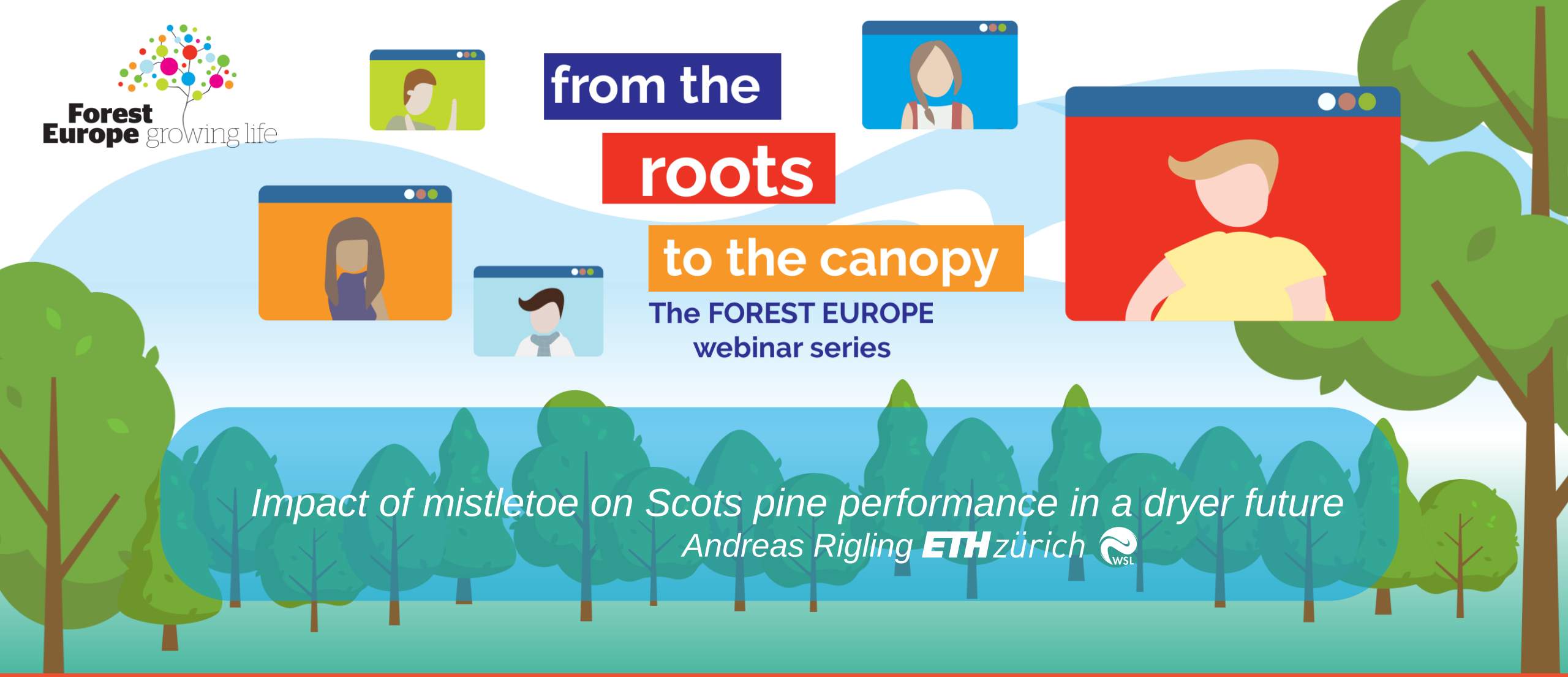
Forest Europe growing life

from the roots to the canopy

The FOREST EUROPE webinar series



Impact of mistletoe on Scots pine performance in a dryer future

Andreas Rigling ETH zürich WSL

Drought Adaptation of Forests in Europe
Practical strategies

FoRISK

Storyline - „Impact of mistletoe on Scots pine performance in a dryer future”

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→ Ecology
of pine mistletoe

→ Physiology
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→ Impact on tree
performance

→ Consequences on
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→ Consequences for
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Mistletoes

- World-wide > 1100 different mistletoe species
- The genus *Viscum* with approx. 70 evergreen species
- In Europe four different species of *Viscum*:
  - *Viscum album ssp. abietis* (on *Abies*)
  - *Viscum album ssp. album. (> 10 different broadleaved sp.)*
  - *Viscum album ssp. Austriacum (*on *Pinus, Picea, Larix)*
  - *Viscum album ssp. Creticum (*on *Pinus brutia)*
- Hemiparasitic evergreen shrubs growing on woody plants, draws water and nutrients from the host trees but carries out its own photosynthesis

e.g. Wang et al. 2023: Frontiers in Forest and Global Change

Ecology of pine mistletoe (*Viscum album ssp. Austriacum*)

