V. TAXONOMIC STUDY OF BRYOPHYTES

Identification has been done on basis of detailed morpho-taxonomic studies of the material under the Binoculars, Dissceting Microscope, Compound Microscope and Trinocular Microscope. The plants were identified using the floras of Kashyap (1929, 1932), Gangulee (1969-1980), Chopra (1975) and Bapna and Kachroo (2000). Other accounts consulted were those of Srivastava and Udar (1976), Srivastava and Srivastava (2002) and Singh and Nath (2007).

Identification of Mosses:

In case of mosses, habit (acrocarpous/ pleurocarpous), colour of plant, presence/ absence of paraphyllia/ pseudoparaphyllia, cross section of axis, leaf arrangement, homophylly/ heterophylly, sporophyte (if and when present), perichaetial leaves, seta, capsule, peristome and spores, leaf anatomy (shape and size, margin, costa, leaf cells, sheathing lamina) and have been studied to identify the taxa.

Identification of Liverworts/ Hornworts:

In case of liverworts and hornworts, habit (thalloid/leafy), thallus shape and size, rhizoids, poration, ventral scales, oil bodies (if present), thallus anatomy, cross section of axis and cell sizes (leafy liverworts), male-female receptacles and sporophytes (if and when present), involucres, perianth and spores were dissected and studied in case of liverworts and hornworts.

Added taxonomic tools such as Scanning Electron Microscopy (SEM) have been employed to circumscribe maximum possible parameters during identification and evaluation of the collected material.

The basionyms for the species have been provided wherever relevant and the species known from India that have been synonamised under a specific name have been included. Any given species may have several synonyms but only those relevant to the Indian bryophyte flora are considered here.

KEY FOR IDENTIFICATION OF BRYOPHYTES

1. Plants leafy ……..…. 2.
1. Midrib present in leaves, rhizoids multicellular and branched with oblique septa, elaters absent ……..…….…… **Mosses**
2. Midrib absent in leaves, rhizoids unicellular and unbranched, elaters present .…….…….……..……..… **Leafy liverworts**
2. Plants thalloid .…….……..…… 3.
3. Sporophyte with foot, seta and capsule, columella absent in the capsule, capsule globose/elliptical……..…….. **Liverworts**
3. Sporophyte with foot and capsule, columella, usually present in the capsule, capsule horn/needle shaped……. **Hornworts**

Key for Identification of Mosses (Bryopsida)

1. Peristome absent ……..…… Sphagnidae, Andreaeidae, Takakiidae
   Peristome present …….... Subclass - Bryidae (True Moss) 2
2. Nematodontous type of Peristome ……..…… Polytrichales, Tetraphidales
   Arthodontous type of Peristome ….....……..... Bryales

Key for Identification of Mosses under Bryales:

1. Peristome present in a single ring…….. Haplolepideae
   (Pottiaceae, Calymperaceae, Dicranaceae, Leucobryaceae, Rhabdoweisiaceae, Fissidentaceae)
   Peristome present in two rings…….…… Diplolepidea
   (Funariaceae, Meilichoferiaceae ,Orthotricaceae, Bartramiaceae, Bryaceae, Thuidiaceae, Myriniaceae, Amblestegiaceae, Brachytheciaceae, Plagiotheciaceae, Entodontaceae, Sematophyllaceae, Leskeaceae, Fabroniaceae, Pterobryaceae, Meteoriaceae, Neckeraceae, Hypnaceae, Hookeriaceae)

I. ORDER: BRYALES

Family: Funariaceae Schwaegr.

Genus: *Funaria* Hedw.

Plants erect, loosely tufted, green, rarely branched 10-13 mm in size. Leaves loosely arranged on stem, smaller and distant below, larger above forming a distinct rosette, oblong- ovate to lanceolate, erect spreading, apex acute, margin entire. Costa strong, percurrent to sometimes reaching tip. Seta apical, long; capsule slightly pendulous, dark brown to red, asymmetrical,; pristome epicarnoid,

Plate-1

***Funaria hygrometrica* Hedw.,** Figs. 1-13: 1,2. Plants with sporophytes, 3. cross section of axis, 4-7. leaves, 8. apical leaf cells, 9. median leaf cells, 10. basal leaf cells, 11. capsule, 12. peristome, 13. spores.

***Funaria hygrometrica* Hedw.,** Sp. Musc.: 172. 1801.

(Plate 1: Figs. 1-13)

Plants erect, loosely tufted, green, rarely branched ± 10 mm in size. **Stem** circular in cross section, outer cortical cells smaller, getting larger towards centre, central cells small. **Leaves** smaller and distant below, larger above forming a distinct rosette, oblong- ovate to lanceolate, erect spreading, 2-3.8 mm long, 0.8-1.3 mm wide, apex acute, margin entire; **costa** strong, percurrent or sometimes reaching tip. **Leaf cells** rhomboidal smaller at apex, ± 35 x 18 µm, elongated to rectangular at base 95 x 30 µm, marginal one row narrower, conspicuous. **Seta** apical, erect, ± 12 mm long; **capsule** slightly pendulous, dark brown to red, asymmetrical, mouth narrow, graduating to wide upper half ± 1.8 mm in diameter, narrower towards base; **pristome** epicarnoid, exostome brownish, high, endostome hyaline of same height; **spores** small, + 12 µm in diameter.

Ecology & Distribution: plants growing on damp wall and rocks near Bus stand, Jalgali and Rajakhoh from 400 to 1056 m.

Range of Distribution: Angola, Antarctica, Argentina, Australia, Austria, Bolivia, Brazil, Cameroon, Canada, Chad, Chile, China, Colombia, Congo, Costa Rica, Cuba, Cyprus, Denmark, Dominica, Dominican Republic, Ecuador, Egypt, Estonia, France, Germany, Greece, Greenland, Guadeloupe, Guatemala, Haiti, Honduras, Iceland, India: central India (Gujarat, Odisha, PBR, Rajasthan), eastern Himalaya (Arunachal Pradesh, Jalpaiguri, Khasi hills, Manipur, Naga hills), Gangetic plains (Chhota Nagpur Plateau) South India (Eravikulim National Park, Goa, Nilgiri, Palni, Shevvaroy hills, western Ghats), western Himalaya (Kashmir), Indonesia, Ireland, Israel, Italy, Jamaica, Japan, Kazakhstan, Kenya, Liberia, Madagascar, Malawi, Mali, Mexico, Namibia, Nepal, Netherlands, New Zealand, Norway, Panama, Papua New Guinea, Paraguay, Peru, Philippines, Poland, Portugal, Russia, Saint Kitts and Nevis, South Africa, South Georgia and the South Sandwich Islands, South Korea, Thailand, Tonga, Turkey, United Kingdom, United States, Uruguay, Venezuela, Vietnam, Wallis and Futuna Islands, Zambia.

Specimens examined: India, Madhya Pradesh, PBR: near Bus stand, alt. ca 1056 m, on damp wall of water tank, 15.12.1993, 205539 (LWG); Jalgali, alt. ca 900 m, on soil over rocks, 16.12.1993, 205562 (LWG); Rajakhoh (Patalkot), alt. ca 400 m, on rocks, 20.12.1993, 205738A (LWG), leg. V. Nath & A.K. Asthana.

Family: Orthotricaceae Arnott.

Genus: *Macromitrium* Bridel

Plants robust, prostrate, dull green to brown up to 35 mm, in dense tufts, branches erect, dense, small to larger in size. Leaves densely arranged on stem, erectopatent, lanceolate plicate at base, ± 3 x 0.6 mm in size apex acute, margin flat to revolute, crenulated due to bulging of upper marginal cells; costa strong, deep brown, reaching leaf apex to percurrent.

Key to the species of genus *Macromitrium* at PBR:

1. Leaf size larger, leaf margin may be revolute at places, costa reaching apex, leaf cells highly papillose …..... ***M. moorcroftii***
   Leaf size smaller, leaf margin flat, costa ending just behind tip, leaf cells less papillose ……..... ***M. sulcatum***

***Macromitrium moorcroftii* (Hooker & Gerv.) Schwägr.,** Sp. Musc. Suppl. 2 (2): 67. 1826.

Basyn: *Orthotrichum moorcroftii* Hook. & Gerv. in Edin. J.Sc., 1: 116. 1824**.**

(Plate 2: Figs. 1-8)

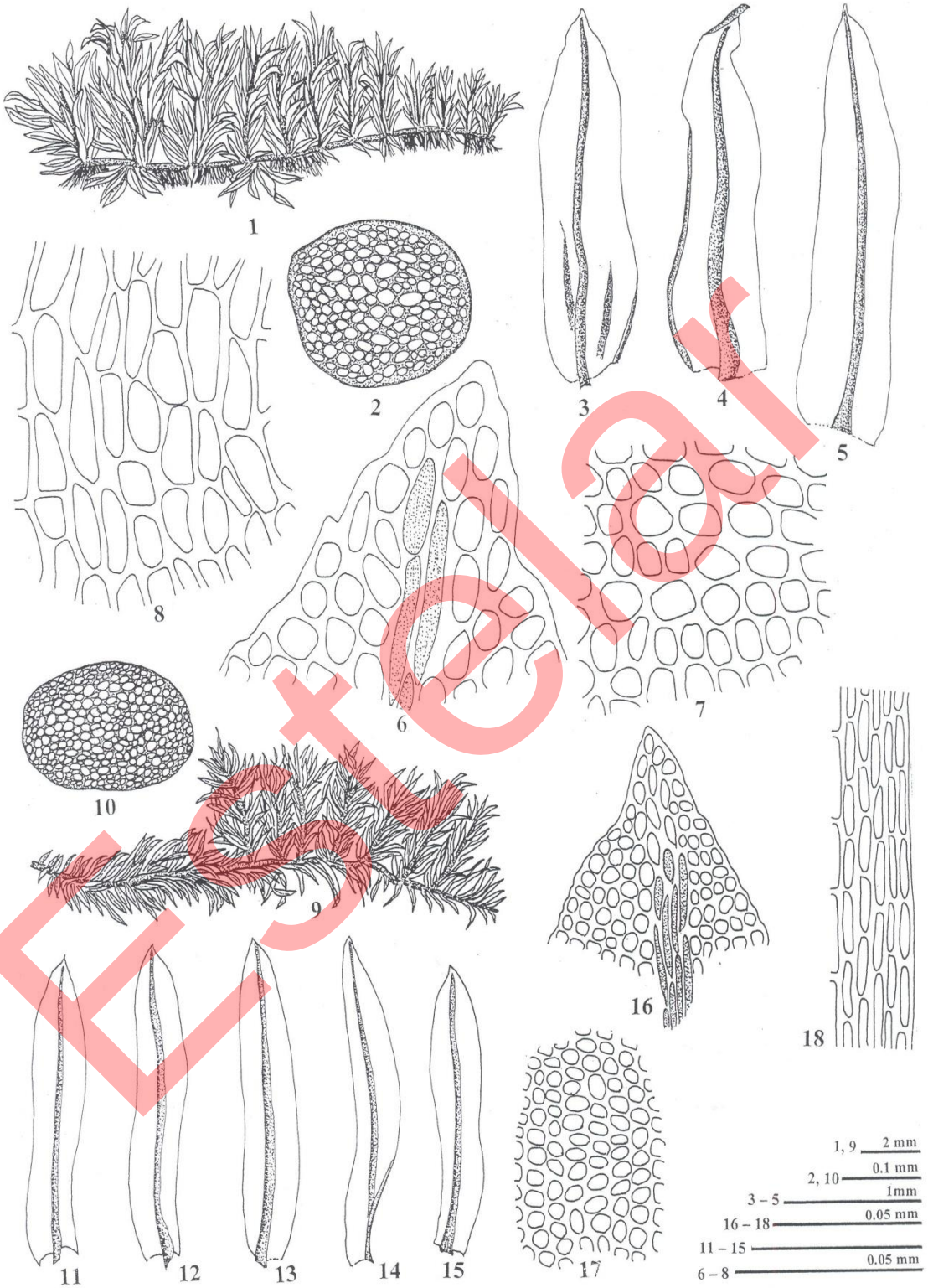
Plants robust, prostrate, dull green to brown up to 32 mm, in dense tufts, branches erect, dense, up to 10 mm in size. **Stem** creeping, circular in cross section, outer cortical cells smaller, graduating to larger inner medullary cells. **Leaves** erectopatent, lanceolate plicate at base, ± 3 x 0.6 mm in size apex acute, margin revolute at places, entire, crenulated due to bulging of upper marginal cells; **costa** strong, deep brown, reaching leaf apex. **Leaf cells** thick walled, papillose, apical leaf cells rounded – quadrate, ± 10 x 7.5 µm, middle leaf cells slightly elongated, ± 12 x 8 µm, basal cells elongated, rectangular, ± 26 x 9.5 µm, extreme marginal 2-3 rows of cells very narrow. Sporophyte not seen.

Ecology & Distribution: plants growing on rocks at Jalgali, 900 m.

Range of Distribution: China, India: central India (PBR), eastern Himalaya (Darjeeling, Khasia hills, Sikkim), South India (Shervaroy hills, Tiruneveli – Travaneore hills), western Himalaya (Kumaon), Myanmar, Nepal.

Specimens examined: India, Madhya Pradesh, PBR; Jalgali, alt. ca 900 m, on rocks, 16.12.1993, 205566 (LWG), leg. V. Nath & A.K. Asthana.

Plate-2



***Macromitrium moorcroftii* (Hook. & Grev.) Schwaegr.,** Figs. 1-8: 1. vegetative plant, 2. cross section of axis, 3-5. leaves, 6. apical leaf cells, 7. median leaf cells, 8. basal leaf cells; ***Macromitrium sulcatum* (Hooker) Bridel.** Figs. 9-18: 9. vegetative plant, 10. cross section of axis, 11-15. leaves, 16. apical leaf cells, 17. median leaf cells, 18. basal leaf cells.

***Macromitrium sulcatum* (Hooker) Bridel,** Bryol. Univ., 1: 319. 1826.

Basyn: *Schlotheimia sulcata* Hook., Musci Exet., 2: 156. 1819.

(Plate 2: Figs. 9-18)

Plants prostrate, dull green to brown, up to 30 mm in size, densely tufted, branches erect, up to 8 mm long. **Stem** oval in cross section, outer cortical cells smaller, inner cells slightly larger. **Leaves** densely arrange, erectopatent, lanceolate, ± 2 x 0.6 mm in size, apex acute to apiculate, margin entire, crenulated due to cell projections at apex; **costa** strong, brown, ending just below tip. **Leaf cells** thick walled, papillose, quadrate to sub-rounded, ± 8 µm in size, middle cells slightly elongated, ± 12 x 4 µm, basal cells rectangular 22 x 6.5 µm, border row of smooth rectangular row distinct, from base to 6 - 8 cell upwards. Sporophyte not seen.

Ecology & Distribution: plants growing on moist rock at Apsara Vihar, 920 m.

Range of Distribution: Borneo, Campuchea, India : central India (PBR), eastern Himalaya (Khasia hills, Arunachal Pradesh, Naga hills), South India (Bombay, Coorg, Eravikulum National Park, Nilgiri, Shevaroy hills, Tiruneveli Travancore hills, Madras), Malay Peninsula, Malaisia Malacca, Myanmar, Nepal, Philippines, Sri Lanka, Thailand, Vietnam.

Specimens examined: India, Madhya Pradesh, PBR Apsara Vihar, alt. ca 920 m, on wet rocks, 07.11.2011, 263148 (LWG), leg. A.K. Asthana & R. Gupta.

Family: Bryaceae Schwaeger

1. Plants smaller (up to 10 mm), with several subfloral innovations, leaves smaller (rearely reaching 2 mm), leaf cells rhomboidal, broader ……. ***Brchymenium***
   Plants variable in size (3-35 mm), with 0-3 subfloral innovations, leaves usually larger (up to 5 mm), leaf cells spindle shaped to rhomboidal, narrow ……. **2**
2. Plants slender, julaceous, with slender sub-floral innovations, leaves smaller, appressed to stem, costa ending much below leaf apex ……... ***Anomobryum***
   Plants broader, julaceous or non-julaceous, with robust sub-floral innovations, leaves larger, maybe appressed to stem or erectopatent, costa percurrent to excurrent ……..….. **3**
3. Plants smaller, julaceous to non-julaceous, costa weaker, percurrent to short excurrent ……..……..…. **4**
   Plants larger, non-julaceous, costa strong, always excurrent ..……..……. **5**

4. Plants branched, with much sub-floral innovations, leaves densely/ closely arranged on stem ……..…… ***Bryum***

   Plants rarely branched, with none or less sub-floral innovations, leaves loosely/distantly arranged on stem …… ***Gemmabryum***

5. Leaves arranged forming distinct terminal rosettes, less than 4 mm in size, bordered by 1-2 rows of slender cells ……..…….…… ***Rosulabryum***

   Leaves arranged uniformly or forming comal aggression, up to 4 mm or more in size, bordered by 2-4 rows of slender cells ..…..…..…… ***Ptychostomum***

Genus: *Brachymenium* Schwaegr

Plants erect, green, forming dense mats, stem short, 3-12 mm in size, erect, branched by 2-4 subfloral innovations, matted together at base. Leaves densely arranged on stem, erectopatent, ovate lanceolate to oblong – lanceolate dense size, acuminate, margin flat to recurved, entire, may be dentate at apex, leaf bordered or non bordered; costa shortly excurrentor ending in long arista.

Key to the species of genus *Brachymenium* at PBR:

1. Plants not much changed when dry, leaves bordered ……..…….…..…. **2**

   Plants contorted when dry, leaves not bordered ……..…….…….. **3**

2. Leaves appressed to stem, leaf margin flat ……..…….…….…... ***B. bryoides***

   Leaves erectopatent, leaf margin irregularly recurved ……..... ***B. sikkimense***

3. Plants smaller, (up to 6 mm), pale yellowish, leaves small, margin entire……..…….……...…….…….. ***B. acuminatum***

   Plants larger (up to 10 mm). glossy green, branched, leaves larger, margin dentate …..……..…….…….…… ***B. ptychothecium***

***Brachymenium bryoides* Hooker ex. Schwägr.**, Sp. Musc. Suppl. 2(1): 134. 1824.

(Plate 3: Figs. 1-12)

Plants green, forming dense mats, stem short, ± 3 mm, erect, branched by 2-3 subfloral innovations, matted together at base. **Stem** ovate-circular in cross section, irregularly sized cells without any distinction of cortical or medullary region. **Leaves** erectopatent, ovate lanceolate, dense, ± 0.85 x 0.185 mm in size, acuminate, margin flat, entire; **costa** excurrent in a short arista, ± 1.7 mm long. **Leaf cells** elongated,

Plate-3

***Brachymenium bryoides* Hooker ex Schwaeger.,** Figs. 1-10: 1,2. vegetative plants, 3. cross section of axis, 4-9. leaves, 10. apical leaf cells, 11. median leaf cells, 12. basal leaf cells; ***Brachymenium sikkimense* Renauld & Cardot.,** Figs. 13-23: 13-14. vegetative plants, 15. cross section of axis, 16-20. leaves, 21. apical leaf cells, 22. median leaf cells, 23. basal leaf cells.

rhomboidal ± 35 x 6.4 µm at apex, 37 x 6.4 µm at middle sub quadrate to rectangular at base, ± 32 x 7 µm, marginal row of cells narrower sporophyte not seen.

Ecology & Distribution: plants growing on dry rocks at Pandav Caves and Rajat Prapat, 988-1004 m.

Range of Distribution: Antarctica, Brazil, India: central India (PBR), eastern Himalaya (Darjeeling, Khasia hills), South India (Nilgiri, Sherveroy hills), western Himalaya (Almora, Simla), Papua New Guinea, Phillipines, Sri Lanka, Nepal.

Specimens examined: India, Madhya Pradesh, PBR: Pandav Caves, alt. ca 1004 m, on dry rocks, 07.11.2011, 263114 (LWG); near Rajat Prapat, alt. ca 988 m, on rocks, 07.11.2011, 263133A (LWG), leg. A.K. Asthana & R. Gupta.

***Brachymenium sikkimense* Renauld & Cardot**, Bull. Soc. R. Bot. Belg., 38(1): 12. 1900.

(Plate 3: Figs. 13-23)

Plants small, glossy green, densely tufted, stem erect, up to 4 mm long, branched by several (2-4) sub floral innovations, matted together by rhizoids at base. **Stem** broadly circular in cross section, uniformly medium sized cells without any demarcation of cortical and medullary regions. **Leaves** erectopatent, ovate – lanceolate, 0.82 x 0.38 mm in size, broad at base, acuminate, margin flat to recurved, entire; **costa** brown, strong, excurrent in an arista 0.18 mm in size. **Leaf cell** rhomboidal ± 28 x 6 µm at apex, ± 28.5 x 6 µm at middle, sub-rectangular to sub rectangular at base, ± 36 x 9.25 µm; marginal row of cells narrower, forming indistinct border. Sporophyte not seen.

Ecology & Distribution: plants growing at Pandav Caves, near Rajat Prapat and Pachmarhi Lake, on dry rocks from 988 – 1050 m.

Range of Distribution: India: central India (Gujarat, PBR), eastern Himalaya (Darjeeling).

Specimens examined: India, Madhya Pradesh, PBB: Pandav Caves, alt. ca 1004 m, 07.11.2011, on dry rocks, 263119 (LWG); near Rajat Prapat, alt. ca 988 m, 07.11.2011, on rocks, 263133B (LWG); Pachmarhi Lake, alt. ca 1050 m, 09.11.2011, on dry rocks, 264827A (LWG), leg. A.K. Asthana & R. Gupta.

***Brachymenium acuminatum* Harv. Hook.,** Icon. Pl. Rar, 1:19. 1836.

(Plate 4: Figs. 1-9)

Plants erect, terrestrial, pale to yellowish green plants in dense mats, up to 6 mm high, branched by several subfloral innovations, matted by tomenta. **Stem** circular in cross section, outer cells smaller, getting slightly larger towards centre, innermost cells again smaller. **Leaves** densely and uniformly arranged on stem, imbricate, erect, oblong – lanceolate up to 1.2 mm long and 0.42 mm wide, acuminate, margin entire; **costa** strong, excurrent in an arista ± 0.11 mm long. **Leaf cells** rhomboid, up to 75 × 12 µm at apex, gradually getting rectangular at base, 50 × 16 µm in size; marginal cells narrower but no distinct margin seen. Sporophyte not seen.

Ecology & Distribution: plants growing on soil and soil over rocks, at Jambu Dweep at 900 m.

Range of Distribution: Argentina, Australia, Bolivia, Botswana, Chile, China, Cong, India : central India (PBR), eastern Himalaya (Darjeeling, Sikkim), South India, Lesotho, Madagascar, Malawi, Mauritius, Mexico, Myanmar, Namibia, Nepal, Nicaragua, Peru, Philippines, Reunion, South Africa, Swaziland, Zimbabwe.

Specimens examined: India, Madhya Pradesh, PBR: Jambu Dweep, alt. ca 900 m, 17.12.1993, 205598 (LWG); growing on soil, 205599 (LWG); growing on soil over rock, leg. V. Nath & A.K. Asthana.

***Brachymenium ptychothecium* (Besch.) Ochi.** Adv. Front. Pl. Sc., 4: 108. 1963.

(Plate 4: Figs. 10-19)

Plants, erect, terrestrial, tufted, glossy, green, reddish at base, up to 10 mm high, with subfloral innovations. **Stem** oval in cross section, outer cortical cells smaller, inner cells larger. **Leaves** distantly arranged on the stem, erectopatent, curled when dry, oblong – spathulate, bordered and apiculate, ± 1.93 mm long and ± 65 mm broad at middle, margin entire below, slightly dentate at apex, usually revolute from base to mid leaf; **costa** strong, deep brownish, excurrent in a slightly denticulate arista, ± 0.27 mm in size. **Leaf cells** rhomboid to hexagonal at apex, ± 37.5 µm long and ± 17.7 µm wide; basal cells sub rectangular, ± 41.7 × 19.8 µm; marginal cells elongated, narrow, forming a border of 2 – 3 rows. Sporophyte not seen.

Ecology & Distribution: plants growing on moist rocks, at Down Fall at 900m.

Plate-4

***Brachymenium acuminatum* Harv.,** Figs. 1-9: 1,2. vegetative plants, 3. cross section of axis, 4-6. leaves, 7. apical leaf cells, 8. middle leaf cells, 9. basal leaf cells. ***Brachymenium ptychothecium* (Besch.) Ochi.,** Figs. 10-19: 10,11. vegetative plants, 12. cross section of axis, 13-16. leaves, 17. apical leaf cells, 18. middle leaf cells, 19. basal leaf cells.

Range of Distribution: China, central India (PBR), eastern Himalaya (Darjeeling, Sikkim).

Specimens examined: India, Madhya Pradesh, PBR: Down Fall, alt. ca 884m, 28.11.2006, 227601; growing on moist rock (LWG), leg. V. Sahu & V. Awasthi.

Genus: *Anomobryum* Schimp.

Plants erect, julaceous, tufted, yellowish to dull green, bounded by rhizoids at base, up to 15 mm long, branched by 2 - 4 subfloral innovations. Leaves densely arranged, closely appressed to the stem, ovate – elliptical with apiculate to blunt rounded tip; costa pale to light coloured, ending much below the leaf apex.

***Anomobryum auratum* (Mitt.) A. Jaeger,** Ber. Thätigk. St. Gallischen Naturwiss. Ges., 1873 – 74: 142. 1875.

(Plate 5: Figs. 1-9)

Plants erect, terrestrial, julaceous, tufted, yellowish green, bounded by rhizoids at base, up to 1.2 cm long, branched by 2 to 3 subfloral innovations. **Stem** oval in cross section, cortical and medullary cells undifferentiated, uniform. **Leaves** densely arranged, closely appressed to the stem, ovate – elliptical with obtusely apiculate to rounded tip ± 1.2 × 0.6 mm in size; **costa** pale, ending much below the leaf apex. **Leaf cells** thick walled, linear up to 48 × 6 µm at apex; basal cells rhomboidal to sub-rectangular up to 40 × 16 µm. Sporophyte not seen.

Ecology & Distribution: plants growing on soil and rocks in thick patches on way to Dhoopgarh, Pandav Caves and Pachmarhi Lake from 820-1056 m.

Range of Distribution: Australia, Bhutan, China, India: central India (PBR), eastern Himalaya (Darjeeling, Sikkim, Khasi & Jaintia Hills, Naga Hills), South India (Mahabaleshwar, Nilgiri, Palni), western Himalaya (Kashmir, Musoorie, Ranikhet), Japan, Korea, Keneya, Medagascar, Nepal, Papua New Guinea, Philippines, Thailand, United Republic of Tanzania.

Specimens examined: India, Madhya Pradesh, Pachmarhi: on way to Dhoopgarh, alt. ca 1056 m, growing on soil, 16.12.1993, 205556 (LWG), leg. V. Nath & A.K. Asthana; Pandav Caves, alt. ca 820 m, growing on rock, 01.12.2006, 227685C (LWG), leg. V. Sahu & V. Awasthi; Pachmarhi Lake, alt. ca 1050 m, on rocks, 09.11.2011, 264825 (LWG), leg. A.K. Asthana & R. Gupta.

Genus: *Bryum* Hedw.

Plants erect, small to robust, dull to pale green, silvery white in colour, loosely tufted, sometimes with short julaceous branches, be up to 15 mm in height. **Leaves** densely and uniformly arranged on stem to smaller and distant below, dense at apex, ovate, concave, acuminate. costa percurrent to excurrent in short arista, may be slightly dentate at tip.

Key to the species of genus *Bryum* at PBR:

1. Pants with julaceous branches, silvery white in colour, leaves very densely arranged ..... ***B. argenteum***
   Plants non- julaceous branches, green to brownish in colour, leaves less densely arranged **2**
2. Stem in cross section with uniformely large cells, leaves larger (±4.4×1.5 mm), margin much revolute ..... ***B. reflexifolium***
   Stem in cross section with smaller cortical and larger medullary cells, leaves smaller (±2.6×0.92 mm), margin less revolute ..... ***B. porphyroneuron* var. *erythrinum***

***Bryum argenteum* Hedw.** Sp Musc.: 181, 1801.

(Plate 6: Figs. 1-9)

Plants erect, terrestrial, small, tufted, short with subfloral julaceous branches which may be up to 15 mm in height, silvery white in colour. **Stem** circular in cross section, cells larger towards periphery, getting smaller towards centre. **Leaves** densely and uniformly arranged on stem, ovate, concave, acuminate. Leaf size 0.8 to 1.1 × ± 0.4 mm, entire; **costa** percurrent in some leaves, in others ending in a hyaline arista. **Leaf cells** rhomboidal above, ± 54 × 12 µm and rectangular up to 40 × 12 µm at base. Sporophyte not seen.

Ecology and Distribution: plants growing on rocks and soil near Pandav Caves and Pachmarhi Lake from 820 – 1050 m.

Range of Distribution: Antarctica, Argentina, Australia, Austria, Bolivia, Botswana, Brazil, Cameroon, Canada, Caribbean, Chile, China, Colombia, Comoros, Congo, Costa Rica, Cuba, Czech Republic, Denmark, Dominica, Dominican Republic, Ecuador, Egypt, Estonia, Ethiopia, Falkland Islands, Finland, France, Germany,

Plate-5

***Anomobryum auratum* (Mitt.) Jaeg.,** Figs. 1-9: 1. vegetative plant, 2. cross section of axis, 3-6. leaves, 7. apical leaf cells, 8. middle leaf cells, 9. basal leaf cells.

Plate-6

***Bryum argenteum* Hedw.,** Figs. 1-9: 1,2. vegetative plants, 3. cross section of axis, 4-6. leaves, 7. apical leaf cells, 8. middle leaf cells, 9. basal leaf cells. ***Gemmabryum caespiticium* (Hedw.) J.R. Spence,** Figs. 10-19: 10,11. vegetative plants, 12. cross section of axis, 13-16. leaves, 17. apical leaf cells, 18. middle leaf cells, 19. basal leaf cells.

Gibraltar, Greenland, Guatemala, Hawaian Islands, Honduras, Iceland, India: central India (Orissa, PBR), eastern Himalaya (Arunachal Pradesh, Darjeeling, Khasi Hills, Shillong, Sikkim), Gangetic plains, Rajasthan & Punjab plains, South India (western Ghats, Nilgiri, Palni), western Himalaya (Kashmir), Indonesia, Iraq, Ireland, Israel, Italy, Jamaica, Japan, Kazakhstan, Kenya, Korea, Lesoth, Madagascar, Malawi, Malaysia, Mali, Martinique, Mexico, Mongolia, Morocco, Namibia, Nepal, Netherlands, New Zealand, Nicaragua, Niger, Nigeria, Norfolk Island, Norway, Pakistan, Panama, Papua New Guinea, Peru, Philippines, Poland, Reunion, Russia, Rwanda, Saint Kitts and Nevis, Sao Tome and Principe, Serbia and Montenegro, South Africa, South Georgia and the South Sandwich Islands, Siberia, Spain, Sri Lanka, Suriname, Swaziland, Sweden, Switzerland, Taiwan, Tanzania, Thailand, Turkey, Turks and Caicos Islands, Uganda, United Kingdom, United States, Venezuela, Vietnam, Zimbabwe.

Specimens examined: India, Madhya Pradesh, PBR: near Pandav Caves, alt. ca 820 m, growing on soil, 01.12.2006, 227688A (LWG), leg. V. Sahu & V. Awasthi; Pachmarhi Lake, alt. ca 1050 m, on rocks (exposed), 09.11.2011, 264829A (LWG), leg. A.K. Asthana & R. Gupta.

***Bryum reflexifolium* (Ochi) Ochi,** Bull. Univ. Mus., Univ. Tokyo, 8: 261. 1975.

Syn: *Bryum paradoxum* var. *reflexifolium* (Ochi) Ochi, Hikobia, 5: 158. 1969.

(Plate 7: Figs. 1-8)

Plants terrestrial, tufted, matted with radicles below, green, with subfloral innovations, about 10 mm high. **Stem** ovato-circular in cross section, cells uniform, large. **Leaves** loosely arranged on stem, smaller and distant below, larger and closer above; erectopatent, oblong – lanceolate, acuminate, ± 4.4 mm long and ± 1.5 mm wide, margin usually revolute all along, entire except showing mild denticulations at tip; **costa** strong, excurrent in an arista, up to 0.16 mm long. **Leaf cells** thin walled; rhomboid to hexagonal at apex up to 69 × 17 µm in size, becoming narrower at margin, forming indistinct border; basal cells rectangular, 92 × 28 µm in size. Sporophyte not seen.

Ecology & Distribution: plants growing on wet rocks on way to Bee fall at 820 m.

Range of Distribution: Argentina, Australia, Austria, Bolivia, Canada, Chile, China, Colombia, Congo, Cyprus, Czech Republic, Denmark, Ecuador, Estonia, Finland,

France, Germany, Greece, Greenland, Hungary, Iceland, India: central India (PBR), eastern Himalaya (Darjeeling, Sikkim), South India (Goa), Ireland, Italy, Japan, Kazakhstan, Lesotho, Mali, Mexico, Morocco, Nepal, Netherlands, Norway, Peru, Poland, Portugal, Rwanda, Saint Kitts and Nevis, Serbia and Montenegro, Slovakia, South Africa, Spain, Sweden, Switzerland, Taiwan, Tanzania, Turkey, United Kingdom, United States, Venezuela.

Specimens examined: India, Madhya Pradesh, PBR: on way to Bee Fall, alt. ca 820 m, growing on wet rocks, 30.11.2006, 227666B (LWG), leg. V. Sahu & V. Awasthi.

***Bryum porphyroneuron* var. *erythrinum* (Mitt.) Fleisch.,** Broth., Nat. Pfl., 1(3): 590. 1904.

(Plate 8: Figs. 1-10)

Plants erect, dull green brownish red below, loosely tufted, slender, up to 12 mm in length, flexuose, sometimes with subfloral innovations. **Stem** sub-triangular in cross section, outer cortical cells smaller, inner medullary cells larger followed by very small inner-most cells. **Leaves** smaller below, bigger above forming comal aggression, erectopatent, lanceolate to ovate- lanceolate, ± 2.6 x 0.92 mm in size, margin revolute, entire with slight denticulations at tip; **costa** stout, reddish – brown, excurrent, arista ± 0.30 µm, denticulations at tip. **Leaf cells** rhomboidal, ± 56 x 8.25 µm at apex, ± 58 x 8.5 µm at middle, subrectangular at base, ± 49 x 13.5 µm, 1-2 marginal row of cells elongated, narrow forming an indistinct border. Sporophyte not seen.

Ecology & Distribution: plants growing on soil at Pachmarhi Lake, 1050 m.

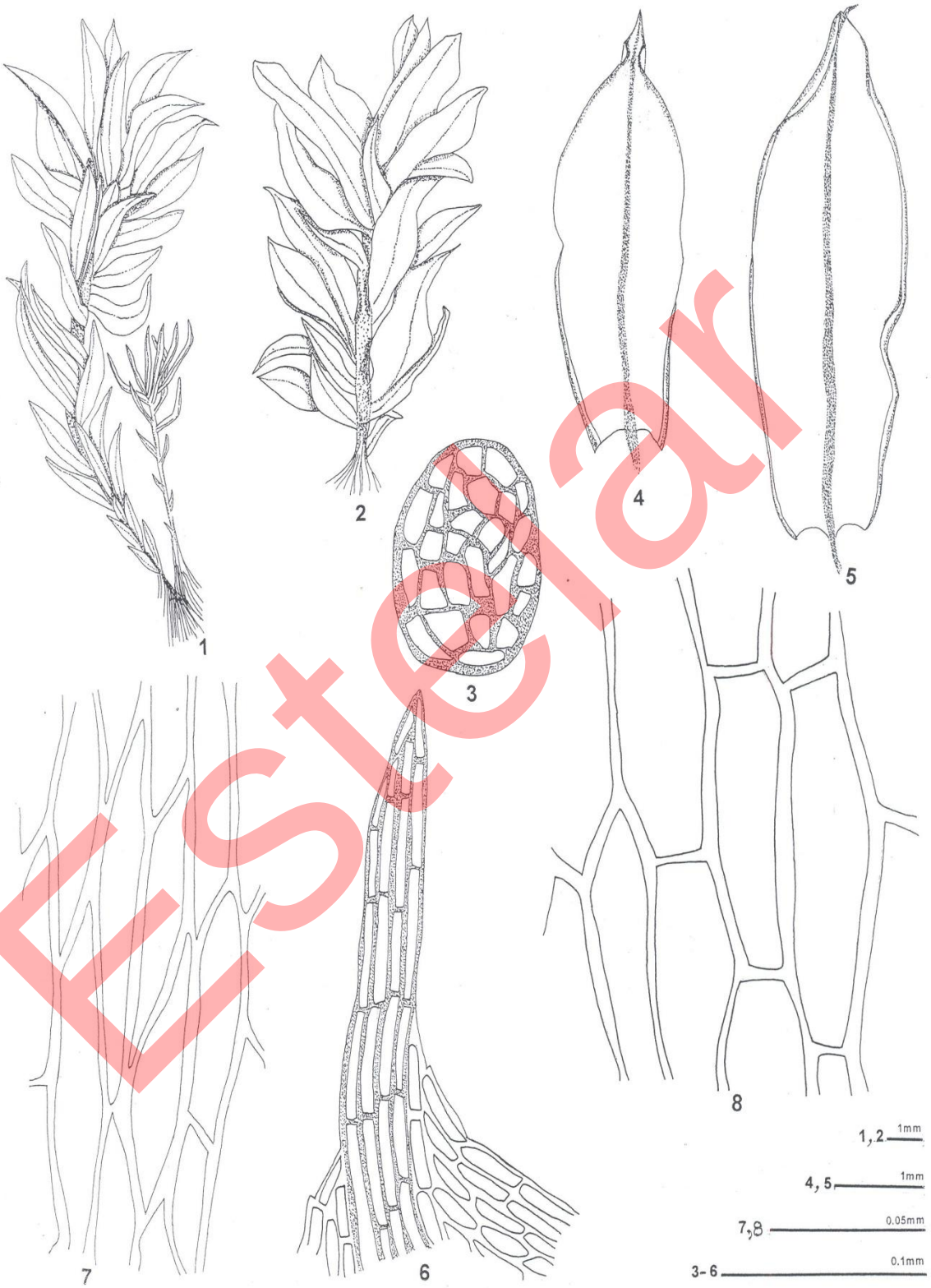
Range of Distribution: India: central India (PBR), eastern Himalaya (Khasia Hills, Sikkim), South India (Coorg, Nilgiri), western Himalaya (Garhwal), Java, Sri Lanka, Sumatra.

Specimens examined: India, Madhya Pradesh, PBR: Pachmarhi Lake, alt. ca 1050 m, on soil 09.11.2011, 264824 (LWG), leg. A.K. Asthana & R. Gupta.

Genus: *Gemmabryum* J.R. Spence & H. P. Ramsay

Plants erect, tufted, yellowish-dull green, up to 5- 15 mm in size, 5-12 mm long, 2-3 subfloral innovations or rarely branched. Leaves smaller at base, dense, larger above ovate to lanceolate, shortly acuminate, up to 3 x 0.38 mm in size, margin flat,

Plate-7



***Bryum reflexifolium* (Ochi) Ochi.,** Figs. 1-8: 1,2. vegetative plants, 3. cross section of axis, 4,5. leaves, 6. apical leaf cells, 7. middle leaf cells, 8. basal leaf cells.

Plate-8

***Bryum porphyroneuron* var. *erythrinum* (Mitt.) Fleisch.,** Figs. 1-10: 1. vegetative plant, 2. cross section of axis, 3-7. leaves, 8. apical leaf cells, 9. median leaf cells, 10. basal leaf cells; ***Gemmabryum apiculatum* (Schwägr.) J.R. Spence & H.P. Ramsay** Figs. 11-20: 11. vegetative plant, 12. cross section of axis, 13-17. leaves, 18. apical leaf cells, 19. median leaf cells, 20. basal leaf cells.

entire, very slight crenulations at tip border undifferentiated to defined by slightly narrower cells; costa strong, excurrent in short arista.

Key to the species of genus *Gemmabryum* at PBR:

1. Plants yellowish-green, with 2-3 sub-floral innovations, costa very short, excurrent, leaves larger (±3×0.38 mm) ……..…….. ***G. apiculatum***

Plants dull green with rare sub-floral innovations, leaves smaller (± 2 ×0.5 mm), costa excurrent in arista ….....……..……. **2**

2. Plants smaller, up to 7 mm, leaves distantly arranged on stem, leaf margin revolute, marginal leaf cells narrow, forming inconspicuous border ……..……..……..……..……..…… ***G. ceaspiticium***

Plants larger, up to 15 mm, leaves densely arranged on stem, leaf margin flat, marginal leaf cells not differentiated, to form border ……..……..…***G. coronatum***

***Gemmabryum apiculatum* (Schwäg.) J. R. Spence & H. P. Ramsay**, Phytologia 87: 65. 2005.

Syn: *Bryum plumosum* Dozy. et Molk., Ann Sc. Nat. Bot. Ser. 3, 3(2): 301. 1844.

(Plate 8: Figs. 11-20)

Plants erect, tufted, yellowish-dull green, 5-12 mm long, 2-3 subfloral innovations or rarely branched. **Stem** circular in cross section, outer cortical cells smaller, inner medullary cells larger, inner most cells smaller, thick walled. **Leaves** smaller at base, dense, larger above lanceolate, shortly acuminate, up to 3 x 0.38 mm in size, margin flat, entire, very slight crenulations at tip border undifferentiated; **costa** excurrent in short arista. **Leaf cells** thin walled, rhomboidal, ± 72 x 10 µm at tip, broader towards middle, ± 65 x 13.5 µm, basal cells rectangular to quadrate, ± 55 x 18.5 µm in size. Sporophyte not seen.

Ecology & Distribution: plants growing on rocks and stony wall at Twynam Pool and near Rajat Prapat, 850-3261 m.

Range of Distribution: China, India: central India (PBR, Rajasthan), eastern Himalaya (Assam), Gangetic plains (Chhota Nagpur, Howrah, Kolkata, Odisha), South India (Tamil Nadu, Wayanad), western Himalaya (Kumaon, Mussoorie).

Specimens examined: India, Madhya Pradesh, PBR: Twynam Pool, alt. ca 853 m, on stony wall, 29.11.2006, 227622 (LWG), leg. V. Sahu & V. Awasthi; near Rajat Prapat, alt. ca 957 m, on rocks, 07.11.20011, 263133A (LWG), leg. A.K. Asthana & R. Gupta.

***Gemmabryum caespiticium* (Hedw.) J.R. Spence,** Phytologia 91(3): 497. 2009.

Syn: *Bryum caespiticium* L. ex Hedw. Sp. Musc.: 180. 1801.

(Plate 6: Figs. 10-19)

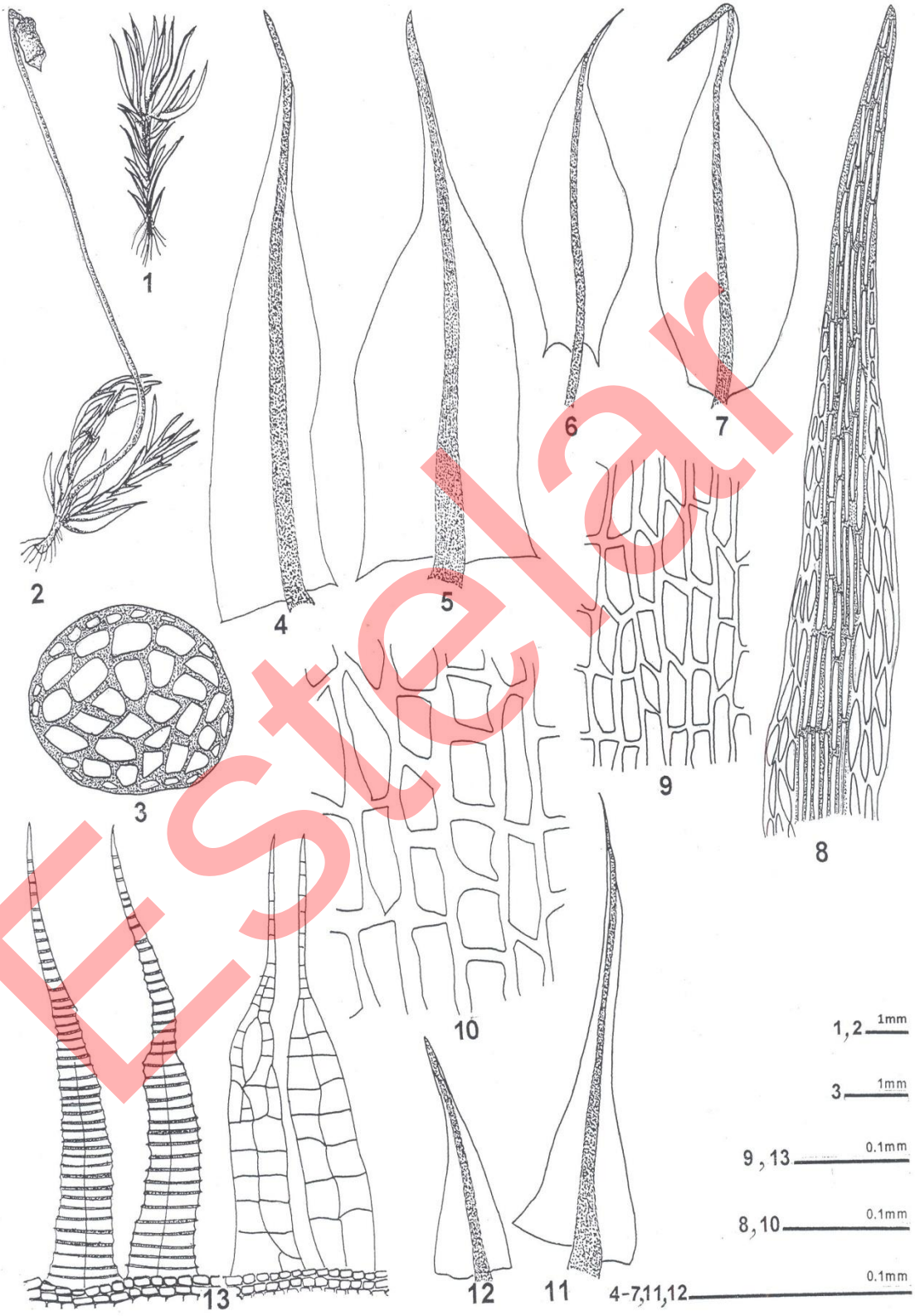
Plants erect, terrestrial, dull green, up to 7 mm long with subfloral innovations. **Stem** circular in cross section, cortical cells smaller, thick walled, medullary cells larger. **Leaves** distantly arranged on stem, small, forming comal tufts only on main shoots, erect to erectopatent, acuminate up to 1.5 mm long and 0.42 mm broad, margin revolute all along the length, entire; **costa** excurrent in arista up to 0.18 mm long. **Leaf cells** rhomboidal, up to 52 ×12.5 µm at apex, becoming sub – rectangular at base, up to 75 µm long and 20.8 µm broad, marginal cells narrower and longer but generally distinct border not seen. Sporophyte not seen.

Ecology and Distribution: plants growing on rocks and on soil covered rocks on way to Chota Mahadev and on way to Bee Fall at 854 – 941 m.

Range of Distribution: Andora, Angola, Antarctica, Antigua, Argentina , Australia, Austria, Belgium, Belize, Bhutan, Bolivia, Brazil, Burkino Faso, Canada, Chile, China, Colombia, Congo, Costa Rica, Cuba, Cyprus, Czech Republic, Denmark, Dominica, Dominican Republic, Ecuador, Egypt, Estonia, Falkland Islands, Finland, France, Germany, Gibraltar, Greece, Greenland, Guatemala, Hawain Islands, Hungary, Iceland, India: central India (PBR), eastern Himalaya (Khasi hills), South India (Goa), western Himalaya (Chakrata, Kashmir, Mussoorie, Nainital, Simla), Iran, Iraq, Ireland, Israel, Italy, Japan, Jordan, Kazakhstan, Korea, Lesotho, Luxembourg, Mali, Mexico, Mongolia, Morocco, Netherlands, New Zealand, Norway, Pakistan, Papua New Guinea, Peru, Poland, Portugal, Russia, Rwanda, Saint Kitts and Nevi, Serbia and Montenegro, South Africa, Spain, Sweden, Switzerland, Taiwan, Thailand, Tunisia, Tonga, Turkey, United Kingdom, United States, Venezuela, Wallis and Futuna Islands.

Specimens examined: India, Madhya Pradesh, PBR: on way to Chota Mahadev, alt. ca 854 m, growing on soil covered rock, 29.11.2006, 227628B (LWG), leg. V. Sahu & V. Awasthi; on way to Bee Fall, alt. ca 941 m, on rocks, 08.11.2011, 263190A, 263196B (LWG), leg. A.K. Asthana & R. Gupta.

Plate-9



Gemmabryum coronatum **(Schwägr.) J.R. Spence & H.P. Ramsay,** Figs. 1-13: 1. vegetative plant, 2. plant with sporophyte, 3. cross section of axis, 4-7. leaves, 8. apical leaf cells, 9. middle leaf cells, 10. basal leaf cells, 11,12. perichaetial leaves, 13. peristome showing exostome and endostome teeth.

This species was until recently cited as *Bryum caespiticium* by workers. However, Spence (2009) has assigned a new generic name *Gemmabryum* for this species, and same has been used in the present work.

***Gemmabryum coronatum* (Schwägr.) J.R.Spence & H.P. Ramsay,** Phytologia 87: 66. 2005.

Basnym: *Bryum coronatum* Schweagr. Suppl. 1(2): 103. 1816.

(Plate 9: Figs. 1-13)

Plants terrestrial, tufted, slender, bright to dull green, tomentose at base, up to 15 mm high, usually branched. **Stem** circular in cross section, outer cells smaller, larger towards centre. **Leaves** arranged densely on stem, lower leaves smaller, upper ones larger; oblong – ovate, acuminate, ± 2 mm long and 0.5 mm wide, margin entire, flat, **costa** reddish at base, excurrent in a arista which shows mild dentitions. **Upper leaf cells** thin walled, narrow, rhomboid, ± 48 × 6.5 µm; basal cells shorter, rectangular, ± 40×16 µm, border cells not differentiated. **Perichaetial leaves** shorter, triangular; seta apical, erect, curved at tip, reddish brown, up to 28 mm long; **capsule** pendulous, thick, ± 2.5 mm long and 1 mm in diameter, capsule mouth wide; **peristome** reddish, outer teeth broad with sharp, hyaline, papillose tips, endostome transparent – yellowish, as high as exostome, with 2 – 3 appendiculate cilia. Spores not seen.

Ecology & Distribution: plants growing on soil and on rocks, near and at Pandav Caves and on way to Irene Pool at 820-1015 m.

Range of Distribution: Antarctica, Argentina, Australia, Austria, Bahamas, Belize, Bolivia, Bouvet Island, Brazil, Cameroon, Canada, Chile, China, Cocos (Keeling) Islands, Colombia, Congo, Costa Rica, Cuba, Cyprus, Czech Republic Dominican Republic, Ecuador, Finland, France, French Guiana, French Polynesia, French Southern Territories, German, Guyana, Greece, Greenland, Guyana, Haiti, Iceland, India: Andaman & Nicobar Islands, central India (Orissa, PBR), Gangetic plains, eastern Himalaya (Burdwan, Darjeeling, Kolkata, Midnapore), Punjab & Rajasthan plains, South India, western Himalaya, Indonesia, Ireland, Italy, Jamaica, Japan, Java, Kazakhstan, Malaysia, Mexico, Morocco, Myanmar, Nepal, Netherlands, New Caledonia, New Zealand, Norway, Panama, Paraguay, Papua New Guinea, Peru, Philippines, Poland, Singapore, Soloman Islands, Spain, Suriname, Sweden,

Switzerland, Taiwan, Tanzania, Thailand, Turkey, United Kingdom, United States, Venezuela, Vietnam.

Specimens examined: India, Madhya Pradesh, PBR: near Pandav Caves, alt. ca 820 m, growing on soil, 01.12.2006, 227688B (LWG); on Pandav Caves, alt. ca 820 m, growing on rock, 01.12.2006, 227681C, 227684 (LWG), leg. V. Sahu & V. Awasthi; on way to Irene pool, alt. ca 1015 m, on rocks 08.11.2011, 264806 (LWG), leg. A.K. Asthana & R. Gupta.

This species was commonly cited as *Bryum coronatum* by workers. However, Spence and Ramsay (2005) have assigned a new generic name *Gemmabryum* for this species, and same has been used in the present work.

Genus: *Rosulabryum* J. R. Spence

Plants erect, densely to loosely tufted, deep green above, brown to reddish below, generally branched up to 12 long mm. **Stem** ovato-circular in cross section, outer 2-3 row of cells smaller, inner medullary cells larger, central cells again slightly smaller. **Leaves** arranged on stem laxly below, densely above in comal tufts; erectopatent, ovate, acuminate, up to 4.25 mm long and 1.8 mm wide; margin entire with fine dentitions at tip, costa stout, excurrent in an arista up to 1.9 mm long. **Leaf cells** thin walled; rhomboid – hexagonal up to 60.5 × 11.5 µm at top, rectangular up to 67 × 21 µm at base, marginal leaf cells narrow, elongated forming border.

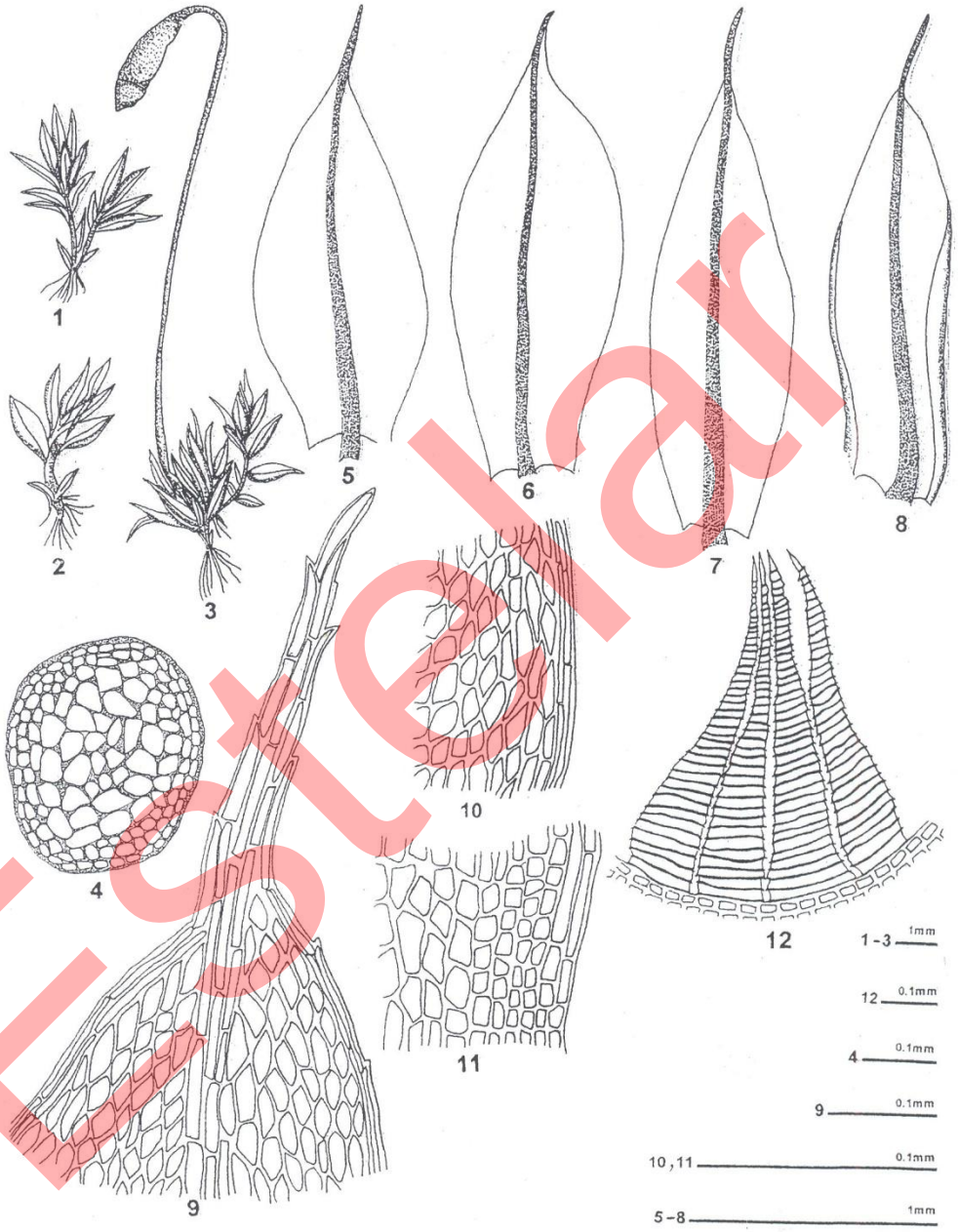
***Rosulabryum capillare* (Hedw.) J.R. Spence,** Bryologist: 99(2): 223. 1996.

