

# NEW COMBINATIONS AND SYNONYMS IN NEOTROPICAL LEJEUNEACEAE (MARCHANTIOPHYTA), WITH DESCRIPTION OF *LEJEUNEA TAMASII*, A NEW SPECIES FROM BARRO COLORADO ISLAND, PANAMA

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**Abstract.** The new species *Lejeunea tamasii* M. E. Reiner, N. Salazar Allen & C. Chung C. from Barro Colorado Island, Panama, named in honor of Professor Tamás Pócs, is described and illustrated. *Lejeunea tonduzana* (Steph.) M. E. Reiner, *comb. nov.* (basionym: *Hygrolejeunea tonduzana* Steph.), *L. recurva* M. E. Reiner, *nom. nov.* (basionym: *Hygrolejeunea recurva* Steph. *ex Bonner, nom. inval.*, *H. herzogii* Steph. 1916, *nom. illeg.*), and new synonyms in *Lejeunea cerina* (Lehm. & Lindenb.) Gottsche, Lindenb. & Nees (= *Hygrolejeunea aspera* Steph., = *H. similis* Steph.) and *Lejeunea flava* (Sw.) Nees (= *Hygrolejeunea bahiensis* Steph.) are proposed. Descriptions and illustrations for *Lejeunea tonduzana* and *L. recurva* are also provided.

**Key words:** liverworts, *Lejeunea*, new species, Panama, *Hygrolejeunea*, synonyms, tropical America

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## INTRODUCTION

The liverwort and hornwort flora of Panama comprises approx. 349 taxa (Stotler *et al.* 1998; Dauphin *et al.* 2006; Dauphin 2007). This number is relative low when compared to the rich liverwort and hornwort flora (approx. 590 taxa) of adjacent Costa Rica (Dauphin 2005), as already commented by Dauphin *et al.* (2006). Additional fieldwork in Panama, especially in areas of difficult access like Darién, Northern Veraguas and forests of the Central Cordillera will probably raise the number of species registered for the country (e.g., Schäfer-Verwimp 2012). Also revisions of incompletely known genera, like *Lejeunea* Lib., will increase our knowledge of the hepatic diversity in Panama, as shown below.

During field work in Barro Colorado, Panama, over 20 years ago, Salazar Allen and Chung collected a small liverwort, growing on rocks on two different trails of the island. It is now recognized as a species of *Lejeunea*, the largest genus within

the family Lejeuneaceae (Reiner-Drehwald 1999). Although numerous papers dealing with this genus and related taxa have been published recently (e.g., Reiner-Drehwald & Schäfer-Verwimp 2008; Pócs 2010; Renner *et al.* 2011; Heinrichs *et al.* 2012), there are still many names in need of revision. The genus *Hygrolejeunea* (Spruce) Schiffn., for example, has been known for over 20 years as a synonym of *Lejeunea* (Grolle 1988), and the status of many species have been recently updated (e.g., Reiner-Drehwald & Ilkiu-Borges 2007; Reiner-Drehwald 2011). However, more than 20 species of *Hygrolejeunea* have not been transferred to other genera or synonymized as yet.

The Barro Colorado Natural Monument in Panama is one of the most famous and studied sites of tropical rainforests worldwide (Leigh *et al.* 1983; Anonymous 1992). It includes the Barro Colorado Island and adjacent peninsulas. The Island is located between the Atlantic and Pacific Oceans

(9°09'N, 79°51'W) and it is the largest island in Gatun Lake in the Panama Canal (Croat 1978).

Seven species of *Lejeunea* have been registered for the island, namely *Lejeunea adpressa* Nees (as *L. magnoliae*), *L. smaragdina* Besch. & Spruce and *L. tapajosensis* Spruce (det. Reiner-Drehwald, cited by Dauphin *et al.* 2006), and *L. laetevirens* Nees & Mont., *L. maxonii* (A. Evans) X.-L. He, *L. minutiloba* A. Evans and *L. ulicina* subsp. *bullata* (Taylor) R. M. Schust. (Stotler *et al.* 1998). But the *Lejeunea* collected by Salazar Allen and Chung in the island differs morphologically from these taxa, and also from all the other *Lejeunea* and *Hygrolejeunea* types and specimens from tropical America studied by the first author, and is therefore proposed here as a new species.

