Contribution to the Hepaticae and Anthocerotae of Mizoram V. Three New Taxa of *Frullania* from India

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ABSTRACT: Three new *Frullania* viz., *Frullania mizoramensis* Sushil K.Singh & Barbhuiya *sp. nov., Frullania evelynae* S.Hatt. & Thaith. var. *devendrae* Sushil K.Singh & Barbhuiya *var. nov.*, *Frullania evelynae* S.Hatt. & Thaith. var. *srivastavae* Sushil K. Singh & Barbhuiya *var. nov.* are described from the Indian State of Mizoram.

KEY WORDS: India, *Frullania,* new taxa.

INTRODUCTION

Frullania Raddi (Frullaniaceae: Marchantiophyta) is one of the largest genus, represented by *ca.* 1000 species in the world (Yuzawa, 1991). In India the genus is represented by approximately 67 taxa including 3 subspecies, 8 varieties and 2 forma (Singh and Barbhuiya, 2011), of which 50 taxa (39 species + 11 infra-specific taxa) distributed in Eastern Himalaya (incl. NE India), 21 taxa (16 species + 5 infra-specific taxa) in Western Himalaya, 19 species in Western Ghats, 6 species in Andaman & Nicobar Islands and 3 species are reported from Central India. Fourteen taxa are endemic to Indian regions (Singh and Barbhuiya, *l.c.*).

While documenting the Bryoflora (Hepaticae and Anthocerotae) of Mizoram under approved Action Plan of Botanical Survey of India, since April 2008, the author (SKS) collected bryophyte samples from various parts of Mizoram- a region which is part of Indo-Myanmar hotspot of India. During laboratory investigation of the collected samples, some interesting population of *Frullania* came to the notice of the authors. A critical study reveals three hitherto undescribed taxa of the genus, which are described in present communication. All the studied material deposited at Cryptogamic Herbarium of Botanical Survey of India, Eastern Regional Centre, Shillong (ASSAM).

TAXONOMIC TREATMENTS

Frullania mizoramensis Sushil K.Singh & Barbhuiya, ***sp. nov.*** Figs. 1 & 2

Frullania mizoramensis Sushil K. Singh & Barbhuiya *sp. nov. similis F. nepalensis sed prsesertim appendicibus minoribus evolutis basin lobi folii, sine rostro in lobulo folii, stylo grandiore, periantioque rotundo, cellulis non-crassitiebus parietis capsulae quadrangularibus vel subquadrangularibus differt.*

Type: INDIA, Mizoram, Thaltlang to Sangau, Terrestrial, 26.06.2008, *S. K. Singh* 119808 (ASSAM: Holotype).

Plant olive green, large, 9.5-10.6 cm long, 1.9-2.1 mm wide, bi-pinnately branched. Stem in cross-section round or subquadrate 0.15-0.16 × 0.13-0.14 mm, 8-9 cells across, not differentiated into cortex and medulla; cells triangular to subquadrate or rhomboidal, 17.5-32.5 × 10-25 µm. Leaves complicate-bilobed, leaf lobe imbricate, wide spreading, elliptical or ovate, concave with incurved apices, dorsally extending beyond the farther edge of stem, when flat, ovate with obtuse apices and rounded-appendaged dorsal bases, 0.9-1.0 × 0.5-0.7 mm, marginal cells towards apex sub quadrate, 17.5-27.5 × 17.5-22.5 µm, thin walled with small trigones and intermediate thickenings, median cells 22.5-35 × 20-25 µm, thin walled with medium sized nodulose trigones, basal cells 30-55 × 17.5-32.5 µm, thick walled with large, nodulose, often more or less confluent trigones, trigones pale yellow; leaf lobule helmet-shaped, erect, 0.1-0.2 × 0.15-0.22 mm, with rounded heads and truncate, wide mouth, distal portion of mouth more or less acute; styli generally large flat 16-30 celled, occasionally small formed by a raw of 6 cells, 0.11-0.23 × 0.02-0.08 mm. Underleaves large, suborbicular to nearly reniform, flat, remote to contiguous, imbricate, appressed to the stem, 0.4-0.6 × 0.5-0.7 mm, 4-5 times the width of stem, 1/5-1/4-bifid, sinus subacute, lobes triangular, apex subacute to obtuse, base rounded-cordate, rhizoid-initial area just below the underleaf-centre, convex. Dioecious. Female inflorescence terminal on stem or on robust branches; female bract ca. 3 pairs; bracts lobe oblong-ovate with subacute or narrowly obtuse or apiculate and usually

