„The Fish of Muddy Waters" – mudminnows, mud loaches & Co.

Including:

"Second International workshop on *Umbra krameri*"

Abstracts

(sequence follows the program)

Oral presentations

Introduction to the "Second International Workshop on *Umbra krameri*"- 30 years after: gains in knowledge on the biology of the species

Wanzenböck, Josef[1]

1) Research Department for Limnology Mondsee, University of Innsbruck, Mondseestrasse 9, 5310 Mondsee, Austria.

A review of the literature published after the first international workshop on *Umbra krameri* in 1995 is given. Most studies deal with faunistic and distribution of the European mudminnow. A noticeable number of new population findings contrasts with reports of declining and vanished populations and challenges the use of detailed distribution maps. Furthermore, some studies explored the species-habitat relationships using various habitat descriptors. Population genetics was another important topic in recent decades showing strong population differentiation across the distribution area. Genome size increase in Umbridae was investigated in relation to other Esocidae with new insights for the European species. Further emphasis was given to interactions with the invasive Amur sleeper (*Percottus glenii*) specifically competition and predation. Conservation programs including ex-situ breeding, reintroductions and habitat improvements have started in several countries showing significant success.

Current status of the mudminnow in Austria – distribution, population development, threats and measures for its protection

Jung, Michael[1]; Ratschan, Clemens[1]; Baumgartner, Christian[2]; Griesbacher, Aaron[2]; Zauner, Gerald[1]

1) ezb – TB Zauner GmbH, Engelhartszell, Austria 2) Nationalpark Donau-Auen GmbH, Orth an der Donau, Austria

The mudminnow (*Umbra krameri*) has its westernmost distribution area in Austria near Vienna. The species is considered the most threatened fish species in Austria and was assumed extinct in the second half of the 20th century. In 1992 it was rediscovered in a backwater system within the Danube Floodplain National Park called Fadenbach and shortly after that in a wetland south of Vienna (Jesuitenbach). Over the past four decades, several conservation measures have been implemented for the mudminnow in the National Park, including research and monitoring programs, habitat restoration, and captive breeding efforts. Furthermore, a reintroduction attempt in a drained wetland at the Austrian-Hungarian border called Hanság was made. Despite some temporary successes and a notable population increase in the Jesuitenbach wetland, recent droughts and low groundwater levels have led to a dramatic decline in the Fadenbach and Hanság populations. Therefore, a new conservation attempt has been started by the Danube Floodplain National Park with a project called "PonDiversity" focusing on European pond turtle, water pineapple and mudminnow. The project includes detailed surveys of the Umbra-habitats within the National Park by electrofishing, determining the status of existing captive stocks founded in the 1990s and genetic investigations of both, wild and captive populations. In a second phase, habitat restoration measures and improved captive breeding will be implemented based on the results of population genetic research.

Population Dynamics of the European Mudminnow (*Umbra krameri*) on Great Rye Island: Challenges and Conservation Strategies in the 21st Century

Ladislav Pekárik[1]; Juraj Hajdú[2]

1) Plant Science and Biodiversity Centre SAS, Bratislava, Slovakia

2) State Nature Conservation of the Slovak Republic, Banská Bystrica, Slovakia

Great Rye Island (Veľký žitný ostrov, Csallóköz) hosts the most significant population of the European mudminnow (*Umbra krameri*) in Slovakia. While this population exhibited relative stability during the first decade of the 21st century, it has experienced a continuous decline, with the core population now primarily confined to the Čilizský potok. The primary driver of this decline is climate change, characterized by increasingly dry and hot summers that lead to the complete desiccation of the mudminnow's habitats. Notably, similar drought conditions were observed in the 1970s and 1980s, suggesting a historical precedent for these fluctuations. In addition to climate change, the proliferation of stagnophilic invasive species poses a secondary threat to the mudminnow population. While the Amur sleeper has not yet been recorded in the area, other invasive species have begun to encroach upon the mudminnow's habitat. Furthermore, human activities represent a tertiary factor contributing to habitat degradation, rendering these environments unsuitable for the species' survival. For the European mudminnow population to recover, it is essential to address both external environmental conditions, such as the occurrence of wet years, and the restoration of habitats to ensure long-term viability. This includes the elimination of invasive species and mitigating direct human impacts on local ecosystems. Effective conservation strategies must prioritize these actions to support the resilience and sustainability of the European mudminnow population in Great Rye Island.

The distribution of the mudminnow (*Umbra krameri*) and the weatherfish (*Misgurnus fossilis*) in Hungary over the past fifty years and the threats to the persistence of their populations

Zoltán Sallai[1], Ákos Harka[2] & István Lehoczky[3]

1) VASKOS CSABAK Bt., Békésszentandrás, Hungary

2) Magyar Haltani Társaság, Tiszafüred, Hungary

3) National Centre for Biodiversity and Gene Conservation, Institute for Farm Animal Conservation, Gödöllő, Hungary

In the Carpathian Basin, large-scale water regulation projects in the 18th century – primarily the drainage of extensive marshlands – led to a significant reduction in wetland habitats, which in turn caused dramatic declines in the populations of marsh-dwelling fish species. Among these, the mudminnow *Umbra krameri* WALBAUM, 1792 suffered the most severe population decrease. In the 21st century, the few remaining relict populations are increasingly threatened by habitat desiccation due to climate change, the spread of the invasive Amur sleeper *Perccottus glenii* DYBOWSKI, 1877, improper water management practices by water authorities (including dredging operations), and pollution from both agricultural and municipal sources. The Mudminnow is currently classified as "strictly protected" in Hungary. Over the past 30 years, we have attempted to locate surviving populations across the entire country. Unfortunately, the species has completely disappeared from several sites where it was previously known to occur, likely due to recurring droughts and the population boom of the Amur sleeper. Most of the surveys were conducted using low-voltage battery-powered electrofishing equipment, often under difficult field conditions caused by dense submerged and emergent aquatic vegetation and deep soft sediment. At most sites, photographic documentation of the habitats was taken, and key water quality parameters (pH, dissolved oxygen, conductivity, temperature) were measured. The number of individuals of captured species was recorded using a digital voice recorder. The weatherfish *Misgurnus fossilis* (LINNAEUS, 1758) has shown somewhat better adaptability to the altered, reduced habitats following historical water regulation measures. Stable populations still exist in several drainage channels, old streambeds, and oxbow lakes. The weatherfish is currently classified as "protected" in Hungary. It has persisted in several marshy habitats from which the Mudminnow has completely disappeared. Nevertheless, its populations are also threatened by inappropriate water level regulation, dredging activities, and pollution of agricultural and urban origin. In this presentation, we aim to provide an overview of the distribution of these two protected and endangered marsh-dwelling fish species in Hungary over the past 50 years, and to identify the main threats to the persistence of their populations.

Population, ecology and habitat associations of the endangered mudminnow (*Umbra krameri*) in Croatia

Dušan Jelić[1], Matej Vucić[2]

1) Croatian Institute for Biodiversity; BIOTA Ltd., Croatia; 2) University of Zagreb, Faculty of Science;

The European mudminnow (*Umbra krameri* Walbaum, 1792) is one of the most threatened freshwater fish in Europe, listed under Annex II of the EU Habitats Directive and classified as Endangered in Croatia. Despite its conservation importance, ecological knowledge on this species in the southern Danube basin remains limited. We investigated the distribution and habitat preferences of *U. krameri* in Croatia, combining historical records with intensive field surveys conducted between 2016 and 2021. A total of 212 localities were surveyed using electrofishing, of which 26 localities confirmed the presence of the species across the Drava, Mura, and Sava River systems. Populations were most abundant in the Drava drainage, particularly in the Virovitica–Podravina County, where some canals supported densities of 2–3 individuals per m² and *U. krameri* comprised up to 90% of the fish community. Habitat analyses revealed strong associations with shallow canals and ponds characterized by dense submerged and floating vegetation, slow or stagnant water, and organic load. Interestingly, stable populations were also recorded in some faster-flowing streams of the Mura system, suggesting a wider ecological amplitude than previously assumed. In the Sava system, populations were more fragmented, restricted to small forest ponds and side-channels (e.g., Žutica forest), where they co-occurred with native loaches and invasive taxa (*Carassius gibelio*, *Ameiurus melas*). Principal component analysis indicated that vegetation cover, water depth, and presence of other fish species were key factors discriminating occupied from unoccupied sites. Our findings confirm that *U. krameri* tolerates habitats with low oxygen and high organic input, but remains vulnerable to habitat fragmentation and competition with invasive species. The Croatian populations of *U. krameri* are of exceptional importance for the long-term survival of the species in the Danube basin. The Drava and Mura populations represent some of the most abundant and genetically interconnected groups, while the Sava system holds small, isolated, and genetically unique remnants. These results underline the urgency of conserving suitable habitats, maintaining connectivity, and controlling invasive species to safeguard this critically threatened fish.

The situation of *Umbra krameri* Walbaum, 1792, in Romania

Nagy, András-Attila[1,2]; Zsigmond, Miklós[3]; Năstase, Aurel[4]; Szilàgyi, Bálint[2]; Imecs, István[5]

1) Milvus Group Bird and Nature Protection Association, Crinului street 22, RO–540343, Târgu Mureș, Romania; nagyandrasattila@yahoo.com

2) Evolutionary Ecology Group, 3B Centre for Systems Biology, Biodiversity and Bioresources, Hungarian Department of Biology and Ecology, Babeş-Bolyai University, Clinicilor street 5–7, RO–400006, Cluj-Napoca, Romania

3) RO-547134, Vălenii de Mureș, 390A, Romania

4) "Danube Delta" National Institute for Research and Development, 165 Babadag street, 820112, Tulcea, Romania

5) Department of Freshwater Fish Ecology, Hungarian University of Agricultural and Life Sciences, HU-2100, Gödöllő, Hungary;

The European mudminnow (*Umbra krameri*) is an endemic species of the Danube and Dniester River basins and is classified as a vulnerable species on the IUCN Red List. Due to the drainage of marshes and swamps, as well as the significant reduction of floodplains, its populations in the Carpathian Basin have drastically declined in recent decades. In Romania, its distribution is restricted to wetland habitats at lower altitudes outside the Carpathians. During our surveys over the past 10 years, the species has not been found in many of its previously known locations. However, we have discovered several new, previously unknown populations (e.g., Homorodul Vechi River, Upper Ier Watershed etc.). These populations do not indicate the species' expansion but rather highlight the under-researched nature of its potential habitats. Restoring the species' former habitats, along with the proper protection of its current habitats, could significantly improve the species' situation. At the same time, reassessing its current status and reclassify the species from the vulnerable category to the endangered category is necessary.

