

RESEARCH ARTICLE

New additions to leafy liverwort flora (Marchantiophyta, Jungermanniopsida) of Sri Lanka

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Abstract: Leafy liverworts (Marchantiophyta, Jungermanniopsida) comprise a morphologically diverse and complex group of liverworts. Based on past checklists and publications, 25 families, 62 genera and 290 species of leafy liverworts are known to occur in Sri Lanka. The existing checklists largely depend on old publications, and lack proper taxonomic descriptions, keys and locality details, hampering further research and conservation of this important group of plants. A detailed taxonomic survey was initiated to explore and document the leafy liverwort flora of Sri Lanka. Fresh samples were collected and surveyed for morphological, anatomical and spore morphological characters. Specimens were identified using the unique characters based on recent taxonomic keys and monographs and authenticated using type specimens and/or descriptions. Six new species were identified as new records to Sri Lanka: *Lejeunea sordida* (Nees) Nees, *Leptolejeunea subdentata* Schiffn., *Spruceanthus polymorphus* (Sande Lac.) Verd., *Frullania udarii* Nath et Singh, *Heteroscyphus turgidus* (Schiffn.) Schiffn. and *Fuscocephalozopsis lunulifolia* (Dumort.) Váňa et L.Söderstr. The genus *Fuscocephalozopsis* Fulford is recorded as a new genus to Sri Lanka. Taxonomic descriptions along with photo plates are provided for all the species reported. Addition of the six new records increases the total number of leafy liverwort species of Sri Lanka from 290 to 296 and the number of genera from 62 to 63.

Keywords: Biodiversity, bryophytes, leafy liverworts, new records, taxonomy.

INTRODUCTION

The tropical island of Sri Lanka covering only a total land area of about 656,110 km² harbours a rich diversity of flora and fauna owing to its varied climate and topography (Gunawardene *et al.*, 2007; Long & Rubasinghe, 2014). According to Myers *et al.* (2000) 1.6 % of the global plant species and 3.9 % of the global animal species are recorded in Sri Lanka and about half of both plants and animals are endemic to the island. However, bryophyte flora (liverworts, mosses, hornworts) of the island remains poorly researched. Among the bryophytes, leafy liverworts (Marchantiophyta, Jungermanniopsida) are one of the least studied. Yet, leafy liverworts comprise one of the most diverse and complex groups among bryophytes and include about 4500 species worldwide (Heinrichs *et al.*, 2007). According to the latest checklist, 25 families, 62 genera and 290 species of leafy liverworts are known to occur in Sri Lanka (Long & Rubasinghe, 2014). Apart from the 03 new additions made by Samarakkody *et al.* (2018) no taxonomic surveys are being carried out on Sri Lankan leafy liverworts. The existing checklists are largely based on previously published old literature rather than actual specimens. Therefore, taxonomic descriptions, keys or illustrations for most of the recorded species are lacking.

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Lack of locality details or phenological data hampers the conservation of leafy liverworts within the island. Therefore, to fulfill this timely requirement, a detailed taxonomic survey was carried out to explore the diversity of leafy liverworts in Sri Lanka.

METHODOLOGY

Field excursions were carried out throughout the country to collect fresh samples of leafy liverworts. The collected samples were thoroughly surveyed for morphological and anatomical characters using light (Hertel and Reuss, Optik Kassel, Germany), binocular (Olympus CX21, Philippines) and trinocular (Zeiss, Primo Star, Germany) microscopes. Cellular measurements were obtained using a binocular microscope (Zeiss, Primo Star, Germany). Characters were recorded for each specimen collected. The specimens were identified using recent taxonomic keys, descriptions and monographs based on the most recent classification by Crandall-Stotler *et al.* (2009). Identified species were authenticated using type descriptions. Herbarium specimens were prepared using Schofield (1985) method, and voucher specimens were deposited at the National Herbarium, Peradeniya (PDA).

RESULTS AND DISCUSSION

Twenty-one families, 46 genera and 132 species of leafy liverworts were identified during the present study. The identified species included 06 new species records to Sri Lanka: *Lejeunea sordida* (Nees) Nees, *Leptolejeunea subdentata* Schiffn., *Spruceanthus polymorphus* (Sande Lac.) Verd., *Frullania udarii* Nath et Singh, *Heteroscyphus turgidus* (Schiffn.) Schiffn. and *Fuscocephaloziopsis lunulifolia* (Dumort.) Vána et L.Söderstr. The genus *Fuscocephaloziopsis* Fulford is recorded as a new genus to Sri Lanka. Taxonomic descriptions and photo plates are provided for all the new species reported.

Family Lejeuneaceae

Lejeunea sordida (Nees) Nees

Nees, Naturgeschichte der Europäischen Lebermoose 3: 278 (1838); Mizutani, J. Hatt. Bot. Lab. 33: 243 (1970); Zhu & So, Nova Hedwigia 121: 142 (2001); Lee *et al.*, Acta Biol. Pl. Agriensis 1: 42 (2010); Söderström *et al.*, PhytoKeys 09: 81 (2010); Lee *et al.*, Gard. Bull. (Singapore) 63 (2011) 164; Söderström *et al.*, PhytoKeys 59: 378 (2016); Lee, Data in brief 28: 3 (2020).

Basionym: *Jungermannia sordida* Nees, Enumeratio Plantarum Cryptogamicarum Javae 41: (1830). **Type:** Indonesia. Java, “Inter muscos *et* Jungermanniae terrestres sparsim; in tumulis Baduorum sanctis; inter alias Jungermannias caespitosa, haud spernenda copia”, Blume *s. n.* (holotype: STR *n.v.*, isotype: W *n.v.*).

Illustrations: Figures 1 and 2; Mizutani, J. Hatt. Bot. Lab. 33 (1970) 243, Fig. XII.