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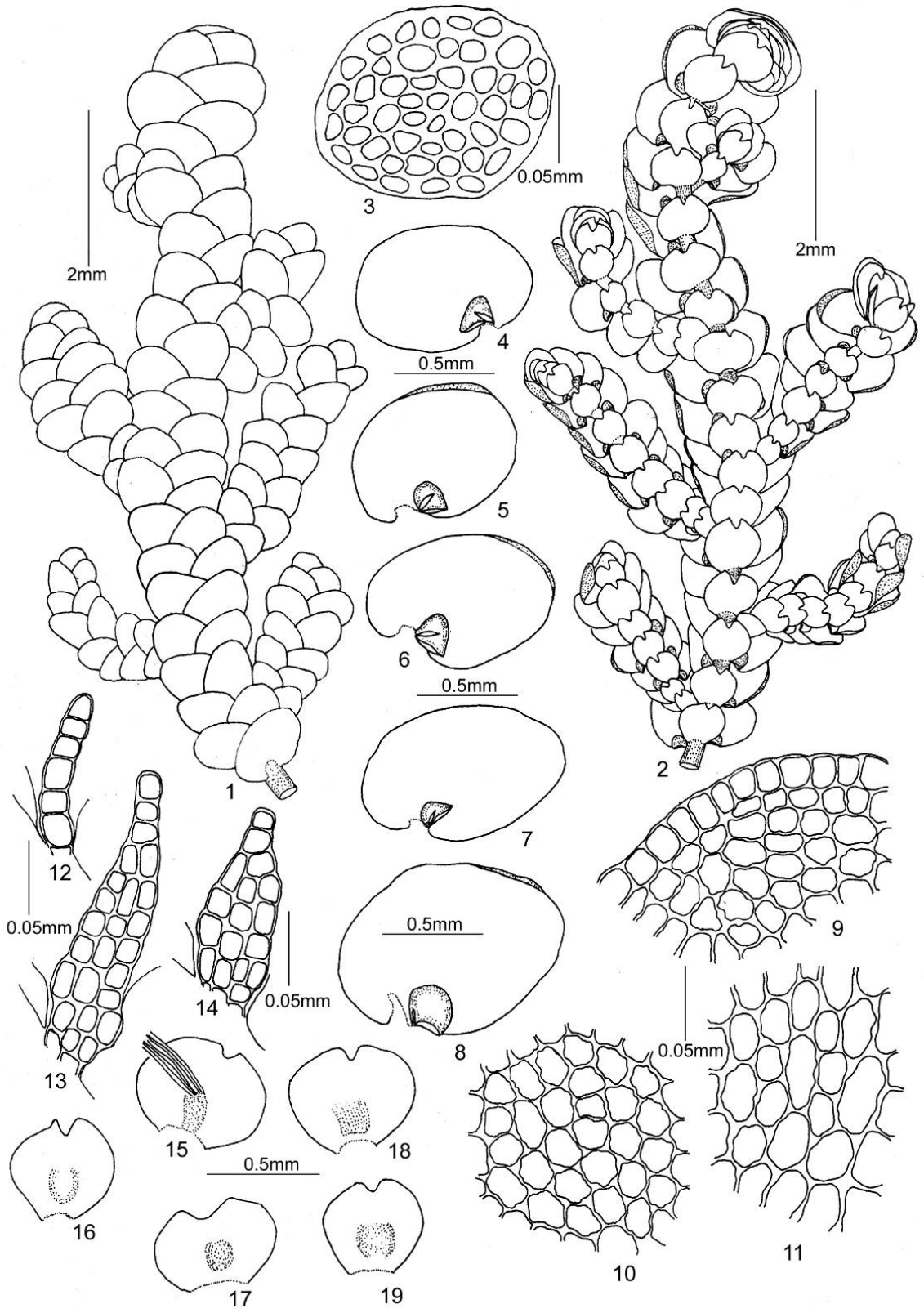


Fig. 1. *Frullania mizoramensis* Sushil K.Singh & Barbhuiya sp. nov. 1. A portion of the plant in dorsal view. 2. The same in ventral view. 3. C.S. of stem. 4-8. Leaves with lobule. 9. Marginal leaf cells towards apex. 10. Median leaf cells. 11. Basal leaf cells. 12-14. Styli. 15-19. Underleaves.

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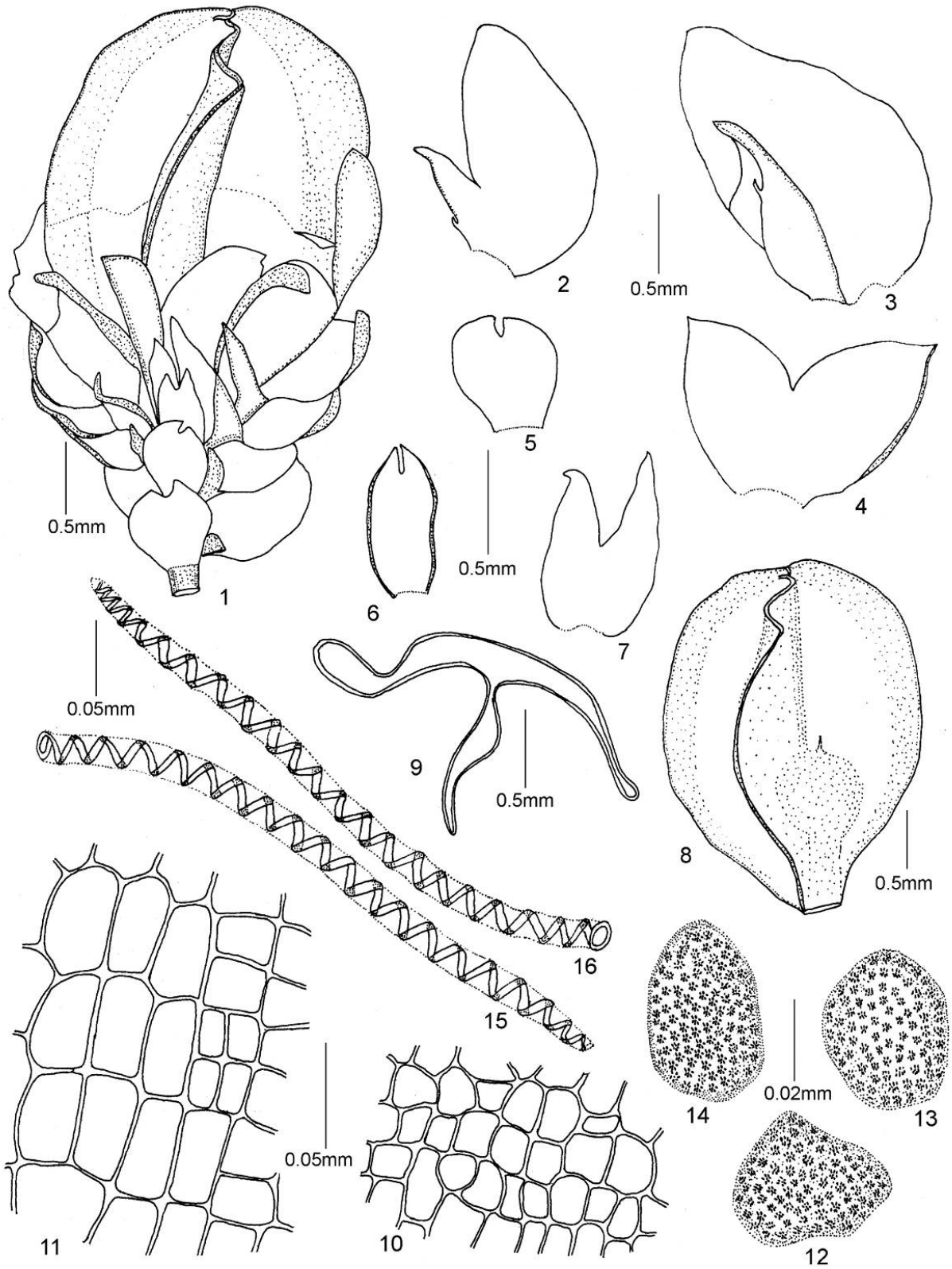


