

Epiphytic liverworts on tea-plantations in Darjeeling*

S.C. Srivastava, Anshu Srivastava & Renu Dixit

Department of Botany, Lucknow University, Lucknow 226 007

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Half a dozen species of corticolous epiphytes belonging to five genera of leafy liverworts (Jungermanniales) growing on tea plants (*Camellia sinensis* (L.) Kuntze) in Darjeeling (Eastern Himalaya), India are described with relevant illustrated details. These are *Plagiochila luthiana* St., *P. forficata* Schiffn., *Porella campylophylla* (Lehm. & Lindenb.) Trev., *Frullania neurota* Tayl., *Lejeunea flava* (Sw.) Nees and *Microlejeunea punctiformis* (Tayl.) Spr. *Plagiochila luthiana*, earlier known from south India, is being reported from Eastern Himalaya thus suggesting its wide range of distribution.

Key-words – Liverworts, Jungermanniales, Epiphytic, Darjeeling, India.

INTRODUCTION

EAST Himalayan territory is known for the luxuriance of liverworts both in frequency and variety (Pande, 1958). It has a highly distinctive flora of bryophytes including mosses (Gangulee, 1969), liverworts (Pande, 1958; Udar, 1976) and hornworts (Asthana & Srivastava, 1991). Liverworts grow in diverse habitats showing tercolous, foliicolous and corticolous populations. Of these, majority of the leafy liverworts occur on bark of trees forming a conspicuous corticolous community. Several taxa of liverworts are described from this territory but the bryophytes, especially liverworts growing on tea plants have attracted little or no attention (Udar, 1976). In the floristic survey during a recent collection trip made by one of us (SCS), half a dozen species of liverworts belonging to five genera were collected from the bark of tea plants (*Camellia sinensis*) in Ranjeet Tea Garden, Darjeeling. The liverworts *Plagiochila* (*P. luthiana* St., *P. forficata* Schiffn.), *Porella* (*P. campylophylla* (Lehm. & Lindenb.) Trev.), *Frullania* (*F. neurota* Tayl.), *Lejeunea* (*L. flava* (Sw.) Nees), and *Microlejeunea* (*M. punctiformis* (Tayl.) Spr.) are being described here with relevant details. All these taxa belong to Jungermanniales, one of the important order of Hepaticae constituting nearly 80% of the total liverwort population.

DESCRIPTION

Plagiochila luthiana St.

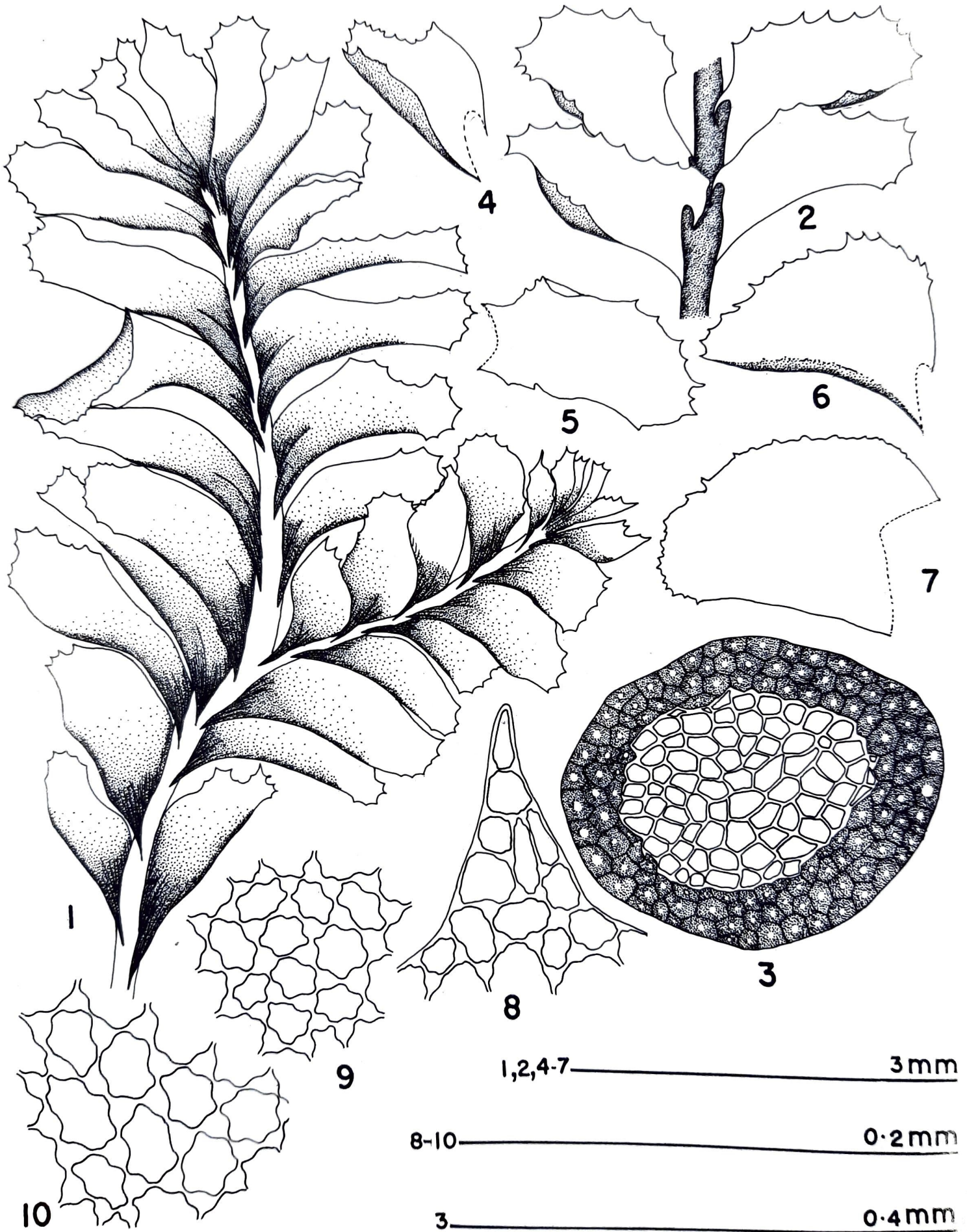
in *Species Hepaticarum* VI. 180 (1921)

Text-figs. 1-10.

