# CENTRE FOR ENHANCED FOREST MANAGEMENT

## ADVANCES IN FORESTRY RESEARCH

DEPARTMENT OF RENEWABLE RESOURCES

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## Does shading affect the ability of trees to conduct water?


SCHOONMAKER A.L., LIEFFERS, V.J., LANDHÄUSSER, S.M., HACKE, U.G., AND M.T. TYREE


Shade tolerance has long been assumed to be related to a tree's ability to photosynthesize in low light and display its foliage in a way that maximizes light capture in understory conditions. There has been little work to assess if trees growing in the shade actually change their ability to conduct water or if they can protect their xylem from cavitation (formation of air bubbles in the wood that stops water flow up the stem) when exposed to high light conditions.

**Methods:** We grew white spruce, black spruce, jack pine and lodgepole pine in understory and open conditions for 6 years. On the leading shoots we measured flow rate of water through the xylem, the vulnerability to cavitation of the xylem, and examined the border pits with a scanning electron microscope, which are the small pores connecting tracheids in the xylem and can act as a potential 'pinch-points' for the flow of water through the stem.

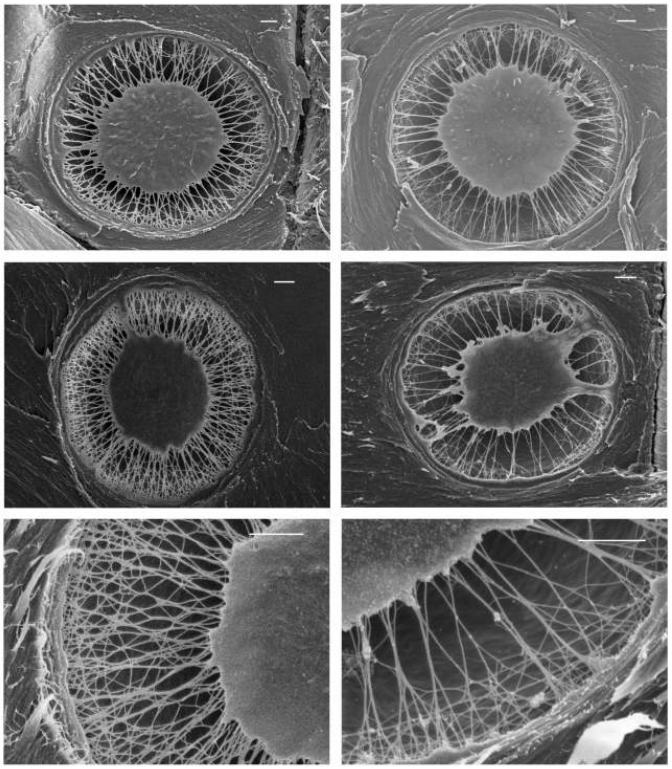
**Results:** On average, understory trees tended to have greater flow rates of water (relative to xylem area) than open-grown trees, but surprisingly understory trees had smaller tracheid diameter.

Trees growing in an understory were more vulnerable to to cavitation which is counter intuitive to the decreased tracheid diameter.

Border pits of understory grown trees were more fragile than pits of open-grown trees. They had a much lower density of filaments to support the torus (the central disc that seals the pit during times of stress, see figure). This resulted in a reduced impact of the border pits as pinch points between the narrower tracheids and therefore allowed for increased flow of water.

**Implications**: Understory trees grew wood that conducted water relatively easily despite living in a shaded and resource-poor environment. In the understory border pits became more fragile, making them more vulnerable to cavitation. This suggests that the hydraulic systems produced in understory trees could be damaged by severe moisture stress.

Silvicultural treatments that rapidly expose these understory grown trees to the more demanding conditions of full light and increased wind could induce cavitation and with that loss of productivity.



*Top two images show typical bordered pit structures of open (left) and understory grown (right) lodgepole pine; Middle images show open (left) and understory grown (right) black spruce, bottom images are a close-up views of the margo (the filamentous zone where water passes through). White bar represents 1 µm.*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**Further Information:**


Schoonmaker, A.L. Hacke U. G., Landhäusser, S.M. Lieffers, V.J., Tyree M.T. 2010. Hydraulic acclimation to shading in boreal conifers of varying shade tolerance. Plant Cell and Environment In press


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Centre for Enhanced Forest Management, Dept. of Renewable Resources, U. of A., Edmonton, AB T6G 2H1

Victor.Lieffers@ualberta.ca;