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Dendroecological Study of *Myrceugenia Glaucescens* (cambess.) D. legrand & Kausel. In Alluvial Mixed Ombrophilous Forest, Parana, Brazil

[1]Tomaz Longhi-Santos, [1]Jaçanan Eloisa de Freitas Milani, [1]Bruno Palka Miranda, [2]Victor Hugo Ferreira Andrade, [1]Franklin Galvão, [3]Maria Raquel Kanieski, [1]Carlos Vellozo Roderjan

[1]Universidade Federal do Paraná, Departamento de Ciências Florestais, Av. Prof. Lothário Meissner, 632, Jardim Botânico, 80210-170, Curitiba, Paraná, Brazil.
[2]Unicentro, Departamento de Engenharia Florestal, PR 153, km 7, Riozinho, 84500-000, Irati, Paraná, Brazil.
[3]Universidade do Estado de Santa Catarina, Departamento de Engenharia Florestal, Av. Luiz de Camões, 2090, Conta Dinheiro, 88.520-000, Lages, Santa Catarina, Brazil.

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ABSTRACT

The anthropic pressure on forest areas highly reduced the existing vegetation cover. Consequently, it brought environmental fragmentation, many of them with very particular local conditions as the flooding forests. Alluvial environments are regions whose main characteristic is the presence of hydromorphic soils that favor the establishment of species typical of these environments. Myrceugenia glaucescens (Cambess.) D.Legrand & Kausel. is found mainly along rivers and streams of southern Brazil. There are few information on environmental and anthropogenic influences on the development of the species that make up these forests. The present study aimed to evaluate the dendrochronological potential of M. glaucescens and determine the age of the trees, establish an indexed series to the specie and to verify the influence of climatic factors on growth. In an alluvial forest, located at Araucaria city, Paraná, samples from 11 trees were collected by the destructive method, received polishing by the use of sandpaper, on different grit sizes, and had demarked four rays to identify and count the growth rings. The growth rings were digitally measured, and the growth curves and indexed series were generated using the software COFECHA and ARSTAN, and relations with climate variables using the Pearson correlation. Individuals sampled from Myrceugenia glaucescens had a mean age of 28.75 years, with an amplitude that ranged from 44 to 20 years, with a correlation of $r = 0.444$ ($p < 0.01$). The indexed mean curve (1956-1999) showed that there is a linear growth trend, with a reduction in growth rates from the mid 60s. The evaluated climate variables responded negatively significantly. The main effects of climate on the specie occurred in the current year. Based on the results of M. glaucescens, both the viewing and marking of growth rings, as implied in the ecological relationships, the specie has potential for dendrochronological studies.

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INTRODUCTION

The southern Brazil experienced an accelerated development process, and one of the consequences was the conversion of large forest areas in agricultural areas, compounded by the fact the remaining have a secular history of irrational use of pressure, especially under the Mixed Ombrophilous Forest.

Mixed Ombrophilous Forest, given its wide distribution and therefore subject to different environmental conditions, recognizes the existence of three categories (IBGE, 2012): (i) Alluvial, on alluvial terraces and floodplains, with or without hydromorphy; (ii) Montane, between 400 m and 1000 m altitude; and, (iii) Upper montane, above 1000 m altitude. These formations shelter peculiar species, adapted to the climatic and soil conditions.

The Alluvial Mixed Ombrophilous Forest is present in environments with some drainage deficiency whose outstanding feature is the proximity of the water table surface (Leite, 1994). May have different degrees of development, from tree communities simplified by the level of hydromorphy of the soil, to more complex associations in which not rarely *Araucaria angustifolia* (Bertol.) Kuntze has participation in physiognomy (Roderjan *et al*., 2002).

