

## Six species of *Frullania* Raddi (Frullaniaceae, Porellales, Hepaticapsida), New distributional records to Andhra Pradesh.

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### Abstract

Six species of *Frullania* Raddi. viz., *Frullania ericoides* (Nees ex Mart.) Mont, *F. inflexa* Mitt., *F. muscicola* Stephani, *F. neurota* Taylor, *F. squarrosa* Gottsche and *F. tamrisci* (L.) Dumort., collected from various localities in Andhra Pradesh, are being reported as new distributional records to the state, of which *F. neurota* Taylor form a new record to South India.

### INTRODUCTION

The genus *Frullania* is described by Raddi in 1818. Gottsche *et al.* (1844-1847), reported 201 species for the genus; Stephani (1900-1918) enumerated 780 species; Yuzaya (1991) reported 1000 species. Astana *et al.* (2017) reported 61 species from India, of which 18 species are from South India. Sandhya Rani *et al.* (2014) reported 2 species from Andhra Pradesh.

The study area, Andhra Pradesh, the seventh largest state in Indian union, covers an area of 162, 970 sq. km and lies between 12°37' and 19° 25' NL and 76° 45' and 84° 72' EL (Map-1). The state comprises 13 districts, 4 fall in Rayalaseema region and 9 in Coastal Andhra. The state has 17.86 percentage of forest cover (FSI 2019), and major portion of it fall in Eastern Ghats. State harbor more than 180 waterfalls (seasonal and perennial). Altitude of the is from sea level to 1680 meters of above MSL.

Part of bryophyte inventory during 2016 to 2019, we could collect curious bryophytes specimens from forest tracks of Eastern Ghats hill ranges in different localities and different districts of the state of Andhra Pradesh. After critical examination of the specimens, all these found belong to the genus *Frullania* Raddi. and the

species: *Frullania ericoides* (Nees ex Mart.) Mont, *F. inflexa* Mitt., *F. muscicola* Stephani, *F. neurota* Taylor, *F. squarrosa* Gottsche and *F. tamrisci* (L.) Dumort. Perusal of published literature (Dandotiya *et al.*, 2011; Sandhya Rani *et al.*, 2014; Astana *et al.*, 2017) revealed that all these six species form new distributional records to the state of Anand present report adds six more liverwort species to Bryoflora of Andhra Pradesh.

### MATERIALS AND METHODS

Extensive field explorations were conducted during 2016-2020. All the bryophyte specimens were collected by using sharp edged knife and terrestrial specimens were scraped by using manually bent and sharpened flat spoon. The collected specimens were placed in zip lock polythene cover with labeled field number. Field observations were recorded in the field notes and live photographs were taken using DSLR-Camera (Nikon D3300). Collected material brought to the laboratory, made it air dried at room temperature and preserved them in brown paper packets (12×18 cm) with detailed label (10×17cm). Critical examination of the specimens was done by using temporary slides and plant parts were separated by using micro forceps (Varin) VR-15 curved,

VR-11 straight with fine sharp edges. Slides were observed under light microscope (Olympus CH20i), light stereo microscope (Olympus SZ61) and micro measurements were taken by using ocular micro meter (ERMA) 19 mm, 100 segments in 1 cm. Photographs were taken by using Moto g3 turbo and Samsung on6 equipped with 13 MP camera with 4x wide digital zoom, different dimensions were measured and identification of the specimens by using standard floras. Descriptions, habitat and ecology, voucher specimens information, field photographs were provided for the species. Voucher specimens are deposited in Sri Krishnadevaraya University Herbarium (SKU) Ananthapuramu. Abbreviations used for the collectors are: AS (Ananthaneni Sreenath) and BR (Boyina Ravi Prasad Rao).

