Taiwania, 57(2): 168-182, 2012

The Erpodiaceae (Bryophyta: Isobryales) of India

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(Manuscript received11November 2011; accepted18January 2012)

ABSTRACT: Three genera, *viz*., *Aulacopilum*, *Erpodium* and *Solmsiella* are recognized in the moss family *Erpodiaceae*. *Aulacopilum* and *Erpodium* have 2 species each while *Solmsiella* has only one. *Aulacopilum beccarii* and *Erpodium glaziovii* are added to the moss flora of Asia, and South and Southeast Asia respectively. *Aulacopilum glaucum* is added to the moss flora of India. The name *Aulacopilum beccarii* is resuscitated. The genera and species are keyed out. Apart from a detailed description and information on habitat, each species is illustrated and its distribution is mapped.

KEY WORDS: *Aulacopilum*, Erpodiaceae, *Erpodium*, *Solmsiella*.

INTRODUCTION

Plants of Erpodiaceae are a group of pleurocarpous mosses with mono- or dimorphic leaves. Dixon (1932) placed Erpodiaceae in the order Orthotrichales of acrocarpous mosses which Pursell (1994) followed. Since Erpodiaceae belongs to pleurocarpous mosses, the family is placed in the Isobryales following Brotherus (1925), Bruehl (1931), Chopra (1975), Gangulee (1976) and Lal (2005).

Müller (1843) established the family Erpodiaceae based on the genus *Erpodium* (Brid.) Brid. ex Rchb. and a single species, *E. domingense* (Spreng.) Brid. Brotherus (1925) included 5 genera, *viz*., *Aulacopilum* Wilson (not assigned to any family when published), *Erpodium* (Brid.) Brid. ex Rchb., *Solmsiella* Müll.Hal., *Venturiella* Müll.Hal. and *Wildia* Müll.Hal. & Broth. ex Broth. Dixon (1931) added the sixth genus *Microtheciella*. These genera together include 40 species after taking into consideration of a few other novelties and reduction to synonyms (*vide* Crum, 1972).

Crum (1972) combined *Erpodium* with *Solmsiella* and recognized 5 genera and 26 species. Miller and Harrington (1977) segregated *Microtheciella* Dixon from the Erpodiaceae and placed it in a separate family, Microtheciellaceae, since it occupies a different niche from the allied families Rhachytheciaceae and Erpodiaceae. Crum (1988) added a new species in the genus *Aulacopilum*, *A. schaeferi*, from Brazil.

Pursell and Allen (2002, 2007) revived *Solmsiella* based on the distinctly dimorphic and number of rows of leaves (4-rowed). As a result, the Erpodiaceae now has 5 genera and 24 species in the world.

Three genera, *viz*., *Aulacopilum, Erpodium* and *Solmsiella* are reportedly distributed in India (Bruehl, 1931; Gangulee, 1974; Chopra, 1975; Daniels, 2004, 2010; Lal, 2005). According to Lal (2005), *Aulocopilum* has 3 species, *viz*., *A. abbreviatum* Mitt., *A. luzonense* E.B. Bartram and *A. tumidulum* Thwaites & Mitt., *Erpodium* contains one species *E. mangiferae* Müll.Hal. and *Solmsiella* is composed of *S. biseriata* (Austin) Steere and *S. ceylonica* (Thwaites & Mitt.) Müll.Hal.

Crum (1972) synonymised *Solmsiella ceylonica* and *S. biseriata* under *Erpodium biseriatum*. He also placed *Aulacopilum luzonense* in *Erpodium*. Stone (1997) combined *Aulacopilum*, *Solmsiella* and *Venturiella* with *Erpodium* and shifted *Aulacopilum abbreviatum* and *A. tumidulum* to *Erpodium* which Lal (2005) overlooked. Since Pursell and Allen (2002, 2007) revived the genus *Solmsiella*, the name *S. biseriata* as given by Lal (2005) is now the correct name for *E. biseriatum*. Based on nomenclatural changes Lal (2005) included 5 species in his checklist, *viz*., *Erpodium abbreviatum* (=*Aulacopilum abbreviatum*), *E. glaucum* (=*A. tumidulum*), *E. luzonense* (=*A. luzonense*), *E. mangiferae* and *Solmsiella biseriata*. Of these, only *Erpodium abbreviatum*, *E. mangiferae* and *Solmiella biseriata* have been authentically recorded for India (*vide* Bruehl, 1931; Foreau, 1931, 1964; Gangulee, 1974; Chopra, 1975; Daniels, 2004, 2010). Lal (2005) gave the distribution of *Aulacopilum tumidulum* (= *Erpodium glaucum*) as South India without mentioning a locality. Southern India is a large region which includes the Deccan Plateau, Eastern and Western Ghats as well as the Eastern and Western Coasts. Chopra (1975) made a theoretically convincing conclusion that *A. tumidulum* is likely to be collected in South India since it occurs in Sri Lanka. However, it has never been collected in India. Lal's (2005) inclusion of this species is perhaps based on the earlier mentioned unfounded assumption of Chopra. Hence, the 3 species

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of *Erpodium*, *viz., E. beccarii*, *E. glaucum* and *E. glaziovii* are now added to the moss flora of India from the Mahendragiri Hills in the Western Ghats, falling within the Tamil Nadu part of the Agasthyamalai Biosphere Reserve. Chopra (1975) stated that *Venturiella sinensis* (Venturi) Müll.Hal. is likely to be collected in Sikkim and South India as it had already been recorded for China and Sri Lanka. However, this name does not figure in the checklist of the mosses of Sri Lanka (O'Shea, 2002). Hence, 3 genera, *Aulacopilum*, *Erpodium* and *Solmsiella* and 5 species, *A. beccarii* (=*E. beccarii*), *A. glaucum* (=*E. glaucum*), *E. glaziovii*, *E. mangiferae* and *S. biseriata* are dealt with. They are keyed out, described in detail, illustrated and their distribution is mapped. The present study is mostly based on material collected in the Agasthyamalai Biosphere Reserve located in the Western Ghats in Peninsular India during the last one decade.

MATERIALS AND METHODS

Collections were made during and after the monsoon showers so as to collect fertile specimens. Details on the habit, habitat and host plants, wherever possible, were recorded. The specimens collected were processed following traditional methods. Figures were made using a camera lucida and notes were made wherever required. Specimens were determined with the help of Gangulee's mosses of Eastern India and adjacent regions (1969-1980) and other related works particularly more recent monographs and revisions as well as by comparing with protologues, types and/or authentic specimens as and when required. The specimens are housed at SCCN [Herbarium, Scott Christian College, Nagercoil] and CAL.

TAXONOMIC TREATMENT

Erpodiaceae Müll.Hal.

Müll.Hal., Bot. Zeitung (Berlin) 1: 775. 1843; Broth. in Engl. & Prantl, Nat. Pflanzenfam. ed. 2, 2(11): 1. 1925.-Type: *Erpodium* (Brid.) Brid. ex Rchb.

Plants pleurocarpous, slender, forming loose or dense mats, appressed to substratum. Stems creeping, terete or complanate, horizontally branched. Leaves mono- or dimorphic; cells thin-walled, smooth, multipapillate or with a distinct, primordial utricle. Rhizoids clustered beneath stem at ventral leaf base or scattered. Perichaetial leaves erect, the innermost sheathing. Setae short, straight. Capsules immersed to emergent. Operculum apiculate to rostrate. Peristome rarely present. Spores globose, finely papillose, green.

Key to the genera

1a. Leaves more than 4-rowed, monomorphic; calyptrae mitrate…... 2
1b.Leaves 4-rowed, dimorphic; calyptrae cucullate ..... *Solmsiella*
2a.Leaves with a hyaline awn at apex; leaf cells multipapillate ..... *Aulacopilum*
2b. Leaves without a hyaline awn at apex; leaf cells epapillate ..... *Erpodium*

Aulacopilum Wilson

Wilson, London J. Bot. 7: 90. 1848; Müll.Hal., Linnaea 39: 423. 1875; Broth. in Engl. & Prantl, Nat. Pflanzenfam. ed. 2, 2(11): 4. 1925; Bruehl, Rec. Bot. Surv. India 13(2): 116. 1931; Pursell, Mem. New York Bot. Gard. 69: 581. 1994; Crum, Beih. Nova Hedwigia 23: 219. 1972; Chopra, Taxon. Indian Moss.: 265. 1975; Hodgetts, J. Bryol. 19: 114. 1996; Magill & van Rooy in Leistner, Fl. S. Africa: 456. 1998.-Type: *A. glaucum* Wilson.

