Bambusicolous polypores collected in Central Thailand

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Choeyklin, R., Hattori, T., Jaritkhuan, S. and Jones, E.B.G. (2009). Bambusicolous polypores collected in Central Thailand. Fungal Diversity 36: 121-128.

The following seven polypores were recorded on bamboo culms in Central Thailand: *Flavodon flavus*, *Grammothele fuligo*, *Irpex lacteus*, *Perenniporia bambusicola* sp. nov., *Piptoporus roseovinaceus* sp. nov., *Rigidoporus* cf. *lineatus*, and *Serpula similis*. *Perenniporia bambusicola* is characterized by orange pores turning dark violet to black in KOH, orange mycelial strands and sheet and oblong, apically truncate basidiospores. A key to the world species of *Perenniporia* with resupinate basidiocarps and bright colored pore surface is provided. *Piptoporus roseovinaceus* is compared to *P. soloniensis*, but its hyphal system is monomitic in the trama while the latter has dimitic tubes.

Key words: Bambusoideae, basidiomycetes, host specificity, *Polyporaceae*, wood-inhabiting fungi

Article Information
Received 15 April 2008
Accepted 23 December 2008
Published online 31 May 2009
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Introduction

Bamboos are widely distributed in Thailand in several forest types, especially mixed deciduous forest and as understory shrubs and in bamboo forests. Eighty two species of bamboo belonging to 15 genera are documented in Thailand with *Dendrocalamus brandisii*, *Dendrocalamus* sp., *Bambusa blumeana*, *Thyrsostachys oliveri*, and *Cephalostachyum pergracile* being the most common species (Rungnapha *et al*., 2001). Hyde *et al*. (2002) based on literature search and scanning the "Index of Fungi" (http://nt.ars-grin.gov.fungaldatabase) listed more than 1,100 species reported on bamboo worldwide including 630 ascomycetes, 150 basidiomycetes and 330 anamorphic fungi. Many basidiomycetes were rusts of the genera *Puccinia*, *Stereostratum* and *Uredo* causing spots on leaves.

Boidin *et al*. (1986) and Sotome *et al*., (2007) have reported polypores on bamboo, while Coelho *et al*. (2006) list 56 worldwide. Only limited information is available on Thai polypores (e.g. Rungjindamai *et al*., 2008), while in this study 124 basidiomycete collections were made on bamboo.

The purpose of this study is to describe two new polypore species collected on bamboo, in the genera *Perenniporia* and *Piptoporus* and to present a key to *Perenniporia* species with resupinate basidiocarps with a yellow to orange pore surface.

Materials and methods

Intensive collections of polypores and other basidiomycetes on bamboo culms were made mainly in Central Thailand. Main

collecting sites were as follows: Prachin Buri Prov.: The Bamboo Park; Wang Bon. Nakhon Ratchasima Prov.: Khao Yai National Park. Nan Prov.: Phu Fa Phattana Centre (Huai Pha Phueng); Huai Pla Pung. Nakhon Si Thammarat Prov.: Khao Luang National Park.

Macroscopic characters were described based on fresh and dried specimens. Microscopic characters were made from dried specimens, examining free-hand cut sections mounted in Melzer's reagent or in 5% (w/v) KOH solution after staining in 1% (w/v) phloxine solution. A non-amyloid and non-dextrinoid reaction was described as IKI-. Basidiospores were measured mounted in Melzer's reagent. The following abbreviations are used in the text: L, mean spore length; W, mean spore width (side view); r, the ratio of length/width of a basidiospore; R, mean of r. The term (n = x/y) means x measurements of basidiospores from y specimens. In presenting the spore size, 5% of the measurements at each end are given in parentheses (Dai and Niemelä 1997). Examined specimens were deposited in BBH or TFM.

Taxonomy

Flavodon flavus (Klotzsch) Ryvarden, Norw. J. Bot. 20: 3 (1973).

