

**NOTES ON EXTENDED DISTRIBUTION OF  
DREPANOLEJEUNEA SPICATA AND LEJEUNEA STEVENSIANA  
(LEJEUNEACEAE: MARCHANTIOPHYTA)  
TWO SCARCELY KNOWN SPECIES IN INDIA**

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Two species of Lejeuneaceae, *Drepanolejeunea spicata* and *Lejeunea stevensiana* have been reported for the first time from Arunachal Pradesh and Meghalaya, respectively. Both the species are poorly known in Indian bryoflora. Till now, the former one is known in India only through collection made by W. Giffith (JE-H3412) from an unknown locality of Assam, while the latter one has limited distribution in India and is known from Kerala, Sikkim and Darjeeling only. The detailed taxonomic descriptions and line drawing illustrations of both the species have been presented to assist with their future identification.

Key words: *Drepanolejeunea*, *Lejeunea*, Lejeuneaceae, India

## INTRODUCTION

Lejeuneaceae are the largest family of the liverworts (Marchantiophyta) with more than 1000 species belonging to 74 genera in the world (Gradstein 2013, Gradstein *et al.* 2018, Söderström *et al.* 2016, Zhu and Ye 2018, Zhu *et al.* 2017). The members of this family are predominantly tropical, subtropical epiphyte and epiphylls (Zhu and So, 2001). Singh *et al.* (2016) listed 233 species (including infraspecific taxa) belonging to 25 genera under the family from India. Since then, eleven more taxa, namely *Cheilolejeunea vittata* (Steph. ex G. Hoffm.) R. M. Schust. et Kachroo, *Cololejeunea khawanglungensis* Sushil K. Singh, *C. manilalia* Manju, Chandini et Rajesh and *C. microscopica* (Taylor) Schiffn. var. *microscopica*, *C. murlenensis* Sushil K. Singh, *Drepanolejeunea mizoramensis* Sushil K. Singh, *Lejeunea bukpuiensis* Sushil K. Singh, *L. eifrigii* var. *indica* Sushil K. Singh, *L. kolasibensis* Sushil K. Singh, *Leptolejeunea mizoramensis* Sushil K. Singh, *Spruceanthus semirepandus* var. *indicus* Sushil K. Singh have been added to the bryoflora of India under the family Lejeuneaceae (Kumar and Singh 2016, Manju *et al.* 2017, Singh 2018, Singh and Kumar 2017). *Acrolejeunea meghalayensis* (A. P. Singh et Nath) J. Wang bis et Gradst. is reduced to synonymy of *Acrolejeunea recurvata* Gradst. (Majumdar and Dey 2017). All the

three species of *Archilejeunea* known from India are now placed under genus *Spruceanthus* Verd. (see Singh and Kumar 2016). Thus, altogether 242 species (including infraspecific taxa) related to 24 genera has now been recognised under the family Lejeuneaceae in India. Within the family, the genus *Cololejeunea* is the largest one with 60 species followed by *Lejeunea* with 53 taxa and *Cheilolejeunea* (22 spp.), *Drepanolejeunea* (19 spp.), 52 taxa are endemic to the country.

Northeast India is a paradise for bryophyte in general and Lejeuneaceae in particular. About 176 taxa (73% of the known taxa) are reported from the East Himalayan bryogeographical territory alone (Singh 2018, Singh and Kumar 2016, Singh *et al.* 2016). In the framework of the 'Taxonomic studies on Lejeuneaceae schizostipae (Marchantiophyta) in Northeast India including Sikkim' project, we encountered two interesting populations of Lejeuneaceae, of these, one is recently collected by one of the authors (SKS) from Khasi Hills and another one was collected in February, 1982 by Dr K. P. Singh from Tirap, Arunachal Pradesh and deposited in ASSAM herbarium. After a careful examination of morphological and anatomical characters of these specimens, their identities are ascertained as *Drepanolejeunea spicata* (Steph.) Grolle et R. L. Zhu and *Lejeunea stevensiana* (Steph.) Mizut. Both the species are poorly known in India, the former one is known from one unknown locality of Assam, while the latter is known from Kerala, Sikkim and Darjeeling only. *Drepanolejeunea spicata* is recorded here for the first time from Arunachal Pradesh, while, *Lejeunea stevensiana* is new to Meghalaya. It is interesting to note that *Drepanolejeunea spicata* is recorded here after more than a century from any other Indian locality. The studied specimens are deposited in Cryptogamic Herbarium of Botanical Survey of India, Eastern Regional Centre, Shillong (ASSAM).

