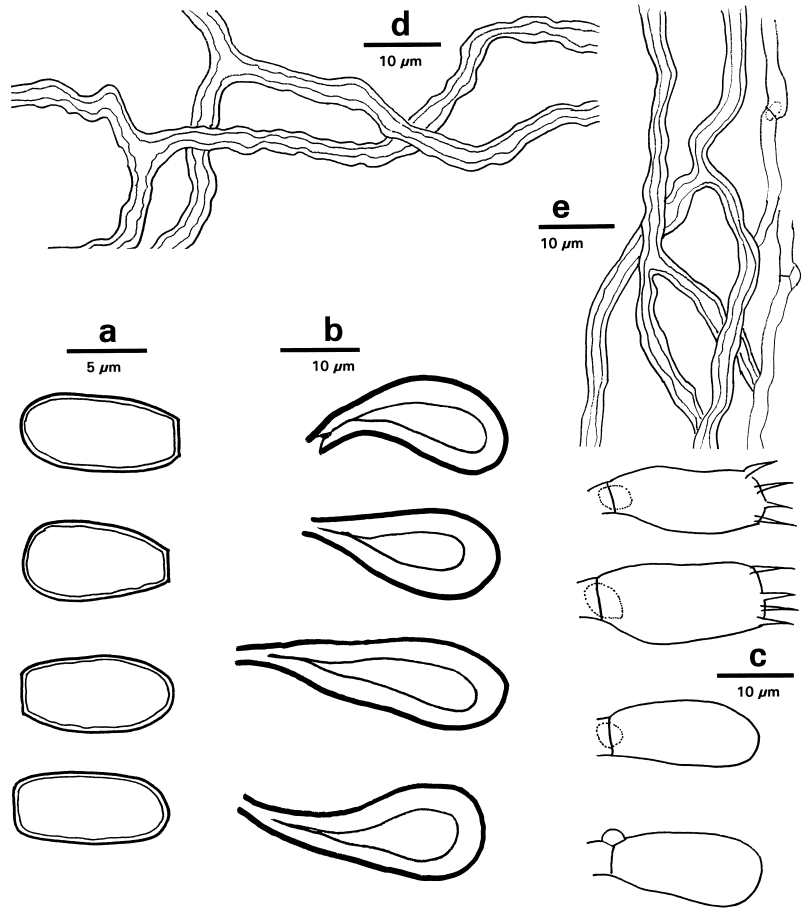


Fig. 3. Microscopical structures of *Perenniporia piceicola* Y.C. Dai (drawn from the holotype). — **a**: Basidiospores. — **b**: Cystidia. — **c**: Basidia and basidioles. — **d**: Hyphae from context. — **e**: Hyphae from trama.

walled, pale yellowish, non-dextrinoid, and shorter than $5\ \mu\text{m}$; the genus was considered to be distributed mainly in the tropics (Ryvarden 1998). These characters do not fit exactly with the definition of *Abundisporus quercicola*: its hyphal structure is indistinctly trimitic, spore size exceeds the limit given by Ryvarden (1998), and it was found in temperate Asia. We describe the new species in *Abundisporus*, because it is the closest match and the only suitable one. The new member makes it necessary to somewhat expand the concept of the genus: hyphal system is dimitic to trimitic, spores are up to $9\ \mu\text{m}$ long, and the distribution ranges from temperate zone to the tropics (*A. pubertatis* occurs in temperate forests as well).

The ecology and macroscopic characters of *Abundisporus quercicola* are somehow similar to the brown-coloured species of *Ganoderma*, but basidiospores in *Ganoderma* are double-walled

and ornamented. Dry specimens of *A. quercicola* resemble *Perenniporia martia* (Berk.) Ryvarden, which has hyaline, dextrinoid spores and cystidia (Decock & Figueroa 2000).

***Perenniporia piceicola* Y.C. Dai, sp. nova (Fig. 3)**

Carpophorum annuum vel bienne, resupinatum, facies pororum lutea, pori 2–4 per mm. Systema hypharum dimiticum vel trimiticum, hyphae generatoriae fibulatae, hyphae skeletales 3–5 μm in diam. Sporae ellipsoideae vel truncatae, 11–13.5 \times 5.3–7.1 μm .

HOLOTYPE: China. Yunnan Prov., Lijiang County, Yunshaping, on fallen trunk of *Picea likiangensis*, 18.VI.1999 Y.C. Dai 3089 & K. Korhonen (H, isotype IFP).

ETYMOLOGY. — *piceicola* (Lat.), living on spruce.



Fig. 4. *Abundisporus pubertatis* (Lloyd) Parmasto. A fresh pileate basidiocarp, specimen Dai 2179. Photograph Y.C.D., *in situ*, $\times 0.8$.

Basidiocarps annual to biennial, resupinate, ca. 5 cm or more in longest dimension, soft corky when fresh, becoming tough corky when dry. Sterile margin very narrow. Pore surface pale yellowish; pores round, 2–3 per mm, tube mouths entire. Subiculum ochraceous, corky, up to 2 mm thick. Tubes yellowish ochraceous or straw coloured, corky, up to 3 mm long.

