

## **Nine New Records of Mosses from Doi Suthep-Pui National Park and a New Variety of *Fissidens* from Thailand**

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**Abstract** – Nine species of mosses collected from Doi Suthep-Pui National Park are reported new to Thailand. Of these, *Rhachithecium* is a new generic record for the moss flora of Thailand. Notes on the ecology, morphology, taxonomy, and distribution of new records are included. *Fissidens flaccidus* Mitt. var. *percurrens* Wongkuna is described as a new variety from Thailand.

**Thai moss flora / Brachytheciaceae / Bryaceae / Hypnaceae / Myuriaceae /  
Plagiotheciaceae / Rhachitheciaceae / Sematophyllaceae**

### **INTRODUCTION**

Thailand is located in Southeast Asia at approximately 6-20° N latitude and 98-105° E longitude and has a total area of 513,115 km<sup>2</sup>. The elevation in the country ranges from sea level to 2,565 m at Doi (Mt.) Inthanon. Doi Suthep-Pui National Park, in Chiang Mai Province, has an elevation range of 350-1,685 m. The two major forest types in the park are seasonally deciduous (<1,000 m) and evergreen (>1,000 m) (Maxwell, 2004).

Historically, the first information on mosses in Thailand was provided by V. F. Brotherus, who published a list of Bryales in the Flora of Koh (island) Chang, Trat Province, including 44 species (Brotherus, 1901). Later, Brotherus identified the moss specimens collected by Hosseus from the summits of Doi Suthep and Doi Pui, Chiang Mai, during 1904-1905, which included three new species of mosses (Hosseus, 1911). The first checklist of Thai mosses prepared

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by Dixon (1932) and based on Dr. A. F. G. Kerr's collections listed 220 species (Dixon, 1932). A later enumeration of mosses from Doi Suthep-Pui and Doi Inthanon listed 126 species (Horikawa & Ando, 1964). Other more recent publications on Thai bryophytes have also been done (Chantanaorrapint *et al.*, 2004; Tan *et al.*, 2006; Lai & Santanachote, 2007; Lai *et al.*, 2008; Pollawatn *et al.*, 2008; Akiyama & Tsubota, 2009; Printarakul *et al.*, 2009; Chantanaorrapint, 2009; Wongkuna *et al.*, 2009; Akiyama *et al.*, 2010; Kornochalart *et al.*, 2010; Nathi *et al.*, 2010; and Sukkharak & Gradstein, 2010).

At present, the moss flora of Thailand includes 52 families, 198 genera, 667 species, and 32 subspecific taxa (see also Tan & Iwatsuki, 1993; Sornsamran and Thaithong, 1995; He, 1998; Printarakul *et al.*, present paper).

## MATERIALS AND METHODS

Mosses were collected along forest trails in Doi Suthep-Pui National Park from April 2009 to December 2010. Specimens were identified by consulting relevant literature, *viz.* Gangulee (1974, 1976), Magill (1980), O'Shea (1995), Eddy (1996), Goffinet (1997), Tan & Jia (1999), Ignatov *et al.* (2005), Zhang & He (2005), Zhang *et al.* (2007), Li & Ireland (2008), *etc.* Voucher specimens are deposited at the Chiang Mai University Herbarium (CMU) and the Singapore Botanic Gardens Herbarium (SING).

## NEW RECORDS

***Chionostomum hainanense*** B.C. Tan *et* Y. Jia (Sematophyllaceae)

**Illustrations:** Tan & Jia (1999, Fig. VIII, 5-12), Jia *et al.* (2005, Plate 598, Figs. 1-12).

This species is similar to *Chionostomum rostratum* (Griff.) Müll. Hal. in general appearance, but is larger. The important morphological difference between the two lies in the alar cells. In *C. hainanense* the alar cells are *Heterophyllum*-like, forming a group of several rows of quadrate-rectangular-shaped and thick-walled cells. *Chionostomum rostratum* has *Brotherella*-like alar cells which are ovoid, thin-walled, in a group of one conspicuous basal row with a few inflated supra-alar cells above. The leaf apex of *C. hainanense* is more elongately acuminate than that of *C. rostratum*. Although *C. hainanense* has *Heterophyllum*-like alar cells, it belongs to subfamily Sematophylloideae because the exothecial cells of the capsule wall are collenchymatous.

