Significance of hydrolytic enzymes expressed during xylem cell death

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Akademisk avhandling

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Abstract
Xylem is an inherent feature of all vascular plants and functions in water transport and mechanical support. In order to efficiently transport water, xylem cells are reinforced by secondary walls before they undergo programmed cell death and their cell contents are removed by autolysis to create a hollow tube. During their differentiation, xylem cells express various hydrolytic enzymes, such as proteases, nucleases and lipases, but only in a few examples has their role in xylem cell death been characterized. This thesis focuses on the regulatory aspects of xylem cell death and the autolytic cell clearance in vessel elements and fibers of hybrid aspen (Populus tremula L. x tremuloides Michx.) and in vessel elements of Arabidopsis thaliana. Using comparative transcriptomic analysis, candidate genes for fiber-specific cell death processes were identified. Further, a hypothesis is presented on the regulation of thermospermine levels in the vasculature by a negative feedback-loop involving auxin and the class III Homeodomain-Leucine Zipper (HD-ZIP III) transcription factor HOMEBOX8 (PtHB8). The role of the Arabidopsis METACASPASE9 (AtMC9) in xylem cell death was characterized using molecular tools, such as reporter lines and fluorescent fusion proteins, and electron microscopy (TEM). This showed that cell death initiation is not controlled by AtMC9. Instead, evidence is presented for the involvement of AtMC9 in the post mortem autolysis of vessel elements that follows tonoplast rupture and leads to the formation of the hollow conduit. Cell death-associated genes were further observed to be expressed during the emergence of lateral roots in Arabidopsis thaliana. This led to the discovery that cells overlying a lateral root primordium undergo cell death, which was demonstrated by detection of DNA degradation and TEM analysis. It is concluded that cell death facilitates emergence of lateral roots through the overlying tissues in a concerted manner with cell wall remodelling. Together, these findings show that although individual hydrolytic enzymes may be dispensable for plant growth and development, their common regulators are the tool for understanding their function and importance.

Keywords
Arabidopsis, Populus, xylem cell death, metacaspase, fiber, lateral root emergence