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

2016

Contents

Structure of the Institute

(*As of 1 January 2017*)

Director
(***Julius LUKEŠ***)

Deputy Director
(***Tomáš Scholz***)

Molecular Parasitology

- **Laboratory of Molecular Biology of Protists** (***Julius Lukeš***)
- **Laboratory of Functional Biology of Protists** (*Alena Zíková*)
- **Laboratory of RNA Biology of Protists** (*Zdeněk Paris*)

Fish Parasitology

- **Laboratory of Helminthology** (***Tomáš Scholz***)
- **Laboratory of Fish Protistology** (*Astrid Holzer*)

Opportunistic Diseases

- **Laboratory of Veterinary and Medical Protistology** (***Martin Kváč***)
- **Laboratory of Parasitic Therapy** (*K. Jirků-Pomajbíková*)

Evolutionary Parasitology

- **Laboratory of Evolutionary Protistology*** (***Miroslav Oborník***)
- **Laboratory of Environmental Genomics** (*Aleš Horák*)
- **Laboratory of Molecular Ecology and Evolution** (*Jan Štefka*)
- **Laboratory of Genomic and Diversity of Protists** (*Martin Kolísko*) since 1st November 2011

Supporting Facilities

- **Laboratory of Electron Microscopy** (*Jana Nebesářová*)
- **Animal Facility** (*Tomáš Douda*)
- **Administrative and technical services**

Folia Parasitologica
(*Tomáš Scholz*)

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***)
- **Laboratory of Arbovirology** (*Daniel Růžek*)

Biology of Disease Vectors

- **Laboratory of Vector Immunology** (***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 leader in bold.

Editorial

Since I was elected for the second term as a director of the Institute of Parasitology (till July 2022), it is in place that I write a brief entrée to the annual brochure covering the activities of our institute in year 2016. The institute is steadily growing, as is our productivity and lab space (we have opened a new building with cutting edge lab space and equipment). Even more importantly, we have more young people working in the positions of post-docs and principal investigators, the staff is more international than in the past, we keep applying to more diverse sources of funding, and there is ever growing list of collaborations. The journal *Folia Parasitologica*, published by our institute for decades, is getting a steady number of submissions and became established in the field. Our supporting facilities, namely the electron microscopy unit and the animal house, secured steady and decent funding and are engaged in a number of projects.

As in the past but even more, we are trying to be a vibrant, flexible, dynamic and competitive group of laboratories, for which parasitology is the common denominator. As we are looking forward to new collaborations and students, I encourage the reader to contact us in case of her/his interest.

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; **Pavel Flegontov** MSc, PhD (part time); **Hassan Hashimi**, MSc, PhD; RNDr. **Eva Horáková**, PhD; **Priscilla Peña Diaz**, MSc, PhD (Venezuela); doc. RNDr. **Jan Votýpka**, PhD; **Vyacheslav Yurchenko**, MSc, PhD
PhD students:	**Paula Andrea Castañeda Londoño** (Colombia), MSc; **Sameer Dixit**, MSc (India); RNDr. **Eva Dobáková** (Slovakia; until May); **Zhenqiu Huang**, MSc (China; until April); **Binnypreet Kaur**, MSc (India); **Josef Kaurov**, MSc (Russia); **Anna Nenarokova**, MSc (Russia); RNDr. **Tomáš Skalický**; RNDr. **Daria Tashyreva**
Research assistants:	Mgr. **Jiří Heller**; Bc. **Sabine Kalterbrunner** (Austria)
Technicians:	Mgr. **Eva Kriegová** (*maternity leave* from March); **Gabriela Ridvanová** (until June); **Renata Lukšová** (from June); RNDr. **Eva Stříbrná-Černotíková**
Undergraduate students:	**Anita Baer** (Austria); **Michaela Boudová** (until August); **Hannah Bruce** (Scotland; until July); **Alexander Haindrich** (Austria); **Michaela Uhrová**

Research priorities

Our primary interest is functional analysis of selected mitochondrial proteins of the kinetoplastid *Trypanosoma brucei*. Its mitochondrion is unique in many aspects and by knocking-down, tagging, over expressing or knocking-in individual genes, we are trying to establish their function(s). We have focused primarily on: (i) proteins involved in RNA editing and regulation of stability of mitochondrial transcripts; (ii) subunits of respiratory complexes, (iii) iron/sulfur cluster assembly proteins; (iv) mitochondrial processing peptidases; and (v) proteins involved in heme metabolism. We are also interested in the evolution, diversity, metabolism, genome structure and content and life cycles of free-living and parasitic kinetoplastid flagellates, but primarily of diplonemids. These are highly diverse and abundant marine protists, a sister group of kinetoplastids, which have been mostly overlooked and hence remain understudied. We initiated studies of various aspects of biology of diplonemids, thanks to dedicated funding. We also have promising data as to their transformation into genetically tractable cells, so that they become amenable for functional studies, and attempt cultivation of deep-sea diplonemids, so far completely unknown from the morphological or genomic points of view.

Selected publications

- **Flegontov P.**, Butenko A., Firsov S., Kraeva N., Eliáš M., Field M.C., Filatov D., Flegontova O., Gerasimov E.S., Hlaváčová J., Ishemgulova A., Jackson A.P., Kelly S., Kostygov A.Y., Logacheva M.D., Maslov D.A., Opperdoes F.R., O'Reilly A., Sádlová J., Ševčíková T., Venkatesh D., Vlček Č., Volf P., **Votýpka J.**, Záhonová K., **Yurchenko V.**, **Lukeš J.** 2016: Genome of *Leptomonas pyrrhocoris*: a high-quality reference for monoxenous trypanosomatids and new insights into evolution of *Leishmania*. *Scientific Reports* 6: 23704. [IF=4.259]
- Flegontova O., **Flegontov P.**, Malviya S., Audic S., Wincker W., de Vargas C., Bowler C., **Lukeš J.**, Horák A. 2016: Extreme diversity of diplonemid eukaryotes in the ocean. *Current Biology* 26: 3060–3065. [IF=8.851]
- Gawryluk R.M.R., del Campo J., Okamoto N., Strassert J.F.H., **Lukeš J.**, Richards T.A., Worden A.Z., Santoro A.E., Keeling P.J. 2016: Morphological identification and single-cell genomics of marine diplonemids. *Current Biology* 26: 3053–3059. [IF=8.851]
- **Hashimi H.**, Kaltenbrunner S., Zíková A., **Lukeš J.** 2016: Trypanosome mitochondrial translation and tetracycline: no sweat about Tet. *PLoS Pathogens* 12: e1005492. [IF=6.608]
- Záhonová K., Kostygov A.Y., Ševčíková T., **Yurchenko V.**, Eliáš M. 2016: An unprecedented non-canonical nuclear genetic code with all three termination codons reassigned as sense codons. *Current Biology* 26: 2364–2369. [IF=8.851]

Research projects

- **Integrated Microbial Biodiversity.** Canadian Institute for Advanced Research (CIFAR) (IMB-LUKE-131600; P.I.: J. Lukeš; 2012–2017).
- **Emergence of pathogenicity for vertebrates: insight from ancestral bodonids and insect trypanosomatids.** Czech Science Foundation (14-23986S; P.I.: J. Lukeš; 2014–2016).
- **Diplonemid.** Moore Foundation, USA (GBMF4983; P.I.: J. Lukeš; 2015–2016).
- **Mitochondrial genome-wide studies of RNA-binding proteins in trypanosomes.** Czech Science Foundation (15-21974S; P.I.: J. Lukeš; 2015–2017).
- **Heme: a putative master regulator in trypanosomatids.** Czech Science Foundation (16-18699S; P.I.: J. Lukeš; 2016–2017).

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)
Undergraduate students:	Bc. **Michaela Kunzová**; **Mykyta Ielanskyi**; **Leonie Lehmayer**; **Simona Urbanová**

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 mitochondrial energy metabolism that exhibits many unique features and interesting variations to the mammalian system. It is our main interest to understand them and to explore them as promising novel targets for chemotherapeutic intervention.

Mitochondrial bioenergetics of *T. brucei*

As *T. brucei* alternates between its mammalian host and insect vector, it must readily adapt its metabolism to utilise the various carbon sources it can scavenge from its environment. In the mammalian bloodstream, this extracellular pathogen relies on the abundant source of glucose for energy production; while in the hemolymph of the tse-tse fly, this flagellated protist must utilise amino acids to synthesise chemical energy in the form of ATP. ATP production in the latter pathway requires oxidative phosphorylation to couple the mitochondrial membrane potential to the synthesis of ATP by the FoF1-ATP synthase. This process is sensitive to inhibitors of the ADP/ATP carrier because this transporter supplies the substrate for the FoF1 in the form of cytosolic ADP. Interestingly, in the infectious stage of *T. brucei*, these same inhibitors significantly lose their efficacy. This is puzzling because while its mitochondrion lacks a cytochrome-mediated electron transport chain, the cell must provide cytosolic ATP to be hydrolysed by the FoF1-ATPase to maintain the mitochondrial membrane potential. This becomes even more intriguing since it has long been thought that the ATP is not created by mitochondrial substrate phosphorylation as the TCA cycle enzymes are not active during this life stage. Our lab is exploring if ADP/ATP carrier is essential in bloodstream cells cells and if not, where does the source of mt ATP come from.

Role of reactive oxygen species (ROS) signaling in differentiation of *T. brucei*

While focusing on the bioenergetics of *T. brucei*, we have identified an endogenous inhibitor of the FoF1-ATPase, called TbIF1. This peptide inhibits ATPase activity and is lethal in the infectious stage of the pathogen when its expression is induced. We are further characterising the specific interactions of this natural inhibitor with its complex to ascertain if the unique structure

of *T. brucei* ATPase provides some species specificity that can be exploited for structure based drug design. Furthermore, we have experimental evidence to suggest that the physiological function of TbIF1 might be to initiate a signalling pathway during the progression of the procyclic stage as the protist transforms from trypomastigotes in the midgut of the insect vector into the epimastigotes and metacyclics that reside in the salivary glands. These latter stages are already preparing their metabolism for the glucose-rich environment they will soon encounter at the next feeding. This requires a dramatic switch from the oxidative phosphorylation to the inefficient use of glycolysis. This is similar to what is reported in cancer cells, where high levels of IF1 expression inhibits ATP synthesis and creates a ROS signal that triggers this metabolic shift. Determining how TbIF1 is regulated and what are the signalling mechanisms are important features of our work.

Mode of action of selected trypanocidal drugs

In collaboration with several international and Czech laboratories we are investigating mode of action of some selected drugs that act on parasites in nanomolar amounts. Importantly, these compounds affect mitochondrial function and physiology. Studying the critical mitochondrial processes (membrane potential, ROS generation, oxygen consumption, activity of respiratory complexes, stability of mitochondrial DNA, protein import, redox metabolism, etc.) we are able to identify putative drug targets followed by their functional validation using RNA interference.