Fig. 2. ***Frullania mizoramensis*** **Sushil K.Singh & Barbhuiya sp. nov. 1. Female inflorescence showing arrangement of bract, bracteoles and perianth. 2-4. Female bract. 5-7. Female bracteoles. 8. Perianth. 9. C. S. perianth. 10. Cells of inner layer of capsule wall. 11. Cells of outer layer of capsule wall. 12-14. Spores. 15-16. Elaters.**

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incurved apices and entire but weakly undulate margins, 1.4-2.2 × 0.8-1.2 mm; bract lobule ca. 1/3-connate, 0.8-1.4 × 0.3-0.7 mm, strongly canaliculate-lanceolate with attenuate and acute apex, free margin incurved, with long tooth, usually 6-8 celled and up to 2-cell wide at base; innermost bracteole nearly flat, oblong in outline, 0.7-0.9 × 0.3-0.5 mm, 1/2-bifid sinus narrow and acute, lobes narrowly triangular-lanceolate with attenuate and acute apex, outermost bracteoles 0.6-0.7 × 0.5-0.6 mm, 1/4-bifid, sinus obtuse, lobes triangular, with subacute apices and barely auriculate bases. Perianth ovate or subspherical, fully exerted, ca. 3.3 × 2.3 mm, surface smooth, dorsally almost flat, 3-keeled (one strong, ventral and 2-lateral). Capsule globose; cells of inner wall 12.5-32.5 × 12.5-40 µm, those of outer wall 27.5-52.5 × 15-50 µm, quadrangular to subquadrangular in shape, hyaline, trigones simple and without nodular thickenings. Spores rhomboidal to elliptical, 28.6-48 × 27.5-34.7 µm, with 55-70 rosettes of each consisting of 15-18 irregular out growth. Elaters unispirate, 0.4-0.5 × 0.013-0.023 mm.

Note: *Frullania mizoramensis* distinctly differs from all the hitherto known species of the genus in having plants with weakly developed basal appendages of leaf lobe, absence of beak in leaf lobule, typically larger and flat styli, ovate or subspherical exerted perianth, capsule wall cells quadrangular to subquadrangular hyaline and without nodular thickenings. However, it shows resemblance with *F. nepalansis* (Spreng.) Lehm. & Lindenb. in plant size, elliptical leaf lobe with obtuse apices, galeate leaf lobule, shape of innermost female bract lobule, innermost female bracteole and exerted perianth but *F. nepalansis* differ from the species in discussion by having strongly developed basal appendages in leaf lobe, and comparatively larger size of leaf lobule with incurved beak, typically smaller stylus, widely subquadrate-ovate underleaves and incurved lateral margin and long perianth (Hattori, 1973).

Frullania mizoramensis also shows similarity with a Micronesian species *F. saipanensis* S.Hatt. & Koike in shape of leaf lobe, leaf lobule, underleaves, in having toothed margin of innermost bract lobule. However, the latter distinctly differs from the former by being comparatively tiny plant, having well developed basal appendages of leaf lobe, with smaller stylus, oblong-elliptical innermost bract lobule which apex are rounded to obtuse, innermost bracteole bearing strong tooth and semi-exerted pyriform perianth (Koike, 1994).

Etymology: This species is named after the Indian State of Mizoram from where it is collected.

Frullania evelynae S.Hatt. & Thaith. var. ***devendrae*** Sushil K. Singh & Barbhuiya, ***var. nov.*** Figs. 3 & 4

Fullania evelynae S. Hatt. & Thaith. *var. devendrae* Sushil K. Singh & Barbhuiya *var. nov. a F. evelyna viridula planta terrestri, caule gracili, rotundis vel subquadrangularibus appendicibus supra basin lobi folii perianthioque fere immerso differt.*

Type: INDIA, Mizoram, towards Pangkhua from Sangau, Terrestrial, 28.06.2008, *S. K. Singh* 119860 (ASSAM: Holotype).

