

Mistletoe infection alters the transpiration flow path and suppresses water regulation of host trees during extreme events



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Overview

- 1) Background on mistletoes
- 2) Assumptions
- 3) Water use of mistletoes
- 4) Ecosystem implications of mistletoe infection
- 5) Mistletoe and tree mortality

Background on mistletoes

Establishment

- spread by birds
- hemi-parasite that relies on host tree
- attaches to branch and taps into xylem
- redirects carbon, nutrients and water
- forms dense branch structure



Benefits of mistletoe presence

- fertilization effect on soil through high leaf turnover
- keystone species for floral and faunal biodiversity

Background on mistletoes

Mistletoe physiology

- lower photosynthesis rates
- maintains lower water potentials
- minimal to no stomatal regulation
- higher transpiration rates
- cooling effect on the ecosystem
- favourable microclimate in mistletoe clumps during warm days



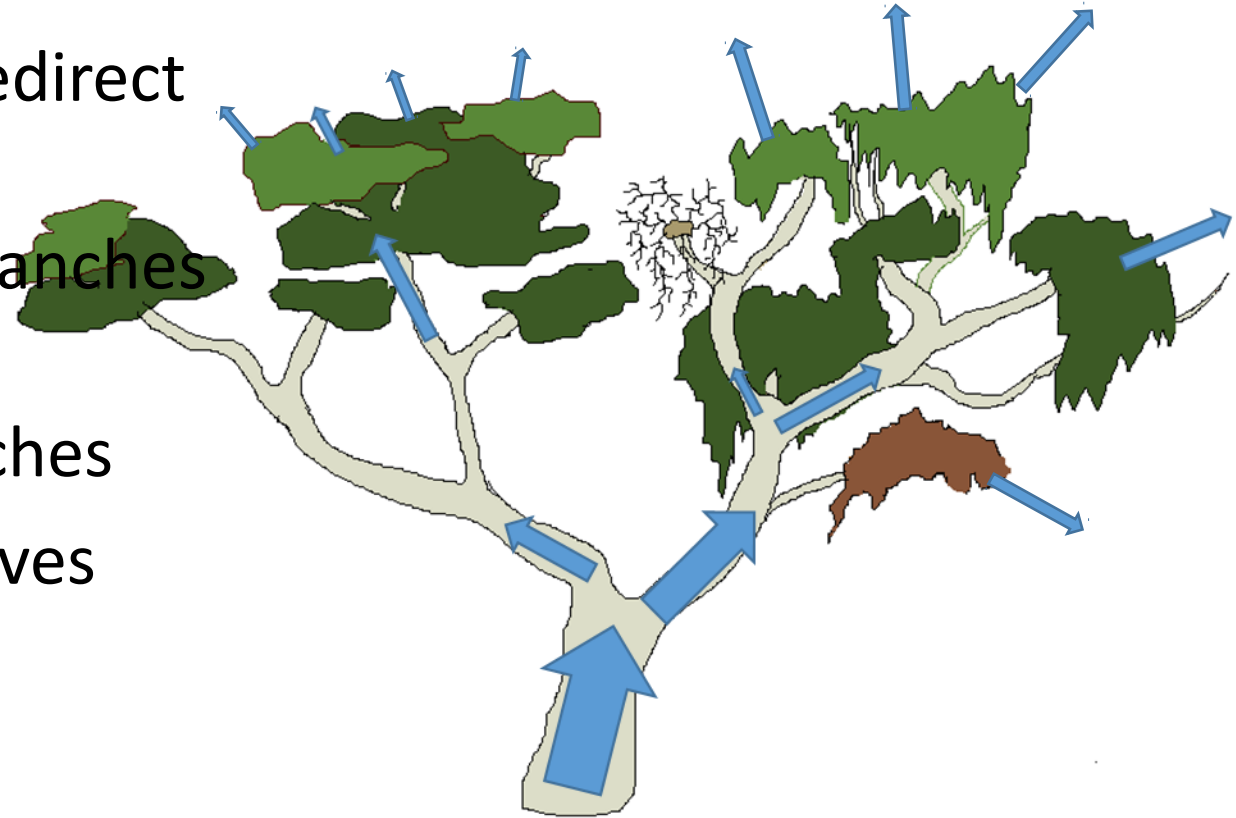
Photo from AU-Cum tower by Wouter Maes

Photo from Skye Wassens

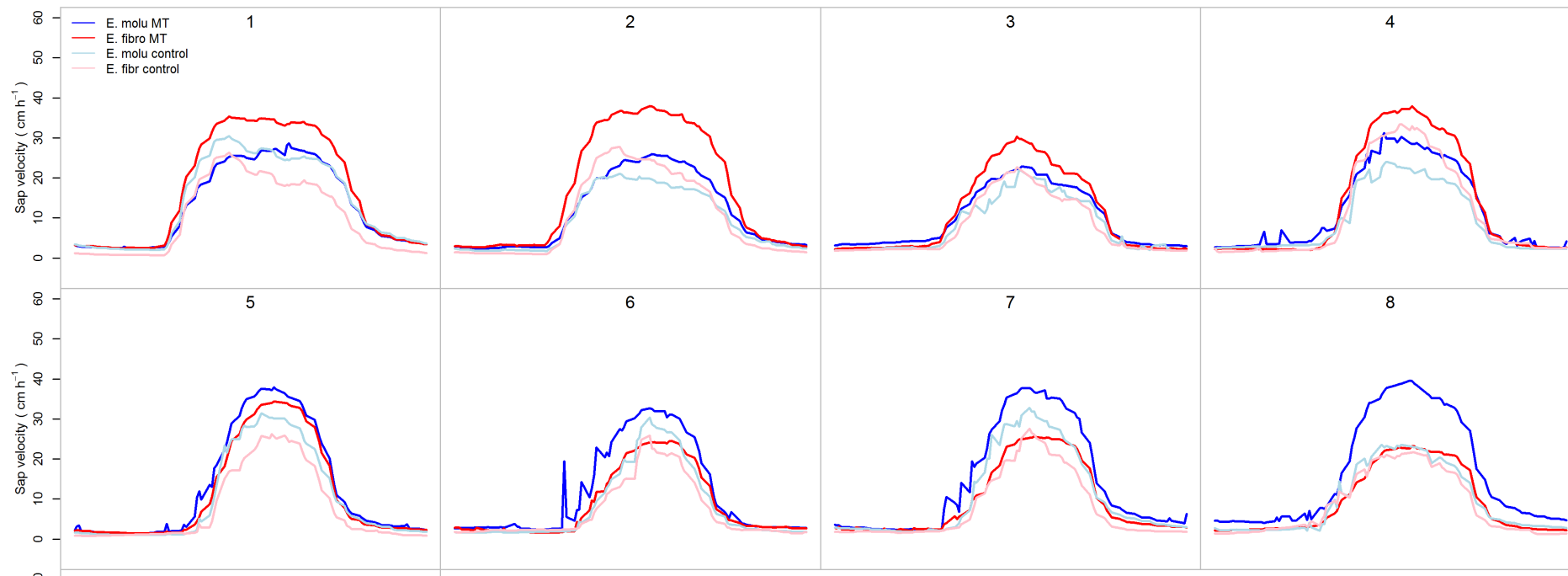
Assumptions

Mistletoe redirects water flow path in host tree

- maintains lower water potentials to redirect water towards mistletoe branch
- higher water flow towards infected branches vs. uninfected branches
- exaggerates water stress in host branches
- increased stomatal closure of host leaves
- *water leaks out through the mistletoe*
- *higher overall water use of infected vs. uninfected trees*

