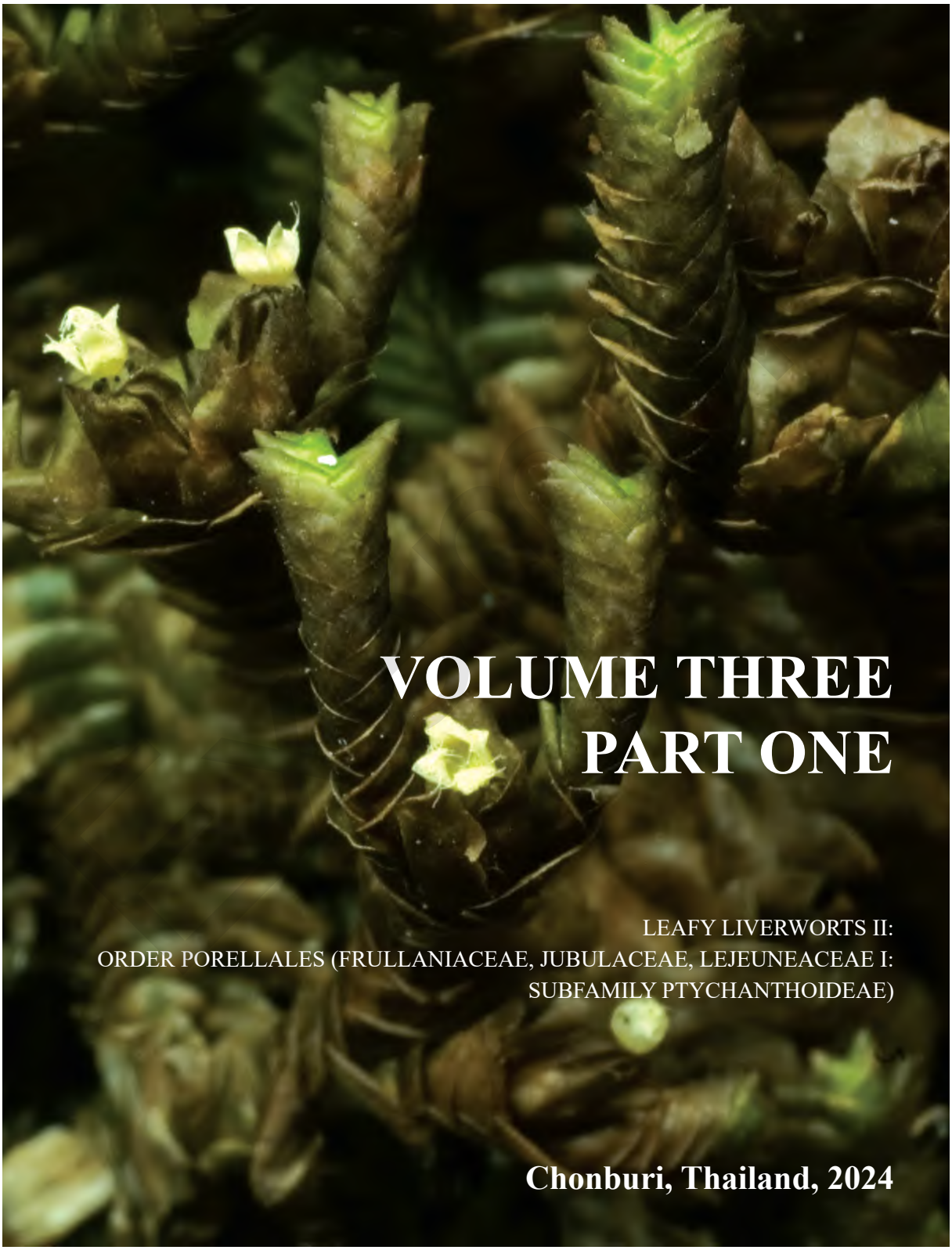
BRYOPHYTE FLORA OF THAILAND



VOLUME THREE PART ONE

LEAFY LIVERWORTS II:
ORDER PORELLALES (FRULLANIACEAE, JUBULACEAE, LEJEUNEACEAE I:
SUBFAMILY PTYCHANTHOIDEAE)

Chonburi, Thailand, 2024

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(FRULLANIACEAE, JUBULACEAE, LEJEUNEACEAE I: SUBFAMILY PTYCHANTHOIDEAE)