Selected publications

- Alkhaldi A.A., Martinek J., **Panicucci B.**, Dardonville C., **Zíková A.**, de Koning H.P. 2016: Trypanocidal action of bisphosphonium salts through a mitochondrial target in bloodstream form *Trypanosoma brucei*. *International Journal for Parasitology: Drugs and Drug Resistance* 6: 23–34. [IF=4.809]
- Hashimi H., Kaltenbrunner S., **Zíková A.**, Lukeš J. 2016: Trypanosome mitochondrial translation: no sweat about Tet. *PLoS Pathogens* 12: e1005492. [IF=6.608]
- Terán D., Hocková D., Česnek M., **Zíková A.**, Naesens L., Keough D.T., Guddat L.W. 2016: Crystal structures and inhibition of *Trypanosoma brucei* hypoxanthine-guaninephosphoribosyltransferase. *Scientific Reports* 6: 35894. [IF=4.259]
- **Zíková A.**, Hampl V., Paris Z., Týč J., Lukeš J. 2016: Aerobic mitochondria of parasitic protists: diverse genomes and complex functions. *Molecular and Biochemical Parasitology* 209: 46–57. [IF=2.536]

Research Projects:

- **Exploitation of the unique characteristics of the *Trypanosoma brucei* FoF1-ATP synthase complex for future drug development against African sleeping sickness.** Ministry of Education, Youth and Sport of the Czech Republic (ERC CZ LL1205; P.I.: A. Zíková; 2013–2017).

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. **Veronika Běhálková**; 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.

Role of the only tRNA intron in trypanosomatids

In yeast *Saccharomyces cerevisiae* and other model organisms, 20% of all tRNAs contain introns. Their removal is an essential step in the maturation of tRNA precursors. In *T. brucei*, there is only one intron containing tRNA: $tRNA^{Tyr}_{GUA}$. Since this tRNA is responsible for decoding all tyrosine codons, intron removal is essential for viability. Using molecular and biochemical approaches, several non-canonical editing events were identified within the intron-containing $tRNA^{Tyr}_{GUA}$. The RNA editing involves guanosine-to-adenosine transitions (G to A) and an adenosine-to-uridine transversion (A to U), which are both necessary for proper processing of the intron. We have been obtaining tRNA intron sequences from our collection of newly identified trypanosomatid species. We hope this will help us understand the process of RNA editing and ultimately identify biological function of the presence of the only intron containing tRNA in these organisms.

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

- Fleming I.M., **Paris Z.**, Gaston K.W., Balakrishnan R., Fredrick K., Rubio M.A., Alfonzo J.D. 2016: A tRNA methyltransferase paralog is important for ribosome stability and cell division in *Trypanosoma brucei*. *Scientific Reports* 6: 21438. [IF=5.578]
- Lopes R.R.S., Silveira G.O., Eitler R., Vidal R., Kessler A., Hinger S., **Paris Z.**, Alfonzo J.D., Polycarpo C. 2016: The essential function of the *Trypanosoma brucei* Trl1 homolog in procyclic cells is maturation of the intron-containing tRNATyr. *RNA* 22: 1190–1199. [IF=4.605]
- Zíková A., Hampl V., **Paris Z.**, Týč J., Lukeš J. 2016: Aerobic mitochondria of parasitic protists: diverse genomes and complex functions. *Molecular and Biochemical Parasitology* 209: 46–57. [IF=2.536]

Research projects

- **Queuosine: The role of an essential tRNA modification in parasitic protist *Trypanosoma brucei*.** Czech Science Foundation (15-21450Y; P.I.: Z. Paris; 2015–2017).

2. EVOLUTIONARY PARASITOLOGY

2.1. Laboratory of Evolutionary Protistology

Research scientists:	Prof. Ing. **Miroslav OBORNÍK**, PhD (*head*) **Heather Esson**, MSc, PhD (Canada); Mgr. **Zoltán Füssy**, PhD; RNDr. **Aleš Tomčala**, PhD; **Abduallah Sharaf**, MSc, PhD (Egypt)
PhD students:	Mgr. **Jaromír Cihlář**; Mgr. **Jan Michálek**; Ing. **Ivana Schneedorferová**
Research assistant:	Mgr. **Kateřina Jiroutová**, PhD
Undergraduate student:	Bc. **Jan Vazač**

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.

Genomics of 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. Chromerid genomes show drastic reduction during transition of a phototrophic ancestor to an apicomplexan parasite. At this stage, over 3 600 genes were lost, while only 80 were retained. This may suggest that phototrophic ancestor already contained most of genes used for parasitism in its apicomplexan descendants.

Reduced respiratory chain in the mitochondrion of *C. velia*

Through investigation of genomic and transcriptomic sequences and those obtained from enriched mitochondrial fraction, we reconstructed respiratory chain of *C. velia*. This respiratory chain is non-canonically reduced, with such reduction not found in the mitochondrion of related *V. brassicaformis*. The respiratory chain is interrupted in *C. velia* forming two functionally independent subchains. The complex III is missing from *C. velia* and its electron transport function is substituted by L- and D- lactate cytochrome c oxidoreductases. Complex I is missing form all chromerids as well as from apicomplexan parasites.

Investigation of tetrapyrrole biosyntheses

Tetrapyrrole synthesis is one of the most fundamental pathways in living organisms. We investigated origins of enzymes involved in the heme biosynthesis in chromerids, dinoflagellates with the green plastid, dinoflagellates with the diatom plastid (dinotoms), chlorarachniophytes, cryptophytes, and predicted their localisations in the cell.

Selected publications

- **Cihlář J.**, **Füssy Z.**, Horák A., **Oborník M.** 2016: Evolution of the tetrapyrrole biosynthetic pathway in secondary algae: conservation, redundancy and replacement. *PLoS ONE* 11: e0166338. [IF=2.806]
- **Oborník M.**, **Kručinská J.**, **Esson H.J.** 2016: Life cycles of chromerids resemble those of colpodellids and apicomplexan parasites. *Perspectives in Phycology* 3: 21–27. (new journal)
- Věchtová P., Dalíková M., Sýkorová M., Žurovcová M., **Füssy Z.**, Zrzavá M. 2016: CpSAT-1, a transcribed satellite sequence from the codling moth, Cydia pomonella. *Genetica* 144: 385–395. [IF=1.207]
- Záhonová K., **Füssy Z.**, **Oborník M.**, Eliáš M., Yurchenko V. 2016: RuBisCO in non-photosynthetic alga *Euglena longa*: divergent features, transcriptomic analysis and regulation of complex formation. *PLoS ONE* 11: e0158790. [IF=2.806]

Research Projects

- **Photosynthesis Research Centre.** Czech Science Foundation (P501/12/G055; Co-P.I.: M. Oborník; 2012–2018).
- **Search for the origin of exosymbiont.** Czech Science Foundation (15-17643S; P.I.: M. Oborník; 2015–2017).
- ***Chromera velia* as a model organism to study evolution of apicomplexans and chrompodellids.** Czech Science Foundation (16-24027S; P.I. M. Oborník; 2016–2018).

2.2. Laboratory of Environmental Genomics

Research scientists:	Mgr. **Aleš HORÁK**, PhD (*head*)
	Mgr. **Jana Veselá**, PhD
PhD student:	**Olga Flegontova**, MSc (Russia)
Bc student	**Michaela Uhrová**

Research priorities

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

Early stages of evolution of parasitism in Apicomplexa

Apicomplexans are probably the most diverse and successful group of parasitic protists, with millions of dollars spent on the research of the key players (*Plasmodium*, *Toxoplasma*, coccidia, etc.). Yet, we know very little about the early phases of their evolution. Therefore, we are characterising the diversity and the genomes of representatives of several enigmatic apicomplexan clades (archigregarines, blastogregarines and agammococcidians) to reveal the evolution of non-photosynthetic plastid (apicoplast) and composition and evolution of the surface proteins associated with the infection of host. Collaboration: Sonja Rueckert, Edinburgh Napier University (UK).

Diversity and ecology of marine diplonemids

Tara Oceans is an international project of unprecedented scale, which aimed to investigate prokaryotic and eukaryotic planktonic diversity of the world oceans. During 2009–2012, almost 28 thousand samples were obtained from 154 locations of the World Ocean. Preliminary analyses of V9 region of the ssu rRNA gene have revealed that some samples, namely from deeper waters are dominated by diplonemid-like excavates. These enigmatic protists were found to be third most diverse and sixth most abundant planktonic organisms of the sunlit oceans. Detailed analysis focused on diplonemids, this time including also samples from mesopelagic zone Diplonemids separate into four major clades, with the vast majority falling into the planktonic DSPD I (deep sea pelagic diplonemid) clade (Lara et al. 2009). 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. Collaboration: Tara Oceans Consortium, namely Colomban de Vargas, Station Biologique de Roscoff (France).

Selected publications

- Cihlář J., Füssy Z., **Horák A.**, Oborník M. 2016: Evolution of the tetrapyrrole biosynthetic pathway in secondary algae: conservation, redundancy and replacement. *PLoS ONE* 11: e0166338. [IF=2.806]
- Flegontov P., Butenko A., Firsov S., Kraeva N., Eliáš M., Field M., Filatov D., **Flegontova O.**, Gerasimov E., Hlaváčová J., Ishemgulova A., Jackson A., Kelly S., Kostygov A., Logacheva M., Maslov D., Opperdoes F., O'Reilly A., Sádlová J., Ševčíková T., Venkatesh D., Vlček Č., Volf P., Votýpka J., Záhonová K., Yurchenko V., Lukeš J. 2016: Genome of *Leptomonas pyrrhocoris*: a high-quality reference for monoxenous trypanosomatids and new insights into evolution of *Leishmania. Scientific Reports* 6: 23704. [IF=4.259]
- Flegontov P., Changmai P., Zidkova A., Logacheva M., Logacheva M., **Flegontova O.**, Nikolsky Y., Starostin G., Stepanova V., Travinsky I., Tříska M., Tříska P., Tatarinova T. 2016: Genomic study of the Ket: a paleo-Eskimo-related ethnic group with significant ancient North Eurasian ancestry. *Scientific Reports* 6: 20768. [IF=4.259]
- **Flegontova O.**, Flegontov P., Malviya S., Audic S., Wincker P., de Vargas C., Bowler C., Lukeš J., **Horák A.** 2016: Extreme diversity of diplonemid eukaryotes in the ocean. *Current Biology* 26: 3060–3065. [IF=8.851]

2.3. Laboratory of Molecular Ecology and Evolution

Research scientists:	Doc. RNDr. **Jan ŠTEFKA**, PhD (*head*) Prof. RNDr. **Václav Hypša**, CSc.; MVDr. **Jana Kvičerová**, PhD; RNDr. **Eva Nováková**, PhD
PhD students:	RNDr. **Filip Husník**; Mgr. **Marie Krausová**; Mgr. **Anna Mácová**; RNDr. **Jana Martinů**; Mgr. **Jakub Vlček**
Technician:	**Lenka Štifterová**
Undergraduate students:	Bc. **Pavlína Kočová**; Bc. **Lukáš Vejsada**

Research priorities

Our research is mainly focused on molecular phylogenetic analysis of the origin, evolution and relationships of parasitic and symbiotic organisms. It further involves investigation into their co-evolution, biogeography and other bionomical features, including intraspecific variability and genealogy. 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 the MHC class IIB locus, we found evidence for lowered genetic diversity in threatened populations of mockingbirds. Microsatellite study of one of the louse parasites showed decreased heterozygosity and potential inbreeding in louse populations on individual hosts. Such genetic pattern indicates that host individuals of a single species play role in creating population structure of 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. Population structure was analysed using mitochondrial genes and selected nuclear markers. Despite observing lineages with relatively strict degree of host specificity, only limited amount of co-speciation was seen in both parasitic groups. Hence, the adaptive component of evolution seems to be the major driver defining genetic differentiation. Obtained patterns will be validated and explored in further detail using sequences of genes putatively under selection in the hosts (MHC II) and using multilocus and genomic data obtained from both counterparts.

