IMPRS CHEMICAL COMMUNICATION IN ECOLOGICAL SYSTEMS

Project 10

Experimentally unravelling the evolution of an intracellular symbiosis

Supervisors:
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Background:
Many insects engage in beneficial interactions with intracellular bacteria that provide nutritional supplementation to their host. Phylogenetic analyses indicate that at least some of these symbioses evolved from previously pathogenic associations. However, the early steps leading to the establishment of intracellular host-beneficial symbioses and the molecular factors underlying the transition from pathogenicity to mutualism remain poorly understood, due to the scarcity of genetically tractable systems. To fill this gap, we have recently established a symbiosis between the grain pest beetle *Oryzaephilus surinamensis* and a genetically tractable bacterium that infects the beetle's cells, is mildly pathogenic and vertically transmitted to the offspring.

Project description:
The availability of a genetically tractable intracellular insect-microbe symbiosis allows for addressing many exciting questions on the intracellular colonization of an insect host, the transmission to the offspring, the transition from pathogenicity to mutualism, and the evolutionary events preceding and following this transition. The successful applicant will have the opportunity to co-develop the project and define its focus. The project will be integrated into the department's larger group of scientists working on the metabolic interplay and molecular control, as well as the ecological context and evolutionary history of microbial symbioses in beetles. The methods relevant for this project include the genetic modification of the bacterial symbiont, beetle manipulation via RNAi, large scale experiments with beetles and their phenotypic characterization, fluorescence in situ hybridization, different fluorescence microscopic techniques and micro computed tomography (µCT).

Candidate profile:

- a deep interest in the molecular biology and evolutionary ecology of insect-microbe interactions
- a strong background in molecular microbiology, molecular entomology, insect or bacterial physiology, or related areas
- skills in targeted and untargeted mutagenesis of bacteria will be important for the project, so expertise in relevant techniques is desirable
- critical scientific thinking skills
- curiosity, creativity, and ambition
- excellent time management and organizational skills

- the ability and willingness to interact with other scientists in the group
- very good communication skills
- fluency in written and spoken English

Reading:

1. Anbutsu, H. et al. Small genome symbiont underlies cuticle hardness in beetles. *Proc. Natl. Acad. Sci*. 114, E8382–E8391 (2017).
2. Engl, T. et al. Ancient symbiosis confers desiccation resistance to stored grain pest beetles. *Mol. Ecol*. 27, 2095–2108 (2018).
3. Kiefer, J. et al. Inhibition of a nutritional endosymbiont by glyphosate abolishes mutualistic benefit on cuticle synthesis in *Oryzaephilus surinamensis*. *Commun. Biol*. 4, 554 (2021)
4. Kiefer, J. et al. Cuticle supplementation and nitrogen recycling by a dual bacterial symbiosis in a family of xylophagous beetles. *ISME J.*, 17, 1029-1039 (2023)
5. Su, Y.H. et al. (2022). Rational engineering of a synthetic insect-bacterial mutualism. *Curr. Biol*. 32, 3925-3938.