



## A new Late Cretaceous (late Campanian to early Maastrichtian) wood flora from southern Patagonia



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### ABSTRACT

The Cerro Fortaleza Formation, in southernmost Patagonia (Argentina), contains a unique Late Cretaceous (Campanian) flora and fauna. This formation is characterized by lithified fluvial sands, overbank mud deposits, and paleosols deposited in fluvial, fluvial–palustrine, and coastal plain environments from the northeastern margin of the Austral (Magellanes) Basin. The overlying and underlying formations have been dated as Campanian and Maastrichtian, respectively. Therefore, the Cerro Fortaleza Formation putatively falls within the late Campanian–Maastrichtian. This formation is known for its diverse fauna including dinosaurs, fishes, and turtles. Furthermore, poorly preserved leaf impressions from indeterminate conifers and cycads have also been discovered but not yet described.

Fossil wood taxa from the Cerro Fortaleza Formation yields a diverse flora of gymnosperm wood but only two genera of angiosperm wood. Gymnosperm genera identified in this study include *Agathoxylon*, *Planoxylon*, *Taxodioxylon*, *Cupressinoxylon*, and *Podocarpoxylon*; and angiosperm genera identified include *Hedycaryoxylon* and *Nothofagoxylon*. This is the first record of *Planoxylon*, *Taxodioxylon*, *Cupressinoxylon*, and *Hedycaryoxylon* from Argentina. Additionally, this is the oldest occurrence of *Nothofagoxylon* in Argentina. Both the angiosperm and gymnosperm wood samples possess distinct growth rings, providing strong evidence for seasonal growth regimes in the region. All of the wood genera from the Cerro Fortaleza Formation, except *Planoxylon*, have also been described from Late Cretaceous sediments of the Antarctic Peninsula. Thus, the presence of these taxa in both regions supports Late Cretaceous plant dispersal between them. Despite sharing the same taxa, the floras from the Cerro Fortaleza Formation and the Antarctic Peninsula exhibit strikingly different relative abundances. The ratio of gymnosperm to angiosperm wood in the Cerro Fortaleza Formation is 75:25; whereas coeval floras from the Antarctic Peninsula are ~25:75. The floral differences between these locations may be a relict from a widespread older flora that included Antarctica, regional floristic variations or a result of different depositional and/or taphonomic controls in discrete paleoenvironments.

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### 1. Introduction

The record of Cretaceous gymnosperm and angiosperm wood in southern South America is relatively incomplete compared to the rest of Gondwana (Philippe et al., 2004; Herbst et al., 2007). Fossil wood is essential to understanding flora turnover events such as the Late Cretaceous gymnosperm to angiosperm turnover. During the Late Cretaceous, worldwide gymnosperm abundance and diversity declined as angiosperm abundance and diversity increased (e.g. Crane, 1987; Stewart and Rothwell, 1993; Willis and McElwain, 2002). The relative abundance of Gondwanan gymnosperm woods from the Antarctic Peninsula decreased from 75% to 80% of the overall fossil wood flora during

the Early Cretaceous, down to 25% by the Late Cretaceous. Thus, the overall forest canopy and understory changed dramatically in a relatively short time (Cantrill and Poole, 2005).

The study of southern Patagonia Cretaceous paleobotany is still in its infancy, and only two primary studies have been published on the paleobotany of the Austral Basin. The first study was conducted by Iglesias et al. (2007) on fossil leaves from the Coniacian Mata Amarilla Formation. They found that gymnosperms were relatively rare and only comprise a small fraction (8%) of the overall flora (Iglesias et al., 2007). The Mata Amarilla Formation is known for its petrified wood, including the Maria Elena petrified forest, but little has been published on this flora (Riccardi and Roller, 1980; Iglesias et al., 2007; Varela, 2010a, b). A second paleobotanical study focused on the palynology of the Maastrichtian Irene Formation where they reaffirmed that fern and angiosperm palynomorphs were far more abundant than those of gymnosperms (Poviluskas et al., 2008).

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The first record of fossil wood assemblages from the Cerro Fortaleza Formation (Campanian) was published in 1892, but no identification was undertaken (Burmeister, 1892). Subsequent researchers have also noted the presence of silicified wood and other plant material (e.g., Burmeister, 1892; Feruglio, 1935; Oviedo, 1982; Arbe and Hechem, 1984; Kraemer and Riccardi, 1997; Povilauskas et al., 2003; Egerton et al., 2010). However, fossil wood from this formation has not been formally described until now. The aim here is to identify and describe the fossil wood from the Cerro Fortaleza Formation and to compare this flora to others from Gondwana, but particularly with those from Antarctica.

