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## A new *Phanerochaete* (Polyporales, Basidiomycota) with brown subicular hyphae from Thailand

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### Abstract

A new species of *Phanerochaete*, *P. thailandica*, is described from Thailand, it has resupinate fruiting body with smooth, beige, creamy hymenophore, a monomitic hyphal system, the presence of leptocystidia, ellipsoid spores and remarkable subicular layer composed of brown clamped hyphae with quasi-binding hyphae. Molecular analysis of rDNA ITS regions shows *P. thailandica* as an independent species. Phylogenetic analysis demonstrates the relationships with closely related species and confirms position the new species in the genus *Phanerochaete*.

**Key words** – Corticioid fungi – Phanerochaetaceae – Southeast Asia – Taxonomy

### Introduction

*Phanerochaete* P. Karst. is widely spreading corticioid genus of fungi from *Polyporales* (Basidiomycota) and it was described by Finnish mycologist P.A. Karsten in 1889 (Karsten 1889). The species of *Phanerochaete* are characterized by the membranaceous, resupinate basidiocarps, a monomitic hyphal system, simple-septate generative hyphae (single or multiple clamps may be present in subiculum), clavate basidia and smooth, thin-walled, inamyloid, hyaline, cylindrical to ellipsoid basidiospores, and by causing white rot on both conifers and hardwoods (Eriksson et al. 1978, Burdsall 1985, Bernicchia & Gorjón 2010, Wu et al. 2010). Morphologically, the genus *Phanerochaete* was divided to several sections and subgenera (Parmasto 1968, Burdsall 1985). Unsurprisingly, phylogenetic studies suggested that *Phanerochaete* is polyphyletic (de Koker et al. 2003, Wu et al. 2010, Floudas & Hibbett 2015).

The genus *Phanerochaete* has been studied outside Europe more by H.H. Burdsall (1985) in North America and then in Asia by Sheng-Hua Wu (e.g. Wu 1990). Our attention is just aimed at tropical Asia where was collected specimen unknown species of *Phanerochaete* in Thailand. Our specimen was remarkable by brown hyphae in subiculum. Most species of *Phanerochaete* have hyaline hyphae, distinctly brown subicular hyphae are present only in several species that appear close to each other in phylogeny (Liu and He 2016). These species are known from America, Asia and New Zealand. The most of them are spreading in limited region of Asia from tropical southeast (mainly at Taiwan) up to central to western part of China (Wu 1995, Dai 2011, Liu and He 2016). Two more comprehensive monographs on *Aphylloroid* from mainland Asia (Himalaya and India)

did not reveal any *Phanerochaete* species with brown subicular hyphae (Sharma 2012, Hakimi et al. 2013).

We were not able to assign our specimen to some known species of *Phanerochaete* (Burdvall 1985, Wu 1990, 1995, 1998, Bernicchia & Gorjón 2010) and so we describe it as a new species here.

## Materials & Methods

The studied specimen was collected from Thailand on Koh Lanta Yai Island in 2015. The specimen is deposited in National Museum of Czech Republic (PRM, for herbarium acronym see Thiers 2017), isotype in mycological herbarium of the second author at Department of Biology, Geosciences and Environmental Education, University of West Bohemia (CBG).

Description on macroscopic characters is based on the observations in the field and dry specimen.

Microscopic characters were observed from dried herbarium specimen by using light microscope OLYMPUS BX51 in Melzer's solution and Congo Red in ammonia. Microscopic measurements are based on 100 × oil immersion lens. Camera OLYMPUS DP72 was used to photograph some microscopic structure. The following abbreviations are used in descriptions below: L – mean spore length, W – mean spore width, Q – L/W ratio, n – number of measured spores.

Processing of DNA according to Spirin et al. (2015). DNA was isolated from herbarium specimen used the CTAB/NaCl extraction buffer following procedure in Murray & Thompson (1980). Nuclear rDNA (ITS regions) was amplified by using primer pair ITS4 and ITS5 (White et al. 1990). Data matrix contains 10 sequences, 9 from Genbank (Table 1) and one newly generated (deposited in GenBank). There were a total of 718 positions in the final dataset. *Phlebiopsis flavidoalba* (Cooke) Hjortstam and *Porostereum spadiceum* (Pers.) Hjortstam & Ryvarden were chosen as outgroups.

