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# Lejeuneaceae subfamily Ptychanthoideae (Marchantiophyta) in Thailand

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**Abstract –** Twelve genera, 37 species, and three varieties of Ptychanthoideae are known in Thailand, including four new records, *Archilejeunea kiushiana* (Horik.) Verd., *Lopholejeunea soae* R.-L. Zhu & Gradst., *Schiffneriolejeunea polycarpa* (Nees) Gradst., and *Schiffneriolejeunea tumida* var. *haskarliana* (Gottsche) Gradst. *et* Terken. *Thysananthus aculeatus* Herzog is excluded from Thailand. A key, brief descriptions and selected illustrations for the species of Ptychanthoideae of Thailand are provided.

**Lejeuneaceae / Ptychanthoideae / Thailand**

## INTRODUCTION

The Lejeuneaceae is the largest family of liverworts (Marchantiophyta), with about 1700 species in 81 genera (He & Zhu, 2011). Lejeuneaceae is usually subdivided into two broad families Ptychanthoideae and Lejeuneoideae (e.g., Mizutani 1961, Gradstein 1994) and this classification was confirmed by Wilson *et al.* (2007) using molecular characters. For subfamily Ptychanthoideae, there are about 25 genera and 170 species worldwide (Gradstein, 1987). Among these, 17 genera and 88 species are found in Asia (Gradstein, 1991). Species of Ptychanthoideae occur on trees, rocks, and even on living leaves, and under wide range of elevations, from sea level to over 4000 m. The characteristics of Ptychanthoideae include the often large-sized plant size (to 5-15 cm long), ovate leaf lobes, thin to thick-walled cells, often large trigones, oil bodies of two forms (homogenous and compound), lobules attached by a wide base to the stem and with 1-3 or more teeth, underleaves undivided, perianth fundamentally 3-keeled and often developing up to 10 supplementary keels, distinctly spiralled elaters, thickened capsule walls, and isodiametric spores.

Thai Ptychanthoideae were first studied by Stephani (1902) who listed 17 species of liverworts from Koh Chang, Trat Province, including six species of Ptychanthoideae, *viz*. *Acrolejeunea aulacophora* (Mont.) Steph., *Archilejeunea caramuensis* Steph. [= *A. planiuscula* (Mitt.) Steph.], *Caudalejeunea stephanii*

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Spruce [= *C. reniloba* (Gottsche) Steph.], *Lopholejeunea sundaica* Steph. [= *L. eulopha* (Taylor) Schiffn.], *Mastigolejeunea humilis* (Gottsche) Steph. [= *M. auriculata* (Wilson) Schiffn.], and *Thysanolejeunea spathulistipa* (Reinw. *et al.*) Steph. [= *Thysananthus spathulistipus* (Reinw. *et al.*) Lindenb.].

Based on previous studies, Thai Ptychanthoideae comprised 12 genera, 35 species and two varieties [Verdoorn (1934), Reed & Robinson (1967), Tixier (1970, 1973), Sornsamran & Thaithong (1995), Chantanaorrapint *et al.* (2004), Lai *et al.* (2008), Sukkharak *et al*. (2008) and Kornochalert *et al*. (2010)]. The purpose of the present paper is to describe the taxonomy, morphology, diversity and ecology of Thai Ptychanthoideae, as baseline information for the conservation of the Ptychanthoideae in Thailand.

## MATERIALS AND METHODS

This research is based on specimens and field observations from 18 National Parks and one Wildlife Sanctuary, representing the seven different floristic regions of Thailand (Smitinand, 1958). Specimens from CMU Herbarium, Professor Kasin Suvatabhandhu Herbarium (BCU), Bangkok Forest Herbarium (BKF), Biological History Museum of East China Normal University (HSNU), National Herbarium of the Netherlands, Leiden (L), and Prince of Songkhla University (PSU) were examined.

## RESULTS AND DISCUSSION

In this study 12 genera, 37 species and three varieties of Ptychanthoideae are recorded for Thailand. *Archilejeunea kiushiana* (Horik.) Verd., *Lopholejeunea soae* R.-L. Zhu *et* Gradst., *Schiffneriolejeunea polycarpa* (Nees) Gradst. and *Schiffneriolejeunea tumida* var. *haskarliana* (Gottsche) Gradst. *et* Terken are new additions to the liverwort flora of Thailand. *Thysananthus aculeatus* Herzog is excluded from Thailand, having been recorded based on misidentified material.

The distribution of Thai Ptychanthoideae can be grouped into three categories according to vegetation type, rainfall, temperature, and elevation of the seven floristic regions of Thailand. Species with a wide distribution are known from more than five floristic regions, with moderately wide distribution from 3-4 floristic regions, and limited distribution from 1-2 floristic regions (Table 1).

*Acrolejeunea fertilis*, *Archilejeunea planiuscula*, *Caudalejeunea reniloba*, *Lopholejeunea nigricans*, *L. subfusca*, *Mastigolejeunea auriculata*, *M. indica*, *M. repleta*, *Ptychanthus striatus*, *Schiffneriolejeunea tumida* var. *haskarliana*, *Spruceanthus polymorphus*, *S. semirepandus*, and *Thysananthus spathulistipus* have a wide distribution. Among these *Lopholejeunea subfusca* is the most common species of this category. *Acrolejeunea pycnoclada* var. *pycnoclada*, *A. recurvata, Lopholejeunea eulopha*, *Mastigolejeunea virens* and *Tuzibeanthus chinensis* have a moderately wide distribution. *Acrolejeunea parvula*, *Archilejeunea kiushiana*, *Caudalejeunea cristiloba*, *Dendrolejeunea fruticosa*, *Lopholejeunea applanata*, *L. ceylanica*, *L. herzogiana*, *L. horticola*, *L. soae*, *L. zollingeri*,

*Mastigolejeunea ligulata*, *Schiffneriolejeunea cumingiana*, *S. polycarpa*, *S. pulopenangensis*, *S. tumida* var. *tumida*, *Thysananthus comosus*, *T. convolutus*, *T. retusus*, *Trocholejeunea infuscata*, and *T. sandvicensis* have limited distribution. *Caudalejeunea cristiloba*, *Dendrolejeunea fruticosa*, *Lopholejeunea herzogiana*, *L. horticola*, *Mastigolejeunea ligulata*, *Schiffneriolejeunea tumida* var. *tumida*, *Thysananthus comosus*, *T. convolutus*, *T. retusus*, and *Trocholejeunea sandvicensis* are limited to the Peninsular region in nearly everwet evergreen forests. *Schiffneriolejeunea pulopenangensis* is found on Chang Island in the South-east region in seasonal evergreen forests. *Lopholejeunea applanata*, *Schiffneriolejeunea polycarpa*, and *Trocholejeunea infuscata* are limited to the Northern region in seasonal evergreen forests. *Lopholejeunea soae* is limited to the North-east region in seasonal evergreen with pine forests.

The Peninsular region has the richest taxa (30 taxa) of Ptychanthoideae followed by the Northern region (24 taxa). The Central region is the only area where no taxa of Ptychanthoideae were found. This region is mostly under cultivation and most forests have been destroyed.

All 38 taxa of Ptychanthoideae in Thailand are epiphytes and usually grow on the barks of woody plants. Some species can also grow on other substrata, *i.e.* litter (15 taxa) and rocks (14 taxa) (Table 1). *Caudalejeunea reniloba* and *Spruceanthus semirepandus* are found only on living leaves and soil, respectively. There are 13 taxa which grow on three substrata, *viz. Acrolejeunea fertilis*, *A. recurvata*, *Lopholejeunea eulopha*, *L. nigricans*, *L. subfusca*, *Mastigolejeunea auriculata*, *M. indica*, *M. repleta*, *Ptychanthus striatus*, *Schiffneriolejeunea tumida* var. *haskarliana*, *Spruceanthus polymorphus*, *S. semirepandus*, and *Thysananthus spathulistipus*.

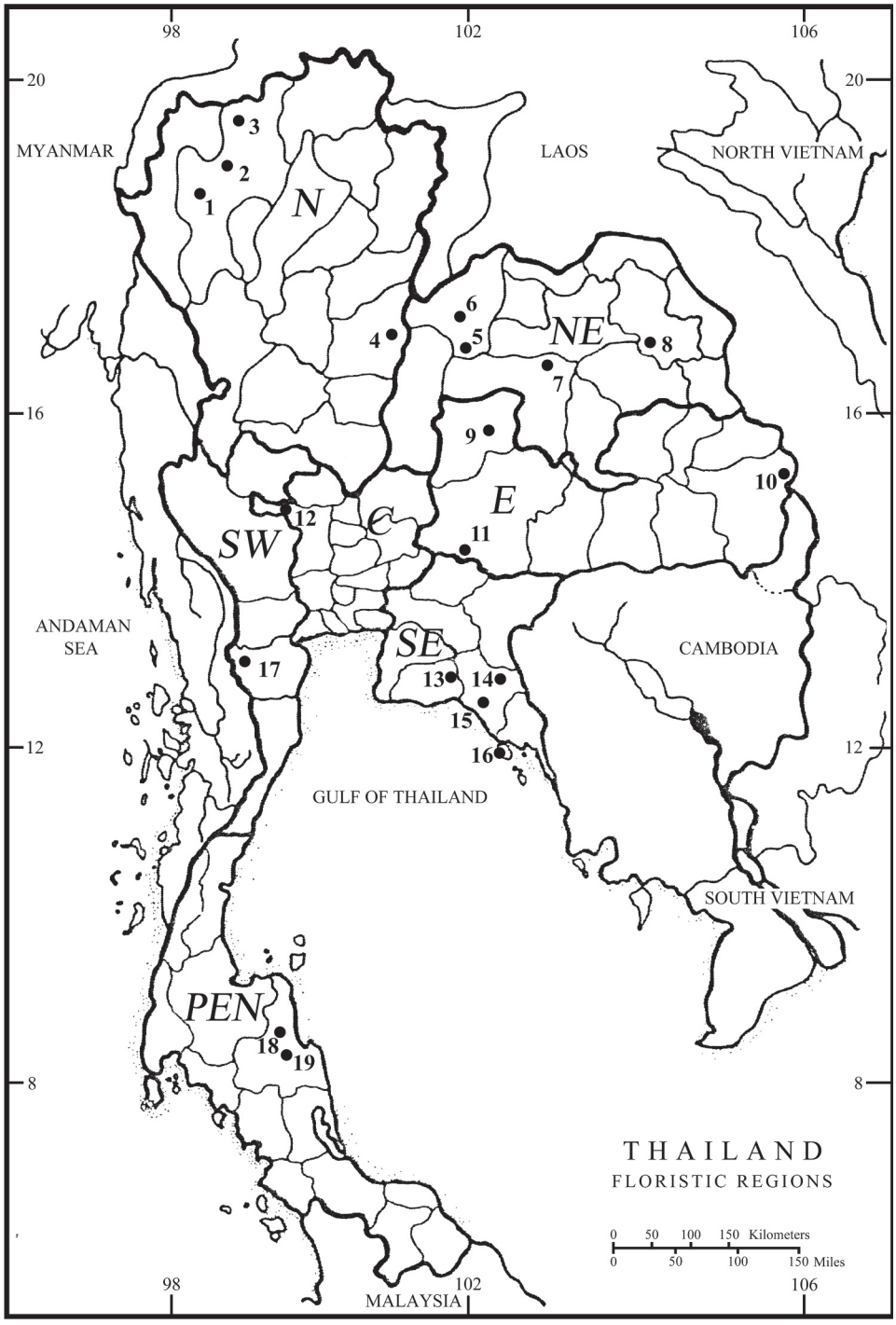
Table 1. Regions and substrata of Thai Ptychanthoideae. Substrata: E = epiphyte, growing on bark of trees and shrubs; EP = epiphyll, growing on living leaves; EL = epilith, growing on rocks; L = litter, growing on fallen tree trunks and branches; T = terrestrial, growing on soil. The abbreviations of regions are shown in Fig. 1.