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TAXONOMIC TREATMENT

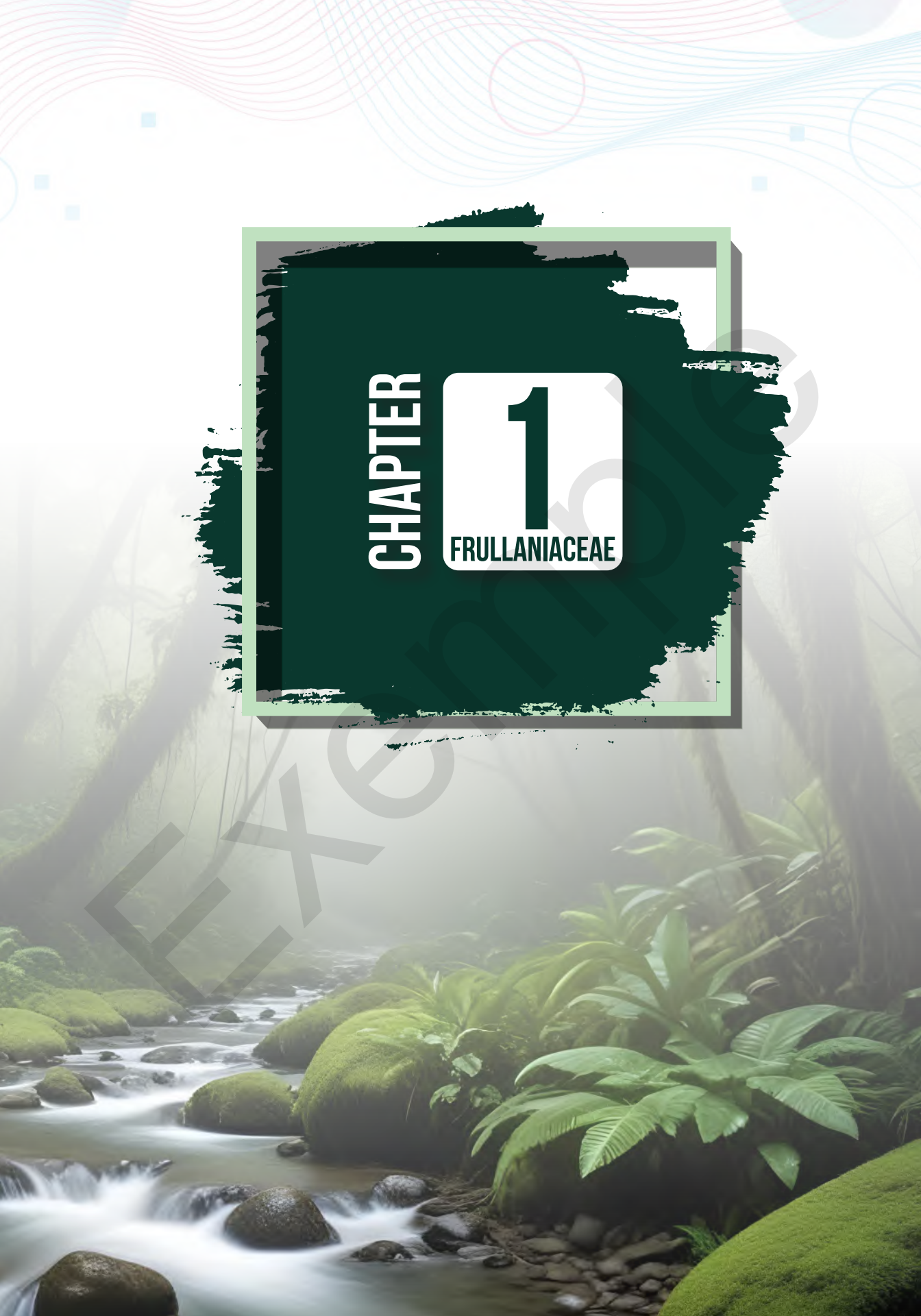
The Flora of Thailand Project has been documenting the diversity of vascular plants in Thailand since 1963 and is producing a large volume of taxonomic knowledge that greatly facilitates other research in plant sciences in Thailand. The taxonomic treatments for Thai embryophytes have been intended except for bryophytes due to the previous shortage of expertise on these plants in Thailand.

