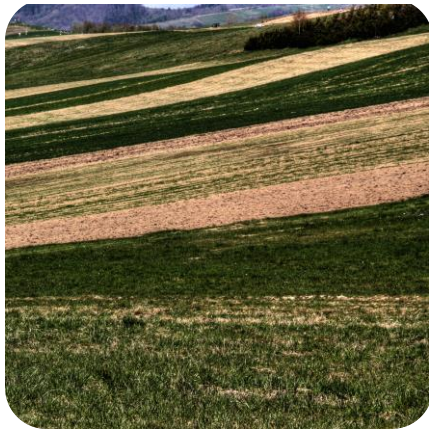
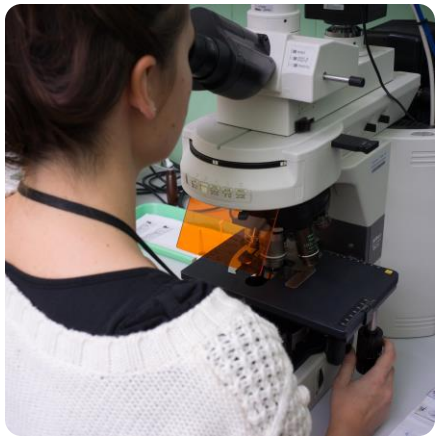
Catalogue for Master's thesis topics offered by the staff of the of the Institute of Environmental Sciences, Faculty of Biology, Jagiellonian University in 2024



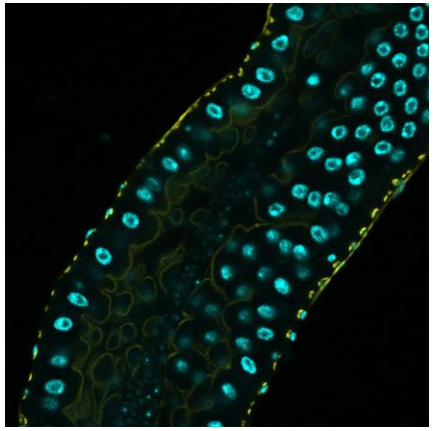


Topics are indicative, final plans will be agreed between supervisor and student. The list is not exhaustive and will be expanded.

Students with their own ideas are also very welcome!

All are invited to contact potential supervisors directly. A full list of the Institute's research teams is available on the website: https://studia.eko.uj.edu.pl/en_GB/instytut/zespoly-badawcze

Barriers to *Wolbachia* transinfection



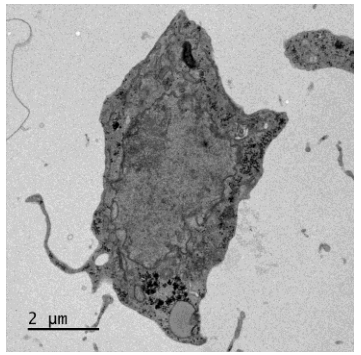
Research problem: *Wolbachia* causes one of the most prevalent intracellular bacterial infections on the planet. Yet, it is mostly transmitted from mother to offspring inside insect eggs. Horizontal (individual-to-individual) *Wolbachia* transmission can occur on the evolutionary timescale, it is also possible to achieve experimentally. ***What are the barriers to horizontal Wolbachia transmission? Is immune system responsible for restricting newly acquired Wolbachia infections?***

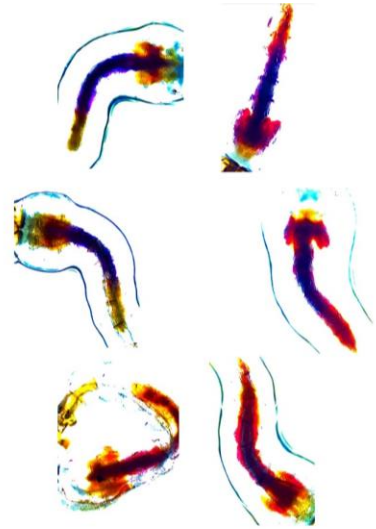
Description: Rearing insects, growing bacteria, *Wolbachia* purification, microinjections, PCR and qPCR, statistical analysis of data.

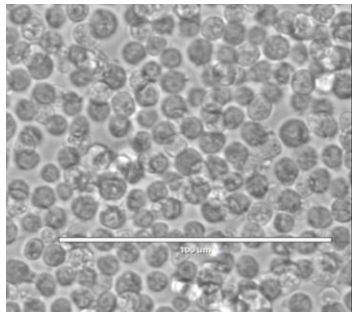
Schedule and place of work: Schedule is flexible. Insect rearing requires daily/every second day presence in the laboratory, while molecular biology will consume a few hours at a time. Work will be performed in the insectaries and molecular laboratory of the Institute of Environmental Sciences.

Other: You cannot fear insects, including mosquitoes. Mosquito bites are rather rare, but you will have a better time if you are not allergic.