Evolution of symbiotic bacteria associated with arthropods

We are broadly interested in intracellular 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

- **Husník F.**, McCutcheon J.P. 2016: Repeated replacement of an intrabacterial symbiont in the tripartite nested mealybug symbiosis. *Proceedings of the National Academy of Sciences* 113: E5416–E5424. [IF=9.661]
- Juhásová L., Králová-Hromadová I., Bazsalovicsová E., Minárik G., **Štefka J.**, Mikulíček P., Pálková L., Pybus M. 2016: Population structure and dispersal routes of invasive parasite, *Fascioloides magna*, in North America and Europe. *Parasites & Vectors* 9: 547. [IF=3.080]
- Kyselková M, Chrudimský T., **Husník F.**, Chroňáková A., Heuer H., Smalla K., Elhottová D. 2016: Characterization of tet(Y)-carrying LowGC plasmids exogenously captured from cow manure at a conventional dairy farm. *FEMS Microbiology Ecology* 92: fiw075. [IF=3.720]
- **Nováková E.**, **Hypša V.**, Nguyen P., **Husník F.**, Darby A.C. 2016: Genome sequence of Candidatus *Arsenophonus lipopteni*, the exclusive symbiont of a blood sucking fly *Lipoptena cervi* (Diptera: Hippoboscidae). *Standards in Genomic Sciences* 11: 72. [IF=1.189]
- **Vlček J.**, Hoeck P.E.A., Keller L.F., Wayhart J., Dolinová I., **Štefka J.** 2016: Balancing selection and genetic drift create unusual patterns of MHCIIβ variation in Galápagos mockingbirds. *Molecular Ecology* 25: 4757–4772. [IF=6.086]

Research project

- **Evolutionary and ecological factors in genome evolution of bacterial symbionts in insects.** Czech Science Foundation (13-01878S; P.I.: V. Hypša; 2013–2016).
- **Evolutionary factors of speciation and genomic diversification in host-parasite system.** Czech Science Foundation (14-07004S; P.I.: V. Hypša; 2014–2016).
- **Phylogenomics and molecular diversity of Mesozoa.** Czech Science Foundation (15-08717S; P.I.: V. Hypša; 2015–2017).
- **Population-genomic analyses on Galapagos mockingbirds.** Swiss Association of Friends of the Galápagos Islands (P.I.: J. Štefka; 2016–2017).

3. TICKS AND TICK-BORNE DISEASES

3.1. Laboratory of Molecular Ecology of Vectors and Pathogens

Research scientists:	Prof. RNDr. **Libor GRUBHOFFER**, CSc. (*head*) **Nataliia Rudenko**, MSc, PhD (Ukraine) (*deputy head*); Mgr. **Jiří Černý**, PhD; **Dimitrij Loginov**, PhD. (Russia); **Ryan O.M. Rego**, MSc, PhD (India); Mgr. **Ján Štěrba**, PhD (Slovakia)
PhD students:	Mgr. **Tereza Chrudimská**; Mgr. **Pavlína Kočová**; Mgr. **Martin Selinger**; RNDr. **Jarmila Štěrbová-Dupejová**; Mgr. **Martin Strnad**; Mgr. **Hana Tykalová-Šťastná**; RNDr. **Pavlína Věchtová**
Research assistants:	**Maryna Golovchenko**, MSc (Ukraine); Bc. **Jana Monhartová**; Mgr. **Zuzana Vavrušková**
Undergraduate students:	Bc. **Jan Černý**; Bc. **Karolína Dostálová**; Bc. **Libor Hejduk**; Bc. **Hanka Mašková**; Bc. **Jana Müllerová**; **Stefan Braunshier** (Austria); **Anna Danklmeier** (Austria); **Armig Kabrelian** (Austria); **Johana Mustacová**; **Aylin Paktan** (Austria); **Hana Pejšová**; **Anda Rados** (Austria); **Jacob Samek** (Austria); **Štěpánka Smolenová**; **Sandra Suleiman** (Austria); **Kateřina Vejvodová**
Laboratory worker:	**Zuzana Němcová**

Research priorities

Diversity and evolution of Lyme borreliosis (LB) spirochetes

Genetically diverse strains of *Borrelia* are often found within the same tick or same vertebrate host, presenting a wide opportunity for genetic exchange. Our results support the hypothesis that recombination maintains a majority of sequence polymorphism within populations of *Borrelia* spp. due to re-assortment of pre-existing sequence variants.

Structural/ultrastructural and functional differences in LB spirochetes: spirochetal forms, cystic forms, ‘blebs’, biofilms, antibiotics and other stress factors (complement, starvation); morphology/functional transformation of spirochetes; dormant forms and persistent LB; experimental approach (model systems); epidemiological study of persistent LB; ecology of LB spirochetes (comparative genetic analyses of borrelia isolates of US and European origin)

Ticks (*Ixodes ricinus*; *Ornithodoros moubata*) – Pathogen interface interactions

Functional analysis of LB genes and their product in interaction with molecular factors of tick inner environment (salivary glands); GFP LB spirochetes; correlative IF and EM; (*Borrelia duttoni vs Ornithodoros moubata*); Tick Glycomics: delineation of atypical glycans (alfa1-3Gal; alfa1-6Fuc), carbohydrate-binding proteinss, glycosyltransferases; (transcriptomics data); Analysis of Tick Transciptome: gene expression in different organs and developmental stages.

Population bottlenecks in the infection cycle of LB spirochetes

We addressed the population dynamics of *B. burgdorferi* throughout its natural infectious cycle. Our results clearly demonstrate that the spirochete population experiences stochastic bottlenecks during both acquisition and transmission by the tick vector, as well as during persistent infection of murine host.

Anti-tick vaccines to prevent transmission of pathogens

Using proteomic and transcriptomic approaches, we identified novel candidates for anti-tick vaccines among tick salivary gland proteins in animal models. Our results will lead to implementation of anti-tick vaccines in public health systems.

Selected publications

- **Černý J.**, **Selinger M.**, Palus M., **Vavrušková Z.**, **Tykalová H.**, Bell-Sakyi L., **Štěrba J.**, **Grubhoffer L.**, Růžek D. 2016: Expression of a second open reading frame present in the genome of tick-borne encephalitis virus strain Neudoerfl is not detectable in infected cells. *Virus Genes* 52: 309–319. [IF=1.431]
- Donald C.L., Brennan B., Cumberworth S.L., Rezelj V.V., Clark J.J., Cordeiro M.T., Freitas de Oliveira França R., Pena L.J., Wilkie G.S., Da Silva Filipe A., Davis C., Hughes J., Varjak M., **Selinger M.**, Zuvanov L., Owsianka A.M., Patel A.H., McLauchlan J., Lindenbach B.D., Fall G., Sall A.A., Biek R., Rehwinkel J., Schnettler E., Kohl A. 2016: Full genome sequence and sfRNA interferon antagonist activity of Zika virus from Recife, Brazil. *PLoS Neglected Tropical Diseases* 10: e0005048. [IF=3.834]
- **Golovchenko M.**, Vancová M., Clark K., Oliver J.H. Jr., **Grubhoffer L.**, **Rudenko N.** 2016: A divergent spirochete strain isolated from a resident of the southeastern United States was identified by multilocus sequence typing as *Borrelia bissettii. Parasites & Vectors* 9: 68. [IF=3.080]
- **Rudenko N.**, **Golovchenko M.**, Clark K., Oliver J.H. Jr., **Grubhoffer L.** 2016: Detection of *Borrelia burgdorferi* sensu stricto in *Amblyomma americanum* ticks in the southeastern United States: the case of selective compatibility. *Emerging Microbes and Infection* 5: e48. [IF=5.605]
- **Rudenko N.**, **Golovchenko M.**, Vancová M., Clark K., **Grubhoffer L.**, Oliver J.H. Jr. 2016: Isolation of live *Borrelia burgdorferi* sensu lato spirochetes from patients with undefined disorders and symptoms not typical for Lyme diseases. *Clinical Microbiology and Infection* 22: 267.e9–267.e15. [IF=5.292]

Research projects

- **ANTIGONE – ANTIcipating the GlobalOnset of Novel Epidemics.** FP7 EU-HEALTH project (278976; Co-P.I.: L. Grubhoffer; 2011–2016).
- **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).
- **Novel functions of viral and cellular proteins in tick-borne encephalitis virus infection.** Czech Science Foundation (585410/3220; P.I.: L. Grubhoffer; 2015–2017).

3.2. Laboratory of Arbovirology

Research scientists:	Doc. RNDr. **Daniel RŮŽEK**, PhD (*head*) RNDr. **Luděk Eyer**, PhD; Mgr. **Václav Hönig**, PhD; RNDr. **Helena Langhansová-Horká**, PhD; **James Jason Valdés**, PhD
PhD students:	Mgr. **Jana Elsterová**; Mgr. **Martin Palus**
Research assistant:	Bc. **Veronika Slavíková** (*maternity leave*)
Technicians:	**Jan Erhart**; **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. Here, 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 8 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

- Cabezas-Cruz A., Alberdi P., Ayllón N., **Valdés J.J.**, Pierce R., Villar M., de la Fuente J. 2016: *Anaplasma phagocytophilum* increases the levels of histone modifying enzymes to inhibit cell apoptosis and facilitate pathogen infection in the tick vector *Ixodes scapularis*. *Epigenetics* 11: 303–319. [IF=4.394]
- **Eyer L.**, Nencka R., Huvarová I., **Palus M.**, Joao Alves M., Gould E.A., De Clercq E., **Růžek D.** 2016: Nucleoside inhibitors of Zika virus. *Journal of Infectious Diseases* 214: 707–711. [IF=6.273]
- **Eyer L.**, Šmídková M., Nencka R., Neča J., Kastl T., **Palus M.**, De Clercq E., **Růžek D.** 2016: Structure-activity relationships of nucleoside analogues for inhibition of tick-borne encephalitis virus. *Antiviral Research* 133: 119–129. [IF=4.271]
- **Valdés J.J.**, Cabezas-Cruz A., Šíma R., Butterrill P.T., **Růžek D.**, Nuttall P. 2016: Substrate prediction of *Ixodes ricinus* salivary lipocalins differentially expressed during *Borrelia afzelii* infection. *Scientific Reports* 6: 32372. [IF=4.259]
- **Valdés J.J.**, Gil V.A., Butterill P.T., **Růžek D.** 2016: An all-atom, active site exploration of antiviral drugs that target Flaviviridae polymerases. *Journal of General Virology* 97: 2552–2562. [IF=2.838]

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. **Daniel Sojka**, PhD; RNDr. **Radek Šíma**, PhD*; RNDr. **Veronika Urbanová-Burešová**, PhD*
PhD students:	Mgr. **David Hartmann**; RNDr. **Marie Jalovecká***; Mgr. **Jan Perner**
Undergraduate students:	**Tereza Hatalová**; **Barbora Plačková**

* Also members of the research team of Ondřej Hajdušek.

