



Open position for the LSM call of applications

Department/Institute:

LMU Faculty of Biology, Division of Evolutionary Biology

Subject areas/Research fields:

Evolutionary Biology, Bioinformatics, Computational Biology, Molecular Biology, Reproduction

Keywords:

sperm storage organs, gene regulation, doublesex, cis-regulatory modules, chromatin accessibility, machine learning

Name of supervisor:

Dr. Sonja Grath

Project title:

The evolution of sperm storage organs in Diptera: mating responsiveness, molecular diversity and gene regulation

Project description:

The majority of females with internal fertilisation have dedicated organs to store sperm. Thereby, females can disentangle mating activity from fertilisation and egg deposition which is important when both activities happen at different locations or are separated in time. Particularly insect females have evolved highly specialized sperm storage organs. In most insect species, females possess one or several spermathecae, but some Dipteran species have an additional sperm storage organ called a seminal receptacle. While on the surface both organs serve the same function, molecular work showed that they possess distinct expression profiles and thus have taken on different specializations. Further, while in the genus *Drosophila* most species use both kinds of organs, some species only use one or the other type to store sperm while the remaining type seems to have lost this function and it is unclear if it evolved new functions. While the morphological variation of these organs is well described, the details of reproductive processes leading to fertilization and particularly the molecules involved, their regulation and the possible variation across species are largely unknown. Intriguingly, the specific transcription factor *doublesex* (*dsx*), long known for its developmental function in sex differentiation, was found to be expressed in adult *Drosophila melanogaster* spermathecae. However, its specific role in adults, particularly its possible interplay with both transcriptional regulation of sperm storage organ function and with other gene regulatory mechanisms remains elusive. Here, we propose a collaborative project to study the evolution of sperm

storage organs across Diptera to address these open questions. First, we aim to investigate the molecular characteristics of female sperm storage organs by studying the possible conservation of *dsx* expression in female storage organs, its mating responsiveness and possible function while assessing molecular diversity

in reproductive tract secretomes across *Drosophila* species. We hypothesize that while *dsx* expression is conserved across the Diptera, the downstream reproductive molecules produced in the respective sperm storage organs are not. Second, we aim to understand the gene regulatory mechanisms underlying the evolution of female reproductive organs in Diptera. We hypothesize that species that use the ancestral spermathecae as main sperm storage organs do not express the same transcription factors or do not have the same accessible chromatin regions compared to species using solely or predominantly the subsequently evolved seminal receptacle after mating. We use a comparative genomics, transcriptomics and epigenomics approach in combination with DNA-protein binding assays and machine learning to establish a framework that can be used for functional and regulatory studies to better understand the complex evolution and interplay of gene regulatory networks before and after mating in Diptera. Project A (at University Halle) will be more focused on gathering experimental data using mostly *Drosophila melanogaster* and will include dissecting out internal organs to collect tissues for subsequent molecular work, while project B (at University of Munich, LMU) will have a stronger focus on bioinformatics analyses. Both projects will be strongly integrated and exchange data/ material.

Here, we advertise for Project B. We are looking for a candidate with a Master's degree in biology, bioinformatics, biotechnology, biostatistics or a related field. We expect bioinformatic and statistical skills to handle and integrate multi-omics data (genomic, RNAseq, ATACseq).

Due to the integrative nature of the project, we expect prospective student to enjoy working in a team and sharing data/experiences. A good basic knowledge of English in written and spoken form is expected.

References:

[1] Orr TJ, Brennan PL. Sperm storage: distinguishing selective processes and evaluating criteria. *Trends Ecol Evol.* 2015;30(5):261-272.

[2] Pitnick S, Marrow T, Spicer GS. Evolution of multiple kinds of female sperm-storage organs in *Drosophila*. *Evolution.* 1999;53(6):1804-1822.

[3] Hopkins BR, Kopp A. Evolution of sexual development and sexual dimorphism in insects. *Curr Opin Genet Dev.* 2021;69:129-139.

[4] Rice GR, Barmina O, Luecke D, Hu K, Arbeitman M, Kopp A. Modular tissue-specific regulation of doublesex underpins sexually dimorphic development in *Drosophila*. *Development.* 2019;146(14):dev178285.

For further information, please contact: Dr. Sonja Grath (grath@bio.lmu.de)

Research group website: <https://evol.bio.lmu.de/research/grath/index.html>

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