

Polypores new to Japan 1. Species of *Polyporus*, with a note on *P. hartmanni*

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Polyporus admirabilis, *P. dictyopus*, *P. guianensis*, *P. pseudobetulinus*, *P. tubaeformis* and *P. udus* are reported for Japan for the first time. *Polyporus tubaeformis* had been confused with *P. melanopus*, but the Japanese collections were conspecific with Norwegian isolates of *P. tubaeformis*. A key to all *Polyporus* species in Japan is provided. *Polyporus hartmanni* is reported for the first time outside the Australian continent. As the species has a bipolar heterothallism and produces brown rot, its taxonomic relationship with *Polyporus* s. str. is discussed.

Key Words—Japan; mating tests; *Polyporus*.

Introduction

Japan has a long tradition in the study of polypores (Yasuda, 1917; Imazeki, 1943; Imazeki et al., 1988). Although the first descriptions of Japanese polypores come from the last century (Fries, 1838; Berkeley and Curtis, 1860), new species, combinations and records appear regularly in recent literature (Abe and Kobayashi, 1989; Hattori and Ryvarden, 1993a, b, 1994).

Eleven species of the cosmopolitan genus *Polyporus* Fr. have been cited before for Japan (Kobayashi and Doi, 1970; Ito, 1955; Hongo, 1994). The genus includes some 30 species all with stipitate to substipitate basidiocarps, a dimittic hyphal system with skeleto-binding hyphae, cylindrical, smooth spores, and producing white rot (Nunez and Ryvarden, in prep.). Species new to Japan are reported in the following, besides *Polyporus hartmanni* Cke., previously known only from the Australian continent.

Materials and Methods

The new records for Japan are based on specimens from TFM (*P. admirabilis* Pk., *P. dictyopus* Mont., *P. hartmanni* Cke., *P. pseudobetulinus* (Murashk.) Thorn, Kot. & Niem.), collecting trips to Japan by L. R. (*P. guianensis* Mont., *P. tubaeformis* (Karst.) Ryv. & Gilbn.), and one collection received recently at the Forestry and Forest Products Research Institute (*P. udus* Jungh.). All collections examined are listed under the species descriptions.

Basidiocarps were torn apart under a WILD M3B binocular microscope using a needle and a razor blade. Both basidiocarps and cultures were mounted in 5%

potassium hydroxide (KOH) or Melzer's reagent and observed at 400× and 1000× magnifications with a Nikon microscope provided with phase contrast. Measurements were made in 5% KOH. Macro-, microanatomical and cultural terms are those in Snell and Dick (1971). Skeleto-binding cells are as described by Corner (1981), but they are called skeleto-binding hyphae in the present work. Codes used for cultural characters are taken from Stalpers (1978). Herbaria abbreviations are taken from Holmgren et al. (1990).

Mating tests in *Polyporus tubaeformis* To obtain monosporic isolates, fresh specimens were placed on plastic slides, covered with a humid cloth and left overnight to sporulate. Twelve hours later the plastic slide was recovered and wrapped in paper for further plating. A suspension of basidiospores in 10 ml of distilled water was poured into a 9-cm Petri dish with water agar and incubated at 24°C until they germinated. Germinating basidiospores were picked up with a sterile needle under a binocular microscope (40× magnification) and transferred to 2% malt extract agar (MEA). Table 1 shows the monosporic isolates used in this work. Further cultural work was performed in Petri dishes with 2% MEA at room temperature (18–20°C).

Monosporic isolates (5 mm³ of agar block) were paired by placing them 3–4 cm apart in a Petri dish. Two weeks after the contact between monosporic mycelia had been established, pairings were assessed for the presence of clamps as a sign of successful mating (Vandendries, 1936). Two pieces of secondary mycelium from the interface zone of each positive pairing were subcultured to confirm the constancy of clamps and reveal possible mating irregularities (Ainsworth et al., 1992). Monosporic subcultures of each isolate were kept as unmated controls.

Table 1. Monosporic isolates of *P. tubaeformis* from Norway and Japan used for mating tests. The herbarium number is specified first. In parenthesis, number of isolates obtained from each specimen.