Plants large and robust, 30-40 mm long and 2.5-4.0 mm wide, light greenish-brown. Stem dark-brown, 10-13 cells across diameter, cortical cells in 3-4 layers, thick-walled, oblong, rectangular; medullary cells relatively elongated, thin-walled; branches frequent, flagelliferous branches absent. Rhizoids absent. Leaves alternate, distant or loosely imbricate, oblong-ovate, 2.8-4.4 mm long and 2.0-2.4 mm wide, free from each other both anticlinal and posticlinal, extends to the stem midline anticlinal, clearly succubous with dentate margin, denticulations 12-15(24) in number, usually extending from the base of the posticlinal margin to the 3/4 of the antical margin, teeth 2-8 cells high and 1-3 cells wide at base. Leaf cells with well developed nodulose trigones, 16-20 x 8-12 μ m at apex, 22-39 x 12-31 μ m in the middle, and 16-37(41) x 28-36 μ m at the base. Underleaf absent. Sterile.

Locality - Darjeeling (Eastern Himalaya), India.

Range - Eastern Himalaya-West Bengal: Darjeeling. South India-Kerala: Vagavurrai, Tamil Nadu: Ootacamund (Nilgiri Hills). Endemic to India.



Text - figures 1-10. *Plagiochila luthiana* St. 1. Plant in dorsal view, 2. A portion of plant in ventral view, 3. Cross section of stem, 4-7. Leaves, 8. Apical cells of leaf, 9. Median cells of leaf, 10. Basal cells of leaf.

Specimens examined- G 6134, *P. luthiana* St., Legit: Rev. B. Luthi, Loc.: Nilgiri India Sw. Dodabetta alt. 8765 p; LWU 10226/92, 10227/92, 10228/92, 10229/92, *P. luthiana* St., Legit: S.C. Srivastava, Loc.: Ranjit Tea Garden, Darjeeling (E.H.), India, Date: 7.6.92, Habitat: on bark, in association with *Lejeunea flava*, *Microlejeunea punctiformis* and *Porella campylophylla*, Det.: S.C. Srivastava, Renu Dixit and Anshu Srivastava.

Discussion- *Plagiochila luthiana* also occurs elsewhere but it forms a most conspicuous cover over the bark of tea plants specially towards the upper half of the stem. This species was earlier known from South India (Kerala and Tamil Nadu) only, thus extending its range of distribution in the Eastern Himalaya although it still maintains the endemic nature.

Plagiochila forficata Schiffn.

in *Species Hepaticarum* VI. 157 (1918)

Text-figs. 11-22

Plants medium-sized, slender, 18-20 mm long and 1.5-2.0 mm wide, light greenish-brown. Stem dark-brown or pale-brown (at apex), 8-10 cells across diameter, cortical cells in 2 layers, thick-walled, oblong-rectangular, medullary cells relatively elongated, thin-walled; branches rather rare, flagelliferous branches absent. Rhizoids absent. Leaves obliquely spreading, subcontiguous, distant, oblong-obcuneate, 2.0-3.2 mm long and 1.0-1.8 mm wide, free from each other anticly and postically, clearly succubous with dentate margin, dentitions 2-6(10) in number, teeth 2-10 cells high and 2-6(7) cells wide at base. Leaf cells without trigones. Apical leaf cells acute-subacute, 16-28 x 8-10 μ m, median cells 20-32 x 18-30 μ m, and basal cells 32-40 x 28-36 μ m. Under leaf absent. Sterile.

Locality- Darjeeling (Eastern Himalaya), India.

Range- Eastern Himalaya-Sikkim, West Bengal. Darjeeling (Ranjit Tea Garden). Endemic to India.

Specimens examined- LWU 10227/92, 10228/92, *P. forficata* Schiffn., Legit: S.C. Srivastava, Loc.: Ranjit Tea Garden, Darjeeling (E.H.), India, Date: 7.6.92, Habitat: on bark, in association with *Lejeunea flava* and *Porella campylophylla*, Det.: S.C. Srivastava, Renu Dixit and Anshu Srivastava.

Discussion- *Plagiochila forficata* was earlier recorded from Sikkim (Stephani, 1918; see also Bonner, 1962). Its occurrence in Darjeeling indicates that the species is widely distributed in Eastern Himalaya, yet it is endemic in nature.

P. luthiana and *P. forficata* resemble only in colour of plants and in leaf cell size (which are approximately identical in both) but differ from each other in the size of plants [*P. luthiana* has robust plants (30-40 mm long and 2.5-4.0 mm wide) while *P. forficata* has relatively smaller and slender plants (18-20 mm long and 1.5-2.0

mm wide)], in the shape of leaf, and number of dentitions. The leaves are oblong-ovate, with 12-15 (24) teeth in the former and oblong, obcuneate with 2-6(10) teeth in the latter.

Porella campylophylla var. *ligulifera* (Tayl.) Hatt.

