Strong correlations between wood anatomy and 13C discrimination within the Quercus robur/Q. petraea complex

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This work follows preliminary results obtained within a co-operative EU program (" Dendroecological analysis of climate-growth relations of five important European trees ", **H. Spieker, H. P. Kahle, J. Hansen, G. Helle and G. Schleser**).

Introduction

Quercus robur and *Q. petraea* are the two major forest species in France. They display distinct ecological optima, *Q. robur* being more sensitive to drought stresses and induced declines.

In spite of several ecophysiological studies, physiological mechanisms involved in this ecological differentiation remained misunderstood.

In this study, isotopic discrimination was used as a screening tool of inter-specific differences. Objectives were:

- to test if a significant difference of intrinsic water-use efficiency, assessed from carbon isotope measurments of wood cellulose, exists between the 2 species growing in adult mixed stands.

- to test if wood anatomy could be related to isotopic discrimination variations at the tree level.

Relationship between isotopic discrimination and intrinsic water-use efficiency

Water-use efficiency (WUE) is defined as the ratio of dry matter production vs. water use and **intrinsic WUE** is one of its components, defined as the ratio of net CO_2 assimilation (A) to stomatal conductance for water vapour (g_{sw}).

During photosynthesis, plants discriminate against ^{13}C at mainly 2 steps (CO_2 diffusion through the stomatal pores, carboxylation of CO_2 within the chloroplast stroma). **Isotopic discrimination** is defined by:

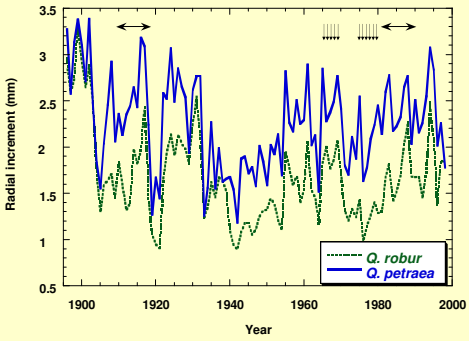
$$\Delta \approx \delta a - \delta p$$

where δa and δp denote the carbon isotopic composition of CO_2 in the air and the photosynthesis products respectively.

According to Farquhar *et al.* (1982), Δ and intrinsic WUE are linked by the following equation:

$$WUE_{(intrinsic)} = \frac{A}{g_{sw}} = \frac{Ca}{1.6} \cdot \frac{(b-\Delta)}{(b-a)}$$

where Ca is the CO_2 concentration in the ambient air, and a and b are discrimination coefficients against ^{13}C during stomatal diffusion and carboxylation respectively.



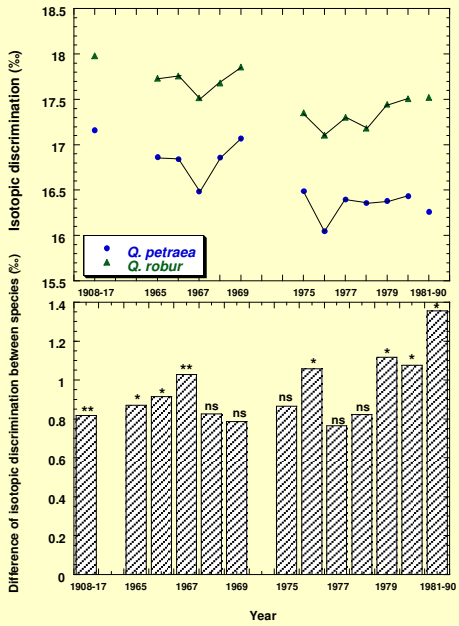
Sampling protocole and growth analysis

Ten adult stands have been chosen in a central France forest on homogeneous soils. In each stand, a couple of adjacent dominant *Q. robur* and *Q. petraea* have been selected and cored.

Growth of each tree was analysed and rings from different time periods were extracted from each tree (corresponding to the years 1965 to 1969 and 1975 to 1980, and to the time period between 1908-1917 and between 1981-1990). Wood cellulose was extracted and spectrometric analysis performed.

⇒ *Q. petraea* displayed a larger growth than *Q. robur* since the begining of the century.

Isotopic discrimination and intrinsic WUE



⇒ - there is a stable and significant 1‰ inter-specific difference of Δ between the 2 oak species.

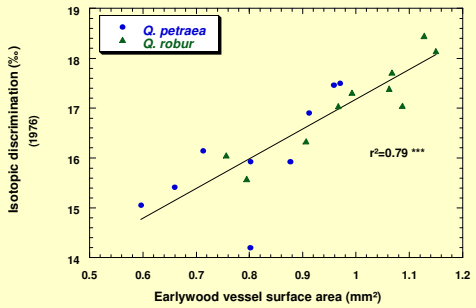
- *Q. petraea* showed a 14% larger intrinsic WUE than *Q. robur*.

Wood anatomy measurements

Measurements have been performed by Feuillat *et al.* (1997). One core has been taken by tree and 4 rings per core were selected for image analysis. Shape, size and proportion of tissues (earlywood and latewood vessels, fiber, parenchyma) were characterized.

Relationship between Δ and wood anatomy

Strong relationship was found between Δ and earlywood vessel surface area. The strongest relationship was obtained with Δ recorded in the 1976 ring.



⇒ - earlywood vessel surface area could control Δ and WUE.

- the inter-specific difference of earlywood vessel surface area explains the major part of the species effect on Δ.

Bibliography

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