



## Research article

## Eight families of Bryophytes as new distributional records for Andhra Pradesh, India

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**Abstract:** Eight families (two liverworts; six mosses) of Bryophytes, with ten representative species *viz.*, Liverworts- Cephaloziellaceae (*Cephaloziella kiaeri*, *Cylindrocolea tagawae*), Porellaceae (*Porella acutifolia*); Mosses- Erpodiaceae (*Solmsiella biseriata*), Hylocomiaceae (*Leptohymenium tenue*), Myuriaceae (*Myurium perplexum*), Pterigynandraceae (*Pterigynandrum filiforme*), Sematophyllaceae (*Sematophyllum humile* and *Sematophyllum subhumile*), and Trachypodaceae (*Bryowijikia ambigua*) are new distributional records for the state of Andhra Pradesh, India.

**Keywords:** Eight Families - Ten Species - Bryophytes - New records - Andhra Pradesh.

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### INTRODUCTION

The study area, Andhra Pradesh (12° 37' and 19° 25' NL and 76° 45' and 84° 72' EL) is the eighth largest state in Indian union extended to 162, 968 km<sup>2</sup>, of which 17.88% is under forest cover. The altitude ranges from sea level to 1680 m above msl. Owing to the presence of rich bryophyte habitats. Part of bryophyte inventory during 2016 to 2018, we could collect curious bryophytes specimens from different localities in the state of Andhra Pradesh. Critical examination of these specimens revealed their identity to three liver wort species representing two families: Cephaloziellaceae (*Cephaloziella kiaeri*, *Cylindrocolea tagawae*), Porellaceae (*Porella acutifolia*); seven moss species representing six families: Erpodiaceae (*Solmsiella biseriata*), Hylocomiaceae (*Leptohymenium tenue*), Myuriaceae (*Myurium perplexum*), Pterigynandraceae (*Pterigynandrum filiforme*), Sematophyllaceae (*Sematophyllum humile* and *Sematophyllum subhumile*), and Trachypodaceae (*Bryowijikia ambigua*). Perusal of literature (Rao *et al.* 1999, Sowghandhika 2010, Dandotiya *et al.* 2011, SandhyaRani *et al.* 2011a & 2011b, Sowghandhika *et al.* 2011, SandhyaRani *et al.* 2012, Pullaiah *et al.* 2012, Sandhyarani *et al.* 2014, Sreenath & Rao 2019) revealed that these species are not recorded from Andhra Pradesh and hence form new distributional records for the state of Andhra Pradesh, India.

### MATERIALS AND METHODS

The plant materials were collected from the substratum by using sharp knife and brought it to laboratory by using zip lock polythene cover with labeled field number, made it air dried at room temperature and preserved the processed specimens in brown paper packets (12 × 18 cm) with detailed label (10 × 17 cm). Critical examination of the collected 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), and measurements were taken by using ocular micro meter (Erma) 19 mm, 100 segments in 1 cm, field photographs were taken by using Nikon D3300; microscopic photographs were taken by using Moto g3 turbo equipped with 13 MP camera, 4x wide digital zoom, different dimensions were measured and identifications were done using standard bryofloras. Description, habitat and ecology, distribution, voucher specimens, microscopic photographs are provided for the all species. Distribution pertaining to the world is adopted from tropicos.org (2020) and for India following relevant literature. Voucher

specimens are deposited in the Sri Krishnadevaraya University Herbarium, Ananthapuramu (SKU). Abbreviations used for institution and collectors are: AS (Ananthaneni Sreenath), BR (B. Ravi Prasad Rao). The species are described under respective families.

## RESULTS

### Species descriptions

#### LIVERWORTS

##### Cephaloziellaceae

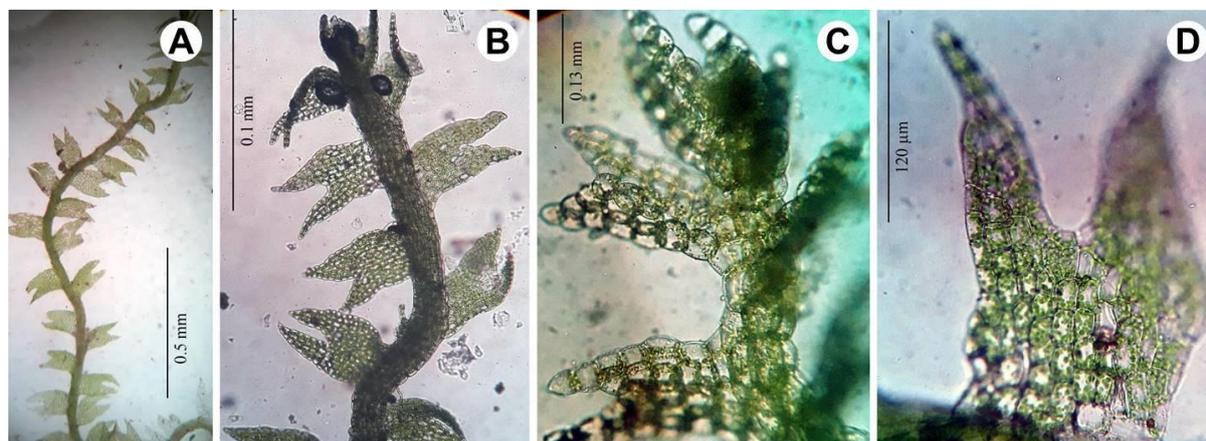
*Cephaloziella kiaeri* (Austin) S. W. Arnell Bot. Not. 3: 329 1952. Manju. Eco-systematic studies on bryophytes of Wayanad, Kerala. 2005: 104–105. [Fig. 1]

Plants prostrate, light to pale green, delicate. Rhizoids few on the basal part of the stem, ventral side on the stem. Stem branched, branches abundant and flagelliferous branches present up to 15 mm; leaves distant to contiguous, bifid, lobes sub-equal, margin entire. Leaves to  $0.13\text{--}0.24 \times 0.12\text{--}0.2$  mm, Peripheral cells smaller,  $5\text{--}15 \times 6\text{--}15$   $\mu\text{m}$ , central cells slightly larger  $8\text{--}16 \times 7\text{--}18$   $\mu\text{m}$ , cells thin walled, surface smooth; under leaves absent. Sporophytes are not seen.