Plant light green, 3.0-3.5 cm long, 1.4-1.6 mm wide, branching 1-2 pinnate. Stem in cross-section spherical or elliptical in outline, 0.17-0.20 × 0.16-0.18 mm, 10-12 cells in across, not differentiated into cortex and medulla; cells triangular, subquadrangular, 12.5-35 × 10-20 µm. Leaves complicate-bilobed, leaf lobes moderately imbricate, wide spreading, ovate to ovate-elliptical, apex obtuse, slightly cordate at base, 0.7-1.0 × 0.6-0.8 mm, dorsally extending beyond the stem, nearly flat but with narrowly incurved distal margin; basal appendages subquadrangular to rounded; marginal cells towards apex subquadrangular, 17.5-22.5 × 10-20 µm, thin walled with small trigones and intermediate thickenings, median cells 22.5-35 × 20-25 µm, due to intermediate thickenings cell walls became sinuate with medium sized trigones, basal cells 27.5-37.5 × 22.5-30 µm, nodulose with triangular trigones; leaf lobules cucullate to lanceolate-canaliculate, 0.2-0.3 × 0.12-0.17 mm, beak not well developed; styli filiform, formed by a raw of 5-7 cells, 87.5-105 × 15-22.5 µm. Underleaves flat, rounded-quadrate, to suborbicular, apex truncate, undulated, slightly incurved 0.4-0.6 × 0.5-0.7 mm, 3-4 times the stem width. Dioecious (?). Female inflorescence terminal on stem or on branches; female bracts triangular-ovate with an obtuse or subacute apex, 2.3-2.5 × 1.8-2.0 mm, connate with lobule, free margin entire, incurved; bract lobules triangular-ovate, *ca.* 1.5 × 0.6 mm, margin slightly incurved, apex acute, margin with 1 large tooth or lacina, bearing two teeth; bracteoles ovate-oblong, *ca.* 2.0 × 1.3 mm, innermost bracteole largest, 1/3rd bifid, sinus narrow, lobes triangular, apex subacute, teeth absent or occasionally with 1 large tooth along the lower half. Perianth pyriform, ca. 2.8 × 1.9 mm, semi exerted, surface smooth, 5-keeled. Capsule globose; cells of inner wall hyaline, subquadrangular, 25-35 × 20-30 µm, those of outer wall quadrangular with noduler thickenings, 40-55 × 30-50.4 µm. Spores spherical to rhomboidal 32.5-82.5 × 31.5-52.5 µm. Elaters unispirate, 582.5 × 17.5-32.5 µm.

Note: *Frullania evelynae* var. *devendrae* shows close affinity with *F. evelynae* in having light green colour of plant, 1-2 pinnate branching pattern, spherical stem which are 10-12 cells across, not differentiated in to cortex and medulla, semi-exerted cucculate leaf lobule filiform stylus. But *F. evelynae* differs in having

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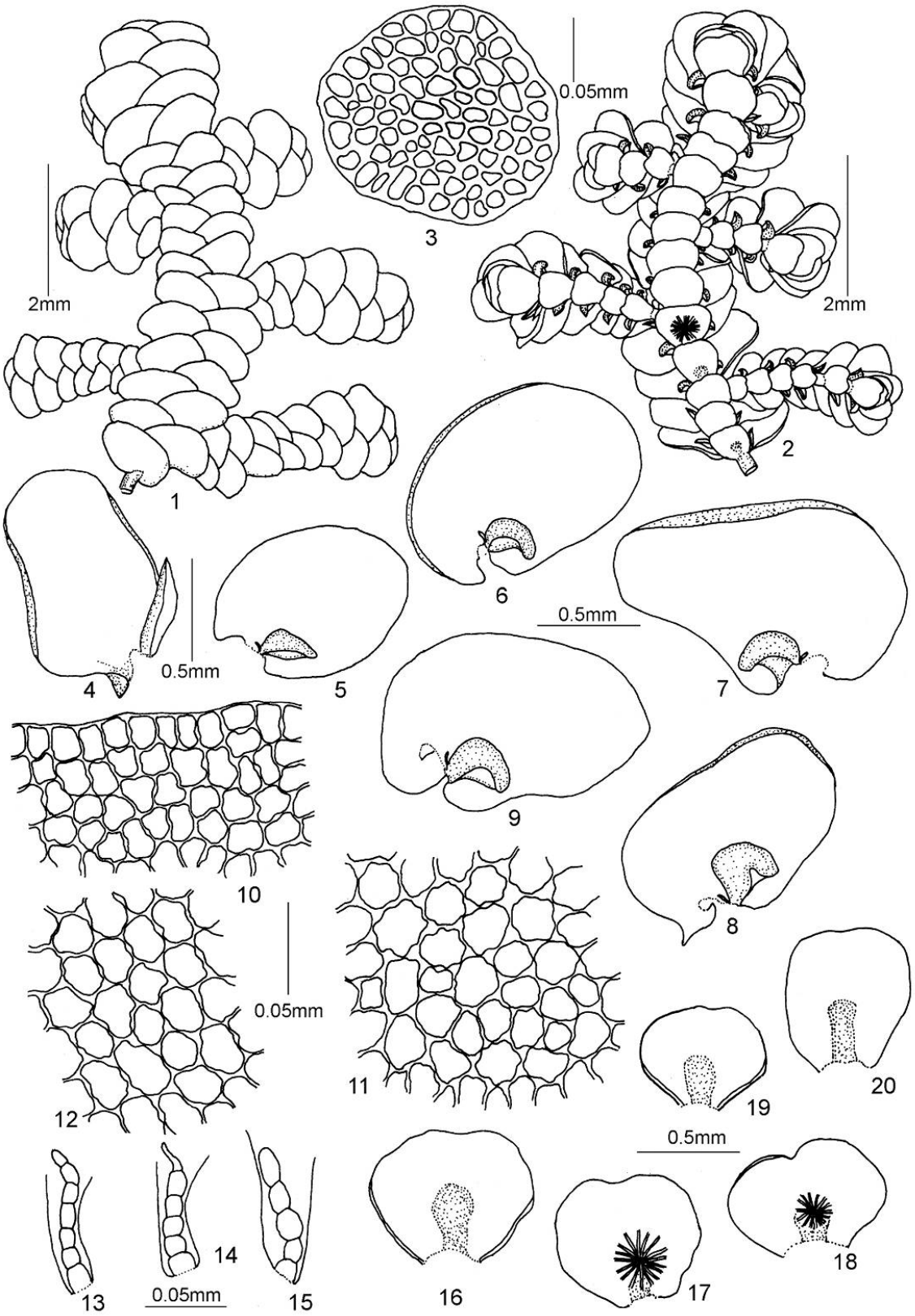


Fig. 3. *Frullania evelynae* S.Hatt. & Thaith. var. *devendrae* Sushil K.Singh & Barbhuiya *var. nov*. 1. A portion of the plant in dorsal view. 2. The same in ventral view. 3. C.S. of stem. 4-9. Leaves with lobule. 10. Marginal leaf cells towards apex. 11. Median leaf cells. 12. Basal leaf cells. 13-15. Styli. 16-20. Underleaves.

