CHAPTER 5

RESULTS

Five hundreds and seventy-five specimens number of bryophytes were collected during May 1999 to July 2002. They are classified into 26 families, 50 genera and 81 species (Table 5.1). The following are descriptions and keys to taxa found from this study.

Table 5.1 List of Bryophytes at the summit of Khao Luang, Huai Yang Waterfall National Park.

Class/Family	Species	Habitat
Anthocerotopsida		
Dendroceraceae	1. *Megaceros flagellaris* (Mitt.) Steph.	T
Bryopsida		
Bryaceae	2. *Bryum coronatum* Schwägr.	T
	3. *Rhodrobryum ontariense* (Kindb.) Kindb.	E, T
Calyperaceae	4. *Calymperes lonchophyllum* Schwägr.	E
	5. *Calymperes palisotii* Schwägr.	T
Dricanaceae	6. *Campylopodium medium* (Duby) Giese & J.-P. Frahm	T
	7. *Campylopus ericoides* (Griff.) Jaeg.	T
	8. *Campylopus* sp.	T
	9. *Dicranella coarctata* (C. Müll.) Bosch & Sande Lac.	T
	10. *Microdus miquelianus* (Mont.) Besch.	T
Fissidentaceae	11. *Fissidens anomalus* Mont.	E
	12. *Fissidens bogoriensis* Fleisch.	T
	13. *Fissidens hollianus* Dozy & Molk.	E
	14. *Fissidens javanicus* Dozy & Molk.	T
	15. *Fissidens* sp.	T
Hookeriaceae	16. *Callicostella papillata* (Mont.) Mitt.	T
	17. *Chaetomitrium orthorrhynchum* (Dozy & Molk.) Bosch. & Sande Lac.	T
	18. *Distichophyllum nigricaule* Mitt. ex Bosch. & Sande Lac.	T
	19. *Distichophyllum schmidtii* Broth.	T
	20. *Hookeriopsis utacamundiana* (Mont.) Broth.	T
Hypopterygiaceae	21. *Cyathophorella adianta* (Griff.) Fleish.	E, T
	22. *Cyathophorella burkillii* (Dixon) Broth.	T

Table 5.1 List of Bryophytes at the summit of Khao Luang, Huai Yang Waterfall National Park (continued).

Class/Family	Species	Habitat
	23. *Cyathophorella tonkinensis* (Broth. & Parish) Broth.	E, T
	24. *Hypopterygium tenellum* C. Müll.	T
	25. *Lopidium struthiopteris* (Brid.) Fleisch	E, T
	26. *Lopidium trichocladon* (Bosch & Sande Lac.) Fleisch.	T
Leucobryaceae	27. *Leucobryum javense* (Brid.) Mitt.	E, T
	28. *Octoblepharum albidum* Hedw.	T
Meteoriaceae	29. *Aerbryopsis subdivergens* (Broth.) Broth.	E
	30. *Barbella flagellifera* (Card.) Nog.	E
	31. *Meteoriopsis squarrosa* (Hook.) Fleisch. ex Broth.	E
	32. *Papillaria chrysoclada* (C. Müll.) Jaeg.	E
Neckeriaceae	33. *Homaliodendron exiguum* (Bosch & Sande Lac.) Fleisch.	E
	34. *Homaliodendron flabellatum* (Sm.) Fleisch.	E
	35. *Neckeriopsis fimbriata* (Harv.) Fleisch.	E
	36. *Neckeriopsis lepineana* (Mont.) Fleisch.	E
Polytrichaceae	37. *Pogonatum cirratum* (Sw.) Brid.	T
	38. *Pogonatum neesii* (C. Müll.) Dozy	T
Pottiaceae	39. *Hyophila involuta* (Hook.) Jeag.	T
Racopilaceae	40. *Racopilum cuspidigerum* (Schwägr.) Ångstr.	E
Rhizogoniaceae	41. *Pyrrhobryum spiniforme* (Hedw.) Mitt.	E, T
Sematophyllaceae	42. *Acroporium* sp.1	E
	43. *Acroporium* sp.2	T
Hepaticopsida		
Frullaniaceae	44. *Frullania apiculata* (Reinw. et al.) Dumort.	E
	45. *Frullania berthoumieui* Steph.	E
	46. *Frullania ericoides* (Nees) Mont.	E
	47. *Frullania gaudichoudii* Nees & Mont.	E
	48. *Frullania wallichiana* Mitt.	E

Table 5.1 List of Bryophytes at the summit of Khao Luang, Huai Yang Waterfall National Park (continued).

Class/Family	Species	Habitat
Geocalyaceae	49. *Heteroscyphus argutus* (Reinw. et al.) Schiffn.	E, T
	50. *Heteroscyphus coalitus* (Hook.) Schiffn.	T
	51. *Heteroscyphus splendens* (Lehm. & Lindenb.) Grolle	E
Herbertaceae	52. *Herbertus dicrnus* (Tayl.) Miller	E
Jugermanniaceae	53. *Anastrophyllum piligerum* (Nees) Spruce	E
	54. *Chandoanthus birmensis* Steph.	E
	55. *Notoscyphus paroicus* Schiffn.	T
Lejeuneaceae	56. *Lejeunea discreta* Lindenb.	E
	57. *Lejeunea sordida* (Nees) Nees	E
	58. *Lejeunea wightii* Lindenb.	E
	59. *Leptolejeunea epiphyllus* (Mitt.) Steph.	E
	60. *Lopholejeunea subfusca* (Nees) Steph.	E
	61. *Mastigolejeunea indica* Steph.	E
	62. *Mastigolejeunea. repleta*(Taylor) A. Evans	E, T
	63. *Ptychanthus striatus* (Lehm. & Lindenb.) Nees	E
	64. *Spruceanthus polymorphus* (Sande. Lac.) Verd.	E
	65. *Spruceanthus semirepandus* (Nees) Verd.	E
	66. *Thysananthus planus* Sande Lac.	E
Lepidoziaceae	67. *Bazzania appendiculata* (Mitt.) S. Hatt.	E
	68. *Bazzania tridens* (Reinw., Blume et Nees) Trev.	E, T
	69. *Bazzania uncigera* (Reinw., Blume & et Nees) Trev.	E
Marchantiaceae	70. *Dumortiera nepalensis* (Taylor) Nees	T
Pallaviciniaceae	71. *Symphyogynopsis filicum* (Nadeaud) Grolle	E, T
Plagiochilaceae	72. *Plagiochila acanthophylla* Gottsche subsp. *acanthophylla*	E
	73. *Plagiochila acanthophylla* Gottsche subsp. *japonica* (Sande Lac.) Inoue	E
	74. *Plagiochila javanica* (Sw.) Dumort.	E
	75. *Plagiochila microdonta* Mitt.	E
	76. *Plagiochila yokurensis* Steph.	E

Table 5.1 List of Bryophytes at the summit of Khao Luang, Huai Yang Waterfall National Park (continued).

Class/Family	Species	Habitat
	77. *Plagiochila* sp.	E
	78. *Plagiochilion opposites* (Reinw., Blume et Nees) S. Hatt.	E
Pleuroziaceae	79. *Pleurozia gigantea* (F. Weber) Lindb.	E
Radulaceae	80. *Radula caduca* Yamada	E
	81. *Radula perottetii* Gottsche ex Steph.	E

Note:- E = Epiphyte, growing on part of plants.
T = Terrestrial, growing on soil or humus rich rocks.

CLASS ANTHOCEROTOPSIDA

DENDROCEROTACEAE

Plants usually irregularly lobed, often dichotomously furcated, often forming partial or complete rosettes but may be ribbon-like. Thallus thicker medially, and gradually thinner laterally, or sharply differentiation between a thick costa and crispate, unistratose wing. **Rhizoids** unicellular, smooth. Only one antheridium develops in each chamber. **Capsule** without stomata, psuedoelaters with single spiral thickening band. **Spores** green, containing large chloroplast, unicellular or muticelluar, verrucate or with granular ornamentation.

MEGACEROS

Megaceros Campb., Ann. Bot. (Oxford) 21: 484. 1907; Hässel, J. Hattori Bot. Lab. 64: 83. 1988; S. Piippo, Acta Bot. Fenn. 148: 48. 1993.

Plants usually radiate, may be broadly strap-shaped when epiphytic, flat, usually multistratose, unistratose only thallus margin. Thallus with two or more chloroplasts per each cell. **Spores** unicellular, with one large chloroplast.

Megaceros flagellaris (Mitt.) Steph.

Sp. Hepat.(Stephani) 5: 951. 1916; J. Haseg., J. Hattori Bot. Lab. 54: 234, fig. 3. 1983; S. Piippo, Acta Bot. Fenn. 148: 48, fig. 16. 1993. — *Anthoceros flagellaris* Mitt. in Seemann, Fl. Vit. 419. 1873.

Plants solid, dull green to blackish, robust, up to 5 cm long and 10 mm wide, 8-14 cells thick in the middle, 1-4 cells near margin, ecostate, flat and smooth; in cross-section epidermal cells much smaller than inner ones. **Margin** shallowly lobed, usually nearly flat or slightly undulate, epidermal cells quadrate to rectangular, 20-40 × 15-50 μm, thin-walled. **Rhizoids** few, scattered along the median part of the ventral surface, hyaline to slightly brownish, often branched nearly the apex. **Capsule** up to 4 cm long, epidermal cells 80-120 μm long and 8-10 μm wide, rectangular, thick-walled cells. **Spores** greenish, globose, 20-25 μm in diameter, distal and proximal surfaces closely verrucate, triradiate marks usually distinct. **Psuedoelaters** brownish, up to 450 μm long (Fig. 5.1, 5.82).

Thailand. — NORTHERN: Chaing Mai; PENINSULAR: Nakhon Si Tamarat, Trang.

Distribution. — Japan, Taiwn, Philippines, North Borneo, Java, India, New Guinea, New Caledonia, Samoa, Tahiti, Hawaii.

Ecology. — On humus rocks along stream.

Specimens examined. — *S. Chantanaorrapint 628* (BCU).

CLASS BRYOPSIDA

Key to the families

1. Leaves with vertical lamellae on the upper surface of costa.....Polytrichaceae

1. Leaves not as above.

    2. Leaves distinctly equitant and distichous.....Fissidentaceae

    2. Leaves in more than 2 rows.

        3. Plants whitish, greenish white or sometimes green when fresh; leaves, with 2 to 10 layers of hyaline cells, enclosing 1 layer of small green cells; lamina very narrow.....Leucobryacae

        3. Plants usually green; leave usually 1 layer of green cells, except costa.

            4. Stems usually erect, dichotomously branched; sporophytes terminal on stems (acrocarpous).

                5. Central part of leaf base with large hyaline cells..... .....Calymperaceae

                5. Central part of leaf base without large hyaline cells.

                    6. Peristome single or absent.

                        7. Peristome teeth entire or cleft above; alar cells often differentiated.....Dicranaceae

                        7. Peristome teeth deeply divided nearly to base, or absent; alar cells never differentiated.....Pottiaceae

                    6. Peristome doubles.

                        7. Leaf margin thickened, more than 2 layers of cells..... .....Rhizogoniaceae

                        7. Leaf margin not thickened, usually single layer of cells.....Bryaceae

            4. Stems usually creeping, often pinnately branched; sporophytes lateral, on short branches (plurocarpous).

                8 Stems with amphigastria on ventral or dorsal side.

9 Leaves usually bordered, amphigastria on ventral side.....
.....Hypopterygiaceae

9. Leaves not bordered, amphigastria on dorsal side.....
.....Rhacopiaceae

8. Stems without amphigastria.

10. Leaves unicostate.

11. Leaves distinctly bordered.....Hookeriaceae

11. Leaves not bordered

12. Leaf-cells papillose.....Meteoriaceae

12. Leaf-cells smooth.....Neckeriaceae

10. Leaves with double costa or ecostate

13. Leaves with double costa; alar cells absent.....Hookeriaceae

13. Leaves ecostate; alar cells present.....Sematophyllaceae

BRYACEAE

Acrocarpous, usually tufted mosses of small to medium, rarely large. **Stems** with central strand, invested with rhizoids and often with micronemata. **Leaves** lanceolate to ovate, erect to erect-spreading, very rarely widely patent or subcomplanate; **lamina cells** rhomboid to elongate, thin- or thick-walled, smooth; bordered usually differentiated. **Monoecious** or dioecious. **Perigonia**, if separate, gemiform or sometimes rosulate and conspicuous. **Perichaetia** typically not very conspicuous but usually terminal on relatively short stems, the apical leaves forming a coma around archegonia and inner, reduced bracts. **Seta** elongate. **Capsule** variable, erect and more or less symmetrical to horizontal or pendulous, usually with a distinct apophysis; **operculum** conical to umbonate; **peristome** double, typically with well-developed exostome teeth which are trabeculate and papillose externally, transversaly lamellate or barred internally; endostome usually well-developed from a basal membrane, with 16 processes interspersed with groups of 1-3 cilia, the latter often appendiculate; reductions and modification of exostome or endostome occurred in many genera.

Key to the genera

1. Plants stoloniferous, large, with rosulate capitula composed of spathulate leaves...
.....2. *Rhodobryum*

2. Plants never stoloniferous, ± small, with evenly foliate barring stems...1. *Bryum*

1. *BRYUM*

Bryum Hedw., Sp. Musc.: 178. 1801; Gangulee, Mosses of Eastern India and Adjacent Regions, Fascicle 4: 961. 1974; A. Eddy, A Handbook of Malesian Mosses Vol. 3: 118. 1996.

Plants extremely variable in size and colour, from very small to robust. **Stems** erect, usually thickly invested with rhizoids, with or without brood filaments or other vegetative propagules such as bulbils or tubers. **Leaves** ovate to lanceolate, usually with differentiated borders; **costa** strong, percurrent to excurrent; **lamina cells** hexagonal to elongate rhomboid, seldom with strongly thick-walled. **Monoicous** or dioicous. **Perigonia** and perichaetia not strongly differentiated; paraphyses numerous. **Capsule** horizontal to pendulous, rarely suberect; **operculum** hemispherical or conical, often umbonate; **peristome** double, with exostome teeth linear-lanceolate, slenderly attenuate, inserted below the mouth, finely papillose in the lower half with large papillae at apex, trabeculate externally, closely transversely barred internally; endostome with high basal membrane, segments large, usually as long as exostome, keeled, perforated, cilia articulate or appendiculate, occasionally absent. **Spores** small, mostly scabrous. **Calyptra** cuculate, deciduous.

Bryum coronatum Schwägr.

Spec. Musc. Suppl. 1(2): 103, t.71. 1816; Gangulee, Mosses of Eastern India and Adjacent Regions, Fascicle 4: 1002, fig. 486. 1974; A. Eddy, A Handbook of Malesian Mosses vol. 3: 124, fig. 412. 1996. — *B. angustifolium* Brid. Sp. Musc. 3: 31. 1817. — *B. caespiticium* var. *angustifolium* (Brid.) Hamp., Linnaea 13: 44. 1839. — *B. pachytheca* C. Müll., Syn. Musc. 1: 307. 1848.

Plants in dense tufts, yellowish-green, not glossy, blackish below. **Stems** ca. 8 mm high. **Leaves** imbricate, erect spreading, lanceolate to ovate-lanceolate, slightly concave, 1.2-2 mm long, 0.8-1.2 mm wide, broadly below; margin entire, revolute throughout; border slightly differentiated with elongate cells and nearly thick-walled; **costa** excurrent with long arista, the apex often pellucid; upper lamina cells rhomboid, thin-walled, 35-45 μm long, 15-20 μm wide; lower lamina cells rectangular 30-50 μm long, 25-35 μm wide, sometime longer rhomboid near costa. **Dioicous**. **Perichaetial** leaves mostly identical to branch leaves, or the innermost narrowly triangular, ending in an arista up to 0.5 mm long. **Seta** reddish brown, smooth, very variable in length but common between 2-3 cm. **Capsule** pendulous, short-cylindric, with a typically conspicuous, rugose, thick appophysis rather wider than the smooth upper part; **peristome** well-developed, exostome linear-lanceolate, transversely striate at base, endostome with appendiculate cilia; **operculum** widely conic or convex (Fig. 5.2, 5.83). **Calyptra** not found.

Thailand. — NORTHERN: Chiang Mai, Lampang, Tak, Phitsanulok.; EASTERN: Khon Kaen.; SOUTH-WESTERN: Kanchanaburi; CENTRAL: Nakhon Nayok; SOUTH-EASTERN: Chon Buri, Prachin Buri, Chanthaburi, Trat; PENINSULAR: Nakhon Si Thammarat, Chumphon.

Distribution. — China, India, Japan, Kampuchea, Myanmar, and Vietnam.

Ecology. — On rocks, in open field.

Specimens examined. — *S. Chantanaorrapint 403* (BCU).

2. *RHODOBRYUM*

Rhodobryum (Schimp.) Limpr., Laubm. Deutschl. Österreichs Schweiz 2: 444. 1892; Gangulee, Mosses of Eastern India and Adjacent Regions, Fascicle 4: 1015. 1974; A. Eddy, A Handbook of Malesian Mosses vol. 3: 152. 1996.

Plants stoloniferous, normally large and conspicuous. Fully developed leaves organised into terminal rosettes (comal), the lower leaves small to vestigial but the terminal very large, spathulate; margin dentate above, with or without a unistratose border; **costa** strong, percurrent to excurrent but often lacking stereids. **Dioicous**: male and female plants similar although the male often less robust; male or female organs borne terminally in the apical comal; sporophytes usually more than one, up to 5 or more per comal. **Seta** long, smooth. **Capsule** ovoid-cylindrical, pendulous; **operculum** short-conic.

Rhodobryum ontariense (Kindb.) Kindb.

Eur. N. Am. Bryinae 2: 346. 1897; Mohamed, J. Hattori Bot. Lab. 55: 289, fig. 9. 1984; A. Eddy, A Handbook of Malesian Mosses vol. 3: 154, fig. 436. 1996. — *Bryum ontariense* Kindb., Ottawa Naturalist 2: 155. 1889. — *B. leptorhodon* C. Müll, Novo Giorn. Bot. Hal. N.S. 3: 95. 1896. — *Rhodobryum leptorhodon* (C. Müll.) Par., Ind. Bryol.: 1117. 1898. — *Bryum globicoma* C. Müll., Novo Giorn. Bot. Ital. N.S. 4: 246. 1987. — *Rhodobryum globicoma* (C. Müll) Par., Ind. Bryol.: 1116. 1898. — *Bryum ptychothecioides* C. Müll., Novo Giorn. Bot. Ital. N.S. 4: 247. 1987. — *Rhodobryum ptychothecioides* (C. Müll) Par., Ind. Bryol.: 1119. 1898. — *Bryum nanorosula* C. Müll., Novo Giorn. Bot. Ital. N.S. 4: 247. 1987. — *Rhodobryum nanorosula* (C. Müll) Par., Ind. Bryol.: 1118. 1898.

Plants large. **Stems** usually 1-2.5 cm high but often innovating from the capitulum and then taller, tomentose below. **Lower stems leaves** vestigial, increasing in size acropetally; **comal leaves** large, forming a distinct rosette up to 2 cm diameter, largest ca. 1 cm long, ovate-spathulate, widest at about 3/4 of leaf length; margin narrowly uniseriate, revolute beyond mid-leaf, dentate above and with distinct border 2-3 cells wide of elongate, thick-walled cells, entire below; **costa** stout at base, narrow above, short excurrent; in cross-section convex below and with a single dorsal stereid band bounded on the abaxial side by a single row of epidermal cells; upper laminal cells rhomboid, 40-50 μm long, 20-30 μm wide; median cells rhomboid-hexagonal, longer than; basal cells rectangular, 80-150 μm long, 40-50 μm wide. **Dioicous**. **Inner perichaetial** leaves ovate to lanceolate-triangular, paraphyses numerous. **Seta** up to 8 cm long. **Capsule** pendulous, cylidrical, asymmetrically; **operculum** short-conic; **peristome** well-developed (Fig. 5.3, 5.84). **Calyptra** not found.

Thailand. — New record to Thailand.

Distribution. — China, Malaysia, India, Africa.

Ecology. — On humus rocks or rarely on tree trunks.

Specimens examined. — *S. Chantanaorrapint 368, 372, 379, 603 ,675, 681 (BCU).*

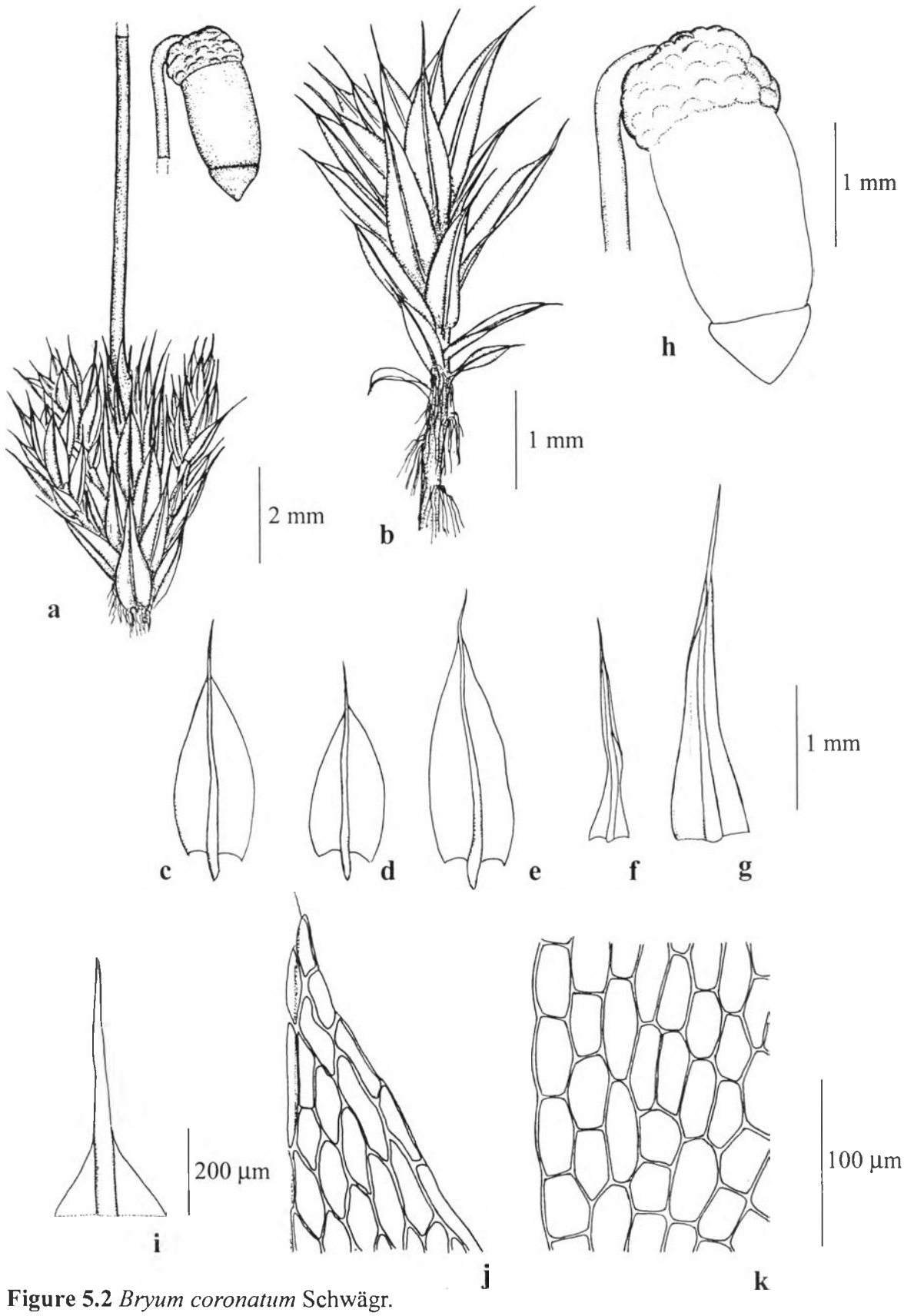

Figure 5.2 *Bryum coronatum* Schwägr.
a-b. habit; c-e. leaves; f-g. perichaetial leaves; h. capsule; i. leaf-apex; j-k. leaf-cells, j. apical cells, k. basal cells. Based on *S. Chantanaorrapint 403*.

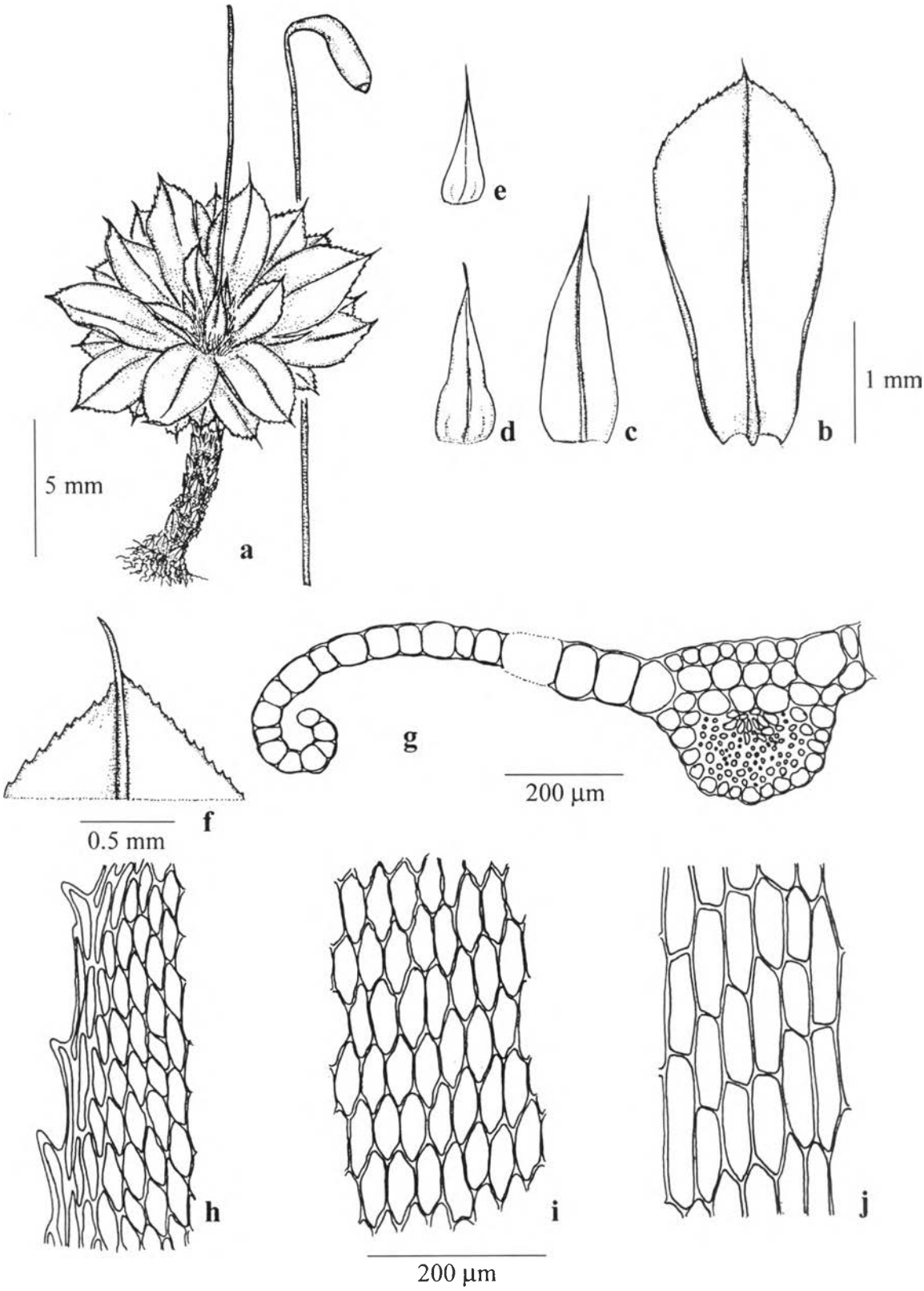

Figure 5.3 *Rhodobryum ontariense* (Kindb.) Kindb.
a. habit; b. leaf; c-e. perichaetial leaves; f. leaf-apex; g. cross-section of leaf; h-j. leaf cells, h. maginal cells, i. median cells, j. basal cells. Based on *S. Chantanaorrapint 603*.

CALYMPERACEAE

Plants small to robust, usually grow on trees and logs, sometimes on rocks or soil. **Stems** mostly erect, very short in some taxa and plants then with stemless appearance. **Rhizoids** mostly scanty, brown to dark purple. **Leaves** crowded, sheathing at base, axillary hairs mostly inconspicuous; leaf margin mostly thickened, often tooth, bordered with elongate hyaline cells in *Mitthyridium* and some *Syrrhopodon*, thicken border often enclosing stereid cells; **costa** strong convex on back, often papillose or spinose on one or both side, ending near apex to excurrent; cells of upper laminae green mostly isodiametric, smooth to papillose; lower laminae including conspicuous fields of enlarged cells (cancellinae), internally and externally porose, hyaline cells, intramarginal fine differentiated cells (teniolae) present in leaves of some *Calymperes* and (rarely) *Syrrhopodon*. **Gemmae** common, uniseriate, borne on leaves. **Dioicous**, rarely monoicous. **Perigonia** axillary, bud-like; **perichaetia** terminal but soon overtopped. **Seta** straight, mostly elongate but very short in some *Syrrhopodon*. **Capsule** cylindrical; annulus lacking; **operculum** rostate; **peristome** lacking, or present and of 16 jointed smooth or papillose teeth, often reduced and imperfect. **Calyptra** cucullate and deciduous, or enveloping the capsule, persistent, and opening by vertical slits, rarely very small and mitrate, **Spore** small, mostly roughened.

CALYMPERES

Calymperes Sw. ex F. Weber, Tab. Calyptr. Operc. Gen. 2. 1813; Gangulee, Mosses of Eastern India and Adjacent Regions, Fascicle 3: 592. 1972; A. Eddy, A Handbook of Malesian Mosses, vol. 2: 95. 1990; W.D. Reese & P.-J. Lin., Moss Flora of China vol. 2: 71. 2001.

Plants small to medium, bright green to olive green. **Stems** erect. **Leaves** oblong-lanceolate to linear; leaves of some species with well-developed teniolae, or teniolae lacking; **costa** stout, usually percurrent, or excurrent; cells of upper lamina mostly isodiametric but transversely elongate in some species; gemmae common, fusiform, borne at leaf tip sometimes forming a distinct gemmae receptacle. **Seta** straight, elongate. **Capsule** cylindrical; **peristome** lacking; **operculum** conic to rostrate. **Calyptra** persistent, enveloping capsule and twist around seta proximally, with vertical fissures through which the spores escape.

Key to species

1. Leaves linear, ribbon-like; cells of upper lamina transversely elongate ....1 *C. lonchophyllum*

1. Leaves oblong-lingulate to broadly linear; cells of upper lamina quadrate to rounded.....2 *C. palisotii*

1. ***Calymperes lonchophyllum*** Schwägr.

Spec. Musc. Suppl. 1(2): 333, tab. 98. 1816; W.D. Reese, T.J. Kop. & D.H. Norris, Acta Bot. Fenn. 133: 156, figs. 4-7. 1986; A. Eddy, A Handbook of Malesian Mosses,

vol. 2: 96, fig. 226. 1990; W.D. Reese & P.-J. Lin, Moss Flora of China vol. 2: 75. 2001. — *C. brunneum* C. Müll. in Par., Ind. Bryol. Suppl. 78. 1900.

Plants forming dull green or dark green tufts, grass-like, stemless, unbranched. **Rhizoids** glossy blackish red. **Leaves** ribbon-like from ovate sheathing base; limbs long, curled when dry, straight when wet, up to 2.5 cm long, 0.3-0.4 mm wide in limb; sheathing ca. 0.6-0.8 mm wide; apex acute; leaf margin unistratose in shoulder region and serrate, becoming thickened and multistratose in limb, entire below, irregularly tooth near the apex; teniolae lacking in leaf shoulder and limb, but present in the lower half of the sheath; **costa** strong, smooth, percurrent, convex below, in cross-section with 2 stereid bands; **lamina cells** small, thick-walled, smooth, transversely elongate to rounded, unistratose or bistratose; **cancellinae** large, rectangular, thin-walled (Fig. 5.4, 5.85). **Sporophytes** not found.

Thailand. — NORTHERN: Chiang Mai; NORTH-EASTERN: Phetchabun; CENTRAL: Nakhon Nayok; SOUTH-EASTERN: Prachin Buri, Trat; Peninsular: Nakhon Si Thammarat, Trang, Phuket.

Distribution. — Borneo, Mainland China, Java, Malaysia, Myanmar, Sri Lanka.

Habitat. — On tree trunks.

Specimens examined. — *S. Chantanaorrapint 739* (BCU).

2. ***Calymperes palisotii*** Schwägr.

Spec. Musc. Suppl. 1(2): 334, tab. 98, figs. 1-13. 1816; W.D. Reese, T.J. Kop. & D.H. Norris, Acta Bot. Fenn. 133: 168, figs 39-40. 1986; A. Eddy, A Handbook of Malesian Mosses, vol. 2: 118, fig. 242. 1990. — *C. moluccense* Schwägr. Sp. Musc. Suppl. 2(1): 99, tab. 127, figs. 1-15. 1824. — *C. kurzianum* Hampe ex C. Müll., Flora 61: 82. 1878; Gangulee, Mosses of Eastern India and Adjacent Regions, Fascicle 3: 567. 1972. — *C. chamaeleonteum* C. Müll. Bot. Jahrb. 5: 86. 1883. — *C. semimarginatum* C. Müll., Bot. Jahrb. 5: 87. 1883. — *C. flaviusculum* Broth. ex Besch., Ann. Sci. Nat. Bot. Sér. 8, 1: 264, 284. 1896. — *C. nicobarense* Hamp ex Besch., Ann. Sci. Nat. Bot. Sér. 8, 1: 294. 1896. — *C. peguense* Besch., Ann. Sci. Nat. Bot. Sér. 8, 1: 299. 1896. — *C. ligulinum* C. Müll. in Schum. & Lauterb., Fl. Deutsch. Schutzgeb. Südsee 86. 1900. — *C. nigrescens* C. Müll. in Par., Ind. Bryol. Suppl. 82. 1900.— C. baldwinii Broth., Boll. Soc. Bot. Ital. 1904: 15. 1904. — *C. brevifolium* Card., Rev. Bryol. 35: 66. 1907. — *C. elimbatum* C. Müll. in G. Roth, Hedwigia 51: 128. 1911. — *C. marginale* Card. in Broth., Nat. Pflanzenfam. Ed. 2, 10: 240. 1924. — *C. nigricans* Lev. in Bruehl, Rec. Bot. Surv. India 13(1): 121. 1931.

Plants dark-green to blackish, small to medium size, in low stiff tufts. **Rhizoids** glossy blackish red. **Leaves** involute and curved when dry, straight and usually remaining involute when wet, oblong-lingulate to broadly linear, ovate base, up to 5 mm long, 0.8-1.0 mm wide in limb; sheathing ca. 1.0-1.2 mm wide; apex acute to obtuse. Leaf margin unistratose in shoulder region and leaf base, becoming thickened and multistratose in limb, entire below, irregularly tooth near the apex; teniolae lacking in limb, but present in the sheath; **costa** strong, smooth or nearly papillose, percurrent to short-excurrent, convex, in cross-section with 2 stereid bands

and single row of guide cells; **lamina cells** small, thick-walled, smooth to mammillose, isodiametric, quadrate to rounded, unistratose; **cancellinae** distinct, large and truncate or rounded distally, thin-walled. **Sporophytes** terminal on shoot. **Seta** elongate, ca. 1.2 mm long, brownish. **Capsule** cylindrical, ca. 2 mm long; peristome absent; **operculum** conical. **Calytra** persistent, campanulate, enclosing capsule. (Fig. 5.5)

Thailand. — NORTHERN: Tak; SOUTH-WESTERN: Kanchanaburi; SOUTH-EASTERN: Trat; PENINSULAR: Nakhon Sri Thammarat, Phuket.

Distribution. — Borneo, Mainland China, India, Java, Malaysia, Myanmar, New Guinea, Philippines, Singapore, Sri Lanka, and Sumatra.

Habitat. — On rocks

Specimens examined. — *S. Chantanaorrapint 707* (BCU).

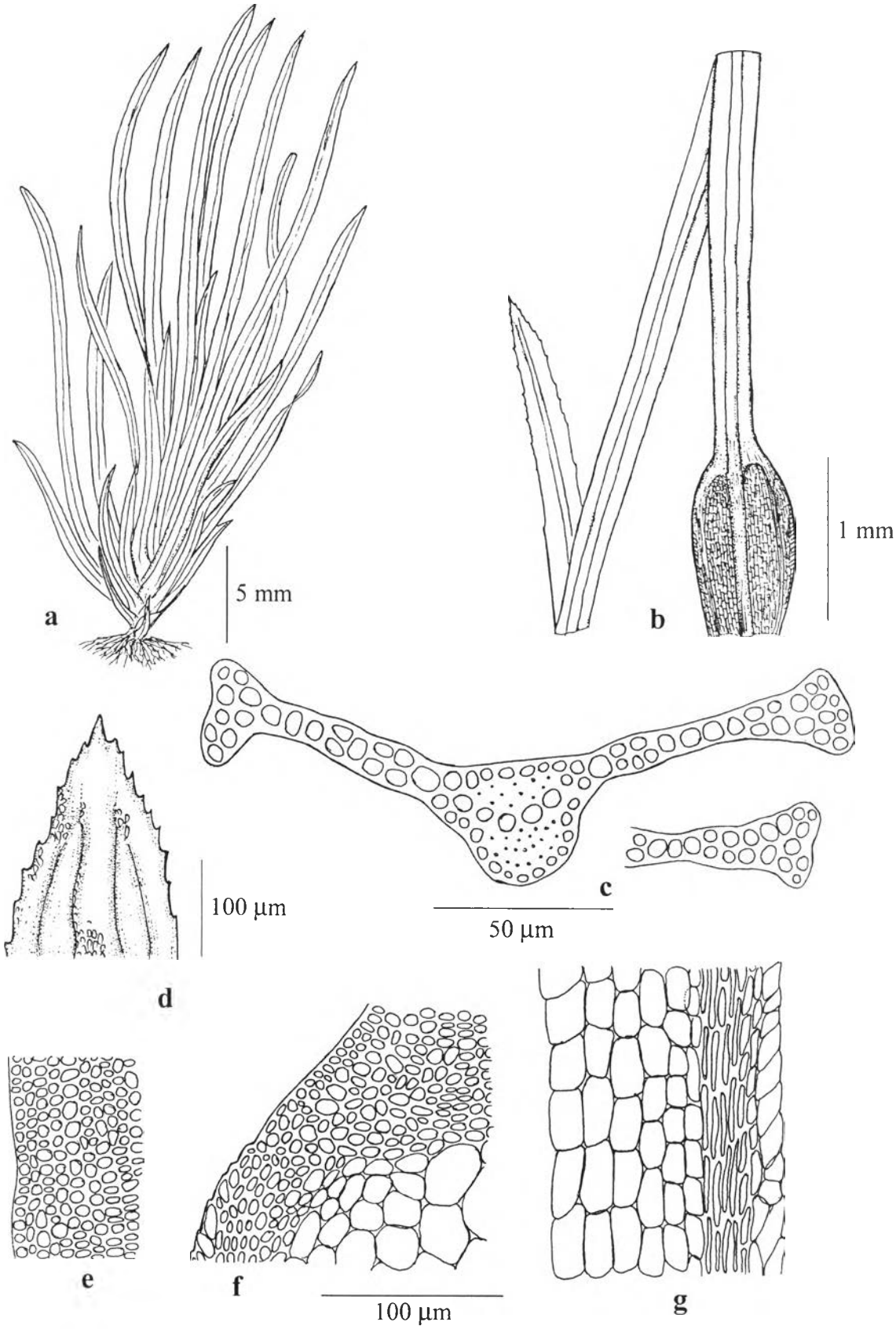

Figure 5.4 *Calymperes lonchophyllum* Schwägr.
a. habit; b. leaf; c. cross-section of leaf; d. leaf-apex; e. upper lamina cells; f. cells at leaf shoulder; g. cells at leaf-base. Based on *S. Chantanaorrapint 739*.

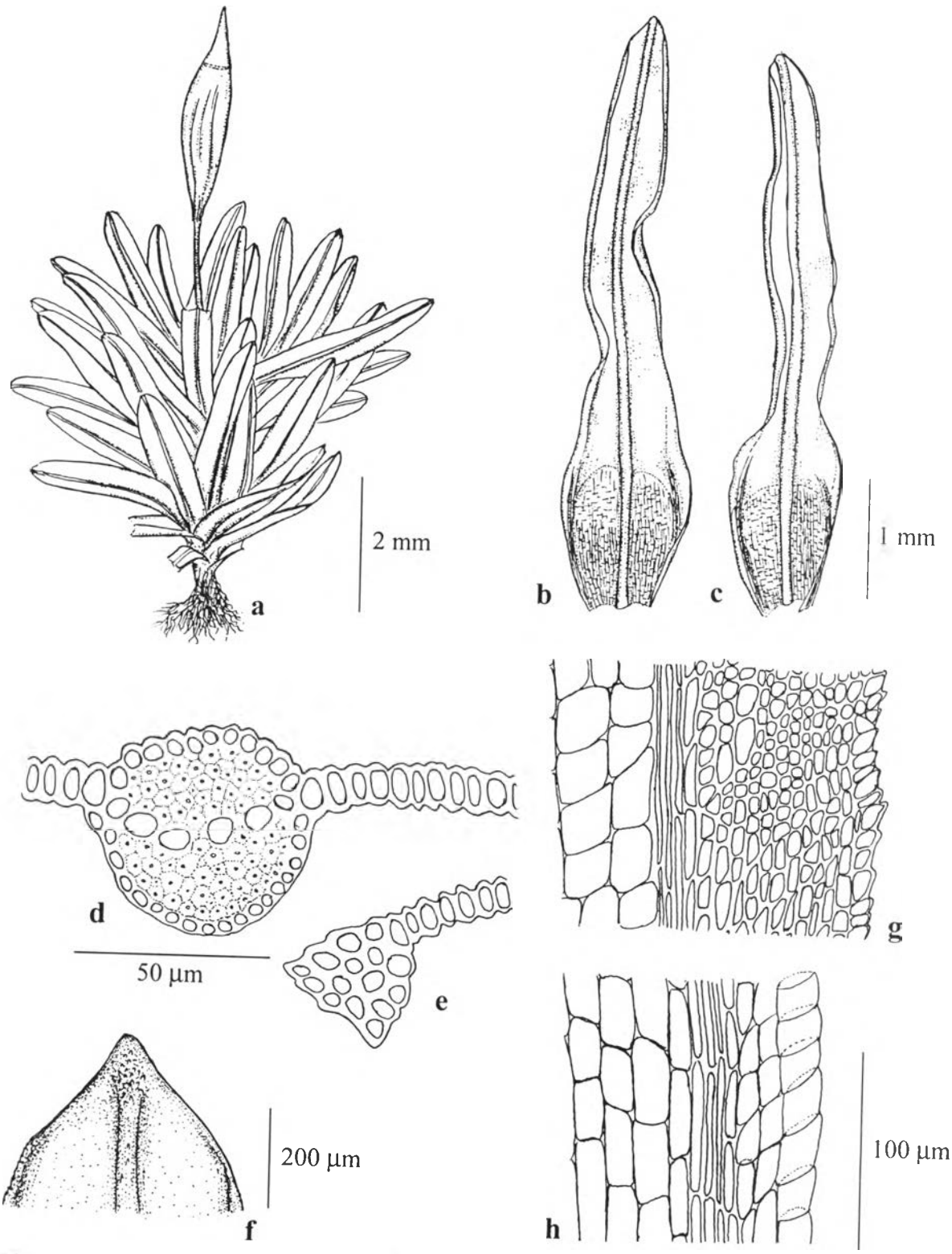

Figure 5.5 *Calymperes palisotii* Schwägr.
a. habit; b.,c. leaf; d. cross-section of costa; e. cross-section of leaf-margin; f. leaf-apex; g. cells at leaf shoulder; h. cells at leaf-base. Based on *S. Chantanaorrapint 707.*

DICRANACEAE

Plants large to small, stems with central strand, often tomentose with a mats of rhizoids. **Leaves** rather uniform in size, the upper rarely much larger, straight to falcate-secund, mostly oblong-lanceolate, often broader at base, subulate in the upper half, acuminate; **costa** usually more or less excurrent, in cross-section with stereids; cells usually smooth, the upper quadrate to elongate, the basal cells elongate, often porose; the **alar cells** differentiated and enlarged or not. **Seta** usually long, straight or arcuate. **Capsule** stegocarpous or cleistocarpous, ovoid to cylindrical, straight or curved, smooth or striate; **peristome** dicranoid, with teeth of exostome lanceolate, entire or split, basal plates striate.

Key to genera

1. Costa very broad, at least 1/3 the width of basal portion of leaf.....2. *Campylopus*

1. Costa narrow, less than 1/4 the width of basal portion of leaf.

    2. Seta cygneous when moist.....1. *Campylopodium*

    2. Seta erect or straight when moist.

        3. Peristome teeth long, divided to about half way, striate-punctate above, irregularly striate below.....3. *Dicranella*

        3. Peristome teeth short, simple, papillose.....4. *Microdus*

1. *CAMPYLOPODIUM*

Campylopodium (C. Müll) Besch., Ann. Sci. Nat. Bot. sér. 5, 18: 189. 1873; A. Eddy, A Handbook of Malesian Mosses vol. 1: 115. 1988; G. Chien,Vitt. & S. He, Mosses Flora of China vol. 1: 104. 1999. — *Anogstroemia* sect. *Campylopodium* C. Müll., Syn. Musc. Frond. 1: 429. 1848.

Plants small, slender, yellowish green to yellowish brown, in loose tufts. **Stems** erect, simple or sparsely branched. **Leaves** appressed, broadly ovate and sheathing at base, abruptly narrowed to long-lanceolate subula; margin entire or serrate at the apex; **costa** strong, filling the whole subula, with a median row of guide cells and several rows of stereids on both sides in cross-section; celled thin-walled, in the upper shoulder short-rectangular to elongate-oval, in the lower shoulder becoming narrowly rectangular; **alar cells** not differentiated. **Dioicous** or autoicous. **Seta** elongate, curved when moist, flexuose when dry and empty; **Capsule** with stomata, annuli developed; **opercula** obliquely rostrate; **peristome** teeth 16, brownish, divided to halfway down or lower, vertically striate below, papillose above. **Calyptra** cuculate, smooth. **Spores** finely papillose, golden yellowish.

Campylopodium medium (Duby) Giese & J.-P. Frahm

In J.-P. Frahm et al., Acta Bot. Fenn. 131: 68. 1985; A. Eddy, A Handbook of Malesian Mosses vol. 1: 115, fig. 107. 1988; G. Chien,Vitt. & S. He, Mosses Flora of

China vol. 1: 105. 1999. — *Didymodon medius* Duby in Moritzi, Syst. Verz. Zollinger Pfl. 134: 1846. — *Anogstroemia euphoroclada* C. Müll., Syn. Musc. Frond. 1: 429. 1848. — *Campylopus euphoroclada* (C. Müll.) Bosch & Sande Lac., Bryol. Jav. 1: 79. 1858. — *Campylopodium euphoroclada* (C. Müll.) Besch., Ann. Sci. Nat. Bot. sér. 5, 18: 189. 1873. — *Dicranella euphoroclada* (C. Müll.) Jaeg., Ber. Thätigk. St. Gallischen Naturwiss. Gess. 1870-71: 372. 1872.

Plants 0.5-2.0 cm high, in loose tufts. **Stem** short, comose foliate in upper parts; central strand slightly differentiated. **Leaves** 2-4 mm long, broadly ovate and sheathing at base, abruptly narrowed to a long subula; margin entire; **costa** occupying 1/4-1/3 of the leaf base width, and all of the subula; upper shoulder cells short-rectangular to rhomboid, thick-walled; lower shoulder cells narrowly rectangular, thin-walled; **alar cells** not differentiated. **Dioicous**. **Perichaetial** leaves not much differentiated. **Seta** up to 5 mm long, flexuose when dry, curved when moisted. **Capsule** ovoid, striate when dry; **operculum** rostrate, with long beak; **peristome** teeth reddish-brown, striate below, hyaline or papillose above, divided halfway down. **Calyptra** entire at base (Fig. 5.6, 5.86)

Thailand. — NORTHERN: Chiang Mai, Chiang Rai; NORTH-EASTERN: Loei.

Distribution. — China, Japan, Indonesia, Malaysia, the Philippines, New Guinea, Pacific Islands, Australia, New Zealand, Chile, and Puerto Rico.

Ecology. — On soil, in open fields.

Specimens examined. — *S. Chantanaorrapint 629, 649, 732* (BCU).

2 *CAMPYLOPUS*

Campylopus Brid., Mant. Musc. 71.1819; A. Eddy, A Handbook of Malesian Mosses vol. 1: 119. 1988; G. Chien,Vitt. & S. He, Mosses Flora of China vol. 1: 105. 1999.

Plants slender to robust, in tufts, often bronze in colour. **Leaves** erect to erecto-patent, form a lanceolate base, often with auricles, to a more or less elongate subulate lamina, entire or denticulate apically, often with a hyaline hair point; **costa** very wide below and flattened, percurrent or excurrent apically, upper part often ridged abaxially; **alar cells** usually inflated and coloured but sometimes hyaline, the basal cells rectangular, the upper cells rhomboid or obliquely eliptical and incrassate. **Seta** usually cygneous when moist. **Capsule** ovate to eliptic, often sulcate when dry; annulus differentiated; **operculum** subulate beaked; **peristome** either dicranoid with broad teeth, or with narrow teeth which are entire or divided part way to the base into two densely papillose segment. **Calyptra** cuculate, usually fringed at the base.

Key to species

1. Plants large, dorsal lamellae present; in cross-section with dorsal and ventral stereids band.....1. *C. ericoides*

1. Plants small, dorsal lamellae absent; in cross-section with only dorsal stereid band .....2. *Campylopus* sp.

1. ***Campylopus ericoides*** (Griff.) Jaeg.

Ber. Thätigk. St. Gallischen Naturwiss. Ges. 1870-71: 424. 1872; A. Eddy, A Handbook of Malesian Mosses vol. 1: 121, fig. 110. 1988; G. Chien,Vitt. & S. He, Mosses Flora of China vol. 1: 109. 1999. — *Dicranum ericoides* Griff., Calcutta J. Nat. Hist. 2: 499. 1842. — *D. involutus* C. Müll., Bot. Zeitung (Berlin) 11: 34. 1853. — *Campylopus involutus* (C. Müll.) Jaeg., Ber. Thätigk. St. Gallischen Naturwiss. Ges. 1870-71: 418. 1872. — *C. tenuinervis* Fleisch., Musci Fl. Buitenzorg. 1: 120. 1904. — *Thysanomitrion involutum* (C. Müll.) P. de la Varde, Rev. Bryol. 49: 41. 1922.

Plants large, up to 8 cm high. yellowish green, in densely tomentose tufts. **Stems** erect or ascending, sterile ones often caudate at the apex with smaller, appressed leaves; fertile ones comose foliate, with larger, clustered and widely spreading leaves. **Leaves** usually flexuose when dry, erect-spreading when moisted, broadly lanceolate, up to 6 mm long, lamina reaching the leaf apex, gradually narrowed above the middle, leaf base auriculate and slightly contracted; margin flat, or somewhat inflexed, mostly entire, serrulate only at the apex; **costa** occupying 1/3 or less of the leaf base width, long-excurrent, ending often in a short to long, serrate hyaline point, with lamellae of 1-2 cells high at back in the upper part, with both dorsal and ventral stereid band in cross-section; upper cells obliquely ovate to rhomboid, thick-walled; basal cells subquadrate to short-rectangular, incrassate, becoming narrower at the margin; **alar cells** well-developed, inflated, reddish-brown. **Dioicous**. **Perichaetial** leaves elongate. **Seta** 4-6 mm long, aggregate, strongly flexuose to twisted when dry, cygneous when moisted. **Capsule** oblong-ovoid, ca. 1.5 mm long, brown; **operculum** rostrate; **peristome** teeth linear, divided below the middle, sometimes nearly to the base, strongly papillose-striate. **Calyptra** fringed at base (Fig. 5.7).

Thailand. — NORTERN: Chiang Mai, Phitsanulok; NORTH-EASTERN: Loei; CENTRAL: Nakhon Nayok.

Distribution. — Mainland China, India, Java, Kampuchea, Myanmar, Nepal, Philippines, Sri Lanka, and Vietnam.

Ecology. — On humus rocks.

Specimens examined. — *S. Chantanaorrapint 419, 600, 620* (BCU); *CLW 4390, 4671*(KLU).

2. ***Campylopus* sp.**

Plants small, 1-1.5 cm high, yellowish green, in densely tomentose tufts. **Stems** erect, sterile ones often caudate at the apex with smaller, appressed leaves; fertile ones comose foliate, with larger, clustered and widely spreading leaves. **Leaves** usually flexuose when dry, erect-spreading when moisted, broadly lanceolate, up to 4.5 mm long, lamina reaching to the leaf apex, gradually narrowed above the middle, leaf base auriculate and slightly contracted; margin flat, or somewhat inflexed, mostly entire, serrulate only at the apex; **costa** occupying 1/3 or less of the leaf base width, long excurrent, hyaline hair point absent, without lamellae on dorsal suface, with ventral stereid band in cross-section; upper cells obliquely ovate to rhomboidal, thick-walled; median cells rectangular, thick-walled; basal cells long-rectangular, thin-

walled, becoming narrower at the margin; **alar cells** developed, inflated. **Dioicous**. **Perichaetial** leaves elongate. **Seta** ca. 5 mm long, aggregate, strongly flexuose to twisted when dry, cygneous when moisted. **Capsule** oblong-ovoid, ca. 1 mm long, brown; **operculum** rostrate. **Calyptra** fringed at base (Fig. 5.8).

Thailand. —
Distribution. —
Ecology. — On soil, in grass land.
Specimens examined. — *S. Chantanaorrapint 607, 725* (BCU).

3 *DICRANELLA*

Dicranella (C. Müll) Schimp., Coroll. Bryol. Eur. 13. 1856; A. Eddy, A Handbook of Malesian Mosses vol. 1: 108. 1988; G. Chien,Vitt. & S. He, Mosses Flora of China vol. 1: 129. 1999. — *Aongstroemia* sect. *Dicranella* C. Müll., Syn. Musc. Frond. 1: 430. 1848.

Plants usually small in tufts or close tufts. **Stems** erect simple or moderately branched. **Leaves** either gradually acuminate from an ovate-lanceolate base or rather abruptly subulate from a broad sheathing base; leaves erect, spreading, flexuous, falcate or not; **costa** percurrent or excurrent; **lamina cells** rectangular or rhomboid, elongated, shorter distally; **alar cells** not differentiated. **Seta** elongated, erect. **Capsule** cylindrical, inclined; **peristome** divided to middle in to papillose segment, striate at base; **operculum** with an oblique beak. **Calyptra** cuculate.

Dicranella coarctata (C. Müll.) Bosch & Sande Lac.

Bryol. Jav. 84. 1858; A. Eddy, A Handbook of Malesian Mosses vol. 1: 109, fig. 103. 1988; D.H. Norris & T.J. Kop., Acta Bot. Fenn. 139: 15, figs. 13(m-r). 1990; G. Chien,Vitt. & S. He, Mosses Flora of China vol. 1: 133, Pl. 30, figs. 12-22. 1999. — *Aongstroemia coarctata* C. Müll., Syn. Musc, Frond. 1: 431. 1848. — *Dicranella cylidrica* Nog., J. Jap. Bot. 22: 27 .1948. — *D. moutierii* Paris & Broth., Rev. Bryol. 27: 76. 1900. — *D. obscura* Sull. & Lesq., Proc. Amer. Acad. Arts 4: 277. 1859. — *D. salsuginosa* Okam., Bot. Mag. (Tokyo) 25: 142. 1911.

Plants small, 5-10 mm high, yellowish green, in loose tufts. **Stems** erect, often simple, rarely branched; central strand absent. **Lower leaves** short 0.5 -2.0 mm long, gradually tapered from an oblong-ovate base to a long setaceous acumen. **Upper leaves** much larger, up to 5 mm long, abruptly tapered from an obovate, clasping base to a long, slender, semi-canaliculate acumen; margin plane, entire; **costa** occupying 1/4-1/3 of the leaf base wide, percurrent to short excurrent, smooth on back; upper cells above shoulder, linear-rectangular, 30-50 μm long, 5-10 μm wide, usually thick-walled; cells at the shoulder region, linear, linear-rhomboidal, usually falcate or curved, shorter near margin, thick-walled; lower cells below the shoulder, rectangular, 20-50 μm long, 10-15 μm wide, thin-walled. **Autoicous**. **Perichaetial** leaves longer than upper stem leaves. **Seta** straight, 1.0-1.5 cm long. **Capsule** erect cylindrical, 1.2-1.4 mm long, with indistinct neck, reddish brown; **operculum** rostrate, with long and oblique beak; **peristome** divided nearly to the middle, striate reddish below, hyaline and papillose above. **Calyptra** smooth (Fig. 5.9).

Thailand. — NORTHERN: Chiang Mai, Tak, Phitsanulok.

Distribution. — China, Japan, Sri Lanka, Indonesia, the Philippines, and Australia.

Ecology. — On wet sandy soil, in open fields.

Specimens examined. — *S. Chantanaorrapint. 601, 731* (BCU).

4. *MICRODUS*

Microdus Schimp. ex Besch., Mém. Soc. Sci. Nat. Cherbourg 16: 161. 1872; A. Eddy, A Handbook of Malesian Mosses vol. 1: 111. 1988; G. Chien,Vitt. & S. He, Mosses Flora of China vol. 1: 204. 1999. — *Dicranella* subg. *Microdus* (Schimp. ex Besch.) Broth., Nat. Pflanzenfam. 1(3): 309. 1901.

Plants small, slender, yellowish green, not glossy, gregarious to loose tufts. **Stems** erect, simple or branched, radiculose at base. **Leaves** carinate, lanceolate, gradually acuminate, shoulder indistinct; margin narrowly recurved, serrulate at apex; **costa** precurrent; leaves cells elongate-hexagonal to linear rectangular; basal cells shorter, becoming quadrate to hexagonal; **alar cells** not differentiated. **Dioicous**. **Perichaetial** leaves only slightly differentiated from vegetative leaves. **Seta** straight, slender, yellowish or reddish. **Capsule** erect, ovoid to short-cylindric; **operculum** rostrate; annulus differentiated, compound; **peristome** teeth usually undivided, rarely divided or perforate in the tips, papillose on both surface. **Spores** spherical, smooth or papillose.

Microdus miquelianus (Mont.) Besch.

In Paris, Ind. Bryol. 805. 1897; A. Eddy, A Handbook of Malesian Mosses vol. 1: 113, fig. 106. 1988. — *Weissia miquelianus* Mont., London J. Bot. 3: 633. 1844. — *Microdus papuanus* Dixon, Farlowia 1: 26. 1943. — *Dicranella insularis* Williams, Bull. N. Y. Bot. Gard. 8: 332. 1914. — *Microdus insularis* (Williams) Broth., Nat. Pflanzenfam Ed. 2, 10: 181.1924.

Plants small, in loose tufts. **Stems** erect, simple or sparsely branched. **Leaves** up to 2 mm long, erect or falcate, flexuose or slightly crispate when dry, lower leaves smaller, upper ones larger, lanceolate from a narrowly ovate base, gradually narrowed to a subulate apex; margin plane or incurved; **costa** thick, occupying 1/4-1/3 the leaf base width, excurrent; cells elongate-rectangular to narrowly rhomboid, 40-80 μm long, 10-20 μm wide, near the base, shorter toward the apex. **Perichaetial** leaves much longer than stem leaves. **Seta** 5-7 mm long, straight, flexuose when dry. **Capsule** small, ovoid or subglobose to cylindrical, smooth; **operculum** rostrate, with oblique beak; **peristome** teeth short, papillose. **Calyptra** cuculate, smooth (Fig. 5.10).

Tahiland. — CENTRAL: Nakhon Nayok; PENINSULAR: Chumphon, Trang, Phuket, Yala.

Distribution. — Borneo, Mainland China, Indonesia, Malaysia, Papua New Guinea, and Philippines.

Ecology. — On wet sandy soil, in open fields.

Specimens examined. — *S. Chantanaorrapint 415, 548* (BCU).

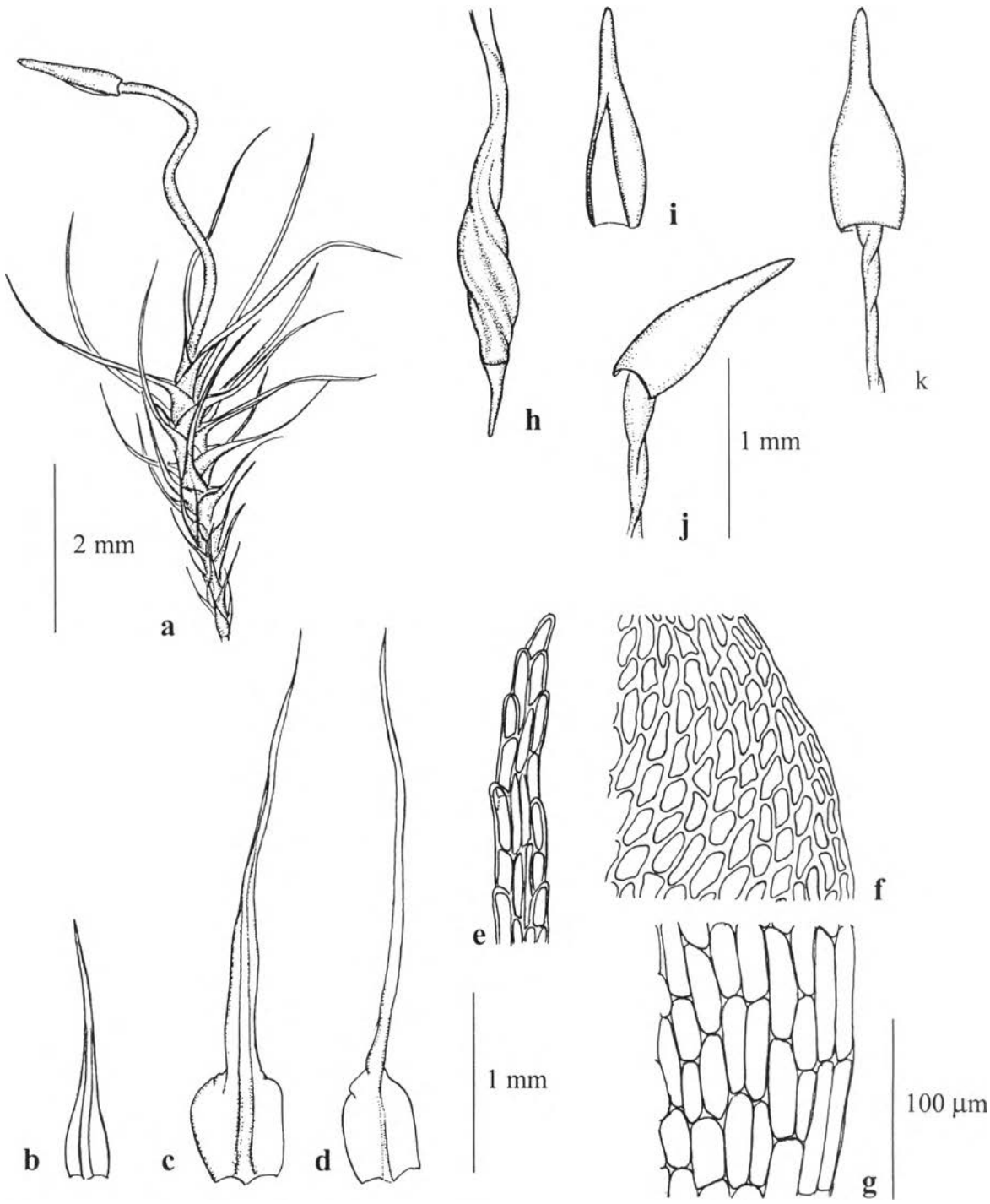

Figure 5.6 *Campylopodium medium* (Duby) Giese & J.-P. Frahm
a. habit; b. lower leaf; c.,d. upper leaves e. cells at leaf-apex; f. cells at leaf shoulder; g. cells at leaf-base; h. capsule; i. calyptra; j.,k. capsules with calyptra. Based on *S. Chantanaorrapint 629.*

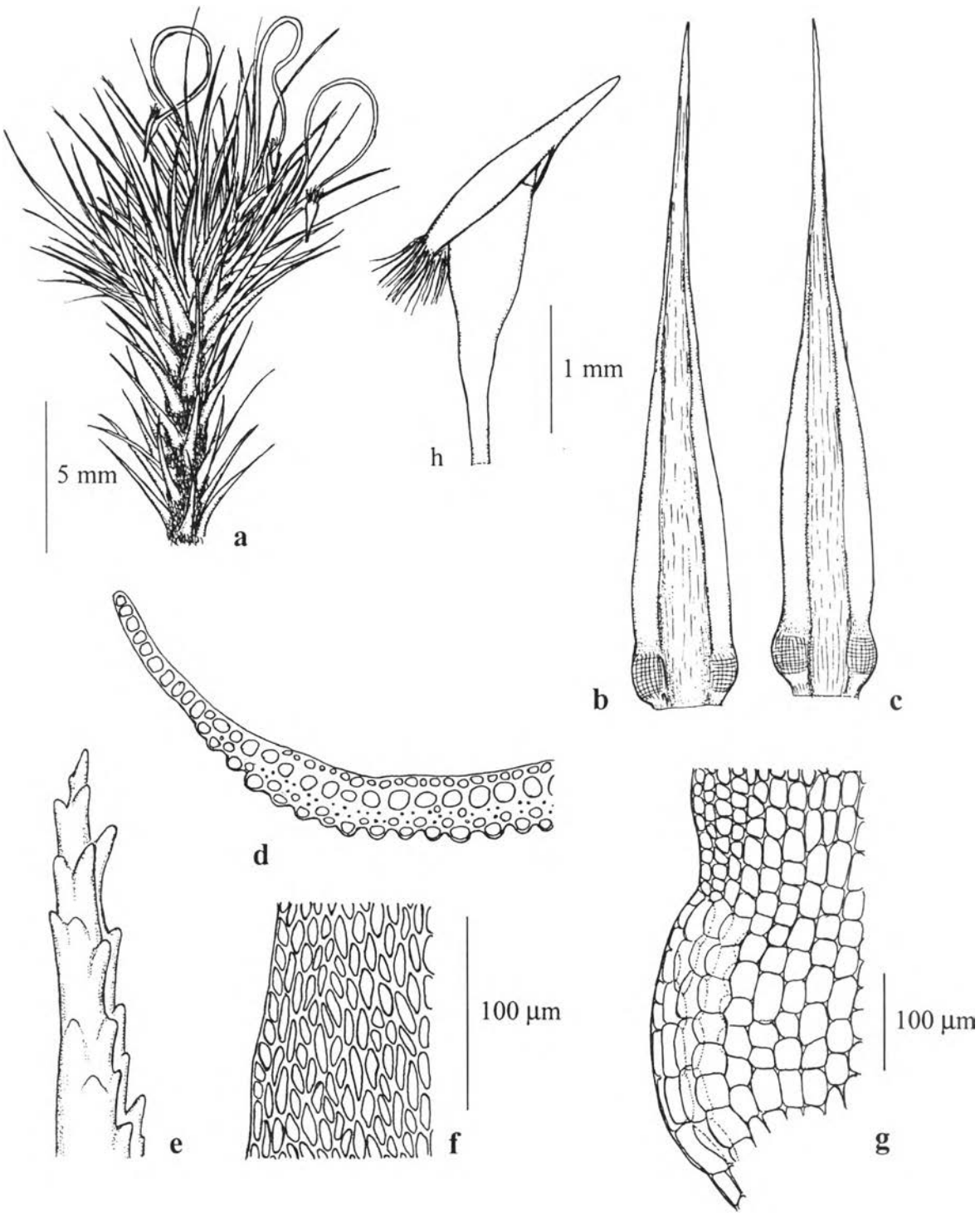

Figure 5.7 *Campylopus ericoides* (Griff.) Jaeg.
a. habit; b.,c. leaves; d. cross-section of leaf; e. leaf-apex; f. upper lamina cells; g. alar cells; h. capsule with calyptra. Based on *S. Chantanaorrapint 600.*

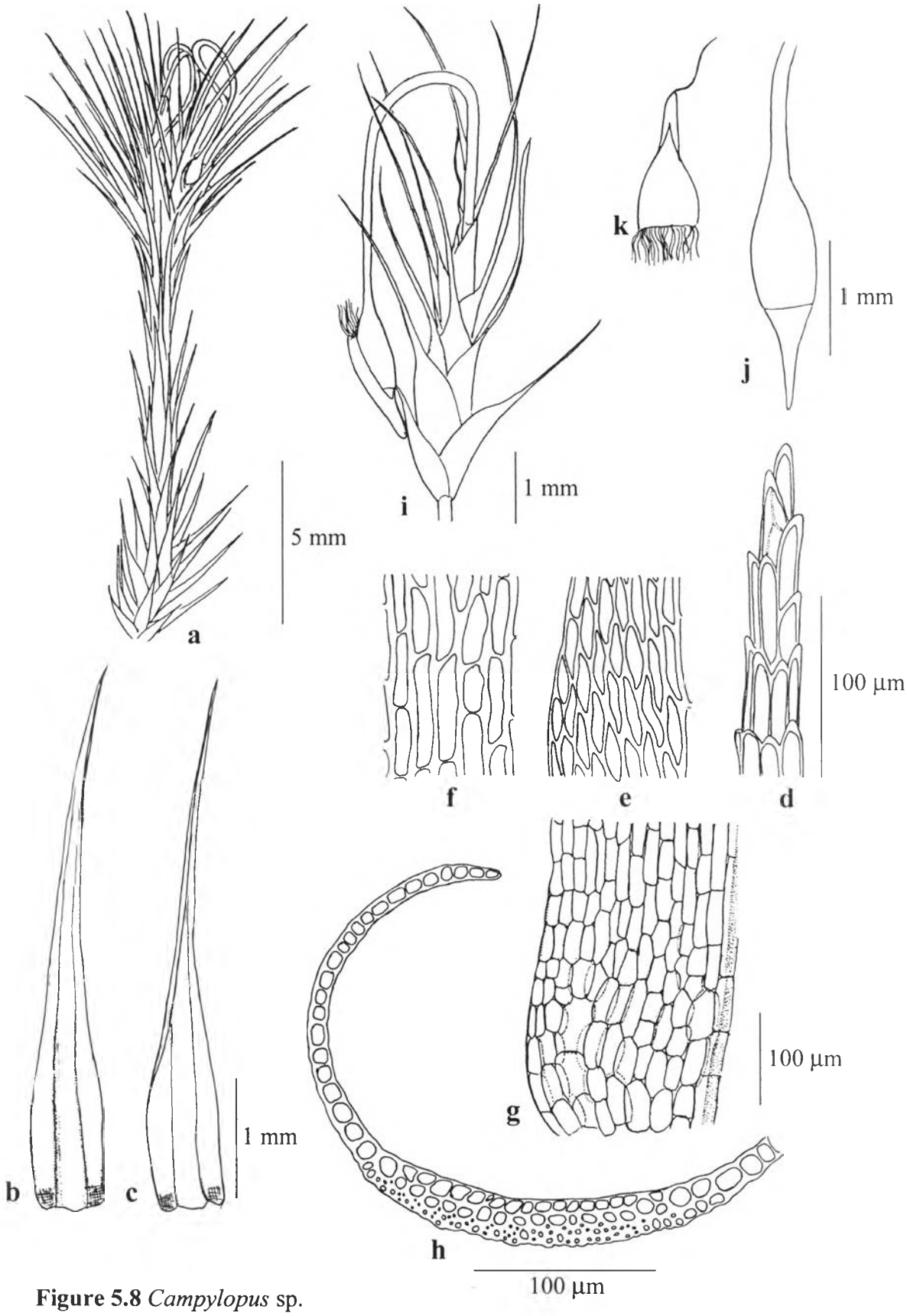

Figure 5.8 *Campylopus* sp.
a. habit; b.,c. leaves; d. leaf-apex; e. upper lamina cells; f. lower lamina cells; g. alar cells; h. cross-section of leaf; i. sporophyte; j. capsule; k. calyptra. Based on *S. Chantanaorrapint 607*.

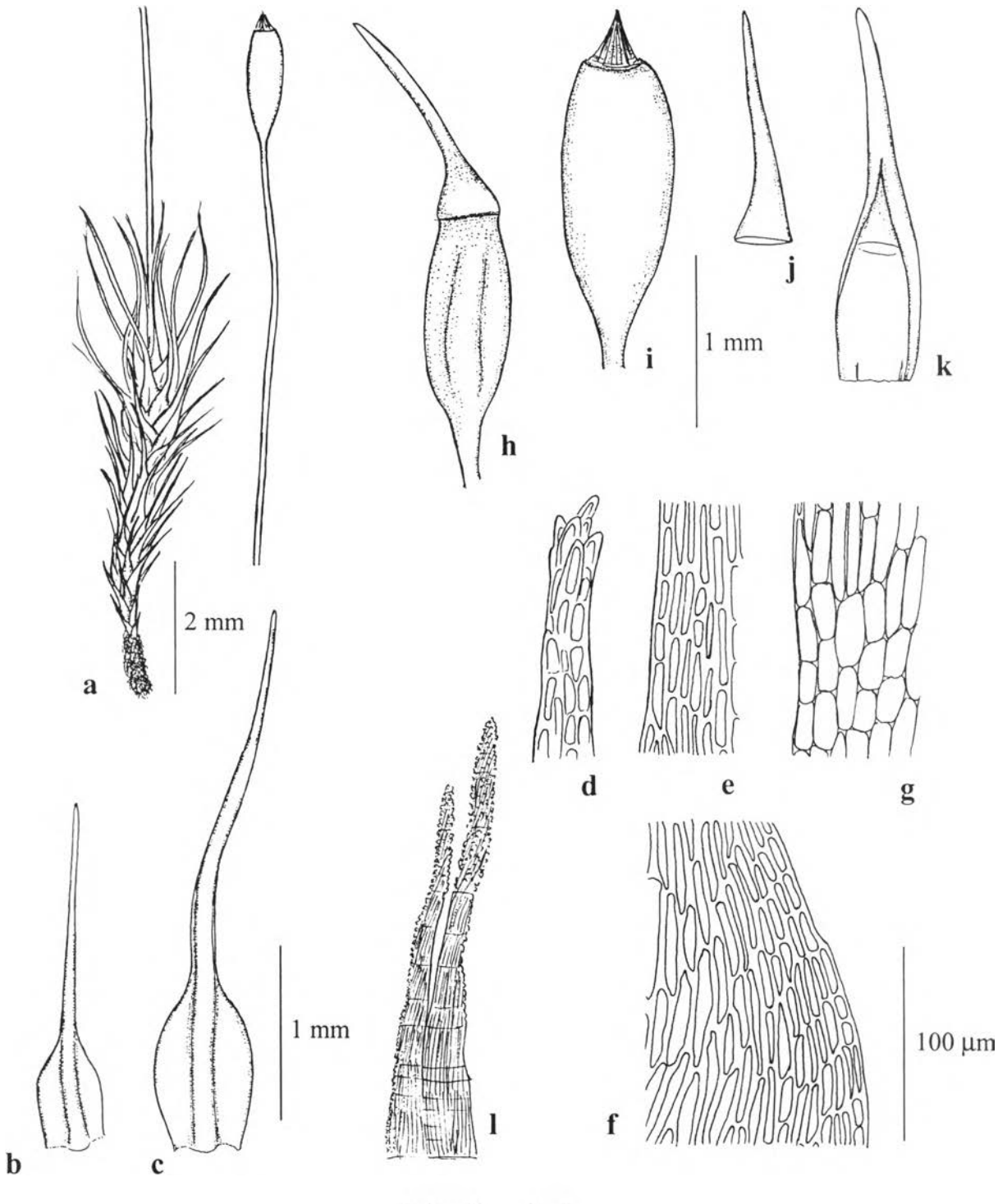

Figure 5.9 *Dicranella coarctata* (C. Müll.) Bosch & Sande Lac.
a. habit; b. lower leaf; c. upper leaf; d. cells at leaf-apex; e. upper lamina cells; f. cells at leaf shoulder; g. cells at leaf-base; h. capsule with operculum; i. capsule without operculum; j. operculum; k. calyptra; l. peristome teeth. Based on *S. Chantanaorrapint 629*.

