Ann. Bot. Fennici 33: 153–163
Helsinki 18 June 1996
ISSN 0003-3847

Changbai wood-rotting fungi 5. Study on *Polyporus mongolicus* and *P. tubaeformis*

Yu-Cheng Dai

Dai, Y.-C., Department of Ecology and Systematics, and Botanical Museum, P.O. Box 47, FIN-00014 University of Helsinki, Finland

Received 2 January 1996, accepted 19 March 1996

Polyporus mongolicus (Pilát) Y. C. Dai, earlier treated as a variety of *P. arcularius* Batsch: Fr. by Pilát, is erected as an independent species. It is separated from the other pale-stiped *Polyporus* species (the *Polyporellus* P. Karst. group) in having duplex context, and fairly big and freely arranged pores; it has both simple-septate and clamped hyphae in the upper hirsute layer of the cap. Its affinities with the other species in the *Polyporellus* group are given. Another polypore species, growing on wood of gymnosperms in NE Asia, is identified as *P. tubaeformis* (P. Karst.) Ryvarden & Gilb. It resembles *P. melanopus* (Pers.) Fr., but differs by having narrower generative hyphae, tightly interwoven tramal hyphae, thick-walled upper surface hyphae making up a palisade, and by bearing cystidioles. The differences between it and the other taxa in the black-stiped group (the *Melanopus* complex) are discussed. *Polyporus hemicapnodes* Berk & Broome, a predominantly tropical species, has been found in the Far East of Russia, and was now collected in N China (new to China). It is characterized by having small and slender basidiocarps, a black stipe, pale luteous upper surface, strongly decurrent pores and subellipsoid spores.

Key words: Changbai Mts., China, *Polyporus hemicapnodes, P. mongolicus, P. tubaeformis*

INTRODUCTION

The genus *Polyporus* P. Micheli ex Adams.: Fr. is one of the oldest and best-known genera among the polypores. Species of the genus *sensu stricto* have been reported from N China rather late; Pilát (1934, 1940) published some *Polyporus* species from N China and the Russian Far East. However, some identifications of these polypores have been ill-defined. Within a project to study wood-rotting fungi of Changbai Mts., NE China, numerous specimens of *Polyporus* were collected. Some of them proved to belong to the taxon identified by Pilát as *Polyporellus arcularius* (Batsch) Pilát var. *mongolicus* Pilát. After studying specimens from N China and the Russian Far East and reexamining the type of *P. arcularius* var. *mongolicus*, I am convinced that this is an independent species, and I describe it here as *Polyporus mongolicus* (Pilát) Y. C. Dai. Another polypore species, inhabitant of gymnosperms (especially *Abies*) in NE Asia, was earlier reported as *P. melanopus* (Pers.) Fr. (Burt 1931) and *Polyporellus varius* (Fr.) P. Karst. f. *melanopodiformis* Pilát (Pilát 1934). On the basis of the

present study, it is referred to *P. tubaeformis* (P. Karst.) Ryvarden & Gilb.

MATERIAL AND METHODS

The study is based on my collections from N China (under investigation in Helsinki, H), on type material from PRM (the Czech Republic), and on some specimens from H (Finland), HMAS (China) and TAA (Estonia).

The measurements and drawings were made from mounts stained with Cotton Blue (CB). Spores were measured from sections cut from the tubes. IKI stands for Melzer's reagent and KOH for 5% potassium hydroxide; CB+ means cyanophilous and CB– acyanophilous; IKI– means inamyloid and indextrinoid. In presenting the variation in the size of the spores (pores, hyphae, basidia, basidioles), 5% of the measurements were excluded from each end of the range, and are given in parentheses. 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), ($n = x/y$) x measurements of spores (pores, hyphae, basidia, basidioles) from y specimens. The width of a basidium (basidiole) was measured at the thickest part, the length of a basidium (basidiole) was measured from the apex (sterigmata excluded for basidium) to the basal septum. The diametre of the skeleto-binding hypha was only measured at its skeletal part. Sections were studied at magnification up to ×1250 by using a Leitz Diaplan microscope and phase contrast illumination. Drawings were made with the aid of a drawing tube. Authors of the scientific names have been abbreviated according to Brummitt and Powell (1992).

TAXONOMY

Polyporus mongolicus (Pilát) Y. C. Dai, *comb. et stat. nova* (Figs. 1–2)

Basionym: *Polyporellus arcularius* (Batsch) Pilát var. *mongolicus* Pilát, Ann. Mycol. 38:69. 1940. — Holotype: "China, Mongolia centralis" [Neimenggu Auto. Reg., Inner Mongolia], IX.1917 *Licent 773* (PRM 808923, studied).

Basidiocarps annual, eccentrically stipitate, solitary or clustered, leathery when fresh, becoming hard upon drying. Pilei circular, 5–9 cm wide, up to 5 mm thick at centre; margin undulating, sharp, sometimes reflexed, below fertile. Upper surface tomentose to densely hirsute, grey, dirty grey to almost black. Pore surface straw-coloured to yellowish brown; pores round to angular, freely arranged, (2–)3–4 per mm ($n = 120/4$); dissepiments thin, entire. Section: context duplex, upper layer grey and soft, lower layer cream and corky and up to 2 mm thick, a thin black line usually present between the two layers; tube layer concolorous with poroid surface, tubes hard and brittle, up to 2 mm long. Stipe up to 3 cm long and 5 mm in diam, surface pale straw-coloured, tomentose to hirsute, sometimes reticulate.

Hyphal system dimitic, generative hyphae with clamp connections (except in tomentum), thin-walled, hyaline; skeleto-binding hyphae thick-walled with a narrow lumen to subsolid, dendritically branched and tapering in the ends, unchanged in KOH.

Context. — Hyphae of the context proper strongly interwoven; generative hyphae infrequent, occasionally branched, 2–3.3(–3.5) µm in diam ($n = 33/1$); skeleto-binding hyphae dominant, winding, CB+, IKI–, (3.5–)4–6 µm in diam ($n = 31/1$). Hyphae in the upper hirsute layer of the generative type only, regularly parallel, hyaline to pale brown-coloured, frequently both simple-septate and clamped, unbranched, a little thick-walled, CB– or weakly CB+, IKI–, (2.5–)2.8–3.7(–4) µm in diam ($n = 30/1$).

