

Physcomitrium schummii sp. nov. from Karnataka, India with a synopsis of the Funariaceae in India

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Abstract: Schwarz, U. (2016): *Physcomitrium schummii* sp. nov. from Karnataka, India with a synopsis of the Funariaceae in India. *Frahmia* 13:1-19.

During the exploration of the bryoflora of Karnataka, India one new species of *Physcomitrium* was discovered and described as new species. Furthermore a synopsis of the family in India, represented by 4 genera, including 13 species of *Entosthodon*, 7 species of *Funaria*, 1 species of *Loiseaubryum* and 12 species of *Physcomitrium* is given. *Funaria excurrentinervis*, *F. sinuatolimbata*, *F. subimmarginata*, and *F. pulchra* are transferred to the genus *Entosthodon*.

1. Introduction

First records of Funariaceae data back to 1842 where GRIFFITH (1842) reported *Funaria hygrometrica* from Upper Assam. He also described *Funaria leptopoda*, *Gymnostomum repandum* (= *Physcomitrium repandum*), and *Gymnostomum pulchellum* (= *Physcomitrium pulchellum*) from the same area. Besides the common *Funaria hygrometrica* MONTAGNE (1842) described in the same year *Funaria physcomitrioides* (= *Entosthodon pulchellum*) and *Physcomitrium perrottetii* (= *Entosthodon perrottetii*) from the Nilgiri Mountains in Southern India. Three more species, *Entosthodon diversinervis* and *Entosthodon submarginatus*, were added by MÜLLER (1853) and finally *Funaria connivens* (= *Funaria hygrometrica* var. *calvescens*) by MÜLLER (1855) to the flora of this area. MITTEN (1859) summarized the knowledge of the bryophytes of the Indian subcontinent which included records of 19 species, of which *Physcomitrium cyathicarpum* (= *Physcomitrium immersum*), *Entosthodon wallichii* (= *Entosthodon buseanus*), *Entosthodon pilifer* (= *Funaria wijkii*), *Entosthodon nutans* (= *Loiseaubryum nutans*) and *Funaria orthocarpa* were described new to science. *Entosthodon planifolius*, described from Ceylon by MITTEN & THWAITES in MITTEN (1873) was later also discovered in Southern India. Within the following years there were additions by BROTHERUS (1899) and (1903), PARIS (1907) and HERZOG (1910). Latest additions to the family date back to CARDOT & POTIER DE LA VARDE in POTIER DE LA VARDE (1923) and DIXON & POTIER DE LA VARDE (1927) with the description of *Funaria excurrentinervis*, *Funaria sinuatolimbata*, *Funaria submarginata*, *Funaria pulchra* and *Physcomitrium insigne* from Southern India. BRÜHL (1931) mentioned a few names from herbar collections that were not validly described. The latest, comprehensive overviews of the Family date back to the 1970s where GANGULEE (1969-1972) covered Eastern India and CHOPRA (1975) the complete Indian subcontinent.

As a result the family Funariaceae is so far represented in India by 4 genera, including 13 species of *Entosthodon*, 7 species of *Funaria*, 1 species of *Loiseaubryum* and 12 species of *Physcomitrium*. During the exploration of the bryoflora of Karnataka one new species of *Physcomitrium* was discovered and described new to science.

2. Collection Area

The author visited the Coorg District several times between 2012 and 2015. The target was to investigate the bryoflora as complete as possible. Different habitats in forests, along roadsides, deforested areas, coffee plantations and open shrub land were investigated. Collection sites resided at elevations between 800 and 1600 m. Typical locations to find Funariaceae were ephemeral habitats along tracks in a sunny to a shaded environment. Only *Funaria hygrometrica* was restricted to anthropogenic habitats that very well match with the typical habitats of this species in other regions.

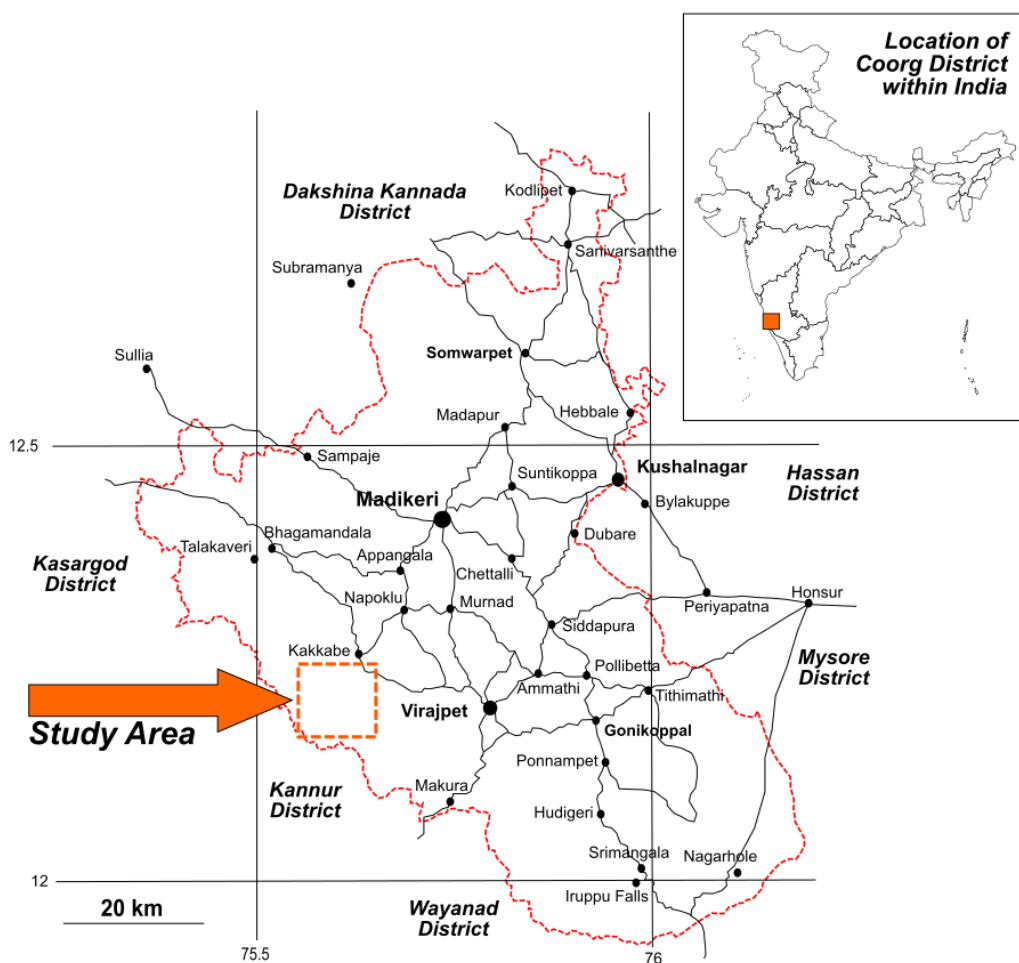


Fig. 1. District of Coorg and collection area

The district of Coorg itself enjoys a seasonal tropical climate where monsoon season starts in June and lasts till September receiving a significant amount of rainfall till November. The annual rainfall for the Madikeri district is up to 3500 mm with an average number of 118 rainy days per year (PASCAL 1982). Misty weather during morning hours of the cooler months contributes to the precipitation. Temperatures range between 19 and 23 degrees Celsius throughout the year. The area between Madikeri and Virajpet consists of granitic gneiss. Rock habitats are usually found

along cliffs of the mountains, on isolated rocks in open areas and at the banks of streams and tracks.

3. *Physcomitrium schummii* U. Schwarz, sp. nov.

Holotype: – INDIA, State Karnataka, District Coorg, Area Kabbinakad, North facing side of Ridge Walk Hill, remnant forest, on soil at the shaded bank along the track, 12° 12' 50.6" N, 75° 39' 24.3" E, 1290 m, 24 December 2013, U. Schwarz, s.n. (hb. Schwarz 12314!)



Fig. 1. Habit of *Physcomitrium schummii*, dry plants. – Scale: 3 mm.

