Review of Palaeobotany and Palynology 154 (2009) 22–33

Contents lists available at ScienceDirect

Review of Palaeobotany and Palynology

journal homepage: www.elsevier.com/locate/revpalbo

Palynological record of the Paleogene Río Leona Formation (southernmost South America): Stratigraphical and paleoenvironmental implications

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ARTICLE INFO

Article history:
Received 10 July 2008
Received in revised form 18 November 2008
Accepted 23 November 2008
Available online 28 November 2008

Keywords:
palynology
Patagonia
Oligocene
biostratigraphy

ABSTRACT

Terrestrial palynomorph assemblages have been recovered from the Río Leona Formation, southwestern Santa Cruz Province, southern South America. Organic debris (spores, pollen grains, fresh water algae, plant tissues and fungi) are preserved in shales associated with other plant fossil remains (leaves and wood). The Río Leona Formation is here assigned to the early Late Oligocene based on the presence of key species of the M–M palynological zone (*Margocolporites tenuireticulatus* Barreda, *Diporites aspis* Pocknall and Mildenhall, *Granodiporites nebulosus* Partridge, *Mutisiapollis* spp.) and the virtual absence of warmth-adapted taxa (abundant from the latest Late Oligocene to Middle Miocene in Patagonia). A temporal gap between the Río Leona Formation and the overlying Centinela Formation (Early Miocene) – exposed in the studied region – is suggested here based on the differences observed in their palynological assemblages. The Río Leona Formation was deposited in a continental environment, with local peat swamps and coastal plain environments. The presence of Antarctic lineages in the lower and middle sections of the Río Leona Formation is consistent with the cooling trend globally recognized during the Late Eocene and Early Oligocene times. The appearance of some Neotropical families in the upper section might indicate the beginning of the Late Oligocene warming event. Records of Asteraceae (*Mutisiapollis telleriae* Barreda and Palazzesi sp. nov.), Menyanthaceae (*Striasyncolpites laxus* Mildenhall and Pocknall), and Rosaceae (*Psilatricolporites quenua* Barreda and Palazzesi sp. nov., *Psilatricolporites* sp.) are the oldest reports in Patagonia to date, and provide significant information on the early divergence and radiation times of these major angiosperm families.

1. Introduction

The Oligocene depositional history of the Austral Basin (southern Argentina) is largely unknown due to the lack of detailed sedimentological and biostratigraphical data. Only recently the influence of some regional events (e.g. tectonic and eustatic controls) have been inferred by new sedimentological information from the Río Leona Formation (Marenssi et al., 2005). However, the biostratigraphy of these Oligocene sediments has not been examined in detail so far.

The Río Leona Formation is approximately 100 m thick, consisting of a fining-upward succession that ranges from conglomerates to carbonaceous shales. It was interpreted as having been deposited in a fluvial setting, beginning with high-energy braided rivers and followed by low-energy meandering and anastomosed rivers (Marenssi et al., 2005). The Río Leona unconformably rests on the Middle to Late Eocene Man Aike Formation (Marenssi et al., 2002) and is conformably covered by the Late Oligocene–Early Miocene Centinela Formation (Marenssi et al., 2003; Guerstein et al., 2004). These stratigraphic relationships were recently used to constrain the age of the Río Leona Formation to the Oligocene (Marenssi et al., 2005). Fossil records from this unit are scarce and mainly referred to leaf and wood remains (Dusén, 1907; Hünicken, 1955, 1995; Barreda et al., 2004; Césari et al., 2006; Pujana, 2007).

Here we present the first spore and pollen record for the Río Leona Formation based on the analysis of three sections located in the region of the Viedma and Argentino Lakes (Fig. 1), southwestern Santa Cruz Province (southern Argentina). We constrain the age of the Río Leona Formation, analyze its stratigraphic relationship with the overlying Centinela Formation, and explore the main floristic trends during its accumulation. The presence of some species confined to gondwanan continents will also be discussed as they are important in the analysis of some paleobiogeographical issues.