Description: Plants light to dull green when fresh and light to dark brown when dry, irregularly and slightly pinnately branched, branches erect and spreading. Stem green, cylindrical, 0.6–0.15 mm in diameter, cross section with 7 cortical cells and 17 medullary cells. Leaves closely imbricate, obliquely spreading when moistened, margin entire, apex broadly rounded to obtuse or flat; cuticle rough, finely punctate or papillose. Leaf lobes flat, ovate to orbicular, 0.5 – 0.7 mm long, 0.4 – 0.5 mm wide, margin entire, ventral margin strongly arched, apex broadly rounded. Leaf cells large, gradually becoming smaller towards the margin, quadrate to pentagonal or rounded, apical cells 13–15 µm long, 14–16 µm wide; median and basal cells almost similar in size, 23–30 µm long, 15–20 µm wide, basal cells same as median cells; basal cells, cell walls hyaline with distinct medium to large trigones and intermediate thickenings. Oil bodies 3–10 per cell, finely segmented, compound, ovoid to oblong. Lobule small, ovate, 0.1–0.2 mm long, 0.1–0.15 mm wide, up to 1/5 of the leaf lobe or smaller. Underleaves 0.30–0.5 mm long, 0.5–0.6 mm wide, reniform, imbricate, shallowly bifid to 1/4–1/3 under leaf length, lobes oblique, sinus, round, U-shaped to V-shaped, base cordate. Reproductive structures not seen.

Note: Dioicous. Androecia terminal on short or long branches, with closely imbricate bracts; bracts in pairs, lobule strongly inflated; bracteole smaller than the under leaf. Gynoecia terminal on short branch, with loosely arranged bracts with one innovation, usually with 1 – 2 gynoecia in a lateral row; bracts slightly larger than the leaf, bracts and bracteoles in 2 series; lobe ovate, apex obtuse, margin entire; lobule lanceolate, apex obtuse. Perianth obovate, with 5-keels and 2 – 3 cells long beak, base straight, stalk-like elongation absent (Lee, 2020).

Habitat: Found growing on tree trunks and rarely on leaves of trees. Commonly found in lowland rain forests.

Distribution: The species is also reported from Australia, Caroline Islands, China, Fiji, India, Indonesia (Java,

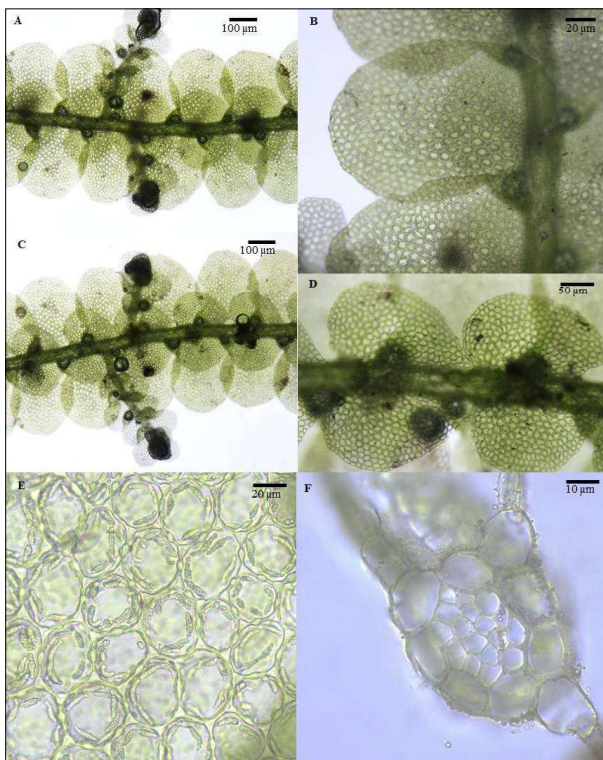


Figure 1: *Lejeunea sordida* (A, B) dorsal view of the plant; (C) ventral view of the plant; (D) underleaves; (E) leaf median cells with oil bodies; (F) stem cross section

Sumatra), Japan, Micronesia, New Caledonia, Papua New Guinea, Peninsular Malaysia, Philippines, Samoa, Sri Lanka, Solomon Islands and Thailand (Lee *et al.*, 2010; Gradstein, 2002; Siregar *et al.*, 2017).

Remarks: Eighteen species of *Lejeunea* are recorded from Sri Lanka (Long & Rubasinghe, 2014). *Lejeunea sordida* is distinguished from other *Lejeunea* sp. by very large, reniform, shallowly bifid underleaves, with a strongly arched insertion at the base and small leaf lobules and leaf lobe with large cells with distinct trigones and intermediate thickenings (Zhu & So, 2001; Yang & Lin, 2009; Lee *et al.*, 2010; Siregar *et al.*, 2017). *Lejeunea leratii* is morphologically closely related to *Lejeunea sordida* (Mizutani, 1970). However, the under leaf of *L. sordida* is bilobed for about 1/3 the length of the leaf lobe, and in *L. leratii* apex of the under leaf is merely emarginate (having a small notch) or truncate (Zhu & So, 2001; Yang & Lin, 2009; Siregar *et al.*, 2017).

Specimens examined: Sri Lanka: Sabaragamuwa Province, Ratnapura District, Sinharaja Rain Forest,