During the first period from 1899 to 1977 most contributions to Thai bryophytes knowledge were made by European and Japanese botanists or bryologists (Sukkharak & Chantanaorrapint 2014). The first Thai bryophyte specimens were collected from Koh Chang Island in Trat (Brotherus 1901, Stephani 1902). The first Thai bryologist was Obchant Thaithong who collaborated with Sinske Hattori and Naofumi Kitagawa (Japan) in the identification of the liverwort specimens collected in Thailand during 1957–1977 in the framework of the botanical expeditions of Kyoto University; Rijksherbarium, Leiden; and Aarhus University (Hattori et al. 1977). In the past thirty years most of the work done by Thai bryologists have focused on the bryophytes of particular areas within the country (Sukkharak & Chantanaorrapint 2014). The situation is changing. Since 2012, several young Thai bryologists have been actively working together to coordinate the efforts on taxonomic revisions of Thai bryophytes, as evident from a number of recent publications and an establishment of social network group among Thai Bryologists (e.g. Sukkharak & Chantanaorrapint 2014, Sukkharak 2022). It is time for this generation to take responsibilities to publish the Bryophyte Flora of Thailand to make it compatible with the Flora of Thailand Project. All of the taxonomic treatments will first be published as research articles in peer reviewed journals. The contents will then be reformatted and condensed to follow the Flora's existing format. The contents of this volume are, therefore, mainly from Sukkharak (2017) for Frullaniaceae, Sukkharak (2013, 2017) for Jubulaceae, and Kornochalert (2012) for Lejeuneaceae subfamily Ptychanthoideae with update and they were reformatted and condensed to follow the Flora of Thailand format. The glossary is based on Gradstein et al. (2001) as well as Malcolm and Malcolm (2006) and the forest type is according to Santisuk (2012), with modifications.

CONTENT

CHAPTER 1

FRULLANIACEAE



FRULLANIACEAE

PHIANGPHAK SUKKHARAK*

As the genus *Frullania* is the only member of the family Frullaniaceae, the family description is given under the genus *Frullania* description.

FRULLANIA

Raddi, Jungermanniogr. Etrusca: 9. 1818; Sukkharak, Nova Hedwigia 106(1–2): 118. 2018; Sukkharak, Liverwort genera of Thailand: 130. 2022.

Plants leafy; pale yellow, yellow, yellowish brown, red, reddish brown, blackish brown, dark red, or dark brown. *Rhizoids* smooth, on underleaf ventral base. *Branches Frullania*-type; irregularly pinnate, regularly pinnate, bipinnate or tripinnate; creeping. *Microphyllous branches* absent or present. *Stems* in cross section with epidermal cells as large as medullary cells. *Leaves* incubous; distant, continuous or imbricate; when dry, appressed; when moist widely spreading, convex with recurved apex or strongly squarrose; divided into three parts: lobe, lobule, stylus. *Lobes* ovate, obovate, oblong or orbicular; apex rounded, obtuse, acute, apiculate or mucronate; dorsal base truncate, cuneate, cordate or auriculate; ventral base plane or curved downward to stem; margins entire, plane or undulate; oil bodies segmented, globose to ellipsoid; ocelli absent or present. *Lobules* attached to stem by stalk-like base or adnate with lobes; parallel, incumbent, oblique, perpendicular to stem or pendulous; explanate or saccate; with or without appendiculum; imbricate, contiguous or distant; not covered by underleaves, partly covered by underleaves or entirely covered by underleaves, beyond ventral lobe margin or within confines of ventral lobe margin; cells mammillose or entire; apex acute, obtuse, rounded or truncate; mouth hemifold, rounded, truncate, twisted backward. *Styli* filiform, foliaceous or triangular; with or without disc-like appendage. *Underleaves* distant, continuous or imbricate; obovate, oblong, spathulate, trapezoid, reniform or orbicular; apex entire, retuse or bilobed; sinus acute, apiculate, obtuse or rounded;

