INSTITUTE OF PARASITOLOGY

Biology Centre of the Czech Academy of Sciences, v.v.i.

České Budějovice, Czech Republic

ANNUAL REPORT

A BRIEF SURVEY OF THE INSTITUTE'S ACTIVITIES AND OUTCOMES

2018

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(*As of 1 January 2019*)

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(***Julius LUKEŠ***)

Deputy Director
(***Tomáš SCHOLZ***)

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Laboratory of Molecular Biology of Protists
(***Julius Lukeš***)

Laboratory of Functional Biology of Protists
(*Alena Zíková-Panicucci*)

Laboratory of RNA Biology of Protists
(*Zdeněk Paris*)

Fish Parasitology

Laboratory of Helminthology
(***Tomáš Scholz***)

Laboratory of Fish Protistology
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Opportunistic Diseases

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(***Martin Kváč***)

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(*Jan Štefka*)

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(*Martin Kolísko*)

Supporting Facilities

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(*Tomáš Douda*)

Administrative and technical services

International journal
Folia Parasitologica

Scientific Council

Miroslav Oborník (Chairman)
Aleš Horák
Petr Kopáček
Martin Kváč
Tomáš Scholz
Alena Zíková

External members
Petr Horák
Ivan Čepička
Ivo Šauman

Tick-Borne Diseases

Laboratory of Molecular Ecology of Vectors and Pathogens*
(***Libor Grubhoffer***)

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(***Petr Kopáček***)

Laboratory of Genomics and Proteomics of Disease Vectors
(*Michail Kotsyfakis*)

Laboratory of Tick-Transmitted Diseases
(*Ondřej Hajdušek*)

* Joint research teams of the Institute and Faculty of Science, University of South Bohemia; team leaders in bold.

Editorial

Time passes by fast and I am already deep in the 2nd term as a Director of the Institute of Parasitology (till June 2022), which is part of the Biology Centre, a group of ecologically and evolutionarily minded institutes of the Czech Academy of Sciences, located in the picturesque city of České Budějovice.

I am happy to say that the year 2018 was a very good one for our institute, both in terms of publication output and funding from a range of sources. Our staff became more international, causing that the lingua franca of the institute is English. I am happy to say that we participated in several high profile publications that appeared in *Science*, *PLoS Pathogens*, *Proceedings of the National Academy of Sciences*, *Current Biology* and others. We also keep publishing our in-house journal Folia Parasitologica that got decent ranking in a recent survey. We have two extensive, increasingly well-equipped supporting facilities, namely the electron microscopy unit and the animal facility that are run by enthusiastic staff, always willing to engage in challenging projects. As a whole, the Institute strives to be a vibrant, flexible, dynamic and competitive group of laboratories, for which parasitology is the common denominator.

Cheers,

Julius Lukeš

Director

Mission statement

The Institute of Parasitology of the Biology Centre is a research institution of the Czech Academy of Sciences performing fundamental research on human and animal parasites at the organismal, cellular and molecular levels. Its mission is to acquire, advance and disseminate knowledge of the biology and host relationships of parasitic protists and related eukaryotic microorganisms, helminths and arthropods. The Institute pursues its mission through research, education and other activities at both the national and international levels. The results obtained have contributed to the prevention and control of human and animal parasitic diseases.

The Institute of Parasitology was established in Prague in 1962, but was relocated to České Budějovice in South Bohemia in 1985. The Institute represents a principal institution devoted exclusively to parasitological research in the Czech Republic. The main research areas encompass protistology, helminthology and medical entomology, including studies on the causative agents of the infections transmitted by arthropods. Investigations into molecular biology of parasitic protists, phylogeny of parasites and their molecular ecology, fish parasites, life-cycles of helminths and parasitic arthropods as vectors of diseases have remained long-term research priorities of the Institute.

Research teams and their activities

1. MOLECULAR PARASITOLOGY

1.1. Laboratory of Molecular Biology of Protists

Research scientists:	prof. RNDr. **Julius LUKEŠ**, CSc. (*head*)
	RNDr. **Drahomíra Faktorová**, PhD;
	doc. Mgr. **Hassan Hashimi**, PhD (USA);
	RNDr. **Eva Horáková**, PhD; **Galina Prokopchuk,** PhD (Ukrajina);
	Mgr. **Daria Tashyreva**, PhD (Ukrajina);
Postdocs:	**Ignacio Miguel Durante**, MSc, PhD (Argentina)
	Michael John Hammond, MSc, PhD (Australia)
	Anzhelika Butenko, MSc (Russia)
PhD students:	**Ambar Kachale**, MSc (Indie); **Binnypreet Kaur**, MSc (India);
	Josef Kaurov, MSc (Russia); **Anna Nenarokova**, MSc (Russia);
Research assistants:	Mgr. **Jiří Heller**, Mgr. **Michaela Svobodová**
Technicians:	**Renata Lukšová**; Mgr. **Eva Kriegová**
Undergraduate students:	**Lawrence Rudy Cadena** (USA)

Research priorities

We are interested in the studies of various aspects of biology of the kinetoplastid and diplonemid flagellates. These are protists that branched off the main eukaryotic lineage and contain numerous departures from the prototypical eukaryotic cell. In particular their mitochondrion has many unique aspects, which we are exploring by knocking down, tagging, over expressing or knocking in individual genes. Especially we are interested in the following groups of proteins: (i) involved in RNA editing and regulation of stability of mitochondrial transcripts; (ii) that are subunits of respiratory complexes, (iii) involved in iron/sulfur cluster assembly; (iv) participating in processing of imported proteins; (v) involved in heme metabolism, and, finally (vi) that build the mitochondrial cristae.

In diplonemids, we are mainly exploring their evolution, diversity, morphology, metabolism, transcriptome and genome structure. Moreover, we are trying to introduce into culture so far uncultivable representatives of the hyperdiverse marine clade. We have also succeeded in first genetic modification of diplonemids, which should allow their genetic dissection and brings them into the family of model organisms.

Selected publications

- Gerasimov E.S., Gasparyan A.A., **Kaurov I.**, Tichý B., Logacheva M.D., Kolesnikov A.A., **Lukeš J.**, **Yurchenko V.**, Zimmer S.L., Flegontov P. 2018: Trypanosomatid mitochondrial RNA editing: dramatically complex transcript repertoires revealed with a dedicated mapping tool. *Nucleic Acids Research* 46: 765–781. [IF=11.561]
- Grybchuk D., Akopyants N.S., Kostygov A.Y., Konovalovas A., Lye L.-F., Dobson D.E., Zangger H., Fasel N., **Butenko A.**, Frolov A.O., **Votýpka J.**, d'Avila-Levy C.N., Kulich P., Moravcová J., Plevka P., Rogozin I.B., Serva S., **Lukeš J.**, Beverley S.M., **Yurchenko V.** 2018: Viral discovery and diversity in trypanosomatids with a focus on relatives of the human parasite *Leishmania*. *Proceedings of the National Academy of Sciences of the United States of America* 115: E506–E515. [IF=9.504]
- **Kaurov I.**, **Vancová M.**, Schimanski B., Cadena L.R., **Heller J.**, **Bílý T.**, Potěšil D., Eichenberger C., Bruce H., Oeljeklaus S., Warscheid B., Zdráhal Z., Schneider A., **Lukeš J.**, **Hashimi H.** 2018: The diverged trypanosome MICOS complex as a hub for mitochondrial cristae shaping and protein import. *Current Biology* 28: 3393–3407.e5. [IF=9.251]
- **Lukeš J.**, **Butenko A.**, **Hashimi H.**, Maslov D.A., **Votýpka J.**, **Yurchenko V.** 2018: Trypanosomatids are much more than just trypanosomes: clues from the expanded family tree. *Trends in Parasitology* 34: 466–480. [IF=7.929]
- **Lukeš J.**, Husník F. 2018: Microsporidia: a single horizontal gene transfer drives a great leap. *Current Biology* 28: R712–R715. [IF=9.251]
- **Tashyreva D.**, **Prokopchuk G.**, **Votýpka J.**, Yabuki A., **Horák A.**, **Lukeš J.** 2018: Life cycle, ultrastructure, and phylogeny of new diplonemids and their endosymbiotic bacteria. *mBio* 9: e02447-17. [IF=6.689]

Research projects

- **Heme: a putative master regulator in trypanosomatids.** Czech Science Foundation (16-18699S; P.I.: J. Lukeš; 2016–2018).
- **DIPLONEMID II.** Gordon and Betty Moore Foundation grant (GBMF4983.01, 09/2017–08/2019)
- **Comprehensive study of diplonemids: emerging key players in the oceans.** ERC CZ, Czech Ministry of Education, Youth and Sports (LL1601, 2017–2021)
- **Trypanosomatids with in-frame sense stop codons: dissecting molecular mechanisms behind the unique ambiguity of the genetic code.** Czech Science Foundation (18-15962S; J. Lukeš; 2018–2020)
- **ERDF/ESF Centre for research of pathogenicity and virulence of parasites** (No. CZ.02.1.01/0.0/0.0/16_019/0000759; M. Oborník – coordinator, 2018–2022)

1.2. Laboratory of Functional Biology of Protists

Research scientists:	RNDr. **Alena ZÍKOVÁ**, PhD (*head*) Mgr. **Eva Doleželová**, PhD; Mgr. **Ondřej Gahura**, PhD
Research assistant:	**Brian Panicucci**, BSc (USA)
PhD students:	**Carolina Hierro Yap**, MSc (Spain); **Gergana Taleva**, MSc (Bulgaria); **Minal Jain**, MSc (India), Mgr. **Michaela Kunzová**
Undergraduate students:	**Michaela Husová**, **David Hollaus**, **Sascha Gratzl**

Research priorities

Trypanosoma brucei, a unicellular parasite of humans and livestock, is being extensively studied because of its unique biology, its impact on human health and economy, and because of its readiness to genetic manipulation. It is a digenetic parasite that alternates between an insect vector and a mammalian host. In order to survive within the specialised environments of its hosts, this protist has developed a wide variety of unique physiological functions. One example is its mitochondrion which exhibits many unique features and interesting variations to the mammalian system. Moreover, this organelle seems to be flexible and able to respond quickly to different available nutrients. It is our main interest to understand the cellular and molecular mechanisms behind the ability of the parasite to functionally adapt to different tissues of its mammalian and insect hosts.

Mitochondrial bioenergetics of the *Trypanosoma brucei* bloodstream form

In the mammalian bloodstream, *T. brucei* relies on the abundant source of glucose for energy production. It is widely considered that the bloodstream form mitochondrion is metabolically idle, does not contribute to glucose and amino acids catabolism and lacks respiratory complexes III and IV. Combining available data we reveal that metabolic flexibility and adaptability of the bloodstream form mitochondrion is much larger than appreciated so far. Further work combining metabolic profiling with functional genomics is needed to get insight into its emerging complexity, which is likely exploited during environmental changes, for example, when the parasite migrates to other tissues than blood (e.g. adipose tissue, spinal and cerebral fluids), but also during the differentiation to a stumpy form. We postulate that although the bloodstream parasite is capable of 'fine-tuning' its metabolism as a function of varying environmental stimuli, glycolysis remains its predominant pathway. Still, the virtually unexplored array of pathways and enzymes, disclosed recently mostly via mass spectrometry and labelling experiments, begs for attention, as it may have important implications for drug target identification and future novel chemotherapeutics.

Mitochondrion remodeling during *Trypanosoma brucei* differentiation

During the life cycle of *T. brucei*, the single mitochondrion undergoes dramatic structural and metabolic remodeling while responding to different nutrients in its environment. Until recently, it was challenging to work with the various intermediate life stages found in the insect vector, tsetse fly, but now each of the insect vector developmental cell types can be created *in vitro* by

simply overexpressing a single RNA binding protein. We aim to study molecular mechanisms underlying mitochondrial metabolic rewiring during the parasite's development. We also focus on the role of mitochondria in signalling that determines metabolic status of the cell and its fate.

The role of ATP synthase structure in the biogenesis and bioenergetics of *Trypanosoma brucei* mitochondrion

Mitochondrial cristae are inner membrane convolutions where protein factories responsible for bioenergy conversion reside. The cristae exhibit an extremely large variability in their ultrastructure, except for one common attribute – the presence of ATP synthase dimer rows at the crista ridges. Little is known about the role of these arrays in cristae structure and mitochondrial bioenergetics. However, *T. brucei* is an excellent model system as the singular mitochondrion of this digenetic parasite is drastically remodelled structurally and metabolically as it progresses through a complex life cycle. Notably, the highly branched, cristae-containing and ATP-producing mitochondrion transitions to a streamlined tubular, cristae-lacking and ATP-consuming organelle. Combining traditional biochemical methods with state-of-art structural approaches (e.g. cryo-EM and cryo-ET), we aim to solve the ATP synthase dimer structure, identify dimer-specific subunits and explore their role in cristae shaping, mitochondrion bioenergetics and biogenesis in two major life stages of this parasite.

Selected publications:

- **Doleželová E.**, Terán D., **Gahura O.**, **Kotrbová Z.**, **Procházková M.**, Keough D., Špaček P., Hocková D., Guddat L., **Zíková A.** 2018: Evaluation of the *Trypanosoma brucei* 6-oxopurine salvage pathway as a potential target for drug discovery. *PLoS Neglected Tropical Disesases* 12: e0006301. [IF=4.367]
- **Gahura O.**, **Panicucci B.**, **Váchová H.**, Walker J.E, **Zíková A.** 2018: Inhibition of F(1)-ATPase from *Trypanosoma brucei* by its regulatory protein inhibitor TbIF(1). *FEBS Journal* 285: 4413–4423. [IF=4.530]
- **Gahura O.**, **Šubrtová K.**, **Váchová H.**, **Panicucci B.**, Fearnley I.M., Harbour M.E., Walker J.E., **Zíková A.** 2018: The F1-ATPase from *Trypanosoma brucei* is elaborated by three copies of an additional p18-subunit. *FEBS Journal* 285: 614–628. [IF=4.530]
- Montgomery M.G., **Gahura O.**, Leslie A.G., **Zíková A.**, Walker J.E. 2018: ATP synthase from *Trypanosoma brucei* has an elaborated canonical F1-domain and conventional catalytic sites. *Proceedings of the National Academy of Sciences of the United States of America* 115: 2102–2107. [IF=9.504]
- **Procházková M.**, **Panicucci B.**, **Zíková A.** 2018: Cultured bloodstream *Trypanosoma brucei* adapt to life without mitochondrial translation release factor 1. *Scientific Report* 8: 5135. [IF=4.120]

Research projects:

- **Determining the effectors of mitochondrion remodeling during procyclic *Trypanosoma brucei* differentiation.** Czech Science Foundation (17-22248S; P.I.: A. Zíková, 2017–2019)
- **The role of ATP synthase structure in the biogenesis and bioenergetics of the unique *Trypanosoma brucei* mitochondrion.** Czech Science Foundation (18-17529S; P.I. A.Zíková, 2018–2020)
- **ERDF/ESF Centre for research of pathogenicity and virulence of parasites** (No. CZ.02.1.01/0.0/0.0/16_019/0000759; M. Oborník – coordinator, 2018–2022)
- **Acyclic nucleoside phosphonates as potential inhibitors of adenine phosphoribosyltransferases in human trypanosomatid parasites.** Czech Science Foundation (19-07707S. Co-P.I. A.Zíková, 2019–2021)

1.3. Laboratory of RNA Biology of Protists

Research scientists:	RNDr. **Zdeněk PARIS**, PhD (*head*) Mgr. **Eva Hegedüsová**, PhD (Slovakia)
PhD student:	**Sneha Sunil Kulkarni**, MSc (India)
Undergraduate students:	Bc. **Michaela Boudová**; **Helmut Stanzl** (Austria)

Research priorities

Our group (established in February 2014) studies various aspects of RNA biology of the protistan parasite *Trypanosoma brucei* and related flagellates. In those early evolved unicellular organisms most genes are post-transcriptionally regulated. Consequently, post-transcriptional processing of RNA becomes of a great importance to regulate complex life cycles of these pathogens. We are mainly interested in processes such as tRNA modifications, nuclear tRNA export and role of the only intron containing tRNA in trypanosomes. Our long-term goal is an identification of unique mechanisms of RNA metabolism. We believe this will help us reveal new drug targets to combat diseases caused by trypanosomatid parasites.

Queuosine biosynthesis in trypanosomes

Transfer RNAs are typical for the large number of post-transcriptional modifications. Most of the tRNA modifications are present in the anticodon loop and have crucial role in proper translation of proteins. Queuosine is one of the most complex tRNA modifications. Despite its omnipresence among bacteria and eukaryotes, role of queuosine tRNA modification is not clear. The main aim of this project is to evaluate the function and subunit composition of the enzyme responsible for queuosine formation in *T. brucei*. Using the RNAi knock-down strategy, we want to address the principal question regarding the role of queuosine tRNA modification with respect to biology and physiology of this protistan parasite.

Nuclear export of tRNAs in trypanosomes

Nuclear tRNA export to the cytoplasm might provide an additional level of regulation of gene expression during the complex life cycle of trypanosomes. However, only a limited set of eukaryotic export factors, conserved in other organisms, can be easily identified in the *T. brucei* genome; thus our knowledge of nuclear tRNA export remains limited. In this project, we employ molecular biological and biochemical approaches to identify and characterise the nuclear tRNA export machinery in trypanosomes and its role in tRNA maturation, with the general idea of tRNA nuclear export as a regulated step.