Stems sometimes with a faint central strand. Leaves 4-rowed, slightly dimorphic, with a hyaline awn at apex; cells multipapillate. Calyptrae mitrate or cucullate, twisted or not.

Species 6, mostly distributed in the tropics; 2 in India.

Key to the species

1a. Capsules immersed; calyptrae mitrate, neither enclosing capsule nor twisted ……*A. beccarii*
1b. Capsules emergent; calyptrae cucullate, enclosing capsule and twisted ……..... *A. glaucum*

Aulacopilum beccarii (Müll.Hal. ex Venturi) Mitt., J. Linn. Soc., Bot. 13: 308. 1873. *Erpodium beccarii* Müll.Hal. ex Venturi, Nuovo Giorn. Bot. Ital. 4: 18. 1872; Broth. in Engl. & Prantl, Nat. Pflanzenfam. ed. 2, 2(11): 3. 1925; Crum, Beih. Nova Hedwigia 23: 211. 1972; Pursell, Mem. New York Bot. Gard. 69: 586. 1994; Hodgetts, J. Bryol. 19: 116. 1996; Stone, J. Bryol. 19: 494. 1997; Magill & van Rooy in Leistner, Fl. S. Africa: 453. 1998; Pursell & Allen, Monogr. Syst. Bot. Missouri Bot. Gard. 90: 524. 2002.-Type: Africa, Ethiopia, *Beccaris.n.* (NY). *E. paraguense* Besch., Mém. Soc. Sci. Nat. Math. Cherbourg 21: 265. 1877.-Type: South America, Paraguay, on tree trunks, May 1877, *Balansa* 1214 (FH). *E. lorentzianum* Müll.Hal., Linnaea 42: 384. 1879.-Type: South America, Argentina, Mt. Crún, Sept. 15, 1873, epiphytic on urundey?, *Lorentz s.n.* (B, STR). *E. hanningtonii* Mitt., J. Linn. Soc., Bot. 22: 313. 1886.-Type: Africa (SW. Kenya), Nyanza Prov., Lake Nyanza, on *Adansonia digitata*, *Hannington s.n.* Herb. Mitt. (NY). *E. joannis-meyeri* Müll.Hal., Flora 73: 486. 1890.-Type: Africa (NE. Tanzania), Mt. Kilimanjaro, 1800 m, on a tree trunk, 1889, *Hans Meyer s.n.* (B). *E.menyharthii* Müll.Hal.,

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Verh. K.K. Zool.-Bot. Ges. Wien 43: 13. 1893.-Type: Africa, Zambezi, around Boroma (Somalia), on bark of tree trunk, Aug. 1890, *Menyharth s.n.* (B). *E. opuntiae* Cardot, Rev. Bryol. 37: 6. 1910.-Type: North America, Mexico, around Oaxaca, on *Opuntia* sp., 1894, *Pringle* 31a (FH, MICH, MO, NY). Fig. 1

Plants 1-2 cm long, slender, in loose or dense mats, dark green. Stems creeping, irregularly branched, green to brown, ca 0.16 × 0.12 mm in cross section, ca 11-celled across; cortex 1-or 2-layered; cells 4-8 × 3-6 μm, thick-walled; medullary ones 12-20 × 10-16 μm, thin-walled; branches horizontal to ascending. Leaves patent, deeply concave, 1-1.2 × 0.35-0.42 mm, oblong-ovate, crenulate-papillose at margin, acute to acuminate, tapering to a uniseriate, brittle awn, ecostate; awn broad at base, ca 0.55 mm long, distantly serrulate; cells thin-walled, hexagonal to quadrate, multipapillate, distinct; papillae 2-5 per cell, verrucose; apical cells 8-20 × 6-10 μm; median ones 8-16 × 6-14 μm; those at base 10-28 × 8-16 μm. Rhizoids clustered along ventral surface of stem, pale brown. Sporophytes on branches. Perichaetial leaves larger than vegetative ones, 1.9-2.2 (including awn) × 0.4-0.6 mm, ovate-oblong, entire, acuminate; cells elongate-rhomboid; apical ones 32-64 × 8-10 μm, epapillate; median ones 28-44 × 10-16 μm, multipapillate; those at base 10-28 × 10-16 μm, epapillate. Setae ca 0.32 mm high. Capsules immersed, ca 0.96 × 0.56 mm, cylindric-ovoid, pale brown; annulus deeply inserted, with 5 or 6 rows of more or less rectangular, 16-32 × 8-12 μm cells. Operculum convex, rostellate, ca 0.4 mm long. Stomata at capsule base only, ca 6 × 4 μm; guard cells ca 26 × 12 μm. Calyptrae ca 0.56 × 0.32 mm, mitrate, plicate, not reaching middle of capsule. Spores globose to ovoid, 28-40 × 24-38 μm, papillose, pale brown.

Habitat: Corticolous on *Albizia odoratissima* (L.f.) Benth. (Mimosaceae), a medium-sized tree in degraded evergreen forests, ca 800 m. In Africa (Kenya) it was corticolous on *Adansonia digitata* L. (Bombacaceae) and in N. America (Mexico) it was epiphytic on *Opuntia* sp. (Cactaceae).

Distribution: Africa, Australia, Mexico, S. America and India: Western Ghats of Tamil Nadu. (Fig. 2)

Specimens examined: INDIA, Tamil Nadu, Tirunelveli Dist., W. Ghats, Mahendragiri, ca 800 m, 17.08.2010, *Daniels, Kariyappa & Mabel* 3927 p.p.

Note: This species is added here to the moss flora of Asia.

Aulacopilum glaucum Wilson, London J. Bot. 7: 91, t. 4, ff. 1-10. 1848; Crum, Beih. Nova Hedwigia 23: 219. 1972.-Type: New Zealand, on trees, growing intermixed with *Fabronia secunda*, 1843, *W. Colenso* 3668a (lectotype and isolectotypes, BM *vide,* Stone, 1997). *A. tumidulum* Thwaites & Mitt. ex Mitt., J. Linn. Soc., Bot. 13: 307. 1873; Bruehl, Rec. Bot. Surv. India 13(1): 60. 1931; Crum, Beih. Nova Hedwigia 23: 219. 1972; Chopra, Taxon. Indian Moss.: 266. 1975; Pursell, Mem. New York Bot. Gard. 69: 582. 1994; Lal, Checklist Indian Moss.: 21. 2005.-Type: Ceylon, *Thwaites s.n.* (BM). *A. balansae* Müll.Hal., Flora 70: 447. 1877.-Type: South America, Paraguay, *Balansa s.n.* (FH). *A. intermedium* Broth., Ark. Bot. 15: 10. 1918.-Type: South America, Argentina, Quinta, near Laguna de la Brea, Prov. Jujuy, *Fries* 3 (H). *A. brittoneae* Pursell, Bryologist 69: 463. 1967.-Type: North America, Mexico, Monterey, Nuevo León, *Pringle* 727 (FH, NY). *Erpodium glaucum* (Wilson) Stone, J. Bryol. 19: 492. 1997. Fig. 3

Plants 2-8 mm long, appressed to substratum, glaucous green, opaque. Stems creeping, irregularly branched, green to brown, ca 0.11 × 0.08 mm in cross section, ca 7-celled across; cortex 1-or 2-layered; cells 4-8 × 3-5 μm, thick-walled; medullary ones 12-32 × 8-24 μm, thin-walled; branches horizontal to ascending. Leaves 4-rowed with 2 dorsal and 2 ventral ones, complanate, glaucous green; dorsal leaves 0.56-0.64 × 0.24-0.32 mm, ovate-lanceolate, crenulate-papillose, acute to acuminate, slightly awned, ecostate; cells thin-walled, oblong-hexagonal to quadrate, multipapillate; apical ones 6-14 × 4-10 μm; median ones 8-16 × 6-10 μm; basal ones 12-32 × 6-10 μm; ventral leaves 0.32-0.48 × 0.13-0.16 mm, narrow, lanceolate, crenulate-papillose, acuminate. Rhizoids clustered at ventral leaf base, pale brown. Sporophytes terminal on branches. Perichaetial leaves broader than vegetative ones, ca 0.64 × 0.4 mm, ovate, acute to acuminate. Setae 0.4-1mm long. Capsules emergent, ca 0.45 × 0.3 mm, cylindric, pale brown; annulus undifferentiated to poorly differentiated. Operculum concave, ca 0.12 mm high, rostellate. Calyptrae cucullate, ca 0.9 mm long, enclosing capsule, ridged, twisted, split on one side.

