

Miscellaneous observation on *Fissidens* in Thailand with five new species records

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Abstract – Five new records of *Fissidens* for the Thailand moss flora are reported, namely *Fissidens flaccidus*, *Fissidens involutus*, *Fissidens jungermannioides*, *Fissidens incognitus* and *Fissidens serratus*. Of these, *Fissidens jungermannioides* and *Fissidens incognitus* are new records also for Indochina. Two nomenclatural synonyms are proposed: *F. papillosus* Broth. is a new synonym of *F. cernulatus* Mitt. and *F. excedens* Broth. is synonymized with *F. taxifolius* Hedw. *Fissidens subspathulatus* Dix. is excluded from the Thai moss flora, while *F. laxitextus* Broth. ex Gangulee is shown to be a perichaetial-limbate species not related to *F. pellucidus* group.

***Fissidens* / Thailand / moss flora / new synonyms / excluded taxa / leaf limbidium**

INTRODUCTION

Thailand is located in continental SE Asia at approximately 6-20° N latitude and 98-105° E longitude. The country encompasses a total land area of 513,115 km². The elevation ranges from sea level to 2,565 m (Doi Inthanon National Park). There are two basic vegetation types in the country, *viz.* evergreen and deciduous forest (Maxwell 2004). He Si at MO presented a brief bryological history of Thailand, focused on mosses (see <http://www.mobot.org/MOBOT/moss/Thailand/history.shtml>), while Wongkuna *et al.* (2009) reviewed the history of the study of *Fissidens* flora in Thailand. Earlier, Tan *et al.* (2006) reported five new records of *Fissidens* taxa from Chiang Mai Province of Thailand.

In a recent countrywide study on the *Fissidens* flora, we have discovered five more new species records for Thailand. We also observed that *F. laxitextus* Broth. ex Gangulee has limbidia developed on perichaetial leaves, and the Thai specimen named and reported as *F. subspathulatus* Dix. is a misidentified *F. crenulatus* Mitt. Two new synonyms are proposed: *F. papillosus* Broth. (= *F. cernulatus* Mitt.) and *F. excedens* Broth. (= *F. taxifolius* Hedw.).

Overall, our latest count of the genus *Fissidens* yields a total of 39 species including two species new to science awaiting description (Wongkuna *et al.*, 2009).

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NEW SPECIES RECORDS

1. *Fissidens flaccidus* Müll. Hal. (syn. *Fissidens splachnobryoides* Broth., *F. maceratus* Mitt.)

Within the genus, the lamina cells of this species are large, rectangular to oval-oblong, smooth, thin-walled, 25-40 µm long and 13-15 µm wide. The cells of vaginant lamina are elongate, up to 60 µm long. Leaf margins are entire and limbate all around, and the costa ends below the apex. Hyaline nodules are not differentiated.

Fissidens flaccidus is widely distributed from mainland China, Taiwan, Sri Lanka, India, Nepal, Japan, Myanmar, Vietnam, Borneo, Philippines, Indonesia to New Guinea. Its presence in Thailand is expected because the species is commonly associated with human settlements in many parts of temperate and tropical Asia.

Specimen studied: Sakhon Nakhorn Province, Phu Phan National Park, 324 m elev., on soil, 19 Sep 2006, coll. K. Wongkuna 362 (CMU, SING); Chiang Mai Province, Chiang Mai University campus, 350 m elev., on soil in garden, 12 Oct 2007, coll. K. Wongkuna 658 (CMU, SING).

2. *Fissidens incognitus* Gangulee

Figs 1-10

This species is easily recognized by the strong unipapillate lamina cells, with the papilla having a branched tip. The limbidia are confined to the vaginant laminae and the hyaline nodules not differentiated.

Fissidens incognitus was reported from China and India. It is a welcome addition to the moss flora of Thailand, which represents a significant expansion of its range to Indochina.

