



## RESEARCH COMMUNICATION

# The genus *Drepanolejeunea* (Spruce) Schiffn. (Lejeuneaceae; Marchantiophyta) in the Western Ghats with special reference to Kerala

Chandini V K, Mufeed B, Manju C N\* & Rajesh K P

Department of Botany, Zamorin's Guruvayurappan College (affiliated to the University of Calicut), Kozhikode 673 014, India

\*Email: [manjucali@gmail.com](mailto:manjucali@gmail.com)

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### ABSTRACT

Diversity of the genus *Drepanolejeunea* (Spruce) Schiffn. of the family Lejeuneaceae in Kerala is discussed in detail. So far, 8 species have been reported from the Western Ghats, of which 6 occur in Kerala. This paper provides detailed descriptions of 5 of the species collected from Kerala during the present survey. Among these, *Drepanolejeunea erecta* (Steph.) Mizut. is new to the Western Ghats, *D. fleischeri* (Steph.) Grolle & Zhu, *D. pentadactyla* (Mont.) Steph. and *D. ternatensis* (Gottsche) Steph. are new records for Kerala.

## Introduction

*Drepanolejeunea* (Spruce) Schiffn. is a widespread genus in the tropics belonging to the family Lejeuneaceae. The genus was instituted by Spruce (1) as a subgenus of *Lejeunea* Lib. Schiffner (2) raised it to a genus. Gradstein (3) treated the genus as a separate subtribe *Drepanolejeuneinae* together with *Vitalianthus* R.M. Schust. & Giancotti. However, this is not widely followed. Based on a previous study, divided this genus into 5 subgenera which is also not followed here (4).

*Drepanolejeunea* is represented in India by 20 species (Table 1). Based on available reports, it appears that the centre of diversity of this genus might be Eastern Himalaya with 11 species closely followed by the Northeast with 10 species.

Reports are on the first record of *Drepanolejeunea angustifolia* (Mitt.) Grolle and *D. ternatensis* (Gottsche) Steph. (as *D. ternatensis* var. *lancispina*), from the Western Ghats of Tamil Nadu (5). Several species were subsequently reported from Karnataka, Kerala and Tamil Nadu part of the Western Ghats as well which total to 8 species. From Kerala, 6 species have been reported so far (Table 1).

The present survey reports a total of 5 species distributed in Kerala namely *Drepanolejeunea angustifolia* (Mitt.) Grolle, *D. erecta* (Steph.) Mizut., *D. fleischeri* (Steph.) Grolle & Zhu, *D. pentadactyla* (Mont.) Steph. and *D. ternatensis* (Gottsche) Steph. Of these, *D. erecta* (Steph.) Mizut. is a new record for the Western Ghats and *D. fleischeri* (Steph.) Grolle & Zhu, *D. pentadactyla* (Mont.) Steph. and *D. ternatensis* (Gottsche) Steph. are new records for Kerala. Detailed descriptions of the 5 species along with photo plates and illustrations are provided here. World distribution and distribution within the Western Ghats are mapped (Map 1A & 1B).

## Results and Discussion

### Key to the species of *Drepanolejeunea* in the Western Ghats

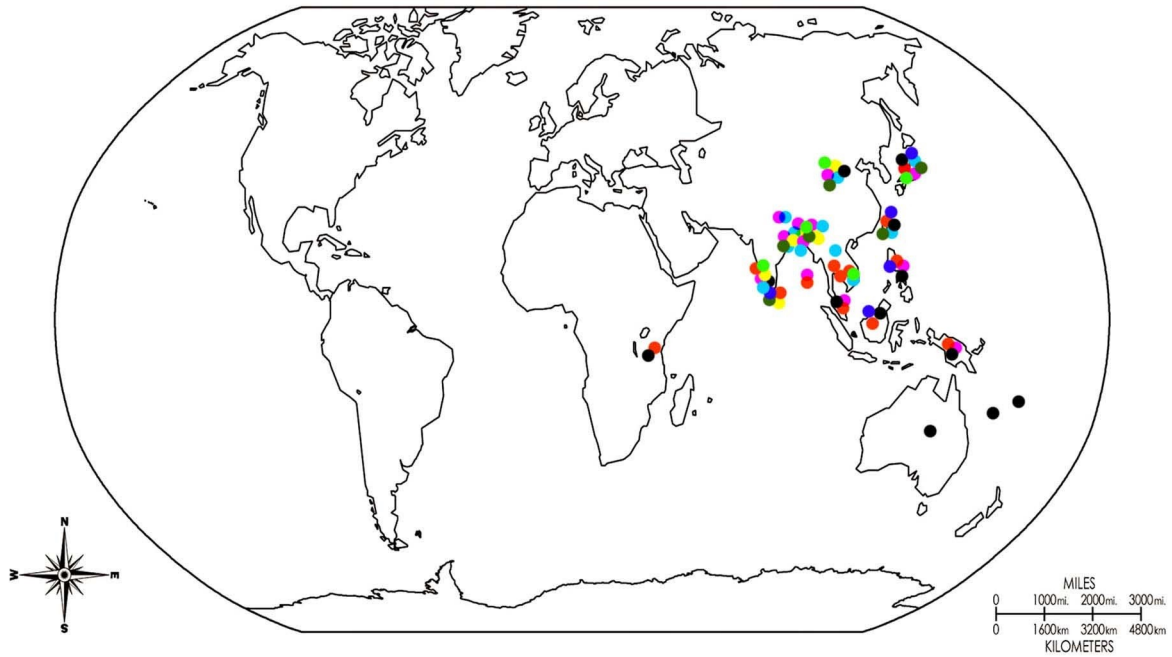
- 1a. Leaves linear-lanceolate ..... 2
- 1b. Leaves ovate or oblong ..... 3
- 2a. Leaves caducous, involute at apex, serrate at margin, with 1 or 2 teeth; teeth 2- or 3-celled ..... *D. ternatensis*

**Table 1.** Diversity and distribution of *Drepanolejeunea* (Spruce) Schiffn. in India

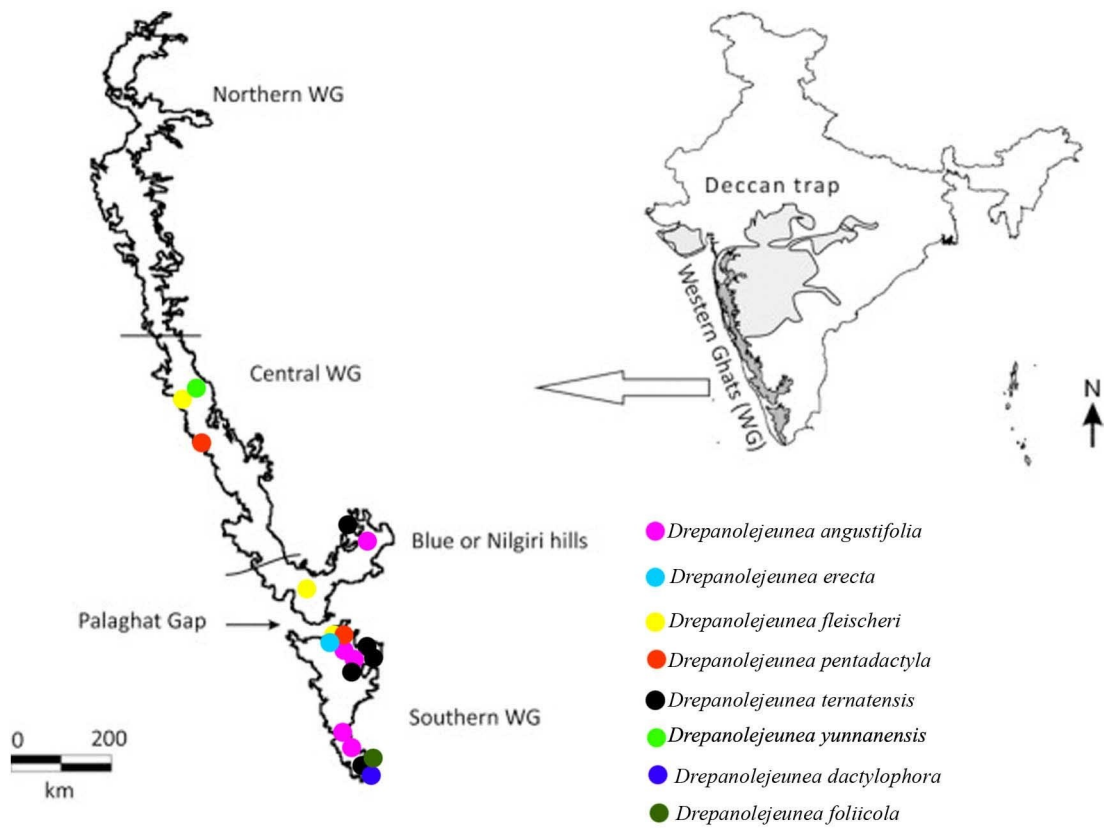
| Sl. No. | Name of the species                                          | Discovered in India by   | Place of discovery in India     | Distribution in India                                                  |
|---------|--------------------------------------------------------------|--------------------------|---------------------------------|------------------------------------------------------------------------|
| 1.      | <i>Drepanolejeunea angustifolia</i> (Mitt.) Grolle           | Mitten, 1861 (7)         | Eastern Himalaya                | Andaman & Nicobar Isl., E. Himalaya and W. Ghats (Kerala & Tamil Nadu) |
| 2.      | <i>D. dactylophora</i> (Nees et al.) Schiffn.                | Daniels & Kariyappa (42) | Western Ghats                   | W. Ghats (Tamil Nadu)                                                  |
| 3.      | <i>D. devendrae</i> S.K. Singh & M. Dey                      | Singh & Dey (43)         | Northeast India                 | NE. India                                                              |
| 4.      | <i>D. erecta</i> (Steph.) Mizut.                             | Udar & Awasthi (7)       | Eastern Himalaya                | E. Himalaya, NE. India and W. Ghats (Kerala*)                          |
| 5.      | <i>D. fleischeri</i> (Steph.) Grolle et R.-L. Zhu            | Asthana & Shukla (31)    | Western Ghats                   | E. Himalaya, NE. India and W. Ghats (Karnataka & Kerala*)              |
| 6.      | <i>D. foliicola</i> Horik.                                   | Pandé et al. (43)        | Eastern Himalaya                | E. Himalaya, NE. India and W. Ghats (Kerala & Tamil Nadu)              |
| 7.      | <i>D. herzogii</i> R.-L. Zhu et M.L. So                      | Dey et al. (27)          | Eastern Himalaya                | E. Himalaya and NE. India                                              |
| 8.      | <i>D. laciniata</i> Q. He et R.-L. Zhu                       | Singh (9)                | Eastern Himalaya                | E. Himalaya                                                            |
| 9.      | <i>D. longii</i> Grolle et R.-L. Zhu                         | Dey & Singh (18)         | Eastern Himalaya                | E. Himalaya                                                            |
| 10.     | <i>D. mawtmiana</i> A.P. Singh et V. Nath                    | Singh & Nath (16)        | Northeast India                 | NE. India                                                              |
| 11.     | <i>D. mizoramensis</i> S.K. Singh                            | Singh (44)               | Northeast India                 | NE. India                                                              |
| 12.     | <i>D. pentadactyla</i> (Mont.) Steph.                        | Asthana & Shukla (31)    | Western Ghats                   | Andaman & Nicobar Isl. and W. Ghats (Karnataka & Kerala*)              |
| 13.     | <i>D. pulla</i> (Mitt.) Grolle                               | Mitten, 1861 (17)        | Eastern Himalaya                | E. Himalaya                                                            |
| 14.     | <i>D. siamensis</i> (Bischn.) Grolle et R.-L. Zhu            | Dey & Singh (18)         | Eastern Himalaya                | E. Himalaya                                                            |
| 15.     | <i>D. spicata</i> (Steph.) Grolle et R.-L. Zhu               | Grolle & R.-L. Zhu (45)  | Northeast India                 | NE. India                                                              |
| 16.     | <i>D. ternatensis</i> (Gottsche) Steph.                      | Udar & Awasthi (7)       | Western Ghats                   | W. Ghats (Kerala* & Tamil Nadu)                                        |
| 17.     | <i>D. thwaitesiana</i> (Mitt.) Steph.                        | Dey et Singh (36)        | Andaman & Nicobar Islands       | Andaman & Nicobar Isl.                                                 |
| 18.     | <i>D. tibetana</i> (P.C. Wu et J.S. Lou) Grolle et R.-L. Zhu | Dey & Singh (18)         | Eastern Himalaya                | E. Himalaya                                                            |
| 19.     | <i>D. vesiculosa</i> (Mitt.) Steph.                          | Udar & Awasthi (7)       | Northeast India                 | NE. India                                                              |
| 20.     | <i>D. yunnanensis</i> (P.C. Chen) Grolle et R.-L. Zhu        | Udar & Awasthi (46)      | Western Ghats/ Eastern Himalaya | E. Himalaya, NE. India and W. Ghats (Karnataka)                        |