The aim of this paper is to describe the species of *Lejeunea* from Barro Colorado as *L. tamasii*, *sp. nov.* and propose new combinations and synonyms for Neotropical *Lejeuneas*, based on the study of types and additional collections.

#### NOVELTIES IN *LEJEUNEAS* FROM TROPICAL AMERICA

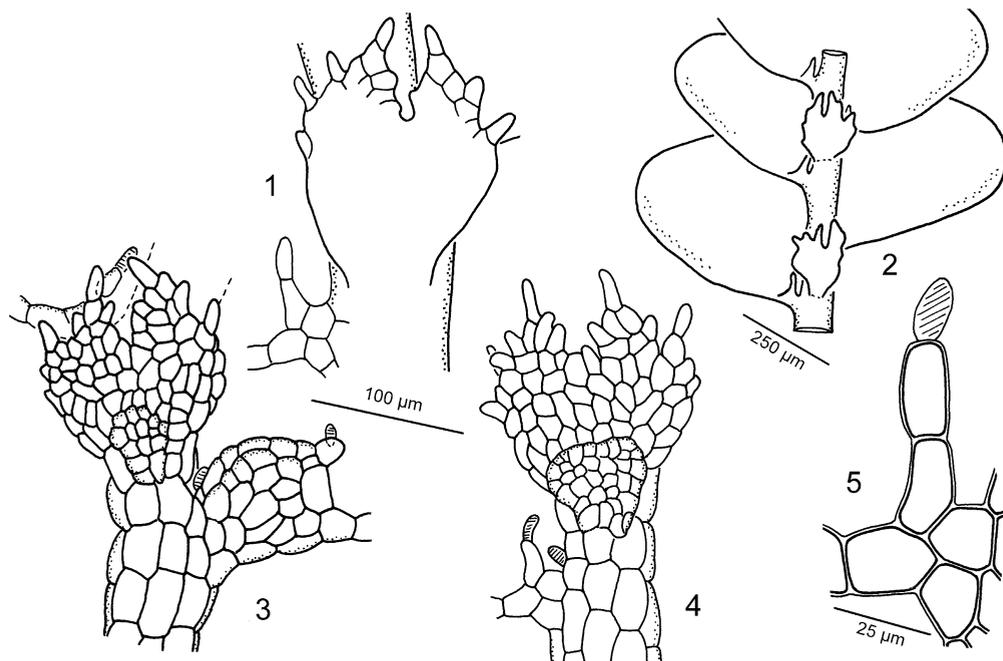
##### 1. *Lejeunea tamasii* M. E. Reiner, N. Salazar Allen & C. Chung C., *sp. nov.* Fig. 1

TYPE. PANAMÁ. Prov. Panamá. Isla Barro Colorado, Zona del Canal, 9°10'N, 79°50'W, camino R. Shannon. Sobre roca, 200 m desde la Quebrada Shannon; 4 March 1987, N. Salazar Allen 4281 (HOLOTYPE: PMA; ISOTYPE: GOET; autoicous, perianths). *Idem*, Camino J. Van Tyne 13. Sobre piedra en quebrada seca; 25 March 1987; N. Salazar Allen & C. Chung C. 4583 (PARATYPE: PMA, GOET). *Idem*, Sendero J. Van Tyne 9. Sobre piedra, en quebrada seca; 25 March 1987, N. Salazar Allen & C. Chung C. 4623 (PARATYPE: PMA, GOET).

ETYMOLOGY. The new species is dedicated to Professor Tamás Pócs, an indefatigable bryologist, expert in the family Lejeuneaceae.