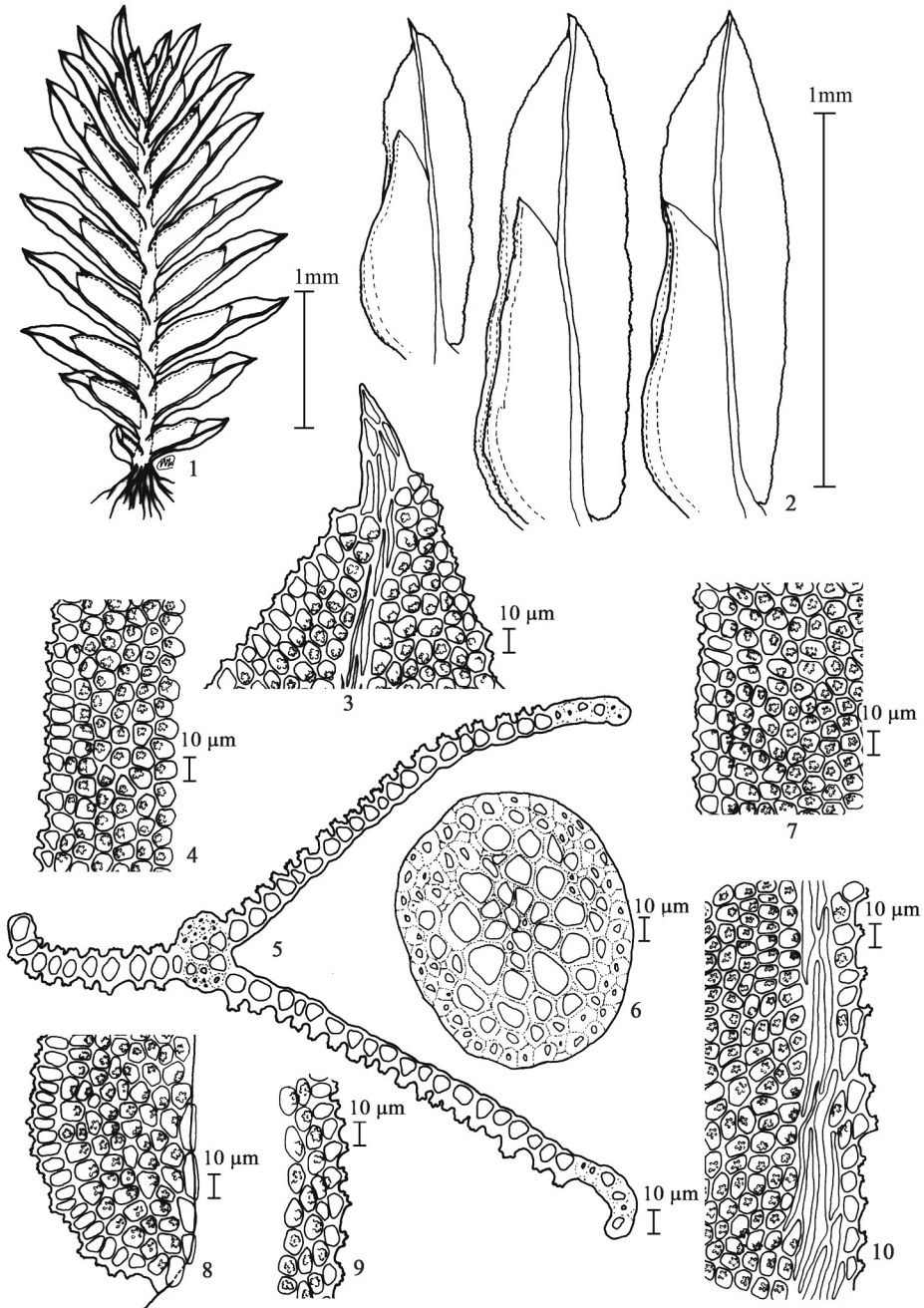
Specimen studied: Chiang Mai Province, Muang District, Doi Suthep-Pui National Park, Montatahn Waterfalls, 730 m elev., on soil, 5 Jun 2006, coll. K. Wongkuna 345 (CMU, SING).

3. *Fissidens involutus* Wilson ex Mitt. (syn. *Fissidens plagiochiloides* Besch., *F. obtuso-apiculatus* Dix.?)