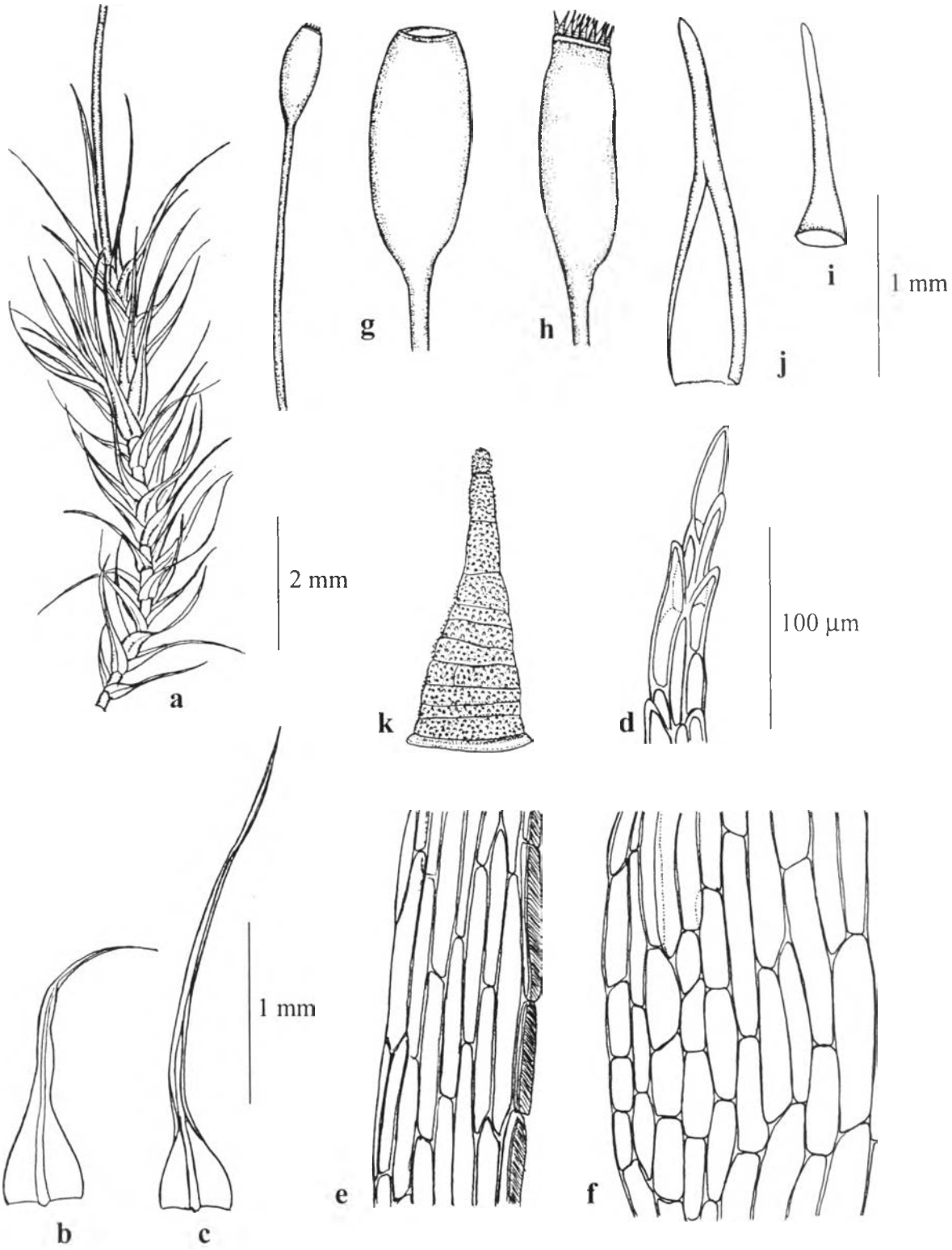

Figure 5.10 *Microdus miquelianus* (Mont.) Besch.
a. habit; b. lower leaf; c. upper leaf; d. cells at leaf-apex; e. upper lamina cells; f. cells at leaf-base; g., h. capsule with operculum; i. operculum; j. calyptra; k. peristome teeth. Based on *S. Chantanaorrapint 548*.

FISSIDENTACEAE

Plants minute to fairly large, terrestrial or epiphytic. **Stems** erect, simple or occasionally branched. **Leaves** distichous and complanate in one plane, base of adaxial side of costa spilt into two vaginant laminae which clasp the stem, costae usually well developed, rarely indistinct to lacking, laminae usually one cell thick, rarely multistratose, leaf cells variable, smooth to multipapillose. **Dioicous** or monoicous. **Seta** terminal or in axils of leaves. **Capsule** erect, symmetrical or curved and asymmetrical, **peristome** single, consisting of 16 teeth, upper portion usually divided into two filaments which are spirally thickened or articulate, stomata usually present at the base of capsule, or rarely lacking. **Calyptra** usually smooth, rarely more or less scarbrous.

FISSIDENS

Fissidens Hedw., Sp. Musc. Frond., 152, 1801; Z. Iwats. & T. Suzuki, J. Hattori. Bot. Lab. 51: 346. 1982. — *Skitophyllum* Pylaie, J. de Bot. Desv. sér. 2, 4: 133. 1814. nom. illeg. — *Conomitrium* Mont., Ann. Sc. Nat. Bot. sér. 2, 8: 245. 1837. nom. illeg. — *Polypodiopsis* (C. Müll.) Jaeg., Ber. S. Gall. Naturw. Ges.,1874-75: 132. 1876. — *Schitophyllum* Lindb. Utkast Nat. Crupp. Eur. Badm.: 16. 1878. — *Nonobryum* Dixon., J. Bot. 60: 100. 1922.

For description of the genus, see that of the family.

Key to species

1. Leaves bordered absent.....5. *Fissidens* sp.

1. Leaves bordered present.

    2. Leaves soft and flaccid; laminal cells large, hexagonal-rhomboidal.....
    .....2. *F. bogoriensis*

    2 Leaves firm; laminal cells small, usually rounded.....3.

        3. Leaves at least partly bordered by elongate cells, laminal cells with 4-6 papillae.....3. *F. hollianus*

        3. Leaves not bordered by elongate cells or none, laminal cells with single papilla or mammillose.

            4. Axillary hyaline nodules well-differentiated.....4. *F. javanicus*

            4. Axillary hyaline nodules not differentiated.....1. *F. anomalus*

1. ***Fissidens anomalus*** Mont.

Ann. Sci., Nat. Bot. sér. 2, 17: 252. 1842; L. Zhi-hua & Z. Iwats., Moss Flora of China vol. 2: 7, Pl. 69. 2001. — *F. cryptotheca* Dozy & Molk., Plantae Junghuhnianae 314. 1854. — *F. neckeroides* Griff. Calcutta J. Nat. Hist. 2: 504. 1842.

Plants medium-sized, dark green. **Stems** simple 0.5-1.5 cm high, with leaves 3-4 mm wide; axillary hyaline nodules not differentiated; central strand differentiated. **Leaves** in 12-20 pairs, the lower leaves smaller, upper leaves much longer; middle and upper leaves oblong-lanceolate, slightly falcate or recurved, ca. 2-3 mm long, 0.5-0.7 mm wide, crispate when dry, acute at apex; vaginant laminae 1/2-3/5 the leaf-length; **costa** stout, excurrent; margin irregularly dentate near leaf-apex, crenulate to serrulate below, bordered by a lighter colored band of 1-3 rows of incrassate, smooth, 1 cell thick; cells of apical and dorsal laminae quadrate, rounded to irregularly hexagonal, ca. 10 μm long, slightly mammillose, 1 cell thick; cells of vaginant laminae similar to those of apical and dorsal laminae (Fig. 5.11). **Sporophytes** not found.

Thailand. — NORTHERN: Chiang Mai; NORTH-EASTERN: Leoi.

Distribution. — China, Nepal, India, Sri Lanka, Myanmar, Vietnam, Indonesia, Philippines.

Ecology. — On tree trunk.

Specimens examined. — *S. Chantanaorrapint 559* (BCU).

2. ***Fissidens bogorensis*** Fleisch.

Musi Fl. Buitenzorg. 1: 22. 1904; Z. Iwats. & T. Suzuki, J. Hattori Bot. Lab. 51: 352, Pl. III, IV. 1982; L. Zhi-hua & Z. Iwats., Moss Flora of China vol. 2: 9, Pl. 71. 2001. — *F. diversiretis* Bartr., Philipp. J. Sc. 68: 21. 1939. — *F. closteroides* Z. Iwats., J. Jap. Bot. 39: 183. 1964. — *F. iriomotejimensis* Shin, Sc. Rep. Kagoshima Univ. 13: 38. 1964. — *F. horikawanus* Shin, Sc. Rep. Kagoshima Univ. 13: 76. 1964.

Plants very small, green to dull green. **Stems** very short, mostly simple, rarely branching, densely foliate, with leaves 1-2.5 mm wide, actual length of stem much shorter than leaf length; cortical cells large and thin-walled in cross-section, other cells are mostly equally large and thin-walled except few smaller cells at center. **Leaves** in 2-6 pairs, lower leaves small, upper leaves much larger, lanceolate to oblong-lanceolate, acuminate at apex, 0.7-1.8 mm long and 0.2-0.4 mm wide; margin almost entire, border differentiated by 1-3 rows of elongate and more or less thicker-walled cells; **costa** usually percurrent, but often reaching near apex; leaf cells lax, smooth, thin-walled, hexagonal to quadrate, 30-50 μm long and 20-30 μm wide. **Autoicous**. **Seta** 2.5-5.0 mm long, smooth. **Capsule** usually horizontal, more or less asymmetrical; **operculum** rostrate; **peristome** teeth distinctly spirally thickened on upper 3/4, often with scattered large papillae at middle, minute papillose below. **Calyptra** campanulate, smooth (Fig. 5.12).

Thailand. — New record to Thailand

Distribution. — China, Japan, Indonesia, Philippines.

Habitat .— On wet sandy soil.

Specimens examined. — *S. Chantanaorrapint 414* (BCU).

3. ***Fissidens hollianus*** Dozy & Molk.

Bryol. Jav. 1: 4. 1855; Iwats. & T. Suzuki, J. Hattori Bot. Lab. 51: 381, Pl. XX. 1982. — *F. japonica-punctatus* Shin, Sc. Rep. Kagoshima Univ. 13: 86, fig. 21. 1964.

Plants medium-sized for the genus, dark green, brownish when old. **Stems** usually simple, 3-6 mm long, 2 mm wide, often with few branches near apex, densely foliated with 6-16 pairs of leaves cortical cells small and thick-walled, central strand differentiated, axillary hyaline nodules absent;. **Leaves** oblong-lanceolate, 0.9-1.2 mm long, 0.3-0.4 mm wide, apex obliquely acute, rounded at base, not decurrent; vaginant laminae 1/2-3/5 of leaf-length; **costa** usually short excurrent, hyaline; margin crenulate, 1 cell-layer; **laminal cells** quadrate to hexagonal, 5-8 μm long, thin-walled, with 4-6 small papillae at conners; cells at extreme base of vaginant laminae more or less elongate and smooth; border present on lower half of vaginant laminae, composed of 2-4 rows of hyaline, elongate, smooth, thick-walled cells. **Autoicous**. **Seta** short, ca. 2 mm long, more or less scabrous throughout. **Capsule** usually inclined to horizontal, short cylindrical; **peristome** divided, spiral thickening above, papillose below; **operculum** rostrate (Fig. 5.13). **Calyptra** not found.

Thailand. — NORTHERN: Chiang Mai, Tak; CENTRAL: Nakhon Nayok; PENINSULAR: Surat Thani, Nakhon Si Thammarat.

Distribution. — Japan, Taiwan, Philippines, Borneo, Java, Sumatra, New Guinea, Malay Peninsular, Indochina, and Burma.

Ecology. — On basal of tree, in shaded site.

Specimens examined. — *S. Chantanaorrapint 616* (BCU).

4. ***Fissidens javanicus*** Dozy & Molk.

Bryol. Jav. 1:11, 1855; Iwats. & T. Suzuki, J. Hattori Bot. Lab. 51: 401, Pl. XXXIII. 1982. — *F. gozadakensis* Hor., Bot. Mag. Tokyo 49: 53, fig. 3. 1935. — *F. newcomeri* Bartr., Rev. Bryol. Lichénol. 23: 243. 1954. — *F. acutifolius* Mitt. J. Linn. Soc. Bot. suppl. 1: 137. 1859.

Plants medium-sized for the genus, yellowish green to brownish. **Stems** simple, 8-18 mm long, 3-5 mm wide; axillary hyaline nodules well developed; central strand slightly differentiated. **Leaves** in 20-40 pairs, densely arranged, linear-lanceolate, 2.0-2.5 mm long, 0.3-0.5 mm wide, acuminate at apex, apical and dosal lamina 1 cell-layer, more or less rugose; base of dorsal lamina usually rounded, not decurrent; vaginant laminae about 1/2 of leaf-length; **costa** stout, shortly excurrent; margin of apical and dorsal laminae thick, making an obscure band of 2-3 cell-rows, in cross-section this band composed of 2-3 layers of thick-walled, mammillose cells; margin of vaginant also making a band of 2-3 cell-rows, composed of large, thick-walled, smooth cells, 1 cell-layer in cross-section; cells of apical lamina rounded to hexagonal, 5-10 μm in diameter, thick-walled, mammillose; cells of vaginant lamina similar to those apical lamina, but mammillose only outside (Fig 5.14). **Sporophytes** not found.

Thailand. — NORTH-EASTERN: Loei; SOUTH-EASTERN: Trat; PENINSULAR: Nakhon Si Thammarat.

Distribution. — Borneo, Mainland China, India, Japan, Java, Malay Peninsula, Myanmar, Nepal, New Guinea, Philippines, Singapore, Sri Lanka, Sumatra, Taiwan, and Vietnam.

Ecology. — On shaded and moist rock.

Specimens examined. — *S. Chantanaorrapint 611, 655* (BCU).

5. ***Fissidens* sp.**

Plants medium to large-sized, dark green, grow in dense mats. **Stems** usually irregularly branched, 1-2 cm high, with leaves 2-3 mm wide; axillary hyaline nodules not differentiated; central strand differentiated. **Leaves** densely foliate, the lower leaves smaller, upper leaves much longer; middle and upper leaves narrowly lanceolate, ca. 1.5-2.0 mm long, 0.3-0.4 mm wide, crispate when dry, acute at apex; vaginant laminae 1/2-3/5 the leaf-length; **costa** stout, ending below apex; margin crenulate throughout, bordered not differentiated; cells of apical and dorsal laminae loosely, quadrate, rounded to irregularly hexagonal, ca. 8 μm long, nearly smooth or slightly mammillose, thian-walled, angular thickening, 1 cell thick; cells of vaginant laminae similar to those of apical and dorsal laminae, but the basal cells of vaginant laminae larger than, transversely elongate or rectangular, thick-walled (Fig. 5.15). **Sporophytes** not found.

Thailand. —

Distribution. —

Ecology. — On tree trunks in shade.

Specimens examined. — *S. Chantanaorrapint 651, 652* (BCU).

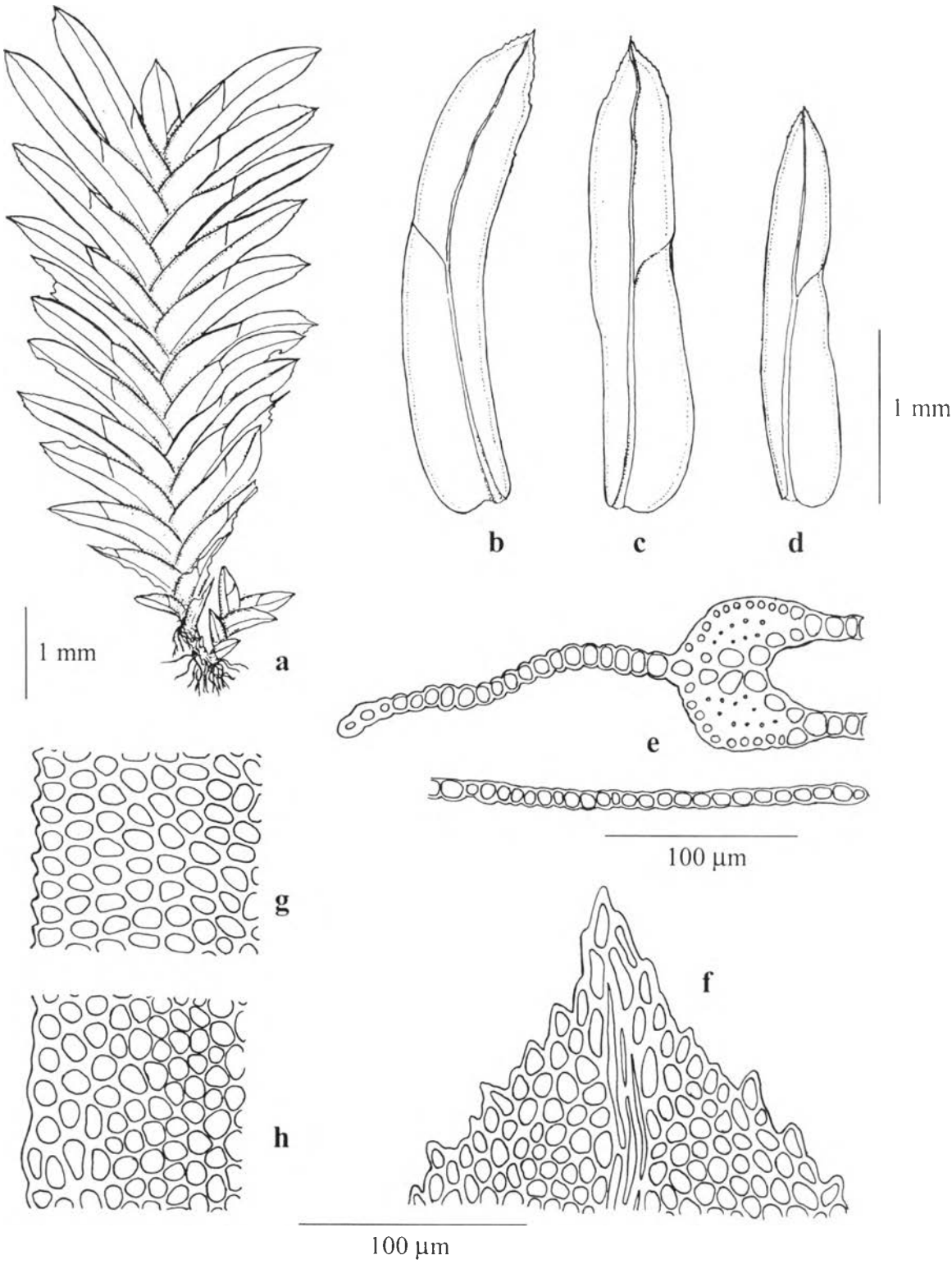

Figure 5.11 *Fissidens anomalus* Mont.
a. habit; b.-d. leaves; e. cross-section of leaf; f. cells at leaf-apex; g. cells at apical lamina; h. cells at vaginant lamina. Based on *S. Chantanaorrapint 599*.

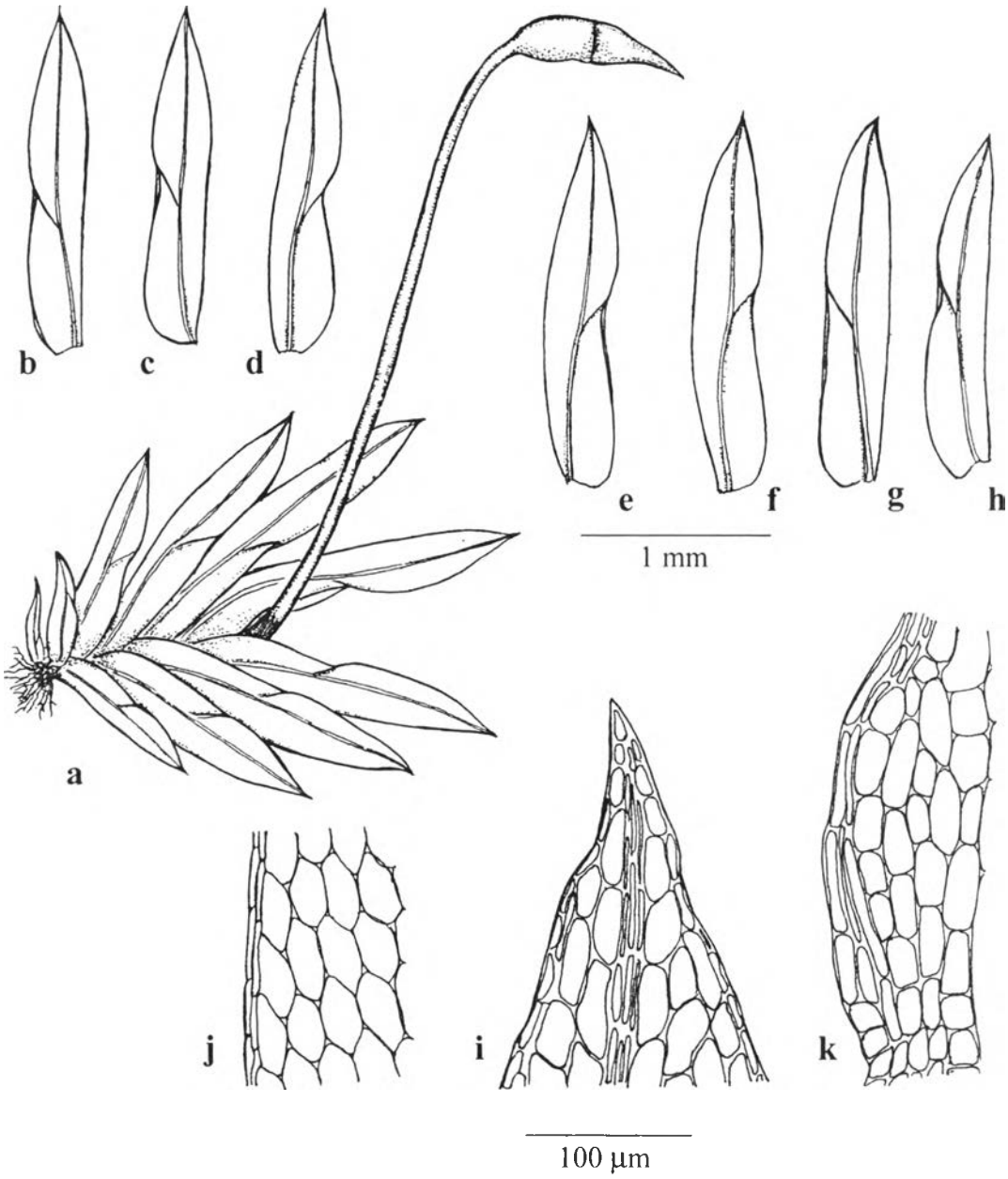

Figure 5.12 *Fissidens bogoriensis* Fleisch.
a. habit; b.-h. leaves; i. cells at leaf-apex; j. cells at leaf-median; k. cells at leaf-base.
Based on *S. Chantanaorrapint 414*.

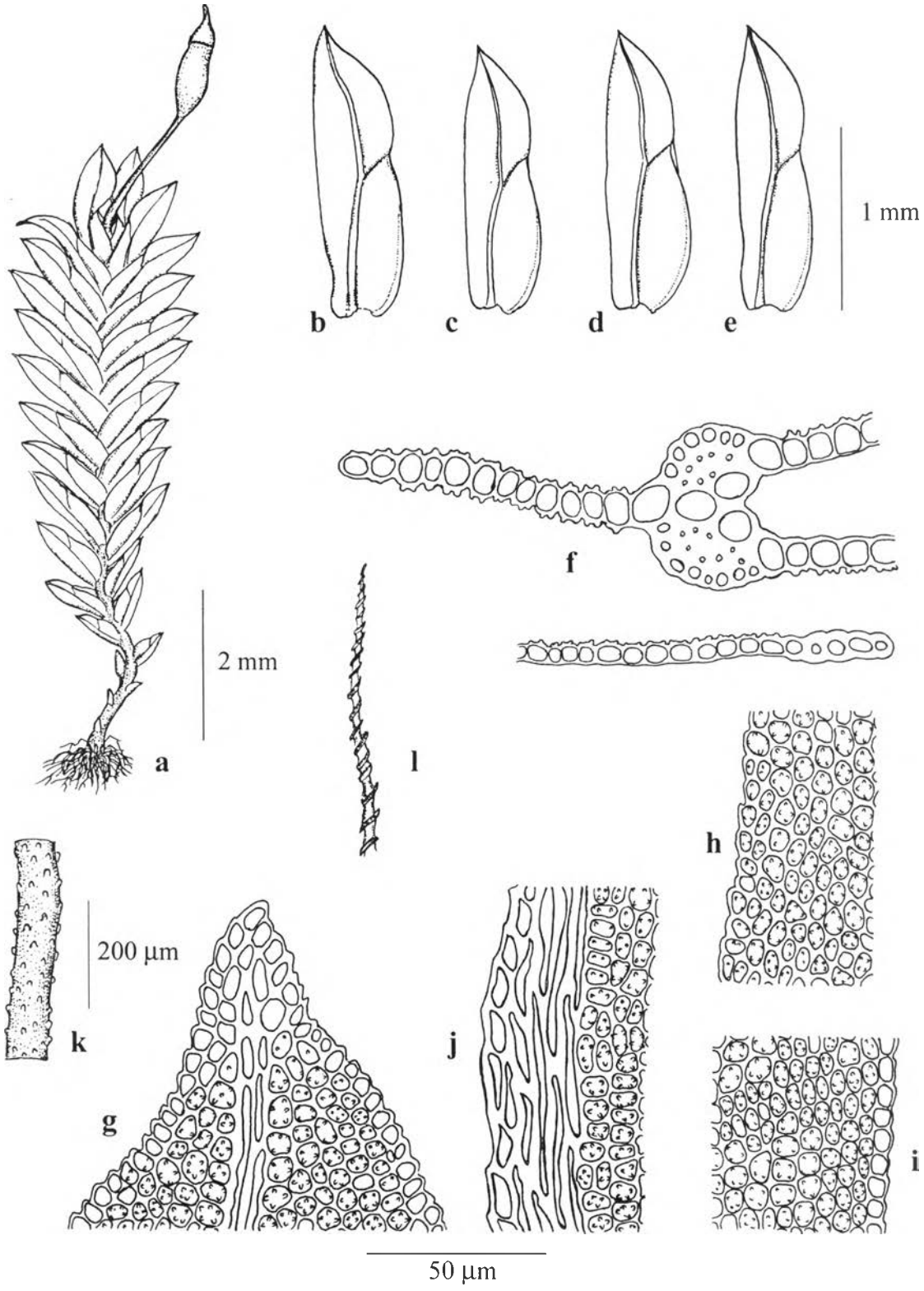

Figure 5.13 *Fissidens hollianus* Dozy & Molk.
a. habit; b.-e. leaves; f. cross-section of leaf; g. cells at leaf-apex; h. cells at upper lamina; i. cells at basal lamina; j. cells at vaginant lamina; k. a part of seta; l. peristome teeth. Based on *S. Chantanaorrapint 616*.

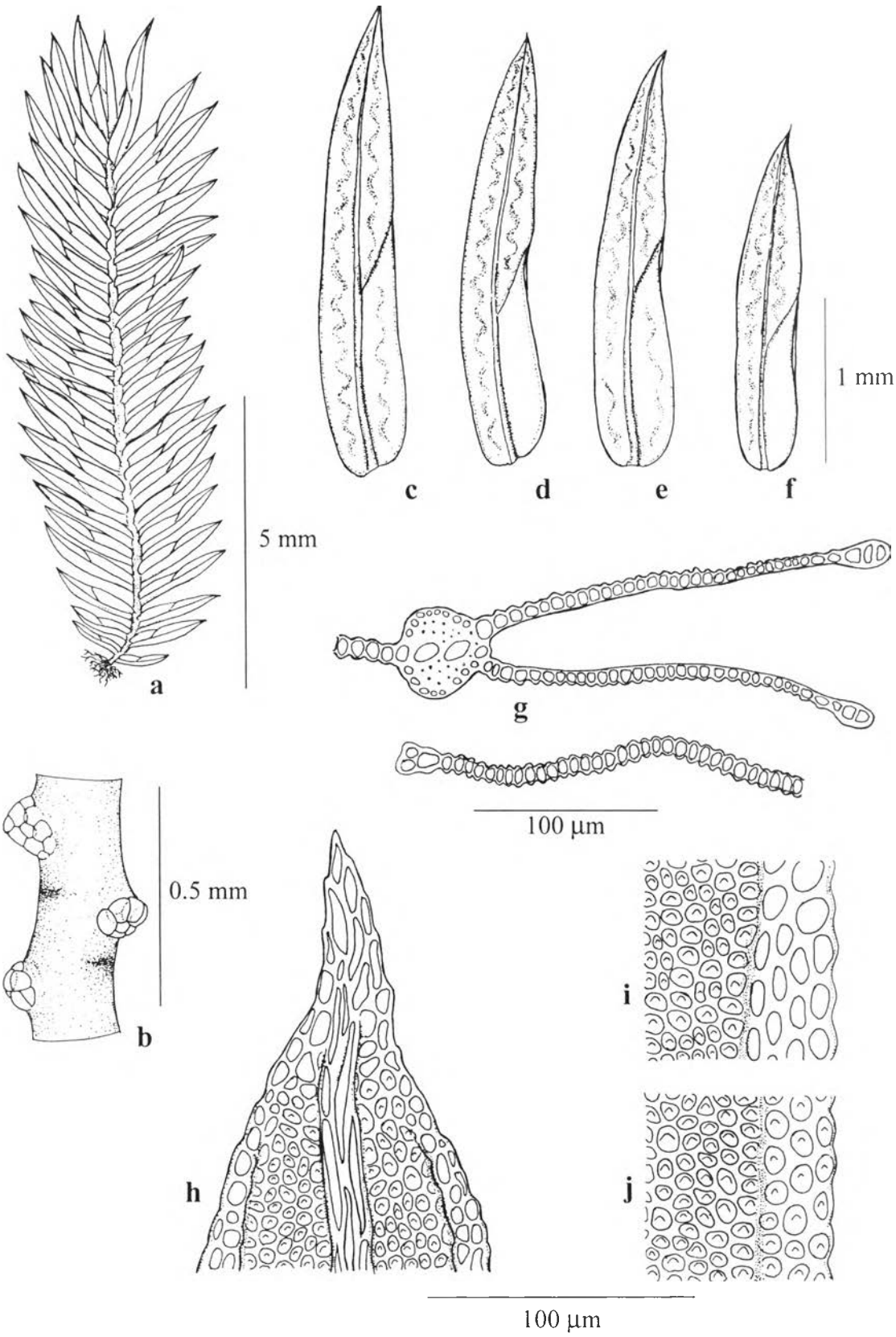

Figure 5.14 *Fissidens javanicus* Dozy & Molk.
a. habit; b. a part of stem; c.-f. leaves; g. cross-section of leaf; h. cells at leaf apex; i. cells at vaginant lamina; j. cells at basal lamina. Based on *S. Chantanaorrapint 611*.

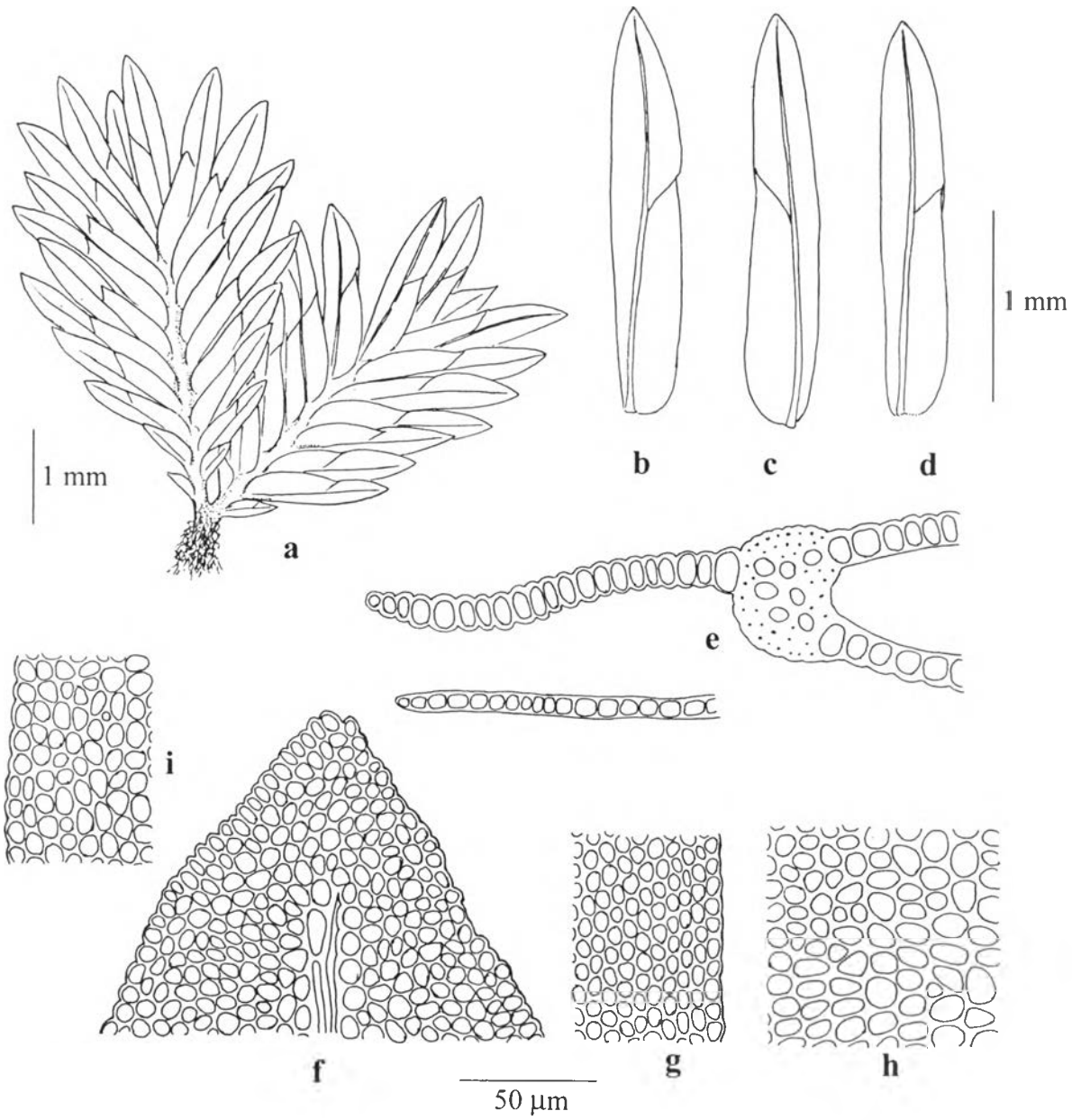

Figure 5.15 *Fissidens* sp.
a. habit; b.-d. leaves; e. cross-section of leaf; f. cells at leaf-apex; h. cells at apical lamina; i. cells at basal lamina; j. cells at vaginant lamina. Based on *S. Chantanaorrapint 652*.

HOOKERIACEAE

Plants small to robust, frequently complante; primary stems usually branched and prostrate, suberect, or pendent. **Leaves** variable in shape, with or without border, the dorsal leaves erect-spreading to spreading; **costa** single, double, or absent; cells smooth or papillose; **alar cells** not differentiated. **Synoicous**, autoicous, or dioicous. **Seta** short or elongate, smooth, papillose, or ciliate. **Capsule** inclined or horizontal, occasionally erect; **peristome** double, exostome teeth papilose or striate, often with a wide median furrow; cilia lacking, rarely rudimentary. **Calyptra** generally mitriform, smooth, scabrous, or pilose, the base usually lobed or fringed-ciliate.

Key to Genera

1. Costa single .....3. *Distichophyllum*

1. Costa double.

   2. Costa weak, less than 1/2 of the leaf length .....2. *Chaetomitrium*

   2. Costa strong, more than 1/2 of the leaf length 3

      3. Costa reaching near the apex, strongly protruding abaxially .....
      .....1 *Callicostella*

      3. Costa reaching 3/4 of the leaf length, or weakly protruding abaxially .....
      .....4. *Hookeriopsis*

1. *CALLICOSTELLA*

Callicostella (C. Müll.) Mitt., J. Linn. Soc. Bot. Suppl., 1: 136. 1859; Gangulee, Mosses of Eastern India and Adjacent Regions, Fascicle 6: 1510. 1977. B.C. Tan & H. Rob., Smithsonian Contr. Bot. 75: 6. 1990; Mohamed & H. Rob., Smithsonian Contr. Bot. 80: 4. 1991; B.-J. Lin & B.C. Tan, Moss flora of China 6: 5. 2002.

Plants slender, yellowish to dark green, in mats. **Stems** creeping, irregularly branched, laxly complanate-foliate. **Leaves** oblong, short-acute to short-acuminate, closely serrate above; costa double, thick, reaching beyond midleaf, ending in abrupt apical protrusion; cells firm, hexagonal, or rhombiodal, nearly isodimetric, smooth or with central papila. **Synoicous**, autoicous, or dioicous. **Seta** elongate, often partly or completely roughened. **Capsule** inclined or horizontal, subcylindric; **operculum** rostrate; outer surface of exostome teeth striolate, with median furrow. **Calyptra** naked, scabrous distally, weaky plicate and laciniate at base.

Callicostella papillata (Mont.) Mitt.

J. Linn. Soc. Bot. Suppl., 1:136, 1859; Gangulee, Mosses of Eastern India and Adjacent Regions, Fascicle 6: 1510, fig. 756. 1977; B.C. Tan & H. Rob., Smithsonian Contr. Bot. 75: 7. 1990; Mohamed & H. Rob. Smithsonian Contr. Bot. 80: 6. 1991. Nog., Illustrated Moss Flora of Japan, part 4: 754, fig. 332. 1991; B.-J. Lin & B.C.

Tan, Moss flora of China 6: 5. 2002. — *Hookeria papillata* Mont., London J. Bot. 3: 632. 1844.

Plants in flat mat, yellow to dark green. **Stems** creeping, prostrate, irregularly branched. **Leaves** complanate, somewhat curved and plicate when dry, oblong-lingulate, 0.9-1.4 mm long and 0.4-0.5 mm wide, broadly acute to abruptly acuminate; margins not bordered above, a single row of elongate cells below, serrulate to dentate in upper half, often with bigeminate teeth, lower half entire; **costa** ceasing just below apex in abaxial protrusion, smooth below, toothed above; median cells hexagonal to oblong, 8-15 μm long and 6-10 μm wide, thick-walled, with a single papilla over each lumen, basal elongate and smooth, 20-45 μm long and 10-15 μm wide (Fig. 5.16). **Sporophytes** not found.

Thailand: — NORTHERN: Tak; NORTH-EASTERN: Loei; SOUTH-EASTERN: Kanchanaburi; CENTRAL: Nakhon Nayok; PENINSULAR: Nakhon Si Thammarat, Chumphon.

Distribution. — Madagasca, South India, Andaman Islands, Sri Lanka, Vietnam, Malaya, Sumatra, Java, Borneo, Philippines, Taiwan, Japan, New Guinea, New Caledonia, Fiji, Tahiti, and Samoa.

Ecology. — On tree branches.

Specimens examined. — *S. Chantanaorrapint 687* (BCU).

2. *CHAETOMITRIUM*

Chaetomitrium Dozy & Molk., Musci Frond. Ined. Archip. Indici 2:117. 1847; Gangulee, Mosses of Eastern India and Adjacent Regions, Fascicle 6: 1498. 1977; B.C. Tan & H. Rob., Smithsonian Contr. Bot. 75: 6. 1990; Mohamed. & H. Rob., Smithsonian Contr. Bot. 80: 4. 1991.

Plants small to medium sized. **Stems** long creeping, usually regularly pinnate, sometimes with cluster of filamentous gemmae among leaves on ultimate branches. **Leaves** erect-spreading, widely spreading or appressed, ovate, concave, acuminate to rounded; margins usually dentate, without differentiated border; **costa** short and double or none; cells linear, shorter near apex, generally prorulose. **Autoicous** or dioicous. **Perichaetial** leaves lager than vegetative leaves. **Seta** elongate, papillose or setose. **Capsule** more or less inclined; **operculum** rostrate; **exostome** teeth striolate, not furrow. **Calyptra** mitrate or cuculate, alway strongly hispid or spinose-ciliate, uasually fringed at the base.

Chaetomitrium orthorrhynchum (Dozy & Molk.) Bosch. & Sande Lac.

Bryol. Jav. 2: 45. 1862; Mohamed & H. Rob., Smithsonian Contr. Bot. 80: 11. 1991. — *Hookeria orthorrhychum* Dozy & Molk., Ann. Sci. Nat. Bot. ser. 3, 2: 305. 1844. — *C. perakense* Broth. ex Dixon, Bull. Torrey Bot. Club. 51: 237. 1924.

Plants small, in gloden-green mats. **Stems** pinnate to bipinnate. **Leaves** ovate-lanceolate, acuminate, 1.2-1.5 mm long and 0.4-0.6 mm wide, widest below mid-leaf; ultimate branch leaves smaller, concave, constricted below the apex; margin sharply serrate in upper 2/3 of leaf, entire below; **costa** short, faint; apical cells oblong, 15-20

μm long and 5 μm wide, median and basal cells linear, 30-50 μm long and 5 μm wide, prorulose, especially on the back of leaf (Fig. 5.17). **Sporophytes** not found.

Thailand. — PENINSULAR: Ranong.
Distribution. — Malaya, Indonesia, and Philippines.
Ecology. — On tree trunks.
Specimens examined. — *S. Chantanaorrapint 632* (BCU).

3. *DISTICHOPHYLLUM*

Distichophyllum Dozy & Molk., Musci Frond. Ined. Archip. Indici 4: 99. 1846; Gangulee, Mosses of Eastern India and Adjacent Regions, Fascicle 6: 1482. 1977; B.C. Tan & H. Rob., Smithsonian Contr. Bot. 75: 6. 1990; Mohamed & H. Rob., Smithsonian Contr. Bot. 80: 4. 1991; Nog., Illustrated Moss Flora of Japan, part 4: 743. 1991; B.-J. Lin & B.C. Tan, Moss flora of China 6: 14. 2002.

Plants small to robust. **Stems** sparingly branched. **Leaves** complanate, weakly dimorphous, dorsal and ventral rows usually weakly differentiated, crowded, ovate or spathulate, usually entire, usually with a border of elongate cells; **costa** single, extending from mid-leaf to leaf apex; upper cells isodiametric, smooth, more lax and elongate at base. **Seta** smooth or papillose. **Capsule** erect to pendulous; **peristome** double; exostome teeth transversely striolate, with a wide median furrow; endostome with high basal membrane, segments sometimes perforated; **operculum** conic-rostrate. **Calyptra** mitriform, fringed at base.

Key to species

1. Leaves ovate to broadly elliptic, widest at the mid-leaf .....1. *D. nigricaule*

1. Leaves obovate to oblong-ovate, widest at 3/4 - 4/5 of leaf length ....2. *D. schmidtii*

1. ***Distichophyllum nigricaule*** Mitt. ex Bosch. & Sande Lac.

Bryol. Jav. 2: 20. 1861; Gangulle, Mosses of Eastern India and Adjacent Regions, Fascicle 6: 1487, fig. 743, 1977; B.C. Tan & H. Rob., Smithsonian Contr. Bot. 75: 20, figs. 23-28. 1990; Mohamed & H. Rob., Smithsonian Contr. Bot. 80: 25, figs. 51, 54, 55, 57. 1991. — *D. gracilicaule* M. Fleisch., Musi Fl. Buitenz. 3: 983. 1908.

Plants in medium-sized mats, light green. **Stems** with leaves to 2 cm long, to 3 mm wide when wet, simple or branched. **Leaves** distantly placed on stem, scarcely shrunken and slightly crispate when dry, slightly concave, ovate to broadly elliptic, rarely obovate, 1.5-2.0 mm long and 0.9-1.1 mm wide, widest at mid-leaf, obtuse to rounded with a distant apiculus, the apiculus 20-30 μm long; margin entire and plane; broaders well differentiated, with 1-2 rows of linear cells near apex, 2-3 rows below; **costa** flexuose above, extending from 3/4 to 4/5 of leaf length; median cells hexagonal to rounded, 15-20 μm wide, moderately thick-walled, weakly collenchymatous, more or less homogeneous in upper half of leaf and submarginal region towards base; paracostal cells towards base larger, hexagonal to rectangular, 45-60 μm long and 20-25 μm wide (Fig. 5.18). **Sporophytes** not found.

Thailand: — PENINSULAR: Nakhon Si Thammarat.
Distribution. — Java, Borneo, and Malaya.
Ecology. — On wet sandy rocks or sandy soil.
Specimens examined. — *S. Chantanaorrapint 521, 620, 648* (BCU).

2. ***Distichophyllum schmidtii*** Broth.

Bot. Tidskr. 24: 122. 1901; Gangulee, Mosses of Eastern India and Adjacent Regions, Fascicle 6:1491, fig. 746. 1977; Mohame & H. Rob., Smithsonian Contr. Bot. 80: 26, figs. 80-86. 1991.

Plants medium-sized, in mats. **Stems** prostrate, 3 cm long and 5 mm wide with leaves when wet, simple or branched. **Leaves** scarcely shrunken and slightly crispate when dry, oblong-ovate to obovate, 2.5-3.5 mm long and 1.1-1.5 mm wide, widest between 3/5 to 4/5 from base of leaf, obtuse to rounded with a small mucro, the mucro 30-60 μm long, margin entire and plane; borders well differentiated, with 2-3 rows of linear cells near the apex, 3-4 rows of linear cells near the base; **costa** flexuose on top, extending from 3/4 to 4/5 of leaf length; median and upper cells irregularly hexagonal, 15-25 μm long and 15-20 μm wide, thin walled; paracostal cells much lager below, lax, hexagonal to rectangular, 50-90 μm long and 20-30 μm wide. **Dioicous**. **Seta** up to 8 mm long, scabrous throughout. **Capsule** inclined or horizontal, ovate, scabrous below; **operculum** rostrate. **Calyptra** smooth, fringed at base (Fig. 5.19).

Thailand. — Northern: Chaing Mai; South-eastern: Trat.
Distribution. — Singapore, Malaya, and Bangladesh.
Ecology. — On wet sandy rocks or sandy soil.
Specimens examined. — *S. Chantanaorrapint 182, 617* (BCU).

4. *HOOKERIOPSIS*

Hookeriopsis (Besch.) Jaeger, Ber. S. Gall. Naturw. Ges. 1875-1876: 358. 1877; Gangulee, Mosses of Eastern India and Adjacent Regions, Fascicle 6: 1512. 1977; B.C. Tan & H. Rob., Smithsonian Contr. Bot. 75: 25. 1990; B.-J. Lin & B.C. Tan, Moss flora of China 6: 33. 2002.

Plants medium-sized, yellow-green (may be brown or reddish below), corticolous plant. **Stems** creeping, irregularly branched, complanate. **Leaves** in several rows, usually heterophyllus, more or less spreading, ovate-oblong, apex rounded to acute; margin serrate near the apex, bordered below; **costa** double, ending at the mid-leaf or running beyond; **leaf-cells** broadly or narrowly rhomboid-hexagonal at top, usually papillose at upturned top, cell angle, sometimes smooth; rectangular and smooth at base. **Seta** long, smooth or scabrous at tip. **Capsule** horizontal, ovate-cylindrical; **peristome** double

Hookeriopsis utacamundiana (Mont.) Broth.

Nat. Pflanzenfam. 1(3): 942. 1907; Gangulee, Mosses of Eastern India and Adjacent Regions, Fascicle 6: 1513, fig. 757. 1977; B.C. Tan & H. Rob., Smithsonian Contr. Bot. 75: 25. 1990; Nog., Illustrated Moss Flora of Japan, part 4: 756, fig. 333. 1991; B.-J. Lin & B.C. Tan, Moss flora of China 6: 33. 2002. — *Hookeria utacamundiana* Mont., Ann. Sc. Nat. Bot. ser. 2, 17: 247. 1842. — *H. secunda* Griff., Calcutta J. Nat. Hist. 3: 280. 1843. — *H. purpurea* C. Müll., Flora 82: 459. 1896. — *Hookeriopsis geminidens* Broth., Philipp. J. Sci. 5C(Bot.): 156. 1910. — *Lepidopilum sumatranum* Bosh. & Sande Lac., Bryol. Jav. 2: 42. 1862. — *Thamniopsis utacamundiana* (Mont.) Buck, Brittonia 39: 219. 1987.

Plants medium-sized, in mats, silky green, with deep purplish tinge. **Primary stems** prostrate, complanate; the **secondary stems** and branches creeping or erect, to 10 mm long. **Leaves** complanate, slightly flexuose when dry, concave when wet; **lateral leaves** ovate-oblong, 2-3 mm long, broadly acute; margin borders not well differentiated, except for the strongly bifid, unicellular teeth along leaf margin near the apex; **costa** double, strong, asymmetrically placed at leaf base, reaching mid-leaf; **dorsal** and **ventral leaves** similar to the lateral ones but smaller, the apices sometimes acuminate; **leaf cells** narrowly rhomboid, 30-60 μm long and 20-25 μm wide, smooth or slightly prorulose, becoming oval near apex and rectangular at base, thin to thick-walled. **Autoicous**. **Seta** up to 2 cm long, reddish-brown, smooth (Fig. 5.20). **Capsules** not found.

Thailand. — NORTHERN: Chiang Mai; NORTH-EASTERN: Phetchabun, Nakhon Nayok, Loei.

Distribution. — Japan, Indo-China, Sri Lanka, India, Sumatra, Borneo, and New Guinea.

Ecology. — On rocks or declay woods.

Specimens examined. — *S. Chantanaorrapint 608, 678* (BCU).

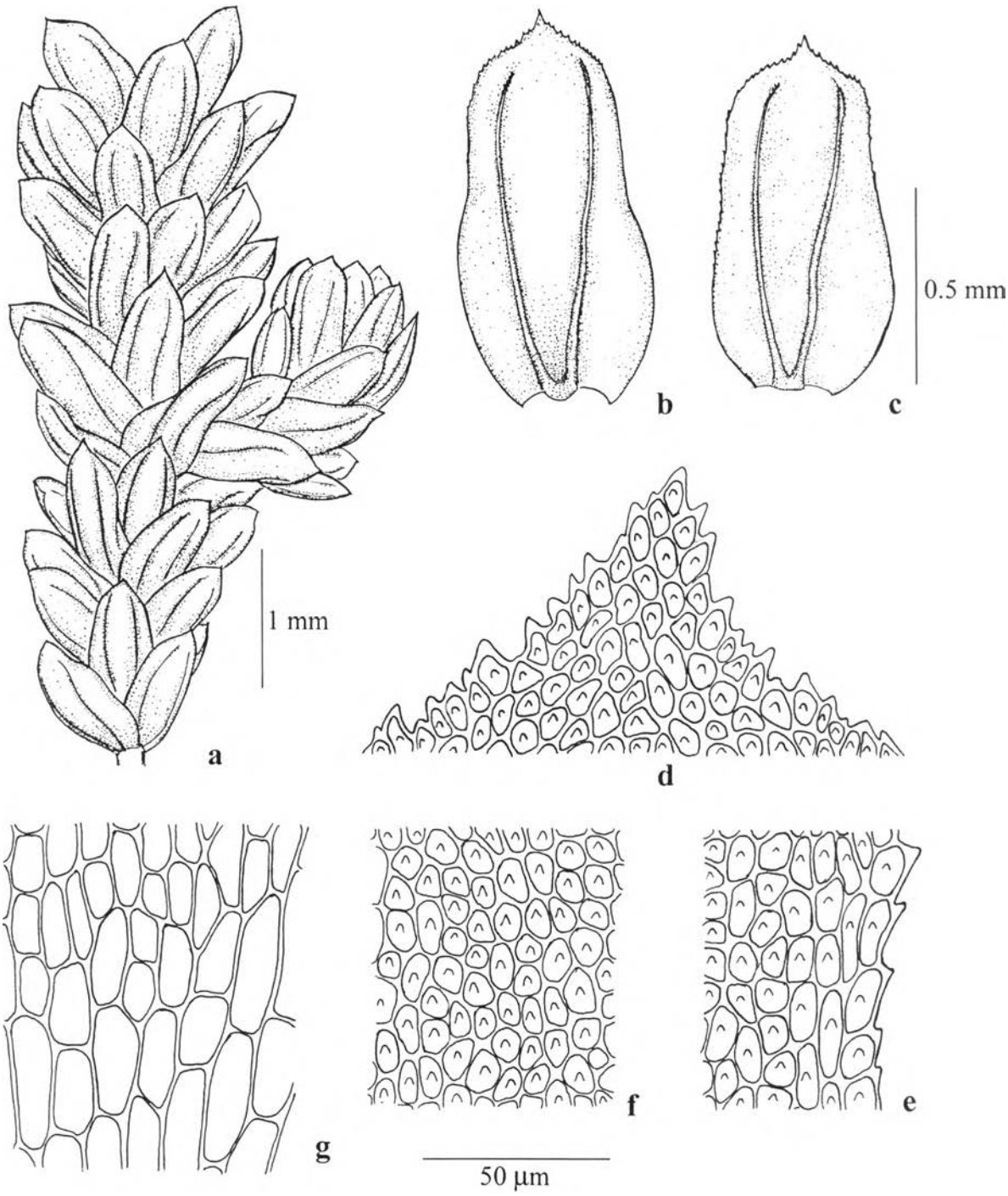

Figure 5.16 *Callicostella papillata* (Mont.) Mitt.
a. a part of plant; b.,c. leaves; d. cells at leaf apex; e. cells at leaf margin; f. cells at median leaf; g. cells at leaf base. Based on *S. Chantanaorrapint 687*.

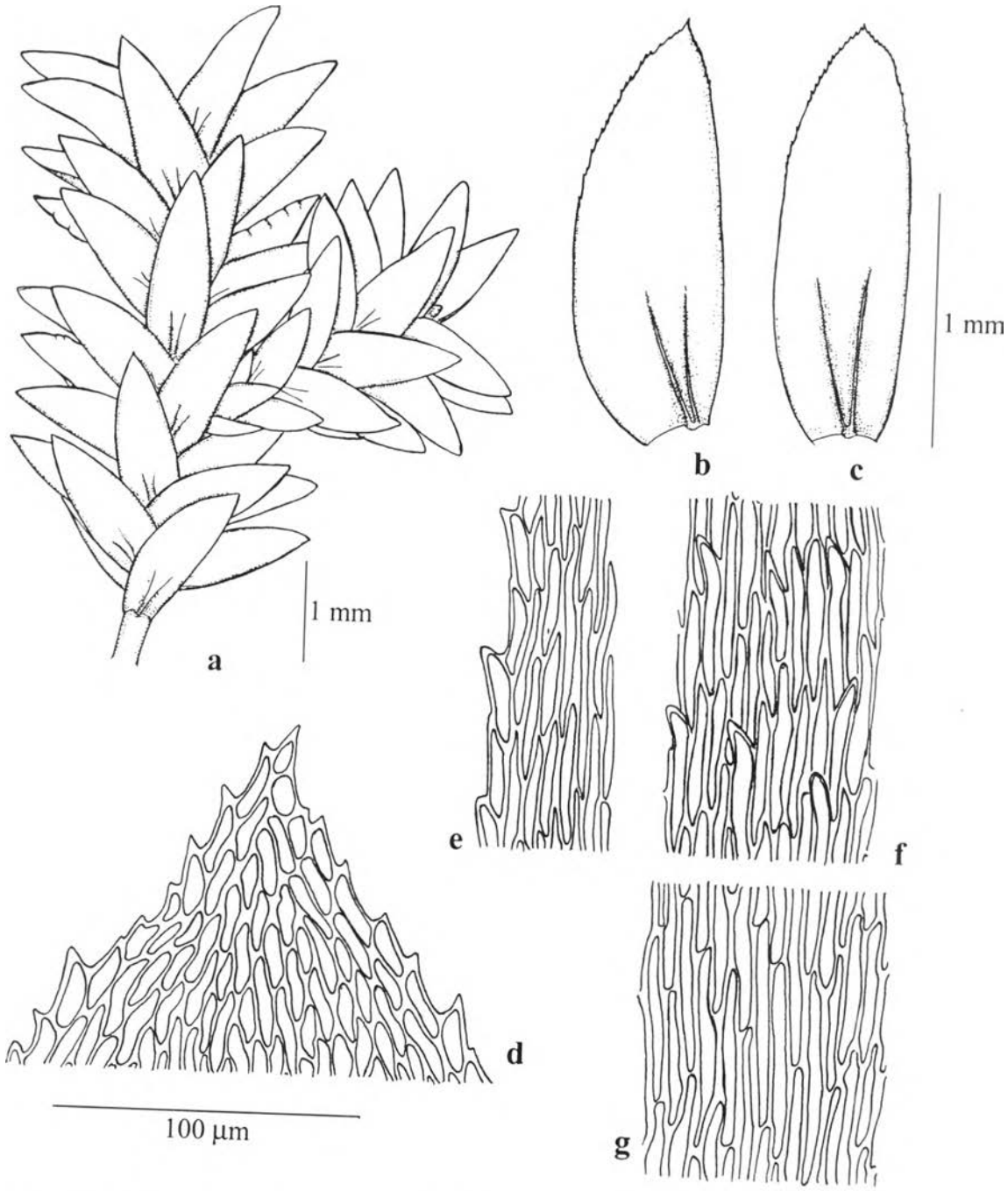

Figure 5.17 *Chaetomitrium orthorrhynchum* (Dozy & Molk.) Bosch. & Sande Lac. a. a part of plant; b.,c. leaves; d. cells at leaf apex; e. cells at leaf margin; f. cells at median leaf; g. cells at leaf base. Based on *S. Chantanaorrapint 632*.

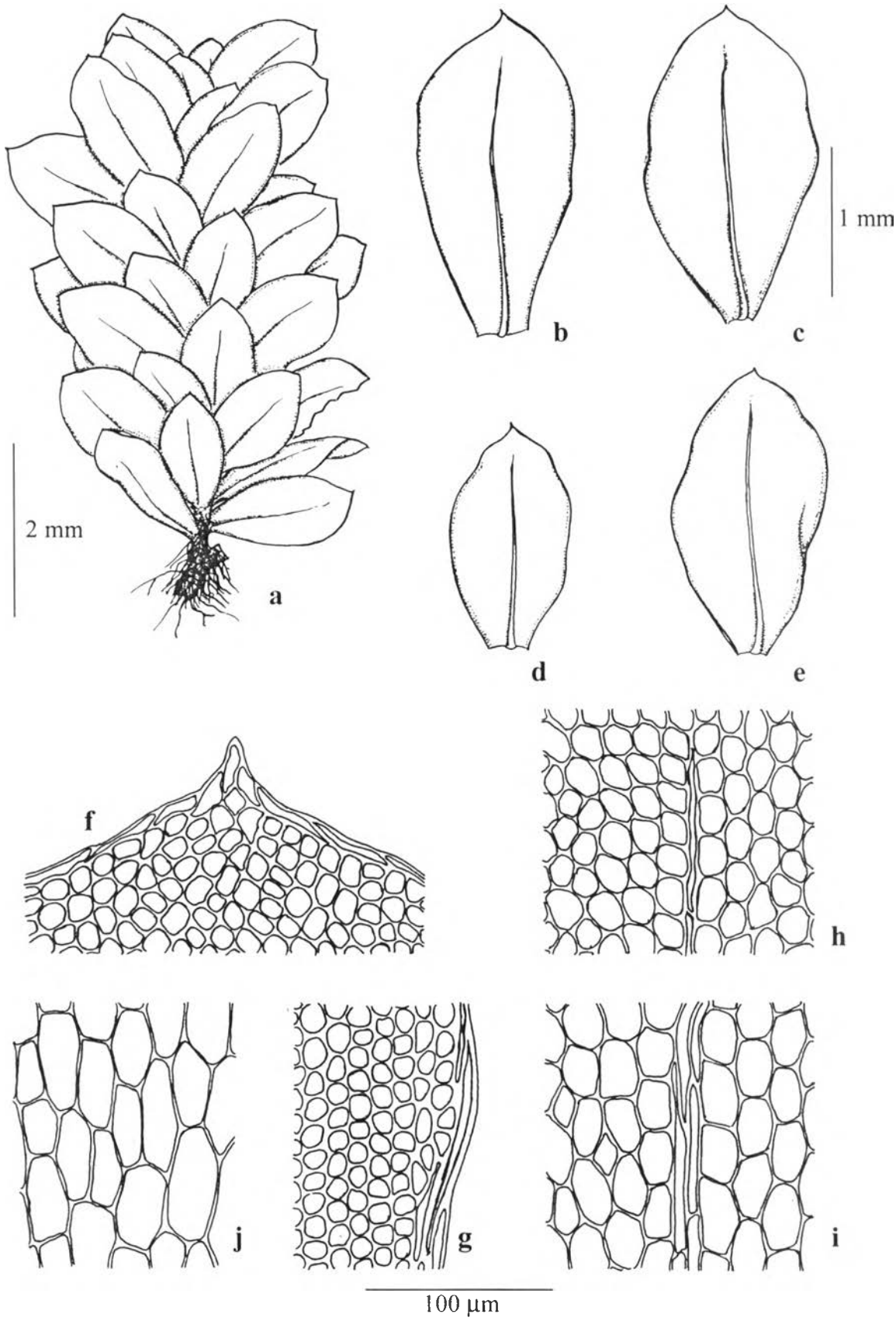

Figure 5.18 *Distichophyllum nigricaule* Mitt. ex Bosch. & Sande Lac.
a. habit; b.-e. leaves; f. cells at leaf apex; g. cells at leaf margin; h.,i. cells at median leaf; j. cells at leaf base. Based on *S. Chantanaorrapint 521*.

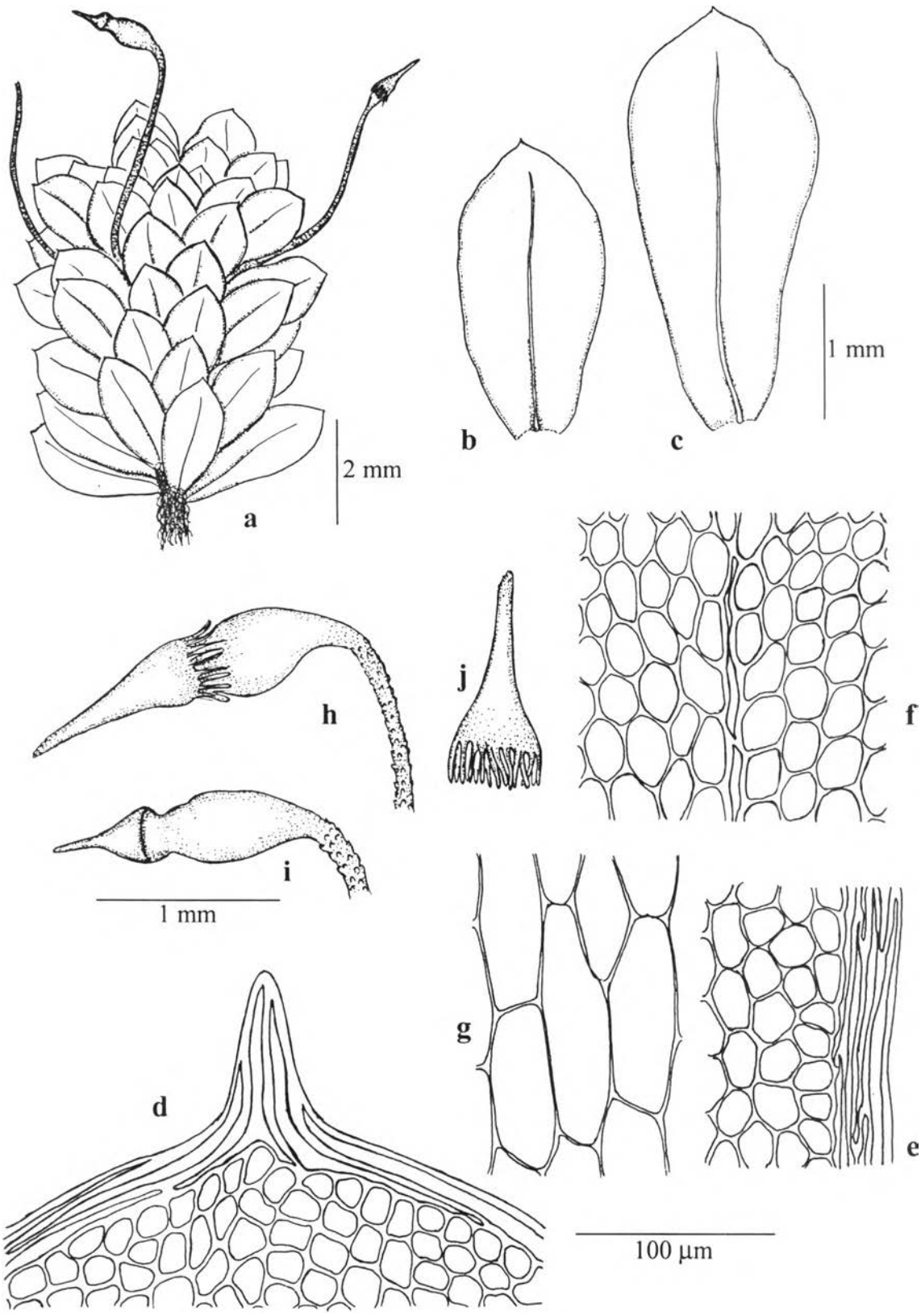

Figure 5.19 *Distichophyllum schmidtii* Broth.
a. habit; b.,c. leaves; d. cells at leaf apex; e. cells at leaf margin; f. cells at median leaf; g. cells at leaf base; h. capsule with calyptra; i. capsule without calyptra; j. calytra. Based on *S. Chantanaorrapint 617*.

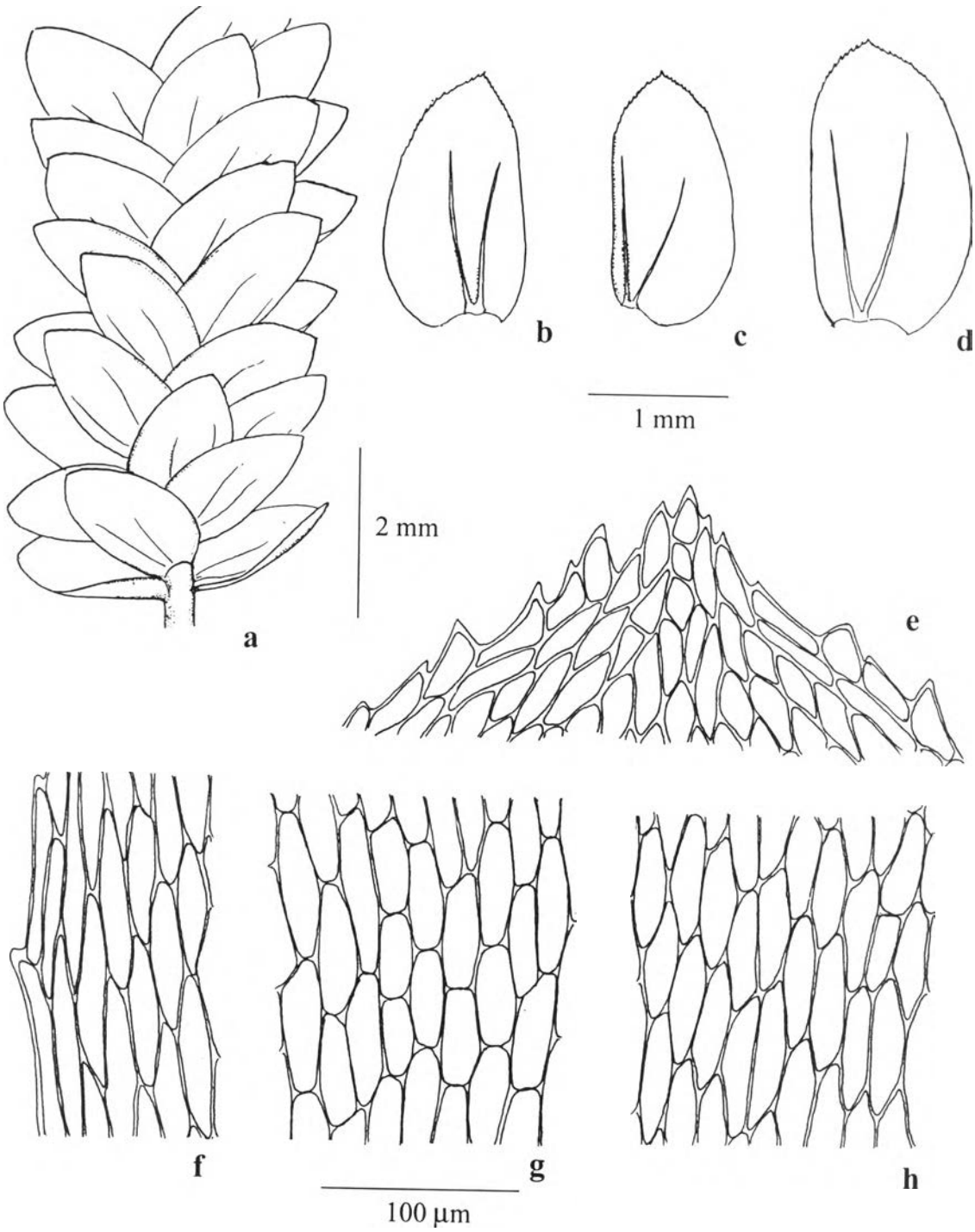

Figure 5.20 *Hookeriopsis utacamundiana* (Mont.) Broth.
a. a part of plant; b.-d. leaves; e. cells at leaf apex; f. cells at leaf margin; g. cells at median leaf; h. cells at leaf base. Based on *S. Chantanaorrapint 608*.

HYPOPTERYGIACEAE

Plants medium-sized to robust. **Primary stems** elongate or creeping, densely tomentose; **secondary stems** simple, plumose, or dendroid, often with cluster of brood filaments on stems among upper leaves. **Leaves** dimorphic, lateral rows complanate, ovate, asymmetrical, serrate, narrowly bordered; **costa** single or forked, ending below tip or excurrent; cell hexagonal, smooth; ventral leaves (amphigastria) smaller, symmetrical, appressed to stem, acuminate. **Capsule** exserted, erect or pendulous; **peristome** double, teeth papillose or striolate, with a zig-zag median line; **operculum** rostrate. **Calyptra** cuculate or conical, naked.

Key to Genera

1. Secondary stems simple, caudate at tips; costae less than 1/2 leaf length ....1. *Cyathophorella*

1. Secondary stems branched, not caudate at tips; pinnately branched or dendroid; costae more than 1/2 leaf length.

    2. Plants often dendroid; stem with central strand; costae ending just above 1/2-1/3 leaf length in lateral leaves.....2. *Hypopterygium*

    2. Plants pinnately branched, often plumose; stem without central strand; costae excurrent in lateral laeves.....3. *Lopidium*

1. *CYATHOPHORELLA*

Cyathophorella (Broth.) Fleisch., Musci Fl. Buitenz. 3: 1088. 1908; Gangulee, Mosses of Eastern India and Adjacent Regions, Fascicle 6: 1531. 1977. — *Cyathophorum* sect. *Cyathophorella* Broth., Nat. Pflanzenfam. 1(3): 965. 1907; Mohamed & H. Rob., Smithsonian Contr. Bot. 80: 32. 1991; Nog., Illustrated Moss Flora of Japan, part 4: 770. 1991; Y. Jia, Z.-H. Li & P.-C. Wu, Moss flora of China 6: 43. 2002.

Plants large, dull green, in lax tufts. **Primary stems** creeping, rhizomatous, tomentose; stems with central strand. **Secondary stems** simple, rarely branched, distantly foliate, tips caudate and often with abundant brood filaments. **Lateral leaves** in two rows, asymmetrical, widely spreading, smaller toward base and tip, ovate, acuminate, not bordered or weakly bordered, more or less toothed; **costa** short, single or forked; cells oval-hexagonal, smooth. **Amphigastria** smaller, in one row, symmetrical, with axis parallel to stem. **Dioicous**. **Seta** smooth; capsule erect; **exostome** teeth papillose; cilia lacking; **operculum** rostrate. **Calyptra** conic, covering only rostrum of operculum, mostly naked, not fringed.

Key to Species

1. Apical margin faintly dentate .....2. *C. burkillii*

1. Apical margin serrate-dentate.

2. Lateral leaves broadly ovate, elliptic to obovate. Amphigastria serrulate with several tooth ..... 1. *C. adianta*

2 Lateral leaves narrowly ovate. Amphigastria nearly smooth...3. *C. tonkinensis*

1. ***Cyathophorella adianta*** (Griff.) Fleish.

Nat. Pflanzenfam. ed. 2, 11: 278. 1925; Gangulee, Mosses of Eastern India and Adjacent Regions, Fascicle 6: 1533, fig. 769. 1977. — *Neckera adiantum* Griff., in Icon. Pl. As. 2: pl. 85-II. 1849. — *Cyathophorum adiantum* (Griff.) Mitt. in Musci Ind. Or. : 147. 1859.

