Open a PhD student position in aquatic microbial ecology

The Department of Aquatic Microbial Ecology, Institute of Hydrobiology, Biology Centre CAS, invites application from prospective PhD students

One PhD student position is open in the Department of Aquatic Microbial Ecology, Institute of Hydrobiology, Biology Centre CAS and Faculty of Science, University of South Bohemia, České Budějovice, Czech Republic within the PhD program in Limnology to study the diversity, dynamics and ecological traits of freshwater eukaryotes using single-cell techniques, sequencing and experimental approaches. This position is in the framework of the 3-year grant from the Czech-Polish bilateral project (PIs: Indranil Mukherjee, CZ and Kasia Piwosz, PL) funded by the Czech Science Foundation (GAČR; see below).

The project title:

How complex are aquatic microbial food webs? Unveiling the trophic role of middle-sized heterotrophic flagellates in freshwater and brackish habitats

Background: The current view of aquatic microbial food webs assume a relatively simple transfer of energy from prokaryotes via heterotrophic nanoflagellates (HNF, cell size 2.5-20 µm) to ciliates, and finally to zooplankton (Fig. 1A). However, the recent studies on aquatic protists discovered not only their enormous phylogenetic diversity, but they also reported unexpected variety of morphology, sizes, feeding modes and life strategies of these less understood microorganisms. The recently discovered groups with different life strategies and feeding modes possibly create highly complex food webs, thus considerably modulating our current understanding of rates and efficiencies of carbon and energy transfer in aquatic habitats. In the light of these new findings, we argue that the classical model of energy transfer in the form of food chain is simplistic and we propose its considerable revision (Fig. 1B).

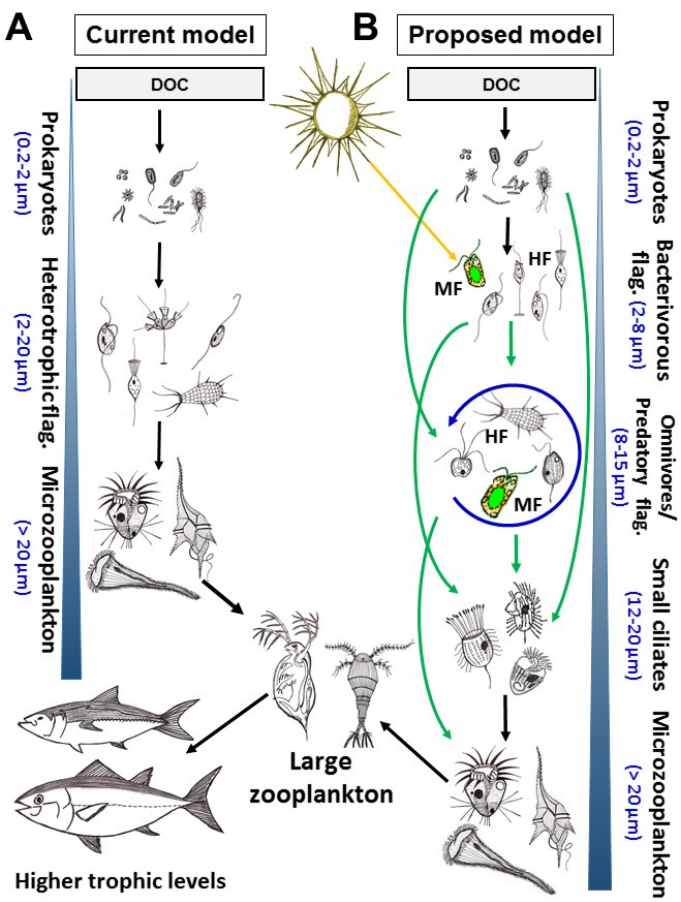

Figure 1. Conceptual models of pelagic microbial food webs (for simplicity, viruses, parasites and primary producers are not included). **(A)** The "classical" model of trophic interactions in microbial communities assumes generally linear carbon transfer in the trophic food chain. **(B)** Our proposed trophic model includes importance of trophic relationships within the nanoplankton size fraction (2–20 µm). Blue arrowhead indicates increasing cell-size of planktonic organisms at different trophic levels. DOC, dissolved organic carbon. HF and MF, heterotrophic and mixotrophic nanoflagellates, respectively. So far understudied, supposedly more complex relationships between the trophic levels are depicted by **green arrows**, trophic relationships within a particular size fraction are shown **in blue**, and well-recognized, "classical" interactions with **black arrows**.