The characters of this species are medium to large plant size, with the stems more than 2 cm long and 3 mm wide including leaves. Leaves are ovate-oblong to oblong-lanceolate, apex broadly acute, base of lamina not decurrent, margins crenulate and not limbate, costa percurrent to shortly excurrent; cell of apical and dorsal laminae polygonal, mammillose, and the hyaline nodules not differentiated. The species is found mostly in wet habitat. Among Thai species, *Fissidens involutus* looks like a large *F. gymnogynus* with percurrent leaf costa. The Thai specimen reported here has exceptionally long seta measuring to 13-14 mm long.

Using the treatments by Iwatsuki and Suzuki (1982) and Li (1885), the Thai specimens keyed to *F. plagiochiloides*, and not *F. involutus*. However, we follow here Li and Iwatsuki (2001) on the updated synonymy of this taxon.

The Thai specimen also looks like *F. curvato-involutus* Dix. from India, with its very long seta. But according to the listed character differences between *F. involutus* and *F. curvato-involutus* in Iwatsuki and Suzuki (1999), the Thai specimen fits better *F. involutus* in nearly all characters, except the setal length.



Figs 1-10. *Fissidens incognitus* Gangulee (based on K. Wongkuna 345). **1.** plant habit. **2.** leaves. **3.** leaf apex. **4.** cells at apical lamina. **5.** cross-section of leaf. **6.** cross-section of stem. **7.** cells at dorsal lamina. **8.** cells at leaf base. **9.** cells at vaginant lamina. **10.** leaf margin showing limbidium.

The duplicate packet of the cited Thai specimen of *Fissidens excedens* Broth. at MO [Nakhon Sawan Province, Langsang National park, W of Tak, near 3rd waterfall, on wet rocks along stream, *Touw 8043*] is a *F. involutus*. See below for taxonomic comments of the type of *F. excedens*.

Additionally, the description and remarks made by Dixon (1932) in the protologue of *F. obtuso-apiculatus* Dix. do not seem distinctive enough to warrant a separate species recognition from *F. involutus*. The reported type specimen of *F. obtuso-apiculatus* grows in a damp habitat by a waterfall in forest. The leaves of the specimens were described to be thickly encrusted in most part with calcareous deposit; hence, the stated leaf character of the marginal cells as somewhat differentiated in several rows would be difficult to ascertain.

Fissidens involutus is known from Japan, Taiwan, China, Nepal, India, Philippine, Vietnam, Myanmar, and Sri Lanka. It is reported here new to Thailand.

Specimen studied: Chiang Mai Province, Chiang Dao District, Pha Dang National Park, Sri Sang Warn Waterfalls, 578 m elev., on soil, 21 Oct 2007, coll. K. Wongkuna 660 (CMU, SING).

4. *Fissidens jungermannioides* Griff.

Figs 11-19

The present species is characterized by partially or incompletely differentiated limbidia around the leaf that are often coloured. In cross-section, the interrupted leaf limbidium is clearly 2-3 layers of cells thick. The lamina cells are quadrate to irregularly hexagonal, thick-walled, smooth to slightly mammillose. No sporophyte specimens found in Thai collection.

In Thailand, as in China (see Li and Iwatsuki, 2001), *F. jungermannioides* is found on wet rocks by streams. But in Hong Kong area, this species were found several times on rocks inside forest (Zhang Li, pers. comm., 2008). *F. jungermannioides* is reported also from India. The species is a new record for Thailand and Indochina (cf. Tan and Iwatsuki, 1993).

Specimen studied: Phitsanulok Province, Nakhon Thai District, Pha Hin Rong Kla National Park, Pha Chu Thong, 1319 m elev., on wet rock, 3 Jun 2006, coll. K. Wongkuna 306 (CMU, SING).