## RESULTS AND DISCUSSION

***Frullania ericoides*** (Nees ex Mart.) Mont, Ann. Sci. Nat. Bot. 2(12): 51. 1839; Mitt. In J. Proc. Linn. Soc., Bot. 5: 119. 1861; S. Hatt. in. J. Hattori Bot. Lab. 44: 179. 1975; S. Hatt. and Thaithong in J. Jap. Bot. 53: 129. 1978; *Jungermannia ericoides* Nees martius, Fl. Bras. 1: 346. 1833; R.S. Chopra in Proc. Indian Acad. Sci. 137: 248. 1938; Daniels, Bryophytes of Southern W. Ghats. 141 - 142. 2003.

Plants leafy, corticolous, deep green to brown, stem 30 – 40 mm long. Leaves squarrose, 0.5 – 0.6 × 0.45 – 0.53 mm, ovate to cordate, concave, obtuse at base; leaf cells 15 – 20 × 15 – 18 µm, irregularly rounded, faintly trigonous with distinct intermediate nodular thickenings in walls; oil bodies about 3 × 1 mm, 3 – 5 per cell, ovoid, segmented, bluish green; leaf lobules about 0.3 × 0.23 mm, explanate to galeate, rounded at mouth. Under leaves imbricate to distinct, transversely to obliquely inserted, ca. 0.45 × 0.3 mm, triangular to ovate, acuminate to acute at apex. Plants dioecious. Female inflorescence terminal on stem or leading branches; bracts and bracteoles 0.3 – 1.1 × 0.12 – 0.45 mm, concave, asymmetrically 2-lobed, one or two-toothed. Perianth terminal or axillary, ca. 1.5 × 1 mm, obovate, 3-keeled; keels sharp, angulate, irregularly toothed. Capsule globose, up to 1 mm in diameter, 4-valved; walls distinctly thickened at corners. Spores rounded with scattered patches of papillae, green-colored, 45 – 53 µm in diameters. Elaters brown with single spiral, up to 530 µm long.

**Habitat and ecology:** Corticolous on *Mangifera indica* and *Terminalia paniculata* tree barks as mono-dominant plants or sometimes associated with other pleurocarpous mosses.

**Specimens examined:** India, Andhra Pradesh, Chittoor district, Horsley hills, near Krishna temple road from guest hose, 15 November 2017, 51683, BR & AS; Prakasam district, Nallamalais, Gundlabrahmeswaram Wild Life Sanctuary, near Isukagundam, top hills of Bapanakonda, 05 August 2017, 53555, BR & AS.

**Distribution:** World: Brazil, Ecuador, Togo **India:** Himalayas, Himachal Pradesh, Kerala, Meghalaya, Sikkim and Tamil Nadu.

***Frullania inflexa*** Mitt., J. Proc. Soc. Bot. 5: 120. 1861; R.S Chopra, J. Indian Bot. Soc. 22: 249. 1943; Kachroo, Bull. Bot. Surv. India 12: 230. 1970; V. Nath and A.K. Asthana, J. Hattori Bot. Lab. 85: 68. 1998; Daniels, Bryophytes of Southern W. Ghats. 143 - 144. 2003.

Plants leafy, corticolous, dark greenish to reddish brown, main stem 1 – 2 cm long. Stem branched, wide-spreading. Leaves closely imbricate, wide-spreading, 0.35 – 0.45 × 0.27 – 0.35 mm, ovate, entire at margin, faintly recurved, rounded at apex; leaf apical cells 10 – 20 × 10 – 18 µm, rounded-quadrate, thick-walled; middle cells 20 – 30 × 10 – 16 µm, rounded-quadrate to elongate, trigonous with intermediate nodular thickenings; basal cells 30 – 48 × 16 – 23 µm, elongate, trigonous with nodulose intermediate nodular thickenings; lobules saccate, 0.15 – 0.17 × 0.06 – 0.08 mm obliquely oriented, partly covering stem with rounded vertex directed towards stem and narrow mouth, stalked. Under leaves distinct, 0.16 – 0.18 × 0.12 – 0.14 mm, ovate-oblong, 2-lobed, subacute at apex, entire margin. Plants monoicous. Male inflorescence on lateral branches. Female bracts 0.9 – 0.98 × 0.33- 0.53 mm irregularly toothed; bracteoles ca 0.53 × 0.3 mm, 2-lobed, acuminate at apex. Perianth ca 1.2 × 0.68 mm, obovate, rostrate, 3-plivcate, smooth. Sporangium seen in immature stage. Spores and elaters not seen.

