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Conifer fossil woods from the Santa Marta Formation (Upper Cretaceous), Brandy Bay, James Ross Island, Antarctica

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ABSTRACT

Conifer fossil woods from the Santonian to lower Campanian Santa Marta Formation are anatomically studied in detail. The wood flora is dominated by conifers, mainly Araucariaceae. Conifer fossil woods represent 84% of the samples (26 of 31) of the assemblage. The remaining samples are dicotyledon woods which are not included in this study. Woods are mostly calcified and preservation is often excellent. Fossil woods include three species of *Agathoxylon*, *Phyllocladoxylon antarcticum*, *Cupressinoxylon hallei* and a new species of *Cupressinoxylon*, *C. rotundum* Pujana sp. nov. The conifer-dominated forests are consistent with the pollen and macrofloras previously described from sediments of the same stratigraphic unit. This fossil wood assemblage contributes to understand the floristic changes that took place in the Cretaceous forests.

1. Introduction

Since the first detailed anatomical study of fossil woods from the Antarctic Peninsula and its adjacent islands of Gothan (1908), fossil woods have been an essential research topic to elucidate the Antarctic paleoflora composition.

Several studies that include fossil woods from the Santa Marta Formation were published in the last decades (Poole and Francis, 1999, 2000; Poole et al., 2000; Poole and Gottwald, 2001). These include the following dicotyledon fossil-species: *Laurelites jamesrossi* Poole and Francis, *Winteroxylon jamesrossi* Poole and Francis, *Illicioxylon antarcticum* Poole, Gottwald and Francis and *Hedyocaryoxylon tamburissoides* Poole and Gottwald. Conifer fossil woods were only superficially mentioned by Torres et al. (2012), but they were collected from the Gamma Member, which is now considered part of the Snow Hill Formation (Olivero, 2012). More fossil woods from the Santa Marta Formation were cited without anatomical descriptions by Cantrill and Poole (2005). Kvaček and Sakala (2011) mentioned that they collected gymnosperm fossil woods from the Santa Marta Formation but because of their poor preservation they could only describe them as conifers. Fossil pollen from the same stratigraphic unit was described by Dettmann and Thomson (1987), Keating (1992) and Baldoni (1992). Fossil leaves were studied by Hayes et al. (2006), Kvaček and Sakala (2011) and Iglesias (2016). All these paleobotanical remains suggest that a vegetation with a canopy dominated by conifers (Araucariaceae and Podocarpaceae), and with an important presence of angiosperms and ferns, developed in an emergent volcanic arc. Cantrill and Poole (2012) indicate that eudicots become more common in the Santa Marta Formation, although Magnoliales were still common. From older sediments (Coniacian) of the Hidden Lake Formation, Kvaček and Vodrážka (2016) described an angiosperm-dominated leaf flora.

In this contribution, a new collection of conifer fossil woods is described and systematics is based on recent trends. The study is the first detailed anatomical study of conifer woods from the Santa Marta Formation. Comments about the composition of the forest are given.

2. Geological setting

In northeastern Antarctic Peninsula, the James Ross Basin contains a relatively complete Upper Cretaceous marine sedimentary succession, the Marambio Group, that records at its top the Maastrichtian–Danian boundary (Fig. 1; Zinsmeister and Feldmann, 1996; Crame et al., 2004; Olivero, 2012; Tobin et al., 2012). The basal unit of the Marambio Group is the Santonian to lower Campanian Santa Marta Formation (Fig. 2), which consists of more than 900 m of shelfal, delta-influenced volcaniclastic deposits (Scasso