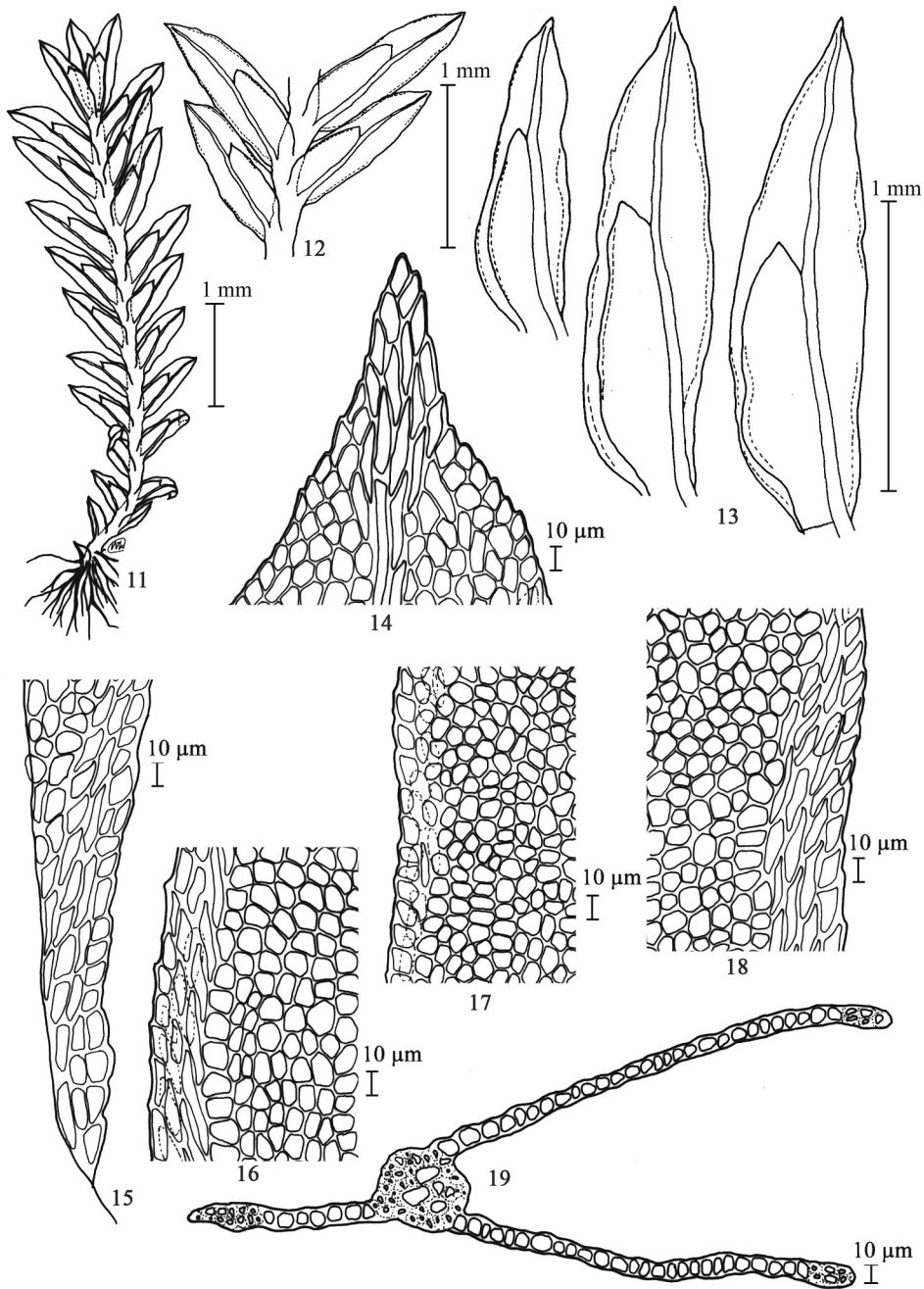
5. *Fissidens serratus* Müll.Hal.

