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A new species of *Archilejeunea* (Spruce) Schiffn. (Lejeuneaceae) from Ecuador

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Abstract – The liverwort *Archilejeunea nebeliana* Gradst. *et* Schäf.-Verw. sp. nov. (Lejeuneaceae) is described from submontane rain forest of southern Ecuador. The new species is a member of *A.* subg. *Archilejeunea* and differs from all other species of this group by narrowly and obtusely pointed leaves, thin-walled lobule cells, stem epidermis with darker-colored middle lamella, and narrowly elongate female bracts and bracteoles with acute to acuminate apices. The new species constitutes the first record of subg. *Archilejeunea* from the Andes and is a further addition to the unusually rich flora of the Andes of southern Ecuador. The species is named in honor of Dr. Martin Nebel.

***Archilejeunea* subgenus *Archilejeunea* / *Archilejeunea nebeliana* / Ecuador / Lejeuneaceae / liverworts / morphology / submontane rain forest / taxonomy**

INTRODUCTION

Archilejeunea (Spruce) Schiffner (Lejeuneaceae subfam. Ptychanthoideae) is a tropical genus of about 15-25 species, four in the subgenus *Archilejeunea* which is purely neotropical in distribution, and the remaining ones in the subgenus *Dibrachiella* (Spruce) Schiffn. which is pantropical in distribution (Gradstein, 1994; Gradstein, in prep.). The species of *Archilejeunea* in tropical America (7) have been monographed (Gradstein, 1994) and may be considered well-known, but those of Africa and Asia have been little studied and are in need of revision; presumably their number will become much reduced by monographic study. The genus *Archilejeunea* is readily recognized by 1) prostrate to procumbent, non-dendroid growth, 2) isodiametric leaf cells lacking blackish pigmentation in the walls, 3) segmented oil bodies, 4) stems without enlarged epidermis, 5) gynoecia with 1-2 innovations, and 6) 4-5-keeled perianths with smooth to somewhat toothed keels. The two subgenera are distinguished by their different innovation types (pycnolejeuneoid in subg. *Archilejeunea*, lejeuneoid in subg. *Dibrachiella*), and the frequent occurrence of reduced lobules in the species of subg. *Dibrachiella* (never reduced in subg. *Archilejeunea*).

An unusual species of *Archilejeunea* (subg. *Archilejeunea*) which appears to be undescribed, was recently collected by the second author during a