Seed ripening in winter

Seed distribution by birds, e.g. the mistle thrush (*Turdus viscivorus)*

Seed are regurgitated from crop or excreted in droppings

Germination on pine bark with the help of an adhesive disk

Start of infestation

Max. age > 30 yrs

No active penetration of the root (haustorium) to the branch, but enclosure by the wood over the years. (Photo: Phyotpathology, WSL)

- Light demanding and warmth-loving plant, mistletoe thrives particularly well on young host branches in the upper part of the treetops → sensitive to Climate Change…

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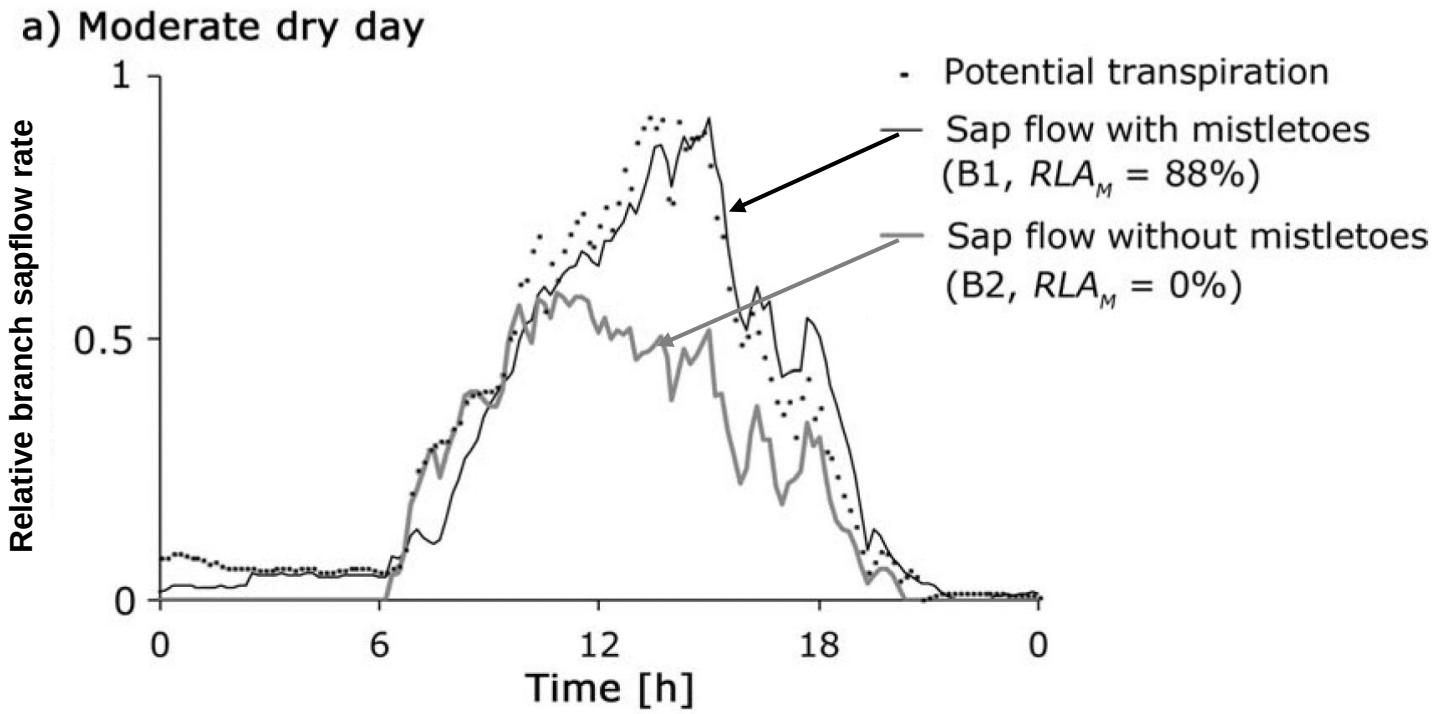
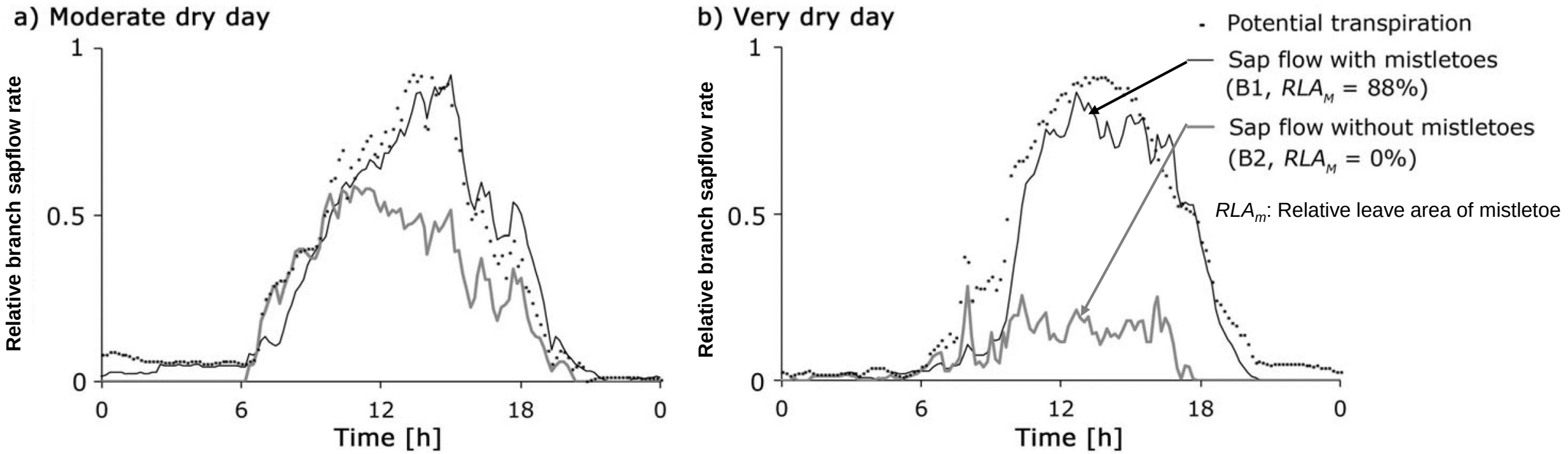
Mistletoe and sapflow