Supervisor: dr Ewa Chrostek, ewa.chrostek@uj.edu.pl







Establishing a model of antiviral protection in dengue vector

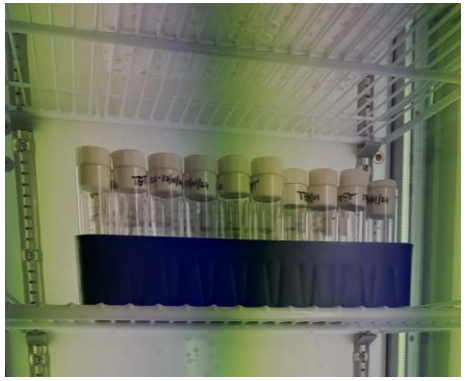
Research problem: *Wolbachia* is an antiviral bacterium which can prevent mosquito vectors of human diseases from infecting humans. The mechanism of antiviral protection is currently unknown. Studying *Wolbachia* in mosquitoes is expensive and laborious due to the demand for a biological safety 3 level (BSL3) facility. **The aim of this project is to establish a non-human-pathogenic model of virus infection and *Wolbachia*-conferred antiviral protection in dengue and Zika vector, *Aedes aegypti*.**

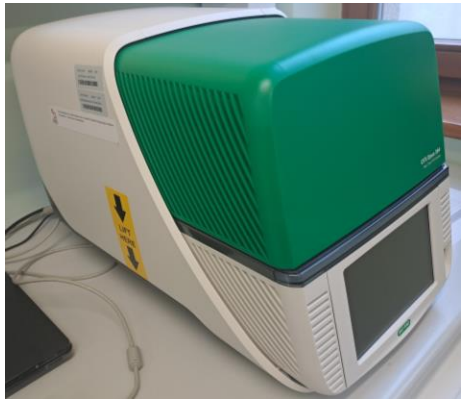
Description: Rearing insects, working with virus, microinjections, PCR and qPCR, statistical analysis of data.

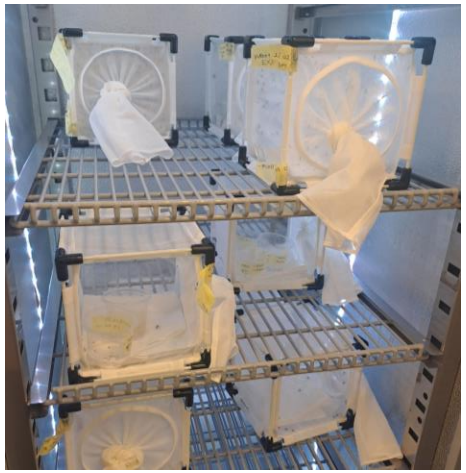
Schedule and place of work: Schedule is flexible. Insect rearing requires daily/every second day presence in the laboratory, while molecular biology will consume a few hours at a time. Work will be performed in the insectaries and molecular laboratory of the Institute of Environmental Sciences.

Other: You cannot fear insects, including mosquitoes. Mosquito bites are rather rare, but you will have a better time if you are not allergic.

Supervisor: dr Ewa Chrostek, ewa.chrostek@uj.edu.pl







Sustainable academic dining. Evaluation of existing solutions and needs in the context of adaptation to climate change

Research tasks:

1) Evaluation of the food offer available at the Jagiellonian University from the point of view of adaptation to climate change and the quality of study conditions
2) Working on proposals to improve the dining conditions at Jagiellonian University from the perspective of adapting to climate change and implementing the UJ climate strategy.

Research methods: document analysis, participant observation, survey – citizen science, social experiment, gamification

Time & place: flexible timing, research at Jagiellonian University Kampus

Supervisors:
prof. Małgorzata Grodzińska-Jurczak, dr Joanna Tusznio

Socio-environmental Research Team
https://natura.wb.uj.edu.pl/en_GB/

Engagement of researchers in addressing local adaptation to climate change

Research tasks:

1) Exploring the motivations and ways in which scientists engage in in pro-climate activities in the local environment.
2) Assessing the institutional and structural factors motivating and inhibiting the involvement of scientists in pro-climate activities.

Methods: interviews, q-method survey, gamification

Time and place: flexible timing, research in Krakow and / or online

Potential supervisors:
prof. Małgorzata Grodzińska-Jurczak, dr Joanna Tusznio

Socio-environmental Research Team https://natura.wb.uj.edu.pl/en_GB/

Literature: Krawczyk et al. 2023, Ivory tower of academia. https://doi.org/10.1016/j.envsci.2023.05.016

Succession and climate change as opposing drivers of microclimatic conditions within meadows

Research problem: Succession and global climate change are nowadays the main threats to European meadows, although they may be expected to have opposite effects and mitigate each other to some extent. The aim of the study will be to determine their interaction impact on microclimatic conditions within mesophilic meadows at their distribution edges, which are particularly vulnerable to environmental changes.

Description of tasks: Programming, reading, field placement and collection of temperature loggers. Analyses of earlier data from meadows at varying stages of succession.

Location and timing: Fieldwork in specific periods (3-4 days in both early April and early October) in the 3rd JU Campus surroundings. Lab work with loggers (ca. 8 h in both March and November). Other tasks: to be agreed - flexible working schedule.

Supervisor: Prof. dr hab. Piotr Nowicki [piotr.nowicki@uj.edu.pl]

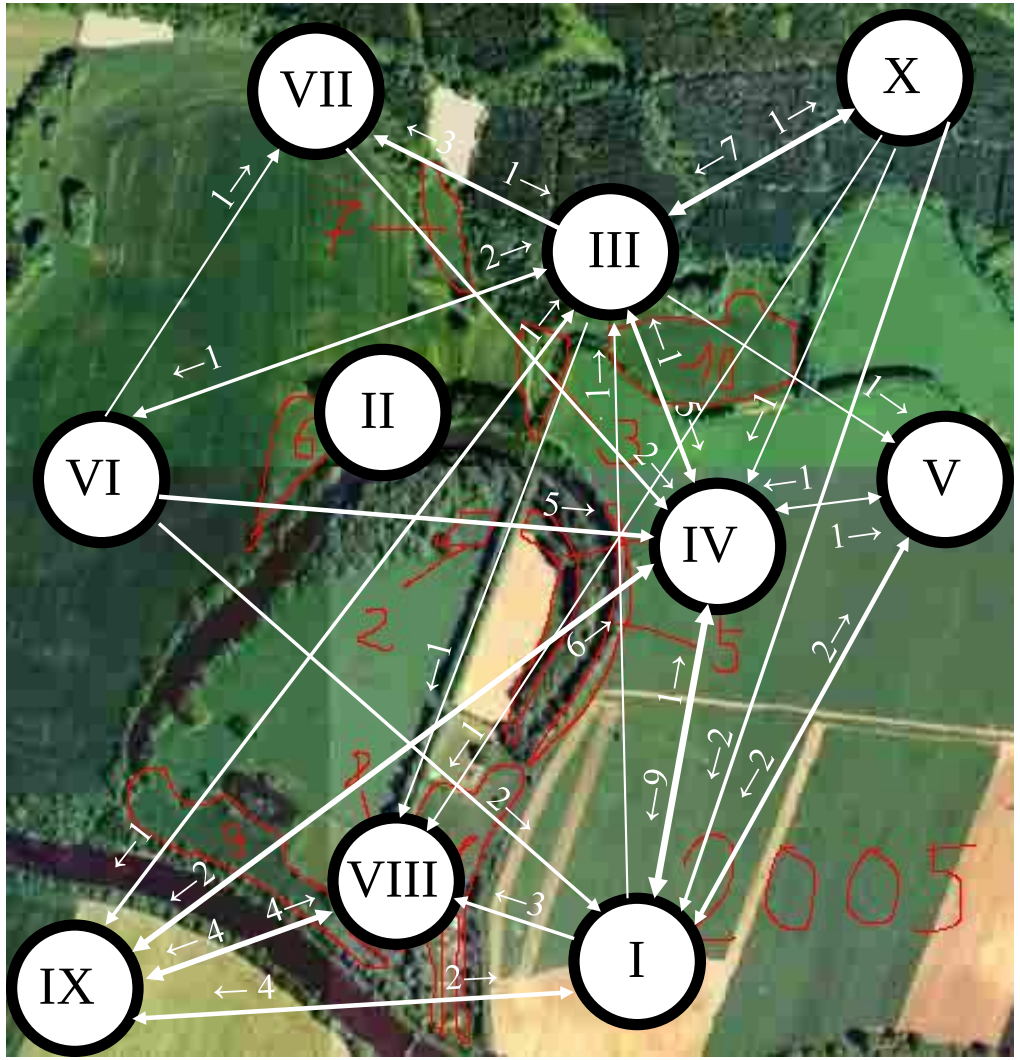
Impact of dispersal parameters on its success

Research problem: The process of dispersal, i.e. movements of individuals between habitat patches, is crucial for the survival of species in fragmented landscapes. The aim of the study will be to evaluate the impact of various elements of this process (emigration rate, movement distance, migrant mortality) on its success level.

Description of tasks: Analyses of existing mark-release-recapture data for estimating dispersal parameters and simulations of dispersal in real metapopulations using simple dedicated software.

Location and timing: To be agreed - flexible working schedule. All the analyses can be performed remotely after short training.

Supervisor: Prof. dr hab. Piotr Nowicki [piotr.nowicki@uj.edu.pl]



Surveys of endangered butterflies within Natura 2000 sites

Research problem: Butterflies, as popular indicator species, are among primary conservation targets for Natura 2000 sites, and the knowledge on their population status helps to determine the state of biodiversity in a given area. The aim of the study will be to assess the occurrence and population size of selected butterfly species within protected meadow complexes in the vicinity of Kraków.

Description of tasks: Field research, population size estimation, comparative analyses based on historical data.

Location and timing: Fieldwork in specific periods (3-6 full days in both the second half of May as well as July) in the Dębnicko-Tynieckie Meadows in Kraków or the Niepołomice Forest. Other tasks: to be agreed - flexible working schedule.

Supervisor: Prof. dr hab. Piotr Nowicki [piotr.nowicki@uj.edu.pl]

Egg laying preferences of the extinction prone Alcon Blue butterfly

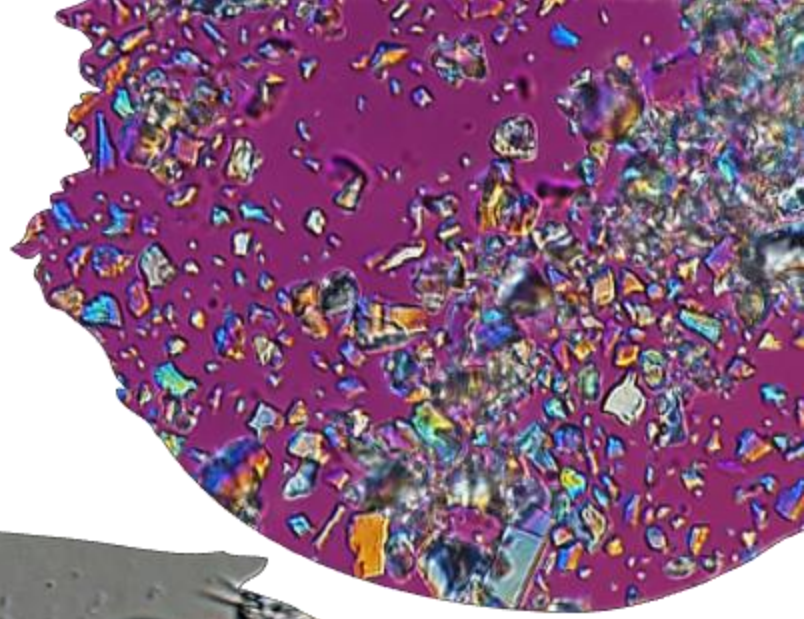
Research problem: Alcon Blue butterfly, once widespread in the Krakow region, is now at the brink of extinction, and the knowledge of its habitat preferences in the few remnant populations would be vital for developing effective conservation programmes. The aim of the study will be to determine the species preferences for egg laying sites.

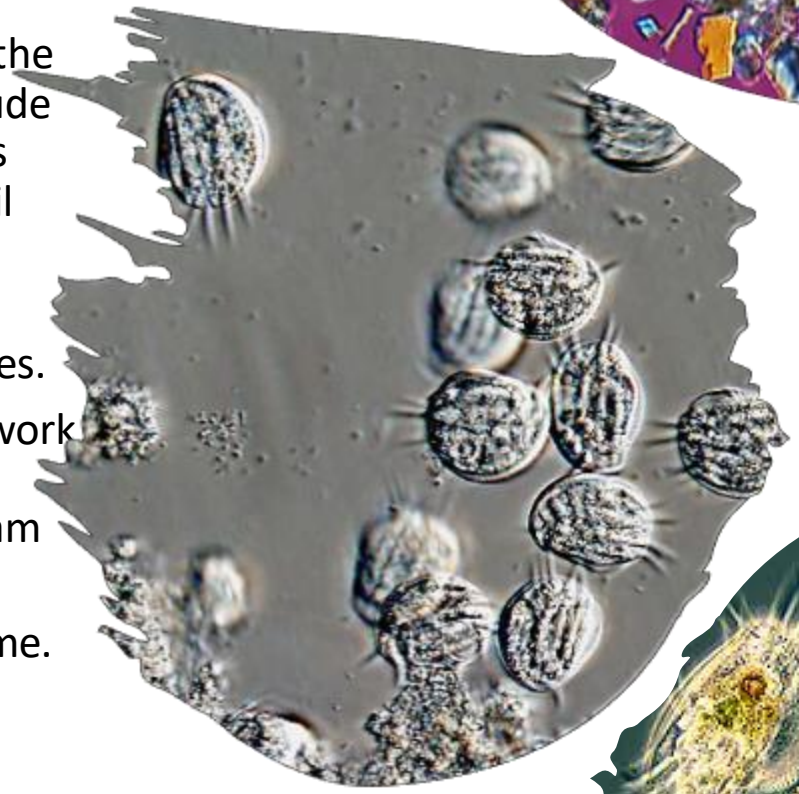
Description of tasks: Field research, including mapping and environmental parameter measurements, simple spatial and statistical analyses.

Location and timing: Fieldwork in specific periods (1-2 weeks in the second half of August as well as possibly single days in early April and early October) in the Dębnicko-Tynieckie Meadows in Kraków. Other tasks: to be agreed - flexible working schedule.

Supervisor: Prof. dr hab. Piotr Nowicki [piotr.nowicki@uj.edu.pl]

Effects of various pollutants on soil protozoa





Research question: A large number of different pollutants enter the soil as a result of agricultural and industrial activities. These include microplastics, pesticides, fertilisers, petroleum-based substances and many others. However, the impact of these pollutants on soil microfauna is still poorly understood.

Description of activities: Working in the laboratory, conducting protozoan cultures, performing experiments, microscopic analyses.

Time and place of work: To be agreed individually. Possibility to work around other commitments and carry out experiments at a convenient time. Work carried out in the Aquatic Ecosystems Team laboratory.

