Role of callose in wood formation and drought resistance in angiosperm plants

The presented project focuses on the secondary xylem (wood), a major terrestrial biomass and one of the most economically important natural materials. Wood is a complex, vascular tissue composed of dead (e.g. vessel elements, fibers) and living (e.g. xylem parenchyma) cells. Vessel elements form elongated conduits responsible for long-distance transport of varied molecules (water, ions, carbohydrates, amino acids, miRNAs, proteins), fibers assure a mechanical support for the whole tissue and xylem parenchyma cells are involved in cell-to-cell transport via cytoplasmic channels transversing cell walls called plasmodesmata. The continues water transport within vessels is seriously threatened by climate changes and repeatable droughts, due to the formation of air bubbles inside the conduits (and thus their cavitation) that leads to transport blockage and even plant mortality. Therefore, it is not surprising that response mechanisms to drought stress are intensively studied, as they hold a promise for developing approaches to counteract cavitation and increase plant survival.

Efficiency of water long-distance transport in wood is dependent on various factors related to wood structure e.g. vessel size and distribution, or the balance between fiber and parenchyma cell amounts. Moreover, one of the factors that efficiently regulates the level of cell-to-cell transport in wood is callose (1,3-β-glucan). This polysaccharide is deposited in the cell wall around plasmodesmata. Increased callose accumulation correlates with reduction of molecular trafficking, whereas callose degradation facilitates transport through plasmodesmata. Thus, in the current project I plan to manipulate the callose content in different wood cell types, to analyse whether the changes in cell-to-cell transport could modify wood formation and increase tree resistance to drought.

Due to limited access to transgenic lines, slower growth rate and bigger plant size, molecular work with trees is difficult and time-consuming. Thus, I will first perform a big set of experiments in *Arabidopsis thaliana*, an important model plant for molecular oriented research, which can be induced to form the secondary xylem and already serves as a model in wood research. I will phenotype at the tissue, cellular and ultrastructural levels (with emphasise put on the three-dimensional wood structure, its chemical composition, and mechanical properties) and perform cell-to-cell transport studies on transgenic *A. thaliana* lines, where overexpressed callose-related genes will increase/reduce callose deposition throughout the plant or in selected wood cell types only. Moreover, by integrating the results from the transcriptome and metabolome profiling I intend to identify callose-related key determinants of wood formation and drought resistance. Finally, to assess the universality of the findings the obtained results will be verified by creating the transgenic Populus (poplar) trees, to test whether similar callose-triggered changes will be induced also in economically important trees, the wood of which is used for biomass and paper production.