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More than just CO_2-recycling: corticular photosynthesis as a mechanism to reduce the risk of an energy crisis induced by low oxygen

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Abstract:

Reassimilation of internal CO_2 via corticular photosynthesis (PS_{cort}) has an important effect on the carbon economy of trees. However, little is known about its role as a source of 02 supply to the stem parenchyma and its implications in consumption and movement of 02 within trees.
PS_{cort} of young *Populus nigra* (black poplar) trees was investigated by combining optical micro-optode measurements with monitoring of stem chlorophyll fluorescence.
During times of zero sap flow in spring, stem oxygen concentrations (cO_2) exhibited large temporal changes. In the sapwood, over 80 % of diurnal changes in cO_2 could be explained by respiration rates ($R_{d(mod)}$). In the cortex, photosynthetic oxygen release during the day altered this relationship. With daytime illumination, oxygen levels in the cortex steadily increased from subambient and even exhibited a diel period of superoxia of up to 110 % (% air sat.). By contrast, in the sapwood, cO_2 never reached ambient levels; the diurnal oxygen deficit was up to 25 % of air saturation.
Our results confirm that PS_{cort} is not only a CO_2-recycling mechanism, it is also a mechanism to actively raise the cortical O_2 concentration and counteract temporal / spatial hypoxia inside plant stems.

Keywords: bark photosynthesis, CO_2 fluxes, corticular photosynthesis, hypoxia, stem CO_2-recycling, superoxia, xylem sap