Stipe. — Hyphae in stipe similar to those in context; skeletal section of the skeleto-binding hyphae CB+, IKI–, hyphae more or less distinctly oriented, thin- to thick-walled, sometimes inflated, (5–)6–9(–10) µm in diam ($n = 32/1$); tips frequently branched,

Tubes. — Tramal hyphae tightly interwoven; generative hyphae thin- to fairly thick-walled, frequently branched, 1.5–3 µm in diam ($n = 30/1$); skeleto-binding hyphae dominant, mostly subsolid, CB+, IKI–, (2–)2.7–5 µm in diam ($n = 34/1$). Cystidia and cystidioles absent, hyphal pegs infrequently present. Basidia clavate, with a basal clamp and four sterigmata, 13–18(–19) × 4–6 µm ($n = 36/1$); basidioles in shape similar to basidia, 11–15(–16) × (3.5–)4–5.5(–6) µm ($n = 30/1$).

Spores. — Basidiospores cylindrical, some slightly bent, thin-walled, hyaline, smooth, bearing one or two guttules, CB–, IKI–, (5–)5.5–6.5(–7) × (1.8–)1.9–2.3(–2.7) µm, L = 6.02 µm, W = 2.08 µm, Q = 2.76–2.95 ($n = 130/4$).

Additional specimens examined. — **China**. Beijing, Baihuashan, on *Betula*, 1957 *Ma* (HMAS 21721); 1978 *Han* (HMAS 39692*);* on fallen branch of *Betula*, 1993 *Dai 1822*. Neimenggu (Inner Mongolia) Auto. Reg., 1917 *Licent* (HMAS 29238 & 29239). Jilin Prov., Huadian County, on fallen trunk of *Tilia*, 1993 *Dai 1663*; Huinan County, on fallen trunks of

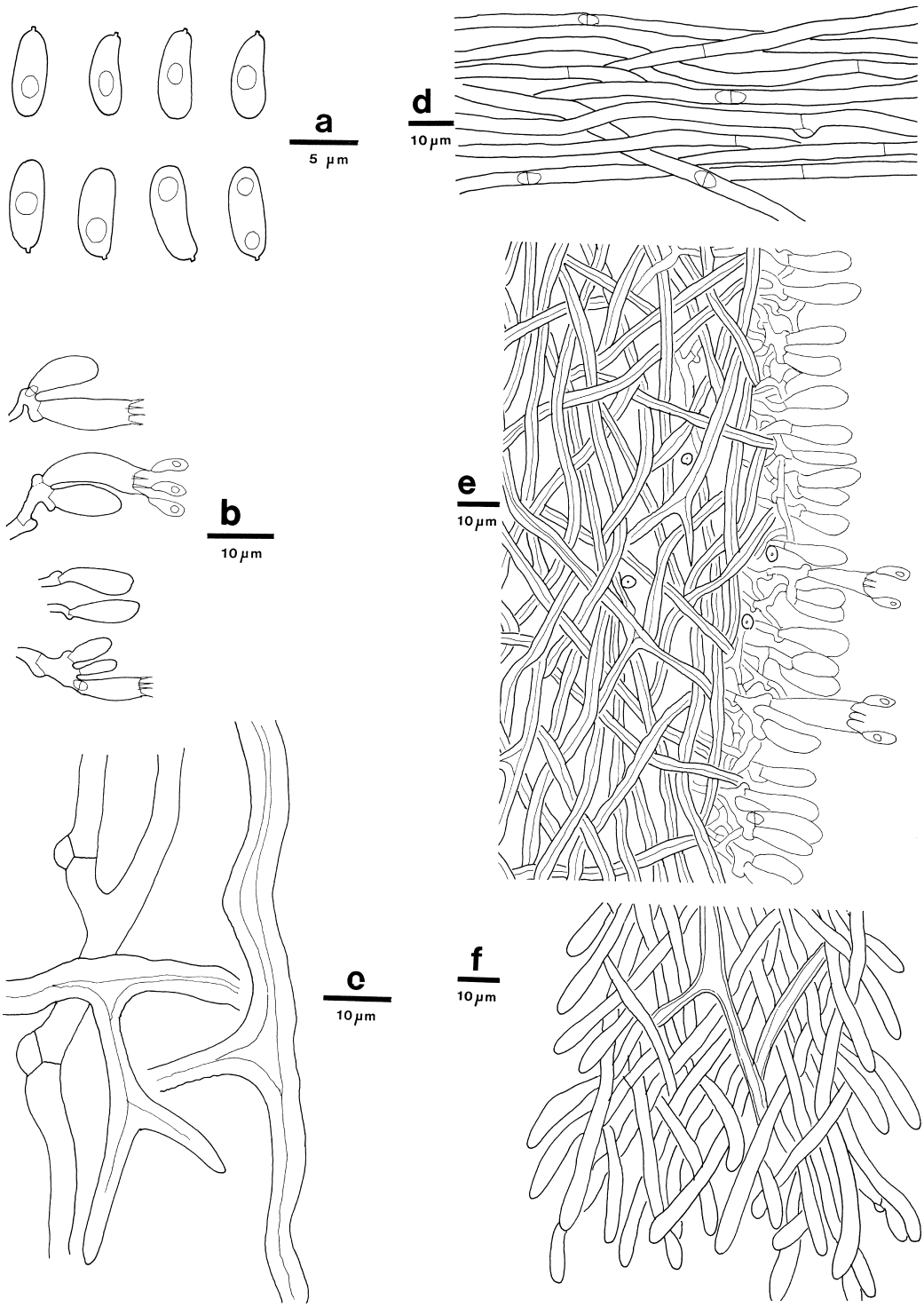

Fig. 1a–f. Anatomical details of *Polyporus mongolicus* (Pilát) Y. C. Dai (drawn from *Dai 1431*). — a: Basidiospores. — b: Basidia and basidioles. — c: Generative hyphae and skeleto-binding hyphae from context. — d: Hyphae from upper hirsute layer. — e: A section through trama. — f: Hyphae at the dissepiment edge.