The major focus of the project is to understand the role of middle-sized HNF in the size range 5-20 µm, which are either omnivores, feeding not only on bacteria, but even more so on bacterivorous HNF and algae, or predators, feeding primarily on bacterivorous or plastidic flagellates (Fig. 2). Similarly, small ciliates (12-20 µm), currently assumed to be primarily omnivorous, actually belong to the key planktonic bacterivores in most eu- and hypertrophic aquatic habitats. The prospective student will work in both environmental samples collected from freshwater lakes in Czech Republic and brackish Baltic Sea (Gulf of Gdansk, Poland) and samples from food web manipulation experiment conducted in the laboratory. Single-cell microscopic techniques like CARD-FISH will be primarily used to study the dynamics of individual groups of HNF and high throughput sequencing will be used to study the diversity patterns of protists.

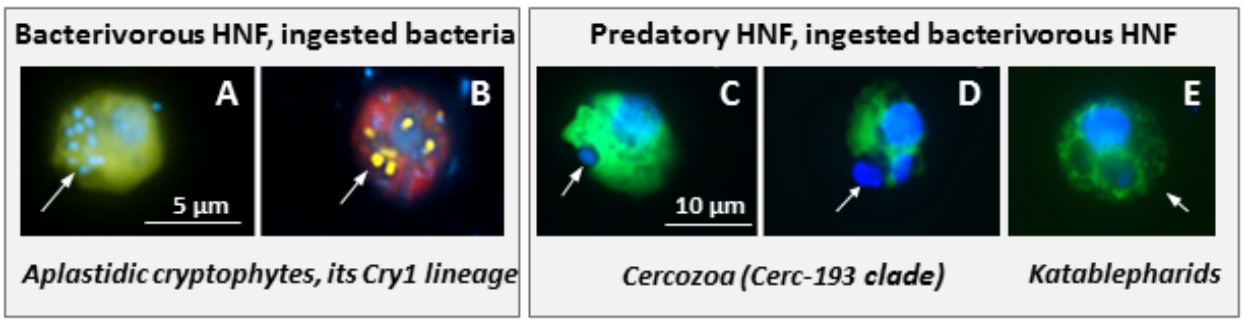

Figure 2. Examples of CARD-FISH targeted HNF (yellow-green color in **A, C-E**; or red color in **B**) with different feeding preferences from the Římov reservoir: (**A**) Aplastidic bacterivorous cryptophytes (probe Crypto B) and (**B**) their Cry1 lineage (probe Cry1-652) with ingested bacteria (**A**) or fluorescently labeled bacteria (**B**); **C–E** omnivorous/predatory HNF from the Cercozoan Cerc-193 lineage (**C, D**) or katablepharids (the Kat-1452 probe) (**E**). Arrows point to the position of ingested bacterial (**A, B**) or flagellate prey (**C–E**)**.**

This project is planned as a collaboration of Institute of Hydrobiology, Biology Centre, Czech Republic and National Marine Fisheries Research Institute, Poland. We will conduct regular sampling from the Římov reservoir in the Czech Republic and our partner institute will conduct sampling from the Baltic Sea. Classical and molecular single-cell microscopic techniques and molecular sequencing-based techniques will be utilized to disentangle mainly the ecological traits of middle-sized omnivorous/predatory protists in freshwater and brackish ecosystem. Examples of our recent publications dealing with this research topic are listed below. Experimental activities will be coordinated by Prof. Karel Šimek, who invented a flexible set of designs for experimental manipulations with bacterial and protistan communities in various environments that have been approved in top microbial ecology journals (please consult: https://www.researchgate.net/profile/Karel-Simek/research).