| *Species* | *Regions* | *Substrata* |
|---|---|---|
| *Acrolejeunea fertilis* | N, NE, E, SE, PEN | E, EL, L |
| *Acrolejeunea parvula* | N, E | E |
| *Acrolejeunea pycnoclada* var. *pycnoclada* | N, NE, SW, PEN | E, EL |
| *Acrolejeunea recurvata* | N, NE, E | E, EL, L |
| *Archilejeunea kiushiana* | E, PEN | E |
| *Archilejeunea planiuscula* | N, NE, E, SE, SW, PEN | E |
| *Caudalejeunea cristiloba* | PEN | E |
| *Caudalejeunea reniloba* | N, E, SE, SW, PEN | E, EP |
| *Dendrolejeunea fruticosa* | PEN | E |
| *Lopholejeunea applanata* | N | E |
| *Lopholejeunea ceylanica* | N, PEN | E |
| *Lopholejeunea eulopha* | N, E, SE, PEN | E, EL, L |
| *Lopholejeunea herzogiana* | PEN | E |
| *Lopholejeunea horticola* | PEN | E |

Table 1. Regions and substrata of Thai Ptychanthoideae. Substrata: E = epiphyte, growing on bark of trees and shrubs; EP = epiphyll, growing on living leaves; EL = epilith, growing on rocks; L = litter, growing on fallen tree trunks and branches; T = terrestrial, growing on soil. The abbreviations of regions are shown in Fig. 1. *(continued)*

| *Species* | *Regions* | *Substrata* |
|---|---|---|
| *Lopholejeunea nigricans* | N, NE, E, SE, SW, PEN | E, EL, L |
| *Lopholejeunea soae* | NE | E |
| *Lopholejeunea subfusca* | N, NE, E, SE, SW, PEN | E, EL, L |
| *Lopholejeunea zollingeri* | N, PEN | E |
| *Mastigolejeunea auriculata* | N, NE, E, SE, SW, PEN | E, EL, L |
| *Mastigolejeunea indica* | N, NE, E, SE, SW, PEN | E, EL, L |
| *Mastigolejeunea ligulata* | PEN | E |
| *Mastigolejeunea repleta* | N, NE, SE, SW, PEN | E, EL, L |
| *Mastigolejeunea virens* | N, NE, E, PEN | E |
| *Ptychanthus striatus* | N, NE, E, SW, PEN | E, EL, L |
| *Schiffneriolejeunea cumingiana* | SE, PEN | E |
| *Schiffneriolejeunea polycarpa* | N | E |
| *Schiffneriolejeunea pulopenangensis* | SE | E, L |
| *Schiffneriolejeunea tumida* var. *haskarliana* | N, NE, E, SW, PEN | E, EL, L |
| *Schiffneriolejeunea tumida* var. *tumida* | PEN | E |
| *Spruceanthus polymorphus* | N, E, SE, SW, PEN | E, EL, L |
| *Spruceanthus semirepandus* | N, NE, E, SE, SW, PEN | E, L, T |
| *Thysananthus comosus* | PEN | E |
| *Thysananthus convolutus* | PEN | E |
| *Thysananthus retusus* | PEN | E |
| *Thysananthus spathulistipus* | N, NE, E, SE, SW, PEN | E, EL, L |
| *Trocholejeunea infuscata* | N | E, L |
| *Trocholejeunea sandvicensis* | PEN | E |
| *Tuzibeanthus chinensis* | N, E, SW | E, EL |

Fig. 1. Map of the seven floristic regions of Thailand showing the 19 study sites (redrawn from Smitinand, 2001). N = Northern, NE = North-east, E = Eastern, SE = South-east, C = Central, SW = South-west, PEN = Peninsular; 1 = Doi Inthanon National Park, 2 = Doi Suthep-Pui National Park, 3 = Pha Daeng National Park, 4 = Phu Hin Rong Kla National Park, 5 = Phu Kradung National Park, 6 = Phu Luang Wildlife Sanctuary, 7 = Phu Kao-Phu Phan Kham National Park, 8 = Phu Phan National Park, 9 = Tat Ton National Park, 10 = Pha Taem National Park, 11 = Khao Yai National Park, 12 = Phu-Toei National Park, 13 = Khao Cha Mao-Khao Wong National Park, 14 = Khao Khitchakut National Park, 15 = Namtok Phlio National Park, 16 = Mu Koh Chang National Park, 17 = Kaeng Krachan National Park, 18 = Khao Nan National Park, 19 = Khao Luang National Park.


98
102
106
20
16
12
8
MYANMAR
LAOS
NORTH VIETNAM
CAMBODIA
SOUTH VIETNAM
ANDAMAN SEA
GULF OF THAILAND
MALAYSIA
N
NE
E
C
SW
SE
PEN
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
THAILAND
FLORISTIC REGIONS
0 50 100 150 Kilometers
0 50 100 150 Miles

**Key to species of Thai Ptychanthoideae**

1. Branches predominantly of the *Frullania*-type . . . . . 2
1. Branches predominantly of the *Lejeunea*-type . . . . . 5
2. Stem regularly pinnate or bipinnate . . . . . 4
2. Stem not regularly pinnate or bipinnate . . . . . 3 (*Trocholejeunea*)
3. Leaves squarrose when moist, lobule semicircular with 3-4 teeth along free margin, underleaf margin flat . . . . . *Trocholejeunea sandvicensis*
3. Leaves not squarrose when moist, lobule triangular with 2 teeth along free margin, underleaf margin strongly recurved . . . . . *Trocholejeunea infuscata*
4. Lobes and underleaves dentate at margin, acute at apex . *Ptychanthus striatus*
4. Lobes and underleaves entire at margin, rounded at apex . . . . . *Tuzibeanthus chinensis*
5. Lobes with a distinct vitta, extending over at least 1/2 of lobe length. . . . . 6
5. Lobes without vitta . . . . . 7
6. Lobes and underleaves dentate. . . . . *Dendrolejeunea fruticosa*
6. Lobes and underleaves entire . . . . . *Thysananthus retusus*
7. Underleaf margin dentate. . . . . 8
7. Underleaf margin entire . . . . . 11
8. Underleaf apex with a broadly V-shaped sinus, underleaf bases not connected with leaves . . . . . *Caudalejeunea reniloba*
8. Underleaf apex without a broadly V-shaped sinus, underleaf bases connected with leaves on one side . . . . . 9 (*Thysananthus*)
9. Lobes symmetrical. . . . . *Thysananthus spathulistipus*
9. Lobes asymmetrical. . . . . 10
10. Leaves spreading when moist, lobe margins entire, wings of perianth laciniate . . . . . *Thysananthus comosus*
10. Leaves squarrose when moist, lobe margins dentate, wings of perianth not laciniate . . . . . *Thysananthus convolutus*
11. Lobule with a strongly involute free margin and forming 2 large sacs inside, with 7-15 teeth . . . . . *Caudalejeunea cristiloba*
11. Lobule not with a strongly involute free margin and not forming 2 large sacs inside . . . . . 12
12. Leaf cells with cordate trigones, median leaf cells elongated . . . . . 13
12. Leaf cells lacking cordate trigones, trigones various, median leaf cell isodiametric (elongate in *Spruceanthus*) . . . . . 26
13. Oil bodies homogenous, ventral epidermis cells in cross section distinctly higher than medulla cells . . . . . 14 (*Acrolejeunea*)
13. Oil bodies compound, ventral epidermis cells in cross section not distinctly higher than medulla cells . . . . . 17
14. Upright flagellae present, underleaf apex recurved. *Acrolejeunea recurvata*
14. Upright flagellae absent, underleaf apex plane . . . . . 15
15. Leaf strongly squarrose when moist; lobule with 4-8 teeth. . . *Acrolejeunea fertilis*
15. Leaf weakly squarrose when moist; lobule with 1-3 teeth . . . . . 16
16. Lobule with 1 tooth . . . . . *Acrolejeunea parvula*
16. Lobule with 3 teeth, first tooth of lobule situated at the extreme end of the free margin . . . . . *Acrolejeunea pycnoclada* var. *pycnoclada*

17. Plants julaceous when dry, perianth with 4-6 rounded keels, innovations absent . . . . . 18 (*Schiffneriolejeunea*)
17. Plants not julaceous when dry, perianth with 3 sharp keels, innovations present . . . . . 22 (*Mastigolejeunea*)

18. Lobule with 3 teeth . . . . . *Schiffneriolejeunea cumingiana*
18. Lobule with 1-2 teeth . . . . . 19

19. Leaves squarrose when moist, free margin of lobule inrolled proximally . . . . . 20 (*S. tumida*)
19. Leaves not squarrose when moist, free margin of lobule plane . . . . . 21

20. Ventral margin and apex of leaves plane . . . . . *Schiffneriolejeunea tumida* var. *haskarliana*
20. Ventral margin and apex of leaves involuted. . . . . *Schiffneriolejeunea tumida* var. *tumida*

21. Lobule with 1 tooth (1-2 cells long) . . . . . *Schiffneriolejeunea polycarpa*
21. Lobule with 2 teeth (2-3 cells long). . . . . *Schiffneriolejeunea pulopenangensis*

