



Towards a natural classification of Pteridaceae: inferring the relationships of enigmatic pteridoid fern species occurring in the Sino-Himalaya and Afro-Madagascar

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Abstract

Using DNA sequences of the chloroplast genome, we addressed the phylogenetic relationships of two understudied fern species belonging to the pteridoid clade of Pteridaceae. The two studied species occur in Afro-Madagascar and the Sino-Himalaya respectively. Our results recovered a sister relationship of the Sino-Himalayan *Cerosora microphylla* and the Afro-Madagascan *Pityrogramma argentea*. The latter is not closely related to the predominantly Neotropical genus *Pityrogramma* and is transferred to the genus *Cerosora*. Our results also confirmed the sister relationship of the predominantly Afro-Madagascan genus *Actiniopteris* and the predominantly Sino-Himalayan genus *Onychium*. These results contribute to the rapidly increasing body of evidence supporting the hypothesis of a frequent exchange between the Asian and Afro-Madagascan fern-floras during the Cenozoic and the formation of relict distribution ranges caused by Cenozoic climatic fluctuations and adaptation to local environments.

Key words: biogeography, chloroplast phylogeny, classification of small genera, Himalaya, Mascarene Islands, paleotropics, relict genera

Introduction

In the last twenty years, our understanding of fern relationships improved rapidly which provided us with an increasingly robust classification of higher levels such as families and orders (e.g., Smith *et al.* 2006, 2008, Christenhusz *et al.* 2011) but still a lot of studies are required to achieve a comprehensive natural generic classification of ferns. The placement of small genera with restricted distribution ranges are of particular concern. Several of these genera were found to be nested within species-rich genera, such as *Ochropteris* Smith (1842: 158) in *Pteris* Linnaeus (1753: 1073) (Schuettpelz *et al.* 2007) and *Anarthropteris* Copeland (1947: 217) in *Loxogramme* (Blume 1828: 73) Presl (1836: 214) (Kreier & Schneider 2006a). However, some of these genera were proven not only to form separate lineages but also to be of special interest to our understanding of processes involved in the evolution of the biogeography and morphological diversity of the lineages investigated such as the genera *Actiniopteris* Link (1841: 79) (Gastony & Johnson 2001), *Christiopteris* Copeland (1917: 331) (Schneider *et al.* 2008), *Cystodium* J.Sm. ex Hooker (1842: t.96) (Korall *et al.* 2006), *Mickelia* R.C.Moran, Labiak & Sundue (in Moran *et al.* 2010: 338) and *Synammia* Presl (1836: 212) (Schneider *et al.* 2006) to name a few.

Here, we explored the relationships of two understudied fern species belonging to one of the three most species-rich lineages of ferns, the Pteridaceae (Schneider *et al.* 2004, Smith *et al.* 2006, 2008, Schuettpelz *et al.* 2007). These species are the Sino-Himalayan *Cerosora microphylla* (Hooker 1854: t.916) Tryon (1986: