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A new species of *Harpalejeunea* (Spruce) Schiffn. (Lejeuneaceae) from montane cloud forest of Colombia and Costa Rica

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Abstract – A new species of Lejeuneaceae from montane cloud forest of Colombia and Costa Rica, *Harpalejeunea scabra*, is described and illustrated. The new species is characterized by the papillose dorsal leaf surface, a feature occurring in several related genera such as *Lejeunea* and *Drepanolejeunea*, but new to *Harpalejeunea*. Further diagnostic characters of *H. scabra* include the dorsal leaf margin with 1-3 teeth and the peculiar lobule with twinned apical teeth, free margin bordered by very narrow cells and aperture circular with the distal end of the apical margin adnate to the surface of the lobe. The new species somewhat resembles the enigmatic *Drepanolejeunea navicularis* Steph. from páramo of Colombia and Venezuela. The affinities of the two species are discussed.

Colombia / Costa Rica / *Harpalejeunea* / *Harpalejeunea scabra* / *Drepanolejeunea navicularis* / Lejeuneaceae / liverworts / morphology / taxonomy

INTRODUCTION

Harpalejeunea (Spruce) Schiffner (Lejeuneaceae) is a tropical genus of about 20-25 species, most of which occur in tropical America (Grolle & Reiner-Drehwald, 1999; Gradstein *et al.*, 2001). The genus has not yet been revised and the status of many species names remains doubtful; probably several of them will turn out to be synonyms after critical scrutiny. *Harpalejeunea* is characterized by emarginate to shallowly bifid underleaves with rounded, diverging lobes (rarely undivided), ± falcate leaves with acute-acuminate apex (rarely obtuse), presence of 2-3 ocelli in an unbroken row at leaf bases and lejeuneoid innovations. *Harpalejeunea* somewhat resembles *Drepanolejeunea* (Spruce) Schiffn. but the latter genus has narrower underleaf lobes, ocelli in a broken row and pycnolejeuneoid innovations.

An unusual species of *Harpalejeunea*, which appears to be undescribed, was detected among the materials collected by the first author in Colombia in the framework of an exploration of the bryophyte flora of the western Cordillera and the Chocó (Frahm, 1994). The new species stands out by papillose leaf cells, a feature previously unreported in *Harpalejeunea*. Additional material was collected in Costa Rica. The new species is described and discussed below.

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TAXONOMIC DESCRIPTION

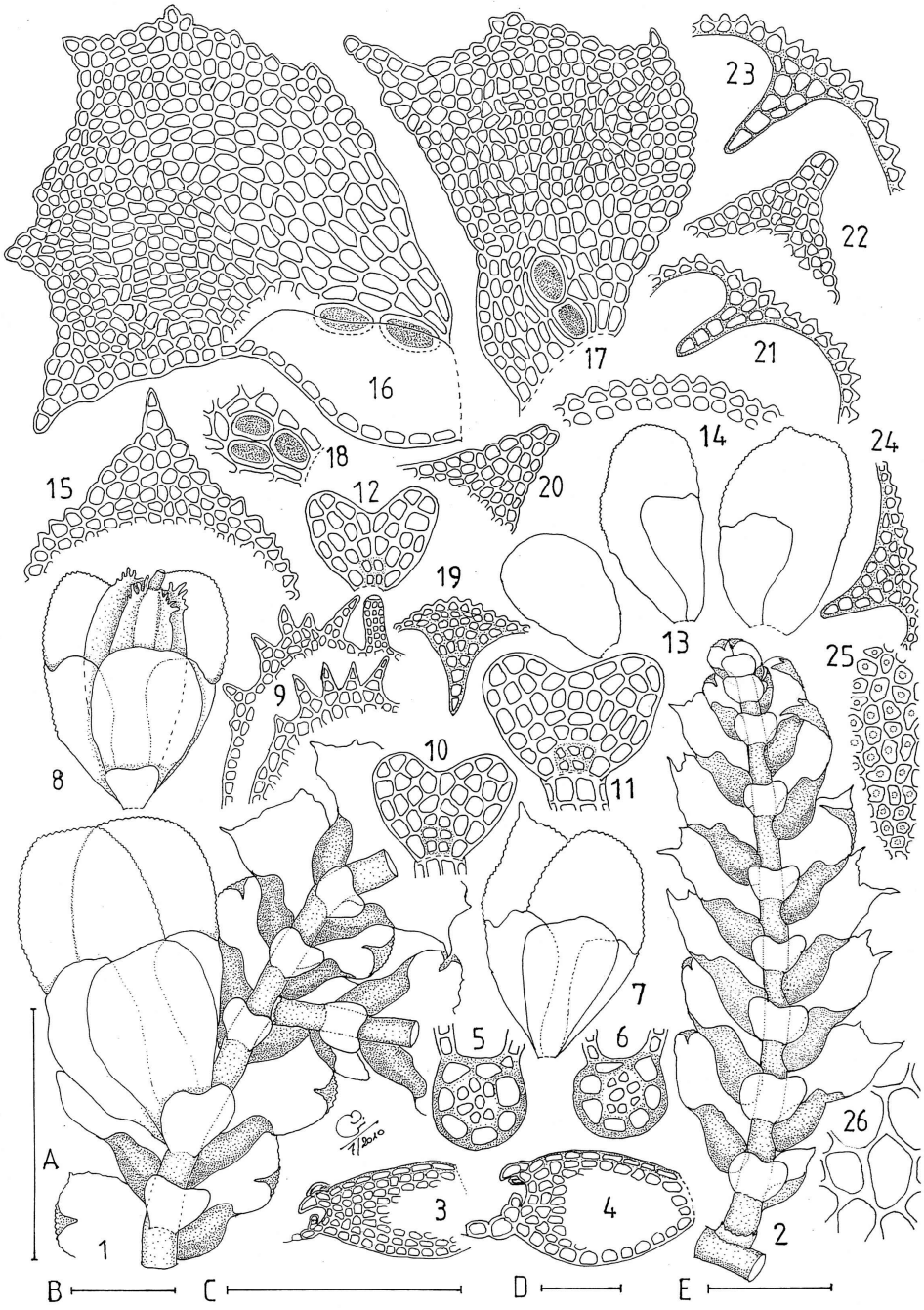
Harpalejeunea scabra Gradst. *et* Schäf.-Verw., **sp. nov.** **Figs 1-26**

