
2 PhD positions in Molecular Diversity and Gene Regulation of Reproduction

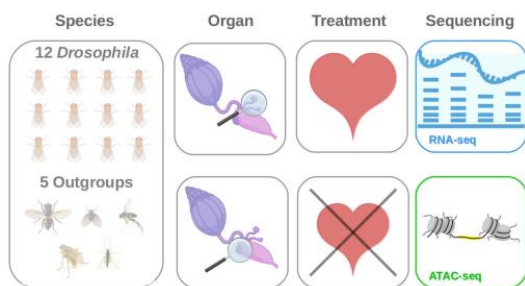
@ University of Munich (LMU) and University of Halle (MLU)

3-years positions (65%) | E13 TV-L | contact: grath@bio.lmu.de (LMU),
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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 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 will have a stronger focus on bioinformatics analyses. Both projects will be strongly integrated and exchange data/ material.

What we offer:

The positions are fixed-term positions within a DFG-funded project with a length of three years. The salary is based on a 65% 13 TV-L scale. We are seeking to fill the positions from the earliest possible date. Our project is a collaboration between Dr. Sonja Grath (LMU Munich) and Prof. Dr. Claudia Fricke (MLU Halle). This highly interdisciplinary team provides an excellent research environment for this project.

Project A will be hosted in the working group of Animal Ecology at the University of Halle and is advertised under Reg.-Nr. 5-4246/24-D (<http://personal.verwaltung.uni-halle.de/jobs/wissmi/>). Project B will be hosted at the Division of Evolutionary Biology at the University of Munich.

Your qualifications:

Master's degree in biology, bioinformatics, biotechnology, biostatistics or a related field. For Project A, we expect good knowledge of molecular biological methods, good statistical skills and preference for prior experience in work with insects. For Project B, 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 students to enjoy working in a team and sharing data/experiences. A good basic knowledge of English in written and spoken form is expected.

Are you interested?

Then, we look forward to receiving your application, written in English, in a single PDF, by **30.05.2024**. Applications should be sent to both Prof. Dr. Claudia Fricke (claudia.fricke@zoologie.uni-halle.de) and Dr. Sonja Grath (grath@bio.lmu.de).

Applications should include: (1) a cover letter that clearly states how your experience and interests match required qualifications, (2) a detailed CV including details about research experience and publications (if any), and (3) contact details for at least two referees.

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.