Selected publications

- **Paris Z.**, Alfonzo J.D. 2018: How the intracellular partitioning of tRNA and tRNA modification enzymes affects mitochondrial function. *IUBMB Life* 70: 1207–1213. [IF= 3.236]
- Kessler A.C., **Kulkarni S.S.**, Paulines M.J., Rubio M.A.T., Limbach P.A., **Paris Z.**, Alfonzo J.D. 2018 Retrograde nuclear transport from the cytoplasm is required for tRNATyr maturation in *T. brucei*. *RNA Biology* 15: 528–536. [IF=5.216]

Research projects

- **ERDF/ESF Centre for research of pathogenicity and virulence of parasites** (No. CZ.02.1.01/0.0/0.0/16 _019/0000759; M. Oborník – coordinator, 2018–2022)

2. EVOLUTIONARY PARASITOLOGY

2.1. Laboratory of Evolutionary Protistology

Research scientists:	prof. Ing. **Miroslav OBORNÍK**, PhD (*head*) **Ansgar Gruber**, PhD (Germany); Mgr. **Zoltán Füssy**, PhD; RNDr. **Aleš Tomčala**, PhD; **Abduallah Sharaf**, MSc, PhD (Egypt)
PhD students:	Mgr. **Jaromír Cihlář**; Mgr. **Jan Michálek**; Mgr. **Jitka Kručinská**; RNDr. Ing. **Pavel Poliak**; **Sireesha Killi**, MSc, **Ayush Sharma**, Ing. **Ivana Schneedorferová,** MSc (supervisor Aleš Tomčala)
Research assistant:	Mgr. **Kateřina Jiroutová**, PhD
Undergraduate student:	Bc. **Tereza Faitová** (supervisor Z. Füssy)

Research priorities

Laboratory of Evolutionary Protistology (LEP) (formerly Laboratory of Molecular Taxonomy) was established in 2000 as a joint laboratory of the Institute of Parasitology and Faculty of Biological Sciences (now Faculty of Science), University of South Bohemia. At present the laboratory is designed to study evolution of protists and algae.

Fatty acid biosynthesis in chromerids

Chromerids are phototrophic algae isolated from Australian corals. Two species have been described so far, *Chromera velia* and *Vitrella brassicaformis*, which have been shown to represent the closest known phototrophic relatives to apicomplexan parasites. We are interested in various metabolic pathways in these algae, including synthesis of fatty acids (FAS). Both types of FAS were found in chromerids, cytosolic FASI as well as plastid located FASII. Evolution of these pathways is studied in context with closely related apicomplexan parasites.

Phytotransferrins in algae

We explored evolutionary history of labile iron binding proteins ISIP2a and transferrins and showed that they share distant evolutionary homology. We conducted a comprehensive phylogenetic analysis of marine microeukaryotes, revealing both proteins to have a common origin in bacterial periplasmic binding proteins (PBP). This novel clade of algal transferrin-like proteins, or phytotransferrins, is the third instance of transferrin-like proteins convergently evolving from anion-binding PBP and highlights the critical nature of the exogenous anion in coordinating high-affinity ferric iron binding. Thus transferrins and phytotransferrins (ISIP2A related proteins) share sequential homology, but because their ability to bind iron evolved twice, they are functional analogs.

Investigation of novel bicosoecid

We isolated novel marine bicosoecid (non-photosynthetic stramenopile) as an accompanying organism in yet unspecified pelagophyte alga from Norway. The bicosoesic is grown in the culture

without the alga, and is now being characterised in terms of morphology, ultrastructure and genomic sequencing. Preliminary results show unprecedented physical association of mitochondria and nucleus, with a conspicuous pore-like structure between the two cellular organelles.

Selected publications

- Brunson J.K., McKinnie S.M.K., Chekan J.R., McCrow J.P., Miles Z.D., Bertrand E.M., Bielinski V.A., Luhavaya H., **Oborník M.**, Smith G.J., Hutchins D.A., Allen A.E., Moore B.S. 2018: Biosynthesis of the neurotoxin domoic acid in a bloom-forming diatom. *Science* 361: 1356–1358. [IF=41.058]
- McQuaid J.B., Kustka A.B., **Oborník M.**, **Horák A.**, Mccrow J., Karas B.J., Zheng H., Kindeberg T., Andersson A.J., Barbeau K.A., Allen A. 2018: Carbonate-sensitive phytotransferrin controls high-affinity iron uptake in diatoms. *Nature* 555: 534–537. [IF=41.577]
- **Oborník M.** 2018: The birth of red complex plastids: one, three, or four times? *Trends in Parasitology* 34: 11. [IF=7.929]
- Vazač J., **Füssy Z.**, **Hladová I.**, **Killi S.**, **Oborník M.** 2018: Ploidy and number of chromosomes in the alveolate alga *Chromera velia*. *Protist* 169: 53–63. [IF=2.702]

Research Projects

- **Photosynthesis Research Centre.** Czech Science Foundation (P501/12/G055; Co-P.I.: M. Oborník; 2012–2018).
- ***Chromera velia* as a model organism to study evolution of apicomplexans and chrompodellids.** Czech Science Foundation (16-24027S; P.I. M. Oborník; 2016–2018).
- **ERDF/ESF Centre for research of pathogenicity and virulence of parasites** (No. CZ.02.1.01/0.0/0.0/16 _019/0000759; M. Oborník – coordinator, 2018–2022)

2.2. Laboratory of Environmental Genomics

Research scientists: Mgr. **Aleš HORÁK**, PhD (*head*)
Olga Flegontova, PhD (Russia)

Research priorities

Study on biodiversity and biology of uncultivable unicellular eukaryotes using next-generation sequencing.

Diversity and ecology of marine diplonemids

Latest results of global metabarcoding of global ocean showed extreme diversity and abundance of previously overlooked lineage of euglenozoan protist: diplonemids. Detailed analysis focused on diplonemids separate them into four major clades, with the vast majority falling into the eupelagonemids (Okamoto et al. 2018). Remarkably, diversity of this clade inferred from metabarcoding data surpasses even that of dinoflagellates, metazoans and rhizarians, qualifying diplonemids as possibly the most diverse group of marine planktonic eukaryotes. Diplonemid communities display no apparent biogeographic structuring, with a few hyper-abundant cosmopolitan operational taxonomic units (OTUs) dominating the communities. Diplonemids display strong vertical separation between the photic and mesopelagic layers, with the majority of their relative abundance and diversity occurring in deeper waters. Our results suggest that the planktonic diplonemids are among the key heterotrophic players in the largest ecosystem of our biosphere. Our ultimate goal is to elucidate the role of these mysterious organisms in the global ocean ecosystem. Compared to diplonemids, kinetoplastids, major human and lifestock pathogens and one of the most studied protozoan group, are much less present in the oceans. The vast majority of kinetoplastid abundance and diversity belong to the neobodonids – mostly free living bacteriovorous flagellates with *Neobodo* and *Rhynchomonas* as the most prominent genera. Some of the most abundant kinetoplastids have distinct geographical distributions and three novel putatively parasitic neobodonids were identified, along with their potential hosts.

Collaboration: Tara Oceans Consortium, namely Colomban de Vargas and Fabrice Not, Station Biologique de Roscoff (France).

Selected publications

- **Flegontova O.**, **Flegontov P.**, Malviya S., Poulain J., de Vargas C., Bowler C., **Lukeš J.**, **Horák A.** 2018: Neobodonids are dominant kinetoplastids in the global ocean. *Environmental Microbiology* 20: 878–889. [IF=4.974]
- McQuaid J.B., Kustka A.B., **Oborník M.**, **Horák A.**, Mccrow J., Karas B.J., Zheng H., Kindeberg T., Andersson A.J., Barbeau K.A., Allen A. 2018: Carbonate-sensitive phytotransferrin controls high-affinity iron uptake in diatoms. *Nature* 555: 534–537. [IF=41.577]
- **Tashyreva D.**, **Prokopchuk G.**, **Votýpka J.**, Yabuki A., **Horák A.**, **Lukeš J.** 2018: Life cycle, ultrastructure, and phylogeny of new diplonemids and their endosymbiotic bacteria. *mBio* 9: e02447–17. [IF=6.689]
- **Tashyreva D.**, **Prokopchuk G.**, Yabuki A., **Kaur B.**, **Faktorová D.**, **Votýpka J.**, Kusaka C., Fujikura K., Shiratori, T., Ishida K.-I., **Horák A.**, **Lukeš J.** 2018: Phylogeny and morphology of new diplonemids from Japan. *Protist* 169: 158–179. [IF=2.702]

2.3. Laboratory of Molecular Ecology and Evolution

Research scientists:	doc. RNDr. **Jan ŠTEFKA**, PhD (*head*) prof. RNDr. **Václav Hypša**, CSc.; doc. RNDr. **Eva Nováková**, PhD
PhD students:	Mgr. **Marie Krausová**; Mgr. **Anna Mácová**; RNDr. **Jana Martinů**; Mgr. **Jakub Vlček**; MSc **Dragomir Damnjanovič** (Serbia)
Technician:	Ing. **Lenka Štifterová**
Undergraduate students:	Bc. **Pavlína Kočová**; Bc. **Lukáš Vejsada**; **Tereza Flegrová**; **Nikola Jachníková**; **Daniela Kotalová**; **Matěj Miláček**; **Stanislava Wolfová**

Research priorities

Our research is mainly focused on population genetic and phylogenetic analysis of the evolution and relationships of parasitic and symbiotic organisms, and their hosts. It involves investigation into their co-evolution, biogeography, intraspecific variability and evolution of adaptations. The research is carried out on several models of parasitic and symbiotic associations.

Coevolution between Galápagos mockingbirds and their ectoparasites

We are studying the character of coevolution between Galápagos mockingbirds and their parasites. The research focuses on determining the factors responsible for formation of population structure, reconciling the mutual evolutionary history and identifying genes under selection in the hosts. With the use of parallel amplicon sequencing of several immune genes (MHC class IIB, TLR) and using the whole genome re-sequencing approach, we are exploring the impact of habitat size on the level of genetic diversity in the populations of mockingbirds and their parasites.

Population genetics, demography and molecular evolution in rodents and their parasites

Adaptive and co-speciation components of host-parasite coevolution are studied in rodents and their parasites. Two rodent groups (voles and wood mice) and their ectoparasites (lice and mites) as well as endoparasites (*Eimeria*) were selected as the model groups. Despite observing lineages with relatively strict degree of host specificity, only limited amount of co-speciation was seen in both parasitic groups using mtDNA and nuclear datasets. Hence, the adaptive component of evolution seems to be the major force defining genetic differentiation. Hypothesised drivers of population structure and selection in the system will be verified using population-genomic data.

Evolution of symbiotic bacteria associated with arthropods

We are broadly interested in intracellular and intestinal symbiotic bacteria and their arthropod hosts. The main goal of our research is complex characterisation of symbiotic systems in several model insect groups using microscopical, genomic, transcriptomic, phylogenomic and metagenomic methods. Our main questions involve genome evolution of both the host and its symbionts, their phylogeny and population structure, and host-symbiont-pathogen interactions.

Selected publications

- Bazsalovicsová E., Koleničová A., Králová-Hromadová I., Minárik G., Šoltys K., **Kuchta R.**, **Štefka J.** 2018: Development of microsatellite loci in zoonotic tapeworm *Dibothriocephalus latus* (Linnaeus, 1758), Lühe, 1899 (syn. *Diphyllobothrium latum*) using microsatellite library screening. *Molecular and Biochemical Parasitology* 225: 1–3. [IF=1.744]
- **Mácová A.**, Hoblíková A., **Hypša V.**, Stanko M., **Martinů J.**, **Kvičerová J.** 2018: Mysteries of host switching: diversification and host specificity in rodent-coccidia associations. *Molecular Phylogenetics and Evolution* 127: 179–189. [IF=4.412]
- **Martinů J.**, **Hypša V.**, **Štefka J.** 2018: Host specificity driving genetic structure and diversity in ectoparasite populations: co-evolutionary patterns in *Apodemus* mice and their lice. *Ecology and Evolution* 8: 10008–10022. [IF=2.340].
- Rodríguez-Ruano S.M., Škochová V., **Rego R.O.M.**, Schmidt J.O., Roachell W., **Hypša V.**, **Nováková E.** 2018: Microbiomes of North American Triatominae: the grounds for Chagas disease epidemiology. *Frontiers in Microbiology* 9: 1167. [IF=4.019]
- Roumbedakis K., **Drábková M.**, Tyml T., di Cristo C. 2018: A perspective around cephalopods and their parasites, and suggestions on how to increase knowledge in the field. *Frontiers in Physiology* 9: 1573. [IF=3.394]

Research project

- **Genomics and population genetics in host-parasite system: switches**, **diversification and adaptation.** (17-19831S; P.I.: V. Hypša; 2017–2019)
- **Ecological, genomic and metabolic processes accompanying adaptations of symbiotic bacteria and blood feeding insects** (18-07711S; P.I.: V. Hypša; 2018–2020).
- **Invasive parasites and pathogens** (CAS-AV21; P.I.: J. Štefka).

2.4. Laboratory of Genomics and Diversity of Protists

Research scientists: Mgr. **Martin Kolísko**, PhD (*head*)
Research Assistants: Mgr. **Serafim Nenarokov** (Russia)
Bc student: **Jessica Drozdz**

Research Priorities

Current and long-term research in the Laboratory of Genomics and Diversity of Protists revolves around the diversity of microbial eukaryotes and their genomes and transcriptomes. We use methods of comparative genomics and transcriptomics to understand the evolution of parasitism and the interactions between gut microbial parasites and the gut microbiome.

Comparative genomics of diplomonads

Some of the microbial eukaryotes are important parasites of humans and animals; however, there are many species that are known to be host-associated, yet their pathogenicity remains unknown. Comparative genomics is a powerful tool for understanding parasitism on a genomic level. Diplomonads are a group of microbial eukaryotes that includes medically and economically important parasites. Additionally, there are several putative secondarily free-living species and host-associated commensalic species. We are performing a taxonomically wide, comparative study of diplomonads, including well-studied parasites, primarily and secondarily free-living species, and commensals. The results will address some of the fundamental questions of biology, including the mechanisms of reversal from free-living to parasitic lifestyle and whether it is possible to predict pathogenicity or host-associated lifestyle based on genomic information.

Diversity of microbial eukaryotes in the gut microbiome

We study the diversity of microbial eukaryotes in human gut microbiomes using amplicon sequencing by combining several approaches to minimise the presence of host DNA in the results. We will take advantage of a current collaboration with the Institute of Experimental Medicine (IKEM, Prague), giving us access to DNA material from human microbiomes of healthy individuals as well as individuals with a variety of infections and medical conditions. We will also perform DNA sampling from diverse animal hosts.

Microbial eukaryotes and their interactions with the gut microbiome

We are using an experimental infection model of a host (mouse or rat) and a microbial eukaryote (*Blastocystis*) to identify any detectable changes in transcription levels in the metatranscriptome of the microbiome (predominantly the prokaryotic part) as well as changes in transcription in the parasite/commensal and in the host. This will help us to elucidate differences in the interactions between parasites/commensals and their hosts and host microbiomes.

