Cryptogamie, Bryologie, 2016, 37 (2): 157-165

A new species of *Leptolejeunea* (Lejeuneaceae, Marchantiophyta) from Fiji with special reference to *Leptolejeunea tripuncta*

Lei SHU[a], Rui-Liang ZHU[a,b] & Tamás PÓCS[c]*

[a]Department of Biology, School of Life Sciences, East China Normal University, 3663 Zhong Shan North Road, Shanghai 200062, P. R. China

[b]Tiantong National Station of Forest Ecosystem, Shanghai Key Lab for Urban Ecological Processes and Eco-Restoration, East China Normal University, 500 Dongchuan Road, Shanghai 200241, P. R. China

[c]Botany Department, Institute of Biology, Eszterházy College, Eger, Hungary

Abstract – *Leptolejeunea latilobula* Lei Shu, R.L.Zhu & Pócs, a new species from Fiji, is described and illustrated. This species stands out within *Leptolejeunea* on account of its large size of leaf lobule with four cells wide on the apical portion, lobe apex acute to apiculate, margin more or less dentate, and underleaf lobes linear, usually two cells long. *Leptolejeunea serrulata* Herzog is proposed as a synonym of *Leptolejeunea tripuncta* (Mitt.) Steph., previously known only from Fiji. A neotype of *Leptolejeunea tripuncta* is designated.

Epiphyllous liverworts / *Leptolejeunea lancifolia* / *Leptolejeunea maculata* / *Leptolejeunea serrulata* / neotype / new synonym

INTRODUCTION

Owning to their unusual habitats, epiphyllous liverworts have received considerable attention (Tixier, 1966; Winkler, 1967; Pócs, 1978; Lücking, 1995; Zhu & So, 2001; Kraichak, 2012; Feldberg *et al.*, 2014). *Leptolejeunea* (Spruce) Steph. (Lejeuneaceae) species are often epiphyllous (Pócs, 1996; Zhu & So, 2001). In the recent global checklist of liverworts and hornworts, 48 species are listed (Söderström *et al.*, 2016). *Leptolejeunea* is characterized by the presence of numerous ocelli in leaf lobes, deeply bilobed underleaves with widely divergent, linear-lanceolate or ligulate lobes, underleaf disc composed of numerous small cells surrounded by six large marginal cells, absence of gynoecial innovations, and the production of cladia for asexual reproduction (Mizutani, 1961; Zhu & So, 2001). *Leptolejeunea* has long been considered as the sister group of *Drepanolejeunea* (Herzog, 1942; Bischler, 1969; Gradstein *et al.*, 2003). Recent molecular studies suggested *Leptolejeunea* belonged to a new subtribe Leptoejeuneinae (Heinrichs *et al.*, 2014). However, as one of the pioneer group of epiphyllous liverworts in the tropics (Richards, 1932; Kraichak, 2012), few papers have focused on *Leptolejeunea* in Southeast Asia and Oceania, except Herzog

* Corresponding author: rlzhu@bio.ecnu.edu.cn

doi/10.7872/cryb/v37.iss2.2016.157

(1942) and Onraedt (1991). Some contributions have subsequently placed many *Leptolejeunea* species in synonymy with more wide-ranging species (Grolle, 1976; Schuster, 1980; Tixer, 1995) and resurrected others (Heinrichs *et al.*, 2014).

Fiji, located in the south Pacific and one of the biodiversity hotspots in the world, is abundant in bryophytes (Konrat *et al.*, 2011; Lumbsch *et al.*, 2011; Söderström *et al.*, 2011), being at the crossroad among Melanesia, Australasia and Polynesia (Mueller-Dombois & Fosberg, 1998). Recently the continuous discovery of new species and records has been reported (Pócs, 2007, 2008a, 2008b, 2012, 2015; Pócs *et al.*, 2011; Pócs & Eggers, 2007). Five species of *Leptolejeunea* are known in Fiji: *L. elliptica* (Lehm.) Besch., *L. epiphylla* (Mitt.) Steph., *L. lancifolia*, *L. maculata* and *L. tripuncta* (Miller *et al.*, 1983; Söderström *et al.*, 2011). While revising worldwide materials of *Leptolejeunea*, we found a new collection from Fiji distinct from other *Leptolejeunea* species, which is described here as a new species.

