



Two genera of Liverworts and Eight genera of Mosses, New records to Bryophyte flora of Andhra Pradesh, India.

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Abstract

Two genera of liverworts and eight genera of mosses representing 3 species and 12 species respectively are being reported as new distributional records for bryophyte flora of Andhra Pradesh. The liverworts are: *Cololejeunia distalopapillata* (E.W. Jones) R. M. Schust., *C. furcilobulata* (Berrie & E.W. Jones) R.M. Schust and *Leptolejeunia elliptica* (Lehm. & Lindeb.) Schiffn. (All belong to Lejeuniaceae) and mosses are *Bryosedgwickia aurea* (Schwagr.) M. Fleisch., *Isopterygium albescens* (Hook.) A. Jaeger., *I. minutirameum* (C. Muell.) Jaeg and *I. pohliaecarpum* (Sull. & Lesq.) A. Jaeger (Hypnaceae); *Himantocladium plumula* (Nees) M. Fleisch., *Homaliodendron exiguum* (Bosch. & Sande-Lac.) M.Fleisch., *H. flabellatum* (Sm.) M.Fleisch., *H. microdendron* (Mont.) M. Fleisch (Neckeraceae); *Tortella tortuosa* (Hedw.) Limpr.) (Potticeae); *Taxithelium nepalense* (Schwagr.) Broth. (Sematophyllaceae); *Claopodium prionophyllum* (Mull. Hal.) Broth., *Pinnatella calcutensis* M.Fleisch. (Thuidiaceae).

Keywords: Liverworts and Mosses of India, Bryophytes of Andhra Pradesh

Introduction

Andhra Pradesh is the seventh largest state in Indian Union extended to 162, 970 km² lies between 12°37' and 19° 25' NL and 76° 45' and 84° 72' EL (Map 1). The state comprises 13 districts, Rayalaseema region with four district and coastal Andhra, 9 districts. The state comprises diversified forest vegetation with 17.86 percentage of forest cover (FSI 2019), the major portion part of the Eastern Ghats hill ranges. There are about 180 waterfalls (seasonal and perennial). Altitude ranges from sea level to 1680 m above mean sea level.

Part of bryophyte inventory during 2016 to 2020, we could collect curious bryophytes specimens from forest tracts of Eastern Ghats hill ranges in different localities of Andhra Pradesh. After critical

examination, these specimens identified belonging to liverworts: *Cololejeunia distalopapillata* (E.W. Jones) R. M. Schust., *C. furcilobulata* (Berrie & E.W. Jones) R.M. Schust and *Leptolejeunia elliptica* (Lehm. & Lindeb.) Schiffn. (all belong to Lejeuniaceae) and mosses: *Bryosedgwickia aurea* (Schwagr.) M. Fleisch., *Isopterygium albescens* (Hook.) A. Jaeger., *I. minutirameum* (C. Muell.) Jaeg and *I. pohliaecarpum* (Sull. & Lesq.) A. Jaeger (Hypnaceae); *Himantocladium plumula* (Nees) M. Fleisch., *Homaliodendron exiguum* (Bosch. & Sande-Lac.) M.Fleisch., *H. flabellatum* (Sm.) M.Fleisch., *H. microdendron* (Mont.) M. Fleisch (Neckeraceae); *Tortella tortuosa* (Hedw.) Limpr.) (Potticeae); *Taxithelium nepalense* (Schwagr.) Broth. (Sematophyllaceae); *Claopodium prionophyllum* (Mull. Hal.) Broth., *Pinnatella calcutensis* M.Fleisch.

(Thuidiaceae). Perusal of literature (Rao *et al.*, 1999; Sowgandhika, 2010; Dandotiya *et al.*, 2011; Sandhya Rani *et al.*, 2011a & 2011b; Sowgandhika *et al.*, 2011; Sandhya Rani *et al.*, 2012; Sandhya Rani *et al.*, 2014; Alam 2015; Sreenath *et al.*, 2020a & 2020b, Sreenath and Ravi Prasad Rao 2020a & 2020b, Sreenath and Ravi Prasad Rao 2021) revealed that above species were not recorded from the state of Andhra Pradesh and hence form new distributional records to the state.

Materials and Methods

Extensive bryophyte explorations were conducted in all the districts of Andhra Pradesh during 2016 to 2020. All the bryophyte specimens collected were kept in zip lock polythene cover with labeled field number. Field observations were recorded on-site and photographs were taken with Nikon D3300. Collected material was 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 using micro forceps (Varin) VR-15 curved, VR-11 straight with fine sharp edges and sides were observed under light microscope (Olympus CH20i), light stereo microscope (Olympus SZ61) and micro measurements were taken by using ocular micro meter (ERMA). Microscopic photos were taken by using Moto g3 turbo equipped with 13 MP Camera. Identification was done following standard floras and relevant literature. Species-wise citation, descriptions, habitat and ecology, voucher specimens, field and microscopic photographs were provided in this paper. All the specimens were deposited in Sri Krishnadevaraya University Herbarium (SKU) Ananthapuramu. Abbreviated names used for the collectors are: AS (Ananthaneni Sreenath) and BR (Boyina Ravi Prasad Rao).

Results

Liverworts - Lejueuniaceae

Cololejeunia distalopapillata (E.W. Jones) R. M. Schust., Nova Hedwigia 9: 173. 1963; *Leptocolea distalopapillata* E.W. Jones, Trans. Brit. Bryol. Soc. 3: 202. 1957; Daniels, Bryophytes of Southern W. Ghats 157 - 158. 2003.

Plants leafy, sterile, 1 – 5 mm long, closely appressed to substratum, yellow-green. Stem irregularly branched. Leaves flat, approximate to imbricate, widely crossing stem, 0.5 – 0.7 × 0.3 – 0.5 mm, ovate, appendiculate at base; leaf marginal cells 14 – 20 × 10

– 16 µm, rectangular, radially elongate, sinuate-dentate, hyaline, 1 or 2-rowed at apex becoming one-rowed of shorter cells 10 – 14 × 8 -10 µm towards base at antical margin; leaf middle cells 20 – 30 × 10 – 20 µm, quadrate-hexagonal; leaf basal cells 30 – 40 × 20 – 30 µm, rectangular; walls with small distinct trigones and occasional intermediate thickenings; cuticle smooth; oil bodies 1 – 3 µm, 4 – 10 per cell, spindle-shaped and globose, faintly granular to smooth, bluish green; lobule ca 0.4 × 0.3 mm, variable, oblong to ovate, swollen near keel, truncate and 2-toothed at apex; apical tooth, 2 or 3 cells high and 2 cells wide at base; lower tooth 2 or 3 cells high and 2 cells wide at base with a large, rounded to pyriform. Sporophyte not seen.