*Chionostomum hainanense* is known from Mt. Jianfengling in Hainan (Island) Province, China (Tan & Jia, 1999; Jia *et al.*, 2005). In Thailand, this species was collected from the summit of Doi Pui at 1,685 m elevation and also from Huay Kog Ma watershed at 1,250 m elevation on Doi Suthep. It grows on tree trunks and branches in primary, seasonal and evergreen, hardwood forests.

**Specimens studied:** *Printarakul* 718, 842, 1873 (CMU, L, SING), 2563 (CMU, L).

***Fissidens bogoriensis* M. Fleisch. (Fissidentaceae)**

**Illustrations:** Iwatsuki & Suzuki (1982, Plate III, Figs. 1-28), Li & Iwatsuki (2001, plate 929, Figs. 1-22).

This species looks like *Fissidens flaccidus* Mitt. in having large and lax laminal cells that are ovoid to oblong-rectangular, thin-walled, about 25-50 µm long, and 13-15 µm wide. The costa of *F. bogoriensis* vanishes well below the leaf apex. The differences between the two above-mentioned species are seen in the limbidia and leaf arrangement. The leaf margin of *F. flaccidus* is distinctly limbate and the leaves are laxly arranged to the base of the stem. *Fissidens bogoriensis* lacks limbidia or is weakly bordered by elongate cells in only 1-2 rows, and the leaves are densely arranged to the base of stem.

*Fissidens bogoriensis* is known from China, Japan, Indonesia, and Philippines (Iwatsuki & Suzuki, 1982; Li & Iwatsuki, 2001). It was collected on soil at Ru See Cave in Doi Suthep-Pui National Park at 1,120 m elevation in primary, seasonal and evergreen, hardwood forests. Chantanaorrapint *et al.* (2004) erroneously reported *Fissidens bogoriensis* from Thailand. The voucher material (*Chantanaorrapint 414*, BCU: Prachuap Khiri Khan, Khao Luang, Huai Yang Waterfall National Park, on soil, 1,000 m, 11 August 2000) has now been determined as *Fissidens flaccidus* Mitt. var. *percurrens* Wongkuna, a new variety which is described below.

