

Guide to the Liverworts and Hornworts of Java

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with 28 plates

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KEYS TO THE SPECIES OF LIVERWORTS AND HORNWORTS OF JAVA¹

Key 1. Introductory key

1. Plants with leaves (leaves sometimes hair-like!) 2
1. Plants thalloid, without leaves (Figs. 1-18) 4
2. Leaves with a midrib (midrib more than 1 cell-layer thick)... Mosses (Bryophyta s.str.)
 For keys to the mosses of Java see: M. Fleischer (1902-1923), *Die Musci der Flora von Buitenzorg*, Bnd. 1-4 (nomenclature outdated); A. Eddy (1988-1996), *Handbook of Malesian Mosses*, Vols. 1-3 (incomplete; treats acrocarpous mosses).
2. Midrib lacking 3
3. Leaves in 2-3 longitudinal rows **Key 4** (Leafy liverworts)
 The moss *Fissidens hyalinus* Hook. & Wils. (= *F. nymani* (Fleischer) Paris) has leaves in 2 rows and no costa and would key out here. When sporophytes are lacking this moss is recognized by 1) narrow lanceolate, transversely inserted leaves with a small double lamina in the lower half; 2) very large, thin-walled leaf cells; and 3) leaves bordered by narrow elongate cells. The plants are very small, only ca. 1 mm high, and occur on soil along rivulets in montane forest.
3. Leaves in 4 or more rows, or in a spiral (but leaves sometimes flattened and seemingly in 2 rows; check carefully) Mosses (Bryophyta s.str.)
4. Thallus only one cell-layer thick 5
4. Thallus more than one cell-layer thick 8
5. Thallus with midrib (Fig. 14a)..... 6
5. Thallus without midrib 7
6. Thallus with one midrib, midrib colorless. Thallus margin with hairs.....
 *Metzgeria* (**Key 3**: couplet 32)
6. Thallus with several midribs or with a branched midrib, midrib usually black. Thallus margin without hairs Hymenophyllaceae (ferns)
7. Thallus on living leaves in montane rainforest, very small and pale-colored, ± pinnate, thallus margins with cilia. Gametangia produced on short leafy branches
Cololejeunea metzgeriopsis (Goebel) Gradst. *et al.* (= *Metzgeriopsis pusilla* Goebel) (Lejeuneaceae)

¹ Full citation of bibliographic references is given in the Introduction.

7. Thallus on soil or bark, light green, simple or irregularly branched, margins without cilia. Leafy branches lacking Fern prothallium
8. Cells with 1(-4) large chloroplasts. Capsules linear (rarely egg-shaped: *Notothylas*), green, turning black after dehiscence. Capsule opening step by step from the apex downwards (over a period of weeks or month) **Key 2** (Hornworts)
8. Cells with numerous small chloroplasts. Capsules rounded to elliptical, black when mature (before dehiscence). Capsule opening at once (not step by step)
 **Key 3** (Thalloid liverworts)

Key 2. Hornworts

1. Thallus surface densely covered by small lacinia. Surface of involucre covered by lamellae. Spores yellow, elaters dark brown
.....*Paraphymatoceros hirticalyx* (Steph.) Stotler (= *Anthoceros tjibodensis* Meijer)
1. Thallus surface not densely covered by small lacinia. Surface of involucre usually smooth (with lamellae in *Notothylas javanicus*). Spores yellow, brown, black, or pale-colored 2
2. At least some epidermis cells of thallus with 2 chloroplasts (Fig. 3: 1a). Thallus dark green to blackish-green. Spores green. On moist rock, rotten wood or bark in montane forest *Megaceros flagellaris* (Mitt.) Steph. (Fig. 3) (= *M. tjibodensis* Campb.)

Hasegawa (1983) considered *M. tjibodensis* a synonym of *M. flagellaris* but Asthana & Srivastava (1991) treated it as a good species based on the presence of a prominent central hump on the distal spore surface (hump lacking in *M. flagellaris*).
2. All epidermis cells with only 1 chloroplast (Fig. 4: 3c). Thallus pale green to dark green. Spores yellow, brown, black or pale-colored, rarely green 3
3. Epiphyte. Thallus with a thick midrib (Figs. 3: 2a, 4: 3a; check carefully; midrib sometimes obscured by the strongly crisped thallus). Thallus surface strongly crisped or almost flat. Spores large, multicellular 4 (*Dendroceros*)
3. On soil. Thallus without thick midrib. Thallus surface flat or somewhat crisped. Spores small, unicellular 8
4. Thallus deeply lobed and strongly crisped. Thallus surface without perforations 5
4. Thallus not or shallowly lobed, not strongly crisped. Thallus surface with or without perforations 6
5. Midrib inconspicuous, ca. 0.5 mm wide, completely covered by the crisped thallus lobes. Midrib without cavities. Spores yellowish-brown
..... *Dendroceros acutilobus* Steph.
5. Midrib conspicuous, to 1.5 mm wide, not completely covered by the crisped thallus lobes. Midrib with large cavities (cross section). Spores green
..... *Dendroceros difficilis* Steph. (Fig. 3)
6. Thallus surface with numerous perforations, especially near the margins. Thallus shallowly lobed, the lobes usually swollen-convex. 7
6. Thallus surface without perforations. Thallus almost unlobed, ± flat
..... *Dendroceros subplanus* Steph.

7. Midrib with large cavities (cross section) *Dendroceros cavernosus* Hasegawa
7. Midrib without cavities *Dendroceros javanicus* (Nees) Nees (Fig. 4)
- Further records from Java: *Dendroceros crassicosatus* Steph., *D. gracilis* Steph., *D. rarus* Steph.
8. Sporophyte lacking 9
8. Sporophyte present 12
9. Thallus with cavities (cross section, Fig. 4: 4b), and with colonies of blue-green algae inside the thallus, visible as black dots 10
9. Cavities and algal colonies lacking 11
10. Thallus narrowly ligulate, not forming complete rosettes 15 (*Folioceros*)
10. Thallus broader, usually forming complete rosettes. Thallus margins finely crisped *Anthoceros punctatus* L.
- The material of *Anthoceros* from Java needs more study (see couplet 14).
11. Thallus forming complete rosettes, lobes imbricate. Thallus margins irregularly crenate-laciniate *Notothylas javanicus* (Sande Lac.) Gottsche
11. Thallus not forming complete rosettes. Thallus margins not crisped *Phaeoceros laevis* (L.) Prosk.
- Phaeoceros laevis* is a variable species that is subdivided into two subspecies: subsp. *laevis* and subsp. *carolinianus* (Michx.) Prosk. (= *P. carolinianus* (Michx.) Prosk.). The material from Java belongs to the subsp. *carolinianus* (Söderström *et al.* 2010). The two taxa are separated as follows:
- subsp. *laevis*: Plants dioicous. Inner spore surface almost smooth.
 - subsp. *carolinianus*: Plants monoicous. Inner spore surface finely papillose.
12. Sporophyte ovoid, lying nearly horizontally on the thallus and almost entirely covered by a fleshy involucre. Surface of involucre rough by lamellae and lacinia. Elaters absent. Spores yellow. *Notothylas javanicus* (Sande Lac.) Gottsche
12. Sporophyte long linear, standing upright. Involucre short, covering the base of the sporophyte only. Surface of involucre smooth. Elaters present. Spores yellow or black 13
13. Spores yellow. Thallus without cavities (cross section) *Phaeoceros laevis* (L.) Prosk.
- For comment on this variable species see couplet 11.
13. Spores black or pale-colored. Thallus with cavities (cross section, Fig. 4: 4b) 14

14. Elaters thin-walled.....*Anthoceros punctatus* L.

Many species of *Anthoceros* have been reported from Java (Meijer 1954, 1957) but the taxonomic status of these species remains unclear. Some of them (*A. argillaceus* (Steph.) Verd., *A. crispulus* (Mont.) Douin) are very similar to *A. punctatus* and may be synonyms. In this key only *A. punctatus* is included; the taxonomy of *Anthoceros* in Java clearly needs further study. Further records from Java: *A. kajumas* (Goebel) Prosk., *A. javanicoides* H.A. Mill., *A. megasporus* Meijer, *A. telaganus* Steph., etc. (see Söderström *et al.* 2010).

14. Elaters thick-walled (cell-lumen hardly visible; Fig. 4: 5a,5b)..... 15 (*Folioceros*)15. Thallus margins with gemmae
.....*Folioceros glandulosus* (Lehm. & Lindenb.) Bharadwaj

15. Gemmae lacking..... 16

16. Outer spore surface covered by large conical outgrowths
..... *Folioceros amboinensis* (Schiffn.) Piippo (Figs. 4, 5a)16. Outer spore surface covered by small, rounded papillae, without large conical outgrowths
Folioceros fuciformis (Mont.) Bharadwaj (Fig. 5b) (= *Anthoceros falsinervis* Lindenb.; ? = *Folioceros vesiculosus* (Aust. ex Steph.) Bharadwaj)

Key 3. Thalloid liverworts

1. Upper surface of thallus with pores (appearing as tiny, whitish or dark dots, visible with handlens). 2
1. Thallus surface without pores or pores indistinct..... 19
2. Gemma cups present on thallus surface3 (*Marchantia*)
2. Gemma cups absent 8
3. Ventral scales over almost entire ventral surface of thallus, reaching the thallus margin or nearly so. Female receptacle deeply divided (to 0.8 of diameter) into numerous linear lobes (Fig. 5: 6a). Male receptacle undivided 3a
.....(subgenus *Marchantia*)
3. Ventral scales only along thallus midline. Female receptacle shallowly or deeply lobed but not deeply divided into numerous linear lobes, upper surface of the lobes flat. Male receptacle usually lobed (Fig. 5: 7b).....4 (subgenus *Chlamidium*)
- 3a. Thallus margin crenulate. Ventral scales reaching the thallus margin, \pm visible at the margin in dorsal view. Dorsal surface of thallus usually with purplish median band. Lobes of female receptacle with papillose surface. On ruderal, nitrate-rich soil
..... *Marchantia polymorpha* L. (Fig. 5)
- 3a. Thallus margin entire. Ventral scales not reaching the thallus margin, invisible in dorsal view. Dorsal surface of thallus without purplish median band. Lobes of female receptacle with smooth surface. At high elevation; one old record from 1848
.....*Marchantia berteriana* Lehm & Lindenb.
4. Outer surface of gemma cups finely and densely papillose, the papillae colorless. Plants large, thallus more than 5 mm wide, without midrib. Male and female receptacles very shallowly lobed, to less than 0.2 of diameter (but plants often sterile)
..... *Marchantia paleacea* Bertol.
4. Outer surface of gemma cups \pm smooth. Plants smaller, thallus less than 5 mm wide, usually with midrib. Male and female receptacles more deeply lobed 5
5. Female receptacle lobed to 0.3 of diameter, with 5-7 lobes. In waterfalls above 1500 m.....*Marchantia miqueliana* Lehm.
5. Female receptacle much more deeply lobed (more than 0.5 of diameter) 6
6. Female receptacle with 3-6 lobes, tip of the lobes bifid 7

6. Female receptacle with more than 6 lobes, lobes not bifid
 *Marchantia emarginata* Reinw. et al. (Fig. 7a-c)
7. Number of female lobes constant, 4 (rarely 6)
 *Marchantia geminata* Reinw. et al. (Fig. 5)
7. Number of female lobes variable, 3-6 *Marchantia treubii* Schiffn.
 Further report: *Marchantia acaulis* Steph.
8. Thallus very thin, 2-4 cell-layers thick, light green, obtuse, conspicuously
 broadened towards apex. Sporophyte embedded in a notch at the thallus apex. Fresh
 plants sometimes with a bad smell 9 (*Cyathodium*)
8. Thallus thicker, light green to dark green, not or only slightly broadened towards the
 apex. Sporophytes on a stalked receptacle or in an involucre below the thallus apex.
 Fresh plants without bad smell 10
9. Plants to 7 mm wide, with a bad smell when fresh. Papillose rhizoids present. Ventral
 scales present, lanceolate, to 10 cells wide at the base.
 *Cyathodium foetidissimum* Schiffn.
9. Plants smaller, to 2-3 mm wide, without bad smell when fresh. Papillose rhizoids
 lacking. Ventral scales lacking or rudimentary, linear, 1-2 cells wide
 *Cyathodium smaragdinum* Schiffn.
 Further record: *C. cavernarum* Kunze ex Lehm.
10. Thallus robust, more than 1 cm wide and to 10 cm long, light green. Pores simple, of
 one layer of cells. Ventral scales with a large, reniform appendage
 *Wiesnerella denudata* (Mitt.) Steph. (Fig. 6)
10. Thallus smaller, light or dark green. Pores simple or compound (of several layers of
 cells). Ventral scales not with a large, reniform appendage 11
11. Ventral scales in 4-6 rows. Pores compound. Male receptacle stalked
 3 (*Marchantia*)
11. Ventral scales in 2 rows. Pores simple, of one layer of cells. Male receptacle not
 stalked 12
12. Ventral scales much wider than long, each scale with 2-4 filiform appendages.
 Female receptacle stalked, without pseudoperianths.
 *Reboulia hemisphaerica* (L.) Raddi
12. Ventral scales \pm longer than wide, each with 1 broad, lanceolate appendage. Female
 receptacle with or without stalk 13

13. Female receptacle not stalked. Sporophyte in a dark, swollen, sac-like involucre below the thallus apex. Thallus linear, upper surface dark-green, margins and underside purplish-black *Targionia hypophylla* L.
- Targionia dioica* Schiffn. also keys out here and may be a synonym.
13. Female receptacle stalked, the underside of the receptacle with large conical, purple or whitish pseudoperianths (Fig. 6). Thallus usually broader, not linear 14 (*Asterella*)
14. Female receptacle convex. Lobes of the pseudoperianth remaining connected at the apex upon maturity of the capsule 15
14. Female receptacle flat. Lobes of the pseudoperianth free upon maturity 16
15. Stalk of female receptacle short, 1-5 mm long. Dioicous
..... *Asterella wallichiana* (Lehm & Lindenb.) Pande *et al.* ex Grolle
15. Stalk of female receptacle longer, 10-30 mm long. Autoicous. On volcanic rock or stones of old temples
..... *Asterella vulcanica* (Schiffn.) Pande *et al.* ex Kachroo & Bapna (Fig. 6)
16. Androecia on the dorsal side of thallus, very close to the base of the stalk of the female receptacle. *Asterella khasyana* (Griff.) Pande *et al.*
16. Androecia at the thallus margin or on ventral branches 17
17. Androecia on the thallus margin *Asterella limbata* Long & Grolle
17. Androecia on short ventral branches 18
18. Female receptacle 3.5-6 mm in diameter, deeply lobed. Scale appendage less than 0.5 mm long *Asterella leptophylla* (Mont.) Pande *et al.* ex Grolle
18. Female receptacle 2.5-4 mm in diameter, shallowly lobed. Scale appendage more than 0.5 mm long *Asterella blumeana* (Nees) Kachroo
19. Thallus large, 0.8-2 cm wide, dark green 20
19. Thallus smaller, pale green to glossy fresh green, rarely dark green (*Riccardia*) 21
20. Rhizoids papillose. Thallus margins plane, entire. Gametangia produced on rounded receptacles arising from the thallus surface, margins of receptacles with hairs. On wet soil or rock *Dumortiera hirsuta* (Sw.) Nees

20. Rhizoids smooth. Thallus margins irregularly incised-undulate. Gametangia produced at the thallus margins, receptacles lacking. On rotten wood
.....*Aneura maxima* Schiffn.
21. Thallus margins with rudimentary leaves consisting of 2 cells, each cell with a large slime papillae. Plants less than 1 mm wide, glossy light green. On rotten wood and trunk bases in montane forest
.....*Zoopsis liukiensis* Horik. (leafy liverworts: Lepidoziaceae; Fig. 11)
21. Thallus margins without rudimentary leaves 22
22. Thallus surface with a groove along the midline (Fig. 7: 12a,c) or with a reticulate pattern. Plants from moist, bare soil, small, lobes 1-4 mm wide, often forming rosettes. Sporophyte produced inside the thallus 23 (*Riccia*)
22. Thallus surface not with a groove along the midline and without reticulate pattern. Plants from bark, rotten wood, rock or soil, small or large, never growing in rosettes. Sporophyte not produced inside the thallus 29
23. Thallus with large, conspicuous air chambers (cross section, Fig. 7: 11b). Thallus ca. 1 mm wide. Spores 50-70 μm in diameter. On wet soil along rice fields, rivers, ponds and in ditches.....24 (*Riccia* subgen. *Ricciella*)
23. Thallus without or with narrow, inconspicuous air chambers (Fig. 7: 12c). Thallus 1-4 mm wide. Spores larger, 70-120 μm in diameter. On moist soil in gardens, along trails and near waterfalls.....25 (*Riccia* subgen. *Riccia*)
24. Thallus forming rosettes. Spores with 6-8 reticulæ across the outer surface.
.....*Riccia hasskarliana* Steph. (Fig. 7)
24. Thallus not forming rosettes. Spores with 4 large reticulæ across the outer surface.
..... *Riccia fluitans* L.
25. Thallus broad, 3-4 mm wide, 4-6 x as wide as thick. Spores with 4 large reticulæ across the outer surface (spores 100-120 μm in diameter). Common species
.....*Riccia treubiana* Steph. (Fig. 7)
25. Thallus narrower, 1-3 mm wide, 2-4 x as wide as thick. Spores with 6-10 reticulæ across the outer surface (spores 70-120 μm in diameter) 26
26. Thallus dark green above, dark reddish or violet below. Spores 90-120 μm in diameter*Riccia billardieri* Mont. & Nees
26. Thallus \pm green, not dark reddish or violet below. Spores smaller, 70-90 μm in diameter 27