*Plants* dull, green to brownish in herbarium, 2–5 mm long, 0.7–1.2 mm wide; branches of the *Lejeunea*-type, few, similar or smaller than the main shoot, collars small. *Stems* 70–80 µm wide, epidermal cells in ventral view rectangular, 25–40 × 35–50 µm; stems in cross section sub-

orbicular, 7 rows of epidermal cells surrounding 9–10 rows of smaller medullary cells, epidermal cells 17–20 × 20–25 µm, medullary cells 7–10 × 10–12 µm; ventral merophyte 2 cells wide. *Leaves* contiguous to imbricate, widely spreading. *Lobes* ovate, plane to slightly concave in ventral view, 400–600 µm long, 300–450 µm wide, margin entire, apex rounded, plane, dorsal margin arched, ventral margin ± straight. Marginal leaf cells ± rectangular, 15–20 × 17–25 µm, median and basal cells similar in size, isodiametric to elongated, 15–25 × 25–40 µm; cell walls thin, trigones small, lacking intermediate thickenings, cuticle smooth; oil bodies not observed. *Lobules* usually reduced to a small, 2–3-celled basal triangle and a 1–2 cells long filament, the upper cell elongated, 10–12 × 25–35 µm, and a long, 7–10 × 20–25 µm apical hyaline papilla; lobules seldom well developed, rounded-rectangular, inflated, 100 µm long, 75 µm wide, less than 1/4 the lobe length, lateral margin slightly incurved, apical tooth oval, small, hyaline papilla apical to ental on the tooth, apical margin straight, 2 cells long, keel straight or slightly arched, entire, at the union with the ventral margin of the lobe not angled. *Underleaves* distant, appressed and curved on the stem, ± oval, 110–125 µm wide, 150–175 µm long, longer than wide, 1.5 × the stem width, 30–50% bifid, sinus V-shaped, narrow, lobes triangular, straight, apex acute, formed by 1–2 cells in a row, margins toothed, 1–3 elongated teeth on each side, teeth often ± elevated, base cuneate, insertion line covered by a pronounced rhizoid disc, occasionally with rhizoids. *Autoicous*, few fertile shoots found. Fertile shoots with numerous gametoecea, nearly one gynoeceium at base of each vegetative leaf. *Androecia* terminal on innovations, small, globose, 2–3 pairs of imbricate bracts, bracteoles could not be observed. *Gynoecea* terminal on lateral branches on the shoot, without vegetative leaves at base, one innovation, probably lejeuneoid-type (first appendage is a lateral leaf), innovation mostly short and ending in an androecium, seldom sterile and long. Female bract lobe oval, margin entire, apex rounded; bract lobule small, oval, apex rounded to acute; bracteole oval to subrectangular, shortly bifid, margin toothed. *Perianth* ± half its length



**Fig. 1.** *Lejeunea tamsii* M. E. Reiner, N. Salazar Allen & C. Chung C., *sp. nov.* 1 & 4 – underleaves with adjacent reduced ventral lobules, 2 – sector of shoot with reduced ventral lobules, 3 – underleaf with adjacent well developed lobule, 5 – reduced lobule with apical hyaline papilla. (All from *Salazar Allen 4281*, holotype).

emergent between the bracts, obovoid, inflated, 300–360 µm wide, 650–750 µm long, margin slightly crenulate due to globose cells, 5-keeled, keels 1/3 the length of the perianth, dorsal keel less distinct, keels entire, beak not seen (broken?). Sporophyte not observed. *Vegetative reproduction* not observed.

**DISTRIBUTION AND ECOLOGY.** *Lejeunea tamsii* is thus far known from only three collections from Barro Colorado, Panama, at 50–100 meters. It was found growing on rocks, on dry creeks, along two different trails in the Island. In one of the collections (Nr. 4583) it was growing with *Fissidens weirii* Mitt. and *F. guianensis* Mont. (det. C. Chung C. 1990).

**DISCUSSION.** The description of *Lejeunea tamsii* should be considered preliminar, as it is based on three collections with few fertile shoots and mature perianths. The underleaves and lobules are also difficult to observe, as they are usually covered by algae and soil.

