

The Indian connection of the Thailand moss flora, with one new species, *Fissidens elizbrowniae*

Narin Printarakul¹, Benito C. Tan^{2,4}, Kanjana Wongkuna-Thananoppakun³
and Kanya Santanachote¹

¹Herbarium, Department of Biology, Faculty of Science, Chiang Mai University, Chiang Mai, 50200, Thailand

²The University Herbarium, University of California at Berkeley, CA, USA 94720

³Department of Biology, Faculty of Science and Technology, Pibulsongkram Rajabhat,
University, Phitsanulok, 5000, Thailand

⁴Author for correspondence: btakakia@yahoo.com

Abstract

Twenty species of mosses from northern Thailand are reported as new to the moss flora of the country. One of these, *Fissidens elizbrowniae* B.C.Tan & K.Wongkuna-Thananoppakun is described as a new species. Among the new records, a number of species exhibit a continuous range or disjunctive distribution between India and Thailand (Indochina), highlighting the little known floristic connection between the moss floras of Thailand (Indochina) and the Indian subcontinent. Other new moss records represent probable members of either the East Asiatic or Sino-Himalayan floras.

Introduction

The moss flora of Thailand has received much attention making its bryoflora the best known of the Indochina region. Recent studies of the moss flora in northern Thailand continue to yield new records and new taxa (Akiyama 2006; Pollawatn et al. 2008; Wongkuna et al. 2009; Nathi et al. 2010; Akiyama et al. 2010, 2011 and references listed therein; Printarakul et al. 2012, 2013). In a recent study, we discovered another 19 species of mosses, collected mostly from Doi Suthep-Pui National Park in Chiang Mai Province, and representing new records for the country. In addition, one undescribed species of *Fissidens* was found. We are pleased to name the new taxon after the late Dr. Elizabeth Brown, a well known Australasian hepaticologist.

The novelties in the Thai moss flora are reported below, with short notes on their diagnostic morphological features, habitat preferences, collection site, field ecological information and distribution. Full illustrations of 15 moss species that are either uncommon, rare and/or phytogeographically important are provided for identification purposes and because the mosses of Thailand are frequently not well illustrated in many publications.

New records and new species

1. *Anomobryum gemmigerum* Broth. (Bryaceae). Fig. 1.

In Thailand, this species is best recognized, among its congeners, by having numerous, reddish-brown gemmae clustered in the appressed leaf axils of the julaceous plant.

Distribution: Nepal, China, Japan, Philippines (see Zhang et al. 2007). New to Thailand.

Specimens examined: Thailand: Chiang Mai Province: Doi Suthep-Pui National Park, Pu Ping Palace, on roadside bank and granite rock in open area in disturbed places of evergreen forest, c. 1,400 m elevation, *Printarakul 5040* (CMU, L), 5365, 5622 (CMU).

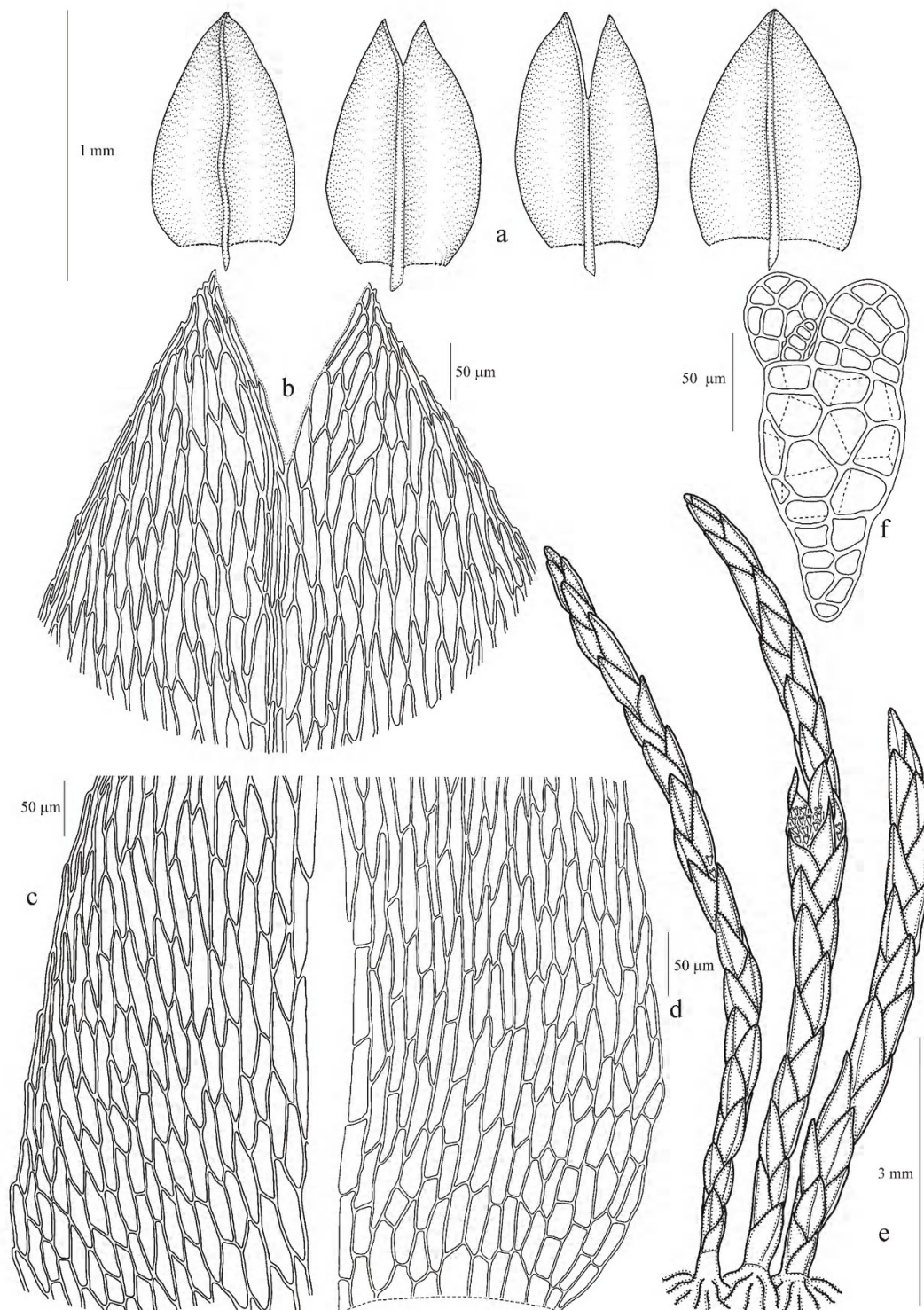


Fig. 1. *Anomobryum gemmigerum* Broth. (Bryaceae). **a**, leaves; **b**, apical leaf cells; **c**, marginal and median leaf cells; **d**, basal leaf cells; **e**, habit; **f**, gemma. All figures drawn from *Printarakul 5040* (CMU).

2. *Anomobryum julaceum* (Schrad. ex P.Gaertn., B.Mey. & Scherb.) Schimp. (Bryaceae).

This species is recognized by the worm-like habit with imbricate leaves having vermiculate to linear, thick-walled, apical cells and a single costa ending below the leaf apex.

Distribution: Subcosmopolitan and common in high mountains in the tropics (Eddy 1996; Zhang et al. 2007).

Specimens examined: Thailand: Chiang Mai Province: Doi Suthep-Pui National Park, San Gu, on roadside soil bank in open area in disturbed sites of evergreen forest, c. 1,650 m elevation, *Printarakul* 1385 (CMU, L); Doi Mon Long, on soil in open area in evergreen forest, c. 1,430 m elevation, *Printarakul* 5593, 5630 (CMU); Doi Chiang Dao National Park: on rock in open grassland, 1,767 m elevation, *Printarakul* 5145 (CMU, L).

3. *Archidium birmannicum* Mitt. ex Dixon (Archidiaceae). Fig. 2.

This species of *Archidium* is rarely collected due to its small size and ephemeral existence. When encountered, it is easily recognized by its globose, immersed capsules containing 8–16 large spores. The narrowly acuminate leaves with elongate rhomboid to hexagonal leaf cells help distinguish this species.

Distribution: India, Burma, Malaysia, New Guinea (see Gangulee 1971; Eddy 1988). New to Thailand.

Specimens examined: Thailand: Chiang Mai Province: Doi Suthep-Pui National Park, Huay Chang Kian stream and Huay Gayo (Kaew) waterfall, on soil near stream in open areas in deciduous dipterocarp-oak forest, c. 375–400 m elevation, *Printarakul* 312 (CMU, L), 5514 (CMU, L).

4. *Entodontopsis nitens* (Mitt.) W. R.Buck & Ireland (Stereophyllaceae). Fig. 3.

Among its congeners in Thailand, this is the only species characterized by having leaves with the apex bluntly obtuse.

Distribution: India, China and Vietnam (see Li 2008). New to Thailand.

Specimen examined: Thailand: Chiang Mai Province: Doi Chiang Dao National Park, on rotten logs in moist sites of primary evergreen hardwood forest, 1,538 m elevation, *Printarakul* 5137 (CMU, L).

5. *Epipterygium tozeri* (Grev.) Lindb. (Mniaceae).

This moss is characterized by having dimorphic leaves in 2 or 3 rows that are distantly arranged: small, oblong and acute dorsal leaves, coupled with large, ovate to elliptic lateral leaves. The single leaf costa ends below the leaf apex, and leaf cells are lax, rhomboid to hexagonal and thin-walled.

Distribution: North America, Europe, Africa, Iran, India, China, Korea, Japan, Philippines, Malaysia, Indonesia (see Noguchi 1988; Eddy 1996; Zhang et al. 2007). New to Thailand.

Specimens examined: Thailand: Chiang Mai Province: Doi Suthep-Pui National Park, Ru See (Hermit) Cave and Doi Pui, on soil and base of tree trunk in moist sites of primary evergreen, hardwood forest, c. 1,120–1,680 m elevation, *Printarakul* 2162 (CMU, L), 2491 (CMU, L, SING).

6. *Eurhynchium laxirete* Broth. (Brachytheciaceae). Fig. 4.

This species is recognized by its loosely complanate-prostrate branches with rather similar stem and branch leaves. The leaf costa is single, ending in a spine, and leaf margins are serrate nearly throughout.

Distribution: China, Korea, Japan (see Wang & Hu 2008). New to Thailand.

Specimen examined: Thailand: Chiang Mai Province: Doi Suthep-Pui National Park: Pu Ping Palace, on moist soil in disturbed places in primary evergreen hardwood forest, c. 1,400 m elevation, *Printarakul* 1242 (CMU, L).

7. *Fissidens closteri* Austin subsp. *kiushiensis* (Sakurai) Z.Iwats. (Fissidentaceae). Fig. 5.

This species is a minute plant with 1–4 leaf pairs, coupled with a scabrid calyptra and an erect, ovoid capsule.

Distribution: China and Japan (see Li & Iwatsuki 2001). New to Thailand.