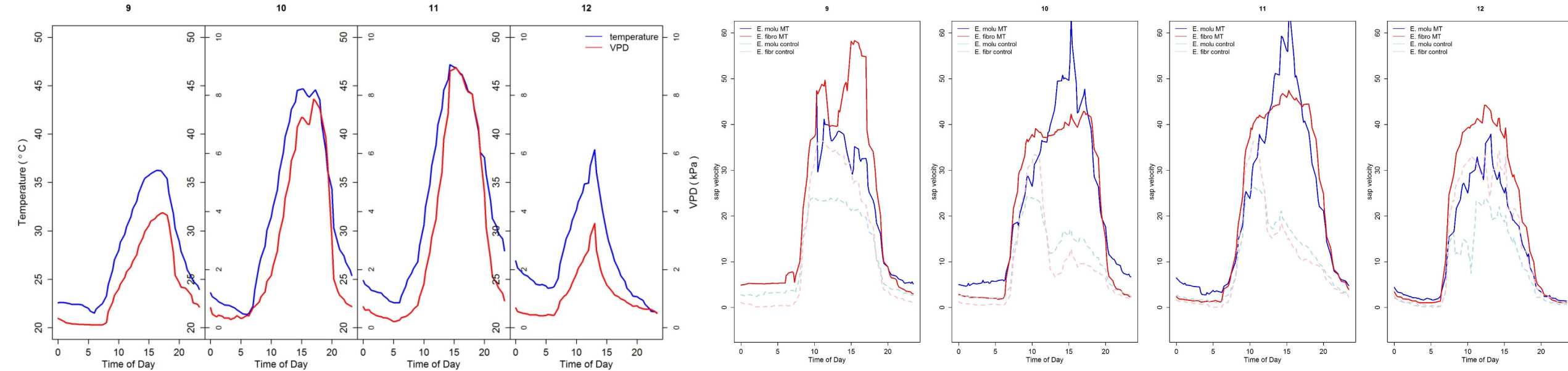


Water use of mistletoes (*monthly scale*)



- monthly diurnals of sap velocity from infected vs. uninfected trees
- infected trees have higher water use than uninfected trees in every month
- uninfected trees show decreased sap velocity rates in the arvo in warm months (January – April)

Water use of mistletoes (*extreme heat*)



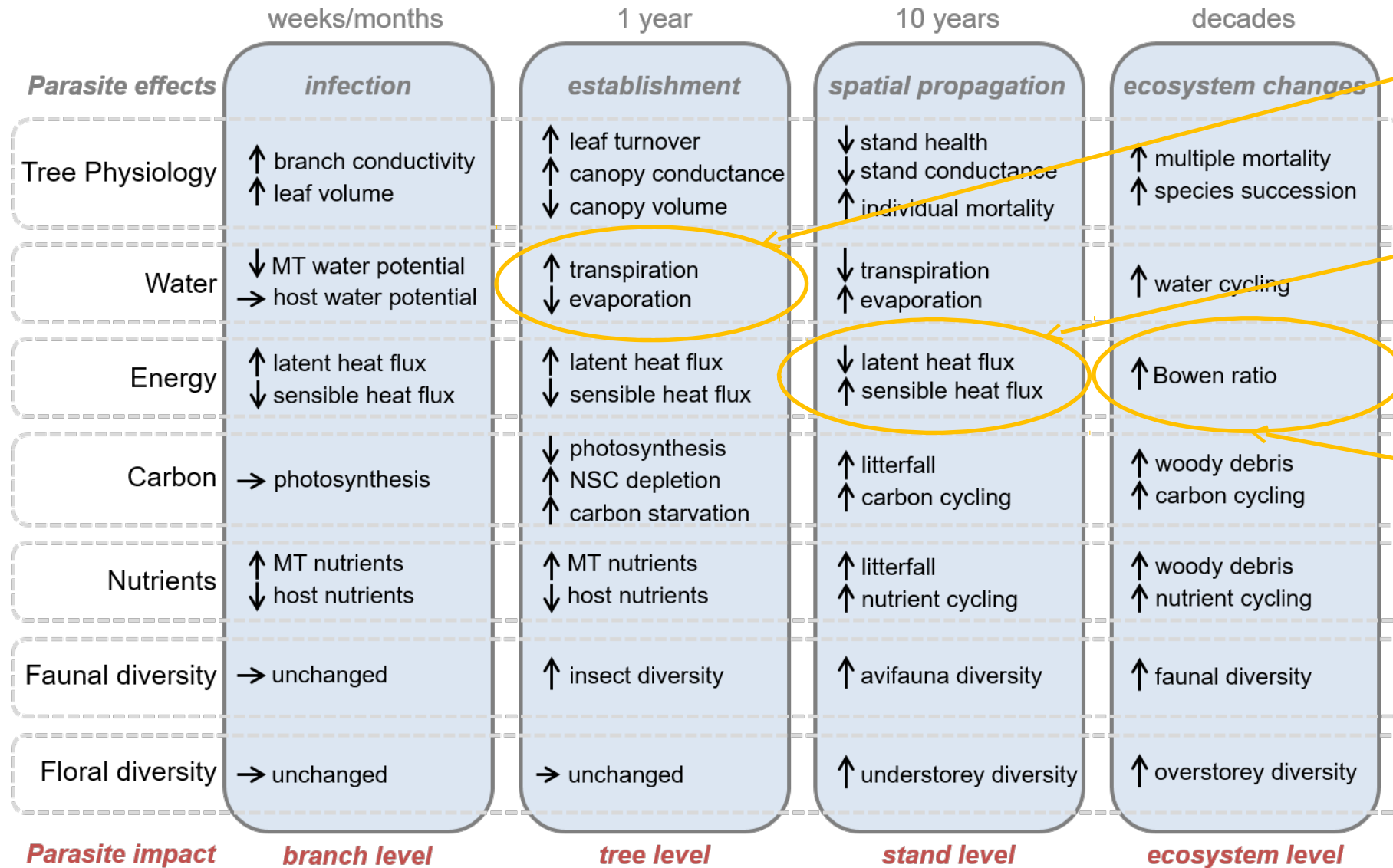
- 4 days during extreme heat in February 2017
- peak air temperature: 47 °C / 117 F
- peak vapour pressure deficit: >9 kPa