**Habitat and ecology:** Corticolous on *Sweetenia mahogani* and *Ficus* spp. barks and mostly found as mono-dominant plants.

**Specimens examined:** India, Andhra Pradesh, Chittoor district, Horsley hills, 23 August 2016, 51605, BR & AS.

**Distribution:** World: China, Japan, Nepal and **India:** Karnataka, Sikkim, Tamil Nadu and Western Ghats.***Frullania muscicola*** Stephani, Hedwigia 33: 146. 1894; Chopra, J. Indian Bot. Soc. 22: 249. 1943; Kachroo, Bull. Bot. Surv. India 12: 229. 1970; S. Hatt. And Thaithong, J. Jap. Bot. 53: 130. 1978; Udar and V. Nath, Quart. J. Pl. Sci. Res. 6: 74. 1979; V. Nath and A. K. Asthana, J. Hattori Bot.

Lab. 85: 75. 1998; Daniels, Bryophytes of Southern W. Ghats. 144. 2003; Manju. Eco-systematic studies on bryophytes of Wayanad, Kerala.118. 2005.

Plants leafy, corticolous, deep green to brown main stem 10 – 20 mm long. Leaves 0.5 – 0.7 × 0.3 – 0.5 mm, ovate to elliptic, entire margin, leaf cells 10 – 32 × 8 – 26 µm; oil bodies 1 – 8.1 × 1.1 – 4.1 µm, globose to elongate-ovoid, 2 – 4 per cell, faintly granular; lobules strongly saccate, rarely cucullate or explanate. Under leaves transversely to obliquely inserted, 0.3 – 0.4 × 0.2 – 0.3 mm, obtuse, angular on either side, 1 or 2-toothed at margin, 2-lobed; lobes acute to subacute at apex. Plants dioecious, female bracts and bracteoles entire, perianth obovoid, 5-keeled, smooth, entire margin with prominent rostrum. Sporangium and spores not seen.

**Habitat and ecology:** Corticolous on Eucalyptus tree bark substratum and Terminalia tree bark, mostly monodominant or sometimes associated with other pleurocarpous mosses.

**Specimens examined:** India, Andhra Pradesh, Chittoor district, Mamandur, 08 January 2017, 52240A, BR & AS; Talakona waterfalls, 29 October 2017, 53674, BR & AS; top hills of Tirumala, near Sreevaripaadaalu waterfalls, 14 November 2017, 53780B & 53781, AS; Visakhapatnam district, Annavaram and Moolakotturu agency area, near Orissa border, Rallagadda RF, 14 December 2017, 53917C, AS; Anantagiri hill ranges, Galikonda, near view point, 21 October 2018, 55194B, AS.

**Distribution: World:** China, Japan, Korea, Manchuria, Magnolia, Nepal and **India:** Himachal Pradesh, Himalayas, Kerala, Tamil Nadu and Uttarakhand.

**Frullania neurota** Taylor, London J. Bot. 5: 400 1846; Steph., Spec. Hep. 4: 674. 1910; Verd., Ann. Bryol. Suppl. 1: 66. f 96 – 103. 1930; Miller, Bryologist 56: 45. 1953; Clark, Bryologist, 57: 29 f. 1-10. 1954; Bapna & Kachroo, Hepac. India. 2: 185 – 186. 2000.