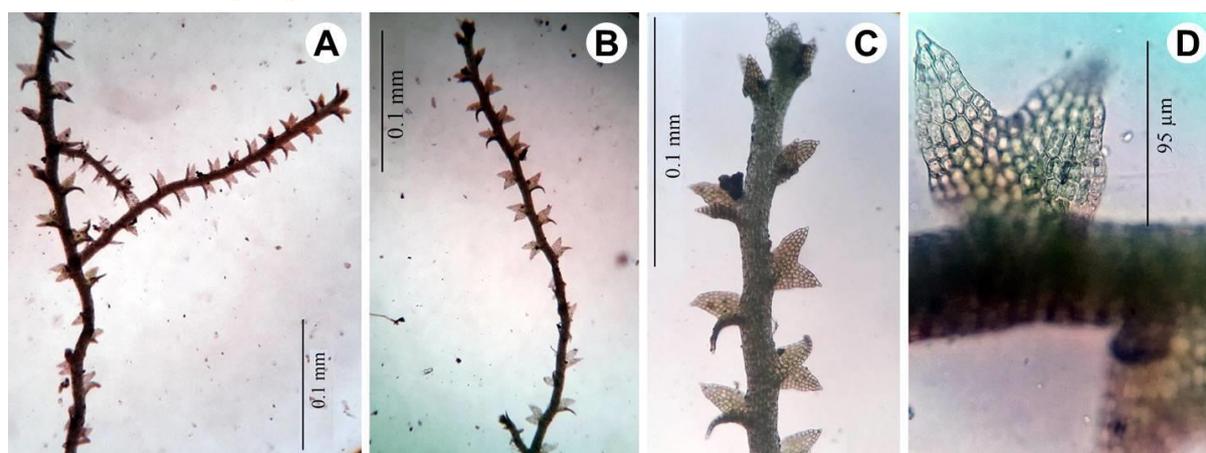
*Habitat and ecology*: Racopilous, generally found associated with other mosses and leafy liverworts.

*Specimens examined*: India, Andhra Pradesh, Visakhapatnam district, Ananthagiri Hill Range, Galikonda, Near view point, 21.10.2018, BR & AS 55203C & 55223B (SKU).

*Distribution*: China, Sri Lanka and India (Kerala and Tamil Nadu).



**Figure 1.** *Cephaloziella kiaeri* (Austin) S. W. Arnell.: **A**, Habit of single plant; **B**, Magnified view of apical portion of plant; **C**, Magnified view of apical portion and leaves; **D**, Magnified view of leaf with leaf cells.



**Figure 2.** *Cyndrocolia tagawae* (N. Kitag.) R.M. Schust.: **A**, Habit of single plant; **B**, Magnified view of branch; **C**, Magnified view of apical portion of plant; **D**, Magnified view of leaf and leaf cells.

*Cyndrocolia tagawae* (N. Kitag.) R.M. Schust. Nova Hedwigia 22: 174 1971. Manju. Eco-systematic studies on bryophytes of Wayanad, Kerala. 2005: 105–106. [Fig. 2]

Plants prostrate, rigid, light green, yellowish green to brownish green towards at apex, stem up to 5 mm long, branches flagelliferous, leaves distant to contiguous, leaves slightly concave, ovate to oblong or sometimes rectangular,  $0.07\text{--}0.16 \times 0.06\text{--}0.09$  mm, weakly bi-lobed at middle of the leaf, emarginated to retuse or rarely

obtuse, sinus extending hardly few cell deep, narrow to wide, lobes generally unequal to sub-equal, peripheral cells  $10\text{--}13 \times 10\text{--}13 \mu\text{m}$  middle cells  $10\text{--}15 \times 10\text{--}13 \mu\text{m}$ , cell walls thin surface smooth to sometimes occasionally verrucose. Under leaves absent. Sporophyte not seen.

**Habitat and ecology:** Found on moist rocks, associated with other pleurocarpous mosses.

**Specimens examined:** India, Andhra Pradesh, Prakasam district, Nallamalais Hill Ranges, Dornala range, Rollapenta water fall, 24.10.2017, BR & AS 53630 & 53631 (SKU); Chittoor district, Seshachalam Hill Ranges, Near Narabailu village, Talakona top hills near Dongala banda, 12.11.2018, BR & AS 55260A (SKU); Talakona top hills near above top of water fall, 12.11.2018, BR & AS 55264A (SKU).

**Distribution:** Thailand and India (Madhya Pradesh, Tamil Nadu & Kerala).

### Porellaceae

*Porella acutifolia* (Lehm. & Lindenb.) Trevis. Mem. Reale Ist. Lombardo Sci., Ser. 3, Cl. Sci. Mat. 4: 408 1877.