Fig. 2. *Polyporus mongolicus* (Pilát) Y. C. Dai. Two young fresh basidiocarps, specimen *Dai 2190*. Photographed *in situ*, ×0.5

Betula and *Tilia*, 1993 *Dai 1431*. Liaoning Prov., Kuandian County, on rotten wood of *Tilia*, 1995 *Dai 2190 & 2196*. **Russia**. Primorye Terr., Ternei Distr., on ? *Populus*, 1979 *Kollom* (TAA 127019); on *Alnus*, 1990 *Parmasto* (TAA 151158).

Polyporus mongolicus, P. arcularius, P. brumalis and P. ciliatus compared

Polyporus mongolicus was first described as a variety of *P. arcularius* Batsch: Fr. by Pilát (1940). Kreisel (1963) considered it a possibly independent species, but he neither named nor described it. After a comparative study I confirm that it is a good species. The fairly big and freely arranged pores, duplex context, and upper hirsute layer made up of parallel, simple-septate and clamped generative hyphae are the diagnostic characters of *P. mongolicus*. According to my measurement, its spores (5.5–6.5 × 1.9–2.3 µm) in fact are smaller than what they were originally reported to be (7–8 × 2–3 µm, Pilát 1940).

Polyporus mongolicus is undoubtedly related to *P. arcularius*, *P. brumalis* Pers.: Fr. and *P. ciliatus* Fr. However, there are several evident differences. A macroscopic comparison of the species is made in Table 1.

Polyporus arcularius has small basidiocarps: its caps do not usually exceed 5 cm in diametre and its context is thinner than 1 mm; on the other hand it has fairly big spores (7–8.5 × 2–3 µm, n = 51/2, in *Dai 574 & 771*; 7–9 × 2.5–3 µm, Ryvarden & Gilbertson 1994). *Polyporus mongolicus* has larger basidiocarps, its mature caps are usually over 5 cm wide and its context is over 2 mm thick. Its spores are smaller (5.5–6.5 × 1.9–2.3 µm).

As pointed out by Kreisel (1963) *Polyporus mongolicus* much resembles *P. brumalis*. The two species share the following characters: pale-coloured stipe, similar hyphal structure, almost the same size of spores, and growth on angiosperms. Microscopically *P. brumalis* has moderately interwoven tramal hyphae. Its generative hyphae are over 3 µm in diam (3–6 µm in *Haikonen 5026*; 4–10 µm, Ryvarden & Gilbertson 1994), and they are frequently found in mature basidiocarps. Its tramal skeletals usually have a distinctly wide lumen. In comparison, *P. mongolicus* has tightly interwoven tramal structure. Its generative hyphae are thinner (1.5–3.3 µm in diam), and infrequent in mature basidiocarps. Its skeletal hyphae are dominant in both context and trama, thick-walled to almost solid, and usually lack a distinct lumen.

Polyporus ciliatus has smaller pores (6–7 per mm vs. 3–4 per mm in *P. mongolicus*), and its tubes are corky (not hard brittle as in *P. mongolicus*). In the microscope, *P. ciliatus* differs from *P. mongolicus* by its subparallel tramal hyphae.

Polyporus mongolicus seems to be widely distributed in N China; it is evidently not a very rare species. My collections were found in mixed secondary forests, especially in open areas of a forest, which shows that the species favours more or less

dry habitats. I do not know what kind of substrate the type and the other collections by Licent come from. My material and Russian specimens (in TAA) grow on angiosperms, especially on *Tilia* and *Betula*.

Affinities with the other taxa of the Polyporellus group

Polyporus corylinus Mauri and *P. meridionalis* (A. David) H. Jahn occur in the Mediterranean area, and they have larger and radially arranged pores and bigger spores (1 per mm; 6–7.5 × 2–3 µm and 7–9 × 3.5–4 µm respectively, Ryvarden & Gilbertson 1994). The former species has glabrous upper surface and stipe; and the latter species has scaly upper surface. By these characters they are easily separated from *P. mongolicus*.

Polyporus rhizophilus Pat. differs from *P. mongolicus* in its terrestrial habit, central stipe, glabrous upper surface, and larger spores (6–10 × 3–4 µm, Domański *et al*. 1967; 8–11 × 3.5 µm, Ryvarden & Gilbertson 1994). According to E. Parmasto and I. Parmasto (1978), its spores are very variable. In most cases the difference of the mean spore size of different specimens from the same locality is significant.

Polyporus sublignosus J. D. Zhao was described from subtropic China. It resembles *P. mongolicus* in having a lateral stipe, and similar pores and spores (2–4 per mm and 4.5–6 × 1.5–2.5 µm respectively, Zhao & Zhang 1992). However, it has glabrous cap surface, strongly decurrent pores, blackish-brown poroid surface, and it grows on the ground. Its stipe extends up to 5 cm inside the soil (Zhao & Zhang 1992).

Polyporus tricholoma Mont. seems to be the closest relative to *P. ciliatus*. It is distinguished from *P. mongolicus* by a central stipe, glabrous or sparsely hairy upper surface, smaller pores and broadly ellipsoid spores (7–9 per mm and 6–8 × 3–4 µm respectively, Ryvarden & Johansen 1980).

In addition to literature, my comparison to related species was based on examination of the following specimens: *Polyporus arcularius*. **China**. Jilin Prov., Antu County, 1993 *Dai 771*; Fushong County, 1993 *Dai 574*; Huinan County, 1993 *Dai 427 & 452*. **Germany**. Dresden Distr., Hoyerswerda, 1983 *Dunger 10884* (H). **Poland**. Olsztyn Distr., Nidzica, 1969 *Niemelä & Domański 1969* (H). **Slovakia**. Trenćı Distr., Krásna Ves, 1973 *Niemelä, Kotlaba & Pouzar* (H). *Polyporus brumalis*. **China**. Jilin Prov., Antu County, 1993 *Dai 1146b*. **Denmark**. Sjaelland, Tisvilde, 1987 *Kotiranta 6702* (H). **Finland**. Etelä-Häme, Padasjoki, 1984 *Haikonen 5026* (H). Uusimaa, Espoo, 1971 *Federley* (H); Helsinki, 1984 *Kotiranta 5304 & 5317* (H); Kirkkonummi, 1970 *Niemelä* (H). **Norway**. Troms, Skjervöy, 1969 *Kytövuori 90443* (H). **Slovakia**. Michalovice Distr., Nová Sedlica, 1990 *Vampola* (H). *Polyporus ciliatus*. **China**. Jilin Prov., Antu County, 1993 *Dai 1146*; Changbaishan For. Res., 1993 *Dai 1020 & 1056*; Wangqing County, 1993 *Dai 1212*. **Finland**. Etelä-Häme, Lammi, 1979 *Niemelä* (H); Padasjoki, 1992 *Dai 36 & Niemelä* (H). Uusimaa, Artjärvi, 1981 *Haikonen 1532* (H); Orimattila, 1983 *Haikonen 3614* (H); Sipoo, 1984 *Kotiranta* (H). **Nor-**

