

# A Key to the African species of the genus *Frullania*

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Vanden Berghen offers two pathways to identification: a long key to all the species, which has been translated by MJW, and a second route, via the initial identification of subgenera, then groups, and finally species. These keys have been translated by CRS. A full list of African *Frullania* taxa is included.

For accuracy of identification the reader should refer to the original text, which provides details of ecology, and a full account of variations in morphology, etc. In particular, the illustrations provided are excellent. The appropriate volume is still available from the National Botanic Gardens in Belgium.

MORPHOLOGICAL TERMS A key feature which Vanden Berghen uses from time to time is the form of the 'Half-leaf' (hemiphylle) which is found at the base of branches. This can be more easily observed by first stripping off the underleaves adjacent to a branch.

## A key to the sub-genera of African *Frullania*

1	Lobules club shaped or sub-cylindrical, non-rostrate. Almost always at least 1.5 times as high as wide. Perianth generally trigonous and smooth	2
1*	The lobules, or the apical part of the lobules, cap or bell shaped; frequently rostrate; rarely more than 1.5 times as high as wide. Perianth generally trigonous, or furnished with two ventral keels; smooth or verrucose. Leaf lobes rounded or obtuse at the tip. No ocelli	subgen. <i>Trachycolea</i>
2	The axis of the lobules parallel to the stem, or forming an angle of not more than 90 to it; the lobule opening directed towards the base of the plant or towards the stem. Leaf lobes rounded or apiculate / mucronate at the tip. Ocelli sometimes present	subgen. <i>Frullania</i>
2*	The axis of lobules at an angle of more than 90 to the stem; the opening of well developed lobules is thus directed towards the summit of the plant (Fig 1). Leaf lobes, in the single African species, are neither apiculate nor mucronate. No ocelli present	subgen. <i>Homotropantha</i>

## SUBGENUS *Frullania*

1	Perianth trigonous, or lacking a ventral keel	2
1*	Perianth with 2 ventral keels	<i>F. variegata</i> group

2	Half-leaf consisting of a well developed lobule, often helmet shaped, and an entire or subentire ventral lamina (Fig. 2)	3
2*	Half-leaf sometimes made up of a well developed lobule and a bilobed ventral lamina often resembling an underleaf (Fig. 3), and sometimes made up of a poorly developed lobule and an entire or bilobed ventral lamina	5
3	Lobules distant from the stem and arranged obliquely to it (Fig 2)	<b><i>F. lindenbergi</i></b> <b>group</b>
3*	Lobules not remote from the stem; arranged more-or-less parallel to it	4
4	Plants densely branched. Lobule longer than the ventral border of the leaf lobe (Fig 4)	<b><i>F. capensis</i></b> <b>group</b>
4*	Plants slender, sparsely branched. Lobule not extending below the ventral border of the leaf lobe (Fig 5)	<b><i>F. angulate</i></b> <b>group</b>
5	Lobules isolated from the stem, and oblique to it. The lobule of the half-leaf well formed, often helmet shaped (Fig 3)	<b><i>F. purpurea</i></b> <b>group</b>
5*	Lobules close to the stem, and more-or-less parallel to it. Lobule on half-leaf often poorly developed	6
6	Perianth habitually lacking a ventral keel	<b><i>F. eplicata</i></b> <b>group</b>
6*	Perianth always trigonous	7
7	Base of lobules greatly inflated (Fig 6)	<b><i>F. loricata</i></b> <b>group</b>
7*	Base of lobules attenuate or only slightly enlarged	8
8	Lobule of half-leaves well developed	<b><i>F. apiculata</i></b> <b>group</b>
8*	Lobules on half-leaves poorly developed	<b><i>F. tamarisci</i></b> <b>group</b>

