Contribution to the bryoflora of Great Himalayan National Park, Kullu, Himachal Pradesh IV: Genus *Porella* (Porellaceae)

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Eleven species of the genus *Porella* L. have been described from the Great Himalayan National Park, Kullu, Himachal Pradesh. *Porella hattorii* Udar & Shaheen and *Porella variabilis* (Kashyap) Kachroo are new records for the state of Himachal Pradesh. A conspectus of the species under the genus in India has been provided.

Key-words *– Porella,* Porellaceae, bryoflora, Great Himalayan National Park.

THE genus *Porella* L. is represented by about 100 species distributed throughout the world except for the Arctic and Antarctic regions (Schuster, 1980). In India, the genus is represented by *ca* 27 species including infraspecific taxa, of which 20 taxa occur in the western Himalaya. So far only three species, viz. *Porella ceaspitans* (Steph.) Hatt., *Porella gracillima* Mitt. and *Porella madagascariensis* (Nees & Mont.) Trevis. were reported from Great Himalayan National Park (Narayan et al., 2001; Singh & Singh, 2003). Present study records 11 species of *Porella* from the Park area which adds eight species more to the Park area, including two species, viz.. *Porella hattorii* Udar and Shaheen and *Porella variabilis* (Kashyap) Kachroo new for Himachal Pradesh. The last species has been recorded for the first time since Kashyap and Chopra's (1932) original description from Mussoorie in Uttaranchal.

MATERIAL AND METHOD

Plant specimens were collected from the Great Himalayan National Park and its adjoining areas in Kullu district, Himachal Pradesh particularly during 2001 to 2003, and are deposited in Cryptogamic section of the herbarium of Botanical Survey of India, Northern Circle, Dehradun (BSD) and Central National Herbarium, Botanical Survey of India, Howrah (CAL). For histo-morphologial study dried herbarium specimens were soaked in tap water for about two hours to stretch them to their original shape. External morphology has been studied under a stereoscopic binocular microscope. Hand sections and dissected parts of the plants were mounted in 30 per cent aqueous glycerin and anatomical features were studied under a compound microscope. All the illustrations have been made with the help of prism-type camera lucida. All plant parts were measured along their maximum length and width. In each case the measurements were taken as an average of at least twenty counts with the help of ocular micrometer and stage micrometer of Erma, Japan make. While recording the dimensions the first figure represents its measurement along the longitudinal axis of the structure to which it belonged and second represents the same along the perpendicular axis.

Key to the species of *Porella* from Great Himalayan National Park

1. Leaf lobes with entire margins.....2
1 Leaf lobes with dentate margins.....7
2. Leaf lobes with recurved margins.....3
2. Leaf lobes with flat or crispate margins.....6
3. Lobules large, widely ovate, flat.....8. *P. obtusata* var. *macroloba*
3. Lobules small, triangular, with recurved apex.....4
4. Underleaves oblong-ovate, with short basal appendages.....5. *P. gracillima*
4. Underleaves widely ovate, without short basal appendages.....5

5. Underleaves recurved at apex, dentate at base; plants green; shoots 1.5-2.0 mm wide.....9. *P. platyphylla*
5. Underleaves recurved along margin, entire at base; plants light green to olive brown; shoots 2.1.2.6 mm wide .....4.*P. decurrens*
6. Margins of leaf lobes, lobules and underleaves not crispate.....7. *P. madagascariensis*
6. Margins of leaf lobes, lobules and underleaves crispate.....3. *P. chinensis*
7. Leaf lobules equal to underleaves in size.....8
7. Leaf lobules smaller than underleaves in size.....9
8. Apex of leaf lobe acute-acuminate; leaf margin with 1-4 teeth up to 5 cells long ...1. *P. caespitans*
8. Apex of leaf lobe rounded or sub truncate; leaf margin with 3-10 teeth up to 9 cells long .....2. *P. campylophylla*
9. Cortical cells in 1-2 rows in cross section of stem; leaf lobes at apex usually rounded or sub acute or very rarely acute with 1-2 tooth..... 11. *P. variabilis*
9. Cortical cells more than 2 rows in cross section of stem; leaf lobes at apex either acute, 2-(-3)-toothed or widely rounded and irregularly 2-5-tooth.....10
10. Cortical cells in 3-4 rows in cross section of stem; leaf lobes oblong; underleaves triangular with truncate apex.....6. *P. hattorii*
10. Cortical cells in 2-3 rows in cross section of stem; leaf lobes ligulate to ovate; underleaves oblong-rectangular with rounded and entire apex.....10. *P. plumosa*

TAXONOMIC DESCRIPTION

1. *Porella caespitans* (Steph.) S.Hatt. in J. Hattori Bot. Lab. 33: 50. 1970. *Madotheca caespitans* Steph. in Mem. Soc. Sci. Nat. Cherbourg 29: 218. 1894 & Sp. Hep. 4: 310. 1910.

Plate 1 Figs. 1-10.

Plants yellowish green to pale brown; shoots 50-80 mm long, 4-5 mm wide pinnately or bipinnately branched; stem in cross section 15-26 cells across; cortical cells in 3-4 rows, thick-walled; medullary cells thin-walled. Leaves imbricate, widely spreading; leaf lobes ovate, 1.8-2.8 mm long, 0.9-1.6 mm wide, apex acute or apiculate, often with 1-2 (-4), small additional teeth, margins widely arched-rounded at base dorsally, more or less undulate-incurved and nearly straight ventrally; middle leaf cells subquadrate-polygonal, 16.3-32.6 x 12.2-24.5 mm; trigones triangular, small-medium sized; leaf lobules slightly obliquely spreading, long ligulate, a little narrower than stem, 0.8-1.2 mm long, 0.3-0.5 mm wide, apex obtuse, lateral margins nearly straight, often narrowly recurved, more or less lobate, long decurrent at base. Underleaves about twice as wide as stem, more or less appressed to the stem, ligutate, 0.8-1 mm long, 0.5-0.7 mm wide, margin entire, lateral margins usually narrowly recurved, apex obtuse acute or truncate, base auriculate on both side. Androecia and gynoecia not seen.

Habitat: Terrestrial or epiphytic, grows in moist places in association with other species of the genus together with *Frullania retusa, F. muscicola, Plagiochila parvifolia, Radula grandifolia, Scapania parva*, etc.

Type locality: China.

Distribution: India [Western Himalaya: Himachal Pradesh (Chamba, Great Himalayan National Park), Uttaranchal], Bhutan (Long & Grolle, 1990), China (Hattori, 1970; Piippo, 1990), Thailand (Hattori, 1976).

Specimens examined: Sainj valley: Neuli - Bah, 25.05.2002, *S.K. Singh* 99590b; Shakti- Maror, 28.05.2002, *S.K. Singh* 99738b; Shakti - Bah, 31.05.2002, *S.K. Singh* 99572; Bah - Neuli, 01.06.2002, *S.K. Singh* 99754; Ropa (*ca* 1400 m), 26.09.2003, *S.K. Singh* 104431; Tirthan valley: Rolla (*ca* 2100m), 01.08.1999, *P.V. Karunakaran*, 99977; Rolla - Basu (*ca* 2400 m), 12.09.2001, *D.K. Singh & S.K. Singh* 99141b, 99151b, 99153, 99156b, 99157a; Kharongcha, 26.09.2003, *S.K. Singh* 104448b.

2. *Porella campylophylla* (Lehm. & Lindenb.) Trevis. in Mem. Reale. Ist. Lombardo Sci. Ser. 3, 4: 408. 1877. *Jungermannia campylophylla* Lehm. & Lindenb. in Lehm., Nov. Strip. Pugillus 6: 40. 1834.

Plate 1; Figs. 11-23.