Figs 20-27

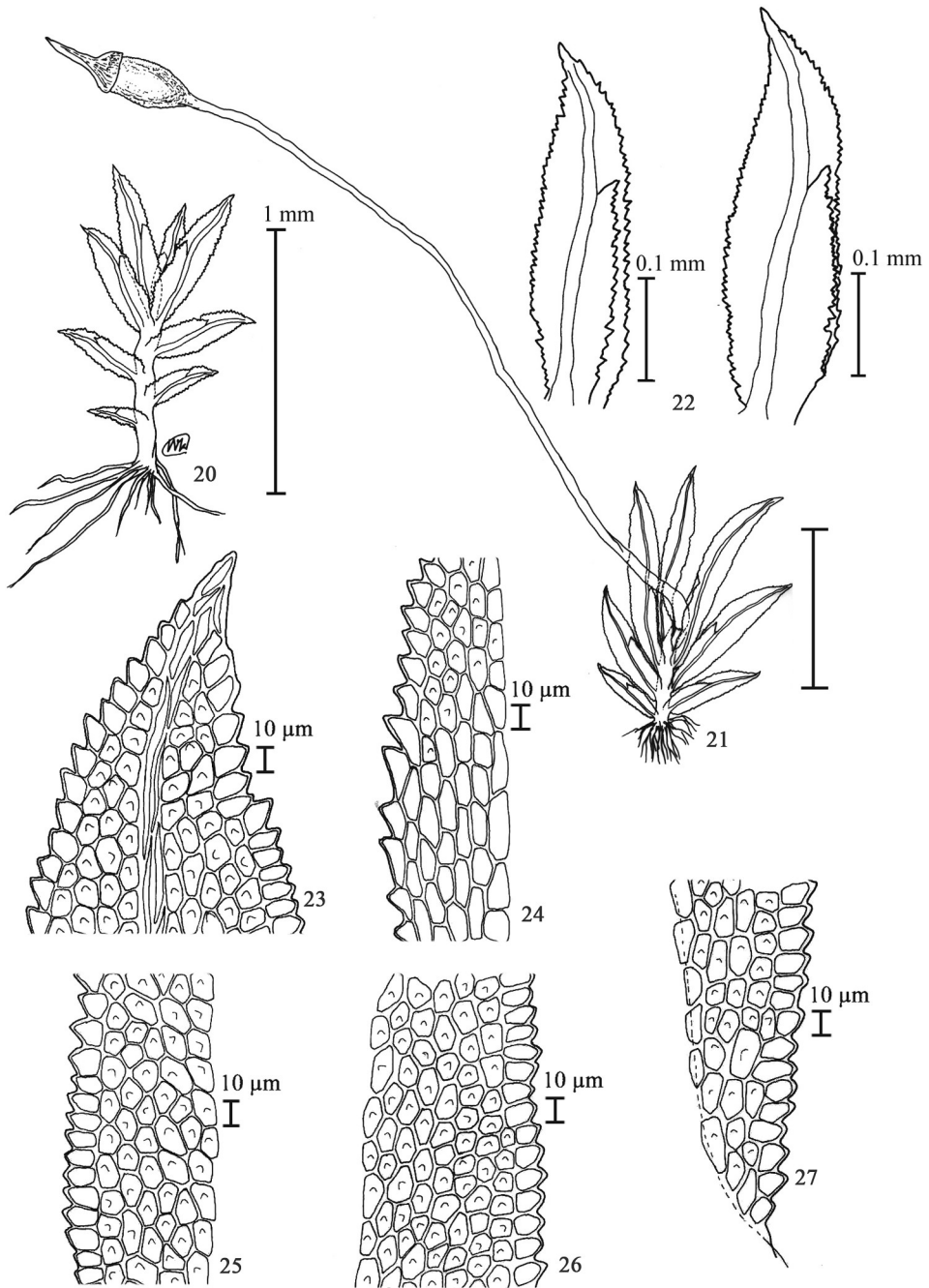
This is a very small *Fissidens*, characterized by the absence of hyaline nodule on the stem, and the presence of strongly serrate leaf margins without limbidia. The leaf cells of apical and dorsal laminae are polygonal, thin-walled, and unipapillose-mammillose, but cells of vaginant laminae are smooth or slightly mammillose and larger in size measurement.

In Bruggeman-Nannenga and Pursell (1995) and Li and Iwatsuki (2001), *Fissidens papillosus* was synonymized with *Fissidens serratus*, while in Iwatsuki and Suzuki (1982), Eddy (1988) and Stone (1994), the two taxa were treated as separate species. Our Thai specimens match well the illustrations of *Fissidens serratus* shown in Iwatsuki and Suzuki (1982), Eddy (1988) and Beever and Stone (1999). Therefore, we are accepting the two as separate taxa. *Fissidens papillosus* has been reduced to a synonym of *F. tenellus* Hook.f. *et* Wils. var. *australiensis* (A. Jaeger) Beever *et* Stone in Beever and Stone (1999).

Based on our study, the distinctions between *F. serratus* and *F. tenellus* var. *australiensis* are listed below.