Habitat: Corticolous on *Sterculia guttata* Roxb. (Sterculiaceae), a medium-sized tree in degraded evergreen forests, ca 800 m.

Distribution: Australia, New Zealand, N. & S. America, Sri Lanka and India: W. Ghats of Tamil Nadu. (Fig. 4)

Specimens examined: INDIA, Tamil Nadu, Tirunelveli Dist., W. Ghats, Mahendragiri, ca 800 m, 17.08.2010, *Daniels, Kariyappa & Mabel* 3919.

Note: This species is added here to the moss flora of India.

Erpodium (Brid.) Brid. ex Rchb.

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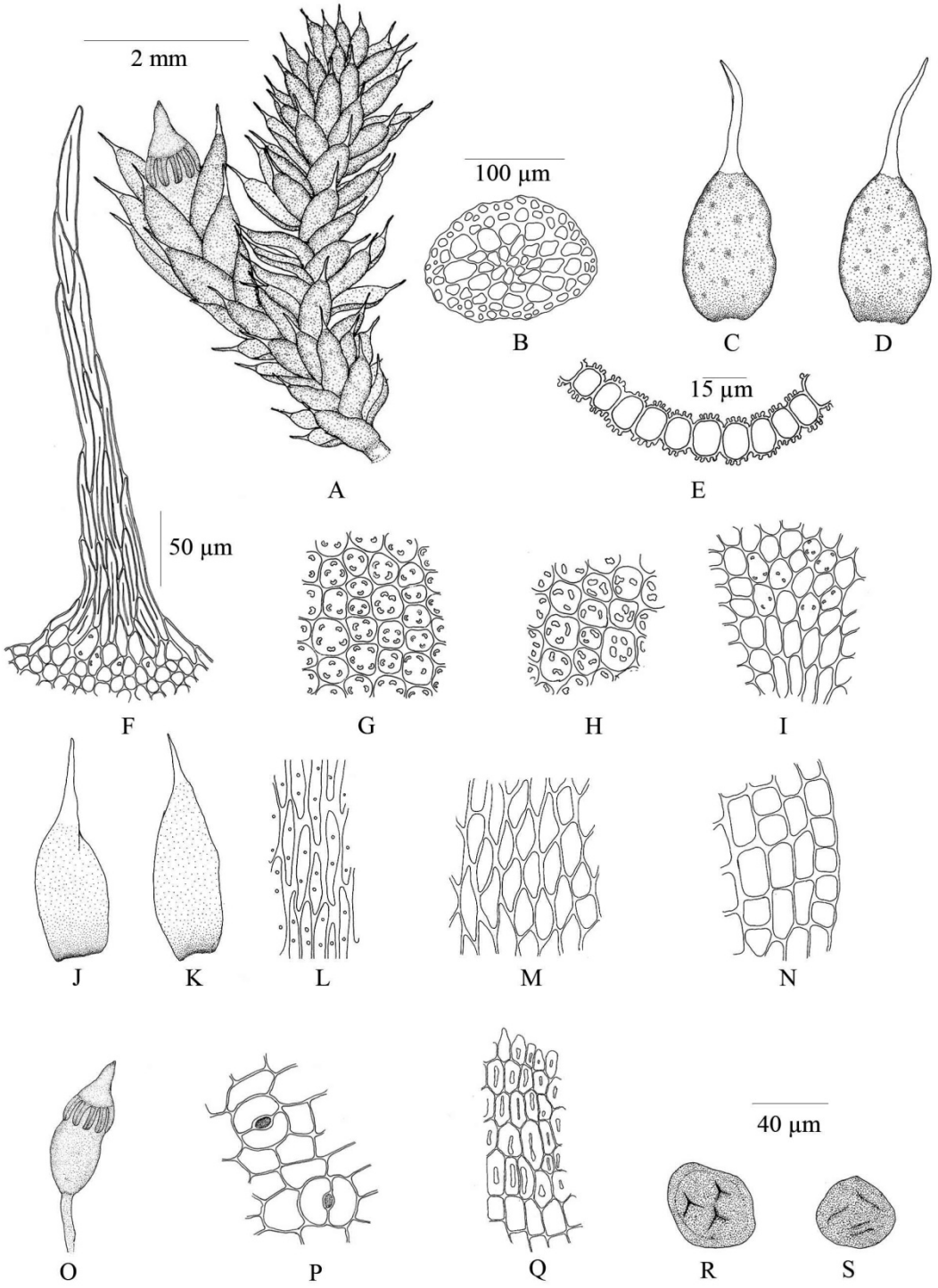


Fig. 1.

Fig. 1. *Aulacopilum beccarii* (Müll.Hal.) Mitt. A: Plant. B: Cross section of stem. C & D: Leaves. E: Cross section of leaf. F: Leaf apical cells. G: Leaf median cells. H: Leaf median cells on abaxial surface. I: Leaf basal cells. J & K: Perichaetial leaves. L: Perichaetial leaf median cells. M: Leaf cells between median and basal region. N: Leaf basal cells. O: Capsule. P: Stomata. Q: Annulus cells. R & S: Spores. Use 2 mm scale for A, C and D, J and K, O, 100 µm scale for B, 15 µm scale for E, 50 µm scale for F-I, L-N, P and I, 40 µm scale for P, Q, R and S. Drawn from Daniels et al. 3927 p.p.

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Fig. 2.

Fig. 2. Distribution of *Aulacopilum beccarii* (Müll.Hal.) Mitt. ● Earlier localities ✦Present locality

Brid. ex Rchb., Consp. Regn. Veg. 2: 32, No. 547. 1828; [Brid. ex Müll.Hal. in] Müll.Hal., Bot. Zeitung (Berlin) 1: 774. 1843, isonym & Linnaea 39: 422. 1875; Broth. in Engl. & Prantl, Nat. Pflanzenfam. ed. 2, 2(11): 2. 1925; Bruehl, Rec. Bot. Surv. India 13(2): 116. 1931; Crum, Beih. Nova Hedwigia 23: 205. 1972, excl. syn. *Solmsiella* Müll.Hal. 1884; Gangulee, Moss. E. India 2(4): 1137. 1974; Chopra, Taxon. Indian Moss.: 265. 1975; Pursell, Mem. New York Bot. Gard. 69: 582. 1994; Hodgetts, J. Bryol. 19: 114. 1996; Stone, J. Bryol. 19: 487. 1997, excl. syns.; Magill & van Rooy in Leistner, Fl. S. Africa: 451. 1998; Pursell & Allen, Monogr. Syst. Bot. Missouri Bot. Gard. 90: 524. 2002 & in Fl. N. America 27: 471. 2007.-Type: *Erpodium domingense* (Spreng.) Brid. (*Anoectangium domingense* Spreng.).

Anoectangium Schwägr. subgen. *Erpodium* Brid., Bryol. Univ. 2: 167. 1827.

Pilotrichum P. Beauv. sect. *Erpodium* (Brid.) Müll.Hal., Syn. Musc. Frond. 2: 184. 1851.

Leptangium Mont., Syll. Gen. Sp. Crypt.: 26. 1856.-Type: *Leptangium perrottetii* (Mont.) Mont.

Erpodium (Brid.) Brid. ex Rchb. sect. *Stephanostoma* Mitt., J. Linn. Soc., Bot. 13: 307. 1873; Crum, Beih. Nova Hedwigia 23: 216. 1972.-Type: *Erpodium bellii* Mitt.

Stephanostoma (Mitt.) Kindb., Bot. Centralbl. 77: 53. 1899.-Type: *Erpodium bellii* Mitt.

Stems without a central strand. Leaves spirally arranged, monomorphic; cells with a primordial utricle. Calyptrae campanulate-mitrate.

Species 15, mostly distributed in the tropics; 2 in India.

