

An overview of family Pottiaceae (Bryopsida) in central India with special reference to Pachmarhi Biosphere Reserve (PBR)

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The family Pottiaceae is one of the dominant acrocarpous moss family of India, with approximately 26 genera and 130 species being encountered. The present work intends to take up distribution of the members of the family in the central Indian region with nearly 22 taxa being reported earlier. Achanakmar – Amarkantak Biosphere Reserve, Bhimbetka world heritage site, Gujarat, Mt. Abu and Pachmarhi Biosphere Reserve (PBR) are some important hotspots of bryophyte vegetation in central India. Among these, PBR listed under UNESCO's Man and Biosphere (MAB) Programme is an important site of bryophyte vegetation. Mosses of PBR however have not been studied until now. Here we assess the status of family Pottiaceae in central Indian zone along with providing an illustrated account of eight species encountered from PBR. Among these, *Hyophila spathulata* (Harv.) Jaeg. and *Oxystegus teneuirostris* (Hook. et Tayl.) A.J.E. Smith are new additions to central India, while *Semibarbula ranuii* Gangulee and *Weissia edentula* Mitt. are being reported from PBR for the first time.

India is well known for its floristic diversity of various plant groups. Indian researchers have broadly divided India into eight bryo-geographical regions (Singh 1997). Pottiaceae is the most dominant erect moss family of India with a wide distribution among the major bryo-geographical regions. Pottiaceae has emerged as an important moss family in recent times with some workers (Zander 1993) performing extensive studies on the members of this family. Workers have provided numerous accounts of the mosses of Pottiaceae from various regions of the country. In the most recent works, Aziz and Vohra (2008) provided an account of 29 genera with 130 species from India.

The central Indian region has a diverse bryophyte flora. Achanakmar – Amarkantak Biosphere Reserve, Bhimbetka world heritage site, Gujarat, Mt. Abu, Pachmarhi Biosphere Reserve are the major hotspots of the central Indian bryoflora. The literature clearly indicates that substantial information is available in case of liverworts and hornworts but moss flora still remains meagerly touched. Workers have reported 22 taxa belonging to Pottiaceae from this zone. Six taxa from Achanakmar – Amarkantak Biosphere Reserve (Kapoor 2007), two taxa from Bhim-

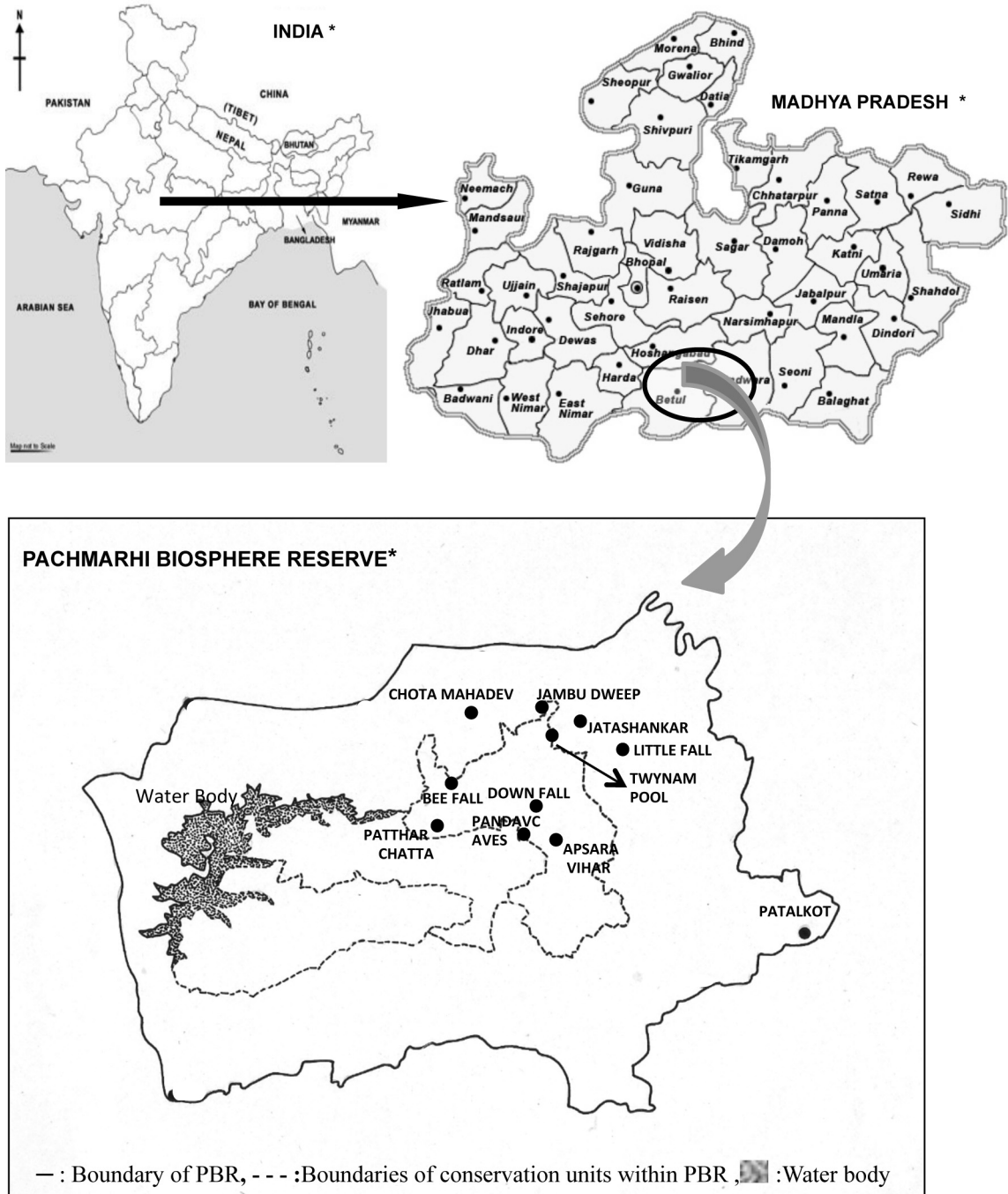
betka world heritage site (Nath and Bansal 2009), 11 taxa from Mt. Abu (Chaudhary and Deora 2001) and eight taxa from Gujarat (Chaudhary et al. 2006) belonging to the family Pottiaceae have been listed so far. Amongst the central Indian regions, PBR is an important Biosphere Reserve. It is situated in Madhya Pradesh (M.P.), India, covering an area of 4987.38 km². It lies between latitudes 22°11' to 22°56' N and longitudes 77°47' to 78°52' E. The region has been declared as a Biosphere Reserve since 1999 under UNESCO's Man and Biosphere (MAB) Programme and also a part of the Project Tiger since 2000.