## TAXONOMIC DESCRIPTIONS

### *Drepanolejeunea spicata* (Steph.) Grolle et R. L. Zhu (Fig. 1)

*Drepanolejeunea spicata* (Steph.) Grolle et R. L. Zhu, Nova Hedwigia 70: 384 (2000). = *Leptolejeunea spicata* Steph., Hedwigia 35: 108 (1896). = *Rhaphidolejeunea spicata* (Steph.) Grolle, J. Hattori Bot. Lab. 28: 53 (1965).

Plants small, pale yellow in herbarium; shoots 5–12 mm long, 0.72–0.88 mm wide, branching irregular, *Lejeunea*-type; stem suborbicular in cross section,  $47.5\text{--}56.2 \times 45.0\text{--}51.2 \mu\text{m}$ , 4 cells across diameter; cortical cells in a layer of 7 cells, subquadrate-rectangular or polygonal,  $15.0\text{--}21.2 \times 8.7\text{--}13.7 \mu\text{m}$ , thin-walled; medullary cells 3, pentagonal or polygonal,  $10.0\text{--}15.0 \times 8.7\text{--}11.2 \mu\text{m}$ , thin-walled. Leaves imbricate-contiguous, obliquely-widely spreading; leaf lobes ovate to oblong-ovate, 0.38–0.50 mm long, 0.25–0.27 mm wide, apex

rounded or occasionally obtuse, margin crenulated, antical margin slightly arched, postical margin nearly straight; marginal leaf cells towards apex subquadrate-pentagonal or polygonal,  $7.5\text{--}12.5 \times 5.0\text{--}10.0 \mu\text{m}$ ; median leaf cells pentagonal-hexagonal,  $15.0\text{--}25.0 \times 10.0\text{--}17.5 \mu\text{m}$ ; basal leaf cells elongated pentagonal-hexagonal or rectangular,  $17.5\text{--}42.5 \times 10.0\text{--}22.5 \mu\text{m}$ ; cells thin-walled, without distinct trigones and intermediate thickenings; cuticle smooth; oil-bodies not observed; ocelli moniliate, 2, near base of leaf lobe, suprabasal, oval-elliptical,  $50.0\text{--}62.5 \times 30.0\text{--}40.0 \mu\text{m}$ . Leaf lobules inflated, ovate,  $1/3$  as long as leaf lobe,  $0.12\text{--}0.16$  mm long,  $0.08\text{--}0.10$  mm wide, bidentate, first tooth unicellular, elongated, strongly curved, hyaline papilla present at the proximal base of first tooth, keel arched, smooth, second tooth obsolete, free lateral margin of lobule bordered by 4 (5-6) rectangular cells. Underleaves remote, spreading nearly horizontally, 4-8 times as wide as the stem,  $(0.15\text{--})0.16\text{--}0.20$  mm long,  $(0.15\text{--})0.26\text{--}0.41$  mm wide, deeply bilobed, bilobed to  $3/4$  of its length, apex acute-subacute, lobes linear-lanceolate, 5-7 cells long, 1-2 cells wide at base, (3-4)-8 cells uniseriate at apex. Brood branches present,  $0.25\text{--}0.62$  mm long,  $0.33\text{--}0.46$  mm wide, lobe of the first five leaves highly dentate, suborbicular-ovate, lobule smaller, the first underleaves suborbicular with an adhesive disc or par-amphigastrium,  $0.12\text{--}0.17$  mm long,  $0.09\text{--}0.15$  mm wide. Dioicous. Androecia on a short or long branches, terminal on main shoots or lateral branches, or intercalary,  $0.47\text{--}1.01$  mm long,  $0.27\text{--}0.38$  mm wide; bracts in 3-8 pairs, densely imbricate, obliquely spreading; bract lobe ovate to oblong-ovate,  $0.20\text{--}0.23$  mm long,  $0.15\text{--}0.16$  mm wide, apex acute-subacute, margin slightly denticulate at apex; bract lobule inflated, almost as long as the lobe length,  $0.15\text{--}0.20$  mm long,  $0.11\text{--}0.12$  mm wide, apex acute-subacute; bracteoles 1, present only at the base of androecium,  $0.10\text{--}0.15$  mm long,  $0.07\text{--}0.13$  mm wide, bilobed to  $3/4$  of its length, lobes linear-lanceolate, lobe 4-6 cells long, 1-2 cells wide at base, apex acute-subacute, sinus "U" or "V" shaped. Gynoecia not observed.

