

## NOTES ON THE GENUS *COLOLEJEUNEA* (LEJEUNEACEAE) IN PANAMA. *C. CINGENS* (NEW RECORD) AND *C. TAMASII*

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**Abstract.** *Cololejeunea cingens* (Herzog) Bernecker & Pócs is recorded for the first time from Panama, extending its distribution in the Neotropics. Additional descriptions based on Panamanian material are provided for *C. cingens* and for *C. tamasii* Schäf.-Verw., a species only known from the type, for which dimorphic leaves and gynoeccial bracts are first described. We therefore view subgen. *Pedinolejeunea* Benedix ex Mizut. as a better subgeneric placement for *C. tamasii* than subgen. *Cololejeunea*.

**Key words:** *Cololejeunea*, distribution, epiphylls, Lejeuneaceae, Marchantiophyta, new records, Panama

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### INTRODUCTION

*Cololejeunea* (Spruce) Schiffn. comprises small plants that occur as epiphylls in subtropical and tropical regions (Zhu & So 2001). It is one of the largest genera of the leafy liverwort family Lejeuneaceae, with 433 accepted names worldwide (Söderström *et al.* 2015). In the Neotropics there are 67 species of *Cololejeunea*, including the former *Aphanolejeunea* A. Evans (Pócs *et al.* 2014), of which around 30 species are currently known to occur in Panama (Stotler *et al.* 1998; Dauphin *et al.* 2006; Dauphin 2007; Schäfer-Verwimp 2014), among them new species first described from Panama: *C. dauphinii* R. L. Zhu (Zhu 2006, as *C. tixieri* by Morales & Dauphin 1998), *C. panamensis* G. Dauphin & Pócs (Dauphin *et al.* 2006) and *C. tamasii* Schäf.-Verw. (Schäfer-Verwimp 2012). Although many new records have been added and new species described in previous years, this genus is still incompletely known in the Neotropics.

During a study of the community dynamics of epiphyllous bryophytes on *Piper grande* Vahl. in G. D. Omar Torrijos H. National Park (PNG-DOTH), *Cololejeunea cingens* (Herzog) Bernecker & Pócs was recorded in several epiphyllous sam-

ples. This is the first record from Panama, extending its discontinuous distribution from Mexico, Central America, the Caribbean, and South America. New collections near the type locality of *Cololejeunea tamasii* Schäf.-Verw. reveal characters undescribed in the protologue. This paper extends the current distribution of *C. cingens* as a new record from Panama, and adds descriptive details of *C. tamasii*. Based on these results, we suggest a more accurate subgeneric placement for *C. tamasii* Schäf.-Verw.

### RESULTS

***Cololejeunea cingens*** (Herzog) Bernecker & Pócs  
 Polish Bot. J. 54: 4. 2009.

BASIONYM: *Aphanolejeunea cingens* Herzog, Svensk Bot. Tidskr. 46: 104. 1952.

Plant small, 1.5–2.0 cm long and 0.6 mm wide, pale green in dried state. Stem in zig zag. Ventral merophyte of stem one cell wide. Lobes distant, spreading (60° from stem), narrow ovate to lanceolate (0.2–0.4 mm × 38–85 μm), longer than wide, falcate, apex acute, margins entire to sinuate by bulging cells, involute; lobes with

reduced lobules occasionally present. Marginal cells subrectangular ( $21\text{--}32 \times 9\text{--}17 \mu\text{m}$ ), median cells hexagonal ( $14\text{--}37 \times 9\text{--}15 \mu\text{m}$ ), basal cells rectangular to quadrate ( $8\text{--}29 \times 5\text{--}10 \mu\text{m}$ ); surface smooth; thin walls. Ocelli lacking. Lobules ovoid,  $1/3\text{--}2/3$  of lobe length, keel arched and smooth, apex emarginated, free margin of lobule narrow lanceolate (with acute apex and slightly involute margins); first lobule tooth elongate-falcate, consisting of two cells, pointing towards ventral margin of lobe; second tooth short; hyaline papilla distal. Underleaves absent. Rhizoids branched in fascicles. Gynoecia on short branches with 1 Lejeuneoid innovation. Bracts lanceolate with acute apex; margins entire to dentate. Perianth not seen.

**SPECIMENS EXAMINED:** PANAMÁ, COCLÉ, Distrito de La Pintada, Corregimiento El Copé, Parque Nacional General Division Omar Torrijos Herrera (PNGDOTH), sendero La Rana Dorada, río Guabal,  $8^{\circ}40'11.91''\text{N}$ ,  $80^{\circ}35'28.36''\text{W}$ , 723 m. Epífila sobre hoja de *Piper grande* Vahl., en bosque húmedo tropical premontano. 10 de enero 2014, A. Sierra & C. A. López 700, 701, 702, 703, 709, 710, 752, 773, 774, 775, 777, 833, 834, 835 (PMA), 708 (INPA).