Corresponding Author: Jaçanan Eloisa de Freitas Milani, Universidade Federal do Paraná, Departamento de Ciências Florestais, Av. Prof. Lothário Meissner, 632, Jardim Botânico, 80210-170, Curitiba, Paraná, Brazil.
Tel: +554133604297 +554198737515 E-mail: jacanan.milani@gmail.com

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The alluvial forests in the context of Mixed Ombrophilous Forest, consist predominantly of *Sebastiania commersoniana* (Baill.) L.B. Sm. & Downs (Cosmo *et al*., 2010), but they still share space with *Schinus terebinthifolius* Raddi, *Allophylus edulis* (A. St.-Hil., Cambess. & A. Juss.) Radlk., *Blepharocalyx salicifolius* (Kunth) O. Berg, *Myrciaria tenella* (DC.) O. Berg, *Myrceugenia euosma* (O. Berg) D. Legrand, *Myrceugenia glaucescens* (Cambess.) D.Legrand & Kausel ., *Calyptranthes concinna* DC., *Daphnopsis racemosa* Griseb. and *Psychotria carthagenensis* Jacq, among others (Roderjan *et al*., 2002).

M. glaucescens, Myrtaceae, is a specie endemic to Brazil, Uruguay, Paraguay and northern Argentina. In Brazil is found specifically in the South, where it is often associated with Mixed Ombrophilous Forest (Grings and Brack, 2009) and is commonly distributed in the canopy and understory of this forest type (Carvalho, 2009). The specie have medium height from 5 to 8 meters (Gomes-Lima-Bruni and Guedes, 2004), with typical anatomical features of Myrtaceae; solitary pores with diffuse porosity, alternate and ornate intervessel pits, fibers with bordered pits, diffuse apotracheal parenchyma and diffuse-in-aggregate, and heterogeneous and tight rays. In the xylem, vessels and vasicentric fibers are observed, with exclusivity of *M. glaucescens* the presence of scalariform perforation plates (Santos, 2012).

Much has been studied about the dynamics of forests in southern Brazil, the richness and complexity of these formations. There are few information about the environmental and anthropogenic influences on the growth of the species that compose these forests. The dendroecology, is a tool that studies the growth rings of trees (Schweingruber, 1996), provides quick answers about not only the age of the individuals, but also of forest dynamics and possible disturbances that occurred over time.

The lack of information concerning the climate or the record of natural / anthropogenic interventions in alluvial forest makes the analysis of growth rings a major auxiliary the seeking information on climate change (Longhi-Santos, 2013).

Thus, knowing the age and the response of plants to changes and environmental conditions is fundamental to interpret the temporal patterns of variation in growth rings. In this context the study had aimed at evaluating the dendrochronogical potential of *Myrceugenia glaucescens* trees in an Alluvial Mixed Ombrophilous Forest in the Paraná State and determine the age of trees, set an indexed chronology for the specie and to evaluate the influence of meteorological factors on growth.

MATERIAL E METHODS

Study area:

The study was located in a fragment of Alluvial Mixed Ombrophilous Forest in the city of Araucaria, Parana, near to the coordinates 25 ° 34'02,5 "S and 49 ° 20'53,5" W (Longhi-Santos, 2013). The region is influenced by the Barigui river, one of the principal affluents of the right bank of the upper Iguaçu river (Barddal *et al*., 2004).