**Specimen studied:** *Printarakul 2489* (CMU, L, SING).

***Fissidens flaccidus* Mitt. var. *percurrens* Wongkuna, var. nov.****Figs 1-12**

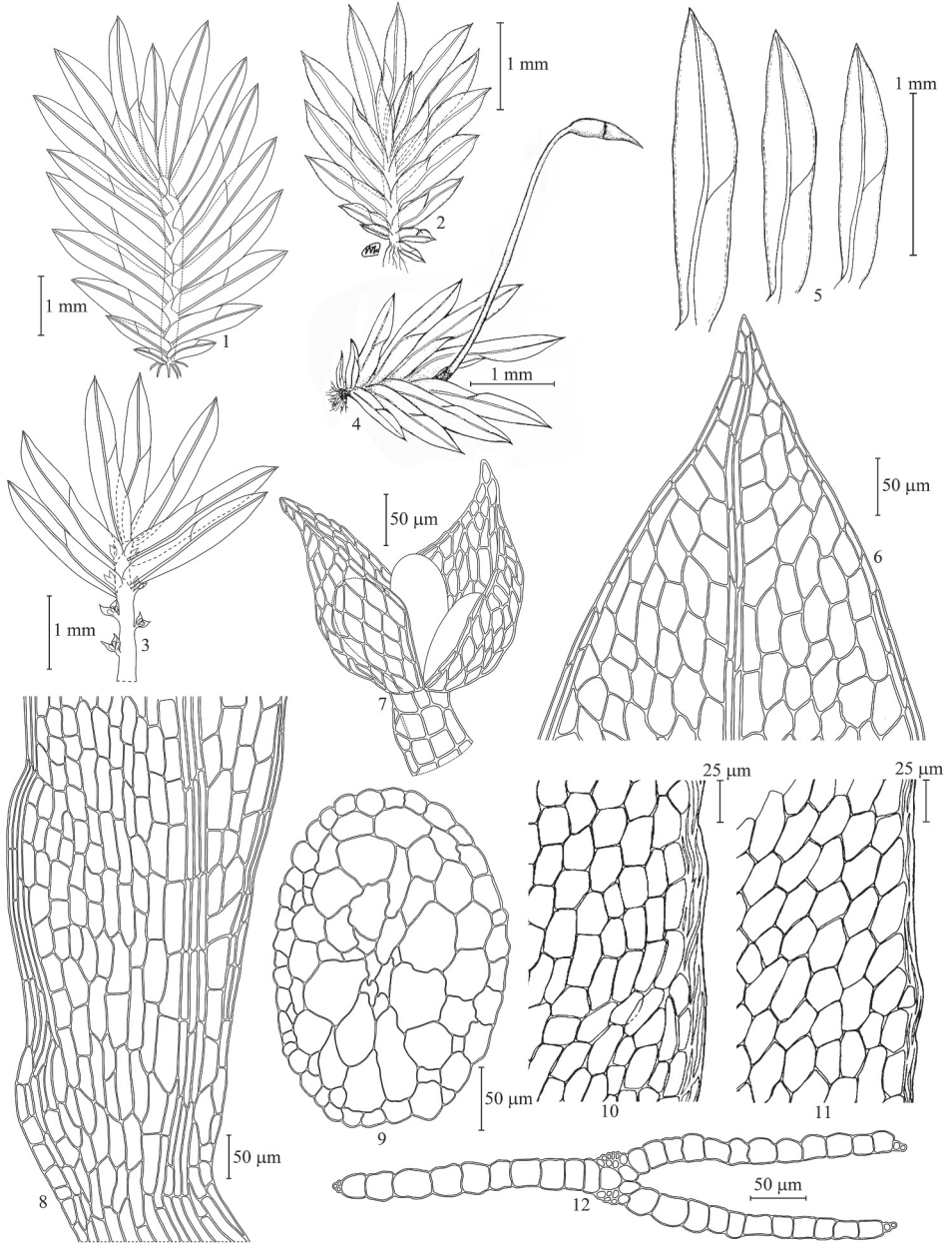
*A varietae flaccidus, foliis 10-14(-18), costis percurrentibus differt.*

**Type:** Thailand, Chantaburi Province, Pliew Falls, Lam Sing District; primary, seasonally evergreen, hardwood forest, granite bedrock, 300 m elevation, 3 July 2009, *Wongkuna 1894* (holotype: CMU; isotypes: L, SING). –Paratypes: Chantaburi, Pliew Falls, Lam Sing District, 320 m, 3 July 2009, *Wongkuna 1879* (CMU, L, SING); Nakorn Nayok, Khao Yai National Park, Dong Tiew, Khao Kieo, 780 m, 23 June 2009, *Wongkuna 1675* (CMU, L, SING); Prachuap Khiri Khan, Khao Luang, Huai Yang Waterfall National Park, on soil, 1,000 m, 11 August 2000, *Chantanaorrapint 414* (BCU).

Plants 4.0-5.0(-6.0) mm tall, 2.0-3.0(4.0) mm wide, pale green; stems usually simple; hyaline nodules and central strand slightly differentiated; densely foliated, leaves 5-7(-9) pairs; lowest leaves small, upper leaves much larger, lanceolate, 1.80-2.75(-3.0) mm long, 0.40-0.50 mm wide, acute at apex, acute and slightly decurrent at the base of dorsal lamina, margins entire, limbidia present on the apical part of the vaginant laminae and dorsal lamina, consisting of 2-3 rows of narrow and thick-walled cells; limbidia of vaginant lamina thicker, consisting of 2-4 rows of linear cells; vaginant lamina about half of leaf length; costa percurrent; cells of apical lamina irregularly rectangular and similar to the dorsal lamina, 25-50 µm long, 13-25 µm wide, smooth, thin-walled; cells of vaginant lamina, rectangular, up to 50 µm long, smooth. Autoicous. Male inflorescences bud like, axillary. Sporophytes terminal.