Type : Colombia, Risaralda, road Mistrato – San Antonio de Chami, just beyond the pass, quebrada of Río Sutú, 1800 m, rather heavily logged, low montane cloud forest along the river, on rock, 30 July 1992, *S. R. Gradstein 8695* (**holotype**, COL; **isotype**, GOET). **Paratype**: Costa Rica, Monteverde, on living leaf in the Monteverde Cloud Forest Reserve, 10º 18' N, 84 º 48' W, ca. 1550 m, *C. Dauphin s.n.* (GOET).

Folia asymmetrico-obovata falcata, margine dorsale 2-3-dentato. Cellulae foliorum papillosae.

Plants to 1 cm long, 0.5-0.7 mm wide, dull, pale brown when dry, creeping, irregularly branched, branches *Lejeunea*-type, innovations *Radula*-type. ***Stems*** to 0.1 mm in diameter, brownish, epidermis cells thick-walled, ventral merophyte 2 cells wide; stems in cross section with 7 thick-walled epidermal cells surrounding 7 medullary cells. ***Leaves*** widely spreading, imbricate, lobe strongly convex, asymmetrically obovate-falcate with ventrad distal portion, *ca* 0.4 × 0.25 µm, dorsal lobe surface rough (except near the base) due to mammillose cells crowned by a conical papilla, papillae 5-6(-10) µm high, positioned towards the distal end of the cells; leaf apex narrow triangular, acute-acuminate, with a 2-3 cells long uniseriate tip, or sometimes narrowly obtuse ending with two cells side by side, margins crenulate to crenate by mammillose cells crowned by a papilla, the dorsal margin strongly arched, with 1-3 teeth, the teeth variable in size, made up of 1-10 cells and sometimes similar in shape to the apex, sometimes almost lacking, uniseriate tip of the teeth 1-2 cells long, dorsal lobe base ± straight, covering half the width of the stem, dorsal insertion line 4 stem cells long; mid-leaf cells isodiametrical to slightly elongate, 15-27 µm long, cells slightly smaller towards the margin and slightly larger towards the base, cell walls with large, often confluent trigones and 0-1 intermediate thickenings; oil bodies not observed; ocelli (1-)2 in an unbroken row at leaf base, conspicuous, ocellus about twice as large as adjacent lamina cells, *ca* 50 × 25 µm, occasionally a 3rd ocellus present side by side to the distal ocellus. ***Lobules*** oblong, 1/2 of leaf length, *ca* 0.2 × 0.1 mm, inflated throughout, surface smooth, keel curved, free margin incurved, bordered by a row of narrow rectangular cells, lobule apex invisible in situ, covered by the basal portion of the ventral lobe margin, with 2 short, blunt, closely associated single-celled teeth, the distal tooth formed by the elongate, falcate

