

**THREE FOLIICOLOUS TAXA OF LEJEUNEACEAE
(MARCHANTIOPHYTA) NEW TO INDIA
FROM GREAT NICOBAR BIOSPHERE RESERVE, ANDAMAN
AND NICOBAR ISLANDS**

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Three liverworts belonging to family Lejeuneaceae (Marchantiophyta), *Cololejeunea equialbi*, *Colura pluridentata* and *Drepanolejeunea thwaitesiana* var. *thwaitesiana* are being reported as new to Indian flora from Great Nicobar Biosphere Reserve in the Andaman and Nicobar Islands. The diversity and distribution of the genera *Cololejeunea*, *Colura* and *Drepanolejeunea* in India have been discussed.

Key words: Andaman and Nicobar Islands, *Cololejeunea equialbi*, *Colura pluridentata*, *Drepanolejeunea thwaitesiana*, India, Lejeuneaceae, new record

INTRODUCTION

Lejeuneaceae is the largest family of liverworts in the world with approximately 1,000 species belonging to 68 currently accepted genera (Gradstein 2013). In India, the family is represented by about 197 taxa belonging to 24 genera (Singh and Singh 2013).

Recent studies on the liverworts of the Andaman and Nicobar Islands revealed the occurrence of three more taxa of the family Lejeuneaceae, which were hitherto unknown in the Indian liverwort flora. These are *Cololejeunea equialbi* Tixier, *Colura pluridentata* Ast and *Drepanolejeunea thwaitesiana* (Mitt.) Steph. var. *thwaitesiana*. The same have been described and illustrated in the present communication.

DESCRIPTION AND DISCUSSION

Cololejeunea equalbi Tixier

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(Figs 1; 4: 1–5)

Plants light green when fresh, yellowish green in herbarium; shoot 5–14 mm long, 1.2–1.5 mm wide; branching *Lejeunea*-type, irregular, sparse. Stem suborbicular to oval in outline in transverse section, 50.0–62.5 × 65.0–75.0 µm, 3 cells across the diameter; cortical cells in 5 vertical rows, rectangular to polygonal, 12.5–25.0 × 20.0–35.0 µm, thin walled; medullary cell one, polygonal, 15.0–20.0 × 25.0–32.5 µm, thin walled; ventral merophytes of stem 1 cell wide. Rhizoids numerous, fasciculate on ventral surface of stem, hyaline. Leaves closely or loosely imbricate, widely to downwardly spreading; leaf lobe elliptical, 0.55–0.80 mm long, 0.35–0.52 mm wide, apex rounded or rounded obtuse, margin irregularly finely denticulate with *Allorgella*-type of denticulations, dorsal margin arched, ventral margin slightly arched to nearly straight; apical leaf cells subquadrate, rectangular or polygonal, 10.0–20.0 × 10.0–22.5 µm; median leaf cells hexagonal, 20.0–30.0 × 17.5–25.0 µm; basal leaf cells polygonal, 27.5–50.0 × 17.5–30.0 µm; walls thin with minute trigones, intermediate thickenings absent; surface smooth; oil bodies not seen; leaf lobule spreading downward, inflated, 1/6–1/5 as long as the leaf lobe, ovate, 0.11–0.15 mm long, 0.08–0.12 mm wide, bidentate; first tooth unicellular, oblong to slightly curved; second tooth obsolete; hyaline papilla oval to elliptical, present at the proximal side of first tooth; keel slightly arched to nearly straight, smooth; stylus unicellular. Gemmae discoid, on the ventral surface of leaf lobe, 16–26-celled, 45.0–62.5 × 50.0–70.0 µm, adhesive cells not seen. Androecial and gynoecial branches not seen.

Habitat: Epiphyllous, growing on *Ficus* L. and *Garcinia nervosa* Miq. leaves in moist and shady condition, in association with *Caudalejeunea recurvistipula* (Gottsche) Schiffn., *Cololejeunea floccosa* (Lehm. et Lindenb.) Schiffn., *Colurari* (Steph.) Steph., *Drepanolejeunea thwaitesiana* var. *thwaitesiana*, *Lejeunea anisophylla* Mont., *Radula protensa* Lindenb. and *Radula tjibodensis* K. I. Goebel.

Distribution: India (Andaman and Nicobar Islands (Great Nicobar Island: present study)), China, Fiji, Indonesia, Japan, Papua New Guinea, Philippines, Taiwan, Vietnam (Ellis *et al.* 2013, Mizutani 1975, 1978, 1986, Pócs *et al.* 1994, 2011, Zhu and So 2001).

Specimens examined: India, Andaman and Nicobar Islands, Great Nicobar Biosphere Reserve, East–West Road, 12 km from Campbell Bay, ca 145 m, 06° 59' 54" N, 93° 52' 54" E, C. Murugan (61505C) 6 April 2013 (CAL); Great Nicobar Biosphere Reserve, Campbell Bay, 07° 0.219' N, 93° 52.794' E, D. K. Singh (61644E), 7 February 2014 (CAL).

Cololejeunea equalbi is characterised by widely to downwardly spreading leaves (Figs 1: 1–2; 4: 1); elliptical leaf lobes with rounded or rounded obtuse apices and irregularly finely denticulate margins with *Allorgella*-type of denticulations (Figs 1: 5–9; 4: 2–3); thin walled leaf cells with minute trigones, devoid of intermediate thickenings (Figs 1: 9–11; 4: 3); ovate, inflated, bidentate leaf lobule, $1/6$ – $1/5$ as long as the leaf lobe, spreading downward, with unicellular, oblong to slightly curved first tooth and obsolete second tooth (Figs 1: 2, 5–8, 12–13; 4: 1–2, 4); unicellular stylus (Figs 1: 14; 4: 5); and 16–26-celled discoid gemmae devoid of adhesive cells (Fig. 1: 15).

The Indian plants of *C. equalbi* are smaller in size as compared to the type from Vietnam, which are 1–2 cm long, 2.3 mm wide with larger leaves (1.2 mm long, 0.8 mm wide), but smaller ($1/10$ as long as the leaf lobe) leaf lobule (Tixier 1970). Our plants, however, compare well with their Chinese counterparts, which are 6–15 mm long and 1.0–1.9 mm wide with 0.7–1.1 mm long and 0.58–0.78 mm wide leaves, with the leaf lobule $1/6$ – $1/5$ as long as the leaf lobe (Zhu and So 2001). The deviations shown by the Indian plants, therefore, are well within the range of variation recorded in the species across its range of distribution.