This new variety differs from var. *flaccidus* in having less number of leaves per plant (10-14(-18) leaves), smaller plant (4-6 mm tall), and a strongly percurrent leaf costa, while var. *flaccidus* has 16-32 leaves, is larger (10 mm tall), and a costa vanishing far below the leaf apex (7-15 cells).

The new variety endemic to Thailand was collected from soil in shaded places near a waterfall in deciduous dipterocarp-oak forest and also in primary, evergreen, hardwood forest, 200-1,000 m elevation, on granite and sandstone bedrocks in northern Thailand.



Figs 1-12. *Fissidens flaccidus* Mitt. var. *percurrrens* Wongkuna. **1-2.** Plant habit. **3.** Plant habit with antheridia. **4.** Plant habit with sporophyte. **5.** Leaves. **6.** Leaf apex cells. **7.** Antheridial bud. **8.** Leaf base cells. **9.** Cross section of stem. **10.** Vaginant lamina cells. **11.** Dorsal lamina cells. **12.** Cross section of leaves. Figs. 1-3, 5-12 drawn from *Wongkuna 1894* (holotype). Fig. 4 drawn from *Chantanaorrapint 414* (drawn by *S. Chantanaorrapint*).

***Isopterygium propaguliferum*** Toyama (Hypnaceae)

**Illustration:** Zhang & He (2005, Plate 694, Figs. 1-14).

This species is easily recognized by having gemmae on the tips of ascending branches. The leaves are ovate-lanceolate and abruptly acuminate to piliform at the apex. The plants are creeping and mat-forming with irregularly pinnate branches. This species looks like *Isopterygium tenerum* (Swartz) Mitt. in having gradually acuminate leaf tips and differentiated alar cells that are shortly rectangular or quadrate. The two species can be separated by the type of gemmae found on the short ascending branches. In *Isopterygium propaguliferum*, the gemmae are clavate-shaped, and found on the tip of branches, while in *I. tenerum*, the gemmae are filiform found in clusters inside the leaf axils.

*Isopterygium propaguliferum* has been reported from China, Japan, Cambodia, and Vietnam (Toyama, 1938; Tan & Iwatzuki, 1993; Zhang & He, 2005). In Thailand, it was collected on a rotten tree trunk in Huay Kog Ma watershed in Doi Suthep-Pui National Park at about 1,350 m elevation in primary, seasonally evergreen, hardwood forest.

**Specimen studied:** *Printarakul 1901* (CMU, L, SING).

***Myurium borii*** (Dixon) Magill (Myuriaceae)

**Illustrations:** Gangulee (1976 as *Symphysodontella borii* Dixon, Fig. 618), Magill (1980, Fig. 15).

This species is characterized by the pinnate primary stem with flagelliform secondary branches. The leaves are broadly ovate to ovate-lanceolate with an apiculate-acute to shortly acuminate tip and concave, incurved margins. It has double and shortly bifid costae. This species has distinct alar cells, consisting of quadrate to rectangular, thick-walled cells with deep reddish-brown pigmentation.

*Myurium borii* is similar to some species of *Symphysodontella* M. Fleisch. (Pterobryaceae) in having a group of colored, thick-walled alar cells and ovate-elliptic leaves with apiculate to acute apices. The species of *Symphysodontella*, however have erect secondary stems that are differentiated into an unbranched proximal part (stipe) and a pinnately branched distal part (frond) (Magill, 1980). *Myurium borii* has slender to flagelliform and pinnately-branched secondary branches that are not differentiated into a stipe and frond.