J. Hattori Bot. Lab. 32: 333 (1969).

Text-figs. 23-35

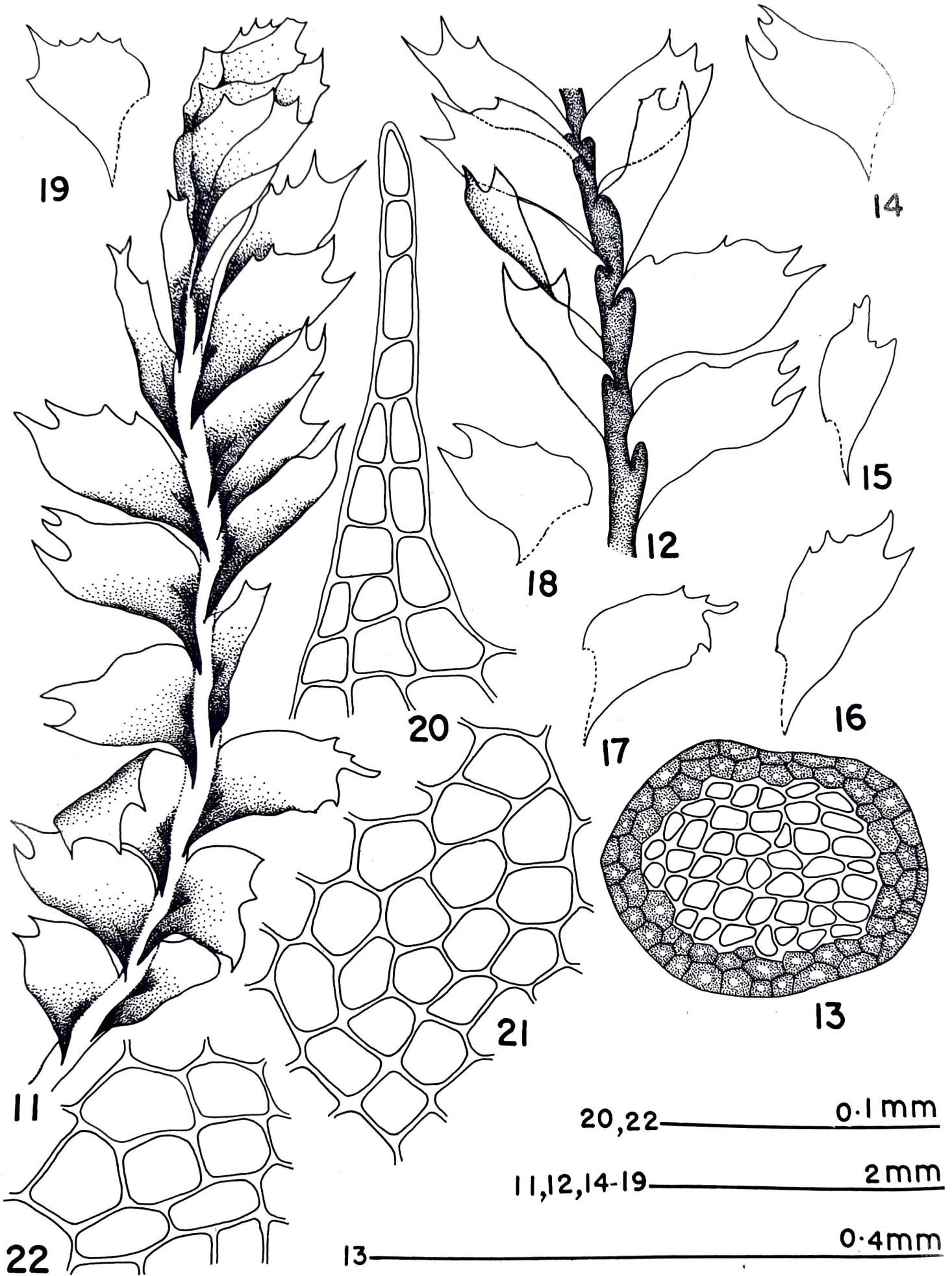
Plants large, 10-40 mm long, 0.18-0.3 mm wide, bipinnately branched, branching usually *Frullania-Ptychanthus* type. Stem dark brown, 10-12 cells across diameter, cortical cells in 2-3 layers, 11-18 x 7-11 μ m, thick-walled, medullary cells 19-30 x 15-22 μ m, thin-walled. Leaves densely imbricate, widely spreading, incubous, leaf lobes usually ovate to oblong-ovate, 1.8-2.3 x 0.9-1.2 mm, apex acute, rarely obtuse with sharp teeth, apical cells 11-22 x 7-18 μ m with small trigones, median cells 22-33 x 926 μ m with large trigones and the basal cells 45-67 (71) x 22-30 μ m with large trigones, branch leaves usually small, leaf lobules ligulate or lanceolate, 0.8-1.6 x 0.2-0.5 mm, apex obtuse, rarely acute to acuminate or sometimes slightly notched, long decurrent base, narrowly incurved, usually entire. Underleaves oblong-ovate, 0.6-1.5 x 0.2-0.6 mm, apex obtuse, truncate or rarely acute with 2-7 small teeth, base longly decurrent, narrowly incurved, entire or sometimes irregularly lacinate. Sterile.

Locality- Darjeeling (Eastern Himalaya), India.