22. Lobule with 2-4(-5) triangular, 4-7 cells long teeth. . *Mastigolejeunea indica*
22. Lobule with (0-)1-2 unicellular teeth. . . . . 23

23. First lobule tooth 4-8 cells long . . . . . *Mastigolejeunea virens*
23. First lobule tooth 1-2 cells long or lacking . . . . . 24

24. Lobe apex acute to apiculate . . . . . *Mastigolejeunea repleta*
24. Lobe apex rounded to obtuse. . . . . 25

25. Lobes oblong, more than 1.5 times longer than wide; lobule 1/5-1/4(-2/5) as long as lobe . . . . . *Mastigolejeunea ligulata*
25. Lobes ovate, less than 1.5 times longer than wide; lobule 2/5 as long as lobe . . . . . *Mastigolejeunea auriculata*

26. Plants usually with blackish pigmentation in leaf cell walls . . . . . 27 (*Lopholejeunea*)
26. Plants without blackish pigmentation in leaf cell walls. . . . . 35

27. Apex of the lobule attached to the lobe by one cell . . . . . 28
27. Apex of the lobule attached to the lobe by 2-4 cells. . . . . 31

28. Lobule strongly constricted at the middle, free margin of lobule involute . . . . . *Lopholejeunea herzogiana*
28. Lobule not constricted at the middle, free margin of lobule nearly plane . . . . . 29

29. Leaf apex acute to acuminate . . . . . *Lopholejeunea applanata*
29. Leaf apex rounded . . . . . 30

30. Well developed underleaves 4-7 times as wide as the stem, female bract lobule strongly dentate at margin, female bracteole sharply dentate . . . . . *Lopholejeunea eulopha*
30. Well developed underleaves 3-4 times as wide as the stem, female bract lobule entire at margin, female bracteole usually entire throughout or weakly dentate at apex . . . . . *Lopholejeunea nigricans*

31. Lobules 1/3-2/5 as long as lobes. . . . . 32
31. Lobules 2/5-3/5 as long as lobes. . . . . 33

32. Well developed underleaves 6-8 times as wide as the stem, female bract lobule well-developed, large, 2/5-1/2 as long as female bract . . . . . *Lopholejeunea zollingeri*
32. Well developed underleaves 3-5 times as wide as the stem, female bract lobule mostly reduced, usually vestigial . . . . . *Lopholejeunea subfusca*

33. Female bracteoles ± toothed and usually shallowly bilobed . . . . . *Lopholejeunea ceylanica*
33. Female bracteoles entire and rounded . . . . . 34

34. Stem with leaves 0.5-0.9 mm wide, leaf apex rounded, dioicous . . . . . *Lopholejeunea horticola*
34. Stem with leaves 1.0-1.6 mm wide, leaf apex rounded to obtuse, autoicous . . . . . *Lopholejeunea soae*

35. Plants robust, shoots 1.4-4.0 mm wide, ventral merophyte 8-14 cells wide, leaf margins entire or toothed, margins of female bracts and bracteoles dentate . . . . . 36 (*Spruceanthus*)
35. Plants not robust, shoots 1.0-1.7 mm wide, ventral merophyte 4-6 cells wide, leaf margins entire, margins of female bracts and bracteoles entire . . . . . 37 (*Archilejeunea*)

36. Stem with leaves 3.0-4.0 mm wide, apex of lobes acute . . . . . *Spruceanthus semirepandus*
36. Stem with leaves 1.4-1.7 mm wide, apex of lobes rounded . . . . . *Spruceanthus polymorphus*

37. Stem with leaves 1.0-1.7 mm, perianth keel smooth, beak 2-3 cells high . . . . . *Archilejeunea planiuscula*
37. Stem with leaves 1.0-1.1 mm, perianth keel slightly crenate, beak 5-7 cells high . . . . . *Archilejeunea kiushiana*

**1. *Acrolejeunea fertilis*** (Reinw. *et al.*) Schiffn.

The species is characterized by the leaves which are strongly squarrose when moist, lobules large (1/2 of lobe length), semicircular, with 4-8 conspicuous teeth.

**Distribution and ecology:** Indomalesia (Gradstein, 1975, 1991). In Thailand it grows on tree trunks, branches, fallen branches, and rocks in evergreen, evergreen with pine, deciduous dipterocarp, degraded, and beach forest; 0-1560 m.

**Representative specimens examined:** N: Chiang Mai, Doi Inthanon National Park, *Kornochalert 674* (CMU, HSNU); Doi Suthep-Pui National Park, *Kornochalert 302* (CMU); Pha Daeng National Park, *Kornochalert 463* (CMU, HSNU); NE: Sakhon Nakhorn, Phu Phan National Park, *Kornochalert 963* (CMU); E: Ubon Ratchathani, Pha Taem National Park, *Kornochalert 939* (CMU, HSNU); SE: Chanthaburi, Khao Khitchakut National Park, *Kornochalert 1336* (CMU, HSNU); Trat, Mu Koh Chang National Park, *Kornochalert 569* (CMU); PEN: Chumphon, La Mae, *Inuthai 193* (PSU); Nakhon Si Thammarat, 7 km. N of the city, *Touw 11344* (BKF); Songkhla, road side between Chana District and Muang Songkhla District, *Chantanaorrapint 1353* (PSU).

**2. *Acrolejeunea parvula*** (Mizut.) Gradst.

This species is recognized by its small size (about 1 cm long, 0.5-1 mm wide) and free margin of lobules with only one tooth.

**Distribution and ecology:** Indochina (Thailand, Andaman Islands) (Gradstein, 1975, 1991). In Thailand it grows on tree trunks and branches in evergreen and evergreen with pine forest; 270-1650 m.

**Representative specimens examined:** N: Chiang Mai, Doi Inthanon National Park, *Printarakul 2848* (CMU); Doi Suthep-Pui National Park, *Kornochalert 1424* (CMU, HSNU, L); E: Ubon Ratchathani, Pha Taem National Park, *Kornochalert 941* (CMU, HSNU).

### 3. *Acrolejeunea pycnoclada* (Taylor) Schiffn. var. *pycnoclada*

This species is distinctive in having lobules with 2-3 teeth and the first tooth situated at the extreme end of the free margin.

**Distribution and ecology:** Tropical Africa, Indomalesia, and Pacific Islands (Gradstein, 1975). In Thailand it grows on tree trunks, shrubs, and rocks in evergreen and degraded forest; 150-1280 m.

**Representative specimens examined:** N: Phitsanulok, Phu Hin Rong Kla National Park, *Kornochalert 703* (CMU, HSNU); NE: Loei, Phu Kradueng National Park, *Kornochalert 862* (CMU, HSNU), Phu Luang Wildlife Sanctuary, *Touw 10527* (BKF); SW: Phetchaburi, Kaeng Krachan National Park, *Kornochalert 1165* (CMU, HSNU); PEN: Nakhon Si Thammarat, Khao Luang National Park, *Touw 11387* (BKF, L); Khao Nan National Park, *Chantanaorrapint 1305* (PSU); Phuket, near Thalang, *Touw 11182* (BKF).

### 4. *Acrolejeunea recurvata* Gradst.

This species is distinctive among the Asiatic members of the genus in having upright flagellae producing caducous leaves, apex of underleaves truncate and recurved, and lobule with 3-7 teeth.

**Distribution and ecology:** India, and Indochina (Gradstein, 1991). In Thailand it grows on tree trunks, branches, rocks, rotten logs, and lianas in evergreen and deciduous dipterocarp forest; 270-2100 m.

**Representative specimens examined:** N: Chiang Mai, Chiang Dao, *Touw 9311* (BKF), Doi Inthanon National Park, *Kornochalert 682* (CMU, HSNU), Pha Daeng National Park, *Kornochalert 471* (CMU, HSNU); Phitsanulok, Phu Hin Rong Kla National Park, *Kornochalert 704* (CMU, HSNU); Nakhon Sawan, near Karen village of Sop Aep, *Touw 9464* (L, holotype), Doi Musae Agricultural Experiment Station, *Touw 8182* (BKF); NE: Khorn Kaen, Phu Kao-Phu Phan Kham National Park, *Kornochalert 907* (CMU, HSNU); Loei, Phu Kradueng National Park, *Kornochalert 876* (CMU), Phu Luang Wildlife Sanctuary, *Touw 10602* (BKF); Sakhon Nakhorn, Phu Phan National Park, *Kornochalert 960* (CMU, HSNU); E: Chaiyaphum, Tat Ton National Park, *Kornochalert 918* (CMU); Ubon Ratchathani, Pha Taem National Park, *Kornochalert 930* (CMU, HSNU, L).

### 5. *Archilejeunea kiushiana* (Horik.) Verd. **Figs 2-16**

The species is characterized by being autoicous, lobes falcate-oblong, lobule about 1/2 as long as lobe, with 1 tooth (1-2 cells long), pycnolejeuneoid innovations (Zhu & Gradstein, 2005), 5-8 slightly crenate perianth keels, and perianth beak 5-7 cells high.

**Distribution and ecology:** China (Zhang *et al.*, 2011), Japan (Mizutani, 1993), Thailand (new record). In Thailand it grows on tree trunks in evergreen forest; 1200-1250 m.

**Representative specimens examined:** E: Nakhon Ratchasima, Khao Yai National Park, *Kornochalert 1200* (CMU); PEN: Nakhon Si Thammarat, Khao Luang National Park, *Kornochalert 1084* (CMU, HSNU).

**6. *Archilejeunea planiuscula*** (Mitt.) Steph.

This species is distinctive in being autoicous, stem with leaves 1.0-1.7 mm wide, ventral merophyte 4-6 cells wide, epidermis cells similar to inner stem cells, lobule with one tooth or obsolete, lejeuneoid innovations, and perianth with 4-6 smooth keels.

**Distribution and ecology:** Indopacific (Gradstein, 1991). In Thailand it grows on tree trunks, twigs, and lianas in evergreen and mixed evergreen deciduous forest; 30-1150 m.

**Representative specimens examined:** N: Chiang Mai, Doi Suthep-Pui National Park, *Kornochalert 418* (CMU, HSNU); Phitsanulok, Phu Hin Rong Kla National Park, *Kornochalert 746* (CMU, HSNU); NE: Loei, Phu Luang Wildlife Sanctuary, *Kornochalert 823* (CMU, HSNU); Sakhon Nakhorn, Phu Phan National Park, *Kornochalert 944* (CMU); E: Nakhon Ratchasima, Khao Yai National Park, *Kornochalert 1266* (CMU, HSNU); SE: Rayong, Khao Chamao-Khao Wong National Park, *Kornochalert 1276* (CMU); Chanthaburi, Khao Khitchakut National Park, *Kornochalert 1297* (CMU, HSNU), Namok Phlio National Park, *Kornochalert 1358* (CMU); SW: Phetchaburi, Kaeng Krachan National Park, *Kornochalert 1151* (CMU, HSNU); PEN: Nakhon Si Thammarat, Khao Luang National Park, *Kornochalert 1128* (CMU, HSNU), Khao Nan National Park, *Kornochalert 1044* (CMU, HSNU).