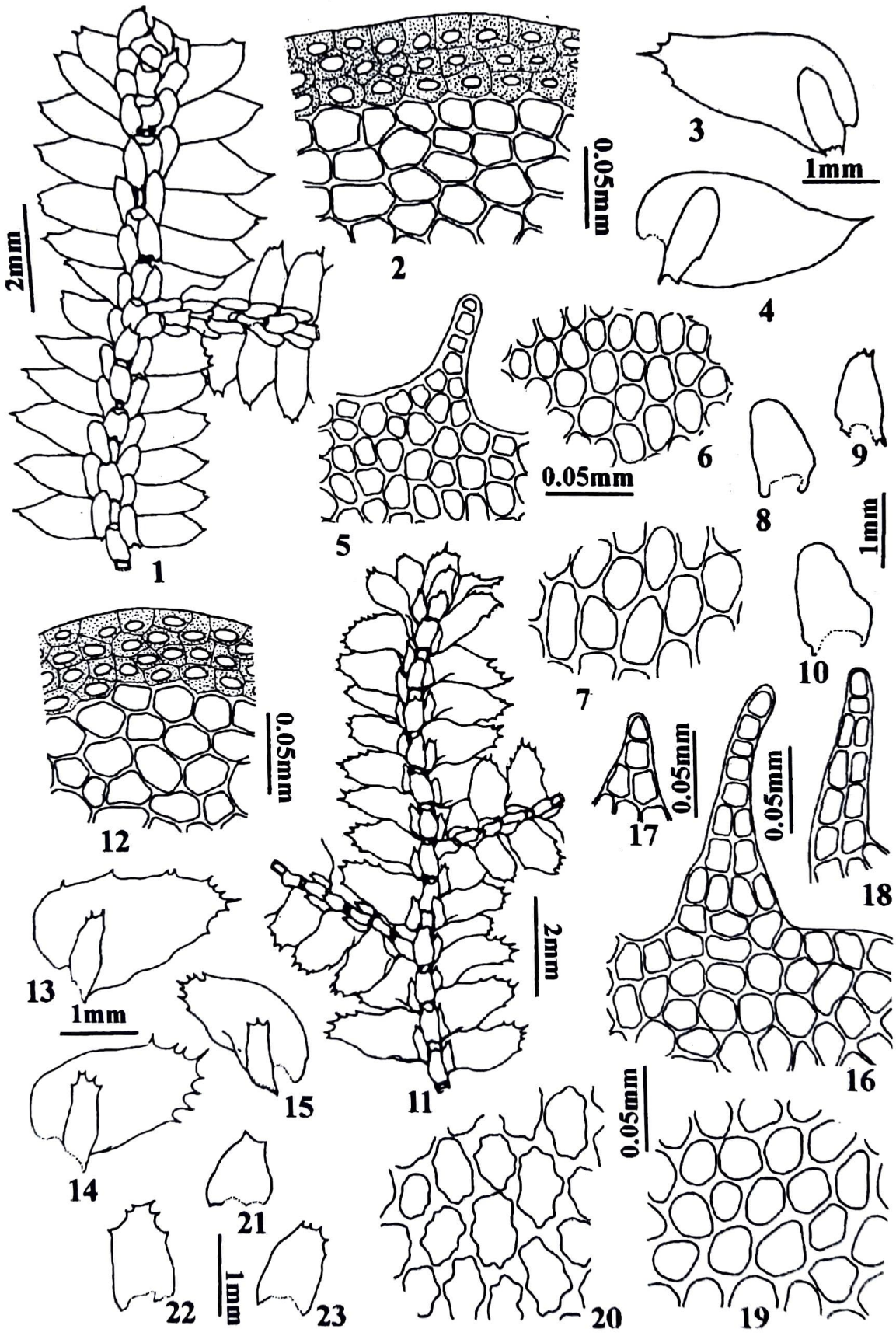

PLATE - 1

Figs. 1-10. *Porella caespitans* (Steph.) S.Hatt. : 1. A portion of plant (ventral view). 2. T.S. stem (a part). 3,4. Leaf lobes with lobule. 5. Marginal cells of leaf lobe towards apex. 6. Median cells of leaf lobe. 7. Basal cells of leaf lobe. 8-10. Underleaves. **Figs. 11-23.** *Porella campylophylla* (Lehm. & Lindenb.) Trevis.: 11. A portion of plant (ventral view). 12. T.S. stem (a part). 13-15. Leaf lobes with lobule. 16. Marginal cells of leaf lobe towards apex. 17,18. Teeth on margin of leaf lobe. 19. Median cells of leaf lobe. 20. Basal cells of leaf lobe. 21-23. Underleaves.

Plants light green to brownish green; shoots 40-70 mm long, 3-5 mm wide, pinnately branched; stem in cross section 14-20 cells across; cortical cells in 2-4 rows, thick-walled; medullary cells thin-walled. Leaves incubous, densely imbricate; leaf lobes usually ovate to oblong-ovate, 1.4-2.2 mm long, 0.9-1.3 mm wide, apex sub truncate, rounded, obtuse or acute, usually with 3-10 sharp teeth, occasionally entire; middle leaf cells polygonal, 20.4-44.8 x 16.3-32.6 mm; trigones nodulose-bulging; leaf lobules lanceolate or ligulate, 0.45-1.1mm long, 0.2-0.49 mm wide, apex obtuse, acute to acuminate or sometimes slightly notched, often with 1-4 small teeth, base longly decurrent, narrowly incurved, usually entire or sometimes more or less crispate, few branches with very small leaf lobules. Underleaves oblong-ovate, 0.49-1.2 mm long, 0.4-0.7 mm wide, apex obtuse, truncate or sometimes acute, with 1-4 small teeth, base longly decurrent, narrowly incurved, entire or sometimes crispate or irregularly laciniate. Androecia and gynoecia not seen.

Habitat: Terrestrial, grows on rock surface over thin layer of soil in moist and shady places in association with *Lejeunia flava, Radula obscura, Frullania retusa, Plagiochila parvifolia, Metzgeria lindbergii* and other species of the genus *Porella*.

Type locality: Nepal.

Distribution: India [Western Himalaya: Himachal Pradesh (Great Himalayan National park - present study), Uttaranchal; Eastern Himalaya: West Bengal (Darjeeling), Sikkim, Arunachal Pradesh, Meghalaya; Western Ghats: Tamil Nadu], Nepal (Hattori, 1966, 1969), Bhutan (Long & Grolle, 1990), China (Hattori, 1975, 1978; Piippo, 1990), Thailand (Hattori, 1976), Myanmar (Hattori, 1978), Vietnam (Pócs, 1968).

Specimens examined: Tirthan Valley: Kharongcha - Rolla (*ca* 1950 m), 11.09.2001, *D.K. Singh & S.K. Singh* 99132b; Rolla - Basu (*ca* 2400 m), 12.09.2001, *D.K. Singh & S.K. Singh* 99147c; Rolla (*ca* 2000 m), 27.09.2003, *S.K. Singh* 104457d. Jalori Pass - Sareusar Lake, 03.06.2002, *S.K. Singh* 99763; Jalori Pass - Shoza, 04.06.2002, *S.K. Singh* 99779. W. Bengal, Darjeelmg (Tonglu), 24.04.1965, *S. Chandra and V. Nath* 10f /1965 (LWU).

3. *Porella chinensis* (Steph.) S.Hatt. in J. Hattori Bot. Lab. 30: 131. 1967. *Madotheca chinensis* Steph., Mem. Soc. Sci. Nat. Math. Cherbourg. 29: 218. 1894 & Sp. Hep. 4: 295. 1910.

Plate 2; Figs. 1-12.

Dioecious. Plants olive green to brown; shoots 40-50 mm long, 2.5-3.5 mm wide, densely bipinnately branched; stem in cross section 14-18 cells across; cortical cells in 2-3 rows, thick-walled; medullary cells thin-walled. Leaves incubous, densely imbricate; leaf lobes ovate, 1.1-1.7 mm long, 0.9-1.2 mm wide, margin entire, highly crispate, apex obtuse; middle leaf cells subquadrate-polygonal, 20.4-40.8 x 20.4-36.7 mm; trigones small, triangular; leaf lobules ligulate, 0.5-0.8 mm long, 0.2-0.3 mm wide, margin entire, narrowly incurved, apex obtuse, base decurrent, more or less crispate or laciniate-toothed. Underleaves oblong or oblong-ovate, 0.5-0.8 mm long, 0.5-0.6 mm wide, margin crispate, apex obtuse or sub truncate, lateral margins narrowly incurved, base long decurrent, more or less crispate or rarely toothed. Androecial bract in 4-5 pairs, densely crowded; antheridia single in axil of each bracts. Gynoecial bracts and bracteole in a single pair. Perianth usually ovoid or sometimes campanulate, without plicae, mouth lobed, lobes usually small with few teeth.

Habitat: Terrestrial or epiphytic, grows in moist places in association with other species of the genus together with *Frullania retusa, F. dilatata, Radula complanata, R. grandifolia, R. obscura, Cyathodium tuberosum,* etc.

Type locality: China.

Distribution: India [Western Himalaya: Jammu & Kashmir, Himachal Pradesh (Chamba, Simla, Rohtang pass, Jalori pass, Great Himalayan National Park - present study), Uttaranchal; Western Ghats: Tamil Nadu], China (Hattori, 1967, 1978; Piippo, 1990), C.I.S. (Hattori, 1976).

