

# ***DIPLASIOLEJEUNEA MAYAYKUENSIS* (LEJEUNEACEAE, MARCHANTIOPHYTA), A NEW LIVERWORT SPECIES FROM SOUTHERN ECUADOR**

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**Abstract.** A new epiphytic species of *Diplasiolejeunea* (Spruce) Schiffn. from the Amazonian region of southern Ecuador is described and illustrated. *Diplasiolejeunea mayaykuensis* Schäf.-Verw. & Heinrichs, *sp. nov.* is characterized by ascending to squarrose leaves, narrowly ovate(-lanceolate) underleaf lobes with acute to subobtusate apices, well developed lobule teeth and lobules with strongly involute free margins. Morphologically, *D. mayaykuensis* closely resembles *D. brunnea* Steph. and *D. cavifolia* Steph. The locality is situated in the western escarpment of the Cordillera del Condor.

**Key words:** integrative taxonomy, Neotropics, Porellales

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## INTRODUCTION

The pantropical genus *Diplasiolejeunea* (Spruce) Schiffn. includes some 65–70 morphologically-typologically defined species. Centres of diversity of *Diplasiolejeunea* are the Neotropics and Africa; only a few species occur in Asia and Australasia (Schäfer-Verwimp 2006). *Diplasiolejeunea* is one of the few genera of Lejeuneaceae with one underleaf per leaf instead of one underleaf per leaf pair. It shares this character state with *Colura* (Dumort.) Dumort.; however, *Colura* usually produces sac-like lobules bearing a movable structure allowing the lobules to be closed (Heinrichs *et al.* 2012) and the lobule exceeds the lobe in length whereas the lobules of *Diplasiolejeunea* may be inflated but never sac like and never exceed the lobe length.

A recent molecular phylogenetic study allowed to identify several main lineages of *Diplasiolejeunea* and allowed for a classification into a Palearctic subgenus *Physolejeunea* R. M. Schust. and the predominantly Neotropical subgenera *Austrolejeuneopsis* R. M. Schust. and *Diplasiolejeunea*

(Dong *et al.* 2012). This study also demonstrated incongruence between morphological and molecular variation and provided evidence for the presence of several still undescribed *Diplasiolejeunea* species. One of these species ('*Diplasiolejeunea* sp. nov. V', Dong *et al.* 2012) is here formally described, based on a herbarium specimen collected in southern Ecuador in the framework of the ABA-GAM project (Acceleration of Biodiversity Assessment – Gametophytes).

## DESCRIPTION OF THE NEW SPECIES

***Diplasiolejeunea mayaykuensis* Schäf.-Verw. & Heinrichs, *sp. nov.*** (Subgen. *Diplasiolejeunea*)

Fig. 1

TYPE: ECUADOR, ZAMORA-CHINCHIPE, Amazonasgebiet südl. Paquisha, Kulturland bei Mayayku, epiphytisch an Solitär-Strauch; 850 m; 3°59.3'S, 78°38.9'W, 30.1.2011, leg. A. Schäfer-Verwimp & M. Nebel 32094 (HOLOTYPE: STU; ISOTYPES: GOET, JE, QCA).