\* Present study

- 2b. Leaves not caducous, not involute at apex, entire at margin ..... *D. angustifolia*
- 3a. Leaves irregularly toothed at margin with 3 to 8 teeth ..... 4
- 3b. Leaves entire at margin ..... 5
- 4a. Leaf lobules 1/2 to 3/4 as long as leaf, 2-toothed at apex; first tooth large, hooked ..... *D. pentadactyla*
- 4b. Leaf lobules 2/3 as long as leaf, 2-toothed at apex; first tooth neither large nor hooked.....  
.....*D. dactylophora*
- 5a. Underleaf sinus 3 to 5 times as wide as stem; free lateral margin of leaf lobule bordered by more than 5 rectangular cells ..... 6
- 5b. Underleaf sinus twice as wide as stem; free lateral margin of leaf lobule bordered by 4 rectangular cells .....*D. erecta*
- 6a. Leaf lobules 1/2 to more than half as long as leaf; first tooth of lobule cell curved like a hook..... 7
- 6b. Leaf lobules not more than 1/2 as long as leaf; first tooth of lobule not curved like a hook.....*D. foliicola*
- 7a. Leaf lobule 1/2-3/4 as long as the leaf lobe, lobes of the lobule uniseriate at extreme tip with 3-4 cells long .....*D. fleischeri*
- 7b. Leaf lobule 2/5 as long as the leaf lobe, lobes of the lobule linear, uniseriate with 6-9 cells long. ....*D. yunnanensis*
- Drepanolejeunea angustifolia*** (Mitt.) Grolle, J. Jap. Bot. 40: 206. 1965; Udar & U.S. Awasthi, J. Hattori Bot. Lab. 53: 420. 1982; Manju et al., Trop. Bryol. Res. Rep. 7: 4. 2008; A.E.D. Daniels, Arch. Bryol. 65. 2010; A.E.D. Daniels & P. Daniel, Bryofl. S. W. Ghats. India: 147. 2013; Manju et al., Act. Biol. Plant. Agri. 2: 132. 2012; M. Dey & D.K. Singh, Epiphyll. Liverw. E. Himal.: 216.



Map 1A. World distribution of the Genus *Drepanolejeunea*



Map 1. B Distribution of the Genus *Drepanolejeunea* and distribution in Western Ghats

2012; M. Dey *et al.*, Trop. Bryol. 35: 15. 2013; D.K.Singh *et al.*, Liverw. & Hornw. India, 134: 2016; A.E.D.Daniels & Kariyappa, Bryo. Agasthyamalai Bio. Res.: 485. 2019. *Jungermannia tenuis* Reinw., Blume & Nees, Nova Acta Acad. Caes. Leop.- Carol. German.

Nat. Cur. 12: 226. 1824. *Lejeunea angustifolia* Mitt., J. Proc. Linn. Soc., Bot. 5: 116. 1861. *Drepanolejeunea tenuis* (Reinw., Blume & Nees) Schiffn., Consp. Hepat. Arch. Ind. 280. 1898; Mizutani, J. Hattori Bot. Lab. 26: 172.1963; Udar & Awasthi, J. Hattori Bot. Lab. 53: 420.

1982. *Physocolea angustifolia* (Mitt.) Steph., Sp. Hepat.5: 887.1916. *Drepanolejeunea longifolia* A.P. Singh & V. Nath, Hepat. Khasi Jaintia Hills: E. Himal. 248. 2007.

**Type:** India, Sikkim, J.D. Hooker 1498 (BM).

Plants pale green when fresh and brownish when dry, 4-10 × 0.31-0.35 mm including leaves, branched; stem in transverse section with 7 cortical cells, 10-15 × 12-14 µm, 4 medullary cells, 4-8 × 6-9 µm diagonally, ventral merophytes 2 cells wide; rhizoids present at the base of underleaves, numerous, tufted, hyaline; rhizoidal disc absent; leaves distant, diverging from stem at an angle of 30-40°; leaf lobe linear-lanceolate, erect-spreading, 0.28-0.30 × 0.09-0.13 mm; apex acute, ending in a single cell; margin slightly serrulate, arched dorsally, straight ventrally; cells at margin polygonal, 11-23 µm; median cells rounded to polygonal, 20-25 × 10-13 µm; basal cells hexagonal, polygonal, 18-20 × 10-15 µm; trigones and intermediate nodular thickenings absent; cells smooth; oil bodies and ocelli not seen; leaf lobule inflated, ½ as long as leaf lobe, ovate, 0.10-0.16 × 0.10-0.11 mm, bilobed; first tooth unicellular, elongate, curved; second tooth indistinct; free lateral margin bordered by 4 linear cells; keel arched; underleaves distant, small, as wide as stem, bilobed, sinus V-shaped, 0.04-0.08 × 0.06-0.07 mm; lobes uniseriate, 2-3 cells long, 2 cells wide at base; reproductive structures not seen (Fig. 1 & 2).

**Specimens examined:** India, Kerala, Idukki, Anamudi shola NP, Mannavan shola, Idalimotta (2200 m, 10°11'40"N 77°10'31"E), 25.09.2018, Mufeed 9972, 10018c (ZGC); Eravikulam NP, Amarshola (2000 m, 10°10'45"N 77°05'26"E), 23.10.2001 Manju C.N. 80241/b (CALI).

**Habitat:** Epiphytic on tree trunk.

**Distribution: World:** Bhutan (6), China (7), Japan (8), Malaysia (9), Nepal (10), Papua New Guinea (11), Philippines (12). **India:** Andaman (13, 14), Arunachal Pradesh (15), Meghalaya (16), Sikkim (17 as *L. angustifolia*, 18), West Bengal (5 & 19 as *D. tenuis*) **Western Ghats;** [Tamil Nadu; Nilgiri BR, Doddabetta (5), Kanyakumari, Upper Kodaiyar (20), **Kerala;** Idukki, Eravikulam NP, Amarshola (21, 22), Anamudi shola National Park, Idalimotta (Present study)].

*Drepanolejeunea erecta* (Steph.) Mizut., J. Hattori Bot. Lab. 40: 442. 1976; A.P.Singh & V.Nath Hepat. Khasi Jaintia Hills: E. Himal: 250 2007; M.Dey & D.K. Singh, Epiphyll. Liverw. E. Himal. 219. 2012; M. Dey et al., Trop. Bryol. 35: 16. 2013; D.K. Singh et al., Liverw. & Hornw. India, 134: 2016. *Leptolejeunea erecta* Steph., Bull. Soc. Roy. Bot. Belgique 38: 44. 1899; Stephani, Sp. Hep. 1044. 1913 *Strepsilejeunea monophthalma* Herzog in Hand.- Mazz., Symb. Sin. 5:47. 1930. *Drepanolejeunea monophthalma* (Herzog) Mizut., J. Hattori Bot. Lab. 29: 291.1996; Hattori, Fl. East. Himalaya, 501- 536: 1966.

**Type:** India, Darjeeling, 1894, Stevens 509 Holotype-G-14859.

Plants yellowish green in fresh, yellowish brown when dried, stem 5-15 × 0.57-0.70 mm including leaves, branched, irregular, stem in transverse

section with 7 cortical cells 13-23 µm, 4 medullary cells, small, 13-17 µm, slightly thick walled, ventral merophytes 2 cells wide; rhizoids tufted at the base of under leaves, hyaline, rhizoidal disc present; leaves contiguous, obliquely spreading, diverging from stem at 32-42° angle, leaf lobe ovate oblong, 0.28-0.32 × 0.12-0.20 mm, apex subacute, margin crenulate due to papillae, dorsal margin arched, concave, ventral margin slightly arched, leaf cells thick walled, cuticle present, trigones and intermediate nodular thickening present, leaf marginal cells rectangular, elongated, 7-14 × 3- 7 µm, median cells polygonal, 6.5-17.6 × 3-7 µm, basal cells elongated, rectangular, 19-26 × 4.90-6.00 µm, ocelli 1-2 per cells; leaf lobule inflated, 1/3-1/2 as long as the leaf lobe, 0.10-0.15 × 0.06-0.07 mm, oblong ovate, bidentate, first tooth unicellular, curved, 28-35 × 6-10 µm, proximal hyaline cell at the tip of first tooth, second tooth indistinct, free lateral margin bordered by 4 linear rectangular cells, keel arched, smooth; underleaves distant, 0.8-0.12 × 0.6-0.8 mm, bilobed, uniseriate lobes, 4-6 cells long, 4 cells wide at base, uniseriate above, lamina composed of 6-7 cells surrounding numerous rhizoidal initial cells, twice wider than stem, spreading at 43-83° angle with stem, similar with *Leptolejeunea* type, ie, the underleaves with uniseriate lobes and rhizoidal discs shown in genus *Leptolejeunea* in some of the underleaves. Asexual and Sexual reproductive structures are not observed. (Fig. 3-5).