27. Thallus glistening light green. Common species.....
 *Riccia junghuhniana* Nees & Lindenb. (= *R. applanata* Meijer; ? = *R. prominens* Meijer)
R. prominens Meijer also keys out here and may be a synonym of *R. junghuhniana* Nees & Lindenb.
27. Thallus dark blue green. Rare species, reported from Central Java
 *Riccia gangetica* Ahmad (? = *Riccia obtusa* Meijer)
Riccia obtusa Meijer from Cibodas resembles *R. gangetica* and may be a synonym; the two taxa seem to differ mainly in the slightly smaller spores and plant size of *R. obtusa* (see Meijer 1958).
- (couplet 28 lacking)
29. Thallus with midrib (Fig. 8). Archegonia and antheridia on the dorsal or ventral side of the midrib 30
29. Midrib lacking (sometimes present on small branches). Archegonia and antheridia at the thallus margins (Fig. 9: 15a,b) 42
30. Thallus margins sharply toothed. Thallus growing erect from a creeping rhizome.....
 *Jensenia decipiens* (Mitt.) Grolle (Fig. 8)
30. Thallus margins entire or with hairs, not sharply toothed. Thallus creeping or erect, rhizome lacking 31
31. Thallus less than 3 mm wide, translucent (1 cell-layer thick). Thallus margins with hairs. Archegonia and antheridia on the ventral side of the midrib. Thallus apex often with large “gemmae”, consisting of short thallus shoots which are easily detached and may grow into new plants 32 (*Metzgeria*) (Fig. 8)
31. Thallus more than 3 mm wide, not translucent (more than 1 cell-layer thick). Thallus margins without hairs. Antheridia and archegonia on the dorsal side of the thallus. Thallus apex without gemmae 38
32. Dorsal surface of midrib with hairs. Plants growing on living leaves
 *Metzgeria foliicola* Schiffn.
32. Dorsal surface of midrib without hairs. Plants growing on bark or rock, rarely on living leaves..... 33
33. Thallus conspicuously narrowed towards apex. Plants yellow green or bluish
 *Metzgeria consanguinea* Schiffn. (Fig. 8)
33. Thallus not conspicuously narrowed to apex 34
34. Hairs single, never in pairs 35

34. Hairs in pairs (but some hairs may be single) 37
35. Dorsal side of midrib to 4 cells wide. Gemmae occurring over the entire dorsal surface of the thallus..... *Metzgeria crassipilis* (Lindb.) Evans
35. Dorsal side of the midrib only 2 cells wide. Gemmae restricted to thallus margins... 36
36. Ventral side of midrib only 2 cell rows wide
..... *Metzgeria ciliata* Raddi (= *Metzgeria decipiens* Schiffn.)
36. Ventral side of midrib more than 2 cell rows wide *Metzgeria furcata* (L.) Dum.
37. Hairs falcate. Dioicous *Metzgeria leptoneura* Spruce (Fig. 8)
37. Hairs straight. Autoicous *Metzgeria lindbergii* Schiffn.
- Metzgeria lindbergii* is closely related to the common holarctic *M. conjugata* Lindb. and may be a synonym or variety of the latter species, this needs further study.
38. Rhizoids dark red or purple. Thallus very large, 0.8-1 cm wide and 3-6 cm long, with a very narrow midrib. In Java?
....*Sandeothallus radiculosus* (Schiffn.) Schust. (= *Calycularia radiculosa* Steph., nom. illeg.)
38. Rhizoids colorless. Thallus smaller, midrib relatively broad 39
39. Gametangia on very short branches at the base of the thallus. Thallus margins without slime hairs (or present only near apex). Not yet recorded from Java (Grolle & Piippo 1986) *Podomitrium malaccense* (Steph.) Campb.
39. Gametangia occurring on the main thallus, not on short branches at the base. Thallus margins with 2-cells long slime hairs..... 40
40. Midrib of thallus with a distinct central strand (Fig. 8: 13b; visible from the dorsal side as a dark line inside the midrib). Archegonia covered by a cup-like involucre or a simple scale 41
40. Midrib of thallus without distinct central strand. Archegonia covered by a simple scale only *Symphyogynopsis gottscheana* (Mont. & Nees) Grolle
41. Archegonia covered by a simple scale, cup-like involucre lacking. Collected near Cibureum waterfall..... *Symphyogyna similis* Grolle
41. Archegonia surrounded by a cup-like involucre. Common species
..... *Pallavicinia lyellii* (Hook.) Carruth. (Fig. 8) (? = *P. levieri* Schiffn.)

Pallavicinia levieri Schiffn. is very similar to *P. lyellii* and differs only in the position of the androecia, which occur over the whole surface of the midrib in *P. levieri* Schiffn. and only on the lateral sides of the midrib in *P. lyellii*.

42. Thallus more than 3 mm wide 43
42. Thallus less than 3 mm wide 44 (*Riccardia*)
43. Thallus pinnately lobed. Thallus bluish green to dark green. Oil bodies brown
..... *Lobatiriccardia coronopus* (De Not.) Furuki (= *L. lobata* (Schiffn.) Furuki)
43. Thallus simple or scarcely branched, glossy fresh green. Oil bodies colorless
..... *Aneura pinguis* (L.) Dum. (Fig. 9)
44. Thallus with dense clusters of tiny branchlets mixed among the normal branches, the
tiny branchlets conspicuously undulate and winged. Thallus margins usually toothed
..... *Riccardia heteroclada* Schiffn. (= *R. serrulata* Schiffn.)
44. Thallus without dense clusters of tiny branchlets. Thallus margins entire (rarely
toothed)..... 45
45. Thallus in cross section with a hyalodermis (= epidermis of large, thin-walled cells)
and a brown subepidermis of smaller, thick-walled cells. Plants large, densely 2-3-
pinnate. Branches opposite, with broad unistratose wings and narrow midribs, the
wings much broader than the midrib
..... *Riccardia hymenophylloides* Schiffn. (= *R. decipiens* Schiffn.)
45. Thallus without hyalodermis and brown subepidermis. Plants small or large. Branches
alternate or subopposite, wings lacking or narrower than midrib 46
46. Thallus surface ± rough by small papillae 47
46. Thallus surface completely smooth 48
47. Papillae narrowly elongate. Thallus irregularly 1-2-pinnate. Branches not or scarcely
winged *Riccardia crassa* (Schwaegr.) Carringt. & Pears. (= *R. scabra* Schiffn.)
47. Papillae not elongate, appearing as very small dots. Thallus regularly and densely 2-
3-pinnate, feather-like. Branches winged..... *Riccardia tamariscina* (Steph.) Schiffn.
48. Thallus margin cells conspicuously enlarged and thick-walled. Found on a tree in
Cibodas Botanical Garden..... *Riccardia canaliculata* (Nees) Kuntze
- Riccardia albo-marginata* Schiffn. also keys out here, and is close to *R. canaliculata*. *Riccardia
canaliculata* is autoicous and *R. albo-marginata* dioicous (Furuki 1995).
48. Thallus margin cells not conspicuously enlarged 49

49. Branching palmate in the upper part of the thallus 50
49. Branching pinnate, never palmate 52
50. Branches broadly winged by large cells. Thallus ca. 1 mm wide. Oil bodies present in epidermis cells *Riccardia graeffei* (Steph.) Hewson (= *R. platyclada* Schiffn.)
50. Branches winged by small cells. Thallus less than 1 mm wide. Oil bodies lacking or present in epidermis cells 51
51. Wings crenulate *Riccardia crenulata* Schiffn. (Fig. 9)
51. Wings entire *Riccardia parvula* Schiffn.
52. Thallus regularly and densely 2-3-pinnate. 53
52. Thallus irregularly pinnate 54
53. Thallus very robust, to 10 cm long and 1.5 cm wide, densely 3-pinnate. Main axis to 20 cells thick *Riccardia elata* (Steph.) Schiffn. (Fig. 9)
53. Thallus smaller, 2-pinnate. Main axis to 10 cells thick *Riccardia diminuta* Schiffn.
- Riccardia jackii* Schiffn., *R. tenuis* (Steph.) Schiffn. and *R. tjibodensis* Schiffn. also key out here. The status of these species needs further study.
54. Thallus axis ± winged 55
54. Thallus axis without wing 56
55. Wings undulate *Riccardia wettsteinii* Schiffn.
55. Wings not undulate *Riccardia multifidoides* Schiffn.
- Riccardia flaccidissima* Schiffn. also keys out here. The difference of this species with *R. multifidoides* is unclear and needs further study. Meijer (1958b) considered *R. multifidoides* a synonym of the widespread holarctic *R. multifida* (L.) Gray. This needs confirmation.
56. Thallus winged by large cells *Riccardia graeffei* (Steph.) Hewson
56. Thallus not winged by large cells *Riccardia subexalata* Schiffn.

Further records: *R. crassiretis* Schiffn., *R. pindensis* Hewson, *R. plumosa* (Mitt.) E.O.Campb., *R. tenuicostata* Schiffn.

Key 4. Leafy liverworts

1. Leaves deeply divided (to near the base) into hair-like lobes, hairs only 1 cell wide (Fig. 10: 20a) 2
1. Leaves not deeply divided into hair-like lobes 5
2. Plants very small, less than 1 mm wide, alga-like. Leaves divided into 3-6 simple hairs 3
2. Plants larger, more than 1 mm wide, not alga-like. Leaves divided into numerous, branched hairs.....
..... *Trichocolea tomentella* (Ehrh.) Dum. (? = *T. pluma* (Reinw. et al.) Mont.)

The plants from Java were originally described as *T. pluma*, which is very similar to the widespread *T. tomentella* and probably not a good species (see Piippo 1994). Further record from Java: *Trichocolea obconica* Steph.

3. Leaves (4-)6-7-lobed to slightly above the base, a short lamina present. Cuticle densely papillose, with small rounded papillae
..... *Telaranea neesii* (Lindenb.) Fulf. (Fig. 10)

Further record from Java: *Telaranea cuneifolia* (Steph.) Engel & Merrill. This eastern Malesian / Pacific species is not recorded from Java in the monograph of *Telaranea* by Engel & Merrill (2004).

3. Leaves 2-4-lobed to the base, without lamina. Cuticle smooth or faintly striate-papillose, with elongate papillae 4
4. Underleaves as long as lateral leaves. Cuticle faintly striate-papillose (especially on stem cells). Gynoecium at stem apex *Blepharostoma trichophyllum* (L.) Dum.
4. Underleaves shorter than lateral leaves, underleaf lobes only 2-3 cells long. Cuticle smooth. Gynoecium on a short lateral branch.....
..... *Kurzia gonyotricha* (Sande Lac.) Grolle (Fig. 10)
5. Plants robust, worm-like, reddish. Leaves divided into two strongly swollen, sac-like lobes of different size, the large lobes imbricate, the small lobes distant, narrow-tubular. Large lobe with an acute apex and coarsely toothed-undulate margin. Underleaves lacking. Perianth large, usually terete, occasionally plicate. Canopy epiphyte in montane and subalpine forest.....
..... *Pleurozia gigantea* (Web.) Lindenb.
5. Plants different. Leaves not divided into two sac-like lobes 6
6. Leaves differentiated into lobe and lobule (Figs. 10 (19,22,23a) and 19-28) 7
6. Leaves not differentiated into lobe and lobule 18

7. Leaves divided into a large dorsal lobe and a smaller ventral lobule. Leaf lobes incubous (Figs. 19-28)..... **Key 7**
7. Leaves differentiated into a large ventral lobe and a small dorsal lobule, the lobule connected with the lobe or free. Leaf lobes succubous (Fig. 10: 19,22,23a) 8
8. Underleaves present 9 (*Schistochila*)
8. Underleaves lacking 13
9. Surface of the ventral leaf lobe with lamellae.....*Schistochila blumei* (Nees) Trevis.
9. Surface of the ventral leaf lobe smooth, without lamellae 10
10. Leaf margin \pm entire. Margins of underleaves recurved
.....*Schistochila reinwardtii* (Nees) Schiffn. (Fig. 10)
10. Leaves toothed-ciliate. Margins of underleaves plane
.....*Schistochila sciurea* (Nees) Schiffn.

(couplets 11 + 12 lacking)

13. Plants very large, up to 2 cm wide and 16 cm long. Lobules free from the lobes, small, scale-like. Leaf margin entire. Leaf lobes more than 1 cell thick, tongue-shaped. On rotten wood in montane forest (rare)... *Treubia insignis* Goebel (Fig. 10)
13. Plants smaller. Lobules connected to the lobes. Leaf margin usually toothed (entire in *Diplophyllum*). Leaf lobes only 1 cell thick..... 14
14. Leaf lobes ovate, 1-1.5 x longer than wide. Dorsal lobe attached to the margin of the ventral lobe (Fig. 10: 23a) 15 (*Scapania*)
- Scapania ciliatospinosa* Horik. and *S. ferruginea* (Lehm. & Lindenb.) Gottsche *et al.*, two eastern Asiatic species from *S.* subgen. *Plicaticalix*, have also been recorded from Java. However, according to Grolle (1965) and Potemkin (pers. com.) these records are erroneous.
14. Leaf lobes more elongate, 2-3 x as long as wide..... 17
15. Terminal cell of leaf margin teeth very long, 3-4 x as long as wide. Ventral leaf-lobe weakly spreading (lobe-stem angle less than 45°). Keel short, less than 1/4 of ventral lobe length.....*Scapania sandei* Schiffn. ex Müll.Frib.
15. Terminal cell of leaf margin teeth shorter, 1-2 x as long as wide. Ventral leaf-lobe more widely spreading (lobe-stem angle more than 45°). Keel longer, more than 1/4 of ventral lobe length..... 16

16. Margins of dorsal leaf lobe entire or with a few small teeth near the apex. Terminal cell of margin teeth subquadrate, 1-1.2 x longer than wide. Gemmae scarce, green
..... *Scapania rigida* Nees
16. Margins of dorsal leaf lobe regularly toothed. Terminal cell of margin teeth elongate, 1.5-2 x longer than wide. Gemmae abundant, brown
..... *Scapania javanica* Gottsche (Fig. 10)
17. Plant very small, about 1 mm wide. Leaf apex rounded, entire. Mt. Pangrango, on soil along trail *Diplophyllum nanum* Herz.
17. Plants larger. Leaf apex acute, coarsely toothed. Common species
..... *Gottschea aligera* (Nees) Nees (= *Schistochila aligera* (Nees) Jack & Steph.)
18. Underleaves almost as large as the leaves 19
18. Underleaves much smaller than the leaves, or lacking 26
19. Leaves undivided *Haplomitrium blumei* (Nees) Schust.
19. Leaves 2-4-lobed 20
20. Plants pinnate, robust. Leaves 2-4-lobed 21
20. Plants not pinnate. Leaves 2-lobed 22
21. Leaves of main stem 4-lobed. Leaf margin \pm ciliate
..... *Lepicolea rara* (Steph.) Grolle
21. Leaves of main stem 2-3-lobed. Leaf margin entire or with a few laciniae in the lower half *Mastigophora diclados* (Brid. ex Web.) Nees (Fig. 11)
22. Leaf margin strongly toothed. Leaves ovate to orbicular. On wet rock
..... *Isotachis armata* (Nees) Gottsche
22. Leaf margin \pm entire. Leaves narrow elongate. Epiphytic or on humus 23
23. Leaves deeply bifid to 1/2-3/4, with a distinct vitta of elongated cells (Fig. 11). Leaf cells with large trigones 24 (*Herbertus*)
23. Leaves bifid to 1/3 only, without vitta. Leaf cells with very small trigones
..... *Triandrophyllum heterophyllum* (Steph.) Grolle
24. Leaf tips narrowly acuminate, mostly made up of rectangular cells. Leaves 2.5-6 x longer than wide, bifid to 2/3-3/4 of leaf length
..... *Herbertus armitanus* (Steph.) Miller (Fig. 11)

24. Leaf tips acute, made up of quadrate cells. Leaves 1.5-3.5 x longer than wide, bifid to 2/3 of leaf length 25
25. Leaves 1.5-2.5 x longer than wide. Basal leaf cells (not those of the vitta) 25-35 μm long. *Herbertus ramosus* (Steph.) Miller
25. Leaves more slender, 2-3.5 x longer than wide. Basal leaf cells 10-25 μm long.....
.....*Herbertus dicranus* (Tayl. ex Gottsche *et al.*) Trevis.
26. Leaves consisting of only 2 cells, each leaf cell with a large slime papillae at the tip. Plants \pm thalloid, filamentose, less than 1 mm wide, glossy light green. On rotten wood and trunk bases in montane forest *Zoopsis liukuensis* Horik. (Fig. 11)
26. Leaves of more than 2 cells, without slime papillae at the tip 27
27. Very small plants with numerous teeth all over the leaf surface. On rotten wood and trunk bases in montane forest *Chiloscyphus muricatus* (Lehm.) Engel & Schust.
27. Leaf surface smooth 28
28. Underleaves present (sometimes small!)..... 29
28. Underleaves lacking 76
29. Leaves incubous (Fig. 2) 30
29. Leaves succubous or transverse (Figs. 2, 13: 34a, 15: 39b, etc.) 47
30. Plants pinnate. Leaves of the main stem divided into (2-)4 or more lobes
..... 31 (*Lepidozia*, *Telaranea p.p.*)
30. Plants not pinnate. Leaves of the main stem divided into 0-3 lobes 41
31. Plants very small, less than 0.6 mm wide, green to brown in color, with minute, distant leaves and underleaves 32
31. Plants larger, pale green 35
32. Leaves of the main stem 2-lobed.....*Lepidozia supradecomposita* Lindenb.
32. Leaves of the main stem 3-4-lobed (on branches sometimes 2-lobed!)..... 33
33. Leaves conspicuous, obliquely spreading, very asymmetrical, dorsal leaf margin strongly curved, ventral leaf margin straight.....
.....*Lepidozia haskarliana* (Lindenb.) Steph. (Fig. 12)