### Key to *F. variegata* group

Only one species in the group, viz. ***F. variegata***

### Key to *F. lindenbergi* group

1	Tip of leaf lobe bearing an apiculus of 3-8 cells (Fig 7)	<b><i>F. brunnea</i></b>
1*	Tip of leaf lobes on main stems rounded, rarely sub-mucronate	2
2	Lobules 1.5 - 1.7 times as long as wide, and with a row of hyaline cells around the opening	<b><i>F. humbertii</i></b>
2*	Lobules (1.6) 2 - 2.5 times as long as wide; opening not bordered by hyaline cells	3
3	Lobules carrying a 'cellula lucida' (pellucid cell); often mammillose at the tip (Fig 8)	<b><i>F. tixierana</i></b>
3*	Lobules lacking a pellucid cell; not mammillose at the summit	4
4	Mid-leaf cells small and sub-quadrangular; 9-15 $\mu$ x 12 - 16 (20) $\mu$	<b><i>F. epiphylla</i></b>
4*	Mid-leaf cells polygonal and larger, in the range 18 - 25 (27) $\mu$ x 20 - 28 (32) $\mu$	5
5	Monoecious species. Gynoecia at the tip of a more-or-less elongated branch. 1 - 2 innovations	<b><i>F. lindenbergii</i></b>
5*	Dioecious species. Gynoecia at the tip of a short lateral branch. No innovations	<b><i>F. letestui</i></b>

### Key to *F. capensis* group

1	Gynoecia at the tip of a short lateral branch; no innovations; beak of perianth (250) 300 - 450 $\mu$ . Leaf lobes greatly involute at the tip. Stem underleaves robust, with narrowly revolute margins. Dioecious	<b><i>F. imerinensis</i></b>
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1*	Gynoecia at the tip of a more-or-less elongate main branch; 1 - 2 innovations; beak of perianth less than 300 (380) $\mu$ . Leaf lobes spreading or incurved at the tip. Underleaves, at least on robust branches, with flat or only narrowly recurved margins. Monoecious or dioecious species	2
2	Leafy branches 430 - 550 $\mu$ wide. Perianth often obcordate at summit, with an obtuse ventral keel at the base. Probably dioecious	<b><i>F. onraedtii</i></b>
2*	Leafy branches usually more than 600 $\mu$ wide. Perianth rounded or truncate at the tip, rarely retuse; possesses an elevated and sharp ventral keel. Dioecious or monoecious	3
3	Monoecious species. Basal dorsal leaf lobes truncate, or feebly convex. Underleaves with plane margins	<b><i>F. capensis</i></b>
3*	Dioecious species. Underleaves with plane or narrowly revolute margins	4
4	Dorsal base of leaf lobes strongly convex. Underleaves on main stems 3 -5 times as wide as the stems, and with frequently revolute margins	<b><i>F. schimperi</i></b>
4*	Dorsal base of leaf lobes truncate or feebly convex. Underleaves on main stems 2 - 3 times as wide as the stem, and with plane margins	<b><i>F. apicalis</i></b>

### Key to *F. angulata* group

1	Leaf tips mucronate, generally spreading when moist	<b><i>F. angulata</i></b>
1*	Leaf tips rounded; incurved / cucullate or inrolled when moist	<b><i>F. longistipula</i></b>

### Key to *F. purpurea* group

1	Base of leaf lobes having large red-walled cells without nodular trigones. Stylet complex, made up of a semi-circular strip with a lateral and distal setaceous appendix (Fig 9)	<b><i>F. purpurea</i></b>
1*	Enlarged cells at leaf base without red colouring, and with nodular trigones. Stylet simple, made up of several cells arranged end to end	<b><i>F. gabonensis</i></b>

### Key to *F. eplicata* group

Only one species in the group, viz. ***F. eplicata***.

### Key to *F. loricata* group

1	Underleaves oblong, 2 - 2.5 times as wide as the stem, often having an apical serration on each side consisting of 3 (4) multicellular teeth or cilia. Monoecious	<b><i>F. usambarana</i></b>
1*	Underleaves reniform, sub-orbicular or oval, (1.8) 2 - 5.5 times as wide as the stem; bidentate or bilobed; lateral margins entire or with an obtuse tooth. Dioecious	2
2	Lobules joined to the stem by a pedicle whose length is 0.2 - 0.5 of the diameter of the lobule (Fig. 13); arranged more-or-less parallel to the stem, even on branches. Underleaves 2.5 - 5.5 times as wide as the stem	<b><i>F. loricata</i></b>
2*	Lobules joined to the stem by a pedicle whose length is half or more than that of the lobule; often arranged obliquely to the stem, particularly on branches (Fig. 14). Underleaves (1.8) 2 - 3 (4) times as wide as the stem	<b><i>F. grossiclava</i></b>