MATERIALS AND METHODS

Observations were made on collections from various herbaria as indicated below. Samples were examined under a light microscope (Zeiss Imager A1 or Olympus BX 43). The photos were made with Spot Flex digital camera and Olympus DP 71 digital camera. Line drawings were made with the aid of an Olympus drawing tube.

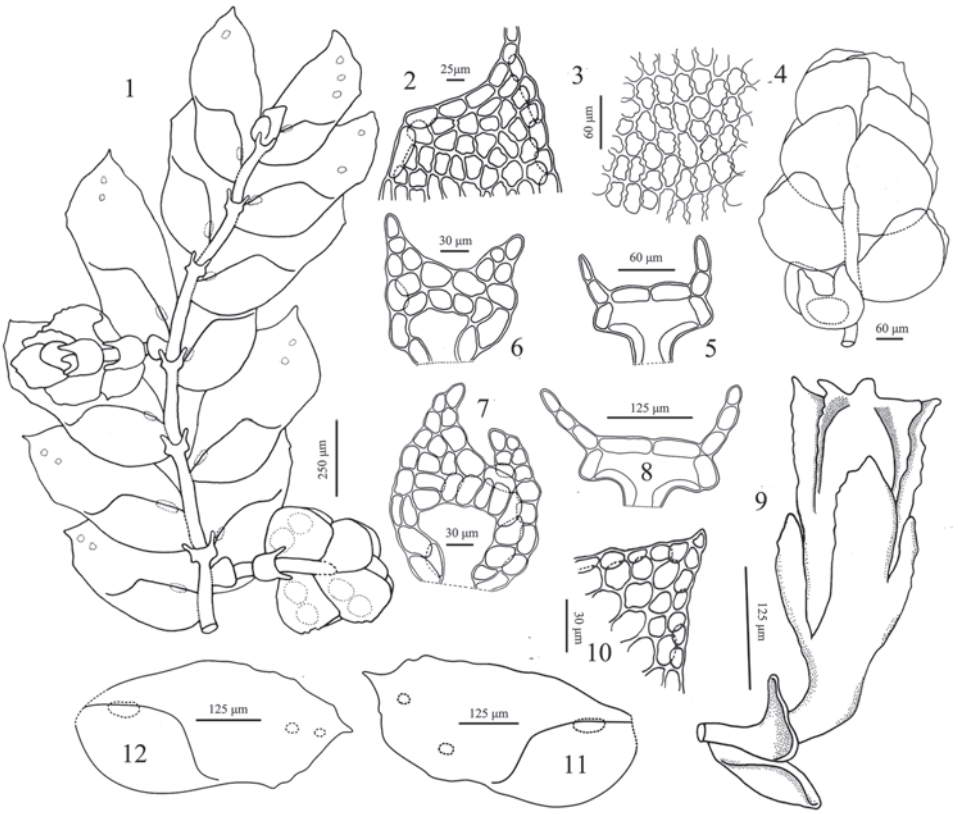
TAXONOMIC TREATMENT

Description of new species

Leptolejeunea latilobula Lei Shu, R.L.Zhu & Pócs, *sp. nov.* **Figs 1-21**

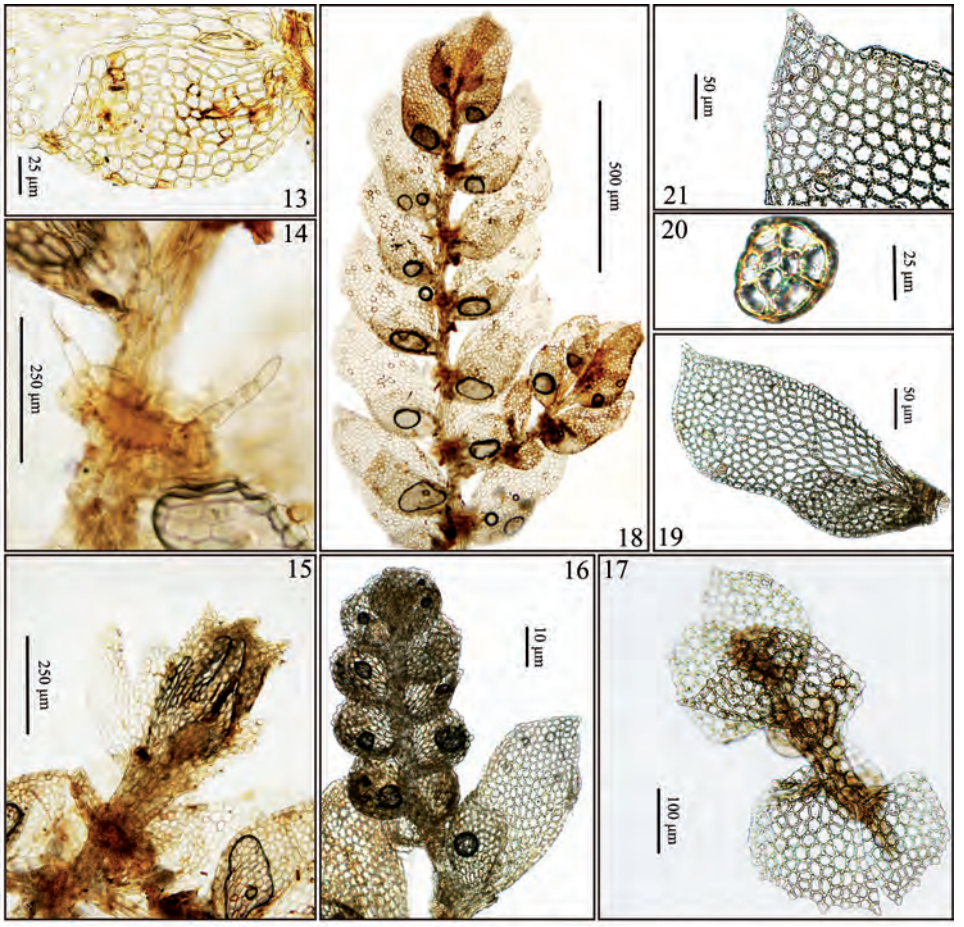
Type: Fiji. Cakaudrove Province, Central part of Taveuni Island. Northwest side of Des Voeux peak, 16°50.295-445'S, 179°58.037-224'W, 1040-1150 m, on living leaves in a 4-8 m tall mossy elfin forest, 27 Aug. 2003, *S. & T. Pócs 03279 AD* (holotype: HSNU!, isotype: EGR!).

Dioicous. Plants pale green to yellowish green, 2 to 5 mm long. Shoots 1.0-1.2 mm wide, usually scarcely irregularly branched, of *Lejeunea*-type, leaf sequence of vegetative branches lejeuneoid. Stem 51-61 μm in diameter, in transverse section with 7 cortical cells and 3 medullary ones, cortical cells subquadrate to oblong, 14.2-25.1×8.5-14.1 μm, medullary cells ± isodiametric, 14.6-20.9×10.9-11.9 μm; ventral merophyte 2 cells wide. Rhizoids arising from basal disc of underleaf, fasciculate, numerous, colorless. Leaves contiguous to imbricate, diverging from stem at an angle of 50-70°; leaf lobe obliquely oblong-ovate, 0.56-0.78 mm long, 0.29-0.33 mm wide, margin more or less dentate, apex acute to apiculate, ventral margin straight or weakly sinuate, dorsal one ± arched near base; leaf lobules ovate, basally strongly inflated, 2/5-1/2 as long as the lobes, 1/2-2/3 as wide as the lobes, apex obliquely truncate, usually somewhat constricted, bordered by 4 subquadrate to rectangular marginal cells, free lateral margin usually straight,