33. Leaves inconspicuous, almost parallel to the stem, symmetrical, dorsal and ventral
Leaf margin \pm straight 34
34. Leaves triangular, very shallowly lobed, to 1/7 of leaf length
..... *Lepidozia subintegra* Lindenb.
34. Leaves subrectangular, more deeply lobed, to 1/4 of leaf length
..... *Lepidozia trichodes* (Reinw. *et al.*) Nees (Fig. 12)
35. Stem-leaves quadrate, widely spreading, flat to \pm concave, divided to 1/3-1/2 into
(3-)4 lobes. Leaf margin entire or with 1-3 short teeth 36
35. Stem-leaves broadly triangular, not widely spreading, strongly concave, \pm
undivided or shallowly divided (to 1/5 or less) into several lobes or teeth. Leaf
margin toothed 40
36. Leaves symmetrical, dorsal margin not longer than ventral margin. Stem with a
hyalodermis 37
36. Leaves asymmetrical, dorsal margin longer than ventral margin. Stem without
hyalodermis 38
37. Leaf cells thin-walled, large, 40-60 μm long
..... *Telaranea wallichiana* Gottsche (Gottsche) Schust. (= *Lepidozia wallichiana* Gottsche)
37. Leaf cells rather thick-walled, smaller, 30-40 μm long
..... *Telaranea papulosa* (Steph.) Engel & Merrill (= *Lepidozia papulosa* Steph.)
38. Leaves imbricate, margins of leaves and underleaves \pm toothed
..... *Lepidozia quadridens* (Nees) Nees
38. Leaves distant or contiguous, margins of leaves and underleaves entire 39
39. Leaves almost transversely inserted, dorsal leaf-base strongly arched-cordate
..... *Lepidozia cordata* Lindenb.
39. Leaves obliquely inserted, dorsal leaf-base straight or slightly curved, not strongly
arched-cordate *Lepidozia stahlii* Steph.
40. Leaf apex narrow triangular, \pm entire or with 4 long, ciliate teeth
..... *Lepidozia cladorrhiza* (Reinw. *et al.*) Nees (Fig. 12)
40. Leaf apex rounded, with numerous ciliate to laciniate teeth (more than 4)
..... *Lepidozia holorrhiza* (Reinw. *et al.*) Nees (Fig. 12)

Further records: *Lepidozia brevifolia* Mitt., *L. loheri* Steph., *L. miqueliana* Sande Lac.

41. Plants simple or irregularly branched. Flagelliform ventral branches lacking. On soil, occasionally on rotten wood 42
41. Plants dichotomously branched. Stems on the ventral side with long and slender, flagelliform branches. On bark or rotten wood 45
42. Plants brown. Leaf apex broadly rounded. Underleaves undivided or shallowly bifid. Cuticle coarsely papillose *Mnioloma fuscum* (Lehm.) Schust.
42. Plants pale green. Leaf apex apiculate or short bifid. Underleaves deeply bifid. Cuticle smooth or finely papillose..... 43
43. Leaf apex apiculate.....*Calypogeia apiculata* (Steph.) Steph.
43. Leaf apex bifid..... 44
44. Cuticle finely papillose. Teeth at leaf apex always separated by a broad lunulate sinus. Apical leaf cells 45-60 μm wide, longer than wide
..... *Calypogeia arguta* Nees & Mont. (Fig. 12)
44. Cuticle smooth. Teeth at leaf apex separated by a variable, narrow V-shaped to rather broad sinus. Apical leaf cells 25-35 μm wide, isodiametrical
..... *Calypogeia goebelii* (Schiffn.) Steph.
45. Leaf apex unequally bifid, dorsal lobe larger than ventral lobe. Stem epidermis cells larger than the inner cells 46 (*Acromastigum*)
45. Leaf apex not unequally bifid. Stem epidermis cells not larger than the inner cells...
..... **Key 5** (*Bazzania*) (Fig. 18)
46. Leaf margin crenulate. Leaf cells with rounded papillae (one per cell). Underleaves 1.5-2 x wider than the stem. Epidermis cells thick-walled
..... *Acromastigum inequilaterum* (Lehm. & Lindenb.) Evans
46. Leaf margin entire. Leaf cells smooth or with elongated papillae. Underleaves not wider than the stem. Epidermis cells thin-walled.....
..... *Acromastigum divaricatum* (Nees) Evans
47. Leaves 3-5-lobed 48
47. Leaves bifid or undivided..... 50
48. Leaves transverse, shallowly divided (to 1/4) into 4-5 lobes, each lobe with a stiff, 6-9 cells long cilium at the apex and with additional shorter cilia on margins. On rotten logs and trunk bases in mossy forest.....
..... *Temnoma setigerum* (Lindenb.) Schust. (Fig. 13)

48. Leaves succubous, divided into 3-4 lobes. Lobe apex acuminate, without stiff, 6-9 cells long cilium 49
49. Leaf margin densely and strongly toothed from base to apex. On canopy branches in montane forest
Chandonanthus hirtellus (Web.) Mitt. (= *Plicanthus hirtellus* (Web.) Schust.; ? = *Chandonanthus birmensis* Steph.)
- According to Grolle (1995, cited in Schuster 2002), *Chandonanthus birmensis* Steph. is probably a synonym of *C. hirtellus*.
49. Leaf margin entire; ventral leaf base with a few long cilia. On trunk bases (?) in montane forest *Barbilophozia lycopodioides* (Wallr.) Loeske
50. Dorsal leaf base decurrent (Fig. 19: 48). Leaf margin and apex toothed 51
50. Dorsal leaf base not decurrent. Teeth lacking or present only at the leaf apex or on the Leaf margin, not on both 53
51. Underleaves well-developed, wider than the stem, connected with the leaves. Perianth sharply 3-keeled along its whole length 52
51. Underleaves very small (or lacking), not wider than the stem, free from the leaves. Perianth flat, not sharply 3-keeled **Key 6** (*Plagiochila*)
52. Underleaves distant, clearly bifid, margins with 2-4 teeth. Plants less than 3 mm wide *Chiloscyphus ciliolatus* (Nees) Engel & Schust.
- Chiloscyphus ciliolatooides* Engel & Schust., *C. paroicus* Engel & Schust. and *C. thermarum* (Schiffn.) Engel & Schust. are very close to *C. ciliolatus* and may be synonyms.
52. Underleaves imbricate, not clearly bifid, margins with 8-20 teeth. Plants robust, more than 3 mm wide
Chiloscyphus costatus (Nees) Engel & Schust. (= *Lophocolea costata* Nees; ? = *C. costatooides* Engel & Schust.)
- Chiloscyphus costatooides* Engel & Schust. (= *Lophocolea massalongoana* Schiffn.) is a delicate form of *C. costatus* (Schiffner 1900, Piippo 1985).
53. Leaf apex rounded, truncate or emarginate, without sharp teeth 54
53. Leaf apex clearly bifid or with sharp teeth 62
54. Leaf cells with well-developed trigones 55
54. Trigones absent or very small. 59
55. Underleaves large, wider than the stem, underleaf margins toothed 56

55. Underleaves very small (often \pm hidden between the rhizoids), narrower than the stem, margins entire 58
56. Leaf cells smooth. Plants green. Leaves oblong, slightly overlapping, not densely convolute. Underleaves with deeply arched insertion line.....
.....*Heteroscyphus splendens* (Lehm. & Lindenb.) Grolle (Fig. 13)
- Heteroscyphus parvulus* (Schiffn.) Schiffn. and *H. caesius* (Schiffn.) Schiffn., both described from Java, also key out here and are very close to *H. splendens* (see Piippo 1985, 1992).
56. Leaf cells papillose or mammillose. Plants yellowish brown to reddish-brown. Leaves ovate, densely convolute. Underleaves not with deeply arched insertion line 57
57. Leaf cells densely papillose, each cell with many small papillae. Underleaf bases with numerous red rhizoids
Acrosyphella tjiwideiensis (Sande Lac.) Kitag. & Grolle (= *Conoscyphus tjiwideiensis* (Sande Lac.) Mitt., *Austrosyphus tjiwideiensis* (Sande Lac.) Schust.)
57. Leaf cells mammillose, each cell with one large mammilla. Underleaf bases without red rhizoids *Conoscyphus trapezioides* (Sande Lac.) Schiffn.
58. Leaves short ovate, almost longitudinally inserted. Underleaves deeply bifid. Leaf cells minutely striate-papillose. Rhizoids mostly in small bundles from underleaf base. Branches ventral. Plants pale green.....
.....*Notoscyphus lutescens* (Lehm. & Lindenb.) Mitt. (Fig. 13)
58. Leaves rounded, obliquely inserted. Underleaves undivided. Leaf cells smooth. Rhizoids scattered, never in bundles. Branches lateral. Plants green to reddish brown. Collected once (in the 19th century) on the summit of Mt. Pangrango (see Journal of Bryology 29: 140. 2007) *Nardia scalaris* Gray
59. Leaves \pm transverse, deeply concave, often folded to the apex. Underleaves undivided, very small, margins entire. Plants with many ventral branches and with stolons at stem base, growing upright on soil at high elevations. Sometimes growing submerged in sulphur springs..... *Hygrolembidium boschianum* (Sande Lac.) Schust.
59. Leaves clearly succubous, not deeply concave or folded. Underleaves bifid or with several teeth. Plants creeping 60
60. Plants more than 3 mm wide. Leaves elongate, narrow rectangular. Perianth on a short lateral branch*Heteroscyphus succulentus* (Gottsche) Schiffn. (Fig. 13)
60. Plants smaller, less than 2 mm wide. Leaves ovate-quadrate or rounded. Perianth terminal on the stem or lacking 61

61. Leaf cells striate-papillose. Leaf apex rounded to shallowly emarginate. Branching ventral. Oil bodies 1-3 per cell, brown. Sporophyte in a short marsupium.....
.....*Notoscyphus lutescens* (Lehm. & Lindenb.) Mitt. (Fig. 13)
61. Leaf cells with small rounded papillae. Leaf apex truncate to short bifid. Branching lateral. Oil bodies 6-15 per cell, colorless. Sporophyte in a perianth.....
.....*Chiloscyphus kurzii* (Schiffn.) Engel & Schust.
- This species somewhat resembles *Chiloscyphus profundus* Engel & Schust. (= *Lophocolea heterophylla* (Schrad.) Dum.), a common holarctic species which is not known from Malaysia.
62. Leaves opposite, dorsal bases of opposite leaves attached to each other. Leaf apex asymmetrically emarginate. Leaf cells finely and densely papillose, papillae rounded 63 (*Saccogynidium*) (Fig. 13)
62. Leaves not opposite, not attached to each other. Leaf apex not asymmetrically emarginate. Leaf cells \pm smooth or slightly striate-papillose..... 64
63. Leaf cells with large trigones. Underleaves 2-3 x wider than the stem. Leaf margin crenulate. *Saccogynidium rigidulum* (Nees) Grolle
63. Leaf cells without or with very small trigones. Underleaves \pm as wide as the stem. Leaf margin usually entire..... *Saccogynidium muricellum* (De Not.) Grolle (Fig. 13)
64. Leaf cells thick-walled or with conspicuous trigones 65
64. Leaf cells thin-walled, trigones \pm lacking 70
65. Shoots and branches often becoming flagelliform towards the tip, stem base with stolons. Plants small, on soil at high elevations, rare 66
65. Shoots and branches not becoming flagelliform, stolons lacking 67
66. Leaves shallowly bifid to 1/5-1/4 of length, leaf margin slightly toothed. Very rare ..
..... *Andrewsianthus recurvifolius* (Nees) Schust.
66. Leaves more deeply bifid to 1/2 of length, leaf margin entire. Only known from the summit of Mt. Pangrango *Andrewsianthus sundaicus* (Schiffn.) Schust.
67. Leaf apex with 2 long teeth separated by a very narrow sinus. Plants large, (3-)5-10 mm wide
..... *Heteroscyphus aselliformis* (Reinw. et al.) Schiffn. (? = *Chiloscyphus bifidus* Schiffn.)
Chiloscyphus bifidus Schiffn. may be a small form of *H. aselliformis* (Schiffner 1900).
67. Leaf apex with 2-3 well-separated teeth. Plants less than 5 mm wide 68

68. Underleaves ovate, distant, margins with 1-4 short teeth.....
..... *Chiloscyphus ciliolatus* (Nees) Engel & Schust.
68. Underleaves reniform, ± imbricate, margins with up to 10 cells long teeth. 69
69. Leaf apex with 3 teeth. Teeth of underleaves sometimes very broad and split into two small teeth *Heteroscyphus wettsteinii* (Schiffn.) Schiffn.
69. Leaf apex with 2 short teeth. Teeth of underleaves simple, never split into two teeth. Very rare species from Java *Heteroscyphus baduinus* (Nees) Schiffn.
70. Plants dark green. Leaf apex with 3-10 small teeth (number of teeth very variable!) .
..... *Heteroscyphus argutus* (Reinw. *et al.*) Schiffn.
70. Plants pale green to dark green Leaf apex with 0-2(-3) teeth 71
71. Leaf apex truncate or shallowly emarginate, with 2 long teeth on the side. Underleaves broadly connected with leaves on both sides
..... *Heteroscyphus coalitus* (Hook.) Schiffn.
71. Leaf apex not truncate-emarginate. Underleaves connected or free 72
72. Leaves bifid with 2 long, narrowly acuminate teeth. Underleaves free from the leaves. Perianth terminal on a long shoot.....
Chiloscyphus coadunatus (Sw.) Engel & Schust. (= *Lophocolea bidentata* (L.) Dum.; ? = *C. mollis* (Nees) Engel & Schust.)
- Chiloscyphus mollis* (Nees) Engel & Schust. may be a small form of *C. coadunatus* from high elevations.
72. Leaves not with 2 long, narrowly acuminate teeth. Underleaves connected with the leaves or free 73
73. Underleaves free from the leaves. Leaf apex with 2 small teeth. Perianth terminal 74
73. Underleaves at the base connected to the leaves. Leaf apex with 0-3 teeth, the teeth small or large. Perianth lateral or terminal 75
74. Leaf margin with gemmae..... *Chiloscyphus propagulifer* Schiffn.
74. Leaf margin without gemmae..... *Chiloscyphus* sp.
75. Leaf apex rounded and with (0-)1-3 small teeth (resembling *C. argutus* but with fewer teeth). Plants green, dioicous. Perianth on a very short lateral branch
..... *Heteroscyphus zollingeri* (Gottsche) Schiffn.

75. Leaf apex clearly bifid, with 2 large teeth separated by a narrow sinus. Plants pale green, paroicous. Perianth terminal on a long branch
 *Chiloscyphus schiffneri* Engel & Schust. (= *Lophocolea javanica* Schiffn.)
- Further records from Java: *Chiloscyphus boulyanus* (Steph.) Engel & Schust., *C. haskarlianus* (Gottsche) Engel & Schust., *C. integerrimus* Schiffn., *C. salacensis* (Steph.) Engel & Schust., *Heteroscyphus acutangulus* (Schiffn.) Schiffn., *H. knightii* (Steph.) Grolle, etc.
76. Leaves 2-lobed 77
76. Leaves undivided 92
77. Leaf base strongly concave, forming a sac. Apex of leaf lobes narrow ciliate-lanceolate, strongly curved. Plants forming reddish mats on dead wood in subalpine environments *Nowellia curvifolia* (Dicks.) Mitt.
77. Leaf base not forming a sac, plants different 78
78. Leaf margin with long rhizoids [not yet recorded from Java but may occur there].....
 *Acrobolbus ciliatus* (Mitt.) Schiffn.
78. Leaf margin not with long rhizoids 79
79. Plants minute, 0.2-0.3 mm wide, shoot tips usually with gemmae. Leaf margin entire 80 (*Cephaloziella*)
79. Plants more than 0.3 mm wide, gemmae present or lacking. Leaf margin entire or with a few teeth 82
80. Leaves transversely inserted. Leaf cells thick-walled, cuticle papillose
 *Cephaloziella kiaeri* (Aust.) Douin
80. Leaves obliquely inserted. Leaf cells thin-walled, cuticle smooth..... 81
81. Leaf lobes unequal, dorsal lobe smaller than ventral lobe
 *Cephaloziella stephanii* Steph. ex Douin (Fig. 14)
81. Leaf lobes equal.....*Cephaloziella capillaris* (Steph.) Douin
- Further record: *Cephaloziella intricata* Schiffn. ex Douin
82. Stems with hyalodermis, fragile, made up of thin-walled cells. Plants pale green, very small, less than 1 mm wide. Leaves deeply bifid (to 1/2-3/4)
 *Cephalozia hamatiloba* Steph. (? = *C. neesiana* Steph.)

According to Vána (1988), *Cephalozia neesiana* Steph. may be a synonym of *C. hamatiloba*.