Umbra krameri populations of the eastern edge of its areal: occurrence, state and eukaryotic symbionts

Moshu, Alexandru[1,2] and Trombitsky, Ilya[1,2]

1) National Institute of Applied Agriculture and Veterinary Medicine, Chisinau, Republic of Moldova; 2) "Eco-Tiras" International Association of River Keepers, Chisinau, Republic of Moldova. *sandumoshu@gmail.com; ilyatrom@gmail.com*

The European mudminnow, *Umbra krameri*, was a widespread fish in the lower reaches of the Dniester and Danube rivers in the first half of the 20th century. In the Dniester River, it was recorded from the junction of the Dniester and its Turunciuc branch to the estuary. Usually, now this endemic fish is found together with the weather loach *Misgurnus fossilis* and gibel carp *Carassius gibelio*. The factors that reduced its population were the construction of the Dubasari hydropower plant upstream in the 1950s and the embankment of the Lower Dniester wetlands to develop irrigated agriculture in the lower reaches of the river. After 1980, the hydrological regime of the Dniester in the spring was influenced by the Dniester hydropower complex in Ukraine, whose regime shapes the hydrology of the lower reaches of the river. Due to this, over the past 25 years, only small populations of this species have remained, recorded in the ditches of the Turunciuc branch near the Cuciurgan lake in the area of the village of Nezavertailovca, and water bodies connected to the Dniester on the border of Moldova and Ukraine south of the village of Palanca. Today, it is not easy to find it. Attempts to populate other suitable biotopes with fry obtained as a result of reproduction in aquariums were unsuccessful. Currently, *U. krameri* is listed in the Red Data Books of the region as most endangered (Moldova) and vulnerable (Ukraine), respectively. In the parasitologically surveyed individuals, inhabiting the lowers Dniester and Danube rivers basins, 176 species of the eukaryotic commensal/parasitic symbionts were revealed: The diversity of parasites of the Lower Dniester populations is much richer and different, compared with those of the Danube basin: although the populations from the Dniester have a rich community of parasites, some typical „Dniester species" are absent or very rare. Almost all identified species present a novelty for this fish-host and 12 of them were described as previously unknown. The parasite fauna of the examined *U. krameri* includes 18 host-specific species, one species common with *U. limi* and 12 species common with *Esox lucius*. The total prevalence of invasion of fishes was 100%. The maximum number of parasite species for one fish reached 18, and usually 4 - 8. Males were slightly more infested than females. The diversity and abundance of parasites adequately reflect the ecological state of the biotopes, their hydrobiocenosis, as well as the impact of the water hydrologic regime, i.e., the intensity of hydropower plants' water discharges. The infestation of *U. krameri* with symbionts wasn't accompanied by fish morbidity or mortality. The parasitological situation of *U. krameri* populations inhabiting the eastern edge area is unfavourable and tense. The prevalence rate of *U. krameri* parasites is alarming; it is difficult to assume that such high values of infestation did not cause severe damage and even mortalities among fish. The carriage of many pathogenic parasites by this fish, under certain circumstances, may pose a potential threat to the survival of its unique populations of the Dniester River basin.

Ex situ and in situ breeding and stocking of the European Mudminnow in Hungary: insights from a 15-year cycle of population reinforcement

Müller Tamás[1], Horváth József[1], Varga Ádám[1], Tóth András[1], Tóth Balázs[2], Bernáth Gergely[3], Demény Ferenc Zoltán[4], Tatár Sándor[5]

1) Department of Freshwater Fish Ecology, Institute of Aquaculture and Environmental Safety, Hungarian University of Agriculture and Life Sciences, 2) Duna-Ipoly National Park Directorate, 3) Department of Aquaculture, Hungarian University of Agriculture and Life Sciences, 4) Mecklenburg-Vorpommern Research Centre for Agriculture and Fisheries, Institute of Fisheries, 5) Tavirózsa Association

Since 2011, our team has been engaged in the conservation biology of the European mudminnow (*Umbra krameri*), focusing on both ex-situ and in-situ methods. Our work includes (captive) breeding, egg incubation, and larval and juvenile rearing under controlled conditions and in natural habitats. Induced reproduction has been attempted in closed systems through the application of various hormonal treatments; however, these efforts have not resulted in success. In contrast, controlled natural reproduction has proven effective for producing offspring. An innovative spawning cage has been developed. This device facilitates the natural spawning of paired individuals, egg incubation, and larval rearing either directly at the original habitat of the parents or in reconstructed sites designated for population reinforcement. This method may result in higher survival rates compared to laboratory-based reintroduction. The spawning cage also allows the assessment of adverse environmental factors (e.g., sudden temperature fluctuations) during natural reproduction in the wild, providing insight into the reproductive success of local populations. Experiments on sperm cryopreservation, spawning substrate preference and feeding behaviour have been conducted under controlled conditions in recent years. Although only a small number of broodstock females are used annually, more than 8,700 individuals of various life stages (larvae, juveniles, adults) have been successfully released back into their original habitat or pilot areas. Currently, we carry out population maintenance and breeding in the artificial ornamental ponds of the Botanical Garden of the Hungarian University of Agriculture and Life Sciences (Gödöllő, Hungary), as most of the natural habitats of the species have dried out in recent years. Furthermore, a multifunctional device has been designed to integrate broodstock spawning, egg incubation, and larval rearing, thereby contributing to the sustainable reinforcement of *U. krameri* populations. Conservation efforts are currently ongoing.

A Case Study of the European Mudminnow Conservation Pilot Program (2008-): Creation of surrogate habitats and self-sustaining populations, risks of climate change

Sándor Tatár[1], István Lehoczky[2], Balázs Tóth[3], Béla Csányi[4], József Szekeres[4], Bálint Bajomi[1] and Tamás Müller[5]

1) Tavirózsa Association for Environmental Protection and Nature Conservation, Veresegyház, Hungary 2) Department of Aquatic Genetic Resources Conservation, Institute for Farm Animal Conservation, National Centre for Biodiversity and Gene Conservation, Gödöllő, Hungary 3) Danube-Ipoly National Park Directorate, Budapest, Hungary 4) Institute of Aquatic Research, HUN-REN Centre for Ecological Research, Budapest, Hungary 5) Department of Freshwater Fish Ecology, Institute of Aquaculture and Environmental Safety, Hungarian University of Agriculture and Life Sciences

The European Mudminnow Conservation Pilot Programme, initiated in 2008, is a long-term, complex, adaptive project designed to respond to changing conditions. The programme's primary aim is to conserve and enhance populations of the European mudminnow (*Umbra krameri*). The number of the mudminnow habitats and the size of its populations have decreased significantly in recent decades in Hungary. The small, isolated, and shallow waters, as well as the small fish populations, are susceptible to environmental change and human impact. Mudminnows face their most remarkable threats from habitat loss (e.g. drying caused by climate change), disturbance (such as dredging), and the spread of the invasive Amur sleeper (*Perccottus glenii*). Between 2008 and 2017, we created ten surrogate habitats (ponds) in the Szada Pilot Area, where we introduced aquatic vegetation and mudminnows rescued from seven endangered habitats/populations of Hungary. Depending on ecological conditions, clear, turbid, shaded, and oxygen-poor alternative stable states developed in the ponds. Five habitats became excellent habitats for European mudminnows. Two of our artificially created ponds have established self-sustaining populations of mudminnows. Our monitoring results highlighted that extreme weather events driven by climate change (e.g., droughts, severe spring coolings) could rapidly degrade both natural and artificial shallow aquatic ecosystems, potentially causing a shift to an oxygen-poor state, and significantly reduce the survival and reproductive success of the European mudminnow. To mitigate the harmful effects of climate change, regular monitoring, habitat management (enhancement), rehabilitation, and ensuring the ecological water demand of habitats are the main priorities. We have recently developed the comprehensive Umbra Habitat Qualification System (UHQS), which is currently under validation. This system aims to reduce stocking risks by pre-assessing newly created surrogate habitats. UHQS will also be suitable for identifying and evaluating potential and current habitats for the mudminnow.

Morphological characterization of *Umbra krameri* and its current and potential invasive competitors in Hungary

Péter Takács[1], Réka Pallos[1,2], Bálint Bánó[1]

1) HUN-REN Balaton Limnological Research Institute, Tihany, Hungary,
2) Doctoral School of Veterinary Science, University of Veterinary Medicine Budapest, Hungary

The European mudminnow (*Umbra krameri*) is the only representative of its genus in the Palearctic region. According to the literature, its evolutionary lineage diverged from its closest North American relatives (*U. limi* and *U. pygmaea*) over 60 million years ago. Although it was formerly widespread in the Middle and Lower Danube regions, the species has undergone a significant decline in recent decades. Its populations are primarily threatened by habitat loss and degradation, as well as the spread of non-native fish species. In this presentation, we describe the morphological and morphometric characteristics of *U. krameri*, with particular emphasis on the variability of these traits across different populations, conservation-, and evolutionarily significant units. Furthermore, we highlight the key morphological and morphometric features of the species' most important current and potential invasive competitors -especially the two Nearctic Umbra species - which may aid species identification during field sampling.

Behavioural responses of the European mudminnow to competition and predation in a habitat invaded by Amur sleeper

Bálint Preiszner[1], Bálint Bánó[1], István Czeglédi[1], Tibor Erős[1], Tomasz Kakareko[2], Jaroslaw Kobak[2], Péter Takács[1], Mateusz Augustyniak[2]

1) HUN-REN Balaton Limnological Research Institute, Tihany; 2) Nicolaus Copernicus University in Toruń, Toruń

The European mudminnow (*Umbra krameri*), a globally threatened fish species, is increasingly forced to coexist with the invasive Amur sleeper (*Perccottus glenii*), its competitor and potential predator. Invasive species often disrupt native ecosystems by altering habitat use, competition dynamics, and predation pressures. To better understand the behavioural implications of this invasion, we conducted a series of aquarium experiments comparing both species. Behavioural differences along the boldness–shyness continuum between individuals can influence competitive outcomes and survival strategies. Our first objective was to assess whether European mudminnows and Amur sleepers differ in boldness and whether prior experience with the invasive species affects the behaviour of the mudminnow. We tested individuals from populations with and without prior exposure to Amur sleepers, measuring boldness through standardised behavioural assays. These revealed no significant difference in boldness between naïve and non-naïve mudminnow populations, suggesting insufficient time for behavioural adaptation or context-dependent trait plasticity. Conversely, Amur sleepers exhibited lower boldness, possibly indicating stronger predation pressure on mudminnows. These findings highlight the complex behavioural dynamics in invaded freshwater ecosystems. Beyond individual traits, direct interactions between the species may shape the invasion outcome. Although the Amur sleeper is considered facultative piscivore, the literature describes cases where it has preyed on the European mudminnow individuals. Therefore, our second set of laboratory experiments investigated whether the mudminnow recognises the invasive species as a potential predator. We focused on the anti-predator behaviours without physical contact between predator and prey. To ensure that observed prey behaviours were predator-avoidance responses, we compared their behaviours in the presence of an obligate predator, the northern pike (*Esox lucius*). By arranging prey in homo- and heterospecific pairs, we tested whether the presence of an Amur sleeper competitor influences the mudminnow's anti-predator behaviour. Furthermore, using naïve and experienced mudminnow individuals, we examined whether prior exposure to the invader leads to behavioural adaptations that improve survival in invaded habitats. Our results will provide insight into the consequences of Amur sleeper invasion for endangered native species, offering valuable information on resource utilization and competition outcomes, especially for limited resources. The results from our predation-related experiments will shed light on how the invader's presence influences predation pressure on native fish. Understanding these behavioural interactions is essential for assessing the long-term impact of Amur sleeper invasions on European mudminnow populations. Our study has potential conservation implications, emphasising the need for targeted management strategies to protect the European mudminnow in the face of biological invasions.

Genetic Diversity and Population Differentiation of European Mudminnow (*Umbra krameri*) in Austria

Donabaum, Raphael[1]; Jung, Michael[2]; Koblmüller, Stephan[1]

1) Institute of Biology, University of Graz, Graz, Austria

2) ezb - TB Zauner GmbH, Engelhartszell, Austria

The European Mudminnow (*Umbra krameri*)—a species adapted to slow-flowing, oxygen-poor backwaters and marshes with dense vegetation—was declared extinct in Austria in 1975. However, it has since been rediscovered at two isolated sites: Fadenbach in the Nationalpark Donau-Auen and Jesuitenbach. Captive breeding programs have since been initiated to support reintroduction and safeguard remaining genetic diversity. To inform conservation strategies, we assessed genetic diversity, structure, and effective population sizes (Ne) using polymorphic microsatellite markers. Preliminary results reveal significant genetic differentiation between the two wild populations and between captive stocks and their presumed source in Fadenbach. Overall genetic diversity is low, and Ne estimates suggest a high risk of inbreeding, genetic drift, and further loss of adaptive potential. Although sample sizes are limited, these findings point to critical conservation concerns, especially for the Fadenbach population. Importantly, this study emphasizes the utility of genetic monitoring as a central tool for evidence-based conservation planning—supporting adaptive management, preventing further genetic erosion, and promoting the long-term survival of this critically endangered species in Austria and beyond.

