Stem bending induces hydraulic pulse in vascular system: a physical remote signal?

J-F. Louf¹, G. Guéna¹, O. Pouliquen¹, Y. Forterre¹, H. Cochard², B. Moula², and É. Badel²

¹IUSTI Laboratory, FRANCE
²PIAF Laboratory, FRANCE

The perception of mechanical stimuli in the environment is crucial to the survival of all living organisms, and plants make no exception. At the tree scale, the bending of a stem leads to a transient growth response, not only locally but also far away from the stimulated area, suggesting the existence of a long distance signal within the plant network. The nature and mechanism of this long distance signal is not well understood, but it has been suggested that it could result from a purely hydraulic pressure signal, in response to the mechanical bending of the hydrated wood tissue. Recently, such hydro/mechanical coupling have been directly demonstrated in wood and living trees in the PIAF/INRA Laboratory. The objective of our work is to better understand the physical mechanisms responsible for this hydro/mechanical coupling by performing experiments on physical poroelastic beams mimicking stems and branches. To this end, we have designed an original three-dimensional micro-device consisting of a transparent elastomer beam (PDMS) perforated with longitudinal micro-channels and filled with a viscous liquid. The poroelastic response of this biomimetic branch to a sudden bending has then been studied in a closed geometry. The main result of this study is that the bending of the artificial branch generates a global overpressure in the system. This overpressure increases quadratically with the bending deformation, and is controlled by the pore bulk modulus of the media. We propose a simple physical model to explain our measurements and discuss the results in the context of plants.

E-mail address: jean-francois.louf@univ-amu.fr