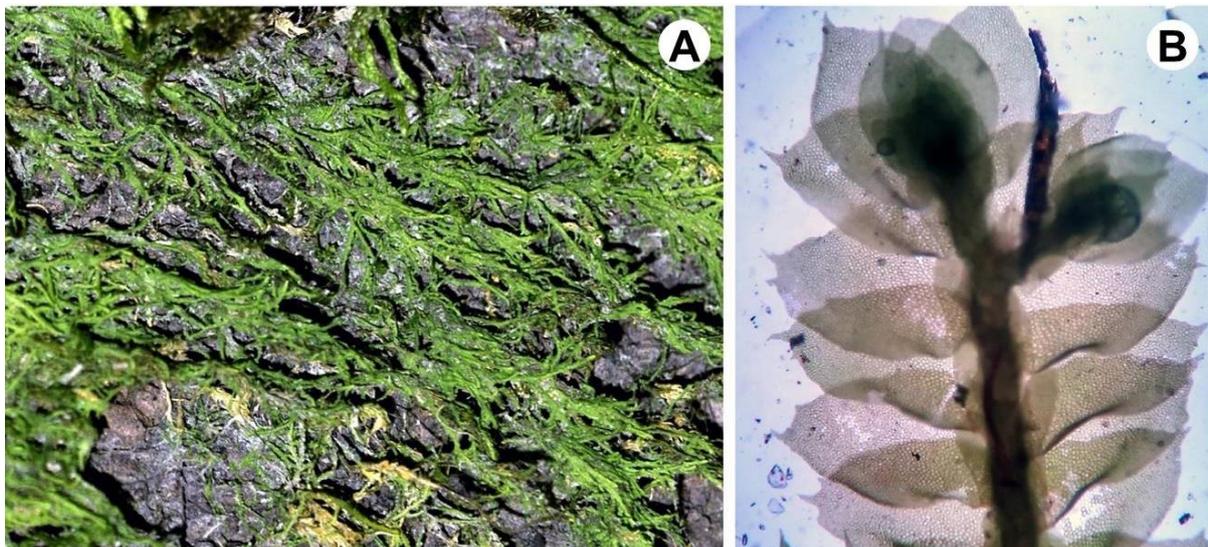
[Fig. 3]

Plants prostrate to hanging from substratum up to 10 cm long, loosely, irregularly, branched, primary branches  $10\text{--}18$  mm long, secondary branches  $4\text{--}8$  mm long and 3 mm wide. yellowish brown to pale greenish brown, leaves in two rows, lobes of stem leaves imbricate densely, lobes  $2.0\text{--}2.5$  mm long, narrowly oblong, usually with 1 to 2 strong teeth at apex, leaf lobules and under leaves irregularly lobed, mostly toothed angulate, obtuse to truncate at apex up to 1mm; leaf marginal cells quadrate to rounded,  $20\text{--}25 \times 10\text{--}15 \mu\text{m}$ , central and basal cells rounded to elongated,  $18\text{--}25 \times 15\text{--}20 \mu\text{m}$ . sporophyte present on apical portion of primary branch, capsules rounded, spores and elaters not seen.

**Habitat and ecology:** Epiphytes on old tree trunks, in high elevations of semi-evergreen forests.

**Specimens examined:** India, Andhra Pradesh, Visakhapatnam District, Seetamma Konda Near Duggem, 25.11.2017, BR & AS 53818D & 53823A (SKU).

**Distribution:** China, Japan, Java, Malay Archipelago, Sri Lanka and India (Kerala, Tamil Nadu, Eastern Himalaya and Western Himalaya).



**Figure 3.** *Porella acutifolia* (Lehm. & Lindenb.) Trevis.: **A**, Plant natural habit; **B**, Magnified view of apical portion of plant.

## MOSSES

### Erpodiaceae

*Solmsiella biseriata* (Austin) Steere. Bryologist 37: 100 1935.

*Erpodium biseriatum* (Austin) Austin. Bot. 2: 142 1877. Daniels, A. E. D., J. L. Mabel & P. Daniel; The Erpodiaceae (Bryophyta: Isobryales) of India; Taiwan, 57(2): 168–182, 2012. [Fig. 4]