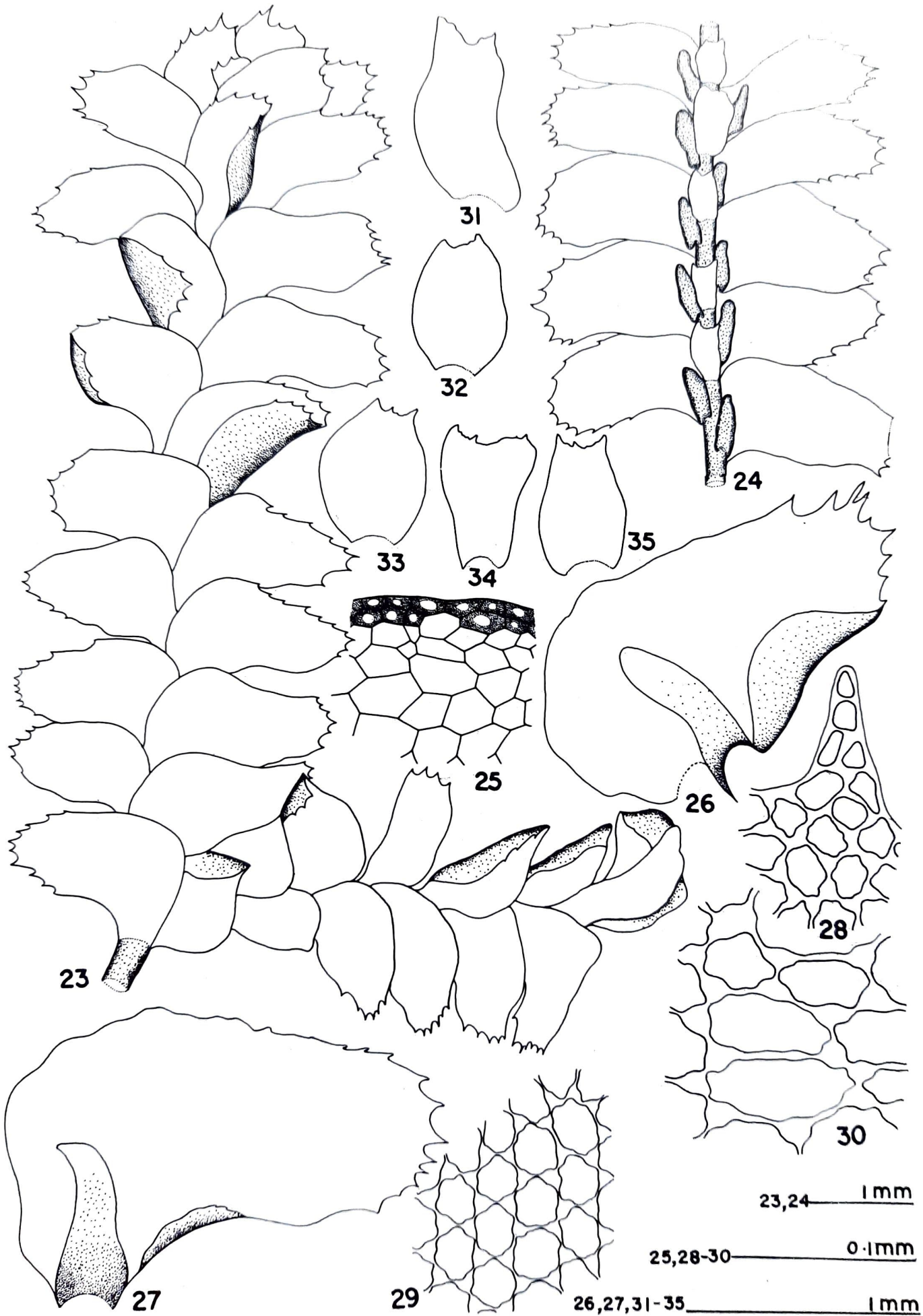
Range- India- Eastern Himalaya- Meghalaya : Cherrapunji, Mawphlong, Shillong; Sikkim: Gangtok; West Bengal: Darjeeling (Ranjit Tea Garden), Manebhanjang; Western Himalaya- Uttar Pradesh: Mussoorie; Nepal, Thailand.

Specimens examined- BM 51114, *Porella campylophylla* var. *ligulifera* (Tayl.) Hatt., Loc.: From Mahe to Chipne (alt. 1800 m), Nepal, Leg.?:, Sept. 20, 1961, Det.: R. Udar, S.C. Srivastava and F. Shaheen; LWU 10228/92, 10229/92, *Porella campylophylla* var. *ligulifera* (Tayl.) Hatt., Legit: S.C. Srivastava, Loc.: Ranjit Tea Garden, Darjeeling (E.H.), India, Date: 7.6.1992, Habitat: on bark, in association with *Plagiochila luthiana*, *Plagiochila forficata* and *Lejeunea flava*, Det.: S.C. Srivastava, Anshu Srivastava and Renu Dixit.

Discussion- *Porella campylophylla* is a complex consisting of two distinct varieties, *P. campylophylla* var. *ligulifera* (Tayl.) Hatt. and *P. campylophylla* var. *ptychantha* Shaheen *et* Srivast. and a subspecies, *P. campylophylla* subsp. *lancistipula* (St.) Hatt. The latter is endemic to South India. The present variety not only occurs on tea plants in Eastern Himalaya but is very widely distributed in various bryologically rich territories of India including, Western Himalaya and hills of south India (Shaheen & Srivastava, 1989).



Text - figures 11-22. *Plagiochila forficata* Schiffn. 11. Plant in dorsal view, 12. A portion of plant in ventral view, 13 Cross section of stem, 14-19. Leaves, 20. Apical cells of leaf, 21. Median cells of leaf, 22. Basal cells of leaf.



Text - figures 23-35. *Porella campylophylla* var. *ligulifera* (Tayl.) Hatu. 23. Plant in dorsal view, 24. A portion of plant in ventral view, 25. Cross section of stem, 26, 27. Leaves, 28. Apical cells of leaf, 29. Median cells of leaf, 30. Basal cells of leaf, 31-35. Underleaves.

Frullania neurota Tayl.