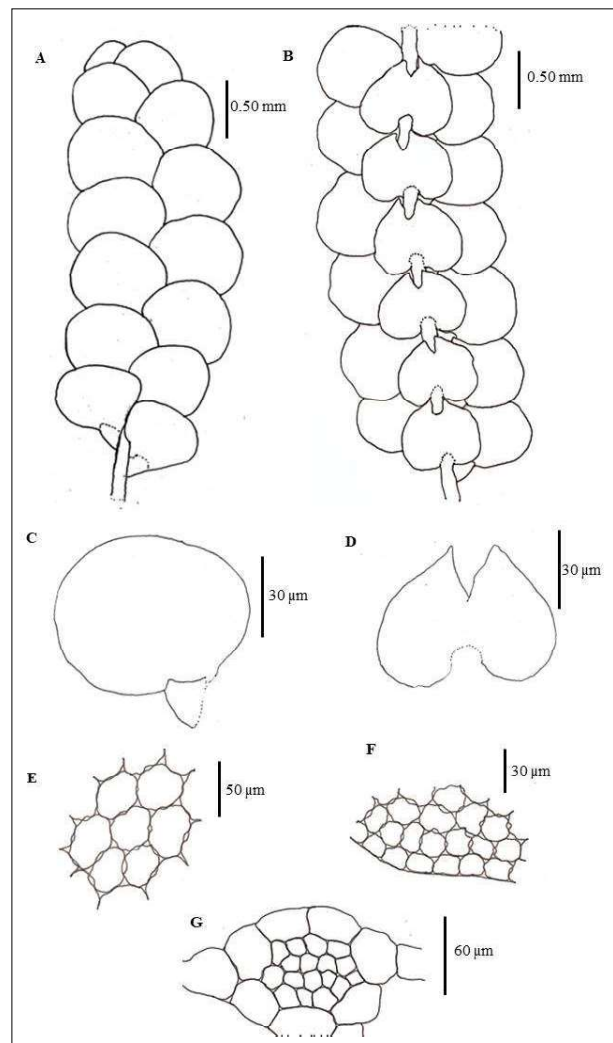


Figure 2: *Lejeunea sordida* (A) dorsal view of the plant; (B) ventral view of the plant; (C) leaf lobe; (D) under leaf; (E) median cells of leaf lobe; (F) marginal leaf cells; (G) transverse section of stem.

06.43140 N, 80.41441 E, 522 m. 26 August 2017, *Bandaranayake & Rubasinghe 759-17 SBSR* (PDA); Sabaragamuwa Province, Ratnapura District, Sinharaja Rain Forest, 06.43467 N, 80.41862 E, 362 m. 26 August 2017, *Bandaranayake & Rubasinghe 794-17 SBSR* (PDA); Southern Province, Galle District, Diyadawa Forest Reserve, 06.34641 N, 80.59909 E, 530 m. 29 April 2017, *Bandaranayake & Rubasinghe 334-17 SBSR* (PDA); Southern Province, Galle District, Kanneliya Rain Forest, 06.25864 N, 80.35043 E, 159 m. 20 January 2018, *Bandaranayake & Rubasinghe, 1311-18 SBSR* (PDA).

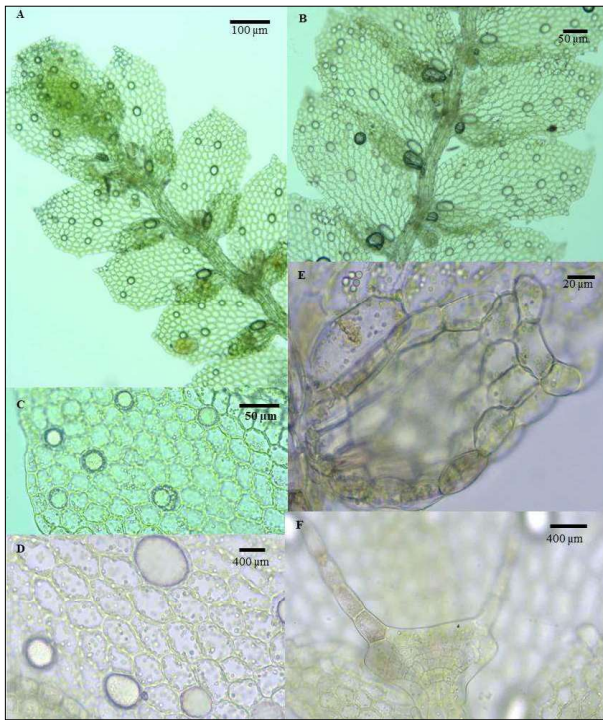


Figure 3: *Leptolejeunea subdentata* (A, B) dorsal view of the plant; (C, D) ocelli of leaf lobe; (E) leaf lobule; (F) under leaf

Family Lejeuneaceae

Leptolejeunea subdentata Schiffn. ex Herzog

Herzog, Flora 135: 403 (1942); Zhu & So, Nova Hedwigia 121: 204 (2001); Singh *et al.*, Indian J. Forest. 29(3): 339 (2006); Söderström *et al.*, PhytoKeys 09: 84 (2010); Verma *et al.*, Archive for Bryology 177: 2 (2013); Söderström *et al.*, PhytoKeys 59: 378 (2016). **Type:** Indonesia. Java, Tjiburum, *Massart s. n.* (holotype JE *n.v.*).

Illustrations: Figures 3 and 4. Zhu & So, Nova Hedwigia 121: 205 (2001) Fig. 77.

Description: Plants light green when fresh, yellow to dark brown when dry, 5.0–25.0 mm long, 1.0–2.0 mm wide, irregularly branched, *Lejeunea*-type. Stem greenish brown, cylindrical to oval, cross 40–100 µm in diameter, cross section with about 7 cortical cells and 3 medullary cells. Leaves contiguous to slightly imbricate, widely spreading (~ 60° from the stem), 0.6–0.9 mm long, 0.4–0.7 mm wide, leaf lobe obovate, apex acute to

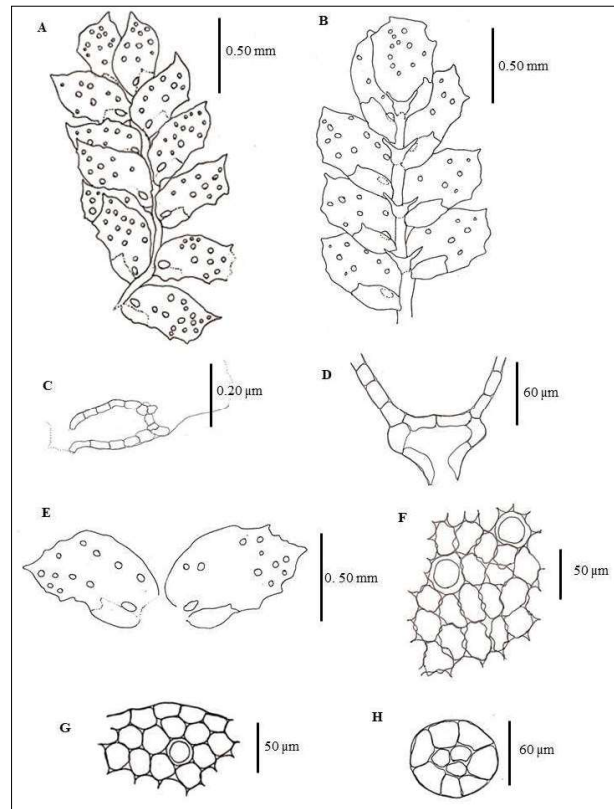


Figure 4: *Leptolejeunea subdentata* (A) dorsal view of the plant; (B) ventral view of the plant; (C) leaf lobule; (D) under leaf; (E) leaf lobes; (F) median cells of leaf lobe; (G) marginal cells of leaf lobe; (H) transverse section of stem