Morphological description (Figs. 1-2) – *Plants* solitary, mixed within other mosses, 2-3 mm tall, yellowish- to pale-green. *Stem* single, sometimes branched, brown, 140 µm in diameter; central strand consisting of a few, thin-walled cells; cells moderately thickened with 1 layer of thick-walled cells; hyalodermis partially present. *Leaves* in dry and wet condition erectopatent; 1.2 – 1.7 mm long, 0.2 – 0.4 mm wide; margin entire to slightly prorate marginal cell end; marginal cells narrower but not distinct limbate. *Costa* ending far before the leaf apex, reaching 70 – 80% of the leaf length; 3 cells wide at the leaf base, cells 105 – 195 x 14 – 18 µm, 6 – 13 times as long as wide. *Leaf cells* apical ovate to elongate rectangular, thin walled 48 – 95 x 21 – 40 µm, 2 – 4 times as long as wide; in leaf middle elongate rectangular, thin walled 57 – 92 x 17 – 26 µm, 2 – 5 times as long as wide; at leaf base elongate rectangular, thin walled 110 – 160 x 27 – 40 µm, 3 – 6 times as long as wide. *Perichaetial leaves* not so much differentiated. *Seta* slender 0.6 mm long, yellowish, cygneous. *Capsule* brown with reddish mouth, contracted below the mouth when dry; almost spherical, 0.55 mm long and 0.45 mm wide; annulus present, 0.2 mm long. Operculum and calyptra not seen. 4-5 rows of exothecial cells with slightly thickened walls, 16 – 28 x 29 – 43 µm,

0.6 – 0.8 times as long as wide, distinct from the adjacent cells; those with strongly thickened longitudinal walls, 21 – 38 x 4 – 11 μm , 3 – 6 times as long as wide; within the neck area slightly thickened, irregularly shaped, 20 – 40 x 12 – 28 μm , 0.6 – 3.3 times as long as wide. Around 10 *stomata* present in the neck area; 30 – 37 x 25 – 30 μm , 1.2 – 1.3 times as long as wide. Spores 25 – 29 μm in diameter; with a vermicular – papillose pattern.

Distribution and ecology. – Only known from 3 locations from the mentioned area. The species doesn't seem to be rare in the areas. On suitable habitats with the associated species mentioned a few plants could be found intermixed.

Distinguishing characters. – The most prominent characters is the cygneous seta that can't be found with any other species of the family in India. The spherical capsule with a distinct annulus, the costa which ends far before the leaf apex and the almost entire margin without a distinct border will distinguish *P. schummii* from related species.

Further specimens. – INDIA, State Karnataka, District Coorg, Area Kabbinakad, Way from Kabbe Holiday Homestay to the Big Hill, on soil, 12° 11' 37.97" N, 75° 39' 53.82" E, 1160 m, 3 November 2012, J.-P. Frahm, F. Schumm & U. Schwarz, s.n. (hb. Schwarz 11018!); INDIA, State Karnataka, District Coorg, Area Kabbinakad, North facing side of Ridge Walk Hill, on half shaded soil along the track, 12° 12' 53.04" N, 75° 39' 13.35" E, 1385 m, 25 December 2014, U. Schwarz, s.n. (hb. Schwarz 12695!)

Associated species. – Within the 3 mentioned specimen the following species grew together with *Physcomitrium schummii*:

- Hb. U. Schwarz 12314: *Cephalozia hamatiloba* STEPHANI, *Cephaloziella* spec., *Jungermannia* spec.
- Hb. U. Schwarz 11018: *Anomobryum auratum* (MITT.) A. JAEGER, *Bryum* spec., *Microdus brasiliensis* (DUBY) THÉR., *Physcomitrium repandum* (GRIFF.) MITT.
- Hb. U. Schwarz 12695: *Entosthodon buseanus* DOZY & MOLK.

Etymology. – Named after the German lichenologist DR. FELIX SCHUMM (Wangen, Germany) on the occasion of his 70th birthday

4. Taxonomic remarks

The new combinations for *Funaria excurrentinervis*, *F. sinuatolimbata*, and *F. subimmarginata* are following POTIER DE LA VARDE (1923) who described these species as new species within the section *Entosthodon*. DIXON & POTIER DE LA VARDE (1927) described *Funaria pulchra* as a member of the section *Euentosthodon*. The placement of species to *Entosthodon* and *Physcomitrium* is challenging. DNA sequencing and analysis indicates that species from both genera appear in the same clade and don't show a clear clustering. Till the research on this topic is progressing the arrangement of genera and species is following a conservative approach based on easily visible morphological characters. It will lead to the following 4 new combinations:

- *Entosthodon excurrentinervis* (CARDOT & P. DE LA VARDE) U. SCHWARZ **comb. nov.**
 \equiv *Funaria excurrentinervis* CARDOT & P. DE LA VARDE EX P. DE LA VARDE. *Revue Bryologique*. 50:18. fig. 4. 1923. Type: Environs de Shembagarur, Madura district, East India, alt. 2000 m, A. Velle, 1910, PC0134209 (Holotype) & PC0150654 (Isotype).