Hyphal system dimitic to trimitic; generative hyphae with clamp connections; skeletal hyphae slightly dextrinoid, CB+, hyphae unchanged in KOH.

Context. — Generative hyphae frequent, hyaline, thin-walled, frequently septate with clamp connections, occasionally branched, 2–4.6 μm in diam.; skeletal hyphae hyaline, thick-walled with a lumen, readily branched (trimitic-like), flexuous, 3–5 μm in diam.

Tube trama. — Generative hyphae infrequent, hyaline, thin-walled, frequently septate with clamps and branches, 2–3.2 μm in diam. Skeletal hyphae dominant, hyaline, thick-walled with a lumen, flexuous, 2.5–4.5 μm in diam. Cystidia usually infrequent, but sometimes common, pyriform, thick-walled, smooth, strongly CB+, 25–40 \times 8–14 μm ; basidia clavate, with four sterigmata

and a basal clamp, 23–27 \times 8–11 μm ; basidioles in shape similar to basidia, but slightly smaller.

Spores. — Basidiospores ellipsoid, truncate, hyaline, fairly thick-walled, smooth, slightly dextrinoid, CB+, (10–)11–14(–16) \times (5–)5.4–7.5(–8) μm , $L = 12.73 \mu\text{m}$, $W = 6.39 \mu\text{m}$, $Q = 1.99$ ($n = 60/1$).

Perenniporia piceicola is characterized by its resupinate basidiocarps, pale yellowish pores, weakly dextrinoid skeletal hyphae, distinctly thick-walled and pyriform cystidia, and large, slightly dextrinoid basidiospores. The type material was collected from the fallen trunk of a spruce in a boreal forest of southwest Yunnan Province, a foothill of the Himalaya Mts.

Previously two resupinate species in *Perenniporia* were known to have large spores ($> 11 \mu\text{m}$ in length): *P. isabellina* (Pat. ex Sacc.) Ryvar den and *P. podocarpi* P.Buchanan & Hood.

Perenniporia isabellina differs from the new species by its pale cocoa brown to buff pore surface, smaller pores (4–5 per mm), the lack of cystidia, and wider spores (11–13 \times 7–8 μm). That species is known from Venezuela, tropical South America (Ryvar den 1983, Decock & Ryvar den 1999).



Fig. 5. *Abundisporus fuscopurpureus* (Pers.) Ryvarden. A fresh pileate basidiocarp, specimen *Dai 3098e*. Photograph Y.C.D., *in situ*, $\times 0.4$.

Perenniporia podocarpi was described from New Zealand (Buchanan 1992). Its basidiocarps are perennial, pore surface is white to cream coloured, and pores are larger (1–2 per mm) than in *P. piceicola*. The lack of cystidia, and distinctly larger, strongly dextrinoid spores ($16.4\text{--}23 \times 7.5\text{--}9.5 \mu\text{m}$, Decock *et al.* 2000) are additional characters that separate *P. podocarpi* from the new species.

Key and summary to species of *Abundisporus*, *Perenniporia* and *Haploporus* from China

1. Basidiospores ornamented (*Haploporus*) 26
1. Basidiospores smooth 2
2. Basidiospores hyaline; context mostly cream coloured to ochraceous, seldom greyish brown, skeletal hyphae mostly hyaline to pale ochraceous in KOH (*Perenniporia*) 5
2. Basidiospores yellowish; context grey, brown to fuscous; skeletal hyphae brown to black in KOH (*Abundisporus*) 3
3. Basidiocarps effused-reflexed, pores pinkish brown when fresh; tramal hyphae parallel *A. pubertatis* (Lloyd) Parmasto (Fig. 4)

Basidiocarp annual to perennial, resupinate to effused-reflexed, pore surface pink to pinkish grey, pores 5–7 per mm; skeletal hyphae IKI–, CB+, tramal hyphae parallel, spores ellipsoid, truncate, IKI–, CB+, $(3.9\text{--})4\text{--}4.8\text{--}(5) \times (2.2\text{--})2.4\text{--}3.2\text{--}(4) \mu\text{m}$, $L = 4.25 \mu\text{m}$, $W = 2.88 \mu\text{m}$, $Q = 1.38$ ($n = 30/1$)