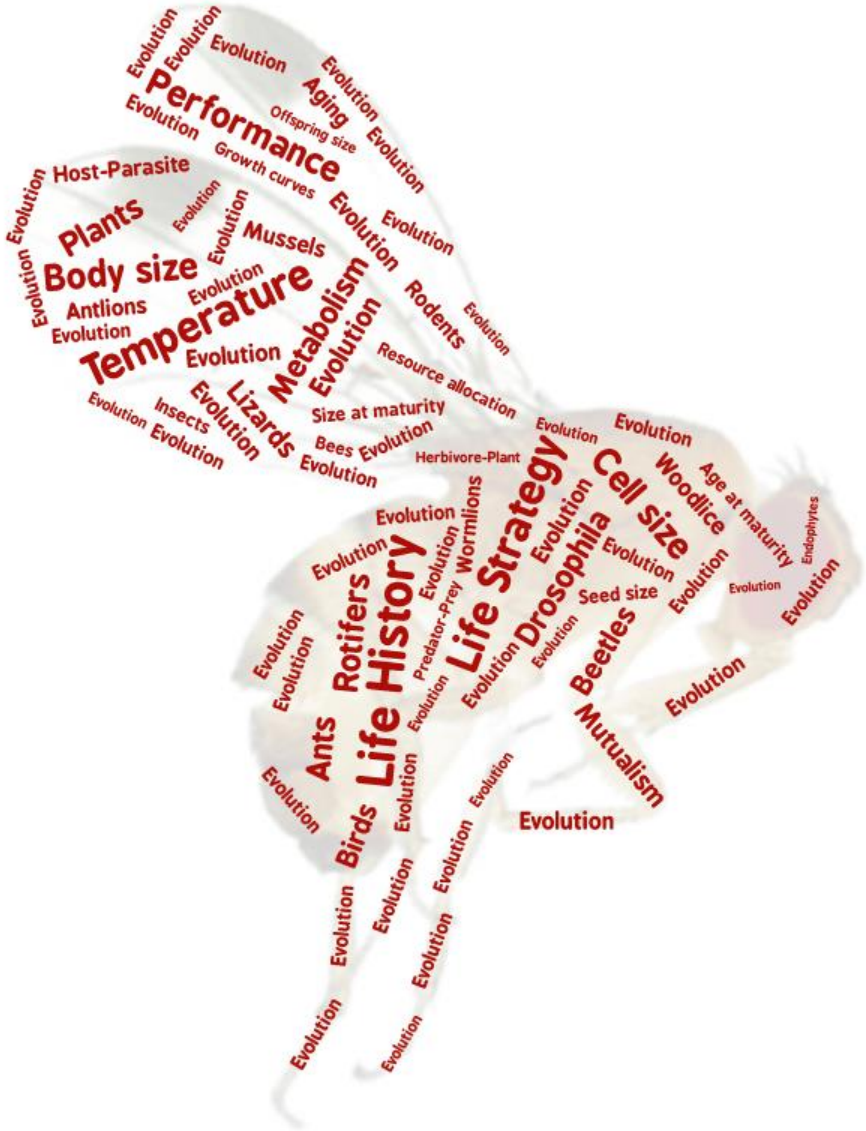
Other: Interest in protozoa and microscopic techniques is welcome.

Supervisor: dr hab. Janusz Fyda, prof. UJ

janusz.fyda@uj.edu.pl

Life History Evolution team

Adaptive consequences of cell size variation in insects



Individuals, populations and species evolve differences in cell sizes, but adaptive consequences of this variance is not well understood. The main **aim of this study is to assess physiological consequences of cell size differences between different phenotypes of fruit flies (*Drosophila melanogaster*)**. Do insects build of smaller or larger cells function similarly across environmental gradients?

Tasks: Handling, feeding, and measuring performance of flies in the laboratory. The student will be assisted with statistical analyses.

Time & place: Thermal biology & histological labs @Gronostajowa 7. Working time is adjusted flexibly to experimental setups and students' calendars.

Supervisor: Prof. dr hab. Marcin Czarnołęski
marcin.czarnoleski@uj.edu.pl

Stimulus generalisationin Zebra Finches

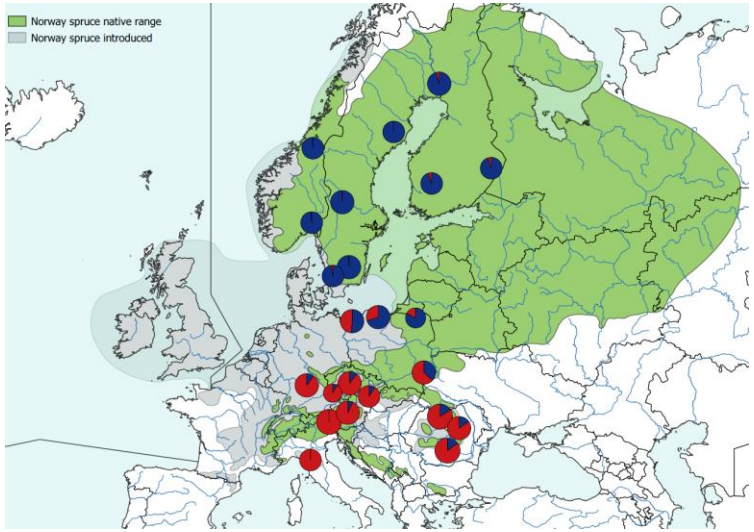
Zebra finches will first learn to associate a food reward with a dot pattern; the birds will be rewarded for responding to big dots. The main **aim of the study is to determine whether zebra finches will generalize this learned association**. When given a choice between feeders with minimal differences, will they choose the one with relatively larger dots?