Plants large, dark green. **Secondary stems** up to 6 cm high and 1.2 cm wide with leaves, densely foliate, often caudate at tips, tomentose at base. **Gemmae** axillary at the tips, filiform, branched, brownish. **Lateral leaves** asymmetrical, to 6 mm long and 3 mm wide, oblong-ovate to elliptic, acuminate, the aristate up to 200 μm long; margin serrate-spinose, the spinous sharp, unicellular, at base where spines are not present; border differentiated by 1-2 rows of elongate cells; **costa** short, 1/4 leaf length, forked; median cells rhomboid to hexagonal, 80-100 μm long, 20-30 μm wide, thick-walled; basal cells lager, thick-walled. **Amphigastria** symmetrical, ovate, 1.5-2.0 mm long and 1.2-1.5 mm wide, widest near mid-leaf, acuminate at apex; margin serrate-spinose, **costa** short, 1/5 leaf length, single or double (Fig. 5.21, 5.87). **Dioicous**. **Sporophytes** not found.

Thailand: — NORTHERN: Chiang Mai.
Distribution. — Bhutan, Borneo, India, Myanmar, Nepal, Philippines, Sikkim.
Ecology. — On tree trunks and rocks.
Specimens examined. — *S. Chantanaorrapint 613, 633, 662, 690* (BUC).

2. ***Cyathophorella burkillii*** (Dixon) Broth.

Nat. Pflanzenfam. ed. 2, 11: 278. 1925; Gangulee, Mosses of Eastern India and Adjacent Regions, Fascicle 6: 1537, fig. 771. 1977; Mohamed & H. Rob., Smithsonian Contr. Bot. 80: 32, figs. 99-109. 1991; Y. Jia, Z.-H. Li & P.-C. Wu, Moss flora of China 6: 44, Pl. 411. 2002.

Plants robust, dull green. **Secondary stems** to 4 cm high and 8 mm wide with leaves, densely foliate, caudate at tips, tomentose at base. **Gemmae** not found. **Lateral leaves** asymmetrical, ovate-lanceolate, 4-5 mm long and 1.5-2 mm wide, acuminate with a long arista, the arista to 400 μm long; margin weakly toothed above; border well differentiated, with 2-3 rows of elongate cells; **costa** short, single, simple or forked; cells ovate-hexagonal, 50-80 μm long and 25-40 μm wide. **Amphigastria** symmetrical, broadly ovate to orbicular, ca.1.5 mm long and 1.2 mm wide; apex obtuse to rounded with a long apiculus to 300 μm long; margin serrulate above; border not differentiated; **costa** absent or indistinct (Fig. 5.22). **Sporophytes** not found.

Thailand: — EASTERN: Nakhon Ratchasima; PENINSULAR: Surat Thani.
Distribution. — Mainland China, Malaya, and India.

Ecology. — On tree trunks.
Specimens examined. — *S. Chantanaorrapint. 702* (BCU).

3. ***Cyathophorellum tonkinensis*** (Broth. & Parish) Broth.

Nat. Pflanzenfam. ed. 2, 11: 278, 1925; Nog., Illustrated Moss Flora of Japan, part 4: 770. 1991. — *Cyathophorum tonkinensis* Broth. & Par., Rev. Bryol. 35: 46. 1908. — *C. japonicum* Broth., in Card., Bull. Soc. Bot. Geneve ser. 2, 3: 279. 1911. — *Cyathophorella japonica* (Broth.) Broth., Oefv. Fisk. Vet. Soc. Foerh. 62A(9): 31. 1921; Y. Jia, Z.-H. Li & P.-C. Wu, Moss flora of China 6: 50, pl. 415(10-18). 2002.

Plants large, dark green. **Secondary stems** up to 5 cm high and 10 mm wide with leaves, densely foliate, caudate at tips with numerous filiform gemmae, tomentose at base. **Lateral leaves** asymmetrical, gradually decreasing in size towards tips, 4.4 –5.0 mm long and 1.5-2.0 mm wide, ovate-lanceolate, acuminate with short aristate, the aristate up to 250 μm long; margins with spinose, unicellular, margin toothed in upper part 1/3-1/2 leaf length, entire below, border weakly differentiated; **costa** short, 1/4 leaf length, forked; median cells ovate-hexagonal, 80-120 μm long, 20-30 μm wide, the walls with localized thickening; basal cells lager, thick-walled. **Amphigastria** symmetrical, ovate, 2.5-3.0 mm long, 1.8-2.0 mm wide, acuminate; margin nearly entire or with few toothed, **costa** short, 1/4 leaf length, single (Fig. 5.23, 5.88). **Dioicous**. **Sporophytes** not found.

Thailand. — NORTHERN: Chiang Mai; NORTH-EASTERN: Loei.
Distribution — Borneo, Mainland China, Himalaya, Japan, Taiwan, Vietnam.
Ecology. — On tree t runks.
Specimen examined. — *S. Chantanaorrapint 366, 507* (BCU).

2. *HYPOPTERYGIUM*

Hypopterygium Brid., Bryol. Univ. 2: 709. 1827; Gangulee, Mosses of Eastern India and Adjacent Regions, Fascicle 6: 1543. 1977. Mohamed & H. Rob., Smithsonian Contr. Bot. 80: 35. 1991; Nog., Illustrated Moss Flora of Japan, part 4: 762. 1991; Y. Jia, Z.-H. Li & P.-C. Wu, Moss flora of China 6: 53. 2002.

Plants medium to robust, yellowish green. **Primary stems** creeping, radiculose; stems with central strand. **Secondary stems** erect, with fan-shaped cluster of tertiary stems arising in upper part. **Leaves** lateral leaves asymmetrically inserted, complanate, usually bordered by 1-3 rows of elongate cells; **costa** single, reaching from 1/2 to 3/4 of leaves length. **Amphigastria** symmetrical, appressed to stem; bordered by 1-2 rows of elongate cells; **costa** single, weakly defined to excurrent. **Autoicous**, dioicous, or hetoroicous. **Seta** elongate, smooth. **Capsule** inclined or pendulous; **exostome** teeth transversely striolate; cilia 2-3; **operculum** rostrate. **Calyptra** cuculate or conical, naked, not fringed.

Hypopterygium tenellum C. Müll.

Bot. Zeitung (Berlin) 12: 557. 1854; Mohamed & H. Rob., Smithsonian Contr. Bot. 80: 37, figs. 141-150. 1991; Nog., Illustrated Moss Flora of Japan, part 4: 768, fig. 338. 1991; Y. Jia, Z.-H. Li & P.-C. Wu, Moss flora of China 6: 59, pl. 420. 2002.

Plants robust, dull green. **Primary stems** tomentose; **secondary stems** to 2 cm high, regularly pinnate branched. **Lateral leaves** spreading, 0.9-1.3 mm long and 0.6-0.8 mm wide, widest below mid-leaf, ovate to elliptic with short-acuminate apex, apiculate, the apiculus to 50 μm long; margin toothed in upper part, entire below, bordered all around by 1(-2) rows of elongate cells; **costa** reaching 3/4 to 4/5 of leaf length; median cells hexagonal, 25-40 μm long and 15-20 μm wide. **Amphigastria** 0.6-0.8 mm long and 0.4-0.5 mm wide, orbicular, apex apiculate, margin crenulate above, entire below, weakly bordered all around with 1(-2) rows of cells; **costa** weakly defined, 1/2 of leaves length (Fig. 5.24, 5.89). **Sporophytes** not found.

Thailand: — NORTHERN: Chiang Mai, Chiang Rai; NORTH-EASTERN: Phetchabun, Loei; PENINSULAR: Trang.

Distribution. — Borneo, Celebes, Mainland China, India, Japan, Java, Myanmar, New Guinea, Philippines, Sri Lanka, Sumatra, Taiwan, Vietnam, New Caledonia, Africa.

Ecology. — On tree trunks and rocks.

Specimens examined. — *S. Chantanaorrapint 388, 599, 659, 660* (BCU).

3. *LOPIDIUM*

Lopidium Hook. f. & Wils., Fl. Nov.-Zel. 2: 119. 1854; Mohamed & H. Rob., Smithsonian Contr. Bot. 80: 37. 1991; Nog., Illustrated Moss Flora of Japan, part 4: 758. 1991; Y. Jia, Z.-H. Li & P.-C. Wu, Moss flora of China 6: 60. 2002.

Plants moderately robust, light green to green. **Primary stems** with creeping stoloniform shoots; without central strand; **secondary stems** erect, elongate, more or less regularly pinnate, with simple or slightly pinnate branches. **Lateral leaves** spreading, narrow, oblong-lingulate, acute with a distinct apiculus; margin denticulate to entire; **costa** single, excurrent; cells small, rounded, smooth, incrassate. **Amphigastria** smaller than lateral leaves, ovate with broad base; margin denticulate; bordered on both sides; **costa** single, percurrent to excurrent. **Autoicous** or dioicous. **Seta** short, variably papillose. **Capsule** suberect; exostome teeth tranversely striolate; cilia lacking; **operculum** rostrate. **Calyptra** cuculate, short, naked, not fringed.

Key to species

1. Plants large, lateral leaves bordered on both side of the lamina .....
.....1. *L. struthiopteris*

1. Plants small, lateral leaves bordered only on one side of the lamina .....
.....2. *L. trichocladon*

1. ***Lopidium struthiopteris*** (Brid.) Fleisch.

Musci Fl. Buitenzorg 3: 1073. 1908; Mohamed & H. Rob., Smithsonian Contr. Bot. 80: 40, figs. 151-158. 1991; Nog., Illustrated Moss Flora of Japan, part 4: 762, fig. 334B. 1991; Y. Jia, Z.-H. Li & P.-C. Wu, Moss flora of China 6: 62, pl. 421(13-24). 2002. — *Hypnum struthiopsis* Bride., Spec. Musc., 2: 87. 1812.

Plants robust, light green. **Secondary stems** erect, to 6 cm long, yellowish green, dull, densely bipinnate in an elongate plumose branches, branched nearly to base. **Gemmae** axillary, filiform, branched, brownish. **Lateral leaves** of stem widely spreading, slightly arched with deflexed points when dry, ovate-lingulate, slightly clasping base, 1.5-1.8 mm long and 0.4-0.5 mm wide (branched leaves smaller than); margin distantly denticulate in upper half; bordered all around with 1-2 rows of elongate cells except at the base; **costa** excurrent in an aristra to 90 μm long; basal portion of lamina often folded on one side; median cells rounded, 8-12 μm long and 6-10 μm wide, thick-walled, distinctly collenchymatous. **Amphigastria** ovate-lanceolate with a wide base, subulate-acuminate, 1.2 mm long and 0.5-0.8 mm wide, widest near base; distinctly bordered by 1-2 rows of elongate cells except near the base; **costa** long-excurrent in an aristra to 200 μm long (Fig. 5.25, 5.90). **Sporophytes** not found.

Thailand. — NORTH-EASTERN: Loei.

Distribution. — Borneo, Mainland China, India, Japan, Java, Malaysia, New Guinea, Philippines, Sri Lanka, Sumatra, Taiwan, Vietnam, and New Caledonia.

Ecology. — On tree trunks and rocks.

Specimens examined. — *S. Chantanaorrapint 605, 631, 644* (BCU).

2. ***Lopidium trichocladon*** (Bosch & Sande Lac.) Fleisch.

Musci Fl. Buitenzong 3: 1069. 1908; Mohamed & H. Rob. Smithsonian Contr. Bot. 80: 40, figs. 159-168. 1991; Y. Jia, Z.-H. Li & P.-C. Wu, Moss flora of China 6: 64, pl. 422. 2002. — *Hypopterygium trichocladon* Bosch & Sande Lac., Bryol. Jav. 2: 9. 1861.

Plants medium, green. **Secondary stems** erect, to 3 cm high, generally smaller than *L. struthiopteris*. **Gemmae** axillary, filiform, branched, brownish. **Lateral leaves** of stem oblong-lanceolate,widest at base, 1.4-1.6 mm long and 0.4-0.5 mm wide (branched leaves smaller than), short acuminate; margin entire to slightly crenulate, bordered on only one side by 1-(2) rows of elongate cells; **costa** excurrent in an aristra; median cells rounded to hexagonal, thick-walled, distinctly collenchymatous, 10-15 μm wide. **Amphigastria** broadly ovate, long acuminate, 0.8-0.9 mm long and 0.4-0.6 mm wide, bordered on both side of lamina by 1(-2) rows of elongate cells; margin entire; **costa** percurrent to excurrent (Fig. 5.26). **Sporophytes** not found.

Thailand. — NORTH-EASTERN: Phetchabun, Loei; PENINSULAR: Nakhon Si Thammarat.

Distribution. — Borneo, Mainland China, Japan, Java, Kampuchea, Laos, Myanmar, Philippines, Sumatra, Taiwan, and Vietnam.

Ecology. — On rocks.
Specimens examined. — *S. Chantanaorrapint. 605* (BCU).

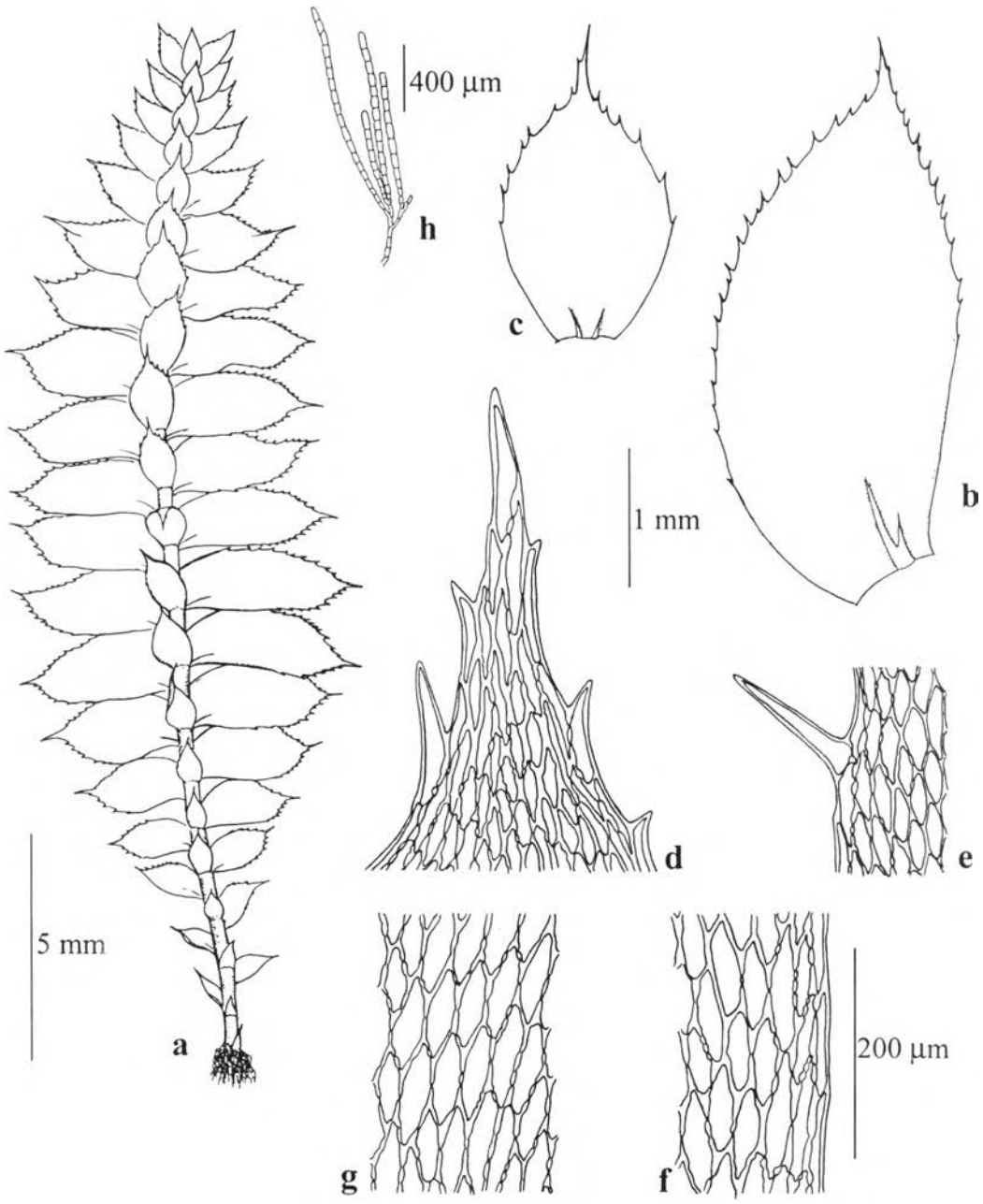

Figure 5.21 *Cyathophorella adianta* (Griff.) Fleish.
a. habit; b. lateral leaf; c. amphigastia; d. cells at leaf apex; e., f. cells at leaf margin; g. cells at median leaf; h. gemma. Based on *S. Chantanaorrapint 613*.

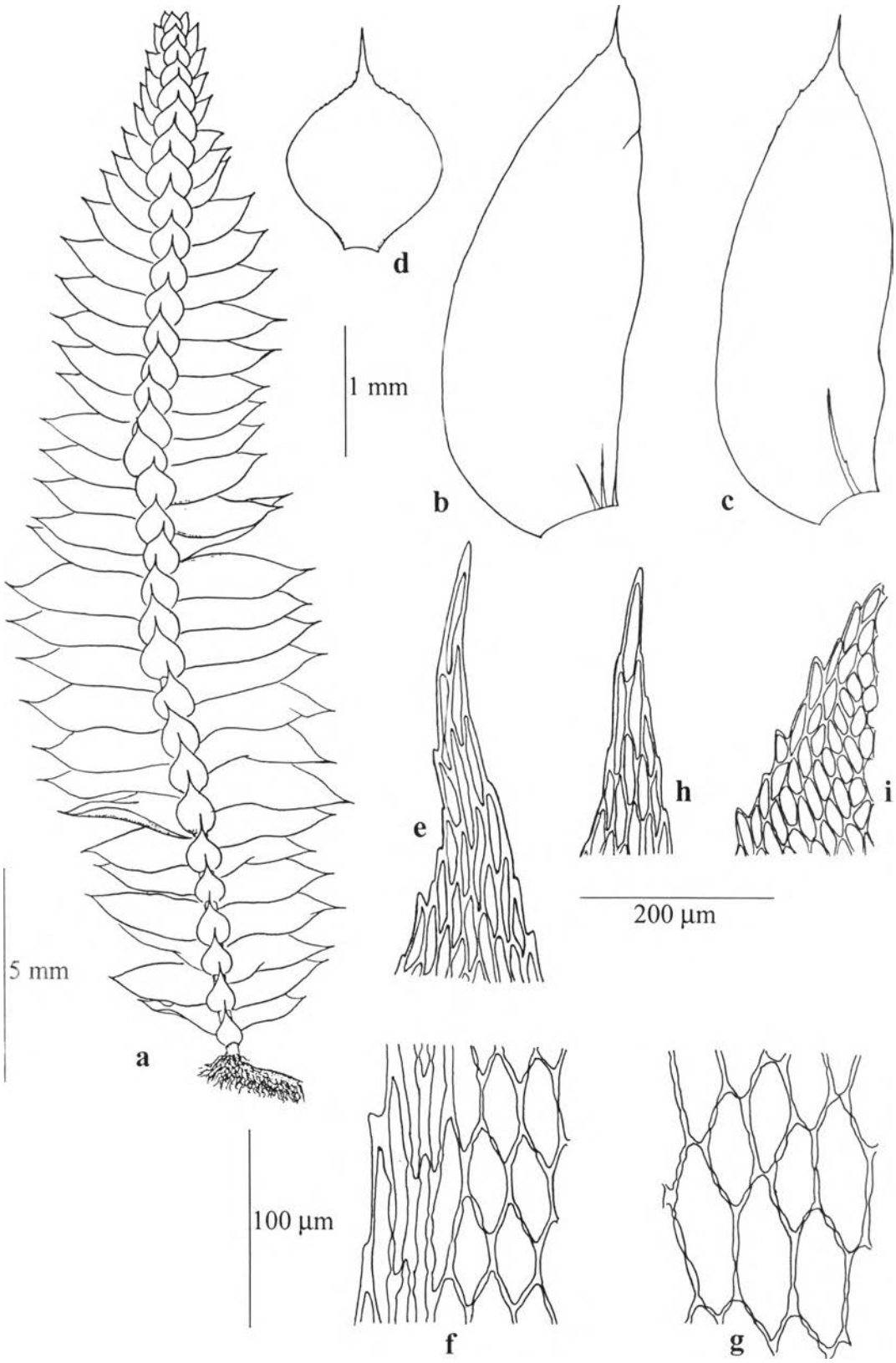

Figure 5.22 *Cyathophorella burkillii* (Dixon) Broth.
a. habit; b., c. lateral leaf; d. amphigastia; e.-g. lateral leaf cells, e. cells at leaf apex, f. cells at leaf margin; g. cells at median leaf; h., i. amphigastria cells, h. cells at leaf apex, i. cells at leaf margin. Based on *S. Chantanaorrapint 702*.

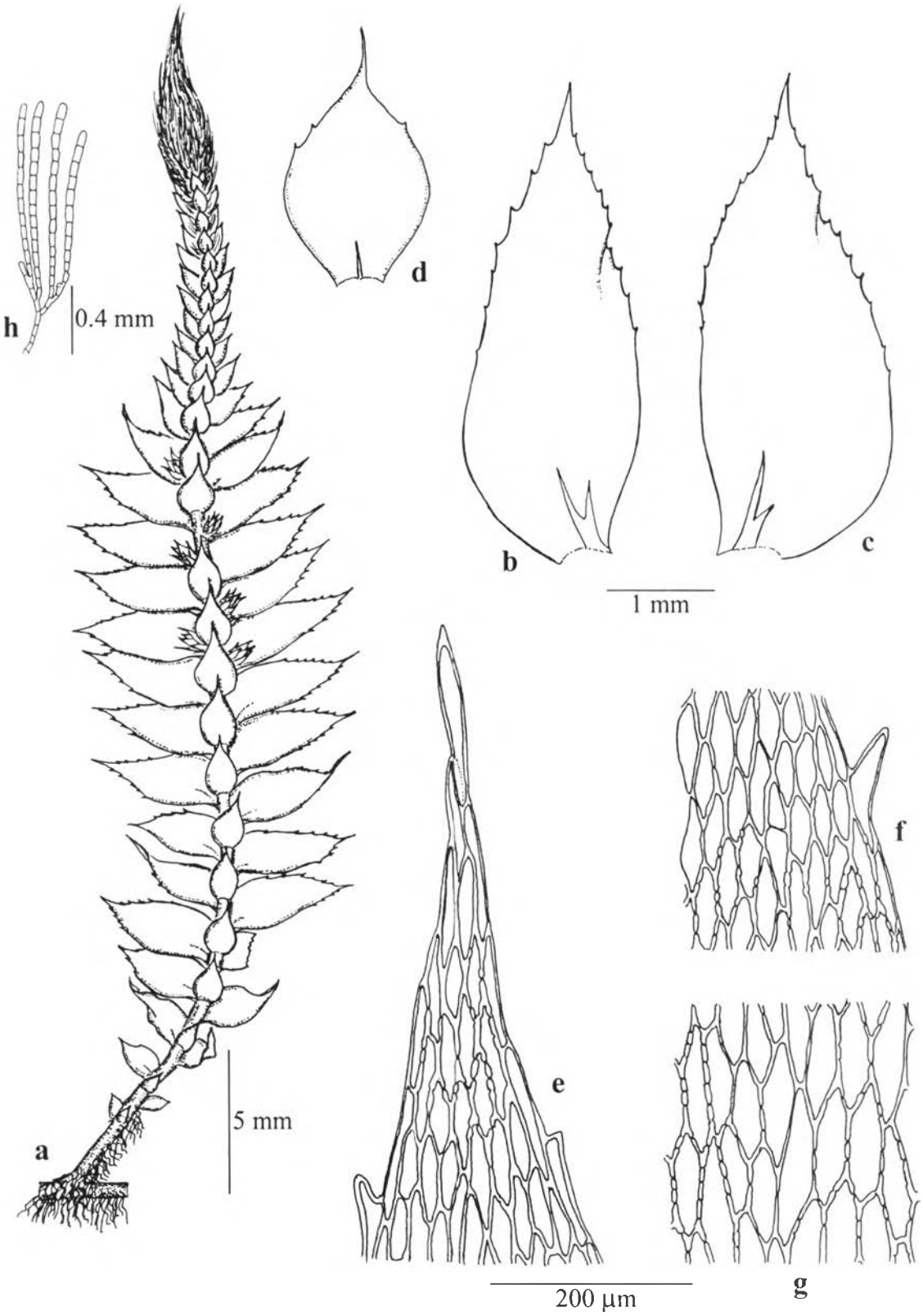

Figure 5.23 *Cyathophorella tonkinensis* (Broth. & Parish) Broth.
a. habit; b., c. lateral leaf; d. amphigastia; e. cells at leaf apex; f. cells at leaf margin; g. cells at median leaf; h. gemma. Based on *S. Chantanaorrapint 507*.

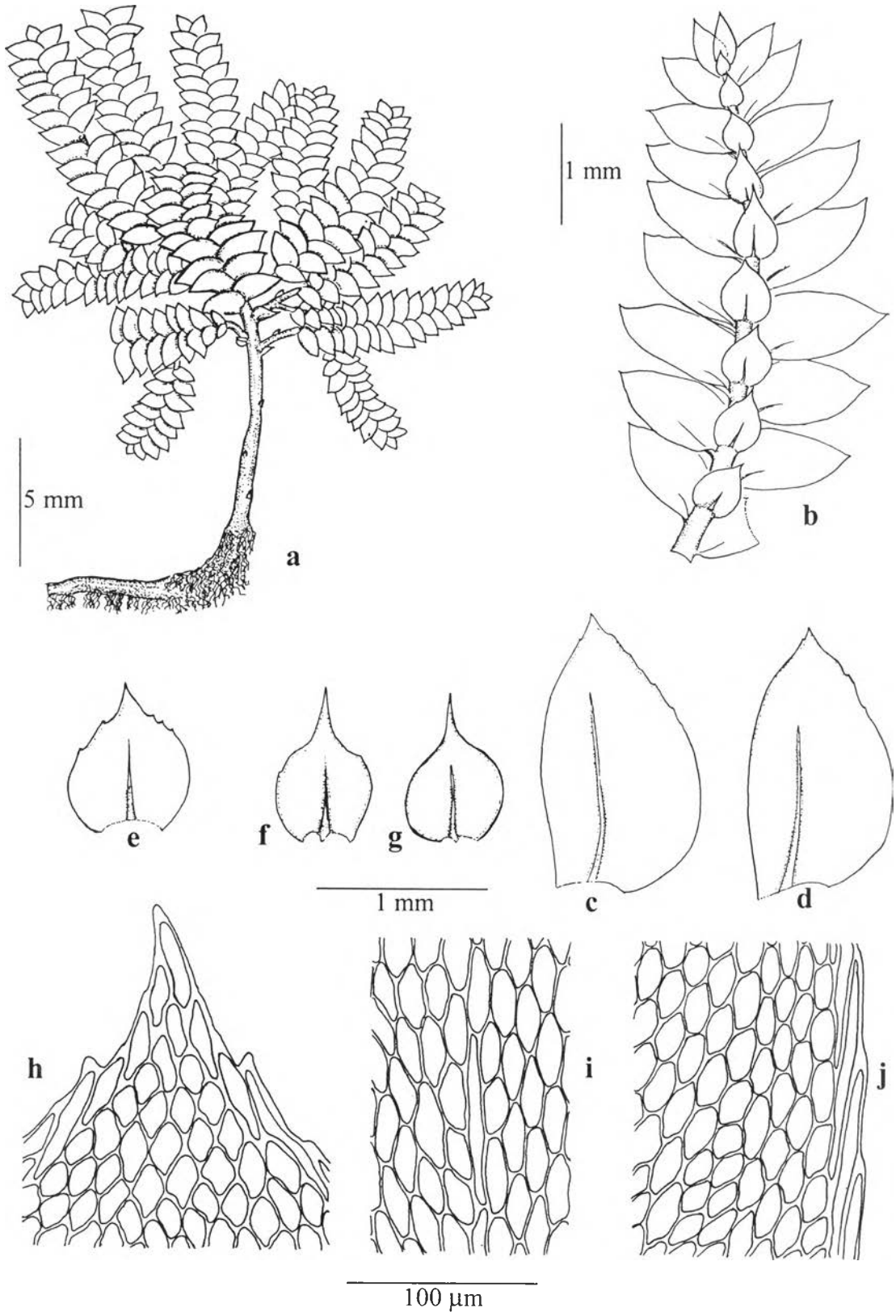

Figure 5.24 *Hypopterygium tenellum* C. Müll.
a. habit; b. branch; c., d. lateral leaf; e.-g. amphigastia; h. cells at leaf apex; i. cells at leaf median; j. cells at leaf base. Based on *S. Chantanaorrapint 599*.

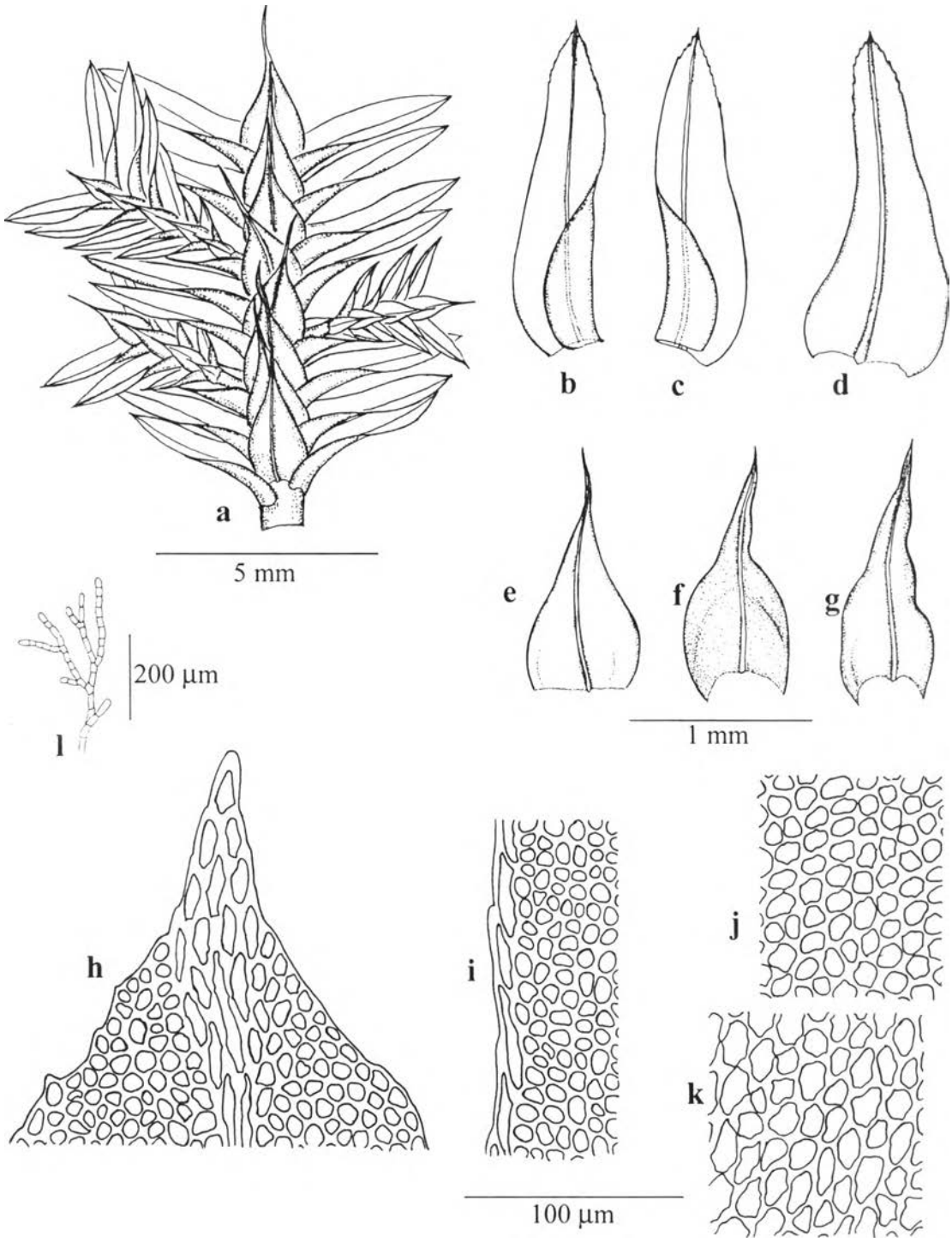

Figure 5.25 *Lopidium struthiopteris* (Brid.) Fleisch.
a. a part of plant; b.-d. lateral leaf; e.-g. amphigastia; h. cells at leaf apex; i. cells at leaf margin; j. cells at leaf median; k. cells at leaf base; l. gemma. *Based on S. Chantanaorrapint 605.*

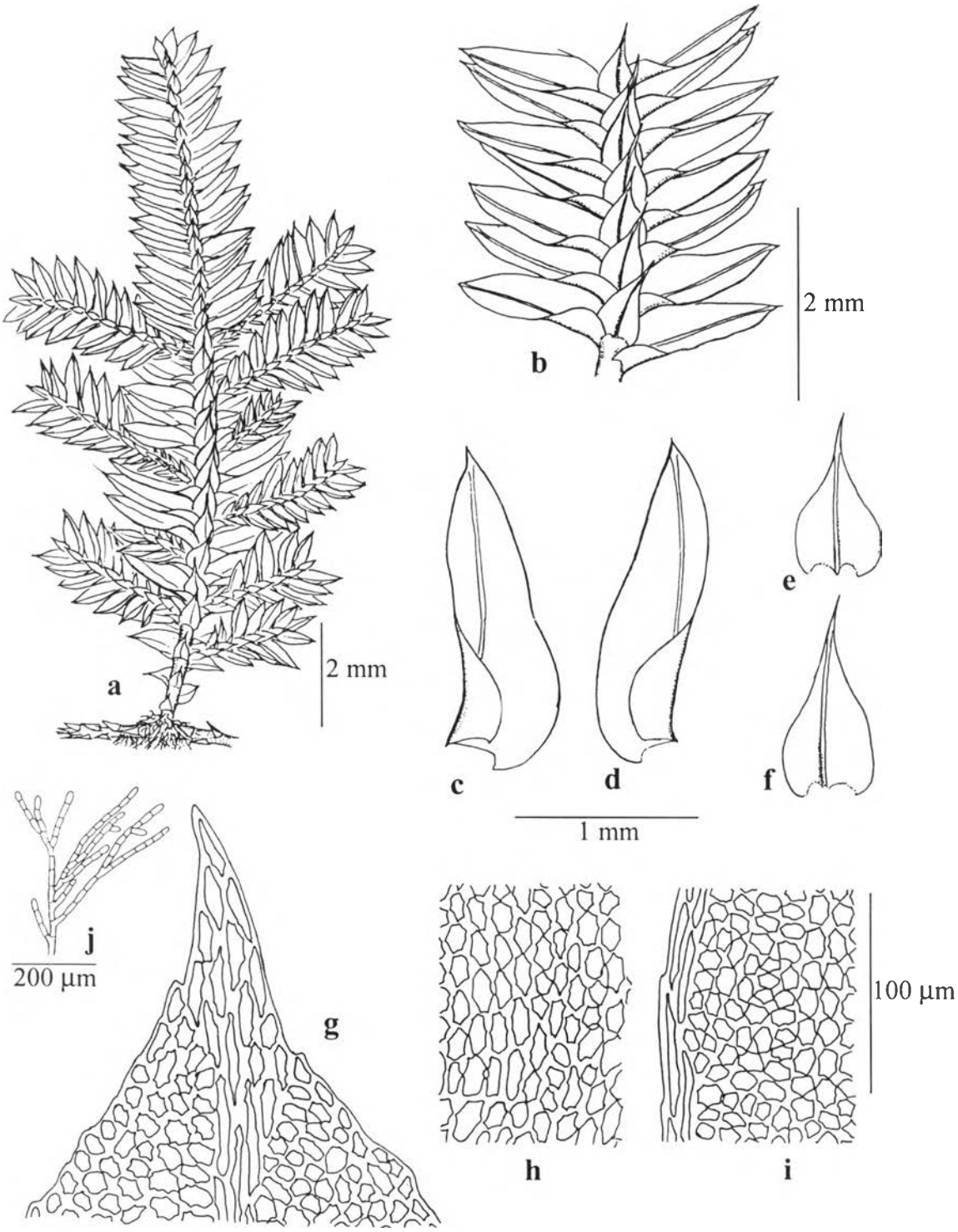

Figure 5.26 *Lopidium trichocladon* (Bosch & Sande Lac.) Fleisch.
a. habit; b. branch; c., d. lateral leaf; e.-f. amphigastia; g. cells at leaf apex; h. cells at leaf median; i. cells at leaf base; j. gemma. Based on *S. Chantanaorrapint 667.*

LEUCOBRYACEAE

Plant whitish, grayish or bluish green, in dense cushions. **Stems** erect, simple or branched. **Leaves** arranged in several rows, thick, fleshy, linear, ligulate or lanceolate from a rather narrow to somewhat broad base; **costa** broad, filling most of leaf base and apex, in cross-section with 2 to 10 layers of large, empty, hyaline and porose cells (leucocysts), enclosing a single, more or less median layer of small green cells (chlorocysts); laminae very narrow, consisting of delicate, hyaline, oblong or linear cells, often restricted to leaf base or extending somewhat above the shoulders as a very narrow, inconspicuous border. **Dioicous**. **Seta** terminal, usually elongate, straight. **Capsule** erect or inclined, usually symmetric; **peristome** single, consisting of 8 or 16 lanceolate teeth, undivided or bifid, smooth or papillose, or vertically pitted-striolate; **operculum** conic-rostrate with a long beak.

Key to genera

1. Chlorocysts in the upper parts of leaf quadrangular in cross-section.....
.....1. *Leucobryum*

2. Chlorocysts in the upper parts of leaf triangular in cross-section.....
.....2. *Octoblepharum*

1. *LEUCOBRYUM*

Leucobryum Hampe, Linnae 13: 42. 1839; T. Yamag., J. Hattori Bot. Lab. 73: 25. 1993; B.-J. Lin & S. He, Mosses Flora of China, English version vol. 1: 257. 1999.

Plants small to large, whitish or grayish green, forming cushions or mats. **Stems** erect, simple or branched; central strand mostly absent, sometimes present. **Leaves** crowed, appressed, or erect-spreading, sometimes falcate-secund above, linear-lanceolate to lanceolate or subtubulose from oblong-ovate base, acute to mucronate at the apex, often with rhizoids at leaf tips, upper parts of leaves filled mostly by the multi-layered broad costa, laminae confined to the basal parts of leaves with multi-rowed liner cells; **alar cells** rarely differentiated; margin entire to slightly serrulate at the apex, bordered by linear cells or not; **costa** thick, broad, consisting of 2-8 layers of enlarged leucocysts enclosing a median row of small, quadrangular chlorocysts in croos-section near leaf base. **Dioicous** or pseudoautoicous. **Male plants** dimorphous, sometimes minute, dwarf male plants growing on tomentose or among leaves of female plants; normal male plants as large as female plants. **Perichaetial** leaves sheathing at the base, abruptly linear-filiform. **Sporophytes** terminal or lateral. **Seta** erect, elongate, sometimes clustered. **Capsule** more or less cylindric, asymmetric, inclined to horizontal, rarely erect; stoma lacking; annular often absent, 1-2 rows of small cells when present; **operculum** rostrate; **peristome** teeth 16, divided to the middle, lanceolate with a broad base, vertically striate below, papillose above. **Calyptra** cuculate. **Spores** small to large, finely papillose.

Leucobryum javense (Brid.) Mitt.

J. Linn. Soc. Bot. suppl. 1: 25. 1859; Enroth, Acta Bot. Fenn. 130: 72. figs. 4-7. 1990; T. Yamag., J. Hattori Bot. Lab. 73: 25, Pl. I-III. 1993; B.-J. Lin & S. He, Mosses

Flora of China 1: 251, figs. 167(A-F). 1999. — *Sphagnum javense* Brid. ex Schwägr., Sp. Musc. Suppl. 2(1): 4, t. 102. 1823. Others synonym see J. Eroth 1990.

Plants usually robust, often more than 5 cm high, whitish-green, in loose tufts or cushions. **Stems** erect, simple or branched; central strand absent. **Leaves** ca. 1 cm long, 2 mm wide, often falcate-secund, broadly lanceolate, gradually narrowed to subtubulose apices from broadly ovate base, acute to bluntly mucronate at apex, dorsal side of leaves acumina papillosely prorate, margin bordered by 2-3 rows of linear cells on the upper parts of leaves, lamina near leaf base consisting of 4-6 rows of quadrate to rectangular cells, costal leucocysts 2-3 layers on both sides of a median layered chlorocysts (Fig. 5.27, 5.91). **Sporophytes** not found

Thailand. — NORTHERN: Chiang Mai; NORTH-EASTERN: Loei; EASTERN: Nakhon Ratchasima; CENTRAL: Nakhon Nayok; SOUTH-EASTERN: Chon Buri.

Distribution. — China, Japan, India, Sri Lanka, Cobodia, Loas, Vietnam, Indonesia, Maly Peninsular, Philippines, and New Guinea.

Ecology. — On soil, rocks, and tree trunks.

Specimens examined. — *S. Chantanaorrapint 364, 367, 369, 371, 382, 566* (BCU); *M.-J. Lai 90122138* (BRU).

2. *OCTOBLEPHARUM*

Octoblepharum Hedw., Sp. Musc. Frounc. 50. 1801; A. Eddy, A Hand Book of Malesian Mosses vol. 2 ; B.-J. Lin & S. He, Mosses Flora of China, English version vol. 1: 257. 1999.

Plants small to medium-sized, whitish to grayish green, in loose to rather dense cushions. **Stems** short, simple or sparsely branched. **Leaves** erect-patent, flexuose or reflexed from a slightly sheathing base, lingulate, obtuse-apiculate to short mucronate apex, flattened or terete-triangular; margin entire to slightly serrulate at the apex: **costa** broad, thick, filling almost entire upper lamina, convex on abaxial side in cross-section, costal leucocysts in 2 -10 layers, enclosing a nearly centrally positioned chlorocyst layer; the chlorocysts triangular in the upper part of leaves, quadrangular at leaf base in cross-section; hyaline lamina cells small, confined to both sides of costa at leaf base. **Autoicous** or dioicous. **Seta** terminal or lateral, short to elongate. **Capsule** erect, oblong-ovoid to cylindrical, symmetric, stomata present; **peristome** teeth 8 to 16, broad-lanceolate or triangular, smooth to vertically striate-reticulate, **properistome** present; **operculum** conic-rostrate with a long oblique beak. **Calytra** cucullate, smooth, entire at base.

Octoblepharum albidum Hedw.

Sp. Musc. 50. 1801; Enroth, Acta Bot. Fenn. 139: 114, fig. 29. 1990; B.-J. Lin & S. He, Mosses Flora of China 1: 257. 1999. — *Bryum albidum* L., Sp. Pl. 1583. 1753. — *Octoblepharum longifolium* Lindb., Öfv. K. Vet. Akad. Förh. 21: 608. 1865. — *O. albidum* var. *cuspidatum* C. Müll., Bot. Jahrb. 23: 318. 1896. — *O. cuspidatum* C. Müll., Gen. Musc. Fr. 88. 1900. — *Leucobryum cycadis* F. Müll. in Watts & Whitel., Proc. Linn. Soc. N.S. Wales Suppl. 27: 58. 1902.

Plants small, 5-10 mm high, whitish-green, in loose cushions. **Stems** short, sparsely branched; central strand absent. **Leaves** erect-patent to curved spreading, 4-6 mm long, flattened, lingulate from an oblong-ovate base, apiculate at apex; hyaline lamina cells small, appearing only on two side of costa at the leaves base; margin entire, with minute seeration at the leaves apex; **costa** broad and thick, filling almost the entire upper lamina, convex below in cross-section, costal leucocysts 2-5 layers on adaxial side, 1-4 layers on abaxial side, supporting a nearly centrally positioned chlorocyst layer, chlorocysts in cross-section triangular in the upper parts of leaves, quadrangular at the leaf base. **Autoicous**. **Seta** ca. 7 mm long, smooth. **Capsule** erect, cylindrical; **peristome** teeth 8, lanceolate-triangular with a broad base, vertically striate; **operculum**. rostrate, with an oblique beak. **Calyptra** cuculate, smooth, entire at the base (Fig. 5.28, 5.92).

Thailand. — NORTHERN: Chiang Mai, Tak; Phitsanulok; NORTH-EASTERN: Loei; EASTERN: Nakhon Ratchasima; SOUTH-WESTERN: Kanchanaburi; CENTRAL: Nakhon Nayok; SOUTH-EASTERN: Chanthaburi, Trat; PENINSULAR, Phuket, Trang, Surat Thani.

Distribution. — China, India, Myanmar, Vietnam, Malesia, Indonesia, the Philippines, Australia, Africa, and North, Central, and South America.

Ecology. — On tree trunks and rocks.

Specimen examined. — *S. Chantanaorrapint 557, 614* (BCU); *M.-J. Lai 90122169* (BRU).

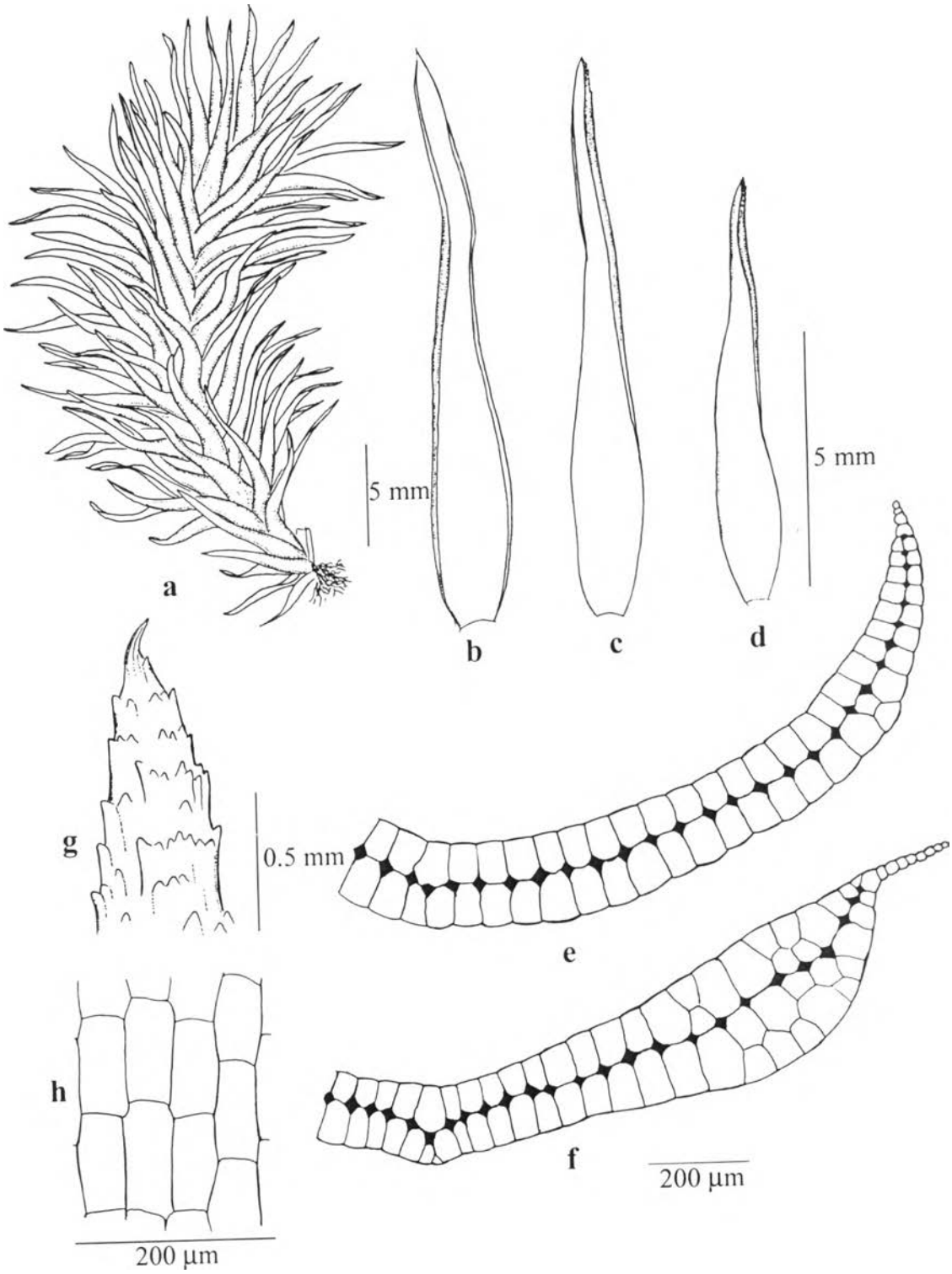

Figure 5.27 *Leucobryum javense* (Brid.) Mitt.
a. a part of plant; b.-d. leaves; e., f. cross-section of leaf, e. median leaf, f. basal leaf; g. leaf apex; h. cells at leaf base. Based on *S. Chantanaorrapint 369*.

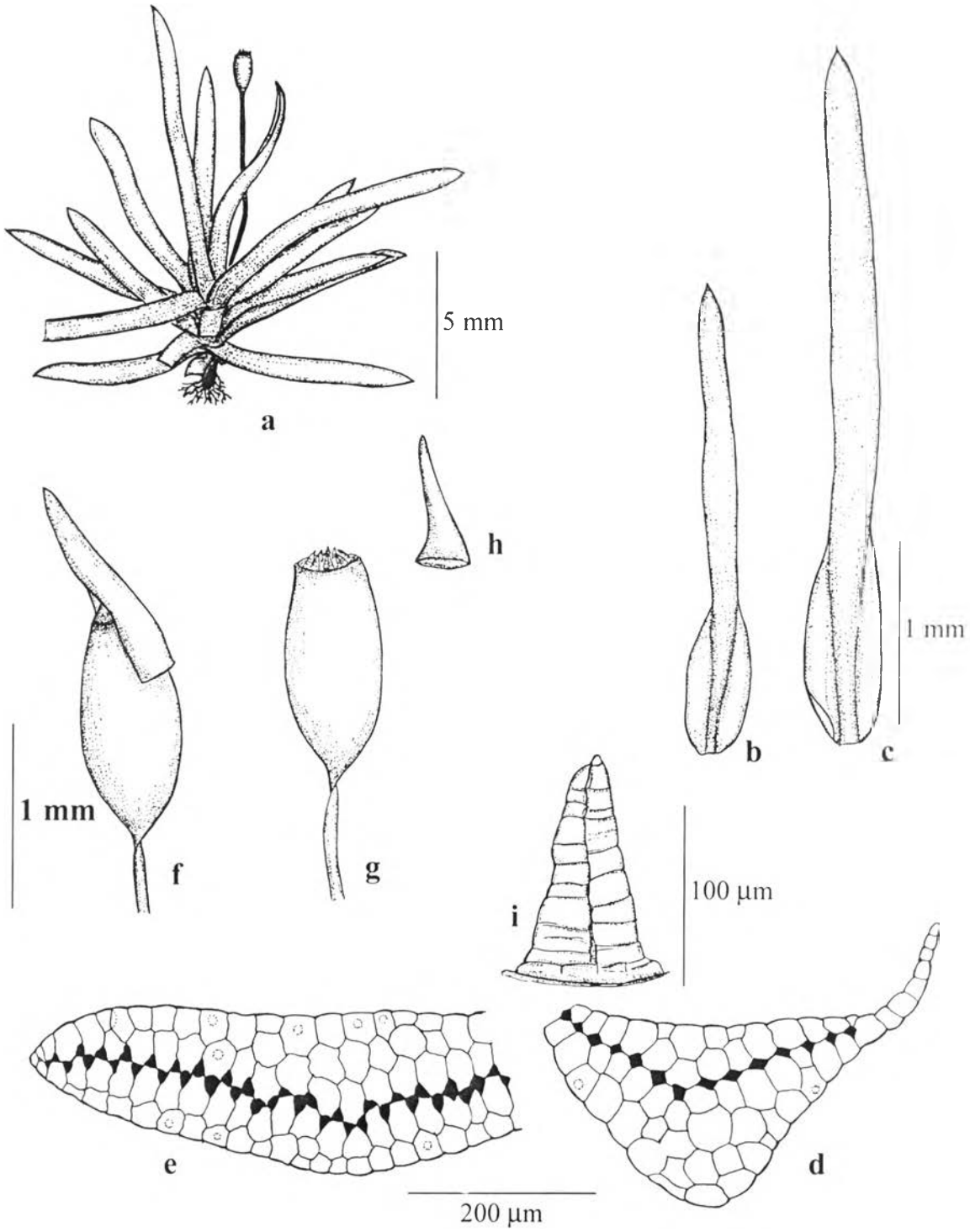

Figure 5.28 *Octoblepharum albidum* Hedw.
a. habit; b.,c. leaves; d., e. cross-section of leaf, d. basal leaf, e. median leaf; f. capsule with calyptra; g. capsule; h. operculum; i. peristome teeth. Based on *S. Chantanaorrapint 557*.

METEORIACEAE

Plants slender to roboust, usually hanging or pendulous from tree. **Primary stems** with or without central strand, creeping filiform; **secondary stems** elongate, terete or flat, flexuose, pendent, branched, densely foliate. **Stem-leaves** ovate-lanceolate, acuminate with a piliferous point; lamina usually undulate or plicate; **costa** single, slender, terminating below tip; **alar cells** differentiated or not; **lamina cells** usually papillose, rarely smooth, incrassate or thin-walled. **Branch leaves** similar to stem leaves or differenced, usually smaller than. **Dioicous**. **Seta** long or short, smooth or scabrous. **Capsule** erect, oblong to oblong-cylindric with a somewhat defined apophysis; **peristome** double; exostome linear-lanceolate, covered with transversely striate below or papilose; endostome well-developed, as long as exostome; **operculum** rostrate. **Calytra** small, cuculate or mitriform, only slightly covering the beak of operculum, smooth or scabrous.

Key to genera

1. Branches terete. Basal angles of leaf auriculate.....4. *Papillaria*

1. Branches mostly flattened. Basal angles of leaf slightly auriculate.

    2. Leaves squarrose or strongly recurved.....3. *Meteoriopsis*

    2. Leaves not squarrose.

        3. Leaf-cells short-rhomboidal, with incrassate walls, middle lamellae visible .....1. *Aerobryopsis*

        3. Leaf-cells linear-rhomboidal, middle lamellae invisible..... .....2. *Barbella*

1. *AEROBRYOPSIS*

Aerobryopsis Fleisch., Hedwigia 44: 304. 1905; Nog., J. Hatt. Bot. Lab. 41: 294. 1976.

Plants large or medium-sized. **Primary stems** elongate, laxly or densely branched, laxly or densely leaved; **secondary stems** elongate, with several branches; branches short, obtuse at apex. **Stem-leaves** appressed or complantely spreading, ovate to oblong, gradually or rapidly attenuate to a long, straight, or flexuose, or crisped acumen, cordate at base, concave, undulate above; margin erect or somewhat undulate at median portion, serrulate throughout; **costa** slender, extending beyond 2/3 of leaf-length; l**aminal cells** rhomboidal to elongate-rhomboidal, with a distinct papilla over each lumen, thick-walled, subporose, middle lamellae visible; upper and lower cells larger without papilla; **alar cells** indistinct, rectangular or subquadrate. **Branch-leaves** similar to those of stem. **Dioicous**. **Perichaetia** on branches. **Seta** elongate, much longer than capsule, slightly scabrous. **Capsule** suberect or erect, oblong-cylindrical, with a distinct apophysis, often asymmetrical, smooth; **operculum** conical, with a long oblique beak; **annulus** present; **peristome** double, exostome teeth linear-lanceolate, papillose throughout; endostome: basal membrane low; segment

linear, as long as exostome, often perforated along the keel; cilia none. **Calyptra** cuculate, smooth. **Perigonia** branches, inner perigonial leaves ovate, cymbiform.

Aerobryopsis subdivergens (Broth.) Broth.

In Engler & Prantl, Nat. Pflanzenfam. 1(3): 820. 1906; Nog., J. Hatt. Bot. Lab. 41: 299, fig. 28. 1976. — *Meteorium subdivergens* Broth., Hedwigia 38: 227. 1899.

Plant large, pale green, the older part darker, not glossy. **Primary stems** creeping, the upper part pendent, loosely branched with dense and complanate leaves; **secondary stems** pendent. **Stem-leaves** complanate and widely spreading, tapering to a linear-lanceolate acumen, wide-ovate base, ca. 2.5 mm long and 1.5 mm wide; margin erect, serrulate, often incurved on one side of base; costa long, reaching the base of acumen; **median laminal cells** rhomboidal, ca. 20 μm long and 8 μm wide, papillae large; marginal cells shorter; upper cells without papillae; basal cells rectangular, ca. 30-70 μm and 15-20 μm wide, without papillae; **alar cells** scarcely differentiated, shorter. **Branch-leaves** similar to those of stem (Fig. 5.29). **Sporophytes** not found.

Thailnad. — New record to Thailand.
Distribution. — Japan, Formosa.
Ecology. — On tree branches.
Specimens examined. — *S. Chantanaorrapint 530, 697; O. Thaithong 12462, 12703* (BCU).

2. *BARBELLA*

Barbella Fleisch. ex Broth., in Engler & Prantl, Nat. Pflanzenfam. 1(3): 823. 1906; Nog., J. Hatt. Bot. Lab. 41: 309. 1976.

Primary stems filiform, elongate, pinnate or subpinnate branched. **Secondary stems** with complanate and spreading leaves on the basal part; filiform part of branches with appressed leaves. **Stems-leaves** appressed or spreading both dry and moist, ovate-oblong or lanceolate, attenuate to elongate apex; margin often undulate at the median portion, serrulate or entire; **costa** slender, extending to mid-leaf, or none; **laminal cells** linear to oblong-rhomboidal, with or without one or more papillae in the center of lumen, thin-walled, walls often with localized thickening; **alar cells** lax, rectangular or subquadrate, forming a well-defined alar group. **Branch-leaves** complanately spreading, similar to those of stem in outline. **Dioicous**, rarely autoicous. **Perichaetia** on branch or stem. Inner perichaetial leaves with or without paraphyses. **Seta** short, almost as long as the capsule, often curved, smooth or scabrous. **Capsule** erect, oblong to oblong-cylindrical, smooth. **Exostome** teeth usually linear-lanceolate, usually papillose throughout. **Endostome** with high basal membrane; segment long, almost as long as the exostome teeth or little short, linear to lonear-lanceolate, usually perforated along the keel, minutely papillose. **Spores** rounded, verruculose. **Operculum** rostrate. **Calyptra** mitriform and lobate at base, or cuculate, smooth or hairy. **Perigonia** on branches; inner leaves widely ovate, short acuminate, cymbiform.

Barbella flagellifera (Card.) Nog.

J. Jap. Bot. 14: 28, fig. 3. 1938: Nog., J. Hatt. Bot. Lab. 41: 324, fig. 40(a, b, f-m). 1976; D.H. Norris & T.J. Kop., Acta Bot Fennica 131: 42, figs. 15a-g. 1985. — *Papillaria capilliramea* Jaeg. et Sauerb. fo. *extenuate* Card., Rev. Bryol. 23: 102. 1896. — *Meteorium wallichii* auct. non (DC.) Mitt.: Dozy et Molk Bryol. Jav. 2: 93. 1864. — *Papillaria wallichii* auct. non (DC.) Ren. et Card.: Paris, Bull. Herb. Boiss. sér. 2, 2: 926. 1902. — *Meteorium flagelliferum* Card., Beit. Bot. Centralbl. 19: 120, fig. 18. 1905. — *Papillaria pendula* auct. non (Sull.) Ren. et Card., Beit. Bot. Centralbl. 19: 115. 1905. — *Barbella trichodes* Fleisch., Musci Fl. Buit. 3: 809, fig. 145. 1907. — *B. asperifolia* Card., Bull. Soc. Bot. Genève 3: 276. 1911.

Plants slender, yellowish-green, not glossy, pendent, more than 10 cm long, irregularly branched. **Leaves** ovate-lanceolate, with wide base, ca. 2 mm long, 0.4-0.6 mm wide, with a filiform awn of uniseriate cells; margin plane, regularly finely serrate except at the nearly entire apex; **median laminal cells** linear to linear-rhomboidal, ca. 70-80 μm long and 5-6 μm wide, usually unipapillose in the center over each lumen, moderately thick-walled, subporose; apical and basal cells shorter, usually smooth; **alar cells** well-defined, quadrate or subrectangular (Fig. 5.30). **Sporophytes** not found.

Thailnad. — NORTHERN: Tak; NORTH-EASTERN: Loei.

Distribution. — Borneo, Mainland Mainland China, India, Japan, Java, Laos, Myanmar, Nepal, Philippines, Sri Lanka, Sumatra, Taiwan, and Vietnam.

Ecology. — On tree branches.

Specimens examined. — *S. Chantanaorrapint 723* (BCU).

3. *METEORIOPSIS*

Meteoriopsis Fleisch. ex Broth. in Engler & Prantl, Nat. Pflanzenfam. 1(3): 825. 1906; Nog., J. Hatt. Bot. Lab. 41: 330. 1976.

Stems creeping, subpinnately branched, densely foliated. **Secondary stems** elongate, prostrate or pendent, subpinnately or laxly branched, densely foliated. **Branches** short or long, often reflex, obtuse at apex. **Stems-leaves** squarrose or widely spreading, ovate to ovate-oblong, gradually tapering to a long or short, apex canaliculated, cordate and mostly clasping at base; margin erect, serrate; **costa** single, slender, usually extending to mid-leaf.; **laminal cells** pellucid, linear-rhomboidal, thin- or thick-walled, usually with 1, rarely 2-3 papillae; **alar cells** slightly differentiated, without papillae. **Branch-leaves** similar to those of stem but usually broader. **Perichaetia** on branches; inner perichaetial leaves narrowly oblong; paraphyses numerous. **Seta** short, smooth or scabrous. **Capsule** erect, ovate to oblong-cylindrical; **operculum** rounded-conical, with an erect, subulate beak; **exostome** teeth linear-lanceolate, papillose above, striate below; endostome with low membrane, segment linear, attenuate. **Spore** large, 20-30 μm, verrucose. **Calyptra** mitriform, lobed at base, or cuculate, long-hairy or naked.

Meteoriopsis squarrosa (Hook.) Fleisch. ex Broth.

In Engler & Prantl, Nat. Pflanzenfam. 1(3): 826. 1906; Nog., J. Hatt. Bot. Lab. 41: 332, fig. 44. 1976; D.H. Norris & T.J. Kop., Acta Bot. Fennica 131: 46, figs. 17a-d. 1985. — *Neckera squarrosa* Hook., Icon. Pl. 1: 22, fig. 3. 1836. — *Pilotrichum squarrosa* (Hook.) C. Müll., Syn. 2: 154. 1851.

Plants large, pale to yellowish-green, the older parts darker, glossy. **Secondary stems** with leaves to ca. 3 mm wide, often recurved, usually simple, obtuse at apex. **Stem-leaves** compact, strongly squarrose-recurved, widely cordate-ovate, ca. 3 mm long and 1.5 mm wide; apex short- or long-tapering, clasping base, plicate; margin widely involute, undulate above, serrulate; **costa** extending to mid-leaf.; **median laminal cells** linear-rhomboidal, 20-25 μm long and 5 μm wide, thin-walled, unipapillose, the papillae small, often indistinct; apical and marginal cells elongate, ca. 20-40 μm long, thick-walled, without papillae; basal cells linear-rectangular, 30-60 μm long, 15 μm wide, without papillae, thick-walls, nearly porose. **Branch-leaves** similar to those of stem, but slightly smaller (Fig. 5.31, 5.94A, 5.94B). **Sporophytes** not found.

Thailnad. — NORTHERN: Chiang Mai, Tak; NORTH-EASTERN: Loei; PENINSULAR: Surat Thani.

Distribution. — Bhutan, Celebes, Mainland China, India, Java, Laos, Malaysia, Myanmar, Nepal, New Guinea, Philippines, Sikkim, Sri Lanka, Sumatra, Taiwan, and Vietnam.

Ecology. — On tree branches or rocks.

Specimens examined. — *S. Chantanaorrapint 381, 540, 665, 722; O. Thaithong 39* (BCU).

4. *PAPILLARIA*

Papillaria (C. Müll.) C. Müll., Öefv. K. Svensk. Ak. Foerh. 33(4): 4. 1876; Gangulee, Mosses of Eastern India and Adjacent Regions, Fascicle 5: 1283. 1976; Nog., J. Hatt. Bot. Lab. 41: 237. 1976.

Plants slender, not glossy. **Stems** densely leaved, terete, densely or laxly branched. Branches often long and pendent, densely leaved, terete, attenuate or blunt at apex. **Stem-leaves** erect, imbricate, ovate, oblong-lanceolate, or oblong-ovate, conspicuously auriculate, the apex obtuse to rounded with a short or long acumen, border absent; **costa** single, weak; **laminal cells** obcure, mostly multipapilose on longitudinal walls or over each lumen, thick-walled. **Branch-leaves** similar to stem-leaves, but with a shorter acumen. **Dioicous**. **Perichartia** mostly on branches; inner perichaetial leaves linear-lanceolate, acuminate, plicate, costa weak; paraphyses numerous. **Seta** short, smooth or scabrous. **Capsule** erect, immersed, oblong-cylindric, smooth; **operculum** high conical, erect or curve; **exostome** teeth 16 in number, linear-lanceolate, densely papillose; endostome papillose, basal membrane low; segments linear to filiform, as long as the exostome teeth. **Spores** spherical to ovate. **Calyptra** miltriform, long-hairy. **Perigonia** on branches; inner perigonial leaves widely ovate, obtuse, cymbiform, ecostate.

Papillaria chrysoclada (C. Müll.) Jaeg.

Ber. S. Gall. Naturw. Ges. 1875-76: 270. 1877; Nog., J. Hatt. Bot. Lab. 37: 244. 1973; 41: 250, fig. 8. 1976. — *Neckera chrysoclada* C. Müll., Syn. 2: 139. 1851. — *Papillaria auriculata* Bartr., Rev. Bryol. Lichénol. 23: 251. 1954; Horik. & Ando, Nat. Life S.E. Asia 3: 16. 1964.

Plants large, rigid, yellowish-green in the younger, blackish-green in older parts, not glossy. **Stems** elongate, densely leaved, pinnately branched. Branches short, often recurved, densely leaved, obtuse at apex. **Stem-leaves** erect, strongly appressed when dry, oblong-ovate, obtuse to rounded at apex, with along flexuous, slightly twisted, piliferous acumen, strongly auriculate, rounded or angular at basal corner, ca. 3.5-4.0 mm long and1.0-1.2 mm wide, cymbiform, scarcely plicate; margin incurved in the upper half, erect or undulate in the lower part, entire in most part, erose-dentate at alar regions; **costa** ca. 1/2 leaf length, pellucid; **median laminal cells** linear-rhomboidal, ca. 20-30 μm long and 5 μm wide, thick-walled, papillose in almost 2 rows on longitudinal wall, obscure; basal cells rectangular, ca. 20-30 μm long and 5 μm, thick-walled, porose, smooth; auricular cells rhomboidal, 20-25 μm long, 6-8 μm wide, with or without papillae. **Branch-leaves** similar to those of stem, but more rounded-obtuse at apex , and more concave (Fig. 5.32). **Sporophytes** not found.

Thailand. — NORTHERN: Chiang Mai, Chiang Rai, Tak; NORTH-EASTERN: Phetchabun, Chaiyaphum, Loei.

Distribution. — Mainland China, India, Myanmar, Sri Lanka, and Vietnam.

Ecology. — On tree branches.

Specimens examined. — *S. Chantanaorrapint 361,376, 726; O. Thaithong 79* (BCU).

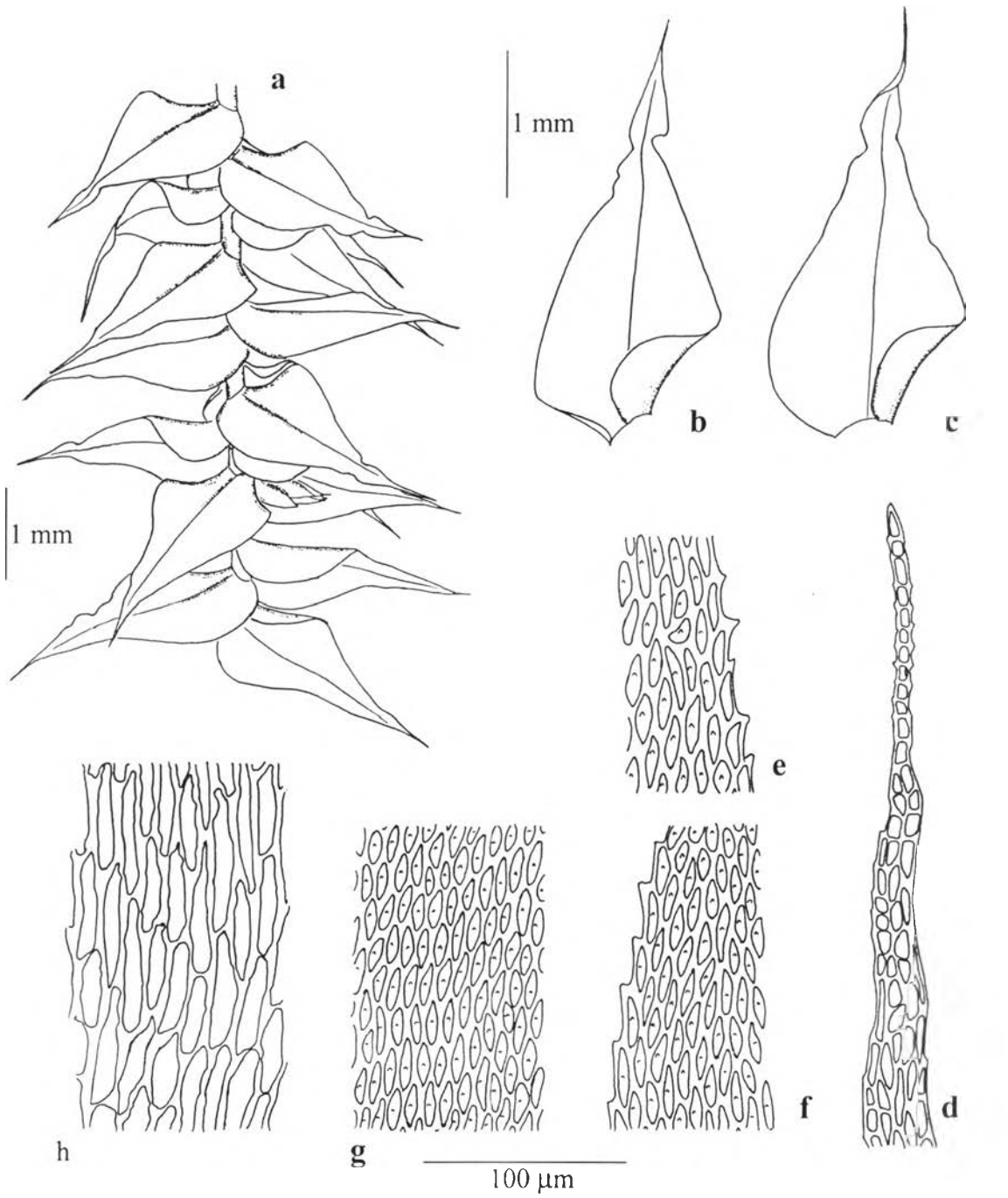

Figure 5.29 *Aerbryopsis subdivergens* (Broth.) Broth.
a. a part of plant; b., c. leaves; d. cells at leaf apex; e., f. cells at leaf margin;
g. cells at leaf median; h. cells at leaf base. Based on *S. Chantanaorrapint 530.*

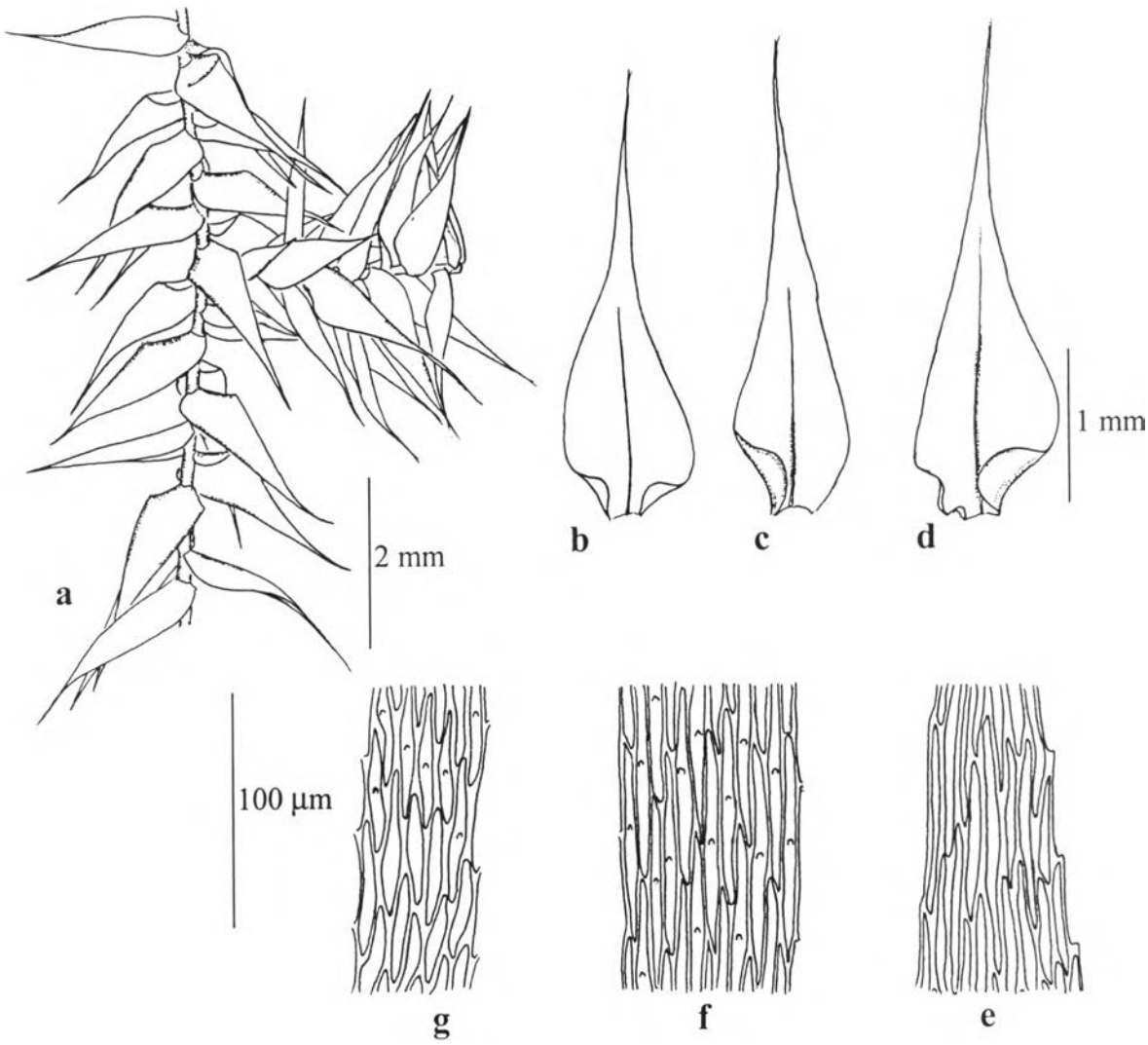

Figure 5.30 *Barbella flagellifera* (Card.) Nog.
a. a part of plant; b.-d. leaves; e. cells at leaf apex; f. cells at leaf median; g. cells at leaf base. Based on *S. Chantanaorrapint 723*.