3. Basidiocarps distinctly pileate, pores white when fresh; tramal hyphae interwoven 4
4. Upper surface greyish black; basidiospores $> 6 \mu\text{m}$ in length *A. quercicola* Y.C.Dai
Basidiocarp perennial, pileate, pore surface white, ochraceous when dry, pores 5–7 per mm; skeletal hyphae IKI–, CB+, tramal hyphae interwoven, spores narrowly ovoid but distinctly tapering at apex, not truncate, IKI–, CB+, $(6.2\text{--})6.8\text{--}8.8\text{--}(9) \times (4\text{--})4.2\text{--}5\text{--}(5.2) \mu\text{m}$, $L = 7.62 \mu\text{m}$, $W = 4.69 \mu\text{m}$, $Q = 1.63$ ($n = 30/1$)
4. Upper surface reddish black; basidiospores $< 4 \mu\text{m}$ in length *A. fuscopurpureus* (Pers.) Ryvarden (Fig. 5)
Basidiocarp perennial, pileate, pore surface white to cream when fresh, becoming greyish to pale brown when dry, pores 7–8 per mm; skeletal hyphae IKI–, CB+, tramal hyphae interwoven, spores broadly ellipsoid, truncate, IKI–, CB+, $(3\text{--})3.1\text{--}4\text{--}(4.1) \times (2\text{--})2.1\text{--}2.8\text{--}(3) \mu\text{m}$, $L = 3.55 \mu\text{m}$, $W = 2.38 \mu\text{m}$, $Q = 1.49$ ($n = 30/1$)
5. Context greyish brown; skeletal hyphae brown to black in KOH *Perenniporia tephropora* (Mont.) Ryvarden
Basidiocarp perennial, resupinate to effused-reflexed, pore surface clay to grey or pale umber, pores 7–8 per mm; skeletal hyphae IKI–, CB+, tramal hyphae interwoven, spores ellipsoid, truncate or not, dextrin-



Fig. 6. *Perenniporia maackiae* (Bondartsev & Ljub.) Parmasto. A fresh pileate basidiocarp, specimen Dai 2397. Photograph Y.C.D., *in situ*, $\times 0.7$.

- oid, CB+, (4.2–)4.4–5(–5.2) \times (3.2–)3.4–4(–4.2) μm , $L = 4.77 \mu\text{m}$, $W = 3.73 \mu\text{m}$, $Q = 1.28$ ($n = 30/1$)
5. Context cream coloured to ochraceous, skeletal hyphae hyaline to pale ochraceous in KOH 6
6. Basidiocarps distinctly pileate 16
6. Basidiocarps resupinate, sometimes effused-reflexed ... 7
7. Skeletal hyphae IKI+, basidiospores IKI–
..... *P. narymica* (Pilát) Pouzar
Basidiocarp annual, resupinate, pore surface yellowish, pores 3–5 per mm; skeletal hyphae IKI+, CB–, dissolved in KOH, tramal hyphae subparallel, spores oblong-ellipsoid, not truncate, IKI–, CB+, (4–)4.3–5.5(–6) \times (2.7–)3–3.6(–4) μm , $L = 4.89 \mu\text{m}$, $W = 3.21 \mu\text{m}$, $Q = 1.51–1.54$ ($n = 60/2$)
7. Skeletal hyphae dextrinoid or IKI–, basidiospores dextrinoid or IKI– 8
8. Basidiospores < 10 μm in length 10
8. Basidiospores > 10 μm in length 9
9. Pores 3–4 per mm, skeletal hyphae slightly dextrinoid, cystidia present *P. piceicola* Y.C.Dai
Basidiocarp annual to biennial, resupinate, pore surface pale yellowish, pores 3–4 per mm; skeletal hyphae slightly dextrinoid, CB+, tramal hyphae interwoven, pyriform cystidia present, spores ellipsoid, truncate, slightly dextrinoid, CB+, (10–)11–14(–16) \times (5–)5.4–7.5(–8) μm , $L = 12.73 \mu\text{m}$, $W = 6.39 \mu\text{m}$, $Q = 1.99$ ($n = 60/1$)
9. Pores 4–6 per mm; skeletal hyphae IKI–, cystidia absent *P. cf. phloiophila* Gilb. & M. Blackw.
Basidiocarp annual, resupinate to effused-reflexed, pore surface isabelline, pores 4–6 per mm; skeletal hyphae IKI–, CB+, tramal hyphae subparallel, spores ellipsoid, truncate, dextrinoid, CB+, (10.4–)10.5–12(–12.5) \times (5.1–)5.3–8(–8.2) μm , $L = 11.26 \mu\text{m}$, $W = 6.79 \mu\text{m}$, $Q = 1.69$ ($n = 30/1$)
10. Basidiocarps with rhizomorphs
..... *P. japonica* (Yasuda) T.Hattori & Ryvar den
Basidiocarp annual to perennial, resupinate, pore surface cream to pale isabelline, pores 5–6 per mm; skeletal hyphae dextrinoid, CB+, swelling in KOH, tramal hyphae interwoven, spores ellipsoid, truncate, dextrinoid, CB+, (3.8–)4–5.2(–5.6) \times (2.8–)3–3.9(–4.1) μm , $L = 4.78 \mu\text{m}$, $W = 3.39 \mu\text{m}$, $Q = 1.34–1.48$ ($n = 60/2$)
10. Basidiocarps without rhizomorphs 11
11. Basidiospores IKI– *P. cf. fergusii* Gilb. & Ryvar den
Basidiocarp annual, resupinate to effused-reflexed, pore surface ochraceous, pores 5–6 per mm; skeletal hyphae strongly dextrinoid, CB+, tramal hyphae interwoven, spores broadly ellipsoid to subglobose, not truncate, IKI–, CB+, (4–)4.2–5(–5.1) \times (3.4–)3.6–4.1(–4.5) μm , $L = 4.74 \mu\text{m}$, $W = 3.78 \mu\text{m}$, $Q = 1.25$ ($n = 30/1$)
11. Basidiospores dextrinoid 12
12. On *Maackia*; basidiocarps resupinate to effused-reflexed, bright yellow
..... *P. maackiae* (Bondartsev & Ljub.) Parmasto (Fig. 6)
Basidiocarp annual to perennial, resupinate to effused-reflexed, pore surface bright yellow, pores 5–8 per mm; skeletal hyphae dextrinoid, CB+, tramal hyphae interwoven, spores ellipsoid, truncate, dextrinoid, CB+, (4.8–)5–6.5(–7) \times (3–)3.5–4.5(–5) μm , $L = 5.51 \mu\text{m}$, $W = 4.05 \mu\text{m}$, $Q = 1.25–1.52$ ($n = 256/9$)



