Competition-growth-relationship of *Cedrela montana* in Southern Ecuador in a Natural Forest Management Experiment

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A Natural Forest Management Experiment And Its Aims:

On the grounds of the ensuing decrease of economic high quality timber species, it is mandatory to develop concepts of sustainable forest management to counteract these devastative tendencies. In 2004, the application of 'Improvement Felling' (felling of the strongest competitor) was an attempt in a natural forest management experiment to achieve a positive influence on the radial growth of high quality timber species, in the protected area of the Reserva Biológica San Francisco, Ecuador **[Figure 1]**. For this purpose, 38 individual trees of *Cedrela montana* (Meliaceae) **[Figure 2]** were examined in two catchment areas [Günter et. al 2008]. The strongest competitor of each of 20 target trees **(Potential Crop Trees [PCT])** was felled. The remaining 18 trees **(Reference Trees [RT])** of the total 38 served as a comparative group, since no fellings were exercised.

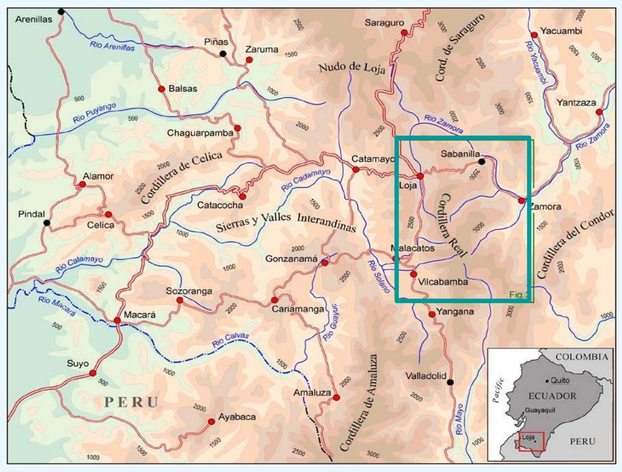


Figure 1: Location of the study area:
Reserva Biológica San Francisco (rectangle)
[http://bergregenwald.de]

Figure 2: *Cedrela montana*
[Volland-Voigt 2009]

Radial Increment of *Cedrela montana* Before and After the Natural Management Experiment …

To evaluate competition-growth relationships, the annual radial increment of *C. montana* were measured (5mm cores) **[Figure 3].**

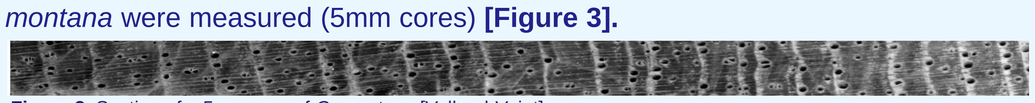


Figure 3: Section of a 5mm core of *C. montana* [Volland-Voigt]

Figure 4 shows the growth patterns of six individuals (dated to pith). The curve reveals, that radial increment is much less with increasing age, thus an age related growth trend is confirmed.

