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► **To cite this version:**

Jean-François Louf, Geoffroy Guena, Eric Badel, Bruno Moulia, Yoel Forterre. Poroelastic coupling in real and artificial branches : relation with plant mechano-perception.. Condensed Matter, Aug 2014, Paris, France. 2 p, 2014. hal-01268752

HAL Id: hal-01268752

<https://hal.science/hal-01268752v1>

Submitted on 3 Jun 2020

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Poroelastic coupling in real and artificial branches: relation with plants mechano-perception.

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Abstract

The perception of mechanical stimuli in the environment is crucial to the survival of all living organisms, and plants make no exception. At the scale of a tree, 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 range information signal within the plant network [1]. The nature and mechanism of this long range signal is not well known, but it has been suggested that it could result from a purely hydraulic pressure signal created in response to the mechanical bending of the hydrated wood tissue [2]. Recently, such hydro-mechanical coupling have been directly observed in plants at INRA, Clermont-Ferrand [3]. Our aim is to investigate the physical mechanisms responsible for this hydro-mechanical response, by performing experiments on physical poroelastic beams mimicking stems and branches. To this end, we have designed an original three-dimensional micro-fluidic device consisting of a transparent elastomer beam (PDMS) perforated with longitudinal micro-channels and filled with a viscous liquid [4], *see figure 1*. 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 model to explain this non-linear response and compare the physical system with similar experiments made on real plants.

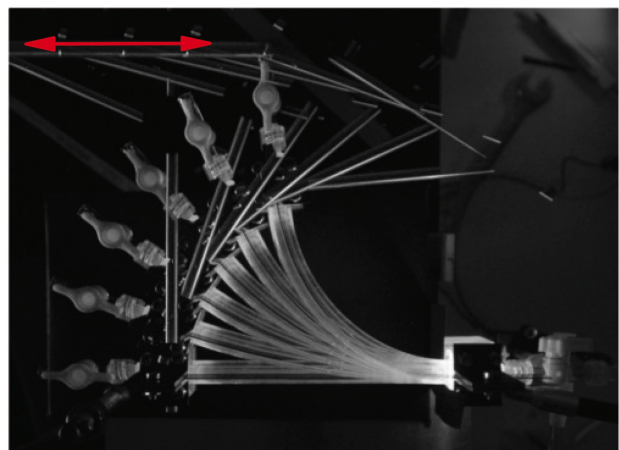


Figure 1: Artificial branch (left) and bending device (right)

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