Fig. 7. *Perenniporia* cf. *corticola* (Corner) C. Decock. A fresh pileate basidiocarp, specimen *Dai 3257*. Photograph Y.C.D., *in situ*, $\times 0.5$.

12. On angiosperms other than *Maackia* or gymnosperms; basidiocarps resupinate, pore surface cream coloured to yellowish 13
13. Skeletal hyphae distinctly dextrinoid, tramal hyphae more or less parallel 15
13. Skeletal hyphae IKI- or very weakly dextrinoid, tramal hyphae interwoven 14
14. Pores cream coloured; skeletal hyphae IKI-, spores $< 4 \mu\text{m}$ in width *P. medulla-panis* (Jacq. : Fr.) Donk
Basidiocarp annual to perennial, resupinate, pore surface cream coloured, pores 5–6 per mm; skeletal hyphae IKI-, CB+, tramal hyphae interwoven, spores broadly ellipsoid, truncate, dextrinoid, CB+, (4.2–)4.5–5(–5.2) \times (3–)3.2–3.8(–4) μm , $L = 4.73 \mu\text{m}$, $W = 3.52 \mu\text{m}$, $Q = 1.34$ ($n = 29/1$)
14. Pores yellow; skeletal hyphae weakly dextrinoid, spores $> 4 \mu\text{m}$ in width
..... *P. cf. corticola* (Corner) C. Decock (Fig. 7)
Basidiocarp perennial, resupinate, pore surface yellow, pores 6–7 per mm; skeletal hyphae weakly dextrinoid, CB+, tramal hyphae interwoven, spores broadly ellipsoid, truncate, dextrinoid, CB+, (4.8–)5–5.5(–5.6) \times (3.8–)4–4.7(–4.8) μm , $L = 5.18 \mu\text{m}$, $W = 4.33 \mu\text{m}$, $Q = 1.20$ ($n = 29/1$)
15. Pores 3–5 per mm; basidiospores $> 5.5 \mu\text{m}$ in length
..... *P. tenuis* (Schwein.) Ryvarden
Basidiocarp annual to perennial, resupinate, pore surface cream coloured to pale yellow, pores 3–5 per mm; skeletal hyphae dextrinoid, CB+, tramal hyphae subparallel, spores ellipsoid, truncate or not, dextrinoid, CB+, (5–)5.5–6.5(–7) \times (4.3–)4.5–5.5(–6) μm , $L = 6.03 \mu\text{m}$, $W = 5.04 \mu\text{m}$, $Q = 1.20$ ($n = 30/1$)
15. Pores 4–6 per mm; basidiospores $< 5.5 \mu\text{m}$ in length
..... *P. subacida* (Peck) Donk (Fig. 8)
Basidiocarp annual to perennial, resupinate, pore surface cream to pale yellowish, pores 4–6 per mm; skeletal hyphae dextrinoid, CB+, tramal hyphae parallel, spores ellipsoid, not truncate, dextrinoid, CB+, (4–)4.3–5.4(–6) \times (3–)3.2–4.1(–4.4) μm , $L = 4.82 \mu\text{m}$, $W = 3.69 \mu\text{m}$, $Q = 1.29$ –1.32 ($n = 105/3$)
16. Basidiospores $< 9 \mu\text{m}$ in length 18
16. Basidiospores $> 9 \mu\text{m}$ in length 17
17. Upper surface cream coloured to brownish; skeletal hyphae dextrinoid *P. ochroleuca* (Berk.) Ryvarden
Basidiocarp annual to perennial, pileate, pore surface cream coloured to ochraceous, pores 5–6 per mm; skeletal hyphae dextrinoid, CB+, becoming swollen in KOH, tramal hyphae interwoven, spores ellipsoid, truncate, dextrinoid, CB+, (8–)9–12(–14) \times (4.5–)5.5–7.5(–9) μm , $L = 10.87 \mu\text{m}$, $W = 6.35 \mu\text{m}$, $Q = 1.70$ –1.73 ($n = 60/2$)
17. Upper surface almost black; skeletal hyphae IKI-
..... *P. ohiensis* (Berk.) Ryvarden
Basidiocarp perennial, pileate, pore surface cream to wood-coloured, pores 5–6 per mm; skeletal hyphae IKI-, CB+, tramal hyphae interwoven, spores ellipsoid, truncate, dextrinoid, CB+, (11.9–)12–14(–14.5) \times (6–)7–8.8(–9) μm , $L = 13.26 \mu\text{m}$, $W = 7.54 \mu\text{m}$, $Q = 1.76$ ($n = 30/1$)



Fig. 8. *Perenniporia subacida* (Peck) Donk. A fresh pileate basidiocarp, specimen *Dai 2138*. Photograph Y.C.D., *in situ*, $\times 0.4$.