Plants leafy, corticolous, reddish brown, stem creeping, 3 - 5 cm long, pinnately or irregularly branched, rhizoids distinct, small brown, arising from the middle of the under leaves; leaf lobes imbricate, concave ventrally, 0.5 – 0.8 × 0.8 – 1.2 mm long, with incurved apex, when flat, ovate with obtuse at apex and rounded dorsal bases; cells thin walled with large nodulose and confluent, hyaline trigones; leaf lobule large, sub cucullate, flat portion is usually narrower than the galeate portion which is pretty high, however the fold of

flat portion formed with leaf lobe is distinct; leaf apical cells 14 – 16 × 8 – 10 µm, basal cells 40 – 42 × 20 – 22 µm; under leaves rotund, 3 times as wide as stem, longer than broad, bilobed with obtuse apex; the perianth is principally trapezoidal with 4-high keels, (2 lateral and 2 ventral), without additional keels. Sporophytes terminal on branches with innovations below bracts in three pairs, innermost bract lobe, oblong elliptical, apex obtuse, lobule strongly canaliculate with one large basal tooth; the inner most bracteole is highly conjugated with the adjacent bracts on both the sides. Capsules too young. Spores and elaters not found.

**Habitat and ecology:** Corticolous on *Mangifera indica* tree bark substratum associated with *Trachyphyllum inflexum*.

**Specimens examined:** India, Andhra Pradesh, Kurnool district, Nallamalais, Gundlabrahmeswaram Wild Life Sanctuary, Gundlabrahmeswaram Temple premises, near Gundlakamma river, 12 July 2017, 53520B, BR & AS.

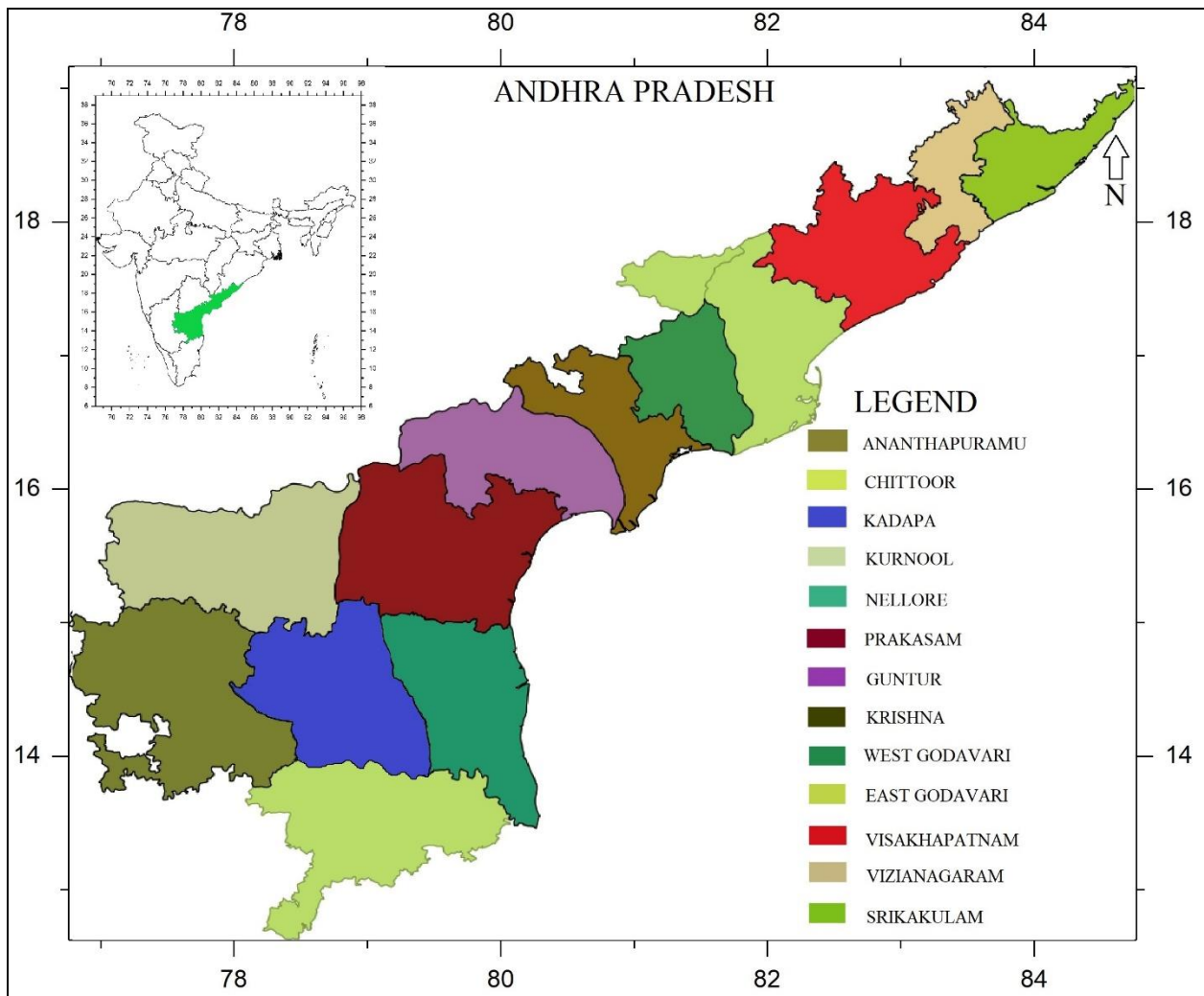
**Distribution: World:** Brazil, China and **India:** Himalaya and Sikkim.