Catching shadows: Development and validation of three primer pairs for eDNA detection of *Umbra krameri*

Hans Rund[1], Lukas Fuxjäger[1], Josef Wanzenböck[1]

1) Research Department for Limnology Mondsee, University of Innsbruck, Mondseestraße 9, 5310 Mondsee, Austria

Environmental DNA (eDNA) is a sensitive, non-invasive approach for surveying rare freshwater fishes, and is particularly effective for species whose low densities and behavioural traits limit conventional detection (e.g., electrofishing). To enable sensitive and reliable detection of the European mudminnow (*Umbra krameri*) from molecular traces, we developed and compared three species-specific primer sets. First, we assembled the complete mitochondrial genome of *U. krameri* from PacBio HiFi reads to identify suitable regions for primer development. We then designed primer pairs to amplify short fragments targeting three mtDNA loci: (I) a 129-base-pair (bp) fragment of cytochrome c oxidase subunit I (COI); (II) a 178-bp fragment of NADH dehydrogenase subunit 2 (ND2); and (III) a 217-bp fragment of NADH dehydrogenase subunit 1 (ND1). The COI and ND2 assays combined primers with FAM-labelled hydrolysis probes, whereas the ND1 assay consisted of primers only (no probe). The specificity was first assessed in silico using Primer-BLAST and then tested empirically on tissue derived DNA extracts from 25 fish species occurring in Austrian waters, as well as on 15 eDNA samples from an old Danubian sidearm system (Fadenbach). This system is home to one of the last self-sustaining populations of *U. krameri* within Austrian borders. Potential method-specific biases were assessed by comparing eDNA detection results with catch data from fish traps collected during the same sampling campaign. This workflow enabled the identification of the most sensitive primer pair, which should be considered for routine monitoring and future conservation assessments.

Saving European weatherfish, a swampy business

Jeroen Van Wichelen[1], Johan Auwerx[1], Rein Brys[2] & Rudi Yseboodt[3]

1) Research Institute for Nature and Forest (INBO), team Monitoring and Restoration of Aquatic Fauna, Dwersbos 28, B-1630 Linkebeek, Belgium

2) Research Institute for Nature and Forest (INBO), team Genetic Diversity, Gaverstraat 4, B-9500 Geraardsbergen, Belgium

3) Agency for Nature and Forest (ANB), Lange Kievitstraat 111-113 (bus 63), B-2018 Antwerpen, Belgium

Once widespread in Flanders (northern part of Belgium), the European weatherfish (*Misgurnus fossilis* L., 1758) has been fading away since the 1950s and has reached a critically endangered status. To save this species from extinction, a Species Protection Plan was launched in 2021 focussing on 1. a regional wide innovative eDNA survey, 2. habitat restoration and 3. genetic strengthening of the relic populations by means of a captive breeding program financially supported by LIFE (B4B). Although a climate change induced shift in general water management - with attention for more ecologically driven river discharge dynamics (Eflows), rewetting and improving lateral connectivity - provides the right momentum, the road to recovery for this species remains bumpy. On the good side, the species distribution in Flanders seems a bit less dramatic since the eDNA campaign revealed 14 more relic populations, bringing the total currently to 23. Also the breeding program started to pay off with a production of ca. 100.000 individuals in 2025 and the first proof of subsequent natural reproduction in at least one population. On the other hand, classical fishery in most investigated relic populations had a very low success rate, potentially pointing to very low densities. Because of the high demand by different users for the little remaining open space, also habitat restoration remains very challenging in Flanders. Even within the nature conservation sector, the objectives are diverse and sometimes incompatible, leading to delays or even failure to initiate certain restoration projects. Last but not least, the settlement and spread of invasive oriental weatherfish species brings with it new threats and challenges. All the more reason to pool our knowledge and expertise at a European scale, for which SWAMP was recently established. Only by joining forces can we save this enigmatic species from fading further into oblivion.

Monitoring and habitat management for weatherfish (*Misgurnus fossilis*) in the Netherlands: Insights from Research, citizen science, habitat management and habitat design.

Mick Vos[1]

1) RAVON (Reptile, Amphibian and Fish Conservation Netherlands)

The weatherfish (*Misgurnus fossilis*) is a cryptic and vulnerable species associated with lowland aquatic systems. These systems are under severe pressure from habitat loss and hydrological alterations. Over the past century, populations in the Netherlands have declined and the remaining dwindling populations are nowadays fragmented, primarily due to river and brook regulation and the loss of natural flood regimes. In the Netherlands, extensive monitoring efforts have been undertaken within the framework of the National Ecological Monitoring Network (NEM), with contributions from citizen science programs and provincial Natura 2000 monitoring schemes. These efforts have enabled RAVON and Statistics Netherlands (CBS) to calculate national distribution trends for the weatherfish since 1990. This presentation provides an overview of recent monitoring data, highlights the value of integrating ecological research with practical conservation, and showcases two case studies of habitat design and restoration. In the first case (Rijskampen), we investigated habitat use and responses to targeted management. A greppel (ditch) system was constructed following an initial negative eDNA result and only one adult female caught during intensive electrofishing: resulting in successful recruitment of juveniles. In the second case (Nieuwegein) a compensation area was created for *Rana arvalis*, *Pelophylax lessonae*, and *M. fossilis*. This case has shown consistent presence of adult and juvenile weatherfish populations annually. These examples demonstrate how ecological knowledge can be effectively applied to design and manage habitats that promote long-term viability of *M. fossilis* populations.

Distribution, Population Dynamics, and Threats of the European weatherfish (*Misgurnus fossilis*) in Mecklenburg-Western Pomerania (NE Germany)

Martin Krappe & Anika Weidig

(GNL e.V., Society for Nature Conservation and Landscape Ecology, Dorfstraße 31, D-17237 Kratzeburg, Germany

Mecklenburg-Western Pomerania is Gemany's north-easternmost federal state. The area is located in the western part of the weatherfish's natural range and also marks its northern border. While natural habitats such as floodplains and stream backwaters have largely disappeared due to human activities, the species has found substitute habitats in drainage ditches, which have been dug since the Middle Ages but mostly during the 19th and 20th centuries. Today the total length of open drainage ditches is estimated to be at least 30.000 kilometres. However, only a part of this network is suitable for the requirements of weatherfish populations. The most important restrictions are strong fragmentation of the waterways by weirs or other barriers as well as a very intensive mechanical maintenance. Nevertheless, the majority of the total weatherfish population currently inhabits drainage ditches. No other local fish species shows such a distinct preference for this type of water environment. With an explicit lower frequency, the species can also be found in various other habitats, especially if these are connected to ditches or backwaters. In historical records, the weatherfish was mentioned only by a small number of authors, and mostly from less typical habitats. This changed significantly in the mid-1990s when effective capture methods became available and targeted surveys were initiated in response to the European Flora Fauna Habitat Directive. Although the species remains rare, current records show a wide distribution across nearly all major drainage systems. A significant overall population trend cannot be recognized. However, it is noteworthy that the occurrence of weatherfish is very sporadic, with most records consisting of only one or just a few individuals. This has made it difficult to identify suitable waters for establishing a monitoring program. Such a monitoring was initiated with six populations in 2008, with a further four populations added to the program until 2016. Following the initial surveys, each of the populations was monitored at three-year intervals using electrofishing. To estimate population density, the removal method after Zippin rsp. Seber & LeCren was applied. So far, the monitored populations have generally shown relatively low densities. In a small number of isolated years of investigation, however, exceptional increases occurred, which were also positively correlated with the level of young individuals. This suggests that either reproduction or recruitment is highly irregular. Under existing conditions, local extinction could be a regular phenomenon. Therefore, a favourable environment for a well-regulated metapopulation is essential. To reduce the risks of ultimate extinction, the upstream permeability of the drainage systems and the proximity of suitable habitats should be improved or re-established. Another measure to reduce the endangerment could be an adaption of mechanical drainage maintenance to the species requirements such as establishing staggered maintenance in alternating years or in smaller sections.

The European weatherfish (*Misgurnus fossilis*) in Hesse and Rhineland-Palatinate - occurrence, threats, protection measures

Korte, Egbert[1], Kalbhenn, Ute[1], Schulz Ralf[2]

1) Institut für Gewässer- Augenökologie GbR Bobbe & Korte Wiesenstr. 6 64347 Griesheim Germany

2) iES Landau, Institut für Umweltwissenschaften, RPTU Kaiserslautern-Landau Fortstrasse 7 D-76829 Landau Germany

The European weatherfish (*Misgurnus fossilis*) is classified as "critically endangered" on the German Red List and occurs in Hesse and Rhineland-Palatinate, in the Upper Rhine Plain and the Wetterau region (Hesse). While populations are stable in the Wetterau region, strong fluctuations within populations can be observed in the Upper Rhine Plain. For this reason, a breeding and stocking program was carried out in 2014 to support and reintroduce the weatherfish in Hesse and Rhineland-Palatinate, as well as ecotoxicological studies on the sensitivity of the weatherfish´s eggs and larval stages. This presentation will provide an overview of the occurrence of the weatherfish in Rhineland-Palatinate and Hesse, the success of the breeding and stocking program, and the threat factors to be considered, including ecotoxicological aspects.

Habitat enhancement for the mud loach (*Misgurnus fossilis*) - project details, construction process and results of fish monitoring

Fischer, Andreas[1]; Gumpinger, Clemens[1] ; Zuna-Kratky, Thomas[2], Käfel, Gerhard[2]

1) blattfisch e.U., Consultancy for Aquatic Ecology, Wels, Austria 2) Nature Conservation Association “AURING” Hohenau. Austria

The drainage ditch system in the foreland of the rivers March (Morava) and Thaya (Dyje) in the municipalities of Rabensburg and Hohenau represents, together with a number of relict watercourses, an important wetland area on the edge of the floodplain. Based on observations made in the course of repeated ditch clearings in Hohenau and recent targeted searches, it is known that this water system represents an important habitat for the protected and endangered mud loach (*Misgurnus fossilis*). In recent years, long periods of drought have lead to the drying up of a large part of the existing water network, until finally only the so-called main ditch still carries water, leaving a very small remnant of the overall system for the mud loach as a refuge. Various measures were developed and implemented on behalf of the AURING association to counteract this increasingly precarious disappearance of the aquatic habitat in the ditches. For example, dam beams were installed at critical points in the ditch system to dam up the water in the ditch system and thus improve the habitat for the mud loach and maintain the ditches as habitats even during dry periods. Connections between ditches, which were originally open but have since silted up, and adjacent depression as spawning and juvenile fish habitats were also restored by dredging. The entire construction process was supervised by biologists. In order to document the impact of the measures, a comprehensive performance review was carried out, including fish monitoring.

Genetic Enhancement of Weatherfish Populations via Targeted Breeding Programs

Auwerx, Johan[1], Van Wichelen, Jeroen[1] & Mergeay, Joachim[2]

1) Research Institute for Nature and Forest (INBO), team Monitoring and Restoration of Aquatic Fauna, Dwersbos 28, B-1630 Linkebeek, Belgium

2) Research Institute for Nature and Forest (INBO), team Genetic Diversity, Gaverstraat 4, B-9500 Geraardsbergen, Belgium

Many populations of the weatherfish (*Misgurnus fossilis* L.) in north-western Europe have experienced significant declines since the end of the Second World War. These declines have been largely attributed to changes in land use practices, such as agricultural intensification and urban development, as well as a deterioration in water quality across their natural habitats. Several of the remaining weatherfish populations are currently characterized by poor conservation status. Decades of habitat fragmentation have resulted in reduced genetic diversity, increased levels of inbreeding, and the presence of phantom populations—small, isolated groups that are demographically unstable and genetically unsustainable in the long term. Although traditional approaches to aquatic restoration—such as habitat enhancement, water quality improvement, and the removal of migration barriers—remain essential and should be prioritized, they are often insufficient to recover genetically depleted populations. To support the recovery of these populations, a targeted breeding program was developed, funded by LIFE B4B, for the weatherfish. This involved introducing genetic material from populations with high genetic diversity into extant, inbred populations. Over recent years, the protocol for artificial reproduction has been gradually optimised, resulting in a stable and scalable production of large numbers of juvenile weatherfish. In parallel, a release program for this endangered species was implemented in Flanders. Thousands of farmed young-of-the-year individuals were introduced at eight sites within the species' historical range. Additionally, as part of a complementary reintroduction strategy, tens of thousands of juvenile fish (2–4 weeks old, 10–20 mm in length) were released into carefully selected river sectors. Recent monitoring at one of the release sites revealed encouraging results, with high survival rates and numerous juveniles originating from natural recruitment. While it is still too early to declare the project a definitive success, the re-establishment of natural reproduction represents a critical first milestone. Ongoing genetic analyses will be necessary to assess the extent of admixture between the introduced genetic lines and the resident populations.

