Coordination of two different genomes in response to light and stress

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Abstract
About 1.5 billion years ago, a photosynthetic bacteria was engulfed by a eukaryotic cell which initiated a symbiotic relationship and the evolution of the chloroplast as we know it today. The chloroplast has retained its own genome encoding for a number of proteins required for the function of the chloroplast. However, during the evolution most genes were transferred to the nucleus and the chloroplast is thus dependent on the nucleus to provide the majority of proteins necessary for its function. The distribution of genes encoding plastid proteins between two different cellular compartments requires a tight communication in order to coordinate gene expression during different growth conditions. The focus of my PhD studies has been to elucidate signalling pathways between the chloroplast and nucleus that enables the coordination of these two genomes in response to light and stress. The results in this thesis demonstrate that chloroplast retrograde signals triggered by changes in tetrapyrrole levels are important both in response to day-night cycles and during the response to stress. We identified a cytosolic regulatory complex and a novel mechanism that could explain how the tetrapyrrole-mediated signal can be transduced from the plastid to the nucleus and regulate nuclear gene expression in response to changes in the environment. My work further demonstrates that the tetrapyrrole-triggered plastid signalling pathway integrates with the circadian clock in order to fine-tune nuclear gene expression during photoperiodic conditions. These findings provide novel insight into how clock components and plastid signals converge in order to obtain the proper output. I have also examined the regulation of nuclear gene expression in response to redox and early-light signals by identifying transcription factors responding to these signals. My work demonstrates a novel mechanism by which redox-regulation of specific transcription factors directly links cellular redox status to gene regulation. The identified transcription factors were further shown to regulate nuclear genes encoding plastid proteins and they are of particular importance for anterograde control during the early light response and establishment of photomorphogenic growth.

Keywords
Arabidopsis thaliana, chloroplast, cellular communication, tetrapyrrole, circadian clock, oxidative stress, light signalling, gene regulation

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