The distinctive characters of *Lejeunea tamsii* are found in the underleaves, that are appressed and curved on the stem and have toothed margins, with the teeth apex often slightly elevated from the underleaf plane. The underleaf margin in most species of *Lejeunea* is entire, but species with a ± blunt or conspicuous tooth on the margin are also known, e.g., *L. boryana* Mont. and *L. laetevirens* Nees & Mont. (Reiner-Drehwald 2000; Reiner-Drehwald & Goda 2000). In *Lejeunea multidentata* M. E. Reiner & Mustelier the underleaf margins are also toothed, but the leaf shape with teeth and cilia on the margins clearly differs from the entire leaves of *L. tamsii* (Reiner-Drehwald & Mustelier Martínez 2004).

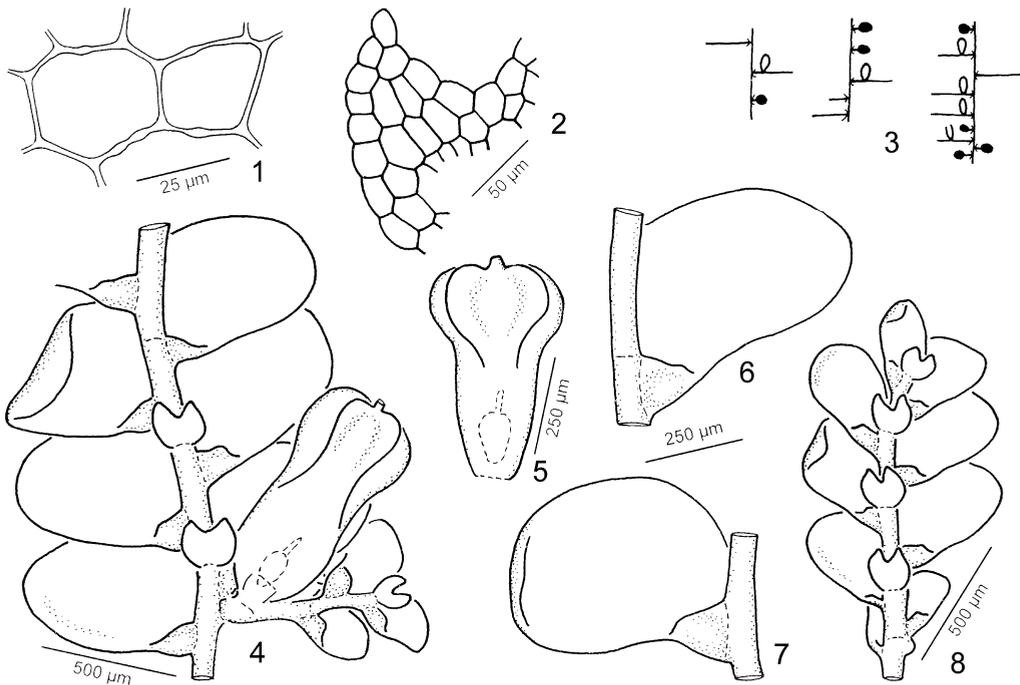
**2. *Lejeunea tonduzana* (Steph.) M. E. Reiner, *comb. nov.*** Fig. 2

*Hygrolejeunea tonduzana* Steph., *Hedwigia* **35**: 105. 1896. TYPE: COSTA RICA, Rio Naranjo, 200–250 m, March 1893, *Tonduz 3077 a* (HOLOTYPE, G 11832 [autoicous, c.per.]; ISOTYPE, JE [autoicous, c.per.]; both

types intermingled with *Lejeunea adpressa* Nees [autoicous, c.per.].

*Plants* shiny, brownish in herbarium, 0.8–1.4 mm wide; branches of the *Lejeunea*-type, ± abundant, similar or smaller than the main shoot, collars small, most branches fertile. *Stems* 60–85 µm wide, epidermal cells in ventral view rectangular, 25–35 × 40–65 µm; ventral merophyte 2 cells wide. *Leaves* imbricate, widely spreading. *Lobes* ovate, slightly concave, 450–700 µm long, 300–500 µm wide, margin entire, slightly crenate, apex rounded, plane, occasionally recurved, dorsal margin arched, ventral margin straight. Marginal leaf cells quadrate to rectangular, median cells isodiametric or elongated, 20–28 × 33–40 µm, basal cells slightly larger; cell walls thin, trigones medium sized, 0–2 intermediate thickenings per wall; cuticle smooth; oil bodies not observed. *Lobules* variable, when well developed triangular, strongly inflated, 110–130 µm long, 80–100 µm wide, ± 1/4 the lobe length, lateral margin incurved, apical tooth 15 ×