The genus *Cololejeunea* (Spruce) Schiffn. is represented in India by 51 species (Asthana and Alam 2013, Manju *et al.* 2012, Singh and Singh 2013). Among the Indian species of the genus, *C. equalbi* only partially resembles *C. trichomanis* (Gottsche) Steph. and *C. tixieriana* M. Dey, D. Singh et D. K. Singh in general appearance, the presence of rounded to obtuse leaf apices, smooth leaf surface, thin walled leaf cells with minute trigones and lack of intermediate thickenings. However, both species differ from *C. equalbi* in lacking downwardly spreading, elliptical leaf lobes with *Allorgella*-type of denticulations along the margins. They further differ in the presence of larger leaf lobule ($1/3$ as long as the leaf lobe) with 2(–3) cells long first tooth with hyaline papilla present at the inner surface of the base of first tooth; 2–3 (in *C. tixieriana*) or 4–6 (in *C. trichomanis*) cells long filiform stylus and gemmae with three adhesive cells (see also Asthana and Srivastava 2003, Dey and Singh 2012, Dey *et al.* 2008, Mizutani 1978, Zhu and So 2001).

With the present addition, the number of species of *Cololejeunea* in India has gone up to fifty-two (Table 1). The Eastern Himalaya, including the northeastern states show maximum diversity with 42 species of which 18 are restricted to this bryogeographical region alone in India, followed by the Western Ghats with 29 species of which nine are confined only to this region and the Andaman and Nicobar Islands with 10 species with two species known in the Indian bryoflora from this region only (Asthana and Alam 2013, Asthana and Sahu 2011, Asthana and Shukla 2010a, Asthana and Srivastava 2003, Daniels 2010, Daniels and Daniel 2009, Das and Singh 2009, Dey and Singh 2012,

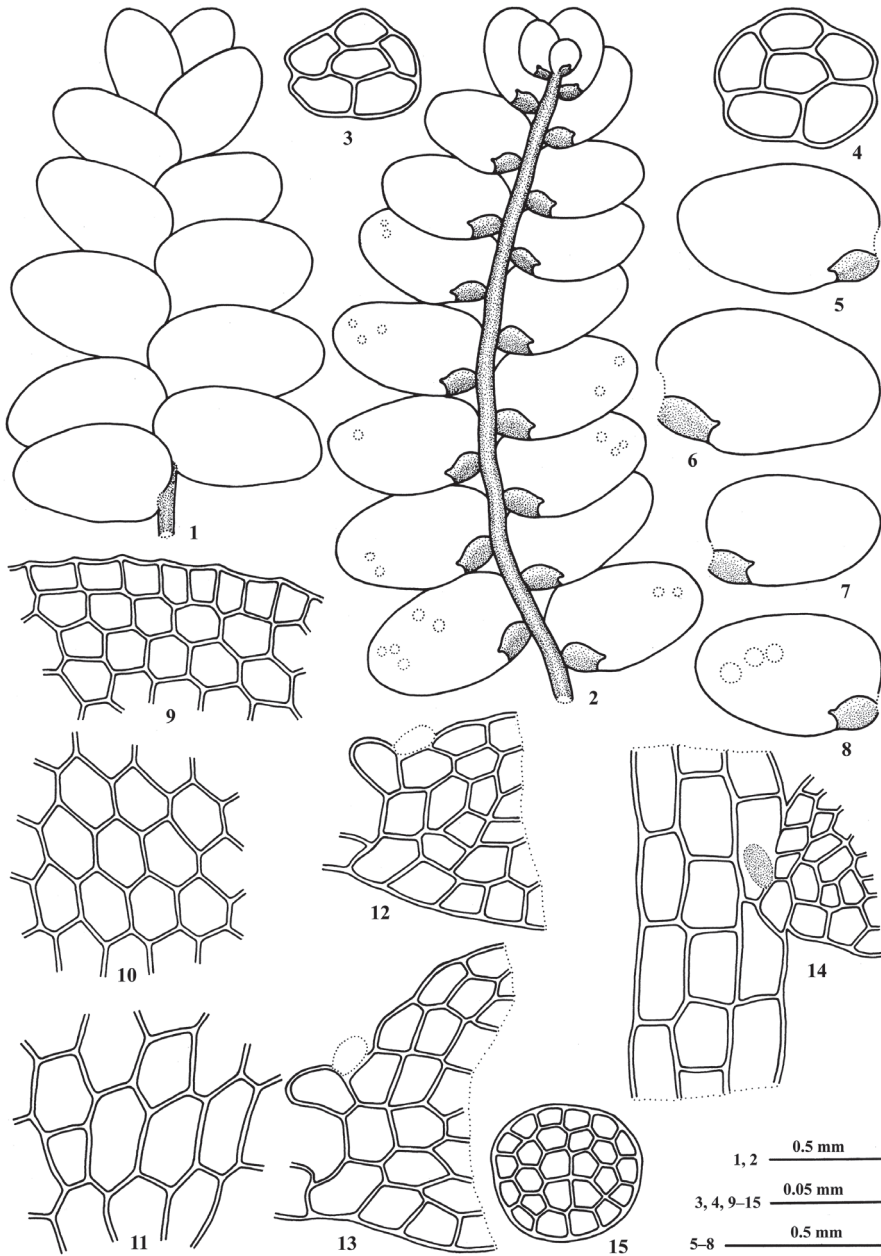


Fig. 1. *Cololejeunea equalbi* Tixier. 1 = A portion of plant in dorsal view. 2 = The same in ventral view (rhizoids not drawn). 3–4 = Transverse sections of stem. 5–8 = Leaves. 9 = Apical leaf cells. 10 = Median leaf cells. 11 = Basal leaf cells. 12–13 = Apices of leaf lobules. 14 = Base of leaf lobule and portion of stem showing a stylus. 15 = A gemma. (All drawn by M. Dey from C. Murugan 61505C)

Table 1

Distribution of genus *Cololejeunea* in India (EH = Eastern Himalaya; WH = Western Himalaya; WG = Western Ghats; CI = Central India; AN = Andaman and Nicobar Islands; * = endemic to the country)