Specimens examined: Sainj valley: Lapah – Shakti, 27.05.2002, *S.K. Singh* 99702; Shakti-Maror, 28.05.2002, *S.K. Singh* 99719; Maror-Parkachi (*ca* 2900 m), 29.05.2002, *S.K. Singh* 99742; Tikku Pathar, 22.09.2003, *S.K. Singh* 104395; On way to Dhela, 22.09.2003, *S.K. Singh*

104399a; Sara thauch, 24.09.2003; *S.K. Singh* 104409c; Tirthan valley: Rolla (*ca* 2100 m), 01.08.1999, *P.V. Karunakaran*, 99975; Kharongcha - Rolla (*ca* 1950 m), 11.09.2001, *D.K. Singh & S.K. Singh* 99131c; Rolla - Basu (*ca* 2400 m), 12.09.2001, *D.K. Singh & S.K. Singh* 99144d, 99147a, 99157d; Near silt (*ca* 2800 m), 13.09.2001, *D.K. Singh & S.K. Singh* 99170a. Rohtang - Pass (*ca* 3700 m), 15.09.2001, *D.K. Singh & S.K. Singh* 99185; Shoza, 05.06.2002, *S.K. Singh* 99789, 99794a, 99797b.

4. *Porella decurrens* (Steph.) S.Hatt. in J. Hattori Bot. Lab. 32: 336. 1969. *Madotheca decurrens* Steph., Sp. Hep. 4: 289. 1910.

Plate 2; Figs. 13-26.

Dioecious. Plants light green - olive brown; shoots 30-60 mm long, 2.1-2.6 mm wide, densely pinnately branched; branches slightly obliquely spreading; stem in cross section 12-15 cells across; cortical cells in 2-3 rows, thick-walled; medullary cells thin-walled. Leaves densely imbricate, widely spreading; leaf lobes strongly concave ventrally, sub triangular-ovate or almost rotund, 1-1.5 mm long, 1-1.3 mm wide, margin entire, apex strongly incurved, dorsal base decurrent; middle leaf cells hexagonal-polygonal, 20.4-28.5 x 16.3-24.5 mm; trigones triangular; leaf lobules ovate-triangular when flattened, 0.5-0.7 mm long, 0.3-0.5 mm wide, apex obtuse, margins strongly recurved, ventral base long, decurrent, repand or lobed. Underleaves about twice as wide as stem, when flattened almost semicircular, 0.5-0.6 mm long, 0.3-0.4 mm wide, margin strongly recurved, base very long decurrent, entire, repand or angulate. Androecial bract in 3-5 pairs, spicate or almost capitate; antheridia single in the axil of each bracts. Gynoecial bracts in a single pair; bracteoles ovate, margin entire apex incurved. Perianth campanulate, mouth wide with margins very shallowly angulate-repand, with few, scattered, minute dentitions.

Habitat: Epiphytic or terrestrial, grows in moist and sheltered places in association with other species of the genus and mosses.

Type locality: India, Uttaranchal (Tehri-Garhwal).

Distribution: India [Western Himalaya: Jammu & Kashmir, Himachal Pradesh (Simla, Great Himalayan National Park - present study), Uttaranchal], China (Hattori, 1969; Wu & al., 1984; Piippo, 1990).

Specimens examined: Sainj valley: Lapah-Shakti, 27.05.2002, *S.K. Singh* 99701, 99706 Tirthan valley: Kharongcha- Rolla (*ca* 1900 m), 11.09.2001, *D.K. Singh & S.K. Singh* 99131b; Rolla-Basu (*ca* 2550 m), 12.09.2001, *D.K. Singh & S.K. Singh* 99157b; above Durga thauch (*ca* 2750 m), 13.09.2001, *D.K. Singh & S.K. Singh* 99164.

5. *Porella gracillima* Mitt. in Trans. Linn. Soc. London 2,3: 202, 1891.

Plate 3; Figs. 1-10.

Plants light green to deep green, older regions brown; shoots 30-50 mm long, 1.5-2.5 mm wide, irregularly bipinnately branched; stem in cross section 12-15 cells across; cortical cells in 2-3 rows, medullary cells thin-walled. Leaves incubous, closely imbricate; leaf lobes ovate-oblong to oblong, 0.7-1.2 mm long, 0.6-1.0 mm wide, apex strongly decurved, rounded, dorsal base entire, covering the stem, ventral slightly decurrent, margins entire or posterior margin with a tooth near base; middle leaf cells hexagonal-polygonal, 20.4-28.6 x 16.3-24.5 mm; trigones minute; leaf lobules oblong-ligulate, 0.4-0.7 mm long, 0.2-0.3 mm wide, slightly decurrent on the inner side, outer base appendaged, rarely with one or a few coarse teeth, margins more or less recurved, entire, apex obtuse. Underleaves quadrate-oblong, 0.4-0.6 mm long, 0.4-0.5 mm wide, base decurrent on both sides, margin entire, rarely lower portion with few coarse teeth, apex rounded, strongly recurved. Androecia and gynoecia not seen.

Habitat: Terrestrial or epiphytic, grows in moist and sheltered places in association with other species of the genus along with *Plagiochila ovalifolia, P. nepalensis, P. parvifolia, Frullania ericoides, F. retusa, Trocholejeunea infuscata, Radula complanata, R. grandifolia, R. lindbergiana, Lejeunea discreta, L. obfusca, Ptychanthus striatus, Metzgeria lindbergii,* etc.

Type locality: Japan.