Habitat and ecology: Corticolous on *Syzgium cumini* bark substratum in moist deciduous forests, and associated with *Thuidium tamariscullum* (Thuidiaceae).

Distribution: World: Africa and **India:** Tamil Nadu.

Specimens examined: India, Andhra Pradesh, East Godavari district, Rampa Waterfalls, 21 Nov. 2018, 55281B & 55285A, AS.

Cololejeunea furcibulata (Berrie & E.W. Jones) R.M. Schust, Nova Hedwigia 9: 178. 1963; Udar *et al.*, Proc. Indian Acad. Sci. (Pl. Sci.) 95(5): 303 – 307. 1985; *Leptocolea furcibulata* Berrie & Jones, Trans. Brit. Bryol. Soc. 2: 408. 1954; Daniels, Bryophytes of Southern W. Ghats 159 - 160. 2003.

Plants leafy, green, closely attached to substratum, 1 – 5 mm long, stem irregularly branched; rhizoids in clusters, hyaline. Leaves imbricate, obliquely to wide-spreading, flat, 0.3 – 0.7 × 0.25 – 0.5 mm, ovate, entire, arched at dorsal margin, almost straight ventrally; leaf marginal cells 14 – 26 × 10 – 18 µm, rectangular; leaf middle cells 20 – 35 × 19 – 26 µm, penta- hexagonal; basal cells 30 – 45 × 20 – 30 µm, elongate-hexagonal; walls without trigones and intermediate thickenings; cuticle smooth; oil bodies 1 – 3 µm, 3 – 15 per cell, globose, faintly granular to smooth, bluish green; lobule 0.02 – 0.4 × 0.02 – 0.17 mm, variable, ligulate, equally 2-ciliate or truncate, swollen and 2-toothed at apex; stylus one-celled, hyaline. Under leaves absent. Perianth ca. 0.4 × 0.23 mm, obovate, 5-plicate. Sporophyte not seen.

Habitat and ecology: Rupicolous, on moist rocks and in deep shade in moist deciduous forests, associated with *Fissidens polysetulus* (Fissidentaceae).

Distribution: World: Africa and **India:** Karnataka, Kerala and Tamil Nadu.

Specimens examined: India, Andhra Pradesh, Prakasam district, Nallamalais, Peddachama base camp, near watch tower, 23 Oct. 2017, 53608, BR & AS.

Leptolejeunia elliptica (Lehm. &Lindeb.) Schiffn., Engl. &Prantl, Nat. Pflanzenfam. 1(3): 126. 1893; R. L. Zhu & M. L. So., Nova Hedwigia 121: 211. 2001. *Jungermannia elliptica* Lehm. &Lindenb., Nov. Strip. Pug. 5: 13. 1833; *Leptolejeunia subacuta* Steph. ex. A. Evans in proc. Washington Acad. Sci. 8: 149. 1906; U.S. Awasthi, J. Indian Bot Soc. 65: 122. 1986; *L. dapinata* Steph., Sp. Hepat. 5: 79. 1913; Kachroo, Bull. Bot. Surv. India 12: 230. 1970; Daniels, Bryophytes of Southern W. Ghats 168 - 169. 2003.

Plants leafy, closely attached to the substratum with suberect female branches, green, 5 – 15 mm. Stem irregularly branched. Leaves distant, obliquely spreading, 0.2 – 0.5 × 0.1 – 0.3 mm, elliptical to obovate, acute or apiculate at apex, margin entire, arched dorsally and almost straight ventrally with a faint notch at about middle; cells rounded-hexagonal with distinct hyaline trigones and intermediate nodular thickening in walls; leaf apical cells 10 – 15 × 9 -14 µm, leaf middle cells 20 – 30 × 18 – 28 µm; basal cells 35 – 40 × 25 – 30 µm; ocelli several; apical ones 25 – 30 µm, rounded; basal ones 58 – 60 × 35 – 38 µm, ovoid; oil bodies 1 µm, globose or ca 2 × 1 µm, ovoid, 3 – 10 per cell, faintly granular, green; lobule 0.19 – 0.21 × 0.12 – 0.14 mm, about 1/3 of lobe length, free and faintly involute at margin, 2-toothed at apex; first tooth one-celled with a proximal hyaline papilla; second one reduced. Under-leaves 0.15 – 0.18 × 0.88 – 0.12 mm deeply 2-lobed; lobes distant, straight or wide spreading, uni-seriate, sometimes 2-toothed at apex; first tooth one-celled with a proximal hyaline papilla; second one reduced. Under-leaves 0.15 – 0.18 × 0.88 – 0.122 mm, deeply 2-lobed; lobes distant, straight or wide-spreading, uni-seriate, sometimes 2-senate at base; sinus roughly 'U' shaped with numerous small rhizoid initial cells at base; mature under-leaves with a tuft of hyaline rhizoids. Dioecious plants. Male inflorescence terminal on main stem or short lateral branches; antheridia 60 -75 µm, globose; bracts 2 – 5 paired, 0.22 – 0.25 × 0.11 – 0.13 mm, ovate, margin entire, obtuse at apex; lobules 0.20 – 0.22 × 0.07 – 0.09 mm, free, entire and involute at margin, acute at apex; bracteoles 1 or 2 restricted to

inflorescence base, similar to under-leaves. Female inflorescence terminal on short lateral branches; perianth ca. 0.75 × 0.33 mm, obconical to obovate, 5-keeled; keels smooth, prolonged in to horns; bracts, bracteole and perianth with scattered ocelli. Capsule and spores are not seen.

Habitat and ecology: Corticolous on old tree trunks, in moist deciduous forests, monodominant.

Distribution: World: Southeast Asia and **India:** Arunachal Pradesh, Assam, Karnataka and Tamil Nadu.

Specimens examined: India, Andhra Pradesh, Chittoor district, Seshachalam Biosphere Reserve, Top hills of Tirumala, 14 Nov. 2017, 53783A, AS.

Mosses

Hypnaceae

Bryosedgwickia aurea (Schwagr.) M. Fleisch. in Hedwigia, 63: 211. 1922; Gangulee, Moss. E. India. 3(8): 1938 – 1939. 1980.

