BIENNIAL REPORT

2021-2022

INSTITUTE OF VERTEBRATE BIOLOGY

THE CZECH ACADEMY OF SCIENCES

BRNO 2023

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INSTITUTE OF VERTEBRATE BIOLOGY
CZECH ACADEMY OF SCIENCES

A periodical continuation of the Institute's previous bulletins: Vertebratologické zprávy (1969–1987), Zprávy ÚSEB (1988–1991) and the ILE Biennial Report (1993–1994).

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Published by the Institute of Vertebrate Biology of the Czech Academy of Sciences, Brno

English editing by Jana Piálková

Layout and pre-press by Michal Zeman
Illustrations by Šimon Bryja
Printed by POINT CZ

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ISBN 978-80-87189-41-2

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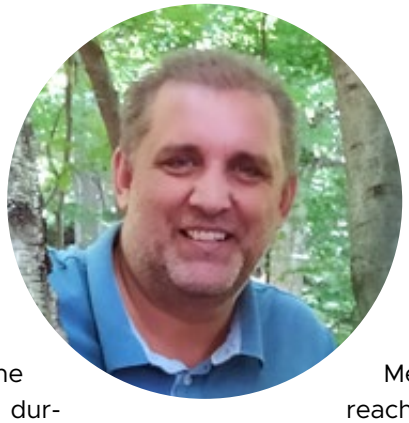
Dear reader,



When I wrote the editorial for the previous issue of the Biennial Report, I did not expect that the situation after the extremely unconventional period of the COVID-19 pandemic would be similarly challenging. The COVID-19 pandemic culminated during 2021, but ongoing vaccination helped to defeat it. The society expected a return to "normal" life, and suddenly we experienced something inconceivable for European people.

The Russian aggression towards Ukraine began in February 2022 and again dramatically influenced both our private and professional life, respectively. I am personally proud of the attitude and support of the Czech people towards the Ukrainian refugees. We also became involved as the Institute, providing not only accommodation at the Mohelský Mill station but also the possibility of study stays for our colleagues within the Researchers At Risk program. At the same time, we, like the whole society, were forced to deal with the effects of the energy crisis.

Fortunately, I may repeat that this Biennial Report shows that even unfavourable times didn't stop our research activities and we have achieved interesting results. Thanks to the proactive attitude of Alena Fornůsková and her team of colleagues, we received the prestigious HR Award which confirms the right trend in HR management. The changes in the organisational structure with the newly established research groups proved to be the right decision. The quality of research was well evaluated within the national Metodika 17+ evaluation, where we reached the highest grade for the first time. Our three scientific divisions, which focus on groundbreaking research in the fields of evolutionary biology, biodiversity, and ecology, have produced around 120 scientific publications per year in peer-reviewed journals. I must stress that the results of our work have also significantly contributed to the applied problems of nature conservation, fisheries, agriculture or epidemiological surveillance.

I believe that the information contained in this report will be of interest not only to our co-workers but also to colleagues from other institutions and to the general public. Maybe it will also stimulate potential future students and post-doctoral researchers to consider directing their professional career and connecting with our institute.

I wish you pleasant reading,

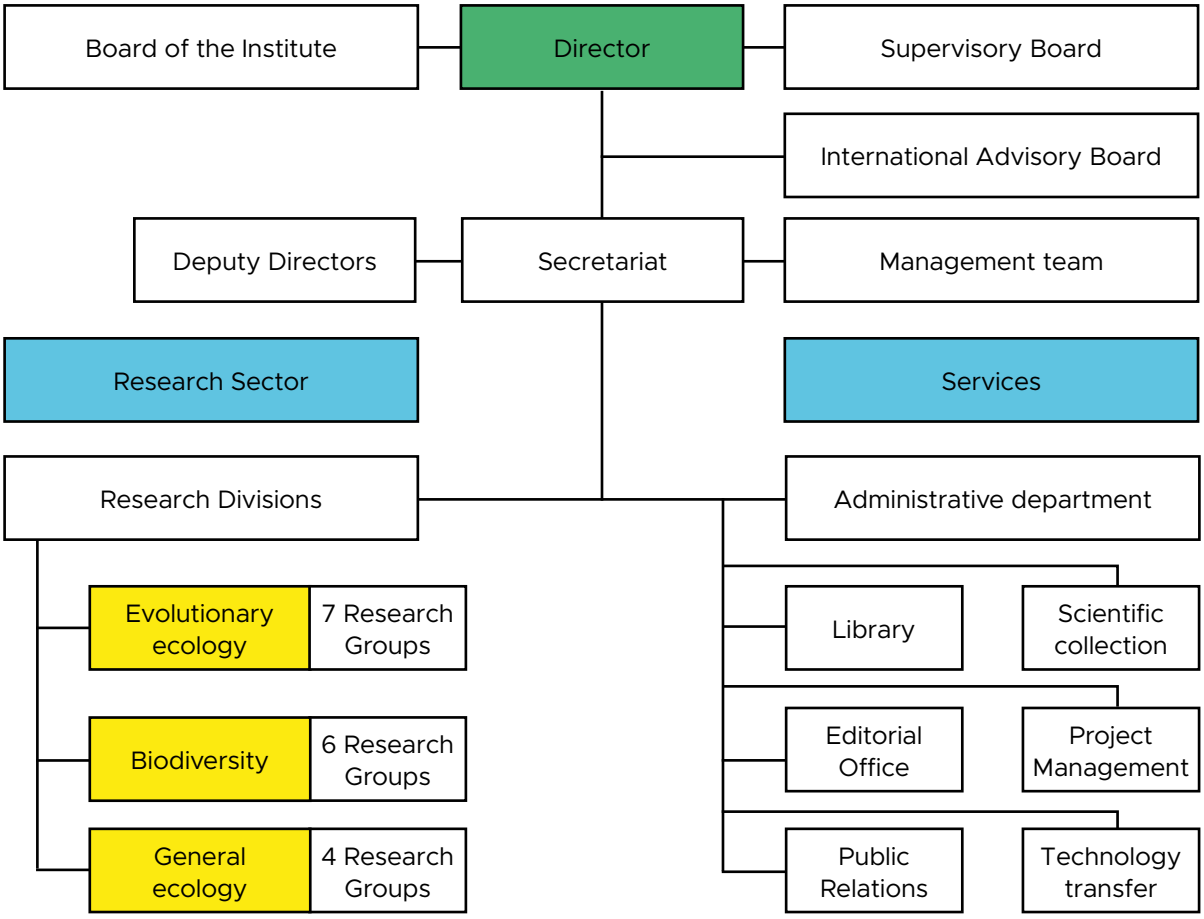
doc. Mgr. Jan Zukal, Dr., MBA
Director of the Institute
of Vertebrate Biology of CAS

MISSION AND VISION

The mission of the Institute of Vertebrate Biology is to contribute to society through the pursuit of research and education about various aspects of vertebrate ecology and evolution at the highest international levels of excellence.

The Institute‘s vision is to be an internationally recognized centre of excellence in evolutionary and ecological vertebrate science.

ORGANIZATION SCHEME



The Institute of Vertebrate Biology (IVB) is a relatively small institute of the Czech Academy of Sciences, and it has been newly structured into three separate research divisions (Evolutionary ecology, Biodiversity and General ecology) and seventeen research groups (see text below for a description of research activities). Senior researchers are responsible for managing their teams and are directly subordinated to the Director. Research groups are flexible, and their close cooperation on specific studies is supported, i.e. individual projects can cover more topics and researchers often use interdisciplinary approaches. Groups are composed of junior researchers, post-doctorates, research assistants, technicians and pre- and post-graduate students (mostly funded through project grants).

RESEARCH STAFF

Only individuals with an employment contract are shown, i.e. not all PhD students are listed (for a complete list of PhD students, see the chapter EDUCATION AND TEACHING ACTIVITIES. Several fellows contracted on the basis of external grant funding have only part-time positions (extent not shown here), often limited to short periods.

Brno Research Facility

The research facilities in Brno include zoological collections, a breeding facility for experimental fish (including facilities for semi-natural experiments), a basic laboratory for molecular genetic studies, a parasitological and ichthyological optical laboratory, and high-quality equipment for field research. Research teams in Brno use model vertebrate groups to study basic questions in the fields of ecology and evolutionary biology, ethology, applied zoology, the roles of parasites and invasive species, and protection and management of freshwater and terrestrial ecosystems. The main topics studied here include:

+ **reproductive strategies in fishes and birds**
+ **adaptation and coevolution between parasites and hosts**
+ **population biology, ecology, and biogeography of annual fishes**
+ **relationships between metazoan parasites and their hosts (fish, birds)**
+ **fish communities and populations of key species in various aquatic habitats**
+ **invasive species in the aquatic environment**
+ **migration connectivity and seasonal interaction of long-distance bird migrants**
+ **ecology and behaviour of bats, especially during hibernation**
+ **population genetics and interspecies hybridisation in deer**
+ **ecology and conservation of carnivores in fragmented landscapes**
+ **food ecology of herbivorous mammals and their impact on the environment**
+ **conservation genetics of endangered species, especially mammals**
+ **diet and parasites of primate**

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Valtice Research Facility

The Valtice research facility is well-equipped with both state-of-the-art molecular equipment and an animal rearing facility that meets all the safety requirements necessary for handling laboratory animals. The research is mainly focused on the ecology and eco-epidemiology of zoonotic microorganisms, with a main emphasis on emerging and re-emerging pathogens.

Specifically, the research focuses on the role of endothermic vertebrates (hosts to pathogenic agents) and hematophagous arthropods (biological vectors) in the circulation of zoonotic pathogens, along with the natural and socio-economic factors that drive the emergence of specific infections.
The main issues being addressed include:

+ **isolation and identification of novel microorganisms, including human pathogens (microbe hunting)**
+ **ecology of arthropod-borne microorganisms with zoonotic potential**
+ **implementation of the 'one health' concept for studying emerging zoonoses**
+ **risk of introduction and establishment of new invasive mosquito vectors and mosquito-borne diseases in Central Europe**
+ **provision of expert advice regarding prevention and control of zoonoses (contribution to preventive human and veterinary medicine) and emerging infectious diseases**

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Studenec Research Facility

The Studenec research facility houses modern, well-equipped molecular-genetic, physiological and microscopic laboratories, a breeding facility for small mammals, birds, and amphibians and facilities for conducting experimentation under semi-natural conditions. IVB Genetic Bank (samples) and also Secretariat of the National Animal Genetic Bank is located there as well. Empirical data from observations, laboratory analysis, and experiments (supplemented by simulation modelling) are used to investigate significant evolutionary questions, primarily at the population level. Research activities are mostly fundamental, including the description of new mammal species, but they may also have applications in biomedicine, species conservation, and epidemiology. Examples of research topics include:

+ **hybrid zones as barriers against gene flow and their role in speciation**
+ **the study of factors affecting population structure and conservation genetics**
+ **mating systems, analysis of reproductive success, and factors affecting fitness**
+ **immunogenetics, exploring links between adaptive genetic variation and fitness**
+ **host-parasite co-evolution, genetic variation in pathogens and their hosts**
+ **mechanisms and evolution of thermal physiology traits in ectotherms**
+ **phylogeography, the reconstruction of historical colonisation, and mechanisms of biodiversity evolution, mainly in Africa**

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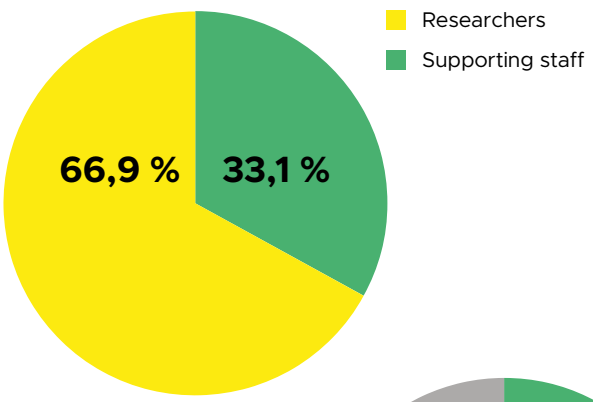
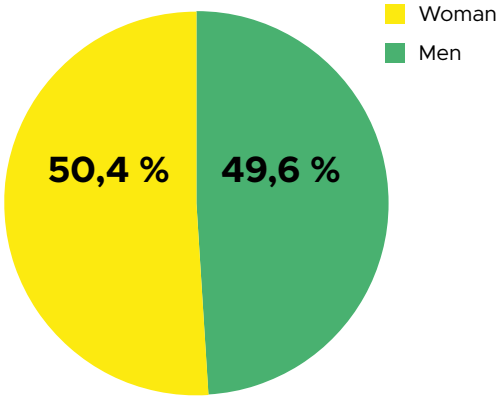
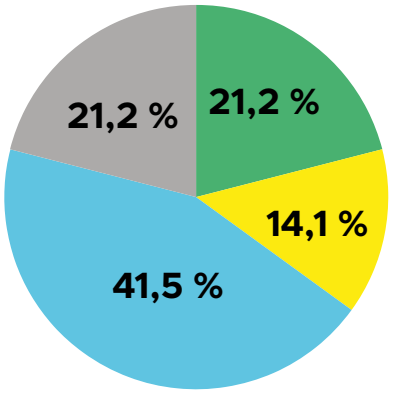
STAFF AND BUDGET

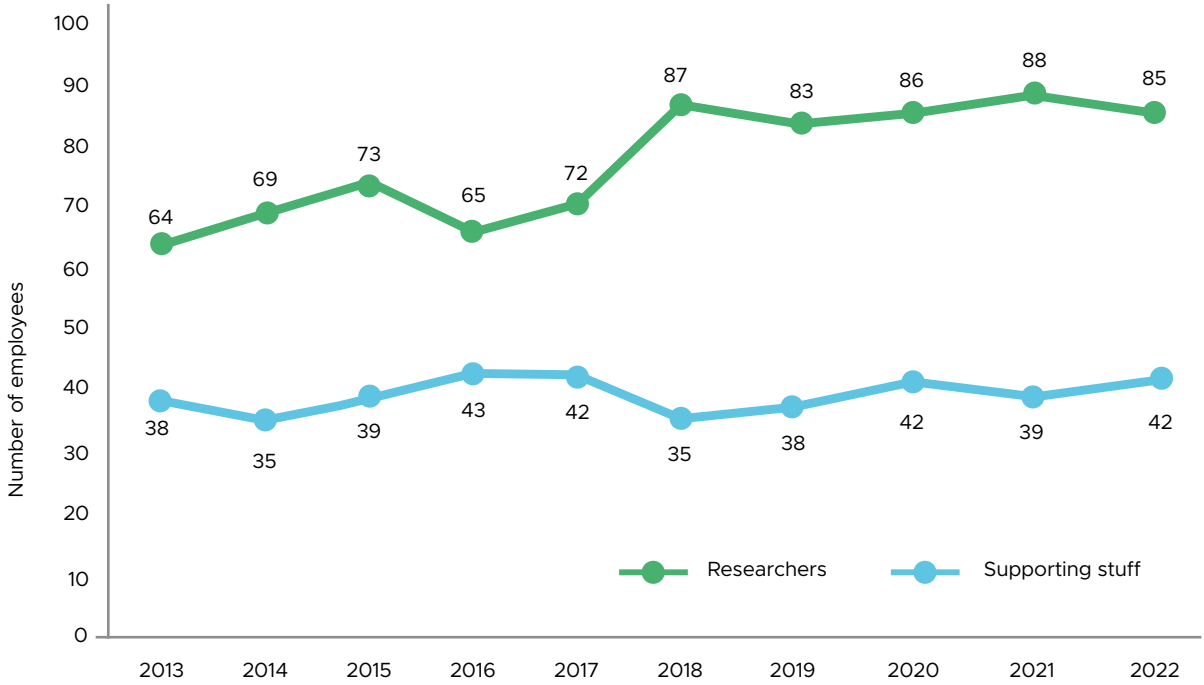
Staff structure as of December 31st 2022



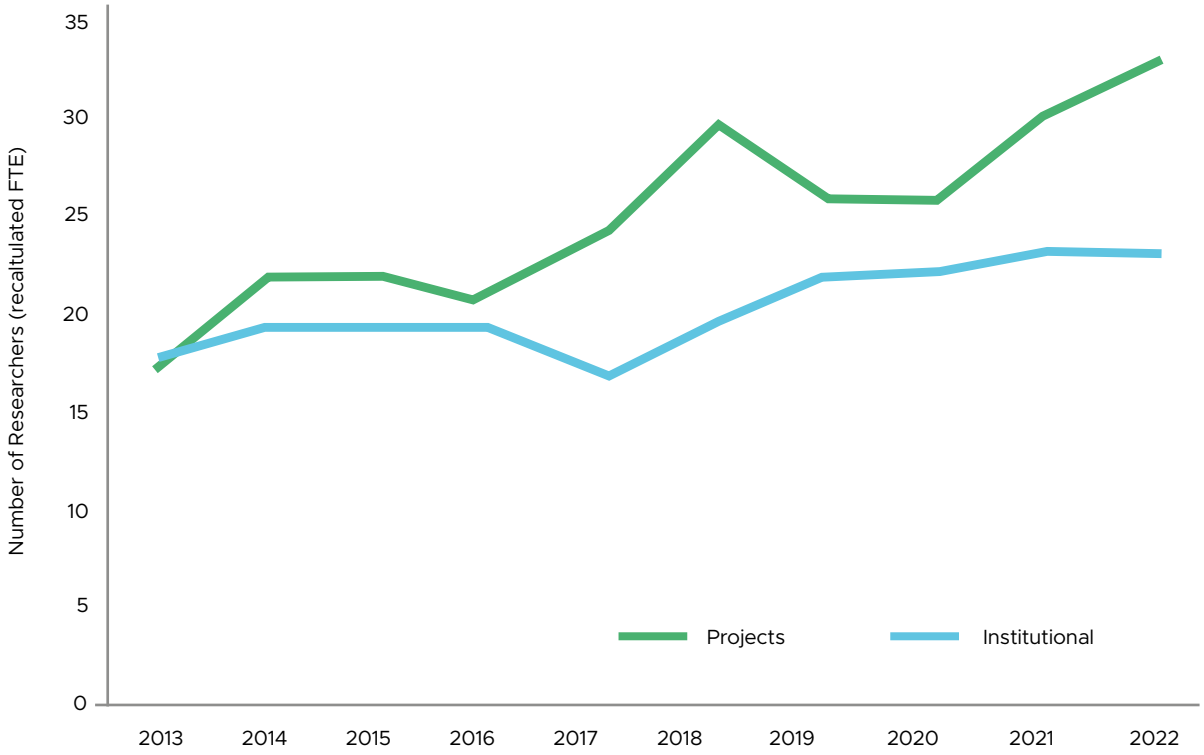




Structure of researcher positions (n = 85)

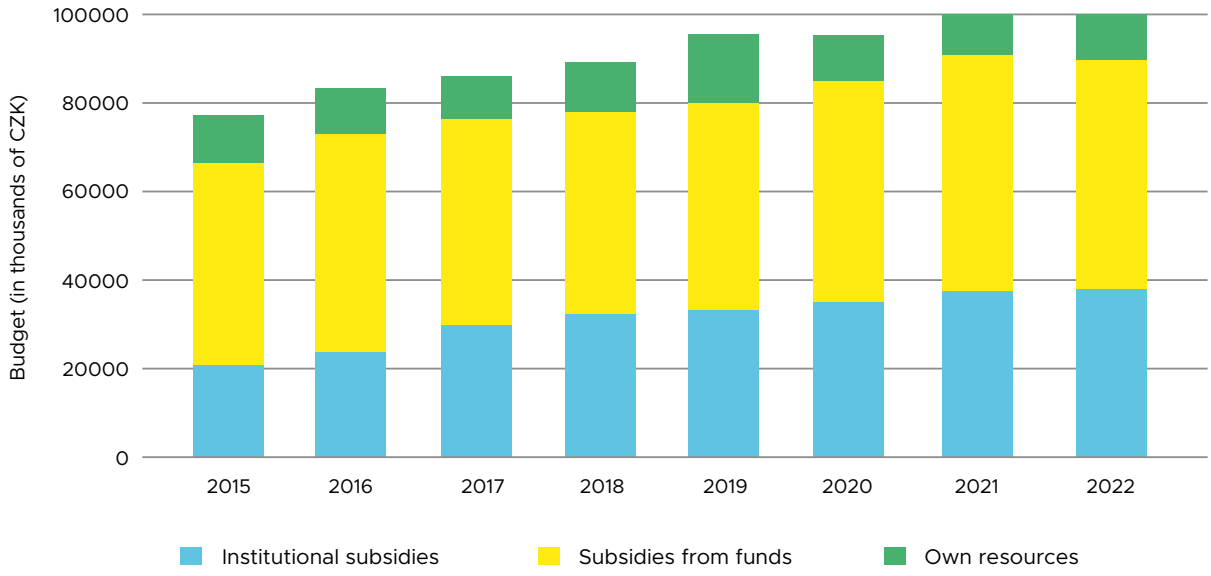


The researchers make up 66.9 % (n = 85), while the supporting staff comprises 33.1 % (n = 42) and their ratio has remained stable in recent years.



The number of researchers paid from institutional sources has not exceeded the number of researchers paid from projects in the last 10 years.

Budget structure (numbers represent thousands of CZK)



The financial budget has increased in recent years, reaching more than 100 million CZK, but the proportion paid from academic sources has remained relatively stable (app. 36 % of the total budget).

Photo credit: archive IVB

RESEARCH DIVISIONS

The research is divided into three basic research directions:

EVOLUTIONARY ECOLOGY

BIODIVERSITY

GENERAL ECOLOGY

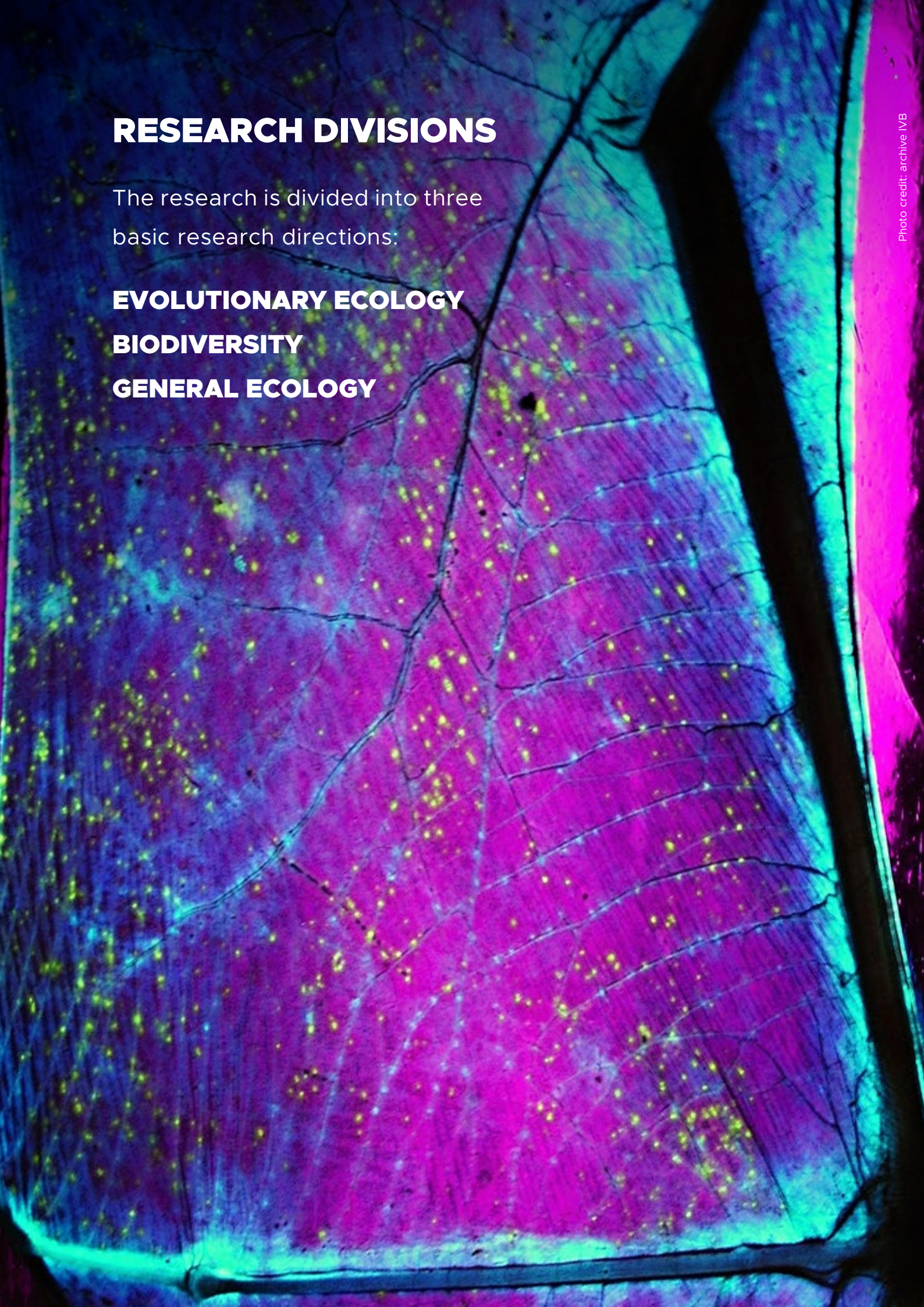


Photo credit: archive IVB

Research within the **Division of Evolutionary Ecology** examines how ecological factors affect evolutionary change and how evolutionary patterns are linked to ecological processes. Specifically, we study how reproductive biology and life histories evolve within and among species, how they respond to environmental changes, and how organismal form coevolves with function. Typical research topics include:

+ **evolution of life histories and ageing**
+ **sexual selection, evolution of mating systems, and reproductive behaviour**
+ **brood parasitism in avian and fish study systems**
+ **coevolution of predator-prey and host-parasite interactions**
+ **migration and dispersal biology**
+ **thermal physiology and individual energetics**
+ **functional approaches to morphological adaptations**

Research within the **Division of Biodiversity** mainly focuses on evolutionary processes that affect the diversity of vertebrates (as holobionts, i.e. the host plus its symbionts) at both the species and intraspecific (genetic) levels. This includes factors responsible for its increase (e.g. speciation) and decrease (conservation genetics, population extinctions). Individual projects primarily address the following issues:

+ **speciation and hybridization**
+ **evolutionary history and phylogeography – the origin of current genetic diversity and its spatial distribution**
+ **factors affecting holobiont diversity, e.g. host-parasite co-evolution and microbiome structure**
+ **biogeography and the evolution of biodiversity hotspots (especially in Africa)**
+ **genetic threats to contemporary populations and conservation genetics**
+ **biological collections and biobanking**

The aim of research in the **Division of General Ecology** is to undertake an interdisciplinary and comprehensive study of ecological interactions among vertebrates and their environment, encompassing both environmental and socio-economic drivers. The typical research topics focus on:

+ **the functioning of ecosystems (especially in agricultural landscapes)**
+ **community structure and its changes**
+ **disease ecology including the biology of vectors and eco-epidemiology of zoonoses**
+ **the implementation of the 'One health' concept for the study of emerging pathogens**
+ **foraging/feeding activity, including food structure**
+ **habitat preferences and the conservation ecology of endangered species**
+ **the ecology of hibernation**

EVOLUTIONARY ECOLOGY

FISH EVOLUTIONARY ECOLOGY GROUP

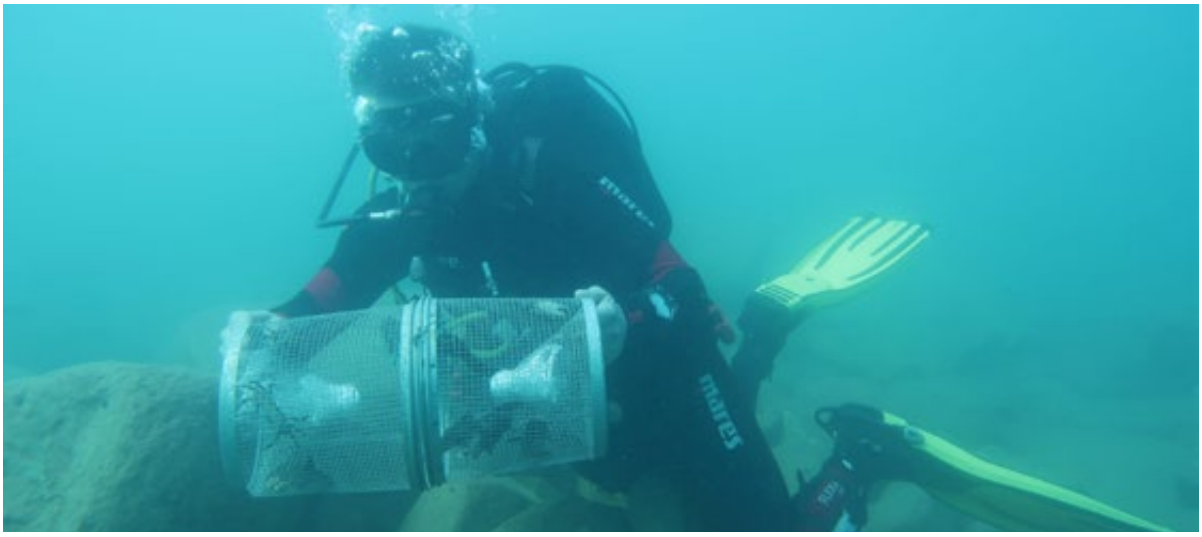
Photo credit: Jan Hošek

Behavioural mechanisms of fish interspecific brood parasitism

Brood parasites take advantage of the brood care provided by their hosts. The hosts may reduce their costs by evolving defences against parasitism, leading to counter-adaptations of the parasite and ensuing coevolutionary arms race. The cuckoo catfish is a brood parasite of mouthbrooding cichlids in Lake Tanganyika. Cichlids accidentally collect eggs of catfish that intrude upon cichlid spawning. In addition to coevolutionary response, we found that the ability of cuckoo catfish to successfully parasitize cichlids improves as they learn from previous attempts. Since cuckoo catfish often intrude on cichlid spawning in larger groups, we also tested whether they cooperate. This was not confirmed, and intrusion by larger groups did not increase individual success. We suggest that cuckoo catfish are capable of individual learning but remain competitive within their social groups.