Name	EH	WH	WG	CI	AN	References
<i>C. aequabilis</i> (Sande Lac.) Schiffn.	+					Dey and Singh (2011, 2012)
<i>C. appresa</i> (A. Evans) Benedix	+		+		+	Asthana and Srivastava (2003), Singh and Barbhuiya (2012)
<i>C. bhutanica</i> Grolle et Mizut.	+					Dey and Singh (2011, 2012), Asthana and Sahu (2011)
<i>C. cardiocarpa</i> (Mont.) A. Evans			+			Asthana and Srivastava (2003)
<i>C. ceratilibula</i> (P. C. Chen) R. M. Schust.	+		+			Asthana and Srivastava (2003), Dey and Singh (2012)
<i>C. ceylanica</i> Onr.	+					Asthana and Srivastava (2003), Dey and Singh (2012)
<i>C. chenii</i> Tixier	+					Singh and Barbhuiya (2013), Singh and Singh (2013)
<i>C. clavatopapillata</i> Steph.				+		Asthana and Alam (2013)
<i>C. denticulata</i> (Horik.) S. Hatt.	+					Singh and Barbhuiya (2012)
<i>C. desciscens</i> Steph.	+				+	Singh and Barbhuiya (2012), Singh <i>et al.</i> (2006)
<i>C. distalopapillata</i> (E. W. Jones) R. M. Schust.						Daniels and Daniel (2009)
<i>C. dozyana</i> (Sande Lac.) Schiffn.	+					Dey and Singh (2011, 2012)
* <i>C. epiphylla</i> G. Asthana et A. Shukla			+			Asthana and Shukla (2010 <i>et</i>)
<i>C. equitabi</i> Tixier					+	present study
<i>C. floccosa</i> (Lehm. et Lindenb.) Schiffn.	+		+			Asthana and Srivastava (2003), Dey and Singh (2012), Singh and Barbhuiya (2012)
* <i>C. foliicola</i> S. C. Srivast. et G. Srivast.	+		+			Asthana and Srivastava (2003), Singh and Barbhuiya (2012)
<i>C. furcilibulata</i> (Berrie et E. W. Jones) R. M. Schust.	+				+	Asthana and Srivastava (2003), Singh and Barbhuiya (2012)

Table 1 (continued)

Name	EH	WH	WG	CI	AN	References
<i>C. gottschei</i> (Steph.) Mizut.	+		+		+	Asthana and Srivastava (2003), Singh and Barbhuiya (2012), Singh <i>et al.</i> (2010b)
<i>C. grossepapillosa</i> (Horik.) Pócs	+					Dey and Singh (2012)
<i>C. haskarihana</i> (Lehm. et Lindenb.) Schiffn.	+		+		+	Asthana and Srivastava (2003), Dey and Singh (2012), Singh and Barbhuiya (2012)
* <i>C. hyalina</i> G. Asthana et S. C. Srivast.						Asthana and Srivastava (2003)
<i>C. inflata</i> Steph.	+					Singh and Barbhuiya (2012)
<i>C. jelinekii</i> Steph.	+				+	Asthana and Srivastava (2003), Das and Singh (2009)
* <i>C. karnatakensis</i> G. Asthana et S. C. Srivast.						Asthana and Srivastava (2003)
* <i>C. kashyapii</i> Udar et G. Srivast.	+		+			Asthana and Srivastava (2003), Singh and Barbhuiya (2012)
<i>C. lanciloba</i> Steph.	+		+		+	Asthana and Srivastava (2003), Dey and Singh (2012)
<i>C. latilobula</i> (Herzog) Tixier	+	+	+	+		Asthana and Srivastava (2003), Dey and Singh (2012)
<i>C. longiana</i> Grolle et Mizut.	+					Dey and Singh (2008, 2012)
<i>C. longifolia</i> (Mitt.) Benedix ex Mizut.	+		+		+	Asthana and Srivastava (2003), Dey and Singh (2012), Singh and Barbhuiya (2012)
<i>C. macounii</i> (Spruce ex Underw.) A. Evans	+					Dey and Singh (2012), Dey <i>et al.</i> (2010)
<i>C. madothecoides</i> (Steph.) Benedix	+		+			Asthana and Srivastava (2003), Manju <i>et al.</i> (2012)
<i>C. minutissima</i> (Sm.) Schiffn.	+		+		+	Joshi (2001), Asthana and Srivastava (2003)
* <i>C. mizutianiana</i> Udar et G. Srivast.	+		+			Asthana and Srivastava (2003), Singh and Barbhuiya (2012)
* <i>C. nilgiriensis</i> G. Asthana et S. C. Srivast.	+		+		+	Asthana and Srivastava (2003), Manju <i>et al.</i> (2012), Singh and Singh (2013)

Table 1 (continued)

Name	EH	WH	WG	CI	AN	References
<i>C. ocellata</i> (Horik.) Benedix	+					Dey and Singh (2012), Dey <i>et al.</i> (2010)
<i>C. planissima</i> (Mitt.) Abeyw.	+		+			Asthana and Srivastava (2003), Dey and Singh (2012)
<i>C. pluridentata</i> P. C. Wu et J. S. Lou	+					Singh and Singh (2013)
<i>C. producta</i> (Mitt.) S. Hatt.	+	+				Asthana and Srivastava (2003)
<i>C. pseudofloccosa</i> (Horik.) Benedix	+		+			Asthana and Srivastava (2003), Dey and Singh (2012)
<i>C. pseudoplagiophylla</i> P. C. Wu et J. S. Lou	+					Asthana and Srivastava (2003), Singh and Barbhuiya (2012)
<i>Cololejeunea raduliloba</i> Steph.	+		+			Manju <i>et al.</i> (2012), Tixier (1967)
<i>C. serrulata</i> Steph.	+					Dey and Singh (2011, 2012), Singh and Barbhuiya (2012), Singh and Singh (2013)
* <i>C. siamensis</i> G. Asthana et S. C. Srivast.	+					Asthana and Srivastava (2003), Singh and Barbhuiya (2012)
<i>C. sigmoidea</i> Ast et Tixier			+			Asthana and Srivastava (2003)
<i>C. spinosa</i> (Horik.) Pandé et Misra	+		+			Asthana and Srivastava (2003), Daniels (2010), Dey and Singh (2012), Singh and Barbhuiya (2012)
<i>C. tenella</i> Benedix					+	Zhu and So (2001)
* <i>C. tixieriana</i> M. Dey, D. Singh et D. K. Singh	+					Dey and Singh (2012), Dey <i>et al.</i> (2008)
<i>C. trichomanis</i> (Gottsche) Steph.	+		+			Asthana and Srivastava (2003), Dey and Singh (2012)
<i>C. truncatifolia</i> (Horik.) Mizut.	+					Asthana and Srivastava (2003), Dey and Singh (2012)
* <i>C. udarii</i> G. Asthana et S. C. Srivast.	+		+			Asthana and Srivastava (2003), Manju <i>et al.</i> (2012), Singh <i>et al.</i> (2010a)
<i>C. vidaliana</i> Tixier			+			Daniels and Daniel (2009)
<i>C. yipii</i> R. L. Zhu	+					Dey and Singh (2007, 2012)

Joshi 2001, Manju *et al.* 2012, Singh and Barbhuiya 2012, 2013, Singh and Singh 2013, Singh *et al.* 2006, 2010a, b, Zhu and So 2001). Whereas, the Western Himalayan and the Central Indian bryogeographical regions of the country are represented by just two and a single species of the genus, respectively (Asthana and Srivastava 2003). Ten species of the genus are endemic to the country as indicated by an asterisk (*) in Table 1.