Basnym: *Bryum capillare* L. ex Hedw. Sp. Musc.: 182. 1801.

(Plate 10: Figs. 1-12)

Plants erect, terrestrial, densely tufted, deep green above, reddish below, generally branched up to 12 long mm. **Stem** ovato-circular in cross section, outer 2-3 row of cells smaller, inner medullary cells larger, central cells again slightly smaller. **Leaves** arranged on stem laxly below, densely above in comal tufts; erectopatent, ovate, acuminate, up to 4.25 mm long and 1.8 mm wide; margin entire with fine dentitions at tip, costa stout, excurrent in an arista up to 1.9 mm long. **Leaf cells** thin walled; rhomboid – hexagonal up to 60.5 × 11.5 µm at top, rectangular up to 67 × 21 µm at base, marginal leaf cells narrow, elongated forming border. **Seta** apical, erect but curved at tip, up to 2.5 cm long, deep red in colour; capsule horizontal, ovate,

Plate-10



***Rosulabryum capillare* (Hedw.) J.R. Spence.,** Figs. 1-12: 1,2. vegetative plants, 3. plant with sporophyte, 4. cross section of axis, 5-8. leaves, 9. apical leaf cells, 10. middle leaf cells, 11. basal leaf cells, 11. Peristome teeth.

cylindrical, with a wide mouth, ± 3 mm long and 1 mm in diameter; **peristome** normal; outer teeth reddish at base, paler at tips, endostome hyaline with segments as high as outer teeth.

Peristome under SEM: surface of peristome teeth minutely papillate with plate like cell arrangement. Spores under SEM spherical, sporoderm exhibits stout and blunt projections densely studded all over. These projections are minutely tuberculated.

Ecology & Distribution: plants growing on soil covered rocks and on wet rocks Down Fall, Jalgali, Little Fall, near Jambu Dweep, on way to Rajat Prapat, Panchali Kund, on way to Bee Fall from 790 – 1056 m.

Range of Distribution: Afghanistan Algeria, Andorra, Argentina, Australia, Austria, Bahamas, Belgium, Belize, Bhutan, Bolivia, Bermuda, Botswana, Brazil, Canada, Chile, China, Colombia, Costa Rica, Cuba, Cyprus, Denmark, Dominica, Dominican Republic, Ecuador, Egypt, Estonia, Falkland Islands, Finland, France, French Guiana, Georgia, Germany, Greece, Greenland, Guatemala, Haiti, Honduras, Hungary, Iceland, India: central India (AABR, PBR), eastern Himalaya (Darjeeling, Sikkim), South India (Nilgiri), western Himalaya (Kashmir), Ireland, Israel, Italy, Jamaica, Japan, Kazakhstan, Korea, Lesotho, Luxembourg, Malawi, Mexico, Morocco, Mozambique, Namibia, Nepal, Netherlands, New Zealand Nicaragua, Norway, Papua New Guinea, Peru, Poland, Portugal Puerto Rico, Reunion, Saint Kitts & Nevis, Serbia and Montenegro, Slovakia, South Africa, Spain, Swaziland, Sweden, Switzerland, Taiwan, Thailand, Tibet, Turkey, United Kingdom, United States, Vietnam, Zimabawe.

Specimens examined: India, Madhya Pradesh, PBR: Down Fall, alt. ca 1056 m, growing on soil covered rock, 15.12.1993, 205546 (LWG); Jalgali, alt. ca 900 m, 16.12.1993, growing on soil covered rock, 205577 (LWG), leg. V. Nath & A.K. Asthana; Little Fall, alt. ca 884 m, on wet rock, 28.11.2006, 229392 (LWG); near Jambu Dweep, alt. ca 790 m, growing on rock, 29.11.2006, 227646, 227655A (LWG), leg. V. Sahu & V. Awasthi; on way to Rajat Prapat, alt. ca 988m, epiphytic, 07.11.2011, 263128; Panchali Kund, alt. ca 938 m, on rocks, 07.11.2011, 263151B (LWG); on way to Bee Fall, alt. ca 976 m, 08.11.2011, 263194 (LWG), leg. A.K. Asthana & R. Gupta.

B. capillare has long been used as a valid name to describe this species, however, Spence (1996) has revised the status of the plant, giving it a new status under the genus *Rosulabryum*. This synonymy has been followed.

Genus: *Ptychostomum* Hornsch.

Plants erect, loosely to densely tufted, dull brownish to deep green, medium to tall, with1-2 sub subfloral innovations. Leaves medium to large, distant below, clustered at apex forming comal tuft, erectopatent, oblong lanceolate, narrower towards base, acuminate, up to 4 x 0.70 mm in size, boardered by 2-3 rows of cells, margin entire, irregularly revolute, mildly dentate at tip; costa dull brown, excurrent in arista.

Key to the species of genus *Ptychostomum* at PBR:

1. Plants smaller, (± 4 mm), leaves narrowly lanceolate, leaf margin irregularly revolute ..... ***P. cernum***

   Plants larger, (± 35 mm), leaves broadly lanceolate, leaf border strongly revolute ..... ***P. pseudotriquetrm***

***Ptychostomum cernuum* (Hedw.) Hornsch.** Syll. Pl. Nov. 1(3): 64. 1824. [1822].

Basnym: *Cladodium uliginosum* Bridel, Bryol Univ., 1: 841. 1827.

Syn: *Bryum uliginosum* (Bridel) B.S.G., Bryol. Eur., 4: 88. 1839.

(Plate 11: Figs. 1-12)

Plants erect, loosely to densely tufted, dull brownish to deep green, ± 4 mm with1-2 sub floral innovations. **Stem** ovato-circular in cross section, outer cortical cells smaller, inner medullary cells larger, innermost patch of cells smaller, thick walled. **Leaves** smaller below, clustered at apex forming comal tuft, erectopatent, oblong lanceolate, narrower towards base, acuminate, up to 4 x 0.62 mm in size, boardered by 2-3 rows of cells, margin entire, flat to irregularly revolute, mildly dentate at tip; **costa** dull brown, excurrent in arista ± 0.21 mm. **Leaf cells** thin walled, rhomboidal to elongate at apex ± 67 x 7.5 µm at apex, ± 65 x 7.5 at middle, basal cells rectangular to rhomboidal ± 54 x 8.1 µm. **Seta** apical ± 25 mm long; **capsule** horizontal to slightly pendulous, deep brown, oval with incurved lower base, ± 3.8 x 1.8 mm in size; **peristome** pale yellow, ± 540 µm in size, exostome and endostome of equal height endostome hyaline; **spores** dull yellowish, 22-30 µm in diameter.

Ecology & Distribution: plants growing as epiphytes on way to Dhoopgarh, 1096 m.

Range of Distribution: Antarctica, Argentina, Austria, Canada, Chile, China, Denmark, Ethiopia, Estonia, France, Germany, Greenland, Iceland, India: central India (PBR), eastern Himalaya (Sikkim, Manipur), western Himalaya (Kashmir), Ireland,

Plate-11

Ptychostomum cernuum **(Hedw.) Hornsch.,** Figs. 1-12: 1. Plant with sporophyte, 2. cross section of axis, 3-6. leaves, 7. apical leaf cells, 8. median leaf cells, 9. basal leaf cells, 10. capsule, 11. Peristome, 12. Spores; ***Ptychostomum pseudotriquetrum*** **(Hedw.) J.R. Spence & H.P. Ramsay.,** Figs. 13-21: 13. vegetative plant, 14. cross section of axis, 15-18. leaves, 19. apical leaf cells, 20. median leaf cells, 21. basal leaf cells.

Kazakhstan, Mexico, Mongolia, Netherlands, New Zealand, Norway, Poland, Russia, Sweden, Switzerland, United Kingdom, United States.

Specimens Examined: India, Madhya Pradesh, PBR: on way to Dhoopgarh, alt. ca 1096 m, epiphytic, 07.11.2011, 263178 (LWG), leg. A.K. Asthana & R. Gupta.

***Ptychostomum pseudotriquetrum* (Hedw.) J. R. Spence & H. P. Ramsay, Phytologia 87: 23. 2005.**

Syn: *Bryum pseudotriquetrum* (Hedw.) Schwaegr., Sp. Musc. Suppl., 1(2): 110. 1816.

(Plate 11, Figs. 13-21)

Plants tall, robust, dark green above, reddish below, up to 35 mm in length, with up to 2 subfloral innovations. **Stem** irregularly circular in cross section, outer cortical cells smaller, inner medullary cells larger followed by very small inner most cells. **Leaves** loose and distant below, dense above in comal aggression, erectopatent, oblong, lanceolate up to 5 x 1.6 mm in size, tapering gradually into acute apex, margin revolute, entire, denticulate at apex; **costa** reddish to deep brown, extending into arista + 0.08 mm. **Leaf cells** rhomboidal, ± 39 x 17.5 µm at apex, ± 45 x16 at middle, rectangular, ± 58 x 20 µm at base, with some reddish tinted cells at extreme base, 2-3 rows of narrow yellowish cells from distinct leaf border. Sporophyte not seen.

Ecology & Distribution: plants growing on moist soil near water stream and soil covered rocks at Panchali Kund, Bee Dam and Irene Pool, 943-1015.

Range of Distribution: Africa, Antarctica, Antigua, Argentina, Australia, Austria, Belgium, Bolivia, Bouvet Island, Canada, Chile, China, Colombia, Congo, Costa Rica, Denmark, Dominica, Dominican Republic, Ecuador, Estonia, Falkland Islands, Finland, France, Germany, Gibraltar, Greece, Greenland, Guatemala, Hungary, Iceland, India: central India (PBR), eastern Himalaya (Sikkim), South India (Eravikulum National Park, Wayanad), western Himalaya (Kashmir, Kedarnath, Kumaon), Iraq, Ireland, Italy, Japan, Kazakhstan, Latvia, Lesotho, Mali, Mexico, Mongolia, Morocco, Netherlands, New Zealand, Norway, Pakistan, Papua New Guinea, Peru, Poland, Portugal, Russia, Rwanda, Saint Kitts and Nevis, Saint Lucia, Serbia and Montenegro, South Africa, South Georgia and the South Sandwich Islands, Spain, Svalbard and Jan Mayen, Sweden, Switzerland, Taiwan, Tasmania, Thailand, Turkey, United Kingdom, United States, Venezuela, Wallis and Futuna Islands, Vietnam.

Specimens examined: India, Madhya Pradesh, PBR: Panchali Kund, alt. ca 943.6 m, on soil near water stream, 07.11.2011, 263162 (LWG); Bee Dam, alt. ca 970 m, on soil near water stream, 08.11.2011, 263195 (LWG); Irene Pool, alt. ca 1015 m, on soil covered rocks, 08.11.2011, 264807 (LWG), leg. A.K. Asthana & R. Gupta.

This species was commonly cited as *Bryum pseudotriquetrum* by workers. However, Spence and Ramsay (2005) have assigned a new generic name *Ptychostomum* for this species, and same has been used in the present work.

Family: Mielichhoferiaceae Schimp.

1. Plants proliferating with subfloral innovations, leaves smaller, costa percurrent ..... ***P. flexuosus***

   Plants not proliferating with subfloral innovations, leaves larger, costa short excurrent ..... ***P. himalayana***

Genus: *Pohlia* Hedw.

Plants erect, terrestrial, in lax tufts, yellowish green to dull green, medium sized, up 12 mm long, proliferating with subfloral innovations.; **Leaves** smaller below, larger towards apex, forming comal tuft erectopatent, lanceolate up to 1.4 mm long, 0.4 mm broad; margin flat, sometimes slight dentitions at apex; **costa** strong, brownish, percurrent to short excurrent.

***Pohlia flexuosa* Harv.** Icon. Pl. 1: pl. 19: f. 5 f. 1836**.**

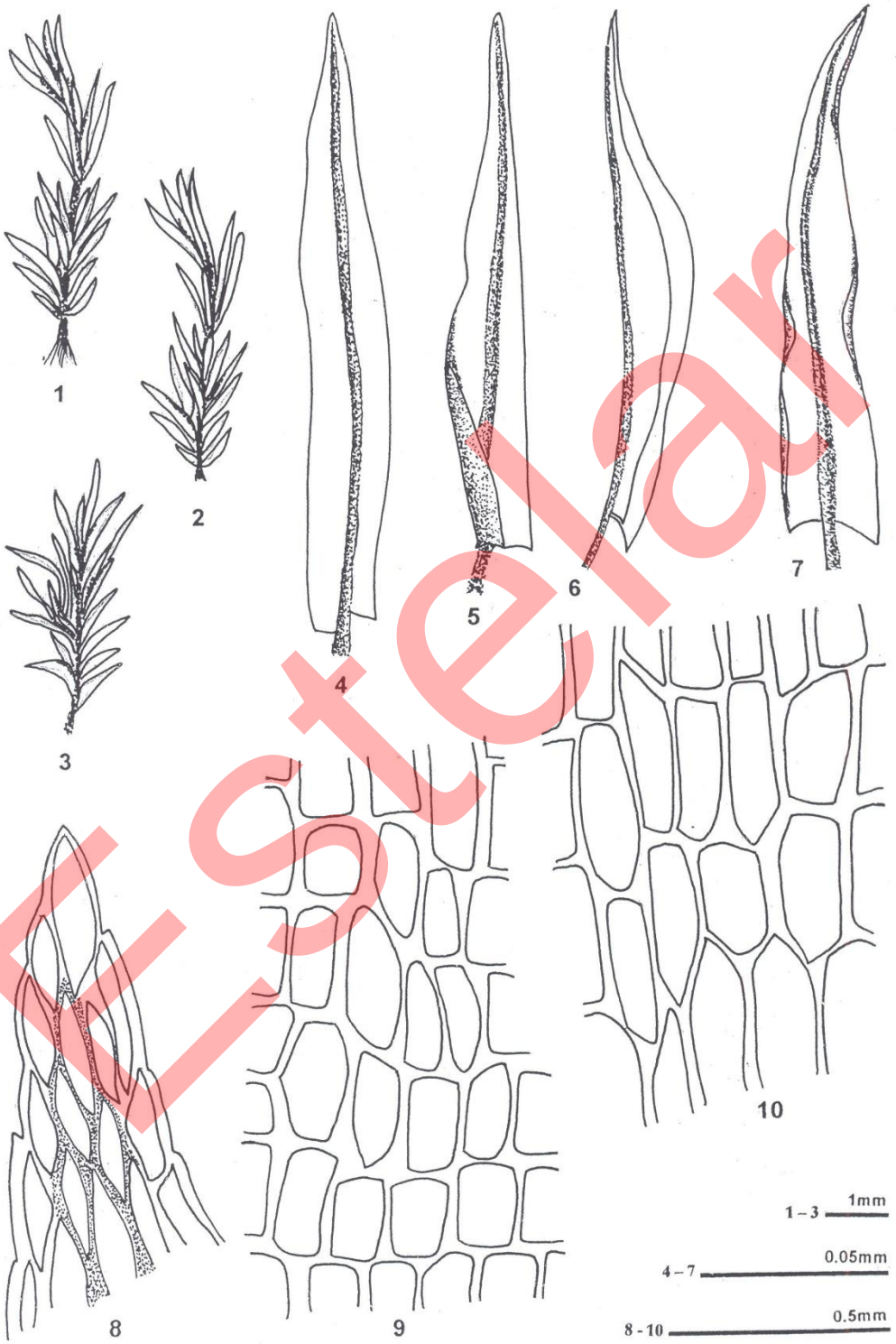
(Plate 12 Figs. 1-10)

Plants erect, terrestrial, in lax tufts, yellowish green, up to 8 mm long, proliferating with subfloral innovations. **Stem** covered with leaves loosely arranged below, dense at apex; **Leaves** erectopatent, lanceolate up to 1.4 mm long, 0.4 mm broad; margin flat, slight dentitions at apex; **costa** strong, brownish, percurrent. **Leaf cells** in the upper region thick walled, rhomboid, $\pm$ 40 × 8 µm in size, basal cells rectangular to quadrate, $\pm$ 36 × 8 µm. Sporophyte not seen.

Ecology & Distribution: plants growing on soil over rocks at Tamia Valley at 1000 m.

Range of Distribution: Australia, Belgium, Bhutan, Caribbean, China, Colombia, Costa Rica, Cyprus, Dominica, Dominican Republic, France, Hawaiian Islands, Indonesia, Ireland, India: central India (Orissa, PBR), eastern Himalaya (Arunachal Pradesh, Darjeeling, Kolkata, Sikkim), Gangetic plains, South India, western Himalaya,

Plate-12



***Pohlia flexuosa* Hook.,** Figs. 1-10: 1-3. vegetative plants, 4-7. leaves, 8. apical leaf cells, 9. middle leaf cells, 10. basal leaf cells.

Plate-13

***Pohlia himalayana* (Mitt.) Broth.,** Figs. 1-13: 1-3. vegetative plants, 4. cross section of axis, 5-10. leaves, 11. apical leaf cells, 12. median leaf cells, 13. basal leaf cells.

Ireland, Jamaica, Japan, Mexico, Nepal, Netherlands, Norway, Panama, Papua New Guinea, Peru, Philippines, Rwanda, Sri Lanka, Sweden, Taiwan, Turkey, United Kingdom, United States, Vietnam.

Specimens examined: India, Madhya Pradesh, PBR: Tamia Valley, alt. ca 1000 m, growing on soil over rock, 10.10.1992, 205486 (LWG), leg. V. Nath & A. K. Asthana.

***Pohlia himalayana* (Mitt.) Broth.,** Nat. Pfl., 1 (3): 548. 1903.

Basyn: *Webera himalayana* Mitt., Musci Ind. Or.: 66. 1859.

(Plate 13: Figs. 1-13)

Plants slender, dull green loosely tufted, erect, ± 10 mm long, rarely branched. **Stem** circular in cross section, outer cortical cells smaller, inner medullary cells much larger, **Leaves** erectopatent, smaller below, larger towards apex, comal tuft formed, ± 1.8 x 0.47 mm in size, decurrent at base, apex acute to acuminate, margin entire at base, very slightly denticulate at apex, reflexed irregularly, costa dull brown, strong, short excurrent. **Leaf cells** rhomboid to broadly spindle shaped, narrow towards margin, apical cells ± 36 x 75 µm, middle cells ± 37 x 75 µm getting sub- quadrate to rectangular at base, ± 19 x 6.25 µm. Sporophyte not seen.

Ecology and Distribution: plants growing on soil over rocks at Panchali Kund, 938 m.

Range of Distribution: India: central India (PBR), eastern Himalaya (Sikkim).

Specimens Examined: India, Madhya Pradesh, PBR: Panchali Kund, alt. ca 938 m, on soil over rocks, 07.11.2011, 263149 (LWG), leg. A.K. Asthana & R. Gupta.

Family: Bartramiaceae Schwaegr.

Genus: *Philonotis* Bridel

Plants loosely tufted to densely tufted, yellowish green to glossy green, usually branched by subfloral innovations. Leaves dense, stiff, linear-lanceolate, variable in size, acuminate; margin irregularly, finely denticulate; costa percurrent to excurrent in short arista.

***Philonotis thwaitesii* Mitten,** Musci Ind. Or.: 60. 1859.

(Plate 14: Figs. 1-11)

Plants loosely tufted, ± 10 mm in size, yellowish green, branched by subfloral innovations, **Stem** circular in cross section, irregularly scattered cells with thick walls.

Leaves dense, stiff, linear-lanceolate, 1.8 x 0.43 mm in size, acuminate; margin irregularly, finely denticulate; **costa** excurrent in arista, ± 0.17 mm. **Leaf cells** linear elongated papillose, ± 59 x 4.5 µm at top, rectangular, smooth towards base ± 19 x 14 µm extreme basal cells quadrate sporophyte not seen.

Ecology & Distribution: plants growing on dry rocks, at Pandav Caves, 1004m.

Range of Distribution: Antarctica, Australia, Bolivia, Borneo, China, Columbia, Hongkong, India: Andaman & Nicobar Islands, central India (PBR), eastern Himalaya (Sikkim), Orissa, South India (Eravikulum National Park, Palni hills, Tiruneveli - Travancae hills), western Himalaya (Simla), Indonesia, Japan, Nepal, Papua New Guinea, Phillipines, Republic of Korea, Sri Lanka, Sumatra, Taiwan, Thailand, Turkey, Vietnam.

Specimens examined: India, Madhya Pradesh, PBR: Pandav Caves, alt. ca 1004 m, on dry exposed rocks, 07.11.2011, 263115B (LWG), leg. A.K. Asthana & R. Gupta.

Family: Thuidiaceae Schimp.

Genus: *Pelekium* Mitt.

Plants prostrate, slender, light green to yellowish green in dense tufts. Stem branched pinnately to bi-pinnalety, paraphyllia numerous, filamentous,simple to branched, apices acute. Stem leaves ovate – lanceolate, acuminate, distantly arranged, branch leaves dense, erectopatent, concave, ovate- lonceolate, tip acute, margin crenulate; costa single, ending at half leaf length or below tip.

***Pelekium fuscatum* (Besch.) A Touw.,** J. Hattori Bot. Lab. 90: 203. 2001.

Syn: *Thuidium koelzii* Robinson, Bryologist 71: 92 1968.

(Plate 15: Figs. 1-23)

Plants prostrate, slender, light green to yellowish green in dense tufts. **Stem** creeping, branched pinnately to bi-pinnalety, circular in cross section, outer certical cells thin walled, smaller, inner medullary cells larger thick walled. Paraphyllia numerous, filamentous, apices acute. **Stem leaves** ovate – lanceolate, acuminate, distantly placed ± 0.45 x 0.3 mm, **branch leaves** dense, erectopatent, concave, ovate-lonceolate, tip acute, ± 2.5 x 1.4 mm in size, margin crenulate; **costa** single, ending below tip. **Leaf cells** small, quadrate to sub - quadrate, ± 10 x 4 µm at apex, median cells ± 11 x 6 µm, basal cells up to 13.5 x 6.3 µm, mostly unipapillate, sporophyte on main shoot. Perichaetial leaves oblong, narrowing in into a long apiculus, ± 1.4 x 0.35

Plate-14

***Philonotis thwaitesii* Mitten.,** Figs. 1-11: 1,2. vegetative plants, 3. cross section of axis, 4-8. leaves, 9. apical leaf cells, 10. median leaf cells, 11. basal leaf cells.

Plate-15

***Pelekium fuscatum* (Besch.) A. Touw.,** Figs. 1-23: 1. vegetative plant, 2. cross section of axis, 3-6. stem leaves, 7-11. branch leaves, 12-14. paraphyllia, 15. apical leaf cells of stem leaf, 16. apical leaf cells of branch leaf, 17. median leaf cells, 18. basal leaf cells, 19-21. perichietial leaves, 22. peristome, 23. spores.

mm in size. **Seta** red, up to 14 mm long smooth; **capsule** semi-erect to inclined, ± 1.7 x 0.6 mm in size; **peristome** normal, endosfome and exostome of similar height; **spores** dull yellow, ± 10 µm in diameter. **Ecology & Distribution:** plants growing on moist rocks at Bee Fall, 941 m.

Range of Distribution: India: central India (PBR), eastern Himalaya (Assam, Khasia hills), Gangetic plains (Odisha), western Himalaya (Mussoorie), Mynmar, Nepal.

Specimens examined: India, Madhya Pradesh, PBR: Bee Fall, alt. ca 941 m, on moist rocks, 08.11.2011, 264804 (LWG), leg. A.K. Asthana & R. Gupta.

Genus: *Thuidium* B.S.G.

Plants, prostrate, small, yellowish - green plants in extensive dense mats, bipinnately to tripinnately branched, simple dense filamentous paraphyllia present, may be branched sometimes. Leaves dimorphic, stem leaves distantly arranged, ovate-chordate narrowing into acumen, larger; branch leaves smaller, densely arranged, concavo-ovate with acute tip, smaller, margin crenulate due to cell projections; costa single, ending mid leaf or just below the tip.

***Thuidium minusculum* (Mitt.) A. Jaeger,** Ber. S. Gall. Naturw. Ges., 1876-77.

Basnym: *Leskea minuscula* Mitt. Ind. Or. 134. 1859.

(Plate 16: Figs. 1-14)

Plants, prostrate, small, yellowish - green plants in extensive dense mats, bipinnately branched, simple dense filamentous, paraphyllia present. **Stem** oval to circular in cross section, outer cortical cells very small, getting gradually larger towards centre. **Leaves** distantly arranged, ovate-chordate narrowing into acumen; ± 0.69 x 0.3 mm in size, branch leaves smaller, densely arranged, concavo-ovate with acute tip, ± 0.15 mm x 0.12 mm, margin crenulate due to cell projections; **costa** single, ending below the tip. **Leaf cells** small, obscure due to papillae, multipapillate, irregularly polygonal, ± 5 µm in size. Sporophyte not seen.

Ecology & Distribution: plants growing on rocks in association with *Plagiothecium cavifolium* on way to Jatashankar 823 m.

Range of Distribution: Australia, Bangladesh, Burma, Cambodia, China, Malaysia, Bangladesh, Borneo, China, India: Andaman Nicobar Islands, central India (AABR, Orissa, PBR), eastern Himalaya (Arunachal Pradesh, Darjeeling, Khasi Hills, Naga

Hills, Sikkim), South India (Croog, Palni Hills: Palamalai, Mundathurai), western Himalaya (Dehradun), Japan, Java, Kampuchea, Laos, Myanmar, Nepal, Papua New Guinea, Philippines, Sikkim, Sri Lanka, Samoa, Sumatra, Thailand, Taiwan, Vietnam.

Specimens examined: India, Madhya Pradesh, PBR: on way to Jatashankar, alt. ca 823 m, 29.11.2006, on rocks, 227658A (LWG), leg. V. Sahu & V. Awasthi.

Family: Pterigyanandraceae Schimp.

Genus: *Trachyphyllum* Gepp.

Plants prostrate, in goldenish green mats, branched irregularly, profusely, branches up to 18 mm in length. Leaves broadly ovate to chordate, concave, acuminate, tapering into a acumen that varies fromshort to long, margin entire to mildly crenulated, costa short double, maximum up to 1/3rd leaf length. Distinc alar present at leaf base.

Key to the species of genus *Trachyphyllum* at PBR:

1. Branches straight in dried condition, smaller to more than 5 mm long -15 mm), leaves broadly- ovate to cordate, graduating to long cuminate apices ..... ***T. borgenii***

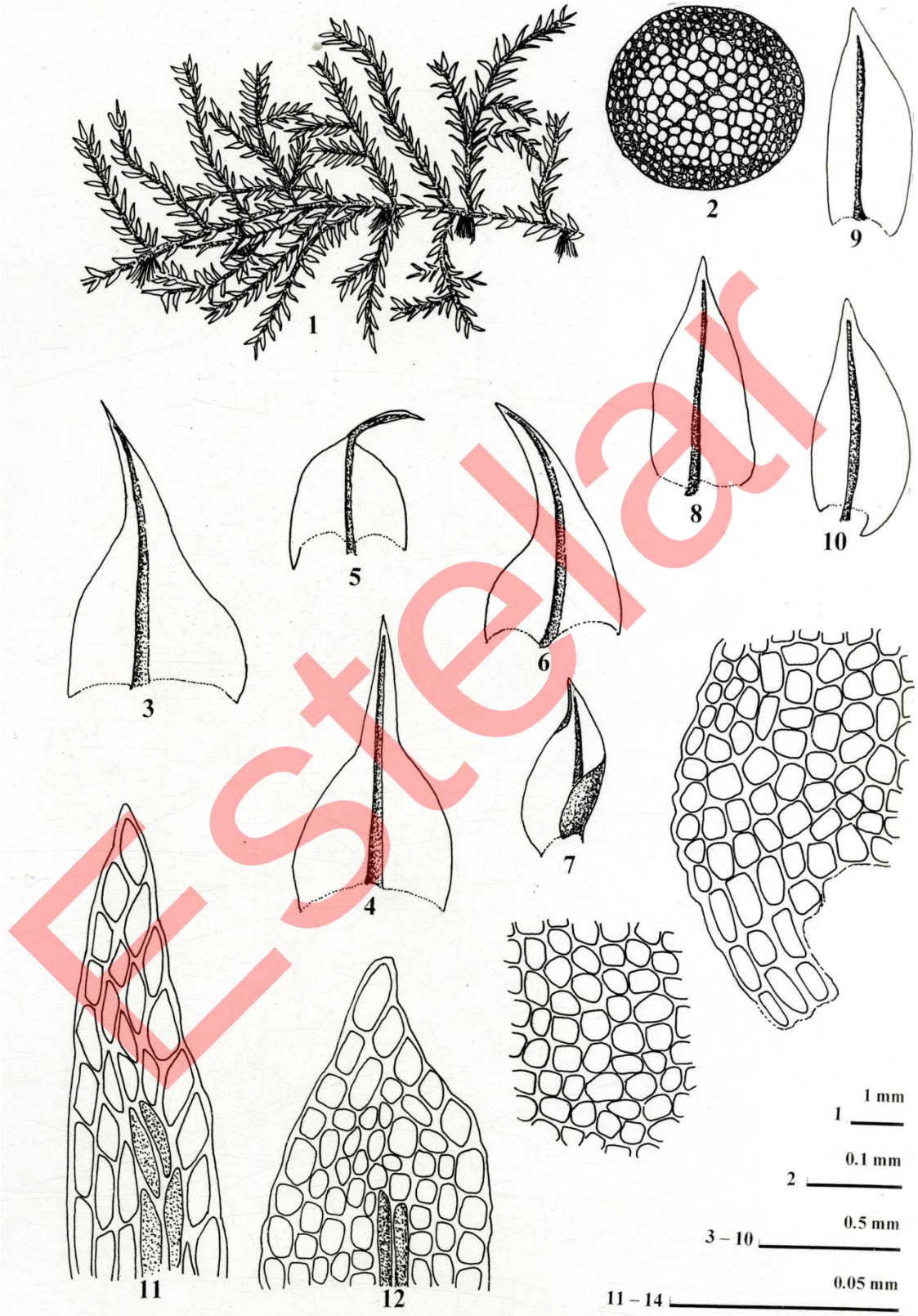
   Branches curled in dried condition, less than 5 mm long, leaves ovate, abruptly tapered at apex ..... ***T. inflexum***

***Trachyphyllum borgenii* (Renauld & Cardot) Brotherus,** Nat Pfl., I(3): 890. 1907.

(Plate 17: Figs. 1-12)

Plants prostrate, in goldenish mats, branched irregularly, profusely, branches up to 18 mm in length. **Stem** creeping, oval in cross section, outer cortical cells smaller, inner medullary cells larger. **Leaves** broadly ovate to chordate, acuminate, tapering into a long acumen, margin entire to mildly crenulated, **costa** short double, up to 1/3rd leaf length, stem leaves larger, $\pm$ 1 x 0.5 mm in size, branch leaves smaller, $\pm$ 0.75 x 0.35 mm. **Leaf cells** elongate, narrow, spindle shaped to rhomboidal, papillose, 28 x 5 µm at apex, median cells larger, $\pm$ 42 x 4.17 µm, basal cells quadrate to squarish, forming alar, $\pm$ 12.5 x 11.4 µm, extending up to 1/3rd leaf length, over 50 cells up the margin in larger leaves. Sporophyte not seen.

Plate-16



***Thuidium minusculum* (Mitt.) A. Jaeger.,** Figs. 1-14: 1. vegetative plant, 2. cross section of axis, 3-6. stem leaves, 7-10. branch leaves, 11. apical leaf cells of stem leaf, 12. apical leaf cells of Branch leaf, 13. median leaf cells, 14. basal leaf cells.

Plate-17

***Trachyphyllum borgenii* (Renauld & Cardot) Brotherus.,** Figs. 1-12: 1. vegetative plant, 2. cross section of axis, 4-9. leaves, 10. apical leaf cells, 11. median leaf cells, 12. basal leaf cells. ***Trachyphyllum inflexum* (Harv.) A. Gepp.,** Figs. 13-22: 13. vegetative plant, 14. cross section of axis, 15-19. leaves, 20. apical leaf cells, 21. median leaf cells, 22. basal leaf cells.

Ecology & Distribution: plants growing epiphytically in extensive mats at Panchali Kund, 944 m.

Range of Distribution: India: central India (PBR), Madagascar.

Specimens examined: India, Madhya Pradesh, PBR: Panchali Kund, alt. ca 944 m, epiphytic, 07.11.2011, 263165 (LWG), leg. A.K. Asthana & R. Gupta.

***Trachyphyllum inflexum* (Harv.) A. Gepp**., Hiern, W. P.: Cat. Afr. Pl. 2(2): 299. 1901.

Basnym: *Hypnum inflexum* Harv. Hook.: Icon Pl. Rar., 1.t.24(6). 1836.

(Plate 17: Figs. 13-22)

Plants prostrate, slender, yellowish green forming dense mats, irregularly branched, giving rise to julaceous branches. **Stem** roughly circular in cross section, outer cells smaller, thick walled, getting larger towards centre, covered distantly with leaves. **Leaves** of branches dense, patent to spreading, chordate to concave, short apiculate, small ± 0.5 x 0.33 µm in size, margin entire, smooth; **costa** short forked. **Leaf cells** elongated, rhomboid above ± 29 x 4.8 µm quadrate below, ± 12.5 x 11.5 µm in size papillose at tip, basal cells are chlorophyllose, up to 4-6 rows upwards. Sporophyte not seen.

Ecology & Distribution: plants growing epiphytically near water stream at Tamia Valley, Jambu Dweep, Chota Mahadeo from 734- 950 m.

Range of Distribution: Australia, Bangladesh, Burma, China, Cambodia, Comoros, India: central India (Amarkantak, Odisha, PBR), eastern Himalaya (Darjeeling, Khasia hills, Manipur, Sikkim), South India (Karnataka, Kanara, Palni hills), western Himalaya (Kumaon, Gupt Kashi), Indonesia, Java, Kenya, Madagascar, Malawi, Mauritius, Nepal, New Caledonia, Papua New Guinea, Philippines, Reunion, South Africa, Tanzania, Thailand, Vietnam, Zambia.

Specimens examined: India, Madhya Pradesh, PBR: Jambu Dweep, alt. ca 900 m, 17.12.1993, epiphytic; Chota Mahadev (Tamia), alt. ca 950 m, epiphytic, 19.12.1993, 205601 (LWG), 205611 (LWG), 205710 (LWG), leg. V. Nath & A.K. Asthana; near Jambu Dweep, alt. ca 854 m, epiphytic; 26.11.2006 on way to Apsara Vihar, alt. ca 734 m, epiphytic, 01.12.2006, 227642 (LWG), 227692B (LWG), leg. V. Sahu & V. Awasthi.

Family: Myriniaceae Schimp.

Genus: *Schwetschkeopsis* Broth.

Plants prostrate, glossyto light green, 20-30 mm in size, irregularly pinnately branched. Leaves small, imbricate, closely appressed to stem, erectopatent, concave, ovate- lanceolate acuminate, ± 1 x 0.5 mm in size, margin flat, entire to dentate throughout; costa lacking or indistinguishable double is present. The basal cells of lesf form distinct short slsr region of quadrate cells.

Key to the species of genus *Schwetschkeopsis* at PBR:

1. Leaves ecostate, margin mildly dentate throughout the leaf length ... ***S. fabronia***
   Leaves with double costa, margin entire to slightly denticulate towards apex .. **2**
2. Plants larger, leaf apex symmetrical, slender, acuminate margin entire, leaf cells faintly papillose ..... ***S. formosana***
3. Plants smaller, leaf apex sometimes asymmetrical, broader acuminate, margin entire below, denticulate half way upwards, leaf cells papillose ….. ***S. elongate***

***Schwetschkeopsis fabronia* (Schwaegr) Broth.,** Engl. & Prantl, Nat. Pflanzenfa. 1 (3): 878. 1907.

(Plate 18: Figs. 1-11)

Plants prostrate, glossy, light green, 20-30 mm in size, irregularly pinnately branched. **Stem** creeping, oval in cross section, outer cortical cells thick walled, smaller, inner medullary cells larger. **Leaves** small, imbricate, closely appressed to stem, erectopatent, concave, ovate- lanceolate acuminate, ± 1 x 0.5 mm in size, margin flat, dentate throughout; **costa** lacking or indistinguishable in present. **Leaf cells** rhomboidal to slender linear, papillate, 32 x 7.0 µm at apex, 28 x 6.8 µm at middle, basal cells sub quadrate to rectangular, forming distinct alar, ± 16 x 6.8 µm in size. Sporophyte not seen.

Ecology & Distribution: plants growing on day exposed rocks near Pachmarhi Lake, 1050 m.

Range of Distribution: Angola, Antarctica, Canada, China, Cuba, India: central India (PBR), Japan, Nepal, Russia, United States, Iran, Sweden, Vietnam.

Specimens examined: India, Madhya Pradesh, PBR: Pachmarhi Lake, alt. ca 1050 m, on rocks (dry, exposed), 09.11.2022, 264823 (LWG), leg. A.K. Asthana & R. Gupta.

Plate-18

***Schwetschkeopsis fabronia* (Schwaegr) Broth.,** Figs. 1-11: 1. vegetative plant, 2. cross section of axis, 3-8. leaves, 9. apical leaf cells, 10. median leaf cells, 11. basal leaf cells; ***Schwetschkeopsis formosana* Nog.,** Figs. 12-21: 12. vegetative plant, 13. cross section of axis, 14-18. leaves, 19. apical leaf cells, 20. median leaf cells, 21. basal leaf cells; ***Schwetschkeopsis elongata* (Dixon & P. Varde) P. Varde,** Figs. 22-33: 22. vegetative plant, 23. cross section of axis, 24-30. leaves, 31. apical leaf cells, 32. median leaf cells, 33. basal leaf cells.

***Schwetschkeopsis formosana* Nog.,** J. Hattori Bot. Lab., 5: 41. 1951**.**

(Plate 18: Figs. 12-21)

Plants prostrate, slender, yellowish green, glossy, densely and irregularly branched. **Stem** broadly circular in cross section, outer cortical cells smaller, inner cells getting larger gradually. **Leaves** dense, erectopatent ovate-lanceolate, entire margin, acute to acuminate apex, ± 0.6 x 6.3 mm; **costa** usually two short, faint or inconspicuous in some cases. **Leaf cells** slender rhomboidal at apex ± 28 x 6 µm becoming smaller and rectangular below ± 24 x 6 µm in size, alar cells quadrate to rectangular up to 15 x 6.5 µm in size. Sporophyte not seen.

Ecology & Distribution: plants epiphytic, growing in association with *Leucobryum* sp., on way to Bee Fall, Duchess Fall 823 m.

Range of Distribution: India: central India (PBR), eastern Himalaya, Nepal, Taiwan.

Specimens examined: India, Madhya Pradesh, PBR: on way to Bee Fall, alt. ca 823 m, 30.11.2006, epiphytic, 227668A (LWG), leg. V. Sahu & V. Awasthi.

***Schwetschkeopsis elongata* (Dixon & P. Varde) P. Varde,** Buck & Crum, J. Hattori Bot. Lab. 44: 347 – 369. 1978.

(Plate 18: Figs. 22-33)

Plants prostrate, dull green, irregularly branched, branches slender. **Stem** ovato – circular in cross section, outer cortical cells thick walled smaller, inner medullary cells larger. **Leaves** lanceolate to ovate- lanceolate, ± 6-8 x ± 0.20 mm in size, papillose, margin plane, slightly serrulate all around; **costa** short double, faint. **Leaf cells** elongated, slender rhomboidal, papillose ± 28 x 6 µm at apex ± 26 x 6 µm at mid leaf, basal alar cells small, quadrate, ± 6-8 x 8 µm in size. Sporophyte not seen.

Ecology & Distribution: plants growing epiphytically and on rocks at Panchali Kund, 944 m.

Range of Distribution: India: central India (PBR), eastern Himalaya (Sikkim), South India (Kannan Deva hills, Kodaikanal, Palni hills, Pulney hills, Manalur, Sirumalai, Travancore).

Specimens examined: India, Madhya Pradesh, PBR: Panchali Kund, alt. ca 944 m, on rocks 07.11.2011, 263158 (LWG); epiphytic, 07.11.2011, 263159 (LWG), leg. A.K. Asthana & R. Gupta.

Family: Amblystegiaceae G. Roth

Genus: *Hygrohypnum* Lindb.

Plants prostrate, small, dendroid , brownish to dull green, glossy in extensive mats, branched densely, branches irregular. **Leaves** spreading, falcate, concave, broadly pointed, margin plane, often recurved, dentate at apex in some cases; **costa** short, double to faint. **Leaf cells** slender, elongated, extreme basal cells slightly rectangular with some small squarish cells; alar indistinct.

***Hygrohypnum choprae* Vohra,** Bull. Bot. Surv. Ind. 22: 117. 1980.

(Plate 19: Figs. 1-10)

Plants prostrate, small, brownish to dull green, glossy in extensive mats, branched densely, branches irregular, ± 8 mm tall. **Stem** ovato-circular in cross section, outer cells smaller, thick walled, graduating to larger cells towards centre, evenly thick walled. **Leaves** spreading, falcate, concave, delicate, bluntly pointed, ± 1.0 x 0.47 mm in size, margin plane, often recurved, dentate at apex; **costa** short, double to indistinct. **Leaf cells** slender, elongated, ± 42 x 5.2 µm at apex, up to 69.2 x 6 µm below; extreme basal cells slightly rectangular with some small squarish cells; alar indistinct. Sporophyte not seen.

Ecology & Distribution: plants growing on rocks near Jambu Dweep, 792 m.

Range of Distribution: India: central India (PBR), eastern Himalaya (Arunachal Pradesh, Darjeeling, Sikkim).

Specimens examined: India, Madhya Pradesh, PBR: Jambu Dweep alt. ca 792 m, on rocks, 29.11.2006, 227645 (LWG), leg. V. Sahu & V. Awasthi.

Family: Brachytheciaceae

1. Branching irregular, leaves plicate, homophyllous, costa slightly more than 1/2 leaf length ..... ***Brachythecium***

Branching pinnate, leaves not plicate, heterophyllous, costa covering 3/4 to 1/2 of leaf length ..... ***Eurhynchium***

Genus: *Brachythecium* Schimp.

Plants prostrate, pale, light to yellowish-green, forming mats, giving rise to irregularly branched. **Leaves** dimorphoic, lax, concave, larger on stem, ovate-

Plate-19

***Hygrohypnum choprae* Vohra.,** Figs. 1-10: 1. vegetative plant, 2. cross section of axis, 3-7. leaves, 8. apical leaf cells, 9. median leaf cells, 10. basal leaf cells.

Plate-20

***Brachythecium rivulare* Schimp.,** Figs. 1-11: 1. vegetative plant, 2. cross section of axis, 3-5. stem leaves, 6-8. branch leaves, 9. apical leaf cells, 10. basal leaf cells, 11. median leaf cells.

lanceolate, smaller, dense on branches, margin entire to mildly denticulate; **costa** dull brown, strong, reaching up to 3/4th of the total leaf length. The basal cells show differentiation.

***Brachythecium rivulare* Schimp.,** Bryol. Eur. 6: 17. 546. 1853**.**

(Plate 20: Figs. 1-11)

Plants prostrate, pale, yellowish-green, forming extensive mats, giving rise to irregular branches. **Stem** circular in cross section, outer cortical cells smaller, inner medullary cells larger. **Leaves** lax, concave, larger on stem, ovate-lanceolate, slightly smaller, dense on branches, ±1.4 x 0.44 mm in size; **costa** dull brown, strong, reaching up to 3/4th of the total leaf length. **Leaf cells** narrow slender, elongate above, ± 62.5 x 5.2 µm at apex, ± 108.4 x 6.2 µm at middle, getting shorter and wider below ± 50 x 13.5 µm, slightly inflated alar cells present. Sporophyte not seen.

Ecology & Distribution: plants growing on moist soil covered rocks near water stream, on way to Chota Mahadev, 793 m.

Range of Distribution: Andorra, Antarctica, Afghanistan, Australia, Austria, Belgium, Bhutan, Bulgaria, Canada, China, Croatia, Cyprus, Czech Republic, Denmark, Dominican Republic, Ecuador, Egypt, Estonia, Faroe Islands, Finland, France, Georgia, Germany, Greece, Greenland, Hungary, Iceland, India: central India (PBR), eastern Himalaya (Sikkim), western Himalaya (Chamba, Garhwal, Jammu, Kashmir), Iran, Iraq, Ireland, Italy, Japan, Kazakhstan, Kenya, Latvia, Lebanon, Luxembourg, Morocco, Nepal, Netherlands, New Zealand, Norway, Poland, Portugal, Russia, Slovenia, South Africa, Spain, Sweden, Switzerland, Taiwan, Tibet, Turkey, United Kingdom, United States.

Specimens examined: India, Madhya Pradesh, PBR: on way to Chota Mahadev, alt. ca 793 m, on soil covered rocks, 29.11.2006, 227636, 227638B (LWG), leg. V. Sahu & V. Awasthi.

Genus: *Eurhynchium* B.S.G.

Plants prostrate, yellowish green, glossly, repetedly branched irregularly, erect to erectopatent. Leaves complanate, slightly heterophyllous, stem leaves slightly larger, oblong-ovate, gradually acute to acuminate, margin slightly crenulate to entire; costa

reaching 1/2 to 3/4th leaf length. Leaf cells elongate, spindle shaped, rhomboidal at the apex, basal cells rectangular.

***Eurhynchium hians* (Hedw.) Sande Lac.,** Ann. Mus. Bot. Lugduno-Batavi 2: 299. 1866.

Basyn: *Hypnum swartzii* Turn., Musc. Hib.: 151. 1804.

Syn: *Eurhynchium swartzii* (Turn.) Curnow, Rabenh.: Bryoth. Eur., 12: 592. 1862.

(Plate 21: Figs. 1-11)

Plants prostrate, yellowish green, glossly, profusely branched, branches irregular, erect to erectopatent. **Stem** creeping, circular in cross section, outer cortical cells small, thick walled, inner medullary cells larger, followed by small cells at the centre. **Leaves** complanate, slightly heterophyllous, oblong-ovate, gradually acute to acuminate ± 1.28 x 0.529 µm in size, margin slightly dentate; **costa** reaching 3/4th leaf length. **Leaf cells** elongate, spindle shaped, rhomboidal at the apex, wider at apex, ± 50.6 x 9 µm, getting larger mid leaf, ± 75 x 9.2 µm, basal cells rectangular 38 - 48 x 11.7 µm with two rows of narrower cells towards margin. Sporophyte not seen.

Ecology & Distribution: plants growing on soil covered rocks at Chota Mahadev, 950m.

Range of Distribution: Algeria, Austria, Belgium, Bhutan, Bulgaria, Cameroon, Canada, China, Czech Republic, Denmark, Estonia, Ethiopia, Faroe Islands, Finland, France, Germany, Hungary, Iceland, India: central India (PBR), eastern Himalaya (Darjeeling, Khasia hills), Indonesia, Ireland, Italy, Ivory Coast, Japan, Kazakhstan, Kenya, Latvia, Luxembourg, Monaco, Morocco, Nepal, Netherlands, Norway, Papua New Guinea, Poland, Portugal, Russian Federation, Slovakia, Siberia, Spain, Sri Lanka, Sweden, Switzerland, Tanzania, Turkey, Uganda, United Kingdom, United States, West Indies. **Specimens examined:** India, Madhya Pradesh, PBR: Chota Mahadev, alt. ca 950 m, growing on soil covered rocks near water stream, 19.12.1993, 205707 (LWG), leg. V. Nath & A.K. Asthana.

Family: Plagiotheciaceae (Broth) Fleisch.

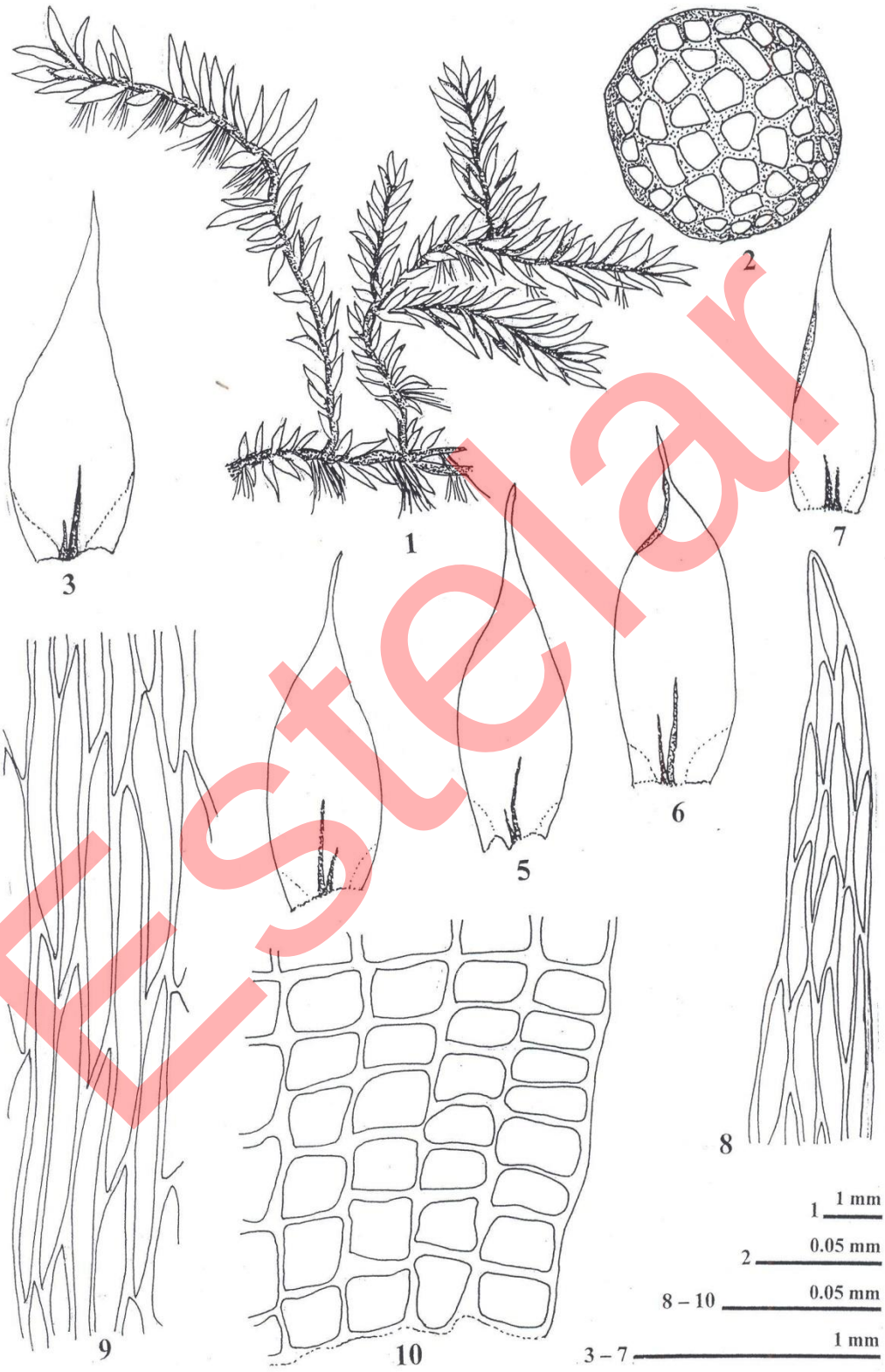
Genus: *Plagiothecium* B.S.G.

Plants prostrate, small, yellowish green, glossy, in dense tufts, irregularly branched forming mats. Leaves erectopatent, ovate-lanceolate, narrowing at decurrent

Plate-21

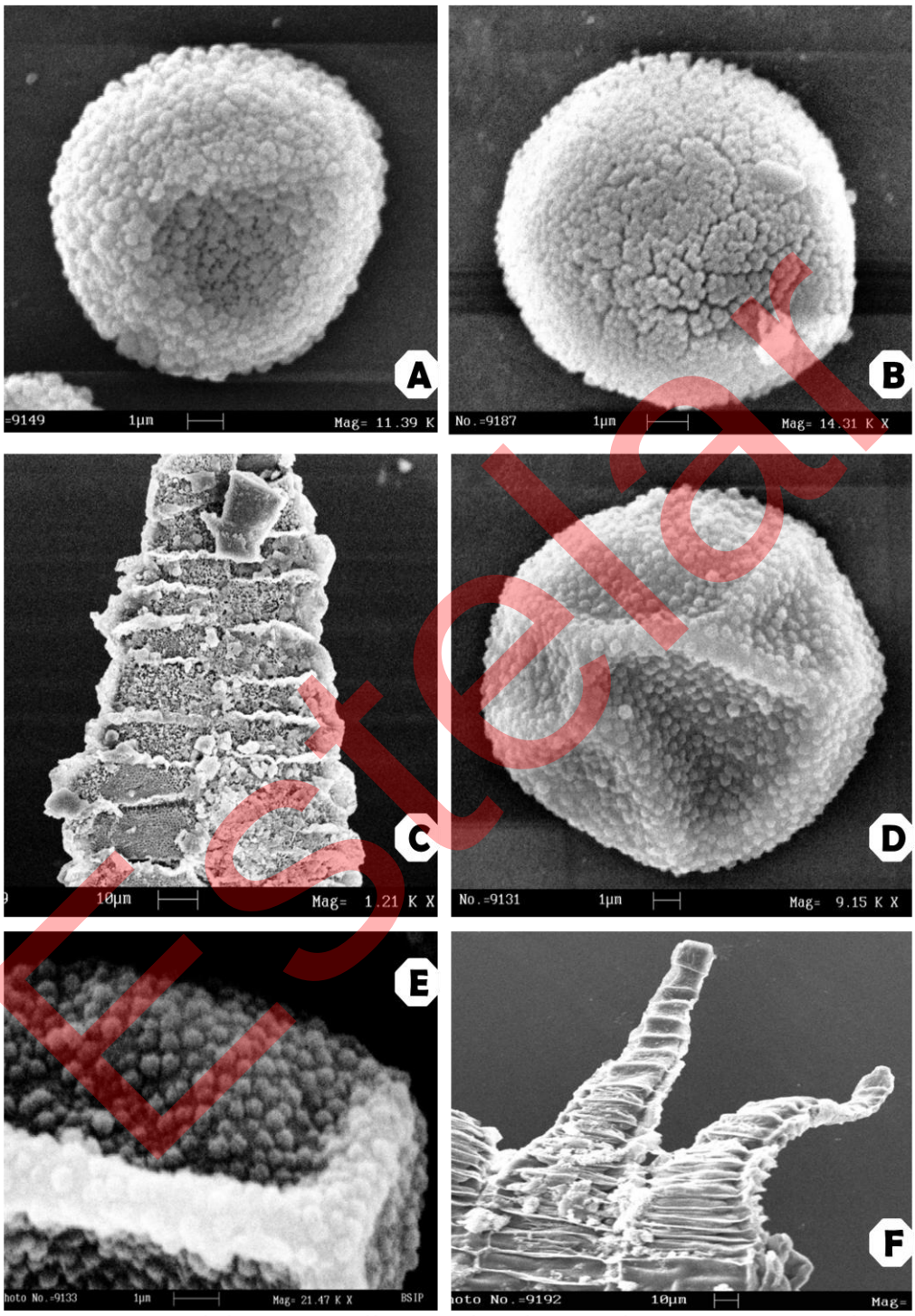
***Eurhynchium hians* (Hedw.) Sande Lac.,** Figs. 1-10: 1. vegetative plant, 2. cross section of axis, 3-8. leaves, 9. apical leaf cells, 10. median leaf cells, 11. basal leaf cells.

Plate-22



***Plagiothecium cavifolium* (Brid.) Z. Iwats.,** Figs. 1-10: 1. vegetative plant, 2. cross section of axis, 3-7. leaves, 8. apical leaf cells, 9. median leaf cells, 10. basal leaf cells.

PLATE- I



Figs. A-C. *Rosulabryum capillare*: A. distal view of spore, B. proximal view of spore, C. enlarged exostome, Figs.D-F. *Plagiothecium cavifolium* (Brid.) Z. Iwats.: D. spore, E. enlarged proximal view of spore, F. peristome.

base, asymmetrical to symmetrical, margin entire, margin denticulate slightly or at apex. costa short double, at times faint. Leaf cells narrow, rhomboidal above, alar cells differentiated, quadrate.

