



Conifer woods from the Salamanca Formation (early Paleocene), Central Patagonia, Argentina: Paleoenvironmental implications



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ABSTRACT

The main objective of the present work is to describe the first conifer assemblage of a mixed forest from the Danian Salamanca Formation at the Estancia Las Violetas locality (San Jorge Basin, Central Patagonia, Argentina), based on detailed descriptions of secondary xylem. Also, sedimentological description of the Estancia Las Violetas outcrops are made in order to understand the paleoenvironmental conditions under which paleocommunities developed. Six conifer woods are described and assigned to one *Podocarpoxylon* Gothan and three *Cupressinoxylon* Göppert species (including a new species). This is the first record of Patagonia forest where the conifer assemblage is dominated by *Cupressinoxylon*, associated with Podocarpaceae and palms (recorded as fruits), conforming a mixed forest with a floristic composition similar to present-day New Caledonia forests. Las Violetas fossil forest represent a parautochthonous community developed in a forested coastal setting, a tide-dominated estuary, at ~51–50° S paleolatitudes of South America during the early–middle Danian.

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1. Introduction

Today, the extra-Andean Patagonia is a great area of semi-arid grass and shrub steppes. However, during the early Paleogene, Central Patagonia had warm-temperate climate and was dominated by evergreen conifer forests and mixed forests (i.e. forests with a mixture of angiosperms and gymnosperms) (Brea et al., 2005a, 2008, 2009, 2011; Brea and Zucol, 2006; Iglesias et al., 2007; Raigemborn et al., 2009). Furthermore, mangroves, swamp woodlands, mossy forests and sclerophyllous forests were also recognized for the early Paleocene in the basin (Petriella, 1972; Petriella and Archangelsky, 1975; Iglesias et al., 2011).

The early Danian Salamanca Formation (following Clyde et al., 2014) of the San Jorge Basin (Central Patagonia, Argentina; Fig. 1) is a marine-coastal unit (Feruglio, 1949; Andreis et al., 1975; Martínez, 1992; Somoza et al., 1995; Matheos et al., 2001; Iglesias,

2007; Foix et al., 2015; Comer et al., 2015; among others) that records a high richness in fossil plants (i.e. compression floras, permineralized trunks and stumps, fruits and microfloras) (Berry, 1937; Romero, 1968; Archangelsky, 1973, 1976; Petriella and Archangelsky, 1975; Archangelsky and Zamaloa, 1986; Somoza et al., 1995; Zamaloa and Andreis, 1995; Matheos et al., 2001; Brea et al., 2005a, 2007, 2008, 2011; Iglesias et al., 2007; Volkheimer et al., 2007; Scafati et al., 2009; Futey et al., 2012; Clyde et al., 2014). Salamanca's flora seems to be key to reconstruct paleocommunities of Patagonia during an interval of time that immediately follows the end-Cretaceous extinction. The interpretation of the sedimentological framework of the Salamanca's floras allows the reconstruction of the early Danian Patagonian environments.

Particularly, the outcrops of the Salamanca Formation at Estancia Las Violetas (Eastern Chubut province, Fig. 1C) preserves conifer and dicot permineralized trunks, branches and twigs, palm stipites, palm fruits, seeds, and leaf impressions (Andreis et al., 1975; Somoza et al., 1995; Brea et al., 2010; Futey et al., 2012). This diverse fossil plant association take place in the upper Salamanca Formation assigned to a littoral paleoenvironment (Andreis