Alignment of sequences was done by Clustal X. The evolutionary history was inferred by using the Maximum Likelihood method with default settings based on the Tamura-Nei model (Tamura & Nei 1993) with 1000 bootstraps replications. Initial tree(s) for the heuristic search were obtained automatically by applying Neighbor-Join and BioNJ algorithms to a matrix of pairwise distances estimated using the Maximum Composite Likelihood (MCL) approach, and then selecting the topology with superior log likelihood value. Phylogenetic analysis was done in MEGA 7.0 (Kumar et al. 2016).

**Table 1** Species, and sequences used in molecular analysis (arranged alphabetically).

Species	GenBank (ITS)	Location	References
<i>Phanerochaete brunnea</i>	KX212220	China	Liu & He 2016
<i>Phanerochaete ericina</i>	KP135165	USA	Floudas & Hibbett 2015
<i>Phanerochaete ericina</i>	KP135167	USA	Floudas & Hibbett 2015
<i>Phanerochaete laevis</i>	KP135149	USA	Floudas & Hibbett 2015
<i>Phanerochaete porostereoides</i>	KX212217	China	Liu & He 2016
<i>Phanerochaete porostereoides</i>	KX212218	China	Liu & He 2016
<i>Phanerochaete stereoides</i>	KX212219	China	Liu & He 2016
<i>Phanerochaete thailandica</i>	MF467737	Thailand	Liu & He 2016
<i>Phlebiopsis flavidoalba</i>	KP135402	USA	this study
<i>Porostereum spadiceum</i>	KJ668473	Korea	Floudas & Hibbett 2015 Jang et al. 2016

## Results

*Phanerochaete thailandica* Kout & Sádliková, sp. nov.

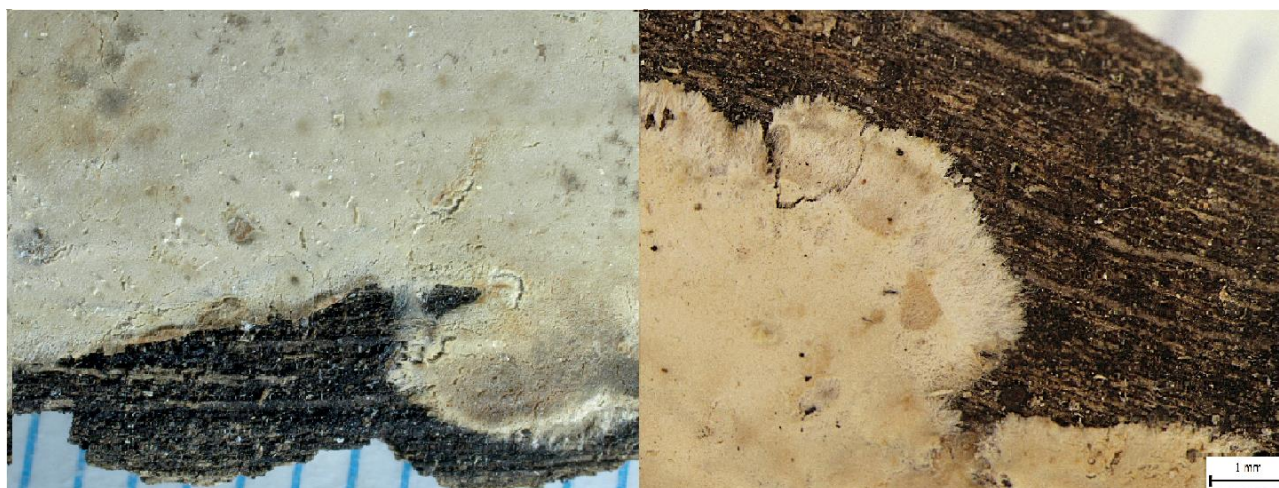
Figs 1–5

Mycobank 821779

Etymology – referring to the locality of the species in Thailand.