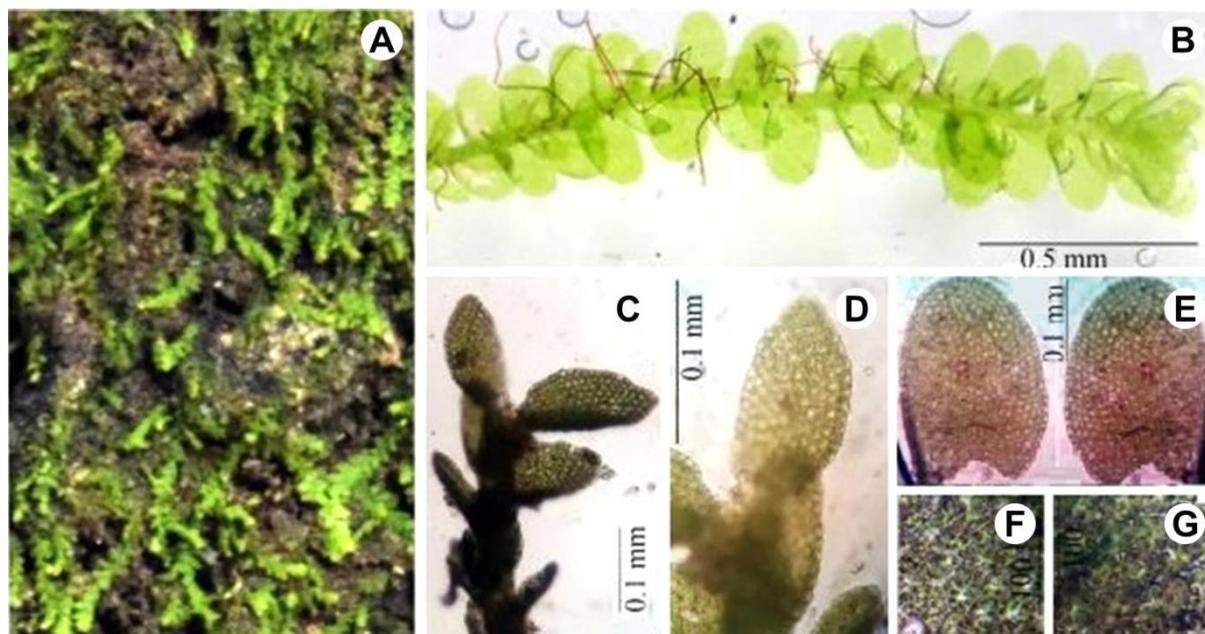
Plants prostrate, densely loose mats, slender, appressed to the substratum, creeping up to 10 cm long; irregularly branched, branches up to 5 mm long, horizontal to ascending. Light green to pale green, sometimes greenish brown. Leaves complanate, found in 4- rowed; 2 rows in dorsal and 2 rows in ventral; these dorsal and ventral leaves are same in shape but both having different sizes; leaves incurved at base, entire margin, obtuse at apex, oblong-ovate; dorsal leaves to  $0.4\text{--}0.46 \times 0.25\text{--}0.35$  mm and ventral leaves  $0.28\text{--}0.3 \times 0.12\text{--}0.14$ ; leaf

cells oblong-hexagonal to quadrate, multipapillate, thin-walled, apical cells  $6\text{--}20 \times 4\text{--}16 \mu\text{m}$ ; middle cells  $6\text{--}32 \times 10\text{--}20 \mu\text{m}$ ; basal cells  $16\text{--}28 \times 8\text{--}16 \mu\text{m}$ . Clustered rhizoids at the base of ventral leaf. Perichaetial leaves slightly differentiated, narrower than other leaves, ovate, obtuse to slightly acute at apex. Sporophytes not found in these specimens.

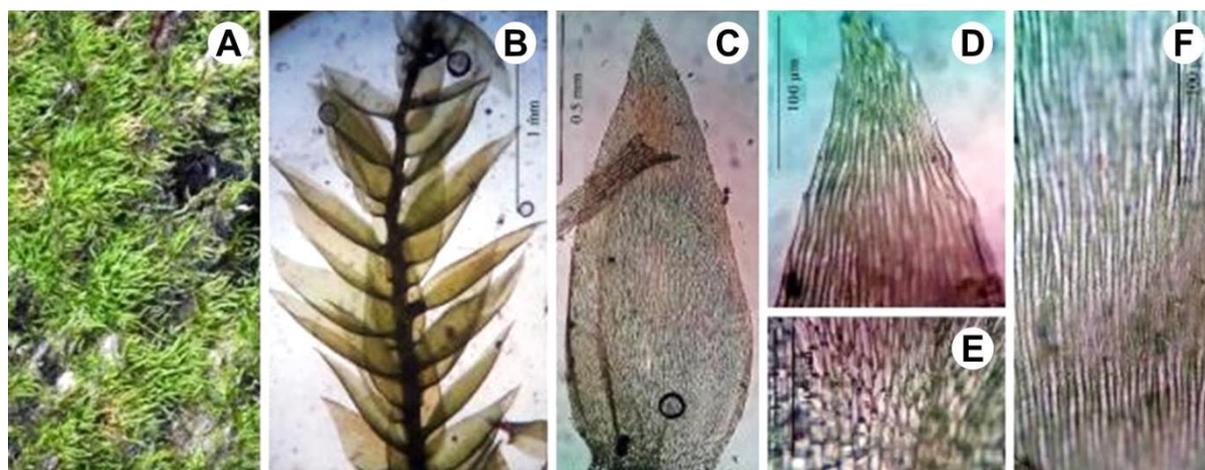
**Habitat and Ecology:** Found as epiphyte on old dry tree trunks in dry and moist deciduous forests.

**Specimens examined:** India, Andhra Pradesh, Nallamalais, Prakasam District, near Istakameswari temple 09.09.2017, BR & AS 53569 (SKU); Visakhapatnam District, Lambasingi, 28.11.2017, BR & AS 53864 & 53866 (SKU); P K Gudem, 15.12.2017, BR & AS 53943C (SKU).

**Distribution:** Cuba, North America, South America, South Asia, South East Asia and India (Eastern Himalaya and Tamil Nadu, Eastern Ghats and Western Ghats).



**Figure 4.** *Solmsiella biseriata* (Austin) Steere.: A, Plant natural habit; B, Magnified view of single plants; C, Ventral row of leaves; D, Magnified view of ventral leaves; E, Magnified view of dorsal leaves; F, Leaf middle cells; G, Leaf marginal cells.



**Figure 5.** *Leptohymenium tenue* (Hook.) Schwagr.: A, Plant natural habit; B, Magnified view of single branch; C, Leaf; D, Leaf apical cells; E, Leaf basal cells; F, Leaf middle cells.