J. Bot. 5: 400 (1846).

Text-figs 36-50

Plants reddish-brown, large, 10-35 mm long, 0.15-0.2 mm wide, prostrate, irregularly pinnately branched, branches obliquely spreading. Stem flaccid, 10-12 cells across diameter, uniformly thick-walled with small trigones, cells 11-23 x 15-18 μ m. Leaves imbricate, widely spreading with incurved apex, lobes ovate to rotundate or oblong, apex obtuse, margin entire, 0.7-1.0 x 0.5-0.8 mm, cells at margin with reddish lumina, 7-18 x 11-15 μ m, trigones triangular, median cells with orange-reddish lumina, 15-23 x 11-19 μ m, and the basal cells with reddish lumina, 26-33 x 19-26 μ m with large nodulose, confluent and hyaline trigones; lobules large, sub-cucullate, without beak, obliquely oriented on a small stalk, mouth truncate, triangular; keel sub-parallel to stem, margin slightly connate to leaf base, obliquely descending. Underleaves ovate-rotundate, little wider than its length, or equally broader than long, 0.4-0.5 x 0.3-0.4 mm, slightly bifid, sinus wide and obtuse, lobes triangular, acute to obtuse, margin entire, insertion transverse. Sterile.

Locality- Darjeeling (Eastern Himalaya) India.

Range- India- Eastern Himalaya- Meghalaya: Shillong; Sikkim: Gangtok; West Bengal: Darjeeling (Ranjit Tea Garden, Llyod Botanical Garden, Teesta Valley Road), Kurseong, Khasi hills; South India: Kodaikanal, Ootacamund (Dodabetta Peak); Nepal, North America and Java.

Specimens examined- G 15937, *Frullania neurota* Tayl., Legit: V. Schiffner, Loc.: Java Occid, J. Jabodus, Date: 1894; LWU 10226/92, *Frullania neurota* Tayl., Legit: S.C. Srivastava, Loc.: Ranjit Tea Garden, Darjeeling (E.H.) India, Date: 7.6.92, Habitat: on bark, in association with *Plagiochila luthiana*, *Lejeunea flava* and *Microlejeunea punctiformis*, Det.: S.C. Srivastava, Anshu Srivastava and Renu Dixit.

Discussion- This species was originally described from Nepal and subsequently reported from Eastern Himalaya (Khasi mountain) *F. breviscula* Mitt. which was later synonymized under *F. neurota* (Mitten, 1861). It prefers high rain fed areas and humid condition for normal profuse growth. Like *Porella campylophylla*, *F. neurota*, is also very widely distributed in India (Stephani, 1910; Mitten, 1861; Verdoorn, 1930; Parihar, 1961-1962; Kachroo, 1970; Hattori, 1972) and elsewhere.

Lejeunea flava (Sw.) Nees.

Naturg. Eur. Leberm. 3: 277 (1938); Evans, *Bull. Torrey Bot. Club.* 38: 207 (1911); Schust. and Hatt., *J. Hatt. Bot. Lab.* 11 (47): 22-23 (1954)

Text-figs 51-63

Plants small, pale or whitish green, 5-15 mm long,

0.6-0.75 mm wide, irregularly pinnately branched, branching *Lejeunea* type. Stem 5-7 cells across diameter with 7 cortical and 8-11 medullary cells, cortical cells large, inflated, thick-walled, 19-22 x 26-34 μ m, medullary cells generally like cortical cells but rarely more thickened, 18-22 x 22-34 μ m. Leaves 0.5-0.8 x 0.4-0.6 mm, imbricate, widely spreading, narrowly ovate, oblong, broadest at base, margin entire, dorsal margin arched, postical margin less arched forming an obtuse angle with keel, apex subacute to rounded, cells thin-walled with trigones, sometime intermediate nodular thickening present, cells at apex 7-18 x 15-22 μ m, median cells 19-22 x 15-19 μ m, and the basal cells 19-23 x 11-18 μ m. Leaf lobules uniformly inflated, small, 1/4 - 1/5 of the lobe length, ovate, margin involute. Underleaves large, contiguous, imbricate, ovate-orbicular, 0.34-0.49 x 0.33-0.44 μ m, rounded, cordate at base, bifid, about 1/2 (1/3) of the length, sinus narrow, lobes triangular with acute apex, margin entire. Sterile.

Locality- Darjeeling (Eastern Himalaya), India.

Range- India- Eastern Himalaya - Darjeeling (Ranjit Tea Garden), South India; Bermuda, Jamaica, West Indies, Mexico, Guatemala, Honduras, Panama, South America, Florida, Cuba, Brazil, Africa, Europe, Japan, Java, Sumatra, Australia, New Zealand and Samoa.

Specimens examined- Herb G 19978, *Eulejeunea flava*, Herbarium E. Levier No- 205, *Eulejeunea flava* Kurseong (Sikkim Himalaya) Bretandeu, Legit: 1894; LWU 10226/92, 10227/92, 10228/92, 10229/92, *Lejeunea flava* (Sw.) Nees, Legit: S.C. Srivastava, Loc.: On Ranjit Tea Garden, Darjeeling (E.H.), India, Date: 7.6.92, Habitat: on bark, in association with *Plagiochila luthiana*, *Plagiochila forficata*, *Porella campylophylla* and *Microlejeunea punctiformis*, Det.: S.C. Srivastava, Anshu Srivastava and Renu Dixit.