Colura pluridentata Ast, Rev. Bryol. Lichénol. 22: 265 (1954)
(Figs 2; 4: 6–10)

Plants light green when fresh, yellowish green in herbarium; shoot 7–11 mm long, 2.5–4.0 mm wide; branching *Lejeunea*-type, irregular, sparse. Stem orbicular in outline in transverse section, 110–135 μm , 4 cells across the diameter; cortical cells in 7 vertical rows, rectangular to polygonal, 17.5–42.5 \times 30.0–50.0 μm , thin walled; medullary cells in 3 vertical rows, polygonal, 20–30 \times 20–35 μm , thin walled; ventral merophytes of stem 2 cells wide. Leaves closely to loosely imbricate, obliquely spreading, ovate-lanceolate; leaf lobe ovate, 1.1–1.5 mm long, 0.6–1.0 mm wide, dorsal margin arched, proximal 1/3 entire, distal 2/3 dentate; teeth 1–3(–4) cells long, 1–2(–3) cells wide at base; marginal leaf cells rectangular to polygonal, 15–30 \times 20–35 μm ; median leaf cells hexagonal to polygonal, 37.5–52.5 \times 17.5–27.5 μm ; basal leaf cells polygonal, 45–60 \times 22.5–32.5 μm ; walls thin with large, cordate to nodulose trigones, intermediate thickenings nodulose, 1–2 per wall; surface smooth; oil bodies not seen; leaf lobule inflated, 1.7–2.1 mm long, 0.25–0.32 mm wide, cylindrical at base, widest at middle, terminating into a strongly inflated, cylindrical to lanceolate sac; sac 0.6–0.7 mm long, widest at base, narrowing towards rounded to obtuse apex, margin entire; valve ovate, 100–150 \times 70–90 μm , composed of 34–44 cells, with 2 median basal cells. Underleaves distant, 3–4 times as wide as the stem, 0.4–0.6 mm long, 0.5–1.0 mm wide, bilobed to 2/3–3/4 of its length, lobes divergent, lanceolate, 8–12 cells wide at base, 1–2 cells uniseriate at apex, margin entire, sinus wide. Rhizoids numerous, fasciculate at base of underleaves; rhizoidal disc absent. Gemmae discoid, 22–24-celled, 45.0–82.5 μm in diam., clustered at the apex of leaf lobule. Androecial and gynoecial branches not seen.

Habitat: Epiphyllous, growing on *Bulbophyllum* Thouars leaves in moist and shady condition, in association with *Caudalejeunea recurvostipula*, *Cheilolejeunea serpentina* (Mitt.) Mizut., *C. trapezia* (Nees) Kachroo et R. M. Schust., *Lejeunea tuberculosa* Steph., *Leptolejeunea epiphylla* (Mitt.) Steph., *L. maculata* (Mitt.) Schiffn., *Lopholejeunea subfusca* (Nees) Schiffn. and *Microlejeunea punctiformis* (Taylor) Steph.

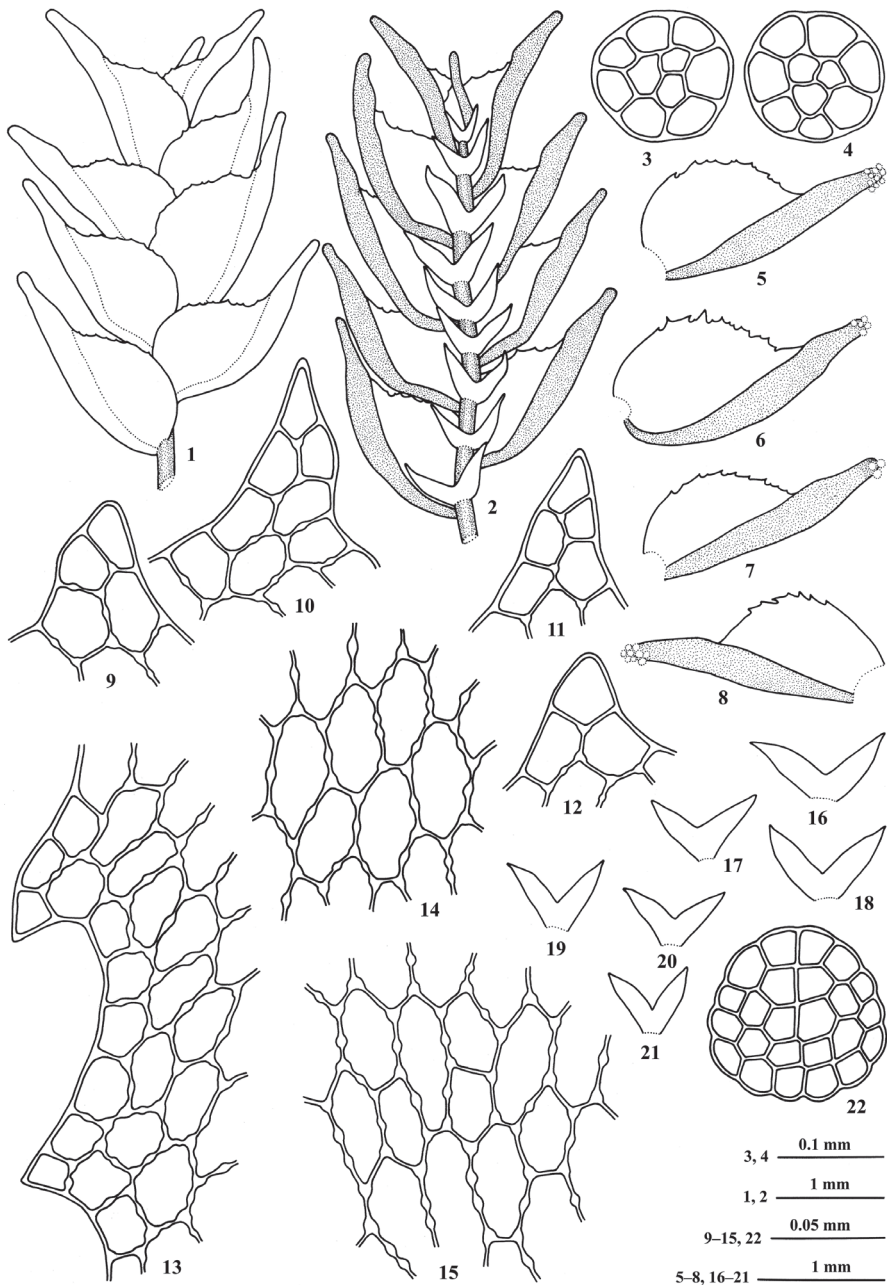


Fig. 2. *Colura pluridentata* Ast. 1 = A portion of plant in dorsal view. 2 = The same in ventral view (rhizoids not drawn). 3-4 = Transverse sections of stem. 5-8 = Leaves. 9-12 = Marginal teeth of leaf lobe. 13 = Marginal leaf cells. 14 = Median leaf cells. 15 = Basal leaf cells. 16-21 = Underleaves. 22 = A gemma. (All drawn by M. Dey from C. Murugan 61507E)

