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## *Lejeunea streimannii* (Lejeuneaceae, Marchantiophyta), a remarkable new species with robust stems and 5(or 6)-keeled perianths from Papua New Guinea

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### Abstract

*Lejeunea streimannii*, a new species from Papua New Guinea, is described and illustrated. The new species is characterized by the dioicous plants, robust stem with 18–21 rows of cortical cells and a ventral merophyte 4–6 cells wide, ovate leaves with a rounded, strongly incurved leaf apex, small lobules with unicellular first tooth and blunt second tooth, large underleaves with a cordate base, inflated perianths with 5(or 6) crenate, slightly winged keels.

**Key words:** Hepaticae, *Lejeunea riparia*, *Lejeunea lumbricoides*, liverworts, rheophytes

### Introduction

Lejeuneaceae is the largest liverwort family with more than 1800 species in about 70 genera (Zhu *et al.* 2017). *Lejeunea* Libert (1820: 373), the type genus of the family, has a complex taxonomic history (Reiner-Drehwald 1999). Particularly over the past two decades, the generic concept has been greatly changed especially owing to the recent progress of molecular phylogenetics. On the one hand, 17 genera were treated as its synonyms, including *Di cladolejeunea* Schuster (1994: 220) (Reiner-Drehwald 2005b), *Papillolejeunea* Pócs (1997: 2) (Schuster 1998), *Crossotolejeunea* (Spruce 1884: 161) Schiffner (1893: 127) and *Dactylolejeunea* Schuster (1970: 341) (Reiner-Drehwald & Goda 2000), *Echinocolea* Schuster (1963: 125) (Ilkiu-Borges 2005), *Amphilejeunea* Schuster (1978: 431) and *Cryptogynolejeunea* Schuster (1994: 215) (Reiner-Drehwald 2005a), *Neopotamolejeunea* Reiner-Drehwald (2000: 449) (Gradstein & Reiner-Drehwald 2007), *Amblyolejeunea* Jovet-Ast (1948: 24) (Zhu & Cheng 2008), *Inflatolejeunea* Arnell (1953: 173) and *Macrolejeunea* (Spruce 1884: 77) Schiffner (1893: 118) (Reiner-Drehwald & Schäfer-Verwimp 2008), *Cardiolejeunea* Schuster et Kachroo in Schuster (1963: 149) and *Stenolejeunea* Schuster (1963: 144) (Söderström *et al.* 2010), *Cladolejeunea* Zwickel (1933: 112) (Pócs 2010), *Sphaerolejeunea* Herzog (1938: 88) (Heinrichs *et al.* 2012), *Oryzolejeunea* (Schuster 1970: 338) Schuster (1992: 249) (Ye *et al.* 2013) and finally *Taxilejeunea* (Spruce 1884: 212) Stephani (1889: 262) too (Heinrichs *et al.* 2013). This led to more species included in the genus, and much morphological variation described for the genus. On the other hand, the relationship of *Lejeunea* and its allies such as *Microlejeunea* (Spruce 1884: 286) Stephani (1888: 61), *Otigoniolejeunea* (Spruce 1884: 77) Schiffner (1893: 125), *Bromeliophila* Schuster (1994: 226), was clarified (Czumay *et al.* 2013; Dong *et al.* 2013; Wei & Zhu 2013; Heinrichs *et al.* 2014; Wei *et al.* 2014). To date there are nearly four hundred currently accepted taxa in the genus *Lejeunea* (Söderström *et al.* 2016). Although many species have been treated as synonyms in recent years, the discovery of new species has still been continuously reported (e.g. Reiner-Drehwald *et al.* 2013; Reiner-Drehwald 2015; Bastos *et al.* 2017; Pócs & Wei 2017).