Key to the species

1a. Primordial utricle present in all leaf cells; capsules urn-shaped, white ……..…….. *E. mangiferae*
1b. Primordial utricle absent in leaf basal cells; capsules cylindric, brown ..……..……..……..…… *E. glaziovii*

Erpodium glaziovii Hampe, Vidensk. Meddel. Dansk Naturhist. Foren. Kjobenhavn 3: 54. 1872; Crum, Beih. Nova Hedwigia 23: 216. 1972; Pursell, J. Bryol. 69: 469. 1966 (as *glazioui*) & Mem. New York Bot. Gard. 69: 588. 1994; Kürschner & Ochyra, Willdenowia 33: 206. 2003.-Type: South America, Brazil, Rio de Janeiro, *Glaziou* 5186 (NY). *E. Balansae* Müll.Hal., Flora 70: 449. 1887.-Types: South America, Paraguay, June 1881 & 1884, *Balansa* 3645 & 3645a (FH). Fig. 5

Plants 3-9 mm long, appressed to substratum, green, opaque. Stems creeping, irregularly branched, green to brown, ca 0.16 × 0.12 mm in cross section, ca 7-celled across; cortex1-layered; cells 8-14 × 6-10 μm, thin-walled; medullary ones 8-32 × 6-20 μm, thin-walled; branches horizontal to ascending. Leaves complanate, patent, 0.8-1 × 0.35-0.45 mm, oblong-ovate, entire, acute to acuminate, ecostate; cells thin-walled, sometimes thickened at corners, ovate-hexagonal with a conspicuous primordial utricle in some apical and

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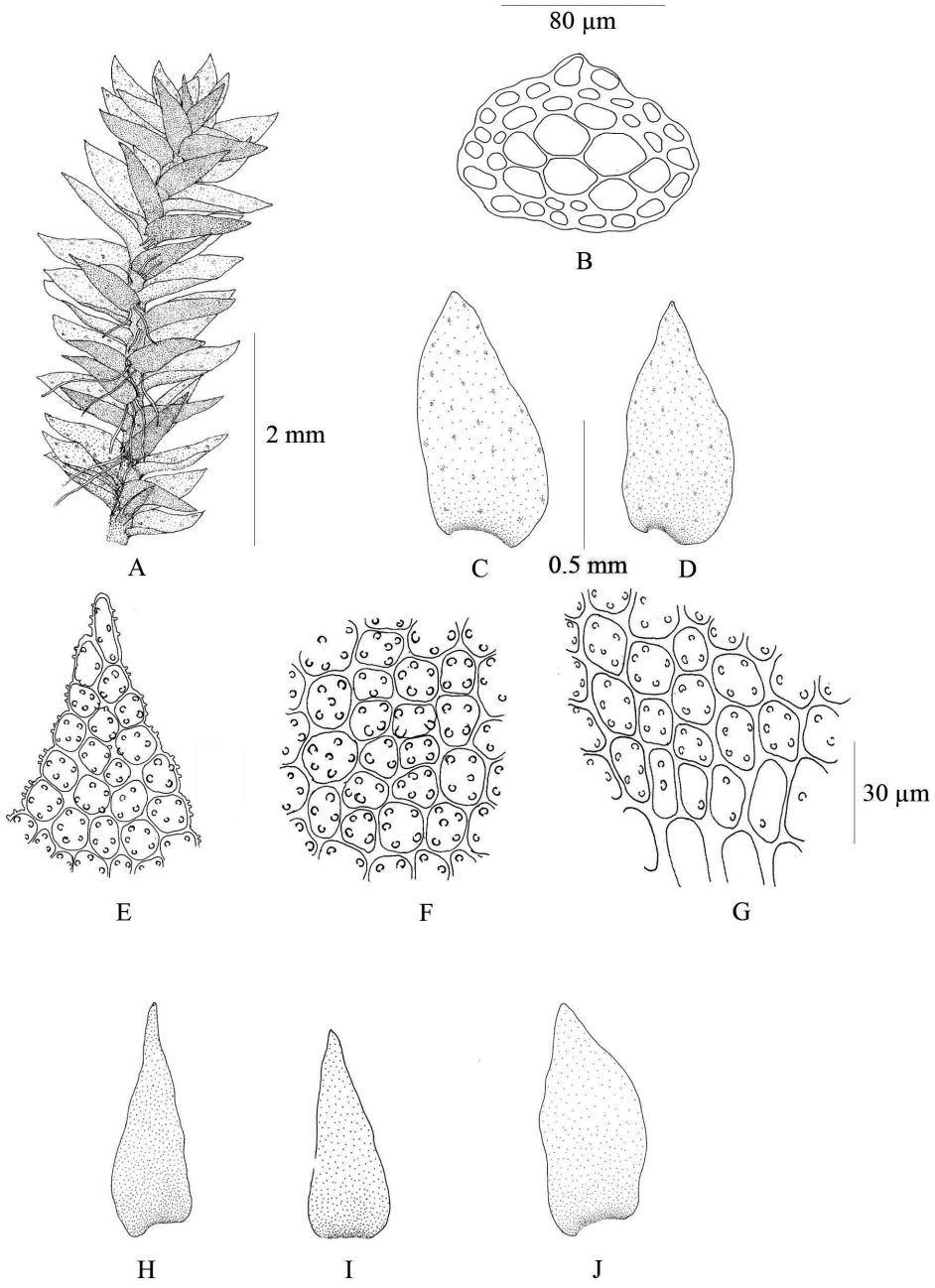


Fig. 3.

Fig. 3. *Aulacopilum glaucum* Wilson. A: Plant. B: Cross section of stem. C & D: Dorsal leaves. E: Leaf apical cells. F. Leaf median cells. G: Leaf basal cells. H & I: Ventral leaves. J: Perichaetial leaf. Use 2 mm scale for A, 80 µm scale for B, 0.5 mm scale for C,D,H,I and J, 30 µm scale for E-G. Drawn from Daniels et al. 3919 p.p.

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Fig. 4.

Fig. 4. Distribution of *Aulacopilum glaucum* Wilson. ● Earlier localities ✦ Present locality

median cells; apical ones 8-20 × 6-10 μm; median ones 8-16 × 6-14 μm; basal ones 10-28 × 8-16 μm. Rhizoids clustered on ventral surface of stem, pale brown. Sporophytes terminal on branches. Perichaetial leaves broader than vegetative ones, ca 0.83 × 0.48 mm, oblong-ovate, acute. Setae ca 0.32 mm high. Capsules emergent, ca 1.2 × 0.56 mm, cylindric, brown. Spores not seen.

Habitat: Corticolous on *Grewia tiliifolia* Vahl (Tiliaceae), a medium-sized tree in degraded evergreen forests, ca 800 m. Kürschner & Ochyra (2003) collected on the trees of *Acacia etbaica* (Mimosaceae), *Acokanthera schimperi* (Apocynaceae) and *Anogeissus dhofarica* (Combretaceae).

Distribution: Brazil, Mexico, Yemen and India: Western Ghats of Tamil Nadu. (Fig. 6)

Specimens examined: INDIA, Tamil Nadu, Tirunelveli Dist., W. Ghats, Mahendragiri, ca 800 m, 17.08.2010, *Daniels*, *Kariyappa & Mabel* 3924 p.p.; ca 850 m, 22.10.2010, *Kariyappa & Mabel* 5574.

Note: This species is added here to the moss flora of South and SE. Asia.

Erpodium mangiferae Müll.Hal., Linnaea 37: 178. 1872; Dixon, J. Bot. 47: 159. 1909; Rec. Bot. Surv. India 6(3): 81. 1914; J. Bombay Nat. Hist. Soc. 39: 780. 1937 & Notes Roy. Bot. Gard. Edinburgh 19: 292. 1938; Sedgw., J. Bombay Nat. Hist. Soc. 19: 941. 1910; Bruehl, Rec. Bot. Surv. India 13(1): 59. 1931; Foreau, J. Madras Univ. 3: 118. 1931 & J. Bombay Nat. Hist. Soc. 61: 224. 1964; Wadhwa, M.V.M. Patrika 4: 90. 1969; Gangulee, Moss. E.India 2(4): 1138, f. 553. 1974; Chopra, Taxon. Indian Moss.: 265. 1975; Mohamed et al., J. Bombay Nat. Hist. Soc. 83: 690. 1986; Dabhade, Moss. Khandala: 61, f. 11(74-77). 1998; Daniels in Annamalai, Tamil Nadu Biodivers.: 52. 2004; Khatun & Hadiuzzaman, Bangladesh J. Pl. Taxon. 11: 29. 2004; Lal, Checklist Indian Moss.: 58. 2005; Chaudhary et al., Bryoph. Fl. Gujarat: 129, f. 55. 2006 & Bryoph. Fl. N. Konkan: 161, f. 48. 2008.-Type: India, Bengal (Terai), Dingra Ghat, on *Mangifera indica* L., Nov. 1868, *Kurz* 1915 (CAL!). *E. bellii* Mitt., J. Linn.Soc., Bot. 13: 307. 1873; Dixon, J. Bot. 47: 160. 1909.-Type: India (Uttar Pradesh), Saharunpore, Bot. Gard., 100 ft., 1863, *Bell* 54 (LHR, NY). Fig. 7

Plants 5-8 mm long, slender, in loose or dense mats, appressed to substratum, pale green. Stems irregularly branched, green to brown, ca 0.1 mm in cross section, ca 6-celled across; cortex 1-layered; cells 8-20 × 6-15 μm, thin-walled; medullary ones 10-24 × 8-20 μm, thin-walled; branches 2-3 mm long, horizontal to ascending. Leaves complanate, 0.6-0.8 × 0.3-0.45 mm, oblong-ovate, concave, entire, acute, ecostate; cells thin-walled, ovate-hexagonal with a distinct, roughly spindle-shaped, primordial utricle; apical cells 6-40 × 5-16 μm; median ones 32-54 × 12-16 μm; basal ones 55-80 × 17-25 μm, sometimes without a primordial utricle; marginal ones 16-28 × 12-24 μm. Rhizoids scattered on ventral side of stem. Sporophytes terminal on branches. Setae very short, ca 0.2 mm high. Perichaetial leaves smaller than vegetative ones, ca 0.45 × 0.17 mm, oblong-ovate, concave, entire, acute.