Plants small, yellowish green, glossy plants forming as tufts. Main stem up to 5 cm long creeping and branching, giving rise to short, erect, simple or once branched shoots. Leaves dense, erectopate when moist, appressed to stem and imbricate when dry; ovate-lanceolate, concave, 1.3 – 1.6 × 0.48 – 0.59 mm, apex narrow apiculate, margin smooth and flat. Costa short, double. Leaf cells irregularly spindle shaped, leaf apical cells 36 – 42 × 7 – 9 µm; lower leaf or middle cells 75 – 82 × 7 – 9 µm, extreme base and angle cells differentiated, rectangular to quadrate, 22 – 25 × 18 – 22 µm often a double- cell at extreme end, lamina cells with raised papillae tips. Sporophytes on main stem. perichaetial leaves ovate-oblong, margin denticulate in upper half. Seta slender, erect, up to 5 cm long, red spirally twisted when dry. Capsule erect, ovate-cylindrical, 1.8 - 2.1 mm long × 0.7 – 0.9 mm in diameter wide, without annulus or apophysis. Exostome teeth 16, normal, lanceolate, with blunt tip, horizontally striate except at top. Endostome segments short, broad, irregular. Operculum short with slightly curved beak. Spores yellowish brown, rounded, up to 20 µm in diameters.

Habitat and ecology: Aquatic; on moist soil or rocks, in moist deciduous forests near waterfall areas, associated with *Vesicularia reticulata* (Hypnaceae) and other pleurocarpous mosses.

Distribution: World: India: Karnataka, Meghalaya, Sikkim, Uttarakhand and West Bengal.

Specimens examined: India, Andhra Pradesh, Chittoor district, Talakona Waterfalls, 29 Oct. 2017, 53703B, BR & AS.

Isopterygium albescens (Hook.) A. Jaeger., in Ber. Thätigk. St. Gallischen Naturwiss. Ges. 1876–77: 433 (Gen. Sp. Musc. 2: 1251) 1878; Gangulee, Moss. E. India, 3(8): 1960 – 1961. 1980.

Plants small to medium, slender, yellowish green, glossy plants in low tufts. Main stem creeping up to 3.5 cm long, with pinnate branching, branches not complanate. Leaves erect to patent to spreading when moist, not much changed when dry, ovate, concave, short or long acuminate, 0.8 – 1 × 0.3 – 0.35 mm, margin almost smooth to dentate at top. Ecostate. Leaf cells linear, apical and middle leaf cells 37 – 42 × 6 – 8 µm; basal leaf cells 72 – 78 × 7 – 9 µm and extreme basal cells a row of sub-rectangular cells, 36 – 40 × 13 – 16 µm with some irregular cells above but there is scarcely any distinction at alar. Sporophytes on strong main stems, perichaetial leaves erect, narrow. Seta slender, erect up to 2 cm long. Capsule horizontal to dropping, ovate to cylindrical, curved at base, 1.1 – 1.3 mm long × 0.54 – 0.57 mm in diameter wide. Operculum conic-rostrate. Peristome normal. Spores, yellowish brown, rounded, up to 20 µm in diameters.

Habitat and ecology: Corticolous on moist bark substratum in moist deciduous forests, associated with *Pallavicinia levierii* (Pallaviciniaceae).

Distribution: World: India: Arunachal Pradesh, Assam, Kerala, Meghalaya, Tamil Nadu, Uttarakhand and Western Ghats.

Specimens examined: India, Andhra Pradesh, Chittoor district, Talakona Waterfalls, 15 Nov. 2016, 51696A, BR & AS; Kurnool district, Gundlabrahmeswaram Wild Life Sanctuary, near temple, beside the Gundlakamma stream, 18 April 2017, 53358 & 53360, BR & AS; Chittoor district, Talakona Waterfalls, 29 Oct. 2017, 53673B & 53698B, BR & AS; Visakhapatnam district, Vantamamidi Reserve Forest, near Lambasingi, 13 Dec. 2017, 53899B, AS;

Visakhapatnam district, near Gudem Kottaveedi colony, Hills of PK Gudem Forest, 15 Dec. 2017, 53929, AS.

Isopterygium minutirameum (C. Muell.) Jaeg. in Ber. S. Gall. Naturw. Ges. 1876 – 77: 434. 1878; *Ectropothecium delicatulum* Thér., Diagn. Esp. Var. Nouv. Mouss. 8: 6 1910; *Sematophyllum argenteum* Sakurai., Bot. Mag. (Tokyo) 64: 197. 1 e f 1951; Gangulee, Moss. E. India, 3(8): 1962 – 63. 1980.

Plants small to medium, slender, yellowish green, brown below, feathery, glossy plants in thin mats. Main stem creeping, ramose, up to 6 cm long, with irregularly pinnate, short branches. Leaves not really complanate, through flattened, spreading horizontal to slightly raised, erect to spreading when moist, shrunk, erect spreading when dry, concave, ovate-lanceolate, narrow long acuminate, 1 – 1.5 × 0.3 – 0.4 mm, margin almost smooth. Costa not distinct, sometimes short double. Leaf cells rectangular to quadrate, leaf apical and middle cells 73 – 78 × 5 – 7 µm; leaf extreme basal cells 35 – 39 × 12 – 16 µm, rectangular to quadrate, not specially differentiated at alar. Sporophytes not seen.

Habitat and ecology: Corticolous, on moist bark substratum in moist deciduous forests, monodominant.

Distribution: World: Japan, New Zealand, Philippines, Thailand and **India:** Assam, Himachal Pradesh, Tamil Nadu and Uttarakhand.

Specimens examined: India, Andhra Pradesh, Visakhapatnam district, Sampangigondi Reserve Forest, near Paderu, 10 Oct. 2019, 57014, AS.

Isopterygium pohliaecarpum (Sull. & Lesq.) A. Jaeger in Ber. S. Gall. Naturw. Ges., 1876 – 1877: 442. 1878; *Hypnum pohliocarpum* Sull. & Lesq. in Proc. Am. Ac. Arts Sc., 4: 280. 1859; *Rhynchostegium textorri* Lac. in Ann. Mus. Bot. Lugd. Bot., 2: 186, 284. 1867; *Hypnum aquatifolium* Bosch & Lac. in Broyl. Jav., 2: 186, 284. 1867; *Isopterygium aquatifolium* (Bosh & Lac.) Jaeg. in Ber. S. Gall. Naturw. Ges., 1876 – 1877; *I. textori* (Lac.) Mitt. in Trans. Linn. Soc. Bot. Lond. Ser. 2, 3: 176. 1891; *I. perchlorosum* Broth. in Symb. Sin., 4: 125. 1929; *I. bellissimum* (Sak.) Sak. in Bot. Mag. Tok., 53: 64. 1939; Gangulee, Moss. E. India, 3(8): 1956 – 1957. 1980.