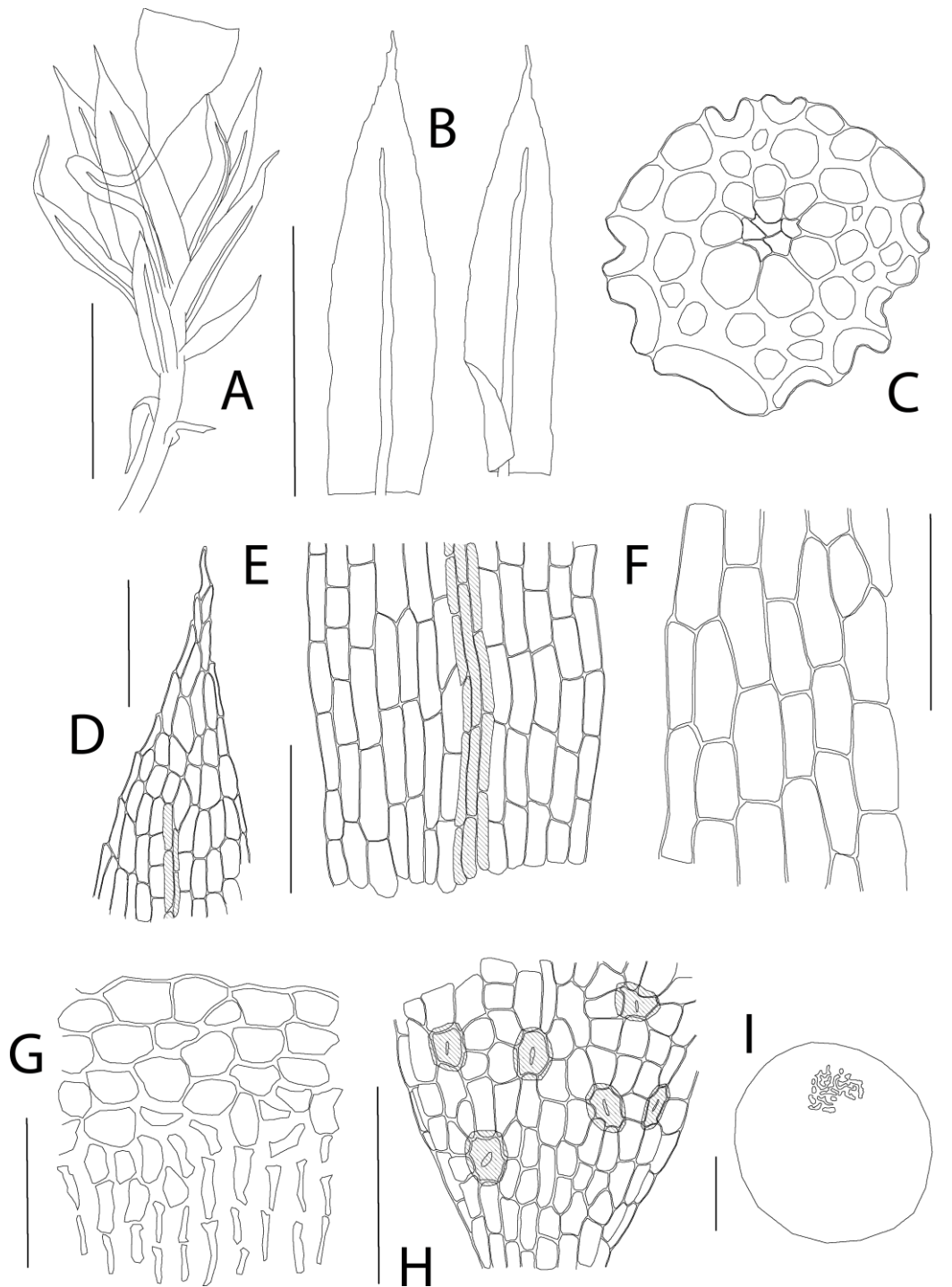


Fig. 3. *Physcomitrium schummii*. A Plant, B Leaves, C Stem Cross Section, D Apical leaf cells, E Basal leaf cells, F Median leaf cells, G Capsule mouth, H Lower part of the capsule, I Spore (ornamentation partially drawn) – Scale: A, B 1 mm; D, E 0.2 mm; C, F, G, H 0.1 mm; I 10 μ m

- *Entosthodon subimmarginata* (CARDOT & P. DE LA VARDE) U. SCHWARZ **comb. nov.**
 ≡ *Funaria subimmarginata* CARDOT & P. DE LA VARDE EX P. DE LA VARDE. *Revue Bryologique*. 50:19. fig. 3. 1923.
 Type: Environs de Shembagarur, Madura district, East India, A. Velle, 1909, PC0150644 (Holotype) & PC0134077 (Isotype).
- *Entosthodon sinuatolimata* (CARDOT & P. DE LA VARDE) U. SCHWARZ **comb. nov.**
 ≡ *Funaria sinuatolimbata* CARDOT & P. DE LA VARDE EX P. DE LA VARDE. *Revue Bryologique*. 50:19. fig. 2. 1923.
 Type: Kodaikanal, Madura district, East India, A. Velle, 1909, PC0134090 (Holotype) & PC-PC0150645 (Isotype).
- *Entosthodon pulchrum* (DIXON & P. DE LA VARDE) U. SCHWARZ **comb. nov.**
 ≡ *Funaria pulchra* DIXON & P. DE LA VARDE. *Archives de Botanique, Bulletin Mensuel*. 1:169. pl. 5, fig. 3. 1927.
 Types: Manalur, Lower Pulneys, S. India, G. Foreau, 1926, coll. no. 333, BM000983276 (Holotype); Kumili, India, G. Foreau, 28 October 1924, coll. no. 607, PC0150648 (Paratype) & PC0692213 (Paratype); Manalur, Lower Pulneys, S. India, G. Foreau, 1924, coll. no. 512, PC0150647 (Paratype) & PC0150649 (Paratype).

BRÜHL (1931) mentioned the following herbar specimen that haven't been validly described that are not treated in the following synopsis.

- *Funaria gollani* BROTH. EX BRÜHL. *inval. Records of the Botanical Survey of India*. 13(1):123. 1931. – Uttarakhand
- *Funaria mussuriensis* BROTH. EX BRÜHL. *inval. Records of the Botanical Survey of India*. 13(1):123. 1931. – Himachal Pradesh, Uttarakhand
- *Physcomitrium saharanpurens* MÜLL. HAL. EX BRÜHL. *inval. Records of the Botanical Survey of India*. 13(1):124. 1931. – Uttar Pradesh – This species is very likely identical with *Physcomitrium sahapurens*.
- *Physcomitrium subsphaericum* BROTH. EX BRÜHL. *inval. Records of the Botanical Survey of India*. 13(1):128. 1931. – West Bengal, Bhutan

The following two species were mentioned by CHOPRA (1975) but were not provided with a description. *Physcomitrium brevinervis* and *Physcomitrium saharanpurens* were considered synonymous by him.

- *Physcomitrium brevinervis* DIXON EX R.S. CHOPRA. *inval. Taxonomy of Indian Mosses*. 181. 1975.
- *Physcomitrium leptodictyon* DIXON EX R.S. CHOPRA. *inval. Taxonomy of Indian Mosses*. 181. 1975.

There are also 2 *Funaria* species (PC0134222 and PC0134079-81) from Himachal Pradesh that seem to be new to science but haven't been published so far.

The family is in urgent need to be worked upon monographically, which applies to many other families whose members have been described in the 19th and early 20th century. As it can be seen from the synopsis there are species which bear only minor, distinguishing characters and might be synonymized in future.

5. Synopsis of the Funariaceae in India

The synopsis will summarize the current status of the family in India to allow future researchers an easy overview of the group in India. Descriptions and an particular keys are still preliminary. During the identification of members of the family collected in Coorg it became obvious that the variability of the species is much bigger than expected. Most of the characters, i.e. leaf serration, leaf margin, leaf shape, costa length, capsule shape, peristom, and seta color vary considerably. The clarification of the circumscription of the species still has to be done with the help of morphological studies of the types as well as their DNA analysis.

1. (1) Funariaceae SCHWÄGR. Species muscorum frondosorum (Species Plantarum. Ed. 4. Tom. 5(2)). 43. 1830.

Small, green or yellowish plants forming open tufts. Stem usually simple, rarely branched. Less than 1 cm high. Central strand present. Leaves usually crowded distally, obovate to spatulate, rarely lanceolate. Leaf apex acuminate to piliferous. Costa single, reaching above mid leaf, percurrent or excurrent. Cells lax, thin walled, sparsely chlorophyllous. Upper leaf cells elongated hexagonal, basal cells rectangular. Margin entire or serrate, sometimes with a row of narrow cells. Capsule erect or inclined, sometimes sulcate, with a more or less developed neck. Operculum almost flat to conic and short rostrate. Calyptra mitrate or cucullate. Peristom lacking, single or double. *Funaria* and *Entosthodon* are sometimes combined since the characters transition gradually between the 2 genera.

Key to taxa:

- 1 Calyptra cucullate without rostrum. Seta very slender. Capsule without neck, irregularly wrinkled, horizontal or pendent *Loiseaubryum* – p. 12
- 1 Calyptra mitrate or cucullate-rostrate. Seta not slender. Capsule not pendent 2
- 2 Capsule asymmetric. Peristom double, teeth fused at the apex. Annulus compound, revoluble sometimes absent. Capsule mostly sulcate when dry. *Funaria* – p. 11
- 2 Capsule symmetric. Peristom double, single or absent, not fused. Annulus not compound or revoluble. Capsule not sulcate or only at the neck. 3
- 3 Calyptra mitrate-rostrate. Operculum more or less rostrate. Peristom absent. Spores uniformly and densely spinnate *Physcomitrium* – p. 13
- 3 Calyptra cucullate-rostrate. Operculum plane, convex or conic. Peristom absent or present. Spores not uniformly spinnate *Entosthodon* – p. 7

1. (1) Entosthodon SCHWÄGR. Species muscorum frondosorum, Suppl. 2. Part 1 (1). 44. 1823.

Green or yellowish small plants. Leaves distally usually larger and crowded, erect spreading. Usually acute to acuminate, sometimes piliferous. Margins plan or erect, entire or serrulate. Costa ending well before the apex or percurrent. Cells rather lax, rectangular at the base, rhomboid at the top, sometimes forming a margin of narrower cells. Capsule exerted, pyriform, smooth when dry (except the neck). Peristom lacking or well developed. Calyptra cucullate-rostrate.