The Biosphere Reserve encompasses three wildlife conservation units viz. Pachmarhi Sanctuary, Bori Sanctuary, Satpura National Park and surrounding areas. The topography of the Wildlife Sanctuary is variable with valleys, plateau, hilly areas etc., having altitudes ranging from 400 to 1065 m a.s.l., temperature ranges from 22°–37° C (max) to 5°–24° C (min), the annual rainfall is approximately 1200 mm and the mean relative humidity ranges from 55.0% to 94.0%. This region holds evolutionary importance as it is the part of the Gondwanaland of the historic past. The region also forms a link between the

biodiversity of the southern Indian region and that of the Himalayan region and this makes a connecting link for the two belts. Thus the flora of this area in general and bryophytes in particular need to be assessed in detail.

In the present work, we describe eight species belonging to six genera of Pottiaceae, namely: *Anoetangium*

stracheyanum Mitt., *Barbula javanica* Doz. et Molk., *Hyophila involuta* (Hook.) Jaeg., *Hyophila nymaniana* (Fleisch.) Menzel, *Hyophila spathulata* (Harv.) Jaeg., *Oxystegus teneuirostre* (Hook. et Tayl.) A.J.E. Smith, *Semibarbula ranuui* Gangulee and *Weissia edentula* Mitt. which were encountered from various localities of PBR,



* Maps not fit to scale

Map 1. Map showing area covered under the Pachmarhi Biosphere Reserve and major localities undertaken in the study.

occurring between an altitudinal range of 400–1000 m a.s.l. with a distribution extending to 20 localities. The habitat ranges from soil covered rocks to moist bare rocks. Among these, *Semibarbula ranuii* Gangulee and *Weissia edentula* Mitt. are being reported from PBR for the first time while *Hyophila spathulata* (Harv.) Jaeg. and *Oxysetegus teneuirostre* (Hook. et Tayl.) A.J.E. Smith are new records from central India.

Material and methods

Out of the 34 localities of PBR surveyed during 1993 and 2006, members of family Pottiaceae encountered from only 20 localities, covering an altitudinal range of 400 to 1000 meters. The specimens were collected from terrestrial habitats such as rocks, soil covered rocks, wet rocks etc., and have been deposited in the bryophyte herbarium, NBRI (LWG), Lucknow, India. Map 1 shows the area under Biosphere Reserve and some major localities from which plant collection was done. All the material was thoroughly examined, identified and morphologically described.

Taxonomic observations

1. *Anoetangium stracheyanum* Mitt. in Musc. Ind. Or. : 31 (1859)

Plants caespitose, often dichotomously branched, ± 10 mm in size. Stem brown, covered with patent leaves in intermittent tufts. Leaves curled when dry, $\pm 1.36 \times 0.22$ mm in size, lanceolate with acute apex, margin unbroken but papillate. Costa prominent, light brown, extended into minute tip. Apical leaf cells rounded – quadrate, $\pm 6.26 \mu\text{m}$ in size, highly papillose, basal cells rectangular, $12.5\text{--}22.9 \times 6.25\text{--}8.3 \mu\text{m}$, generally getting shorter from costa to margin, Seta erect, ± 6 mm long, yellowish brown, lateral in position. Capsule pale, brownish - orange, erect, $\pm 0.86 \times 0.54$ mm in size. Peristome absent. Spores yellow, spherical, $\pm 12 \mu\text{m}$ in diameter.

Range of distribution: Asia: China, India: central India (Mt. Abu, PBR); eastern Himalaya (Arunachal Pradesh, Assam, Darjeeling, Meghalaya); Punjab and west Rajasthan Plains (Rajasthan); S India (Tamil Nadu); western Himalaya (Himachal Pradesh, Kashmir, Uttarakhand), Japan, Nepal, Taiwan, Thailand, Vietnam.

Specimens examined: India, Madhya Pradesh, Pachmarhi: Jatashankar (alt. ca 1000 m), 17.12.1993, 205630 (LWG); Mahadev (alt. ca 1000 m), 17.12.1993, 205641 (LWG) Leg. V. Nath & A.K. Asthana; Down Fall (alt. ca 884 m), 28.11.2006, 229399 (LWG); on way to Chota Mahadev (alt. ca 854 m) 18.11.2006, 227626 (LWG) Leg. V. Sahu & V. Awasthi.

