



Enabling comparisons of characters using an Xper² based knowledge-base of fern morphology

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Abstract

Ferns comprise both extant and fossil taxa displaying a broad morphological and anatomical disparity. In order to compare their features, we propose a knowledge base of 46 genera, 101 characters and 273 character states with illustrations, bibliographical references and annotations with terms from the Plant Ontology Consortium (amongst others). The knowledge base is designed with the Xper² program. Descriptions are exhaustive (*i.e.*, all the taxa have been given values for every character) thanks to the management of inapplicable and missing data. The Xper² format is compatible with the standard interchange format Structured Descriptive Data (SDD). The user-friendly and intuitive environment provided by Xper² should help users to take ownership of our conceptualization.

Key words: character matrices, descriptive model, extant and fossil taxa, identification, pteridophytes, systematics, taxonomy, Xper² software.

Introduction

As it is the interface between comparative biology and evolutionary studies, systematics addresses all relevant issues about biodiversity and paleobiodiversity. Fossil and extant fern taxa are very often considered separately by pteridologists (Pryer *et al.* 1995, Schneider 1996, Schneider *et al.* 2009, Stevenson & Loconte 1996) and palaeobotanists (Galtier 1970, 2010, Kenrick & Crane 1997, Soria *et al.* 2001, Stein *et al.* 1984). Ferns were originally called Moniliformopses, which is an illegitimate name. Later this was rendered into the colloquial word ‘monilophyte’, a term that was never properly defined (Christenhusz & Chase 2014) but widely used by pteridologists and palaeobotanists. Ferns are embryophytes and were found to be the sister group to seed plants (Kenrick & Crane 1997, Pryer *et al.* 2001). Their oldest representatives are Middle Devonian fossils such as *Pseudosporochnus* (Potonié & Bernard 1904) and *Ibyka* (Skog & Banks 1973). These two Paleozoic genera belong to the “cladoxylopsids”, a group whose monophyly is not demonstrated. *Pseudosporochnus* is a tree-like plant with an erect trunk bearing an apical crown of helical ramifications (Stein & Hueber 1989, Taylor *et al.* 2009). *Ibyka* is a genus from the Givetian (Middle Devonian period) displaying monopodial growth with glabrous helical ramifications (Taylor *et al.* 2009, Skog & Banks 1973).

Extant ferns include ca 10,535 species (Christenhusz & Chase 2014) that can be defined as vascular plants with free-living, alternating generations (gametophytes and sporophytes) and developed macrophylls on which the sporangia are formed. This description is emblematic of extant taxa, but of limited use to characterize fossil diversity. It emphasizes the need for characterizing the entire diversity of the fern lineage to allow comparative approaches.

The capacity to use digitized information effectively creates the opportunity to make information about organisms instantaneously available globally with the added benefit of possibility to regularly update and improve the information. Computer Aided Taxonomy (*i.e.*, e-taxonomy) enhances the automated reasoning possibilities (*i.e.*, the generation of new knowledge) and the integration of knowledge from various sources, especially since the development of standard interchange formats such as the SDD standard (Structured Descriptive Data, Hagedorn *et al.* 2006). Biological systems are expected to follow a model of knowledge (Lebbe 1991) with non ambiguous representation of the concepts (such as characters) and relationships between them (such as character dependencies). The modeling activity allows for a wide range of services such as the verification of the exhaustiveness of descriptions (*i.e.*, that each taxon has been

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