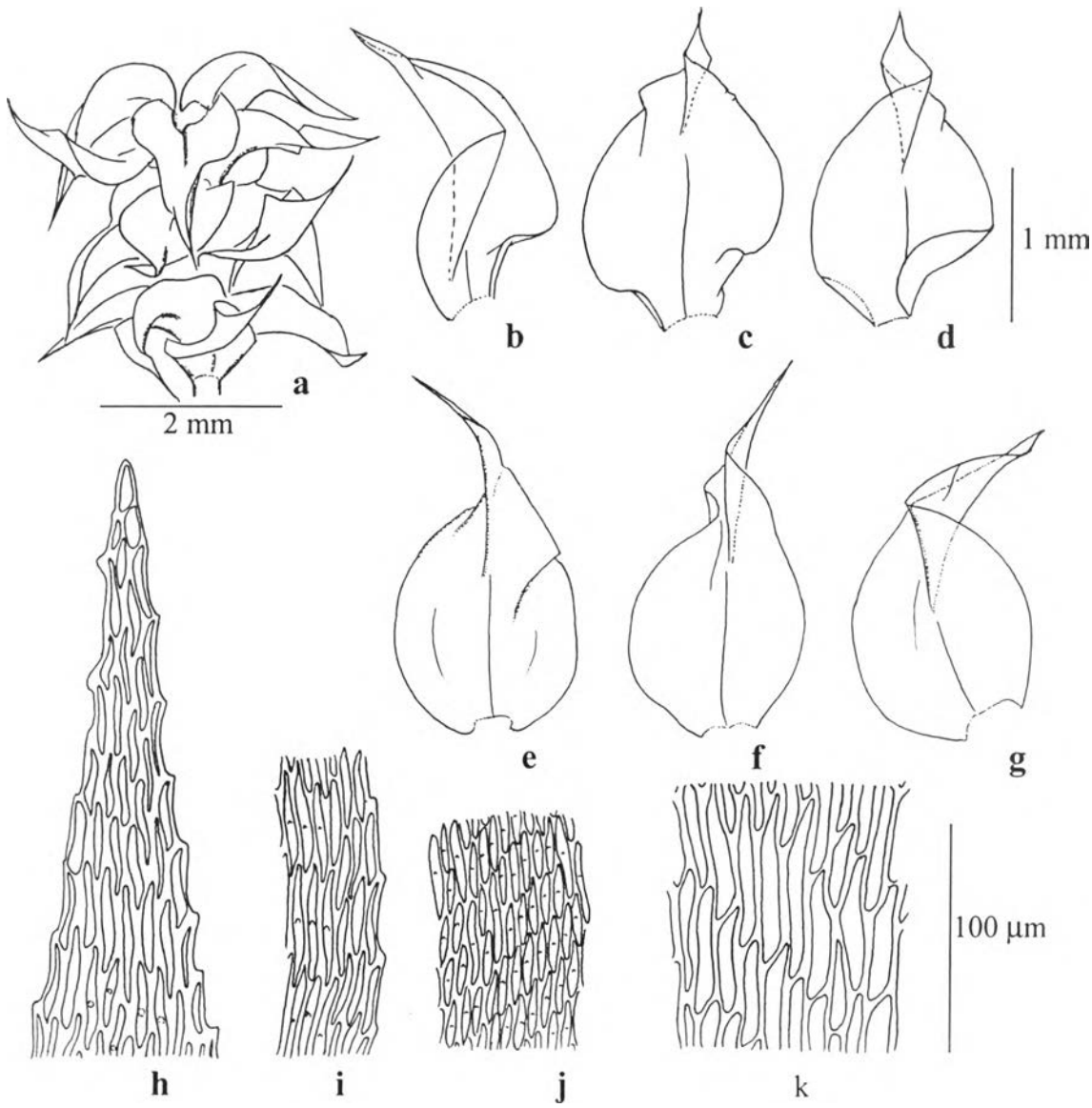

Figure 5.31 *Meteoriopsis squarrosa* (Hook.) Fleisch. ex Broth.
a. a part of plant; b.-g. leaves; h. cells at leaf apex; i. cells at leaf margin; j. cells at leaf median; k. cells at leaf base. Based on *S. Chantanaorrapint 665*.

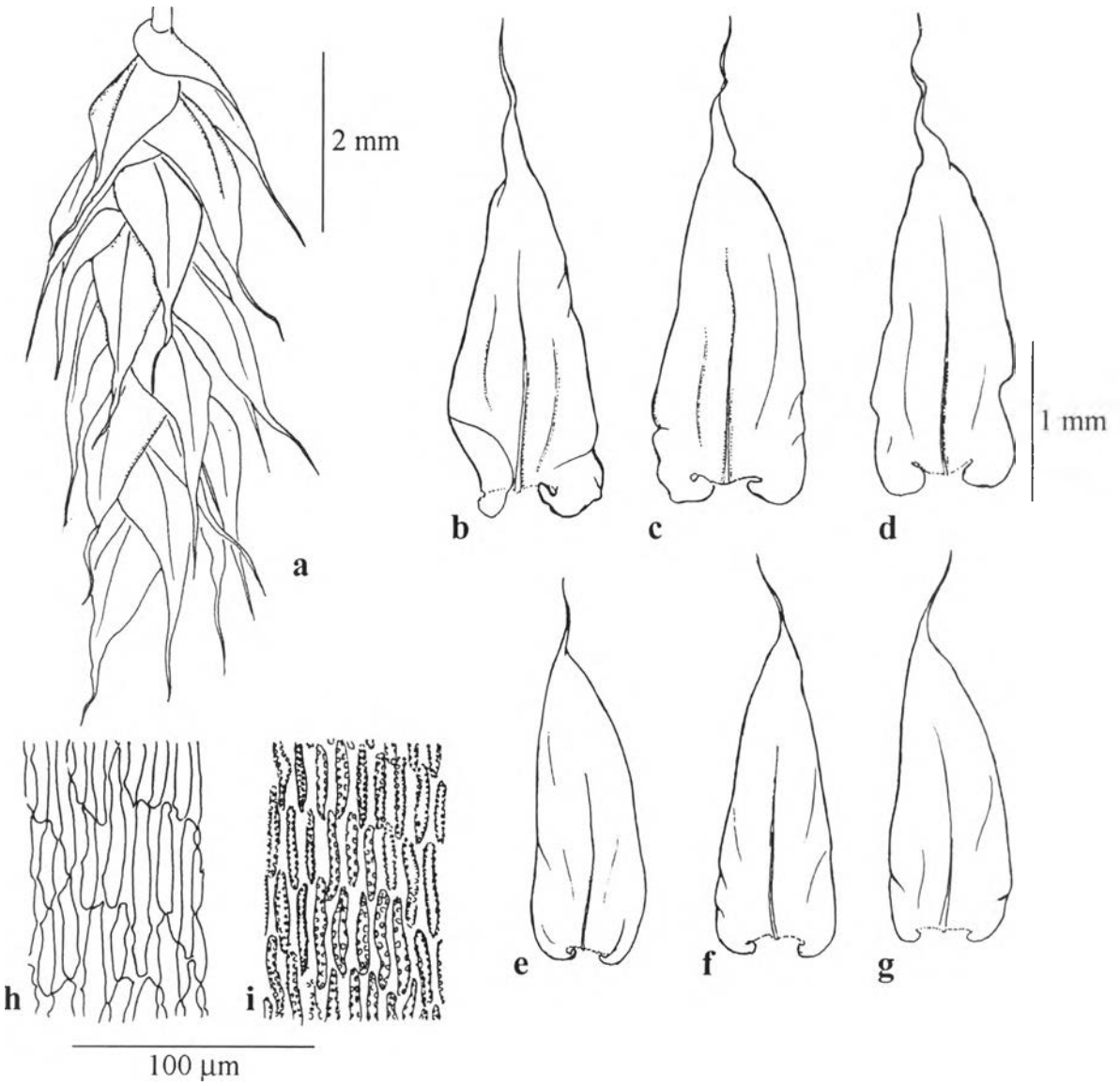

Figure 5.32 *Papillaria chrysoclada* (C. Müll.) Jaeg.
a. a part of plant; b.-d. stem leaves; e.-g. branch leaves; h. cells at leaf median; i. cells at leaf base. Based on *S. Chantanaorrapint 726*.

NECKERACEAE

Plants usually large, glossy. **Primary stems** filiform, creeping, bearing very small leaves and tufts of reddish brown rhizoids which are situated just below the leaf insertion. mostly with central strand; secondary stems erect or pendulous, 1-2 time pinnately or irregularly and remotely branched, mostly complanate. **Leaves** are usually lingulate, more or less asymmetric with the basiscopic side inflexed near base, sometimes ariculate, often transversely undulate; **costa** simple, variable in length, occasionally short and double or almost absent. **Leaf cells** smooth, incrassate, linear or rectangular towards base, rhomboidal above, alar cells slightly differentiated or not. **Sporophytes** lateral on branches of secondary stems. **Capsule** erect, cylindrical immersed or exserted; annulus not differentiated; **operculum** conical, often obliquely rostrate; **peristome** double, complete, with no singe of reduction in most taxa but with few taxa high reduced endostome.

Key to Genera

1. Plants rhizomatous, stipe present; leaves dimorphic, transversely undulate indistinct.....1. *Homaliodendron*

1. Plants pendulous, stipe absent; leaves monomorphic, transversely undulate distinct.....2. *Neckeropsis*

1. *HOMALIODENDRON*

Homaliodendron Fleisch., Hedwigia 45: 74. 1906; Gangulee, Mosses of Eastern India and Adjacent Regions, Fascicle 5: 1411. 1976

Plants usually robust, glossy of frondose habit. **Primary stems** creeping; secondary stems ascending or erect, bipinnate or tripinnate, sometimes irregularly pinnate branches from a rigid stipe. **Leaves** spreading, usually not transversely undulate but longitudinally furrowed, usually lingulate and serrate above, rarely rounded-spathulate and subentire; **costa** single, usually not strong, ending at or a little above mid-leaf; **leaf cells** roughly polygonal above, rhomboid at middle, elongate below; **alar cells** usually distinct. **Exostome** narrowly lanceolate, often transversely striate at base. **Operculum** obliquely rostrate. **Calyptra** mostly small, pilose, cuculate.

Key to species

1. Plants slender, irregularly branched; leaf apex nearly entire to crenate.....1. *H. exiguum*

1. Plants usually robust frondose; leaf apex coarsely dentate.....2. *H. flabellatum*

1. ***Homaliodendron exiguum*** (Bosch & Sande Lac.) Fleisch.

Musci Fl. Buitenzorg 3: 897. 1908; Enroth, Acta Bot. Fenn. 137: 59, fig. 7. 1989. — *Homalia exiguum* Bosch & Sande Lac., in Dozy & Molk., Bryol. Jav. 2: 55. 1862. — *Thamnium exiguum* (Bosch & Sande Lac.) Kindb., Hedwigia 41: 240. 1902. —

Homalia bibrachiata (C. Müll.) Geh., Biblioth. Bot. 13: 6. 1889. — *Neckeropsis psuedonitidula* Okam., J. Col. Sci. Imp. Univ. Tokyo 38(4): 39. 1916. — *Homaliodendron psuedonitidalum* (Okam.) Nog., Trans. Nat. Hist. Soc. Formosa 24: 291. 1934. — *Homolia laxiretis* Sak., Bot. Mag. Tokyo 50: 618. 1935. — *H. rotundata* Broth. ex Tran Ninh, J. Hattori. Bot. Lab. 57: 12. 1984.

Plants slender, pale green, growing epiphytically in small lax tufts. **Primary stems** with scale leaves. Secondary stems erect up to 4 cm high, pinnate or bipinnate, complanate sometimes flagelliform. **Stipe leaves** small, closely appressed, base broadly ovate, apex rounded, margin distinctly crenulate. **Leaves** psuedotetrastrichous with dorsal and ventral rows sometimes differentiated, broadly lingulate or weakly spathulate, strongly complanate, horizontal spreading, smooth or nearly longitudinally plicate, 1.2-1.4 mm long, 0.8-1.0 mm wide but smaller upwards; base strongly asymmetric with the basiscopic side narrowly inflexed and acroscopic almost auriculate; apex rounded, margin crenulate at apex, nearly entire below. **Costa** simple, sometimes branched above, 2/3-4/5 of the leaf length. **Leaf cells** incrassate; upper part cells rounded, oavte or hexagonal, 10-20 μm long, 10-15 μm wide; basal cells rectangular, 30-40 μm long, 10-15 μm wide; at margin 1-2 rows of small and quadrate or shortly rectangulate cells. Branch leaves somewhat smaller, more spathulate and asymmetrically, rounded at apex. (Fig. 5.33). **Dioicous**. **Perichaetia** small, ovate with long apex, 0.5-0.7 mm long, 0.3-0.4 mm wide. **Sporophytes** not found.

Thailand. — NORTHERN: Chiang Mai, Tak, Phitsanulok; NORTH-EASTERN: Phetchabun, Loei; SOUTH-WESTERN: Kanchanaburi, Prachuap Khiri Khan; CENTRAL: Nakhon Nayok; SOUTH-EASTHERN: Chanthaburi; PENINSULAR: Chumphon, Surat Thani, Nakhon Si Thammarat, Krabi, Trang.

Distribution. — Borneo, Celebes, Mainland China, Japan, Java, India, Malay Peninsula, Myanmar, Nepal, Philippines, New Guinea, Sri Lanka, Sumatra, Taiwan, and Vietnam.

Ecology. — On basal of tree trunks.

Specimens examined. — *S. Chantanaorrapint 664, 656, 701* (BCU).

2. ***Homaliodendron flabellatum*** (Sm.) Fleisch.

Hedwigia 45: 74. 1906; Enroth, Acta Bot. Fenn. 137: 59, fig. 7. 1989. — *Hookeria flabellata* Sm., Trans. Linn. Soc. 9: 280. 1808. — *Leskea flabellata* (Sm.) Brid., Bryol. Univ. 2: 325. 1827. *Hypnum flabellatum* Dicks. ex C. Müll., Syn. Musc. Fr. 2: 225. 1851. — *Neckera flabellata* (Sm.) Mitt., J. Proc. Linn. Soc. Bot. Suppl. 1: 118. 1859. — *Homolia flabellata* (Sm.) Bosch. & Sande Lac. in Dozy & Molk., Bryol. Jav. 2: 58. 1863. — *Thamnium flabellatum* (Sm.) Kindb., Hedwigia 41: 224. 1902. — *Neckera javanica* C. Müll., Syn. Musc. Fr. 2: 41. 1851. — Homalia javanica (C. Müll.) Bosch & Sande Lac. in Dozy & Molk., Bryol. Jav. 2: 54. 1863. — *N. scalpellifolia* Mitt., J. Proc. Linn. Soc. Bot. Suppl. 1: 119. 1859. — *N. ligulifolia* Mitt. J. Proc. Linn. Soc. Bot. Suppl. 1: 119. 1859. Other synonym see J. Enroth 1989.

Plants usually large, frondose or almost dendroid, variable in size, green to yellowish, more or less glossy. **Secondary stems** up to 10 cm long, bi- or tripinnate branched, branches of variable length thus forming very variable, low and triangular or long, narrow and rather lax fronds; branch tips mostly attenuate, sometimes obtuse

to rounded, flagelliform branchlets common. **Stipe leaf** small, scale-like. **Upper stem leaves** spathulate to oblong-lingulate, ca. 2.5-3 mm long and 1.3-1.5 mm wide, more or less asymmetric, mostly complanate and spreading, usually longitudinal plicate when dry; basiscopic side inflexed near base, apex obtuse to widely acute and coarsely dentate, margin entire elsewhere; costa rather weak, simple, reaching 3/4 leaf length. Branch leaves similar to stem leaves but smaller. **Leaf cells** smooth, pellucid, incrassate, at apex rhomboid or irregularly angular, ca. 10-20 μm long and 8-10 μm wide, becoming elongate towards mid-leaf, at base up to 60 μm long with highly porose walled; alar cells usually differentiated, composed of a group of small, quadrate-rectangular cells thick-walled. (Fig. 5.34, 5.93). **Sporophyte** not found.

Thailand. — NORTHERN: Chiang Mai, Phitsanulok; NORTH-EASTERN: Phetchabun, Loei; SOUTH-WESTERN: Prachuap Khiri Khan; PENINSULAR: Nakhon Si Thammarat, Trang.

Distribution. — Bhutan, Borneo, Celebes, Mainland China, India, Japan, Java, Laos, Malaysia, Myanmar, Nepal, New Guinea, Philippines, Sikkim, Sri Lanka, Sumatra, Taiwan, and Vietnam.

Ecology. — On basal of tree trunks.

Specimens examined. — *S. Chantanaorrapint 511, 553, 602, 636, 666, 679, 692* (BCU).

2. *NECKEROPSIS*

Neckeropsis Reichardt., Reise Oesterr. Freg. Novara Bot. 1(3): 181. 1870; Gangulee, Mosses of Eastern India and Adjacent Regions, Fascicle 5: 1391. 1976.

Plants slender to robust, glossy, with pendant to procombent; irregularly branched, complanate. **Leaves** in four horizontal spreading rows, usually transversely undulate and asymmetrically lingulate, broadly rounded or truncate at apex. **Costa** usually single, very short; leaf cells smooth, short rhomboidal above, more elongate below. **Capsule** immersed, sometimes exserted. **Operculum** conic-rostrate. **Calyptra** small, cuculate, more or less pilose. **Peristome** double, neckeroid.

Key to species

Costa more than 5/6 leaf-length, auricle very large.....1. *N. fimbriata*

Costa less than 1/2 leaf-length, auricle small or indistinct.....2. *N. lepineana*

1. ***Neckeropsis fimbrita*** (Harv.) Fleisch.

Musci Fl. Buitenzorg 3: 878. 1908; Touw, Blumea 11(2): 401, pl. 11. 1962. — *Neckera fimbriata* Harv., Musci Indici. Hook. J. Bot. 2:13. 1840.

Plants rather robust, growing epiphytically or sometimes lithophyte, yellowish green, usually with purple or occasionally blackish. **Primary stems** creeping; secondary stems pendent or procumbent, sometimes ridiculous, up to 10 cm long and 4-5 mm wide, irregularly and remotely branched. **Leaves** pseudotetrastichous, slightly complanate, asymmetrically ovate to lingulate, ca.1.8-2.0 mm long and 0.8-1.0 mm wide; apex rounded-truncate, distinctly apiculus; base often much widest, auricles

large, the proximal one clasping the stem; lamina shallow to deep transversely undulate; margin rugose at auricles, crenulate to serrulate at apex and auricles, solid or minutely crenulate elsewhere. **Costa** unbranched, robust, ca. 7/8 of leaf-length, never reaching the apex. **Leaf-cells** pellucid, walls incrassate, often porose; cells near apex shorter, rounded quadrate to rhomboid, ca. 10-15 μm long and 5-8 μm wide, walls incrassate, solid; cells near base elongate to linear, ca. 25-45 μm long and 5 μm wide, longitudinal walls highly incrassate, porose; cells at auricle elongate, shorter than cells at base. (Fig. 5.35). **Sporophytes** not found.

Thailand. — NORTHERN: Chiang Mai, Phitsanulok; NORTH-EASTERN: Phetchabun; EASTERN: Nakhon Ratchasima; SOUTH-WESTERN: Kanchanaburi; CENTRAL: Nakhon Nayok; SOUTH-EASTWRN: Chanthaburi: Trat; PENINSULAR: Krabi, Chumphon, Surat Thani.

Distribution. — Bhutan, India, Kampuchea, Laos, Malay Peninsula, Myanmar, Nepal, Philippines, Sikkim, and Vietnam.

Ecology. — On tree trunks and branches or rocks.

Specimens examined. — *S. Chantanaorrapint 624,630, 670, 682, 694, 708, 709* (BCU).

2. ***Neckeropsis lepineana*** (Mont.) Fleisch.

Musci Fl. Buitenzorg 3: 879. 1908; Touw, Blumea 11(2): 383, pl. 3. 1962; Enroth, Acta Bot. Fenn. 137: 43, fig. 1. 1989. — *Neckera lepineana* Mont., Ann. Sci. Nat. Bot. sér. 10: 107. 1848. — *N. undulata* acut. non. Hedw.: Mont., Voyage au Pole Sud et dans l'Océanie, Bot. 1. 1845. — N. Comorae C. Müll., Linnaea 40: 268. 1876. *N. crinita* auct. non Griff.: Mitt., J. Proc. Linn. Soc. Bot. Suppl. 1: 120. 1859.

Plants usually robust, growing epiphyically, often forming mass vegetations, prostrate or pendulous, slightly glossy, green or yellowish green, older parts often dark with a reddish tinged. **Primary stems** creeping; secondary stems flexuose, up to 10 cm long, with leaves 3-7 mm wide, remotely and irregularly branched, tips usually rounded. **Leaves** pseudotetrastichous, asymmetric, lingulate, variable in size, 1.7-3.5 mm long, 0.6-1.5 mm wide, transversely undulate; base somewhat narrowed with the acoscopic side narrowly decurrent, auricles, inconspicuous; apex truncate or slightly rounded; margin usually faint crenulate above, entire below. **Costa** short, faint, usually less than 1/4 leaf length, simple. **Leaf cells** incrassate; cells at apex mostly subrhomboid to rounded, 10-20 μm long, 10-15 μm wide; lower cells linear-rectangular, porose walls, 40-80 μm long, 15-20 μm wide; alar cells indistinct, slightly shorter than; margin usually composed of 1-2 rows of shorter cells. (Fig. 5.36). **Sporophytess** not found.

Thailand. — PENINSULAR: Chumphon, Nakhon Si Thammarat, Krabi, Phangnga, Trang.

Distribution. — Bangladash, Bhutan, Borneo, Celebes, Mainland China, India, Japan, Java, Kampuchea, Laos, Malaysia, Papua New Guinea, Philippines, Sri Lanka, Sumatra, Taiwan, and Vietnam.

Ecology. — On tree trunks and branches.

Specimens examined .— *S. Chantanaorrapint 640, 671, 676* (BCU).

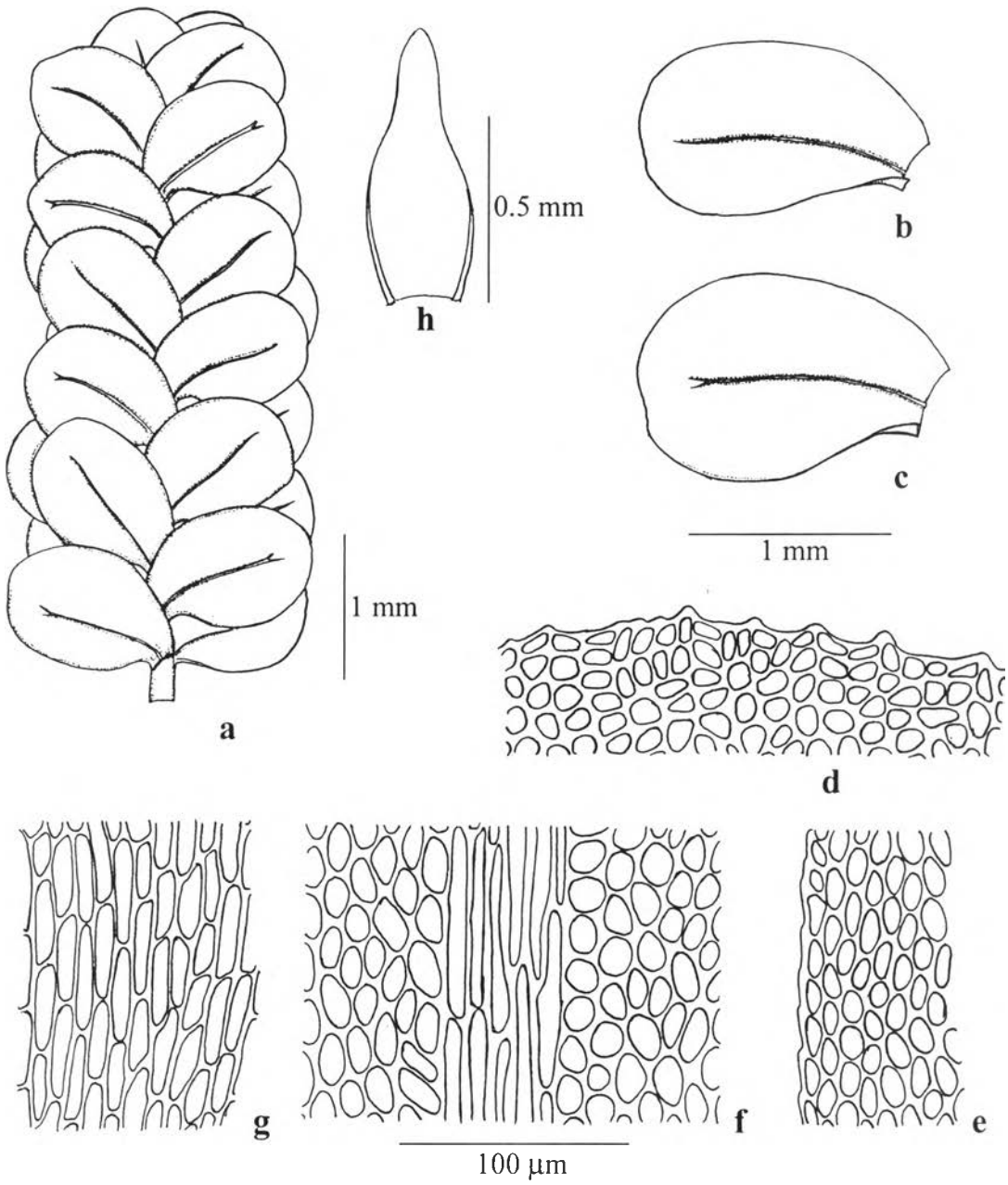

Figure 5.33 *Homaliodendron exiguum* (Bosch & Sande Lac.) Fleisch.
a. a part of plant; b., c. leaves; d. cells at leaf apex; e. cells at leaf margin; f. cells at leaf median; g. cells at leaf base; h. perichaetial leaf. Based on *S. Chantanaorrapint 656*.

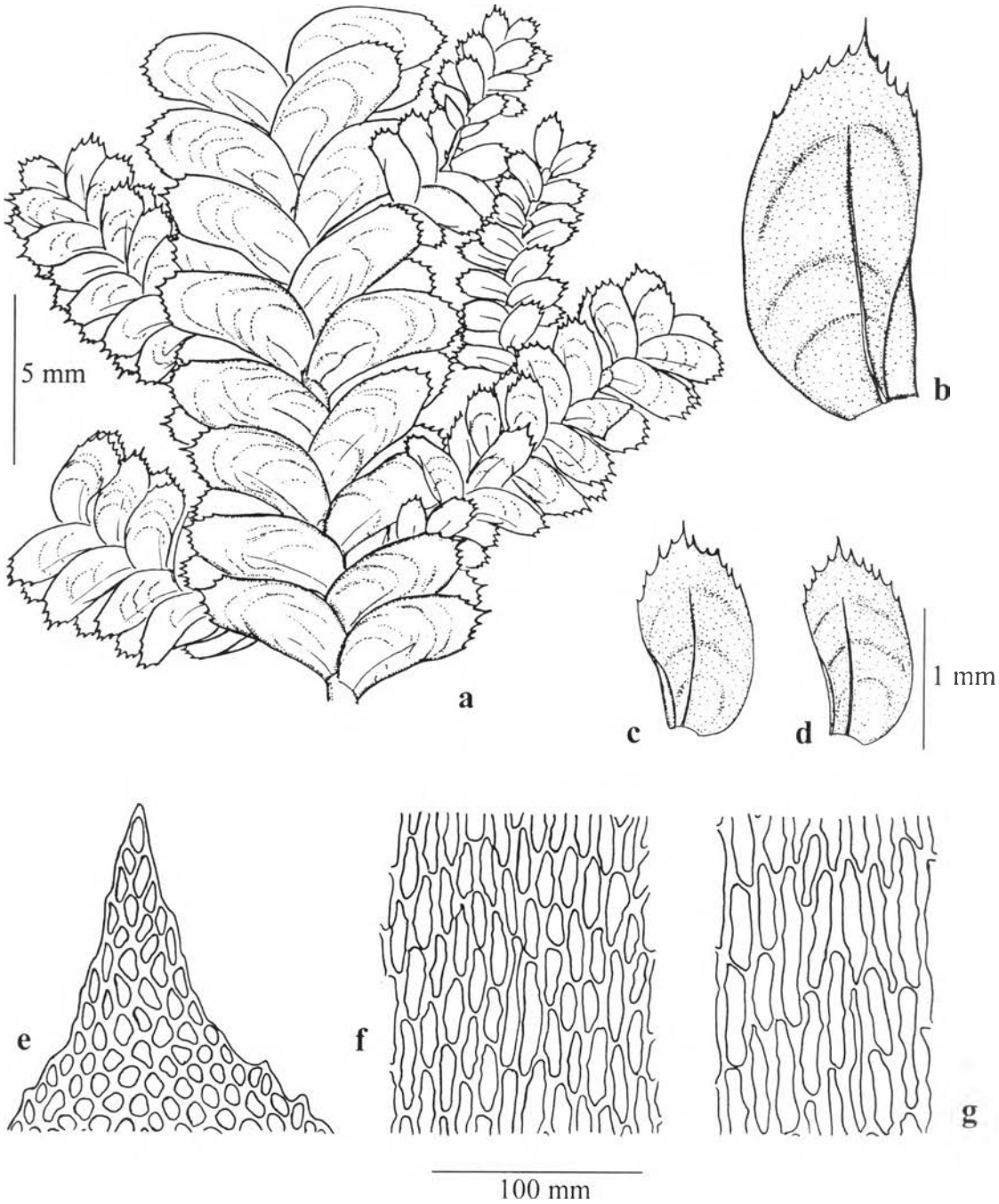

Figure 5.34 *Homaliodendron flabellatum* (Sm.) Fleisch.
a. a part of plant; b. stem-leaf; c., d. branch-leaves; e. cells at leaf apex; f. cells at leaf margin; g. cells at leaf base. Based on *S. Chantanaorrapint 602*.

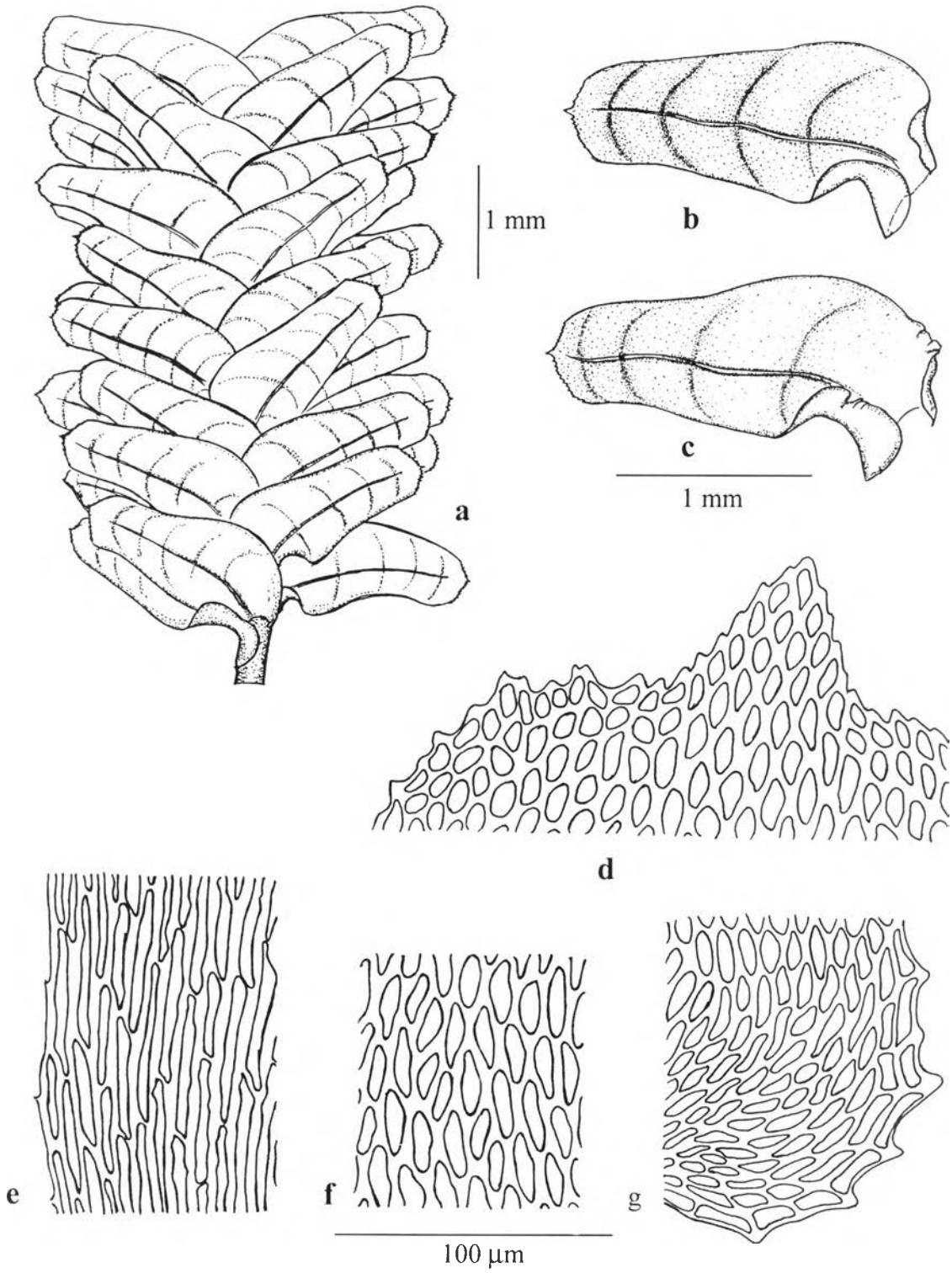

Figure 5.35 *Neckeriopsis fimbriata* (Harv.) Fleisch.
a. a part of plant; b., c. leaves; d. cells at leaf apex; e. cells at leaf base; f. cells at leaf median; g. cells at auriculate leaf base. Based on *S. Chantanaorrapint 608*.

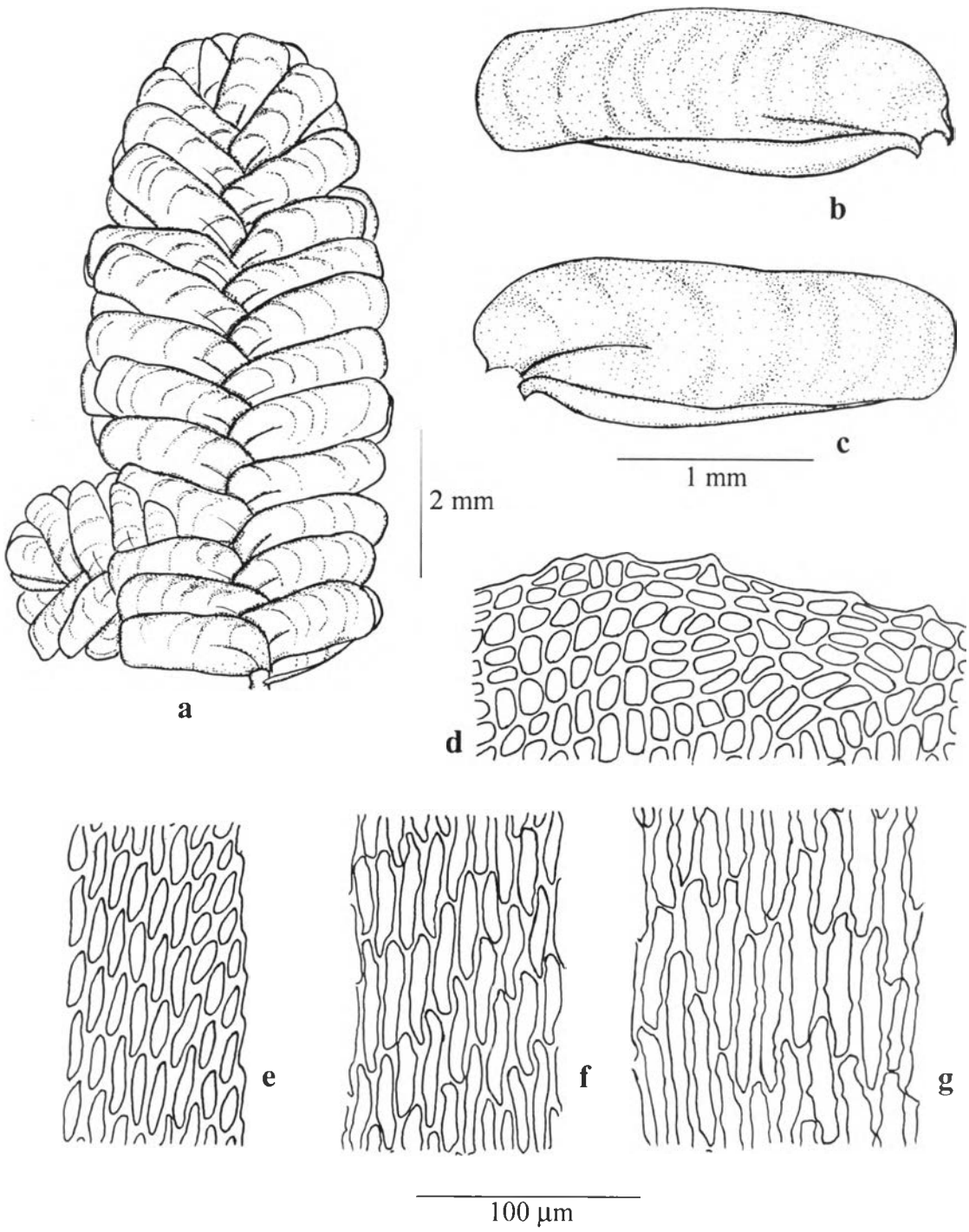

Figure 5.36 *Neckeriopsis lepineana* (Mont.) Fleisch.
a. a part of plant; b., c. leaves; d. cells at leaf apex; e. cells at leaf margin; f. cells at leaf median; g. cells at leaf base. Based on *S. Chantanaorrapint 676*.

POLYTRICHACEAE

Plants small to very roboust, gregarious. **Stems** erect, usually simple or sparingly branched, arising from a prostrate underground rhizome. **Leaves** narrow, mostly rigid, blade usually well differentiated from sheathing base; **costa** strong, percurrent or excurrent, often toothed on back above, usually broader on ventral surface and covered with thin, parallel, longitudinal lamellae. **Seta** elongate. **Capsule** erect or inclined, cylindrical or angled; **peristome** single, teeth 32 or 64, solid, not barred, triangular in cross-section, columella bearing an expanded shieldlike membrane at apex covering mouth of capsule. **Calyptra** cuculate, usually more or less pilose with erect or deflexed hairs.

POGONATUM

Pogonatum P. Beauv., Prodr. 84. 1805; Bartram, Phillip. J. Sci. 68: 387. 1939.

Plants small to very robust, in lax tufts. **Stems** arising from subterranean, curved, tomentose rhizomes. **Lower leaves** small, scale-like; upper leaves much lager, mostly crisped and twisted when dry, mostly with a lingulate to oblong-lanceolate limb and a well-defined, enlarged, membranous sheathing base; basal cells elongate, narrowly rectangular, mostly hyaline; apex acute to obtuse, often with a spinous tooth at tip; margin of limb usually dentate, not bordered, usually with numerous longitudinal lamellae on ventral face; **costa** stout, often tooth on back near apex. **Seta** long, smooth or papillose. **Capsule** erect or inclined, cylindrical; **peristome** teeth 32, **operculum** rostrate. **Calyptra** densely hairsed.

Key to species

1. Lamellae 1-2 cells high, straight in side-view, apical cells smooth...1. *P. cirratum*

1. Lamellae 4-6 cells high, strongly crenate in side-view, apical cells papillose..... .....2. *P. neesii*

1. ***Pogonatum cirratum*** (Sw.) Brid.

Bryol. Univ. 2: 110. 1827. J. Hyvönen, Acta. Bot. Fenn. 133: 131, fig. 14. 1986. — *Polytrichum cirratum* Sw., J. Bot. 1800(2): 175, 176. tab. 4. 1801. — *Pogonatum serpentinum* C. Müll. ex Par., Ind. Bryol. 987. 1897.

Plants medium-sized to robust, stems erect, stiffed, loosely caespitose, 2.5-5.0 cm high, tomentose at base. **Upper leaves** linear-lanceolate, distant, twisted to incurved when dry, erect-spreading to squarrose when moist, widely sheathing the stem; blade of the leaves ca. 6-10 mm long and 0.7-0.8 mm wide, leaf apex acute and dentate; costa strong, but not distinct; leaf margin plane when moist, inflexed when dry, bistratose, dentate above, entire below; basal sheath cells rectangular, hyaline, thick-walled; cells at shoulder region rounded to subquadrate, hyaline, thick-walled; **lamella** 1-2 (rarely 3) cells high, straight in side-view, apical cells solitary or rarely geminate, rounded to subquadrate or transversely ovate above, in side-view higher than wide; lower cells subquadrate to wider than high, transversely rectangular (Fig. 5.37, 5.95). **Sporophytes** not found.

Thailalnd. — NORTHERN: Chiang Mai.

Distribution. — China, Japan, Bhutan, Sikkim, Sri Lanka, Indonesia, Papua New Guinea.

Ecology. — on slope with moist sandy-soil, in shade.

Specimens examined. — *S. Chantanaorrapint 523, 618* (BCU).

2. ***Pogonatum neesii*** (C. Müll.) Dozy

Ned Kruidk. Arch. 4(1): 75. 1856. J. Hyvönen, Acta. Bot. Fenn. 133: 127, fig. 12. 1986. — *Polytrichum neesii* C. Müll., Syn. Musc. Frond. 2: 563. 1851. — *Pogonatum junghuhnianum* (Dozy & Molk.) Dozy & Molk., Bryol. Jav. 1: 40, tab. XXXI. 1856. — *P. klossii* Dixon, Linn. Soc. J. Bot. 45: 483. 1922.

Plants medium-sized, stems erect, stiffed, loosely caespitose, 0.5-2.5 cm high. **Rhizoids** concentrate on base of old leaves. **Leaves** linear-lanceolate, distant, twisted to incurved when dry, erect-spreading to squarrose when moist, widely sheathing the stem; blade of the leaves ca. 3.0-4.0 mm long and 0.4-0.5 mm wide, leaf apex acute and dentate; costa strong, but not distinct; leaf margin plane when moist, inflexed when dry, unistratose, dentate above, entire below; basal sheath cells rectangular, hyaline, thick-walled; cells at shoulder region irregular, ovate, rounded or subquadrate, hyaline, thick-walled; **lamella** 4-6 cells high, strongly crenate in side-view, transversely ovate above, lower cells subquadrate to irregulary rectangular; apical cells differentiated with finely papillose (Fig. 5.38). **Sporophytes** not found.

Thailalnd. — NORTHERN: Chiang Mai, Phitsanulok; NORTH-EASTERN: Loei; EASTERN: Nakhon Ratchasima; CENTRAL: Nakhon Nayok; SOUTH-EASTWRN: Chanthaburi, Trat; PENINSULAR: Ranong.

Distribution. — China, Japan, Korea, Bhutan, Burma, India, Laos, Nepal, Sikkim, Sri Lanka, Vietnam, Indonesia, Malaysia, Papua New Guinea, Philippines, Australia, Fiji, New Caledonia, Samoa, Vanuatu.

Ecology. — on slope with moist sandy-soil, open area.

Specimens examined. — *S. Chantanaorrapint 619* (BCU).

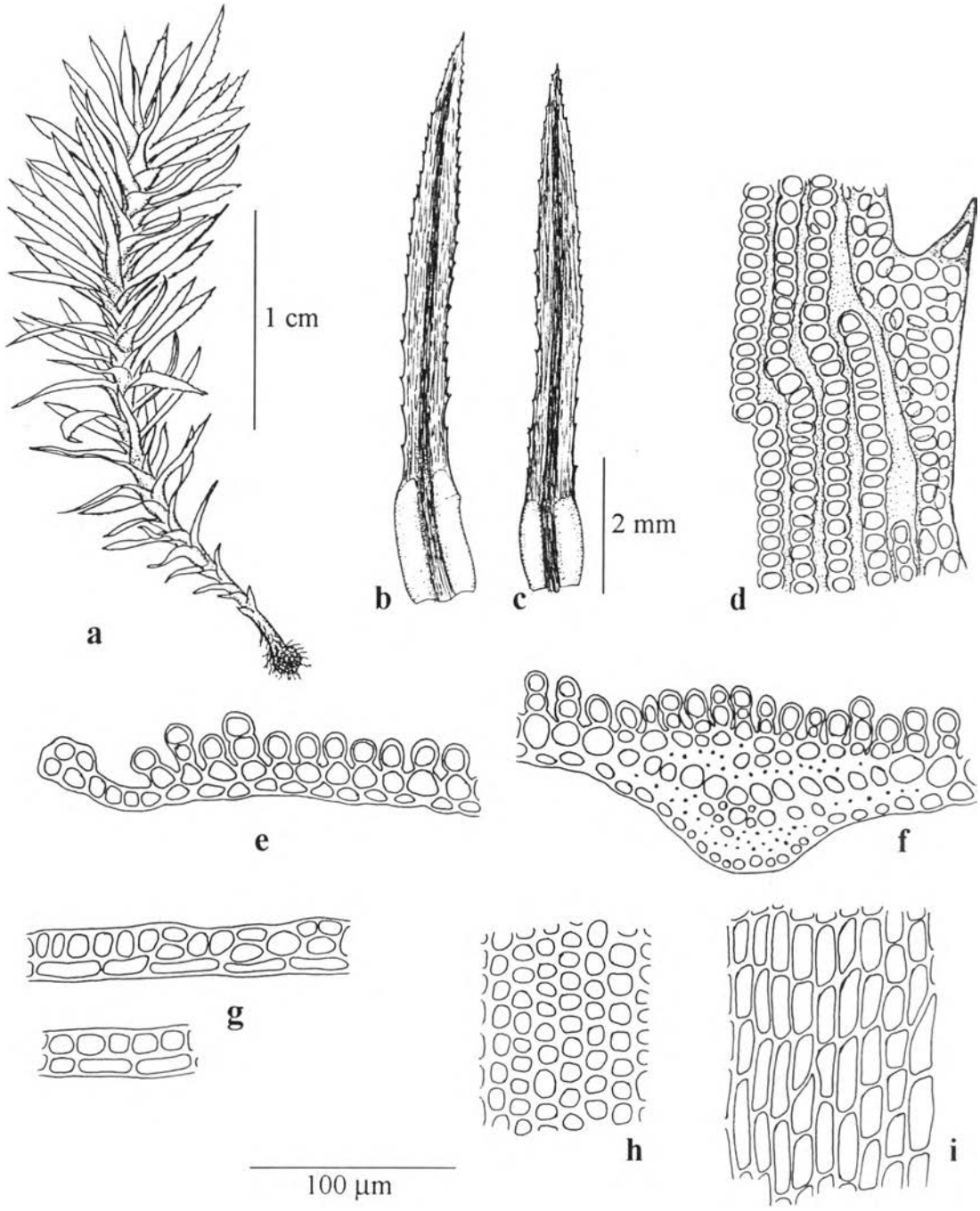

Figure 5.37 *Pogonatum cirratum* (Sw.) Brid.
a. habit; b., c. leaves; d. top view of lamella; e., f. cross-section of leaf, e. shown lamina, f. shown costa; g. lamellae, shown side view; h. cells at shoulder region; i. basal sheath cells. Based on *S. Chantanaorrapint 523*.

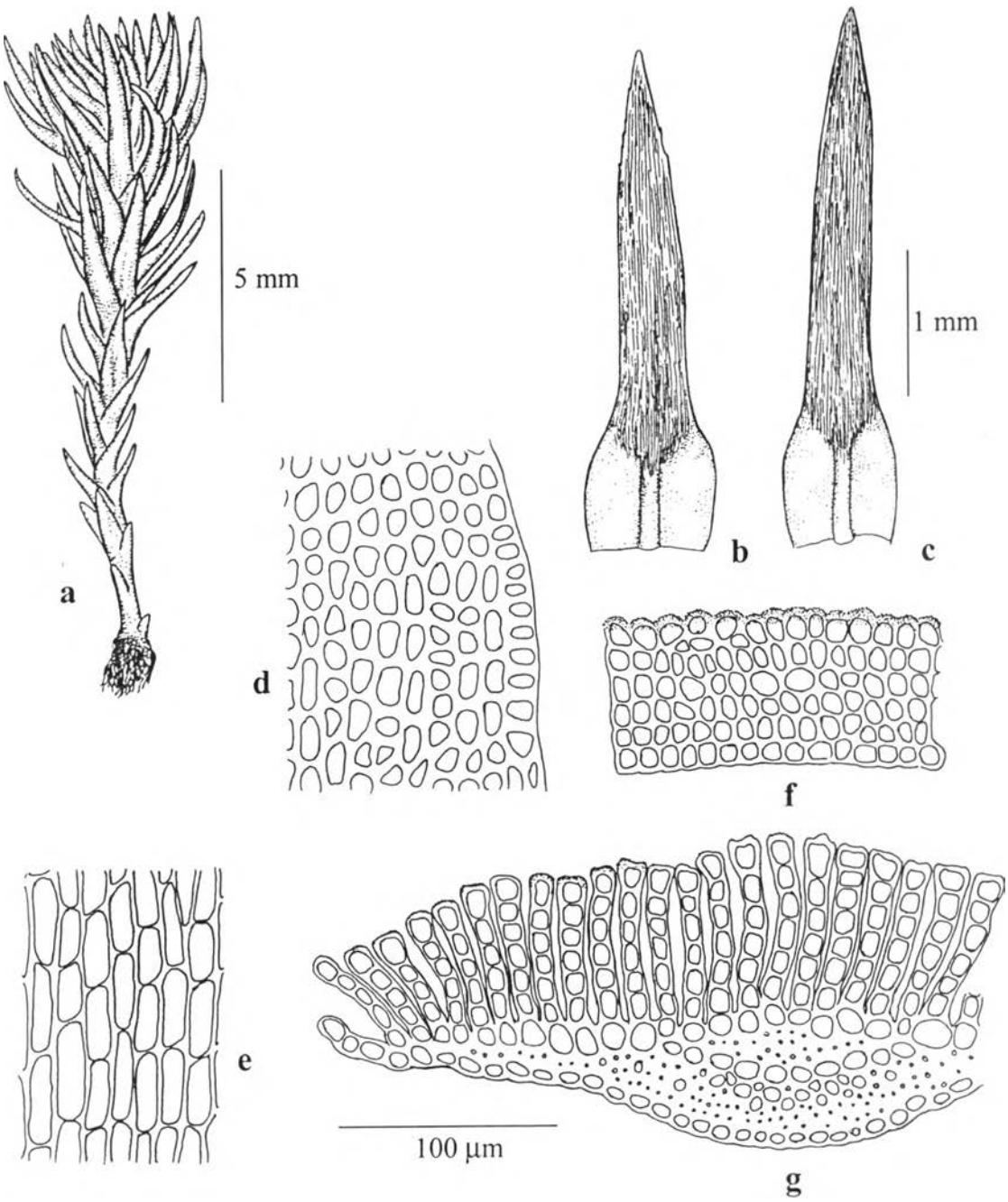

Figure 5.38 *Pogonatum neesii* (C. Müll.) Dozy
a. habit; b., c. leaves; d. cells at shoulder region; e. basal sheath cells; f. lamella, shown side view; g. cross-section of leaf. Based on *S. Chantanaorrapint 619.*

POTTIACEAE

Plants small to medium-sized, or rather large, often tuft-forming or in loosely caespitose patches, dull greenish above, brownish below. **Stems** erect to elongate, simple or irregularly compositely branching; central strand mostly developed, sometimes absent. **Leaves** in several rows, usually twisted, or appressed when dry, erect-spreading or squarrose-recurved when moist, often narrowly lanceolate to linear-lanceolate, or ovoid, elliptic or lingulate; apices usually gradually acuminate or abruptly acute, occasionally obtuse or rounded; bases usually narrowly ovate to oblong, sometimes sheathing; margin entire, sometimes dentate above, bordered by thick-walled or elongate cells, often unistratose, sometimes multistratose, commonly recurved or incurved below, sometimes plane; **costa** single, well developed, percurrent to shortly excurrent, in cross-section usually with 1 or 2 stereid bands, upper leaf cells small, subquadrate to hexagonal, usually firm-walled or incrassate, mostly papillose, rarely smooth; lower cells usually smooth, rectangular, thin-walled, alar cells not differentiated, central cells slightly differentiated. **Gemmae** rather common. **Dioicous** or autoicous. **Seta** terminal, elongate, erect, but often twisted. **Capsule** usually erect, symmetric, ovoid to cylindrical, mostly stegocarpous, rarely cleistocarpous and spherical; **operculum** mostly conic to rostrate; **peristome** single, consisting of 16, erect, oblique or often spirally twisted teeth, occasionally absent or rudimentary, teeth entire, linear-lanceolate or deeply split into 2 filiform, striate or papillose divisions; basal membrane usually low or absent, sometimes high. **Calyptra** smooth, usually cuculate, seldom mitrate. **Spores** spherical, small, usually dense papillose.

A large family, widely distributed in temperate regions of the world, with a small number of species and genera in tropical and arctic regions. Found only one genus and one species in the area studied.

HYOPHILA

Hyophila Brid., Bryol. Univ. 1: 760. 1827; Gangulee, Mosses of Eastern India and Adjacent Regions, Fascicle 3: 677. 1972; Nog., Illustrate Moss Flora of Japan, part 2: 289. 1988; A. Eddy, A Handbook of Malesian Mosses, vol. 2: 196. 1990; X.-J. Li, S. He & Z. Iwats., Moss Flora of China vol. 2: 191. 2001.

Plants small, to 10 mm high, green above, red to reddish brown or dark green below, in dense tufts. **Stems** simple, rarely branched; central strand present or absent. **Leaves** usually rosulate, incurved to twisted when dry, oblong-elliptic to oblong-spatulate or oblong-lanceolate to lanceolate-lingulate, blunt to rounded-obtuse or weakly apiculate at the apex; margin entire or serrulate; **costa** stout, percurrent to short excurrent; upper leaf cells small, quadrate to rounded-hexagonal, smooth or papillose; basal cells rectangular, smooth, hyaline. **Dioicous** or autoicous. **Perichaetial** leaves smaller than or similar to stem leaves. **Seta** elongate, straight. **Capsule** erect, oblong-cylindrical; annulus differentiated, deciduous; **peristome** absent; **operculum** conic-rostrate, usually with long oblique beak. **Calyptra** cuculate, smooth. **Spores** spherical, small, smooth.

Hyophila involuta (Hook.) Jeag.

Ber. Thätigk. St. Gallischen Naturwiss. Ges. 1871-72: 354. 1873; Gangulee, Mosses of Eastern India and Adjacent Regions, Fascicle 3: 681, fig. 322. 1972; Nog., Illustrated Moss Flora of Japan, part 2: 290, fig. 120B. 1988; A. Eddy, A Handbook of Malesian Mosses, vol. 2: 199. fig. 293. 1990; X.-J. Li, S. He & Z. Iwats., Moss Flora of China vol. 2: 191. 2001. — *Gymnostomum involutum* Hook., Musci Exot. 2: 154. 1819. — *H. attenuata* Broth., Symb. Sin. 4: 37. 1929. — *H. micholitzii* Broth., Öfvers. Forh. Finska Vetensk.-Soc. 35: 39. 1893. — *H. moutieri* Paris & Broth. In Paris, Rev. Bryol. 28: 38. 1901. — *H. sinensis* Dixon, Sci. Rep. Natl. Tsing Hua Univ., ser. B, Biol. Sci. 2: 117. 1936. — *H. tortula* (Schwaegr.) Hampe, Bot. Zeitung (Berlin) 4: 267. 1846.

Plants with sporophytes to 3 cm high, yellowish green, in dense tufts. **Stems** erect, simple or branched; central strand absent. **Leaves** involute to subtubulose when dry, erect- to wide-spreading when moist, oblong-ovate to oblong-spathulate, 1.7-3.0 mm long and 0.6-0.8 mm wide, broadly acute to obtusely apiculate, slightly reflexed at the base; margin serrate in the upper half; **costa** stout, percurrent to shortly excurrent; upper leaf cells small, subquadrate to rounded hexagonal, 5-8 μm in diameter, somewhat thick-walled, slightly mammillose on the ventral surface; basal cells rectangular, 30-50 μm long and 15-30 μm wide, pale or hyaline. **Dioicous**. **Seta** ca. 10-15 mm long, yellowish green to reddish brown, not twisted. **Capsule** erect, cylindrical; **operculum** conic-rostrate with long beak. **Calyptra** cuculate (Fig. 5.39, 5.96).

Thailand.— NORTHERN: Mae Hong Son, Chiang Mai, Chiang Rai, Tak, Phitsanulok; EASTERN: Khon Kaen; SOUTH-WESTERN: Kanchanaburi, Ratchaburi; CENTRAL: Bangkok, Nakhon Nayok; SOUTH-WESTERN: Chanthaburi; PENINSULAR: Chumphon, Trang.

Distribution.—China, Japan, Nepal, India, Myanmar, Vietnam, Indonesia, Russia, Europe, South and North America, and Ocenia.

Ecology. — On rocks or soil.

Specimens examined. — *S. Chantanaorrapint 606, 719* (BCU).

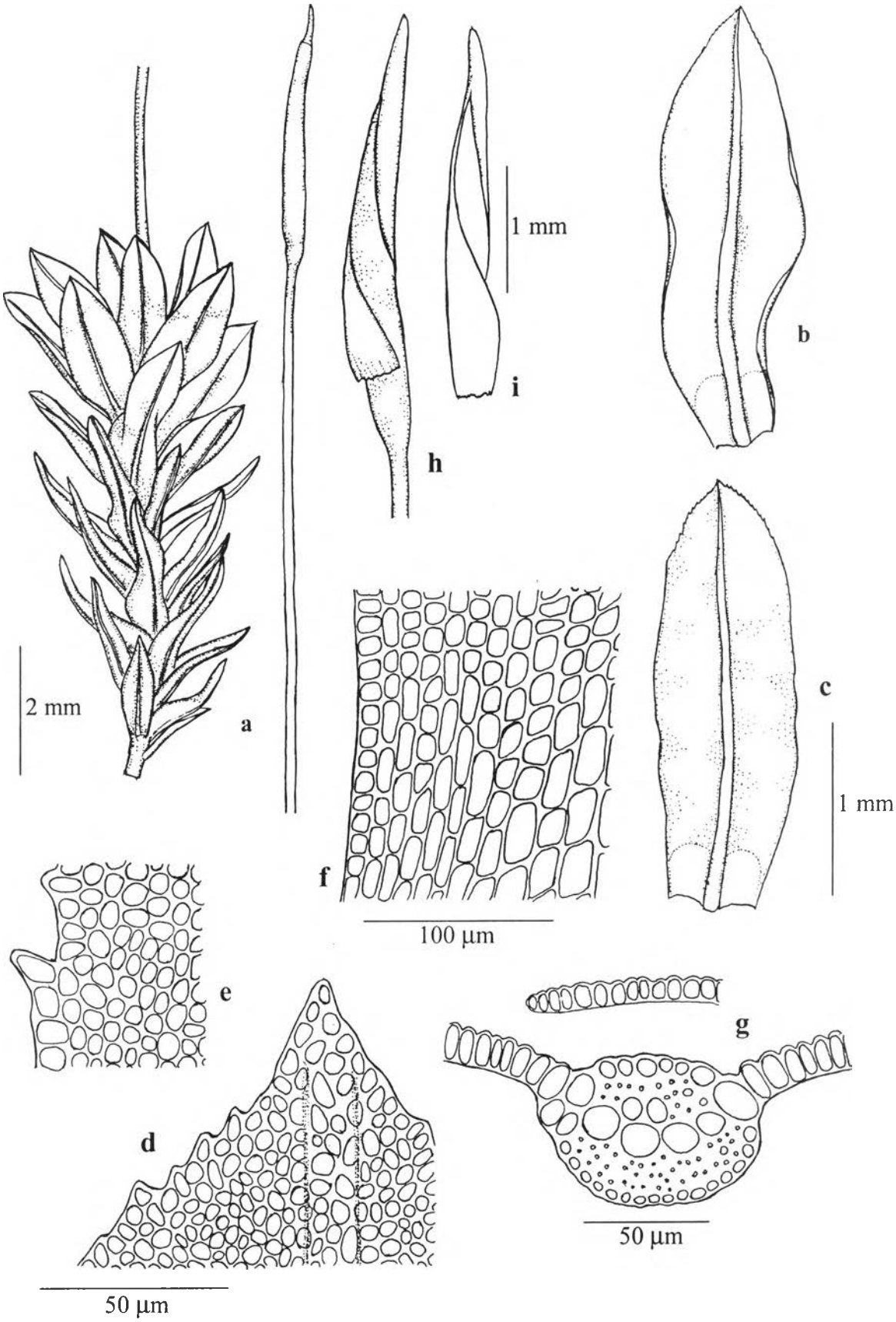

Figure 5.39 *Hyophila involuta* (Hook.) Jeag.
a. habit; b., c. leaves; d. cells at leaf apex; e. cells at leaf margin; f. cells at leaf base; g. cross-section of leaf; h. capsule; i. calyptra. Based on *S. Chantanaorrapint 606*.

RACOPILACEAE

Plants small to medium sized. **Stems** prostate and creeping, pinnately branched and rather complanate, bearing 3 or 4 rows of leaves, 2 lateral and 1 or 2 on the upper side usually smaller, densely tomentose on the under side, with tufts of rhizoids sprouting from nearly the base of each lateral leaf; lamina cells hexagonal to quadrate, smooth or with a papilla; **costa** excurrent or not reaching the apex. **Seta** long. **Capsule** cylindrical, inclined or erect; annulus broad, separeting; **operculum** conical, rostrate; **peristome** double. **Calyptra** hairy. Apparently usually dioecious with dwarf male plant.

RACOPILUM

Racopilum P. Beauv., Prodr. p. 36. 1898; Catches., Mosses of South Australia: 291. 1980; T.J. Kop. & D.H. Norris, Acta Bot. Fenn. 133: 86. 1986; Nog., Illustrated Moss Flora of Japan 3: 543. 1989.

Stems elongate, creeping, with dense rhizoids on the ventral side, in cross-section with a central strand. **Leaves** 3 or 4 rows, usually dimorphic. **Lateral leaves** twisted when dry, spreading when moist, ovate-lanceolate to oblong-ovate, somewhat asymmetrical, rounded to widely acute; margin plane, entire or several small teeth above; **costa** stout, excurrent as a long arista. **Dorsal leaves** suberect, ovate to triangular, symmetric, acute; **costa** excurrent; margin serrulate or subentire above; median lamina cells rounded-hexagonal or subquadrate, thin-walled; upper cells smaller. **Perichaetia** on stem, with rhizoids at base; inner perichaetial leaves ovate, acuminate at apex; **costa** long-excurrent; paraphyses numerous. **Seta** elongate. **Capsule** inclined or suberect, cylidrical, apophysis indistinct, striate when dry; stoma present; annulus in 2 rows of small cells; **operculum** conic; **peristome** double; exostome teeth linear-lanceolate, papillose; endostome segments large, strongly perforate or clefted into 2 division, the cilia long.

Racopilum cuspidigerum (Schwägr.) Ångstr.

Öfv. K. Vet. Akad. Förh. 29(4): 20. 1872: T.J. Kop. & D.H. Norris, Acta Bot. Fenn. 133: 87, fig. 3. 1986. — *Hypnum cuspidigerum* Schwaegr. in Gaud. in Freyc., Voyage Aut. Monde Oranie Phys. Bot. 229. 1828. — *R. ambonense* Broth., Philipp. J. Sci. Bot. 12: 79. 1917. — *R. brevisetum* Bartr., Bishop Mus. Oc. Pap. 19: 226. 1948. — *Powellia bervisetum* (Bartr.) Zant., Jaarb. Konink. Bot. Ver. 1969: 56. 1969.

Plants small to medium, loosely caespitose or in mats, light to dark green. **Stems** 1-2 cm long, pinnately branching: branches perpendicular to the main stem. Rhizoids arising along the abaxial insertion of the leaf; cortex 1-2 rows of cells, central strand present, epidermal cells with equally thick-walled. **Leaves** dimorphic; **lateral leaves** 1.2-1.5 mm long and 0.4-0.8 mm wide, complanate, slightly asymmetric, twisted when dry, spreading when moist, ovate-lanceolate; leaf apex acuminate and setaceous; margin plane, not bordered, nearly entire or crenulate; dosal leaves smaller, narrowly triangular from ovate base, acuminate; **costa** concolourous, long excurrent or not reaching the apex in small leaves; **lamina cells** isodiametric, hexagonal or elongate, thin-walled or equally thickened, 10-25 μm long, 10-15 μm wide, smooth; basal laminal cells not differentiated or rectangular. **Dioicous**.

Perichaetia lateral in leaf axils of main stems, inner perichaetial leaves ovate-lanceolate, long setaceous. **Seta** ca. 2 cm long. **Capsule** inclined to erect, 2.5-3.0 mm long, striate when dry or nearly smooth, apophysis differentiated; annulus slightly differentiated; **operculum** conical, with oblique beak; **peristome** double, exostome striated below, papillose above; endostome, segments perforated, basal menbrane high. **Calyptra** hairy (Fig. 5.40, 5.97).

Thailand. — NORTHERN: Chiang Mai, Lamphun, Tak, Phitsanulok; EASTERN: Nakhon Ratchasima; SOUTH-WESTERN: Ratcha Buri; CENTRAL: Nakhon Nayok; SOUTH-EASTERN: Chanthaburi.

Distribution. — Borneo, Celebes, Mainland China, India, Java, Kampuchea, Laos, Myanmar, Nepal, Philippines, Vietnam.

Ecology. — On declay woods and humus rocks.

Specimens examined. — *S. Chantanaorrapint 598, 637, 673* (BCU).

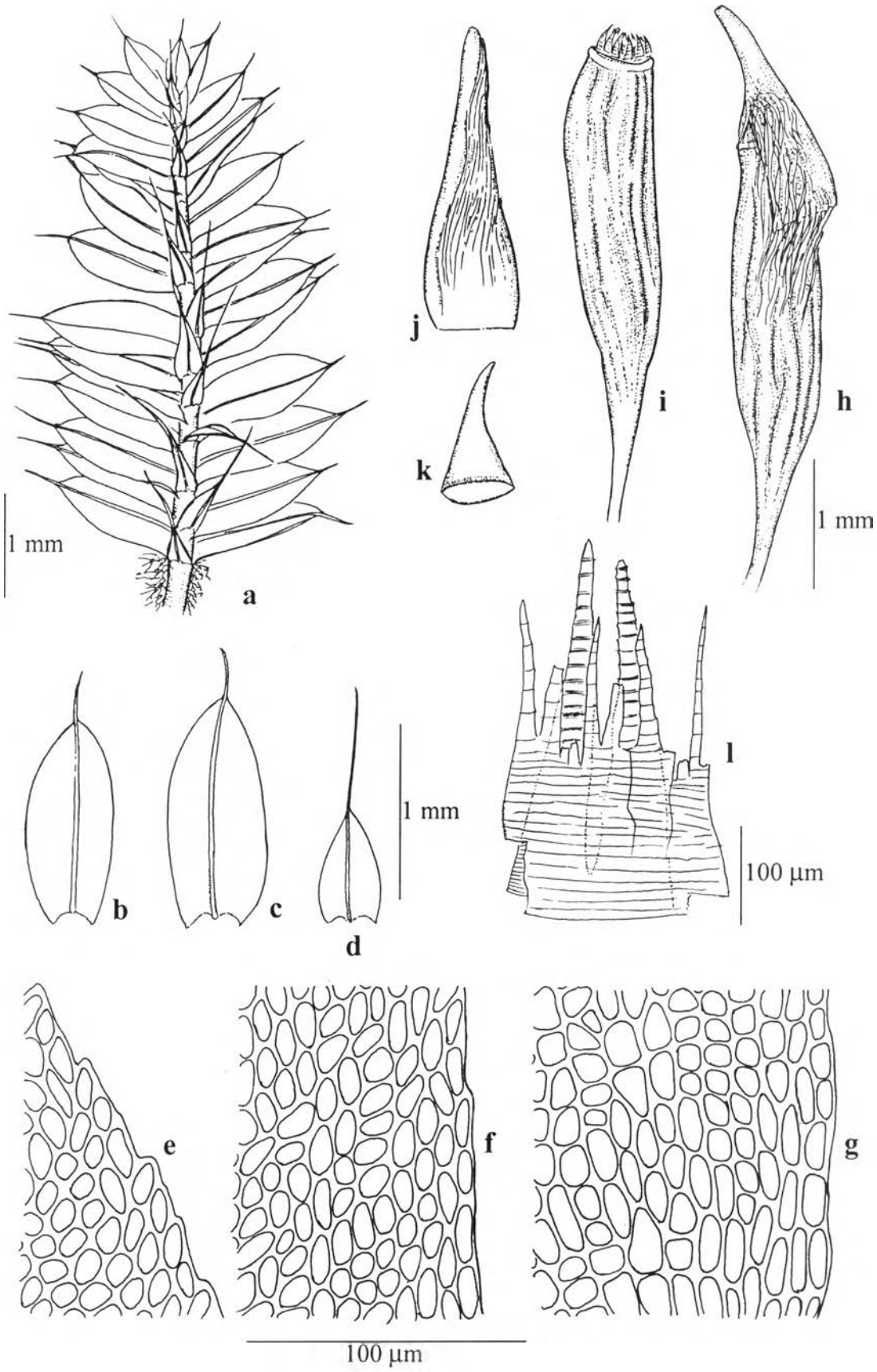

Figure 5.40 *Racopilum cuspidigerum* (Schwägr.) Ångstr.
a. habit; b., c. leaves; d. amphigastria; e. cells at leaf apex; f. cells at leaf leaf median; g. cells at leaf base; h., i. capsules; j. calyptra; k. operculum; l. peristome teeth. Based on *S. Chantanaorrapint 598*.

RHIZOGONIACEAE

Plants medium to roboust, in lax or close tufts of erect or flexuose shoots, densely tomentose below. **Stems** with central strand, more or less uniformly covered by leaves without comal aggregation. **Leaves** complanate with 2 rows or radially with several rows, erect-spreading, linear-lanceolate or ovate-oblong; margin flat, usually dentate, often thickened at the border; **costa** strong, excurrent, often spinose on back, with 1 or 2 stereid bands in cross-section; **leaf cells** thick-walled, small, rounded to irregularly hexagonal, usually smooth. **Seta** long, lateral from nearly base. **Capsule** inclined to horizontal, ovate to cylindrical; **peristome** double; exostome composed of 16 lanceolate undivided teeth, densely articulate and internally transversely trabeculate; endostome thin, pale; **operculum** conic to rostrate. **Calytra** cuculate, smooth.

PYRRHOBRYUM

Pyrrhobryum Mitt., J. Linn. Soc. Bot. 10: 174. 1868; A. Eddy, A Handbook of Malesian Mosses, vol. 3: 204, 1996.

Plants medium-sized to robust, forming tufts, olive-green or brownish. **Stems** erect, from dense rhizoidal mats, central strand well-developed. **Leaves** radially arranged, stiff, spreading, linear-lanceolate, bordered and dentate; **lamina cells** isodiametric, smooth. **Perigonia** and **perichaetia** on small branches from vegetative stems; bracts strongly modified. **Seta** long, usually overtopping stems. **Capsule** horizontal with distinct apophysis and conical lids; **peristome** typically bryoid with tall, trabeculate and internally lamellate exostome; endostome with tall basal membrane, processes as tall as exostome; cilia present, appendiculate or not. **Calyptra** cuculate.

Pyrrhobryum spiniforme (Hedw.) Mitt.

J. Linn. Soc. Bot. 10: 174. 1868; Acta Bot. Fenn. 133: 17. figs. 8a-h. 1986; A. Eddy, A Handbook of Malesian Mosses, vol. 3: 206, fig. 472, 1996.— *Hypnum spiniforme* Hedw., Spec. Musc. 236. 1801.— *Rhizogonium spiniforme* (Hedw.) Bruch in Krauss, Flora 29: 134. 1846.

Plants robust, olive-green, usually laxly tufted mainly unbranched. **Stems** up to 6 cm long, naked above but densely rhizoidal at base. **Leaves** patent, narrow at base and gently upcurved, very variable in length; lower mostly vestigial, becoming lanceolate, middle and upper narrowly linear and finely tapered to serrate subulate, up to 7 mm long , 0.8 mm wide; margin thickened, double-serrate; apex gradually tapered, subulate; **costa** stout, percurrent to excurrent, toothed in the upper part on dorsal side, in cross-section shallowly convex on the adaxial side, strongly convex bolow, with 2 stereid bands; superficial cells forming a distinct epidermal layer; **lamina cells** uniform, unistratose, rounded-quadrate with evenly thick-walled, smooth, 10-15 μm in diameter; marginal cells bistratose, sometimes slightly elongate. **Synoicous**. **Perichaetia** basal on stems, bud-like; outer leaves triangular-ovate to triangular-lanceolate; inner leaves brownish, acute to acuminate from a broad ovate base, margin toothed by single teeth; back of costa toothed distally; cells in ovate part rectangular, thin-walled, 80-120 μm long, 20 μm wide, cells in tapering part short-

rectangular to quadrate, thick-walled, similar to lamina cells of vegetative leaf. **Seta** very long up to 8 cm, brownish, smooth. **Capsule** inclined to horizontal, curved and gibbose, 3.5-4.5 mm long and ca. 1.5 mm wide; apophysis rather indistinct demarcated; **peristome** typical of the genus; **operculum** conical to rostrate. **Calytra** cuculate, smooth (Fig. 5.41, 5.98).

Thailand.— NORTHERN: Phitsanulok; NORTH-EASTERN: Loei; EASTERN: Nakhon Ratchasima; CENTRAL: Nakhon Nayok; SOUTH-EASTERN: Chanthaburi, Trat; PENINSULAR: Nakhon Si Thammarat, Satun, Surat Thani.

