

Short tree ring series: the study materials of the dendro-anthracologist

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Summary: *This paper is a review of the recent developments in dendro-anthracology. On large fragments of charcoal, the growth ring width can be measured and, in parallel, the tree ring estimated or even the caliber of the original wood measured. This method can provide fundamental information on the interaction of societies with the environment, such interesting data about palaeoenvironmental conditions, supply area, history of arboriculture... In spite of some method limitations, the dendro-anthracology has a bright future and the ANR DENDRAC is one of the projects likely to popularize this approach.*

Key words: *dendro-anthracology, charcoal, ring width, ring curvature, caliber estimation.*

This paper is a review of the recent developments in dendro-anthracology. When charcoal fragments are large enough, the growth ring widths can be measured and tree ring curvature estimated. This approach was referred to as a « dendrotypological » study by Billamboz (1992), who applied it to large waterlogged woods.

MEASUREMENT OF GROWTH RING WIDTH

Rare are charcoals which present long series of rings. It is generally a fragmented support which suffers the carbonization and taphonomy effects. The study of the radial growth on charcoals thus consists in the calculation of an average ring width. In one sample of charcoals, an average ring width is calculated for each rest with readable and measurable rings. This procedure minimizes the influence of extreme values and reveals trends in the growth of woods.

It is also possible to produce growth curves for large charcoals that contain dozens of rings.

EVALUATION OF TREE RING CURVATURE

The evaluation of tree ring curvature (and the angle of the rays) enables to identify which part of the tree was used. The ring curvature is estimated according to a standard classification: with a constant magnification and using a transparent test card placed on top of or under the fragment (Marguerie, 1992; Carcaillet, 2007; Ludemann and Nelle, 2002). While such an approach reveals trends, it is not a measurement of the diameter of the wood, but merely a characterization.

CALIBER ESTIMATION

A. Dufraisse (2002) continued and adjusted this approach by measuring the diameter of original wood under an image analyzer according to nine classes between 0 and 50 cm. With her, S. Paradis (2007) used the trigonometrical method in an isosceles triangle. This method makes it possible to obtain very good performances with only 9% of measurements

presenting a percentage of error higher than 15%. Now the measurements can be taken and treated rapidly with the software *AnthracoLoJ* (Paradis *et al.*, in press).

APPLICATION

Palaeoenvironment in north-western France: From the systematic measurement of the average ring-widths of oak charcoals on forty sites in north-western France compared with the number of heliophilic taxa used, we are able to distinguish two states of the forest environment: tree cover remained dense during the Neolithic, but was degraded and varied during the Late Iron Age (Marguerie *et al.*, 2010).

Supplies area: At the late Neolithic site of La Hersonnais (France), the different settlement complexes were not contemporaneous. In this case, the increase of the average ring width over the studied time interval reflects forest degradation and the evolution of woodland potential around the site. It seems that a single forest was exploited throughout the occupation of the site. As a result of the decreasing timber availability, buildings became smaller (Bernard and Thibaudeau, 2002).

A dendrotypological classification of long series of rings from large charcoals allows to operate groupings of wood according to the ring width patterns. Charcoals can come from a single tree or from the same stand (Augier *et al.*, 2001; Bernard and Thibaudeau, 2002; Carrion, 2003; Marguerie, 2009). Since already a long time, the average growth ring widths were only measured on charcoal samples with a weak curvature of rings (outer rings derived from trunks or large branches, far away from the pith). Now the coupling between wood diameter and radial growth delivers new prospects in the application of the dendro-anthracology (Dufraisse, 2006).

The story of the cultivation of olive trees in Mediterranean region: J.-F. Terral used an eco-anatomical approach with morphometric analyses of charcoals to determine the origin of cultivation of olive

trees and grapevines in the western Mediterranean region. In this case, the ring width is one of the parameters taken into account besides of surface of the vessels, the density of vessels and the number of vessels by group (Terral and Durand, 2006).

METHOD LIMITATIONS

Average ring width in case of young stems or twigs:

The rings near the pith are always thicker than the outer rings. Serious criticisms may put forward about the method of handling the tree ring data obtained from specimens of young stems with eccentric growth because of the development of reaction wood. The ring widths are thus highly variable on two opposite rays.

Validity of the growth ring width measurement modified by carbonization:

The radially shrinkage which varies according to the species and the combustion processes could explain the differences in the variations of the average growth-rings causing problems with a dendrochronological referential established on dry or waterlogged wood. In addition, the vitrification of charcoals, a variable fusion of anatomical constituents within the wood, leading to homogenisation of the structure that makes sometimes series of rings impossible to read. Many stages of alteration by fusion are known (Marguerie and Hunot, 2007). Recently, J.-C. Oillic (2011) got some new results in this field by testing the size of charcoal, the species and some combustion parameters.

PROSPECTS

The next step of dendro-anthracology will be the development and the standardization of some measurements tools. The project DENDRAC (*Development of dendrometrical tools used in anthracology*) supported in France by the ANR (*Agence nationale de la Recherche*) and directed by A. Dufraisse is adapted for that. 28 researchers from 7 laboratories work in it. Three workshops of "measurements methods" will working soon: classical morphometry (curvature and width of rings), multivariate morphometry (population and climatic parameters), quantitative anatomy (caliber/age - climatic parameters).

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