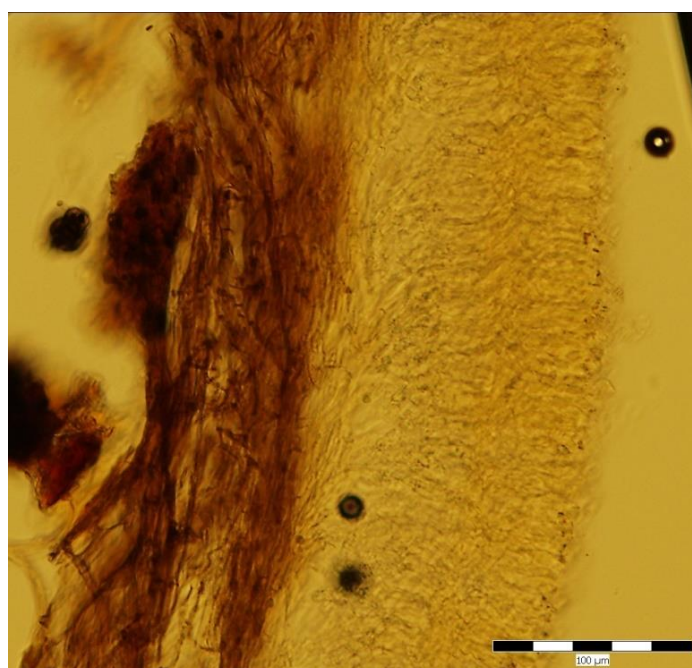
Type –Thailand, Krabi Province, south of Koh Lanta Yai island, near Mu Koh Lanta National Park, Bamboo Bay resort, on the dead angiosperm trunk, 1 July 2015, M. Sádliková (holotype in PRM 945578, isotype in CBG).

Fructing body annual, easily separable, resupinate, soft, 250–270  $\mu\text{m}$  thick in section, with remarkable brown subiculum. Hymenial surface smooth, not cracked when dry, beige, buff, creamy; margin sometimes fimbriate, whitish, colour unchanged with KOH solution (except darkening).



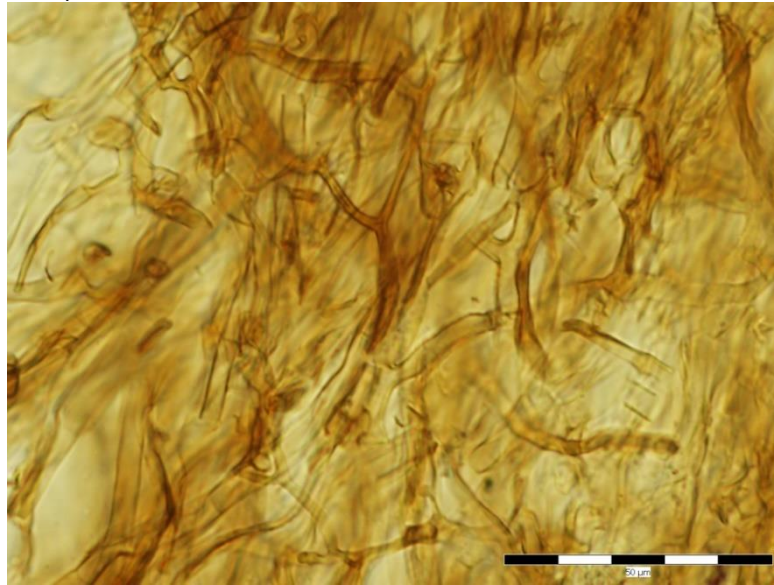
**Figure 1** – *Phanerochaete thailandica*. Fructing body. – Bars = 1 mm.

Hyphal system monomitic with predominant unclamped, thin-walled hyphae; in subhymenium often finely incrustated by granular crystals, with right-angled anastomoses between hyphae, relatively short celled, hyaline, 2–4  $\mu\text{m}$  in diam; subiculum approx. 150  $\mu\text{m}$  thick, hyphae horizontal, loosely interwoven, branching, often septate, occasionally with single clamp or multiple clamps, mainly thin-walled, sometimes slightly thick-walled, partially incrustated, brown, 3–6  $\mu\text{m}$  in diam., quasi-binding hyphae often.