Figs 1-12. *Leptolejeunea latilobula* Lei Shu, R.L.Zhu & Pócs. **1.** Shoot with an androecium, ventral view. **2.** Apical potion of leaf lobule. **3.** Middle cells of leaf lobe. **4.** Androecium, ventral view. **5.** Underleaf. **6.** Male bracteole. **7.** Underleaf on female branch. **8.** Underleaf. **9.** Gynoecium, ventral view. **10.** Apical cells of leaf lobe. **11 & 12.** Leaves, ventral view. All from *S. & T. Pócs 03279 AD.*

bordered by 4 long rectangular marginal cells, keel arched, almost smooth to weakly crenulate, hyaline papilla oblong, 6.0-8.0×12-15 μm, situated at proximal side of first tooth. Cells of leaf lobe thin-walled, usually shrunk after dry, trigones large, sometimes small, intermediate thickenings distinct, usually nodulous, 1 per cell near the apex, 1-4 per cell near the base, at margin quadrate to rectangular, 9.0-24.5×9.0-12 μm, in the middle ± hexagonal, 21.4-28.7×16.7-26.2 μm, near base similar to median ones in shape, but slightly larger. Oil bodies not seen. Ocelli hexagonal to ovate, 1-4 per leaf lobe, usually arranged in a non-continuous longitudinal series or scattered, 27.0-36.9×22.4-30.3 μm in middle, the lowermost 75.9-89.3×36.3-40.8 μm, always basal (next to stem cell, the basal type, cf. Zhu & So, 2001). Underleaves distant, small, 3-4 times as wide as stem, deeply bilobed, lobes lanceolate, usually spreading from stem at an angle of approximately 90-140° (-150°), 2(-3) cells long, 1(-2) cell(s) wide at base. Androecia on a short or long branch, bracts in 3-7 pairs, terminal, densely imbricate, obliquely spreading, ocelli 1-2, bracteoles 1, similar to underleaf, present only at the basal portion of the androecium. Gynoecia terminal on short branches, without innovations; bracts



Figs 13-21. *Leptolejeunea latilobula* Lei Shu, R.L.Zhu & Pócs. **13.** Lobule showing apical portion. **14.** Underleaf. **15.** Gynoecium, ventral view. **16.** Androecium, ventral view **17.** Cladium. **18.** Shoot with a branch, ventral view. **19.** Leaf, ventral view. **20.** Transverse section of stem. **21.** Apical cells of leaf lobe. All from *S. & T. Pócs 03279 AD.*

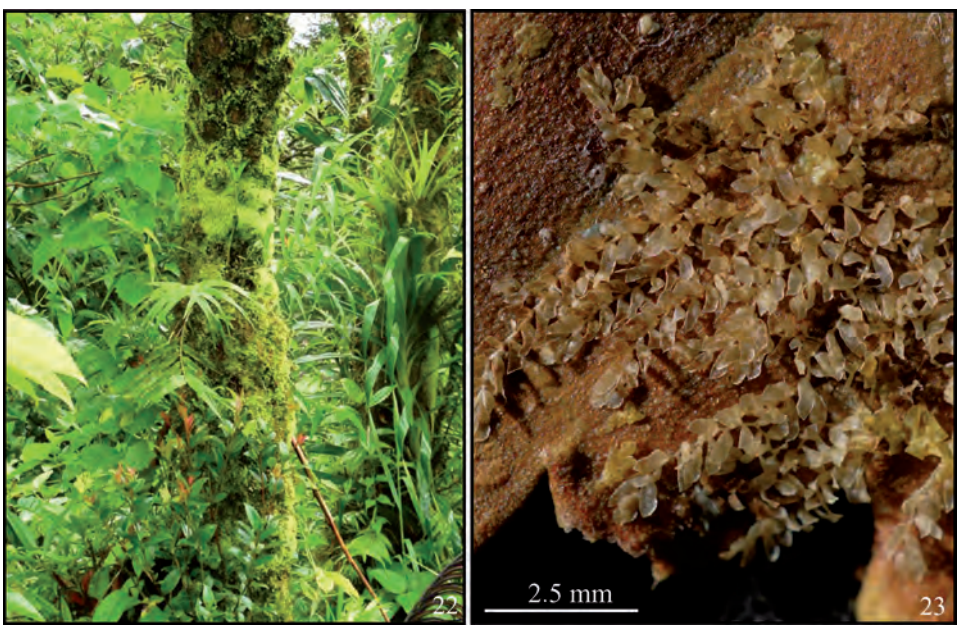
obovate, 0.45-0.48 mm long, 0.16-0.24 mm wide, with several scattered ocelli, margin dentate, apex apiculate, bract lobule ligulate-oblong, almost as long as bract lobe; bracteole oblong, bilobed to 1/5-1/6 bracteole length, margin almost entire, lobes ligulate. Perianths obovate to cylindrical, 0.61-0.72 mm long, 0.27-0.32 mm wide at middle, inflated, with 5 keels, keel apex almost entire, composed of three cells, surface of perianth smooth, beak short, 1(-2) cells long, with several scattered ocelli. Asexual reproduction by cladia.