82. Stems without hyalodermis, rigid. Plants green to brown or reddish-purple. Leaves shallowly to deeply bifid. Plants from high elevations 83
83. Leaves shallowly bifid, maximally to 1/3 of leaf length..... 84
83. Leaves more deeply bifid 87
84. Leaf lobes rounded (rarely alpiculate). Stem base usually with stolons 85
84. Leaf lobes (sub)acute. Stem base without stolons..... 86
85. Leaves succubous. Plants with flagelliform dorsal branches. On soil, rock or wood, plants green to brown or purple.....*Andrewsianthus puniceus* (Nees) Schust.
85. Leaves transverse. Flagelliform dorsal branches lacking. Very small, blackish plants growing on lava in volcanic craters.....*Marsupella neesii* Sande Lac. ex Schiffn.
86. Plant glossy blackish brown. Leaves subtransverse, canaliculate, dorsal lobe much smaller than ventral lobe. Perianth plicate, upper part of perianth white*Anastrophyllum assimile* (Mitt.) Steph.
86. Plant not glossy, green to pale brown. Leaves succubous, not canaliculate, dorsal lobe not or only slightly smaller than ventral lobe. Perianth smooth, upper part of perianth not white*Hattoriella subcrispa* (Herz.) Bakalin (= *Lophozia dubia* Schiffn., fide J. Váňa)
87. Plants less than 1.5 mm wide. 88
87. Plants 1.5-3 mm wide 90
88. Leaf margin narrowly reflexed. Lumen of leaf cells conspicuously star-shaped (due to very large, bulging trigones)*Anastrophyllum squarrosum* Herz. (Fig. 14)
88. Leaf margin not reflexed. Lumen of leaf cells rounded or sinuate (trigones smaller) 89
89. Plants with flagelliform dorsal branches. Leaves bifid to 1/3-1/2 of leaf length. Underleaves sometimes present, very small.....*Andrewsianthus bidens* (Mitt. ex Steph.) Schust.
89. Flagelliform dorsal branches lacking. Leaves bifid to 1/2-2/3 of leaf length. Underleaves lacking*Anastrophyllum bidens* (Reinw. *et al.*) Nees
90. Plants pale green, with stolons at the base. Branches from the ventral side of the stem. Leaves rather flat, lobes unequal (dorsal lobe smaller than ventral lobe). Leaf

- cells without trigones. Gynoecia on short ventral branches. Known only from Telaga Bodo, 1650 m, epiphytic *Marsupidium sumatranum* (Schiffn.) Grolle
90. Plants green to reddish brown, stolons lacking. Branches from the lateral side of the stem. Leaves concave, lobes equal. Leaf cells with trigones. Gynoecia terminal on the stem..... 91
91. Leaf lobes apiculate, margins overlapping in the sinus between the two leaf lobes. Outer leaf margins plane *Anastrophyllum piligerum* (Nees) Steph.
91. Leaf lobes acute, margins not overlapping in the sinus. Outer leaf margins recurved *Anastrophyllum revolutum* Steph.
- Further record from Java: *Anastrophyllum karstenii* Schiffn.,
92. Plants with a flat, thalloid appearance, stems very broad. Leaves laterally attached to the stem, margins entire, leaf base several cell-layers thick. On rotten wood or wet soil in montane cloud forest, shaded, rare 93
92. Plants different, not with a flat, thalloid appearance. 94
93. Plants large, 1-2 cm wide and 10-15 cm long, green. Dorsal side of the stem with small, leaf-like scales alternating with the leaves. Leaves longer than wide, lingulate. Leaf cells ca. 50-60 μm long (in mid-leaf).....
..... *Treubia insignis* Goebel (Fig. 10)
93. Plants smaller, glossy pale green. Dorsal side of stem without leaf-like scales. Leaves rounded. Leaf cells very large, ca. 85 μm long. Collected on Mt. Tangkuban Perahu by E.A.P. Iskandar *Schiffneria hyalina* Steph. (Fig. 14)
94. Leaves irregularly undulate-crispate (plant looking like salad), more than 1 cell-layer thick in the lower half. Rhizoids deep purple (occasionally pale brown). Antheridia naked on the stem surface, not enveloped by bracts. Spores large, 40-60 μm in diameter. Spore surface coarsely sculptured by a lamellate or reticulate pattern. On soil in gardens, nurseries, disturbed waste places, etc.....
..... 95 (*Fossombronina*) (Fig. 9)
94. Leaves not irregularly undulate-crispate, only 1 cell-layer thick. Rhizoids colorless, pale brown or reddish, never purple. Antheridia in the axils of bracts. Spores smaller. Spore surface smooth or finely papillose, not sculptured by a lamellate or reticulate pattern. On bark, rock or soil..... 96
95. Leaf margin toothed. Rhizoids always purple. Outer spore surface reticulate. Elaters lacking or scarce, with 0-1 spiral band..... *Fossombronina japonica* Schiffn.

95. Leaf margin \pm entire. Rhizoids purple or (occasionally) pale brown. Outer spore surface irregularly lamellate. Elaters frequent, with 2-3 spiral bands
 *Fossombronina himalayensis* Kashyap
96. Leaves opposite, leaf bases connected 97
96. Leaves not opposite, leaf bases free 101
97. Leaves oblong to ligulate (more than 1.4 x longer than wide). Leaf margin entire or with a few small teeth at the apex. 98
97. Leaves \pm rounded to ovate-triangular (1-1.3 x longer than wide). Leaf margin coarsely toothed (or entire: *P. braunianum*). Plants dark green to brown
 99 (*Plagiochilion*)
98. Plants grayish-green to brown, terrestrial. Leaf cells very large, ca. 50-100 μ m long in the lower half of the leaf, becoming longer and narrower to the ventral margin
 *Gongylanthus javanicus* Grolle
98. Plants yellowish green, usually epiphytic. Leaf cells smaller, less than 50 μ m long, not becoming longer and narrower to the ventral margin
 *Syzygiella subintegerrima* (Reinw. *et al.*) Spruce (? = *S. securifolia* (Nees) Inoue)
- Syzygiella securifolia* differs from *S. subintegerrima* only by fewer teeth at the leaf apex (0-2 teeth in *S. securifolia*, (0-)3-6 in *S. subintegerrima*) and may be a synonym or variety.
99. Leaf margin entire *Plagiochilion braunianum* (Nees) Hatt.
99. Leaf margin with large, triangular teeth 100
100. Leaves longer than wide, ovate-triangular
 *Plagiochilion theriotianum* (Steph.) Inoue
100. Leaves not longer than wide, \pm rounded
 *Plagiochilion oppositum* (Reinw. *et al.*) Hatt.
101. Leaf margin toothed (sometimes only weakly toothed at apex) 102
101. Leaf margin entire 103
102. Dorsal leaf margin curved upwards. Stem with thin-walled epidermis cells
 *Wettsteinia inversa* (Sande Lac.) Schiffn. (Fig. 15)
102. Dorsal leaf margin curved downwards. Stem with thick-walled epidermis cells
 **Key 6** (*Plagiochila*) (Fig. 18)
103. Leaf apex pointed *Cuspidatula contracta* (Reinw. *et al.*) Steph.

103. Leaf apex rounded or short bifid 104
104. Dorsal leaf bases strongly overlapping and closely enveloping the stem. Leaf insertions extending beyond the dorsal midline of the stem. Trigones large 105
104. Dorsal leaf bases not strongly overlapping. Leaf insertions not extending beyond the dorsal midline of the stem. Trigones small or medium-sized 106
105. Trigones inside with dark, star-like markings. Leaf margin without gemmae. Plants reddish or brown in color *Denotarisia linguifolia* (De Not.) Grolle (Fig. 15)
105. Trigones without dark markings. Leaf margin often with gemmae
..... *Gottschelia schizopleura* (Spruce) Grolle
106. Leaf apex bifid. Flagelliform branches and stolons present. Small plants on soil at alpine elevations *Andrewsianthus puniceus* (Nees) Schust. ex Grolle
106. Leaf apex rounded or obtuse. Flagelliform branches and stolons absent 107
107. Sporophyte in a marsupium (Fig. 15: 41b). Leaves longer than wide. Leaf margin often with gemmae. Rhizoids colorless 108
107. Sporophyte in a perianth (Fig. 16: 43a). Leaves wider than long, rounded or longer than wide. Leaf margin never with gemmae. Rhizoids colorless or reddish 109
108. Marsupium at the stem apex, very long and slender (to 1 cm long). Branching lateral. Plants green to yellow-brown. Leaves very densely imbricate. Leaf cells elongated along the ventral leaf margin. Oil bodies brown. Asexual reproduction via large, multicellular, discoid gemmae. On shaded earth banks
..... *Lethocolea javanica* (Schiffn.) Grolle (= *Symphyomitra javanica* Schiffn.)
108. Marsupium on a short ventral branch, shorter. Branching ventral. Plants brown to blackish-brown. Leaves loosely imbricate. Leaf cells not elongated along the ventral leaf margin. Oil bodies colorless. Asexual reproduction via small, 1-2-celled gemmae. On exposed, soil-covered rock *Jackiella javanica* Steph. (Fig. 15)
109. On tree trunks in montane forest. Dorsal leaf bases distinctly decurrent. Rhizoids colorless, scattered 110
109. On soil, rock or in water Dorsal leaf bases not or short decurrent. Rhizoids colorless or reddish, in bundles or scattered 111 (*Solenostoma*, *Jungermannia*)
110. Leaves ovate-elongate, with rounded apex. Ventral leaf base auriculate, much broader than dorsal leaf base. Branches *Frullania*-type, without collar at the base. Perianth inflated, cylindrical, plicate. Dioicous
..... *Jamesoniella flexicaulis* (Nees) Schiffn. (Fig. 15)

110. Leaves short rectangular, with truncate to retuse apex. Ventral leaf base straight, not auriculate, not broader than dorsal leaf base. Branches lateral-intercalary, always with a collar at the base. Perianth flat, campanulate, smooth. Autoicous *Pedinophyllum autoicum* (Steph.) Inoue
111. Leaf cells papillose (sometimes only weakly so). Leaves longer than wide 112
111. Leaf cells smooth. Leaves variable, longer than wide, rounded, or wider than long 115
112. Trigones well-developed, bulging. Leaf margin recurved. Leaves ligulate. Rhizoids light rosa *Solenostoma comatum* (Nees) Gao
112. Trigones lacking or very small. Leaf margin plane. Leaves ovate to ligulate. Rhizoids purple or colorless 113
113. Rhizoids purple, in long, dense bundles. Oil bodies present only in some leaf cells, very large, 1 per cell (Fig. 16: 43b) *Solenostoma tetragonum* (Lindenb.) Schust. ex Vána & Long (Fig. 16)
113. Rhizoids colorless or pale brown, not in bundles. Oil bodies present in all cells, more than one per cell 114
114. Leaf margin bordered by 2-4 rows of small, thick-walled cells. Dioicous *Solenostoma truncatum* (Nees) Schust. ex Vána & Long
114. Leaf margin not bordered by small, thick-walled cells, all cells thin-walled. Paroicous. On wet rock in spring, collected in the crater of Mt Gedeh in the spring Kapala Tjiliwong *Jungermannia pumila* With. (= *Jamesoniella ruttneri* Schiffn.)
115. Rhizoids red to purple, usually in bundles 116
115. Rhizoids mostly colorless (sometimes slightly red or brown at the base) 118
116. Trigones absent or very small. Leaves ovate. Oil bodies present only in some leaf cells, very large, 1 per cell (Fig. 16: 43b) *Solenostoma tetragonum* (Lindenb.) Schust. ex Vána & Long (Fig. 16)
116. Trigones well-developed. Leaves ovate to rounded. Oil bodies present in all leaf cells 117
117. Mid-leaf cells very large, 45-100 μm long. Leaves rounded, deeply concave. Rhizoids originating from stem and leaf cells *Solenostoma ariadne* (Tayl. ex Lehm.) Vána & Long

117. Mid-leaf cells smaller. Leaves longer than wide, not deeply concave. Rhizoids originating only from stem cells.....
.....*Solenostoma obliquifolium* (Schiffn.) Schust. ex Váňa *et al.*
118. All leaves closely appressed to the stem
.....*Solenostoma appressifolium* (Tayl. ex Lehm.) Váňa & Long
118. Leaves spreading (at least some leaves)..... 119
119. Leaf margin with a border of evenly thick-walled cells in 1-4 rows 120
119. Leaf margin not bordered by evenly thick-walled cells 121
120. Leaf margin bordered by 2-4 rows of thick-walled cells. Trigones absent or very small. Leaves longer than wide
.....*Solenostoma truncatum* (Nees) Schust. ex Váňa & Long
120. Leaf margin bordered by 1 row of thick-walled cells. Trigones large. Leaves rounded or wider than long
.....*Solenostoma haskarlianum* (Nees) Schust. ex Váňa & Long
121. Plants very small, less than 1 cm long and less than 1 mm wide
..... *Solenostoma javanicum* (Schiffn.) Steph.
121. Plants larger 122
122. Rhizoids in dense bundles, the bundles decurrent along the stem
.....*Solenostoma strictum* (Schiffn.) Váňa *et al.*
122. Rhizoids rather few, not in dense, decurrent bundles..... 123
123. Leaf margin recurved *Solenostoma stephanii* (Schiffn.) Steph.
123. Leaf margin plane or incurved 124
124. Leaf cells thin-walled, trigones absent or minute. Leaves reniform, much wider than long. Growing in sulphur-rich water of crater lakes and hot springs, recorded from the crater lake of Mt. Telaga Bodas and the hot springs in the crater of Mt. Papandayan.....*Solenostoma vulcanicola* (Schiffn.) Váňa *et al.*
124. Leaf cells with distinct trigones. Leaves orbicular to slightly wider than long. On moist soil, sometimes near crater lakes but not growing in water
.....*Solenostoma baueri* (Schiffn.) Steph.

Key 5. *Bazzania*

1. Leaf apex entire. Leaf margin denticulate, at least towards the apex 2
1. Leaf apex with 2 or 3 lobes. Leaf margin entire or denticulate..... 4
2. Leaf cells smooth... *Bazzania loricata* (Reinw. *et al.*) Trevis. (? = *B. distans* (Nees) Trevis.)
Bazzania distans (Nees)Trevis. may be a small, poorly developed form of *B. loricata* (Meijer 1960).
2. Leaf cells papillose (each with a large papilla) 3
3. Leaves lingulate, with a narrow base. Leaf apex plane. Trigones large, nodulose
..... *Bazzania angustisedens* (Steph.) Kitag.
3. Leaves triangular-ovate, with a wide base. Leaf apex reflexed. Trigones small
..... *Bazzania horridula* Schiffn.
4. All leaves with only 2 lobes. Plants dark brown *Bazzania fallax* (Sande Lac.) Schiffn.
4. Leaves with 2-3 lobes 5
5. Leaves with a distinct vitta. Plants small, less than 3 mm wide..... 6
5. Leaves without distinct vitta. Plants small or large 7
6. Leaf cells finely papillose. Underleaf cells thin-walled, hyaline. Plants blue-green.
Common in montane forest.....*Bazzania vittata* (Lindenb. & Gottsche) Trevis.
6. Leaf cells almost smooth. Underleaf cells thick-walled (similar to those of leaves).
Rare species.....*Bazzania subtilis* (Sande Lac.) Trevis.
7. Underleaves coarsely dentate-laciniate all around. Ventral leaf bases with a few sharp
teeth or an appendage 8
7. Underleaves entire or toothed, but not coarsely dentate-laciniate all around. Ventral
leaf bases without sharp teeth or appendages 9
8. Leaves more than 2 x longer than wide. Ventral leaf bases with 2-5 sharp teeth
.....*Bazzania calcarata* (Sande Lac.) Schiffn.
8. Leaves less than 2 x longer than wide. Ventral leaf bases with an appendage
.....*Bazzania paradoxa* (Sande Lac.) Steph.
9. Underleaves largely made up of colorless, hyaline cells. Plants less than 3.5 mm wide.
Common in montane forest.....*Bazzania tridens* (Reinw. *et al.*) Trevis.

9. Underleaves green, not made up of hyaline cells, or with a hyaline border only 10
10. Leaf margin denticulate. Robust plants, more than 3.5 mm wide..... 11
10. Leaf margin entire. Plants small or large 15
11. Underleaves with a narrow hyaline border of colorless cells (check carefully)..... 12
11. Underleaves without hyaline border..... 13
12. Underleaves distant, small, margins recurved.....
.....*Bazzania spiralis* (Reinw. *et al.*) Meijer
12. Underleaves imbricate, large, margins plane
.....*Bazzania erosa* (Reinw. *et al.*) Trevis. (Fig. 17)
13. Leaves ovate-triangular, less than 2 x longer than wide
.....*Bazzania indica* (Gottsche & Lindenb.) Trevis.
13. Leaves narrowly oblong, more than 2 x longer than wide 14
14. Underleaves longer than wide, underleaf margin toothed, plane. Plants very robust,
stems up to 10 cm long, little branched.....
.....*Bazzania longicaulis* (Sande Lac.) Schiffn. (Fig. 17)
14. Underleaves wider than long, underleaf margin entire, recurved. Plants smaller
.....*Bazzania desciscens* (Steph.) Meijer
15. Underleaves with a narrow hyaline border of colorless cells (check carefully!) 16
15. Hyaline border lacking 18
16. Leaves falcate and deflexed. Trigones large, nodulose. Underleaves small, apex
recurved.....*Bazzania serpentina* (Nees) Trevis.
16. Leaves not falcate, not deflexed. Trigones small. Underleaf apex plane 17
17. Leaf cells finely papillose..... *Bazzania manillana* (Gottsche ex Steph.) Hatt.
17. Leaf cells smooth..... *Bazzania intermedia* (Gottsche & Lindenb.) Trevis.
18. Underleaf bases with large, dentate-laciniate auricles (underleaves very large, 3-4 x
stem width, strongly overlapping)..... *Bazzania gedeana* (Steph.) Meijer
18. Underleaf bases not with large, dentate-laciniate auricles 19

19. Leaves broadly triangular, with a very broad base and a narrow apex. Trigones large, nodulose 20
19. Leaves ovate to oblong to linear-lanceolate, not triangular. Trigones small or large. 22
20. Leaves strongly falcate. Underleaves rectangular, with irregularly lobed margins
..... *Bazzania uncigera* (Reinw. *et al.*) Trevis.
20. Leaves not strongly falcate. Underleaves rounded or quadrate, margins entire..... 21
21. Underleaf margins recurved, bases straight. Leaves strongly asymmetrical, dorsal margins strongly curved and much longer than the almost straight ventral margin. Leaf apex with three small teeth
..... *Bazzania commutata* (Lindenb. & Gottsche) Schiffn.
21. Underleaf margins plane, bases cordate. Leaves not strongly asymmetrical. Leaf apex with three large, divergent teeth..... *Bazzania praerupta* (Reinw. *et al.*) Trevis.
22. Leaf cells with large bulging trigones. Plants robust, to 5 mm wide. Underleaves imbricate..... *Bazzania linguiformis* (Sande Lac.) Schiffn.
22. Leaf cells with small trigones. Plants smaller. Underleaves usually not imbricate 23
23. Underleaves reflexed..... 24
23. Underleaves not reflexed..... 25
24. Underleaf margins denticulate..... *Bazzania japonica* (Sande Lac.) Lindb.
Bazzania sumbavense (Gottsche ex Steph.) Steph. also keys out here and seems similar to *B. japonica*.
24. Underleaf margins entire *Bazzania densa* (Sande Lac.) Schiffn. (Fig. 17)
25. Leaves very narrow, more than 2 x longer than wide. Underleaf margins denticulate at apex
..... *Bazzania pectinata* (Lindenb. & Gottsche) Schiffn.
25. Leaves less than 2 x longer than wide. Underleaf margins entire 26
26. Leaves falcate and deflexed. Underleaves very small, narrower than the stem.....
..... *Bazzania zollingeri* (Lindenb.) Trevis.
26. Leaves not falcate, not deflexed. Underleaves \pm broader than the stem
..... *Bazzania javanica* (Sande Lac.) Schiffn.