Specimens examined: Thailand: Chiang Mai Province: Doi Suthep-Pui National Park, Sirindhorn Observatory Area, on soil and rocks in moist areas in mixed deciduous forests, 810–850 m elevation, *Printarakul* 3314, 3341 (CMU, L).

8. *Fissidens curvato-involutus* Dixon (Fissidentaceae). Fig. 6.

This species resembles *F. crispulus* Brid. in having mammillose cells and being elimbate. It differs by having a long seta and an asymmetric, horizontal capsule.

Distribution: Pakistan, India, Nepal, Indonesia, New Guinea (see Suzuki & Iwatsuki 2011a). New to Thailand.

Specimen examined: Thailand: Chiang Mai Province: Doi Chiang Dao National Park, on moist rocks in evergreen forest, 2,033 m elevation, *Printarakul* 5173 (CMU, L).

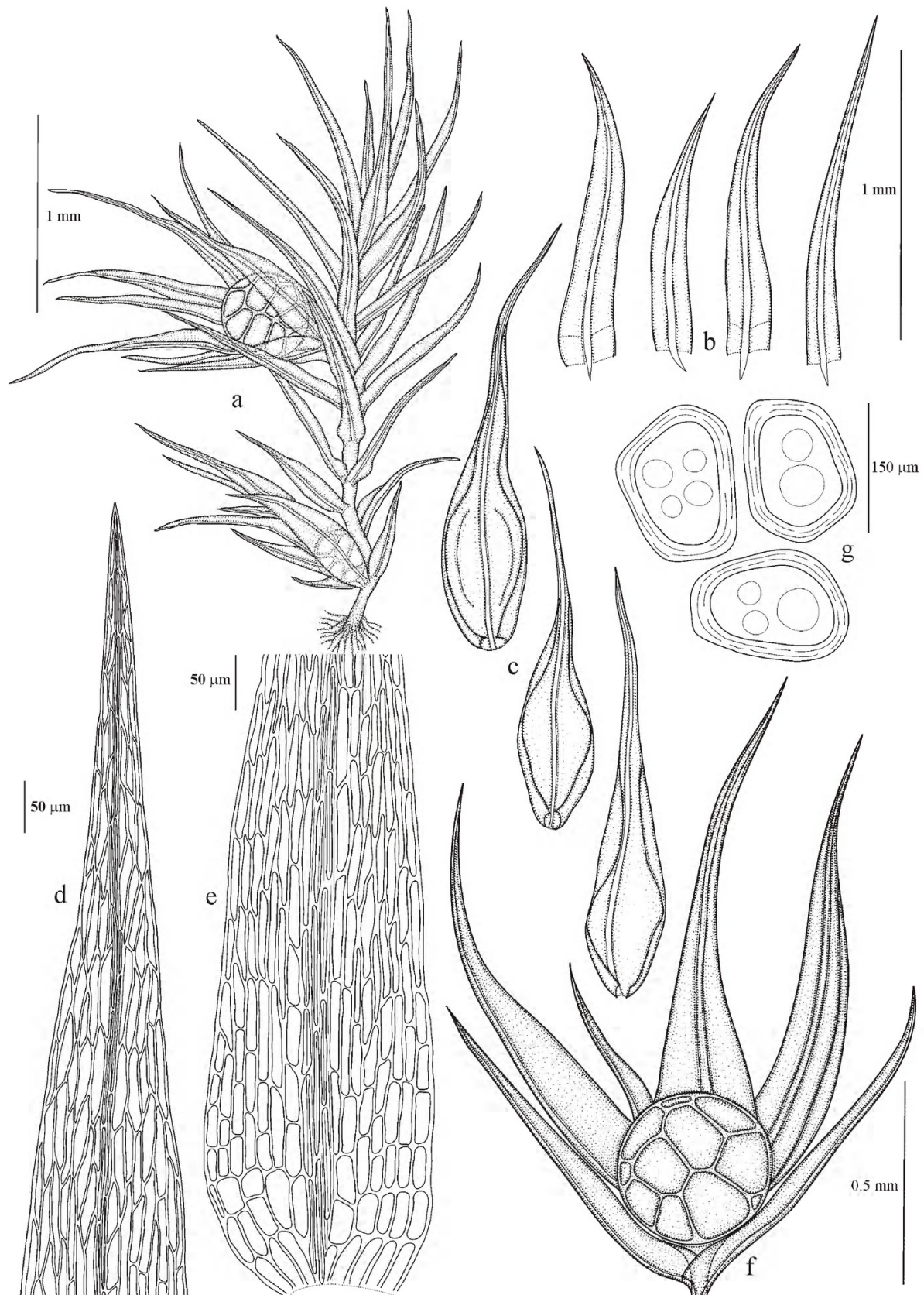


Fig. 2. *Archidium birmannicum* Mitt. ex Dixon (Archidiaceae). **a**, plant with sporophytes; **b**, leaves; **c**, perichaetial leaves; **d**, apical leaf cells; **e**, basal leaf cells; **f**, sporophyte and perichaetial leaves; **g**, spores. All figures drawn from *Printarakul 312* (CMU).

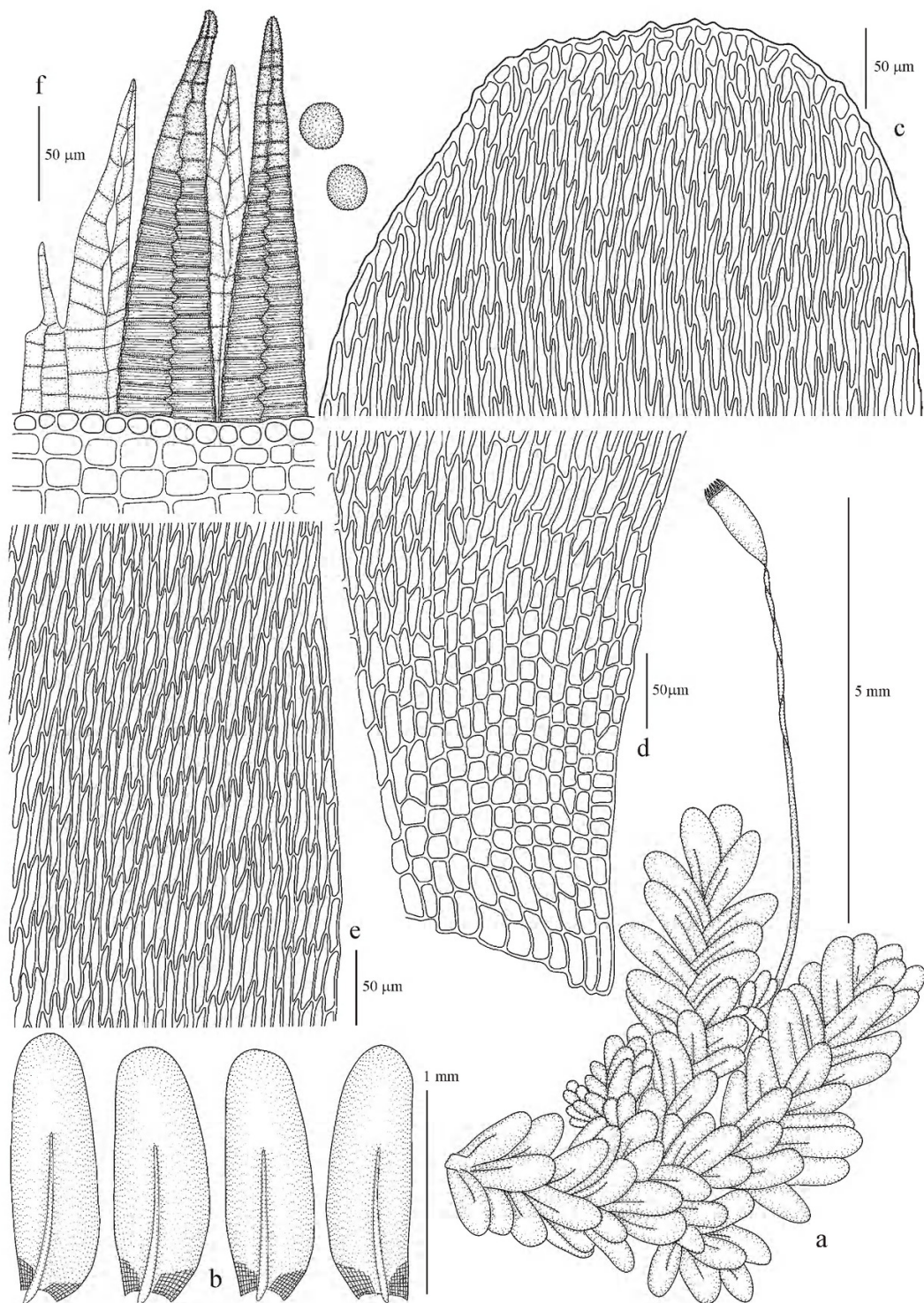


Fig. 3. *Entodontopsis nitens* (Mitt.) W.R.Buck & R.R.Ireland (Stereophyllaceae). **a**, plant with sporophyte; **b**, leaves; **c**, apical leaf cells; **d**, basal leaf cells; **e**, median leaf cells; **f**, portion of peristome and spores. All figures drawn from *Printarakul 5137* (CMU).