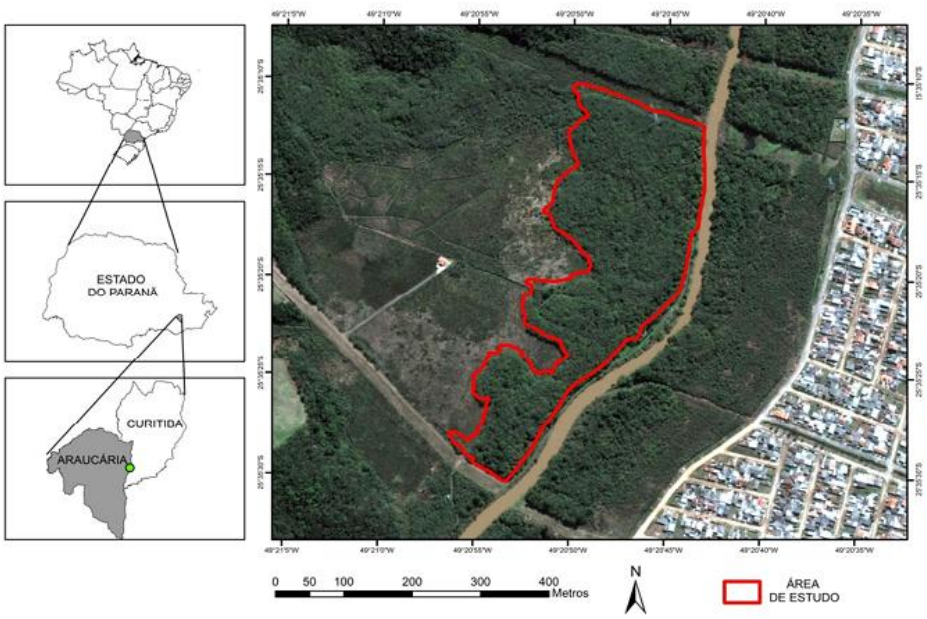

Fig. 1: Location of study area. Source: Milani, 2013.

With an average elevation of 880 m.a.s.l, the region is geologically grounded by granulite-migmatitic complex, under which are deposited cineritic sediments from Guabirotuba formation

(Milani, 2013). On the floodplain, Quaternary unconsolidated sediments are present (EMBRAPA, 2008), under which develop Gleysoils, predominant type of the plain. These soils have alluvial-colluvial origin, formed by deposition of fine-grained sediments (Barddal *et al*., 2004), and are hydromorphic, badly or very poorly drained, subjected to permanent or seasonal water saturation by ascension water table or overflow the river (EMBRAPA, 2013).

The regional climate, according to Koeppen classification is the type Cfb -temperate with cool summers, frequent frosts without a dry season (Maack, 2012; Troppmair, 1990). The average annual precipitation is about 1460 mm, with annual values may be less than 800 mm (1985) and higher than 2000 mm (1998) (INMET, 2014). The average relative humidity values are around 85% (SIMEPAR, 2013).

The average annual temperature is 17.9 ° C, and the average minimum in the coldest month is 8.7 ° C (July) and the maximum in the hottest month is 27.2 ° C (January) with minimum temperatures may reach values lower than -5 ° C and higher maximum at 33 ° C (SIMEPAR, 2013). The formation of rime is quite common in the region, although the number of occurrences can vary widely from one year to the next, ranging from two to more than 20 (Maack, 2012).

Data Gatering:

Near the study area was installed in 2000, a natural gas power plant (UEG Araucaria), which the construction of transmission lines was required, and one of the towers was designed over an area of 200 m^2 of Alluvial Mixed Ombrophilous Forest. After the authorization by the state environmental agency, 11 trees of *M. glaucescens* had their main biometric characteristics measured and analyzed. Samples were collected at the height of 0.10 m (base of the tree) in 2001, to dendroecological studies.

The samples were polished at their transversal surface by using sandpapers of different grit sizes (80 g / cm² to 600 g / cm²), in order to evidence the growth rings. In the samples, four rays were drawn to identify the growth rings with the use of a stereoscopic microscope Leica S8AP0.

After the delimitation of all the growth rings, the samples were scanned at HP Scanjet G4050 scanner with a resolution of 1200 dpi and then measured the width between the limits of the rings. Data were transferred to digital spreadsheets for further analysis.