25 µm, hyaline papilla proximal, apical margin 2–3 cells long, keel straight to slightly arched, at the union with ventral margin of lobe slightly angled or straight; reduced lobules only few cells large. *Underleaves* distant, suborbicular, 160–225 µm wide, 140–190 µm long, wider than long or longer than wide, 2–3 × the stem width, 25–45% bifid, sinus mostly U-shaped, lobes triangular, straight, 1 cell at the apex, 5–6 cells at the base, margins entire, base cuneate, insertion line slightly arched, rhizoids often developed. *Autoicous*. *Androecia* terminal on short branches without vegetative leaves at base, 2–3 pairs of bracts, bracts imbricate, hypostatic, 1 (or more?) bracteoles at base of spike, 2 antheridia per bract. *Gynoecia* terminal on short branches without vegetative leaves at base, one sterile innovation of the lejeuneoid-type. Female bracts and bracteole most broken. *Perianths* emergent 1/2–1/3 its length between the bracts, ± clavate, inflated, constricted at 1/2–1/3 its length, 230–320 µm wide in the bottom, 350–450 µm wide



**Fig. 2.** *Lejeunea tonduzana* (Steph.) M. E. Reiner. 1 – median leaf cells, 2 – part of underleaf, 3 – cladographs of fertile plants (solid ellipse = androecium, open ellipse = gynoecium with perianth, U = gynoecium without perianth), 4 – sector of shoot with mature perianth, ventral view, 5 – perianth, ventral view, 6 & 7 – leaves, 8 – sector of shoot, ventral view. (All from G11832, holotype).

at the upper part, 550–900  $\mu\text{m}$  long, 5-keeled, keels  $\pm 1/2$  the length of the perianth, all keels equally developed,  $\pm$  inflated and expanded, entire, slightly crenate, (probably) not winged, beak 35  $\mu\text{m}$  (1–2 cells) long. *Vegetative reproduction* not observed. *Sporophyte* not observed.

**DISTRIBUTION AND ECOLOGY.** *Lejeunea tonduzana* is only known from the type material, collected in Costa Rica, at 200–250 m. It was growing as an epiphyll on fern, together with *L. adpressa* and *Radula* sp.

**DISCUSSION.** Two fertile species of *Lejeunea* are growing intermixed in the type sample of *Hygrolejeunea tonduzana*. The plants with 5-keeled and inflated perianths are those specimens described and illustrated by Stephani as *H. tonduzana* (Stephani 1985, nr. 4363). The second species, *Lejeunea adpressa*, has a dorsally compressed perianth (Reiner-Drehwald 2009).

*Lejeunea tonduzana* is characterized by the strongly inflated perianth, with the keels expanded in the upper 1/3. The female bracts and bracteoles are broken and could not be described. Dauphin (2005: 208) described the androecia of *Hygrolejeunea tonduzana* as “Androecia terminal on main branches or on the gynoeical innovations!, with 1–3 bract pairs”. In the studied plants the androecia are terminal on short branches and the observations of Dauphin could not be confirmed. However, additional collections are needed to determine the morphological plasticity of this species.