Key to taxa:

- 1 Costa short or long excurrent 2
- 2 Leaf margin serrate. Costa short excurrent *Entosthodon rottleri* – p. 9
- 2 Leaf margin entire. Costa long excurrent *Entosthodon excurrentinervis* – p. 9
- 1 Costa percurrent or shorter 3
- 3 Costa ending above mid leaf *Entosthodon planifolius* – p. 9
- 3 Costa longer, almost reaching leaf apex or percurrent 4

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- 4 Leaf margin serrate, sometime only weakly 5
 - 5 Leaf apex piliferous, costa ending before leaf apex. Leaves ovate to lanceolate
..... *Entosthodon physcomitrioides* – p. 9
 - 5 Leaf apex acuminate 6
 - 6 Peristom rudimentary 7
 - 7 Operculum without small apiculus. Leave apex bluntly pointed
..... *Entosthodon buseanus* – p. 9
 - 7 Operculum with small apiculus. Leave apex sharper pointed
..... *Entosthodon wichurae* – p. 13
 - 6 Peristom absent 8
 - 8 Costa flexuous. Operculum with small apiculus *Entosthodon submarginatus* – p. 10
 - 8 Costa straight. Operculum without apiculus 9
 - 9 Costa extended into the flexuous leaf apex *Entosthodon perrottetii* – p. 9
 - 9 Costa ending before leaf apex 10
 - 10 Leaves narrowed at the base 11
 - 11 Seta brown, 5 mm long *Entosthodon subimmarginatus* – p. 9
 - 11 Seta pale, 8 mm long *Entosthodon pulchrum* – p. 9
 - 10 Leaves hardly narrowed at the base *Entosthodon diversinervis* – p. 8
 - 4 Leaf margin entire 12
 - 12 Leaves strongly narrowed at the base *Entosthodon sinuatolimbatus* – p. 9
 - 12 Leaves not strongly narrowed at the base *Entosthodon eberhardtii* – p. 8

1. (1) *Entosthodon buseanus* DOZY & MOLK. *Bryologia javanica*. Vol. 1. 31. pl. 22, fig. 1-23. 1855. [syn. *Entosthodon wallichii* MITT., *Funaria buseana* (DOZY & MOLK.) BROTH., *Funaria wallichii* (MITT.) BROTH., *Weissia templetonii* GRIFF.] – Pl. 1. Fig. 1

Plants 8 mm high. Leaves ovate, acuminate, margin serrate in the upper half. Margin formed by 1-2 rows of narrow cells. Capsule pyriform, neck as long as the urn. Operculum conic, with a small apiculus. Peristom very rudimentary or absent. Similar to *E. physcomitrioides* but with less piliferous leaf apex and a small, but well developed, apiculus of the operculum. – Assam, Karnataka, Meghalaya, Tamil Nadu, Uttar Pradesh, Uttarakhand, West Bengal, Nepal, Sri Lanka

2. (2) *Entosthodon diversinervis* MÜLL. HAL. *Botanische Zeitung (Berlin)*. 11:20. 1853. [syn. *Funaria diversinervis* (MÜLL. HAL.) BROTH.]

Plants very small, stem short. Leaves wide ovate, long acuminate, margin serrate. Costa percurrent. Cells hexagonal at the top, rectangular at the base. Capsule globose to pyriform. Operculum conic. Peristom absent. Similar to *E. perrottetii* but in all parts smaller. – Tamil Nadu

3. (3) *Entosthodon eberhardtii* BROTH. & PARIS EX PARIS. *Revue Bryologique*. 34:43. 1907. [syn. *Funaria eberhardtii* (BROTH. & PARIS) BROTH.]

Plants 2-3 mm high, unbranched with leaves crowded at the top. Leaves ovate 1 mm long and 0.5 mm wide, sinuous in the upper part. Costa yellowish, percurrent. Capsule 2 mm long and 0.5 mm wide, brown. Seta thin, reddish, 4 mm long. The species resembles *E. buseanus* in the shape of the capsule and the straight seta. In contrast the species is dioecious whereas male and female plants growing in the same turf. – South India

4. (4) *Entosthodon excurrentinervis* (CARDOT & P. DE LA VARDE) U. SCHWARZ. *Frahmia*. 13:5. 2016. [syn. *Funaria excurrentinervis* CARDOT & P. DE LA VARDE EX P. DE LA VARDE.] – Pl. 1. Fig. 2

Plants small, 1-2 mm high with densely crowded leaves. Leave ovate, acuminate, widest above mid leaf. Costa excurrent as a twisted, long hair. Cells lax 35-45 x 20 µm. Capsule conic, seta 6

mm long. Peristom lacking. *E. excurrentinervis* is the only *Entosthodon* species in the region with a long excurrent, twisted costa. – *Tamil Nadu*

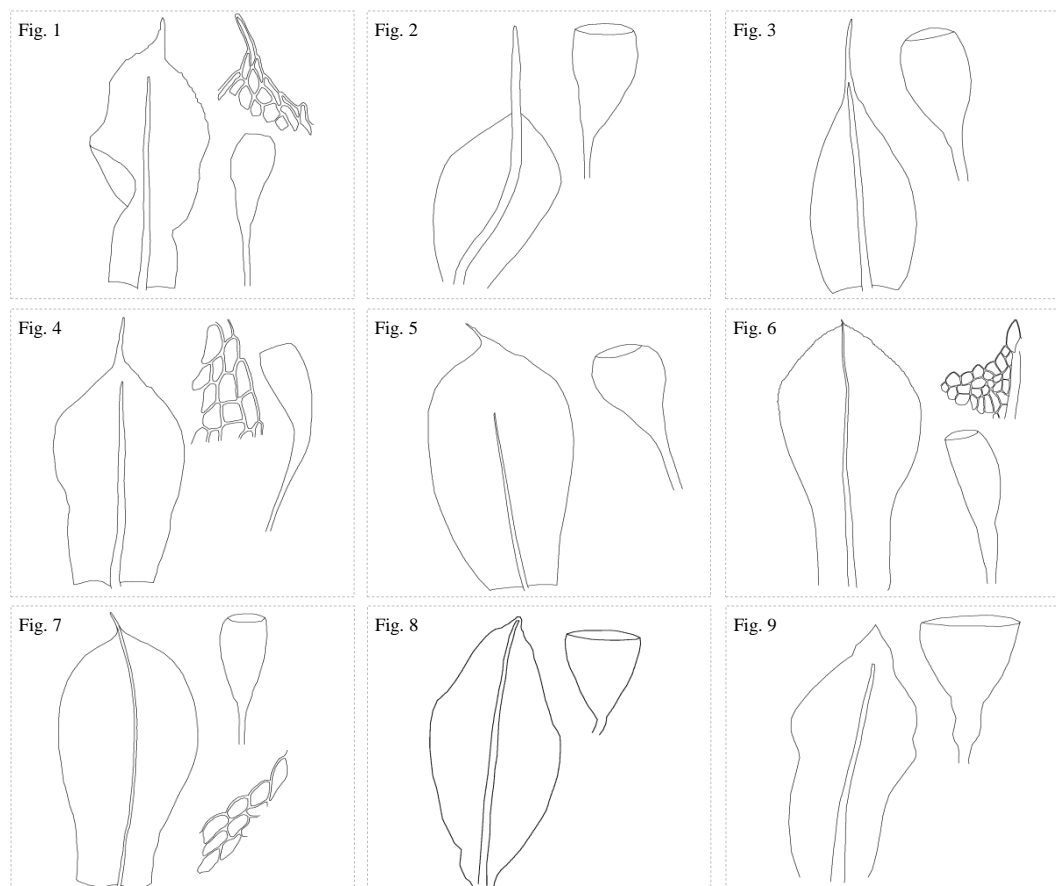


Plate 1: Fig. 1: *Entosthodon buseanus*, Fig. 2: *Entosthodon excurrentinervis*, Fig. 3: *Entosthodon perrottetii*, Fig. 4: *Entosthodon physcomitrioides*, Fig. 6: *Entosthodon planifolius*, Fig. 6: *Entosthodon pulchrum*, Fig. 7: *Entosthodon rotleri*, Fig. 8: *Entosthodon sinuatolimbatus*, Fig. 9: *Entosthodon subimmarginatus*