Selected publications

- del Campo J., **Kolísko M.**, Boscaro V., Santoferrara .LF., **Nenarokov S.**, Massana R., Guillou L., Simpson A.G.B., Berney C., de Vargas C., Brown M., Keeling P., Parfrey L.W. 2018. EukRef: phylogenetic curation of ribosomal RNA to enhance understanding of eukaryotic diversity and distribution. *PLoS Biology* 16: e2005849. [IF=9.163]
- Heiss A., **Kolísko M.**, Ekelund F., Brown M.W., Roger A.J., Simpson A.G.B. 2018: Combined morphological and phylogenomic re-examination of malawimonads, a critical taxon for inferring the evolutionary history of eukaryotes. *Royal Society Open Science* 5: 171707. [IF=2.504]
- Mathur V., del Campo J., **Kolísko M.**, Keeling P.J. 2018: Global diversity and distribution of close relatives of apicomplexan parasites. *Environmental Microbiology* 20: 2824–2833. [IF=4.974]
- Pyrihová E., Motycková A., Voleman L., Wandyszewska N., Fišer R., Seydlová G., Roger A., **Kolísko M.**, Doležal P. 2018: A single tim translocase in the mitosomes of *Giardia intestinalis* illustrates convergence of protein import machines in anaerobic eukaryotes. *Genome Biology and Evolution* 10: 2813–2822. [IF=3.940]
- Vacek V., Novák L.V.F., Treitli S.C., Táborský P., Cepicka I., **Kolísko M.**, Keeling P.J., Hampl V. 2018: Fe-S Cluster Assembly in oxymonads and related protists. *Molecular Biology and Evolution* 35: 2712–2718. [IF=10.217]

3. TICKS AND TICK-BORNE DISEASES

3.1. Laboratory of Molecular Ecology of Vectors and Pathogens

Research scientists:	prof. RNDr. **Libor GRUBHOFFE**R, CSc., Hon. D.Sc. (*head*) **Nataliia Rudenko**, MSc, PhD (Ukraine) (*deputy head*); RNDr. **Jiří Černý**, PhD; **Katherina Kotsarenko**, MSc, PhD (Ukraine); **Dmitrij Loginov**, MSc, PhD (Russia); **Ryan O.M. Rego**, MSc, PhD (India); RNDr. **Ján Štěrba**, PhD (Slovakia)
PhD students:	Mgr. **Libor Hejduk**; Mgr. **Pavlína Kočová**; Mgr. **Hana Mašková**; Mgr. **Martin Selinger**; Mgr. **Martin Strnad**; RNDr. **Jarmila Štěrbová-Dupejová**; Mgr. **Hana Tykalová-Šťastná**; RNDr. **Pavlína Věchtová**
Research assistants:	**Maryna Golovchenko**, MSc (Ukraine); Bc. **Jana Monhartová**; Mgr. **Helena Roháčková**; Mgr. **Zuzana Vavrušková**
Undergraduate students:	Mgr. **Jana Müllerová**; Bc. **Maximilian Bayer** (Austria); **Katharina Böttinger**, BSc (Austria); Bc. **Jan Černý**; Bc. **Karolína Dostálová**; **Nora Hagleitner**, BSc (Austria); **Lisa Hain**, BSc (Austria); Bc. **Tereza Liduchová**; Bc. **Hana Mašková**; Bc. **Veronika Morávková**; Bc. **Johana Mustacová**; Bc. **Hana Pejšová**; Bc. **Štěpánka Smolenová**; Bc. **Radomír Vokurka**; **Ana Cetkovic** (Austria); **Anna Danklmaier** (Austria); **Armig Kabrelian** (Austria); **Matthias Kalthoff** (Austria); **Daniel Kitzberger** (Austria); **Iryna Kondrashenko** (Ukraine); **Aylin Paktan** (Austria); **Ida Ramzy** (Austria); **Jakob Samek** (Austria); **Lukas Schröger** (Austria); **Vitus Stemmer** (Austria); **Sandra Suleiman** (Austria); **Kateřina Vejvodová**; **Peter Weber** (Austria)
Laboratory worker:	**Zuzana Němcová**

Research priorities

Transcriptomic and proteomic analyses of TBEV-host cells interactions

Transcriptomic and proteomic analyses are used to study the interaction of tick-borne encephalitis virus proteins and viral RNA with host cell and molecules and are complemented by molecular biological and microscopic techniques. Gene expression changes in DAOY HTB-186 medulloblastoma cells infected with tick-borne encephalitis virus were confirmed.

Involvement of *Borrelia* adhesins in spirochete movement

Using *in-vitro* feeding that simulate tick suction on an infected with LB spirochetes host, we found that some of the *Borrelia* adhesins accelerate the movement of borrelia in the extracellular matrix (ECM) of the host. Using single molecule force microscopy (SMFS), we found significant differences in the physical properties of bonds between DbpA and various ECM components.

Mechanism of survival of Lyme disease spirochetes

Using the correlative light electron microscopy we are studying the processes of survival of Lyme disease spirochete in vertebrate host (including human). We confirmed that Lyme disease spirochetes survive extended antibiotic treatment (monotherapy) being hidden in hosts' extracellular matrix as persistent forms (round bodies or cysts). Lyme disease spirochetes are able to alter their metabolic state in response to hostile environment including antibiotic pressure. Formation of persistent forms is reversible process.

Tick cell lines as model systems (MS) for investigation of host-vector-pathogen interactions.

Comparison of MS profiles of tick cell lines and tick organs revealed several organ-specific MS signals. Five peaks in the cell lines profiles were also present in ovaries, three in the gut and salivary glands, and one in Malpighian tubules. Moreover, 11 MS signals in the cell line profiles were assigned with proteins for the first time.

Selected publications

- Gerhart J.G., Auguste Dutcher H., Brenner A.E., Moses A.S., **Grubhoffer L.**, Raghavan R. 2018: Multiple acquisitions of pathogen-derived *Francisella* endosymbionts in soft ticks. *Genome Biology and Evolution* 10: 607–615. [IF=3.940]
- **Müllerová J.**, **Elsterová J.**, **Černý J.**, Ditrich O., Žárský J., Culler L. E., Kampen H., Walther D., Coulson S.J., **Růžek D.**, **Grubhoffer L.** 2018: No indication of arthropod-vectored viruses in mosquitoes (Diptera: Culicidae) collected on Greenland and Svalbard. *Polar Biology* 41: 1581–1586. [IF=1.949]
- Rodríguez-Ruano S.M., Škochová V., **Rego R.O.M.**, Schmidt J.O., Roachell W., **Hypša V.**, **Nováková E.** 2018: Microbiomes of North American Triatominae: the grounds for Chagas disease epidemiology. *Frontiers in Microbiology* 9: 1167. [IF=4.019]
- **Věchtová P.**, **Štěrbová J.**, **Štěrba J.**, **Vancová M.**, **Rego R.O.M.**, **Selinger M.**, **Strnad M.**, **Golovchenko M.**, **Rudenko N.**, **Grubhoffer L.** 2018: A bite so sweet: the glycobiology interface of tick-host-pathogen interactions. *Parasites & Vectors* 11: 594. [IF= 3.163]

Research projects

- **ANTIDotE (Anti-tick vaccines to prevent tick-borne diseases in Europe).** FP7 EU-HEALTH project (2013.2.3.4-1; Co-P.I.: L. Grubhoffer; 2013–2018).
- **Identification of novel antigens/diagnostic markers for the development of diagnostic tests for early diagnosis of Lyme disease in Europe – Technology Agency of the Czech Republic.** (TG02010034; P.I.: R. Rego; 2017–2018).
- **Delineating the role of *Borrelia afzelii* genes required for disseminating within the tick during feeding.** Czech Science Foundation (17-21244S; P.I.: R. Rego; 2017–2019)
- **Development of technologies for early detection of tick borne encephalitis, based on changes in gene expression and protein production in infected antigen-presenting cells.** MEYS INTER-ACTION project (LTARF18021; P.I.: L. Grubhoffer; 2018–2020).
- **Interactions of flaviviral genomic and subgenomic RNA with host and viral proteins.** Czech Science Foundation (18-27204S; P.I.: L. Grubhoffer; 2018–2020).

3.2. Laboratory of Arbovirology

Research scientists:	doc. RNDr. **Daniel RŮŽEK**, PhD (*head*) RNDr. **Luděk Eyer**, PhD; Mgr. **Václav Hönig**, PhD; RNDr. **Martin Palus**, PhD; **James Jason Valdés**, PhD
PhD students:	Mgr. **Jana Elsterová**
Research assistant:	Bc. **Veronika Slavíková**
Technicians:	**Jan Erhart**; Bc. **Eva Výletová**
Laboratory worker:	**Lenka Marešová**
Undergraduate students:	**Martina Papajová**; **Veronika Prančlová**

Research priorities

Mechanisms of neuronal injury during tick-borne encephalitis infection in the CNS

Tick-borne encephalitis (TBE), a disease caused by tick-borne encephalitis virus (TBEV), represents one of the most important human neuroinfections in Europe and northeastern Asia. Despite the medical importance of this disease, some crucial steps in the development of encephalitis remain poorly understood. In particular, the mechanisms of TBEV-induced injury to the central nervous system (CNS) are unclear. In our laboratory, we study interactions of TBEV with primary human neurons, mechanisms of their injury and antiviral defence, as well as the interaction of the infected neurons with other key cells in the CNS (astrocytes, pericytes, microglia and brain microvascular epithelial cells). We propose that the innate immune response is an important cause of neuron death during the acute infection. This is in contrast to the prevailing hypothesis that neuron loss is mediated solely by virus. The results of this project should provide new crucial data about the neuropathogenesis of TBE.

Role of the host genetic background in the development of tick-borne encephalitis

In humans, TBEV may produce a variety of clinical symptoms from an asymptomatic disease to a fever and acute or chronic progressive encephalitis. This is influenced by a variety of factors, e.g. inoculation dose and virulence of the virus, age and immune status of the host, but also, as our results strongly suggest, by susceptibility based on host genetic background. We study differences in clinical course of tick-borne encephalitis and its genetical determination. We developed a unique animal model based on BALB/c-c-STS/A (CcS/Dem) recombinant congenic mouse strains showing different severities of the infection in relation to the host genetic background: BALB/c mice showed medium susceptibility to the TBE virus infection, STS mice were resistant and CcS-11 mice were highly susceptible. The resistant STS mice showed lower and delayed viremia, lower virus production in the brain and low cytokine/chemokine mRNA production, but had a strong neutralising antibody response. The most sensitive strain (CcS-11) failed in production of neutralising antibodies, but exhibited strong cytokine/chemokine mRNA production in the brain. We performed transcriptomic profiling that revealed distinct gene-expression patterns in brains of

mice differing in susceptibility to TBEV infection. The susceptible and resistant strains differed in the expression of key cytokines/chemokines, particularly interferon gamma-induced protein 10 (IP-10/CXCL10) and monocyte chemotactic protein-1 (MCP-1/CCL2) in the brain. A linkage analysis of F2 CcS-11 and BALB/c intercross progeny revealed a novel suggestive locus that controls survival after TBEV infection. It is located on chromosome 7 linked to marker D7Nds5. We sequenced whole genomes of strains BALB/c and STS using next generation sequencing. Analysis of segment covering peak of linkage on chromosome 7 from 36.2 Mb to 74.5 Mb for polymorphisms between BALB/c and STS that change RNA stability and gene functions revealed eight candidate genes of host susceptibility to TBE virus infection.

Development and testing of novel perspective antivirals and their prodrug forms active against tick-borne encephalitis virus

Despite the medical importance of tick-borne encephalitis (TBE), there is no specific treatment of this disease. In our laboratory, we identified nucleoside analogues with high antiviral effect against TBE virus (TBEV) observed *in vitro* as well as in TBEV-infected mice (reduction of viral titres in the brain, reduction of clinical signs of neuroinfection, prolonged mean survival time, lower mortality). The main goal of the current project is to modify these effective molecules into prodrug forms with increased therapeutical potential based on efficient crossing the blood-brain barrier and targeted delivery to the central nervous system. We experimentally combine these antiviral molecules with immunomodulatory therapies with the purpose to maximise viral clearance and minimise immunopathology after TBEV infection in the central nervous system. The results should provide new and important data about the possibilities and directions of antiviral and immunomodulatory therapy of TBE.

Selected publications

- Füzik T., Formanová P., **Růžek D.**, Yoshii K., Niedrig M., Plevka P. 2018: Structure of tick-borne encephalitis virus and its neutralisation by a monoclonal antibody. *Nature Communications* 9: 436. [IF=12.353]
- Haviernik J., Štefánik M., Fojtíková M., Kali S., Tordo N., Rudolf I., Hubálek Z., **Eyer L.**, **Růžek D.** 2018: Arbidol (Umifenovir): a broad-spectrum antiviral drug that inhibits medically important arthropod-borne flaviviruses. *Viruses* 10: 184. [IF=3.761]
- Salát J., Formanová P., Huňady M., **Eyer L.**, **Palus M.**, **Růžek D.** 2018: Development and testing of a new tick-borne encephalitis virus vaccine candidate for veterinary use. *Vaccine* 36: 7257–7261. [IF=3.285]
- Širmarová J., Salát J., **Palus M.**, **Hönig V.**, **Langhansová H.**, Holbrook M.R., **Růžek D.** 2018: Kyasanur forest disease virus infection activates human vascular endothelial cells and monocyte-derived dendritic cells. *Emerging Microbes and Infections* 7: 175. [IF=6.032]
- Stefanik M., Formanova P., **Bílý T.**, **Vancová M.**, **Eyer L.**, **Palus M.**, Salát J., Braconi C.T., Zanotto P., Gould E.A., **Růžek D.** 2018: Characterisation of Zika virus infection in primary human astrocytes. *BMC Neuroscience* 19: 5. [IF=2.173]

Research projects

- **Development and testing of novel perspective antivirals and their prodrug forms active against tick-borne encephalitis virus.** Czech Health Research Council (16-34238; P.I.: D. Růžek; 2016–2019).
- **Czech-Austrian Centre for Supracellular Medical Research** (Interreg: ATCZ14 – CAC-SuMeR; Co-P.I.: D. Růžek; 2016–2019).

4. BIOLOGY OF DISEASE VECTORS

4.1. Laboratory of Vector Immunology

Research scientists:	RNDr. **Petr KOPÁČEK**, CSc. (*head*) RNDr. **Lenka Grunclová**, PhD; RNDr. **Marie Jalovecká**, PhD*; Mgr. **Jan Perner**, PhD; **Luise Robbertse**, PhD; RNDr. **Daniel Sojka**, PhD; RNDr. **Veronika Urbanová-Burešová**, PhD*
Research assistant:	Mgr. **Helena Frantová**
PhD students:	Mgr. **David Hartmann**; Mgr. **Matěj Kučera**.
Undergraduate students:	Bc. **Tereza Kozelková**; Bc. **Pavla Šnebergerová**; **Tereza Hatalová**; **Sára Kropáčková**; **Barbora Plačková**; **Dominika Reichensdörferová**

***** Also members of the research team of Ondřej Hajdušek

Research priorities

Molecular physiology of blood digestion and haem and iron metabolism in ticks. Tick membrane feeding as a tool for the discovery of potential targets for efficient anti-tick intervention. Molecules involved in the tick innate immunity and interactions with transmitted pathogens.

Tick membrane feeding as a tool for the discovery of potential anti-tick targets

We have finished and published the functional and biochemical characterisation of a heme-inducible glutathione S-transferase tagged *Ir*GST1 that functions as an intracellular heme-scavenger. The orthologs of this delta-class GST is found only in ticks and not in mites or other invertebrates. A panel of compounds targeting different metabolic pathways and nutrition uptake was screened using an artificial membrane feeding system. Among the most promising chemicals which warrant further investigation belong 2-deoxy-D-glucose (the inhibitor of glucose uptake and metabolism) or rapamycin (inhibiting TOR signalling pathway). RNAi-based studies revealed that silencing of selected amino-acid tRNA synthetases exerts striking phenotype on tick feeding and survival. Testing of potential drugs specifically targeting these enzymes (e.g. cladosporin) is ongoing. The major attention has been paid to the tyrosine catabolism in ticks. We found that both inhibitors of hydroxyphenyl-pyruvate dehydrogenase (HPPD) (mezotrione, nitisinone) caused a high mortality of engorged *I. ricinus* females and nymphs. The same phenotype was achieved upon RNAi-silencing of *hppd* gene. In order to understand the reason for the toxicity of HPPD inhibitors, we currently perform (in cooperation with Laboratory of Analytical Chemistry), a quantitative analyses of metabolites associated with tyrosine metabolism in ticks.

Interactions of tick immune system with model pathogens

Based on our previous results showing that the immune reactions within the tick haemocoel hardly affects transmission of *Borrelia* spirochetes, we further focused on other important tick-borne pathogens, namely protozoan parasites *Babesia* spp. We have optimised a laboratory model for

Babesia microti transmission employing BALB/c mice. The transmission experiments linked with RNAi silencing of selected genes have been performed. For detection of *Babesia* during acquisition in the tick vector, we have prepared two specific anti-*Babesia* antibodies. These antibodies can be used for parasite detection (by methods of western blotting and confocal microscopy) in salivary glands and midguts of *I. ricinus* nymphs in the course of blood-feeding. We also attempted to implement a laboratory transmission model for the Gram-negative bacterium *Anaplasma phagocytophilum*, which invades neutrophils and causes anaplasmosis in animals or granulocytic anaplasmosis in humans. However, we found that the *Anaplasma* infection in *I. ricinus* larvae and nymphs gradually decreases in time and the ticks become not infectious to the native mice. In order to solve the problem, we have established a new colony of *Ixodes scapularis* to perform a comparative study of *A. phagocytophilum* transmission between these two closely related species.

Selective inhibition of *Babesia* proteasome

Babesiosis treatment has been based on empirical trials and novel drug targets and therapy strategies are urgently needed. An increasing body of research underlines the vital importance of the 26S proteasome for the development and survival of parasitic organisms and within this project we thus investigate the effect of epoxyketone (carfilzomib, ONX-0914 and epoxomicin) and boronic acid (bortezomib and ixazomib) proteasome inhibitors on the growth and survival of *Babesia.* Overall, our results demonstrate that the *Babesia* proteasome is a valid target for drug development and warrants the design of potent and selective *B. divergens* proteasome inhibitors for the treatment of babesiosis. Our current research effort is to explore for next generation proteasome inhibitors with high selectivity index for the parasite while not affecting the host as a base for novel anti-*Babesia* applications.