2. *Barbula javanica* Doz. et Molk. in Ann. Sci. Nat. Bot. Ser. 3., 2 : 300 (1884)

Plants in dense green tufts, unbranched, stems erect, less than 10 mm long, covered with erectopate leaves, clustered near apex. Leaves spatulate, soft, erect and incurved, $\pm 2 \text{ mm} \times 0.54 \text{ mm}$ in size. Leaf base broad, narrowing towards the apex, tip bluntly pointed. Costa brown, ending just below tip. Leaf apex cells quadrate - rounded, papillose, $7\text{--}8.4 \times 7.3 \mu\text{m}$; median cells $\pm 8 \mu\text{m}$ as long as broad; basal cells elongated, rectangular, hyaline, smooth, up to $66.7 \mu\text{m}$ broad. Seta apical, erect, deep red below, lighter above, 15 mm long. Capsule erect, cylindrical, deep red, $\pm 1 \text{ mm} \times 0.37 \text{ mm}$ in size. Peristome comprising 32 filiform papillose segments, deep red, twisted spirally. Operculum and spores not seen.

Range of distribution: Asia [Bangladesh, Bhutan, China, India: central India (PBR); eastern Himalaya (Arunachal Pradesh, Darjeeling, Meghalaya); Gangetic plains (Bengal Plains, Orissa, Uttar Pradesh); Punjab and west Rajasthan Plains (Rajasthan); western Himalaya (Kashmir), Indonesia, Japan, Nepal, Oman, Phillipines, Sri Lanka, Taiwan, Thailand, Vietnam], North America, Oceania.

Specimens examined : India, Madhya Pradesh, Pachmarhi : Chota Mahadev (alt. ca 950 m), 19.12.1993. Leg. V. Nath & A.K. Asthana. 205683 (LWG); Down Fall (alt. ca 884 m) 28.11.2006. Leg. V. Sahu & V. Awasthi. 227603B (LWG).

3. *Hyophila involuta* (Hook.) Jaeg. in Ber. S. Gall. Naturw. Ges 1871-72: 356 (1873)

Plants dense, erect, simple or branched. Stem, radiculose, up to 12 mm high with upper leaves spreading in rosettes. Leaves spatulate, oblong- lanceolate. Leaves $1.8\text{--}2.8 \times 0.56\text{--}0.86$ mm broad, apex broadly pointed, margin smooth with denticulations at apex. Costa reddish-brown, prominent, percurrent. Apical leaf cells mamillate, $\pm 7.5 \mu\text{m}$ in diameter. Leaf base cells rectangular, $35 \times 18 \mu\text{m}$ in size. Seta apical, erect, reddish- brown below, Capsule 2.5×0.5 mm in size. Peristome absent. Spores dull brown, round, $\pm 12 \mu\text{m}$ in diameter.

Range of distribution: Africa, Asia [China, India: Andaman and Nicobar Islands; central India (Achanakmar – Amarkantak Biosphere Reserve, Gujarat, Mt. Abu, PBR); eastern Himalaya (Arunachal Pradesh, Assam, Darjeeling, Meghalaya, W Bengal, Sikkim); Punjab and west Rajasthan Plains (Rajasthan); Gangetic plains (Bengal Plains, Jharkhand, Uttar Pradesh); S India (Karnataka, Tamil Nadu); western Himalaya (Himachal Pradesh, Uttarakhand), Indonesia, Japan, Jordan, Malaysia, Mali, Oman, Phillipines, Sri Lanka, Taiwan, Thailand], Europe, North America, Oceania, South America.

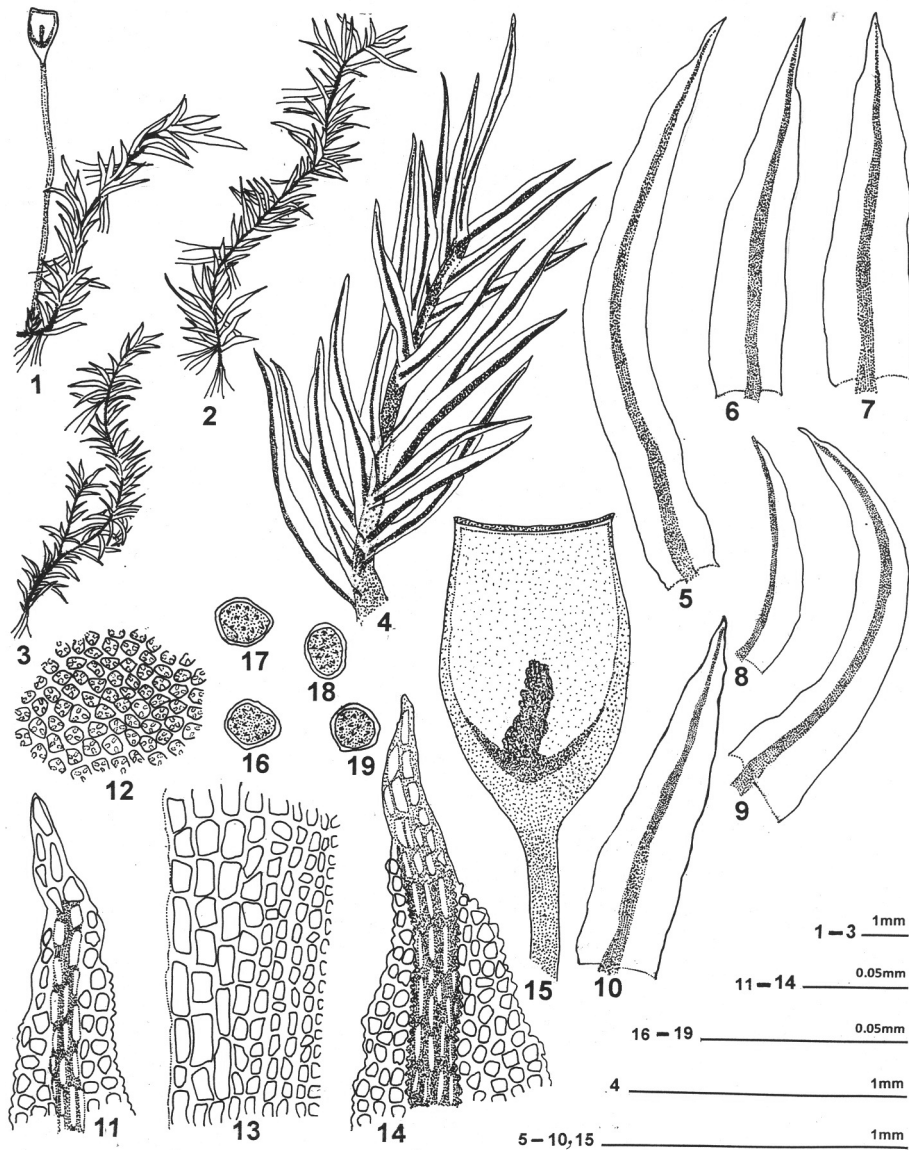


Plate 1. Figure 1–19. (LWG 227626) *Anoectangium stracheyanum* Mitt.: 1. plant with sporophyte, 2, 3. vegetative plants, 4. enlarged view of vegetative plant, 5–10. leaves, 11. apical leaf cells, 12. middle leaf cells, 13. basal leaf cells, 14. adaxial leaf surface showing costa, 15. capsule, 16–19. spores.

Specimens examined: India, Madhya Pradesh, Pachmarhi: on way to Jambu Dweep (alt. ca 900 m), 17.12.1993, 205595A (LWG); Jambu Dweep (alt. ca 900 m), 17.12.1993, 205594, 205610, 205613 (LWG); Rajakhoh, Pataalkot (alt. ca 400 m), 20.12.1993, 205738B (LWG). Leg. V. Nath & A.K. Asthana; Near Police Training School (alt. ca 914 m), 28.11.2006, 229384 (LWG); Twynam Pool (alt. ca 854m), 29.11.2006, 227622B (LWG); Chota Mahadev Mandir (alt. ca 793 m), 29.11.2006, 227640B (LWG); Bee Fall (alt. ca 823 m), 30.11.2006, 227665; on way to Duchess Fall (alt. ca

823 m), 30.11.2006, 227669; Pandav Caves (alt. ca 823 m), 1.12.2006, 227680, 227682, 227684B, 227685D, 227686A (LWG) Leg. V. Sahu & V. Awasthi.

4. *Hyophila nymaniana* (Fleisch.) Menzel, 22: 198 (1992); Zander in Bull. Buffalo Soc. Nat. Sc., 32:174. (1993)

Plants simple, unbranched, lax, up to 13 mm long, leaves in intermittent rosette tufts, erectopatent. Leaves spatulate, narrower at base, broadening above, apex broadly pointed, blunt $\pm 1.15 \times 0.5$ mm in size. Costa brown,

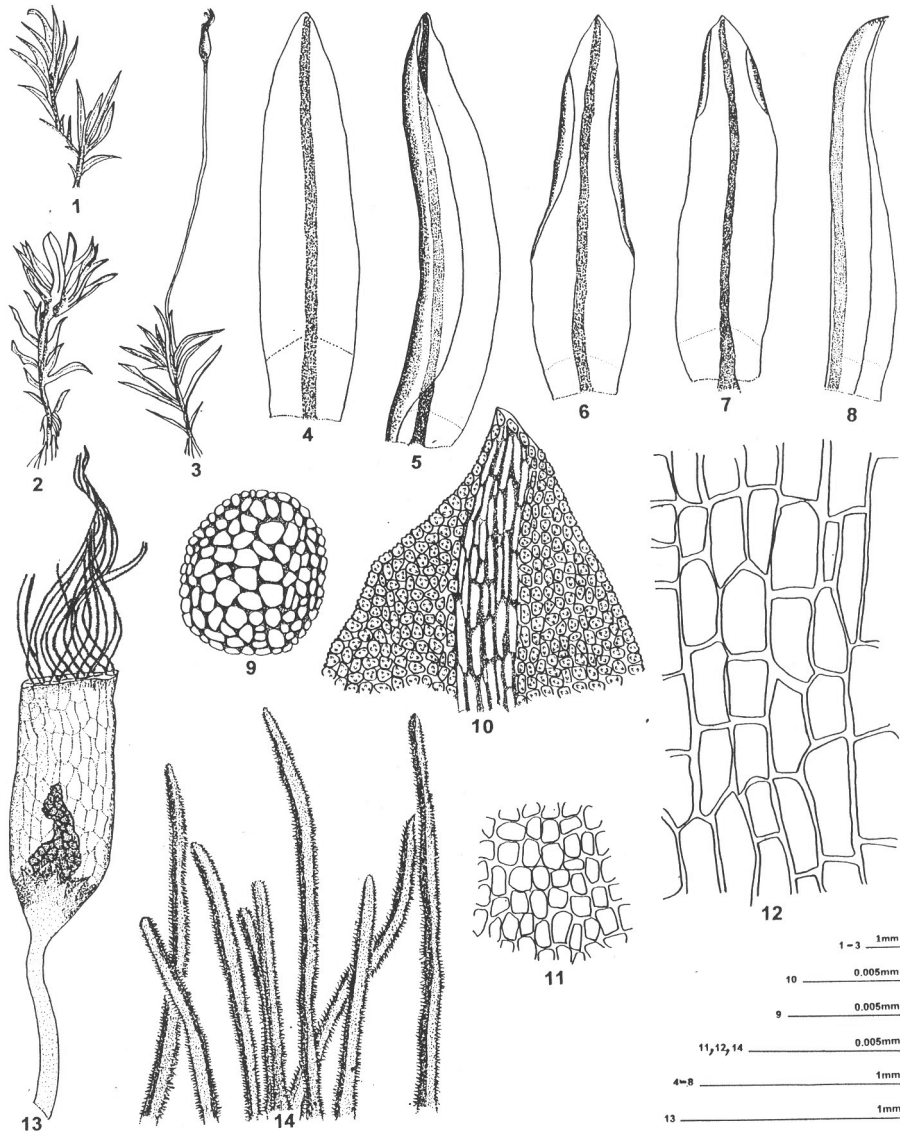


Plate 2. Figure 1–14. (LWG 205683) *Barbula javanica* Dox. et Molk.: 1, 2. vegetative plants, 3. plant with sporophyte, 4–8. leaves, 9. cross-section of axis, 10. apical leaf cells, 11. median leaf cells, 12. basal leaf cells, 13. capsule with peristome, 14. enlarged section of peristome.

percurrent ending in a short apiculus. Apical leaf cells chlorophyllose, multipapillose, rounded-quadrata, $10.5 \times 7 \mu\text{m}$ in size, basal leaf cells rectangular, $3 \times 10 \mu\text{m}$ or more becoming shorter above. Sporophyte not seen.

Range of distribution: Africa, Asia [China, India: central India (Achanakmar – Amarkantak Biosphere Reserve, Gujarat, PBR); Gangetic plains (Uttar Pradesh, Orissa); S India (Karnataka, Kerala, Tamil Nadu); western Himalaya (Uttarakhand), Indonesia, Philippines, Thailand], North America.

Specimens examined: India, Madhya Pradesh, Pachmarhi: on way to Jambu Dweep (alt. ca 900 m) 17.12.1993, 205591 (LWG) Leg. V. Nath & A.K. Asthana; on way to Little Fall (alt. ca 914 m), 28.11.2006, 229385 (LWG); Near Duchess Fall (alt. ca 856 m), 1.12.2006, 227681B (LWG) Leg. V. Sahu & V. Awasthi.

5. *Hyophila spathulata* (Harv.) Jaeg. in Ber. S. Gall. Naturw. Ges. 1871- 72: 353 (1873)

Plants tufted, erect, usually unbranched, up to 6 mm high. Leaves erectopate, folded, recurved with inrolled

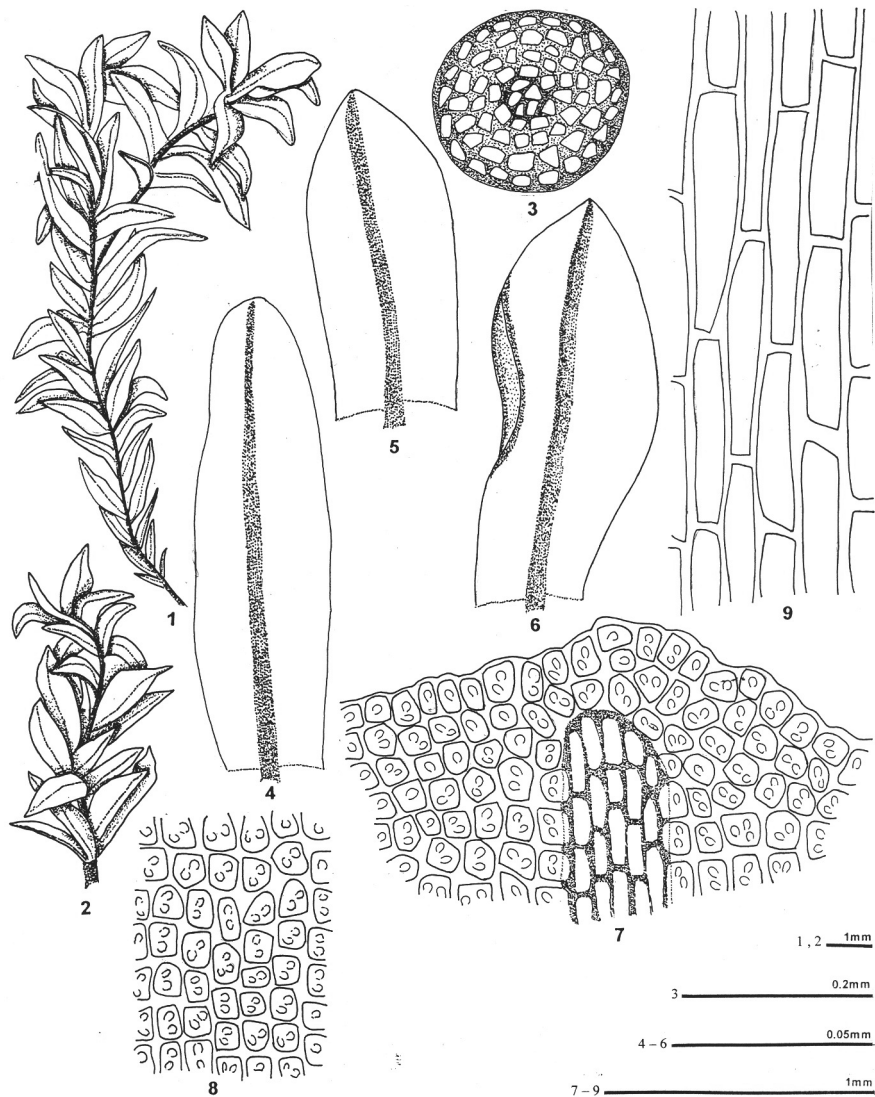


Plate 3. Figure 1–9. (LWG 227681B) *Hyophila nymaniana* (Fleisch.) Menzel.: 1, 2. vegetative plants, 3. T.S. of axis, 4–6. leaves, 7. apical leaf cells, 8. median leaf cells, 9. basal leaf cells.

margins; spatulate, erect spreading, $\pm 1.8 \times 0.4$ mm, apex pointed, margin flat, entire. Costa dull brown, prominent, percurrent; Upper lamina cells chlorophyllose, mamilllose, rounded-quadrate, 8–9 μm in diameter; basal leaf cells rectangular, hyaline, up to 48×14 μm in size. Seta apical, erect, ± 1.4 cm long. Capsule cylindrical, dull brown 1.7×0.4 mm in size. Operculum conical. Peristome absent. Spores not seen.

