Institute: Institute of Zoology and Biomedical Research

Topic: The variability of insects microbiome

Name of supervisor: dr hab. Anna Michalik

Background information:
Nutritional, heritable symbiosis is ubiquitous within Auchenorrhyncha - a hemipteran clade comprising planthoppers, leafhoppers, treehoppers, spittlebugs, and cicadas. Almost all of them feed predominantly or exclusively on plant sap deficient in essential amino acids and other nitrogenous compounds. Mutualistic association with microorganisms that supplement their unbalanced diet has allowed them to adapt to such restricted food, expand into previously inaccessible ecological niches, and subsequently undergo adaptive diversification. Most Auchenorrhyncha harbor two co-primary bacterial symbionts which complement each other in the supplementation of the insect's diet: *Sulcia*, and depending on the host clade, one of the proteobacterial symbionts, including *Nasuia* (in some leafhoppers and treehoppers), *Zinderia* (in spittlebugs), *Vidania* (in planthoppers), *Baumannia* (in sharpshooters) and *Hodgkinia* (in cicadas). The descendants of these symbionts are still present in many extant lineages of Auchenorrhyncha. However, in several clades, they have been supplemented by additional microorganisms or were replaced by new microbes, including other bacteria or Hypocreales fungi.

The main question to be addressed in the project:
We know that the high diversity of heritable microbiome in Auchenorrhyncha is mainly due to symbiont replacement and complementation, which seem to be major driving forces of Auchenorrhyncha-microbes symbiosis evolution. However, the lack of knowledge on the spatial and temporal dynamics of these replacements is a key gap that prevents a full understanding of processes shaping Auchenorrhynchan diversity. We don't know how stable are those associations, and what factors affect their stability? How frequent are acquisitions of novel symbionts? and which factors hamper or facilitate the replacement of the existing symbiont by another one? To address these and related questions, we will conduct broad Auchenorrhyncha sampling across Central Europe and Baltic countries, followed by a comprehensive characterization of their microbiomes.

Information on the methods/description of work:
The student will conduct a comprehensive analysis of symbiotic systems of different Auchenorrhyncha species, including microscopic (LM, TEM, FISH) and bioinformatic analyses (next-generation sequencing data). They will also be involved in preparing insect specimens (potentially, including fieldwork in Poland and abroad) and the molecular work on these specimens (DNA extraction, next-generation sequencing library preparation). They will work closely with members of the Symbiosis Evolution Group at JU.

Additional information (e.g Special requirements from the student)**:**
The student will be supported by a research stipend 5000 PLN per month (for 44 months). This stipend may be combined with the Ph.D. program scholarship. Because the stipend recipient will be selected in a separate competition, the applicants interested in this project are asked to contact Dr hab. Anna Michalik (a.michalik@uj.edu.pl) directly as soon as possible.
Essential qualifications:
- M.Sc. degree in biology or a related field
- Demonstrated interest in entomology, symbiosis, evolution
- Experience with or interest in learning molecular biology, bioinformatics, and microscopy techniques - Good organization and interpersonal skills
- Good English language skills

Place/name of potential foreign collaborator:
Prof. Dr. Martin Kaltenpoth, Johannes Gutenberg University Mainz, Germany, Prof. Rosario Gil, University of Valencia, Spain

References (3**):**

[1] Sudakaran, S.; Kost, C.; Kaltenpoth, M. Symbiont Acquisition and Replacement as a Source of Ecological Innovation. *Trends Microbiol.* 2017, *25*, 375–390.
[2] Łukasik, P.; Nazario, K.; Van Leuven, J.T.; Campbell, M.A.; Meyer, M.; Michalik, A.; Pessacq, P.; Simon, C.; Veloso, C.; McCutcheon, J.P. Multiple Origins of Interdependent Endosymbiotic Complexes in a Genus of Cicadas. *Proc. Natl. Acad. Sci.* 2018, *115*, E226.
[3] Michalik, A.; Castillo Franco, D.; Kobiałka, M.; Szklarzewicz, T.; Stroiński, A.; Łukasik, P. Alternative Transmission Patterns in Independently Acquired Nutritional Co-Symbionts of Dictyopharidae Planthoppers. *mBio* 2021, 12(4) e01228-21.