### 3. *Lejeunea recurva* M. E. Reiner, *nom. nov.*

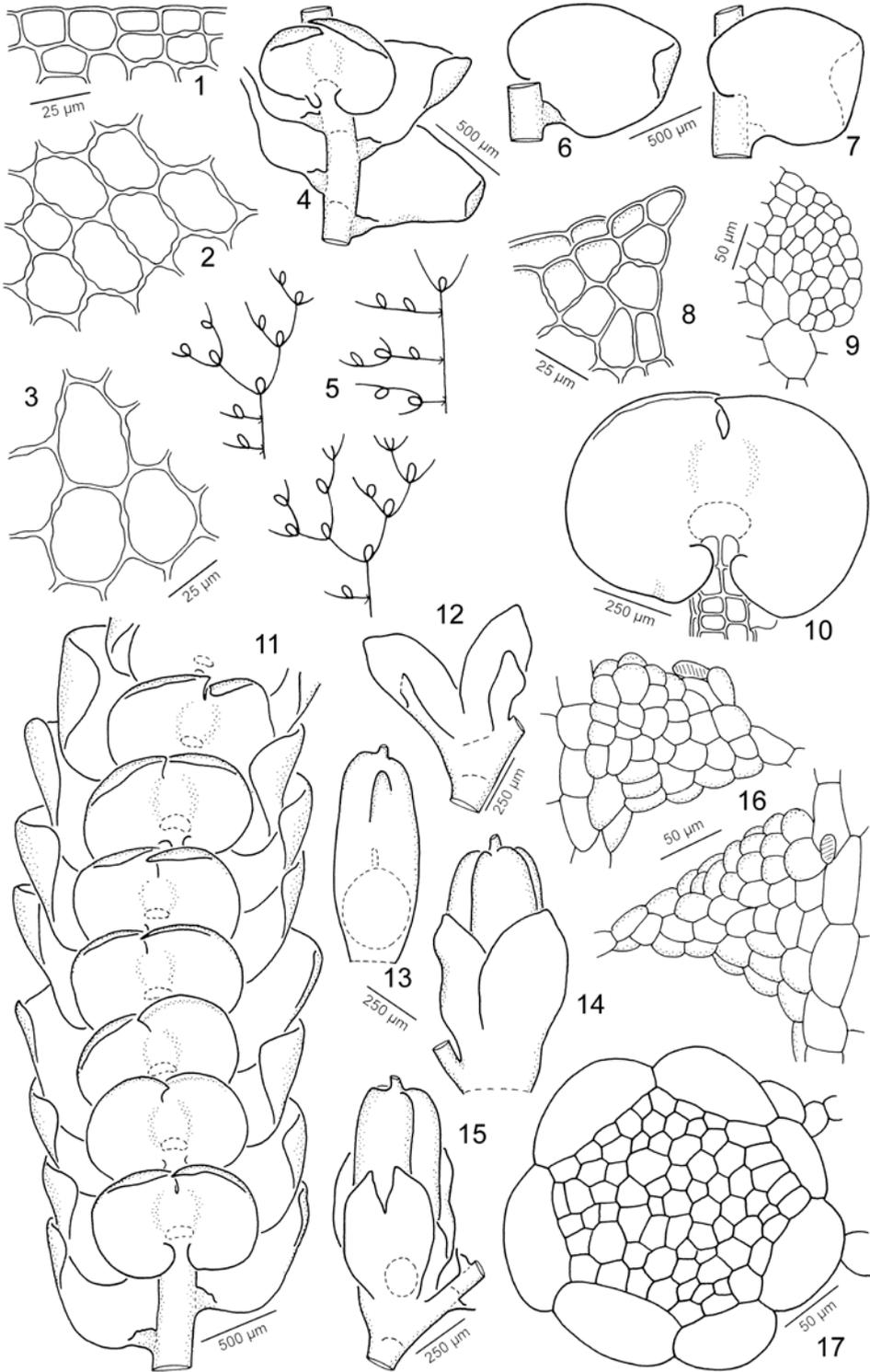
Fig. 3

$\equiv$  *Hygrolejeunea recurva* Steph. *nom. herb. Hygrolejeunea recurva* Steph. *ex* Bonner, Index Hepaticarum 6: 653, 663. 1966, *nom. inval. nom. nud.*, Art. 32.1 Melbourne Code.

$\equiv$  *Hygrolejeunea herzogii* Steph. *in* Herzog, Biblioth. Bot. 87: 265. 1916, *nom. illeg.*, later homonym, Art. 53.1 Melbourne Code. Non *Hygrolejeunea herzogii* Steph., *Spec. hepat.* 5: 530. 1914 (= *Lejeunea catinulifera* Spruce, see Reiner-Drehwald 2005). Non *Lejeunea herzogii* Mizut. 1967 (TYPE: Indonesia; = *Lejeunea papilionacea* Steph., see Zhu & Grolle 2001).