Selected publications

- Hánová I., Brynda J., Houštecká R., Alam N., **Sojka D.**, **Kopáček P.**, Marešová L., Vondrášek J., Horn M., Schueler-Furman O., Mareš M. 2018: Novel structural mechanism of allosteric regulation of aspartic peptidases via an evolutionarily conserved exosite. *Cell Chemical Biology* 25: 318–329. [IF=5.592]
- **Jalovecká M.**, **Hajdušek O.**, **Sojka D.**, **Kopáček P.**, Malandrin L. 2018: The complexity of piroplasms life cycles. *Frontiers in Cellular Infection Microbiology* 8: 248. [IF=3.520]
- **Jalovecká M.**, **Hartmann D.**, Miyamoto Y., Eckmann L., **Hajdušek O.**, O'Donoghue A.J., **Sojka D.** 2018: Validation of *Babesia* proteasome as a drug target. *International Journal for Parasitology-Drugs and Drug Resistance* 8: 394–402. [IF=3.030]
- **Perner J.**, **Kotál J.**, Hatalová T., **Urbanová V.**, **Bartošová-Sojková P.**, Brophy P.M., **Kopáček P.** 2018: Inducible glutathione S-transferase (IrGST1) from the tick *Ixodes ricinus* is a haem-binding protein. *Insect Biochemistry and Molecular Biology* 95: 44–54. [IF=3.562]
- **Perner J.**, **Kropáčková S.**, **Kopáček P.**, Ribeiro J.M. 2018: Sialome diversity of ticks revealed by RNAseq single tick salivary glands. *PLoS Neglected Tropical Diseases* 12: e0006410. [IF=4.367]

Research projects

- **Selective inhibition of babesial proteasomes.** Czech Science Foundation (17-14631S; P.I.: D. Sojka; 2017–2019)
- **Nutritional factors essential for tick development and reproduction.** Czech Science Foundation (18-01832S; P.I.: P. Kopáček; 2018–2020)
- **ANTIDotE (Anti-tick vaccines to prevent tick-borne diseases in Europe).** FP7 EU-HEALTH project (602272; Coordinator: J.W. Hovius; 2014–2018).
- **ERDF/ESF Centre for research of pathogenicity and virulence of parasites** (No. CZ.02.1.01/0.0/0.0/16_019/0000759; M. Oborník – coordinator, 2018–2022)

4.2. Laboratory of Genomics and Proteomics of Disease Vectors

Research scientist: **Michail KOTSYFAKIS**, MSc, PhD (Greece) (*head*)
PhD student: Mgr. **Jan Kotál**
Administration associate: Mgr. **Markéta Kremlová**

Research priorities

Our research maximises the public health benefits from the latest technical developments in molecular biology, genetics, genomics and proteomics; we employed the latest next-generation sequencing and quantitative proteomics methodologies with the ultimate goal of improving our understanding of the genetics underlying tick feeding and pathogen transmission. Given the technical difficulties in sequencing tick genomes, our high-throughput transcriptomic studies have provided new insights into how biological processes such as haematophagy and pathogen transmission are regulated by the underlying genetics, and enabled the first quantitative proteomic project on the tick *Ixodes ricinus*. We are currently developing a publicly available platform to host the sequencing data (and the resulting gene annotations) as a key step to support research on *I. ricinus* and to maximise the long-term value of our research results and datasets.

Our work aims to uncover tick proteins that facilitate the transmission of tick-borne pathogens. Tick-borne diseases are a serious public health concern in the Czech Republic (and Europe/the western world in general). Our results shed light on the molecular mechanisms that mediate transmission and pathogenesis of tick-borne diseases. Our group aims to discover novel gene functions, with an emphasis on describing novel tick salivary anti-proteases. We apply our well-established functional and structural analysis approaches to question whether salivary anti-proteases play an important role in the tick life-cycle. This knowledge will be important for the long-term development of improved tools and applications to control tick-borne diseases. Similar to most emerging and re-emerging infections, tick-borne diseases are thought to be vector-borne and transmitted to humans from animal reservoirs, but much remains unknown about the molecular events that take place at the tick-vertebrate host interface. Part of our work is to investigate the potential effects of various tick *I. ricinus* cysteine and serine protease inhibitors in macrophage, neutrophil and monocyte activation.

Our research advances the frontiers of knowledge in the field of tick-borne diseases. We are one of the few groups worldwide that couple high-throughput molecular and cellular techniques/disciplines to address important questions concerning the transmission life-cycle of ticks.

At the same time, our experience in characterising the pharmacological action of salivary anti-proteases in the vertebrate host brings us closer to novel practical applications such as drug and vaccine development that have the potential to better connect science with society (as demonstrated by our patents: 1. Patent number WO2012162611-A1; 2. Patent number WO2009017689-A2; WO2009017689-A3; US2010278752-A1; 3. Patent number: WO2018197736A2, PCT/ES2018/070325).

Selected publications

- Assumpcao T., Mizurini D., Ma D., Monteiro R., Ahlstedt S., Reyes M., **Kotsyfakis M.**, Mather T., Andersen J., Lukszo J., Ribeiro J., Francischetti I. 2018: Ixonnexin from tick saliva promotes fibrinolysis by interacting with plasminogen and tissue-type plasminogen activator, and prevents arterial thrombosis. *Scientific Reports* 8: 4806. [IF=4.122]
- Hackenberg M., **Kotsyfakis M.** 2018: Exosome-mediated pathogen transmission by arthropod vectors. *Trends in Parasitology* 34: 549–552. [IF=7.929]

Patent

- **Kotsyfakis M.**, Hackenberg M., Corrales J.A.M., Navaja G.M., Tassi H.B. 2018: Composition comprising mirnas for use as a drug. Patent number: WO2018197736A2, PCT/ES2018/070325.

Research projects

- **ERDF/ESF Centre for research of pathogenicity and virulence of parasites** (No. CZ.02.1.01/0.0/0.0/16 _019/0000759; M. Oborník – coordinator, 2018–2022)

4.3. Laboratory of Tick-Transmitted Diseases

Research scientists:	RNDr. **Ondřej HAJDUŠEK**, PhD (*head*) RNDr. **Radek Šíma**, PhD
Postdocs:	RNDr. **Marie Jalovecká**, PhD*
PhD students:	Mgr. **Sazzad Mahmood**; Mgr. **Tereza Pospíšilová**
Undergraduate students:	Bc. **Kamila Bendová**; Bc. **Miriama Peklanská**; Bc. **Hana Velanová**; **Veronika Průchová**; **Aneta Zemanová**
Technicians:	Ing. **Gabriela Loosová**; Bc. **Zuzana Šmejkalová**

* Also members of the research team of Petr Kopáček

Research priorities

Laboratory of Tick Transmitted Diseases (founded in 2012) is focused on the molecular interactions between ticks (e.g. iron and heme metabolism pathway, tick immune molecules) and tick-transmitted pathogens and testing of anti-tick vaccines (improvement of the recent vaccine based on Ferritin 2) and vaccines interfering with the pathogen transmission. We have set-up in our laboratory (BSL2) complete transmission model for *Borrelia* infections, which we use for testing the tick candidate genes implicated in the tick-parasite interactions using method of RNA interference (RNAi) and also vaccines blocking the pathogen transmission. Recently, we set-up a system for testing *Babesia* infections and make an effort to set-up a system for *Anaplasma*. We have developed sensitive molecular methods for testing tick-borne diseases in humans and animals. The laboratory works in a close collaboration with the Laboratory of Vector Immunology (head P. Kopáček).

Antigens for a new vaccine against ticks and tick-transmitted diseases

Ticks are blood-feeding parasites and vectors of some of the most devastating viral, bacterial and protozoan diseases of humans and animals. *Ixodes ricinus* is a common tick in Europe including the Czech Republic, transmitting tick-borne encephalitis (TBE), Lyme disease (borreliosis), anaplasmosis and babesiosis. Immunisation of the hosts using recombinant tick proteins reduces tick feeding and, more importantly, blocks transmission of pathogens from the tick into the host. However, available tick antigens still do not reach sufficient efficacy. We use RNA interference (RNAi) to screen genes of *I. ricinus* potentially involved in the tick iron metabolism and heme acquisition in order to find suitable vaccine candidates affecting tick feeding and development. We also search for tick proteins present in tick saliva and involved in the tick-host interactions. These candidates can be further tested for their potential to inhibit transmission of the pathogens. We believe that vaccination with these proteins may have a great potential as a control strategy to reduce tick feeding and transmission of pathogens.

Lyme disease and babesiosis transmission models

Lyme borreliosis is an emerging vector-borne disease of temperate climates with a concurrent distribution spanning North America and Eurasia. It is caused by spirochetes of the *Borrelia burgdorferi* sensu lato complex, which are transmitted through the *Ixodes* ticks. Although Lyme

borreliosis is one of the best studied tick-borne zoonosis, the annual incidence leads over other vector-borne diseases with a continuous increase. There is currently no vaccine available to prevent Lyme disease in humans. One of the promising strategies to break *Borrelia* transmission development is a vaccine affecting basic tick physiological processes. Development of a promising vaccine against Lyme borreliosis would be greatly facilitated by a reproducible vector-host transmission model. We have succesfully implemented this model in our laboratory and use omics aproaches to find a molecule with proven anti-borrelial effect.

Babesiosis is a tick-borne, malaria-like disease of mammals. Because of the global environmental changes and continuous expansion of tick range, importance of babesiosis as an emerging zoonosis is increasing. Interplay between the parasite, tick and vertebrate host represents a complex system of multiple molecular interactions. To date, only a limited number of molecules have been identified to play a role in this system. Our research is focused on the identification and characterisation of molecular mechanisms of *Babesia* persistence within the tick vector and its transmission to the vertebrate host. We have currently set up the *Babesia microti* transmission model in our laboratory and use it for testing the tick immune genes in infection with *Babesia* spp. by RNA interference and vaccination.

Selected publications

- **Hartmann D.**, **Šíma R.**, **Konvičková J.**, **Perner J.**, **Kopáček P.**, **Sojka D.** 2018: Multiple legumain isoenzymes in ticks. *International Journal for Parasitology* 48: 167–178. [IF=3.078]
- **Jalovecká M.**, **Hajdušek O.**, **Sojka D.**, **Kopáček P.**, Malandrin L. 2018: The complexity of piroplasms life cycles. *Frontiers in Cellular Infection Microbiology* 8: 248. [IF=3.520]
- **Jalovecká M.**, **Hartmann D.**, Miyamoto Y., Eckmann L., **Hajdušek O.**, O'Donoghue A.J., **Sojka D.** 2018: Validation of *Babesia* proteasome as a drug target. *International Journal for Parasitology – Drugs and Drug Resistance* 8: 394–402. [IF=3.030]
- **Kopáček P.**, **Perner J.**, **Sojka D.**, **Šíma R.**, **Hajdušek O.** 2018: Molecular targets to impair blood meal processing in ticks. In: C.Q. Meng, A.E. Sluder and P.M. Selzer (Eds.), Ectoparasites: Drug Discovery Against Moving Targets. Wiley, Weinheim, pp. 139–165.
- **Urbanová V.**, **Hajdušek O.**, **Šíma R.**, Franta Z., **Hönig-Mondeková H.**, **Grunclová L.**, **Bartošová-Sojková P.**, **Jalovecká M.**, **Kopáček P.** 2018: IrC2/Bf – a yeast and *Borrelia* responsive component of the complement system from the hard tick *Ixodes ricinus*. *Developmental and Comparative Immunology* 79: 86–94. [IF=2.913]

Research projects

- **ANTIDotE (Anti-tick vaccines to prevent tick-borne diseases in Europe).** FP7 EU-HEALTH project (602272; Coordinator: J.W. Hovius; 2014–2018).
- **Identification and characterisation of the tick salivary glands and midgut molecules involved in the interaction with pathogens.** Czech Science Foundation (17-27386S; P.I.: O. Hajdušek; 2017–2019)
- **Revision of *Borrelia afzelii* transmission cycle: essential step for Lyme disease interventions.** Czech Science Foundation (17-27393S; P.I.: R. Šíma; 2017–2019)
- **ERDF/ESF Centre for research of pathogenicity and virulence of parasites** (No. CZ.02.1.01/0.0/0.0/16_019/0000759; M. Oborník – coordinator, 2018–2022)

5. FISH PARASITOLOGY

5.1. Laboratory of Helminthology

Research scientists:	prof. RNDr. **Tomáš SCHOLZ**, CSc. (*head*) RNDr. **František Moravec**, DrSc. (*researcher emeritus*) RNDr. **Jan Brabec**, PhD; **Ana Born-Torrijos**, MSc, PhD (Spain); RNDr. **Anna Faltýnková**, PhD; **Simona Georgieva**, MSc, PhD (Bulgaria); **Aneta Kostadinova**, MSc, PhD (Bulgaria); doc. RNDr. **Roman Kuchta**, PhD; Mgr. **Miroslava Soldánová**, PhD
Temporary contracts from projects:	
	MVDr. **Daniel Barčák**, PhD (Slovakia); **Jesus Hernández-Orts**, MSc, PhD (Mexico); **Bjoern C. Schaeffner**, MSc, PhD (Germany); **Aneta Yoneva**, MSc, PhD (Bulgaria)
PhD students:	Mgr. **Hynek Mazanec**; **Camila Pantoja de Oliveira** (Brazil); Mgr. **Jana Roháčová** (maternity leave)
Research assistants:	Ing. **Radmila Řepová**; Ing. **Blanka Škoríková**
Technician:	**Martina Borovková**
Laboratory worker:	**Alena Widnerová**
Undergraduate students:	Bc. **Pavla Heinclová**; Bc. **Lucie Uhrová**; Bc. **Tereza Vyhlídalová**; **Miroslava Čeňková**

Research priorities

Diversity, systematics, phylogeny and ecology of helminth parasites, especially tapeworms, trematodes and nematodes, and fish-borne parasitic diseases (broad fish tapeworms).

Parasites of African freshwater fishes: diversity, ecology and research methods

Based on long-term research including several field trips to Ethiopia, Kenya, South Africa and Sudan, and collaboration with researchers from Masaryk University in Brno (Czech Republic) and institutions in South Africa and Belgium, a monograph on the parasites of freshwater fishes in Africa was published. It describes methods used in studies on fish parasites and provides the first comprehensive list of all known freshwater fish parasites in Africa, with information on their known hosts and distribution, keys to all genera and representative illustrations for every genus. This information should facilitate and stimulate the development of fish parasitology on the African continent which has great potential for aquaculture and fishery development.

Diversity and systematics of helminths

Using methods of integrative taxonomy, several groups of parasitic flatworms (Cestoda, Digenea and Monogenea) and nematodes (Nematoda), parasites of freshwater and marine fish and other vertebrates, have been revised and new data on their diversity, host associations and interrelations provided. Studies have been focused on hot spots of teleost diversity in freshwaters (Amazonia, North America), and seas off Africa, America and Asia. Several projects are carried out also in Europe, especially in the sub-Arctic (Iceland and Norway).

Trematodes in sub-Arctic lake food webs

The ecological role of cercariae, larval stages of trematodes released by mollusc intermediate hosts, in energy flow and trophic interactions (food webs) in subarctic ecosystems was studied, linking a field and experimental study of subarctic lake with food-web approach towards estimates for cercarial production (output rates), productivity (biomass) and survival of trematode species with different transmission strategies, and predation on their cercarial populations.

Selected publications

- **Brabec J.**, **Scholz T.**, **Štefka J.** 2018: Development of polymorphic microsatellites for the invasive Asian fish tapeworm *Schyzocotyle acheilognathi*. *Parasitology International* 67: 341–343. [IF=2.055]
- **Kuchta R.**, Choudhury A., **Scholz T.** 2018: Asian fish tapeworm: the most successful invasive parasite in freshwaters. *Trends in Parasitology* 34: 511–523. [IF=7.929]
- **Moravec F.**, Justine J.L. 2018: Three new species of *Cucullanus* (Nematoda: Cucullanidae) from marine fishes off New Caledonia, with a key to species of *Cucullanus* from Anguilliformes. *Parasite* 25: 51. [IF=2.069]
- **Scholz T.**, Vanhove M.P.M., Smit N., Jayasundera Z., Gelnar M. (Eds.) 2018: Guide to the Parasites of African Freshwater Fishes: Diversity, Ecology and Research Methods. ABC Taxa. CEBioS, Royal Belgian Institute of Natural Sciences, 18: 421 pp.
- Schwelm J., **Soldánová M.**, **Vyhlídalová T.**, Sures B., Selbach C. 2018: Small but diverse: larval trematode communities in the small freshwater planorbids *Gyraulus albus* and *Segmentina nitida* (Gastropoda: Pulmonata) from the Ruhr River, Germany. *Parasitology Research* 117: 241–255. [IF=2.558]

Research projects

- **ECIP – European Centre of Ichthyoparasitology.** Czech Science Foundation – centres of excellence (P505/12/G112; Co-P.I.: T. Scholz; P.I.: M. Gelnar, Masaryk University, Brno; 2012–2018).
- **Neglected role of parasites: does biomass of trematode cercariae matter in subarctic freshwater ecosystems?** (17-20936Y; P.I.: M. Soldánová; 2017–2019).
- **Trematodes in sub-Arctic lake food webs: development of quantitative diversity baselines and a framework for community ecology research in the Arctic.** Czech Science Foundation (18-18597S; P.I: A. Faltýnková; 2018–2020).

5.2. Laboratory of Fish Protistology

Research scientists:	**Astrid HOLZER**, MSc, PhD (Austria) (head) **Gema Alama-Bermejo**, MSc, PhD (Spain); **Ana Born-Torrijos**, MSc, PhD (Spain); RNDr. **Ivan Fiala**, PhD; RNDr. **Miloslav Jirků**, PhD; Mgr. **Tomáš Korytář**, PhD; **Anush Kosakyan**, MSc, PhD (Armenia/Italy); RNDr. **Alena Lövy Kodádková**, PhD; **Sneha Patra**, MSc, PhD (India); RNDr. **Pavla Sojková**, PhD (Slovakia); **Carlos Yanes-Roca**, MSc, PhD (Spain)
PhD students:	RNDr. **Martina Lisnerová**; RNDr. **Jiří Kyslík**; **Baveesh Pudhuvai**, MSc (India)
Research assistant:	RNDr. **Hana Pecková**
Technician:	**Marie Fučíková** (part time)
Laboratory worker:	**Ivana Reitingerová**
Undergraduate students:	**Vyara Ganeva** (Bulgaria), BSc; **Bronislava Dostalová**; **Ricarda Marko** (Austria)

Research priorities

Our research is focused on eukaryotic microorganisms infecting fish, including all aspects of their biology, life cycles, host-parasite interactions, their phylogeny and evolution as well as applied reseach based on genomics, proteomics and immunology. The latter aims at the development of functional diets and vaccines for the aquaculture industry. Our main group of interest is the Myxozoa but we carry out research into a range of other protists, which create economic and health consequences, in collaboration with various academic and commercial partners worldwide.