Cuckoo catfish | Photo credit: Radim Blažek

Field work in Zambia in Lake Tanganyika | Photo credit: Radim Blažek



Field work in Zambia in Lake Tanganyika | Photo credit: Martin Reichard

Zimmermann H, Blažek R, Polačik M, **Reichard M**, 2022. Individual experience as a key to success for the cuckoo catfish brood parasitism. *Nature Communications* 13: 1723.

Blažek R, Polačik M, **Reichard M**, 2022. Group intrusions by a brood parasitic fish are not cooperative. *Behavioral Ecology* 33: 178-183.

Improving laboratory practices for an emerging animal model in studying senescence

The extremely short-lived annual killifish of the genus *Nothobranchius* serve as an emerging model in many research fields, particularly in senescence research. The husbandry of this model species requires standardisation to ensure that research is replicable across different laboratories. The extensive experience we have gathered over the years with breeding *Nothobranchius* fishes has led to improvements in specific aspects of their husbandry and histopathology.

For example, our team identified discordances in the classification of tumorous and inflammatory tissues among laboratories. An important aspect of husbandry standardisation was the development of a formula for an appropriate pelleted diet. Dry food enables the control of consumed nutrients and potential health risks, in contrast to the live or frozen food that fish typically prefer. These steps contribute to enhancing the status of *Nothobranchius* fish as the model organism for studying senescence.

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Proximate factors and markers associated with senescence in an annual killifish

Life expectancy and the rate of ageing are fundamental parameters of life history. In many vertebrates, males live shorter than females, but it is not fully understood why that is the case. We studied multiple wild and laboratory populations of naturally short-lived killifish under various conditions.

We found that males possess shorter telomeres, which function as protective chromosome ends, likely due to their more intensive growth. However, the shorter lifespan of males is not a consequence of their more rapid physiological ageing but is primarily linked to male-male competition. Regarding reproductive senescence, these extremely short-lived fish show a decline in the number and quality of eggs laid towards the end of female lives. Highly fecund young females also laid more eggs later in life and lived longer. Our results thus indicate that despite their condensed lifespan, annual killifish age similarly to other vertebrates and that high-quality individuals live longer.

Old male of *Nothobranchius* | Photo credit: Milan Vrtílek

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EVOLUTIONARY ECOLOGY

BIRD ECOLOGY AND MIGRATION GROUP

Photo credit: Petr Procházka

The importance of spatiotemporal organisation of the annual cycle for population dynamics of migratory birds

The study of spatiotemporal patterns in long-distance migration is crucial for understanding a wide array of ecological and evolutionary mechanisms affecting migratory species. However, investigating small avian migrants throughout the entire annual cycle has proven challenging due to logistic constraints. Advances in tracking technology now allow us to follow small birds year-round in much detail. This way, we studied the effect of infection by haemosporidian parasites on spatiotemporal migration patterns and activity budgets of migrating great reed warblers.

Similarly, we investigated the consequences of fostering brood parasitic offspring on the timing of the host's autumn migration. Finally, we demonstrated that conditions in staging areas or stationary non-breeding grounds can have a significant impact on the survival and trajectories of migratory populations.

A good understanding of the temporal and spatial organisation of the annual cycle and non-breeding conditions is vital not only for the effective conservation of declining migratory species but also for predicting the impact of global changes in climate and land use on migratory populations.

A combination of geolocator tracking, weather conditions throughout the annual cycle, and long-term capture–recapture data of Finnish little ringed plovers (*Charadrius dubius*) has revealed that apparent adult survival is strongly influenced by between-year variation in precipitation during post-breeding staging in northern South Asia | Photo credit: Veli-Matti Pakanen

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EVOLUTIONARY ECOLOGY

THERMAL ECOLOGY GROUP

Photo credit: archive IVB

Unveiling Adaptive Responses and Species Interactions: Insights into Climate Change Effects on Ectotherms

Current climate change poses a serious threat to the world's biota. Identifying mechanisms of how climate change affects population dynamics and species interactions in cold-blooded (ectothermic) taxa is one of the most important tasks in current ecological research. We have identified two previously undetected mechanisms that may play important roles in addressing climate change.

First, a series of long-term measurements on the same individuals showed that acute thermally induced plasticity of metabolic and behavioural traits consistently varies among individuals, but seasonal acclimation does not. Second, long-term experiments under semi-natural conditions demonstrated the importance of (1) thermoregulatory behaviour of amphibian larvae in accelerating their development in a thermally challenging aquatic environment and (2) species interactions in shaping ectotherm responses to changing temperatures. These results demonstrate the potential adaptive capacity to the increasing stochasticity of temperature variation under climate change and highlight the importance of interactions between biotic and abiotic factors in predicting impacts of climate change on population dynamics, species interactions, and ecosystem services.

Newts are kept during experiments in a breeding facility in Studenec | Photo credit: archive IVB

Female of the Alpine newt (*Ichthyosaura alpestris*) | Photo credit: Lumír Gvoždík

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EVOLUTIONARY ECOLOGY

AVIAN EVOLUTIONARY ECOLOGY RESEARCH GROUP

Photo credit: Tomáš Albrecht

Avian Mate Choice, Fitness Optimization, and Evolutionary Adaptations: Insights from Passerines and Tropical Bird Communities

Our research focuses on understanding how birds find their sexual partners and optimising the allocation of resources in survival and reproduction to maximise fitness. Detailed reproductive data, along with 'omics' approaches, were used to study pre- and post-copulation episodes of mate choice in passerines (Passeriformes), as well as to identify sections of the genome associated with variation of selected sexual traits related to fitness (sperm morphology and sexual ornamentation) and their role in the process of speciation.

We evaluated hypotheses regarding the roles of extrinsic and intrinsic physiological mechanisms in life history evolution and unravelled factors explaining interspecific variation in avian physiology along latitudinal and altitudinal gradients. Specifically, our research in tropical Africa and Europe focused on physiological adaptations associated with breeding in the relatively stable tropical environment ('tropical syndromes'). We have shown that reduced energy-intense investment in feather growth and low blood glucose levels, a key energetic source, evolve convergently across unrelated lineages and reflect the slow pace of life of tropical birds. Our research on forest bird communities along an elevational gradient on Mount Cameroon has significantly contributed to a better understanding of vegetation structuring in understudied Afrotropical montane forests.

We investigated the distribution of various sexual, physiological and life-history traits across avian phylogenies and large spatial scales - by compiling data from almost all passerine species, we created global maps of the occurrence of behavioural

The foothills of Mount Cameroon | Photo credit: Tomáš Albrecht

Juvenile Grey-necked Rockfowl (*Picathartes oreas*). Two rockfowl species are iconic birds of the rainforests of western Africa. | Photo credit: Tomáš Albrecht

Researchers and students during fieldwork on barn swallows | Photo credit: Michal Šulc

traits associated with sexual selection (song frequency, aerial displays) and evaluated the role of environment on optimal sexual signalling in passerines. Finally, we evaluated ageing patterns using data on telomere degradation and reproductive senescence from long-term studied populations of short-lived passerine species.

Grey-headed Broadbill (*Smithornis sharpei*) is a suboscine passerine species found in Afrotropical rainforests | Photo credit: Tomáš Albrecht

Field work at Mount Cameroon in November 2022 | Photo credit: archive IVB

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EVOLUTIONARY ECOLOGY

BROOD PARASITISM RESEARCH GROUP

Photo credit: Marcel Honza

Avian brood parasitism: an alternative reproductive strategy

Brood parasitism is an interesting reproductive strategy in which one female lays its eggs in the nest of another, leaving the host birds to raise their offspring. It has been observed in a variety of bird species worldwide. During the arms race between the host and the parasite many adaptations and counter-adaptations have evolved, and some of these were the subjects of our research. The common cuckoo (*Cuculus canorus*) is an interspecific brood parasite that we have been studying for a long time. Using a long-term dataset, we found that when the number of available nests suitable for parasitism is low, the cuckoo lays more parasite eggs in a single nest, and individual parasitic females avoid laying in nests they have already parasitized.

Common cuckoo chick and common cuckoo egg in the great reed warbler nest | Photo credit: Michal Šulc

This highlights the cuckoo's remarkable spatial orientation and memory. We have also developed an automated analytical method to predict female identity based on their egg appearance, aiding the study of this mysterious species. Our records also indicate that cuckoo eggs have 2.2 times greater strength than expected based on their size, supporting the hypothesis of a stronger structural integrity as an adaptation for their brood parasitic lifestyle. The capability of hosts to reject the odd egg from their nest is one of the key defences against avian brood parasitism.

We reviewed studies addressing salient egg traits involved in the rejection of foreign eggs and used a formal meta-analysis to quantify their relative importance. We also studied the ability to recognize and remove foreign eggs in barn swallows (*Hirundo rustica*). This species is an intraspecific brood parasite, where some females lay their eggs in the nests of other swallows. Results of our experiments indicate that egg ejection is likely a part of nest cleaning rather than a direct defence against brood parasitism. Our research reveals intriguing tactics that brood parasites and host birds have evolved through coevolution, providing important insights into their ecology and evolution.

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Colour variation of common cuckoo eggs | Photo credit: Michal Šulc

Common cuckoo female removing one host great reed warbler egg during parasitism | Photo credit: Oldřich Mikulica

Taking photographs of the barn swallow eggs for later analysis of egg colouration | Photo credit: Michal Šulc

The colour-ringed adult of barn swallow photographed at its nest to identify the social parent of the offspring | Photo credit: Michal Šulc

The adult barn swallow in one of our study breeding areas | Photo credit: Vladimír Pokorný

The barn swallow fledglings leaving the nest | Photo credit: Vladimír Pokorný

Cryptic host-parasite associations in temperate, subtropical and tropical zones

Identifying units of biological diversity is a major goal of organismal biology. We focused on avian host-parasite associations in Central Europe and Central and South America. While some parasites are species-specific, others tend to exhibit a more generalist strategy. A total of 3776 birds (367 species, 12 orders, 42 families) were examined. Six ectoparasite species have been recorded for the first time on bird hosts.

Four species new to science have been described – the feather mite *Lamellodectes favus* (Proctophyllodidae) from the Spotted Barbtail *Premnoplex brunnescens* (Furnariidae), and the chiggers *Eutrombicula talamancensis*, *E. cathari* and *E. gonzalezi* (Trombiculidae) from pigeons (Columbidae), motmots (Momotidae), ovenbirds (Furnariidae), antbirds (Thamnophilidae), tyrant flycatchers (Tyrannidae), thrushes (Turdidae) and wrens (Troglodytidae). We paid special attention to bird communities in reed beds that include species of similar body size, feeding and breeding ecology but with different migration strategies. Our study has shown that bird migration can be one of the factors affecting chewing lice (Phthiraptera) abundance. Despite a higher infestation in general, louse presence on resident birds may not be as burdensome compared to migrants, for which any handicap could mean a significant loss of energy. A difference in louse abundance can also be affected by the social behaviour of their hosts, which can explain only slight differences found in louse load between males and females of the Bearded Reedling *Panurus biarmicus*.

Due to population dynamics, the louse abundance gradually descends from spring to fall. Therefore, spring is probably the crucial season for the colonisation of new hosts by lice. The knowledge of the occurrence and population dynamics of lice on wild passerines can be useful in endangered species conservation programs and can also be applied to captive passerine birds, which may be analogous to resident birds in this sense.

Wedge-billed Woodcreeper *Glyphorynchus spirurus* is a widespread suboscine passerine in which the paratype larvae of *Eutrombicula talamancensis* were collected. Cordillera Occidental, Colombia. | Photo credit: Miroslav Čapek

M. Čapek examining a Scarlet-rumped Tanager of the subspecies *Ramphocelus passerinii costaricensis* endemic to western parts of Costa Rica and Panama. Cordillera de Talamanca Mts., the range of global importance and a center of endemism for many plant and animal taxa. | Photo credit: Oldřich Sychra

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EVOLUTIONARY ECOLOGY

EVOLUTIONARY MODELLING GROUP

Photo credit: Radovan Smolinský

Adaptations to seasonal challenges

In the temperate zone, changing seasons result in significant differences in the environment at different times of the year. Food and shelter availability, as well as weather conditions, fluctuate. One of the strategies for surviving resource scarcity and adverse environmental conditions is tolerance to starvation, which is associated with lowering of the metabolism during hibernation (torpor during cold periods) or aestivation (torpor during hot and dry periods).

Consequently, life strategies utilising torpor at different times of the year require specific adaptations, including a short and intensive breeding season. We have developed possibilistic models that help predict the range of temperatures that bats can choose from for hibernation under different climatic conditions. We found that body temperatures of hibernating bats differ by up to 8 °C within a single hibernaculum. This is important because our genome-wide association study revealed the importance of metabolic changes, immune regulation, and tissue regeneration in the heat and cold challenges that bats experience during the active season and torpor. In addition to the winter torpor period, lizards also utilise summer aestivation during days with a high risk of overheating. We discovered that the ectoparasite load on sand lizards decreases in mid-summer when aestivation is most frequent, and most ectoparasites feed on sexually active lizards during the reproduction season.

Apart from experiencing higher numbers of ticks and mites, reproducing lizards also face an increased risk of predation. While our statistical models show that tail autotomy improves survival by approximately 5 %, gravid females of sand lizards are unable to survive predator attacks in areas where non-native pheasants are common.

A tail regenerate in sand lizards indicates that a successful escape from a predator attack improves survival by about 5% | Photo credit: Radovan Smolinský

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BIODIVERSITY

HOLOBIONT EVOLUTIONARY INTERACTIONS GROUP

Photo credit: Laura Cuypers

Evolutionary history and diversity of rodent-borne RNA viruses

Rodents are the most diverse order of mammals, with 20% of this diversity found in Africa. They are reservoirs of emerging viruses such as the Lassa virus, responsible for causing Lassa hemorrhagic fever in West Africa. The Lassa virus belongs to the genus *Mammarenavirus*. Studying the ecology and evolutionary history of these viruses can provide significant information into understanding what shapes their geographic distribution and why some viruses are pathogenic to humans while others are not.

In this context, we have explored the diversity of mammarenaviruses in Angola, discovering three different viruses. Among these, two species new to science have been officially recognized by the International Committee on Taxonomy of Viruses (ICTV) and one, the Luna virus, is now described in *Mastomys natalensis* across various southern African countries (Tanzania, Zambia and Angola). These findings expand the known host range of these viruses. In addition, we found a new mammarenavirus, the Mafiga virus, in a wild grass mouse in Tanzania. This virus was a particularly signinicant discovery because its genomic characterization revealed one S but two L segments in the infected individual, suggesting a co-infection. This was the first report of a co-infection in the genus *Mammarenavirus* in a wild animal, the phenomenon being known only from *Reptarenavirus* in captive snakes. The possibility of co-infection is important because it is the only way to give rise to a recombinant virus.

In collaboration with KU Leuven in Belgium, the small mammals sampled during our fieldwork in Africa were screened for the presence of other important rodent-borne viruses. This work led to the discovery of numerous new hepaciviruses, paramyxoviruses, and viruses from the family *Arteriviridae*, thereby expanding the known diversity and host range of these important groups of RNA viruses.

Finally, we studied the lymphocytic choriomeningitis virus (LCMV) in Central Europe, considering its strategic location for investigating the evolutionary history and host specificity of this virus, given the presence of a hybrid zone (genetic barrier) between two house mouse subspecies, *Mus musculus musculus* and *M. musculus domesticus*. Indeed, the natural reservoir of this virus, which can be pathogenic to humans, is the

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house mouse. We detected LCMV only in a small area in the Czech Republic and fully characterised the genomes of two variants. This is the first report of LCMV in natural mouse populations in the Czech Republic. Using data from public databases, we demonstrated that the main division in the LCMV phylogenetic tree corresponds to mouse host subspecies, and when the virus is found in human hosts, it aligns with the mouse subspecies found at the spillover location. Therefore, LCMV strains infecting humans can be predicted from the genetic structure of house mice.

Mice trapping at farms at house mice hybrid zone | Photo credit: archive IVB

Mice trapping at farms at house mice hybrid zone | Photo credit: archive IVB

Multitrapping happened in several cases, especially when Ugglan traps were used | Photo credit: archive IVB

Dissection in the field | Photo credit: archive IVB

Team in the field at Nebanice | Photo credit: archive IVB

Small but mighty - bacterial communities in the vertebrate gut

Bacterial communities inhabiting the digestive tract of vertebrates play important roles in host metabolism, immunity, and neuroendocrine functions, influencing their fitness and evolution. The patterns of variation in the gut bacteriome (GB) of wild vertebrates exposed to the selective pressures of their natural environment are of great interest for evolutionary inferences about bacteriome-host interactions.

However, collecting GB samples from wild hosts is often a difficult task with numerous technical and ethical problems. Using a house mouse as an example, we experimentally demonstrated that collecting samples from host faeces, instead of the digestive tract or from animals that are already dead, provides sufficient material for assessing patterns of variation in the gut bacteriome. These findings helped us plan the ongoing sampling of GB in small mammals in Africa and New Guinea.

Exploration of the evolutionary outcomes of bacteriome-host interactions in free-living populations is typically influenced by high variation in environmental factors that modulate the GB and the spatial autocorrelation of microbial communities. To test the specificity of GB for two house mouse subspecies under more controlled conditions, we examined gut bacteria in the offspring of wild mice from a semi-natural breeding system. Although the breeding conditions allowed contact between the subspecies, we found marked differentiation of the GB between them in all three intestinal sections examined. The differentiation was mainly caused by bacteria of the genus Helicobacter.

Laboratory mice represent a prime model for biomedical research, including the role of gut bacteria in various diseases. However, the composition and function of the GB in laboratory mice differs from that in wild mice. We have shown that co-housing of laboratory and wild mice significantly alters the composition of the gut and oral microbiome of laboratory mice, including bacteria of the genus Helicobacter.

Interestingly, the shift in microbiota caused by co-housing had a minimal effect on the immune phenotype of the mice. This contrasts with a previous study in which co-housing of laboratory and pet-shop mice had resulted in dramatic changes in immune profiles.

Using a house mouse as an example, we experimentally demonstrated that collecting samples from host faeces instead of the digestive tract or from animals that are already dead provides sufficient material for assessing patterns of variation in the gut bacteriome | Photo credit: archive IVB

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BIODIVERSITY

EVOLUTIONARY GENETICS OF MAMMALS GROUP

Photo credit: archive IVB

Evolutionary relationships in most diversified clades of African small mammals resolved

The knowledge of the evolutionary diversity of animals and its spatial distribution is crucial for the identification of biodiversity hot-spots and efficient nature conservation. African small terrestrial mammals (rodents, shrews, sengis) serve as excellent models not only for such studies, but also for understanding the past evolutionary processes through the contemporary distribution of genetic diversity. The unique collection of small mammals and their tissue samples at IVB was further developed by sampling in understudied areas (such as the Afar triangle in Ethiopia, the Livingstone Mts. in southern Tanzania, or various ecosystems in Angola) and genetic/genomic data were used for reconstructing the evolutionary history of these mammals.

The most species-diverse (and one of the most practically important for humans) groups of mammals in Africa are the murid rodents from the tribes Arvicanthini and Praomyini. Due to the rapid radiation at the Miocene-Pliocene boundary, their phylogenetic relationships have never been satisfactorily resolved. Only the advent of new technologies, namely high-throughput sequencing, has made it possible to obtain sufficient genomic data and reconstruct their evolutionary history. Based on several hundred loci on nuclear DNA, we have solved the relationships between their major lineages (= genera) and proposed new taxonomic arrangements. This includes the description of five new mammalian genera, one of which (an endemic of tropical forests in south-eastern Ethiopia) is completely new to science.

A similar approach was used for the first resolved reconstruction of the evolutionary history of some rodent genera, such as savannah specialists *Lemniscomys* and *Mastomys*, montane genera *Dendromus* and *Lophuromys*, subterranean mole-rats *Heliophobius* and *Georychus*, or Afrotherian sengis. The results not only discovered unusual

→

The emergence and spreading of savannahs in tropical Africa 5-7 million years ago caused radiation in many groups of African mammals, including the ancestors of our own species | Photo credit: Radim Šumbera

The Chingawa tropical rainforest in southwestern Ethiopia is isolated from other African forests by the wide belt of dry savannah. The rodent genus *Chingawaemys* originated here 6 million years ago, and today it is its only known locality. | Photo credit: Leonid A. Lavrenchenko

The only known specimen of the rare newly discovered genus and species *Chingawaemys rarus* is kept in the collections of the Zoological Museum of Moscow State University | Photo credit: Leonid A. Lavrenchenko

processes forming African biodiversity (e.g. reticulate evolution in the Ethiopian Highlands), but also have taxonomic implications, and several taxa were already newly described or rearranged.

The resolved phylogeny of the strikingly coloured mice of the genus *Lemniscomys* can be used to study the mechanisms of the development of coat coloration in mammals | Photo credit: Alexandra Hánová

The Rufous Sengi (*Galegeeska rufescens*) from Somali-Masai savannahs looks like a mouse-like rodent, but it is more closely related to elephants, aardvarks, or sirenians | Photo credit: Alexandra Hánová

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Photo credit: archive IVB

BIODIVERSITY

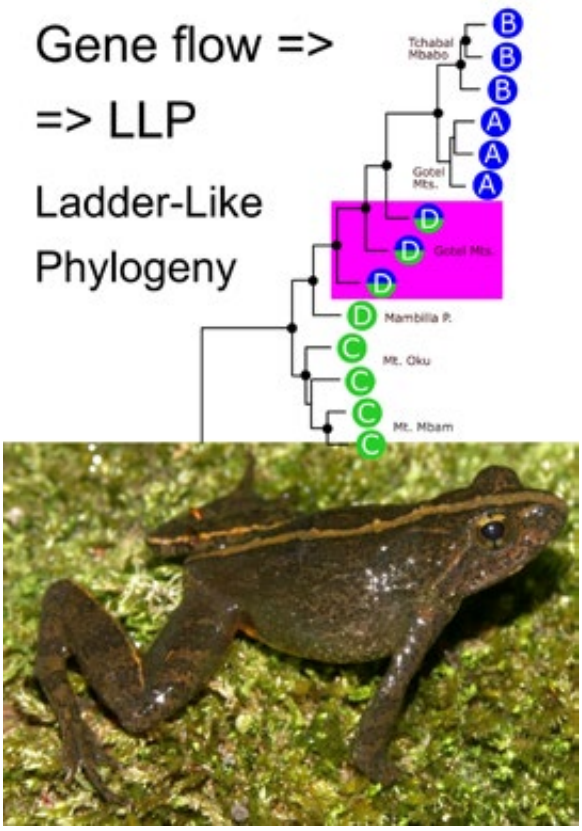
HERPETOLOGICAL DIVERSITY GROUP

Photo credit: Václav Gvoždík

Evolution, biogeography and systematics of Central African amphibians

The region of Central Africa remains largely unexplored, and the amphibians of this region have been studied using various models. One of these studies focused on African puddle frogs and used genomic and morphological data to examine their evolutionary history, diversification, and hybridization within the unique ecosystem of montane forests in the Cameroon Highlands. This study also discovered a new species of frog, named *Phrynobatrachus amieti* (Amiet's Puddle Frog), and identified a problem/artefact in phylogenomic data analysis called the "Ladder-Like Phylogeny" (LLP).

Another study of reed frogs found an ancient evolutionary lineage in the lowland rainforests of central Congo, which likely evolved due to convergent evolution. This newly discovered frog genus, named *Congolius*, is endemic to the area. A third study investigated the amphibian community in the Kokolopori reserve in the central Congolian lowland forest and discovered several previously undescribed species. Last but not least, another study proposed a new classification scheme for the reed frog family, which elucidates the systematic placement of the obscure frog genus *Kassinula*.