18. Basidiospores more or less ellipsoid, not tapering 22
 18. Basidiospores drop-shaped, distinctly tapering 19
 19. Upper surface reddish brown, pores ochraceous when fresh, subtropical species 21
 19. Upper surface pale grey, pores cream coloured when fresh, temperate species 20
 20. Contextual hyphae trimitic, skeletal hyphae subsolid in KOH, basidiospores $> 5.3 \mu\text{m}$ in width
 *P. robiniophila* (Murrill) Ryvar den
 Basidiocarp annual to perennial, pileate, pore surface cream coloured when fresh, pores 4–5 per mm; skeletal hyphae dextrinoid, CB+, tramal hyphae interwoven, spores drop-shaped, not truncate, dextrinoid, CB+, $(5.8\text{--}6\text{--}7\text{--}7.8) \times (5.4\text{--}5.5\text{--}6\text{--}6.2) \mu\text{m}$, $L = 6.63 \mu\text{m}$, $W = 5.54 \mu\text{m}$, $Q = 1.20$ ($n = 30/1$)
 20. Contextual hyphae dimitic, skeletal hyphae with large lumen in KOH, basidiospores $< 5.3 \mu\text{m}$ in width
 *P. fraxinea* (Bull. : Fr.) Ryvar den
 Basidiocarp annual to perennial, pileate, pore surface cream coloured when fresh, pores 4–6 per mm; skeletal hyphae dextrinoid, CB+, tramal hyphae interwoven, spores drop-shaped, not truncate, dextrinoid, CB+, $(5\text{--}5.2\text{--}6.1\text{--}7) \times (4.1\text{--}4.6\text{--}5.2\text{--}5.4) \mu\text{m}$, $L = 5.72 \mu\text{m}$, $W = 4.95 \mu\text{m}$, $Q = 1.16$ ($n = 31/1$)
 21. Dendrohyphidia present at dissepiment edges, tramal hyphae parallel *P. detrita* (Berk.) Ryvar den
 Basidiocarp annual to perennial, pileate, pore surface ochraceous, pores 6–7 per mm; skeletal hyphae dextrinoid, CB+, becoming swollen in KOH, tramal hyphae parallel, dendrohyphidia present, spores drop-shaped, not truncate, dextrinoid, CB+, $(5.5\text{--}6.8\text{--}8.2\text{--}9) \times (4.4\text{--}5\text{--}6\text{--}6.2) \mu\text{m}$, $L = 7.38 \mu\text{m}$, $W = 5.30 \mu\text{m}$, $Q = 1.39$ ($n = 30/1$)
 21. Dendrohyphidia absent, tramal hyphae interwoven
 *P. subadusta* (Z.S.Bi & G.Y.Zheng) Y.C.Dai
 Basidiocarp annual, pileate, pore surface ochraceous, pores 5–6 per mm; skeletal hyphae dextrinoid, CB+, tramal hyphae interwoven, dendrohyphidia absent, spores drop-shaped, not truncate, very weakly dextrinoid, CB+, $5\text{--}7 \times 4\text{--}5 \mu\text{m}$
 22. Dendrohyphidia absent from dissepiment edges 24
 22. Dendrohyphidia present at dissepiment edges 23
 23. Cystidia present, chlamydospores absent
 *P. martia* (Berk.) Ryvar den
 Basidiocarp perennial, pileate, pore surface sordid ochraceous, pores 5–7 per mm; skeletal hyphae dextrinoid, CB+, tramal hyphae interwoven, dendrohyphidia present at dissepiment edges, thick-walled cystidia present, spores ellipsoid, not truncate, dextrinoid, CB+, $(5.4\text{--}5.9\text{--}8\text{--}8.2) \times (4.9\text{--}5\text{--}6\text{--}6.4) \mu\text{m}$, $L = 6.66 \mu\text{m}$, $W = 5.43 \mu\text{m}$, $Q = 1.23$ ($n = 29/1$)
 23. Cystidia absent, chlamydospores present
 *P. formosana* T.T. Chang
 Basidiocarp annual, pileate, pore surface dull ochraceous, pores 4–6 per mm; skeletal hyphae dextrinoid, CB+, tramal hyphae interwoven, dendrohyphidia present at dissepiment edges, chlamydospores present in context, spores ellipsoid, not truncate, dextrinoid,