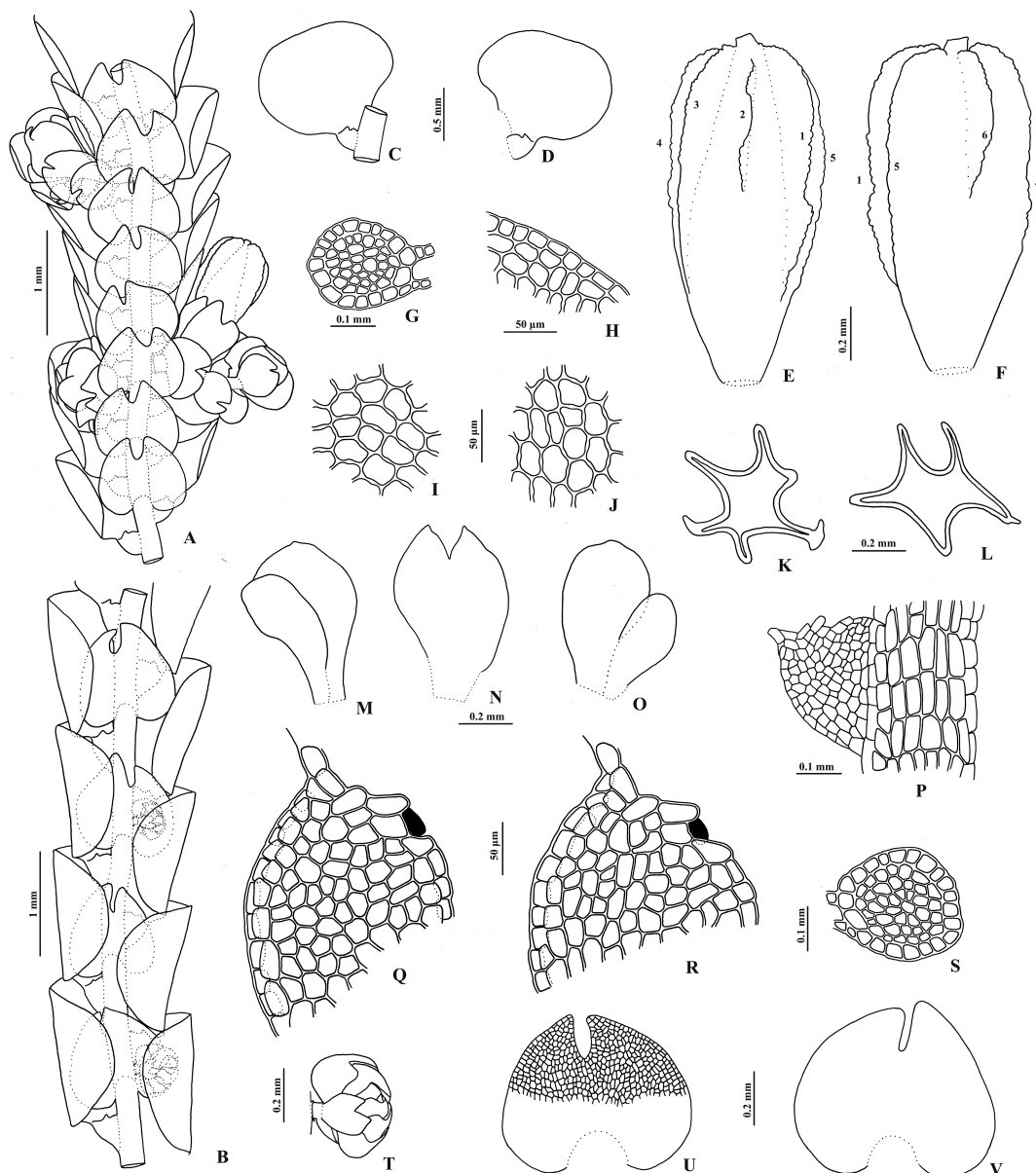
In the course of our study on *Lejeunea* specimens from the Australian National Herbarium (CANB), an undescribed taxon, previously determined as *Lejeunea lumbricoides* (Nees 1830: 40) Nees in Gottsche *et al.* (1845: 342) by M. Mizutani in March, 1987, was detected from two Papua New Guinea's collections made by H. Streimann in 1982 and

1983. This species has typical characteristics of the genus *Lejeunea* including the *Lejeunea*-type branches, proximal hyaline papilla, lack of ocelli, lejeuneoid gynoecial innovations. Several key characters of this species such as its robust stems, presence of 2-toothed lobules, and 5(or 6)-crenate keeled perianths, however, make it distinct from *L. lumbricoides* and other known *Lejeunea* species. Hence, we describe it here as a new species.

## Taxonomy

*Lejeunea streimannii* Y.M.Weï & R.L.Zhu, *spec. nov.* Fig. 1

Type:—PAPUA NEW GUINEA. Enga province: Mape Creek, Mount Hagen-Wapenamanda Road, 17 km SE of Wapenamanda, 5°46' S, 143°57' E, 2500 m, Urticaceae dominated slope, on the ground, 29 Jun. 1982, *H. Streimann 21509* (holotype CBG 8402078!, isotype EGR).



