Ontogenetic shifts in ecological strategy in a tall tropical tree species

Y. Zou[1], Y. Chen[1], H. Hartmann[2]*

*[1]Xishuangbanna Tropical Botanical Garden, Chinese Academy of Sciences, Mengla, Yunnan, 666303, China, *Yike.Zou@julius-kuehn.de*
[2]Institute for Forest Protection, Julius Kühn Institute, Erwin-Baur 27, Quedlinburg, 06484, Germany

Keywords: climate change, hydraulic strategies, *Parashorea chinensis*, tropical rainforest, vulnerability curves

The frequency and intensity of drought events have increased globally, causing tree mortality and forest decline on all continents. Tall trees have been reported to be more susceptible to drought stress than smaller ones, owing to their inherent hydraulic architecture and microenvironmental factors in the upper canopy, threatening the survival of these important components of forest ecosystems under future climate scenarios. We investigated *Parashorea chinensis*, a tropical tree species of southwestern China known as "Wangtianshu", meaning "tree that looks to the heavens", that can grow up to >70 m tall. To better understand how such species can attain such great heights, we looked at shifts in functional traits related to carbon and water processes over ontogenetic development, binning trees into six groups by tree height. We analyzed 24 leaf-branch traits related to photosynthesis, hydraulics, and mechanics.

Our results showed that most trait values related to photosynthetic activity first increased with tree height and then decreased in taller trees, reaching a maximum at the 5–15 m stage. By contrast, most trait values related to hydraulic and mechanical function increased linearly, reaching a maximum at the >50 m stage. As individuals of *P. chinensis* grow taller, the vapor pressure deficit within their canopies increases, indicating a drier microenvironment. Leaf long-term water-use efficiency is significantly positively correlated with photosynthetic rate and drought tolerance. Leaves at later growth stages exhibit higher construction costs and greater drought tolerance. Although the drought tolerance of the trees' branches decreased, the hydraulically weighted mean diameter increased, improving sapwood-specific hydraulic conductivity. Branch hydraulic conductivity and leaf long-term water-use efficiency were significantly coupled, reflecting functional synergy between plant water transport and photosynthetic carbon assimilation. Moreover, functional trait values vary with tree height, enabling individuals of different growth stages to exhibit distinct ecological strategies, including low-light acclimation and hydraulic safety; fast growth; and mechanical stability. Our findings provide insights into physiological responses of tall trees, and offer a physiological basis for the scientific management and conservation of *P. chinensis* under future climate change.

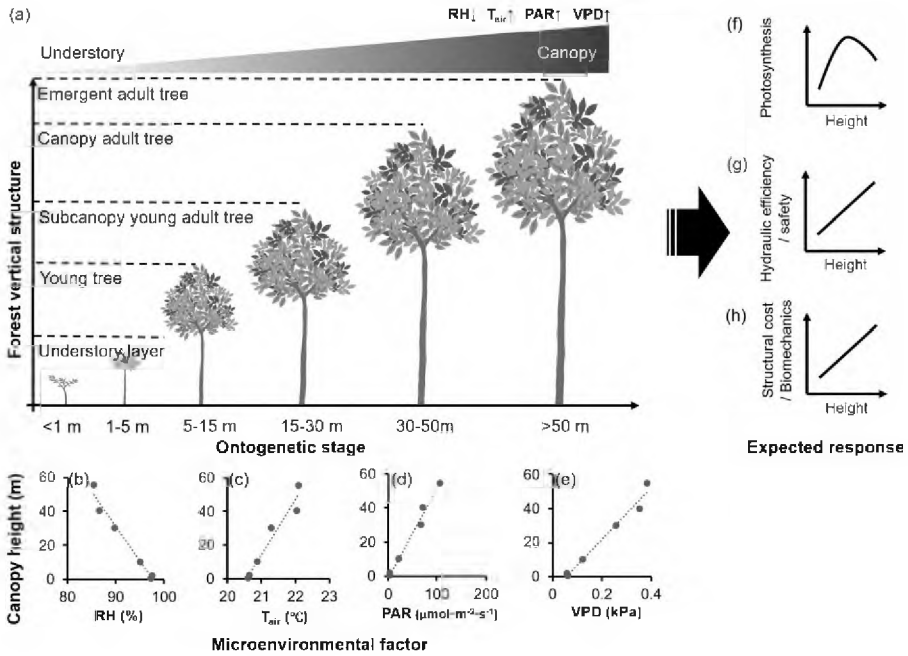

Fig. 1. Experimental design including plant materials, microenvironmental factors and hypotheses of shifts in functional traits along ontogenetic growth stages. PAR, photosynthetically active radiation; RH, relative humidity; T_{air}, air temperature; VPD, vapor pressure deficit