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lobe apices plane or bending toward each other; margins entire, plane, undulate, incurved or recurved; bases cuneate or auriculate; auricles plane or folded inward. Monoicous or dioicous. *Gynoecia* terminal or lateral on branches; without innovations; bracts in 2–3 pairs; margins entire, toothed or serrate, plane; bracteoles bilobed; margins entire, toothed or serrate, plane; archegonia 2–5 per perianth; perianth oblong or pyriform, 3–4-keeled (2 lateral, 1–2 ventral); keels entire, sinuate, toothed, or spinose, plane; beak absent or present, inner surface entire or with single-celled protuberances. *Androecial bracts and bracteoles* in 1–7 pairs. *Sporophyte* in perianth; foot not penetrating into stem; setae numerous rows of cells; capsule globose, wall 2-layered; elaters attached to capsule valves; spore germination endosporic, surface with rosettes. *Asexual reproduction* by gemmae, caducous leaves, fragmenting leaves or absent.

With accepted 576 species distributed worldwide, 39 species are reported in Thailand.

1. *Frullania alstonii*
2. *Frullania apiculata*
3. *Frullania berthoumieui*
4. *Frullania brotheri*
5. *Frullania campanulata*
6. *Frullania claviloba*
7. *Frullania ericoides*
8. *Frullania gaudichaudii*
9. *Frullania gemmulosa*
10. *Frullania gracilis*
11. *Frullania hamatiloba*
12. *Frullania hypoleuca*
13. *Frullania intermedia*
14. *Frullania junghuhniana*
    var. *tenella*
15. *Frullania meyeniana*
16. *Frullania moniliata*

17. *Frullania monocera*
    var. *acutiloba*
18. *Frullania muscicola*
19. *Frullania nepalensis*
20. *Frullania neurota*
21. *Frullania nigricaulis*
22. *Frullania nodulosa*
23. *Frullania obscura*
24. *Frullania ornithocephala*
25. *Frullania pallidevirens*
26. *Frullania parvistipula*
27. *Frullania polyptera*
28. *Frullania ramuligera*
29. *Frullania retusa*
    var. *retusa*
30. *Frullania rio-janeirensis*
31. *Frullania sackawana*
32. *Frullania schensiana*
33. *Frullania serrata*
34. *Frullania shanensis*
35. *Frullania sinuata*
36. *Frullania tagawana*
37. *Frullania trichodes*
38. *Frullania warnckeana*
39. *Frullania yuennanensis*
    var. *yuennanensis*
    var. *siamensis*

KEY TO THE SPECIES

1. Microphyllous branches present
   2. Underleaf apex 1/3-bilobed. Female bract and bracteole margins entire. Perianth inner surface with single-celled protuberances **12. F. hypoleuca**
   2. Underleaf apex 1/2-bilobed. Female bract and bracteole margins toothed. Perianth inner surface without single-celled protuberances **28. F. ramuligera**
1. Microphyllous branches absent
   3. Lobes with ocelli
      4. Ocelli restricted to lobe base
         5. Lobules not covered by underleaves. Styli foliaceous, without semicircular disc-like appendage or ovate disc-like appendage **10. F. gracilis**
         5. Lobules entirely covered or partly covered by underleaves. Styli filiform, with semicircular disc-like appendage or ovate disc-like appendage
            6. Leaves imbricate, ocelli basal type >10 cells per lobe. Lobules partly covered by underleaves. Styli with semicircular disc-like appendage. Underleaves contiguous **35. F. sinuata**
            6. Leaves contiguous, ocelli basal type ≤10 cells per lobe. Lobules entirely covered by underleaves. Styli with ovate disc-like appendage. Underleaves distant **37. F. trichodes**
      4. Ocelli moniliform only or dispersed with moniliform type
         7. Lobe apex rounded; ocelli dispersed with moniliform type. Styli without disc-like appendage **1. F. alstonii**
         7. Lobe apex apiculate; ocelli moniliform only. Styli with semicircular disc-like appendage **16. F. moniliata**
   3. Lobes without ocelli
      8. Underleaf apex entire or retuse
         9. Gemmae on dorsal lobe surface present. Dorsal base of lobes cordate **9. F. gemmulosa**

9. Gemmae on dorsal lobe surface absent. Dorsal base of lobes auriculate
    10. Lobule mouth hemifold, recurved toward beak forming obtuse rostrum. Underleaf base cuneate **29. F. retusa var. retusa**
    10. Lobule mouth truncate or twisted backward, ventral portion parallel to dorsal portion. Underleaf base auriculate
        11. Lobes ovate. Lobule mouth truncate. Styli filiform or triangular. Underleaf apex toward margins recurved **39a. F. yuennanensis var. yuennanensis**
        11. Lobes obovate. Lobule mouth twisted backward. Styli foliaceous. Underleaf apex toward margins plane **39b. F. yuennanensis var. siamensis**