Plants small to medium, glossy, pale green plants in dense tufts with patches of wine-red shoots. Main stem creeping up to 5 cm long with irregularly pinnate, complanate branches. Leaves spreading, when moist, spreading to shrunk when dry, not really distichous, concave, ovate-lanceolate, $1 - 1.2 \times 0.35 - 0.38$ mm, apex narrow acuminate, margin faintly denticulate at tip. Leaves often clustered like buds at tips of branches. Costa very short double, often indistinct. Leaf cells narrow elongated rhomboid to linear, leaf apical and middle cells $40 - 45 \times 7 - 9$ μm ; leaf basal cells $72 - 78 \times 7 - 8$ μm , cell tips with fine papillose projections, specially at leaf tip; some extreme basal row of cells irregularly rectangular $40 - 45 \times 14 - 17$ μm with some porose cells above, scarcely differentiated at alar. Sporophytes not seen.

Habitat and ecology: Corticolous, on moist bark substratum in dry and moist deciduous forests, monodominant or sometimes associated with other acrocarpous mosses.

Distribution: World: India: Eastern Himalaya and Tamil Nadu.

Specimens examined: India, Andhra Pradesh, Visakhapatnam district, Lankapakala RF, near Gudem, 27 Nov. 2017, 53859A, AS.

Neckeraceae

Himantocladium plumula (Nees) M. Fleisch., Die Musci Fl. Buitenz. 3: 889. 1908; Gangulee, Moss. E. India 2 (5): 1406. 1976; *Pilotrichum plurnula* Nees in Bird., Bryol. Univ. 2: 759. 1827; *Neckera pumila* (Nees) C. Muell., Synop. Musc. Found. 2: 53. 1850. *N. acutata* Mitt., Musc. Ind. Orient. 121. 1859. *N. arbuscula* Hamp. ex C. Muell., Flora 61: 83. 1878. *Neckeropsis cutata* (Mitt.) M. Fleisch., Die Musci Fl. Buitenz. 3: 878. 1908; Bryophytes of Wayanad in W. Ghats, 274 & 275. 2005.

Plants small to medium, dark greenish to yellowish green; main stem creeping up to 3 cm, with scaly leaves, secondary shoots erect; leaves erectopate to spreading when moist and slightly revolute to spreading when dry, leaves up to $1.6 - 2.1 \times 0.8 - 1$ mm, longitudinally plicate, rounded apex with an abruptly acute apiculus, base wider, auriculate, margin entire to minutely denticulate at tip, inflexed on one side covering the stem; leaf cells irregularly quadrate to rectangular, incrassate, $30 - 35 \times 5 - 8$ μm , few shorter at extreme base. Costa strong ending below the

apex. Seta erect, orange brown, up to 1.5 cm long. Capsule globose, orange brown, peristome teeth normal, whitish. Spores small, rounded.

Habitat and ecology: Corticolous, near bases of tree trunks in semi evergreen forests, associated with *Entodon scariosus* (Hypnaceae) and other mosses.

Distribution: World: Australia, Bangladesh, Borneo, China, Indonesia, Japan, New Caledonia, New Guinea, Pacific Ocean Islands, Philippines, Sumatra, Taiwan and India: Arunachal Pradesh, Assam, Kerala and Meghalaya.

Specimens examined: India, Andhra Pradesh, Visakhapatnam district, Gudem hills, 27 Nov. 2017, 53854A, AS.

Homalio dendronexiguum (Bosch. & Sande-Lac.) M.Fleisch., Musci Fl. Buitenz. 3: 897. 1908; Gangulee, Moss. E. India 2(5): 1413. 1976. *Homalia exigua* Bosch. & Sande-Lac., Bryol. Jav. 2: 55. 1862; *H. valentinii* Besch., Ann. Sci. Nat. Bot. Ser. 6, 10: 274. 1880; *Hypnum bibrachiatum* C.Muell., Bot. Jahrb. 5: 86. 1883; *Homalia bibrachiata* (C.Muell.) Geheeb, Biblioth. Bot. 13: 6. 1889; *Neckeropsis pseudonitidula* Okam., J. Coll. Sc. Imp. Univ. Tokyo 38(4): 39. 1916; *Homali dendron pseudonitidulum* (Okam.) Nog., Trans. Nat. Hist. Soc. Formosa 24: 291. 1934; *Homalia laxiretis* Sak., Bot. Mag. Tokyo 50: 61 8. 1935; Bryophytes of Wayanad in W. Ghats, 277. 2005.

Plants medium to large, pale greenish to glossy green, primary stem creeping very closely, secondary shoots rigid, erect, up to 5 cm long; leaves on main stem, horizontally spreading, longitudinally plicate when dry, spreading and not plicate when moist, leaf apex obtuse to suddenly narrowed into a apiculus, leaf base reflexed on one side; margin entire to minutely serrate at tip; all leaf cells smooth, rhomboidal towards apex; apical cells $15 - 20 \times 8 - 11$ μm , larger towards base, basal cells linear- elongate, $40 - 45 \times 7 - 8$ μm . Costa single, reaches up to mid leaf. Sporophytes on lateral branches. Seta short, up to 2 mm long. Capsule erect, brownish, ovoid, immersed, up to $0.8 - 1 \times 0.4 - 0.5$ mm. Calyptra beaked.

Habitat and ecology: Lignicolous, on rocky patches, near waterfalls stream areas, in moist forests, associated with *Stereophyllum confusam* (Stereophyllaceae), *Mastigolejuenia humalis* (Lejuniaceae) and other mosses.

Distribution: World: Comoros, Japan, Madagascar, Mauritius, Philippines, Reunion, Tanzania and **India:** Arunachal Pradesh, Assam, Kerala, Manipur, Meghalaya, Tamil Nadu, Uttarakhand and Western Ghats.

Specimens examined: India, Andhra Pradesh, Visakhapatnam district, Seleru (Ice) Waterfalls, 26 Nov. 2017, 53844B, AS; Visakhapatnam district, hills of Gudem, 27 Nov. 2017, 53851D, AS; East Godavari district, Papikondalu National Park, Jalatarangini Waterfalls, 23 Nov. 2018, 55845, AS.