apiculate, with 3–6 blunt teeth, 1–3 cells long, lateral margin entire. Leaf lobe cells thin walled, trigones small, intermediate thickenings 1–3 per wall, usually nodulous, marginal cells sub-quadrate, 14–20 µm long, 11–19 µm wide, median cells hexagonal, 15–25 µm long, 10–25 µm wide. Supra-basal ocellus single, light brown, 50–90 µm long, 25–30 µm wide, ocelli up to 14 per leaf lobe, scattered, 10–30 µm long, 7–28 µm wide. Leaf-lobule oblong, 1/3 as long as the lobe, inflated, rectangular, free lateral margin usually slightly incurved, apex obliquely truncate with 2 teeth, tooth obtuse, first tooth one celled, second tooth obsolete, hyaline papilla at proximal side of first tooth, keel faintly arched to straight, smooth. Underleaves distant, deeply bilobed, about 1/2 of the under leaf length, lobes lanceolate to ligulate, sinus ‘U’ shaped, 2–3 cells long. Rhizoids hyaline, fasciculate and numerous at basal disc of underleaves. Reproductive structures not seen.

Note: Dioicous. Androecia on short or long terminal branches, bracts in pairs, densely imbricate. Gynoecia terminal on very short lateral branches, bracts connate with bracteole on both sides. Perianth cylindrical to obovate, with 5 horizontally spreading keels towards apex (Zhu & So, 2001; Singh *et al.*, 2006).

Habitat: An epiphyllous leafy liverwort found in low land rain forest.

Remarks: Seven species of *Leptolejeunea* are recorded in Sri Lanka (Long & Rubasinghe, 2014). Larger size of the plant, obovate to fan-shaped leaves with 3–6 blunt teeth at margin, up to 14 ocelli scattered on leaf lobe, and leaf lobule 1/3–2/5 as long as the leaf lobe, are some unique characters that can be used to distinguish *L. subdentata* from the other species. *Leptolejeunea emarginata* is closely related to *L. subdentata* but differs from the latter by having comparatively smaller elliptic to obovate leaf lobes with an entire margin, and basal part of under leaf rectangular (Zhu & So, 2001; Singh *et al.*, 2006; 2010).

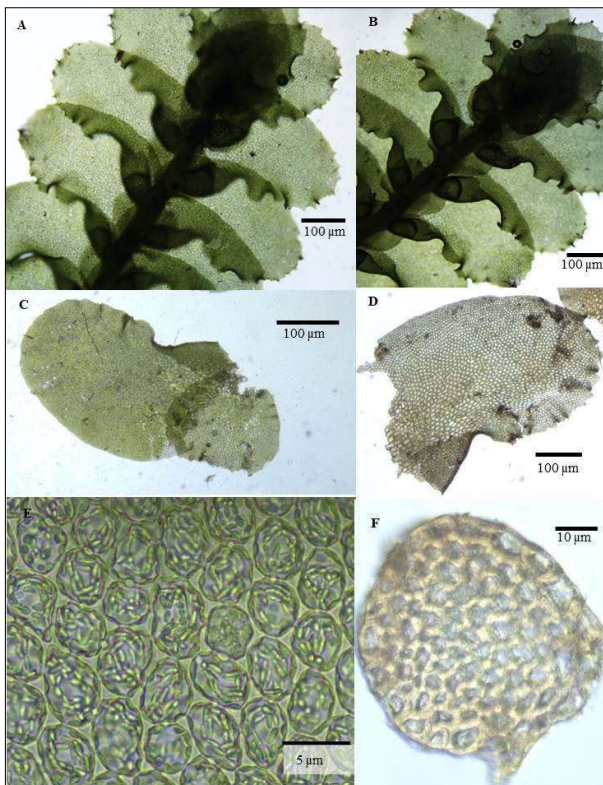


Figure 5: *Spruceanthus polymorphus* (A) dorsal view of the plant; (B) ventral view of the plant; (C) under leaf with and lobe; (D) leaf lobe with lobule; (E) oil bodies of leaf lobe; (F) stem cross section

Distribution: The species is also reported from China, India, Indonesia, Japan, Malaysia, Philippines, New Caledonia and Vietnam (Zhu & So 2001; Singh *et al.*, 2006).

Specimens examined: Sri Lanka. Sabaragamuwa Province, Ratnapura District, Sinharaja Rain Forest, 06.43140 N, 80.41441 E, 522 m. 26 August 2017, *Bandaranayake & Rubasinghe 743-17 SBSR* (PDA); 06.43467 N, 80.41862 E, 362 m. 26 August 2017, *Bandaranayake & Rubasinghe, 793-17 SBSR* (PDA); 06.25864 N, 80.35043 E, 159 m. 26 August 2017, *Bandaranayake & Rubasinghe 1323-18 SBSR* (PDA); 06.26134 N, 80.35216 E, 173 m. 26 August 2017, *Bandaranayake & Rubasinghe 1347-18 SBSR* (PDA); 06.25630 N, 80.34893 E, 143 m, 26 August 2017, *Bandaranayake & Rubasinghe 1363-18 SBSR* (PDA); 06.25137 N, 80.33922 E, 29 m, 26 August 2017, *Bandaranayake & Rubasinghe 1385-18 SBSR* (PDA).