Biodiversity and evolution of the Myxozoa

We transformed much of our systematic and phylogenetic research from individual species descriptions to more holistic interpretations of the most important events in the evolution of the Myxozoa. We examined the history of adaptive radiations in myxozoans and their hosts by determining the degree of congruence between their phylogenies. We used multigene analyses to time the emergence of myxozoan lineages in relation to their hosts and other eukaryotes. We demonstrated that the Myxozoa emerged long before fish populated Earth and that phylogenetic congruence with their invertebrate hosts is evident down to the most basal branches of the tree, indicating bryozoans and annelids as original hosts and challenging previous evolutionary hypotheses. We were able to provide evidence that, following invertebrate invasion, fish hosts were acquired multiple times, leading to parallel cospeciation patterns in all major phylogenetic lineages. We identified the acquisition of vertebrate hosts that facilitate alternative transmission and dispersion strategies as reason for the distinct success of the Myxozoa, and identify massive host specification-linked parasite diversification events. The novelty of these studies has created an avalanche of inquiries for the datasets used for our analysis and hence are presently fostering further evolutionary and ecological studies.

Model organism-based applied reseach

Much progress was made in further establishing our myxozoan model organism, *Sphaerospora molnari*, a parasite of common carp. We are the only laboratory worldwide that has an *in vivo* and *in vitro* culture system for early proliferative stages of myxozoans in the blood, and we are able to study the first stages of infection rather than investigating the processes surrounding spore formation. A large infection experiment elucidated the whereabouts of the parasite during the first 63 days of infection in parallel to the cellular and humoral immune responses produced by the host. We demonstrated the acquisition of specific immunity of carp to *S. molnari*. However host-evasion mechanisms such as a skewed anti-inflammatory cytokine profile and polyclonal antibody production, which exhausts the pool of host B cells while diluting specific antibodies, allow the parasite to further proliferate during later stages of infection. Based on these findings, we tested the effect of immunostimulatory and parasiticidal diets on parasite proliferation rates and antibody production profiles and showed that beta glucan based diets strongly reduce parasite numbers while creating a strong specific antibody response. We also produced a genomic and three transcriptomic databases for *S. molnari*, allowing us to analyse stage-specific gene expression and investigate target molecules as vaccine candidates in the near future. This research concentrates mostly on host-parasite interplay via proteolytic enzymes and their inhibitors.

Selected publications

- **Bartošová-Sojková P.**, **Lövy A.**, Reed C., **Lisnerová M.**, Tomková T., **Holzer A.**, **Fiala I.** 2018: Life in a rock pool: radiation and population genetics of myxozoan parasites in hosts inhabiting restricted spaces. *PLoS ONE* 13: e0194042. [IF=2.766]
- **Holzer A.S.**, **Bartošová-Sojková P.**, **Born-Torrijos A.**, **Lövy A.**, **Hartigan A.**, **Fiala I.** 2018: The joint evolution of the Myxozoa and their alternate hosts: a cnidarian recipe for success and vast biodiversity. *Molecular Ecology* 27: 1651–1666. [IF=6.131]
- **Patra S.**, **Bartošová-Sojková P.**, **Pecková H.**, **Fiala I**., Eszterbauer E., **Holzer A.S.** 2018: Biodiversity and host-parasite cophylogeny of *Sphaerospora* (*sensu stricto*) (Cnidaria: Myxozoa). *Parasites & Vectors* 11: 347. [IF=3.163]
- **Yanes-Roca C.**, Mráz J., **Born-Torrijos A.**, **Holzer A.S.**, Imentai A., Policar T. 2018: Introduction of rotifers (*Brachionus plicatilis*) during pike-perch first feeding. *Aquaculture* 497: 260–268. [IF=2.710]

Research projects

- **ECIP – European Centre Ichthyoparasitology.** Centre of Excellence, Czech Science Foundation (505/12/G112; P.I.: M. Gelnar, Masaryk University, Brno; 2012–2018).
- **ParaFishControl – Advanced tools and research strategies for parasite control in European farmed fish.** European Commission, RIA – Research and Innovation action, H2020 SFS-2014-2 Sustainable Food Security (634429; Coordinator: A. Sitjà-Bobadilla; 2015–2020).
- **Testing parasiticidal and immunomodulatory substances to combat myxozoan infections in aquaculture using novel *in vitro* and *in vivo* models.** Technology Agency of the Czech Republic (TG02010016; P.I.: A.S. Holzer; 2016–2018).
- **Large scale fish and water environment screening to assess the biodiversity of the Myxozoa: a metagenomic approach.** Czech Science Foundation (16-20744S; P.I.: I. Fiala; 2016–2018).
- **Marine Myxozoa and their link to meiofauna: communities, biodiversity and life cycles.** Swedish Research Council (2016-00541; PI: I. Martinek, 2016–2019).
- **Turn the tide on limited myxozoan phylogeny: using high throughput sequencing to discover new Myxozoa species from the Southwest Atlantic Ocean.** CR, Argentina – bilateral mobility project (CONICET-16-10, PI: A.S. Holzer, 2017–2018).
- **Inhibitors of cysteine proteases crucial for myxozoan pathogenicity and their interaction with the fish host.** Program Inter-Excellence (LTAUSA17201; P.I.: P. Sojková, 2017–2021)
- **Transmission strategy and parasitic load of *C. longicollis* hosts in relation to Mediterranean aquaculture**. Postdoctoral Fellowships of CAS (MSM200961706; P.I.: A. Born-Torrijos; 2017–2019)

6. OPPORTUNISTIC DISEASES

6.1. Laboratory of Veterinary and Medical Protistology

Research scientists:	prof. Ing. **Martin KVÁČ**, PhD (*head*) prof. MVDr. **David Modrý**, PhD (part time); RNDr. **Bohumil Sak**, PhD; RNDr. **Klára Petrželková**, PhD (part time)
PhD students:	Ing. **Šárka Čondlová**; Ing. **Nikola Havrdová**; Ing. **Nikola Holubová**; Ing. **Michaela Horčičková**; RNDr. **Jana Ježková**, RNDr. **Michaela Kotková**, DiS; Ing. **Veronika Prantlová**; MVDr. **Jitka Prediger**
Research assistants:	Ing. **Lenka Hlásková**; RNDr. **Dana Květoňová**
Undergraduate students:	Bc. **Klára Brdíčková**; Bc. **Klára Kellnerová**; Bc. **Tereza Vecková**; **Jana Ferencová**; **Michal Havelka**; **Jana Kopecká**; **Petr Kozák**; **Zlata Limpouchová**; **Kristýna Pačesová**; **Tereza Schulzová**; **Kamila Švajlenová**; **Veronika Tomancová**; **Veronika Zikmundová**

Research priorities

The focus of this group is to determine the zoonotic sources of emerging parasitic diseases, especially the opportunistic nature of the occurrence of cryptosporidia and microsporidia in immunodeficient (e.g. AIDS) patients and animals.

Diversity of *Cryptosporidium* spp. in wild rodents

We reported an occurrence of *Cryptosporidium* ssp. in wild rodents. The isolates were characterised by sequence and phylogenetic analyses of the small subunit ribosomal RNA, actin, *Cryptosporidium* oocyst wall protein, 70 kDa heat shock protein and 60 kDa glycoprotein genes. A phylogeny analysis showed presence at least nine, four and six different species of *Cryptosporidium* and genotypes in wild voles (*Microtus* spp.), mice of the genus *Apodemus* and rats (*Rattus* spp.), respectively. Genetic and biological data support description of five new species of cryptosporidia, *C. alticolis* and *C. microti* in voles, *C. ditrichi* and *C. apodemi* in *Apodemus* mice and *C. occultus* in rats.

Host specificity and age-dependent resistance to *Cryptosporidium avium*

Host specificity and age-dependent resistance to *C. avium* were studied in chickens (*Gallus gallus*), domestic ducks (*Anas platyrhynchos*) and ring-necked pheasants (*Phasianus colchicus*). *Cryptosporidium avium* was not infectious for ring-necked pheasants, but it was infectious for ducks and chickens. Unlike chickens, the course of infection in ducks did not differ among age categories. Our findings emphasise that biological properties of species of *Cryptosporidium* cannot be accurately predicted based on phylogenetic relatedness, and therefore experimental infectivity studies are critically important.

Migration of *Encephalitozoon cuniculi* induced by chronic inflammation

Microsporidia could represent hidden threat for human health as they cause disseminated infection, particularly in hosts with impaired immune function. Thus, they could be responsible for various diseases with ambiguous etiology. *Encephalitozoon cuniculi* was reported to be employed in periprosthetic osteolysis causing loss of implant stability after hip replacement. The experimental infection of mice with induced chronic inflammation revealed the potential of microsporidia to migrate towards inflammation loci. Moreover, the transmission of *E. cuniculi* from infected mother with hemotrichorial type of placenta to its offsprings was proved under experimental conditions.

Selected publications

- Kicia M., Sędzimirska M., **Sak B.**, **Kváč M.**, Wesołowska M., Hendrich A.B., Kopacz Ż. 2018: Respiratory microsporidiosis caused by *Enterocytozoon bieneusi* in an HIV-negative hematopoietic stem cell transplant recipient. *International Journal of Infectious Diseases* 77: 26–28. [IF=3.202]
- Kicia M., Wesolowska M., Kopacz Z., **Kváč M.**, **Sak B.**, Sokulska M., Cebulski K., Hendrich A.B., Pozowski A. 2018: Disseminated infection of *Encephalitozoon cuniculi* associated with osteolysis of hip periprosthetic tissue. *Clinical Infectious Diseases* 67: 1228–1234. [IF=9.117]
- Mapua M.I., Fuehrer H.P., **Petrželková K.J.**, Todd A., Noedl H., Qablan M.A., **Modrý D.** 2018: *Plasmodium ovale wallikeri* in western lowland gorillas and humans, Central African Republic. *Emerging Infectious Diseases* 24: 1581–1583. [IF=7.422]
- Pafčo B., Čížková D., Kreisinger J., Hasegawa H., Vallo P., Shutt K., Todd A., **Petrželková K.J.**, **Modrý D.** 2018: Metabarcoding analysis of strongylid nematode diversity in two sympatric primate species. *Scientific Reports* 8: 5933. [IF=4.122]
- Plutzer J., Lassen B., Jokelainen P., Djurković-Djaković O., Kucsera I., Dorbek-Kolin E., Šoba B., Sréter T., Imre K., Omeragić J., Nikolić A., Bobić B., Živičnjak T., Lučinger S., Stefanović L.L., Kučinar J., Sroka J., Deksne G., Keidāne D., **Kváč M.**, Hůzová Z., Karanis P. 2018: Review of *Cryptosporidium* and *Giardia* in the eastern part of Europe, 2016. *Eurosurveillance* 23 [IF=7.100]
- Vlčková K., Pafčo B., **Petrželková K.J.**, **Modrý D.**, Todd A., Yeoman C.J., Torralba M., Wilson B.A., Stumpf R.M., White B.A., Nelson K.E., Leigh S.R., Gomez A. 2018: Relationships between gastrointestinal parasite infections and the fecal microbiome in free-ranging western lowland gorillas. *Frontiers in Microbiology* 9: 1202. [IF=3.520]

Research projects

- **Elucidation of different virulence and drug resistance of genotypes of *Encephalitozoon cuniculi* using murine model.** Czech Science Foundation (17-12871S; P.I.: B. Sak; 2017–2019).
- **Role of urban wildlife in circulation of vector-borne zoonotic pathogens with emphasis on *Anaplasma phagocytophilum*.** Czech Science Foundation (17-16009S; P.I.: D. Modrý; 2017–2019)
- **Diversity and co-evolution of *Cryptosporidium* parasiting in rodents: linking genetic variation to parasite biology.** Ministry of Education, Youth and Sports (LTAUSA17165; P.I.: M. Kváč; 2017–2020).
- **Bird derived *Cryptosporidium*: filling knowledge gaps within unjustifiably marginalised group of hosts.** Czech Science Foundation (18-12364S; P.I.: M. Kváč; 2018–2020).

6.2. Laboratory of Parasitic Therapy

Research scientists:	MVDr. **Kateřina JIRKŮ-POMAJBÍKOVÁ**, PhD (*head*)
	RNDr. **Milan Jirků**; Mgr. **Kateřina Sobotková**, PhD
Technicians:	RNDr. **Blanka Macháčková**; Bc. **Oldřiška Hložková**
Undergraduate students:	Bc. **Jana Levá**; Bc. **Zuzana Lhotská**; Bc. **Lucie Řežábková**; **Kristýna Brožová**; **Andrea Růžičková**; **Jiřina Růžková**

Research priorities

Main research lines of this laboratory are focused on investigation of the role of the commensal gut eukaryotes (protists and helminths) in human health and disease. Abundant evidence suggests that a dysbiosis of the gut microbiome (alteration in diversity) is one of the main risk factors for developing of chronic inflammation-mediated diseases (CIMDs). CIMDs are collection of diseases that share common, ostensibly unrelated risk factors and occur predominantly in industrialised societies. Best-known representatives are inflammatory bowel diseases, multiple sclerosis, rheumatoid arthritis or allergies. The increase in CIMDs incidence and prevalence is also associated with loss of helminth colonisation, which have gone from ubiqitous to nearly absent in the western countries. Very recently, the emerging body of research has shown that helminths and commensal protists inhabiting gut may positively influence the health status of individuals suffering from some CIMDs.

Here, we investigate the effect of gut symbionts on the chemically induced colitis, the *in vivo* model resembling to Crohn's disease in humans. So far, we have identified two candidates such as the benign helminth, *Hymenolepis diminuta*, and protist, *Blastocystis* ST1. In case of *H. diminuta*, our results clearly showed that it is able to ameliorate chronic colitis in the rat model system during patent period of colonisation. Further, we need to identify the imunological mechanisms reponsible for supression of inflammation. Another project in our laboratory is focused on the identification of *Hymenolepis*-derived compounds with immunomodulatory abilities and testing of their effect on inflammation. The results on an effect of *Blastocystis* ST1 on the colitis in the rat model system are unambiguous and it is matter of subsequent studies.

Contrary to helminths, the gut commensal protists are common in the gut microbiome of people in western countries. However, the real prevalence of most of these commensal protists in healthy human population in western countries are not known, even though this information is highly essential for understanding of their role in human health and disease (i.e. CIMDs). Thus, we focus also on the epidemiology of the gut protists in healthy human population in Czech Republic and their associations with gut bacterial microbiota.

Selected publications

- **Jirků Pomajbíková K.**, Hůzová Z. 2018: Coproscopic examination techniques. In: D. Modrý, B. Pafčo, K.J. Petrželková, H. Hasegawa (Eds.), Parasites of Apes: An Atlas of Coproscopic Diagnostics. Chimaira, Frankfurt, pp. 22–28.
- **Jirků Pomajbíková K.**, **Jirků M.**, **Levá J.**, **Sobotková K.**, Morien E., Wegener Parfrey L. 2018: The bening helminth *Hymenolepis diminuta* ameliorates chemically induced colitis in a rat model system. *Parasitology* 145: 1324–1335. [IF=2.511]
- **Jirků Pomajbíková K.**, Modrý D. 2018: *Balantioides coli* and related cyst-forming ciliates. In: D. Modrý, B. Pafčo, K.J. Petrželková, H. Hasegawa (Eds.), Parasites of Apes: An Atlas of Coproscopic Diagnostics. Chimaira, Frankfurt, pp. 112–115.
- Pafčo B., Tehlárová Z., **Jirků-Pomajbíková K.**, Todd A., Hasegawa H., **Petrželková K.J.**, **Modrý D.** 2018: Gastrointestinal protists and helminths of habituated agile mangabeys (*Cercocebus agilis*) at Bai Hokou, Central African Republic. *American Journal of Primatology* 80: e22736. [IF=2.288]
- **Růžková J.**, **Květoňová D.**, **Jirků M.**, **Lhotská Z.**, Stensvold C.R., Wegener Parfrey L., **Jirků Pomajbíková K.** 2018: Evaluating rodent experimental models for studies of *Blastocystis* ST1. *Experimental Parasitology* 191: 55–61. [IF=1.821]

Research projects

- **Interplay of eukaryotic symbionts with gut microbiome and influence on immune-mediated disorders.** Young investigator category, agency: Human Frontiers Science Program Organisation (RGY0078/2015; P.I.: K. Jirků-Pomajbíková; 2015–2019)

Supporting facility

Laboratory of Electron Microscopy

Research scientists:	Ing. **Jana NEBESÁŘOVÁ**, CSc. (*head*) RNDr. **Marie Vancová**, PhD; Ing. **Zdenko Gardian**, PhD (part-time)
PhD students:	Mgr. **Tomáš Bílý**; Mgr. **Martin Strnad**; Mgr. **Eva Ďurinová** (since September)
Technicians:	Mgr. **Jan Langhans**; Mgr. **Martina Tesařová**; **Petra Masařová**; **Jiří Vaněček**
Undergraduate students:	**Dominik Bauman** (Austria) (till June); **Johannes Grahammer** (Austria) (till June) **Magdalena Victoria Baranyi** (Austria) (since September); **Maximiliam Bayer** (Austia) (since September)

Research priorities

Electron microscopy is used to image the structure of molecules, cells and tissues at sub-nanometer resolution. Transmission electron microscopy (TEM) is dedicated for the examination of samples cut into ultrathin sections with the thickness 80–100 nm so that the electron beam can pass through the sample and form an image on the detector. In scanning electron microscopy (SEM), the electron beam is scanned over the small sample area to produce secondary signals carrying information about the specimen surface topography or composition. The team of the Laboratory of Electron Microscopy (LEM) works closely with several research groups of the Biology Centre but also from other institutions to plan, optimise and implement experiments, producing images that allow scientists to understand their samples at the subcellular level. Members of LEM are experts in preparing, imaging and interpreting a wide range of biological samples. They use a broad spectrum of traditional and novel preparation techniques for optimum preservation of sample morphology and localisation of proteins. Since 2016 LEM has been involved in a distributed national research infrastructure Czech-BioImaging (https://www.czech-bioimaging.cz/), which provides an open access to a wide range of imaging technologies and expertise to all scientists in the Czech Republic and from abroad by a unified and coordinated logistic approach.