Figs 11-19. *Fissidens jungermanniodes* Griff. (based on *K. Wongkuna* 306). **11.** plant. **12.** part of stem. **13.** leaves. **14.** leaf apex. **15.** cells at leaf base. **16.** leaf cells and thick limbidium at apical lamina. **17.** cells at dorsal lamina with part of the limbidium. **18.** margin of vaginant lamina showing the not well-differentiated limbidium. **19.** cross-section of leaf.



Figs 20-27. *Fissidens serratus* Müll.Hal. (based on *K. Wongkuna 440*). **20.** plant habit. **21.** plant with sporophyte. **22.** leaves. **23.** leaf apex. **24.** cells at vaginant lamina. **25-26.** cells at dorsal lamina. **27.** cells at apical lamina.

<i>Character</i>	<i>Fissidens serratus</i>	<i>Fissidens tenellus</i> var. <i>australiensis</i> (syn. <i>F. papillosus</i>)
Leaf shape	narrowly oblong lanceolate to narrowly lanceolate	oblong- lanceolate
Leaf apex	narrowly acute	broadly acute to acute
Leaf costa	percurrent to short excurrent	ending below apex
Leaf margin	regularly and strongly toothed; limbidia absent	serrate to spinose-serrate; limbidia at times weakly differentiated on perichaetial leaves

F. serratus sensu Iwatsuki and Suzuki (1982) and Beever and Stone (1999) is known from Japan, Java, India, Sri Lanka, Philippines, Papua New Guinea, and Australia and it is new to Thailand (cf. Tan and Iwatsuki, 1993).

Specimen studied: Chiang Mai Province, Muang District, Doi Suthep-Pui National Park, Ru See Cave, 960 m elev., on soil, 19 Nov 2006, coll. *K. Wongkuna 440* (CMU, SING).

MISCELLANIES AND EXCLUDED TAXA

1. *Fissidens excedens* Broth.

The first report of this southern Indian species of *Fissidens* from Thailand was made by Giesy and Richards in 1959. The holotype [India, Coorg, Sidapur, on shady clay banks, Feb 1898, coll. *T.L. Walker* (*Herb. Walker 284*), H-BR] was examined by us. The plants appear very close to *F. taxifolius* in many details, except that the leaves are more linear-lanceolate with more acute apices. However, the small, mammillose leaf cells, the lack of leaf limbidia and hyaline nodules on the stem, in addition to the unmistakably excurrent leaf costae, are strong similarities. Although no sporophyte is seen in the type specimen (see also Brotherus, 1899), but we find basal perichaetia attached to a few stems. Furthermore, the discussion of Smith (1978) on the variability of the leaf morphology of *F. taxifolius* as seen in Great Britain has convinced us that *F. excedens* is a new synonym of the widespread *F. taxifolius*.

2. *Fissidens laxitextus* Broth. ex Gangulee

A Thailand collection of this species from tree trunk along a streamlet in humid evergreen forest on Doi Ithanon in Payap, Chiang Mai (*Touw 10214*, MO), was determined as such by A.H. Norkett. Upon closer examination, the Thai specimen has limbidia clearly developed on some perichaetial leaves. Gangulee (1971) described the leaf border cells as slightly differentiated from inner laminal cells. Unaware of its limbate perichaetial leaf character, Gangulee (1971) had placed this species in the group of non-limbate species, together with *F. pellucidus* Hornsch. (syn. *F. mittenii* Par.), in his key to the *Fissidens* species in India.

3. *Fissidens papillulosus* Broth.

This reportedly Thailand and Myanmar species of *Fissidens* was originally described by Brotherus (1901) as a small limbate species with minutely papillose leaf cells. The holotype at H-BR (Siam, Koh Chang, coll. *J. Schmidt*) was examined and found to be the same as *Fissidens crenulatus* var. *elmeri* (Broth.) Z. Iwatsuki et T. Suzuki. The type specimen collected in 1900 has partially limbate leaves with mammillose-unipapillose leaf cells, and is without hyaline nodule on the stem. The setae are terminal measuring about 3-4 mm long. In the holotype packet was an annotation made by M. Bruggeman-Nannenga in 1994 suggesting a synonym of this species with *F. crenulatus*. Eddy (1988) and Li and Iwatsuki (2001) do not recognize the var. *elmeri*.