***Plagiothecium cavifolum* (Bridel) Z. Iwats.,** J. Hattori Bot. Lab., 33: 360 1970.

Basyn: *Hypnum cavifolum* Bridel, Bryol. Univ. 2: 556 1827.

(Plate 22: Figs. 1-10)

Plants prostrate, small, yellowish green, glossy, in dense tufts, irregularly branched forming mats. **Stem** circular in cross section shows thick walled central cells forming strand, outer cortical cells smaller, inner medullary cells cells larger thin walled. **Leaves** erectopatent, ovate-lanceolate, narrowing at decurrent base, asymmetrical to symmetrical, ±1.2 x 0.56 mm in size, margin entire; **costa** short double, at times faint. **Leaf cells** narrow, rhomboid, ± 76 x 7.8 µm at apex, ± 87 x 7.8 µm at middle, alar cells differentiated, quadrate-rhomboid, ± 27 x 16 µm in size. Sporophyte not seen.

Ecology & Distribution: plants growing on moist rocks is association with *Herpetineuron toccoae* and *Campylopus ericoides* at Apsara Fall and Jambu Dweep, 734-793 m.

Range of Distribution: Austria, Bhutan, Bulgaria, Canada, Caucasus, China, Chinese Taipei, Czech Republic, Faroe Islands, Finland, France, Germany, Greenland, Hungary, Iceland, India: central India (PBR), Ireland, Italy, Japan, Korea, Nepal, Netherlands, Norway, Poland, Portugal, Russian Federation, Siberia, Slovakia, Spain, Sweden, Switzerland, Turkey, United Kingdom, United States.

Specimens examined: India, Madhya Pradesh, PBR: Apsara Fall, alt. ca 734 m, 1.12.2006, on moist rocks, 227699A (LWG), near Jambu Dweep, alt. ca 793 m, 29.11.2006, 227652A (LWG), leg. V. Sahu & V. Awasthi.

Family: Stereophyllaceae W.R. Buck & Ireland

Genus: *Entodontopsis* Broth.

Plants prostrate, light greenish to glossy green, branching dense, irregular. Leaves appressed to the stem or spreading, oblong - lanceolate, with obtuse apex which abruptly narrows into a small tip, margin smooth, revolute usually at lower region; costa single dull brown, strong, reaching nearly half of leaf length or more. Leaf cells

elongated, spindle shaped, alar well developed. Sporophytes on erect seta, capsule ovate – cylindrical, deep red.

Key to the species of genus *Entodontopsis* at PBR

1. Leaves mostly symmetrical, ovate-lanceolate, leaf tip acute, endostome splits along the median line or ill formed ……..…… **2**
   Leaves mostly asymmetrical, oblong-lanceolate, leaf tip obtuse, endostome well formed ……..…… ***E. nitens***
2. Costa reaching 2/3 of the leaf length, endostome completely formed with segments usually split along the median line ……..…… ***E. leucostega***
   Costa reaching 1/2 of the leaf length, endostome incompletely formed with segments not split along the median line …….…… ***E. setschwanica***

***Entodontopsis nitens* (Mitt.) Buck & Ireland,** Nova Hedwigia 41: 104. 1985.

Syn: *Stereophyllum ligulatum* A. Jaeger & Sauerb., Ber. Tatigk. St. Gall. Naturw. Ges. 1877 – 78. 277. 1880.

(Plate 23: Figs. 1-14)

Plants prostrate, light greenish, glossy, branching dense. **Stem** ovato-circular in diameter, cortical cells thick walled, smaller, medullary cells larger. **Leaves** appressed to the stem or spreading, oblong - lanceolate, usually asymmetrical with obtuse apex which abruptly narrows into a small tip, ± 1.5 × 0.6 mm, margin smooth, revolute usually at lower region; **costa** single dull brown, strong, reaching nearly half of leaf length. **Leaf cells** elongated, spindle shaped measuring ± 40 × 6 µm at apex, 55 × 8 µm at midleaf, alar region distinct with larger, quadrate cells 42 × 14 µm in size. **Seta** straight or bent, smooth, dull brown in colour; **capsule** ovate – cylindrical ± 12 × 0.34 mm in size; **peristome** normal, double with exostome and endostome teeth; spores dull brownish - yellow, smooth ± 20 - 25 µm in diameter.

Peristome under SEM: peristome teeth with plate like cell arrangement with minute papillae densely arranged on the 3/4 – 1/2 upper portion of the teeth.

Spores under SEM: subspherical in shape, sporoderm with blunt apexed projections, arranged compactly, proximal face with prominent ridge having similar pattern of ornamentation.

Plate-23

***Entodontopsis nitens* (Mitt.) Buck & Ireland.,** Figs. 1-14: 1. plant with sporophyte, 2. cross section of axis, 3-6. leaves, 7. apical leaf cells, 8. middle leaf cells, 9. basal leaf cells, 10. peristome showing endostome and exostome teeth, 11-14. spores.

Ecology & Distribution: plants growing epiphytically (on tree bark) at Tamia Valley, Chota Mahadev (Tamia), near Pachmarhi Lake, Pathar Chatta, on way to Rajakhoh (Patalkot), near Jambu Dweep, Apsara Vihar and on way to Bee Fall from 400 – 1000 m.

Range of Distribution: Argentina, Bolivia, Brazil, Central African Republic, Comoros, Congo, Ghana, Guyana, India: central India (Achanakmar, Amarkantak, Gujarat, PBR), Gangetic plains (Chhota Nagpur), Punjab & West Rajasthan Plains (Rajasthan), South India (Botampalli, Kanan Deva hills, Palni hills, Pune, western Ghats), Laos, Madagascar, Mexico, Myanmar, Paraguay, Peru, South Africa, Suriname, Tanzania, Venezuela.

Specimens examined: India, Madhya Pradesh, PBR: Tamia valley, alt. ca 1000 m, epiphytic, 10.10.1992, 205493 (LWG); Chota Mahadev (Tamia), alt. ca 953 m, epiphytic, 11.10.1992, 205522 (LWG); near Pachmarhi Lake, alt. ca 900 m, epiphytic, 16.12.1993, 205589 (LWG); on way to Jambu Dweep, alt. ca 900 m, epiphytic, 17.12.1993, 205592(A) (LWG); Pathar Chatta, alt. ca 1000 m, epiphytic (near water stream), 18.12.1993, 205659 (LWG); on way to Rajakhoh, Patalkot, alt. ca 400 m, epiphytic, 20.12.1993, 205718, 205732, 205733 (LWG), leg. V. Nath & A.K. Asthana; near Jambu Dweep, alt. ca 854 m, on rock, 29.11.2006, 227644 (LWG), leg. V. Sahu & V. Awasthi; Apsara Vihar, alt. ca 920 m, on soil covered rocks, 07.11.2011, 263147 (LWG); on way to Bee Fall, alt. ca 940 m, epiphytic, 08.11.2011, 263120 (LWG), leg. A.K. Asthana & R. Gupta.

***Entodontopsis leucostega* (Bridel) Buck & Ireland,** Nova Hedwigia 41: 103 – 104. 1985.

Syn: *Stereophyllum decorum* (Mitt.) Wijk. & Marg., Taxon 9: 52.1960.

(Plate 24: Figs. 1-15)

Plants prostrate, yellowish – green, main stem creeping, branching distant and irregular. **Stem** oval in cross section, cortical cells thin walled smaller, medullary cells larger. **Leaves** erectopatent, bent at one side or revolute on one side, ovate – lanceolate, tip acute, $\pm$ 2 × 0.7 mm in size, margin smooth; costa strong, light coloured, covering more than half leaf length. **Leaf cells** linear, slender, spindle shaped $\pm$ 65 × 6 µm at apex, $\pm$ 64 × 6 µm at midleaf region, basal cells quadrate and broader than rest leaf cells $\pm$ 26 × 22 µm forming characteristic alar region. **Seta** erect or slightly bent, dull

brownish orange in colour, ±12 mm long; **capsule** ovate – cylindrical, ± 18 × 0.4 mm in size; **peristome** normal, double with high basal membrane, endostome light coloured, may be split along the median line, as high as exostome; spores yellowish brown, smooth, ± 23 µm in diameter.

Peristome under SEM: a row of exostome teeth exhibiting minute papillae over the upper 3/4th region of teeth, while lower region is smooth. Cells are alternatively arranged in a plate like manner on each tooth.

Spores under SEM: sub-spherical in shape, sporoderm ornamented with rounded pebbles which are scattered to densely arranged all over, proximal face with very thick ridge having the same ornamentation pattern.

Ecology & Distribution: plants growing epiphytically at Chota Mahadev, on way to Chota Mahadev, on way to Bee Fall, on way to Apsara Fall near and at Rajat Prapat, Panchali Kund, on way to Dhoopgarh and on way to Bee Fall from 800 – 1096 m.

Range of Distribution: Bolivia, Brazil, Colombia, Costa Rica, Ecuador, El Salvador, Guatemala, Honduras, India: central India (Achanakmar, Amarkantak, Gujarat, PBR), Punjab & west Rajasthan Plains (Rajasthan) Western Himalaya (Kumaon), Nepal, Mexico, Myanmar, Panama, Paraguay, Peru, Thailand, Venezuela.

Specimens examined: India, Madhya Pradesh, PBR: Chota Mahadev (Tamia), alt. ca 953 m, epiphytic, 11.10.1992, 205520 (LWG), leg. V. Nath & A.K. Asthana; on way to Chota Mahadev, alt. ca 953 m, epiphytic, 29.11.2006, 227629, 227630B (LWG); on way to Bee Fall, alt. ca 854 m, epiphytic, 30.11.2006, 227659 A (LWG); on way to Apsara Vihar, alt. ca 822 m, epiphytic, 01.12.2006, 227689 (LWG), leg. V. Sahu & V. Awasthi; Pandav Caves, alt. ca 1004; 1065 m, on dry rocks, epiphytic, 07.11.2022, 263120, 263124 (LWG); on way to Rajat Prapat, alt. ca 988 m, epiphytic, 07.11.2011, 263130 (LWG); Rajat Prapat, alt. ca 963 m, epiphytic & on soil, 07.11.2011, 263136 (LWG); Panchali Kund, alt. ca 938 m, on rocks, epiphytic 07.11.2011, 263151A, 263157 (LWG); on way to Dhoopgarh, alt. ca 1096 m, epiphytic, 07.11.2011, 263169, 263172B, 263173, 263175, 263176, 263177 (LWG); on way to Bee Fall, alt ca 940 m, epiphytic, 08.11.2011, 263198 (LWG), leg. A.K. Asthana & R. Gupta.

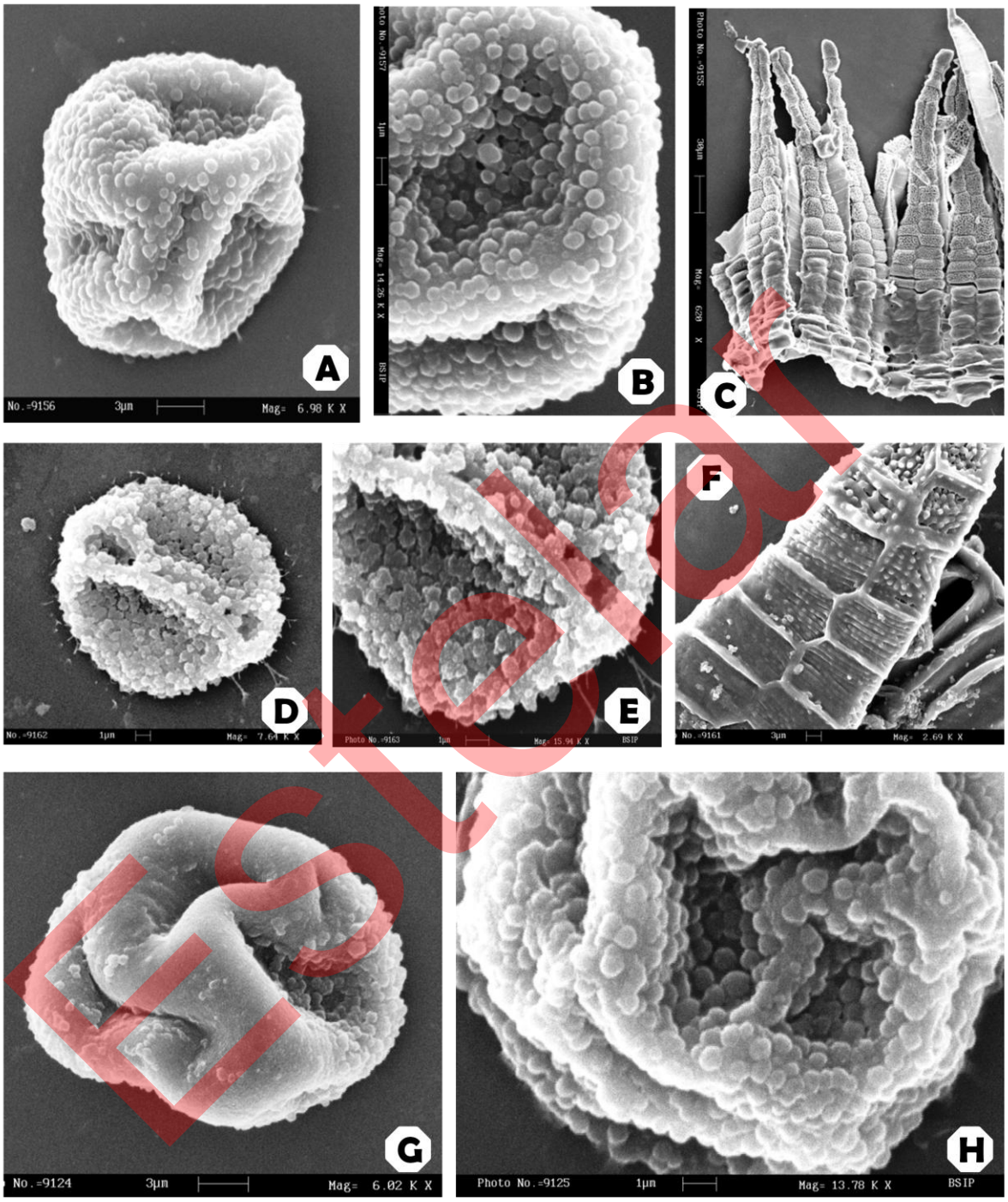
Plate-24

***Entodontopsis leucostega* (Brid.) Buck & Ireland.,** Figs. 1-15: 1. plant with sporophyte, 2. cross section of axis, 3-6. leaves, 7. apical leaf cells, 8. median leaf cells. 9. basal leaf cells, 10,11. peristome, 12-15. spores.

Plate-25

***Entodontopsis setshwanica* (Broth.) Buck & Ireland.,** Figs. 1-14: 1. plant with sporophyte, 2. vegetative plant, 3. cross section of axis, 4-6. leaves, 7. apical leaf cells, 8. median leaf cells, 9. basal leaf cells, 10. peristome showing endostome and exostome teeth, 11-14. spores.

PLATE- II



Figs. A-C.: *Entodontopsis leucostega* (Brid.) W. R. Buck & Ireland: A. spore, B. enlarged view of spore, C. peristome, Figs. D-F. *E. nitens* (Mitt.) W. R. Buck & Ireland: D. spore, E. enlarged view of spore, C. enlarged peristome, G,H. *E. setschwanica*: G. spore, H. enlarged view of spore.

***Entodontopsis setschwanica* (Broth.) Buck & Ireland,** Nova Hedwigia 41: 103 – 104. 1985.

Syn: *Stereophyllum setschwanicum* Broth., Sitz. Ak. Wiss. Wien Math. Nat. Kl. Abt. 1, 133: 581. 1924.

(Plate 25: Figs. 1-14)

Plants prostrate, light green to yellowish green, densely arranged leaves, creeping stem with rhizoid clusters at intervals, branching non – uniform, scarce. **Stem** oval to circular in diameter, thick walled cortical cells gradually becoming larger towards centre. **Leaves** mostly tilted and appressed to stem on one side, ovate – lanceolate, ± 1.9 × 0.75 mm in size, acute, acuminate apex, margin smooth; **costa** light brown, strong, ending after the midleaf, cells around upper region of the costa tinted in most of the leaves. **Leaf cells** linear, spindle shaped, ± 89 × 8 µm at apex, ± 87 × 7.6 µm at midleaf, alar cells quadrate – rectangular ± 20 × 18 µm in size, prominent. **Seta** erect, smooth brownish – wheatish coloured; capsule horizontal or bent, ovate – cylindrical, deep brownish red, ± 18 × 0.6 mm in size; **peristome** double with endostome not well developed, represented by pale segments; spores smooth, dull brownish – green coloured, ± 17 µm in size. **Spores under SEM**: irregularly spherical in outline with rounded pebbles all over the sporoderm. Proximal face with very thick and wavy tri-radiate ridge.

Ecology & Distribution: plants growing epiphytically near Down fall and on way to Apsara Vihar, on way to Dhoopgarh, on way to Bee Fall from 720 – 1096 m.

Range of Distribution: China, India: central India (Achanakmar, Amarkantak, Gujarat, PBR), eastern Himalaya (Darjeeling), Punjab & west Rajasthan Plains (Rajasthan), Nepal, Myanmar.

Specimens examined: India, Madhya Pradesh, PBR: near Down Fall, alt. ca 884 m, epiphytic, 28.11.2006, 227606 (LWG); on way to Apsara Vihar, alt. ca 732 m, epiphytic, 01.12.2006, 227690 (LWG), leg. V. Sahu & V. Awasthi; on way to Dhoopgarh, alt. ca 1096 m, epiphytic, 07.11.2011, 263171 (LWG); on way to Bee Fall, alt ca 940 m, epiphytic 08.11.2011, 263197 (LWG), leg. A.K. Asthana & R. Gupta.

Family: Hypnaceae Schimp.

Key to the genera of family Hypnaceae at PBR:

1. Leaves homophyllous, leaf base cells well differentiated, capsule erect, cilia rudimentary or absent ..... ***Platygyriella***

   Leaves homophyllous or slightly heterophyllous, leaf base cells less differentiated, capsule inclined or pendulous, cilia well developed **2**

2. Branches complanate ……..... **3**

   Branches non complanate **5**

3. Leaves in two rows, pseudoparaphyllia foliose …… ***Taxiphyllum***

   Leaves in more than two rows, pseudoparaphyllia filamentous or absent …..... **4**

4. Pseudoparaphyllia filamentous, propagules absent ..... ***Isopterygium***

   Pseudoparaphyllia absent, propagules present …… ***Pseudotaxiphyllum***

5. Leaves falcate, sharply acuminate ..... ***Hypnum***

   Leaves less falcate, sharply to broadly acuminate ……..... **6**

6. Leaf cells narrower, linear, margin entire to strongly dentate ……..... ***Ectropothecium***

   Leaf cells broader, margin entire to weakly denticulate ..... ***Vesicularia***

Genus: *Platygyriella* Cardot.

Plant prostrate, yellowish-green to, goldenish, glossly, small, forming tuft. Leaves small, densely arranged, ovate-lanceolate to concave, narrowly acuminate margin entire, smooth; costa short double, faint at times, basal cells may be conspicuosly larger, distinct.

***Platygyriella aurea* (Schwägr) W.R. Buck,** Brittonia 36: 86.1984**.**

Basyn: *Neckera aurea* Schwägr., Sp. Musc. Frond. Suppl., 3(1): 2176. 1827.

Syn: *Bryosedgwickia aurea* (Schwägr) M. Fleisch., Hedwigia, 63: 211. 1922.

(Plate 26: Figs. 1-10)

Plant prostrate, yellowish-green, goldenish tinted, glossly, small, forming tufts, giving rise to short branches, rhizoids dark brown in tufts. **Stem** creeping, ovato-circular in cross section, outer cortical cells, smaller, thick walled, inner medullary cells larger, thick walled. **Leaves** small, densely arranged, ovate-lanceolate, concave, 1.12-1.5 mm long, 0.368-0.45 mm wide; costa short, yellowish-golden, double, faint at times. **Leaf cells** papillate, irregular, spindle shaped to rhomboidal, small at apex, ± 52

Plate-26

***Platygyriella aurea* (Schwagr.) W.R. Buck.,** Figs. 1-10: 1. vegetative plant, 2. cross section of axis, 3-7. leaves, 8. apical leaf cells, 9. median leaf cells, 9. basal leaf cells.

x 6 µm, getting larger downwards, ± 70 x 8 µm at base, extreme basal cells may be conspicuosly larger. Sporophyte not seen.

Ecology & Distribution: plants growing epiphytically on way to Jalgali and on way to Bee Fall from 850 – 900 m.

Range of Distribution: Bhutan, India: central India (PBR), eastern Himalaya (Darjeeling, Khasi hills, Sikkim), western Himalaya (Dharamsala, Ranikhet), Nepal.

Specimens examined: India, Madhya Pradesh, PBR: on way to Jalgali, alt. ca 900 m, epiphytic (on *Shorea robusta*), 16.12.1993, 205559 (LWG). leg. V. Nath & A.K. Asthana; on way to Bee Fall, alt. ca 854 m, epiphytic, 30.11.2006, 227659B (LWG). leg. V. Sahu & V. Awasthi; Pandav Caves, alt. ca 1065 m, on dry rocks, 07.11.2011, 263122 (LWG); near Rajat Prapat alt. ca 988 m, epiphytic, 07.11.2011, 263129 (LWG); on way to Dhoopgarh, alt. ca 1096 m, epiphytic, 07.11.2011, 263172A, 263174, 263183 (LWG); Bee Dam, alt ca 976 m epiphytic 08.11.2011, 263190B (LWG). leg. A. K. Asthana & R. Gupta.

The species is widely known and accepted as *Bryosedgwickia aurea* (Schwägr) M. Fleisch and authors still use this name to address the species, but Buck (1984) has suggested a new combination for the same under the name *Platygyriella aurea* (Schwägr.) W.R. Buck. Considering the details in that work and the synonymy thereof, the species has been treated and described here in accordance to Buck's work.

Genus: *Taxiphyllum* Fleisch.

Plants prostrate, glossy, yellowish- green forming dense mats, branching irregularly. Leaves in two rows, dense, erectopatent, ovate-lanceolate, short accuminate, margin very slightly denticulateto smooth; costa short double, indistinct in some leaves. Leaf cells slender, distinc row at basal region.

Key to the species of genus *Taxiphyllum* at PBR:

1. Plants small, forming loose mats, leaves smaller, margin faintly dentate towards apex, costa double, distinct ..... ***T. giraldii***

   Plants medium, forming extensive mats, leaves larger, margin mildly dentate from top to base, costa double, may be indistinct ……..…… ***T. taxirameum***

***Taxiphyllum giraldii* (C. A. Müll.) M. Fleisch.**, Musci. Fl. Buitenz. 4: 1435. 1923.

Bsyn: *Plagiothecium giraldii* C. A. Müll., Neuv. Giorn. Bot. Ital. n. ser. **3**: 114 1896.

Syn: *Isoptergygium giraldii* (C. A. Müll.) Paris, Index Bryol. Suppl. 219. 1900.

(Plate 27: Figs. 1-11)

Plants prostrate, glossy, slender, yellowish green forming extensive mats. Stem creeping, branching irregular. **Stem** circular in cross section, shows smaller cells at periphery getting larger towards centre, uniformly thin walled. **Leaves** in two rows, dense, erectopatent, concave, ovate-lanceolate, short accuminate, ± 1.12 x 0.40 mm, margin very slightly denticulate; **costa** short double, indistinct in some leaves. **Leaf cells** rhomboid, spindle shaped slightly papillate ± 36 x 8.5 µm at apex, ± 55 x 7.9 µm at basal region, extreme basal cells quadrate to rectangular. Sporophyte not seen.

Ecology & Distribution: plants growing on soil over rocks, Rajakhoh (Patalkot), 400m.

Range of Distribution: Argentina, China, India: Andaman & Nicobar Islands, central India (Amarkantak, PBR), eastern Himalaya, South India, western Himalaya (Kumaon). Japan, Malaysia, Nepal, Taiwan, Vietnam.

Specimens examined: India, Madhya Pradesh: Rajakhoh (Patalkot), alt. ca 400 m, 20.12.1993, on soil over rocks, 205734, 205736 (LWG), leg. V. Nath & A.K. Asthana.

***Taxiphyllum taxirameum* (Mitt.) M. Fleisch.,** Musci Fl. Buitenz., 4: 1436. 1923.

Basyn: *Isopterygium maniae* Ren. & Par., Rev. Bryol., 29: 84.1902.

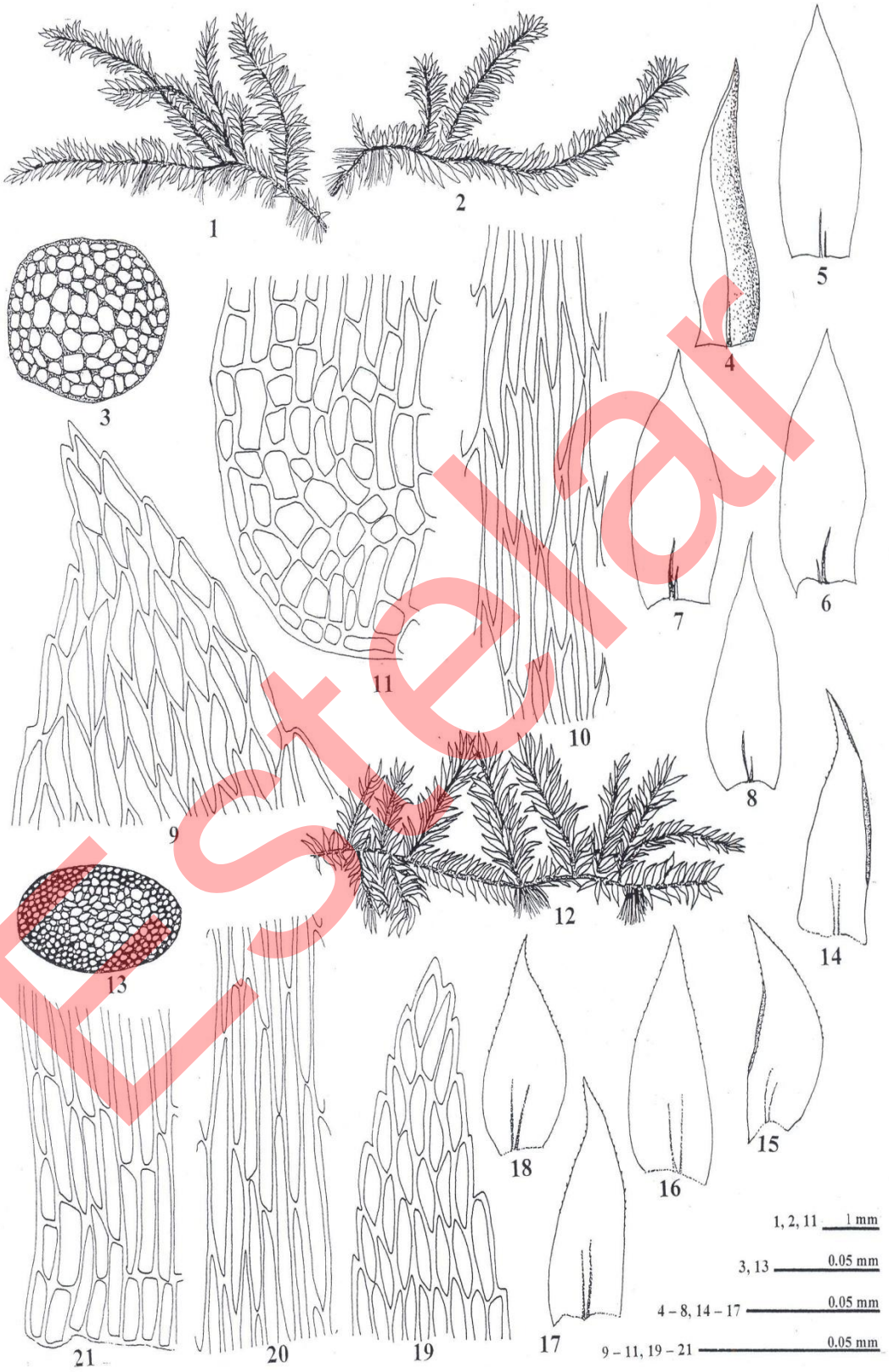
Syn: Taxiphyllum maniae (Renauld & Paris) M. Fleisch., Musci Fl. Buitenz., 4: 1436. 1923

(Plate 27: Figs. 12-21)

Plants prostrate, yellowish-green to pale green, glossy, matted, branching profuisely, irregularly, branches short. **Stem** oval in cross section, outer cortical cells smaller, thick walled, inner medullary cells larger, thin walled. creeping. **Leaves** spreading, ovate, lanceolate, short acuminiate, ± 0.8 x ± 0.25 mm in size, margin slightly dentate; costa short, double. **Leaf cells** narrow, spindle shaped to rhomboid, papillose at tips, ± 42 x 4.17 µm at apex, longer ± 55 x 4.17 µm at middle, basal cells recatngular, large, 58-66.7 x 8 µm in size. Sporophyte not seen.

Ecology & Distribution: plants growing near water stream on rocks at Patthar Chatta, near Jambu Dweep, on way to Apsara Vihar; 854-914m.

Plate-27



***Taxiphyllum giraldii* (C. A. Mull.) M. Fleisch.,** Figs. 1-11: 1,2. vegetative plants, 3. cross section of axis, 4-8. leaves, 9. apical leaf cells, 10. median leaf cells, 11. basal leaf cells; ***Taxiphyllum taxirameum* (Mitt.) M. Fleisch.** Figs. 12-21: 12. vegetative plant, 13. cross section of axis, 14-18. leaves, 19. apical leaf cells, 20. median leaf cells, 21. basal leaf cells.

Range of Distribution: Australia, Bangladesh, India: Andaman & Nicobar Islands, central India (Amarkantak, PBR), eastern Himalaya (Arunachal Pradesh, Assam, Darjeeling, Khasia Hills, Orissa), South India (Croog, Palni), western Himalaya (Almora, Musoorie, Nainital, Ranikhet, Simla), Japan, Java, Korea, Madagascar, Nepal, Paupa New Guinea, Phillipines, Siberia, Sumatra, Taiwan, Thailand, Vietnam.

Specimens examined: India, Madhya Pradesh, PBR: on way to Little Fall, alt. ca 914 m, on wet rocks, 28.11.2006, near Jambu Dweep, 854 m, on rocks, 29.11.2006, on way to Apsara Vihar, alt. ca 732 m, on rocks, 01.12.2006; 229386B (LWG), 227645 (LWG), 227664B (LWG), 227693B (LWG), 227698 (LWG), leg. V. Sahu & V. Awasthi.

Genus: *Isopterygium* Mitt.

Plants prostrate, slender, yellowish – green in lax tufts, branching irregularly to pinnate. Stem oval in cross section, outer cortical cells smaller, inner medullary cells longer. Leaves in three rows, ovate- lanceolate, concave, acuminate, margin smooth sometimes crenulated at top or throughout; costa short double, sometimes faint. Leaf cells slender, basal cells slightly differentiated.

Key to species of genus *Isopterygium at* PBR:

1. Plants irregularly branched, Leaves less broad, tips long acuminate ……..……..... ***I. assamicum***

   Plants regularly pinnately branched, Leaves broader, tips short acuminate ……..... ***I. pallidulum***

***Isopterygium assamicum* (Mitt.) A. Jaeger**, Ber. S. Gall Naturw. Ges. 1876-77: 432. 1878.

(Plate 28: Figs. 1-12)

Plants prostrate, slender, yellowish – green in lax tufts, branching irregularly. **Stem** oval in cross section, outer cortical cells smaller, inner medullary cells longer. **Leaves** ovate- lanceolate, concave, acuminate, ± 0.98 x 0.25 mm, margin smooth; **costa** short double, sometimes faint. **Leaf cells** linear, elongated, ± 35 x 4.5 µm at apex, ± 58 x 6.0 µm at middle, ± 60 x 6 µm towards base, basal row of irregular rectangular cells present. Sporophyte not seen.

Ecology & Distribution: plants growing on soil near water stream and on damp rocks at Jambu Dweep and Mahadeo Caves from 900-1000 m.

Range of Distribution: Antarctica, India: central India (PBR), eastern Himalaya (Assam, Naga hills), Myanmar, Thailand.

Specimens examined: India, Madhya Pradesh, PBR: Jambu Dweep, alt. ca 900 m, on soil near stream, 17.12.1993, 205616 (LWG); Mahadeo Caves, alt. ca 1000m, on damp rocks, 17.12.1993. 205645 (LWG), leg. V. Nath & A.K. Asthana.

***Isopterygium pallidulum* (Mitt.) A. Jaeger**, Ber. S. Gall. Naturw. Ges., 1876-77: 832. 1878.

Basnym: *Stereodon pallidus* Mitt., Musci Ind Or.: 105. 1859.

(Plate 28: Figs. 13-23)

Plants prostrate, yellowish green, glossy in lax patches, parallel, pinnate branches. **Stem** oval in cross section, outer cortical cells very small thick walled, inner medullary cells larger. **Leaves** erectopatent, ovate, apiculate, ± 0.80 x 0.34 mm, margin crenulate; **costa** short double, sometimes indistinct. **Leaf cells** linear, elongated, ± 40 x 6µm at apex, ± 52 x 6.5 µm below, extreme basal cells slightly larger. Sporophyte not seen.

Ecology & Distribution: plants growing on soil over rocks at Chota Mahadev (Tamia), 950 m.

Range of Distribution: China, India: central India (PBR), eastern Himalaya (Assam, Manipur), western Himalaya (Chamba, Dalhousie, Kumaon), Japan.

Specimens examined: India, Madhya Pradesh, PBR: Chota Mahadov (Tamia), alt. ca 950 m, on soil over rocks, 19.12.1993, 205707 (LWG), leg. V. Nath & A.K. Asthana.

Genus: *Pseudotaxiphyllum* (Bridel) Iwats.

Plants prostrate, yellowsh-green, glossy, slender, branching irregularly, branches complanate. Leaves spreading, ovate lanceolate, rounded at base, apex acute, margin flat, smooth to slightly dentate; costa short double, faint. Leaf cells elongated, rhomboidal, slender, extreme basal row made up of differentiated cells.

***Pseudotaxiphyllum elegans* (Bridel) Iwats.,** Jour. Hattori Bot. Lab. 63: 449. 1987.

Basyn: *Isothecium elegans* Bridel, Bryol. Univ., 2: 366. 1827.

Syn: *Isopterygium elegans* (Bridel) Lindb., Not. Sällsk. Fauna Fl. Fenn. Förh. 13: 416. 1874.

(Plate 29: Figs. 1-11)

Plate-28

***Isopterygium assamicum* (Mitt.) A. Jaeger.,** Figs. 1-12: 1. plant with sporophyte, 2. cross section of axis, 3-6. leaves, 7. apical leaf cells, 8. median leaf cells, 9. basal leaf cells, 10. capsule, 11. peristome, 12. Spores; ***Isopterygium pallidulum* (Mitt.) A. Jaeger.** Figs. 13-23: 13. vegetative plant, 14. cross section of axis, 15-20. leaves, 21. apical leaf cells, 22. median leaf cells, 23. basal leaf cells.

Plate-29

***Pseudotaxiphyllum elegans* (Brid.) Iwats.,** Figs. 1-11: 1. vegetative plant, 2. cross section of axis, 3-8. leaves, 9. apical leaf cells, 10. median leaf cells, 11. basal leaf cells.

Plants prostrate, yellowsh-green, bright, glossy, slender, growing in patches, branching irregularly, branches complanate. **Stem** circular in cross section, outer cortical cells smaller, thick walled, inner medullary cells larger. **Leaves** spreading, ovate lanceolate, concave, rounded at base, acute apex, ±1.0 x 0.29 mm in size, margin dentated at tip; **costa** short double, faint sometimes. **Leaf cells** elongated, rhomboidal, slender, ± 50 x 6.5 µm at apex, ± 67 x 6.5 µm below, extreme basal row made up of rectangular but less differentiated cells. Sporophyte not seen.

Ecology & Distribution: plants growing on soil at Little Fall, 884 m.

Range of Distribution: Austria, Belgium, Finland, France, Germany, India: central India (Amarkantak, PBR), western Himalaya (Simla), Ireland, Japan, Nepal, Netherlands, New Zealand, Norway, Poland, Spain, Sweden, United Kingdom, United States.

Specimens examined: India, Madhya Pradesh, PBR: Little Fall, alt. ca 884 m, 28.11.2006, on wet rocks, 299393 (LWG), leg. V. Sahu & V. Awasthi.

Genus: *Hypnum* Hedw.

Plants prostrate, yellowish green, tufted, branching pinnately, profusely. Stem leaves less densely arranged, falcato-secund, hooked at apex, branch leaves dense, erectopatent, falcatosecund or hooked at tip when dry, concave, ovate-lanceolate, apex acuminate, acute, margin slightly denticulate at tip, to smooth; costa very indistinct, short, double.

***Hypnum plumaeforme* Wilson,** London J. Bot., 7: 277. 1848.

(Plate 30: Figs. 1-11)

Plants prostrate, medium sized, yellowish green, glossy forming tufts, branching pinnately, profusely. **Stem** oval in cross section, outer cortical cells smaller, thick walled, inner cells larger conspicuously, uniformely. **Stem leaves** less densely arranged, branch leaves dense, erectopatent, falcatosecund or hooked at tip when dry, concave, ovate-lanceolate, ± 0.7 x 0.24 mm in size, apex narrow, acute, margin slightly denticulate at tip, smooth below; **costa** very slightly distinct, short, double. **Leaf cells** slender, linear with wavy prose walls, ± 27 x 5 µm at apex, ± 58 x 5.25 µm below, extreme basal cells large rectangular ± 25 x 18 µm, followed by 1-2 rows of irregular cells upwards, stem leaves usually have larger alar cells. Sporophyte not seen.

Ecology & Distribution: plants growing on moist rocks at Chota Mahadev, Apsara Vihar, on way to Twynam Pool. 732-854 m.

Range of Distribution: Canada, China, India: central India (PBR), Japan, Korea, Laos, Malaysia, Nepal, Philippines, Russia, Sri Lanka, Taiwan, United States, Vietnam.

Specimens examined: India, Madhya Pradesh, PBR: on way to Twynam Pool, alt. ca 854 m, 29.11.2006, on rocks; Duchess Fall, alt. ca 732 m, 30.11.2006, on moist rocks; Apsara Vihar, alt. ca 732 m, 01.12.2006, on moist rocks, 227620B (LWG), 227623 (LWG), 227677 (LWG), 227694B (LWG), leg. V. Sahu & V. Awasthi.

Genus: *Ectropothecium* Mitt.

Plants prostrate, small, yellowish-green, in lax tufts, profusely, irregularly to pinnately branched. Leaves ercetopatent, falcate to ovate-lanceolate apex acute, margin denticulate at apex, smoother below; costa short double faint to distinct. Leaf cells, narrow, spindle shaped to rhomboid, basal row of smaller or distinct cells.

Key to the species of genus *Ectropothecium* at PBR:

1. Plants irregularly branched, leaf cells smooth throughout the leaf ..... ***E. dealbatum***

   Plants pinnately branched, leaf cells weakly to distinctly papillose (at least at tips) **2**

2. Leaf tip broader, slightly assymetrical at times ..... ***E. rostellatum***

   Leaf tip narrower, always symmetrical ..... ***E. cyperoides***

***Ectropothecium dealbatum* (Reinw. & Hornsch.) A. Jaeger,** Ber. S. Gall. Naturw. Ges., 1977-78: 264. 1880.

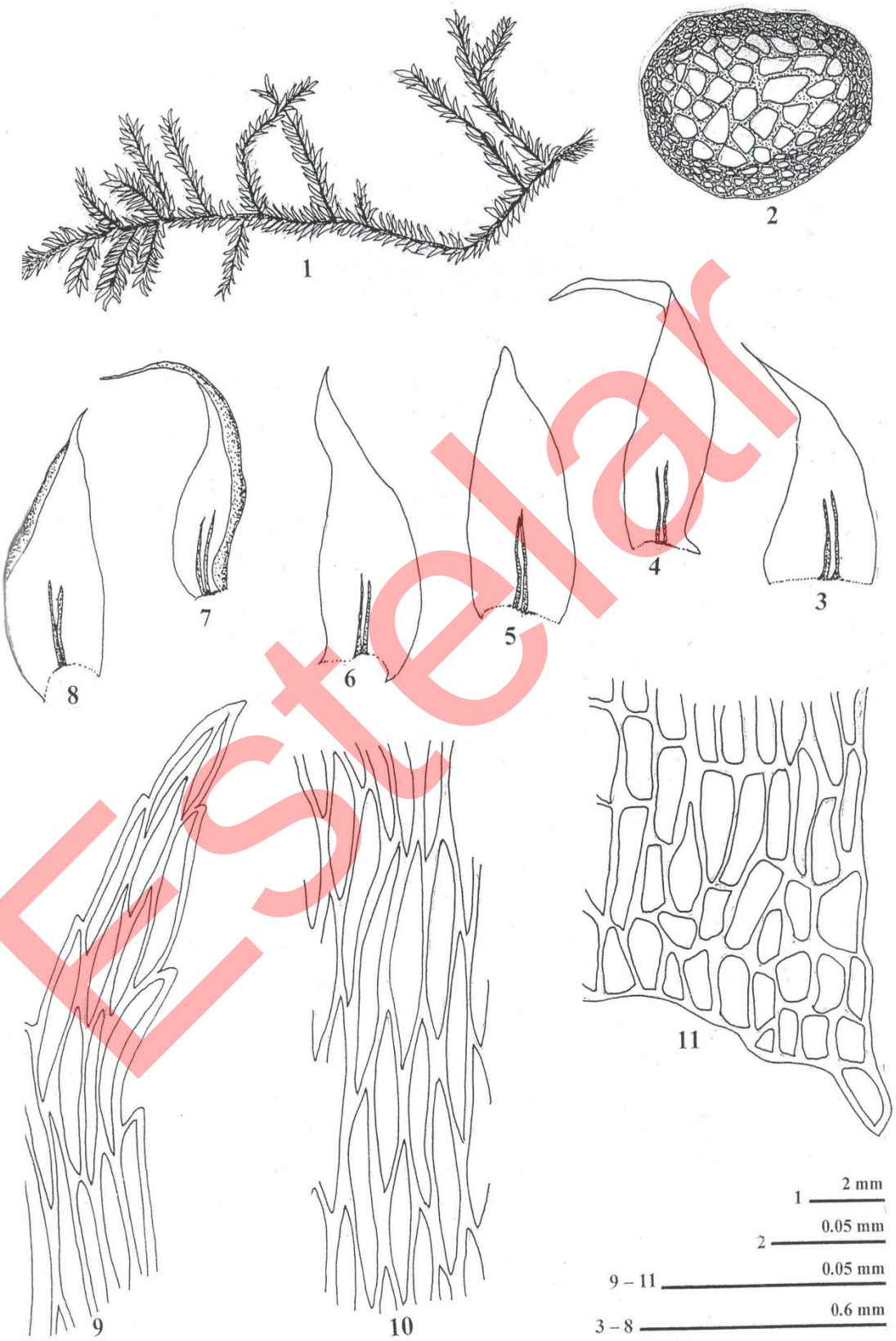
Basyn: *Hypnum dealbatum* Reinw & Hornsch., Nov. Act. Ac. Car. Leop. Caes. 14(2): 729. 1829.

Syn: *Hypnum ochron* Schwägr in Sp. Musc. Frond. Suppl., 3(2): 285. 1830.

(Plate 31: Figs. 1-9)

Plants prostrate, small, yellowish-green, sikly in lax tufts, profusely, irregularly branched. **Stem** circular in cross section, cortical cells smaller, thick walled, medullary cells larger, graduating to smaller 4-6 cells towards centre. **Leaves** ercetopatent, shrunk, ovate-lanceolate, ± 0.9 x 0.34 mm, acute apex, margin denticulate at apex,

Plate-30



***Hypnum plumaeforme* Wilson.,** Figs. 1-11: 1. vegetative plant, 2. cross section of axis, 3-8. leaves, 9. apical leaf cells, 10. median leaf cells, 11. basal leaf cells.

Plate-31

***Ectropothecium dealbatum* (Reinw. & Hornsch.) A. Jaeger.,** Figs. 1-9: 1. vegetative plant, 2. cross section of axis, 3-6. leaves, 7. apical leaf cells, 8. median leaf cells, 9. basal leaf cells.

smoother below; **costa** short double. **Leaf cells** non-papillate, narrow, spindle shaped to rhomboid, ± 58 x 5 µm at tip, ± 90 x 5.25 µm at middle, basal cells rectangular ± 25 x 14 µm, alar slightly distinguished with one bigger marginal cell at base, rest quadrate-rectangular cells. Sporophyte not seen.

Ecology & distribution: plants growing on rocks, on way to Chota Mahadev and near Jambu Dweep. 793-854 m.

Range of Distribution: Borneo, India: central India (PBR), eastern Himalaya (Arunachal Predesh), Indonesia, Java, Papua New Guniea, Philippines, Sumatra, Thailand.

Specimens examined: India, Madhya Pradesh, PBR: on way to Chota Mahadev, alt. ca 853.5m, 29.11.2006, on rocks; near Jambu Dweep, alt. ca 793 m., 29.11.2006, on rocks, 227624A (LWG), 227647 (LWG), leg. V. Sahu & V. Awasthi.

***Ectrophothecium rostellatum* (Mitt.) A. Jaeger**, Ber. S. Gall. Naturw. Ges., 1877-78: 258. 1859.

(Plate 32: Figs. 1-10)

Plants prostrate, medium sized, glossy, forming mats, branching pinnately. **Stem** oval in cross section, outer cortical cells small, thick walled, inner madullary cells, thin walled, larger. **Leaves** falcate, erectopatent, ovate - lanceolate, ± 1.02 x 0.36 mm, asymmetrical sometimes, apex acute, margin dentate at apex; **costa** short double. **Leaf cells** narrow, rhomboidal, ± 30 x 5.2 µm at apex, broader and longer below, ± 52 x 6 µm, basal row of cells smaller, quadrate, alar indistinct. Sporophyte not seen.

Ecology & Distribution: plants growing on moist soil over rocks at Patthar Chatta, 1000 m.

Range of Distribution: Thailand, Nepal, India: central India (PBR), eastern Himalaya (Darjeeling).

Specimens examined: India, Madhya Pradesh, PBR: Patthar Chatta, alt. ca 1000 m, on soil over rocks, 18.12.1993, 205665 (LWG), leg. V. Nath & A.K. Asthana.

***Ectropothecium cyperoides* (Hook. ex Harv.) A. Jaeger,** Ber. S. Gall. Naturw. Ges., 1877-78: 259. 1880.

Basyn: *Hypnum cyperoides* Hook. Icon. Pl. 1: pl. 23: f. 5. 1836.

(Plate 33: Figs. 1-10)

Plants prostrate, small, creeping, yellowish-green, silky forming extensive mats of loose tufts. **Stem** oval in cross section, outer cells very small, thick walled in 3-4 rows, gradually increasing in size towards centre, central 4-6 cells again small in size. **Leaves** erectopatent, ovate-laceolate, shortly acuminate ± 0.67 x 0.28 mm in size; margin slightly dentate and revolute generally to one side; costa short double. **Leaf cells** rhomboid to spindle shaped, elongate, mostly papillose ± 44 x 5 µm at apex, ± 50 x 5 µm at middle, extreme basal cells quadrato-rectangular ± 12 x 6 µm in size. Sporophyte not seen.

Ecology & Distribution: plants growing on soil covered rocks, on wet rocks, on way to Twynam Pool, on way to Chota Mahadev, Jambu Dweep, Near Bee Fall, 793-854 m.

Range of Distribution: India: central India (PBR), Gangetic plains (Bihar), eastern Himalaya (Arunachal Pradesh, Assam, Nagaland), Manipur, Sikkim), South India (Khandala, Mahabaleshear), western Himalaya (Garhwal, Lohaghat), Indonesia, Java, Nepal, Sumatra.

Specimens examined: India, Madhya Pradesh, PBR: on way to Twynam Pool, alt ca 853 m, 29.11.2006, on moist rocks; on way to Chota Mahadev, alt. ca 853.5m, 29.11.2006, on soil covered rocks; Chota Mahadev Mandir, alt. ca 793 m, 29.11.2006 on wet rocks; Jambu Dweep, alt. ca 793 m, 29.11.2006 on soil covered rocks; near Jambu Dweep, alt. ca 793 m, 29.11.2006, on moist rocks, 227621 (LWG), 227628A (LWG), 227640A (LWG), 227649 (LWG), 227650 (LWG), 227654 (LWG), leg. V. Sahu & V. Awasthi.

Genus: *Vesicularia* (C. Muell) C. Muell.

Plants prostrate, small, brownish to yellowish green, glossy, in extensive mats, branched profusely, branches spreading, irregular. Leaves spreading, falcate at tips, concave, ovate-lanceolate, acuminate to abruptly acute, margin smooth to slightly dentate at apex; costa short, double, indistinct: extreme basal cells slightly rectangular.

Key to the species of genus *Vesicularia* at PBR:

1. Plants less profusely branched, leaf and leaf cells smaller, leaf tip short, gradually acute ..... ***V. reticulata***
   Plants profusely branched, leaf and leaf cells larger, leaf tip longer, narrow, abruptly acuminate ..... ***V. montagnei***

Plate-32

***Ectropothecium rostellatum* (Mitt.) A. Jaeger.,** Figs. 1-10: 1. vegetative plant, 2. cross section of axis, 3-7. leaves, 8. apical leaf cells, 9. median leaf cells, 10. basal leaf cells.

Plate-33

***Ectropothecium cyperoides* (Hook. ex Harv.) A Jaeger.,** Figs. 1-10: 1. vegetative plant, 2. cross section of axis, 3-7. leaves, 8. apical leaf cells, 9. median leaf cells, 10. basal leaf cells.

***Vesicularia reticulata* (Dozy & Molk.) Broth.,** Nat. Pfl.,1(3): 1094. 1908**.**

Basyn: *Hypnum reticulatum* Dozy & Molk., Ann. Sc. Nat., Bet., Ser. 3, 2: 309. 1844.

(Plate 34: Figs. 1-9)

Plants prostrate, small, brownish to yellowish green, glossy in extensive mats, branched densely, branches spreading, irregular, secondary branches pinnate. **Stem** creeping, oval in cross section, outer cells smaller, graduating to larger cells cells towards centre, evenly thick walled. **Leaves** spreading, falcate at tips, concave, ovate-lanceolate, acuminate, ± 1.0 x 0.47 mm in size, margin slightly dentate at apex; costa short, double, indistinct. **Leaf cells** slender, rhomboid to hexagonal, ± 32 x 7.2 µm at apex, ± 79.2 x 13 µm below; extreme basal cells slightly rectangular; alar indistinct. Sporophyte not seen.

Ecology & Distribution: plants growing on rocks at Patthar Chatta, 1000 m.

Range of Distribution: Australia, China, India: central India (PBR), eastern Himalaya (Arunachal Pradesh, Assam, Naga Hills, Sikkim), South India (Khandala, Mahabaleshwar), western Himalaya, Indonesia, Japan, Malaysia, Nepal, Papua New Guinea, Japan, New Caledonia, Philippines, Singapore, Sumatra, Taiwan, Thailand, Vietnam.

Specimens examined: India, Madhya Pradesh, PBR: Patthar Chatta, alt. ca 1000 m, on rocks, 18.12.1993, 205654 (LWG), leg. V. Nath & A.K. Asthana.

***Vesicularia montagnei* (Schimp.) Broth.,** Nat. Pfl., 1(3):1094. 1908.

Basyn: *Pterygophyllum montagnei* Bel., Voyag. Ind. Or. Bet., **2** (crypt.): 85. 1834.

(Plate 34: Figs. 10-21)

Plants prostrate, yellowish-green, forming extensive mats, branching profusely, irregular primary branches, pinnate, complanate secondary branches. **Stem** creeping, circular in cross section, cortical and medullary cells irregular in size, innermost cells, smaller. **Leaves** spreading, ovato-concave, acuminate, slightly dentate at top, ± 0.97 x 0.5 mm; **costa** short double, very faint, mostly not seen in maximum leaves here, except a few. **Leaf cells** lax, rhomboid, ± 33.4 x 14 µm at apex, ± 50.04 x 15.6 µm at middle basal cells larger, rectangular, ± 70.9 x 16.7 µm, extreme basal cells shorter; alar not differentiated. **Seta** long, dark, ± 20 mm; **capsule** pendulous, ovate-cylindrical, ± 1.65 x 0.79 mm in size; **peristome** hypnoid; **spores** dull greenish-brown, ± 13.6 µm in size.

Ecology & Distribution: plants growing epiphytically on wet soil covered rocks and moist rocks at Chota Mahadeo (Tamia), Bee Dam, Bada Mahadev and Mahadev Mandir, from 953-1075 m.

Range of Distribution: Australia, Bangladesh, Borneo, China, India: central India (PBR), eastern Himalaya (Arunachal Predesh) Gangetic Plains (lower Bengal), South India (Shervaroy Hills), western Himalaya, Indonesia, Japan, Korea, Malaysia, Papua New Guinea, Philippines, Sri Lanka, Thailand, Vietnam.

Specimens examined: India, Madhya Pradesh, PBR: Chota Mahadev (Tamia), alt. ca 953 m, epiphytic, 11.10.1992; on moist rocks, 19.12.1993, 205512 (LWG), 205694 (LWG), leg. V. Nath & A.K. Asthana; Mahadev Mandir, alt. ca 1005 m, on rocks, 28.11.2006, 227613 A (LWG), leg. V. Sahu & V. Awasthi; Bee Dam, alt. ca 963 m, on soil covered rocks, 08.11.2011, 263185 (LWG); on moist rocks, 08.11.2011, 264801, 264802, 264803 (LWG); Bada Mahadev, alt. ca 1075 m, on moist rocks, 08.11.2011, 264819 (LWG), leg. A.K. Asthana & R. Gupta.

Family: Entodontaceae Kindb.

Genus: *Entodon* C. Muell.

Plants prostrate, yellowish green, glossy, forming loose to dense tufts, dendroid, irregularly pinnately branched.. **Leaves** complanate, erectopatent, ovate-elliplical, tip acute, margin flat, sometimes finely crenulate at top; **costa** short, double, unequal, reaching up to ½ leaf length. Basal cells rectangular to quadrate.

Key to the species of genus *Entodon* at PBR:

1. Branches complanate, leaves smaller, leaf margin slightly crenulate at tip ……...……..……...…… ***E. laetus***

   Branches non-complanate, leaves larger, leaf margin dentate at tip ..…….…… ***E. nepalensis***

***Entodon laetus* (Griffith) A. Jaeger, Ber**. S. Gall. Naturw. Ges. 1876-77: 294. 1878.

Basyn: *Neckera latea* Griffith, Cal. J. Nat. Hist., 3: 67. 1843.