Table 1. A macroscopic comparison of *Polyporus arcularius* Batsch: Fr., *P. brumalis* Pers.: Fr., *P. ciliatus* Fr. and *P. mongolicus* (Pilát) Y. C. Dai

Species	Pores	Stipe	Upper surface	Context
P. arcularius	1–3 per mm, radially elongated, dissepiments lacerate	central, glabrous	rugose to glabrous	homogeneous
P. brumalis	2–3 per mm, radially aligned, dissepiments even	central, glabrous	mostly glabrous, rarely with stiff hairs	homogeneous
P. ciliatus	6–7 per mm, freely arranged, dissepiments lacerate	central, ciliate to glabrous	ciliate	homogeneous
P. mongolicus	3–4 per mm, freely arranged, dissepiments even	eccentric, tomentose to hirsute	densely hirsute	duplex

way. Akershus, Frogn, 1960 *Ahti 12459* (H). Rogaland, Flekkefjord, 1969 *Ryvarden* (H).

Polyporus tubaeformis (P. Karst.) Ryvarden & Gilb. (Figs. 3–4)

Polyporellus varius (Fr.) P. Karst. subsp. *tubaeformis* P. Karst., Medd. Soc. Fauna Fl. Fennica 9:69. 1882. — Holotype: Finland, Etelä-Häme, Tammela, Mustiala, 18.VII.1880 *Karsten 1945* (H, studied).
Polyporellus varius f. *melanopodiformis* Pilát, Bull. Soc. Mycol. France 49:257. 1934 (1933). — Holotype: Russia. Siberia, Omsk Reg., Tara Distr., on *Abies*, 1928 *Murashkinsky* (PRM 163609, studied). — *Polyporellus picipes* (Fr.) P. Karst. f. *melanopodiformis* Pilát, Beih. Bot. Centralblatt 56 (B):65. 1937 (1936). — Holotype: PRM 163609 (see above).

Basidiocarps annual, centrally stipitate, solitary or clustered, when fresh coriaceous, and becoming hard upon drying. Pilei circular to infundibuliform, up to 7 cm wide, and thin (not exceeding 3 mm); margin sharp, below sterile. Upper surface reddish brown to deep bay, glabrous, having a cuticle, bearing indistinctly concentric zones when fresh, and azonate to more or less radially wrinkled upon drying. Pore surface cream, when dry straw-coloured to pale brownish, shining; pores round, a little decurrent, 6–9(–10) per mm (n = 150/5); dissepiments thin to fairly thick, entire. Section: context cream, hard corky, up to 2 mm thick; tube layer concolorous with poroid surface, tubes hard and brittle, up to 1 mm long. Stipe bearing a black cuticle, glabrous, slender, up to 3 cm long and 5 mm in diam.

Hyphal system dimitic, generative hyphae with clamp connections, thin-walled, hyaline; skeleto-binding hyphae thick-walled, with dendritic branching and branches tapering, unchanged in KOH.

Context. — Hyphae strongly interwoven; generative hyphae infrequent in mature fruit bodies, (2–)2.5–4(–4.5) µm in diam (n = 32/1); skeleto-binding hyphae thick-walled to almost solid, dominant, CB+, IKI–, (2.5–)2.7–4(–4.5) µm in diam (n = 60/2). Upper surface cuticle dark brown, (18–)20–30(–35) µm thick (n = 30/1), hyphae in cuticle thick-walled, brown-coloured and arranged into a palisade, CB– or weakly CB+, IKI–, 3–5(–6) µm in diam (n = 30/1).

Stipe. — Hyphal structure similar to those in context; generative hyphae frequently branched, (1.5–)2.1–3(–3.2) µm in diam (n = 30/1); skeletal hyphae thick-walled, CB+, IKI–, 3–4 µm in diam (n = 30/1); binding hyphae (i.e., binding sections of the skeleto-binding hyphae) abundant. Cuticle layer dark brown, (40–)45–70 µm thick (n = 30/1), hyphae in cuticle pale brown, thick-walled, with a wide lumen, CB–, IKI–, 5–6(–7) µm in diam (n = 30/1).

Tubes. — Tramal hyphae moderately gelatinized, interwoven with more or less a vertical orientation; generative hyphae usually present near to hymenium, (2–)2.2–3.2(–3.5) µm in diam (n = 30/1); skeleto-binding hyphae dominant, thick-walled to subsolid, moderately branched, 3–4.5(–5) µm in diam (n = 60/2). Hyphae at dissepiment edges a little swollen. Cystidia absent, cystidioles scanty to frequent, subulate. Basidia clavate, with a basal clamp and four sterigmata, 11–13 × 5–7 µm (n = 30/1). Basidioles slightly smaller, otherwise similar in shape.

Spores. — Basidiospores cylindrical, thin-walled, hyaline, smooth, bearing one guttule, CB–, IKI–, (5.8–)6–7.8(–8.2) × (2.1–)2.3–3.2(–3.5) µm, L = 6.49 µm, W = 2.75 µm, Q = 2.27–2.50 (n = 150/5).