Phrynobatrachus amieti and a diagram unveiling an analytical artefact in phylogenomic trees, Ladder-Like Phylogeny (LLP) resulting from gene flow | Photo credit and artwork: Václav Gvoždík

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BIODIVERSITY

FARMLAND BIODIVERSITY RESEARCH GROUP

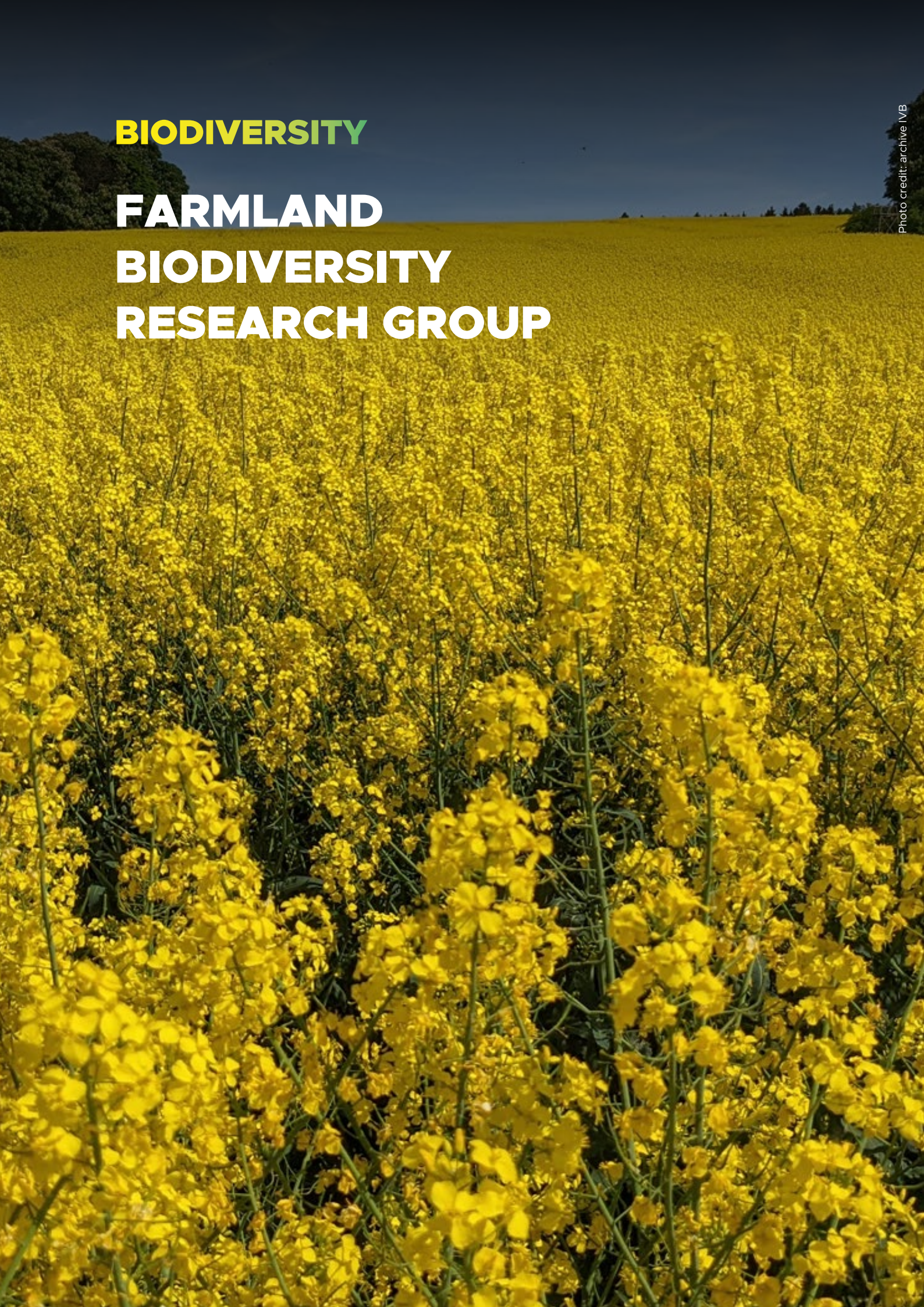


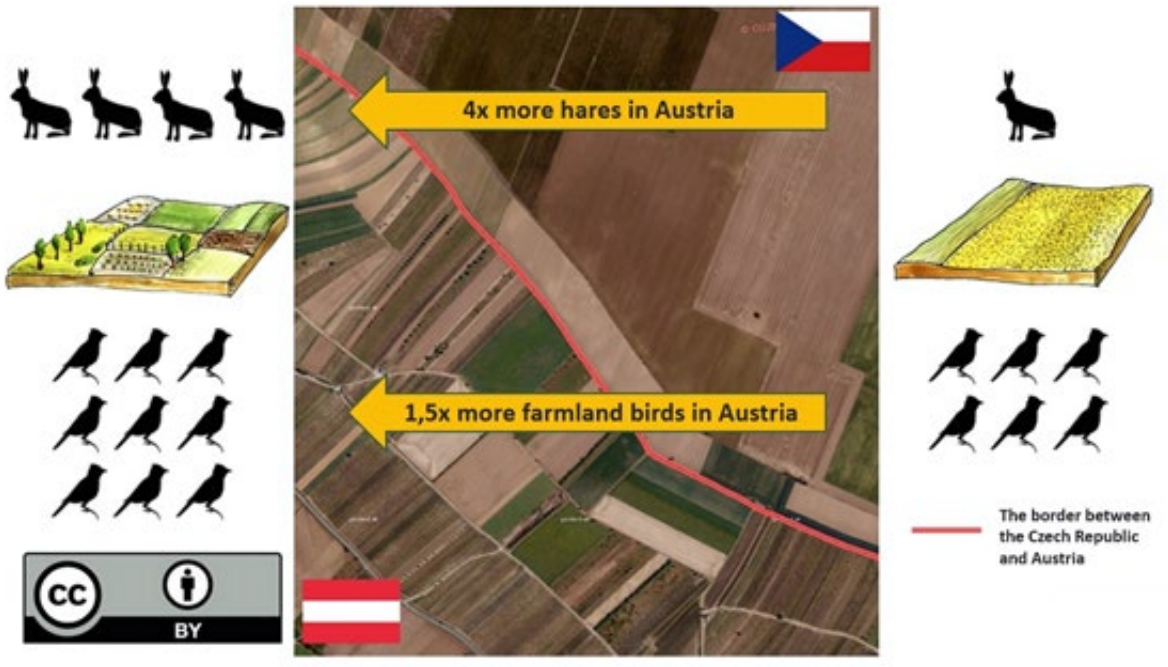
Photo credit: archive IVB

Optimising agricultural landscapes for farmland species

Agricultural intensification led to the transformation of structurally complex agricultural landscapes, resulting in subsequent landscape heterogeneity loss. We compared farmland bird communities in two cross-border regions (Austria and the Czech Republic) that have a similar share of arable land and non-crop habitats but markedly differ in landscape heterogeneity.

We found a substantially higher abundance (ca. 1.5-fold) and species richness of farmland birds in Austria compared to the Czech Republic. This finding demonstrates that conservation measures promoting small and fragmented crop fields over large ones, along with increasing field margins, may be an effective measure to increase declining farmland biodiversity.

Another simple and cost-effective measure for conserving farmland biodiversity might involve creating wildlife strips within farmland. In particular, we found that seed-rich strips (SRS) are strongly preferred by most farmland species wintering in intensively used farmland, providing



Higher landscape heterogeneity in Austria results in higher abundance and species richness of farmland birds and higher number of hares in Austria compared to the Czech Republic | Photo credit: Martin Šálek

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them with essential resources, primarily food and cover from predators. Improving the performance of current seed mixtures in supplying late-winter seeds could help increase their conservation value for farmland species.

Finally, semi-natural habitats might be viewed as potential buffers against agricultural intensification, yet a thorough evaluation of their ability to support farmland biodiversity was lacking. Therefore, we explored the conservation potential of two different types of semi-natural habitats for birds in farmland – hedges and open scrubland. Our results demonstrate that both open scrubland and hedges provide suitable habitats for bird species with different ecological requirements. Decisions regarding their restoration and management depend on the target of conservation. Specifically, to support the open habitat species, efforts should aim on open scrubland, whereas hedges should be maintained and restored for woodland birds.

Seed-rich strips may provide key food resources and shelter opportunities for farmland species during the winter | Photo credit: Václav Zámečník

Financial support for the agricultural production of small-scale farming may effectively help to protect farmland species | Photo credit: Martin Šálek

Photo credit: Shutterstock

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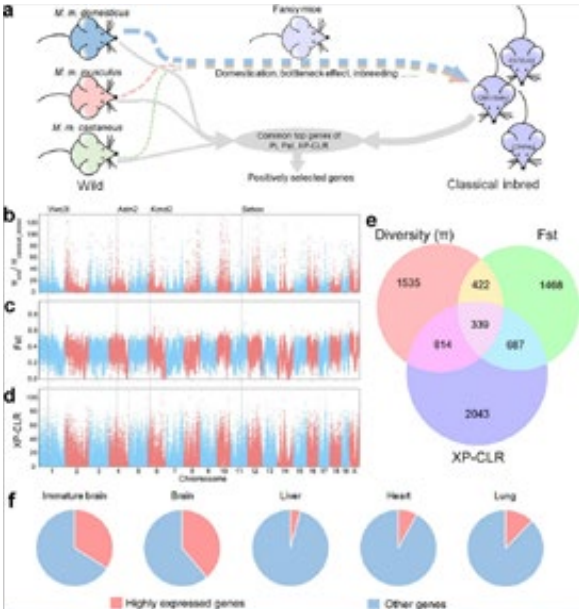
HOUSE MOUSE RESEARCH GROUP

Photo credit: archive IVB

Unveiling the genetic basis of domestication: Insights from wild and laboratory mouse genomes

Animal domestication represents a unique evolutionary event involving artificial selection, entwined with the history of human society. During the process of domestication by humans, animals are forced to adapt to new environments and display traits that differ from those of their wild relatives, such as changes in coat colour, body shape, more frequent estrus cycles, and milk production. Modification in behaviour, especially increased tameness, occurs in almost all domesticated animals.

Thanks to their easy handling and reproduction in captivity, classical laboratory mouse strains (CLS) are used worldwide as animal models in biomedical research. However, the genetic mechanism behind laboratory mouse domestication remained unknown due to a lack of adequate genomic sequences from wild mice.



To shed light on the domestication process, we sequenced the whole genomes of 36 wild mice and 36 CLS. All laboratory mice clustered together distinctly from wild mice. By using three different methods designed to reveal genetic differentiation between the two populations (nucleotide diversity analysis, Fst, and XP-CLR), we identified 339 positively selected genes closely associated with nervous system function. Approximately one-third of these positively selected genes are highly expressed in brain tissues, and genetic mouse models of 125 genes among them exhibit abnormal behavioural or nervous system phenotypes.

These positively selected genes show a higher ratio of differential expression between wild and classical inbred mice compared to all genes. Using a mutant mouse model, we discovered that the SNP rs27900929 (T>C) in the *Astn2* gene significantly reduces the tameness of mice. Tameness might be linked to the *Astn2* mutation in laboratory strains, which was preferentially selected in captivity to ease their handling. The discovery of the 339 PSGs in our study will benefit future studies in behaviour or physiology of these genes in classic inbred mice.

Positively selected genes (PSGs) associated with domestication in mice. **a** The diagram of domestication history of classical inbred mice and the strategy for selecting PSGs. **b–d** Manhattan plots indicate high and low positive selected regions by nucleotide diversity ($\pi_{wild}/\pi_{classical\_inbred}$), Fst, and XP-CLR. The highly selected genes marked by grey lines are individually validated by the following experiments. **e** The Venn diagram depicting genes identified by three independent approaches illustrated in **b–d**. The intersection includes 339 PSGs (Figure taken from Liu et al. 2022)

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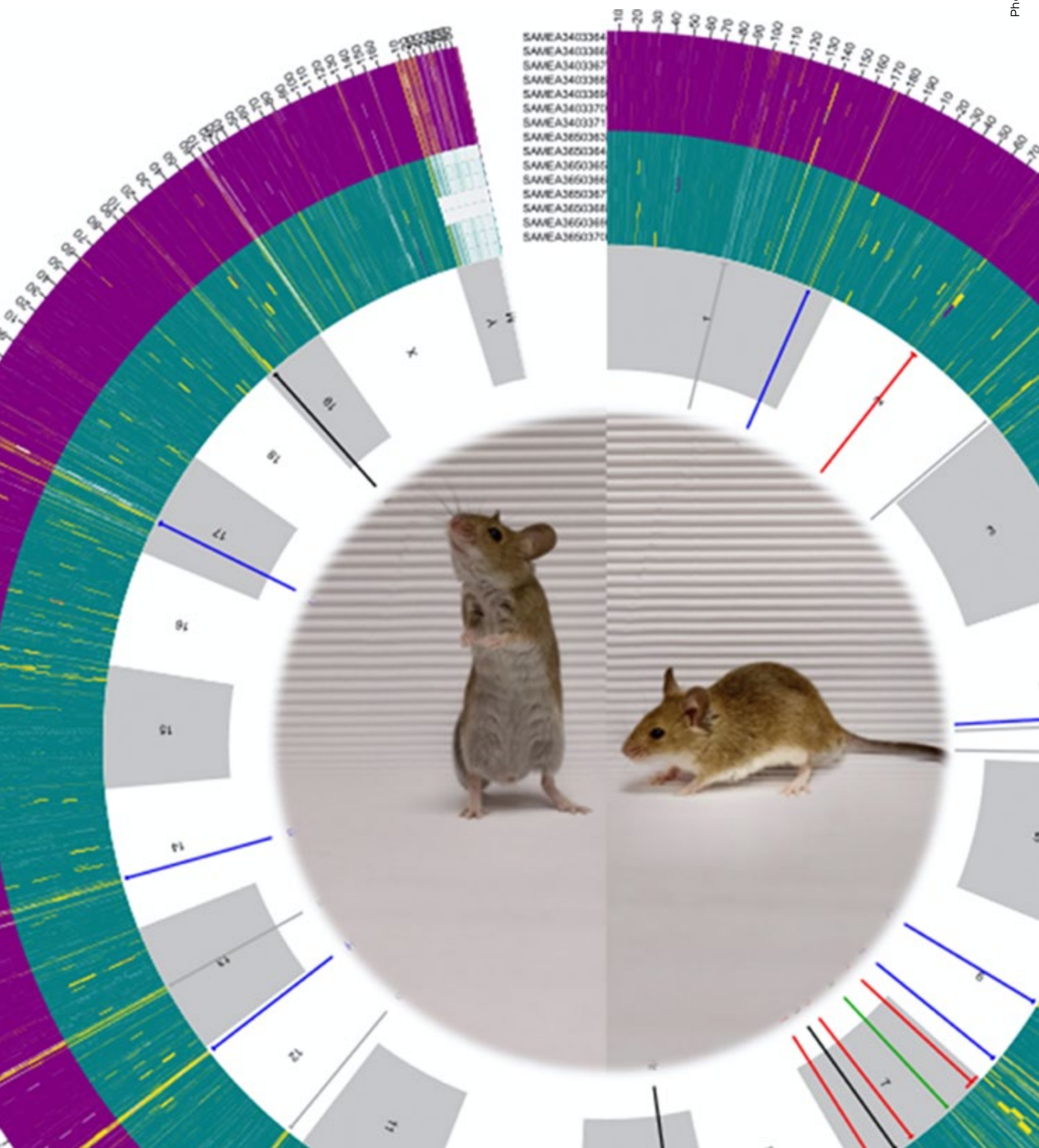

Photo credit: archive IVB

Distinguishing DNA sequencing arising from either side of a barrier to geneflow

in collaboration with Evolutionary Modelling Research Group

The strength of barriers to geneflow between populations governs how fast they can adapt: In a changing environment, populations may 'borrow' adaptive DNA sequence from neighbours, a process called adaptive introgression. This is slow when barriers are strong, but fast when they are weak. An empirical understanding of the presence/absence of barriers, and barrier strengths, will aid in predicting population survival through periods of rapid environmental change such as the current climate crisis. To measure barrier strength one must first distinguish which sequences arose from either side of a barrier. Our algorithm lies at the base of such analyses, but has even wider application.

S. J. E Baird and N. Martínková developed and implemented an Expectation Maximisation algorithm with general application over genomic admixture studies | Photo credit: archive IVB

Baird SJE, Petružela J, Jaroň I, Škrabánek P, **Martínková N**, 2022. Genome polarisation for detecting barriers to geneflow. *Methods in Ecology and Evolution*, doi: https://doi.org/10.1101/2022.03.24.485605

Distinguishing DNA sequencing arising from gametes versus soma

Many aspects of natural selection can disproportionately act on the haploid phase of life cycles – the gametes. Teasing apart haploid/diploid differences using modern mass sequencing approaches requires researchers to have tools that distinguish reads originating from haploid vs. diploid tissues. A comparison of k-mer spectra and classical population genomic approaches shows, for example, 40% of the DNA in male Springtails originates from haploid (stored) sperm.

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BIODIVERSITY

CONSERVATION BIOLOGY GROUP

Photo credit: Ivan Khaze

Eurasian lynx in Europe: factors limiting further growth of isolated populations

Eurasian lynx experienced significant recovery during the second half of the 20th century and the beginning of the 21st century in Western and Central Europe. Several reintroductions and legal protection have aided in re-establishing lynx populations. However, the initial abundance increase has stopped in many areas, leaving their future uncertain. Current conservation efforts are leading to further reinforcements and reintroductions, but these activities should be coordinated at an international level, as we pointed out for the European scientific community. Our research further helps identify intrinsic factors, especially on the genetic level, and extrinsic factors that have negatively affected lynx populations, contributing to their effective protection. For example, at the genome level, a significant loss of genomic variability in reintroduced populations has been confirmed to threaten their long-term viability.

Collecting sufficient data about this elusive species presents a challenge. Several modern methodological approaches, and the efficient scientific collaboration on a pan-European scale (platform Eurolynx), enables us to bring together data from different areas within the large but fragmented lynx European distribution range and study ecological and evolutionary processes on robust datasets.

Our study revealed that human disturbances (roads, human settlements) are the most limiting factors driving lynx habitat selection throughout continental Europe. Nevertheless, lynx can tolerate these factors to a great extent, provided that enough refuges are available. Long-term camera-trapping further revealed fluctuating annual densities and high turnover rates on the western edge of the Carpathians.

This fact, in combination with documented lynx mortality (poaching, road kills), indicates that also this native population, a source for many previous and ongoing reintroductions, faces several human-induced mortalities, which restrict population growth and limit dispersion to subsequent areas, even though lynx males are capable of dispersing hundreds of kilometres far away through human-dominated landscapes. We have uncovered such lynx movements, which rank among the longest ever described for lynx in Central Europe, suggesting to some extent plasticity and adaptability of this iconic predator.

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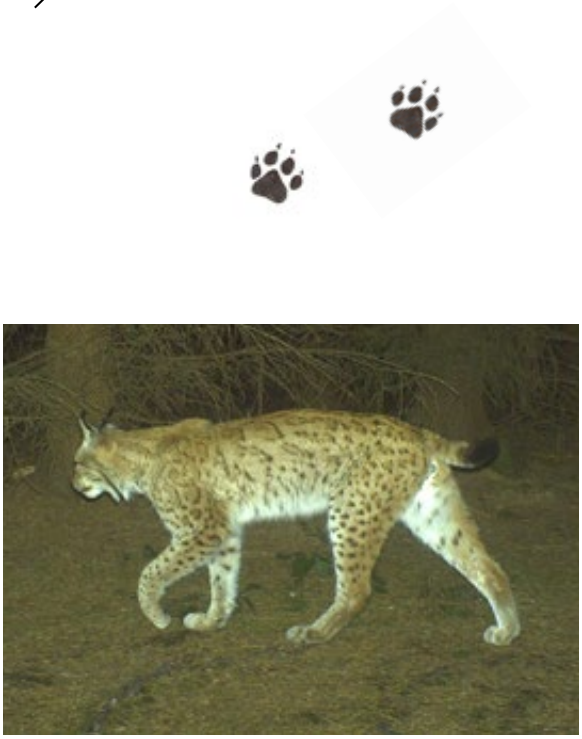
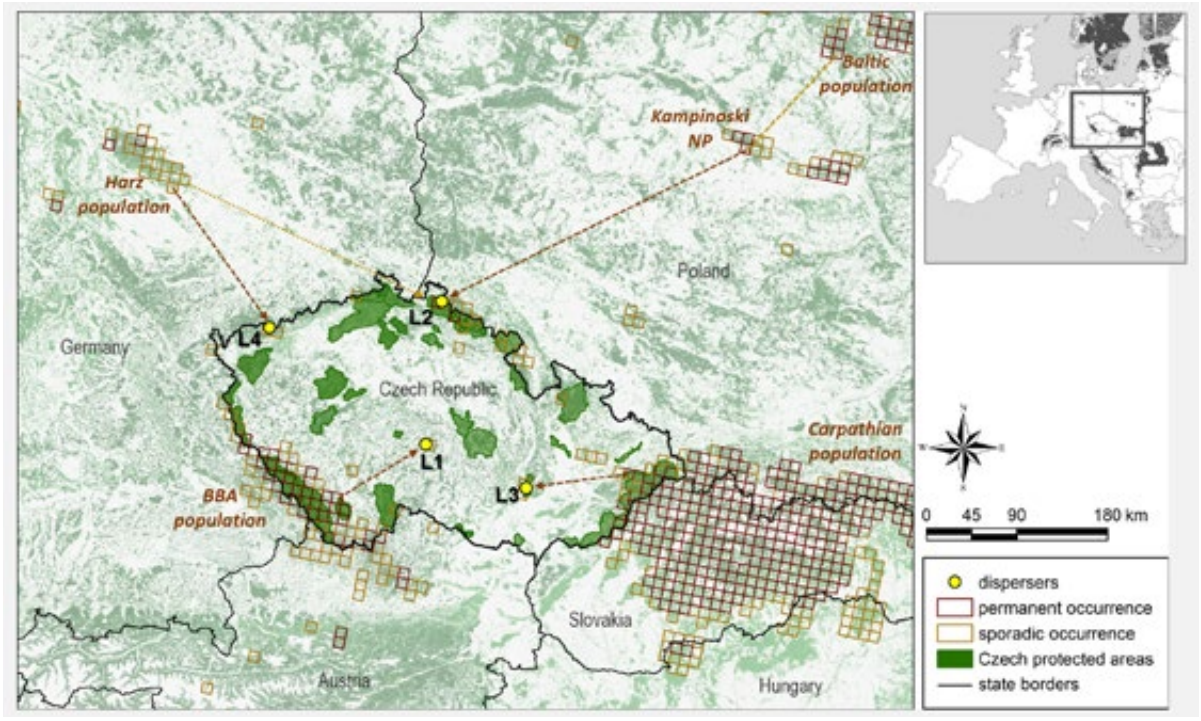
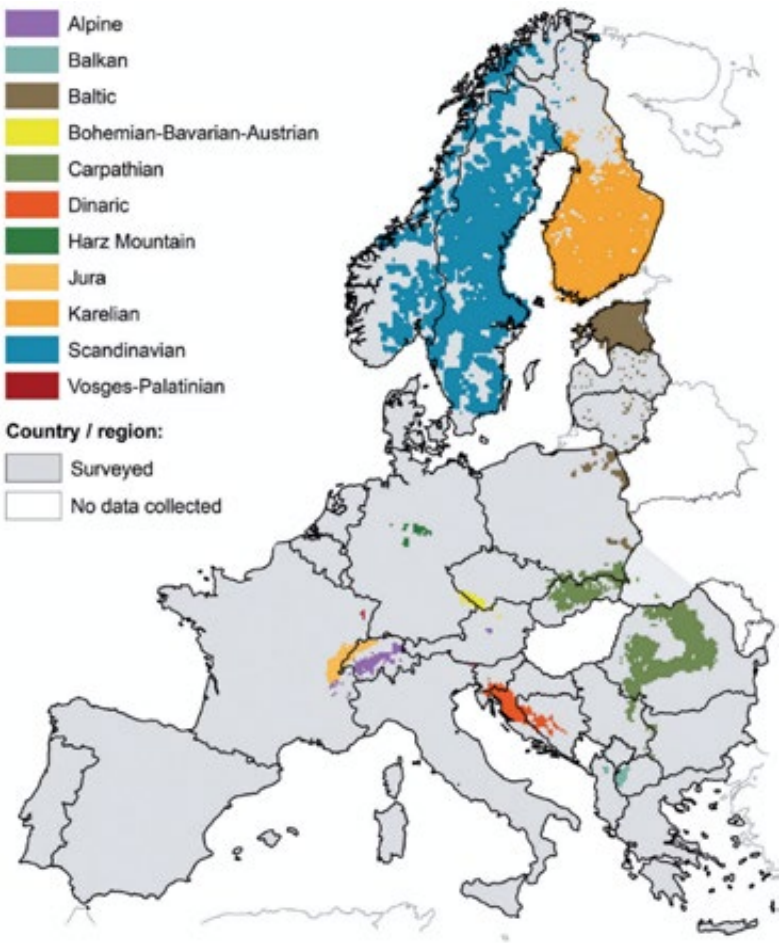


Eurasian lynx captured by camera-trap in Javorníky Mountains | Photo credit: camera-trap of IVB CAS

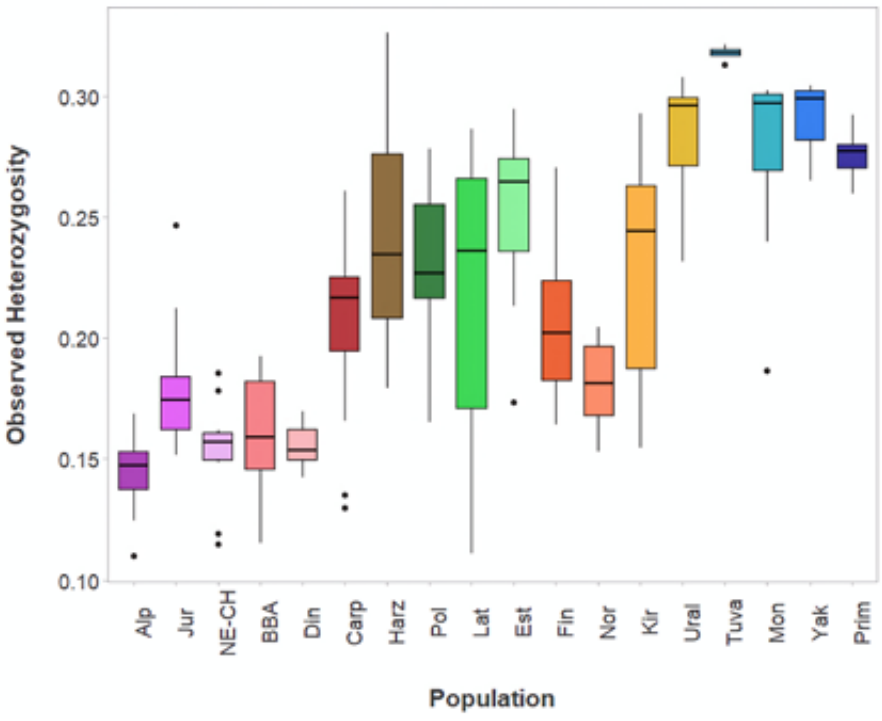
Eurasian lynx captured by camera-trap in Moravian-Silesian Beskids | Photo credit: camera-trap of IVB CAS



Distribution of Eurasian lynx populations in Europe 2012–2016 according to von Arx et al. (2021). The map is showing only the permanent presence. | © Large Carnivore Initiative for Europe



The arrows indicate supposed origin of four dispersing lynx detected outside the permanent distribution range in Czechia, all four belonged to different populations | Gajdárová et al. 2021



Observed heterozygosity calculated for different European lynx populations indicates lower values for five reintroduced populations on the left | Mueller et al. 2022

European beaver: problematic species in the cultural landscape

The beaver is a protected species, but in the cultural landscape a problematic species. While contributing to increased biodiversity, it also causes damage to the forest. The aim of this study was to analyse the foraging behaviour of beaver in different habitat types and to propose its appropriate management. Optimal conditions for beavers are found in alluvial forests, where they, however, cut down farm trees. Forest protection can be ensured by planting willows and poplars along watercourses. In agricultural landscapes, beavers do not cause damage, because they occur in small numbers. Beaver management must flexibly adapt to local conditions to protect the species and limit damage.

Mikulka O, Adamec Z, Kamler J, **Homolka M**, Drimaj J, Plhal R, Pyszko P, 2022. Using deciduous softwoods to protect commercial forest stands against damage by Eurasian beaver (Castor fiber L.). *Forest Ecology and Management* 520: 120328.

Mikulka O, Pyszko P, Skoták V, Kamler J, Drimaj J, Plhal R, **Homolka M**, 2022. The influence of forestry management on the selection of a non-vegetative diet by the Eurasian beaver (*Castor fiber* L.). *Animals* 12: 2949.

Mikulka O, **Homolka M**, Drimaj J, Kamler J, 2022. Feeding Behaviour of Eurasian Beavers (Castor fiber) Along Small Streams in an Agricultural Landscape. *Universitatis Agriculturae et Silviculturae Mendelianae Brunensis* 70(2):71-82. DOI: 10.11118/actaun.2022.007.