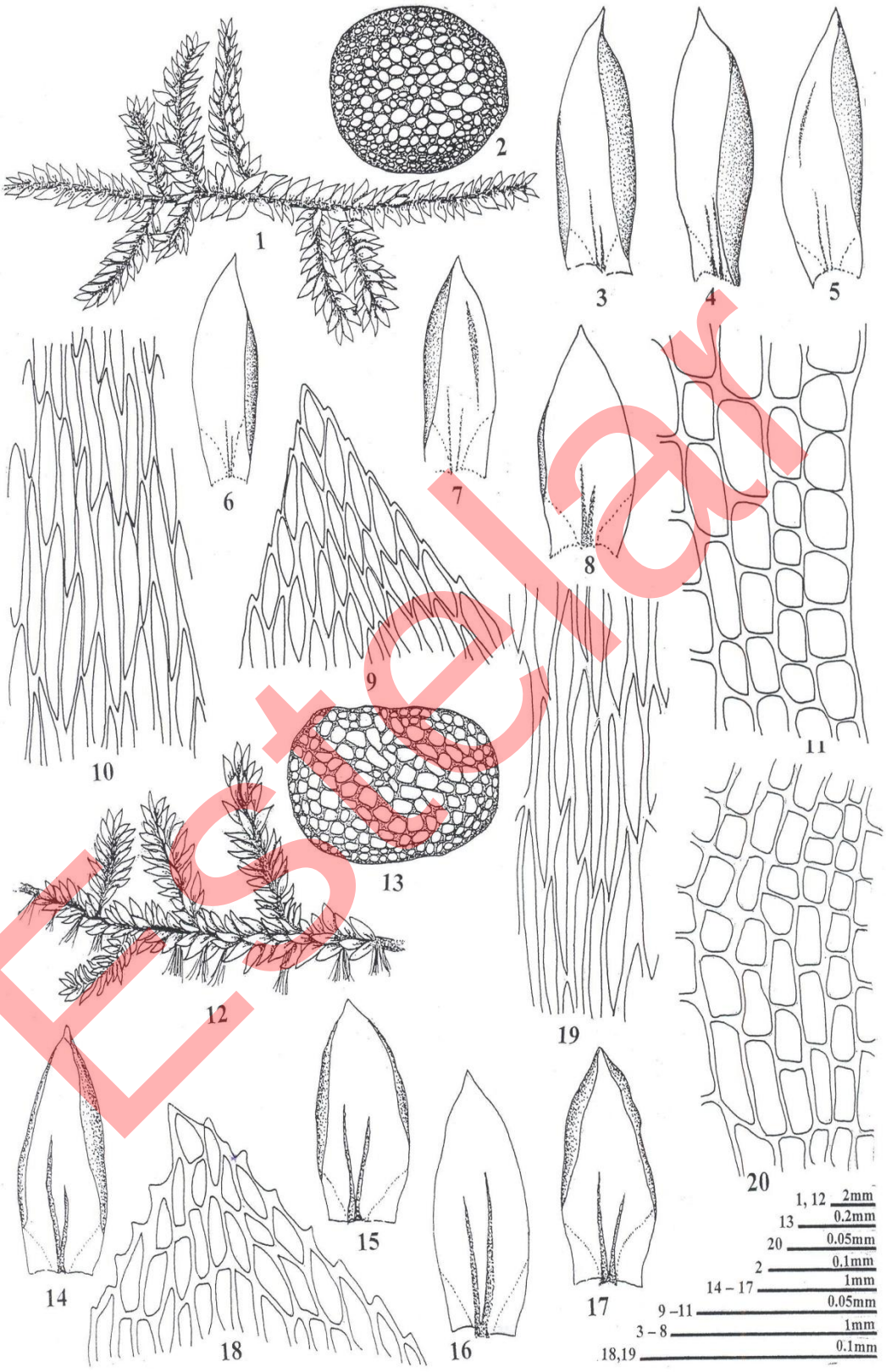
(Plate 35: Figs. 1-11)

Plants prostrate, glossy, yellowish green forming loose to dense tufts, dendroid, irregularly pinnately branched. **Stem** circular in cross section, outer cortical cells small, thick walled, inner medullary cells irregularly larger, thin walled. **Leaves** complanate,

Plate-34

***Vesicularia reticulata* (Dozy & Molk.) Broth.,** Figs. 1-9: 1. vegetative plant, 2. cross section of axis, 3-6. leaves, 7. apical leaf cells, 8. median leaf cells, 9. basal leaf cells; ***Vesicularia montagnei* (Schimp.) Broth.**, Figs. 10-21: 10. plant with sporophyte, 11. cross section of axis, 12-15. leaves, 16. apical leaf cells 17. median leaf cells, 18. basal leaf cells, 19. capsule, 20. peristome, 21. spores.

Plate-35



***Entodon laetus* (Griffith) A. Jaeger.,** Figs. 1-11: 1. vegetative plant, 2. cross section of axis, 3-8. leaves, 9. apical leaf cells, 10. median leaf cells, 11. basal leaf cells; ***Entodon nepalensis* Mizushima.** Figs. 12-20: 12. vegetative plant, 13. cross section of axis, 14-17. leaves, 18. apical leaf cells, 19. median leaf cells, 20. basal leaf cells.

erectopatent, ovate-elliplical, tip acute, ± 1.4 x 0.52 mm in size, margin flat, finely crenulate at top; **costa** short, double, unequal. **Leaf cells** elongate, ± 54 x 5.5 µm at apex, ± 57 x 8 at midleaf, basal cells rectangular to quadrate, ± 32 x 17.5 µm in size. Sporophyte not seen. **Ecology & Distribution:** plants growing on moist rocks at Apsara Fall, 734m. **Range of Distribution:** Bhutan, India: central India (Gujarat (Girnar hills), PBR), eastern Himalaya (Assam, Darjeeling, Khasia hills), western Himalaya (Uttarakhand).

pecimens examined: India, Madhya Pradesh, PBR: Apsara Fall, alt. ca 734 m, on moist rocks 01.12.2006, 227699B (LWG), leg. V. Sahu & V. Awasthi.

***Entodon nepalensis* Mizushima,** Hara: Fl. E. Him.: 584, f. 42.1966.

(Plate 35: Figs. 12-20)

Plants prostrate, glossy, yellowish - green, in loose tufts, irregularly pinnalety branched. **Stem** oval in cross section, outer cells smaller, graduating into larger cells towards inside. **Leaves** concave, imbricate, 1.7 - 2.1 x 0.60 - 0.9 mm in size, margin entire, dentate at tip; **costa** double, unequal. **Leaf cells** linear, 42-59 x 5.5-7.5 µm at apex, ± 60 x 8.3 µm at mid leaf, basal cells, numerous, quadrate, ± 30 x 16.9 µm in size. Sporophyte not seen.

Ecology & Distribution: plants growing on rocks on way to Jatashankar, 818 m.

Range of Distribution: China, India: central India (PBR), Nepal.

Specimens examined: India, Madhya Pradesh, PBR: on way to Jatashankar, alt. ca 818 m, on rocks, 29.11.2006, 227658B (LWG), leg. V. Sahu & V. Awasthi.

Family: Sematophyllaceae Broth

Genus: *Foreauella* Dix.et. P. Varde.

Plants prostrste, yellowish-green, robust, in dense mats, branches short, parallel. Leaves falcate, arranged densely on stem and branches, dimorphic. Stem leaves broadly triangular with narrow apiculate apex, branch leaves ovate-lanceolate, broadly acute tip, margin faintly crenulate, costa very short, double, faint to distinctirregular, rhomboid, alar differentiated by large cells.

***Foreauella orthothecia* (Schwägr.) Dixon. & P**. de la Varde., J. Bot., 75: 129. 1937.

Basyn: *Hypnum orthothecium* Schwäegr, Sp. Musc. Suppl., 3(1): 220b. 1827.

(Plate 36: Figs. 1-9)

Plants prostrste, yellowish-green, robust in dense mats, branches short, erect, parallel. **Stem** creeping, ovato-circular, cortical and medullary cells small, uniformely distributed. **Leaves** falcate, arranged densely on stem and branches, dimorphic. Stem leaves broadly triangular with narrow apiculate apex, branch leaves ovate-lanceolate, broadly acute tip, margin faintly crenulate, ±1.0 x 0.4 mm in size; costa very short, double, faint at times**. Leaf cells** elongated, irregular, rhomboid, thin above, ± 37 x 4.5 µm at apex, ± 39 x 4.5 µm at middle, lower cells rectangular, large rounded at alar region, ± 19 x 13 µm, hyaline, inflated. Sporphyte not seen.

Ecology & Distribution: plants growing on moist rocks at Apsara Fall, 732 m.

Range of Distribution: China, India: central India (Orissa, PBR), eastern Himalaya (Assam, Darjeeling, Khasi hills), South India (Palni), Laos, Myanmar, Nepal, Pacific Ocean Islands, Philippines, Thailand.

Specimens examined: India, Madhya Pradesh, PBR: Apsara Fall, alt. ca 732 m, on moist rocks, 01.12.2006, 227697A (LWG), leg. V. Sahu & V. Awasthi.

Family: Leskeaceae Schimp.

Genus: *Herpetineuron*(C. Muell.) Card.

Plants yellowish-green, non glossy in dense tufts. Leaves larger near branch apex, smaller below. Upper leaves erectopatent, look like at apex, ovate-lanceolate, acute apex, margin smooth below usually dentate at apex; costa extending up to the tip, flexuose at apex. Leaf cells smaller, quadrate-ciorcular, hyaline at base.

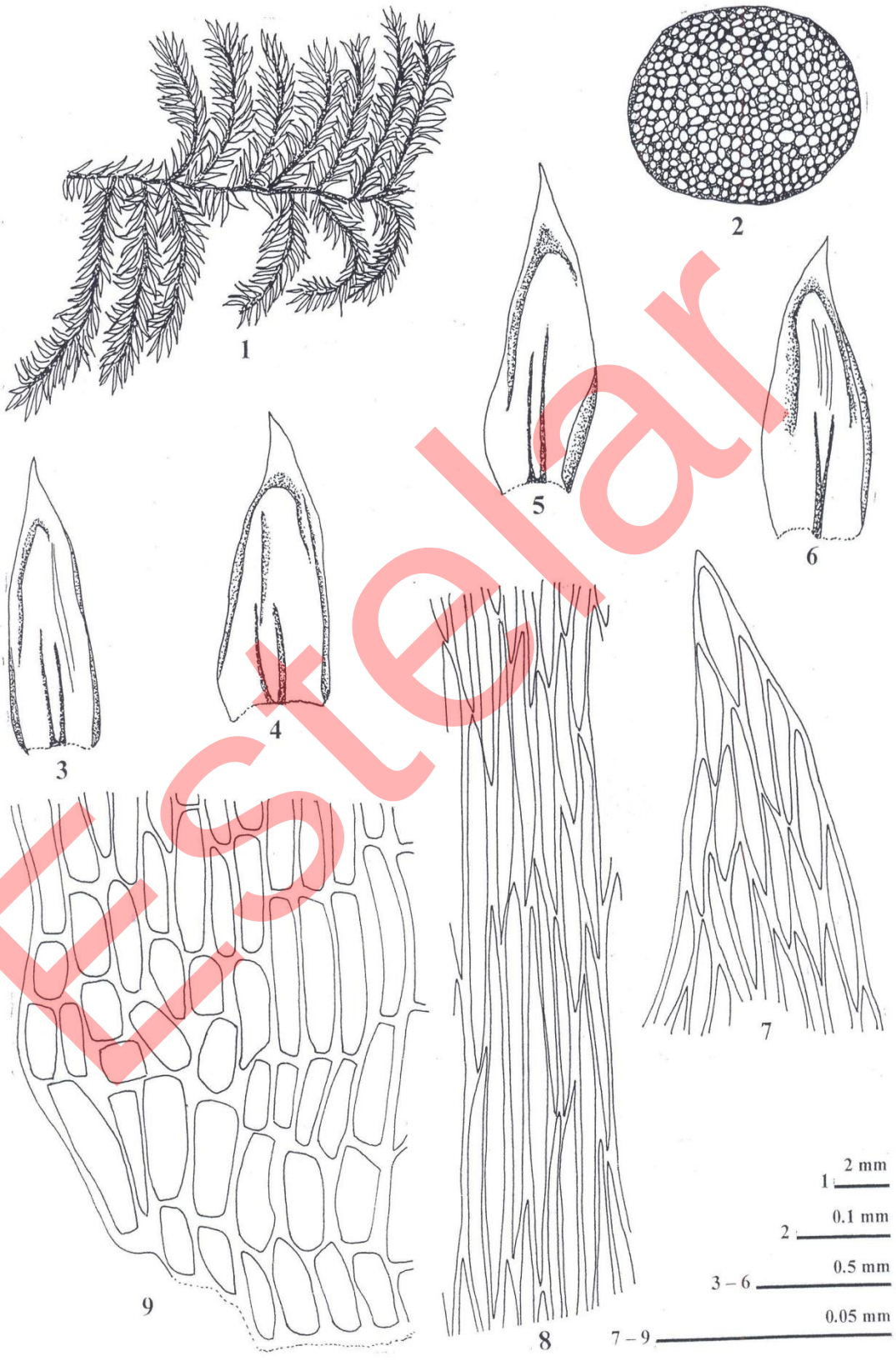
***Herpetineuron toccoae* (Sull. & Lesq.) Cardot.,** Beih. Bot. Centralbl., 19(2): 128. 1905.

Basyn: *Anomodon toccoae* Sull. & Lesq. in Musci. Bor. Am: 52. 1856.

(Plate 37: Figs. 1-10)

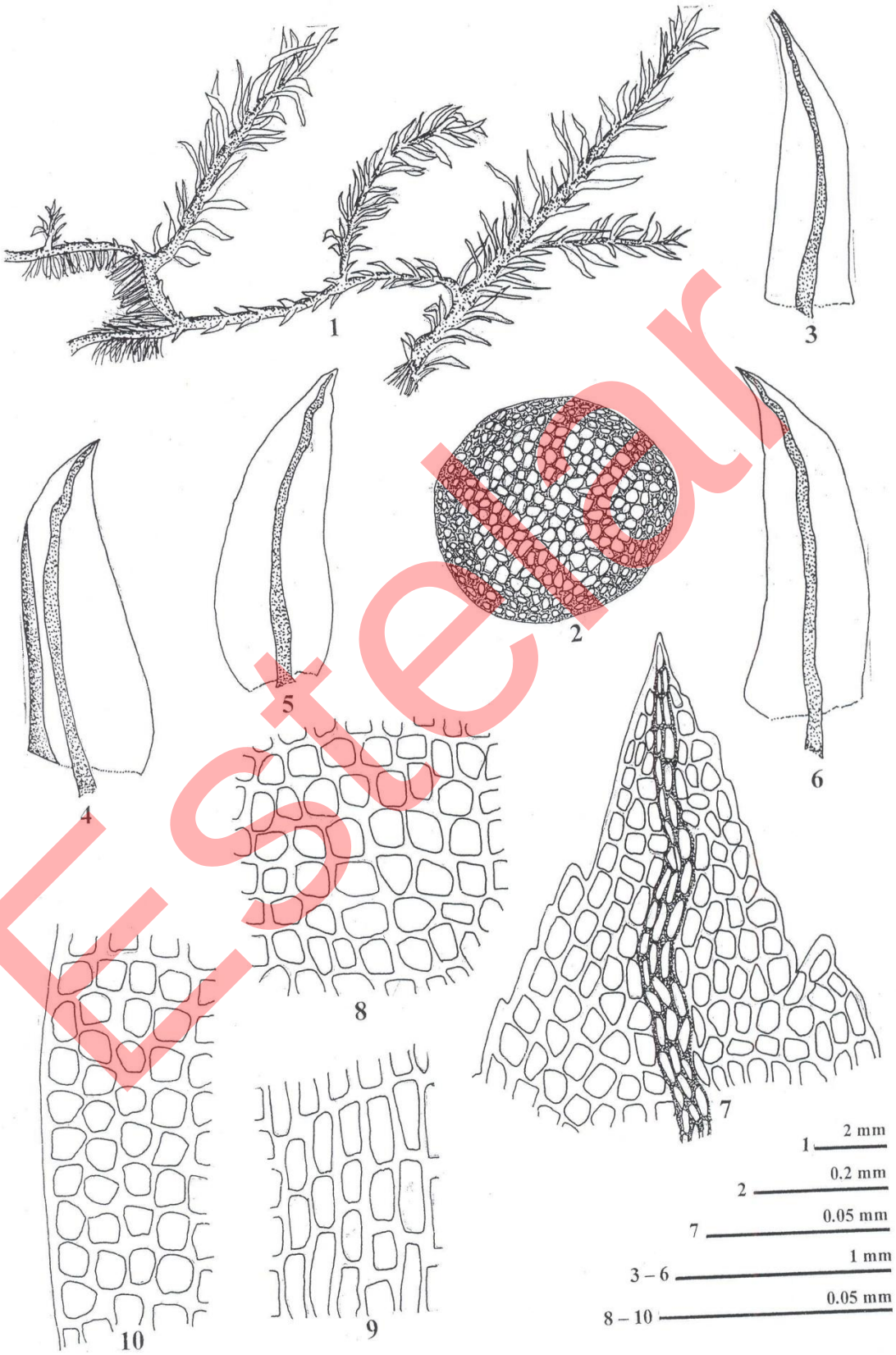
Plants yellowish-green in dense tufts, non glossy. Main stem creeping with scaly distant leaves and long rhizoids. **Stem** circular in cross section, outer cortical cells smaller, rounded, thick walled, followed by bigger quadrate-rounded thin walled medullary cells. Branches densely covered with leaves. **Leaves** larger near branch apex, smaller below. Upper leaves erectopatent, look like at apex, ovate-lanceolate, ± 2.0 x 0.65 mm in size, acute apex, margin smooth below but dentate at apex; costa extending up to the tip, flexuose at apex. **Leaf cells** small, thick walled, quardate rhomboid, ± 9 x

Plate-36



***Foreauella orthothecia* (Schwagr.) Dix. & P. dela Varde.,** Figs. 1-9: 1. vegetative plant, 2. cross section of axis, 3-6. leaves, 7. apical leaf cells, 8. median leaf cells, 9. basal leaf cells.

Plate-37



***Herpetineuron toccoae* (Sull. & Lesq.) Cardot.,** Figs. 1-11: 1. vegetative plant, 2. cross section of axis, 3-6. leaves, 7. apical leaf cells, 8. median leaf cells, 9. basal leaf cells, 10. basal cells towards margin.

4.8 µm, arranged characteristically, extreme basal cells hyaline, large, ± 18 x 9 µm. Sporophyte not seen.

Ecology & Distribution: plants growing on moist rock in association with *Plagiothecium cavifolium* near Apsara Fall and Jatashankar from 734-986 m.

Range of Distribution: Australia, Bolivia, Brazil, Bhutan, Celebes, China, Comoros, Dominic, Dominican Republic, Ethiopia, Honduras, Hong Kong, India: central India (Odisha, PBR), Gangetic plains (Bihar), eastern Himalaya (Assam, Darjeeling, Khasia hills, Manipur, Sikkim), South India, western Himalaya (Lohaghat), Indonesia, Japan, Java, Korea, Laos, Malavi, Mexico, Nepal, Nicaragua, Papua New Guinea, Philippines, Sikkim, Sri Lanka, Sumatra, Taiwan, Thailand, United States, Vanuatu, Vietnam.

Specimens examined: India, Madhya Pradesh, PBR: Apsara Fall, alt. ca 734m, 01.12.2006, on moist rocks, 227699B (LWG), leg. V. Sahu & V. Awasthi; Jatashankar, alt. ca 986 m, on moist rocks, 09.11.2011, 263834B (LWG), leg. A.K. Asthana & R. Gupta.

Family: Fabroniacaeae Schimp.

Genus: *Levierella* C. Müell.

Plants prostrate, yellowish green, lax, pinnately branched. Stem oval in cross section, outer cells smaller, gradually getting larger towards centre. Leaves erectopatent, imbricate, ovate, acuminate or oblong, lanceolate, margin dentated at apex, smooth below; costa single, stout, vanishing near midleaf or below. Leaf cells elongate, rhomboid,. Sporophyte on lateral branches, erect.

***Levierella fabroniacea* C. Müell**. Bull. Sec. Bot. Ital. 1897: 73. 1897.

(Plate 38: Figs. 1-10)

Plants prostrate, yellowish green, lax, non-glossy, pinnately branched. **Stem** oval in cross section, outer cells smaller, gradually getting larger towards centre. **Leaves** erectopatent, imbricate, ovate, acuminate or oblong, lanceolate, ± 1.3 x 0.6 mm in size; margin dentated at apex, smooth below; costa single, stout, vanishing near midleaf or below. **Leaf cells** elongate, rhomboid, ± 36 x 5.8 µm at apex, ± 36 x 8 µm at lower middle, basal cells quadrate - rectangular, ± 13.67 x 9 µm in size. Sporophyte on branches, erect; **seta** ± 8mm long; capsule erect, ± 2.3 x 0.65 mm, dull brown to deep

red, operculum conic-rostrate, **peristome** well developed, exostome teeth smooth, light yellow, endostome not developed; **spores** dull yellowish, small, ± 12 µm in size.

Ecology & Distribution: plants growing epiphytically, on way to Dhoopgarh, 1352 m.

Range of Distribution: China, Ethiopia, India: central India (Bilaspur, Gujarat, Mandla), eastern Himalaya (Darjeeling), Rajasthan & Punjab plains (Rajasthan), South India (Khandala, Mahabaleshwar, Purandhar), western Himalaya (Kumaon, Mussoorie), Malavi, Nepal, South Africa, Swaziland.

Specimens examined: India, Madhya Pradesh, PBR: on way to Dhoopgarh, alt. ca 1352 m, epiphytic, 16.12.1993, 205558 (LWG). leg. V. Nath & A.K. Asthana; Dhoopgarh (Sunset Point), alt. ca 1350 m, epiphytic, 07.11.2011, 263179, 263180, 263181, 263182, 263184 (LWG), leg. A.K. Asthana & R. Gupta.

Family: Pterobryaceae Kindb.

Genus: *Pterobryopsis* Fleisch.

Plants prostrate, yellowish-green at upper region, brownish below, branched, secondary branches pinnately branched, distant. Leaves concave, ovato-cordate, dense, spreading, acute tip, margin smooth to slightly dentate; costa single, vanishing below tip, usually minutely bifurcated at apical point. Leaf cells rhomboid, porose with thin walls.

***Pterobryopsis tumida* (Hook.)** Dixon, J. Bot., 75: 122. 1937.

Basyn:*Neckera tumida* Dicks. ex Hook. Crusci Exot., **2**:158. 1819.

(Plate 39: Figs. 1-9)

Plants prostrate, yellowish-green at upper region, brownish below, branched, secondary branches pinnately branched, pendulous, branching distant. **Stem** circular in cross section, small thick walled cortical cells that gradually get larger towards the centre. **Leaves** concave, ovato-cordate, moderately dense, spreading, ± 1.9 x 0.1 mm in size, acute tip, margin slightly dentate; **costa** single, vanishing below tip, usually minutely bifurcated at apical point. **Leaf cells** rhomboid, porose with thin walls, ± 25.2 x 6.3 µm at apex, ± 50 x 5 µm at mid leaf, basal cells irregularly rectangular, thick walled, ± 30 x 6.3 µm in size. Sporophyte not seen.

Ecology & Distribution: plants growing on wet rocks at Duchess Fall, 732 m.

Plate-38

***Levierella fabroniacea* C. Muell.,** Figs. 1-10: 1,2. plants with sporophyte, 3. cross section of axis, 4-7. leaves, 8. apical leaf cells, 9. median leaf cells, 10. basal leaf cells.

Plate-39

***Pterobryopsis tumida* (Hook.) Dixon.,** Figs. 1-9: 1. vegetative plant, 2. cross section of axis, 3-6. leaves, 7. apical leaf cells, 8. median leaf cells, 9. basal leaf cells.

Range of Distribution: India: central India (PBR), South India (Croog, Kanara, Palni), Indonesia, Java, Nepal, Sri Lanka.

Specimens examined: India, Madhya Pradesh, PBR: Duchess Fall, alt. ca 732 m, on moist rocks, 30.11.2006, 227673B (LWG), leg. V. Sahu & V. Awasthi.

Family: Meteoriaceae Kindb.

Genus: *Meteoriopsis s* Fleisch. Ex. Broth.

Plants prostrate, green, glossy, sturdy in dense tufts, branching profuse, secondary branches pendulous. Leaves squarrose, ovate-lanceolate, base broad, margin dentate, revolute leaf apex; costa larger, ending at 3/4 of leaf length. Leaf cells linear, rhomboid, papillate,. Leaf cells linear, rhomboid, papillate.

***Meteoriopsis squarrosa* (Hook. ex Harv.) M. Fleisch**., Nat. Pfl., I(3): 826. 1906.

(Plate 40: Figs. 1-11)

Plants prostrate, dull green, glossy, sturdy in dense tufts, sturdy, branching profuse, secondary branches pendulous. **Stem** circular in cross section, outer cortical cells smaller, inner medullary cells larger. **Leaves** squarrose, ovate-lanceolate, base broad, sheathing, ±1.6 x 0.7 mm in size, margin dentate, leaf apex folded with characteristic infoldings; **costa** long, ending at 3/4 of leaf length. **Leaf cells** linear, rhomboid, papillate, ± 30 x 4.0 µm at apex, ± 30 x 0.4 µm at middle and ± 36 x ± 5 µm at base. Sporophyte not seen.

Ecology & Distribution: plants growing on soil over rock, on rocks at Patalkot (Rajakhoh), Jalgali, Patthar Chatta, on way to Chota Mahadev from 400-1000 m.

Range of Distribution: Bhutan, Burma, Celebes, China, India: central India (PBR), eastern Himalaya (Arunachal Predesh, Assam, Darjeeling, Khasia hills, Manipur, Meghalaya, Naga hills, Sikkim), Gangetic plains (Bihar), South India (Croog, Khandala, Mahabaleshwar, Nilgiri, Palni, Tiruneveli), western Himalaya (Garhwal, Kumaon, Lohaghat, Mussoorie, Simla), Indonesia, Java, Laos, Malaysia, Myanmar, Nepal, Papua New Guinea, Philippines, Taiwan, Thailand, Vietnam.

Specimens examined: India, Madhya Pradesh, PBR Patalkot (Rajakhoh), alt. ca 400 m, on soil 06.10.1992, 205466 (LWG); Jalgali, alt. ca 900 m, on soil covered rocks, 06.12.1993, 205583 (LWG); Patthar Chatta, alt. ca 1000 m, on rocks, 18.12.1993,

205657 (LWG), leg. V. Nath & A.K. Asthana; on way to Chota Mahadev, alt. ca 734 m, 29.11.2006, on soil, 227634 (LWG), leg. V. Sahu & V. Awasthi.

Family: Neckeraceae Schimp.

Genus: *Thamnobryum* Bosch et Lac.

Plants dendroid, larger, yellowish – green to brownish- green, up to 60 mm, with distant secondary shoots, irregularly pinnately branched, branches short. Leaves spreading, ovate, short acute at± 2.5 x ± 1 mm in size; costa strong, en tip margin dentate below, revolute at places. Leaf cells ovato-quadrate, intralaminal zone of elongated cells covering two thirds of leaf length followed by smaller cells.

***Thamnobryum latifolium* (Bosch & Lac.)** Nieuwl, Am. Mldl. Nat., 5: 50. 1917. *Prototrichum latifolium* Bosch & Lac. in Bryol. Jav., 2:69. 1863.

(Plate 41: Figs. 1-9)

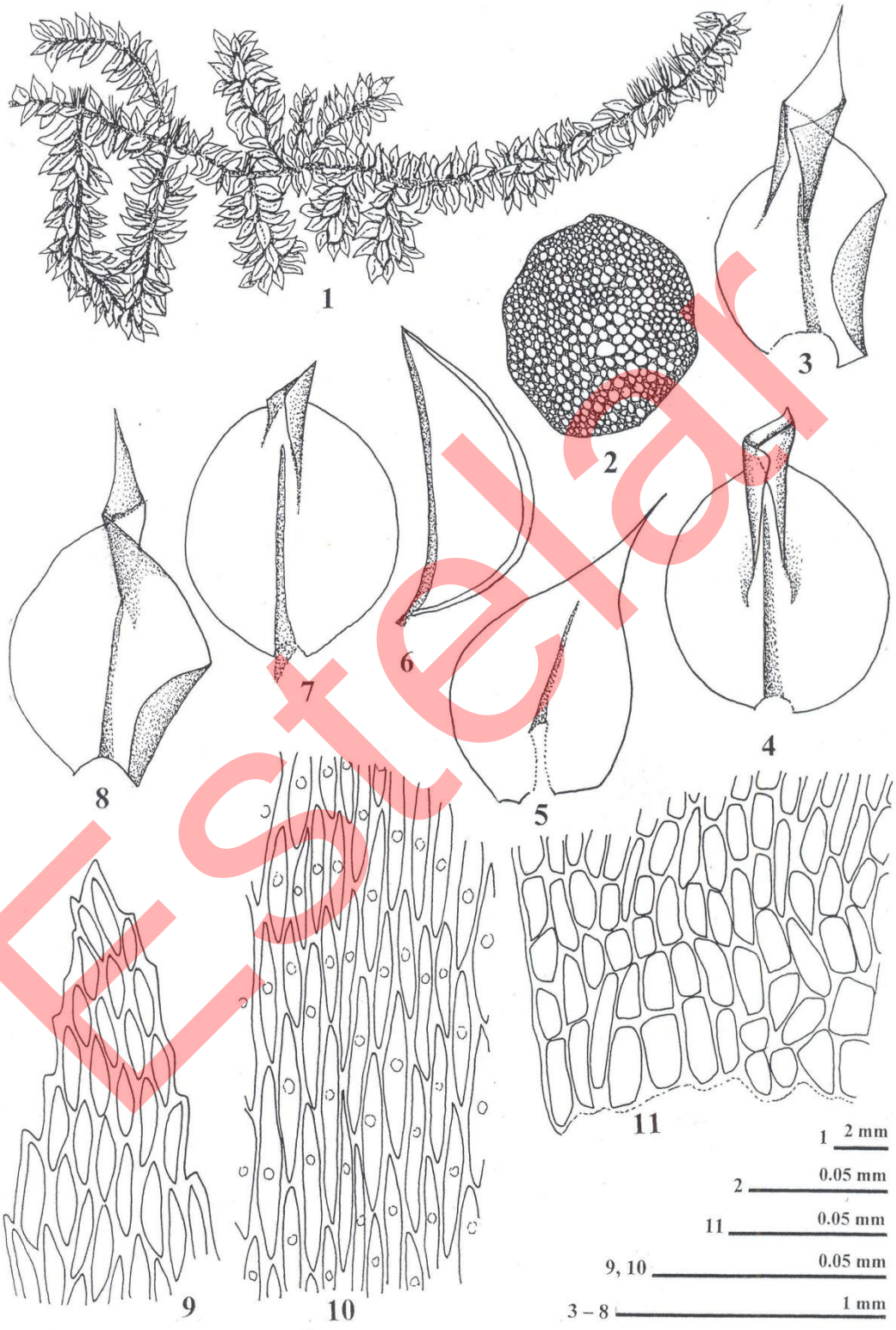
Plants dendroid, yellowish – green to brownish- green, up to 60 mm, with distant secondary shoots, irregularly pinnately branched, branches short. **Stem** circular in cross section, outer cortical cells smaller, thick walled, inner medullary cells larger, thin walled. **Leaves** spreading, ovate, short acute at tip margin dentate at tip, entire below, revolute at places, ± 2.5 x ± 1 mm in size; costa strong, ending below tip. **Leaf cells** ovato-quadrate, ± 10 x 8 µm at apex, longer ± 55 x 10.25 µm at base, intralaminal zone of elongated cells covering two thirds of leaf length followed by smaller cells. Sporophyte not seen.

Ecology & Distribution: plants growing on rocks as well as epiphytically on *Mangifera indica* at Patthar Chatta, 1000 m.

Range of Distribution: Australia, Bhutan, China, India: central India (PBR), eastern Himalaya (Assam, Darjeeling, Sikkim), South India (Croog, Mahabaleshwar, Nilgiri, Palni), Indonesia, Java, Laos, Malaysia, Myanmar, Nepal, New Caledonia, Papua New Guinea, Philippines, Sri Lanka, Thailand, Vietnam.

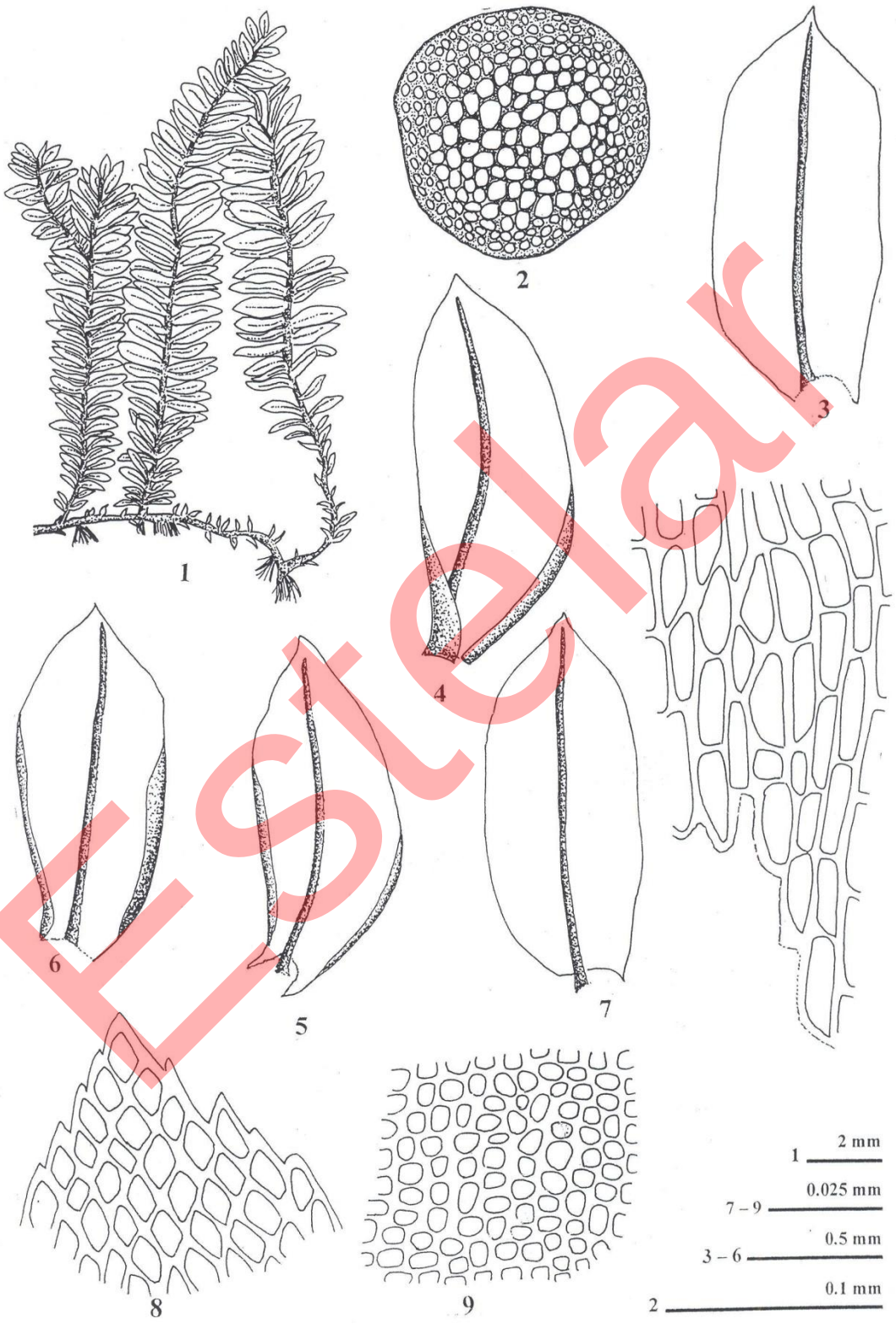
Specimens examined: India, Madhya Pradesh, PBR: Patthar Chatta, alt. ca 1000 m, 18.12.1993, epiphytic. 205655 (LWG), 205656 (LWG), leg. V. Nath & A.K. Asthana.

Plate-40



***Meteoriopsis squarrosa* (Hook. ex Harv.) M. Fleisch.,** Figs. 1-11: 1. vegetative plant, 2. cross section of axis, 3-8. leaves, 9. apical leaf cells, 10. median leaf cells, 11. Basal leaf cells.

Plate-41



***Thamnobryum latifolium* (Bosch & Lac.) Nieuwl.,** Figs. 1-9: 1. vegetative plant, 2. Cross section of axis, 3-7. leaves, 8. apical leaf cells, 9. median leaf cells, 10. basal leaf cells.

Family: Hookeriaceae Schimp.

Key to the species of genera Hookeriaceae at PBR:

1. Leaf margin entire, costa single, leaf cells irregularly hexagonal- rhomboid ..…….…….……..…….. ***Distichophyllum***

   Leaf margin dentate in upper half, costa double, leaf cells elongated rhomboid ……..…….…… ***Thamniopsis***

Genus: *Distichophyllum* Dozy. et. Molk.

Plants prostrate, goldenish green to dark green, lax, densely tufted, up to 30 mm long, rarely branched. Leaves smaller below, larger and denser towards apex, complanate, ovate-lanceolate, narrower at base, apex obtuse, apiculus short; margin entire, boardered, wavy, recurved at places; costa single, ending 1/4 below tip to reaching the tip. Leaf cells small, irregularly hexagonal.

***Distichophyllum schmidti* Broth.** Bot. Tidskar., 24: 122. 1901.

(Plate 42: Figs. 1-11)

Plants prostrate, goldenish green to dark green, lax, densely tufted, ascending, up to 28 mm long, rarely branched. **Stem** oval in cross section, outer cortical cells smaller, inner medullary cells oval, larger. **Leaves** smaller below, larger and denser towards apex, complanate, ovate-lanceolate, 2.0-2.96 x 0.83-1 mm in size, narrower at base, apex obtuse, apiculus short; margin entire, boardered, wavy, recurved at places; **costa** single, ending 1/4 below tip. **Leaf cells** small, irregularly hexagonal, ± 27.12 x 18 µm at apex, larger, ± 58.4 x 25 µm at middle and rectangular large ± 100 x 33.4 µm at base, leaf bordered by two rows of cells. Sporophyte not seen.

Ecology & Distribution: plants growing on rocks near water stream, Jalgali, and Irene Pool 900-1015 m.

Range of Distribution: India: central India (PBR), eastern Himalaya (Arunachal Pradesh, Khasi Hills), Nepal.

Specimens examined: India, Madhya Pradesh, PBR: Jalgali, alt. ca 900 m, on rocks near water stream, 16.12.1993, 205576 (LWG), leg. V. Nath & A.K. Asthana; Irene Pool, alt. ca 1015 m. on wet rocks, 08.11.2011, 264810 (LWG), leg. A.K. Asthana & R. Gupta.

Genus: *Thamniopsis* (Mitt.) Fleisch.

Plants prostrate, yellowish green, glossly, scarcely to profusely branched, branches irregular, appressed closely to substratum. Leaves complanate, slightly heterophyllous, oblong-ovate, gradually and broadly acute, margin slightly dentate near apex; costa double, reaching more than 1/2 leaf length or more, divergent. Leaf cells short, wider at apex, basal cells rectangular.

***Thamniopsis secunda* (Griff.) W.R. Buck,** Brittonia 39: 219. 1987.

B*syn:Hookeria secunda* Griff., Cal. J. Nat. Hist., 3: 280.1843.

Syn: *Hookeriopsis secunda* (Griff.) Broth., Nat. Pfl. 1(3): 942. 1907.

(Plate 43: Figs. 1-10)

Plants prostrate, yellowish green, glossly, profusely branched, branches irregular, appressed closely to substratum. **Stem** circular in cross section, outer cortical cells smaller, thick walled, inner medullary cells larger, thick walled. Leaves complanate, slightly heterophyllous, oblong-ovate, gradually and broadly acute ± 1.21 x 0.629 µm in size, margin slightly dentate near apex; **costa** double, reaching more than 1/2 leaf length, divergent. **Leaf cells** short, wider at apex, ± 62.6 x 20 µm, getting larger mid leaf, ± 100 x 19.8 µm, basal cells recangular ± 58 x 16.7 µm with a prominent border of 4-5 rows. Sporophyte not seen.

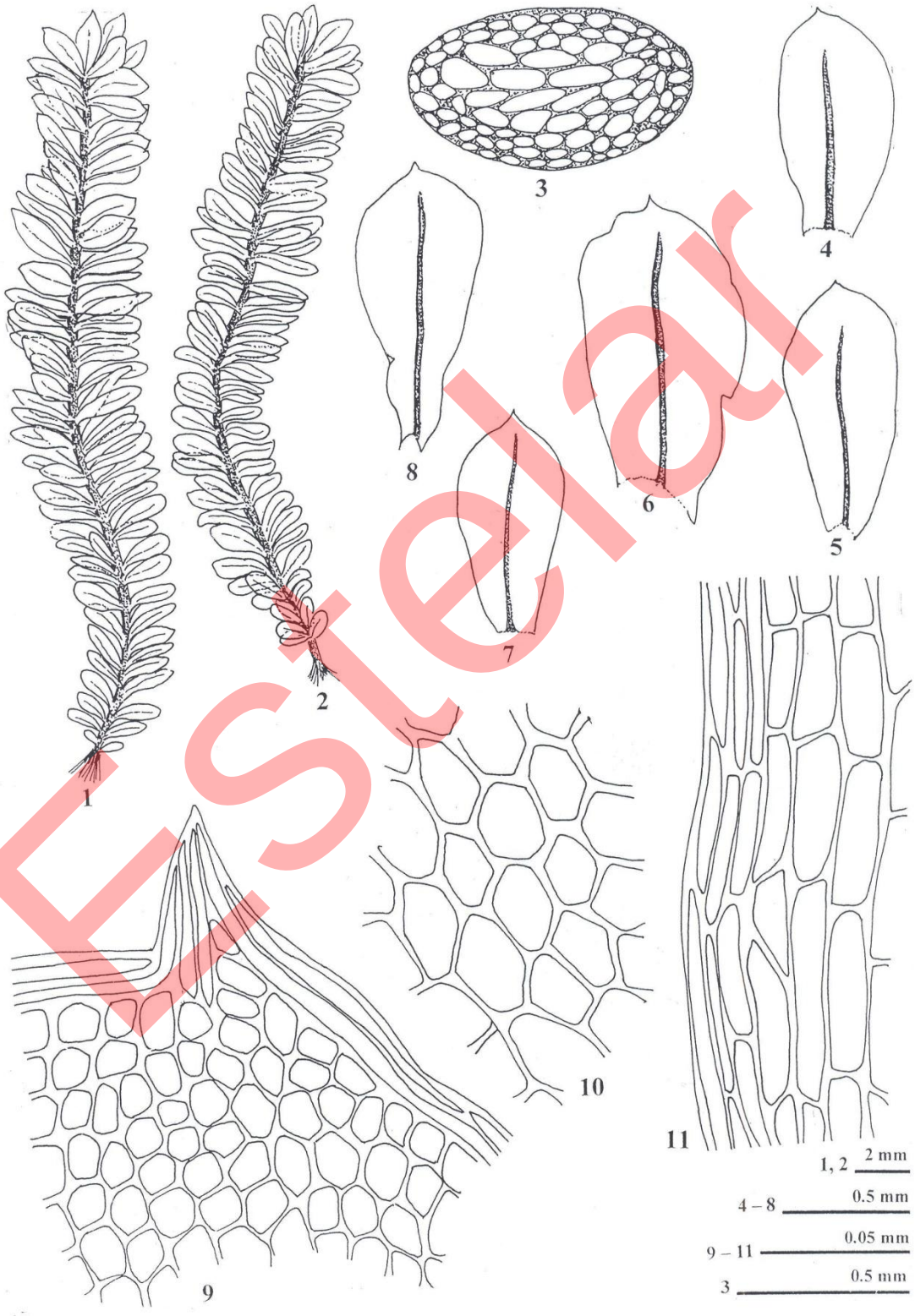
Ecology & Distribution: plants growing on moist rocks at Patthar Chatta, 1000 m.

Range of Distribution: India: central India (PBR), eastern Himalaya (Khasi Hills), Sri Lanka, West Indies.

Specimens examined: India, Madhya Pradesh, PBR: Patthar Chatta, alt. ca 1000 m, growing on rocks near water stream, 18.12.1993, 205653 (LWG). leg. V. Nath & A.K. Asthana.

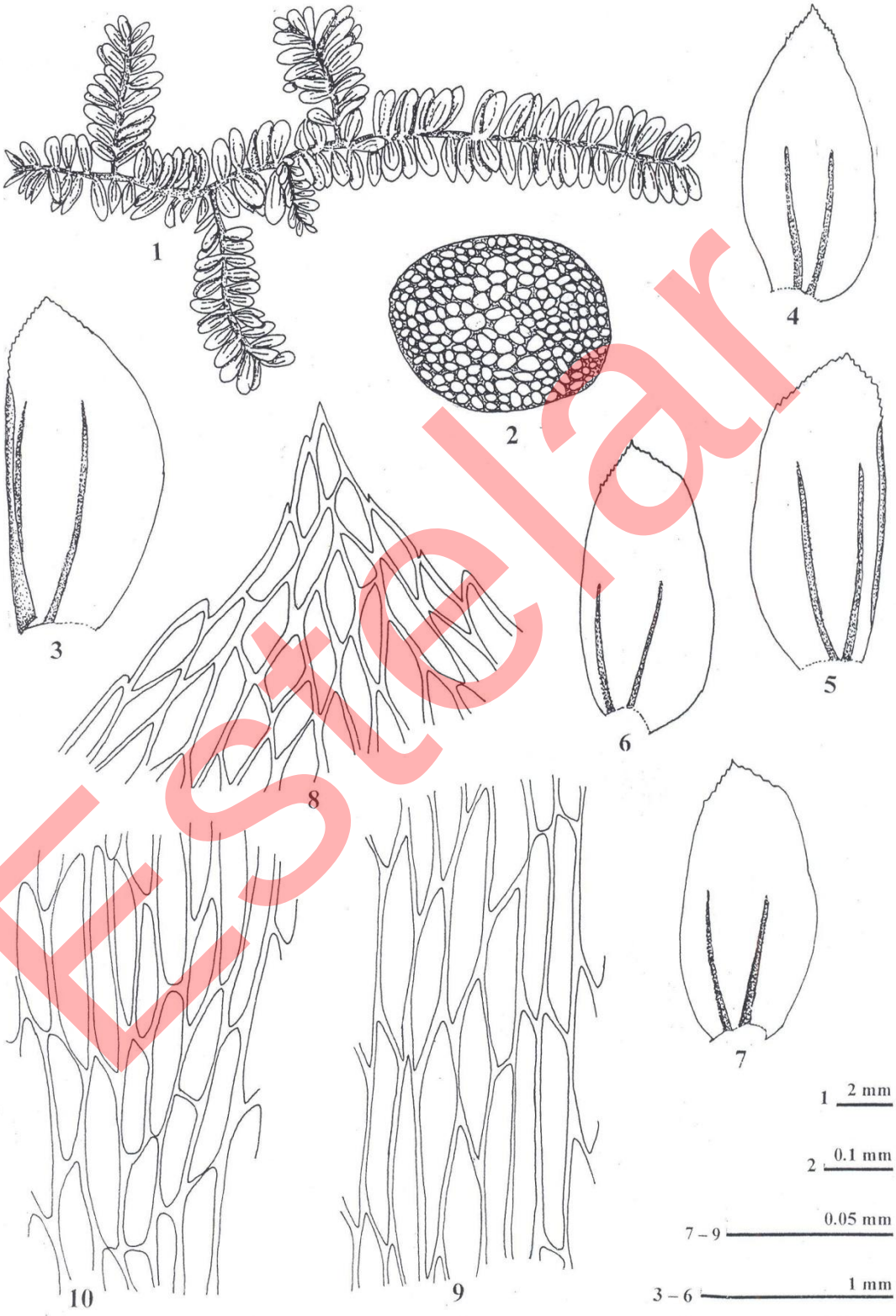
The species has been described as *Hookeriopsis secunda* (Griff.) Broth. by Gangulee (1978-80) and has been used by workers under the same name. Buck (1987) has however provided a revision of the order Hookeriales where he has suggested the name of the species as *Thamniopsis secunda* (Griff.) W.R. Buck making the former as synonym. This latest status has been adhered to in the present work.

Plate-42



***Distichophyllum schmidtii* Broth.,** Figs. 1-11: 1,2. vegetative plants, 3. cross section of axis, 4-8. leaves, 9. apical leaf cells, 10. median leaf cells, 11. basal leaf cells.

Plate-43



***Thamniopsis secunda* (Griff.) W.R. Buck.,** Figs. 1-10: 1. vegetative plant, 2. cross section of axis, 3-7. leaves, 8. apical leaf cells, 9. median leaf cells, 10. basal leaf cells.

Family: Pottiaceae Schimp.

Key to the genera of family Pottiaceae at PBR:

1. Peristome absent **2**
   Peristome present **4**
2. Sporophyte on lateral shoot, leaf margin flat …….. ***Anoectangium***
   Sporophyte on terminal shoot, leaf margin involute **3**
3. Leaves linear, lanceolate, acuminate, costa excurrent ……..... ***Weissia***
   Leaves spathulate or ligalate costa percurrent ..... ***Hyophila***
4. Plants with erect peristome **5**
   Plants with spirally twisted peristome **6**
5. Plants larger (±25 mm), leaves longer, brittle ..... ***Oxygstegus***
   Plants smaller (±16 mm), leaves shorter, not brittle …….. ***Didymodon***
6. Leaf tip broadly acuminate, costa ending in short apiculus, peristome not completing one spiral turn ……..……. ***Semibarbula***
   Leaf tip bluntly pointed, costa percurrent, peristome completing more than one spiral turn ..... ***Barbula***

Genus: *Anoectangium* Schwaer

Plants erect, yellow-green, caespitose, up to 12 mm in siz, often dichotomously branched. Stem brownish, covered with patent leaves in intermittent tufts; rhizoids arising from the surface in between the leaves. Leaves curled when dry, lanceolate with acute apex, margin crenulate; costa prominent, extended into minute tip, rough on back. Leaf cells rounded - quadrate, highly papillose at apex, basal cells rectangular, generally getting shorter from costa to margin.

***Anoectangium stracheyanum* Mitt.,** J. Linn. Soc. Bot. Suppl., 1:31. 1859.

(Plate 44: Figs. 1-19; Plate III: Figs. A-B)

Plants erect, dioeceous, yellow-green, caespitose, up to 12 mm in size, often dichotomously branched. **Stem** brownish, covered with patent leaves in intermittent tufts; rhizoids arising from the surface in between the leaves. **Leaves** curled when dry, up to 1.36 mm long and 0.22 mm wide at base, lanceolate with acute apex, margin unbroken but papillate; costa prominent, light brown, extended into minute tip, rough on back. **Leaf cells** rounded - quadrate, ± 6.26 µm in size, as long as broad, highly

papillose at apex, basal cells rectangular, 12.5 - 22.9 µm long, 6.25 - 8.3 µm broad, generally getting shorter from costa to margin. **Seta** erect, ± 6 mm long, yellowish brown; capsule present on lateral branch, pale brownish- orange, erect, ± 0.86 x 0.54 mm in size, operculum not found, **peristome** absent, three rows of horizontal annulus cells seen, deep red in colour; spores yellow, spherical, pellucid, ±12 µm in diameter.

Spores under SEM: spores exhibits densely arranged pebble like projections with more or less rounded and smooth head.

Ecology & Distribution: plants growing on rocks, both dry and wet, and on soil covered rocks at Jatashankar, Mahadev, Down Fall, on way to Chota Mahadev from 850-1000 m.

Range of Distribution: China, India: central India (Mt. Abu, PBR); eastern Himalaya (Arunachal Pradesh, Assam, Darjeeling, Meghalaya); Punjab & west Rajasthan Plains (Rajasthan); south India (Tamil Nadu); western Himalaya (Himachal Pradesh, Kashmir, Uttarakhand), Japan, Nepal, Myanmar, Pakistan, Vietnam.

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

Genus: *Weissia* Hedw.

Plants erect, yellow- green forming dense mats, up to 12 mm hig, rarely branched. Leaves densely covering the stem getting larger at top linear - lanceolate, forming a sheathing base, margin involute in the lamina, unbroken; costa light brown, excurrent. Upper leaf cells rounded- quadrate, basal cells hyaline ± becoming shorter towards margin. Seta apical, erect; capsule erect, brown, wide, peristome absent.

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

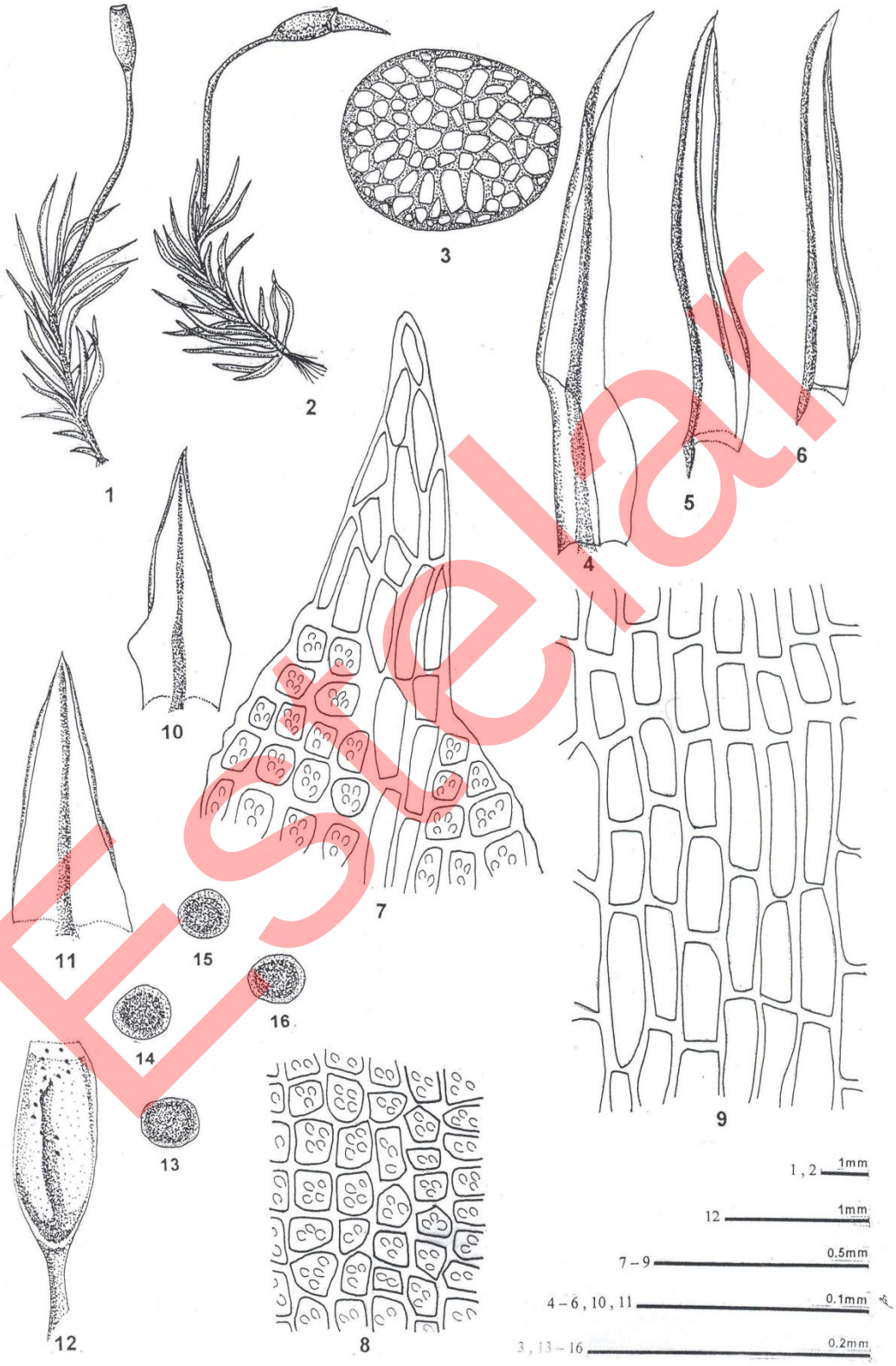
(Plate 45: Figs. 1-16; Plate III: Figs. D-F)

Plants erect, yellow- green forming dense mats, up to 12 mm high, rarely branched. **Stem** brown, ovato-circular, outer cells slightly smaller than the inner cells but non-uniform pattern seen. **Leaves** densely covering the stem getting larger at top linear - lanceolate, forming a sheathing base, narrow, pointed, up to 2 mm long and 0.4 mm wide, margin involute in the lamina, unbroken; costa light brown, excurrent.

Plate-44

***Anoectangium stracheyanum* Mitt.,** Figs. 1-19: 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.

Plate-45



***Weissia edentula* (Mitt.) Besch.,** Figs. 1-10: 1,2. plant with sporophyte, 3. cross section of axis, 4-6. leaves, 7. apical leaf cells, 8. median leaf cells, 9. basal leaf cells, 10-11. perichaetial leaves, 13-16. spores.

Upper leaf cells rounded- quadrate, ± 6.3 µm wide, densely papillose, basal cells hyaline ± 48 x 9.5 µm in size, becoming shorter towards margin. **Seta** apical, erect, ± 7 mm long, brownish; capsule erect, brown, ± 1 mm long and ± 0.7 mm wide, **peristome** absent; **spores** warty, round, dull reddish- brown ± 16 µm in diameter.

Spores under SEM: spores spherical, sporoderm exhibits coarse baculate projections which coalesce with each other.

Ecology & Distribution: plants growing on bare rocks, moist rocks and soil covered rocks at Down Fall, on way to Jambu Dweep, near Bee Fall, near Pandav from 750-850m.

