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Floral anatomy of Neotropical species of Mayacaceae

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Abstract

The Mayacaceae are a monogeneric monocot family of herbs that grow on swampy areas in the Americas and in Africa. Both the number of species constituting the family and its inter-familial relationships are unclear. By describing and comparing the floral anatomy of *Mayaca fluviatilis*, *M. fluviatilis* f. *kunthii*, *M. longipes* and *M. sellowiana* we have identified some features that delimit the species. These include: arrangement of flowers on the stem, shape of stamens, size of apical pores, disposition of microsporangia, number of ovules and shape of the stylar canal. We concluded that *M. fluviatilis* f. *kunthii* should be considered as a species (*M. kunthii*) rather than a *forma*. Other characters such as number of stamens and microsporangia, placentation, ovule type and cell numbers in the pollen grain support the placement of the Mayacaceae within Poales.

Keywords: Anatomy; Flowers; *Mayaca*; Monocots; Morphology; Poales

Introduction

Mayacaceae Kunth is a small family of amphibious and/or aquatic herbs (Lourteig, 1952) that, except for the African *Mayaca baumii* Gürke, are restricted to the Neotropical areas being in particular concentrated in South America (Dahlgren et al., 1985; Heywood, 1993; Stevenson, 1998; Wanderley and Giulietti, 2002).

Recent molecular analysis has recognized the Mayacaceae as members of Poales where they form the "xyrid clade" together with Xyridaceae, Eriocaulaceae and Rapateaceae (APG II, 2003; Bremer, 2002; Chase et al., 2000, 2005; Linder and Rudall, 2005; Soltis et al., 2005; Stevenson and Loconte, 1995). Within Poales, Mayacaceae is distinguishable by the aerenchymatic canals in its stem (Venturelli and Bouman, 1986), by its isolated axillary flowers and by the occurrence of protein in the outer layer of the endosperm of its seeds (Stevens, 2006). However, the exact relationships between Mayacaceae and the related families within Poales is unclear, although it is always recognized as occupying a basal position (APG II, 2003; Bremer, 2002; Chase et al., 2000, 2005; Linder and Rudall, 2005; Soltis et al., 2005; Stevenson and Loconte, 1995). The number of stamens and the type of ovules and endosperm brings Mayacaceae close to Eriocaulaceae, Xyridaceae and Cyperaceae (APG II, 2003; Dahlgren and Clifford, 1982; Rudall and Sajo, 1999; Stevenson, 1998), but the development of the walls of its anthers differs from that observed in these families (Furness and Rudall, 1998, 1999). Mayacaceae also differs from other Poales, such as Bromeliaceae, Rapateaceae, Juncaceae and Thurniaceae, in the number of stamens and in the type of ovules and

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placentation (Balslev, 1998; Dahlgren and Clifford, 1982; Kubitztki, 1998; Munro and Linder, 1997; Stevenson, 1998; Venturelli and Bouman, 1986, 1988).

The family comprises only one genus, *Mayaca* Aubl., separated by Lourteig (1952) into four species (*Mayaca baumii* Gürke, *M. fluviatilis* Aubl., *M. longipes* Mart. ex Seub. and *M. sellowiana* Kunth) and one *forma* (*M. fluviatilis* f. *kunthii* (Seub.) Lourt. They were distinguished by the mode of dehiscence of the anthers (a slit in *M. fluviatilis* and *M. fluviatilis* f. *kunthii* and an apical pore in the other species) and by the arrangement of flowers on the stem (single in *M. fluviatilis* and *M. sellowiana* and in an umbellate inflorescence in *M. baumii* and *M. longipes*). However, studies on their vegetative and reproductive organs (Tomlinson, 1969; Venturelli and Bouman, 1986) revealed similarities that question this separation.

In this paper, we described the floral anatomy of the Neotropical species *M. fluviatilis*, *M. fluviatilis* f. *kunthii*, *M. longipes* and *M. sellowiana* with the purpose of further delimiting them and revaluating the family relationships within Poales.

Material and methods

The material of *M. fluviatilis* and *M. sellowiana* were collected in their natural environment in Itirapina and Brotas, in São Paulo State, Brazil, and the vouchers are deposited at the Herbarium Rio Clarense (HRCB), as follow: *M. fluviatilis* HRCB 38163; *M. sellowiana* HRCB 35650 and HRCB 46193. The flowers were fixed in formalin acetic alcohol and stored in 70% ethanol. Additional material of *M. fluviatilis*, *M. fluviatilis* f. *kunthii* and *M. longipes* were provided as dry specimens by the Missouri Botanical Garden (*M. fluviatilis* MO 3626866), by the New York Botanical Garden (*M. fluviatilis* f. *kunthii* NY 31623) and by the Embrapa Amazonia Ocidental (*M. longipes* IAN 97846). In these cases, the flowers were rehydrated and preserved in ethyl alcohol at 70%.

