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Growth rings and Phenology in temperate trees and anatomical climatic markers for fossil wood interpretation

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Introduction

Wood anatomy is intimately correlated with climate.

Fossil wood is frequently used as a tool in order to reconstruct past climate.

Recent researches have shown the existence of more or less clear relationships between some qualitative anatomical features of wood and plant ecology.

More quantitative approaches concerning the relationship between wood and climate have been developed in order to predict climate on the basis of the occurrence of some anatomical features.

Wood and Fossil wood are thus an important source of information about climate but tree rings may bring a more precise information.

The understanding of tree-ring development over a short temporal scale is essential in order to understand growth dynamics in trees and the main factors affecting xylogenesis.

The timing and mechanism of wood formation is still poorly known. Almost all the studies deal with homoxyle wood.

The aim of this study was to refine the timing and the influence of climatic factors on wood formation.

The observation made during our study could be particularly meaningful for interpreting fossil wood and brought us a better knowledge of the window during which the climatic signal enter the tree.

Method

Species:

We have worked on two common species, Chestnut (*Castanea sativa* Mill.) and beech (*Fagus sylvatica* L.) which have respectively a ringporous wood and diffuse porous wood in order to analyze and compare developmental patterns of vessel size and density in different wood species (and wood type).

Sampling method

Wood samples have been harvested at breast height (1.30 m) using a 8 to 12 mm diameter punch. To compare leaf formation and their growth with xylogenesis, we have followed foliage development during all the growing season.



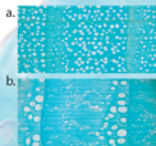
Areas and climatic factors :

In order to test and study the impact of a potential regional climate on wood formation, samples have been harvested since February 2005 until December 2005 in two sites with contrasting climate conditions. The main difference is situated in the level and occurrence of precipitation, the first site, in Ille-et-Vilaine being under the influence of Atlantic climate, the second one, in Ardèche, of Mediterranean climate.



	Ardèche	Ille-et-Vilaine
Mean annual temperature (°C)	12.3	11.7
Cold month mean temperature	4.7	5.5
Hot month mean temperature	21.4	18.8
Mean annual precipitation (mm)	1575	677

Cross sections of
a. *Fagus sylvatica*
and
b. *Castanea sativa*.



Results :

Cambial reactivation occurs a few weeks after bud flushing. In *Castanea sativa*, wood formation begins roughly with leafing whereas, in *Fagus sylvatica*, wood begins to be formed after leafing.

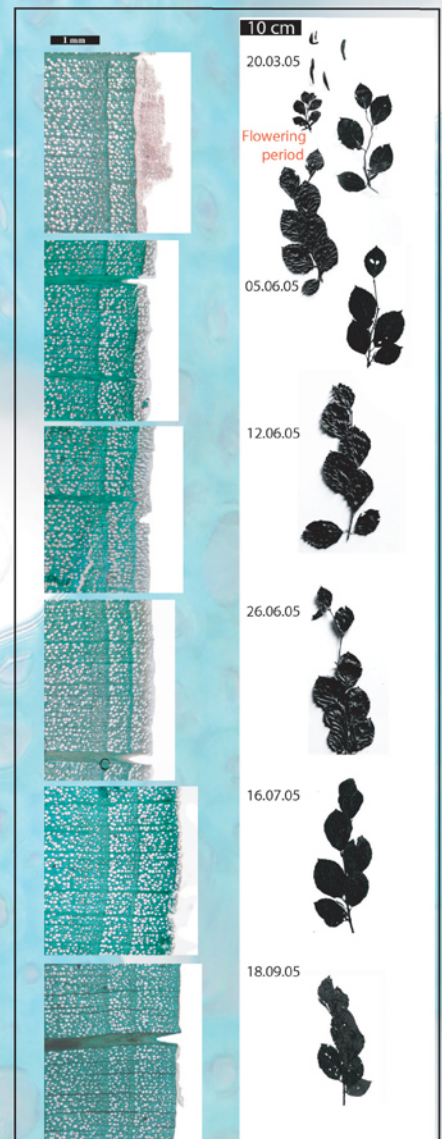
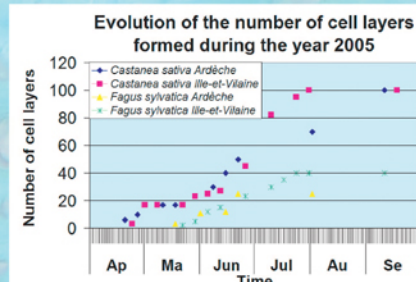
The length of the wood formation period is relatively short, from the end of April for the chestnut and May for the beech to August for both.

The two species have a more or less pronounced sigmoid shape in their wood formation, with a slow beginning, followed by a fast growth in the middle of the vegetation period and a decreasing wood formation activity towards the end of the period.

In *Castanea sativa*, wood formation can be divided in two growing phases; big vessels are formed rapidly at the beginning of the growing period (middle of April) and in a second time, final wood is formed from middle of May to August.

In both *Castanea sativa* and *Fagus sylvatica*, layers of cells are formed gradually. In each layer, vessels are formed before fibers. Lignification occurs approximately one week after cells have been formed, firstly on vessels and then spreads to fibers around.

The first results do not show any time lag between the two regions, either in the date of beginning of wood formation or in the duration of xylogenesis.



Interpretation and perspectives :

The differences in foliar phenology related to wood formation for the two species may reflect alternative design of growth and survival.

In *Castanea sativa* which is more sensitive to embolism caused by freeze-thaw events, big vessels are formed at the beginning of the growing season in order to conduct sap and most probably substitute embolised vessels.

There also may be a difference in the way of using resources, particularly in the time of flowering.

The lack of differences between the two regions could not be generalized and study have to be repeated over several years.

Our knowledge of wood formation have to be extended to more climatic zones, growth form, wood strategies.

A complete understanding of wood formation and the factors affecting xylogenesis is essential to make realistic reconstructions of climate based on fossil wood structural features.