Distribution.— Borneo, Celebes, Mainland China, India, Japan, Java, Kampuchea, Korea, Malaysia, Myanmar, Nepal, New Guinea, Philippines, Sikkim, Sri Lanka, Sumatra, Taiwan, and Vietnam.

Habitat.— On tree trunks and rocks.

Specimens examined.— *S. Chantanaorrapint 154, 661, 699, 740* (BCU); *M.-J. Lai 90111636, 90122104* (BRU).

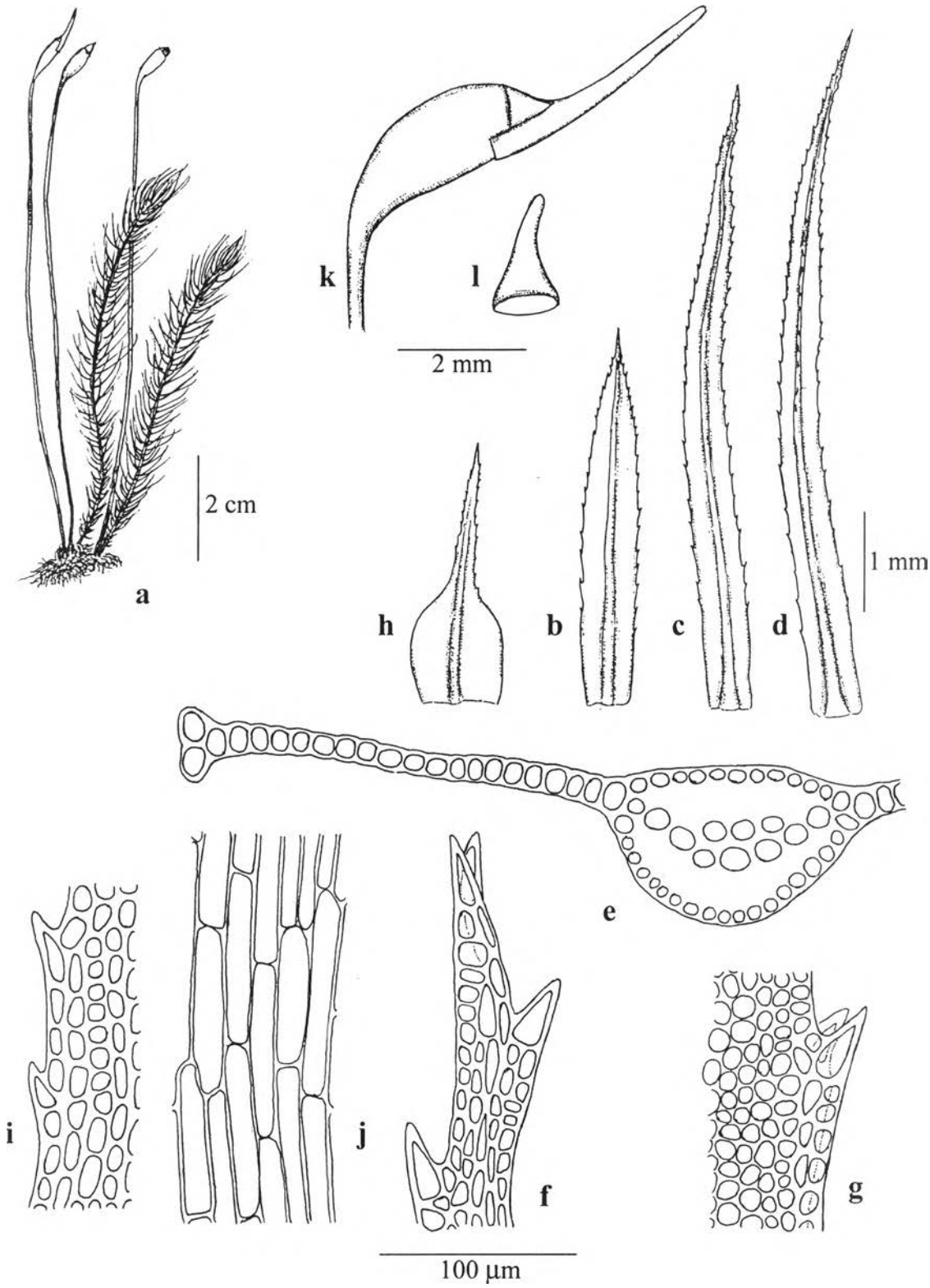

Figure 5.41 *Pyrrhobryum spiniforme* (Hedw.) Mitt.
a. habit; b.-d. leaves; e. cross-section of leaf; f. cells at leaf apex; g. cells at leaf margin; h. perichaetial leaf; i. upper perichaetial leaf cells; j. basal sheath cells of perichaetial leaf; k. capsule; l. operculum. Based on *S. Chantanaorrapint 699*.

SEMATOPHYLLACEAE

Plants various in sized, pale, robust, slender, in dense mats or tufts. **Stems** creeping or ascending, often pinnate or irregularly branched, without amphigastria, paraphyllia absent. **Leaves** ovate, lanceolate, mostly acuminate; **costa** absent or slightly short or double; leaf cells linear or elongate-rhomboid, smooth or papillate over the lumen; **alar cells** well-developed, large, few in number, often inflated, usually coloured, sometimes concolourous, thick-walled. **Seta** elongate, smooth or rough or papillose above. **Capsule** rather small, ovoid to cylindric, inclined or horizontal, rarely erect; **operculum** rostrate to conic, slenderly beaked; **peristome** double; exostome linear-lanceolate, composed of 16, thin, transversely barred. **Calytra** cuculate, smooth or rough above.

ACROPORIUM

Acroporium Mitt., J. Linn. Soc., Bot. 10: 182. 1868; Gangulee, Mosses of Eastern India and Adjacent Regions, Fascicle 8: 1875. 1980.

Plants slender to robust, glossy, in dense deep tufts or mats. **Branches** numerous, suberect, rather stiff, densely foliated, frequently cuspidate at tips. **Leaves** erect spreading, ovate-lanceolate, linear, acuminate, subentire; **costa** absent; leaf cells elongate, smooth or somewhat scabrous; alar cells few but large, inflated and coloured. **Seta** slender, smooth or papillose above. **Capsule** small, inclined to horizontal; exostome teeth transversely striate, with a narrow median furrow; **operculum** rostrate, with a needle-like beak.

Key to species

1. Seta smooth above. Leaves ovate, long-acuminate.....1. *Acroporium* sp.1

1. Seta papillose above. Leaves ovate, short-acuminate.....2. *Acroporium* sp.2

1. ***Acroporium* sp. 1**

Plants rather large, golden green in deep tufts. **Stems** erect, irregularly branched, cuspidate at the tips. **Leaves** horizontal spreading, crowded, ovate, widest at base, long-acuminate or narrowly acuminate, ca. 2.0-2.3 mm long and 1.0-1.2 mm wide; leaf margin entire or inflexed; leaf cells linear, incrassate, porose, 40-60 μm long and 4 μm wide, smooth; **alar cells** 3-4, large, inflated, thick-walled, deep brown or sometimes hyaline. **Seta** ca. 2 cm long, smooth. **Capsule** obovate-cylindric, inclined or suberect, ca. 1.2 mm long and 0.7 mm wide; **exostome** teeth linear-lanceolate, with a narrow median furrow, transversely striate; **operculum** not found (Fig. 5.42). **Calyptra** not found.

Thailalnd. —
Distribution. —
Ecology. — On slope of moist sandy-soil.
Specimens examined. — *S.Chantanaorrapint 505, 569, 626* (BCU).

Acoporium **sp.2**

Plants small to medium sized, glossy, bright green to brownish green, in dense mats. **Stems** creeping, irregularly pinnate branched, suberect, cuspidate at the tips. **Leaves** crowded, ovate to oblong-ovate, widest at base, short-acuminate or widely acuminate, ca. 1.8-2.0 mm long and 0.7-0.8 mm wide; leaf margin entire or inflexed; leaf cells linear, porose, thin-walled, 40-60 μm long and 4 μm wide, smooth; **alar cells** 3-4, large, inflated, thick-walled, deep brown or sometimes hyaline. **Seta** ca. 1.5 cm long, papillose above, smooth below. **Capsule** small, cylindrical, inclined or suberect, ca. 0.9 mm long and 0.6 mm wide; **exostome** teeth linear-lanceolate, with a narrow median furrow, transversely striate; **operculum** rostrate. **Calyptra** cuculate, smooth (Fig. 5.43).

Thailalnd. —
Distribution. —
Ecology. — On tree trunks or branches.
Specimens examined. — *S. Chantanaorrapint 625, 683* (BCU).

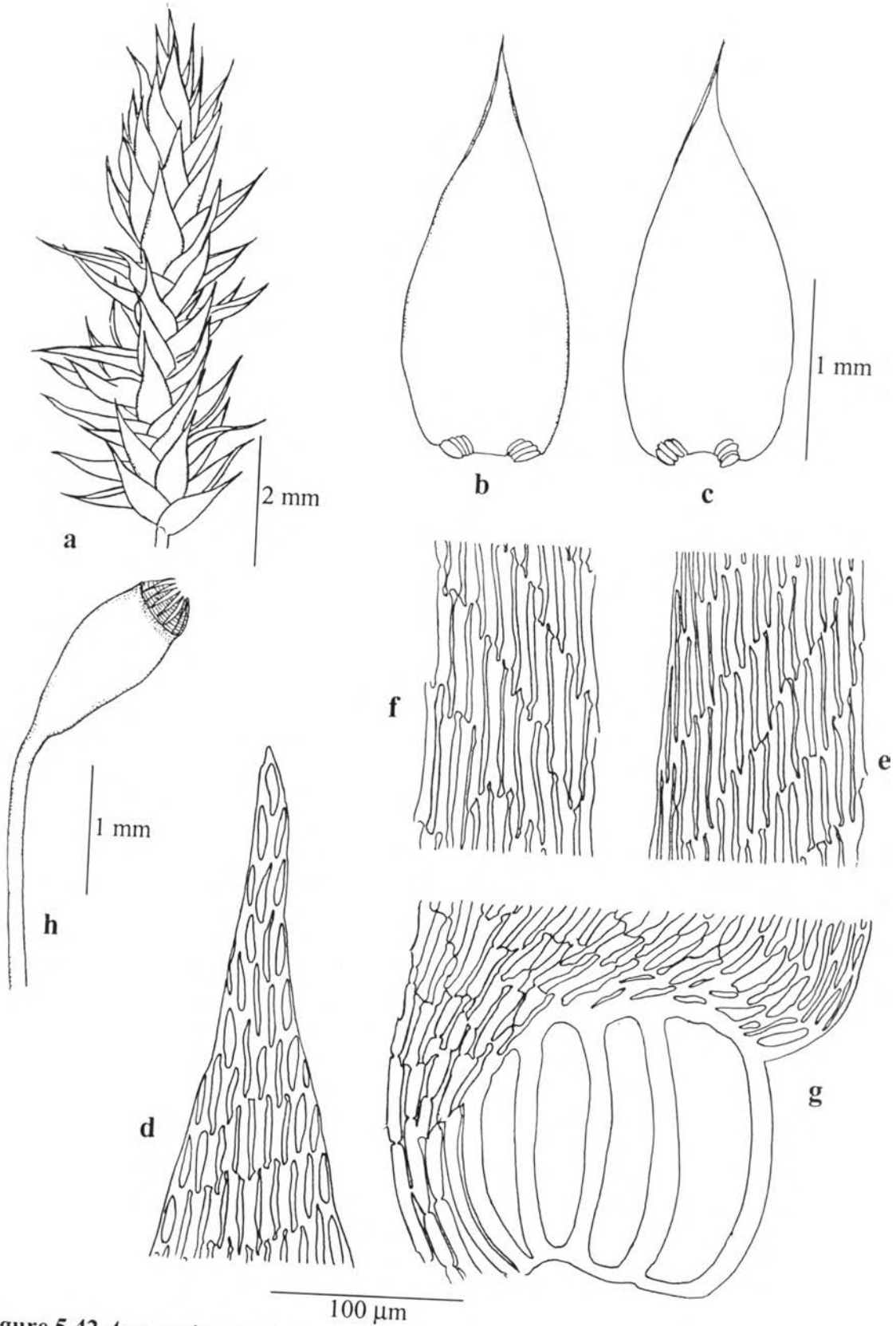

Figure 5.42 *Acroporium* sp.1
a. Shoot; b., c. leaves; d. cells at leaf apex; e. cells at leaf margin; f. cells at leaf median; g. cells at leaf base; h. capsule. Based on *S. Chantanaorrapint 626.*

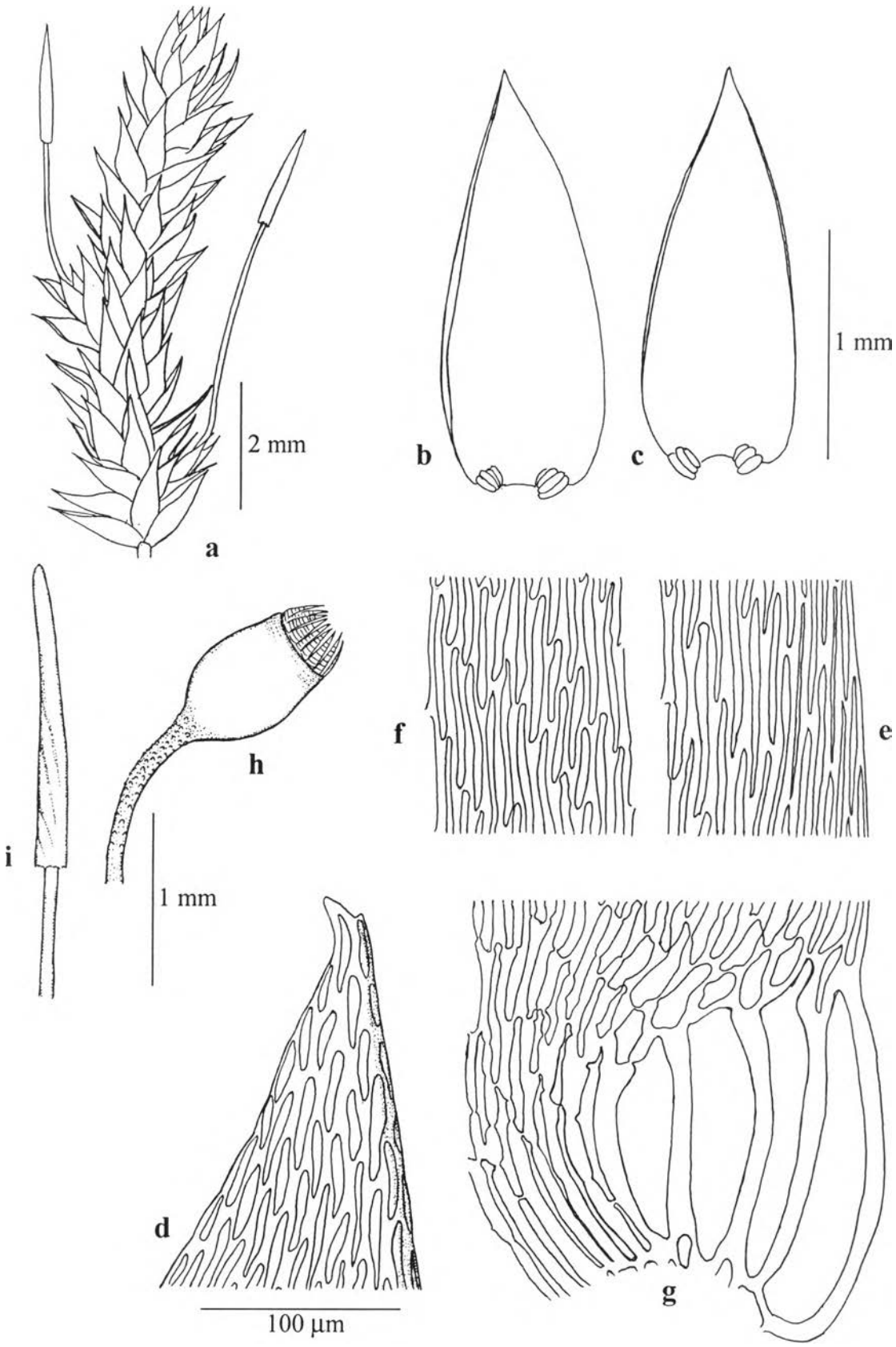

Figure 5.43 *Acroporium* sp.2
a. Shoot; b., c. leaves; d. cells at leaf apex; e. cells at leaf margin; f. cells at leaf median; g. cells at leaf base; h. mature capsule; i. young capsule cover by calyptra. Based on *S. Chantanaorrapint 625.*

CLASS HEPATICOPSIDA

Key to the families

1. Plants thalloid form.
    2. Rhizoids dimorphic, smooth-walled and peged rhizoid.....Marchantiaceae
    2. Rhizoids monomorphic, smooth-walled.....Pallaviciniaceae
1. Plants leafy form.
    3. Leaves succubous to transverse.
        4. Underleaves lacking
            5. Leaves bilobed or emarginated, magin entire.....Jungermanniaceae
            5. Leaves rarely bilobed, margin entire or dentate.....Plagiochilaceae
        4. Underleaves present
            6. Underleaves usually connate with lateral leave at base....Geocalyaceae
            6. Underleaves remote, never connate with lateral leaves..... .....Jungermanniaceae
    3. Leaves incubous.
        7. Underleaves lacking
            8. Rhizoids only locally restricted on leaf-lobule; lobules inflated, not forming water sac.....Radulaceae
            8. Rhizoids absent on leaf-lobules; lobules deeply concave and forming hooded water sac.....Pleuroziaceae
        7. Underleaves present
            9. Lobules usually differentiated.
                10. Lobules forming water sac, helmet-shaped or galeate; rhizoids restricted to the central part of underleaves.....Frullaniaceae
                10. Lobules various in side and shaped, never helmet-shaped usually inflated, rhizoids restricted to the base of underleaves..... .....Lejeuneaceae
            9. Lobules undifferentiated.

11. Underleaves similar to lateral leaves.....Herbertaceae

11. Underleaves difference from lateral leaves.....Lepidoziaceae

FRULLANIACEAE

Plants small to robust, bright to dark green, or reddish brown. **Stems** irregularly branched. **Rhizoids** restricted to the central portion of underleaves. **Lateral leaves** incubous; **leaf-lobe** usually ovate, margin entire, rarely dentate; leaf-cells usually nodulose-walled, trigones large; **leaf-lobule** usually saccate, rarely explanate; stylus often present. **Underleaves** usually rounded, entire or bilobed, margin entire or dentate. **Monoicous** or dioicous. **Androecia** usually on short lateral branch. **Gynoecia** with 2-4 pairs of bracts; bract usually larger than leaf, innermost bracts connate to bracteole or not, margin entire to dentate. **Periant** usually inflate, sharply 3-5-keeled. **Capsule** spherical, seta short.

FRULLANIA

Frullania Raddi, Atti Soc. Ital. Modena. 18: 20. 1818; Kamim., J. Hattori Bot. Lab. 24: 12. 1961.

Plants small to large, reddish brown to blackish. **Stems** prostrate, pinnately branched; branches replacing the lobule of leaf. **Lateral leaves** imbricate; **leaf-lobe** ovate to suborbicular, entire; cells with thick-walled and well marked trigones, often with intermediate thickening, ocelli sometimes present; **leaf-lobule** cuculate, campanulate, cylindrical or clavate, attached to the stem by a stalk-like base and to the lobe by a keel; stylus small. **Underleaves** bilobed. **Androecia** globose to ellipsoid; bracts in 2-5 pairs or more bracteoles limited to the base of androecium or absent. **Gynoecia** terminal on main branch, lacking subfloral innovations or rarely with 1; female bracts 2-5 pairs;' bracteole free or connate to bracts. **Perianth** usually inflated, smooth or sometimes with tubercules or scales, typiclly 3-keeled, sometimes with additional keels

Key to species

1. Leaf-lobules cylindrical or clavate, usually longer than wide.

   2. Plants small; underleaves ca. 2.0-2.5 times as wide as stem.....1. *F. apiculata*

   2. Plants large; underleaves widely reniform, more than 4 times as wide as stem .....4. *F. gaudichaudii*

1. Leaf-lobules galeate or helmet-shaped, almost as long as wide.

   3. Leaf-lobules strongly asymmetric, inner portion much larger..... .....5. *F. wallichina*

   3. Leaf-lobules symmetric, outer portion and inner portion almost equal.

4. Leaf-lobes strongly squarrose when moist; underleaves obovate, 2.0-2.5 as wide as stem.....3. *F. ericoides*

4. Leaf-lobes not squarrose; underleaves reniform, more than 3 times as wide as stem.....2. *F. berthoumieui*

1. ***Frullania apiculata*** (Reinw. et al.) Dumort.

Rec. d'Obs.: 13. 1835; S. Hatt., J. Hattori. 36: 109, figs. 1-3; 420, fig. 6. 1972; 38: 224, figs. 107-108. 1974; 39: 278. 1975; 47: 104, fig. 228(a-g). 1980. — *Junggermannia apiculata* Reinw. et al., Nova Acta 12: 222. 1824. — *F. apiculata* fo. *warburgii* Verd., Ann. Br. Suppl. 1: 101. 1930. — *F. apiculata* fo. *aculeata* Verd., Ann. Br. Suppl. 1: 101. 1930. — *F. apiculata* var. *obtusata* S. Hatt., J. Jap. Bot. 53(2): 129. 1958. — *F. apiculata* subsp. *kaindimontana* S. Hatt., J. Hattori Bot. Lab. 36: 417, figs. 4-5. 1972. — *F. pacificae* Tayl., London J. Bot. 5: 406. 1846. — *F. densifolia* Steph., Hedwigia 33: 161. 1894. — *F. acutistipula* Steph., Sp. Hep. (Stephani) 4: 550. 1911. — *F. anamensis* Steph., Sp. Hep. (Stephani) 4: 511. 1911. — *F. pandanicola* Steph., Sp. Hep. (Stephani) 6: 553. 1924.

Plants small, reddish-brown. **Stems** 3-5 cm long, bipinnately branched, primary branches ca. 5 mm long, rarely longer and similar to the stem, secondary branches very short, branches widely spreading. **Leaf-lobe** widely spreading, concave with narrowly incurved apex, when flattened ovate, ca. 0.6 mm long, 0.5 mm wide, apices minutely apiculate-acute, dorsal bases truncate without appendage; marginal cells thick-walled, subquadrate, 10-12 × 8-10 μ, median cells 15-20 × 10 μ, basal cells 10-12 × 8-10 μ; cuticle smooth; **leaf-lobule** remote, almost parallel to the stem, cylindrical, with rounded head and widely arched; stylus linear. **Underleaves** remote or rarely contiguous, 2-2.5 times as wide as the stem, when flatten ovate, narrowly recurved along margin, ca. 1/3-bilobed, sinus acute, lobes triangular, acute. **Androecia** not found. **Gynoecium** terminal on stem or short branches; bracts usually 3 pairs, entire, innermost connate to bracteole; perianths obovat to widely clavate, inflated, sharply 3-keeled (2 lateral, 1 ventral), keels smooth, long-beaked (Fig. 5.44, 5.100). **Sporophytes** not found.

Thailand. — NORTHERN: Chiang Mai; NORTH-EASTERN: Loei; EASTERN: Nakorn Ratchasrima; SOUTH-EASTERN: Trat; PENINSULAR: Trang.

Distribution. — Widely distributed in tropical Asia.

Ecology. — On tree trunk.

Specimens examined. — *S. Chantanaorrapint 257, 268, 271, 273, 287, 612* (BCU).

2. ***Frullania berthoumieui*** Steph.

Hedwigia 33:140. 1894; S. Hatt., J. Hattori Bot. Lab. 38:188, figs. 87, 88. 1974. — *F. fauriana* Steph., Sp. Hept. (Stephani) 4: 402. 1910.

Plants medium, olive-green. **Stems** prostrate, 2-3 cm long, with leaves 2.2-2.5 mm wide, irregularly pinnately branched. **Rhizoids** numerous. **Lateral leaves** widely spreading; **leaf-lobe** slightly convex, oblong-ovate, ca. 1.1-1.3 mm long, 0.9-1.0 mm

wide, apex obtuse to rounded, dorsal base with rounded appendages, apex obtuse to rounded, usually incurved, margin entire; marginal cells 25-30 × 20-25 μm, median cells 30-35 × 25-30 μm, thick-walled, more or less nodulose intermediate thickening, basal cells up to 50 μm, thin-walled, trigones large, nodulose; cuticle smooth; **leaf-lobule** symmetric, helmet-shaped. **Underleaves** remote to contiguous, nearly flat, appressed to stem, reniform, ca. 3 times as wide as stem, strongly convex at rhizoid-initial area, margin crenulate, ca. 1/3-bilobed, sinus narrow to wide, obtuse to rounded, lobes acute. **Androecia** not found. **Gynoecia** terminal on stem and branches, usually with subfloral innovations (Fig. 5.45). **Perianth** not found.

Thailand. — NORTHERN: Chiang Mai; EASTERN: Nakorn Ratchasrima; SOUTH-EASTERN: Trat.

Distribution. — Nepal, Burma, Ambon, Borneo, Philippines.

Ecology. — On tree trunks.

Specimens examined. — *S. Chantanaorrapint 197, 399* (BCU).

3. ***Frullania ericoides*** (Nees) Mont.

Ann. Sci. Nat. Bot. sér 2, 12: 51. 1839.

Plants medium, olive-green to brown. **Stems** prostrate, 2-3 cm long, with leaves 2.0-2.4 mm wide, irregularly pinnately branched. **Rhizoids** numerous. **Lateral leaves** widely spreading; **leaf-lobe** squarrose, widely ovate to nearly rounded, ca. 1.0-1.2 mm long, 1.0-1.2 mm wide, apex rounded, dorsal base with rounded appendages, margin entire; marginal cells subquadrate 20-25 μm, median cells 30-35 × 25-30 μm, thick-walled, more or less nodulose intermediate thickening, basal cells 40-45 × 30 μm, thin-walled, with intermediate thickening, trigones large, nodulose; cuticle smooth; **leaf-lobule** symmetric, helmet-shaped. **Underleaves** remote, inflat, obovate, ca. 2-2.5 times as wide as stem, strongly convex at rhizoid-initial area, margin recurved, ca. 1/5 -1/4-bilobed, sinus acute or obtuse, lobes acute. **Gemmae** present on leaf surface, globose (Fig 5.46). **Fertile plants** not found.

Thailand. — NORTHERN: Mae Hong Son, Chiang Mai, Chiang Rai, Lamphang, Phitsanulok; EASTERN: Nakorn Ratchasrima; SOUTH-WESTERN: Kanchanaburi; PENINSULAR: Phangnga, Nakorn Si Thammarat.

Distribution. — Widely distributed in warm-temperate to tropical regions of the world.

Ecology. — On tree trunk.

Specimens examined. — *S. Chantanaorrapint 398* (BCU).

4. ***Frullania gaudichaudii*** Nees & Mont.

In Gottsche et al., Syn. Hepat.: 435. 1845; S. Hatt., J. Hattori Bot. Lab. 36: 123-128, figs. 10-13. 1972.

Plants large, olive to brownish green. **Stems** up to 10 cm long, with leaves 2.5-3.0 mm wide, regularly bipinately branched. **Rhizoids** not found. **Lateral leaves** widely spreading; **leaf-lobe** ovate, ca. 1.3-1.5 mm long, 1.0-1.2 mm wide, apex obtuse, more or less cordate with both dorsal and ventral appendages at base; the

insertion almost longitudinal and comparatively long; marginal cells subquadrate, ca. 20 × 20 μm, median cells 25-35 × 20 μm, basal cells 50 × 30 μm, thin-walled, trigones and intermediate thickening large, nodulose often, more or less flexuosely confluent; cuticle smooth; **leaf-lobule** small, narrowly helmet-shaped or calvate, parallel to the stem, rarely explanate. **Underleaves** widely reniform, slightly plicate, base cordate, 3-4 times as wide as stem, loosely imbricate to remote, 1/4-bilobed, sinus narrow, lobes subacute to obtuse. **Dioicous. Gynoecia** on short lateral branch, bracts in 2-3 pairs; innermost bract-lobes elongate ovate; lobule 1/2-2/3 connate with the lobe, lanceolate, margin often narrowly recurved, almost entire or with several teeth; innermost bracteole large, as long as the bract-lobule, usually free, or sometimes connate with one bract, more or less 1/2-bilobed, sinus narrow, base inflated. **Perianths** pyriform or ovate-triangular, inflated, obtusely 3-keeled, keel smooth, beak short (Figs. 5.47). **Androecia** and **sporophytes** not found.

Thailand. — PENINSULAR: Nakorn Si Thamarat.

Distribution. — Widely distributed in tropical regions of Asia, Pacific Island, Africa.

Ecology. — On tree trunks and branches.

Specimens examined. — *S. Chantanaorrapint 140, 149, 212, 213, 277, 502* (BCU).

5. ***Frullania wallichina*** Mitt.

J. Proc. Linn. Soc. 5: 118. 1861; S. Hatt., J. Hattori Bot. Lab. 36: 135. 1972.

Plants medium-sized, reddish-brown. **Stems** ca. 2 cm long, with leaves 2.5 mm wide, rather irregularly branched; branches similar to stem. **Rhizoids** numerous, brownish. **Lateral leaves** densely imbricate, widely spreading; **leaf-lobe** obliquely ovate to broadly triangular-ovate, dorsal base with rounded appendage; apex rounded, usually incurved, margin nearly entire or undulate; marginal and median cells subquadrate, 20-25 × 25-30 μm, thin-walled, triangular to more or less nodulose trigones, occasionally intermediate thickening, basal cells 30-35 × 30-35 μm, thin-walled, trigones large, nodulose; cuticle smooth; **leaf-lobule** asymmetric, helmet-shaped, inner portion almost flat, much larger than outer portion, outer portion usually inflated. **Underleaves** imbricate, rotund-reniform, ca. 3 times as wide as stem, appressed, strongly convex at rhizoid-initial area, ca. 1/6-bilobed, sinus wide, obtuse to rounded, lobes acute, base gibbose, appendaged rounded. **Androecia** not found. **Gynoecia** terminal on stems and leading branches; bracts 3-5 pairs, dentate-spinose, innermost connate to bracteole. **Perianth** oblong-ovate, inflate, usually 5-keeled (1 dorsal, 2 lateral, 2 ventral), up to 10 plicate when young, keels smooth (Fig. 5.48, 5.99).

Thailand. — PENINSULAR: Nakorn Si Thamarat.

Distribution. — Himalayas, India, Ceylon, Sumatra, Java, Philippines.

Ecology. — On tree trunks and branches.

Specimens examined. — *S. Chantanaorrapint 345* (BCU).

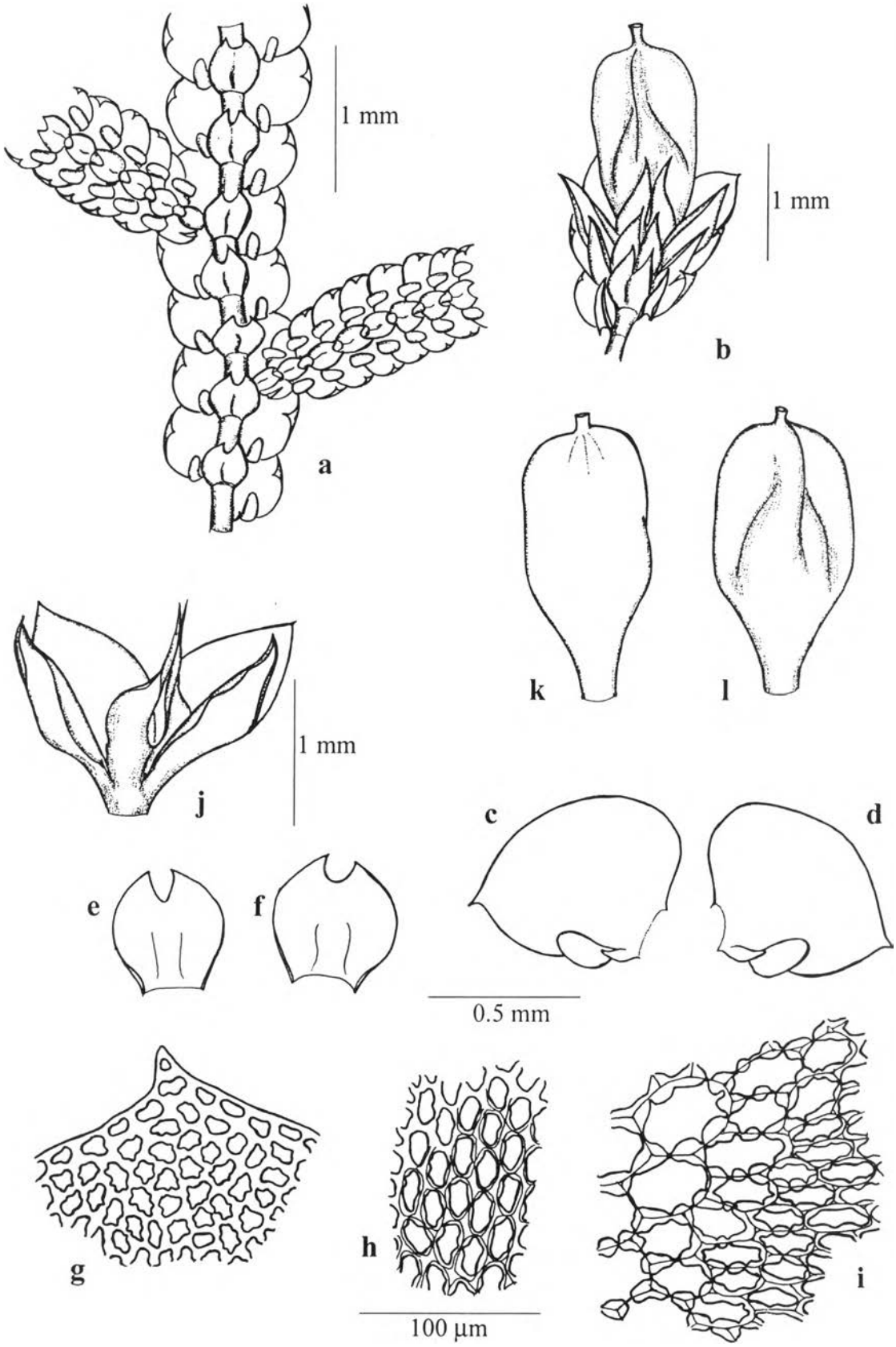

Figure 5.44 *Frullania apiculata* (Reinw. et al.) Dumort.
a. ventral portion of plant; b. gynoecium; c., d. lateral leaves; e., f. underleaves; g. cells at leaf apex; h. cells at leaf median; i. cells at leaf base; k., l. perianth, k. dorsal view, l. ventral view; j. innermost female bracts and bracteole. Based on *S. Chantanaorrapint 271*.

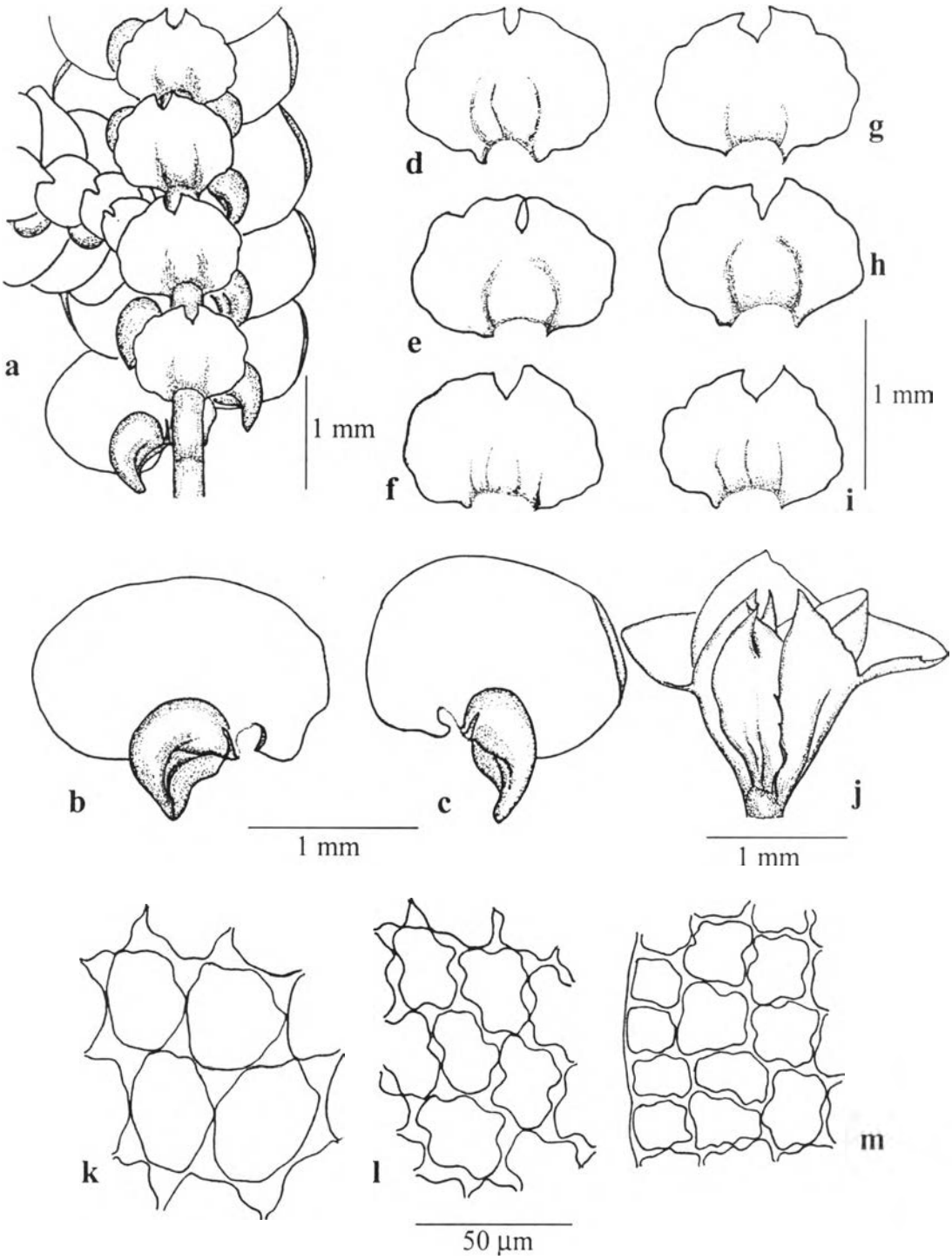

Figure 5.45 *Frullania berthoumieui* Steph.
a. ventral portion of plant; b., c. lateral leaves; d.-i. underleaves; j. young gynoecium; k. cells at leaf apex; l. cells at leaf median; m. cells at leaf base. Based on *S. Chantanaorrapint 197.*

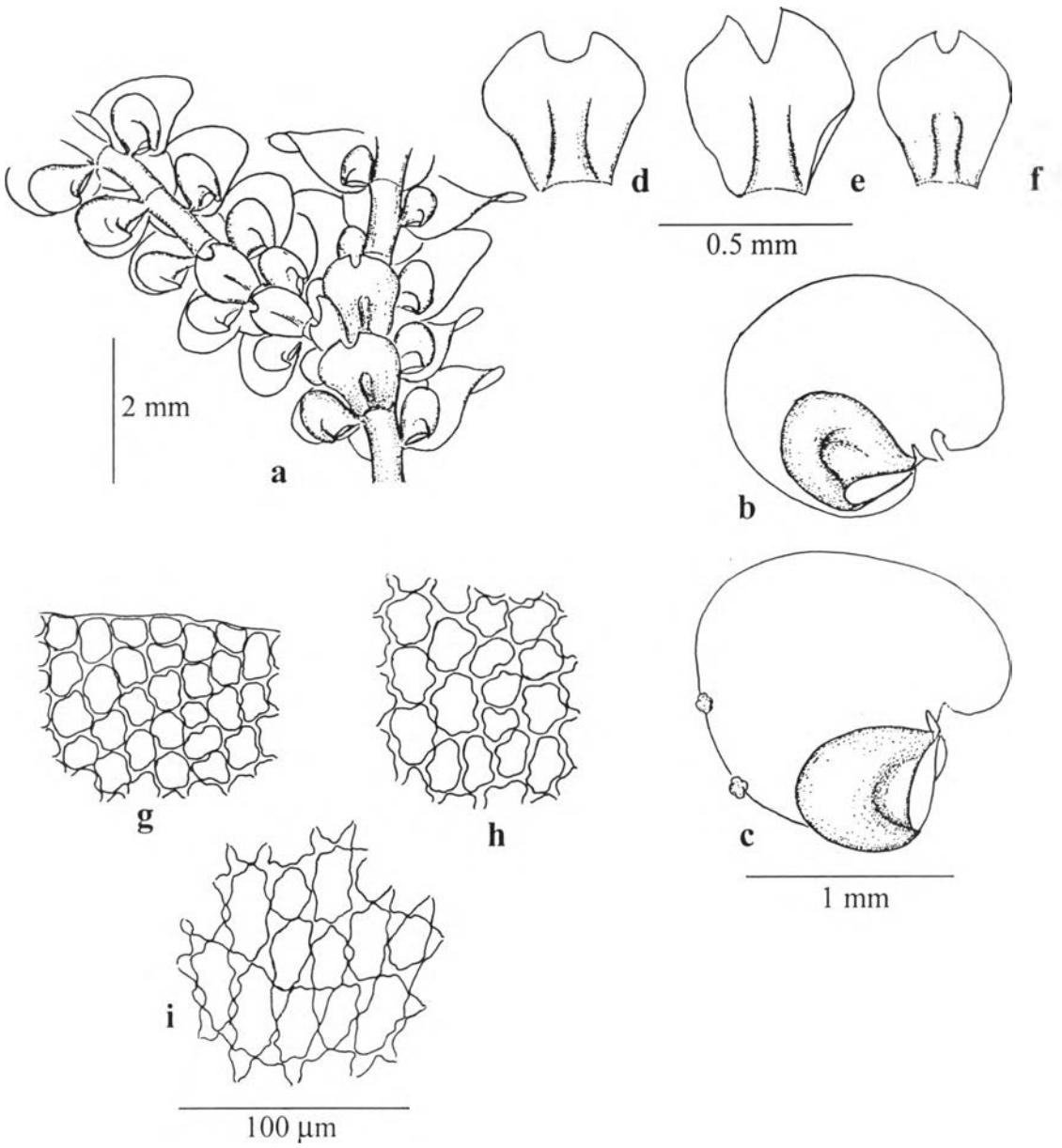

Figure 5.46 *Frullania ericoides* (Nees) Mont.
a. ventral portion of plant; b., c. lateral leaves, c. showing gemmae; d.-f. underleaves; g. cells at leaf apex; h. cells at leaf median; i. cells at leaf base. Based on *S. Chantanaorrapint 398.*

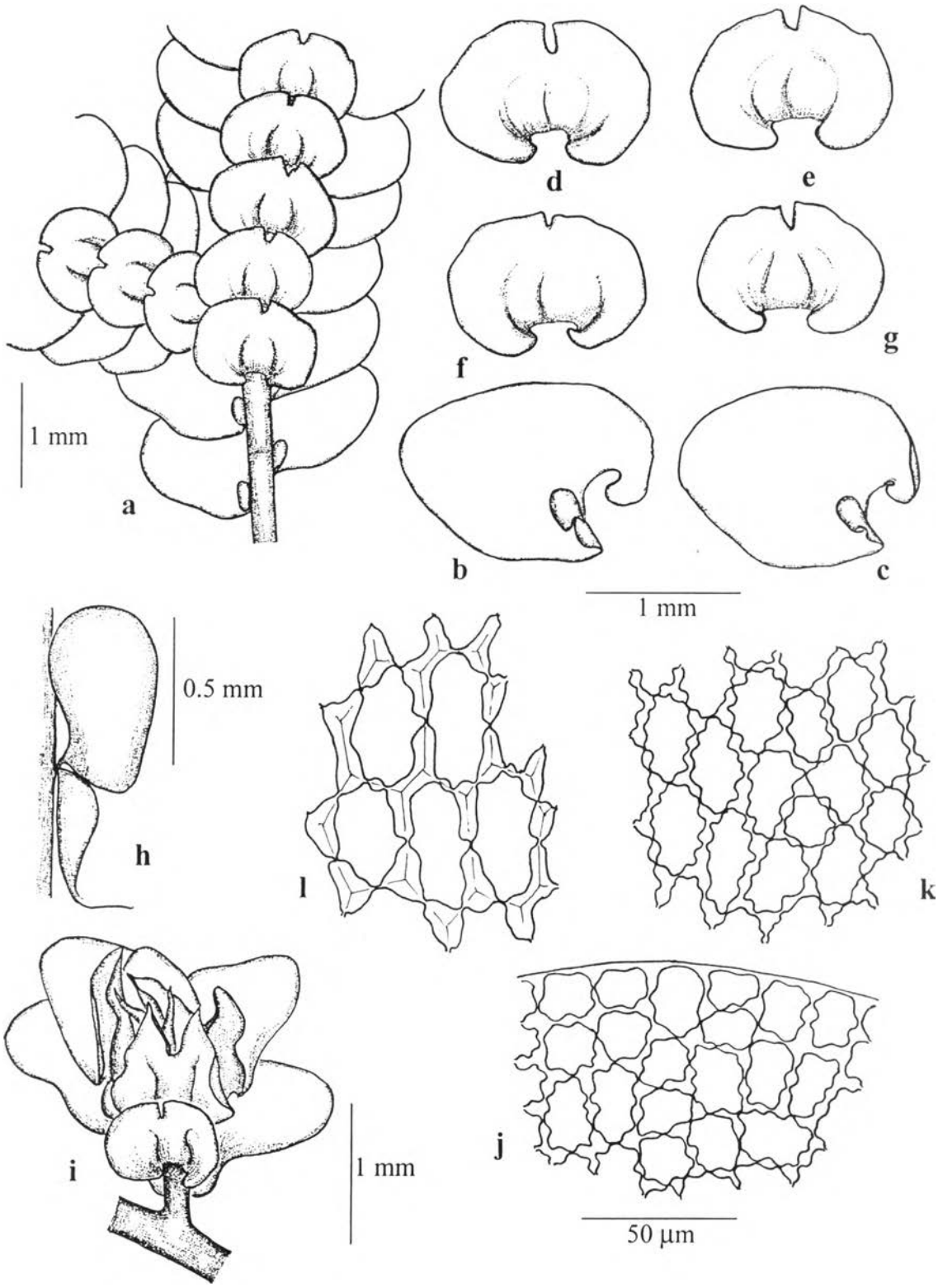

Figure 5.47A *Frullania gaudichoudii* Nees & Mont.
a. ventral portion of plant; b., c. lateral leaves; d.-g. underleaves; h. lobule; i. young gynoecium; j. cells at leaf apex; k. cells at leaf median; l. cells at leaf base. Based on *S. Chantanaorrapint 140*.

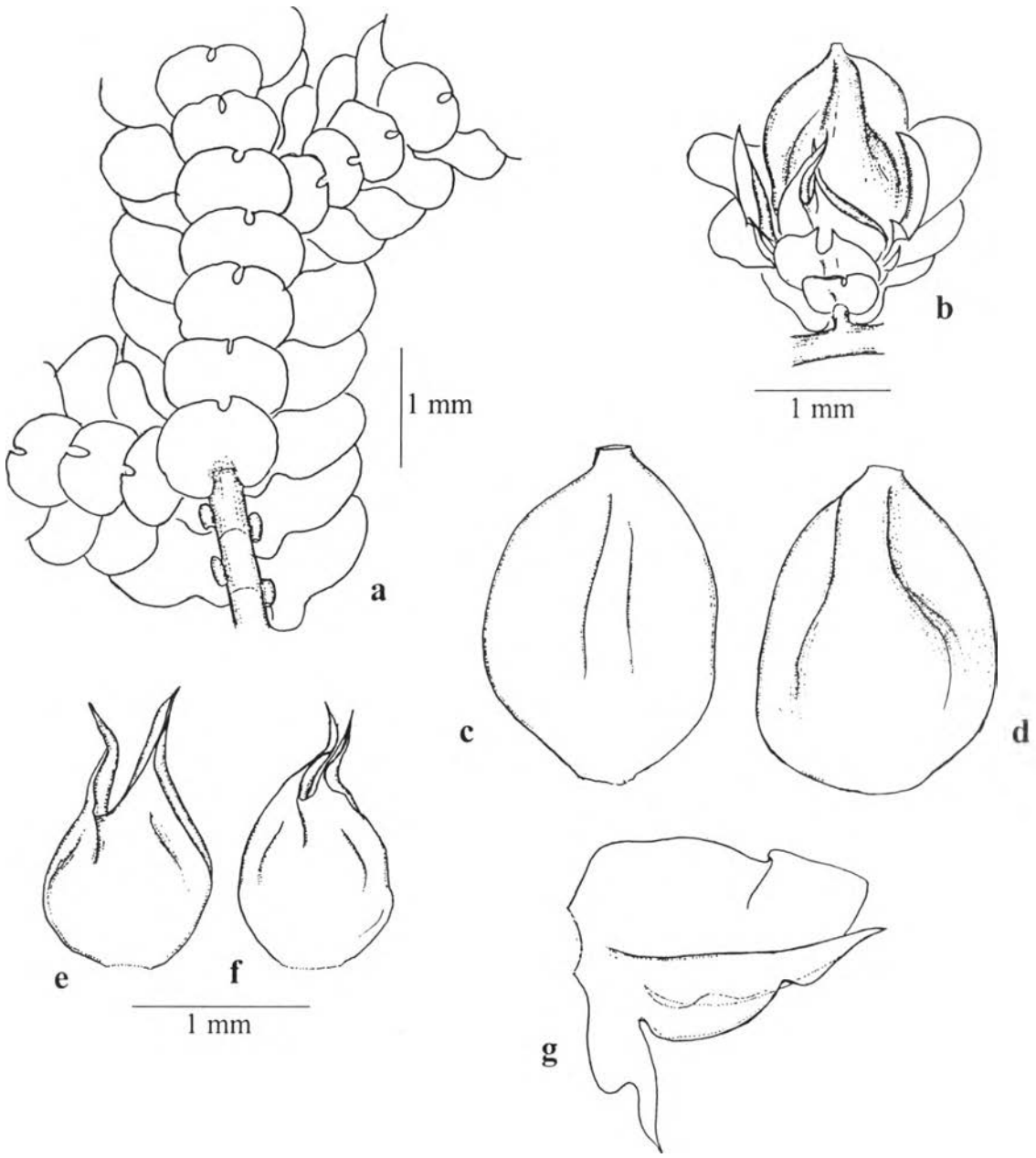

Figure 5.47B *Frullania gaudichoudii* Nees & Mont.
a. ventral portion of plant; b. gynoecium; c., d. perianthes, c. dorsal view, d. ventral view; e., f. female bracteoles; g. female bract. Based on *S. Chantanaorrapint 213*.

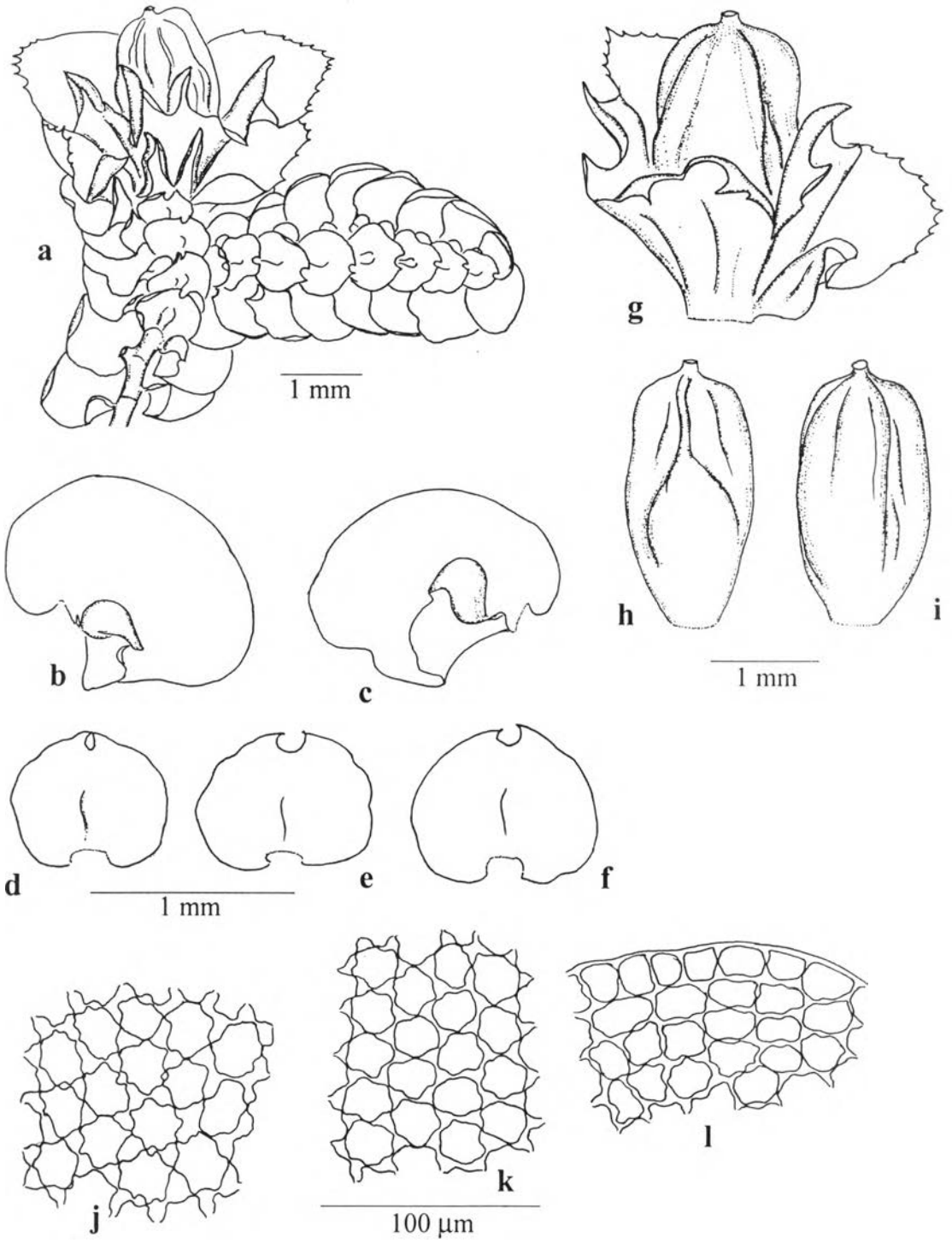

Figure 5.48 *Frullania wallichiana* Mitt.
a. ventral portion of plant; b., c. lateral leaves; d.-f. underleaves; g. gynoecium; h., i. perianthes, h. dorsal view, i. ventral view; j. cells at leaf apex; k. cells at leaf median; l. cells at leaf base. Based on *S. Chantanaorrapint 345*.

GEOCALYCACEAE

Plants small to large, whitish or light to dark green, rarely brownish. **Stems** creeping or prostrate, irregularly branched; in cross-section, cortical cells nearly smaller than the medullary cells. **Rhizoids** scattered on the ventral side of stem or the base of underleaves. **Lateral leaves** succubous, slightly remote to loosely or densely imbricate, widely to obliquely spreading or sometimes recurved, apex obtuse to rounded or truncate, usually bifid to bidentate, often becoming unlobed, margin entire to dentate; leaf-cells variable, usually medium-sized, generally sharply polygonal, mostly with minute to moderately trigones, cells never evenly thick-walled; leaf-lobules absent. **Oil-bodies** several per cell. **Underleaves** almost present, often connate with lateral leaves at base, bilobed to bifid with additional teeth, often becoming unlobed. **Androecia** slender, with many pairs of bracts. **Gynoecia** terminal on main stems or short lateral or postical-intercalary branches; female-bracts variably developed, large, sometimes reduced, or almost entirely suppressed. **Perianth** well-developed, perigynium sometimes presented. **Seta** elongate. **Capsule** ovoid to ovoid-cylindrical, 4-valved to base.

HETEROSCYPHUS

Heteroscyphus Schiffn., Öesterr. Bot. Z. 60: 171. 1910; R.L. Zhu & M.L. So, Hedwigia 121: 45. 2001.

Stems creeping or ascending, rarely branched. **Rhizoids** numerous, hyaline. **Lateral leaves** usually flat; apex truncate or rounded, entire to dentate; **oil-bodies** compound. **Underleaves** often connate to lateral leaves. **Androecia** on lateral branches. **Gynoecia** on lateral branches; perigynium absent; female bracts similar to leaves but often smaller. **Capsule** ovoid to cylindric.

Key to species

1. Lateral-leaves entire; leaf-cells thin-walled, trigones nodulose.....3. *H. splesdens*

1. Leaves with 2-10 teeth; leaf-cells thick-walled, trigones small or indistinct.

2. Leaf-apex rounded, 4-8 teeth.....1. *H. argutus*

2. Leaf-apex truncate, 2-bilobed.....2. *H. coalitus*

1. ***Heteroscyphus argutus*** (Reinw. et al.) Schiffn.

Österr. Bot. Z. 60: 172. 1910; Acta Bot. Fenn. 131: 137. figs. 4k-m. 1985; R.L. Zhu & M.L. So, Hedwigia 121: 50, fig. 20. 2001. — *Jungermannia argutus* Reinw. et al., Hep.

Javan. 206. n. 14. 1824. —*Chiloscyphus argutus* (Reinw. et al.) Nees in Gottshe et al., Syn. Hepat. 183. 1845. — *C. cubans* Taylor, London J. Bot. 5: 282. 1846. — *Heteroscyphus cubans* (Taylor) Schiffn., Österr. Bot. Z. 60: 172. 1910.

Plants yellowish, pale or olive-green, medium to large sized, 2-3 cm long, with leaves 1.5-3.0 mm wide. **Stems** creeping, lateral branched. **Rhizoids** in bundle, at underleaf base. **Lateral leaves** closely imbricate or nearly remote, flat, rectangular, 1.0-1.5 mm long, 0.8-1.2 mm wide, almost equally broad at apex and baase, slightly alternate; apex broadly rounded, with 4-8 teeth; leaf-cells 20-27 × 18-22 μm, thick-walled, without trigones; cuticle smooth. **Underleaves** small, distant, base of one of the corresponding base narrowly connate with the lateral leaf, other indistinctly connate or not connate, deeply 4-lobed, lobes distant from each other, entire to toothed. **Dioicous**. **Androecia** not found. **Gynoecia** on short lateral branch; female-bract rectangular, much smaller than lateral-leaf, with irregularly spinulate-dentate; fremale-bracteole similar to female-bract. **Perianth** campanulate, inflated, indistinctly 3-plicate; mouth wide with 3-lobed, lobes lanceolate, spinose-tooth (Fig. 5.49, 5.101). **Sporophytes** not found.

Thailand. — NORTH-EASTERN: Loei; EASTERN: Nakhon Ratchasima; SOUTH-EASTERN: Chanthaburi, Trat.

Distribution. — Malaya, Sumatra, Java, Borneo, Ambon, Philippenes, Formosa, Japan, New Guinea, New Caledonia, Fiji.

Ecology. — On wet sandy soil.

Specimens examined. — *S. Chantanaorrapint 196, 250* (BCU); *M.-J. Lai 90122105, 90122170* (BRU).

2. ***Heteroscyphus coalitus*** (Hook.) Schiffn.

Österr. Bot. Z. 60: 172. 1910; Acta Bot. Fenn. 131: 141. figs. 4(a-g). 1985; R.L. Zhu & M.L. So, Hedwigia 121: 46, fig. 18. 2001. — *Jungermannia coalitus* Hook., Musci Exot. 2: 23, t. 123. 1820. — *Chiloscyphus coalitus* (Hook.) Nees in Gott. et al., Syn. Hepat. 180. 1845.— *Lophocplea reflexistipula* Steph., Hedwigia 28: 265. 1889.— *C. communis* Steph., Spec. Hep. 3: 211. 1906. — *H. communis* (Steph.) Schiffn., Österr. Bot. 60: 172. 1910. — *Lophocolea tamina* Steph., Sp. Hepat. (Stephani) 6: 295. 1922.

Plants large, upto 5 cm long, with leaves 2.0-5.0 mm wide, pale or olive-green. **Stems** creeping, usually unbranched. **Rhizoids** numerous at the underleaf base. **Lateral leaves** imbricate, opposite or subopposite, rectangular, ca 1.0-2.5 mm long, 1.2-1.5 mm wide, widest at base, slightly convex; apex truncate with 2 distinct teeth at corners; leaf-cells variable, hexagonal to isodiametric, median cells 25-30 × 25-30 μm, basal cells 30-40×30-40 μm, thick-walled, trigones small; cuticle smooth. **Underleaves** distant, broadly connate with the lateral leaves, slightly wider than stem; apex nearly truncate to slightly emarginated, usually with 4-6 teeth (Fig. 5.50). **Fertile plants** not found.

Thailand. — NORTHERN: Chiang Mai, Chiang Rai, Phisanulok; NORTH-EASTERN: Loei; EASTERN: Nakhon Ratchasima; PENINSULAR: Ranong.

Distribution. — Widely distributed in tropical Asia, extending to Himalayas, New Guinea, Samoa.

Ecology. — On wet sandy soil or rocks.

Specimens examined. — *S. Chantanaorrapint 141, 190, 191, 204, 265, 374, 430, 431, 533* (BCU).

3. ***Heteroscyphus splendens*** (Lehm. & Lindenb.) Grolle

In Grolle & Piippo, Acta Bot. Fenn. 125: 68; Piippo, Acta Bot. Fenn. 131: 145, fig. 9. 1985. — *Jungermannia splendens* Lehm. & Lindenb. in Lehm., Nov. Min. Cogn. Stirp. Pugillus 4: 22. 1832. — *J. decurrens* Reinw. et al., Hep. Javan. 206, n. 15. 1824, non Desvaux 1818. — *Chiloscyphus decurrens* (Nees) Nees in Gott. et al., Syn Hepat. 173. 1845. — *Heteroscyphus decurrens* (Reinw. et al.) Schiffn., Österr. Bot. Z. 60: 172. 1910. — *Lophocolea umida* Steph., Sp. Hepat. (Stephani) 6: 301. 1922.

Plants large, shoot apices pale green to yellowish green; below becoming brown. **Stems** creeping, 3-5 cm long, with leaves 3-5 mm wide, rarely branched. **Rhizoids** in bundle, at underleaf base. **Lateral leaves** nearly opposite, densely imbricate, widely ovate, 1.5-2.5 mm long, 1.5-2.0 mm wide; apex rounded or obtuse, usually strongly recurved, margin entire; cells almost isodiametric, ca. 35-40 μm, thin-walled, intermediate thickening absent, trigones large, middle lamella visible; cuticle smooth. **Underleaves** imbricate, large, rounded in outline, long-decurrent, connate with the lateral leaves; apices usually irregularly lobed; margin dentate throughout (Fig. 5.51). **Fertile plants** not found.

Thailand. — EASTERN: Nakhon Ratchasima.

Distribution. — Ceylon, Malaya, Java, Borneo, Ceram, Ambon, New Guinea, Samoa.

Ecology. — On tree trunks or branches.

Specimens examined. — *S. Chantanaorrapint 153, 155, 178, 206, 262, 363, 545* (BCU)

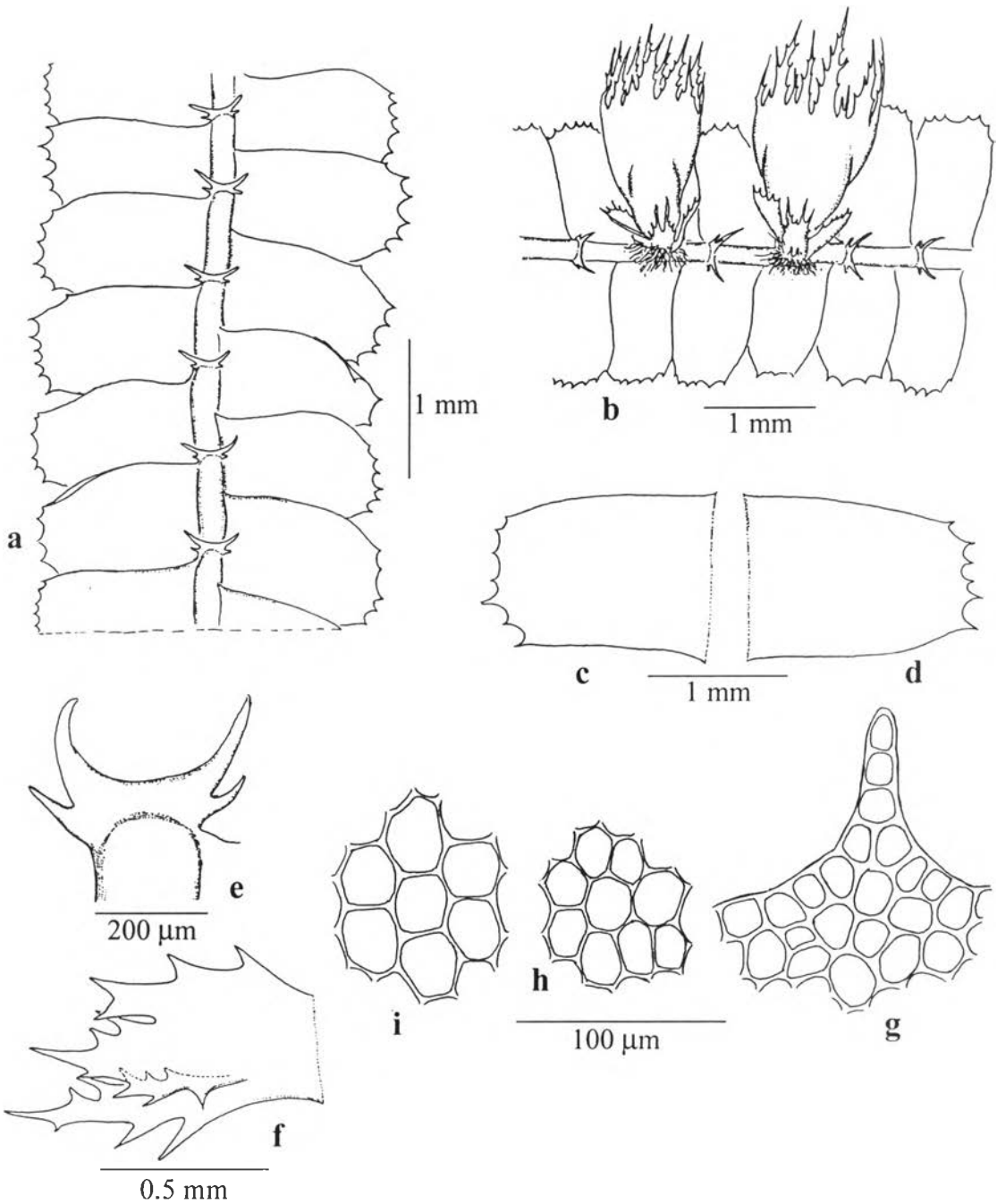

Figure 5.49 *Heteroscyphus argutus* (Reinw. et al.) Schiffn.
a. ventral portion of plant; b. plant with gynoecia; c., d. lateral leaves; e. underleaf; f. female bract; g. cells at leaf apex; h. cells at leaf median; i. cells at leaf base. Based on *S. Chantanaorrapint 196*.

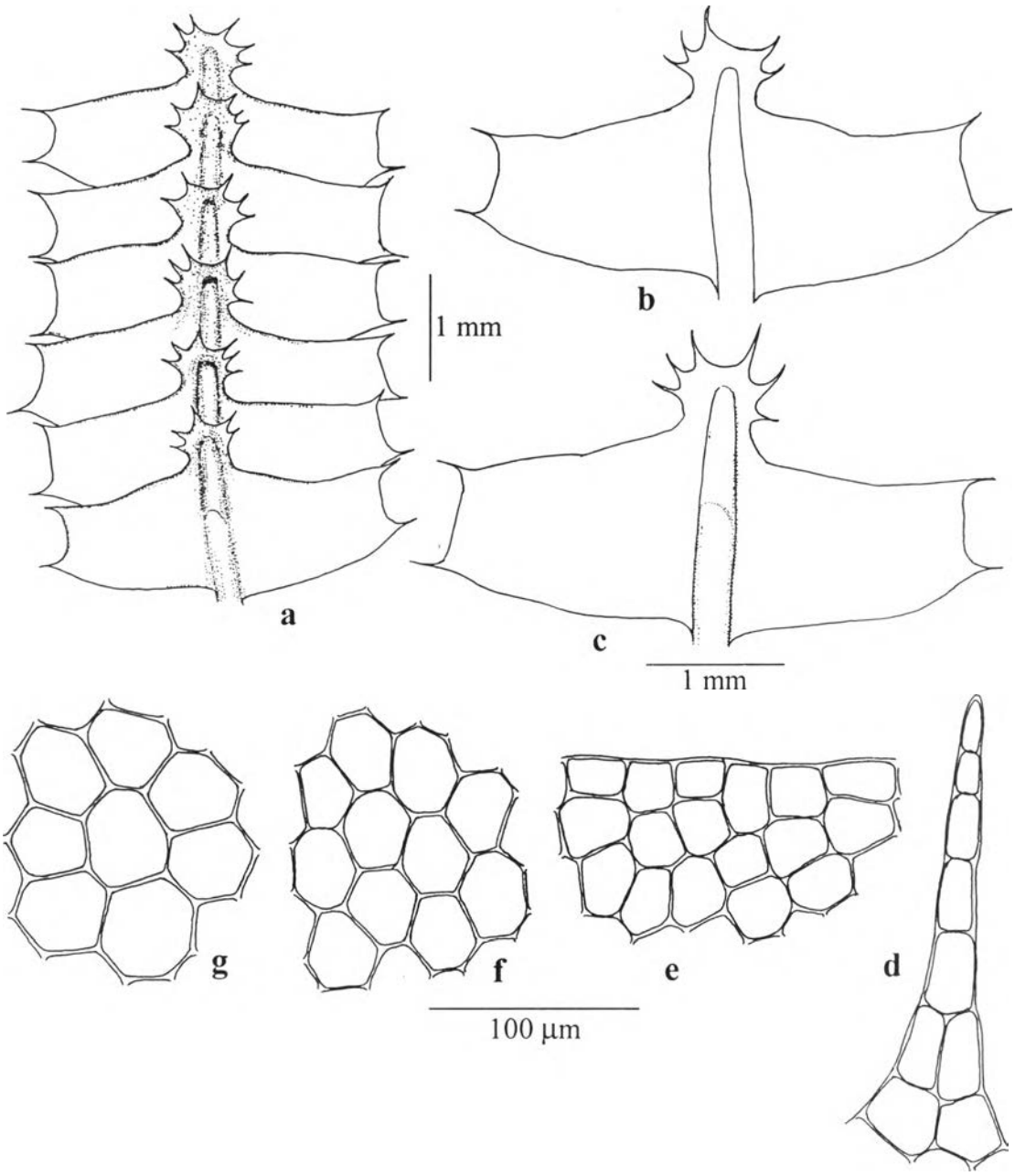

Figure 5.50 *Heteroscyphus coalitus* (Hook.) Schiffn.
a. ventral portion of plant; b., c. lateral leaves and underleaves; d cells at leaf apex; e. cells at leaf margin; f. cells at leaf median; g. cells at leaf base. Based on *S. Chantanaorrapint 190.*

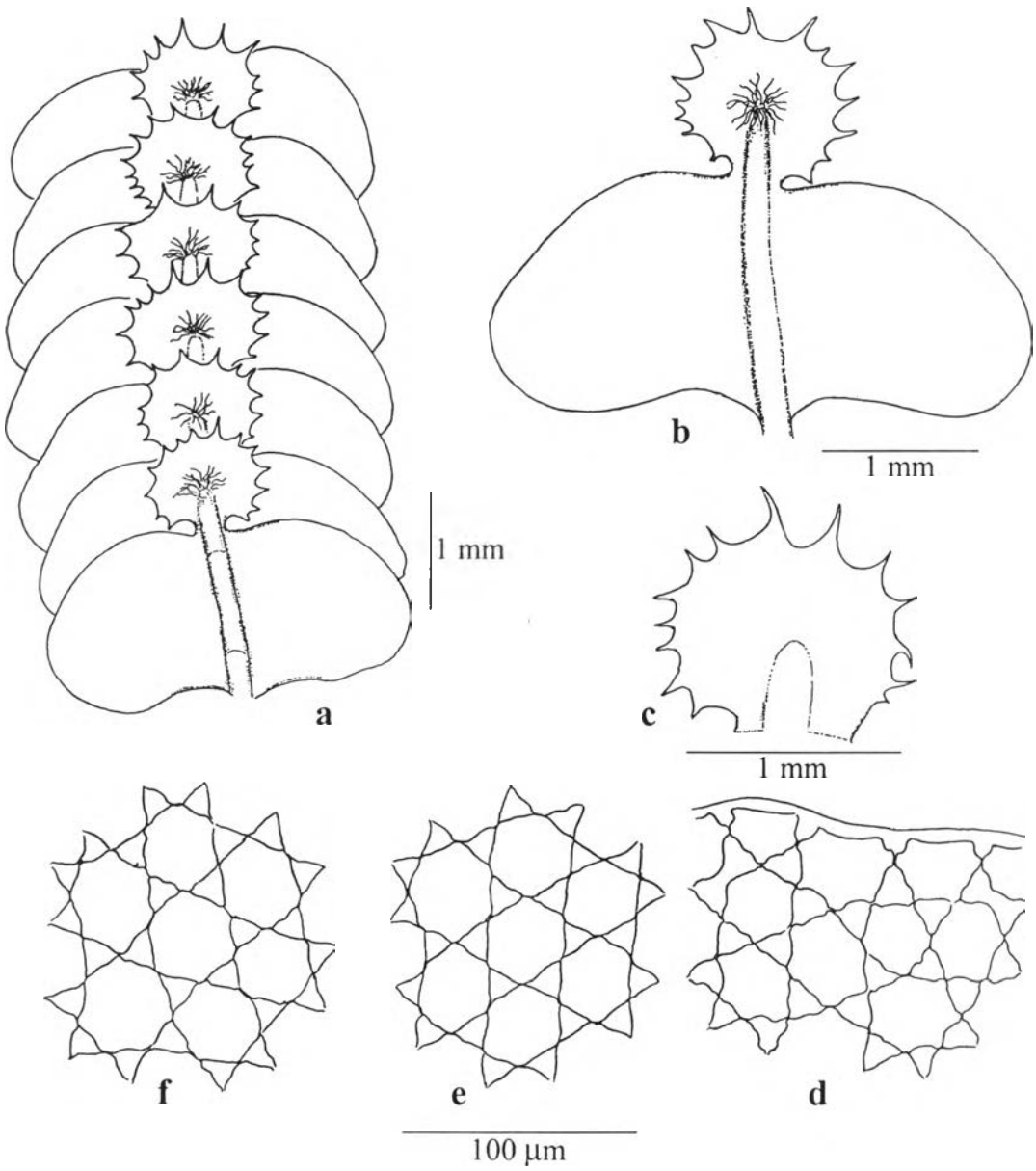

Figure 5.51 *Heteroscyphus splendens* (Lehm. & Lindenb.) Grolle
a. ventral portion of plant; b. lateral leaves and underleaves; c. underleaf; d cells at leaf apex; e. cells at leaf margin; f. cells at leaf median; g. cells at leaf base. Based on *S. Chantanaorrapint 155*.