**Specimens examined:** India, Kerala, Kollam, Shenduruni WLS, Pandimotta (1300 m, 8°49'05"N 77°13'52") 22.09.2019 Chandini 10785c, 10786, 10791 (ZGC).

**Habitat:** Epiphyllous, growing along with *Cololejeunea ocellata* (Horik.) Benedix, *Cololejeunea haskarliana* (Lehm. & Lindenb.) Schiffn., *Lejeunea tuberculosa* Steph. and *Lejeunea exilis* (Reinw. et al.) Grolle.

**Distribution: World;** Bhutan (6), China (7), Japan (23), Laos (24), Nepal (25), Taiwan (26), Vietnam (24).

**India;** Assam (18), Arunachal Pradesh (18, 27), Manipur (28), Meghalaya (5, 16), Sikkim (9, 13, 18, 29, as *D. monophthalma*, as *Leptolejeunea erecta*; (5), West Bengal (29 as *D. monophthalma*, 18), **Western Ghats;** (Kerala, Present study). Present study records this species for the first time from the Western Ghats.

*Drepanolejeunea fleischeri* (Steph.) Grolle & R. L. Zhu, Nova Hedwigia 70: 379. 2000; A.K. Astahana & Shukla, J. Bryol. 31: 139: 2009; M. Dey & D.K. Singh, Epiphyll. Liverw. E. Himal.: 223. 2012; D.K. Singh et al., Liverw. & Hornw. India: 135: 2016. *Leptolejeunea fleischeri* Steph., Sp. Hepat. 5: 382. 1913.

**Type:** Sri Lanka, Fleischer 2024 (Lectotype- G-11858).

Plant light green in fresh, yellowish brown when dried, stem 5-10 × 0.6-1.2 mm including leaves, branched, irregular, stem in transverse section with 7 cortical cells, 4 small medullary cells, slightly thick walled, ventral merophytes 2 cells wide; rhizoids tufted at the base of underleaves, hyaline, rhizoidal disc absent; leaves contiguous, imbricate, obliquely spreading, leaf lobe oblong ovate, 0.30-0.60 × 0.2-0.35 mm, apex acute, margin denticulate, dorsal margin



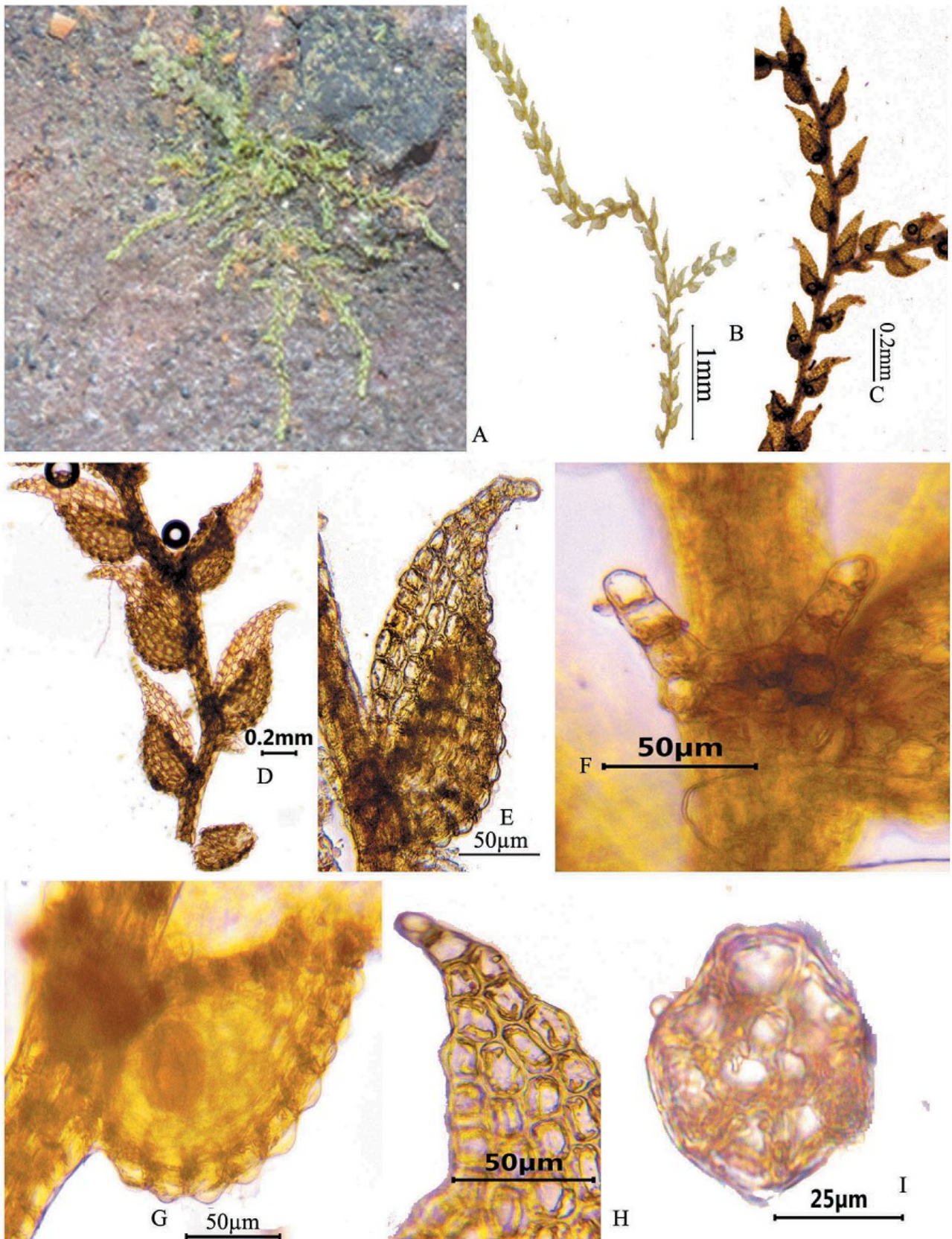


Fig. 1 (A-I). *Drepanolejeunea angustifolia* (Mitt.) Grolle, A. habit, B. single plant, C & D. branch enlarged view, E. leaf with lobule, F. underleaf, G. leaf lobule, H. leaf tip cells, I. C. S. of stem.

arched, ventral margin almost straight, apical leaf cells quadrate to sub quadrate, polygonal,  $4-8 \times 5-7 \mu\text{m}$ , median cells hexagonal,  $9-22 \times 10-16 \mu\text{m}$ , basal cells large, polygonal,  $17-36 \mu\text{m}$ , leaf cells thin walled,

trigones small or indistinct, ocelli 1-2 per cells, oil bodies single and clustered, 5-10 in number; leaf lobule; inflated,  $1/2-3/4$  as long as the leaf lobe, ovate,  $0.08-0.15 \text{ mm}$  long,  $0.30-0.34 \text{ mm}$  wide, 2 toothed,

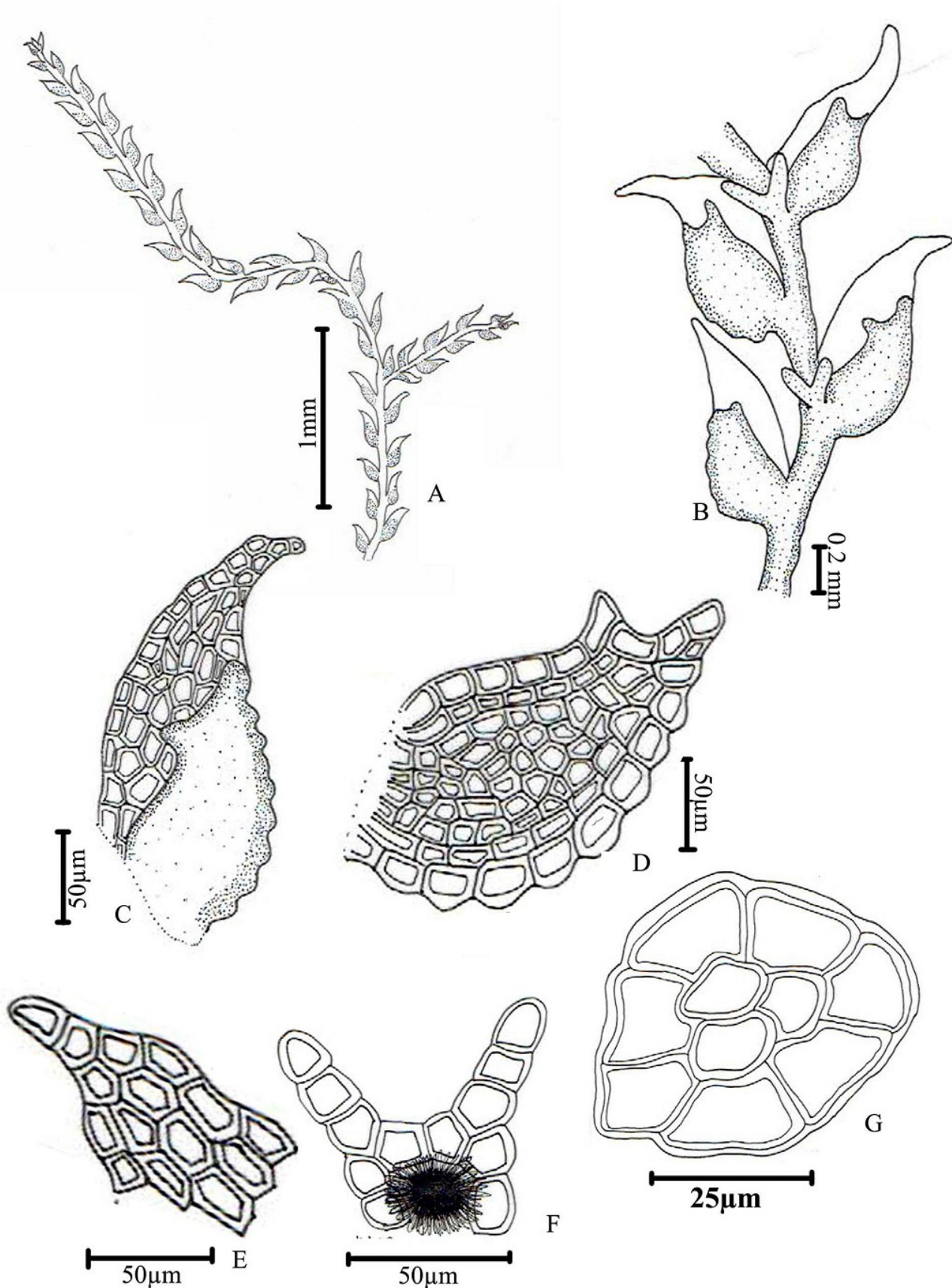


Fig. 2 (A-G). *Drepanolejeunea angustifolia* (Mitt.) Grolle. A. portion of plant, B. a portion of stem ventral view, C. single leaf, D. leaf lobule, E. cells at leaf apex, F. underleaf, G. stem C.S.