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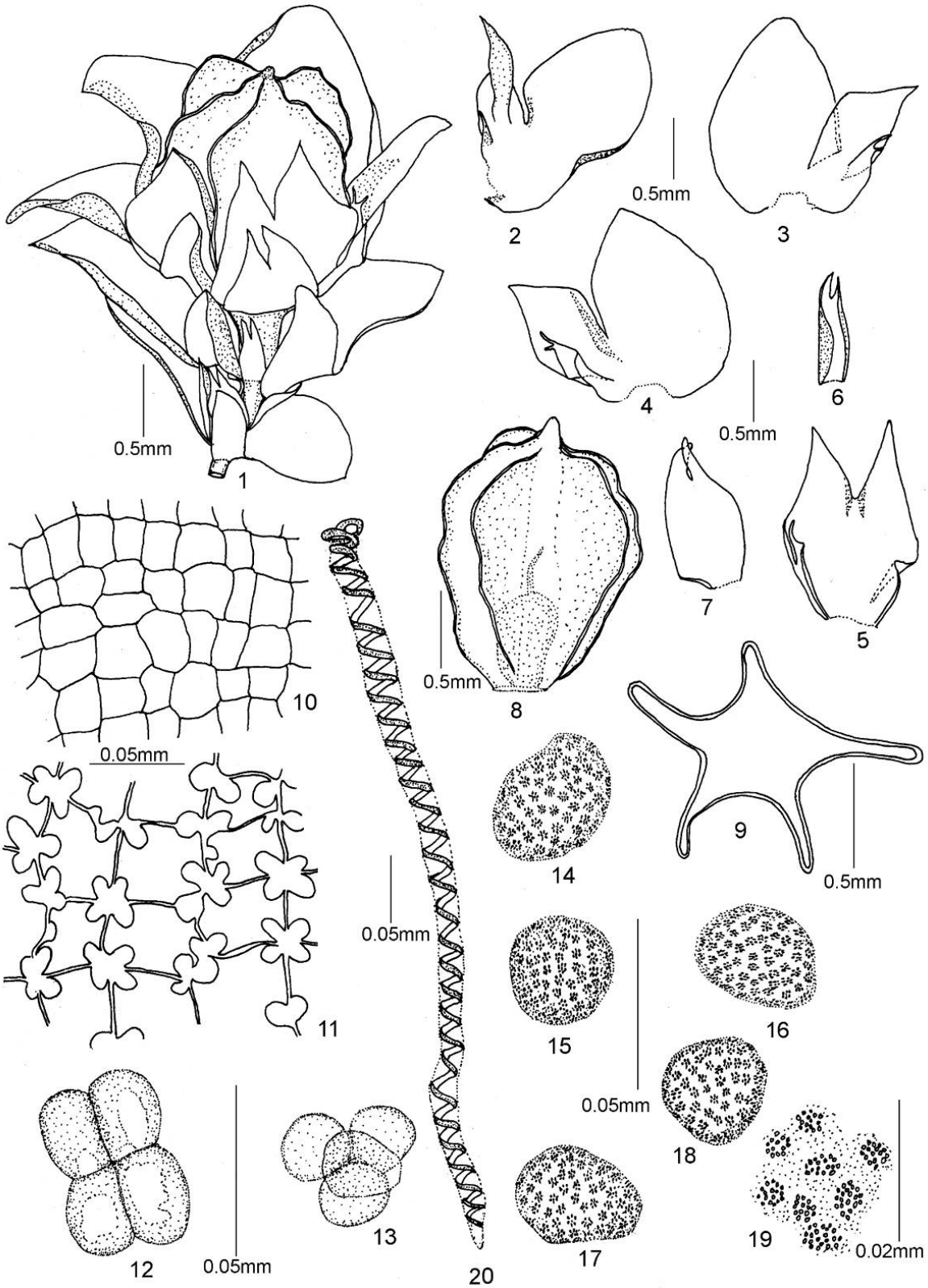


Fig. 4. *Frullania evelynae* S.Hatt. & Thaith. var. *devendrae* Sushil K.Singh & Barbhuiya *var. nov*. 1. Female inflorescence showing arrangement of bract, bracteoles and perianth. 2-4. Female bract. 5-7. Female bracteoles. 8. Perianth. 9. C. S. perianth. 10. Cells of inner layer of capsule wall. 11. Cells of outer layer of capsule wall. 12-13. Spore tetrad. 14-18. Spores. 19. A portion of the spore magnified. 20. An elater.

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epiphytic nature of habitat, ovate to nearly orbicular leaf lobule which lacks basal appendages, 4-11-cells long, up to 2-cells wide (at base) stylus, slightly larger suborbicular to reniform underleaves, 4-5 times the stems width, semi exerted pyriform perianth with 5 undulated keels which are spread up to the half of perianth, slightly smaller ovate-orbicular bract lobe with subacute apex, subtriangular, ovate to lanceolate-canalliculate bract lobule with 1-2 large teeth near base and 1 blunt basal tooth, 1/6-1/5th bifid broadly ovate or obovate bracteole with 1 large tooth along the lower half (Hattori and Thaithong, 1978).

Frullania evelynae var. *devendrae* also shows similarity with *F. physantha* Mitt. in stem anatomy, structure of stylus, underleaf width which is 3-4 times of the stem width, bract lobule. However, *F. physantha* by being brown to dark brown, epiphytic nature, irregularly bi or tri-pinnate having stem differentiated into cortex and medulla, elliptical leaf lobe with rounded basal appendages, galeate nature of leaf lobules completely covered by under leaves, smaller size of stylus, comparatively larger suborbicular under leaves, widely ovate-cordate bract lobe, oblong bract lobule with acuminate-acute apex, slightly larger ovate bracteole which bases usually with few furcated minute teeth and exerted almost spherical large perianth with 5 short keels which are confined at apex, differ from the *Frullania evelynae* var. *devendrae*.