HERBERTACEAE

Plants medium to large sized, variable from yellowish green to reddish brown, in loose tufts. **Stems** erect or suberect, or spreading from substrate, with or without flagella on ventral side, in cross-section cortical cells strongly differentiated or undifferentiated. **Rhizoids** restricted to base of underleaves, usually lacking on leafy shoots. **Lateral leaves** incubous to subtransverse, usually postically secund, bifid, asymmetric, lanceolate, triangular, or ovate-triangular, to lanceolate-acuminate lobes. **Underleaves** as large as and similar to the leaves, symmetric or nearly so, the lobes never falcate. **Dioicous**. **Androecia** on main shoots, becoming intercalary; bracts similar to leaves but saccate at base; bracteoles similar to underleaves, somewhat ventricose at base. **Gynoecia** terminal on main stem; bracts and bracteoles similar to leaves and underleaves but smalle. **Perianths** ovate, deeply 3-6-plicate, more or lees deeply lobed at mouth.

HERBERTUS

Herbertus Gray, Nat. Arr. Brit. Pl. 1: 678, 705. 1821; R.M. Schust., Hepat. Anthocerotae N. Amer. 1: 709. 1966.

Primary stems sometimes forming a prostrate rhizome, bearing reduced leaves; leafy stems, small to robust, often crowded; cortical cells usually thickened, the medullary cells or also slightly thick-walled; flagella occasionally conspicuous. **Lateral leaves** usually deeply bifid, lobes acute to attenuate, often falcate; **leaf cells** strongly collenchymatous, trigones coarse and bulging, vitta differentiated or none. **Perianths** usually nearly included or only half-emergent.

Herbertus dicranus (Tayl.) Miller.

J. Hattori Bot. Lab. 28: 306, figs. 4, 11, 12, 17. 1965. —*Sendtnera dicran*a Tayl. in Gottshe, Lndnb. & Nees, Syn. Hepat. 239. 1845. — *Herbertia dicrana* (Tayl.) Trevis., Mem. R. Ist. Lombardo Sci. 4: 397. 1877. — *Schisma dicrana* (Tayl.) Steph. Sp. Hepat. (Stephani) 4: 24. 1909.

Plants medium-sized, dark brown to black when dry. **Stems** up to 8 cm long, with numerous attenuated flagelliform on ventral side. **Lateral leaves** imbricate, 2.0-2.2 mm long and 0.6-0.8 mm wide, secund, spreading to recurved, decurrent, bifid about 3/5, sinus acute and slightly curved, segments lanceolate ; basal disc ovate; the vitta concave-depressed, bifid below mid-base and disappearing below the tip; **leaf cells** verruculose with intermediate thickening and nodulose trigones, cells of the antical margin 15×20 μm, basal vitta cells 50-70×20 μm. **Underleaves** similar to leaves but smaller and straight from an oblong basal disc, narrower and less deeply bifid, about 1.8-2.0 mm long and 0.5 mm wide (Fig. 5.52). **Fertile plants** not found.

Thailand. — NORTHERN: Chiang Mai.

Distribution.— Nepal.

Ecology.— On tree-trunks and branches.

Specimens examined.— *S. Chantanaorrapint 121, 180, 185, 195, 215, 283, 351, 373, 501, 510, 520, 536, 537, 613* (BCU).

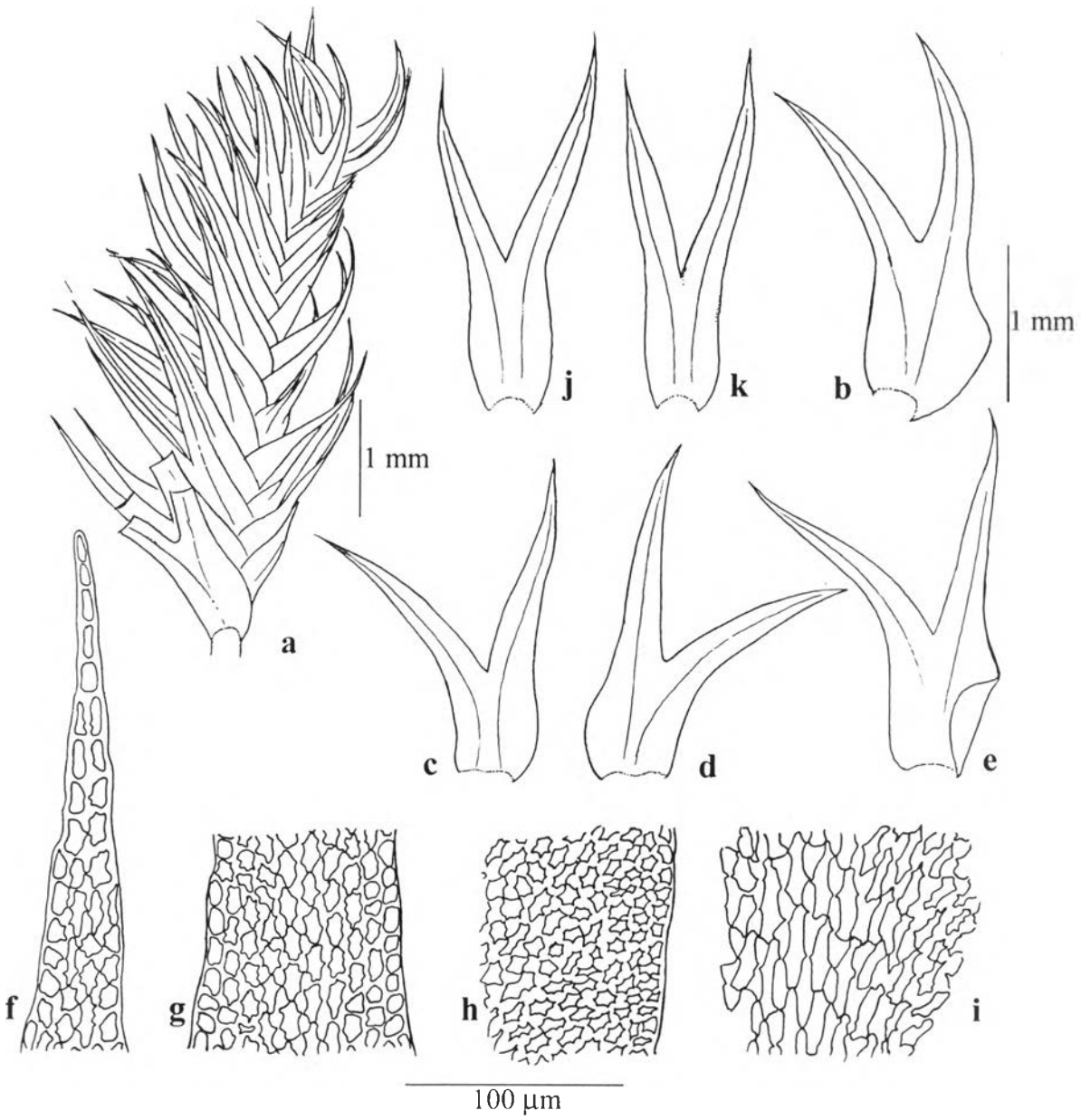

Figure 5.52 *Herbertus dicrnus* (Tayl.) Miller
a. a part of plant; b.-e. lateral leaves; f. cells at apex of leaf segment; g. cells at base of leaf segment; h. cells at margin of leaf base; i. vitta cells at leaf base; j., k. underleaves. Based on *S. Chantanaorrapint 180*.

JUNGERMANNIACEAE

Plants small to robust, pale green to dark brown, flaccid to rigid. **Stems** creeping to erect. **Rhizoids** scattered along ventral merophytes or occurring at insertions of leaves. **Leaves** succubous to transverse, entire, emarginate or bilobed to several lobed; leaf-cells with or without bulging trigones, cells of marginal row swollen or equally thick-walled; cuticle smooth or verrucose; **oil-bodies** of various types, few to many per cell, small to large, homogeneous or composed of few to numerous globules. **Underleaves** small, unlobed or bilobed, lanceolate to triangular, or lacking. **Androecia** terminal or intercalary by successive vegetative growth; antheridial stalks uniformly 2-seriate. **Perianth** terminal, closed at mouth, ovate, fusiform, pyriform, clavate to cylindrical, usually plicate above or smooth throughout, reduced or almost absent when perigynium developed. **Female bracts** more or less similar to leaves, free from or connate with each other; bracteole conspicuous to vestigial or absent. **Capsule** subspherical to ovoid.

Key to genera

1. Lateral leaves unlobed.....3. *Notoscyphus*

1. Lateral leaves 2-lobed or more

   2. Underleaves absent; leaves lobed less than 2/3 the leaf length..... .....1. *Anastrophyllum*

   2. Underleaves present; leaves lobed more than 2/3 the leaf length..... .....2. *Chandonanthus*

1. *ANASTROPHYLLUM*

Anastrophyllum (Spruce) Steph., Hedwigia 32: 140. 1893; N. Kitag., J. Hattori Bot. Lab. 29: 122. 1966. — *Jungermannia* subgen. *Anastrophyllum* Spruce, J. Bot. 14: 234. 1876.

Plants small to very large, rigid, reddish brown to blackish brown. **Stems** ascending to erect; differentiated into cortical layer of small, thick-walled cells; medulla of large, thin-walled cells; branching intercalary, from leaf axils or from ventral side of stems. **Lateral leaves** obliquely inserted on ventral half of stem but subtransversely at dorsal half, more or less canaliculated, emarginate to deeply 2-lobed (rarely entire), strongly secund dorsally, embracing stems with dilate base; **leaf cells** small to moderate, with unevenly thickened wall, often very large with bulging trigones; cuticle more or less verrucose; **oil-bodies** rather few, coarsely granular. **Underleaves** absent. **Perianth** large, highly emergent, deeply pluriplicate above the middle; female bracts similar to leaves but often larger; bracteoles lacking.

Anastrophyllum piligerum (Nees) Spruce

J. Bot. London 14: 235. 1876; N. Kitag., J. Hattori Bot. Lab. 33: 212, figs. 4: 1-7. 1970. — *Jungermannia piligerum* Nees, Nova Acta Acad. Leop.-Caral. 12: 414. 1824.

Plants medium-sized, rigid, reddish brown, 1.5-3.0 mm long, prostrate with ascending tips, branching from ventral side of stems. **Stems** rigid; in cross-section cortical cells small and thick-walled, medullary cells larger and thin-walled. **Lateral leaves** densely imbricate, nearly symmetric, ca. 2-3 mm long, 1.5-3 mm wide, erect spreading and strongly secund dorsally, lobes broadly ovate, distinctly concave and terminating in a subulate point, sinus descends more than half the length of the leaf and strongly gibbous (thus, both lobes of a leaf are widely overlapped when it is expanded under the cover-glass); **leaf-cells** regularly seriate longitudinally, trigone very large and nodulose; apical cells 10 × 10 μm, median cells 15-20 × 10 μm, basal cells 20-30 × 10-15 μm; cuticle verrucose. **Dioicous**. **Androecia** not found. **Gynoecia** terminal on main stem, with 1 subfloral innovation; **perianths** cylindrical-obovate, mouth spinose-ciliate; female bracts wider than leaves (Fig. 5.53). Sporophytes not found.

Thailand. — PENINSULAR: Nakhon Si Tammarat

Distribution. — Widely distributed in tropical and subtropical regions of Asia, Oceania, Central and South America.

Ecology. — On sandy soil slope.

Specimens examined. — *S. Chantanaorrapint 514, 515 (BCU).*

2. *CHANDONANTHUS*

Chandonanthus Mitt., in Hook, Handb. New Zealand Fl. 2: 750. 1867; R.M. Schust., J. Hattori Bot. Lab. 23: 204. 1960; N. Kitag., J. Hattori Bot. Lab. 28: 254. 1965.

Plants small to robust, rigid, dark green to yellowish or reddish brown. **Stems** ascending to erect, slightly to strongly differentiated into cortical layers of small thick-walled cells; medulla of large, thin-walled cells; branching intercarlary from axils of leaves or underleaves, rarely terminal. **Lateral leaves** transversely to obliquely inserted, equally 4-lobed or 2-3-lobed, with marginal teeth at least at their base, sinus descending nearly to the base of leaves; lobes nearly equal or strongly unequal; when unequal, dorsal lobes larger than median and ventral ones, more or less adaxially convex, margins reflexed; **leaf cells** rather small, more or less unevenly thickened walls, often with bulging, large trigones (thus, cell-lumina becoming irregularly star-shaped); oil-bodies 3-5 per cell, 2-6 μm, finely or coarsely granulate. **Underleaves** about 1/2 the size of leaves, deeply 2-lobed, with marginal teeth. **Perianths** large, ovoid-cylindrical, highly emergent, deeply pluri-plicate to the base, more or less contracted to, and ciliate at the mouth; **female bracts** similar to leaves but transversely inserted to the stem and less deeply lobed; **bracteole** large, 2-lobed more shallowly than in underleaves; bracts and bracteole free from each other. **Androecia** secoundary-intercalary; bracts ventricose at base, less deeply lobed.

Chandonanthus birmensis Steph.

Sp. Hepat.(Stephani) 3: 643. 1909; N. Kitag., J. Hattori Bot. Lab. 28: 255. — *Temnoma birmense* (Steph.) Horik., Hikobia 1: 90. 1951; S. Hatt., J. Hattori Bot. Lab. 7: 46. 1952.

Plants medium-sized, rather rigid, dark green or yellowish brown, scattered or in dense mats. **Stems** creeping or ascending; in cross-section cortical cells 2-3 layers of smaller cells, thicker than medullary cells. **Rhizoids** few, colorless. **Lateral leaves** imbricate, dorsally secund, obliquely inserted, convex strongly adaxially, especially the dorsal lobes, more or less reniform in outline, 0.6-1.0 mm long, 0.7-1.7 mm wide, very unequally 3-lobed (dorsal lobe twice or trice as wide as ventral one); sinus descending near the leaf base, acute to rounded, often gibbous; dorsal and median lobes oblong-ovate but the ventral lobe lanceolate, all lobes acuminate or cuspidate, entire or with a few occasional teeth along margin; teeth usually weak but occasionally large; cells of the leaf apex 10-15 μm, median cells 10-15 × 15-20 μm, basal cells 13-16 μm, thick-walled, trigones very large, confluent and conspicuously bulging; cuticle faintly verrucose. **Underleaves** large, 0.4-0.6 mm long, 0.2-0.3 mm wide at base, deeply 2-lobed, lobes divaricate, acuminate or subulate, with a few marginal teeth especially at base (Fig. 5.54). **Fertile plants** not found.

Thailand. — NORTHERN: Chiang Mai; PENINSULAR: Nakhon Si Tammarat.
Distribution. — Widely distributed in Eastern Asia and Madagascar.
Ecology. — On humus rocks or tree trunks and branches.
Specimen examined. — *S. Chantanaorrapint 127, 394, 571* (BCU).

3. *NOTOSCYPHUS*

Notoscyphus Mitt., Fl. Vit.: 407. 1873; Amakawa, J. Hattori Bot. Lab. 21: 271. 1959; Udar & A. Kumar, J. Hattori Bot. Lab. 49: 247. 1981.

Plants small to medium sized, green, yellowish green, greenish yellow or yellow. **Stems** creeping; apex forming a pendant, bulbous, fleshy perigynium; ventral intercalary branches. **Rhizoids** mostly arise the base of underleaves. **Lateral leaves** succubous, simple, apex rounded, margin entire; leaf cells collenchymatous. **Underleaves** small to very small, bifid. **Male bracts** with lager ventral and smaller dorsal lobed, often an additional lobe may also be present, enclosing a single antheridium. **Perianth** usually distinct, a psuedoperianth of connivent bracts and bracteoles presented. **Capsule** elliptic-cylindric.

Notoscyphus paroicus Schiffn.

In Denkschr. Math.-Nat. Class Kais. Akad. Wiss., Wien 67: 192. 1898; Amakawa, J. Hattori Bot. Lab. 21: 273, figs. 5l-z. 1959; Ram Udar & Adarsh Kumar, J. Hattori Bot. Lab. 49: 258, text-figs. 69-89. 1981. — *Nardia lutescens* auct. non (L. et L.) Mitt., Steph. Bull. Herb. Boiss. 5: 81. 1897. — *Prasanthus paroicus* (Schiffn.) Kammim., Contrib. Fl. Hep. Shikoku. 42. 1952. — *Saccogyna subalternifolia* Steph., Sp. Hepat (Stephani). 6: 317. 1922.

Plants small, yellowish green, prostrate. **Stems** 5-15 mm long, in cross-section cortical cells thick-walled, medullary cells thin-walled. **Lateral leaves** simple, subopposite, ovate, apex obtuse to rounded, margin entire, obliquely inserted marginal cells 30-40 μm long, 25-30 μm wide; middle cells 40-45 × 25-30 μm; basal cells 40-50 × 30-40 μm; thin-walled, usually with intermediated thickening in marginal cells, trigones prominent and bulging; cuticle verrucose. **Underleaves** distinct, bifid more

than half, occasionally with single small tooth at any side; lobes large, unequal to subequal, acuminate, erect (Fig. 5.55). **Fertile plants** not found.

Thailand. — NORTH-EASTERN: Loei; PENINSULAR: Phuket.
Distribution. — India, Java, Tonkin, Sumatra, Banca, Ceylon, Lozon, Japan.
Ecology. — On shady and moist sandy soil slope.
Specimens examined. — *S. Chantanaorrapint 519, 619* (BCU).

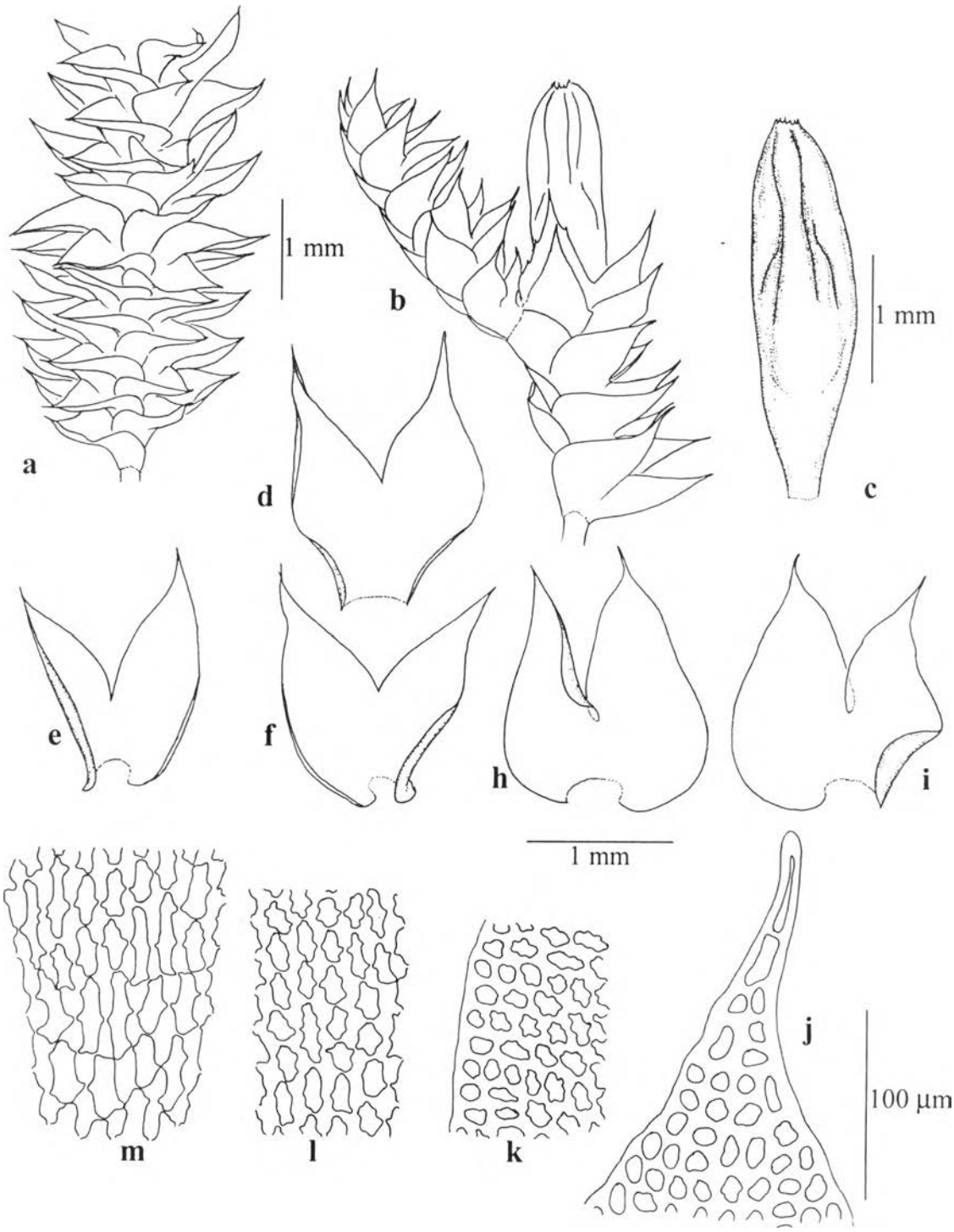

Figure 5.53 *Anastrophyllum piligerum* (Nees) Spruce
a. dorsal portion of plant; b. plant with gynoecium; c. perianth; d.-i. lateral leaves; j. cells at leaf apex; k. cells at leaf margin; l. cells at leaf median; m. cells at leaf base. Based on *S. Chantanaorrapint 514*.

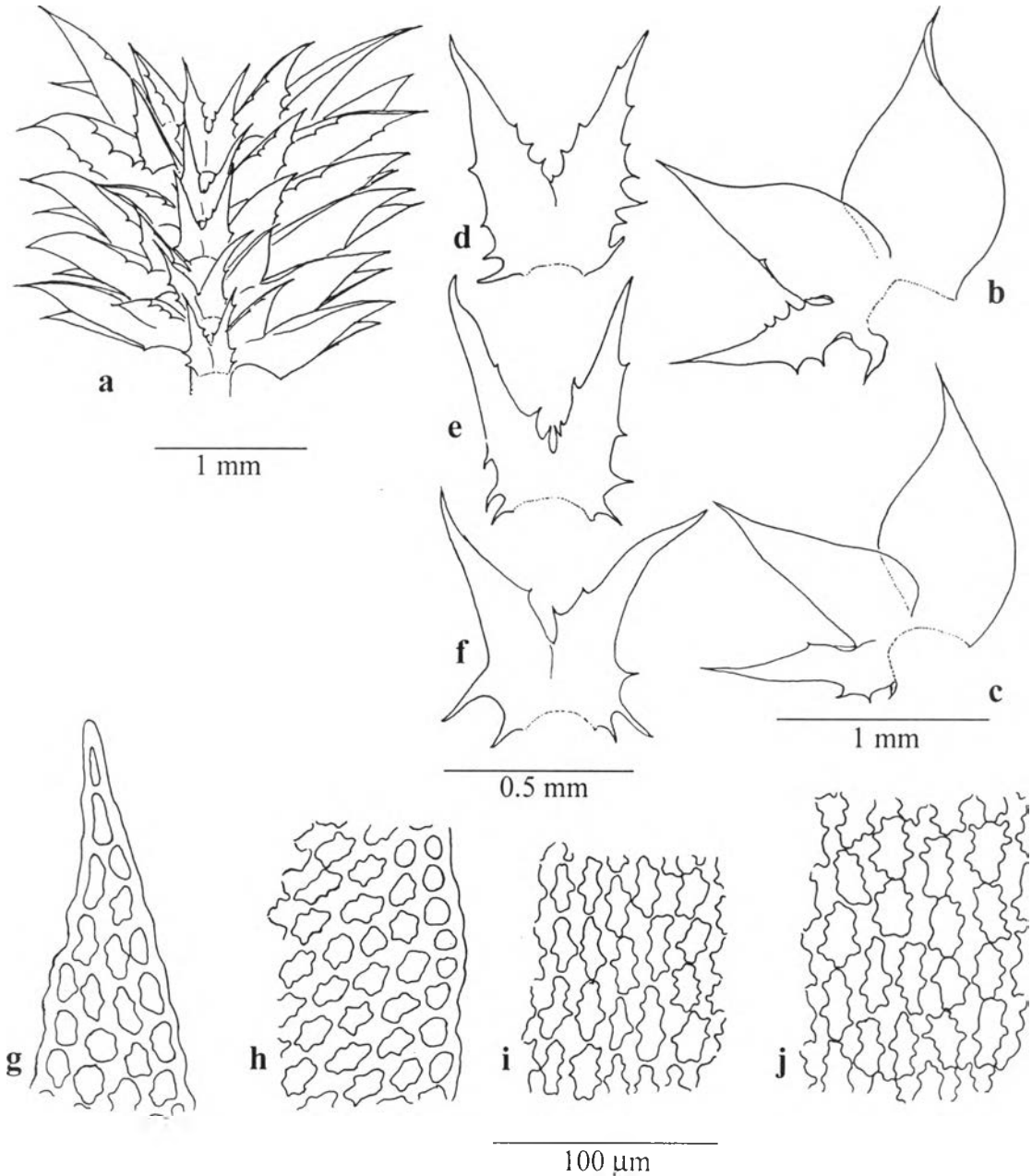

Figure 5.54 *Chandoanthus birmensis* Steph.
a. ventral portion of plant; b., c. lateral leaves; d.-f. underleaves; g. cells at leaf apex; h. cells at leaf margin; i. cells at leaf median; j. cells at leaf base. Based on *S. Chantanaorrapint 394*.

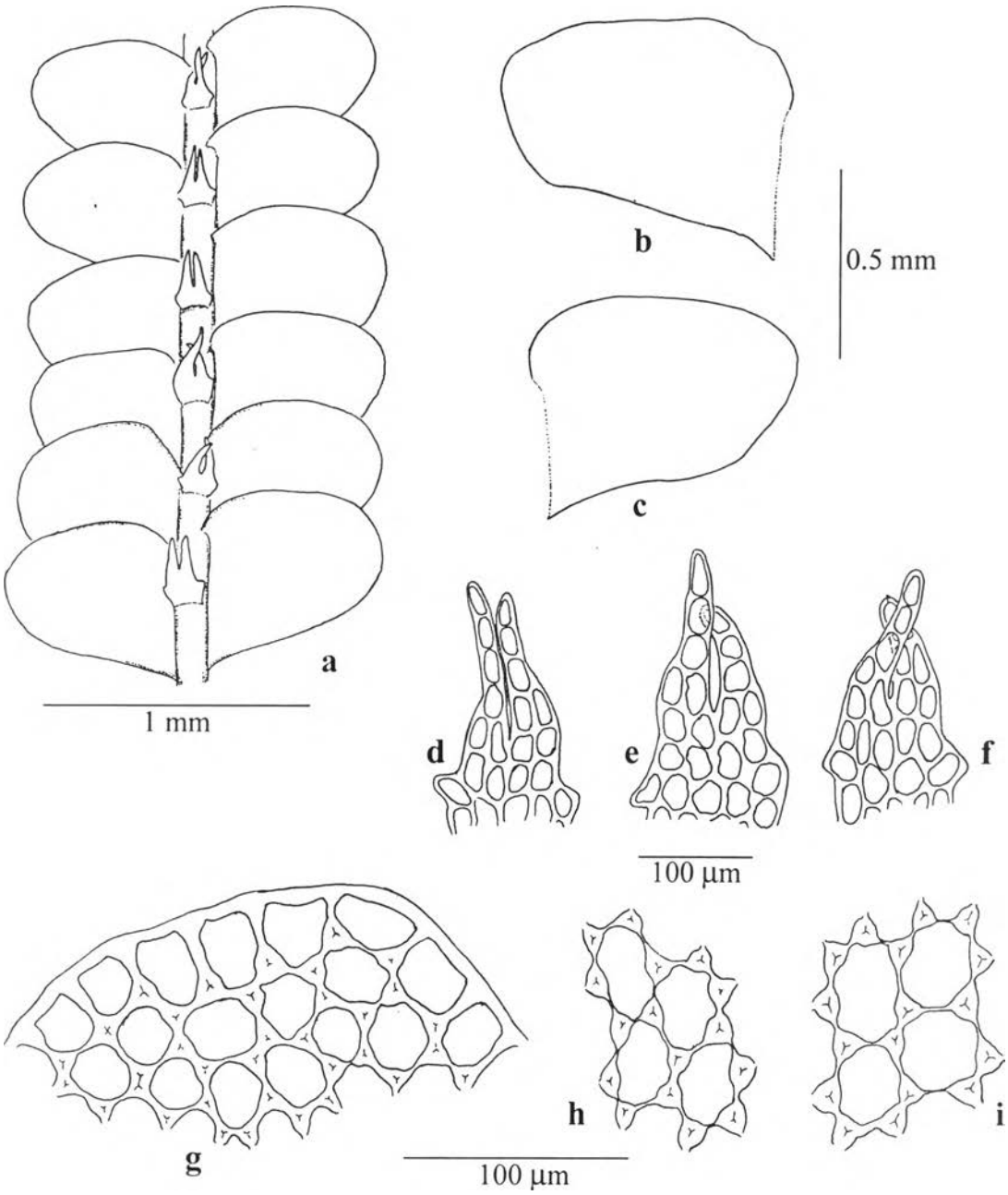

Figure 5.55 *Notoscyphus paroicus* Schiffn.
a. ventral portion of plant; b., c. lateral leaves; d.-f. underleaves; g. cells at leaf apex; h. cells at leaf median; i. cells at leaf base. Based on *S. Chantanaorrapint 619*.

LEJEUNEACEAE

Plants minute to robust, pale green to dark brown, flaccid to rigid. **Stems** creeping or prostrate, appressed to the substrate, terminal or lateral branched, sometimes with 1-2 subfloral innovations. **Rhizoids** restricted to the basal portion of underleaves. **Lateral leaves** incubous, imbricate, contiguous or remote; **leaf-lobe** various in shaped and sized, margin entire or dentate; **leaf-lobule** various in shaped and sized, usually inflated, sometimes lingulate. **Underleaves** present, entire or bilobed, margin entire or dentate, rarely lacking. **Androecia** usually on terminal intercalary branches. **Gynoecia** terminal on stems or elongate branch, usually one pair of bracts; bract and bracteole entire to dentate at margin. **Perianthes** obovate, inflated or often flattened, with several keeled, keels smooth or dentate

Key to Genera

1. Plants usually robust; cortical cells of stem with more than 7 longitudinal rows; usually brown pigmented; underleaves entire.

    2. In cross-section of stem, cortical cells larger than medullary cells.....
    .....3. Lopholejeunea

    2. In cross-section of stem, cortical cells nearly or smaller than medullary cells.

        3. Oil-bodies small, homogenous.....6. *Spruceanthus*

        3. Oil-bodies large, compound.

            4. Perianth multiplicate.....5. *Ptychanthus*

            4. Perianth sharply 3-keeled.

                5. Perianth-keels dentate; leaves with vitta cells.....7. *Thysananthus*

                5. Perianth-keels entire; leaves without vitta cells.....
                .....4. *Mastigolejeunea*

1 Plants usually flaccid; cortical cells of stem with 7 longitudinal rows; never brown pigmented; underleaves more or less bilobed.

    6. Female bracts and bracteoles entire at margin; ocelli absent.....1. *Lejeunea*

    6. Female bracts and bracteoles dentate at margin; ocelli present.....
    .....2. *Leptolejeunea*

1. *LEJEUNEA*

Lejeunea Lib., Ann. Gén. Sci. Phys. 6: 372. 1820; Mizut., J. Hattori Bot. Lab. 24: 199. 1961. — *Microlejeunea* Step., Hedwigia 27:61. 1888.

Plants minute to small, green or yellowish green. **Stems** irregularly pinnate, intercalary branched; in cross-section with 7 cortical cells, cortical cells much larger than the thin-walled medullary cells. **Lateral leaves** remote to imbricate; **leaf-lobe** entire at margin, apex usually rounded, rarely apiculate to acute; ocelli absent; oil-bodies small, homogenous, numerous; **leaf-lobule** usually inflated, the first tooth usually unicellular, forming an obtuse angles, the second tooth almost reduced. **Underleaves** bilobed, margin entire. **Androecia** mostly capitate on a long or short lateral branches, male bracteoles mostly limited to the base of androecium. **Gynoecia** usually on an elongate branches, with 1 subfloral innovation; female bracts-lobe entire at margin, usually connate to bracteole; female bracteole bilobed, margin entire. **Perianth** usually inflated, 5-keeled (1 dorsal, 2 lateral, 2 ventral), keels smooth.

Key to species

1. Leaf-lobules large, about 1/3 as long as leaf-lobes.....1. *L. discreta*

1. Leaf-lobules small, less than 1/3 as long as leaf-lobes.

   2. Underleaves very large, 1/6-bilobed, as wide as the lateral leaves..... .....2. *L. sordida*

   2. Underleaves small, 1/3-bilobed, ca. 2 times as wide as stem.....3. *L. wightii*

1. ***Lejeunea discreta*** Lindenb.

In Gottsche, Lindenb. & Nees, Syn. Hepat.: 361. 1845; R.L. Zhu & M.L. So, Hedwigia 121: 142, fig. 55. 2001. — *Eulejeunea ordinaria* Steph., Hedwigia 35: 92. 1896. — *Hygrolejeunea discreta* (Lindenb.) Schiffn., Consp. Hepat. Archip. Indici: *Lejeunea longiloba* Steph., Sp. Hepat. (Stephani) 5: 779. 1915. — *L. ordinaria* (Steph.) Steph., Sp. Hepat. (Stephani) 5: 783. 1915. — *L. stahliana* Steph., Sp. Hepat. (Stephani) 5: 791. 1915. — *L. subdiversiloba* Horik., Bot. Mag. Tokyo 48: 602, fig. 1. 1934. — *Taxilejeunea discreta* (Lindenb.) R.M. Schust., Hedwigia 3: 138. 1963.

Plants small, whitish green or golden green. **Stems** ca. 25-30 mm long, with leaves ca. 1.0-1.2 mm wide, rarely branched. **Rhizoids** few. **Lateral leaves** imbricate to contiguous, usually widely spreading; **leaf-lobe** strongly convex, obliquely ovate, 0.5-0.7 mm long, 0.5-0.6 mm wide, apex rounded or obtuse, margin entire, dorsal margin obliquely truncate at base, ventral margin slightly falcate; marginal cells elongate, 10 ×15-20 μm, median cells 25-30 × 25-30 μm, basal cells 40-50 × 25-35 μm, thin-walled, trigones small, intermediate thickening present; cuticle verrucose; **leaf-lobule** obliquely ovate, strongly inflated, ca. 1/3 as long as lobe, free margin involute, apex obliquely truncate, the first tooth small. **Underleaves** distant, ca. 3 times as wide as the stem, transversely inserted, orbicular or reniform, ca. 0.4 mm long, 0.4-0.5 mm wide, slightly cordate at base, bilobed to about 1/3 the length, the sinus acute, lobes nearly triangular, margin entire. **Androecia** not found. **Gynoecia** on short lateral branches, subfloral innovations not seen; bract-lobe obovate, narrower than leaf-lobe, apex obtuse to acute, margin entire; bract-lobule usually large, lingulate or rectangular; bracteole obovate, ca. 0.5 mm long, 0.3 mm wide, bilobed to about 1/4 the length, connate to bracts at base. **Perianth** oblong-obovate or calvate,

ca. 1 mm long, 0.4 mm wide, 5-keeled, keels smooth, beak short (Fig. 5.56). **Sporophytes** not found

Thailand. — New record to Thailand.

Distribution. — India, Nepal, Ceylon, Sumatra, Java, Borneo, Molucca, New Guinea, New Caledonia, Japan.

Ecology. — On tree trunks and branches.

Specimens examined. — *S. Chantanaorrapint 264, 380, 700* (BCU).

2. ***Lejeunea sordida*** (Nees) Nees

Naturgesch. Eur. Leberm.3: 278. 1838; R.L. Zhu & M.L. So, Hedwigia 121: 142, fig. 55. 2001. — *Jungermannia sordida* Nees, Enum. Pl. Crypt. Javae: 41. 1830. — *Hygrolejeunea sordida* (Nees) Steph., Sp. Hepat. (Stephani) 5: 570. 1914. — *Taxilejeunea sordida* (Nees) Eifrig, Ann. Bryol. 9: 101. 1937.

Plants small, yellowish green. **Stems** 10-15 mm long, with leaves ca. 1 mm wide, irregularly branched; **Rhizoids** few. **Lateral leaves** imbricate, obliquely spreading; **leaf-lobe** strongly convex, rotundate to ovate, 0.5-0.6 mm long, 0.4-0.5 mm wide, apex rounded, margin entire, dorsal margin slightly auriculate at base, ventral margin slightly falcate; marginal cells 10-15 × 15-20 μm, median cells 25-30 × 20-25 μm, basal cells 30-40 × 30 μm, thin-walled, with very large intermediate thickening and trigones; cuticle slightly verrucose; **leaf-lobule** small, obliquely ovate to rotundate, strongly inflated, ca. 1/5 as long as lobe, free margin involute, apex obliquely truncate. **Underleaves** very large, distant, as wide as the lateral leaves, transversely inserted, reniform or kidney shape, 0.4-0.5 mm long, 0.7-0.8 mm wide, bilobed to about 1/3 the length, the sinus obtuse, lobes nearly triangular, slightly auriculate at base, margin entire (Fig. 5.57). **Fertile plants** not found.

Thailand. — SOUTH-EASTERN: Chantaburi.

Distribution. — Australia, Caroline Island, China, Fiji, Indonesia, Malaysia, Japan, Micronesia, New Caledonia, Papua New Guinea, Philippines, Samoa Island.

Ecology. — On tree trunks and branches.

Specimens examined. — *S. Chantanaorrapint 592* (BCU).

3. ***Lejeunea wightii*** Lindenb.

In Gottsche, Lindenb. & Nees, Syn. Hepat. 379. 1845; Herzog & Nog., J. Hattori Bot. Lab. 14: 51, figs. 14, a-g. 1955; Mizut., J. Hattori Bot. Lab. 27: 147, figs. IV, 7-11. 1964.

Plants minute, pale green. **Stems** ca. 5 mm long, with leaves ca. 0.6 mm wide, irregularly branched. **Rhizoids** few. **Lateral leaves** approximate or often distant, obliquely spreading; **leaf-lobe** strongly convex, rotundate to ovate, 0.2-0.3 mm long, 0.2-0.25 mm wide, apex rounded, margin crenulate or nearly entire, dorsal margin slightly arched, ventral margin falcate; marginal cells 10-15 μm, median cells 25-30 × 20-25 μm, basal cells as large as in the middle, thin-walled, with small intermediate thickening and trigones; ocelli absent; cuticle slightly verrucose; **leaf-lobule** obliquely ovate to rotundate, strongly inflated, ca. 1/3 as long as lobe, free margin involute, the

first tooth unicellular, the second tooth indistinct, apex ring-like. **Underleaves** distant, ca. 1.5 times as wide as the stem, transversely inserted, ovate to rotundate, 0.12-0.15 mm long, 0.1-0.12 mm wide, bilobed to about half the length, the sinus obtuse, lobes nearly triangular, margin entire or slightly crenulate. **Gynoecia** terminal on stem or branch, subfloral innovations present; bract-lobe obovate, narrower than leaf-lobe, apex rounded, margin entire; bract-lobule usually large, lingulate; bracteole larger than underleaves, oblong or ligulate, ca. 0.25 mm long, 0.15 mm wide, bilobed to about 1/5 the length, connate to bracts at base. **Perianth** widely obovate or pyriform or oblong, ca. 0.5 mm long, 0.3 mm wide, 5-keeled, keels smooth, beak short (Fig. 5.58). **Androecia** and **sporophytes** not found.

Thailand. — SOUTH-EASTERN: Prachin Buri.
Distribution. — India, Northwestern Himalaya and Japan.
Ecology. — On tree trunks and branches.
Specimens examined. — *S. Chantanaorrapint 592* (BCU).

2. *LEPTOLEJEUNEA*

Leptolejeunea (Spruce) Schiffn. in Engler & Prantl, Nat. Pflanzenfam. 1(3): 126. 1893; Mizut., J. Hattori Bot. Lab. 24: 229. 1961. *Lejeunea* subgen. *Lepto-Lejeunea* Spruce, Trans. Proc. Bot. Soc. Edinburgh 15: 193. 1884.

Plants small to medium, pale green. **Stems** closely appressed to the substrata, irregularly pinnate by the intercalary branching; in cross-section with 7 cortical cells and 3 small medullary cells. **Rhizoids** from group of cells of underleaves. **Lateral leaves** remote to slightly imbricate; **leaf-lobe** elliptic to ovate, apex obtuse to acute, margin entire to dentate; ocelli one at base, often additional ones scattered in the lamina; oil-bodies 5-10 per cell, homogenous, those in the ocellus single but nearly filling cell-lumen; **leaf-lobule** large, inflated, the first tooth small, usually with one projecting cell, the second tooth reduced. **Underleaves** small, deeply bilobed, lobes divaricate, acute, lanceolate, the basal portion brodered by 6 elongate cells. **Androecia** mostly capitate, male bracteoles mostly limited to the base of androecium. **Gynoecia** usually on a short lateral branches, subfloral innovations lacking; female bracts and bracteoles more or less acute at apex, dentate at margin; bracteoles dentate to entire at margin, often emarginated to slightly bilobed. **Perianth** usually inflated, 5-keeled (1 dorsal, 2 lateral, 2 ventral), keels wide, smooth, apex extending upwards and outwards as acute to truncate horns.

Leptolejeunea epiphylla (Mitt.) Steph.

Sp. Hepat. (Stephani) 5: 380. 1913; R.L. Zhu & M.L. So, Hedwigia 121: 216, fig. 82. 2001. — *Lejeunea epiphylla* Mitt., J. Proc. Linn. Soc., Bot. 5: 118. 1861.

Plants small, pale green. **Stems** up to 10 mm long, with leaves ca. 1.0-1.2 mm wide, densely irregularly branched. **Rhizoids** numerous, fasciculate, arising from basal disc of underleaf. **Lateral leaves** imbricate or contiguous, rarely remote, widely spreading; **leaf-lobes** obliquely oblong-ovate, 0.4-0.6 mm long, 0.25-0.3 mm wide, apex truncate or obtuse, margin entire; marginal cells subquadrate 12-18 × 10 μm, median and basal cells 25-35 × 15-20 μm, thin-walled, trigones small, intermediate thickening distinct; ocelli scattered; cuticle smooth; **leaf-lobule** usually small,

rectangular, flatted, ca. 1/6 as long as lobe, apex obliquely truncate, with 1-2 elongate cells of toothed. **Underleaves** distant, 5-6 times as wide as the stem, transversely inserted, deeply bilobed, lobes linear, 3-4 cells long, 1 cells wide throughout. **Androecia** not found. **Gynoecia** on short branches, subfloral innovations absent; bracts and bracteole connate at base, margin dentate. **Perianth** obovate, 0.4-0.5 mm long, 0.3-0.4 mm wide, 5-keeled, keels somewhat wing-like, spreading horizontally (Fig. 5.59, 5.102). **Sporophytes** not found.

Thailand. — PENINSULAR: Ranong.

Distribution. — Africa, Cambodia, China, Japan, Laos, Papua New Guinea, Solomon Island

Ecology. — Epiphyllus plants.

Specimens examined. — *S. Chantanaorrapint 498* (BCU).

3. *LOPHOLEJEUNEA*

Lopholejeunea (Spruce) Schiffn., in Engler & Prantl, Nat. Pflanzenfam. 1(3): 129. 1895; Mizut., J. Hattori Bot. Lab. 24: 174. 1961. — *Lejeunea* subgen. *Lopho-Lejeunea* Spruce, Trans. Proc. Bot. Soc. Edinburgh 15: 119. 1884.

Plants small to medium, dark green to blackish brown. **Stems** usually irregularly pinnate by the intercalary branching; in cross-section cortical cells slightly larger than the medullary cells, 10-12 longitudinal rows. **Lateral leaves** imbricate; **leaf-lobe** entire at margin, apex rounded or rarely apiculate; **oil-bodies** small, homogenous, numerous; **leaf-lobule** more or less inflated, angles obtuse or with 1-2 small teeth. **Underleaves** large, orbicular or reniform, margin entire. **Androecia** capitate, occupying a short lateral branch, male bracteoles similar to underleaves but smaller. **Gynoecia** usually on lateral intercalary branch, without or rarely with 1 innovation; female bracts-lobe large, dentate toward the acute apex; bracteoles dentate to entire at margin, often emarginated to slightly bilobed. **Perianth** usually flat, 4(-5)-keeled (1 slightly dorsal or none, 2 lateral, 2 ventral), keels irregularly dentate.

Lopholejeunea subfusca (Nees) Steph.

Hedwigia 29: 16. 1890; Mizut., J. Hattori Bot. Lab. 24: 180, fig. XII, 14-23. 1961. — *Jungermannia subfusca* Nees, Hepat. Javan. 36. 1830.

Plants medium, dark green or blackish brown. **Stems** 10-20 mm long, with leaves ca. 1 mm wide, irregularly branched. **Rhizoids** numerous, fasciculate at base of underleaves. **Lateral leaves** widely spreading: **leaf-lobe**, falcately ovate, 0.7-0.9 mm long, 0.6-0.75 mm wide, apex rounded, margin entire, dorsal margin nearly truncate at base; marginal cells 10-15 μm, median cells 20-25 × 15-20 μm, thick-walled, with large, acute intermediate thickening and trigones, basal cells ca. 40 × 25 μm; cuticle smooth; **leaf-lobule** obliquely ovate, strongly inflated, ca. 1/3 as long as lobe, free margin involute, teeth triangular, apex nearly truncate, keels arched. **Underleaves** approximate or slightly imbricate, 3-4 times as wide as the stem, orbicular to reniform 0.3-0.4 mm long, 0.4-0.5 mm wide, flatted, apex rounded, margin entire. **Autoicous**. **Androecia** terminal on short branches, bract 5-8 pairs, densely imbricate, ovate, ca. 1/3-1/2 as long as leaf-lobes; bracteoles imbricate, rounded, smaller than underleaves, present throughout. **Gynoecia** terminal on stems or branches, innovation lacking;

bract-lobe widely obovate, ca 1.5 as long as leaf-lobe, apex rounded, margin dentate; bract-lobule usually small; bracteole large rotundate, ca. 1 mm long and wide, inflated, apex rounded. **Perianth** widely obovate or pyriform, 1-1.2 mm long 0.4-0.5 mm wide, 4-keeled, keels densely spinose or dentate, beak short (Fig. 5.60). **Sporophytes** not found.

Thailand. — NORTHERN: Chiang Rai; EASTERN: Nakhon Ratchasima; PENENSULAR: Ranong.

Distribution. — Japan, Formosa, India, Ceylon, Malay, Sumatra, Java, Borneo, Philippenes, New Guinea, New Claedonia, Tahiti, North and South America, British Hondurus, Africa.

Ecology. — On tree trunks.

Specimens examined. — *S. Chantanaorrapint 241, 255* (BCU).

4. *MASTIGOLEJEUNEA*

Mastigolejeunea (Spruce) Schiffn, in Engler & Prantl, Nat. Pflanzenfam. 1(3): 129 .1895; Mizut., J. Hattori Bot. Lab. 24: 155. 1961. — *Lejeunea* subgen. *Mastigo-Lejeunea* Spruce, Trans. Proc. Bot. Soc. Edinburgh 15: 100. 1884. — *Lejeunea* subgeb. *Mastigo-Lejeunea* sect. *Trigono-Lejeunea* Spruce, ibid 15: 101. 1884.

Plants rather small to medium. **Stems** irregularly branched by intercalary branching except in the subfloral innovation; cortical cells of the stem in 20-30 longitudinal rows, as large as medullary cells, both cortical cells and medullary cells thick-walled, trigones large, particularly. **Lateral leaves** imbricate, **leaf-lobe** entire at margin, apex acute or obtuse; cells thick-walled with intermediate thickenings and trigones; oil-bodies large, 2-3 per cell, of the grape cluster type; **leaf-lobule** usually inflated, with 1-2 teeth, or occasionally without. **Underleaves** orbicular, entire, the apex more or less emarginated. **Androecia** terminal on lateral branch, bracts and bracteole nearly same as, but smaller than leaves and underleaves, bracteoles present throughout. **Gynoecia** terminal on main branch, usually with 1-2 innovation; female bracts obtuse or occasionally saccate to acute at apex, the margin entire; bracteoles more or less emarginated at apex, the margin entire. **Perianth** sharply 3-keeled and often with 1-7 additional keels (0-3 dorsal, 2 lateral, 1-5 ventral), keels smooth.

Key to species

1. Leaf-lobe obtuse to rounded at apex; leaf-lobule large, about 1/2 as long as the lobe, free margin with 2-4 large teeth.....1. *M. indica*

1. Leaf-lobe acute at apex; leaf-lobule small, about 1/5-1/4 as long as the lobe, free margin nearly entire.....2. *M. replete*

1. ***Mastigolejeunea indica*** Steph.

Sp. Hepat. (Stephani) 4: 776. 1912; Mizut., J. Hattori Bot. Lab. 61: 294, fig. . 1986.

Plants medium, olive green to dark brown. **Stems** 10-30 mm long, with leaves 1.2-2.0 mm wide, irregularly branched. **Rhizoids** numerous, brown, fasciculate. **Lateral leaves** densely imbricate, obliquely spreading; **leaf-lobe** ovate, 0.7-1.0 mm long, 0.6-0.75 mm wide, apex rounded or obtuse, often incurved, ventral margin flat, dorsal margin more or less with auriculate base; apex cells 5-8 × 5-10 μm, median cells 20-25 × 15-20 μm, thin-walled, trigones large, cordate, intermediate thickening few but large, basal cells ca. 35 × 30 μm; cuticle smooth; **leaf-lobule** large, ovate or triangular, ca. 1/2 as long as lobe, free margin with 2-4 large teeth, teeth triangular, apex acute or obtuse, margin of teeth more or less recurved, keels straight. **Underleaves** approximate or imbricate, 3-4 times as wide as the stem, reniform 0.4-0.5 mm long, 0.5-0.6 mm wide, margin usually narrowly recurved, slightly plicate. **Androecia** not found. **Gynoecia** terminal on stem or branch, with 1-2 subfloral innovations, innovation often again floriferous; bract-lobe ovate or oblong, 0.8-0.9 mm long, 0.5-0.6 mm wide, apex usually obtuse, margin somewhat undulate; bract-lobule oblong or ovate, 2/3-3/4 as long as bract-lobe, apex obtuse to rounded; bracteole oblong or obovate, 0.7-0.8 mm long, 0.5 mm wide, apex obtuse and slightly recurved, plicate. **Perianth** obovate, 1-1.2 mm long 0.4-0.5 mm wide, 3-keeled, ventral keel usually weakly with 1-2 additional keels, beak short (Fig. 5.61).

Thailand. — NORTHERN: Chiang Rai; NORTH-EASTERN: Loei; EASTERN: Nakhon Ratchasima; SOUTH-WETERN: Uthai Thani, Ratchaburi.

Distribution. — China, Nicobars.

Ecology. — On tree trunks or rocks, in shade.

Specimens examined. — *S. Chantanaorrapint 237* (BCU).

2. ***Mastigolejeunea repleta*** (Taylor) A. Evans

Mem. Torrey Bot. Club 8: 131. 1902; Mizut., J. Hattori Bot. Lab. 61: 283, fig. 2. 1986. — *Lejeunea replete* Taylor, London J. Bot. 5: 392. 1846. — *Phragmicoma replete* (Taylor) Taylor. in Gottsche et al., Syn. Hepat.: 742. 1847. — *Lejeunea wardiana* Mitt., Hepat. Indiae orient.: 109. 1861. — *Brachiolejeunaea wardiana* (Mitt.) Steph., Sp. Hepat. (Stephani) 5: 129. 1912. — *Lejeunea atypos* Schiffn., Leberm., Forschungsr. Gazelle 4: 22. 1890. — *Mastigolejeunea atypos* (Schiffn.) Steph. Sp. Hepat. (Stephani) 4: 768. 1912. — *M. spectabilis* Steph. Sp. Hepat. (Stephani) 4: 772. 1912.

Plants large, olive green to dark brown. **Stems** 20-40 mm long, with leaves 2-2.5 mm wide, irregularly branched. **Rhizoids** numerous, fasciculate. **Lateral leaves** loosely imbricate, widely spreading, **leaf-lobe** ovate to oblong, 1.0-1.3 mm long, 0.7-0.9 mm wide, apex acute or apiculate, ventral margin usually incurved, dorsal margin usually flat, base more or less auriculate; apex cells 7-12 × 5-10 μm, median cells rhomboidal, 20-25 × 10-15 μm, thin-walled, trigones large, cordate, intermediate thickening few, small, basal cells ca. 35-45 × 30 μm; cuticle smooth; **leaf-lobule** small, ovate, 1/5-1/4 as long as lobe, apex obliquely truncate, keels nearly straight. **Underleaves** imbricate, 3-4 times as wide as the stem, reniform 0.4-0.5 mm long, 0.5-0.6 mm wide, apex and margin usually recurved, usually plicate (Fig 5.62). **Fertile plants** not found.

Thailand. — NORTHERN: Mae Hong Son, Chiang Mai; NORTH-EASTERN: Loei; EASTERN: Nakhon Ratchasima; SOUTH-WETERN: Uthai Thani, Kanchanaburi, Ratchaburi; SOUTH-EASTERN: Prachin Buri, Chanthaburi.

Distribution. — India, Bhutan, Andamans, Philippens, Borneo, New Guinea.

Ecology. — On tree trunks or rocks, in shade.

Specimens examined. — *S. Chantanaorrapint 247, 252* (BCU).

5. *PTYCHANTHUS*

Ptychanthus Nees, Naturg. Eur. Leberm. 3: 212. 1838; Mizut., J. Hattatori Bot. Lab. 24: 147. 1961. — *Lejeunea* subgen. *Ptycho-Lejeunea* Spruce, Trans. Proc. Bot. Soc. Edinburgh, 15: 97. 1884. — *Ptychilejeunea* Steph. Hedwigia, 28: 258. 1889.

Plants large. **Stems** irregularly pinnate or bipinnate, branching terminal, *Frullnia* type; cortical cells of stem in about 50 longitudinal rows, the outermost cells of medulla smaller and with thicker walls than the inner cells which are thin-walled and about as large as the cortical cells; **Lateral leaves** imbricate; **leaf-lobe** dentate at margin, apex acute or acuminate, cells thick-walled; oil-bodies about 10 per cell, large and of the grape cluster type; **leaf-lobule** saccate, usually with a single tooth. **Underleaves** orbicular to obovate, apex dentate or occasionally emarginately bilobed. **Androecia** terminal on lateral branches; male bracteoles present throughout. **Gynoecia** on primary and secondary lateral branches, with a single innovation, innovations mostly succsesively floriferous; female bracts resembling leaves but with smaller plane lobule; bracteoles resembling underleaves. **Perianth** obovate, inflated, 10-keeled (3 dorsal, 4 lateral, 3 ventral), keels sharp, smooth.

Ptychanthus striatus (Lehm. & Lindenb.) Nees

Natrug. Eur. Lemberm. 3: 212. 1838; Mizut., J. Hattori Bot. Lab. 24: 148, fig. V, 1-17. 1961. — *Jungermannia striata* Lehm. & Lindenb. in Lehm., Pugillus 4: 16. 1832. — *Frullania striata* (Lehm. & Lindenb.) Mont., Ann. Sci. Nat. ser. 2 17: 16. 1842. — *Ptychanthus squarrosus* Mont. in Lehm., Pugillus 8: 22. 1844. — *P. wightii* Gott. in Gott., Lndnb. & Nees, Syn. Hepat. 291. 1845.

Plants robust, dark green or olive green. **Stems** up to 10 mm long, with leaves 2.5-3 mm wide, regularly pinnately or bipinnately branched. **Rhizoids** not found. **Lateral leaves** slightly to densely imbricate, widely spreading; **leaf-lobe** convex, oblong-ovate, 1.3-1.5 mm long, 1.0-1.2 mm wide, apex acute or acuminate, margin dentate to nearly entire, ventral margin usually incurved, base dorsal margin auriculate; apex cells 10-15 μm, median cells rhomboidal, 35-40 × 20-25 μm, thick-walled, with large intermediate thickening and trigones, basal cells ca. 40-50 × 20-30 μm, trigones large; cuticle smooth; **leaf-lobule** small, nearly rectangular, 1/5-1/4 as long as lobe, apex obliquely truncate, keels nearly straight. **Underleaves** loosely imbricate, 3-4 times as wide as the stem, orbicular, 1.0-1.2 mm long, 0.7-1.0 mm wide, apex rounded, irregularly dentate or sometimes nearly entire, lateral margin more or less recurved, bases mostly appendiculate. **Androecia** not found. **Gynoecia** on primary or secondary branches, with single subfloral innovations; bract-lobe oblong-ovate, slightly smaller than leaf-lobe, 1.2-1.4 mm long, 0.6-0.7 mm wide, apex acute to acuminate, more or less dentate; bract-lobule dimorphic; ones large

oblong or ovate, 1/3-2/5 as long as bract-lobe, usually plane, keel short, other ones smaller, linear, free margin incurved, keel long; bracteole oblong, smaller and narrower than underleaves, apex dentate. **Perianth** oblanceolate to obovate, inflated, ca. 1.5 mm long 0.4-0.7 mm wide, usually 10-keeled, keels rounded and smooth, beak short (Fig. 5.63, 103). **Sporophytes** not found.

Thailand. — NORTHERN: Chiang Mai, Chiang Rai; NORTH-EASTERN: Loei.

Distribution. — Japan, Formosa, Amboina, Malay, Burma, Assam, India, Madagascar, Tropical Africa.

Ecology. — On tree trunks and branches.

Specimens examined. — *S. Chantanaorrapint 118, 258, 284, 333, 344,393, 509, 542, 586, 610* (BCU).

6. *SPRUCEANTHUS*

Spruceanthus Verd., Ann. Bryol. Suppl. 4: 151. 1934; Mizut., J. Hattori Bot. Lab. 24: 160. 1961.

Plants medium to large. **Stems** irregularly branched by the intercalary branching; in cross-section of stem, cells thick-walled, trigones large, cortical cells in 30-35 longitudinal rows, slightly smaller than medullary cells. **Lateral leaves** contiguous to imbricate; **leaf-lobe** dentate to almost entire at margin, acute or rarely obtuse at apex; cells thick-walled, intermediate thickening, trigones large, nodulose; oil-bodies numerous, 20-40 per cell, minute, homogenous, hyaline; **leaf-lobule** with 1-3 teeth. **Underleaves** orbicular, margin entire or dentate. **Androecia** usually terminal on a short lateral branches; male bracts and bracteole similar to leaves and underleaves, bracteoles present throughout. **Gynoecia** terminal on the main branches, usually with 1-2 subfloral innovations; female bracts spinose-dentate at margin, acute at apex; bracteoles entire or dentate at margin. **Perianth** 5-10 keeled (1-2 dorsal, 2 lateral, 2-5 ventral), keels smooth.

Key to species

1. Leaf-lobes rounded at apex; plants small.....1. *S. polymorphus*

1. Leaf-lobes acute at apex; plants large.....2. *S. semirepandus*

1. ***Spruceanthus polymorphus*** (Sande. Lac.) Verd.

Ann. Bryol. suppl. 4: 155. 1934; Mizut., J. Hattori Bot. Lab. 24: 164, figs. IX, 20-30; X ,1-4. 1961. — *Phragmicoma polymorpha* Sande. Lac. Natuurk. Tijdsch v. Nederl.-Indië. 10: 396. 1856.

Plants medium, green to dark green. **Stems** 10-30 mm long, with leaves about 2.5 mm wide, irregularly pinnately branched, in cross-section cortical cells slightly larger than medullary cells, wall thinner. **Rhizoids** few. **Lateral leaves** imbricate, widely spreading; **leaf-lobe** convex, obliquely ovate or falcate-ovate, 1.1-1.2 mm long, 0.8-0.9 mm wide, apex obtuse to rounded, margin entire, ventral margin slightly incurved, base of dorsal margin rounded; marginal cells 10-12 μm, thick-walled, trigones indistinct, median cells hexagonal, 20-25 × 15-20 μm, trigones large, with

nodulate intermediate thickening, basal cells ca. 45-60 × 20-30 μm, thick-walled, with large trigones; cuticle smooth; **leaf-lobule** oblong to ovate, saccate, 1/3-2/5 as long as lobe, apex obliquely truncate, keels curved. **Underleaves** loosely imbricate or not, 2.5-3 times as wide as the stem, widely obovate to orbicular or reniform, 0.4-0.5 mm long, 0.5-0.7 mm wide, apex truncate to rounded, usually entire, sometimes plicate. **Androecia** usually on short lateral branches, often with single innovation; bract-lobe in 4-8 pairs, closely imbricate, about half the length of leaf-lobe; bract-lobule large, about 2/3 as long as bract-lobe; bracteole almost similar to underleaf but smaller. **Gynoecia** terminal on lateral branches, usually with 1-2 innovations, innovation usually again floriferous; female bracts obovate, ca. 1.5 mm long, 0.8-1.0 mm wide, apex acute, margin nearly entire, bract-lobule 1/2 as long as lobe; bracteole ovate or spathulate, 2.0-2.5 mm long, 1.0-1.5 mm wide, apex slightly dentate, more or less emarginate. **Perianth** obovate to subclavate, 1.2 mm long, 0.5-0.7 mm wide, 5-keeled (1 dorsal, 2 lateral, 2 ventral), often with 2-3 small additional keels, keels smooth (Fig. 5.64).

Thailand. — NORTHERN: Chiang Rai; EASTERN: Nakhon Ratchasima.

Distribution. — Japan, Bonin, Formosa, India, Philippines, Borneo, Sumatra, Java, New Guinea, New Caledonia, Samao, Tahiti, Hawaii.

Ecology. — On tree trunks.

Specimens examined. — *S. Chantanaorrapint 246, 318, 320* (BCU).

2. ***Spruceanthus semirepandus*** (Nees) Verd.

Ann. Bryol. Suppl. 4: 153.1934; Mizut., J. Hattori Bot. Lab. 24: 161, fig. IX, 1-19. 1961. — *Jungermannia semirepanda* Nees, Hepat. Javan. 39. 1830. — *Ptychanthus semirepandus* (Nees) Nees, Naturg. Eur. Leberm. 3: 212. 1838. — *Phragmicoma semirepanda* (Nees) Gott. in Gott., Lndnb. & Nees, Syn. Hepat. 302. 1845. — *Lejeunea semirepanda* (Nees) Mitt. J. Proc. Linn. Soc. Bot. 5: 111. 1861. — *Thysananthus rotundistipulus* Steph., Sp. Hepat. (Stephani) 6: 566. 1924.

Plants large, yellowish to brownish green. **Stem** 3-10 cm long, with leaves 3-5 mm. wide; in cross-section of the stem, cells thick-walled, the cortical slightly smaller than the medullary cells. **Rhizoids** scarce. **Lateral leaves** densely imbricate, widely spreading, **leaf-lobe** convex, when flattened obliquely ovate, 1.5-2.5 mm. long, 1.1-1.5 mm. wide, apex acute, margin more or less dentate towards, ventral margin often incurved, base of dorsal margin cordate; marginal cells 15-20 μm, thick-walled, trigones large; median cells hexagonal, ca. 40 × 25 μm, wall with intermediate thickening and large trigones; basal cells ca. 40-60 × 25-30 μm, wall with intermediate thickening and large trigones; cuticle smooth; **leaf-lobule** 1/4 as long as lobe, inflated, apex obliquely truncate, keels nearly straight. **Underleaves** imbricate, 3-4 times as wide as the stem, orbicular,0.7-1.0 mm long, 0.6-1.1 mm wide, apical margin entire, lateral margin often recurved, usually plicate along median line. **Androecia** usually on short lateral branch; male bracts 5-12 pairs, densely imbricate, ca. 1/2-1/3 the length of leaf-lobe, inflated; bracteole almost similar to underleaf but smaller. **Gynoecia** terminal on main branches, usually with 1-2 innovations, innovation usually again floriferous; female bracts oblong, ca. 2.5 mm long, 1.0-1.2 mm wide, apex acute, margin more dentate than leaves, lobules small; bracteole obovate, 2.5 mm long, 1.5 mm wide, apex emarginated or bilobed, irregularly dentate.

Perianth obovate, inflated, 2.0-2.5 mm long, 1.2-1.5 mm wide, 5-10-keeled, often with 2-3 small additional keels, keels smooth (Fig. 5.65, 5.104).

Thailand. — New record to Thailand.

Distribution. — Japan, Formosa, China, India, Borneo, Java, Philippines.

Ecology. — On tree trunks and branches.

Specimens examined. — *S. Chantanaorrapint 131, 181, 189, 260, 285, 329, 356, 618* (BCU).

7. *THYSANANTHUS*

Thysananthus Lindenb., in Lehm. Pugillus 8: 24. 1844; Mizut., J. Hattatori Bot. Lab. 24: 153. 1961. — *Lejeunea* subgen. *Thysano-Lejeunea* Spruce, Trans. Proc. Bot. Soc. Edinburgh 15: 105. 1884. — *Lejeunea* subgen. *Dendro-Lejenea* Spruce, ibid. 15: 110. 1884. — *Thysanilejeunea* Sim, Trans. Roy. Soc. S. Afr. 15: 50. 1926.

Plants medium to large. **Stems** irregularly pinnate, mostly intercalary branched except the subfloral innovation; cortical cells in about 30 longitudinal rows, as large as the medullary cells. **Lateral leaves** densely imbricate; **leaf-lobe** usually dentate at margin, acute at apex; leaf cells thick-walled, with large intermediate thickening and trigones; oil-bodies large, of the grape cluster type, usually 2-3 per cells; vitta cells present, along median line; **leaf-lobule** saccate, the free margin mostly involute, with 1-2 teeth at apex. **Underleaves** densely imbricate, usually dentate at margin, the apex often emarginated. **Androecia** terminal or intercalary on a short lateral branches; male bracts and bracteoles similar to leaves and underleaves. **Gynoecia** terminal on main branches, usually with 1-2 innovations; female bracts and bracteoles similar to leaves and underleaves, but slightly longer and more acute at apex. **Perianth** sharply 3-keeled, often with 1-7 (0-3 dorsal, 2 lateral, 1-3 ventral) small additional keels, keels irregularly dentate.

Thysananthus planus Sande Lac.

Ned. Kruidk. Arch. 3: 419. 1854; Mizut., J. Hattori Bot Lab. 63: 413, fig. 2. 1987. — *Phragmicoma plana* (Lac.) Mitt. in Seem., Fl. Vit.: 412: 1873. — *Thysanolejeunea plana* (Lac.) Steph., Hedwigia 28: 263. 1889. — *Thysananthus subplanus* Steph., Sp. Hepat. (Stephani) 4: 790. 1912. — *T. furcatus* Herz., Ann. Bryol. 4: 87. 1931.

Plants small, olive-green. **Stems** 10-20 mm long, with leaves 1.1-1.8 mm wide, irregularly branched; ventral merophyte of the stem about 8 cells wide. Rhizoids few, at base of stem. **Lateral leaves** imbricate, obliquely spreading; **leaf-lobe** oblong-lanceolate 0.8-1.1 mm long, 0.45-0.6 mm wide, apex apiculate or acute; ventral margin entire, slightly undulate; dorsal margin entire, flat, auriculate at base; apices cells 10-12 × 5-8 μm, median cells 15-20 × 8-12 μm, thick-walled, trigones and intermediate thickening large; vitta from base to middle of leaf-lobe, median vitta cells 25-45 × 10-12 μm, basal vitta cells 30-50 × 15-17 μm; cuticle smooth; **leaf-lobule** small ca. 1/4 as long as lobe, oblong-ovate, flat, apex truncate with 1 tooth; tooth linear, curved, 4-6 cells long; keel nearly straight. **Underleaves** imbricate, obliquely spreading, obovate to oblong, ca. 0.5 mm long, 0.4 mm wide, plicate, margin entire, apex more or less recurved. **Androecia** not found. **Gynoecia**

terminal on stem or branch, with 1-2 subfloral innovations, innovation usually again floriferous; bract-lobe lanceolate, 1.2-1.5 mm long, 0.4-0.5 mm wide, apex acute, margin slightly tooth near apex, entire below; bract-lobule oblong to ovate, ca. 1/2 as long as bract-lobe, nearly entire; bracteole oblong, 0.6-0.8 mm long, 0.4-0.5 mm wide, folded along median line, apex slightly bilobed, margin recurved and spinose above. **Perianth** obovate, ca. 1.2 mm long, 0.7 mm wide, sharply 3-keeled, keels irregularly spinose, beak very short (Fig. 5.66). **Sporophytes** not found

Thailand. — PENESULAR: Nakhon Si Thamarat.
Distribution. — Philippines, Borneo, Java, New Guinea, Somoa.
Ecology. — On tree trunks or rocks.
Specimens examined. — *S. Chantanaorrapint 535, 581* (BCU).

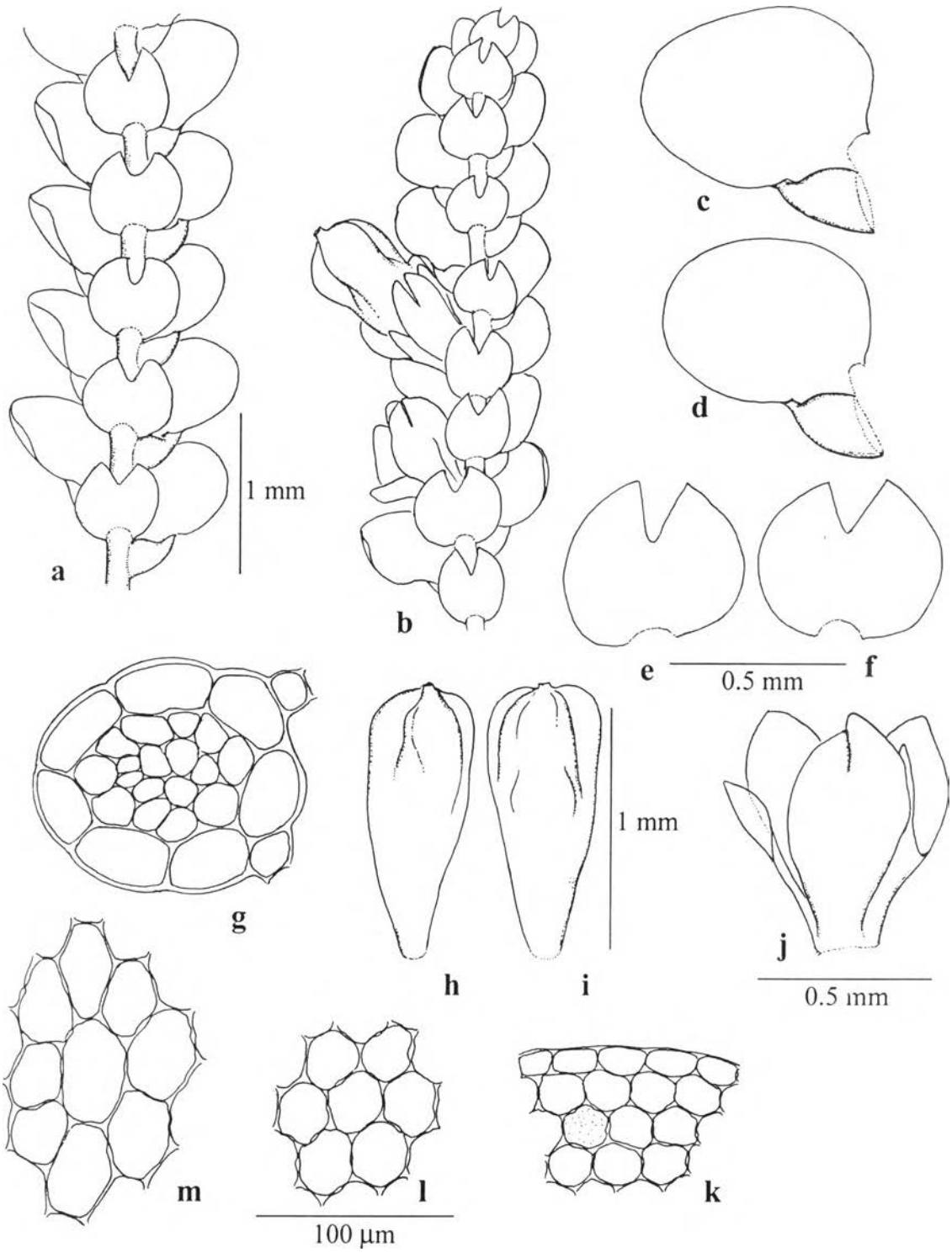

Figure 5.56 *Lejeunea discreta* Lindenb.
a. ventral portion of plant; b. plant with gynoecium, c., d. lateral leaves; e.-f. underleaves; g. cross-section of stem; h., i. perianthescells, h. dorsal view, i. ventral view; j. female bracts and bracteole; k. cells at leaf apex; l. cells at leaf median; m. cells at leaf base. Based on *S. Chantanaorrapint 264*.