**7. *Caudalejeunea cristiloba*** (Steph.) Gradst.

This species is characterized by lobules with 7-15 teeth with strongly involute free margin, forming two large sacs inside.

**Distribution and ecology:** Indopacific (Gradstein, 1991). In Thailand it grows on tree trunks and branches in evergreen and beach forest; 0-200 m.

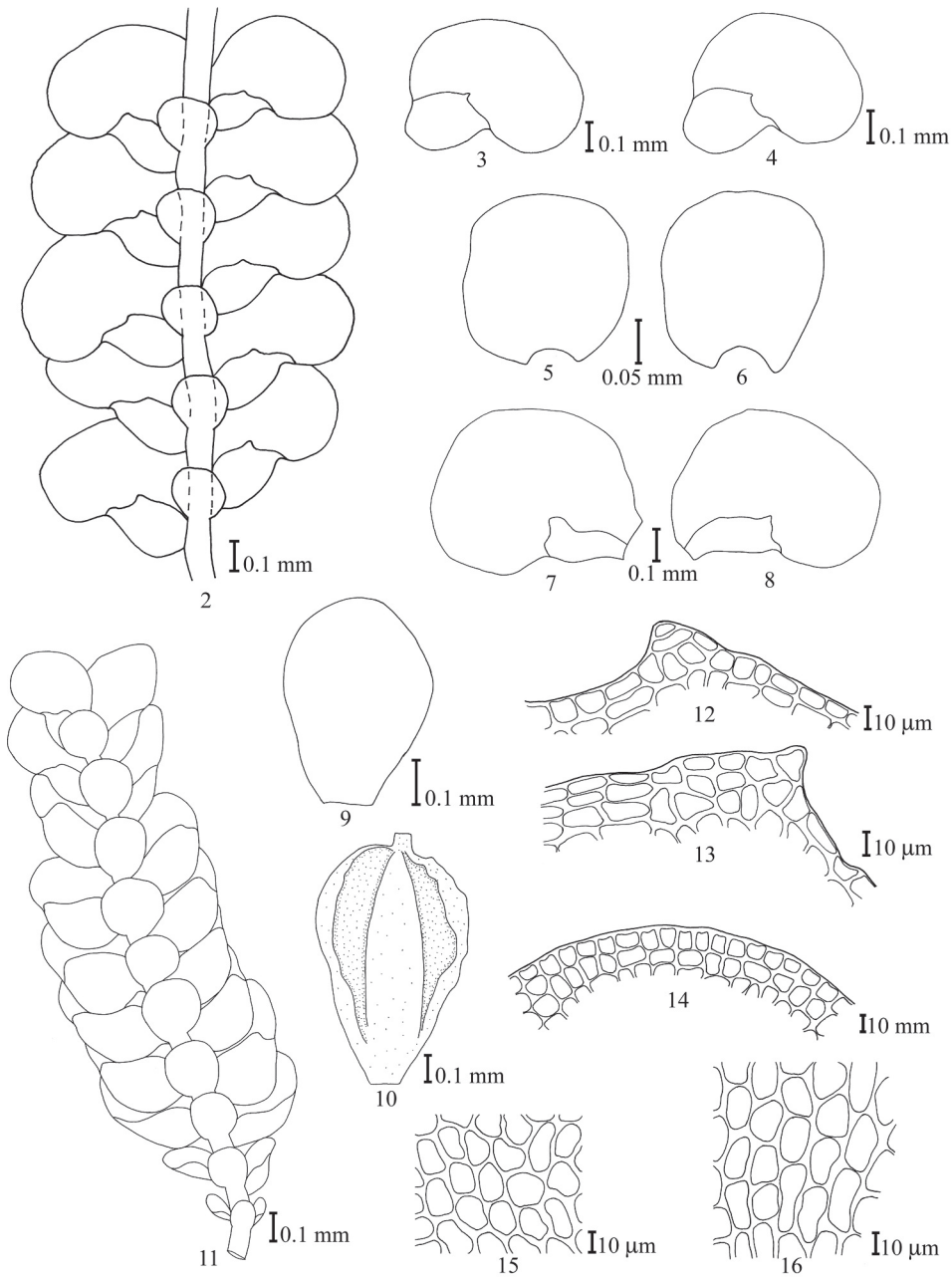
**Representative specimens examined:** PEN: Chumphon, La Mae, *Inuthai 236* (PSU), Phanang Tak, *Inuthai 175* (PSU); Surat Thani, Ratchaprapa Dam, *Chantanaorrapint et al. 012* (PSU); Nakhon Si Thammarat, Khao Nan National Park, *Chantanaorrapint 1395* (PSU)

**8. *Caudalejeunea reniloba*** (Gottsche) Steph. (= *C. recurvistipula* (Gottsche) Schiffn.; Verdoorn, 1934; Zhu *et al.* 2011)

The species is characterized by lobules with two teeth, distal tooth elongate, 3-4 cells long, proximal tooth triangular or obtuse, 1-2 cells long.

**Distribution and ecology:** Tropical regions of Asia and Oceania (Zhu & So, 2001). In Thailand it grows on tree trunks, branches, twigs, and leaves in evergreen, deciduous dipterocarp, degraded, and beach forest; 0-1400 m.

**Representative specimens examined:** N: Nakhon Sawan, Doi Musae Agricultural Experiment Station, *Touw 8095* (BKF); SE: Prachinburi, Khao Yai National Park, *Touw 12198* (BKF), Khao Khiew, *Chantanaorrapint 994* (PSU); Chanthaburi, Khao Khitchakut National Park, *Kornochalert 1318* (CMU, HSNU), Namtok Phlio National Park, *Kornochalert 1369* (CMU, HSNU); Trat, Mu Koh Chang National Park, *Kornochalert 559* (CMU, HSNU); SW: Phetchaburi, Kaeng Krachan National Park, *Kornochalert 1140* (CMU, HSNU); PEN: Chumphon, La Mae, *Inuthai 238* (PSU), Phanang Tak, *Inuthai 161* (PSU); Surat Thani, Khao Sok National Park, *Chantanaorrapint 2085* (PSU), Ratchaprapa




Figs 2-16. *Archilejeunea kiushiana* (all from *Kornochalert 1084*). **2.** Ventral part of plant. **3-4.** Leaves. **5-6.** Underleaves. **7-8.** Female bracts. **9.** Female bracteole. **10.** Perianth. **11.** Androecium. **12-13.** Leaf lobule teeth. **14.** Apical leaf cells. **15.** Median leaf cells. **16.** Basal leaf cells.

Dam, *Chantanaorrapint et al. 014* (PSU); Nakhon Si Thammarat, Khao Luang National Park, *Kornochalert 1097* (CMU, HSNU), Khao Nan National Park, *Chantanaorrapint 1396* (PSU); Songkhla, Khao Nam Kang, *Chantanaorrapint 2297* (PSU); Phuket, Khao Phara, near Thalang, *Touw 11263* (BKF).

**9. *Dendrolejeunea fruticosa*** (Lindenb. *et* Gottsche) Lacout.

This species is recognized by dendroid habit, pinnate branching, apex of lobes and underleaves dentate, lobes with a vitta present from base to near apex, and keel of lobe with a foliar appendage.

**Distribution and ecology:** Australia (Queensland), Malesia, and the Pacific region (Sukkharak, 2011). In Thailand it grows on tree trunks in evergreen forest; 100-550 m.

**Representative specimens examined:** PEN: Surat Thani, Khao Sok National Park, *Chantanaorrapint 2082* (PSU); Pang Nga, Sri Pang Nga National Park, *Chantanaorrapint 2311* (PSU); Yala, Mu Bo stream, *Wai 1019* (PSU).

**10. *Lopholejeunea applanata*** (Reinw. *et al.*) Schiffn.

This species is distinctive among the Asiatic members of the genus in the apex of lobule attached to lobe by one cell, acuminate to acute apex of lobe, and large underleaves, being 5-7 times as wide as stem.

**Distribution and ecology:** China, India, Indonesia, Malaysia, Myanmar, Philippines, Sri Lanka, Papua New Guinea, and Samoa (Zhu & Gradstein, 2005). In Thailand it grows on tree trunks in evergreen forest; 2300 m.

**Representative specimens examined:** N: Chiang Mai, Doi Inthanon National Park, *Printarakul 2846* (CMU).

**11. *Lopholejeunea ceylanica*** Steph.

The species can be readily recognized by the apex of lobule attached to the lobe by 2-4 cells, lobules large, about 1/2 as long as lobe, female bract lobule large, about 2/3-4/5 as long as female bract, and female bracteole usually shallowly bifid at apex.

**Distribution and ecology:** Cambodia, China, Indonesia, Malaysia, and Sri Lanka (Zhu & Gradstein, 2005). In Thailand it grows on tree trunks and twigs in evergreen forest; 1000-1740 m.

**Representative specimens examined:** N: Chiang Mai, Doi Inthanon National Park, *Printarakul 2634* (CMU, HSNU); PEN: Nakhon Si Thammarat, Khao Luang National Park, *Kornochalert 1076* (CMU), Khao Nan National Park, *Kornochalert 1033* (CMU, HSNU).

**12. *Lopholejeunea eulopha*** (Taylor) Schiffn.

Easily recognized from other Asiatic members of the genus by the apex of lobule attached to the lobe by one cell, rounded lobe apex, well-developed underleaves 4-7 times as wide as stem, and margins of female bracts and bracteoles strongly dentate.

**Distribution and ecology:** Pantropical (Zhu & Gradstein, 2005). In Thailand it grows on tree trunks, branches, fallen branches, lianas, and rocks in evergreen and deciduous dipterocarp forest; 120-2300 m.

**Representative specimens examined:** N: Chiang Mai, Doi Inthanon National Park, *Printarakul 2998* (CMU); E: Nakhon Ratchasima, Khao Yai National Park, *Kornochalert 1199* (CMU); SE: Chanthaburi, Khao Khitchakut National Park, *Kornochalert 1283* (CMU, HSNU), Namtok Phlio National Park, *Kornochalert 1345* (CMU, HSNU, L); Trat, Mu Koh Chang National Park, *Kornochalert 540* (CMU, HSNU); PEN: Chumphon, Koh Tao *Chantanaorrapint 2212* (PSU); Nakhon Si Thammarat, Khao Lam Lom, *Chantanaorrapint 1406* (PSU), Khao Luang National Park, *Kornochalert 1099* (CMU, HSNU), Khao Nan National Park, *Kornochalert 1017* (CMU, HSNU); Songkhla, Khao Lang Nation Wildlife Reserve Station, *Chantaorrapint 1339* (PSU).

