Cedrela angustifolia Ses. et Moc. ex Dc., Meliaceae: potential species for tropical dendrochronology

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ABSTRACT


The characteristics of Cedrela angustifolia, i.e., its dendrology, ecology, silviculture and wood anatomy were described. This Meliaceae species naturally occurring in Latin America produces annual growth rings with sensibility to climatic variables, such as rainfall and temperature, showing potentiality to climatic reconstruction. The X-ray densitometry of the wood constitutes, besides the usual wood anatomy analysis, a suitable method to delimit the annual growth rings, as well as, to determine the wood density variation from pith to bark and within the growth rings.

Key-words—Cedrela angustifolia, Meliaceae, Dendrochronology, X-ray densitometry, Growth rings.

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INTRODUCTION

CEDRELA constitutes an important neotropical genus occurring from Mexico (latitude 26° N) to northern Argentina and the south of Brazil (latitude 28° S), including all countries of Latin America, except Chile. The Cedrela species occur in dry and wet low lands up to an altitude of 1,200 m as well in drained soils of the tropical and subtropical forests usually associated with broadleaves and conifers (Hueck, 1972; Rizzini, 1978). They are highly demanding of sunlight, frequently occurring as a pioneer, with high growth rates in secondary forests (Pennington, 1981). The genus consists of seven species, namely (i) C. angustifolia, occurring from Mexico to northern Argentina, except on the Antilles Islands, (ii) C. fissa, from Costa Rica to Argentina, (iii) C. liloi, in Peru, Bolivia and Argentina, (iv) C. montana, in Venezuela, Colombia and Equador, (v) C. oaxacensis, from Mexico to Panama, (vi) C. odorata, from Mexico to Argentina, and (vii) C. weberbauerii, in Peru (Smith, 1960; Gonzales, 1976; Ramirez & Styles, 1978; Rizzini, 1978). In Brazil three species of Cedrela occur naturally; C. odorata, considered the Amazonian forest cedar, C. angustifolia, the Atlantic forest cedar, and C. fissa, the dry forest cedar, from the state of Minas Gerais to southern Brazil. According to Rizzini (1978) these species are interpenetrating in their areas of natural distribution in the Brazilian central region. Besides these, a fourth species, C. liloi, is cited as occurring in southern Brazil (Carvalho, 1994).

In this paper particular emphasis is given to review the prospects of tree-ring analysis of Cedrela angustifolia because of its ecological importance, distribution and dendrochronological applications.
The wood of *C. angustifolia* has a yellowish-rose coloured sapwood and the heartwood colour varies from reddish-brown to darkened rose beige, depending on the provenance. The wood has a wide utilization in marquetry, carpentry, aeronautics, naval and civil constructions, etc. (Tortorelli, 1956; Rizzini, 1978; Villalba et al., 1985). The anatomical wood characteristics of *C. angustifolia* were described by Pérez Mogollon (1973), Lebacq (1973) and Dechamps (1985), examining wood samples collected from Venezuela, Peru and Brazil, respectively. The presence of well-defined growth rings marked by initial parenchyma bands and vessels forming semi-porous rings have been reported in all these studies.

**CEDRELA ANGUSTIFOLIA: POTENTIAL IN TROPICAL DENDROCHRONOLOGY**

The Meliaceae is included within the list of many tropical families which seems to be potential for dendrochronological studies with emphasis on its genus *Cedrela* (Chalk, 1983; Tomazello Filho et al., 2000). This tree combines fundamental characteristics like, (i) large trunk diameter and high growth rates, (ii) distinct phenophases with the trees leaf-fall in the dry season, in natural stands and plantations, (iii) wood with important anatomical features, i.e., distinct and well-defined annual growth rings, (iv) medium density wood, permitting the extraction of samples by non-destructive methods. These features make *C. angustifolia* more significant for dendrochronological studies in trees (Villalba et al., 1985, 1987, 1992; Villalba, 1995; Boninsegna & Villalba, 1996).