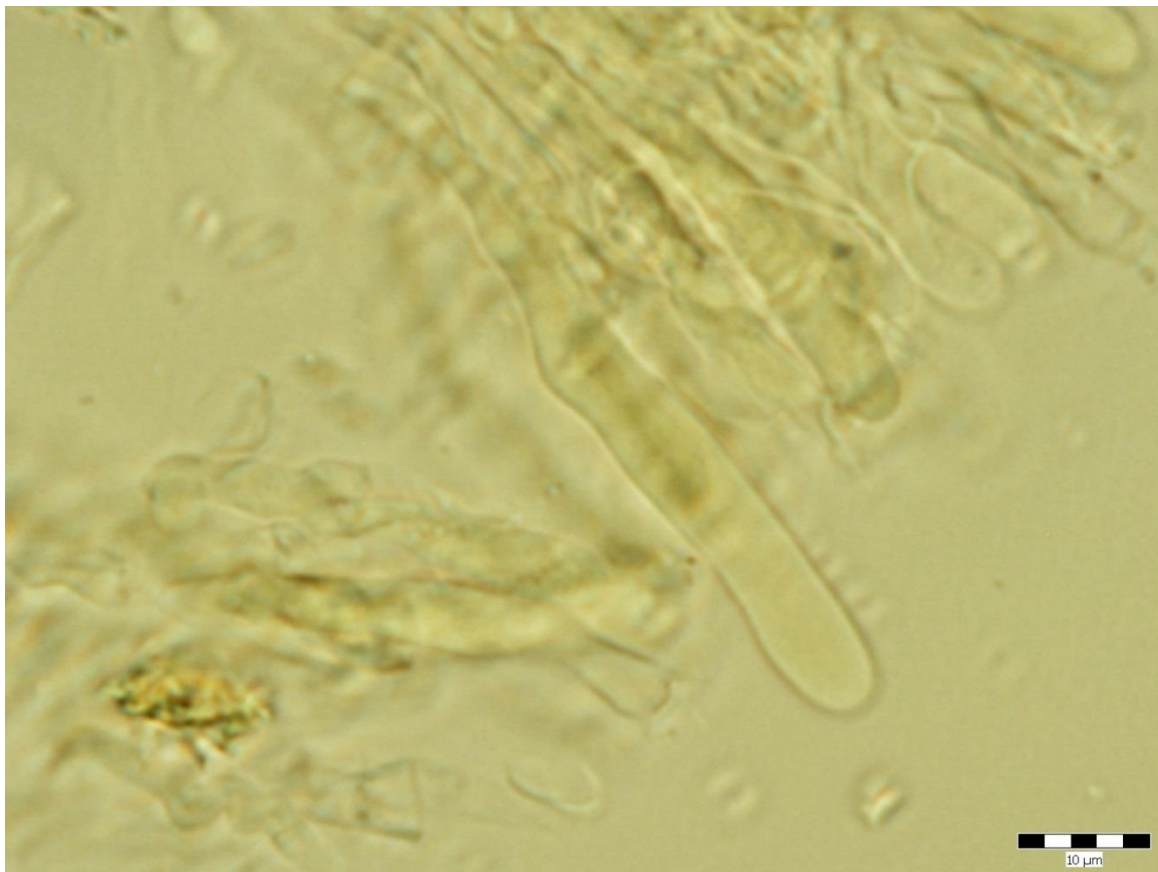


**Figure 2** – *Phanerochaete thailandica*. Vertical section of fruiting body with remarkable brown subiculum. – Bar = 100  $\mu\text{m}$ .