### Hylocomiaceae

*Leptohymenium tenue* (Hook.) Schwagr. Sp. Musc. Frond., Suppl. 31(2): pl.246c 1828. Gungulee, Mosses of E. India and adjacent regions III (8): 1980. 2035–2037. [Fig. 5]

Plants prostrate, fairly robust to rigid, brownish green to glossy green. Main stem creeping up to 5 cm, wiry; secondary branches ascending or erect, semi-dendroid by further pinnate branching to 2 cm; branches densely leafy above. Leaves somewhat spreading when moist; appressed to stem and imbricate when dry; ovate-lanceolate to oblong-lanceolate,  $1.25\text{--}1.48 \times 0.5\text{--}0.75 \text{ mm}$ , concave, short acute to apiculate at apex. Margin

entire, dentate at apex. Costa short double. Leaf cells linear rhomboid,  $30\text{--}38 \times 5\text{--}7 \mu\text{m}$ , cell tips raised into papillae; alar cells distantly differentiated, irregularly rectangular, hyaline; insertion region of cells is also short. Seta erect, slender, long up to 2.5 cm long. Capsule erect, symmetrical, ovate-cylindrical,  $3.0\text{--}4.0 \times 1.0\text{--}1.5 \text{ mm}$ . operculum conic, short rostrate, rostrum slightly bent one side. Spores rounded.

*Habitat and ecology:* Found on old tree bark, associated with other pleurocarpus mosses and leafy liverworts.

*Specimens examined:* India, Andhra Pradesh, Visakhapatnam district, P K Gudem, 15.12.2017, BR & AS 53932A (SKU); Ananthagiri Hill Ranges, Galikonda, near View point, 21.10.2018, BR & AS 55207 (SKU).

*Distribution:* China, Guatemala, Mexico, Philippines and India (Darjeeling, Kerala, Khasia hills, Mussoorie, Naga hills, Western Himalayas).

### Myuriaceae

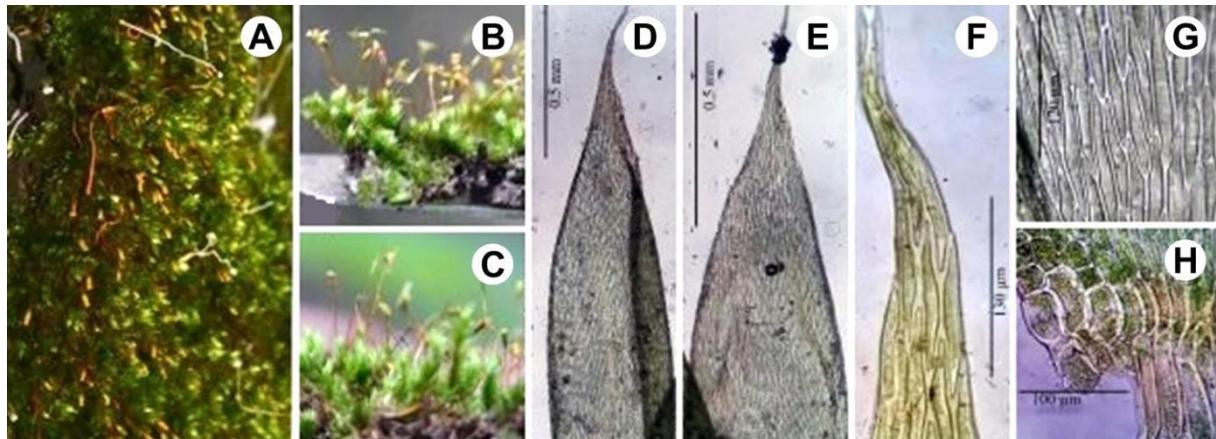
*Myurium perplexum* (Renauld & Cardot) Broth. Nat. Pflanzenfam. (ed. 2) 11: 124 1925. R.S. Chopra, Tax. Indian mosses. 1:1975. 318. [Fig. 6]

Plants decumbent to prostrate up to 3 cm long, dense tufted branches, reddish to golden green to dark green, golden when dry. Leaves dense, erect, imbricate when moist and slightly changed or not changed when dry; concave, obovate to oblong-ovate,  $2.3\text{--}3.4 \times 0.7\text{--}1.0 \text{ mm}$ , apex narrowly acuminate, margin entire. Ecostate. Leaf cells thick walled, smooth, apical cells  $65\text{--}88 \times 10\text{--}15 \mu\text{m}$ ; middle cells  $34\text{--}48 \times 9\text{--}15 \mu\text{m}$ ; basal cells slightly shorter  $37\text{--}42 \times 7\text{--}10 \mu\text{m}$ , alar cells slightly large rectangular to quadrate, deep golden brown,  $38\text{--}45 \times 17\text{--}20 \mu\text{m}$ . sporophyte present on lateral shoots. Seta slender smooth, erect up to 2 cm high. Capsule sub-erect to horizontal ovoid,  $18\text{--}2 \times 0.5\text{--}0.8 \text{ mm}$  in diameter, peristrome appear like a exostome, with lanceolate teeth, endostome teeth not seen clearly. Spores greenish brown to brown, rounded.

*Habitat and ecology:* Corticolous on the base of old tree trunks, in high elevations of moist deciduous forests.

*Specimens examined:* India, Andhra Pradesh, Chittoor district, Horsley hills, 23.08.2016, BR & AS 51624 (SKU); 15.11.2016, BR & AS 51678 (SKU); Visakhapatnam district, Ananthagiri hill Range, Galikonda view point, near water fall, 21.10.2018, BR & AS 55189 (SKU).

*Distribution:* India (Darjeeling and Sikkim).



**Figure 6.** *Myurium perplexum* (Renauld & Cardot) Broth.: A, Plant natural habit; B–C, Magnified view of plants; D–E, Leaves; F, Leaf apical cells; G, Leaf middle cells; H, Leaf basal cells.