5. (5) *Entosthodon perrottetii* (MONT.) MÜLL. HAL. *Botanische Zeitung (Berlin)*. 11:19. 1853. [syn. *Funaria perrottetii* (MONT.) BROTH., *Physcomitrium perrottetii* MONT.] – Pl. 1. Fig. 3
Small plants. Leaves crowded at the top, ovate, acuminate. Leaf margin serrate in the upper part. Costa yellowish, percurrent. Capsule pyriform with elongated neck. Operculum conic. Peristom and annulus absent. Similar to *E. diversinervis* but plants overall stronger. Peristom information differs between the authors. MITTEN 1859 mentions a short, pale peristom. – *Tamil Nadu*, Sri Lanka

6. (6) *Entosthodon physcomitrioides* (MONT.) MITT. *Journal of the proceedings of the Linnean Society. Botany. Suppl.* 1:55. 1859. [syn. *Funaria physcomitrioides* MONT.] – Pl. 1. Fig. 4
Plants 3-5 mm high with leaves clustered at the top. Leaves obovate to lanceolate, 2-3.5 x 0.7-1.2 mm, acuminate, apex tapering into a long capillary point. Margin nearly entire. Costa yellowish, ceasing before the apex. Cells rhomboid at the top, rectangular at the base, border scarcely differentiated. Capsules erect, elongate pyriform, neck have of the capsule length. Operculum flat.

Peristom single or rudimentary. On soil. Similar to *E. buseanus* but usually smaller, with a hardly defined boarder, serrate margin, piliferous leaf apex and a flat operculum. – *Karnataka, Tamil Nadu, Pakistan*

7. (7) *Entosthodon planifolius* THWAITES & MITT. EX MITT. *Journal of the proceedings of the Linnean Society. Botany.* 13:304. 1873. [syn. *Funaria planifolia* (THWAITES & MITT.) BROTH.] – Pl. 1. Fig. 5

Plants small. Leaves spreading, ovate, short acuminate, margin entire. Costa vanishing above mid leaf. Capsule pyriform, with elongated neck, reddish. Operculum flat. Peristom absent. The species resembles *E. physcomitrioides* but differs in the distinct limbidium and the lack of a peristom. – *Tamil Nadu, Sri Lanka*

8. (8) *Entosthodon pulchrum* (DIXON & P. DE LA VARDE) U. SCHWARZ. *Frahmia.* 13:6. 2016. [syn. *Funaria pulchra* DIXON & P. DE LA VARDE.] – Pl. 1. Fig. 6

Stem 5-8 mm high. Leaves curled when dry, from narrow base spatulate, acuminate. Margin dentate above. Costa yellowish, vanishing before the apex. Seta pale, 8 mm long. Capsule conical, 3 mm long. Operculum flat. Peristom absent. – *Kerala, Tamil Nadu*

9. (9) *Entosthodon rottleri* (SCHWÄGR.) MÜLL. HAL. *Synopsis Muscorum Frondosorum omnium hucusque Cognitorum* 1. 121. 1848. – Pl. 1. Fig. 7

Small plants. Lower leaves distant, crowded above, ovate, long acuminate. Margin serrate above. Costa reddish, short excurrent. Capsule pyriform with a long neck. Operculum flat. Characterized by the excurrent costa and the capsule with a long neck. – *Tamil Nadu*

10. (10) *Entosthodon sinuatolimbatus* (CARDOT & P. DE LA VARDE) U. SCHWARZ. *Frahmia.* 13:6. 2016. [syn. *Funaria sinuatolimbata* CARDOT & P. DE LA VARDE EX P. DE LA VARDE.] – Pl. 1. Fig. 8
Plants in loose turfs, stem 5 mm high. Upper leaves crowded at the top. Leaves oblong ovate, acuminate, strongly narrowed at the base. Costa yellow, percurrent. Leaf margin entire, boarder consisting of 1 row of narrow cells. Capsule conic, brown. Seta 4 mm long. Differs from the similar *E. planifolia* by its more erect leaves which have more acute teeth. – *Tamil Nadu*

11. (11) *Entosthodon subimmarginatus* (CARDOT & P. DE LA VARDE) U. SCHWARZ. *Frahmia.* 13:6. 2016. [syn. *Funaria subimmarginata* CARDOT & P. DE LA VARDE EX P. DE LA VARDE.] – Pl. 1. Fig. 9

Small plants. Leaves crowded, ovate, from a narrow base acuminate. Cells 60 x 24 µm. Margin consisting of 1 row of narrow cells. Costa percurrent. Capsule cyathiform. Seta brown, 5 mm long. Peristom lacking. Similar to *E. planifolia* which has wider and more acuminate leaves, cells are more narrow and the margin is more serrate. – *Tamil Nadu*

12. (12) *Entosthodon submarginatus* MÜLL. HAL. *Botanische Zeitung (Berlin).* 11:20. 1853. [syn. *Funaria submarginata* (MÜLL. HAL.) BROTH.]

Plants small. Leave crowded at the top. Leaves ovate, from a narrow base acute. Margin formed by 1 row of narrow cells. Costa flexuous, yellowish, percurrent. Capsule upright, red older becoming blackish, ovate. Peristom lacking. Operculum with a small mammillae. Characterized by its leaf shape, the flexuous, yellowish costa and the ovate capsule. – *Tamil Nadu*

13. (13) *Entosthodon wichurae* M. FLEISCH. *Die Musci der Flora von Buitenzorg. Zweiter Band.* 481. 1904. [syn. *Funaria wichurae* (M. FLEISCH.) BROTH.] – Pl. 2. Fig. 1

Plants 5 mm high. Leaves crowded at the top, ovate to spatulate, serrate in the upper two third of the leaf. Cells elongated hexagonal at the top, rectangular at the bottom, at the margin 1 row of narrow cells. Costa reddish, percurrent. Capsule red, pyriform. Seta 8-25 mm long. Operculum

conic. Peristom rudimentary. With its relatively short and thick capsule the species links to *Physcomitrium*. – Assam, Kerala, Meghalaya, Mizoram, Tamil Nadu, Uttar Pradesh, Uttarakhand, Sri Lanka

2. (2) *Funaria* HEDW. Species muscorum frondosorum. 172. 1801.

Gametophyte similar to *Entosthodon* with which the genus is sometimes combined. Distinguished by its asymmetric capsules with a long apophysis and the double peristom. Capsules are sometimes sulcate, the annulus is often developed.

Key to taxa:

- 1 Capsule erect, symmetrical to slightly asymmetrical. Leaves not serrate 2
- 2 Leaves very narrow, lanceolate, with piliferous apex *Funaria capillipes* – p. 13
- 2 Leaves ovate to spatulate, acuminate to piliferous 3
- 3 Costa ending far before leaf apex, leaves ovate, widest in the lower half *Funaria orthocarpa* – p. 13
- 3 Costa ending near the leaf apex, leaves spatulate, widest in the upper half *Funaria aequidens* – p. 13
- 1 Capsule inclined, markedly asymmetrical 4
- 4 Capsule not sulcate. Annulus lacking 5
- 5 Costa excurrent, extending into a long, entire hair *Funaria wijkii* – p. 12
- 5 Costa not excurrent *Funaria muehlenbergii* – p. 13
- 4 Capsule sulcate. Annulus present 6
- 6 Leaf apex filiform. Costa ending far before the apex *Funaria koelzei* – p. 12
- 6 Leaf apex not filiform. Costa percurrent *Funaria hygrometrica* – p. 13

1. (14) *Funaria aequidens* LINDB. EX BROTH. *Acta Societatis Scientiarum Fennicae*. 19(12):32. 1892. [syn. *Funaria kashmirensis* BROTH.] – Pl. 2. Fig. 2

Stem 5 mm high. Leaves ovate – spatulate, acuminate. Margin entire. Border of narrow cells not developed. Costa strong, percurrent. Seta up to 3 cm long, upright. Capsule pyriform, symmetric, sulcate, with a narrowed mouth. Operculum slightly conic, not apiculate. Peristom double, completely developed. Annulus present. – Jammu and Kashmir, Sikkim