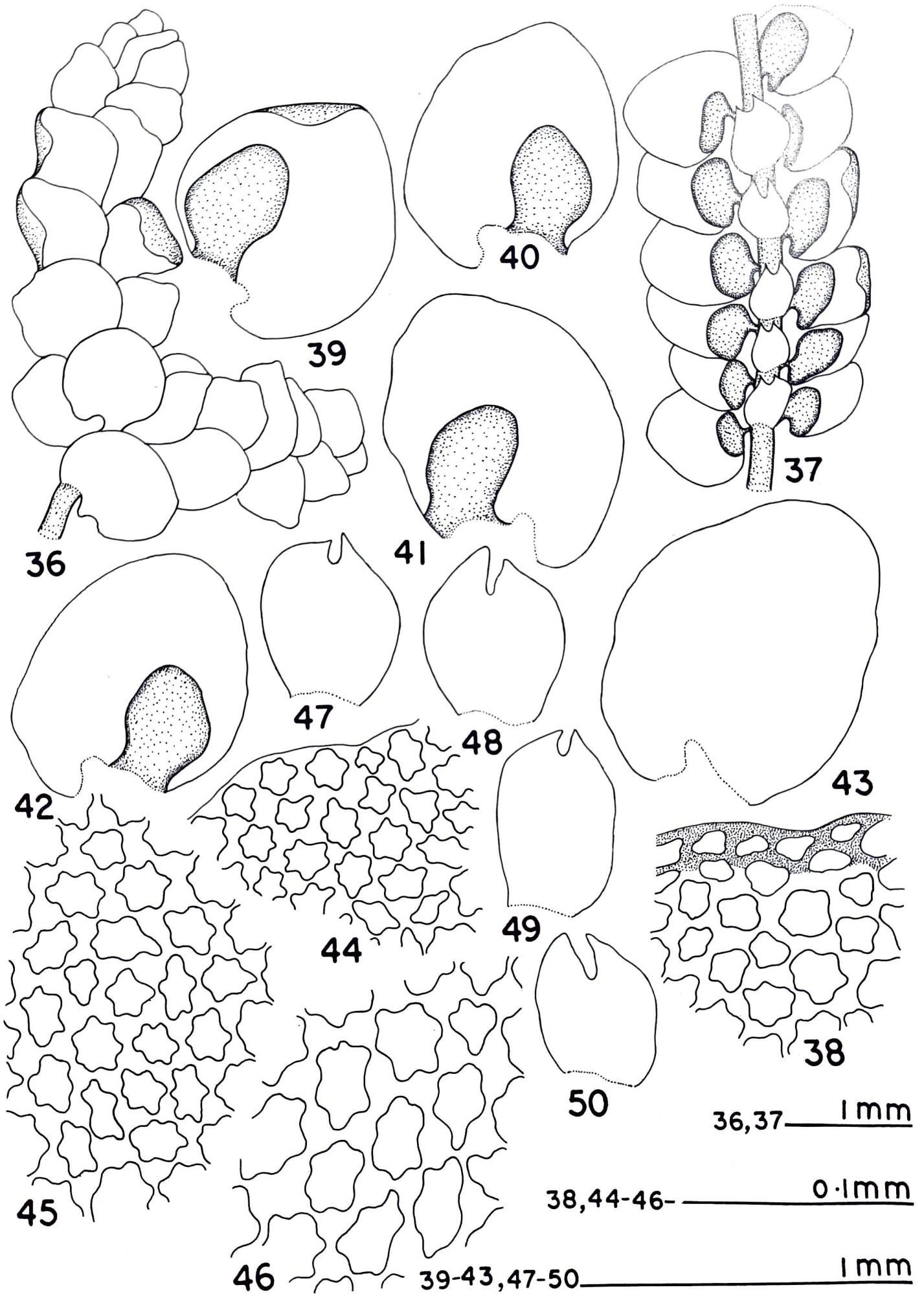
Discussion- *Lejeunea flava* is one of the commonest species of *Lejeunea* growing in the richly rain fed areas of India. Although the plants are copiously fertile in nature during October-November, it has remarkable capacity to develop regenerants from the sterile parts of the plant (Agarwal, 1986; Gupta & Udar, 1982).

Microlejeunea punctiformis (Tayl.) Spr.

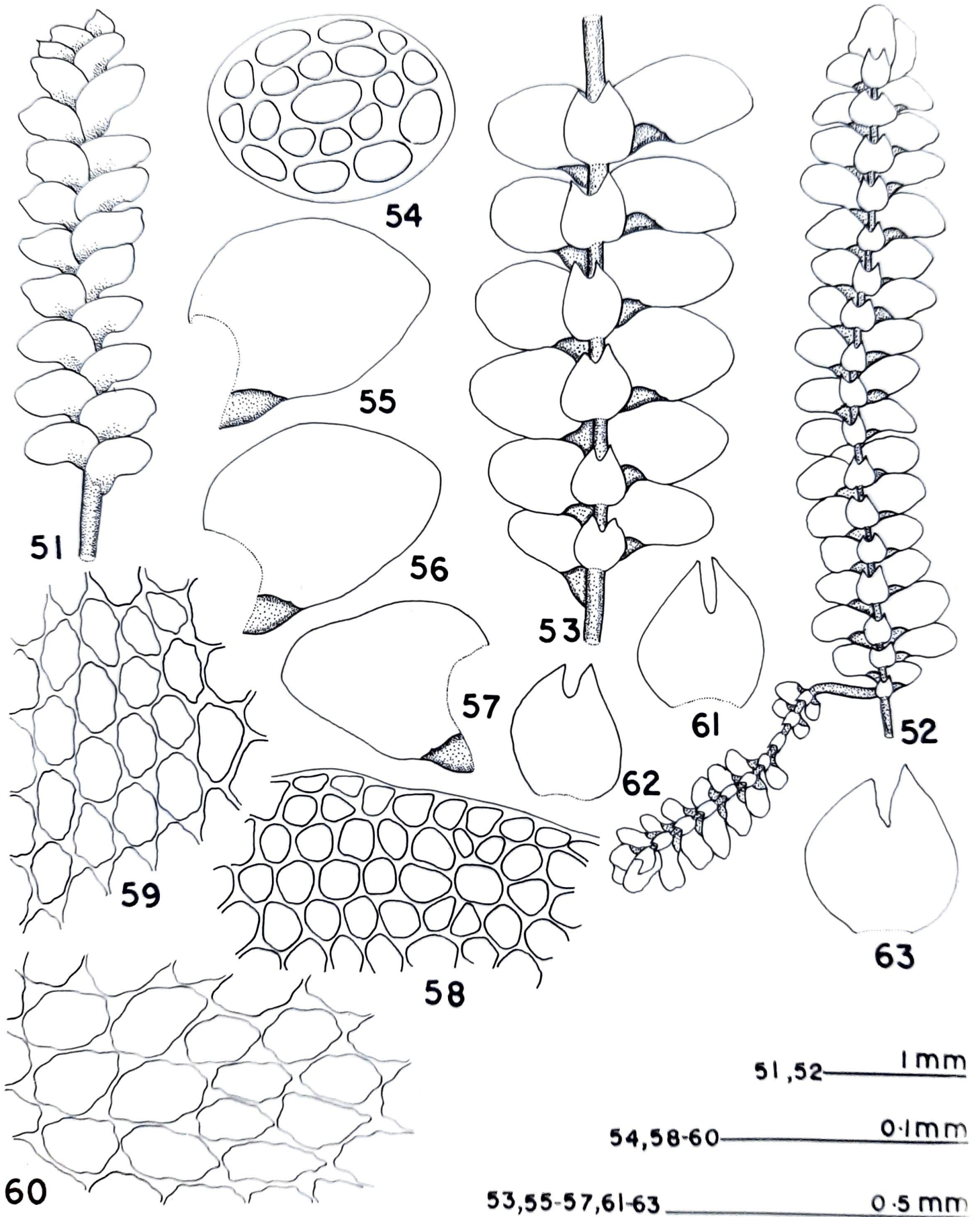
in *Species Hepaticarum* 5: 832 (1915).