Frullania evelynae var. *devendrae* is characterized by plants having ovate to ovate-elliptical leaf lobe with subquardangular to rounded basal appendages, comparatively smaller rounded-quadrate or suborbicular underleaves, ovate or sub quadrangular almost immersed perianth with 5 smooth keels spread up to base, bract lobe triangular-ovate with an obtuse or subacute apex, triangular-ovate bract lobule, ovate-oblong bracteole which occasionally with 1 large tooth along the lower half and terrestrial habitat of plants.

Etymology: This variety is named in honour of Jankiammal Awardee Dr Devendra Kumar Singh, Addl. Director BSI, Kolkata, the mentor of one of the authors (SKS).

Frullania evelynae S.Hatt. & Thaith. var. ***srivastavae*** Sushil K.Singh & Barbhuiya, ***var. nov.*** Figs. 5 & 6

Fullania evelynae S. Hatt. & Thaith. *var. srivastavae* Sushil K.Singh & Barbhuiya *var.nov. conferta F. evelynae et F. evelynae var. devendrae. Sed F. evelynae var. evelynae planta rubenti-brunneola, andricio terminali 3-4 paribus masculis bracteis, majoribus pyriformibus perianthis, 5 carinis undulatis patentibus usque as supernum medium differt. F. evelynae var. devenrae viridula planta terrestri, appendicibus folii supra basin subquadrangularibus vel rotundatis, fere immesro periantho in quo plicis patentibus supra basin differt.*

Type: INDIA, Mizoram, Thaltlang, epiphytic, growing in association with *Frullanoides sp.,* 25.06.2008, *S. K. Singh* 119728 (ASSAM: Holotype).

Plant dark brown to blackish, 2.5-3.5 cm long, 1.5-2.2 mm wide; branching irregularly pinnate or tri-pinnate. Stem in cross-section round to elliptical, 9-11 cells across, margin wavy, 0.14-0.16 × 0.15-0.23 mm, differentiated into cortex and medulla; cortical cells slightly smaller than the medullary cells, both cortical and medullary cells with heavily thickened walls, but the cortical cells more heavily pigmented, generally one layered, 10-30 × 7.5-15 µm, medullary cells triangular to subrectangular 7.5-32.5 × 10-22.5 µm, with large intercellular spaces. Leaves complicate-bilobed, leaf lobes imbricate, obovate to oblong-obovate, widely spreading but concave with incurved distal margin, dorsally far beyond the farther edge of stem, 0.8-1.2 × 0.6-1.0 mm apices rounded, base profoundly cordate, dorsal base subtriangular, ventral base rounded, marginal cells towards apex subquadrangular, 12.5-22.5 × 12.5-17.5 µm, walls slightly sinuate, thick, median cells rhomboidal, 20-30 × 17.5-27.5 µm, walls sinuate with subnodulose trigones and intermediate thickenings, basal cells large subrectangular, 27.5-47.5 × 25-45 µm, with large nodulose trigones and intermediate thickenings; leaf lobules contiguous to the stem, semi exerted, rounded-cucullate, 0.2-0.3 × 0.3-0.4 mm, with widely truncate apices, beaks poorly developed; styli small, filiform of a raw of 5-6 cells, 62.5-100 × 15-17.5 µm. Underleaves suborbicular, reniform or rounded-quadrate, entire, slightly truncate at apex, 0.4-1.1 × 0.6-1.0 mm, densely or moderately imbricate, large, 4-4.5 times the stem width, narrowly but strongly recurved above or along the sides, rhizoid-initial area just below the underleaf-centre, convex, rhizoids hyaline, in a short bundle. Dioecious. Male inflorescence bearing plant comparatively smaller, 2.3-2.5 cm long, 1.3-1.5 mm wide; inflorescence intercalary or terminal, intercalary one slightly longer than the terminal one, ca. 1.5 × 0.8 mm, bracts 5-7 pairs, lobes 0.5-0.7 × 0.4-0.6 mm, the lobule almost similar to the lobe, basal bract lobule sometimes smaller, comprising a basal tooth on the free margin, almost 2/3-connate to the lobe; terminal one short-stalked, capitate, ca. 1.3 × 0.9 µm, bracts 5-6 pair, bract lobes 0.5-0.6 × 0.3-0.5 mm, the lobule almost similar to the lobe ca. 0.4-0.5 × 0.3 mm, 2/3-connate with the lobe; bracteole small rounded-quadrate, 0.2-0.3 × 0.3-0.4 mm. Female inflorescence terminal on main stem or on branches; female bracts in 3 pairs, ovate-oblong with an

