

Institute: Institute of Zoology and Biomedical Research

Topic: The diversity and dynamics of insect heritable microbiota

Name of supervisor: dr hab. Waclaw Tworzydło, prof. UJ (dr Anna Michalik)
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Background information:

Nutritional, heritable symbiosis is ubiquitous within Auchenorrhyncha - a hemipteran clade comprising planthoppers, leafhoppers, treehoppers, spittlebugs, and cicadas, and feeding exclusively on nutrient-limited diet of plant sap. Most Auchenorrhyncha harbor two ancient heritable bacterial symbionts that have co-diversified with hosts for hundreds of million years. However, in many lineages, one or both of these symbionts has been replaced by other bacteria or fungi. Alternatively, in other Auchenorrhynchan lineages, the ancestral co-primary symbionts were joined by additional microbes that now contribute additional nutritional functions. Finally, these insects commonly host heritable facultative symbionts from broadly distributed clades such as *Wolbachia* and *Rickettsia*, who may also provide nutrients but also affect insect reproduction or resistance to natural enemies. All these microbes play critical importance in insect biology, but there is rapidly accumulating evidence that the infections may vary among insect clades, species, populations, and even individuals sampled at the same time, at the same site. Unfortunately, we know very little about these diversity and spatiotemporal distribution patterns or their biological importance.

The main question to be addressed in the project:

How stable are these host-symbiont associations, and what factors affect their stability? How frequent are acquisitions of novel symbionts? 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 that will be broadly and repeatedly sampled across Central Europe and Baltic countries. The primary responsibilities will include microscopic (LM, TEM, FISH) and bioinformatic analyses (next-generation sequencing data) of the collected material. The student will have an opportunity to also participate in insect sampling and identification (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 the Institute of Environmental Sciences of JU.

Additional information:

Essential qualifications:

- M.Sc. degree in biology or related field by September 2022
- 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

The Student will be considered for the PhD position within the NCN Opus 21 project "The patterns, processes, and drivers of insect microbiome variability", which may provide an additional research stipend and travel opportunities to the successful candidate. The stipend recipient will be selected in a separate competition, and the applicants interested in this opportunity are encouraged to contact Dr. Anna Michalik (a.michalik@uj.edu.pl) directly as soon as possible.

Place/name of potential foreign collaborator:

Prof. Dr. Martin Kaltenpoth, Johannes Gutenberg University Mainz, Germany

References:

Sudakaran, S.; Kost, C.; Kaltenpoth, M. Symbiont Acquisition and Replacement as a Source of Ecological Innovation. *Trends Microbiol.* 2017, 25, 375–390.

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.

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.