Two chronologies of *C. angustifolia* were elaborated in Argentina and northern Bolivia from trees growing in low latitude forests, where the growth period is from September to April-May with the fall of leaves and the trees are completely leafless. The distinct and well-defined annual tree rings are formed in response to the phenological phases, presenting a fine uniformity in the cross section of a trunk, which allows to get a high quality cross-dating. For these trees, temperature and precipitation in the beginning of the vegetative growth period seems to induce an increase in the width of growth rings. The statistical analysis of chronologies shows a high average sensitivity and signal-to-noise ratio, with a high percentage of variance explained by the first "eigenvector" and a high correlation between the trees. Consequently, the chronologies have a very strong common signal with a good potential for climatic reconstruction (Villalba et al., 1985) (Fig. 1).

In mountain forests of northwestern Argentina, two chronologies of *C. angustifolia* trees were constructed, establishing the relationship between growth rings and local climatic variations. In xeromorphic environmental conditions the diameter growth of the trees was controlled by temperature and precipitation of spring and beginning of summer. A positive correlation between growth rings and climate was detected at the upper limits of the occurrence of the species. Thus, tree ring data of *C. angustifolia* can be used for local climatic reconstruction, like the periodicity of dry periods in northwestern Argentina. In Jujuy city, for example, correlation coefficients between the precipitation of the dry season (June-November) and four tree-rings chronologies were calculated for the period 1909-1979. Then, these correlation coefficients were applied to the growth-ring chronologies until 1788, extending the winter precipitation back to 200 years. The reconstructed climate data reveal extremely dry periods in 1795-1807, 1858-1870, 1877-1892, 1934-1938 (Villalba, 1995) (Fig. 2).

In the transition area of Tucumano-Orense forest and Chaqueño Park, Argentina, tree ring samples were collected from 26 *Cedrela angustifolia* trees. These samples were dated through cross dating technique. Tree growth climate relationship is yet to built. In Cerro Chañar site, 1,600 m a.s.l. and 1,400 mm of annual average precipitation, the trees showed a positive relationship with spring-summer precipitation and a negative relationship with summer temperature. In Río
Fig. 3—Chronologies of the growth rings thickness index of *Cedrela angustifolia* trees in Cerro Chanar/Salta and Río Blanco/Jujuy, Tucumano-Ocrique forest/Chaquenó Park, Argentina (after Villalba et al., 1987).

Fig. 4—Comparison of the tendencies of growth ring index of *Cedrela angustifolia* trees in Cerro Chanar and Río Blanco with seasonal climate. The tendencies were determined by the average of the index with low frequency digital filter. The significance levels are indicated to (a) coefficient of correlation, (b) percentage de acceptance (c) inverse relation (after Villalba et al., 1987).
In Brazil, the wood anatomical analysis of *Cedrela angustifolia* trees enables the distinction of clearly visible annual growth rings, delimited by initial parenchyma bands and semi-ring porosity. Under stereomicroscopy it was possible to determine the tree age and annual and cumulative increment rates, with significant variations between the 3 different phases of the tree growth, higher at 1-5th and 16-20th and lower at 6-15th years (Fig. 6). The X-ray densitometry can also be applied for the delimitation of annual growth rings and the determination of wood density variation, from pith to bark. Maximum wood density values of latewood of some years, i.e., 15th year (0.90 g/cm³) were distinct comparing with other, i.e., 3th, 7th (0.45 g/cm³), probably due to climatic variation. These results show the potentiality of both methodologies in dendrochronological studies of tropical species, i.e., *Cedrela angustifolia*, including tree age.
determination, stand dynamics and relationship between climate, etc. (Fig. 7).

CONCLUSIONS

The number of tropical and subtropical species applied in dendrochronology has been increased, allowing the age and growth rate determination through growth-ring analysis. Among the species, emphasis has to be given to Cedrela, an important member of the Meliaceae family and, in particular, to C. angustifolia. Occurring in large areas of the Latin American continent, in different ecological conditions, C. angustifolia produces annual growth-rings with climatic sensitivity used to the construction of chronologies related to climate, population dynamics, phenology, forest management, etc. Usually the tree-ring analysis consisted of the observation and measurement directly on polished wood cross section. However, the X-ray densitometry commonly used in conifer species, can be also applied to C. angustifolia for dendrochronological purposes.

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REFERENCES