Technical equipment

Transmission electron microscopes

- JEOL 2100F (2012) equipped for cryo-EM, electron tomography, Phase Plate technology, STEM and image recording with direct detection camera K2 and CCD camera Orius SC1000 (Gatan)
- JEOL 1010 (1996) equipped with SSC camera MegaView 3

Scanning electron microscopes

- Apreo – Thermo Fisher Scientific equipped with serial block-face imaging (SBF) and low-energy STEM
- JEOL 7401F (2005) with cryo-attachment ALTO 2500 GATAN

Ultramicrotomes Leica with and without cryo-chamber.

High Pressure Freezer Leica EM Pact2 – a system for vitrifying samples up to 200 μm in thickness without the artifacts of chemical fixation.

Automatic freeze substitution system Leica EM AFS for substitution and low temperature embedding after cryofixation and for the PLT technique.

Selected publications

- **Kaurov I.**, **Vancová M.**, Schimanski B., Cadena L.R., **Heller J.**, **Bílý T.**, Potěšil D., Eichenberger C., Bruce H., Oeljeklaus S., Warscheid B., Zdráhal Z., Schneider A., **Lukeš J.**, **Hashimi H.** 2018: The diverged trypanosome MICOS complex as a hub for mitochondrial cristae shaping and protein import. *Current Biology* 28: 3393–3407.e5. [IF=9.251]
- Kučera D., Pernicová I., Kovalcik A., Koller M., Müllerová L., Sedláček P., Mravec F., **Nebesářová J.**, Kalina M., Márová I., Krzyzanek V., Obruca S. 2018: Characterisation of the promising poly(3-hydroxybutyrate) producing halophilic bacterium *Halomonas halophila*. *Bioresource Technology* 256: 552–556. [IF=5.807]
- **Věchtová P.**, **Štěrbová J.**, **Štěrba J.**, **Vancová M.**, **Rego R.O.M.**, **Selinger M.**, **Strnad M.**, **Golovchenko M.**, **Rudenko N.**, **Grubhoffer L.** 2018: A bite so sweet: the glycobiology interface of tick-host-pathogen interactions. *Parasites & Vectors* 11: 594. [IF= 3.163]
- Kučera D., Pernicová I., Kovalcik A., Koller M., Müllerová L., Sedláček P., Mravec F., **Nebesářová J.**, Kalina M., Márová I., Krzyzanek V., Obruca S. 2018: Characterization of the promising poly(3-hydroxybutyrate) producing halophilic bacterium *Halomonas halophila*. *Bioresource Technology* 256: 552–556. [IF=5.807]

Research projects

- **Electron Microscopy.** Programme of the Technology Agency of the Czech Republic to support the development of long-term collaboration of the public and private sectors on research, development and innovations. The project is managed by a consortium of representatives of eight participating organisations – Thermo Fisher Scientific, Delong Instruments, Crytour, Institute of Macromolecular Chemistry of the Czech Agency of Sciences (CAS), Institute of Molecular Genetics of CAS, Institute of Scientific Instruments of CAS, Biology Centre of CAS (LEM), Research and Testing Institute Plzeň (2012–2019).
- **National Infrastructure for Biological and Medical Imaging – Czech-BioImaging.** Ministry of Education, Youth and Sports. Programme of Large Research Infrastructure (LM2015062; main coordinator: Institute of Molecular Genetics of CAS; 2016–2022).
- **Modernisation and support of research activities of the national infrastructure for biological and medical imaging Czech-BioImaging.** Project is supported by Ministry of Education, Youth and Sports, project n. CZ.02.1.01/0.0/0.0/16_013/0001775; main coordinator: Institute of Molecular Genetics, 2017–2020.

Special activities

Collections of parasitic organisms

An extensive collection of helminths (curator Tomáš Scholz) is available for comparative studies. It comprises more than 3,000 species from around the world, including numerous type specimens. A collection of holotypes and paratypes of about 300 species of parasitic arthropods, on 430 microscopic slides, is deposited at the Institute, as well as a large collection of several thousand specimens of parasitic mites and fleas from mammals, birds and reptiles, and a small collection of ticks in alcohol. The Institute maintains laboratory colonies of ticks (8 species), mosquitoes (4 species, 5 lines) and arboviruses (33 species and strains). A collection of cryopreserved cultures of blood flagellates and amphizoic amoebae is maintained at the Laboratory of Fish Protistology. More information can be found at http://www.paru.cas.cz/en/collections/.

Publishing and editorial activities

FOLIA PARASITOLOGICA – an international journal

Editor-in-Chief: **Tomáš Scholz**

Assistant Editors: **Ivan Fiala** (parasitic protists & myxozoans; molecular phylogenetics)
Jan Štefka (ecology of parasites & parasitic arthropods)
Tomáš Scholz (helminths)

Editorial Assistant: **Kateřina Homrová**

Folia Parasitologica is an international journal for parasitology, publishing articles written in English. It was founded in 1953 as an annual edition; from 1966 until 2014, it was published four times a year. Since January 2015, the journal has been moved to an Open Access mode, without any hard copies published. Editor-in-Chief and three Assistant Editors from the Institute of Parasitology are aided by an international Board of Editorial Advisors, consisting of 23 highly regarded scientists, overwhelming majority of them being foreign parasitologists. The rejection rate is more than 60%. *Folia Parasitologica* has a wide international authorship; its impact factor is 1.405 in 2018; five-year Impact Factor is 1.224.

Publications

Published in 2018

Authors explicitly affiliated to the Institute of Parasitology are enboldened

Monographs

1. **MODRÝ D.**, PAFČO B., **PETRŽELKOVÁ K.**, HASEGAWA H. (Eds) 2018: Parasites of Apes: An Atlas of Coproscopic Diagnostics. Chimaira, Frankfurt, 200 pp.
2. **SCHOLZ T.**, VANHOVE M.P.M., SMIT N., JAYASUNDERA Z., GELNAR M. (Eds) 2018: Guide to the Parasites of African Freshwater Fishes: Diversity, Ecology and Research Methods. ABC Taxa 18. CEBioS, Royal Belgian Institute of Natural Sciences, 421 pp.

Chapters in monographs

1. **BARTOŠOVÁ-SOJKOVÁ P.**, **FIALA I.** 2018: Basic methods to study the principal groups of fish parasites: Myxozoa. In: T. Scholz, M.P.M. Vanhove, N. Smit, Z. Jayasundera and M. Gelnar (Eds), Guide to the Parasites of African Freshwater Fishes: Diversity, Ecology and Research Methods. ABC Taxa 18. CEBioS, Royal Belgian Institute of Natural Sciences, pp. 85–87.
2. DOLEŽELOVÁ J., PAFČO B., **MODRÝ D.**, **JIRKŮ POMAJBÍKOVÁ K.** 2018: Parasite quantification. In: D. Modrý, B. Pafčo, K.J. Petrželková and H. Hasegawa (Eds), Parasites of Apes: An Atlas of Coproscopic Diagnostics. Chimaira, Frankfurt, pp. 34–38.
3. **DYKOVÁ I.**, TYML T., **HOLZER A.S.** 2018: Basic methods to study the principal groups of fish parasites: fish-infecting eukaryotic microorganisms (Eds). In: T. Scholz, M.P.M. Vanhove, N. Smit, Z. Jayasundera and M. Gelnar (Eds), Guide to the Parasites of African Freshwater Fishes: Diversity, Ecology and Research Methods. ABC Taxa 18. CEBioS, Royal Belgian Institute of Natural Sciences, pp. 71–84.
4. ESPINOSA P J., ALBERDI P., VILLAR M., **CABEZAS-CRUZ A.**, DE LA FUENTE J. 2017: Heat shock proteins in vector-pathogen interactions: the *Anaplasma phagocytophilum* Model. In A.A. Asea and P. Kaur (Eds), Heat Shock Proteins in Veterinary Medicine and Sciences. Springer, Cham, pp. 375–398.
5. **FAKTOROVÁ D.**, VALACH M., **KAUR B.**, BURGER G., **LUKEŠ J.** 2018: Mitochondrial RNA editing and processing in diplonemid protists. In: M.W. Gray and J. Cruz-Reyes (Eds), RNA Metabolism in Mitochondria. Springer, Cham, pp. 145–176.
6. **FIALA I.**, **BARTOŠOVÁ-SOJKOVÁ P.** 2018: Myxozoa. In: T. Scholz, M.P.M. Vanhove, N. Smit, Z. Jayasundera and M. Gelnar (Eds), Guide to the Parasites of African Freshwater Fishes: Diversity, Ecology and Research Methods. ABC Taxa 18. CEBioS, Royal Belgian Institute of Natural Sciences, pp. 169–183.
7. **FIALA I.**, **BRABEC J.** 2018: Molecular taxonomy. In: T. Scholz, M.P.M. Vanhove, N. Smit, Z. Jayasundera and M. Gelnar (Eds), Guide to the Parasites of African Freshwater Fishes: Diversity, Ecology and Research Methods. ABC Taxa 18. CEBioS, Royal Belgian Institute of Natural Sciences, pp. 119–125.
8. **FÜSSY Z.**, **OBORNÍK M.** 2018: Complex endosymbioses I: from primary to complex plastids, multiple independent events. In: E. Maréchal (Ed.), Plastids. Methods in Molecular Biology. Humana Press, New York, pp. 17–35.
9. **JIRKŮ POMAJBÍKOVÁ K.**, HŮZOVÁ Z. 2018: Coproscopic examination techniques. In: D. Modrý, B. Pafčo, K.J. Petrželková and H. Hasegawa (Eds), Parasites of Apes: An Atlas of Coproscopic Diagnostics. Chimaira, Frankfurt, pp. 22–28.
10. **JIRKŮ POMAJBÍKOVÁ K.**, **MODRÝ D.** 2018: *Balantioides coli* and related cyst-forming ciliates.. In: D. Modrý, B. Pafčo, K.J. Petrželková and H. Hasegawa (Eds), Parasites of Apes: An Atlas of Coproscopic Diagnostics. Chimaira, Frankfurt, pp. 112–115.

11. **JIRKŮ POMAJBÍKOVÁ K.**, **MODRÝ D.** 2018: Principles and limits of microscopic parasite identification. In: D. Modrý, B. Pafčo, K.J. Petrželková and H. Hasegawa (Eds), Parasites of Apes: An Atlas of Coproscopic Diagnostics. Chimaira, Frankfurt, pp. 20–21.

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13. **KOPÁČEK P.**, **PERNER J.**, **SOJKA D.**, **ŠÍMA R.**, **HAJDUŠEK O.** 2018: Molecular targets to impair blood meal processing in ticks. In: C.Q. Meng, A.E. Sluder and P.M. Selzer (Eds), Ectoparasites: Drug Discovery Against Moving Targets. Wiley, Weinheim, pp. 139–165.

14. **KUCHTA R.** 2018: Key to the principal groups of the parasites of freshwater fishes in Africa. In: T. Scholz, M.P.M. Vanhove, N. Smit, Z. Jayasundera and M. Gelnar (Eds), Guide to the Parasites of African Freshwater Fishes: Diversity, Ecology and Research Methods. ABC Taxa 18. CEBioS, Royal Belgian Institute of Natural Sciences, pp. 137–138.

15. KUDLAI O., **SCHOLZ T.**, SMIT N. 2018: Trematoda. In: T. Scholz, M.P.M. Vanhove, N. Smit, Z. Jayasundera and M. Gelnar (Eds), Guide to the Parasites of African Freshwater Fishes: Diversity, Ecology and Research Methods. ABC Taxa 18. CEBioS, Royal Belgian Institute of Natural Sciences, pp. 245–268.

16. KUFELOVÁ M., **MODRÝ D.** 2018: Acanthocephala. In: D. Modrý, B. Pafčo, K.J. Petrželková and H. Hasegawa (Eds), Parasites of Apes: An Atlas of Coproscopic Diagnostics. Chimaira, Frankfurt, pp. 130–132.

17. **KVÁČ M.**, HŮZOVÁ Z. 2018: Staining techniques for protists. In: D. Modrý, B. Pafčo, K.J. Petrželková and H. Hasegawa (Eds), Parasites of Apes: An Atlas of Coproscopic Diagnostics. Chimaira, Frankfurt, pp. 29–33.

18. **KVÁČ M.**, MCEVOY J. 2018: *Chilomastix mesnili*. In: D. Modrý, B. Pafčo, K.J. Petrželková and H. Hasegawa (Eds), Parasites of Apes: An Atlas of Coproscopic Diagnostics. Chimaira, Frankfurt, pp. 100–101.

19. **KVÁČ M.**, MCEVOY J. 2018: *Cryptosporidium*. In: D. Modrý, B. Pafčo, K.J. Petrželková and H. Hasegawa (Eds), Parasites of Apes: An Atlas of Coproscopic Diagnostics. Chimaira, Frankfurt, pp. 116–117.

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21. MAPUA M.I., **VOTÝPKA J.** 2018: Detection of blood parasites in primate feces. In: D. Modrý, B. Pafčo, K.J. Petrželková and H. Hasegawa (Eds), Parasites of Apes: An Atlas of Coproscopic Diagnostics. Chimaira, Frankfurt, pp. 51–53.

22. MAŠOVÁ Š., **KUCHTA R.** 2018: Nematoda. In: T. Scholz, M.P.M. Vanhove, N. Smit, Z. Jayasundera and M. Gelnar (Eds), Guide to the Parasites of African Freshwater Fishes: Diversity, Ecology and Research Methods. ABC Taxa 18. CEBioS, Royal Belgian Institute of Natural Sciences, pp. 297–331.

23. **MODRÝ D.** 2018: Coproscopic examination and its limits. In: D. Modrý, B. Pafčo, K.J. Petrželková and H. Hasegawa (Eds), Parasites of Apes: An Atlas of Coproscopic Diagnostics. Chimaira, Frankfurt, pp. 48–50.

24. **MODRÝ D.** 2018: Pseudoparasites. In: D. Modrý, B. Pafčo, K.J. Petrželková and H. Hasegawa (Eds), Parasites of Apes: An Atlas of Coproscopic Diagnostics. Chimaira, Frankfurt, pp. 174–179.

25. **MODRÝ D.**, ČERVENÁ B. 2018: Trematodes. In: D. Modrý, B. Pafčo, K.J. Petrželková and H. Hasegawa (Eds), Parasites of Apes: An Atlas of Coproscopic Diagnostics. Chimaira, Frankfurt, pp. 120–121.

26. **MODRÝ D.**, ESCALANTE A. 2018: Parasites of orangutans. In: D. Modrý, B. Pafčo, K.J. Petrželková and H. Hasegawa (Eds), Parasites of Apes: An Atlas of Coproscopic Diagnostics. Chimaira, Frankfurt, pp. 71–75.

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28. **PETRŽELKOVÁ K.J.**, HUFFMAN M.A. 2018: Parasites of chimpanzees and bonobos. In: D. Modrý, B. Pafčo, K.J. Petrželková and H. Hasegawa (Eds), Parasites of Apes: An Atlas of Coproscopic Diagnostics. Chimaira, Frankfurt, pp. 56–63.

29. **RŮŽEK D.**, YOSHII K., BLOOM M.E., GOULD E.A. 2018: Tick-borne encephalitis virus – virology. In: G. Dobler, W. Erber and H.-J. Schmitt (Eds), Tick-Borne Encephalitis (TBE). Global Health Press, Singapore, pp. 12–26.

30. **SAK B.**, **KVÁČ M.** 2018: Microsporidia. In: D. Modrý, B. Pafčo, K.J. Petrželková and H. Hasegawa (Eds), Parasites of Apes: An Atlas of Coproscopic Diagnostics. Chimaira, Frankfurt, pp. 118–119.

31. SCHOENIAN G., **LUKEŠ J.**, STARK O., COTTON J. 2018: Molecular evolution and phylogeny of *Leishmania*. In: A. Ponte-Sucre and M. Padrón-Nieves (Eds), Drug Resistance in *Leishmania* Parasites, Consequences, Molecular Mechanisms, and Possible Treatments. Second Edition. Springer, Cham, pp. 19–57.

