Inherent expression of water relation traits in eucalypts are strongly influenced by the environment

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In increases in tree and forest drought mortality worldwide → forest ecosystems impacted in many areas

Drought events are predicted to increase due to climatic changes

Need to understand how trees adapt to drought, why and when they are vulnerable

Need to understand the relevance of key functional traits

Traits linked to hydraulic vulnerability are linked to tree mortality
Eucalypts are a widely distributed genus
>900 different species
Occurs in almost every ecosystem in
Australia
Many eucalypts have very narrow climatic ranges. Over 140 eucalypt species in Victoria (SE Australia).
Meta-analyses indicate → drought tolerant water relation traits mainly in arid landscapes

More arid climate:

- Lower turgor loss point
- Lower minimum water potentials
- Lower vulnerability to cavitation
- More anisohydric behaviour (tolerance of low Ψ, weaker control of gₛ)
  (Bartlett et al 2012, Choat et al 2012, Klein 2014)

BUT

Trait vs climate relationships investigated mainly in distantly related species

How is this expressed within ONE genus that grows everywhere???
Objectives

What are the water relation strategies within one genus (*Eucalyptus*)?

Does expression of water relation traits depend on climate?

- How important are water relation traits for the distribution of eucalypts?
- Are these traits expressed inherently?
- How plastic are these traits?
- Do we observe adjustment of traits?
- Common garden in Melbourne,
- 20 eucalyptus species from contrasting environments, grown from seed
- 2 yo trees, well watered at time of measurement
- 6-10 replicate trees

- **pV curve** traits by bench-drying method
  http://landflux.org/Tools.php

- **P<sub>50</sub> leaf** according to Brodribb & Holbrook 2003
TLP & osmotic potential are correlated to mean annual rainfall

Significant correlations btw TLP & OP and mean annual rainfall
Species from more arid environments have lower TLP and more solutes
→ Inherent expression of traits, strong genetic control over trait expression
Eucalypts from more arid environments:
→ Less vulnerable to cavitation
→ Lower P50
→ Much lower P88
→ Have a greater hydraulic safety margin (difference btw TLP and P88)
• PV curves in spring (wet) and in autumn (dry)
• Similar adjustment for osmotic potential & TLP (relationship holds in drought)
• Equal shift of osmotic potential & TLP (~0.6 MPa), similar adjustment regardless of origin
  → similar response to similar stress?
Are wet eucalypts isohydric and arid ones anisohydric?

Midday water potential ($\Psi_{\text{leaf}}$) was more negative in summer & autumn than in spring.

Species from drier and wetter climates showed similar change from wet to dry seasons.

→ all species are anisohydric
Stomatal control of water loss

High conductance in all species in spring (wettest season)

Stomatal conductance reduced in all species in summer and autumn

Arid species maintained higher conductance in the summer (dry season) compared to mesic species
Trait variation within a species?

Two species with broad climate range, 9 provenances each, glasshouse.

- More arid species: 495 – 750 mm mean annual rainfall
- More mesic species: 710 – 1500 mm mean annual rainfall

**E. melliodora**

- Turgor loss point (MPa) vs. mean annual rainfall (mm)
- \( R^2 = 0.29 \)
- More arid species has lower TLP, consistent with species differences

**E. obliqua**

- Turgor loss point (MPa) vs. mean annual rainfall (mm)
- \( R^2 = 0.02 \)
- No relationship between climate of origin and TLP **within** a species
  → Need to assess plasticity of traits in the field
Strong correlations between tree traits and rainfall in SE AUS eucalypts

Greater aridity →
- smaller trees
- denser wood
- smaller and thicker leaves

Ellis & Hatton (2008) AgWatMgmt 95: 743
Conclusions – southern eucalypts

What are the water relation strategies within one genus?
All species show a degree of anisohydrie

Does expression of water relation traits depend on climate?
Yes, more negative water relations traits in more arid species BUT not populations

• How important are water relation traits for the distribution of eucalypts?
  Probably important, inherently expressed, chronic vs transient drought

• Are these traits expressed inherently?
  Yes, expressed also under non-stressed conditions

• How plastic are these traits? Do we observe adjustment of traits?
  Similar degree of plasticity, experimental design? Field?