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Cavitation resistance and the functional role of bordered pits in xylem of conifers: from inter-specific to within a tree variability.

Summary

This thesis aimed to improve our understanding of xylem cavitation resistance (i.e. resistance to drought-induced formation and spread of air in the water transport system) in conifers by carrying out experiments at two different levels: at the interspecific and intra-plant level. We first investigated the mechanism of cavitation based on 115 conifer species, covering seven conifer families and four major biomes (Bouche et al. 2014). Also, the trade-offs associated with cavitation resistance were studied in details (Bouche et al. 2014, Bouche et al. in prep). Secondly, we developed new approaches to estimate cavitation resistance within and between different organs (needles, branches, trunks and roots). These allowed me to investigate the "vulnerability segmentation hypothesis" in conifers which suggest that leaves and branches are more vulnerable to cavitation that trunks and roots (Tyree and Ewers

without considerably sacrificing hydraulic efficiency. However, while cavitation resistance was not associated with tracheid dimensions, the role of the torus-aperture overlap was considerable, suggesting a trade-off at the pit level. Yet, xylem hydraulic efficiency mainly depended on the size of the margo pores in hydrated conditions (neutral position of the torus-margo structure, see Fig 2b p. 5), while cavitation resistance was mainly driven by the ability of the torus to seal the pit aperture (torus-aperture overlap) when aspirated (aspirated position, see Fig. 2b p. 5). Therefore, efficiency and safety of conifer xylem are uncoupled from each other and can vary independently (Bouche et al. in prep).

Cavitation resistance at the whole plant level

All findings mentioned above apply to conifer branches. However, little is known about xylem hydraulic behaviour at the whole plant level. We used in h

branches (Bouche et al., submitted to Tree Physiology). However roots and trunks were not as highly vulnerable as suggested by previous studies (Sperry and Ikeda 1997, Martínez-Vilalta et al. 2002, Domec et al. 2006, McCulloh et al. 2014).

The vulnerability segmentation hypothesis was not supported in the four species studied. It is worth noting that all our results were strengthen by anatomical observations. Indeed, we found that organs with similar cavitation resistance had similar torus-aperture overlap and that only the most vulnerable organs had the lowest torus-aperture overlap. A link between cavitation resistance and pit anatomy might therefore be suggested at the whole plant level.

Perspectives

Prospective work taking into account the inter- and intra-specific variability of cavitation resistance for all vegetative organs, might help us to fully understand the hydraulic architecture of plants. However, such investigations are destructive and time consumi(r)-3(s-8(nt.)on)3(s.