*Myurium borii* has been reported from eastern India (Assam) (Gangulee, 1976 as *Symphysodontella borii* Dixon; Magill, 1980). In Thailand, it was collected from a tree trunk at the summit of Doi Pui at 1,685 m elevation in Doi Suthep-Pui National Park and on a rotten log and shrub branches at 1,650 m elevation in Doi Inthanon National Park. The collection habitat is in primary, seasonally evergreen, hardwood forest.

**Specimens studied:** *Printarakul 2155, 2545, 2617, 2691A* (CMU, L, SING), 2678, 3028 (CMU, L).

***Palamocladium leskeoides*** (Hook.) E. Britton (Brachytheciaceae)

**Illustrations:** Gangulee (1978 as *Homalothecium nilgheriense* (Mont.) H. Robinson, Fig. 847), Wang & Hu (2008, Plate 545, Fig. 7-14).

This species is closely allied to *Brachythecium buchananii* (Hook.) A. Jaeger, which has inclined to arcuate capsules and more broadly ovate-lanceolate leaves with abruptly acuminate apices. In contrast, *Palamocladium leskeoides* has erect, oblong-cylindrical capsules, and ovate-lanceolate leaves with gradually acuminate apex.



*Palamocladium leskeoides* is known from Sri Lanka, India, Nepal, Sikkim, China, Japan, Korea, Vietnam, Indonesia (Bali, Java, Lombok, Sumbawa, Flores), Philippines, Hawaii, North and South America, and central and southern Africa (Gangulee, 1978; Ignatov *et al.*, 2005; Wang & Hu, 2008). In Thailand, it was found on tree trunks and roadside concrete channels at 1,680 m elevation near the summit of Doi Pui in Doi Suthep-Pui National Park in primary, seasonally evergreen hardwood forest.

**Specimens studied:** *Printarakul 816* (CMU, L, SING); *Santanachote 67-03* (CMU, L).

***Plagiothecium laetum*** Schimp. (Plagiotheciaceae)

**Illustration:** Hu & Wang (2005, Plate 100, Figs. 8-18).

Comparing to other species of *Plagiothecium*, this species has rather robust, prostrate, complanate, and rarely julaceous stems. The leaves are imbricate, erect-spreading, often slightly undulate, asymmetric, and with acute apices. The costa is shortly bifid, sometimes unequally so. The leaf base is narrowly decurrent with a small triangular alar region, consisting of 1–3 vertical rows of rectangular cells.

*Plagiothecium laetum* differs in one important leaf character from *P. neckeroideum* Schimp., which was reported from Thailand by Horikawa & Ando (1964). The latter often has brood bodies present at the leaf apex, while in *P. laetum* the brood bodies, consisting of 3-6 cells, are clustered on a branched stalk in the leaf axils.

*Plagiothecium laetum* is known from China, Europe, and North America (Li & Ireland, 2008; Hu & Wang, 2005). In Thailand, this species was collected on tree trunks at 1,076-1,250 m elevation in the area of Ru See Cave, Doi Suthep-Pui National Park, in primary, seasonal and evergreen, hardwood forests.

**Specimens studied:** *Printarakul 2115, 2278* (CMU, L, SING).

***Pohlia flexuosa*** Hook. (Bryaceae)

**Illustrations:** Gangulee (1974, Fig. 431), Eddy (1996, Fig. 438), Li (2006, Plate 5, Figs. 8-15).

Individuals of this species are small, laxly gregarious, with the upper leaves of each stem forming a comal tuft. The leaves are distantly and spirally arranged, ovate-lanceolate, with an acute apex and long-decurrent, hastate-like, base. The stems usually produce two types of propagules, *viz.* filamentous and ovoid-bulbiform, in small clusters in the leaf axils. The capsules are ovoid to pyriform, about 2 mm long, and inclined to suberect.