Further records from Java: *Bazzania fleischeri* (Steph.) Abeyw., *B. grandiretis* (Steph.) Herz., etc.

Key 6. *Plagiochila*

1. Stems densely branched (pinnate or flabellate). Plants dendroid..... 2
1. Stems simple, irregularly branched or forked, but never densely branched. Plants not dendroid..... 6
2. Stems with paraphyllia. Leaves laterally appressed to the stem, secund 3
2. Paraphyllia lacking. Leaves not laterally appressed to the stem 4
3. Paraphyllia only 1(-2) cells wide at the base. Leaves rounded
..... *Plagiochila abietina* (Nees) Lindenb.
3. Paraphyllia broader, 3-7 cells wide at the base. Leaves usually longer than wide.....
..... *Plagiochila hampeana* Gottsche (= *P. gedeanana* Schiffn.)
4. Ventral flagelliform branches present 5
4. Ventral flagelliform branches lacking 6
5. Leaf apex with only 2-3 teeth. Leaves very small, less than 1 mm long. Ventral branches numerous *Chiastocaulon dendroides* (Nees) Carl
5. Leaf apex with 3-6 teeth. Leaves larger, more than 1 mm long. Ventral branches scarce..... *Plagiochila frondescens* (Nees) Lindenb.
6. Plants large, 4-6 mm wide. Leaves more than 1 mm wide, ventral leaf base dilated
..... *Plagiochila arbuscula* (Brid. ex Lehm.) Lindenb.
6. Plants small, 2-3 mm wide. Leaves less than 1 mm wide, ventral leaf base not dilated.
..... *Plagiochila spathulifolia* Mitt.
7. Ventral leaf base forming a rounded sac. Ventral merophyte 5-10 cells wide. Plants robust, ventral leaf margin strongly ciliate 8
7. Ventral leaf base plane or recurved but not forming a rounded sac. Ventral merophyte less than 5 cells wide. Plants small or large, ventral leaf margin entire or toothed to ciliate 10
8. Sac with entire margin.....
Plagiochila blepharophora (Nees) Lindenb. (? = *P. integrilobula* Schiffn., *P. stephanii* Schiffn.)

Plagiochila integrilobula and *P. stephanii* Schiffn. are similar to *P. blepharophora* and may be synonyms. *Plagiochila integrilobula* differs by the entire dorsal leaf margin (toothed in *P. blepharophora*) and *P. stephanii* by leaves less than 2 x longer than wide (2-2.5 x longer than wide in *P. blepharophora*) (see Inoue 1984).

8. Sac with ciliate margin 9
9. Plants large, 10-15 mm wide. Underleaves lacking *Plagiochila sandei* Dozy
9. Plants less than 10 mm wide. Underleaves present, ciliate
..... *Plagiochila bantamensis* (Reinw. *et al.*) Dum. (Fig. 48)
10. *Frullania*-type branches present, branching dichotomous 11
10. *Frullania*-type branches \pm lacking, stems simple or irregularly branched by
intercalary branching (rarely dichotomous by intercalary branching!)..... 18
11. Leaves caducous. Leaf propagules absent..... 12
11. Leaves not caducous. Vegetative reproduction by small propagules from leaf surfaces
..... 13
12. Underleaves present (small, ciliate). Leaves oblong, falcate
..... *Plagiochila parvifolia* Lindenb.
12. Underleaves lacking. Leaves ovate to ovate-oblong, not falcate
..... *Plagiochila salacensis* Gottsche
13. Leaves densely imbricate, stem \pm invisible. Ventral stem surface with paraphyllia.....
..... *Plagiochila obtusa* Lindenb.
13. Leaves less densely imbricate, stem visible. Paraphyllia lacking 14
14. Leaves 2-3 x longer than wide, leaf base not wider than the apex
..... *Plagiochila massalongoana* Schiffn.
14. Leaves usually less than 2 x longer than wide, leaf base wider than apex..... 15
15. Leaves with 15-30 teeth 16
15. Leaves with less than 15 teeth 17
16. Leaves imbricate, forming a ventral keel *Plagiochila teysmannii* Sande Lac. (Fig. 18)
16. Leaves distant to contiguous, ventral keel lacking.....
..... *Plagiochila javanica* (Sw.) Dum. (Fig. 18) (= *P. infirma* Sande Lac., *P. tjibodensis* Schiffn.)
17. Leaf apex with 2 large teeth, that are much larger than the other teeth
..... *Plagiochila junghuhniana* Sande Lac.

17. Teeth at leaf apex not much larger than the other teeth
 *Plagiochila javanica* (Sw.) Dum. (Fig. 18)
- Plagiochila propinqua* also key out here and is similar to *P. javanica* but has somewhat longer leaves, 1.6-2.5 x longer than wide (Inoue 1984).
18. Dorsal stem surface with paraphyllia. Leaves secund, vitta present in the lower half of the leaf 19
18. Paraphyllia absent. Leaves without vitta 20
19. Leaves widest at the base. Leaves short decurrent, basal margin straight
 *Plagiochila renitens* (Nees) Lindenb.
19. Leaves widest beyond the base, at about 1/3 of leaf length. Leaves long decurrent, basal margin undulate *Plagiochila trapezoidea* Lindenb.
20. Leaves with 15-40 teeth 21
20. Leaves with less than 15 teeth 22
21. Leaves widest in the middle, oblong, ca. 2 x longer than wide.....
 *Plagiochila nobilis* Gottsche
21. Leaves widest near the base, ovate to ovate-oblong, ca. 1.5 x longer than wide
 *Plagiochila fusca* Sande Lac. (Fig. 18)
- Plagiochila gymnoclada* also keys out here and resembles *P. fusca* but differs by the dilated ventral leaf base (Inoue 1984).
22. Leaves narrow rectangular, 2-3 x as long as wide 23
22. Leaves shorter, less than 2 x as long as wide 24
23. Leaf cells finely papillose. Leaves caducous *Plagiochila singularis* Schiffn.
23. Leaf cells smooth. Leaves not caducous
 *Plagiochila bicornuta* Steph. (= *P. laxissima* Schiffn.)
24. Teeth of leaf margin long ciliate, ending in a uniseriate row of 3-10 cells.....
 *Plagiochila sciophila* Nees
- Plagiochila kuhliana* also keys out here and is similar to *P. sciophila* but differs by the dilated ventral leaf base (Inoue 1984).
24. Teeth of leaf margin short triangular, ending in a uniseriate row of 1-3 cells
 *Plagiochila gracilis* Lindenb. & Gottsche
- Further records: *Plagiochila densifolia* Sande Lac., *P. korthalsiana* Molk. ex Sande Lac., *P. kurzii* Steph., *P. manillana* Mont. & Gottsche, *P. peculiaris* Schiffn., *P. semidecurrens* (Lehm. & Lindenb.) Lindenb., *P. ungarangana* Sande Lac.

Key 7. Leafy liverworts with a small ventral lobule

1. Underleaves lacking (Figs. 19: 52, 25: 77) 2
1. Underleaves present 21
2. Stem thin and fragile, epidermis of 5 rows of thin-walled cells. Plants usually less than 1 mm wide. Rhizoids originating from the stem. Leaf cells with many small, colorless oil bodies. Usually epiphyllous, more rarely on bark **Key 9** (*Cololejeunea*) (Fig. 25)
2. Stem rigid, epidermis of numerous thick-walled cells. Plants usually more than 1 mm wide. Rhizoids originating from the lobule. Leaf cells with 1-4 large, brown oil bodies. On bark, rock and living leaves 3 (*Radula*) (Fig. 19)
3. Leaf margin toothed 4
3. Leaf margin entire 5
4. Leaf cells with distinct trigones, thick-walled..... *Radula lacerata* Steph.
4. Leaf cells without trigones, thin-walled *Radula anceps* Sande-Lac.
5. Plants with numerous amentulose branches (= tiny leafy branches arising from leaf axils and hardly longer than the leaf). Cells with large, bulging trigones..... 6
5. Amentulose branches lacking..... 7
6. Lobules obovate, widest in the upper half, with a broad rounded apex *Radula amentulosa* Mitt.
6. Lobules ovate-subquadrate, widest in the lower half, with a truncate apex..... *Radula formosa* (Meissn. ex Spreng.) Nees
7. Leaves with gemmae. On living leaves, occasionally on bark..... 8
7. Leaves without gemmae. On bark or rock, not on living leaves. 12
8. Gemmae on the ventral surface of the leaf..... 9
8. Gemmae on leaf margins..... 10

Further study is needed to determine whether place of origin of gemmae is a good taxonomic character. When not a good character, *Radula nymannii* may be a synonym of *R. protensa* and *R. acuminata* a synonym of *R. tjibodensis*.

9. Apex of lobules conspicuously elongated and abruptly curved outwards (90°)
 *Radula protensa* Lindenb.
9. Apex of lobules erect, not curved outwards *Radula acuminata* Steph.
10. Cells of leaf lobes very irregular in size and shape *Radula gedena* Gottsche
10. Cells of leaf lobes almost equal in size and shape 11
11. Apex of lobules conspicuously elongated and abruptly curved outwards (90°)
 *Radula nymanii* Steph.
11. Apex of lobules erect, not curved outwards *Radula tjibodensis* Goebel (Fig. 19)
12. Leaf lobules narrow lingulate, 2-3 x longer than wide, standing parallel to the stem
 *Radula lingulata* Gottsche
12. Leaf lobules not narrow lingulate 13
13. Leaves caducous 14
13. Leaves not caducous 15
14. Lobules rectangular, ca. 2 x longer than wide *Radula madagascariensis* Gottsche
14. Lobules subquadrate, about as long as wide *Radula javanica* Gottsche (Fig. 52)
15. Plants very small, less than 1 mm wide, growing at high, subalpine elevations. Leaves
 deeply concave, with a very large lobule, keel about as long as the lobe
 *Radula cavifolia* Hampe ex Gottsche *et al.*
15. Plants larger. Leaves not deeply concave, keel shorter 16
16. Branching dichotomous. Lobules with auriculate base and truncate apex, rather
 irregular in shape *Radula ventricosa* Steph.
16. Branching irregularly pinnate (not dichotomous). 17
17. Lobules of main stem very large, overlapping the stem and partly covering each other
 *Radula sumatrana* Steph. (Fig. 19)
- Plants from Java illustrated by Yamada (1979, Fig. 30) as "*P. pinnulata* Mitt." may belong to *R. sumatrana*. The type of *R. pinnulata*, however, belongs to *R. javanica* (So 2006).
17. Lobules of main stem smaller, not overlapping the stem and not covering each other
 19

(couplet 18 lacking)

19. Leaf lobes strongly falcate, apex narrowly obtuse. Lobule apex conspicuously elongated. Leaf cells with star-like, tri-radiate trigones..... *Radula retroflexa* Mitt.
19. Leaf lobes not or only slightly falcate, apex broadly rounded. Lobule apex not elongated. Trigones simple, not star-like 20
20. Plants less than 2.5 mm wide. Lobules quadrate. Leaves \pm imbricate, often caducous. Trigones small, not swollen.....*Radula javanica* Gottsche
20. Plants more than 2.5 mm wide. Lobules rounded to ovate. Leaves distant, not caducous. Trigones large, swollen*Radula campanigera* Mont.
21. Lobules attached to lobe along a keel and usually widely diverging from stem. Plants variously colored but never reddish or purple **Key 8** (Lejeuneaceae)
21. Lobules almost free from the lobe and more or less parallel to the stem or only weakly diverging 22
22. Underleaves undivided. Lobules flat (never sac-like), ligulate, parallel to the stem. Lobule margins often toothed. Plants dark green to brown, very robust 23 (*Porella*) (Fig. 19)
22. Underleaves bifid (rarely undivided). Lobules sac-like, or concave with upcurved margins, rarely flat. Lobule margins entire. Plants green to reddish or purple, small or large 24 (*Frullania*, *Jubula*) (Fig. 20)
23. Leaf apex rounded. Basal margins of lobules and underleaves crispate *Porella javanica* (Gottsche ex Steph.) Inoue (Fig. 19)
23. Leaf apex acute-acuminate. Basal margins of lobules and underleaves not crispate..... *Porella acutifolia* (Lehm. & Lindenb.) Trevis.
24. Margins of stem leaves ciliate or toothed (at least in some leaves) 25
24. Margins of stem leaves \pm entire 27
25. Plants very long, 5-20 cm, hanging from branches, yellowish-brown to purple. Leaf base with a group of large, reddish, thin-walled cells (ocelli) *Frullania vaginata* (Sw.) Dum.
25. Plants smaller, creeping, green or reddish-brown. Leaf base without ocelli..... 26

26. Plants reddish-brown, minute, ca. 0.7 mm wide. Lobules narrow cylindrical. Underleaf margins recurved. Cells with large trigones. Only known from Cibodas, very rare.....*Frullania dentiloba* Hatt.
26. Plants green, larger. Lobules rounded, ball-shaped (sometimes flat and ligulate). Underleaf margins plane. Cells thin-walled, trigones lacking or very small
..... *Jubula hutschinsiae* subsp. *javanica* (Steph.) Verd.
27. Lobules distant from the stem (separated from the stem by their own width; Fig. 20: 56,57), usually obliquely spreading28 (*Frullania* subgen. *Diastaloba*)
27. Lobules closer to the stem (separated from the stem by less than their own width; Fig. 20: 58,60), erect or slightly spreading..... 36
28. Apex of lobule rough by numerous conical mammillae. Lobules widely spreading (almost 90°)*Frullania repandistipula* Sande Lac.
28. Apex of lobule smooth. Lobules less widely spreading..... 29
29. Minute plants from subalpine forest, less than 1 mm wide. Mid-leaf cells very small, ca. 12 µm long, with evenly thickened walls (no distinct trigones). Leaves often somewhat squarrose. *Frullania junghuhniana* Gottsche (Fig. 20)
29. Plants larger. Mid-leaf cells larger, with trigones. Leaves not squarrose. 30
30. Plants large, pendent from branches, 5-25 cm long. Leaves when dry strongly convolute around the stem.....*Frullania ternatensis* Gottsche
30. Plants smaller, 1-5 cm long, creeping or ascending, rarely pendent (*F. trichodes*). Leaves when dry not strongly convolute around the stem 31
31. Leaf base with a group of large, somewhat reddish ocelli. 32
31. Leaf base without group of reddish ocelli 34
32. Plants very small, leaves ca. 0.5 mm long. Dorsal leaf base not auriculate. Underleaves 1-2 x stem width. Stylus minute.....
..... *Frullania gracilis* (Reinw. *et al.*) Dum.
- Forms of *F. gracilis* with entire female bracts have been described as *F. minor* Sande Lac., forms with large trigones as *F. claviloba* Steph. *Frullania neosheana* Hatt., reported from Indonesia, resembles *F. gracilis* but differs by the larger lobule (I. Haerida, pers. com.).
32. Plants larger. Dorsal leaf base auriculate. Underleaves broader, ca. 3 x stem width. Stylus often large, foliose 32