- CB+, (5.1–)5.3–7.1(–7.5) × (4–)4.2–5.2(–5.5) μm , $L = 6.07 \mu\text{m}$, $W = 4.79 \mu\text{m}$, $Q = 1.27$ ($n = 30/1$)
24. On *Maackia*; pore surface bright yellow
 *P. maackiae* (Bondartsev & Ljub.) Parmasto
 Basidiocarp annual to perennial, resupinate to effused,
 pore surface bright yellow, pores 5–8 per mm; skeletal
 hyphae dextrinoid, CB+, tramal hyphae interwoven,
 spores ellipsoid, truncate, dextrinoid, CB+,
 (4.8–)5–6.5(–7) × (3–)3.5–4.5(–5) μm , $L = 5.51 \mu\text{m}$,
 $W = 4.05 \mu\text{m}$, $Q = 1.25–1.52$ ($n = 256/9$)
24. On angiosperms other than *Maackia*; pores ochraceous
 25
25. Basidiospores IKI–, > 5.2 μm in length
 *P. truncatospora* (Lloyd) Ryvarden
 Basidiocarp perennial, pileate, pore surface ochraceous
 to pale dirty brown, pores 6–8 per mm; skeletal hyphae
 slightly dextrinoid, CB+, tramal hyphae interwoven,
 spores ellipsoid, truncate, IKI–, CB+, (5–)5.3–7.5(–8)
 × (3.8–)4–5(–5.5) μm , $L = 6.12 \mu\text{m}$, $W = 4.56 \mu\text{m}$,
 $Q = 1.27–1.43$ ($n = 60/2$)
25. Basidiospores dextrinoid, < 5.2 μm in length
 *P. malvena* (Lloyd) Ryvarden
 Basidiocarp perennial, pileate, pore surface ochraceous
 to pale brown, pores 7–8 per mm; skeletal hyphae
 dextrinoid, CB+, tramal hyphae interwoven, spores
 ellipsoid, truncate, dextrinoid, CB+, (4–)4.2–5.1(–5.2)
 × (3–)3.1–4(–4.1) μm , $L = 4.74 \mu\text{m}$, $W = 3.64 \mu\text{m}$,
 $Q = 1.30$ ($n = 30/1$)
26. Basidiocarps pileate, basidiospores small, < 8 μm in
 length *H. odoratus* (Sommerf.) Bondartsev & Singer
 Basidiocarp perennial, pileate, pore surface white, pores
 3–4 per mm; skeletal hyphae IKI–, CB+, tramal hyphae
 interwoven, spores ellipsoid, thick-walled, ornamented,
 IKI–, CB+, (4–)4.5–5.3(–6) × (3.1–)3.5–4.1(–4.8) μm ,
 $L = 4.93 \mu\text{m}$, $W = 3.91 \mu\text{m}$, $Q = 1.24–1.29$ ($n = 60/2$)
26. Basidiocarps resupinate, basidiospores large, > 8 μm in
 length 27
27. Basidiocarps perennial, pores 3–5 per mm; skeletal
 hyphae non-dextrinoid (an extra-Chinese
 taxon) *H. subtrameteus* (Pilát) Y.C.Dai & Niemelä
 Basidiocarp perennial, resupinate, pore surface cream
 coloured, pores 3–5 per mm; skeletal hyphae IKI–,
 CB+, tramal hyphae interwoven, spores oblong-ellip-
 soid, thick-walled, ornamented, IKI–, CB+, (7.9–)8.1–
 10.5(–11) × (4.5–)5–6.3(–7) μm , $L = 9.36 \mu\text{m}$, $W =$
 $5.57 \mu\text{m}$, $Q = 1.68$ ($n = 30/1$)
27. Basidiocarps mostly annual, if perennial, pores 1–2 per
 mm; skeletal hyphae dextrinoid 28
28. Basidiocarps up to 1.5 cm thick, pores 1–2 per mm (an
 extra-Chinese taxon)
 *H. tuberculosus* (Fr.) Niemelä & Y.C.Dai
 Basidiocarp perennial, resupinate, pore surface light
 buff to ochraceous, pores 1–2 per mm; skeletal hyphae
 dextrinoid, CB+, tramal hyphae interwoven, spores
 oblong-ellipsoid, thick-walled, ornamented, IKI–, CB+,
 (9–)9.6–11.5(–12.5) × (5–)5.1–6.2(–6.7) μm , $L = 10.67$
 μm , $W = 5.65 \mu\text{m}$, $Q = 1.89$ ($n = 30/1$)
28. Basidiocarps less than 4 mm thick, pores 2–5 per mm .. 29
29. Pores 2–3 per mm; dendrohyphidia absent
 *H. papyraceus* (Schwein.) Y.C.Dai & Niemelä

- Basidiocarp annual, resupinate, pore surface cream
 to ochraceous, pores 2–3 per mm; skeletal hyphae
 dextrinoid, CB+, tramal hyphae interwoven, spores
 cylindrical-ellipsoid, thick-walled, ornamented, IKI–,
 CB+, (10.5–)11–14(–14.5) × (5–)5.5–7.5(–8) μm ,
 $L = 12.81 \mu\text{m}$, $W = 6.16 \mu\text{m}$, $Q = 2.08$ ($n = 30/1$)
29. Pores 4–5 per mm; dendrohyphidia present at dissepiment
 edges
 *H. alabamae* (Berk. & Cooke) Y.C.Dai & Niemelä
 Basidiocarp annual, resupinate, pore surface cream to
 ochraceous, pores 4–5 per mm; skeletal hyphae IKI–,
 CB+, tramal hyphae interwoven, dendrohyphidia present
 at dissepiment edges, spores cylindrical-ellipsoid,
 thick-walled, ornamented, IKI–, CB+, 10–12(–12.5)
 × (4.8–)5–6.5(–6.8) μm , $L = 11.11 \mu\text{m}$, $W = 5.62 \mu\text{m}$,
 $Q = 1.98$ ($n = 30/1$)

Notes on selected species

Abundisporus fuscopurpureus and *A. roseoalbus*

Abundisporus roseoalbus was reported from China (Zhao and Zhang 1992). Its voucher specimen was examined, and it in fact represents *A. fuscopurpureus*.