### 13. *Lopholejeunea herzogiana* Verd.

This species resembles *L. eulopha*, but is more robust, lobule with a distinct medial constriction and strongly involute free margin, large underleaves with a strongly arched insertion line, and strongly immersed perianths.

**Distribution and ecology:** Indonesia, Malaysia, New Caledonia, and Papua New Guinea (Zhu & Gradstein, 2005); recorded new to Thailand by Kornochalert *et al.* (2010). In Thailand it grows on branches in evergreen forest; 1400 m.

**Representative specimens examined:** PEN: Nakhon Si Thammarat, Khao Luang National Park, *Kornochalert 1103* (CMU).

### 14. *Lopholejeunea horticola* Schiffn.

The species is characterized by the small plant size (0.5-0.9 mm), apex of lobule attached to the lobe by 2-4 cells, female bract lobule large, about 3/4 as long as the bract, and female bracteole suborbicular with entire and recurved margins.

**Distribution and ecology:** Indonesia and Malaysia (Zhu & Gradstein, 2005). In Thailand it grows on tree trunks and lianas in evergreen and degraded forest; 80-1300 m.

**Representative specimens examined:** PEN: Nakhon Si Thammarat, Khao Nan National Park, *Kornochalert 1029* (CMU, HSNU); Phuket, Khao Kluay, *Touw 11137* (BKF, L).

### 15. *Lopholejeunea nigricans* (Lindenb.) Schiffn.

This species is distinctive among the Asiatic members of the genus in the apex of lobule attached to lobe by one cell, lobe apex rounded to acute (variable), female bract lobule well-developed, 1/3-2/3 as long as bract, and the perianth usually exserted.

**Distribution and ecology:** Pantropical, in Asia known from Bangladesh, Bhutan, China, India, Indonesia, Japan, Malaysia, Myanmar, Nepal, Papua New Guinea, Philippines, Vietnam, and Yemen (Zhu & Gradstein, 2005). In Thailand it grows on tree trunks, branches, twigs, rocks, and rotten logs in evergreen, evergreen with pine, deciduous dipterocarp, and deciduous with bamboo forest; 270-2300 m.

**Representative specimens examined:** N: Chiang Mai, Doi Chiang Dao, *Touw 9070* (BKF), Doi Inthanon National Park, *Printarakul 2853* (CMU, HSNU), Doi Suthep-Pui National Park, *Kornochalert 685* (CMU, HSNU); NE: Loei, Phu Kradueng National Park, *Kornochalert 858* (CMU, HSNU); Sakhon Nakhorn, Phu Phan National Park, *Kornochalert 961* (CMU, HSNU); E: Chaiyaphum, Tat Ton National Park, *Kornochalert 926* (CMU, HSNU); Ubon Ratchathani, Pha Taem National Park, *Kornochalert 942* (CMU, HSNU); SE: Chanthaburi, Namtok Phlio National Park, *Kornochalert 1344* (CMU); Trat, Mu Koh Chang National Park, *Kornochalert 537* (CMU); SW: Phetchaburi, Kaeng Krachan National Park, *Kornochalert 1188* (CMU); PEN: Nakhon Si Thammarat, Khao Nan National Park, *Kornochalert 1051* (CMU).

### 16. *Lopholejeunea soae* R.-L. Zhu *et* Gradst. **Figs 17-30**

The species can be recognized by the ovate-triangular leaf lobule 2/5-1/2 as long as the lobes, lobule apex attached to lobe across 2-3 cells, ovate-oblong female bract lobes, and large female bract lobules about 2/3 as long as the bract lobes.

**Distribution and ecology:** Eastern China (Zhu & Gradstein, 2005), Thailand (new record). In Thailand it grows on tree trunks in evergreen with pine forest; 1400 m.

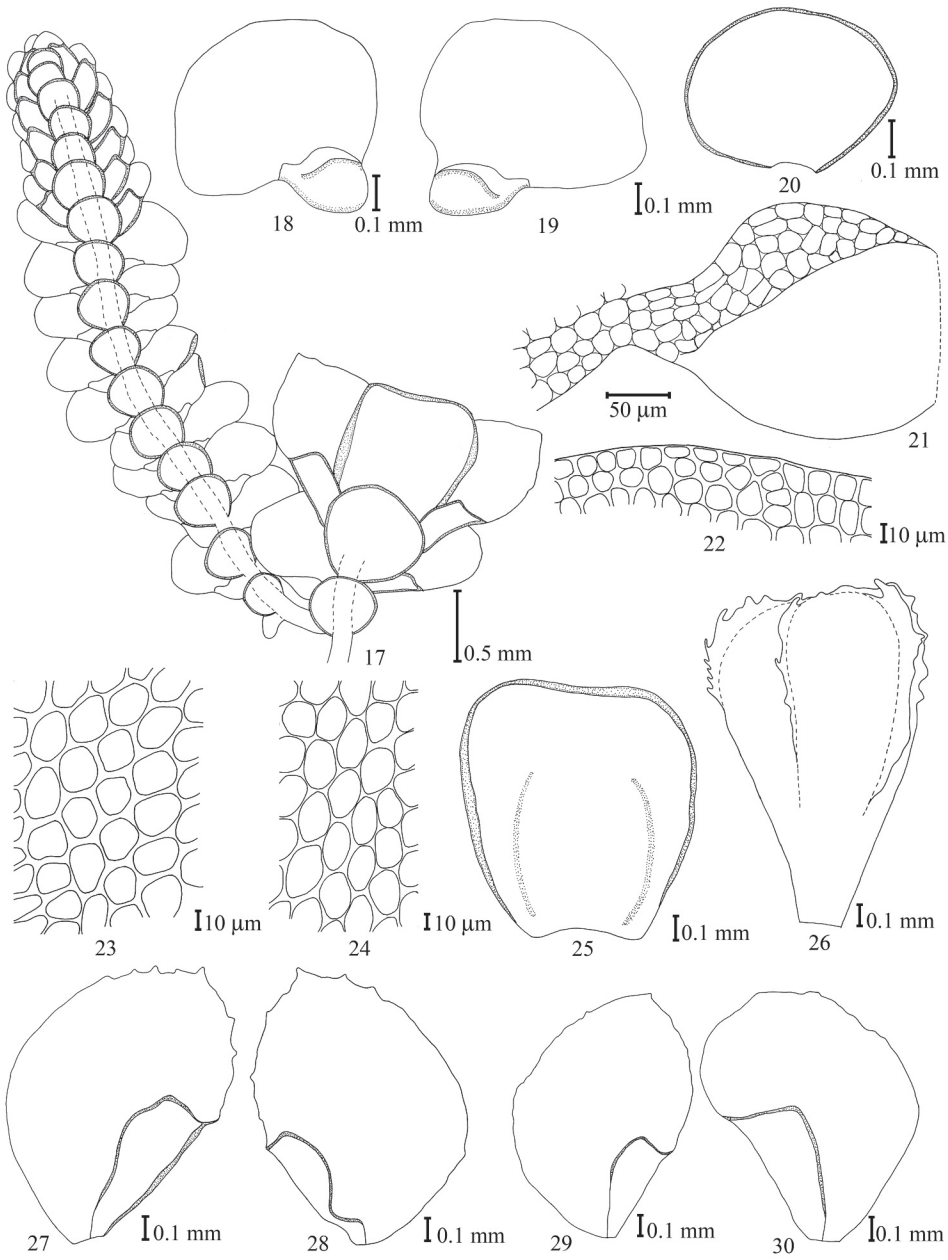
**Representative specimens examined:** NE: Loei, Phu Luang Wildlife Sanctuary, *Kornochalert 803* (CMU, HSNU).

### 17. *Lopholejeunea subfusca* (Nees) Schiffn.

This species can be distinguished by the apex of lobule attached to the lobe by 2-4 cells, female bract lobule reduced, female bracteole large, suborbicular and with entire margin, and usually immersed perianth.

**Distribution and ecology:** Pantropical and very common, in Asia known from Bangladesh, Bhutan, Cambodia, China, India, Indonesia, south and central Japan, Malaysia, Nepal, Papua New Guinea, Philippines, Singapore, Sri Lanka, and Vietnam (Zhu & Gradstein, 2005). In Thailand it grows on tree trunks, twigs, lianas, rotten logs, and rocks in evergreen, evergreen with pine, deciduous dipterocarp, degraded, and beach forest; 0-2300 m.

**Representative specimens examined:** N: Chiang Mai, Doi Inthanon National Park, *Printarakul 2852* (CMU, HSNU), Doi Suthep-Pui National Park, *Kornochalert 1436* (CMU, HSNU, L); Phitsanulok, Phu Hin Rong Kla National Park, *Kornochalert 741* (CMU, HSNU); NE: Loei, Phu Kradueng National Park, *Kornochalert 873* (CMU, HSNU); Sakhon Nakhorn, Phu Phan National Park, *Kornochalert 946* (CMU); E: Nakhon Ratchasima, Khao Yai National Park, *Kornochalert 1219* (CMU, HSNU); SE: Chanthaburi, Khao Khitchakut National Park, *Kornochalert 1322* (CMU, HSNU), Makam Rubber Plantation, *Larsen et al. 1712* (BKF), Namtok Phlio National Park, *Kornochalert 1353* (CMU, HSNU); Prachinburi, Khao Yai National Park, *Touw 12230* (BKF), Haew Suwat Waterfall, *Touw 12188* (BKF), *Larsen et al. 127* (BKF); SW: Phetchaburi, Kaeng Krachan National Park, *Kornochalert 1168* (CMU, HSNU); PEN: Chumphon**,** Bang Burd, *Inuthai 295* (PSU), La Mae, *Inuthai 222* (PSU), Phanang Tak, *Inuthai 166* (PSU); Nakhon Si Thammarat, Khao Lam Lom, *Chantanaorrapint 1406* (PSU), Khao Luang National Park, *Touw 11372* (BKF), Khao Nan National Park, *Kornochalert 1052* (CMU, HSNU); Songkhla, Khao Lang Nation Wildlife Reserve Station, *Chantaorrapint 1339* (PSU); Krabi, Khao Phanom Bencha National Park, *Wongkuna 650* (CMU, HSNU); Pang Nga, Khao Nang Hong, *Touw 11291* (BKF); Phuket, Khao Kluay, *Touw 11168* (BKF), Khao Phara, *Touw 11200* (BKF).




