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What signs of climate variability can be extracted from the quantitative wood anatomy of *Cedrela fissilis* Vell. rings?

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Dr. D. Ricardo Ortega-Rodriguez, from Brazil, traveled to the Instituto de Investigación de Zonas Desérticas of Universidad Autónoma de San Luis Potosí, Mexico, as a PAGES-IAI Mobility Research Fellow from 6 August to 6 November 2023. Under the coordination of Dr. Laura Yáñez, he evaluated the potential of interannual variations of the anatomical-elements proportion of *Cedrella fissilis* to study climate variability.

A decrease in precipitation, and an increase in temperature and evapotranspiration, has been observed in the southern region of the Amazon basin since 1970 CE, as well as an increase in the length and severity of the dry season since 1990 CE (Fig. 1a). These extreme conditions suggest an alarming future, with possible forest dieback (Lovejoy and Nobre 2018). In this context, timeseries studies of growth-ring parameters (dendrochronology) are an essential tool to understanding the climate variability and periodicity of extreme events on an annual scale, and possible adaptive processes of species.

Background of the dendroclimatic analysis of *Cedrela fissilis*

The *C. fissilis* population analyzed during this fellowship was collected in Rondonia, Brazil, in the southern region of the Amazon basin. Previous studies of this population show that the increase in the frequency of droughts after 1990 CE led to a long-term trend of decreased growth, and an increase in wood density (Ortega Rodriguez et al. 2023a). Furthermore, during dry years, *C. fissilis* showed narrower, less-dense rings, lower concentrations of S and Ca, and higher $\delta^{18}O$ (the opposite was found in wet years; Ortega Rodriguez et al. 2023b). The observed long- and short-term adaptation by this species requires a better understanding of the trade-off processes between structural, transport and storage tissues. This can be achieved by using quantitative wood-anatomy methods.

Quantitative wood anatomy as a climate proxy

We obtained gray-tone images of 11 *C. fissilis* individuals (14 radial samples) through X-ray densitometry (Quintilhan et al. 2021), and classified and measured the proportion (%) of vessel (VA, a transport tissue), fiber (a structural tissue, FA) and parenchyma (a storage tissue, PA) areas in ImageJ software. Then, we obtained a timeseries (1970–2018 CE) of these anatomical parameters. We also evaluated the cross-dating among series using the COFECHA program and removed the age-size-related and non-climatic trends using the ARSTAN program.

Raw series trend showed a significant ($p < 0.05$) increase in VA% ($r = 0.38$) and FA% ($r = 0.54$) similar to the increase observed in RD; while PA ($r = -0.70$) showed a decrease, mainly since 2000 CE, similar to the trend observed in RW (Fig. 1b) (Ortega Rodriguez et al. 2023a). Furthermore, during dry years there was a higher and lower VA% and FA% in tree rings, respectively, without significant alterations in the PA%.

Contrary to expectations, there were no significant correlations between anatomical variables and precipitation, temperature, or the difference between precipitation and potential evapotranspiration (P-PET). Positive and significant correlations between the PA% and the standardized precipitation-evapotranspiration index (SPEI) values at the beginning of the rainy season (September–November) of a previous year were identified. In contrast, the FA% showed positive, and significant, correlations with the SPEI values of the end of the rainy season (March–May) of a previous year and the beginning of the rainy season (September–November) of the current year.

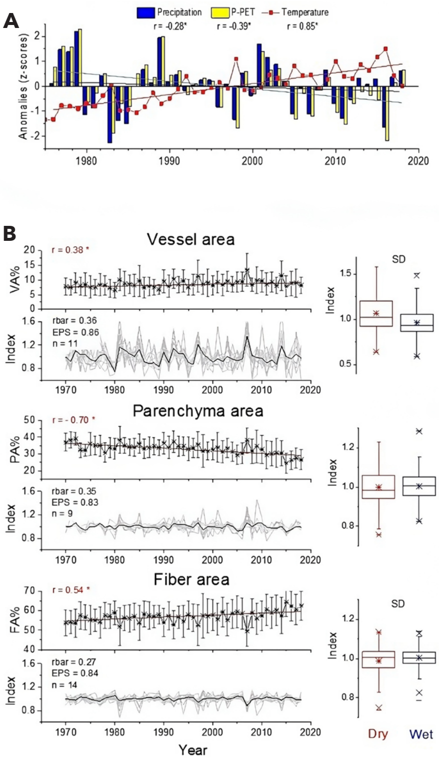

Figure 1: (A) Bar plots show anomalies (standardized values) of total annual precipitation (P), total annual difference between precipitation and potential evapotranspiration (P-PET), and mean annual temperature (T). **(B)** Mean raw series with ± standard error, mean index residual chronologies (black lines) and number of trees and radii (bottom gray shading) of the proportion of vessel (VA%), parenchyma (PA%) and fiber area (FA%) in tree rings, and boxplot of normalized parameters in dry (red) and wet (blue) years (significant difference between means, SD, $p < 0.05$).

Final comments

The SPEI signal recorded in the PA% and fibers may suggest the importance of these variables for compensation strategies between storage tissues and structural support formed by *C. fissilis* in response to dry conditions. Furthermore, the opposite trend of both parameters suggests a vulnerability of the normal growth and wood density conditions of the species, in response to climate change, mainly since 2000 CE, when extreme droughts became more frequent in the region.

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