Research priorities

Molecules involved in the tick innate immunity playing a role at the tick-pathogen interface. Molecular physiology of blood digestion and haem and iron acquisition in ticks as a potential target for efficient anti-tick intervention.

The role of tick complement system in *Borrelia* transmission

The hard tick *Ixodes ricinus* possesses components of primordial complement system such as thioester-containing proteins (TEPs), fibrinogen-related lectins (ixoderins) and putative convertases (Factor C and Factor B/C2). We focused mainly on RNAi-based functional characterisation of TEPs and putative convertases in the phagocytosis of the model microbes including the Lyme diseases spirochete *Borrelia afzelii*. We found that RNAi-mediating silencing of two molecules related to the C3 complement component (IrC3-3 and IrC3-3) significantly suppressed phagocytosis of *B. afzelii* by tick hemocytes. However, elimination of phagocytosis by injection of latex beads-infected *I. ricinus* nymphs had no effect on spirochete transmission to the naïve mice.

Multi-enzyme digestive system of ticks

We have finished and published characterisation of the role of multi-enzyme digestive network of *I. ricinus* in processing of serum albumin, the second most abundant protein in tick diet. We have used artificial membrane feeding of females of *I. ricinus* on a hemoglobin-free diet to characterise the proteolytic machinery involved in albuminolysis. Morphological comparisons of ticks fed on whole blood (BF) and serum (SF) at microscopic and ultrastructural levels showed that albumin and hemoglobin have different trafficking routes in tick digest cells. Multiple genes encoding legumains were characterised in the American hard tick *Ixodes scapularis*. Out of nine genes present in tick genome, four are specifically expressed in the tick gut and most likely play a role in blood digestion. The isoform IsAE1, the closest analogue of our previously characterised legumain from *I. ricinus* (IrAE) is dominant and its expression is up-regulated by blood feeding in all developmental stages. By contrast, the second major isoform IsAE2 is mainly expressed in unfed ticks.

The role of hemoglobin and haem in the tick diet

We have succeeded to publish a 'flag-ship' paper of the project entitled "Acquisition of exogenous haem is essential for tick reproduction" by Perner et al. in a highly prestigious open acces journal eLife. This is quite comprehensive paper (20 printed pages) comprising of 6 multipanel figures accompanied by 14 supplementary figures and three supplementary files. Moreover, we demonstrated that that ticks are also capable to acquire haem non-physiologicaly from soluble hemin or myoglobin added to the serum diet. We have also provided an evidence that iron needed for tick metabolic enzymes originate from host transferrin. This physiological paper was followed by an extensive transcriptomic study by Perner et al., entitled "RNA-seq analyses of the midgut from blood- and serum-fed *Ixodes ricinus* ticks" published in Scientific Reports . To address specific adaptations to the haemoglobin-rich diet, sixteen individual RNA libraries were prepared from four groups of four *I. ricinus* female siblings fed on the whole blood or serum for 3 days and 8 days (fully engorged). Our results demonstrate that tick gut transcriptomes are subject to substantial temporal-dependent expression changes between day 3 and day 8 of feeding. In contrast, the number of transcripts significantly affected by the presence or absence of host red blood cells was surprisingly low.

Selected publications

- **Kopáček P.**, **Perner J.** 2016: Vector biology: tyrosine degradation protects blood feeders from death via La Grande Bouffe. *Current Biology* 26: R763–R765. [IF=8.851]
- **Perner J.**, Provazník J., Schrenková J., **Urbanová V.**, Ribeiro J.M.C., **Kopáček P.** 2016: RNA-seq analyses of the midgut from blood- and serum-fed *Ixodes ricinus* ticks. *Scientific Reports* 6: 36695. [IF=4.259]
- **Perner J.**, Sobotka R., **Šíma R.**, **Konvičková J.**, **Sojka D.**, de Oliveira P.L., Hajdušek O., **Kopáček P.** 2016: Acquisition of exogenous haem is essential for tick reproduction. *eLife* 5: e12318. [IF=7.725]
- **Sojka D.**, **Hartmann D.**, Bartošová-Sojková P., Dvořák J. 2016: Parasite cathepsin D-like peptidases and their relevance as therapeutic targets. *Trends in Parasitology* 32: 708–823. [IF=6.333]
- **Sojka D.**, Pytelková J., **Perner J.**, Horn M., **Konvičková J.**, Schrenková J., Mareš M., **Kopáček P.** 2016: Multienzyme degradation of host serum albumin in ticks. *Ticks and Tick-Borne Diseases* 7: 604–613. [IF=3.230]

Research projects

- **The role of hemoglobin in tick metabolism and transmission of tick-borne pathogens.** Czech Science Foundation (13-110435S; P.I.: P. Kopáček; 2013–2017).
- **Multiple tick legumains in blood processing, innate immunity and pathogen transmission.** Czech Science Foundation (14-33693S; P.I.: D. Sojka; 2014–2016).
- **ANTIDotE (Anti-tick Vaccines to Prevent Tick-borne Diseases in Europe).** FP7 EU-HEALTH project (602272; Coordinator: J.W. Hovius; 2014–2018).
- **Interraction of tick complement with *Borrrelia* and *Babesia*.** Czech Science Foundation (15-12006Y; P.I.: V. Urbanová; 2015–2017).

4.2. Laboratory of Genomics and Proteomics of Disease Vectors

Research scientists:	**Michail KOTSYFAKIS**, MSc, PhD (Greece) (*head*)
PhD student:	Mgr. **Jan Kotál**
Administration associates:	Ing. **Martina Dědouchová** (until June 2016); Mgr. **Isabela Okřinová** (July – December)
Undergraduate students:	**Simone Röhrnbacher**; **Marnol Vacarescu-Linder** (both from Austria)

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).

Selected publications

- Chmelař J., **Kotál J.**, Karim S., Kopáček P., Francischetti I.M., Pedra J.H., **Kotsyfakis M.** 2016: Sialomes and mialomes: a systems-biology view of tick tissues and tick-host interactions. *Trends in Parasitology* 32: 242–254. [IF=6.333]
- Chmelař J., **Kotál J.**, Kopecký J., Pedra J.H., **Kotsyfakis M.** 2016: All for one and one for all on the tick-host battlefield. *Trends in Parasitology* 32: 368–377. [IF=6.333]
- Ferreira V.P., Vale V.F., Pangburn M.K., Abdeladhim M., Mendes-Sousa A.F., Coutinho-Abreu I.V., Rasouli M., Brandt E.A., Meneses C., Lima K.F. III, Araújo R.N., Pereira M.H., **Kotsyfakis M.**, Oliveira F., Kamhawi S., Ribeiro J.M.C., Gontijo N.F., Collin N., Valenzuela J.G. 2016: SALO, a novel classical pathway complement inhibitor from saliva of the sand fly *Lutzomyia longipalpis*. *Scientific Reports* 6: 19300. [IF=4.259]
- Wang X., Shaw D.K., Hammond H.L., Sutterwala F.S., Rayamajihi M., Shirey K.A., Perkins D.J., Bonventre J.V., Velayutham T.S., Evans S.M., Rodino K.G., VieBrock L., Scanlon K.M., Carbonetti N.H., Carlyon J.A., Miao E.A., McBride J.W., **Kotsyfakis M.**, Pedra J.H. 2016: The prostaglandin E2-EP3 receptor axis regulates *Anaplasma phagocytophilum*-mediated NLRC4 inflammasome activation. *PLoS Pathogens* 12: e1005803. [IF=6.608]
- Wang X., Shaw D.K., Sakhon O.S., Snyder G.A., Sundberg E.J., Santambrogio L., Sutterwala F.S., Dumler J.S., Shirey K.A., Perkins D.J., Richard K., Chagas A.C., Calvo E., Kopecký J., **Kotsyfakis M.**, Pedra J.H. 2016: The tick protein sialostatin L2 binds to annexin A2 and inhibits NLRC4-mediated inflammasome activation. *Infection and Immunity* 1796–1805. [IF=3.593]

Research projects

- **Rickettsial immunity during tick transmission.** National Institutes of Health, USA, R01 grant (1R01AI093653-01A1; P.I.: J. Pedra; 2011–2016).
- **The effect of tick salivary serine protease inhibitors on host immune response.** Grant Agency of the University of South Bohemia in České Budějovice (038/2016/P; J. Kotál).

4.3. Laboratory of Tick Transmitted Diseases

Research scientists:	RNDr. **Ondřej HAJDUŠEK**, PhD (*head*) RNDr. **Radek Šíma**, PhD*;
PhD students:	RNDr. **Marie Jalovecká***; Mgr. **Sazzad Mahmood**
Undergraduate students:	Bc. **Tereza Pospíšilová**; Bc. **Jiří Ťápal**; **Kamila Bendová**; **Miriama Pekĺanská**
Technicians:	Ing. **Gabriela Loosová**; **Zuzana Zemanová**

* 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. These candidates will be then 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. Our aim is to implement such model 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 are currently working on the setting of the *Babesia microti* transmission model in our laboratory and use of this model for testing the tick immune genes in infection with *Babesia* spp. by RNA interference and vaccination.

Selected publications

- Aase A., **Hajdušek O.**, Øines Ø., Quarsten H., Wilhelmsson P., Herstad T.K., Kjelland V., **Šíma R.**, **Jalovecká M.**, Lindgren P.-E., Aaberg I.S. 2016: Validate or falsify: lessons learned from a microscopy method claimed to be useful for detecting *Borrelia* and *Babesia* organisms in human blood. *Infectious Diseases* 48: 411–419. [IF=1.119]
- **Hajdušek O.**, **Šíma R.**, Perner J., Loosová G., Harcubová A., Kopáček P. 2016: Tick iron and heme metabolism – new target for an anti-tick intervention. *Ticks and Tick-Borne Diseases* 7: 565–572. [IF=3.230]
- **Jalovecká M.**, Bonsergent C., **Hajdušek O.**, Kopáček P., Malandrin L. 2016: Stimulation and quantification of *Babesia* divergens gametocytogenesis. *Parasites & Vectors* 9: 439. [IF=3.080]
- Perner J., Sobotka R., **Šíma R.**, Konvičková J., Sojka D., de Oliveira P.L., **Hajdušek O.**, Kopáček P. 2016: Acquisition of exogenous haem is essential for tick reproduction. *eLife* 5: e12318. [IF=7.725]
- Valdés J.J., Cabezas-Cruz A., **Šíma R.**, Butterrill P.T., Růžek D., Nuttall P. 2016: Substrate prediction of *Ixodes ricinus* salivary lipocalins differentially expressed during *Borrelia afzelii* infection. *Scientific Reports* 6: 32372. [IF=4.259]

Research projects

- **ANTIDotE – Anti-tick vaccines to prevent tick-borne diseases in Europe.** FP7 HEALTH project (602272; P.I.: J. Hovius; 2014–2018).
- **Přenosový model Lymeské borreliózy.** Technology Agency of the Czech Republic (TG02010034; P.I.: R. Šíma; 2016–2017).