**Frullania squarrosa** Gottsche Syn. Hep. 416. 1845; Steph., sp. Hepat. 4: 388. 1910; V. Nath & A.K. Asthana, J. Hattori Bot. Lab. 85: 75. 1998; Manju. Eco-systematic studies on bryophytes of Wayanad, Kerala.120. 2005.

Plants leafy, corticolous, green to deep brown, main stem 3 – 4 cm long, pinnately branched; rhizoids rare, small, brown, arising from the middle of the under leaves; leaf lobes imbricate, spreading, 0.4 – 0.7 × 0.7 – 1.1 mm long, base cordate, margin entire or wavy, apex rounded, leaf apical cells 16 – 18 × 8 – 10 µm, basal cells 42 – 45 × 22 – 25 µm, trigones small, wall thick, nodulose; leaf lobule triangular with a blunt apex; under leaves large, broadly ovate, margin entire, apex bilobed. Plants dioecious; female inflorescence terminal on the main axis or on the leading branches, bracts and bracteoles entire, perianth obovate to oblong, dorsally compressed, strongly 3-keeled with ornamentations on the surface and the margins. Sporangium not seen.

**Habitat and ecology:** Corticolous on Eucalyptus tree bark substratum and Ficus spp. bark, mostly mono-dominant or sometimes associated with other pleurocarpous mosses

**Specimens examined:** India, Andhra Pradesh, Chittoor district, Horsley hills, on the way of Krishna Temple from Forest guest house, 15 November 2016, 51687, BR & AS.



Map 1: Map of Andhra Pradesh.

**Distribution:** **World:** Endemic to **India:** Himalayas, Kerala, Tamil Nadu and Uttarakhand.

*Frullania tamrisi* (L.) Dumort., Recueil Observ. Jungerm. 13. 1835; Steph., Sp. Hepat. 4: 562. 1911; *Jungermannia tamarisci* L., Sp. Pl. 1134. 1753; V. Nath & A. K. Asthana, J. Hattori Bot. Lab. 85: 68. 1998; Manju. Eco-systematic studies on bryophytes of Wayanad, Kerala. 121. 2005.