Range of distribution: Asia [India: central India (PBR); eastern Himalaya, Gangetic plains (Delhi, Uttar Pradesh); south India (Karnataka, Kerala, Tamil Nadu); western Himalaya (Uttarakhand); Japan, Thailand].

Specimens examined: India, Madhya Pradesh, Pachmarhi: Patthar Chatta (alt. ca 1000 m), 18.12.1993, 205647 (LWG) Leg. V. Nath & A.K. Asthana; On way to Apsara Vihar (alt. ca 732 m), 1.12.2006, 227691B (LWG) Leg. V. Sahu & V. Awasthi.

6. *Oxystegus tenuirostre* (Hook. et Tayl.) A.J.E. Smith, in J. Bryol., 9(3): 393 (1977)

Plants in loose tufts. Stem up to 25 mm long. Leaves fragile, flexuose, lanceolate-ligulate, long, up to 3.5×0.8 mm; margin flat, smooth, may be crenulate near the apex; tip acute with an apiculus. Costa light brown, excurrent. Upper lamina cells $\pm 8.34 \times 8.0$ μm , multipapil-

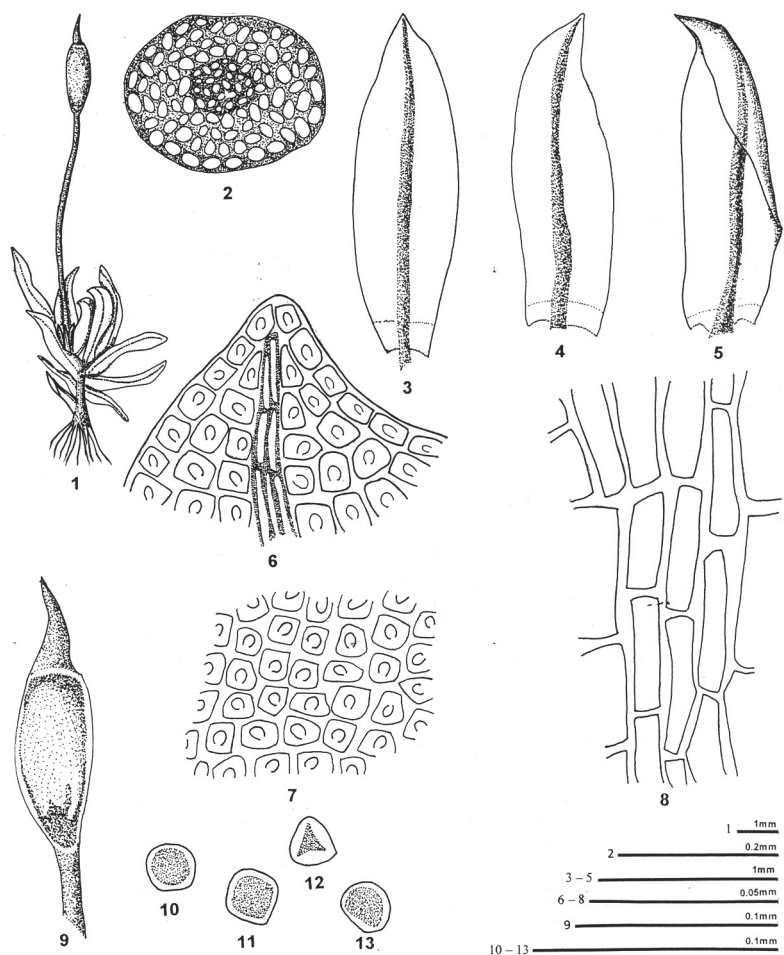


Plate 4. Figure 1–13. (LWG 227691B) *Hyophila spatulata* (Harv.) Jaeg.: 1. plant with sporophyte, 2. T.S. of axis, 3–5. leaves, 6. apical leaf cells, 7. median leaf cells, 8. basal leaf cells, 9. capsule, 10–13. spores.

late, basal cells wide, rectangular, up to $73 \times 24 \mu\text{m}$ near costa, becoming shorter towards margin. Sporophyte not seen.

Range of distribution: Africa, Asia [China, India: central India (PBR); eastern Himalaya (Darjeeling, Meghalaya, Nagaland); S India (Tamil Nadu), western Himalaya (Himachal Pradesh, Kashmir, Uttarakhand), Japan], Europe, North America, Oceania, South America.

Specimens examined: India, Madhya Pradesh, Pachmarhi: on way to Patalkot (alt. ca 400 m), 20.12.1993, 205719 (LWG) Leg. V. Nath & A.K. Asthana; on way to Mahadev (alt. ca 975 m), 28.11.2006, 227617 (LWG); Duchess Fall (alt. ca 732 m), 30.11.2006, 227671 (LWG) Leg. V. Sahu & V. Awasthi.

