Stand dynamics and competition processes in abandoned chestnut coppices in Southern Switzerland

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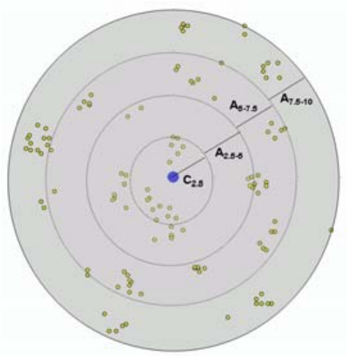
Introduction

Chestnut (*Castanea sativa* Mill.) forest ecosystems are an important landscape element in the Mediterranean mountain regions and the Alps. Widely propagated and intensively managed since ancient times, chestnut forests became neglected after the Second World War. Regularly short rotation coppices (< 20 years) were abandoned and for the first time they were left to evolve naturally. Analyses of stand development and of competition processes between chestnut and other species are therefore crucial to understand forest succession and to predict landscape development within the extended chestnut belt of the Southern Alps.

Objectives:
The present study intends to perform in a first attempt a tree-ring based dynamic reconstruction of past competition processes. Using as an example an abandoned sweet chestnut coppice stand in the Southern Alps, we studied tree rings i) to reconstruct past competition, analyzing growth and mortality processes, and ii) to assess the evolution of the specific competition potential of chestnut, beech (*Fagus sylvatica* L.) and Turkey oak (*Quercus cerris* L.), to anticipate expected changes in stand structure and composition before they actually occur.

Material and Methods

Difference in competition potential among species has been analyzed by comparing how chestnut, beech and oak have differently affected the **growth** and **mortality** of their close neighborhood.



Analyses were carried out on selected target trees (9 chestnut, 5 beech and 5 oak) embedded in a 60 year old abandoned chestnut coppice from Southern Switzerland. All living and dead trees within 10 m radius from the target tree have been mapped and tree-ring width measured (**Fig. 1**). Analyses were performed by taking into account changes in time and space.

The reduction in the density of living neighboring trees along time (number of trees per surface unit) was considered as indicator of the **mortality** induced by the target tree. Analyses were performed for each sub-plot and calendar year.

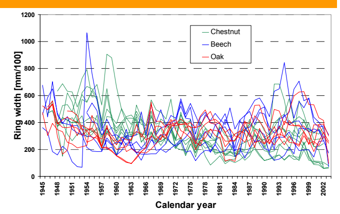


Figure 2: Ring widths of the selected dominant target trees.

The annual **growth** rate of each target tree has been compared with the one of his competitors (neighboring trees) and calculated as a ratio of the basal area increment for each calendar year t as:

$$BAIratio_t = \frac{\sum_{i=1} \frac{BAI_{target}}{BAI_{competitor(i)}}}{n}$$

where BAI is the annual basal area increment of the calendar year t of the target tree and the competitor(i) respectively. Results were transformed in continuous time-series, averaged per species and sub-plot, and finally compared to each another.

Figure 1: *Map of the study plot F4. The large blue point in the centre represents the beech target tree. Dots are the neighbouring competitors (filled circles for the living trees and empty for dead trees: status 2002). Circles delimit the 4 sub-plots considered for the analysis.*

Results

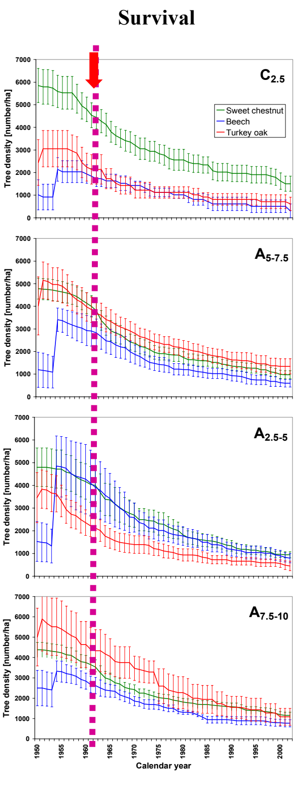


Figure 3: *Evolution of the density of living trees in all the sub-plots considered from 1950 to 2002. Lines refer to mean values and bars to SE.*