Specimens examined: THAILAND, Prachin Buri Prov., The Bamboo Park, 27 September 2005, coll. R. Choeyklin (BBH 19092); the same place, 20 September 2006, coll. R. Choeyklin (BBH 19090); the same place, 6 December 2006, coll. R. Choeyklin (BBH 19091; 19283).

Remarks: This is a common species in SE Asia, frequently found on hardwood trees, but also occasionally reported on bamboo in Papua New Guinea (Quanten, 1997). For a detailed description, see Ryvarden and Johansen (1980).

Grammothele fuligo (Berk. & Broome) Ryvarden, Trans. Br. Mycol. Soc. 73: 15 (1979).

Specimens examined: THAILAND, Prachin Buri Prov., The Bamboo Park, 6 December 2006, coll. R. Choeyklin (BBH 19763).

Remarks: This species is restricted to monocotyledons (Ryarden and Johansen, 1980), and has been recorded on bamboo in India (Virdi, 1990) and Costa Rica (Carranza-Morse, 1991). For a detailed description, see Ryvarden and Johansen (1980).

Irpex lacteus (Fr.) Fr., Elench. Fung. 1: 142 (1828).

Specimens examined: THAILAND, Prachin Buri Prov. Wang Bon, June 2006, coll. R. Choeyklin (BBH 19101).

Remarks: This species occurs most frequently on hardwood trees (Gilbertson and Ryvarden, 1986), but has also been recorded on bamboo by Coelho *et al*. (2006). For a detailed description, see Gilbertson and Ryvarden (1986).

Perenniporia bambusicola Choeyklin, T. Hatt. & E.B.G. Jones, **sp**. **nov**. (Figs 2, 3-6) MycoBank: 511874

Etymology: bambusicola (Latin), growing on bamboo.

Basidiocarpia resupinata. *Pori angularia*, aurantiaca, 6–8/mm. *Systema hypharum* dimitica. *Hyphae generativae* hyalinae, fibulatae. *Hyphae skeletales* arboriformes, hyalinae, haud dextrinoideae. *Basidiosporae* oblongae, truncatae, infirme dextrinoideae, 3.8–5.8 × 1.8–2.5 µm.

Basidiocarps annual, resupinate, effused. *Marginal sterile zone* fimbriate, orange to pale orange, up to 1 mm wide, often lacking. *Pore surface* even, orange when fresh, drying dark orange to orange brown, grayish orange or not discolored; pores angular, 6–8/mm; dissepiments thin and entire. *Tubes* concolorous with the pore surface, tough-fibrous to leathery, up to 1 mm deep, often shallow. *Context* almost lacking, cream to light orange. *Mycelial strands* flat and sheet-like, often conspicuous, orange to cream.

Hyphal system dimitic. *Tramal generative hyphae* with clamp-connections, occasionally branched, hyaline, 1.2–2.2 µm wide. *Tramal vegetative hyphae* arboriform with stalk and side branches, thick-walled, hyaline, IKI- to slightly dextrinoid in mass, with granules discoloring into violet in KOH solution, up to 2.0 µm wide at the base. *Hyphae composing mycelial strands* similar to *P. aurantiaca*, see Decock and Ryvarden (1999). *Basidia* only one seen, clavate, 13 µm long, 7.8 µm wide. Cystidia absent. *Basidiospores* flat, oblong ellipsoid in the side view, ellipsoid and truncate in the front view, thick-walled, hyaline, slightly dextrinoid, (3.5–)3.8–5.8 × (1.5–)1.8–2.5(–2.8) µm (side view) × (2.2–)2.5–3.6(–3.9) µm (front view), L = 4.7 µm, W_1 = 2.0 µm (side view), W_2 = 3.1 µm (front view), R = 2.3 µm (n = 60/2).

