

Description of the research topic

General information

Institute: W. Szafer Institute of Botany Polish Academy of Sciences.

Research topic: The role of plant-associated microbiota in shaping tolerance strategies to potentially toxic metals.

Scientific discipline: biological sciences.

Name of potential supervisor: dr hab. Elżbieta Cieślak.

Background information

The research topic will be carried out within the framework of the National Science Centre (NCN) OPUS 29 project (2025/57/B/NZ9/02515) led by Dr Agnieszka Domka (potential auxiliary supervisor). The project is conducted in collaboration with Jagiellonian University in Kraków, with the W. Szafer Institute of Botany, Polish Academy of Sciences serving as the host institution. The doctoral scholarship is funded through a scientific scholarship awarded within the project.

The aim of the research is to understand how microorganisms influence different plant adaptation strategies to potentially toxic metals present in the environment. The PhD student will investigate whether plants employing contrasting metal tolerance mechanisms (hyperaccumulation versus exclusion) recruit distinct microbial communities and how these microbiota affect metal uptake, transport, and detoxification. The project will integrate microbiota, metabolome, and gene expression analyses with inoculation experiments conducted under both laboratory and field conditions.

The main question to be addressed in the project

- Do plants employing different metal tolerance strategies (hyperaccumulation versus exclusion) recruit distinct microbial communities?
- Which microbial taxa or functional groups are responsible for supporting hyperaccumulation or metal exclusion in their host plants?
- How do plants shape the composition of their microbiota in response to metal stress?
- How do microorganisms influence the molecular and physiological mechanisms underlying metal tolerance in plants?

- What role does root-to-shoot communication play in regulating metal uptake, translocation, and the assembly of plant-associated microbial communities?

Information on the methods/description of work

The PhD student will investigate plant–microbiota interactions in environments contaminated with potentially toxic metals. The research will involve field sampling of plant and soil material, laboratory experiments, and analyses of the effects of microorganisms on plant metal tolerance. The project will employ modern approaches in molecular biology, microbiology, metabolomics, and bioinformatics. Planned analyses include characterization of microbial communities using next-generation sequencing (NGS), isolation and cultivation of microorganisms, gene expression profiling, analysis of root metabolites and exudates, and quantification of metal concentrations in plant tissues. An important aspect of the project will be the integration of microbiological, physiological, and molecular datasets to identify the mechanisms underlying plant adaptation to metal stress.

Additional information

Requirements from the candidate:

- MSc degree in biology, biotechnology, microbiology, environmental biology, or a related field;
- interest in plant biology, environmental microbiology, and plant–microorganism interactions;
- basic knowledge of molecular biology, genetics, and microbiology;
- laboratory experience acquired during university studies or through a Master’s research project;
- ability to analyze biological data and basic knowledge of statistical methods;
- good command of English, enabling the use of scientific literature and preparation of scientific publications;
- ability to work both independently and as part of a research team, with strong organizational skills;
- willingness to conduct both field and laboratory research

Place/name of potential collaborators

The project is conducted in collaboration with Jagiellonian University in Kraków. Part of the research will be carried out in the laboratories of the Plant–Microorganism Interactions Group under the supervision of dr. hab. Piotr Rozpądek, Professor at Jagiellonian University.

References

Ważny, R., Jędrzejczyk, R. J., Domka, A., Pliszko, A., Kosowicz, W., Githae, D., & Rozpądek, P. , How does metal soil pollution change the plant mycobiome? (2023), artykuł, *Environmental Microbiology*, Dec;25(12):2913-2930

Domka, A., Gustab, M., Jędrzejczyk, R. J., Ważny, R., Tognacchini, A., Puschenreiter, M., ... & Rozpądek, P. (2025). Regulation of plant Ni uptake by soil-borne microorganisms occurs independently of their Ni-solubilizing capabilities. *The ISME Journal*, 19(1), wraf265.

Belloeil, C., Garcia de la Torre, V. S., Contreras-Aguilera, R., Küpper, H., Courtin, O., Klopp, C., ... & Merlot, S. (2026). Gain and loss of gene function shaped the nickel hyperaccumulation trait in *Noccaea caerulea*. *The Plant Cell*, 38(1), koaf281.