IMPRS CHEMICAL COMMUNICATION IN ECOLOGICAL SYSTEMS

Application Call 2023 - Project 9

The molecular basis of symbiosis establishment in beetles

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Background:
Beneficial symbioses with bacteria are widespread and important in insects, allowing them to exploit otherwise inaccessible ecological niches. While symbiont contributions to host fitness are often well characterized, the molecular interactions between hosts and symbionts that enable establishment and maintenance of the symbiosis remain poorly understood, due to the scarcity of experimentally and genetically tractable systems. Across multiple beetle symbioses, we have cultured symbiotic microbes and established tools for genetic manipulation, which now allow for unraveling the molecular host-symbiont interplay at unprecedented levels of detail.

Project description:
The aim of the project is to unravel the molecular factors that are important for symbiont establishment and the beneficial function for the beetle host. To this end, molecular tools will be employed for targeted and random mutagenesis of the symbionts. The manipulated symbionts will then be introduced into the host, and the impact of the mutations on symbiont establishment and on host phenotypic traits will be characterized using bioassays, microscopy, and chemical analytics. The results are expected to shed light on the molecular underpinnings of an insect-associated lifestyle in bacteria and reveal why some clades of bacteria have been particularly successful in establishing symbiotic associations with insects. In addition, lifestyle switches between insect mutualism and plant pathogenicity can be characterized on the molecular level to understand whether shared pathways are responsible for colonizing disparate hosts.

Candidate profile:
- a deep interest in the molecular biology and evolutionary ecology of insect-microbe interactions
- a strong background in molecular (micro)biology, alternatively in insect or bacterial physiology

- excellent skills in targeted and untargeted mutagenesis of bacteria will be required for the project, so expertise on relevant techniques is highly 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
- Proficiency in written and spoken English

Reading:

Anbutsu H, Moriyama M, Nikoh N, Hosokawa T, Futahashi R, Tanahashi M, Meng XY, Kuriwada T, Mori N, Oshima K, Hattori M, Fujie M, Satoh N, Maeda T, Shigenobu S, Koga R, Fukatsu T (2017) Small genome symbiont underlies cuticle hardness in beetles. *Proc. Natl. Acad. Sci. U.S.A*. 114: E8382-E8391.

Engl T, Eberl N, Gorse C, Krueger T, Schmidt THP, Plarre R, Adler C, Kaltenpoth M (2018) Ancient symbiosis confers desiccation resistance to stored grain pest beetles. *Mol. Ecol*. 27: 2095-2108.

Flórez LV, Scherlach K, Gaube P, Ross C, Sitte E, Hermes C, Rodrigues A, Hertweck C, Kaltenpoth M (2017) Antibiotic-producing symbionts dynamically transition between plant pathogenicity and insect defensive mutualism. *Nat. Commun*. 8: 15172.

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Ganesan R, Kaltenpoth M, Florez LV (2021) Transposon-insertion Sequencing as a Tool to Elucidate Bacterial Colonization Factors in a *Burkholderia gladioli* Symbiont of *Lagria villosa* Beetles. *J. Vis. Exp*.: 21.

Kiefer JST, Batsukh S, Bauer E, Hirota B, Weiss B, Wierz J, Fukatsu T, Kaltenpoth M, Engl T (2021) Inhibition of a nutritional endosymbiont by glyphosate abolishes mutualistic benefit on cuticle synthesis in *Oryzaephilus surinamensis*. *Comm. Biol.* 4: 554.

Wierz J, Gaube P, Klebsch D, Kaltenpoth M, Flórez LV (2021) Transmission of bacterial symbionts with and without genome erosion between a beetle host and the plant environment. *Front. Microbiol*. 12: 715601.