ISOLATE	LOCALITY
MN 84 (5)	Hedmark, Norway
MN 86 (3)	Oslo, Norway
LR 30173 (5)	Tadami, Japan
LR 30214 (6)	Tadami, Japan

Descriptions

Polyporus admirabilis Pk., Bull. Torrey Bot. Club **26**: 69. 1899.

Basidiocarps annual, laterally stipitate or substipitate, solitary or imbricate. Single pilei infundibuliform to dimidiate, 6–43 cm wide, up to 4.5 cm thick, upper surface white when fresh, ochraceous in different tones when dry and old, glabrous and pelliculose, smooth to radially striate, sometimes mottled with dark spots. Pore surface white, drying ochraceous, tubes brittle when dry. Pores angular, 4–5 per mm, enlarging at maturity, decurrent on the stipe. Context white to cream, firm, up to 4 cm thick. Stipe up to 8 cm long and 3.5 cm thick, usually poorly developed, concolorous with the pileus and darkening to black at the base, glabrous to finely tomentose. **Hyphal system** dimitic. Generative hyphae clamped, 2.5–4 μm wide, forming a cutis on the stipe and pilear surfaces. Gloeopleurous hyphae present in the context of young specimens. Skeleto-binding hyphae hyaline, solid, 3–7(10) μm in diameter. **Basidia** clavate, 4-sterigmate, 22–35 \times 5–8 μm . **Basidiospores** cylindrical, (6.5–)7–9 \times 2.5–3.5 μm .

Cultural characters: Burdsall and Lombard, 1989 (as *P. loweii*).

Substrata: On dead hardwood: *Acer*, *Betula*, *Carya*, *Fraxinus*, *Juglans*, *Malus*, *Pyrus*, *Quercus*, and *Salix*.

Distribution: North America, Europe, Japan.

Remarks: The species is recognized by its large and thick, creamish, laterally stipitate basidiocarps and medium-sized spores (6.5–9 \times 2.5–3.5 μm). Large specimens of *P. varius* Fr. can be separated by their larger spore size (8.5–12 \times 2.5–4 μm). *Piptoporus quercinus* (Fr.) Pilat, growing on living *Quercus*, could be mistaken macroscopically for *P. admirabilis*. However, the former species is trimitic (Ryvardeen, 1978) and causes a brown rot. Specimens examined: JAPAN: Kanagawa prefecture, R. Imazeki, July 1987 (TFM14764). USA: Maine, C. A. Burt, on *Malus*, Aug. 1898 (lectotype, NYS); Arizona, AZ010680, Martin, on *Quercus hypoleucoides*, Aug. 1971 (holotype of *P. coronadensis*, ARIZ=*P. admirabilis*).

Polyporus dictyopus Mont., Ann. Sci. Nat. Ser. II **3**: 349. 1835.

Basidiocarps annual to biannual, laterally to centrally stipitate. Pileus circular to flabelliform, up to 12 cm in di-

ameter and 5 mm thick, upper surface white when young, darkening to purplish black, finely tomentose to glabrous, finely radially striate. Pore surface ochraceous to dark amber, pores round to angular, 5–8 per mm, slightly decurrent but sharply limited towards the stipe. Context straw-coloured, dense, up to 5 cm thick. Stipe up to 4 cm long and 1 cm thick, dark brown and velutinate when young, developing a black cuticle, glabrous when old. **Hyphal system** dimitic. Generative hyphae clamped, 2–6 μm wide, brown, forming a palisade in the stipe surface and a cutis in the pilear surfaces. Skeleto-binding hyphae yellowish to dark brown, solid and tortuous, up to 10 μm wide in the context. **Basidia** clavate, 4-sterigmate, 18–26 \times 5.4–8 μm . **Basidiospores** elliptical, (5–)6–8.5(–9) \times 2.5–4 μm . **Cultural characters:** Wright and Deschamps, 1972.

Substrata: On dead hardwood.

Distribution: Pantropical. In Japan known from Iriomote and Ishigaki islands in Okinawa prefecture.