TYPE. BOLIVIA. Santa Cruz, prov. Caballero, Sillar, 1800 m, 1911, *Herzog 2687* (HOLOTYPE, G [c. per.]; ISOTYPE, JE [c. per.]).

*Plants* dull to shiny, yellowish green in herbarium, 1.5–2.0 mm wide; branches of the *Lejeunea*-type, few, smaller than the main shoot, 1.0–1.3 mm wide, collars large. Stems 140–200  $\mu\text{m}$  wide, epidermal cells in ventral view rectangular, 70–75  $\times$  80–100  $\mu\text{m}$ ; stems in cross section suborbicular, epidermis of 7 rows of enlarged cells surrounding  $\pm$  70 rows of small medullary cells, epidermal cells 40–50  $\times$  85–105  $\mu\text{m}$ , medullary cells 15–25  $\times$  20–30  $\mu\text{m}$ , cell walls thin, hyaline to yellowish; ventral merophyte 2 cells wide. *Leaves* imbricate, obliquely to widely spreading. *Lobes* ovate,  $\pm$  concave, 850–1200  $\mu\text{m}$  long, 700–900  $\mu\text{m}$  wide, margin entire, apex rounded, recurved, dorsal margin arched, ventral margin slightly arched. Marginal leaf cells quadrate to rectangular, 10–18  $\times$  17–25  $\mu\text{m}$ ; median leaf cells isodiametric to elongated, 20–25  $\times$  30–35  $\mu\text{m}$ ; basal cells elongated, 30–33  $\times$  40–50  $\mu\text{m}$ ; cell walls thin, trigones medium-sized, intermediate thickenings common, (0–)1–2(–3) per wall, cuticle papillose; oil bodies not observed. *Lobules* variable, when well developed,  $\pm$  rectangular to triangular, strongly inflated, 130–140  $\mu\text{m}$  long, 100–125  $\mu\text{m}$  wide,  $<1/6$  the lobe length, lateral margin inrolled or the distal portion with the tooth seen in situ, lateral margin 5–6 cells long, tooth oval, hyaline papillae obovoid, at the proximal base of the tooth, apical margin lunulate to straight, 2–3 cells long, keel straight to slightly arched,  $\pm$  crenate, at the union with ventral margin of lobe slightly angled; reduced lobules variable in shape and size. *Underleaves* imbricate to contiguous, appressed on the stem, central part between rhizoid disc and sinus  $\pm$  convex, reniform, 600–1100  $\mu\text{m}$  wide, 400–700  $\mu\text{m}$  long, wider than long, 4–5  $\times$  the stem width, 15–25% bifid, sinus V-shaped, narrow, lobes triangular, connivent, apex acute, ending in 1 cell, margins entire, apical half recurved, base auriculate, insertion line slightly arched, rhizoid disc pronounced. *Dioicous*? *Androecia* not observed. *Gynoeica* terminal on branches or on the main stem, 1–2 innovations, gynoeical pattern often dichasial, up to 3 gynoeica in a row. Female bract lobes oval, 600–1000  $\mu\text{m}$  long,



250–370 µm wide, margin slightly crenate, apex rounded to subacute; bract lobules oval to rhomboidal, 400–700 µm long, 120 µm wide, margin slightly crenate, apex subacute, keel straight, not winged; female bracteole oval, 400–600 µm wide, 550–800 µm long, free, 20–35% bifid, sinus V-shaped, lobes acute. *Perianth* 1/3–1/2 emergent between the bracts, cylindrical to ellipsoidal, not compressed, 350–400 µm wide, 800–900 µm long, 5-keeled to 1/3–1/2 the length of the perianth, all keels equally developed, keels entire, not winged, perianth surface papillose, beak 60–75 µm (2–4 cells) long. *Vegetative reproduction* not observed. *Sporophytes* not observed.

**DISTRIBUTION AND ECOLOGY.** *Lejeunea recurva* is until now known only from the Andes in Bolivia (type material, with perianths) and Peru (sterile), between 1300–1800 m, where it was growing as an epiphyte.