Range of Distribution: Australia, Benin, China, Cuba, India: central India (Orissa, PBR), South India (Tamil Nadu, Karnataka), Indonesia, Japan, Java, Mauritius, New Caledonia, Pakistan, Philippines, Sri Lanka, Taiwan, Thailand, Vietnam.

Specimens examined: India, Madhya Pradesh, PBR: Down Fall, alt. ca 884 m, on moist rocks, 28.11.2006, 227602B (LWG); on way to Jambu Dweep, alt. ca 793 m, on soil covered rocks, 29.11.2006, 227642 (LWG); near Bee Fall, alt. ca 823 m, on soil covered rocks, 30.11.2006, 227664 (LWG); near Pandav Caves, alt. ca 823 m, on rocks, 01.12.2006, 227687 (LWG), leg. V. Sahu & V. Awasthi.

Genus: *Hyophila* Bridel

Plants erect, dense to laxy, dull green, dark greenish – brown, radiculose, up to 12 mm high, simple or branched. Leaves densely arranged, upper leaves spreading in rosettes, spathulate, oblong- lanceolate, erect- spreading, curved when dry, margins inrolled when moist, apex broadly pointed, margin smooth with minor to strong denticulations at apex; costa reddish brown, prominent, percurrent to short excurrent.

Key to the species of genus *Hyophila* at PBR:

1. Upper leaf margin serrulate ..... ***H. involuta***
   Upper leaf margin smooth or crenulated **2**
2. Leaves in intermittent tufts, margin crenulated, costa percurrent or slightly excurrent ..... ***H. nymaniana***
   Leaves is single apical tufts, margin smooth, costa percurrent ..... ***H. spathulata***

***Hypohila involuta* (Hook.) A. Jaeger,** Ber. S. Gall. Naturw. Ges 1871-72: 356. 1873**.**

(Plate 46: Figs. 1-17)

Plants erect, dense, dark greenish – brown, radiculose, up to 12 mm high, simple or branched. **Leaves** densely arranged, upper leaves spreading in rosettes, spathulate, oblong- lanceolate, erect- spreading, curved when dry, margins inrolled when moist, 1.8 to 2.8 mm long, 0.56 to 0.86 mm broad, apex broadly pointed, margin smooth with denticulations at apex; costa reddish brown, prominent, percurrent. **Apical** leaf cells mamillose, rounded- quadrate, ± 7.5 µm in diameter, basal cells rectangular, 35 × 18 µm in size. **Seta** apical, erect, up to 18 mm in size; **capsule** reddish- brown below, 2.5 mm long and 0.5 mm in diameter, **peristome** absent; spores dull brown, round, ± 12 µm in diameter.

Spores under SEM: spores more or less spherical having blunt apexed small projections which are arranged in compact manner except at central depression. Proximal face bears tri-radiate ridge, reaching the periphery. Ridge exhibits similar projections on the surface as on general sporoderm.

Ecology & Distribution: plants abundantly growing mostly on bare rocks, also on soil covered rocks and stony wall at Jambu Dweep, Rajakhoh (Patalkot), near Police Training School, Twynam Pool, Chota Mahadev Mandir, on way to Duches Fall, Pandav Caves, Bee Dam, Pachmarhi Lake from 400-1050 m.

Range of Distribution: Antilles, Australia, Belize, Benin, Bolivia, Brazil, Burundi, Canada, China, Colombia, Comoros, Cook Islands, Costa Rica, Cuba, Dominica, Dominican Republic, Ecuador, Equatorial Guinea, Fiji, France, French Guiana, Guadeloupe, Guatemala, Honduras, India: Andaman & Nicobar Islands; central India (Amarkantak & Achanakmar Sanctuary, Gujarat, Jharkhand, Mt. Abu, PBR); eastern Himalaya (Arunachal Pradesh, Assam, Darjeeling, Meghalaya, West Bengal, Sikkim); Punjab & West Rajasthan Plains (Rajasthan); Gangetic plains (Uttar Pradesh, Bengal Plains); South India (Karnataka, Tamil Nadu); western Himalaya (Himachal Pradesh, Uttarakhand), Indonesia, Jamaica, Japan, Jordan, Kiribati, Liberia, Madagascar, Malawi, Malaysia, Malaysia, Mali, Mayotte, Mexico, Netherlands, Nicaragua, Oman, Panama, Papua New Guinea, Paraguay, Peru, Philippines, Reunion, Samoa, Seychelles, Sierra Leone, South Africa, Sri Lanka, Suriname, Switzerland, Taiwan, Tanzania, Thailand, Trinidad and Tobago, Turks and Caicos Islands, Uganda, United States, Vanuatu, Venezuela.

Plate-46

***Hyophila involuta* (Hook.) Jaeg.,** Figs. 1-12: 1. plant with sporophyte, 2. vegetative plant, 3. cross section of axis.4-6. leaves, 7. apical leaf cells, 8. median leaf cells, 9. basal leaf cells, 10,11. Perichaetial leaves, 12. capsule, 13-17. spores.

Plate-47

***Hyophila nymaniana* (Fleisch.) Menzel.,** Figs. 1-9: 1,2. vegetative plants, 3. cross section of axis, 4-6. leaves, 7. apical leaf cells, 8. median leaf cells, 9. basal leaf cells.

Specimens examined: India, Madhya Pradesh, PBR: on way to Jambu Dweep, alt. ca 900 m, on rocks, 17.12.1993, 205594, 205595A (LWG); Jambu Dweep alt. ca 900 m, on soil; on rocks,17.12.1993, 205610, 205613 (LWG); Rajakhoh, Patalkot, alt. ca 400 m, on rocks, 20.12.1993, 205738B (LWG) leg. V. Nath & A.K. Asthana; near Police Training School, alt. ca 914 m, on rocks, 28.11.2006, 229384 (LWG); Twynam Pool, alt. ca 854 m, on stony wall, 29.11.2006, 227622B (LWG); Chota Mahadev Mandir, alt. ca 793 m, on wet rocks, 29.11.2006, 227640B (LWG); Bee Fall, alt. ca 823 m, on rocks, 30.11.2006, 227665; on way to Duchess Fall, alt. ca 823 m, on rocks, 30.11.2006, 227669; Pandav Caves, alt. ca 823 m, on rocks, 01.12.2006, 227680, 227682, 227684B, 227685D, 227686A (LWG), leg. V. Sahu & V. Awasthi; Pandav Caves, alt. ca 1004 m, on dry rocks, 07.11.2011, 263114, 263117 (LWG); Apsara Vihar, alt. ca on soil covered rocks 920 m, 07.11.2011, 263141B (LWG); Bee Dam, alt. ca 964 m, on soil covered rocks, 08.11.2011, 263186 (LWG); Pachmarhi Lake, alt. ca 1050 m, on rocks, 09.11.2011 264826, 264827B (LWG), leg. A.K. Asthana & R. Gupta.

***Hyophila nymaniana* (Fleisch.) Menzel,** Willdenowia 22: 198. 1992.

Syn: *Hyophila rosea* Williams, Bull. New York Bot. Gard. 8: 341. 1914.

(Plate 47: Figs. 1-9)

Plants erect, simple, laxy, dull green, up to 13 mm long, unbranched. **Stem** circular in cross section, thick walled cells at cortex, getting thin walled towards centre, innermost cells thick walled. **Leaves** erectopatent, in intermittent rosette tufts, spathulate, narrower at base, broadening above, apex broadly pointed, blunt $\pm$ 1.15 × 0.5 mm in size; costa brown, percurrent ending in a short apiculus. **Apical** leaf cells chlorophyllose, multipapillose, rounded- quadrate, 10.5 × 7 µm in size, basal cells rectangular 3 × 10 µm or more becoming shorter above. Sporophyte not seen.

Ecology & Distribution: plants growing on soil covered rocks and bare rocks at Jambu Dweep, on way to Little Fall, near Duchess Fall, and Pandav Caves from 850-1004 m.

Range of Distribution: China, Colombia, Costa Rica, India: central India (Amarkantak & Achanakmar Sanctuary, Gujarat, PBR), Gangetic plains (Uttar Pradesh, Orissa), South India (Karnataka, Kerela, Tamil Nadu), western Himalaya (Uttarakhand), Indonesia, Liberia, Mexico, Philippines, Thailand.

Specimens examined: India, Madhya Pradesh, PBR: on way to Jambu Dweep, alt. ca 900 m, on soil covered rocks, 17.12.1993, 205591 (LWG), on way to Rajakhoh (Patalkot), alt. ca 400 m, epiphytic, 20.12.1993, 205720, 205721 (LWG), leg. V. Nath & A.K. Asthana; on way to Little Fall, alt. ca 914 m, on rocks, 28.11.2006, 229385 (LWG); near Duchess Fall, alt. ca 856 m, on rocks, 01.12.2006, 227681B (LWG), leg. V. Sahu & V. Awasthi; Pandav Caves, alt. ca 1004 m, 07.11.2011, 263121, 263121, 263123 (LWG), leg. A.K. Asthana & R. Gupta.

***Hyophila spathulata* (Harv.) A. Jaeger,** Ber. S. Gall. Naturw. Ges. 1871-72: 353. 1873.

(Plate 48: Figs. 1-13)

Plants erect, tufted, green, up to 6 mm high, usually unbranched. **Stem** ovato-circular in cross section, uniform sized cells troughout with innermost cells conspicuously thick walled. **Leaves** erectopatent, folded, recurved with incurved margins; spathulate, erect spreading, up to ± 1.8 mm long and ± 0.4 mm broad, apex pointed, margin flat, entire; **costa** dull brown, prominent, percurrent. **Upper lamina cells** chlorophyllose, mamillose, rounded- quadrate, 8-9 µm in diameter, basal cells rectangular, hyaline, up to 48 × 14 µm in size. Seta apical, erect reddish brown, ± 1.4 mm long; **capsule** cylindrical, dull brown 1.7 mm long and 0.4 mm in diameter, operculum conical, dull brown, peristome absent.

Spores under SEM: nearly spherical, sporoderm shows coarsely vermiculate surface with densely arranged projections, proximal face with thick ridge studded with similar projections.

Ecology & Distribution: plants growing both on rocks at Patthar Chatta and as epiphyte on way to Apsara Vihar and Pachmarhi Lake from 700-1050 m.

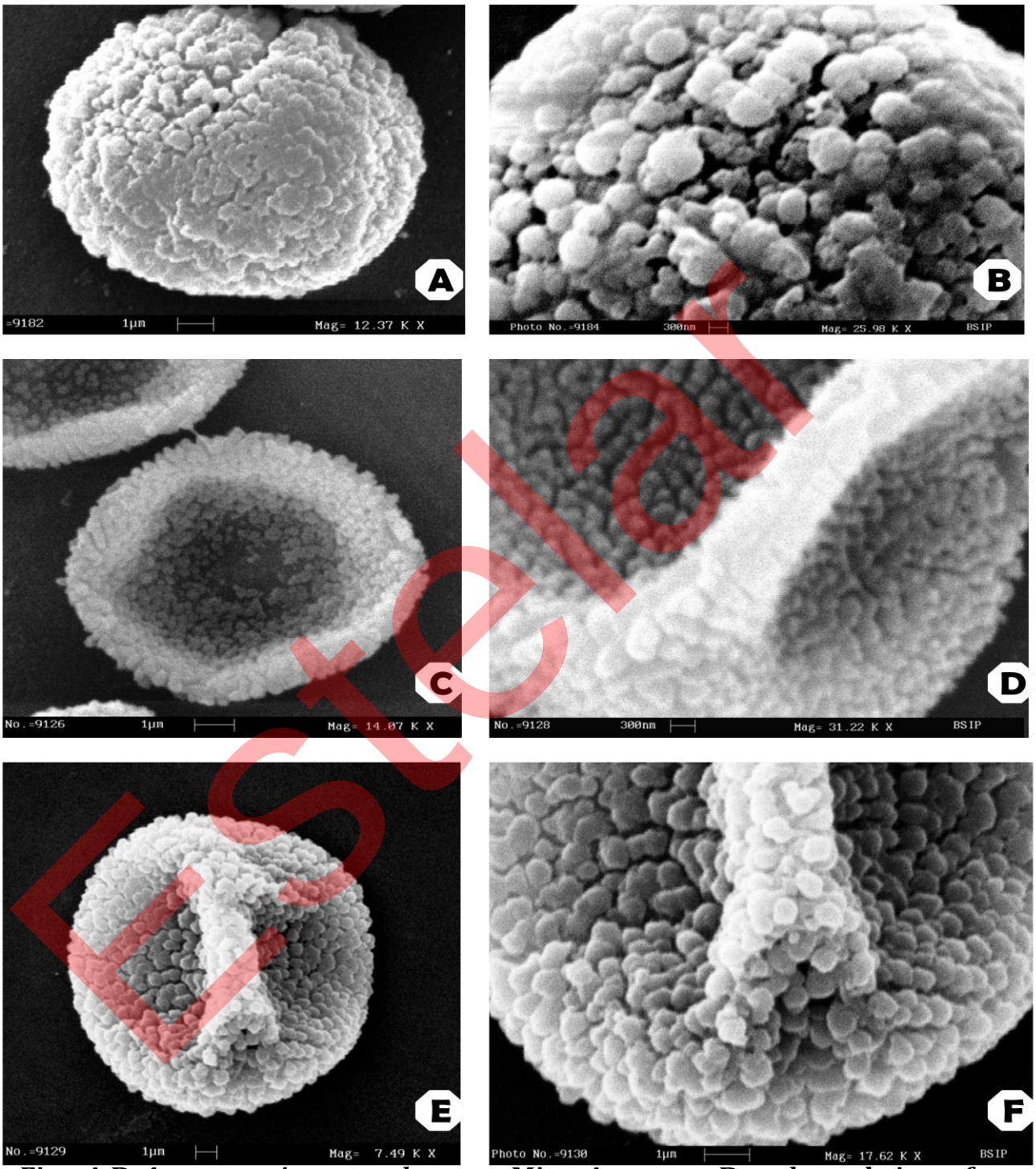
Range of Distribution: China, India: central India (PBR), eastern Himalaya, Gangetic plains (Delhi, Uttar Pradesh), South India (Karnataka, Kerala, Tamil Nadu); western Himalaya (Uttarakhand), Japan, Myanmar, Nepal, Sri Lanka, Thailand.

Specimens examined: India, Madhya Pradesh, PBR: Patthar Chatta, alt. ca 1000 m, on rocks, 18.12.1993, 205647 (LWG), leg. V. Nath and A.K. Asthana; on way to Apsara Vihar, alt. ca 732 m, epiphytic, 01.12.2006, 227691B (LWG), leg. V. Sahu and V. Awasthi; Pachmarhi Lake, alt. ca 1050 m, on rocks, 09.11.2011, 264821 (LWG), leg. A.K. Asthana & R. Gupta.

Plate-48

***Hyophila spathulata* (Harv.) Jaeg.,** Figs. 1-13: 1. plant with sporophyte, 2. cross section of axis, 3-5. leaves, 6. apical leaf cells, 7. median leaf cells, 8. basal leaf cells, 9. capsule, 10-13. spores.

PLATE- III



Figs. A,B. *Anoectangium strachyanum* Mitt.: A. spores, B. enlarged view of spore, Figs.

C, D. *Hyophila involuta* (Hook.) A. Jeager: C. spore, D. enlarged view of spore, Figs. E, F.

***Hyophila sapthulata* (Harv.) A. Jeager: E. spore, F. enlarged view of spore.**

Genus: *Oxystegus* Limpr.

Plants erect, light green to yellowish green above, brown below, in loose unbranched. Leaves flexuose, lanceolate- ligulate, long, broad, margin flat, smooth, may be crenulate near the apex; tip acute forming apiculus; costa light brown, excurrent. Upper lamina cells rounded - quadrate, multipapillate, basal cells wide, rectangular

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

(Plate 49: Figs. 1-13)

Plants erect, light green to yellowish green above, brown below, in loose tufts up to 25 mm long, unbranched. **Stem** circular in cross section, outer cells smaller, inner medullary cells larger. **Leaves** fragile, flexuose, lanceolate- ligulate, long, up to 3.5 mm and up to 0.8 mm broad; margin flat, smooth, may be crenulate near the apex; tip acute with an apiculus; **costa** light brown, excurrent. **Upper** lamina cells rounded - quadrate, ± 8.34 x 8.0 µm, multipapillate, basal cells wide, rectangular, up to 73 x 24 µm near costa, becoming shorter towards margin. Sporophyte not seen.

Ecology & Distribution: plants growing on bare rocks, moist rocks and soil covered rocks on way to Patalkot, on way to Mahadev and Duchess Fall from 400-750 m.

Range of Distribution: Belize, Africa, Canada, China, Costa Rica, Cuba, Dominican Republic, Ecuador, France, Iceland, India: central India (PBR); eastern Himalaya (Darjeeling, Meghalaya, Nagaland); South India (Tamil Nadu), western Himalaya (Himachal Pradesh, Kashmir, Uttarakhand), Japan, Korea, Luxembourg, Malaysia, Mexico, Myanmar Nepal, Norway, Papua New Guinea, Peru, Reunion, Serbia and Montenegro, Spain, Sri Lanka, Sweden, Switzerland, Turkey, United States.

Specimens examined: India, Madhya Pradesh, PBR: on way to Patalkot, alt. ca 400 m, on soil covered rocks, 20.12.1993, 205719 (LWG), leg. V. Nath & A.K. Asthana; on way to Mahadev, alt. ca 975 m, on rocks, 28.11.2006, 227617 (LWG); Dutchess Fall, alt. ca 732 m, on moist rocks, 30.11.2006, 227671 (LWG), leg. V. Sahu & V. Awasthi.

Genus: *Didymodon* Hedw.

Plants erect reddish-brown, rarely branched, in dense tufts, up to 10 mm long. **Stem** circular in cross section, outer cortical cells thick walled, smaller, inner medullary cells larger. **Leaves** patent, ovate- lanceolate, ± 1 x 0.35 mm in size, wider at

base, tapering upwards to acute to broadly pointed tip, margin revolute along the length; **costa** prominent, deep brown, slightly excurrent. **Leaf cells** multipapillose except at base (Smooth), ± 6 - 7 x 4-5 µm at apex, ± 14

***Didymodon recurvus* (Griffith) Broth.,** Nat. Pfl., 1(3): 405. 1902.

Basyn: *Gymnostomum recurvum* Griffith, Cal. J. Nat. Hist. 2: 482. 1842.

(Plate 50: Figs. 1-12)

Plants erect reddish-brown, rarely branched, in dense tufts, up to 10 mm long. **Stem** circular in cross section, outer cortical cells thick walled, smaller, inner medullary cells larger. **Leaves** patent, ovate- lanceolate, ± 1 x 0.35 mm in size, wider at base, tapering upwards to acute to broadly pointed tip, margin revolute along the length; **costa** prominent, deep brown, slightly excurrent. **Leaf cells** multipapillose except at base (Smooth), ± 6 - 7 x 4-5 µm at apex, ± 14 x 11 mm at base. Sporophyte not seen.

Ecology & Distribution: plants growing on dry rocks and soil covered rocks at Rajat Prapat and Apsara Vihar, 920-988 m.

Range of Distribution: Bhutan, India: central India (PBR) eastern Himalaya Darjeeling, Khasia hills, Sikkim), South India, western Himalaya, Nepal.

Specimens examined: India, Madhya Pradesh, PBR : near Rajat Prapat, alt. ca 988 m, on dry rocks, 07.11.2011, 263131 (LWG); Apsara Vihar, alt. ca 920 m, on soil covered rocks, 07.11.2011, 263141C (LWG), leg. A.K. Asthana & R. Gupta.

***Semibarbula ranuii* Gangulee,** Nova Hedwigia, 8: 149. 1964.

(Plate 51: Figs. 1-11)

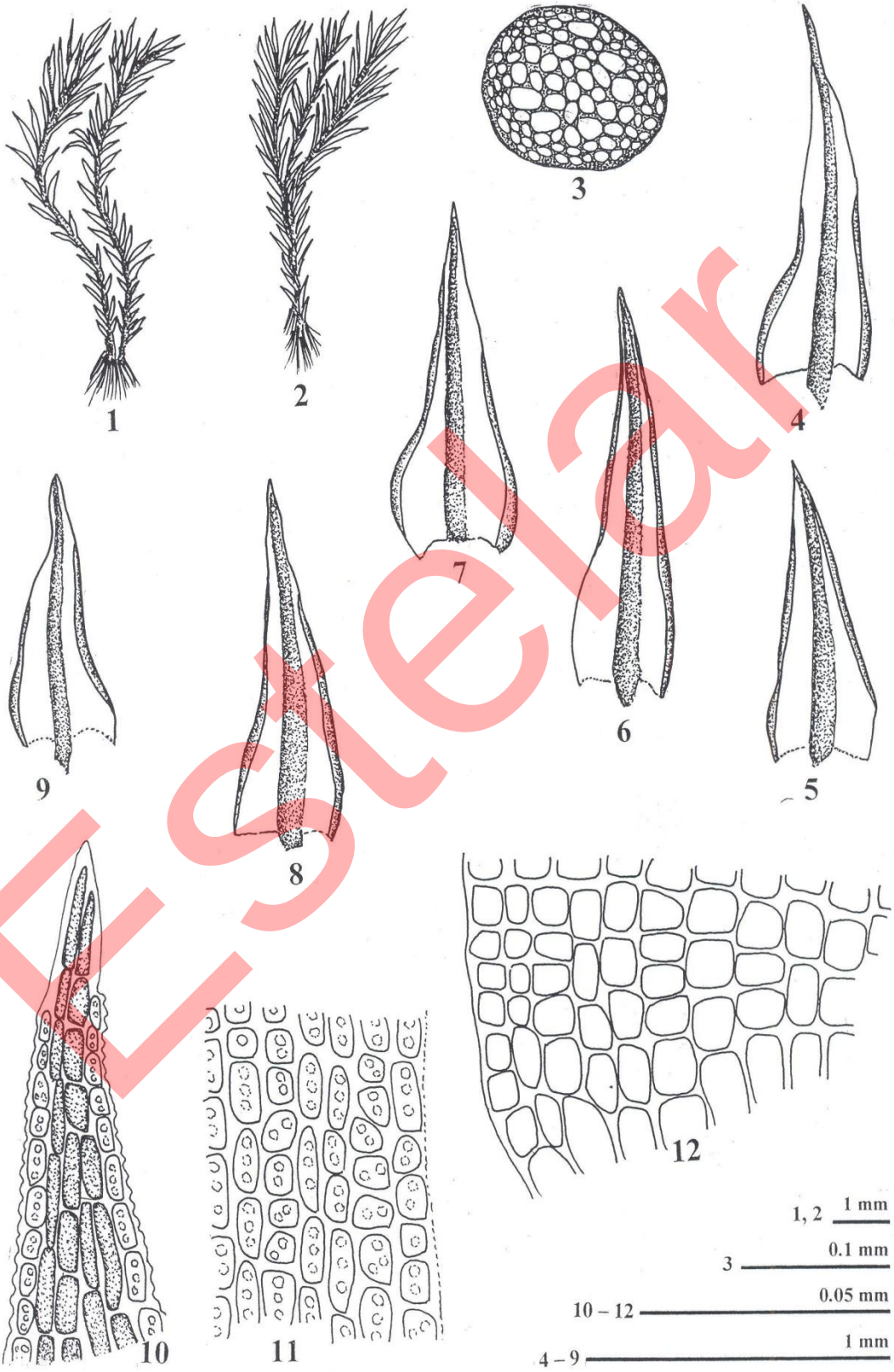
Plants erect, dull green, in loose tufts, up to 16 mm long, unbranched. **Stem** circular in cross section, outer cells thin smaller, gradually becoming larger towards the centre. **Leaves** long, oblong- lanceolate, erectopatent, up to 1.6 mm long and 0.4 mm wide. **Leaf** margin flat, apex broadly acuminate; costa prominent, golden brown, excurrent in a short apiculus, coarse papillae on back. **Upper** laminal cells rounded-quadrate to hexagonal, 6.25 × 8.3 µm in diameter, multipapillose, basal lamina cells rectangular, hyaline, up to 22 × 10 µm in size. Sporophyte not seen.

Ecology & Distribution: plants growing on soil covered rocks near Police Training School, 914 m.

Plate-49

***Oxystegus tenuirostre* (Hook. *et* Tayl.) A.J.E. Smith.,** Figs. 1-8: 1,2. vegetative plants, 3. cross section of axis, 4,5. leaves, 6. apical leaf cells, 7. median leaf cells, 8. basal leaf cells.

Plate-50



***Didymodon recurvus* (Griffith) Broth.,** Figs. 1-12: 1,2. vegetative plants, 3. cross section of axis, 4-9. leaves, 10. apical leaf cells, 11. median leaf cells, 12. basal leaf cells.

Plate-51

***Semibarbula ranuii* Gangulee,** Figs. 1-11: 1,2. vegetative plants, 3. cross section of axis, 4-8. leaves, 9. apical leaf cells, 10. median leaf cells, 11. basal leaf cells.

Range of Distribution: India: central India (Amarkantak & Achanakmar Sanctuary, PBR); Gangetic plains (Chotta Nagpur).

Specimens examined: India, Madhya Pradesh, PBR: near Police Training School, alt. ca 914 m, on soil covered rocks, 28.11.2006, 229383 (LWG), leg. V. Sahu & V. Awasthi.

Genus: *Barbula* Hedw.

Plants erect, dense, green tufts, unbranched, rarely branched. **Leaves** erectopatent, clustered near apex, spathulate, soft, erect, incurved, apexacute to bluntly pointed; margin incurved at places, entire except few projections attributed to cell papillae; **costa** brown, ending just below tip to short excurrent. **Leaf cells** quadrate rounded, papillose, as long as broad, basal cells elongated, rectangular, hyaline.

***Barbula javanica* Dozy. & Molk.,** Ann. Sci. Nat. Bot. Ser 3, 2: 300. 1884.

(Plate 52: Figs. 1-14; Plate IV: Figs. A-C)

Plants erect, dioecious, dense green tufts, less than 10 mm long, unbranched, branch formation rare. **Stem** circular in cross section, cortical cells smaller, thick walled, medullary cells larger. **Leaves** erectopatent, clustered near apex, spathulate, soft, erect, incurved, ± 2 mm x ± 0.54 mm at mid leaf, leaf base broad, slightly sheathing, narrowing towards the apex, tip bluntly pointed; margin incurved at places, entire except few projections attributed to cell papillae; **costa** brown, ending just below tip. **Leaf cells** quadrate rounded, papillose, 7 to 8.4 µm x 7.3 µm at apex, middle cells ± 8 µm as long as broad, basal cells elongated, rectangular, hyaline, smooth, up to 66.7 µm x ± 16.7 µm. **Seta** apical, erect, deep red below, lighter above, ± 15 mm long; **capsule** erect, cylindrical, deep red, ± 1 mm long and ± 0.37 mm in diameter, operculum conic-rostrate as long or longer than capsule, endothecial cells irregularly hexagonal, ± 66.7 x 33 µm, **peristome** comprising 32 filiform papillose segments, twisted spirally, deep red in colour; spores 12.5-16 µm in diameter, greenish yellow - brown.

Peristome under SEM: peristome teeth with densely arranged peg like projections under SEM.

Spores under SEM: spherical with vermiculate sporoderm, proximal face with prominent tri-radiate ridge.

Ecology & Distribution: plants growing on soil covered rocks and on bare rocks at Chota Mahadev and Down Fall, from 880-950 m.

Range of Distribution: Australia, Bangladesh, Bhutan, China, India: central India (PBR); eastern Himalaya (Arunachal Pradesh, Darjeeling, Meghalaya); Gangetic plains (Bengal Plains, Uttar Pradesh, Orissa); Punjab & west Rajasthan Plains (Rajasthan); western Himalaya (Kashmir), Indonesia, Japan, Nepal, Oman, Papua New Guinea, Phillipines, Soloman Islands, Sri Lanka, Taiwan, Thailand, United States, Vanuatu, Vietnam.

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

Family: Calymperaceae Kindb.

Genus: *Octoblepharum* Hedw.

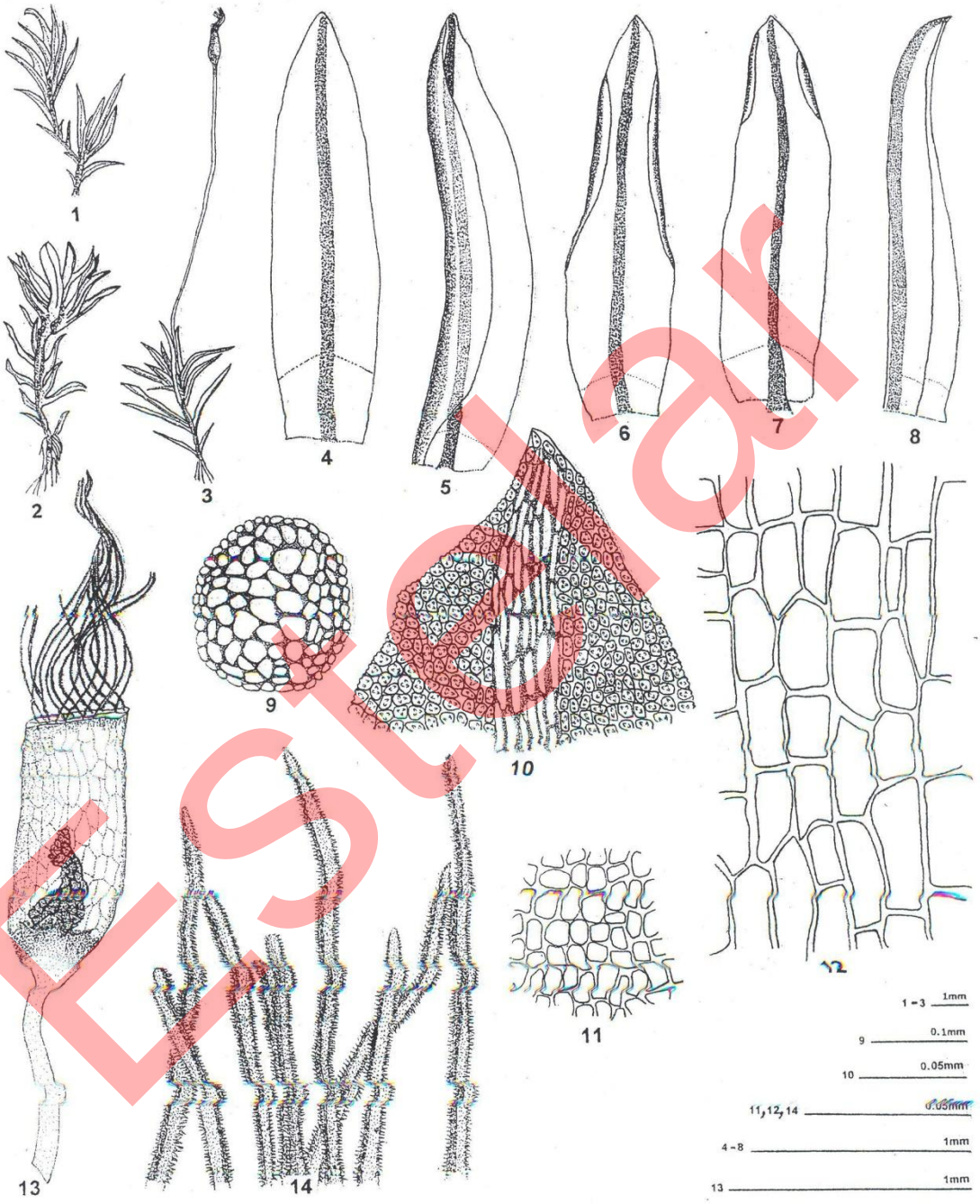
Plants erect, light greenish, forming tufts, 8unbranched. **Leaves** dense, erect-spreading, forming rosette near apex, ligulate, apiculate, large, **costa** wide, running throughout the leaf, shows a median row of triangular chlorocyst cells between 5 - 6 layers of leucocysts in the middle. **Leaf cells** rectangular to squarish, basal row of cells has 5 - 8 rows of hyaline cells, border cells in 1-2 rows, linear, hyaline.

***Octoblepharum albidum* Hedw.,** Sp. Musc. Frond.: 50. 1801.

(Plate 53: Figs. 1-15)

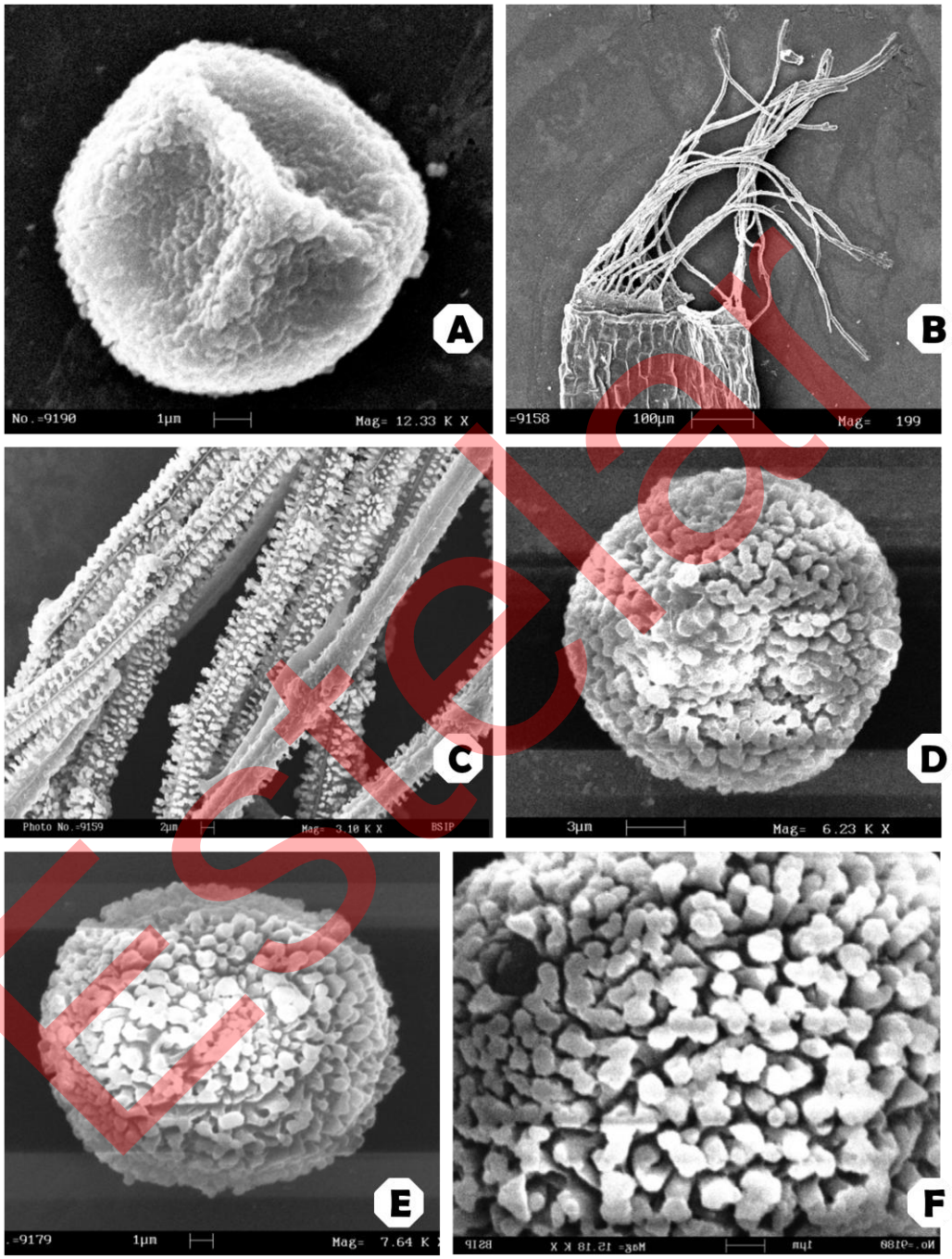
Plants erect, light greenish, forming tufts, 8–15 mm long, 0.3 mm broad, unbranched. **Stem** circular in cross section, with larger cells of similar size, central strand not present. **Leaves** dense, erect- spreading, forming rosette near apex, ligulate, apiculate, ± 5 x 1.5 mm in size; **costa** wide, running throughout the leaf, shows a median row of triangular chlorocyst cells between 5 - 6 layers of leucocysts in the middle, surrounded by 2 layers on the side. **Leaf cells** rectangular to squarish, ± 30 x 19.5 µm in size near base, basal row of cells has 5 - 8 rows of hyaline cells, border cells in 2 rows, linear, hyaline. **Seta** elongated ± 5 mm; **capsule** erect, symmertrical, red, ± 2.3 x 1.4 mm; operculum conical, peristome teeth 8, thick, not split but exhibit longitudinal line; **spores** light brown, finely papillose, 18 - 20 µm in diameter.

Plate-52



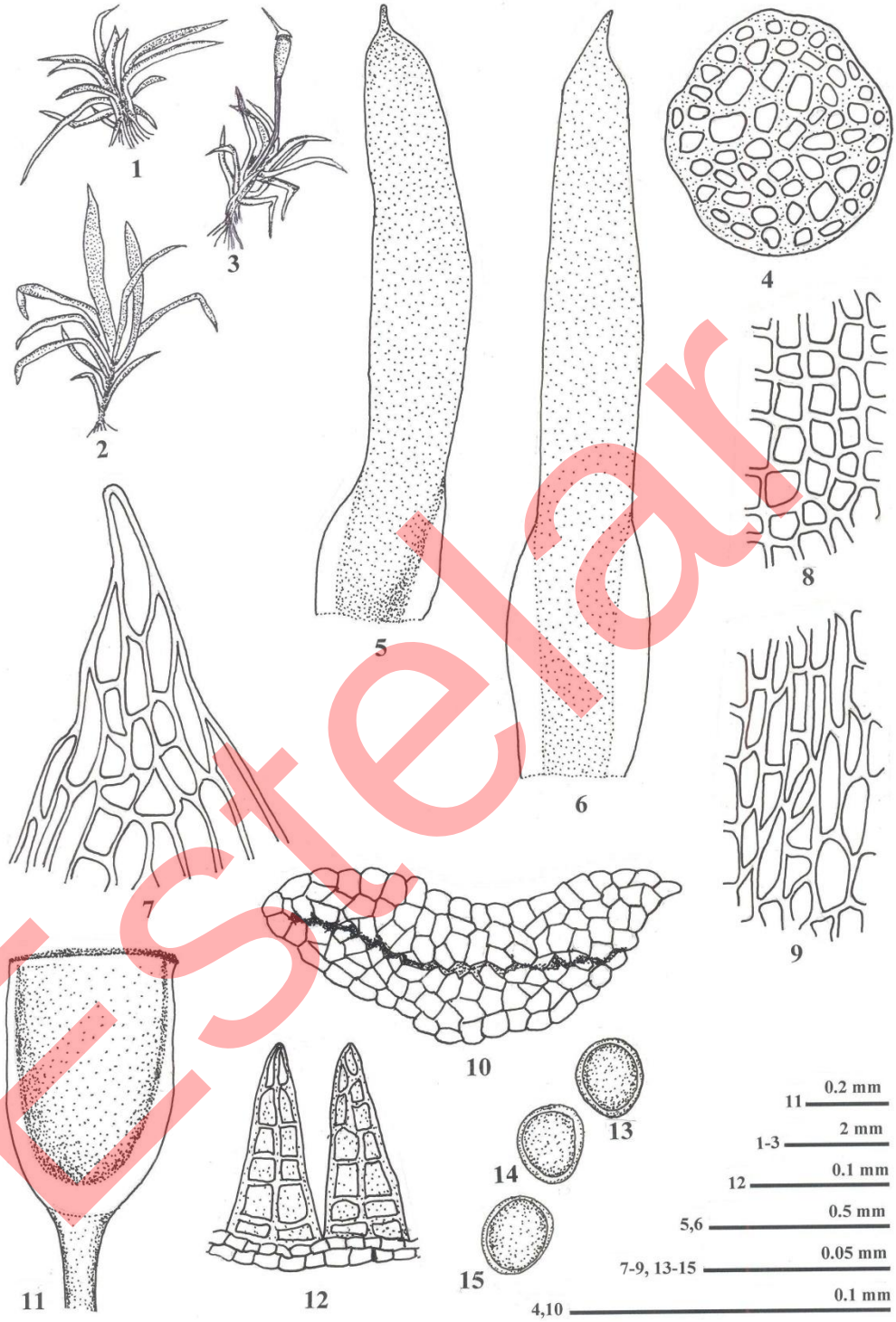
***Barbula javanica* Dox. et Molk.,** Figs. 1-14: 1,2. vegetative plants, 3. plant with sporophyte, 4-8. leaves, 9. cross –section of axis, 10. apical leaf cells, 11. middle leaf cells, 12. basal leaf cells, 13. capsule with peristome, 14. enlarged section of peristome.

PLATE- IV



Figs. A-C.: *Barbula javanica* Dozy & Molk: A. proximal view of spore, B. peristome, C. enlarged view of peristome, Figs. D-F. *Weissia edentula* Mitt.: D,E. distal view of spores, F. enlarged view of spore.

Plate-53



***Octoblepharum albidum* Hedw.,** Figs. 1-15: 1,2. vegetative plants, 3. plant with sporophyte, 4. Cross section of stem, 5,6. leaves, 7.apical leaf cells, 8. middle leaf cells, 9. basal leaf cells, 10. Cross section of leaf, 11. Capsule without operculum, 12. Peristome, 13-15. spores.

Ecology & Distribution: plants growing as epiphyte on way to Chota Mahadev and near Bee Fall and Panchali Kund, from 790-938 m.

Range of Distribution: Antilles, Argentina, Australia, Bahamas, Belize, Benin, Bolivia, Brazil, Burundi, Cameroon, China, Colombia, Comoros, Congo, Costa Rica, Cuba, Dominica, Dominican Republic, Ecuador, El Salvador, Fiji, French Guiana, Gabon, Galapagos, Ghana, Guadeloupe, Guatemala, Guyana, Haiti, Honduras, Iceland, India: Andaman Nicobar Islands, central India (Odisha, PBR), Gangetic plains (Howrah, Kolkata, lower Bengal), eastern Himalaya (Assam, Darjeeling, Manipur, Sikkim), South India (Eravikulum National Park, Goa, Karnataka, Khandala, Kerela, Mahabaleshwar, Shervaroy Hills, Tamil Nadu), western Himalaya (Kumaon), Indonesia, Jamaica, Madagascar, Malaysia Martinique, Mauritius, Mexico, Mozambique, Nepal, Netherlands, Nicaragua, Niger, Nigeri, Panama, Papua New Guinea, Paraguay, Peru, Philippines, Reunion, Saint Kitts and Nevis, Seychelles, South Africa, Sri Lanka, Suriname, Taiwan, Tanzania, Thailand, Trinidad and Tobago, United States, Vanuatu, Venezuela, Vietnam.

Specimens examined: India, Madhya Pradesh, PBR: on way to Chota Mahadev, alt. ca 793 m, epiphytic, 29.11.2006, 227632 (LWG); Near Bee Fall, alt. ca 823 m, epiphytic, 30.11.2006, 227663 (LWG), leg. V. Sahu & V. Awasthi; Panchali Kund, alt. ca 938 m, epiphytic, 07.11.2011, 263152B (LWG), leg. A.K. Asthana & R. Gupta.

Family: Dicranaceae Schimp.

Key to the species of genera of Dicranaceae at PBR:

1. Plants small, in dense tufts, leaves abruptly narrowed to form subulate point, alar not differentiated ……..…….. ***Dicranella***

   Plants large, in lax tufts, leaves gradually narrowed to form subula, alar well differentiated ……..…..…….…… **2**

2. Leaf not bordered by distinct border cells, costa broad, upper leaf cells smaller, clear ……..……..…… ***Campylopus***

   Leaf bordered by distinct border cells, costa narrow, upper lamina cells obscure, incrassate ……..……..…… ***Leucoloma***

Genus: *Campylopus* Bridel

Plants, erect, caespitose, dull brown to bright green, unbranched. Stem thick, brown circular in cross section, innermost cells small, thick walled, forming distinct

conducting region. Leaves densely arranged on stem, smaller bellow, larger upwards, erectopatent, ± dense at apex, lanceolate, extending into canaliculated subula; margin smooth, dentated slightly at tipin many species; costa robust, occupying half to 1/3rd width at leaf base.Leaf section has steroids in one to two rows. Leaf cells smaller, rhomboidal at apex, basal cells larger narrower towards the margin, alar distinct, non-bulging to inflated.

Key to the species of genus *Campylopus* at PBR:

1. Costa almost homogenous, without sterieds…….....…… **2**
   Costa with stereids on either dorsal side or both the sides……..…… **3**
2. Upper lamina cells quadrate to rhomboidal, can be incrassate ……..……..... ***C. fragilis* subsp. *goughii***
   Upper lamina cells rectangular, usually not incrassate .....…….. ***C. gracilis***
3. Plants smaller, unbranched, ± 10 mm in size, costa with stereids on both sides of deuter row ….....……..…… ***C. savannarum***
   Plants larges, unbranched to branched, > 1.5 mm in size, costa with stereids on one side of deuter row…….…….....…… **4**
4. Nerve back grooved, alar not much inflated, colourless to reddish …….....***C. ericoides***
   Nerve back almost smooth, alar much inflated, brownish ……..… ***C. flexuosus***

***Campylopus fragilis* subsp. *goughii* (Mitt.) J.-P. Frahm,** Trop. Bryol. 4: 61. 1991.

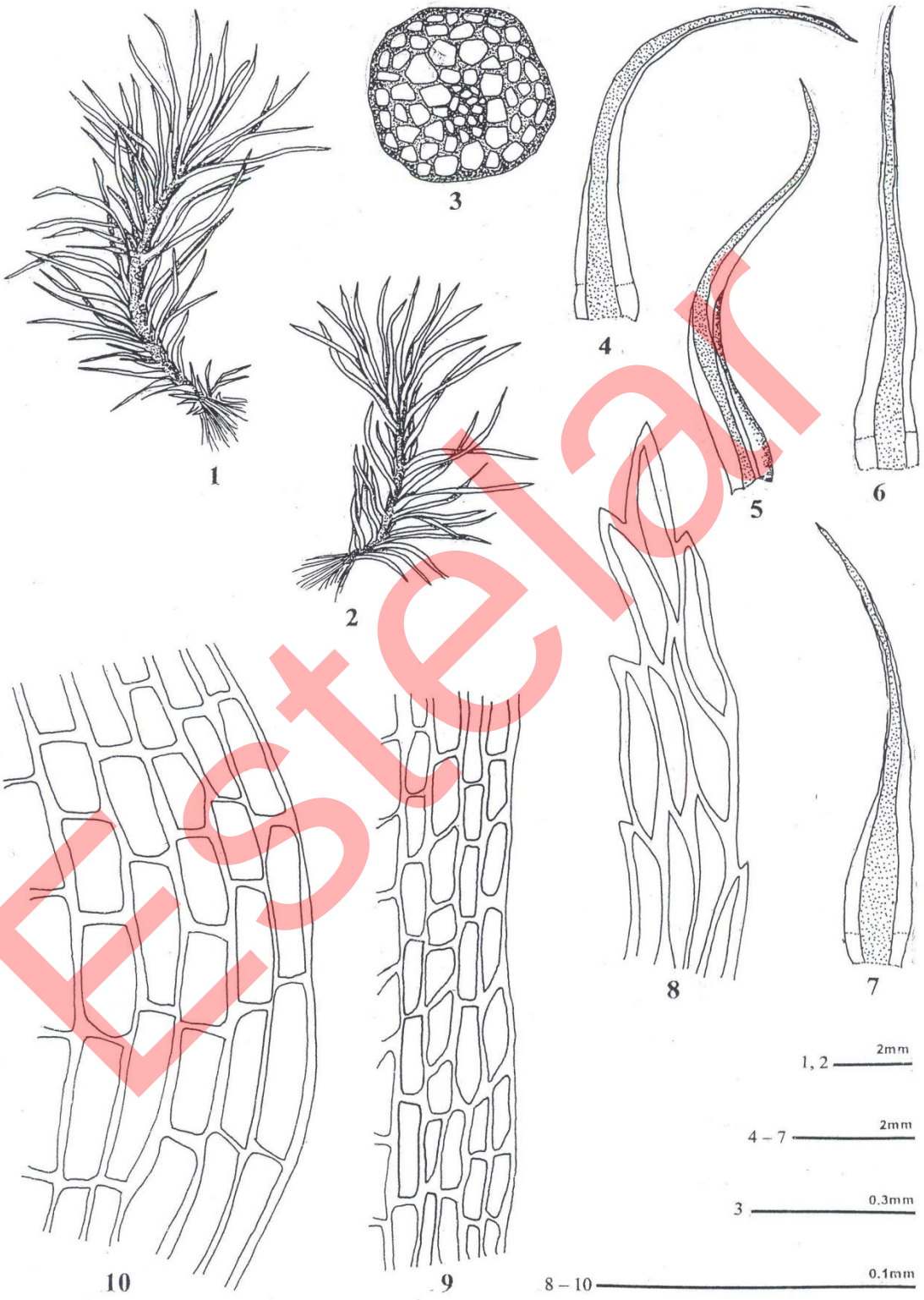
Basyn: *Dicranum goughii* Mitt., Musc. Ind. Or.:17. 1859.

Syn: *Campylopus goughii* (Mitt.) A. Jaeger , Ber. S. Gall. Naturw. Ges.,1870-71: 424. 1872.

(Plate 54: Figs. 1-10)

Plants, erect, caespitose, dull brown stem, green leaves, ± 15 mm, unbranched. Stem circular in cross section, outer cortical cells smaller, medullary cells larger, innermost cells small, thick walled, forming distinct conducting region. **Leaves** densely arranged on stem, smaller bellow, larger upwards, erectopatent, ± 3.03 × 0.43 mm dense at apex, lanceolate, extending into canaliculated subula; margin smooth, dentated slightly at tip; **costa** light, occupying half width at leaf base ± 220 µm wide. **Leaf cells** smaller, rhomboidal, ± 21 × 6.8 µm at apex, basal cells larger, ± 41.7 x 20.1µm,

Plate-54



***Campylopus fragilis* (Brid.) B.S.G. ssp *goughii* (Mitt.) Jaeg.,** Figs. 1-10: 1, 2. vegetative plants, 3. cross section of axis, 4-7. leaves, 8. apical leaf cells, 9. median leaf cells, 10. basal leaf cells.

becoming narrower towards the margin, alar distinct, not bulging, inflated, ± 42 × 28 µm, hyaline. Sporophytes not seen.

Ecology & Distribution: plants growing on wet rocks near Jambu Dweep at 793 m.

Range of Distribution: China, Bhutan, Nepal, India: central India (PBR), eastern Himalaya (Darjeeling, Khasi Hills, Sikkim), western Himalaya, western Ghats (Palni, Tirunelveli - Travancore Hills), Sri Lanka.

Specimens examined: India, Madhya Pradesh, PBR: near Jambu Dweep, alt. ca 793 m, on wet rock, 29.11.2006, 227652B, 227655B (LWG), leg. V. Sahu & V. Awasthi.

***Campylopus gracilis* (Mitt.) A. Jaeger,** Ber. Thätigk. St. Gallischen Naturwiss. Ges. 1870 -71: 427. 1872.

Basyn: *Dicranum gracile* Mitt. Musc. Ind. Or. 17. 1859.

Syn: *Campylopus latinervis* (Mitt.) A. Jaeger, Ber. S. Gall. Naturw. Ges., 1870-71: 426. 1872.

Syn: *Dicranum latinervis* Mitt., Musc. Ind. Or.: 17.1859.

(Plate 55: Figs. 10-20)

Plants erect, up to 18 mm long, branched by proliferations. **Stem** circular in cross section, outer cortical cells small, graduating into larger medullary cells, small cells at extreme centre. **Leaves** erectopatent, ± 4.02 mm x 0.68 mm in size, lanceolate, subulate extending into canaliculated subula, margin inflexed, tip denticulate, not hyaline; **costa** strong, dull yellow, covering whole apex. Leaf shows absence of sterieds, large irregular thin walled cells. Leaf cells elongated ± 24 x 8 µm, rectangular towards apex, narrow at margins broad at base, 32 x 20 µm; alar cells large, hyaline not inflated, not-auriculate. Sporophyte not seen.

Ecology & Distribution: plants growing epiphytically on way to Jalgali towards Dhoopgarh, 1056 m.

Range of Distribution: Africa, Antartica, Austria, Canada, China, Faroe Islands, India: central India (PBR), eastern Himalaya (Darjeeling, Manipur, Sikkim), South India (Nilgiri), western Himalaya (Kumaon), Ireland, Japan, Nepal, Norway, Peru, Sri Lanka, Thailand, United Kingdom, United States.

Specimens examined: India, Madhya Pradesh, PBR: on way to Jalgali towards Dhoopgarh, alt. ca 900 m, epiphytic, 16.12.1993, 205541A (LWG), leg. V. Nath & A.K. Asthana.

***Campylopus savannarum* (C. Mull) Mitt.,** J. Linn. Soc. Bot. 12: 85. 1869.

Syn: *Dicranum laeteum* Mitt. in Musc. Ind. Or.: 19. 1859.

Syn: *Campylopus laetus* (Mitt.) A. Jaeger, Ber. S. Gall. Naturw. Ges.,1870- 71: 417. 1872.

(Plate 56: Figs. 1-10)

Plants erect, caespitose, deep green up to 12 mm (can be more due to proliferation), unbranched. **Stem** oval in cross section, shows smaller outer cortical cells followed by larger medullary cells; extreme central cells small and thick walled forming a distinct conducting zone. **Leaves** densely arranged throughout the stem, erectopatent, long, lanceolate, ± 2 × ± 0.5 mm in size, extending into a long subula, margin incurved mostly at apex, sometimes at lower leaf as well, serrated at apex; **costa** strong, brownish yellow, ± 270 µm wide, extending into the tip. **Leaf cells** irregular at apex, rectangular to rhomboidal, ± 24 × 6 µm in size, getting larger towards base, rectangular, up to 50.0 × 20.9 µm, alar not bulging, cells large, hyaline, ± 63.5 × 33.4 µm in size; cross section of leaf shows stereides on both sides. Sporophytes not seen.

Ecology & Distribution: plants growing epiphytically (on tree bark) at Twynam Pool at 853 m.

Range of Distribution: Angola, Australia, Belize, Bolivia, Brazil, Burundi, Cambodia, Cameroon, Colombia, Comoros, Congo, Costa Rica, Ecuador, El Salvador, French Guiana, Gabon, Guatemala, Guyana, Honduras, India: central India (PBR), eastern Himalaya (Darjeeling, Khasi Hills, Sikkim), South India (Palni, Tirunelveli - Travancore Hills), Indonesia, Madagascar, Malaysia, Mexico, Nicaragua, Niger, Panama, Philippines, Reunion, Rwanda, Sao Tome and Principe, South Africa, Suriname, Taiwan, Tanzania, Thailand, Trinidad and Tobago, United States, Venezuela, Zambia.

Specimens examined: India, Madhya Pradesh, PBR: Twynam Pool, alt. ca 853 m, epiphytic, 29.11.2006, 227619 (LWG), leg. V. Sahu & V. Awasthi.

***Campylopus ericoides* (Griffith) A. Jaeger,** Ber. S. Gall. Naturn. Ges. 1870-71: 424. 1872.

Basyn: *Dicranum ericoides* Griffith, Cal. J. Nat. Hist., **2**: 499. 1842.

(Plate 57: Figs. 1-10)

Plate-55

Campylopus flexuosus **(Hedw.) Brid.,** Figs. 1-9: 1. vegetative plant, 2. cross section of axis, 3-5. leaves, 6. cross section of leaf, 7. apical leaf cells, 8. median leaf cells, 9. basal leaf cells; ***Campylopus gracilis*** **(Mitt.) A. Jaeger.,** Figs. 10-20: 10,11. vegetative plants, 12. cross section of axis, 13-16. leaves, 17. cross section of leaf, 18. apical leaf cells, 19. median leaf cells, 20. basal leaf cells.

Plate-56

***Campylopus savvanarum* (C. Mull) Mitt,** Figs. 1-10: 1,2. plants, 3. cross section of axis, 4-7. leaves, 8. apical leaf cells, 9. median leaf cells, 10. basal leaf cells.

Plants erect, comose, green, ± 18 mm, covered leaves becoming denser at apex, unbranched. **Stem** quadrate-oval in cross section with larger cortical cells, medullary cells smaller, thick walled, concentrated at centre. **Leaves** erectopatent, ± 2.6 x 0.57 mm in size, extending into canaliculate subula, upper leaf margin dentate, rhizoids growing from leaf base; **costa** light yellow, covering up to 1/2 of the leaf base. **Leaf** cells slender, rhomboidal, smaller, ±12 x 8 µm, middle cells larger, ± 16 x12 µm becoming larger and rectangular at base, ± 48 x 18 µm, alar well developed, slightly inflated, colourless to hyaline. Sporophyte not seen.