Additional specimens examined. — **China**. Jilin Prov., Antu County, on fallen trunk of gymnosperm, 1993 *Dai 798*; Changbaishan For. Res., on rotten *Abies*, 1993 *Dai 837*, *851* & 1995 *Dai 2152*; on rotten *Pinus*, 1993 *Dai 1081;* Fushong County, on rotten *Abies*, 1993 *Dai 626*. **Finland**. Etelä-Häme, Hollola, on *Salix*, 1981 *Haikonen 1510* (H); Lammi, on *Betula*, 1992 *Dai 134* & *Niemelä* (H); Tampere, 1986 *Salo 118* (H). Perä-Pohjanmaa, Rovaniemi, on *Alnus*, 1970 *Niemelä* (H). **Norway**. Sör-Tröndelag, Bjugn, 1979 *Kytövuori 79038* (H). **Russia**. Khabarovsk Terr., Ultshki Distr., on *Abies*, 1982 *Parmasto* (TAA 125491). Primorye Terr., Kuril Is., on *Picea*, 1960 *Parmasto* (TAA 12914); Ternei Distr., on *Taxus*, 1987 *Parmasto* (TAA 149190). **Sweden**. Ångermanland, Ullångers, 1979 *Kytövuori 79264* (H); Nordingrå, 1979 *Kytövuori 79282* (H).

Identification

A specimen collected from Siberia on *Abies* was once identified as *Polyporus melanopus* by Burt (1931). Pilát (1934) identified one such specimen from Siberia as a new taxon, *Polyporellus varius* f. *melanopodiformis*; later he (Pilát 1937) treated the same specimen as *Polyporellus picipes* (Fr.) P. Karst. f. *melanopodiformis*. Kotlaba and Pouzar (1989) restudied its type and referred it to *Polyporus badius* (Pers.) Schwein. Bondartsev (1953) and Bondartsev and Lyubarsky (1964) reported that *P. badius* f. *melanopodiformis* grows on *Abies* and *Pinus* in the Russian Far East.

I re-examined the type of f. *melanopodiformis*, and studied specimens from NEChina and the Rus-

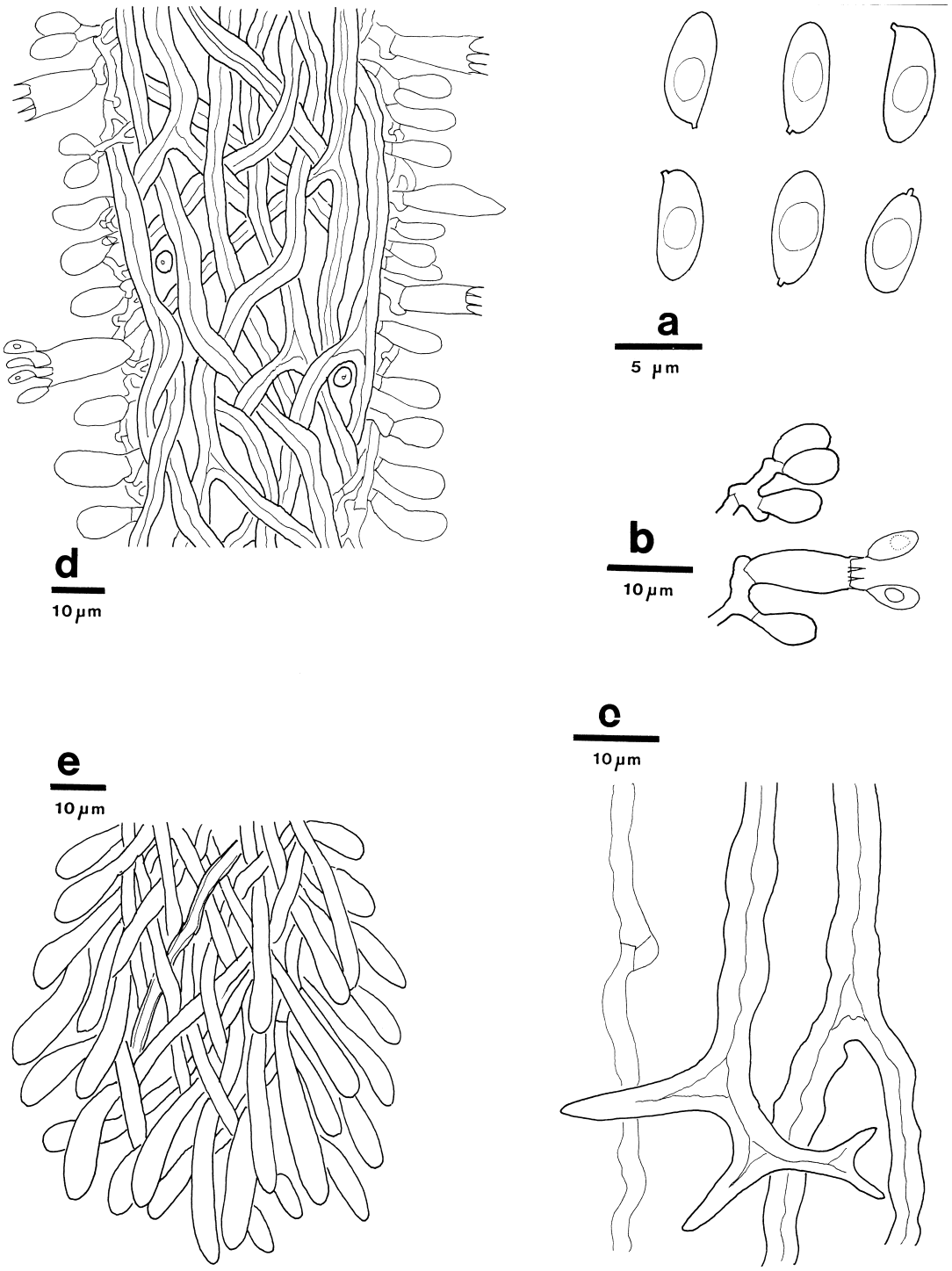

Fig. 3a–e. Anatomical details of *Polyporus tubaeformis* (P. Karst.) Ryvarden & Gilb. (drawn from *Dai 626*). — a: Basidiospores. — b: Basidia and basidioles. — c: Generative hyphae and skeleto-binding hyphae from context. — d: A section through trama. — e: Hyphae at the dissepiment edge.

Fig. 4. *Polyporus tubaeformis* (P. Karst.) Ryvarden & Gilb. Two fresh basidiocarps, specimen *Dai 626*. Photographed *in situ*, ×0.6

sian Far East. All these belong to the same species, and they are identical with the European *Polyporus tubaeformis* (I could not get the specimens identified by Burt and Bondartsev and Lyubarsky, but they evidently also represent this species).