Data Analysis:

In order to verify the accuracy of and the presence of false rings and / or wood density fluctuations, the time series were compared visually within and between trees (Longhi-Santos, 2013). The standardization and synchronization of the time series were performed by the software COFECHA (Holmes, 1983). In order to build a chronology, that removes biological growth trends, Arstan software was employed, that transforms the width values in indices (Cook and Holmes, 1984). Based on these indices, the chronology was correlated through Pearson correlation with the meteorological variables maximum, average and minimum temperatures, and precipitation, from 1961 to 2001 (INMET, 2014), for your previous year and current year, once the growth can be affected by past environmental conditions.

RESULTS AND DISCUSSIONS

As biometric information of the individuals studied, the average diameter at breast high 8.26 cm and total average height was 9.58 m. The total height ranged from 6.3 m to 11.7 m (Table 1), showing that the sampled individuals were in the understory of the study area, since, according Funpar (2011), in an area adjacent to the present study, the height of the canopy of individuals is around 16m and the understory of individuals ranges from 7 to 11 meters.

To evaluate the chronological series, at first the data were graphically analyzed in order to identify possible errors in measurement and marking of the growth rings. Therefore, 23 chronological series originated from 8 trees were selected, while those who did not obtain satisfactory results, were removed. From counting and marking of growth rings, a mean age of 28.75 years was obtained of the samples with an amplitude ranging from 44 years (maximum age) and 20 years (minimum age).

Table 1: Biometric data of *Myrceugenia glaucescens*. Where: DBH – Diameter at Breast Height; Ht – Total Height; MIP – Morphological Inversion Point.

Individual	DBH (cm)	Ht (m)	MIP (m)	Sociological position
1	8.1	11.2	3.7	Canopy
2	11.9	10.9	3.6	Canopy
3	8.9	10.8	3	Canopy
4	12.1	11.9	1.6	Canopy
5	5.7	8.7	3.3	Understory
6	5.1	7.6	2.8	Understory
7	7.6	10.5	3.0	Understory
8	13.5	11.0	2.9	Canopy
9	5.1	7.9	4.8	Understory
10	11.8	11.7	2.7	Canopy
11	6.4	6.3	1.8	Understory

Table 2: Results generated via COFECHA, to data synchronization of the individuals concerned.

	Chronology
Trees	8
Number of dated series	23
Years	44
Master series	1956-1999
Total dated rings	529
Intercorrelation	0.444
Critical correlation (p<0.01)	0.515
Average mean sensitivity	0.350

Because of the individuals are all in the understory position, the average age of 28 years corresponds close to the values found by Longhi-Santos (2013), working with understory samples of *Sebastiania commersoniana*. At the end of the temporal synchronization between series, we obtained a correlation of 0.444, as Table 2.

The standardization of time series allowed generating growth rates. This causes the removal of biological growth trends, and the minimization of the variation of the rings width, a fact cited by Fritts (1976).

The samples indicate a smoothness of the indexed curve, from the 1970s, as seen in Figure 2. This can be explained by the rectification of the Barigui River channel in the mid-60s, which may have caused changes in the water regime of its associated plains, as to accelerate water flow, result in higher erosion rates and disposal of sediments on the plain (Curcio, 2006). Consequently, altered the growth rates of species established there (Longhi-Santos, 2013; Kanieski, 2013).

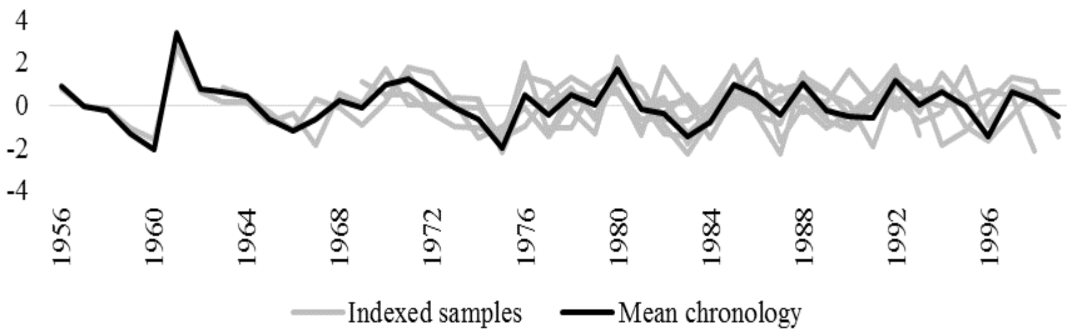

Fig. 2: Indexed samples; Featured, the mean chronology of all samples.