33. Plants 3-pinnate. Underleaves rounded or wider than long.....
 *Frullania sinuata* Sande Lac.
33. Plants 2-pinnate. Underleaves longer than wide
 *Frullania trichodes* Mitt. (= *F. tenuicaulis* Mitt., fide J. Uribe M., pers. com.)
34. Leaf apex always apiculate. Lobules \pm upright, parallel to the stem. Plants regularly 2-pinnate.....*Frullania apiculata* (Reinw. *et al.*) Dum. (Fig. 20)
34. Leaf apex not always apiculate, rounded at least in some leaves. Lobules obliquely spreading, not parallel to the stem. Plants regularly or irregularly (2-)pinnate..... 35
35. Plants regularly 2-pinnate. Underleaves longer than wide, margins entire. Female bracts toothed *Frullania ramuligera* (Nees) Mont.
35. Plants irregularly pinnate Underleaves rounded, not longer than wide, margins entire or with a few blunt teeth. Female bracts entire *Frullania hypoleuca* Nees
F. tricarinata Sande Lac. also keys out here and is similar to *F. hypoleuca* but differs by the perianth with 3 ventral keels (only 1 ventral keel in *F. hypoleuca*).
36. Lobules \pm hanging down, opening of the lobule turned towards the apex of the plant .
 37 (*Frullania* subgen. *Homotropantha*)
36. Lobules standing up, opening of the lobule towards the base of the plant..... 40
37. Underleaves undivided *Frullania integristipula* (Nees) Nees
37. Underleaves 2-lobed (sometimes only shallowly) 38
38. Leaf margin recurved. Leaf apex always rounded. Underleaves with large auricles.....
 *Frullania nodulosa* (Reinw. *et al.*) Nees (? = *F. brotheri* Steph.)
Frullania brotheri seems to be a small dioicous form of *F. nodulosa* from high elevation (> 1200 m).
38. Leaf margin flat. Leaf apex apiculate on branches, rounded on stems. Underleaves without or with small auricles 39
39. Underleaves 5 x stem width, as long as the leaves..... *Frullania fallax* Gottsche
39. Underleaves smaller, 3-4 x stem width, shorter than leaves
 *Frullania intermedia* (Reinw. *et al.*) Dum.
40. Lower portion of the lobules flat (not saccate) (Fig. 20: 58)
 41 (*Frullania* subgen. *Chonanthelia*)
40. Lobules fully saccate, not flat below 43

41. Leaf margin undulate. Perianth with 10 keels *Frullania arecae* (Spreng.) Gottsche
41. Leaf margin not undulate. Perianth with 4 keels 40
42. Underleaves large, more than 3x as wide as the stem, wider than long, auriculate at base. Flattened part of the lobule \pm as long as the sac, ligulate.....
..... *Frullania riojaneirensis* Raddi (Fig. 20)
42. Underleaves smaller, 2-3 x stem width, rounded or longer than wide, not auriculate. Flattened part of the lobule shorter than the sac..... *Frullania neurota* Tayl.
43. Lobules 2-3 x longer than wide. Leaf apex usually acute (rounded in *F. meyeniana*: 30). Underleaves 1-4 x stem width..... 44 (*Frullania* subgen. *Thyopsiella*)
43. Lobules shorter, less than 2 x longer than wide. Leaf apex rounded. Underleaves small or large, 1-10 x stem width 48 (*Frullania* subgen. *Frullania*)
44. Leaf apex rounded *Frullania meyeniana* Lindenb.
44. Leaf apiculate or acute-acuminate 45
45. Leaves with a conspicuous row of ocelli (= large, reddish oil cells) in the middle of the lobe *Frullania moniliata* (Reinw. *et al.*) Dum.
45. Leaves without a row of ocelli 46
46. Plants hanging freely from branches in cloud forest, stems 5-25 cm long. Bases of leaves (ventral and dorsal base) and underleaves with large auricles
..... *Frullania orientalis* Sande Lac.
46. Plants creeping or ascending, not hanging, stems 2-7 cm long. Large auricles lacking or present only at the dorsal leaf base 47
47. Dorsal leaf base auriculate. Underleaves rounded or wider than long, the base cordate
..... *Frullania cordistipula* (Reinw. *et al.*) Dum. (? = *F. serrata* Gottsche)
- These two species differ only by the degree of dentation of the female bracts and are probably conspecific; sterile material of the two cannot be separated (Verdoorn 1930, Hattori 1986).
47. Dorsal leaf base not auriculate. Underleaves longer than wider, the base \pm straight
..... *Frullania hasskarliana* Lindenb.
48. Leaves squarrose, brittle *Frullania ericoides* (Nees) Mont.
48. Leaves not squarrose, not brittle 49

49. Underleaves undivided, margins recurved. *Frullania reflexistipula* Sande Lac.
49. Underleaves 2-lobed (sometimes only shallowly), margins plane or recurved.. 50
50. Lobule base with a long and curved beak.. 51
50. Lobule without long and curved beak. 54
51. Beak acute-ciliate. Underleaf bifid to 1/3 of length, margins with one or several teeth
..... *Frullania monocera* (Hook. & Tayl.) Tayl. ex Gottsche et al. (? = *F. acutiloba* Mitt.)
- According to Hattori (1973), *Frullania. acutiloba* may be just a variety of *F. monocera*.
51. Beak rounded or obtuse, never acute. Underleaves less deeply bifid (maximally to 1/6), margins without teeth 52
52. Underleaf bases straight, without auricles. Plants pendent, very long (to 15 cm)
..... *Frullania subnigricaulis* Hatt.
52. Underleaf bases cordate, with large auricles. Plants not pendent, shorter. 53
53. Underleaves wider than long, reniform
..... *Frullania ornithocephala* (Reinw. et al.) Nees (Fig. 59)
53. Underleaves rounded or longer than wide
..... *Frullania nepalensis* (Spreng.) Lehm. & Lindenb.
54. Ventral leaf base conspicuously auriculate. Underleaves with large auricles..... 55
54. Ventral leaf base not auriculate. Underleaves without large auricles 56
55. Plants creeping or ascending, not freely hanging, stems to 10 cm long. Underleaves bifid to 1/4. Female branches very short, with only 1-2 pairs of bracts
..... *Frullania gaudichaudii* Nees & Mont.
55. Plants hanging freely from branches in cloud forest, stems 10-30 cm long. Underleaves very short bifid (to 1/10). Female branches longer, with more than 2 pairs of bracts *Frullania nigricaulis* (Reinw. et al.) Nees
56. Lobules longer than wide 57
56. Lobules not longer than wide *Frullania microauriculata* Verd. (Fig. 20)
57. Underleaves distant, small, ca. 2 x stem width, margins with a blunt tooth. Plants small, to 1 mm wide
..... *Frullania campanulata* Sande Lac. (? = *F. tjibodensis* Hatt. & Thaithong)

Frullania tjibodensis differs from *F. campanulata* only by the rough perianth (smooth in *F. campanulata*) and is probably a synonym, since smooth and rough perianths occur within other, related species such as *F. ericoides* and *F. ornithocephala*.

57. Underleaves imbricate, large, 5-8 x stem width, margins entire. Plants larger, 1.5-2 mm wide *Frullania grandistipula* Lindenb.

Further records: *Frullania emarginatula* Steph., *F. kurzii* Steph., *F. pinnulata* Sande Lac., *F. recurvistipula* S.Hatt., *F. relictata* Steph., etc.

Key 8. Lejeuneaceae

1. Underleaves lacking. Usually epiphyllous, more rarely on bark or rock **Key 9 (*Cololejeunea*)** (Fig. 25)
1. Underleaves present 2
2. Underleaves undivided 3
2. Underleaves 2-lobed 43
3. Plants dendroid, regularly pinnate, usually robust 4
3. Plants not dendroid, irregularly branched 5
4. Leaves with a long vitta. Branches *Lejeunea*-type. Perianth with 3 keels. In lowland and submontane forests, below 1000 m
.....*Dendrolejeunea fruticosa* (Lindenb. & Gottsche) Lacout.
4. Leaves without vitta. Branches *Frullania*-type. Perianth with 10 keels. Common shade epiphyte in montane forest, above 1000 m
.....*Ptychanthus striatus* (Lehm. & Lindenb.) Nees (Fig. 21)
5. Underleaves toothed (and often the leaves also), at least near the stem apex 6
5. Underleaves always entire 11
6. Plants pale green. Leaves conspicuously elongated and often somewhat falcate. Underleaves in upper portions of shoots sometimes becoming very large. Leaf cells on longer walls with 1-3 intermediate thickenings. Gynoecia without innovations
.....*Caudalejeunea reniloba* (Gottsche) Steph. (= *C. recurvistipula* (Gottsche) Schiffn.)

In the *Checklist of the hornworts and liverworts of Java* (Söderström *et al.*, 2010) this species is called *C. recurvistipula*, following Zhu & So (2001). However, the basionym of *Caudalejeunea reniloba* was published slightly earlier than that of *C. recurvistipula* (see Stafleu & Cowan 1976, Taxonomic Literature 2nd ed., Vol. 1, p. 974) and therefore *Caudalejeunea reniloba* is the correct name for this species, following Verdoorn (1934).
6. Plants green to brown. Leaves not conspicuously elongated nor falcate. Underleaves never enlarged in upper portion of shoots. Leaf cell walls with 0-1 intermediate thickenings. Gynoecia with innovations 7
7. Midleaf cells isodiametric. Oil bodies homogeneous, more than 10 per cell 8
7. Midleaf cells longer than wide. Oil bodies segmented, less than 10 per cell 9

8. Leaves oblong, more than 1.5 x longer than wide, apex narrow, acute to acuminate.....
..... *Spruceanthus semirepandus* (Nees) Verd.
8. Leaves ovate, less than 1.5 x longer than wide, apex broad, rounded or apiculate. Leaf margin plane to undulate-crispate
..... *Spruceanthus polymorphus* (Sande Lac.) Verd. (Fig. 21)
9. Underleaves obovate, flat *Thysananthus comosus* Lindenb.
9. Underleaves spatulate, recurved 10
10. Upper part of leaf ventrad (curved in ventral direction) and very asymmetric, apex positioned at the ventral side of leaf *Thysananthus convolutus* Lindenb.
10. Upper part of leaf not ventrad, symmetric
..... *Thysananthus spathulistipus* (Nees) Lindenb.
11. Mid-leaf cells longer than wide. Leaves when dry usually strongly convolute (only weakly so in *Caudalejeunea reniloba*: 14) 12
11. Mid-leaf cells isodiametric. Leaves when dry \pm plane 21
12. Lobule semicircular in outline, with 4-10 teeth, all or at least some teeth 2-3 cells long *Acrolejeunea fertilis* (Reinw. et al.) Schiffn.
12. Lobule not semicircular in outline, with 0-3 teeth 13
13. Upper part of leaf ventrad (curved in ventral direction) and very asymmetric, apex positioned at the ventral side of leaf *Thysananthus convolutus* Lindenb.
13. Upper part of leaf not ventrad, symmetric 14
14. Plants pale green. Leaves hardly convoluted when dry, conspicuously elongated and often somewhat falcate, margins entire or toothed. Underleaves sometimes becoming very large and strongly toothed in upper portions of shoots
..... *Caudalejeunea reniloba* (Gottsche) Steph.
14. Plants green to brown or black. Leaves strongly convoluted when dry, not conspicuously elongated or falcate, margins entire. Underleaves not becoming very large and toothed in upper portion of shoots, underleaf margins always entire 15
15. Plants green to black, rather flat when dry, not worm-like. Perianth with 3 sharp keels and 1-2 innovations. Lobule with 1 tooth 16 (*Mastigolejeunea*)
15. Plants green to brown, never black, worm-like when dry. Perianth with 4-10 rounded keels, innovations lacking. Lobule with more than 1 tooth 17

16. Lobule tooth 3-5 cells long, sharp, curved
 *Mastigolejeunea virens* (Aongstr.) Steph. (Fig. 21)
16. Lobule tooth 1 cell long, blunt, not curved
 *Mastigolejeunea humilis* (Gottsche) Schiffn.
- Recent studies indicate that *Mastigolejeunea humilis* is a good species and not a synonym of the neotropical *M. auriculata* (Wils.) Schiffn. (see Sukharak et al. 2011, Taxon 60).
17. Stems fragile, epidermis cells thin-walled. Oil bodies homogeneous, 20-30 per cell. Perianth with 8-10 keels (Fig. 22: 64a) 18 (*Acrolejeunea*)
17. Stems rigid, epidermis cells thick-walled. Oil bodies segmented, less than 10 per cell. Perianth with 4-6 keels 20 (*Schiffneriolejeunea*)
18. Lobule 2-3 x longer than wide. Plants often reddish-brown. In mossy montane forests, above 1500 m *Acrolejeunea arcuata* (Nees) Grolle & Gradst.
18. Lobule 1.5-2 x longer than wide. Plants not reddish-brown 19
19. First tooth of the lobule situated at the extreme tip of the free margin, at the junction with the lobe (Fig. 64b). Female involucre cucullate
 *Acrolejeunea pycnoclada* (Tayl.) Schiffn. (Fig. 22)
19. First tooth of the lobule not situated at the extreme tip of the free margin. Female involucre not cucullate *Acrolejeunea tjibodensis* (Verd.) Grolle & Gradst.
20. Free margin of lobules strongly involute in the lower half, forming a narrow sac
 *Schiffneriolejeunea tumida* (Nees) Gradst. (Fig. 22)
20. Free margin of lobules plane, not involute in the lower half
 *Schiffneriolejeunea pulopenangensis* (Gottsche) Gradst.
21. Leaves with a long vitta
 *Thysananthus retusus* (Reinw. et al.) B.Thiers & Gradst. (Fig. 66)
21. Leaves without vitta 22
22. Leaves and underleaves with numerous scattered ocelli; normal green cells without oil bodies 23
22. Leaves without ocelli; normal green cells with oil bodies 24
23. Underleaves rounded. Plants dark green to blackish-green. Margins of leaves and underleaves sometimes with a narrow, whitish border. Perianth apex with 2 large auricles. On rock and wood near running water in lowland rain forest; collected in West Java by I. Haerida *Stictolejeunea balfourii* (Mitt.) E.W. Jones

23. Underleaves distinctly wider than long. Plants pale green to olive-brown. Margins of leaves and underleaves without whitish border. Perianth apex with 5 inflated keels
..... *Lepidolejeunea integristipula* (Jack & Steph.) Schust.
24. Plants green to dark-brown or black. Perianth toothed, without innovations (Fig. 23: 67a).....25 (*Lopholejeunea*)
24. Plants green or pale-colored, never dark-brown or black. Perianth entire, with 1-2 innovations 34
25. At least some leaf apices acute..... 26
25. All leaf apices rounded 27
26. Underleaves 1.5-2 x as wide as long. Perianth not exerted beyond the bracts
..... *Lopholejeunea applanata* (Reinw. *et al.*) Schiffn.
26. Underleaves rounded. Perianth longly exerted beyond the bracts
..... *Lopholejeunea nigricans* (Lindenb.) Schiffn. (Fig. 23)
27. Leaf lobule strongly constricted at the middle *Lopholejeunea herzogiana* Verd.
27. Leaf lobule constricted at the apex or not constricted..... 28
28. Well-developed underleaves very large, reniform, 1.5-2 x wider than long..... 29
28. Well-developed underleaves smaller, orbicular or only slightly wider than long..... 31
29. Apex of the leaf lobule attached to the leaf lobe by only one cell
..... *Lopholejeunea eulopha* (Tayl.) Schiffn.
29. Apex of the leaf lobule attached to the leaf lobe across 2-8 cells (Fig. 23: 68) 30
30. Leaf lobules 1/3-2/5 as long as lobes. Keel strongly curved. Stems usually densely branched. Autoicous *Lopholejeunea zollingeri* (Steph.) Schiffn.
30. Leaf lobules shorter, 1/5-1/4(-1/3) as long as lobes. Keel straight. Stems scarcely branched. Dioicous *Lopholejeunea wiltensii* Steph.
31. Leaf lobule less than 1/2 the length of leaf lobe..... 32
31. Leaf lobule larger, 1/2-2/3 the length of leaf lobe..... 33
32. Underleaf margins strongly recurved. Insertion line of underleaves deeply arched. Lobules of female bracts large, ca. 2/3 x lobe length.....
..... *Lopholejeunea recurvata* Mizut.

32. Underleaf margins \pm plane. Insertion line of underleaves straight or slightly curved. Lobules of female bracts very small, reduced *Lopholejeunea subfusca* (Nees) Schiffn.
33. Plants very small, less than 1 mm wide. Female bracteole undivided, without teeth. Lowlands *Lopholejeunea horticola* Schiffn.
33. Plants larger. Female bracteole bifid, toothed. Montane *Lopholejeunea ceylanica* Steph. (Fig. 23)
34. Underleaves reniform, ca. 1.5-2 x wider than long. Plants 1-2 mm wide, green or pale-colored 35
- Phaeolejeunea latistipula* (Schiffn.) Mizut., a Pacific species which has been recorded from Java as "*Lopholejeunea latistipula* var. *minor* Schiffner" (Zhu & Gradstein 2005, p. 88), also keys out here. It is recognized by very broad, reniform underleaves, brown color, large plants (to 3 mm wide), and a peculiar, constricted lobule apex. The occurrence of *P. latistipula* on Java needs confirmation.
34. Underleaves rounded. Plants 1.5-4 mm wide, brown or green, not pale-colored 39
35. Ventral merophyte 4-8 cells wide. Plants pale yellowish-green 36 (former genus *Leucolejeunea*)
35. Ventral merophyte 2 cells wide. Plants green 37
36. Ventral leaf margin \pm plane. Lobule very small, less than 1/5 of leaf length *Cheilolejeunea mizutanii* Ye & Zhu (= *Leucolejeunea decurrens* (Steph.) Mizut.)
36. Ventral leaf margin strongly rolled inwards. Lobule larger, 1/3-2/5 of leaf length *Cheilolejeunea xanthocarpa* (Lehm. & Lindenb.) Malombe (Fig. 23) (= *Leucolejeunea xanthocarpa* (Lehm. & Lindenb.) Evans)
37. Leaf apex recurved. Hyaline papilla distal of the first tooth. Perianth with a small, cylindrical beak that is less than 1/5 x the width of the perianth *Cheilolejeunea lindenbergii* (Gottsche) Mizut.
37. Leaf apex plane. Hyaline papilla proximal of the first tooth. Perianth with a small or large beak that is 1/2 x the width of the perianth 38
38. Perianth with a large, funnel-shaped beak that is 1/2 x the width of the perianth. Underleaves overlapping. Plants 1-1.5 mm wide *Lejeunea mimula* Hürl. (Fig. 27) (= *L. luteola* (Steph.) Mizut.)
38. Perianth with a small beak that is 1/6 or less the width of the perianth. Underleaves not overlapping. Plants smaller, 0.7-1 mm wide *Lejeunea leratii* (Steph.) Mizut.
39. Leaves apex acute to acuminate *Spruceanthus semirepandus* (Nees) Verd.

