MSc Thesis in Comparative Quantitative Morphology and Computational Developmental Biology

An evo-devo MSc thesis is available in the lab of Prof. Kay Schneitz, Dept. of Plant Developmental Biology, TUM School of Life Sciences, Technical University of Munich in Freising/Germany.

How morphogenesis (Gestaltgebung) translates genotype into form remains an eminent open question in biology. To bridge the gap between gene function and final morphology, it is essential to obtain a formal quantitative description of the cellular architecture within an organ in three-dimensional space and with single-cell resolution over the entire organ throughout its development. However, a thorough understanding of the 3D cellular basis of morphogenesis in different animal or plant species and its impact on morphogenesis is currently lacking. A promising new approach to this problem is to generate 3D digital organs with single cell resolution [1].

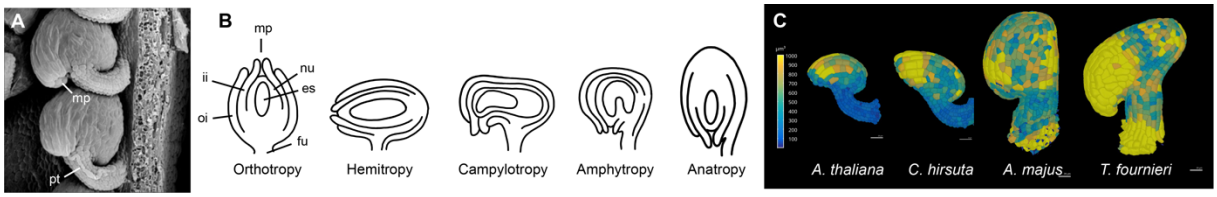

Fig. 1. (A) SEM of wild-type Arabidopsis ovules undergoing fertilization. Note the curved shape of the ovules. (B) Main types of ovule curvature in angiosperms. (C) 3D digital ovules of different species. Color gradient indicates cell volume.

The Schneitz lab has pioneered the generation of 3D digital ovules [2-4] and has successfully generated 3D digital atlases of ovule development in *Arabidopsis thaliana* and *Cardamine hirsuta* at single cell resolution [5,6].

Applying an evo-devo approach, the Schneitz lab uses the curvature of angiosperm ovules as a model to investigate the cellular basis of morphogenesis. The ovule is the major female reproductive organ in seed plants. It is the oldest floral organ in evolutionary terms, dating back nearly 400 million years to the earliest seed plants. Ovule curvature is interesting for three reasons. First, ovules of flowering plants undergo a species-specific characteristic curvature, a unique morphogenetic process whose cellular and mechanistic basis is not understood (Fig. 1). Second, curvature is biologically relevant because it places a small cleft, the micropyle, in an optimal position for fertilization by the pollen tube. Third, curved ovules represent a defining feature and the ancestral state in flowering plants. By examining ovule curvature in various mutants and angiosperms, the lab aims to shed light on this exciting morphogenetic process and the evolution of flowering plants.

The successful candidate will analyze the 3D cellular architecture of ovules of an Arabidopsis ovule mutant with altered curvature as well as generate a digital 3D atlas of ovule development in *A. majus* (snapdragon) and/or *E. californica* (California poppy). Work on the thesis can start ideally as soon as possible or by arrangement.

We are looking for a highly motivated young scientist interested in cell biology and/or plant systematics with a strong affinity for comparative morphometry and plant evo-devo as well as for interdisciplinary work at the interface of bioinformatics, advanced confocal microscopy, image processing, 3D computer visualization, modeling and cell and developmental genetics. Fluency in English and computer affinity are a must. Programming skills (Python, R) are not required but would be an advantage.

For more info about the lab please scan the QR code:

References:

[1] Mody et al. (2025) Investigating plant morphogenesis using 3D digital organs. J. Exp. Botany *in press*.

[2] Wolny et al. (2020) Accurate and versatile 3D segmentation of plant tissues at cellular resolution. eLife 9, e57613.

[3] Vijayan et al. (2022) The annotation and analysis of complex 3D plant organs using 3DCoordX. Plant Physiol. 189, 1278–1295.

[4] Vijayan et al. (2024) A deep learning-based toolkit for 3D nuclei segmentation and quantitative analysis in cellular and tissue context. Development 151, dev202800.

[5] Vijayan, Tofanelli et al. (2021) A digital 3D reference atlas reveals cellular growth patterns shaping the Arabidopsis ovule. eLife 10, e63262.

[6] Mody et al. (2024) Topological analysis of 3D digital ovules identifies cellular patterns associated with ovule shape diversity. Development 151, dev202590.

YouTube: https://youtu.be/QJ9ymZXke40.

Please submit your application as a single PDF file by email to office.plantdev.wzw@tum.de.

TUM is an equal opportunity employer. Applicants with disabilities are treated with preference given comparable qualifications.

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