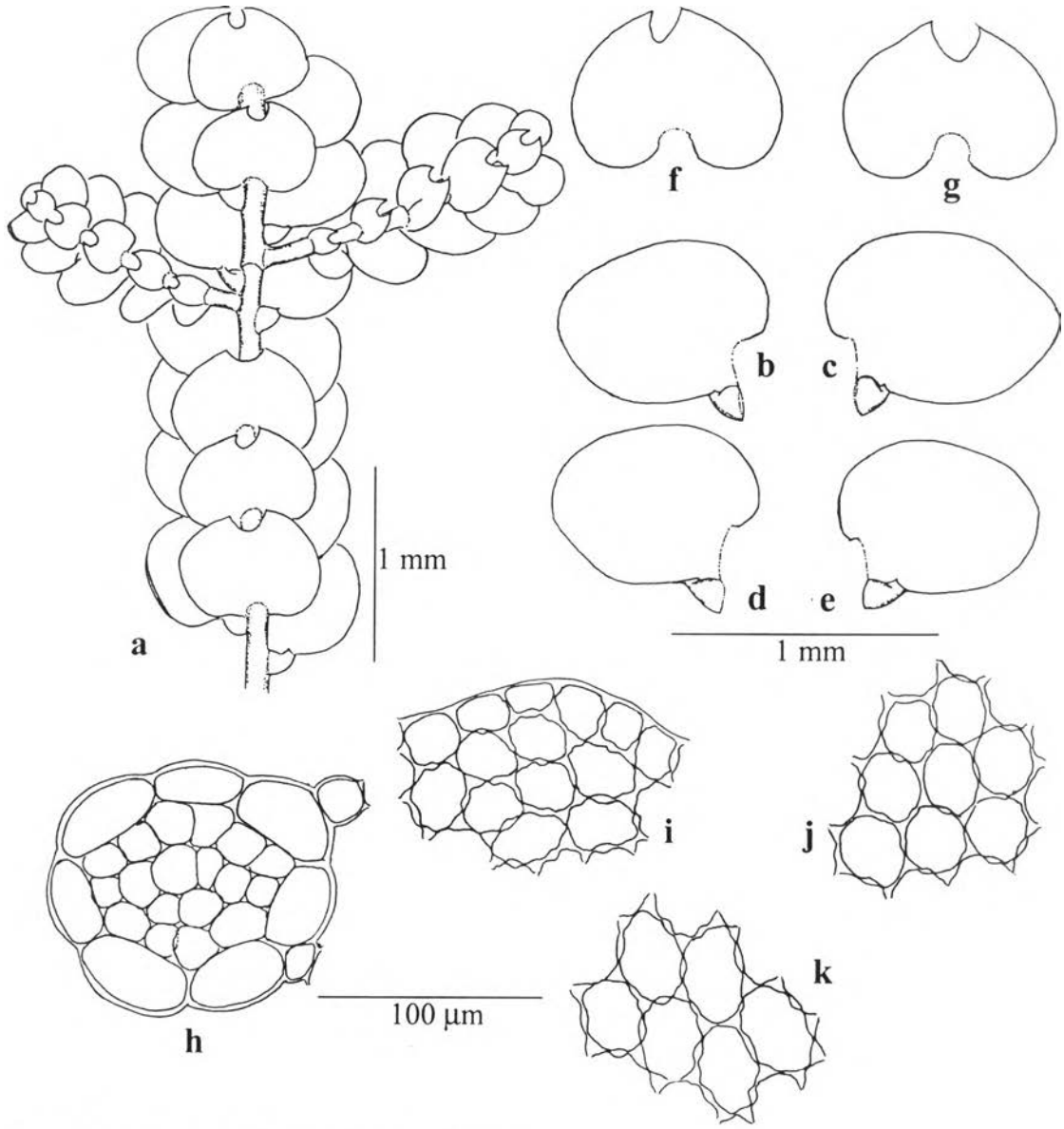

Figure 5.57 *Lejeunea sordida* (Nees) Nees
a. ventral portion of plant; b.-e. lateral leaves; f., g. underleaves; h. cross-section of stem; i. cells at leaf apex; j. cells at leaf median; k. cells at leaf base. Based on *S. Chantanaorrapint 592.*

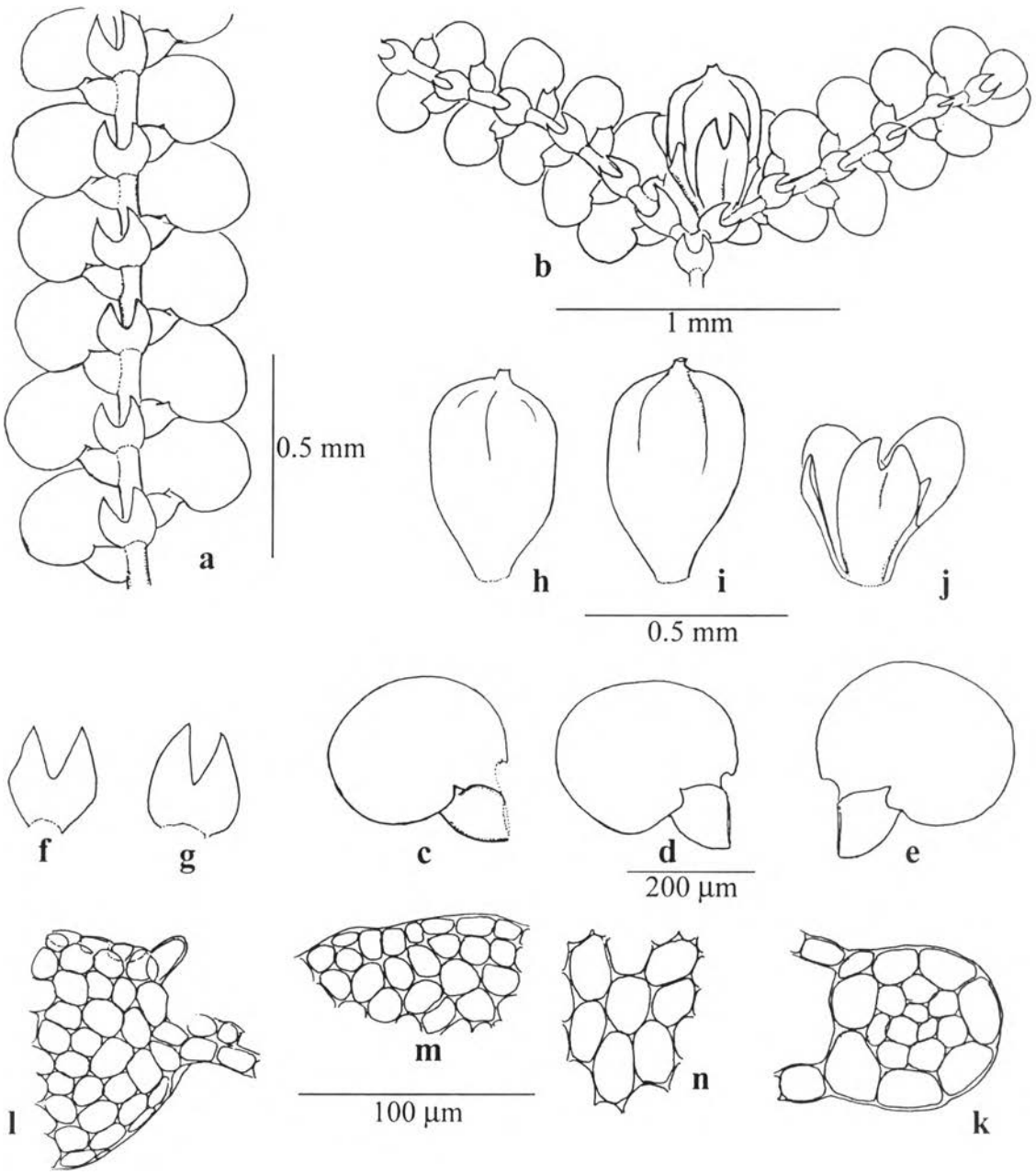

Figure 5.58 *Lejeunea wightii* Lindenb.
a. ventral portion of plant; b. gynoecium; c.-e. lateral leaves; f., g. underleaves; h., i. perianthes, h. dorsal view, i. ventral view; j. female bracts and bracteole; k cross-section of stem; l. leaf lobule; m. cells at leaf apex; n. cells at leaf base. Based on *S. Chantanaorrapint 592*.

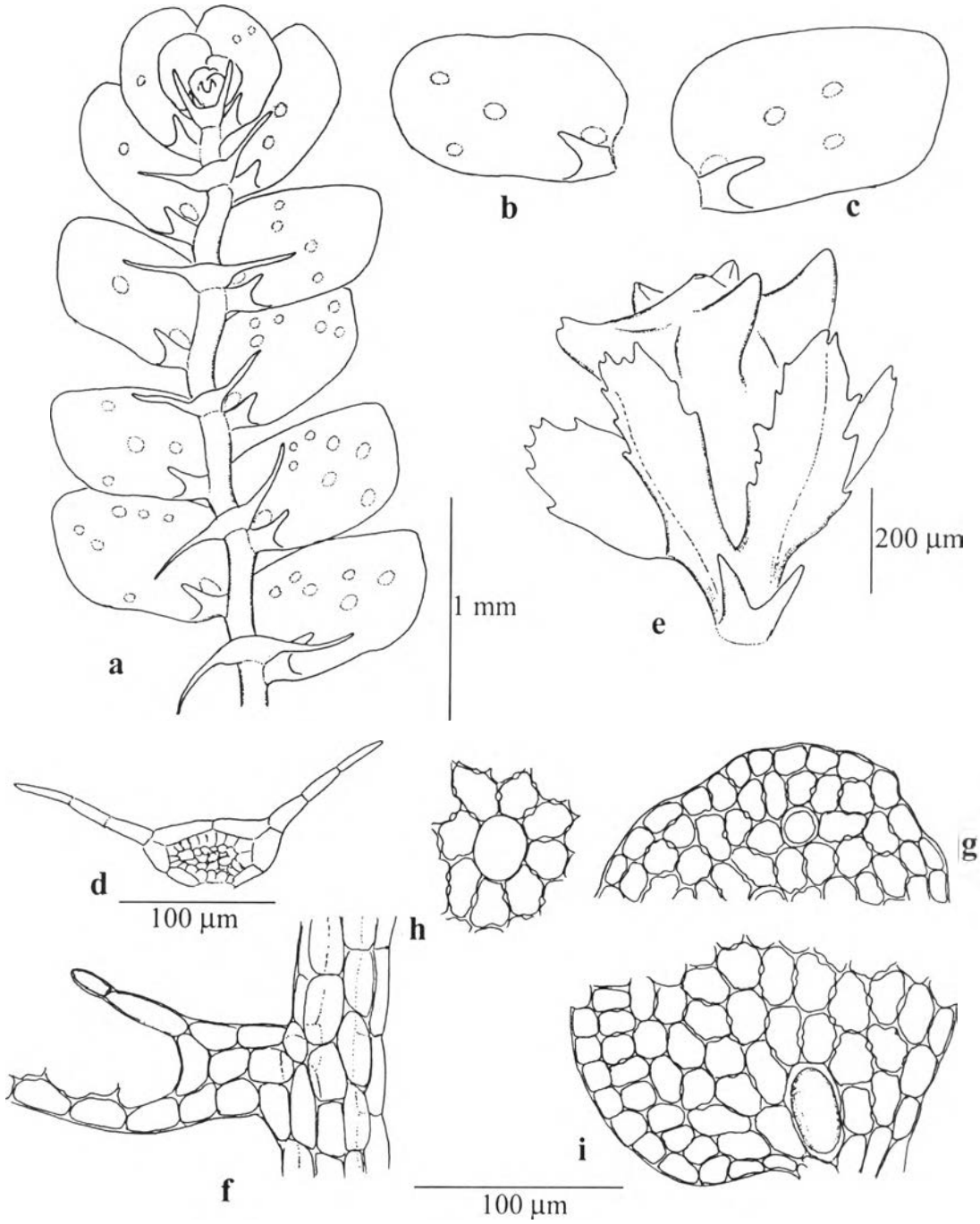

Figure 5.59 *Leptolejeunea epiphyllus* (Mitt.) Steph.
a. ventral portion of plant; b., c. lateral leaves; d. underleaf; e. gynoecium; f. leaf-lobule; g. cells at leaf apex; h. cells at leaf median; i. cells at leaf base. Based on *S. Chantanaorrapint 498*.

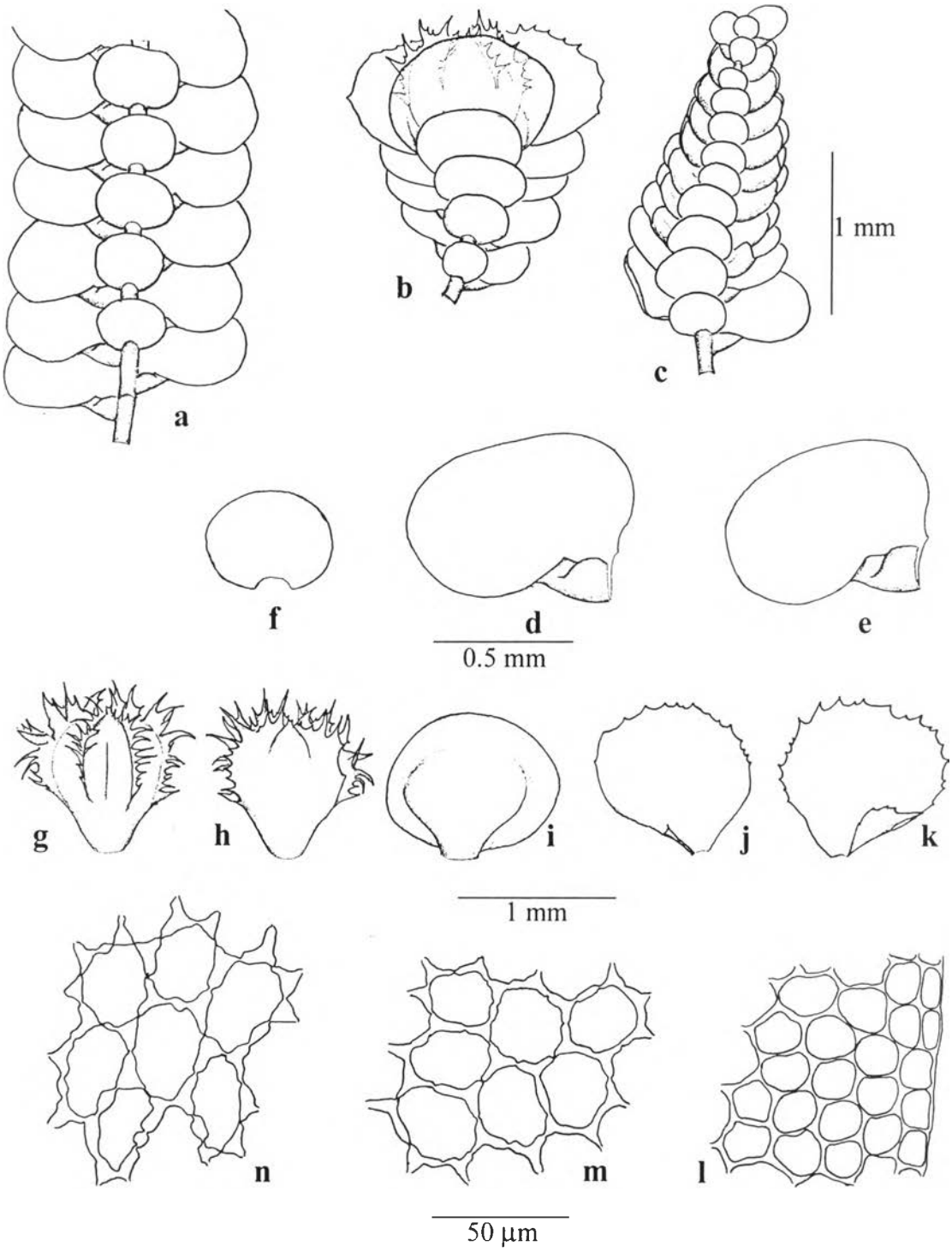

Figure 5.60 *Lopholejeunea subfusca* (Nees) Steph.
a. ventral portion of plant; b. gynoecium; c. androecium; d., e. lateral leaves; f. underleaf; g., h. perianthes, g. ventral view, h. dorsal view; i. female bracteole; j., k. female bracts; l. cells at leaf apex; m. cells at leaf median; n. cells at leaf base. Based on *S. Chantanaorrapint 241*.

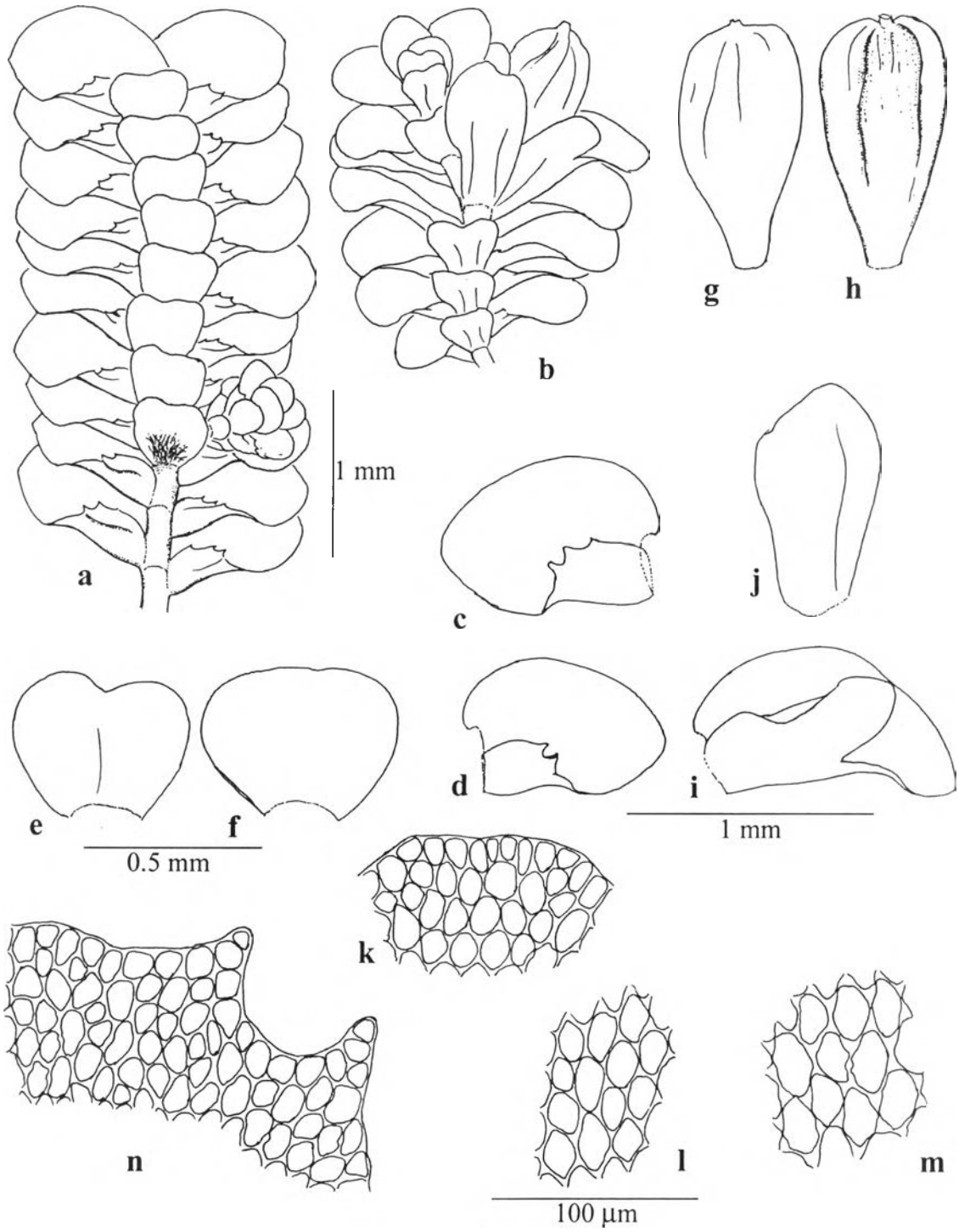

Figure 5.61 *Mastigolejeunea indica* Steph.
a. ventral portion of plant; b. gynoecium; c., d. lateral leaves; e., f. underleaves; g., h. perianthes, g. dorsal view, h. ventral view; i. female bract; j. female bracteole; k. cells at leaf apex; l. cells at leaf median; m. cells at leaf base; n. cells at apex of lobule. Based on *S. Chantanaorrapint 237*.

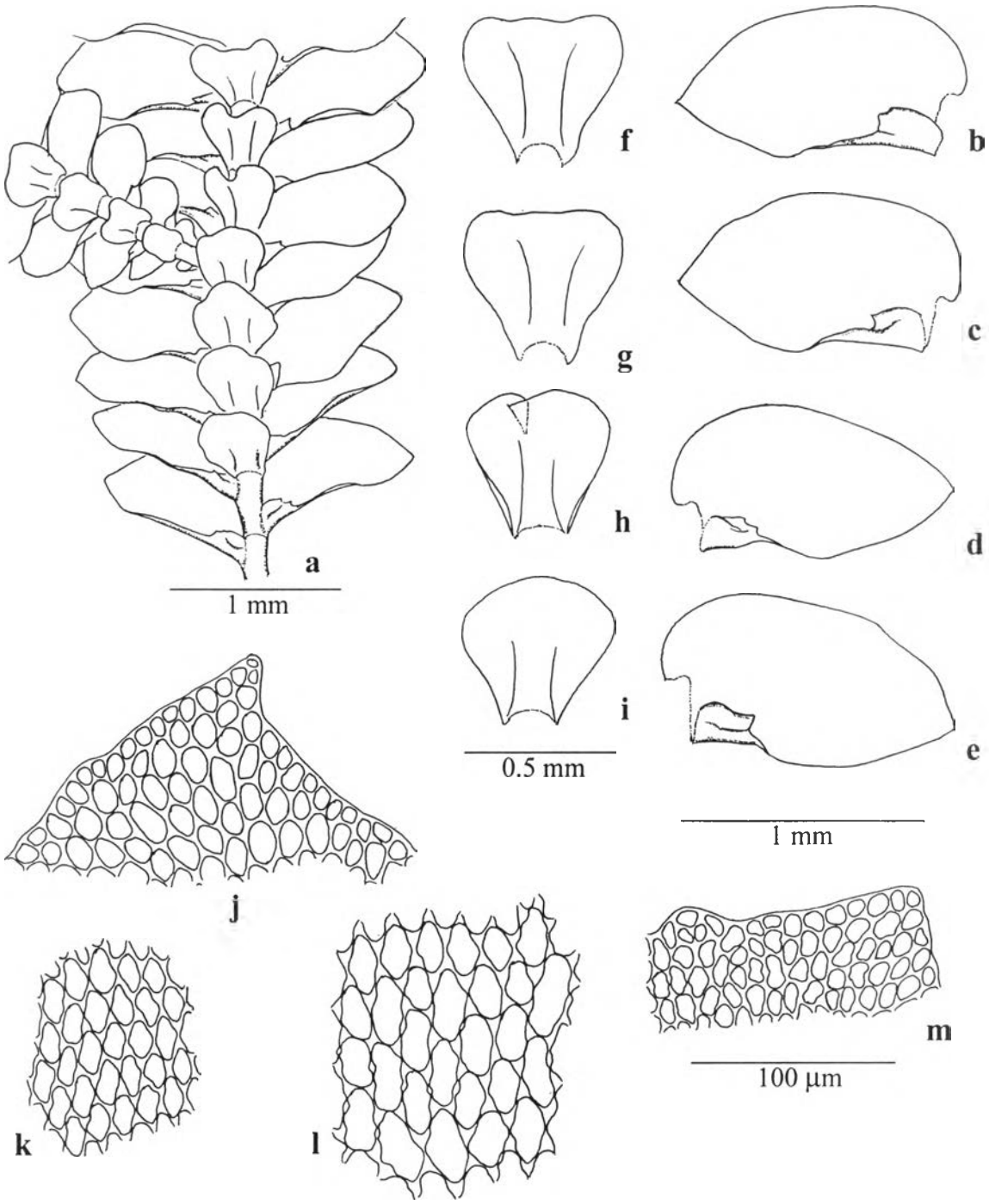

Figure 5.62 *Mastigolejeunea. repleta* (Taylor) A. Evans
a. ventral portion of plant; b.-e. lateral leaves; f.-i. underleaves; j. cells at leaf apex; k. cells at leaf median; l. cells at leaf base; m. cells at apex of lobule. Based on *S. Chantanaorrapint 247*.

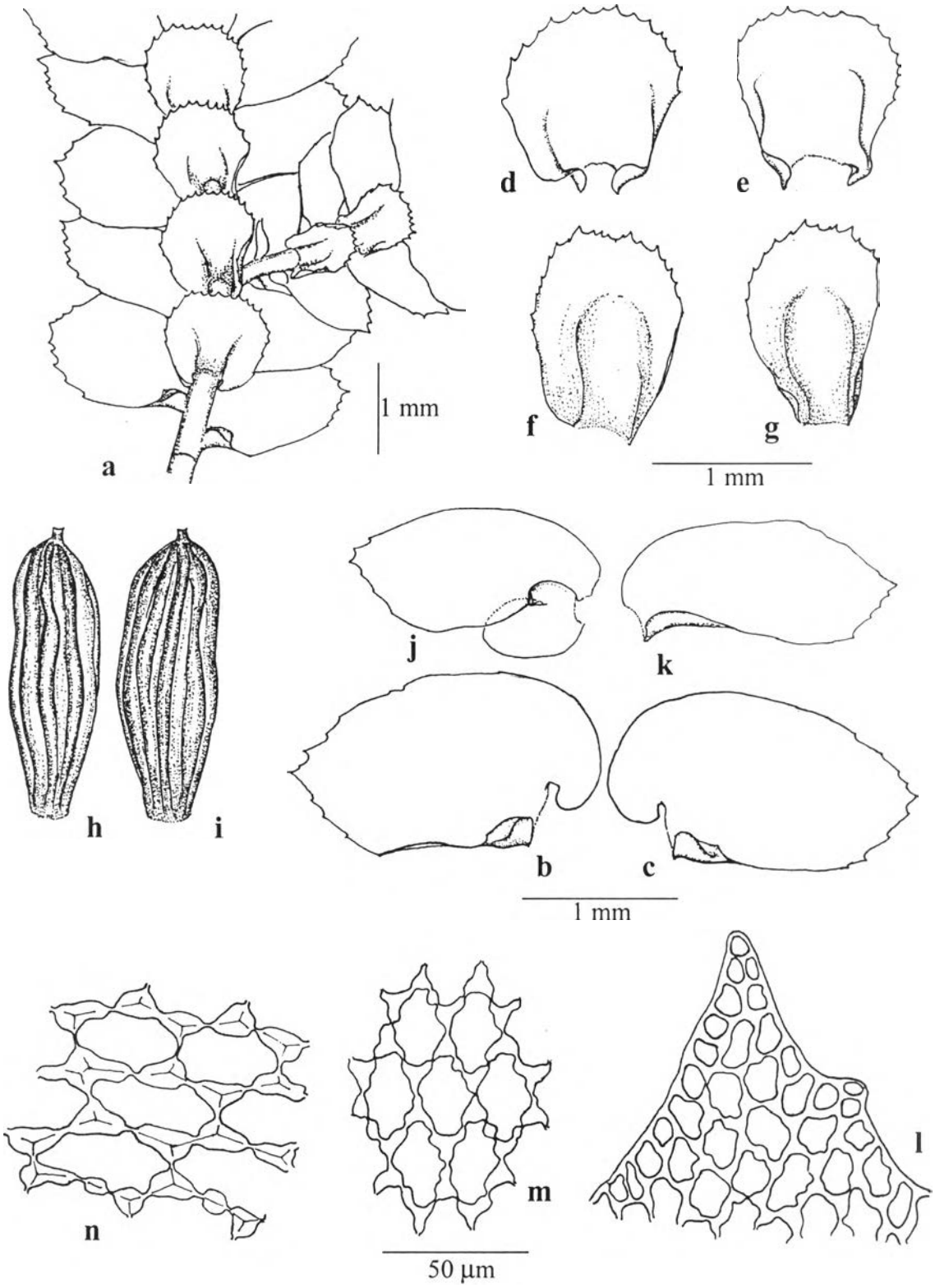

Figure 5.63 *Ptychanthus striatus* (Lehm. & Lindenb.) Nees
a. ventral portion of plant; b., c. lateral leaves; d.-g. underleaves; h., i. perianthes, h. dorsal view, i. ventral view; j., k. female bract; l. cells at leaf apex; m. cells at leaf median; n. cells at leaf base. Based on *S. Chantanaorrapint 284*.

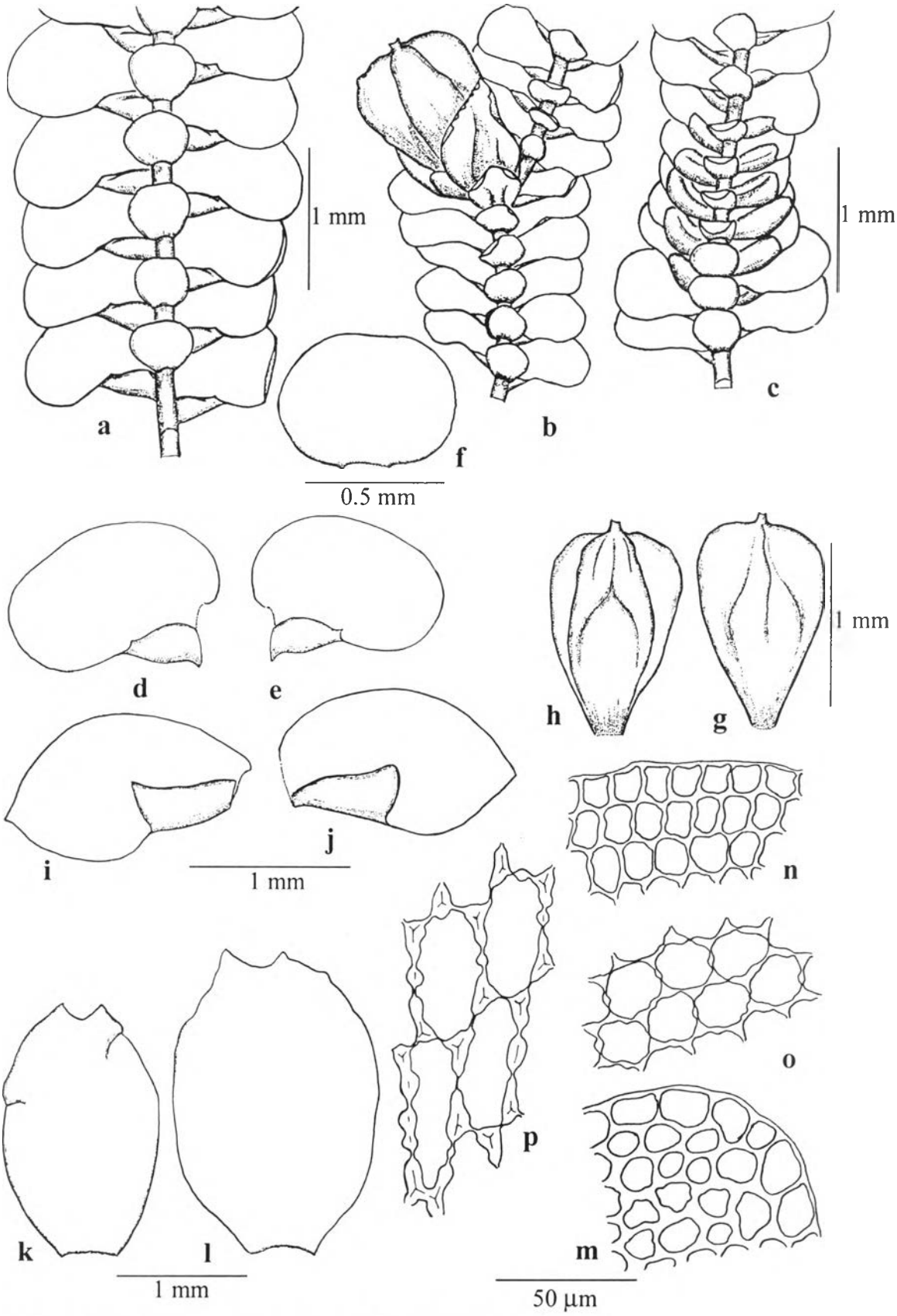

Figure 5.64 *Spruceanthus polymorphus* (Sande. Lac.) Verd.
a. ventral portion of plant; b. gynoecium; c. androecium; d., e. lateral leaves; f. underleaf; g., h. perianthes, g. dorsal view, h. ventral view; i., j. female bracts; k., l. female bracteoles; m. cross-section of stem; n. cells at leaf apex; o. cells at leaf median; p. cells at leaf base. Based on *S. Chantanaorrapint 318.*

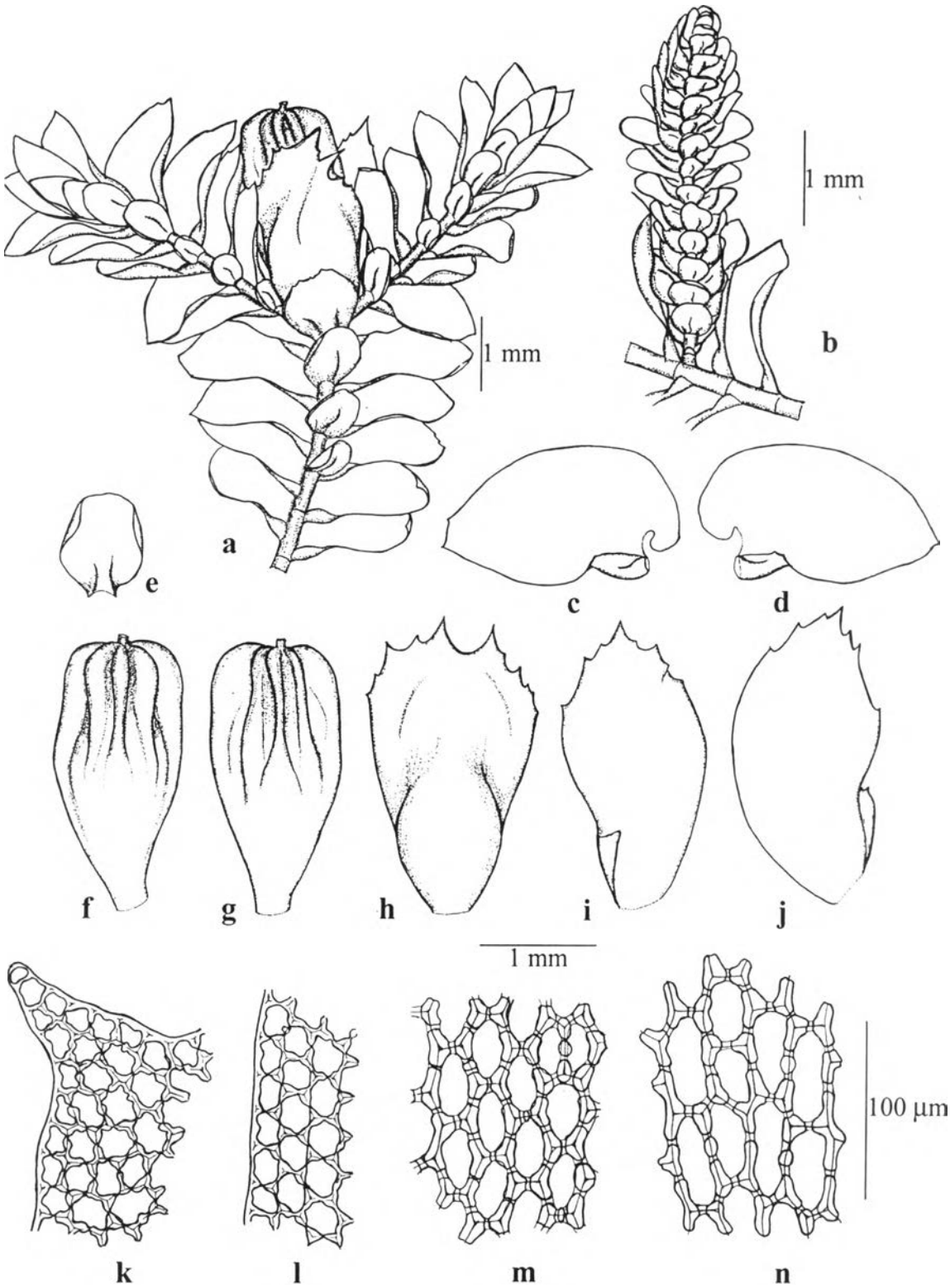

Figure 5.65 *Spruceanthus semirepandus* (Nees) Verd.
a. ventral portion of plant with gynoecium; b. androecium; c., d. lateral leaves; e. underleaf; f., g. perianthes, f. dorsal view, g. ventral view; h. female bracteole; i., j. female bracts; k. cells at leaf apex; l. cells at leaf margin; m. cells at leaf median; n. cells at leaf base. Based on *S. Chantanaorrapint 131*.

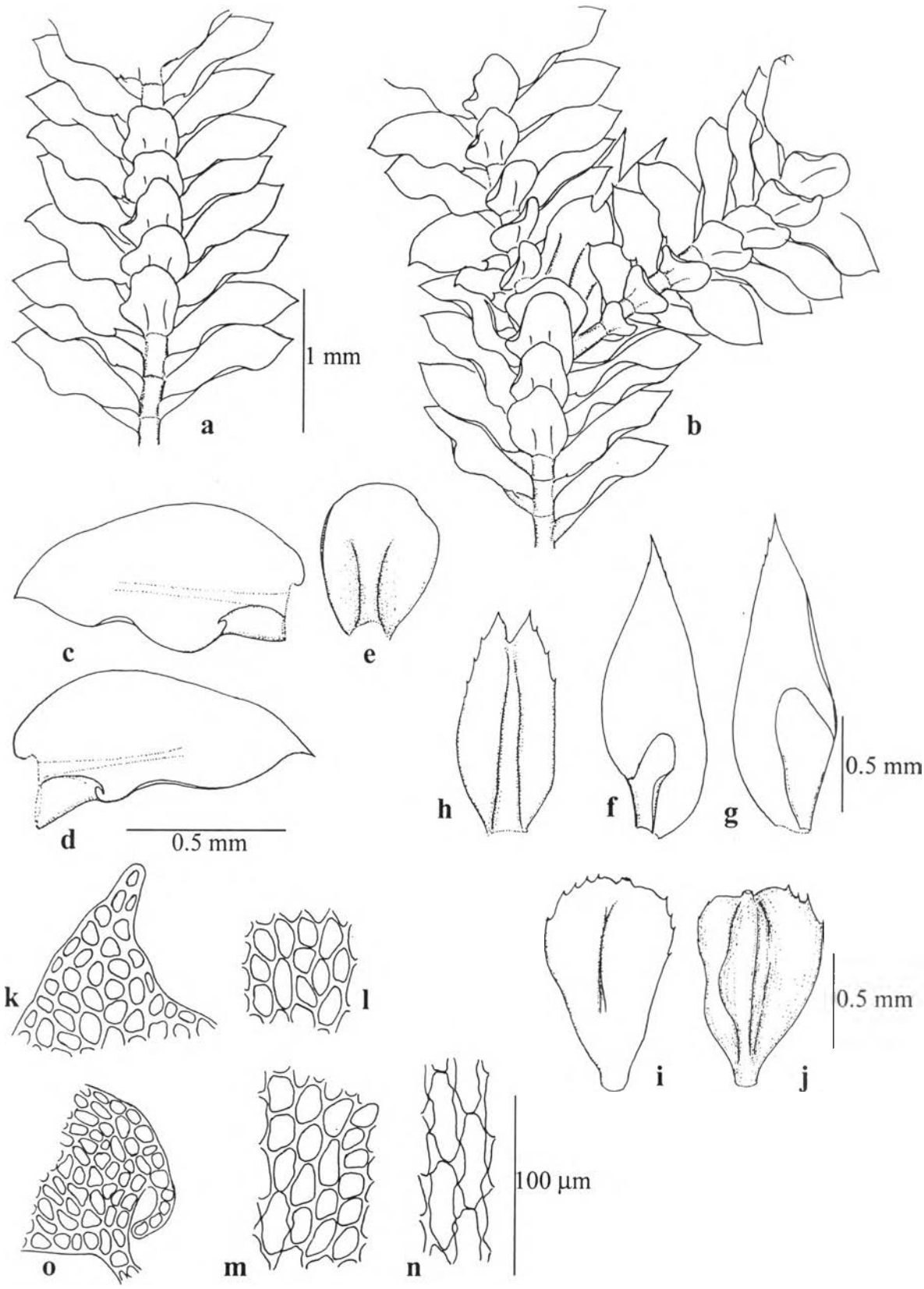

Figure 5.66 *Thysananthus planus* Sande Lac.
a. ventral portion of plant; b. plant with gynoecium; c., d. lateral leaves; e. underleaf; f., g. female bracts; h. female bracteole; i., j. perianthes, i. dorsal view, j. ventral view; k. cells at leaf apex; l. cells at leaf median; m. cells at leaf base; n. vitta cells; o. cells at apex of lobule. Based on *S. Chantanaorrapint 581*.

LEPIDOZIACEAE

Plants small to robust, whitish-green, drak green to brownish or reddish-brown, flaccid to rigid. **Stems** creeping or erect. **Rhizoids** scattered on underleaves bases. **Lateral leaves** incubous, alternate; leaf-lobe usually 3-4 lobe at apex, margin entire or dentate; leaf-cells thin- or thick-walled, trigones differentiated or not; cuticle smooth or verrucose; leaf-lobule absent. **Underleaves** rather large, margin entire or dentate. **Monoicous** or dioicous. **Androecia** on short ventral intercalary branched, bract similar to leaf but smaller. **Gynoecia** on short ventral intercalary branches, bracts densely imbricate, innermost much larger than leaf. **Perianth** large, cylindric-ovate. **Capsule** cylindrical to ovoid, seta elongate.

BAZZANIA

Plants small to medium, yellowish-green to olive green or brownish. **Stems** pseudodichotomous branched, flagella usually present on ventral side of stem. **Lateral leaves** imbricate to remote, subopposite to alternate, usually asymmetrical, variable in shape, sublinear to ovate-triangular; dorsal base usually cordate or auricular, leaf margin entire to crenulate, leaf-apex usually incurved with 2-3 teeth; leaf-cells usually quadrate or hexagonal, trigones small to large nodulose; oil-bodies large, homogenous. **Underleaves** large, appressed to stem, apex rounded or truncate, sometimes reflexed. **Androecia** small, bracts densely imbricate. **Perianths** fusiform.

Key to species

1. Underleaves appressed to stem; cells hyaline and thin-walled.....2. *B. tridens*

1. Underleaves reflexed; cells not as above

    2. Leaves ovate to oblong-ovate; underleaves with auricles...1. *B. appendiculata*

    2. Leaves sublinear with ovate base; underleaves without auricles.....
    .....3. *B. uncigera*

1. ***Bazzania appendiculata*** (Mitt.) S. Hatt.

In Hara, Fl. E. Himalaya: 505. 1966; Mizut., J. Hattori Bot. Lab. 30: 83, figs. V, 1-9. 1967; N. Kitag., J. Hattori Bot. Lab. 30: 265. 1967. — *Mastigobryum appendiculata* Mitt., J. Proc. Linn. Soc.. Bot. 5: 105. 1861. — *M. cuspidatum* Steph., Sp. Hepat. (Stephani) 3: 495. 1908. — *M. constrictum* Steph., Sp. Hepat. (Stephani) 3: 515. 1908.

Plants large, olive-green. **Stems** 20-40 mm long, with leaves 3-5 mm wide, flagella numerous. **Lateral leaves** imbricate, widely spreading, strongly deflexed when dry, long-ovate, slightly falcate, 1.5-2.2 mm long, 1.3-1.5 mm wide at base; apex 3-toothed, teeth triangular, acute, the sinus lunate to obtuse; dorsal margin strongly arched toward an auriculate base, the ventral margin almost straight or slightly falcate, with slightly auriculate base; apical cells15-20 × 10-15 μm, median cells 30-40 × 20-25 μm, rather thick-walled, trigones very large, nodulose, basal cells ca. 50 × 30 μm, thin-walled, trigones very large; cuticle strongly verrucose.

Underleaves imbricate, about 3 times as wide as stem, reflexed, rotund, 0.5-1.0 mm long, 0.8-1.2 mm wide, margin repanded, more or less plicate, auriculate at base; the auricles large, toothed and plicate; cells monomorphic, thin-walled, trigones large and nodulose. (Fig. 5.67). **Fertile plants** not found.

Thailand. — NORTH-EASTERN: Loei;Central: Nakhon Nayok; SOUTH-EASTERN: Chantaburi.

Distribution. — West Bengal, Assam, Nepal, Sikkim, Bhutan, Burma.

Ecology. — On tree trunks and branches.

Specimens examined. — *S. Chantanaorrapint 128, 152, 156,179, 181, 299* (BCU)

2. ***Bazzania tridens*** (Reinw., Blume et Nees) Trev.

Mem. Reale Ist. Lombardo Sci., Ser. 3, Cl. Sci. Mat. 4: 415. 1877; Meijer, Blumea 10(2): 372. 1960; Mizut., J. Hattori Bot. Lab. 30: 72, figs. I, 1-8. 1967; N. Kitag., J. Hattori Bot. Lab. 30: 259. 1967; T. Pócs, J. Hattori Bot. Lab. 32: 82, figs. I-II, 2-11, III-IV, 12-13. 1969. — *Jungermannia tridens* Reinw., Blume et Nees, Nova Acta Leop. 12: 228. 1824. — *Mastigobryum tridens* (Reinw., Blume et Nees) Dumort., Rec. d'Obs.20. 1835. — *Bazzania albicans* Steph., Hedwidgia 32: 204. 1893; S. Hatt. & Mizut., J. Hattori Bot. Lab. 19: 110, fig. X,1-27. 1958. —*Mastigobryum oblongum* Mitt., J. Proc. Linn. Soc., Bot. 5: 106. 1861. — *Bazzania. oblonga* (Mitt.) Schiffn., Nova Acta Leop. 60: 259. 1893. — *Mastigobryum olivaceum* Steph., Sp. Hepat. (Stephani) 3: 441. 1908. — *M. pinniforme* Steph., Sp. Hepat. (Stephani) 3: 462. 1908. — *Bazzania pinniformis* (Steph.) S. Hatt. in Hara, Fl. E. Himalaya 506: 1966. — *Mastigobryum lobulistipum* Steph., Sp. Hepat. (Stephani) 3: 462. 1908. — *Bazzania lobulistipa* (Steph.) S. Hatt. in Hara, Fl. E. Himalaya 505: 1966. — *Mastigobryum cardotii* Sp. Hepat. (Stephani) 3: 515. 1908.

Plants small to medium-sized, olive-green or brownish green. **Stems** 15-30 mm long, with leaves 2-3 mm wide; flagella numerous. **Lateral leaves** imbricate, widely spreading, slightly deflexed when dry, ovate or oblong, slightly falcate, 1.0-1.5 mm long, 0.5-0.7 mm wide at base; apex with 3-toothed, teeth triangular, acute, the sinus lunate to obtuse; apical cells15-20 × 10-12 μm, thick-walled, trigones small or indistinct, median cells 20-35 × 15-30 μm, basal cells 30-50 × 30 μm, thin-walled, trigones large; cuticle smooth. **Underleaves** distant, appressed to stem, connate with lateral leaf, subquadrate, 0.3-0.6 mm long, 0.3-0.5 mm wide, margin entire or repand; basal area cells small, green, thick-walled; upper cells hyaline, larger than, thin-walled (Fig. 5.68, 5.105). **Fertile plants** not found.

Thailand. — NORTHERN: Chiang Mai, Chiang Rai; NORTH-EASTERN: Loei; SOUTH-EASTERN: Chantaburi, Trat; PENINSULAR: Trang.

Distribution. — South-India, West-Bengal, Assam, Nepal, Sikkim, Bhutan, Burma, Ceylon, Sumatra, Java, Celebes, Borneo, Ceram, China, Formosa, Japan, Korea.

Ecology. — On tree trunks or declay wood.

Specimens examined. — *S. Chantanaorrapint 132, 137, 209, 281, 286* (BCU).

3. ***Bazzania uncigera*** (Reinw., Blume & et Nees) Trev.

Mem. Reale Ist. Lombardo Sci., Ser. 3, Cl. Sci. Mat. 4: 415. 1877; N. Kitag., J. Hattori Bot. Lab. 30: 264. 1967. — *Jugermannia uncigera* Reinw., Blume & et Nees, Nova Acta Leop. 12: 230. 1824. — *Mastigobryum uncigrum* (Reinw., Blume & et Nees) Lindenb. in Gottsche, Lindenb. & Nees, Syn. Hepat.: 233. 1845.

Plants medium-sized, olive-green. **Stems** 20-40 mm long, with leaves 3-4 mm wide, flagella numerous. **Lateral leaves** imbricate, widely spreading, strongly deflexed when dry, sublinear, ovate base, strongly falcate, 1.3-2.0 mm long, 0.8-1 mm wide at base; sharply 3-lobed, lobes triangular, acute; dorsal margin slightly arched; apical cells15-25 × 15-20 μm, median cells 25-30 × 20-25 μm, rather thick-walled, trigones very large, nodulose, basal cells ca. 45 × 30 μm, thin-walled, trigones very large; cuticle verrucose. **Underleaves** strongly reflexed, imbricate, about 2 times as wide as stem, slightly longer than wide, ca. 0.5-0.7 mm long, 0.4-0.5 mm wide, apex truncate bearing four principle apical lobes, often made obscure by the irregular, supplementary lobes or teeth; cells of underleaves similar to those of leaves (Fig 5.69). **Fertile plants** not found.

Thailand. — NORTHERN: Chiang Mai; NORTH-EASTERN: Loei; SOUTH-EASTERN: Chantaburi; PENINSULAR: Nakown Si Tammarat.

Distribution. — Widely distributed in South-Eastern Asia, extending to New Guinea and Fiji.

Ecology. — On tree trunks and branches.

Specimens examined. — *S. Chantanaorrapint 150, 192, 302* (BCU).

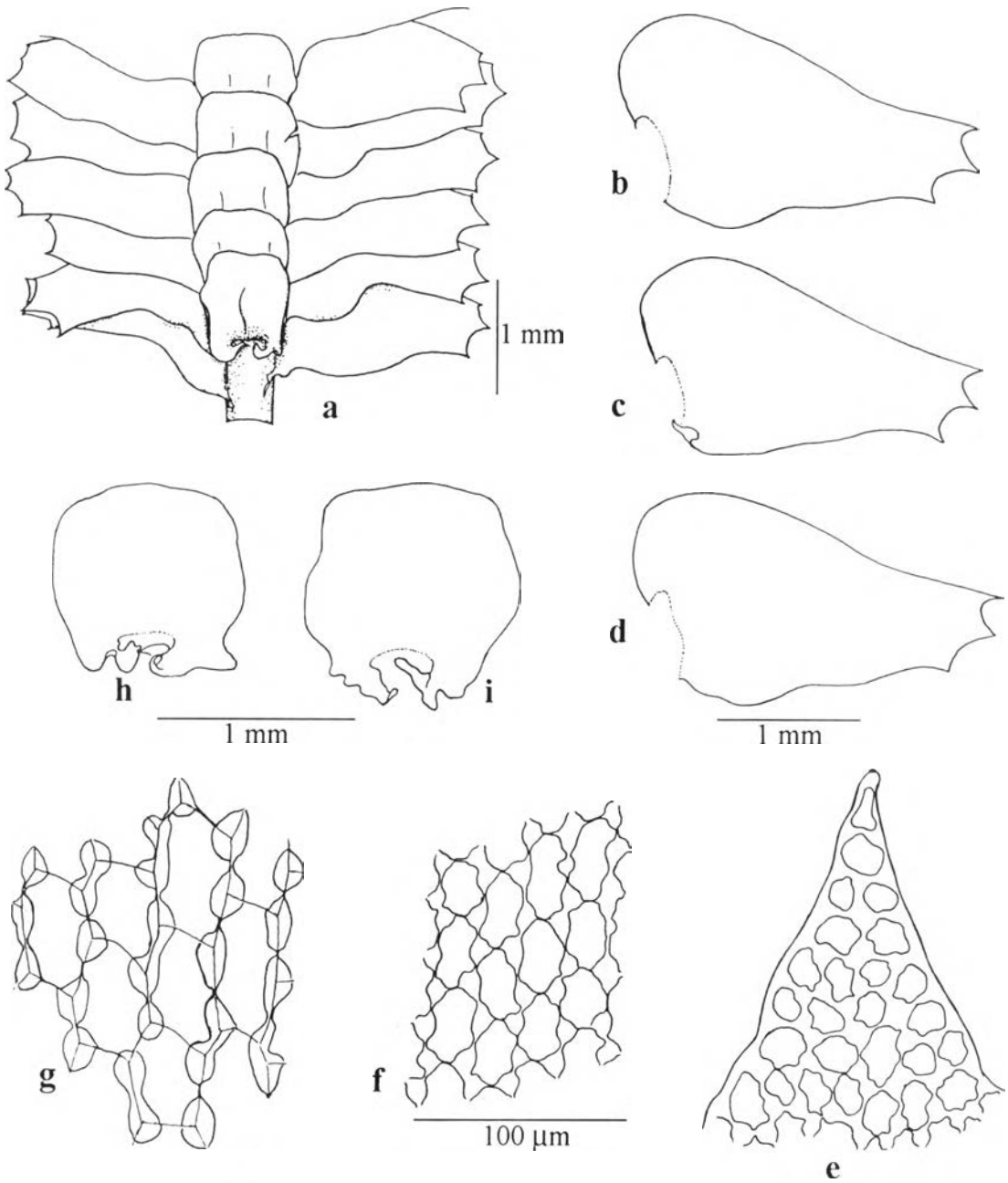

Figure 5.67 *Bazzania appendiculata* (Mitt.) S. Hatt.
a. ventral portion of plant; b.-d. lateral leaves; e. cells at leaf apex; f. cells at leaf median; g. cells at leaf base; h., i. underleaves. Based on *S. Chantanaorrapint 152*.

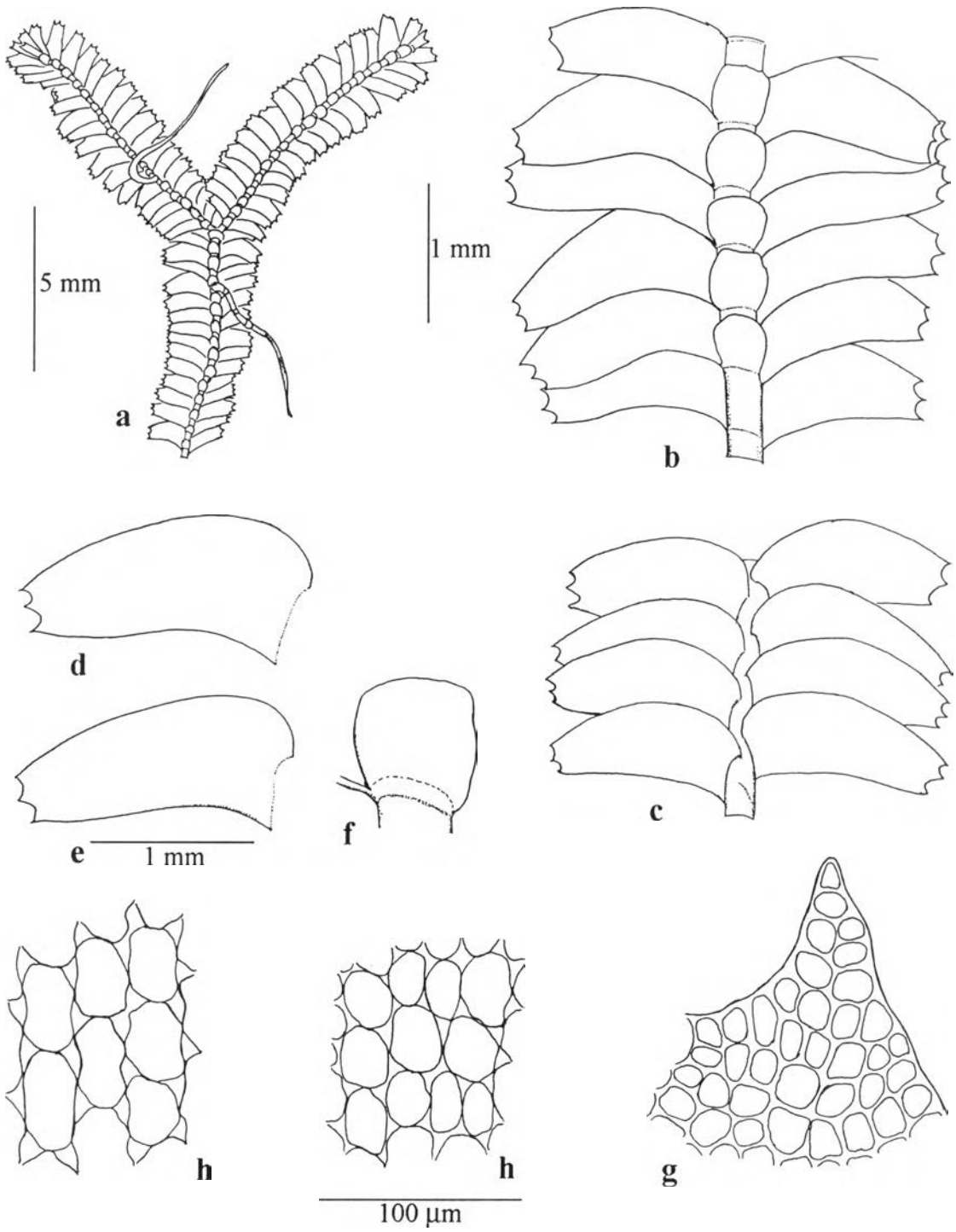

Figure 5.68 *Bazzania tridens* (Reinw., Blume et Nees) Trev.
a. habit; b. ventral portion of plant; c. dorsal portion of plant; d., e. lateral leaves; f. underleaf; g. cells at leaf apex; h. cells at leaf median; i. cells at leaf base. Based on *S. Chantanaorrapint 595*.

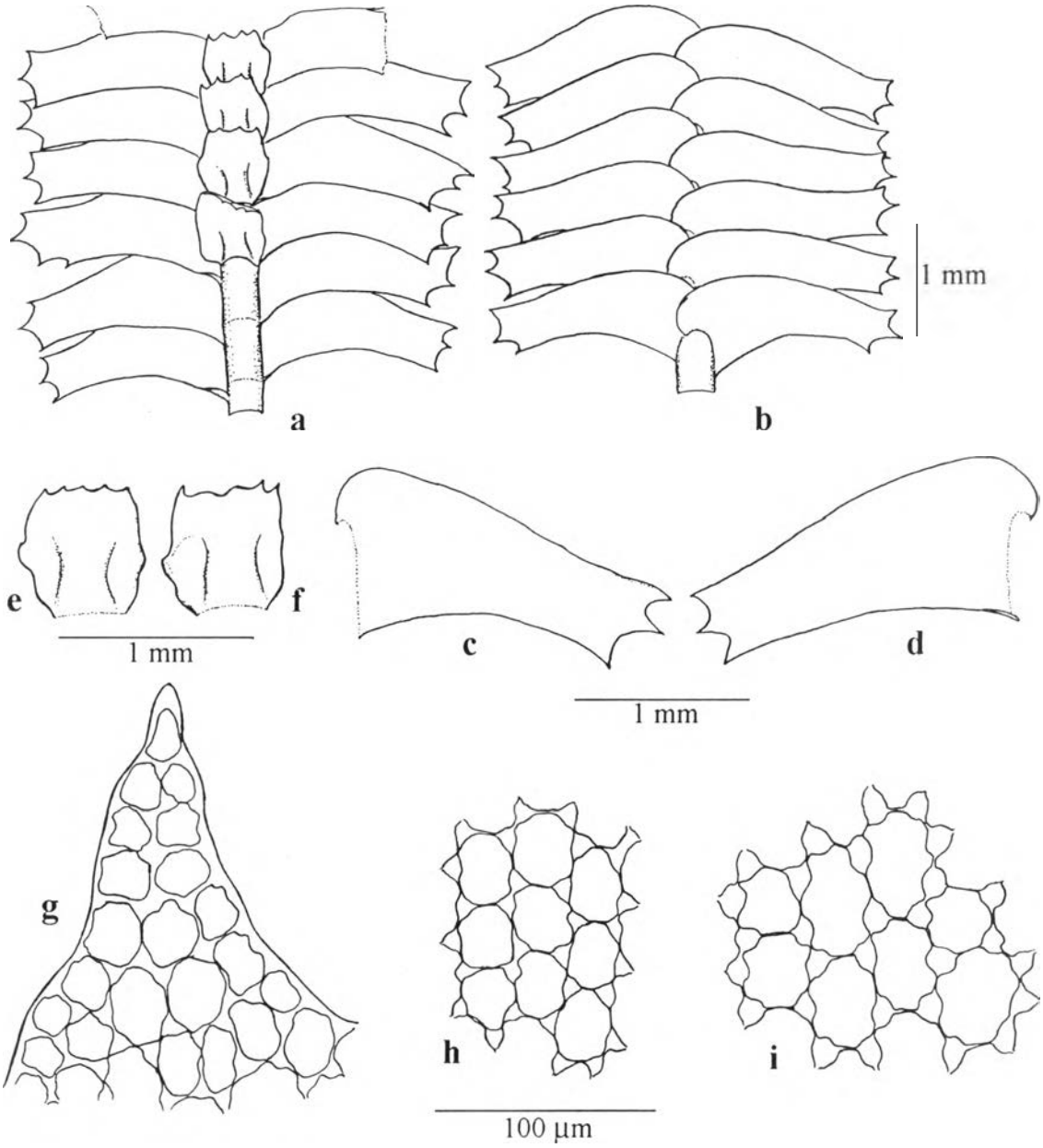

Figure 5.69 *Bazzania uncigera* (Reinw., Blume & et Nees) Trev.
a. ventral portion of plant; b. dorsal portion of plant; c., d. lateral leaves; e., f. underleaves; g. cells at leaf apex; h. cells at leaf median; i. cells at leaf base. Based on *S. Chantanaorrapint 562*.

MARCHANTIACEAE

Plants medium to large, prostrate, rigid, dull green, usually dichotomously branched, midrib present. Air pores and air chambers well-developed, sometimes reduced. The ventral side of thallus covering by scales, or sometimes scales reduced. **Rhizoids** numerous, usually on ventral side of thallus, dimorphic (smooth walled and peg rhizoid). **Dioicous**. **Androecia** aggregated in antheridiophores or on thallus. **Gynoecia** aggregated in archegoniophores. Sporophytes pendulous, each sporophyte with separate psuedoperianth; seta short; capsule borne on the underside of an umbrella-shape receptacle, never cleistocarpous; elaters well-developed, with spiral thickening walled. **Asexual** reproduction by gemmae, usually gemmae cup developed.

DUMORTIERA

Dumortiera Nees, Nova Acta Phys.-Med. Acad. Caes. Leop.-Carol. Nat. Cur. 12: 410. 1824; R.M. Schust., New Manual of Bryology vol. 2: 1054. 1984.

Plants large, more or less dichotomous branching, without or only with vestigial pores or polygonal area; midrib not distinct; scales reduced, very short or indistinctly. **Androecia** without antheridiophores.

Dumortiera nepalensis (Taylor) Nees

Naturgesch. Eur. Leberm. 4: 169. 1838; R.M. Schust., New Manual of Bryology vol. 2: 1054, fig. 94. 1984 — *Hygrophila nepalensis* Taylor, Trans. Linn. Soc. London 17: 392. 1837. —

Plants dark green, usually undulate, up to 15 cm long, 1-2 cm wide; in cross-section, epidermal cells with chloroplasts and smaller, inner cells larger, thin-walled and hyaline; margin more or less entire. Cells of dorsal side pentagonal to hexagonal. **Androecia** not found. **Gynoecia** with long archegoniophores; archegonial heads rounded, margin divided, 5-7 lobes, hairs present on the upper surface, usually with 1-4 mature sporophytes per each head. **Capsules** obovate or broadly elliptic. **Elaters** with 2-spiral thickening walled (Fig. 5.70). **Gemmae** not found.

Thailand. — NORTHERN: Chiang Mai, Chiang Rai, Phisanulok.

Distribution. — Nepal, Assam.

Ecology. — On sandy rocks along streams.

Specimens examined. — *S. Chantanaorrapint 738* (BCU).

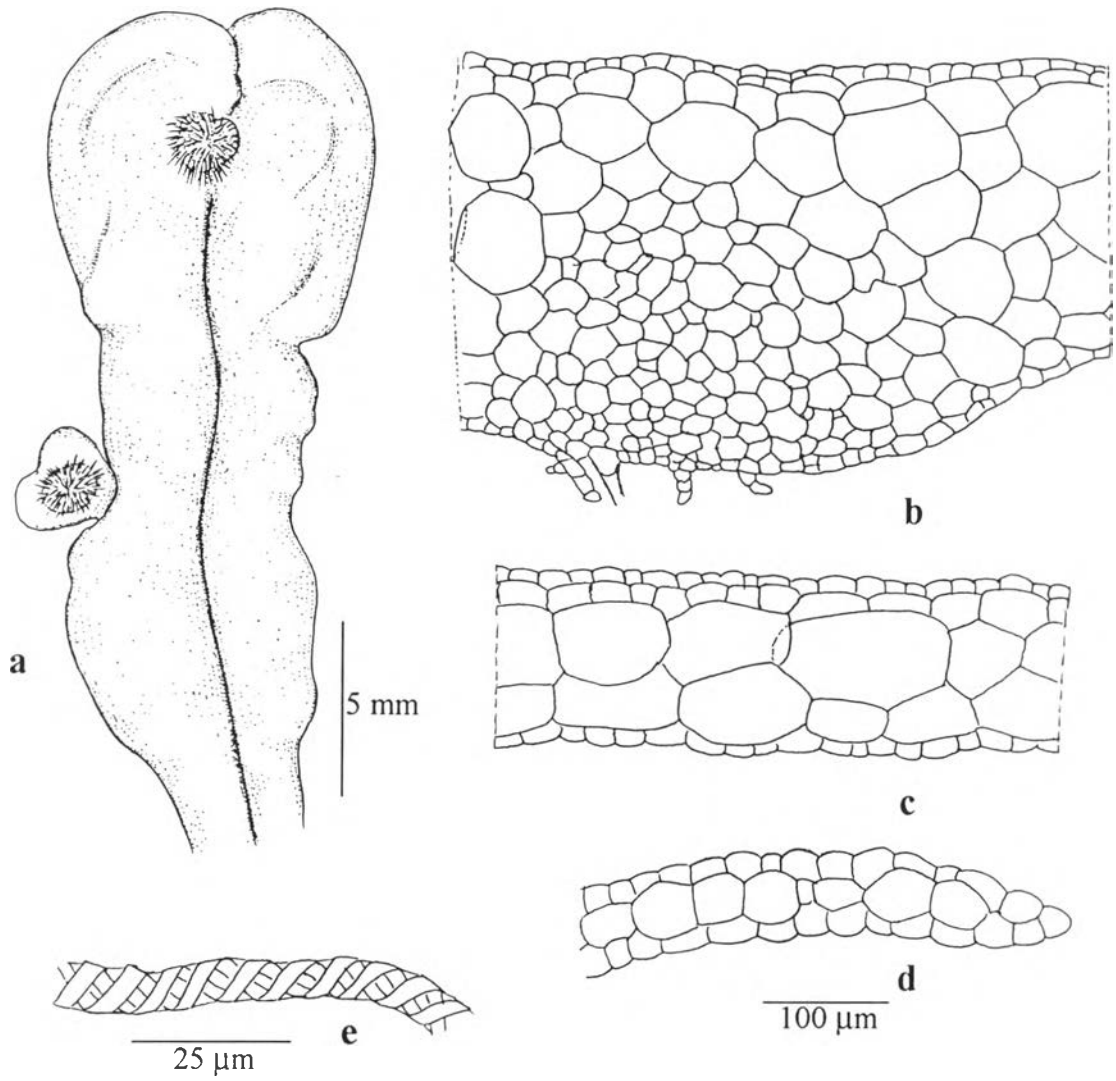

Figure 5.70 *Dumortiera nepalensis* (Taylor) Nees
a. habit with young archegonial heads; b.-d. cross-section of thallus, b. midrib, c. middle, d. margin; e. elator. Based on *S. Chantanaorrapint 738*.

PALLAVICINIACEAE

Plants medium to large-size, thalli prostrate, flaccid to rigid, usually bright green. **Midrib** distinct, cord-like a cord along lower side of plant, with thin- or thick-walled cells of central strand; thallus wing only 1 cell thick. Air chamber absent. **Rhizoids** numerous, usually on ventral side of thallus, smooth walled rhizoid.**Gynoecia** on upper side along midrib. **Seta** elongate when mature; capsule cylindrical, dehiscing in to 4 valves.

SYMPHYOGYNOPSIS

Symphyogynopsis Grolle in Grolle & Piippo, Acta Bot. Fenn. 133: 72. 1986.

Plants large, flaccid, with ventral intercalary branching. Cell walls of the central strand not incrassate, clearly thinner than those of the surrounding parenchymatous tissue. Female involucre deeply laciniate-ciliate, psuedoperianth lacking.

Symphyogynopsis filicum (Nadeaud) Grolle

In Grolle & Piippo, Acta Bot. Fenn. 133: 73, figs. 4k-n, 5. 1986. — *Symphyogyna filicum* Nadeaud, Enum. Pl. Ind. Île Tahiti 9: 1873. — *S. vitiensis* Jack & Steph., Bot. Centralb. 60: 108. 1894. — *S. exincrassata* Steph., Sp. Hepat. (Stephani) 1: 342. 1900. — *Pallavicinia levieri* var. *imperfecta* Schiffn., Denkschr. Kaiserl. Akad. Wiss., Wien. Math.-Naturwiss. Kl. 67: 185. 1895.

Plants green, transparency, thallus 2-4 cm long, simple or ventral intercalary branched; rhizome portion very short or lacking. **Rhizoids** colourless, from the ventral side of midrib in younger part, in older part sometimes from the thallus margin. **Thallus** 4-6 mm wide, nearly flat or shallowly undulate, margin more or less entire, sometimes with bicellular slime-hairs, hairs crowded towards the dorsal and ventral surface near the apex. **Wing cells** thin-walled, pentagonal to hexagonal, 35-50× 50-100 μm, without trigones. **Dioicous**. **Androecia** not found. **Gynoecia** single or 2-3 along the midrib. Involucral scale pale, variable, irregularly laciniate, from 5-10 cleft into 3-4 or more narrow divisions (Fig. 5.71, 5.107). **Sporophytes** not found.

Thailand. — New record.
Distribution. — Malaysia, Java, Papua New Guinea, Tahiti and Fiji.
Ecology. — On humus rock or tree trunks.
Specimens examined. — *S. Chantanaorrapint 738* (BCU).

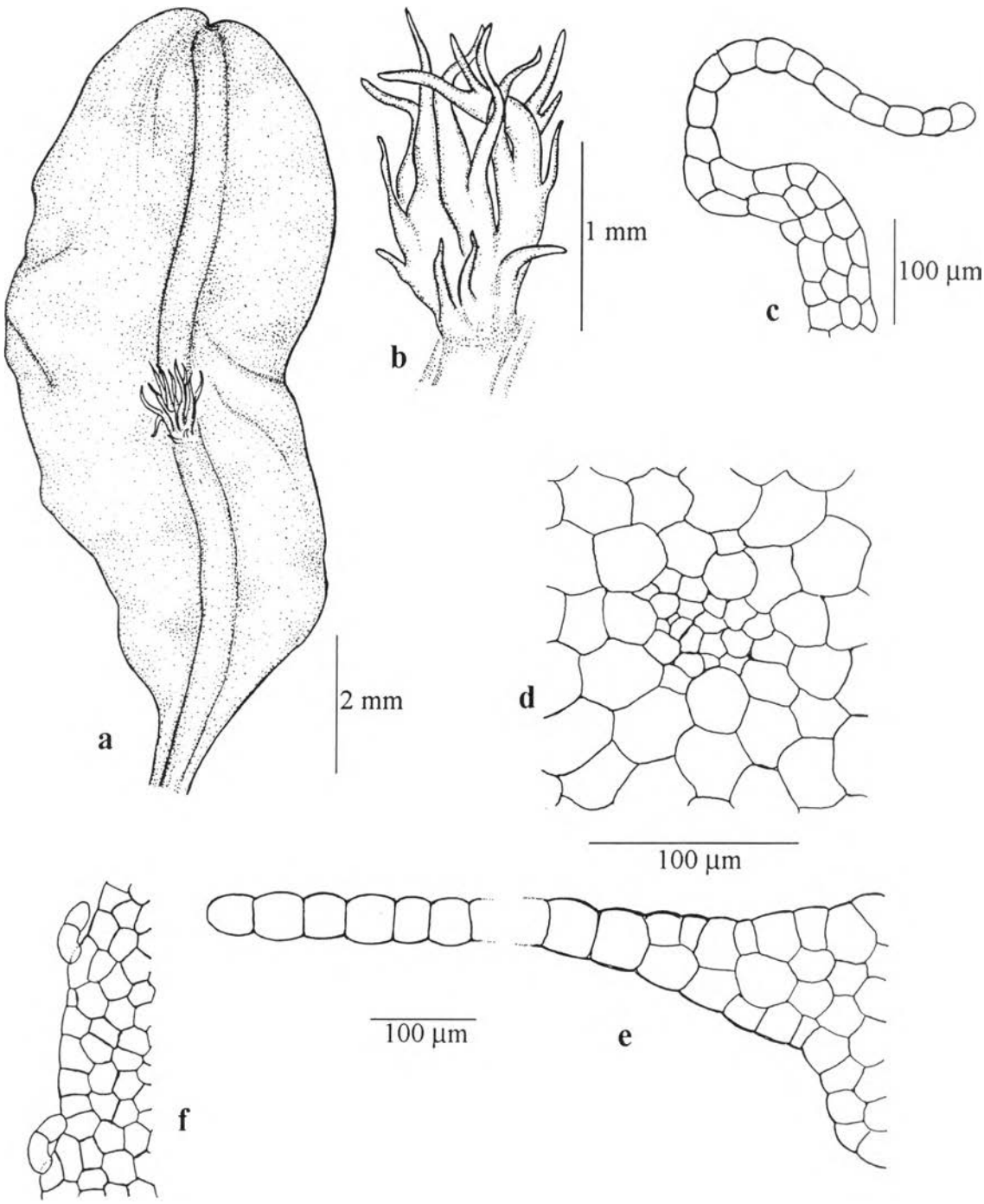

Figure 5.71 *Symphyogynopsis filicum* (Nadeaud) Grolle
a. habit with young gynoecium; b. gynoecium; c. gynoecial scale;d., e. cross-section of thallus, d. shown central stand, e. shown thallus wing; f. margin of thallus.
Based on *S. Chantanaorrapint 738*.

PLAGIOCHILACEAE

Plants small to very large, pale green to olive green, or sometimes brownish green. **Stems** creeping or ascending, terminal or lateral branched. **Rhizoids** scattered on ventral side of stems. **Lateral leaves** succubous, alternate or subopposite to opposite, variously dentate to spinose-dentate, sometimes entire or subentire; leaf cells collenchymatous, trigones small to large. **Underleaves** very small, sometimes reduced or lacking. **Dioicous** (except genus *Pedinophyllum* monoicous). **Androecia** terminal on lateral branches or main stems, often becoming intercalary. **Gynoecia** terminal on main or lateral branches. **Perianthes** typically bilabiate, perigynium absent, often with 1-2 subfloral innovations.

Key to Genera

1. Stem without flagella; leaves alternate or subalternate.....1. *Plagiochila*

1. Stem with flagella; leaves opposite.....2. *Plagiochilion*

1. *PLAGIOCHILA*

Plagiochila (Dumort.) Dumort., Rec. d'Obs.: 14. 1835; Inoue & R.M. Schust., J. Hattori Bot. Lab. 34: 24. 1971; R.M. Schust., Hepat. Anthocerotae N. Amer. 4: 342. 1980. — *Radula* sect. *Plagiochila* Dumort., Syll. Jungerm.: 42. 1831. — *Martinellia* sect. B Gray, Nat. Arr. Brit. Pl. 1: 692. 1821.