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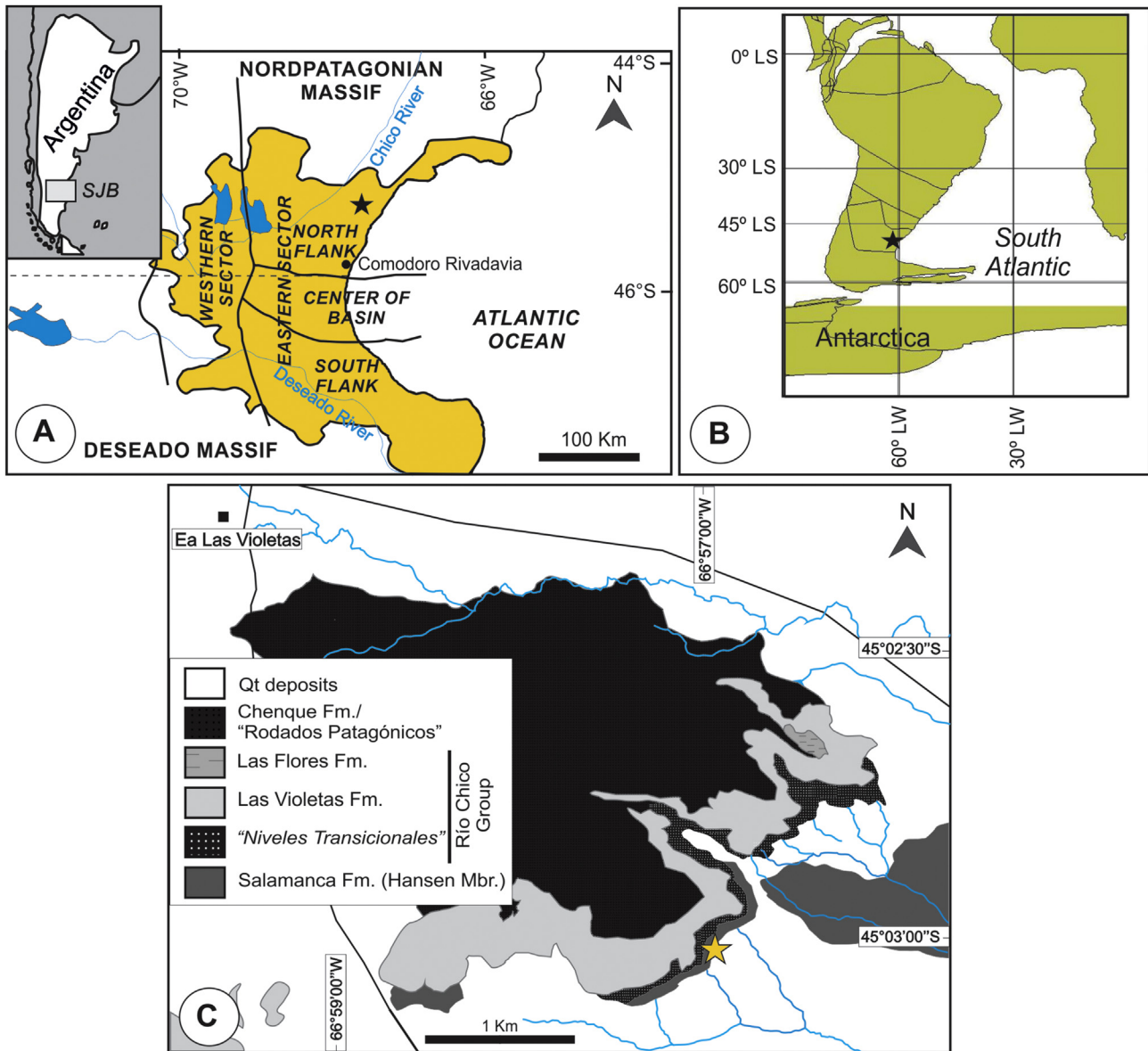


Fig. 1. A- Map showing position and boundaries of the San Jorge Basin (following Homocv et al., 1995) and location (start) of the study area. B- Situation of the study area at 65 Ma (adapted from ODSN paleomap project; <http://www.odsn.de/odsn/services/paleomap/paleomap.html>). C- Geological map of the study area (modified from Raigemborn et al., 2010).

et al., 1975; Somoza et al., 1995).

At present, there are c. 627 conifer species within eight families (Farjon, 2008), conforming monospecific and mixed forests in all continents around the world, except for Antarctica. The major radiation of conifers occurred in the Triassic (Willis and McElwain, 2002; Farjon, 2008). Today, in Southern South America, this type of forests can be found in the native Andean Patagonian forests, the Atlantic forests, and the Yungas montane tropical forests (Cabrera, 1976; Donoso, 1993; Armesto et al., 1996; Josse et al., 2003; Brown et al., 2009). However, in the Paleocene, conifers had an extensive fossil record constituting important fossil forests in central and south-eastern Patagonia (Petriella, 1972; Brea et al., 2005a, 2005b, 2007, 2011; Iglesias et al., 2007; Raigemborn et al., 2009).

This research focuses on the description of six permineralized conifer wood specimens found at the Estancia Las Violetas locality, and on the sedimentological description of the Estancia Las Violetas outcrops in order to understand the paleoenvironmental conditions under which paleocommunities developed.

2. Materials and methods

Fossil woods were found at the Estancia Las Violetas locality (Salamanca Formation), Chubut Province, Argentina (45° 04' S, 66° 59' W). Four fossiliferous levels, here named as L1 to L4, were identified with silicified trunks (gymnosperms and angiosperms), branches, twigs, palm stipites and fruit remains. In this work, we describe six samples corresponding with four species of coniferous woods from the L2 fossiliferous level.

Petrographic slides of the six samples were made in the three standard sections used in the study of wood anatomy: transversal section (TS), tangential longitudinal section (TLS), and radial longitudinal section (RLS).

The anatomical terminology employed for descriptions and comparisons follows the recommendations of the IAWA List of the Microscopic Features for Softwood Identification (IAWA committee, 2004). The systematic assignments were made according to Bamford and Philippe (2001) and Philippe and Bamford (2008), and

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