Figs 17-30. *Lopholejeunea soae* (all from *Kornochalert 803*). **17.** Ventral part of plant with androecium and gynoecium. **18-19.** Leaves. **20.** Underleaves. **21.** Leaf lobule. **22.** Apical leaf cells. **23.** Median leaf cells. **24.** Basal leaf cells. **25.** Female bracteole. **26.** Perianth. **27-30.** Female bracts.

**18.** ***Lopholejeunea zollingeri*** (Steph.) Schiffn.

The species is readily recognized by being autoicous, apex of lobule attached to the lobe across 2-4 cells, lobe margin incurved, well-developed underleaves 6-8 times as wide as stem, reniform and with recurved margin, and female bracteole dentate.

**Distribution and ecology:** China, Fiji, Indonesia, Japan, Malaysia, Papua New Guinea, Philippines, and Sri Lanka (Zhu & Gradstein, 2005). In Thailand it grows on tree trunks, branches, and twigs in evergreen forest; 1000-2300 m.

**Representative specimens examined:** N: Chiang Mai, Doi Inthanon National Park, *Printarakul 2995* (CMU, HSNU); Phitsanulok, Phu Hin Rong Kla National Park, *Kornochalert 744* (CMU, HSNU); PEN: Ranong, *Thaithong 989* (BCU); Nakhon Si Thammarat, Khao Luang National Park, *Kornochalert 1106* (CMU), Khao Nan National, *Chantanaorrapint 1497* (PSU).

**19.** ***Mastigolejeunea auriculata*** (Wilson) Schiffn.

This species is distinctive in having an ovate lobe with obtuse apex and entire margins, lobule with a small apical tooth (1-2 cells long) or obsolete, dorsal stem epidermis cells enlarged, and perianth with 3 narrow, entire keels.

**Distribution and ecology:** Pantropical (Gradstein, 1994). In Thailand it grows on tree trunks, branches, rocks, and rotten logs in evergreen, evergreen with pine, mixed evergreen + deciduous, deciduous dipterocarp, and beach forest; 0-1400 m.

**Representative specimens examined:** N: Chiang Mai, near Fang, *Touw 9423* (BKF), Chiang Dao, *Touw 8958* (BKF), Doi Inthanon National Park, *Kornochalert 662* (CMU), Pha Daeng National Park, *Kornochalert 457* (CMU, HSNU); NE: Loei, Phu Kradueng National Park, *Kornochalert 887* (CMU, HSNU); Khorn Kaen, Phu Kao-Phu Phan Kham National Park, *Kornochalert 906* (CMU, HSNU); Sakhon Nakhorn, Phu Phan National Park, *Kornochalert 947* (CMU, HSNU); E: Chaiyaphum, Tat Ton National Park, *Kornochalert 922* (CMU, HSNU); SE: Chanthaburi, Khao Khitchakut National Park, *Kornochalert 1298* (CMU); Namtok Phlio National Park, *Kornochalert 1373* (CMU, HSNU); SW: Phetchaburi, Kaeng Krachan National Park, *Kornochalert 1184* (CMU); PEN: Nakhon Si Thammarat, Khao Luang National Park, *Kornochalert 1123* (CMU, HSNU), Khao Nan National Park, *Chantanaorrapint 1382* (PSU); Krabi, Khao Phanom Bencha National Park, *Wongkuna 643* (CMU, HSNU).

**20.** ***Mastigolejeunea indica*** Steph.

This species can be distinguished from other Asiatic members of the genus by its large leaf lobule (1/2 as lobe length) with undulate free margin and 2-4(-5) triangular large teeth.

**Distribution and ecology:** Indomalesia (Gradstein, 1991). In Thailand it grows on tree trunks, branches, twigs, fallen branches, rotten logs, rocks, and lianas in evergreen, evergreen with pine, mixed evergreen + deciduous, deciduous dipterocarp, deciduous with bamboo, degraded, and beach forest; 0-1050 m.

**Representative specimens examined:** N: Chiang Mai, Khun Yuam, *Touw 10320* (BKF), Doi Inthanon National Park, *Kornochalert 670* (CMU, HSNU), Doi Suthep-Pui National Park, *Kornochalert 420* (CMU, HSNU), Pha Daeng National Park, *Kornochalert 465* (CMU, HSNU); Nan, Si Nan National Park, *Kornochalert 1440* (CMU), Nakhon Sawan, Doi Musae Agricultural Experiment Station, *Touw 8178* (BKF), near Karen village of Sop Aep, *Touw 9497* (BKF); NE: Khorn Kaen, Phu Khao-Phu Phan Kam National Park, *Kornochalert 908* (CMU, HSNU); Loei, Phu Kradueng National Park, *Kornochalert 899* (CMU, HSNU); Sakhon

Nakhorn, Phu Phan National Park, *Kornochalert 973* (CMU, HSNU); E: Chaiyaphum, Tat Ton National Park, *Kornochalert 915* (CMU, HSNU); Ubon Ratchathani, Pha Taem National Park, *Kornochalert 940* (CMU, HSNU, L); SE: Chanthaburi, Khao Khitchakut National Park, *Kornochalert 1333* (CMU, HSNU); Trat, Mu Koh Chang National Park, *Kornochalert 564* (CMU, HSNU); SW: Phetchaburi, Kaeng Krachan National Park, *Kornochalert 1135* (CMU, HSNU); PEN: Chumphon, Koh Tao, *Chantaorrapint 2213* (PSU); Songkhla, Khao Lang Nation Wildlife Reserve Station, *Chantaorrapint 1335* (PSU); Krabi, Khao Phanom Bencha National Park, *Wongkuna 657* (CMU, HSNU).

**21. *Mastigolejeunea ligulata*** (Lehm. *et* Lindenb.) Schiffn.

The species differs from *M. auriculata* by having narrowly oblong leaf lobes.

**Distribution and ecology:** Indopacific (Gradstein, 1991). In Thailand it grows on tree trunks in evergreen forest; 200 m.

**Representative specimens examined:** PEN: Songkla, Khao Nam Kang, *Chantanaorrapint 2298* (PSU).

**22. *Mastigolejeunea repleta*** Steph.

This species is distinctive among the Asiatic members of the genus in having the lobe apex usually acute, lobule small about 1/4 as long as lobe, and apical tooth small to obsolete.

**Distribution and ecology:** Indomalesia (Gradstein, 1991). In Thailand it grows on tree trunks, branches, rotten logs, and rocks in evergreen, mixed evergreen deciduous, and deciduous dipterocarp forest; 60-1500 m.

**Representative specimens examined:** N: Chiang Mai, near Fang, *Touw 9444* (BKF), Doi Chiang Dao, *Touw 8965* (BKF), Doi Inthanon National Park, *Kornochalert 668* (CMU, HSNU); Nakhon Sawan, Doi Musae Agricultural Experiment Station, *Touw 8208A* (BKF); NE: Loei, Phu Kradueng National Park, *Kornochalert 855* (CMU, HSNU), Phu Luang Wildlife Sanctuary, *Touw 10806* (BKF); SE: Chanthaburi, Khao Khitchakut National Park, *Kornochalert 1303* (CMU, HSNU), Namtok Phlio National Park, *Kornochalert 1348* (CMU, HSNU); Rayong, Khao Chamao-Khao Wong National Park, *Kornochalert 1275* (CMU, HSNU); SW: Phetchaburi, Kaeng Krachan National Park, *Kornochalert 1191* (CMU, HSNU); PEN: Ranong, Namtok Ngao National Park, *Wongkuna 554* (CMU); Nakhon Si Thammarat, Khao Luang National Park, *Touw 11467* (BKF), Khao Nan National Park, *Chantanaorrapint 1392* (PSU); Krabi, Khao Phanom Bencha National Park, *Wongkuna 656* (CMU, HSNU).

**23. *Mastigolejeunea virens*** (Aongstr.) Steph.

This species is easily recognized by the elongate apical lobule tooth (4-8 cells long), lobe oblong, and apex always obtuse.

**Distribution and ecology:** Indopacific (Gradstein, 1991). In Thailand it grows on tree trunks in evergreen, evergreen with pine, and degraded forest; 600-1260 m.

**Representative specimens examined:** N: Chiang Mai, near Fang, *Touw 9433* (BKF), Doi Inthanon National Park, *Kornochalert 641* (CMU, HSNU), Doi Suthep-Pui National Park, *Kornochalert 578* (CMU, HSNU); NE: Loei, Phu Kradueng National Park, *Kornochalert 861* (CMU, HSNU, L); E: Nakhon Ratchasima, Khao Yai National Park, *Kornochalert 1237* (CMU, HSNU); PEN: Nakhon Si Thammarat, Khao Nan National Park, *Chantanaorrapint 1456* (PSU).

**24.** ***Ptychanthus striatus*** (Lehm. *et* Lindenb.) Nees

This species is distinguished by the predominantly *Frullania*-type branching and regularly pinnate branches, lobes with acute apex and dentate margins, underleaf apex truncate to emarginate, underleaf margin dentate, and perianth with 8-10 keels.

**Distribution and ecology:** Tropical and subtropical regions of Asia, Oceania, and Australasia; not in Africa (Ahonen *et al.* 2005). In Thailand it grows on tree trunks, branches, twigs, shrubs, lianas, fallen branches, rotten logs, litter, and rocks in evergreen, evergreen with pine, and degraded forest; 50-2480 m.

**Representative specimens examined:** N: Chiang Mai, Doi Chiang Dao, *Touw 8952* (BKF), Doi Inthanon National Park, *Kornochalert 634* (CMU, HSNU), Doi Suthep-Pui National Park, *Kornochalert 423* (CMU, HSNU), near Fang, *Touw 9438* (BKF); Phitsanulok, Phu Hin Rong Kla National Park, *Kornochalert 742* (CMU, HSNU); Nakhon Sawan, Doi Musae Agricultural Experiment Station, *Touw 8143* (BKF), Lansang National Park, *Touw 8080* (BKF), near Karen village of Sop Aep, *Touw 9503* (BKF); NE: Loei, Phu Luang Wildlife Sanctuary, *Kornochalert 791* (CMU, HSNU, L); E: Nakhon Ratchasima, Khao Yai National Park, *Kornochalert 1248* (CMU, HSNU); SE: Trat, Chang Klav, Hui Rang, *Smitinand 1447* (BKF); SW: Kanchanaburi, Thong Pha Phum National Park, *Chantanaorrapint 915* (PSU); Phetchaburi, Kaeng Krachan National Park, *Kornochalert 1177* (CMU, HSNU); PEN: Nakhon Si Thammarat, Khao Nan National Park, *Chantanaorrapint 1471* (PSU), *Kornochalert 1037* (CMU, HSNU).