Habitat: Epiphyllous, growing in moist and shady places, in association with *Colura acroloba* (Mont. ex Steph.) Jovet-Ast, *Cheilolejeunea trapezia* (Nees) Kachroo et R. M. Schust. and *Cololejeunea siangensis* G. Asthana et S. C. Srivast.

Specimens examined: India, Arunachal Pradesh, Tirap district, Khonsa, February, 1982, K. P. Singh s.n. (ASSAM).

Distribution: India [Arunachal Pradesh – present study; Assam – without specific locality], China, Indonesia, Japan, Malaysia, Thailand, Cambodia, Laos, Vietnam (Singh *et al.* 2016).

Notes and differentiation: This Asiatic species is belonging to subg. *Rhaphidolejeunea* (Herzog) Grolle et R. L. Zhu (Söderström *et al.* 2016). In India, the species is very poorly known and no identified herbarium material is available in any Indian Herbaria. Till now, the species was recorded in India based on a collection made by W. Giffith (JE-H3412) from unknown locality of

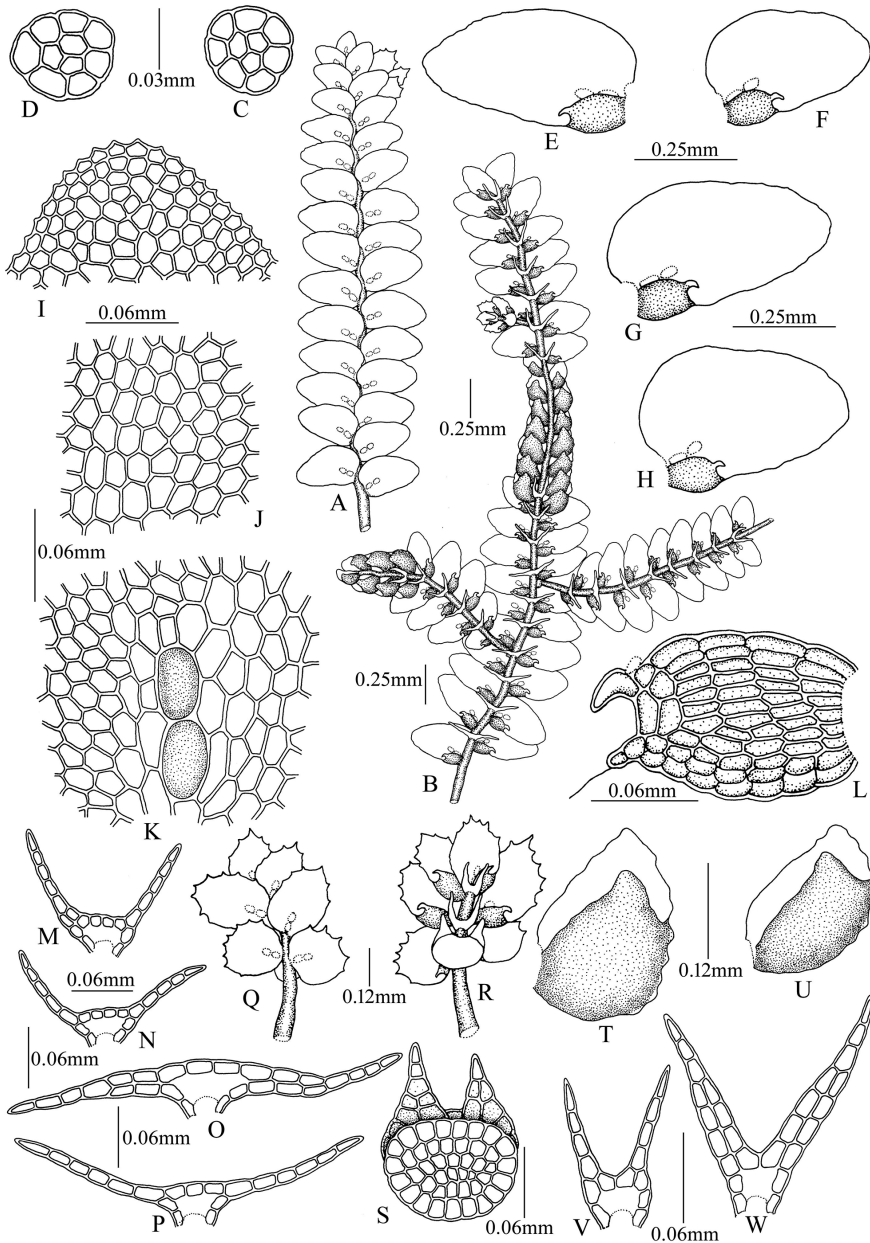


Fig. 1. *Drepanolejeunea spicata*. A = a portion of plant in dorsal view; B = a portion of plant in ventral view bearing androecia; C–D = cross sections of stem; E–H = leaves; I = marginal leaf cells towards apex; J = median leaf cells; K = basal leaf cells; L = a leaf lobule; M–P = underleaves; Q = brood-branch in dorsal view; R = brood-branch in ventral view; S = first underleaf of brood-branch; T – U = male bracts; V–W = male bracteoles