Balancing risks and opportunities in ex situ conservation: host–parasite dynamics of the European weatherfish

Gobbin, Tiziana[1]; Kmentová, Nikol[1,2]; Auwerx, Johan[3]; Martel, An[4]; Nelson, Alexandria[5]; Terriere, Naomi[4]; Van Wichelen, Jeroen[3]; Vanhove, Maarten[1,2]

1) Centre for Environmental Sciences, Hasselt University, 2) Operational Directorate Natural Environment, Royal Belgian Institute of Natural Sciences, 3) Research Institute for Nature and Forest (INBO), Research Center for Aquatic Fauna, Linkebeek, Belgium, 4) Department of Pathobiology, Pharmacology and Zoological Medicine, Faculty of Veterinary Medicine, Ghent University, Merelbeke, Belgium, 5) Department of Applied Ecology, North Carolina State University, Raleigh, North Carolina, USA

The European weatherfish (*Misgurnus fossilis*), once widespread across Eurasia, is now critically endangered in Flanders (Belgium), prompting the establishment of a captive breeding programme as part of conservation efforts. During rearing, juvenile weatherfish suffered heavy infections from the ectoparasitic flatworm *Gyrodactylus fossilis*, leading to mortality events. Although *G. fossilis* is a natural parasite of *M. fossilis*, high host densities in hatchery conditions facilitated pathological infection intensities, while adult fish maintained at lower densities showed no visible pathology. This suggests that husbandry practices strongly modulate dynamics of this host–parasite system in captivity. To place these observations in a historical context, we screened both captive-bred fish and archival material (1881–1973, i.e. prior to the anthropogenic introduction of Asian congeners in Misgurnus) for ectoparasites. Morphological and molecular characterisation revealed infections of three monopisthocotylan flatworms: *G. fossilis*, *Gyrodactylus misgurni* (Gyrodactylidae), and *Actinocleidus cruciatus* (Dactylogyridae). All represent new records for Belgium, with *G. misgurni* and *A. cruciatus* considered native due to their occurrence in historical material. Notably, these parasites' abundance has declined compared to historical collections, raising concerns about their own conservation status. Since parasites contribute substantially to species-richness, ecosystem functioning, and even the health of their host individuals and populations (e.g., their immunological development and resilience) their co-decline alongside endangered hosts represents a hidden and meaningful dimension of biodiversity loss. Our findings highlight both risks and opportunities associated with parasite conservation in ex situ programmes focused on fishes or other vertebrate hosts. High juvenile stocking densities increased parasite burdens and mortality, while improved husbandry practices allowed stable co-existence of host and parasite populations. This indicates that carefully managed captive breeding facilities may act as refugia not only for *M. fossilis* but also for its specialist parasites, maintaining ecological interactions and genetic diversity that would otherwise be lost. While parasites are often overlooked or actively eliminated in wildlife management, they play essential roles in ecosystems and represent species of conservation concern in their own right. These results emphasise the possibility of including parasites in conservation planning. For the weatherfish and its parasites, ex situ conservation thus provides an experimental framework for developing integrated strategies that safeguard both host and parasite persistence. Future reintroduction initiatives should therefore consider whether to also re-establish native parasite populations, a decision that requires informed discussion among conservation stakeholders. By demonstrating the feasibility of host–parasite co-conservation, this study advances the idea that conservation programmes can optimise resource allocation while preserving the evolutionary and ecological relationships of multiple species simultaneously.

An (inter)national network to support the FishBase Consortium in parasitology, pathology, ichthyo(parasito)logical mainstreaming and capacity development

Vanhove, Maarten P.M.[1,2]; Kmentová, Nikol[1,2]; Mushagalusa Mulega, Archimède[1,3]; Musschoot, Tobias[2]; Van Steenberge, Maarten[1,4]

1) Centre for Environmental Sciences, Hasselt University, 2) Operational Directorate Natural Environment, Royal Belgian Institute of Natural Sciences, 3) Département de Biologie, Centre de Recherche en Hydrobiologie-Uvira, 4) Operational Directorate Taxonomy & Phylogeny, Royal Belgian Institute of Natural Sciences

FishBase, a global biodiversity information system on finfishes (www.fishbase.org), is a knowledge resource for the management and conservation of fishes. It is the largest and most frequently accessed online database on fishes. This multifunctional ecological tool, widely cited in scientific publications, reached the top 1% of all cited items published in the 21st and 20th centuries. Recently, it attracted >1200 citations/year in the peer-reviewed literature. FishBase receives ca. 80 million hits/month (2023) and up to 1 million visits from over 300 000 unique users monthly. The FishBase Consortium scientifically guides the development and functioning of FishBase and SeaLifeBase (www.sealifebase.org), a similar information platform for marine organisms other than fishes with a focus on policy-relevant species. FishBase is an intensively used resource in fish parasitology, rendering parasitologists among the users most frequently citing FishBase. Conversely, the FishBase tools that pertain to fish parasites and diseases are underdeveloped compared to other applications within the database. Hence, parasitologists mainly use FishBase to find information on fishes but not on parasites. They rarely contribute data themselves to FishBase, and new fish-related results in parasitological literature go largely unnoticed. This also relates to, and exacerbates, the limited extent to which biodiversity databases of hosts and their pathogens are, in general, interoperable. FishBase and comparable informatics resources for aquatic biodiversity, such as the World Register of Marine Species (WoRMS), and the Freshwater Animal Diversity Assessment (FADA), mostly inaccurately reflect host-parasite relationships. The information they contain on aquatic parasites is far from complete. Fish parasites constitute risks because of their potential pathogenicity towards their hosts, while also providing important ecosystem services to their hosts and ecosystems, e.g., related to the development of immunity, the regulation of energy fluxes and populations, and the maintenance of species-richness. Parasites are especially abundant, diverse, and impactful in ecotones such as wetlands. Lack of accessible information on the parasites of fishes, therefore, is a limitation to the management and conservation of wetland fishes in situ and ex situ. The principal investigators of the Aquatic Biodiversity team at Hasselt University focus on fish parasitology, ichthyology, wetland monitoring, and the management of aquatic ecosystems. In collaboration with the Royal Belgian Institute of Natural Sciences, an observer within the FishBase Consortium, they initiated and obtained funding for a network of national and international partners to support the FishBase Consortium in: (1) updating information on host-parasite links underlying parasitological and pathological tools within FishBase, and expanding these tools for diagnostics; (2) mainstreaming information on fish (parasites) in response to priorities proposed by stakeholders; and (3) developing (inter)national ichthyo(parasito)logical capacity through training and awareness raising. This project builds on the expertise of 22 Flemish and 48 international partners, encompassing stakeholders from universities, natural history institutions, other governmental research institutes, public aquariums, and the policy, non-profit and private sectors. Referring to empirical data on, e.g., the weatherfish *Misgurnus fossilis,* we hope to grasp this short introduction to our project as opportunity to hear from the audience how our approach can contribute to understand and conserve European wetland fishes.

Ex situ breeding and stocking of the European Weatherfish in Hungary and Romania

Müller Tamás[1], Demény Ferenc[2], †Buza Eszter[1], Horváth József[1], Kalocsai Levente[1], Kucska Balázs[1], Kiss Péter[1], Varga Ádám[1], Tóth András[1], Tóth Balázs[3], Horváth Ákos[4], Tatár Sándor[5], Imecs István[1]

1) Department of Freshwater Fish Ecology, Institute of Aquaculture and Environmental Safety, Hungarian University of Agriculture and Life Sciences, 2) Mecklenburg-Vorpommern Research Centre for Agriculture and Fisheries, Institute of Fisheries, 3) Duna-Ipoly National Park Directorate, 4) Department of Aquaculture, Hungarian University of Agriculture and Life Sciences, 5) Tavirózsa Association

The weatherfish (*Misgurnus fossilis*) was first successfully bred by our research group in 2010. Since then, an induced spawning protocol combined with in vitro fertilization techniques has been applied, and experiments on sperm cryopreservation have also been conducted in this species. The stages and specific characteristics of embryogenesis and early larval development have been monitored and recorded. Larval growth and survival have been examined under various feeding regimes. It has been revealed that *M. fossilis* is capable of reproducing through parthenogenesis. Through further propagation of parthenogenetic offspring, F2 individuals exhibiting a unique hexaploid chromosomal structure—unobserved in natural populations—have been produced. In Hungary, approximately 2,000 individuals (both juveniles and sexually mature fish) were released into natural habitats during several stocking cycles between 2009 and 2016. Additionally, more than 16,000 individuals (larvae and juveniles) were reintroduced into the marshlands of the Olt River region in Transylvania (Romania) within the framework of a two-year conservation program. In 2024, we resumed our work related to the propagation of the weatherfish. These results contribute to the development of effective propagation, conservation, and reintroduction protocols for this protected and ecologically significant species.

Ex-situ conservation of weatherfish (*Misgurnus fossilis*) and crucian carp (*Carassius carassius*) in rice fields in Hungary

Demény, Ferenc Zoltán[1]; (†) Buza, Eszter[2]; Müller, Tamás[2]; Jancsó, Mihály[3]

1) Mecklenburg-Vorpommern Research Centre for Agriculture and Fisheries, Institute of Fisheries, 18276 Gülzow-Prüzen, Germany, 2) Department of Freshwater Fish Ecology, Institute of Aquaculture and Environmental Safety, Hungarian University of Agriculture and Life Sciences, 2100 Gödöllő, Hungary, 3) Research Center for Irrigation and Water Management, Institute of Environmental Sciences, Hungarian University of Agriculture and Life Sciences, 5540 Szarvas, Hungary

The rice-fish production dates back to the 15th-12th centuries BC in China. This technology is advantageous for rice and fish simultaneously. The fish can grow in a safe environment, without any feed supplementation, while providing the plants with biological control of different aquatic insect pests, mixing up the anaerobic zones and manuring the plants. In Hungary, we had rice production on 50,000 – 60,000 ha before the 1960s, and carp production technology on rice fields was developed until the intensification of agriculture. The use of insecticides made it impossible to continue this organic method for a while; however, the importance of organic rice production has risen in recent decades. In 2010 and 2012, weatherfish (*Misgurnus fossilis*) and crucian carp (*Carassius carassius*) fingerlings (10-20 mm) were stocked to experimental rice paddies (2000-2400 m2) for a 2-month rearing period during July-September in Szarvas, Hungary. We aimed to observe the survival and growth of this species and evaluate the technology for further research and development. The fish performed well in the special environment and showed intensive growth in the extensive conditions. Weatherfish juveniles reached 4,5-19,5 g, while crucian carp juveniles 1,9-18,5 g final body weight. According to our observations, the survival rates were different for the two species. Weatherfish was able to reach a maximum of 10%, while crucian carp performed better and had a 30-40% survival rate. Our preliminary observations showed potential for ex-situ conservation of weatherfish and crucian carp on rice fields. Further investigations are necessary to refine the exact technology and improve the survival and harvesting rate of weatherfish. Rice fields are excellent habitats for extensive juvenile rearing, while organic rice production can benefit from the biological control of these species.