4. *Fissidens subspathulatus* Dix.

This Papua endemic (see Dixon, 1943; Eddy, 1988) was reported new to Thailand in the electronic moss checklist of Thailand posted at MO (<http://www.mobot.org/MOBOT/moss/Thailand/thai-f.shtml>) based on a Thai specimen [*LSaW 1976*, MO]. The specimen was studied and proved to be a misidentified *Fissidens crenulatus* Mitt. The detailed locality information of *LSaW 1976* is, "Northern Province, 10 km S of Bo Luang along the Om Koi trail".

Fissidens subspathulatus remains a New Guinea endemic not known from Thailand.

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REFERENCES

- BEEVER J.E. & STONE I.G., 1999 — Studies of *Fissidens* (Bryophyta: Musci): new taxa and new records for New Zealand. *New Zealand journal of botany* 37: 643-657.
- BROTHERUS V.F., 1899 — Contributions to the bryological flora of southern India. *Records of the botanical survey of India* 1(12): 315.
- BROTHERUS V.F., 1901 — Bryales. In: J. Schmidt. Flora of Koh Chang, Contributions to the knowledge of the vegetation in the Gulf of Siam. *Botanisk tidskrift* 24: 61-71.
- BRUGGEMAN-NANNENGA M.A. & PURSELL R.A., 1995 — Notes on *Fissidens* V. *Lindbergia* 20: 49-55.
- DIXON H.N., 1932 — On the moss flora of Siam. *Journal of the Siam society, natural history supplement* 9(1): 1-51.
- DIXON H.N., 1943 — Alpine mosses from New Guinea. *Farlowia* 1: 25-40.
- EDDY A., 1988 — *A Handbook of Malaysian Mosses. I. (Sphagnaceae to Dicranaceae)*. London, British Museum (Natural History).
- GANGULEE H.C., 1971 — *Mosses of Eastern India and Adjacent Regions. Vol. 1*. Calcutta, University of Calcutta.
- GIESY R.M. & RICHARDS P.W., 1959 — A collection of bryophytes from Thailand (Siam). *Transaction of British bryological society* 3: 575-581.

- IWATSUKI Z. & SUZUKI T., 1982 — A taxonomic revision of the Japanese species of *Fissidens* (Musci). *Journal of Hattori botanical laboratory* 51: 329-508.
- IWATSUKI Z. & SUZUKI T., 1999 — The status of *Fissidens involutus* and *F. curvato-involutus* (Musci, Fissidentaceae). *Hausknechtia Beiheft* 9 (*Ricléf Grolle Festschrift*): 217-220.
- Li Z.-H., 1985 — A revision of the Chinese species of *Fissidens* (Musci, Fissidentaceae). *Acta botanica Fennica* 129: 1-65.
- Li Z.-H. & IWATSUKI Z., 2001 — Fissidentaceae, pp. 3-67. In: Li X.-J. and M.R. Crosby (eds.) *Moss Flora of China (English Version), Vol. 2 (Fissidentaceae-Ptychomitriaceae)*. Beijing, Science Press and St. Louis, Missouri Botanical Garden.
- MAXWELL J.F., 2004 — A Synopsis of the Vegetation of Thailand. *The natural history journal of Chulalongkorn university* 4(2): 19-29.
- SMITH A.J.E., 1978 — *The Moss Flora of Britain and Ireland*. Cambridge, Cambridge University Press.
- STONE I.G., 1994 — *Fissidens* Section *Crenularia* C. Muell. in Australia. *Journal of bryology* 18: 169-180.
- TAN B.C. & IWATSUKI Z., 1993 — A checklist of Indochinese mosses. *Journal of Hattori botanical laboratory* 74: 325-405.
- TAN B.C., WONGKUNA (VONGKUNA) K., MANACHIT S. & SANTANACHOTE K., 2006 — New records of Thailand mosses collected from Chiang Mai Province. *Tropical bryology* 27: 95-100.
- WONGKUNA K., TAN B.C. & SANTANACHOTE K., 2009 — Two new *Fissidens* species from Thailand. *Gardens bulletin Singapore*: submitted.