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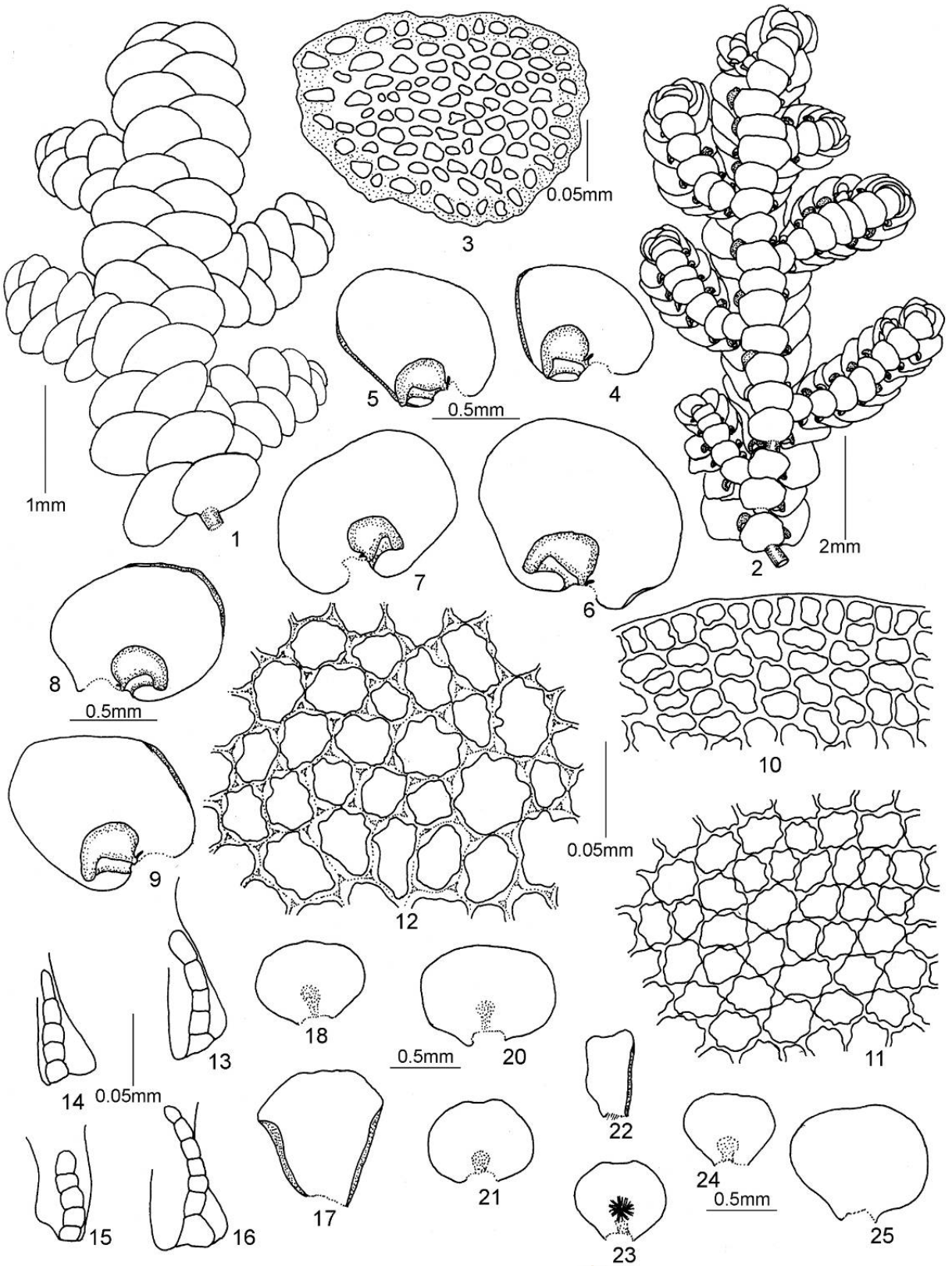


Fig. 5. *Frullania evelynae* S.Hatt. & Thaith. var. *srivastavae* Sushil K.Singh & Barbhuiya *var. nov*.1. A portion of the plant in dorsal view. 2. The same in ventral view. 3. C.S. of stem. 4-9. Leaves with lobule. 10. Marginal leaf cells towards apex. 11. Median leaf cells. 12. Basal leaf cells. 13-16. Styli. 17-25. Underleaves.

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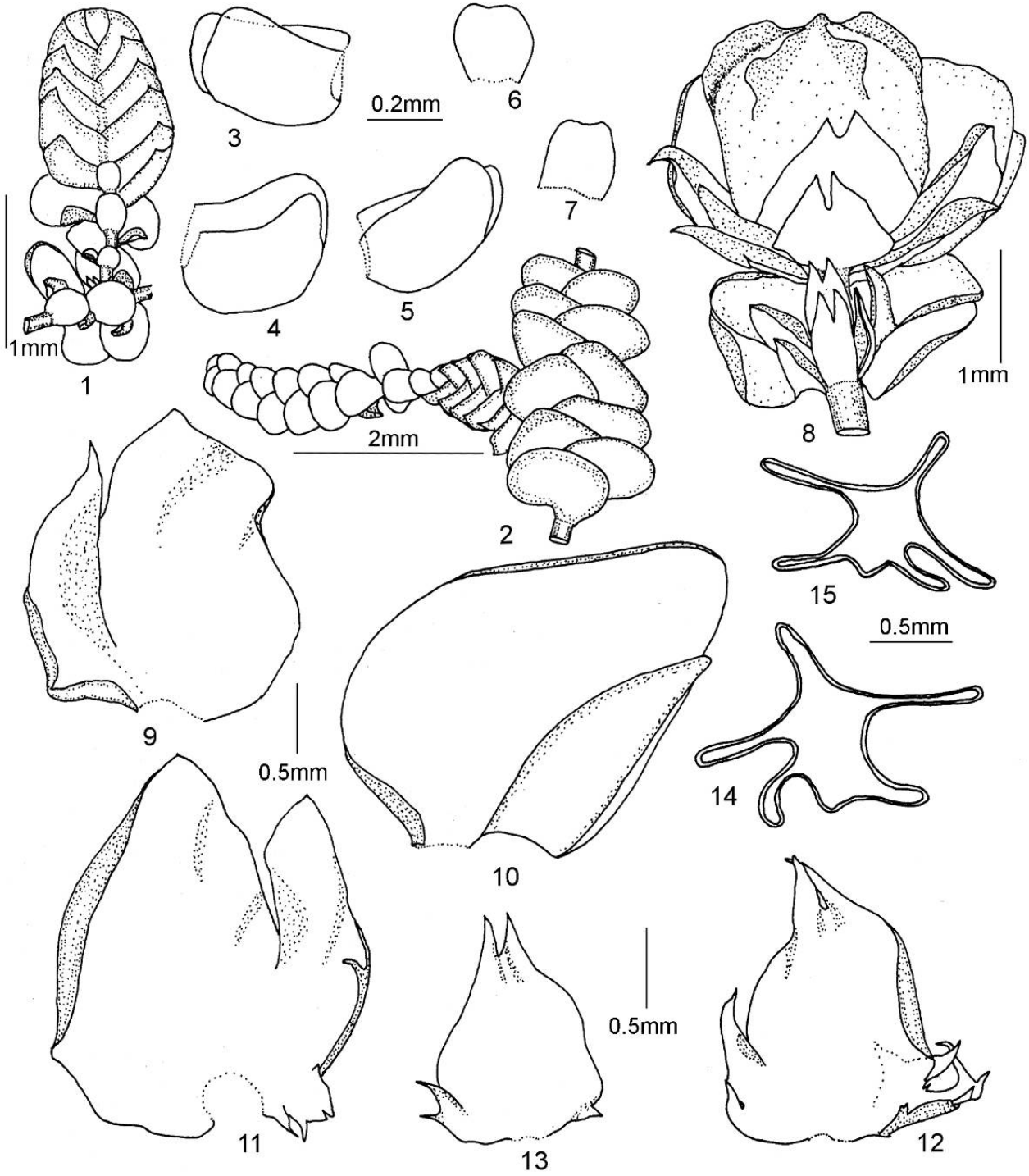