### Key to the *F. apiculata* group

1	Dorsal base of leaf lobes truncate. Stylets complex, formed of a semi-elliptic lamina, often bent back towards the base, and bearing a setaceous appendage distally and laterally (Fig 10). Gynoecia at tips of main stems, or on more-or-less elongated branches; usually 1 - 2 innovations. Lobe of male bracts entire	<b><i>F. apiculata</i></b>
1*	Dorsal base of leaf lobes convex and cordate. Stylets simple, needle-like. Gynoecium habitually at the tip of a short lateral branch; generally no innovations. Lobes of female bracts lacinate - dentate	<b><i>F. serrata</i></b>

### Key to the *F. tamarisci* group

1	No ocelli present on leaf lobes	<b><i>F. teneriffae</i></b>
1*	Ocelli present on leaf lobes, either scattered or forming a false nerve	2
2	Tip of leaf lobes rounded. Underleaves flat	<b><i>F. microphylla</i></b>
2*	Leaf tips apiculate. Underleaves normally with narrowly recurved margins	3
3	Ocelli present in the underleaves. Gynoecia at tip of short lateral branches; no innovations	<b><i>F. polysticta</i></b>
3*	No ocelli on the underleaves. Gynoecia at the tip of more-or-less elongate branches; 1 - 2 innovations	<b><i>F. tamarisci</i></b>

### SUBGENUS *Homotropantha*

There is only one African species in this subgenus, viz. ***F. nodulosa***

### SUBGENUS *Trachycolea*

1	Stem erect, regularly bipinnate; plant robust, with leafy branches (1200) 1700 - 2200 $\mu$ wide. Mid-leaf cells 15 - 17 $\mu$ x 17 - 21 (26) $\mu$	<b><i>F. rigida</i> group</b>
1*	Stem more-or-less closely applied to the substrate; not regularly bipinnate. Plants delicate or, if robust, with larger leaf cells	2
2	Half leaf connate to the base of the leaf lobe subtending the branch, forming a bilobed lamina (Fig 11)	<b><i>F. trinervis</i> group</b>
2*	Half-leaf not connate at its base with the leaf lobe subtending the branch; consisting of a lobule and a ventral lamina, the latter sometimes entire, sometimes bilobed	3
3	Ventral lamina of half-leaf often entire. Perianth smooth	4
3*	Ventral lamina of half-leaf generally bilobed or bisect, often unequally so. Perianth often verrucose	5
4	Ventral portion of lobules approximately equal to dorsal portions (Fig 12)	<b><i>F. obscurifolia</i> group</b>
4*	Ventral portion of lobules much smaller than the dorsal (Fig 13)	<b><i>F. arecae</i> group</b>
5	Gynoecia at tip of short lateral branches; no innovations	<b><i>F. ericoides</i> group</b>
5*	Gynoecia at tip of a more-or-less elongate branch; 1 (-2) innovations habitually present	6
6	Perianth trigonous	<b><i>F. dilatata</i> group</b>
6*	Perianth with 2 ventral keels	<b><i>F. diptera</i> group</b>

### Key to *F. rigida* group

There is only one species in this group, viz. *F. rigida*

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### Key to *F. trinervis* group

1	Perianth trigonous, with 3 - 5 secondary plicae. Mid-leaf cells 23 - 28 (33) $\mu$ long	<i>F. hedbergii</i>
1*	Perianth with 2 (-3) ventral keels. Leaf cells slightly smaller, 19 - 27 (30) $\mu$ long in mid-leaf	2
2	Underleaves bilobed to 0.25 - 0.5 of their length. Leafy branches (850) 1200 - 1600 (-1850) $\mu$ wide	<i>F. trinervis</i>
2*	Underleaves bidentate, with a sinus 0.1 - 0.2 (0.25) % deep. Leafy branches (1200) 1400 - 2000 (-2400) $\mu$ wide	<i>F. depressa</i>

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### Key to *F. obscurifolia* group