32. **SCHOLZ T.**, **KUCHTA R.** 2018: Cestoda. In: T. Scholz, M.P.M. Vanhove, N. Smit, Z. Jayasundera and M. Gelnar (Eds), Guide to the Parasites of African Freshwater Fishes: Diversity, Ecology and Research Methods. ABC Taxa 18. CEBioS, Royal Belgian Institute of Natural Sciences, pp. 269–286.

33. **SCHOLZ T.**, **KUCHTA R.**, MÁŠOVÁ Š., **KOSTADINOVÁ A.** 2018: Basic methods to study the principal groups of fish parasites: Endoparasitic helminths. In: T. Scholz, M.P.M. Vanhove, N. Smit, Z. Jayasundera and M. Gelnar (Eds), Guide to the Parasites of African Freshwater Fishes: Diversity, Ecology and Research Methods. ABC Taxa 18. CEBioS, Royal Belgian Institute of Natural Sciences, pp. 99–104.

34. **SCHOLZ T.**, ŘEHULKOVÁ E., **KUCHTA R.** 2018: Basic methods to study the principal groups of fish parasites: Parasitological examination of fish (dissection). In: T. Scholz, M.P.M. Vanhove, N. Smit, Z. Jayasundera and M. Gelnar (Eds), Guide to the Parasites of African Freshwater Fishes: Diversity, Ecology and Research Methods. ABC Taxa 18. CEBioS, Royal Belgian Institute of Natural Sciences, pp. 65–70.

35. **SCHOLZ T.**, SMIT N., VANHOVE M.P.M. 2018: Introduction. In: T. Scholz, M.P.M. Vanhove, N. Smit, Z. Jayasundera and M. Gelnar (Eds), Guide to the Parasites of African Freshwater Fishes: Diversity, Ecology and Research Methods. ABC Taxa 18. CEBioS, Royal Belgian Institute of Natural Sciences, pp. 9–13.

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37. SMIT N., BASSON L., VANHOVE M.P.M., **SCHOLZ T.** 2018: History of fish parasitology in Africa. In: T. Scholz, M.P.M. Vanhove, N. Smit, Z. Jayasundera and M. Gelnar (Eds), Guide to the Parasites of African Freshwater Fishes: Diversity, Ecology and Research Methods. ABC Taxa 18. CEBioS, Royal Belgian Institute of Natural Sciences, pp. 15–29.

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40. **VOTÝPKA J.**, **LUKEŠ J.**, HORÁK P. 2018: Paraziti jako naši spojenci. In: J. Votýpka, I. Kolářová, P. Horák et al. (Eds), O parazitech a lidech. Triton, Praha; pp. 206–237.

41. ACOSTA A.A., **SCHOLZ T.**, BLASCO-COSTA I., **ALVES P.V.**, DA SILVA R.J. 2018: A new genus and two new species of dactylogyrid monogeneans from gills of Neotropical catfishes (Siluriformes: Doradidae and Loricaridae). *Parasitology International* 67: 4–12. [IF=2.017]

42. **ALAMA-BERMEJO G.**, HERNÁNDEZ-ORTS J.S. 2018: *Ortholinea concentrica* n. sp. (Cnidaria: Myxozoa) from the Patagonian seabass *Acanthistius patachonicus* (Jenyns, 1840) (Perciformes: Serranidae) off Patagonia, Argentina. *Parasitology Research* 117: 3953–3963. [IF=2.067]

43. **ALVES P.V.**, DE CHAMBRIER A., LUQUE J., **SCHOLZ T.** 2018: Towards a robust systematic baseline of Neotropical fish tapeworms (Cestoda: Proteocephalidae): amended diagnoses of two genera from the redtail catfish, *Phractocephalus hemioliopterus*. *Zootaxa* 4370: 363–380. [IF=0.990]

44. ARTIGAS-JERÓNIMO S., VILLAR M., CABEZAS-CRUZ A., **VALDÉS J.J.**, ESTRADA-PEÑA A., ALBERDI P., DE LA FUENTE J. 2018: Functional evolution of subolesin/akirin. *Frontiers in Physiology* 9: 1612. [IF=3.201]

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46. AVILA A., **CABEZAS-CRUZ A.**, GISSOT M. 2018: mRNA export in the apicomplexan parasite *Toxoplasma gondii*: emerging divergent components of a crucial pathway. *Parasites & Vectors* 11: 62. [IF=3.163]

47. **BARTOŠOVÁ-SOJKOVÁ P.**, **LÖVY A.**, REED C., **LISNEROVÁ M.**, TOMKOVÁ T., **HOLZER A.**, **FIALA I.** 2018: Life in a rock pool: radiation and population genetics of myxozoan parasites in hosts inhabiting restricted spaces. *PLoS ONE* 13: e0194042. [IF=2.776]

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205. VLČKOVÁ K., PAFČO B., **PETRŽELKOVÁ K.J.**, **MODRÝ D.**, TODD A., YEOMAN C.J., TORRALBA M., WILSON B.A., STUMPF R.M., WHITE B.A., NELSON K.E., LEIGH S.R., GOMEZ A. 2018: Relationships between gastrointestinal parasite infections and the fecal microbiome in free-ranging western lowland gorillas. *Frontiers in Microbiology* 9: 1202. [IF=4.259]

206. VLČKOVÁ K., SHUTT-PHILLIPS K., HEISTERMANN M., PAFČO B., **PETRŽELKOVÁ K.J.**, TODD A., **MODRÝ D.**, NELSON K.E., WILSON B.A., STUMPF R.M., WHITE B.A., LEIGH S.R., GOMEZ A. 2018: Impact of stress on the gut microbiome of free-ranging western lowland gorillas. *Microbiology* 164: 40–44. [IF=1.027]

207. **VOTÝPKA J.**, PAFČO B., **MODRÝ D.**, MBOHLI D., TAGG N., **PETRŽELKOVÁ K.J.** 2018:

An unexpected diversity of trypanosomatids in fecal samples of great apes. *International Journal for Parasitology*: *Parasites and Wildlife* 7: 322–325. [IF=2.075]

208. VYCHODILOVÁ L., NEČESANKOVÁ M., ALBRECHTOVÁ K., HLAVÁČ J., **MODRÝ D.**, JÁNOVÁ E., VYSKOČIL M., MIHALCA A.D., KENNEDY L.J., HORIN P. 2018: Genetic diversity and population structure of African village dogs based on microsatellite and immunity-related molecular markers. *PLoS ONE* 13: e0199506. [IF=2.776]

209. XIN M., SHALIUTINA-KOLESOVÁ A., **ŠTĚRBA J.**, KONIK P., BORYSHPOLETS S., RODINA M., LI P., NIAN R., LINHART O. 2018: Impact of cryopreservation on sterlet, *Acipenser ruthenus* sperm motility and proteome. *Animal Reproduction Science* 192: 280–289. [IF=1.817]

210. XIN M., **ŠTĚRBA J.**, SHALIUTINA-KOLESOVA A., DZYUBA B., **LIESKOVSKÁ J.**, BORYSHPOLETS S., SIDDIQUE M.A.M., KHOLODNYY V., LEBEDA I., LINHART O. 2018: Protective role of antifreeze proteins on sterlet (*Acipenser ruthenus*) sperm during cryopreservation. *Fish Physiology and Biochemistry* 44: 1527–1533. [IF=1.729]

211. YAMADA F.H., **ACOSTA A.A.**, YAMADA P.O.F., **SCHOLZ T.**, DA SILVA R.J. 2018: A new species of *Aphanoblastella* (Monogenea: Dactylogyridae), parasites of heptapterid catfishes (Siluriformes) in the Neotropic Region. Acta Parasitologica 63:772–780. [IF=0.968]

212. YANES-ROCA C., MRÁZ J., **BORN-TORRIJOS A.**, **HOLZER A.S.**, IMENTAI A., POLICAR T. 2018: Introduction of rotifers (*Brachionus plicatilis*) during pike-perch first feeding. *Aquaculture* 497: 260–268. [IF=3.022]

213. YANES-ROCA C., TOLEDO-CUEVAS E.M., SÁNCHEZ J.L, **BORN-TORRIJOS A.**, RHODY N., MAIN K.L. 2018: Digestive enzyme activity during larval development of black snook (*Centropomus nigrescens*). *Journal of World Aquaculture* 49: 612–624. [IF=1.386]

214. **YONEVA A.**, **SCHOLZ T.**, **KUCHTA R.** 2018: Comparative morphology of surface ultrastructure of diphyllobothriidean tapeworms (Cestoda: Diphyllobothriidea). *Invertebrate Biology* 137: 38–48. [IF=1.451]

215. **YURCHENKO V.**, **LUKEŠ J.** 2018: Parasites and their (endo)symbiotic microbes. *Parasitology* 145: 1261–1264. [IF=2.456]

216. ZÁHONOVÁ K., **FÜSSY Z.**, BIRČÁK E., NOVÁK VANCLOVÁ A., KLIMEŠ V., VESTEG M., KRAJČOVIČ J., **OBORNÍK M.**, ELIÁŠ M. 2018: Peculiar features of the plastids of the colourless alga *Euglena longa* and photosynthetic euglenophytes unveiled by transcriptome analyses. *Scientific Reports* 8: 17012. [IF=4.011]

Patents 2018:

217. **KUČERA M.**, **PERNER J.**, **KOPÁČEK P.** 2018: Zařízení pro chov a testování klíšťat. Úřad průmyslového vlastnictví No. A01K 29/00.

218. **KUČERA M.**, **PERNER J.**, **KOPÁČEK P.**, **HATALOVÁ T.** 2018: Krmítko pro chov a testování klíšťat ve stádiu larev a nymf. Úřad průmyslového vlastnictví No. A01K 67/033

Others 2018:

219. BEVERIDGE I., **SCHAFFNER B. C.** 2018: Trypanorhynch cestodes (Platyhelminthes) parasitic in elasmobranchs and crustaceans in Moreton Bay, Queensland. *Memoirs of the Queensland Museum* 61: 109–142.

220. **EYER L.**, NENCKA R., DE CLERCQ E., SELEY-RADTKE K., **RŮŽEK D.** 2018: Nucleoside analogs as a rich source of antiviral agents active against arthropod-borne flaviviruses. *Antiviral Chemistry & Chemotherapy* 26: 1–28.

221. **LUKEŠ J.** 2018: Jiří Vávra osmdesátipětiletý. *Živa* 4: 88.

222. MCALLISTER C.T., CLOUTMAN D.G., CHOUDHURY A., **SCHOLZ T.**, TRAUTH S.E., FAYTON T.J., ROBINSON H.W. 2018: Parasites of the Spotted Sucker, *Minytrema melanops* (Cypriniformes: Catostomidae) from Arkansas and Oklahoma. *Journal of the Arkansas Academy of Science* 72: 87–93.

223. MOYA A.; **LUKEŠ J.**, 61 additional authors 2018: Harassment charges: injustice done? *Science* 361: 655–656. [IF=41.037]

International activities

Cooperation with foreign research institutions

Research area: Molecular biology of parasitic protists and nematodes & molecular taxonomy and phylogeny of parasites

- Berkeley Lab – Biosciences, Berkeley, USA (K.M. Davies)
- Boston University, Boston, USA (R. Aphasizhev)
- CNRS, Ecole Normale Supérieure, Paris, France (C. Bowler)
- Comenius University, Bratislava, Slovakia (A. Horváth)
- Dalhousie Univeristy in Halifax, Canada (A.J.Roger, A.G.B. Simpson)
- Edinburgh Napier University, Edinburgh, UK (S. Rueckert)
- Mitochondrial Biology Unit, Cambridge, UK (J.E. Walker)
- Natural History Museum, London, UK (V. Smith)
- Ohio State University, Columbus, Ohio, USA (J. Alfonzo)
- Station Biologique de Roscoff, Roscoff, France (C. de Vargas)
- Staten Serum Institute, Copenhagen, Denmark (C.R. Stensvold)
- The State University of New York at Buffalo, Buffalo, New York, USA (L. Read)
- University of Bordeaux, Bordeaux, France (F. Bringaud)
- University of British Columbia, Vancouver, Canada (P.J. Keeling, L.W. Parfrey)
- University of California, Riverside, California, USA (D.A. Maslov)
- University of Edinburgh, UK (A. Schnaufer)
- University of Glasgow, Glasgow, UK (H. de Koning)
- University of Huddersfield, Huddersfield, UK (M.L. Ginger)
- University of Montreal, Québec, Canada (G. Burger)
- University of Zurich, Zurich, Switzerland (L. Keller)

Research area: Biology of disease vectors

- Academic Medical Center, Amsterdam, The Netherlands (J.W.R. Hovius)
- Barcelona Supercomputing Center, Barcelona, Spain (V. Guallar)
- Catholic University Leuven, Belgium (E. de Clercq)
- Dresden University of Technology & University Clinic Carl Gustav Carus, Dresden, Germany (T. Chavakis)
- Hokkaido University, Sapporo, Hokkaido, Japan (K. Yoshii)
- Institute for Systems Biology, Seattle, USA (M. Brunkow, C. Lausted, N. Jabbari)
- Institute of Bioorganic Chemistry and Fundamental Medicine, Novosibirsk, Russia (S. Tkachev)
- Institute of Virology, Slovak Academy of Sciences, Bratislava, Slovakia (B. Klempa)
- Institute of Zoology, Slovak Academy of Sciences, Bratislava, Slovakia (D. Žítňan, M. Kazimírová)
- Johannes Gutenberg University of Mainz, Mainz, Germany (E. Schmitt, S. Tenzer)
- Mount Allison University, New Brunswick, Canada (V. Lloyd)
- National Institutes of Health, Rockville, Maryland USA (J. Valenzuela, J. Ribeiro)
- National Institute of Public Health and Environment (RIVM), Bilthoven, The Netherlands (H. Sprong, K. Takumi)
- Norwegian Institute of Public Health, Oslo, Norway (A. Aase)
- Oklahoma State University, Stillwater, Oklahoma, USA & Instituto de Investigación en Recursos Cinégeticos, Ciudad Real, Spain (J. de la Fuente)
- Parasitological Institute, Slovak Academy of Sciences, Košice, Slovakia (B. Peťko)

- State University of New York, Stony Brook, USA (B.J. Luft)
- The Pirbright Institute, Surrey, UK (L. Bell-Sakyi)
- University of Arizona, Tucson, Arizona, USA (C. Bender, J. Winzerling)
- University of Glasgow (A. Kohl)
- University of Granada, Granada, Spain (M. Hackenberg)
- University of Neuchâtel, Neuchâtel, USA (P. Guerin)
- University of Rome La Sapienza, Roma, Italy (B. Arca)
- University of Southern Mississippi, Hattiesburg, Mississippi (S. Karim)
- University of Strasbourg, Illkirch, France (N. Boulanger)

Research area: Parasites of fish

- ECOSUR, Chetumal, Mexico (D. González-Solís)
- Federal Rural University of Rio de Janeiro, Brazil (J. Luque)
- Fish and Wildlife Research Institute, St. Petersburg, Florida, USA (M. Bakenhaster)
- Muséum d'Histoire Naturelle, Genève, Switzerland (A. de Chambrier)
- Natural History Museum, London, UK (D.T.J. Littlewood, A. Waeschenbach)
- Parasitological Institute, Slovak Academy of Sciences, Košice, Slovakia (I. Hromadová, M. Oros)
- University of Iceland, Reykjavik, Iceland (K. Skirnisson)
- University of Oran, Algeria (D. Marzoug)
- University of Valencia, Valencia, Spain (F. Montero, A. Pérez del Olmo)

Research area: Parasitic protists of man and animals with special reference to opportunistic parasites

- Canadian Institute for Advanced Research, University of Ottawa, Ottawa, Ontario, Canada (N. Corradi)
- CDC, Division of Parasitic Diseases, Atlanta, Georgia, USA (L. Xiao, V. Cama, E.W. Secor)
- Center for Food Safety, University of Georgia, Griffin, Georgia, USA (Y. Ortega)
- Christchurch Science Centre, Christchurch, New Zealand (E. Moriarty)
- Higher National School of Veterinary, EL Harrach, Algiers, Algeria (A.E. Laatamna, M. Aissi)
- North Dakota State University, Fargo, North Dakota, USA (J. McEvoy)
- Parasitological Institute, Slovak Academy of Sciences, Košice, Slovakia (M. Stanko)
- South China Agricultural University, Guangzhou, China (Y. Feng, L. Xiao)
- Technical University in Zvolen, Zvolen, Slovakia (D. Rajský)
- University of Kent, School of Biosciences, Canterbury, UK (Anastasios D. Tsaousis)
- Wroclaw Medical University, Wrocław, Poland (M. Wesolowska, M. Kicia)
- Wroclaw University, Institute of Genetics and Microbiology, Wrocław, Poland (A. Perec-Matysiak)

Membership in international organisations

Maryna Golovchenko

- Member of the European Study Group for Lyme Borreliosis

Libor Grubhoffer

- Member of General Assembly of the International Union of Biochemistry and Molecular Biology
- President of the Czech Society for Biochemistry and Molecular Biology

Astrid Holzer

- Member of the British Society for Parasitology
- Member of the Fisheries Society of the British Isles

Martin Kolísko
- Member of the International Society for Evolutionary Protistology
- Member of the International Society of Protistologists