**25.** ***Schiffneriolejeunea cumingiana*** (Mont.) Gradst.

This species is distinctive among the Asiatic members of the genus in having three lobule teeth, free margin of lobule revolute near the base instead of involute and not developing a closed sac.

**Distribution and ecology:** Malesia (Gradstein, 1991; Gradstein *et al.*, 2002). In Thailand it grows on tree trunks in degraded and fresh water swamp forest; 60-500 m.

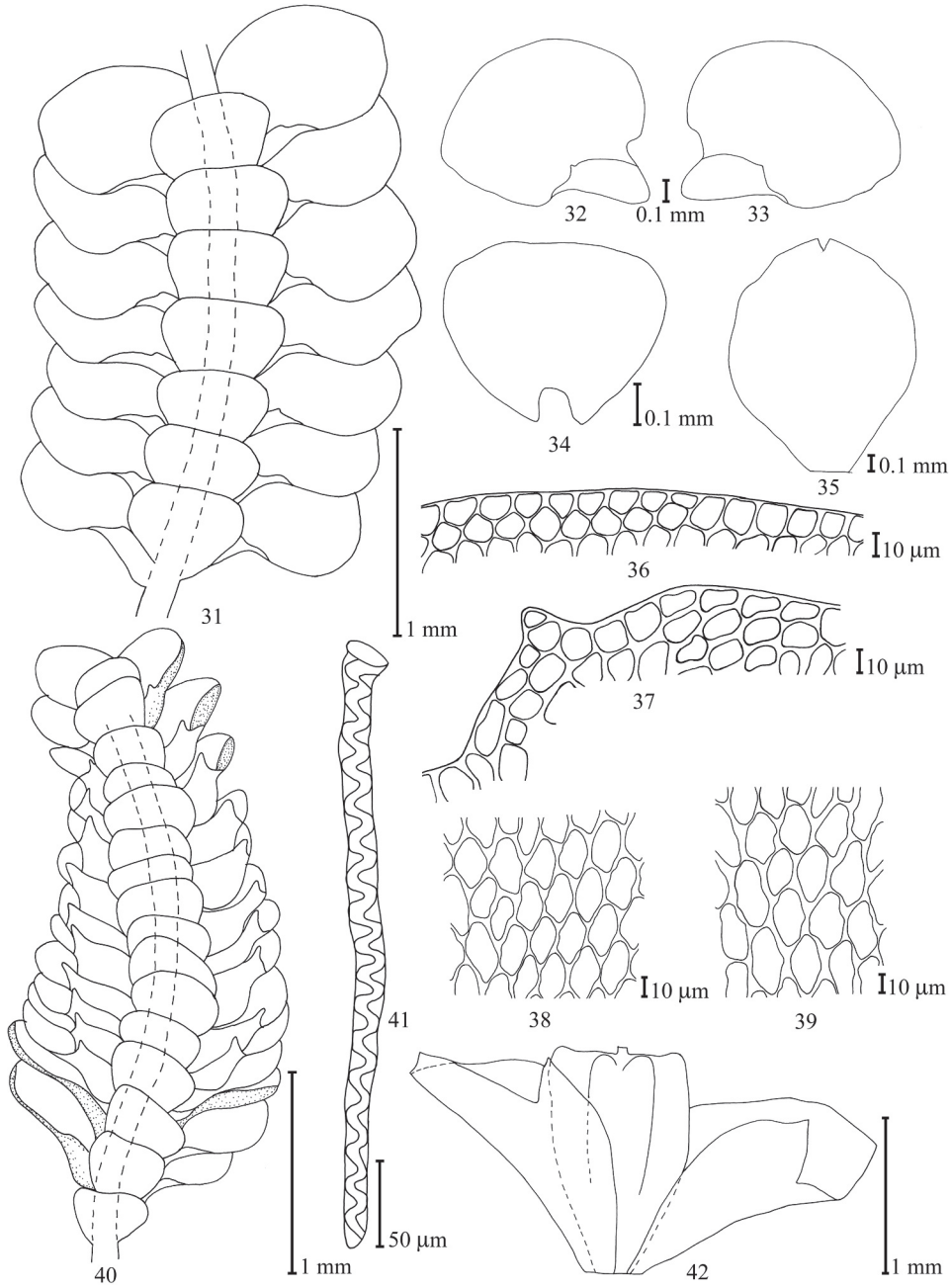
**Representative specimens examined:** SE: Chanthaburi, Khao Khitchakut National Park, *Kornochalert 1327* (CMU, HSNU); PEN: Phang-Nga, Sri Phang-Nga National Park, *Chantanaorrapint 2105* (PSU).

**26.** ***Schiffneriolejeunea polycarpa*** (Nees) Gradst. **Figs 31-42**

This species differs from *S. pulopenangensis*, to which it is closely related, by the lobule with only one tooth. The gynoecia lack innovations, the apex of female bracts is acute to acuminate, and the perianth has 4-5 short, broadly rounded keels in the upper 1/4.

**Distribution and ecology:** Tropical Africa, tropical America, southern India, and Sri Lanka (Gradstein, 1994), Thailand (new record). In Thailand it was found on tree trunks in evergreen forest; 1225 m.

**Representative specimens examined:** N: Phitsanulok, Phu Hin Rong Kla National Park, *Kornochalert 745* (CMU, HSNU).




Figs 31-42. *Schiffneriolejeunea polycarpa* (all from *Kornochalert 745*). **31.** Ventral part of plant. **32-33.** Leaves. **34.** Underleaf. **35.** Female bracteole. **36.** Apical leaf cells. **37.** Leaf lobule tooth. **38.** Median leaf cells. **39.** Basal leaf cells. **40.** Androecium. **41.** Elater. **42.** Perianth with female bracts.

**27. *Schiffneriolejeunea pulopenangensis*** (Gottsche) Gradst.

This species is recognized among the Asiatic members of the genus by the leaves and lobules being flattened, not squarrose when moist, lobules not saccate, and free margin plane with 2 teeth.

**Distribution and ecology:** Indomalesia (Gradstein, 1991). In Thailand it grows on tree trunks and rotten logs in evergreen and degraded forest; 0-300 m.

**Representative specimens examined:** SE: Trat, Mu Koh Chang National Park, *Kornochalert 570* (CMU, HSNU).

**28a. *Schiffneriolejeunea tumida*** var. ***haskarliana*** (Gottsche) Gradst. *et* Terken **Figs 43-63**

This variety is recognized among the Asiatic members of the genus in having which are leaves squarrose when moist, plane ventral leaf margins, lobules saccate, free margin with two large teeth.

**Distribution and ecology:** Indopacific (Gradstein, 1991); new to Thailand. In Thailand it grows on tree trunks, branches, shrubs, rocks, and rotten logs in evergreen, evergreen with pine, deciduous dipterocarp, degraded, and beach forest; 0-1550 m.

**Representative specimens examined:** N: Chiang Mai, Chiang Dao, *Touw 9087* (BKF); Nakhon Sawan, near Karen village of Sop Aep, *Touw 9464* (BKF); NE: Loei, Phu Kradueng National Park, *Kornochalert 891* (CMU, HSNU); E: Nakhon Ratchasima, Khao Yai National Park, *Kornochalert 1211* (CMU, HSNU, L); SW: Phetchaburi, Kaeng Krachan National Park, *Kornochalert 1169* (CMU); PEN: Chumphon, Bang Burd, *Inuthai 273* (PSU), La Mae, *Inuthai 183* (PSU), Phanang Tak, *Inuthai 157* (PSU); Surat Thani, Ratchaprapa Dam, *Chantanaorrapint et al. 011* (PSU); Nakhon Si Thammarat, Khao Luang National Park**,** *Touw 11369* (BKF), Khao Nan National Park, *Chantanaorrapint 1375* (PSU); Phuket, near Thalang, *Touw 11285* (BKF, L).

**28b. *Schiffneriolejeunea tumida*** (Nees) Gradst. var. ***tumida***

This variety is similar *S. tumida* var. *haskarliana*, but differs in the ventral leaf margin and apex strongly involuted.

**Distribution and ecology:** Indomalesia (Gradstein, 1991). In Thailand it grows on tree trunks in dry evergreen forest; 100 m.

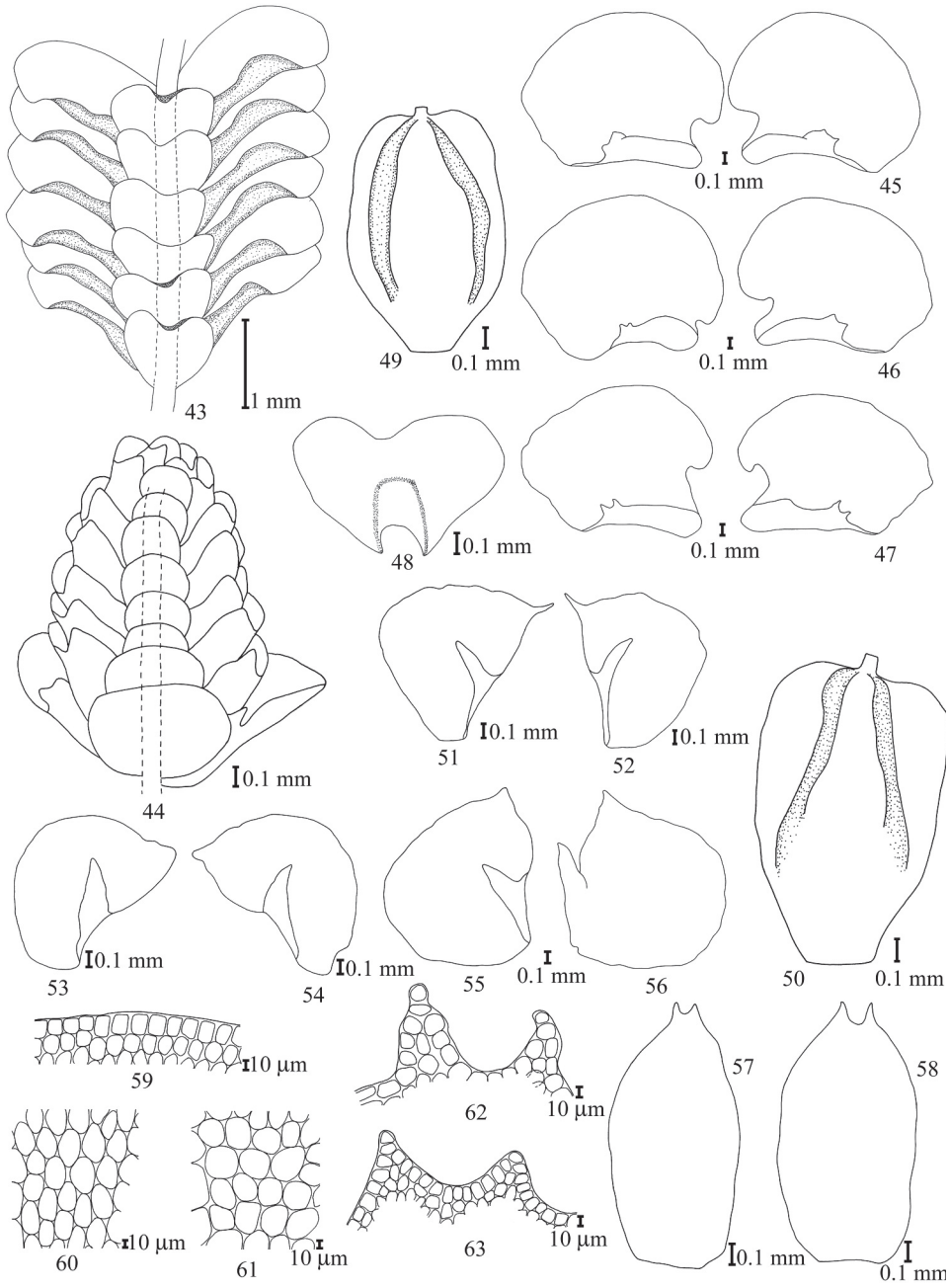
**Representative specimens examined:** PEN: Songkhla, Ko Hong Hill, *Inuthai 56* (HSNU).

