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ORIGINAL ARTICLE

Lauraceae: A promising family for the advance of neotropical dendrochronology

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ABSTRACT

The botanical family Lauraceae is ecologically and physiognomically very important in neotropical forests. It is one of the most frequent and distributed family both in number of individuals and species. Despite of this, we have noticed that a very few Lauraceae species have been considered in dendrochronological investigations. In order to analyze the potential of Lauraceae species in dendrochronology and to facilitate future studies we: (1) reviewed the literature on wood anatomy, cambial activity, tree growth and dendrochronology and compiled a list of species' tree-ring features throughout the Neotropics; (2) Investigated wood anatomy, growth synchronism and climate-growth relationship using dendrochronological standard techniques in 14 species from subtropical forests of southern Brazil. Our review pointed out that the majority of Lauraceae forms distinct tree-rings in several biomes and climates in the Neotropics. Seasonal growth pattern related to water stress and to seasonal air temperature were identified in Amazonia and in subtropical high elevation sites, respectively. Time series of tree-ring width of Lauraceae species were successfully cross-dated and were already used in reconstruction of fire and vegetation dynamics. Our own dendrochronological investigations brought to light that all the 14 studied species form distinct tree-rings in seasonal or even rainforests. By analyzing time series of tree-ring width we found the same growth tendency within trees of *Cinnamomum amoenum* and *Ocotea pulchella*. Moreover, year-to-year variation in the growth time-series was linked to climate variations of temperature and precipitation, showing growth decreases when summer water stress occur. We evinced Lauraceae has distinct, synchronic and climate-sensitive tree-rings. Therefore, since Lauraceae has wide distribution and high frequency in the Neotropics and since many species become centenary, we strongly encourage the use of Lauraceae's tree-rings in autoecology, climatology and on the reconstruction of vegetation and disturbance dynamics.

1. Introduction

The Neotropics comprises subtropical and tropical ecosystems from southern North America to South America, presenting high variation in rainfall, temperature and topography (Burnham and Graham, 1999). Ecosystems as diverse as deserts, savannas, grasslands, seasonal forests or humid rainforests occur in the region (Burnham and Graham, 1999), which includes seven biodiversity hotspots with high number of endemism and rarity (Myers et al., 2000). Major tropical forests extension is present at this domain, turning the Neotropics relevant to biodiversity conservation at a global scale. To understand complex forest processes and to support correct management and conservation of forests, we need long-term data about age and growth rates of trees and related environmental factors, such as climate and disturbances. However, such data are barely sufficient in Neotropics, because continuous forest inventories are still very few and do not encompass the long lifespan of trees. Besides that, dendrochronological evidences – the most temporal and geographical extended records to provide precise and high-resolution information on tree and forest ecology (Schweingruber, 1988) – are also scarce.

Dendrochronology uses tree-rings to date trees, in order to reconstruct past environmental events and conditions, and to obtain ecological information from individuals to ecosystems. It has been used in many fields, such as forestry, botany, climatology, Earth sciences (Worbes, 1995) and in anthropology and archaeology (Stokes and Smiley, 1968). Tree-ring records are much more prolific and studied in temperate and boreal than in the complex biodiverse tropical zone. In the Neotropics, much progress has been achieved concerning methods to prove the occurrence of annual tree-rings (*e.g.* Worbes and Junk, 1989; Worbes, 1995; Soliz-Gamboa et al., 2011; López et al., 2012;

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Baker et al., 2015); to indicate useful species for dendrochronological purposes (*e.g.* Bravo et al., 2008; Brienen et al., 2009; Ferrero and Villalba, 2009; Oliveira et al., 2009; Mundo et al., 2012; Ferrero et al., 2014; Pereyra-Espinoza et al., 2014); to assess dendroclimatic signal (*e.g.* Schöngart et al., 2004; Dünisch, 2005; Oliveira et al., 2010; Mundo et al., 2012; Locosselli et al., 2016); to reconstruct forest and population dynamics (*e.g.* Villalba and Veblen, 1997; Brienen and Zuidema, 2006; Carilla and Grau, 2010; Canetti et al., 2016) and climate (see reviews in Boninsegna et al., 2009; Villalba et al., 2009). Basic investigations to assess the appearance and timing of wood layers in neotropical species are the main body of research and should be further encouraged, since the dendrochronological potential of the neotropical tree diversity was evaluated only in few species and ecological conditions.

In this context, Lauraceae Jussieu is a large tree family driving physiognomic importance in tropical and subtropical ecosystems of the world (Stern, 1954; Richter, 1981; Rohwer, 1993a,b). There are approximately 55 genera and 2500–3500 species occurring mainly in the tropics and subtropics of America and Asia, with few species in Australia, Madagascar and Africa (Werff and Richter, 1996). The Neotropics is the most important Lauraceae's diversity center. Approximately 30 genera and more than 800 species occur over tropical and subtropical regions, in wet forests from sea level to high altitudes of Andes (Werff and Richter, 1996). Therefore, this is one of the most frequent groups inhabiting the upper stratum, both in number of individuals and species (Gentry, 1988; Werff and Richter, 1996). Lauraceae also has significant economic value, offering high quality timber and non-timber resources as spices and essential oils (Marques, 2001). In addition, several Lauraceae's species are currently in red lists due to overexploitation and deforestation.