Assam. Thus, the present study confirms the occurrence of this species in India with supporting herbarium materials from Arunachal Pradesh once again.

In having ovate to oblong-ovate leaf lobe with rounded-obtuse apex and almost similar leaf lobules and in presence of single bracteoles at the base of androecium *Drepanolejeunea spicata* is closely allied to *D. foliicola* Horik. However, *D. foliicola* differs from the species in discussion by having usually 1 ocellus per leaf lobe, leaf lobe acute (to rounded) at apex and denticulate margins (Grolle and Zhu 2000). *Drepanolejeunea spicata* is also showing resemblance with *D. commutata* Grolle et R. L. Zhu – another species of the subgenus *Rhaphidolejeunea*. However, the latter differs from former in having presence of bracteoles throughout the androecium, smaller leaf lobules ca 1/4–1/3 of the leaf lobe and leaf lobes with acute-subacute apex and subentire-serrulate margins and usually 1 ocelli per leaf lobe and underleaves lobe 2–4 cells uniseriate at apex (Grolle and Zhu 2000). *Drepanolejeunea yunnanensis* is also somewhat similar to *D. spicata* when sterile, but the former differs in its 7–10 free lateral marginal cells of leaf lobule (Grolle and Zhu 2000).

### *Lejeunea stevensiana* (Steph.) Mizut.

(Fig. 2)

*Lejeunea stevensiana* (Steph.) Mizut., J. Hattori Bot. Lab. 34: 452 (1971); R.-L. Zhu and M. L. So, Ann. Bot. Fenn. 36: 244 (1999). = *Taxilejeunea stevensiana* Steph., Hedwigia 35: 136 (1896). = *Harpalejeunea indica* Steph., Sp. Hepat. 6: 392 (1923).

Plants green when fresh, pale yellowish in herbarium; shoots 12–40 mm long, 1.37–1.62 mm wide; branching irregular, *Lejeunea*-type. Stems suborbicular in cross section, 132.5–150.0 × 115.0–125.0 µm, 6–8 cells across the diameter; cortical cells in a layer of 7 cells, subquadrate–rectangular, 32.5–62.5 × 17.5–30.0 µm, thin-walled; medullary cells 18–22, polygonal, 12.5–27.5 × 10.0–17.5 µm, thin-walled; ventral merophytes 2 cells wide. Leaves imbricate-contiguous or occasionally remote, widely spreading; leaf lobes 0.75–0.87 mm long, 0.52–0.62 mm wide, triangular-ovate, apex apiculate or acuminate sometimes incurved, margin entire, antical margin strongly arched toward the base, postical margin slightly arched; marginal leaf cells towards apex subquadrate-rectangular or pentagonal, 12.5–20.0 × 10.0–15.0 µm, median leaf cells pentagonal-hexagonal, 22.5–40.0 × 17.5–25.0 µm, basal leaf cells slightly elongated, pentagonal-hexagonal or polygonal, 35.0–50.0 × 25.0–37.5 µm; cells thin to slightly thick-walled, hyaline with triradiate-subnodulose trigones and small 0–1(–2) intermediate thickenings on each cell wall; cuticle verrucose; oil-bodies spherical-elliptical, 4–17 each leaf cells, spherical 2.5 × 3.75 µm, when elliptical 6.25–12.5 × 2.5–5.0 µm; leaf lobules small, 0.11–0.12