2. (15) *Funaria capillipes* (MÜLL. HAL. EX BROTH.) BROTH. *Die Natürlichen Pflanzenfamilien* 1(3) ... Musci. 522. 1903. – Pl. 2. Fig. 3

Very small plants. Leaves very narrow, lanceolate, with piliferous apex. Margin dentate towards the apex. Border absent. Seta 3 mm long, thin. Capsule semiglobose. Peristom double. The size and the very narrow leaves distinguish this species from all other in the area. – Himachal Pradesh, Jammu and Kashmir

3. (16) *Funaria hygrometrica* HEDW. Species muscorum frondosorum. 172. 1801. – Pl. 2. Fig. 4

Plants forming green to yellow tufts. Stem up to 15 mm high. Leaves broadly lanceolate to ovate-spathulate, acuminate, crowded at the top. Margins entire or weakly serrate. Border not differentiated. Costa percurrent. Seta 4-5 cm long. Capsule asymmetric, elongated pyriform, sulcate, mouth narrow. Operculum slightly convex. Peristom double, teeth united to a small central disc. Annulus with 2-3 cell rows. – Andhra Pradesh, Arunachal Pradesh, Assam, Gujarat, Himachal Pradesh, Jammu and Kashmir, Jharkhand, Karnataka, Kerala, Maharashtra, Manipur, Meghalaya, Mizoram, Orissa, Rajasthan, Sikkim, Tamil Nadu, Uttar Pradesh, Uttarakhand, West Bengal, Gangetic Plain, Nepal, Sri Lanka

— *Funaria hygrometrica* var. *calvescens* (SCHWÄGR.) MONT. *Annales des Sciences Naturelles, Botanique, Sér. 2.* 12:54. 1839. [syn. *Funaria connivens* MÜLL. HAL., *Funaria leptopoda* GRIFF.]

Compared to the main form the stem is elongated, leaves are soft, the capsule is longer, narrower, almost erect and the seta is erect. – *Andhra Pradesh, Jharkhand, Karnataka, Meghalaya, Orissa, Sikkim, Tamil Nadu, Uttarakhand, Central India, Gangetic Plain, Western Himalayas, Bhutan, Nepal*

4. (17) *Funaria koelzei* E.B. BARTRAM. *Revue Bryologique et Lichénologique.* 29:167. 1961.

Plants 2-3 mm high. Leaves crowded at the top, oblong-ovate, with filiform acumen, not serrate, elimbate, 2 mm long and 1 mm wide. Costa ending far before the apex. Upper cells oblong-hexagonal, 25 µm wide, basal cells rectangular. Seta 5 mm long. Capsule asymmetric, inclined. Peristom double. The species resembles *F. muehlenbergii* but in *F. koelzei* the leaves are broader, entire with the costa ending well below the filiform, acuminate apex and the segments of the endostom are broader and longer nearly reaching the length of the exostome. – *Himachal Pradesh, Jammu and Kashmir, Uttarakhand*

5. (18) *Funaria muehlenbergii* TURNER IN SCHWÄGR. *Species muscorum frondosorum, Suppl. 1.* Part 2. 198. pl. 66. 1816. [syn. *Entosthodon muehlenbergii* (TURNER) FIFE., *Funaria calcarea* var. *mediterranea* (LINDB.) C.E.O. JENSEN & MEDELIUS., *Funaria calcarea* WAHLENB., *Funaria mediterranea* LINDB.] – Pl. 2. Fig. 5

Leaves up to 3 mm long, obovate to oblong, acuminate, rather suddenly contracted to a short point. Costa ceasing below tip. Upper leaf margin serrate. Marginal cells usually a bit longer and wider as the adjacent cells. Seta around 10 mm long. Capsule asymmetric, not sulcate. Operculum conical, mammillate. Spores 20-27 µm. – *Jammu and Kashmir, Uttarakhand*

6. (19) *Funaria orthocarpa* MITT. *Journal of the proceedings of the Linnean Society. Botany.* Suppl. 1:56. 1859. [syn. *Entosthodon orthocarpus* (MITT.) A. JAEGER.] – Pl. 2. Fig. 6

Leaves ovate, acuminate and piliferous. Costa ending before leaf apex. Margin entire. Capsule erect, symmetrical, narrowed from the neck into the urn. Operculum conical. Peristom double, exostome red, endostom filiform. The plants are only known from Leh (Kashmir) and the original collection from Tibet. – *Jammu and Kashmir, Western Himalayas*

7. (20) *Funaria wijkii* R.S. CHOPRA. *Taxonomy of Indian Mosses.* 185. 1975. [syn. *Entosthodon pilifer* MITT.]

Stem erect, 8 mm long. Leaves densely arranged. Leaves ovate-lanceolate. Margin remotely serrate in the upper half, border absent. Costa vanishing in the piliferous apex. Seta around 10 mm long. Capsule asymmetric, small, inclined. Spores 15-18 µm. Similar to *F. muehlenbergii* but differs in leaf shape, the slim seta, the small capsule and smaller spores. – *Jammu and Kashmir, Tamil Nadu, Uttarakhand, Pakistan*

3. (3) *Loiseaubryum* BIZOT *Revue Bryologique et Lichénologique.* 42:850. 1976.

Stem 1-3 mm long. Leaves lanceolate to linear-lanceolate, piliferous, crowded at the top. Margin serrate towards the leaf apex, cells narrower towards the margin. Seta pale-brown, 1-3 mm long, slender and flexuous. Capsules hemispheric, neck lacking, strongly and irregularly wrinkled, horizontal or pendent. Peristom absent. Operculum flat. Calyptra cucullate, lacking a rostrum, slightly split into two lobes at the base.

1. (21) *Loiseaubryum nutans* (MITT.) FIFE. *Journal of the Hattori Botanical Laboratory.* 58:192. 1985. [syn. *Entosthodon nutans* MITT., *Funaria nutans* (MITT.) BROTH.] – Pl. 2. Fig. 7

Monotypic taxon consisting only of *L. nutans*, with the characters of the genus. – *Jharkhand, Maharashtra, Punjab, Rajasthan, Uttar Pradesh, Uttarakhand, West Bengal, Eastern Himalayas, Gangetic Plain, South India*