Other specimens seen: Fiji. Central part of Taveuni Island, along the road from WAIRIKI village to Des Voeux Peak, on the NW slopes, 715-750 m, 16°49.831-915'S, 179°58.643-731'W, on living leaves in mossy montane rain forest, 1 Sept. 2003, *S. & T. Pócs 03289/CP* (EGR, SPRH); on the NW slope of Des Voeux peak, 960 m, 16°50.220'S, 179°58.369'W, epiphyllous in a 10-20 m tall mossy cloud forest, 27 Aug. 2003, *S. & T. Pócs 03280/BL, BP, BQ & BR* (EGR, F, SPRH); NW

side of Des Voeux peak at the type locality, 1040-1150 m, 16°50.295-445'S, 179°58.037-224'W, in 4-8 m tall mossy elfin forest, 27 Aug. 2003, *S. & T. Pócs 03279/BL* (EGR, F, SPRH).

Distribution and Ecology: *Leptolejeunea latilobula* is known only from three localities in the altitudinal range of 700-1150 m, of the mossy cloud forests and elfin woodlands on the northwest slopes of Des Voeux peak in the central part of Taveuni Island, where it was found frequently and exclusively on living leaves (Figs 22-23). It seems to be a strict endemic to this island, with similar altitudinal distribution as the beautiful floral emblem of Fiji, the endemic "Tagimoucia" liana (*Medinilla waterhousii* Cogn., Melastomataceae, with white flowers surrounded by dark purple bracts).

Leptolejeunea latilobula is characterized by the large lobule nearly 1/2 as long as the lobe (Figs 11-12), wide lobular apex with four rectangular or quadrate marginal cells (Figs 2 & 13), deeply bilobed underleaves with 2(-3) cells long underleaf lobes (Figs 5, 8 &14), and more or less dentate leaves (Figs 11, 12 & 19). In the previously known species of *Leptolejeunea*, the lobular apex is bordered by only 2-3 marginal cells. In appearance this species may be confused with *L. lancifolia* (Mitt.) Steph. and *L. maculata* (Mitt.) Schiffn. *Leptolejeunea maculata* is recognized as a polymorphic species with 12 synonyms (Grolle, 1976; Heinrichs *et al.*, 2014). But *L. lancifolia* and *L. maculata* differ from *L. latilobula* by the apical portion of leaf lobule only 2-3 cells wide and underleaf lobe more than two cells long. *Leptolejeunea latilobula* is also similar to *L. tripuncta*, which shares the same features of the underleaves, but the latter can be immediately distinguished by the minute size of plants less than 1 mm wide, leaf lobe oval with several teeth and furcate perianth horns (Figs 24-26 & 30).



Figs 22-23. **22.** View of the mossy cloud forests and elfin woodlands on the northwest slopes of Des Voeux peak in the central part of Taveuni Island, Fiji. **23.** *Leptolejeunea latilobula* growing on living leaves from *S. & T. Pócs 03279 AD.*

Notes on *Leptolejeunea tripuncta* (Mitt.) Steph.

Leptolejeunea tripuncta was first described by W. Mitten as *Lejeunea tripuncta* Mitt. based on type material from Fiji; however, no drawings were provided (Mitten, 1871). Because no specimen was available to him, Stephani (1913) recorded *L. tripuncta* with the original description given by Mitten (1871). According to the protologue, this species is identified by the presence of 2-3 teeth on the dorsal and ventral lobe margin, ocelli in a row in the middle of the leaf lobe and minute plant size. These character states are in accordance with *Leptolejeunea serrulata* Herzog (Herzog, 1942) rather than *L. latilobula. Leptolejeunea serrulata* is a common species in Southeast Asia and Oceania (see below). Here *Leptolejeunea serrulata* is proposed as a synonym of *L. tripuncta.* The authors requested type material of *Lejeunea tripuncta* in the herbaria BM, E, G, FH, HIRO, JE, MO, NY, PC, STR, TNS, and W, but no material could be located. As stated in Thiers (1983), some type material of species published in Seemann's *Flora Vitiensis* is missing. Thiers (1983) likewise could not locate any original material matching the protologue of *Lejeunea tripuncta*. Thus, it is necessary to designate a neotype. We selected the fertile material collected by *T. Pócs* (*S. & T. Pócs 03301/BB-1*) from Fiji as neotype.