first tooth unicellular, strongly curved like a hook, 20-24  $\mu\text{m}$  long, second tooth unicellular, hyaline papilla at the proximal side of first tooth, free lateral margin bordered by 7-10 linear rectangular cells, keel

arched, smooth, trigones minute; underleaves distant, 0.16-0.2  $\times$  0.11-0.18 mm, bilobed, sinus 5 times wider than stem, uniseriate at extreme tip, 3-4 cells long, biseriate below, 5-6 cells long, 4 cells wide at base,



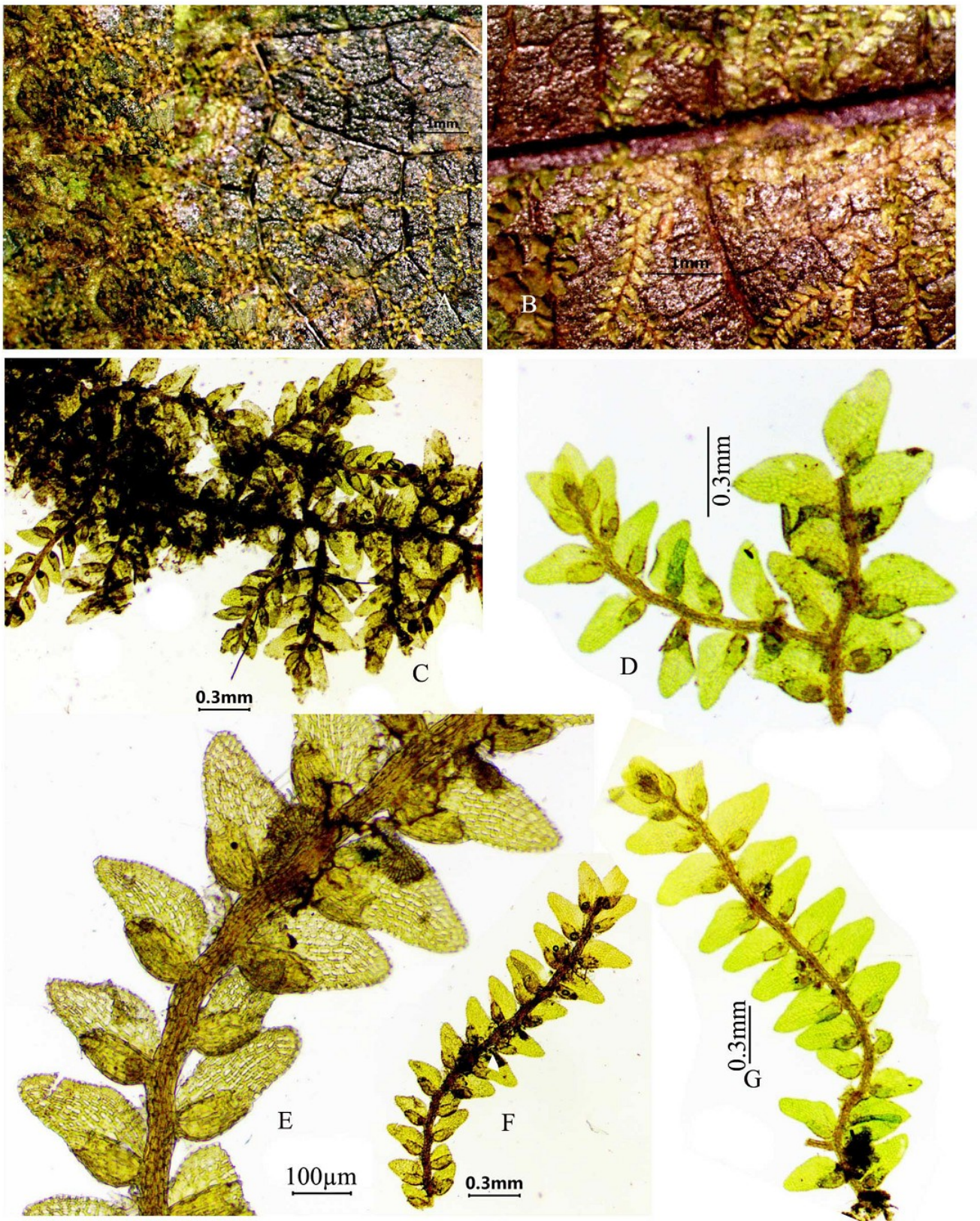


Fig. 3 (A-E). *Drepanolejeunea erecta* (Steph.) Mizut., A & B. thallus on leaf surface, C. branched thallus separated from leaf surface, D, F & G. single branch enlarged, E. enlarged view of portion of thallus.

cells rectangular to hexagonal, perianth on short lateral branches without innovations, perianth sharply 5 plicate with horizontal, triangular shaped horns, androecia not seen, mature sporophytes, asexual reproductive structures not observed (Fig. 6 & 7).

**Specimens examined:** India, Kerala, Wayanad, Meppadi, (850 m,- 11°33'18"N 76°11'09"E) 04.05.2017 K.P. Rajesh 10230, 10238 (ZGC); Palakkad, Parambikulam Tiger Reserve, Karimala (1110 m, 10°27'59"N 76°53'42"E) 05.12.2019 Chandini & Sajitha 11032b (ZGC).



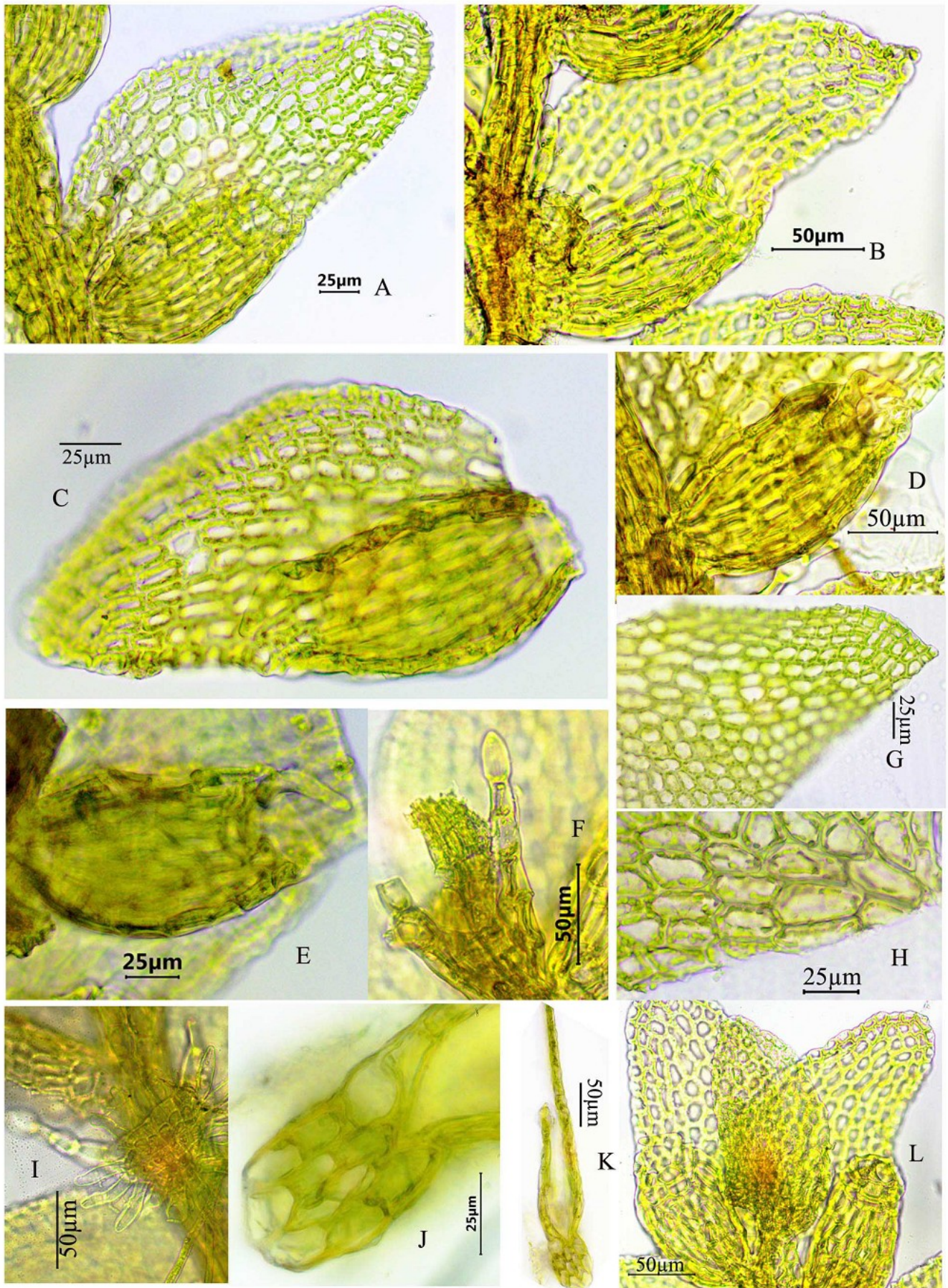


Fig. 4 (A-L). *Drepanolejeunea erecta* (Steph.) Mizut., A & B. leaf attached to stem, C. leaf lobe with lobule, D & E. lobule enlarged view, F & I. under leaves, G. leaf tip cells, H. leaf basal cells, J. C. S. of stem, K. C. S. of stem and leaf, L. branch tip.