1	Lobules habitually claviform (club shaped). Stylets large, generally obtuse: 2 - 3 cells wide at base, (60) 100 - 180 (220) $\mu$ long (Fig 14). Propagules rare	<i>F. socotrana</i>
1*	Lobules habitually sub-cylindric. Stylets triangular, lanceolate or ligulate, pointed at the tip, 2 - 3 cells wide at base, (30) 60 - 90 (130) $\mu$ long (Fig 15). Propagula frequent	<i>F. obscurifolia</i>

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### Key to *F. arecae* group

	Paroicous species. Gynoecia often preceded, on the same branch, by male bracts. Perianths 5-carinate, 2 of them ventral	<i>F. africana</i>
	Monoicous species. Gynoecia never preceded by male bracts. Perianth 8 - 10 carinate	<i>F. arecae</i>

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### Key to *F. ericoides* group

1	Perianth inflated, devoid of keels or obtusely trigonous. Smooth. Lobules often sub-triangular in profile	<i>F. bullata</i>
1*	Perianth trigonous, always more-or-less verrucose. Lobules rarely sub-triangular when seen in profile	2
2	Leaf cells large, often more than 30 $\mu$ long in mid-leaf. Leafy stems often more than 2000 $\mu$ wide	3
2*	Mid-leaf cells rarely as long as 30 $\mu$ . Width of leafy stems always less than 2000 $\mu$	4
3	Leaf lobes having a long arcuate rostrum which is never prolonged into an apiculus, and which usually, towards the base, extends beyond the ventral margin of the leaf lobe (Fig 16). Underleaves often clearly constricted towards the base; spatulate	<i>F. anderssonii</i>
3*	Well developed lobules having a cylindrical border, or arcuate rostrum which is sometimes extended into an apiculus consisting of 2 - 3 (6) cells, end to end. Never extending beyond the ventral margin of the leaf lobe (Fig 17). Underleaves never constricted towards their base	<i>F. caffraria</i>
4	Leaves squarrose when moist. Rostrum on lobules only rarely extending beyond the ventral margin of the leaf. Underleaves (2) 3 - 4 times as wide as the stem; longer than wide	<i>F. ericoides</i>
4*	Leaves flat or only slightly convex. Rostrum of lobules frequently extending beyond the ventral margin of the leaf (Fig. 28). Underleaves 4 - 5 times as wide as the stem; wider than long	<i>F. spongiosa</i>

### Key to *F. dilatata* group

There is only one species in this group, viz. *F. dilatata*

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### Key to *F. diptera* group

There is only one species in this group, viz. *F. diptera*

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### A key to the species of African *Frullania*

1	Lobules parallel to the stem or oblique to it; the mouth of the lobule directed towards the base of the plant; angle between the axis of the lobule and the stem less than 90°	2
1*	Lobules pendent; mouth of the lobule directed towards the apex of the shoot; angle between its axis and the stem greater than 90°	<i>F. nodulosa</i>
2	Lobules claviform or sub-cylindric, generally more than 1.5 times as long as wide, not rostrate (subgen. <i>Frullania</i> )	3
2*	Lobules, or the apical part of the lobule, helmet-, bell- or cap-shaped, mostly less than 1.5 times as long as wide, often rostrate (subgen. <i>Trachycolea</i> )	34
3	Lobules parallel to the stem or nearly so (angle less than 30°), or sometimes on branch leaves, the apex of the lobule directed towards the stem	4
3*	Lobules oblique to the stem, axis inclined away from the stem at angle of 30-60°	25
4	Most of the leaf lobes, at least those of the branches, acuminate/apiculate or mucronate at the apex	7
4*	Lobes mostly rounded at apex, exceptionally a few mucronate near a gynoeceium or on ultimate branches	14
5	Lobes with ocelli which are dispersed or ordered, forming a pseudo-nerve	6
5*	Lobes without ocelli, or ocelli in a group at the base of the lobe	7
6	Ocelli scattered in the underleaf and lobe	<i>F. polysticta</i>
6*	Ocelli frequently organised into a pseudo-nerve, present on the leaf lobe, at least on branch leaves, absent from underleaves	<i>F. tamarisci</i>
7	Perianth on a more or less elongate shoot with 1(-2) innovations beneath it; base of lobe appendiculate, rounded or truncate	8
7*	Perianth on a generally short lateral shoot, without innovations; base of lobe rounded or appendiculate	11
8	Underleaves bilobed to 1/8 - 1/5 (-1/4) of their length; width of main axis 1400-2000µm	<i>F. teneriffae</i>
8*	Underleaves bilobed to 1/4 - 1/3 of their length; width of main axis (650-)800-1400 (-1600) µm	9
9	Peduncle of lobule shorter than the diameter of the lobule; stylet setaceous, formed of 2-4 cells placed end to end; dorsal base of lobes convex or truncate; dioecious	10
9*	Peduncle of lobule equal to or longer than the diameter of the lobule; stylet well developed in the form of a lamina bearing, laterally or distally, a setaceous appendage formed by 3-4 cells placed end to end; dorsal base of lobes truncate; monoecious	<i>F. apiculata</i>
10	Base of lobule strongly arched; plant relatively robust; width of main axis (800-)1000-1400(-1600) µm	<i>F. schimperi</i>
10*	Base of lobe truncate or feebly arched; plant relatively slender; width of main axis	<i>F. apicalis</i>