Table 2
Distribution of genus *Colura* in India (EH = Eastern Himalaya; WH = Western Himalaya; WG = Western Ghats, CI = Central India; AN = Andaman and Nicobar Islands)

Name	EH	WH	WG	CI	AN	References
<i>C. acroloba</i> (Mont. ex Steph.) Ast					+	Udar and Awasthi (1985)
<i>C. ari</i> (Steph.) Steph.	+				+	Lal (1980), Singh and Barbhuiya (2012)
<i>C. calyptrofolia</i> (Hook.) Dumort.	+					Lal (1977), Singh (1996)
<i>C. conica</i> (Sande Lac.) K. I. Goebel	+					Lal (2003) (as <i>C. acutifolia</i> Ast)
<i>C. leratii</i> (Steph.) Steph.			+			Asthana and Shukla (2010b)
<i>C. pluridentata</i> Ast					+	present study
<i>C. tenuicornis</i> (A. Evans) Steph.	+					Dey and Singh (2012), Lal (1977)

Distribution: India (Andaman and Nicobar Islands (Great Nicobar Island: present study)), Africa (Seychelles), Fiji, Indonesia, Papua New Guinea (Jovet-Ast 1954, Pócs 2013, Pócs and Eggers 2007, Wigginton 2009).

Specimen examined: India, Andaman and Nicobar Islands, Great Nicobar Biosphere Reserve, East-West Road, 12 km from Campbell Bay, ca 176 m, 06° 59' 53" N, 93° 52' 56" E, C. Murugan, (61507E) 6 April 2013 (CAL).

Colura pluridentata is characterised by closely to loosely imbricate, obliquely spreading, ovate-lanceolate leaves (Figs 2: 1–2, 5–8; 4: 6); ovate leaf lobes with arched dorsal margin having proximal 1/3 portion entire and distal 2/3 portion dentate; teeth 1–3(–4) cells long, 1–2(–3) cells wide at base (Figs 2: 5–13; 4: 7–8); large inflated leaf lobule, which is cylindrical at base, widest at middle, terminating into a strongly inflated, cylindrical to lanceolate sac, which is the widest at base, narrowing towards apex having rounded to obtuse apices and entire margins (Figs 2: 2, 5–8; 4: 6–7); distant underleaves bilobed to 2/3–3/4 of their length with divergent, lanceolate lobes, which are 8–12 cells wide at base, 1–2 cells uniseriate at apex (Figs 2: 2, 16–21; 4: 6, 9); and 22–24-celled discoid gemmae clustered at the apex of leaf lobule (Figs 2: 5–8, 22; 4: 6–7, 10).

The Indian plants of *C. pluridentata* fully conform to those from Borneo (Indonesia) described by Jovet-Ast (1954) in all the vital taxonomic parameters except the base of underleaf lobes, which are 8–12 cells wide in Indian plants, while those from Borneo are up to 8 cells wide.

The genus *Colura* (Dumort.) Dumort. has so far been represented in India by six species (Asthana and Shukla 2010b). The Indian species of the genus can be broadly divided into two groups, (i) those with underleaf lobes 2–4 cells wide at base, viz. *C. acroloba* (Mont. ex Steph.) Ast, *C. calyptrifolia* (Hook.) Dumort., *C. leratii* (Steph.) Steph. and *C. tenuicornis* (A. Evans) Steph. and (ii) those with underleaf lobes 4–6 cells wide at base, viz. *C. ari* and *C. conica* (Sande Lac.) K. I. Goebel. Thus *C. pluridentata* is readily distinguished from hitherto all the known Indian species of the genus in having underleaf lobes 8–12 cells wide at base (Asthana and Shukla 2010b, Dey and Singh 2012, Jovet-Ast 1954, Lal 1980, 2003, Udar and Awasthi 1985). Nevertheless, *C. pluridentata* shows some resemblance with *C. ari*, *C. conica* and *C. leratii* in having denticulate to dentate leaf lobe margins. But, the similarity ends there, as the three species differ from the former in having obovate leaf lobes with lobule sacs with acute to apiculate apices and denticulate to dentate margins (Asthana and Shukla 2010b, Jovet-Ast 1954, Lal 1980, 2003, Pócs and Eggers 2007).

With the present addition, the number of species of *Colura* in India has gone up to seven (Table 2). Of these three species are restricted to the Eastern Himalaya in Indian bryoflora, two to Andaman and Nicobar Islands and one to the Western Ghats, while one species is common between the Eastern Himalaya and the Andaman and Nicobar Islands (Asthana and Shukla 2010b, Dey and Singh 2012, Lal 1977, 1980, 2003, Singh 1996, Singh and Barbhuiya 2012, Udar and Awasthi 1985).

Drepanolejeunea thwaitesiana var. *thwaitesiana* (Mitt.) Steph.,
Sp. Hepat. 5: 350 (1913) ≡ *Lejeunea thwaitesiana* Mitt.,
J. Proc. Linn. Soc., Bot. 5: 117 (1861)
(Figs 3; 4: 11–15)

Plants light green when fresh, yellowish-brownish green in herbarium; shoot 5–13 mm long, 0.8–1.2 mm wide; branching *Lejeunea*-type, irregular. Stem orbicular to sub-orbicular in outline in transverse section, 50.0–62.5 µm, 4 cells across the diameter; cortical cells in 7 vertical rows, rectangular to polygonal, 10.0–20.0 × 12.5–27.5 µm, slightly thick walled; medullary cells in 3 vertical rows, rectangular to polygonal, 10.0–12.5 × 10.0–12.5 µm, slightly thick walled; ventral merophytes of stem 2 cells wide. Leaves imbricate, obliquely spreading; leaf lobe ovate, slightly falcate, 0.49–0.62 mm long, 0.34–0.42 mm wide, apex acute to apiculate, margin irregularly dentate, dorsal margin arched, narrowing towards base, ventral margin nearly straight; apical leaf cells rectangular to polygonal, 10–15 × 10.0–17.5 µm; median leaf cells polygonal, 20.0–27.5 × 17.5–22.5 µm; basal leaf cells polygonal, 25.0–52.5 × 10.0–20.0 µm; walls thin to slightly thick with small to medium trigones, in-