Remarks: The species is similar to *P. tubaeformis* from temperate areas. However, mating tests revealed incompatibility between the temperate and the tropical taxa (Nunez, 1993).

Specimens examined: JAPAN: Okinawa prefecture, Iriomote Island, June 1994, Shiira river, T. Hattori (TFM16934), MN369, MN407, MN412 (O); Urauchi river, T. Hattori (TFM16920). Ishigaki island, Sept. 1993, Banna forest, T. Hattori (TFM16309, TFM16316); Omoto forest, T. Hattori (TFM16288).

Polyporus guianensis Mont., Ann. Sci. Nat. Bot. Ser. 2 **13**: 201. 1840.

Basidiocarps annual, centrally to laterally stipitate. Pileus flabelliform, spatulate or infundibuliform, up to 5 cm wide and 2 mm thick, tan to beige, glabrous to finely radially striate. Pore surface tan to greyish brown, pores angular, often radially elongate, 1–2 per mm, slightly decurrent on the stipe. Context cork-coloured, coriaceous, up to 1 mm thick. Stipe up to 5 mm thick, smooth to slightly wrinkled, covered with a black cuticle. **Hyphal system** dimitic. Generative hyphae clamped, up to 3.5 μm wide, forming a palisade on the stipe surface and a cutis on the pilear surfaces. Skeleto-binding hyphae yellowish to dark brown, solid and tortuous, up to 5 μm wide. **Basidia** clavate, 4-sterigmate, 21–27 \times 8–10 μm . **Basidiospores** cylindrical, (7–)8–12 \times 2.5–4 μm .

Cultural characters: Stalpers's codes 1, 9, 13, 25, 29, (30), 36, 37, 45, 47, 53, 63, 67, 89, 94, 95, 99. From MN60, O.

Substrata: On dead hardwood.

Distribution: Tropical and sub-tropical Asia and South America. The Japanese collection was made in a warm-temperate area.

Remarks: *Polyporus lepriurii* Mont. (= *P. hemicapnodes* Berk. & Br.) is closely related to the species described here, but, the pores of *P. lepriurii* are smaller (3 or more per mm). Compatibility tests between both species are desirable.

Specimens examined: JAPAN: Chiba prefecture,

LR20886 (O). FRENCH GUIANA: Leprieur (lectotype, K).

Polyporus hartmanni Cke., Grevillea 12: 14. 1883.

Basidiocarps annual, centrally to eccentrically stipitate developing from a pseudosclerotium, sometimes trichetous developing from wood. Pileus circular to reniform, convex, 5–15 cm in diameter, up to 1.5 cm thick, upper surface reddish brown with orange periphery, finely velutinate to squamulose, concentrically areolated when old. Pore surface white, orange-brown when old, pores angular, brittle, 3 to 6 per mm. Context white to cream, up to 1.5 cm thick, corky, with resinous zones. Stipe up to 4 cm long and 2 cm thick, single to bifurcate, orange to brick colour, even or finely velutinate, with a cortex. **Hyphal system** dimitic. Generative hyphae clamped, 3–4 μm wide, inflated in the context, filled with brown contents on the pilear surface forming a palisade. Skeletal hyphae straight to sparsely branched, solid, up to 10 μm wide, only present in the context. **Basidia** clavate, 4-sterigmate, 16–20 \times 4–5 μm . **Basidiospores** narrowly cylindrical to fusiform, (6.5–)7–9 \times 2.5–3.5 μm .

Cultural characters: Stalper's codes 2, 6, 7, 12, 21, 32, 36, 39, 44, 45, 46, 48, (52), 53, 79, (84), 89, 93. From TFM17388.

Substrata: Either growing from a pseudosclerotium on the ground at the base of tree trunks, or on wood.

Distribution: Australia, Tasmania, Japan.