Zweifel et al. 2012: Experimental Botany

Mistletoe and sapflow

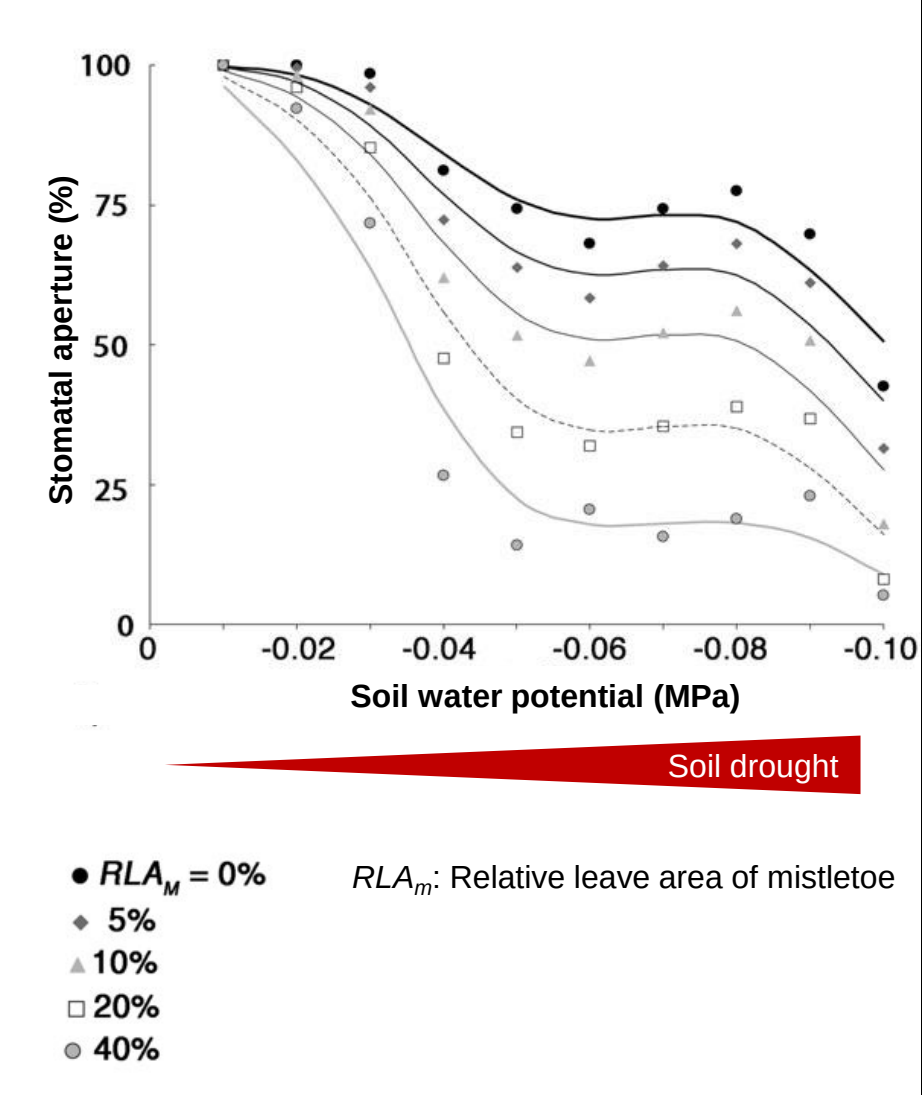


- Mistletoe hardly regulates its stomata
- Pines regulate their stomata to reduce transpiration during drought.