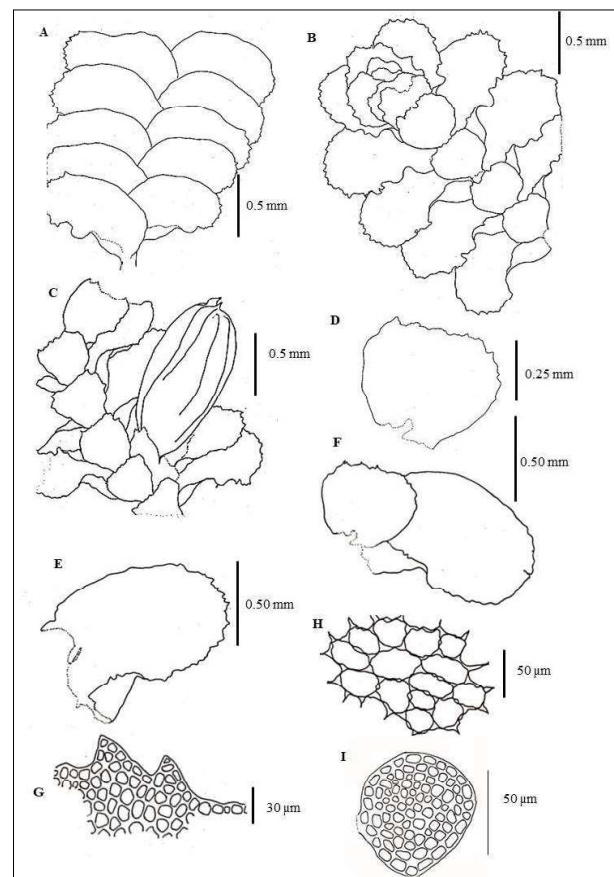


Figure 6: *Spruceanthus polymorphus* (A) dorsal view of plant; (B) ventral view of plant; (C) perianth; (D) under leaf, utriculus; (E) leaf lobe; (F) leaf lobe and under leaf; (G) marginal cells of leaf lobe; (H) median cells of leaf lobe; (I) transverse section of stem

Family Lejeuneaceae

Spruceanthus polymorphus (Sande Lac.) Verd.

Verdoon, *Annales Bryologici*, Supplement 4: 155 (1934); Gradstein, *Acta Bot. Fennica* 174: 68 (2002); Haerida et al., *Gard. Bull. Singapore* 62(1): 87 (2010); Söderström et al., *PhytoKeys* 09: 101 (2010); Kornochalert et al., *Cryptog. Bryol.* 33(1): 58 (2012); Söderström et al., *PhytoKeys* 59: 412 (2016); Wang et al., *Bryo. Biblioth.* 65: 63 (2016). **Basionym:** *Phragmicoma polymorpha* Sande Lac., *Nederlandsch Kruidkundig Archief. Verslangen en Mededelingen der Nederlandsche Botanische Vereeniging* 34: 420 (1854 [1855]). **Type:** Indonesia. Java, *Junghuhn s.n.* (holotype L *n.v.*; isotype NY *n.v.*).

Illustrations: Figures 5 and 6. Wang et al., *Bryo. Biblioth.* 65: 128 (2016) Plate 37

Description: Plants dull green when fresh, yellow when dry, 2–3 cm long, 1–3 mm wide, branching irregularly pinnate, *Lejeunea*-type with microphyllous branches. Stem greenish brown, rigid, cylindrical, 85–177 µm in diameter, cross section with 17–18 cortical cells and 33–42 medullary cells, stem cells with thickened walls, cortical cells slightly larger and thinner-walled than medullary cells. Leaves imbricate, convex, widely spreading when moist, lobe broadly ovate, 0.6–2.0 mm long, 0.5–1.2 mm wide, apex round or acute, margin entire or dentate towards apex, ventral margin plane or undulate, entire or weakly dentate, dorsal margin slightly arched and auriculate at base, entire, cell walls of lobe thin to slightly thickened, trigones slightly large, robust, simple-triangular, intermediate thickenings frequent, marginal cells sub-quadrate 10–20 µm long, 3–14 µm wide, median cells hexagonal, 20–50 µm long, 12–28 µm wide, basal cells elongated 32–54 µm long, 12–30 µm wide. Oil bodies, 15–25 per median cell, homogeneous, oblong or fusiform, 6–10 × 3–4 µm. Leaf lobule ovate, 1/4–2/5 as long as the lobe, inflated, free lateral margin plane, apex obliquely truncate, with 2 teeth, teeth 1–2 celled. Underleaves imbricate to contiguous, appressed or sub-squarrose, suborbicular or transversely oblong, 0.3–0.9 mm long, 0.3–0.7 mm wide, 2–4 times as wide as the stem, apex round to truncate, usually recurved, dentate or entire, bases cuneate. Reproductive structures not seen.

Note: Autoicous. Androecia on different kinds of branches, in spikes of ~ 15 pairs of bracts, bracteoles similar to underleaves in size and shape. Gynoecia on main stem and elongate branches, with 1–2 subfloral

innovations, bracts ovate, toothed, subequally bifid, bracteole orbicular or oblong. Perianth oblong, with 7 smooth keels, margin entire (Gradstein, 2002; Haerida et al., 2010; Wang et al., 2016).

Habitat: Found on tree barks and branches in rain forests.

Distribution: The species is reported from Indopacific region (Wang et al., 2016).

Remarks: Important characters of *S. polymorphus* that can be used to separate the species from other similar species include: robust nature of the plant; dimorphic differentiation of gynoecial and vegetative branches (leaves and underleaves of vegetative branches have plane and entire margins but those in gynoecial branches are toothed and with undulate ventral margin); large leaf trigones; large and toothed female bracteoles (Thiers & Gradstein 1989; Gradstein, 2002; Wang et al., 2016). *Spruceanthus polymorphus* and *S. planiusculus* are morphologically closely related. However, the size of *S. planiusculus* is smaller than *S. polymorphus* and also *S. planiusculus* does not have microphyllous branches, and vegetative and gynoecial shoots are not morphologically different (Wang et al., 2016; Gradstein, 2002).

Specimens examined: Sri Lanka. Sabaragamuwa Province, Ratnapura District, Sinharaja Rain Forest, 06.42637 N, 80.41560 E, 454 m. 26 August 2017, Bandaranayake & Rubasinghe 926-17 SBSR (PDA).

Family Lophocoleaceae

Heteroscyphus turgidus (Schiffn.) Schiffn.