Text-figs. 64-71

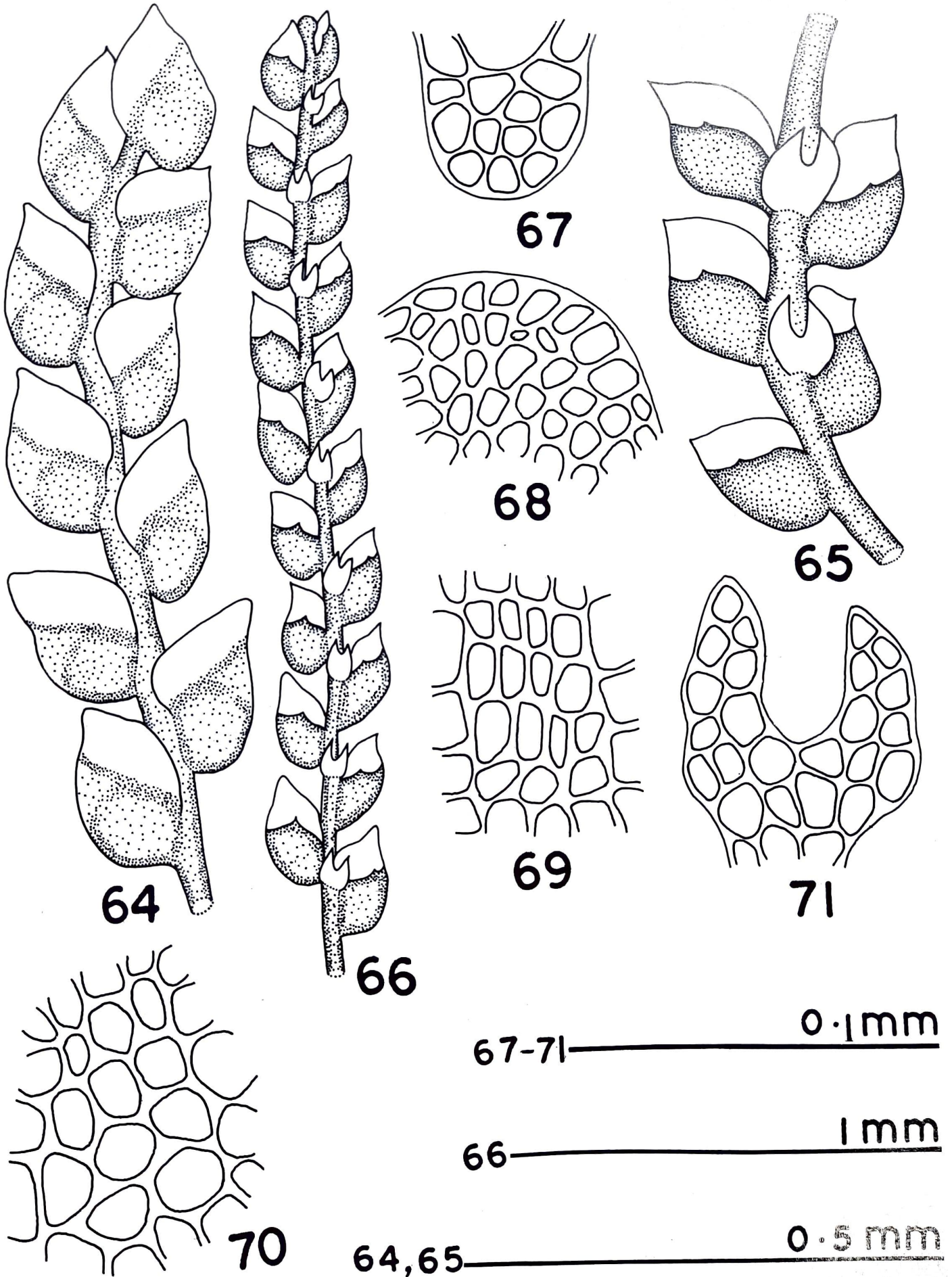
Plants small, yellowish-green, very few branches by *Lejeunea*- type of branching. Stem 3-5 cells across diameter with 7 cortical cells and 3 medullary cells, almost of equal size, 11-22 x 15-22 μ m, cells thin-walled. Leaves small, distantly widely spreading, 0.2-0.3 x 0.12-0.17 mm, suberect with slightly bulging cells at the postical margin, ovate-oblong, apex subacute, margin entire, leaf cells thin-walled, 2-3 basal cells show ocelli, cells at apex 4-11 x 11-15 μ m, median cells 7-11 x 11-18