**ADDITIONAL SPECIMEN EXAMINED:** PERU. SAN MARTÍN: prov. Rioja, distrito Pardo Miguel, near bridge Serranoyacu, 1300–1400 m, 05°40'32"S, 77°40'28"W, 8 Jan. 2001, *Drehwald 4870* (USM, GOET).

**DISCUSSION.** *Lejeunea recurva* is easily recognized by the large and reniform underleaves, which are shortly bifid and recurved at the upper half. The leaf lobes are also recurved, the lobules small, less than 1/6 the lobe length, the cells are thin walled, with trigones and intermediate thickenings and papillose cuticle. Androecia were not observed; the female plants often possess a characteristic dichasial gynoeical pattern, the perianths are long, cylindrical and the 5 keels are entire.

The species resembles *Lejeunea reflexistipula* (Lehm. & Lindenb.) Gottsche *et al.*, mainly by the large and reniform underleaves, but in the latter they are entire and the bases are rounded, whereas in *L. recurva* the bifid underleaves have large auriculate bases (Reiner-Drehwald 2005).

#### 4. *Lejeunea cerina* (Lehm. & Lindenb.) Gottsche

Lindenb. & Nees, Syn. Hep.: 391. 1845. *Jungermannia cerina* Lehm. & Lindenb. in Lehmann, Nov. Stirp. Pug. 5: 16. 1833. *Hygrolejeunea cerina* (Lehm. & Lindenb.) Schiffner in Engler & Prantl, Nat. Pflanzenfam. 1(3): 125. 1893 (Preprint). *Macrolejeunea cerina* (Lehm. & Lindenb.) Gradst., Bryologist 92: 345. 1989. TYPE: BRAZIL. Rio de Janeiro: Serra dos Orgãos, *Beyrich s.n.* (LECTOTYPE, S, not seen, designated by Grolle 1987: 440; ISOLECTOTYPE, U [sterile, few stems]).

= *Hygrolejeunea aspera* Steph., Spec. hepat. 5: 543. 1914. TYPE. MEXICO. Veracruz: Zacuapan, *Liebman 539 b*, ex Herb. Lindenb. 6741 (HOLOTYPE, G 27315 [gyn.]); *syn. nov.*

= *Hygrolejeunea similis* Steph., Spec. hepat. 5: 541. 1914. TYPE. COSTA RICA. Buenos Aires, 1892, *Tonduz 15553* (HOLOTYPE, G 11817 [gyn.]); *syn. nov.*

#### 5. *Lejeunea flava* (Sw.) Nees

Naturgesch. Eur. Leberm. 3: 277. 1838. *Jungermannia flava* Sw., Nova Gen. Spec. Pl. Prodr.: 144. 1788. TYPE. JAMAICA. *Swartz s.n.* (LECTOTYPE, UPS [Hb. Thunb. 25916, c.per.], not seen, designated by Grolle 1976: 201; ISOLECTOTYPES, S [scanty, 2 shoots], BM [c.per.]).

= *Hygrolejeunea bahiensis* Steph., Hedwigia 35: 99. 1896. TYPE. BRAZIL. Bahia, *Didrichsen s.n.* (HOLOTYPE, G [scanty, 4 shoots, autoicous, c.gyn.]); *syn. nov.*

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**Fig. 3.** *Lejeunea recurva* M. E. Reiner. 1 – marginal leaf cells, 2 – median leaf cells, 3 – basal leaf cells, 4 – shoot sector, two underleaves removed, ventral view, 5 – cladographs of fertile plants (open ellipse = gynoeicum with perianth), 6 – leaf, ventral view, 7 – leaf, dorsal view, 8 – underleaf lobe apex, 9 – underleaf base, 10 – underleaf, 11 – shoot sector, ventral view, 12 – female bracts, 13 – perianth, dorsal view, 14 & 15 – perianth with bracts (14 in dorsal view, 15 in ventral view), 16 – leaf lobules, 17 – cross section of stem. (4, 9, 12–15 from JE, isotype; 5 from G, holotype; 1–3, 6–8, 10, 11, 16, 17 from *Drehwald 4870*, GOET).

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