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; RNDr. **Anna Faltýnková**, PhD; **Simona Georgieva**, MSc, PhD (Bulgaria); **Aneta Kostadinova**, MSc, PhD (Bulgaria); RNDr. **Roman Kuchta**, PhD; Mgr. **Miroslava Soldánová**, PhD
	Temporary contracts from projects: **Ana Born-Torrijos**, MSc, PhD (Spain); **David González-Solís**, MSc, PhD (Mexico); **Olena Kudlai** (Ukraine); RNDr. **Mikuláš Oros**, PhD (Slovakia); **Jesus Hernández-Orts**, MSc, PhD (Mexico); **Aneta Yoneva**, MSc, PhD (Bulgaria)
PhD students:	Mgr. **Kateřina Leštinová**; Mgr. **Jana Roháčová**
Research assistants:	Ing. **Radmila Řepová** (part time); Ing. **Blanka Škoríková**
Technician:	**Martina Borovková**
Laboratory worker:	**Alena Widnerová**
Undergraduate students:	Bc. **Lucie Cibulková**; Bc. **Hynek Mazanec**; **Lucie Uhrová**; **Tereza Vyhlídalová**

Research priorities

Systematics, phylogeny, life-cycles & ecology of parasitic flatworms, taxonomy of nematodes, diversity of fish helminths, and fish-borne parasitic diseases (broad fish tapeworm).

Diversity of helminths parasitising teleost fish

Morphological and taxonomic evaluation of parasitic flatworms (Cestoda, Digenea and Monogenea) and nematodes (Nematoda), parasites of freshwater and marine fish and other vertebrates, enabled us to revise several helminth groups and provide new data on their diversity, host associations and interrelations. Studies have been focused on hot spots of teleost diversity in freshwaters (Amazonia) and seas off Africa, America and Asia. Several projects are carried out also in Europe.

Systematics and evolution of basal tapeworms (Cestoda)

Based on collaborative effort supported by a NSF-PBI funded project, global diversity of tapeworms has been assessed using morphological and molecular evaluation of newly collected and museum materials. Data on the diversity, morphology, host-associations and phylogenetic relationships of ten cestode orders have been compiled by the lab staff for a monograph that would provide a most comprehensive survey of the current knowledge of this group of helminth parasites.

Integrative taxonomy approaches to trematode diversity and life-cycles

A series of studies focused on species delimitation using integrated molecular, morphological and ecological evidence provided reliable estimates of the diversity and/or information on the life histories of the trematodes in natural host populations.

Selected publications

- **Brabec J.**, **Kuchta R.**, **Scholz T.**, Littlewood D.T.J. 2016: Paralogues of nuclear ribosomal genes conceal phylogenetic signal within the invasive Asian fish tapeworm lineage: evidence from next generation sequencing data. *International Journal for Parasitology* 46: 555–562 [IF=3.730]
- **Faltýnková A.**, Sures B., **Kostadinova A.** 2016: Biodiversity of trematodes in their intermediate mollusc and fish hosts in the freshwater ecosystems of Europe. *Systematic Parasitology* 93: 283–293. [IF=1.181]
- **Leštinová K.**, **Soldánová M.**, **Scholz T.**, **Kuchta R.** 2016: Eggs as a suitable tool for species diagnosis of causative agents of human diphyllobothriosis (Cestoda). *PLoS Neglected Tropical Diseases* 10: e0004721. [IF=3.834]
- **Scholz T.**, Besprozvannykh V.V., Boutorina T.E., Choudhury A., Cribb T.H., Ermolenko A.V., **Faltýnková A.**, Shedko M.B., Shimazu T., Smit N.J. 2016: Trematode diversity in freshwater fishes of the Globe I: 'Old World'. *Systematic Parasitology* 93: 257–269. [IF=1.181]
- Tkach V.V., **Kudlai O.**, **Kostadinova A.** 2016: Molecular phylogeny and systematics of the Echinostomatoidea Looss, 1899 (Platyhelminthes: Digenea). *International Journal for Parasitology* 46: 171–185. [IF=3.730]

Research projects

- **A Survey of the Tapeworms (Cestoda: Platyhelminthes) from the Vertebrate Bowels of the Earth.** National Science Foundation, USA (Planetary Biodiversity Inventory; Co-P.I.: T. Scholz; P.I.: J.N. Caira, University of Connecticut, Storrs; 2008–2017).
- **From fish to man and from water to the earth: evolutionary history of tapeworms parasitizing tetrapods (Cestoda: Diphyllobothriidea).** Czech Science Foundation (P506/12/1632; P.I.: R. Kuchta; 2012–2016).
- **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).
- **Species boundaries and microevolutionary patterns in parasites with high dispersal abilities: a model study of two flatworm systems.** Czech Science Foundation (15-14198S; P.I.: T. Scholz; 2015–2017).

5.2. Laboratory of Fish Protistology

Research scientists:	**Astrid HOLZER**, PhD (Austria) (*head*) **Gema Alama-Bermejo**, MSc, PhD (Spain); RNDr. **Ivan Fiala**, PhD; **Ashlie Hartigan**, MSc, PhD (Australia); RNDr. **Miloslav Jirků**, PhD; RNDr. **Alena Kodádková**, PhD; **Anush Kosakyan**, MSc, PhD (Armenia/Italy); RNDr. **Martin Kostka**, PhD; Mgr. **Inga Martinek**, PhD (Germany); RNDr. **Pavla Sojková-Bartošová**, PhD (Slovakia)
PhD students:	RNDr. **Jiří Kyslík**; **Sneha Patra** MSc (India)
Research assistant:	RNDr. **Hana Pecková**
Technician:	**Marie Fučíková** (part time)
Laboratory worker:	**Ivana Reitingerová**
Undergraduate students:	Bc. **Anna Feix**; Bc. **Martina Jedličková**; Bc. **Tereza Tomková**; **Dariya Baiko**; **Jolana Danhelová**, **Viktor Sieranski**; **Anna Tomanová**

Research priorities

We focus on eukaryotic microorganisms infecting fish and amphibians, including all aspects of their structure, biology, life cycles, host-parasite relationships, and especially their phylogeny and evolution. More recently, we have initiated a new line of functional research focusing on parasite motility mechanisms and the characterisation of virulence factors and proteolytic enzymes at the host-parasite interface, based on genomic and proteomic studies. Our main group of interest is the Myxozoa but we carry out research into a range of protists, some of which create economic and health consequences for the aquaculture industry, in collaboration with various academic and commercial partners worldwide.

Myxozoa

Biodiversity research included SSU rDNA sequencing and phylogenetic positioning of myxozoan type species and scarcely characterised genera, which contributed to a better understanding of biodiversity, molecular phylogeny and evolution of several poorly characterised lineages. This research included the exciting discovery of previously unknown host groups such as the Gymnophiona. Ongoing eDNA studies show that the diversity of myxozoans is approximately. 20 times higher than previously estimated and that Central European freshwater habitats as well as tropical marine areas are myxozoan diversity hotspots. We furthermore demonstrated that myxozoans, despite their indirect life cycle are extremely successful *de novo* settlers of new aquatic habitats, with invasion from genetically diverse sources (likely straying fish and bird faeces). A functional study on proliferative myxozaon blood stages elucidated a cell motility mechanism, which is new to eukaryotes and which is used to evade cellular recognition and immunity in the host fish.

Other aquatic parasites

Research on amoebae forms a fundamental part of the commercially funded research in the lab and, it focused in 2016 on the development of amoeboicidal in-feed diets for Atlantic salmon suffering from amoebic gill disease (research funded by Skretting Aquaculture Research Centre). Furthermore, taxonomic, phylogenetic and ecological studies were performed on apicomplexans, microsporidians, amoebae, trematodes and acanthocephalans. Thereby, it has been shown on fishery discards in the Mediterranean to enhance trophic parasite transmission to scavenging birds; attracted special attention also in public media.

Selected publications

- Born-Torrijos A., Poulin R., Pérez-Del-Olmo A., Culurgioni J., Raga J.A., **Holzer A.S.** 2016: An optimised multi-host trematode life cycle: fishery discards enhance trophic parasite transmission to scavenging birds. *International Journal for Parasitology* 46: 745–753. [IF=3.730]
- **Hartigan A.**, Estensoro I., Vancová M., Bílý T., **Patra S.**, Eszterbauer E., **Holzer A.S.** 2016: New cell motility model observed in parasitic cnidarian *Sphaerospora molnari* (Myxozoa: Myxosporea) blood stages in fish. *Scientific Reports* 6: 39093. [IF=4.259]
- **Hartigan A.**, Wilkinson M., Gower D.J., Streicher J.W., **Holzer A.S.**, Okamura B. 2016: Myxozoan infections of caecilians demonstrate broad host specificity and indicate a link with human activity. *International Journal for Parasitology* 46: 375–381. [IF=3.730]
- Sojka D., Hartmann D., **Bartošová-Sojková P.**, Dvořák J. 2016: Parasite cathepsin D-like peptidases and their relevance as therapeutic targets. *Trends in Parasitology* 32: 708–823. [IF=6.333]
- Wünnemann H., **Holzer A.S.**, **Pecková H.**, **Bartošová-Sojková P.**, Eskens U., Lierz M. 2016: Repatriation of an old fish host as an opportunity for myxozoan parasite diversity: the example of the allis shad, *Alosa alosa* (Clupeidae), in the Rhine. *Parasites & Vectors* 9: 505. [IF=3.080]

Research projects

- **ECIP – European Centre Ichtyoparazitology.** Centre of Excellence, Czech Science Foundation (505/12/G112; Coordinator: M. Gelnar, Masaryk University, Brno; I. Co-P.I.: A.S. Holzer; II. Co-P.I.: I. Fiala; 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. Sitjá-Bobadilla; 2015–2020).
- **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).
- **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).
- **Marine Myxozoa and their link to meiofauna: communities, biodiversity and life cycle**s. Swedish Research Council (2016-00541; P.I.: I. Martinek; 2016–2019).

6. OPPORTUNISTIC DISEASES

6.1. Laboratory of Veterinary and Medical Protistology

Research scientists:	Doc. Ing. **Martin KVÁČ**, PhD (*head*) Prof. MVDr. **David Modrý**, PhD (part time) RNDr. **Bohumil Sak**, PhD
PhD students:	Ing. **Šárka Čondlová**; Ing. **Nikola Havrdová**; Ing. **Michaela Horčičková**; Mgr. **Michaela Kotková**, DiS; MVDr. **Jitka Prediger-Poláková**; Ing. **Veronika Prantlová-Rašková**; Ing. **Pavla Wagnerová**
Research assistants:	Ing. **Lenka Hlásková**; Ing. **Nikola Holubová-Hromadová**; RNDr. **Dana Květoňová**; RNDr. **Anna Mynářová**
Undergraduate students:	Bc. **Jana Ježková**; Bc. **Klára Kellnerová**; Bc. **Zuzana Reifová**; Bc. **Vendula Tomanová**; **Veronika Tomancová**; **Tereza Vecková**; **Gabriela Vlnatá**

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.

Microsporidia, *Cryptosporidium* and *Giardia* in orangutans

We conducted a monitoring of microsporidia, *Cryptosporidium* and *Giardia* infections in both *Pongo pygmaeus* and *P. abelii* at different stages of the habituation process in Gunung Leuser National Park (*P. abelii*) and from Sabangau National Park, Tuanan, Orangutan Care and Quarantine Centre, and Tanjung Puting *(P. pygmaeus*). We detected *E. cuniculi* genotype III, *E. bieneusi* genotypes D and novel Pongo 2, *G. intestinalis* B subtype MB6, *C. muris* and *C. parvum* Type A and B.