intermediate thickenings small; surface smooth; oil bodies not seen; ocelli 6–12 per leaf lobe, irregularly scattered, suprabasal ocelli 1–2, $35.0\text{--}47.5 \times 15\text{--}20$ μm ; median ocelli 5–11, $27.5\text{--}32.5 \times 15\text{--}20$ μm ; leaf lobule inflated, $1/3\text{--}2/5$ as long as the lobe, oblong to ovate, 0.16–0.22 mm long, 0.09–0.12 mm wide, bidentate, first tooth unicellular, oblong, straight; second tooth obsolete; hyaline papilla at the proximal side of first tooth; free lateral margin bordered by 6–7 subquadrate to rectangular cells; keel straight to slightly arched, smooth. Underleaves distant, 4–6 times as wide as stem, 0.06–0.11 mm long, 0.17–0.34 mm wide, bilobed to $3/4$ of its length; lobes lanceolate, 5–8 cells long, 2 cells wide at base, 2–4 cells uniseriate at apex, very widely spreading to nearly horizontal. Rhizoids numerous, fasciculate at the base of underleaves. Asexual reproduction by means of brood branches, 0.8–1.4 mm long, 0.6–0.9 mm wide; the lobule of the first leaf reduced; the first underleaf with an adhesive disc or paramphigastrium.

Dioicous. Androecia terminal on main shoot or lateral branches; bracts in 4–8 pairs, densely imbricate; bract lobe ovate, 0.15–0.24 mm long, 0.12–0.16 mm wide, apex acute, margin dentate; bract lobule strongly inflated, almost as long as the bract lobe; bracteole 1, present only at the base of androecium, 0.11–0.13 mm long, 0.10–0.16 mm wide, bilobed to $2/3$ of its length; lobes linear to lanceolate, 4–5 cells long, 2 cells wide at base, 2–3 cells uniseriate at apex. Gynoecial branches not seen.

Habitat: Epiphyllous, growing on *Calamus andamanicus* Kurz, *Garcinia nervosa* and *Teijsmanniodendron pteropodum* (Miq.) Bakh. leaves in moist and shady condition, in association with *Caudalejeunea recurvistipula*, *Cololejeunea equialbi*, *C. floccosa*, *Colura ari*, *Drepanolejeunea pentadactyla* (Mont.) Steph., *Lejeunea anisophylla*, *Leptolejeunea maculata*, *Lopholejeunea sikkimensis* Steph. var. *sikkimensis*, *Radula acuminata* Steph., *Radula tjibodensis*.

Distribution: India (Andaman and Nicobar Islands (Great Nicobar Island: present study)), Cambodia, China, Indonesia, Malaysia, New Guinea, Sri Lanka, Thailand, Vietnam (Mizutani 1990, Onraedt 1981, Zhu and So 2001).

Specimens examined: India, Andaman and Nicobar Islands: Great Nicobar Biosphere Reserve, East–West Road, 15.5 km from Campbell Bay, ca 80 m, $06^{\circ} 59' 15''$ N, $93^{\circ} 51' 92''$ E, C. Murugan. (61511A), 6 April 2013 (CAL); Great Nicobar Biosphere Reserve, Campbell Bay, $07^{\circ} 0.219'$ N, $93^{\circ} 52.794'$ E, D. K. Singh. (61642B, 61644F, 61645B), 7 February 2014 (CAL); Great Nicobar Biosphere Reserve, Campbell Bay, ca 56 m, $07^{\circ} 0.282'$ N, $93^{\circ} 52.765'$ E, D. K. Singh. (61650E, 61652F), 7 February 2014 (CAL).

Other specimens examined: Hepaticae Selectae et Criticae (ed. Fr. Verdoorn), ser. XI, 1939, Indonesia. Java Occid.: Priangan, ca 2,200 m, Fr. Verdoorn. (505), July 1930 (CAL); Java Centr.: Banjoemas, ca 1,700 m, Fr. Verdoorn. (506), June 1930 (CAL).

Drepanolejeunea thwaitesiana var. *thwaitesiana* is characterised by ovate, slightly falcate leaf lobes with acute to apiculate apices and irregularly dentate