	(650-)800-1100(-1300) $\mu\text{m}$	
11	Dioecious; apiculus of lobes conspicuous, lobes usually spreading when moist; female bracts entire or sub-entire; ventral lamina of hemiphyll entire, oval	<b><i>F. angulata</i></b>
11*	Monoecious; apiculus of moist leaves incurved, inconspicuous; female bracts lacinate-dentate; ventral lamina of hemiphyll bifid	<b><i>F. serrata</i></b>
14	Stylet well-developed, either in the form of a semi-circular limb (sometimes channelled), with a lateral and distal setaceous appendage, or in the form of an asymmetric triangle with a broad base	15
14*	Stylet setaceous, symmetrically triangular, or ligulate	17
15	Monoecious; underleaves oblong, 2-2.5 times as wide as stem, bilobed, margins with 2-3(-4) sometimes ciliate teeth	<b><i>F. usambarana</i></b>
15*	Dioecious; underleaves reniform, suborbicular or ovate, (1.8-)2-5.5 times as wide a stem, bilobed or bidentate, margins entire, sinuose or with an obtuse tooth	16
16	Lobules more or less parallel to stem; peduncle of lobule 1/5-1/2 as long as the diameter of the lobule; stylet erect	<b><i>F. loricata</i></b>
16*	Lobules often oblique to the stem, particularly on branch leaves; peduncle as long as or longer than the diameter of lobule; stylet often curved at the base	<b><i>F. grossiclava</i></b>
17	Perianth compressed, without a ventral keel, or with only a low obtuse keel; shoots (1200-)1300-1700(-2100) $\mu\text{m}$ wide; monoecious	<b><i>F. eplicata</i></b>
17*	Perianth trigonous with 1-3 well-defined ventral keels; shoots (430-)500-1300(-1600) $\mu\text{m}$ wide; monoecious or dioecious	18
18	Perianth with 2(-3) ventral keels, usually undulate or crispate; lobules less than twice as long as wide, enlarged or not at base	19
18*	Perianth trigonous; lobule more than twice as long as wide and generally attenuate at base	20
19	Plant relatively robust; shoots (820-)1000-1450 $\mu\text{m}$ wide; lobules normally 1.5-1.8 times as long as wide, usually widened towards the mouth; gemmae not formed on leaf margins; perianth sometimes having some 'warts' at the base; dioecious	<b><i>F. variegata</i></b>
19*	Plant relatively slender; shoots (400-)600-900(-1000) $\mu\text{m}$ wide; lobules normally 1.0-1.6 times as long as wide, often narrowed towards the mouth; leaves often caducous, their margins either bearing gemmae, or with enlarged cells which give rise to gemmae; dioecious (rarely monoecious); perianth non-verrucose	<b><i>F. obscurifolia</i></b>
20	Monoecious; gynoeceum at apex of a short lateral branch, innovations lacking	21
20*	Monoecious or dioecious; gynoeceum at apex of a long branch, with 1(-2) basal innovations	22
21	Stem to 8-12(-15) cm, laxly branched; lobes strongly convex at base, or with a well-developed appendage, involute/cucullate at apex, or the apical part inrolled	<b><i>F. longistipula</i></b>
21*	Stem to 2-4(-6) cm, densely branched; lobes concave at base, without a well-developed appendage, flat or involute at apex	<b><i>F. imerinensis</i></b>
22	Shoot 430-550 $\mu\text{m}$ wide; perianth often obcordate at apex, widely claviform, with a widely rounded ventral keel; probably dioecious	<b><i>F. onraedtii</i></b>
22*	Shoot normally more than 600 $\mu\text{m}$ wide; perianth rounded or truncate at apex (rarely retuse), with a winged ventral keel	23
23	Monoecious; margin of underleaf plane	<b><i>F. capensis</i></b>
23*	Dioecious; margin of underleaf flat or narrowly revolute	10
24	Base of leaves strongly convex; underleaves on main stems 3-5 times as wide as the stem, the borders often narrowly-involute	<b><i>F. schimperii</i></b>
24*	Base of leaves truncate or feebly convex; underleaves on main stems 2-3 times as wide as the stem, normally with plane margins	<b><i>F. apicalis</i></b>
25	Apex of leaf lobes on main stems mostly mucronate or apiculate	26
25*	Apex of leaf lobes on main stems usually rounded, rarely sub-mucronate	27
26	Leaf lobes with an apiculus formed of a row of 3-8 cells; underleaves flat, with lateral teeth; ventral lamina of hemiphyll entire or sinuate	<b><i>F. brunnea</i></b>
26*	Leaf lobes usually mucronate at apex, sometimes apiculate; margin of underleaf flat or narrowly recurved, entire or with a very obtuse tooth; ventral lamina of hemiphyll	<b><i>F. apiculata</i></b>