Ecology & Distribution: plants growing on rocks and moist rocks near Jambu Dweep and Pandav Caves from 700 – 800 m.

Range of Distribution: China, India: central India (PBR), Gangetic plains (West Bengal), eastern Himalaya (Darjeeling, Khasi Hills, Manipur), South India (Agasthyamala, Chinnar Wildlife Sanctuary, Tirunelveli), Indonesia, Java, Myanmar, Nepal, Philippines, Sri Lanka, Thailand, Vietnam.

Specimens examined: India, Madhya Pradesh, PBR: near Jambu Dweep, alt. ca 793 m, on moist rocks, 29.11.2006, 227652B, 227655B (LWG); Pandav Caves, alt. ca 715 m, on rocks, 01.12.2006, 227683A (LWG), leg. V. Sahu & V. Awasthi; Bee Dam, alt. ca 976 m, on soil covered rocks, 08.11.2011, 263191 (LWG), leg. A.K. Asthana & R. Gupta.

***Campylopus flexuosus* (Hedw.) Bridel,** Mant. Musc. 4: 71. 1819.

Basyn: *Dicranum flexuosum* Hedw., Sp. Musc. : 145. 1801.

(Plate 55: Figs. 1-9)

Plants erect, shiny green in dense tufts, variable in size, ± 20 mm dichotomously branched. **Stem** circular in cross section, outer cortical cells small, inner madullary cells larger. **Leaves** flexuose, erectopatent, ± 4.25 x ± 0.68 mm broad, narrowing into a canaliculated subula; margins incurved, leaf tip serrate, not hyaline; **costa** brownish, covering 2/3 rd of base, whole of tip. **Leaf** in t.s. shows sterieds on dorsal side, dorsal surface smooth. **Leaf cells** short rectangular, + 14 x 6.02 µm near costa, marginal cells narrow, basal cells rectangular, + 30 x 8.4 µm, alar slightly inflated, bulging reddish to dull hyaline cells. Sporophyte not seen.

Ecology & Distribution: plants growing on rocks on way to Chota Mahadev, 853 m.

Range of Distribution: Algeria, Argentina, Australia, Austria, Belgium, Bolivia, Canada, Caribbean, Chile, China Colombia, Congo, Costa Rica, Cuba, Czech Republic, Denmark, Dominic Republic, Ecuador, Salvador, France, Germany, Greenland, Guatemala, Haiti, Honduras, Iceland, India: central India (PBR), eastern Himalaya, South India (Eravikulum National Park, Idduki Distt., Shervaroy hills, Wayanad), Ireland, Jamaica, Japan, Madagascar, Mauritius, Mexico, Netherlands, New Zealand, Norway, Panama, Peru, Poland, Portugal, Puerto Rico, Reunion, Rwanda, Saint Helena, Soapstone and Principe, Siberia, Spain, Sweden, Switzerland, Tanzania, Thailand, United Kingdom, United States, Venezuela, Vietnam.

Specimens examined: India, Madhya Pradesh, PBR: Chota Madadev, alt. ca 853 m, on rocks, 29.11.2006, 227631 (LWG), leg. V. Sahu & V. Awasthi.

Genus: *Dicranella* C. Muell.

Plants caespitose, pale green to brown, up to 15 mm in size, usually unbranched. Leaves covering the stem laxly below, densely at apex; erect, lanceolate, smaller below, larger above, concave, base wide, passing into canaliculated acute subula; leaf lamina incurved at places, usually at apex; costa very darker than leaf color, broader at base, narrowing upwards, smooth, may be slightly irregular at extreme apex, percurrent or ending at tip. Leaf cells elongated, rectangular or slightly spindle shaped, alar cells distinct.

***Dicranella leptoneura* Dixon,** J. Bomb. Nat. Hist. Soc., 39: 774. 1937.

(Plate 58: Figs. 1-12)

Plants caespitose, pale green to brown, ± 10 mm in size, unbranched. **Stem** circular in cross section, outer cortical cells smaller compared to medullary cells which are irregular and large. **Leaves** covering the stem laxly below, densely at apex; erect, lanceolate, smaller below, ± 1.4 × 0.23 mm, larger near the apex, ± 2.1 × 0.32 mm, base wide, concave, tapering above, passing into canaliculated acute subula; leaf lamina incurved at places, usually at apex; **costa** very slightly darker than leaf color, broader at base, narrowing upwards, smooth, may be slightly irregular at extreme apex. **Leaf cells** elongated, rectangular or slightly spindle shaped, ± 24 × 19 µm, basal cells broader, up to 10.4 × 17 µm; leaf cell size increases from margin towards costa. **Anthredial cluster** present at apex, surrounded by large leaves. Antheridia broadly spindle shaped,

Plate-57

***Campylopus ericoides* (Griff.) A. Jaeger.,** Figs. 1-10: 1,2. vegetative plants, 3. cross section of axis, 4-7. leaves, 8. apical leaf cells, 9. median leaf cells, 10. basal leaf cells.

Plate-58

***Dicranella leptoneura* Dixon,** Fig. 1-12: 1,2. plants, 3. cross section of axis, 4-7. leaves, 8. apical leaf cells, 9. median leaf cells, 10. basal leaf cells, 11. antheridial cluster, 12. antheridium

sometimes slightly broader at upper region as compared to lower region. Female plants or sporophyte not seen.

Ecology & Distribution: plants growing epiphytically (on tree bark) near Jambu Dweep at 853 m.

Range of Distribution: China, India.

Specimens examined: India, Madhya Pradesh, PBR: near Jambu Dweep, alt. ca 853 m, epiphytic, 29.11.2006, 227643 (LWG), leg. V. Sahu & V. Awasthi.

Genus: *Leucoloma* Bridel

Plants erect, large – green up to 22 mm long, scarcely branched. **Leaves** erectopatent, secund, densely arranged on stem, broad at base,narrowing towards apex; **costa** narrow reddish- brown to dark brown, completely occupies tip. **Leaf cells** quadrate, incrassate, at apex, middle leaf cells elongate, getting narrower towards margin, basal cells forming alar bulging.

Key to the species of genus *Leucoloma* at PBR:

1. Plants slender, rarely branched, alar hyaline towards margin, reddish towards costa ..... ***L. taylorii***
   Plants robust, branched, alar reddish – orange ..... ***L. amoene-virens***

***Leucoloma taylorii* (Schwaegr.) Mitt.,** Musci India. Or.: 13. 1859**.**

Basyn: *Sryrrhopodon taylorii* Schwaegr., Sp. Musc. Suppl., 2 (2): 115. 1824.

(Plate 59: Figs. 1-9)

Plants erect, yellowish – green up to 15 mm long, scarcely branched. **Stem** ovato-circular in cross section with irregularly scattered thick walled cells. **Leaves** erectopatent, secund, densely arranged on stem, up to 3.8 mm long, ± 2.5 mm broad, narrowing towards apex; **costa** narrow reddish brown completely occupies tip, rough and obscure. **Leaf cells** quadrate, incrassate, ± 8 µm in diameter at apex, middle leaf cells elongate – rectangular at costa, getting narrower towards margin, basal cells ± 26 x 8.5 µm, rectangular, alar bulging, cells rectangular, hyaline at periphery, brown towards interior, margin bordered by 2-3 rows of very narrow elongated cells. Sporophyte not seen.

Ecology & Distribution: plants growing epiphytically at Jalgali and Patthar Chatta (near water stream), at 900- 1000m.

Range of Distribution: Antarctica, India: central India (PBR), South India (Kerala), Malaysia, Myanmar, Nepal, Philippines, Thailand, United States.

Specimens examined: India, Madhya Pradesh, PBR: Jalgali alt. ca 900 m, epiphytic, 16.12.1993, 205580 (LWG); Patthar Chatta, alt. ca 1000 m, epiphytic, 18.12.1993, 295650C (LWG), leg. V. Nath & A.K. Asthana.

***Leucoloma amoeno- virens* Mitt.** Musc. Ind. Or.: 13. 1859.

(Plate 59: Figs. 10-19)

Plants erect, yellowish green, up to 20 mm long, branched. **Stem** circular in cross section, scattered irregular thick walled cells. **Leaves** lanceolate, carinate, wider at base narrowing towards apex into a canaliculated tip, ± 3 x 0.45 mm in size, margin recurved; **costa** light brown, occupying apex majorly, extending into the subula. **Leaf cells** incrassate, papillose towards apex ± 8 x 4 µm, getting obscure at subula, elongated towards base, ± 27 x 6.8 µm, boarder rows of transparent, thin slender cells, up to 2/3 rd of leaf length. Sporophyte not seen.

Ecology & Distribution: plants growing epiphytically at Down Fall, 884 m.

Range of Distribution: Sri Lanka, Thailand, India : central India (PBR), eastern Himalaya (Khasi hills), South India (Kerla, Nilgiri hills, South western Ghats, Tamil Nadu).

Specimens examined: India, Madhya Pradesh, PBR: Down fall, alt. ca 884 m, epiphytic, 28.11.2006, 229400 (LWG), leg. V. Sahu & A. Awasthi.

Family: Rhabdoweisiaceae Limpr.

Genus: *Cynodontium* Schimp.

Plants, erect, tufted, dull green, radiculose, variable in size, rarely branched. Leaves densely arranged throughout the stem, erectopatent, lanceolate, broader below, crumpled when dry, sheathing and broad below, tapering at apex, margin wavy, involute, slightly dentate due to cell projections; costa strong, dull brown, prominent, wider at base, tapering above and vanishing just below the apex. Leaf cells highly incrassate and at apex, basal cells rectangular, hyaline.

Plate-59

***Leucoloma taylorii* (Schwaegr.) Mitt.,** Figs. 1-9: 1. vegetative plant, 2. cross section of axis, 3-6. leaves, 7. apical leaf cells, 8. median leaf cells, 9. basal leaf cells; ***Leucoloma amoeno-virens* Mitt.** Figs. 10-19: 10. vegetative plant, 11. cross section of axis, 12-16. leaves, 17. apical leaf cells, 18. median leaf cells, 19. basal leaf cells.

***Cynodontium gracilescens* (F. Weber & D. Mohr) Schimp.,** Coroll. Bryol. Eur. 12. 1856.

Basyn: *Dicranum gracilescens* F. Weber & D. Mohr., Bot. Taschenb.: 184. 1807.

(Plate 60: Figs. 1-11)

Plants, erect, tufted, dull green, radiculose, 8 - 20 mm in size, rarely branched. **Stem** round to triangular in cross section, cortical cells smaller inner medullary cells larger. **Leaves** densely arranged throughout the stem, erectopatent, lanceolate, broader below, crumpled when dry, ± 3.8 x 0.62 mm in size, sheathing and broad below, tapering at apex, margin wavy, involute, slightly dentate due to cell projections; **costa** strong, dull brown, prominent, wider at base, tapering above and vanishing just below the apex. **Leaf cells** highly incrassate and mamillose, ± 14 × 9.4 µm at apex, ovate – quadrate, basal cells rectangular, hyaline, ± 18 × 7.5 µm in size; cross section of leaf shows larger thin walled cells in the middle surrounded by smaller thick walled cells starting from bistratose at the midrib becoming unistratose towards wings. Sporophytes not seen.

Ecology & Distribution: plants growing on soil over rock at Rajakhoh (Patalkot) at 400 m.

Range of Distribution: Austria, Canada, China, Finland, France, Germany, Greenland, India: central India (PBR), eastern Himalaya (Darjeeling, Sikkim), Italy, Japan, Luxembourg, Norway, Poland, Portugal, Sweden, Switzerland, Tanzania, United States.

Specimens examined: India, Madhya Pradesh, PBR: Rajakhoh (Patalkot), alt. ca 400 m, 20.12.1993, on soil covered rock, 205724 (LWG), leg. V. Nath & A.K. Asthana.

Family: Leucobryaceae Schimp.

Genus: *Leucobryum* Hamp.

Plants erect, small, branched, variable in size. Leaves delicate, erectopatent, flexucose, broader below, gradually narrowing to a tubular tip; costa wide, smooth, formed by one layer of chlorocyst cells sandwitched between two layers of leucocysts. Lamina made up of hyaline cells, irregularly rectangular cells, basal cells boardered by two rows of hyaline cells.

***Leucobryum juniperoideum* (Bridel) Müll. Hal.,** Linnaea, 18: 389. 1945.

Basyn: *Dicranum junporoideum* Bridel, Bryol. Univ. 1:409. 1826.

(Plate 61: Figs. 1-12)

Plants erect, small, branched, ± 7mm x 5.5 mm in size. **Stem** circular in cross section, outer cells slightly slender, inner cella broader, thin walled, no demarcation of cortical or medullary region. **Leaves** delicate, erectopatent, flexucose, broader below, gradually narrowing to a tubular tip, ± 2.9 x 0.9 mm in size; **costa** wide, smooth, formed by one layer of chlorocyst cells sandwitched between two layers of leucocysts. **Lamina** made up of hyaline cells, irregularly rectangular, ± 32 x 15 µm at apex, 37.5 x 18 µm at base, lamina boardered by two rows of hyaline slender cells. Bi-celled to multicellular stalked gemmae are seen arising from leaves. Sporophyte not seen.

Ecology & Distribution: plants growing as epiphyte on way to Bee Fall at 823 m.

Range of Distribution: Austria, China, France, Germany, India: central India (PBR), eastern Himalaya, South India (Kalakkad, Tirunelveli), Indonesia, Ireland, Japan, Luxembourg, Madagascar, Papua New Guinea, Poland, Portugal, Russia, Serbia and Montenegro, Slovakia, Spain, Sri Lanka, Switzerland, Taiwan, Thailand, Turkey, United Kingdom, United States.

Specimens examined: India, Madhya Pradesh, PBR: on way to Bee Fall, alt. ca 823 m, epiphytic, 30.11.2006, 227668B (LWG), leg. V. Sahu & V. Awasthi.

Family: Fissidentaceae Schimp.

Genus: *Fissidens* Hedw.

Plants erect, yellowish green to light green, variable in size with up to 30 leaf pairs. Leaves arranged alternately, oblong, ligulate with narrow to broader tip; leaves characterized by with sheathing lamina (vaginant lamina) which may be unequal (open) or equal (closed), margin shows slight crenulations attributed to the projecting marginal cells; leaf cells with 1 - 2 papillae to smooth, costa ending just below tip. Semilimbidium may be present or absent.

Key to the species of genus *Fissidens* at PBR:

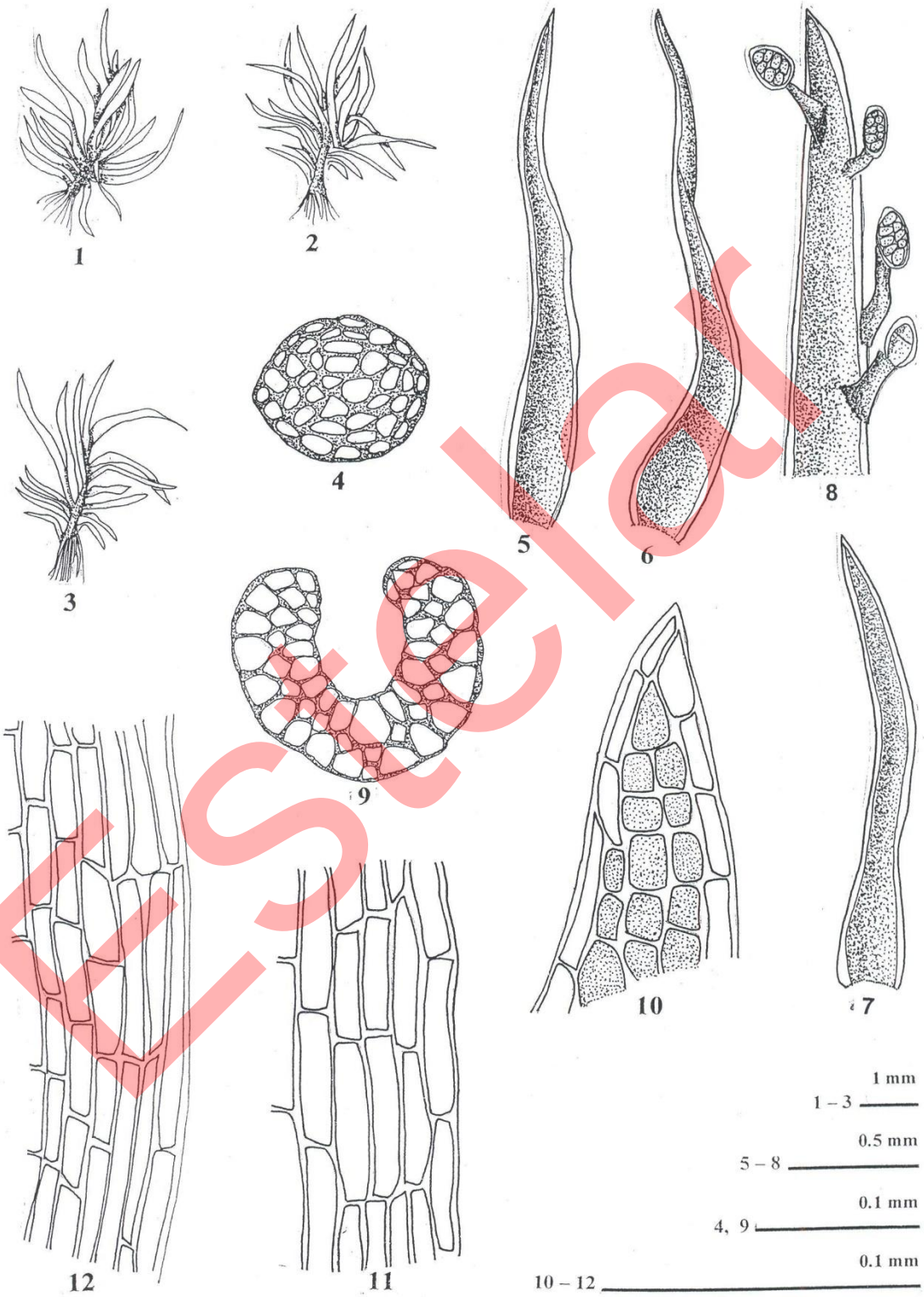
1. Plants with incomplete semilimbidium ……..…….…….....…… **2**

   Plants without semilibidium …….....……. **3**

Plate-60

***Cynodontium grascilescens* (F. Weber & D. Mohr). Schimp.,** Figs. 1-11: 1,2. plants, 3. cross section of axis, 4-7. leaves, 8. T.S. of leaf, 9. apical leaf cells, 10. median leaf cells, 11. basal leaf cells.

Plate-61



***Leucobryum juniperoideum* (Brid.) Mull. Hal.,** Figs. 1-12: 1-3. vegetative plants, 4. cross section of axis, 5-7. leaves, 8. leaf with stalked gemmae, 9. Cross section of leaf, 10. apical leaf cells, 11. median leaf cells, 12. basal leaf cells.

2. Plants larger in size, with more than 20 leaf pairs, leaf tip broader, margin leaf cells lighter in colour at times ……..... ***F. asperisetus* var. *andamnensis***

Plants smaller in size, with 8-12 leaf pairs, leaf tip acute, marginal leaf cells of same colour ……..…….……..……. ***F. ceylonensis***

3. Plants with up to 14 leaf pairs, leaves mostly equally broad frombase till near the tip ……..…….…… **4**

Plants with usually 14 or more leaf pairs, leaves broader at base, narrower upwards ……..…….....……..…… **6**

4. Leaf tips acute, vaginant lamina slightly less than ½ leaf length ……..... ***F. pulchellus***

Leaf tips obtuse to obtusely acute, vaginant lamina ½ the length of leaf.……..... **5**

5. Leaves densely arranged throughout the stem, lower leaves smaller, upper ones larger, base of dorsal lamina rounded ……..…….…… ***F. formosanus***

Leaves densely arranged towards apex, distantly arranged below, lower & upper leaves nearly equal, base of dorsal leaf lamina wedge shaped ……..…….. ***F. mangarevensis***

6. Leaf margin crenulated due to cell projections, dorsal leaf lamina rounded at base, costa ending below (3-4 cells below tip) ……..……..……. ***F. involutus***

Leaf margin slightly irregular due to cell projection, costa ending just below tip or slightly extended forming a mucronate apex ……..……..... **7**

7. Dorsal lamina gradually tapering to base and ending at leaf insertion …….... **8**

Dorsal lamina undulating at base, not narrowing much before reaching base ……..... ***F. taxifolius***

8. Dorsal leaf lamina narrower that sheathing lamina; costa ending just before tip ……..... ***F. crispulus* var. *crispulus***

Dorsal leaf lamina of equal width as sheathing lamina; costa ending on mucronate tip ..... ***F. sylvaticus* var. *teraicola***

***Fissidens asperisetus* var. *andamanensis* Gangulee,** Mosses of Eastern India and Adjacent Regions 1: 507, 1972.

(Plate 62: Figs. 1-13)

Plants erect, terrestrial, yellowish green, up to 14 mm long with 26 leaf pairs. **Stem** oval in cross section, cortical cells smaller, medullary cells larger. **Leaves** arranged alternately, oblong, ligulate with somewhat broader tip ± 1.93 × 0.43 mm in size; with sheathing lamina up to 1.12 mm long (B/L = ± 22/100, S/L = 57.8/100), mostly unequal (open), margin shows slight crenulations attributed to the projecting marginal cells; **leaf cells** with 1 - 2 papillae, ± 6 µm in upper and middle region; **costa** ending just below tip. Semilimbidium covers nearly half of the leaf length, vanishing afterwards. **Archegonial clusters** of 8 – 10 archegonia are present on apical portion of lateral shoots, deep red in colour. Sporophyte not seen.

Ecology & Distribution: plants growing on wet rocks near Bee Fall at 818 m, in association with *Phaeoceros laevis* (L.) Prosk. and *Bryum paradoxum* var. *reflexifolium* Ochi (Ochi).

Range of Distribution: Celebs, Java, India: Andaman & Nicobar Islands, central India (PBR), South India (Kerala), Philippines, Sri Lanka.

Specimens examined: India, Madhya Pradesh, PBR: near Bee Fall, alt. ca 818 m, growing on wet rock, 30.11.2006, 227666C (LWG), leg. V. Sahu & V. Awasthi.

***Fissidens ceylonensis* Dozy & Molk.,** Annls Sci. Nat. Bot. Ser. 3, 2: 304, 1844.

(Plate 63: Figs. 1-13)

Plants erect, terrestrial, yellowish green, ± 6 mm in length, 1.5 mm in width; with 12 leaf pairs, slightly overlapping. **Stem** circular in cross section, outer cortical cells smaller, medullary cells larger. **Leaves** oblong, ± 0.75 × 0.24 mm in size, sheathing lamina slightly unequal (open), 0.36 – 0.05 mm (B/L = 31/100 to 35/100, S/L = 53/100 to 65/100); limbidium in the specimen poorly developed or reduced to 2 – 3 cells, composed of linear to sublinear cells, the outermost row gives rise to crenulated cells, giving the limbidium an intramarginal appearance; **costa** brownish-orange, percurrent, ending just below the tip. **Leaf cells** rounded- hexagonal, ± 6 × 5 µm in size. Sheathing lamina usually unequal. Sporophyte not seen.

Ecology & Distribution: plants growing on rocks on way to Jambu Dweep at 900 m in association with *Hypohila involuta* (Hook.) A. Jaeger and *Phaeoceros laevis* (L.) Prosk.

Range of Distribution: Australia, Borneo, China, Chile, Greece, Fiji Islands, India: central India (PBR), Gangetic plains, eastern Himalaya (Darjeeling, Sikkim), South India (Nilgiri, Palni, Trivandrum), western Himalaya, Indonesia, Java, Malaysia,

Plate-62

***Fissidens asperisetus* var. *andamanensis* Gangulee.,** Figs. 1-13: 1,2. plants, 3. plant with archegonial cluster, 4. cross section of axis, 5-8. leaves, 9. apical leaf cells, 10. middle leaf cells, 11. basal leaf cells, 12. cells of sheathing lamina, 13. single enlarged archegonia.

Plate-63

***Fissidens ceylonensis* Dozy & Molk.,** Figs. 1-13: 1,2. plants, 3. cross section of axis, 4-8. leaves, 9. apical leaf cells, 10. middle leaf cells, 11. portion of the leaf showing unequal (open) leaf lamina, 12. basal leaf cells, 13. cells of sheathing lamina.

Meluccas, Nepal, New Caledonia, New Zealand, Papua New Guinea, Philippines, Sarawak, Singapore, Sri Lanka, Sumatra, Thailand, Vietnam, Western Samona.

Specimens examined: India, Madhya Pradesh, PBR: on way to Jambu Dweep, alt. ca 900 m, on rocks, 17.12.1993, 205595C (LWG), leg. V. Nath & A. K. Asthana.

***Fissidens pulchellus* Mitt.,** J. Linn. Soc. Bot. Suppl.1: 140. 1859.

Syn: *Fissidens subpulchellus* Norkett. Gangulee, Mosses of Eastern India and Adjacent Regions 1. 521.1971.

(Plate 64: Figs. 10-19)

Plants erect, terrestrial, dull brownish – green, up to 8 mm long with about 8 – 10 pairs of leaves. **Stem** oval in cross section, cortical cells smaller thick walled, medullary cells thin walled, larger. **Leaves** alternately arranged, dorsal leaf lamina decurrent, ending much near the nerve base, oblong – ligulate, ± 1.7 × 0.30 mm in size; sheathing lamina usually unequal (open), rarely closed; (B/L = ± 20.3/100, S/L = 59/100); **costa** bright orange, percurrent, ending below tip. **Leaf cells** rounded-hexagonal, ± 8 × 6 µm in size at midleaf region. Sporophyte not seen.

Ecology & Distribution: plants growing near water stream on soil covered rocks at Patthar Chatta at 1000 m.

Range of Distribution: India: central India (Amarkantak, PBR), eastern Himalaya (Burkill, Abor Hills, Darjeeling), Nepal.

Specimens examined: India, Madhya Pradesh, PBR: Patthar Chatta, alt. ca 1000 m, near water stream in valley, 18.12.1993, 205650 (LWG); on rock, 205661(LWG), leg. V. Nath & A.K. Asthana.

***Fissidens formosanus* Noguchi,** J. Hattori Bot. Lab. 7: 63. 1952.

(Plate 65: Figs. 1-14)

Plants erect, small, dull green, loosely tufted ± 6 mm long with up to 12 leaf pairs. **Stem** oval in cross section, outer cortical cells thick walled, smaller, inner medullary cells large. **Leaves** densely arranged, narrowly lanceolate, lowermost smallest, getting larger above, upper leaves + 2.0 x 0.32 mm in size, apex obtusely acute, vaginant lamina up to ½ leaf length, unequal, B/L= 16/100, S/L= 60/100, margin serrulate by cell projections; **costa** light yellowish brown, flexuose, ending well below apex. **Leaf cells** mamillose, thin walled, ± 5 x 3.5 µm in size. Sporophyte not seen.

Ecology & Distribution: plants growing on soil covered rocks at Apsara Vihar, 920 m.

Range of Distribution: China, Japan, India: central India (PBR), United States.

Specimen examined: India, Madhya Pradesh, PBR: Apsara Vihar, alt. ca 920 m, on soil covered rocks, 07.11.2011, 263146 (LWG), leg. A.K. Asthana & R. Gupta.

***Fissidens mangarevensis* Mont.,** Ann. Sci. Nat. Bot. Ser. 3, 4: 113, 1845.

(Plate 65: Figs. 15-25)

Plants erect, small, yellowish green, tufted, unbranched, ± 8 mm long with up to 10 leaf pairs. **Stem** oval in cross section, outer cortical cells small, inner medullary cells larger, thin waleed. Leaves narrowly lanceolate, distant, smaller below, larger, dense above, ± 2.2 x 0.5 mm long, acute, vaginant lamina unequal, up to ½ of leaf length, B/L = 23/100, S/L = 54/100, margin crenulated by cell projections; **costa** stout, ending few cells below tip. **Leaf cells** mamillose, thick walled, ± 6.5 x 5.0 µm in size. Sporophyte not seen.

Ecology & Distribution: plants growing on wet rocks at Irene Pool, 1015 m.

Range of Distribution: Antarctica, China, Fiji Islands, French Polynesia, India: central India (PBR), Japan, South Pacific Islands, Samoa, Thailand.

Specimen examined: India, Madhya Pradesh, PBR: Irene Pool, alt. ca 1015 m, on wet rocks, 08.11.2011, 264809 (LWG), leg. A.K. Asthana & R. Gupta.

***Fissidens involutus* Wils. ex Mitt.,** Musc. Ind. Or.: 138, 1859.

(Plate 64: Figs. 1-9)

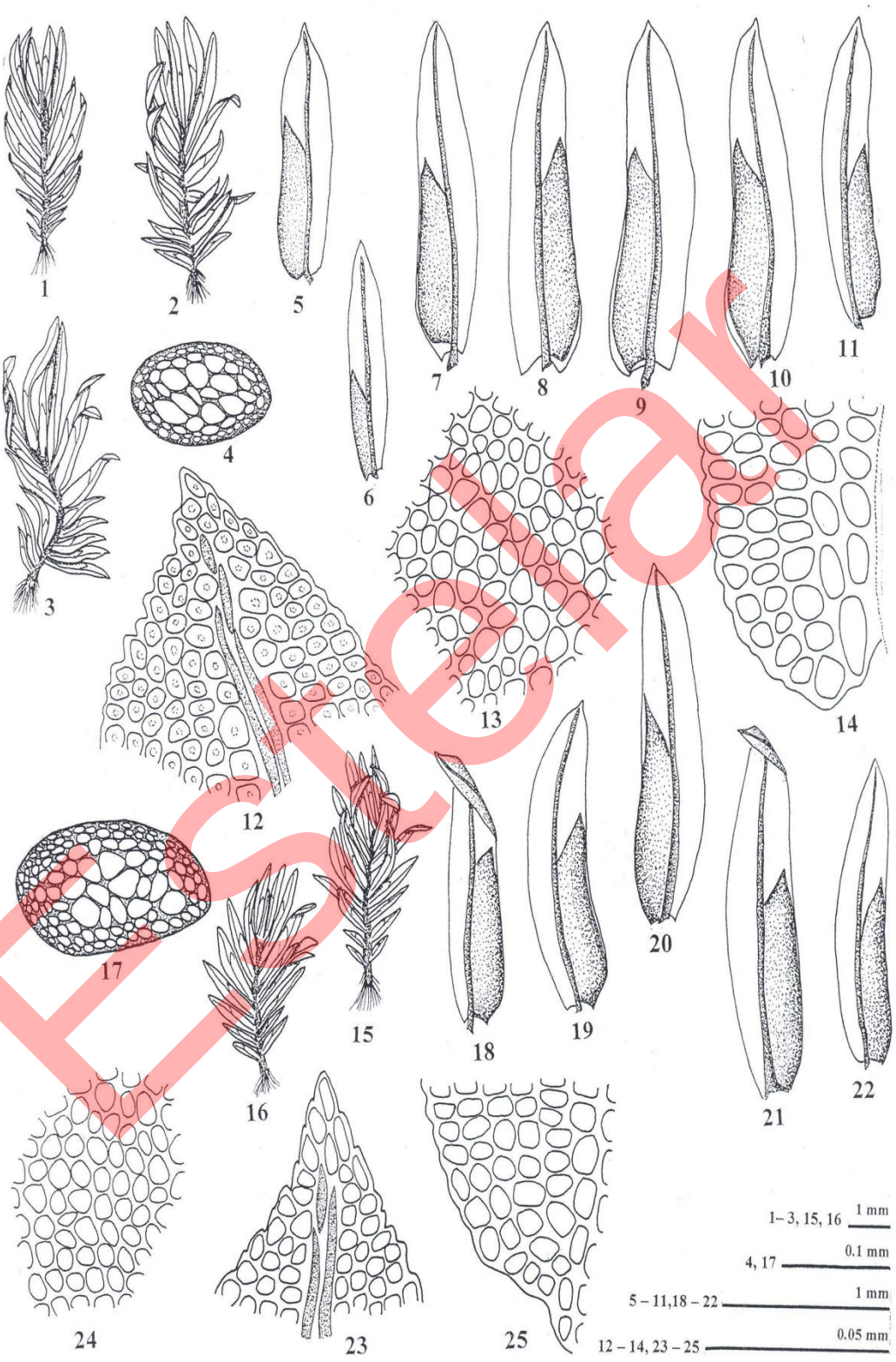
Plants erect, terrestrial, dull green, up to 12 mm in length, most frequently 14 leaf pairs seen. **Stem** oval in cross section, cortical cells small, thick walled, medullary cells larger. **Leaves** apiculate with acute apex, ± 1.8 × 0.35 mm in size, sheathing lamina mostly equal (closed), may be unequal (open) at times (B/L = ± 20/100, S/L = ± 60 / 100), margin slightly projecting and dentate owing to protruding cell margins; **costa** ending 2 – 3 cells below the apex, dull light brown to light orange in colour, dorsal lamina slowly rounded at the base. **Leaf cells** rounded - hexagonal, upper leaf cells ± 9 × 10 µm in size. Sporophyte not seen.

Ecology & Distribution: plants growing on wet rocks at Mahadeo Mandir and Chota Mahadev Mandir from 885 – 1006 m.

Plate-64

***Fissidens involutus* Wils. ex Mitt.,** Figs. 1-9: 1,2. plants, 3. cross section of axis, 4-6. leaves, 7. apical leaf cells, 8. middle leaf cells, 9. basal leaf cells; ***Fissidens pulchellus* Mitt.,** Figs. 10-19: 10,11. plants, 12. cross section of axis, 13-15. leaves, 16. apical leaf cells, 17. middle leaf cells, 18. basal leaf cells, 19.cells of sheathing lamina.

Plate-65



***Fissidens formosanus* Noguchi.,** Figs. 1-14: 1-3. vegetative plants, 4. cross section of axis, 5-11. leaves, 12. apical leaf cells, 13. median leaf cells, 14. basal leaf cells; ***Fissidens mangarevensis* Mont.,** Figs. 15-25: 15-16. vegetative plants, 17. cross section of axis, 18-22. leaves, 23. apical leaf cells, 24. median leaf cells, 25. basal leaf cells.

Range of Distribution: Chile, China, India: central India (Amarkantak, Bastar, PBR), Gangetic plains (Chhota Nagpur), eastern Himalaya (Darjeeling, Sikkim), western Himalaya, Japan, Nepal, Myanmar, Papua New Guinea, Thailand, Vietnam.

Specimens examined: India, Madhya Pradesh, PBR: Mahadeo Mandir, alt. ca 1005.84 m, 28.11.2006, on rock; leg. V. Nath & A.K. Asthana; 227612 (LWG); Chota Mahadev Mandir, alt. ca 855 m, on wet rock, 227641 (LWG), leg. V. Sahu & V. Awasthi.

***Fissidens involutus* Wils. ex. Mitten subsp. *curvato involutus* (Dixon) Gangulee,** Mosses of Eastern India & Adjacent Regions – I. 1969-72.

(Plate 67: Figs. 1-11)

Plants erect, up to 14 mm long, 2 mm broad, unbranched, up to 16 leaf pains. **Stem** ovato-circular in cross section, outer cortical cells smaller, inner medullary cells oval, larger. **Leaves** curled and crumpled when dry, oblong- ligulate, ± 1.3 x 0.33 mm in size dorsal lamina base rounded, sheathing lamina usually closed, (B/L = ± 27/100, S/L = ± 60 /100), margin crenulated, **costa** light brown, excurrent. **Leaf cells** obscure, rounded- hexagonal ± 8 x 1 µm at apex, ± 11 x 8 µm at base. Sporophyte not seen.

Ecology & Distribution: plants growing on soil covered rocks at Patalkot (Rajakhoh), 400 m.

Range of Distribution: India: central India (Bastar, Gujarat, Mt. Abu, PBR), eastern Himalaya (Darjeeling, Sikkim), Gangetic plains (Chotanagpur), South India (Eravikulum National Park), western Himalaya, Myanmar, Thailand, Vietnam.

Specimens examined: India, Madhya Pradesh, PBR: Patalkot (Rajakhoh), alt. ca 400 m, on soil over rocks, 06.10.1992, 205481 (LWG), leg. V. Nath & A.K. Asthana.

***Fissidens taxifolius* Hedw.,** Sp. Musc.: 155, 1801.

Syn: *Fissidens sylvaticus* Griff. Cal. J. Nat. Hist., 2: 507, 1842.

(Plate 66: Figs. 1-8)

Plants erect, both terrestrial and epiphytic, yellowish green, up to 10 mm long with an average 16 pairs of leaves (leaf pairs ranging from 14 – 18). **Stem** oval in cross section, cortical cells smaller, medullary cells larger. **Leaves** oblong, ligulate, ± 1.5 × 0.314 mm with unequal (open) sheathing lamina (B/L = ± 21/100, S/L = ± 66/100), dorsal lamina base undulating; **costa** deep coloured, may be deep orange at base, lighter above, reaching up to the tip which may form slightly mucronate or end just below tip.

Leaf cells irregular, upper and middle cells quadrate- hexagonal, ± 4.2 µm wide in the middle leaf region, getting larger towards the costa. Sporophyte not seen.

Ecology & Distribution: plants growing on soil covered rocks, wet rocks & epiphytic, Downfall, on way to Jambu Dweep, Rajakhoh (Patalkot), Chota Mahadev, on way to Apsara Vihar, 400 – 1056 m, growing in association with *Phaeoceros laevis* (L.) Prosk.

Range of Distribution: Algeria, Armenia, Austria, Bermuda, Brazil, Burma, Canada, Chad, Cuba, Durussalam, Denmark, Dominican Republic, Egypt, France, Germany, Guatemala, Haiti Islands, Honduras, India: Andaman & Nicobar Islands, central India (Amarkantak, PBR), eastern Himalaya (Darjeeling, Khasia Hills, Upper Assam), Gangetic plains (Chhota Nagpur, West Bengal, Bihar), South India (Goa), western Himalaya, Ireland, Japan, Mexico, Netherlands, New Zealand, Norway, Papua New Guinea, Poland, Portugal, Russia, Spain, Sweden, Switzerland, Taiwan, Thailand, Turkey, United Kingdom, United States of America.

Specimens examined: India, Madhya Pradesh, PBR: Downfall, alt. ca 1056 m, on moist rock, 17.12.1993, 205545 (LWG); on the way to Jambu Dweep, alt. ca 900 m, on rock, 17.12.1993, 205595B (LWG); Rajakhoh, Patalkot, alt. ca 400 m, on rock, 20.12.1993, 205735 (LWG), leg. V. Nath & A.K. Asthana; Downfall, alt. ca 884 m, on soil covered rock, 28.11.2006, 227605B (LWG); on way to Chota Mahadev, alt. ca 853.5 m, on soil covered rock, 29.11.2006, 227627 (LWG); on the way to Apsara Vihar, alt. ca 731 m, epiphytic, 01.12.2006, 227692A (LWG), leg. V. Sahu & V. Awasthi.

***Fissidens crispulus* var. *crispulus* Bridel,** Musc. Rec. Suppl. 4:187, 1819.

Fissidens sylvaticus var. *zippelianus* (Dozy & Molk.) Gangulee, Mosses of Eastern India and Adjacent Regions 1: 537. 1972.

(Plate 66: Figs. 9-17)

Plants erect, terrestrial, small, up to 12 mm long with usually 14 leaf pairs. Stem ovato- circular in cross section, cortical cells thick walled, smaller, medullary cells larger. **Leaves** oblong, ligulate, ranging from 1.2 – 1.8 mm in length and ± 0.04 mm in breadth with sheathing lamina equal (closed) (B/L = ± 16/100, S/L = 57.4/100), margin slightly crenulated due to projection of cells; costa dull greenish brown, ending

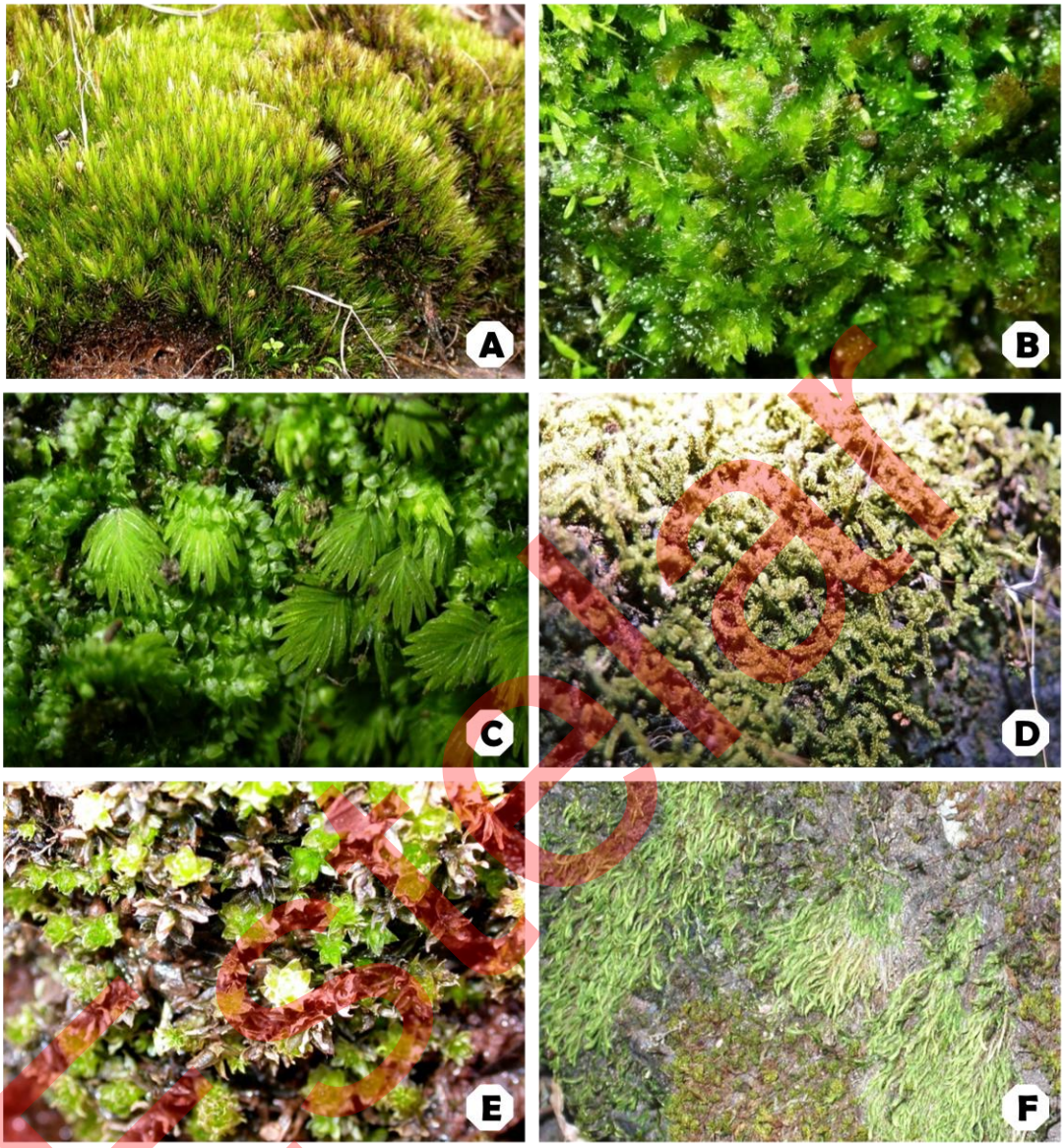
Plate-66

***Fissidens taxifolius* Hedw.,** Figs. 1-8: 1. plant, 2. cross section of axis, 3-5. leaves, 6. apical leaf cells, 7. middle leaf cells, 8. basal leaf cells; ***Fissidens crispulus* var. *crispulus* Brid.,** Figs. 9-17: 9,10. plants, 11. cross section of axis, 12-14. leaves, 15. apical leaf cells, 16. median leaf cells, 17. basal leaf cells.

Plate-67

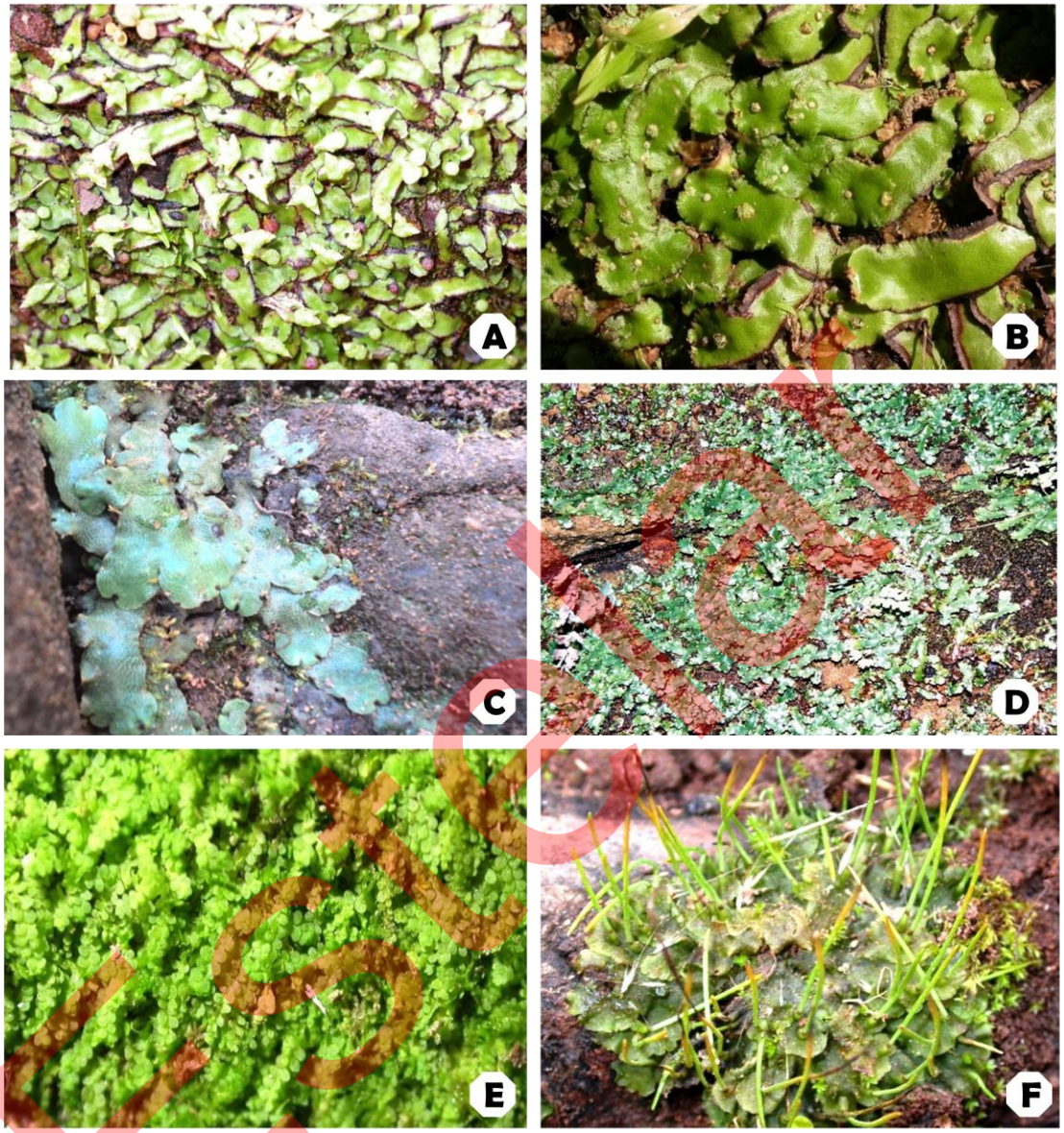
***Fissidens involutus* Wils. ex Mitten ssp. *curvato-involutus* (Dixon) Gangulee.,** Figs. 1-11: 1,2. vegetative plants, 3. cross section of axis, 4-8. leaves, 9. apical leaf cells, 10. median leaf cells, 11. basal leaf cells; ***Fissidens sylvaticus var. teraicola* (C. Muell.) Gangulee.**, Figs. 12-22: 12,13. vegetative plants, 14. cross section of axis, 15-19. leaves, 20. apical leaf cells, 21. median leaf cells, 22. basal leaf cells.

PLATE- V



A. *Campylopus ericoides*, B. *Meteoriopsis reclinata,* C. *Fissidens formosanus*,
D. *Pinnatella alopecuroides,* E. *Bryum pseudotriquetrum,* F. *Anomobryum auratum*

PLATE- VI



A. *Asterella wallichiana*, B. *Plagiochasma appendiculatum* , C. *Conocephalum conicum*, D. *Marchantia paleacea,* E.*Lejeunea wightii*, F. *Phaeoceros carolinianus*

just below the tip. **Leaf cells** rounded – hexagonal, 8 – 12 × 8 µm in size; chlorophyllose, slightly obscure. Sporophyte not seen.

Ecology & Distribution: plants growing on soil at Rajakhoh (Patalkot) and Bee Fall from 400 - 944 m.

Range of Distribution: Australia, Brunei, Cameroon, central African Republic, China, Fiji Islands, India: central India (PBR), Gangetic plains (Jhargram), South India, western Himalaya, Indonesia, Malaysia, Mauritius, Mayotte, Niger, Papua New Guinea, Philippines, Sri Lanka, Sudan, Taiwan, Thailand.

Specimens examined: India, Madhya Pradesh, PBR: Rajakhoh, Patalkot, alt. ca 400 m, on soil, 06.10.1992, 205465 (LWG), leg. V. Nath & A.K. Asthana; Panchali Kund, alt. ca 944 m, on moist soil (near stream), 07.11.2011, 263161 (LWG); Bee Fall, alt. ca 726 m, on rocks, 08.11.2011, 264805 (LWG), leg. A.K. Asthana & R. Gupta.

***Fissidens sylvaticus* var. *teraicola* (C. Muell.)** Gangulee, Mosses of Eastern India & Adjacent Regions-I. 1969-1972.

(Plate 67: Figs. 12-22)

Plants, erect, dull green, up to 16 x 2 mm in size with up to 12 leaf pairs. **Stem** circular in cross section, with small outer cortical cells, inner medullary cells larger, thin walled. **Leaves** densely arranged, lanceolate, lowerones smaller, distant, upper ones dense, larger, + 1.3x0.32 mm in size, apex broadly acute mostly asymmetric, vaginant lamina more than half leaf length, usually unequal, B/L = 24.8/100, S/L = 61/100, margin crenulated due to cell projections; **costa** orangish – brown, slightly excurrent or ending at tip. **Leaf cells** rounded, hexagonal, + 6-5 x 5.5 µm in size. Sporophyte not seen.

Ecology & Distribution: plants growing on moist rocks, at Jatashankar, 986 m.

Range of Distribution: India: central India (PBR), Gangetic plains (West Bengal), South India (Tirunelveli - Travancore hills).

Specimens examined: India, Madhya Pradesh, PBR: Jatashankar, alt. ca 986 m, on moist rocks, 09.11.2011, 264835 (LWG), leg. A.K. Asthana & R. Gupta.

Key for Identification of Liverworts

1. Plants may be thalloid or sometimes leafy, thallus undifferentiated…….. **Metzgeriales**

   Plants with leafy organization, thallus differentiated ….....… **Jungermanniales**

Plants thalloid, thallus internally differentiated into assimilatory and storage zones, ventral scales present .....…….... Order **Marchantiales**

II. ORDER: METZGERIALES SCHUST. EMEND. SCHLJAK.

Family: Fossombroniaceae Evans

Genus: *Fossombronia* Raddi.

Plants leafy, caespitose, dull green to brownish- green, compact, 5-15 mm long (may be longer due to branching), branched. Stem dull brown, leaves oblong to irregularly circular, obliquely to transversely inserted; rhizoids hyaline to purple, simple; amphigastria absent. Leaves oblong, margin entire to slightly toothed. Capsule spherical, brown, seta short, capsule wall usually bistratose; spores dark to dull brown.

Key to the species of genus *Fossombronia* at PBR:

1. Plants smaller (4-8 mm), rhizoids hyaline ……. **2**

   Plants larger (7-15 mm), rhizoids purple ……...……. ***F. himalayensis***

2. Plants dioicous, leaves not aggregated towards apex, spores smaller with up to 5 reticulations across the diameter …..……..…… ***F. kashyapii***

   Plants monoicous, leaves aggregated towards apex, spores larger with 1 - 2 reticulations across the diameter ……... ***F. wondraczekii***

***Fossombronia himalayensis* Kash.,** New Phytol. Vol. XIV, P. 4, 1915.

Syn: *Fossombronia levieri* St., Sp. Hep. Vol. VI, p. 74, 1917.

Plants monoicous leafy, caespitose, dull green to brownish- green, compact, 7-15 mm long (may be longer due to branching), 2-4 mm broad, branched. **Stem** dull brown, leaves oblong to irregularly circular, transversely inserted; rhizoids purple, simple; amphigastria absent. **Leaves** oblong, margin entire to slightly toothed, leaf cells 20 - 45 x 20 - 40 µm at apex, 28 - 80 x 28 - 50 µm at mid leaf, 40 -100 x 20 - 45 µm towards base. **Capsule** spherical, dark brown, seta short, capsule wall bistratose; **spores**

dark brown, irregularly lamellate distally, 35 - 42 µm in diameter; elaters up to 130 µm long, pale yellowish.

Ecology & Distribution: plants growing on soil over rocks, on rocks (moist or at sides of water stream) at Tamia valley alt. ca 1000 m; on base rocks in shade at Jalgali, Jambu Dweep, Mahadeo, Vanshri Vihar at way to Little Fall and Apsara Vihar from 400-1000 m.

Range of Distribution: India: central India (PBR, Mt. Abu), eastern Himalaya (Darjeeling), South India (Bangalore, Kodaikanal, Lonavala, Mahabaleshwar, Mumbai, Ootacamund, Panchgani), western Himalaya (Bhowali, Kumaon, Mussoorie, Ranikhet).

Specimens examined: India, Madhya Pradesh, PBR: Tamia valley, alt. ca 1000 m, on soil over rocks, 10.10.1992, 205483 (LWG); Jalgali, alt. ca 900 m, on rock, 16.12.1993, 205568, 205570, 205571, 205572, 205573. (LWG); Jambu Dweep, alt. ca 900 m, on rocks near water stream, 17.12.1993, 205621A (LWG); Mahadeo, alt. ca 1000 m, on extremely wet rocks, 17.12.1993. 205633 (LWG); Vanshri Vihar, alt. ca 1000 m, on rocks, 17.12.1993, 205668B, 205671 (LWG). leg. V. Nath & A.K. Asthana; on way to Little Fall, alt. ca 914 m on wet rocks, 28.11.1996, 229368A (LWG); Apsara Vihar, alt. ca 734 m, on moist rocks, 01.12.2006, 227694C, 227696A (LWG). leg. V. Sahu & V. Awasthi.

***Fossombronia kashyapii* Srivast. et Udar,** Nova Hedwigia 26: 816 1975**.**

Plants dioicous, leafy, small, dull green, dichotomously branched, ± 10 mm in size. **Stem** up to 8 mm long, tuberous at apex, covered with rhizoids on ventral side. **Leaves** simple, succubous, quadrate, obliquely inserted, arranged in two rows laterally, margin undulate to wavy; marginal cells 28 - 64 x 24 µm, median cells 60 - 163 x 28 - 43 µm. Antheridia not seen. **Pseudoperianth** campanulate, margin lobed; **capsule** spherical, deep brown; capsule wall bistratose; **spores** ± 52 µm in diameter, lamellate, reticulations on middle of distal face, tri-radiate mark faintly developed; elaters 160-258 µm in size.

Ecology & Distribution: plants growing on soil and on rocks under moist exposed conditions at Tamia, Pandav Alt. caves and Apsara Vihar at 920-1076 m.

Range of Distribution: India: central India (PBR), western Himalaya (Kullu Valley, Manali, Rohila).

Specimens examined: India, Madhya Pradesh, PBR: Tamia, alt. ca 1000 m, on rocks, 10.10.1992. 205487 (LWG). leg. V. Nath & A.K. Asthana; Pandav caves, alt. ca 1076 m, on dry (exposed rocks), 07.11.2011, 263125 (LWG); Apsara Vihar alt. ca 920 m, on soil, 07.11.2011, 263140. leg. A.K. Asthana & R. Gupta.

