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Mechanism of sugar export from long conifer needles I: osmosis, stagnation, and grouping of phloem sieve tubes TOMAS BOHR, SEAN MARKER, RODRIGUE BRAVARD, Technical University of Denmark, Lyngby, Denmark, JOHANNES LIESCHE, XIAOYU HAN, Northwest A&F University, Yangling, China, ALEXANDER SCHULZ, GAO CHEN, University of Copenhagen, Frederiksberg, Denmark, CHRISTOPHER VINCENT, University of Florida, Lake Alfred, FL, USA, MACIEJ ZWIENIECKI, University of California, Davis, CL, USA
— According to the Münch hypothesis, plants transport sugars in the phloem vascular system by osmosis. In conifer needles, sugar, produced in the mesophyll, is loaded into the phloem, essentially a bundle of semi-permeable tubes, where osmotic intake of water pushes it along and exports it at the needle base. It was recently pointed out (Rademaker et al. 2017) that this mechanism is problematic for long needles, since the osmotic water uptake would only affect the flow near the base, where the pressure is lowest, causing the flow near the tip to be stagnant. The "effective length" limiting needle size depends on the permeability and radii of the tubes and the viscosity of the sap, and is 6-10 cm. We have investigated several species with much longer needles (up to 45 cm for *Pinus Palustris*) and we find experimental evidence for a characteristic spatial organization of the phloem. Starting from the tip and moving towards the base, the sieve elements appear in separated groups every few cm, with each new group appearing on the outer flank of the phloem vascular tissue and continuing all the way to the base. We hypothesize that only the outmost group is loaded and that stagnation of the sugar flow can be avoided in this way.

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