Specimens examined: THAILAND, Prachin Buri Prov., The Bamboo Park, on *Gigantochloa albociliata* (Munro) Kurz (*Bambusoideae*), 28 June 2006, coll. R. Choeyklin (BBH 19093; holotype); the same place and the same date (BBH 19096; 19097; 19384); the same place, 20 September 2006 (BBH 19094; 19098); the same place, 6 December 2006 (BBH 19095; BBH 19284); the same place, 11 June 2007 (BBH, 19099); Chanthaburi Prov., Khao Kitchakoot Nat. Park, on bamboo, 28 May 1997, coll. M. Núñez (TFM F-23198).

Remarks: This species is peculiar with a restricted occurrence on bamboo. After intensive collections in Central Thailand, it is hitherto known only on bamboo culms and thus possibly specific to bamboo. Additionally, the vivid orange pore surface turning dark violet to black with KOH and orange coloured mycelial strands are good field characters. Sometimes, mycelial strands are widespread on the substrates and more conspicuous than the basidiocarps.

This species is morphologically closely related to *P. aurantiaca* (A. David & Rajchenb.) Decock & Ryvarden and *P. xantha* Decock & Ryvarden sharing similar yellow to orange pores discoloring into violet with KOH solution, tiny and truncate basidiospores and small arboriform hyphae in the trama (Decock and Ryvarden, 1999). However, *P. aurantiaca* has wider basidiospores (3–4 µm wide; David and Rajchenberg, 1985; Decock and Ryvarden, 1999) while *P. bambusicola* has flat and oblong basidiospores measuring 1.8–2.5 µm wide in side view. In *P. xantha*, basidiospores are also wider, and additionally the pores are more yellowish and no mycelial strands are produced (Decock and Ryvarden, 1999).

There are several species of *Perenniporia* with resupinate basidiocarps and vividly yellow to orange pore surface, and a key to the world species are provided below.

A key to the worldwide of *Perenniporia* with resupinate basidiocarps and yellow-orange pores

1. Basidiospores shorter than 5.5 µm on average..... 2
1. Basidiospores longer than 5.5 µm on average..... 6

2. Pore surface unchanged or slightly darker with KOH solution..... 3
2. Pore surface violet to almost black with KOH solution; basidiospores IKI- to weakly dextrinoid ... 4

3. Pore surface bright yellow to light brown, 7–9/mm. Vegetative hyphae arboriform, IKI- to slightly dextrinoid in mass. Basidiospores ovoid to truncate, slightly thick walled, weakly to moderately dextrinoid, 4–5 × 3–4 µm. Known from SE Asia, on Dipterocarpaceae trees (Hattori and Lee, 1999 as '*P. dipterocarpicola'*, Decock, 2001)..... .....***P. corticola*** (Corner) Decock
3. Pore surface creamy to yellow or light brown, 8–10/mm. Vegetative hyphae arboriform, IKI-. Basidiospores subglobose to ellipsoid, apically sub- to distinctly truncate, thick-walled, IKI- to distinctly dextrinoid, 3–3.8 × 2.5–3.2 µm. Known from Philippines and Japan (Decock, 2001)..... .....***P. straminea*** (Bres.) Ryvarden

4. Basidiospores flat, short cylindrical in side view, ellipsoid and truncate in front view. Pore surface orange, 6–8/mm. Usually with distinct mycelial strands. Vegetative hyphae arboriform, IKI- to weakly dextrinoid in mass. Basidiospores thick-walled, slightly dextrinoid, 3.8–5.8 × 1.8–2.5 (side view) × 2.5–3.6 µm (front view). Known from Thailand. On bamboo.....***P. bambusicola***
4. Basidiospores ellipsoid and truncate..... 5