→ Pines have to compensate for the additional water loss caused by mistletoe by closing their own stomata.

Zweifel et al. 2012: Experimental Botany

Mistletoe and stomatal aperture / carbon assimilation



- Despite the reduced stomata opening, the total water loss of the branches with mistletoe increases
  → Mistletoe is increasing the drought stress for pine during drought (atmospheric (VPD) and soil drought)

- Closed stomata reduce the carbon assimilation of the pine by up to 80%! This negative effect of mistletoe on the stomatal conductivity and carbon uptake of the pine was particularly pronounced during dry periods.

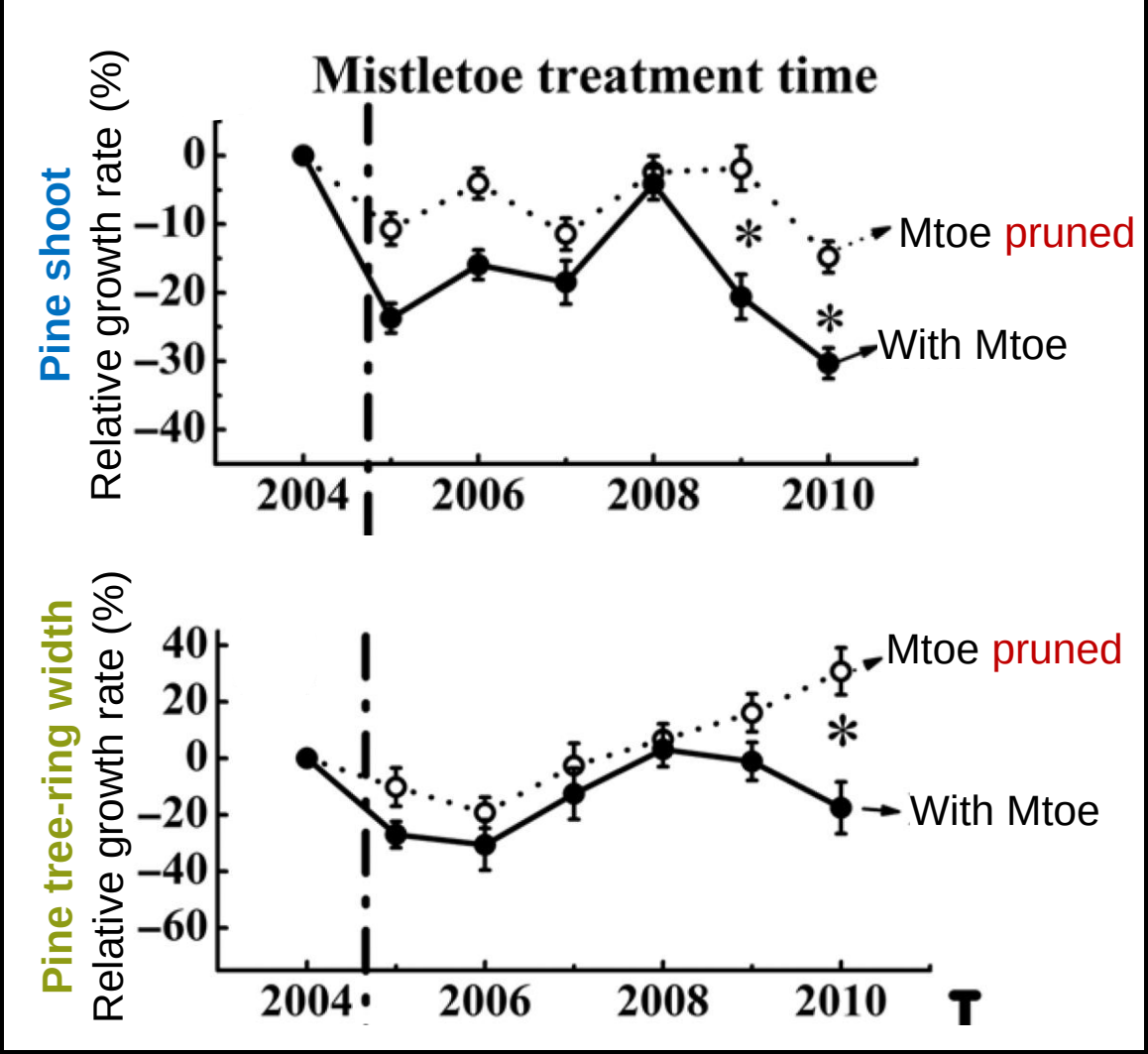
Zweifel et al. 2012: Experimental Botany

Mistletoe pruning experiment – can pine branches recover?

Can pruning of mistletoes reduce the drought stress of the host tree?