*Cololejeunea cingens* (Herzog) Bernecker & Pócs, is an epiphyllous species, characterized by its small size and by distant, narrow ovate to lanceolate, falcate lobes with involute margins. The lobes with reduced lobules are short ovate and more than two cells wide. The lobules when fully developed are ovoid,  $1/3\text{--}2/3$  of lobe length, and with a two-celled elongate-falcate apical tooth pointing to the ventral margin.

*Cololejeunea cingens* is a rare species known from few collections (ELPT distribution database, Anders Hagborg, pers. comm.), with a scattered distribution in the Neotropics, known from Ecuador, Costa Rica, Brazil, the lesser Antilles (Dominica, Martinique), Mexico and Cuba (Herzog 1952; Gradstein *et al.* 1994; Pócs & Bernecker 2009; Gradstein & Costa 2003; Schäfer-Verwimp 2010; Bernarda & Schäfer-Verwimp 2011; Eggers *et al.* 2004; Mustelier 2012; ELPT distribution database, Anders Hagborg, pers. comm.). The present record from Panama indicates a continuous distribution of this species across Central America to South America and the Caribbean. In PNGDOTH,

*C. cingens* is relatively common on leaves on the understory shrub *Piper grande* Vahl.

***Cololejeunea (Pedinojeunea) tamasii*** Schäf.-Verw. Fig. 1A–D

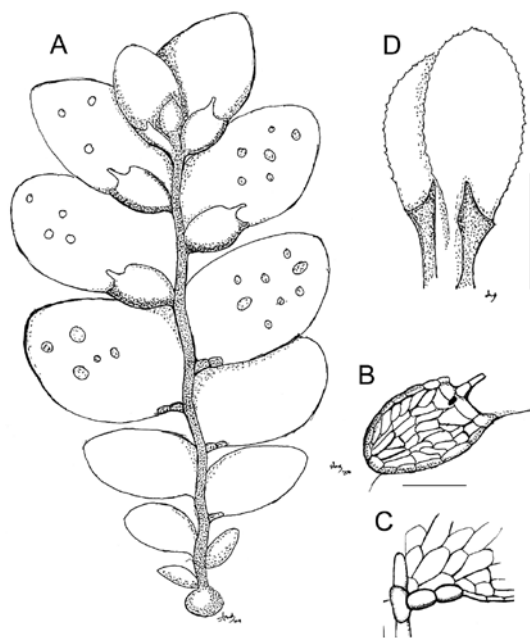
Phytotaxa **60**: 9–12. 2012.

Plants small, unbranched shoots, 2–6 mm long and 0.3–0.6 mm wide, whitish green, tightly appressed to substrate. Stem in zig zag. Ventral merophyte of stem one cell wide. Lobes dimorphic, obliquely spreading at  $70\text{--}90^{\circ}$  angle from stem, continuous to slightly imbricate; suborbicular to broadly ovate, with rounded to slightly acute apex, plane, rounded base, antical base partly to completely covering stem; lobe surfaces in upper  $2/3\text{--}4/5$  rough and margins irregularly crenulate denticulate from conically protuberant cells except at lobe base; lobe cells varying in shape and size (description in Schäfer-Verwimp 2012); cells with small trigones. Lobule when reduced consisting of two cells; when developed, lobules ovate,  $1/3$  of lobe length, saccate, smooth; lobule cells rectangular to sigmoid ( $13\text{--}26 \times 4\text{--}9 \mu\text{m}$ ), with border of small, rectangular cells on free margin ( $11\text{--}26 \times 4\text{--}6 \mu\text{m}$ ); keel slightly curved, smooth; first tooth consisting of two cells, pointing straight to lobe apex, second tooth short, one-celled; hyaline papilla ental at base of first tooth. Discoid gemmae abundant on dorsal and ventral leaf surfaces and on female bracts. Gynoecia several (1–3) in one shoot, with 1–2 Lejeuneoid innovations, bracts suborbicular to ovate ( $330\text{--}400 \times 170\text{--}200 \mu\text{m}$ ), apex rounded, surfaces rough and margins irregularly crenulate to denticulate from conically protuberant cells except at base of bracts; bract lobule entire, apex acute. Perianth not seen.

**SPECIMEN EXAMINED:** PANAMA, CHIRIQUÍ, Boquete, Secondary forest, La Culebra Trail to the hidden waterfall, alt. ca. 800 m. Epiphyll on fern frond. 29<sup>th</sup> January 2016. C. A. López & W. Testo 806 (PMA, INPA).

**DISTRIBUTION.** This species is only known from the type locality in Panama (Chiriquí: Boquete).

*Cololejeunea tamasii* was described as a small plant with suborbicular to short oval leaf lobes with crenulate margins and papillose leaf cells,



**Fig 1.** *Cololejeunea tamsii* Schäf.-Verw. A – plant in ventral view with dimorphic lobes, B – detail of developed lobules, C – detail of reduced lobules, D – female bracts. Scale bars: A = 300  $\mu$ m, B = 50  $\mu$ m, C = 20  $\mu$ m, D = 150  $\mu$ m.

with lobules ‘seemingly always reduced to two cells’ (Schäfer-Verwimp 2012). Recent collections show that reduced lobules are not a constant character in this species; instead, *C. tamsii* may show dimorphic leaf lobes, with reduced lobules as described from the type and with saccate lobules on the same branch as described here.