Tasks: Handling, feeding, and observing birds in the laboratory. The student will be assisted with statistical analyses.

Time & place: An intensive 1.5 months of work, including ca. 60 hours of observations, which must be conducted in the mornings, @Gronostajowa 7

Supervisor: Prof. dr hab. Joanna Rutkowska, joanna.rutkowska@uj.edu.pl

Genetic structure of the double-spined bark beetle (*Ips duplicatus*)



Research problem: Are European populations of the bark beetle divided into genetically diverse populations? Is the genetic structure of the bark beetle similar to that of the spruce? What is the level of genetic variation in the bark beetle? Is it possible to delineate refugial areas and recolonization routes of Europe after glaciations?
Description: Work in a molecular laboratory. Analyzing whole genome sequencing data.
Schedule and place of work: We agree individually. We offer flexibility in shaping working time. Data analysis can be performed remotely.
Other: We expect willingness to learn basics of programming.

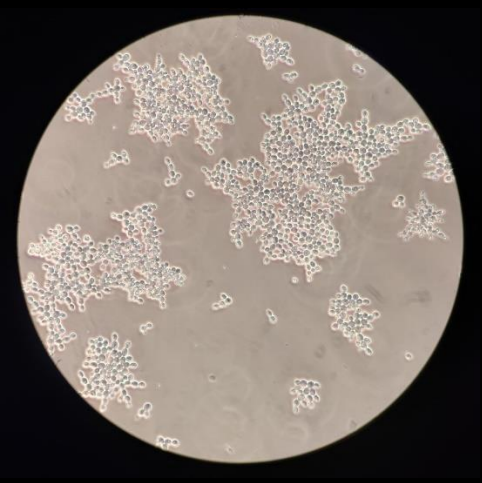
Supervisor: dr Piotr Zieliński
piotr.zielinski@uj.edu.pl

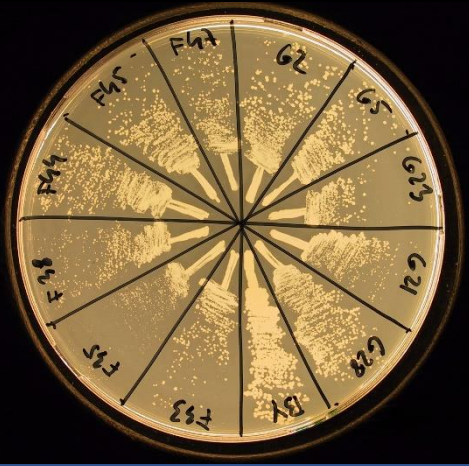
The influence of ecological factors on the quiescent state of the yeast *Saccharomyces cerevisiae*

- *What do cells do when they don't divide?*
- *Well, most living cells on Earth spend their lives in a state of quiescence.*

Unlike the traditional view, quiescent cells are not like a frozen 'Sleeping Beauty' but rather like 'Little Red Riding Hood,' energy-demanding living systems that interact, communicate, and respond to both biotic and abiotic factors.
Ecological factors such as temperature changes, nutrient availability, toxin presence, and social interactions contribute to cell diversity in the quiescent state in populations.

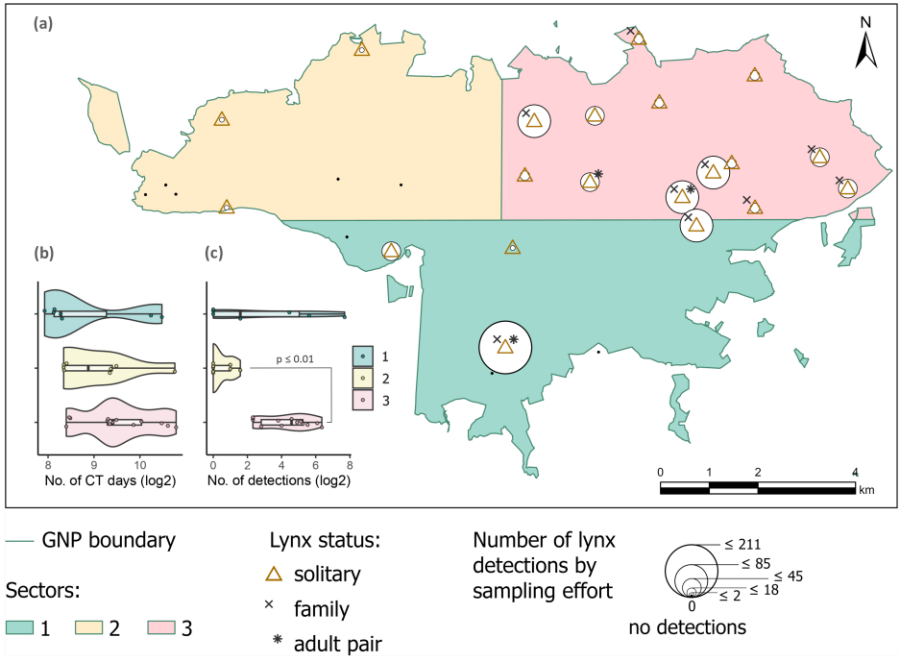
Tasks: Performing plannded wet-lab experiments.
The student will be assisted with results analyses.
Time & place: microbiology and genetics laboratory (IES, Gronostajowa 7)
Supervisor: dr hab. Dominika Włoch-Salamon,
dominika.wloch-salamon@uj.edu.pl





Spatio-temporal distribution of wildlife species in different habitats

- **Research problem:** Determination of the main factors contributing to geographical range and temporal activity of wildlife species such as large and medium-sizes predators (eg., Eurasian lynx (*Lynx lynx)*, grey wolf (Canis lupus), brown bear (*Ursus arctos*), red fox (*Vulpes vulpes*), European badger (*Meles meles*) and ungulates (red deer (*Cervus elaphus*), roe deer (*Capreolus capreolus*), wild boar (*Sus scrofa*) in urban and wild areas.
- **Description:** Work in field and in the office. Deployment and collection of records from camera-traps.
- Creating data-bases and analysing seasonal, diel activity and geographic distribution (work with ArcGIS Pro, RStudio)
- **Schedule and place of work:** Regular meeting of the research team (at least once a month), individual schedule of work upon agreement with a project coordinator in the office – field work once a month, computer work – once a week
- **Other:** English fluency minimum level B1



- **Supervisor:** Dr hab. Izabela Wierzbowska
- i.wierzbowska@uj.edu.pl

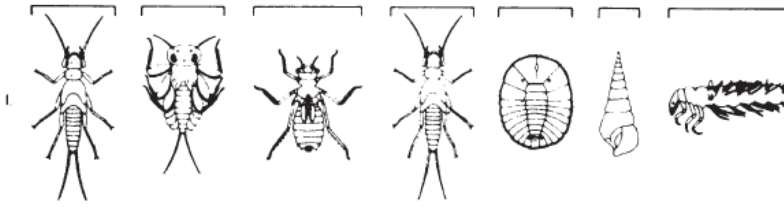
How to assess the ecological status of aquatic biota without identifying macrobenthic species?

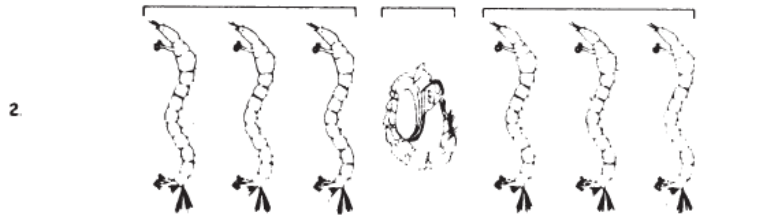
Assessing the ecological health of aquatic biota with biotic indices requires identification of macrobenthic taxa, which slows down analyses. **The aim of the project will be assessing the applicability of diversity indices,** for which species identification is not necessary.

Tasks: Field trips to collect samples of macrobenthos. Work in laboratory: sorting of collected specimens and calculating indices. Student will be assisted in data analysis.

Time & place: Field trips 2 - 3× per year, laboratory work @Gronostajowa 7

Supervisor: dr hab. Wojciech Fiałkowski, wojciech.fialkowski@uj.edu.pl





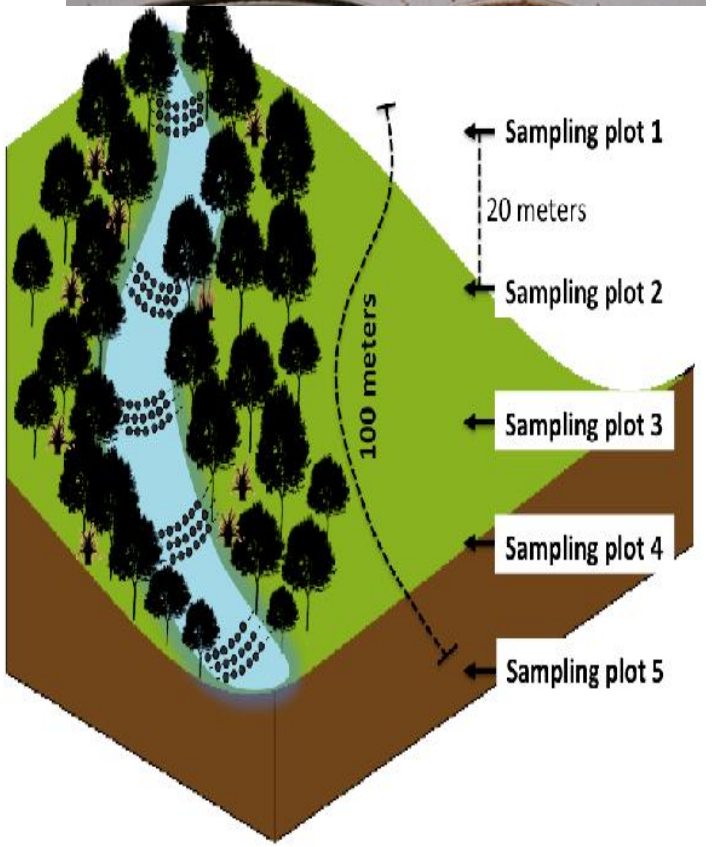
Artificial substrata as an aid in the assessment of watercourses' ecological status

Macrobenthos community is closely related to the character of the river bottom. This hampers comparisons of sites with different substrata. One of possible solution is the employment of artificial substrata. **The aim of the project will be assessing to what extent artificial substrata aid comparison** of different aquatic biota.