5. Pores bright yellow when fresh, 6–8/mm, without mycelial strands. Vegetative hyphae arboriform, IKI- to slightly dextrinoid. Basidiospores ellipsoid, truncate, thick-walled, IKI- to slightly dextrinoid, 4.2–5.8 × 3.2–4.2 µm. Known from S America and SE Asia. On hardwoods. (Decock and Ryvarden, 1999)..... ***P. xantha***
5. Pores orange when fresh, 7–8/mm, with or without orange mycelial strands. Vegetative hyphae arboriform, IKI- to slightly dextrinoid. Basidiospores ellipsoid, truncate, thick-walled, IKI- to slightly dextrinoid, 4.2–5.5 × 3.0–4.0 µm. Known from S America. On hardwoods. (Decock and Rycarden, 1999).....***P. aurantiaca***

6. Basidiospores thin-walled, ellipsoid and IKI-, 6–7.5 × 4–5 µm. Pore surface yellow, 4–5/mm. Vegetative hyphae unbranched to branched, IKI-. Widespread in N Hemisphere. On hardwoods. (Gilbertson and Ryvarden, 1987)..... ***P. tenuis*** (Schwein.) Ryvarden
6. Basidiospores thick-walled, more or less dextrinoid 7

7. Pore surface yellow, 5–8/mm, often effused-reflexed, marginal sterile zone reddish. Vegetative hyphae frequently branched, dextrinoid. Basidiospores thick-walled, ellipsoid, slightly truncate, dextrinoid, 5–7 × 3–5 µm. Known from temperate areas of E Asia. On *Maackia* and other hardwoods. (Núñez and Ryvarden, 2001)... ***P. maackiae*** **(**Bondartsev & Ljub.) Parmasto

7. Pores 4-6/mm, without reddish marginal zone.....8

8. Vegetative hyphae distinctly arboriform, IKI-. Pore surface yellow, 4−5/mm. Basidiospores thick-walled, broadly ellipsoid, dextrinoid, 5.6−7.7 × 4.1−5.9 µm. Known from S America. On dead wood. (Decock and Ryvarden, 1999)..... ***P. chromatica*** (Berk. & Cooke) Decock & Ryvarden

8. Vegetative hyphae unbranched to branched, but not arboriform, weakly to strongly dextrinoid. Pore surface bright yellow or cream, 4−6/mm. Basidiospores thick-walled, broadly ellipsoid, weakly to strongly dextrinoid, 5−6.5 × 3.5−4.5 µm. Widespread in N Hemisphere. On hardwoods. (Gilbertson and Ryvarden, 1987)..... .....***P. medulla-panis*** (Jacq.) Donk

Piptoporus roseovinaceus Choeyklin, T. Hatt. & E.B.G. Jones, **sp. nov.** (Figs 1, 7–9)
MycoBank: 511875

Etymology: roseus + vinaceus (Latin), after the rose to wine colored pileus.

Basidiocarpia sessilia. *Pilei* dimidiati vel flabelliformes, velutini vel hirsuti, rosei vel vinacei. *Pori* rosei, angulares, 3−4/mm. *Systema hypharum* dimiticum in contextu, monomiticum in tramate. *Hyphae generativae* fibulatae. *Hyphae skeletales* hyalinae, IKI-. *Basidiosporae* prelate ellipsoideae vel ellipsoideae, IKI-, 4.8−6.0 × 3.8−4.5 µm.

Basidiocarps annual, sessile, single. *Pilei* dimidiate to flabelliform, applanate, to triquetrous, pileus surface velutinous to hirsute drying scrupose, with irregular or radial ridges, azonate, pink to reddish violet in fresh condition, drying light orange to grayish orange; pileus margin undulating, rounded. *Pore surface* even to partly nodulose, pinkish to pink, darker on bruising in fresh condition, drying sordid white to grayish orange; pores angular, 3–4/mm; dissepiments moderately thick and entire. *Context* fleshy in fresh condition, drying fibrous-corky, light in weight, without a crust, white to pale orange, up to 10 mm thick. *Tubes* soft in fresh condition drying brittle, sordid white to grayish orange, up to 2 mm deep.