Remarks: *Polyporus hartmanni* should be excluded from *Polyporus* s. str. because it has a bipolar heterothallism (Table 2) and causes a brown-rot. This species is recognized by its orange tints in the pileus and stipe. The pseudosclerotium is conspicuous in species growing on the ground. *Polyporus mylittae* Cke. & Masee, a similar species from Australia developing from a sclerotium (Cunningham, 1965), lacks skeleto-binding hyphae, and also produces brown-rot (J. Simpson, pers. comm.). Both species should be put close taxonomically, perhaps under the Australian sclerotium-forming genus *Laccocephalum* MacAlp. & Teppe, if the type species, *L. basilapiloides*, proves to produce brown rot. If no taxonomic value is given to the presence of sclerotium and a stipe, the species is close to *Piptoporus quercinus*, a species always growing on wood and where sclerotia have never been

reported (Ryvarden, 1978).

Specimens examined: JAPAN: Miyagi prefecture. 21 Aug. 1931. Under *Abies firma*, R. Imazeki; Hiroshima prefecture, Yoshiwa, Saeki, T. Yamamoto, 10 July 1994 (TFM17385); Ibaraki prefecture, Ogawa, M. Nunez, 11 Aug. 1994 (TFM17388). AUSTRALIA: Queensland, Toivooma (lectotype, K); New South Wales, A. E. Wood, R. E. Simpson (O).

Polyporus pseudobetulinus (Murashk. ex Pilát) Thorn, Kotiranta & Niemelä., Mycologia 82: 583. 1990. = *Ungulina pseudobetulina* Murashk. ex Pilát, Bull. Soc. Myc. Fr. 48: 23. 1932.

Basidiocarps annual, attached to the substrate by a narrow base. Pileus first unguulate, then convex, dimidiate, solitary or imbricate in pairs, 6–18(24) cm broad and up to 4.5 cm thick, with an involved margin. Upper surface yellowish white to greyish orange, with a thin, peelable cuticle and fine brownish to greyish orange fibrils, becoming areolate. Pore surface whitish to yellowish orange, pores round, 1–3 per mm. Context white to cream, up to 3 cm thick, fleshy, drying tough and corky. **Hyphal system** dimitic. Generative hyphae simple-septate, 2.5–6 μm wide, embedded in an amorphous matrix on the pilear surface. Skeleto-binding hyphae up to 13 μm wide, many unbranched vegetative hyphae in the upper context. **Basidia** clavate, 4-sterigmate, 18.5–40.5 \times 5–7 μm . **Basidiospores** cylindrical to slightly fusiform, (6.5–)7.2–10 \times 2.5–3.4 μm .

Cultural characters: Thorn et al., 1990.

Substrate: On standing trunks of dead *Populus* spp., usually high above the ground. Growing on *Salix* in Japan.

Distribution: From continental areas in Canada, Finland, Russia, Japan (Hokkaido).

Remarks: The most similar species is *P. gyanus* Lev., a smaller species with radially fibrous pileus from temperate areas in the Southern Hemisphere (Wright and Deschamps, 1972). The presence of many unbranched vegetative hyphae in the context and the lack of clamps make *P. pseudobetulinus* a deviating species in *Polyporus*.

Specimens examined: JAPAN: Hokkaido, A. Horoya 1991 (O); Sounkyo, Kamikawa, S. Satoh, on *Salix*, 28

Table 2. Results of polarity tests performed with monospore isolates of *P. hartmanni* (TFM17388). Numbers of monospore isolates are indicated after the TFM number. A + sign indicates formation of secondary mycelium, and therefore compatibility. A – sign means incompatibility and no formation of secondary mycelium.

	17388.2	17388.3	17388.4	17388.5	17388.6	17388.7	17388.8
17388.1	–	–	–	–	–	–	–
17388.2		–	–	–	+	–	–
17388.3			–	–	+	–	–
17388.4				–	–	–	–
17388.5					–	–	–
17388.6						+	–
17388.7							–

Aug. 1993 (TFM16868). CANADA: Ontario, R. G. Thorn 880607/01 (aut. mat., O).

Polyporus tubaeformis (Karst.) Ryv. & Gilbn., European Polypores vol. 2: 578. 1994. = *Polyporellus varius* ssp. *tubaeformis* Karst., Soc. Flora Fauna Fenn. Medd. 9: 69. 1882.