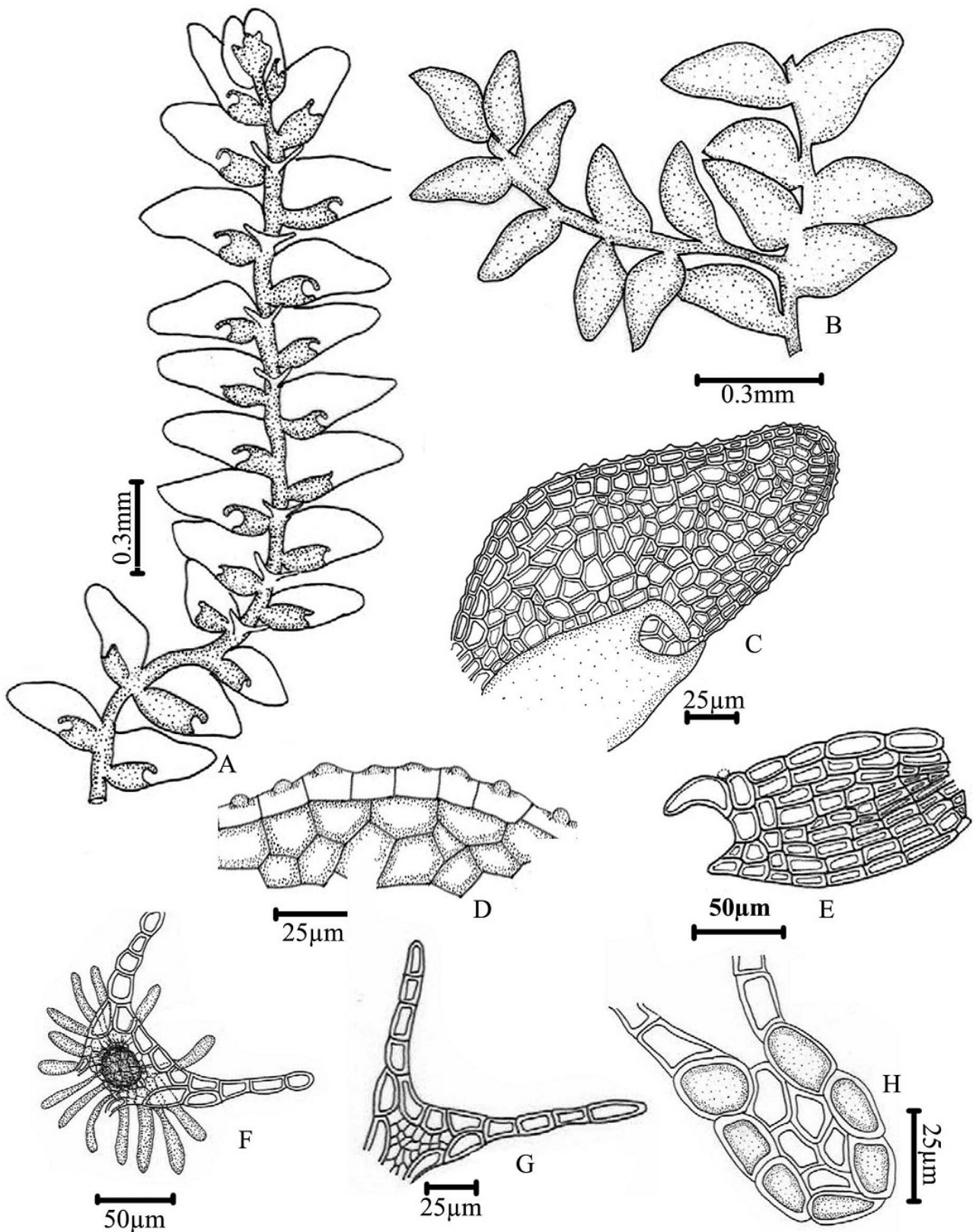


Fig. 5 (A-H) . *Drepanolejeunea erecta* (Steph.) Mizut., A. plant ventral view, B. branch dorsal view, C. single leaf, D. leaf marginal cells, E. leaf lobule, F. underleaf with rhizoids, G. underleaf, H. stem C. S.

**Habitat:** Epiphyllous on leaves of angiosperm tree and fronds of *Hymenophyllum* sp. growing along with *Cololejeunea truncatifolia* (Horik.) Mizut., *Drepanolejeunea pentadactyla* (Mont.) Steph. and *Leptolejeunea latifolia* (Herzog) R. M. Schust.

**Distribution:** World; China (24), Sri Lanka (30), India; Arunachal Pradesh, Sikkim, West Bengal, Meghalaya (9, 18) **Western Ghats;** Karnataka, Kudremukh, (31); Kerala, Wayanad, Palakkad (Present collections).



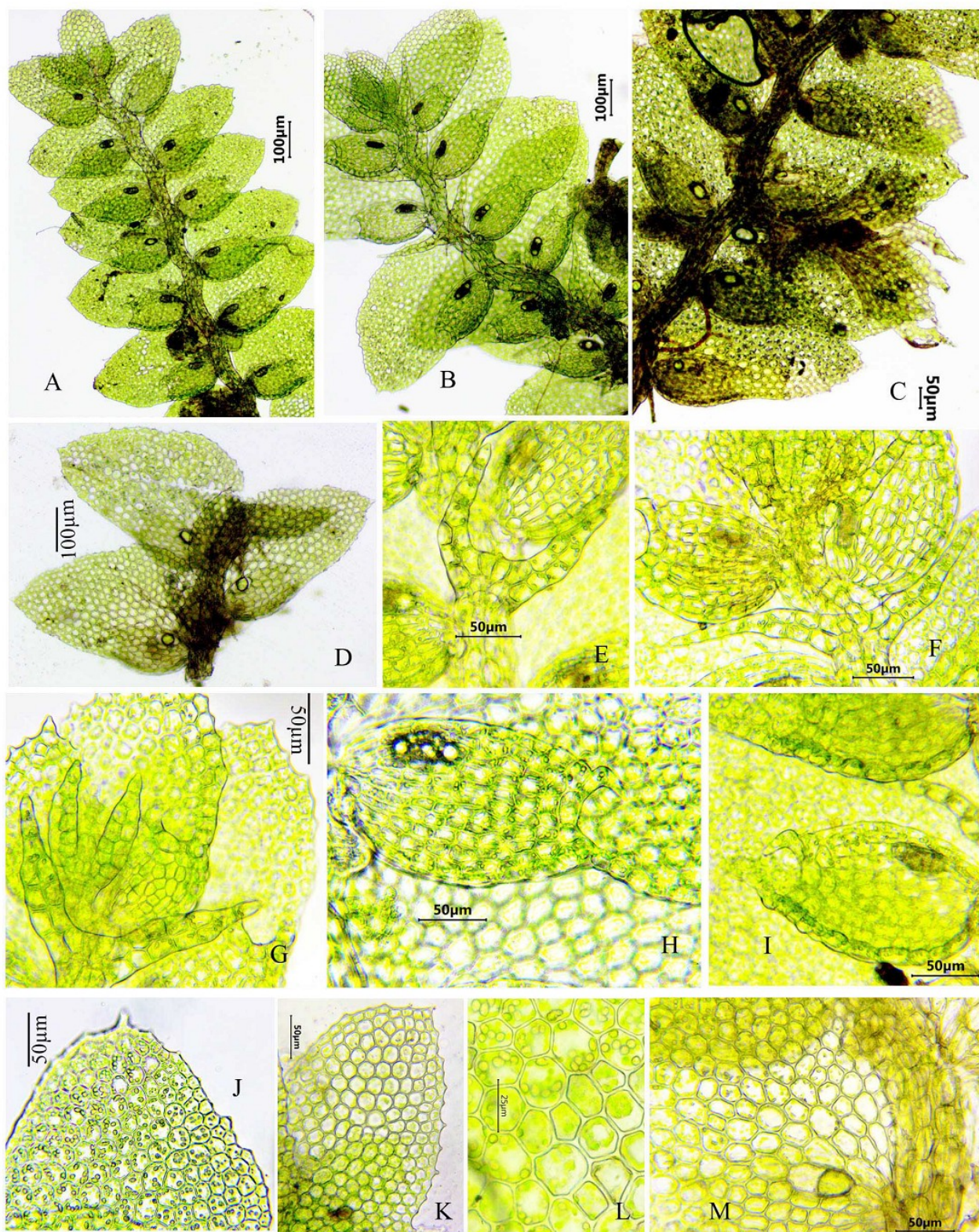


Fig. 6 (A-M). *Drepanolejeunea fleischeri* (Steph.) Grolle & R. L. Zhu, A & B. a portion of plant ventral view, C. plant with perianth, D. leaf arrangement, E & F. under leaves, G. plant apex with underleaves, H & I. leaf lobule, J & K. leaf apex, L. leaf cells with oil bodies, M. leaf basal cells.

*Drepanolejeunea pentadactyla* (Mont.) Steph., Spec. Hepat. 5: 357. 1913; A.K. Astahana & Shukla, J. Bryol. 31: 142: 2009; M. Dey & D.K. Singh Trop. Bryol. 35: 19. 2013; D.K. Singh *et al.*, Liverw. & Hornw. India 136: 2016. *Lejeunea pentadactyla* Mont., Ann. Sci. Not., Bot., Ser.3, 10: 113. 1848. *Drepanolejeunea micholitzii* Steph., Sp. Hepat. 5: 347. 1913. *D. chiponensis* Horik., J. Sci. Hiroshima Univ., Ser. B, Div.

2: 262. 1934. *D. tenuioides* Horik., J. Sci. Hiroshima Univ., Ser. B, Div. 2, Bot. 2: 262. 1934.