Abundisporus fuscopurpureus and *A. roseoalbus* were treated as two independent species by Ryvarden and Johansen (1980), Ryvarden (1998), and Decock and Laurence (2001). However, Ryvarden and Johansen (1980) noted that the two species are almost identical, the only difference being the slightly larger spores of *A. roseoalbus*. Parmasto and Hallenberg (2000) made a statistical study on the spores of both species (including the type specimen of *A. roseoalbus*), and they concluded that the dimensions of the basidiospores in the two taxa overlap. *Abundisporus roseoalbus* was then treated as a synonym of *A. fuscopurpureus*.

Perenniporia cf. corticola

Two collections from Hunan Province, subtropical China, are here tentatively identified as *Perenniporia cf. corticola*. They have perennial and resupinate basidiocarps, and their pores are yellow. The skeletal hyphae of our Hunan material are weakly dextrinoid, and their spores are broadly ellipsoid, truncate, dextrinoid, cyanophilous, 5–5.5 × 4–4.7 μm . So the collections are

very close to *Parmastomyces corticola* Corner and *Perenniporia dipterocarpicola* Hattori & S.S.Lee. Both of them were described from Malaysia (Corner 1989, Hattori & Lee 1999). Decock (2001) restudied the types of the two taxa, and concluded that they represent a single taxon. However, *P. corticola* grows on *Dipterocarpus* in lowland forests of Southeast Asia (Hattori & Lee 1999, Decock 2001), but the material from Hunan was collected on fallen trunk of angiosperm which was certainly not *Dipterocarpus*. *Perenniporia* cf. *corticola* produces extensive basidiocarps, which may be up to 2 metres long and 30 cm wide.

Perenniporia* cf. *fergusii

The sole specimen of this taxon was collected from the warm-temperate forests in the Guizhou Province. It is fairly close to *P. fergusii*, but not identical. Type specimen of *P. fergusii* was studied; the species has been known from North America only. Its pores are pinkish salmon, and its dry basidiocarps are bone hard. Basidiospores of the American species are distinctly dextrinoid. In contrast, the Chinese material has ochraceous pore surface, and dry basidiocarps are corky. Basidiospores of the Guizhou collection are negative in Melzer's reagent. Because no existing name matches completely with the specimen, we treat it for the time being as *Perenniporia* cf. *fergusii*.

Perenniporia formosana

Perenniporia formosana was described from Taiwan (Chang 1994); now several specimens of the species were collected from Hunan Province, Central China. Its upper surface is covered by a reddish brown cuticle, and so the basidiocarps are very similar to some species of *Ganoderma*, which, however, have brown, ornamented and double-walled spores. Another important character for *P. formosana* is the presence of chlamydospores, and this character was not mentioned in its original description. Type material and collections from Central China were examined, and chlamydospores were consistently found in their context.

Perenniporia narymica

Perenniporia narymica has several distinct characters which are untypical to *Perenniporia*. For instance, basidiospores of the species are negative in Melzer's reagent, its skeletal hyphae are amyloid and acyanophilous, and its hyphae dissolve in KOH. *Perenniporia narymica* is the only species in the genus whose skeletal hyphae are acyanophilous, and its basidiospores are not particularly thick-walled. This species seems to be distant from the others in *Perenniporia*. It is included in the genus because the spores are ellipsoid and cyanophilous, but a revision would be welcome to confirm its generic position.

Perenniporia subadusta* (Z.S.Bi & G.Y.Zheng) Y.C.Dai, *comb. nova

BASIONYM: *Wrightoporia subadusta* Z.S.Bi & G.Y.Zheng, Bot. Res. 7: 76. 1987.

Type material of *Wrightoporia subadusta* was studied. It has di- to trimitic hyphal structure, and its skeletal hyphae are strongly dextrinoid. Basidiospores are hyaline, thick-walled, and distinctly cyanophilous, but negative or very weakly dextrinoid in Melzer's reagent. It is therefore a typical member of *Perenniporia*, and the new combination is proposed. [A note by an anonymous reviewer: All species of *Wrightoporia* have amyloid basidiospores, this being the main reason for excluding *W. subadusta* from the genus and transfer it to *Perenniporia*.] *Perenniporia subadusta* was originally described from Guangdong Province, subtropical China, and the type was collected on rotten trunk of an unidentified angiosperm. The species has similar basidiospores as *P. detrita*, but the spores of the latter species are distinctly dextrinoid and there are dendrohyphidia at dissepiment edges.