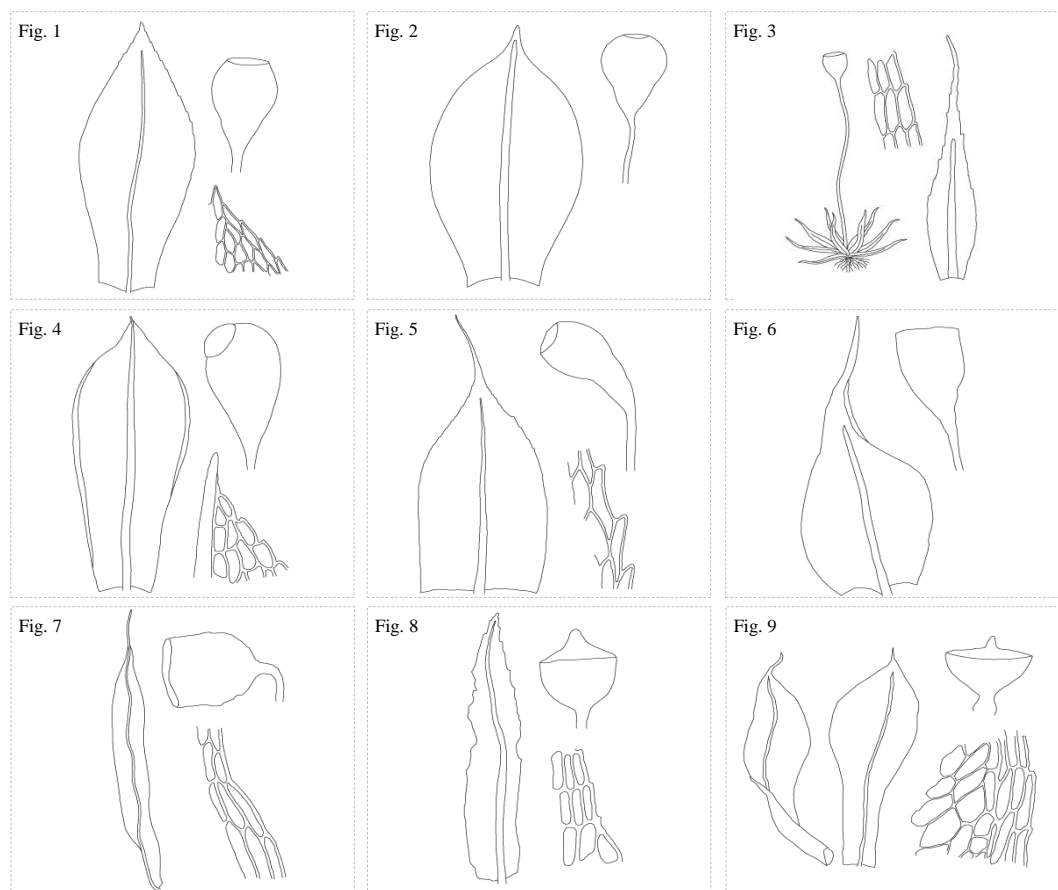


Plate 2: Fig. 1: *Entosthodon wichurae*, Fig. 2: *Funaria aequidens*, Fig. 3: *Funaria capillipes*, Fig. 4: *Funaria hygrometrica*, Fig. 5: *Funaria muehlenbergii*, Fig. 6: *Funaria orthocarpa*, Fig. 7: *Loiseaubryum nutans*, Fig. 8: *Physcomitrium coorgense*, Fig. 9: *Physcomitrium delicatulum*

4. (4) *Physcomitrium* (BRID.) BRID. *Bryologia universa*. Vol. 2. 815. 1827.

Small, yellow-green or green plants forming loose tufts. Stem simple with central strand. Leaves erect spreading, usually more crowded at the top, ovate to spatulate. Costa ending before apex or excurrent. Capsule erect, symmetrical, turbinate pyriform. Peristom absent. Annulus present. Operculum apiculate or with a short rostrum.

Key to taxa:

- 1 Capsule immersed 2
- 2 Plant thin, delicate. Leaves lanceolate. Costa not reaching the apex 3
- 3 Margin not bordered by elongated cells *Physcomitrium indicum* – p. 15
- 3 Margin bordered by elongated, yellowish, thicker-walled cells
..... *Physcomitrium delicatulum* – p. 13

2	Plant sturdy. Leave spatulate. Costa percurrent	<i>Physcomitrium immersum</i> – p. 15
1	Capsule exerted	4
4	Seta twisted, cygneous	<i>Physcomitrium schummii</i> – p. 16
4	Seta straight	5
5	Special cells at the rim of the theca more or less quadrate ...	<i>Physcomitrium repandum</i> – p. 15
5	Special cells at the rim of the theca transversely rectangular	6
6	Leaves serrate	7
7	Leaves bordered	8
8	Leaf apex broad, apiculate	<i>Physcomitrium insigne</i> – p. 15
8	Leaf apex narrowed, acuminate	<i>Physcomitrium coorgense</i> – p. 13
7	Leaves not or indistinctly bordered	9
9	Capsule pyriform, with short apophysis	<i>Physcomitrium pyriforme</i> – p. 15
9	Capsule almost spherical, without apophysis	10
10	Leaves oblong ovate	<i>Physcomitrium sphaericum</i> – p. 17
10	Leaves spatulate-lanceolate	<i>Physcomitrium sahapureense</i> – p. 15
6	Leaves not serrate	11
11	Capsule mouth wider than the urn	<i>Physcomitrium eurystomum</i> – p. 15
11	Capsule mouth narrower as the urn	12
12	Leaves on fertile shoots broad ovate	<i>Physcomitrium pulchellum</i> – p. 15
12	Leaves on fertile shoots narrower, ovate-lanceolate ...	<i>Physcomitrium japonicum</i> – p. 15

1. (22) *Physcomitrium coorgense* BROTH. *Records of the Botanical Survey of India*. 1(12):319. 1899. – Pl. 2. Fig. 8

Small plant, up to 4 mm high. Leaves lax below, clustered above, erect to erecto-patent, narrow obovate, acuminate. Margin finely denticulate above, bordered by one row of cells. Costa prominent, percurrent. Capsule turbinate, approx. 1 mm, wide mouthed. On soil. The narrow obovate leaves with the wide mouthed capsule distinguish the species from others. – *Delhi, Karnataka, Maharashtra, Tamil Nadu, Uttar Pradesh, Uttarakhand, West Bengal, Central India, Gangetic Plain*

2. (23) *Physcomitrium delicatulum* H.A. CRUM & L.E. ANDERSON. *The Bryologist*. 58:1. fig. 6-9. 1955. – Pl. 2. Fig. 9

Plants small, green. Leaves 3 mm long, spatulate and acuminate, getting smaller at the base. Margin plane, finely serrulate in upper half, bordered by 2-3 rows of linear, thicker-walled cells. Costa slender, disappearing well below apex. Capsule immersed, hemispherical, without neck. A verification of the record for this species described from Mexico and reported by VASHISTHA 2007 is required. – *India*

3. (24) *Physcomitrium eurystomum* SENDTN. *Denkschriften der Königlich-Bayerischen Botanischen Gesellschaft in Regensburg*. 3:142. 1841. [syn. *Physcomitrium acuminatum* BRUCH & SCHIMP.] – Pl. 3. Fig. 1

Plants 3-8 mm high. Stem short and slender. Leaves crowded at the top, shrunken when dry, ovate-lanceolate, acuminate. Margin dentate in upper half. Costa strong, percurrent. Border by 1 row of narrow cells. Seta 4-10 mm long. Capsule short pyriform, with distinct apophysis. Operculum short rostrate. – *Assam, Kerala, Manipur, Rajasthan, Uttar Pradesh, Uttarakhand, West Bengal, Gangetic Plain, Nepal*

4. (25) *Physcomitrium immersum* SULL. *A manual of the botany of the Northern United States*. Ed. 1. 648. 1848. [syn. *Physcomitrium cyathicarpum* MITT.] – Pl. 3. Fig. 2

Plants sturdy, often forming wide patches. Stem around 4 mm long. Leaves oblong ovate, acuminate. Margin serrulate above. Border lacking. Costa percurrent. Seta short 0.6 mm long.

Capsule immersed, globose. Operculum apiculate. – Bihar, Delhi, Punjab, Rajasthan, Uttar Pradesh, Uttarakhand, West Bengal, Eastern Himalayas, Gangetic Plain, South India, Nepal