Leptolejeunea tripuncta (Mitt.) Steph., *Sp. Hepat.* 5: 388. 1913 **Figs 24-31**

≡ *Lejeunea tripuncta* Mitt., *Fl. Vit.*: 415. 1871 [1873]. Type: Fiji. "viti in foliis Spiridentis, *Seemann*." (NY, missing, "No original material matching the protologue has been located" (Thiers 1983)). **Neotype**, designated here: Fiji. Central part of Kadavu Island, 19°01.826-923'S, 178°775-815'E, 110-150 m, epiphyllous, 10 Sept. 2003, *S. & T. Pócs 03301/BD-1* (HSNU!, dupl. in EGR!).

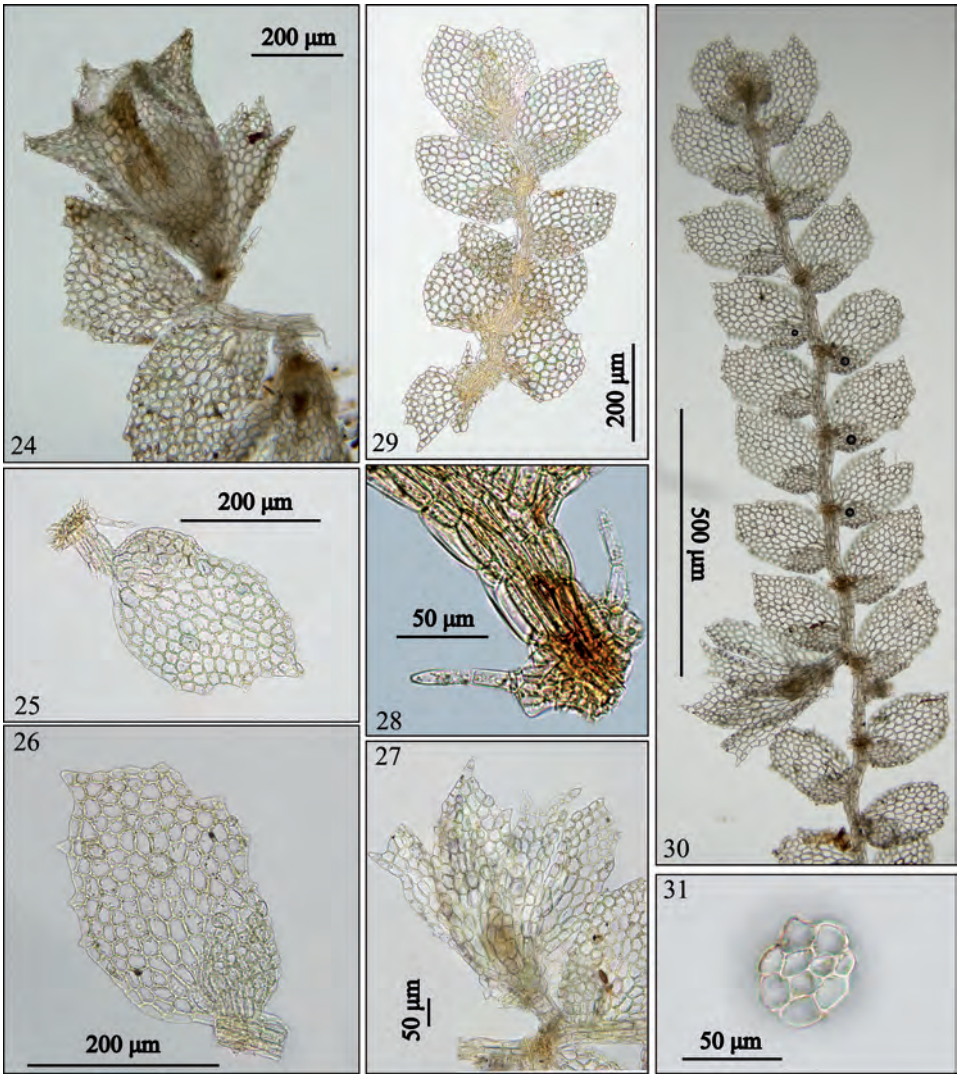
= *Leptolejeunea serrulata* Herzog, *Flora* 135: 426. 1942. Type: Malaysia. "Tambeling, Pahang, 1930, leg. Corner" (holotype: JE!); *syn. nov*.