Plants leafy, corticolous, olive green to brown, stem 3 – 5 cm long, pinnately branched, about 0.14 × 0.1mm, up to 9-celled across; cells 4 – 20 × 4 – 14 μm, quadrate-hexagonal, thick-walled. Leaves imbricate, 0.7 – 0.8 × 0.4 – 0.5 mm, ovate or obovate, concave, entire, short – or long-acuminate; leaf apical cells 10 – 16 × 8 – 12 μm, leaf middle cells 22 – 32 × 12 – 24 μm; basal cells 26 – 30 × 12 – 16 μm; ocelli 1- or 2-rowed, 10 – 25 cells long, along leaf midline or scattered; oil bodies 5 – 7 per

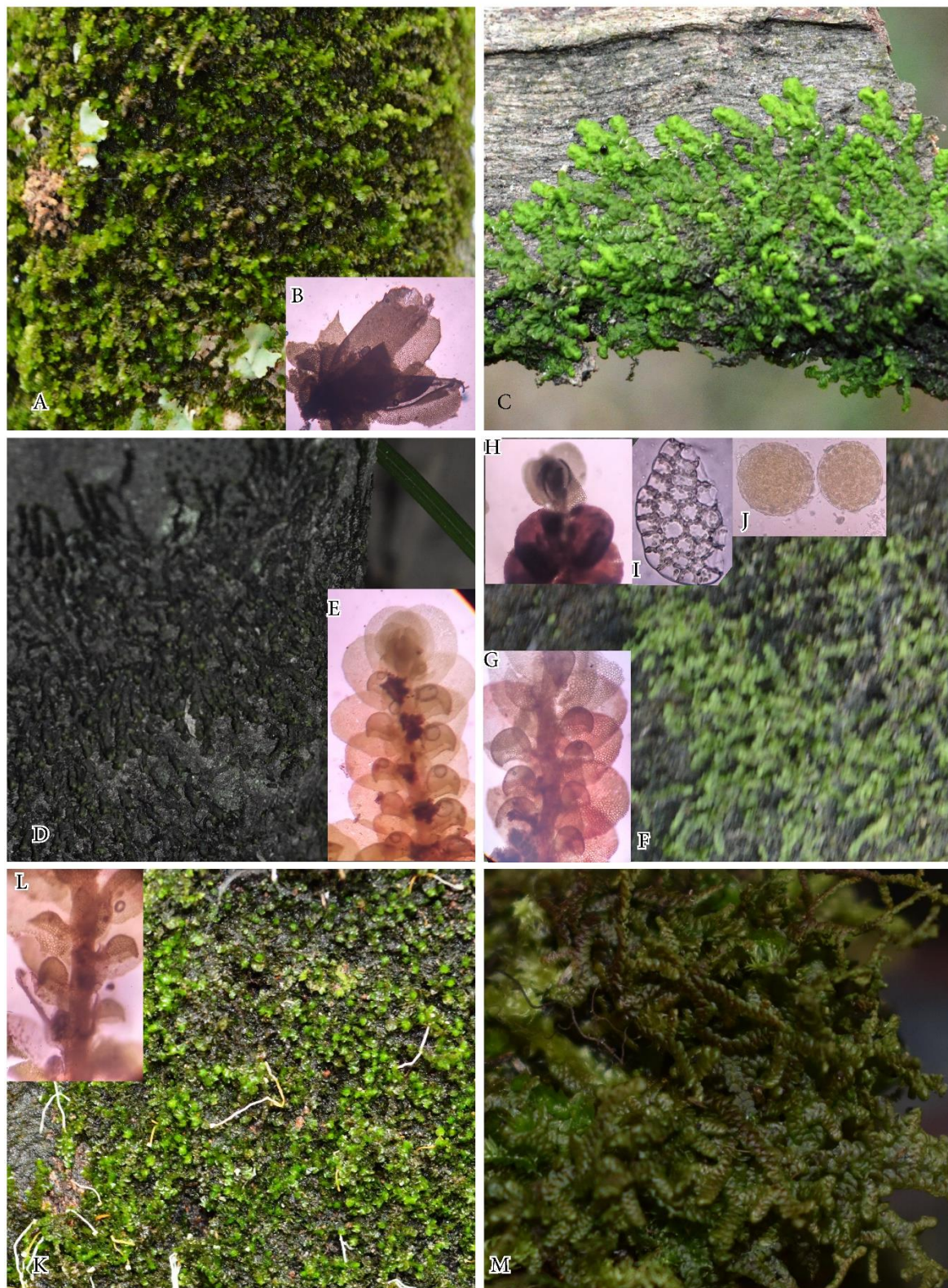
cell, 1 – 3 × 1 – 2 μm, globose or ovoid, faintly granular; lobules parallel or obliquely oriented to stem, 0.14 – 0.18 × 0.07 – 0.08 mm, clavate or explanate, longer than wide, with a rounded vertex and constructed mouth, stalked. Style with or without a distinct, semicircular disc. Under leaves 0.2 – 0.35 × 0.2 – 0.4 mm, reniform, 2-lobed; lobes roughly triangular, entire or 1 – or 2-toothed at margin, subacute. Sporangium not seen.