Tasks: Field trips to deploy and collect artificial substrata. Identification of collected material in the laboratory. Student will be assisted in data analysis.

Time & place: Field trips 4× per year, laboratory work @Gronostajowa 7

Supervisor: dr hab. Wojciech Fiałkowski, wojciech.fialkowski@uj.edu.pl



Predatory fungi in activated slugde

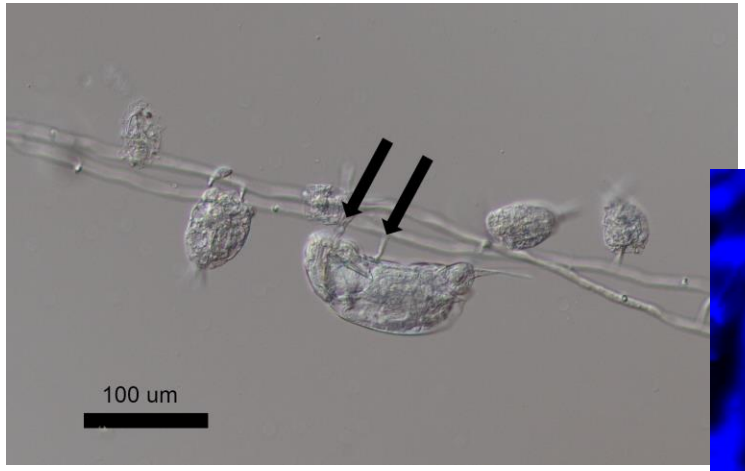
Research problem: Predatory fungi, specialized in feeding on rotifers, pose a serious threat to the population of these valuable animals in activated sludge in Wastewater Treatment Plants (WWTPs). By feeding on filamentous bacteria, rotifers prevent the phenomenon of active sludge bulking, which is one of the biggest operational problems in WWTPs. Can commonly used fungicides limit the ability of predatory fungi to “trap” rotifers without harming other microorganisms inhabiting activated sludge? Are different rotifers species equally susceptible to predatory fungi?

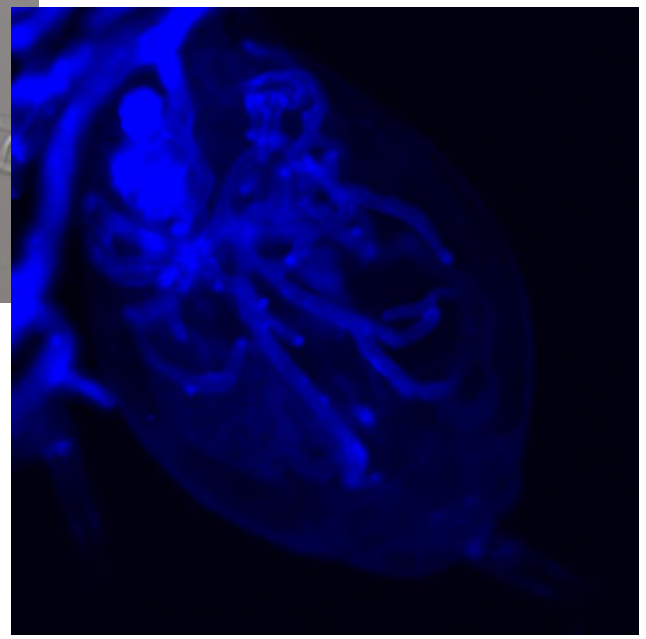
Description: maintenance of rotifers and fungi cultures, work with microscopes (binocular, inverted and fluorescent), work with NIS image analysis programm.

Scheduel and place of work: experiments carried out in Laboratory of Protozoology, schedule of experiments is set individually, flexibly.

Other: manual skills related to the efficient use of the pipette in activities requiring simultaneous use of stereomicroscope are welcome.

Supervisor: dr hab. Edyta Fiałkowska
edyta.fialkowska@uj.edu.pl





Microplastics in water habitats- their influence on freshwater microorganisms

Research problem: One of the biggest environmental problems is the pollution of the environment with microplastics. Microplastics are found in both natural water reservoirs and wastewater treatment plants (WWTPs). Despite many studies, the impact of microplastic particles on aquatic organisms is still poorly understood. Do microplastic particles negatively affect aquatic microorganisms such as rotifers or ciliates? Do microplastic particles accumulate in successive levels of the food chain? Can rotifers contribute to the separation of microplastics from water and activated sludge?

Description: maintenance of rotifers and ciliates cultures, work with microscopes (binocular, inverted and fluorescent), work with NIS image analysis programm.

Scheduel and place of work: experiments carried out in Laboratory of Protozoology, schedule of experiments is set individually, flexibly.

Other: manual skills related to the efficient use of the pipette in activities requiring simultaneous use of stereomicroscope are welcome.

Supervisor: dr hab. Edyta Fiałkowska
edyta.fialkowska@uj.edu.pl