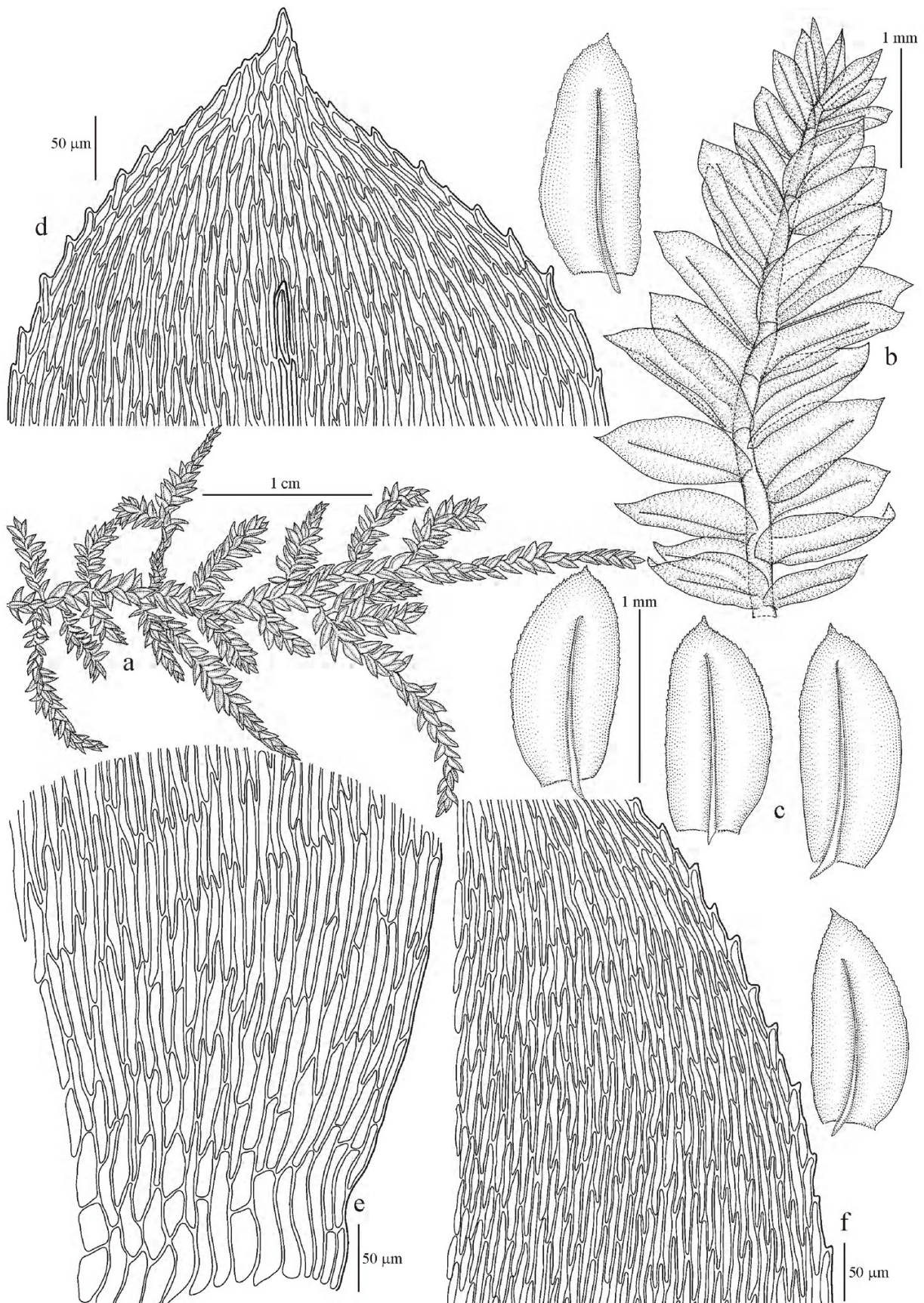


Fig. 4. *Eurhynchium laxirete* Broth. (Brachytheciaceae). **a**, habit; **b**, branch; **c**, leaves; **d**, apical leaf cells; **e**, basal leaf cells; **f**, marginal and median leaf cells. All figures drawn from *Printarakul 1242* (CMU).

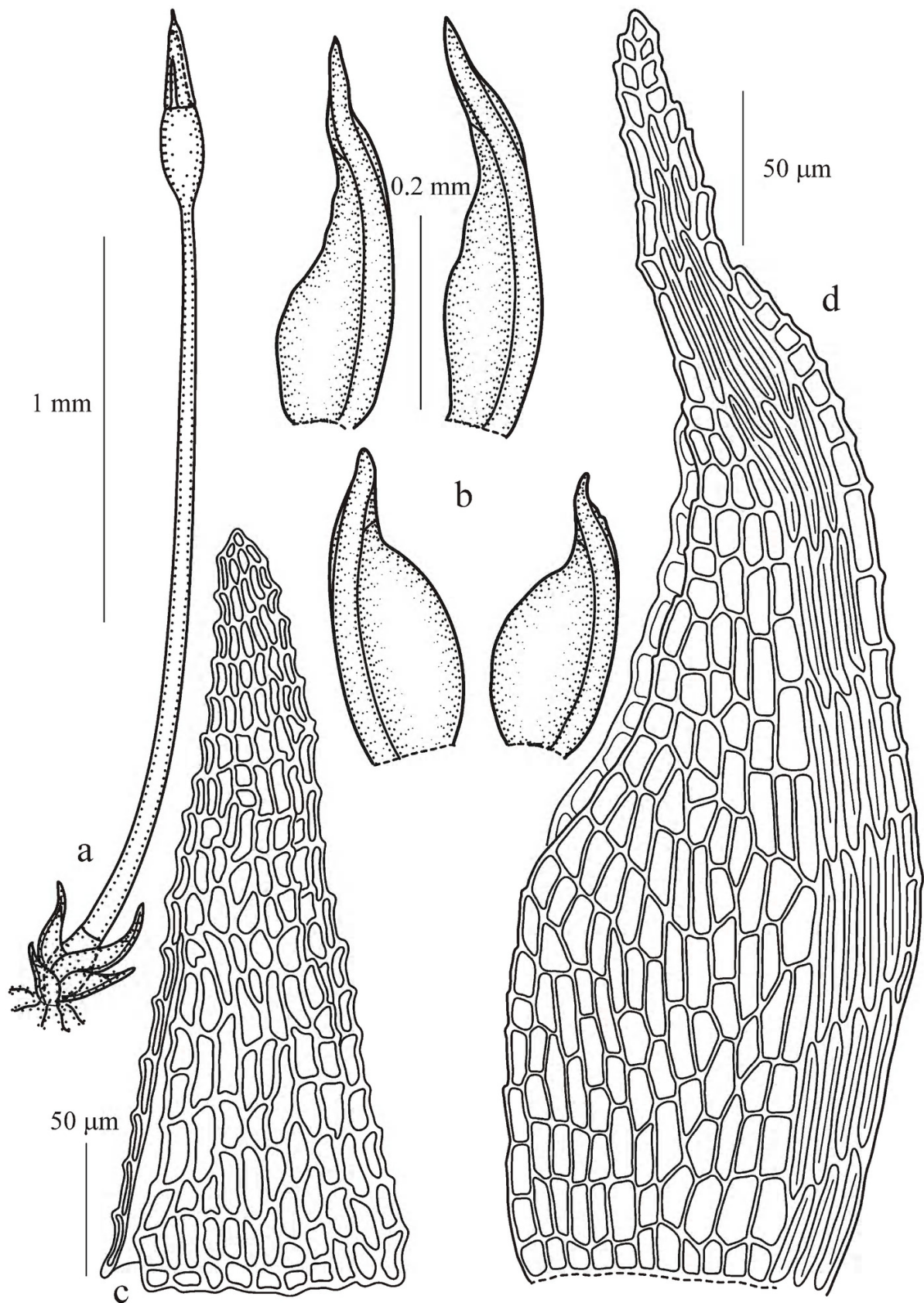


Fig. 5. *Fissidens closteri* Austin subsp. *kiushiuensis* (Sakurai) Z.Iwats. (Fissidentaceae). **a**, plant with sporophyte; **b**, leaves; **c**, calyptra; **d**, leaf areolation. All figures drawn from *Printarakul 3314* (CMU).

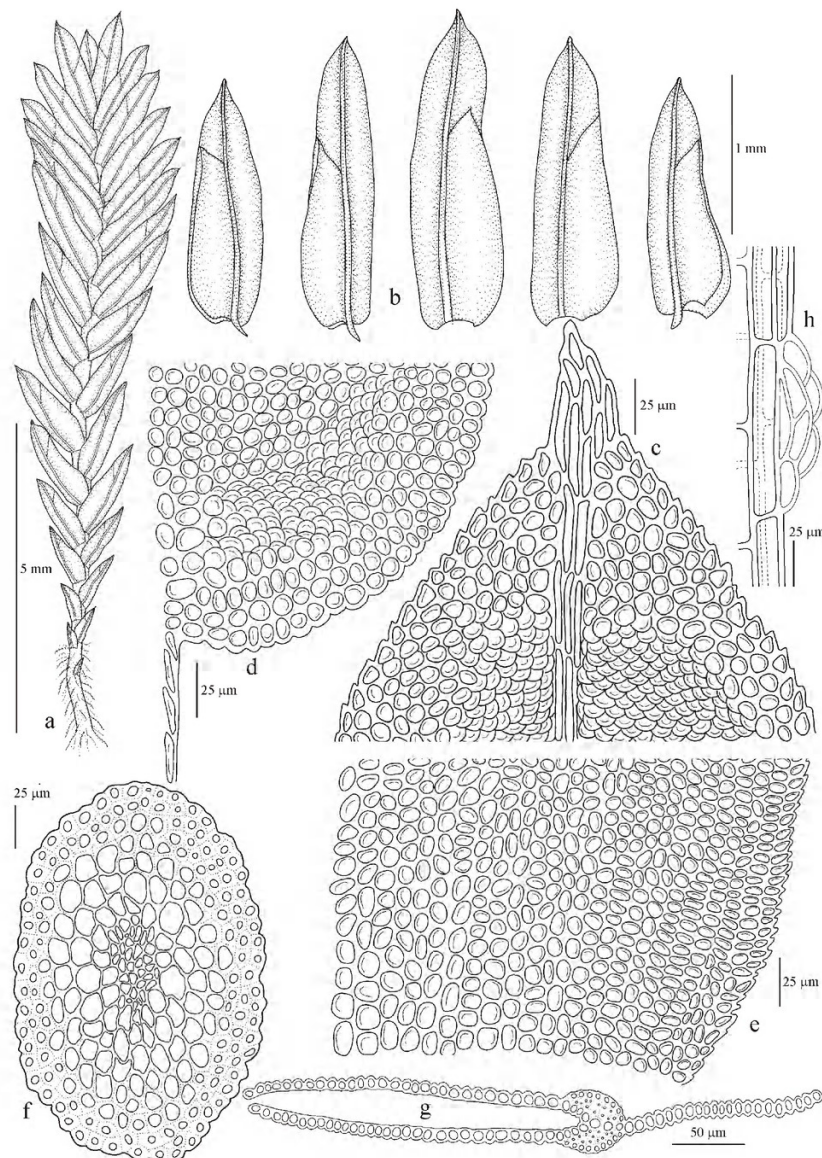


Fig. 6. *Fissidens curvato-involutus* Dixon (Fissidentaceae). **a**, habit; **b**, leaves; **c**, apical leaf cells; **d**, cells at base of dorsal lamina; **e**, vaginant lamina cells; **f**, cross section of stem; **g**, cross section of leaf; **h**, axillary hyaline nodule. All figures drawn from Printarakul 5173 (CMU).

9. *Fissidens elizbrowniae* B.C.Tan & K.Wongkuna-Thananoppakun, *sp. nov.* (Fissidentaceae). Fig. 7.

Holotype: Thailand: Phetchaburi Province: Kaeng Krachan National Park, on shaded soil in mixed evergreen and deciduous, hardwood forest, c. 960 m elevation, *Wongkuna 1532* (CMU).

Plants small. Stems to 5 mm tall, yellow-green, simple, not branched, central strand not differentiated, hyaline nodules well-developed. Leaves 18–24, densely arranged, lowest leaves small, middle to upper leaves much larger, narrowly lanceolate, 1.5–2 mm long, 0.2–0.25 mm wide, apex long and narrowly acuminate, leaf base not decurrent; leaf margin entire, with limbidia, consisting of 1 or 2 rows of elongate cells, differentiated all around the leaves, but weakly developed at leaf apex; leaf costa strongly excurrent; vaginant lamina about 3/5 of leaf length; apical laminal cells similar to those on dorsal lamina, polygonal, 6–10 µm long, 5–8 µm wide, thin-walled, multipapillose with more than 8 small papillae per cell; vaginant laminal cells similar to those of the apical lamina. Sporophyte not seen.