1.1. Geographic and environmental setting

Patagonia represents the southernmost region of South America and comprises the Andes to the west and south, and vast steppe-like plains to the east. The Argentine region of Patagonia, as most commonly defined, includes the provinces of Neuquén, Río Negro, Chubut, Santa Cruz, and Tierra del Fuego.

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doi:10.1016/j.revpalbo.2008.11.005

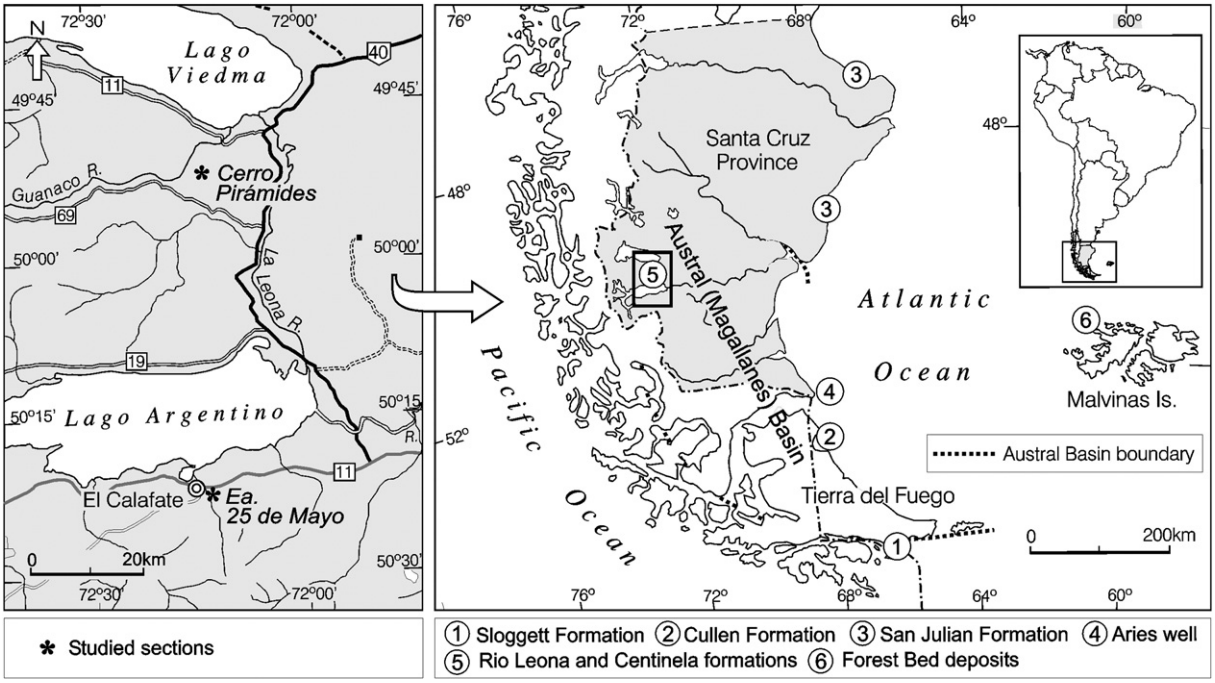

Fig. 1. Location map.

In the studied region (eastern part of the Cordillera lakes, southwestern Santa Cruz) rainfall occurs essentially in autumn and winter, with mean annual values of 200 mm. The western winds are the most distinctive climatic feature in the region, reaching maximum speeds from December to February. The mean annual temperature is 7.5 °C. These climatic conditions have a direct impact on the abundance, distribution and composition of the floristic elements. The general vegetation structure is characterized by the presence of shrubs and cushion plants with low cover (Mancini, 1993). The most important taxa in this region are Poaceae (*Agropyron fuegianum*), Rubiaceae (*Oreopolus glacialis*), Fabaceae (*Astragalus nivicola*) and Asteraceae (*Nassauvia revoluta*, *N. pygmea*, and *N. magellanica*). Also Ericaceae (*Empetrum rubrum*) and Apiaceae (*Bolax gummifera*) are represented in this semi-desert landscape (Mancini, 2002). Southern beech forests (*Nothofagus antarctica* and *N. pumilio*) grow to the west, where mean annual precipitations exceed 400 mm, in the Subantarctic Province *sensu* Cabrera (1976).