Relevant papers of the team members related to the project rationale:

Šimek K., Mukherjee I., Nedoma J., Paula C. C. P., Jezberová J., Sirová D., Vrba J. 2022: CARD-FISH and prey tracer techniques reveal the role of overlooked protistan groups as major bacterivores in hypertrophic ponds**.** Environ. Microbiol. doi:10.1111/1462-2920.15846

Piwosz K., Mukherjee I., **Salcher M.M., Grujčić V., Šimek K.** 2021: CARD-FISH in the sequencing era: opening a new universe of protistan ecology. Front. Microbiol. 12: article 640066. *(Review)*

Šimek K., Grujčić V., Mukherjee I., Kasalický V., Nedoma J., Posch T., Mehrshad M., Salcher M.M. 2020: Cascading effects in freshwater microbial food webs by predatory Cercozoa, Katablepharidacea and ciliates feeding on aplastidic bacterivorous cryptophytes. FEMS Microb. Ecol. 96 (10): fiaa121.

Mukherjee I., Salcher M.M., Andrei A.-S., Kavagutti V., Shabarova T., Grujčić V., Haber M., Layoun P., Hodoki Y., Nakano S., Šimek K., Ghai R. 2020: A freshwater radiation of diplonemids. Environ. Microbiol. 22: 4658–4668.

Piwosz K., Shabarova T., Pernthaler J., Posch T., Šimek K., Porcal P., Salcher M. M. 2020: Bacterial and eukaryotic small-subunit amplicon data do not provide a quantitative picture of microbial communities, but are they reliable in the context of their ecological interpretation. mSphere 5:e00052-20.

Šimek K., Grujčić V., Nedoma J., Jezberová J., Šorf M., Matoušů A., Pechar L., Posch T., Bruni E. P., Vrba J. 2019: Microbial food webs in hypertrophic fishponds: omnivorous ciliate taxa are major protistan bacterivores. Limnol. Oceanogr. 64: 2295–2309.

Mukherjee I., Hodoki Y., Okazaki Y., Fujinaga S., Ohbayashi K., Nakano S. 2019: Widespread dominance of kinetoplastids and unexpected presence of diplonemids in deep freshwater lakes. Front. Microbiol. 10: 2375.

Grujčić V., Nuy J., Salcher M., Shabarova T., Kasalický V., Boenigk J., Jensen M., Šimek K. 2018: Cryptophyta as major bacterivores in freshwater summer plankton. ISME J. 12: 1668–1681.

Šimek K., Grujčić V., Hahn M. W., Horňák K., Jezberová J., Kasalický V., Nedoma J., Salcher M. M., Shabarova T. 2018: Bacterial prey food characteristics modulate community growth response of freshwater bacterivorous flagellates. Limnol. Oceanogr. 63: 484–502.

Šimek K., Pitsch G., Salcher M.M., Sirová D., Shabarova T., Adamec L., Posch T. 2017: Ecological traits of a zoochlorellae-bearing *Tetrahymena* sp. (Ciliophora) living in traps of the carnivorous aquatic plant *Utricularia reflexa*. J. Eukaryot. Microbiol. 64: 336-348.

Mukherjee I., **Hodoki Y., Nakano S.** 2017: Seasonal dynamics of heterotrophic and plastidic protists in the water column of Lake Biwa, Japan. Aquat. Microb. Ecol. 80: 123-137.

Mukherjee I., **Hodoki Y., Nakano S.** 2015: Kinetoplastid flagellates overlooked by universal primers dominate in the oxygenated hypolimnion of Lake Biwa, Japan. FEMS Microbiol. Ecol. 91: fiv083.

