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A classification of Lejeuneaceae (Marchantiophyta) based on molecular and morphological evidence

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Abstract

Lejeuneaceae are the largest family of the liverworts with at least one thousand species in 68 currently accepted genera. The number of genera is much lower than accepted previously and was reduced based on recent molecular work. This paper present a first classification of Lejeuneaceae based on integrated molecular-phylogenetic and morphological evidence. The family is subdivided into two broad subfamilies, Ptychanthoideae (19 genera) and Lejeuneoideae (49 genera). Ptychanthoideae are not further subdivided whereas Lejeuneoideae are classified into three tribes: Brachiolejeuneeae (8 genera), Symbiezidieae (new; 1 genus) and Lejeuneeae (40 genera). Lejeuneeae, the largest tribe in the family, are classified into eight subtribes: Ceratolejeuneinae (2 genera), Cheilolejeuneinae (4 genera), Cololejeuneinae (12 genera), Cyclolejeuneinae (3 genera), Drepanolejeuneinae (2 genera), Echinolejeuneinae (3 genera), Lejeuneinae (5 genera) and Lepidolejeuneinae (2 genera). Seven genera of Lejeuneeae have not yet been studied by molecular methods and are not classified.

Key words: liverworts, new tribe, generic classification

Introduction

Lejeuneaceae are the largest family of the liverworts with at least one thousand species placed in some 70 to 80 genera. Attempts to classify the genera have been numerous (see Gradstein *et al*. 2003 for review) but no classification exists that takes account of the modern molecular-phylogenetic evidence. In recent years several studies have analysed generic relationships in Lejeuneaceae by means of rigorous phylogenetic methods, using a morphological (Gradstein *et al*. 2003) or a combined molecular and morphological approach (Ahonen *et al*. 2003, Groth-Malonek *et al*. 2004, Wilson *et al*. 2004, Gradstein *et al*. 2006, Hartmann *et al*. 2006, Wilson *et al*. 2007, Sukkharak *et al*. 2011, Heinrichs et al. 2012a, 2012b, Dong et al. 2013). The morphological-phylogenetic study of Gradstein *et al*. (2003) analysed 31 gametophytic and 18 sporophytic characters of sixty genera (genera known only from gametophytes were excluded), including several novel or little-known sporophytic traits described by Weis (2001). The authors recovered 14 clades and 2 grades, all of which were briefly diagnosed using informal clade names. No attempt was made to establish a formal classification. The largest molecular study to date was by Wilson *et al*. (2007) who analysed a 4-marker molecular dataset (3 plastid, one nuclear) of 46 genera. These authors recovered four main clades, three of which had been recognized previously (Ptychanthoideae, Brachiolejeuneeae, Lejeuneeae). In addition, a large number of smaller clades were detected. Ten lineages were named by letter and numbers, and relationships were briefly discussed. Again, no attempt was made to establish a formal classification.

The recent molecular data also helped in defining the perimeters of the family and the genera. They showed that *Nipponolejeunea* Hattori (1944: 124), which had been variously placed in a separate subfamily Nipponolejeuneoideae Schuster (1963: 90) or tribe Nipponolejeuneae (Schuster 1963: 90) Gradstein (1994:

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