Hyphal system dimitic in context, monomitic in trama. *Contextual generative hyphae* with clamp-connections, unbranched to occasionally branched, thin-walled, hyaline, 1.5–7 µm wide (in KOH solution). *Contextual skeletal hyphae* straight to sinuous, often irregularly swelled, thick-walled to almost solid, abundantly seen in Melzer's reagent, but swelled and dissolved in KOH solution, hyaline, IKI-, 3–10 µm wide. *Tramal generative hyphae* with clamp-connections, occasionally branched, hyaline, 1.5–3 µm wide. *Basidia* collapsed. *Cystidia* absent. *Basidiospores* short ellipsoid to ellipsoid, thin-walled, hyaline, IKI-, (4.2–)4.8–6.0(–6.8) × (3.7–)3.8–4.5(–4.8) µm, 1.1 = r = 1.6, L = 5.5 µm, W = 4.1 µm, R = 1.4 (n = 50/1).

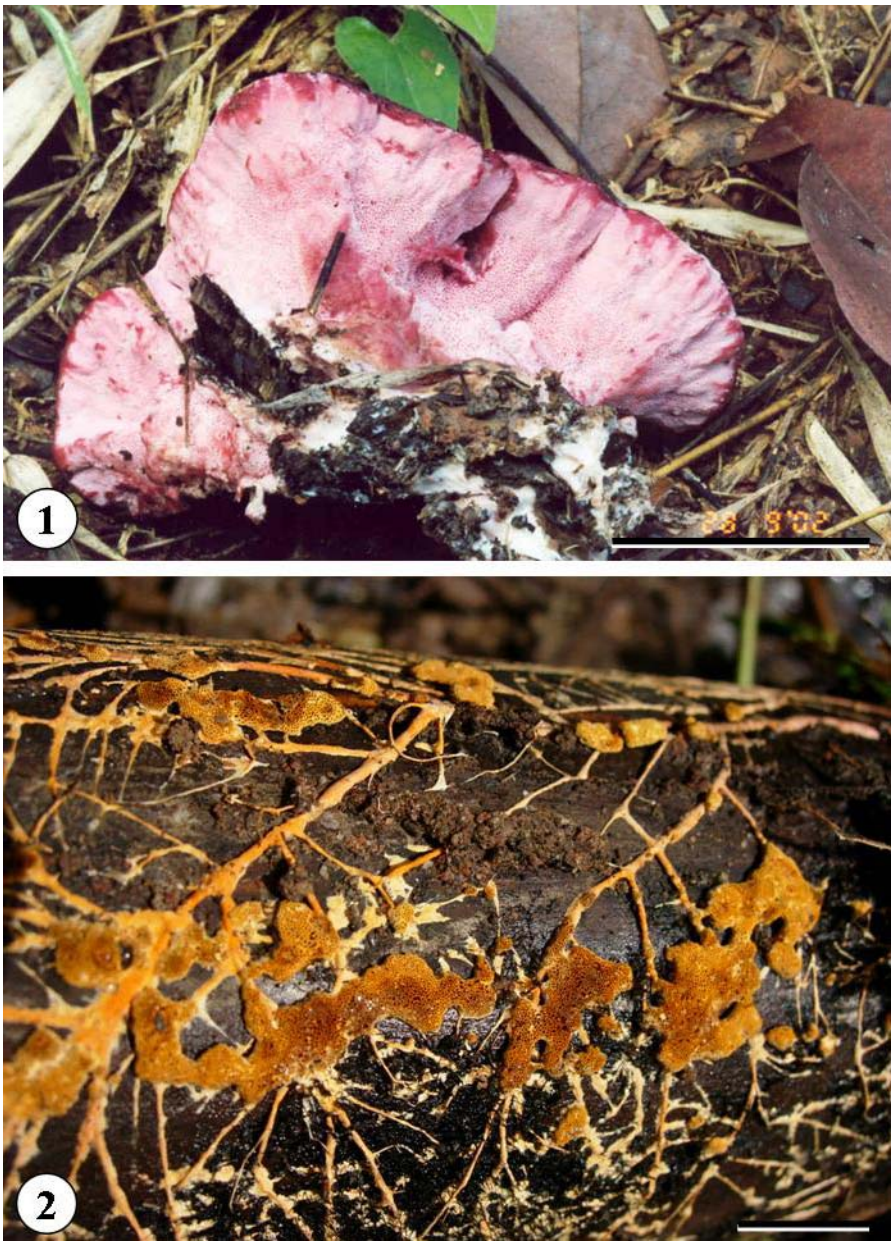
Specimens examined: THAILAND, Prachin Buri Prov. The Bamboo Park, on dead bamboo culms, 28 September 2002, coll. R. Choeyklin (BBH 19084).

