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**Tree-on-a-chip: a microfluidic osmotic pump mimicking passive phloem loaders** JEAN COMTET, Massachusetts Institute of Technology, KAARE H. JENSEN, Technical University of Denmark, ABRAHAM D. STROOCK, Cornell University, ANETTE (PEKO) HOSOI, Massachusetts Institute of Technology — According to the Münch mechanism, vascular plants rely on osmotic pressure gradients to export sugars from regions of synthesis (mature leaves) to regions of consumption (roots, fruits). A crucial step in this process is the loading of sugars from photosynthetic cells (known as mesophylls) to the export conduit (the phloem). In some plants, known as passive loaders, sugars are thought to simply diffuse from mesophylls to the phloem. In this case, we show that a single nondimensional "flushing number," characterizing the relative balance of diffusive sugar loading and convective phloem transport, accurately describes the state of the system (phloem hydrostatic pressure, sugar export rates...). We build a synthetic microfluidic osmotic pump mimicking this biological transport mechanism. In particular, our pump can work in a diffusion-limited regime, for which the flow rate scales weakly with the resistance of the hydraulic circuit. This bio-inspired device provides insight into the biophysical mechanism of passive phloem loading, and could be relevant for microfluidic or micro-robotic applications, where high actuation pressures and steady-state flow rates are necessary.

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