In N Europe *Polyporus tubaeformis* mostly grows on wood of angiosperms, such as *Alnus, Betula, Salix, Corylus, Populus, Sorbus* and *Rubus* etc. (Niemelä & Kotiranta 1991). The collections from Changbai Mts. come from *Abies*, *Pinus* and some unidentified gymnosperms, and three specimens from the Far East of Russia derived from *Abies*, *Picea* and *Taxus*. So *P. tubaeformis* can occur on several genera of gymnosperms which is exceptional in the genus. It seems to be not rare in NE Asia. The material from NE Asia agrees very well with that from N Europe: hyphal structure is identical, pores are similar (6–9 per mm vs. 5–8 per mm in *Dai 134* & *Niemelä*, *Haikonen 207*, *Karsten 1945*, *Kytövuori 79264*, *Niemelä* and *Salo 118*, n = 150/5), and spores are similar (6–7.8 × 2.2–3.2 µm vs. 6.5–8 × 2.6–3.8 µm, L = 7.26 µm, W = 3.02 µm, Q = 2.17–2.60 in *Dai 134* & *Niemelä*, *Karsten 1945*, *Kytövuori 79264* and *Salo 118*, n = 120/4). The type of *P. tubaeformis* has a little larger pores and wider spores (5–7 per mm and 7–8 × 3–4 µm, L = 7.30 µm, W = 3.37 µm, Q = 2.17, n = 30/1), but the difference is not significant.

Polyporus tubaeformis was recently reported from Japan (Nuñez & Ryvarden 1995). In Japan it mostly lives on angiosperms, but one collection was made on *Abies*. Spores in the Japanese material are a little bigger (7–9 × 3–3.5 µm). The mating test revealed that the isolates from Japan and Norway are compatible (Nuñez & Ryvarden 1995). Because *P. tubaeformis* is widely distributed in Honshu of Japan and lately it was found in E China (Hattori & Zang 1995), it is not only boreal but extends also to the temperate zone.

Polyporus tubaeformis, P. melanopus and P. badius compared

Polyporus tubaeformis was long included in *P. badius* or *P. melanopus* (Bondartsev 1953, Domański *et al*. 1967, Jahn 1972–1973; Donk 1974, Ryvarden 1976–1978), until Niemelä and Kotiranta (1991) recognized its diagnostic differences, accepted it as an independent species, and indicated that *P. melanopus* and *P. tubaeformis* have different ecology.

On the basis of the present study, the main differences between *Polyporus melanopus* and *P. tubaeformis* are listed in Table 2.

Polyporus badius is widely distributed in temperate northern hemisphere, and is a common species in the Changbai Mts. area. *Polyporus badius* resembles *P. tubaeformis*, but it has more robust basidiocarps and its generative hyphae are simple-septate. Nevertheless, the simple septa of *P. badius* are usually not easily seen in mature fruit bodies. Another evident difference is found in the hyphae of upper surface: *P. badius* has fairly thick-walled

hyphae which make up a cutis (hyphae are not projecting out of the brown layer), while they are very thick-walled and form a palisade (hyphae penetrate out of dark-brown layer) in *P. tubaeformis*.

Corner (1984) had a much wider species concept in this group, and considered the difference between *Polyporus badius*, *P. blanchettianus* Berk. & Mont., *P. dictyopus* Mont. and *P. melanopus* to be only varietal, regardless of disagreements in pore-size, spore-size, clamps, strongly inflated skeletal cells, and development of the blackening palisade on stem. I can not accept his opinion. *Polyporus dictyopus* and *P. blanchettianus* are tropical species and *P. melanopus* is found only in boreal and temperate zones. *Polyporus badius* differs from *P. melanopus* not only in morphology, but also in ecology and phytogeography (Jahn 1972–1973, Niemelä & Kotiranta 1991).

Affinities to the other taxa in the Melanopus complex

Polyporus varius Fr. is a common species in the Changbai Mts. area and the Russian Far East (Lyubarsky & Vasilyeva 1975). In old specimens its upper surface is sometimes brownish to pale bay, and in that respect it is similar to *P. tubaeformis*. However, it usually has strongly decurrent pores and only the foot of the stipe is black.

Polyporus hemicapnodes Berk. & Broome, a predominantly tropical element, was found in the Russian Far East by Parmasto (1984), and it occurs in N China as well. It has a black stipe and elegantly circular to flabelliform caps, but its upper surface is pale luteous to pale leather-coloured at centre and its pores are strongly decurrent along the stipe. It has subellipsoid spores (7–9 × 3.5–4.5 µm, n = 72/5, specimens listed below), which is a critical character in comparison with *P. tubaeformis*. Nuñez & Ryvarden (1995, 1996) regarded *P. hemicapnodes* to be a synonym of *P. leprieurii* Mont., but gave no details to the decision.

Polyporus admirabilis Peck bears a black stipe and occurs in Changbai Mts., too. Robust basidiocarps, cream-coloured upper surface, larger pores (3–4 per mm) and lacerate to dentate dissepiments make it differ from *P. tubaeformis*. *Polyporus subadmirabilis* Bondartsev was described from the Russian Far East. I could not examine its type. It has a little bigger spores (8–10 × 3.5–5 µm, Bondartsev 1962), but otherwise it is very close to the collection of *P. admirabilis* from Changbai Mts. Nuñez (1994) also pointed out the close relationship of *P. subadmirabilis* and *P. admirabilis*. *Polyporus chozeniae* (Vassilkov) Parmasto was described from Magadan of Russia. It is somehow similar to *P. admirabilis*, but grows on Salicaceae, especially on *Chosenia* (*Salix*); its dissepiments are entire (not lacerate as *P. adimirabilis*), and its spores are bigger (10–12.5×3.7–5 µm, Parmasto

Table 2. A comparison of *Polyporus melanopus* Fr. and *P. tubaeformis* (P. Karst.) Ryvarden & Gilb.