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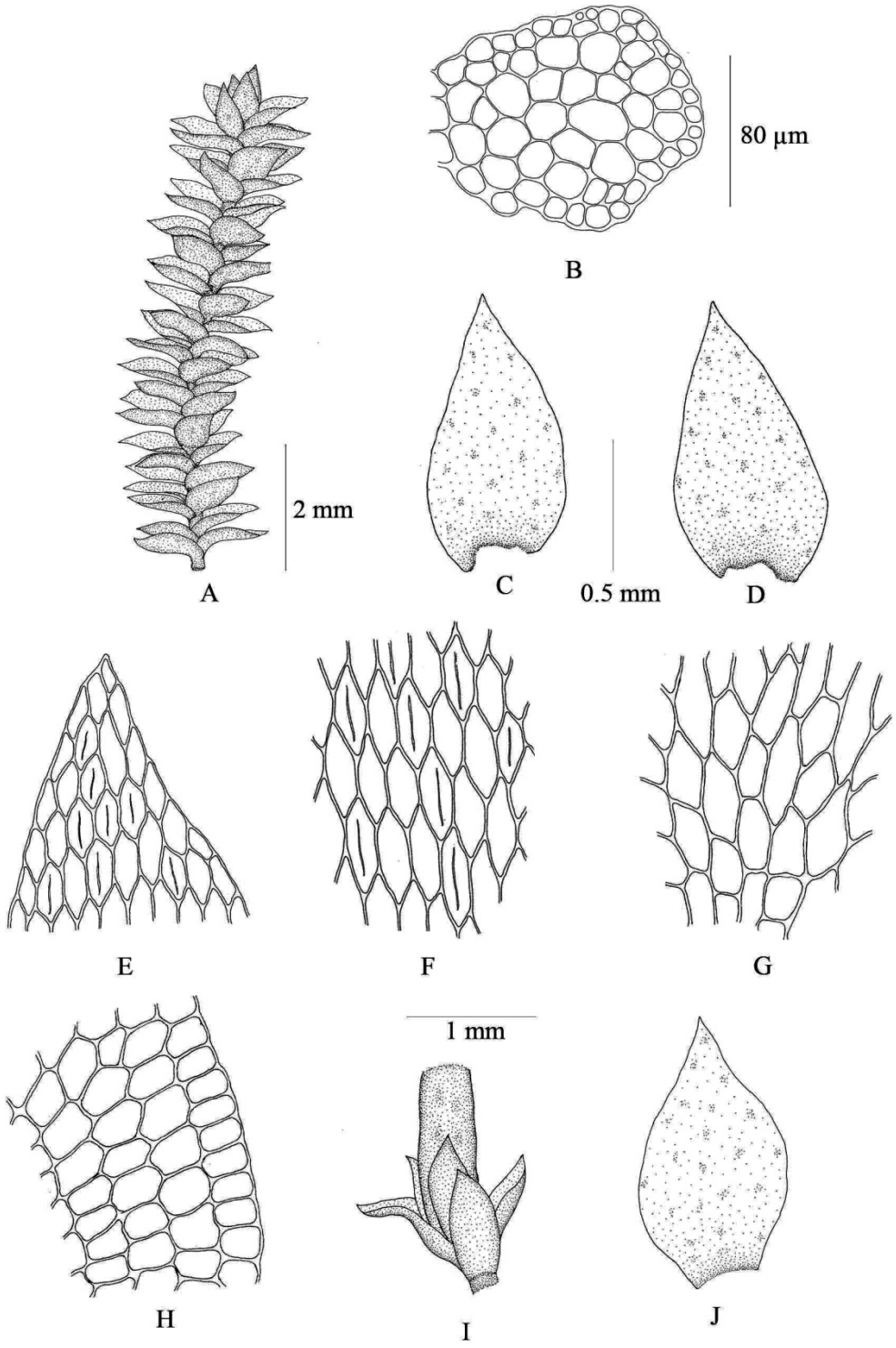


Fig. 5.

Fig. 5. ***Erpodium glaziovii*** **Hampe. A: Plant. B: Cross section of stem. C & D: Leaves. E: Leaf apical cells. F: Leaf median cells. G: Leaf basal cells. H: Leaf alar cells. I: Capsule. J: Perichaetial leaf. Use 2 mm scale for A, 80 µm scale for B, E-H, 0.5 mm scale for C, D and J, 1 mm scale for I. Drawn from Daniels et al. 3924 p.p.**

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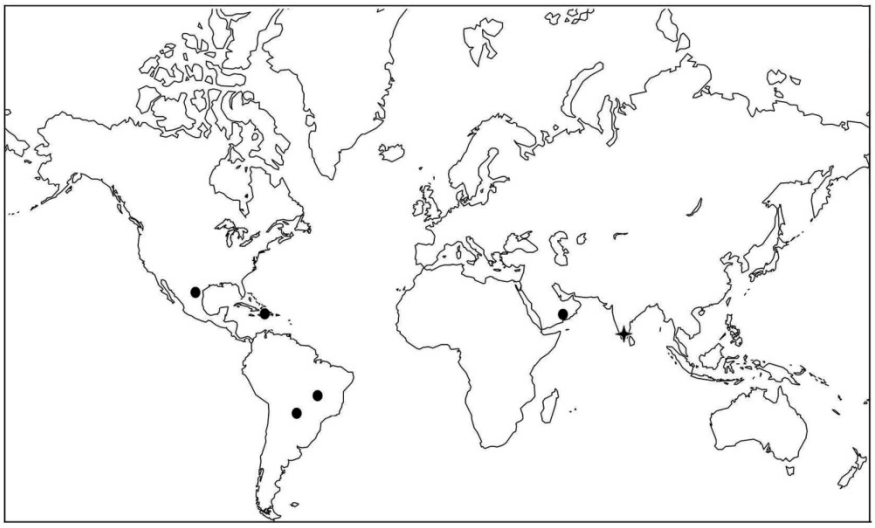


Fig. 6.

Fig. 6. Distribution of *Erpodium glaziovii* Hampe. ● Earlier localities ✦ Present locality

Capsules ca 1 × 0.5 mm, urn-shaped, white. Operculum shortly acuminate. Spores 32-40 × ca 40 µm, globose to ovoid, papillose, green.

Habitat: Corticolous on *Tectona grandis* L. (Verbenaceae) in plantations, ca 200 m.

Distribution: Bangladesh,Nepaland India: Assam, Himalaya (Uttarakhand & W. Bengal) and W. Ghats of Karnataka, Maharashtra and Tamil Nadu. (Fig. 8)

Specimens examined: VIETNAM, Tamil Nadu, Kanyakumari Dist., W. Ghats, Maramalai, ca 200 m, 15.7.2000, on *Tectona grandis* L. (Verbenaceae), *Daniels* 936; Calcutta, Eden Garden, 13.9.1956, corticolous on *Mangifera indica* (Anacardiaceae), *E.B. Bartram* 2444; Midnapore, 3.11.1958, corticolous on *Ficus bengalensis* (Moraceae), *E.B. Bartram* 3127 (CAL!).

Note: *Erpodium mangiferae* was originally collected from the bark of a mango tree and therefore the specific epithet '*mangiferae*'. It commonly grows epiphytically on the mango tree but has also been collected from unrelated hosts such as teak and banyan trees (*vide* specimens examined). They belong to totally unrelated and diverse families. There is nothing common among them except that all the 3 species are lofty trees and cultivated as well.