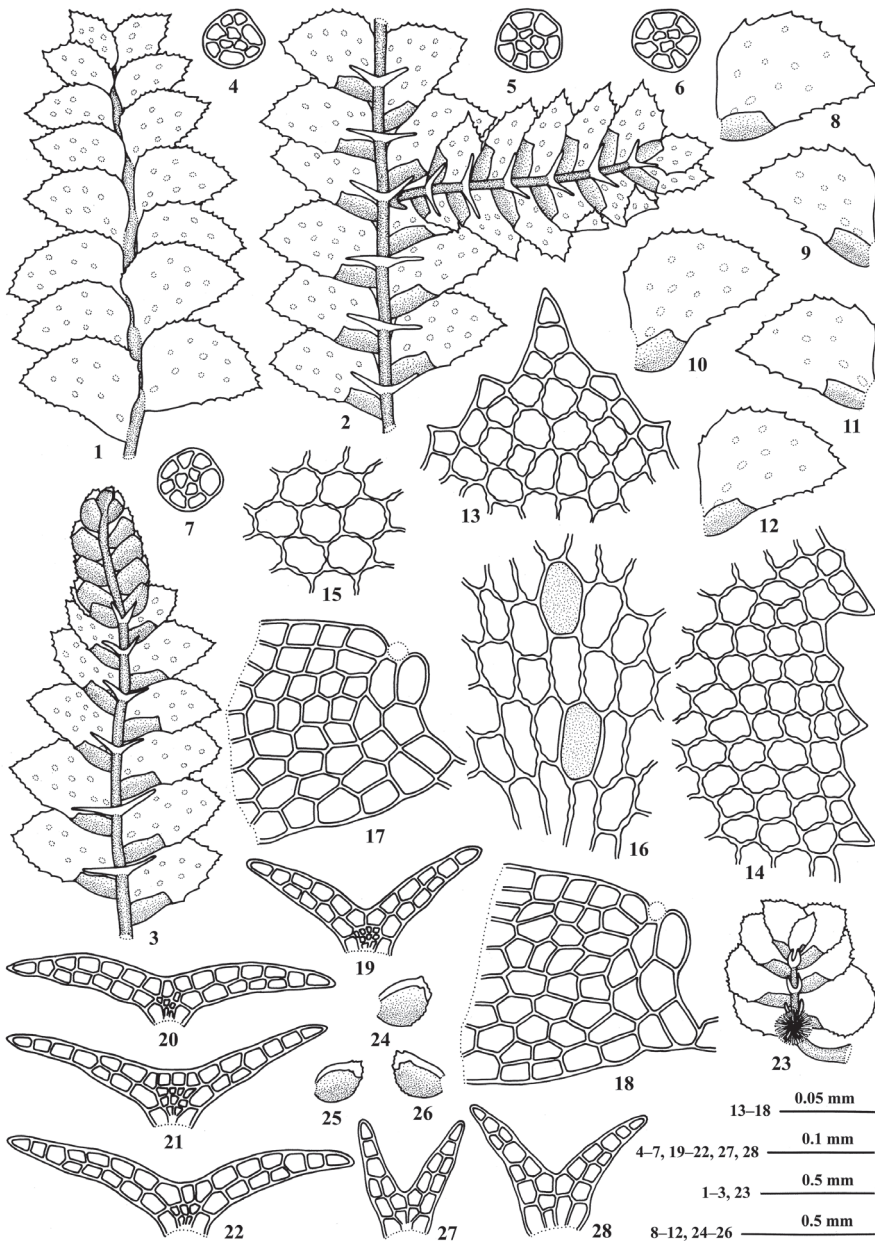


Fig. 3. *Drepanolejeunea thwaitesiana* (Mitt.) Steph. var. *thwaitesiana*. 1 = A portion of plant in dorsal view. 2 = The same in ventral view (rhizoids not drawn). 3 = A portion of male plant in ventral view. 4-7 = Transverse sections of stem. 8-12 = Leaves. 13 = Apical leaf cells. 14 = Marginal leaf cells. 15 = Median leaf cells. 16 = Basal leaf cells showing ocelli. 17-18 = Apices of leaf lobules. 19-22 = Underleaves. 23 = A brood branch in ventral view. 24-26 = Male bracts. 27-28 = Male bracteoles. (All drawn by M. Dey from C. Murugan 61511A)

Table 3

Distribution of genus *Drepanolejeunea* in India (EH = Eastern Himalaya; WH = Western Himalaya; WG = Western Ghats, CI = Central India; AN = Andaman and Nicobar Islands; * = endemic to the country)

Name	EH	WH	WG	CI	AN	References
<i>D. angustifolia</i> (Mitt.) Grolle	+		+		+	Dey <i>et al.</i> (2013), Udar and Awasthi (1982)
* <i>D. devendrae</i> Sushil K. Singh et M. Dey	+					Singh and Dey (2012)
<i>D. erecta</i> (Steph.) Mizut.	+					Dey <i>et al.</i> (2013), Udar and Awasthi (1982)
<i>D. fleischeri</i> (Steph.) Grolle et R. L. Zhu	+		+			Asthana and Shukla (2009), Dey and Singh (2010), Dey <i>et al.</i> (2013)
<i>D. foliicola</i> Horik.	+					Dey <i>et al.</i> (2013), Pandé <i>et al.</i> (1957), Singh and Barbhuiya (2012)
<i>D. herzogii</i> R. L. Zhu et M. L. So	+					Dey <i>et al.</i> (2013), Herzog (1950) (as <i>Strepsilejeunea ocellata</i> Herzog)
<i>D. longii</i> Grolle et R. L. Zhu	+					Dey <i>et al.</i> (2013)
* <i>D. maotmiana</i> Ajit P. Singh et V. Nath	+					Dey <i>et al.</i> (2013), Singh and Nath (2007)
<i>D. pentadactyla</i> (Mont.) Steph.				+		Asthana and Shukla (2009), Dey <i>et al.</i> (2013)
<i>D. pulla</i> (Mitt.) Grolle	+					Dey <i>et al.</i> (2013), Udar and Awasthi (1982)
<i>D. siamensis</i> (Bischl.) Grolle et R. L. Zhu	+					Dey <i>et al.</i> (2013)
<i>D. spicata</i> (Steph.) Grolle et R. L. Zhu	+					Dey <i>et al.</i> (2013), Grolle and Zhu (2000)
<i>D. ternatensis</i> (Gottsche) Steph.			+			Dey <i>et al.</i> (2013), Udar and Awasthi (1982)
<i>D. thwaitesiana</i> (Mitt.) Steph. var. <i>thwaitesiana</i>					+	present study
<i>D. tibetana</i> (P. C. Wu et J. S. Lou) Grolle et R. L. Zhu	+					Dey <i>et al.</i> (2013)

Table 3 (continued)

Name	EH	WH	WG	CI	AN	References
<i>D. vesiculosa</i> (Mitt.) Steph.	+					Dey <i>et al.</i> (2013), Udar and Awasthi (1982)
<i>D. yunnanensis</i> (P. C. Chen) Grolle et R. L. Zhu	+		+			Dey <i>et al.</i> (2013), Singh and Barbhuiya (2012), Udar and Awasthi (1984) (as <i>Rhaphidolejeunea yunnanensis</i> P. C. Chen)

margin (Figs 3: 1–3, 8–14; 4: 11–14); irregularly scattered 6–12 ocelli per leaf lobe (Fig. 3: 1–3, 8–12); oblong to ovate, inflated leaf lobule, 1/3–2/5 as long as the leaf lobe with unicellular, oblong, straight first tooth and the free lateral margin bordered by 6–7 subquadrate to rectangular cells (Figs 3: 2–3, 8–12, 17–18; 4: 11–12, 15); underleaves divided to 3/4 of its length with very widely spreading to nearly horizontal lanceolate lobes 5–8 cells long, 2 cells wide at base, 2–4 cells uniseriate at apex (Figs 3: 2–3, 19–22; 4: 15); terminal androecia with 4–8 pairs of densely imbricate bracts and a single bracteole present only at the base of androecium (Figs 3: 3; 4: 11).

Drepanolejeunea thwaitesiana var. *thwaitesiana* shows considerable variation in the size of plants and leaves and the number of ocelli per leaf and male bracteole per androecial branch. Stephani (1913) described larger, up to 2 cm long plants with larger, 1.5 × 0.67 mm leaves, each having 4–5 ocelli only in plants from Java, Mauritius, New Guinea and Sri Lanka. Mizutani (1990) reported 10–15 mm long plants with 0.55–0.75 × 0.32–0.5 mm leaves bearing 10–30 ocelli per lobe, while Zhu and So (2001) observed 5–12 mm long plants with 0.54–0.72 × 0.35–0.45 mm leaves bearing 6–25 ocelli per lobe and with or without a single male bracteole in Chinese plants of the species. Similarly, the specimens from Java (Fr. Verdoorn 505, 506 (CAL)) show 8–15 mm long plants with 0.55–0.85 × 0.35–0.48 mm leaves bearing 8–14 ocelli per lobe and 1–2 male bracteoles present at the base of androecium. The Indian plants of *D. thwaitesiana* var. *thwaitesiana*, therefore, compare well with those from China, fall within the overall range of variation of the species across its range of distribution.