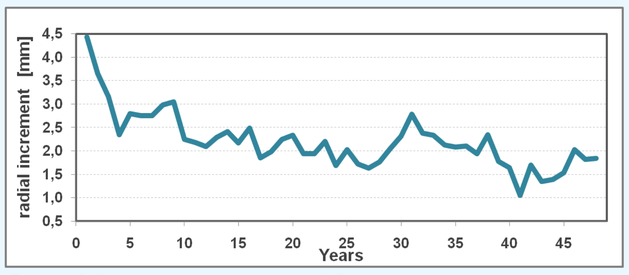


Figure 4: Age related growth trend of *C. montana*

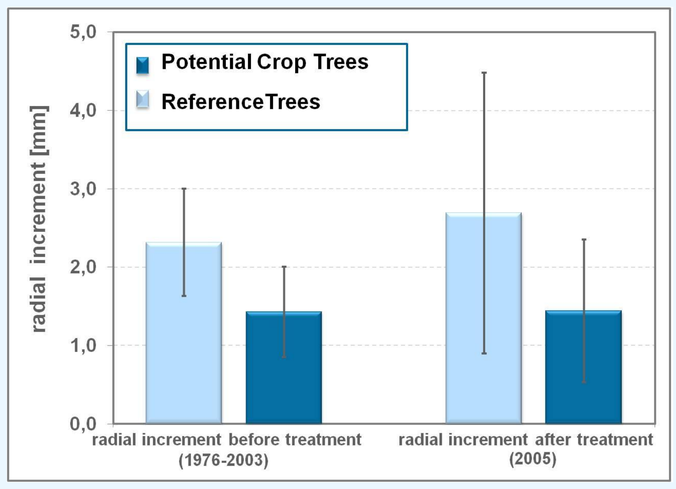


Figure 5 documents the influence of the treatment to annual growth. RT grow more after the treatment. PCT remain approx. constant in growth RT and PCT significantly differ both before [$t\ (36) = -4.34$; $p < .001$] and after [$t\ (24.64) = -2.66$; $p < .05$] the experiment.

Figure 5: Radial increment of *C. montana* before and after the treatment
(**RT:** $N = 18$; **PCT** $N = 20$)

Growth and competition with neighbor trees …

The competitive pressure on *C. montana* by neighbor trees was quantified by the HEGYI-Index (Hegyi 1974), a distance-weighted size ratio Index **[Figure 6].**

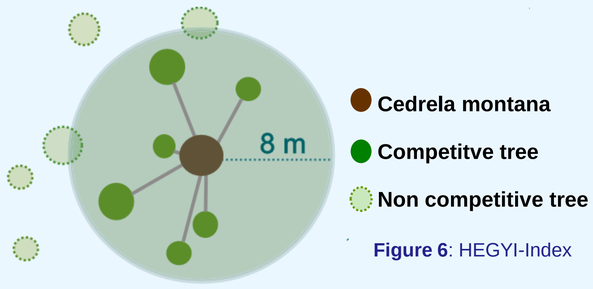


Figure 6: HEGYI-Index

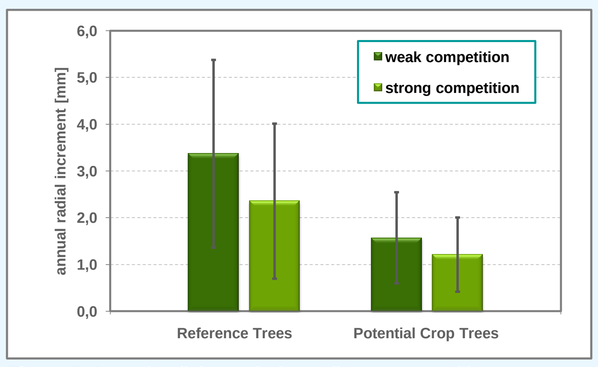


Figure 7: Annual radial growth depending on competitive pressure
(**RT**: „weak competition" $N = 6$, „strong competition" $N = 12$;
PCT: „ weak competition" $N = 13$ „strong competition" $N = 7$)

C. montana were differentiated in groups of weak and strong competition. **Figure 7** explains that both the RT and the PCT grow much more with a weak competitive pressure compared to that with strong competition.

The bi-factorial analysis of variance **[Figure 8]** results in a highly significant main effect for the factor "group" ($F=9.54$; $p<.01$), i.e. the RT grow significantly more than the PCT.

However, for the factor "Competitive pressure" and the interaction$_{\text{group X competitive pressure}}$ there were no statistically significant effects [Spannl 2009].