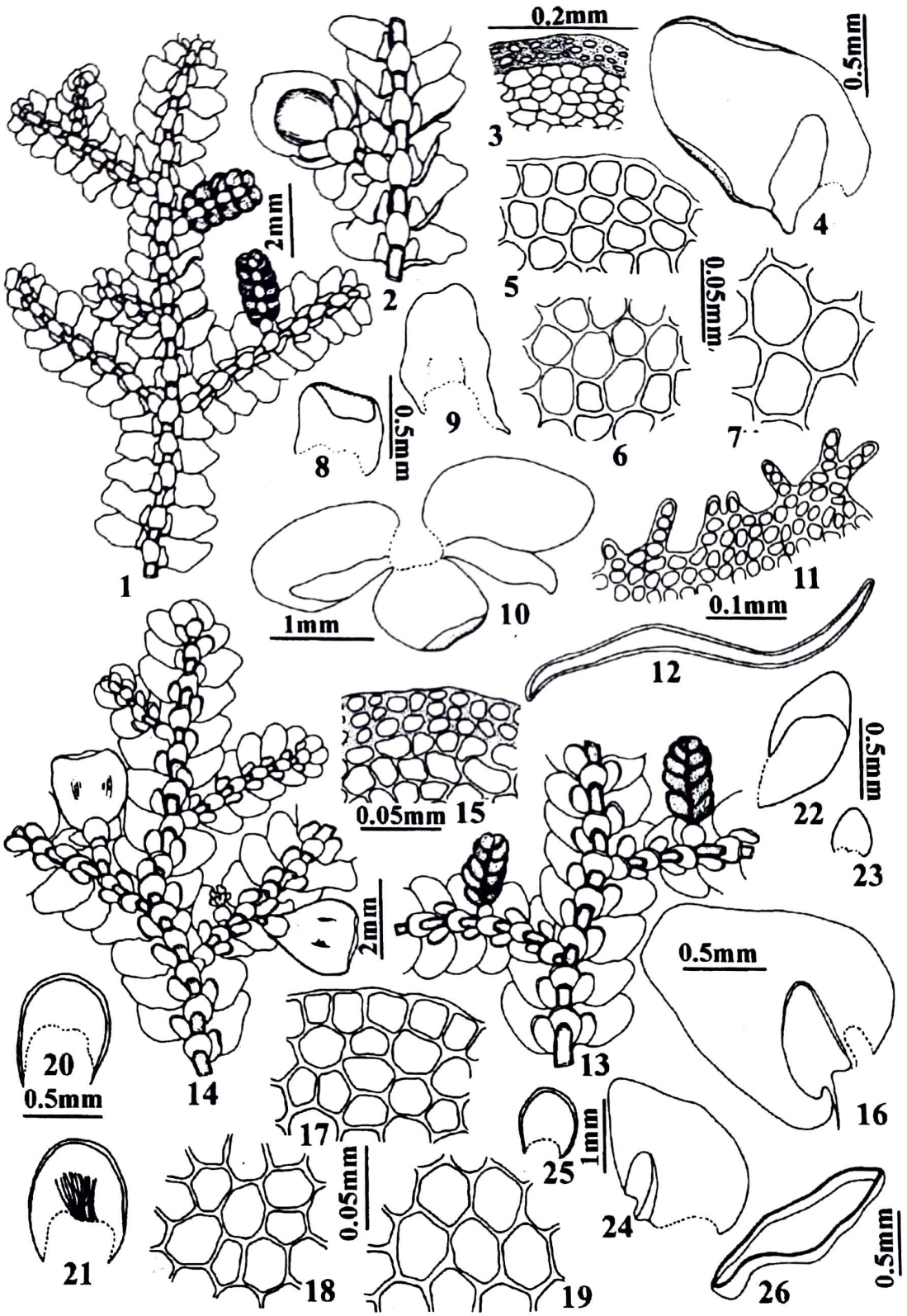

PLATE - 2

Figs. 1-12. *Porella chinensis* (Steph.) S.Hatt. : 1. A portion plant with male inflorescences (ventral view). 2. The same with female inflorescences. 3. T.S. stem (a part). 4. Leaf lobe with lobule. 5. Marginal cells of leaf lobe towards apex. 6. Median cells of leaf lobe. 7. Basal cells of leaf lobe. 8, 9. Underleaves. 10. Female bracts with bracteole. 11. A portion of perianth from apex. 12. Cross section of perianth. **Figs. 13-26.** *Porella decurrens* (Steph.) S.Hatt.: 13. A portion of plant with male inflorescences (ventral view). 14. The same with female inflorescence. 15. T.S. stem (a part). 16. Leaf lobe with lobule. 17. Marginal cells of leaf lobe towards apex. 18. Median cells of leaf lobe. 19. Basal cells of leaf lobe. 20-21. Underleaves. 22. Male bract. 23. Male bracteole. 24. Female bract. 25. Female bracteole. 26. Cross section of perianth.

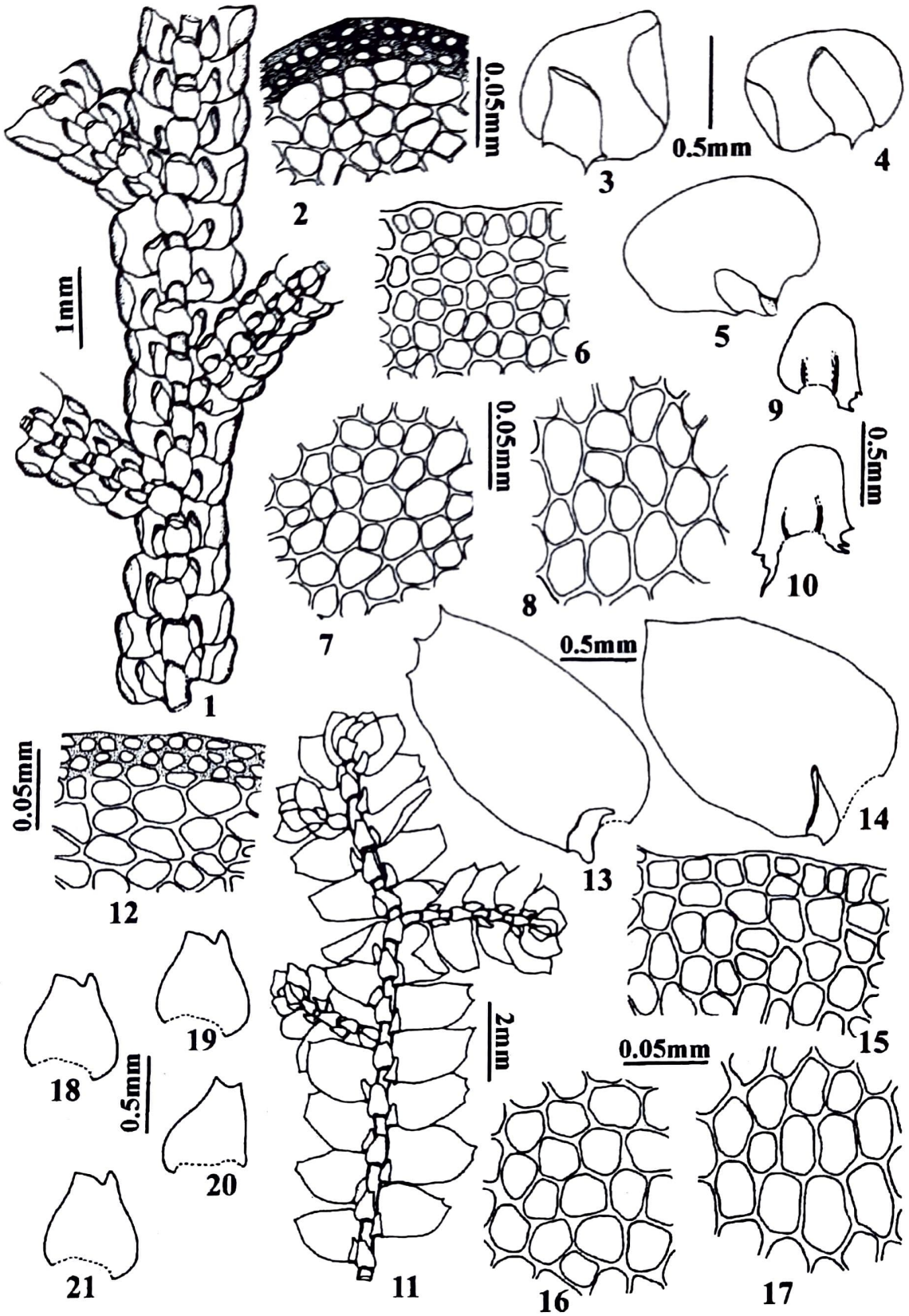

PLATE - 3

Figs. 1-10. *Porella gracillima* Mitt. : 1. A portion of plant (ventral view). 2. T.S. stem (a part). 3-5. Leaf lobes with lobule. 6. Marginal cells of leaf lobe towards apex. 7. Median cells of leaf lobe. 8. Basal cells of leaf lobe. 9,10. Underleaves. **Figs. 11-21.** *Porella hattorii* Udar & Shaheen. : 11. A portion of plant (ventral view). 12. T.S. stem (a part). 13,14. Leaf lobes with lobule. 15. Marginal cells of leaf lobe towards apex. 16. Median cells of leaf lobe. 17. Basal cells of leaf lobe. 18-21. Underleaves.

Distribution: India [Western Himalaya: Jammu & Kashmir, Himachal Pradesh (Dalhausie, Panji, Simla, Jalori pass, Great Himalayan National Park), Uttaranchal], China (Hattori, 1969, 1978; Wu & al., 1984; Piippo, 1990), Korea (Hong, 1966), Japan (Hattori, 1969), C.I.S. (Hattori, 1969).

Specimens examined: Sainj valley: Ropa (*ca* 1400 m) 13.02.2002, *S.K. Singh* 99565, 99568b; Bah - Lapah, 26.05.2002, *S.K. Singh* 99593a, 99596b, 99598; Lapah - Shakti (*ca* 2300m) 27.05.2002, *S.K. Singh* 99708a; Shakti - Maror, 28.05.2002, *S.K. Singh* 99737, 99732b; Maror-Parkachi, (*ca* 2900 m), 29.05.2002, *S.K. Singh* 99743a; Ghatghar, 13.09.2003, *S.K. Singh* 101588; Sara thauch, 24.09.2003, *S.K. Singh* 104402, 104411b; Shanger, 19.09.2003, *S.K. Singh* 104318, 104339; Lapah, 21.09.2003, *S.K. Singh* 104358, 104371, 104376; Khodu thauch, 22.09.2003, *S.K. Singh* 104393; Tirthan valley: Rolla (*ca* 2100 m), 02.08.1999, *P.V. Karunakaran*, 99981, 99984; Kharongcha - Rolla (*ca* 2000 m) 11.09.2001, *D.K. Singh & S.K. Singh* 99116, 99131a; Rolla - Basu (*ca* 2500 m) 12.09.2001, *D.K. Singh & S.K. Singh* 99140, 99144b; Kharongcha (*ca* 1950 m) 26.09.2003, *S.K. Singh* 104442b, 104446b; Rolla, 27.09.2003, *S.K. Singh* 104466a. Shoza, 05.06.2002, *S.K. Singh* 99793b, 99794b.