Figs 1-26. *Harpalejeunea scabra* Gradst. *et* Schäf.-Verw. **1, 2:** part of plant, ventral view. **3, 4:** lobules. **5, 6:** cross section of stem. **7:** female bracts and bracteole. **8:** perianth with bracts, bracteole and involucral underleaf. **9:** upper part of perianth keel. **10-12:** underleaves. **13:** female bracts and bracteole. **14:** uper margin of female bract, part of fig. 13. **15:** apex of female bract, part of fig. 7. **16:** leaf lobe, ventral view. **17:** leaf lobe, dorsal view, papillae omitted. **18:** group of three basal ocelli. **19-24:** different leaf apices. **25:** cells of upper central part of female bract. **26:** cells from central leaf lobe, ventral view, largest cell 26 µm long. Figs. 1, 2, 5-16, 19, 20, 22, 24, 26 from the type, Gradstein 8695; figs. 3, 4, 17, 18, 21, 23, 25 from the paratype, *Dauphin s. n.* (Scales: A = 500 µm for 1, 2; B = 100 µm for 3-6, 15, 19-24; C = 750 µm for 7, 8, 13; D = 100 µm for 9; E = 100 µm for 10-12, 14, 16-18, 25).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upper cell of the apical margin, the apical margin of the lobule (beyond the apex) U-shaped, together with the base of the ventral leaf margin forming a ± circular aperture, 7 cells long, the 2-3 outermost cells of the apical margin adnate to the surface of the lobe, forming a low ridge; hyaline papilla not seen; cells of the lobule smooth, isodiametrical or narrow rectangular in the lower half, isodiametrical above. ***Underleaves*** rather small, 2-3 × stem width, distant, flat, wider than long, obtrapezoid, emarginate to short bifid (to 1/3), lobes rounded, 3-4 cells wide, diverging, margins plane, entire, surface smooth, base cuneate, insertion line curved, underleaf cells as in the leaves but smooth, without papilla, ocelli lacking; rhizoid disc inconspicous, of few small cells, rhizoids ± absent.

Monoicous (?). ***Androecia*** (? to be confirmed by additional observation) intercalary on leafy branches, bracts in a few pairs, resembling leaves, lobules epistatic, slightly more strongly inflated than vegetative lobules, lobule apex strongly constricted and apical teeth visible, protruding, male bracteoles present throughout. ***Gynoecia*** on elongated branches, each gynoecium with one lejeuneoid innovation, the innovation sterile or again fertile; female bracts much larger than leaves, erect, free, without ocelli, lobe oblong, to 0.8 × 0.4 mm, apex obtuse or one rarely apiculate, dorsal surface and margins rather sharply crenate by mammillose cells crowned by a conical papilla, lobule oblong, ca.1/2-2/3 of bract length, apex obtuse, surface smooth, free margin near the base of the lobule with 2 twinned teeth, hyaline papilla present on the free margin just beyond the teeth; keel ± straight, with a 1-4 cells wide wing over the entire length; female bracteole oblong-rectangular, *ca* 0.5 mm long, about half the length of the perianth, apex shallowly retuse, margins entire, the base adnate to the bracts on one side, bracteole cells smooth, ocelli lacking. ***Perianths*** ellipsoidal, almost 1 mm long, sharply 5-keeled over its entire length, keels smooth except at apex, the apex densely dentate-ciliate by 1-3 cells long teeth, the cells thick-walled, cuticle smooth, ocelli lacking; beak short, *ca* 5 cells long.

Sporophyte not seen. ***Asexual reproduction*** lacking.

Distribution and ecology: *Harpalejeunea scabra* is thus far known from two localities, the type locality in Colombia and another locality in Costa Rica. In Colombia (Risaralda) the species was found at *ca* 1800 m on a boulder in a small stream in degraded, heavily logged montane cloud forest, in partial shade. Associated rock-inhabiting species were *Cyclolejeunea convexistipa* (Lehm. *et* Lindenb.) A. Evans, *Drepanolejeunea lichenicola* (Spruce) Steph., *Prionolejeunea decora* (Tayl.) Steph., *Calypogeia rhombifolia* (Spruce) Steph., *Heteroscyphus thraustii* (Spruce) Fulf., *Kymatocalyx dominicensis* (Spruce) Váňa and *Radula schaefer-verwimpii* Yamada. In Costa Rica the species was found in the montane cloud forest of Monteverde (*ca* 1550 m), growing scattered over a dense, epiphyllous mat of *Cyclolejeunea convexistipa*.

DISCUSSION

The description of the androecia of *Harpalejeunea scabra* is preliminary and the sexuality of the new species, tentatively described here as being monoicous, needs confirmation. Since presence of antheridia could not be determined with certainty, we are not sure whether the leaves described here as

male bracts are indeed bracts, being very similar to vegetative leaves except for the slightly more strongly inflated lobules.