The presence of dimorphic leaf lobules, suborbicular to short oval with crenulate margins and papillose leaf cells are diagnostic characters of *C. tamsii* and separate it from all congeners. *Cololejeunea linopteroides* H. Rob. (subgen. *Chlorocolea* R. M. Schust.) differs from *C. tamsii* by its constantly reduced lobules consisting of one cell, its flat, ribbon-like stems, and smooth, sigmoid leaf cells (Robinson 1964). *Cololejeunea standleyi* Herzog (Herzog 1951, subgen. *Chlorocolea* R. M. Schust), a species with fully developed lobules, differs in having minute, appressed (= plane, *fide* Tixier 1985) and subtriangular lobules, with an apical tooth 2–3 cells long, smooth leaf cells and hyaline marginal cells, and they

usually are larger plants (Morales-Zürcher 2009). *Cololejeunea tamsii* with saccate lobules resembles *C. obliqua* (Nees & Mont.) Schiffn. [subgen. *Leptocolea* (Spruce) Schiffn.], but the latter differs by its larger size, the lobules always developed, with the keel denticulate due to papillose cells, and the leaf surface partially to completely roughened by papillae.

Schäfer-Verwimp (2012) tentatively placed the new species in subgen. *Cololejeunea* and compared it with species of subgen. *Leptocolea*. This placement was also followed by Söderstrom *et al.* (2015), but the presence of dimorphic lobules in *C. tamsii* suggests its placement in subgen. *Pedinolejeunea* Benedix *ex* Mizut. instead.

Subgenus *Pedinolejeunea* was diagnosed by Mizutani (1961) as having plane lobes, an ovate to elliptical, rounded apex, entire; marginal cells frequently hyaline, median cells large, dorsal papillae absent, trigones almost absent, and polymorphic lobules.

Most species in subgen. *Pedinolejeunea* show hyaline leaf margins or linear-flexuose cells, with the exception of the African-Indian *C. furciculobulata* (Berrie & Jones) R. M. Schust. and *C. producta* (Mitt.) Hatt. (Asthana & Srivastava 2003), as well as the Asian *C. japonica* (Schiffn.) Mizut., *C. magnistyla* (Horik.) Mizut., and *C. schwabei* Herzog, and the Palaeotropical *C. raduliloba* Steph (Zhu & So 2001). The Oceanic *Cololejeunea hybridensis* Tixier also lacks a margin with hyaline cells. It was placed by Tixier (1985) in its own section *Pseudolasiolejeunea* Tixier, Bryophy. Biblioth. 27: 27. 1985. Despite the fact that both share differentiated (flexuose) marginal cells, *Cololejeunea tamsii* hardly fits in sect. *Pseudolasiolejeunea*, defined by their smooth lobe cells, plants appressed to the substrate, and three-toothed lobules (Tixier 1985).

Current subgeneric and sectional divisions in *Cololejeunea* are unclear. According to Yu *et al.* (2013), in *Cololejeunea* several new subgenera should be introduced for ‘newly detected clades’. They suggest that of those hitherto described, only subgen. *Chondriolejeunea* Benedix and *Pedinolejeunea* Benedix *ex* Mizut. may be kept. In subgen. *Pedinolejeunea*, Yu *et al.* (2013) included a series

of Palaeotropical species (D5) with or without hyaline lobe margins, such as *Cololejeunea japonica* (Schiffn.) Mizut. Another species, *C. raduliloba* Steph. with no hyaline margins but with dimorphic leaf lobules, was included by Zhu and So (2001) in subgen. *Pedinolejeunea* but excluded by Yu *et al.* (2013) in a non-sister clade (D3).

The presence of dimorphic leaf lobules seems to be a prevalent character in subgen. *Pedinolejeunea* (Mizutani 1961; Zhu & So 2001) but was not included in the morphological data matrix analyzed by Yu *et al.* (2013). Mizutani (1961) considered the position of the hyaline papillae to be an important distinction between *Pedinolejeunea* (hyaline papillae on the tip or proximal base of the end of the first tooth), or hyaline papillae ental in subgen. *Leptocolea*, subgen. *Chalarolejeunea* and subgen. *Rhadinolejeunea*. However, Yu *et al.* (2013) found that the position of hyaline papillae has the highest homoplasy index (HI) among included morphological characters (0.913), followed by the presence of dorsal protrusions (0.900) and hyaline cells in the lobe margins (0.837). However, the presence of a vitta and sigmoid cells on the leaf margins showed a lower HI (0.714 & 0.750 respectively).

Due to the presence of dimorphic leaf lobules and sigmoid marginal leaf cells, we therefore tentatively place *Cololejeunea tamasii* Schäf.-Verw. in subgen. *Pedinojeunea* Benedix *ex* Mizut. A comprehensive analysis of the subgenera and sections of *Cololejeunea* using a wide set of Neotropical and Palaeotropical species, including morphological and molecular characters, is needed.

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