Mikulka O, Pyszko P, Kamler J, Patočka Z, Drimaj J, Plhal R, **Homolka M**, Korbelová J, 2023. Landscape settlement and parameters of Eurasian beaver (*Castor fiber*) home ranges in the Czech Republic. *European Journal of Wildlife Research* 69:7. https://doi.org/10.1007/s10344-022-01624-4

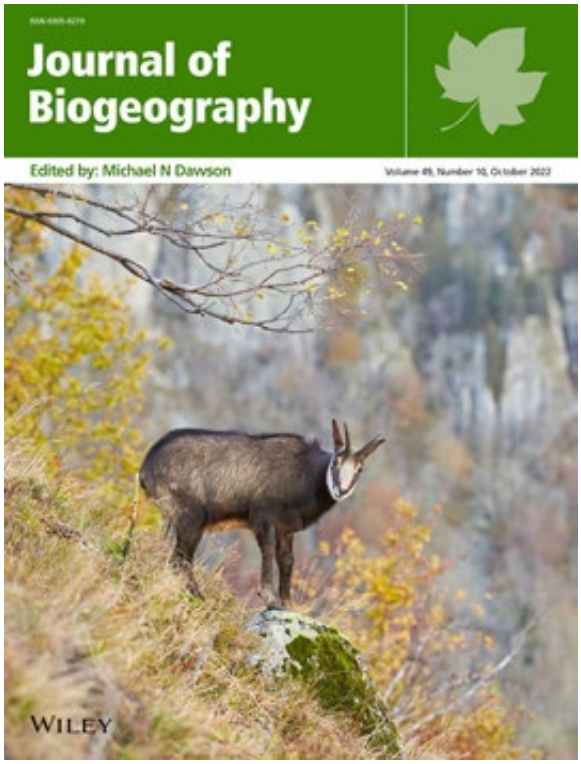
Dispersal and habitat dynamics shape the genetic structure of the Northern chamois in the Alps

Mathematical modelling was used to investigate the connectivity of Northern chamois populations in the changing landscape of the Alps, spanning from the last glaciation (20,000 years ago) to the present. Additionally, almost 450 chamois samples from its entire Alpine distribution range were collected due to cooperation of many organisations, including IVB Genetic Bank. These samples were used to assess the current genetic structure based on whole-genome markers. Comparison of the observed genetic structure with the resulting mathematical models of the current state enabled verification of the modelling accuracy. Thus, a procedure was developed that allows not only to understand the origin of biodiversity in different mountain areas, but also to predict the future development of population structure and size of species distribution range as a response to climate change. This is particularly relevant for conservation management planning.

Leugger F, Broquet T, Karger DN, Rioux D, Buzan E, Corlatti L, Crestanello B, Curt-Grand-Gaudin N, Hauffe HC, **Rolečková B**, Šprem N, Tissot N, Tissot S, **Valterová R**, Yannic G, Pellissier L, 2022. Dispersal and habitat dynamics shape the genetic structure of the Northern chamois in the Alps. *Journal of Biogeography* 49: 1848-1861.

Although little populations of Alpine chamois live in Slovakia and even in the Czech Republic, where they were introduced, the original and largest population inhabits the entire Alps | Photo credit: Jozef Kormančík

Alpine chamois (*Rupicapra rupicapra*) | Photo credit: Jozef Kormančík



Our comprehensive study showed that the chamois population in the Alps is further structured due to limited dispersal ability of chamois and landscape connectivity and that time changes of distribution range size can be effectively estimated based on habitat and climate conditions using modelling methods.

GENERAL ECOLOGY

FISH ECOLOGY GROUP

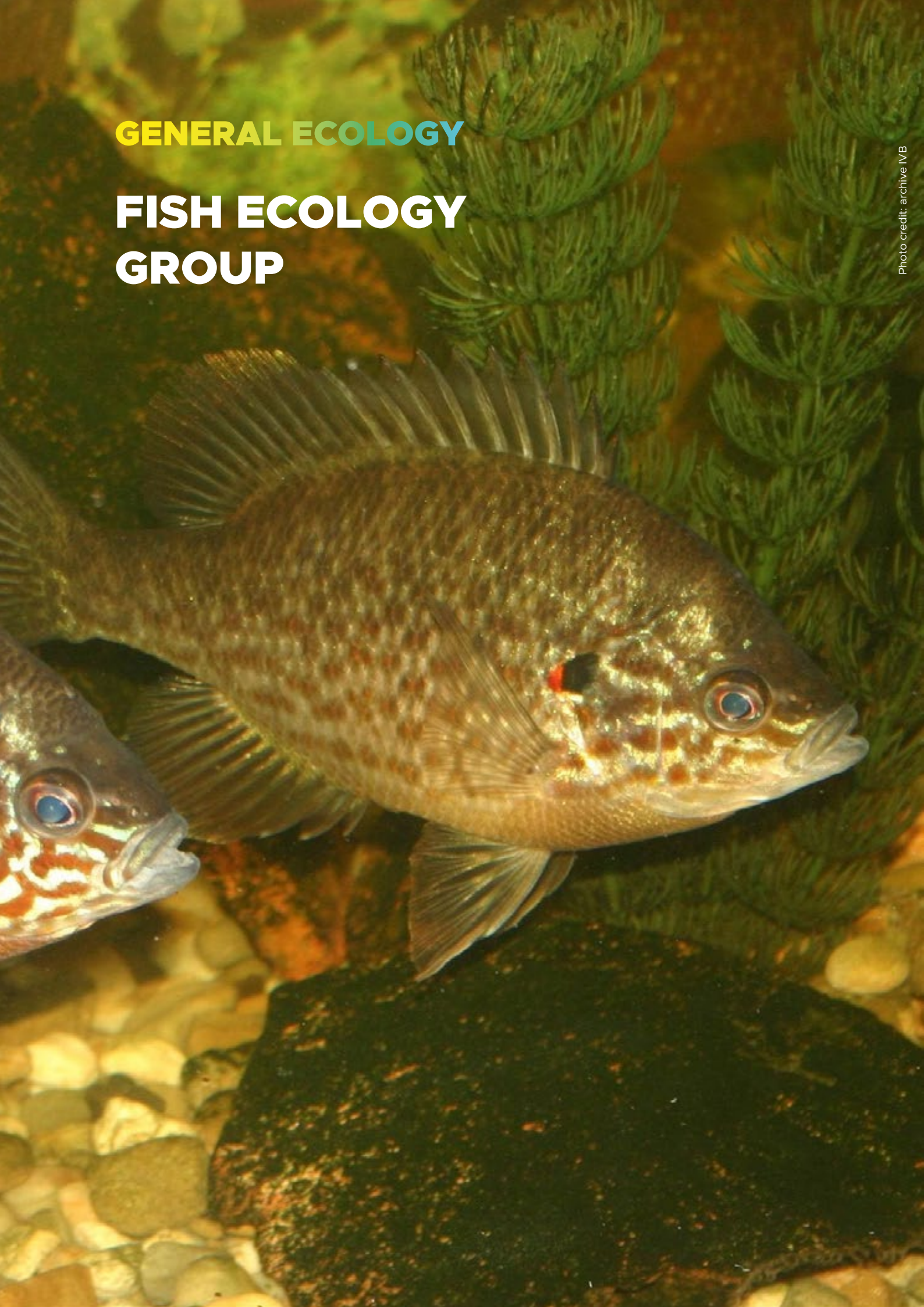


Photo credit: archive IVB

Interactions of non-native fish species

Invaders themselves evolve in response to new abiotic environments, their interactions with native species, including parasites, but also in response to other invasive species. Therefore, with the increasing number of invasive species, studies on their mutual interactions became increasingly important. Our studies on interactions between two invasive fish species, the round goby and the tubenose goby, shows the essential role of habitat alterations in their invasions of European rivers.

Round goby invasion is, in general, facilitated by river channelization and bank stabilisation, resulting in homogeneous rip-rap banks. Being a stronger competitor, round goby usually suppresses tubenose goby populations. However, microhabitat variability within stabilised bank structures can facilitate their coexistence via fine-scale niche separation.

Non-native fish species showed the ability to acquire a wide range of local parasite species, particularly in their larval stages with low host specificity. Some of these new host-parasite interactions indicate that novel hosts may serve as additional definitive hosts, contributing to an increase in parasite numbers at sites with high densities of non-native fish hosts. Such an example is the cestode *Bothriocephalus claviceps*, naturally infecting eels, which matured also in American *Lepomis gibbosus*.

This fish species also appears to be one of the preferred hosts of *Neoergasilus japonicus*, a parasitic copepod introduced from Asia, indicating a potential invasion meltdown. The brown bullhead catfish, Ameiurus nebulosus, introduced to Europe from North America, has become a common intermediate/paratenic host for the colubrid snake cestode *Ophiotaenia europaea*. This finding indicates that this non-native fish species has been successfully included into the life cycle of the local parasite.

Janáč M, Šlapanský L, Kopeček L, Prudík B, Mrkvová M, **Halačka K, Jurajda P**, 2022. Fine-scale microhabitat niche separation allows coexistence of two invasive species. *Hydrobiologia* 849: 4407-4425.

Kvach Y, Kutsokon Y, **Janáč M**, Dykyy I, Dzyziuk N, Dudliv I, Nazaruk K, 2022. Parasites of the invasive Chinese sleeper *Perccottus glenii* (Actinopterygii: Odontobutidae) in the region of the first introduction of the Carpathian population. *Oceanological and Hydrobiological Studies* 51: 1-9.

Kvach Y, Tkachenko M, Bartáková V, Zięba G, **Ondračková M**, 2021. The role of the non-indigenous pumpkinseed *Lepomis gibbosus* (Actinopterygii: Centrarchidae) in the life cycle of *Bothriocephalus claviceps* (Cestoda: Bothriocephalidae) in Europe. *Parasitology Research* 120: 3163-3171.

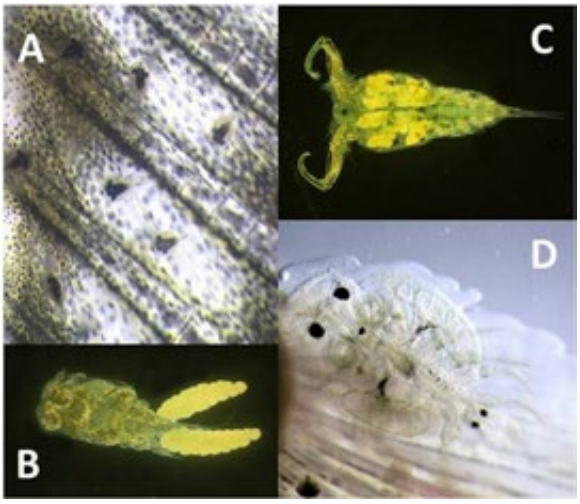
Kvach Y, Tkachenko M, Seifertová M, **Ondračková M**, 2021. Insights into the diversity, distribution and phylogeny of three ergasilid copepods (*Hexanauplia:* Ergasilidae) in lentic water bodies of the Morava river basin, Czech Republic. *Limnologica* 91: 125922.

Ondračková M, Janáč M, Borcherding J, Grabowska J, **Bartáková V, Jurajda P**, 2021. Non-native gobies share predominantly immature parasites with local fish hosts. *Journal of Vertebrate Biology* 70: 21050.

Ondračková M, Bartáková V, Kvach Y, Bryjová A, Trichkova T, Ribeiro F, Carassou L, Martens A, Masson G, Zechmeister T, **Jurajda P**, 2021. Parasite infection reflects host genetic diversity among non-native populations of pumpkinseed sunfish in Europe. *Hydrobiologia* 848: 2169-2187.

Ondračková M, Bartáková V, Kvach Y, 2021. *Ophiotaenia europaea* Odening, 1963 (Cestoda: Onchoproteocephalidea) adopts a North American brown bullhead catfish *Ameiurus nebulosus* Lesueur, 1819 as intermediate/paratenic host in Europe. *BioInvasions Records* 10: 948-959.

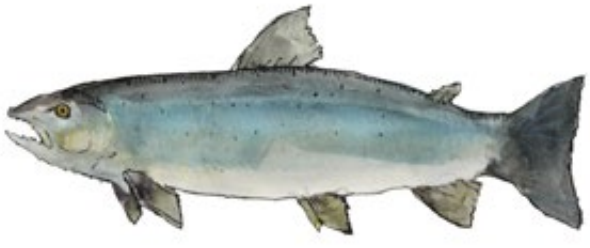
Roche K, Šlapanský L, Trávník M, **Janáč M, Jurajda P**, 2021. The importance of rip-rap for round goby invasion success - a field habitat manipulation experiment. *Journal of Vertebrate Biology* 70: 21052.



Parasites acquired by non-native fish hosts in their new range: (A,B) *Neoergasilus japonicus*, introduced from Asia, (C) *Ergasilus sieboldi*, parasitic copepod common in Europe, and (D) *Argulus foliaceus*, generalist branchiuran infecting wide range of fish species.

Fish sampling using beach seine in typical habitat in the floodplain of the Dyje River, invaded by several non-native fish species | Photo credit: Luděk Šlapanský

Round goby (*Neogobius melanostomus*), introduced to Morava and Dyje rivers from its native range in the lower Danube | Photo credit: Luděk Šlapanský



Pharmaceutical contamination, parasite load and condition in freshwater fishes

In the aquatic environment, human and veterinary pharmaceuticals and their metabolites belong to emerging pollutants because of their ever-increasing use to enhance human and animal health. Due to their biological activity, these substances can affect aquatic organisms and their interactions. Once released into the environment, pharmaceutical compounds can create a pollutant 'cocktail' that may act additively or antagonistically on living, mostly non-target, organisms. As such, it is hard, if not impossible, to identify specific effects at this time.

The effluent of municipal sewage treatment plants (STPs) contains numerous organic and inorganic pollutants due to the insufficient removal efficiency during the treatment processes. In our studies, we focused on fish exposed to pollutants, particularly pharmaceuticals, released from municipal STPs. Fish serve as good indicators of aquatic pollution because they are able to bioaccumulate pollutants in water via their food. In a lotic system, we tested pharmaceutical uptake, condition, and parasite infection in brown trout, collected both upstream and downstream of an STP effluent, with both sites separated by a weir. The same parameters were tested in a lentic system, using common carp stocked in both polluted and control ponds.

Our results showed that the direct and indirect impacts of pharmaceuticals on fish, particularly in terms of biometric parameters, could be highly variable, often reflecting food availability. In addition, unsuitable conditions for some parasites, the natural regulators, could contribute to a better condition of fish within polluted environments. The links between pollution and parasitism were not general in lentic and lotic systems, indicating that parasite-host relationships are often complex and may reflect the impacts of other competing factors. However, we found major differences in response to pollution between parasite families within taxonomic groups, especially in ectoparasites.

Common carp *Cyprinus carpio* stocked in ponds in Vodnany town was studied for accumulation of pharmaceutical compounds and the effect of organic pollution on parasite infection | Photo credit: Zdeněk Adámek

Zivny stream in South Bohemia downstream the sewage treatment plant | Photo credit: Luděk Šlapanský

Pravdová M, Kolářová J, Grabicová K, Randák T, **Janáč M**, **Kvach Y, Jurajda P, Ondračková M**, 2022. Pharmaceutical contamination and biotic factors affecting parasitism in common carp (*Cyprinus carpio*). *Aquaculture Research* 53: 4116-4127.

Pravdová M, Kolářová J, Grabicová K, Mikl L, Bláha M, Randák T, **Kvach Y, Jurajda P, Ondračková M**, 2021. Associations between pharmaceutical contaminants, parasite load and health status in brown trout exposed to sewage effluent in a small stream. *Ecohydrology & Hydrobiology* 21: 233-243.

GENERAL ECOLOGY

PRIMATE SYMBIONT ECOLOGY GROUP

Photo credit: Babrora Červená

Success in mountain gorilla conservation leads to unexpected challenges

The endangered mountain gorillas live in two populations in national parks in Rwanda, Uganda and the Democratic Republic of the Congo and intensive conservation efforts have led to their increase. Limited spatial expansion resulted in increased population densities, which may alter the epidemiology of infectious diseases, for example, higher stress levels. Our study of lowland gorillas showed increased strongylid infection intensities in groups with higher levels of glucocorticoid metabolites, indicators of stress. Recently, clinical cases of gastrointestinal illness linked to helminth infections have been recorded in both mountain gorilla populations. To understand patterns and drivers of helminth infections, we quantified strongylid and tapeworm infections in samples collected across both Virunga Massif and Bwindi populations. Significant geographic differences in strongylid infections were recorded, and gorillas living in areas with a higher incidence of gastrointestinal disease had higher numbers of strongylid eggs. This increased strongylid infection intensity was associated with a smaller size of proxy for home range, higher gorilla density, and vegetation occurring at higher elevation and lower temperatures. Our results suggest that strongylid nematodes may partially regulate the mountain gorilla population at higher gorilla densities. Hence, successful conservation led to recovery of mountain gorilla populations and significant increase in gorilla numbers in recent decades, however, the limited amount of habitat impedes population expansion and probably leads to the emergence of new health challenges. Further research should investigate potential reservoirs of infection for the mountain gorillas or e.g., compare the mountain gorilla strongylid nematode communities with those in wild lowland gorillas, which do not show any clinical signs of helminth infections.

Shutt-Phillips K, **Pafčo B**, Heistermann M, Kasim A, **Petrželková KJ**, Profousová-Pšenková I, Modrý D, Todd A, Fuh T, Dicky J-F, Bopalanzognako J-B, Setchell JM, 2021. Fecal glucocorticoids and gastrointestinal parasite infections in wild western lowland gorillas (*Gorilla gorilla gorilla*) involved in ecotourism. *General and Comparative Endocrinology* 312: 113859.

Petrželková KJ, Uwamahoro C, **Pafčo B, Červená B, Samaš P**, Mudakikwa A, Muvunyi R, Uwingeli P, Gilardi K, Nziza J, Noheri JB, Eckardt W, Ndagijimana F, Ssebide B, Okwirokello R, Nizeyimana F, Syaluha EK, Nzayisenga G, Flores Girón L, Bahizi M, Ntwar, AE, Lukusa JP, Tumushime JC, Mangura D, Mapilanga J, Kalonji A, Aruho R, Stryková A, Tehlarová Z, Cameira R, Lowenstine L, Šlapeta J, Romportl D, Ferrari N, Cranfield M, Modrý D, 2021. Heterogeneity in patterns of helminth infections across populations of mountain gorillas (*Gorilla beringei beringei*). *Scientific Reports* 11: 10869.

Petrželková KJ, Samaš P, Romportl D, Uwamahoro C, **Červená B, Pafčo B,** Prokopová T, Cameira R, Granjon AC, Shapiro A, Bahizi M, Nziza J, Noheri JB, Syaluha EK, Eckardt W, Ndagijimana F, Šlapeta J, Modrý D, Gilardi K, Muvunyi R, Uwingeli P, Mudakikwa A, Mapilanga J, Kalonji A, Hickey JR, Cranfield M, 2022. Ecological drivers of helminth infection patterns in the Virunga Massif mountain gorilla population. *International Journal for Parasitology: Parasites and Wildlife* 17: 174-184.

Mason B, Petrželková KJ, Kreisinger J, Bohm T, **Červená B**, Fairet E, Fuh T, Gomez A, Knauf S, Maloueki U, Modrý D, Shirley MH, Tagg N, Wangue N, **Pafčo B**, 2022. Gastrointestinal symbiont diversity in wild gorilla: A comparison of bacterial and strongylid communities across multiple localities. *Molecular Ecology* 31: 4127-4145.

Group of mountain gorillas (*Gorilla beringei beringei*) in Bwindi Impenetrable National Park, Uganda | Photo credit: Barbora Červená

Collection of mountain gorilla faecal samples in night nests in the Bwindi Impenetrable National Park, Uganda. Faeces are inspected for presence of parasite stages, e.g. adult nematodes or cestode proglottids and subsequently, samples are collected for subsequent examination in the laboratory. The IVB team closely collaborates with the Gorilla Doctors, an organisation monitoring the mountain gorilla health. | Photo credit: Jalika Joyner

Adult strongylid nematodes collected from faeces of a mountain gorilla. The individual exhibited symptoms of gastrointestinal disease, thus anthelmintic drugs were administered, leading to the expulsion of the parasitic nematodes. | Photo credit: Barbora Červená

Photo credit: Barbora Červená

GENERAL ECOLOGY

BAT RESEARCH GROUP

Photo credit: Jiří Pikula

Bat adaptations for hibernation

Hibernation is a characteristic feature of the life cycle of temperate bats. It represents optimal energetic adaptation to the long winter period accompanied by a scarcity of alimentary resources. Successful overwintering is influenced by a number of internal and external factors, including the selection of the right hibernation site. European bats hibernate in shelters that make it possible to minimise energy expenditure and maintain a good condition of the individual until the end of hibernation.

Increased activity at the end of the hibernation period then leads to the rapid depletion of fat reserves. Therefore, excessive disturbance of bats during hibernation is dangerous for bats, which may increase the energy expenditure associated with arousals from hibernation and may even cause the individual to leave the shelter completely or even die. Bats prevent this with a behavioural adaptation called "cold arousal", which conserves their energy reserves.

After a disturbance, they do not arouse from hibernation to full normothermy, but only briefly increase their body temperature to a low "operating" temperature (approx. 12 ˚C) so that they are able to evaluate the reason for the disturbance. This adaptation allows them to avoid the energetic costs of disturbance and successfully survive the winter with enough fat reserves for spring activity.

Hibernating *Myotis myotis* in the Kateřinská cave | Photo credit: Jan Zukal

Bachorec E, Bartonička T, Heger T, Pikula J, **Zukal J**, 2021. Cold arousal - a mechanism used by hibernating bats to reduce the energetic costs of disturbance. *Journal of Thermal Biology* 101: 103107.

Bats and pathogens with zoonotic potential

In recent years, bats have become particularly associated with the origin of the SARS-CoV-2 virus. Simultaneously, research is progressing on other types of pathogens for which bats act as temporary hosts or vectors, with varying potential for transmission to humans. Such agents include rotavirus A, leptospira, trypanosomes, babesia, and non-tuberculous mycobacteria, whose presence has been confirmed in various European bat species. Pathogenic species with zoonotic potential were represented in all groups of microorganisms. Their transmission to humans is possible mainly through the faeces or urine of infected individuals and thus represents a certain risk, especially for people who come into direct contact with bats, i.e. veterinarians, workers in nature protection or rescue stations, firefighters, or speleologists.

However, pathogenic species do not cause massive bat hosts mortality, and their prevalence within bat populations is also relatively low.

Sampling of bats in the Suhata Yantrenska cave (Bulgaria) | Photo credit: Jiří Pikula

Aicher S-M, Streicher F, Chazal M, Planas D, Luo D, Buchrieser J, Němcová M, **Seidlová V, Zukal J,** Serra-Cobo J, Pontier D, Pain B, Zimmer G, Schwartz O, Roingeard P, Pikula J, Dacheux L, Jouvenet N, 2022. Species-specific molecular barriers to SARS-CoV-2 replication in bat cells. *Journal of Virology* 96: e0060822.

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Simsek C, Corman VM, Everling HU, Lukashev AN, Rasche A, Maganga GD, Binger T, Jansen D, Beller L, Deboutte W, Gloza-Rausch F, Seebens-Hoyer A, Yordanov S, Sylverken A, Oppong S, Sarkodie YA, **Vallo P,** Leroy EM, Bourgarel M, Yinda KC, Van Ranst M, Drosten C, Drexler JF, Matthijnssens J, 2021. At least seven distinct rotavirus genotype constellations in bats with evidence of reassortment and zoonotic transmissions. *mBio* 12: e02755-20.

Bat blood sampling | Photo credit: Photo credit: Jana Pikulová

Sampling of bat guano beneath the summer colony | Photo credit: Jan Zukal

GENERAL ECOLOGY

GROUP FOR ZOONOTIC AND EMERGING INFECTIOUS DISEASES

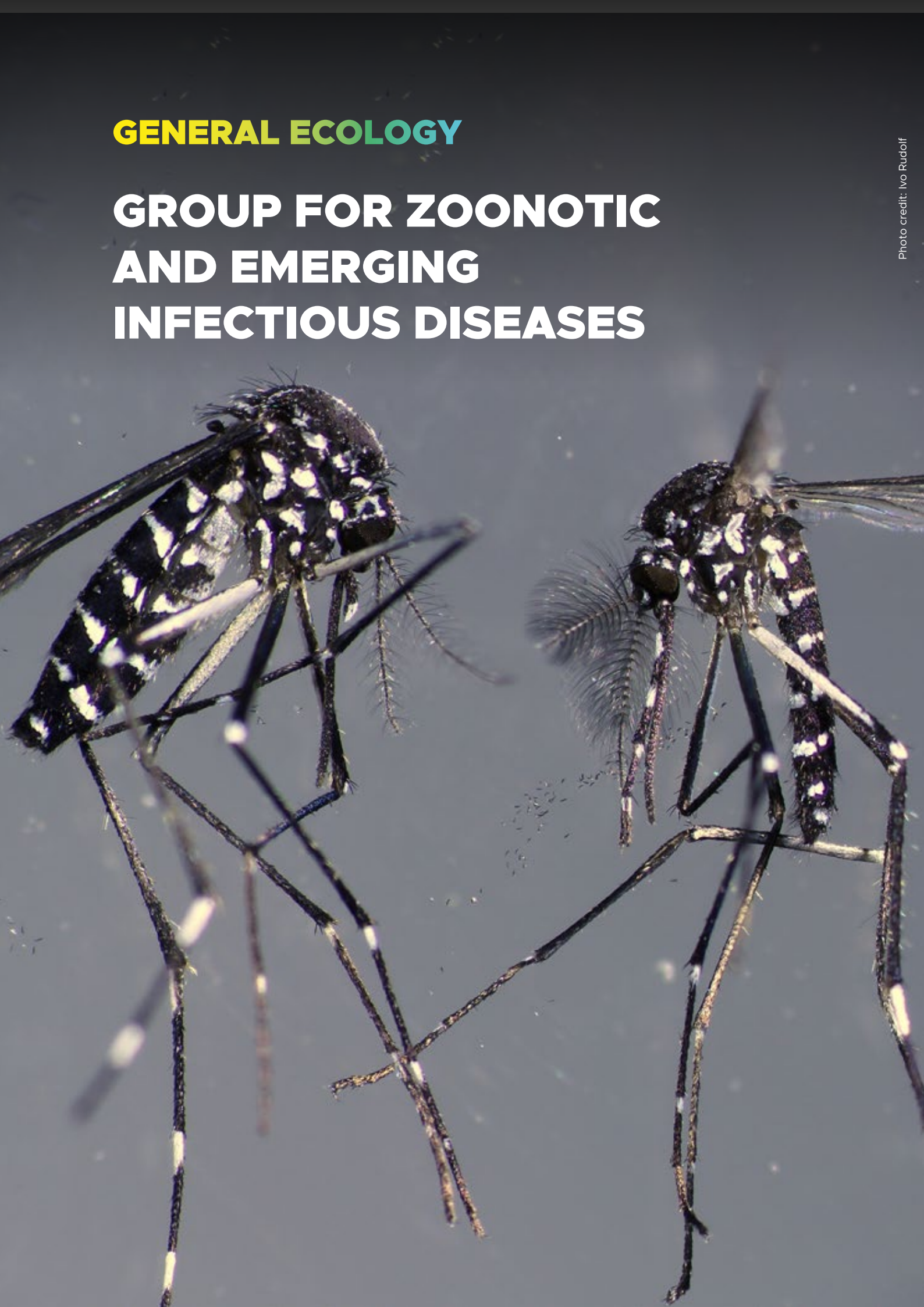


Photo credit: Ivo Rudolf

Leptospira species in bat cadavers

in collaboration with Bat Research Group

The current situation concerning the COVID-19 pandemic is an important reminder that discovering new pathogens in wild vertebrates and quickly determining their pathogenic potential is a key element to reduce global health hazards. As wildlife reservoirs play a major role in the maintenance and spread of emerging zoonoses, uncovering novel pathogens from wildlife remains a highly challenging global research topic. Bats may play a critical role in the spread and emergence of new zoonotic agents.

However, despite numerous detections of potential zoonotic pathogens in bats, little is known about the actual impact of these agents on bats, and thus, on human health. Kidney samples from 300 bat cadavers from the Czech and Slovak Republics were tested for *Leptospira* DNA using PCR and sequencing of three genes (lipL32, flaB, and 16S ribosomal RNA). The overall detection rate was 4.7% and two bat species (*Myotis myotis* and *Nyctalus noctula*) were PCR-positive for at least one gene. Phylogenetically, three lineages were detected within the pathogenic clade of *Leptospira*, one related to *L. borgpetersenii*, another to *L. interrogans*, and a third more distantly related to *L. weilii* (potentially a novel *Leptospira* species), in kidney samples from bat cadavers.

