



Two new angiosperm leaf morphotypes from the Anfiteatro de Ticó Formation (mid-Aptian) Santa Cruz Province, Argentina



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ABSTRACT

Floodplain deposits of the Anfiteatro de Ticó Formation (Baqueró Group, Aptian), in Patagonia (Argentina), are rich in plant remains and contain some of the oldest angiosperm records of southern Gondwana. Many gymnosperm and pteridophyte species, as well as three morphotypes of medium sized angiosperm leaves, have already been described from this unit at different fossiliferous outcrops. We report two new angiosperm morphotypes from the Bajo Tigre locality. Both morphotypes (AT1 and AT2) consist of nano- to microphyllous leaves, nearly elliptic, with untoothed margins and pinnate brochidodromous venation. These leaves mostly exhibit characteristics of a high first or low second rank vein system. This combination of characters is associated with early angiosperm evolution. Morphotype AT1 is similar to one of the brochidodromous morphotypes from the La Cantera Formation (uppermost Aptian), which could be possibly conspecific. Morphotype AT2 has gross features already observed in leaf records from the younger Kachaika Formation (Albian–lower Cenomanian) though they differ in lamina shape and secondary venation features. The angiosperm leaves of the Anfiteatro de Ticó Formation suggest that the early stages of angiosperm evolution in Patagonia had included forms with more than one type of growth habit.

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1. Introduction

Increased documentation of Cretaceous angiosperms, with good stratigraphic control, is crucial to understanding the early global radiation and dispersion processes of the group. The oldest undisputed angiosperm evidence comes from nearly paleoequatorial, Hauterivian–Barremian deposits (i.e. Hughes, 1994; Brenner, 1996; Penny, 1991; Zhang, 1999; Sun and Dilcher, 2002). However, an increasing number of pre-Cretaceous pollen and plant megafossil remains have also been postulated as putative angiosperms (i.e. Hochuli and Feist-Burkhardt, 2013; Wang, 2015). In any case, ample evidence shows that by the Aptian the group extended across the world, including mid-latitudes in both hemispheres (see references in Lupia et al., 1999; Barrett and Willis, 2001; and also Hochuli et al., 2006; Pérez Loinaze et al., 2013 among others).

The southern South American fossil record of early angiosperms has improved in recent years (i.e. Archangelsky et al., 2009; Puebla, 2009; Archangelsky and Archangelsky, 2013; Vallati, 2013; Pérez Loinaze et al., 2012, 2015; Llorens and Pérez Loinaze, 2016). Based on leaf and pollen morphotypes from five basins, three evolutionary stages in the

angiosperm radiation process have been distinguished in the region (Archangelsky et al., 2009). The earliest records of angiosperm leaves in southern South America are restricted to the late Aptian and were found in the Deseado Massif Basin (Baqueró Group) and San Luis Basin (La Cantera Formation). They belong to six different morphotypes, ranging from a festooned brochidodromous nymphaeaphyll morphotype (but probably magnoliid according to Mohr and Bernardes-de-Oliveira, 2004) to a possible eudicot craspedodromous trifoliolate morphotype (Archangelsky et al., 2009). The diversified physiognomy of these earliest angiosperm leaves suggests a rather complex previous evolutionary pattern. This is further supported by a variety of monoaperturate, semi-tectate reticulate pollen types from Aptian (and probably Barremian) sequences from different basins in southern South America (see references in Archangelsky et al., 2009; but also Archangelsky and Archangelsky, 2013; Vallati, 2013; Llorens and Pérez Loinaze, 2016).

The Baqueró Group is well known for its rich flora. The non-flowering component includes more than a hundred species of conifers, cycads, bennettites and ferns, among other plant groups (Archangelsky, 2003; see also Del Fueyo et al., 2007; Limarino et al., 2012). The angiosperm evidences from the Baqueró are among the oldest known for southern Gondwana, and among them are the only accurately dated records from the Early Cretaceous. Angiosperm pollen grains from the Baqueró Group are known mostly from dispersed material recovered from the Anfiteatro de Ticó and Punta del Barco Formations

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(Archangelsky and Gamarro, 1967; Llorens, 2003; Archangelsky and Archangelsky, 2013; Llorens and Pérez Loinaze, 2016), although an anther containing 'in situ' *Clavatiipollenites* pollen masses was also studied (Archangelsky and Taylor, 1993). Previously known angiosperm leaves from Baqueró Group consist of three morphotypes found in the Anfiteatro de Ticó (Romero and Archangelsky, 1986; Passalia et al., 2003) and Punta del Barco Formations (Archangelsky et al., 2009).

In this paper we present records of two new angiosperm leaf morphotypes from the accurately dated Anfiteatro de the Ticó Formation (c. 118 Ma, mid-Aptian; Baqueró Group). These new records may shed light on the early evolutionary development of flowering plants in southern Gondwana.

2. Material and methods

The fossils consist of impressions of isolated leaves. They were collected in Estancia Bajo Tigre, Santa Cruz province (Argentina) several years ago by Dr. R. Herbst and one of the authors, in outcrops exposed

along the Tigre Creek, in rather small sedimentary lenses of limited extent (Fig. 1). The fossiliferous beds belong to the Anfiteatro de Ticó Formation (Aptian, see below). These same outcrops have yielded abundant specimens of the lobate serrate morphotype described by Romero and Archangelsky (1986).