2. Palynological framework

Reference sedimentary sequences from the Oligocene–Miocene Epochs in Patagonia (Atlantic Coast and the Argentinean Continental Shelf between latitudes 40° and 53° S) are primarily based on the integrated distributions of both continental and marine palynomorphs. Four angiosperm and dinocyst assemblage zones were recognized (Fig. 2, modified from Barreda and Palamarczuk, 2000b). These are: 1– (M-M/R) *Mutisiapollis viteauensis – Margocolporites tenuireticulatus / Reticulatosphaera actinocoronata* (Late Oligocene, Chattian), 2– (C-T/L) *Cyperaceaepollis neogenicus – Tricolpites trioblatus / Lingulodinium hemicystum* (Early Miocene, early Aquitanian), 3– (G/C) *Glencopollis ornatus / Cannosphaeropsis utinensis* (Early Miocene, late Aquitanian), 4– (T-B/H) *Tubulifloridites antipodica – Baumannipollis chubutensis / Hystrichosphaeropsis obscura* (Early Miocene, Burdigalian).

In southern Patagonia, the palynology of the Oligocene–Miocene interval has been investigated from different deposits in Santa Cruz and Tierra del Fuego Provinces (Barreda, 1997; Olivero et al., 1998; Zetter et al., 1999; Zamaloa, 2000; Barreda and Palamarczuk, 2000a; Guerstein et al., 2004) and Argentinean Continental Shelf (Palamarczuk and Barreda, 2000). The Oligocene–Early Pliocene Forest Beds deposits from Malvinas (Falkland) Islands (Macphail and Cantrill, 2006) also provided diverse palynological assemblages. Sequences analyzed from the Austral Basin belong to the San Julián, Monte León (southeastern Santa Cruz), Centinela (southwestern Santa Cruz), Sloggett and Cullén (Tierra del Fuego) formations; and to possible correlative formations in the offshore Aries well (Argentine continental shelf) and Forest Bed sequence (Malvinas Islands) on the Falkland Plateau.

The spore-pollen assemblages are strongly biased by the depositional environment into which they were preserved. In distal marine deposits pollen and spores mainly represent the regional and extra

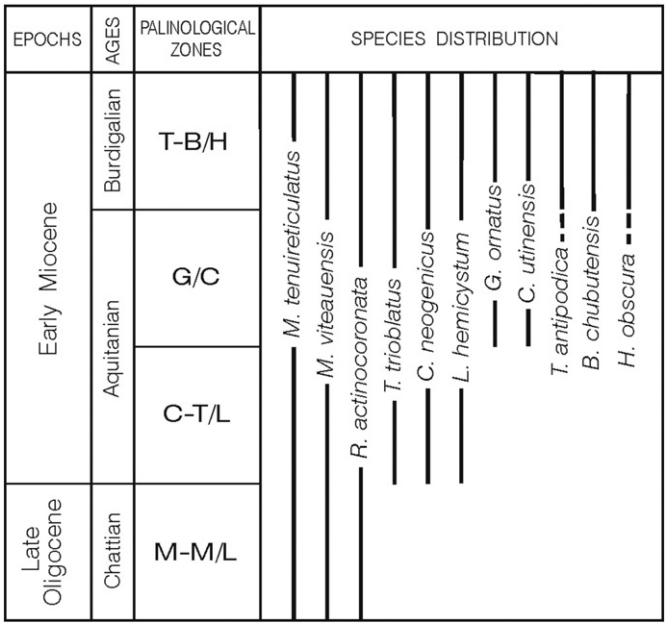

Fig. 2. Oligocene–Miocene palynological zones recognized by Barreda and Palamarczuk (2000b) from eastern Patagonia (Colorado, Golfo San Jorge, Austal basins and Mazarredo sub-basin) between latitudes 40° and 53° S based on integrated distributions of both continental and marine palynomorphs.