

Tropical *Swietenia macrophylla* wood reveals a systematic recurring carbon isotope pattern

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The highly resolved radial distribution of $\delta^{13}\text{C}$ values in wood from an evergreen broad-leaf Mahogany tree (*Swietenia macrophylla* King) of a subtropical site near Caparo, Venezuela, South America is presented. The wood structure of the tree investigated is more or less uniform and growth zones are separated only by narrow parenchyma bands (Fig. 1).

This short study was aimed at testing whether or not a systematic carbon isotope pattern can be detected and if so, to what extent this pattern compares with the universal intra-annual $\delta^{13}\text{C}$ pattern that was found in broadleaf deciduous trees from temperate zones (Helle 1997, Schleser et al. 1999, Helle & Schleser 2004a, b).

High resolution measurements of the radial distribution of $\delta^{13}\text{C}$ were performed on a wood segment of c. 10×5mm size taken from a stem disk. Because of the varying curvature of growth zones a segment with parenchyma bands, as straight as possible, was identified and selected with the aid of the gridlock of a binocular. The chosen wood segment was trimmed to fit into a specially designed sample mount attached to a fixed-blade sledge microtome (Polycut E, LEICA Microsystems, Bensheim, Germany). The sample mount allows appropriate sample adjustment without loosening the sample during the cutting process. Contiguous tangential slices of 25µm thickness were cut. Accurate sample adjustment, as well as meticulous identification of conspicuous wood anatomical features like terminal parenchyma bands was provided by visual inspection using a binocular. The assignment of each micro-slither position to wood anatomical features was documented with a digital camera (DC100, LEICA Microsystems, Bensheim, Germany). Details of this procedure are given by Helle 1997.

As documented in Fig. 1 the results reveal a systematic and recurring $\delta^{13}\text{C}$ pattern in wood of *Swietenia macrophylla*. In this case three cycles can be observed. Each cycle begins with a marked increase of $\delta^{13}\text{C}$ values of up to 1.5‰. After reaching a maximum a more or less gradual decline towards a minimum $\delta^{13}\text{C}$ value follows. It is interesting to note that the minimum is always located in the terminal parenchyma bands of each growth zone. Contiguous $\delta^{13}\text{C}$ values rarely differ from each other by more than 0.2‰, i.e. the data point to data point variability along each isotope profile is generally low. Minimum and maximum $\delta^{13}\text{C}$ -values show slightly different levels. The isotope minima and maxima of each cycle differ by no more than 0.3‰.

Although the difference between minima and maxima of the $\delta^{13}\text{C}$ pattern in Mahogany wood is lower compared with broadleaf deciduous trees a remarkable similarity to the fundamental and seasonally recurring $\delta^{13}\text{C}$ pattern of broadleaf deciduous trees from temperate zones is evident (see Helle & Schleser 2004b for comparison). At the very beginning of tree-ring development of these trees, i.e. during the early vegetation period, the $\delta^{13}\text{C}$ trend shows an increase of up to 5‰. There the maximum $\delta^{13}\text{C}$ -value of each vegetation period always occurs during earlywood development, i.e. in the first third of a tree-ring, when growth mostly depends on carbon reserves. Each maximum is followed by a subsequent decline by up to 3.5‰. The minimum $\delta^{13}\text{C}$ -value is normally located in the late wood, i.e. the last third of each tree-ring. The only difference between the $\delta^{13}\text{C}$ pattern of Mahogany and that of deciduous broadleaf trees can be recognized at the end of each cycle. $\delta^{13}\text{C}$ -values in tree-rings from temperate zones start rising again before crossing the tree-ring border from one tree-ring to another. An increase at the end of a growth zone in *S. macrophylla* can not be observed in Fig. 1.