Solmsiella Müll.Hal.

Müll. Hal., Bot. Centralbl. 19: 149. 1884; Broth. in Engl. & Prantl, Nat. Pflanzenfam. ed. 2, 2(11): 5. 1925; Bruehl, Rec. Bot. Surv. India 13(2): 116. 1931; Steere, Bryologist 37: 97. 1934; Chopra, Taxon. Indian Moss.: 266. 1975; Pursell & Allen, Monogr. Syst. Bot. Missouri Bot. Gard. 90: 529. 2002 & Fl. N. America 27: 473. 2007. -Type: *S. javanica* Müll.Hal. (*S. biseriata* (Austin) Steere).

Stems without a central strand. Leaves 4-rowed, dimorphic; cells multipapillate. Calyptrae cucullate orcylindric, split on one side.

Monotypic, mostly distributed in the tropics.

Solmsiella biseriata (Austin) Steere, Bryologist 37: 100. 1934; Pursell, J. Bryol. 69: 471. 1966; Pursell & Allen, Monogr. Syst. Bot. Missouri Bot. Gard. 90: 529. 2002 & in Fl. N. America 27: 473. 2007; Lal, Checklist Indian Moss.: 124. 2005. *Lejeunea biseriata* Austin, Proc. Acad. Nat. Sci. Philadelphia 21: 225. 1870.-Type: U.S.A., Georgia, near Augusta, *Sullivant* 1845 (NY). *Erpodium ceylonicum* Thwaites & Mitt. ex Mitt., J. Linn. Soc., Bot. 13: 306. 1873.-Types: Ceylon, *Thwaites s.n.* (NY, FH); India, Travancore, Anamallay Hills, *Beddome s.n.* (NY). *E. biseriatum* (Austin) Austin, Bot. Gaz. (Crawfordsville) 2: 142. 1877; Crum, Beih. Nova Hedwigia 23: 209. 1972; Pursell, Mem. New York Bot. Gard. 69: 582. 1994; Stone, J. Bryol. 19: 488. 1997; Daniels in R. Annamalai, Tamil Nadu Biodivers.: 52. 2004; Khatun & Hadiuzzaman, Bangladesh J. Pl. Taxon. 11: 32. 2004; Chaudhary et al., Bryoph. Fl. N. Konkan: 161, f. 49. 2008. *Solmsiella ceylonica* (Thwaites & Mitt. ex Mitt.) Müll.Hal., Bot. Centralbl. 19: 149. 1884; Paris, Index Bryol. ed. 2, 4: 255. 1905; Broth. in Engl. & Prantl, Nat. Pflanzenfam. ed. 2, 2(11): 5. 1925; Bruehl, Rec. Bot. Surv. India 13(1): 60. 1931; Chopra, Taxon. Indian Moss.: 266, f. 64. 1975; Lal, Checklist Indian Moss.: 124. 2005. *S. javanica* Müll.Hal., Bot. Centralbl. 19: 149. 1884.-Type: Indonesia, Java, on

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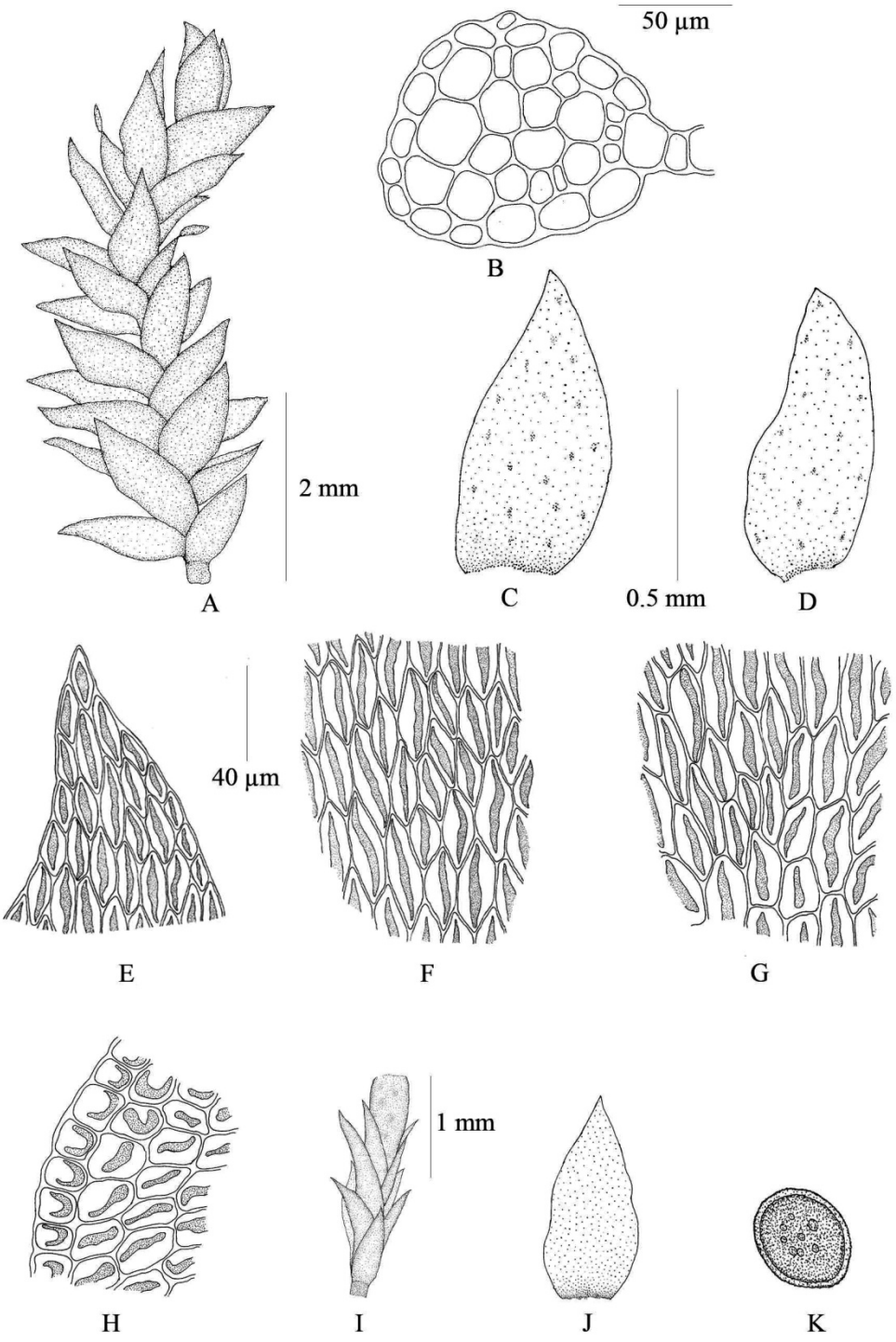


Fig. 7.

Fig. 7. ***Erpodium mangiferae*** **Müll.Hal. A: Plant. B: Cross section of stem. C & D: Leaves. E: Leaf apical cells. F: Leaf median cells. G: Leaf basal cells. H: Leaf alar cells. I: Capsule. J: Perichaetial leaf. K: Spore. Use 2 mm scale for A, 50 µm scale for B, 0.5 mm scale for C, D and J, 40 µm scale for E-H and K, 1 mm scale for I. Drawn from Daniels 936 p.p.**

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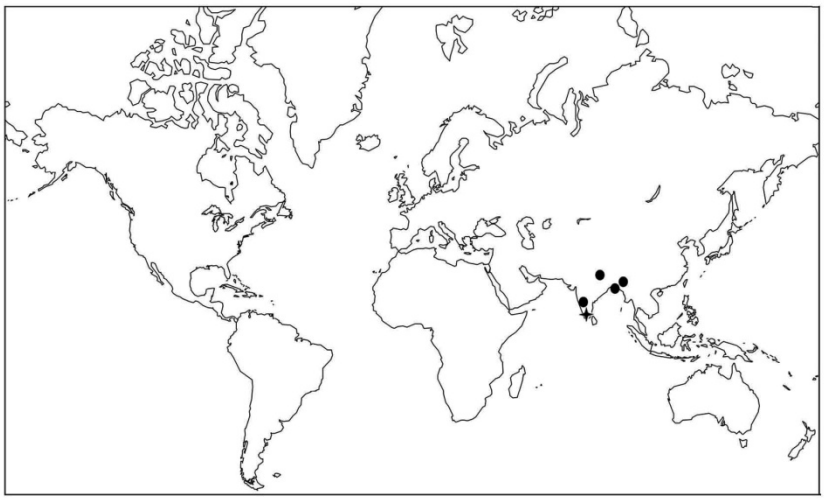


Fig. 8.