Basidiocarps annual, solitary, centrally to laterally stipitate. Pileus circular, flat to infundibuliform, up to 6 cm in diameter and 5 mm thick, upper surface first light brown, then chestnut brown to bay, smooth to radially striate, finely velutinate to glabrous when old, very hard when dry. Pore surface cream colour to ochraceous, pores circular to angular, 5–7 per mm, tubes cartilaginous, frequently with an orange tint when dry. Context white, dense, up to 5 mm thick. Stipe slender, up to 6 cm long and 5 mm thick, usually wrinkled, with a black cuticle initially covered by a fine, brown tomentum. **Hyphal system** dimitic. Generative hyphae clamped, 3–5 μm wide, dark brown, forming a palisade on the stipe and pilear surfaces. Skeleto-binding hyphae mostly solid, yellowish to dark brown, up to 6 μm wide. **Basidia** clavate, 4-sterigmate, 14–20 \times 6–8 μm . **Basidiospores** cylindrical, 7–9 \times 3–3.5 μm .

Cultural characters: Stalper's codes 1, 3, 6, 13, 14, 22, 25, (28), 30, 31, 37, 39, 44, 47, 52, 53, 63, 67, 84, 94, 95, 97, 100. From MN86, O.

Substrata: On dead hardwood branches, rarely on conifers (one collection from Japan was made on *Abies* (TFM16904)).

Distribution: Temperate zones in the Northern Hemisphere.

Remarks: The Japanese collections of *P. tubaeformis* were filed in TFM herbarium as either *P. varius* or *P. picipes*. The first species has a cream to light brown pileus, and a black cuticle up to only the basal half of the stipe. *Polyporus picipes* Fr. is a nomen dubium (Nunez and Ryvarden, in prep.). *Polyporus tubaeformis* has mainly been confused in Japan with *P. badius* (Pers.) Fr. (Hattori, pers. comm.), a species devoid of clamps. *Polyporus melanopus* has thicker basidiocarps and larger pores (3–4 per mm) than the species studied here. Young specimens are usually devoid of a stipe cuticle. We have not yet seen specimens of *P. melanopus* from Japan. The mating tests between Norwegian and Japanese isolates were all positive.

Specimens examined: JAPAN: Chiba prefecture, Imba, Sakae, Fudoki-no-oka, Y. Abe, July 1991 (TFM, not numbered); Fukushima prefecture, LR30166, LR30173, LR30214, LR30231, 1991 (O); Ibaraki prefecture, T. Hattori, TFM15747; Nagano prefecture, T. Hattori, Aug. 1991, TFM16165, TFM16226, TFM16233, T. Hattori, Aug. 1993 (TFM16904); Niigata prefecture, LR30173, LR30214 (O); Yamanashi prefecture, Mt. Fuji, Y. Abe, Sept. 1982 (TFM, not numbered). FINLAND: Mustiala, P. Karsten, Aug. 1880, lectotype (H). NORWAY: Akerhus, I. Johansen 891/74, LR24043, MN84; Hedmark, LR22976, MN85; Oslo, LR12260, MN86 (O).

Polyporus udus Jungh., Tidschr. v. Nat. Gesch. Phys. 7: 289. 1840.

Basidiocarps annual, laterally to centrally stipitate. Pileus conchate to fan-shaped, flat to strongly infundibuliform, up to 10 cm in diameter and 1 cm thick, pilear surface greyish brown, often with pinkish tints when fresh, smooth or with adpressed squamules, glabrous and covered by a wrinkled, papery cuticle when dry. Pore surface white to ochraceous, pores irregular to angular, 1–2(–3) per mm, easily crushed. Context white to pale ochraceous, distinctly paler than the pore layer, brittle when dry, up to 1 cm thick. Stipe up to 6 cm long and 1.5 cm thick, light brown, glabrous or with tufts of brown hairs, often with a shallow pattern of decurrent pores at its top. **Hyphal system** dimitic, generative hyphae clamped, up to 10 μm wide, forming a cutis on the stipe and pilear surfaces. Skeleto-binding hyphae hyaline to yellowish, up to 10 μm wide, almost absent in the trama. **Basidia** clavate, 4-sterigmate, 35–38 \times 8–10 μm . **Basidiospores** cylindrical to broadly ellipsoid, 10–15 \times 4–6 μm .