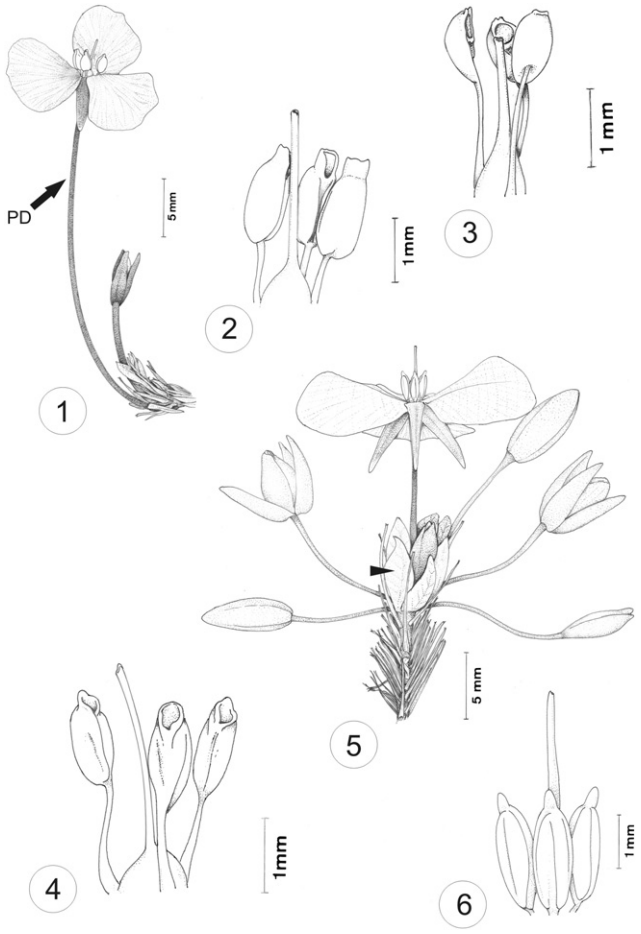
For the anatomical study, the material was prepared using standard methods of embedding in Historesin (Leica) according to the manufacturer's protocol, and serially sectioned using a rotary microtome. Transverse and longitudinal sections, 5–7 μm thick, were mounted on glass slides and stained in toluidine blue (Feder and O'Brien, 1968). Slides were examined using a Leica DMLB photomicroscope fitted with a Leica IM50 digital camera program.

For scanning electron microscope (SEM) examination, stamens of all species were dehydrated in an acetone series to 100% acetone. Then they were critical-point dried, mounted on metal stubs, coated with gold and examined in a Philips SEM 505.

Results

The Mayacaceae flowers are monoclinous, actinomorphic, trimerous, dichlamydeous and heterochlamydeous (Figs. 1 and 5). Each flower, supported by a peduncle (Fig. 1), is surrounded by a hyaline oval bract (Fig. 5). The sepals are valvate and present an acute apex and a variable base; the sepals usually persist in the fruit (Figs. 1 and 5). The petals, purple distally and white at the proximal region, are imbricate (Fig. 5) and oval to orbicular with expanded lobules (Figs. 1 and 5). In *M. sellowiana*, *M. fluviatilis*, *M. fluviatilis* f. *kunthii*, they are solitary and appear in the axils or in the stem apex, depending on the stem growth (Fig. 1). In *M. longipes*, the flowers are arranged in an axillary umbellate inflorescence (Fig. 5).

In all species the three stamens alternate to the petals and the anthers are basifixed on free filaments (Figs. 2–4 and 6). The anthers, formed by four microsporangia



Figs. 1–6. Mayacaceae. (**1** and **5**) Gross morphology of *Mayaca sellowiana* Kunth and *M. longipes* Mart. ex Seub.; (**2–4** and **6**) Stamens of *M. sellowiana*, *M. fluviatilis* Aubl., *M. kunthii* Seub. and *M. longipes*; ARROW HEAD: basal bract. Scales: **1** = 6 mm; **4** = 8.7 mm; **5** and **6** = 80 mm (PD: peduncle).