Fig. 8. Distribution of *Erpodium mangiferae* Müll.Hal. ● Earlier localities ✦ Present locality

tree trunk, in Hort. Bogor., Dec. 1883, *Solms-Laubach s.n*. (B, L). *Erpodium exsertum* Besch., J. Bot. 5: 254. 1891.-Type: South America, Paraguay, Cordillère de Péribébui, *Balansa* 3646 (PC). *Solmsiella paraguayensis* Broth., Bih. Kongl. Svenska Vetensk.-Akad. Handl. 3(7): 33. 1900; Paris, Index Bryol., ed. 2, 4: 255. 1905 (as *paraguensis*); Broth. in Engl. & Prantl, Nat. Pflanzenfam. ed. 2, 2(11): 5. 1925 (as *paraguensis*).-Type: South America, Paraguay, Santo Antonio, *Lindman* 223, 234(H). *Erpodium latifolium* Williams ex Blake, Contr. U.S. Natl. Herb. 20: 519. 1924.-Type: South America, Venezuela, Bosque de Catuche, near Caracas, 1000 m, Jan. 22, 1922, on bark, with *Stereophyllum radiculosum*, *Pittier* 10080a (NY, US). *Solmsiella kurzii* Steere, Bryologist 37: 97. 1934.-Type: U.S.A., Florida, Lake Miccosukee, Mar. 6, 1927, on *Magnolia foetida*, *Kurz* 85 (FH, MICH, NY). Fig. 9

Plants 4-10 mm long, slender, in loose or dense mats, appressed to substratum, pale green. Stems creeping, irregularly branched, green to brown, ca 0.09 × 0.08 mm in cross section, ca 5-celled across; cortex 1-layered; cells 8-20 × 6-18 μm, thin-walled; medullary ones 10-26 × 8-20 μm, thin-walled; branches horizontal to ascending. Leaves complanate, 4-rowed with 2 dorsal and 2 ventral ones; dorsal leaves 0.4-0.46 × 0.24-0.33 mm, oblong-ovate, incurved at base, entire, obtuse, ecostate; cells thin-walled, oblong-hexagonal to quadrate, multipapillate; apical ones 6-20 × 4-16 μm; median ones 6-32 × 10-20 μm; those at base 16-28 ×8-16 μm;ventral leaves 0.29-0.3 × 0.12-0.14 mm, lingulate, incurved at base or not, entire, obtuse. Rhizoids clustered at ventral leaf base, pale brown. Sporophytes on short, erect branches. Perichaetial leaves narrower than vegetative ones, 0.4-0.5 × 0.16-0.2 mm, ovate, obtuse to slightly acute. Setae 0.6-1 mm high. Capsules emergent, ca 0.88 × 0.29 mm, cylindric, pale brown; annulus poorly differentiated. Operculum convex, apiculate to rostellate. Calyptrae cucullate, ca 0.55 mm, covering upper part of capsules, not plicate, split on one side for ca 1/2 its length. Spores globose to subglobose, 12-16 × 10-12 μm, papillose, pale brown.

Habitat: Rupicolous, and corticolous on *Crataeva magma* (Lour.) DC. (Capparaceae), a small tree in riparian forests; *Pterospermum reticulatum* Wight & Arn. (Sterculiaceae), a large tree in degraded forests; *Sterculia guttata* Roxb. (Sterculiaceae), a medium-sized tree in degraded forests; *Syzygium aromaticum* (L.) Merr. & Perry (clove) (Myrtaceae) in plantations, 450-1000 m. The Kurz material from U.S.A. was corticolous on *Magnolia foetida* (L.) Sarg. (Magnoliaceae).

Distribution: North and S. America, Cuba,South and SE. Asia and India: W. Ghats of Tamil Nadu. (Fig. 10)

Specimens examined: VIETNAM, Tamil Nadu, Kanyakumari Dist., W. Ghats, Maramalai, ca 400 m, 6.11.1999, *Daniels* 438; ca 450 m, 11.4.2000, *Daniels* 848. Tirunelveli Dist., W. Ghats, Mahendragiri, ca 1000 m, 26.5.2010, *Kariyappa & Mabel* 3895; Mahendragiri, ca 800 m, 17.08.2010, *Daniels*, *Kariyappa & Mabel* 3959.

Note: *S. biseriata* also grows epiphytically on a wide range of unrelated hosts that belong to diverse families (*vide* habitat).

DISCUSSION

The 5 genera assigned to the family *Erpodiaceae* and

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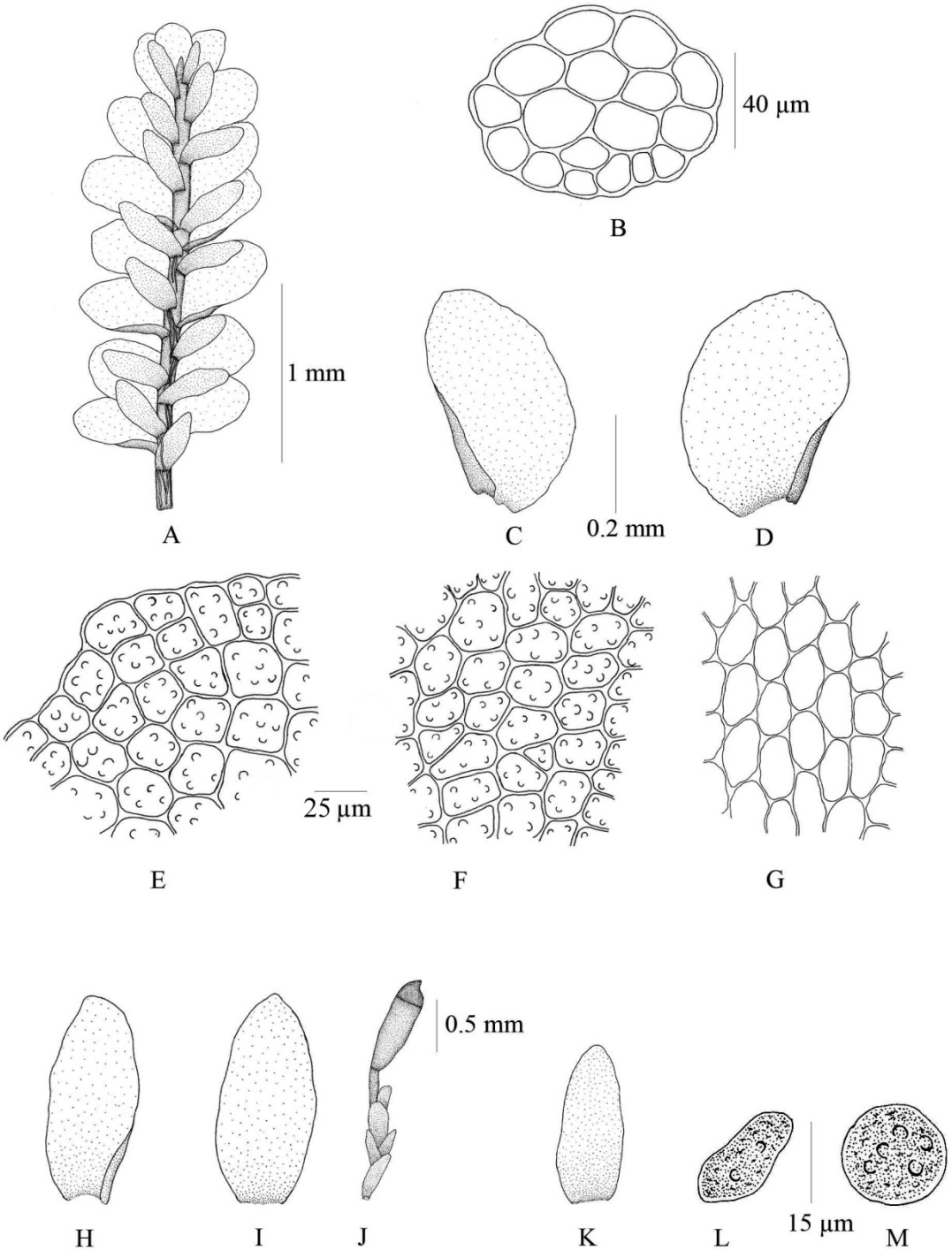


Fig. 9.

