Investigating variation of fine root vessel traits in topological order within and across tropical tree species

March 20 2024, by Zhang Nannan

Credit: Unsplash/CC0 Public Domain

Anatomical and hydraulic traits can indirectly and directly measure the transport capacity of a root, respectively. Exploring variation in root

traits along topological orders within species is key to understanding functional shifts along root architecture and its anatomical underpinnings. However, no study has examined variation in fine root vascular traits along topological orders within and across species.

In a study published in *Journal of Experimental Botany*, researchers from the Xishuangbanna Tropical Botanical Garden (XTBG) of the Chinese Academy of Sciences and their collaborators investigated the variation in fine root tubular traits along topological orders within and across tropical tree species. They also explored how the fine root traits are affected by environmental factors, species characteristics, and ecological niches.

The researchers characterized fine root traits related to cortex, stele, and vessels across five topological orders in 80 individual trees of 20 species in Xishuangbanan, China.

They found strong variation in most of the traits studied across root topological orders. In particular, they found a strong increase in theoretical specific xylem hydraulic conductivity (K_{th}, the most commonly used parameter to study xylem water transport), mean vessel diameter (MVD) and mean hydraulic diameter with increasing root topological orders.

Furthermore, fine root vessel and hydraulic traits show strong covariation patterns among species. Species with thicker fine roots tend to favor hydraulic efficiency over safety. MVD and vessel fraction were always positively related to K_{th} across species, highlighting the mechanistic importance of vessel size and fraction in contributing to fine root transport capacity.

Within each species, root diameter (RD), stele diameter (SD), and stele to rot diameter ratio (SDR), and K_{th} all increased with increasing root topological orders, and K_{th} had significant positive relationships with

RD, SD, and SDR.

The results showed the dominant role of topological order in controlling root water transport capacity, reflecting the phenotypic plasticity and structural adaptations of the root xylem in response to varying soil water availability under climate change.

"Our work is one of the first studies to jointly examine the variation and covariation of root vessel traits across a continuous gradient of topological orders. It provides new insights into the variation of fine root anatomical traits and highlights the important role of order-based frameworks in elucidating fine root hydraulic processes in tropical forest species," said Xia Shangwen of XTBG.

More information: Guangqi Zhang et al, Root topological order drives variation of fine root vessel traits and hydraulic strategies in tropical trees, *Journal of Experimental Botany* (2024). DOI: 10.1093/jxb/erae083

Provided by Chinese Academy of Sciences