Perenniporia* cf. *phloiophila

This taxon has annual, resupinate to effused-reflexed basidiocarps, and its pore surface is pale buff to isabelline. Skeletal hyphae show no reac-

tion in Melzer's reagent, and tramal hyphae are subparallel. Basidiospores are ellipsoid, truncate, dextrinoid, cyanophilous, $10.5\text{--}12 \times 5.3\text{--}8 \mu\text{m}$. So our material is very close to *Perenniporia phloiophila*, but the two are not identical. The type of *P. phloiophila* was studied; its spores are slightly dextrinoid (weakly IKI red), while skeletal hyphae are strongly dextrinoid (strongly IKI red). In contrast, basidiospores of *P. cf. phloiophila* have a striking dextrinoid reaction, but skeletal hyphae remain unchanged in Melzer's reagent. The material of *P. cf. phloiophila* was collected on fallen angiosperm branches in Guangdong Province, subtropical China. *Perenniporia phloiophila sensu typi* is restricted to living *Quercus* trees in the Gulf Coast region and lower Atlantic coast of North America (Gilbertson & Ryvarden 1986–1987).

A note on *Haploporus* and *Pachykytospora*

The genus *Haploporus* was erected by Singer (1944) with *H. odorus* (Sommerf.) Bondartsev & Singer as the type species. It shares almost all the critical characteristics with *Perenniporia*: the type species produces a white rot, hyphal system is trimitic (dimitic in most part of the basidiocarp, Niemelä 1971), skeletal hyphae are slightly cyanophilous, and spores are thick-walled, truncate, dextrinoid, and in particular, strongly cyanophilous. In fact the only clear character differentiating it from *Perenniporia* is the warted ornamentation of the spore surface. The last-mentioned character is so striking that we still accept the common practice to keep *Haploporus* apart from *Perenniporia*.

Kotlaba and Pouzar (1963) described a new genus *Pachykytospora* for *Polyporus tuberculosus* Fr. Also it belongs to the *Perenniporia* generic complex, and we cannot find any good characters that could be used to keep *Pachykytospora* apart from *Haploporus*. The pileate habit and small pore size of *H. odorus*, and resupinate and large-pored basidiocarps of *P. tuberculosus* are minor differences after all. In the microscope the two closely remind each other in all important features. The spores are larger in *P. tuberculosus* than in *H. odorus*, but truncate ellipsoid

in shape, and strongly cyanophilous. A SEM picture of the spores of *H. odorus* (Niemelä 1971) shows roundish warts, arranged in an irregular longitudinal fashion. In *P. tuberculosus* the warts are similar in shape, though a little more distant and more clearly longitudinally aligned (SEM in Esteve-Raventós *et al.* 1984). Keller (1986) compared the spores with TEM and concluded: "The spores [of *Haploporus odorus*] are identical with those of *P. tuberculosus* in their cyanophily and, in particular, in their ultrastructure..." (translated from French). The skeleto-binding hyphae of *P. tuberculosus* stain stronger blue in CB than those of *H. odorus*, but similar difference is also seen within the species of *Perenniporia*, e.g., between *P. medulla-panis* (hyphae slightly CB+) and *P. subacida* (hyphae strongly CB+). In a similar way the differences in spore-wall dextrinoidy (fairly strong in *Haploporus*, negative in *Pachykytospora*) have parallel examples within *Perenniporia*. For these reasons the following combinations are made:

Haploporus tuberculosus (Fr.) Niemelä & Y.C.Dai, *comb. nova*

BASIONYM: *Polyporus tuberculosus* Fr., Syst. Mycol. 1: 380. 1821.

Haploporus alabamae (Berk. & Cooke) Y.C.Dai & Niemelä, *comb. nova*

BASIONYM: *Polyporus alabamae* Berk. & Cooke, Grevillea 6: 130. 1878.

Haploporus papyraceus (Schwein.) Y.C.Dai & Niemelä, *comb. nova*

BASIONYM: *Boletus papyraceus* Schwein., Natur. Ges. Leipzig Schrift. 1: 99. 1822.

Haploporus subtrameteus (Pilát) Y.C.Dai & Niemelä, *comb. nova*

BASIONYM: *Poria subtrametea* Pilát, Sborník Nár. Mus. Praha 9: 106. 1953.

At least 6 species are now included in *Pachykytospora*. Here we treat only those that have been studied by us.

Haploporus tuberculosus has been found in Europe and North America, but not recorded

in China so far. *Haploporus subtrameteus* is known from the Russian Far East, and may very well occur in North China, too. *Haploporus alabamiae* and *H. papyraceus* have been found from subtropical China (Núñez & Ryvarden 2001).

Acknowledgements

Dr. Marja Härkönen (University of Helsinki, Finland) and Mr. Reijo Penttilä, M.Sc. (Finnish Environment Inst., Finland) kindly let us study their Chinese collections and include the results here. We express our gratitude to Prof. Teuvo Ahti (University of Helsinki, Finland) for helping with the preparation of the Latin descriptions, and to Dr. Cony Decock (Univ. Cathol. de Louvain, Belgium) for helping in identifications of some specimens.

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