	bilobed	
27	Lobule 1.5-1.7 times as long as wide, the mouth bordered by a row of hyaline cells	<b><i>F. humbertii</i></b>
27*	Lobule (1.6-)2.0-2.5 times as long as wide, the mouth not bordered by hyaline cells	28
28	Lobule with a 'light cell', and often mamilllose at apex	<b><i>F. tixieriana</i></b>
28*	Lobule lacking a 'light cell', and never mamilllose at apex	29
29	Shoots at least 1400 µm wide; leaf lobes with or without a dorsal appendage	30
29*	Shoots mostly less than 1250 µm wide; leaf lobes without a dorsal appendage	32
30	Monoecious; gynoeceium at the apex of a more or less elongate branch, with 1(-2) innovations	<b><i>F. lindbergii</i></b>
30*	Dioecious; gynoeceium at the apex of a short lateral branch, lacking basal innovations	31
31	Ventral lamina of hemiphyll bilobed, mostly inserted on the branch; leaf lobules on main stems 360-500(-540) µm, often enlarged and rounded at base	<b><i>F. grossiclava</i></b>
31*	Ventral lamina of hemiphyll entire, mostly inserted on the peduncle of the lobule; leaf lobules on main stems (170-)250-400(-420) µm, normally truncate at base, not enlarged	<b><i>F. letestui</i></b>
32	Lamina of hemiphyll entire; cells in centre of lobe sub-quadrangular	<b><i>F. epiphylla</i></b>
32*	Lamina of hemiphyll bilobed; cells in centre of lobe not sub-quadrangular	33
33	Lobes with a group of large bright red cells at the base; walls devoid of nodular trigones	<b><i>F. purpurea</i></b>
33*	Lobes lacking a basal group of large red cells, but cells with reddish or brownish walls showing well-marked nodular trigones	<b><i>F. gabonensis</i></b>
34	Dorsal part of lobule clearly larger than the ventral part, partially joined beneath the pedicel to the ventral margin of the lobe; perianth smooth, never obviously trigonous	35
34*	Dorsal part of the lobule about the same size as the ventral, or a little larger, but usually not joined beneath the peduncle to the ventral margin of the lobe; perianth smooth, or rough with verrucae, clearly trigonous or with more than 3 keels	40
35	Dorsal part of lobule more than 1.5 times as long as ventral part; line of suture between dorsal part of lobule and ventral part of lobe relatively long; female bracts and bracteole joined, forming a kind of broad cup-shape	36
35*	Dorsal part of lobule less than 1.5 times as long as the ventral part; line of suture between dorsal part of lobule and ventral margin of lobe relatively short; female bracts and bracteole not longly joined, not forming a broad cup-shape	38
36	Monoecious; androecia at the apex of a short lateral branches; perianth with (5-)8-10 keels, or with 4 keels	37
36*	Monoecious/paroecious; male bracts on the same branch immediately below the gynoeceium; perianth with 4-5 keels, of which 2 are ventral	<b><i>F. africana</i></b>
37	Perianth with (5-)8-10 longitudinal keels; female bracts and bracteole longly joined; basal foliaceous part of the lobule usually longer than the hooded part	<b><i>F. arecae</i></b>
37*	Perianth with 4 keels, two of which are ventral; female bracts and bracteole shortly joined; basal foliaceous part of the lobule rarely as long as the hooded part, exceptionally longer	<b><i>F. depressa</i></b>
38	Perianth trigonous, with 3-5 secondary plicae; leaf cells 23-28(-33) µm long in centre of lobe	<b><i>F. hedbergii</i></b>
38*	Perianth with 2(-3) ventral keels; leaf cells smaller, (18-)19-27(-30) µm in centre of lobe	39
39	Underleaves (1.8-)2-3(-4) times as wide as the stem, bilobed to 1/2 -1/4 of their length; perianth keels generally undulate; leafy stems (850-)1200-1600(-1850) µm wide	<b><i>F. trinervis</i></b>
39*	Underleaves (2-)3-5 times as wide as the stem, bilobed to 1/10-1/5(-1/4) of their length; perianth keels straight; leafy stems (1200-)1400-2000(-2400) µm wide	<b><i>F. depressa</i></b>
40	Stem erect, regularly bipinnate; main shoots (1200-)1700-2200 µm; lobules strongly compressed, about twice as long as wide, with an obtuse rostrum; stylet absent; cells in centre of lobe 15-17 x 17-21(-26) µm	<b><i>F. rigida</i></b>
40*	Stem more or less appressed to the substrate, or pendent, not regularly bipinnate; main shoots as wide as 1700-2200 µm, or narrower; lobules not strongly	41