Towards a genome variation atlas of the weatherfish (*Misgurnus fossilis*) in the Netherlands

Hendrik-Jan Megens[1]*, Io S. Deflem[2], Maarten Bruns[3]*, Arjan P. Palstra[1,4], Reindert Nijland[5], Stan Coppis[5], Mick Vos[3], Jelger Herder[3], Jeroen van Wichelen[2], Johan Auwerx[2], Joachim Mergeay[2]*

1) Wageningen University and Research, Animal Breeding & Genomics, The Netherlands 2) Research Institute for Nature and Forest (INBO), Belgium 3) Reptile, Amphibian and Fish Conservation (RAVON), Nijmegen, The Netherlands 4) Wageningen University and Research, Wageningen Livestock Research, The Netherlands 5) Wageningen University and Research, Marine Animal Ecology, The Netherlands

* Corresponding authors

The weatherfish (*Misgurnus fossilis*) was once widespread across the floodplains of rivers in Northwestern Europe. Today, it serves as an important indicator species for marshy wetlands. Most remaining populations are now considered relics, and many continue to decline, which may result in loss of genetic diversity, and even inbreeding depression, increasing the risks of local extinction. To support effective management and restoration of these relic populations, a better understanding of their genetic diversity, biogeographic structure, and demographic history is needed. Here we present an initiative to characterize the genome diversity of the weatherfish across Belgium and The Netherlands. Since genome resources for the species are currently lacking, our initiative includes the development of a genome assembly and functional annotation. In collaboration with governmental stakeholders, we have initiated a pilot project to re-sequence genomes of weatherfish in three biogeographically distinct areas, each with specific population management objectives. By applying a genome re-sequencing strategy, these and future efforts can be integrated in a regional genome variation atlas for the weatherfish. Such a resource is particularly valuable for interpreting results from marginalized populations where obtaining more than just a few fish to sample has become a serious challenge. Ultimately a regional genome variation atlas will not only inform local conservation strategies, but can also contribute to a European genome variation atlas for the weatherfish.

Genetic diversity of *Misgurnus fossilis* in Austria

Palandačić, Anja[1,2,*]; Bogutskaya, Nina G.[1,3]; Chai, Min J.[1]; Reier, Susanne[1]; Bohlen, Jörg[4]; Ratschan, Clemens[5]; and Jung, Michael[5]

1) First Zoological Department, Vienna Museum of Natural History, Burgring 7, 1010 Vienna, Austria, 2) Department of Biology, Biotechnical Faculty, University of Ljubljana, Ljubljana, Slovenia 3) BIOTA j d.o.o., Dolga Gora 2, SI-3232 Ponikva, Slovenia 4) Laboratory of Fish Genetics, IAPG AS CR, v.v.i., Liběchov, Czech Republic 5) ezb – TB Zauner GmbH, Engelhartszell, Austria

The weatherfish (*Misgurnus fossilis*, L., 1758) is a species of the Cobitidae family. It is a small, benthic fish that feeds mostly on aquatic invertebrates and some detritus. Its native distribution area extends from the Meuse drainage basin in France to the Volga drainage basin in Russia. However, it is highly specialised to habitats in floodplain waters and ditches, and has low dispersal ability. This leads to strong population fragmentation and often results in regional extinction. Previous studies have shown that *M. fossilis* exhibits low genetic diversity, which may be explained by the recent dispersal of a bottlenecked population from a single refuge after the last glaciation. This study analysed cytochrome oxidase I in several populations of *M. fossilis* throughout its distribution range in Austria. However, most of the sequences were found to be identical, with a few exhibiting one or two mutations. These results, in accordance with previous studies, demonstrate that *M. fossilis* in Austria exhibits low genetic diversity at the mtDNA level, which may increase its vulnerability to recent habitat changes.

Towards the Establishment of Conservation Units of the Endangered Weatherfish (Misgurnus fossilis) in Central Europe

Bohlen, Jörg[1]; Choleva, Lukáš[1,2]; Bezányiová, Kateřina[1,3]; Dvořák, Tomáš[1]; Labajová, Veronika[1,2]; Šmejkal, Marek[4,5]; Marta, Anatolie[6,7]; Pavlica, Tomáš[1,3]; Sember, Alexandr[1]; Bohlen Šlechtová, Vendula[1]

1) Laboratory of Fish Genetics, Institute of Animal Physiology and Genetics, Czech Academy of Sciences, Rumburská 89, Liběchov 277 21, Czech Republic 2) Department of Biology and Ecology, Faculty of Science, University of Ostrava, Chittussiho 10, 710 00 Ostrava, Czech Republic 3) Department of Zoology, Faculty of Science Charles University in Prague, Viničná 7, 128 44 Prague, Czech Republic 4) Institute of Hydrobiology, Biology Centre of the Czech Academy of Sciences, Na Sádkách 702/7, 370 05 České Budějovice, Czech Republic 5) Faculty of Science, University of South Bohemia, Branišovská 1645/31a, 370 05 České Budějovice, Czech Republic 6) Laboratory of NonMendelian Evolution, Institute of Animal Physiology and Genetics, Czech Academy of Sciences, Rumburská 89, Liběchov 277 21, Czech Republic 7) Institute of Zoology, Academy of Science of Moldova, Chisinau MD-2028, Republic of Moldova* These authors contributed equally to this work

The weatherfish (*Misgurnus fossilis*) has suffered significant declines across Central Europe due to extensive anthropogenic habitat destruction. As a result, many European countries classify the species currently as ‘endangered’ or ‘critically endangered’. *Misgurnus fossilis* is also known for exhibiting exceptionally low genetic diversity throughout Central Europe if compared to other freshwater fish species. This study analyses the genetic diversity of *M. fossilis* based on mitochondrial (mtDNA) and nuclear DNA (nuDNA) sequence data from 30 populations across Central Europe and two from Eastern Europe. Both datasets reveal that populations from the Czech Republic, Austria, and Bavaria form a genetically distinct lineage, separate from other European populations. This lineage is found in three major river basins—the Elbe, Danube, and Oder—but is geographically isolated by surrounding mountain ranges. Despite at least two natural contact zones between the Central European lineage and other groups and a relatively small genetic distance between them, the two should be recognised as separate conservation units. In Austria, Bavaria, and the Czech Republic, the populations are typically geographically extremely limited and small, making them highly vulnerable to the ongoing landscape and climatic changes leading to the disappearance of surface water. These populations are experiencing a rapid and alarming decline. Given their precarious status and ecological uniqueness, this Central European conservation unit should be classified as critically endangered and prioritised for protection. Urgent habitat conservation efforts are essential, not only for *M. fossilis* but also for the broader ecological community that coexists with it. This project is financed with state support from the Technology Agency of the Czech Republic and the Ministry of the Environment of the Czech Republic under the Environment for Life Program (reg. no. SS07010366).

Identification and invasive potential of Asian weatherfish in Europe

Thomas Klefoth[1], Isabel Tanzberger[1], Meret Neske[1], Asia Gabajdulina[1]

1) Ecology and Conservation, Faculty of Nature and Engineering, Hochschule Bremen, Bremen, Germany

Asian weatherfish are increasingly spreading in Germany and Europe. However, the exact species composition of the non-native fishes and their invasion potential have been insufficiently studied. We integrated genetic, morphological, and behavioural methods to identify and assess the invasive potential of Asian weatherfish (*Misgurnus* spp.) and their threat to the endangered native *Misgurnus fossilis* in northern Germany. COI sequencing of 107 specimens confirmed the presence of *Misgurnus anguillicaudatus* and indicated possible occurrence of additional cryptic species, though species-level resolution remained limited due to genetic overlap. Morphological investigations, together with an extensive review of peer-reviewed and grey Asian literature on morphological characteristics, revealed insufficient morphological differentiation within Asian weatherfish. This was either because no species other than *Misgurnus anguillicaudatus* were present in our samples or because the morphological characteristics were also overlapping. Additionally, two-way choice behavioural experiments were conducted to compare habitat preferences of European and Asian weatherfish, testing muddy sediment against sand and gravel. Under controlled conditions, Asian weatherfish showed greater swimming activity, oxygen-independent air-breathing, and higher burrowing intensity than European weatherfish. The Asian species tolerated all sediment types, whereas *Misgurnus fossilis* preferred mud and avoided gravel. Our results demonstrate that non-native Asian weatherfish possess enhanced morphological and ecological plasticity, as well as greater dispersal capacity, which likely facilitates the competitive displacement of native species. This underscores the need for robust molecular and morphological identification methods and targeted conservation measures to secure European weatherfish populations against the advancing spread of invasive congeners.

Beyond the Net: Optimizing eDNA Sampling and Analysis for Challenging Muddy Habitats and the Endangered Weatherfish (*Misgurnus fossilis*)

Bezányiová, Kateřina[1,2]; Bohlen, Jörg[1]; Bohlen Šlechtová, Vendula[1]; Labajová, Veronika[1,3]; Dvořák, Tomáš[1]; Choleva, Lukáš[1,3]

1) Laboratory of Fish Genetics, Institute of Animal Physiology and Genetics, Czech Academy of Sciences, Rumburská 89, Liběchov 277 21, Czech Republic 2) Department of Zoology, Faculty of Science Charles University in Prague, Viničná 7, 128 44 Prague, Czech Republic 3) Department of Biology and Ecology, Faculty of Science, University of Ostrava, Chittussiho 10, 710 00, Ostrava, Czech Republic

Elusive and endangered species are prime candidates for environmental DNA (eDNA) monitoring. The weatherfish (*Misgurnus fossilis*) is one such species where traditional fishing methods (trapping or electrofishing) may not yield conclusive results on its presence/absence. On the other hand, eDNA monitoring is less labour-intensive than traditional methods and may require only a small amount of water if species-specific qPCR/ddPCR markers are utilised. We aim to develop a standardised eDNA protocol that would provide additional information in tandem with traditional fishing surveys. We are currently testing field sampling procedures and laboratory analyses that will be functional for all known *M. fossilis* haplotypes, tailored to the specific challenges of muddy water habitats (e.g., clogging of filters, qPCR inhibition) and cost-effective enough to be used by citizen science projects. The species-specific markers are primarily optimised to be multiplexed, allowing us to combine multiple markers from a single species to increase the probability of detection as well as to simultaneously discriminate other co-occurring fish species, such as the endangered crucian carp (*Carassius carassius*). Further markers—such as those specific to invasive species of *Misgurnus* or *Carassius*—may be added to the multiplex to gain further information on the current state of localities in question. This project is financed with state support from the Technology Agency of the Czech Republic and the Ministry of the Environment of the Czech Republic under the Environment for Life Program (reg. no. SS07010366).

Competitive exclusion of native species by invasive species within *Carassius* genus

Šmejkal, Marek[1]; Tapkir, Sandip[1]; Thomas, Kiran[1]; Kalous, Lukáš[2]

1) Institute of Hydrobiology, Biology Centre of the Czech Academy of Sciences, Na Sádkách 7, 370 05, České Budějovice, Czech Republic 2) Department of Zoology and Fisheries; Faculty of Agrobiology, Food and Natural Resources; Czech University of Life Sciences Prague; Kamýcká 129, 165 00 Praha-Suchdol, Czech Republic

Successful invasive non-native fish species can cause enormous damage to native biodiversity. On the European mainland, the introduction of the gibel carp (*Carassius gibelio*) has led to a decline in populations of the formerly widespread native crucian carp (*Carassius carassius*). Due to the invasion of the gibel carp, the crucian carp had been moved from the status of least concern to the status of critically endangered in Czechia, and its population has also declined in other countries where the gibel carp has invaded. This contribution summarises the findings on the competitive displacement of native species by invasive species from both experimental approaches and historical trends. The recent findings demonstrated that the gibel carp utilises food sources much more efficiently than its native counterpart. The gibel carp are not only more aggressive and utilise shared resources faster, but also use plant material that is not available to the crucian carp as an effective food source. Finally, this contribution provides circumstantial evidence that the gibel carp is behind the transition from the relative abundance of large deep-bodied form of crucian carp to its near extirpation in Czechia, while large and deep-bodied gibel carp have taken over the reports of record angling catches in the genus *Carassius*. Taken together, the current findings strongly suggest that the crucian carp is being locally extirpated by the gibel carp. Due to the uneven competition between *Carassius* species, programmes to repopulate selected waters with crucian carp are necessary.

Goldfish, Gibel, or Crucian? Testing Public Recognition of *Carassius* Species

Milan Gottwald[1], Kiran Thomas[2], Yevdokiia Stepanyshyna[2] and Marek Šmejkal[2]

1) Department of Zoology and Fisheries; Faculty of Agrobiology, Food and Natural Resources; Czech University of Life Sciences Prague; Kamýcká 129, 165 00 Praha-Suchdol, Czech Republic 2) Institute of Hydrobiology, Biology Centre of the Czech Academy of Sciences, Na Sádkách 7, 370 05, České Budějovice, Czech Republic

The crucian carp (*Carassius carassius*) is a native freshwater species whose populations in the Czech Republic have been rapidly declining in recent decades. The main driver of this decline is the expansion of the invasive gibel carp (*Carassius gibelio*), which is morphologically similar and occupies similar habitat. The resemblance among *Carassius* species leads to frequent misidentification, not only among citizens but also among experts. Such confusion complicates species monitoring and hinders the effective implementation of conservation measures. Reliable identification of *C. carassius*, *C. gibelio*, and the domesticated goldfish (*C. auratus*) is essential, especially in light of repopulation measures citizens are conducting in recent years. To explore the public's ability to distinguish between these species, we conducted a species determination experiment during the largest angling trade fair, For Fishing 2023. A total of 327 participants were randomly assigned one of five image sets, each containing nine photographs: three of *C. carassius*, three of *C. gibelio*, and three of *C. auratus*. Results showed high recognition accuracy for ornamental goldfish and large *C. gibelio* individuals. However, participants often confused smaller *C. gibelio* with *C. carassius*, particularly when determination characteristics were subtle. These findings highlight that species recognition depends on individual fish size and prominent determination characteristics. Accurate identification is not only vital for public education but also for safeguarding the genetic integrity of *C. carassius*, a critically endangered species. As a flagship for pond biodiversity and wetland restoration, its protection represents a broader commitment to conserving native aquatic ecosystems.

Names and Terminology Matter: The case of the genus *Carassius*

Kalous, Lukáš[1]; Kumkar, Pradeep[1]; Wanzenböck, Josef [2]; Šmejkal, Marek[3], Choleva, Lukáš[4], Lamatsch, Dunja K.[2]

1) Department of Zoology and Fisheries, Faculty of Agrobiology, Food and Natural Resources, Czech University of Life Sciences Prague, Prague, Czech Republic 2) Research Department for Limnology Mondsee, University of Innsbruck, Mondsee, Austria 3) Institute of Hydrobiology, Biology Centre of the Czech Academy of Sciences, České Budějovice, Czech Republic 4) Laboratory of Fish Genetics, Institute of Animal Physiology and Genetics, Czech Academy of Sciences, Liběchov, Czech Republic

The naming of objects, processes, and various entities is crucial for effective communication. Precision is essential in both technical contexts and in the interpretation of natural phenomena. Clear and accurate terminology facilitates communication among specialized scientists and with stakeholders who make decisions affecting the environment and the behaviour of human society. While simplification is sometimes necessary to make scientific concepts more accessible to target audiences, it should never lead to bias or a misrepresentation of underlying biological facts. The fishes of the genus *Carassius* exhibit numerous unique characteristics, these include a combination of sexual and asexual (gynogenetic) modes of reproduction, resulting in both clonal and recombinant offspring. The appearance of males within clonal all-female populations remains an unresolved phenomenon. Chromosomal diversity in *Carassius* is substantial, with some lineages exhibiting a tetraploid count of 100 chromosomes, while others show both 100 and approximately 150 chromosomes, indicating a shift toward hexaploidy. The higher chromosome counts are often accompanied by the presence of microchromosomes, further contributing to the cytogenetic diversity of the genus. Octoploid individuals have also been reported, typically arising from genome addition events. Hybridization between individuals of maternally distinct evolutionary lineages resulting in fertile descendants contribute to the genetic and reproductive multifaceted nature of this genus. Such mismatches can lead researchers to reinterpret biological or ecological patterns in ways that align with established terminology, even if this oversimplifies or distorts the underlying complexity. On the other hand, the above mentioned complexity also leads to the creation of new terminology that may be recognized only within the scientific groups that introduced them. Scientific understanding is shaped by shifts in prevailing scientific paradigms, shifts that have been remarkably dynamic in the case of fishes of the genus *Carassius*. Our intention is to enhance conceptual clarity and support accurate communication about this taxonomically and ecologically complex group.

The Phylogenetic Imperative: A Genetics-Informed Framework Delineating Conservation Units for *Carassius carassius* in Czechia

Choleva, Lukáš[1,2]*; Šmejkal, Marek[3,4]*; Matějů, Jan[5]; Janda, Benedikt[6]; Bezányiová, Kateřina[1,6]; Bohlen, Jörg[1]; Kalous, Lukáš[7]

1) Laboratory of Fish Genetics, Institute of Animal Physiology and Genetics, Czech Academy of Sciences, Rumburská 89, Liběchov 277 21, Czech Republic 2) Department of Biology and Ecology, Faculty of Science, University of Ostrava, Chittussiho 10, 710 00 Ostrava, Czech Republic 3) Institute of Hydrobiology, Biology Centre of the Czech Academy of Sciences, Na Sádkách 702/7, 370 05 České Budějovice, Czech Republic 4) Faculty of Science, University of South Bohemia, Branišovská 1645/31a, 370 05 České Budějovice, Czech Republic 5) Museum Karlovy Vary, Nová louka 23, 360 01 Karlovy Vary, Czech Republic 6) Department of Zoology, Faculty of Science Charles University in Prague, Viničná 7, 128 44 Prague, Czech Republic 6) Department of Zoology, Faculty of Science Charles University in Prague, Viničná 7, 128 44 Prague, Czech Republic 7) Faculty of Agrobiology, Food and Natural Resources, Czech University of Life Sciences Prague, Kamýcká 129, 165 00 Prague - Suchdol, Czech Republic

* These authors contributed equally to this work

The conservation of declining wetland fish species in Central Europe necessitates a paradigm shift from species-level management to the preservation of evolutionarily significant phylogenetic lineages. The crucian carp (*Carassius carassius*) represents a compelling case study in the challenges of modern conservation, where a species' apparent widespread distribution belies a complex and fragmented genetic structure. Within Europe, the species is not a monolithic entity but rather comprises two distinct and highly divergent phylogenetic lineages. The first, a northern lineage, is found across a vast expanse of Northern and Eastern Europe, including the Labe (Elbe) and Odra (Oder) River Basins. The second, a Danubian lineage, is geographically restricted to the Danube River Basin. Critically, both of these natural, evolutionarily distinct lineages are native to the Czech Republic, with some regions serving as a vital contact zone where their historical ranges overlap. The explicit recommendation to classify this Central European lineage as "critically endangered" and to prioritize its protection is a powerful argument for a new framework of conservation. It moves the discussion beyond simply asking, "Is the species endangered?" to a more nuanced question: "What specific, irreplaceable genetic units are at highest risk?" This approach elevates a population's conservation priority based not only on its vulnerability but also on the irreplaceability of its unique evolutionary history. This model is directly applicable to the conservation of *C. carassius* and other species with similar fragmented genetic structures. It suggests that policy and funding decisions should be guided by a species' unique evolutionary trajectory and the critical need to preserve its genetic subgroups as distinct ecological and evolutionary entities.

A comparative study of pelagic and benthic resource use by invasive gibel carp (*Carassius gibelio*) and native crucian carp (*Carassius carassius*)

Stepanyshyna, Yevdokiia[1,2], Thomas, Kiran[1,2], Gorule, Pankaj A.[1], Šmejkal, Marek[1]

1) Institute of Hydrobiology, Biology Centre of Czech Academy of Sciences, Na Sádkách 7, České Budějovice 370 05, Czech Republic 2) Faculty of Sciences, University of South Bohemia, Branišovská 1645/31a, České Budějovice 370 05, Czech Republic

The efficient exploitation of available food resources is important for the prosperity and survival of any species. It influences not only growth and reproduction, but also the competitiveness of a species in the ecosystem. The native crucian carp (*Carassius carassius*) is currently considered critically endangered in the Czech Republic, primarily due to competitive pressure from the invasive gibel carp (*Carassius gibelio*). The underlying mechanisms driving this strong interspecific interaction are still poorly understood. This study explores differences in pelagic and benthic foraging between these two species under contrasting environmental conditions (clear vs. turbid water), using controlled laboratory experiments. To identify species-specific differences in foraging efficiency as determined by prey type and size, we conducted manipulative predation experiments using model prey organisms consisting of two size classes of *Daphnia galeata* and larvae of *Chironomus plumosus*. The results demonstrated that gibel carp exhibited significantly higher prey capture rates than native crucian carp in both pelagic and benthic prey types, suggesting a greater potential to exploit and successfully utilize available food resources. The invasive gibel carp also displayed higher levels of activity and boldness, supporting its propensity for more aggressive exploitation of the environment. Such superior foraging efficiency of invasive gibel carp may be a major factor contributing to the decline of crucian carp populations in small water bodies where both species co-occur.

Trait-based mechanisms of invasion: Divergence in morpho-functional traits between the native and invasive *Carassius* species

Tripathi, Sakshi R. [1,2]; Takács, Péter[3]; Gorule, Pankaj A.[1]; Thomas, Kiran[1]; Gottwald, Milan[4]; Šmejkal, Marek[1,2];

1) Institute of Hydrobiology, Biology Centre of the Czech Academy of Sciences, České Budějovice, Czech Republic 2) Faculty of Science, University of South Bohemia, České Budějovice, Czech Republic 3) HUN-REN Balaton Limnological Research Institute, Tihany, Hungary 4) Department of Zoology and Fisheries; Faculty of Agrobiology, Food and Natural Resources; Czech University of Life Sciences Prague; Kamýcká 129, 165 00 Praha-Suchdol, Czech Republic

Functional trait divergence underpins many biological invasions, yet its role in native-invasive fish interactions remains poorly understood. Invasive species significantly threaten the native biodiversity by disrupting the functional structure of aquatic communities. The widespread expansion of the invasive gibel carp (*Carassius gibelio*) throughout the European freshwater systems has potentially led to notable decline of the native crucian carp (*Carassius carassius*), yet the specific functional trait mechanisms driving this shift remain unclear. To address this unexplored aspect, we aimed to study the detailed morphometric measurements with a standardized functional trait approach in order to understand whether divergence in the key morpho-functional ecological traits gives the invasive gibel carp a competitive edge. Samples for both native crucian carp and invasive gibel carp were collected across five sympatric pond systems in Czechia, wherein we quantified fourteen morpho-functional traits related to feeding and locomotion in both the species. Our analysis revealed that gibel carp consistently exhibited higher gut length ratios and larger oral gape surfaces than crucian carp, reflecting broader digestive capabilities and an increased ability to exploit diverse food resources, particularly plant and detrital material. Gibel carp also displayed significantly higher values for fin morphological traits, including pectoral fin aspect ratio and fin surface to body size ratio, suggesting enhanced maneuverability and habitat access. On the other hand, certain traits such as eye position and body shape showed substantial overlap between the two *Carassius* species. The observed divergence in feeding and locomotory traits under sympatric conditions indicates that the invasion success of gibel carp is closely associated with increased trophic flexibility and resource acquisition. These functional trait advantages likely underpin rapid population growth and enhanced competitive pressure on the native crucian carp populations, which continues to decline in the invaded habitats. Our findings therefore underscore the importance of trait-based analysis for elucidating the ecological processes underlying invasion and highlight the urgent need for targeted conservation actions to protect the critically endangered native crucian carp population.