Yan et al. 2016: *Tree Physiology*

Mistletoe pruning experiment – can pine branches recover?



Can pruning of mistletoes reduce the drought stress of the host tree?

Mistletoe pruning leads to an increase in:

- Needle length, single needle area, nitrogen, soluble sugars and NSC in the pine needles
- Annual ring width and shoot growth of the pine branch

Yan et al. 2016: *Tree Physiology*

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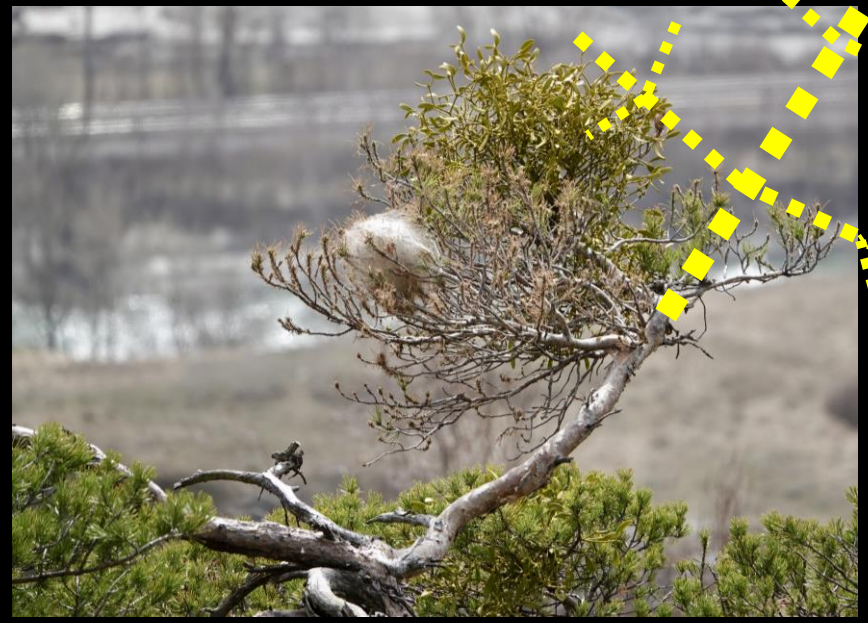
Mistletoe and growth of pine branches

Mistletoe has a negative effect on the pine branch- it reduces:

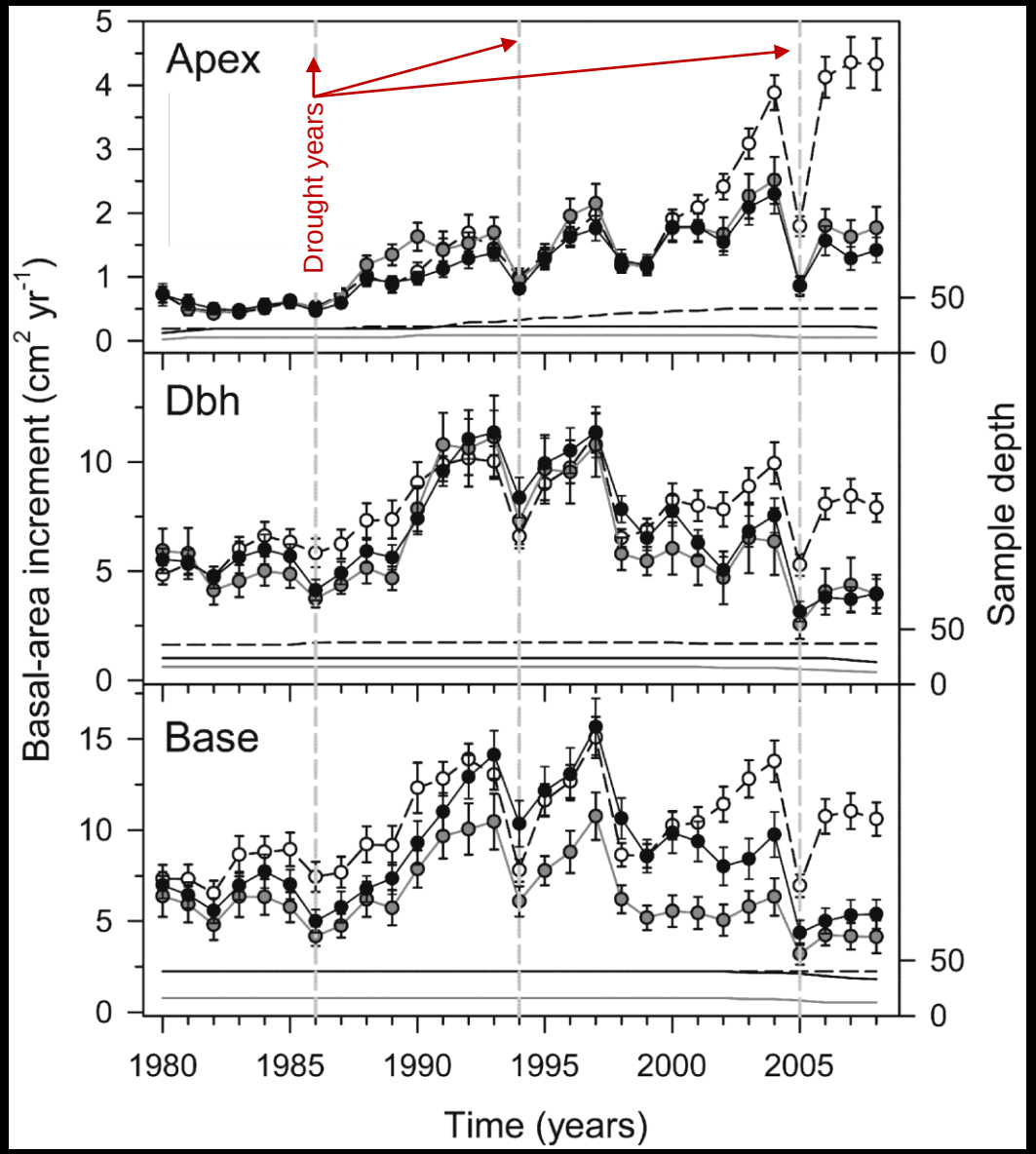
Moderate infestation



Severe infestation

- Branch diameter
- Branch length
- Ramification
- Needle length
- Needle years
- Needle mass

Mistletoe impacts defoliation, growth & water-use efficiency and of pines



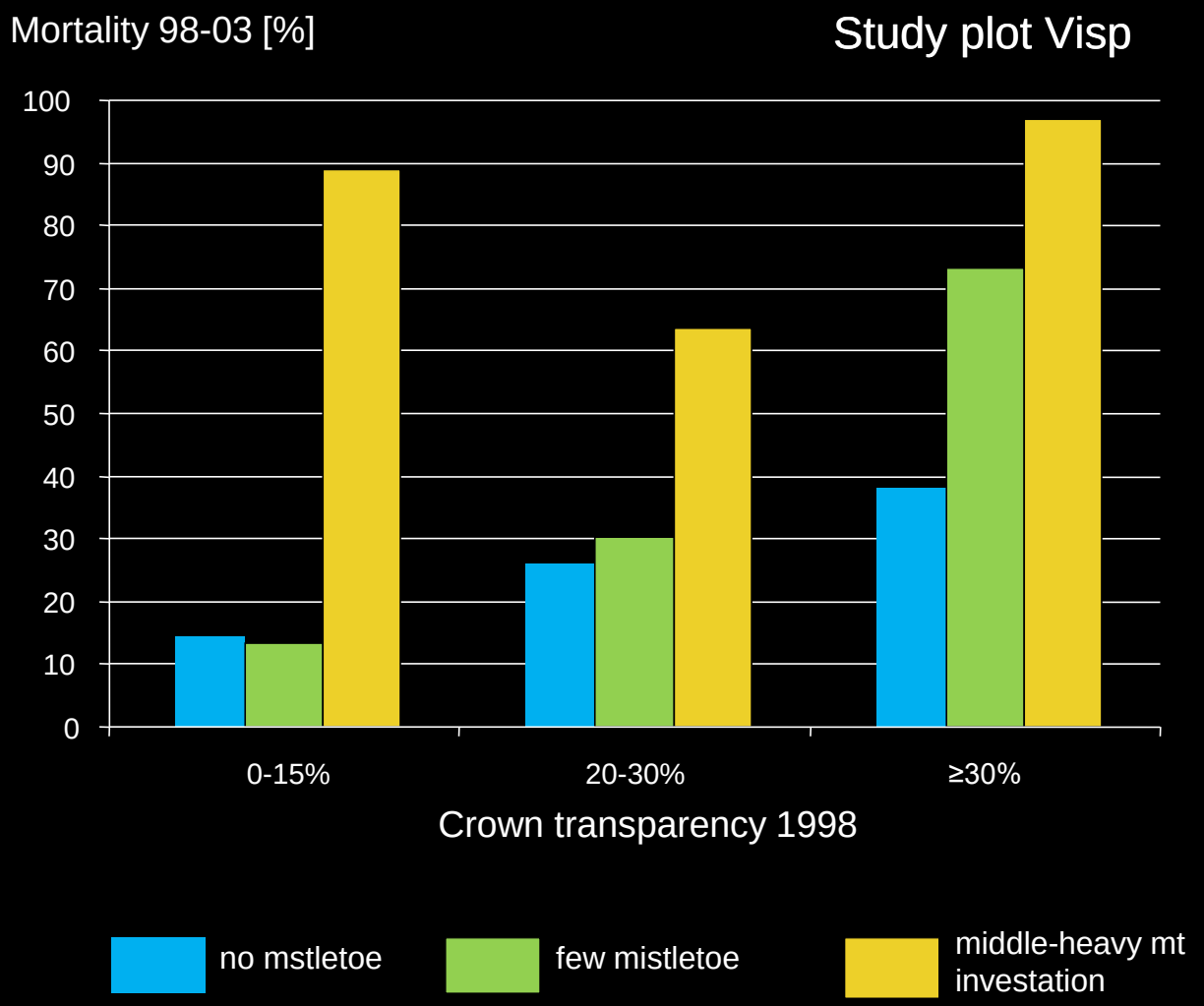
- Mistletoe mistletoe infestation increased defoliation and induced growth decline in host trees. The decline in radial growth was exacerbated by drought stress.