## 2. Geological setting

The Austral (Magellan) Basin is the southernmost basin in southern Argentina and extends from the Deseado Massif to the north to the Scotia Plate to the south (Biddle et al., 1986; Marensi et al., 2003). The Campanian–Maastrichtian stratigraphy of the Austral Basin is a regressive sequence, which allowed for the progradation of continental deposits to the southeast (Spalletti and Franzese, 2007). The early–mid Campanian La Anita Formation consists of nearshore and prograding deltaic facies and is overlain by meandering fluvial deposits of the Cerro Fortaleza Formation (e.g., Macellari et al., 1989; Kraemer and Riccardi, 1997; Arbe, 2002). The Cerro Fortaleza Formation is then overlain by braided fluvial deposits of La Irene Formation (Maastrichtian) (Macellari et al., 1989; Arbe, 2002; Povilauskas et al., 2008). The ages of La Anita and La Irene Formations are biostratigraphically constrained;

therefore, the Cerro Fortaleza Formation should then be at most late Campanian and at least early Maastrichtian (e.g., Macellari et al., 1989; Kraemer and Riccardi, 1997; Arbe, 2002).

The fossil wood reported here is from the Cerro Fortaleza Formation located in the Río La Leona Valley of Santa Cruz Province (Fig. 1). This formation consists predominantly of cross-bedded friable sandstones interbedded with mudstones, lignitic horizons, paleosols, and volcanic ash. The bulk of the Cerro Fortaleza Formation appears to have been deposited in a southwestern oriented meandering fluvial environment; however, the base of the formation also consists of coastal floodplain environments with some marine intercalations in the uppermost strata of the formation (e.g., Kraemer and Riccardi, 1997; Arbe, 2002; Novas et al., 2002). Avulsion horizons, histosols, and carbonaceous root fossils point to a poorly drained, low-gradient, forested landscape (Macellari et al., 1989). Dinosaur and turtle bones, silicified wood, fossil pollen, shark teeth, lungfish tooth plates, fish scales, mollusks, bivalves, gastropods, ostracods, and marine microplankton have been discovered in the Cerro Fortaleza Formation (e.g., Feruglio, 1944; Arbe and Hechem, 1984; Kraemer and Riccardi, 1997; Novas et al., 2002; Povilauskas et al., 2003; Terada et al., 2006; Novas et al., 2008; Egerton et al., 2010; Egerton, 2011; Lacovara et al., 2014).

## 3. Methods and samples

Permineralized wood was collected from the Cerro Fortaleza Formation from three localities (northern, southwestern, and southeastern sites) on the western flank of Cerro Fortaleza, near the Río La Leona.

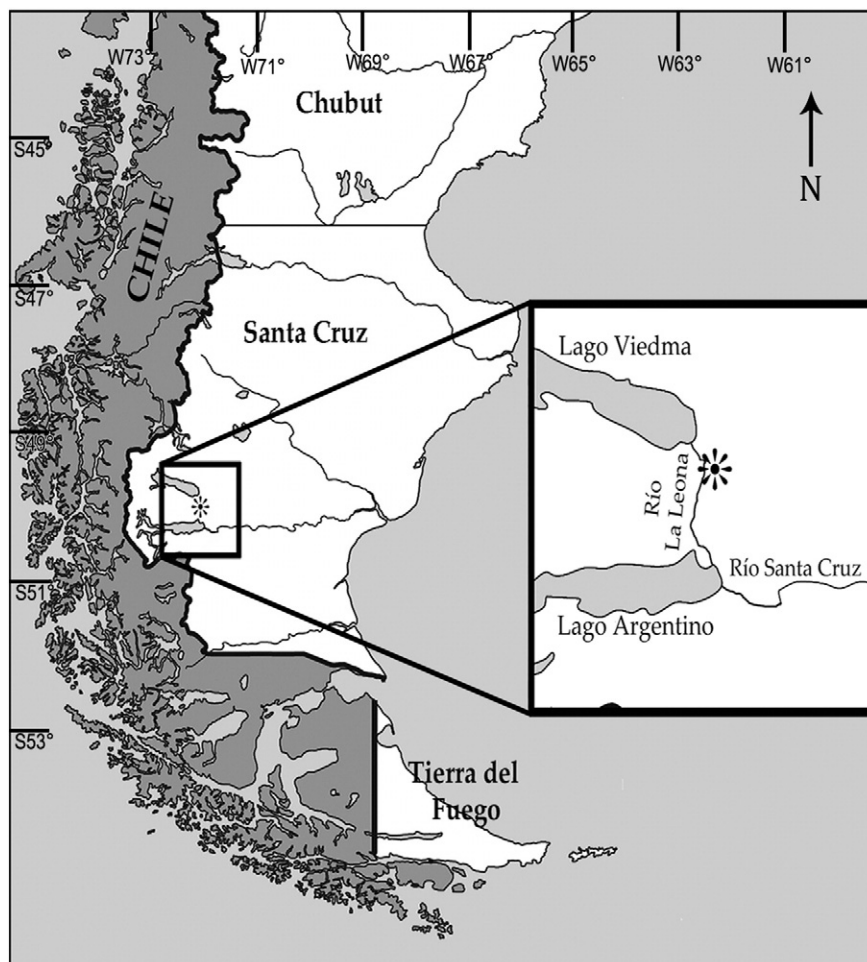


Fig. 1. Modern geography of Southern Patagonia with the collection site location.

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