Citizen science to complement professional data: towards conservation of declining native freshwater fish, the crucian carp

Kiran Thomas[1,2], Lukáš Kalous[3], Marek Brabec[4], Zuzana Šmejkalová[1], Marek Šmejkal[1,2]

1) Institute of Hydrobiology, Biology Centre of the Czech Academy of Sciences, České Budějovice, Czech Republic 2) Faculty of Science, University of South Bohemia, České Budějovice, Czech Republic 3) Faculty of Agrobiology, Food and Natural Resources, Czech University of Life Sciences, Prague, Czech Republic 4) Institute of Computer Science, Czech Academy of Sciences, Prague, Czech Republic

The citizen science approach enables the collection of extensive ecological data while reducing time and cost, offering a valuable tool to address complex conservation challenges. However, its precision in monitoring morphologically similar freshwater fish species remains insufficiently explored. This study evaluates the effectiveness of citizen science in distinguishing between the critically endangered crucian carp (*Carassius carassius*) and the invasive gibel carp (*Carassius gibelio*), two closely related species often confused due to their similar appearance. The native crucian carp has experienced a sharp population decline in Central Europe and is currently classified as critically endangered in the Czech Republic. In response, the citizen science initiative, save the crucian carp was launched to map the species' distribution and support its conservation and restoration. We assessed the project's effectiveness using data submitted by 953 participants, which included current and historical occurrence records for both crucian and gibel carp. The analysis focused on species identification accuracy, public engagement, and the influence of media outreach on participation. Field verification of reported sightings revealed a 35% accuracy rate for crucian carp identification. A positive correlation was observed between respondents' species identification quiz scores and the number of valid occurrence tips submitted. Participants aged 31–50 showed the highest engagement in conservation efforts. Notably, media campaigns significantly boosted public involvement, highlighting the importance of awareness-building in fostering biodiversity stewardship. Data collected through citizen science exhibited broader coverage and greater reporting regularity compared to records from the Nature Conservation Agency of the Czech Republic, underscoring the value of citizen contributions in shaping conservation strategies. Overall, this study illustrates the promise of citizen science as a scalable and impactful approach for monitoring and conserving threatened freshwater fish species.

Workshop: Engaging people in conservation of crucian carp through a citizen science approach

Led by Marek Šmejkal[1,2]

1) Institute of Hydrobiology, Biology Centre of the Czech Academy of Sciences, České Budějovice, Czech Republic 2) Faculty of Science, University of South Bohemia, České Budějovice, Czech Republic

The citizen science project “Save the Crucian carp” (zachrankarase.cz/en/) in Czechia represents a successful example of public engagement in freshwater fish conservation. Initially launched as a passive platform for collecting species presence tips from the general public, it gradually gained momentum. Remarkably, many participants went beyond reporting, becoming actively involved in breeding crucian carp in privately owned ponds. Some even voluntarily paid for genetic testing to verify the purity and lineage of the fish, supporting conservation of the two distinct phylogenetic lineages present in the country. This success story serves as a valuable model that could be replicated in other countries. A key step would be translating and adapting the Czech-language website and outreach materials for international use. In this workshop, our goal is to familiarize you with the potential challenges involved in reaching target audiences, filtering citizen-contributed data, and effectively communicating the project’s objectives. We will also explore strategies for engaging participants meaningfully, such as offering incentives or recognition to ensure sustained and impactful public involvement. Citizen science is gaining momentum in the conservation of freshwater fish species, serving as an effective bridge between professional scientists and target groups within society. Media plays a crucial role in fostering this connection. Developing a user-friendly mobile application supported by an informative website can significantly enhance this engagement. Such platforms facilitate the proper dissemination of information, raise awareness, and simultaneously enable the collection of valuable data from the public.

Designing critical pond infrastructure for conservation of wetland fishes in the Czech Republic

Kořen, Vladimír[1]; Thomas, Kiran[2]; Šmejkal, Marek[2]

1) Charles University, Institute for Environmental Studies, Faculty of Science, Benátská 2, Praha 2, CZ12800, Czech Republic 2) Institute of Hydrobiology, Biology Centre of the Czech Academy of Sciences, Na Sádkách 7, 370 05, České Budějovice, Czech Republic

River regulations and ill-considered steps in fisheries and aquaculture management have led to substantial changes in the original Czech ichthyofauna. These changes are particularly noticeable in species that are not economically important such as crucian carp (*Carassius carassius*), sunbleak (*Leucaspius delineatus*), or weatherfish (*Misgurnus fossilis*). Compared to original fish species with economic importance, there is no organized support for the repatriation of these small fish species. Thus, the goal of this large-scale project is to secure the remaining populations of these species, with crucian carp serving as a flagship species. The citizen science approach was used to identify remaining populations of crucian carp and their populations were subjected to genetic testing. A collaboration between authors and Forests of the Czech Republic was set to secure 30 pool-like ponds spanning across Czech Republic covering each region, aiming to cover potential differences in genetic variability among remaining populations. This approach provides critical infrastructure without presence of invasive fish species, thus enabling native wetland fish repatriation and natural reproduction. These ponds will serve as centres for the reintroduction of these fish species regionally, thus minimizing risk of loosing important genetic diversity during repopulation measures for these invasive species. Our goal is to obtain a permanent source of genetically verified fish, and the surplus of their populations will be locally spread in cooperation with fishermen and citizen scientists within individual regions. This contribution demonstrates how citizens can be embedded in effective conservation of small fish species with no economic importance.

Propagation and conservation of crucian carp in Hungary: insights from laboratory, semi-intensive, and pond rearing

Müller Tamás[1], Horváth József[1], Varga Ádám[1], Demény Ferenc[2]

1) Department of Freshwater Fish Ecology, Institute of Aquaculture and Environmental Safety, Hungarian University of Agriculture and Life Sciences, 2) Mecklenburg-Vorpommern Research Centre for Agriculture and Fisheries, Institute of Fisheries

We first began working on the propagation and rearing of the crucian carp (*Carassius carassius*) in 2002, when our initial stockings also took place. More intensive research started in 2007, focusing on issues related to the reproduction and rearing of the species under laboratory, semi-intensive, and pond farming conditions. Within induced spawning cycles, we examined the effects of egg treatment (Woynarovich solution combined with tannin treatment) and different incubation temperatures on reproductive parameters, as well as on embryo and larval development. In a series of larval rearing experiments, we compared various feeding strategies, including the use of commercially available feeds, live food, and different combinations of both. We also determined the optimal weaning strategy to achieve optimal survival and growth for an economically feasible production. During intensive juvenile rearing (up to the one-summer-old stage), we carried out experiments to evaluate different feeding regimes, to determine optimal feed rations, and to assess the role of live food supplementation in survival and growth, with special attention to the occurrence of deformities. In pond-based trials, we investigated the possibilities of monoculture rearing of crucian carp and co-rearing with tench (*Tinca tinca*) in nursery ponds and pond-cage systems. We also studied the development of restocked populations at the "*Umbra krameri*" species protection area. In a separate series of experiments, we monitored the migration patterns of tagged crucian carp in Lake Balaton. Additionally, we conducted morphometric comparisons of crucian carp, Prussian carp (*Carassius auratus gibelio*), and their hybrids, as well as population studies in habitats where all three genotypes occur. In the course of our work, we have so far restocked 150,000 individuals (larvae, juveniles, and sexually mature specimens. Our research is ongoing, with a special focus on developing rearing protocols and feeding strategies tailored to the species' needs, in order to support effective conservation and restocking programs.

Conservational rights and wrongs – protection of invasive populations of *Carassius carassius* and artificial habitats for repopulation of damaged native populations?

Buj, Ivana[1], Beno, Ivan[1], Renić, Nikola[1], Zoran Marčić[1]

1) Faculty of Science, University of Zagreb

Similar to many other regions, Crucian carp (*Carassius carassius* (Linnaeus, 1758)) is facing strong anthropogenic threats in Croatia, resulting in a reduction of its distribution range, local extinctions, lowering of its population abundances and diversities, presence of genetically contaminated populations and bringing several remaining populations on the verge of extinction. Despite the global IUCN assessment of this species as least concerned (LC) and its wide distribution range (throughout majority of Europe), scientists are expressing raising concerns that genetically pure and viable populations of Crucian carp have become rare and that real distribution range, population sizes and their future prospects are much worse than currently presumed. Due to the lack of scientific investigation, real status of this species in Croatian watersheds has not been described so far nor any conservational measures designed, despite field observations indicating strong reduction in distribution and abundances, and even local extinctions. Thereafter, for the first time, we have conducted comprehensive field investigation in order to check the presence of Cruacian carp populations on seemingly adequate localities, as well as localities that correspond with literature reports. We have employed molecular genetic analyses (based on mitochondrial and nuclear genetic markers) in order to check whether the sampled populations are genetically pure or genetic contamination occurred (mostly due to hybridization with the Prussian carp (*Carassius gibelio* (Bloch, 1782)). Furthermore, we have analyzed genetic diversity of the sampled populations, their effective population sizes and gene flows among them. The obtained results corroborated significant reduction in the native distribution range of the Crucian carp in Croatia and its replacement with Prussian carp on majority of localities. Interestingly, Crucian carp is present in many artificial habitats, but also on several water bodies in the Alpine region of Croatia, outside of its native distribution range, where this species can be considered invasive. Since few remaining native populations have fragmented distribution, low population sizes and genetic diversities, we will discuss the importance of artificial habitats and non-native populations for assuring the survival of this rare and endangered species in Croatia, as well as possible conservation measures.

Assessing the use of Small Inland Wetlands by fish in the Lower Tagus Basin (Portugal)

Diogo Ribeiro[1], Diogo Dias[1,2], João Gago[3,4], Joana Martelo[2], Rui Rivaes[1], Luis da Costa[5], David Santos[6], Filipe Ribeiro[1], João Catalão[7], Maria Filomena Magalhães[2]

1) Centro de Ciências do Mar e do Ambiente (MARE)/ARNET – Rede de Investigação Aquática, Faculdade de Ciências da Universidade de Lisboa, Campo Grande, 1749-016 Lisboa, Portugal 2) Centro de Ecologia, Evolução e Alterações Ambientais (cE3c)/Change – Instituto para as Alterações Globais e Sustentabilidade, Faculdade de Ciências da Universidade de Lisboa, Campo Grande, 1749-016 Lisboa, Portugal 3) CERNAS, Centro de Estudos de Recursos Naturais, Ambiente e Sociedade, Escola Superior Agrária de Coimbra Bencanta, 3045-601 Coimbra, Portugal 4) Escola Superior Agrária de Santarém, Quinta do Galinheiro – S. Pedro, 2001-904 Santarém, Portugal 5) MUHNAC, Museu Nacional de História Natural e da Ciência, Universidade de Lisboa, 1250-102 Lisboa, Portugal 6) Centro de Ciências do Mar e do Ambiente (MARE)/ARNET – Rede de Investigação Aquática, Faculdade de Ciências e Tecnologia da Universidade Nova de Lisboa, Campus da Caparica, 2829-516 Caparica, Portugal 7) Instituto Dom Luiz, Faculdade de Ciências da Universidade de Lisboa, Campo Grande, 1749-016 Lisboa, Portugal

Inland wetlands have long been recognized as important biodiversity hotspots and amongst the most impacted ecosystems worldwide, requiring urgent conservation management and restauration. However, focus has been mostly on wetland use by iconic birds and mammals, largely ignoring other highly endangered animals, such as fish. The Tagus Basin harbours the most diverse regional pool of freshwater fish in Portugal, with a total of 28 native species, 2 of which are Lusitanian endemics. In particular, the Lisbon arched-mouth nase (*Iberochondrostoma olisiponense*) is strongly associated to small inland wetlands and restricted to the Lower Tagus basin. Multiple wetlands were historically found in this region, with periodic floods inundating the riverside floodplain. However significant changes in land and water uses have occurred, potentially affecting the spatial availability, distribution and dynamics of small wetlands and their use by fish. Here we aimed to identify small inland wetlands in the Lower Tagus Basin (Portugal) and assess local fish communities. Using the Sentinel-2 imagery combined with Normalized Difference Water Index (NDWI), a total of 409 small wetlands were identified in the Lower Tagus basin, 30 of which were persistent and showed potential to host fish. From these, 10 wetlands covering the perceived variability in environmental conditions and distributed across the basin were sampled for fish. Data obtained using multiple sampling techniques were combined using the Gear Mean Standardization (MGMS) approach, and related to habitat, landscape, and land use variables using Canonical Correspondence Analysis (CCA). Fish communities included five native species, but were dominated by eight non-native species. Fish community structure was significantly related to habitat depth and wetland connectivity to the Tagus river, and showed no measurable association with land uses. Isolated, deep wetlands were mostly used by angling non-native species such as Largemouth bass (*Micropterus nigricans*) and Pumpkinseed sunfish (*Lepomis gibbosus*). Wetlands most connected to the Tagus mainstem, harboured mobile species such as Iberian barbel (*Luciobarbus bocagei*) and Thinlip grey mullet (*Chelon ramada*). Shallow wetlands were habitat for threatened European eel (*Anguilla anguilla*), and Lisbon arched-mouthed nase. Our results indicate that small inland wetlands may act as refuges for threatened fish species, and should be managed and restored to help hamper fish diversity loss. However, connected wetlands they may also provide potential spreading hotspots for non-native fish, and should thus require population eradication and control programs to help boost native fish diversity.

