Embolism growth in biomimetic leaves : from veins to networks

Ludovic Keiser[1], François-Xavier Gauci[1], Céline Cohen[1], Xavier Noblin[1], Philippe Marmottant[2] & Benjamin Dollet[2]

[1] Université Côte d'Azur, CNRS, INPHYNI, avenue Joseph Vallot, 06000 Nice
[2] Université Grenoble Alpes, CNRS, LIPhy, 140 rue de la Physique, 38402 Saint-Martin-d'Hères
ludovic.keiser@univ-cotedazur.fr

In case of drought, the water in the xylem hydraulic circuits of trees falls down to very negative pressures. Cavitation bubbles can nucleate, initiating an air embolism that propagates, a process called air-seeding, leading to the failure of the water circulation. Observations on real leaves showed that the embolism advances by a succession of long stops and sudden jumps. To understand the nature of jumps, we propose an experimental model using biomimetic leaves in silicone (PDMS), made of a thin water-permeable membrane [1,2]. The veins of these artificial leaves are channels filled with water, and here we have introduced constrictions to mimic the pits in between real leaf channels. We observed that the jumps after each constriction are due to the sudden release of an elastic deformation of the channels, occurring when the meniscus is pinned and evaporation continues. The jumps of the meniscus can reach directly the next constriction (when it is nearby) or can reach the inside of the next channel and are followed by a slow progression of the evaporation. A simple model enables to capture this peculiar stop-and-go dynamics, and is successfully applied to quantitative data extracted from experiments realized with real *Adiantum* leaves (Figure 1.a).

The geometry of our biomimetic leaves can be made more complex by using branched vein networks similar to those of oak trees (Figure 1.b). In this case, the embolism exhibits complex propagation fronts, which we aim to control by modifying the spatial distribution of the pit-like constrictions.

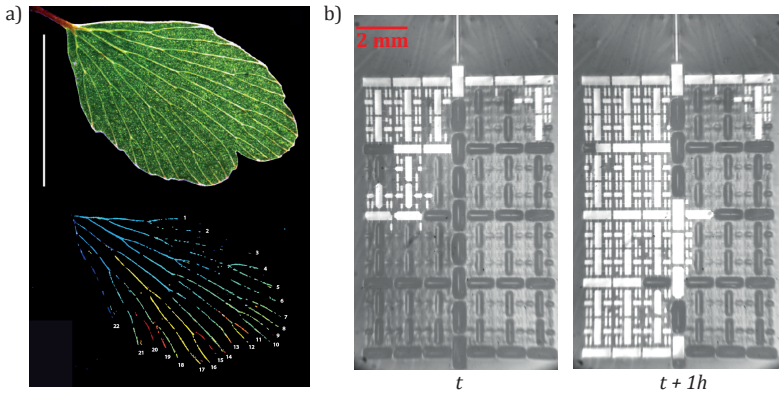

Figure 1. a) Picture of a drying *Adiantum* leaf (top) and reconstruction of the embolism propagation path (bottom) in each of the 22 veins. The color represents time, from early (blue) to late embolism (red). b) Biomimetic branched network of veins. Air embolism (light) propagates by jumps, from pits to pits as water (dark) evaporates.

Références

1. B. Dollet & J.-F. Louf & M. Alonzo & K. H. Jensen & P. Marmottant, Drying of channels by evaporation through a permeable medium mimicking embolism in plant leaves, *J. Roc. Soc. Interface*, **16**, 20180690 (2019).
2. L. Keiser & P. Marmottant & B. Dollet, Intermittent air invasion in pervaporating compliant microchannels, *J. Fluid Mech.*, **948**, A52 (2022).

© **Non-Linéaire Publications**, Bâtiment 508, rue John von Neumann, 91400 ORSAY