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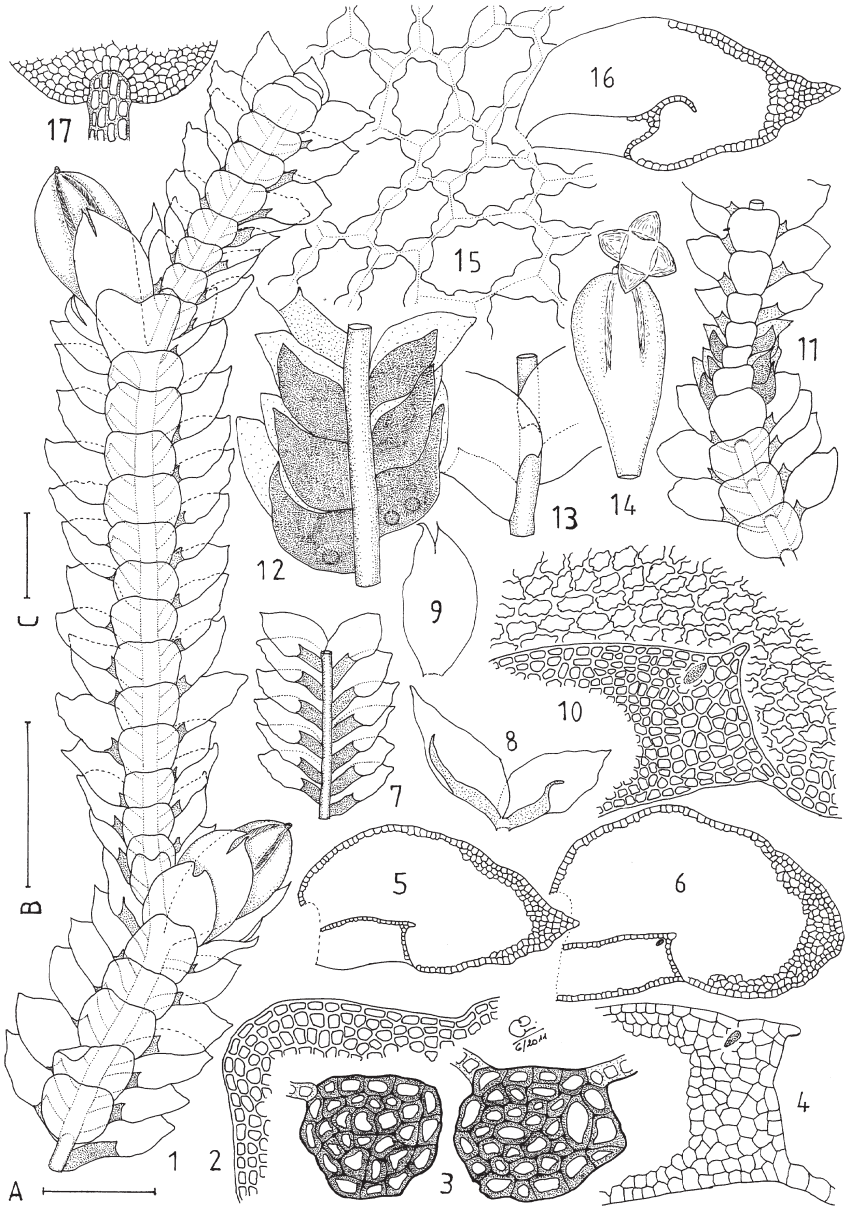
bryological exploration in Ecuador together with Dr. Martin Nebel, Stuttgart, in the framework of the ABA-GAM project (Acceleration of Biodiversity Assessment – Gametophytes) of the German Research Foundation. The new species stands out by the pointed leaves and several other features previously unreported in *Archilejeunea*. It is a pleasure to dedicate the new species to our colleague and friend Martin Nebel.

TAXONOMIC DESCRIPTION

Archilejeunea nebeliana Gradst. *et* Schäf.-Verw., **sp. nov.** Figs 1-17

Type: Ecuador, Zamora-Chinchipe: *ca* 5 km S of Zamora, Parque Nacional Podocarpus, entrance Río Bombuscara, sendero Mirador, 4º 06,831' S, 78 º 58,017' W, on thin trunks in submontane rain forest, 1075 m alt., 25. January 2011, *A. Schäfer-Verwimp & M. Nebel 31924* (**holotype**, STU; isotypes, JE, QCA). **Paratypes** from the same locality: epiphytic on stem of *Trattinnickia* aff. *lawrancei*, *A. Schäfer-Verwimp & M. Nebel* 31913 (STU), on branch of shrub, *A. Schäfer-Verwimp & M. Nebel 31916* (STU, JE, QCA), on thin stem, *M. Nebel & A. Schäfer-Verwimp* 111599 (STU, QCA).