7. *Semibarbula ranuii* Gangulee in Nova Hedwigia, 8: 149 (1964)

Plants in loose tufts, stem unbranched, up to 16 mm long. Leaves, oblong-lanceolate, erectopatent, $1.6 \times 0.4 \text{ mm}$ in size. Leaf margin flat, apex broadly acuminate. Costa prominent, golden brown, excurrent in a short apiculus, coarse papillae on back. Upper laminal cells rounded-quadrate to hexagonal, $6.25 \times 8.3 \mu\text{m}$, multipapillose. Basal lamina cells rectangular, hyaline, up to $22 \times 10 \mu\text{m}$ in size. Sporophyte not seen.

Range of distribution: India: central India (Achanakmar – Amarkantak Biosphere Reserve, Chotanagpur, PBR); Gangetic plains.

Specimens examined: India, Madhya Pradesh, Pachmarhi: near Police Training School (alt. ca 914 m), 28.11.2006, 229383 (LWG) Leg. V. Sahu & V. Awasthi.

8. *Weissia edentula* (Mitt.) Besch. in Bull. Soc. Bot. France, 34: 95 (1887)

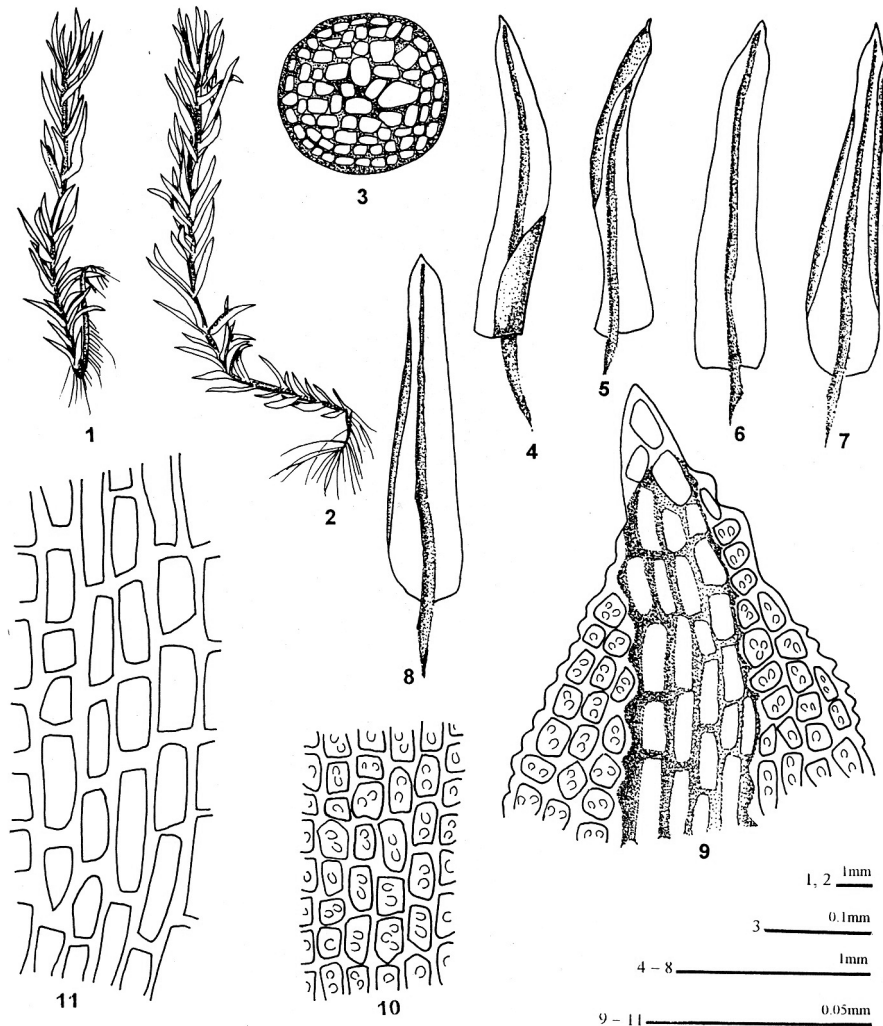


Plate 5. Figure 1–11. (LWG 229383) *Semibarbula ramuii* Gangulee: 1,2. vegetative plants, 3. T.S. of axis, 4–8. leaves, 9. apical leaf cells, 10. median leaf cells, 11. basal leaf cells.

Plants erect, forming dense mats. Stem rarely branched, up to 12 mm high, densely covered with leaves which are larger at top. Leaves linear-lanceolate, forming a sheathing base, $\pm 2 \times 0.4$ mm in size. Leaf narrow, pointed, margin involute in the lamina, unbroken. Costa light brown, excurrent. Upper leaf cells $\pm 6.3 \mu\text{m}$, densely papillose, basal cells hyaline $\pm 48 \times 9.5 \mu\text{m}$ in size, becoming shorter towards margin. Seta apical, erect, ± 7 mm long, brownish. Capsule erect, brown, $\pm 1 \times 0.7$ mm. Peristome absent. Spores warty, round, dull reddish - brown $\pm 16 \mu\text{m}$ in diameter.

Range of distribution: Africa, Asia [China, India: central India (PBR); Gangetic plains (Orissa); South India (Tamil Nadu), Indonesia, Japan, Pakistan, Sri Lanka, Thailand], North America, Oceania.

Specimens examined: India, Madhya Pradesh, Pachmarhi: Down Fall (alt. ca 884 m) 28.11.2006, 227602B (LWG); on way to Jambu Dweep (alt. ca 793 m), 29.11.2006, 227642 (LWG); near Bee Fall (alt. ca 823 m), 30.11.2006, 227664 (LWG); Near Pandav Caves (alt. ca 823 m), 1.12.2006 (LWG) Leg. V. Sahu & V. Awasthi.