### Pterigynandraceae

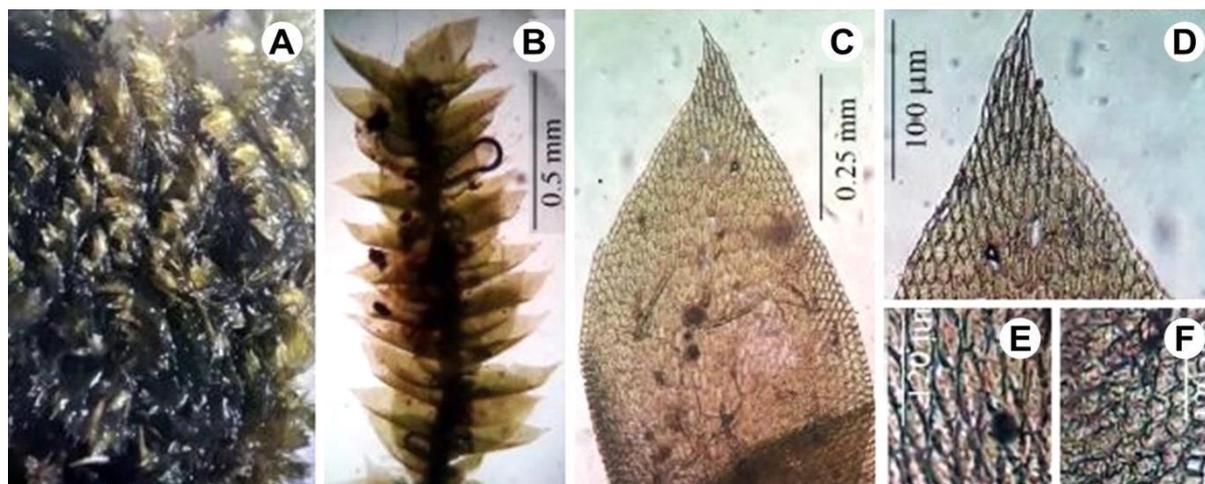
*Pterigynandrum filiforme* Hedw. Sp. Musc. Frond. 81 1801. [Fig. 7]

Plants prostrate, closely attached to the substratum, creeping up to 5 cm long, irregularly branched; branches up to 18 mm long. Yellowish brown to pale greenish-brown. Stem and branch leaves imbricate, erect, slightly falcate to homolamellose, ovate to obovate,  $0.6\text{--}1 \times 0.3\text{--}0.5 \text{ mm}$  margins narrowly reflexed below, erect to serrulate above. Leaf apical and middle cells rhomboid to obovate, smooth,  $22\text{--}30 \times 9\text{--}12 \mu\text{m}$ ; leaf basal cells quadrate to rounded, smooth,  $15\text{--}18 \times 12\text{--}14 \mu\text{m}$ , alar cells slightly larger. Costa absent or sometimes inconspicuously visible. Sporophytes not seen.

*Habitat and ecology:* Found moist dead tree bark, associated with *Fissidens gangulee*.

*Specimens examined:* India, Andhra Pradesh, East Godavari District, Rampa Waterfall, 21.11.2018, BR & AS 55288A (SKU).

*Distribution:* Caribbean, Costa Rica, Mongolia, United States and India (Manipur, Kumaon and Western Himalaya).



**Figure 7.** *Pterigynandrum filiforme* Hedw.: A, Plant natural habitat; B, Magnified view of apical portion of plant; C, leaf; D, Leaf apical cells; E, Leaf middle cells; F, Leaf basal cells.

### Sematophyllaceae

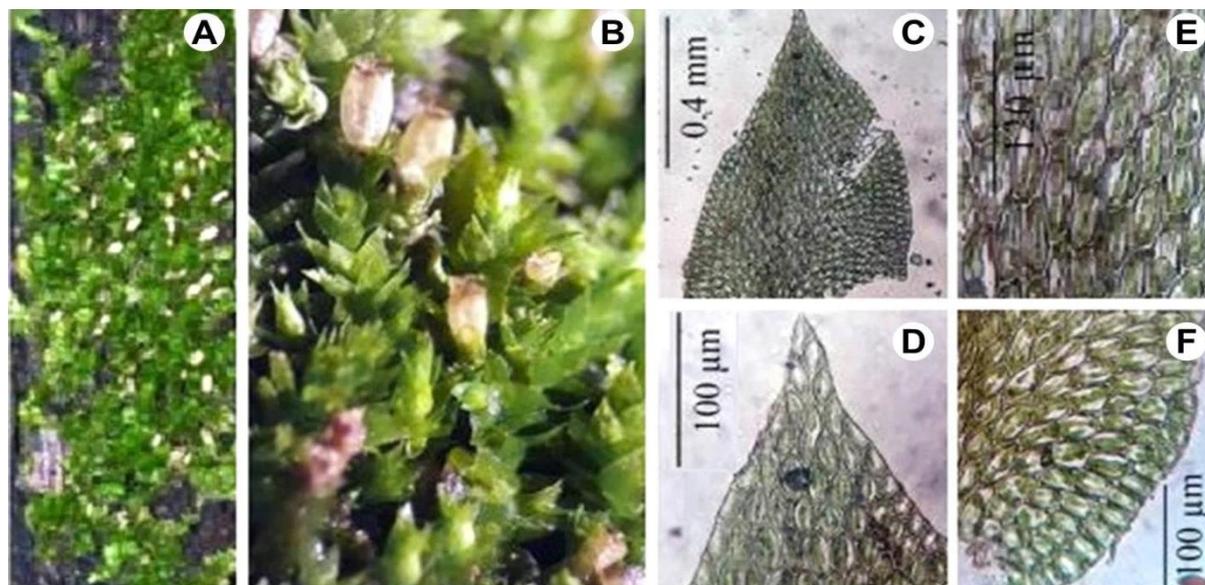
*Sematophyllum humile* (Mitt.) Broth. Nat. Pflanzenfam. (ed. 2) 11: 431 1925; R.S. Chopra, Tax. Indian Mosses.: 512. 1975; Gangulee, Mosses. E. India 3 (8):1885 1980. [Fig. 8]

