



## Phylogenetic position of *Trocholejeunea* and a new infrageneric classification of *Acrolejeunea* (Lejeuneaceae, Marchantiophyta)

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### Abstract

We address phylogenetic relationships of *Acrolejeunea* and *Trocholejeunea*, two putatively related members of Lejeuneaceae subfam. Ptychanthoideae, by using nuclear (ITS) and chloroplast (*rbcL*, *trnL-F*) DNA regions. Bayesian, likelihood and parsimony phylogenetic analyses of a broad sampling of the two genera resolved *Acrolejeunea* as monophyletic. The species of *Acrolejeunea* were resolved in five clades, which partly correspond to previously described sections. *Trocholejeunea* was nested in *Acrolejeunea* as a sixth, monophyletic lineage. Based on our molecular-phylogenetic results, the species of *Acrolejeunea* are arranged in six sections including two new ones, sect. *Recurvatae* sect. nov. for *A. recurvata* from subtropical Asia and sect. *Trocholejeunea* (Schiffn.) stat. nov. The five species of *Trocholejeunea* are transferred to *Acrolejeunea*, which becomes a pantropical genus of 21 species (including a fossil one). New lectotypes are designated for *A. infusca* and *A. sandvicensis*.

**Keywords:** *Acrolejeunea* sect. *Recurvatae*; *Acrolejeunea* sect. *Trocholejeunea*; *Acrolejeunea* subg. *Acrolejeunea*; *Acrolejeunea* subg. *Isolejeunea*; *Frullanoides*; molecular phylogeny; Lejeuneaceae subfam. Ptychanthoideae; taxonomy

### Introduction

Lejeuneaceae Cavers (1910: 291) with more than a thousand species in 69 genera are the largest family of leafy liverworts and notoriously difficult in terms of generic delimitation (e.g., Schuster 1963; Gradstein 1979, 2013). Several recent studies have analysed generic relationships in Lejeuneaceae using molecular evidence (e.g., Ahonen *et al.* 2003; Dong *et al.* 2013; Gradstein *et al.* 2006; Hartmann *et al.* 2006; Heinrichs *et al.* 2012a, b, 2013; Sukkharak *et al.* 2011; Wilson *et al.* 2007; Ye *et al.* 2013), the most comprehensive one being the study by Wilson *et al.* (2007). These studies showed that the number of genera is much lower than previously accepted and that several genera, including *Aphanolejeunea* A.Evans (1911: 272), *Chondriolejeunea* (Benedix 1953: 75) Kis & Pócs (2001: 239), *Cystolejeunea* A.Evans (1906: 16), *Dendrolejeunea* (Spruce 1884: 110) Lacouture (1908: 104), *Leucolejeunea* A.Evans (1907: 225), *Metzgeriopsis* K.I.Goebel (1888: 54), *Myriocolea* Spruce (1884: 305), *Oryzolejeunea* (R.M.Schuster 1970: 338) R.M.Schuster (1992: 249), *Pluvianthus* R.M.Schuster & A.Schäfer-Verwimp (1994: 213), *Sphaerolejeunea* Herzog (1938: 88) and *Taxilejeunea* (Spruce 1884: 212) Schiffner (1893: 125), should be reduced to subgeneric rank or synonymy. However, a large number genera of Lejeuneaceae have not been studied in detail based on molecular evidence.

This paper focuses on the relationships of *Acrolejeunea* (Spruce 1884: 115) Schiffner (1893: 128) and *Trocholejeunea* Schiffner in Dixon *et al.* (1932: 160) (Lejeuneaceae subfam. Ptychanthoideae). *Acrolejeunea* is a pantropical genus of 15 extant species, including two varieties and five subspecies (Gradstein 1975, Renner 2013). In addition, a fossil species has been described from Late Eocene amber from Ukraine (Mamontov *et al.* 2013). The centre of diversity is Southeast Asia with 10 species. *Acrolejeunea* is circumscribed to include species with predominantly *Lejeunea*-type branches, stems with hyalodermis, entire underleaves and entire margins of leaf lobe, cordate trigones, homogeneous oil bodies, epistatic male bracts with one antheridium, absence of innovations, 5–10-keeled perianths, and a non-articulate seta with 16 outer and four inner cell rows. The genus was monographed by Gradstein (1975) who

**Lin. F:** *Acrolejeunea* sect. *Minores* (Verd.) L.Söderstr. & A.Hagborg, **comb. nov.**  $\equiv$  *Ptychocoleus* Trevis. sect. *Minores* Verd., Ann. Bryol. suppl. 4: 132. 1934  $\equiv$  *Acrolejeunea* sect. *Isolejeunea* Gradst., Bryophyt. Biblioth. 4: 103. 1975, *nom. illeg.*

Branching predominantly *Lejeunea*-type. Stem with 10–20(–25) medullary cells, dorsal epidermis cells in straight longitudinal rows, ventral merophyte (2–)4 epidermis cells wide. Leaf lobule  $1/2$ – $2/3 \times$  lobe length, with 1–9 teeth. Underleaf apex plane or recurved. Autoicous or dioicous. Lobule of female bract slightly shorter than lobe. Perianth isoplicate, with 5–10 rounded, straight keels. Vegetative reproduction lacking.

TYPE: *A. pycnoclada* (Taylor) Schiffn.

DISTRIBUTION: Tropical Africa, tropical Asia, Australasia, Pacific region; on bark in lowland and lower montane forests, scrub, isolated trees, gardens and plantations, usually in rather open locations; from sea level to 3500 m.

INCLUDED SPECIES: *A. arcuata*, *A. fertilis*, *A. parvula*, *A. pycnoclada*, *A. tjibodensis*.

NOTE: This section is morphologically very similar to the previous one. Further study focusing on hitherto neglected features (e.g., sporophytes, secondary metabolites), might reveal better characters separating the two groups.

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