Fig. 6. *Frullania evelynae* S.Hatt. & Thaith. var. *srivastavae* Sushil K.Singh & Barbhuiya *var. nov*. 1. Terminal male inflorescence. 2. Intercalary male inflorescence. 3-5. Male bracts. 6-7. Male bracteoles. 8. Female inflorescence showing arrangement of bract, bracteoles and perianth. 9-11. Female bract. 12-13. Female bracteoles. 14-15. C. S. perianth.

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obtuse or subacute apex, free margin incurved, 2.3-2.6 × 1.5-1.8 mm; bract-lobule oblong-ovate to lanceolate-canalliculate, free margin with a small tooth and base with few furcated teeth, 2.0-2.4 × 0.8 mm; bracteole traingular-ovate 1.5-2.1 × 1.2-2.0 mm, 1/6-1/5–bifid, sinus acute, lobes lanceolate-acute, with 1-2 large tooth along the lower half which often subdivided. Perianth quadrangular or suborbicular, ca. 1.8 × 1.6 mm, semi-exerted, 5-keeled, keels slightly undulated confined at apex only.

Note: *Frullania evelynae* var. *srivastavae* is a distinct variety by having unequal size of male and female plant, stem 9-11 cells across, comparatively smaller size of leaf lobe, terminal and intercalary position of androecia, ovate-oblong bract lobe with an obtuse or subacute apex, oblong-ovate or lanceolate-canalliculate bract lobule which free margin with a small tooth and base with few furcated teeth, traingular-ovate braceteole with 1-2 large tooth along the lower half which is often subdivided and quadrangular to sub-orbicular perianth.

Both varities i.e. *F. evelynae* var. *evelynae* and *F. evelynae* var. *devendarae* are quite distinct from the species in discussion. *F. evelynae* var. *evelynae* differs in having light green to reddish brown plant, equal size of male and female plant, comparatively larger size of leaf lobule, terminal androecia bearing 3-4 pairs of male bracts, comparatively smalle r, ovate-orbicular female bract lobe, subtraingular or lanceolate-canalliculate bract lobule with 1-2 large teeth near base and 1 blunt basal tooth, bracteole broadly ovate or obovate with 1 large tooth along the lower half, slightly larger pyriform perianth with 5 undulated keels spread up to half of the perianth (up to 1/3 of perianth in *Frullania evelynae* var. *srivastavae*) (Hattori and Thaithong, 1978, Singh and Barbhuiya, 2011). The variety in discussion also shows similarity with *Frullania evelynae* var. *devendarea* but differs in having light green terrestrial plants, undifferentiated stem, ovate to ovate-elliptical leaf lobe which basal appendages subquadrangular to rounded, triangular-ovate female bract with an obtuse or subacute apex, bract lobule margin with 1 large tooth or lacina bearing two teeth, immersed perianth on plicae spread up to base.

Frullania evelynae var. *srivastavae* also show the resemblance with *F. physantha* in colouration of plant, habitat, branching pattern of plant, stem anatomy, number of male bract, perianth and keels type. But, *F. physantha* differs from the species in discussion in having, slightly larger elliptical leaf lobe, with rounded basal appendages, lobules galeate often canaliculate -lanceolate at apex, completely covered by underleaves, well developed stylus (up to 31 cells long, up to 4 cells wide at base), terminal androecia, female bract lobe widely ovate-cordate with acute apex, bract lobule oblong with acuminate-acute which free margin with 1 large tooth or lacina, bracteole ovate 1/5th bifid usually with few furcated minute teeth at base, larger spherical exerted perianth (Nath and Udar,1984; Thaithong and Hattori, 1977).

Etymology: This variety is named in honuor of Prof. S. C. Srivastava, former Head, Dept. of Botany, Lucknow University, Lucknow for his illustrious contribution in Indian bryology.

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印度米佐蘭姆地區新增之三個耳葉蘚分類群

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摘要：本文描述了印度米佐蘭姆邦的三個耳葉蘚屬新分類群 (*Frullania mizoramensis* Sushil K.Singh & Barbhuiya *sp. nov., Frullania evelynae* S.Hatt. & Thaith. var. *devendrae* Sushil K.Singh & Barbhuiya *var. nov.*, *Frullania evelynae* S.Hatt. & Thaith. var. *srivastavae* Sushil K. Singh & Barbhuiya *var. nov.*)

關鍵詞：印度，耳葉蘚屬，新分類群。

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