Plants prostrate, closely attached to appressed to the substratum, glossy green to yellowish green, main stem creeping up to 4 cm long and branches pinnate, tufted to erect, parallel, sometimes, fascicled up to 1 cm. Densely imbricate leaves, mostly erect, closely appressed to stem when dry and loosely appressed to the stem when moist; leaves distinctly concave, ovate-lanceolate, apex narrowly acute, margin smooth; stem leaves 0.9–1.1 × 0.5–0.6 mm; branch leaves 1.5–2.0 × 0.7–0.9 mm; narrow leaf cells, rhomboid; apical and middle cells 43–46 × 6–8 μm; basal cells 63–65 × 6–8 μm, papillae slightly present at apex; swollen at alar region with 3 large extreme angles, ovate to oblong 30–45 × 15–18 μm; cells and few smaller irregular cells on top of the alar region. Ecostate. 5 archegonia present in a clutch of perichaetial leaves, archegonia 170–180 × 40–45 μm. Sporophytes present on main stem; sporophyte not fully developed.

*Habitat and Ecology:* Found epiphytic on smooth branches, as mono-dominant robust small mats.

*Specimens examined:* India, Andhra Pradesh, Kurnool district, Nallamalais, near Naramamidi cheruvu Basecamp, 22.09.2017, BR & AS 53605 (SKU); Visakhapatnam district, Ananthagiri Forest Range, Sunkarimetta, 21.09.2018, BR & AS 55235B (SKU).

*Distribution:* Thailand and India (Kumaon and Tamil Nadu (Eastern Ghats and Western Ghats)).



**Figure 8.** *Sematophyllum humile* (Mitt.) Broth.: A, Plant natural habit; B, Magnified view of plant with capsules; C, Leaf; D, Leaf apical cells; E, Leaf middle cells; F, Leaf basal cells.

*Sematophyllum subhumile* (Mull. Hal.) M. Fleisch. Musi Buitenzorg 4: 1264 1923.

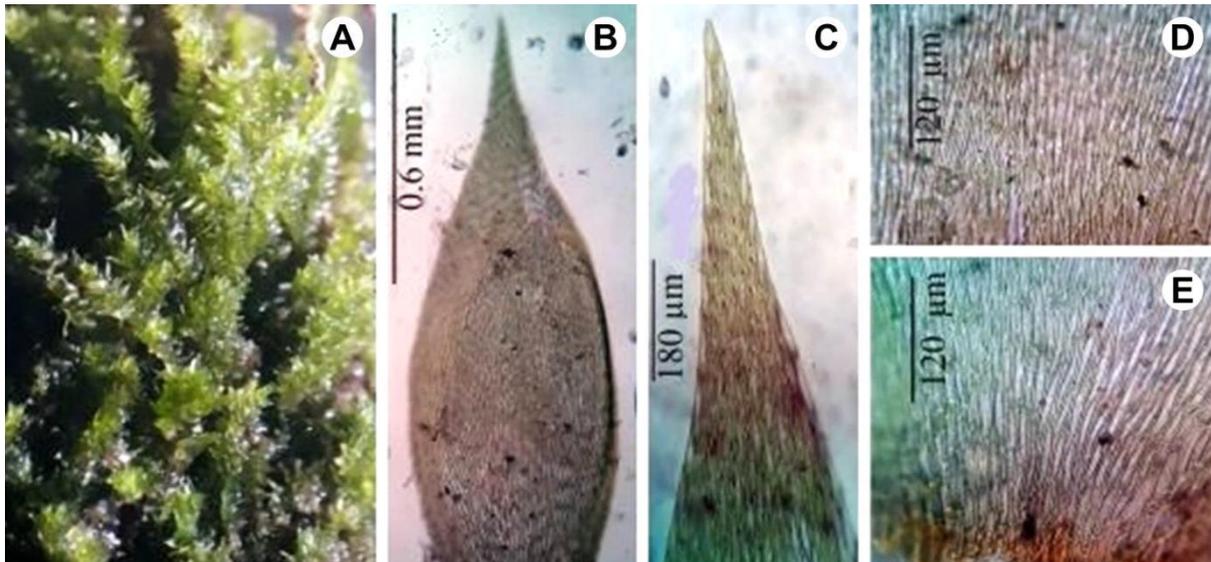
[Fig. 9]

Plants prostrate, closely attached to appressed to the substratum, glossy green to yellowish green, main stem creeping up to 4 cm long and branches pinnate, tufted to erect, parallel, sometimes, fascicled up to 1 cm. laxly erectopatient leaves, concave, ovate-lanceolate, from an ovate base with entire flat margin, faintly crenulate at apex; stem leaves  $1.0\text{--}1.2 \times 0.6\text{--}0.7$  mm; branch leaves  $1.0\text{--}1.3 \times 0.29\text{--}0.4$  mm; narrow leaf cells, rhomboid; apical and middle cells  $30\text{--}45 \times 5\text{--}10$   $\mu\text{m}$ ; basal cells  $55\text{--}60 \times 7\text{--}10$   $\mu\text{m}$ ; broadly elliptic to oblong hyaline alar region, cells  $55\text{--}60 \times 8\text{--}10$   $\mu\text{m}$ . Ecostate. Sporophytes on main stem. Capsules not found clearly in this specimen.