Harpalejeunea scabra is readily recognized by the thickwalled, somewhat mammillose leaf cells with a conspicuous, conically elevated papilla on the dorsal side of the leaf. The papillosity of the leaf surface of *Harpalejeunea scabra* is a unique feature that has not been observed in the genus *Harpalejeunea* (the report of conically elevated mammillae in *Harpalejeunea* by Gradstein *et al.* (2001) a was based on the new species described in this paper). Papillose leaf cells are found in several related genera, however, such as *Drepanolejeunea* (Spruce) Schiffn. and *Echinocolea* R.M. Schust.; the latter genus is now placed in the synonymy of *Lejeunea* Lib. (Ilkiu-Borges, 2005). Some members of *Echinocolea*, e.g. *Lejeunea asprella* Spruce and *L. subspathulata* Spruce, have been assigned in the past to *Harpalejeunea* (Stephani, 1912-1917), but are readily separated by the lack of ocelli and the very different underleaves which do not produce diverging lobes.

Besides its papillose leaf cells, *Harpalejeunea scabra* is recognized by the frequent occurrence of a few triangular teeth on the dorsal leaf margin. The teeth vary considerably in size, however, and are very small, 1-2 cells long only, in the Costa Rican material; the latter specimen also stands out by its rather small leaf cells (15-20 μm long, vs. 23-27 μm in the type material). Further characters separating the new species from its congeners are seen in the leaf lobule, which has twinned apical teeth, a band of very narrow cells bordering the free margin and a more or less circular aperture at the lobule apex. The latter is formed by the U-shaped apical margin of the lobule which is adnate to the lobe surface at its distal end. Within *Harpalejeunea*, teeth on the dorsal leaf margin are also produced in *Harpalejeunea tridens* (Besch. *et* Spruce) Steph., which, however, has very thin-walled and smooth leaf cells. A circular aperture at the lobule apex has not been reported from *Harpalejeunea* but has been described from, e.g., *Lejeunea subspathulata* (Ilkiu-Borges, 2005). Twinned teeth and free margin bordered by narrow elongated cells are also unknown from *Harpalejeunea* but occur in *Drepanolejeunea navicularis* Steph. from Colombia and Venezuela (Bischler, 1964; Schuster, 1996, Fig. 9: 15-16) (twinned lobule teeth are otherwise present in the unrelated *Trachylejeunea* (Spruce) Schiffn., now considered a synonym of *Cheilolejeunea* (Spruce) Schiffn.; Ilkiu-Borges & Gradstein, 2008; Gradstein & Ilkiu-Borges, 2009). The latter species also resembles *Harpalejeunea scabra* by the similar shape of the underleaves, very different from that of most other members of *Drepanolejeunea*, and by the unbroken row of ocelli at leaf bases (but ocelli are absent in *D. navicularis* var. *subsquarrosa* R.M. Schust.). The generic affinities of *D. navicularis* to *Harpalejeunea* have been discussed by Schuster (1996). *Drepanolejeunea navicularis* grows as an epiphyte in páramo vegetation, between 3000-3700 m, and is known only from sterile material. Since leaves of the latter species are not falcate and the innovation leaf sequence (which is lejeuneoid in *Harpalejeunea* and pycnolejeuneoid in *Drepanolejeunea*) is unknown, the generic placement of *D. naviculare* remains doubtful and its possible transfer to *Harpalejeunea*, although tempting, is not warranted. A morphological comparison of *Drepanolejeunea navicularis* and *Harpalejeunea scabra* is presented in Table 1. A field search in potentially suitable habitats (shrubby wet páramo) of *Drepanolejeunea navicularis*, aimed at detecting gynoecial material, should be undertaken in order to try to resolve the taxonomic position of this enigmatic species and its putative relationship to *Harpalejeunea*.

Table 1. A comparison of *Harpalejeunea scabra* and *Drepanolejeunea navicularis*.

	Harpalejeunea scabra	*Drepanolejeunea navicularis (incl. var. subsquarrosa)*
Leaves	imbricate, asymmetrically obovate falcate	distant, ovate-triangular, erect or slightly falcate
Leaf apex	acute to acuminate	acute to apiculate
Dorsal leaf margin	strongly arched, with 1-3 teeth	almost straight, without teeth
Leaf cells	with a conical papilla positioned near the distal end of the cell	with a low, lenticular papilla position in the centre of the cell
Ocelli	(1-)2(-3) in a row at leaf base	2 in a row at leaf base or absent
Lobule	1/2 of leaf length, not extending along the ventral margin of the lobe	ca. 2/3 of leaf length, not extending along the ventral margin of the lobe
Lobule free margin	bordered by narrow cells	bordered by narrow cells
Lobule apex	with twinned teeth, teeth visible in situ; aperture circular, apical margin adnate to the surface of the lobe	with twinned teeth, teeth invisible in situ; aperture not circular, apical margin not adnate to the surface of the lobe
Underleaves	emarginate to bifid to 1/3, lobes diverging, rounded, 3-4 cells wide	bifid to 1/3, lobes diverging, rounded, 4 cells wide

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