Negative impact of the invasive topmouth gudgeon (*Pseudorasbora parva*) on population growth of a native fish species, the sunbleak (*Leucaspius delineatus*)

Šmejkal, Marek[1,2]; Rektor, Aleš[1]; Thomas, Kiran[1,2]; Gorule, Pankaj A.[1]; Tripathi, Sakshi R.[1]; Stepanyshyna, Yevdokiia[1]; Ložek, Filip[3]; Bláha, Martin[3]; Boukal, David[2,4]

1) Institute of Hydrobiology, Biology Centre of the Czech Academy of Sciences, České Budějovice, Czech Republic 2) Faculty of Science, University of South Bohemia, České Budějovice, Czech Republic 3) Faculty of Fisheries and Protection of Waters, South Bohemian Research Center of Aquaculture and Biodiversity of Hydrocenoses, University of South Bohemia in České Budějovice, Zátiší 728/II, Vodňany 389 25, Czech Republic 4) Institute of Entomology, Biology Centre of the Czech Academy of Sciences, České Budějovice, Czech Republic

Biotic interactions of invasive and native species are one of the main drivers of declining freshwater biodiversity. The recent population declines of sunbleak (*Leucaspius delineatus*) in its native range have been attributed to the spread of the rosette agent (*Sphaerothecum destruens*) carried by the invasive topmouth gudgeon (*Pseudorasbora parva*). However, both fish species highly overlap in their habitat preferences and omnivorous feeding strategy, and their interspecific interactions may have contributed to the decline of sunbleak populations. To test this hypothesis, we carried out two experiments in small (0.8 m3 water volume) and large (8 m3 water volume) outdoor mesocosms and followed their population and individual responses over one growing season in single-species and syntopy treatments. In each experiment, both species reached similar final abundance, final biomass and biomass-based population growth rate in the single-species treatment. However, the final biomass and biomass-based population growth rate of sunbleak were much lower than those of topmouth gudgeon in the syntopy treatment in both experiments. That is, the biomass-based population growth rate of topmouth gudgeon was not affected by interspecific competition, while that of sunbleak significantly declined. These disparate population-level responses of both species to syntopy were not reflected in the individual-level responses. At the end of each experiment, topmouth gudgeon individuals were heavier than sunbleak individuals of the same size and individuals in the large mesocosms were heavier than conspecific individuals of the same size in the small mesocosms, but we found no difference between the single-species and syntopy treatments. Taken together, these results suggest that presence of topmouth gudgeon in the small water bodies can significantly impact sunbleak populations. More broadly, it underscores the need to mitigate invasive species' effects on native fish through proactive conservation and management strategies.

Is there any chance in a three-front war? The past, present and possible future of muddy water fish species in Hungarian waters

Weiperth, András[1,2]; Bányai, Zsombor Márk[3]; Berényi, Dániel András[4]; Bláha, Martin[5]; Kouba, Antonín[5]; Müller, Tamás[6]

1) F6 Association for Sustainability, 2) HUN-REN National Laboratory for Water Science and Water Security, Institute of Aquatic Ecology, Centre for Ecological Research, 3) Doctoral School of Environmental Sciences, Hungarian University of Agriculture and Life Sciences, 4) Department of Aquatic Genetic Resources Conservation, Institute for Farm Animal Conservation, National Centre for Biodiversity and Gene Conservation, 5) Faculty of Fisheries and Protection of Waters, South Bohemian Research Center of Aquaculture and Biodiversity of Hydrocenoses, University of South Bohemia in České Budějovice, 6) Department of Freshwater Fish Ecology, Institute of Aquaculture and Environmental Safety, Hungarian University of Agriculture and Life Sciences

We present what aspects have affected the muddy water fish species in the past and present, and the new challenges we will face in the future. The fish fauna of the Carpathian Basin has been influenced by numerous factors over the centuries. The first major changes were caused by river regulation from the beginning of the 18th century. This was followed by the introduction, illegal and legal stoking, and natural spread of non-native species, and then, increasingly rapid climate change has begun to cause ever greater problems. Due to the combined effects of these three processes, muddy water fish populations are now on the edge of extinction. Here, we demonstrate how current maintenance practices are destroying the remaining populations of weatherfish (*Misgurnus fossilis*) in the lowland stream and channel network systems. Additionally, the co-occurrence of invasive marbled crayfish (*Procambarus virginalis*) and several invasive fish species (e.g. Chinese sleeper *Perccottus glenii*, Jaguar guapote *Parachromis managuensis*, Eastern mosquitofish *Gambusia holbrooki*) has affected the population of the European mudminnow (*Umbra krameri*) in the western drainage region of Lake Balaton. We stress the issue of non-native species we will have to deal with in the future, as well as the water management practices, angling stocking programs and education programs for everyone from kids to adults that we need to change immediately to maintain and preserve the muddy water fish species in the Hungarian waters.

Poster presentations

When both prey (*Umbra krameri*) and predator (*Lutra lutra*) are strictly protected species

Bálint Bánó[1], Péter Takács[1], Mariann Miklós[1], Zsófia Dévai[2], Gabriella Lanszki-Széles[2], József Lanszki[1]

1) HUN-REN Balaton Limnological Research Institute
2) Hungarian University of Agriculture and Life Sciences

In our study, we aimed to characterize the diet composition of the strictly protected Eurasian otter (*Lutra lutra*) by analyzing fish scales and pharyngeal teeth found in its feces (spraints). As a sampling site, we selected the Marótvölgyi Canal, one of Hungary's most important habitats for the European mudminnow (*Umbra krameri*). The samples collected originated from different years and seasons, providing a broad temporal overview. Due to the long-term fish monitoring program of the Balaton Limnological Research Institute, the fish fauna of the area is well-documented. However, further insights into the dietary preferences of local piscivorous animals, including otters, can be gained through the identification of fish scale remains in their spraints. In contrast to areas with large fish resources, the otter's diet in this canal includes a large proportion of small mammals, frogs, and water beetles. Preliminary results indicate that scales of the European mudminnow (*Umbra krameri*) were the most frequently occurring from fishes in the samples. The invasive and highly competitive Chinese sleeper (*Perccottus glenii*) was also present in the diet, albeit in lower quantities.

Umbra krameri (WALBAUM 1792) – eine Darstellung des Erkenntnisstandes in den 1960ziger Jahren

Klaus Grahl

Gutachterbüro Dr. Grahl – Fisch- und aquatische Toxikologie, Friedensweg 17, D-09387 Jahnsdorf, Deutschland

Der Erkenntnisstand zum Europäischen Hundsfisch *Umbra krameri* WALBAUM 1792 ist in den 1960iger Jahren vergleichsweise bereits weit fortgeschritten. Das Ergebnis einer Literaturrecherche, einschließlich eigener Erfahrungen mit Verweis auf Hundsfische als Geschenk von Herrn Dr. Balon (Fischerei - Institut Bratislava) sind in der Zeitschrift Aquarien Terrarien, Jahrgang 15, (8) 268-269, (9) 302-303 und (10) 334-337 veröffentlicht. Die betreffende Publikation kann als PDF-Datei per E-Mail unter Grahl.GSB.Jahnsdorf@t-online kostenlos angefordert werden.

Looking beyond the water's edge; ex-situ activities for the European mudminnow, *Umbra krameri*

Weissenbacher, Anton

Schönbrunner Tiergarten GmbH (Vienna Zoo), Maxingstraße 13b 1130 Vienna

For many years, Schönbrunn Zoo in Vienna has been maintaining ex-situ-populations of highly endangered freshwater fish species. Most of these species are microendemic, inhabiting extremely small areas. These species often consist of a single population whose individuals are usually in permanent contact with each other. In the case of species with large ranges, such as *Umbra krameri*, these ranges have often been arbitrarily divided into small sections due to anthropogenic degradation of water systems. Since it is often no longer possible to restore the original condition, these sub-areas of an original large habitat are being stabilized at great expense as part of renaturation measures. A good example of this is the Fadenbach in the Donau-Auen National Park. Over 150 years ago, in the course of the major regulation of the Danube, many permanent and temporary water areas, such as the Fadenbach, were permanently separated from the main stream. Today, the Fadenbach represents one of only two habitats of *Umbra krameri* in Austria. In this habitat, which is severely threatened by succession, structural measures have been and continue to be carried out on a regular basis in order to preserve this isolated section of water as a habitat for Umbra krameri in the long term. In 2013, 50 *Umbra krameri* were removed from the Fadenbach and transferred to Schönbrunn Zoo for an ex-situ breeding program. Current genetic studies of the Fadenbach population of *Umbra krameri* indicate that the wild population does not have a good long-term prognosis. It is also striking that the Fadenbach population and the ex-situ population originating from this watercourse differ significantly in terms of population genetics. This is surprising and concerning after such a short time. In order to sustainably manage populations with formerly large ranges, it is not enough to protect only the individual, isolated populations. Studies in which isolated populations from the same range are planned would be a good basis for the sustainable protection of *Umbra krameri.*

The Alien Invasive Fish Species of Muddy Waters in the Odra River Basin: Current Situation and Future Trends

Stoszková Valérie[1]; Choleva, Lukáš[1,2]

1) Department of Biology and Ecology, Faculty of Science, University of Ostrava, Chittussiho 10, 710 00, Ostrava, Czech Republic

2) Laboratory of Fish Genetics, Institute of Animal Physiology and Genetics, Czech Academy of Sciences, Rumburská 89, Liběchov 277 21, Czech Republic

Non-native invasive fish species pose a significant and growing threat to the biodiversity and ecological stability of the Odra River basin. This abstract examines the current status and future trends of key alien species within the Odra, including the Prussian carp (*Carassius gibelio*), pumpkinseed sunfish (*Lepomis gibbosus*), topmouth gudgeon (*Pseudorasbora parva*), and brown bullhead (*Ameiurus nebulosus*). Their introduction and spread are primarily driven by human activities, such as intentional stocking for aquaculture and recreational fishing, as well as unintentional transfers. The establishment and success of these species are facilitated by their functional and ecological traits, including resilience to pollution and low oxygen levels, strong parental care, and a highly plastic diet. These invasive species are causing significant ecological changes. The topmouth gudgeon has been found in "enormous amounts" in fishponds and severely suppresses zooplankton populations, which in turn leads to a substantial decrease in native fish production. Similarly, the Prussian carp has rapidly enlarged its range and can negatively influence indigenous species, such as the native crucian carp (*Carassius carassius*), by directly competing for food and space. Other species, like the brown bullhead and pumpkinseed, also outcompete native species and prey on their eggs and young. