



Molecular evidence for the occurrence of the lichen genus *Biatora* (Lecanorales, Ascomycota) in the Southern Hemisphere

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Abstract

Based on anatomical investigations and a DNA barcoding approach the occurrence of a *Biatora* species from the *B. rufidula* group in Argentina and Chile is confirmed and the biogeographical implications briefly discussed. No morphological differences could be found that would distinguish the southern collections from typical *B. rufidula*. However, southern and northern samples appear paraphyletic within the *B. rufidula* clade. The South American material might therefore represent an undescribed species. Alternatively, the taxonomic status of the three northern species *B. aegrefaciens*, *B. nobilis* and *B. rufidula* might have to be reconsidered or the placement might be an artifact caused by the poor character sampling involved in the barcoding approach.

Key words: amphitropical disjunction, lichenized ascomycota, phylogeny, Ramalinaceae, Argentina, Chile

Introduction

In its current circumscription *Biatora* Fr. combines species developing a crustose thallus with green algal photobiont, biatorine apothecia with an exciple composed of anticlinal parallel hyphae, weakly branched, anastomosed and strongly conglutinated paraphyses, *Biatora*-type asci and simple to 3(–7)-septate colourless ascospores (Printzen 1995, 2004, 2014). Until this modern delimitation of the genus, the species now accepted as *Biatora* were distributed over a heterogeneous group of taxa including e.g. *Bacidia* De Not., *Catillaria* A. Massal. and *Lecidea* Ach. (Fries & Sandberg 1817; Coppins 1983; Hafellner 1984; Printzen 1995).

Since the second half of the 19th century, *Biatora* was treated as a subgenus of *Lecidea* until Coppins (1983) reinstated it as a monotypic genus based on *B. vernalis* (L.) Fr. The circumscription of the genus has changed since then and the number of species increased from 17 to 42 (Printzen 1995, 2014). All of them are thought to be restricted to the Holarctic region (Printzen et al. 1999) and studies of the genus so far focused on European and North American material (Coppins 1983, Printzen 1995, Printzen & Palice 1999; Printzen & Tønsberg, 1999, 2003, 2004).

Molecular studies, based on a single or two gene loci, supported the monophyly of *Biatora* and its position within Ramalinaceae (Printzen & Lumbsch 2000; Printzen et al 2001; Spribille et al. 2009). A comprehensive study based on three gene loci also showed that *Biatora* comprises at least six clades, which correspond to different morphological groups of species, viz. the *beckhausii*-, *hertelii*-, *meiocarpa*-, *ocelliformis*-, *rufidula*- and *vernalis*-groups (Printzen 2014).

The *Biatora rufidula*-group is characterized by three-septate, colourless ascospores with slightly thickened walls and a mostly amyloid exciple composed of hyphae with a more or less distinct cell wall. The group includes three species widely distributed in boreal and temperate regions of Europe and North America: *B. aegrefaciens* Printzen, *B. nobilis* Printzen & Tønsberg and *Biatora rufidula* (Graewe) S. Ekman & Printzen (Printzen & Tønsberg 1999; Printzen et al. 2002).

Early studies on the distribution ranges of lichens showed that several arctic and boreal species occur also in the Antarctic, showing an amphitropical or bipolar distribution pattern since those species were largely absent in the tropics (Hooker & Taylor 1844; Du Rietz 1926; Lyngby 1941; Galloway & Aptroot 1995). Recent research on the bipolar distribution of several species has focused on the evolutionary origin of these species and historical range-

The type specimen for *B. albipraetextata* (Knight) Hellb. reported from Chile and New Zealand has not been found in WELT. However its ovoid ascospores with 10 µm width also indicate that it does not belong to *Biatora*, all species of which have narrowly ellipsoid to bacilliform ascospores (Galloway & Quilhot 1998; Galloway 2007). Hence, the discovery of *B. rufidula* s. lat. in Patagonian forests of Chile and Argentina represents the first reliable report of this genus from the Southern Hemisphere.

At present, we can only speculate about the origin of the bipolar distribution in the *Biatora rufidula* group. In the Northern Hemisphere, *B. aegrefaciens* and *B. rufidula* show a more and less circumboreal distribution (Printzen 1995, Printzen & Tønsberg 1999; Printzen et al. 2002), although *B. aegrefaciens* has only been collected very rarely. A collection of *B. rufidula* from *Larix decidua* on Iceland (Printzen 1995) may indicate a relatively recent dispersal of the species. *Larix* is not naturally occurring on Iceland and a typical forest species is rather unlikely to have survived the last glaciation there. Several other species with a bipolar distribution have recently been investigated, e. g. *Flavocetraria cucullata* (Bellardi) Kärnefelt & Thell, *F. nivalis* (L.) Kärnefelt & Thell (Bjerke & Elvebakk 2004), *Usnea sphacelata* R. Br. (Wirtz et al. 2004), *U. lambii* (Imshaug) Wirtz & Lumbsch (Wirtz et al. 2008), and *Cetraria aculeata* (Schreb.) Fr., (Fernández-Mendoza & Printzen 2013). The dispersal of *C. aculeata* to the Southern Hemisphere has been dated to the late Pleistocene by Fernández-Mendoza and Printzen (2013). Because *C. aculeata* is a terricolous species of open habitats, it is unclear whether a similar age can be assumed for the disjunction of a species group that is restricted to forest stands. If the basal position of the South American samples in the phylogenetic tree (Fig. 1) were supported by further data, this would indicate a higher age of the disjunction, which then would seem to predate the diversification of the group in the Northern Hemisphere. Before any firm conclusions can be drawn it is, however, necessary to clarify the species status of *B. aegrefaciens*, *B. nobilis* and *B. rufidula* in the north, based on a population-level sampling and more gene loci.

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