Maintenance and expression of plant mitochondrial genome

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The scientific challenge

Mitochondria are key players in plant development and reproduction. The interactions between their genetic system and the one of the nucleus determine or influence essential plant traits. The plant mitochondrial DNA (mtDNA) is strikingly dynamic in structure and evolution, due to active recombination driving mtDNA organization and repair. As a consequence, new mitochondrial genome configurations can be generated by recombination and rapidly segregated in next generations, a process called stoichiometric shifting. These processes are under the control of nuclear-encoded factors. Mutation of the corresponding genes releases recombination control and promotes mtDNA rearrangements. Our objective is to decipher the mechanisms underlying mtDNA dynamics, repair, transmission and shifting. In the context of a general failure to develop regular mitochondrial transformation in plants, mutating nuclear-encoded recombination factors opens an alternative way to generate mitochondrial genetic diversity. Such a possibility to promote new phenotypes has been notably underexploited so far.

The strategic (innovation-oriented) challenge

Existing

- Characterize the full set of plant mitochondrial DNA recombination and repair factors
- Characterize the developmental and molecular phenotypes of single or double mutants
- Determine the plant mitochondrial DNA recombination and repair pathways, characterize their inter-connections and their relation with replication and transcription
- Understand the mtDNA segregation, transmission and shifting mechanisms

Potential

- Extend the knowledge on mitochondrial recombination factors and pathways from model plants to crop species
- Exploit mutation of recombination factors to generate mitochondrial genetic diversity in crop species
- Create GMO-free crop lines with novel traits based on mitochondrial genome rearrangements