Encephalitozoon cuniculi as foodborne pathogen and risk for transplant recipient

We described that milk of cows could contain spores of *E. cuniculi*. Under experimental conditions, spores of this microsporidium remained infective following pasteurisation treatment. Thus pasteurised cow milk should be considered a potential source of *E. cuniculi* infection. In other study, the transplant recipients have been identified as a risk group for microsporidial infection. We characterise for the first time the prevalence of microsporidia in urinary tracts of renal transplant recipients and indicate that microsporidial infection should be considered in the assessment of these patients.

Novel species of *Cryptosporidium* from reptiles, birds and mammals

We described the morphological, biological and molecular characteristics of *Cryptosporidium* tortoise genotype I, avium genotype V and *Cryptosporidium muris* genotype TS03 and proposed the species name *C. testudinis*, *C. avium* and *C. proliferans* to reflect their specificity to various hosts. In our study, we also provide previously unreported data on *C. ducismarci* to confirm its validity.

Selected publications

- **Holubová N.**, **Sak B.**, **Horčičková M.**, **Hlásková L.**, **Květoňová D.**, Menchaca S., McEvoy J., **Kváč M.** 2016: *Cryptosporidium avium* n. sp. (Apicomplexa: Cryptosporidiidae) in birds. *Parasitology Research* 115: 2243–2251 [IF=2.329]
- **Ježková J.**, **Horčičková M.**, **Hlásková L.**, **Sak B.**, **Květoňová D.**, Novák J., Hofmannová L., McEvoy J., **Kváč M.** 2016: *Cryptosporidium testudinis* sp. n., *Cryptosporidium ducismarci* Traversa, 2010 and *Cryptosporidium* tortoise genotype III (Apicomplexa: Cryptosporidiidae) in tortoises. *Folia Parasitologica* 63: 035. [IF=1.082]
- Kicia M., Wesolowska M., Kopacz Z., Jakuszko K., **Sak B.**, **Květonová D.**, Krajewska M., **Kváč M.** 2016: Prevalence and molecular characteristics of urinary and intestinal microsporidia infections in renal transplant recipients. *Clinical Microbiology and Infection* 22: 62.e5-462.e. [IF=5.292]
- **Mynářová A.**, Foitová I., **Kváč M.**, **Květoňová D.**, Rost M., Morrogh-Bernard H., Nurcahyo W., Nguyen C., Supriyadi S., **Sak B.** 2016: Prevalence of *Cryptosporidium* spp., *Enterocytozoon bieneusi*, *Encephalitozoon* spp. and *Giardia intestinalis* in wild, semi-wild and captive orangutans (*Pongo abelii* and *Pongo pygmaeus*) on Sumatra and Borneo, Indonesia. *PLoS ONE* 11: e0152771. [IF=2.806]
- Pelin A., Moteshareie H., **Sak B.**, Selman M., Naor A., Eyahpaise M.È., Farinelli L., Golshani A., **Kváč M.**, Corradi N. 2016: The genome of an *Encephalitozoon cuniculi* type III strain reveals insights into the genetic diversity and mode of reproduction of a ubiquitous vertebrate pathogen. *Heredity* 116: 458–465. [IF=3.961]

Research projects

- **The application of molecular methods to identify and characterize microsporidia in immunocompetent and immunosuppressed patients with kidney disease and evaluating the impact of selected drugs on the process of microsporidia invasion in *in vitro* research.** National Science Centre, Poland (P.I. Kicia; Contractor: M. Kváč; 2013–2017).
- **Latent microsporidiosis of immunocompetent individuals: ticking time-bomb threatening human health.** Czech Science Foundation (14-20684S; P.I.: B. Sak; 2014–2016).
- **Revealing *Cryptosporidium* diversity: linking genetic variation to parasite biology.** Czech Science Foundation (15-01090S; P.I.: M. Kváč; 2015–2017).

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**; **Jana Vášová**
Undergraduate students:	**Oldřiška Hložková**; **Jana Levá**; **Zuzana Lhotská**; **Lucie Řežábková**; **Jiřina Růžková**

Research priorities

Main lines of this laboratory are focused on investigation of an impact of the commensal gut eukaryotes (protists and helminths) on some immune-mediated diseases (IMD). The incidence and prevalence of IMD has increased in Western countries over the past decades. IMDs continue to emerge in new countries as they develop and adopt to Western life-styles and is becoming a global disease. Abundant evidence now suggests that the dysbiosis of gut microbiome (including viruses, bacteria, archaea, fungi and eukaryotes) is one of the main risk factors for developing some IMD (e.g. Inflammatory Bowel Diseases). The increase in IMD incidence is also associated with loss of helminth infection. Very recently, the research has shown that helminths, gut bacterial communities and even commensal protist inhabiting gut may positively influence the health status of individuals suffering from some IMD.

When the Laboratory of Parasitic Therapy opened at the Institute of Parasitology (in October 2013), it was obvious that the fulfilling of the early promise of helminth therapy likely requires widening the scope of investigation to its influence on the gut bacterial microflora and additional organisms (more suitable helminth candidates and protists) and novel therapeutic strategies. Within a very short existence of the laboratory, we have identified two symbionts, one helminth and one protist, as promising candidates for the treatment or prevention of IMD, using animal models and immunological and serological methods. Helminth model shows ability to modulate the immune system of even healthy host organism and it also influences the community composition of gut bacterial populations. Now, we test this candidate for its effect on the induced colitis that reflects Crohn's disease. In case of protist candidate, we established the animal model for the research on its impact on IMD.

Characterisation of the diversity and functional changes of the bacterial microbiota in the intestine using next-generation sequencing is conducted in the collaborative laboratory headed by Laura Wegener Parfrey at the University of British Columbia, Vancouver, Canada.

Selected publications

- **Jirků-Pomajbíková K.**, Čepička I., Kalousová B., Jirků M., Stewart F., Levecke B., Modrý D, Piel AK, Petrželková K.J. 2016: Molecular identification of *Entamoeba* species in savana woodland chimpanzees (*Pan troglodytes* Schweinfurthii). *Parasitology* 143: 741-8. [IF=3.031]

Research projects

- **Interplay of eukaryotic symbionts with gut microbiome and influence on immune-mediated disorders.** Young investigator category, agency: Human Frontiers Science Program Organization (RGY0078/2015; P.I.: K. Jirků-Pomajbíková; 2015–2018)

- **Monitoring of the interleukin 10 gene expression in an immune response in the rat model during *Hymenolepis diminuta* infection.** Student Grant Agency of Faculty of Science, University of South Bohemia (P.I.: J. Levá; 2016).
- **Molecular-phylogenetic characteristics of *Hymenolepis diminuta* isolate maintained under laboratory conditions.** Student Grant Agency of Faculty of Science, University of South Bohemia (P.I.: L. Řežábková; 2016).
- **Effect of helminth protein extract on the host immune system and gut microbiome in individuals suffer from induced colitis** (this sub-project is a part of the project for support of commercialization of results). Technology Agency of the Czech Republic (co-investigator: K. Jirků-Pomajbíková; 2016–2018).

SUPPORTING FACILITY

Laboratory of Electron Microscopy

Research scientists:	Ing. **Jana NEBESÁŘOVÁ**, CSc. (*head*) RNDr. **Marie Vancová**, PhD
PhD students:	Mgr. **Tomáš Bílý**; Mgr. **Martin Strnad**
Technicians:	Mgr. **Jan Langhans**; **Petra Masařová**; Mgr. **Martina Tesařová**; **Jiří Vaněček**
Undergraduate students:	Bc. **Ayya Tashlieva**; **Dominik Bauman** (Austria); **Johannes Grahammer** (Austria); **Christian Grechhamer** (Austria)

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 logistics approach.

Technical equipment

- **Transmission electron microscopes**
  - JEOL 2100F (2012) equipped for electron tomography, STEM and image recording with CCD camera Orius SC1000 (Gatan)
  - JEOL 1010 (1996) equipped with SSC camera MegaView 3
  - Low voltage electron microscope LV EM 5 (2002), Delong Instruments, Inc.
- **Scanning electron microscopes**
  - JEOL 7401F (2005) with cryo-attachment ALTO 2500 GATAN
  - JEOL 6300 (1993)
- **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 results

- Hartigan A., Estensoro I., **Vancová M.**, **Bílý T.**, Patra S., Eszterbauer E., Holzer A.S. 2016: New cell motility model observed in parasitic cnidarian *Sphaerospora molnari* (Myxozoa: Myxosporea) blood stages in fish. *Scientific Reports* 6: 39093. [IF=4.259]
- Mravec F., Obruca S., Krzyzanek V., Sedláček P., Hrubanová K., Samek O., Kučera D., Benešová P., **Nebesářová J.** 2016: Accumulation of PHA granules in *Cupriavidus necator* as seen by confocal fluorescence microscopy. *FEMS Microbiology Letters* 363: fnw094. [IF=1.765]
- **Nebesářová J.**, Wandrol P., **Vancová M.** 2016: Novel method of simultaneous multiple immunogold localization on resin sections in high resolution scanning electron microscopy. *Nanomedicine: Nanotechnology, Biology, and Medicine* 12: 105–108. [IF=5.720]
- Vávra J., **Bílý T.**, **Nebesářová J**., Federici B.A. 2016: Occurrence, pathology, and ultrastructure of *Iridovirus* and cytoplasmic polyhedrosis viruses in daphnids from the Czech Republic. *Journal of Invertebrate Pathology* 140: 35–38. [IF=2.379]

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 – FEI Czech Republic, 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 Large Research Infrastructure (LM2015062; Main coordinator: Institute of Molecular Genetics of CAS; 2016–2022).

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) (from January)
Tomáš Scholz (helminths)

Editorial Assistant: **Petra Rozkošná**

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 about 60%. *Folia* has a wide international authorship. The Impact Factor of *Folia* was 1.082 in 2016; five-year Impact Factor is 1.130.

EMBO Practical Course on Advanced Methods of Electron Microscopy in Cell Biology, České Budějovice, 14–24 June 2016

This prestigious international course funded by the European Molecular Biology Organization (EMBO) was organised in České Budějovice for the fifth time. The aim of the course is teaching of cutting-edge electron microscopy techniques that can be used to study cellular processes at the ultrastructural level. Team of 20 expert teachers from around the word was explaining all difficulties in EM techniques to 24 foreign students selected on the basis of their projects. The majority of the course was dedicated to the practical training to teach students the best methods of preserving, visualising and localising molecules of interest on cellular structures.

Based on feedback from participants, the course was very successful. It brought many new contacts, international collaboration and friendships and a number of keen young microscopists.

BSP Trypanosomiasis & Leishmaniasis Seminar, České Budějovice, 4–7 September 2016

The mission of the The British Society for Parasitology (BSP) is to draw attention to the unique importance of parasitology as a distinct discipline within biology. This prestigious meeting of the BSP was organised by the Institute of Parasitology in České Budějovice for the second time and facilitated central networking and meeting for many professional and student parasitologists throughout the UK and across the world. More than 100 international attendees participated in presentation focused on the recent advances in molecular and biochemical research of trypanosomatid parasites. See the program. We plan to organise the same meeting in 2022.

