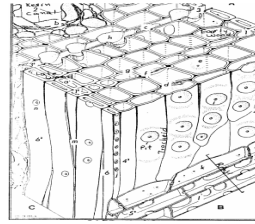


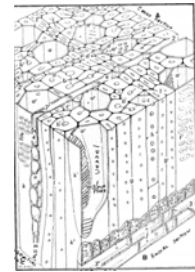
Impacts of Xylem Structure on Seedling Growth

Patrick Sowers
Kellen Ryan
Adaptation Report

Structural Comparison Tracheid vs. Vessel



Gymnosperm Xylem



Angiosperm Xylem

Main Question

- Do gymnosperm & angiosperm seedlings show distinct patterns of light adaptation and growth that is attributed to the presence/absence of vessels in xylem structure?



Motivation for the Question

- Evolution of vessels in angiosperms may explain movement of early angiosperms out of the understory
- Better understanding of why gymnosperms are nearly absent in lowland subtropical and tropical forests.

Testing Angiosperms versus Gymnosperms

- Species used
 - Gymnosperms:
 - Family Podocarpaceae
 - » Nageia fleuryi
 - » Podocarpus greyii
 - » Dacrycarpus dacrydioides

Large leaved pan-tropical species chosen for their similarity to angiosperms with the exception of vessels

Species Involved: Gymnosperms

Nageia fleuryi



Dacrycarpus dacrydioides



Podocarpus

Angiosperms

- Angiosperms
 - Family Rutaceae
 - » Flindersia Breyleyana
 - Family Meliaceae
 - » Toona australis
 - Family Myrtaceae
 - » Eucalyptus regnans

Angiosperms

Flindersia Brayleyana



Toona australis



Eucalyptus regnans

Growth Measurement

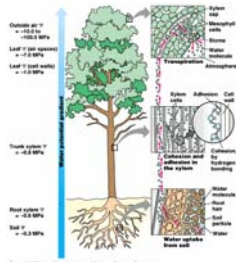
- Seedling stage was used to observe differences because this is the stage where competition is greatest and where conifers suffer competitive exclusion by angiosperms
- Leaf and stem growth measured over a 250 day period
- Low light conditions and high light conditions used to observe variability in conduction and support

Hydraulic Conductivity

- Hydraulic Conductivity
 - Measured as the flow of water over the potential gradient per sapwood area in the stem (K_{sp})
 - Also expressed as (K_1), hydraulic conductivity per leaf area

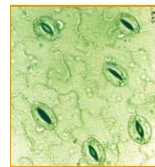
Hydraulic Conductance Cont.

- Gymnosperms have lower hydraulic conductivity than do angiosperm xylems due to lower cross sectional areas in tracheids in comparison to vessels
- Gymnosperms compensate by:
 - 1) Carrying less foliage per leaf
 - 2) Produce lower rates of water loss (and photosynthesis) per leaf
 - 3) Creating a larger potential water gradient than angiosperms



Stomatal Conductance

- Maximum stomatal conductance measured in both high and low light in mmol per area over time



Authors Involved

- T.J. Brodribb, member of the Department of Plant Science at the University of Tasmania, Australia
- R.S. Hill, member of the Department of Environmental Biology at the University of Adelaide, Australia
- N.M. Holbrook, professor of biology in the Department of Organismic and Evolutionary Biology at Harvard University

Results & Authors Positions

- “Hydraulic conductivity when normalized to leaf area is still generally lower in conifers than in associated angiosperms” (Brodribb 750).
- Inference...possible obstructions in tracheids especially during cold and freezing
- “Hydraulic conductivity of seedling angiosperm stems (K_{sp}) was substantially higher than that of seedling conifer stems (Brodribb 753).
- Inference...absence of vessels in conifers limits hydraulic conductivity

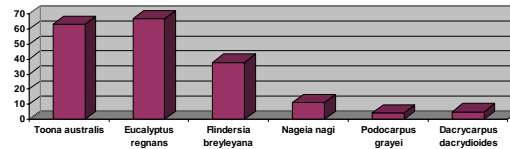
Results & Authors Positions

- “There is evidence that conifer wood is more resistant to dysfunction at low H_2O potentials than associated angiosperms” (Hill 750).
- Inference: low H_2O potentials have little if any threat to cause disturbances in conifer tracheids
- “Recent studies suggest that conifer and angiosperm leaves display consistently different physiologies with respect to hydraulics and gas exchange” (Brodribb and Holbrook).
- Inference: research is still needed to fully understand the differences between angiosperms and gymnosperms

Leaf Area Growth Rates of Selected Angiosperms & Gymnosperms

X axis: Species

Y axis: Growth rate cm^2



Can you guess which 3 species are the angiosperms?

Relevance of This Research to Class Discussion and Learning

- Adaptation of trees and plants in sun vs. shade conditions...(i.e.). Angiosperms may have evolved in under story of forests where less light gave way to the need for adequate H_2O and nutrient transport
- Tree growth, competition, and dominance or co-dominance