While the phylogenetic placement of these lineages suggests their pathogenic potential for humans and/or other mammals, this assessment is preliminary, pending further clinical and ecological data. Clarifying the epizootiology of *Leptospira* in European bats would help assess potential risks to public health and identify mitigation measures.

Summer colony of *M. myotis* females. | Photo credit: Jan Zukal

Nyctalus noctula females | Photo credit: Jaroslav Červený

Seidlová V, Straková P, Kejíková R, Němcová M, Bartonička T, Salát J, Dufková L, **Šikutová S**, Mendel J, McKee C, **Zukal J**, Pikula J, **Rudolf I,** 2022. Detection of Leptospira species in bat cadavers, Czech and Slovak Republics. *Emerging Microbes & Infections* 11: 2211-2213.

West Nile fever research - example of One-health approach

West Nile fever is the most important mosquito-borne viral disease in Europe today. We present epidemiologic, clinical, and laboratory findings from five Czech patients diagnosed with an autochthonous mosquito-borne disease – four patients with confirmed West Nile infection (WNV) and one patient with confirmed Usutu virus infection (USUV) – from July to October 2018, including one fatal case due to WNV.

This is the first documented human outbreak caused by WNV lineage 2 in the Czech Republic and the first evidence of neuroinvasive disease in humans caused by USUV, highlighting the simultaneous circulation of WNV and USUV in the country. This study is an excellent example of the spread of the One Health approach to vector-borne infections in Europe

Installation of a CO2-baited trap to collect *Culex* spp. mosquitoes in a reed habitat at a local fish pond | Photo credit: Jan Pešl

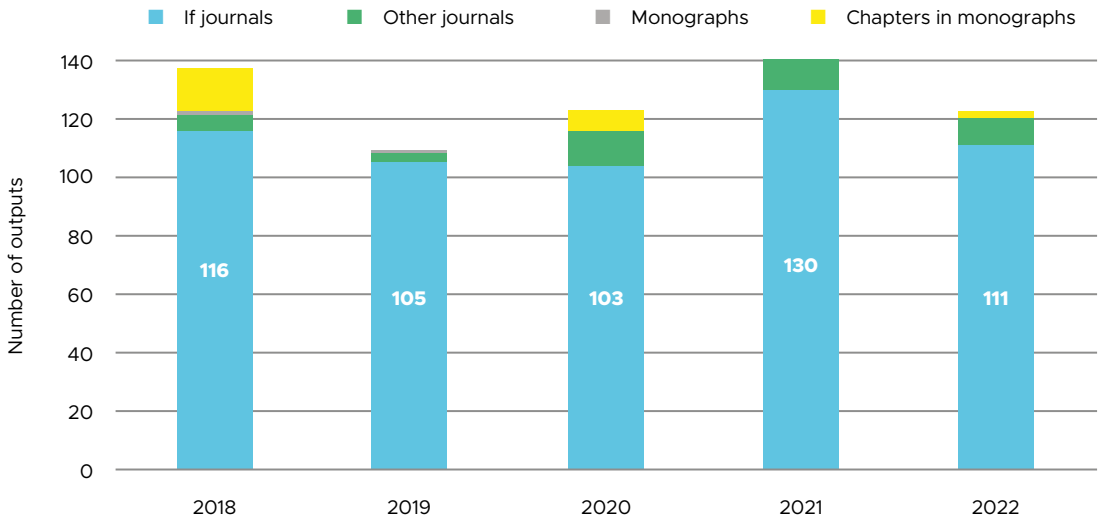
Zelená H, Kleinerová J, **Šikutová S, Straková P**, Kocourková H, Stebel R, Husa P, Husa jr P, Tesařová E, Lejdarová H, Šebesta O, Juráš P, Ciupek R, Mrázek J, **Rudolf I**, 2021. First autochthonous West Nile lineage 2 and Usutu virus infections in humans, July to October 2018, Czech Republic. Pathogens, 10: 651.

Photo credit: Shutterstock

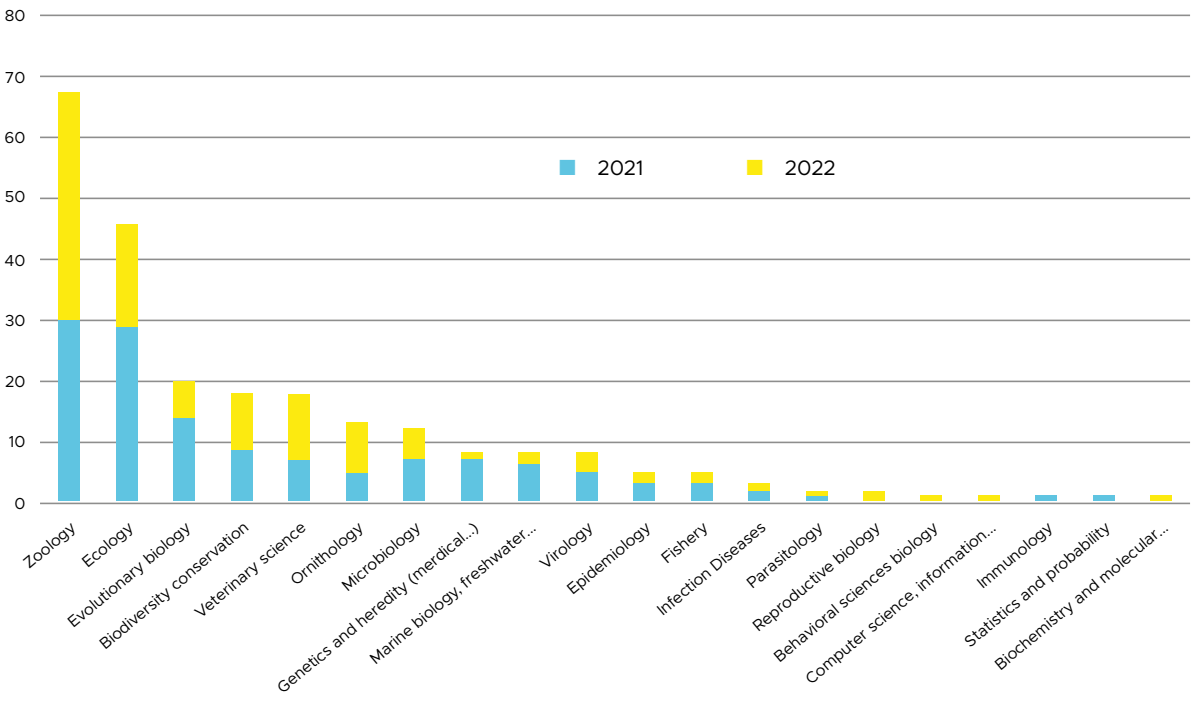
SCIENTIFIC RESULTS

Summary of publication output

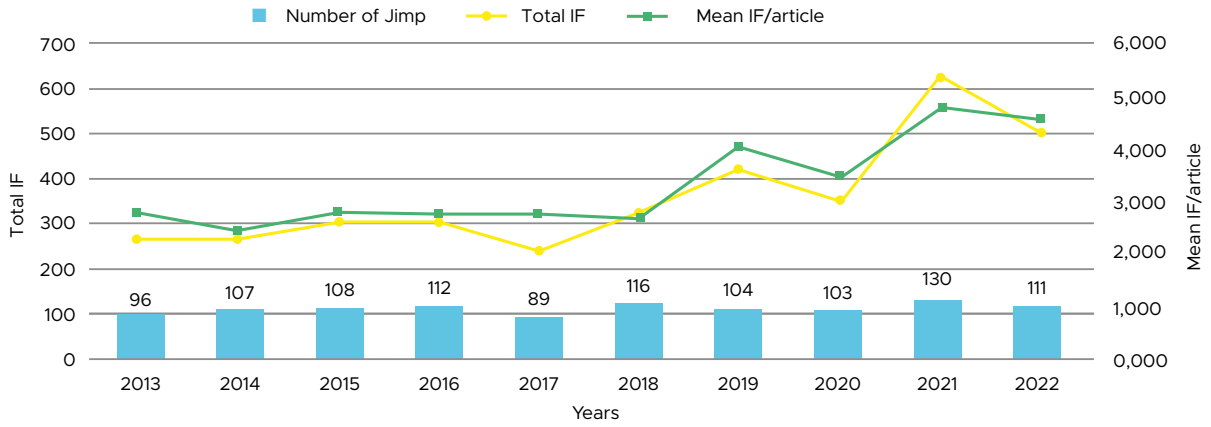
Researchers at the IVB produced 241 scientific articles in SCI (Science Citation Index) journals between 2021 and 2022. The publication profile and main scientometric criteria are shown below.



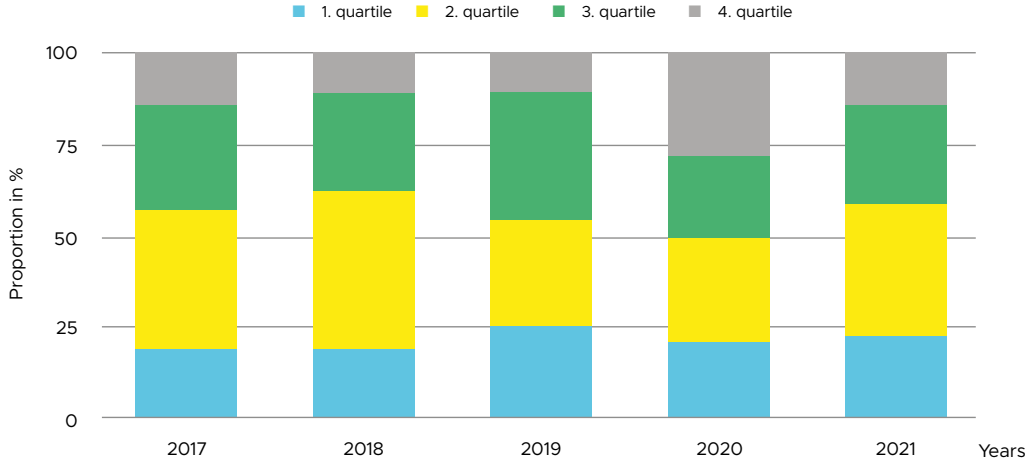
Structure of scientific publication produced by IVB over 5 years. The majority of the output consists of the articles in journals with IF (Jimp) fluctuating above 100 per year.



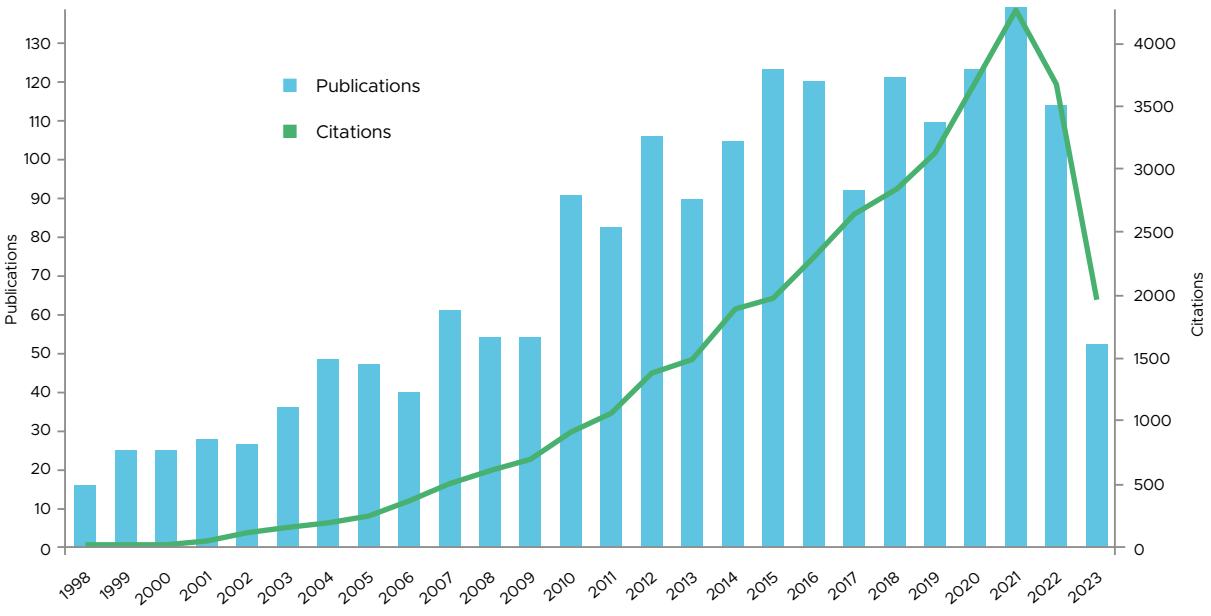
Distribution of papers categorised according to the Web of Science database over 2021 and 2022.



The impact factor (IF) values of journals published over the last two years confirm the increasingly high quality of IVB publications.



The proportion of scientific articles in the first two quartiles according to the Qais index is more than 60 %.



Citations of IVB papers over the last two years confirm the increasing trend seen in previous years (note that the Institute of Vertebrate Biology was founded in 1998), and reached the highest value in 2021. The graph adopted from the Web of Science database.

Geographic distribution of the most important international cooperation activities

NORTH AMERICA

- California Academy of Sciences, San Francisco, USA
- Centre for Disease Control and Prevention (CDC), Fort Collins, Colorado, USA
- Colorado University Denver, Colorado, USA
- Cornell University, Ithaca, USA
- Denver University, Colorado, USA
- Field Museum of Natural History, Chicago, USA
- Florida State University, Tallahassee, USA
- Jackson Laboratory, Bar Harbor, USA
- Minnesota University, USA
- Museum of Comparative Zoology, Harvard University, Cambridge, USA
- Northern Arizona University, USA
- Portland State University, Oregon, USA
- Smithsonian National Museum of Natural History, Washington, USA
- Texas A&M University, College Station, Texas, USA
- University of Colorado, Boulder (Denver), USA
- University of Colorado, Denver, USA
- University of Connecticut, Storrs, Connecticut, USA
- University of Florida, Gainesville, USA
- Université de Sherbrooke, Sherbrooke, Canada
- United States Department of Agriculture Forest Service, Columbia, Missouri, USA
- U.S. Fish and Wildlife Service, La Crosse Fish Health Center-Midwest Fisheries Center, Onalaska, Wisconsin, USA
- U.S. Geological Survey, Fort Collins Science Center, Colorado, USA
- York University, Toronto, Canada

SOUTH AMERICA

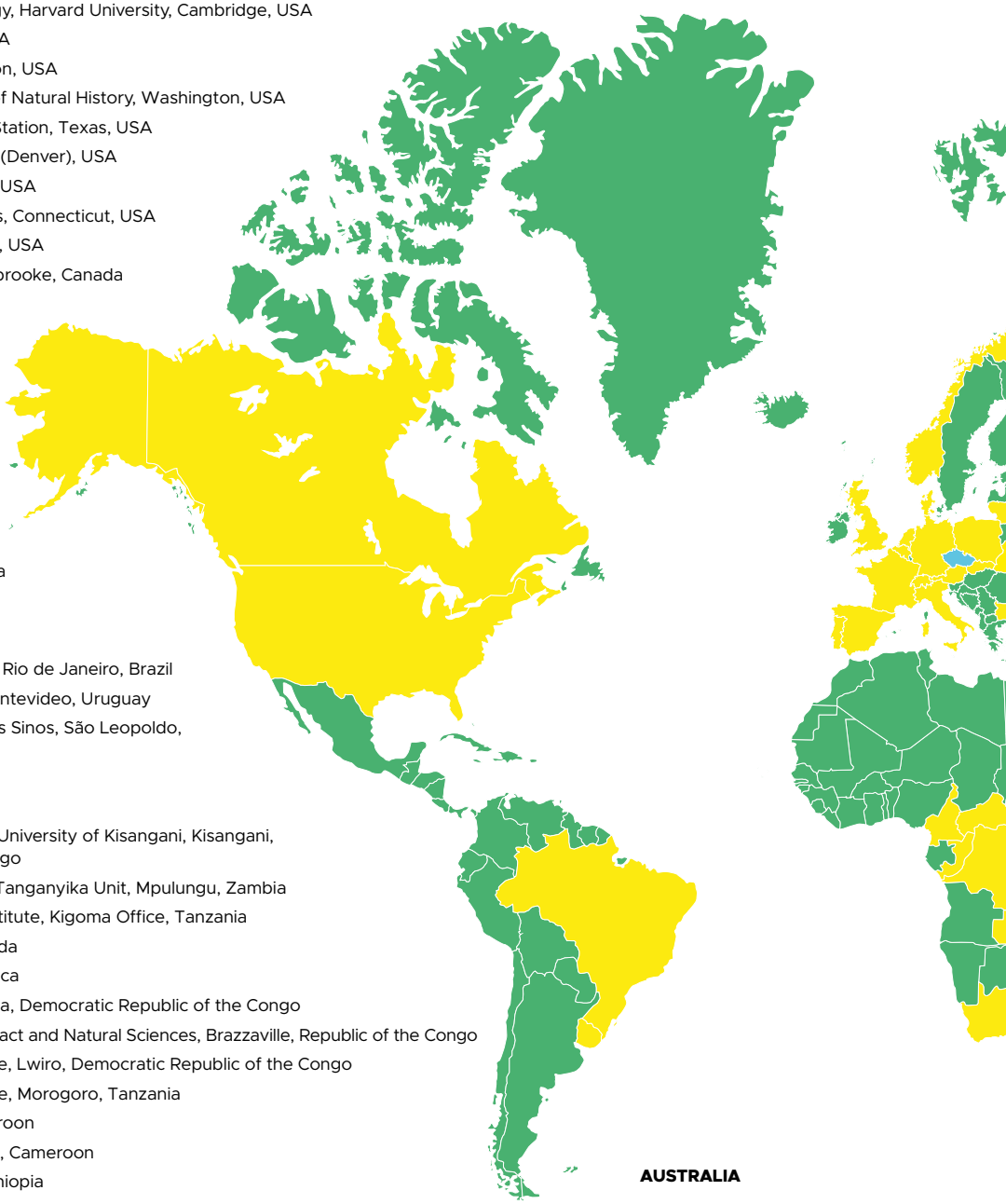
- Instituto Oswaldo Cruz, Fiocruz, Rio de Janeiro, Brazil
- Universidad de la República, Montevideo, Uruguay
- Universidade do Vale do Rio dos Sinos, São Leopoldo, Brazil

AFRICA

- Biodiversity Monitoring Centre, University of Kisangani, Kisangani, Democratic Republic of the Congo
- Department of Fisheries – lake Tanganyika Unit, Mpulungu, Zambia
- Tanzania Fisheries Research Institute, Kigoma Office, Tanzania
- Dian Fossey Gorilla Fund, Rwanda
- Kruger National Park, South Africa
- Gorilla Doctors, Uganda, Rwanda, Democratic Republic of the Congo
- National Research Institute of Exact and Natural Sciences, Brazzaville, Republic of the Congo
- Natural Science Research Centre, Lwiro, Democratic Republic of the Congo
- Sokoine University of Agriculture, Morogoro, Tanzania
- University of Buea, Buea, Cameroon
- University of Dschang, Dschang, Cameroon
- University of Mekelle, Tigray, Ethiopia
- Wolaita Sodo University, Sodo, Ethiopia
- Ugalla Primate Project, Tanzania
- World Wildlife Fund Central African Republic
- University of Makerere, Kampala, Uganda

ASIA

- Institute of Hydrobiology, Chinese Academy of Sciences, Wuhan, China
- Institute of Ecology and Biological Resources (IEBR), Vietnamese, Academy of Science and Technology, Hanoi, Vietnam
- Oita University, Dannoharu Oita-shi, Japan
- Primate Research Institute, Kyoto University, Japan
- Udon Thani Rajabhat University, Mueang Udon Thani District, Udon Thani, Thailand
- Yerevan State University, Yerevan, Armenia

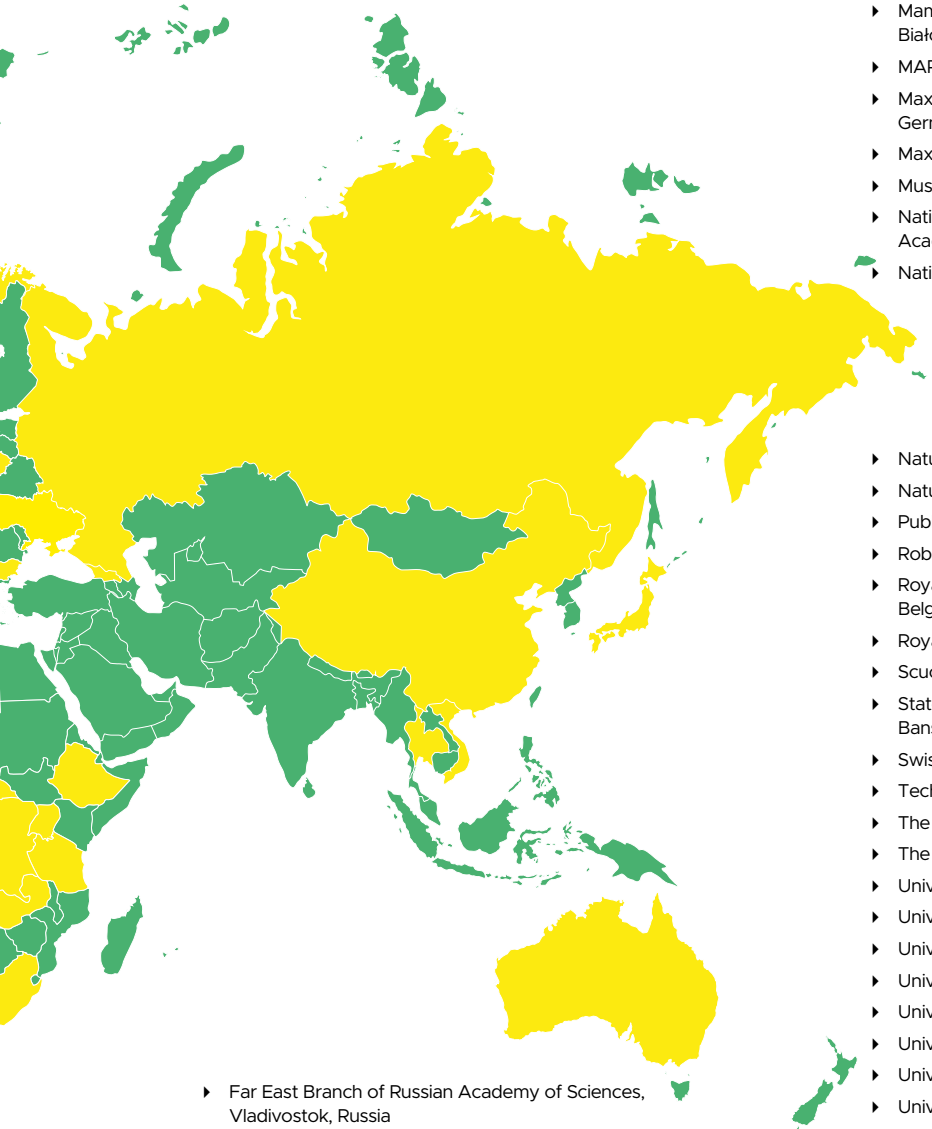


AUSTRALIA

- University of New South Wales, Sydney, Australia
- University of Sydney, Sydney, Australia

EUROPE

- Aarhus University, Aarhus, Denmark
- Administration of the Lazovsky State Reserve and National Park Zov Tigra, Lazo, Russia
- Aix Marseille University, Marseille, France
- A. N. Severtsov Institute of Ecology and Evolution of the Russian Academy of Sciences, Moscow, Russia
- Biomedical Research Centre, SAV, Bratislava, Slovakia
- Biological Station Lake Neusiedl, Illmitz, Austria
- Botanic Garden and Botanical Museum, Berlin, Germany
- Centre de Biologie pour la Gestion des Populations, Montferrier sur Lez cedex, France
- CIBIO-InBIO, Research Centre in Biodiversity and Genetic Resources, Portugal
- Comenius University in Bratislava, Bratislava, Slovak Republic
- Conservation Genetics Group, Senckenberg Research Institute and Natural History Museum Frankfurt, Gelnhausen, Germany
- Daugavpils University, Daugavpils, Latvia
- Institut de Radioprotection et de Sûreté Nucléaire, Cadarache, France
- Institute for Research on Cancer and Aging of Nice (IRCAN), Université Côte d'Azur, Nice, France
- Institut Pasteur, Université Paris Cité, Paris, France
- Institute of Biodiversity and Ecosystem Research, BAS, Sofia, Bulgaria
- Institute of Biology, Karlsruhe University of Education, Karlsruhe, Germany
- Institute of Hydrobiology, NAS of Ukraine, Kyiv, Ukraine
- Institute of Marine Biology, NAS of Ukraine, Odessa, Ukraine
- Institute of Parasitology, Slovak Academy of Sciences, Slovakia
- Irkutsk State Medical University, Irkutsk, Russia
- Laboratoire Interdisciplinaire des Environnements Continentaux, CNRS – Université de Lorraine, Metz, France
- Leiden University, Leiden, Netherlands
- Lund University, Lund, Sweden
- Mammal Research Institute, Polish Academy of Sciences, Białowieża, Poland
- MARÉ, Universidade de Lisboa, Lisboa, Portugal
- Max Planck Institute for Biology of Ageing, Cologne, Germany
- Max Planck Institute for Ornithology, Seewiesen, Germany
- Muséum National d´Histoire Naturelle, Paris, France
- National Museum of Natural History at the Bulgarian Academy of Sciences, Sofia, Bulgaria
- National Zoological Garden Bojnice, Bojnice, Slovakia



- Far East Branch of Russian Academy of Sciences, Vladivostok, Russia
- Friedrich Loeffler Institute, Riems, Germany
- The Leibniz Institute on Aging - Fritz Lipmann Institute, Jena, Germany
- German Primate Center, Leibniz Institute for Primate Research, Germany
- INRAE, UR EABX, Centre Nouvelle-Aquitaine, Cestas Cedex, France
- Natural History Museum, London, England
- Natural History Museum, University of Oslo, Oslo, Norway
- Public Health England, Porton Down, England
- Robert Koch Institute, Berlin, Germany
- Royal Belgian Institute for Natural Sciences, Brussels, Belgium
- Royal Zoological Society of Antwerp, Antwerp, Belgium
- Scuola Normale Superiore, Pisa, Italy
- State Nature Conservancy of the Slovak Republic, Banská Bystrica, Slovakia
- Swiss Ornithological Institute, Sempach, Switzerland
- Technical University in Zvolen, Zvolen, Slovakia
- The Humboldt-Universität zu Berlin, Berlin, Germany
- The University of Sheffield, Sheffield, England
- University of Edinburgh, Edinburgh, Scotland
- University of Essex, Essex, England
- University of Exeter, Exeter, England
- University of Graz, Graz, Austria
- University of Groningen, Groningen, Netherlands
- University of Lodz, Lodz, Poland
- Université Montpellier, France
- University of Antwerp, Antwerp, Belgium
- University of Barcelona, Barcelona, Spain
- Ural State Medical University, Yekaterinburg, Russia
- Veterinary University Vienna, Vienna, Austria
- Wrocław University of Environmental and Life Sciences, Wrocław, Poland
- Zurich University, Zurich, Switzerland

APPLICATION AND COMMERCIALISATION OF RESEARCH OUTPUTS

The transfer of knowledge and implementation of technology into practice are considered important activities that complement the main mission of the Institute of Vertebrate Biology. Between 2010 and 2022, the Institute's intellectual property database expanded with 43 applied results, consisting of two patents (national and European), seven utility models, 15 methodologies, four verified technologies, two prototypes, 11 functional samples, one software and one trademark.

Intellectual property	Quantity	Group
Patent	**2**	Fish
Utility Model	**7**	Fish, Mammals
Trademark	**1**	Fish
Certified Methodology	**15**	Virus, Insects, Fish, Birds, Mammals
Verified Technology	**4**	Fish
Prototype, Functional Sample	**13**	Fish, Mammals
Software	**1**	Fish

Between 2021 and 2022, the institute developed one certified methodology - Marking of rainbow trout with Alizarin and introduced three reliable and affordable tools for fish producers to monitor water environments and early detection of pathogens: 1) Diagnostic set RT-qPCR FLAVident for for detection and quantification of *Flavobacterium psychrophilum* in water, tissue and skin samples, 2) Diagnostic set RT-qPCR AEROMident for detection and quantification of *Aeromonas* spp. in water, tissue and skin samples, 3) Diagnostic set RT-qPCR TETRACAPSident for detection and quantification of *Tetracapsuloides bryosalmonae* in water, tissue and skin samples. Additionally, a new unified design of documents such as Certified Methodologies, Verified Technologies, and Functional Samples was prepared. Some of the applied outputs are also featured in the new technology and equipment database of the Czech Academy of Sciences (techtransfer.cas.cz).

As part of the Institute's research and development commercialisation results between 2021 and 2022, contracts were completed between Czech and partners to the value of approximately CZK 10 million per year. These collaborations were primarily in the form of licence sales, contract research, expert services, and custom research. The Institute cooperated with a wide range of institutions, including universities, scientific centres, angling unions, and fish farming concerns. These included the University of South Bohemia in České Budějovice, the Nature Conservation Agency of the Czech Republic, the Czech Academy of Sciences' Biology Centre, the Czech Anglers Union, the University of Ostrava, the European

Centre for Disease Prevention and Control, the European Mammal Foundation, the Czech Ministry of the Environment, various River Basin Water Authorities (e.g. Elbe, Oder, Morava), the Krkonoše Mountains National Park (KRNAP), Šumava National Park, AQ-Service s.r.o., Wild Park n.o., ZOO parks, and many others.

OTHER ACTIVITIES

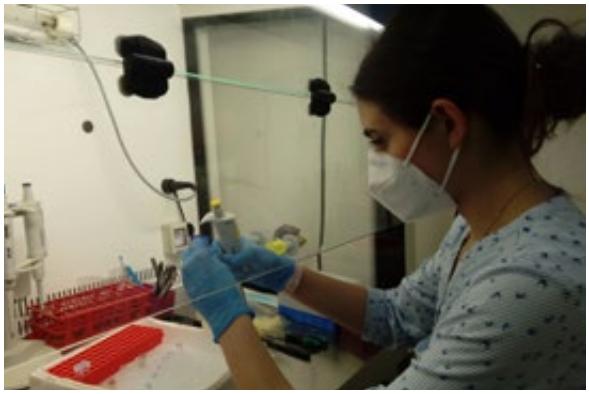
POPULARISATION

Popularisation of science and research is an important part of the IVB's activities. In 2021 and 2022, we organised many seminars, workshops, field excursions and other activities for the public.

Activities for schools and university students

Our researchers take pride in mentoring high school students who can participate in different research tasks as part of the Czech Academy of Sciences' Open Science program or the Secondary School Professional Activity (SSPA) course.

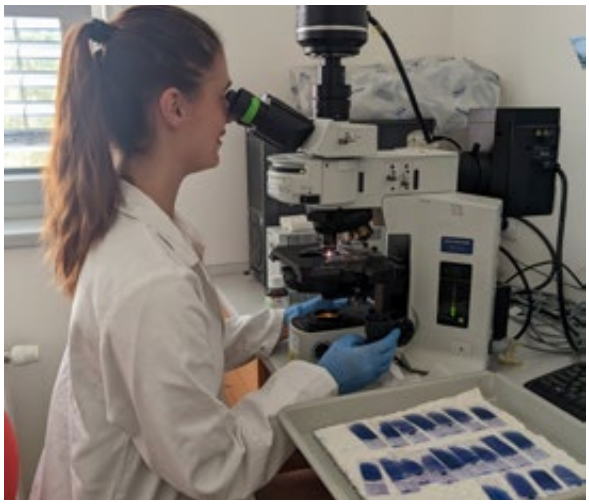
Martina Frýbová, a high school student from Gymnázium Žatec, achieved third place during the final conference of the Open Science competition with her project. Under the guidance of Michal Šulc, Martina focused on the rate of rejection of parasitic eggs by the IVB common cuckoo in the nest of the Red-backed shrike. | Photo credit: archive IVB



Iva Holásková, a high school student from Technical lyceum Třebíč during her lab work at the research facility Studenec. In her project, Iva focused on the variability of rabbit hemorrhagic virus in rodent populations and rabbits from the highland. | Photo credit: archive IVB

Eliška Pipalová, a high school student from Gymnázium Moravské Budějovice, worked at the research facility Studenec under the supervision of Alena Fornůsková. She worked on the variability of trypanosomas from marsupilas and rodents of Papua New Guinea. | Photo credit: archive IVB

The IVB also organises many educational activities, including the ornithology course for University students, which took place in April 2019 at the Mohelno field station, led by Vojtěch Brlík and Kryštof Horák. This course aims to introduce students to all aspects of ornithological practice, such as how to catch and ring birds, how to observe them and how to recognise different birds by their calls.



Nikola Šeneklová, a high school student from Gymnázium Jihlava, during her 14 day practice at the research facility Studenec | Photo credit: archive IVB

The IVB also organises many educational activities, including the ornithology course for university students, which took place in April 2021 and 2022 at the Mohelno field station, led by Ondřej Kauzál and Oldřich Tomášek. This course aims to introduce students to all aspects of ornithological practice, such as how to catch and ring birds, how to observe them, and how to recognise different birds by their calls.

European greenfinch (*Chloris chloris*) | Photo credit: archive IVB

Ondřej Kauzál is demonstrating birds to University students | Photo credit: archive IVB

During the ornithology exercise, students will learn how to handle birds properly | Photo credit: archive IVB

Excursions for schools are always tailored to each group (educational level, numbers attending and time spent at the research facility) and may include a visit to see the newt, mouse, and bird breeding facilities or a tour round the laboratories. It is possible to adapt excursions to the needs of the youngest visitors or provide a professional lecture for university students. We also visit schools, where we may present educational programs geared toward evolution and adaptation, or provide talks on the latest results from our research.

Numerous popularization activities are organized in the Studenec research facility | Photo credit: archive IVB

ACTIVITIES FOR THE PUBLIC

The IVB organises different activities for the general public, including excursions to all of our facilities during the Week of Czech Academy of Sciences (Open Days), the Science Fair in Prague (organised in 2021 and 2022), popularisation lectures and ornithological excursions.

We also co-organise the regular International Bat Nights in the Moravian Karst and at Brno Zoo. The collaboration with the Zoological garden in Brno was deepened in 2022 by organising the African day event "Africa with All Senses".

Michal Šulc during his "Easter talk" in Studenec | Photo credit: archive IVB

Participants of the Bird Festival had the opportunity to see a variety of bird species, their ringing, and also learned many interesting facts about their lives. Various games were prepared for children as well. | Photo credit: archive IVB

Veronika Javůrková demonstrated different bird species during the Bird festival in Koněšín. On the photo she is holding Eurasien Wren *(Troglodytes troglodytes)*. | Photo credit: archive IVB

Bird festival in Studenec led by Ondřej Kauzál and Oldřich Tomášek | Photo credit: archive IVB

"AFRICA WITH ALL SENSES" IN ZOO BRNO

On June 26, 2022, an event called "Africa with All Senses" took place at the Brno Zoo. Creative workshops were organised for children, including the "Spice Journey" with a tasting of traditional African food and a playful workshop featuring African musical instruments. Visitors had the opportunity to delve into the heart of Africa through a lecture about a scientific expedition to Uganda, organised by scientists from the Institute of Vertebrate Biology (IVB) under the leadership of Josef Bryja. To conclude the African-themed day, the group Denbaya performed with African drums.

Photo credit: archive IVB

SCIENCE FAIR

Organised annually by the Czech Academy of Sciences, the Science Fair is the largest popular science event in the Czech Republic. The fair presents science in all its forms and allows visitors to experience the world of natural, technical, and social sciences by presenting at one site the most interesting findings that Czech science has to offer. In June 2021, the sixth Science Fair once again took place in the modern exhibition halls of the PVA EXPO complex in Prague. Over 100 exhibitions from the Czech Academy of Sciences, universities, scientific institutions and innovative companies, as well as other external exhibitors, provided new insights to scientific enthusiasts. The IVB presented results of its research into brood parasitism in fish and birds, conservation biology, and research in biodiversity in Africa and also Czech farmland.

Photo credit: archive IVB

WEEK OF CZECH ACADEMY OF SCIENCES
Open Door days

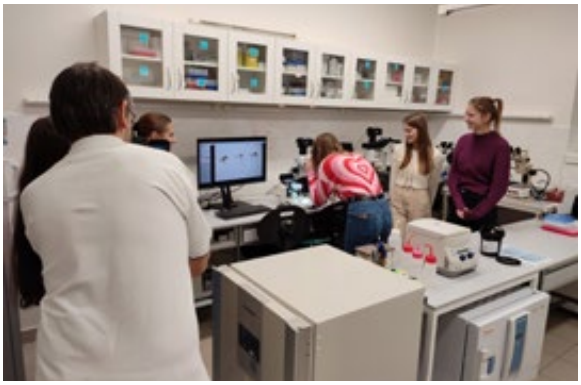
The Czech Academy of Sciences opens its doors to the public in a series of open house events. All IVB research facilities participated in the event that took place in November 2021 and 2022 and welcomed a diverse range of visitors. Attendees gained insights into the ongoing research at the different facilities and had the opportunity to observe the regular operations of the laboratories and breeding facilities.

Josef Bryja is wellcoming visitors in Studenec research facility | Photo credit: archive IVB

Lumír Gvoždík is showing newts and explaining his research to visitors | Photo credit: archive IVB

Kateřina Janotová is showing mice breeding facility to visitors | Photo credit: archive IVB

Open door days are organised aslo in Valtice research facility, where Ivo Rudolf is showing their research activities | Photo credit: archive IVB



Laboratories are also open for visitors | Photo credit: archive IVB

Week of Czech Academy of Sciences is a great opportunity to invite also schools to our research facilities. On the photo is research facility in Brno. | Photo credit: archive IVB

STRATEGY AV21

The IVB is an active institute within Strategy AV21, the research strategy of the Czech Academy of Sciences aimed at increasing direct contact and collaboration between the Academy and the wider application sector. As part of these efforts, a number of activities took place over 2021–2022 under the program "LAND CONSERVATION AND RESTORATION", which seeks to find ways to use the landscape that will be sustainable in the long run and at the same time develop procedures to restore the damaged landscape.

The IVB itself is undertaking two projects under this new programme: "Biodiversity of Cultural Landscapes", led by Martin Šálek and Alena Fornůsková, and "Saving Genetic Diversity ex situ", led by Barbora Rolečková. The latter project brings together the collections of biological material of several academic institutes, including the IVB Genetic Bank.

PROJECT THE BIODIVERSITY OF CULTURAL LANDSCAPES

Effectiveness of different types of bio-strips on the biodiversity of the field landscape

The biological diversity of agricultural land has sharply declined in recent decades. Various measures, including agro-environmental programs within the EU, are being implemented to counteract further loss of biodiversity. Despite the long-term use of these programs, many of them have not been adequately researched and evaluated, making it difficult to determine their actual contribution to biological diversity. Bio-strips, both non-nectar-rich to support pollinators and feeding strips, are among the measures to increase biodiversity in agricultural landscapes. Feeding bio-strips primarily serve as food sources and shelters for birds and certain mammal species, especially during the winter period. Since evidence of the effectiveness of feeding bio-strips on various animal groups during winter was lacking, a group of scientists from the Czech Republic and Poland decided to verify their impact on the occurrence of typical species in the agricultural landscape during this season. The results clearly demonstrated that species richness and abundance of field birds and hares were significantly higher in bio-strips compared to the surrounding agricultural landscape. As a result, bio-strips can serve as an effective element for numerous declining species. This study provides the first extensive and comprehensive verification of the effectiveness of different types of bio-strips on the biodiversity of the field landscape. The results show that they can represent relatively inexpensive and simple measures to support various bird, hare, and small mammal species, potentially saving a significant amount of money and providing more effective protection for declining species.

Šálek M, Bažant M, Żmihorski M, Gamero A, 2022. Evaluating conservation tools in intensively-used farmland: Higher bird and mammal diversity in seed-rich strips during winter. Agriculture, *Ecosystems and Environment*, 327: 107844.

Conservation potential of windbreaks and open scrubland

The intensification of agriculture has led to a substantial loss of biological diversity in agricultural landscapes. Semi-natural habitats are considered potential buffers against these adverse impacts on biodiversity, yet a thorough assessment of their capacity to support biodiversity in agricultural landscapes is still lacking. In our study, we investigated the conservation potential of two different types of semi-natural habitats for birds in intensively used agricultural landscapes – windbreaks (linear strips of shrubby and woody vegetation) and open scrubland (scattered shrubs and abandoned orchards). The results of our study showed that both types of semi-natural habitats have significant potential for bird population protection, but their efficacy varies based on the ecological associations of individual species. Species of open landscapes have higher abundance and diversity in open scrublands, while forest species are more numerous in windbreaks. Management measures aimed at increasing their area in combination with appropriate management (such as regulating natural succession in open scrublands, enhancing structural diversity in windbreaks) can significantly contribute to bird protection in agricultural landscapes.

Šálek M, Kalinová K, Reif J, 2022. Conservation potential of semi-natural habitats for birds in intensively-used agricultural landscapes. *Journal for Nature Conservation*, 66: 126124.

Farms, islands of avian species diversity? Depends on its age!

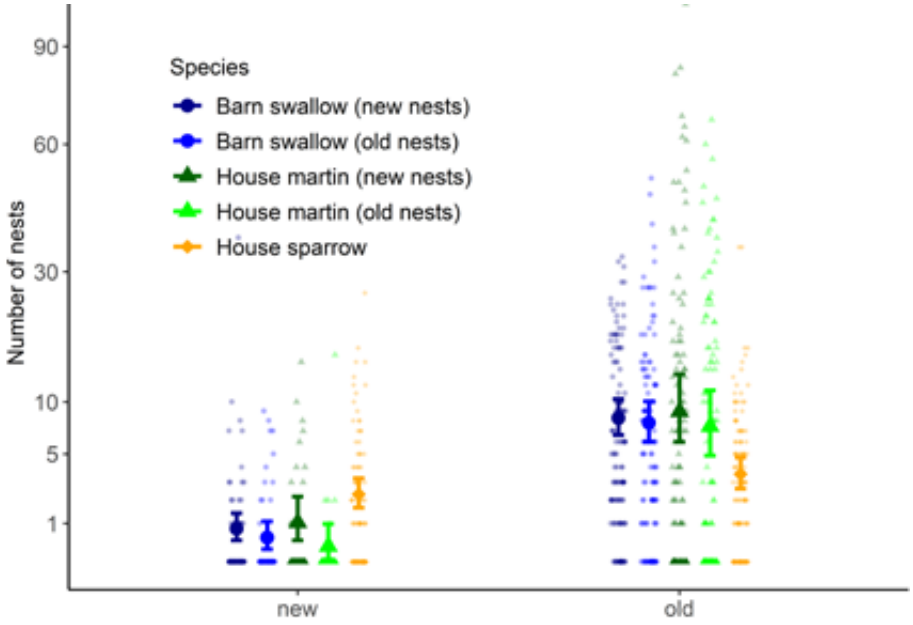
In intensively managed homogeneous landscapes with a lack of landscape features, different non-agricultural habitats can represent islands of avian species diversity and are crucial for their protection. Agricultural farms serve as overlooked refuges for many birds within the agricultural landscape.

Therefore, if we want to halt or at least slow down the decline of birds in the agricultural landscape, it is essential to focus on these habitats as well. The conservation potential of farms for birds can be significantly reduced by two opposing processes – abandonment of active farming and, on the other hand, farm modernization. Based on these assumptions, we decided to examine the impact of livestock farming modernization on bird population numbers, species diversity, and the numbers of nests of typical synanthropic birds nesting on farms, such as swallows, martins, and house sparrows. Our results showed that the abundance of birds in the agricultural landscape was three times lower in modernised farms compared to old or mixed (farms containing both new and old barns) farms. Similarly, species richness was significantly lower than in old farms. Furthermore, we found that modernised barns exhibited much lower numbers of nests of synanthropic birds compared to old barns. Modernization of farms thus has a strongly negative impact on bird populations in the agricultural landscape and contradicts various nature conservation strategies (such as the EU Biodiversity Strategy) and practical conservation

→

Šálek M, Mayer M, 2022. Farmstead modernization adversely affects farmland birds. *Journal of Applied Ecology*, 60, 101–110. https://doi.org/10.1111/1365-2664.14314

efforts for endangered species. Moreover, farm modernization and construction are currently primarily funded by various EU subsidy programs. For this reason, we propose various measures that could enhance nesting and foraging opportunities in modernised farms.



The number of nests of Barn Swallows, House Martins, and House Sparrows in new/modernised and old barns | Photo credit: Šálek and Mayer 2022

Furthermore, we have been involved in other projects closely related to supporting biodiversity in cultural landscapes:

i) Monitoring and protection of the critically endangered tawny owl (*Strix aluco*) (this project involves monitoring the distribution and breeding success, implementation of protective measures, communication with farmers, etc.).

ii) Influence of large herbivore grazing on bird communities (the research aims to determine the impact of extensive grazing by large herbivores on bird populations in the former military training area of Milovice. We focus on observing long-term and species-specific changes in bird communities in extensively managed grassy areas through large herbivore grazing).

iii) Impact of ecologically friendly farming on bird populations (the research aims to verify whether the newly established rules of ecological farming actually benefit birds and other groups. Birds are also monitored in control areas where farming practices remain unchanged. The robust research design will enable us to evaluate the impact of farming changes on bird populations.

IV) In 2022, we also continued the field monitoring of bat flight activity using ultrasonic detection. The results are used to compare the biodiversity and population density of the bat community with that of 30 years ago. Preliminary results show an increase in the number of individuals and estimated densities of dominant bat species in South Moravian agroecosystems. Additionally, linear transects were selected in areas with smaller expanses of field habitats, and pilot surveys were conducted. Preliminary results confirm higher bat community diversity in areas with a higher density of linear vegetation elements for bats.

In addition to the research itself, Strategy AV21 has enabled the IVB to organise a range of field excursions and seminars for the general public, primary and secondary school students, university students, and stakeholders on agricultural landscape use and its effects on biodiversity.

In 2022, we also developed a simple educational app called “Go-Diverse!” for preschool children. This app aims to explain various methods to children that can help increase biodiversity. These methods include creating hedgerows, bio-strips, and alleys. These elements, which enhance the diversity of agricultural landscapes, serve a dual purpose – providing shelter for various organisms and also aiding in retaining water in the landscape, increasing organic content in the soil, and preventing erosion.

The goal of the educational tool “Go-Diverse!” is to raise awareness about this issue and present it in an engaging manner to children. Their future is currently threatened by intensive agriculture. The “Go-Diverse!” app showcases proven agricultural practices that lead to sustainable and healthy farming. You can view the app here: https://happyporch.github.io/Go-Diverse/

Protection of species diversity in agricultural landscapes - a lecture for hunters as part of the seminar "Supporting residual populations of brown hares in different types of agricultural landscapes,“ Radešín, March 2022 | Photo credit: archive IVB

We introduced the “Go-Diverse!” app for the first time at the Science Fair in Prague in June 2022, which was attended by tens of thousands of visitors. We also utilised the app during the Open Day in Brno and during school excursions to our facility in Studenec.

GENETIC BANK OF THE INSTITUTE OF VERTEBRATE BIOLOGY (IVB GENETIC BANK) AND THE NATIONAL ANIMAL GENETIC BANK OF THE CZECH REPUBLIC (NAGB)

The IVB genetic bank, together with the national network of animal genetic collections, the National Animal Genetic Bank, both founded in 2015, continued their activities and were thus available to both scientists requesting genetic samples and providers depositing samples in the collections. Data digitization work has become more effective since 2021, with the IVB supporting the genetic bank with a new part-time technical officer dedicated to this work. As a result, 2,835 new samples were prepared for publication during 2021 and 2022 (published in February 2023). The bank and its actívities were showcased to a broader public audience, through a one-hour television programme on conservation genetics, which is available in the TV Noe archive. At the 6th European Congress of Conservation Biology (ECCB) in Prague in August 2022, it was introduced to professionals.

Among the new bank material were, for example, samples of the wild cat from Romania. These samples were deposited in the bank as type material, upon which an international team of parasitologists described three new species of *Cytauxzoon* protist, parasitic to felids and closely related to genera *Babesia* and *Theileria* (Panait et al. 2021). In 2021, we have provided samples to the farthest destination so far, to South Africa. Samples of red-legged partridge (*Alectoris rufa*) and white-eye bream (*Ballerus sapa*) were requested by researchers from the University of Johannesburg within the initiative to enhance South African biosecurity by DNA barcoding invasive and alien plant and animal species at the port of entry.

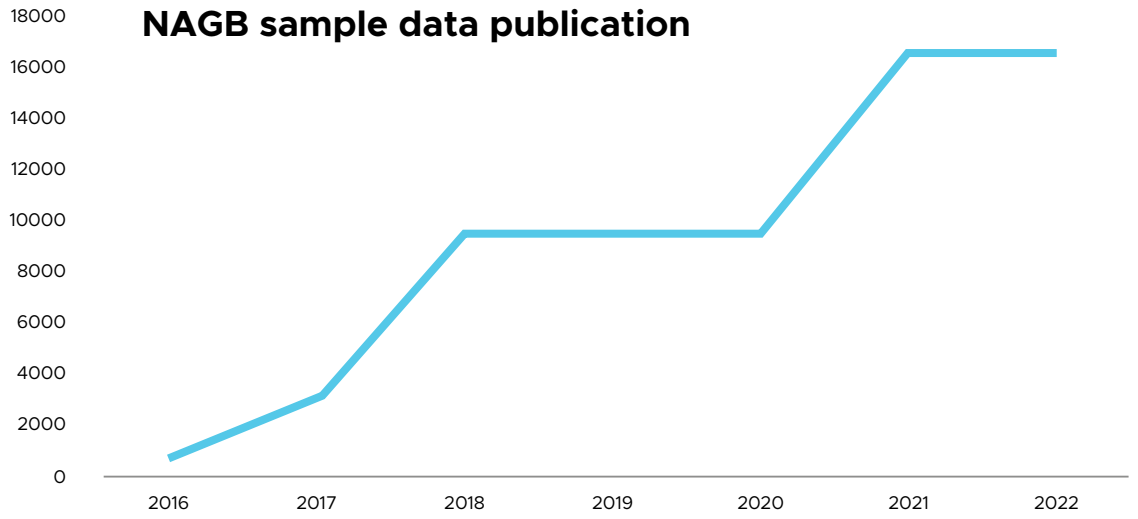
Already in 2019, the Wallachian Region Museum joined the NAGB network as its official fifth core member. However, in 2022, it confirmed its active membership by publishing the first genetic sample data. They are available on the museum's webpages and are being prepared for publication on the NAGB and GGBN Data Portals through the IVB Genetic Bank. Consequently, the network was enriched with new species, the striped field mouse (*Apodemus agrarius*), as well as additional samples of black stork (*Ciconia nigra*), white-tailed eagle (*Haliaeetus albicilla*), etc. Another valuable partner, this time as a sample provider, has become the Pavlov animal rescue station. Since autumn 2021, it has provided the genetic bank with over 70 bird and mammal specimens, including e.g. the red-throated loon (*Gavia stellata*), little bittern (*Ixobrychus minutus*) or eight different owl species.

The Genetic Bank initiated a completely new activity in 2021. Since not only genetic samples but also whole animal carcasses are sometimes received, we decided to use those in good condition for taxidermy. As a result, the first stuffed specimens were introduced in April 2021, forming the foundation of the "*Between Wilderness and Genetic Bank*" collection. This collection primarily focuses on our vertebrate fauna and presently encompasses 33 stuffed bird and 16 mammal specimens. The visit by approximately 400 primary and secondary school students in 2022 shows that the collection is very useful for the educational and popularisation activities carried out at the Studenec research facility of the institute.

In addition to school excursions, the genetic bank is also involved in other educational and popularisation activities. With the gradual easing of anti-Covid measures, two secondary school students (from the Otokar Březina Gymnázium in Telč and the Secondary Veterinary School in Třebíč) partic-

Panait LC, Mihalca AD, Modrý D, Juránková J, Ionică AM, Deak G, Gherman CM, Heddergott M, Hodžić A, Veronesi F, Reichard M, Zieman EA, Nielsen CK, Jiménez-Ruiz FA, Hrazdilová K, 2021. Three new species of Cytauxzoon in European wild felids. *Veterinary Parasitology* 290, 109344. https://doi.org/10.1016/j.vetpar.2021.109344.

ipated in the operation of the genetic bank during the summer of 2022. Each of them completed a three-week student internship at the IVB research facility in Studenec. The NAGB sample repository at the Mohelský mlýn field station was introduced to members of the Committee on Economy, Agriculture and Transport of the Senate of the Czech Parliament, who visited it in August 2022.



Sample data digitization and publication work involves transcribing information from various paper notes or different Excel spreadsheets, verifying data accuracy, and further investigations of missing data, including geographic coordinates. Because of this, data are not published immediately upon sample receipt, but with a delay. Additionally, since publication is carried out through the Technical Management Office of the Global Genome Biodiversity Network, usually only larger amounts of processed data are published at once. By 2021, data for 16,626 samples, deposited in two NAGB member collections, had been gradually published, with an additional 2,835 samples prepared for publication during 2021 and 2022, and more samples are being processed on an ongoing basis.

The Genetic Bank of the Wallachian Region Museum has become an active member of the National Animal Genetic Bank network. Its curator and museum zoologist, Zdeněk Tyller, is collecting tissue samples from bird cadavers. | Photo credit: archive Zděněk Tyller

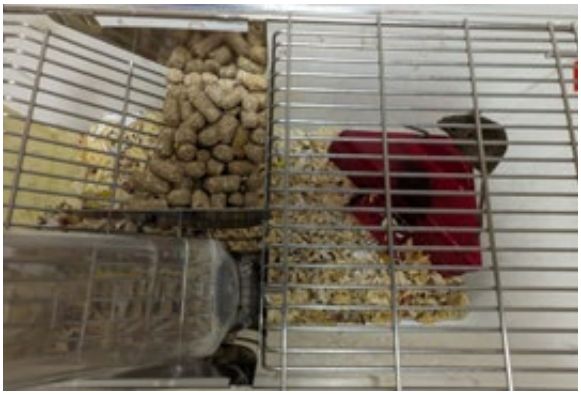
In August 2022, members of the Committee on Economy, Agriculture and Transport of the Senate of the Czech Parliament, including its chairman Vladislav Vilímec, visited the IVB field station Mohelský Mill. Their Vysočina Region tour was organized by Senator Hana Žáková from the Třebíč district. The Mohelský Mill facility, where one of the NAGB sample repositories is located, was introduced to visitors by Barbora Rolečková, IVB Genetic Bank curator and NAGB secretary. The senators attentively listened to a brief talk about basic research and the nearby Mohelenská hadcová step National Nature Reserve, and they explored both the station itself and its picturesque surroundings. We are pleased with the senators' interest in our work. | Photo credit: archive IVB

BREEDING FACILITIES

Mouse breeding facility / House mouse research group

The IVB's mouse breeding facility at the Studenec houses the world's largest collection of wild derived strains (WDS). This unique collection resulted from merging the expansive strain collection developed at the IVB since 2008 with the WDS collection maintained since 1976 by Francois Bonhomme in France. Presently, there are over 70 strains derived from the wild house mouse (*Mus musculus*), alongside strains derived from the Mediterranean mouse (*Mus spretus*), Macedonian mouse (*Mus macedonicus*), Steppe mouse (*Mus macedonicus*), and *Mus caroli*, spanning more than 4 million years of mouse evolution. These strains are used in experimental research, with a particular focus on the study of speciation, especially genetic barriers that hinder gene flow in hybrid zones between mouse subspecies. All mouse strains are available to the wider scientific community, and those interested should contact Jaroslav Piálek at jpialek@ivb.cz or https:// housemice.cz/en.