Other specimens examined: *Piptoporus soloniensis* (Dubois) Pilát, JAPAN, Tottori Pref., Mt. Daisen, 26 September 1986, coll. Y. Abe, (TFM F-14485); Kouchi Pref., Monobe, Nishikuma, 13 Nov. 1991, coll. T. Hattori (TFM F-16426); Nagano Pref., Kiso, Kaida, 9 September 1994, coll. T. Hattori (TFM F-17210).

Remarks: This species is close to *Piptoporus soloniensis* (Dubois) Pilát, a species with a distribution mainly in the temperate area. It has also vivid coloured pileus surface, hyphal characters in context and short ellipsoid basidiospores, but the latter has orange, cream to whitish pileus surface, buff to pinkish context and fibrous-corky tubes with a dimitic hyphal system as in context (Gilbertson and Ryvarden, 1987).

Piptoporus soloniensis is now widely accepted in *Piptoporus* P. Karst. because of the sessile basidiocarps light in weight when dry, the light colored and corky context, the dimitic hyphal system in the context, the negative reaction with Melzer's reagent, and the decay type (Ryvarden and Gilbertson, 1994; Gilbertson and Ryvarden, 1987). Kim *et al.* (2005) suggested that *P. soloniensis* is phylogenetically not related to *P. betulinus* (Bull.) P. Karst., the type species of *Piptoporus*, but no nomenclatural conclusion was made for the placement of *P. soloniensis*. Before emendation of *Piptoporus* and other related genera based on phylogenetic analyses, we prefer to keep *P. soloniensis* and *P. roseovinaceus*, most possibly allied to the former, in this genus.

Tyromyces armeniacus (Corner) T. Hatt. and *T. incarnatus* Imazeki (= *T. roseipileus* Corner) also have pink to reddish basidiocarps and fleshy context and were reported from Southeast Asia, but have a monomitic hyphal system in the context (Corner, 1989; Hattori, 2003a, 2003b).



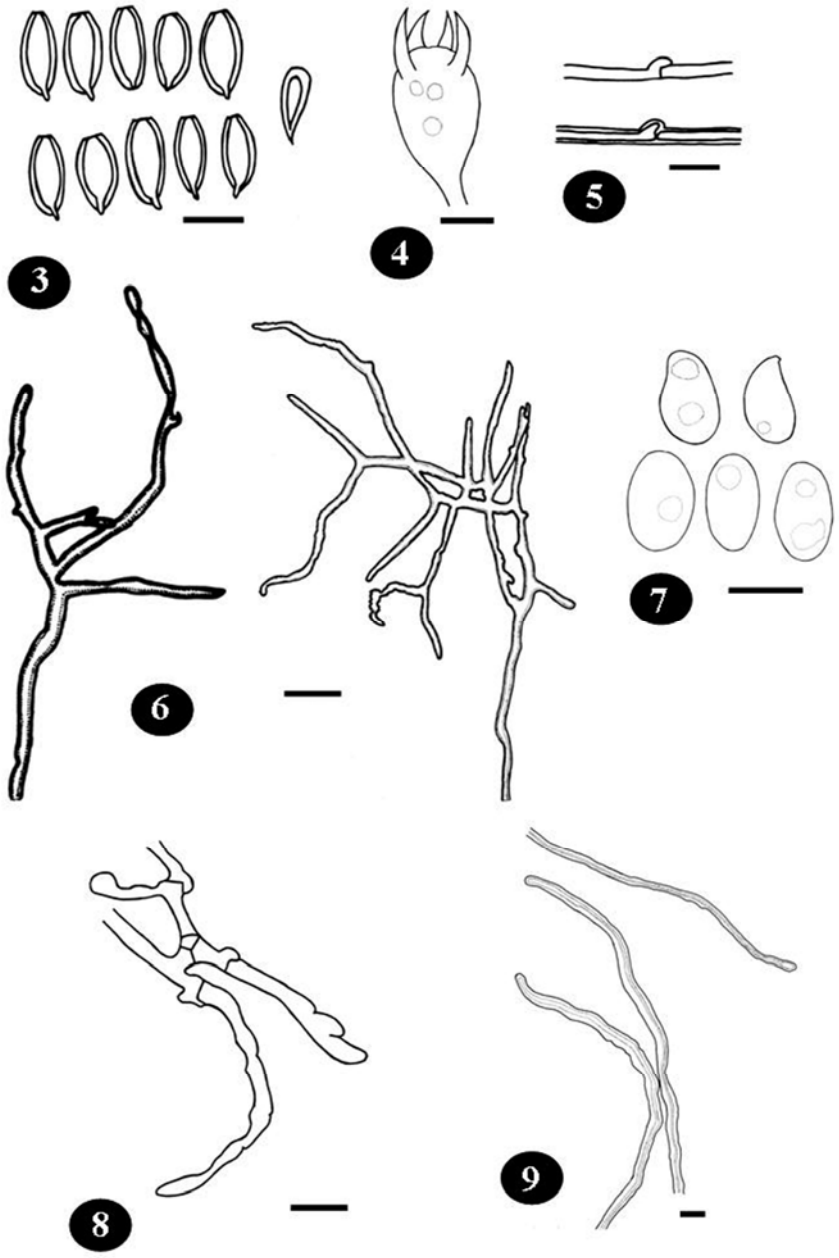
Figs 1-2. Basidiocarps (holotypes). **1**. *Piptoporus roseovinaceus* sp. nov. **2**. *Perenniporia bambusicola* sp. nov. Bars: 1. = 5 cm; 2. = 2 cm.

Rigidoporus cf. ***lineatus*** (Pers.) Ryvarden, Norw. J. Bot. 19: 236 (1972).

Pileus dimidiate, applanate, pileus surface glabrous, concentrically sulcate, light brown up to 2 cm wide. *Pore surface* grayish orange, pores angular, 8–10/mm. *Context* fleshy-leathery in fresh condition, drying woody, without a crust, up to 1.5 mm thick. *Tubes* rigid, concolourous with pore surface, up to 1 mm deep. *Hyphal system* mono-dimitic. *Cystidial hyphae* abundant in trama, encrusted with crystals. *Basidiospores* globose to subglobose, thin-walled, hyaline, IKI-, 4–5 × 3.5–4.5 µm.

Specimens examined: THAILAND, Nakhon Si Thammarat Prov., Khao Luang National Park, 11 October 2006, coll. R. Choeyklin (BBH 19103).

Remarks: This is similar to *R. lineatus*, but basidiocarps and basidiospores are smaller than in the typical form. This form was also collected on bamboo in Malaysia and is possibly distinct from *R. lineatus*. For the time being, we leave this as *R.* cf. *lineatus* because there are several names that have been considered synonyms of *R. lineatus* but some of them have different morphology from the typical form (Hattori, 2001).



Figs 3-6. Line drawings of *Perenniporia bambusicola* sp.nov. **3**. Basidospores. **4**. Basidia. **5**. Generative hyphae with clamp-connections from trama. **6**. Arboriform vegetative hyphae with stalk and side branches from trama. **Figs 7-9**. Line drawings of *Piptoporus roseovinaceus* sp. nov. **7**. Basidiospores. **8**. Generative hyphae with clamp-connections from trama. **9**. Skeletal hyphae from context. **Bars**: 3–9 = 5 μm.

Serpula similis (Berk. & Broome) Ginns, Mycologia 63: 231 (1971).

= *Serpula eurocephala* (Berk. & Broome) W.B. Cooke, Mycologia 49:212, 1957; sensu W.B. Cooke, non sensu Berk. & Broome.

Specimens examined: Thailand, Prachin Buri Prov., The Bamboo Park, 27 September 2005, coll. R. Choeyklin (BBH 19087); the same place, 28 June 2006, coll. R. Choeyklin (BBH 19088; 19089).

Remarks: This is widely distributed in SE Asia, and commonly seen on bamboo (Cooke, 1957) but also on hardwoods. For detailed descriptions, see Cooke (1957) as '*S. eurocephala'* and Ginns (1971).

Discussion

Among the species listed here, *F. flavus* and *I. lacteus* are more frequently reported on hardwood trees (Gilbertson and Ryvarden, 1986; Ryvarden and Johansen, 1980), and these species are suggested to have wide host range. *Grammothele fuligo* has a peculiar host range,

specific to monocotyledons, and more frequently collected on palms in Thailand.

Serpula similis is most probably a paleotropical species, frequently collected on bamboo, both in the wild and in buildings, but also on other wood such as *Leucaena glauca* (Cooke 1957) suggesting that it has a preference for *Bambusoideae* but is not a specialist.

Perenniporia bambusicola is an outstanding species with a vivid orange pore surface and conspicuous mycelial strands. It is hitherto known only on bamboo, in two localities in Thailand and Yunnan in southern China (Decock, pers. comm.). Therefore, it might be restricted to and a specialist on bamboo. *Perenniporia aurantiaca*, a closely related species, is hitherto known only from South America (David and Rajchenberg, 1985; Decock and Ryvarden, 1999) and so far known only on hardwood trees.

Rigidoporus cf. *lineatus* can be another species that has specificity or preference for bamboo. This is similar to *R. lineatus*, but its basidiocarps are usually less than 1 cm long, and basidiospores are mostly less than 5 µm long contrasting that they are 4.5–6 µm long in *R. lineatus* (Gilbertson and Ryvarden, 1987; Ryvarden and Johansen, 1980). Detailed studies are needed to resolve its identity from *R. lineatus* and its nomenclature. *Piptoporus roseovinaceus* is hitherto known only from the holotype, and its host range is unclear.

A number of other polypores on bamboo culms in our collections are not discussed here. Some of them may be new to science, but we refrain from describing them as new because of the limited number of specimens and their quality.

After a world comprehensive survey of polypores on bamboo, Coelho *et al*. (2006) suggested that only 14 out of 57 species are specific to bamboo as a substrate. Several polypores growing on bamboo culms are expected from tropical Asia including Thailand, but hitherto limited information is available from this area. More intensive collections and further studies may reveal more polypores specific to bamboo in tropical Asia.

Acknowledgements

We thank Dr. Cony Decock (MUCL) for information about *P. bambusicola*. We also thank the Biodiversity Research and Training Program (BRT R_148008) for financial support. Rattaket Choeyklin would like to thank Thailand Graduate Institute of Science and Technology (TG−B−11−22−25−744D) for the award of a Doctoral degree Scholarship. Tsutomu Hattori thanks BIOTEC for funding to enable him to work in Thailand. We thank to Prof. Morakot Tanticharoen and Dr. Kanyawim Kirtikara for their continued support for our mycological studies.

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