**FIGURE 1.** *Lejeunea streimannii* Y.M.Weï & R.L.Zhu. A: part of plant with perianth, ventral view. B: part of plant with two androecia, ventral view. C, D: leaves, ventral view. E, F: a perianth showing its keels, ventral view (E), dorsal view (F). G, S: transverse sections of stem. H: marginal cells of leaf lobe. I: median cells of leaf lobe. J: basal cells of leaf lobe. K, L: transverse section of perianths. M, O: female bracts. N: female bracteole. P: leaf lobule with part of stem. Q, R: apex of leaf lobules. T: androecium. U, V: underleaves. A, C–S and U–V from *H. Streimann 21509* (holotype), B and T from *H. Streimann 33431* (paratype).

The new species is characterized by the dioicous plants, robust stem with 18–21 rows of cortical cells and a ventral merophyte 4–6 cells wide, small lobules with unicellular first tooth and blunt second tooth, bifid underleaves with a cordate base, inflated perianth with 5 (or 6) crenate, weakly winged keels.

Dioicous. Plants yellowish in herbarium, 2–4 cm long. Shoots 1.0–1.6 mm wide, irregularly branched, of the *Lejeunea*-type, leaf sequence of vegetative branches lejeuneoid. Stem 170–200 µm in diameter, in transverse section suborbicular, 18–21 rows of cortical cells surrounding 26–39 smaller medullary cells, cortical cells subquadrate to oblong, 18–38 × 20–30 µm, medullary cells ± isodiametric, 15–30 × 13–25 µm; ventral merophyte 4–6 cells wide. Rhizoids at base of underleaves, few, tufted, usually hyaline, rhizoid disc absent. Leaves imbricate, diverging from stem at an angle of 45°–60°; leaf lobules asymmetrically triangular-ovate, usually concave, 0.8–1.5 mm long, 0.8–1.5 mm wide, margin entire, dorsal margin arched, apex rounded, strongly incurved; leaf lobules subovate, slightly inflated, 1/6–1/5 as long as the lobes, lateral free margin usually slightly incurved (except for apex), apex obliquely truncate, with two teeth, first tooth unicellular, usually rectangular, second tooth blunt, sometimes obsolete, keel slightly arched, smooth, hyaline papilla oblong, 30 × 15 µm, situated at the proximal base of first tooth. Cells of leaf lobe thin-walled, trigones small, intermediate thickenings 0–1 per cell wall, small; margin cells quadrate to rectangular, 13–20 × 8–15 µm, median cells hexagonal, 18–35 × 13–25 µm, basal cells similar to median ones in shape, but slightly larger, cuticle smooth. Oil bodies and ocelli not seen. Underleaves imbricate to distant, wider than long, 3–4.5 times as wide as stem, bilobed to 1/3–1/2 their length, sinus narrow with obtuse to acute base, insertion line deeply arched, base cordate. Androecia terminal, rarely intercalary, usually on very short lateral branches, bracts in 2–6 pairs, bracteoles 1–2, borne only at the basal portion of the androecium, smaller than ordinary underleaves. Gynoecia usually on short branches, with 1–2 lejeuneoid innovations; bracts obovate, 0.6–0.7 mm long, 0.3–0.5 mm wide, deeply and unequally bifid, the lobe broadly ovate, apex rounded to obtuse-rounded, margin entire, bract lobule rectangular, 2/3–4/5 as long as the bract lobe, apex obtuse, keel 2/3 as long as the lobule; bracteole connate with bracts on both sides at base, oblong, 0.6–0.7 mm long, 0.4–0.5 mm wide at middle, margin entire, apex bilobed to 1/4–1/3 its length. Perianths about 1/2–2/3 exerted, obovate, 1.1–1.4 mm long, 0.6–0.7 mm wide at middle, inflated, with 5 (or 6) keels (2–3 ventral, 2 lateral, 1 dorsal), keels usually crenulated, sometimes with weak wing, surface of perianth smooth, beak short, 1 cell long. Asexual reproduction not seen.

**Etymology:**—This new species is dedicated to the late Heinar Streimann who collected the type specimens.

**Ecology and distribution:**—*Lejeunea streimannii* occurs on the ground and shaded rock face in an Urticaceae dominated slope or disturbed lower montane forest beside road at ca. 1300 to 2500 m. It is thus far known only from Papua New Guinea.