Publication activities

Papers in journals with impact factor

Authors explicitly affiliated to the Institute of Parasitology are enboldened

1. AASE A., **HAJDUŠEK O.**, ØINES Ø., QUARSTEN H., WILHELMSSON P., HERSTAD T.K., KJELLAND V., **ŠÍMA R.**, **JALOVECKÁ M.**, LINDGREN P.-E., AABERG I.S. 2016: Validate or falsify: lessons learned from a microscopy method claimed to be useful for detecting *Borrelia* and *Babesia* organisms in human blood. *Infectious Diseases* 48: 411–419. [IF=1.119]
2. AKHOUNDI M., KUHLS K., CANNET A., **VOTÝPKA J.**, MARTY P., DELAUNAY P., SERENO D. 2016: A historical overview of the classification, evolution, and dispersion of *Leishmania* parasites and sandflies (review). *PLoS Neglected Tropical Diseases* 10: e0004349. [IF=3.834]
3. **ALAMA-BERMEJO G.**, **JIRKŮ M.**, **KODÁDKOVÁ A.**, **PECKOVÁ H.**, **FIALA I.**, **HOLZER A.S.** 2016: Species complexes and phylogenetic lineages of *Hoferellus* (Myxozoa, Cnidaria) including revision of the genus: a problematic case for taxonomy. *Parasites & Vectors* 9: 13. [IF=3.080]
4. ALKHALDI A.A.M., **MARTÍNEK J.**, **PANICUCCI B.**, DARDONVILLE C., **ZÍKOVÁ A.**, DE KONING H.P. 2016: Trypanocidal action of bisphosphonium salts through a mitochondrial target in bloodstream form *Trypanosoma brucei*. *International Journal for Parasitology: Drugs and Drug Resistance* 6: 23–34. [IF=4.809]
5. ASSUMPÇÃO T.C., MA D., MIZURINI D.M., KINI R.M., RIBEIRO J.M., **KOTSYFAKIS M.**, MONTEIRO R.Q., FRANCISCHETTI I.M. 2016: *In vitro* mode of action and anti-thrombotic activity of boophilin, a multifunctional Kunitz protease inhibitor from the midgut of a tick vector of babesiosis, *Rhipicephalus microplus*. *PLoS Neglected Tropical Diseases* 10: e0004298. [IF=3.834]
6. D'AVILA-LEVY C., **YURCHENKO V.**, **VOTÝPKA J.**, GRELLIER P. 2016: Protist collections: essential for future research. *Trends in Parasitology* 32: 840–842. [IF=6.333]
7. **BASU S.**, **HORÁKOVÁ E.**, **LUKEŠ J.** 2016: Iron-associated biology of *Trypanosoma brucei. Biochimica et Biophysica Acta - General Subjects* 1860: 363–370. [IF=4.702]
8. BENZ C., **KOVÁŘOVÁ J.**, **KRÁLOVÁ-HROMADOVÁ I.**, PIERIK A.J., **LUKEŠ J.** 2016: Roles of the Nfu Fe-S targeting factors in the trypanosome mitochondrion. *International Journal for Parasitology* 46: 641–651. [IF=3.730]
9. BORN-TORRIJOS A., POULIN R., PÉREZ-DEL-OLMO A., CULURGIONI J., RAGA J.A., **HOLZER A.S.** 2016: An optimised multi-host trematode life cycle: fishery discards enhance trophic parasite transmission to scavenging birds. *International Journal for Parasitology* 46: 745–753. [IF=3.730]
10. BORN-TORRIJOS A., RAGA J.A., **HOLZER A.S.** 2016: Trematode maturation patterns in a migratory snail host: what happens during upshore residency in a Mediterranean lagoon? *Parasitology Research* 115: 547–285. [IF=2.329]
11. **BRABEC J.**, **KUCHTA R.**, **SCHOLZ T.**, LITTLEWOOD D.T.J. 2016: Paralogues of nuclear ribosomal genes conceal phylogenetic signal within the invasive Asian fish tapeworm lineage: evidence from next generation sequencing data. *International Journal for Parasitology* 46: 555–562 [IF=3.730]
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156. **VÁVRA J.**, **BÍLÝ T.**, **NEBESÁŘOVÁ J.**, FEDERICI B.A. 2016: Occurrence, pathology, and ultrastructure of *Iridovirus* and cytoplasmic polyhedrosis viruses in daphnids from the Czech Republic. *Journal of Invertebrate Pathology* 140: 35–38. [IF=2.379]

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Papers in peer-reviewed journals (not yet with impact factor)

1. AKOPYANTS N.S., LYE L.F., DOBSON D.E., **LUKEŠ J.**, BEVERLEY S.M. 2016: A narnavirus in the trypanosomatid protist plant pathogen *Phytomonas serpens*. *Genome Announcements* 4: e00711-16.

2. AKOPYANTS N.S., LYE L.F., DOBSON D.E., **LUKEŠ J.**, BEVERLEY S.M. 2016: A novel bunyavirus-like virus of protozoan parasites. *Genome Announcements*.

3. **FAKTOROVÁ D.**, **DOBÁKOVÁ E.**, **PEÑA-DIAZ P.**, **LUKEŠ J.** 2016: From simple to supercomplex: mitochondrial genomes of euglenozoan protists. *f1000research* 5: 392.

4. HINNEY B., **SAK B.**, JOACHIM A., **KVÁČ M.** 2016: More than a rabbit's tale – *Encephalitozoon* spp. in wild mammals and birds. *International Journal for Parasitology: Parasites and Wildlife* 5: 76–87.

5. **OBORNÍK M.**, **KRUČINSKÁ J.**, **ESSON H.** 2016: Life cycles of chromerids resemble those of colpodellids and apicomplexan parasites. *Perspectives in Phycology* 3: 21–27.

6. **SCHOLZ T.**, **KUCHTA R.** 2016: Fish-borne, zoonotic cestodes (*Diphyllobothrium* and relatives) in cold climates: a never-ending story of neglected and (re)-emergent parasites. *Food and Waterborne Parasitology* 4: 23–38.

7. SHAW D.K., **KOTSYFAKIS M.**, PEDRA J.H.F. 2016: For whom the bell tolls (and nods): spit-acular saliva. *Current Tropical Medicine Reports* 3: 40–50.

8. WESOŁOWSKA M., SZOSTAKOWSKA B., KICIA M., **SAK B.**, **KVÁČ M.**, KNYSZ B. 2016: *Cryptosporidium meleagridis* infection: the first report in Poland in an HIV-positive woman. *Annals of Parasitology* 62: 239–241.

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)
- 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)
- Georgia Southern University, Statesboro, Georgia, USA (J.H. Oliver, Jr.)
- Hokkaido University, Sapporo, Hokkaido, Japan (K. Yoshii)
- 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)
- National Institutes of Health, Rockville, Maryland USA (J. Valenzuela, J. Ribeiro)
- 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)
- University of Arizona, Tucson, Arizona, USA (C. Bender, J. Winzerling)

- University of Liverpool, Institute of Infection and Global Health, (L. Bell-Sakyi)
- University of Glasgow (A. Kohl)
- University of Granada, Granada, Spain (M. Hackenberg)
- University of Neuchâtel, Neuchâtel, USA (P. Guerin)
- University of North Florida, Jacksonville, USA (K. Clark)
- University of Rome La Sapienza, Roma, Italy (B. Arca)
- University of Southern Mississippi, Hattiesburg, Mississippi (S. Karim)
- University of Strasbourg, Illkirch, France (N. Boulanger)
- University of Tampa, Tampa, Florida, USA (N. Belfiore)
- The Pirbright Institute, Surrey, UK (L. Bell-Sakyi)

Research area: Parasites of fish

- ECOSUR, Chetumal, Mexico (D. González-Solís)
- Fish and Wildlife Research Institute, St. Petersburg, Florida, USA (M. Bakenhaster)
- Hungarian Academy of Sciences, Budapest, Hungary (E. Eszterbauer)
- Mote Marine Laboratory, Sarasota, Florida, USA (K. Main, C. Yanes-Roca)
- Muséum d'Histoire Naturelle, Genève, Switzerland (A. de Chambrier)
- Muséum National d'Histoire Naturelle, Paris, France (J.-L. Justine)
- Natural History Museum, London, UK (D.T.J. Littlewood, A. Waeschenbach)
- Oregon State University, Corvallis, Oregon, USA (J. Bartholomew, S. Atkinson)
- Ross University School of Veterinary Medicine, St. Kitts, West Indies (M. Freeman)
- Parasitological Institute, Slovak Academy of Sciences, Košice, Slovakia (M. Oros, I. Hromadová)
- Skretting Aquaculture Research Centre, Stavanger, Norway (C. McGurk)
- University of Cape Town, Cape Town, South Africa (C.C. Reed)
- University of Geneva, Switzerland (D. Soldati-Favre)
- University of Haifa, Israel (T. Lothan)
- University of Iceland, Reykjavik, Iceland (K. Skirnisson)
- University of Tasmania, School of Aquaculture, Launceston, Tasmania, Australia (B. Nowak)
- University of Valencia, Valencia, Spain (F. Montero, A. Pérez del Olmo)
- University of Oran, Algeria (D. Marzoug)
- Federal Rural University of Rio de Janeiro, Brazil (J. Luque)
- Wageningen University and Research, Wageningen, Netherlands (G. Wiegertjes)

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 of Slovak Academy of Sciences, Košice, Slovakia (M. Stanko)
- Wroclaw Medical University, Wrocław, Poland (M. Wesolowska, M. Kicia)
- Wroclaw University, Institute of Genetics and Microbiology, Wrocław, Poland (A. Perec-Matysiak)
- University of Kent, School of Biosciences, Canterbury, UK (Anastasios D. Tsaousis)

Membership in international organisations

Maryna Golovchenko

- Member of European Study Group for Lyme Borreliosis

- ***Astrid Holzer***
- Member of the British Society for Parasitology
- Member of the Fisheries Society of the British Isles

Petr Kopáček

- International Society of Developmental and Comparative Immunology

Michail Kotsyfakis

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

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 European Study Group for Lyme Borreliosis

Daniel Růžek

- Member of the International Scientific Working Group on Tick-Borne Encephalitis
- National Representative at the International Committee for Taxonomy of Viruses
- Member of the American Society for Microbiology
- Member of the Czechoslovak Society for Microbiology

Tomáš Scholz

- Corresponding member of the Natural History Museum, Geneva, Switzerland

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*** (Associate Editorial Board)

Antiviral Chemistry and Chemotherapy (USA): ***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), ***J. Vávra***, ***V. Yurchenko***

Helminthologia (Slovakia): ***F. Moravec***

Journal of Agrobiology (Czech Republic): ***M. Kváč***

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***

Scientific World Journal (UK, USA, Egypt): ***D. Růžek***

Ticks and Tick-Borne Diseases (Germany): ***D. Růžek (Section 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)

- **Černý Jiří**: Molecular evolution of flaviviral genes.
  Supervisor: D. Růžek, *Consultant: L. Grubhoffer*
- **Koubová Jana**: Proportion of important fatty acids in milk fat and selected milk products.
  Supervisor: M. Kváč
- **Palus Martin**: Tick-borne encephalitis – from pathogenesis to therapy.
  Supervisor: D. Růžek