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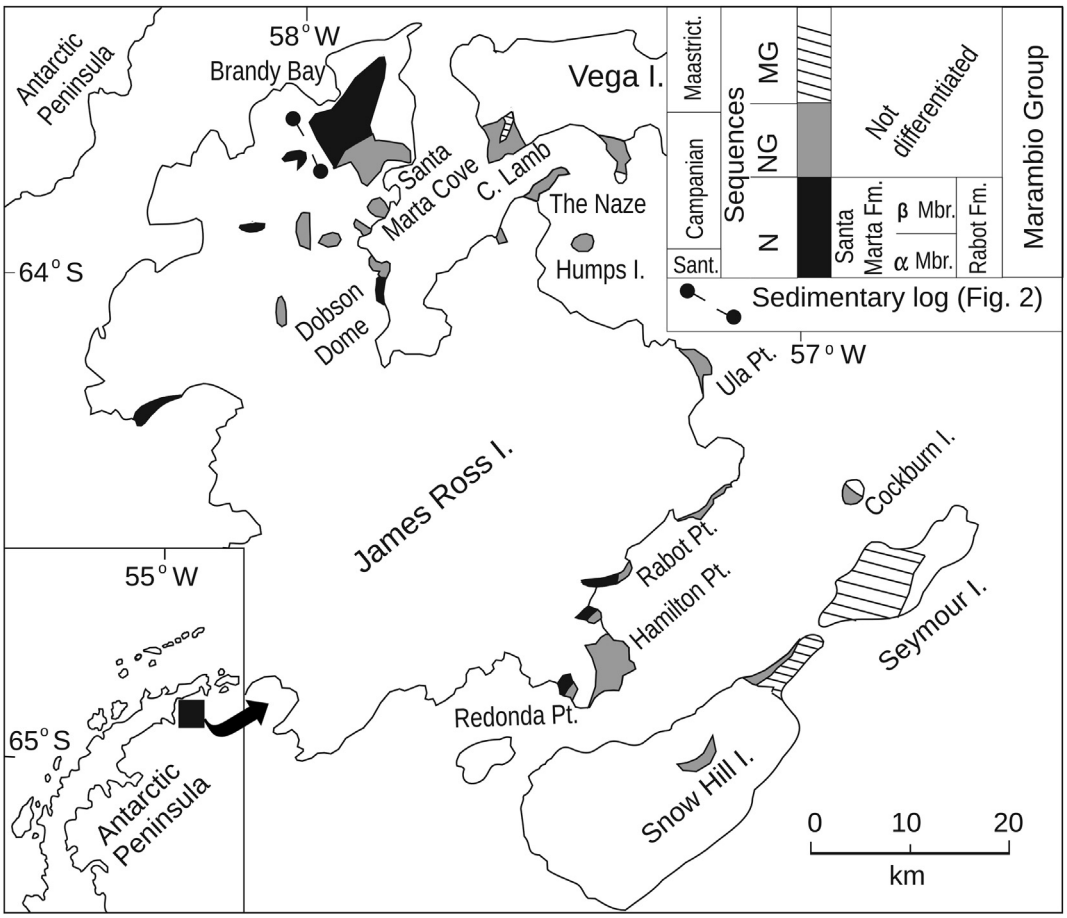

Fig. 1. Location map and geological sketch showing distribution of Upper Cretaceous strata of the Marambio Group in the James Ross Basin and location of the sedimentary log of Fig. 2.

et al., 1991; Olivero, 2012). During the deposition of the Santa Marta Formation, the paleogeography of the area consisted of an elevated mountain belt, with active volcanoes, located along the present axis of the Antarctic Peninsula; and adjacent lowland, coastal plains to the east, flanking the incipient shelf area that was developing further east, into the Weddell Sea. The general trend of the shoreline was oriented NNE-SSW; the main clastic source was the Antarctic Peninsula; and the sediments were delivered to deltaic systems by major rivers flowing to the east-southeast (see Scasso et al., 1991; Olivero, 2012 and the bibliography therein).

At the type locality of Brandy Bay, James Ross Island (Fig. 1) the Santa Marta Formation comprises the Alpha and Beta members. These members represent a regressive, deep-water delta sequence that includes four vertically stacked intergrading facies associations, interpreted as prodelta-basin plain; base of slope depositional lobes; delta slope channel complexes; and delta plain-inner shelf depositional settings, respectively (Fig. 2; Scasso et al., 1991; Olivero, 2007). In the Brandy Bay section, six successive ammonite assemblages are recognized in the Alpha and Beta members. The lowest, Santonian Ammonite Assemblage 1 (*Baculites* cf. *kirki*) lacks kossmaticeratids (Olivero, 2012), but the bases of the following early Campanian ammonite assemblages 2–6 were defined at the first occurrence of a particular kossmaticeratid genus and/or species (Fig. 2). Fossil plant material comprising large tree trunks, twig fragments, seeds, and leaves are common throughout the formation, but they are particularly abundant in the mid-upper part of the Beta Member. The samples of studied fossil wood cover most of the stratigraphic thickness of the Santa Marta Formation, representing the four intergrading facies association and different environmental settings mentioned above (Fig. 2).

3. Material and methods

A collection of 31 pieces of fossil woods from different stratigraphic levels of the Santa Marta Formation were collected at Brandy Bay by two of the authors (MER, EBO) (Fig. 2; Table 1). Conifers are represented by 26 samples and the remaining samples (5) are dicotyledon woods, which are not included in this study. Most woods are calcified (they react with HCl) and some calcified/silicified (react with HCL and HF); they usually have a very good preservation. Thin cuts and acetate peels following standard techniques were made by one of the authors (RRP). All samples were observed under scanning electron microscopy (SEM), mostly radially orientated. Measurements in the descriptions are given as the weighted mean of the samples assigned to the fossil-species followed by the range between parentheses. On the new species, values are those of the holotype, unless specified. IAWA committee (2004) code and Cp and Si indices by Pujana et al. (2016) were used when possible. These two indices quantify the seriation and contiguity of the tracheid pits. Samples are housed at the Paleobotanical Collection of the Museo Argentino de Ciencias Naturales (BA Pb). Conifers have the following numbers: 16500–16509, 16511–16513, 16515–16517, 16519–16533 and 16543 (Table 1).

Suprageneric nomenclature follows Chase and Reveal (2009) and Christenhusz et al. (2011). Philippe and Bamford (2008) for