Schiffner, *Österreichische Botanische Zeitschrift* 60: 171 (1910); Gao et al., *J. Bryol.* 26(2): 99 (2004); Söderström et al., *PhytoKeys* 59: 204 (2016). **Basionym:** *Chiloscyphus turgidus* Schiffn., *Denkschriften der Kaiserlichen Akademie der Wissenschaften, Wien. Mathematisch-naturwissenschaftliche Klasse* 70: 212 (1900). **Type:** Indonesia, Sumatra occid., Mt Singalang, 2800 m a.s.l., *Schiffner 1424* (syntype FH *n.v.*).

Illustrations: Figures 7 and 8. Gao et al., *J. Bryol.* 26(2): 101 (2004) Figure 3

Description: Plants medium or large, olive-green to dark brownish green, 4–7 cm long, 2–3 mm wide, irregularly and rarely branched. Stem irregularly and sparsely branched. Leaves succubus, imbricate, cuticle smooth, margin entire, apex plane, rounded or with a small

notch. Leaf lobes narrowly connected with each other dorsally, slightly broader than long or almost rounded, 1.8–2.5 mm long, 2–3 mm wide, slightly convex. Leaf cells isodiametric, sub-rounded, trigones large, knot-like, marginal cells 10–24 μm long, 10–20 μm wide, median cells 14–35 μm long, 12–28 μm wide, basal cells same as median cells. Underleaves connected with lateral leaves,

almost rounded, broader than long, apex shallowly 2-lobed, 1.0–1.8 mm long, 1–2 mm wide, margins with several teeth. Rhizoids at base of underleaves or scattered on ventral side of stem, numerous, fasciculate. Plants dioicous. Perianth large, mouth lobed, lobes lanceolate to ovate. Perichaetial leaves ovate, 2-lobed, irregularly toothed. Sporophyte not seen.

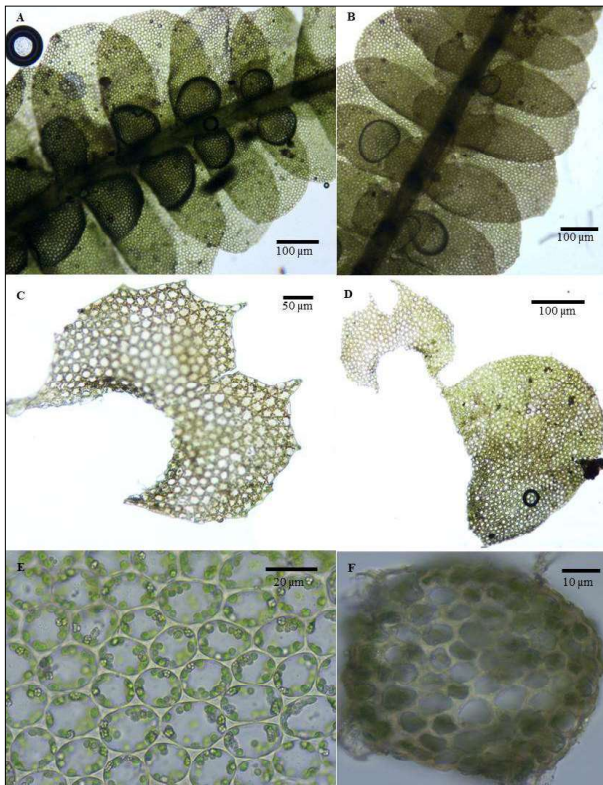


Figure 7: *Heteroscyphus turgidus* (A) dorsal view of the plant; (B) ventral view of the plant; (C) under leaf; (D) connected leaf lobe and under leaf; (E) leaf lobe cells with oil bodies; (F) stem cross section

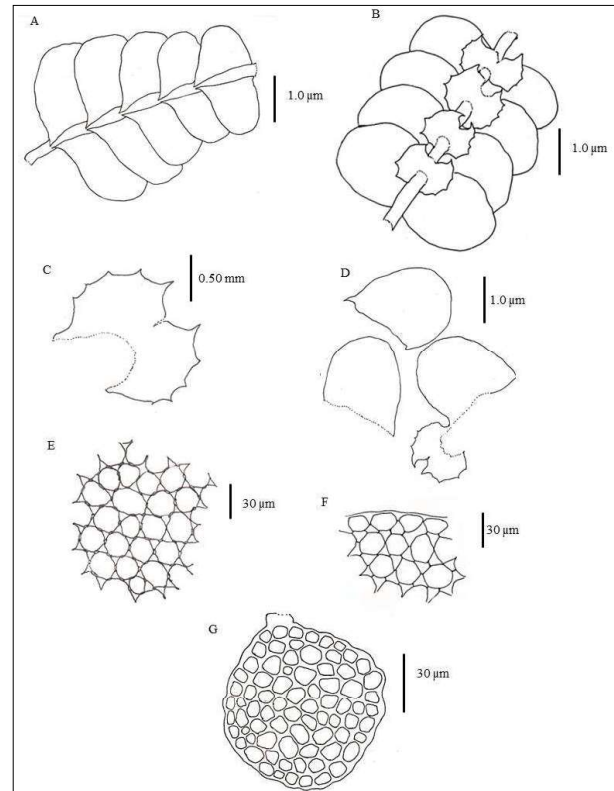


Figure 8: *Heteroscyphus turgidus* (A) dorsal view of the plant; (B) ventral view of the plant; (C) under leaf; (D) leaf lobes; (E) median cells of leaf lobe; (F) marginal cells of leaf lobe; (G) transverse section of stem

Habitat: On trunks of trees in low land rain and sub montane forests.

Distribution: The species is also reported from China (Taiwan), Indonesia (Sumatra) and Papua New Guinea (Gao *et al.*, 2004).

Remarks: Five species are recorded under the genus *Heteroscyphus*, from Sri Lanka (Long & Rubasinghe, 2014). The species can be easily identified from other species of the genus by the medium to large plants with olive green colour, glossy appearance of fresh plants,

slightly convex leaves, leaf cells with very large trigones (Gao *et al.*, 2004).

