

## Session 4: Xylem structure and function– Talk S4.06

**Tip-to-base conduit widening in conifer needles and the possible adaptive significance of needle length plasticity**

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The greatest hydraulic resistance along the root-to-leaf pathway is typically found in the leaves. In conifers, leaf length is remarkably plastic, with leaves often being shorter in dry environments or in the upper crown. We tested the hypothesis that shorter leaves represent an adaptive strategy reducing total root-to-leaf hydraulic resistance. Sampling over 100 species spanning all conifer and cycad families, we examined the ways that tracheid diameter scales with leaf length. We sectioned leaves to measure mean tracheid diameter at various points along their lengths, and calculated the exponents describing the rate at which tracheids widen with distance from the leaf tip. At the intraspecific level, the slope of tracheid widening from tip to base is minimal (approximately 0.1), suggesting that longer needles incur higher hydraulic resistance. This contrasts sharply with angiosperms, which exhibit a scaling exponent of around 0.5, allowing for effective compensation for increased leaf length. These results shed light on why conifer needles tend to be shorter in xeric conditions or at the upper crown. Shorter needles reduce total pathlength resistance, representing an adaptive response that improves fitness in water-limited environments. Our results highlight the tight integration between leaf and stem-root hydraulic systems.