***Fossombronia wondraczekii* (Corda) Dum**. Rec. d' observ. P.II. 1835.

Basyn: *Jungermannia wondraczekii* Corda, Sturm, Deutschl. Fl. Fasc. 2, Lfg. 19-20, 30, 1830.

Plants monoicous, leafy, green to yellowish-green rarely branched dichotomously, up to 7 mm long. **Stem** ± 6 mm long, 2 - 4 mm broad, densely covered with hyaline rhizoids over the ventral surface. **Leaves** succubous, densely arranged towards apex; cells thin walled, marginal cells 20 - 24 x 34 - 68 µm, median cells, 34 - 42 x 85 µm, basal cells ± 42 x 153 µm in size. **Male receptacle** not seen. **Pseudoperianth** inverted bell shaped; **seta** elongated, capsule spherical; **capsule** wall bistratose; **spores** tetrahedral to spherical, ± 58 µm in diameter, lamellate with 1 - 2 reticulations in the middle at distal surface; elaters ± 160 x 20 µm, bi to tri spirate yellowish.

Ecology & Distribution: plants growing on soil covered rocks near Rajakhoh (Patalkot valley), 400 m.

Range of Distribution: India: central India (PBR), eastern Himalaya, South India (Coonoor, Kodaikanal, Ootacamund).

Specimens examined: India, Madhya Pradesh, Patalkot (near Rajakhoh), alt. ca 400 m, 06.10.1992, 205474 (LWG). leg. V. Nath & A.K. Asthana.

Family: Pallaviciniaceae Shust.

Genus: *Pallavicinia* Gray.

Plants thalloid, dull- deep green to light green, ribbon shaped densely matted prostrate thallus, dichotomously branched, variasble in size. Dorsal surface smooth, margin entire, ventral surface slightly convex, midrib prominent, rhizoids usually scarce. Thallus in transverse section 10 - 11 cell high in the middle, gradually narrowing towards lamina.

***Pallavicinia lyellii* (Hook.) Gray.,** J. Bot. Brit. Foreign 3: 302, 1865.

Basyn*: Jungermannia lyellii* Hork. British Junger. Pl. 77. 1986.

Plants dioicous, thalloid, dull- deep green to light green, densely matted prostrate thallus, dichotomously branched, ± 90 mm and ± 5 mm wide. **Dorsal** surface smooth, margin entire, ventral surface very slightly convex, midrib prominent, rhizoids scarce. **Thallus** in transverse section shows broad thallus in middle, 10 - 11 cell high, gradually narrowing towards lamina, central conducting zone well formed. Male/ female receptacles not seen. Sporophyte not seen.

Ecology & Distribution: plants growing on soil covered rocks in extreme moist conditions at Tamia (on way to Chota Mahadev), Little Fall, Jalgali, Jambu Dweep, Mahadeo, Patthar Chatta, Vanshri Vihar, Chota Mahadev Mandir, on way to Little Fall on way to Twynam Pool, Jambu Dweep, near Bee Fall, Apsara Vihar from 734 - 1056 m.

Range of Distribution: Africa, Australia, Belize, Bermuda, Bhutan, Bolivia, Brazil, Canada, China, Colombia, Costa Rica, Cuba, Dominican Republic, Ecuador, France, Germany, Guadeloupe, Honduras, India: central India (PBR), eastern Himalaya (Assam, Gauhati, Shillong), South India (Kanara, Karnataka, Kerala), western Himalaya, Ireland, Jamaica, Japan, Java, Martingale, Mexico, Moluccas, Netherlands, New Zealand, Norway, Panama, Peru, Philippines, Poland, Portugal, Puerto Rico, Russian Federation, Ryukyu, Saint Lucia, Sao Tome and Principe, Singapore, South Africa, Singapore, Spain, Sri Lanka, Suriname, Sweden, United Kingdom, United States, Venezuela.

Specimens examined: India, Madhya Pradesh, PBR: Tamia valley, alt. ca 1000 m, on soil, 10.10.1992, 205490B, 205499A, 205500, 205501, 205502 (LWG); Tamia (Chota Mahadev), alt. ca 1000 m, on soil, 10.10.1992, 205504A, 205505, on way to Chota Madadev (Tamia) alt. ca 1000 m, on soil, 10.10.1992, 205511A (LWG); Little Fall, alt. ca 1056 m, on wet rocks (near waterfall), 16.12.1993, 205555 (LWG); Jalgali, alt. ca 900 m, on wet rocks, 16.12.1993, 205586B, 205587A (LWG); Jambu Dweep, alt. ca 900 m, on rocks (at sides of stream), 17.12.1993, 205608, 205619 (LWG); Mahadeo alt. ca 1000 m, on moist rocks (near caves), 17.12.1993, 205636, 205637 (LWG); Patthar Chatta, alt. ca 1000 m, on rocks (near water stream), 18.12.1993, 205651, 205652, 205660A, 205662 (LWG); Vanshri Vihar (at bank of river Denwa), alt. ca 1000 m, on rocks, 18.12.1993, 205668A (LWG); Chota Mahadev Mandir, alt. ca 950

m, on wet rocks, 19.12.1993, 205682, 205702, 205703, 205704, 205705 (LWG). leg. V. Nath & A.K. Asthana; on way to Little Fall, alt. ca 914 m, on soil over rocks, 28.11.2006, 229387, 229390 (LWG); on way to Twynam Pool, alt. ca 853 m, on rocks, 227620A (LWG); Jambu Dweep, alt. ca 793 m, on wet rocks, 29.11.2006, 227648A (LWG); near Bee Fall, alt. ca 823 m, on soil covered rocks, 30.11.2006, 227662 (LWG); Apsara Vihar, alt. ca 734 m, on moist rocks, 1.12.2006, 227694A (LWG), leg. V. Sahu & V. Awasthi; Apsara Fall, alt. ca 920 m, on soil covered rocks, 07.11.2011, 263138, 263144 (LWG); Panchali Kund, alt. ca 944 m, on rocks, 07.11.2011, 263156 (LWG); Irene Pool, alt. ca 1015 m, on wet rocks, 08.11.2011, 264812 (LWG). leg. A.K. Asthana &

R. Gupta.

Family: Aneuraceae Klinggr.

Genus: *Riccardia* Gray

Plants dioicous, thalloid, green, variable in size, (up to 50 mm long), irregularly branched, branches opposite, stoloniferous branches may be present or absent. Main axis convex below, slightly concave above to biconvex in cross section,5-8 cells thick at middle, wings multistratose, thinner towards margin. Dorsal surface smooth, margin entire, epidermal cells small, rhizoids present, ventral surface smooth, scales absent.

Key to the species of genus *Riccardia* at PBR:

1. Plants dioicous ……...…… **2**
   Plants monoicous …….……..…….. **3**
2. Thallus larger, ± 30 x 1.25 mm in size; main axis plain above, convex below, 6-7 cells thick at middle in cross section ……..…..…..…… ***R. levieri***
   Thallus smaller, 8-15 x 0.7 -1 mm in size; main axis biconvex, 5-6 cells thick at middle in cross section …..….……..……..…… ***R. platyclada***
3. Thallus dark greenish brown, large, 30-50 x 1-1.75 mm, stoloniferous branches present, 6-7 cell thick in middle in cross section ……...…… ***R. santapauii***
   Thallus reddish- brown, small, ± 12 x 0.6 mm, stoloniferous branches absent, 4-6 cells thick in middle in cross section ……...…… ***R. tenuicostata***

***Riccardia levieri* Schiffn.,** Osterr. Bot. Zeitschr. 49: 130, 1899.

Plants dioicous, thalloid, green up to 30 mm long, ± 1.25 mm wide, irregularly branched, branches opposite. **Main axis** convex below, slightly concave above in cross section, 6 cells thick at middle, wings multistratose, thinner towards margin. **Dorsal surface** smooth, margin entire, epidermal cells small, rhizoids present, **ventral surface** smooth, scales absent. Male/ Female receptacle / sporophyte not seen.

Ecology & Distribution: plants growing in extremely wet rocks under water stream at Tamia (on way to Chota Mahadev), 1000 m.

Range of Distribution: Bhutan, India: central India (PBR), eastern Himalaya (Darjeeling), South India (Karnataka, Kerala, Nilgiri hills, Palni hills, Tamil Nadu), western Himalaya (Himachal Pradesh, Uttarakhand).

Specimens examined: India: Madhya Pradesh, PBR: on way to Chota Mahadev (Tamia), alt. ca 1000 m, 10.10.1992, 205510 (LWG). leg. V. Nath & A.K. Asthana.

***Riccardia platyclada* Schiffn., Denkschr**. Akad. Wiss., Wien, Math.-Nat. Kl. 47: 153 – 203, 1898.

Plants thalloid diocious, small, yellowish–green to dull green, in patches, 8–15 mm long, 0.7 – 1 mm broad, branched. **Main axis** slightly bi–convex in cross section with 4 – 5 cells in middle, unistratose at margins. Dorsal surface has smaller cells, margin entire, pinnules narrow at base, broader at middle. **Male branches** thick & short, antheridia is alternating rows. **Female branches** short, calyptras ± 2 mm x 0.57 mm in size, broad, smooth. **Spores** dull brown, 12 – 15 µm in diameter.

Ecology & Distribution: plants growing on moist rocks and soil covered rocks at Down Fall, on way to Bee Fall and Duchess Fall from 732–884 m.

Range of Distribution: China, India: central India (PBR), Indonesia, Java, Sumatra, Taiwan.

Specimens examined: India, Madhya Pradesh, PBR: Pathar Chatta, alt. ca 1000 m, on stony wall 18.12.2993, 205648 (LWG). leg. V. Nath & A. K. Asthana; Down Fall, alt. ca 884 m, on moist rocks, 28.11.2006, 227602A (LWG); on way to Bee Fall, alt. ca 823 m, on soil covered rocks, 30.11.2006, 227667 (LWG); Duchess Fall, alt. ca 732 m, on moist rocks, 30.11.2006, 227675B (LWG). leg. V. Sahu & V. Awasthi.

***Riccardia santapaui* Udar et Srivastava,** Rev. Bryol. Lichenol. 39(1): 155-159, 1973.

Plants monoicous thalloid, dark green, robust, in dense patches, large, 30 - 50 mm long, 1 - 1.75 mm wide, pinnately branched. **Main axis** biconvex in cross section, 6 - 7 cells thick in the middle, unistratose towards margin. **Dorsal surface** has smaller, rectangular cells, margin entire, apex of thallus slightly broader, **ventral surface** smooth, scales absent. Male/ Female receptacles, sporophyte not seen.

Ecology & Distribution: plants growing luxuriantly in patches on extremely wet rocks at Tamia valley (near Chota Mahadev), 950 m.

Range of Distribution: India: central India (PBR).

Specimens examined: India: Madhya Pradesh, PBR: on way to Chota Mahadev (Tamia), alt. ca 950 m, 19.12.1993. 205693, 205696, 205697, 205699, 205700 (LWG). leg. V. Nath & A.K. Asthana.

***Riccardia tenuicostata* Schiffn.** Denkschr. Math.–Nat. Cl. Kais. Akad. Wiss. Wien 67: 166, 1898.

Plants monoicous, thalloid, yellowish brown to dull brown, thin, up to 12 mm long, ± 0.6 mm wide, repeatedly branched, branches spreading in fan shaped manner, scales and rhizoids absent; stolons absent. **Stem** biconvex to plano–convex in cross section, up to 6 cell thick at middle, margin 1 – 2 cells thick, central cells larger. **Antheridial** branches long, narrow, antheridia globose, 3 – 10 pairs, arranged in 2 rows. **Archegonia** on very small branches; calyptra obovate, warty. Sporophyte not seen.

Ecology & Distribution: plants growing on extremely wet rocks, at Pathar Chatta, 1000 m.

Range of Distribution: India: central India (PBR), South India (Palni Hills, Kodaikanal), western Himalaya (Mussoorie), Java, Singapore.

Specimens examined: India, Madhya Pradesh, PBR: Pathar Chatta, alt. ca 1000 m, on extremely wet rocks, 18.12.1993, 205674 (LWG). leg. V. Nath & A.K. Asthana.

III. ODRER: JUNGERMANNIALES LIMPR.

Family: Lophoziaceae (Dumort.) Dumort.

Genus: *Lophozia* (Dumort.) Dumort

Plants small, loosely tufted, light brown to dull green , 5-12 mm long. **Stem** slender, ovato – circular in diameter, 5 - 6 cells across in transverse section, cells undifferentiated. **Leaves** arranged distantly, transversely to obliquely inserted, non – decurrent, quadrate to oblong ovate, bilobed, sinus 1/6-1/2th of leaf length, lobes usually unequal, obtuse, under leaves absent; trigones generally absent.

***Lophozia mayebarae* (Hatt.) N. Kitag.**, J. Hattori Bot. Lab. 29: 106. 1966.

Basyn: *Cephalozia mayebarae* Hatt., J. Hattori Bot. Lab. 3: 37, 1948.

Plants small, loosely tufted, light brown, ± 5 mm long, 0.6 - 0.8 mm wide. **Stem** slender, ovato – circular in diameter, 5 - 6 cells across in transverse section, cells undifferentiated. **Leaves** arranged distantly, transversely inserted, non – decurrent, quadrate to oblong ovate, 0.3 mm long 0.18 -0.3 mm wide, bilobed, sinus 1/6-1/3 rd of leaf length lobes unequal, obtuse, under leaves absent. Apical leaf cells 15 x 12 µm, marginal cells 16 - 20 x 8 - 12 µm, median cells 28 - 32 x 12 - 24 µm, basal cells 40 - 48 x 20 µm in size, thin walled, trigones absent. Male/Female receptacles, Perianth not seen.

Ecology & Distribution: plants growing over dead logs in shady places of Tamia, 1000 m.

Range of Distribution: India: central India (PBR), Japan.

Specimens examined: India, Madhya Pradesh, PBR: Tamia, alt. ca 1000 m, over dead logs, 10.10.1992, 205497 (LWG). leg. V. Nath and A.K. Asthana.

Family: Jungermmaniaceae Reichenb.

Genus: *Solenostoma*

Plants green, olive green to brownish, rhizoids usually colourless, rarely purple. Leaves subtranseversely or obliquely inserted, often deccurrent on both the sides, orbicular, reniform. Cell walls thin, trigones more or less bulging. Perianth suddenly contracted to a short beak or gradually contracted or without beak.often present or if absent then perianth with tubular beak.

Key to the species of *Jungermannia* (*Solenostoma*) and *Solenostoma* at PBR:

1. Plants up to 20 mm in size, rhizoids scattered, sometimes in fascicles along the steam…… **2**

   Plants more than 20 mm in size, rhizoids in fascicles along the stem …….. **9**

2. Plants up to 10 mm in size …… **3**

   Plants 10-20 mm in size …… **4**

3. Rhizoids dull purple, at basal part of stem, trigones in leaf cells feebly developed; perianth triplicate ……. ***S. rubripunctatum***

   Rhizoids colourless to light brown, at leaf bases, trigones in leaf cells conspicuous; perianth irregularly plicate …… ***S. trunctatum***

4. Rhizoids colourless …… **5**

   Rhizoids brown or purple …… **6**

5. Leaves appressed to stem, sinuately inserted, trigones in leaf cells bulging …… ***S. appressifolium***

   Leaves not appressed to stem, obliquely inserted, trigones absent ….. ***S. gollanii***

6. Plants greenish- brown, leaves distantly arranged ..…… **7**

   Plants dull brown, leaves closely arranged ..…… **8**

7. Leaves sinuately inserted, ± 0.7x0.5 mm in size, trigones in leaf cells absent …… ***S. atrobrunnea***

   Leaves obliquely inserted, ± 1.4 x 1 mm in size, trigones in leaf cells bulging …… ***S. subrubrum***

8. Marginal leaf cells thin walled, trigones conspicuous …… ***S. hyalinum***

   Marginal leaf cells thick walled, trigones indistinct …….. ***S. rotundatum***

9. Leaf margin recurved ..…… **10**

   Leaf margin not recurved …….. ***S. limbatifolium***

10. Leaves rotundate, leaf cells thin walled, basal cells smaller, 42-56 x 22-25 µm …….. ***J.* (*Solenostoma*) *pyrifora* var. *major***

    Leaves ovate to rectangular, leaf cells thick walled, basal cells larger, 70-100 x 28-40 µm …….. ***S. tetragonum***

***Solenostoma rubripuncatum* (S. Hatt.) R.M. Schust.,** Nova Hedwigia. 89 (3–4): 485 – 517, 2009.

Syn: *Jungermannia rubripuncata* (Hatt.) Amak., J. Hattori Bot. Lab. 22: 38, 1960.

Plants leafy, small, greenish – brown, ± 8 x 2 mm, rarely branched, rhizoids at basal part of stem, dull purple. **Leaves** distant, obliquely inserted, alternate, ovate, obtuse apex, slightly decurrent. **Marginal cells** ± 10-25 12-30 µm, basal cells ± 28 - 58 x 24-50 µm, thin walled, trigones feebly developed to absent. **Perianth** terminal, shortly exerted, fusiform, triplicate, bracts undulating.

Ecology & Distribution: plants growing on soil over rocks at Tamia valley and Jalgali from 900 – 1000 m.

Range of Distribution: China, India: central India (PBR), eastern Himalaya (Darjeeling, Jaintia hills, Khasia hills, Meghalaya), Nepal, Japan.

Specimens examined: India, Madhya Pradesh, PBR: Tamia Valley, alt. ca 1000 m, on soil over rocks, 10.10.1992, 205490A, 205492 (LWG); Jalgali, alt. ca 900 m, on soil over rocks, 16.12.1993, 205569 (LWG), leg. V. Nath & A.K. Asthana.

***Solenostoma truncatum* (Nees) R.M. Schust.** [Austral Hept. 2: 378, 2002, (nom. Inval) ex Vana et D.G. Long, comb. nov., Nova Hedwigia 89 (3–4): 485–517, 2009.

Syn: *Jungermannia truncata* Nees, Enum. Pl. Crypt. Jav. 29, 1830.

Syn: *Jungermannia shinii* Amakawa, J. Hatt. Bot. Lab. 33: 156. 1970.

Plants leafy, moderate, greenish – brown, matted, 5 – 10 mm long, unbranched to occasionally branched, rhizoids long, numerous, colourless to light brown, present at leaf bases. **Leaves** loosely imbricate, ovate to subquadrate, ± 1.3 x 1.1 mm in size, incurved, mildly decurrent at base. **Marginal leaf cells** ± 20-26 x 15-24 µm, thick walled, basal cells ± 20-45 x 12-36 µm, thin walled; trigones conspicuous. **Perianth** shortly exerted, crusiform, ± 1 x 0.6 mm in size, irregularly plicate, mouth crenulated, cells elongate.

Ecology & Distribution: plants growing on moist soil and rocks and on soil covered rocks at Down Fall, Jambu Dweep, Chota Mahadev (Tamia) and on way to Chota Mahadev from 854 – 1056 m.

Range of Distribution: Bhutan, Borneo, China, India: central India (PBR), eastern Himalaya (Assam, Darjeeling, Meghalaya, Sikkim), South India (Nilgiris), western Himalaya, (Kumaon), Japan Java, Korea, Malaysia, Myanmar, Nepal, Pakistan, Papua New Guinea, Philippines, Sri Lanka, Sumatra, Taiwan, Thailand.

Specimens examined: India, Madhya Pradesh, PBR: Down Fall, alt. ca 1056 m, on moist soil, 15.12.1993, 205552A (LWG); on moist rocks, 15.12.1993, 205553B

(LWG); Jambu Dweep, alt. ca 900 m, on soil over rocks, 17.12.2993, 205604 (LWG); Chota Mahadev (Tamia) alt. 950 m, on soil over rocks, 19.12.1993, 205676 (LWG). leg. V. Nath & A.K. Asthana; on way to Chota Mahadev, alt. ca 854 m, on rocks, 29.11.2006, 227625 (LWG). leg. V. Sahu & V. Awasthi.

***Solenostoma appressifolium* (Mitt.) Vana et D.G.,** Long comb. nov., Nova Hedwigia 89 (3-4): 485-517, 2009.

Basyn: *Jungermannia appressifolia* Mitt., J. Proc. Linn. Soc., Bot. 5:91, 1861, 1860.

Plants leafy, medium, dull green in turfs, up to 14 mm long, 1 mm wide, rigid, unbranched, rhizoids numerous, colourless, in fascicles. **Leaves** imbricate, sinuately inserted, deccurent, laterally appressed to the stem, orbicular, ± 0.7 x 0.6 mm in size. **Marginal leaf cells** 15-18 x 16-18 µm, medium cells 20-30x 18-22 µm, basal cells 24-48 x 18-24 µm, trigones bulging. Perianth not seen.

Ecology & Distribution: growing on rocks under moist conditions at Vanshri Vihar, 1000 m.

Range of Distribution: Australia, Bhutan, Borneo, China, Japan, India: western Himalaya (Dehra Dun, Mussoorie), eastern Himalaya (Assam, Darjeeling, Kurseong, Kasia hills, Sikkim), central India (PBR) South India (Kerala), Nepal, Java, Malaysia, Papua New Guinea, Sri Lanka, Vietnam.

Specimens examined: India, Madhya Pradesh, PBR: Vanshri Vihar, alt. ca 1000m, on rocks, 18.12.1993, 205673C (LWG), leg. V. Nath & A.K. Asthana.

***Solenostoma gollanii* Stephani** Spec. Hepat. 6: 81. 1917.

Syn: *Jungermannia (Luridae) tenerrima* Steph., Spec. Hepat. 6: 93, 1917.

Plants dioicous, thalloid medium to large, yellowish brown to light green, up to 10 mm long, unbranched. **Stem** triangular in outline, ± 0.25 mm in diameter, 7 - 8 cells across the diameter, thick walled cortical cells, rhizoids colourless scattered. **Leaves** obliquely inserted, slightly deccurent dorsally, in single row, ovate, ± 1x1 mm in size, wider at base, apex obtuse; leaf marginal cells 36 - 48 x 28 µm, median cells 40 - 44 x 28 - 40 µm, basal cells 64 - 80 x 24 - 28 µm, thin walled, trigones absent. Male/Female receptacles not seen.

Ecology & Distribution: plants growing on soil covered moist rocks near Rajakhoh in Patalkot valley at 400 m.

Range of Distribution: Australia, China, India: central India (PBR), Italy, Japan.

Specimens examined: India, Madhya Pradesh, PBR: Rajakhoh (Patalkot), alt. ca 400 m, on soil over rocks, on rocks, 20.12.1993. 205725, 205726, 205729, 205739 (LWG). leg. V. Nath & A.K. Asthana.

***Solenostoma atrobrunnea* (Amakawa) Vana et D.G. Long,** comb. nov., Nova Hedwigia 89 (3–4): 485–517, 2009.

Basyn: *Jungermannia atrobrunnea* Amakawa, sp. nov., J. Hattori Bot. Lab. 30. 181–198.1967.

Plants leafy, small, dull greenish–brown, ± 12 mm long, 1 – 1.2 mm wide, matted, rarely branched, rhizoids long brownish, moderately dense. **Leaves** distant, sinuately inserted, slightly decurrent, margins recurved, ovate, ± 0.7 x 0.5 mm in size. **Marginal leaf cells** 10-18 x 8-13 µm, middle cells 94-28 x 12-18 µm, basal cells 15-35 x 12-15 µm, thick walled, trigones absent. Perianth not seen.

Ecology & Distribution: plants growing on wet rocks at Jambu Dweep at 793 m.

Range of Distribution: Bhutan, China, India: central India (PBR), eastern Himalaya (Darjeeling), Nepal.

Specimens examined: India, Madhya Pradesh, PBR: Jambu Dweep, alt. ca 793 m, on wet rocks, 29.11.2006, 227651 (LWG). leg V. Sahu & Awasthi.

***Solenostoma subrubrum* (Schiffn. ex Steph.) Vana *et* D.G.** Long, Comb. nov., Nova Hedwigia 89(3–4): 485–517, 2009.

Basyn: *Jungermannia subrubra* Steph., Sp. Hept. 6: 93, 1911.

Plants leafy, greenish brown, ± 10 mm long, 1.2-1.8 mm wide, growing in patches, unbranched, rhizoids in fiscicles, light brown in colour. **Leaves** distantly arranged, alternate, obliquely inserted, decurrent dorsally, ovate, ± 1.4 x 1mm in size. **Marginal leaf cells** ± 16-32 x 22 - 30 µm middle cells 32 - 45 x 18 - 35 µm, basal cells 42 - 72 x 35-45 µm in size, trigones bulging. **Perianth** terminal about 1/2 exerted, oblong, triplicate, mouth contracted to form a beak, perigynium erect.

Ecology & Distribution: plants growing on moist rocks at Down Fall, 1056 m.

Range of Distribution: Bhutan, India: central India (PBR), eastern Himalaya (Darjeeling, Meghalaya, Sandakphu, Sikkim), western Himalaya (Kullu), Nepal.

Specimens examined: India, Madhya Pradesh, PBR: Down Fall, alt. ca 1056 m, on moist rocks, 15.12.1993, 205553B (LWG). leg. V. Nath & A.K. Asthana.

***Solenostoma hyalinum* (Lyell) Mitt.,** Nova Hedwigia 89 (3–4): 485–517. 2009.

Basyn: *Jungermannia hyalina* Lyell., Hook. Brit. Jungerm. pl. 63, 1814.

Plants leafy, small, dull green to hyaline, up to 10 mm long, 1.5 mm wide, rhizoids long, hyaline to slightly brown, dense. **Leaves** obliquely inserted, slightly decurrent, ovate to semilunate or semicircular, ± 1 x 1.2 mm, in size. **Marginal leaf cells** 22-28 x 16-22 µm, middle cells ± 30-34 x 25-34 µm basal cells 42-48 x 20-30 µm, in size, thin walled, trigones conspicuous. **Perianth** delicate, ovoid to fusiform, pleuriplicate (more than 4), mouth crenulated, bracts 2 – 3 pairs, size similar to leaves.

Ecology & Distribution: plants growing on soil over rocks, on soil and on rocks at Patalkot, Chota Mahadev (Tamia), Vanshri Vihar and Duchess Fall from 400 – 1000 m.

Range of Distribution: Africa, China, Europe, India: central India (PBR), eastern Himalaya (Darjeeling, Meghalaya), Japan, Nepal, United States.

Specimens examined: India, Madhya Pradesh, PBR: Patalkot (near Rajakhoh), alt. ca 400 m, on soil over rocks, 06.10.1992, 205477, 205479 (LWG); Chota Mahadev (Tamia), alt. ca 953 m, on soil, 11.10.1992, 205529 (LWG); Vanshri Vihar (near river Denwa) alt. ca 1000 m, on rocks, 18.12.1993, 205668, 205673A (LWG), leg. V. Nath & A.K. Asthana, Duchess Fall, alt. ca 823 m, 30.11.2006, on wet rocks, 227670 (LWG). leg. V. Sahu & V. Awasthi.

***Solenostoma rotundatum* Amakawa,** Nova Hedwigia.89: 485–517, 2009**.**

Syn: *Jungermannia rotundata* (Amakawa) Amakawa, J. Hattori Bot. Lab. 22: 25. 1960.

Syn: *Jungermannia harana* Amakawa, Miscel. Bryol. Lichenol. 2 (3): 33. 1960.

Plants leafy, small, up to 10–12 mm long, 1.5 – 2 mm wide, dull green, tufted to matted, rhizoids decurrent, long purple, dense. **Leaves** imbricate, obliquely inserted, ovate to rotundate, ± 1.4 x 1.2 mm in size. **Marginal leaf cells** 15-28 x 16-22 µm in size, basal cells ± 35-60 x 20-35 µm, thin walled, getting thicker towards margin, trigones in district.

Ecology & Distribution: Plants growing on wet rocks on way to Chota Mahadev, 788m.

Range of Distribution: Japan, China, India: central India (PBR).

Specimens examined: India, Madhya Pradesh, PBR: on way to Chota Mahadev, alt. ca 788 m, on wet rocks, 29.11.2006, 227637 (LWG). leg. V. Sahu & V. Awasthi.

***Solenostoma limbatifolium* (Amak.) Vana & D.G. Long,** Nova Hedwigia 89: 485 – 517, 2009.

Basyn: *Jungermannia (Solenostoma) limbatifolia* Amak., J. Hattori Bot. Lab. 31: 112, 1968.

Plants leafy, dull greenish– brown, up to 30 mm long, 1.5 mm wide, rarely branched; rhizoids prominent, colourless, in fasicles. **Stem** circular in cross section, 12 cells across diameter, cortical cells thick walled medullary cells slightly larger. **Leaves** succubous, obliquely inserted, decurrent at dorsal base, flattened, oval to sub–circular, entire, ± 0.5 – 0.6 mm long, 0.38 – 0.49 mm wide. **Marginal leaf cells** 12 – 14 x 6.5 – 19 µm, slightly thick walled, basal cells 22 – 40 x 35 – 48 µm, thin walled, trigones present. Perianth not seen.

Ecology & Distribution: plants growing on wet rocks at Jalgali, 900 m.

Range of Distribution: central India (PBR), eastern Himalaya (Darjeeling, Jaintia hills, Khasi hills), Nepal, Bhutan.

Specimens examined: India, Madhya Pradesh, PBR: Jalgali, alt. ca 900 m, on moist rocks, 16.12.1993, 205564 (LWG), leg. V. Nath & A.K. Asthana.

Genus: *Jungermannia* Linn.

Plants olive green to brownish, often tinted with red, in mats. Stems creeping; leaves obliquely and widely inserted, spreading, ovate to oblong, rectangular. Perianth gradually contracted and not beaked. Perigynium absent.

***Jungermannia pyriflora* var. *major* (Hatt.) Amakawa,** comb. nov., J. Hattori Bot. Lab. 22: 1–89, 1960.

Basyn: *Jungermannia monticola* fo. *major* S. Hatt. Jour. Hattori Bot. Lab. 3:8.f.143. 1948(1950).

Plants leafy, dull green, up to 25 mm long, 2.0 mm wide, present in tufts; rhizoids light purplish, numerous. **Leaves** loosely imbricate, rotundated obliquely inserted, shortly decurrent, margins recurved, ± 1.2 x 1.4 mm in size. **Marginal leaf cells** 20-25 x 12-18 µm, middle cells 30-38 x 22-26 µm, basal cells 42-56 x 22-25 µm,

thin walled, small trigones present. **Perianth** apical, exerted, beaked at mouth, bracts smaller than leaves.

Ecology & Distribution: plants growing on soil and on rocks (moist), at Chota Mahadev (Tamia) and Vanshri Vihar (near river Denwa) from 950–1000 m.

Range of Distribution: India: central India (PBR), eastern Himalaya, Japan.

Specimens examined: India, Madhya Pradesh, PBR: Chota Mahadev (Tamia) alt. ca 953 m, on soil, 11.10.1992, 205517 (LWG); Vanshri Vihar, alt. ca 1000 m, on rocks, 18.12.1993, 205673B (LWG), leg. V. Nath & A.K. Asthana.

***Solenostoma tetragonum* (Lindenb.) R. M. Schust.** [Austral Hepat. 2: 377, 2002, nom. inval.] J ex Vana et D.G. Long, comb. nov., Nova Hedwigia. 89 (3–4) 485–517: 2009.

Basyn: *Jungermannia tetragona* Lindb., Meissn., Bot. Zeit. 6: 462, 1848.

Plants leafy, dull green, up to 22 mm long prostrate to suberect, rhizoids dull brownish. **Leaves** loosely imbricate, obliquely spreading, dorsally decurrent, ovate, rectangular, ± 1.4 x 0.9 mm in size, apex obtuse**. Marginal leaf cells** 10-32 x 16-32 µm, median cells 30-70 x 20-38 µm, basal cells 70-100 x 28-40 µm, moderately thick walled; trigonous. Perianth not seen.

Ecology & Distribution: plants growing on rocks (dry & moist) and on moist soil near water stream at Down Fall, Jalgali, Vanshari Vihar and Panchali Kund, from 900 – 1056 m.

Range of Distribution: Bhutan, Borneo, China, India: Andaman & Nicobar Islands (Port Blair), central India (PBR), eastern Himalaya (Assam, Darjeeling, Gangtok, Khasi hills, Meghalaya, Sikkim), South India (Mahabaleshwar), weatern Himalaya (Mussoorie), Japan, Java, Nepal, Papua New Guinea, Rukyus, Sumatra.

Specimens examined: India, Madhya Pradesh, PBR: Down Fall, alt. ca 1056 m, on rocks, 15.12.1993, 205554 (LWG); Jalgali, alt. ca 900 m, on moist rocks, 16.12.1993, 205563 (LWG); Vanshri Vihar, alt. ca 1000 m, on rocks, 18.12.1993, 205568C (LWG); leg. V. Nath & A.K. Asthana; Panchali Kund, alt. ca 944 m, on moist soil, 07.11.2011, 263164 (LWG). leg. A.K. Asthana & R. Gupta.

Family: Geocalycaceae Schust.

1. Leaves ovate to oblong, without dentitions; underleaves oblong with base as wide as apex ……..…….…….…….. ***Chilopscyphus***
   Leaves quadrate to rectangular, with 5-6 dentitions; underleaves obcordate with base narrower than apex ..……...…….. ***Heteroscyphus***

Genus: *Chilopscyphus* Corda.

Plants eafy, delicate, light to dark green, dorsoventral, medium sized, 8 - 20 mm long, 2 - 3 mm wide branched. Thallus a bit adaxially convex, stem 8-12 cells across diameter, cell undifferentiated; leaves slightly obliquely inserted in two rows, subopposite, underleaves in one row, rhizoids in bunches. Leaves flat to curved, oblong- ovate, margin entire, base broader than apex, trigones feebly developed to prominent. Underleaves free, small to medium, bifid at apex up to ½ way, lobes diverging in broad sinus, 6 - 10 cells long.

***Chiloscyphus himalyaensis* (A. Srivast. et S.C. Srivast.) J. J. Engel**, Fieldiana, Bot. n.s. 48: 20, 2010.

Plants monoicous leafy, delicate, light green, dorsoventral, medium sized, 8 - 12 mm long, 2 - 3 mm wide branched. Thallus a bit adaxially convex, stem 8-10 cells across diameter, cell undifferentiated; leaves slightly obliquely inserted in two rows, subopposite, underleaves present in one row on ventral surface, rhizoids present in bunches. **Leaves** flat, oblong- ovate, margin entire, + 0.8 x 0.65 mm in size, base broader than apex, leaf cells 14 - 34 x 15 - 40 µm at apex, 20 - 42 x 20 - 45 µm at mid leaf, 25 - 60 x 12 - 45 µm at base, trigones prominent. **Underleaves** free, small, bifid at apex up to ½ way, lobes diverging in broad sinus, 6 - 10 cells long, . Male/ Female receptacles not seen.

Ecology & Distribution: plants growing on rocks at Vanshri Vihar, 1000 m.

Range of Distribution: Australia, India: central India (PBR), western Himalaya (Bhowali, Chaubatia, Himachal Pradesh, Jammu, Kausani, Kilbury, Mussoorie, Nainital, Sheetlakhet, Uttarakhand).

Specimens examined: India, Madhya Pradesh, PBR: Vanshri Vihar, alt. ca 1000 m, 18.12.1993. 205675B (LWG). leg. V. Nath & A.K. Asthana.

Genus: *Heteroscyphus* Schiffn.

Plants leafy, delicate, dull green to medium green, dorsiventral, medium to large sized, ± 10 to 48 µm long, ± 2-4 mm broad, branched. Stem 8 to 10 cells across diameter. Leaves imbricate, alternate, quadrate – rectangular to ovato- rectangular, margin entire, equal width nearly from apex to base, 5 - 6 uniseriate dentations at apical portion, trigones absent to developed. Underleaves distant, on ventral surface, usually free, deeply lobed, diverging lobes, sinus broad 4 - 10 cells long 2 - 5 cells wide, toothed.

***Heteroscyphus argutus* (Nees) Schiffn.,** Oesterr. Bot. Zeitschr., 60: 172, 1910.

Basyn: *Jungermannia arguta* Reinw. et al. Hep. Javan, 206, n 14. (1824).

Syn: *Chiloscyphus argutus* (Reinw. et al.) Nees, Gott. et al., Syn. Hepat.: 183, 1845.

Plants dioicous leafy, delicate, dull green, dorsiventral, medium sized, ± 15 to 45 µm long, ± 2-4 mm broad, branched. **Stem** 8 to 10 cells across diameter, outer cells thick walled, inner cells thin walled. **Leaves** imbricate, alternate, quadrate – rectangular to ovato- rectangular, 0.3 - 0.6 x 0.2 - 2.3 mm in size, margin entire, equal width nearly from apex to base, 5 - 6 uniseriate dentations at apical portion. **Leaf cells** 11 - 22 x 8 - 20 µm at apex, 14 - 28 x 14 - 30 µm at middle, 19 - 55 x 19 - 39 µm at base, trigones absent. **Underleaves** distant, usually free, deeply lobed, diverging lobes, sinus broad 4 - 10 cells long 2 - 5 cells wide, tooth on both lateral margins. Male/ Female receptacles not seen.

Ecology & Distribution: plants growing on extremely damp rocks at Jatashankar, 1000 m.

Range of Distribution: Australia, China, Hawaii, India: central India (AABR, PBR), eastern Himalaya (Assam, Khasia hills Manipur (Kanchipur), Ukhrul, Meghalaya: Cherrapunji, Jowai, Shillong, Elephant Falls, Sikkim: Bhuspate, Danra, Gangtok, Kabi, Mangam, Manul, W. Bengal: Darjeeling), western Himalaya (Himachal Pradesh: Chamba, Kausani, Nainital Sheet- lakhet), South India (Karnataka, Kerla: Munnar, Tamil Nadu: Kodaikanal, Ootakamund, Palni hills), Japan, Java, Papua New Guinea, Nepal, New Zealand.

Specimens examined: India, Madhya Pradesh, PBR: Jatashankar, alt. ca 1000 m, on extremely damp rocks. 17.12.1993, 205628 (LGW). leg. V. Nath & A.K. Asthana.

Family: Jubulaceae Klinggr.

Genus: *Frullania* Raddi.

Plants, leafy, complicate bilobed, medium to large sized, light yellow to dull green, branched irregularly. Leaves squarrose with cordate base, oblong– ovate to oval, entire, apex rounded. Leaf cells semiquadrate. Lobules variable, saccate, helmet shaped, Underleaves small, suborbicular, narrow at base, broader upwards, entire, apex acute.

***Frullania ericoides* Nees.,** Syn. Hepat. 417, 1846.

Frullania squarrosa (Reinw., Blume et Nees) Dum., Rec. d'ods 13: 1835.

Plants dioicious, leafy, medium sized, light yellow to dull green, up to 19 mm long, 1.5 mm wide, branched irregularly. **Leaves** squarrose with cordate base, oblong–ovate to oval, entire, ±1.2 x 0.80 mm in size, apex rounded. **Leaf cells** semiquadrate, ± 21 x 16 µm at margin, 22 – 35 x ± 18 µm at middle and 37 – 42 x 22 – 25 µm at base. **Lobules** variable, saccate, helmet shaped, ± 0.30 x 0.32 m in size. **Underleaves** small, suborbicular, narrow at base, broader upwards, entire, apex acute.

Ecology & Distribution: plants growing epiphytically on way to Jatashankar, 818 m.

Range of Distribution: Australia, Angola, Antarctica, Antilles, Bhutan, Bolivia, Brazil, Burundi, Cameroon, China, Colombia, Chile, Comoros, Congo, Cuba, Dominican, Republic, Ecuador, Ethiopia, Fiji, French, Guiana, French Polynesia, Gabon, Guatemala, Guyana, Haiti, Hong Kong, India: central India (PBR), eastern Himalaya (Khasia hills, Shillong), Indonesia, Jamaica, Japan, Kenya, Lesotho, Madagascar, Malawi, Mauritius, Mayotte, Mexico, Mozambique, Netherlands, New Caledonia, New Zealand, Niger, Nigeria, Pacific Islands, Papua New Guinea, Paraguay, Peru, Philippines, Portugal, Puerto Rico, Rwanda, Saint Helena, Seychelles, South Africa, Sri Lanka, Suriname, Syria, Taiwan, Tanzania, Thailand, Uganda, United Kingdom, United States, Venezuela, Vietnam, Zambia, Zimbabwe.

Specimens examined: India, Madhya Pradesh, PBR: on way to Jatashanka, alt. ca 818 m, epiphytic, 29.11.2006, 227656A (LWG). leg. V. Sahu & V. Awasthi.

Family: Lejeuneaceae Dumort.

Genus: *Lejeunea* Libert.

Plants leafy, dull green, small, up to 7 mm long, rarely branched, rhizoids few to dense, scattered. Leaves imbricate, incubous, obliquely inserted, distant, apex rounded to sinuate, margin entire, trigones present. Leaf lobule small, ± 1/3rd of lobe in size, ovate. Underleaves small, broad, bifid up to 1/2 leaf length, ovate–orbicular.

***Lejeunea wightii* Lndnb.,** Gott., Lndnb. & Nees, Syn. Hep. 379, 1845.

Plants diocous leafy, dull green, small, up to 5.5. mm long, 0.4 mm wide, rarely branched, rhizoids few, scattered. **Leaves** imbricate, incubous, obliquely inserted, distant, ± 0.30 x 0.28 mm in size, apex rounded, margin entire trigones present. **Marginal leaf cells** 10-12 x 14 µm, median cells ± 25-30 x 20-25 µm, basal cells 28-30 x 22-25 µm in size. Leaf lobule small, ± 1/3rd of lobe in size, ovate. **Underleaves** small, broad, bifid up to 1/2 leaf length, ovate–orbicular. Male/ Female receptacles not seen.

Ecology & Distribution: plants growing epiphytically on way to Chota Mahadev, 854m.

Range of Distribution: Australia, China, India: central India (PBR), eastern Himalaya (Manipur, Meghalaya, Darjeeling, Kalimpong), South India (Tamil Nadu, Karnataka, Kerala), western Himalaya (Chaubatia, Dehradun, Nainital, Musoorie, valley of Flowers), Taiwan.

Specimens examined: India, Madhya Pradesh, PBR: on way to Chota Mahadev, alt. ca 854 m, epiphytic, 29.11.2006, 227630A (LWG). leg. V. Sahu & V. Awasthi.

Genus: *Lopholejeunea* (Spruce) Schiffn.

Plants leafy, yellowish – green, up to 15 mm long and 1.5 mm wide, branching rare, irregular. Stem in cross section, 6 – 7 cells across in diameter. Leaves rounded to orbicular – ovate, widely spreading, margin entire, apex rotundate, non trigonous to mildy trigonous. Leaf lobules inflate, less than or equal to 1/2 of leaf length, quadrate, apex truncate. Underleaves distant small orbicular, margin entire.

***Lopholejeunea abortiva* (Mitt.) Steph., Spec. Hepat. 5: 70, 1912.**

Plants dioicous, leafy, yellowish – green, up to 10 mm long and 1 mm wide, branching rare, irregular. **Stem** circular in cross section, 6 – 7 cells across in diameter. Leaves rounded to orbicular – ovate, widely spreading, 0.35 - 0.6 mm long, 0.30 – 0.40 mm wide, margin entire, apex rotundate. **Marginal** leaf cells 7.5 – 9.5 x ± 10.9 µm in size, thick walled, rectangular to squarrose, basal cells ± 16 x 28 µm in size, non trigonous. **Leaf lobules** inflate, less than or equal to 1/2 of leaf length, quadrate, apex truncate, tooth single, inconspicuous. **Underleaves** distant small orbicular, margin entire. Perianth not seen.

Ecology & Distribution: plants growing on rocks, at Apsara Vihar, 734 m.

Range of Distribution: India: central India (PBR), eastern Himalaya (BSI Campus, Cherrapunji, Mawphlong Forest, Meghalaya, Shillong, west Khasi hills), South India (Karnataka, Kerala), South Africa.

Specimens examined: India, Madhya Pradesh, PBR: Apsara Vihar, alt. ca 734 m, on rocks, 01.12.2006. 227695B (LWG). leg. V. Sahu & V. Awasthi.

Family: Radulaceae (Dumort.) K. Müll.

Genus: *Radula* Dumort.

Plants leafy, pale green to brownish green, up to 35 mm long, 2.0 – 2.5 mm wide, irregularly branched rhizoids numerous, fasciculate. Stem circular in cross section, cortical cells thick, dark coloured, medullary cells lighter in comparison. Leaves bilobed, caducous, diverging from stem at 45 – 90^0 degree angle, ovate, falcate, sometimes asymmetric, apex rounded, margin entire; lobule quadrate, smooth, apex truncate, entire, keel sinuate, covering up to ½ of leaf.

***Radula javanica* Gottsche,** Syn. Hepat.: 257, 1845.

Plants dioicous leafy, pale green, up to 30 mm long, 2.0 – 2.2 mm wide, irregularly branched rhizoids numerous, fasciculate, in the middle of leaf lobule. **Stem** circular in cross section, 8 cell thick, cortical cells dark coloured, medullary lighter in comparison. **Leaves** bilobed, caducous, diverging from stem at 60 – 90^0 degree angle, ovate, falcate, sometimes asymmetric, 1.1 – 1.3 x ± 0.9 mm, apex rounded, margin entire; **lobule** quadrate, smooth, apex truncate, entire, keel sinuate. Sporophyte not seen.

Ecology & Distribution: plants growing on soil over rocks and on rocks at Jalgali and Pathar Chatta, from 900 – 1000 m.

Range of Distribution: Antarctica, Australia, Borneo, Brazil, China, Ecuador, Fiji, French Guiana, French Polynesia, Hong Kong, India: central India (PBR), eastern Himalaya (Assam, Khasia hills), South India (Kerala, Karnataka), Japan, Java, New Caledonia, Papua New Guinea, Philippines, Samoa, Sri Lanka, Sumatra, Taiwan, Thailand, Vietnam.

Specimens examined: India, Madhya Pradesh, PBR: Jalgali, alt. ca 900 m, on soil over rocks, 16.12.1993, 205575 (LWG); Patthar Chatta, alt. ca 1000 m, on rocks, 18.12.1993, 205666 (LWG). leg. V. Nath & A. K. Asthana.

IV. ORDER: MARCHANTIALES LIMPR.

Family: Aytoniaceae Cavers

Key to the genera of *Aytoniaceae* at PBR:

1. Thallus with terminal archigoniophore …..……………………..………………. **2**
   Thallus with dorsal archigoniophore …..………………………... ***Plagiochasma***
2. Dorsal surface with cospicuous areolae, ventral scales in one row on each side of midrib ……………….………………………………………..…..….. ***Asterella***
   Dorsal surface with cospicuous areolae, ventral scales in two rows on each side of midrib …………….……………………………………………….. ***Reboulia***

Genus: *Plagiochasma* Lehm. et Lindb.

Plants thalloid, dark green to medium green, forming large patches, 10 to 30 mm long, 1.5 - 5 mm broad, dichotomous at apex. Thallus lobed, oblong, dorsal surface smooth, margins undulate, air pores large, ventral surface convex purple, dimorphic rhizoids present, ventral scales overlapping, in one row on each side of the midrib, broadly lunate, appendiculate, appendage single to two, entire, round – ovate to oblong, acute, hyaline to purple in colour; midrib conspicuous. Thallus in transverse section shows empty chambers in several layers. Male receptacles horse shoe shaped. Female receptacle subsessile to shortly stalked with 1 - 7 lobes.

Key to the species of *Plagiochasma* at PBR:

1. Plants monoicous, appendage of ventral scale single, rotund to ovate, entire; spores larger, 60-80 µm with 6-8 reticulations across diameter ..…… ***P. appendiculatum***

   Plants dioicous, appendage of ventral scale two, small, oblong, constricted at base; spores smaller, up to 60 µm with 2-3 reticulations across diameter ..…….……..…… ***P. intermedium***

***Plagiochasma appendiculatum* Lehm. et Lindb.,** Pug. IV: 14, 1832.

(Plate VII: A-B)

Plants monoicous, thalloid, dark green, forming large patches, 10 to 28 mm long, 1.5 - 4 mm broad, dichotomous at apex. Thallus lobed, oblong, dorsal surface smooth, margins undulate, purplish, **air pores** large, bounded by 3 - 4 rings of 6 - 10 cells, ventral surface convex purple, dimorphic rhizoids present, **ventral scales** overlapping, in one row on each side of the midrib, broadly lunate, appendiculate, appendage single, entire, round to ovate, acute, hyaline to purple in colour; midrib conspicuous. Thallus in transverse section shows empty chambers in several layers, opening by air pores, storage zone well developed. **Male receptacles** horse shoe shaped. **Female receptacle** shortly stalked with 5 - 7 lobes. **Spores** dark brown, 13 - 15 reticulations.

Spores under SEM: spores spherical to somewhat triangular in shape, 60 - 80 µm in size, sporoderm prominently reticulate formed of deep lumens usually up to 5 across the diameter, exhibits very minute rather scattered papillae all over the surface.

Ecology & Distribution: plants growing on soil, on soil covered rocks, on dry exposed rocks and moist to wet rocks at Batka Khapa, Patalkot (Rajakhoh), Tamia Valley, Chota Mahadev (Tamia), Jalgali, on way to Jambu Dweep, Jatashankar, Mahadev (near caves), near Bee Fall, Bee Dam, near Police Training School, Little Fall, on way to Mahadev Mandir, Duchess Fall, Pandav caves, Apsara Vihar, on way to Rajat Prapat, Bada Mahadev, Pachmarhi Lake, from 400 - 1075 m.

Range of Distribution: Afghanistan, Africa, Bhutan, Celebes, China, Europe, India: central India (AABR, PBR, Mt. Abu), eastern Himalaya (Assam, Darjeeling, Sikkim), Gangetic plains (Haridwar, Saharanpur), Punjab and Rajasthan plains (Rajasthan), South India (Nagpur, Nilgiri hills), western Himalaya (Dehradun, Garhwal, Gollan,

Jammu, Kangra, Kullu, Kumaon, Mussoorie, Nainital, Patni pass, Pathankot, Simla), Indonesia, Kenya, Myanmar, Nepal, Pakistan, Philippines, Rhodesia, Socotra, Taiwan, Vietnam.

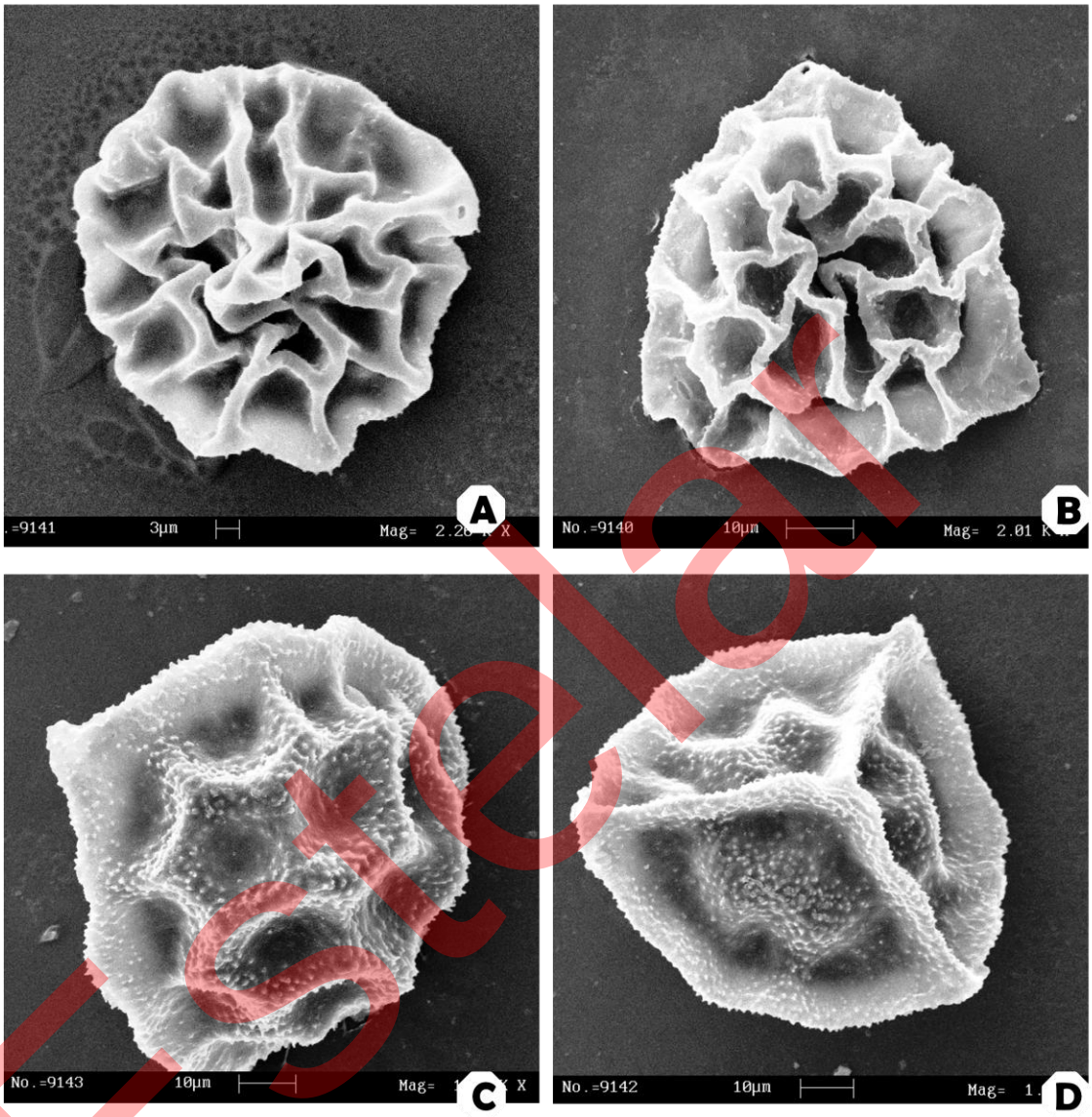
Specimens examined: India, Madhya Pradesh, PBR: Batka Khapa (near River Kundi), alt. ca 600 m, on soil, 05.10.1992, 205463 (LWG); Patalkot (Rajakhoh), alt. ca 400 m, on soil, 06.10.1992; on soil over rocks, 06.10.1992, 205464, 205473C, 205474 (LWG); Tamia valley, alt. ca 1000 m, on soil over rocks, 10.10.1992, 205484 (LWG); Chota Mahadev (Tamia), alt. ca 950 m, on soil, 30.11.1992, 205530 (LWG); Jalgali, alt. ca 900 m, on rocks, 16.12.1993, 205567, 205574 (LWG); on way to Jambu Dweep, alt. ca 900 m, on soil over rocks, 17.12.1993, 205612 (LWG); Jatashankar, alt. ca 1000 m, on soil over rocks 17.12.1993, 205625, 205626, 205627 (LWG); Mahadev (near caves), alt. ca 1000 m, on moist rocks, 17.12.1993, 205631, 205639 (LWG); Chota Mahadev (Tamia), alt. ca 950 m, on moist rocks, 19.12.1993, 205679, 205680, 205684, 205691, 205706, 205716, 205717 (LWG); Rajakhoh (Patalkot), alt. ca. 400 m, on rocks, 20.12.1993, 205731, 205737 (LWG). leg. V. Nath & A.K. Asthana; near Bee Fall, alt. ca 823 m, on soil covered rocks, 30.11. 2006, 227661A (LWG); near Police Training School, alt. ca 914 m, on soil over rocks, 28.11.2006, 229382 (LWG); Little Fall, alt. ca 884 m, on wet rocks, 28.11.2006, 229391B, 229396 (LWG); on way to Mahadev Mandir, alt. ca 1006 m, on soil covered rocks, 28.11.2006, 227614 (LWG); Duchess Fall, alt. ca 732 m, on soil covered rocks, 30.11.2006, 227678A (LWG); Pandav caves, alt. ca 832 m, on moist rocks, 12.02.2006, 227681A (LWG); Apsara Vihar, alt. ca 734 m, on rocks, 01.12.2006, 227695A (LWG). leg. V. Sahu & V. Awasthi; on way to Rajat Prapat, alt. ca 988 m, on dry rocks, 07.11.2011, 263132 (LWG); Apsara Vihar, alt. ca 920 m; on soil covered rocks, 07.11.2011, 263145 (LWG); Bee Dam, alt. ca 964 m, on soil covered rocks, 08.11.2011, 263187 (LWG); Bada Mahadev, alt. ca 1075 m, on soil covered rocks, 08.11.2011, 264817 (LWG); Pachmarhi Lake, alt. ca 1050 m, on dry rocks, 09.11.2011, 264828 (LWG), leg. A.K. Asthana & R. Gupta.