Plants relatively robust, to 5 cm long, 1.5-2 mm wide, glossy brown green when dry, not brittle, loosely creeping to ascending to horizontally spreading from branches of shrubs, little and irregularly branched, with a few long vegetative *Lejeunea*-type branches and (female plants) long, repeatedly fertile, single *Radula*-type innovations; flagelliform branches lacking. **Stems** (0.1-)0.12-0.15 mm in diameter, brownish, epidermis cells strongly thick-walled and *with a darker, brownish-pigmented middle lamella,* ventral merophyte 4 cells wide; stems in cross section with 13-14 thick-walled epidermal cells surrounding (16)17-19(-20) similar medullary cells, walls of the medullary cells thickened, brown, with middle lamella usually slightly thickened at the corners. **Leaves** obliquely spreading at an angle of 50-70º, weakly imbricate, dorsal lobe plane with flat apex to slightly convex and with weakly recurved apex, *oblong, 0.8-1.0(-1.2) × 0.45-0.65(-0.8) mm, 1.5-2 × longer than wide, the apex narrowed and obtusely pointed, obtuse to apiculate to short acuminate,* occasionally narrowly rounded, plane, the dorsal base rounded, arching across but not beyond the stem, opposite bases narrowly interlocking (by one cell row), a long hyaline papilla inserted at the dorsal base; lobe margins entire, plane, *slightly and irregularly sinuate especially along the ventral margin,* dorsal margin curved, ventral margin almost straight, forming a broad to rather narrow angle of 150-100º with the keel, keel junction without auricle; mid-lobe cells isodiametrical to slightly elongate, ca. 25-40 µm in largest diameter, cells slightly smaller towards the margin and slightly larger towards the base, cell walls with conspicuous triradiate trigones and 0-1 intermediate thickenings; lobe cells becoming slightly larger towards the base and with darker brownish colored walls suggesting a broad, ill-defined vitta (but cells not elongated), somewhat smaller, quadrate, and with more pronounced, confluent wall-thickenings towards lobe margins and apex, the marginal cells seemingly equally thickened; oil bodies not observed; ocelli lacking. **Lobules** never reduced, short rectangular with truncate apical margin, twice as long as wide, 0.32-0.36(-0.4) × 0.17-0.18(-0.2) mm, 1/3-2/5 × leaf length, weakly inflated throughout, keel almost straight, free margin plane, apex usually with a short, outwardly pointing tooth consisting of a single, elongate,



Figs 1-17. *Archilejeunea nebeliana* Gradst. *et* Schäf.Verw. **1.** Habit of female plant, ventral view, with two perianths. **2.** Part of underleaf. **3.** Two stem cross sections. **4.** Part of leaf lobule with slime papilla. **5, 6.** Two leaf lobes with lobules. **7.** Part of plant, ventral view, underleaves removed. **8, 9.** Female bracts and bracteole. **10.** Cell structure of leaf lobe and lobule. **11.** Part of male plant, ventral view. **12.** Androecia, bracteoles removed. **13.** Dorsal leaf insertion. **14.** Shape of perianth, ventral view, with opened capsule. **15.** Mid leaf cells. **16.** Female bract. **17.** Insertion of underleaf. All from the holotype. (Scales: A = 1 mm for 1, 7-9, 11, 14; B = 500 µm for 5, 6, 16; C = 100 µm for 2; C = 67 µm for 3; C = 78 µm for 4; C = 85 µm for 10; C = 217 µm for 12; C = 20 µm for 15; C = 435 µm for 13; C = 280 µm for 17).

obtuse cell (rarely tooth up to 4-5 cells long); hyaline papilla positioned at the proximal base of the tooth on the inner surface of the lobule 2-3 cells below the apex and one cell below the free margin, below a small sinus on the free margin (the presence of the sinus on the free margin near the apex and the position of the apical tooth suggest that the apical tooth is in fact triangular in shape, consisting of 3-5 cells and expanding beyond the sinus, towards the leaf apex); *cells in the distal half to 2/3 of the lobule very different from those of the lobe, smaller, rather thin-walled and almost colorless, 12-16 µm in largest diameter, with small trigones.* **Underleaves** loosely imbricate, large, usually slightly wider than long and broadly ovate, 0.5-0.55(-0.6) mm long x 0.5-0.65(-0.7) mm wide, 4.5-5(-6) × stem width, *apex emarginate (to ca. 70(-100) µm deep),* margins plane, slightly sinuate, bases rounded to subauriculate, insertion line arched, to 60(-80) µm deep**;** underleaf cells as in the leaves; underleaf base 2 cells thick, with 4(-6?) U-shaped superior central cells; rhizoid disc inconspicuous, of few small cells, rhizoids ± absent.