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

This species is recognized among the Asiatic members of the genus by its relatively small plant size (stem with leaves 1.4-1.7 mm wide) and lobe apex rounded.

**Distribution and ecology:** Indopacific (Gradstein, 1991). In Thailand it grows on tree trunks, lianas, rocks, and rotten logs in evergreen, mixed evergreen + deciduous, and deciduous dipterocarp forest; 120-1050 m.

**Representative specimens examined:** N: Chiang Mai, Doi Suthep-Pui National Park, *Kornochalert 510* (CMU); E: Nakhon Ratchasima, Khao Yai National Park, *Kornochalert 1250* (CMU, HSNU); SE: Chanthaburi, Namtok Phlio National Park, *Kornochalert 1354* (CMU); SW: Phetchaburi, Kaeng Krachan National Park, *Kornochalert 1189* (CMU); PEN: Nakhon Si Thammarat, Khao Nan National Park, *Kornochalert 1057* (CMU, HSNU).




Figs 43-63. *Schiffneriolejeunea tumida* var. *haskarliana* (47, 50-52, 55-57, and 62 from *Inuthai 157*, 44, 49, 53-54, and 58 from *Inuthai 194*, 43, 45-46, 48, 59-61, and 63 from *Kornochalert 1211*). **43.** Ventral part of plant. **44.** Androecium. **45-47.** Leaves. **48.** Underleaf. **49-50.** Perianths. **51-56.** Female bracts. **57-58.** Female bracteoles. **59.** Apical leaf cells. **60.** Median leaf cells. **61.** Basal leaf cells. **62-63.** Leaf lobule teeth.

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

This species is distinctive in large plant size (3-4 mm wide), lobe acute at apex, and lobe margins dentate towards the apex.

**Distribution and ecology:** Tropical and subtropical regions of Asia (Zhu & So, 2001). In Thailand it grows on tree trunks, branches, shrubs, lianas, fallen branches, fallen twigs, rotten logs, and soil in evergreen, evergreen with pine, and degraded forest; 120-2540 m.

**Representative specimens examined:** N: Chiang Mai, Doi Chiang Dao, *Thaithong 758* (BCU), Doi Inthanon National Park, *Kornochalert 677* (CMU, HSNU), Doi Suthep-Pui National Park, *Kornochalert 1441* (CMU, HSNU, L); Phitsanulok, Phu Hin Rong Kla National Park, *Kornochalert 731* (CMU); NE: Loei, Phu Luang Wildlife Sanctuary, *Kornochalert 790* (CMU, HSNU); E: Nakhon Ratchasima, Khao Yai National Park, *Kornochalert 1192* (CMU, HSNU); SE: Chanthaburi, Khao Khitchakut National Park, *Kornochalert 1306* (CMU); SW: Phetchaburi, Kaeng Krachan National Park, *Kornochalert 1153* (CMU, HSNU); PEN: Nakhon Si Thammarat, Khao Luang National Park, *Kornochalert 1105* (CMU, HSNU), Khao Nan National Park, *Kornochalert 1015* (CMU, HSNU).

**31. *Thysananthus comosus*** Lindenb.

This species is characterized by having asymmetrical lobes which are not squarrose, entire lobe margins, and flat, obovate underleaves (Sukkharak, 2011).

**Distribution and ecology:** Indomalesia (Sukkharak, 2011). In Thailand it grows on tree trunks in evergreen and mangrove forest; sea level up to 500 m.

**Representative specimens examined:** PEN: Pang Nga, Khao Luk National Park, *Pornsooksawang 15* (BCU); Songkla, Ton Nga Chang Waterfall, *Chantanaorrapint 2341* (PSU).

**32. *Thysananthus convolutus*** Lindenb.

This species can be distinguished by having leaves with asymmetrical lobes which become squarrose when moist, toothed leaf margins, and slightly squarrose, spathulate underleaves (Sukkharak, 2011).

**Distribution and ecology:** Indomalesia (Sukkharak, 2011). In Thailand it grows on tree trunks, branches, and twigs in evergreen forest; 990-1450 m.

**Representative specimens examined:** PEN: Nakhon Si Thammarat, Khao Nan National Park, *Sukkharak 208* (BCU).

**33. *Thysananthus retusus*** (Reinw. *et al.*) B. Thiers *et* Gradst.

This species is easily recognized by lobes with a distinct vitta, extending over at least 1/2 of lobes length, lobule with one tooth (4-7 cells long), and underleaves with retuse apex and entire margins.

**Distribution and ecology:** Australia (Queensland and New South Wales), India (Uttarakhand), southern Japan, Malesia, and the Pacific region (Sukkharak, 2011). In Thailand it grows on tree trunks in evergreen forest; 950-1000 m.

**Representative specimens examined:** PEN: Nakhon Si Thammarat, Khao Luang National Park, *Kornochalert 1071* (CMU, HSNU), Khao Nan National Park, *Kornochalert 1041* (CMU, HSNU).

**34. *Thysananthus spathulistipus*** (Reinw. *et al.*) Lindenb.

This species is distinctive among the Asiatic members of the genus in having symmetrical, ovate-falcate lobes with dentate margin and without vittae, and spathulate underleaves with the upper margin coarsely dentate.

**Distribution and ecology:** Africa, Australia (Queensland), Indochina, Malaysia, and the Pacific region (Sukkharak, 2011). In Thailand it grows on tree trunks, branches, twigs, shrubs, lianas, rocks, rotten logs, fallen branches, and fallen twigs in evergreen, evergreen with pine, deciduous with bamboo, degraded, and beach forest; 0-1740 m.

**Representative specimens examined:** N: Chiang Mai, Doi Inthanon National Park, *Touw 9613* (BKF); Phitsanulok, Phu Hin Rong Kla National Park, *Kornochalert 708* (CMU); NE: Loei, Phu Luang Wildlife Sanctuary, *Kornochalert 811* (CMU), Phu Kradueng National Park, *Touw 10959* (BKF); E: Nakhon Ratchasima, Khao Yai National Park, *Kornochalert 1212* (CMU, HSNU); SE: Trat, Chang Klau, Hui Rang, *Smitinand 1453* (BKF), Mu Koh Chang National Park, *Kornochalert 561* (CMU, HSNU); SW: Phetchaburi, Kaeng Krachan National Park, *Kornochalert 1174* (CMU, HSNU); PEN: Nakhon Si Thammarat, Khao Luang National Park, *Kornochalert 1126* (CMU, HSNU), Khao Nan National Park, *Kornochalert 1020* (CMU, HSNU, L).

**35. *Trocholejeunea infuscata*** (Mitt.) Verd.

The species is charactized by having the *Frullania*-type branches, lobes obliquely ovate with an obtuse apex, lobule subtriangular or ovate with two small apical teeth, and underleaf margin recurved.

**Distribution and ecology:** China, Himalayas, India, Sri Lanka, Myanmar, and Thailand (Mizutani, 1989; Gradstein, 1991). In Thailand it grows on tree trunks and rotten logs in evergreen and deciduous with bamboo forest; 1100-1400 m.

**Representative specimens examined:** N: Chiang Mai, Doi Chiang Dao, *Touw 8875* (L).

**36. *Trocholejeunea sandvicensis*** (Gottsche) Mizut.

This species is recognized by having the *Frullania*-type branching, leaves squarrose when moist, and lobule semicircular with 3-4 teeth along free margin.

**Distribution and ecology:** Bhutan, China, Hawaii, India, Japan, Korea, Malaysia, Nepal, Pakistan, and Vietnam (Zhu & So, 2001). In Thailand it grows on tree trunks in beach forest; 0-5 m.

**Representative specimens examined:** PEN: Nakhon Si Thammarat, 7 km N of the city, *Touw 11344* (BKF, L, det S.R. Gradstein).

**37. *Tuzibeanthus chinensis*** (Steph.) Mizut.

This species is similar to *Ptychanthus striatus*, but differs in the lobes, underleaves, female bracts, and female bracteoles with entire along margins.

**Distribution and ecology:** East Asia (Gradstein, 1991). In Thailand, it grows on tree trunks, branches, and rocks in evergreen and fresh water swamp forest; 100-2100 m.

**Representative specimens examined:** N: Chiang Mai, Doi Chiang Dao, *Touw 9358* (BKF); SW: Kanchanaburi, Phu Nong Pling, Thong Pha Phum District, *Lai 94-01-023* (PSU); Phetchaburi, Kaeng Krachan National Park, *Kornochalert 1187* (CMU).

## Excluded species

1. *Thysananthus aculeatus* Herzog

This species was reported from Thailand by Reed & Robinson (1967), based on the collection *Tem Smitinand 1027* from Khao Luang, Nakhon Si Thammarat (BKF). The specimen is *Thysananthus spathulistipus* (Reinw. *et al.*) Lindenb.

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