**Model-based reconstruction of whole organ growth dynamics reveals invariant patterns in leaf morphogenesis**

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# Abstract

Morphogenesis is a process that spans several orders of magnitude in both time and space. Because it is generally impossible to follow developing organs all along growth, analyses typically rely on static data sampled at different developmental stages. We propose a model-based approach for the accurate dating of organs, allowing spatio-temporal reconstruction of organ morphogenesis over unlimited time windows, based on static data collected from different individuals. Although considered leaves in wild-type and mutant plants displayed contrasted final shapes and sizes, we revealed invariant, iterated developmental schemes, and identical critical time points, suggesting conserved morphogenetic modules. We provided evidence that modules determining local features may act independently of global leaf growth. In particular, we showed that serrations developing at different times and/or in different leaves grow in a remarkably synchronized way. In addition, graded differences in growth dynamics and final shapes of successive leaves suggest continuous variations in module expression. Altogether, we illustrated that our strategy is powerful to finely dissect multi-scale morphogenetic processes.