Sangüesa-Barreda et al. 2012: Tree Physiology

Camarero et al. 2019: Dendrochronologia

Bilgili et al. 2020 Scandinavian J Forest Research

Mistletoe and pine mortality



- Mortality rates are significantly higher for mistletoe-infested pines

Dobbertin & Rigling 2006: Forest Pathology

Galiano et al. 2010: Ecosystems

Impressions

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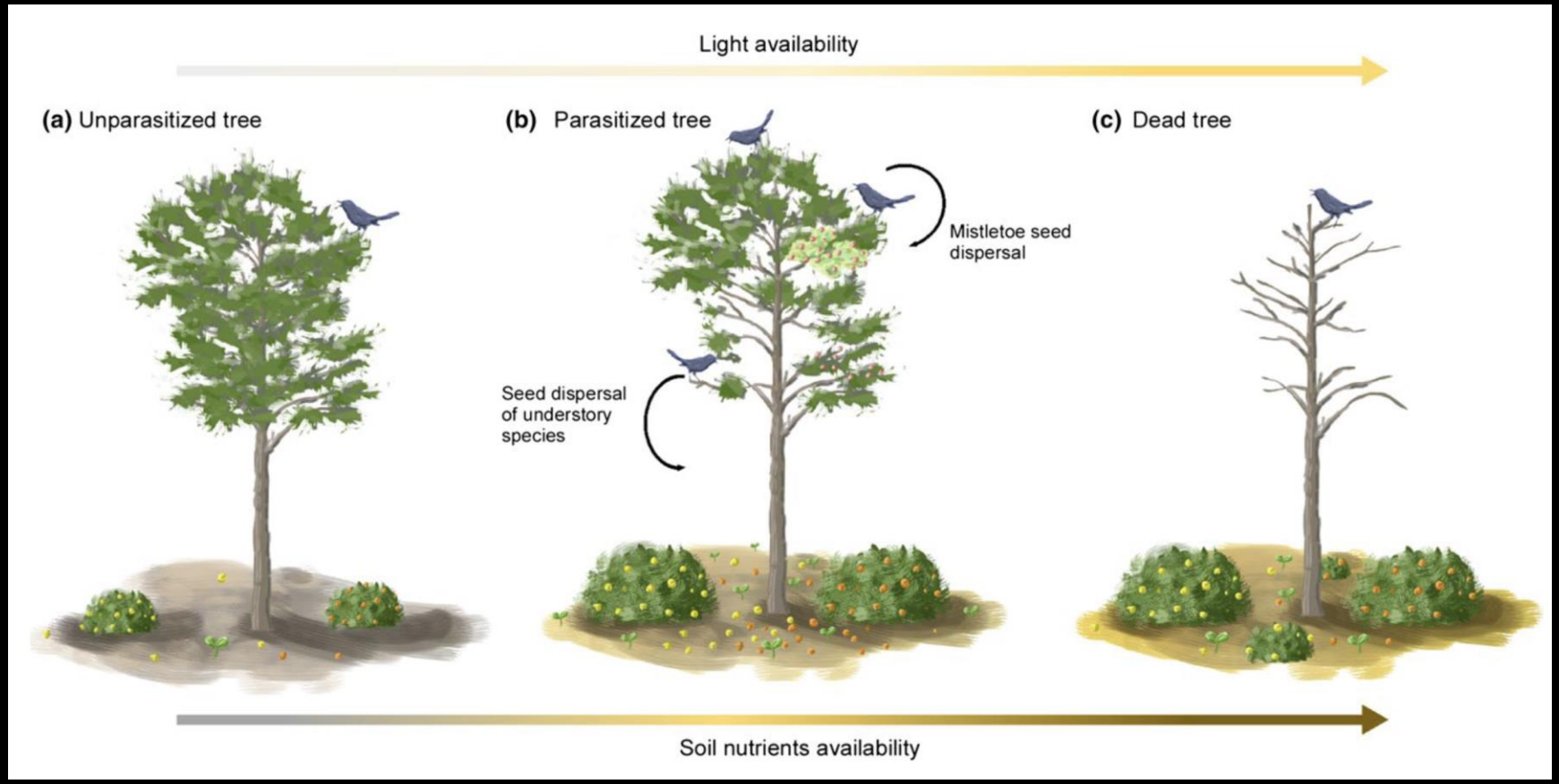
Impressions