Note: Porella gracillima is closely related to *Porella decurrens*, but the former can be easily separated from the latter in having narrower plants, leaf lobes, and oblong-ovate underleaves with short basal appendages.

6. Porella hattorii Udar & Shaheen in Lindbergia 9: 70. 1983.

Plate 3; Figs. 11-21.

Plants yellowish brown to light green; shoots 40-55 mm long, 3.0-4.5 mm wide, bipinnately branched; stem in cross section 11-15 cells across; cortical cells in 3-4 rows, thick-walled; medullary cells thin-walled. Leaves imbricate, incubous; leaf lobes oblong- rarely ovate, 0.4-0.6 mm long, 0.4-0.5 mm wide, margin entire, apex acute, usually 2 (-3) toothed; middle leaf cells subquadrate-hexagonal to polygonal, 20-36.7 x 16.3-32.6 mm; trigones triradiate - subnodulose; leaf lobules smaller than underleaves, lanceolate, 0.41-0.61 mm long, 0.17-0.27 mm wide, apex obtuse-sub acute, margin entire, base broad, shortly decurrent. Underleaves triangular, 0.44-0.89 mm long, 0.30-0.55 mm wide, base shortly decurrent, margin entire, apex truncate to shallowly bilobed. Androecia and gynoecia not seen.

Habitat: Terrestrial or epiphytic, grows in moist places in pure population or in association with other species of the genus together with *Plagiochila ovalifolia*, *Plagiochasma intermedium,* etc.

Type locality: India, Uttaranchal (Mussoorie).

Distributin: India [Western Himalaya: Himachal Pradesh (Great Himalayan National Park - present study) Uttaranchal; Eastern Himalaya: Meghalaya], endemic.

Specimens examined: Epiphytic, Uttranchal – Mussorrie (*ca* 2100 m), 15.09.1981, *R. Udar, S.C. Srivastava & D. Kumar* 4809/1981 (LWU-Holotype!); Uttaranchal – Nainital, Govt. House (*ca* 2100 m) 30.04.1971, *R. Udar & party*, 5373/1971 (LWU). Tirthan valley: Rolla - Basu (*ca* 2400 m), 12.09.2001, *D.K. Singh & S.K. Singh* 99157c; Below Silt (*ca* 2800 m), 13.09.2001, *D.K. Singh & S.K. Singh* 99173b; Jathor- Nara, 28.09.2003, *S.K. Singh* 104472.

Note: The present study records this species for the first time from the State of Himachal Pradesh.

7. Porella madagascariensis (Nees & Mont.) Trevis. in Mem. Reale. Ist. Lombardo Sci. Ser. 3,4: 407. 1877. *Lejeunea madagascariensis* Nees & Mont., Ann. Sci. Nat. Ser. 2,5: 6. 1836.

Plate 4; Figs. 1-8.

Plants light green to brownish green; shoots 30-50 mm long, 2.5-3.5 mm wide; bi-pinnately branched; stem in cross section 11-13 cells across; cortical cells in 2-3 rows, thick-walled; medullary cells thin-walled. Leaves incubous, imbricate; leaf lobes ovate, 1.24-1.39 mm long, 0.99-1.16 mm wide, apex rounded, margin entire, slightly decurrent at base; middle leaf cells hexagonal-polygonal, 16.6-29.9 x 13.3-23.3 mm; trigones nodulose; leaf lobules half as wide as long, lanceolate, 0.34-0.45 mm long, 0.22-0.25 mm wide,

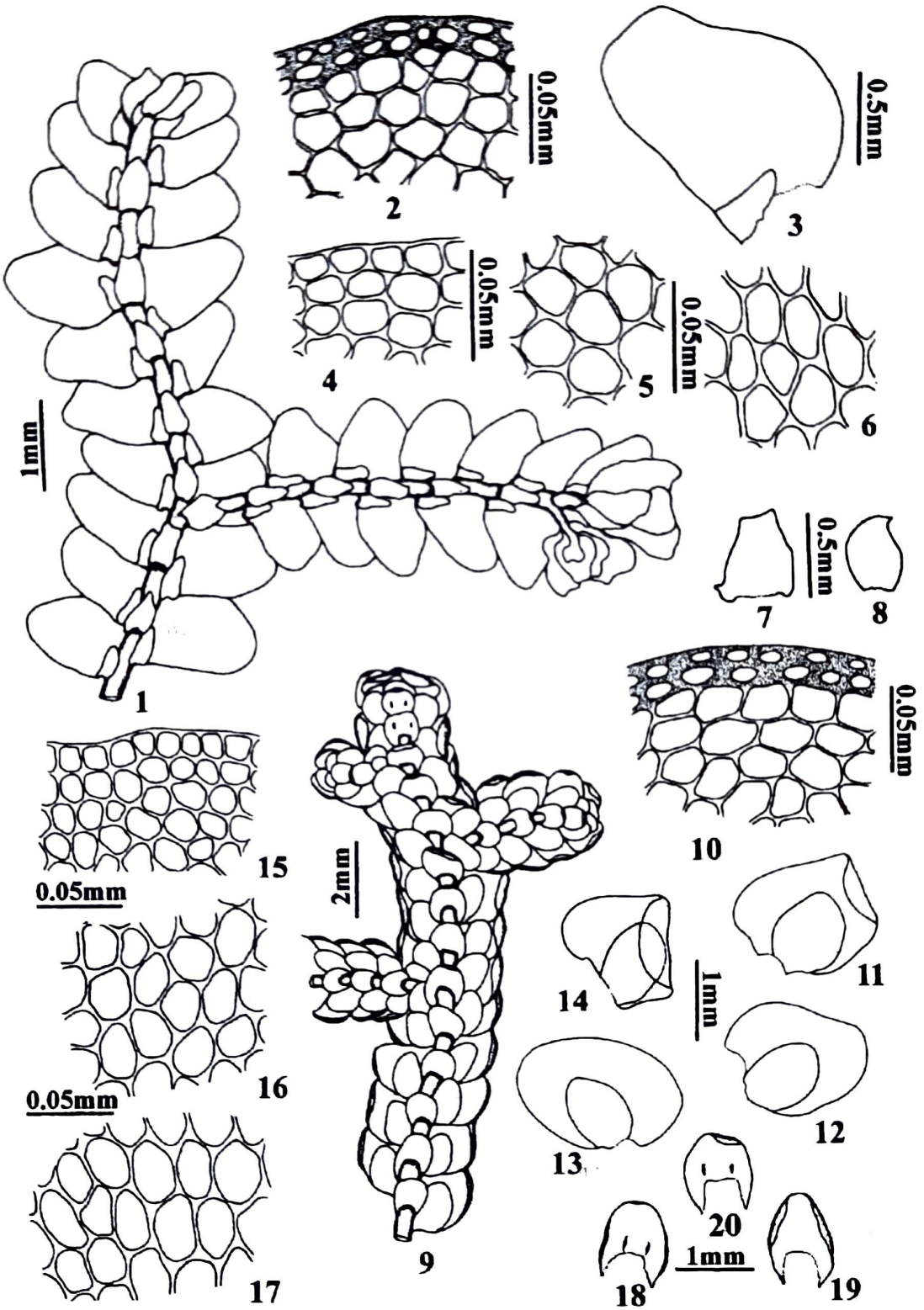

PLATE - 4

Figs. 1-8. *Porella madagascariensis* (Nees & Mont.) Trevis. : 1. A portion of plant (ventral view). 2. T.S. stem (a part). 3. Leaf lobe with lobule. 4. Marginal cells of leaf lobe towards apex. 5. Median cells of leaf lobe. 6. Basal cells of leaf lobe. 7,8. Underleaves. **Figs. 9-20.** *Porella obtusata* (J.Taylor.) Trevis. var. macroloba (Steph.) S.Hatt. & Zhang : 9. A portion of plant (ventral view). 10. T.S. stem (a part). 11-14. Leaf lobes with lobule. 15. Marginal cells of leaf lobe towards apex. 16. Median cells of leaf lobe. 17. Basal cells of leaf lobe. 18-20. Underleaves.

base broad, apex obtuse or rounded, margin entire, sometimes 1-2-toothed; oil-bodies oval-elliptical 3.5-5.3 x 2.6-3.5 mm, finely segmented. Underleaves triangular to sub rectangular, 0.4-0.55 mm long, 0.3-0.51 mm wide, apex acute or shallowly bilobed, slightly decurrent at base, margin entire. Androecia and gynoecia not seen.

Habitat: Terrestrial, grows in moist and sheltered places in association with *Plagiochila parvifolia, Radula complanata, Radula lindbergiana*, etc.