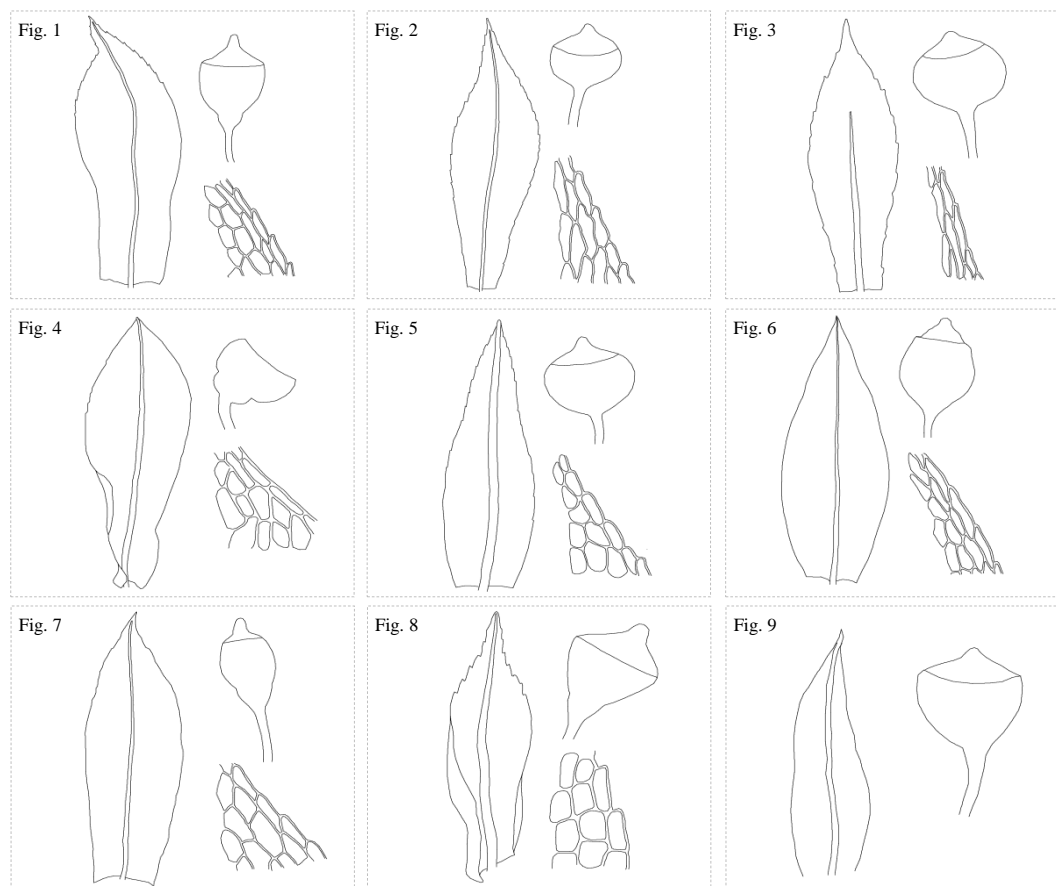


Plate 3: Fig. 1: *Physcomitrium eurystomum*, Fig. 2: *Physcomitrium immersum*, Fig. 3: *Physcomitrium indicum*, Fig. 4: *Physcomitrium insigne*, Fig. 5: *Physcomitrium japonicum*, Fig. 6: *Physcomitrium pulchellum*, Fig. 7: *Physcomitrium pyriforme*, Fig. 8: *Physcomitrium repandum*, Fig. 9: *Physcomitrium sahapurensense*

5. (26) *Physcomitrium indicum* (DIXON) GANGULEE. *Bulletin of the Botanical Society of Bengal*. 23:131. 1969 [1970]. [syn. *Physcomitrellopsis indica* DIXON EX K.M. GUPTA.] – Pl. 3. Fig. 3
Plants slender. Stem around 2 mm high. Leaves lax, ovate-lanceolate, upper ones narrower. Costa vanishing well before the leaf apex. Margin in upper part or throughout serrate. Border not differentiated. Seta very short, 1 mm long. Capsule immersed, globose. Operculum small, acuminate. – Manipur, Uttar Pradesh, West Bengal, Gangetic Plain

6. (27) *Physcomitrium insigne* DIXON & P. DE LA VARDE. *Archives de Botanique, Bulletin Mensuel*. 1:168. pl. 3, fig. 5. 1927. – Pl. 3. Fig. 4
Plants small, stem 4-5 mm. Leaves lanceolate, broad acuminate. Margin plane, entire. Border differentiated of 1-2 rows of narrow cells. Costa broad, excurrent. Seta 5 mm, brown. Capsule cyathiform. Operculum short apiculate. Most characteristic are entire leaf margin and the synoicous inflorescence as the other species of *Physcomitrium* do have an autoicous inflorescence. – Karnataka, Kerala, Tamil Nadu

7. (28) *Physcomitrium japonicum* (HEDW.) MITT. *Transactions of the Linnean Society of London, Botany*. 3:164. 1891. [syn. *Gymnostomum pulchellum* GRIFF.] – Pl. 3. Fig. 5

Plants about 5 mm high. Leaves crowded at the top, oblong lanceolate to spatulate, acuminate. Margin slightly serrulate, on top almost entire. Border with a row of narrow cells. Costa percurrent or short excurrent. Seta 5 mm long. Capsule short pyriform, neck absent. Operculum apiculate. – Assam, Madhya Pradesh, Manipur, Rajasthan, Sikkim, Uttar Pradesh, Uttarakhand, West Bengal, Gangetic Plain, Bhutan, Sri Lanka

8. (29) *Physcomitrium pulchellum* (GRIFF.) MITT. *Journal of the proceedings of the Linnean Society. Botany. Suppl.* 1:54. 1859. – Pl. 3. Fig. 6

Plants 5-7 mm high. Leave crowded at the top, ovate to spatulate, acuminate. Margin entire. Border of 1 row of narrow, vermicular cells. Costa strong, short excurrent. Seta around 11 mm long. Capsule turbinate-pyriform with a short apophysis. Operculum apiculate. Similar to *P. japonicum* but with larger leaves on fertile shoots and a narrower capsule mouth. – Arunachal Pradesh, Assam, Delhi, Manipur, Sikkim, Uttarakhand, Gangetic Plain

9. (30) *Physcomitrium pyriforme* (HEDW.) HAMPE. *Prodromus florae hercyniae*. 64. 1836. – Pl. 3. Fig. 7

Plants 2-5 mm high. Leaves soft, obovate to spatulate, acuminate. Margin in upper half serrate. Costa vanishing before the leaf apex. Seta reddish, 3-10 mm long. Capsule pyriform, apophysis short. Operculum apiculate. Annulus in 2 rows. – Mizoram, Uttarakhand

10. (31) *Physcomitrium repandum* (GRIFF.) MITT. *Journal of the proceedings of the Linnean Society. Botany. Suppl.* 1:54. 1859. [syn. *Gymnostomum repandum* GRIFF.] – Pl. 3. Fig. 8

Plants up to 5 mm high. Leaves spatulate-lanceolate. Margin serrate in the upper part, often incurved at the base. Costa percurrent. Border of narrow cells not clearly developed. Seta 5 mm, reddish-brown. Capsule turbinate, wide-mouthed, apophysis short. Operculum mammillae. – Arunachal Pradesh, Assam, Kerala, Punjab, Eastern Himalayas, Western Himalayas, Nepal

11. (32) *Physcomitrium sahapurense* MÜLL. HAL. EX P. DE LA VARDE. *Revue Générale de Botanique*. 29:299. 1917. – Pl. 3. Fig. 9

Plants up to 2-3 mm high. Leaves spatulate-lanceolate. Costa percurrent. Seta 4 mm, yellowish-brown. Capsule turbinate, wide-mouthed, apophysis short. Operculum mammillae. – Assam, Uttar Pradesh, Eastern Himalayas

12. (33) *Physcomitrium schummii* U. SCHWARZ. *Frahmia*. 13:3. Fig. 3. 2016.

See description above. – Karnataka

13. (34) *Physcomitrium sphaericum* (C.F. LUDW.) FÜRN. EX HAMPE. *Flora*. 20 (1):285. 1837. [syn. *Physcomitrium perflaccidum* BROTH. EX P. DE LA VARDE.] – Pl. 4. Fig. 1

Plants usually 3-5 mm high. Leaves elongated or oblong-elongated, acuminate. Margin almost entire, plane. Costa percurrent or shortly excurrent. Border not clearly developed or sometime in 1 row. Seta 3-5 mm. Capsule almost spherical, mouth nearly equal as or slightly smaller than the larger part of the theca, apophysis indistinct. Operculum with beak-like apiculus. The type of *Physcomitrium perflaccidum* (PC 0133193) was identified by H. Ochi in 1966 as *P. sphaericum*. – Jammu and Kashmir, Manipur, Mizoram, West Bengal, Bhutan

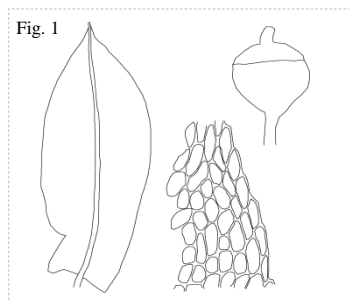


Plate 4: Fig. 1: *Physcomitrium sphaericum*

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8. Index to Taxa

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