**Habitat and ecology:** Corticolous on *Garuga pinnata* tree bark substratum associated with *Fabonia seceunda* (Fabroniaceae).

**Specimens examined:** India, Andhra Pradesh, Visakhapatnam district, Vantamamidi RF, near Lambasingi, 13 December 2017, 53902D, AS; Sampagi Gondi RF, 10 October 2019, 57013B, AS.

**Distribution:** **World:** Endemic to **India:** Kerala, Sikkim and Tamil Nadu.





**Plate 1**

Legend:

Plate 1: A & B: *Frullania ericoides* (A. Habit B. Magnified view of perianth) C. *F. inflexa* D. & E. *F. muscicola* Stephani, (D. Habit E. Magnified view of plant) F – J. *F. neurota* (F. Habit, G. Magnified view of plant H. Magnified view of perianth, I. Leaf cells, J. Magnified view of Sporangiu. K & L. *F. squarrosa* (K. Habit L. Magnified view of plant). M. *F. tamrisci*-Habit

Sandhya Rani *et al.* (2014) reported 2 species of *Frullania*, *F. calcarata* and *F. udarii* from Andhra Pradesh. Present work added 6 more species of *Frullania* to the bryoflora of Andhra Pradesh. With this, Andhra Pradesh represents 45% of the *Frullania* of South India.

**Acknowledgements:** We sincerely thank Andhra Pradesh Forest Department for according permission to field work.

**Reference:**

**Asthana, A.K., P. Srivastava and I. Omar** 2017. *Frullania larjiana* S.K. Singh & D.K. Singh, a New addition to South Indian Bryoflora. *Natl. Acad. Sci. Lett.*: 1-3.

**Dandotiya, D.H., Govindaparyari, S. Suman and P.L. Uniyal**, 2011. Check list of the Bryophytes of India, *Archive for Bryology* :1-126. [http://framhia.de/downloads/archive\\_of\\_bryology/Archive%2088](http://framhia.de/downloads/archive_of_bryology/Archive%2088).

**Forest Survey of India.** 2019. *India State of Forest Report*, Ministry of Environment and Climate Change, Dehra Dun, ed 16: 1-24.

**Gottsche, C.M., J.B.W. Lindenberg. and C.H. Esenbeck**, 1844-1847. *Synopsis Hepaticarum*. Meissner, Hamburg.

**Nath, V. and A.K. Asthana**, 1998. Diversity and distribution of genus *Frullania* Raddi in South India. *J. Hatt. Bot. Lab.* 85: 63-82.

**Raddi, G.** 1818. *Jungermannnigrafia Etrusca*. Modenena, 45 pp.

**Sandhya Rani, S., M. Sowghandhika, K.S. Nagesh, B. Suseela and T. Pullaiah**, 2014. *Bryophytes of Andhra Pradesh*. Bishen Singh Mahendra Pal Singh, Dehra Dun. iii+279pp.

**Stephani, F.** 1900 - 1918. *Species Hepaticarum I - VI*. Georg et Cie, Lyon, meme Maison, Geneve & Bale.

**Yuzawa, Y.** 1991. A monograph of subgen. *Chonanthelia* of genus *Frullania* (Hepaticae) of the world. *J. Hattori Bot. Lab.* 70: 181-291.

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