Fig. 9. ***Solmsiella biseriata*** **(Austin) Steere. A: Plant. B: Cross section of stem. C & D: Dorsal leaves. E: Leaf apical cells. F: Leaf median cells. G: Leaf basal cells. H & I: Ventral leaves. J: Sporophyte. K: Perichaetial leaf. L & M: Spores. Use 1 mm scale for A, 40 µm scale for B, 0.2 mm scale for C, D, H, I and K, 25 µm scale for E-G, 0.5 mm scale for J, 15 µm scale for L, M. Drawn from Daniels et al. 959 p.p.**

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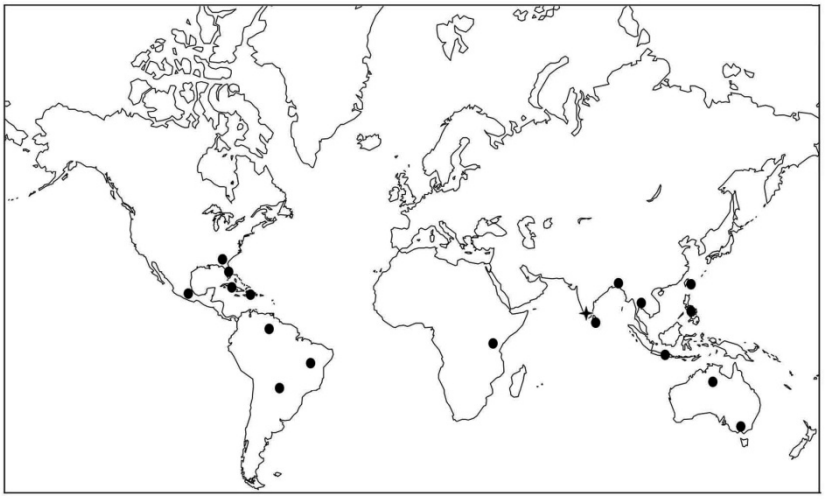


Fig. 10.

Fig. 10. Distribution of*Solmsiella biseriata* (Austin) Steere ●Earlier localities ✦Present locality

the species falling thereunder are still not free fromdispute owing to the variations exhibited by the species and their restricted global distribution. Crum (1972) discussed these parameters at length. However, critical studies made on material collected in the Western Ghats and a comparative analysis made with the descriptions of the other species suggest the need for a re-organization of the existing species. Gametophytic characters such as arrangement of leaves, smooth to papillate laminal cells, type of calyptrae and sporophytic characters such as capsules being eperistomate or with rudimentary peristome to a well-developed one as in *Venturiella* and *Wildia* may indicate the range of infra-familial variations.

All species except *Solmsiella biseriata* and *Erpodium glaucum* possess either slightly dimorphic and 4-rowed or monomorphic and spirally arranged leaves. *Solmsiella biseriata* obviously shows a leafy liverwort character in possessing distinct dimorphic leaves and stem anatomy that closely resembles that of a Lejeuneaceous member. No wonder that Austin (1870) originally described this species as *Lejeunea biseriata*. *Aulacopilum glaucum* possesses dimorphic leaves and at the same time the stem anatomy shows a little more complexity than that of *Solmsiella biseriata* since it is differentiated into a thick-walled cortex and a thin-walled medulla, and a twisted calyptra characteristic of the genus. *Aulacopilum* with a hyaline awn at leaf apex, multipapillate laminal cells and twisted calyptra enclosing the capsule shows close affinity to *Wildia* which also has multipapillate laminal cells and calyptra enclosing the capsule but with a well-developed peristome and an annulus. Besides, a gradation in the leaf dimorphism can be seen starting from *Solmsiella* with distinctly dimorphic leaves to *Aulacopilum* with a slight reduction in this feature and to *Wildia* with a faint manifestation of the same. Similarly, *Erpodium* with spirally arranged leaves and campanulate-mitrate calyptrae shows close affinity to *Venturiella* which also has spirally arranged leaves and a campanulate-mitrate calyptra but with a well-developed peristome and an annulus. Besides, in *Venturiella* the leaf laminal cells are smooth, a character also exhibited by some species of *Erpodiumviz*., *E. coronatum*, *E. grossirete* and *E. distichum* (*vide* Magill & van Rooy, 1998). The random host preferences by the species in varied habitats in continents suggest that the members of the *Erpodiaceae* are opportunists competing to colonizenew areas.

Erpodium with 15 species is the largest in the family. Of the 7 species included under *Erpodium* by Crum (1972), 4 possess 3 consistent characters *viz*., presence of primordial utricles in leaf laminal cells, campanulate-mitrate calyptrae and cylindric capsules which is a sporophytic character. Of the remaining 3 *viz*., *Erpodium beccarii*, *E. domingense* and *E. biseriatum*, *E. biseriatum* has already been shifted back to *Solmsiella*. Since the hyaline leaf apical awn, the multipapillate laminal cells and the twisted nature of calyptrae are characters attributed to the genus *Aulacopilum* and *E. beccarii* possesses 2 of them (except the twisted nature of calyptra), *E. beccarii* is better placed in *Aulacopilum*. This necessitates the resuscitation of the name *A. beccarii*.

Earlier muscologists also had difficulties in classifying mosses since the evolution of one generation (gametophytic) is apparently independent of the other (sporophytic) (Dixon, 1932; Steere, 1947; Buck, 1980). According to Buck and Crum (1978),

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since sporophytes are attached to gametophytes and are partially dependent on them for their survival, they are protected from the rigors of the environment and are less subject to natural selection. Therefore, gametophytic characters are more often useful at lower taxonomic levels as evidence of adaptive radiation at the specific or sometimes the generic levels (Buck and Crum, 1978). But according to Wyatt and Stoneburner (1984), the usual elevation of the sporophytes "above the insulating mat formed by the gametophytes may actually project them into a much less protected, severe microclimate" and therefore subject to more environmental stress thereby leading to variations. According to Crosby (1974), "the overall similarity of the groups is much greater than if the gametophyte had been used as the main criterion for classification". Rohrer (1988) stated, "if the objective of classification is a system that makes a valid attempt to reflect phylogeny, then dictum such as 'the sporophyte is more conservative' is no longer a substitute for thorough cladistic analysis". Considering all the above opinions the present nomenclatural changes have been adopted mostly based on gametophytic characters since they are more in number and rather more consistent than that of the sporophytic ones. Such consideration appears warranted since fruiting is rare in most species found in the Western Ghats particularly at lower altitudes.

ACKNOWLEDGEMENTS

We thank the Tamil Nadu State Forest Department, for permission to explore the forests in the respective areas. A.E.D.D. thanks the Ministry of Environment & Forests, Government of India, New Delhi, for the financial support through a project under the All India Co-ordinated Project on Capacity Building in Taxonomy (AICOPTAX) and J.L.M. thanks the MoEF, for a fellowship. We are also thankful to Drs. R.E. Magill, R.H. Zander (MO), R.A. Pursell, Professor Emeritus, Pennsylvania State University, U.S.A., G. Hardy (E), Director (K) and V.P. Prasad, Indian Liaison Officer (K), M.J. Wigginton, Peterborough, England, for help with literature, J. Enroth, Helsinki, Finland and G. Winter, Senckenberg Natural History Museum, Germany, for help with literature and translating German publications into English, P. Venu (CAL), for permission to study holdings at CAL and loaning specimens. AEDD is thankful to Dr. M. Sanjappa, former Director, Botanical Survey of India, Kolkata, for his keen interest in the work and Dr. M.J. Jebanesan, Principal, Scott Christian College, for facilities.

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印度的樹生蘚科（蘚類植物門：變齒蘚目）

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(收稿日期：2011 年 11 月 11 日；接受日期：2012 年 1 月 18 日)

摘要：本文針對印度產樹生蘚科中的*Aulacopilum,Erpodium* 和*Solmsiella*三個屬作重新整理。其中*Aulacopilum*和 *Erpodium*此兩屬分別有兩個物種，而*Solmsiella*此屬則僅具一個物種。*Aulacopilum beccarii* 和*Erpodium glaziovii*兩個種分別新增至亞洲蘚苔植物誌和南亞蘚苔植物誌中；*Aulacopilum glaucum*此物種則加入印度蘚苔植物誌當中。三個屬與其下的物種除附有檢索表可參考外，也附有各自的手繪圖與地點分布圖。而*Aulacopilum beccarii*此學名則重新被使用。

關鍵詞：*Aulacopilum*，樹生蘚科，樹生蘚屬，*Solmsiella*。

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