	compressed, rarely as much as twice as long as wide, usually with a prominent rostrum; stylet well-developed; cells in centre of lobe 15-17 x 17-21(-26) $\mu\text{m}$ , or larger	
41	Rostrum of lobules usually, towards the base, extended beyond the ventral border of the leaf; opening of lobule oblique to the stem or directed towards it	42
41*	Rostrum of lobules not usually extending beyond the ventral border of the leaf; lobule opening directed towards the base of the plant, or oblique to the stem	44
42	Underleaves bilobed to about 1/3 their length, margins frequently with 1-2 acute or obtuse teeth; cells in centre of lobe 18-20(-25) $\mu\text{m}$ long	<b><i>F. diptera</i></b>
42*	Underleaves bidentate, the sinus 1/10 to 1/5(to 1/4) their length, margins entire, sinuose, or with a very blunt tooth; cells in centre of lobe more than 20 $\mu\text{m}$	43
43	Cells in centre of lobe (23-)25-35(-40) $\mu\text{m}$ long; underleaves often abruptly narrowed in the lower 1/3 to 1/4, and thus spatulate	<b><i>F. anderssonii</i></b>
43*	Cells in centre of lobe (20-)23-26(-30) $\mu\text{m}$ long; underleaves subelliptic, never abruptly narrowed in the lower 1/3 to 1/4	<b><i>F. spongiosa</i></b>
44	Perianth either trigonous or with 5 keels, of which only one is ventral, or keels absent	45
44*	Perianth with 2-5 ventral keels, or trigonous with 3-5 secondary plicae	50
45	Cells in centre of lobe frequently more than 30 $\mu\text{m}$ long; plants robust, main shoots (1400-)2000-2500(-2800) $\mu\text{m}$ wide; perianth usually at apex of a lateral branch, without innovations	46
45*	Cells in centre of lobe rarely as long as 30 $\mu\text{m}$ ; plants less robust, main shoots less than 2000 $\mu\text{m}$ wide; perianth at apex of a short lateral branch without innovations, or at apex of a long branch with 1(-2) innovations	48
46	Perianth inflated, lacking keels or obtusely trigonous, smooth; lobules often sub-triangular in profile	<b><i>F. bullata</i></b>
46*	Perianth trigonous, smooth or verrucose; lobules rarely sub-triangular in profile	47
47	Lobules with a long arched rostrum, not prolonged into an apiculus, generally extending beyond the lower margin of the lobe; underleaves often clearly narrowed in the basal 1/4 to 1/3, therefore appearing spatulate	<b><i>F. anderssonii</i></b>
47*	Lobules well-developed, with a pointed rostrum, often prolonged into an apiculus 2-3(-6) cells long; lobule not extending beyond the lower margin of the lobe; underleaves $\pm$ cordate, never narrowed at the base, therefore not appearing spatulate	<b><i>F. caffraria</i></b>
48	Underleaves (2-)3-5(-6) times as wide as stem, margins rarely with a sharp tooth; stylus small, narrowly triangular, 2(-3) cells wide at base; gynoeceum at apex of a short lateral branch, without innovations	49
48*	Underleaves 1.5-2.5 times as wide as stem, often with 1(-2) sharp teeth on margin; stylet frequently lanceolate, (4-)5-9 cells wide at greatest width; gynoeceum at the apex of a branch, usually with an innovation	<b><i>F. dilatata</i></b>
49	Lobes squarrose when moist; rostrum of lobule rarely extending beyond the lower margin of lobe; underleaves (2-)3-4(-5) times as wide as stem, longer than wide	<b><i>F. ericoides</i></b>
49*	Lobes plane or convex; rostrum of lobule often extending beyond the lower margin of the lobe; underleaves 3-5(-6) times as wide as stem, wider than long	<b><i>F. spongiosa</i></b>
50	Stylet large, forming a ligulate band/blade 3-6 cells wide at base	<b><i>F. socotrana</i></b>
50*	Stylet sometimes small and setaceous, or narrowly triangular, lanceolate or ligulate, but in that case 2-3 cells wide at the base	51
51	Margins of lobes with enlarged gemma-initial cells or with multi-cellular gemmae; lobules not or weakly rostrate; lobes often caducous; dioecious	<b><i>F. obscurifolia</i></b>
51*	Margins of lobes not producing gemmae; lobules generally rostrate; lobes not caducous; monoecious or dioecious	52
52	Perianth trigonous, with 3-5 secondary plicae	<b><i>F. hedbergii</i></b>
52*	Perianth with 2-3 ventral keels	53
53	Monoecious; lobes suborbicular; union between lobule and lobe moderately long, obvious	<b><i>F. trinervis</i></b>
53*	Dioecious; lobes obtuse; union between lobule and lobe very short	<b><i>F. diptera</i></b>