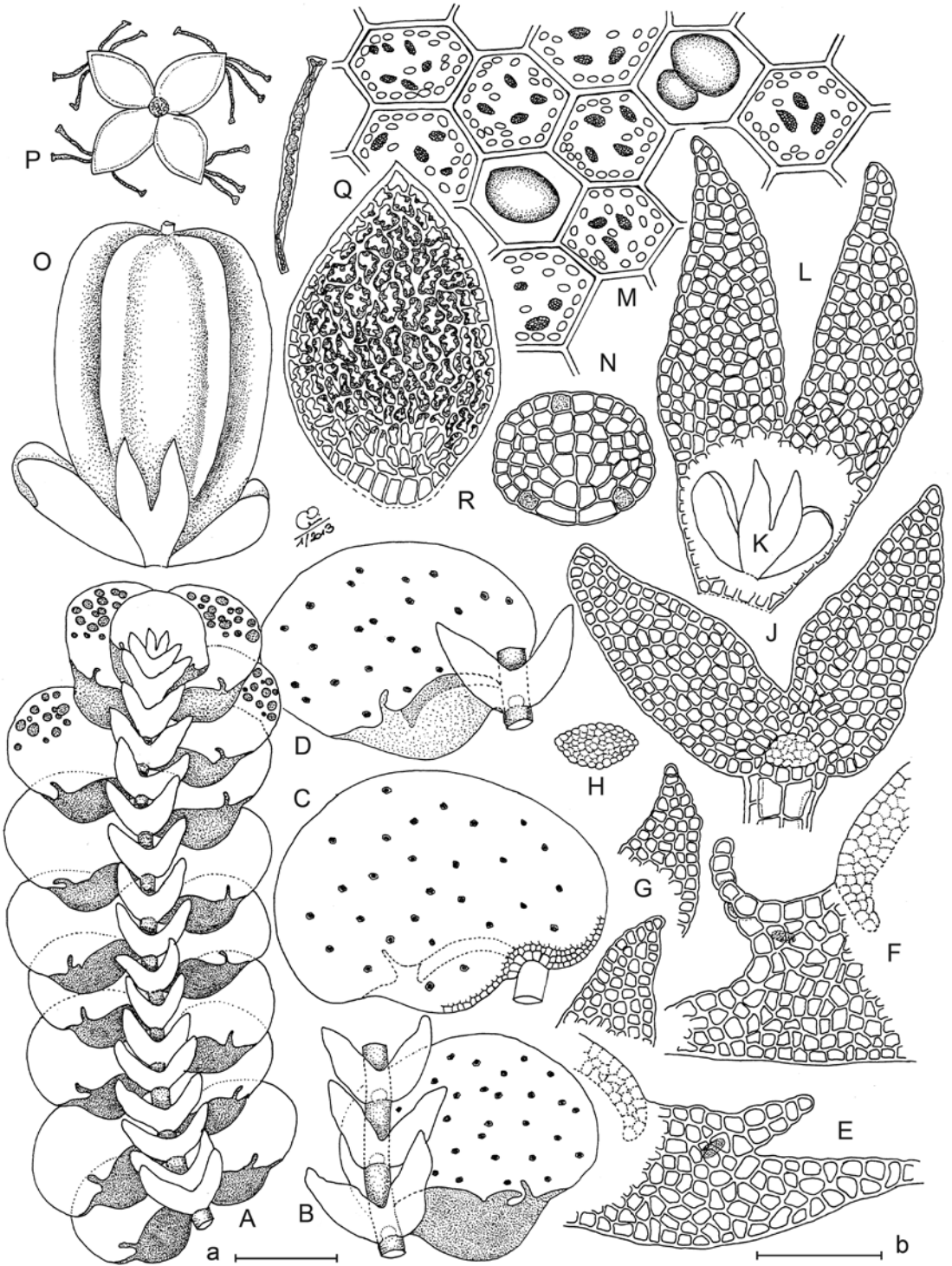
DESCRIPTION: *Plants* creeping on bark, small, in yellowish-green patches; shoots 10–15(–20) mm long and 1.4–1.7 mm wide. *Stems* closely adnate to substrate, (75–)80–95(–100)  $\mu\text{m}$  in diameter, in cross section with 3 medullary and 7 cortical cells, irregularly branched; branches widely spreading, similar to main stems, of *Lejeunea* type. *Leaves* imbricate,  $\pm$  flat, horizontally spreading, in younger parts of shoots loosely appressed to substrate, in older parts often ascending to squarrose, lobes broadly ovate, (700–)750–1000  $\mu\text{m}$  long  $\times$  600–750  $\mu\text{m}$  wide, arching across the stem, margin entire. Cells of lobes in central part often regularly hexagonal, nearly isodiametric to somewhat longer than wide, *ca* 18–20  $\times$  (18–)20–24  $\mu\text{m}$ , marginal cells smaller and irregular in outline, (sub-)quadrate to pentagonal, 10–14  $\times$  12–15  $\mu\text{m}$ , near lobe base elongate to rectangular, up to 20  $\times$  40  $\mu\text{m}$ , sometimes 5–6 larger cells along insertion line, all cells (moderately) thick walled, without or with weak triangular trigones and a few ill defined intermediate thickenings. Chlorophyllous cells with oval chloroplasts, usually slightly smaller than the oil bodies; oil bodies (2–)3–6(–8) per cell, spherical or oval to fusiform, sharply crenulate, 2–3(–4)  $\mu\text{m}$  wide  $\times$  3–7(–9)  $\mu\text{m}$  long. Ocelli scattered, 20–30 per leaf lobe, each containing a single, large glistening, homogeneous oil-body (*ca* 14  $\times$  16  $\mu\text{m}$ ), this large oil body occasionally accompanied by 1(–2) smaller ones, size of ocelli similar to surrounding cells, hence not visible in dried herbarium material. *Lobule* oblong-ovate, *ca* 350–420  $\mu\text{m}$  long  $\times$  170–240  $\mu\text{m}$  wide, moderately inflated at least along keel but often throughout, ventral margin strongly curved, free margin strongly involute throughout, appearing under the microscope as narrow dark stripe,

2–3(–4) cells wide. First tooth (median tooth) always well developed, usually 5–6 cells long and 2–3 cells wide at base, terminating in 2–3 superposed cells, with the tendency to be slightly twisted (see Fig. 1F), at least partly orientated (sub-)parallel to the stem. Second tooth (apical tooth) inflexed (as prolongation of the involute free margin of the lobule), rarely visible when lobule flattened, (2–)3–4 cells long and 2–3 cells wide, obtuse; hyaline papilla entally displaced. Cells of the lobule smaller than those of leaf lobe and more irregular in outline, from 10  $\times$  12  $\mu\text{m}$  to 18  $\times$  18  $\mu\text{m}$ . *Underleaves ca* 4–6  $\times$  stem width, up to 320  $\mu\text{m}$  long and 460  $\mu\text{m}$  wide apically, distant to subimbricate, deeply divided into two narrowly ovate(–lanceolate) lobes, sometimes for some distance with parallel sides, sinus acute to narrowly rounded, only 2–3(–4) cells from sinus to rhizoid disc; lobes up to 320  $\mu\text{m}$  long from base to apex (about 18–26 cells, from sinus to apex 14–22 cells), 120–140  $\mu\text{m}$  wide, mostly acute, occasionally subobtuse, ending with one cell, rarely with two superposed cells, cells usually (sub-)quadrate along margins, elongate to (sub-)rectangular in central part (up to 1.5–1.7  $\times$  as long as wide), from 14  $\times$  14  $\mu\text{m}$  up to 16  $\times$  20  $\mu\text{m}$ , apical cells usually isodiametric or wider than long. *Asexual reproduction* by discoid gemmae produced in great quantity on both surfaces of distal leaves; fully developed gemmae 6 cells long and 10(–11) cells wide [100–120  $\times$  120–160(–190)  $\mu\text{m}$ ], consisting of 50–60 cells, with three rhizoid initials.

*Dioecious*(?). Androecia not seen. Gynoecia on abbreviated lateral branches. Female bracts strongly complicate, *ca* 1/3 – 1/2 bifid, lobes nearly equal in shape and size, 450–500(–530)  $\mu\text{m}$  long and 150–200  $\mu\text{m}$  wide, apex broadly rounded,



**Fig. 1.** *Diplasiolejeunea mayaykuensis* Schäf.-Verw. & Heinrichs, *sp. nov.* A – upper part of plant, ventral view, 1.6 mm wide, 4 mm long, B – leaf lobe and stem with three subsequent underleaves, ventral view, with second tooth of lobule visible (scale bar a = 300  $\mu\text{m}$ ), C – leaf lobe, dorsal view, with insertion line (scale bar a = 300  $\mu\text{m}$ ), D – leaf lobe with lobule and underleaf, ventral view (scale bar a = 300  $\mu\text{m}$ ), E & F – details of lobule teeth, hyaline papilla stipulated (scale bar b = 100  $\mu\text{m}$ ), G – apex of two underleaves (scale bar b = 130  $\mu\text{m}$ ), H – oil body, 4  $\times$  7  $\mu\text{m}$ , J – cell structure of underleaf (scale bar b = 130  $\mu\text{m}$ ), K – female bracts and bracteole (scale bar b = 450  $\mu\text{m}$ ), L – female bracteole (scale bar b = 130  $\mu\text{m}$ ), M – cells of central central leaf lobe, with oil bodies and chloroplasts (scale bar a = 25  $\mu\text{m}$ ), N – propagule, 105  $\times$  130  $\mu\text{m}$ , O – perianth with bracts and bracteole, perianth 1.1 mm long, 620  $\mu\text{m}$  wide, P – capsule valves, flattened, with elaters (scale bar a = 400  $\mu\text{m}$ ), Q – elater, 240  $\times$  16  $\mu\text{m}$ , R – outer side of capsule valve, 210  $\times$  340  $\mu\text{m}$ . All figures from the holotype, drawn by ASV.



margin entire to slightly crenulate. Bracteoles oblong-lanceolate, 400–480  $\mu\text{m}$  long, 300  $\mu\text{m}$  wide, divided to 0.6–0.7, sinus sharp, lobes narrowly triangular, acute to subobtuse, 300  $\mu\text{m}$  long and 130  $\mu\text{m}$  wide at base, margins partially slightly crenulate. *Perianth* rostrate, sharply 5-carinate, oblong obovate in outline, up to 1100  $\mu\text{m}$  long and 600–650  $\mu\text{m}$  wide, carinae running down nearly the entire length. *Capsule* short elliptical, 340  $\mu\text{m}$  long, 280  $\mu\text{m}$  wide, valves 330–340  $\mu\text{m}$  long and 200–210  $\mu\text{m}$  wide, cells of outer side in upper 2/3 with sinuose walls and strongly nodular and irregular thickenings, in lower part elongate-rectangular with straight or only slightly sinuose walls and without nodulose thickenings. Elaters *ca* 4–5(–6) per valve, 240  $\mu\text{m}$  long and 16  $\mu\text{m}$  wide, obsoletely 1-spiral. Spores not seen.

ETYMOLOGY. The species epithet refers to the type locality in southern Ecuador.

#### ECOLOGY AND DISTRIBUTION

*Diplasiolejeunea mayaykuensis* was found on dead and living bark of a solitary shrub at the edge of a cultivated field near the village Mayayku in southern Ecuador in the western escarpment of the Cordillera del Condor. The bedrock consists of Zamora batholith, a granitoid rock (Spikings *et al.* 2001). Currently the species is known only from the type locality, however, further localities may be discovered when more field work is done in the region. According to the observed growing preferences, *D. mayaykuensis* seems to be a sun epiphyte and a pioneer which may have its natural habitat in the canopy of rain forests. Only a few associated species were observed in the type collection, namely the liverworts *Frullania riojanensis* (Raddi) Ångstr. and *Frullania kunzei* (Lehm. & Lindenb.) Lehm. & Lindenb., the lichen *Leptogium* sp. as well as an unidentified crustaceous lichen. On neighbouring shrubs and trees grew, among others, *Metzgeria lechleri* Steph., *Orthostichidium quadrangulare* (Schwägr.) B. H. Allen & Magill, *Dicranolejeunea axillaris* (Nees & Mont.) Schiffn., and *Schoenobryum rubricaula* (Mitt.) Manuel.

#### DISCUSSION

##### DELIMITATION OF *D. MAYAKUENSIS* FROM MORPHOLOGICALLY SIMILAR SPECIES

The new species was already tentatively recognized in the field (by ASV) by its unique combination of morphological characters: (1) narrowly ovate(-lanceolate) (not triangular) underleaf lobes with acute to subobtuse apices; (2) yellowish green colour with broadly ovate leaf lobes up to 1 mm long and 750  $\mu\text{m}$  wide, presence of 20–30 scattered ocelli per lobe (visible only in fresh material); (3) two well developed lobule teeth; (4) lobules with narrowly but strongly involute free margins; (5) abundant production of discoid gemmae on upper and lower surfaces of leaves; (6) its habit with younger leaves loosely appressed to the substrate and older parts of the shoots with ascending to squarrose leaves.

Superficially, *Diplasiolejeunea mayaykuensis* resembles the two common species *Diplasiolejeunea brunnea* Steph. and *D. cavifolia* Steph. However, *D. brunnea* is best distinguished from *D. mayaykuensis* by its strongly appressed leaves and narrowly triangular underleaves; *D. cavifolia* by its lobule teeth. *Diplasiolejeunea borhidiana* Reyes and *D. eggertii* Pócs have underleaves most similar to *D. mayaykuensis*, however, both are readily distinguished by lobule structure and lobule teeth (Reyes 1983, fig. 21; Tixier 1985, fig. 21, as *D. magnistipulata*; Pócs 2006, figs 1–16). Differential characters of *D. mayaykuensis* and morphologically or genetically similar species (Dong *et al.* 2012) are summarized in Table 1.

##### INVESTIGATING THE LIVERWORT FLORA OF SOUTHERN ECUADOR

Several new taxa of liverworts have been described from southern Ecuador only recently, namely *Diplasiolejeunea erostrata* Schäf.-Verw. and *D. grandirostrata* Schäf.-Verw. (Schäfer-Verwimp 2004), *Cololejeunea stotleriana* Gradst., Ilkiu-Borges & Vanderpoorten (Gradstein *et al.* 2011), *Cololejeunea kuciana* Pócs & Schäf.-Verw. (Pócs & Schäfer-Verwimp 2012), *Archilejeunea nebeliana* Gradst. & Schäf.-Verw. (Gradstein & Schäfer-Verwimp

**Table 1.** Differential characters of *Diplasiolejeunea mayaykuensis* and related taxa.

	<i>D. mayaykuensis</i>	<i>D. brunnea</i>	<i>D. cavifolia</i>	<i>D. cubensis</i>	<i>D. borhidiana</i>	<i>D. eggersii</i>
UNDERLEAF LOBES						
– shape	narrowly ovate(–lanceolate) with acute to (sub-) obtuse apices	narrowly triangular with acute apices	triangular with acute apices	narrowly triangular with acute apices	narrowly ovate(–lanceolate) with acute to (sub-) obtuse apices	with parallel sides and auriculate base, apices subacute to obtuse
– angle at sinus	(70°–)90–120°	(90°–)120–150°(–180°)	(70°–)90–120°	(90°–)120–150°(–180°)	90°–120°(–150°)	90°–120°
– cells	isodiametric to (sub-) rectangular or shortly elongate, 1.0–1.7 × as long as wide	(sub-)quadrate to mainly (elongate-) rectangular, 1.0–2.5(–3) × as long as wide	isodiametric to (sub-) rectangular or shortly elongate, 1.0–2.0 × as long as wide	(sub-)quadrate to mainly (elongate-) rectangular, 1.0–2.5(–3) × as long as wide	(sub-) quadrate to irregular polygonal, mostly isodiametric	mostly (sub-) quadrate
LOBULE						
– shape	oblong-obovate, moderately inflated	obovate, flat to moderately inflated	obovate, flat to moderately inflated	obovate, flat to moderately inflated	obovate, moderately inflated	ovate-lanceolate, partly strongly inflated with flattened apical part
– first tooth	finger-like, almost well developed, 5–6 cells long, 2–3(–4) cells wide at base, often slightly twisted	very variable, finger-like or nearly triangular, (2–)3–10 cells long and 1–5 cells wide at base	usually T-like, finger-like teeth only 1–3 cells long	(1–)2 cells long, 1 cell wide at base	large, broadly truncate, 4–6 cells long, (2–)3–4 cells wide at base, ending usually with (3–)4 cells side by side	4–5 cells long, 2 cells wide near to its apex, usually 2-layered
– second tooth	usually inflexed, 2–4 cells long, 2–3 cells wide, obtuse	always inflexed, 1–5 cells long, 1(–2) cells wide at base	short and usually free, sometimes hidden, 1–2(–3) cells long and 1(–2) cells wide	absent or obsolete	inflexed, usually inconspicuous, rarely up to 3(–4) cells long and 2–3 cells wide at base	1–2 cells long, often 2-layered
– additional teeth	absent	absent	absent	absent	absent	present (one small tooth along free margin)
– free margin	narrowly but strongly inflexed	(partially) flat to broadly involute-inflexed	usually flat	flat	partially involute	partly involute
HABIT AND SUBSTRATE	yellowish green patches on bark with appressed to squarrose leaves	pale green plants growing epiphyllous with strongly appressed leaves	pale green plants on living leaves or on twigs and bark, appressed to substrate (when epiphyllous) or often with patent to squarrose leaves (when epiphytic)	pale green plants on living leaves and branchlets with appressed leaves	pale green plants growing epiphyllous with leaves (loosely) appressed to substrate	pale green plants growing epiphyllous with leaves (loosely) appressed to substrate

2012), *Lobatirricardia oberwinkleri* Nebel, Preussing, Schäf.-Verw. & D. Quandt (Preussing *et al.* 2010), *Leptoscyphus autoicus* (Engel & Gradst.) Vanderpoorten & Gradst. (Engel & Gradstein 2003, as *Physotheca*), *Plagiochila cucullifolia* var. *anomala* Heinrichs & Gradst. (Heinrichs *et al.* 2003) and *Odontoschisma engelii* Gradst. & Burghardt (Gradstein & Burghardt 2008). Recent fieldwork in southern Ecuador between 2003 and 2012 and accompanying molecular studies revealed five new species of *Diplasiolejeunea* (Dong *et al.* 2012) of which one is described in the present study. *Diplasiolejeunea mayaykuensis* adds to growing evidence that the liverwort flora of Southern Ecuador is still incompletely known, although more than 400 liverwort species were already recorded, indicating that southern Ecuador has the most diverse liverwort flora of the country (Schäfer-Verwimp & Nebel, in prep.).

ACKNOWLEDGEMENTS. Fieldwork in Ecuador by ASV and MN in the framework of the ABA-GAM project was supported by the German Research Foundation (grant LE 1826/4-1).

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Received 25 March 2013