Lauraceae plays an important ecological role in neotropical forests due to its wide distribution and frequency (see Fig. 1). This would turn it into a powerful family for dendrochronological purposes because of the facility in finding enough individuals to compute a site chronology and due to the possibility of establishing a tree-ring network, once annual tree-rings are formed. Despite of this, a very low number of species has been included in dendrochronological investigations. Updating the state of art regarding studies of Lauraceae in the Neotropics can contribute to clarify demands to further studies and to fill the gaps in dendrochronological tropical and subtropical species.

Here, we intended to analyze whether Lauraceae species have potential to improve dendrochronology in the Neotropics by studying Lauraceae's tree-rings and answering the following questions: (1) Do Lauraceae species have annual rings? (2) Are their tree-rings climate-sensitive? (3) What are the climatic factors that drive tree growth? To achieve our purpose, we (1) reviewed the literature on wood anatomy, cambial activity, tree growth and dendrochronology and compiled a list of species' tree-ring features distributed throughout the Neotropics (from Mexico to subtropical South America); and (2) investigated wood anatomy, growth synchronism and climate-growth relationship by dendrochronological standard techniques of Lauraceae species in southern Brazilian subtropical forests.

2. Material and methods

2.1. Literature review

We exhaustively searched in databases (Web of Science, Scopus and Google Scholar) for papers concerning Lauraceae and then selected those that comprised cambial activity, tree growth and dendrochronology. We also used as keywords the genus names that occur in the Neotropics; and the terms "neotropical dendrochronology"; "neotropical tree-rings". We recorded presence and anatomical features of tree-rings and provenance of samples.

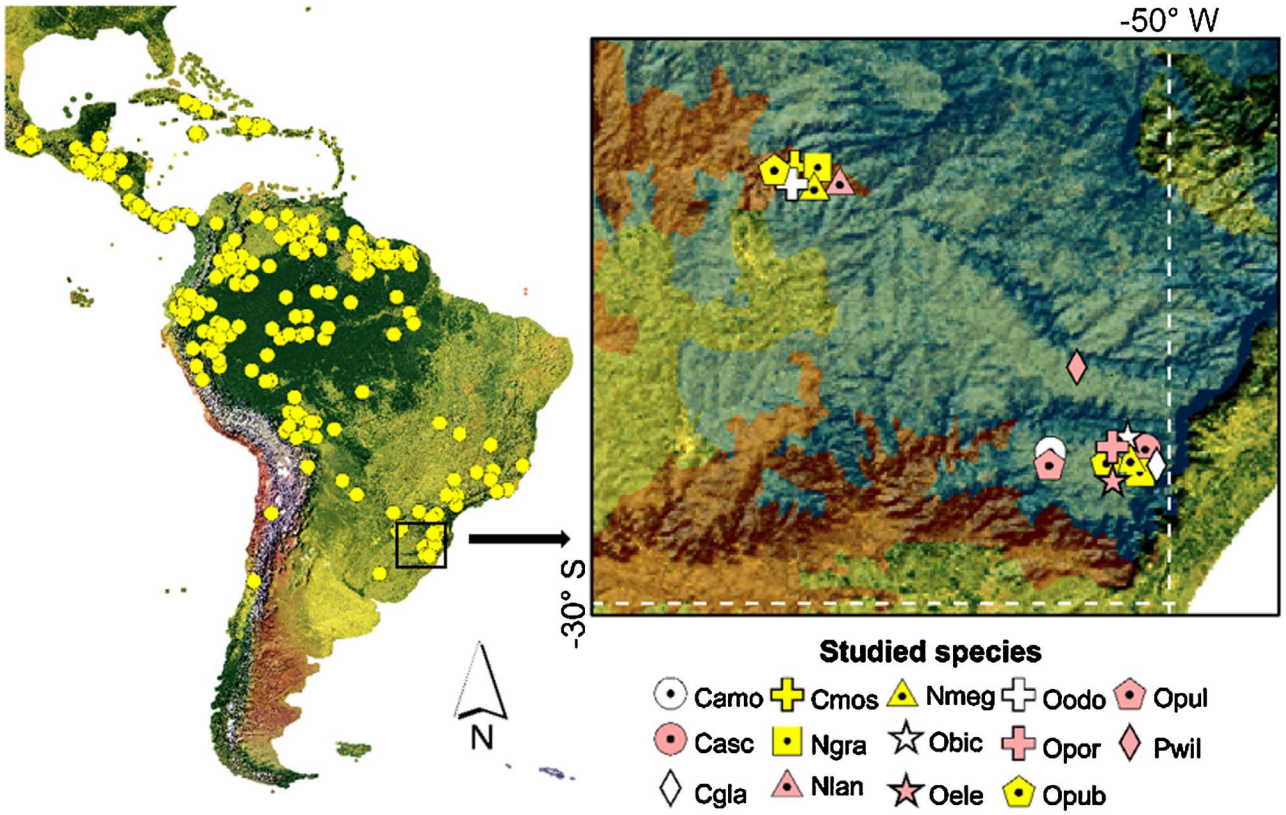

Fig. 1. Occurrence of the 113 inventoried Lauraceae species (yellow dots) in the Neotropics based on records of Tropicos® database (available in http://www.tropicos.org/) and site of origin of 14 studied species in subtropical seasonal (red area) and *Araucaria* (blue area) forests in southern Brazil. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)