*Pohlia flexuosa* is different from *P. elongata* Hedw., a look-alike species reported from Thailand (Horikawa & Ando, 1964). The latter has more elongate to narrowly cylindrical, horizontal capsules, about 5 mm long, and lacks propagules.

*Pohlia flexuosa* is known throughout tropical and temperate Asia, as well as in North and South America (Eddy, 1996; Li, 2006; Zhang *et al.*, 2007). In Thailand, this species was collected on a roadside soil bank at 1,500 m elevation in Kuhn Chang Kian (Hmong) village on Doi Pui, Doi Suthep-Pui National Park. The habitat is open grassland near primary, seasonal and evergreen, hardwood forests.

**Specimens studied:** *Printarakul 2186* (CMU, L, SING), *2506* (CMU, L).

***Rhachithecium perpusillum*** (Thwaites *et* Mitt.) Broth. (Rhachithecaceae)

**Illustration:** Gangulee (1976, Fig. 561).

*Rhachithecium* is a new generic record for Thailand and is a rare genus among epiphytic mosses. The Thai specimens are identified as *Rhachithecium perpusillum*. Individuals of this species are small, 3-5 mm tall (including sporophyte), forming lax tufts, or cushions. It has lingulate-spathulate leaves with obtuse to broadly acute tips, a single costa ending well below the leaf apex, perichaetial leaves which are sheath-forming at the base, short setae, ovoid capsules with sulcate ornamentation consisting of 8 lines, and a single smooth peristome.

This species looks somewhat like the more widely scattered, *R. papillosum* (Williams) Wijk *et* Marg., and the Japanese endemic, *R. nipponicum* (Toyama) Wijk *et* Marg.. However, the latter two species have papillose or mamilllose leaf cells, while *R. perpusillum* has smooth leaf cells. In addition, *R. perpusillum* has 16 peristome teeth that are fused in pairs of eight, while *R. papillosum* has peristome teeth that are free and *R. nipponicum* is eperistomate (Goffinet, 1997).

*Rhachithecium perpusillum* is known from Sri Lanka (type locality), Himalayas, China (Yunnan), and has disjunct distribution extending from Mexico, along the Andes to Brazil, as well as in central, south, and west Africa, and Madagascar (Gangulee, 1976; O'Shea, 1995; Goffinet, 1997). In Thailand, it was found at the base of a tree trunk in an open, disturbed place near Puping Palace at about 1,400 m elevation in Doi Suthep-Pui National Park. The site is surrounded by primary, seasonally evergreen, hardwood forest with planted pine grove.

**Specimens studied:** *Printarakul 301, 3021* (CMU, L, SING); *Maxwell B-71* (CMU, L).

***Trichosteleum stigmatosum*** Mitt. (Sematophyllaceae)

**Illustration:** Tan *et al.* (2007, Fig. 5).

This species has creeping, irregularly branched stems forming dense tufts. The leaves are flattened, sometimes falcate, lanceolate to oblong-lanceolate, with a gradually long-acuminate to slender, linear acumen. These characters serve to separate *T. stigmatosum* from the other widespread species of *Trichosteleum* in the region, *viz.* *T. mammosum* (Müll. Hal.) A. Jaeger, *T. pseudo-mammosum* M. Fleisch., and *T. boschii* (Dozy *et* Molk.) A. Jaeger. The latter three species have more concave, ovate-lanceolate leaves with somewhat abruptly acute to shortly acuminate apices. In addition, *Trichosteleum stigmatosum* differs also from *T. mammosum* in the absence of warty-tuberculose capsules.

*Trichosteleum stigmatosum* was collected on the trunks of planted *Cupressus torulosa* D. Don (Cupressaceae) at the summit of Doi Pui at 1,685 m elevation in Doi Suthep-Pui National Park. The habitat is primary, seasonally evergreen, hardwood forest. This species is known from China, Philippines, Papua New Guinea, Samoa, and Fiji (Tan & Jia, 1999; Tan *et al.*, 2007).

**Specimens studied:** *Santanachote 01-01, 246* (CMU, L, SING).

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