Homaliodendron flabellatum (Sm.) M.Fleisch., Hedwigia 45: 74. 1906; Foreau in P.Bruehl, Rec. Bot. Surv. India 13(1): 77. 1931; Dixon, J. Bombay Nat. Hist. Soc. 39: 785. 1937; J. Madras Univ. Sect. B. 3: 121. 1931 & J. Bombay Nat. Hist. Soc. 58: 34. 1961; Wadhwa, M.V.M. Patrika 6: 72. 1971; R.S.Chopra, Tax. Indian Mosses 369. 1975; Gangulee, Moss. E. India 2(5): 1426. 1976; M.C.Nair & Madhus. J. Econ. Taxon. Bot. 25: 574. 2001. *Hookeria flabellata* Sm., Trans. Linn. Soc. 9: 280. 1808; *Leskea flabellata* (Sm.) Schwaegr., Sp. Musc. Frond. Suppl. L (2): 164. 1816; *Neckera dentata* Griff., Not. Pl. Asiat. 2: 463. 1849; *N. australasica* C.Muell., Syn. Musc. Frond. 2: 42. 1850; *Hypnum flabellatum* (Sm.) Dixon ex C.Muell., Syn. Musc. Frond. 2: 225. 1850; *Neckera flabellate* (Sm.) Mitt., Musc. Ind. Orient. 118. 1859; *Homalia flabellata* (Sm.) Bosch. & Sande-Lac., Bryol. Jav. 2: 58. 1863; Broth., Rec. Bot. Surv. India 1 (12): 325. 1899; *Homaliodendron dentatum* (Griff.) M.Fleisch., Hedwigia 45: 75. 1906; Bryophytes of Wayanad in W. Ghats, 277 & 278. 2005.

Plants small to medium, yellowish-green, main stem creeping up to 5 cm long, branched and often with stolon's, secondary stem pinnately branched; leaves not much changed when both dry and moist conditions; stem leaves lanceolate to oblong ligulate, branch leaves ovate, shortly acuminate, margin entire to dentate, toothed at extreme tip, revolute on one side of the base. Perichaetial bracts longitudinally plicate when dry, bracts lanceolate with unicellular teeth, lower stem leaves smaller. Leaf cells smooth, apical leaf cells polygonal, middle cells rhomboid, basal cells elongated, leaf middle and apical cells 10 -30 × 5 -15 µm and basal cells 45 - 60 × 15 - 18 µm. Seta 2 -3 mm long. Capsule erect to slightly inclined. Spores rounded, smooth, 12 - 15 µm in diameters.

Habitat and ecology: Corticolous, in deep shade and saxicolous, associated with *Taxithelium nepalense* (Hypnaceae) and *Lopholejeunia abortiva* (Lejeuniaceae).

Distribution: World: Australia, Borneo, Java, Japan, Pacific Ocean Islands, Philippines, Sumatra, Sri Lanka, Thailand and **India:** Arunachal Pradesh, Darjeeling, Karnataka, Kerala, Meghalaya, Sikkim and Tamil Nadu.

Specimens examined: India, Andhra Pradesh, East Godavari district, Amruthadara Waterfalls, 22 Nov 2018, 55810B, AS.

Homaliodendron microdendron (Mont.) M. Fleisch. in 1-Icdwigia 45: 78. 1906; Bruehi in Rec. Bot. Surv. India 13(1): 77. 1931; Foreau in J. Bombay Nat. Hist. Soc. 58:34.1961; WadhL in M.V.M. Patrika 6:72. 1971; R.S. Chopra, Tax. Indian Moss.: 369. 1975; Gangulee, Moss. E. India 2(5): 1414. 1976. *Hookeria nicrodendron* Mont. In Ann. Sci. Nat. Bot. 2, 19: 240. 1843. - Type: Ind. Orient. (PC). *Hypnum nicrodendron* (Mont.) Müll.Hal., Syn. Muse. Frond. 2: 231. 1851; Daniel, Bryophytes of S. W. G. 109. 2003.

Plants yellowish green, slender; stem wiry, creeping up to 4 cm long; secondary stem erect up to 1.5 cm high, pinnately branched, complanate; leaf not much changed when both dry and moist conditions; stem leaves 0.8 - 1 × 0.4 - 0.5 mm, appressed to stem; branch leaves 1 - 1.2 × 0.6 - 0.7 mm, horizontally spread out, faintly longitudinally plicate when dry, oblong-spathulate, blunt or faintly apiculate, asymmetric, entire below, slightly crenulate at apex, inflexed on one side at the base; leaf apical and middle cells incrassate, smooth, quadrate-rhomboid 6 -30 × 4 - 6 µm, basal cells elongate, rectangular 20 -60 × 4 - 8 µm, some cells shorter at the leaf attachment; marginal cells 2-rowed, more thin-walled in upper half. Costa single, reaches above the mid leaf, more than half of the leaf length. Sporophyte not seen.

Habitat and ecology: Corticolous in deep shade on tree trunks, associated with *Hyophila involuta* (Pottiaceae) and *Pinnatella calacuttense* (Neckeraceae).

Distribution: World: Southeast Asia, Pacific Ocean Islands and **India:** Arunachal Pradesh, Manipur, Meghalaya, Sikkim, Tamil Nadu and West Bengal.

Specimens examined: India, Andhra Pradesh, East Godavari district, Forests of Papikondalu National Park, Amruthadara Waterfalls, 22 Nov. 2018, 55812B; 55814 & 55820A, AS.

Pottiaceae

Tortella tortuosa (Hedw.) Limpr. in Laubm. Deutshl., 1: 604 1888; *Totrula tortuosa* Hedw. in Sp. Musc.: 124. 1801; *Bryum tortuosum* (Hesw.) With in syst. Arr. Brit. Pl. ed. 4, 3: 813. 1801; *Barbula tortuosa* (Hedw.) Web. et. Mohr. In Ind. Musc. Fl. Crypt.: 2. 1803; *Molia tortuosa* (Hedw.) Schrnk ex Lindb. in Musciscand.: 21. 1879; *Barbula subtortuosa* C.Mull. in N. Giorn. Bot. Ital. n.s., 3: 100. 1896; Gangulee, Mosses Eas. India, 1(3): 666 – 667. 1972.

