WHERE DOES STEM CAPACITANCE WATER COME FROM?

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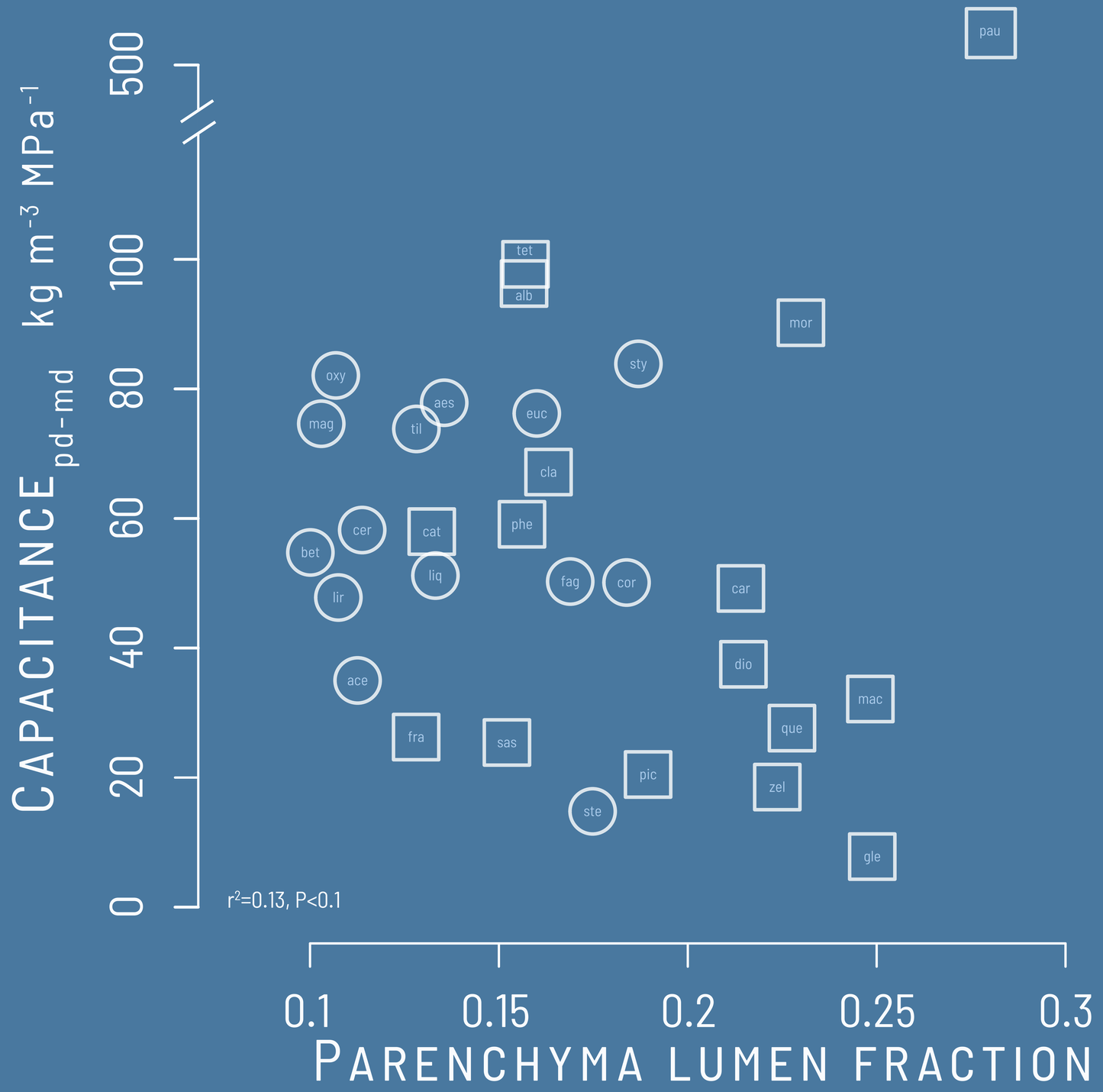

FIGURE 2. Relationship between capacitance and parenchyma lumen fraction (ray+axial). Capacitance is defined as water (kg) released from wood (m^3) between predawn and midday per stem water potential change (MPa). This result suggests that high parenchyma fraction may not be required for high capacitance. However, this does not imply that parenchyma doesn't contribute to capacitance.
'gle' three letter code stands for first three letters of the genus in Latin (have a guess or ask me about them). ○ diffuse-porous, □ semi/ring-porous

BACKGROUND AND QUESTIONS

Stored water can contribute significantly to trees' daily transpiration stream[1-4]. But where does this water come from? It is often suggested that parenchyma tissue (Fig. 1) contributes this water, yet there has been no convincing evidence supporting this claim. Parenchyma proportion varies greatly across species (from ~5-90%)[5], so could this variation drive different capacitance strategies?

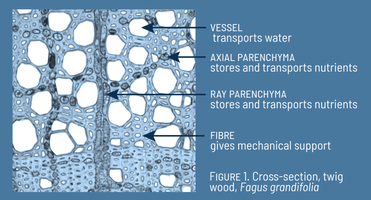

FIGURE 1. Cross-section, twig wood, *Fagus grandifolia*

METHODS

• 30 tree species from 26 families (3 reps/species) • temperate angiosperms • Arnold Arboretum of Harvard University • twig wood • predawn (pd) and midday (md) stem water potential measured using bagged leaf method (Aug 2017) • capacitance$_{pd-md}$: water released between predawn and midday per unit volume of wood (kg m^{-3}) / stem water potential change between predawn and midday (MPa) • wood anatomical traits: all tissues lumen and wall fractions, vessel diameter, proportion of vessel circumference in contact with other tissues

RESULTS

- Capacitance$_{pd-md}$ was not related to parenchyma lumen fraction (Fig. 2) or to any other tissue fraction except for, weakly, to vessel lumen fraction (r^2=0.14*).
- Instead, wood density and lumen volumetric water content (proportion of wood volume that is occupied by water in lumen) were strongest predictors of capacitance (r_{adj}^2=0.44, P<0.0001):

$$\text{CAPACITANCE}_{PD\text{-}MD} \sim + \text{LUMEN VOLUMETRIC WATER CONTENT}_{PD} - \text{WOOD DENSITY}$$

- Vessel-tissue contact fractions (vessel-ray, vessel-axial parenchyma, vessel-fibre) each explained an additional ~10% of variation in capacitance$_{pd-md}$.
- Average relative water content was 0.65±0.13 and average volumetric water contet change between predawn and midday was 0.04±0.02 (Fig. 3).

CONCLUSIONS

- Tissue fractions don't seem to limit capacitance$_{pd-md}$ across the studied species.
- Rather, capacitance$_{pd-md}$ may depend on total stored water, bulk wood properties resulting from wood density (e.g. elastic shrinkage) and tissue connectivity.
- Relative water content values indicate parts of wood are devoid of water.
- Small volume of water released between predawn and midday imply that water could be released from any tissue and more sophisticated techniques need to be used to observe this phenomenon.

SIGNIFICANCE

This study challenges the conviction that more parenchyma provides higher wood capacitance. The functional meaning of vast parenchyma fraction variation remains unclear and intriguing.

THIS WORK IS AVAILABLE AS A PREPRINT ON BIORXIV LINK

ACKNOWLEDGEMENTS
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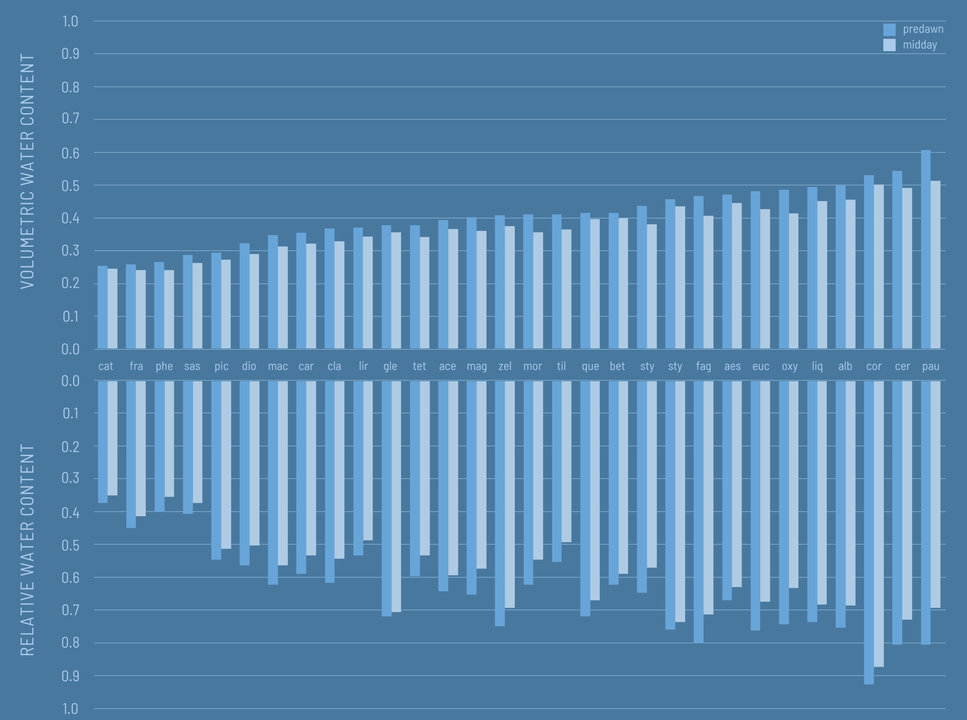

FIGURE 3. Volumetric and relative water content. 'Volumetric water content' is the volume of water in a fresh wood sample per volume of that entire sample (water+wood). 'Relative water content' is the mass of water in a fresh sample per mass of water in a saturated sample. Caution: some of the water may be within cell walls. 'gle' three letter code stands for first three letters of the genus in Latin.