39. Leaf apex rounded 40
40. *Frullania*-type branches present (Fig. 70). Stem epidermis cells larger than the inner cells. Plants pale brown *Acanthocoleus javanicus* (Steph.) Kruijt (Fig. 23)
40. *Frullania*-type branches lacking. Stem epidermis cells not larger than the inner cells. Plants green to greenish-brown 41
41. Underleaves reflexed-squarrose. Ventral leaf margin somewhat undulate-crispate
..... *Spruceanthus polymorphus* (Sande Lac.) Verd.
41. Underleaves plane. Ventral leaf margin plane, not undulate-crispate 42
42. Plants robust, 2.5-3 mm wide. Ventral merophyte 8-10 cells wide. Perianth with 10-12 keels, without beak *Spruceanthus sulcatus* (Nees) Gradst.
42. Plants smaller, 1.5-2 mm wide. Ventral merophyte 4-6 cells wide. Perianth with 4-5 keels and with beak *Archilejeunea planiuscula* (Mitt.) Steph.
43. All or some leaves with an inflated sac at the leaf apex (Fig. 26: 81a). Usually epiphyllous, more rarely on bark **Key 10** (*Cohura*)
43. Leaves never with an inflated sac at the apex 44
44. Underleaves strongly spinose-dentate. Margins of the leaf lobes divided into 4-5 lobes and densely spinose, the teeth in two rows
..... *Dactylophorella muricata* (Gottsche) Schust.
44. Underleaves not strongly spinose-dentate. Margins of the leaf lobes not divided into 4-5 lobes, teeth (when present) never in two rows 45
45. Lobules long and narrow tubular, 5-10 x longer than wide, lobule apex swollen and curved upwards. On living leaves *Siphonolejeunea schiffneri* Herz.
45. Lobules different 46
46. One underleaf to each leaf (underleaves twice as many as usual; Fig. 24: 71). Leaf apex rounded. Usually epiphyllous, more rarely on bark 47 (*Diplasiolejeunea*)
46. One underleaf to each leaf pair. Leaf apex acute-acuminate to rounded. Underleaf lobes very narrow, subulate 48
47. Leaf cells with large trigones *Diplasiolejeunea patelligera* Herz.
47. Leaf cells without or with very small trigones
..... *Diplasiolejeunea cavifolia* (Steph.) Steph. (Fig. 24)

48. Leaf lobule very narrowly attached to the stem, by only 1 stem cell. Small epiphyllous plant, less than 0.5 mm wide
 *Tuyamaella angulistipa* (Steph.) Schust. & Kachroo
48. Leaf lobule more broadly attached to the stem, by 2 or more stem cells 49
49. Underleaf lobes widely diverging (Fig. 24: 72a,b). Leaves usually with ocelli 50
49. Underleaf lobes not widely diverging. Ocelli present or lacking 57
50. Lobule tooth short and blunt. Underleaf margins bordered by large cells (this character may be difficult to see when the underleaf is covered by a large rhizoid disc). Leaf apex rounded to acute. Usually epiphyllous, more rarely on bark
 51 (*Leptolejeunea*)
50. Lobule tooth long-falcate. Underleaf margins not bordered by large cells. Leaf apex acuminate, occasionally rounded 56
51. Leaf margin toothed 52
51. Leaf margin entire 54
52. Leaves with 1 ocellus (at leaf base).....*Leptolejeunea vitrea* (Nees) Schiffn. (Fig. 24)
52. Leaves with several ocelli 53
53. Ocelli scattered through the leaf lobe, not in a row. Dorsal and ventral leaf margin with a large tooth (larger than the other teeth)
*Leptolejeunea subdentata* Schiffn. ex Herz.
53. Ocelli in a "broken" row (= ocelli not side by side, separated from each other by one or more ordinary leaf cells). Teeth on the dorsal and ventral leaf margin similar in size, conspicuously larger tooth lacking..... *Leptolejeunea maculata* (Mitt.) Schiffn.
54. Underleaf lobes 2 cells wide*Leptolejeunea foliicola* Steph.
54. Underleaf lobes 1 cell wide 55
55. Leaves subrectangular, leaf apex broadly rounded to truncate
*Leptolejeunea epiphylla* (Mitt.) Steph. (Fig. 24)
55. Leaves ovate-oblong, leaf apex narrowly rounded to obtuse
Leptolejeunea elliptica (Lehm. & Lindenb.) Schiffn. (? = *L. subacuta* Steph., *L. massartiana* Schiffn. ex Herz.)

56. Leaf cells strongly mammillose, with thickened outer wall. Leaves widely spreading, broadly ovate, leaf apex narrow and strongly reflexed. Leaf base with 2-3 ocelli in an unbroken row. On bark..... *Harpalejeunea filicuspis* (Steph.) Mizut.

Harpalejeunea renneri Herz., described from Java, is a member of the genus *Lejeunea* (Grolle & Reiner-Drehwald 1999) and possibly a synonym of one of the species in that genus.

56. Leaf cells smooth or with a large papilla, not mammillose. Leaves suberect or spreading, narrower in shape, lanceolate to triangular. Ocelli present or absent, scattered, not 2-3 in row at leaf base. Usually epiphyllous, more rarely on bark
..... **Key 11** (*Drepanolejeunea*) (Fig. 26)

57. Plants greenish-brown to brown. Branch bases sometimes with one or more utriculi (= leaf modified into a huge watersac). Perianth apex with 4 horn-like extensions ... 58

57. Plants green or pale-colored, not brown. Utriculi lacking. Perianth without horns 59

58. Underleaves bifid to 1/3 or more. Leaves with 0-2 ocelli at the base. Perianth horns narrow, elongate
..... *Ceratolejeunea belangeriana* (Gottsche) Steph. (= *C. oceanica* (Mitt.) Steph.)

58. Underleaves shallowly emarginate (almost undivided). Leaves with scattered ocelli. Perianth horns swollen, rounded. Only known from Mt. Pangrango, ca. 2000 m, on tree trunk..... *Ceratolejeunea inflata* Mizut.

Ceratolejeunea inflata is very similar to *C. grandiloba* Steph. from tropical America.

59. Leaves with numerous ocelli *Lepidolejeunea bidentula* (Steph.) Schust.

59. Leaves without ocelli..... 60

60. Leaves suberect, almost parallel to the stem. Lobules on main stem very large, 1/2-3/4 of lobe length (some lobules may be reduced, however). Plants minute, less than 0.5 mm wide. Autoicous. Innovations pycnolejeuneoid (first leafy appendage of the innovation is an underleaf) *Metalejeunea cucullata* (Reinw. et al.) Grolle (Fig. 24)

Metalejeunea closely resembles the genus *Microlejeunea* (e.g. *M. ulicina*, *M. punctiformis*) but in *Microlejeunea* the innovations are lejeuneoid (first leafy appendage of the innovation is a leaf, not an underleaf), not pycnolejeuneoid. The genus *Microlejeunea* is not yet known from Java.

60. Leaves obliquely to widely spreading. Lobules on main stem smaller (but in some species of *Cheilolejeunea* very long and narrow; in that case plants larger than 1 mm) 61

61. Lobule with 2 teeth. Underleaves very shallowly bifid. Leaves elongated-falcate, margins often toothed *Caudalejeunea reniloba* (Gottsche) Steph.

61. Lobule with 1 tooth. Underleaves more deeply bifid. Leaves not falcate, margins entire 62
62. Oil bodies large (often more than 1/2 the cell lumen in length), 1-3(-8) per cell, coarsely segmented. Lobules never reduced. Hyaline papilla distal to the lobule tooth (on the side towards the leaf apex) **Key 12** (*Cheilolejeunea*)
62. Oil bodies much smaller (less than 1/4 the cell lumen in length), 5-20 per cell, finely segmented or homogeneous. Lobules sometimes reduced. Hyaline papilla proximal to the lobule tooth (on the side towards the stem) 63
63. Leaf margin denticulate. Perianth with 2 large auricles. On living leaves
..... *Otolejeunea semperiana* (Gottsche ex Steph.) Grolle
63. Leaf margin entire. Perianth without large auricles **Key 13** (*Lejeunea*)

Key 9. *Cololejeunea*

1. Lobe cells papillose or mammillose..... 2
1. Lobe cells smooth..... 3
2. Leaves with vitta (weakly developed in *C. pseudofloccosa*). Plants whitish green, strongly appressed to the substrate..... subgen. *Taeniolejeunea* (**Key 9b**)
2. Leaves without vitta. Plants green to dark green, not strongly appressed to the substrate subgen subgen. *Cololejeunea* and papillose members of subgen. *Leptocolea* (**Key 9a**)
3. Leaf lobes with a white margin of large, rectangular, hyaline cells. Lobules erect ligulate-triangular or wide-spreading ovate..... *Cololejeunea planissima* (Mitt.) Abeyw. (? = *C. lanciloba* Steph.)
3. Leaf lobes without white margin... 4
4. Leaf lobes bordered by narrow, sigmoid cells 5
4. Leaf lobes not bordered by narrow, sigmoid cells 6
5. Lobules \pm lacking, consisting of only 1(-2) thick-walled cells. Leaves ovate-elliptical, symmetric. Gynoecium with one innovation *Cololejeunea sigmoidea* Jovet-Ast & Tixier
5. Lobules present, narrow-triangular, 5-10 cells long. Leaves broadly ovate, asymmetric. Gynoecium without innovation *Cololejeunea zangii* Zhu & So
6. Lobules erect and parallel to the stem, ligulate to triangular, flat 7
6. Lobules wide-spreading, ovate and \pm inflated (never ligulate to triangular) 8
7. Stems robust, ventral merophyte 4-6 cells wide. Growing near running water, usually on wet rock *Cololejeunea madothecoides* (Steph.) Benedix (Fig. 25)
7. Stems thin, ventral merophyte 1 cell wide *Cololejeunea raduliloba* Steph. (? = *C. paucimarginata* Tixier)
8. Free margin of lobule very strongly involute. Cell walls \pm brown, with distinct trigones. Plants robust, brown 9 (subgen. *Cryptolejeunea*)
8. Free margin plane or slightly incurved only. Cell walls colorless, without or with small trigones. Plants usually green or pale-colored, small or large 10 (subgen. *Leptocolea* p.p.)

9. Lobule very large, ca. 3/4 x lobe length
 *Cololejeunea vesicaria* (Sande Lac.) Schiffn. (Fig. 25)
9. Lobule smaller, ca. 1/3-1/2 x lobe length *Cololejeunea inflectens* (Mitt.) Benedix
10. Leaf apex broadly rounded. Stylus (1-)2-8 cells long
 *Cololejeunea trichomanis* (Gottsche) Steph. (= *C. goebelii* (Gottsche ex Schiffn.) Schiffn.)
- Cololejeunea cordifolia* Steph., recorded from Java, is very similar to *C. trichomanis* (T. Pócs, pers. com.).
10. Leaf apex obtuse to acute. Stylus consisting of 1 cell only
 *Cololejeunea angustiflora* (Steph.) Mizut.

Further records of *Cololejeunea* from Java: *C. decliviloba* Steph., *C. fusca* (Steph.) Mizut., *C. hirta* Steph., *C. hyalina* Asthana & Srivast., *C. maritima* Tixier, *C. peponiformis* Mizut., *C. reineckeana* Steph., *C. spinosa* (Horik.) Hatt., *C. thailandensis* Tixier, *C. triapiculata* (Herz.) Tixier, etc.

Key 9a. Subgen. *Cololejeunea* and papillose members of subgen. *Leptocolea*

1. Leaf margin regularly and densely spinose, all margin cells tooth-like 2
1. Leaf margin entire or with scattered teeth (not all margin cells tooth-like) 3
2. Leaf lobes with a vitta (to 1/3-1/2 of leaf length). Lobules often reduced, without or with one tooth *Cololejeunea planiflora* Benedix
2. Leaf lobes without vitta. Lobules not reduced, with two teeth
 *Cololejeunea haskarliana* (Lehm. & Lindenb.) Schiffn. (Fig. 25) (? = *C. pretiosa*)
- Cololejeunea pretiosa* Benedix, which has a perianth with 2 very large auricles (see Benedix 1953, Fig. 20), is sometimes treated as a synonym of *C. haskarliana*.
3. Leaf margin toothed 4
3. Leaf margin not toothed, only with papillae 7
4. Leaf margin with papillae between the teeth 5
4. Leaf margin without papillae between the teeth
 6 (papillose members of subgen. *Leptocolea*)
5. Leaf lobes obovate (widest in the upper half), obliquely spreading (45-60°), ± falcate. Leaf margin with a few small teeth (less than 10), ventral margin with a conspicuously larger tooth (1-2 cells long)
 *Cololejeunea dozyana* (Sande Lac.) Schiffn. (Fig. 25)

5. Leaf lobes ovate-elliptical (widest in the lower half), widely spreading (90°). Leaf margin with 15-30 teeth, ventral margin not with a larger tooth *Cololejeunea serrata* (Steph.) Benedix
6. Perianth apex with 2 large, ear-like wings. *Cololejeunea aequabilis* (Sande Lac.) Tixier
6. Perianth apex truncate, without ear-like wings *Cololejeunea obliqua* (Nees & Mont.) Schiffn.
7. Second tooth of lobule long and sharp, 3 cells long, longer than the first tooth. Cell walls with intermediate thickenings *Cololejeunea filidens* Benedix
7. Second tooth of lobule absent or short, consisting of 1 cell only, shorter than the first tooth. Cell walls without intermediate thickenings 8
8. First tooth of lobule falcate 9
8. First tooth of lobule straight 10
9. Papillae of leaf lobes stellate *Cololejeunea verrucosa* Steph.
9. Papillae of leaf lobes rounded *Cololejeunea tenella* Benedix
10. Plants 0.5-0.7 mm wide. Keel papillose. Dorsal leaf surface rough by long papillae..... *Cololejeunea schmidtii* Steph. (? = *C. benedixii* Tixier)
10. Plants larger, 0.9-1 mm wide. Keel smooth. Dorsal leaf surface almost smooth, papillae rudimentary *Cololejeunea plagiophylla* Benedix

Key 9b. Subgen. *Taeniolejeunea*

1. Leaf lobe with a white border of large, hyaline cells 2
1. Leaf without white border 3
2. Vitta longer than the lobule, clearly visible in ventral view. First tooth of lobule falcate *Cololejeunea stephanii* Schiffn. ex Benedix (Fig. 25)
2. Vitta shorter than the lobule, ±invisible in ventral view. First tooth of lobule straight .. *Cololejeunea inflata* Steph.

3. Lobule with one tooth (2nd tooth reduced)
Cololejeunea floccosa (Lehm. & Lindenb.) Schiffn. (? = *C. amoena* Benedix, *C. mutabilis* Benedix)
3. Lobule with two teeth..... 4
4. Vitta indistinct, ocelli absent*Cololejeunea pseudofloccosa* (Horik.) Benedix
4. Vitta distinct (but often hidden behind the lobule), made up of ocelli..... 5
5. First lobule tooth longer than the second tooth. Keel papillose or smooth
 *Cololejeunea peraffinis* (Schiffn.) Schiffn.
5. First lobule tooth not longer than the second tooth. Keel always smooth..... 6
6. Lobule large, ½ of lobe length. Lobule teeth crossing each other, the first tooth shorter than the second tooth *Cololejeunea ocelloides* (Horik.) Mizut.
6. Lobule smaller, ca. 1/3 of lobe length. Lobule teeth not crossing each other, the two teeth of about the same length 7
7. Vitta 2-3 cell rows wide and (4-)5-6 cells long. Leaves falcate
 *Cololejeunea falcata* (Horik.) Benedix (= *C. falcatoides* Benedix)
7. Vitta smaller, 1 cell row wide and 4 cells long. Leaves not falcate
 *Cololejeunea appressa* (Evans) Benedix (? = *C. gynophthalma* Benedix)

Key 10. *Colura*

1. All leaves with a sac at the tip (Fig. 26: 80,81a) 2
1. Some or many leaves without sac 7
2. Sac with a long, linear prolongation at the tip, the prolongation $1/2$ x leaf length
..... *Colura tenuicornis* Steph.
2. Sac without linear prolongation at the tip 3
3. Sac very small, ca. 0.3 mm long, positioned at the ventral side of the leaf apex,
resembling a bird's beak *Colura ari* (Steph.) Steph. (Fig. 26)
3. Sac larger, more than 0.5 mm long, not positioned at the ventral side of the leaf apex 4
4. Apex of sac acute *Colura*
4. Apex of sac broadly rounded..... 5
5. Leaf margin distinctly toothed *Colura herzogii* Jov.-Ast
5. Leaf margin crenulate or entire *Colura conica* (Sande Lac.) Goebel
6. Underleaf lobes 4 cells wide at base. Sac ca. $1/3$ x leaf length
..... *Colura meijeri* Jov.-Ast
6. Underleaf lobes broader, ca. 8 cells wide at base. Sac ca. $1/2$ x leaf length
..... *Colura hemisphaerica* Jov.-Ast
7. Apex of sac rounded, smooth 8
7. Apex of sac with teeth 9
8. Most leaves without sac, saccate leaves smaller than leaves without sac. Not yet
recorded from Java with certainty *Colura corynephora* (Nees) Trevis.
8. Most leaves with a sac, saccate leaves not smaller ... *Colura acroloba* Steph. (Fig. 26)
9. Apex of sac with 4-5 teeth..... *Colura ornata* Goebel
9. Apex of sac with 1-2(-3) teeth..... 10
10. Lobule + sac longer than the lobe *Colura leratii* (Steph.) Steph.
10. Lobule + sac \pm shorter than the lobe 11

11. Leaf margin with ca. 25-30 teeth. Known only from Tjisaru-Selatan (600 m, on living leaves)..... *Colura denticulata* Jov.-Ast.