***Plagiochasma intermedium* Lindb. et Gott.,** Syn. Hep. 513, 1844.

(Plate VII: C-D)

Plants dioicous, thalloid in patches, green to dull brown, 13-25 mm long, 3-5 mm wide, occasionally dichotomous, lobes strap shaped, purple margin entire. Dorsal surface slightly concave, **air pores** distinct, bounded by 3-4 rings of 7-8 cells each,

PLATE- VII



Figs. A,B. *Plagiochasma appendiculatum* Lehm. et Lindb.: A. distal view of spore, B. proximal view of spore, figs. C,D. *P. intermedium*: C. distal view of spore, D. proximal view of spore.

ventral surface purplish, rhizoids dimorphic midrib broad, ventral scales purple, lunate, appendiculate, appendages two, small, oblong, constricted at base. **Male receptacles** absent. **Female receptacles** dorsal, subsessile, with 1-4 involucres. **Spores** dark brown, lamellate, winged, ± 60 µm in diameter, elaters yellow, uniformly thickened, spiral bands absent.

Spores under SEM: spores nearly spherical to triangular in outline, sporoderm reticulate, with scattered minute papillae, usually forming pentagonal luminae with coarse ridges, lumens rather shallow, ridges enclosing lumens are studded with minute papillae whereas the lumens are smooth, proximal face with prominent triradiate mark, triradiate rays reaching periphery and extending up to equator.

Ecology & Distribution: plants growing on soil at Patalkot and Tamia, both shady and exposed places from 400-953 m.

Range of Distribution: China, Guatemala, India: central India (AABR, PBR, Bhopal, Sagar, Mt. Abu), eastern Himalaya (Cherrapunji, Meghalaya), Gangetic plains (Ranchi, Lucknow), Punjab & Rajasthan plains (Punjab, Rajasthan), South India (Panchgani, Purandhar, Nagpur), western Himalaya (Dalhousie Road, Nurpur, Pathankot), Japan, Korea, Manchuria, Mexico, Philippines, Taiwan.

Specimens examined: India: Madhya Pradesh, PBR: Patalkot (near Rajakhoh) alt. ca 400 m, on soil 06.10.1992, 205470 (LWG); 20.12.1993, 205728 (LWG); Tamia (Chota Mahadeo) alt. ca 953 m, on soil, 11.10.1992. 205516, 205525 (LWG). leg. V. Nath & A.K. Asthana.

Genus: *Asterella* Beauv.

Plants thalloid, dioicous, deep green, dichotomously branched, up to 32 mm long, 3 - 4 mm broad, notched. **Dorsal** surface smooth, flat, margin wavy, green to purple, apex notched, pores large; ventral surface covered by **ventral scales** one on each side of midrib, purplish, acuminate appendage. Anthridia sunken on dorsal thallus surface in chambers, **Female receptacle** terminal, stalked 2 - 5 lobed, **perianth** horizontal, beak like.

Key to the species of *Asterella* at PBR:

1. Plants dioicous ……..……..……. ***A. wallichiana***
   Plants monoicous ……..…….. **2**

2. Plants large (up to 60 x 3.2 mm), air pores surrounded by more than 6 layers of cells …….…….. ***A. leptophylla***

   Plants medium to large (up to 29x4 mm), air pores surrounded by than 6 layers of cell ……..……...……. **3**

3. Plants small, up to 10 x 3.2 mm), ventral scales with single broad appendage, air pores surrounded by 2 rows of cells …….…….…….. ***A. khasyana***

   Plants larger, up to 20 x 4 mm, ventral scales with 1-2 lanceolate appendages, air pores surrounded by 5-6 rows of cells ….…….. ***A. multiflora***

***Asterella wallichiana* (Lehm. et Lindb.) Grolle.,** J. Hattori Bot. Lab. 11:8, 1954.

Basyn: *Fimbriaria wallichiana* Lehm., Pugillus 4: 4, 1832.

(Plate VIII: Figs. A-C)

Plants thalloid, dioicous, deep green, dichotomously branched, up to 32 mm long, 3 - 4 mm broad. **Dorsal** surface smooth, flat, margin wavy, purple, apex notched, pores large surrounded by 3 layers of 6 cells each; ventral surface covered by **ventral scales** in two rows, one on each side of midrib, purplish, acuminate appendage. Male plants not seen. **Female receptacle** terminal, stalked 2 - 5 lobed, **perianth** horizontal, beak like; **spores** dark brown up to 63 µm in diameter, sporoderm papillose, lamellate; elaters dull yellow up to 150 µm long, 1 - 2 spiral thickening bands.

Spores under SEM: spores subspherical, sporoderm lamellate with coarse and thick lamellae running all over having scattered thin finer like ornamentation.

Ecology & Distribution: plants growing over rocks and soil covered rocks in both exposed and shady places (near water stream) at Patalkot (Rajakhoh), Tamia (on way to and at Chota Mahadev), near New Hotel (FRH Road), Down Fall, Jalgali, Jambu Dweep, Little Fall, on way to Mahadev, on way to Bee Fall, Duchess Fall, on way to Rajat Prapat, Pandav caves, Apsara Vihar, Panchali Kund, Bee Dam, Jatashankar, from 400 -1056.

Range of Distribution: Bhutan, Burma, India: central India (Amarkantak, Mt. Abu, PBR), eastern Himalaya (Assam, Cherrapunji, Darjeeling, Sikkim), Gangetic plains (Pratapgarh, Uttar Pradesh, west Bengal), South India (Kerela, Karnataka, Maharashtra, Tamil Nadu), western Himalaya (Simla, Dalhousie, Ranikhet, Pithoragarh, Mussoorie, Kotagiri, Uttaranchal), Indonesia, Italy, Japan, Myanmar, Nepal, Pakistan, Papua New Guinea, Philippines, Solomon, Islands.

Specimens examined: India, Madhya Pradesh, PBR: Patalkot (Rajakhoh), alt. ca 400 m, on soil over rocks, 06.10.1992, 205473B, 205482 (LWG); Tamia Valley, alt. ca 1000 m, on soil over rocks, 10.10.1992, 205489 (LWG); Chota Mahadev (Tamia) alt. ca 1000 m, on rocks, 11.10.1992, 205519 (LWG); near New Hotel (FRH Road) alt. ca 1056 m, on soil, 15.12.1993. 205535, 205537 (LWG); Down Fall, alt. ca 1056 m, on moist rocks (near water stream), 15.12.1993, 205551 (LWG); Jalgali, alt. ca 900 m, on rocks 16.12.1993, 205578, 205581 (LWG); Jambu Dweep alt. ca 900 m, on rocks (near water stream), 17.12.1993, 205596, 205607 (LWG), on soil over rocks, 17.12.1993, 205609A, 205620 (LWG); Chota Mahadev (Tamia), alt. ca 950 m, on rocks, 19.12.1993, 205677, 205678, 205681,205685,205686, 205688, 205689 (LWG). leg. V. Nath & A.K. Asthana; Little Fall, alt. ca 884 m, on soil covered rocks, 28.11.2006, 229397 (LWG); Down Fall, alt. ca 884 m, on rocks (wet), 28.11.2006, 229399B (LWG); on way to Mahadev, alt. ca 975 m, on rocks 28.11.2006, 227616 (LWG); on way to Chota Mahadev, alt. ca 854 m, on rocks, 29.11.2006, 227624B (LWG); Duchess Fall, alt. ca 732m, on wet rocks, 30.11.2006, 227674A, 227679(LWG); Pandav caves, alt. ca 823 m, on rocks, 01.12.2006, 227685A (LWG). leg. V. Sahu & V. Awasthi; way to Rajat Prapat, alt. ca 988, on dry rocks, 07.11.20011, 263126 (LWG); Apsara Vihar, alt. ca 920 m, on soil over rocks, 07.11.2011, 263143 (LWG); Panchali Kund, alt. ca 938m, on dry exposed rocks, 07.11.2011, 263154 (LWG); Panchali Kund, alt. ca 944 m, on soil over rocks (moist), 07.11.2011, 263167 (LWG); Bee Dam, alt. ca 976 m, on moist soil over rocks, on rocks, 08.11.2011, 263193; 263196 A (LWG); Jatashankar, alt. ca 986 m, on moist rocks, 09.11.2011, 264834A (LWG). leg. A.K. Asthana & R. Gupta.

***Asterella leptophylla* (Mont.) Grolle.,** Feddes Repert. 87: 246. 246, 1976.

Basyn: *Fimbriaria leptophylla* Mont. Annales des Sci. Natur.; Botanique Sér. 2, 18: 16, 1842.

Plants monoicous, thalloid, deep – dull green, dichotomously branched, up to 60 mm long, 3 – 3.2 mm broad. Dorsal surface smooth, flat with faint areslae, margins apex notched undulate, midrib thick, fleshy, **air pores** large, surrounded by 6 – 8 radial rows of 2 – 4 cells each, ventral surface dark purplish, **ventral scales** in two rows, one on each side of midrib, scales dull reddish, single oblong-lanceolate appendage, margin slightly dentate. **Male branches** smaller, androecia on small heart shaped small

branches, **female receptacle** terminal, borne at apical notch, stalk flexible, long, 20 – 30 mm in size, 4 – 6 lobed, perianth not seen.

Ecology & Distribution: plants growing on wet rocks at Irene Pool, 1015 m.

Range of Distribution: Bhutan, China, India: central India (PBR), eastern Himalaya (Assam, Sikkim), Gangetic plains (West Bengal), South India (Tamil Nadu), western Himalaya (Himachal Pradesh, Kashmir, Uttarakhand), Indonesia, Japan, Korea, Nepal, Pakistan, Philippines, Russia.

Specimens examined: India, Madhya Pradesh, PBR: Irene Pool, alt. ca. 1015 m, on rocks, 08.11.2011, 264813 (LWG). leg. A. K. Asthana & R. Gupta.

***Asterella khasyana* Griff. Pande, K. P. Srivast. & Sultan Khan in J. Hattori Bot. Lab. 11: 7, 1954.**

Basyn: *Octokepos khasyanum* Griff., Notulae Ad Plantas Asiatics (2): 343, 1849.

Syn: *Fimbriraria blumeana* Nees., Sp. Hept. 89. p 564, 1899.

Plants monoicous, thalloid, dull green, dichotomously branched, up to 10 mm long, 3 – 3.2 mm broad. Dorsal surface green, smooth, apex notched pores large, surrounded by 2 layers of 5 – 6 cells each, ventral surface dull green, **scales** less dense, purple, lanceolate, broad appendage. Male and Female receptacles not seen.

Ecology & Distribution: plants growing on soil covered rocks, 823 m.

Range of Distribution: Bhutan, Burundi, China, India: central India (PBR) eastern Himalaya, (Assam, Sikkim), Gangetic plains (west Bengal), South India (Wayanad), western Himalaya (Himanchal Pradesh, Mussoorie, Simla, Uttaranchal), Indonesia, Nepal, Pakistan, Philippines, Thailand, Uganda.

Specimens examined: India, Madhya Pradesh, PBR: near Bee Fall, alt. ca 822 m, on soil covered rocks, 30.11.2006, 227661B (LWG), leg V. Sahu & V. Awasthi.

According to Long (2006), *Asterella khasyana* is a widely known warm temprate and sub tropical species and it has been wrongly misapplied/ misidentified as *A. blumeana* Nees. by workers (Mitten, 1860–1861, Stephani, 1898–1900, Kashyap 1929–1934) Long (2006) has however ascertained that the Indian *A. blumeana* is actually *A. khasyana* and now put under this name.

***Asterella multiflora* (Steph.) Pande et al.,** J. Hattori Bot. Lab. 11: 8, 1954.

Basyn: *Fimbriaria multiflora* Steph., Spec. Hepaticarum 1: 124, 1899.

Plants monoicious, thalloid, deep green, forming loose mats on substratum, 10 – 20 mm long, 2 – 4 mm wide, rarely dichotomous. Dorsal surface flat to slightly concave, margins undulate, purple, rounded and notched at apex, **air pores** small, visible surrounded by 5 – 6 rows of 2 – 4 cells each, ventral surface purplish to dull green, covered by scales in two rows, one on each side of midrib, **scales** purplish-red, usually 1 – 2 appendages, lanceolate. **Male receptacles** present at apex of main branch, cushion like, 1.0 – 1.2 mm in diameter. **Female receptacles** terminal on short branches, stalk 15 – 17 mm long, 2 – 4 lobed. **Perianth** ending in tubular beak.

Ecology & Distribution: plants growing on soil covered rocks near water stream at Bee Dam, 964 m.

Range of Distribution: China, India: central India (PBR), eastern Himalaya (Assam), Gangetic plains (west Bengal), Punjab & west Rajasthan plains (Punjab), western Himalaya (Himachal Pradesh, Uttarakhand), Nepal, Pakistan.

Specimens examined: India, Madhya Pradesh, PBR: Bee Dam, alt. ca 964 m, on soil over rocks, 08.11.2011, 263189 (LWG). leg. A.K. Asthana & R. Gupta.

Genus: *Reboulia* Raddi.

Plants, thalloid, deep dull green, in dense patches, smooth, rarely dichotomously branched, up to 30 mm long, 2 – 6.5 mm broad. Dorsal surface smooth, pores minute, 3 – 5 concentric rings of 6 cells each; ventral surface purple, covered by scales in two rows, one on each side of midrib; ventral scales purple, lunate, two linear appendages.

***Reboulia hemispherica* (L.) Raddi. Opusc. Scient. di Bologna II**, p. 357, 1818.

Marchantia hemespherica Spec. Plant. 1138. 1753.

Plants diocious, thalloid, deep dull green, in dense patches, rarely dichotomously branched, up to 28 mm long, 2 – 6.5 mm broad. Dorsal surface smooth, pores minute, 3 – 5 concentric rings of 6 cells each; ventral surface purple, covered by scales in two rows, one on each side of midrib, **ventral scales** purple, lunate, two linear appendages. Male / Female receptacles not seen.

Ecology & Distribution: plants growing on soil ever rocks at Jambu Dweep, 900 m.

Range of Distribution: Afghanistan, Algeria, Antarctica, Antilles, Argentina, Australia, Austria, Belgium, Bonin, Borneo, Bermuda, Brazil Bulgaria, Canada, Chad, Chile, China, Cuba, Cyprus, Czech Republic, Estonia, Ethiopia, France, Formosa,

Germany, Haiti, Hungary, Iceland, India: central India (Mt. Abu, PBR), eastern Himalaya (Darjeeling, Khasia hills, Jantia hills, Shillong), South India (Madras, Nilgiri hills, Palni hills, Tirunevely hills, Kaghan valley), western Himalaya Dalhousie, Mussoorie, Lahul, Pangi, Simla, Spiti), Indonesia, Iran, Ireland, Israel, Italy, Jamaica, Japan, Java, Jordan, Kazakhstan, Korea, Lebanon, Luxembourg, Malawi, Mali, Mexico, Moldova, Morocco, Nepal, Netherlands, New Caledonia, New Zealand, Norway, Pakistan, Papua New Guinea, Peru, Philippines, Portugal, Romania, Russia, Slovakia, South Africa, Spain, Sri Lanka South Africa, Sumatra, Sweden, Switzerland, Syria, Tahiti, Taiwan, Tanzania, Turkey, Ukraine, United Kingdom, United States, Uruguay, Venezuela, West Indies.

Specimens examined: India, Madhya Pradesh, PBR: Jambu Dweep, alt. ca 900 m, on soil over rocks, 17.12. 1993. 205603 (LWG). leg. V. Nath & A.K. Asthana.

Family: Conocephalaceae K. Müll

Genus: *Conocephalum* Wigg.

Plants thalloid, dorsiventral, dark green to bright green, large, in patches, dichotomously branched, up to 60 mm long and 10 mm broad. Dorsal surface flat, large conspicuous areolae present uniformly, pores visible to naked eye; ventral surface pale green, midrib conspicuous, scales purple, diststant, present in one row in each side of midrib reniform to orbicular appendage, rhizoids tuberculate.

***Conocephalum conicum* (L.) Necker, Elem. Bot. III p. 344, 1759.**

Plants dioicous, thalloid, dorsiventral, dark green, in patches, dichotomously branched, up to 60 mm long and 10 mm broad. Dorsal surface flat, large conspicuous areolae present uniformly, epidermal cells thin walled, margin undulate, **pores** visible to naked eye with 5 – 6 concentric rings of cells surrounding; **ventral surface** pale green, midrib conspicuous, scales purple, present in one row in each side of midrib reniform to orbicular appendage seen, rhizoids tuberculate. Male/Female receptacles not seen.

Ecology & Distribution: plants growing on rocks at Jalgali, 900 m.

Range of Distribution: Austria, Belgium, Canada, China, Denmark, Finland, Estonia, Finland, France, Germany, Hungary, Iceland, India: central India (PBR), eastern Himalaya (Sikkim), South India (Sherveroy hills), western Himalaya (Garhwal,

Kumaon), Ireland, Italy, Japan, Luxembourg, Madagascar, Nepal, Netherlands, Norway, Poland, Portugal, Russia, Slovenia, Spain, Sweden, Switzerland, Tanzania, Turkey, United Kingdom, United States.

Specimens examined: India, Madhya Pradesh, PBR: Jalgali, alt. ca 900 m, on rocks, 16.12.1993, 205567 (LWG). leg. V. Nath & A. K. Asthana.

Family: Marchantiaceae (Bisch.) Lindl.

Genus: M*archantia* L.

Plants thalloid, thick, green, dichotomously branched, up to 120 mm long, 4 - 6 mm broad. Thallus differentiated in assimilatory and storage zones. Dorsal surface flat, margin entire, air pores present, conspicuous, surrounded by superimposing rings, inner surface of pores cruciate; ventral surface dull green to brownish, scales in 2 rows on each side of midrib, appendaged, midrib conspicous, rhizoids dense, dimorphic. Gemma cups present on dorsal surface, discoid gemmae oval rounded to ovoid-spherical, biconvex, vertically inserted.

Key to the species of M*archantia* at PBR:

1. Thallus without dark median band on dorsal surface, inner opening of epidermal pores cruciate ……..…… ***M. pleaecea* subsp. *pleaecea***
   Thallus with dark median band on dorsal surface, inner opening of epidermal pores not cruciate ……..…….. ***M. papillata* subsp. *grossibarba***

***Marchantia paleacea* Bertol. subsp. *paleacea* Bertol.,** Bryo. Biblio, 38: 1989.

Syn: *Marchantia nepalensis* Lehm. et Lindb., Lehmann, Nov. Strip. Pug. 4:10. 1832.

Plants dioicous, thalloid, thick, green, dichotomously branched, 60 - 120 mm long, 4 - 6 mm broad. Thallus differentiated in assimilatory and storage zones. Dorsal surface flat, margin entire, epidermal cells 5 - 6 angled, **air pores** present, conspicuous, surrounded by superimposing 5 - 6 rings of 4 - 5 cells each, inner surface of pores cruciate; ventral surface dull green to brownish, **scales** in 2 rows on each side of midrib, median scales appendaged, laminal scales non – appendaged, midrib conspicous, rhizoids dense, dimorphic. Male/ Female receptacles not seen. **Gemma cups** present on dorsal surface, discoid, **gemmae** ovoid- spherical, biconvex, dentate at margins, vertically inserted.

Ecology & Distribution: plants growing on wet rocks (near water stream) and on soil covered rocks at Vanshri Vihar, Apsara Fall, Panchali Kund, Bee Fall and Irene Pool from 920-1015 m.

Range of Distribution: Afganistan, Bhutan, Borneo, China, India: central India (PBR), eastern Himalaya (Assam, Darjeeling, Manipur, Meghalaya), Gangetic plains (Uttar Pradesh, west Bengal), South India (Tamil Nadu), western Himalaya (Himachal Pradesh, Kashmir), Punjab & west Rajasthan plains (Punjab), Iran, Japan, Java, Korea, Myanmar, Nepal, Papua New Guinea, Pakistan, Philippines, Russia, Sumatra, Taiwan, Turkey, Vietnam, Yemen.

Specimens examined: India, Madhya Pradesh, Vanshri Vihar, alt. ca 1000 m, on rocks 18.12.1993, 205669 (LWG); leg. V. Nath & A.K. Asthana, Apsara Fall, alt. ca 920 m, on soil covered rocks, 07.11.2011 263137, 263139, 263142 (LWG); Panchali Kund, alt. ca 944 m, on rocks (near water stream), 07.11.2011, 263155 (LWG); Bee Fall, alt. ca 940 m, on moist rocks, 08.11.2011, 263199 (LWG); Irene Pool, alt. ca 1015 m, on wet rocks, 08.11.2011, 263811 (LWG). leg. A.K. Asthana & R. Gupta.

***Marchantia papillata* Raddi. subsp. grossibardba (Steph.) Bisch.,** Bryo. Biblio 38: 1989.

Basyn: *Marchantia hemispherica* L. in Spec. Plant. 1, Stockholm Laurent Salvi. 560 p. 1753.

Syn: *Marchantia linearis* Lehm. et Lindb., Lehman, Nov. Strip. Pug. 4: 8, 1832; Sp. Hep. 1: 187, 1900.

Syn: *Marchantia palmata* Nees., Nova Acta XII, p. 193.1824.

Plants dioicous, thalloid, golden green in medium patches, dichotomously branched. Thallus 15 - 30 mm long, 2 - 3 mm wide, midrib narrow, dark green, conspicuous, margin entire, undulate to wavy; dorsal surface smooth, **air pores** scarce, ± 85 µm in diameter, bordered by 5 - 6 rings of 4 - 6 cells each; **ventral surface** greenish- brown, scales present in 4 rows, 2 median rows of scales appendiculate with decurrent base, other two rows hyaline to purplish, orbicular with obtuse apex. Male/ Female receptacles not seen. **Gemma cups** at median region on dorsal surface near apex, margin toothed; **gemmae** oval rounded with a constriction on both surfaces towards middle.

Ecology & Distribution: plants growing on moist soil covered rocks and on rocks under shady conditions at Tamia (near Chota Mahadev), Down Fall, Jalgali, Jambu Dweep, near Bee Fall, on way to and at Apasra Vihar, Bada Mahadev, from 730-1075m.

Range of Distribution: Afghanistan, Bangladesh Bhutan, China, India: central India (PBR, Amarkantak), eastern Himalaya (Arunachal Pradesh, Darjeeling, Assam, Bengal, Khasia hills, Meghalaya, Nagaland, Sikkim), Gangetic plains (Uttar Pradesh, west Bengal), Punjab & west Rajasthan plains (Punjab), western Himalaya (Himachal Pradesh, Kashmir), South India (Tamil Nadu).

Specimens examined: India, Madhya Prades, PBR: near Chota Mahadev (Tamia), alt. ca 950 m, on soil covered rocks 19.12.1993. 205711, 205712, 205713 (LWG); Down Fall, alt. ca 1056 m, on rocks (near water stream), 15.12.1993 205548, 205550 (LWG); Jalgali, alt. ca 900 m. on rocks (near water), on soil over rocks, 16.12.1993, 205579, 205582 (LWG); Jambu Dweep, alt. ca 900 m, on soil over rocks, 17.12.1993, 205602 (LWG). leg. V. Nath & A.K. Asthana; near Bee Fall, alt. ca 822 m, on soil covered rocks, 30.11.2006, 227660 (LWG); Down Fall, alt. ca 884 m, on rocks, 28.11.2006, 227603A (LWG); on way to Apsara Vihar, alt. ca 734 m, on soil, 01.12.2006, 227693A (LWG). leg. V. Sahu & V. Awasthi; Bada Mahadeo, alt. ca 1075 m, on wet rocks, 08.11.2011, 264815 (LWG). leg. A.K. Asthana & R. Gupta .

Family: Dumortieraceae D.G. Long

Genus: *Dumortiera* Nees.

Plants thalloid, dark, dull green in overlapping patches. Thallus up to 100 mm long, 6-10 mm wide, dichotomously branched. Dorsal surface smooth, margin entire, smooth, ventral surface green, rhizoids dimorphic, midrib prominent, ventral scales simple, rarely seen. Thallus in cross section shows compactly arranged cells, air chambers absent, well developed storage zone. Female receptacles sessile.

***Dumortiera hirsuta* (Sw.) R. Bl. et Nees.** Nov. Act. Leop. Altcarol. 7: 410, 1824.

Plants dioicous, thalloid, dark, dull green in overlapping patches Thallus 40-100 mm long, 6-10 mm wide, dichotomously branched. Dorsal surface smooth, margin delicate, entire, smooth, ventral surface green, rhizoids dimorphic, midrib prominent, **ventral scales** translucent, simple, delicate, rarely seen. Thallus in cross section shows

thick 10-11 celled midrib passing gradually to lamina, compactly arranged cells, air chambers absent, papillate cells on the dorsal surface, well developed storage zone. **Female receptacles** sessile. Male receptacles and sporophyte not seen.

Ecology & Distribution: plants growing luxuriantly in large patches or rocks under dripping water at Tamia, on way to Chota Mahadeo, Down Fall, Jalgali, Jambu Dweep, Jatashankar, Mahadeo, Pathar Chatta, Chota Mahadev (Tamia), on way to Little Fall, Mahadeo Mandir, Chota Mahadev Mandir, Duchess Fall and Irene Pool from 730 - 1015.

Range of Distribution: Brazil, China, Europe, Hawaii, India: eastern Himalaya: (Arunachal Pradesh, Assam, Darjeeling, Jaintia hills, Khasia hills, west Bengal) central India, (PBR), South India (Madras, Kotigiri, Kerala), western Himalaya (Dalhousie, Lahaul, Pangi, Simla, Mussoorie, Kumaon), Indonesia, Jamica, Japan, Korea, Mexico, New Zealand, Philippines, Samoa, South Africa, Sri Lanka, United States.

Specimens examined: India: Madhya Pradesh, PBR: on way to Chota Mahadev (Tamia), alt. ca 1000 m, on soil, 10.10.1992, 205507, 205508, 205511, 205514, 205515, 205528 (LWG); Down Fall, on moist rocks, 15.12.1993, 205540, 205541, 205542, 205543 (LWG); Jalgali, alt. ca 900 m, on moist rocks, 16.12.1993, 205585, 205586A (LWG); Jambu Dweep, alt. ca 900 m, on rocks, 17.12. 1993, 205624A (LWG); Jatashankar, alt. ca 1000 m, on moist rocks, 17.12.1993, 205629 (LWG); Mahadeo, alt. ca 1000 m, on moist rocks, 17.12.1993, 205642 (LWG); Patthar Chatta, alt. ca 1000 m, on rocks, 18.12.1993. 205663, 205664A (LWG); Chota Mahadev (Tamia), alt. ca 950 m, on moist rocks, 19.12.1993, 205701, 205714, 205715 (LWG). leg. V. Nath and A.K. Asthana; on way to Little Fall, alt. ca 914 m, on moist rocks, 28.11.2006, 229388 (LWG); Mahadev Mandir, alt. ca 1006 m, on moist rocks, 24.11.2006, 227611 (LWG); Chota Mahadev Mandir, alt. ca 793 m, on wet rocks, 29.11.2006, 227639A (LWG); Duchess Fall, alt. ca 732 m, on moist rocks, 30.11.2006, 227675A (LWG). leg. V. Sahu and V. Awasthi; Irene Pool, alt. ca 1015 m, on wet rocks, 08.11.2011, 264808 (LWG). leg. A.K. Asthana & R. Gupta.

Family: Cyathodiaceae Grolle

Genus: *Cyathodium* Kunze.

Plants thalloid, dull brown, delicate, translucent, ± 6 mm long, ± 3 - 5 mm broad, dichotomously branched, fan shaped. Dorsal surface smooth, air chambers in

single row, pores bounded by 2 - 3 concentric rings, midrib absent, ventral surface flat, rhizoids smooth walled, ventral scales very few semilunar with purplish margin, hyaline, confined to apex. Involucre terminal. Capsule ovoid, dark brown.

***Cyathodium cavernarum* Kunze.,** Lehm., Pugillus 6: 17, 1844.

Plants monoicous, thalloid, dull brown, delicate, translucent, ± 3 - 6 mm long, ± 3 - 5 mm broad, dichotomously branched, fan shaped. **Dorsal** surface smooth, thin walled epidermal surface, air chambers in single row, pores bounded by 2 - 3 concentric rings of 4 - 5 cells each, midrib absent, ventral surface flat, rhizoids smooth walled, **ventral scales** very few semilunar with purplish margin, hyaline, confined to apex. Antheridia not seen. **Involucre** present near margin at apex, globose, rim of the involucres bordered by 2 - 3 rows or thick walled brownish cells. **Capsule** ovoid, dark brown; **spores** spherical, dark brown, 52 - 56 µm in diameter with spinose- baculate ornamentation; **elaters** up to 561 µm with bi-spiral thickening bands.

Ecology & Distribution: plants growing on soil and soil covered rocks in damp places at Rajakhoh (Patalkot), Tamia (near Chota Mahadev), Police Training School and Jatashankar, from 400-990 m.

Range of Distribution: Africa, Burma, Brazil, China, Cuba, India: central India (Amarkantak, Gujarat, PBR), eastern Himalaya (Assam, Darjeeling, Khasia & Jaintia hills, Shillong), Punjab & Rajasthan plains, Gangetic plains (Bareilly, Lucknow, Pratapgarh, Varanasi), South India (Bombay, Khandala, Mahabaleshwar, Malabar hills, Panchgani), western Himalaya (Dehra Dun, Gumkhal, Karn Prayag, Mussoorie, Salkuli), Java, Mexico, Oman, UAE, United States.

Specimens examined: India, Madhya Pradesh, PBR: Patalkot (near Rajakhoh), alt. ca 400 m, on soil, 06.10.1992, 205467, 205468, 205469 (LWG); Chota Mahadev (Tamia), alt. ca. 953 m on soil, 11.10.1992, 205518, 205527 (LWG). leg. V. Nath & A.K. Asthana; near Police Training School, alt. ca 914 m, on soil covered rocks, 28.11.2006, 229381B (LWG). leg. V. Sahu & V. Awasthi; Jatashankar, alt. ca 986 m, on moist rocks 29.11.2011, 264830, 264831, 264832 264833 (LWG). leg. A.K. Asthana & R. Gupta.

Family: Targioniaceae Dumort.

Genus: *Targionia* Linn.

Plants thalloid, dull brownish-green thallus, up to 18 mm long, 2 - 4 mm broad, dichotomously branched. Dorsal surface smooth, margin entire, simple pores, ventral surface purplish, scales delicate, purplish with small appendage in some cases. Involucre dark boat shaped near apex on ventral surface; spores dark brown.

***Targionia hypophylla* L.** Spec. Plant. 1604, 1753.

(Plate VIII: Figs. D-F)

Plants dioicous, thalloid, dull brownish-green thallus, 7 - 15 mm long, 2 - 3 mm broad, dichotomously branched in some cases. **Dorsal surface** smooth, margin entire, simple pores with 3 - 4 concentric rings of 6 cells each, ventral surface purplish, **scales** delicate, purplish, delicate with small appendage in some cases. Male plants not seen. **Involucre** dark boat shaped near apex on ventral surface; **spores** dark brown, 60 - 68 µm in diameter, sporoderm reticulate minutely on distal face, irregular lamellae on proximal face; elaters 170 - 300 µm long, usually 2 thickening bands.

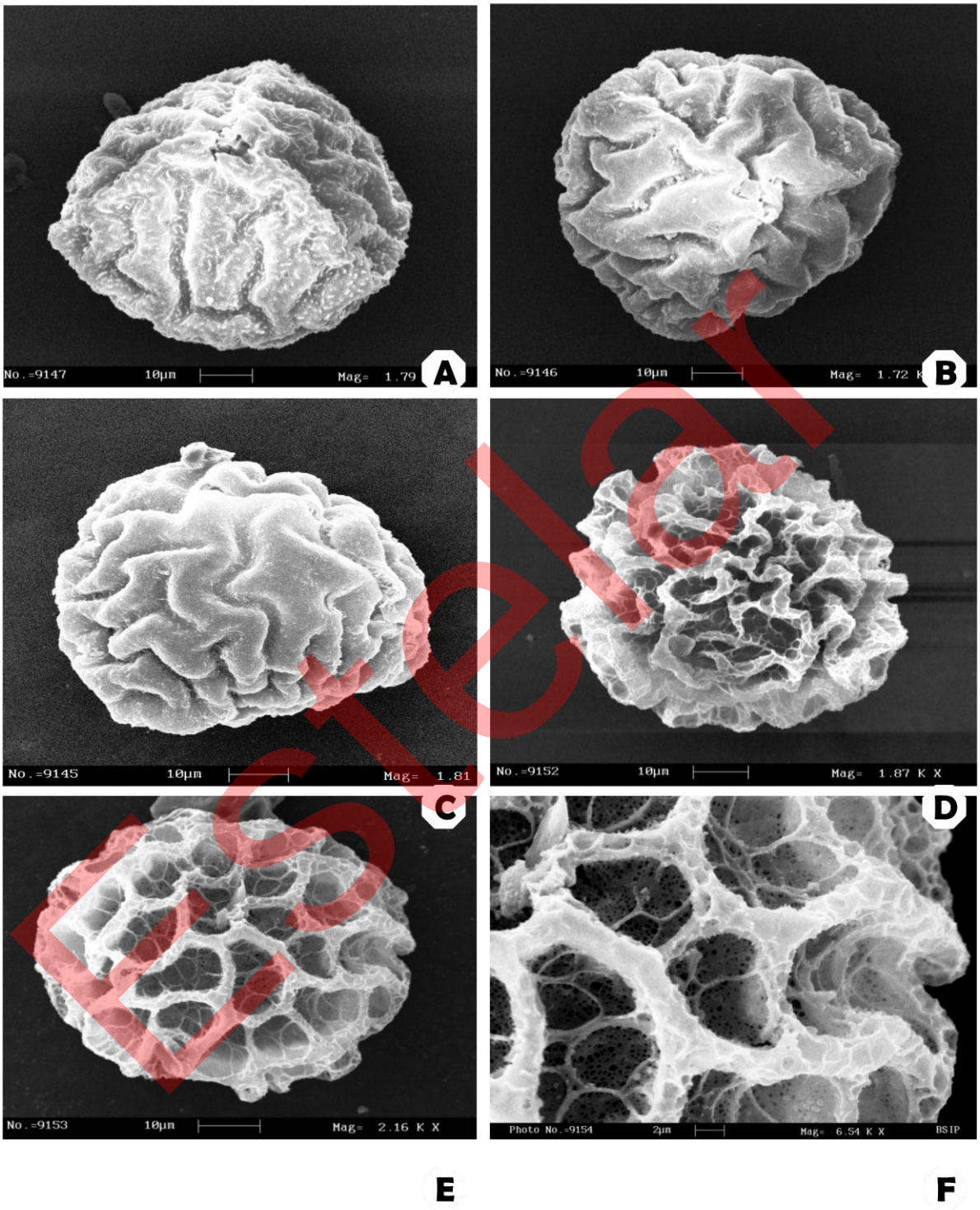
Spores under SEM: spores spherical to subspherical with prominent equatorial wing, sporoderm perfectly reticulate with up to 6 or more reticulations across the diameter, characteristically exhibits gradation of mesh forming small and large reticulations. The luminae exhibit small and thin mesh within, while ridge forming the ridge forming lumens also possess reticulate surface. Proximal face exhibits rather irregularly formed reticulations.

Ecology & Distribution: plants growing over soil covered rocks under exposed conditions at Rajakhoh (Patalkot) and Tamia (near Chota Mahadev) and Down Fall from 400 to 1056 m.

Range of Distribution: Africa, Australia, Chile, China, Ecuador, Europe, Hawaii, India: eastern Himalaya (Darjeeling, Cherrapunji, Khasia hills, Sikkim), central India (Amarkantak, Mt. Abu, PBR), South India (Lonavala, Khandala, Panchgani, Mahabaleshwar, Madras, Mysore, Victoria Falls), western Himalaya (Mussoorie, Dalhousie, Shimla), Japan, Korea, New Zealand, Madagascar, Mexico, Peru, Taiwan, Tasmania

Specimens examined: India, Madhya Pradesh, PBR: Rajakhoh (Patalkot) alt. ca 400 m, 6.10.1992. 205472, 205480 (LWG); Chota Mahadev (Tamia), alt. ca 953 m,

PLATE- VIII



Figs. A-C. *Asterella wallichiana* (Lehm. et Lindb.) Grolle: A. proximal view of spore, B,C. distal view, of spore, Figs.E-G. *Targionia hypophylla* L.: D. proximal view of spore, E. distal view of spore, F. enlarged distal view of spore.

11.10.1992, 205526 (LWG); Down Fall, alt. ca 1056 m, on rocks, 15.12.1993, 205544 (LWG); Chota Mahadev (Tamia), alt. ca 950 m, on soil over rocks, 19.12.1993, 205709 (LWG). leg. V. Nath & Asthana.

Family: Ricciaceae Dumort.

Genus: *Riccia* L.

Plants thalloid, forming incomplete rosettes to slender ribbon like mats, green, 6-14 mm long. Thallus thin to broad, flat to convex on ventral side, margin wavy, entire, geen or purple, thallus with distinct assimilatory and storage zones, ventral scales small, semilunar, in one row on each side of midrib; rhizoids dimorphic. Sporogonia in 1 - 2 rows, sunken inside the tissue of thallus on dorsal side; spores dark brown, in diameter.

Key to the species of *Riccia* at PBR:

1. Plants in incomplete rosettes, green, 6-14x1.5-2.5 mm in size ……..…….…….. ***Riccia billarderi***

   Plants delicate, thin and long strap shaped, yellowish green to light green, 4 - 8 x 0.5-1mm in size ……..……..…….…… ***Riccia fluitans***

***Riccia billardieri* Mont. et Nees.**, Syn. Hep.: 602, 1844-1847.

Plants monoicous, thalloid, forming incomplete rosettes, green, 6-14 mm long, 1.5 - 2.5 mm broad. Thallus broad, convex on ventral side, margin wavy, entire, purple, cross section shows distinct assimilatory and storage zones, **ventral scales** small, semilunar, in one row on each side of midrib; rhizoids dimorphic. **Sporogonia** in 1 - 2 rows, sunken inside the tissue of thallus on dorsal side; **spores** dark brown, 80 - 120 µm in diameter, reticulate (13 - 15 reticulations) tri-radiate mark inconspicuous. Male receptacles not seen.

Ecology & Distribution: plants growing on soil near the river bank at Batka Khapa, 600 m.

Range of Distribution: India: central India (Mt. Abu, PBR, Sagar), eastern Himalaya (Darjeeling, Gauhati, Kamakhya hills, west Bengal hills), Gangetic plains (Uttar Pradesh), Punjab & Rajasthan plains (Aravallis), South India (Maharashtra, Karnataka:

Agumbe, Mangalore, western Ghats), western Himalaya (Garhwal, Nainital, Pauri), Indonesia, Pakistan, Sri Lanka.

Specimens examined: India, Madhya Pradesh, PBR: Balka Khapa, alt. ca 600 m, on soil, 05.10.1992, 205462 (LWG). leg. V. Nath & A.K. Asthana.

***Riccia fluitans* L.**, Spec. Plant. : 1139, 1753.

Plants monoicious, thalloid, delicate, thin, yellowish - light green, 4 - 8 mm long, 0.5 - 1 mm broad, dichotomously branched. Thallus slightly biconvex to flat in cross section with large air spaces. **Dorsal surface** smooth, grooved at apex, ventral surface devoid of scales, rhizoids hyaline. Male receptacles absent. **Involucre** globose, sessile, deep brown; spores golden – brown, ± µm in size, broadly reticulate.

Ecology & Distribution: plants growing on extremely wet soil under shade at FRH market Road (near New Hotel) and Bada Mahadev from 1056-1075 m.

Range of Distribution: Antarctica, Australia, Austria, Brazil, Cameroon, Canada China, Denmark, France, Germany, Hungary, India: central India (Mt. Abu, PBR), eastern Himalaya (Assam, Sikkim), South India (Nilgiris, Madras), western Himalaya (Garhwal, Kashmir, Kumaon), Ireland, Italy, Jamaica ca, Japan, Netherland, New Zealand, Norway, Paraguay, Poland, Portugal, Romania, Russia, Spain, Sweden, United Kingdom, Unites States.

Specimens examined: India, Madhya Pradesh, PBR: near New Hotel (FRH Market Road), alt. ca 1056 m, on extremely wet soil 15.12.1993. 205534 (LWG), Mahadeo, alt. ca. 1000 m, on wet rocks, 17.12.1993. 205632, 205634, 205644, (LWG). leg. V. Nath & A.K. Asthana; Bada Mahadev, alt. ca 1075 m, on moist rocks, on moist soil covered rocks, 08.11.2022, 264818, 264820 (LWG). leg. A.K. Asthana & R. Gupta.

V. ORDER: ANTHOCEROTALES LIMPR.

Key to the families of Anthocerotales at PBR:

1. Thallus spongy with mucilage chambers, spores dark brown …….. **Anthocerotaceae**

   Thallus compact with out mucilage chambers, spores yellowish- light brown ……..……. **Notothyladaceae**

Family: Anthocerotaceae (Gray) Trevisan em. Bharad.

Genus: *Anthoceros* L.

Plants thalloid, dark green, fan shaped with lobes, up to 12 mm wide, spongy. Dorsal surface smooth, mucilage chambers present. Involucre long, mouth narrow; capsule wall has stomata, spores dark brown, spinulate.

***Anthoceros bharadwajii* Udar *et* Asthana,** Proc. Indian Nat. Sci. Acad. B 51(4): 484, 1985.

(Plate IX: Figs. A-B)

Plants dioicous, thalloid, dark green, fan shaped with lobes, up to 10 mm wide, spongy. **Dorsal surface** smooth, mucilage chambers seen along the margin. Male plants not seen. **Involucre** ± 3 mm long, mouth narrow; capsule wall has stomata, stoma ± 65 µm long, up to 50 µm wide, guard cells reniform; **spores** dark brown, 35 - 45 µm in size, spinulate projections forming reticulate pattern, proximal face has triradiate mark; pseudoelaters light brown, up to 120 µm long, 4 celled, rarely branched.

Spores under SEM: spores nearly spherical, sporoderm exhibits reticuloid pattern having spinulate and blunt projections all over the distal face.

Ecology & Distribution: plants growing luxuriantly on soil covered rocks under moist conditions at Tamia, 1000 m.

Range of Distribution: India: central India (Amarkantak, Mt. Abu, PBR), eastern Himalaya (Darjeeling, Elephant Fall, Mao, Shillong peak, Ukhrul), South India (Devicolam, Kerala, Munnar, Murukkady, Naduvattam, Periavurrai, Trichur), western Himalaya (Deoban, Nainital, Pauri).

Specimens examined: India, Madhya Pradesh, PBR: Tamia, alt. ca 1000 m, 10.10.1992. 205488 (LWG). leg. V. Nath & A.K. Asthana.

Family: Notothyladaceae Hyvoven & Pippo

Genus: *Phaeoceros* Prosk.

Plants thalloid, dark green, deeply lobed, ± 14 x 10 mm in size, non-spongy. broader towards apex, narrower at base. Dorsal surface smooth, androecial chambers scattered irregularly; rhizoids present on ventral surface. Involucres cylindrical, 2 - 4 mm, compact, narrower at mouth; capsule wall has stomata; spores yellowish-dull green.

Key to the species of *Phaeoceros* at PBR:

1. Plants monoicous **2**
   Plants dioicous **3**
2. Proximal face of spore with thin tri-radiate mark, bordered by tubercles in form of stripe ..... ***P. carolinianus***
   Proximal face of spores with lamellate markings on sporoderm, small clusters of minute papillae on each tri-radiate face ..... ***P. kashyapii***
3. Stomata on capsule wall smaller, 56-84 x 33-56 µm, pseudoelaters with smooth surface ..... ***P. laevis***
   Stomata on capsule wall larger, 90-100 x 50 µm, pseudoelaters with papillate surface ..... ***P. udarii***

***Phaeoceros carolinianus* (Michx.) Prosk.** Bull. Torrey Bot. Club. 78. 347: 1951.

Basyn: *Anthoceros carolinianus* Michx., Fl. Bor. Amerialt. ca 2: 280, 1803.

(Plate IX: Figs. C-E)

Plants monoicous, thalloid, dark green, deeply lobed, ± 12 x 10 mm in size, broader towards apex, narrower at base, **Dorsal surface** smooth, androecial chambers scattered irregularly; rhizoids present on ventral surface. **Involucres** cylindrical, 2 - 4 mm, compact, narrower at mouth; **capsule** wall has stomata, up to 80 x 40 mm in size, two reniform guard cells; **spores** yellowish-dull green, ± 35 µm in diameter, sporoderm papillate, triradiate mark on proximal face; preudoelaters yellowish-brown, up to 150 µm long, irregular thickening bands present.

Spores under SEM: spores show prominent equatorial crossitudo, sporoderm papillate to minutely spinulate having scattered to densely arranged papillae with acute apices,

proximal face with thin but prominent tri-radiate rays aligned to papillae along the rays. A small cluster of papillae is seen on each tri-radiate area.

Ecology & Distribution: plants growing over soil covered rocks, over wet rocks and on soil in moist conditions at Chota Mahadev (Tamia), near new Hotel, Down Fall, Jambu Dweep, Mahadeo caves, Rajakhoh (Patalkot), Mahadev Mandir, near Bee Fall, Apsara Fall and Bee Dam area from 400-1056 m.

Range of Distribution: Antarctica, Australia, Belize, Bhutan, Brazil, Costa Rica, Czech Republic, Denmark, Europe, French Polynesia, Japan, Nepal, India: central India (Amarkantak- Achanakmar, Mt. Abu, PBR), eastern Himalaya (Darjeeling, Gangtok, Manipur, Ray valley Road, Sikkim, Teesta valley), South India (Kodaikanal), Indonesia, Italy, Jamaica, Japan, Mexico, Netherland, New Caledonia, New Zealand, Norway, Papua New, Guinea, Portugal, Puerto Rico, Romania, Russia, Spain, Sri Lanka, Sweden, Switzerland, Thailand, United Kingdom.

Specimens examined: India, Madhya Pradesh, PBR: Tamia valley, alt. ca 1000 m, on soil, 10.10.1992, 205503 (LWG); Chota Mahadev (Tamia) alt. ca 953 m, on soil, 11.10.1992, 205524 (LWG); near new Hotel (FRH Road), alt. ca 1056 m, on soil (at sides of Nallah), 15.12.1993, 205531, 205536; 205538 (LWG); Down Fall, alt. ca 1056 m, on moist rocks, 15.12.1993, 205550, 205553 (LWG); Jambu Dweep alt. ca 900 m, on soil over rocks, 17.12.1993, 205623A (LWG); Mahadev caves, alt. ca 1000 m, on extremely wet rocks, 17.12.1993, 205635, 205638B, 205640, 205643 (LWG); Chota Mahadev (Tamia), alt. ca 950 m, on soil covered rocks, 19.12.1993, 205708 (LWG); Rajakhoh (Patalkot), alt. ca 400 m, on rocks, 20.12.1993, 205727, 205730 (LWG). leg. V. Nath & A.K. Asthana; Down Fall, alt. ca 884 m, on rocks, 28.11.2006, 227605A (LWG); Mahadev Mandir, alt. ca 1006 m, on wet rocks, 28.11.2006, 227609 (LWG); on way to Mahadev Mandir, alt. ca 1006 m, on rocks, 28.11.2006, 227615A (LWG). on way to Chota Mahadev, alt. ca 793 m, on rocks, 29.11.2006, 227634 (LWG); on way to Bee Fall, alt. ca 823 m, on wet rocks, 30.11.2006, 227666A (LWG); Apsara Fall, alt. ca 734 m, on moist rocks, 01.12.2006, 227700 (LWG). leg. V. Sahu & V. Awasthi; Bee Dam, alt. ca 976 m, on wet soil, 08.11.2011, 263192 (LWG); Bada Mahadev, alt. ca 1075 m, on soil covered rocks, 08.11.2011, 264816 (LWG). leg. A.K. Asthana & R. Gupta.

***Phaeoceros kashyapii* Asthana et Sriv.** Bryophyt. Biblioth. Band 42: 129, 1991.

Plants monoicous, thalloid, light green, lobed, ± 6 - 4 mm in size, broader above, narrower at base, compact. Male receptacles not seen. **Involucre** cylindrical, smooth, ± 3 mm long; capsule wall stomatiferous, stoma surrounded by 2 reniform guard cells. **Spores** yellowish green, 37 - 40 µm in diameter, sporoderm with lamellate projections, prominent tri-radiate mark on proximal face; pseudoelaters pale to light brown, smooth, 70 - 100 µm long.

Ecology & Distribution: plants growing on soil covered rocks under moist conditions on way to Rajakhoh, 400 m.

Range of Distribution: India: central India (PBR) western Himalaya (Deoban, Vyas Shikhar).

Specimens examined: India, Madhya Pradesh, PBR: on way to Rajakhoh (Patalkot), alt. ca 400 m, 06.10.1992. 205475 (LWG) leg. V. Nath & A.K. Asthana.

***Phaeoceros laevis* (L.) Prosk.,** Bull. Torrey Bot. Club 78: 347, 1951.

Basyn: *Anthoceros laevis* Linn. Spec. Plant 2: 1139, 1753.

(Plate IX: Figs. F-G)

Plants dioicous, thalloid, light to dark green, branched, up to 11 x 10 mm in size, deeply lobed, wider at apex, margin entire, wavy. Male plants not seen. **Involucre** cup shaped, cylindrical, 2 - 6 mm long, mouth wide; smooth; **capsule** wall with stomata, 50 - 75 x 40 µm in size; surrounded by two reniform guard cells; **spores** yellowish green, spherical, ± 45 µm in diameter, sporoderm papillate, distinct tri-radiate mark on proximal surface; pseudoelaters light brown, 4 celled, up to 168 µm long.

Spores under SEM: sub-spherical with equatorial crossitudo, sporoderm minutely papillate to spinulate with acute apexed spines all over the surface on distal face.

Ecology & Distribution: plants growing on base rocks near water stream and on soil covered rocks at Chota Mahadev (Tamia), near Police Training School and Jambu Dweep from 914 - 1000 m.

Range of Distribution: Antarctica, Antilles, Australia, Belgium, Bonin, Brazil, Bulgaria, Canada, China, Coimbra, Cyprus, Czech Republic, Ecuador, France, Germany, Greece, Guatemala, Honduras, Iceland, India: central India (AABR, PBR), eastern Himalaya (Manipur, Mongpo, Nathula road, Sikkim, Ukhrul), South India

(Mahabaleshwar, Mukurty, Kodaikanal, Shembaganur, Devicolam, Vagavurrai, Mysore), Japan, Iran, Ireland, Israel, Italy, Japan, Lebanon, Madrid, Malta, Mauritius, Mexico, Moldova, Morocco, Nepal, Nicaragua, Pakistan, Papua New Guinea, Peru, Philippines, Poland, Pompeii, Portugal, Reunion, Romania, Russia, South Africa, Spain, Sri Lanka, Sweden, Switzerland, Taiwan, Turkey, Ukraine, United Kingdom, United States, Venezuela, Yemen.

Specimens examined: India, Madhya Pradesh, PBR: Jambu Dweep, alt. ca 1000 m, on rocks, 17.12.1993, 205624B (LWG); Chota Mahadev (Tamia), alt. ca 950 m, on rocks, 19.12.1993. 205687 (LWG). leg. V. Nath & A.K. Asthana; near Police Training School, alt. ca 914 m, on soil covered rocks, 28.11.2006, 229381A (LWG). leg V. Sahu & V. Awasthi.

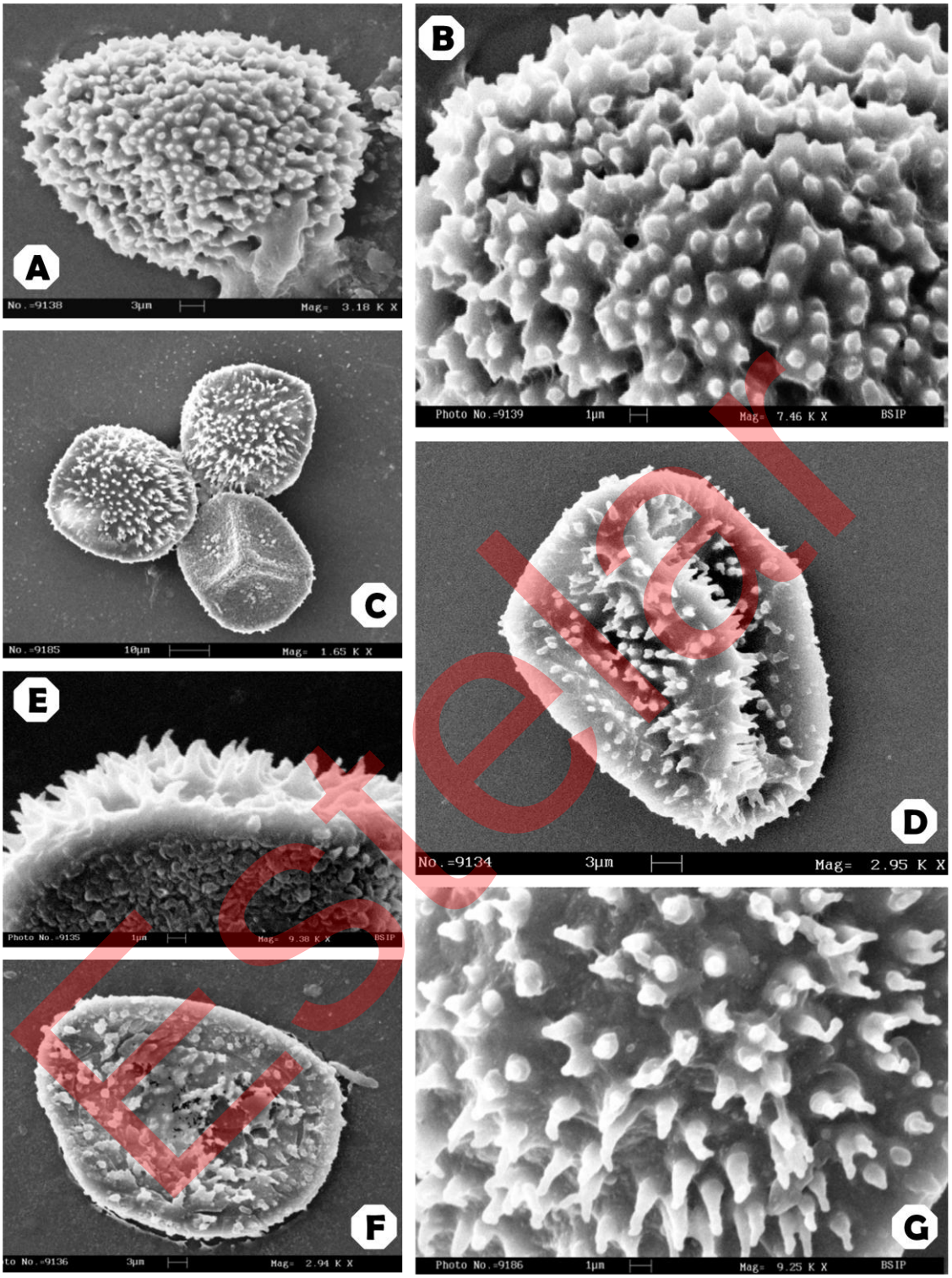
***Phaeoceros udarii* Asthana et Nath,** Proc. Nat. Acad. Sci. India 63(B) IV: 461 – 464, 1993.

Plants thalloid, dull green in patches, broader above, narrow at base, broader above, compact. Male receptacles not see. **Involucre** smooth, ± 3.2 mm capsule long, wall 5 – 6 layers thick, stomata ferrous, stoma guarded by 2 reniform guard cells. **Spores** light green, ± 37 µm in size, sporoderm minutely papillate; prominent tri-radiate mark on proximal face; pseudo elaters dull brownish, 90 – 120 µm long.

Ecology & Distribution: plants growing on soil over rock at Jambu Dweep, 900 m.

Range of Distribution: India: central India (PBR), western Himalaya (Mussoorie).

Specimens examined: India, Madhya Pradesh, PBR: Jambu Dweep, alt. ca 900 m, on soil over rock, 17.12.1993, 205606 (LWG). leg. V. Nath & A.K. Asthana.



Figs. A,B. *Anthoceros bharadwajii* Udar *et* Asthana: A. spore, B. enlarged view of spore, C-E. *Phaeoceros carolinianus* (Michx.) Prosk.: C. group of spores (pv=proximal view of spore), D. distal view of spores, E. enlarged view of spore surface, Figs. F,G. *Phaeoceros leavis* Prosk.: G. spore, F. enlarged proximal view of spore.