- sap velocity measurements indicate unregulated water use of infected trees
- water use of uninfected trees declines with increasing VPD

Ecosystem implications

	weeks/months	1 year	10 years	decades
<i>Parasite effects</i>	<i>infection</i>	<i>establishment</i>	<i>spatial propagation</i>	<i>ecosystem changes</i>
Tree Physiology	↑ branch conductivity ↑ leaf volume	↑ leaf turnover ↑ canopy conductance ↓ canopy volume	↓ stand health ↓ stand conductance ↑ individual mortality	↑ multiple mortality ↑ species succession
Water	↓ MT water potential → host water potential	↑ transpiration ↓ evaporation	↓ transpiration ↑ evaporation	↑ water cycling
Energy	↑ latent heat flux ↓ sensible heat flux	↑ latent heat flux ↓ sensible heat flux	↓ latent heat flux ↑ sensible heat flux	↑ Bowen ratio
Carbon	→ photosynthesis	↓ photosynthesis ↑ NSC depletion ↑ carbon starvation	↑ litterfall ↑ carbon cycling	↑ woody debris ↑ carbon cycling
Nutrients	↑ MT nutrients ↓ host nutrients	↑ MT nutrients ↓ host nutrients	↑ litterfall ↑ nutrient cycling	↑ woody debris ↑ nutrient cycling
Faunal diversity	→ unchanged	↑ insect diversity	↑ avifauna diversity	↑ faunal diversity
Floral diversity	→ unchanged	→ unchanged	↑ understorey diversity	↑ overstorey diversity
<i>Parasite impact</i>	<i>branch level</i>	<i>tree level</i>	<i>stand level</i>	<i>ecosystem level</i>

Ecosystem implications



Initially increased cooling through LE ↑

when too abundant decreased cooling through LE ↓

Mistletoe modifies the energy balance of the ecosystem

positive + negative feedback with climate change

Mistletoe amplifies mortality

- Mistletoe distribution is increasing in SE Australia (*Turner et al., 2016*)
- Mistletoe distribution is shifting northwards with warming climate (*Dobbertin et al., 2006*)
- Higher mortality in forests with mistletoe in combination with droughts



- Mistletoe infection adds stress on host tree on top of increased climate stress
- With a warming climate extreme heat and prolonged droughts will be more frequent
- We anticipate that mortality rates in infected forests will increase further

Questions?!



Thank you

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