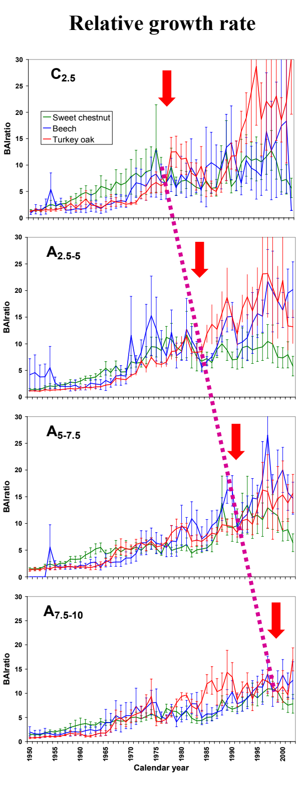
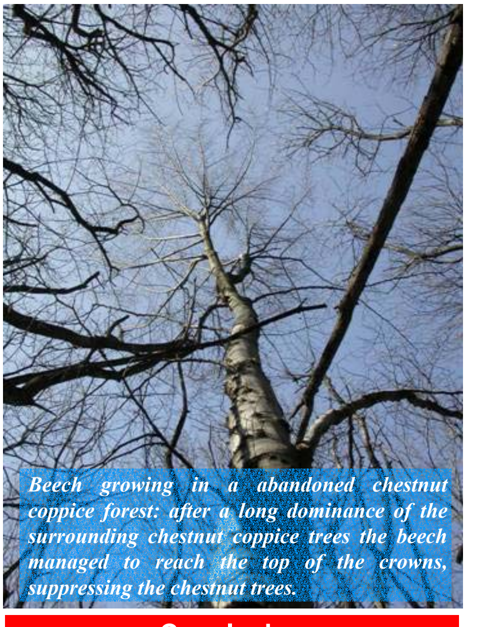


Figure 4: *Evolution of the BAI-ratio for all the sub-plots considered from 1950 to 2002. Line refers to mean values and bars to SE. Arrows and dotted line mark the change in pattern of BAIratio.*

Survival:
The reduction in tree density match a negative power function with the exception of the early years after coppicing, i.e. prior to 1962 (**Fig. 3**). In the last 40 years the mortality rate over the whole period ranged from a maximum of 68 trees/ha/year for chestnut to a minimum of 53 trees/ha/year for oak.
The 60 years since the last coppicing is too short to already detect differences in species-induced mortality.

Relative growth rate:
Chestnut dominates in the early stages of stand development, beginning immediately after the coppicing. However, after approx. 30-35 years (1980-1985) the pattern has begun to change with increased BAI-ratio values for beech and oak but constant values for chestnut.
This change in BAI-ratio between the species occurs with a delay depending on the distance to the target tree: an increase of distance of 2.5 m corresponds to a delay of about 7 years (**Fig. 4**).



Beech growing in a abandoned chestnut coppice forest: after a long dominance of the surrounding chestnut coppice trees the beech managed to reach the top of the crowns, suppressing the chestnut trees.

Conclusions

- Tree rings can be used as indicators to reconstruct with annual resolution past growth and mortality of trees in the stand, focussing on the relationships between a target tree and its close neighbourhood.
- In particular it was possible to determine and quantify the timing and rate of competition processes allowing an early recognition of the forthcoming changes in stand composition and structure.
- Species relative growth rates clearly show a time dynamic where chestnut is eventually outcompeted by oak and beech. However, the species survival curves do not appear to be influenced by the changing competitive dynamics between species. .
- Without sylvicultural interventions this coppice will develop within a few decades into mixed stands of beech and oak.