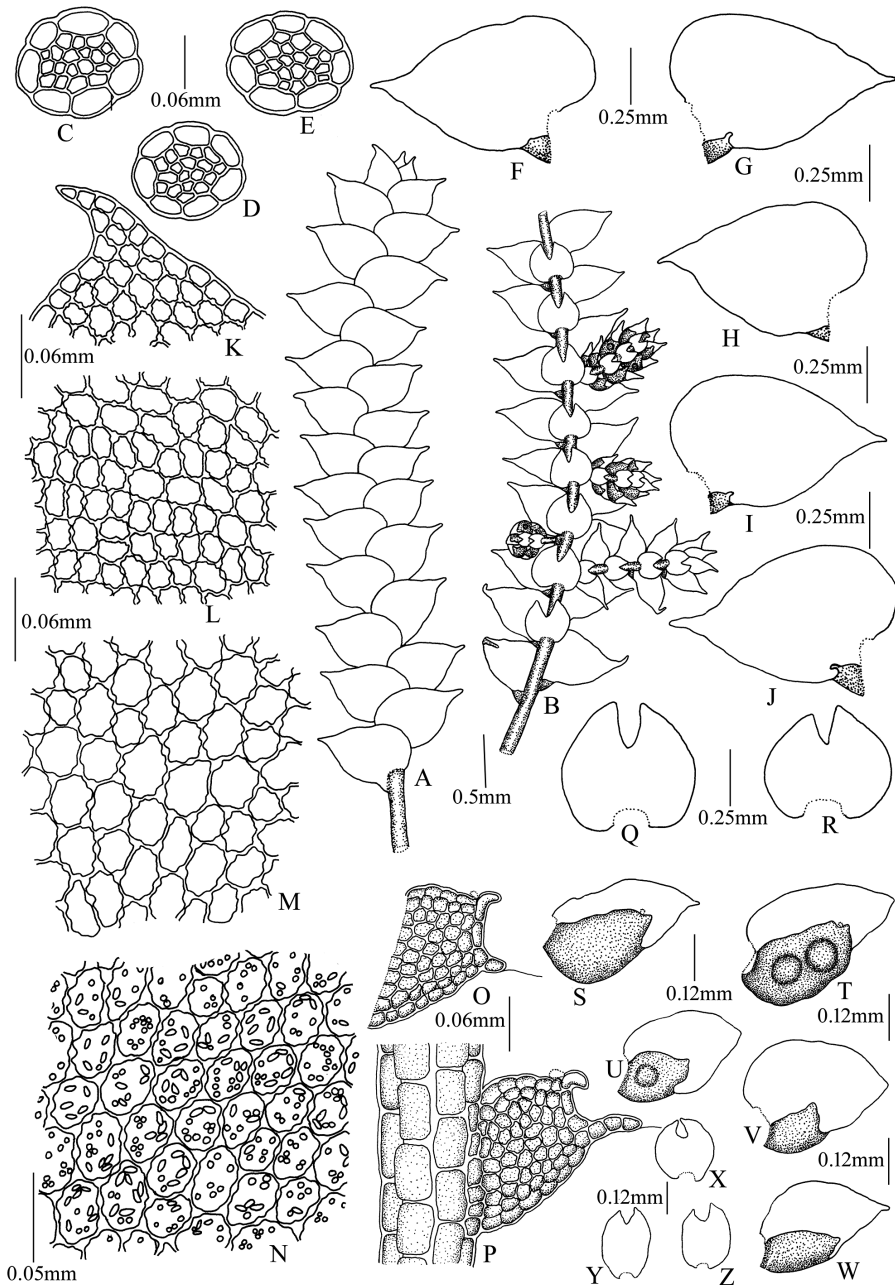


Fig. 2. *Lejeunea stevensiana*. A = a portion of plant in dorsal view; B = a portion of plant in ventral view bearing androecia; C-E = cross sections of stem; F-J = leaves; K = marginal leaf cells towards apex; L = median leaf cells; M = basal leaf cells; N = median leaf cells showing oil-bodies; O-P = leaf lobules; Q-R = underleaves; S-W = male bracts; X-Z = male bracteoles

mm long, 0.07–0.18 mm wide, inflated, triangular-rectangular-ovate,  $1/8$ – $1/5$  as long as the lobe, bidentate, first tooth small, unicellular, slightly curved, second tooth obsolete; hyaline papilla present at the proximal base of first tooth, free lateral margin slightly bordered with 4–5 subquadrate-rectangular cells. Underleaves contiguous-remote, 0.37–0.50 mm long, 0.52–0.62 mm wide, 3–4 times as wide as stem, usually covering the lobules, suborbicular-reniform, deeply bilobed to  $2/5$ – $1/2$  of its length; lobes triangular, 6–9 cells long, 6–9 cells wide at base, margin entire, apex acute-subacute, sinus “U” or “V” shaped. Dioicous. Androecium terminal on main shoot or lateral branches, 0.62–1.20 mm long, 0.37–0.55 mm wide; bracts in 3–5 pairs, densely imbricate; bract lobe ovate, 0.30–0.47 mm long, 0.21–0.28 mm wide, apex acute-subacute, margin entire, bract lobules strongly inflated,  $1/3$ – $2/3$  as long as the bract lobe, 0.17–0.25 mm long, 0.11–0.17 mm wide; male bracteoles present throughout the androecium, suborbicular to nearly oblong, 0.13–0.27 mm long, 0.14–0.25 mm wide, bilobed to  $2/5$ – $1/4$ th of its length, lobes triangular, apex acute-subacute and margin entire. Gynoecial branch not observed.

Habitat: Terrestrial, growing on a thin layer of soil over rocks in moist and shady places in association with mosses.

Specimens examined: India, Meghalaya, near Mawjem,  $25^{\circ} 25' 23.06''$  N,  $91^{\circ} 51' 47.34''$  E, 1715 m, 3 June 2018, S. K. Singh TSLI-4070 (ASSAM).

Distribution: India [Kerala, Meghalaya – present study, Sikkim, West Bengal], Bhutan, Nepal (Singh *et al.* 2016).