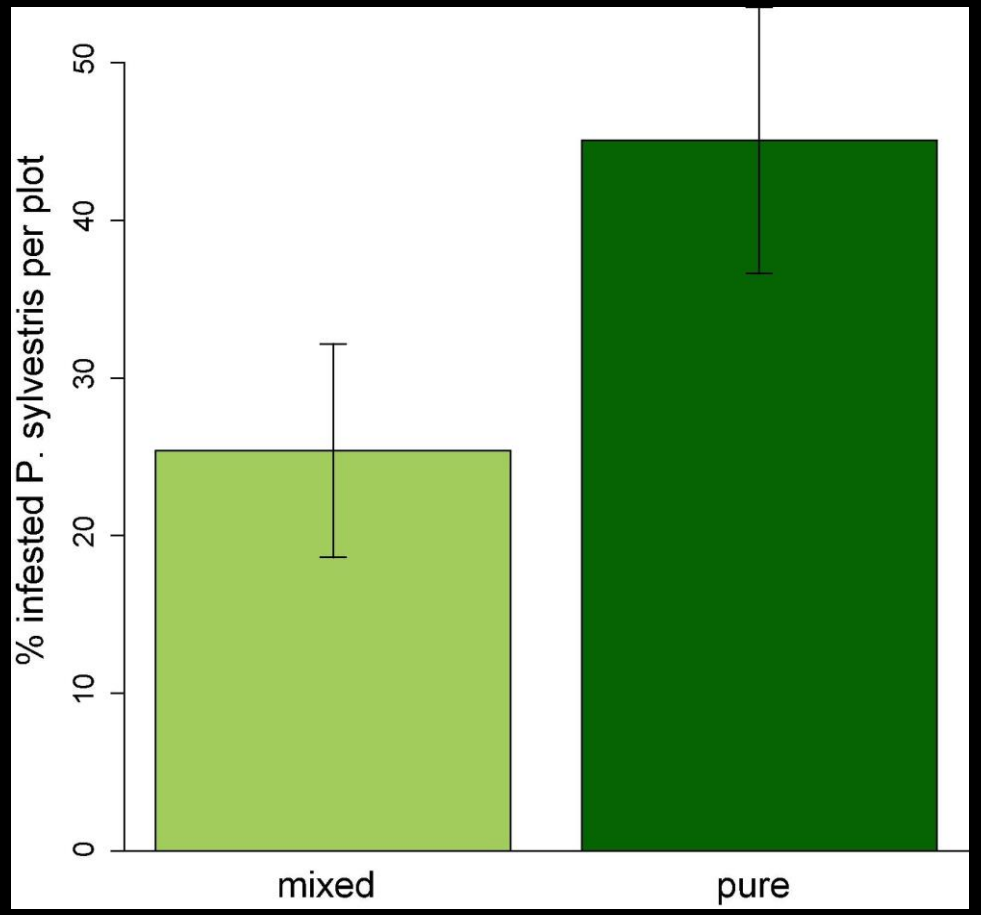
Mistletoe changes soil nutrient and light availability in pine stands



- Mistletoe increased amount, quality, and diversity of organic matter input beneath the host canopy, directly through its nutrient-rich litter and indirectly through a reduction in host litterfall and an increase in bird-derived debris → promoting changes in shrub and tree species composition

Mellado et al. 2016: New Phytologist
Mellado & Zamorra 2017 Functional Ecology

Tree diversity reduces mistletoe infestation of Scots pine



- Mistletoe infestation was higher in pure Scots pine stands than in mixtures with maritime pine (*Pinus pinaster*).

- Resistance against infestation was partly driven by relative tree height → the bigger the tree compared to the surrounding trees, the higher the risk being infested.

Van Halder et al. 2019: Forest Ecology and Management

Summary

- Scots pine (*Pinus sylvestris*) is increasingly suffering from hotter droughts.
- Pine mistletoe (*Viscum album* ssp. *Austriacum*) is a hemi-parasite depriving water and nutrients from its host tree Scots pine.
- Mistletoes are currently increasing in abundance in many European regions and increasing its range of distribution.
- Mistletoe infection can alter processes of tree performance and forest dynamics:
  - ➢ negative effects on vegetative and reproductive development, the water status and hence, can decisively increase drought stress of the host tree
  - ➢ potentially positive effects on nutrient cycling and regeneration dynamics of forest ecosystems

  → overall mistletoe have the potential to alter forest dynamics and in the long term contribute to reshape our forests in structure and species composition.

Thank you for your attention

ETH zürich WSL