Text - figures 36-50. *Frullania neurota* Tayl. 36. Plant in dorsal view, 37. A portion of plant in ventral view, 38. Cross section of stem, 39-43. Leaves, 44. Apical cells of leaf, 45. Median cells of leaf, 46. Basal cells of leaf, 47-50. Underleaves.



Text - figures 51-63. *Lejeunea flava* (SW.) Nees 51. Plant in dorsal view, 52. Plant in ventral view, 53. A portion of plant in ventral view, 54. Cross section of stem, 55-57. Leaves, 58. Apical cells of leaf, 59. Median cells of leaf, 60. Basal cells of leaf, 61-63. Underleaves.



Text - figures 64-71. *Microlejeunea punctiformis* (Tayl.) Spr. 64. Plant in dorsal view, 65. A portion of plant in ventral view, 66. Plant in ventral view, 67. Cross section of stem, 68. Apical cells of leaf, 69. Median cells of leaf, 70. Basal cells of leaf, 71. Underleaves.

μm and basal cells $9-11 \times 7-18 \mu\text{m}$; leaf lobules large, about $2/3$ of the lobe length and falcate, first tooth formed of single cell. Underleaves small, orbicular-ovate, $40-55 \times 34-48 \mu\text{m}$; nearly to stem width, bifid for $1/2$ of their length, sinus narrow, lobes triangular. Sterile.

Locality- Darjeeling (Eastern Himalaya), India.

Range- India-Eastern Himalaya- Sikkim, Nathula Road; West Bengal: Darjeeling; South India: Agumbe, Mercara, Ponnudi. Endemic to India.

Specimens Examined- LWU 2853/41, *Microlejeunea punctiformis* (Tayl.) Spr., Legit: S.K. Pande, Loc.: Rimbic, Darjeeling (E.H.), India, Date: 16.10.41, Det.: R. Udar and Anita Agarwal; LWU 10226/92, *Microlejeunea punctiformis* (Tayl.) Spr., Legit: S.C. Srivastava, Loc.: Ranjit Tea Garden, Darjeeling (E.H.), India, Date: 7.6.92, Habitat: on bark, in association with *Plagiochila luthiana* and *Lejeunea flava*, Det.: S.C. Srivastava, Anshu Srivastava and Renu Dixit.

Discussion- *Microlejeunea punctiformis* was originally known from India Orientalis (South India) and later reported from Eastern Himalaya (Agarwal, 1986). This species is a close relative of *M. ulicina* Evs. (Mizutani, 1961; Schuster, 1980) but differs from the latter in nature of sexuality. The former is monoecious and the latter is dioecious (see Mizutani, 1961).

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REFERENCES

- Agarwal, A. 1986. *Studies in Indian Lejeuneoideae*. Ph. D. Thesis, Lucknow Univ., Lucknow.
- Asthana, A.K. & Srivastava S.C. 1991. *Indian Hornworts (A taxonomic study)* J. Cramer, Berlin. Stuttgart.
- Bonner, C.E.B. 1962. *Index Hepaticarum Part I. Plagiochila* (Dum.) Dum. J. Cramer, Weinheim (Germany).
- Gangulee, H.C. 1969. Mosses of eastern India and adjacent regions. III *Bull. bot. Soc. Beng.* 23: 131-134.
- Gupta, A. & Udar, R. 1982. Natural regeneration in *Lejeunea flava*. *New Botanist* 9: 5-8.
- Hattori, S. 1972. *Frullania tamarisci* complex and the species concept. *J. Hattori Bot. lab.* 35: 202-251.
- Kachroo, P. 1970. Hepatics of India- A taxonomic survey and census. IV. Lejeuneaceae. *Bull. bot. Surv. India.* 12: 226-241.
- Mitten, W. 1861. Hepaticae India orientales, an enumeration of the hepaticae of the East Indies. *J. Proc. Linn. Soc.* 5: 89-128.
- Mizutani, M. 1961. A revision of Japanese Lejeuneaceae. *J. Hattori Bot. Lab.* 24: 115-202.
- Pande, S.K. 1958. Some aspects of Indian Hepaticology. *J. Indian bot. Soc.* 37: 1-26.
- Parihar, N.S. 1961-62. An annotated revised census of Indian Hepatics. Univ. Allahabad studies (India), Botany section, Senate House. 1-56.
- Schuster, R.M. 1980. *The Hepaticae and Anthocerotae of North America East of the Hundredth meridian IV*. Columbia Univ. Press. New York.
- Shaheen, F. & Srivastava, S.C. 1989. *Porella campylophylla* (Lehm. & Lindenb.) Trev. Complex in India. *Geophytology* 19 (1): 34-48.
- Stephani, F. 1910. *Species Hepaticarum* 4: 350.
- Stephani, F. 1918. *Species Hepaticarum* 6: 157.
- Udar, R. 1976. *Bryology in India*. The Chronica Botanica Co., New Delhi.
- Verdoorn, F. 1930. Die Frullaniaceae der Indomalaischen Inseln De Frullaniaceis VII. *Annls. bryol. Suppl.* 1: 1-187.