Notes and differentiation: *Lejeunea stevensiana* is a Himalayan species reported in Indian bryoflora from Sikkim and Darjeeling hills of West Bengal (Mizutani 1971). This species was recently reported from Kerala, Western Ghats by Manju *et al.* (2008, 2012).

Among the known species *Lejeunea* in India, *Lejeunea stevensiana* is closely allied to *Lejeunea apiculata* Sande Lac. in having similar arrangement of leaves, triangular-ovate leaf lobes with apiculate or acuminate apex, leaf cells with small to large trigones and 0–2 intermediate thickenings on each cell wall. However, *Lejeunea apiculata* distinctly differs from the species in discussion in having cross sections of stem with 4–6 medullary cells, larger leaf lobule ( $1/4$ – $1/3$  as long as the leaf lobe), comparatively smaller underleaves, which is 1.5–2.5 times as wide as stem (Dey and Singh 2012).

It also shows resemblance with *Lejeunea neelgherriana* Gottsche in general appearance of plant and arrangement of leaves, in its leaf lobe apices which are apiculate-acuminate, in verrucose-punctuate cuticle of leaf cells. In both the species lobule first tooth is slightly curved and hook-shaped, underleaves large, distant to contiguous, dioicous sexuality and bracteoles present throughout the androecium. But, *Lejeunea neelgherriana* differs from *L. stevensiana* in having large well-developed lobule ( $1/3$ – $1/2$  as long as the lobe) and

leaf cells usually with smaller trigones and without intermediate thickenings (Zhu and So 2000, Bakalin and Borovichev 2014).

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## REFERENCES

- Bakalin, V. and Borovichev, E. (2014): *Lejeunea neelgherriana* Gottsche (Lejeuneaceae, Hepaticae) – an unexpected record of a Tertiary relict in the Russian Far East. – *Cryptog. Bryol.* **35**(4): 417–421. <https://doi.org/10.7872/cryb.v35.iss4.2014.417>
- Dey, M. and Singh, D. K. (2012): *Epiphyllous liverworts of eastern Himalaya*. – Botanical Survey of India, Kolkata.
- Gradstein, S. R. (2013): A classification of Lejeuneaceae (Marchantiophyta) based on molecular and morphological evidence. – *Phytotaxa* **100**: 6–20. <https://doi.org/10.11646/phytotaxa.100.1.2>
- Gradstein, S. R., Zhu, R.-L., Shu, L. and Perez, A. J. (2018): *Reinerantha foliicola*, a new genus and species of Lejeuneaceae subtribe Cololejeuneinae (Marchantiophyta) from Ecuador. – *J. Syst. Evol.* **56**: 67–75. <https://doi.org/10.1111/jse.12293>
- Grolle, R. and Zhu, R.-L. (2000): A study of *Drepanolejeunea* subg. *Rhaphidolejeunea* (Herzog) Grolle & R. L. Zhu, stat. nov. (Hepaticae, Lejeuneaceae) in China with notes on its species elsewhere. – *Nova Hedwigia* **70**: 373–395.
- Kumar, S. and Singh, S. K. (2016): *Cheilolejeunea vittata* (Steph. ex G. Hoffm.) R. M. Schust. & Kachroo (Lejeuneaceae: Marchantiophyta) – a newly recorded species from India. – *Bangladesh J. Pl. Taxon.* **23**(2): 209–213. <https://doi.org/10.3329/bjpt.v23i2.30853>
- Majumdar, S. and Dey, M. (2017): *Acrolejeunea meghalayensis*, a new synonym of *Acrolejeunea recurvata* (Lejeuneaceae: Marchantiophyta). – *Phytotaxa* **328**(1): 95–98. <https://doi.org/10.11646/phytotaxa.328.1.7>
- Manju, C. N., Rajesh, K. P. and Madhusoodanan, P. V. (2008): Checklist of the bryophytes of Kerala, India. – *Trop. Bryol. Res. Rep.* **7**: 1–24.
- Manju, C. N., Pócs, T., Rajesh, K. P. and Prakashkumar, R. (2012): Lejeuneaceae (Marchantiophyta) of the Western Ghats, India. – *Acta Biol. Pl. Agriensis* **2**: 125–145.
- Manju, C. N., Chandini, V. K. and Rajesh, K. P. (2017): *Cololejeunea manilalia* (Lejeuneaceae, Marchantiophyta), a new species from the Western Ghats of India. – *Acta Bot. Hung.* **59**(1–2): 261–268. <https://doi.org/10.1556/034.59.2017.1-2.8>
- Mizutani, M. (1971): *Lejeunea* from the Himalayan region. – *J. Hattori Bot. Lab.* **34**: 445–457.
- Singh, S. K. (2018): Description of six new species and two new infraspecific taxa of Lejeuneaceae (Marchantiophyta) from India. – *Nelumbo* **60**(1): 69–84. <https://doi.org/10.20324/nelumbo/v60/2018/130181>
- Singh, S. K. and Kumar, S. (2016): Two new and noteworthy records of Lejeuneaceae (Marchantiophyta) from Jharkhand, India. – *Keanean J. Sci.* **5**: 25–32.