Šimek K., Kasalický V., Jezbera J., Horňák K., Nedoma J., Hahn M. W., Bass D., Jost S., Boenigk J. 2013: Differential freshwater flagellate community response to bacterial food quality with a focus on *Limnohabitans* bacteria. ISME J. 7: 1519-1530.

Requirements: Applicants should have Masters in Biological Sciences (e.g. Limnology, Marine Biology, Microbiology, Ecology, Molecular Biology, Biochemistry, Bioinformatics) and must be strongly motivated to work with protists using modern microscopic approaches (CARD-FISH, prey-tracer techniques) and sequencing-based molecular setting. The work is expected to be 50% laboratory based, 30% computational and 20% fieldwork. Prior experience in R and high-throughput sequence analysis pipelines might be favourably considered but is not a prerequisite for selection. Candidates must be proficient in English.

Please submit (preferably all information combined in a single PDF file):
1) A detailed CV (including your grades), 2) a brief statement of your research interests and work performed and 3) the name and contact information for at least two referees. Please indicate your research interest and the motivation to work with protists in your application. The positions will remain open until suitable candidates are found, applications will be evaluated monthly starting January 2022. Target starting date is February 2022 and the position is for 3 years.

Contact: Please send your application to **indranil.mukherjee@hbu.cas.cz** and c/c to Prof. Karel Šimek (**ksimek@hbu.cas.cz**) and indicate “PhD Application“ in the message subject.

For further information about the position please don’t hesitate to contact:

Dr. Indranil Mukherjee
Department of Aquatic Microbial Ecology, Institute of Hydrobiology, Biology Centre CAS
Na Sadkach 7, 37005 České Budějovice, Czech Republic

Links:
https://www.hbu.cas.cz/en/

https://www.hbu.cas.cz/en/staff/profil/19136/

https://www.hbu.cas.cz/en/staff/profil/181-karelsimek/

The Department of Aquatic Microbial Ecology (Institute of Hydrobiology, Biology Centre of the Czech Academy of Science) is an internationally recognized high-class institution for studying freshwater microbes. There are four well-equipped microbiological laboratories: one lab for microbial isolation and cultivation, two for molecular biology, one for working with radioisotopes and two walk-in climate-controlled chambers for cultivation and experiments. Instrumentation: A fully automated fluorescence microscope with image analysis for high-throughput evaluation of CARD-FISH stained samples, three fluorescence microscopes equipped with image analysis systems, inverted microscopes, a micromanipulator and microinjector, a spectrofluorometer, hybridization chambers, incubators, basic equipment for cultivation and molecular biology, ultra-low temperature freezers. A flow cytometry equipped with an autosampler for 96-well plates for a semi-automated high-throughput screening of dilution-to-extinction cultures. Full equipment for sampling is available including sampling boats, water samplers, automated winch, YSI multiprobes, bbe fluoroprobe, etc. A MinION and MinIT (Oxford Nanopore) for generating ultra-long sequencing reads, three 128-core Unix servers (768 Gb RAM), two 64-core Unix servers (512 Gb RAM) and three 100/160 Tb NAS storage are available for analysis of sequence data.

České Budějovice (Budweis) is a medium-sized city ca. 150 km south of Prague with 100,000 inhabitants, a relaxed atmosphere, and a growing expat community at the Biology Centre and the University of South Bohemia. Both the town and the surrounding countryside provide numerous opportunities for research and leisure activities. Living costs are low by international standards.

Infrastructure and Benefits: Position includes standard health insurance and social security and five weeks of yearly holiday. PhD student will have access to accommodation in dormitories at the campus shared by the Biology Centre and the University of South Bohemia. Czech courses are available for foreign students to reach a basic level of proficiency in everyday situations. The Biology Centre provides assistance in the visa application process for foreigners.

Application deadline: Open until filled

Start date: ASAP

Location: Institute of Hydrobiology, Biology Centre CAS, Ceske Budejovice, Czech Republic