Specimens examined: Sri Lanka. Sabaragamuwa Province, Ratnapura District, Sinharaja Rain Forest, 06.43030 N, 80.41408 E, 477 m. 26 August 2017, *Bandaranayake & Rubasinghe 920-17 SBSR* (PDA); 06.42637 N, 80.41560 E, 455 m. 26 August 2017, low land rain forest, *Bandaranayake & Rubasinghe 927-17 SBSR* (PDA); Southern Province, Galle District, Kanneliya Rain Forest, 06.25137 N, 80.33922 E, 29 m, 20 January 2018, *Bandaranayake & Rubasinghe 1411-18 SBSR*;

Central Province, Nuwara Eliya District, Maskeliya fishing hut, 6.7983 N, 80.52386 E, 1370 m, 05 May 2018, Peak Wilderness Sub Montane Forest, *Bandaranayake & Rubasinghe 1593-18 SBSR* (PDA); 6.79514N, 80.52256 E, 1411 m, 05 May 2018, *Bandaranayake & Rubasinghe 1664-18 SBSR* (PDA).

Family Frullaniaceae

Frullania udarii Nath et Singh

Nath & Sing, *Current Science* 91(6): 744 (2006); Söderström *et al.*, *PhytoKeys* 59: 295 (2016). **Type:** India, BSI campus, Barapani, Meghalaya, altitude ca. 765 m, *V. Nath & party s. n.* (holotype LWG *n.v.*).

Illustrations: Figures 9 and 10. Nath & Sing, *Current Science* 91(6): 745 (2006) Figure 2

Description: Plants light green to dark green or yellowish brown, strongly appressed to the substrate, 15–40 mm long, 1.5–2.5 mm wide, branching *Frullania*-type.



Figure 9: *Frullania udarii* (A, B) dorsal view of the plant; (C) ventral view of the plant; (D) perianth; (E) underleaves; (F) stem cross section

Stem brownish, cylindrical, 0.12–0.18 mm in diameter, cortical cells 20–23, subquadrate, thick walled, one layered, medullary cells quadrate to subquadrate, thick walled. Leaves loosely imbricate or imbricate, widely spreading, slightly concave, ovate–oblong, margin entire, leaf lobes 1.0–1.5 mm long, 0.80–0.98 mm wide, apex rounded or sub-obtuse, marginal cells thin to thick walled, 10–15 μm long, 14–23 μm wide, median cells thin walled, 12–22 μm long, 16–28 μm wide, basal cells thin walled, 18–65 μm long, 25–40 μm wide, trigones present. Leaf lobules explanate, oblong, margin entire, apex acute, 1/3–1/2 of the lobe length, 0.5–1 mm long, 0.15–0.25 mm wide, attached to the stem and postical margin of the antical lobe. Underleaves distant, appressed to the stem, wide as or wider than the

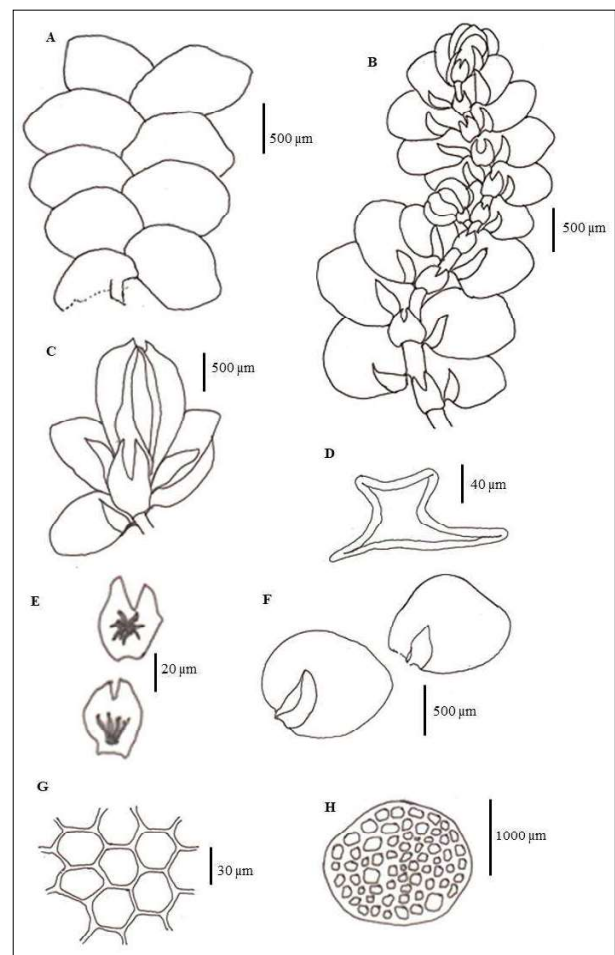


Figure 10: *Frullania udarii* (A) dorsal view of the plant; (B) ventral view of the plant; (C) perianth; (D) cross section of perianth; (E) underleaves; (F) leaf lobes with leaf lobules; (G) median cells of leaf lobe; (H) transverse section of a stem

stem, 0.40–0.50 mm long, 0.30–0.40 mm wide, ovate, 1/3 bilobed, lobes triangular, subacute, margin entire. Rhizoids at under leaf bases. Monoecious. Androecia on short lateral branches, bracts 3–4 paired, imbricate, bracteoles bilobed. Gynoecia terminal on the main stem or branches, innovations absent, bracts 2–3 paired. Perianth 1.75–2.0 long, 0.90–0.95 mm wide, 1/2–2/3 emergent, pyriform, smooth, four-keeled, apex beaked. Sporophyte not developed.

Habitat: Frequently found on tea stem barks of tea plantations in montane zone.

Distribution: The species is reported as endemic to India (Nath & Singh, 2006). This is the first record of the species from outside of India.

Remarks: *Frullania udarii* resembles *F. muscicola* Steph. by occasionally having explanate lobules. However, *F. muscicola* is dioecious with saccate lobules and usually five-keeled perianth and *F. udarii* is monoecious with always explanate lobules and four keeled perianth (Nath & Singh, 2006).



Figure 11: *Fuscocephaloziopsis lunulifolia* (A, B) dorsal view of the plant; (C) ventral view of the plant; (D, E) leaf lobes; (F) stem cross section

Specimens examined: Sri Lanka: Central Province, Nuwara Eliya District, 07.0416 N, 80.69660 E, alt 1070 m. 21 October 2016, *Bandaranayake & Rubasinghe 32-16 SBSR* (PDA); Nuwara Eliya District, 07.0416 N, 80.69660 E, alt 1070 m. 21 October 2016, *Bandaranayake & Rubasinghe 57-16 SBSR* (PDA).