The mouse breeding facility in Studenec | Photo credit: archive IVB



Cage with wild derived strain of *Mus m. musculus* | Photo credit: archive IVB

The mouse breeding facility in Studenec - inside | Photo credit: archive IVB

Newt breeding facility / Thermal ecology group

The newt breeding facility is used for experimental research, with a focus on behavioural and ecophysiological research of caudate amphibians. The findings of thermal ecology research will better enable us to predict the impact of intensive human-induced changes on individual ecosystems. Furthermore, a greater understanding of vertebrate temperature-physiological dependence will improve our chances of reversing the current risks of global climate change.

The newt bredding facility in Studenec | Photo credit: archive IVB

The Mexican axolotl is a typical example of an amphibian that exhibits neoteny. In the wild, it maintains a larval stage, in which it is capable of reproduction. Metamorphosis, the transition to an adult form, can be induced artificially in captivity, but it occurs very rarely in nature. | Photo credit: archive IVB

Bird breeding facility / Avian evolutionary ecology research group

The bird breeding facility specialises in experimental research, with a particular focus on sexual selection and the study of life strategies (e.g. evolution of ageing). The study of reproductive mechanisms and mating systems, in particular, may help explain the emergence of infertility and find ways to avoid it.

The outdoor part of bird breeding facility in Studenec | Photo credit: archive IVB

The indoor part of bird breeding facility in Studenec | Photo credit: archive IVB

Fish breeding facility / Fish evolutionary ecology group

The Brno fish breeding facility was upgraded and re-accredited in 2018. It currently includes seven indoor rooms with aquaria, 100 outdoor tanks, and a large pond for underwater behavioural observations. The facility has proved indispensable for several ongoing projects on various aspects of fish behaviour, evolution, and ecology.

The fish breeding facility in Brno | Photo credit: archive IVB

Photo credit: Radim Blažek

CONFERENCES ORGANISED BY THE INSTITUTE

4th Nothobranchius Symposium

On June 3-4, 2021, the 4th edition of the conference "The 4th Nothobranchius Symposium“ took place. Prof. M. Reichard (IVB CAS), who has long been engaged in behavioural and evolutionary ecology of fish, teamed up with molecular oncologist Prof. O. Slabý (CEITEC MU) to organise a meeting for experts on the Nothobranchius fish genus, also known as annual killifish.

The conference traditionally focused on all aspects related to the biology of annual killifish, covering various fields from genetics and anatomy to metabolism, ageing, ecology, and evolution of these short-lived fish. The symposium started with a plenary lecture by Dr. Jason Podrabsky from Portland State University in Oregon, USA, which delved into the embryonic development and diapause of annual killifish. A total of 261 experts from around the world registered for the event, and they could all follow the presentations online from a distance. The conference featured a total of 30 presentations and showcased 16 posters. The best student presentations were selected by a vote, with Johannes Krug from Germany winning the best presentation award and Chiara Giannuzzi from Italy receiving the best poster award.

Male of *Nothobranchius furzeri* | Photo credit: archive IVB

The next gathering is planned for 2023 in Belgium, where scientists will exchange their new insights into the ever-surprising world of annual killifish. This event takes place every two years, and this year‘s edition occurred with a one-year delay due to the COVID-19 pandemic. Given the current situation, the conference was shifted to the online space.

IN SEARCH OF A WILD CAT - ATTENTION!

On Thursday, May 26, 2022 the planned final conference of the Felis SKCZ project took place via the Zoom platform. The project was funded by the Interreg V-A SK-CZ 2014–2020 program.

The conference was organised by the IVB, in collaboration with Hnutí DUHA Šelmy and the National Zoological Garden Bojnice. A total of 51 participants from the Czech Republic and Slovakia attended. The conference not only presented the project‘s results but also featured three invited lectures by experts from both countries. Participants were informed about the latest updates concerning the conservation and presence of the wild cat on the Moravian-Slovak border and in other regions of the Czech Republic and Slovakia.

https://www.kockadivoka.cz/aktuality/prohlednete-si-prispevky-ze-zaverecne-konference/

G-BiKE COST Action – 4th Management Committee Meeting

As a member of pan-European COST Action ***G****enomic* ***Bi****odiversity* ***K****nowledge* for Resilient ***E****cosystems* (G-BiKE), the IVB (J. Bryja, B. Rolečková, J. Vrbová Komárková) was local organiser of the 4th Management Committee and Working Group Meetings of the action, that took place in Prague in April 2022. Using support from the Centre of Administration and Operations of the CAS, it arranged the meeting in academic Neo-Renaissance Villa Lanna in Bubeneč district of Prague. Forty-five participants from 25 European countries met in person there and others joined the meetings online.

The meeting was held in Prague in Villa Lanna | Photo credit: archive IVB

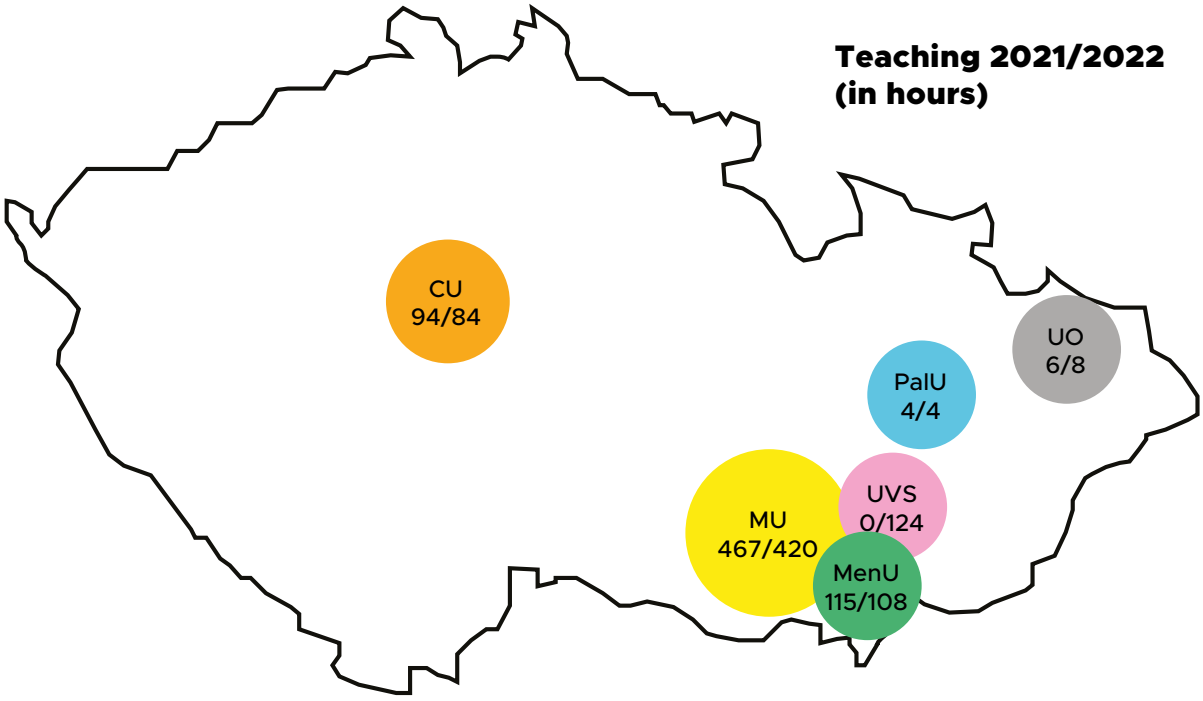
The objective of G-BiKErs is to cycle towards biodiversity protection at genomic and genetic level, i.e. to raise awareness of the importance of genetic diversity as part of biodiversity and to strengthen the protection of this biodiversity component in conservation policies and practice. During three working days, the next steps in achieving this goal, including preparation of scientific manuscripts, organisation of workshops for stakeholders, as well as design of comic strips introducing the topic of genetic diversity to children and youth were discussed. One of the major meeting focuses was to prepare for the upcoming CBD meetings in Montreal in December 2022, where G-BiKE members planned to propose an effective population size as a suitable indicator for biodiversity monitoring.

Forty-five participants from 25 European countries met in person during the meeting | Photo credit: archive IVB

EDUCATION AND TEACHING ACTIVITIES

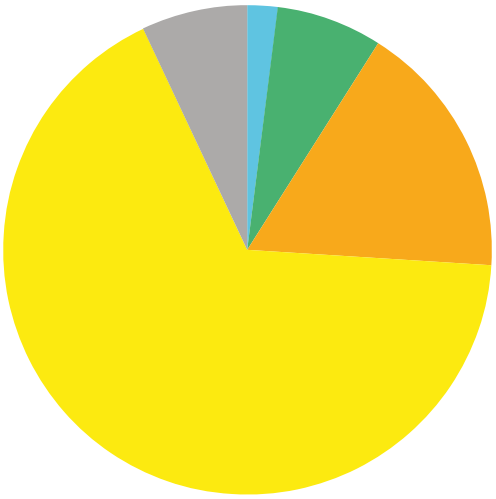
Teaching at universities and supervision of students

IVB employees have been very active in lecturing at universities around the country providing a total of 686 hours of lectures in 2021 and 748 hours in 2022. Additionally, many graduate students are actively involved in IVB's research programs. The Institute's researchers supervised a total of 46 Bachelor's and 45 Master's students during the period 2021–2022. In 2021, 17 students graduated (eight with Bachelor's degrees and nine with Master's degrees), while in 2022, 18 students graduated (13 with Bachelor's degrees and five with Master's degrees).



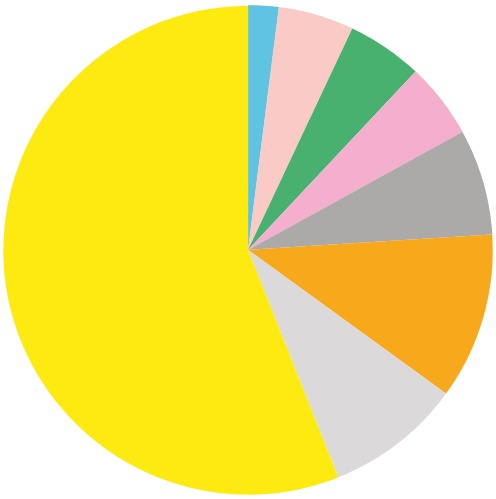
Number of hours IVB researchers spent lecturing at Czech universities in 2021 and 2022. **MU** = Masaryk University, Brno; **MenU** = Mendel University in Brno; **PalU** = Palacký University, Olomouc; **CU** = Charles University, Prague; **UO** = University of Ostrava; **UVS** = University of Veterinary Sciences. The numbers in the circles indicate the hours of lecturing in 2021 and 2022, respectively:

Bachelor student affiliation 2021–2022



MU - **31**
CULS - **3**
CU - **8**
MenU - **3**
PalU - **1**

Master student affiliation 2021–2022



MU - **26**
USB - **2**
CU - **5**
UVS - **2**
PalU - **1**
MenU - **2**
CULS - **3**
Others - **4**

Affiliation and number of Bachelor's and Master's students supervised by IVB researchers in 2019 and 2020. **MU** = Masaryk University, Brno; **MenU** = Mendel University in Brno; **CU** = Charles University, Prague; **CULS** = Czech University of Life Sciences, Prague; **USB** = University of South Bohemia, České Budějovice; **PalU** = Palacký University, Olomouc; **UVS** = University of Veterinary Sciences, Brno.

PhD students working at the Institute and/or supervised by the Institute's fellows

Over 2021 and 2022, researchers at the IVB supervised 49 PhD students, 15 of them successfully defended their theses during that period.

Table 1: List of PhD students supervised by IVB researchers over 2021 and 2022.

PhD student	**Affiliation****	Supervisor/Consultant*	Start of study	Defended thesis
ADÁMKOVÁ Marie	1	Albrecht/Tomášek*	2013	2021
ALILA Okinyi David	7	Reichard*	2019	
BAARS Maureen	6	Gvoždíková-Javůrková	2021	
BADJEDJEA BABANGENGE Gabriel	4	Gvoždík V.	2017	
BAŚKIERA Senka	1	Gvoždík L.	2017	2022
BEDNAŘÍKOVÁ Šárka	8	Zukal	2020	
BOBEK Lukáš	1	Albrecht/Tomášek*	2013	2022

PhD student	**Affiliation****	Supervisor/Consultant*	Start of study	Defended thesis
BRLÍK Vojtěch	2	Procházka	2019	
CEDROWSKA Martyna	2	Albrecht*	2021	
CUYPERS Laura	3	Goüy de Bellocq/ Baird*	2017	
DIANAT Malahatosadat	1	Bryja*	2018	
DOLINAY Matej	1	Gvoždík V.	2015	2022
DZURJA Jan	9	Krojerová	2022	
HÁNOVÁ Alexandra	1	Bryja*	2016	2021
HARAZIM Markéta	1	Martínková	2018	2021
HAVLÍČEK Jan	5	Šálek	2014	2021
HEGER Tomáš	8	Zukal	2017	2022
HNILIČKA Michal	1	Jurajda	2021	
HORÁK Kryštof	1	Albrecht	2019	
ILÍK Vladislav	1	Pafčo	2020	
JANČA Matouš	1	Tomášek/Albrecht*	2021	
JIROUŠOVÁ Eva	1	Pafčo	2020	
KAČMAŘÍKOVÁ Jana	8	Červená*	2022	
KAUZÁL Ondřej	2	Albrecht/Tomášek*	2017	
KRÁSOVÁ Jarmila	5	Bryja	2015	
KUMAR Sampath Anandan	1	Tomášek/Albrecht*	2017	2022
LOTANA LOKASOLA Albert	4	Gvoždík V.	2018	2022
MADĚROVÁ Lucie	9	Červená*	2021	
MADHAVAN Malavika	5	Šálek	2021	
MASON Bethan	1	Petrželková	2019	
MÍČKOVÁ Kristýna	2	Albrecht	2018	
MICHÁLKOVÁ Romana	2	Albrecht	2012	2021
MICHÁLKOVÁ/NEZHYBOVÁ Veronika	1	Ondračková/Reichard*	2012	2021
MIZEROVSKÁ Daniela	1	Bryja	2018	
MULUALEM Getachew	1	Bryja	2020	
NEČAS Tadeáš	1	Gvoždík V.	2019	
PAZDERA Lukáš	2	Tomášek/Albrecht*	2020	
PETRUŽELA Jan	1	Goüy de Bellocq/ Baird*	2018	
POIGNET Manon	2	Albrecht*	2018	
PRAVDOVÁ Markéta	1	Ondračková	2015	
SAILAS Sangeeth	5	Šálek	2021	
SAMBUCCI Kelly M.	1	Petrželková/Červená*	2021	
SAU Shubhra	1	Martínková	2021	
ŠMÍDOVÁ Lucie	2	Kreisinger/Albrecht*	2012	2022
ŠTĚTKOVÁ Gabriela	2	Honza/Šulc*	2022	
TĚŠICKÝ Martin	2	Albrecht*	2016	
TĚŠÍKOVÁ Jana	1	Goüy de Bellocq / Bryja*	2014	2022
ZUKALOVÁ Kateřina	8	Zukal	2018	
ŽÁK Jakub	2	Reichard	2017	2022

** FACULTY: 1 = Faculty of Science, Masaryk University, Brno; 2 = Faculty of Science, Charles University, Prague; 3 = University of Antwerp; 4 = Université de Kisangani, Faculté des Sciences, RD Congo; 5 = Faculty of Science, University of South Bohemia, České Budějovice; 6 = Universidad de la República, Montevideo, Uruguay; 7 = Institute of Ecology & Evolution, University of Bern, Switzerland; 8 = Faculty of Veterinary Medicine, University of Veterinary and Pharmaceutical Sciences, Brno; 9 = Faculty of AgriSciences, Mendel University, Brno.

PhD theses supervised by Institute fellows that were defended in 2021 and 2022

ADÁMKOVÁ Marie, 2021: Individual condition, ornament expression and sexual selection in the barn swallow Hirundo rustica, Faculty of Science, Masaryk University, Brno. Supervisor: T. Albrecht, co-supervisor: O. Tomášek.

BAŚKIERA Senka, 2022: Individual phenotypic variation in thermal ecology of amphibians, Faculty of Science, Masaryk University, Brno. Supervisor: L. Gvoždík.

BOBEK Lukáš, 2022: Life-histories and bird ecophysiology: latitudinal and altitudinal processes in passerines, Faculty of Science, Masaryk University, Brno. Supervisor: T. Albrecht, co-supervisor: O. Tomášek.

DOLINAY Matej, 2022: Species diversification of African frogs in spatial and ecological context, Faculty of Science, Masaryk University, Brno. Supervisor: V. Gvoždík.

HÁNOVÁ Alexandra, 2021: Evolutionary history of selected African rodents living in open habitats assessed at multiple spatial and evolutionary scales, Faculty of Science, Masaryk University, Brno. Co-supervisor: J. Bryja.

HARAZIM Markéta, 2021: Physiology and pathology of infection in bats, Faculty of Science, Masaryk University, Brno. Supervisor: N. Martínková.

HAVLÍČEK Jan, 2021: House sparrow feeding ecology in temporary rural settlement, Faculty of Science, University of South Bohemia, České Budějovice. Supervisor: M. Šálek.

HEGER Tomáš, 2022: Physiology of bat hibernation with respect to multistressor impacts, Faculty of Veterinary Medicine, University of Veterinary and Pharmaceutical Sciences, Brno. Supervisor: J. Zukal.

KUMAR Sampath Anandan, 2022: Molecular mechanisms of life-history evolution in birds, Faculty of Science, Masaryk University, Brno. Supervisor: O. Tomášek, co-supervisor: T. Albrecht.

LOTANA LOKASOLA Albert, 2022: Diversity and biogeography of lacertilians in the central Congo Basin (Squamata: Sauria), University of Kisangani, Faculty of Sciences, Dem. Rep. Congo. Supervisor: V. Gvoždík.

MICHÁLKOVÁ Romana, 2021: Extra-pair fertilizations and the opportunity for sexual selection in Barn swallows, Faculty of Science, Charles University, Prague. Supervisor: T. Albrecht.

MICHÁLKOVÁ/NEZHYBOVÁ Veronika, 2021: Parasite-associated changes in fish host physiology and behaviour, Faculty of Science, Masaryk University, Brno. Supervisor: M. Ondračková, co-supervisor: M. Reichard.

ŠMÍDOVÁ Lucie, 2022: Ecological aspects affecting microbiota in the digestive tracts of birds, Faculty of Science, Charles University, Prague. Supervisor: J. Kreisinger, co-supervisor: T. Albrecht.

TĚŠÍKOVÁ Jana, 2022: Diversity and evolutionary history of selected rodent-borne viruses, Faculty of Science, Masaryk University, Brno. Supervisor: J. Goüy de Bellocq, co-supervisor: J. Bryja.

ŽÁK Jakub, 2022: The biology of aging in Nothobranchius fishes, Faculty of Science, Charles University, Prague. Supervisor: M. Reichard.

Jana Těšíková (on the right) after her PhD defence with her supervisor Joëlle Goüy de Bellocq (on the left) | Photo credit: archive of Masaryk University

Sampath Anandan Kumar during his PhD defence at Masaryk University | Photo credit: archive IVB

EDITORIAL ACTIVITIES

Journal of Vertebrate Biology

The Journal of Vertebrate Biology (formerly Folia Zoologica, founded in 1938) publishes high-quality original research papers of broad interest. The Journal welcomes papers on the behaviour, ecology, physiology, anatomy, developmental biology, taxonomy, and evolution of vertebrates, including research at the interface of these disciplines (see www.ivb.cz/jvertbiol).

It is published quarterly, with each volume comprising four issues, and additional issues published occasionally.

The improved quality of the Journal is reflected in its move into Q2 journals in Zoology with IF rank of 1,5. Full papers published in the Journal of Vertebrate Zoology are available at https://www.jvertbiol.cz/index.php.

The Journal provides editorial support to assist authors in producing review papers. We promote transparency in publication and encourage authors to deposit data and data analysis code in a trusted repository, preregister studies and data analysis plans, and submission of replication studies.

Publisher and Editorial Office

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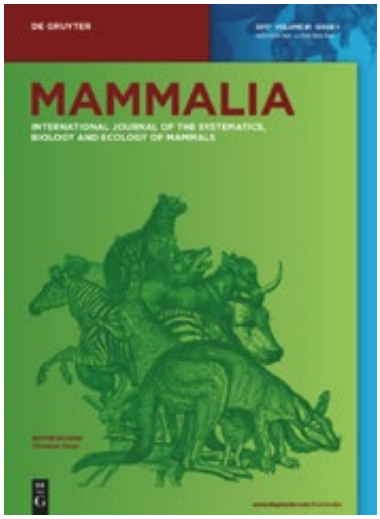
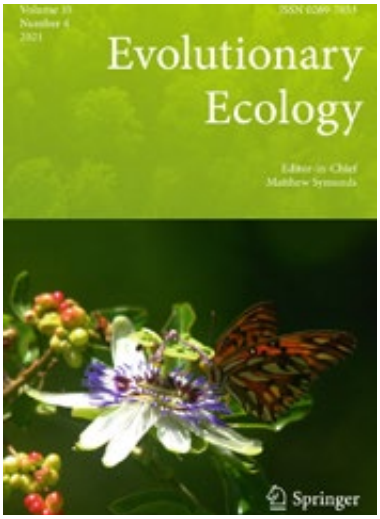
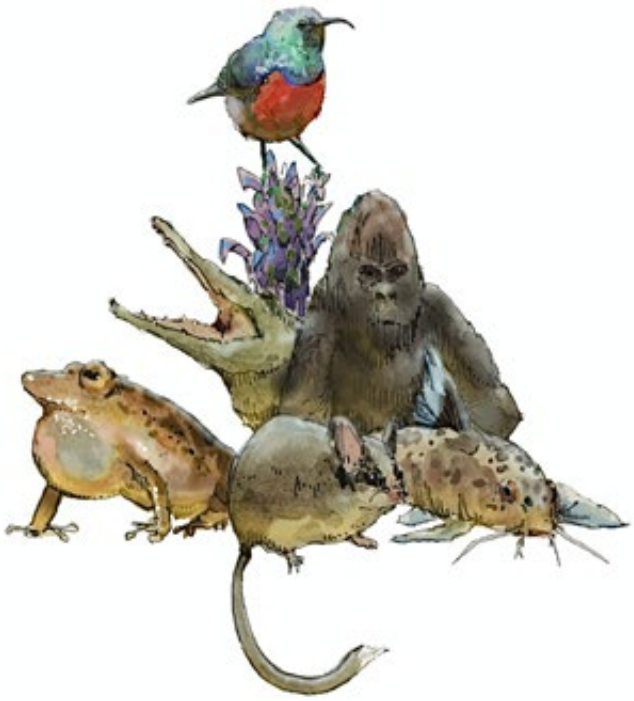
MEMBERSHIP OF EDITORIAL BOARDS

In 2021 and 2022, our scientists acted as Associate Editors on a number of international peer-reviewed journals, including Evolutionary Ecology, Mammalia, Frontiers in Zoology, Frontiers in Ecology and Evolution, Frontiers in Amphibian and Reptile Science, Aquatic Invasions, BioInvasions Records and Journal of Field Ornithology. A number of researchers at the IVB are also editorial board members for international peer-reviewed journals, including Herpetology Notes, BMC Zoology, Behavioral Ecology, International Journal of Primatology, Journal of Vertebrate Biology (formerly Folia Zoologica), International Studies on Sparrows, and the Croatian Journal of Fisheries.







AWARDS

IVB Achieved the PRESTIGIOUS HR AWARD!

On February 22, 2022, the IVB received the prestigious HR Award, granted by the European Commission to research institutions. Achieving the HR Award signifies not only a mark of quality but also a lasting commitment to ongoing development and creating favourable conditions for IVB employees.

The process of obtaining the award began in July 2020 when we aligned ourselves with the principles outlined in the "European Charter for Researchers and the Code of Conduct for the Recruitment of Researchers." These documents establish a set of general principles and requirements that specify the responsibilities and rights of researchers and their employers.

The first step involved a Gap Analysis that identified shortcomings at our institute. Based on this analysis, we devised a concrete improvement plan for the following two years, known as the Action Plan. Both documents are available for download on our website.

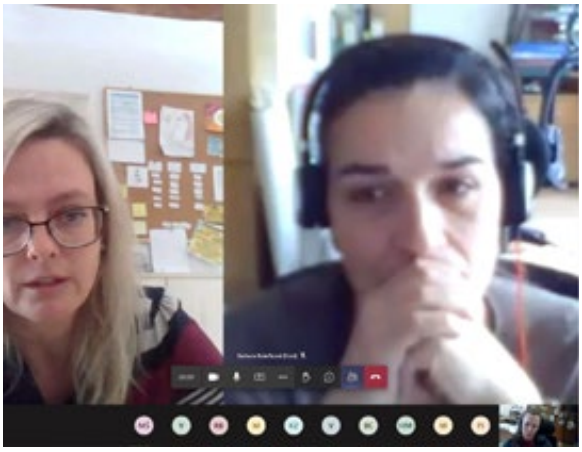
The European Commission evaluated and provided feedback on this plan, which was incorporated, leading to the approval of the HR Award. With this, our institution joined the ranks of other excellent institutions (58 in the Czech Republic) (https://www.euraxess.cz/jobs/hrs4r/awarded).

By obtaining the HR Award, IVB also commits to:

- **Increasing the prestige and attractiveness for researchers and staff**
- **Creating conditions for a more appealing career in research and development**
- **Creating conditions for a better balance between work and private life for employees**
- **Enhancing the quality of human resources management**
- **Ensuring transparent recruitment and selection of new staff**
- **Enhancing international prestige and integration of the institute into the pan-European network of research organisations**

What‘s next? Within 24 months of receiving the award, a midterm evaluation will take place, followed by subsequent evaluations every three years. As part of the HR Award, IVB also plans to introduce Gender Equality Plans (GEP).

Among the activities that took place in the first two years of project implementation were events improving science popularisation and providing opportunities to balance family and work life, such as organising a Media Logic Course, Children‘s Day at IVB, and a Children‘s Summer Camp during the ESEB conference, which happened in August 2022 in Prague.



Media Logic Course was organised by colleagues from Center for shared activities of CAS | Photo credit: archive IVB

Children‘s Day at IVB in Brno with the group Denbaya | Photo credit: archive IVB

Children‘s Day at IVB in Brno with the group Denbaya | Photo credit: archive IVB

The Children‘s Summer Camp at Mohelno field station organised for children of IVB employees was held during the ESEB conference from August 14th to 19th, 2022 | Photo credit: archive IVB

Barbora Pafčo was awarded the ODILE BAIN MEMORIAL PRIZE 2021

Barbora Pafčo holding the Odile Bain Memorial Prize | Photo credit: archive IVB

Parasites & Vectors, in collaboration with Boehringer Ingelheim Animal Health, awarded the Odile Bain Memorial Prize to Barbora Pafčo in the field of veterinary parasitology.

The Odile Bain Memorial Prize (OBMP) has been recognizing early-career scientists who have made significant contributions to the medical and veterinary parasitology fields, in memory of Odile Bain, an exceptional and inspiring female scientist. The Prize has become a prestigious acknowledgement in the field, and this year the evaluation committee, chaired by Professor Domenico Otranto, received a very high number of excellent nominations.

