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Structural and physiological contrasts between tropical forest and savanna trees within their transitional zones: Results from Africa, South America and Australia

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In contrast to most ecotones, the change from savanna to tropical forest is often very sharp with just a narrow zone of transition (ZOT). Forests and savannas in the resulting 'mosaics' of vegetation are characterised by distinct woody species whose ecophysiology could account for part of the structure and dynamics of the ZOT (1).
We sampled plant traits from an ecophysiological viewpoint, considering what factors may be important for the competition between forest and savanna trees in tropical ZOTs. These included: (1) relative abundance; (2) wood xylem density; (3) leaf specific mass (LMA); (4) maximum diameter at breast height (dbh) and height; (5) foliar nutrient concentrations; (6) foliar isotopic composition; (7) Huber value; (8) stem/gas/water fractions.
Traits where measured in trees with a dbh above 10cm across the forest-savanna ZOTs in Cameroon, West Africa (Mali, Burkina-Faso and Ghana), Bolivia, Brazil and Australia. The dataset spans 66 one ha permanent sampling plots established as part of TROBIT (Tropical Biomes in Transition) between 2006 and 2009 (2).

Generally, forest trees had a larger maximum dbh and height, significantly higher total foliar nutrients and ratios of nitrogen to phosphorus (N/P) concentrations, as well as lower LMA and δ13C, and a higher wood xylem density than savanna trees. After accounting for differences in LMA, the difference in nutrient foliar concentrations ceased to be significant, apart from phosphorus, which was higher in African and lower in Australian savanna trees. African and South American savanna trees were found to store a higher proportion of water (as compared to wood) in their stems in comparison to forest trees.
Partitioning of the variation within each trait into genetic, environmental and error components showed distinct differentiation between forest and savanna traits as well. For example, whereas most of the proportion of total variance in LMA and δ13C was explained by genetic terms in savanna trees, in forest trees, the variance was mainly due to environmental and intraspecific variability.

The results of this study point towards a functional differentiation between forest and savanna trees growing under similar environmental conditions. The most striking difference was found in traits which are related to the higher water use efficiency and water storage of savanna trees (foliar δ13C and high water/stem in the wood), as well as lower phosphorus limitation (foliar N/P fractionation) compared to forest trees. Perhaps more importantly, also how much of the variation within the traits is due to environmental conditions – which may indicate higher plasticity - compared to inherent genetic effects differs considerably between forest and savanna trees. Australian trees often did not mirror the trends shown in African and South American trees, possibly due to the unique environmental history on this continent.

Tropical forest and savanna are likely going to be affected differentially by the changing environmental conditions expected in the future. This study has the potential to significantly improve our understanding and thus the accuracy of our predictions of the resulting potential changes in the dynamic co-existence of these two spatially most extensive tropical ecotones.

References

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2.http://www.geog.leeds.ac.uk/projects/TROBIT