Illustrations: Herzog (1942, p. 426, Fig. 26 as *Leptolejeunea serrulata*).

Representative specimens examined: Australia. Queensland, 17°26'S, 145°52'E, 70 m, epiphyllous, 3 Dec. 1990, *J. A. Curnow 3042* (CBG). Fiji. Viti Levu Island, 18°11.025'S, 177°41.914'E, 34 m, epiphyllous, 19 Aug. 2003, *T. Pócs 03256/V* (EGR, HSNU). Malaysia. Cameron Highlands, Tanah Rata town, 04°28.445'N, 101°23.034'E, 1430 m, epiphyllous, 1 Nov. 2013, *T. Pócs, G. E. Lee & D. Tang 13168/AD p.p.* (EGR, HSNU). New Caledonia. Mont Mou bei Paita, 1200 m, epiphyllous, 10 Sept. 2001, *F. Müller 2L* (DR, HSNU). Papua New Guinea. Central Province, 40 m, epiphyllous,13 Feb. 1981, *H. Streimann & E. K. Naoni 16074* (CBG). Philippines. Butuan subprovince, Mindanao, epiphyllous, Mar.-Jul. 1911, *C. M. Weber 1350* (E); Island of Polillo, epiphyllous, Aug. 1909, *C. B. Robinson 9596B* s.n. p.p. (E). Thailand. Songkhla Province, Sadao District, Ton Nga Chang Wildlife sanctuary, Pha Dam Waterfall, 06°49'09.4"N, 100°13'50.24"E, 197 m, epiphyllous, 14 Dec. 2011, *R.-L. Zhu et al. 20121214-14G* (HSNU). Vietnam. Dong Nai, Cat Tien National Park, along trail to Bau Chim, 11°28'34.5"N, 107°11'44"E, 200 m, epiphyllous, 11 Dec. 2013, *T. T. Luong 13324* (HSNU).

Distribution and Ecology: Australia, Malaysia, New Caledonia, Papua New Guinea, the Philippines, Thailand, and Vietnam (Jovet-Ast & Tixier, 1958; Grolle & Piippo, 1984; Pócs & Streimann, 1999; Lai *et al.*, 2008; Pócs & Podani, 2015); epiphyllous at altitudes of 34-1430 m.

Acknowledgements. We are grateful to the curators of the herbaria E, EGR, FH, G, HIRO, HSNU, IBSC, JE, MO, NICH, and NY for the loan of specimens. We also thank Sahut Chantanaorrapint, Luong Thien Tam and Janejaree Inuthai for providing samples for our studies, C. Cargill, D. G. Long, M. Mizutani, M. Price, A. Sass-Gyarmati, B. M. Thiers



Figs 24-31. *Leptolejeunea tripuncta* (Mitt.) Steph. **24.** Gynoecium, ventral view. **25 & 26.** Leaves, ventral view. **27.** Female bract. **28.** Underleaf. **29.** Cladium. **30.** Gynoecium, ventral view. **31.** Transverse section of stem. All from *S. & T. Pócs 03301/BD-1.*

and H. J. Zündorf for help in obtaining specimens on loan, and the reviewer (M. Renner) for constructive comments on the manuscript. This research was supported by the grants from the National Natural Science Foundation of China (nos. 31370238 & 31570206) and the Special Program for the National Basic Work of the Ministry of Science and Technology, China (No. 2012FY110600). T. Pócs is grateful to the AMFK (Hungarian Ministry of Education) and to ALCOA Foundations (USA) for their financial support of the journey and especially to his wife, Sarolta Pócs, for her help in the collecting and preparation of the specimens.

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