**Additional specimen examined.** PAPUA NEW GUINEA. Morobe Province: Mt. Kaindi Road, 3 km W of Wau, 7°20' S, 146°42' E, 1300 m, disturbed lower montane forest beside road, on shaded rock face, 9 Jan. 1983, *H. Streimann* 33431 (paratype CANB 778500!).

## Discussion

*Lejeunea streimannii* is easily confused with the tropical Asian and Oceanian *L. lumbricoides*. The two species share several common characters, especially including the large underleaves with a cordate base, rounded and strongly incurved apex of the leaf, and small leaf lobules. *Lejeunea lumbricoides*, however, differs in the seven rows of cortical cells in the transverse section of stem, narrow ventral merophyte of stem only two cells wide, underleaves longer than wide, presence of a large, rectangular disc cell below the first tooth and lack of the second tooth of the leaf lobule.

In most species of *Lejeunea* the stem bears seven rows of cortical cells and the ventral merophyte of the stem is only two cells wide (Zhu & So 2001). The most remarkable character of *L. streimannii* is its robust stem consisting of 18–21 rows of cortical cells and its ventral merophyte 4–6 cells wide. At present in *Lejeunea* there are seven species with robust stems whose ventral merophyte are more than two cells wide. Most of them were previously placed in *Neopotamolejeunea*, *Di cladolejeunea* and *Cryptogynolejeunea*. Except for Asian *L. riparia* Mitten (1860: 113), the remaining six species are known only from Neotropics, including *L. polyantha* Montagne (1856: 350), *L. juruana* Gradstein & Reiner-Drehwald (2007: 488), *L. tenera* (Swartz 1788: 143) Gottsche *et al.* (1845: 406), *L. topoensis* Gradstein & Reiner-Drehwald (2007: 488), *L. rotundifolia* Mitten (1851: 359), *L. reflexistipula* var. *costaricensis* (Stephani 1896: 100) Reiner-Drehwald (2005a: 408). *Lejeunea polyantha*, *L. juruana* and *L. tenera* are well characterized by the long leaf insertions, flat leaves, and perianths with smooth keels, distinctly different from the present new species. *Lejeunea topoensis* and *L. riparia* share short leaf insertions as in *L. streimannii*, but they can be immediately separated from *L. streimannii* by their reduced lobules, small underleaves with almost straight insertion

lines, and perianths with smooth keels. *Lejeunea reflexistipula* var. *costaricensis* has unlobed underleaves remarkably unlike the new species. Morphologically, *Lejeunea streimannii* is most similar to *L. rotundifolia* especially in the large bifid underleaves with deeply arched insertion lines, ovate leaves with rounded, incurved leaf apex, and leaf lobules with a unicellular first tooth and blunt second tooth. The latter, however, differs in having male bracteoles throughout the androecium, auriculate base of the underleaf, and perianths with five smooth keels (Mizutani 1963; Reiner-Drehwald 1999, 2000, 2005a, 2005b; Gradstein & Reiner-Drehwald 2007). In addition, the Asian species, *Lejeunea aquatica* Horikawa (1929: 643), also has robust stems with 10–12 rows of cortical cells, but its ventral merophyte is only two cells wide (Mizutani 1961). Furthermore, the small underleaves and usually obtuse apex of the leaf are quite different from *L. streimannii*. Robust stems in *Lejeunea* are deemed adaptation to the rheophytic habitat (Gradstein & Reiner-Drehwald 2007). According to herbarium specimen data, *L. streimannii* grows in an Urticaceae dominated slope and in a disturbed lower montane forest. Whether this new species from Asia also grows in periodically submerged habitats is unknown.

Another interesting feature of *Lejeunea streimannii* is the number of its perianth keels, which is not always 5. Sometimes 6-keeled perianths were also observed (Fig. 1 E and F). Out of thirteen mature perianths in the type specimen (*H. Streimann* 21509), seven have six keels. Generally, the perianth form within *Lejeunea* is highly variable, but the number of its keel was considered to be 0 to 5 (Zhu & So 2001; Heinrichs *et al.* 2013). Perianths with more than five keels haven't been discovered in *Lejeunea* before. Even within Lejeuneoideae, it is also a rare case. The only example occurred in the genus *Cheilolejeunea* (Spruce 1884: 251) Schiffner (1893: 124) (*Cheilolejeunea pluriplicata* (Pearson 1887: 5) Schuster (1980: 430) (Zhu & So 1999; Zhu *et al.* 2002).

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