Plants small to medium, dense tufts, up to 2.5 cm, high, yellowish green above, brown to dark brown below, covered by reddish brown tomentose on stem which is often dichotomously branched. Leaves dense, erectopatent to erect-spreading, strongly curled when dry, somewhat fragile at tips, 4 – 5 × 0.4 – 0.5 mm, linear-lanceolate, canaliculate, narrowly pointed at tip, margin flat, slightly crenulated at top by cell projections; base slightly broader (up to 0.52 mm wide at base, 0.4 mm at mid-lamina), costa strong (with median deuter), up to 65 µm wide at base, excurrent in a stiff point. Leaf one-layer thick throughout; basal cells transparent elongated rectangular, 50 – 57 × 28 – 34 µm, rendering the leaf base transparent, these cells being delimited from the upper chlorophyllose, papillose cells by a roughly V-shaped notch. Chlorophyllose cells rounded-quadrangle, small, up to 9 µm in diameter wide, incrassate, multi-papillose. Sporophytes are not seen.

Habitat and ecology: Rupicolous or corticolous on moist rocks or on base of tree trunks, in moist deciduous forests, associated with other pleurocarpous mosses.

Distribution: World: Afghanistan, Canary Islands, China, Guatemala, Hawaiian Isl, Iraq, Japan, Malawi, Mexico, Mongolia, Nepal, United States and **India:** Kashmir, Kerala, Uttarakhand and Western Himalaya.

Specimens examined: India, Andhra Pradesh, East Godavari district, Papikondalu National Park, Pamuleruvagu, near Valamuru Ghat, 22 Nov. 2018, 55842B, AS.

Sematophyllaceae

Taxithelium nepalense (Schwagr.) Broth. Monsunia 1: 51. 1899; *Hypnum turgidellum* Mull. Hal. Bot. Jahrb. Syst. 5: 87. 1883; *Taxithelium trachelophyllum* Dixon., Bull. Torrey Bot. Club 51: 243. f. 3: 17. 1924; Gangulee, Moss. E. India, 3(8): 1920 – 1921. 1980.

Plants medium to large, yellowish green to dull green, slightly glossy plants, forming dense tufts. Main stem creeping, up to 8 cm long, with irregularly giving rise to erect or ascending branches of unequal heights. Branches usually terete, sometimes may be slightly complanate. Leaves dense, erectopatent spreading when moist, appressed to stem when dry, strongly concave, ovate with acute tips, 1 – 1.2 × 0.4 – 0.45 mm; margin faintly denticulate at top, flat. Ecostate. Leaf cells spindle-shaped, leaf cells 35 – 39 × 5 – 7 µm, few shorter cells at extreme tip, with one longitudinal row of firm papillae, smaller but somewhat larger at base; alar and attachment cells smooth, alar cells large rectangular but not inflated. Sporophytes on main stem. perichaetial leaves long, narrow erect. Seta erect, up to 1.8 cm long, smooth. Capsule inclined to horizontal, curved constricted under mouth when dry, oval 1.2 – 1.28 mm long × 0.45 – 0.5 mm in diameter. Operculum conical, apiculate. Calyptra cucullate. Peristome double, hypnoid up to 335 µm high, cilia single, basal membrane high. Spores yellowish brown.

Habitat and ecology: Corticolous or lignicolous, in moist deciduous forests in deep shade, mostly monodominant, sometimes associated with other leafy liver worts.

Distribution: World: China, Philippines, Thailand and **India:** Andaman Islands, Assam, E. Himalaya, Meghalaya, Orissa, Tamil Nadu and West Bengal.

Specimens examined: India, Andhra Pradesh, Chittoor district, Kailasakona Waterfalls, 11 Nov. 2017, 53734A & 53741, AS; Chittoor district, Moolakona Waterfalls, 12 Nov. 2017, 53750C; 53755B; 53756B; 53758; 53761; 53762; 53763 & 53768, AS; Visakhapatnam district, hills of Paderu forest, 25 Nov. 2017, 53823C, AS.