Dioicous (male plants growing mixed with female plants). **Androecia** intercalary on long shoots, of 3-8 pairs of subequally bifid bracts with reduced lobes and large, swollen, hypostatic lobules; bracteoles present throughout, deeply emarginate; antheridia one or two per bract, often not well developed. **Gynoecia** on elongated branches, each gynoecium with one pycnolejeuneoid innovation, the innovation repeatedly fertile, the bracts and bracteoles in 2 series, erect, about as long as vegetative leaves but much narrower; *inner bract lobes ovate-lanceolate, ca. 1.2 mm long, 3 × longer than wide, apex acuminate, deeply bifid and with a very narrow, linear-lanceolate lobule ca. 2/3-3/4 of lobe length,* keel ± straight, ca. 2/5 of lobule length, without wing; *inner bracteole very large, as long as the lobes, longer than wide, ovate-oblong, ca. 1.2 mm long, apex very narrowly bifid to ca. 1/5 of lobe length with narrowly obtuse to acute lobes touching each other*, the margins sinuate above, bases free from the bracts; outer female bracteole about half the length of inner bracteole, ovate, with rounded apex. **Perianths** long exserted, ellipsoidal to obpyriform, about twice as long as wide, 1.8 mm long × 0.75-0.9 mm wide, ± 4-keeled with 2 broad lateral keels and 2 low ventral keels, the ventral keels sometimes almost reduced, upper surface of the lateral keels irregularly mammillose and rudimentary winged (1 cell wide) to almost smooth; beak very short, 2-3 cells long.

Sporophyte as in other members of *Archilejeunea* (Gradstein, 1994); seta not articulate, elaters 72 per capsule. **Asexual reproduction** lacking.

Distribution and ecology

Archilejeunea nebeliana is thus far known only from the type locality in the Bombuscara river valley in Podocarpus National Park near Zamora, southern Ecuador. The species was found growing as an epiphyte on thin trunks and branches of shrubs in the understory of somewhat disturbed, epiphyte-rich submontane rain forest at 1075 m. All four collections are from a single, 400 m^2 forest plot where ecosociological studies have been performed by Parolly & Kürschner (2004). Syntaxonomically, the epiphytic bryophyte vegetation of the plot belongs to the alliance *Symbiezidio transversalis-Ceratolejeunion cubensis* Kürschner *et* Parolly 1998, which is considered characteristic of lowland and submontane rain forests of tropical America. Two communities, the *Porotrichum substriatum* community and the *Frullania mucronata* community, have been described within this alliance by Parolly & Kürschner (2004). Although none of the character and differential species of the two communities were seen in

the plot, judging from the species composition the local epiphytic bryophyte vegetation belongs to the *Frullania mucronata* community which is "a strictly epiphytic, moderately xerotolerant unit, widespread both in the semi-shady interior and the sunny margins (…) of the submontane forest along the Rio Bombuscara" (Parolly & Kürschner, 2004: 388). The epiphytic bryophyte vegetation at the type locality was made up of various characteristic species of the alliance *Symbiezidio transversalis-Ceratolejeunion cubensis* (*Bryopteris filicina* (Sw.) Nees, *Octoblepharum albidum* Hedw. a.o.), the alliance *Omphalantho filiformis-Plagiochilion apicedentis* (*Bryohumbertia filifolia* (Hornsch.) J.-P. Frahm), the order *Prionodontetalia fusco-lutescentis* (*Anoplolejeunea conferta* (Meissn.) Schiffn., *Plagiochila aerea* Taylor) and the class *Taxilejeuneo-Prionodontetea fusco-lutescentis* (*Acroporium pungens* (Hedw.) Broth., *A. estrellae* (Müll.Hal.) W.R. Buck *et* Schäf.-Verw., *Bazzania hookeri* (Lindenb.) Trevis., *Meteoridium remotifolium* (Müll.Hal.) Manuel, *Plagiochila heterophylla* Lindenb. *ex* Lehm., *P. punctata* (Taylor) Taylor, *P. superba* (Nees *ex* Spreng.) Mont. *et* Nees, *Squamidium leucotrichum* (Taylor) Broth., etc.). In addition, a suite of liverwort species were collected in the forest plot that were not previously recorded by Parolly & Kürschner (2004), including (besides the new species) *Archilejeunea fuscescens* (Hampe *ex* Lehm.) Fulford, *Bazzania phyllobola* Spruce, *Cheilolejeunea beyrichii* (Lindenb.) E. Reiner and *Drepanolejeunea anoplantha* (Spruce) Steph., all of which were growing intermingled with *Archilejeunea nebeliana*; furthermore *Calypogeia laxa* Gottsche *et* Lindenb., *Cololejeunea sicaefolia* (Gottsche) Pócs *et* Bernecker subsp. *jamaicensis* (R.M. Schust.) Bernecker *et* Pócs (new to Ecuador; on dead, fallen leaf), *Colura tortifolia* (Nees *et* Mont.) Trevis., *Diplasiolejeunea brunnea* Steph., *D. unidentata* (Lehm. *et* Lindenb.) Schiffn., *Drepanolejeunea lichenicola* (Spruce) Schiffn., *Lejeunea adpressa* Nees, *Plagiochila bryopteroides* Spruce, *P. cristata* (Sw.) Lindenb., *Prionolejeunea scaberula* (Spruce) Steph., *Rectolejeunea berteroana* (Gottsche *ex* Steph.) A. Evans and *Xylolejeunea crenata* (Nees *et* Mont.) X.-L. He *et* Grolle (new to Ecuador; epiphyllous on Hymenophyllaceae on forest floor). From a fallen branch *Herbertus bivittatus* Spruce (= *H. divergens* (Steph.) Herzog) was gathered.

DISCUSSION

By its pycnolejeuneoid innovations, lobules which are never reduced, glossy brown-green plant color, large imbricate underleaves and dioicous sexuality, *Archilejeunea nebeliana* is a characteristic member of the subgenus *Archilejeunea*. The new species differs from all other members of this group, and possibly also from those of subgen. *Dibrachiella*, by 1) narrowly and obtusely pointed leaves, 2) almost colorless, thin-walled cells of the leaf lobule, very different from those of the lobes, 3) darker-colored middle-lamella of the stem epidermis, 4) narrowly elongate, acuminate female bracts (ca. 3 × longer than wide) with linear-lanceolate lobules, and 5) narrowly bifid female bracteole with acute lobes. In the other species of subg. *Archilejeunea* the leaf apex is broadly rounded, the lobule cells have thickened walls similar to those of the lobe, the middle-lamella of stem epidermis is not darker-colored, the female bracts are shorter and broader with rounded to obtuse apices, and the female bracteole is undivided or obtusely bifid. The new species also differs by its occurrence in submontane rain forest and constitutes the first record of subg. *Archilejeunea*

from the Andes. The other species of subg. *Archilejeunea* are restricted to lowland rain forests of northern South America, below 600 m, being common in Amazonia and the Guianas (Gradstein, 1994). The new species keys out near to *A. badia* (Spruce) Steph., a twig epiphyte from lowland Amazonia and Guyana, with which it shares a procumbent growth and oblong leaves. However, *A. badia* differs from *A. nebeliana*, in addition to the features mentioned above, by more strongly swollen leaf lobules, longer lobule tooth (2-5 cells long), rounded underleaf apex (emarginate in *A. nebeliana*) and paroicous sexuality.

The new species is a further addition to the rich flora of the Andes of southern Ecuador. With almost 400 species of liverworts recorded (León-Yánez *et al.*, 2006; Gradstein *et al.*, 2007; Benitez & Gradstein, 2011; Schäfer-Verwimp & Nebel, unpubl.), southern Ecuador has about 2-3 times more recorded species of liverworts than other parts of Ecuador. Many new additions to the local flora have been published recently, including several unusual, undescribed taxa (e.g., Engel & Gradstein, 2003; Schäfer-Verwimp, 2004; Gradstein & Burghardt, 2008; Preussing *et al.*, 2009; Gradstein *et al.*, 2011). The discovery of three taxa new to Ecuador (*Archilejeunea nebeliana, Cololejeunea sicaefolia* subsp. *jamaicensis, Xylolejeunea crenata*), including one new to science, in the small, 20 x 20 m forest plot at Bombuscara indicates that southern Ecuador still remains incompletely collected and that further discoveries may be made in this floristically unusually rich part of the world.

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