Type locality: Madagascar.

Distribution: India [Western Himalayas: Jammu & Kashmir, Himachal Pradesh (Great Himalayan Ntional Park); Western Ghats: Tamil Nadu], China (Wu & al., 1984; Piippo, 1990), Madagascar (Gottshce & al., 1845), Sri Lanka (Hattori, 1978).

Specimens examined: Sainj valley: Sainj-Bihali, 08.02.2002, *S.K. Singh* 99521; Bihali (*ca* 1400 m), 09.02.2002, *S.K. Singh* 99532a; Sara thauch, 24.09.2003, *S.K. Singh* 104414b; Shanger (*ca* 2100 m), 19.09.2003, *S.K. Singh* 104336. Tamil Nadu-Nilgiri hills (Conoor *ca* 1800 m), 31.12.1971, *R. Udar & party* 87S/1971 (LWU).

8. Porella obtusata (J.Taylor) Trevis. var. *macroloba* (Steph.) S.Hatt. & Zhang in J. Jap. Bot. 60 (11): 325. 1985. *Madotheca macroloba* Steph., Sp. Hep. 4: 292. 1910.

Plate 4; Figs. 9-20.

Plants deep green to brownish green; shoots 30-55 mm long, 2-3 mm wide, pinnately or irregularly bipinnately branched; stem in cross section 11-15 cells across; cortical cells in 2 rows, thick-walled; medullary cells thin-walled. Leaves imbricate, patent, divergent to horizontal; leaf lobes broadly ovate to semi rotund, 1.3-1.6 mm long, 1.0-1.4 mm wide, apex rounded, slightly recurved, margins entire, slightly decurrent at base; middle leaf cells hexagonal-polygonal, 20.4-32.6 x 20.4-28.5 mm; trigones triangular-subnodulose; leaf lobules large broadly ovate, 0.7-1.1 mm long, 0.6-0.9 mm wide, outer base entire, inner base appendaged, appendage decurrent along stem, margins entire, apex rounded or obtuse. Underleaves orbicular-suborbicular, 0.6-1.0 mm long, 0.4-0.6 mm wide, inserted by a broad base, longly decurrent on both sides, margins incurved, apex rounded, incurved. Androecia and gynoecia not seen.

Habitat: Terrestrial or epiphytic, grows in moist and sheltered places in association with *Plagiochila parvifolia, Frullania muscicola, F. retusa, Porella campylophylla, Cyathodium tuberosum, Bryum sp. Minium sp.* and other mosses.

Type locality: India, Uttaranchal (Mussoorie).

Distribution: India [Western Himalaya: Jammu & Kashmir, Himachal Pradesh (Alwas, Chamba, Kulu, Panji, Simla, Great Himalayan National Park - present study), Uttaranchal], China (Hattori & Zhang, 1985), Taiwan (Horikawa, 1934), Vietnam (Pócs, 1968), Japan (Hattori, 1970), Caucasus (Hattori, 1976), Europe (Paton, 1999), Africa (Hattori, 1978).

Specimens examined: Sainj valley: Bah - Lapah, 26.05.2002, *S.K. Singh* 99592; Lapah – Shakti, 27.05.2002, *S.K. Singh* 99712a, 99714; Shakti - Maror, 28.05.2002, *S.K. Singh* 99739; Bagi, 13.09.2003, *S.K. Singh* 101570b, 101571; Bagi, 14.09.2003, *S.K. Singh* 99579a; Majhan, 17.09.2003, *S.K. Singh* 101592; Tirthan valley: Rolla (*ca* 2200 m), 12.09.2001, *D.K. Singh & S.K. Singh* 99135a; Kharongcha, 26.09.2003, *S.K. Singh* 104447; Rolla (*ca* 2200 m), 27.09.2003, *S.K. Singh* 104457b. *Porella obtusata* fo. *macroloba* (Steph.) S.Hatt & Zhang, Uttaranchal - Chakrata (Near laingate chauki), 28 10.1980, *V. Nath* 6841/1980 (LWU).

9. Porella platyphylla (L.) Pfeiff., F., Neidehessen und Munden 2: 243. 1855. *Jungermannia platyphylla* L., Sp. Pl. 1134. 1753.

Plate 5; Figs. 1-9.

Plants light green to deep green; shoots 40-60 mm long, 1.5-2.0 mm wide, repeatedly, irregularly branched; stem in cross section 12-14 cells across; cortical cells in 2-3 rows, highly thick-walled; medullary cells thin-walled. Leaves densely imbricate, incubous; leaf lobes triangular-ovate, 0.8-1.1 mm long, 0.5-0.8 mm wide, margin entire, apex obtuse, strongly recurved, base slightly decurrent; middle leaf cells hexagonal-polygonal, 10.2-24.5 x 8.1-20.4 mm; trigones triangular; leaf lobules ovate-triangular to

lanceolate, 0.4-0.7 mm long, 0.2-0.3 mm wide, apex usually incurved, margin entire, base long decurrent, entire or with few dentitions. Underleaves usually entire, rotund-quadrate to triangular, 0.4-0.7 mm long, 0.4-0.6 mm wide, apex usually recurved, base broad, long decurrent with few minute dentitions. Androecia and gynoecia not seen.

Habitat: Terrestrial or epiphytic grows in moist places in pure patches or in association with *Porella chinensis, Radula grandifolia*, etc.

Type locality: Europe.

Distribution: India [Western Himalaya: Jammu & Kashmir, Himachal Pradesh (Lahaul Valley, Jalori pass, Great Himalayan National Park - present study), Uttaranchal], China (Piippo, 1990), C.I.S. (Hattori, 1976, 1978), Europe (Paton, 1999), North America (Schuster, 1980).

Specimens examined: Sainj valley: Dharta, 10.09.2003, *S.K. Singh* 101508; Bagishaidi, 12.09.2003, *S.K. Singh* 101539; Khandesa, 13.09.2003, *S.K. Singh* 101552. Shoza, 05.06.2002, *S.K. Singh* 99785. Kashmir, Khilanmarg, 28.10.1976, *S.C Srivastava* 214/1976 (LWU).

Note: *Porella platyphylla* resembles *P. gracillima* in general habit, size and coloration of plant but distinctly differs from latter, which has rounded, ovate-oblong to oblong leaves with oblong-ligulate lobules and quadrate-oblong underleaves.

10. *Porella plumosa* Inoue in Bull. Nat. Sci. Mus. 9(3): 385. 1966.

Plate 5; Figs. 10-18.

Plants light green to pale green; shoots 40-60 mm long, 1.8-2.5 mm wide, regularly pinnately branched; stem in cross section 11-15 cells across; cortical cells in 2-3 rows, highly thick-walled; medullary cells thin-walled. Leaves loosely imbricate, widely spreading; leaf lobes ovate-oblong, 1.6 mm long, 0.7-1.0 mm wide, apex widely rounded, irregularly toothed, teeth 2-5, small, base narrow, dorsal basal portion entire, rounded covering the stem, ventral margin straight; middle leaf cells hexagonal-polygonal, 16.3-36.7 x 12.2-28.5 mm; trigones triangular; leaf lobules small, nearly parallel to the stem, lanceolate to ovate-oblong or ovate, 0.3-0.4 mm long, 0.1-0.2 mm wide, margin entire, apex obtuse to sub acute. Underleaves ovate-oblong, 0.4-0.6 mm long, 0.3-0.5 mm wide, apex truncate or retuse or acute, margin entire, base broad. Androecia and gynoecia not seen.

Habitat: Terrestrial, grows in moist places in association with *Apometzgeria pubescens, Frullania pariharii, Lejeunea discreta* and mosses.

Type locality: India, Meghalaya (Khasia hills).

Distribution: India [Western Himalaya: Himachal Pradesh (Chamba, Dalhousie, Great Himalayan National Park - present study), Uttaranchal; Eastern Himalaya: Meghalaya; Western Ghats: Tamil Nadu], China (Wu et al., 1984; Piippo, 1990), Taiwan (Hattori, 1970), Myanmar (Hattori, 1967), Philippines (Hattori, 1967), Vietnam (Pócs, 1968).

Specimens examined: Sainj valley: Shakti - Maror, 28.05.2002, *S.K. Singh* 99734a; Bah - Neuli, 01.06.2002, *S.K. Singh* 99758; Majhan, 17.09.2003, *S.K. Singh* 104301b.