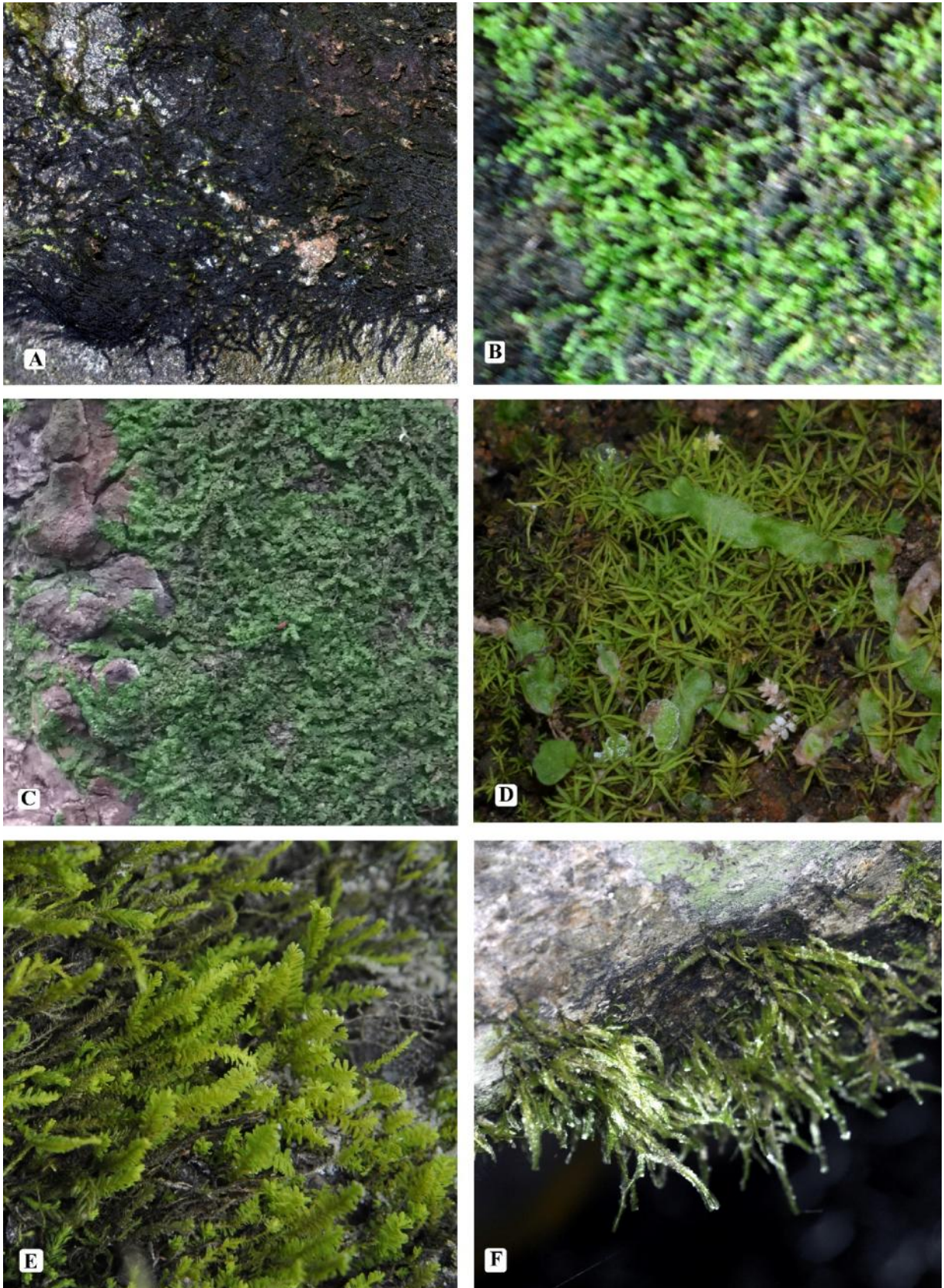


Plate 1: A. *Cololejeunia distalopapillata* (E.W. Jones) R. M. Schust., B. *C. furcilobulata* (Berrie & E.W. Jones) R.M. Schust, C. *Leptolejeunia elliptica* (Lehm. & Lindeb.) Schiffn., D. *Tortella tortuosa* (Hedw.) Limpr, E. *Himantocladium plumula* (Nees) M. Fleisch., and F. *Homaliodendron exiguum* (Bosch. & Sande-Lac.) M. Fleisch.

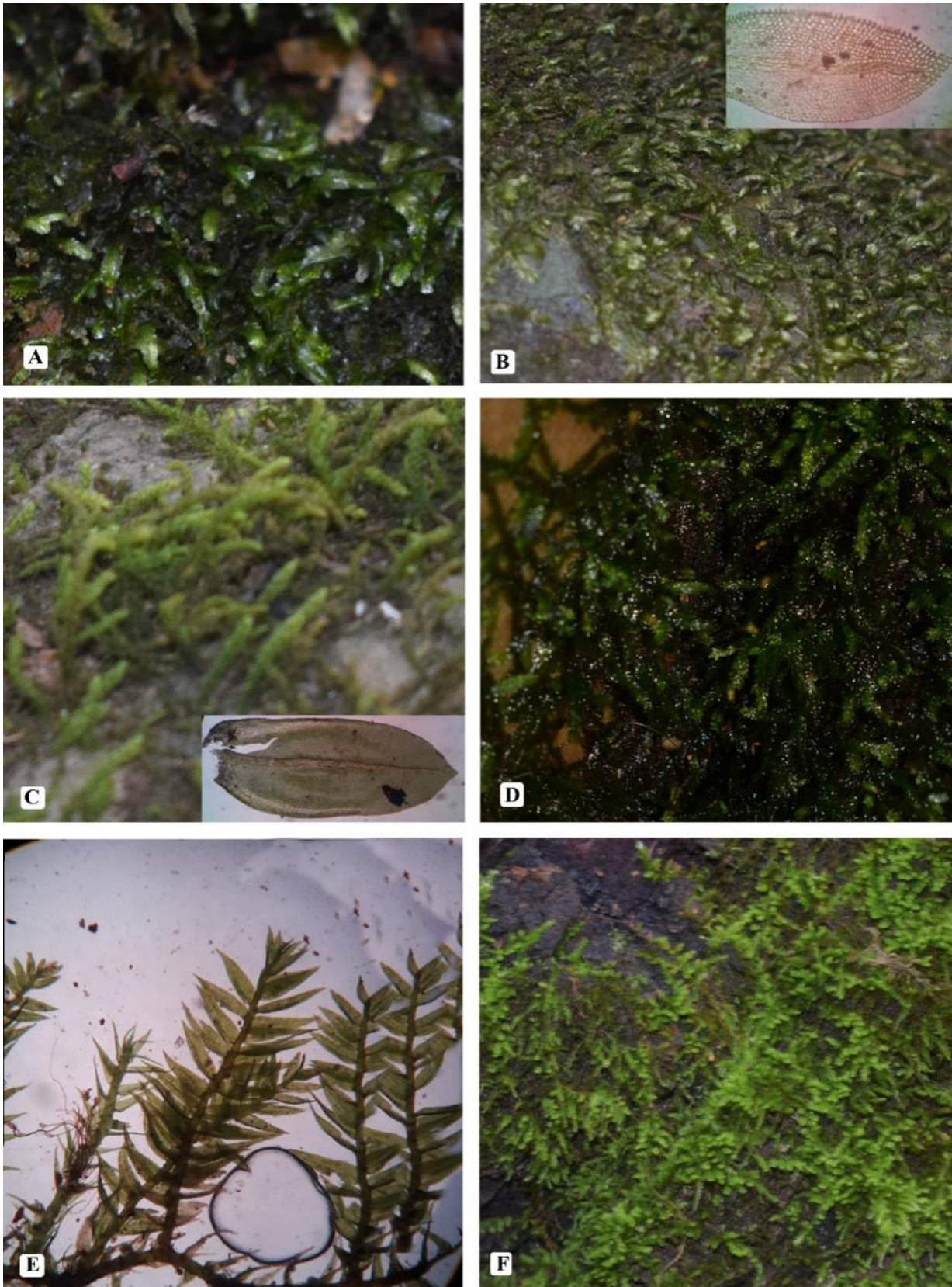


Plate 2: A. *Homaliodendron flabellatum* (Sm.) M. Fleisch, B. *H. microdendron* (Mont.) M. Fleisch, C. *Pinnatella calcutensis* M.Fleisch., D. *Taxithelium nepalense* (Schwagr.) Broth, E. *Claopodium prionophyllum* (Mull. Hal.) Broth., and F. *Bryosedgwickia aurea* (Schwagr.) M. Fleisch.