This species is closely allied to *F. kinabaluense* Z.Iwats. (see Iwatsuki 1969) in having similar foliation with linear-lanceolate leaves, but differs in having strongly excurrent costa and the presence of limbidium all around the laminae. In *F. kinabaluense*, the costa is short-excurrent and the limbidium is present only on vaginant laminae of leaves.

Additional specimen examined: Thailand: Phetchaburi Province: Kaeng Krachan National Park, on shaded soil in mixed evergreen and deciduous, hardwood forest, c. 960 m elevation, *Wongkuna 1533* (paratype, CMU).

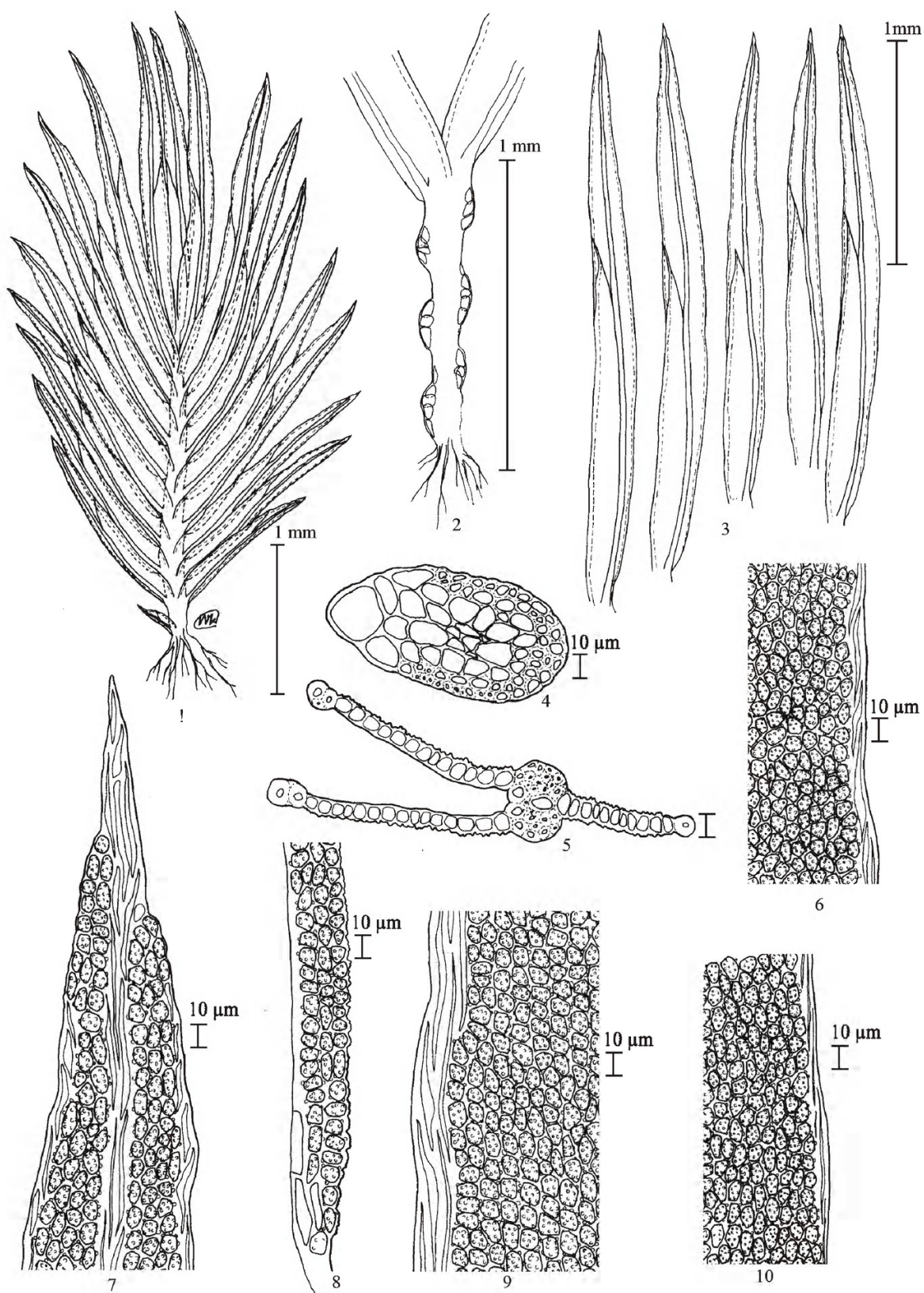


Fig. 7. *Fissidens elizbrowniae* B.C.Tan & K.Wongkuna-Thananoppakun (Fissidentaceae). **a**, habit; **b**, axillary hyaline nodules; **c**, leaves; **d**, cross section of stem; **e**, cross section of leaf; **f**, dorsal laminal cells; **g**, apical leaf cells; **h**, cells at base of dorsal lamina; **i**, vaginant laminal cells; **j**, upper laminal cells. All figures drawn from holotype *Wongkuna 1532* (CMU).

Distribution: Endemic to Thailand.

10. *Fissidens hyalinus* Hook. & Wilson (Fissidentaceae). Fig. 8.

In Thailand this species is easily identified by the leaf having very lax areolation, ecostate, and with a limbidium of 1 or 2 rows of cells.

Distribution: Subcosmopolitan (Gangulee 1971; Eddy 1988; Li & Iwatsuki 2001). New to Thailand.

Specimens examined: Thailand: Chiang Mai Province: Doi Suthep-Pui National Park, Sirindhorn Observatory and Ru See Cave area, locally not uncommon on shaded, moist soil in mixed evergreen and deciduous forests, *Printarakul* 2290, 2375, 4212 (CMU, L); summit of Doi Inthanon National Park, between 897–2,565 m elevation, *Wongkuna* 448, 981, 982 (CMU).

11. *Fissidens serratus* Müll. Hal. (Fissidentaceae). Fig. 9.

The plants in the Thai population differs from the typical plants of this species in having more narrowly acuminate leaf apices, more strongly and irregularly toothed margins of the vaginant laminae of perichaetial leaves, and the presence of often weakly and incompletely developed limbidia in upper and perichaetial leaves. Although *F. serratus* is reported to be a variable species (see Pursell 2007), the differences in leaf morphology outlined above may warrant a separate taxonomic recognition of the Thai population in a future revision of the morpho types of *Fissidens serratus* on a worldwide basis.

Distribution: Pantropical, reaching Australia and New Zealand and South America (Li & Iwatsuki 2001; Pursell 2007). A new species record for Thailand.

Specimen examined: Thailand: Chiang Mai Province: Doi Suthep Pui National Park, Ru See (Hermit) Cave and Pu Ping Palace, on soil in shaded primary, evergreen hardwood forest, c. 1,250–1,400 m elevation, *Printarakul* 3056 (CMU), *Wongkuna* 162 (CMU).

12. *Phyllodon bilobatus* (Dixon) P.Câmara (Hypnaceae). Fig. 10.

This species is characterized by having rounded-bilobed, ovate-oblong leaves with the margin doubly spinose. Leaf cells are linear-rhomboid and leaf cell papillae are formed by an extension of the cell tip.

Distribution: Southeast Asia (Gangulee 1980). New to Thailand.

Specimens examined: Thailand: Chiang Mai Province: Doi Suthep-Pui National Park, Sai Yoi Waterfall, on wet rocks near a stream in mixed evergreen and deciduous forests, 925 m elevation, *Printarakul* 3595A, 3852 (CMU, L).

13. *Physcomitrium eurystomum* Sendtn. (Funariaceae).

This species has oblong-obovate leaves with margin bluntly denticulate in the upper part and distinctly bordered by 1 or 2 rows of elongate cells. The costa is percurrent to shortly excurrent and the operculum has a conical-rounded apiculus. The seta is long, 4–10 mm, and yellowish orange.

Distribution: Europe, Russia, Africa, India, China, Japan, Vietnam, (see Li et al. 2003). New to Thailand.

Specimens examined: Thailand: Chiang Mai Province: Doi Suthep-Pui National Park, Doi Pui, on soil in disturbed places of primary evergreen hardwood forest, c. 1,550 m elevation, *Printarakul* 2192, 2531 (CMU, L).

14. *Physcomitrium sphaericum* (C.F.Ludw.) Fühnr. (Funariaceae). Fig. 11.

Compared to *Physcomitrium eurystomum*, this species is characterized by having leaves with the upper margin bluntly serrulate and indistinctly bordered by elongate cells. The costa is percurrent and the seta is short, 2–3 mm long and reddish brown.

Distribution: North America, Europe, Russia, China, Japan, (see Li et al., 2003). New to Thailand.

Specimens examined: Thailand: Chiang Mai Province: Doi Suthep-Pui National Park, Pu Ping Palace, on soil in disturbed places of evergreen hardwood forest, c. 1,400 m elevation, *Printarakul* 196 (CMU, L); Chiang Mai University Main Library Garden, on soil, c. 350 m elevation, *Printarakul* 2577 (CMU, L).

15. *Splachnobryum obtusum* (Brid.) Müll. Hal. (Splachnobryaceae). Fig. 12.

This species has the following diagnostic features: a small plant with lingulate to oblong-elliptic leaves and a leaf costa ending below the obtuse apex. The leaf cells at apex and margin are smaller than the inner cells, usually subquadrate or irregularly rhomboid. The leaf margin is flat (plane) or sometimes recurved.

Distribution: Subcosmopolitan fide He & Gao (2003). New to Thailand.

Specimens examined: Thailand: Chiang Mai Province: Chom Thong District, Chiang Mai Moss Garden, on soil in moist areas, c. 900 m elevation, *Printarakul* 1836 (CMU, L); Doi Suthep-Pui National Park, Mae Sa Waterfall, Tad Yoi Waterfall,

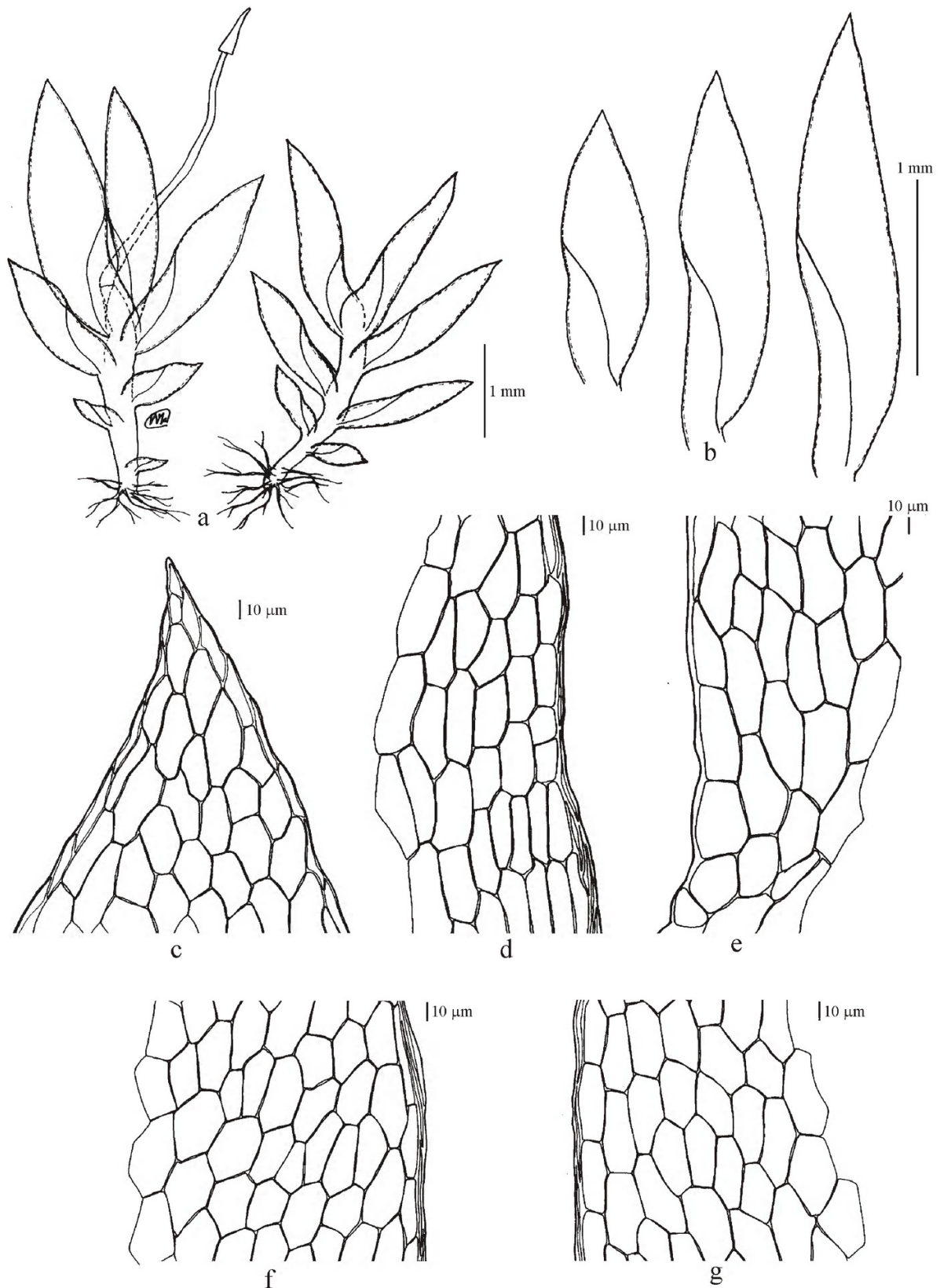


Fig. 8. *Fissidens hyalinus* Hook. & Wilson (Fissidentaceae). **a**, plants with a sporophyte; **b**, leaves; **c**, apical leaf cells; **d**, vaginant laminal cells; **e**, cells at base of dorsal lamina; **f**, apical laminal cells; **g**, dorsal laminal cells. All figures drawn from Wongkuna 981 (CMU).

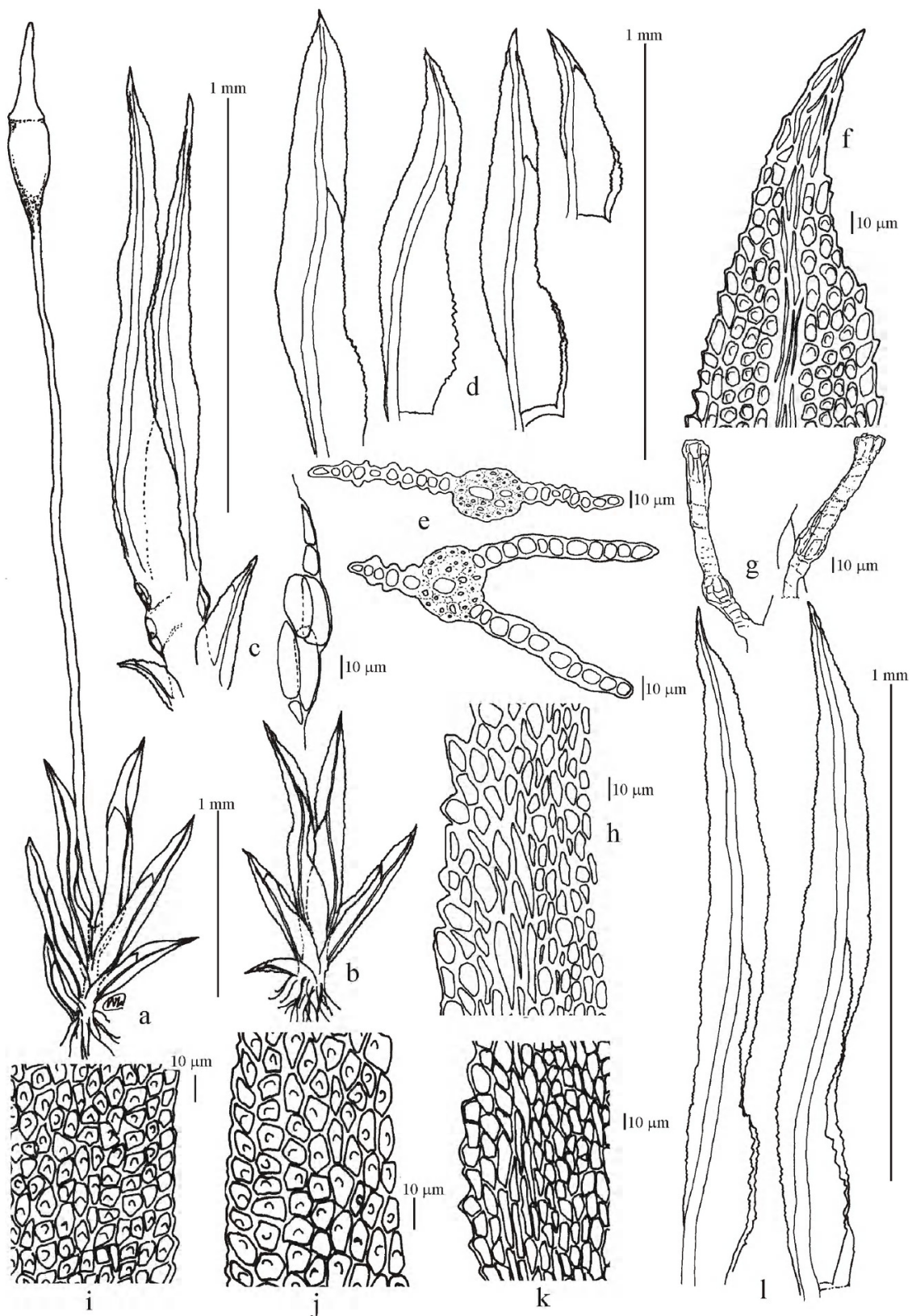


Fig. 9. *Fissidens serratus* Müll. Hal. (Fissidentaceae). **a**, plan with sporophyte; **b**, plant; **c**, axillary hyaline nodules; **d**, leaves; **e**, cross sections of leaves; **f**, apical leaf cells; **g**, archaegonia; **h**, margin of perichaetial leaf showing the poorly differentiated limbidium; **i**, dorsal laminal cells; **j**, apical laminal cells; **k**, vaginant laminal cells; **l**, perichaetial leaves. All figures drawn from Wongkuna 162 (CMU).

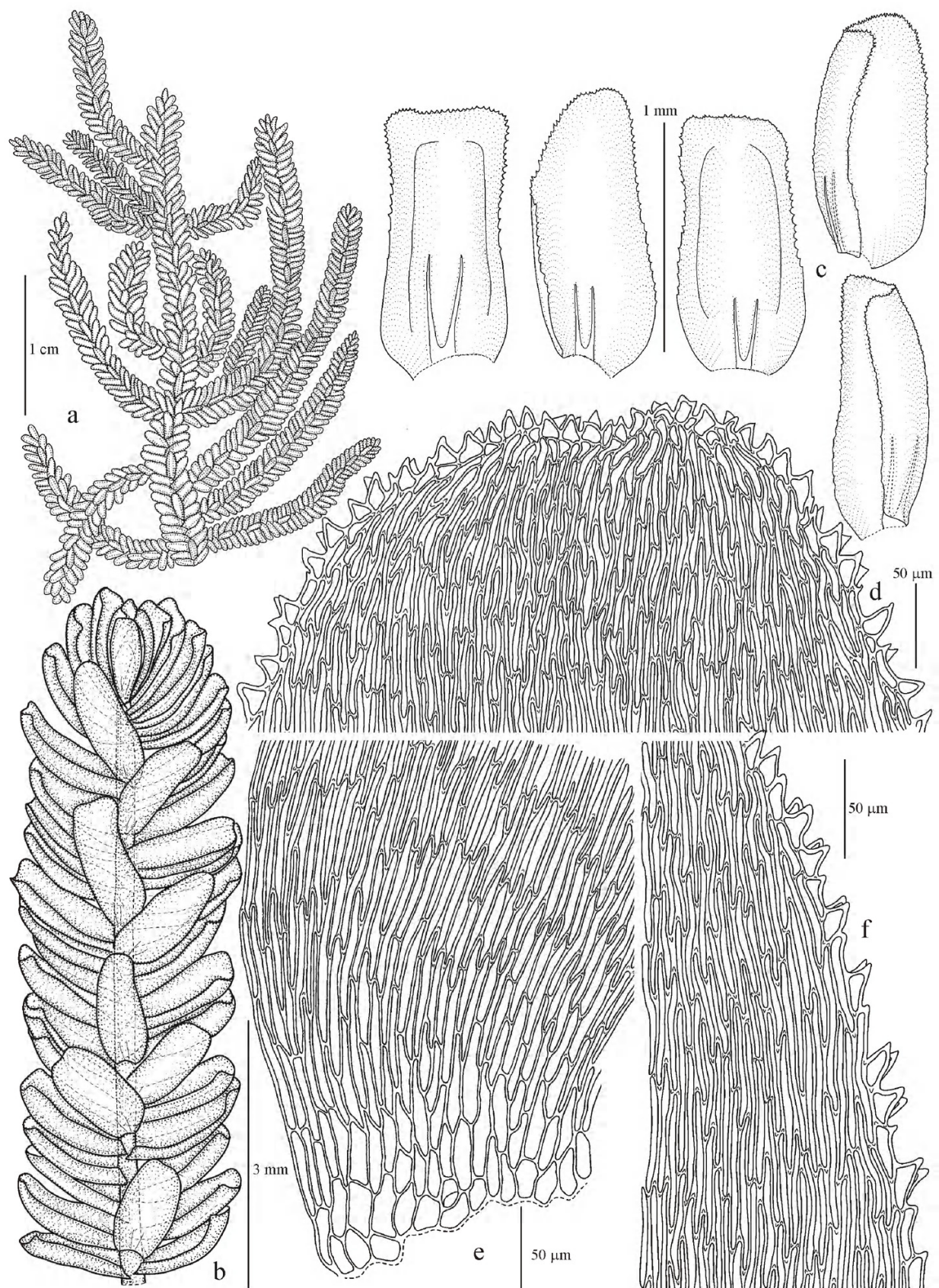


Fig. 10. *Phyllodon bilobatus* (Dixon) P.Câmara, (Hypnaceae). **a**, habit; **b**, branch; **c**, leaves; **d**, apical leaf cells; **e**, basal leaf cells; **f**, marginal leaf cells. All figures drawn from *Printarakul 5395A* (CMU).

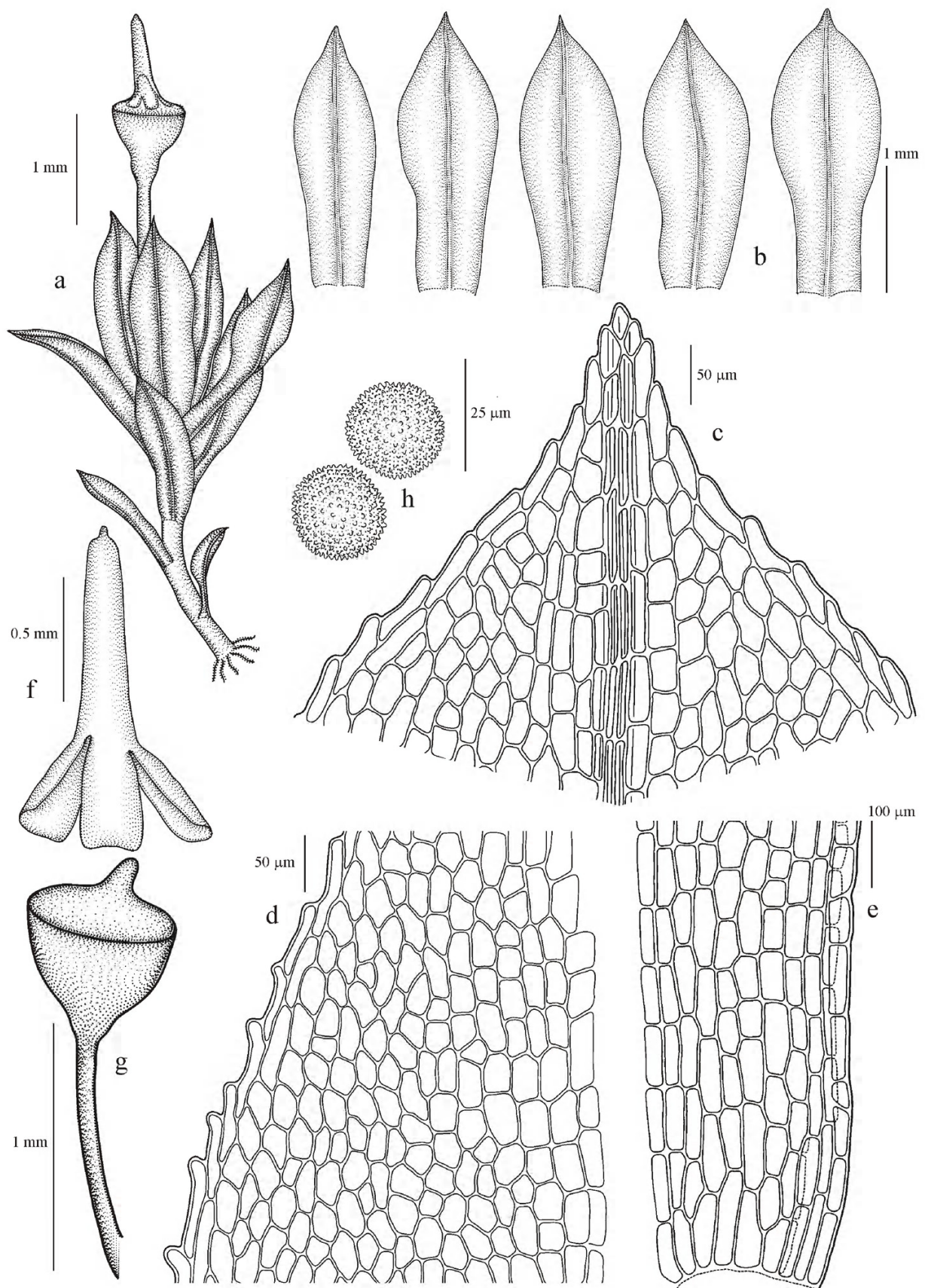


Fig. 11. *Physcomitrium sphaericum* (C.F.Ludw.) Fühnr. (Funariaceae). **a**, plant with sporophyte; **b**, leaves; **c**, apical leaf cells; **d**, marginal leaf cells; **e**, basal leaf cells; **f**, calyptra; **g**, capsule; **h**, spores. All figures drawn from *Printarakul 2577* (CMU).

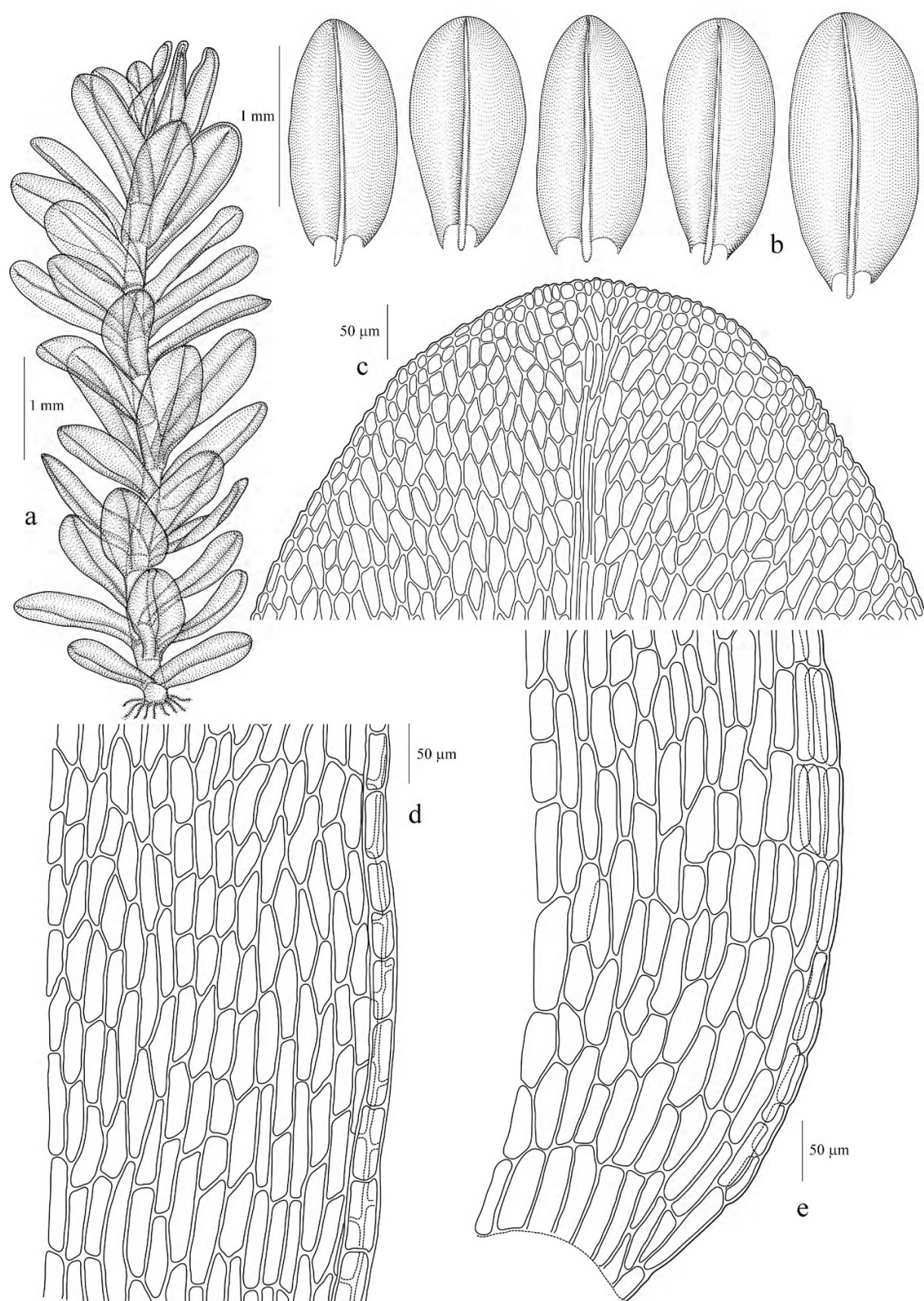


Fig.12. *Splachnobryum obtusum* (Brid.) Müll. Hal. (Splachnobryaceae). **a**, habit; **b**, leaves; **c**, apical leaf cells; **d**, marginal leaf cells; **e**, basal leaf cells. All figures drawn from *Printarakul 1836* (CMU).

and Gayo (Kaew) Ta Chang Fall, on thin soil on rock near waterfalls, in deciduous dipterocarp-oak forest, c. 417–530 m elevation, *Printarakul* 5787, 5797, 6151, 6164, 6170, 6220 (CMU).

16. *Tortella walkeri* (Broth.) R.H.Zander (Pottiaceae). Fig. 13.

This species is characterized by having a small and rosette forming plant habit. The leaves are oblong-spathulate, obtuse, with apex mucronate, and the leaf cells are obscure and multi-papillose. Capsules erect, ovoid-cylindrical, with no peristome.

Distribution: India (Gangulee 1972, as *Hyophila walkeri* Broth.). New to Thailand.

Specimen examined: Thailand: Chiang Mai Province: Doi Chiang Dao National Park, on tree trunk in primary, evergreen hardwood forest, 1,593 m elevation, *Printarakul* 5141A (CMU, L).

17. *Trachyphyllum jeyporens* Thér. & Dixon in P.Varde (Entodontaceae). Fig. 14.

This species is characterized by having narrowly acuminate leaves with double unequal costae ending at the middle of the leaf. The leaf cells are prorulose at the upper ends and leaf alar region is well differentiated with several quadrate cells.

Distribution: India (Gangulee 1980). New to Thailand.

Specimens examined: Thailand: Chiang Mai Province: Doi Suthep-Pui National Park, Monthathan waterfalls, on rocks in moist sites in mixed evergreen and deciduous forests, 820 m elevation, *Printarakul* 1259 (CMU, L, SING), 3828 (CMU, L).

18. *Venturiella sinensis* (Venturi) Müll. Hal. (Erpodiaceae).

This species is recognized by having oblong-ovoid and immersed capsules that are surrounded with large perichaetial leaves. The leaves are ovate to oblong-ovate often with long hyaline acumen. The leaf cells are rounded, rhomboid to hexagonal or subquadrate at margins. The annulus of capsule is persistent, 3–5 cells high, and the single peristome is reddish brown (when fresh) and papillose.

Distribution: North America, China, Korea, Japan (see Noguchi 1988; Wang 2011). New to Thailand. *Venturiella sinensis* is a widespread species in eastern Asia and eastern North America. Therefore, its presence in Thailand is not surprising. This monotypic genus is also a new record for Indochina.

Specimens examined: Thailand: Chiang Mai Province: Doi Suthep-Pui National Park, Huay Chang Kian Stream, on branches of tree trunks and shrub near a semi-shaded stream in deciduous dipterocarp-oak forest, 474 m elevation, *Printarakul* 4834 (CMU, L); Doi Khum, on tree trunk in deciduous, dipterocarp-oak forest, 413 m elevation, *Printarakul* 6019 (CMU).

19. *Zygodon viridissimus* (Dick.) Brid. (Orthotrichaceae).

This species has small leaves with apex acuminate. The leaf cells are obscure and multi-papillose. Fusiform gemmae are abundant. Capsules are pyriform, furrowed and peristome is absent.

Distribution: Widespread in Northern Hemisphere (see Jia et al. 2011; Suzuki & Iwatsuki 2011b). New to Thailand.

Specimen examined: Thailand: Chiang Mai Province: Doi Chiang Dao National Park, on tree trunk in primary, evergreen hardwood forest, 1,593 m elevation, *Printarakul* 5141B (CMU, L).

Hondaella caperata and *Entodon longifolius*

Hondaella caperata (Mitt.) B.C.Tan & Z.Iwats. (Fig. 15) is locally common in Doi Suthep-Pui and Doi Chiang Dao National Parks. This hypnaceous species has distinctive leaf alar region consisting of numerous leaf cells, an erect oblong capsule, and a yellowish, cross-striate exostome. The combined morphological features make the species look like *Entodon longifolius* (Müll. Hal.) A.Jaeger. The latter appears to be a species of confused taxonomic status in many publications. According to the latest revision of *Entodon* in eastern Asia (Zhu et al. 2010), the species was originally described from India based on sterile material. Although considered an endemic to India, Gangulee (1980) did not treat it in his flora. In publications on the moss flora of China, the leaf apex of this species was described differently, either as acute to shortly acuminate (Hu 1983; Zhu et al. 2010) or long-acuminate (see Hu and Wang 2008). The illustration of *E. longifolius* showing long-acuminate leaf apices, an erect, oblong capsule and striolate peristome teeth in the newly published English version of Chinese moss flora (see Hu and Wang 2008, Plate 562) is misleading. The illustration is probably based on a misidentified specimen of *Hondaella caperata* because in the species description of *E. longifolius* (Hu and Wang 2008, p. 183), the sporophyte is reported as “not seen”.

Hondaella caperata was first reported from Thailand by Horikawa and Ando (1964).

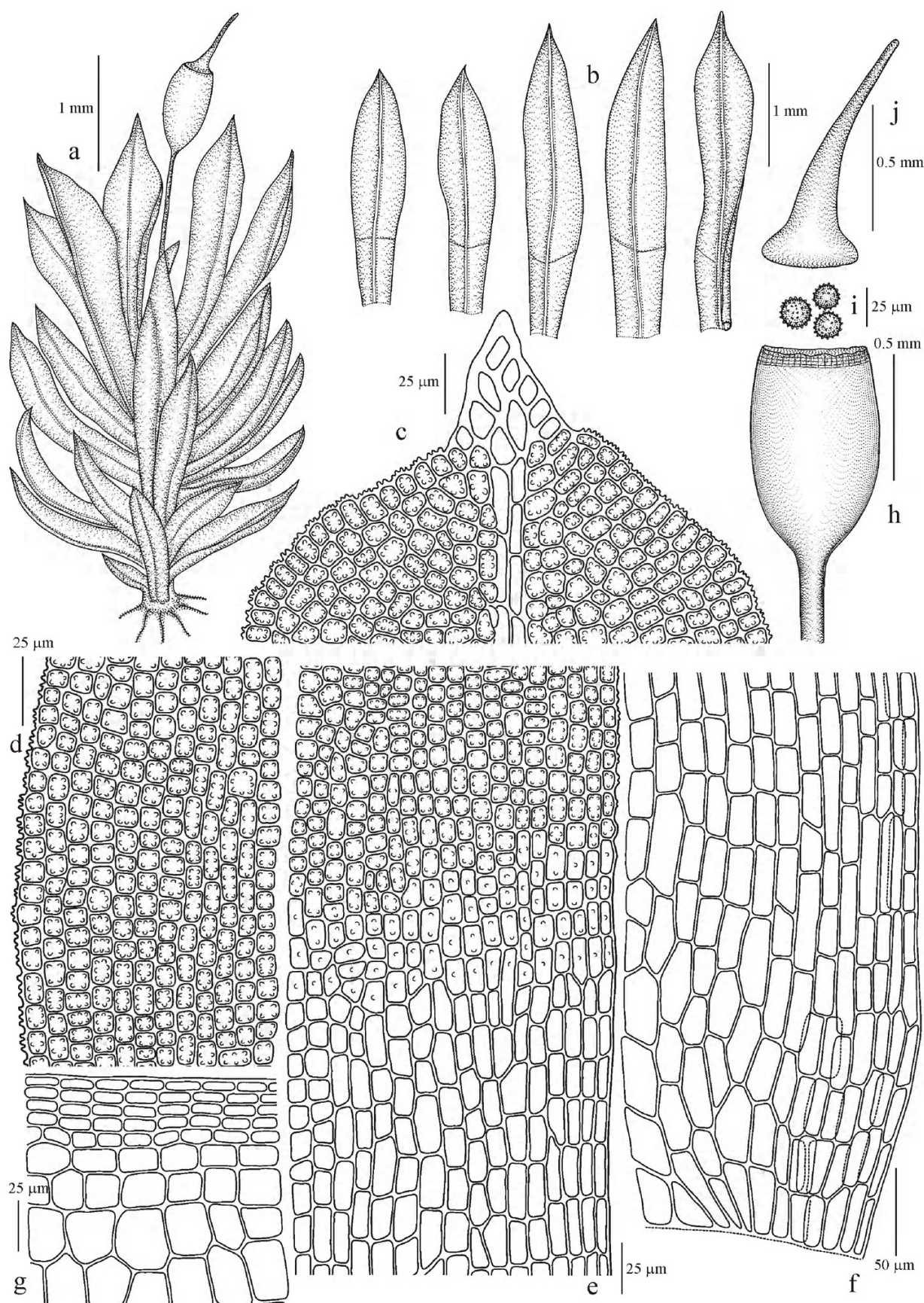


Fig. 13. *Tortella walkeri* (Broth.) R.H. Zander (Pottiaceae). **a**, plant with sporophyte; **b**, leaves; **c**, apical leaf cells; **d**, marginal leaf cells; **e**, transitional cells; **f**, basal leaf cells; **g**, exothecial cells of capsule; **h**, capsule; **i**, spores; **j**, operculum. All figures drawn from *Printarakul 5141A* (CMU).

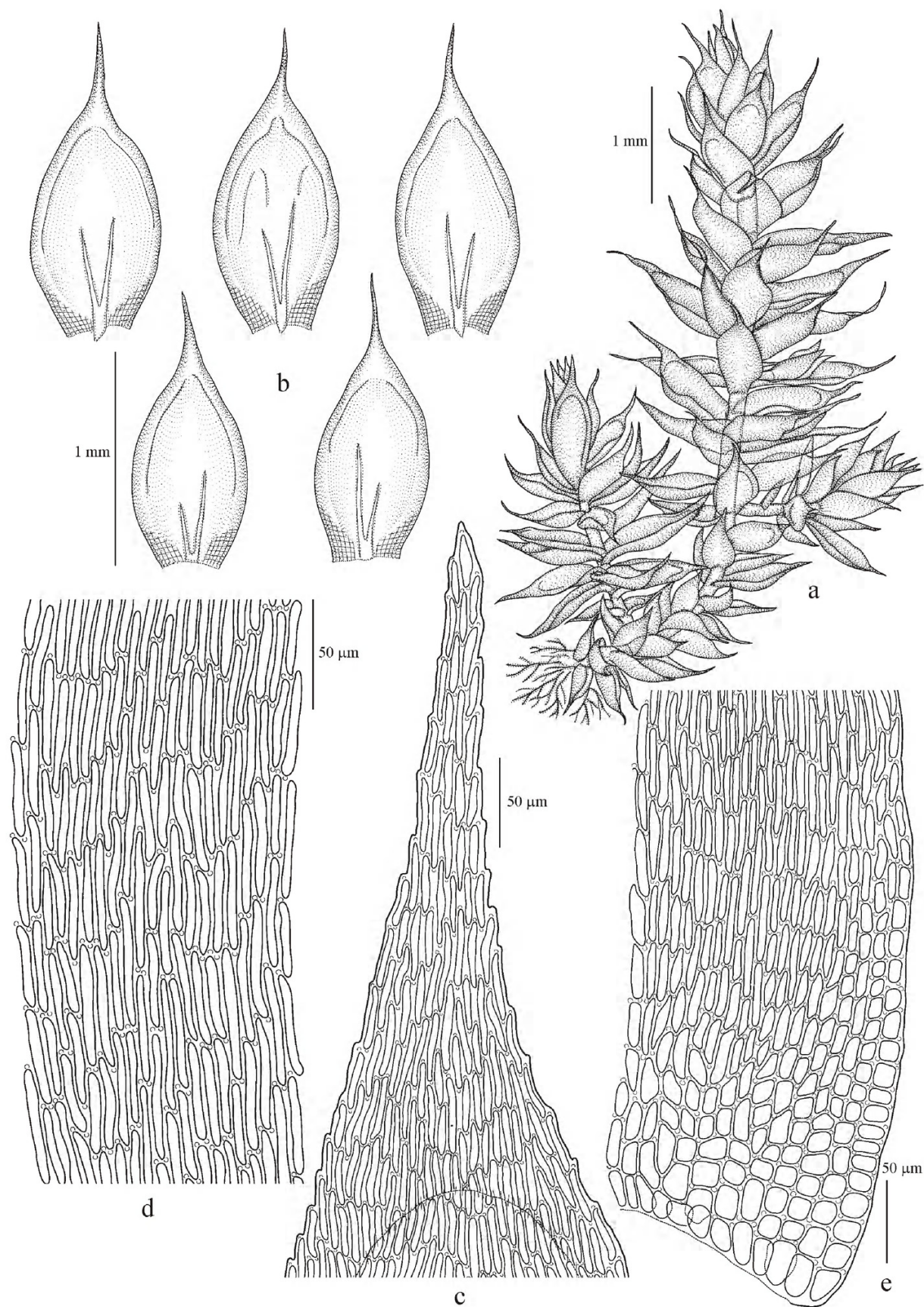


Fig. 14. *Trachyphyllum jeyporensis* Thér. & Dixon (Entodontaceae). **a**, habit; **b**, leaves; **c**, apical leaf cells; **d**, median leaf cells; **e**, basal leaf cells. All figures drawn from *Printarakul 1259* (CMU).

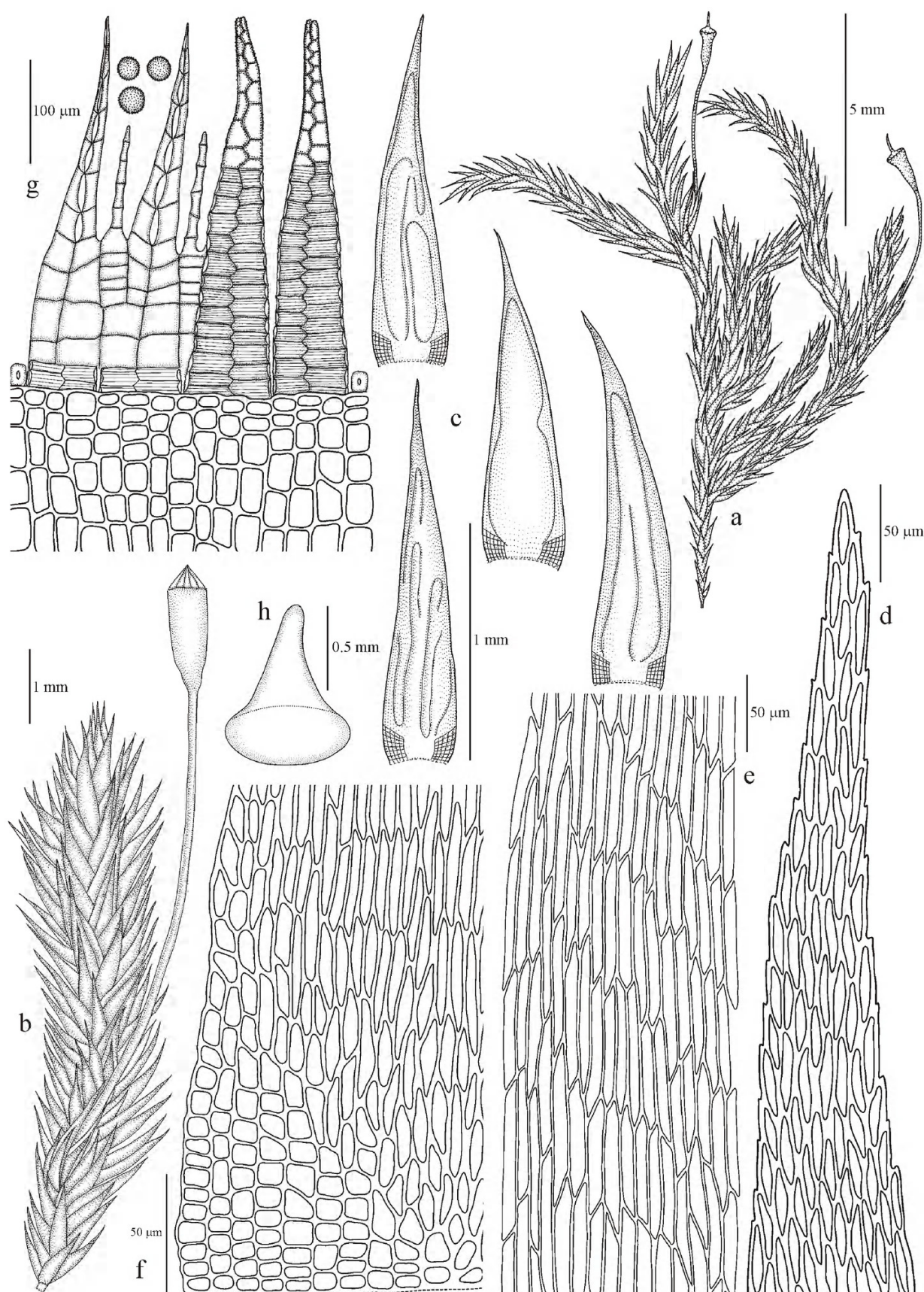


Fig. 15. *Hondaella caperata* (Mitt.) B.C.Tan & Z.Iwats. **a, b**, plants with sporophytes; **c**, leaves; **d**, apical leaf cells; **e**, median leaf cells; **f**, basal leaf cells; **g**, portion of peristome and spores; **h**, operculum. All figures drawn from *Printarakul 3035* (CMU).

Phytogeographical consideration

The present report of 19 new Thai moss species has significant implication in the phytogeographical consideration of the moss flora of Thailand. The distribution patterns exhibited by the moss taxa newly found in Thailand, discounting the widespread Asiatic to nearly subcosmopolitan species, have highlighted the little known phytogeographical connection between the moss floras of Thailand and the Indian subcontinent. *Entodontopsis nitens*, *Tortella walkeri* and *Trachyphyllum jeyporensis* are three examples of continuous range or disjunctive distribution between the two geographical areas. These species can be predicted to be present also in other Indochinese countries and in southwestern China. They represent members of Indo-Himalayan-Burmese/Thailand moss flora.

Phytogeographically, it is interesting that some of these new moss records for Thailand were known previously from China, Korea and Japan, for example, *Fissidens closteri* subsp. *kiushiuensis* and *Eurhynchium laxirete*. Their discovery in Thailand suggests their probable presence in other Indochinese countries. However, these species may be proven to be members of either the broad East Asiatic or Sino-Himalayan floras.

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References

- Akiyama H (2006) New records of mosses from Thailand. *Tropical Bryology* 28: 59.
- Akiyama H, Chang Y, Tan BC (2010) *Clastobryopsis imbricata* (Pylaisiadelphaceae), *sp. nov.*, from Doi Inthanon, northern Thailand. *Bryologist* 113: 752–759. <http://dx.doi.org/10.1639/0007-2745-113.4.752>
- Akiyama H, Furuki T, Sri-Ngernyuan K, Kanzaki M (2011) Alphabetical list of bryophytes occurring in a 15 ha long-term monitoring plot at Doi Inthanon, northern Thailand. *Bryological Research* 10: 153–164.
- Eddy A (1988) *A Handbook of Malesian mosses. Sphagnales to Dicranales, volume 1*. (British Museum (Natural History), London)
- Eddy A (1996) *A Handbook of Malesian mosses. Splachnobryaceae to Leptostomataceae, volume 3*. (British Museum (Natural History), London)
- Gangulee HC (1971) *Mosses of Eastern India and Adjacent Regions, Fascicle 2*. Calcutta.
- Gangulee HC (1972) *Mosses of Eastern India and Adjacent Regions, Fascicle 3*. Calcutta.
- Gangulee HC (1980) *Mosses of Eastern India and Adjacent Regions, Fascicle 8*. Calcutta.
- He S, Gao C (2003) Splachnobryaceae. Pp. 121–123, in Gao C, Crosby MR (eds) *Moss Flora of China, volume 3*. (Science Press, Beijing, New York and Missouri Botanical Garden, St. Louis)
- Horikawa Y, Ando H (1964) Contributions to the moss flora of Thailand. *Nature and Life in Southeast Asia* 3: 1–44.
- Hu R-L (1983) A revision of Chinese species of *Entodon* (Musci, Entodontaceae). *Bryologist* 86: 193–233. <http://dx.doi.org/10.2307/3242710>
- Hu R-L, Wang Y-F (2008) Entodontaceae. Pp. 168–211, in Hu R-L, Wang Y-F, Crosby MR (eds) *Moss Flora of China, volume 7*. (Science Press, Beijing, New York and Missouri Botanical Garden, St. Louis)
- Iwatsuki Z (1969) Bryological miscellanies XIX–XX. *Journal of Hattori Botanical Laboratory* 32: 269–289.
- Jia Y, He S, Guo S-L (2011) Orthotrichaceae. Pp. 22–117 in Wu P-C, Crosby MR (eds) *Moss Flora of China, volume 5*. (Science Press, Beijing, New York and Missouri Botanical Garden, St. Louis)
- Li D-K (2008) Stereophyllaceae. Pp. 212–218 in Hu R-L, Wang Y-F, Crosby MR (eds) *Moss Flora of China, volume 7*. (Science Press, Beijing, New York and Missouri Botanical Garden, St. Louis)
- Li X-J, He S & Zhang D-C (2003) Funariaceae. Pp. 79–100 in Gao C & Crosby MR (eds.) *Moss Flora of China, volume 3*. (Science Press, Beijing, New York and Missouri Botanical Garden, St. Louis)
- Li Z-H, Iwatsuki Z (2001) Fissidentaceae., Pp. 3–67 in: Li X-J, Crosby MR (eds) *Moss Flora of China, volume 2*. (Science Press, Beijing, New York and Missouri Botanical Garden, St. Louis)

- Nathi Y, Tan BC, Seelanan T (2010) Ten new records of mosses from Doi Inthanon National Park in Thailand. *Gardens' Bulletin Singapore* 61: 389–400.
- Noguchi A (1988) *Illustrated Moss flora of Japan, volume 2*. Hattori Botanical Laboratory.
- Pollawatn R, Frahm JP, Boonkerd T (2008) New species records of Sematophyllaceae (Musci) from Thailand. Pp. 41–48 in Mohamed H, Baker BB, Boyce AN, Lee PKY (eds). *Bryology in the New Millenium*. (University of Malaya, Kuala Lumpur)
- Printarakul N, Tan BC, Santanachote K, Wongkuna K (2012) Nine new records of mosses from Doi Suthep-Pui National Park and a new variety of *Fissidens* from Thailand. *Cryptogamie Bryologie* 33: 23–31. <http://dx.doi.org/10.7872/cryb.v33.iss1.2012.023>
- Printarakul N, Tan BC, Santanachote K, Akiyama H (2013) New and noteworthy records of mosses from Doi (Mt.) Inthanon, Chiang Mai, Chom Tong District, Northern Thailand. *Polish Botanical Journal* 58: 245–257. <http://dx.doi.org/10.2478/pbj-2013-0025>
- Pursell RA (2007) Fissidentaceae. *Flora Neotropica Monograph* 101: 1–278.
- Suzuki T, Iwatsuki Z (2011a) *Fissidens* (Fissidentaceae, Bryopsida) from Papua New Guinea located in the herbarium of the Australian National Botanical Gardens (CBG). *Hattoria* 2: 1–33.
- Suzuki T, Iwatsuki Z (2011b) Four newly recorded species of Orthotrichaceae (Musci) from Japan. *Hattoria* 2: 35–42.
- Wang M-Z (2011) Erpodiaceae. Pp. 3–9 in Wu P-C, Crosby MR (eds). *Moss Flora of China, volume 5*. (Science Press, Beijing, New York and Missouri Botanical Garden, St. Louis)
- Wang Y-F & Hu R-L (2008) Brachytheciaceae. Pp. 71–167 in Hu R-L, Wang Y-F, Crosby MR (eds). *Moss Flora of China, volume 7*. (Science Press, Beijing, New York and Missouri Botanical Garden, St. Louis)
- Wongkuna K, Santanachote K, Tan BC (2009) Miscellaneous observations on *Fissidens* in Thailand with five new species records. *Cryptogamie Bryologie* 30: 301–309.
- Zhang D-C, Li X-J, He S (2007) Bryaceae. Pp. 3–92 in Li X-J, Crosby MR (eds). *Moss Flora of China, volume 4*. (Science Press, Beijing, New York and Missouri Botanical Garden, St. Louis)
- Zhu Y-Q, Buck WR, Wang Y-F (2010) A revision of *Entodon* (Entodontaceae) in East Asia. *Bryologist* 113: 516–589.



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