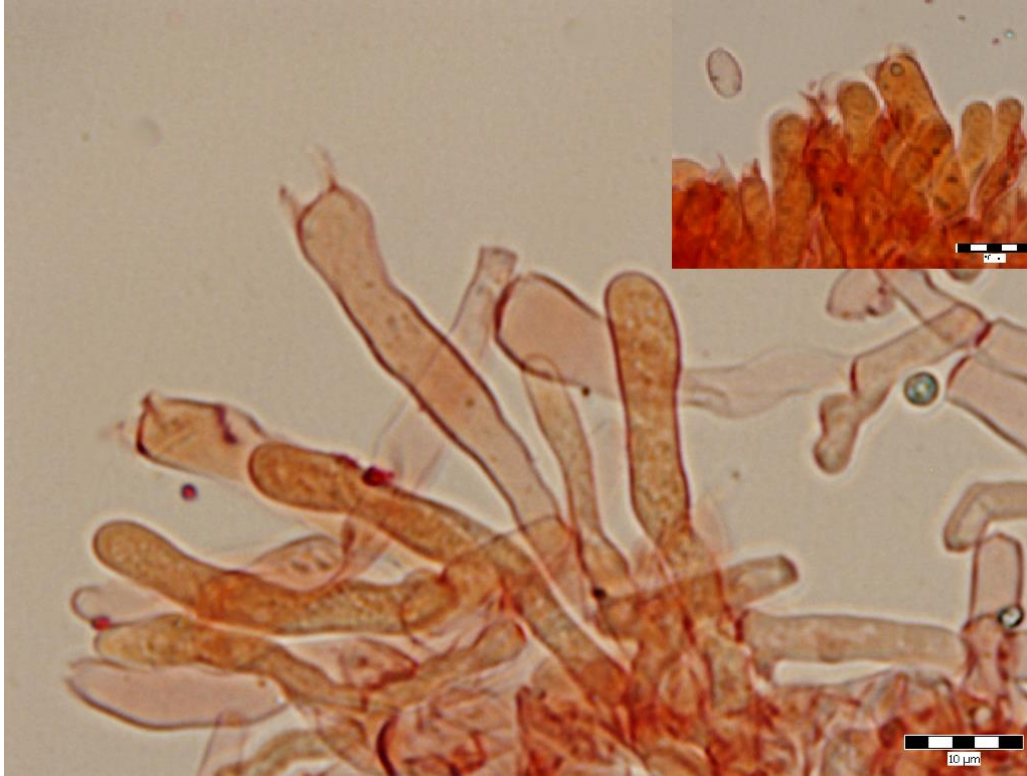


**Figure 3** – *Phanerochaete thailandica*. Detail view in subiculum with quasi-binding hyphae. – Bar = 50  $\mu\text{m}$ .

Leptocystidia occasionally present, slightly projecting outside of hymenium, thin-walled, cylindrical, obtuse, sometimes up to subcapitate, attenuated to the base, hyaline,  $33\text{--}62 \times 5\text{--}7 \mu\text{m}$ . Basidia with four sterigmata, without basal clamp, narrowly clavate,  $25\text{--}38 \times 5\text{--}7 \mu\text{m}$ . Basidiospores ellipsoid, thin-walled, smooth, hyaline, sometimes with one guttule,  $7\text{--}8(-8.5) \times (3.5\text{--})4\text{--}4.5(-5) \mu\text{m}$ ,  $L = 7.39$ ,  $W = 4.11$ ,  $Q = 1.79$  ( $n = 20$ ). All structures without reaction in Melzer's solution.



**Figure 4** – *Phanerochaete thailandica*. Leptocystidium. – Bar = 10 µm.



**Figure 5** – *Phanerochaete thailandica*. Part of hymenium with basidia. – Bars = 10 µm.

Type of rot – White rot.

Known distribution – Known from type locality only but probably more spreading at least in tropical region in Asia.