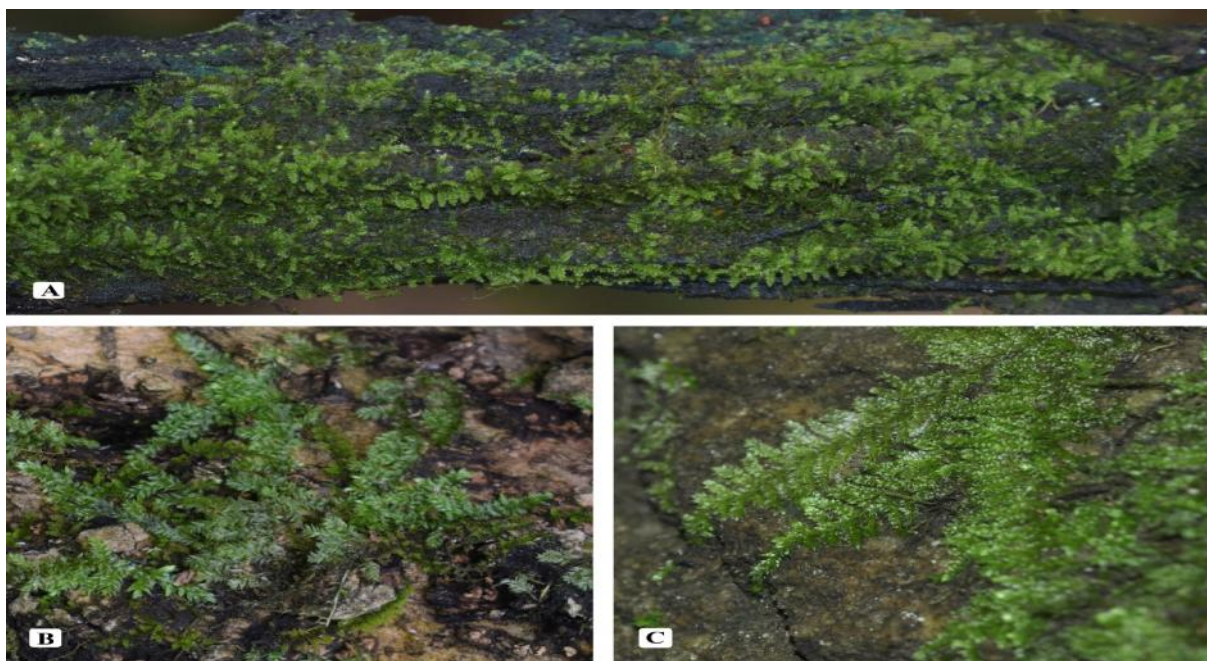


Plate 3: A. *Isopterygium albescens* (Hook.) A. Jaeger., B. *I. minutirameum* (C. Muell.) Jaeg and C. *I. pohliaecarpum* (Sull. & Lesq.) A. Jaeger.

Thuidiaceae

Claopodium prinophyllum (Mull. Hal.) Broth. in Nat. Pfl., 1(3): 1009. 1908; *Hypnum prinophyllum* C. Muell. in Syn., 2: 481. 1851; *H. nervosum* Harv. in Hook. in Icon. Pl. Rar., 1: 24: 1836; *Leskea prinophylla* (Harv.) Mitt. in Musci Ind. Or.: 132. 1859; *Pseudoleskea prinophylla* (C. Muell.) Bosch & Lac. in Bryol. Jav., 2: 124. 1857; *Claopodium subaciculum* Broth. in Oefv. Finsk. Vet. Soc. Foerh., 62A (9): 34 1921; *C. nervosum* (Harv.) Fleisch. in Musci fl. Buitz., 4: 1504. 1923; *C. amblystegioides* Dix. in Proc. Linn. Soc. N. S. Wales, 55: 281. 1990; Gangulee, Moss. E. India 3(7): 1602 – 1604. 1980.

Plants small to medium, yellowish green to dark green in dense tufts. Main stems creeping up to 6 cm, with branches pinnately arranged simple or again pinnately branched, even dendroid when strongly developed. Paraphyllia present. Stem leaves larger, widely cordate-lanceolate. Branch leaves spreading when moist, curled when dry, narrowly cordate-lanceolate, 0.8 – 1.2 × 0.24 – 0.26 mm wide at base, tip very narrow, margin flat, faintly but distinctly dentate. Costa strong, percurrent. Leaf cells ovate-hexagonal, 7 – 9 × 5 – 7 μm usually with a single papilla on lumen; marginal row distinct in being larger up to 23 μm long, dentate and smooth. Cells at middle of both halves of base long 18 – 24 × 5 – 7 μm and pellucid. Sporophytes are not seen.

Habitat and ecology: Saxicolous on moist rocks in moist deciduous forests, associated with *Dumortia hirsuta* or *Fissidens sylvaticus*.

Distribution: World: Hawaiian Is. and **India:** Arunachal Pradesh, Assam, Kerala, Meghalaya, Sikkim, Tamil Nadu, Uttarakhand and West Bengal.

Specimens examined: India, Andhra Pradesh, Visakhapatnam district, Galikonda, near view point, 21 Oct. 2018, 55197B, AS.

Pinnatella calcutensis M.Fleisch., Hedwigia 45: 84. 1906; *Neckeropsis calcutensis* (M. Fleisch.) Enroth., Acta Bryolichenol. Asiatica 2: 9. 1990 (1991); *Pinnatella plopecuroides* var. *calcutensis* (M. Fleisch.) Gangulee Moss. E. India 2 (5): 1440. 1976; Bryophytes of Wayanad in W. Ghats. 281. 2005.

Plants dark greenish to green, main stem creeping up to 10 cm long, branches weak, not erect, having scale leaves, secondary stems up to 8 cm long, branching regular and closely pinnate; leaves not much changed when both moist and dry conditions, sometimes leaves flaccid when dry, wavy, ovate-ligulate, 2 – 2.5 × 0.8 – 1 mm, base broad, obtuse with apiculus, entire to dentate at apex. Costa strong, percurrent or ending below the apex. Leaf cells incrassate, rough papillae on lumen, marginal and basal cells broadly rhomboid to ovate 50 – 75 × 8 – 15 µm, slightly small near at apex, a conspicuous intramarginal zone of elongated cells from near at base, all cells 40 – 50 × 5 – 10 µm, covering more than two third of the leaf length, flanked by a border of 2 or 3 rows of very small cells upper cells irregularly rounded, 11 – 13 × 7 – 8 µm, alar cells distinct, orange colored. Sporophyte not seen.

Habitat and ecology: Corticolous, in deep shade on base of tree trunk near water stream areas, associate with *Stereophyllum confusum* (Stereophyllaceae) and other pleurocarpous mosses.

Distribution: World: South-east Asia, Thailand and India: Darjeeling, Karnataka, Kerala, Orissa and West Bengal.

Specimens examined: India, Andhra Pradesh, East Godavari district, Forests of Papikondalu National Park, Amruthadara Waterfalls, 22 Nov. 2018, 55808; 55816A & 55820B, AS; Jalatarangini WF, 23 Nov. 2018, 55850B & 55852B, AS.

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