The terminology used in the descriptions follows the Manual of Leaf Architecture (Ellis et al., 2009). However, some terminology used, such as that referring to the vein course or the relative thickness of veins, was taken from Hickey (1973). Quotation marks indicate either extant genera questionably identified in the Cretaceous flora (i.e. "Myrcia") or new fossil genera or species proposed exclusively in a unpublished dissertation or thesis (i.e. "Ellipticophyllum alatum"), which are not considered validly published according to the International Code of Botanical Nomenclature of Melbourne (i.e. Arts. 29 and 30, specially Arts. 29.1, 30.8 and the Recommendation 30A.2, McNeill et al., 2012). The studied material is housed in the National Collection of Fossil Plants in the Museo Argentino de Ciencias Naturales "Bernardino Rivadavia" under the initials BAPb.

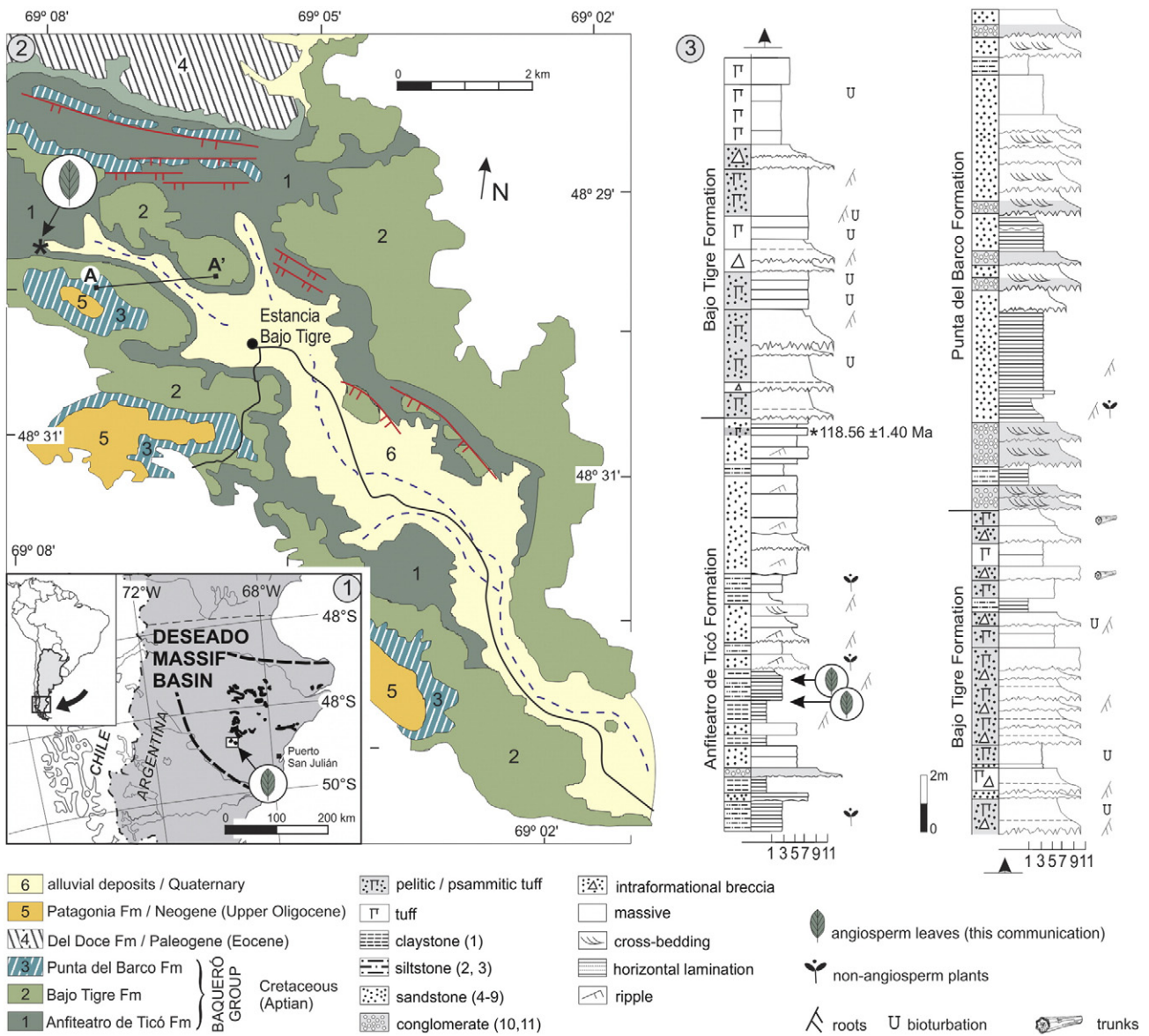


Fig. 1. 1. Map showing the Deseado Massif Basin (dashed line), the distribution of Cretaceous outcrops in this area (black) and the Bajo Tigre fossiliferous locality (modified from Césari et al., 2011). 2–3. Geological map and stratigraphical section (A–A') of the Bajo Tigre area containing angiosperm leaves (modified from Cladera et al., 2002). The age indicated in the profile, at the top of Anfiteatro de Ticó Formation, was obtained by Corbella (2001) using the ⁴⁰Ar/³⁹Ar method.

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