The genus *Drepanolejeunea* (Spruce) Schiffn. has so far been represented in India by 16 species (Dey and Singh 2012, Dey *et al.* 2013, He and Zhu 2014, Singh and Dey 2012). All the Indian species of *Drepanolejeunea* known so far have only 1–2 ocelli per leaf lobe, except *D. pentadactyla*, which has 2–4 ocelli per leaf lobe (Asthana and Shukla 2009, Dey and Singh 2012, Dey *et al.* 2013, Grolle and Zhu 1999, 2000, Singh and Dey 2012, Singh and Nath 2007, Udar and Awasthi 1982, 1984, Zhu

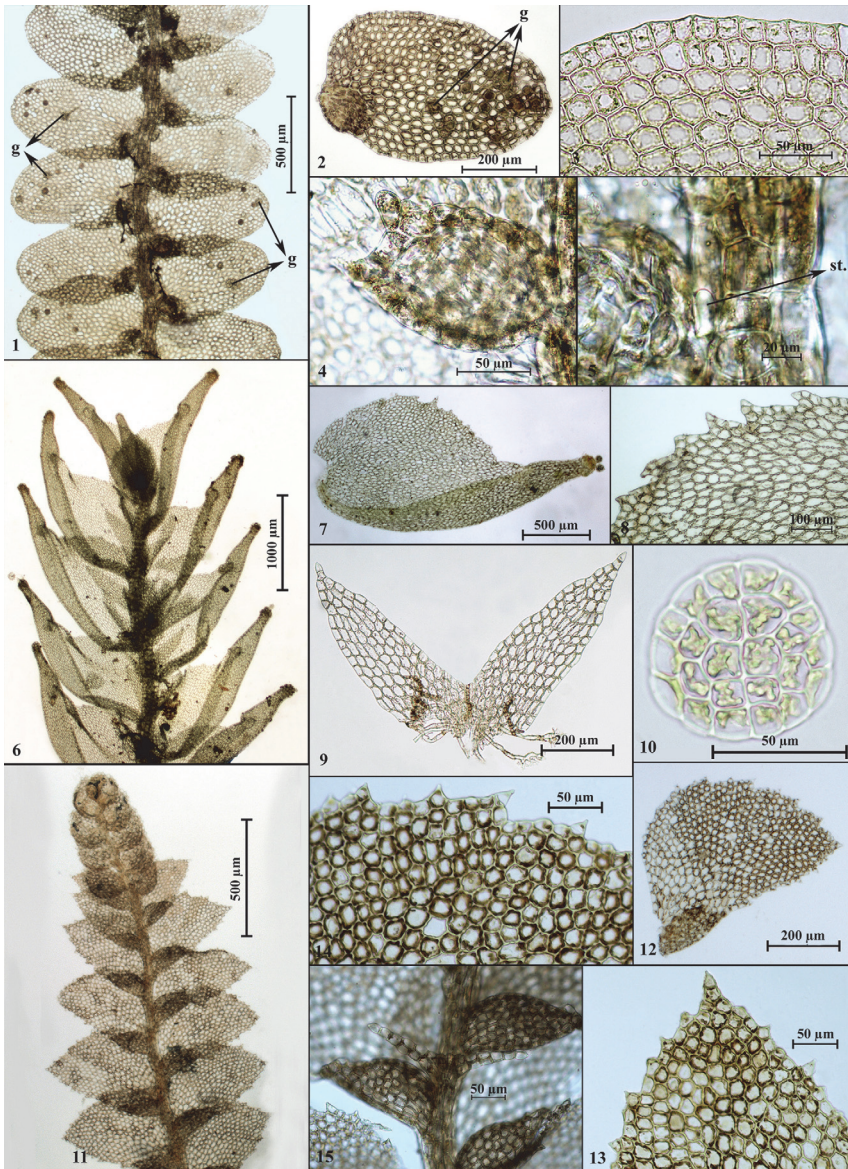


Fig. 4. *Cololejeunea equalbi* Tixier. 1 = A portion of plant in ventral view. 2 = A leaf bearing gemmae (g = gemmae). 3 = Marginal leaf cells. 4 = A leaf lobule. 5 = Base of leaf lobule and portion of stem showing a stylus (st. = stylus). – *Colura pluridentata* Ast. 6 = A portion of plant in ventral view. 7 = A leaf. 8 = Marginal leaf cells. 9 = An underleaf. 10 = A gemma. – *Drepanolejeunea thwaitesiana* (Mitt.) Steph. var. *thwaitesiana*. 11 = A portion of male plant in ventral view. 12 = A leaf. 13 = Apical leaf cells. 14 = Marginal leaf cells. 15 = A portion of stem showing underleaf. (All photographs by M. Dey, 1–5 from C. Murugan 61505C, 6–10 from C. Murugan 61507E, 11–15 from C. Murugan 61511A)

and So 2001). In the presence of 6–12 irregularly scattered ocelli per leaf lobe, therefore, *D. thwaitesiana* var. *thwaitesiana* is considerably distinct from all the hitherto known Indian species of the genus. Yet, *D. thwaitesiana* var. *thwaitesiana* partially resembles *D. longii* Grolle et R. L. Zhu in general appearance and the presence of ovate, slightly falcate leaf lobes with acute apices and irregularly dentate margin. However, *D. longii* can be easily distinguished from the present species in having strongly curved first tooth of leaf lobule and male bracteoles present throughout the androecium (Dey and Singh 2012, Dey *et al.* 2013, Grolle and Zhu 1999).

The present addition raises the number of taxa of *Drepanolejeunea* known in the Indian bryoflora to seventeen (Table 3). The Eastern Himalaya, including the northeastern states, with 14 species recorded from the region show the maximum diversity of the genus in India. Of these 11 species are restricted to this bryogeographical region alone in the Indian bryoflora. This is followed by the Western Ghats with five species, two of which are confined to this region and the Andaman and Nicobar Islands with two species. *D. fleischeri* (Steph.) Grolle et R. L. Zhu and *D. yunnanensis* (P. C. Chen) Grolle et R. L. Zhu are common between the Eastern Himalaya and the Western Ghats, while *D. angustifolia* (Mitt.) Grolle is known from all the three regions (Dey *et al.* 2013, Singh and Barbhuiya 2012, Singh and Dey 2012). Two of these species, viz. *D. devendrae* Sushil K. Singh et M. Dey and *D. mawotmiana* Ajit P. Singh et V. Nath are endemic to the country as indicated by an asterisk (*) in Table 3.

*

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