P. melanopus	*P. tubaeformis*
upper surface greyish-brown, cap and stipe more or less shrunken upon drying, context soft corky	upper surface reddish-brown, cap and stipe not constricted upon drying, context hard corky
tramal hyphae loosely interwoven, not gelatinous; generative hyphae frequent, 3-5 µm in diam	tramal hyphae tightly interwoven, gelatinous; generative hyphae infrequent, 2.2–3.2 µm in diam
cystidioles absent	cystidioles usually present
upper surface hyphae fairly thick-walled, making up a cutis	upper surface hyphae definitely thick-walled, forming a palisade
*fruit bodies decaying soon after sporulation	*fruit bodies can be easily found in late summer and autumn

* According to Niemelä and Kotiranta (1991).

1975). Nuñez and Ryvarden (1996) considered *P. chozeniae* as a synonym of *P. varius*. I have studied one specimen of *P. chozeniae* from the Lake Baikal, which has large pores (2–3 per mm). In my opinion it should be regarded as an independent species rather than a variety of *P. varius*.

Polyporus xinjiangensis J. D. Zhao & X.Q. Zhang was reported from NW China (Zhao & Zhang 1981). It is separated from *P. tubaeformis* by its a lateral or eccentric and robust stipe (7–15 mm in diam vs. up to 5 mm in diam in *P. tubaeformis*), and larger pores (3–4 per mm).

In the *Melanopus* group, besides *Polyporus melanopus* and *P. badius*, the following species have a black stipe, and more or less brownish to black upper surface: *P. austroafricanus* Nuñez & Ryvarden, *P. blanchettianus*, *P. diabolicus* Berk., *P. dictyopus*, *P. doidgeae* Wakef., *P. guianensis* Mont., *P. infernalis* Berk., *P. leprieurii*, *P. nigrocristatus* E. Horak & Ryvarden, *P. virgatus* Berk. & M. A. Curtis and *P. xerophyllus* Berk. All the above species are tropical in their distributions, and I have not studied specimens of them. The following discussion is based on literature.

Polyporus austroafricanus was recently described from E Africa (Nuñez & Ryvarden 1994). It differs from *P. tubaeformis* by having larger pores (1–2 per mm), thicker stipe (up to 15 mm in diam), and bigger spores (10–12 × 3–5 µm).

Polyporus blanchettianus, *P. diabolicus*, *P. dictyopus*, *P. doidgeae*, *P. infernalis* and *P. xerophyllus* belong to the *P. dictyopus* group. They have more or less ellipsoid spores and swollen whip-like binding hyphae (Ryvarden & Johansen 1980). On the other hand, spores are distinctly cylindrical, and binding hyphae are not inflated in *P. tubaeformis.* Moreover, *P. blanchettianus* has a lateral stipe, and shorter spores (5–6.2 × 2–2.5 µm, Ryvarden & Johansen 1980). *Polyporus diabolicus* and *P. dictyopus* have lateral stipe, crenate to toothed margin, decurrent pores, and lacerate dissepiments (Cunningham 1965, Ryvarden & Johansen 1980). The mating test study by Nuñez & Ryvarden (1995) proved that *P. dictyopus* is incompatible with *P. tubaeformis*. *Polyporus doidgeae* has larger pores and smaller spores (3–4 per mm, 4–5.5 × 2.5–3.5 µm respectively, Ryvarden & Johansen 1980). *P. infernalis* is very close to *P. xerophyllus*, and Ryvarden (1977) mentioned that the latter is probably a small form of the former. These two species have strongly crenate margin, and lateral, rudimentary stipe. Recently Nuñez and Ryvarden (1996) transfer *Polyporus doidgeae* to *Microporellus* Murrill, and treat *P. blanchettianus*, *P. diabolicus*, *P. infernalis* and *P. xerophyllus* as synonym of *P. dictyopus*.

Polyporus guianensis and *P. leprieurii* are close relatives (Corner 1984, Ryvarden & Johansen 1980, Nuñez and Ryvarden 1996). They are readily separated from *P. tubaeformis* by their subellipsoid spores.

Polyporus nigrocristatus E. Horak & Ryvarden resembles *P. tubaeformis* by its pores and spores (7–8 per mm and 6–7 × 2.5–3 µm respectively, Horak & Ryvarden 1984), but it is characterized by a greyish upper surface bearing black radially arranged crests.

Polyporus virgatus is a pantropical to subtropical species, and its range reaches S China, too. Its spores are much larger (9–12.5 × 4–5 µm, Ryvarden & Johansen 1980) than the spores of other taxa in this complex.

For comparison the following specimens were studied. — *Polyporus admirabilis*. **China**. Jilin Prov., Antu County, 1993 *Dai 1127*. **Norway**. Akershus, Asker, 1993 *Jorgensen* (H). *Polyporus badius*. **China**. Jilin Prov., Antu County, 1993 *Dai 1123*; Changbaishan For. Res., 1993 *Dai 826*; Fushong County, 1993 *Dai 578*. **Finland**. Etelä-Häme, Lammi, 1979 *Niemelä* (H). *Polyporus chozeniae*. **Russia**. Irkutsk Reg., Baikal, 1989 *Zene* (H). *Polyporus hemicapnodes*. **China** (**first record**)**.** Beijing, Baihuashan, 1993 *Dai 1827 & 1849a.* Jilin Prov., Antu County, 1993 *Dai 823*. Huinan County, 1993 *Dai 422, 458, 1597 & 1599*. **Russia.** Primorye Terr., Chuguevka, 1981 *Parmasto 103725* (TAA); Ussuriysk, 1979 *Parmasto 97910* (TAA). *Polyporus melanopus*. **Finland**. Uusimaa, Helsinki, 1984 *Niemelä 2953* (H); Kirkkonummi, 1979 *Kytövuori 79704* (H). Varsinais-Suomi, Parainen, 1988 *Kytövuori 881676* (H). **Norway**. Nordland, Hattfjelldal, 1985 *Kytövuori 85778* (H). Oppland, Dovre, 1979 *Kytövuori 10361* (H). **Sweden**. Dalarna, Rättvik, 1979 *Kytövuori 79573* (H); Närke, 1990 *Kytövuori 901355* (H). *Polyporus varius*. **China.** Beijing, Baihuashan, 1993 *Dai 1844*. Jilin Prov., Huadian county, 1993 *Dai 416 & 1742*. **Finland.** Uusimaa, Mäntsälä, 1987 *Kotiranta 6510* & *Niemelä* (H); Tuusula, 1990 *Saarenoksa 14990* (H).

