

The role of gene regulation in the division of labour in ants



PhD position in Evolutionary Biology

Registration deadline: 20 January 2022

Application deadline: 27 January 2022

The Foitzik group at the Johannes Gutenberg University of Mainz (Germany) is offering a 3-year PhD position (DFG, fully funded with the possibility of extension, 65% TVL E13) to study the role of gene regulation in the division of labour in the ant *Temnothorax longispinosus*. The PhD student will be supervised by Susanne Foitzik (JGU Mainz) in collaboration with Peter Baumann (JGU Mainz & IMB), Susanne Gerber (UM Mainz) and Franjo Weissing (University of Groningen), and will be integrated in the GenEvo research training program (<https://www.genevo-rtg.de/>).

Social insects are models for the evolution of phenotypic plasticity. Insect workers specialise on specific tasks. This **division of labour** is not only adaptive, but largely contributes to the ecological success of their societies. Task specialisation is neither genetically determined nor rigid, but changes with age and in response to colony needs. Typically, young workers take over brood care and older workers focus on risky outside tasks such as foraging. We could show that gene expression is often more linked to task than to age (Kohlmeier et al. 2018) and histone acetylation can regulate worker behaviour in ants (Libbrecht et al. 2020, Simola et al. 2016). Further regulatory mechanisms, such as other histone modifications, microRNAs or DNA Methylation could also be involved and may interact in regulating division of labour. We aim to understand how these regulatory processes respond to external cues, the expression of what kind of genes they alter and how fast these can change their expression. We have focussed on **ant *Temnothorax longispinosus*** with its small colonies and long-lived workers to investigate division of labour, the expression and functions of task-specific genes, and the importance of histone-modifications for their expression. Theory posits that task switching requires shifts in responsiveness to task-related cues. We identified a candidate gene, *vg-like A*, that regulates task allocation and social cue responsiveness (Kohlmeier et al. 2018): Once knocked down via RNAi, young workers reduce brood- but increase nestmate care, a behaviour typical for older workers. This was accompanied by a shift in worker responsiveness from brood to adult worker odorant cues. Our newest results reveal that gene expression in the antennae - the organ of odorant perception – differs more than eight times as strongly between brood carers and foragers than brain transcriptomes, indicating the importance of the peripheral nervous system for the regulation of division of labour. The administration of histone acetyltransferase (HAT) inhibitors influenced the ability of workers to switch between tasks, pointing to the role of histone acetyltransferase in altering gene expression. A high HAT activity keeps young workers in a “brood caring mode”, possibly to prevent them from leaving the nest prematurely. We established a ChIP-seq protocol and identified histones with worker task-specific acetylation in the brain, which are associated with differentially expressed genes. We also obtained microRNA sequences, which we currently analyse to detect differences between worker castes and their link to brain gene expression.

In this **PhD project**, we will deepen our understanding of the molecular regulation of division of labour in ants by experimentally influencing gene regulation using various epigenetic inhibitors, followed by behavioural, transcriptome and epigenetic readouts. For the latter, we will focus on ChIP-seq and CUT&RUN), DNA methylation (Bisulfite-Seq) and miRNA to link regulatory mechanisms to the behavioural phenotype and gene

expression (RNAseq). Not only are we interested in how fast these epigenetic processes work and how they interact, but also which tissues play a major role. This could be the antenna, where social cues are perceived or the mushroom body or antennal lobes of the brain, where information is processed. The theoretical aspects of our project will be developed in collaboration with Franjo Weissing, including research stays in his group at the University of Groningen.

We are looking for a highly motivated student with a Master degree (or equivalent) in biology, good English skills, and a keen interest in evolutionary biology. Previous experience with social insects, molecular biology, statistics and bioinformatics is advantageous, but is not required. The successful applicant will join an international, interactive, dynamic and English-speaking scientific environment in a brand new building with access to state-of-the-art, newly equipped laboratories and climate-controlled rooms. The JGU of Mainz hosts many excellent scientific institutions, and Mainz is a historic city located on the Rhine River with a large student population and a rich social and cultural life.

Interested candidates should [register](#) to the IPP before 20 January 2022 and complete their application before 27 January 2022. Informal enquiries should be sent to Prof. Dr. Susanne Foitzik (foitzik@uni-mainz.de). The starting date for the position is 1 July 2022. The Johannes Gutenberg University of Mainz is interested in increasing the number of women in science. Applications from women are therefore strongly encouraged. In addition, qualified candidates with disabilities will be preferred.