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## Names of African *Frullania* taxa

africana Steph.  
anderssonii Angstr.  
angulata Mitt.  
apicalis Mitt.  
apiculata Pears.  
arecae (Spreng.) Gottsche.  
brunnea (Spreng.) Gottsche et al.  
bullata Steph.  
caffraria Steph.  
capensis Gottsche  
depressa Mitt.  
dilatata (L) Dum.  
diptera (Lehm. & Lindenb.) Gottsche et al.  
ecklonii (Spreng.) Spreng.  
epiphylla Vanden Berghen  
eplicata Steph.  
ericoides (Nees) Mont.  
gabonensis Vanden Berghen  
grossiclava Steph.  
hedbergii Vanden Berghen  
humbertii Vanden Berghen  
imerinensis Steph.  
letestui Vanden Berghen  
lindenbergii Lehm.  
longistipula Steph.  
loricata Pears.  
microphylla (Gottsche) Pears  
nodulosa (Reinw., Blume & Nees) Nees  
obscurifolia Mitt.  
onraedtii Vanden Berghen  
polysticta Lindenb.  
purpurea Steph.  
repandistipula Sande Lac.  
rigida Steph.  
schimperi Nees  
serrata Gottsche  
socotrana Mitt.  
spongiosa Steph.  
tamarisci (L.) Dum.  
teneriffae (Weber) Nees  
tixierana Vanden Berghen (= repandistipula)  
trinervis (Lehm. & Lindenb.) Gottsche et al.  
usambarensis Steph.  
vandenberghii Pocs  
variegata Steph.

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