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The Ant and the Grasshopper: contrasting responses and behaviors to water stress of riparian trees along a hydroclimatic gradient

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The increasing threat of forest decline and mortality associated with more severe and frequent droughts calls for a better understanding of the tree response mechanisms to water stress. Among forest ecosystems, riparian forests, despite their privileged location in lowlands, are particularly vulnerable to drought because they are highly dependent on soil water availability for survival. At the scale of a large river and along a hydroclimatic gradient, riparian tree species may respond differently to water stress and, therefore, may not be equally vulnerable to drought events outside their normal range. To analyze the responses of white poplar (*Populus alba*) to seasonal changes in drought along a hydroclimatic gradient, we conducted a multi-tool analysis combining multispectral and thermal infrared remote sensing with in-situ ecophysiological measurements at different temporal scales.

Using this approach, we demonstrated that white poplars along the Rhône River (France) exhibit contrasting responses and behaviors during drought. We found that white poplars located downstream of the hydroclimatic gradient in a Mediterranean climate rapidly close their stomata during drought to reduce water loss and maintain high levels of minimum water potential (Ψ_m), but at the expense of leaf density and greenness. Conversely, white poplars located upstream in a temperate climate show high levels of transpiration and stable greenness, but lower Ψ_m and water content. These results demonstrate that white poplars along an aridity gradient can have two opposing responses to drought, with isohydric regulation on the one hand and anisohydric regulation on the other. These results indicate that trees located upstream in an area unaccustomed to drought are at a high risk of hydraulic failure during more intense and prolonged droughts.

The combined use of different tools and metrics at different spatial and temporal scales is

therefore essential to consider the full range of tree responses to drought. These two distinct behaviors remind us of Aesop's fable, where upstream trees behave like the grasshopper, not paying attention to their water consumption and jeopardizing their long-term survival. In contrast, downstream white poplars respond quickly to drought and show greater long-term resilience, just like the ant. These results are important in light of future climate conditions because they show that the same species can have different levels of resilience to drought, but they also raise the question of the ability of trees to switch from grasshopper to ant to adapt to these future conditions.