8. Underleaf apex bilobed
    12. Lobules saccate with appendiculum, ligulate laminal portion of leaf lobules extending beyond ventral margin of lobes
        13. Lobe and underleaf margins undulate. Styli filiform. Female bract and bracteole margins toothed **23. F. obscura**
        13. Lobe and underleaf margins plane. Styli foliaceous. Female bract and bracteole margins entire **30. F. rio-janeirensis**
    12. Lobules saccate or explanate without appendiculum
        14. Lobules adnate with lobes
            15. Lobule cell surface mammillose **13. F. intermedia**
            15. Lobule cell surface entire
                16. Underleaf base cuneate **31. F. sackawana**
                16. Underleaf base auriculate
                    17. Lobes ovate, dorsal base cordate. Underleaf sinus acute, lobe apices plane **4. F. brotheri**
                    17. Lobes orbicular, dorsal base auriculate. Underleaf sinus obtuse, lobe apices bending toward each other **22. F. nodulosa**
        14. Lobules attached to stem by stalk-like base
            18. Lobules incumbent to stem

19. Lobule apex acute. Underleaf margins plane. Female bract and bracteole margins serrate **15. F. meyeniana**

19. Lobule apex obtuse. Underleaf margins recurved. Female bract and bracteole margins entire **36. F. tagawana**

18. Lobules oblique, parallel or perpendicular to stem

20. Lobules cylindrical or campanulate

21. Underleaf base auriculate

22. Lobes orbicular, apex rounded. Underleaves orbicular, 1/5–1/4-bilobed, margins plane **21. F. nigricaulis**

22. Lobes ovate, apex apiculate. Underleaves obovate, 1/3-bilobed, margins recurved **33. F. serrata**

21. Underleaf base cuneate

23. Dorsal base of lobes cordate. Lobules campanulate **5. F. campanulata**

23. Dorsal base of lobes truncate. Lobules cylindrical

24. Lobe apex apiculate **2. F. apiculata**

24. Lobe apex obtuse or rounded

25. Leaves convex. Lobule cell surface mammillose **14. F. junghuhniana var. tenella**

25. Leaves widely spreading. Lobule cell surface entire

26. Underleaves distant, obovate **6. F. claviloba**

26. Underleaves contiguous, ovate-oblong **38. F. warnckeana**

20. Lobules cucullate

27. Underleaf base auriculate

28. Ventral base of lobes curved downward to stem, extending beyond lobules **8. F. gaudichaudii**

28. Ventral base of lobes plane, not exceed lobules

29. Underleaf margins plane, auricles inward folded **25. F. pallidevirens**

29. Underleaf margins incurved, auricles plane

30. Lobules longer than wide, apex obtuse, mouth obliquely truncate, wide open, ventral portion parallel to dorsal portion **19. F. nepalensis**

30. Lobules wider than long, apex rounded, mouth hemifold, recurved toward well-developed beak forming acute rostrum, extending beyond ventral lobe margin **24. F. ornithocephala**

27. Underleaf base cuneate

31. Leaves strongly squarrose **7. F. ericoides**

31. Leaves widely spreading or convex with recurved apex

32. Lobule mouth hemifold, recurved towardwell-developed beak forming rostrum

33. Underleaves orbicular **3. F. berthoumieui**

33. Underleaves spathulate or trapezoid

34. Lobule rostrum obtuse. Underleaves spathulate **11. F. hamatiloba**

34. Lobule rostrum caudate. Underleaves trapezoid **17. F. monocera var. acutiloba**

32. Lobule mouth obliquely truncate, wide open, without beaks

35. Lobules wider than long **34. F. shanensis**

35. Lobules as wide as long or longer than wide

36. Ventral portion of lobule mouth 2/3 × dorsal portion **20. F. neurota**

36. Ventral portion of lobule mouth parallel to dorsal portion

37. Styli foliaceous

38. Leaves convex. Underleaf apex 1/3–1/2-bilobed **27. F. polyptera**

38. Leaves widely spreading. Underleaf apex 1/7–1/4-bilobed **32. F. schensiana**

37. Styli filiform or triangular

39. Underleaves trapezoid. Lobules extend beyond ventral lobe margin **26. F. parvistipula**

39. Underleaves obovate. Lobules within confines of ventral lobe margin **18. F. muscicola**

1. Frullania alstonii Verd., Ann. Bryol., Suppl. 1: 76, fig. 110. 1930; S.Hatt. et al., J. Hattori Bot. Lab. 43: 441. 1977; Sukkharak, Nova Hedwigia 106(1–2): 199, fig. 40. 2018.