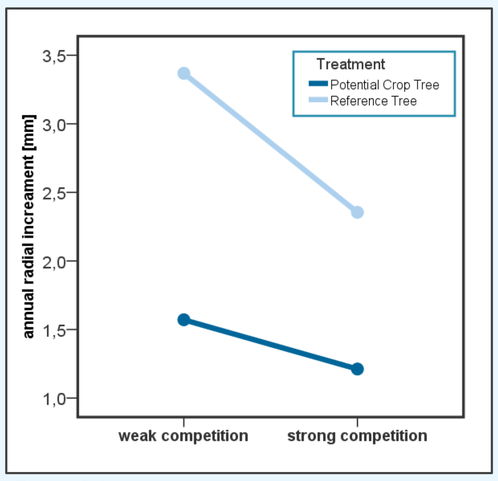
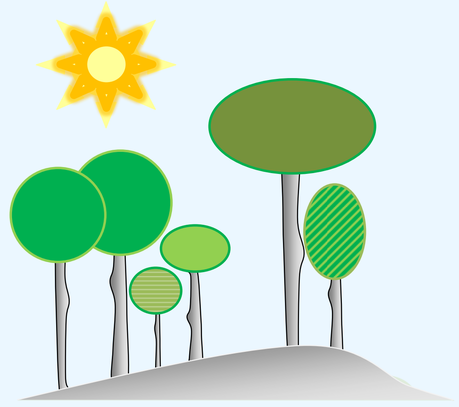


Figure 8: Interaction between both subgroups

Growth and competition for light …



To evaluate the competition for light *C. montana* were classified according to the fivefold stepped Dawkins-Classification [**Figure 9**], that reflects the availability of light for each tree [Dawkins 1958]. The frequency distribution [**Figure 10]** of the Dawkins-Classification shows that PCT are less shaded than their comparative group

Score	Name	Definition	
5	EMERGENT	Entirely exposed, free from competition for light.	
4	UPPER CANOPY	Exposed in entire vertical plan but in contact with other crowns laterally.	
3	LOWER CANOPY	Partly exposed and partly shaded vertically by other crowns.	
2	UPPER UNDERSTORY	Entirely shaded vertically but with some direct side light	
1	LOWER UNDERSTOREY	Entirely shaded vertically and laterally by other crowns.	

Figure 9: Dawkins-Classification

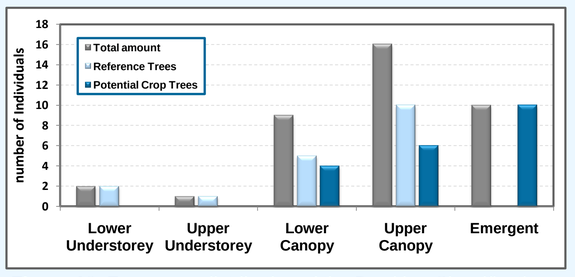


Figure 10: Frequency distribution of the Dawkins-Classification

Figure 11 illustrates that enhanced availability of light negatively correlates with annual tree growth ($N=38$; $r=0.33$; $p< 0.01$).

This finding confirms that drier conditions as they are induced by higher light exposure are not favorable for the growth of *C. montana* [Spannl 2009].

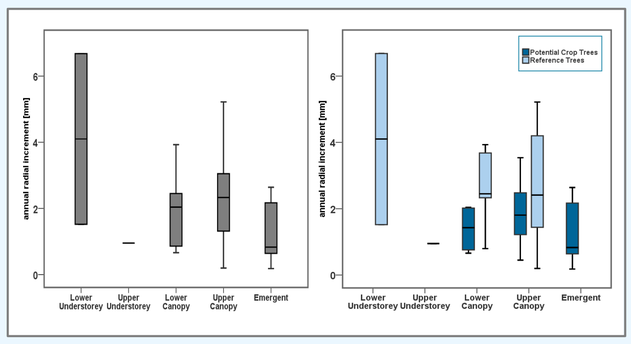


Figure 11: Relationship between annual radial growth and light availability (left part: total amount N=38; right part: differentiated groups with RT: $N = 18$; PCT: $N = 20$).
Black horizontal bars represent the Median; ***Box limits*** give the 25-75% quartiles; ***Short horizontal bars*** indicate the minimum and maximum values

Conclusion …

The results show that despite the reduced pressure of competitors and the enhanced consumption of light on Potential Crop Trees, the latter grew less than their comparative group. However, these preliminary results do not allow the general conclusion that the measures of the experiment have a negative effect on Potential Crop Trees. In contrast to *C. montana*, other tree species showed positive growth reactions after removing competitors [Bräuning et. al 2008]. Thus, *C. montana* might belong to a group of species showing a delayed positive reaction.

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