"The main focus of Odile's activity", said Professor Otranto at the award ceremony at the World Association for the Advancement of Veterinary Parasitology (WAAVP) conference, "was the study of evolution, systematics and biology of filaroids of veterinary and medical concern, and the relationship of these worms with other groups of nematodes. These studies led Odile towards the exploration of many aspects of the biology of vectors responsible for the transmission of these parasites and the interaction with the vertebrate host. Her research greatly impacted the current knowledge of filarial disease, chemotherapy, immunology, and many other aspects of parasitology. Therefore, this prize was established to celebrate her outstanding contributions to medical and veterinary parasitology, and for her actions in encouraging productive collaboration among biologists, veterinarians, physicians, and fundamental and applied parasitologists worldwide".

Dr. Barbora Pafčo's merits as an outstanding early-career scientist are in relation to significant contributions to the field of strongylid nematodes infecting sympatric primates (e.g., western lowland gorillas, central chimpanzees) and humans in the Central African Republic.

"I am truly honoured to receive the Odile Bain Memorial Prize. For me, it is proof of the quality of my work", said Dr. Pafčo. "Sometimes it is difficult to evaluate one's work and sometimes even find its purpose, which every researcher is likely to experience at some point. Winning the Odile Bain Memorial Prize gives me new energy for further research. I would like to start my own team focused on the diversity, distribution and coevolution of nematodes with host species".

Dr. Pafčo is interested in parasite ecology, host-parasite relationship, and molecular diversity of pathogens. Her work is focused on studying strongylid nematodes, recently shedding light on the factors leading to gastritis caused by parasitic nematodes in mountain gorillas. She has also been studying the diversity and distribution of strongylid nematodes in cattle in the Czech Republic and the worldwide distribution of nematodes of the genus Necator, with implications for the potential of drug resistance or zoonotic risk. The approaches employed in Barbora's research combine classical and experimental parasitology.

OTTO WICHTERLE PRIZE 2021 and 2022

The Otto Wichterle Premium Prize for young scientists is named after Professor Otto Wichterle in memory of an exceptional Czech chemist of global renown who became the President of the Czechoslovak Academy of Sciences after November 1989. The award has been granted since 2002 and is accompanied by a financial reward of 330,000 Czech crowns distributed over three years. To date, 480 laureates have received this prize.

Barbora Pafčo Receives the OTTO WICHTERLE PREMIUM PRIZE 2021

Photo credit: archive CAS

Twenty-four remarkable young scientific talents were awarded the prestigious Otto Wichterle Premium Prize for the year 2021 by the Czech Academy of Sciences. The award ceremony took place at the Lanna Villa in Prague on Tuesday, June 29, 2021, and the prizes were presented to the laureates by Eva Zažímalová, the President of the Czech Academy of Sciences. Among the recipients was scientist Barbora Pafčo from IVB.

Barbora Pafčo (born 1988) has been involved in the study of the evolution and ecology of parasites since her biology studies at Masaryk University. Her specialisation lies in the transmission of pathogens between free-living animals, particularly primates, and humans. This research is significant not only for its direct impact on the health of both humans and animals but also in terms of biodiversity and ecosystem protection. Another scientific focus of hers involves studying the microbiome of primates, including humans.

Working at the Institute of Vertebrate Biology, Academy of Sciences of the Czech Republic since 2018, Barbora Pafčo also conducts parasite diagnostics in the field, specifically among primates. Over the past ten years, she has undertaken several field expeditions in Africa, including the Central African Republic, Cameroon, Congo Republic, Tanzania, and Rwanda.

She collaborates with prestigious institutions in the USA (Cornell University in Ithaca, University of Minnesota) and Japan (Kyoto University, Oita University). She consulted with researchers at these institutions during her master's and later doctoral studies, and she also completed postdoctoral stays there.

Peter Mikula was awarded the OTTO WICHTERLE PRIZE in 2022

Peter Mikula in USA during his Fulbright stay | Photo credit: archive IVB

Twenty-five remarkable young scientific talents were awarded the prestigious Otto Wichterle Premium Prize for the year 2022 by the Czech Academy of Sciences. The award ceremony took place at the Lanna Villa in Prague on Monday, June 20, 2022, and the prizes were presented to the laureates by Eva Zažímalová, the President of the Czech Academy of Sciences.

The award was given to promising scientists who achieve outstanding results in their fields, hold scientific degrees (CSc., Dr., Ph.D., DrSc.), and are under the age of 35 at the time of nomination. Parental leave is not included in this age calculation. Among the recipients was scientist Peter Mikula from IVB.

"We believe that these are the future scientific generation who will act as a 'navigation' for the excellent research of the Czech Academy of Sciences. After all, many past laureates are already proof of this: including Tomáš and Pavel Jungwirth, Jan Konvalinka, Julius Lukeš, and other outstanding scientists who are now receiving significant grants and becoming team leaders," says Eva Zažímalová, the President of the Czech Academy of Sciences.

Peter Mikula (born 1990), originally from Slovakia, mainly focuses on the behaviour of birds and other animals across large spatial and taxonomic scales. His research not only contributes to scientific knowledge but also to the protection of nature and biodiversity. A special part of his work is the study of songbirds: he has been investigating the acoustic and visual signals of birds since his bachelor's degree. In his recent publications in journals like Ecology Letters and Proceedings of the Royal Society B, he and his collaborators have shared information about the singing height and the presence of aerial displays for thousands of bird species.

These are currently the largest available datasets concerning these fascinating phenomena in the world. Starting from fall 2022, Peter Mikula spent half a year working in the team of the prominent contemporary behavioural ecologist, Prof. Daniel Blumstein, at the University of California, Los Angeles, as part of the Fulbright scholarship. His focus was on studying bird tolerance towards human presence on a global scale. He has also gained valuable research experience at other prestigious institutions, including the Max Planck Institute for Ornithology in Germany.

Martin Reichard receives the CZECH GRANT AGENCY AWARD

In 2022, the Chairman‘s Awards from the Czech Grant Agency (GA ČR) were a significant success for scientists from the Czech Academy of Sciences. Among the five laureates, four were affiliated with the Academy‘s institutions. Martin Reichard from IVB was among them.

The award ceremony took place at the Mathematical-Physical Faculty of Charles University. The event was opened by the Minister of Science, Research, and Innovation, Helena Langšádlová, who mentioned the ongoing significant crisis. "For their resolution, we need collaboration with scientists. Therefore, we must focus on even stronger interconnection between basic and applied research,“ she highlighted the fundamental importance of knowledge transfer in science. "Thanks to the support of the Czech Grant Agency, colleagues at our institutes can work because without this support, especially in experimental fields, they wouldn‘t be able to pursue their work in the long term,“ said Eva Zažímalová, the President of the Czech Academy of Sciences, in her speech, emphasising the importance of the Czech Grant Agency for scientific research. She also noted the positive relationship between the Czech Grant Agency and the Academy of Sciences and appreciated the fair selection process of project leaders.

This year‘s award ceremony marked the premiere for the current Chairman of the Czech Grant Agency, Petr Baldrian, who rewarded scientists in five traditional categories. Martin Reichard received the award for his project "Sources of Intrapopulation Heterogeneity in Aging.“ The project identified the causes of different ageing rates in male and female turquoise killifish in both nature and the laboratory. It described how environmental conditions, embryonic development, and growth rate can influence the ageing process. Understanding the sources of differences in ageing rates is also important for addressing current issues related to the ageing human population.

The Chairman‘s Award from the Czech Grant Agency has been regularly awarded since 2003 to recognize outstanding results achieved in solving grant projects completed in the previous year. Laureates are selected based on recommendations from several hundred scientists who evaluate projects funded by the Czech Grant Agency. Each laureate receives a financial reward of 100,000 Czech crowns as part of the award. The awards are granted in five areas of basic research: technical sciences; natural sciences; medical and biological sciences; social and humanities sciences; and agricultural and biological-environmental sciences.

Martin Reichard (third from right) receives the Czech Grant Agency Award | Photo credit: archive IVB

Gabriela Štětková receives the DEAN'S AWARD from the Faculty of Science, Masaryk University

Gabriela Štětková recieves the Dean´s award from the Faculty of Science, Masaryk University | Photo credit: archive IVB

Dean Tomáš Kašparovský ceremoniously presented awards to the best students of the Faculty of Science at Masaryk University. The Dean's Awards for this year were granted to a total of eight laureates in the category of Best Student in Bachelor's and Master's study programs, and to sixteen promising researchers in the category of Best Student in Doctoral study programs. Additionally, the collective achievement of eight students belonging to the Mendel Generation was recognized for the very first time.

Among the awardees in the category of Best Student in Bachelor's and Master's study programs was Gabriela Štětková, a student who conducted her bachelor's thesis at IVB. Gabriela Štětková has been engaged in research on brood parasitism for a significant period. During her studies and research, she contributed to various topics and is a co-author of six published scientific papers. Gabriela received a grant from the rector of Masaryk University to support outstanding master's theses, one of which was also recognized by an expert jury at the 47th conference of the Czech Ethological Society.

Award for OUTSTANDING RESULTS granted to doctoral students and their supervisors – Lumír Gvoždík from the IVB and his student Senka Baškiera among the awardees

In December 2022, Vice-Rector for Research and Doctoral Studies Šárka Pospíšilová awarded a prize for outstanding results in doctoral studies to 33 graduates and their supervisors at Masaryk University (MU).

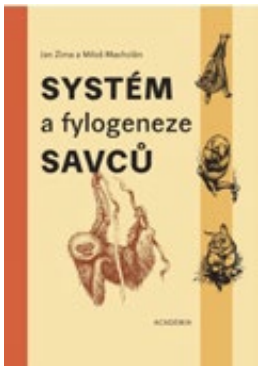
The award was granted to individuals who successfully completed their doctoral studies within the standard period of 4 years, with an optional extension of up to one year, while also achieving exceptionally high-quality research outcomes included in their dissertations. The criteria for this award align with the Principles for Effective and High-Quality Doctoral Studies at MU, which form the foundation for the entire doctoral study transformation process at the university.

Vice-Rector Pospíšilová introduced the award for the first time last year and plans to recognize successful doctoral students and their supervisors annually. "The main objective of this award is to motivate current doctoral students to complete their studies within the standard timeframe and with high-quality results. Recognizing those who achieve this goal is part of a series of activities that Masaryk University organises to enhance the quality of doctoral studies," Vice-Rector Pospíšilová stated. The award includes a financial prize of 25,000 CZK for both the graduate and the supervisor.

Senka Najman Baškiera and Lumír Gvoždík received the award for their work titled: "Individual Phenotypic Variability in the Thermal Ecology of Amphibians." The research was conducted within the study program of Ecology and Evolutionary Biology, focusing on Zoology.

Senka Baškieara (on the laft) recieves award for outstanding results during her doctoral studies | Photo credit: archive IVB

ACADEMIA PUBLISHING HOUSE AWARD for the book "Systém a fylogeneze savců“ (System and Phylogeny of Mammals)



The book "Systém a fylogeneze savců“ (System and Phylogeny of Mammals) by Jan Zima (in memoriam) from the Institute of Vertebrate Biology CAS and Miloš Macholán from the Institute of Animal Physiology and Genetics CAS received the award from Academia Publishing House in the category of dictionaries or encyclopaedic publications. The work presented a comprehensive summary of knowledge about evolutionary relationships between mammal groups and caught the attention of a ten-member expert jury among 78 nominated publications released in 2021 at the workplaces of the Czech Academy of Sciences.

The diversity of species in the evolutionary lineages of organisms on Earth is incredibly rich and still only partially understood. "Mammals have always attracted the attention of scientists and the general public. Undoubtedly, they are among the best-studied animal groups, perhaps because humans themselves are mammals. In the book, we present a current summary of knowledge about the evolutionary relationships between mammal groups, based on the study of chromosomes and DNA sequences,“ describes the content of the publication Miloš Macholán from the Institute of Animal Physiology and Genetics CAS. Systematics and phylogeny are fields that have undergone significant changes and progress over the last decades thanks to the application of molecular and genetic methods as well as advanced computational techniques.

Today, the phylogeny of mammals is already very well-known, and the system of the group created in the last decade can be considered close to the final state of knowledge. "Such comprehensive work is currently lacking, even on a global scale. A significant contribution here is the integration of the most modern methods with traditional knowledge of palaeontology, morphology, and evolutionary developmental biology,“ highlights the significance of the publication Miloš Macholán. The focal point of the publication is the groups of living mammals, where advanced methods of molecular phylogenetics and systematics can be fully applied. Therefore, the book starts with general methodological chapters on how phylogenetic relationships are studied. Conversely, chapters on domesticated mammals and extinct forms, which were investigated using archaic DNA, are included at the end. The book concludes with a chapter on human evolution, including racial questions.

"The book primarily summarizes the current state of knowledge but also represents a significant source of key primary publications, carefully selected to be representative and not overwhelming for the readers. We believe that this is why the book can become an important source of information for a wide range of readers, from specialists in the field and university students in natural sciences to high school and elementary school teachers,“ says co-author of the publication Miloš Macholán.

The book was completed after the death of Jan Zima, who is the author of the majority of the chapters. "I am very pleased that we managed to complete the book, thanks to the enormous support of many people. Alongside many others, I would like to highlight the assistance of Hynek Burda and František Sedláček, who thoroughly reviewed the initial manuscript versions with great care. The incredible work was then done by editor Eva Leinerová during the language correction process, as she was able

to identify errors and inconsistencies even in complex, almost unpronounceable Latin names of individual taxa throughout the publication," describes Miloš Macholán regarding the challenges of completing the publication. (Source: ÚŽFG website, Author: Barbora Vošlajerová)

Miloš Macholán (on the left) recieves the award of the Academia Publishing House | Photo credit: archive IVB

Milan Peňáz received MEDAL from the Czech Academy of Sciences

Photo credit: Jiří Bárta, 5plus2.cz

The award was presented by the President of the Academy, Eva Zažímalová on Monday, June 13th, at the Villa Lana.

Milan Peňáz was awarded an honorary medal for his significant contributions to establishing the Institute of Vertebrate Biology of the Czech Academy of Sciences. He is an accomplished ichthyologist specialising in the ecological aspects of fish life.

Milan Peňáz dedicated a significant part of his life and creative effort to the Vysočina region. In his youth, he captured numerous valuable photographs that, after fifty years, became the foundation of a book about the vanished village of Chudobín. He also gained recognition as an unwavering promoter of the Chudobín pine, later recognized as the European Tree of the Year.

Photo credit: Laura Cuypers

PROJECTS

PROJECTS SUPPORTED BY THE CZECH SCIENCE FOUNDATION (GA ČR)

GA 18-19629S Comparative parasite hybridisation genomics controlling for host divergence. **Recipient**: Institute of Vertebrate Biology, Czech Academy of Sciences, Brno. **Principal Investigator**: Joelle Gouy de Bellocq. **Research years**: 2018-2021.

GA18-24544S Genomic insights into the evolutionary history and contact zones of slow-worm lizards (*Anguis*). **Recipient**: Institute of Vertebrate Biology, Czech Academy of Sciences, Brno. **Principal Investigator**: Václav Gvoždík. **Research years**: 2018-2021.

GA18-17796Y Consequences of vertebrate microbiota changes due to symbiotic associations with humans. **Recipient**: Institute of Vertebrate Biology, Czech Academy of Sciences, Brno. **Principal Investigator**: Jakub Kreisinger. **Research years**: 2018-2021.

GA18-24345S Epidemiology and pathological effects of gastrointestinal helminthiases in critically endangered mountain gorillas. **Recipient**: Institute of Vertebrate Biology, Czech Academy of Sciences, Brno. **Principal Investigator**: Klára Petrželková. **Research years**: 2018-2021.

GA18-26284S Embryo and environment – annual fish as a unique model to study embryo ecology. **Recipient**: Institute of Vertebrate Biology, Czech Academy of Sciences, Brno. **Principal Investigator**: Matej Polačik. **Research years**: 2018-2021.

GA18-00682S A novel system to understand brood parasitism: the cuckoo catfish parasiting African cichlids. **Recipient**: Institute of Vertebrate Biology, Czech Academy of Sciences, Brno. **Principal Investigator**: Martin Reichard. **Research years**: 2018-2021.

GA19-22538S Molecular mechanisms of sperm morphology variation in passerine birds. **Recipient**: Institute of Vertebrate Biology, Czech Academy of Sciences, Brno. **Principal Investigator**: Tomáš Albrecht. **Research years**: 2019-2021.

GA19-20873S Driver mutations in cancer genome of Nothobranchius furzeri: from tumor biology to concept of experimental model of spontaneous carcinogenesis. **Recipient:** Masaryk University in Brno, CEITEC. **Sub-recipient**: Institute of Vertebrate Biology, Czech Academy of Sciences, Brno. **Principal Investigator**: Ondřej Slabý. **Principal Co-Investigator:** Radim Blažek. **Research years:** 2019-2021.

GA19-19307S Evolutionary patterns of gastrointestinal microbiota on murine rodents example. **Recipient:** Charles University in Prague. **Sub-recipient:** Institute of Vertebrate Biology, Czech Academy of Sciences, Brno. **Principal Investigator:** Jakub Kreisinger. **Principal Co-Investigator:** Dagmar Čížková. **Research years**: 2019-2022.

GA19-12774S Evolution of hybrid male sterility in the European house mouse. **Recipient**: Institute of Vertebrate Biology, Czech Academy of Sciences, Brno. **Principal Investigator**: Jaroslav Piálek. **Research years**: 2019-2022.

GA19-01781S The sources of intra-population heterogeneity in senescence. **Recipient**: Institute of Vertebrate Biology, Czech Academy of Sciences, Brno. **Principal Investigator**: Martin Reichard. **Research years**: 2019-2021.

GA19-05510S Individual variability and resilience of interspecific relationships in freshwaters: insights from fishmussel interactions. **Recipient:** Czech University of Life Science in Prague. **Sub-recipient:** Institute of Vertebrate Biology, Czech Academy of Sciences, Brno. **Principal Investigator:** Karel Douda. **Principal Co-Investigator:** Martin Reichard. **Research years**: 2019-2022.

GA20-23794S Germ-line restricted chromosome in songbirds: understanding its origin, function and evolutionary significance. **Recipient:** Charles

University in Prague. **Sub-recipient:** Institute of Vertebrate Biology, Czech Academy of Sciences, Brno. **Principal Investigator:** Radka Reifová. **Principal Co-Investigator:** Tomáš Albrecht. **Research years**: 2020-2023.

GA20-10222S Phylogeny, adaptation and evolution of sociality in African mole-rats, a model group in evolutionary and biomedical research. **Recipient**: University of South Bohemia in České Budějovice. **Sub-recipient**: Institute of Vertebrate Biology, Czech Academy of Sciences, Brno. **Principal Investigator**: Radim Šumbera. **Principal Co-Investigator**: Ondřej Mikula. **Research years**: 2020-2022.

GA20-29111S Parasite acquisition by non-native fish hosts: determinants and impacts on native fish fauna. **Recipient**: Institute of Vertebrate Biology, Czech Academy of Sciences, Brno. **Principal Investigator**: Markéta Ondračková. **Research years**: 2020-2023.

GA20-00648S Integrating migratory patterns, phenology, year-round habitat use and demography to understand drivers of population dynamics of migratory birds. **Recipient**: Institute of Vertebrate Biology, Czech Academy of Sciences, Brno. **Principal Investigator**: Petr Procházka. **Research years**: 2020-2022.

GA20-006110Y Conspecific brood parasitism in an altricial passerine: physiological conditions, behavioural adaptations and fitness consequences. **Recipient**: Institute of Vertebrate Biology, Czech Academy of Sciences, Brno. **Principal Investigator**: Michal Šulc. **Research years**: 2020-2023.

GA20-07091J Small mammals of Eastern African Mountains: evolutionary diversification and endemism in one of the world´s most important biodiversity hot-spots. **Recipient**: Institute of Vertebrate Biology, Czech Academy of Sciences, Brno. **Principal Investigator**: Josef Bryja. **Research years**: 2020-2022.

GA21-22160S Diversity and physiological mechanisms of senescence in a wild bird population. **Recipient:** Masaryk University in Brno. **Sub-recipient**: Institute of Vertebrate Biology, Czech Academy of Sciences, Brno. **Principal Investigator**: Oldřich Tomášek. **Principal Co-Investigator:** Tomáš Albrecht. **Research years:** 2021-2023.

GA21-17125S A hazy barrier: Mid-elevation exchange of avian communities on Mt. Cameroon. **Recipient:** Charles University in Prague. **Sub-recipient:** Institute of Vertebrate Biology, Czech Academy of Sciences, Brno. **Principal Investigator**: David Hořák. **Principal Co-Investigator:** Oldřich Tomášek. **Research years:** 2021-2023.

GX21-00788X The role of coevolution in ecological speciation. **Recipient**: Institute of Vertebrate Biology, Czech Academy of Sciences, Brno. **Principal Investigator**: Martin Reichard. **Research years**: 2021-2025.

GA21-29169S Strategie sladkovodních ektotermů pro oteplující se svět: pohled od jedince po společenstva. **Recipient:** Institute of Vertebrate Biology, Czech Academy of Sciences, Brno. **Principal Investigator:** Lumír Gvoždík. **Research years**: 2021-2024.

GA22-26136S Ongoing global invasion of zoonotic parasitic nematode Angiostrongylus cantonensis: an assessment of risks of its emergence in Europe. **Recipient:** Masaryk University in Brno. **Sub-recipient:** Institute of Vertebrate Biology, Czech Academy of Sciences, Brno. **Principal Investigator:** David Modrý. **Principal Co-Investigator:** Barbora Červená. **Research years**: 2022-2024.

GA22-32394S Viromics of the European house mouse hybrid zone: a model to understand how viruses cross host species barriers. **Recipient**: Institute of Vertebrate Biology, Czech Academy of Sciences, Brno. **Principal Investigator**: Joelle Gouy de Bellocq. **Research years**: 2022-2024.

GA22-26812S Coevolutionary struggle between a highly virulent brood parasite and its major host. **Recipient**: Institute of Vertebrate Biology, Czech Academy of Sciences, Brno. **Principal Investigator**: Marcel Honza. **Research years**: 2022-2024.

GA22-16475S Gastrointestinal symbiont communities of great apes: bioindicators for tropical

ecosystem health. **Recipient**: Institute of Vertebrate Biology, Czech Academy of Sciences, Brno. **Principal Investigator**: Klára Petrželková. **Research years**: 2022-2024.

GA22-21198S Parental senescence effects and their mechanisms in a short-lived vertebrate. **Recipient:** Institute of Vertebrate Biology, Czech Academy of Sciences, Brno. **Principal Investigator:** Milan Vrtílek. **Research years**: 2022-2024.

PROJECTS SUPPORTED BY THE MINISTRY OF AGRICULTURE

QK21010030 Globalization, modern technologies and climate change provide both new opportunities and hazards for salmonid breeding management. **Recipient**: Institute of Vertebrate Biology, Czech Academy of Sciences, Brno. **Principal Investigator**: Jan Mendel. **Research years**: 2021-2025.

PROJECTS SUPPORTED BY THE MINISTRY OF EDUCATION, YOUTH AND SPORT OF THE CZECH REPUBLIC

OLTAUSA18209 The impact of diet and the gut microbiome on risk of cardiometabolic diseases in western lowland gorillas. **Recipient:** Institute of Vertebrate Biology, Czech Academy of Sciences, Brno. **Principal Investigator:** Klára Petrželková. **Research years:** 2019-2022. **Managed by:** The Ministry of Education, Youth and Sport of the Czech Republic.

LTAUSA19092 Genetic variability and parasitism in one of the most successful fish invader across Europe. **Recipient:** Institute of Vertebrate Biology, Czech Academy of Sciences, Brno. **Principal Investigator:** Markéta Ondračková. **Research years:** 2020-2022. **Managed by:** The Ministry of Health of the Czech Republic.

LTAUSA19147 Evolution and speciation mechanisms in a cryptic species complex of pan-African bats. **Recipient:** Institute of Vertebrate Biology, Czech Academy of Sciences, Brno. **Principal Investigator:** Peter Vallo. **Research years:** 2020-2022. **Managed by:** The Ministry of Education, Youth and Sport of the Czech Republic.

INTER-COST LTC20021 Conservation genetics and genomics of vertebrate species in Central European region. **Recipient:** Institute of Vertebrate Biology, Czech Academy of Sciences, Brno. **Principal Investigator:** Josef Bryja. **Research years:** 2020-2023. **Managed by:** The Ministry of Education, Youth and Sport of the Czech Republic.

OP VVV MOZOOLEC MOZOOLEC: Mobility project to support international research collaboration in zoology and ecology. **Recipient:** Institute of Vertebrate Biology, Czech Academy of Sciences, Brno. **Principal Investigator:** Tomáš Albrecht. **Research years:** 2021-2023

PROJECTS SUPPORTED BY THE MINISTRY OF HEALTH OF THE CZECH REPUBLIC

NV19-09-00036 Preparedness for introduction of exotic mosquito-borne viral fevers - One Health approach. **Recipient:** Institute of Vertebrate Biology, Czech Academy of Sciences, Brno. **Principal Investigator:** Ivo Rudolf. **Research years:** 2019-2021.

NU21-05-00143 Hidden zoonoses – uncovering new pathogenic agents from wildlife. **Recipient:** Institute of Vertebrate Biology, Czech Academy of Sciences, Brno. **Principal Investigator:** Ivo Rudolf. **Research years:** 2021-2024.

INTERNATIONAL PROJECTS

EU COST CA17108 Aedes Invasive Mosquitoes. **Recipient:** Institute of Vertebrate Biology, Czech Academy of Sciences, Brno. **Principal Investigator:** Ivo Rudolf. **Research years:** 2018-2022.

JPN Mobility PLUS Morphological and molecular identification of parasitic nematodes in non-human primates: strengthening the connection between traditional and modern approaches. **Recipient**: Institute of Vertebrate Biology, Czech Academy of Sciences, Brno. **Principal Investigator:** Klára Petrželková. **Research years**: 2019-2021.

COST CA18134 Genomic blodiversity knowledge for resilient ecosystems. **Recipient:** Institute of Vertebrate Biology, Czech Academy of Sciences, Brno. **Principal Investigator:** Josef Bryja. **Research years:** 2019-2023.

304021R971 We are looking for a wildcat! **Recipient:** Institute of Vertebrate Biology, Czech Academy of Sciences, Brno**. Principal Investigator:** Jarmila Krojerová. **Research years:** 2020-2022. **Financed by:** Interreg V-A SK-CZ 2014-2020.

3201200009 Save the little owl. **Recipient:** Czech Society for Ornithology. **Sub-recipient:** Institute of Vertebrate Biology, Czech Academy of Sciences, Brno. **Principal Co-Investigator:** Martin Šálek. **Financed by:** Norway Grants. **Research years:** 2021-2024.

22130047 Help bats in V4. **Recipient:** Saola – Conservation Biology. **Sub-recipient:** Institute of Vertebrate Biology, Czech Academy of Sciences, Brno. **Principal Co-Investigator:** Jan Zukal. **Research years:** 2022-2023. **Financed by:** Visegrad Funds.

D21ZO-042 The role of strongylid nematodes in chronic. **Recipient:** Institute of Vertebrate Biology, Czech Academy of Sciences, Brno. **Principal Investigator:** Barbora Červená. **Research years:** 2021-2023. **Financed by:** Morris Animal Foundation.

F22AP02231-00 Parasites in Bwindi great apes: Ecology, epidemiology and health impacts. **Recipient:** Gorilla Doctors (MGVP Inc). **Sub-recipient:** Institute of Vertebrate Biology, Czech Academy of Sciences, Brno. **Principal Co-Investigator:** Barbora Červená. **Research years:** 2022-2025. **Financed by:** U.S. Fish & Wildlife Service, Great Apes Conservation Fund.of Sciences, Brno. **Principal Investigator:** Jarmila Krojerová-Prokešová. **Research years:** 2020-2021. Financed by: Interreg V-A SK-CZ.

COMPLETE LIST OF PUBLICATIONS

Books, textbooks, edited proceedings

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Adámková M, Tomášek O, Albrecht T, 2022. An unexpected age-related pattern in feather growth contributes to age-dependent ornament expression in a passerine bird. *Journal of Ornithology* 163: 987-996.

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