List of Master of Science theses

- **Havrdová Nikola**: Laparotomy infections hosts intestinal and gastric *Cryptosporidium*.
  Supervisor: M. Kváč
- **Keplová Nelly**: Isolation and characterisation of novel antimicrobial peptide (defensin) expressed in *Ixodes ricinus* tick
  Supervisor: N. Rudenko
- **Kyslík Jirka**: Phylogeny of Myxozoa based on cnidarian-specific genes.
  Supervisor: I. Fiala
- **Maršíková Anna**: Haemogregarines in *Pelusios* turtles: phylogenetic relationships, morphology, and host specificity.
  Supervisor: J. Kvičerová
- **Mynářová Anna**: The prevalence and diversity of *Cryptosporidium*, *Giardia* and microsporidia in orangutans (*Pongo* spp.) and the effect of selected plant extracts on the course of experimental infection with *Encephalitozoon cuniculi* in BALB/c mice.
  Supervisor: B. Sak
- **Šochová Eva**: Evolution and genomics of symbionts in Hippoboscidae.
  Supervisor: F. Husník

- **Ťápal Jiří**: Optimization of *Babesia microti* transmission model.
  Supervisors: O. Hajdušek, *M. Jalovecká*
- **Tichá Lucie**: Sensitivity of spirochetes from *Borrelia burgdorferi* sensu lato complex to human complement: infection potential of selected species
  Supervisors: M. Golovchenko, *N. Rudenko*
- **Tomková Tereza**: The morphological and molecular study of *Ceratomyxa* species (Myxozoa) in clinid fish from the tip of South Africa.
  Supervisor: I. Fiala
- **Vazač Jan**: Study on the chromosome number in the alveolate alga *Chromera velia* by TSA-FISH.
  Supervisor: Z. Füssy

List of Bachelor of Science theses

- **Boudová Michala**: The role of Ervl in the mitochondrial import machinery and iron sulphur cluster export machinery in *Trypanosoma brucei*.
  Supervisor: A. Haindrich
- **Davidová Marie**: Study of antimicrobial effect of bee venom on borrelia species from *B. burgdorferi* sensu lato complex: isolation of gene encoding antimicrobial melittin peptide from venom gland of honey bee *Apis mellifera*.
  Supervisor: N. Rudenko
- **Hejduk Libor**: Possibilities of usage of programmable necleases for gene therapy of HIV positive patients.
  Supervisor: D. Růžek
- **Kunzová Michaela**: Identifying protein-protein interactions of *Trypanosoma brucei* FoF1-ATP synthase subunits using the yeast two hybrid system.
  Supervisor: A. Zíková
- **Lhotská Zuzana**: Axenization of intestinal protist of the genus *Blastocystis.*
  Supervisor: K. Jirků
- **Machová Kamila**: RNA biology of symbiotic bacteria in insects.
  Supervisor: F. Husník
- **Morávková Veronika**: Diversity and geographical distribution of tapeworms of the order Diphyllobothriidea in Pinnipedia.
  Supervisor: R. Kuchta
- **Papajová Martina**: The role of papillomaviruses in ethiology carcinomas of ano-genital areas in men.
  Supervisor: D. Růžek
- **Pospíšilová Tereza**: Growth kinetics and transmission dynamics of *Borrelia afzelii* in *Ixodes ricinus.*
  Supervisors: R. Šíma, *O. Hajdušek*
- **Prančlová Veronika**: The controversy of the protein-only theory.
  Supervisor: D. Růžek
- **Reifová Zuzana**: The susceptibility of selected hosts to infection *Cryptosporidium avium.*
  Supervisor: M. Kváč
- **Růžková Jiřina**: Introduction of a suitable experimental *in vivo* model for the study of intestinal protist of the genus *Blastocystis*.
  Supervisor: K. Jirků
- **Stanzl Helmut**: Evaluating the role of Tb TGT in the formation of Q-tRNA in the bloodstream stage of trypanosomes.
  Supervisor: Z. Paris
- **Uhrová Lucie**: Diversity of larval stages of the family Gryporhynchidae (Cestoda: Cyclophyllidea) in cichlid fish (Perciformes: Cichlidae) from southern Africa.
  Supervisor: T. Scholz

Stays of foreign researchers

- **Ana Isabel Born-Torrijos**: University of Valencia, Spain (6. 6.–31. 12. 2016; A. Holzer and T. Scholz)
- **Alain de Chambrier**: Natural History Museum, Geneva, Switzerland (25. 2.–14. 3. 2016; T. Scholz)
- **David González-Solís**: ECOSUR Chetumal, Mexico (7. 6.–31. 8. 2016; T. Scholz and F. Moravec)
- **Jesus Hernández-Orts**: University of Valencia, Spain (2. 9.–17. 11. 2016; R. Kuchta)
- **Arlene Jones**: UK (8.–30. 10. 2016; T. Scholz)
- **Marta Kicia**: Wroclaw Medical University, Faculty of Medicine, Department of Biology and Medical Parasitology, Wroclaw, Poland (29. 2.–6. 3. 2016; M. Kváč)
- **Abd Elkarim Laatamna**: Higher National School of Veterinary, BP 161 Hacène Badi, EL Harrach, Algiers, Algeria (2.–16. 4. 2016; M. Kváč)
- **Douniazed Marzoug**: University of Oran Es-Sénia, Oran, Algeria (21.–31. 8. 2016; A. Kostadinova)
- **Salvatore Mele**: University of Sassari, Italy (8. 1.– 5. 3. 2016; S. Georgieva and A. Kostadinova)
- **Francisco Esteban Montero**: University of Valencia, Spain (26.–30. 9. 2016; A. Kostadinova and S. Georgieva)
- **Carlos Alonso Mendoza-Palmero**: Universidad Nacional Autónoma de México, Mexico City, Mexico (3. 12. 2015–19. 2. 2016; T. Scholz)
- **Mikuláš Oros**: Parasitological Institute, Košice, Slovakia (1. 5.–3. 6. 2016; T. Scholz)
- **Ana Pérez-del-Olmo**: University of Valencia, Spain (10. 1.–24. 1. 2016; A. Kostadinova)
- **Sareh Tavakol**: University of Limpopo, South Africa (14.–28. 8. 2016; T. Scholz)
- **Anastasios D. Tsaousis**: University of Kent, School of Biosciences, Canterbury, UK (25.–30. 4. 2016; M. Kváč)
- **Andrea Waeschenbach**: Natural History Museum, London, UK (5.–15. 5. 2016; T. Scholz and R. Kuchta)
- **Aneta Yoneva**: Institute of Biodiversity and Ecosystem Research, Bulgarian Academy of Sciences, Bulgaria (1. 9.–30. 11. 2016; R. Kuchta)
- **Maria Weselovska**: Wroclaw Medical University, Faculty of Medicine, Department of Biology and Medical Parasitology, Wroclaw, Poland (26.– 30. 9. 2016; M. Kváč)

Stays of foreign students

- **Aline Angelina Acosta**: São Paulo, Brazil (15. 2.–15. 10. 2016; T. Scholz)
- **Daniel Barčák**: Parasitological Institute, Košice, Slovakia (20.–29. 5. 2016; T. Scholz)
- **Seongjun Choe**: Chungbuk National University, South Korea (3.–17. 9. 2016; A. Kostadinova and S. Georgieva)
- **Nessrine Ghanmi**: University of Tunis, Tunisia (14. 7.–15. 8. 2016; T. Scholz and F. Moravec)
- **Zana Kopac**: Wroclaw Medical University, Faculty of Medicine, Department of Biology and Medical Parasitology, Wroclaw, Poland (29. 2.–6. 3. 2016; M. Kváč)
- **Lamia Lablack**: University of Oran Es-Sénia, Oran, Algeria (21. 8.–10. 9. 2016; A. Kostadinova and S. Georgieva)
- **Chris Miller**: University of Kent, School of Biosciences, Canterbury, UK (25. 4.–14. 6. 2016; M. Kváč)
- **Maria Villora-Montero**: University of Valencia, Valencia, Spain (1. 6.–30. 9. 2016; A. Kostadinova and S. Georgieva)
- **José Francisco Palacios-Abella**: University of Valencia, Valencia, Spain (1. 9.–30. 11. 2016; A. Kostadinova and S. Georgieva)
- **Camila Santos Pantoja de Oliveira**: Universidade Federal Rural de Rio de Janeiro, Seropédica, Brazil (6. 9.–3. 11. 2016; T. Scholz)
- **Mohammed Rima**: University of Oran Es-Sénia, Oran, Algeria (28. 7.–10. 9. 2016; A. Kostadinova and S. Georgieva)
- **Javier Rodríguez-Llanos**: University of Valencia, Valencia, Spain (19. 9.–5. 11. 2016; A. Kostadinova and S. Georgieva)
- **Micah Amber Secor**: University of Arizona, USA (May–July 2016; Hajdušek)

Survey of lectures and courses[1]

Name	Course
I. Fiala	Field Parasitology
I. Fiala	Protistology
L. Grubhoffer	Biochemistry (CB + Linz)*
L. Grubhoffer	Glycobiochemistry (CB+Linz)
L. Grubhoffer	Development & Comparative Biochemistry (CB+Linz)
L. Grubhoffer	Advance Seminar in Biological Chemistry (CB+Linz)
L. Grubhoffer	Bachelor Seminar in Biological Chemistry (CB+Linz)
L. Grubhoffer	Diagnosis of Vector-Transmitted Diseases
L. Grubhoffer	Vaccines Against Tick-Borne Diseases
H. Hashimi	Cell Regulation and Signalling
H. Hashimi	Bioenergetics
A. Horák	Introduction to Bioinformatics
A. Horák	Introduction to Genomics
V. Hypša	Biology of Parasitism
V. Hypša	Molecular Phylogenetics
V. Hypša	Molecular Ecology
V. Hypša	Molecular Parasitology
R. Kuchta	Special Zoology of Invertebrates
R. Kuchta	Biology of Helminths
R. Kuchta	Field Course of Marine Organisms
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	Biology of Parasitic Protists
J. Lukeš	Biochemistry and Molecular Biology of Parasites
J. Nebesářová	Electron Microscopy for Biologists[1+5]
J. Nebesářová	Electron Microscopy[1+2]
J. Nebesářová	Electron Microscopy and Microanalysis
J. Nebesářová	Analytical Methods in Biochemistry
M. Oborník	Introduction to Bioinformatics
M. Oborník	Molecular Taxonomy[6]
M. Oborník	Bioinformatics Project
D. Růžek	Medical Virology
D. Růžek	Pathogenesis of Viral Infections[3]
D. Růžek	Diagnosis of Vector-Transmitted Diseases
D. Růžek	Vaccines Against Tick-Borne Diseases
T. Scholz	Biology of Helminths
T. Scholz	Special Zoology of Invertebrates
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 2 and 3 year

J. Štěrba	Instrumental Methods in Biochemistry and Biophysics
J. Štěrba	Introduction to Toxicology
J. Štěrba	Introduction to Proteomics (Wels, Austria)
A. Zíková	Molecular Biology of Cell

[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)