Stems with leaves 1–1.2 mm wide. *Branches* regularly pinnate. *Leaves* imbricate; widely spreading. *Lobes* orbicular, 0.4–0.5 mm long × 0.3–0.4 mm wide; apex rounded; dorsal base cordate; ventral base plane; margins plane; median cells 13–22 × 9–16 µm; ocelli dispersed with moniliform, dispersed 15–19 cells per lobe, moniliform 4–5 cells in 1 row per lobe. *Lobules* attached to stem by stalk-like base; incumbent to stem; cylindrical; without appendiculum; distant; not covered by underleaves, within confines of ventral lobe margin; cells entire; apex obtuse; mouth rounded, arched, entire. *Styli* filiform; without disc-like appendage. *Underleaves* distant; oblong, 0.2–0.3 × 0.1–0.2 mm; apex 1/2-bilobed; sinus acute; lobe apices plane; margins plane; bases cuneate. *Gynoecia and androecia* not seen.

Thailand.— NORTHERN: Chiang Mai; SOUTH-EASTERN: Prachin Buri, Chanthaburi; SOUTH-WESTERN: Prachuap Khiri Khan; PENINSULAR: Nakhon Si Thammarat.

Distribution.— India, Sri Lanka, China, Thailand, Malaysia, Indonesia, Philippines.

Ecology.— Lower montane rain forests; epiphyte; 1105–1254 m alt.

Note.— *Frullania alstonii* is distinguished by the presence of both dispersed and moniliform ocelli in lobes.

2. Frullania apiculata (Reinw., Blume & Nees) Nees in Gottsche et al., Syn. Hepat. 3: 452. 1845; S.Hatt. et al., J. Hattori Bot. Lab. 43: 441. 1977; Sukkharak, Nova Hedwigia 106(1–2): 134, fig. 5. 2018.— *Jungermannia apiculata* Reinw., Blume & Nees, Nova Acta Phys.-Med. Acad. Caes. Leop.-Carol. Nat. Cur. 12(1): 222. 1824.