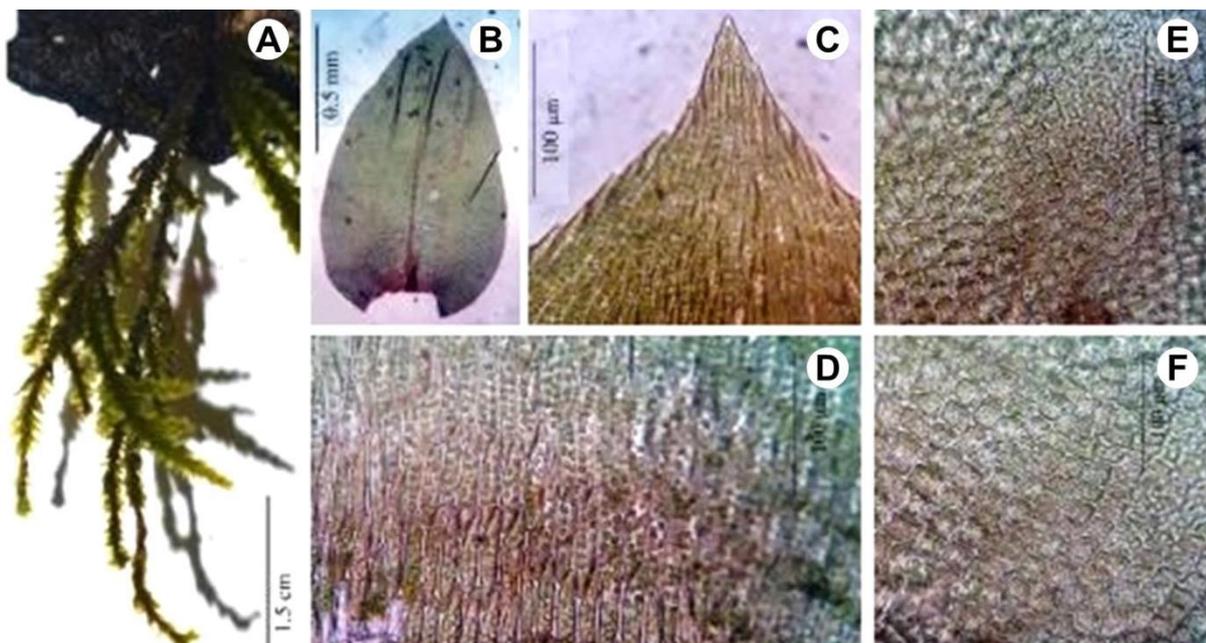
*Habitat and Ecology*: Epiphytic on old tree trunks appear as mono-dominant in gregarious patches.

*Specimens examined*: India, Andhra Pradesh, Visakhapatnam district, Lankapakala, near Gudm, 27.11. BR & AS 2017, 53861 (SKU).

*Distribution*: Indonesia, Myanmar, Nepal, Thailand and India (Upper Assam, Maharashtra, Tamil Nadu (Eastern Ghats and Southern Western Ghats)).



**Figure 9.** *Sematophyllum subhumile* (Mull. Hal.) H. Fleisch.: A, Plant natural habit; B, Leaf; C, Leaf apical cells; D, Leaf middle cells; E, Leaf basal cells.



**Figure 10.** *Bryowijkia ambigua* (Hook.) Nog.: A, Natural habit of plant; B, Leaves; C, leaf apical cells; D, Leaf middle cells; E–F, Leaf basal cells.

### Trachypodaceae

*Bryowijkia ambigua* (Hook.) Nog. J. Hattori Bot. Lab. 37: 241 1973. Gangulee, Mosses. E. India 2(5):1205–

1207 1976.

[Fig. 10]

Plants prostrate to hanging, up to 10 cm long and two or three times branched, sturdy, yellowish-green, brownish-green near at older stem and branches. Leaves densely arranged on stems and branches, erect to erectopate when moist, erect to appressed when dry; concave, ovate-lanceolate, plicate in lower half,  $0.9\text{--}1.3 \times 0.5\text{--}0.65$  mm, acute apex, bent one side, entire margin and slightly projected at apex, costa ending much below the leaf tip. Leaf cells elongated-rhomboidal,  $23\text{--}26 \times 3\text{--}4$   $\mu\text{m}$ , thick finely papillose. Some cells transparent at leaf apex, smooth, sub rectangular,  $28\text{--}30 \times 6\text{--}9$   $\mu\text{m}$ , near at base marginal row of transparent sub-rectangular cells present,  $14\text{--}18 \times 9\text{--}12$   $\mu\text{m}$  and several rows of similar but gradually shorter and narrower cells, the number of rows increasing towards alar region and there some larger brown cells at alar. Sporophytes not seen.

*Habitat and Ecology*: Found on old tree trunk in high elevated moist deciduous forests, with *Plagiochila beddomei* (Plagiochilaceae).

*Specimens examined*: India, Andhra Pradesh, Visakhapatnam, P K Gudem, 15.12.2017, BR & AS 53942A (SKU).

*Distribution*: China, Nepal, Thailand and India (Arunachal Pradesh, Darjeeling, Meghalaya, Uttarakhand and Western Himalaya).

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