**Type:** Tahiti. Coll.: Lepin (s.n.), s.d. Holotype: PC.

Plants green to yellowish when fresh, golden brownish when dry, 4-10 × 0.24-0.3 mm including leaves, branched, vegetative branches 1-3mm long, stem in transverse section with seven cortical cells



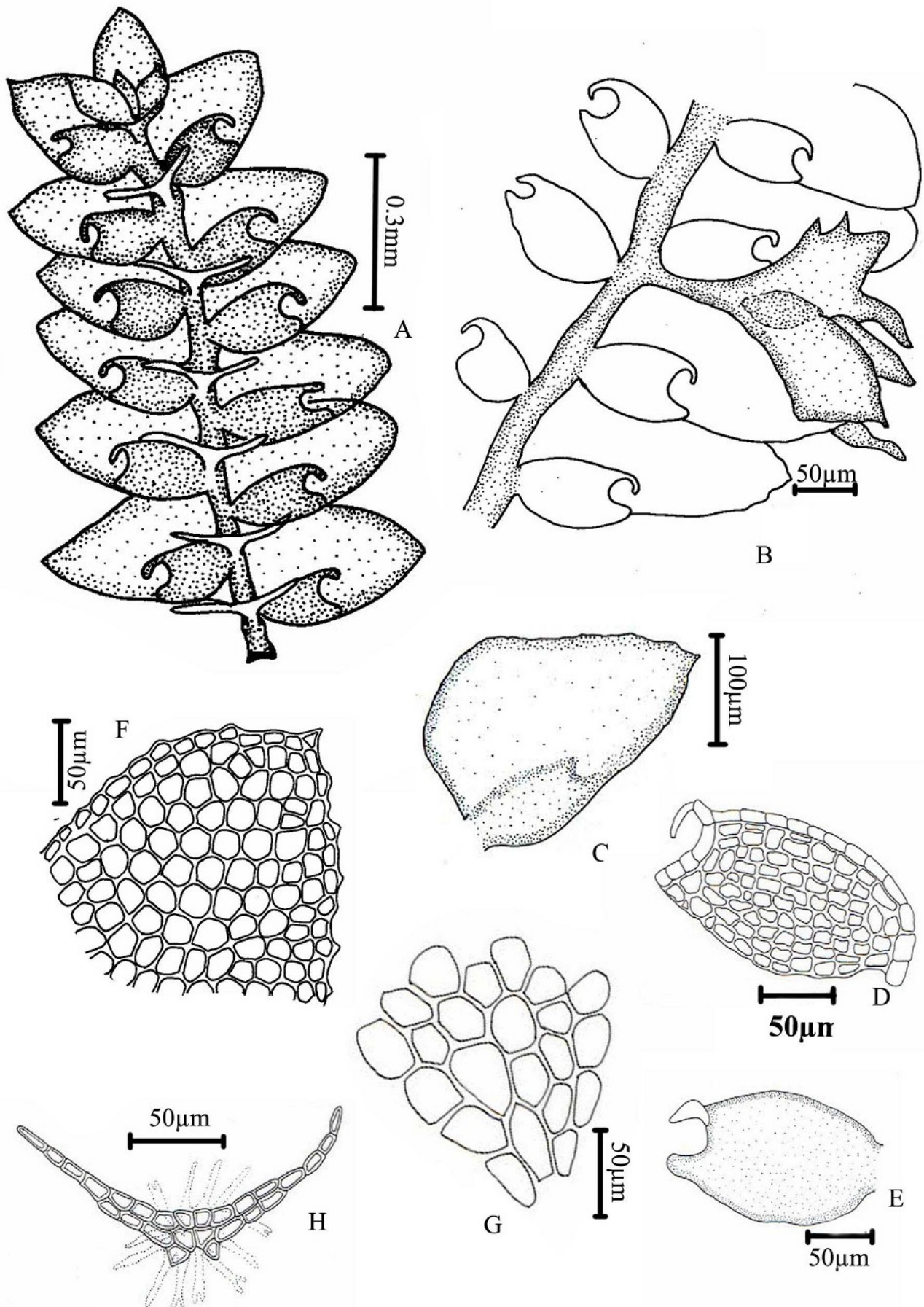


Fig. 7 (A-H). *Drepanolejeunea fleischeri* (Steph.) Grolle & R. L. Zhu, A. portion of plant ventral view, B. female plant with perianth, C. single leaf, D & E. leaf lobule, F. cells at leaf apex, G. leaf basal cells, H. under leaf.



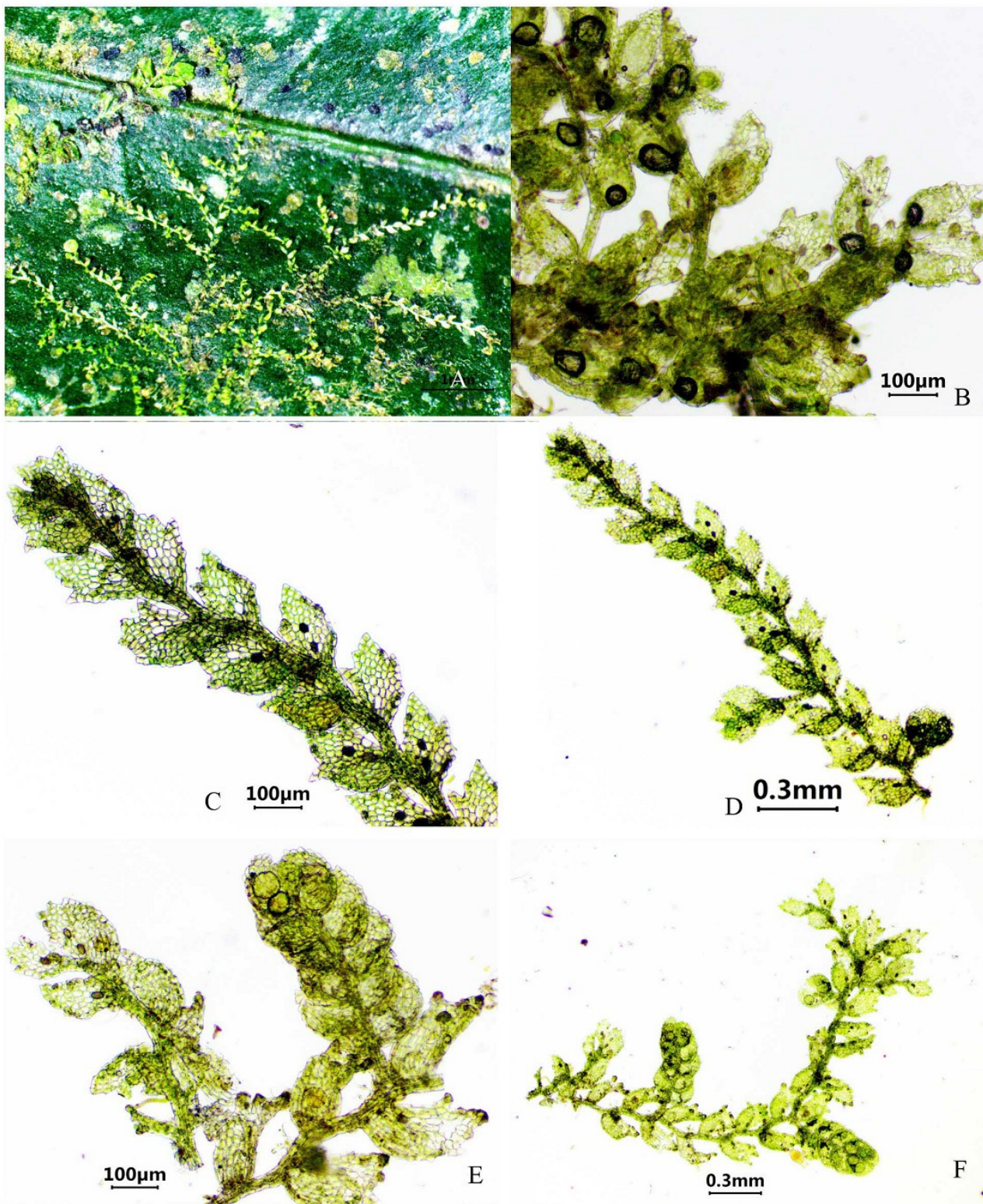


Fig. 8 (A-F). *Drepanolejeunea pentadactyla* (Mont.) Steph., A & B. habit, C & D. single plant dorsal view, E & F. male plant with antheridium.

and three medullary cells; ventral merophytes 2 cells wide; rhizoids present at the base of underleaves, few, tufted, hyaline, rhizoidal disc absent; leaves contiguous, distant, diverging from stem at an angle of  $41-54^\circ$ , leaf lobe oblong-lanceolate to elliptic,  $0.18-0.25 \times 0.09-0.13$  mm, apex acute, margin with 5 tooth, rarely 3, teeth 2-3 cells long, 2-3 cells wide, each teeth with the apical cells acuminate and subquadrate, thin walled,  $13.6-$

$22.68 \times 5.90-10.25$   $\mu\text{m}$ , median cells rectangular to hexagonal,  $16-28 \times 9.15$   $\mu\text{m}$ , basal cells elongated rectangular,  $30-42$   $\mu\text{m}$ , trigones and intermediate nodular thickenings absent, ocelli present in some leaves, if present two in number, not seriate, separated by one normal leaf cell; leaf lobule dimorphic, reduced lobules  $0.07-0.09 \times 0.02-0.04$  mm, 4-5 cells long along the margin with two layer cells long, large lobules inflated, ovate,  $\frac{1}{2}$  to  $\frac{3}{4}$  as