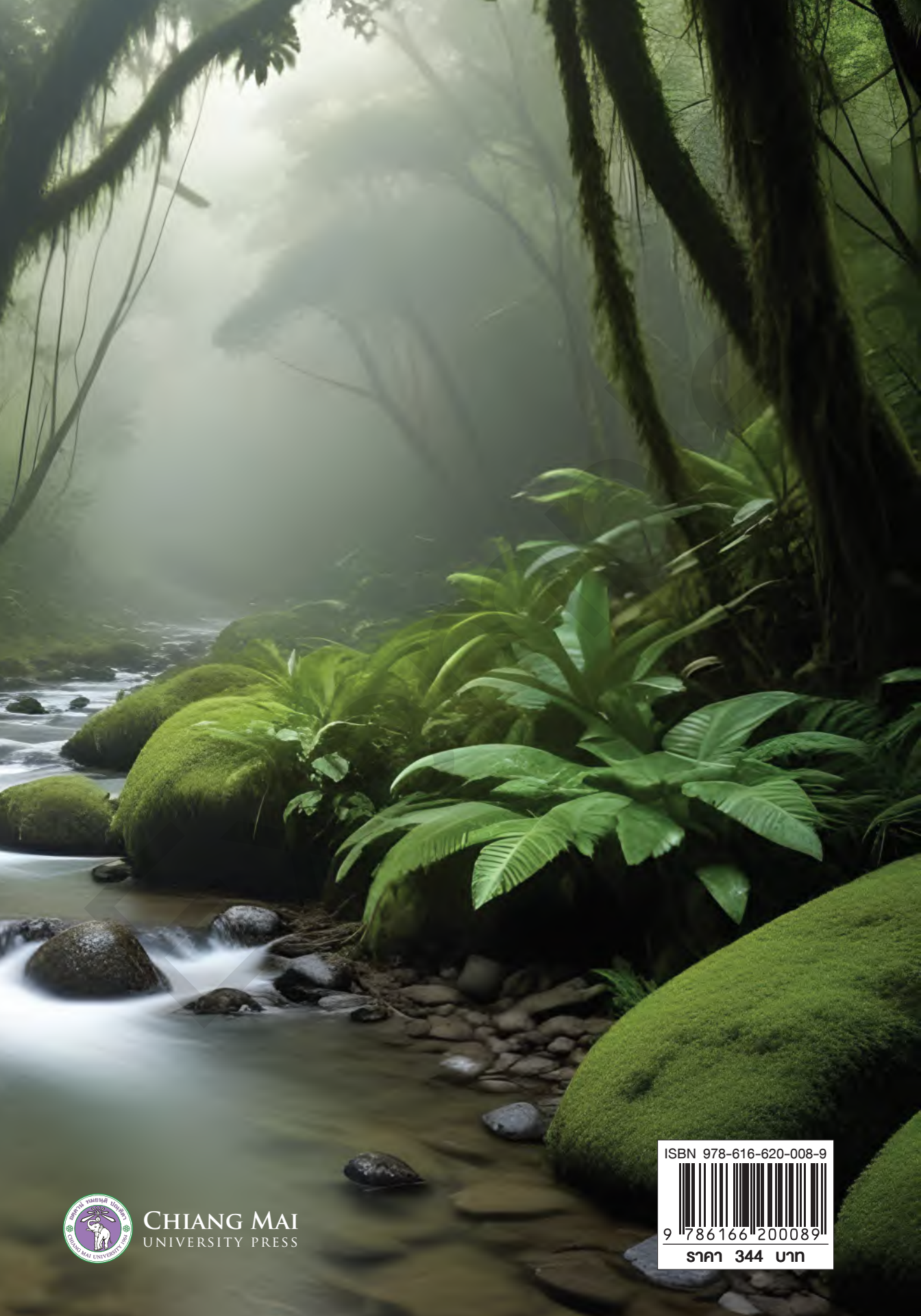
Stems with leaves 0.8–1 mm wide. *Branches* bipinnate. *Leaves* imbricate; convex with strongly recurved apex. *Lobes* ovate, 0.4–0.7 mm long × 0.4–0.6 mm wide; apex apiculate; dorsal base truncate; ventral base plane; margins plane; median cells 13–21 × 8–11 µm. *Lobules* attached to stem by stalk-like base; oblique to stem; cylindrical; without appendiculum; distant; not covered by underleaves, beyond ventral lobe margin; cells entire; apex acute; mouth rounded, arched, crenate. *Styli* foliaceous; without disc-like appendage. *Underleaves* distant to slightly imbricate; obovate, 0.3–0.4 × 0.3–0.4 mm; apex 1/4–1/3-bilobed; sinus acute; lobe apices plane; margins plane; bases cuneate. Monoicous. *Gynoecia* terminal on branches; bracts in 3 pairs, margins entire; bracteole bilobed, margins entire; perianth oblong, 1.3–1.4 × 0.6–0.7 mm, 3-keeled (2 lateral, 1 ventral); keels entire; beak 66–83 µm long, inner surface entire. *Androecial bracts* in 2–4 pairs.

Thailand.— NORTHERN: Chiang Mai, Nakhon Sawan; NORTH-EASTERN: Loei; EASTERN: Nakhon Ratchasima; SOUTH-EASTERN: Prachin Buri, Chanthaburi, Trat; SOUTH-WESTERN: Prachuap Khiri Khan; PENINSULAR: Nakhon Si Thammarat, Trang, Yala.

Distribution.— Pantropical.

Ecology.— Montane rain forests, lower montane rain forests, plantations; epiphyte, lithophyte; 514–2000 m alt.

Note.— *Frullania apiculata* resembles *F. serrata* in having apiculate lobe apex. However, *F. serrata* differs by lobules entirely covered by underleaves (not covered by underleaves in *F. apiculata*) and toothed female bract and bracteole margins (entire in *F. apiculata*).



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