Petr Kopáček
- Member of the International Society of Developmental and Comparative Immunology

Michail Kotsyfakis
- Member of the American Society of Biochemistry and Molecular Biology
- Member of the International Proteolysis Society

Julius Lukeš
- Fellow of the American Academy for Microbiology
- Member of the Faculty of 1000
- President of the International Society for Evolutionary Protistology
- Senior Fellow of the Canadian Institute for Advanced Research
- Vice-President of the International Society of Protistologists

František Moravec
- Honorary Member of the American Society of Parasitologists
- Honorary Member of the Slovak Society of Parasitologists

Jana Nebesářová
- Member of the European Microscopy Society
- President of the Czechoslovak Microscopy Society

Miroslav Oborník
- Member of the International Society for Evolutionary Protistology

Ryan O. M. Rego
- Member of American Society for Microbiology
- Member of European Society of Clinical Microbiology and Infectious Diseases

Nataliia Rudenko
- Member of the American Society for Microbiology
- Member of the European Society of Clinical Microbiology and Infection
- Member of the European Study Group for Lyme Borreliosis

Daniel Růžek
- Member of the American Society for Microbiology
- Member of the Czechoslovak Society for Microbiology
- Member of the International Scientific Working Group on Tick-Borne Encephalitis
- Member of the Membership Review Committee and Country Coordinator, World Society for Virology
- National Representative at the International Committee for Taxonomy of Viruses

Tomáš Scholz
- Corresponding member of the Natural History Museum, Geneva, Switzerlandd

Jan Štefka
- Member of the International Society of Phthirapterists

Jiří Vávra
- Member of the International Society of Protistologists

Membership on editorial boards

Acta Parasitologica (Poland): ***F. Moravec***
Acta Protozoologica (Poland): ***J. Vávra***
Acta Virologica (Slovakia): ***D. Růžek***
American Journal of Blood Research (USA): ***M. Kotsyfakis***
Antiviral Chemistry and Chemotherapy (USA): ***D. Růžek***
Antiviral Research (The Netherlands): ***D. Růžek***
BMC Genomics (UK): ***M. Kotsyfakis*** (Associate Editor)
Clinical and Vaccine Immunology (USA): ***D. Růžek***
Developmental & Comparative Immunology (UK): ***P. Kopáček***
Epidemiology and Vaccinal Prevention – Scientific and Practical Journal (Russia): ***D. Růžek***
Folia Parasitologica (Czech Republic): ***I. Fiala*** (Associate Editor), ***F. Moravec***, ***T. Scholz*** (Editor-in-Chief), ***J. Štefka*** (Associate Editor), ***V. Yurchenko***
Frontiers in Cellular and Infection Microbiology: ***L. Grubhoffer***
Helminthologia (Slovakia): ***F. Moravec***
International Journal of Environmental Research and Public Health: ***L. Grubhoffer***
Journal of Agrobiology (Czech Republic): ***M. Kváč***
Journal of Applied Biomedicin (Czech Republic): ***L. Grubhoffer***
Parasite (France): ***F. Moravec***, ***T. Scholz***
Parasite & Vectors (UK): ***A. Kostadinova*** (Editor-in-Chief), ***M. Kotsyfakis*** (Associate Editor)
Scientific Reports (UK): ***D. Růžek***
Systematic Parasitology (UK): ***A. Kostadinova*** (Editor-in-Chief), ***F. Moravec***, ***T. Scholz***
Ticks and Tick-Borne Diseases (Germany): ***D. Růžek*** (Associate Editor)
World Journal of Virology (China): ***D. Růžek***

Teaching activities

The principal mission of the Institute of Parasitology is to perform basic research. However, participation of the staff in teaching is an integral part of their activities and is essential for further development of the Institute. Therefore, most of the key scientists participate in teaching, both by giving lectures and supervising graduate and undergraduate students.

The students actively participate in research projects of the Institute and all graduate students and selected undergraduates have part-time contracts at the Institute. Most students are from the University of South Bohemia in České Budějovice, especially its Faculty of Science, but also from other faculties (Faculty of Agriculture; Faculty of Health and Social Studies) and universities, such as Charles University in Prague, Masaryk University in Brno and the University of Veterinary and Pharmaceutical Sciences in Brno.

To facilitate scientific cooperation and participation of students in the research performed at the Institute, the Laboratory of Molecular Ecology of Vectors and Pathogens (head *L. Grubhoffer*) and the Laboratory of Evolutionary Protistology (head *M. Oborník*) have been established jointly with the University of South Bohemia.

List of PhD theses

(Faculty of Science, University of South Bohemia unless otherwise stated)

- **ČONDLOVÁ Šárka**: Diversity, phylogeny and biology of *Cryptosporidium* spp. infecting rodents of genus *Apodemus*. (Faculty of Agriculture, University of South Bohemia)
  Supervisor: Kváč Martin
- **FLEGONTOVA (BUTYRSKAYA) Olga**: Diversity and biogeography of diplonemid and kinetoplastid protists in global marine plankton
  Supervisor: Horák Aleš
- **HORČIČKOVÁ Michaela:** Diversity and biology of *Cryptosporidium* in Arvicolinae rodents (Faculty of Agriculture, University of South Bohemia)
  Supervisor: Kváč Martin
- **JALOVECKÁ Marie**: Establishment of *Babesia* laboratory model and its experimental application
  Supervisor: Hajdušek Ondřej, *Malandrin Laurence (France)*
- **JIRSOVÁ Dagmar**: Population genetics of the fish tapeworm *Wenyonia virilis* (Caryophyllidea: Caryophyllaeidae) and its fish host *Synodontis schall*
  Supervisor: Jirků Miloslav
- **KOČOVÁ Pavlína**: Monitoring of protein expression in mammalian cells during tick-borne encephalitis infection
  Supervisor: Štěrba Ján
- **ONDRUŠ Jaroslav:** The importance of the sialylated glycoproteins for the tick *Ixodes ricinus*
  Supervisor: Štěrba Ján
- **PATRA Sneha**: Malacosporea and *Sphaerospora* sensu stricto: myxozoan clades with unique biology and evolution
  Supervisor: Holzer Astrid S.
- **PERNER Jan**: Nutritional requirements of ticks
  Supervisor: Kopáček Petr
- **SKALICKÝ Tomáš**: Insight into insect trypanosomatid biology via whole genome sequencing
  Supervisor: Lukeš Julius

List of Master of Science theses

- **CIBULKOVÁ Lucie**: Trematode diversity in freshwater pulmonate snails from the St Lawrence Wetlands, Canada
  Supervisor: Georgieva Simona
- **HÁJKOVÁ Hana**: Patogens in ticks collected from dogs and cats captured in the area of České Budějovice and neighboring regions.
  Supervisor: Rudenko Nataliia
- **HEJDOVÁ Barbora**: The effect of tick saliva on signalling pathways in mast cells
  Supervisor: Lieskovská Jaroslava
- **HEJDUK Libor**: Effect of OASL protein overexpression on the developement of infection by tick-borne encephalitis virus
  Supervisor: Štěrba Ján
- **KALTENBRUNNER Sabine**: Characterisation of TbPH1, a kinetoplastid-specific pleckstrin homology domain containing kinesin-like protein
  Supervisor: Hassan Hashimi
- **KELLNEROVÁ Klára:** Diversity of *Cryptosporidium* in wild canines and bears
  Supervisor: Kváč Martin
- **LISNEROVÁ (JEDLIČKOVÁ) Martina**: Localisation and quantification of *Sphaerospora molnari* (Myxozoa) in common carp
  Supervisor: Fiala Ivan
- **MARŠÁLKOVÁ Eliška**: The effect of tick saliva on phagocytosis of borrelia in dendritic cells
  Supervisor: Lieskovská Jaroslava
- **MAŠKOVÁ Hana**: Antiviral effects of stilbenoids against pathogenes transmitted by ticks *in vivo*
  Supervisor: Štěrba Ján
- **MÜLLEROVÁ Jana**: Detection of zoonotic infection in samples from Arctic
  Supervisor: Grubhoffer Libor
- **POSPÍŠILOVÁ Tereza:** Gene expression and infectivity of *Borrelia afzelii* in the course of tick feeding.
  Supervisor: Šíma Radek
- **SLABÁ Hana**: Characterisation of novel serpin TILIr and its relatives from the superfamily of serine protease inhibitors from *Ixodes ricinus* tick
  Supervisor: Rudenko Nataliia
- **SMOLENOVÁ Štěpánka**: Analysis of infectious potential of "European" species *B. garinii*, isolated from North American rodents using laboratory model of infected mammals
  Supervisor: Rudenko Nataliia
- **ŠOLCOVÁ Lucie**: Analysis of invasive capabilities and infectious potential of newly described species of borrelia from *Borrelia burgdorferi* sensu lato complex, *B. americana* and *B. carolinensis* on laboratory model of infected mammals
  Supervisor: Rudenko Nataliia
- **TOMANOVÁ Vendula**: Presence of specific DNA and coproantigen of *Cryptosporidium* as an indicator of ongoing infection
  Supervisor: Kváč Martin

List of Bachelor of Science theses

- **BĚHÁLKOVÁ Veronika**: Elucidating the subunit composition of tRNA-guanine transglycosylase in *Trypanosoma brucei*
  Supervisor: Paris Zdeněk
- **BENDOVÁ Kamila**: *Ixodes holocyclus* – life cycle, toxicity and ability to transmit borrelia.
  Supervisor: Šíma Radek

- **BRAUNSHIER Stefan**: Investigating the infectious life-cycle of the pathogen ***Borrelia duttonii***
  Supervisor: Rego Ryan
- **BROŽ Marek**: Intestinal parasites of mammals introduced to Svalbard
  Supervisor: Ditrich Oleg
- **DANKLMAIER Anna**: Generation of GFP producing *Borrelia afzelii*, the Lyme Disease pathogen, and its evaluation using a tick-mouse model/
  Supervisor: Rego Ryan
- **DI BLASIO Beatrice (Italy)**: Identification of *Borrelia burgdorferi* sensu lato species in human samples from the southeastern United States
  Supervisor: Golovchenko Maryna
- **DOSTÁLOVÁ Karolína**: Interaction of *Borrelia burgdorferi* s. s. and *Borrelia afzelii* with tick cell lines of *Ixodes ricinus* and *Ixodes scapularis*
  Supervisor: Rego Ryan
- **HONEDER Sophie**: Construction and use of GFP and DsRed expressing vectors and transformation in *Borrelia afzelii*
  Supervisor: Rego Ryan
- **JUHAŇÁKOVÁ Eliška**: Mosquito host microbiome: metodological revision existing studies by using amplicon sequenation on Illumina platforms.
  Supervisor: Nováková Eva
- **KALTHOFF Matthias**: Understanding the Pathogenic Life-Cycle of the Lyme Disease Pathogen *Borrelia bavariensis*
  Supervisor: Rego Ryan
- **KŘEPELKOVÁ Simona**: Diversity of the selected species of horseflies (Diptera: Tabanidae) and its effect on the transmission of trypanosomes (*Trypanosoma* sp.)
  Supervisor: Nováková Eva
- **LEVÁ Jana**: Interleukin 10 gene expression mobilized by rats during *Hymenolepis diminuta* infection
  Supervisor: Jirků-Pomajbíková Kateřina
- **LONGO Rossana (Italy)**: Identification of *Borrelia burgdorferi* sensu lato species transmitted by different North American tick vectors
  Supervisor: Golovchenko Maryna
- **MUSTACOVÁ Johana**: Identification of tick promoters for use in molecular biology applications
  Supervisor: Štěrba Ján
- **PEJŠOVÁ Hana**: Allergenogenic epitopes in ticks
  Supervisor: Štěrba Ján
- **PEKĽANSKÁ Miriam**: Identification of the tick NF-KB immune pathway read-out genes in *Ixodes ricinus*.
  Supervisor: Hajdušek Ondřej
- **RADOS Anda**: OASL protein isoforms in human neural cell lines infected by tick-borne encephalitis
  Supervisor: Štěrba Ján
- **ŘEŽÁBKOVÁ Lucie:** Molecular-fylogenetic characteristic of the isolate *Hymenolepis diminuta* kept under laboratory conditions
  Supervisor: Jirků-Pomajbíková Kateřina
- **RINGHOFER Brian**: Establishing a Tick-Mouse Model for the relapsing fever pathogen *B. duttonii*
  Supervisor: Rego Ryan
- **ŠKOCHOVÁ Veronika:** The micriobiomes of blood-sucking bugs of the subfamily Triatominae.
  Supervisor: Nováková Eva
- **TOMANCOVÁ Veronika**: Diversity of *Cryptosporidium* parasitising in wild ducks
  Supervisor: Kváč Martin
- **VESELÁ Dominika:** The influence of tick saliva on neutrophils upon activation by tickborne encephalitis virus
  Supervisor: Lieskovská Jaroslava

- **VECKOVÁ Tereza:** Risk assessment of *Encephalitozoon cuniculi* infection acquired from fermented meat products.
  Supervisor: Kváč Martin
- **VEJVODOVÁ Kateřina**: Antiviral effects of selected natural substances against tick-borne pathogens in dendritic cells
  Supervisor: Štěrba Ján
- **VOKURKA Radomír**: Potential antiviral effects of derivatives of natural compounds against tick-borne encephalitis virus
  Supervisor: Štěrba Ján
- **VYHLÍDALOVÁ Tereza:** Composition of larval trematode communities in selected pulmonate gastropods (Planorbidae)
  Supervisor: Soldánová Miroslava
- **ZEMANOVÁ Zuzana**: Characterization of urease gene from the hard tick
  Supervisor: Hajdušek Ondřej
- **ŽIŽKOVÁ Kateřina:** Diversity and population structure of the bacterial symbionts from lice of the genus *Polyplax*
  Supervisor: Nováková Eva

Survey of lectures and courses[1]

Name	Course
I. Fiala	Field parasitology
I. Fiala	Protistology
L. Grubhoffer	Biochemistry 1; 2 (CB + Linz)*
L. Grubhoffer	Glycobiochemistry (CB + Linz)
L. Grubhoffer	Development & Comparative Biochemistry (CB + Linz)
L. Grubhoffer	Advanced Seminar in Biological Chemistry (CB + Linz)
L. Grubhoffer	Bachelor Seminar in Biological Chemistry (CB + Linz)
H. Hashimi	Cell Regulation and Signalling
H. Hashimi	Seminar in Molecular Biology
A. Horák	Introduction to Bioinformatics
A. Horák	Introduction to Genomics
A. Horák	Seminar of Master's Courses – Genetics
V. Hypša	Biology of Parasitism
V. Hypša	Molecular Phylogenetics
V. Hypša	Molecular Ecology
V. Hypša	Seminar of Master's Courses – Parasitology
V. Hypša	Biology of Parasitic Arthropods
V. Hypša	Molecular Phylogenetics
M. Kolísko	Introduction to Bioinformatics
R. Kuchta	Biology of Helminths
R. Kuchta	Field Course of Marine Organisms
R. Kuchta	Practical Course of Invertebrate Zoology
R. Kuchta	Introduction to Parasitology[4]
M. Kváč	Zoohygiene and Prevention of Diseases of Farm Animals[6]
M. Kváč	Animal Health[6]
M. Kváč	Veterinary Parasitology[6]
M. Kváč	Breeding and Use of Laboratory Animals[6]
J. Lukeš	Cell Biology
J. Nebesářová	Electron Microscopy for Biologists[1+5]
J. Nebesářová	Electron Microscopy[1+2]
J. Nebesářová	Natural Bioactive Substances
J. Nebesářová	Analytical Methods in Biochemistry
M. Oborník	Introduction to Bioinformatics
M. Oborník	Molecular Taxonomy[6]
M. Oborník	Bioinformatics Project
Z. Paris	Epigenetics and Regulation of Gene Expression
D. Růžek	Medical Virology
D. Růžek	Pathogenesis of Viral Infections[3]
T. Scholz	Biology of Helminths
J. Štefka	Conservation Genetics
J. Štefka	Molecular Phylogenetics
J. Štefka	Molecular Ecology
J. Štefka	Population and Evolutionary Genetics
J. Štěrba	Advanced Biochemistry Laboratory
J. Štěrba	Biochemistry Laboratory [1+](CB + Linz)
J. Štěrba	Xenobiochemistry and Toxicology (CB + Linz)
J. Štěrba	Chemistry Seminar for Second Year
J. Štěrba	Instrumental Methods in Biochemistry and Biophysics
J. Štěrba	Glycobiochemistry
J. Štěrba	Pharmacology and Toxicology

J. Štěrba	Practice in Biochemistry (Praktikum z biochemie)
J. Štěrba	Biochemical Practice for Biology and the Environment
J. Štěrba	Experimental Methods – Practice
A. Zíková	Molecular Biology

[1] Faculty of Science, University of South Bohemia, České Budějovice, unless otherwise stated; [2] Faculty of Health and Social Studies, University of South Bohemia, České Budějovice; [3] Faculty of Science, Masaryk University, Brno; [4] Faculty of Science, University of Ostrava, Ostrava; [5] Faculty of Science, Charles University, Prague; [6] Faculty of Agriculture, University of South Bohemia, České Budějovice; *(CB + Linz) – crossborder curriculum of Biological Chemistry (University of South Bohemia, České Budějovice & Johannes Kepler University in Linz, Austria)

INSTITUTE OF PARASITOLOGY

Biology Centre CAS

České Budějovice, Czech Republic

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