In order to verify the level of influence of standardized values of *M. glaucescens* with the *S. commersoniana*, in a study conducted by Longhi-Santos (2013), a graph comparing of the two averages indexed series was generated. From figure 3 it can be observed a similar tendency to the growth of both species in relation to the Barigüi river channel rectification effect in the middle of 1970s. Older than this period, both types have their growth tied to the natural dynamics of alluvial environments, a fact that can be checked with the negative growth trend in 1960, the period before the change of the water regime of the region.

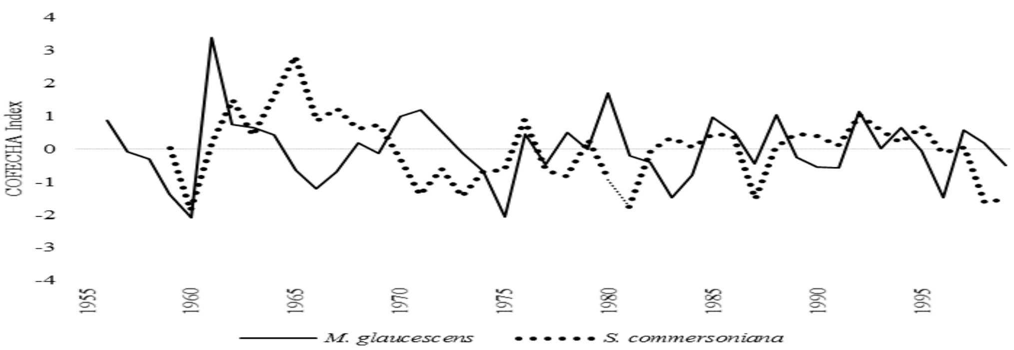

Fig. 3: Mean series of *Myrceugenia glaucescens* e *Sebastiania commersoniana*, when compared, have common points.

Although the intercorrelation value has not reached the critical level (r = 0.515, p <0.01), it exceeded the mean sensitivity (see Table 2). This value represents the relative change of the width index of the rings from one year to another (Grissino-Mayer, 2001). This may indicate variations that are related to environmental signals (Fritts, 1976).

In this study, the meteorological variables of precipitation (Figure 4), maximum and minimum temperatures were negatively correlated with the increment of the trees. The precipitation had significant correlation in July and October of previous year and June in current year.

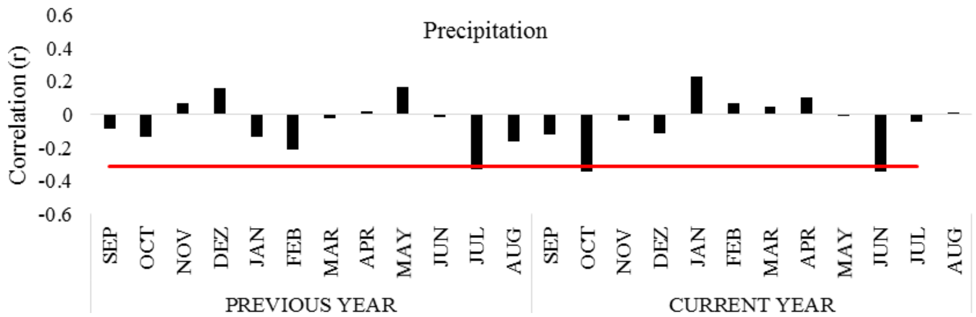

Fig. 4: Correlation between precipitation and increment. Red line indicates critical level (p<0.05).

Kanieski (2013), in their work with *S. commersoniana* in the same study area, found similar trends to precipitation answers. The author found significant negative correlation values and suggests that it can be explained by the superficial condition of the water table of these environments, which makes the precipitation not a limiting factor to growth.

For minimum temperature (Figure 5), the correlation was significant only in the months of June and July of current year, thus pointing to the sensitivity of *M. glaucescens* to cooler temperatures and thereby limiting their growth. Similar results were found by Kanieski (2013), studying *S. commersoniana* in area of Alluvial Mixed Ombrophilous Forest.

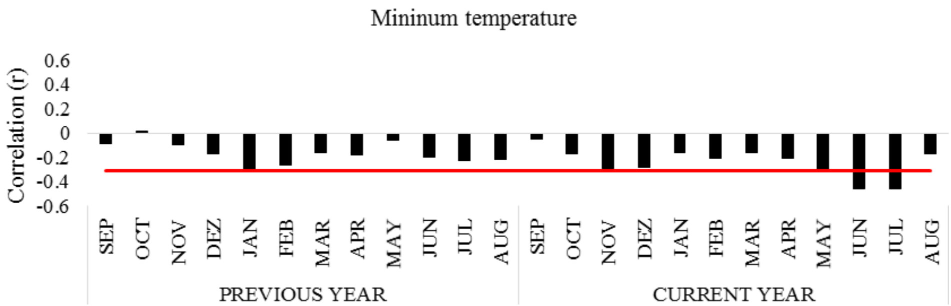

Fig. 5: Correlation between minimum temperature and increment. Red line indicates critical level (p<0.05).

The maximum temperatures own positive correlation values, although not significant, indicating that higher temperatures can contribute to the growth of the species. There were no significant correlations during this period, both for the previous year and for the current year.

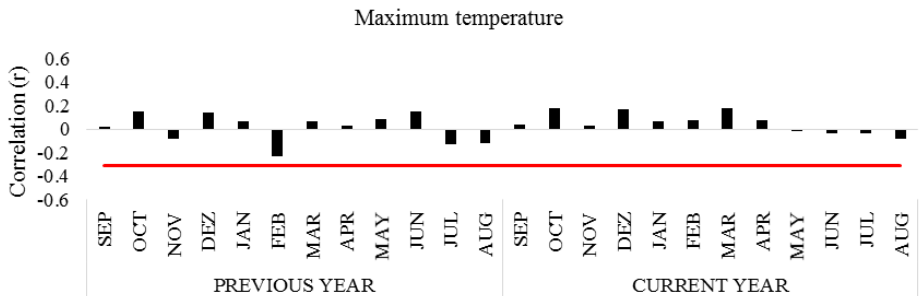

Fig. 6: Correlation between maximum temperature and increment. Red line indicates critical level (p<0.05).

Several studies emphasize the relationship between the growth rings and environmental changes (Callado *et al*., 2001; Oliveira, 2007; Anholetto Junior, 2013; Longhi-Santos, 2013; Kanieski, 2013; Tomazello *et al* 2001), allowing a better understanding the sensitivity of the species in a given location with environmental changes and risks of these changes.

Conclusions:

The trees sampled of *Myrceugenia glaucescens* had a mean age of 28.75 years that ranged from 44 to 20 years. The degree of correlation obtained from the synchronization of the time series was r = 0.444 (p <0.01). From the index of raw increment, the average curve (1956-1999) showed that there is a linear trend, but with a decrease in indexed increment rates over time. Regarding the climatic influence on growth, it was observed that all variables responded negatively significantly. The main climatic effects on the species occurred in the current year.

Based on the results obtained from *M. glaucescens*, and associated with favorable anatomical features, such as the presence of well-defined growth rings, it can be affirmed that the specie has potential for dendrochronological studies.

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