Family Cephaloziaceae

***Fuscocephaloziopsis lunulifolia* (Dumort.) Váňa et L. Söderstr.**

Váňa *et al.*, Phytotaxa 112(1): 10 (2013); Potemkin & Sofronova, Arcota 22: 203 (2013); Feldberg *et al.*, Org. Divers. Evol. 16: 728 (2016); Söderström *et al.*, PhytoKeys 59: 60 (2016); Górski *et al.*, Steciana 21(4): 160 (2017). **Basionym:** *Jungermannia lunulifolia* Dumort., *Sylloge Jungermannidearum Europae indigenarum, earum genera et species systematice complectens*: 61: (1831). **Type:** France. Dép. Vosges [Lorraine]: Bruyères, Mougeot, Nestler & Schimper, *Stirpes Crypt. Vogeso-Rhen. no 432*. (lectotype BR *n.v.*, isolectotype GL, HAL, JE, W *n.v.*).

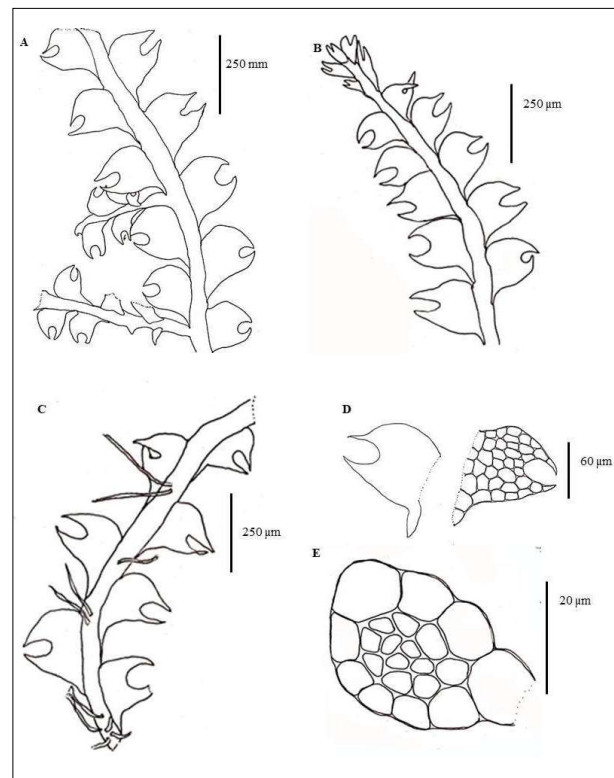


Figure 12: *Fuscocephaloziopsis lunulifolia* (A, B) dorsal view of the plant; (C) ventral view of the plant; (D) leaf lobes; (E) transverse section of a stem

Illustrations: Figures 11 and 12.

Description: Plants pale green or yellowish green, 2 cm long, less than 1 mm wide, irregularly branched on the ventral side. Stem 25–35 µm in diameter, fragile, cortex translucent, with large thin-walled 8–10 cells, revealing the medulla, made up of small thin-walled, hyaline 12–15 medullary cells. Rhizoids hyaline scattered along the ventral surface of the stem. Leaves sub-orbicular to ovate-orbicular or sub-ovate, about 45–85 µm long, 35–70 µm wide, distant, longitudinally inserted, decurrent or not, concave, plane, rarely convex, deeply bifid, 1/2–3/4, two lobes pointing towards each other and with a wide crescent-shaped gap between them, leaf lobes ending in a row of 1–2 cells; marginal cells and median cells approximately same size, spherical, 5–10 × 6–11 µm, basal cells larger than marginal and median cells, spherical 8–13 × 8–15 µm, lobes 4–6 cells wide at base. Leaf lobules absent. Underleaves absent. Dioicous. Reproductive structure not seen.

Note: Androecia on main shoot or on short lateral branches. Female bracts lobed. Perianth apex crenulate to dentate (Potemkin & Sofronova, 2013).

Habitat: Found on wet soil of roadsides and on rocks and soil in montane forests.

Distribution: The species is also reported from Croatia, Estonia, Iberian Peninsula, Russia, Sweden, Japan, China and Cuba (Ros *et al.*, 2007; Casas *et al.*, 2009; Potemkin & Sofronova, 2013).

Remarks: The genus *Fuscocephaloziopsis* Fulford is newly reported from Sri Lanka. Twenty seven species are recorded under the genus (Söderström *et al.*, 2016). *Fuscocephaloziopsis lunulifolia* is morphologically closely related to *F. loitlesbergeri* (Schiffn.) Váňa *et al.* Söderstr. However, *F. lunulifolia* can be easily distinguished by the yellowish green plants, leaf lobes ending in a row of 1–2 cells and perianth mouth with 1(2) celled teeth. In *F. loitlesbergeri* plants are brownish in colour, leaf lobes end in a row of 2–3 cells and perianth mouth has 2–6 celled cilia (Casas *et al.*, 2009; Potemkin & Sofronova, 2013).

Specimens examined: Sri Lanka: Central Province, Nuwara Eliya District, 06.92040 N, 80.79235 E, 1928 m, 06 January 2018, *Bandaranayake & Rubasinghe 1122-18 SBSR* (PDA).

CONCLUSION

Six species of leafy liverworts are reported new to Sri Lanka: *Lejeunea sordida* (Nees) Nees (Lejeuneaceae), *Leptolejeunea subdentata* Schiffn. (Lejeuneaceae), *Spruceanthus polymorphus* (Sande Lac.) Verd. (Lejeuneaceae), *Frullania udarii* Nath *et* Singh (Frullaniaceae), *Heteroscyphus turgidus* (Schiffn.) Schiffn. (Lophocoleaceae) and *Fuscocephaloziopsis lunulifolia* (Dumort.) Váňa *et al.* Söderstr. (Cephaloziaceae). The leafy liverwort genus *Fuscocephaloziopsis* Fulford is newly reported from Sri Lanka. Addition of the six new records increases the total number of leafy liverwort species of Sri Lanka from 290 to 296 and the number of genera from 62 to 63.

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