11. *Porella variabilis* (Kashyap) Kachroo in J. Sci. Univ. Kashmir 1 (1/2): 157. 1978; *Madotheca variabilis* Kashyap, Liverw. W. Himalayas & Punjab Pl. 2: 33. 1932.

Plate 6; Figs. 1-12.

Plants light green to slightly brownish green; shoots 35-55 mm long, 1.9-2.5 mm wide, pinnately branched; stem in cross section 12-16 cells across; cortical cells in 1-2 rows, thick-walled; medullary cells thin-walled. Leaves slightly imbricate, horizontal; leaf lobes ovate to ovate-oblong, 0.7-1.0 mm long, 0.5-0.8 mm wide, apex usually rounded or sub acute or very rarely acute, with 1-2 tooth, dorsal basal portion entire, rounded, ampliate, covering stem, ventral basal portion decurrent along the stem; middle leaf cells polygonal, 12.2-24.5 x 12.2-22.4 mm; trigones triradiate to nodulose; leaf lobules small, distant, triangular-agulate to sagittate, 0.16-0.26 mm long, 0.10-0.15 mm wide, base auriculate, with a tooth like appendage, margins entire, apex obtuse to subacute. Underleaves oblong-ligulate, ovate to quadrate, 0.29-0.45 mm long, 0.16-0.33 mm wide, apex usually truncate, occasionally rounded,

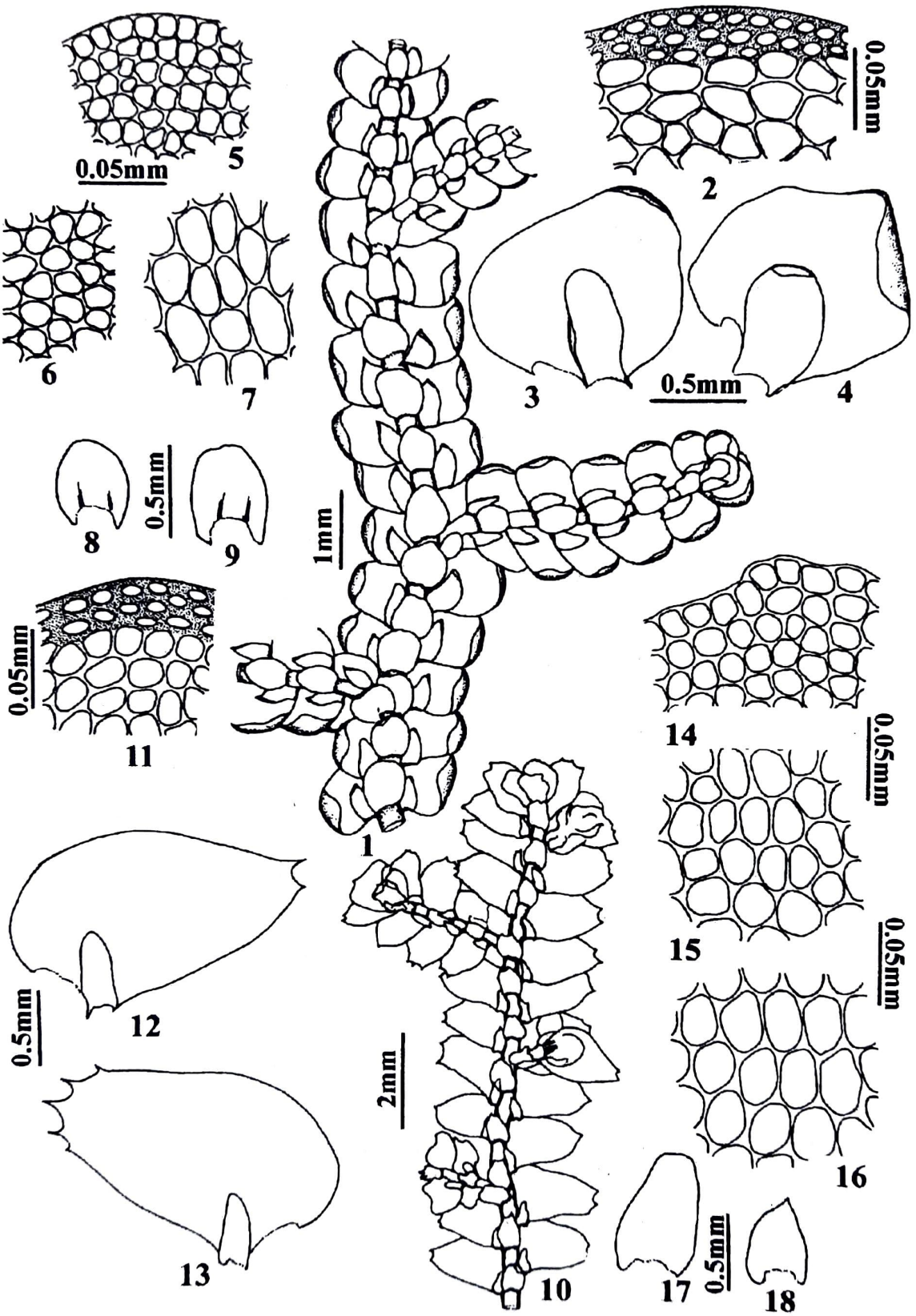

PLATE - 5

Figs. 1-9. *Porella platyphylla* (L.) Pfeiff. : 1. A portion of plant (ventral view). 2. T.S. stem (a part). 3,4. Leaf lobes with lobule. 5. Marginal cells of leaf lobe towards apex. 6. Median cells of leaf lobe. 7. Basal cells of leaf lobe. 8,9. Underleaves. **Figs. 10-18.** *Porella plumosa* Inoue : 10. A portion of plant (ventral view). 11. T.S. stem (a part). 12,13. Leaf lobes with lobule. 14. Marginal cells of leaf lobe towards apex. 15. Median cells of leaf lobe. 16. Basal cells of leaf lobe. 17,18. Underleaves.

obtuse, rarely retuse or toothed, margin entire, base hardly decurrent, slightly auriculate on each side. Androecia and gynoecia not seen.

Habitat: Terrestrial or epiphytic, grows in moist and shady places in association with other species of the genus together with *Frullania retusa, Metzgeria lindbergii, Ptychanthus striatus, Lejeunia flava, Radula lindbergiana,* etc.

Type locality: Uttaranchal (Mussoorie).

Distribution: India [Western Himalaya: Himachal Pradesh (Great Himalayan National Park- present study), Uttaranchal], endemic.

Specimens examined: Sainj valley: Ropa (*ca* 1400 m), 13.02.2002, *S.K. Singh* 99568a; Neuli (*ca* 1500 m), 13.02.2002, *S.K. Singh* 99574; Bida Shanger (*ca* 1900 m), 16.02.2002, *S.K. Singh* 99578; Bah - Lapah, 26.05.2002, *S.K. Singh* 99596a; Lapah - Shakti, 27.05.2002, *S.K. Singh* 99710; Bah - Neuli, 01.06.2002, *S.K. Singh* 99756; Kadia, 13.09.2003, *S.K. Singh* 101563, 101564b; Cholara, 14.09.2003, *S.K. Singh* 101583; Majhan, 17.09.2003, *S.K. Singh* 101593, 101599, 104310; Tirthan valley: Rolla - Basu (*ca* 2400 m), 12.09.2001, *D.K. Singh & S.K. Singh* 99142b, 99144c; Kharongcha, 26.09.2003, *S.K. Singh* 104435, 104450b, 104451b; Rolla (*ca* 2200 m), 27.09.2003, *S.K. Singh* 104459a.

Note: Present study records this species for the first time since its original description by Kashyap and Chopra (1932) from Mussoorie in Uttaranchal. This constitutes its first record from the state of Himachal Pradesh.