Acknowledgements. I am indebted to my supervisor Prof. Tuomo Niemelä (Helsinki) for his guidance and support, and for a critical revision of the manuscript. Special thanks are due to Prof. Erast Parmasto (TAA, Estonia) and Dr. Zdeněk Pouzar (PRM, the Czech Republic) for loans of specimens, and to the Systematic Mycology & Lichenology Laboratory (Beijing, China) for arranging specimens in HMAS for me to study. The study was financed by the Academy of Finland (Project No. 2435, 1995–1996).

REFERENCES

Bondartsev, A. 1953: Polyporaceae of the European part of the URSS and of the Caucasus. — Akad. Nauk SSSR, Leningrad. 1106 pp. (Translated from Russian, Israel Program for Scientific Translation, Jerusalem, 1971. 896 pp.).

Bondartsev, A. 1962: Polypori novi ex oriente extremo. — Bot. Mater. Otd. Spor. Rast. 15: 103–111.

Bondartsev, A. & Lyubarsky, L. 1964: Polyporaceae rarae et pro parte asiatica URSS ignotae. — Novosti Sist. Nizsh. Rast. 1: 175–186.

Brummitt, P. K. & Powell, C. E. 1992: Authors of plant names. — Royal Bot. Gardens, Kew. 732 pp.

Burt, E. A. 1931: Hymenomycetous fungi of Siberia and Eastern Asia – mostly of wood-destroying species. — Ann. Missouri Bot. Gard. 18: 469–487.

Corner, E. J. H. 1984: Ad polyporaceas 2 & 3. Polyporus, Mycobonia, and Echinochaete. — Beih. Nova Hedwigia 78: 1–222.

Cunningham, G. H. 1965: Polyporaceae of New Zealand. — New Zealand Dept. Sci. Industr. Res. Bull. 164: 1–304.

Domański, S., Orłoł, H. & Skirgiełło, A. 1967: Basidiomycetes: Aphyllophorales: Polyporaceae pileatae, Mucronoporaceae pileatae, Ganodermataceae, Bondarzewiaceae, Boletopsidaceae, Fistulinaceae. Flora Polska (Grzyby) 3. — Foreign Sci. Publ. Dept., Warsaw. 398 pp., 29 plates.

Donk, M. A. 1974: Checklist of European polypores. — Verhand. Kon. Nederl. Akad. Wetensch. Naturk., Ser. 2, 62: 1–469.

Hattori, T. & Zang, M. 1995: List of polypores collected in East China. — Bull. Natn. Sci. Mus., Tokyo, Ser. B, 21: 95–105.

Horak, E. & Ryvarden, L. 1984: Polyporus nigrocristatus sp. n., a new polypore from New Zealand. — Sydowia 37: 47–49.

Jahn, H. 1972–1973: Polyporus melanopus und P. badius (picipes) – ein Vergleich. — Westfälische Pilzbr. 9: 50–60.

Kotlaba, F. & Pouzar, Z. 1990: Type studies of polypores described by A. Pilát 3. — Česká Mykol. 44: 228–237.

Kreisel, H. 1963: Über Polyporus brumalis und verwandte Arten. — Feddes Repert. 68: 128–138.

Lyubarsky, L. V. & Vasilyeva, L. N. 1975: Derevorazrushayushchie griby Dal´nego Vostoka. — Nauka, Novosibirsk. 163 pp., 53 plates. (In Russian.).

Niemelä, T. & Kotiranta, H. 1991: Polypore survey of Finland 5. The genus Polyporus. — Karstenia 31: 55–68.

Nuñez, M. 1994: Polyporus admirabilis (Polyporaceae), new to Europe. — Karstenia 34: 1–3.

Nuñez, M. & Ryvarden, L. 1994: Polyporus austroafricanus sp. nov. — Sydowia 46: 63–65.

Nuñez, M. & Ryvarden, L. 1995: Polypores new to Japan 1. Species of Polyporus, with a note on P. hartmanni. — Mycoscience 36: 61–65

Nuñez, M. & Ryvarden, L. 1996: Polyporus (Basidiomycotina) and related genera. — Synopsis Fungogrum 10: 1–85.

Parmasto, E. 1975: On Polyporus chozeniae (Vassilkov) Parmasto comb. nov. and related species. — Folia Crypt. Estonica 5: 33–40.

Parmasto, E. 1984: Species variability in the Polyporus varius group. — Eesti NSV Teaduste Akad. Toim. Biol. 33: 57–61.

Parmasto, E. & Parmasto, I. 1978: Izmenchivostb razmerov spor u Polyporus rhizophilus Pat. — In: Mater. VI Konfer. Spor. Rast. Srednei Azii i Kazakhstana: 219–220. Akad. Nauk Tadzhik. SSR, Dushanbe. (In Russian.).

Pilát, A. 1934 (1933): Additamenta ad floram Sibriae Asiaeque orientalis mycologicam. — Bull. Soc. Mycol. France 49: 256–339.

Pilát, A. 1937 (1936): Monographie der europäischen Polyporaceen. — Beih. Bot. Centralblatt 56 (B): 1–82.

Pilát, A. 1940: Basidiomycetes chinenses. — Ann. Mycol. 38: 61–82.

Ryvarden, L. 1977: Type studies in the Polyporaceae 10. Species described by J. M. Berkeley, either alone or with other authors, from 1844 to 1855. — Norwegian J. Bot. 24: 213–230.

Ryvarden, L. 1976–1978: Polyporaceae of North Europe 1–2. Fungiflora, Oslo. 507 pp.

Ryvarden, L. & Gilbertson, R.L. 1994: European polypores 2. Meripilus – Tyromyces. — Synopsis Fungorum 6: 389–743.

Ryvarden, L. & Johansen, I. 1980: A preliminary polypore flora of East Africa. — Fungiflora, Oslo. 636 pp.

Zhao, J. D. & Zhang, X. Q. 1981: On the genus Polyporus of China and its taxonomic position (In Chinese.). — Acta Microbiol. Sinica 21: 428–437.

Zhao, J. D. & Zhang, X. Q. 1992: The polypores of China. — Bibl. Mycol. 145: 1–524.