- Singh, S. K. and Kumar, S. (2017): *Cololejeunea microscopica* var. *microscopica* (Marchantiophyta: Lejeuneaceae) – a new record for India. – *Bangladesh J. Pl. Taxon.* **24**(2): 233–236. <https://doi.org/10.3329/bjpt.v24i2.35120>
- Singh, D. K., Singh, S. K. and Singh, D. (2016): *Liverworts and hornworts of India: an annotated checklist*. – Botanical Survey of India, Kolkata.
- Söderström, L., Hagborg, A., Konrat, M. v., Bartholomew-Began, S., Bell, D., Briscoe, L., Brown, E., Cargill, D. C., Costa, D. P., Crandall-Stotler, B. J., Cooper, E. D., Dauphin, G., Engel, J. J., Feldberg, K., Glenny, D., Gradstein, S. R., He, X., Heinrichs, J., Hentschel, J., Ilkiu-Borges, A. L., Katagiri, T., Konstantinova, N. A., Larrain, J., Long, D. G., Nebel, M., Pócs, T., Puche, F., Reiner-Drehwald, E., Renner, M. A. M., Sass-Gyarmati, A., Schäfer-Verwimp, A., Segarra Moragues, J. G., Stotler, R. E., Sukkharak, P., Thiers, B. M., Uribe, J., Várna, J., Villarreal, J. C., Wigginton, M., Zhang, L. and Zhu, R.-L. (2016): World check list of hornworts and liverworts. – *Phytokeys* **59**: 1–828. <https://doi.org/10.3897/phytokeys.59.6261>.
- Zhu, R.-L. and So, M. L. (2000): Notes on the taxonomy and distribution of *Lejeunea neelgherriana* and *Tuyamaella serratistipa* (Hepaticae, Lejeuneaceae). – *Ann. Bot. Fenn.* **37**: 149–153.
- Zhu, R.-L. and So, M. L. (2001): Epiphyllous liverworts of China. – *Nova Hedwigia, Beih.* **121**: 1–418.
- Zhu, R.-L. and Ye, W. (2018): *Gaolejeunea*, a new genus from China and new member of subtribe *Echinolejeuneinae* (Lejeuneaceae, Marchantiophyta). – *Bryologist* **121**(1): 41–48. <https://doi.org/10.1639/0007-2745-121.1.041>
- Zhu, R.-L., Shu, L., Maryani, A., Mustapeng, A. and Suleiman, M. (2017): *Thiersianthus* (Marchantiophyta: Lejeuneaceae), a new genus from lowland rainforests in Borneo. – *Bryologist* **120**(4): 511–520. <https://doi.org/10.1639/0007-2745-120.4.511>