Indian species of the genus *Porella* show maximum representation in Western Himalaya where they are represented by 20 taxa (14 species, 1 subspecies, 4 variety and 1 forma), followed by 8 taxa each from Eastern Himalaya and the Western

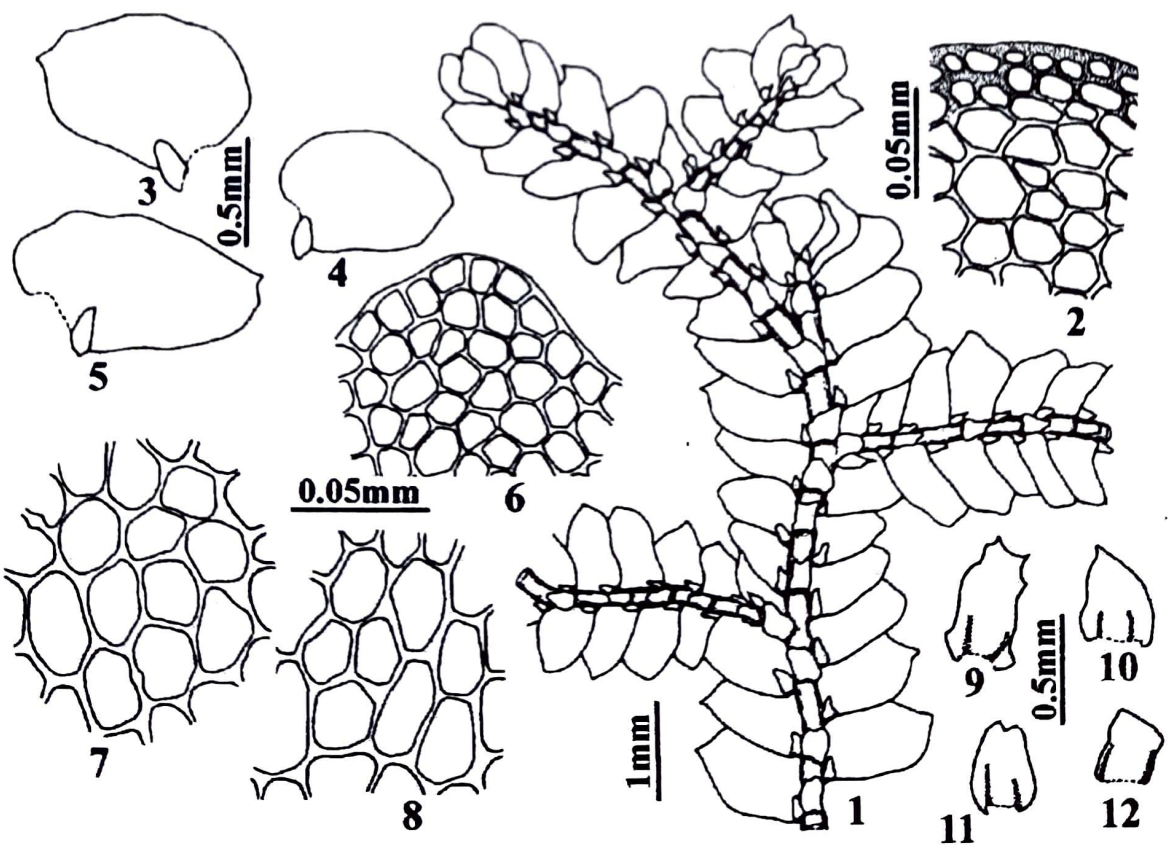

PLATE - 6

Figs. 1-12. *Porella variabilis* (Kashyap) Kachroo : 1. A portion of plant (ventral view). 2. T.S. stem (a part). 3-5. Leaf lobes with lobule. 6. Marginal cells of leaf lobe towards apex. 7. Median cells of leaf lobe. 8. Basal cells of leaf lobe. 9-12. Underleaves.

Table 1: A conspectus of the genus *Porella* L. in India

S.N.	Name of the species of *Porella* L.	Distributin in India				Reference
		WH	EH	WG	A&N	
1.	*P. acutifolia* (Lehm. & Lindenb.) Trevis.			+		Hattori, 1969, 1978
2.	*P. borellii* (Gola) Parihar	+				Gola, 1914; Kashyap, 1932 (as *Madotheca borellii* Gola); Srivastava, 1979
3.	*P. caespitans* (Steph.) S. Hatt.	+				Hattori, 1978; Bapna & Kachroo, 2000.
4.	*P. caespitans* var. *nipponica* S. Hatt.		+			Hattori, 1970
5.	*P. caespitans* var. *setigera* (Steph.) S. Hatt.			+		Kashyap, 1932 (as *M. acutifolia* Kashyap); Hattori, 1969, 1970
6.	*P. campylophylla* (Lehm. & Lindenb.) Trevis.	+	+	+		Kashyap, 1932 (as *M. campylophylla* Lehm. & Lindenb., *M. gollanii* Steph. *M. denticulata* Kashyap); Hattori, 1969, 1975; Shaheen & Srivastava, 1989
7.	*P. campylophylla* var. *ligulifera* (J. Taylor) S. Hatt.	+	+			Hattori, 1969; Shaheen & Srivastava, 1989
8.	*P. campylophylla* var. *lancistipula* (Steph.) S. Hatt.			+		Hattori, 1970; Shaheen & Srivastava, 1989
9.	*P. campylophylla* var. *ptychantha* Shaheen & S.C. Srivast.	+	+			Hattori, 1970 (*as P. ptychantha* (Mitt.) S. Hatt.); Shaheen & Srivastava, 1989
10.	*P. chinensis* (Steph.) S. Hatt.	+				Kashyap, 1932 (as *M. densiramea* Steph., *M. gambleana* Steph.); Hattori, 1967, 1970, 1971, 1976; Shaheen & Srivastava, 1986 a
11.	*P. chinensis* (Steph.) S. Hatt. var. *hastata* S. Hatt.	+				Kashyap, 1932 (as *M. hastata* Steph.); Hattori, 1970, 1975
12.	*P. chinensis* (Steph.) S. Hatt. var. *irregularis* (Steph.) S. Hatt.			+		Hattori, 1970, 1975
13.	*P. decurrens* (Steph.) S. Hatt.	+				Kashyap, 1932 (as *M. decurrens* Steph.); Hattori, 1969
14.	*P. densifolia* (Steph.) S. Hatt.	+			+	Kashyap, 1932 (as *M. densifolia* Steph.); Joshi, 2001
15.	*P. densifolia* subsp. *andamana* S. Hatt.				+	Hattori, 1969, 1978; Bapna & Kachroo, 2000
16.	*P. densifolia* subsp. *appendiculata* (Steph.) S. Hatt.	+				Kashyap, 1932 (as *M. appendiculata* Steph.); Hattori, 1969, 1978; Bapna & Kachroo, 2000
17.	*P. gracillima* Mitt.	+				Kashyap, 1932 (as *M. gracillima* (Mitt.) Steph., *M. angusta* Steph., *M obtusifolia* Kashyap); Hattori, 1976, 1978
18.	*P. gracillima* Mitt. var. *urogea* (C. Massal.) S. Hatt.	+				Udar & Shaheen, 1982
19.	*P. hattorii* Udar & Shaheen	+	+			Udar & Shaheen, 1983a; Singh et al., 2001
20.	*P. japonica* (Sande Lac.) Mitt.	+				Hattori, 1967
21.	*P. kashyapii* (R.S. Chopra) Kachroo			+		Chopra, 1938 (as *M. kashyapii* R.S. Chopra); Bapna & Kachroo, 2000
22.	*P. madagascariensis* (Nees & Mont.) Trevis.	+		+		Hattori, 1967; Singh & Singh, 2003
23.	*P. obtusata* (J. Taylor) Trevis. var. *macroloba* (Steph.) S. Hatt. & M. Zhang	+	+			Kashyap, 1932 (as *M. maroloba* Steph., and also as *M. ovalis* Gottsche); Hattori, 1970, 1978 (as *P. obtusata* (J.Taylor) Trevis. fo *macroloba* (Steph.) S.Hatt.); Hattori & Zhang, 1985; Bapna & Kachroo, 2000
24.	*P. perottetiana* (Mont.) Trevis.	+	+	+		Hattori, 1967, 1969, Singh & al., 2004
25.	*P. platyphylla* (L.) Pfeiff.	+				Kashyap, 1932 (as *M. platyphylla* Dumort., *M. trigonifolia* Steph., *M. virens* Steph.); Shaheen & Srivastava 1986 b; Narayan & al., 2001
26.	*P. plumosa* (Mitt.) Inoue	+	+			Kashyap, 1932 (as *M. plumosa* Mitt.); Hattori, 1967, 1970; Udar & Shaheen, 1983b
27.	*P. variabilis* (Kashyap) Kachroo	+				Kashyap, 1932 (as *M. variabilis* Kashyap); Bapna & Kachroo, 2000

WH: Western Himalaya; EH: Eastern Himalaya; WG: Western Ghats; A & N: Andman & Nicobar Islands.

Ghats and 2 taxa from Andaman & Nicobar Islands (Table 1). Interestingly, no species of the genus has so far been recorded from other bryo-geographical regions of the country, viz. Punjab, west Rajasthan, *Gangetic* Plains, Central India, Eastern Ghats and Deccan Plateau.

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