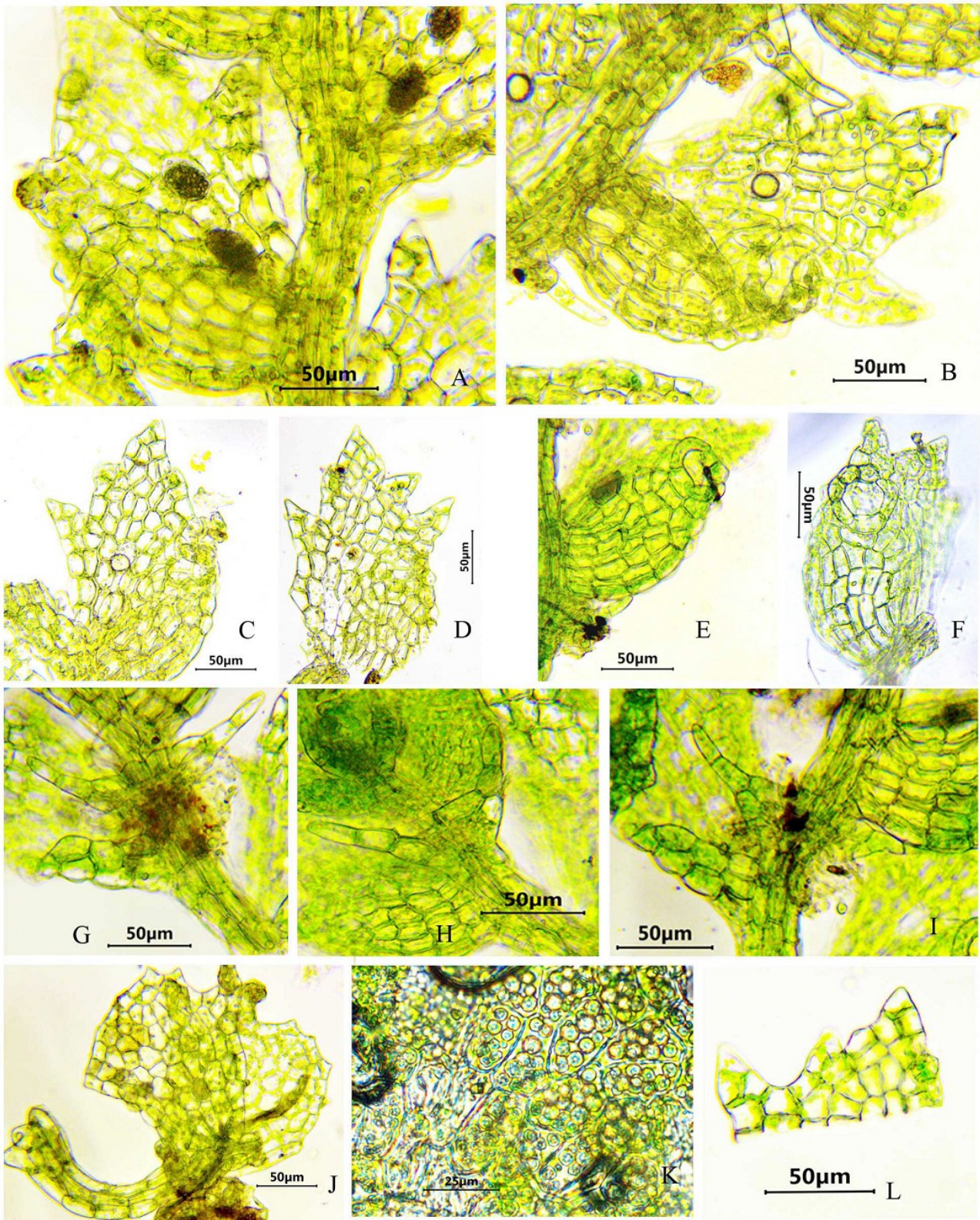


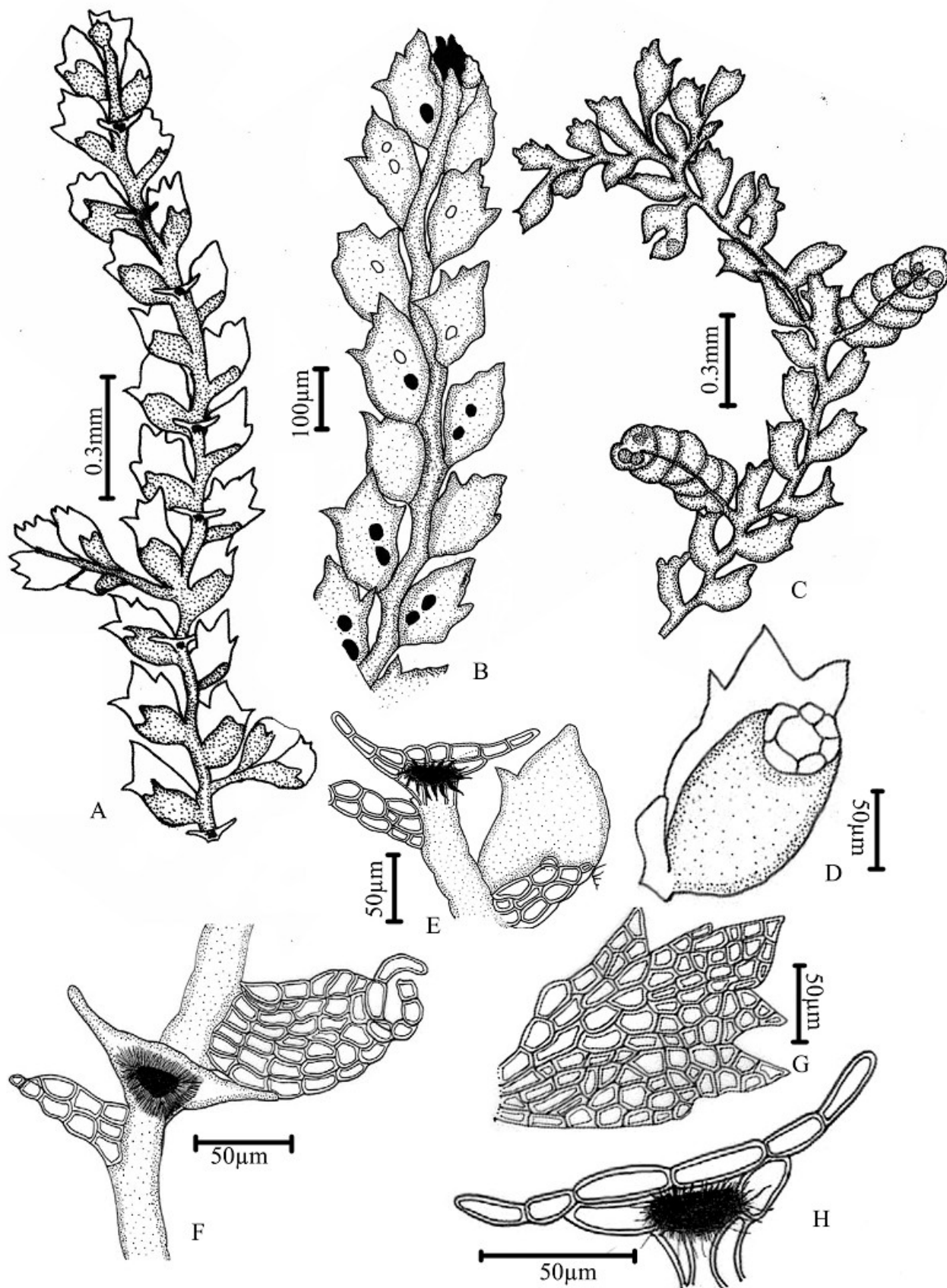
Fig. 9 (A-L). *Drepanolejeunea pentadactyla* (Mont.) Steph., A. leaf with ocelli, B. leaf with lobule, C& D. single leaf, E & F. inflated lobule, G, H & I. underleaf and reduced leaf lobule, J. Perianth, K. leaf cell with oil bodies, L. leaf apex with teeth.

long as leaf lobe, 0.10-0.13 × 0.06-0.09 mm wide, lateral margin of lobule bordered by 4 rectangular cells, 15-25 × 9-11 µm, first tooth large, single hook shaped cell, 22-24 µm, hyaline papilla present on the proximal base of the first tooth, second tooth indistinct, keel arched, serrated; underleaves bilobed, distant, one underleaf for each pair of leaf

lobes, 0.03-0.05 mm long, 0.12-0.14 mm wide, 3 times wide as stem, lobes uniseriate, 2-3 cells long, 2 cells wide at base, spreading, 80-100° angle with stem.

Dioecious, androecia capitate, on short lateral branches, 2-5 pairs of bracts, imbricate, antheridium globular, 60-62.5 µm in diameter, bracteoles rarely





**Fig. 10 (A-H).** *Drepanolejeunea pentadactyla* (Mont.) Steph., **A.** portion of plant ventral view, **B.** plant dorsal view, **C.** male plant dorsal view, **D.** leaf with lobule, **E & F.** leaf lobule and underleaf, **G.** single leaf, **H.** under leaf.

one or absent, position of gynoecia not clearly identified because of the rare occurrence of female reproductive structures, only fragmented and immature form of perianth is observed, perianth

serrated, 0.16 × 0.13 mm, female bract same as leaf lobe, cells polygonal in shape, 15-22 µm. (Fig. 8-10).

**Specimens examined:** India, Kerala, Palakkad, Parambikulam Tiger Reserve, on the way to Karimala



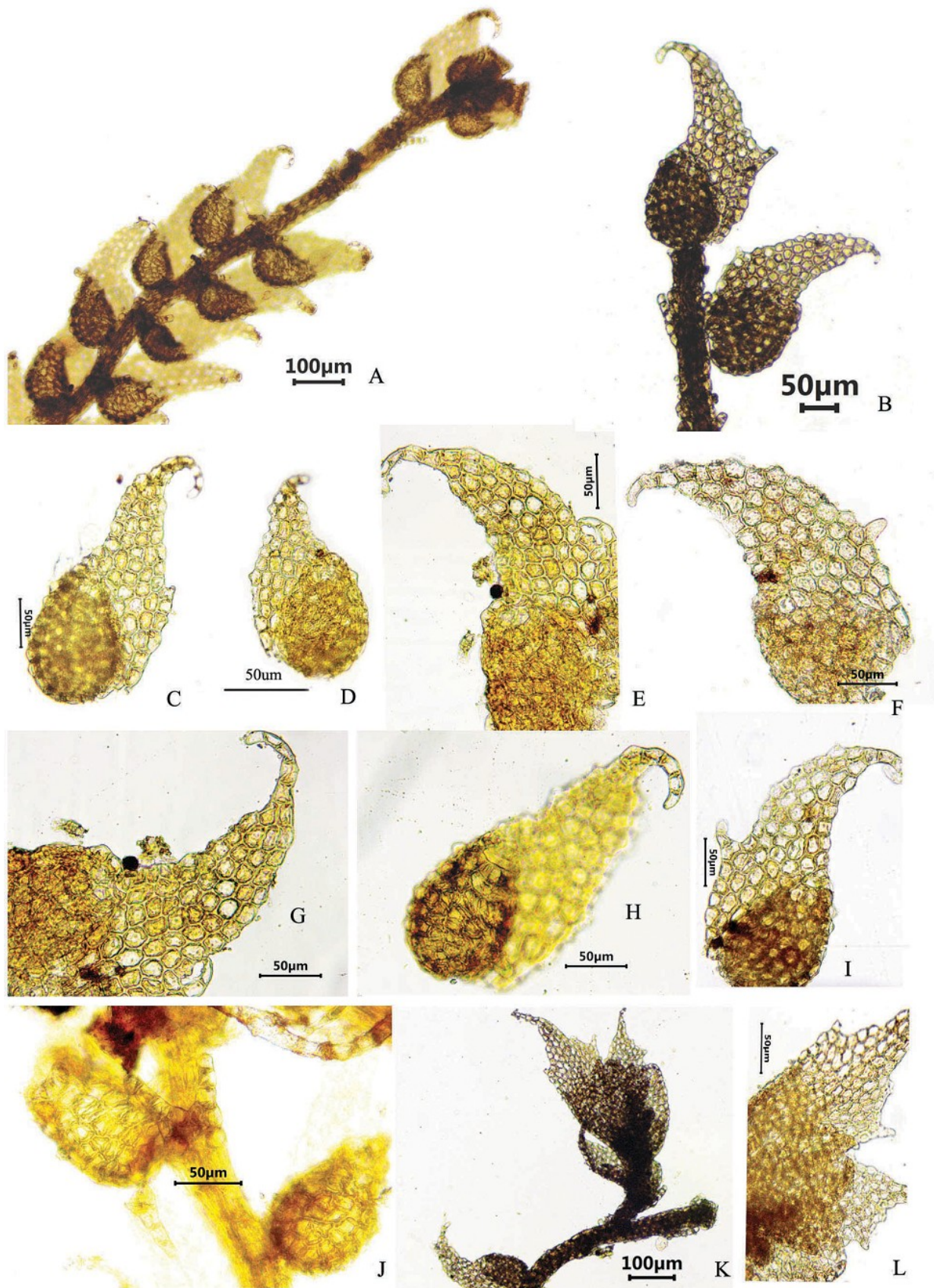


Fig. 11 (A-L). *Drepanolejeunea ternatensis* (Gottsche) Steph., A. portion of plant with cauducous leaves, B. leaves attached to stem, C-G. leaf lobes, H & I. leaf lobule and involute leaf apex, J. stem with underleaf, K. perianth, L. Perianth cells enlarged view.

(1110 m, 10°27'59"N 76°53'42"E) 05. 12. 2019 Chandini & Sajitha 11028, 11029b, 11032 d, 11033 (ZGC).

**Habitat:** Epiphyllous, growing along with *Cololejeunea truncatifolia* (Horik.) Mizut.,

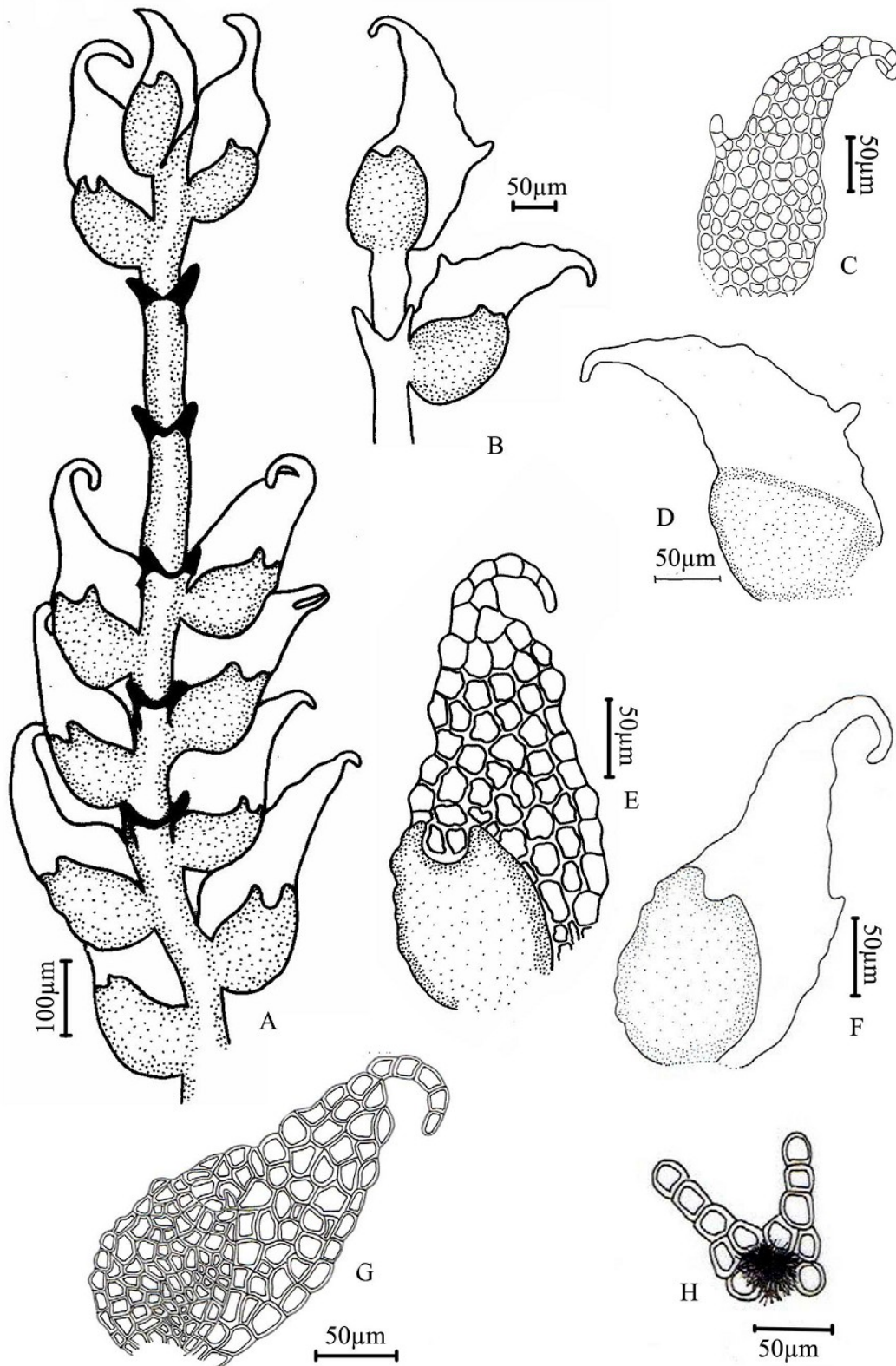


Fig. 12 (A-H). *Drepanolejeunea ternatensis* (Gottsche) Steph., A. plant ventral view with caducous leaf, B. portion of stem ventral view, C & D. leaf dorsal view, E-G. different view of leaf lobule with unerleaf, H. Underleaf.

*Drepanolejeunea fleischeri* (Steph.) Grolle & Zhu. and *Leptolejeunea latifolia* (Herzog) R.M. Schust.

**Distribution:** World; Africa (32), Cambodia (24), China (7), Indonesia (33), Japan (32), Malaysia (33), Vietnam (24), Papua New Guinea (11), Philippines

(12), Sri Lanka (30), Taiwan (26), Thailand (34), **India**; Andaman Nicobar (35), Nagaland (9); **Western Ghats**; [Karnataka, Kudremukh (31), Kerala (Present Collection)]. The present collection is a new record to Kerala.



*Drepanolejeunea ternatensis* (Gottsche) Steph., Hedwigia 28: 169. 1889; A.E.D. Daniels, Arch. Bryo 65: 13. 2010; A.E.D. Daniels & P. Daniel, Bryofl. S. W. Ghats. India: 147. 2013; A.E.D. Daniels & Kariyappa, Bryo. Agasthyamalai Bio. Res.: 490. 2019. *Lejeunea ternatensis* Gottsche in Gottsche *et al.*, Syn. Hepat. 346. 1845. *Drepanolejeunea ternatensis* (Gottsche) Steph. var. *lancispina* Herzog, Ann. Bryol. 12: 119. 1939; Udar & Awasthi, J. Hattori Bot. Lab. 53: 430. 1982; A.K. Asthana & S.C. Srivasthava, Pl. Sci. Today 2 (4): 185. 2015.

**Type:** Indonesia, Java (JE).

Plant light green, brown when dried, small, 1.15-3 × 0.23-0.28 mm including leaves, deeply appressed to the substratum; branching irregular, rhizoids few, hyaline; ventral merophytes two cells wide; stem c.s. with 7 cortical cells and 3 medullary cells; leaves distant, diverging from stem at 35-40° angle, caducous, linear lanceolate, 0.24-0.3 × 0.10-0.12 mm, margin falcate, dorsal margin convex, irregularly toothed, tooth with 1-2 celled, ventral margin arched, serrated, apex acuminate, uniseriate at extreme tip, 4-6 cells long, curled towards dorsal margin, 19-20 × 7-9 µm, marginal cells papillate, rounded-quadrate, 23-31 × 14-15 µm, basal cells of toothed margin of leaf lobe elongated, 36.74 × 76.88 µm, basal and median cells quadrate to rounded, 20-40 × 15-20 µm, trigones and intermediate thickenings are present throughout the cells; leaf lobule inflated, ovate 0.05-0.1 × 0.04-0.10 mm, ovate, involute at margin, first tooth distinct, second one indistinct; underleaves bilobed, 0.05-0.07 × 0.03-0.04 mm, sinus as wide as stem, 3 cells long, 0.04 mm long, attached with two lateral cells on each side, 6 marginal cells encircling the stem attachment area, cells circular, polygonal, 9-14 µm.

Androecia is not seen, perianth is present on short lateral innovation, lobes toothed, 2-3 cells long, margin serrated, cells 29-34 µm, perianth lobe up to 0.35 mm long, male and other asexual reproductive structures are not seen (Fig. 11 & 12).

**Specimens examined:** India, Kerala, Idukki, Anamudi shola National Park (1697 m, 10°12'21"N 77°11'09"E), 31.01.2016 Manju, A.C. 10227 (ZGC).

**Habitat:** Epiphytic on bark.

**Distribution:** **World;** Australia (36), Africa (37), China (24), Japan (8), Fiji, Indonesia (38), Malaysia (34 as *D. ternatensis* var. *lancispina*), New Caledonia (39), Papua New Guinea (11), Philippines (12), Taiwan (26), India; **Western Ghats** [Tamil Nadu: Nilgiri, on the way to Avalanche (5), Doddabetta (5, as *D. ternatensis* var. *lancispina*), Kanyakumari, Upper Kodaiyar (40), Palani Hills, Kodaikanal, Coasan road (42, as *D. ternatensis* var. *lancispina*), Kerala, Idukki, Anamudi Shola NP (Present collection)]. The present collection is a new distributional record to Kerala.

## Conclusion

The present study records new distribution of four species in the Western Ghats part of Kerala viz., *Drepanolejeunea ternatensis* (Gottsche) Steph., *D. fleischeri* (Steph.) Grolle & Zhu, *D. pentadactyla*

(Mont.) Steph. and *D. erecta* (Steph.) Mizut. *Drepanolejeunea erecta* was previously reported only from Eastern Himalayas. The study also found that most of the species occur at high altitudes above 1000 m MSL. Among these, *Drepanolejeunea angustifolia* (Mitt.) Grolle is distributed only above 2000 m. *Drepanolejeunea yunnanensis* (P.C. Chen) Grolle & R.L., Zhu is another species distributed in the Western Ghats of Karnataka. But the species is not yet reported from Kerala, hence, only five species have been dealt with here.

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## Authors' contributions

CVK collected most of the specimens from different localities of Kerala and prepared illustration and contributed for the preparation of manuscript. MB collected some specimens and prepared some photo plates and contributed for the preparation of manuscript. MCN collected some specimens for the study, prepared the photo plates and contributed for the preparation of manuscript and the mentor of first two authors. KPR collected some specimens and given comments on the manuscript.

## Conflict of interests

The authors declare no competing interests.

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