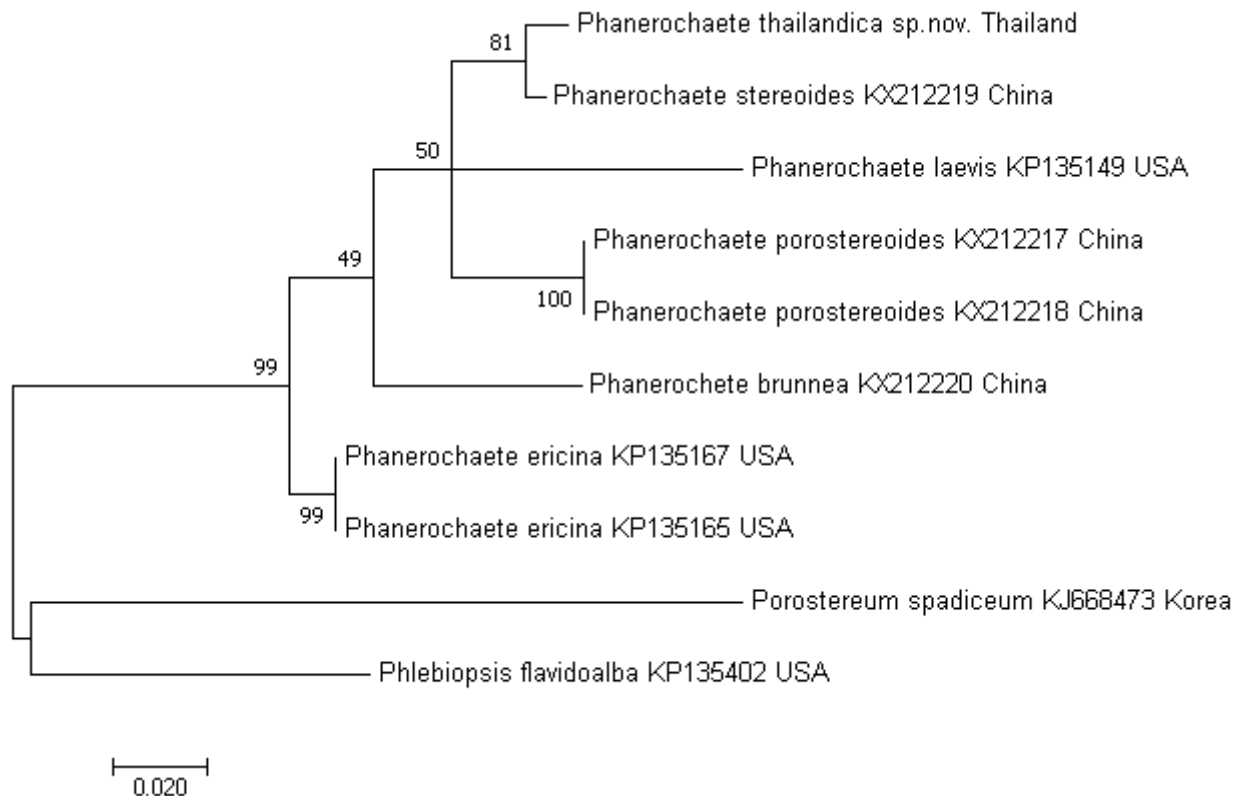
### Discussion

*Phanerochaete thailandica* is described based on morphological and molecular evidence, and is characterized by brown subicular hyphae with clamps, quasi-binding hyphae and rather big ellipsoid basidiospores. In addition, it formed a lineage in the *Phanerochaete* clade (Fig. 6).

The term of quasi-binding hyphae was introduced by Wu (Wu 1990) for distinguishing from true binding hyphae. It is expected that, as a morphological feature, quasi-binding hyphae are not specific only for corticioid species; e.g. Chen and Cui (2013) reported it by polypore. *Phanerochaete ericina* (Bourdot) J. Erikss. & Ryvardeen and *Phanerochaete subceracea* (Burt) Burds. have densely branched subicular hyphae, but they are hyaline, and their basidiospores are smaller than that of *P. thailandica* (Burdsall 1985, Wu 1990).

*Phanerochaete brunnea* Sheng H. Wu, known from China, is similar to *P. thailandica* by external habitat and brown subicular hyphae (Liu & He 2016) but it has smaller basidiospores ( $4.5\text{--}5.5 \times 2.3\text{--}3 \mu\text{m}$ , Wu 1990) and lacks quasi-binding hyphae. Similarly *Phanerochaete singularis* (G. Cunn.) Burds., from New Zealand and South America (Burdsall 1985, Martínez & Nakasone 2005) with spores  $5.5\text{--}7.5 \times 2.5\text{--}3.5 \mu\text{m}$  (Burdsall 1985).

*Phanerochaete stereoides* Sheng H. Wu is closely related to *P. thailandica* (Fig. 6) but the former has greyish hymenophore.



**Figure 6** – Maximum-likelihood phylogram of evolutionary relationships of *Phanerochaete thailandica*. The tree with the highest log likelihood (-2269.19) is shown. The percentage of trees in which the associated taxa clustered together is shown next to the branches. The tree is drawn to scale, with branch lengths measured in the number of substitutions per site.

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