Cultural characters: Stalper's codes 1, 3, 8, 12, 14, 19, 25, 28, 29, 30, (34), 38, 39, 44, 46, (47), 53, 63, 65, 67, (80), 84, 89. From TFM17202.

Substrata: On dead hardwood.

Distribution: This is the first record of *P. udus* outside tropical areas. Although Kyushu island is considered to belong to the warm-temperate area, its flora has similarities with tropical regions (Ohwi, 1965). Aoshima and Ogimi (1974) have reported other tropical and subtropical polypores in this island that are not found further north in Japan.

Specimens examined: JAPAN: Kyushu, Oita prefecture, Mie-cho, Ohno-gun, T. Suda, on *Ulmus parvifolia*, 16 Sept. 1993 (TFM17202). INDONESIA: Java, L910.270.899 (lectotype, L).

Key to the *Polyporus* species in Japan

1. Basidiocarps composed of more than 20 connate, centrally stipitate pilei, arising from a sclerotium *P. umbellatus*
1. Basidiocarps solitary, or with up to 5 connate pilei 2.
2. Basidiocarps spatulate, attached to the substrate by a narrow basis. Pilei convex to flat, thicker than 8 mm 3.
2. Basidiocarps centrally stipitate. If spatulate, pilei thinner than 8 mm 4.
3. Basidiocarps brownish, becoming areolate. Hyphae with simple-septa *P. pseudobetulinus*
3. Basidiocarps white to ochraceous-buff, glabrous. Hyphae clamped *P. admirabilis*
4. Basidiocarps spatulate, without a cuticle on the stipe, pileus thinner than 8 mm 5.
4. Basidiocarps centrally stipitate, with a cuticle on the stipe or thicker than 8 mm if spatulate 7.
5. Pileus brown when fresh, radially striate and with squamules at the base. More than 3 pores per mm *P. grammacephalus*
5. Pileus white when fresh. Less than 1 pore per mm 6.

6. Temperate species. Pileus with flat squamules
.....*P. alveolaris*
6. Tropical to subtropical species. Pileus without squamules*P. tenuiculus*
7. Basidiocarps leathery, with a black cuticle at least on the stipe basis, spores shorter than 9 μm 8.
7. Basidiocarps without a black cuticle on the stipe, or with spores longer than 10 μm 14.
8. Pileus cream to leather colour 9.
8. Pileus dark brown to purple 12.
9. Tropical to subtropical species. Cuticle covering the whole length of the stipe 10.
9. Temperate species. Cuticle covering only part of the stipe 11.
10. One to 2 pores per mm*P. guianensis*
10. More than 3 pores per mm*P. leprieurii*
11. Two to 3 pores per mm. Cuticle only at the very basis of the stipe*P. mikawai*
11. More than 5 pores per mm. Cuticle up to the lower half of the stipe*P. varius*
12. Tropical to subtropical species. Pileus mostly flat*P. dictyopus*
12. Temperate species. Pileus mostly infundibuliform 13.
13. Hyphae with simple septa*P. badius*
13. Hyphae with clamps*P. tubaeformis*
14. Leathery species. Spores shorter than 10 μm 15.
14. Fleshy species. Spores longer than 10 μm 16.
15. Pores 1 per mm or larger, always radially elongated. Spores longer than 7 μm *P. arcularius*
15. Pores usually randomly arranged, and more than 2 per mm. Spores up to 7 μm long*P. brumalis*
16. Pileus with squamules 17.
16. Pileus glabrous, with a papery cuticle*P. udus*
17. Pilear squamules as raised tufts of hyphae embedded in an amorphous matter. Hyphae forming a cutis in the stipe cuticle*P. tuberaster*
17. Pilear squamules adpressed, not embedded in an amorphous matter. Hyphae forming a palisade in the stipe cuticle*P. squamosus*

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