11. Leaf margin with fewer teeth, less than 15 teeth..... *Colura imperfecta* Steph.

Further records from Java: *Colura junghuhniana* (Steph.) Steph., *C. mosenii* Steph., *C. superba* (Mont.) Steph.

Key 11. *Drepanolejeunea*

1. Leaf margin entire or with 1-5 teeth. Leaves parallel to the stem or obliquely spreading (Fig. 26: 82a), rarely wide spreading (*D. cyclops*) 2
1. Leaf margin with more than 5 teeth. Leaves obliquely to widely spreading (Fig. 26: 83a) 6
2. Apex of stem leaves broadly rounded (on branch leaves sometimes acute). Lobules of upper branch leaves often reduced and with a 4 cells long tooth. Underleaf lobes very long, 6-9 cells long *Drepanolejeunea cyclops* (Sande Lac.) Grolle & Zhu
2. Apex of stem leaves acute-acuminate (rarely obtuse). Lobules of upper branch leaves not reduced, with a 1 cell long tooth. Underleaf lobes smaller 3
3. Ocelli 2-4 in a row through the leaf lobe. Leaf margin with 2-5 long teeth
..... *Drepanolejeunea pentadactyla* (Mont.) Steph. (? = *D. tenera* Goebel)
3. Ocelli lacking or 1-2 at leaf base. Leaf margin entire or with a few teeth 4
4. Leaf cells and keel ± mammillose or papillose. Leaves ovate to ovate-lanceolate, sometimes caducous 5
4. Leaf cells and keel quite smooth. Leaves narrow lanceolate, never caducous
..... *Drepanolejeunea angustifolia* (Mitt.) Grolle
5. Underleaf lobes 2-3 cells wide *Drepanolejeunea vesiculosa* (Mitt.) Steph.
5. Underleaf lobes 1 cell wide (rarely 2 cells wide at the base)
Drepanolejeunea ternatensis (Gottsche) Steph. ex Schiffn. (Fig. 26) (incl. *D. obliqua* Steph., *D. teysmannii* Gottsche ex Steph.)
6. Leaves obliquely spreading, with 8-10 large teeth (the teeth 2-6 cells long). Upper part of leaf lobe and teeth strongly recurved
..... *Drepanolejeunea dactylophora* (Gottsche *et al.*) Schiffn.
6. Leaves widely spreading (90°), with more than 10 teeth. Upper part of leaf lobe and teeth not recurved 7
7. Ocelli lacking or 1-2 at leaf base. Gynoecia without innovations. Plants small, less than 1 mm wide *Drepanolejeunea levicornua* Steph.
7. Ocelli numerous scattered throughout the leaf lobe (Fig. 26: 83a). Gynoecia with innovations. Plants small or large 8

8. Underleaf lobes obliquely spreading. Lobule with two teeth.....
*Drepanolejeunea intermedia* Zwickel
8. Underleaf lobes horizontally spreading (90°) (Fig. 26: 83a). Lobule with one tooth ... 9
9. Leaf margin coarsely dentate (teeth 1-4 cells long). Lobules $2/5-1/2$ x leaf length. Autoicous..... *Drepanolejeunea fissicornua* Steph.
9. Leaf margin finely dentate (teeth 1-2 cells long). Lobules smaller, $1/3-2/5$ x leaf length. Dioicous..... 10
10. Plants less than 1 mm wide. Ocelli very large, at least 2 x larger than neighbouring cells. Male bracts with ocelli *Drepanolejeunea tricornua* Herz.
10. Plants larger, more than 1 mm wide. Ocelli smaller, less than 2 x larger than neighbouring cells (Fig. 26: 83b). Male bracts without ocelli
*Drepanolejeunea thwaitesiana* (Mitt.) Steph. (Fig. 26)

Drepanolejeunea hampeana Steph., *D. longicornua* (Herz.) Mizut., *D. nymanii* Steph. and *D. serricalyx* Herz. also key out here and are very similar to *D. thwaitesiana*. The relationships of these five species need further study.

Further records from Java: *D. blumei* Steph. ex Schiffn., *D. elegans* Herz., *D. pleiodictya* Herz., *D. spinoso-cornuta* Steph., etc.

Key 12. *Cheilolejeunea*

1. Ventral merophyte 4-8 cells wide. Underleaves undivided
..... 2 (former genus *Leucolejeunea*)
1. Ventral merophyte 2 cells wide. Underleaves \pm bifid (sometimes only very shallowly bifid) 3
2. Ventral leaf margin \pm plane. Lobule very small, less than 1/5 of leaf length
..... *Cheilolejeunea mizutanii* Ye & Zhu (= *Leucolejeunea decurrens* (Steph.) Mizut.)
2. Ventral leaf margin strongly rolled inwards. Lobule larger, 1/3-2/5 of leaf length
Cheilolejeunea xanthocarpa (Lehm. & Lindenb.) Malombe (Fig. 23) (= *Leucolejeunea xanthocarpa* (Lehm. & Lindenb.) Evans)
3. Lobules 1/2-3/4 as long as the leaf lobe, rectangular (Fig. 26: 84) 4
3. Lobules shorter, 1/4-1/2 as long as the leaf lobe, ovate (Fig. 26: 85a) 10
4. Ocelli present, arranged in a long and narrow row (2 cells wide) row that extends almost to leaf apex, ocelli also scattered elsewhere in leaf lobe
..... *Cheilolejeunea falsinervis* (Sande Lac.) Schust. & Kachroo
4. Ocelli lacking 5
5. Underleaves very short bifid, to 1/5 or less of underleaf length
..... *Cheilolejeunea incisa* (Gottsche) Schust. & Kachroo (Fig. 26)
5. Underleaves more deeply bifid 6
6. Leaf lobes with a distinct, 6-8 cells wide vitta that extends to about 3/4 of leaf length .
..... *Cheilolejeunea vittata* (Steph. ex Hoffm.) Schust. & Kachroo
6. Leaf lobes without vitta or with a weak vitta only 7
7. Lobules very long and narrow, about 3/4 of leaf length, 3-4 x longer than wide. Leaves oblong
Cheilolejeunea meyeniana (Nees *et al.*) Schust. & Kachroo
7. Lobules shorter, 1/2-2/3 of leaf length, 2-3 x longer than wide. Leaves ovate 8
8. Plants small, less than 0.8 mm wide. Leaves obliquely spreading. Lobule tooth 1 cell long
..... *Cheilolejeunea decursiva* (Sande Lac.) Schust.
8. Plants larger. Leaves widely spreading. Lobule tooth 2-7 cells long 9

9. Ventral merophyte on main stems 3-4 cells wide. Lobule tooth curved
 *Cheilolejeunea trapezia* (Nees) Schust. & Kachroo
9. Ventral merophyte on main stems 2 cells wide. Lobule tooth straight
 *Cheilolejeunea ceylanica* (Gottsche) Schust. & Kachroo
10. Leaf apex narrowly pointed, obtuse or acute. Perianth without keels (or occasionally
 with 3-4 weak keels).....*Cheilolejeunea krakakammae* (Lindenb.) Schust.
10. Leaf apex broadly rounded. Perianth distinctly keeled 11
11. Underleaves 2-3 x stem width, insertion line straight or slightly curved. Small, fragile
 dioicous plants 12
11. Underleaves 4-8 x stem width, insertion line deeply curved 13
12. Trigones well developed. Leaf sequence of innovations lejeuneoid (first, basal leafy
 appendage of the innovation is a lateral leaf).....
 *Cheilolejeunea serpentina* (Mitt.) Mizut.
12. Trigones lacking or minute. Leaf sequence of innovations pycolejeuneoid (basal leafy
 appendage of innovation is an underleaf; Fig. 26: 85b)
 *Cheilolejeunea intertexta* (Lindenb.) Steph. (Fig. 26)
13. Underleaves almost undivided, very shallowly bifid (to 1/10)
 *Cheilolejeunea lindenbergii* (Gottsche) Mizut.
13. Underleaves bifid to 1/3-1/2..... 14
14. Underleaves rounded. Leaves longer than wide. Trigones very large, bulging, cell-
 lumen stellate..... *Cheilolejeunea orientalis* (Gottsche) Mizut.
14. Underleaves somewhat wider than long. Leaves rounded. Trigones smaller, not
 bulging, cell-lumen rounded.....*Cheilolejeunea trifaria* (Reinw. *et al.*) Mizut.

Further records from Java: *Cheilolejeunea suborbicularis* (Herz.) Miller *et al.* (= *Microlejeunea suborbicularis* Herz.) from Mt. Salak, *C. gardneri* (Mitt.) Mizut., *C. serpentina* (Mitt.) Mizut.

Key 13. *Lejeunea*

1. Underleaves bifid and undivided on single stems. Plants very small, less than 0.7 mm wide. Leaves obliquely spreading, diverging from the stem at an angle of 30-50°
..... *Lejeunea exilis* (Reinw. *et al.*) Grolle (= *Byssolejeunea abnormis* Herz.)
1. Underleaves bifid or undivided, not both. Plants small or large. Leaves usually widely spreading (rarely obliquely spreading)..... 2
2. Leaf apex acute-apiculate 3
2. Leaf apex rounded or obtuse 7
3. Underleaves overlapping, large (more than 5 x stem width). Apex of lobule strongly constricted. Leaf cells thick-walled (trigones indistinct)
..... *Lejeunea molkenboeriana* Sande Lac.
3. Underleaves distant, small (2-3 x stem width). Apex of lobule not constricted. Leaf cells thin-walled, with or without trigones 4
4. Leaf apex long apiculate, ending in a row of (2-)3-4 cells. Underleaves deeply bifid to 2/3 of length, with narrow lanceolate lobes. Lobe margins sometimes with linear-shaped gemmae 5 (former genus *Stenolejeunea*)
4. Leaf apex short apiculate or acute, ending in a row of 1-2 cells. Underleaves less deeply bifid (1/3-1/2), with broader lobes. Lobe margins never with linear-shaped gemmae 6
5. Cuticle finely punctate. Leaf cells with trigones. Female bracts entire. Autoicous
..... *Lejeunea apiculata* Sande Lac. (= *Stenolejeunea apiculata* (Sande Lac.) Schust.)
5. Cuticle smooth. Leaf cells without trigones. Female bracts toothed. Dioicous
..... *Lejeunea thallophora* (Eifr.) Gradst. (= *Stenolejeunea thallophora* (Sande Lac.) Schust.)

Stenolejeunea Schust. has recently been reduced to synonymy under *Lejeunea* because there is no single morphological character separating the two genera (see Söderström *et al.* 2010).
6. Underleaves contiguous, 4 x stem width, insertion line deeply curved
..... *Lejeunea denticuspis* (Steph.) Mizut.
6. Underleaves smaller, distant, 2(-3) x stem width, insertion line shallowly curved only
..... *Lejeunea eifrigii* Mizut. (Fig. 27)
7. Underleaves ± undivided, reniform 8
7. Underleaves clearly bifid 9

8. Perianth with a large, funnel-shaped beak that is 1/2 x the width of the perianth Underleaves overlapping. Plants 1-1.5 mm wide.....
 *Lejeunea mimula* Hürl. (Fig. 27) (= *L. luteola* (Steph.) Mizut.)
8. Perianth with a small beak that is 1/5 or less the width of the perianth Underleaves not overlapping. Plants smaller, 0.7-1 mm wide *Lejeunea leratii* (Steph.) Mizut.
9. Underleaves 4-10 x stem width, overlapping or contiguous. Gynoecia usually several in a row on branches 10
9. Underleaves smaller, less than 4 x stem width, distant. Gynoecia single or in a row 18
10. Lobules large, 2/5-1/2 x leaf length, usually with a large "disk cell" distal to the apical tooth (disk cell 2-3 x larger than adjacent cells) 11
10. Lobules smaller, large disk cell lacking (except in *L. lumbricoides*: couplet 14) 13
11. Free margin of lobule strongly involute (except at apex). Leaf margin crenulate *Lejeunea fleischeri* (Steph.) Mizut.
11. Free margin of lobule plane or slightly incurved only. Leaf margin entire 12
12. Lobule tooth more than 2 x as long as wide. Lobule ca. 2/5 x leaf length.....
 *Lejeunea mizutanii* Grolle
12. Lobule tooth less than 2 x as long as wide. Lobule larger, ca. 1/2 x leaf length.....
 *Lejeunea discreta* Lindenb.
Lejeunea stephaniana Mizut. also keys out here but this species has no large disk cell (see Mizutani 1964b, p. 143).
13. Underleaves huge, as large as leaves, deeply cordate-auriculate at the base, shallowly bifid (to 1/6). Leaf margin crenulate *Lejeunea albescens* (Steph.) Mizut.
13. Underleaves smaller than leaves, base not deeply cordate-auriculate, more deeply bifid. Leaf margin entire or crenulate..... 14
14. Lobule apex with large disk cell. Leaf apex recurved. Underleaves longer than wide, with very narrow incision. Robust, pendent plants
 *Lejeunea lumbricoides* (Nees) Nees (Fig. 27)
14. Large disk cell lacking. Leaf apex plane. Underleaves variable, incision not very narrow. Plants not pendent 15

15. Leaf margin crenulate. Perianth without keels or weakly 4-keeled at the apex 16
15. Leaf margin entire. Perianth with 5 long keels 17
16. Underleaf lobes and sinus between the lobes obtuse. Perianth smooth, without keels ...
..... *Lejeunea umbilicata* (Nees) Grolle
16. Underleaf lobes and sinus between the lobes acute. Perianth weakly 4-keeled at the
apex *Lejeunea cuculliflora* (Steph.) Mizut.
17. Underleaves wider than long, shallowly bifid to 1/4(-1/3). Cuticle finely punctate-
papillose..... *Lejeunea sordida* (Nees) Nees (Fig. 28)
17. Underleaves longer than wide, bifid to ca. 2/5. Cuticle smooth
..... *Lejeunea flava* (Sw.) Nees
18. Leaves caducous. Plants very small, less than 0.6 mm wide *Lejeunea cocoes* Mitt.
18. Leaves not caducous. Plants 0.6-2 mm wide..... 19
19. Leaf margin crenulate and with ribbon-like, filamentous gemmae. Perianth keels
toothed *Lejeunea propagulifera* Gradst. (= *Stenolejeunea schiffneri* (Herz.) Pócs)
19. Leaf margin entire or crenulate, without gemmae. Perianth keels entire or crenulate
(or keels lacking) 20
20. Lobes of underleaf lanceolate, usually with a blunt tooth on the outer margin.
Underleaves very small (2 x stem width) and deeply bifid
..... *Lejeunea anisophylla* Mont.
20. Lobes of underleaf broader, triangular, outer margins without tooth 21
21. Lobules 1/3 x leaf length, not reduced. Dioicous 22
21. Lobules smaller, to 1/4 x leaf length, often reduced. Usually autoicous 23
22. Leaf margin entire. Leaf cells with large trigones. Perianth surface mammillose, keels
crenulate *Lejeunea tuberculosa* Steph.
22. Leaf margin crenulate. Leaf cells with minute trigones. Perianth surface and keels
smooth *Lejeunea patersonii* (Steph.) Steph.
23. Perianth keels expanded towards the apex into wings or auricles 24
23. Perianth keels not expanded 25

24. Perianth apex with 2 large, rounded auricles, which extend far beyond the beak. On living leaves in montane forest
Lejeunea papilionacea (Steph.) E.W. Jones (= *Cardiolejeunea cardiantha* Schust. & Kachroo)
24. Perianth apex with 5 broad wings, which do not extend beyond the beak. On bark in montane forest*Lejeunea alata* Gottsche (Fig. 28) (= *L. mitracalyx* (Eifrig) Mizut.)
25. Leaf margin crenulate. Underleaves turning upwards, away from the stem. Oil bodies segmented. Dioicous. Gynoecia 2 or more in a row on branches
*Lejeunea micholitzii* Mizut.
25. Leaf margin entire. Underleaves appressed to the stem. Oil bodies homogeneous. Autoicous. Gynoecia single*Lejeunea obscura* Mitt.

Lejeunea aloba Sande Lac. and *Lejeunea novoguineensis* Schiffn. from Java also key out here. *Lejeunea novoguineensis* has male spikes with 1-3 bracteoles (present almost throughout the spike) while in *L. obscura* male spikes have only 1 male bracteole (restricted to the base of the spike); see X.-L. He, *Annales Botanici Fennici* 34, p. 67-69. 1997. *Lejeunea aloba* is very similar to *L. obscura* according to Zhu & So (2001, p. 140). When the two prove to be synonyms, *L. aloba* is the older name and should replace *L. obscura*.

Further records from Java: *Lejeunea caviloba* (Steph.) Steph. ex Besch., *L. fissistipula* (Steph.) Steph., *L. microstipula* Steph., *L. tenella* Tayl. and *L. utriculata* (Steph.) Mizut. The report of *Lejeunea pectinella* Mizut. new to Java (Gradstein et al. 2010) was erroneous; the material belonged to *L. fleischeri* (Steph.) Mizut.