Discussion

Pottiaceae is a family, which shows cosmopolitan distribution as its members are well adapted to varying climatic conditions. Among the eight bryo-geographical zones of the country, the mosses of this family show either abundant or moderate presence. Concentrating on the central Indian region, it can be aptly stated that the central Indian

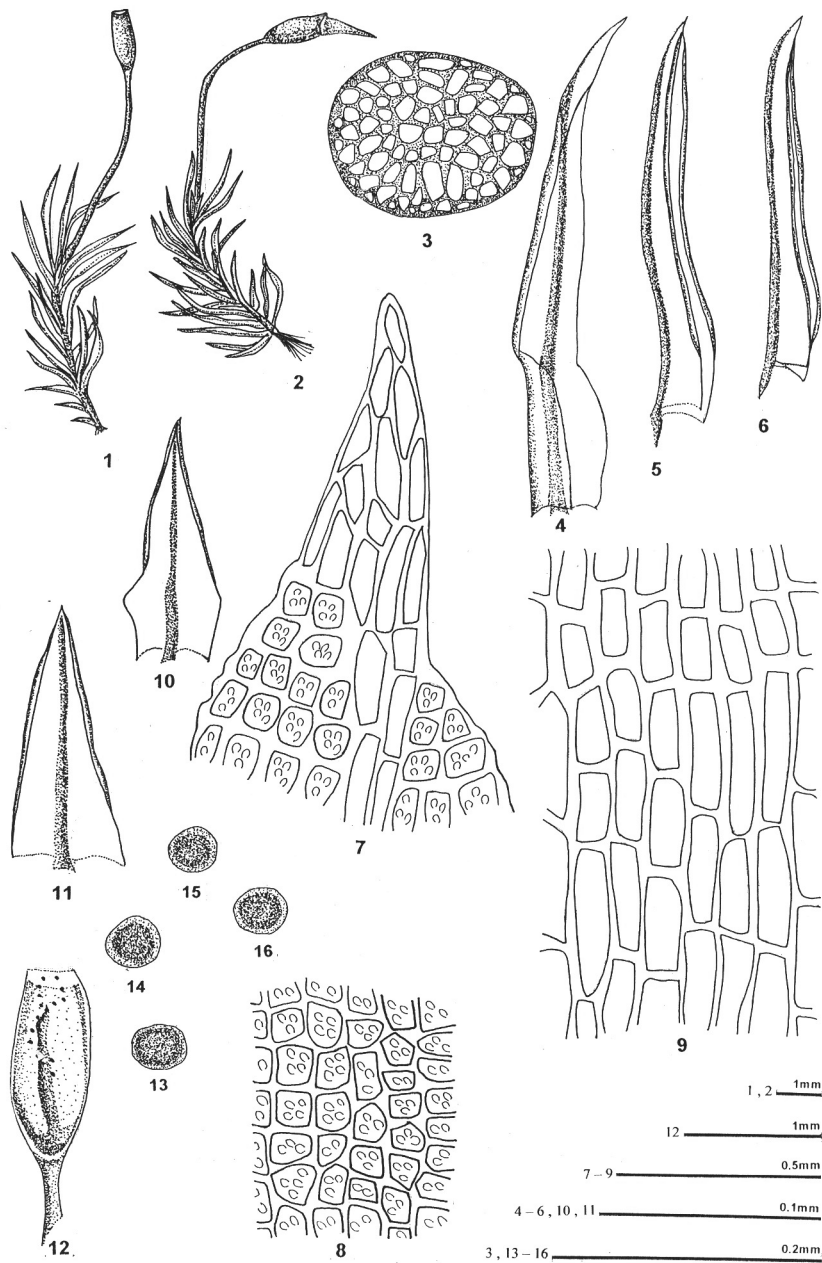


Plate 6. Figure 1–16. (LWG 227602B) *Weissia edentula* (Mitt.) Besch.: 1, 2. plants with sporophyte, 3. T.S. of axis, 4–6. leaves, 7. apical leaf cells, 8. median leaf cells, 9. basal leaf cells, 10, 11. perichaetial leaves, 12. capsule, 13–16. spores.

species of Pottiaceae belong to some dominant genera like *Weissia* Hedw., *Barbula* Hedw., *Hyophila* Brid. and *Anoetangium* Mitt. Approximately 22 species of Pottiaceae have been reported to occur from the various localities of central India (Chaudhary and Deora 2001, Chaudhary et al. 2006, Chaudhary and Sharma 2007, Kapoor 2007, Nath and Gupta 2007, 2008, Aziz and Vohra 2008, Nath and Bansal 2009). Individually among the taxa, *Anoetangium*

stracheyanum and *Oxystegus teneuirostre* are found in the eastern and western Himalayan region and South India, apart from central India. Both *Hyophila nymaniana* and *Hyophila spathulata* occur in western Himalaya, Gangetic plains, southern India and central India. *Semibarbula ranuui* and *Weissia edentula* show restricted distribution in India with *S. ranuui* being present at the Punjab and Rajasthan plains and Gangetic plains, apart from central India,

while *W. edentula* is present at southern India along with central India. *Barbula javanica* and *Hyophila involuta* are the most abundant and widely distributed taxa in India being known from all the bryo-geographical zones of India with an exception of southern India in case of *B. javanica*. The family also exhibits considerable representation at PBR. It emerges as the most dominant terrestrial and erect moss family in the region, in terms of distribution. This is also evident from the fact that the other prominent erect moss families of the region being Fissidentaceae, Bryaceae and Dicranaceae, are represented by a single, five and four genera respectively and further, the frequency of occurrence of these genera among the various localities of collection is lesser in comparison to those of Pottiaceae. The genus *Hyophila* Brid. has emerged as the most dominant one among the six genera investigated during present study. Bryophyte flora of the Indian region in general and moss flora in particular is being worked upon and promises to reveal more taxa from India in near future.

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