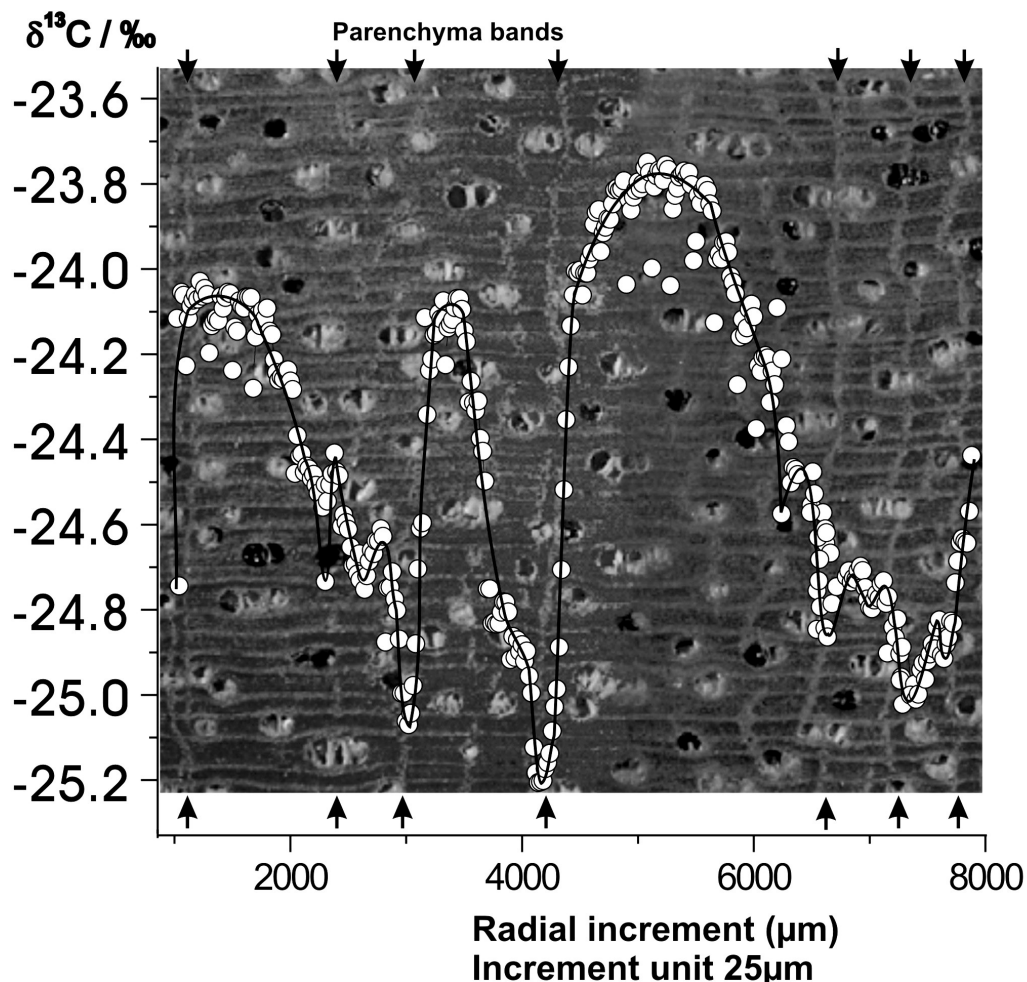


Figure 1: Radial distribution of $\delta^{13}\text{C}$ values in tropical *Swietenia macrophylla* showing three cycles of an unambiguous recurring pattern.

Due to the narrowness of the terminal parenchyma bands of Mahogany wood it can not be decided whether an increase in $\delta^{13}\text{C}$ at the end of each cycle does not occur or can just not be seen at the present data resolution.

Unfortunately, this study did not allow any comparison with climate or other environmental data since the radial growth zones could not be dated. The reason being that suitable ring width sequences normally can not be established due to indistinct tree ring boundaries and master chronologies are not available. However, the remarkable cyclicity in the high-resolution profiles of stable carbon isotopes has also been found in tropical *Rhizophora mucronata*, a mangrove species from Kenya, lacking any distinct growth rings (Verheyden et al. in review). Verheyden et al. have proven that the observed cyclicity in *R. mucronata* is annual and that high resolution $\delta^{13}\text{C}$ sequences of wood from tropical trees promise a high potential for tropical dendrochronology. For example pointer years could be identified in three different trees of a site indicating that crossdating can be successfully applied to high-resolution isotope sequences of tropical timbers.

Nonetheless, more tropical tree species and longer high resolution $\delta^{13}\text{C}$ sequences have to be studied in order to prove whether or not the method of crossdating is generally applicable to stable isotope variations in tropical timbers allowing the identification of the exact year in which each ring or growth zone was formed. An important question remains to be answered: what are the ecophysiological causes for the seasonal $\delta^{13}\text{C}$ pattern in wood of tropical trees?

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