



## **A new good candidate for a long distance signaling of mechanical strain events: the hydraulic pulses**

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# A new good candidate for a long distance signaling of mechanical strain events: the hydraulic pulses

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## Abstract

Wind is known to increase water stresses by increasing evaporation rates, but a possible additional negative effect of wind sways mechanically impairing water conductivity has remained disputed. Coupling flow-meters and pressure sensors with a mechanical testing device, we investigated the hydraulic effects of mechanical deformation of saturated branches and stems. Experiments have been carried out on isolated branch segments of several angiosperm and gymnosperm species or *in planta* on a stem of a living tree (poplar). Permanent bending generates only a negligible effect on conductivity, even with very large deformations. This indicates that there are no major changes in the anatomical structure, i.e. mainly the vessel lumens (angiosperms) or tracheids (gymnosperms) dimensions, that could lead to a loss of efficiency of the vascular system.

Nevertheless, for the first time, we display that bending strains generate a transient high pressure variation that is able to propagate rapidly along the water conduits. We quantified these pressure pulses and we observed i) that living cells were not involved in the phenomenon, ii) an high inter-specific variability of its magnitude, iii) a proportional relationship of this magnitude with the strained volume. We hypothesize that the origin of this hydraulic pulse is the poroelastic behavior of the saturated wood material and we proposed a first modelling to explain the mechanism: during deformation of the conduits the incompressible water contained in lumens and cell walls moves in the conduits with no contribution of the living parenchyma cells. This generates a local transient overpressure in the conduit that propagates in the vascular system.

*In planta* experiments confirmed that hydraulic pulses propagate along the vascular system of the xylem symmetrically to the upper and lower regions of the stem. As a signaling process, this hydraulic behavior could be an efficient for a fast long distance signal transporting mechanobiological information to the extreme organs as leaves, roots and apices.

## Keywords

bending, strain, hydraulic, pressure, wood, trees, poroelasticity, signaling