Plants small to robust. **Stems** simple, dichotomous to dendroid. ascending to erect, without flagella from ventral side of lower stem; paraphyllia present or absent; in cross-section cortical cell layers distinctly differentiated or undifferentiated. **Lateral leaves** alternate or subopposite, various in shaped and side, marginal entire to dentate; cells along leaf margin with somewhat thick-walled; median and basal leaf-cells with rather thin walls and large trigones. **Underleaves** ciliate or lacking. **Dioicous**. **Androecia** intercalary, bracts in many pairs, margin entire or weakly toothed. **Gynoecia** terminal on stem or branches, with innovations, bracts similar to leaves but more strongly toothed; **perianth** triangular- or cylindrical-campanulate, usually dentate to ciliate mouth.

Key to species.

1. Median leaf-cells small triangular-trigones or indistinct.

    2. Plants dichotomous or dendroid; leaf-cells thick-walled, trigones indistinct.....3. *P. javanica*

    2. Plants usually simple or intercalary branched; leaf-cells thin-walled, trigones small triangular.....*P. acanthophylla*

        3. Plants simple, rarely branched; leaves ovate-oblong, rarely caducous.....1. subsp. *acanthophylla*

3. Plants intercalary branched; leaves oblong to oblong-ovate, usually much caducous.....2. subsp. *japonica*

1. Median leaf-cells nodulose trigones.

5. Leaves broadly ovate, usually with 2-4 teeth.....4. *P. microdonta*

5. Leaves oblong-ovate or triangular ovate, amplicate at base, with several teeth.

6. Plants psuedodichotomous; leaves usually caducous.....5. *P. yokogurensis*

6. Plants usually simple; leaves not caducous.....6. *Plagiochila* sp.

1. ***Plagiochila acanthophylla*** Gottsche subsp. ***acanthophylla***

Bot. Zeit., Beil. z. 16: 38. 1858; Inoue, J. Hattori Bot. Lab. 25: 97, fig. III. 1962. — *P. tonkinensis* Steph., Sp. Hepat. (Stephani) 6: 232. 1924. — *P. acanthophylla* var. *plurilaciniata* Herz., Ann. Bryol. 5: 73. 1932.

Plants medium to large in size, light green to yellowish brown, 3-4 cm long, with leaves 4.0-4.5 mm wide. **Stems** with few branches; in cross-section of stem, cortical cells brownish, 2-3 layers, thick-walled cells, medullar cells much larger than cortical cells, thin-walled. **Rhizoids** not seen. **Lateral leaves** approximate to imbricate, widely spreading, nearly flat, 2.0-2.2 long, 1.5-1.8 mm wide, ovate-oblong, obliquely truncate at base; dorsal margin nearly straight, entire, ventral margin slightly convex, bearing 4-6 small teeth, dorsal margin, nearly straight, entire, apex subtruncate to rounded, usually with two large acuminate teeth and few small teeth; median leaf cells up to 50 × 40 μm, thin-walled, trigones small; cuticle smooth. **Underleaves** lacking. **Androecia** not found. **Gynoecia** terminal on main stems or on long lateral branches, with 1-2 subfloral innovations; bracts similar to leaves, but larger and densely spinose-dentate, inflated. **Perianthes** campanulate, ca. 2.0-2.5 mm long, up to 3 mm wide, widest at mouth; mouth rounded, irregularly spinose-ciliate (Fig. 5.72). **Sporophytes** not found.

Thailand. — PENINSULAR: Nakhon Si Thamarat.
Distribution.— Java, Sumatra, Andaman Island, Celebes, Philippines, Tonkin.
Ecology.— On tree trunks.
Specimens examined.— *S. Chantanaorrapint 312 (BCU).*

2. ***Plagiochila acanthophylla*** Gottsche subsp. ***japonica*** (Sande Lac.) Inoue.

J. Hattori Bot. Lab. 25: 100, fig. 5: D-E. 1962. — *P. japonica* Sande Lac. Ann. Mus. Bot. Lugduno-Batavi 1: 290. 1863-4.

Plants medium to large in size, light green to yellowish brown, 3-4 cm long, with leaves 3.5-4.0 mm wide. **Stems** usually lateral branched; in cross-section of stem, cortical cells brownish, 2-3 layers, thick-walled cells, medullar cells much larger than cortical cells, thin-walled. **Rhizoids** not seen. **Leaves** approximate to imbricate, usually much caducous, widely spreading, nearly flat, 1.7-2.0 long, 1.2-1.5 mm wide, oblong to oblong-ovate, obliquely truncate at base; dorsal margin nearly

straight, entire or with 1-3 teeth nearly apex, ventral margin slightly convex, bearing 2-4 small to large teeth, entire, apex subtruncate to rounded, usually with two large acuminate teeth, sometimes teeth falcate, teeth 6-8 cells long, 2-3 cells wide at base; apical and marginal leaf cells 20-30 × 20-25 μm, thick-walled cells, trigones small or indistinct, median and basal cells up to 40 × 35 μm, thin-walled, trigones small. **Underleaves** lacking (Fig. 5.73). **Fertile plants** not found.

Thailand. — New record to Thailand.

Distribution.— Java, Sumatra, Andaman Island, Celebes, Philippines, Tonkin.

Ecology.— On tree trunks.

Specimens examined.— *S. Chantanaorrapint 117, 120, 288, 295, 532, 558, 593 (BCU).*

3. ***Plagiochila javanica*** (Sw.) Dumort.

Recueil Observ. Jungerm. 15. 1835; Inoue, J. Hattori Bot. Lab. 32: 53, figs. 1, 2. 1969. — *Jugermannia javanica* Sw., Methodus Muscorum Illustrata 35, tab. II, fig. 2. 1781. — *Plagiochila terebrans* Nees et Mont. in Sande Lac., Syn. Hepat. Javae 11. 1856. — *P. tenuis* Lindenb. in Sande Lac., Ann. Mus. Bot. Lugduno-Batavi. 1: 291. 1864. — *P. revolutifolia* Schiffn., Denkschr. Kaiserl. Akad. Wiss., Wien. Math.-Naturwiss. Kl. 70: 172. 1900.

Plants medium, yellowish brown in dried specimens, 4-6 cm long, with leaves 2.5-4.5 mm wide. **Stems** deep brown; in cross-section cortical cells wells differentiated, 3-4 layers of thick-walled cells, fiber-like cells, medulary cells larger, more or less thick-walled. **Rhizoid** not found. **Lateral leaves** contiguous or slightly imbricate, obliquely spreading, more or less revolute along dorsal margin which is long-decurrent on the dorsal stem-midline; leaves when flat, oblong or oblong-ovate to retangular 1.3-2.2 mm long, 0.8-1.2 mm wide at base, apex more or less obliquely truncate with 3-4 teeth, dorsal margin nearly straight, entire, sometimes with 1-2 teeth near apex, ventral margin more or less basal arched, 4-8 teeth; middle cells 25-35 × 20-25 μm, more or less thick-walled, trigones distinct, basal cells 35-50 × 25 μm, ca. 2 times as long as wide, thick-walled cells; cuticle smooth. **Underleaves** lacking. **Androecia** not found. **Gynoecia** terminal on branches, bracts oblong-ovate to broadly ovate, 2.0-2.5 mm and long 1.8-2.0 mm wide, strongly undulate and dentate-spinose on ventral margin, dorsal margin strongly incurved, inflated at base. **Perianths** obovoid, about 2.2 mm long, 1.5 mm wide, mouth rounded to nearly truncate, margin laciniate-dentate (Fig. 5.74). **Sporophytes** not found.

Thailand. — New record to Thailand.

Distribution. — Java, Borneo.

Ecology.— On tree trunks.

Specimens examined.— *S. Chantanaorrapint 124, 129, 147, 290, 543, 588* (BCU).

4. ***Plagiochila microdonta*** Mitt.

J. Proc. Linn. Soc., Bot. 5: 97. 1861; Inoue, J. Hattori Bot. Lab. 46: 221, figs. 12, 13. 1979. — *P. aciculifera* Steph., Sp. Hepat. (Stephani) 2: 352. 1903.

Plants medium, about 2-5 cm long, with leaves 3-5 mm wide; dark brown to reddish brown. **Stems** deep brown; in cross-section cortical, cells thick-walled, in 3-4 layers, smaller than medullary cells; with 1-2 subfloral innovations. **Rhizoid** not found. **Lateral leaves** imbricate, subopposite, usually widely exposing the dorsal stem-surface, not secund, obliquely or sometimes nearly horizontally spreading, dorsal margin more or less revolute, long decurrent along dorsal stem-midline, ventral margin short decurrent; leaves ovate to oblong-ovate or sometimes broadly ovate when flat, 1.8-2.5 mm long, 1.5-2.0 mm wide; apex obtuse to rounded, teeth usually restricted to the apex, sometimes on ventral margin, usually 2-4 or sometimes up to 10 in number, small and spinosely, 1-3 cells long, terminal cell 3-5 times as long as wide; apical cells 30 × 25 μm, median cells 35-40 × 30-35, thin-walled, trigones large nodulose or triangular-nodulose, basal cells moderately elongated, up to 2 times as long as wide, 55-75 × 30-35 μm, wall thin, trigones large, truncate; cuticle smooth. **Underleaves** lacking. **Male plants** slightly smaller than the female plants, usually slender, with leaves 2.5-3.5 mm wide. **Androecia** on lateral branches, bracts 7-10 pairs, closely imbricate and strongly inflated at base, small-toothed around apex. **Gynoecia** terminal on leading shoot, with 1-2 subfloral innovations, bracts similar to leaves in shape an size except for the more densely and strongly dentate ventral margin. **Perianthes** cylindrical to campanulate, 4-5 mm long and 1.8-2.0 mm wide; mouth shallowly bilabiate, rounded to truncate, irregularly ciliate-dentate at mouth (Fig 5.75). **Sporophytes** not found.

Thailand. — New record to Thailand.
Distribution. — Malaysia, Ceylon.
Ecology. — On tree trunks.
Specimens examined. — *S. Chantanaorrapint 269, 293, 547, 554, 616* (BCU).

4. ***Plagiochila yokogurensis*** Steph.

Bull. Herb. Boissier 5: 104. 1897; R.M. Schust., J. Hattori Bot. Lab. 18: 15, figs. 1-4. 1957; Inoue, J. Hattori Bot. Lab. 20: 87, fig. 13, 14: 1-10. 1958. — *P. okamurana* Steph., Sp. Hepat. (Stephani) 6: 190. 1921. — *P. curiosissima* Horik., J. Jap. Bot. 11: 411, fig. 1. 1935. — *P. yokogurensis* var. *okamurana* (Steph.) S. Hatt., J. Jap. Bot. 25: 142. 1950. — *P. appalachiana* Inoue, J. Hattori Bot. Lab. 40: 415. 1976.

Plants medium to large, 2-4 cm long, with leaves 3.0-4.5 mm wide. **Stems** psuedodichotomous branching or nearly simple; in cross-section of stem, cortical cells 2-3 layers, brownish, thick-walled cells, usually smaller than medullary cells. **Rhizoids** not found. **Lateral leaves** contiguous to densely imbricate, triangular-ovate, slightly falcate, 1.5-2.3 mm long, 1.5-1.8 mm wide at base, dorsal margin curved, with 1-2 teeth near apex, apex truncate with small teeth, ventral margin nearly straight from amplicate base, with 5-10 teeth, teeth mostly 4-6 cells long and 2-3 cells wide at base, terminal cell 3-5 time as long as wide; leaves much caducous; apical and marginal cells 25-30 × 20 μm, thick-walled, trigones small, median and basal cells hexagonal, ca. 35-50 × 35 μm, thin-walled, trigones large, triangular nodulose; cuticle smooth. (Fig. 5.76). **Underleaves** lacking. **Fertile plants** not found.

Thailand. — New record to Thailand.

Distribution.— China, Sumatra, Taiwan, Japan, India, Madagascar, East Afarica, Bourbon, Hawaii.

Ecology.— On tree trunks

Specimens examined.— *S. Chantanaorrapint 199, 289, 292, 353, 360, 556,* (BCU).

6. ***Plagiochila* sp.**

Plants robust, up to 8 cm long, with leaves 4-5 mm wide. **Stems** usually simple or terminal branched; in cross-section of stems, cortical cells 2-3 layers, brownish, thick-walled cells, usually smaller than medullary cells. **Rhizoids** not found. **Lateral leaves** imbricate, oblong-ovate to triangular-ovate, slightly falcate, 2.0-2.5 mm long, 1.5-1.8 mm wide at base, dorsal margin slightly decurrent, with 1-2 teeth near apex, apex obtuse to truncate with small teeth, ventral margin nearly straight from amplicate base, with 5-7 teeth, teeth mostly 4-6 cells long and 2-3 cells wide at base, terminal cell ca. 2 time as long as wide; apical and marginal cells 30-35 × 20-25 μm, thick-walled, trigones bulging-like, median and basal cells rectangular, ca. 35-40 × 25 μm, thick-walled, trigones large; cuticle smooth. (Fig.). **Underleaves** not seen (Fig. 5.77). **Fertile plants** not found.

Thailand. —

Distribution.—

Ecology.— On tree trunks.

Specimens examined.—*S. Chantanaorrapint 205, 294, 359, 370, 590* (BCU).

2. *PLAGIOCHILION*

Plagiochilion S. Hatt., Biosphaera 1: 7. 1947. — *Plagiochila* Dum. subg. *oppositae* Carl, Ann. Bryol. suppl. 2: 39. 1932. — *Noguchia* S. Hatt., J. Hattori Bot. Lab. 12: 83. 1954.

Plants medium to robust. **Stem** ascending to erect, with few flagella from ventral side of lower stem; paraphyllia absent; in cross-section cortical cell layers distinctly differentiated from medullary cells. **Lateral leaves** opposite, orbicular to ovate, with or rarely without marginal dentation; cells along leaf margin with somewhat thick-walled, median and basal leaf-cells with rather thin walls and large trigones. **Underleaves** lacking. **Dioicous**. **Androecia** intercalary, bracts in many pairs, margin entire or weakly toothed. **Gynoecia** terminal on stem or branches, with innovations, bracts similar to leaves but more strongly toothed. **Perianthes** triangular- or cylindrical-campanulate, mouth truncate to slightly arched, irregularly ciliate-dentate.

Plagiochilion oppositus (Reinw., Blume et Nees) S. Hatt.

Biosphaera 1: 7. 1947., J. Hattori Bot. Lab. 27: 61. 1964.—*Jungermannia opposita* Reinw., Blume et Nees, Hepat. Jav. 236. 1824.—*Plagiochila opposita* (Reinw., Blume et Nees) Dum., Rec. d' Obs. 15. 1835.—*Noguchia opposita* (Reinw., Blume et Nees) Inoue, J. Hattori Bot. Lab. 20: 102. 1958.

Plants medium, about 1.5-5.0 cm long, and 1.5 mm wide; yellowish brown. **Stems** blackish brown, ascending to erect, usually with one flagella from ventral base of lower stem; in cross-section cortical cells smaller than medullary cells. **Rhizoid** not found. **Lateral leaves** obliquely spreading, ovate to suborbicular (scale-like on flagella), usually as wide as, or wider than long, 0.7-1.1 mm long, 0.8-1.3 mm wide, dorsal margin slightly decurrent, concave, apex subtruncate to rounded, dentate; apical and median leaf-cells 20-26 x 14-20 μm, thick-walled, trigones minute; basal cells 30-50 × 20-30 μm, thin-walled, trigones large, nodulose. **Gynoecia** terminal, with subfloral innovation, bracts similar to leaves in shape except for the more densely and strongly dentate margin, 1.7 mm long, 2 mm wide, inflated at base. **Perianths** ovate to cylindrical, 3-4 mm long and 1.2-1.6 mm wide, mouth rounded to truncate, irregularly dentate at margins (Fig. 5.78). **Male plants** and **Sporophytes** not found.

Thailand. — New record to Thailand.

Distribution. — China, Sumatra, Taiwan, Japan, India, Madagascar, East Afarica. Bourbon, Hawaii.

Ecology. — On tree-trunks in hill-evergreen forest.

Specimens examined. — *S. Chantanaorrapint 122, 130, 142, 159, 161, 351, 501, 510* (BCU); *P.W. Richards 2391, R.H. Holttum s.n.* (S).

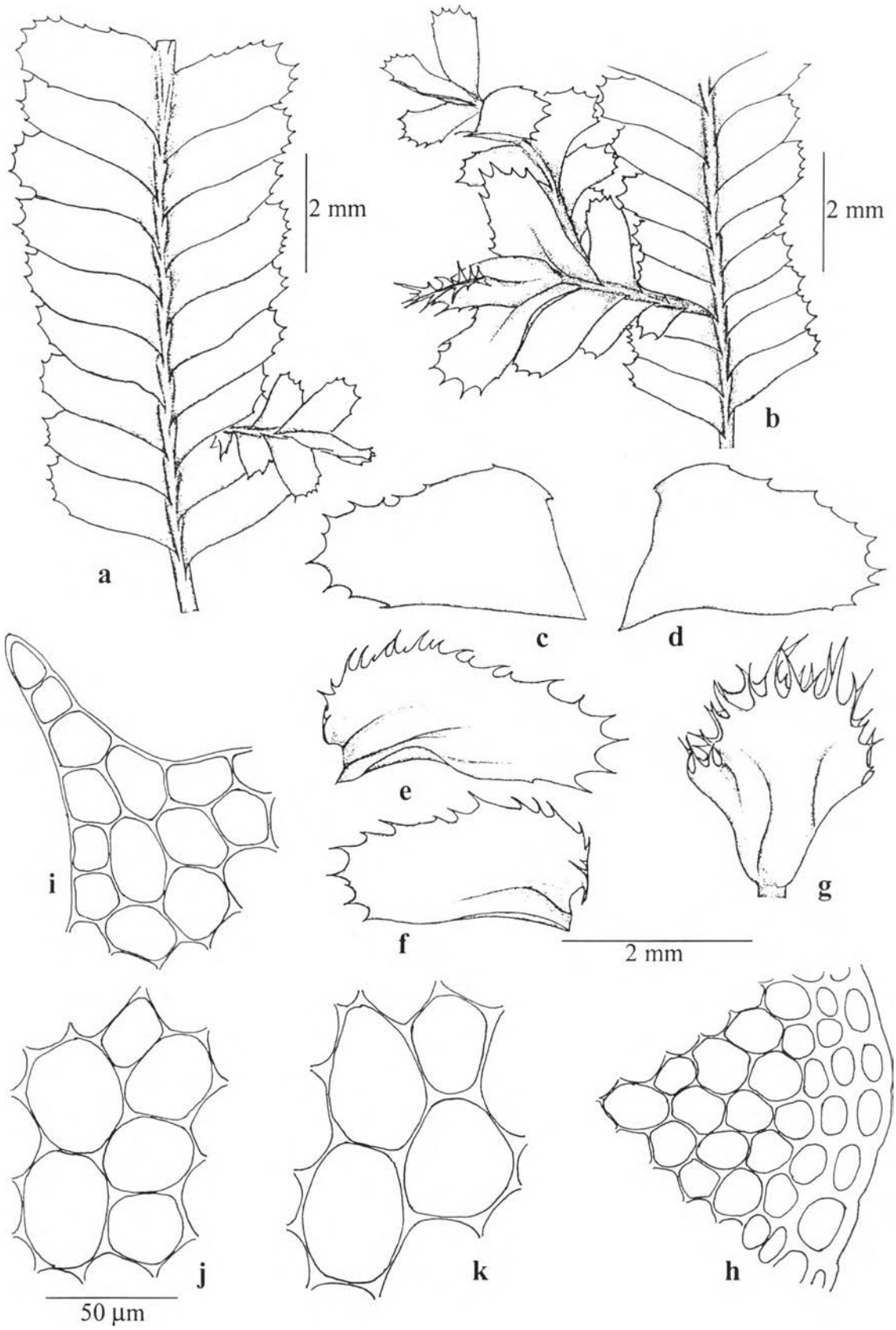

Figure 5.72 *Plagiochila acanthophylla* Gottsche subsp. *acanthophylla*
a. dorsal portion of plant; b. gynoecium; c., d. leaves; e., f. female bracts; g. perianth; h. cross-section of stem; i. cells at leaf apex; j. cells at leaf median; k. cells at leaf base. Based on *S. Chantanaorrapint 312*.

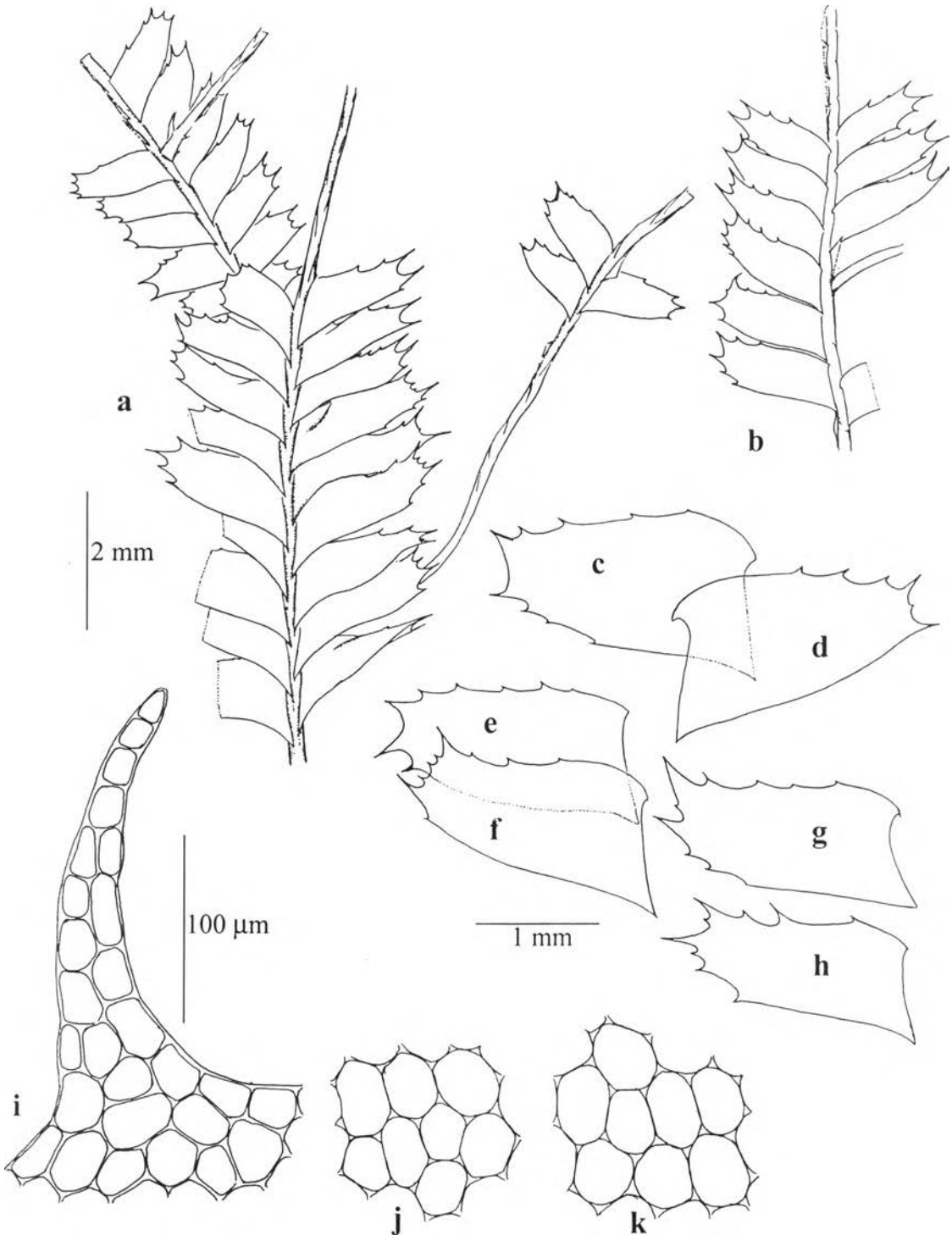

Figure 5.73 *Plagiochila acanthophylla* Gottsche subsp. *japonica* (Sande Lac) Inoue a., b. dorsal portion of plant; c.-h. leaves; i. cells at leaf apex; j. cells at leaf median; k. cells at leaf base. Based on *S. Chantanaorrapint 295*.

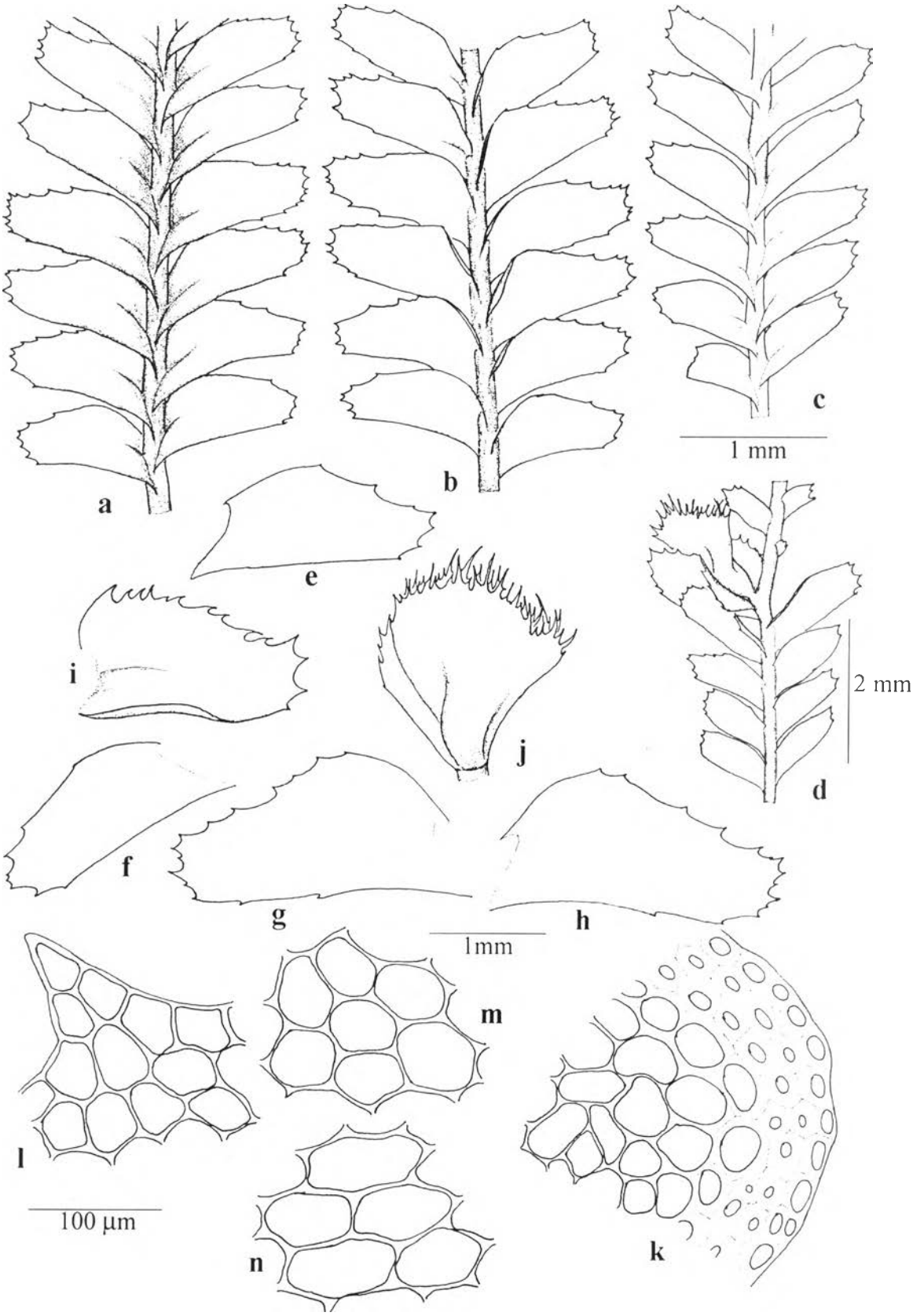

Figure 5.74 *Plagiochila javanica* (Sw.) Dumort.
a. dorsal portion of plant; b., c. ventral portion of plants; d. gynoecium; e.-h. leaves; i. female bracts; j. perianth; k. cross-section of stem; l. cells at leaf apex; m. cells at leaf median; n. cells at leaf base. Based on *S. Chantanaorrapint 147*.

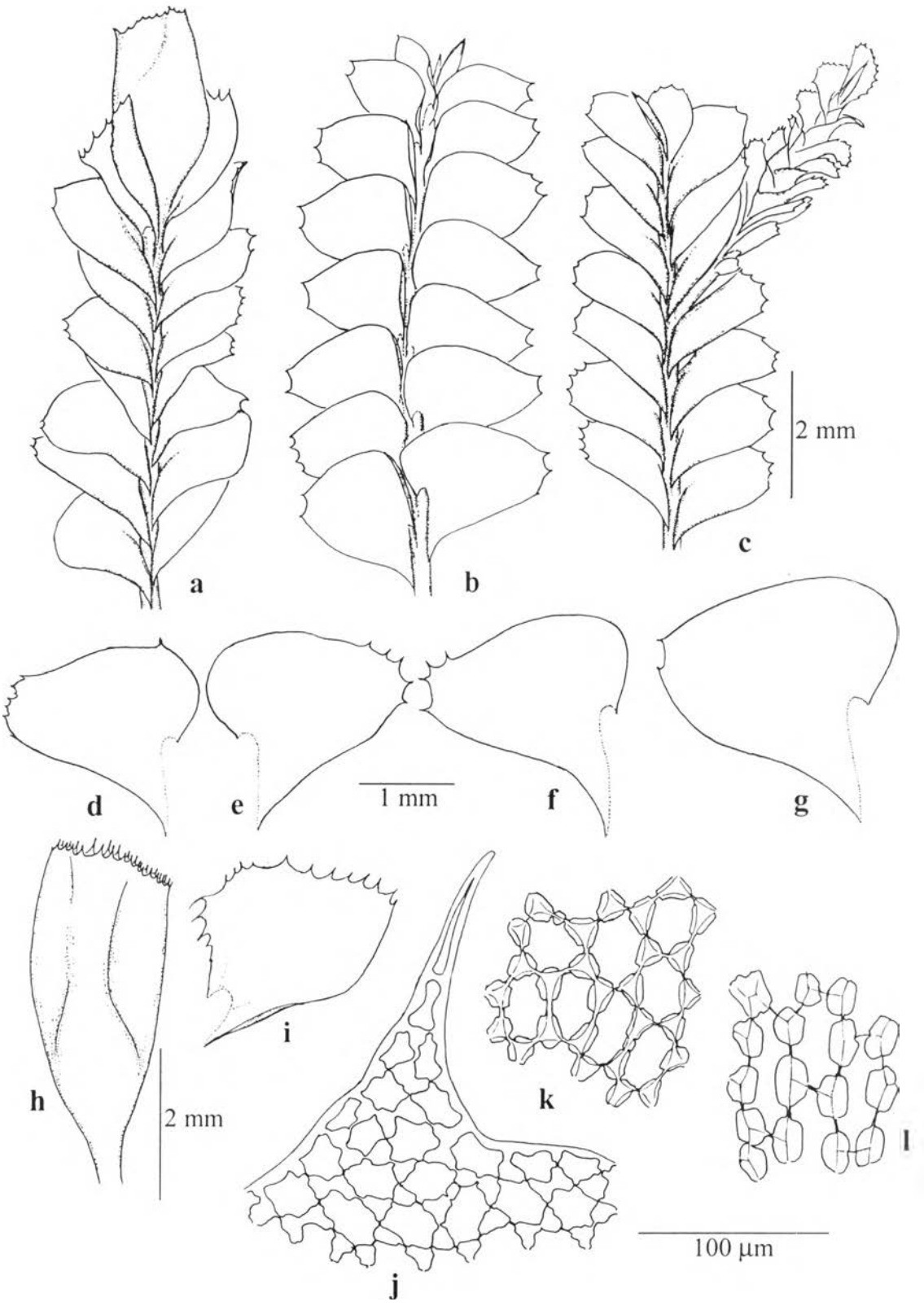

Figure 5.75 *Plagiochila microdonta* Mitt.
a. female plant; b. ventral portion of sterile plant; c. male plant; d.-g. leaves; h. perianth; i. female bract; j. cells at leaf apex; k. cells at leaf median; l. cells at leaf base. Based on *S. Chantanaorrapint 293* (except c. from *547*).

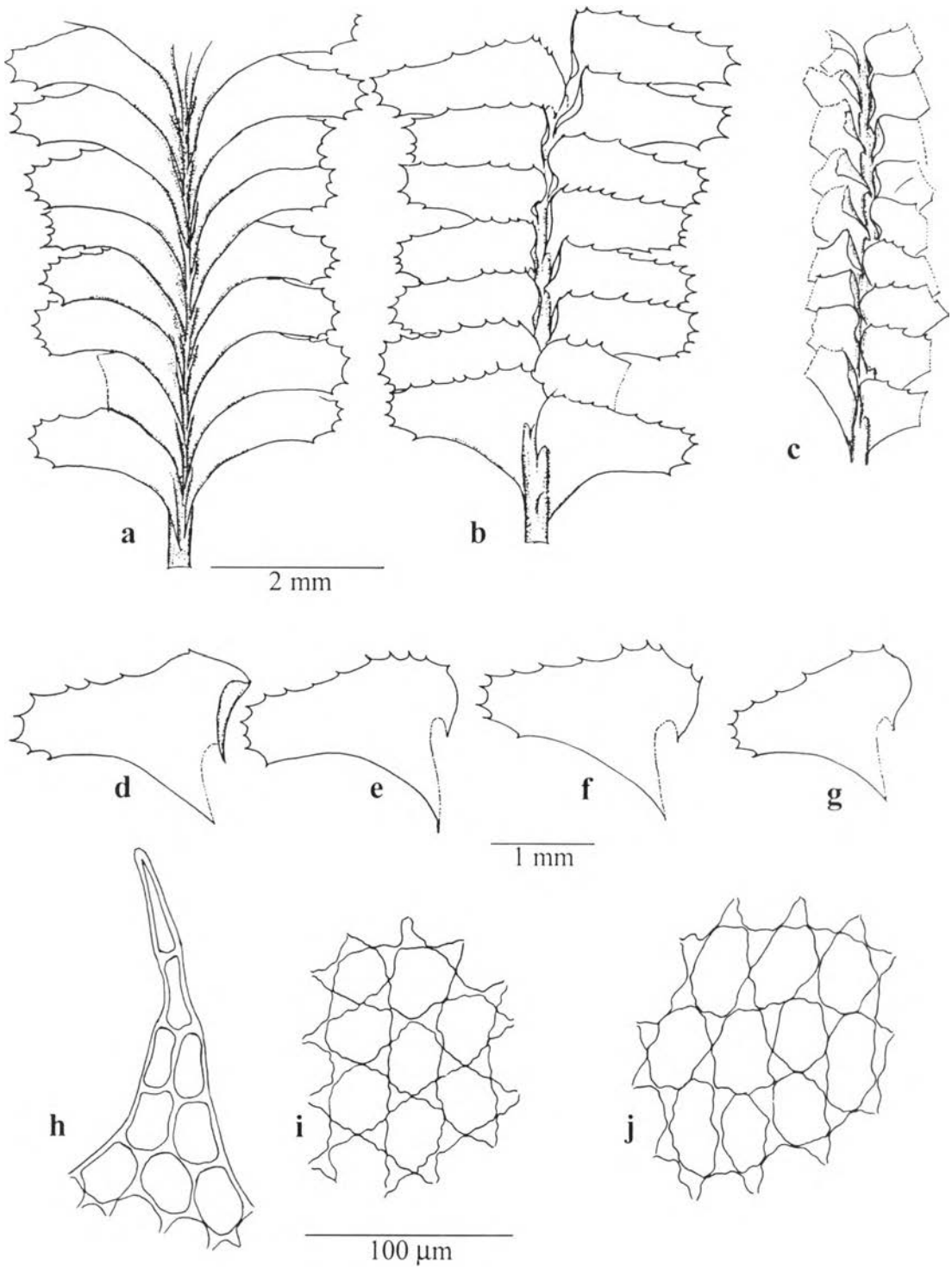

Figure 5.76 *Plagiochila yokurensis* Steph.
a. dorsal part of plant; b., c ventral portion of plant; d.-g. leaves; h. cells at leaf apex; i. cells at leaf median; j. cells at leaf base. Based on *S. Chantanaorrapint 289*.

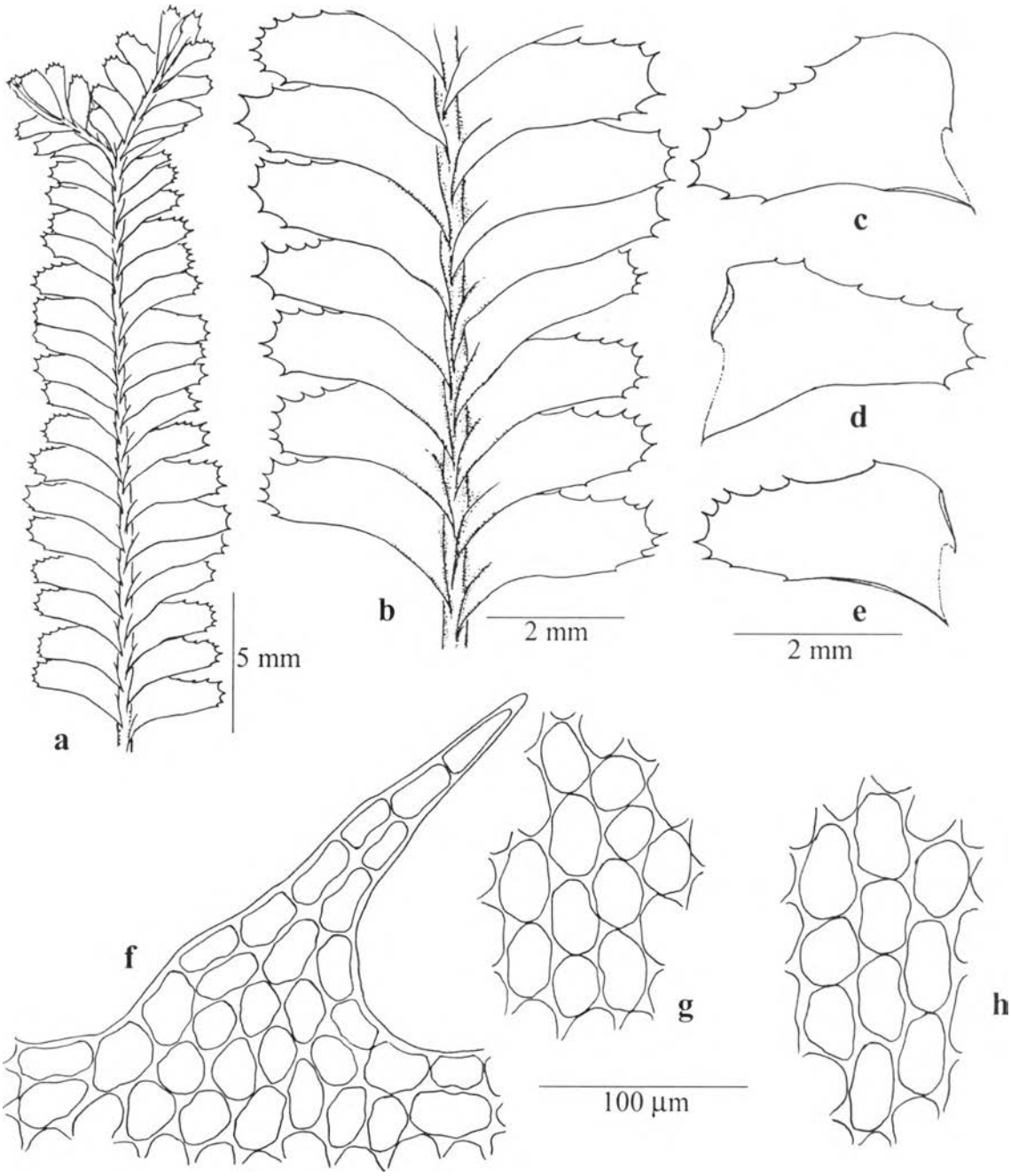

Figure 5.77 *Plagiochila* sp.
a., b. dorsal part of plants; c.-e. lateral leaves; f. cells at leaf apex; g. cells at leaf median; h. cells at leaf base. Based on *S. Chantanaorrapint 370.*

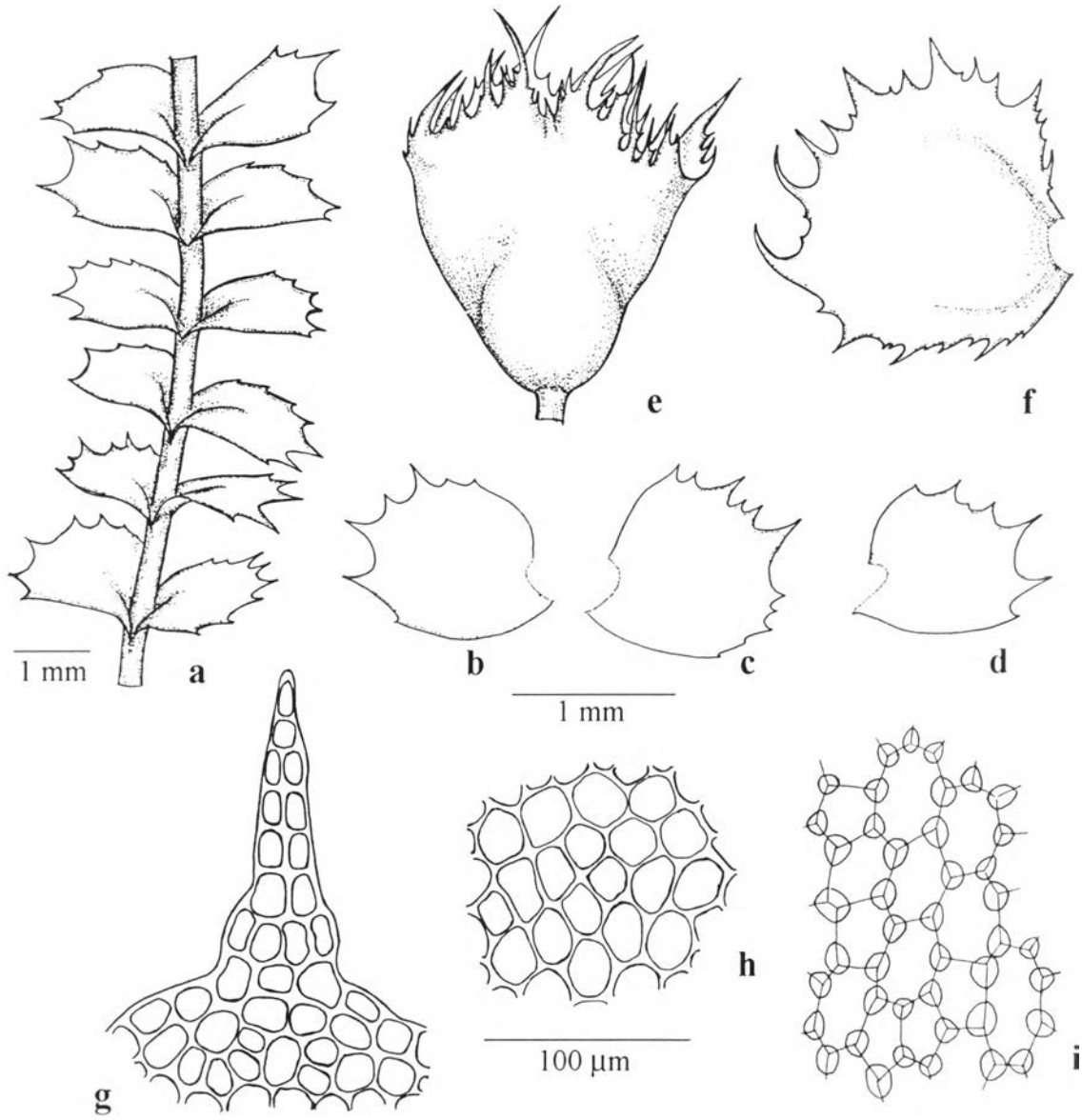

Figure 5.78 *Plagiochilion opposites* (Reinw., Blume et Nees) S. Hatt.
a. dorsal part of plants; b.-d. lateral leaves; e. perianth; f. female bract; g. cells at leaf apex; h. cells at leaf median; i. cells at leaf base. Based on *S. Chantanaorrapint 159*.

PLEUROZIACEAE

Plants medium to large, usually with secondary pigments. **Stems** ascending, prostrate or suberect, lacking ventral merophytes, lateral-intercalary branched. **Rhizoids** scattered. **Lateral leaves** incubous, complicated bilobed, lobules well-developed into water-sac. **Underleaves** lacking. **Dioicous**. **Gynoecia** on short lateral branches, perianths well-developed, capsules spherical, wall polystratose; seta short.

PLEUROZIA

Pleurozia Dumort. Recueil Observ. Jungerm. 15. 1835; R.M. Schust., New Manual of Bryology vol. 2: 1021. 1984.

For description of the genus, see that of the family.

Pleurozia gigantea (F. Weber) Lindb.

Hepat. Scand. Exsicc. 5. 1874. — *Jungermannia gigantea* F. Weber, Hist. Musc. Hepat. Prodr. 57. 1815.

Plants robust, reddish brown or dark purple. **Stems** up to 8 cm long, with leaves up to 1 cm wide. **Rhizoids** not seen. **Lateral leaves** densely imbricate, **leaf-lobe** ovate, up to 5 mm long, 3.5 mm wide, convex; dorsal margin with 2-3 triangular teeth, slightly arched at base; ventral margin strongly incurved; apex acute, with several teeth; apical cells 20 × 20-30 μm, thick-walled, trigones large, median cells 35-45 × 25-30 μm, trigones nodulose, thin-walled, sometimes with intermediate thickening, basal cells very large up to 100 × 30 μm, thin-walled, trigones nodulose; cuticle smooth; **leaf-lobule** large saccate, inflated, 1/2-2/3 as long as the lobe, ovate to lanceolate, usually incurved at apex, apex acute. **Androecia** not found. **Gynoecia** on short lateral branches, without subfloral innovation, usually on opposite side of stem; bracts subquadrate to rounded, apex truncate or rounded and irregularly lobed, appressed around the perianth. **Perianths** large, up to 8 mm long and 3 mm wide, cylindrical, widest at middle, strongly plicate above, entire below, mouth ciliate. (Fig. 5.79, 5.106).

Thailand. — EASTERN: Nakon Ratachasima.

Distribution. — St. Helena Island, Mascarene Island, Ceylon, Malay Archipelago, Hawaii.

Ecology. — On tree trunks or branches.

Specimens examined. — *S. Chantanaorrapint 306, 615* (BCU); *Inoue s.n.* (KLU).

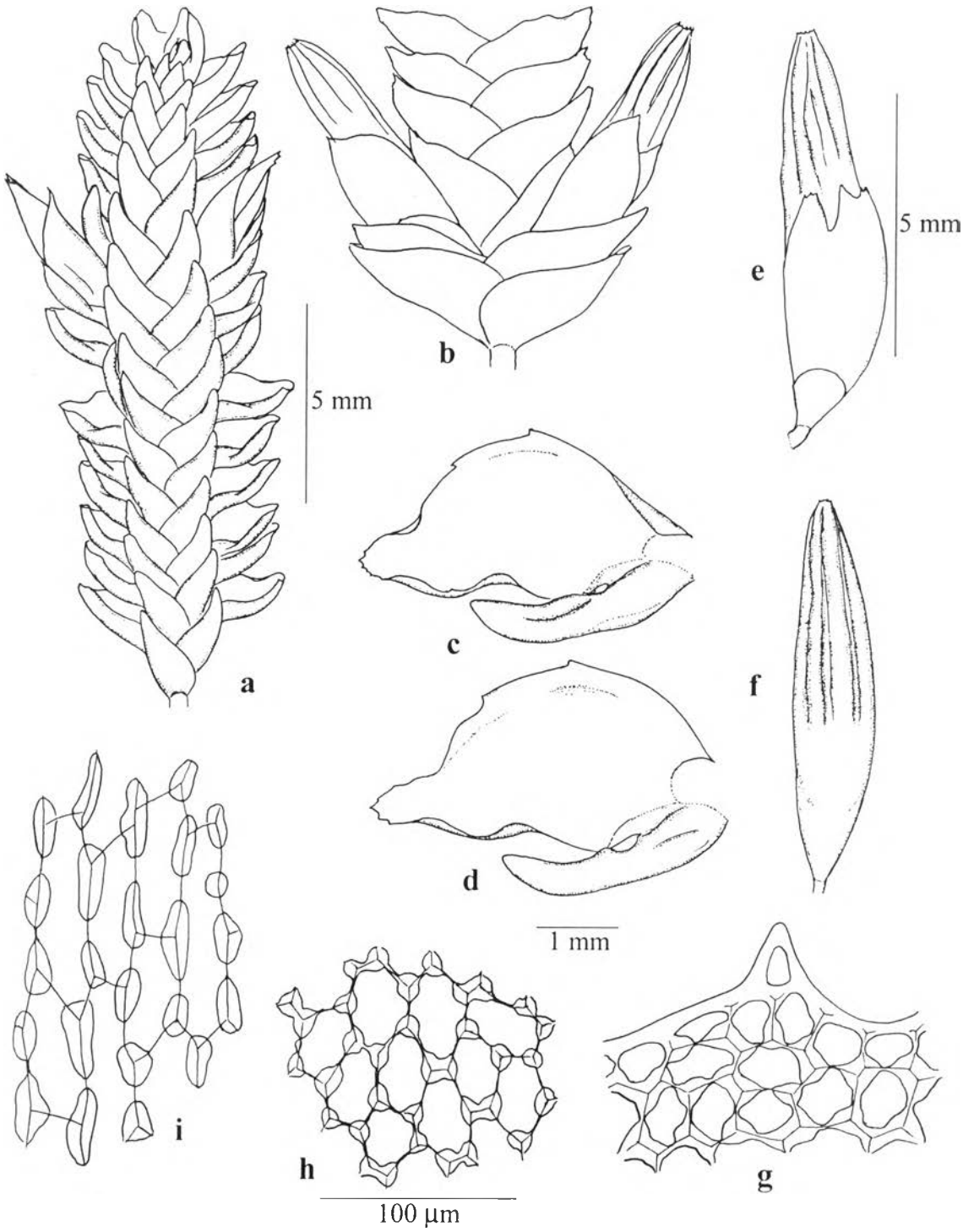

Figure 5.79 *Pleurozia gigantea* (F. Weber) Lindb.
a. ventral part of plants; b. dorsal part of plant with gynoecia; c., d. lateral leaves; e. gynoecium, f. perianth; g. cells at leaf apex; h. cells at leaf median; i. cells at leaf base. Based on *S. Chantanaorrapint 615.*

RADULACEAE

Plants small to large, olive to yellowish-green, brown to reddish-brown. **Stems** irregularly pinnately or bipinnately branched, branches usually obliquely spreading; cortical cells nearly as large as, to much smaller than, the medullary cells. **Rhizoids** present on leaf-lobules, often disc-like in outline, rarely absent. **Lateral leaves** incubous; **leaf-lobe** slightly remote to loosely or densely imbricate, widely or obliquely spreading, often fragile or caduceus, ovate, obovate, often more or less falcate, apex obtuse to rounded, or apiculate or subacute, margin entire or rarely dentate; leaf-cells thin- or thick-walled, with or without trigones; cuticle smooth or rarely minutely verrucose; **leaf-lobule** obliquely or widely spreading, or rarely erect, ovate, quadrate, orbicular, obovate, rectangular, or lingulate; rhizoid-initial area usually convex. **Underleaves** absent. **Dioicous** or rarely monoicous. **Androecia** terminal on intercalary branches, amentiform, with 5-20 pairs of densely imbricate bracts. **Gynoecia** terminal on stems and branches, with 1-2 subfloral innovations, or rarely on very short gynoecial branches lacking, subfloral innovation, with 1 or rarely 2-4 pairs of bracts, bract-lobe ovate or oblong-ovate, apex widely obtuse to rounded or rarely apiculate, margin entire or rarely dentate. **Perianth** flat-cylindric, or rarely trumpet-shaped, mouth usually ± two-lipped, truncate, repanded, or rarely toothed.

RADULA

Radula Dumort., Comm. Not. 112. 1822; K. Yamada, J. Hattori Bot. Lab. 45: 208. 1979. — *Martinellius* S.F. Gray, Nat. Arr. Brit. Pl. 1: 690. 1821.

For description of the genus, see that of the family

Key to species

1. Cortical cells not strongly differentiated from medullary cells.....1. *R. caduca*

1. Cortical cells very thick-walled so that cell-cavities much smaller than those of medulary cells.....2. *R. perrottetii*

1. ***Radula caduca*** Yamada

J. Hattori Bot. Lab. 45: 225, fig. 8. 1979.

Plants medium, yellowish brown. **Stems** 10-15 mm long, with leaves 1.5-1.7 mm wide, irregularly pinnate branched, branches obliquely spreading; in cross-section, cortical cells slightly smaller than medullary cells. **Lateral leaves** moderately imbricate, widely spreading, **leaf-lobe** often fragile, slightly convex, ovate, 0.7-1.2 mm long, 0.5-1.0 mm wide, apex rounded, dorsal base fully covering the stem; marginal cells 10-13 × 7-10 μm, median cells 20-25 × 15-20 μm, thin-walled with large trigones, basal cells 25-30 × 15-20 μm; cuticle densely verrucose; **leaf-lobules** subquadrate, 0.3-0.4 mm long, 0.3 mm wide, apex obtuse or subacute, covering the stem ca. 1/2-2/3 of the stem-width, carinal region strongly inflated; rhizoid-initial area convex, small, rhizoids few (Fig. 5.80). **Fertile plants** not found.

Thailand. — PENINSULAR: Nakhon Si Thammarat.
Distribution. — Endemic to Thailand.
Ecology. — On tree trunks.
Specimens examined. — *S. Chantanaorrapint 272, 582, 583* (BCU).

2. ***Radula perrottetii*** Gottsche ex Steph.

Hedwigia 23: 154. 1884; K. Yamada, J. Hattori Bot. Lab. 45: 310, fig. 62. 1979. — *R. gigantea* Horik., Sci. Rep. Tohoku Univ. ser. 4, 5: 636. 1930. — *R. valida* Steph., Sp. Hepat. (Stephani) 4: 164. 1910.

Plants large, olive-green or brown, **Stems** 6-10 cm long, with leaves ca. 3 mm wide, irregularly pinnate branched; in cross-section, cortical cells brown, small than medullary cells, strongly thick-walled (so that the walls are much wider than the cavities), medullary cells thin-walled but with large trigones. **Lateral leaves** loosely imbricate to slightly remote, widely spreading; **leaf-lobe** concave, ovate or narrow ovate, 1.2-1.5 mm long, 1.1-1.2 mm wide, apex obtuse or rounded, dorsal base arched, extending slightly beyond the farther edge of stem; marginal cells 10-12 × 10 μm, median cells 15-20 × 12-15 μm, thin-walled, with large trigones, basal cells 20-25 × 13-15 μm; cuticle smooth; **leaf-lobules** contiguous to slightly remote, ovate-triangular, extending slightly to almost the stem-width beyond the farther edge of stem, ca. 0.6-0.7 mm long, 0.5-0.6 mm wide, apex obtuse, base arched to auriculate, carinal region not inflated; rhizoid-initial area not developed, rhizoids not found. **Dioicous**. **Androecia** terminal on branches, spicate, with 4-10 pairs of bracts, sometimes with subfloral innovation. **Gynoecia** on short lateral branches, without subfloral innovations; bract-lobe divergent, narrowly ovate with rounded to obtuse apex; bract-lobule ovate. **Perianth** trumpet-shaped, flat, but usually with few plication, ca. 2.5 mm long, 1.5 mm wide at mouth, truncate, repand (Fig. 5.81). **Sporophytes** not found.

Thailand. — NORTHERN: Chiengmai; NORTH-EASTERN: Leoi; CENTRAL: Nakhon Nayok; SOUTH-EASTERN: Chantaburi.
Distribution. — China, Sumatra, Taiwan, Japan, India, Madagascar, East Afarica, Bourbon, Hawaii.
Habitat. — On tree-trunk and -branches, rocks, and rarely on decayed wood.
Specimens examined. — *S. Chantanaorrapint 123, 138, 200, 203, 257, 266, 280, 296* (BCU).

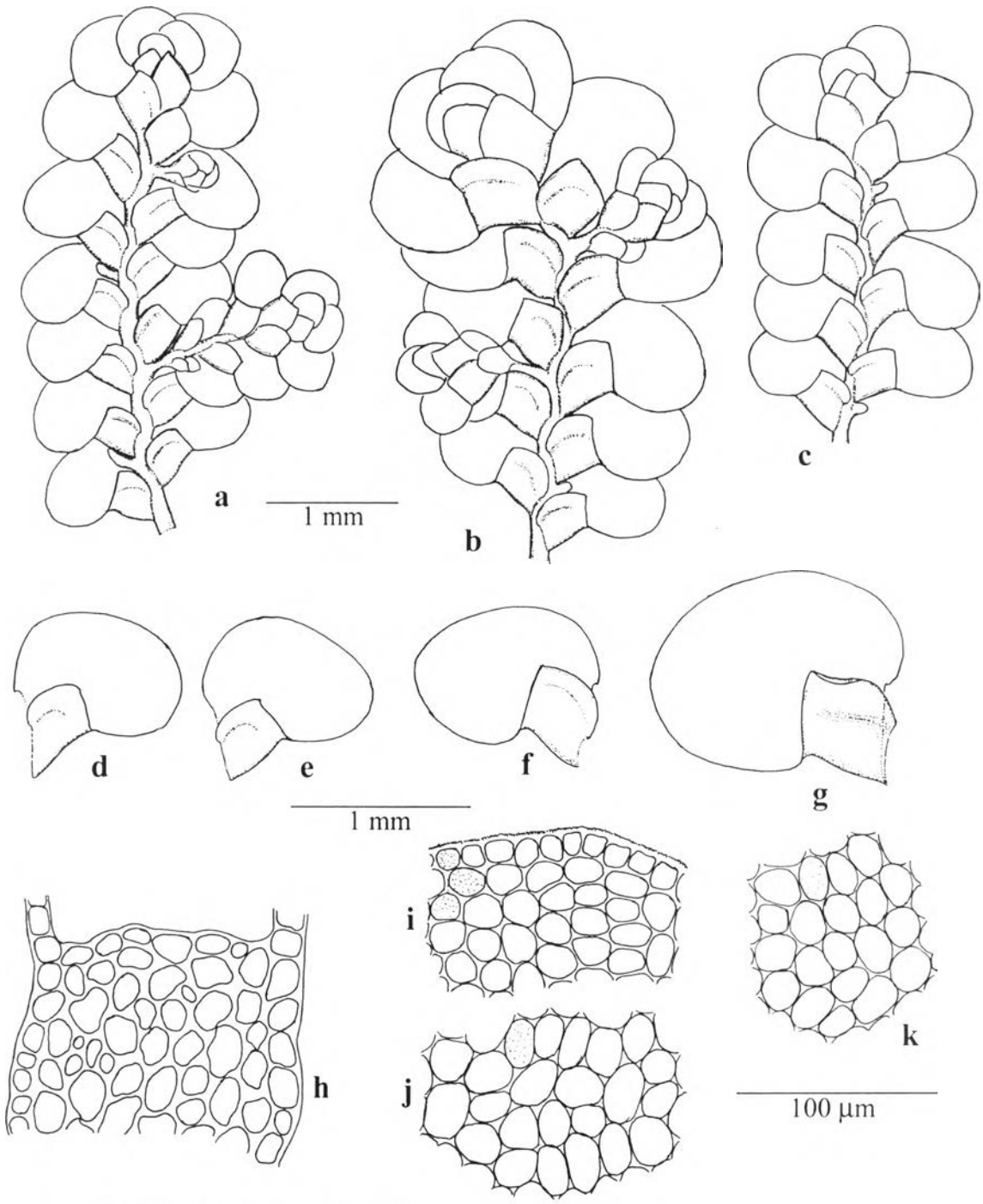

Figure 5.80 *Radula caduca* Yamada
a.-c. ventral part of plants; d.-g. lateral leaves; h. cross-section of stem; i. cells at leaf apex; j. cells at leaf median; k. cells at leaf base. Based on *S. Chantanaorrapint 272.*

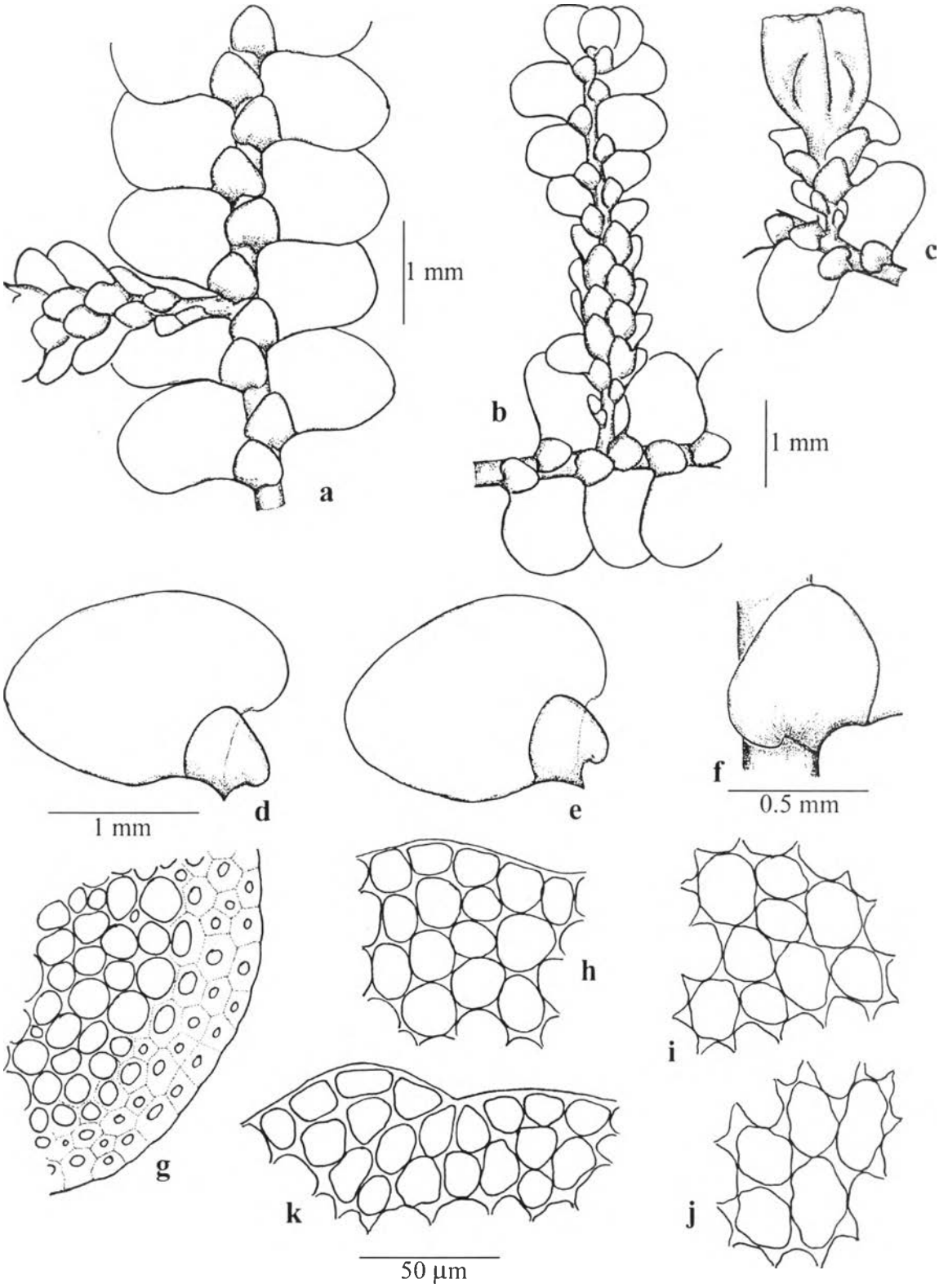

Figure 5.81 *Radula perottetii* Gottsche ex Steph.
a. ventral part of plants; b. androecium; c. gynoecium; d., e. lateral leaves; f. leaf-lobule; g. cross-section of stem; h. cells at leaf apex; i. cells at leaf median; j. cells at leaf base; k. cells at apex of lobule Based on *S. Chantanaorrapint 138*.

Figure 5.82 *Megaceros flagellaris* (Mitt.) Steph., gametophytes and sporophytes.

Figure 5.83 *Bryum coronatum* Schwägr., gametophytes and sporophytes.

Figure 5.84 *Rhodrobryum ontariense* (Kindb.) Kindb., habit.

Figure 5.85 *Calymperes lonchophyllum* Schwägr., habit.

Figure 5.86 *Campylopus ericoides* (Griff.) Jaeg., gametophytes and sporophytes.

Figure 5.87 *Cyathophorella adianta* (Griff.) Fleish., habit.

Figure 5.88 *Cyathophorella tonkinensis* (Broth. & Parish) Broth., habit.

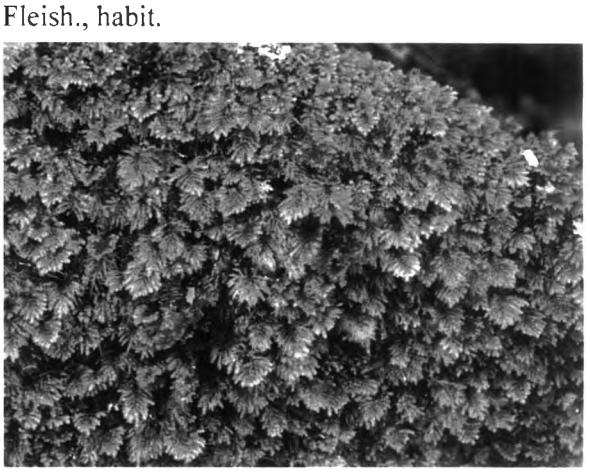

Figure 5.89 *Hypopterygium tenellum* C. Müll., habit.

Figure 5.90 *Lopidium struthiopteris* (Brid.) Fleisch., habit.

Figure 5.91 *Leucobryum javense* (Brid.) Mitt., habit.

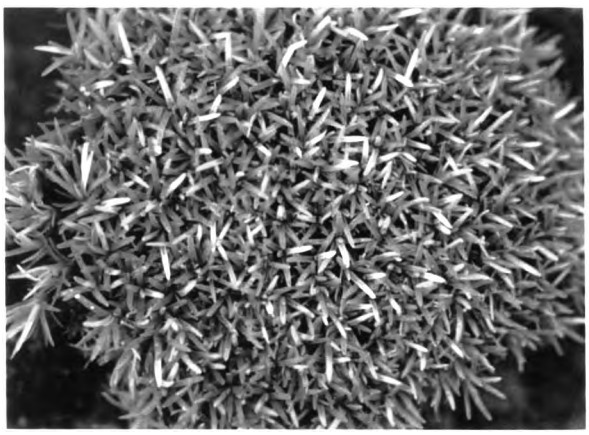

Figure 5.92 *Octoblepharum albidum* Hedw., sgametophytes and sporophytes.

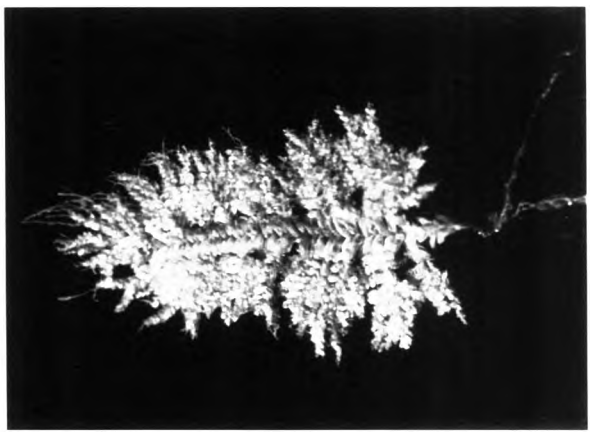

Figure 5.93 *Homaliodendron flabellatum* (Sm.) Fleisch., habit.

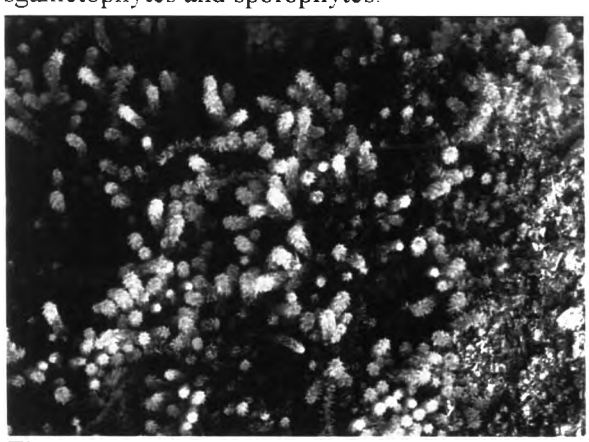

Figure 5.94A *Meteoriopsis squarrosa* (Hook.) Fleisch. ex Broth., habit.

Figure 5.94B *Meteoriopsis squarrosa* (Hook.) Fleisch. ex Broth., branch.

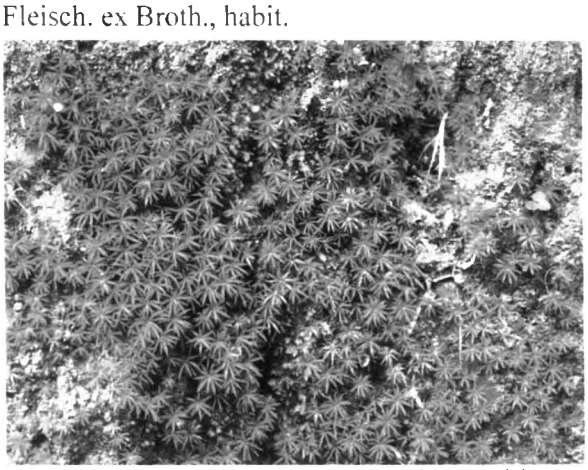

Figure 5.95 *Pogonatum cirratum* (Sw.) Brid., habit.

Figure 5.96 *Hyophila involuta* (Hook.) Jeag., gametophytes and sporophytes.

Figure 5.97 *Racopilum cuspidigerum* (Schwägr.) Ångstr., gametophytes and sporophytes.

Figure 5.98A *Pyrrhobryum spiniforme* (Hedw.) Mitt., habit.

Figure 5.98B *Pyrrhobryum spiniforme* (Hedw.) Mitt., gametophytes and sporophytes.

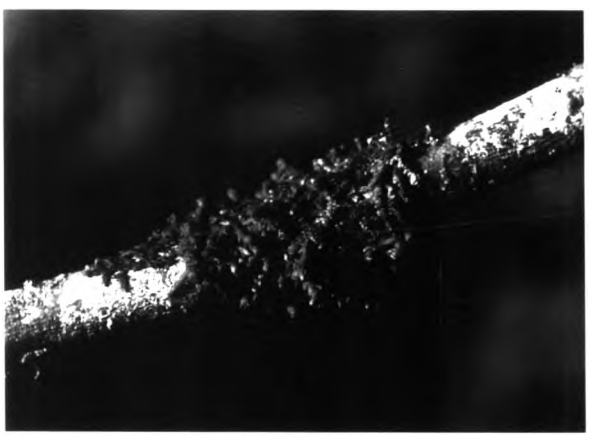

Figure 5.99 *Frullania wallichiana* Mitt., habitat.

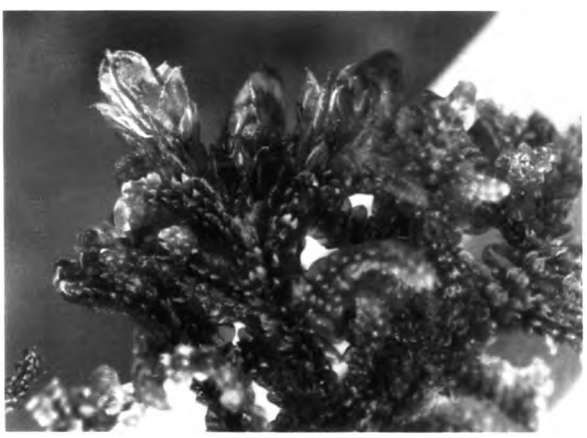

Figure 5.100 *Frullania apiculata* (Reinw. et al.) Dumort., gynoecium.

Figure 5.101 *Heteroscyphus coalitus* (Hook.) Schiffn., habit.

Figure 5.102 *Leptolejeunea epiphyllus* (Mitt.) Steph., habitat.

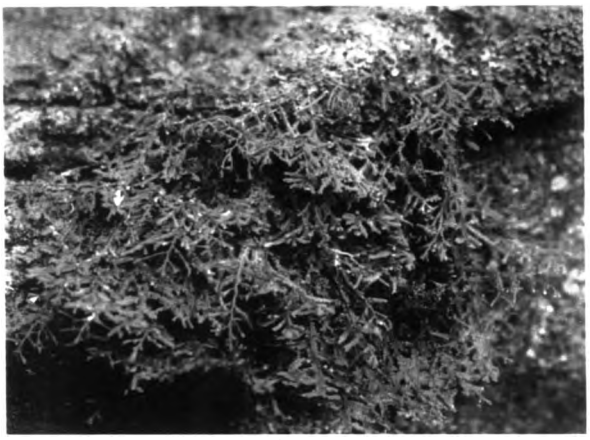

Figure 5.105 *Ptychanthus striatus* (Lehm. & Lindenb.) Nees, habitat.

Figure 5.106 *Spurceanthus semirepandus* (Nees) Verd., habitat.

Figure 5.107 *Bazzania tridens* (Reinw., Blume et Nees) Trev., habitat.

Figure 5.109 *Pleurozia gigantea* (F. Weber) Lindb., gynoecium.

Figure 5.108 *Pleurozia gigantea* (F. Weber) Lindb., habitat.

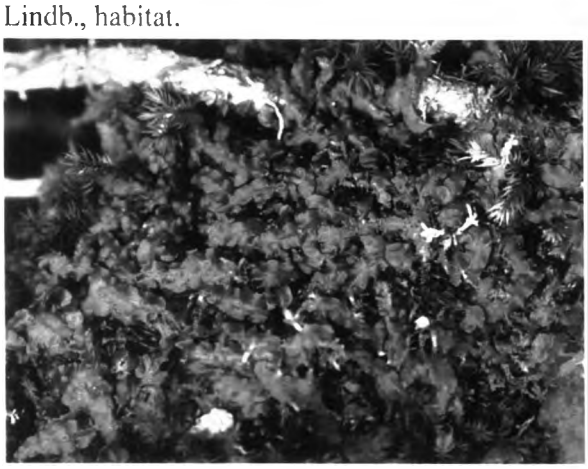

Figure 5.110 *Symphyogynopsis filicum* (Nadeaud) Grolle, habitat.

Figure 5.111 *Symphyogynopsis filicum* (Nadeaud) Grolle, young sporophytes.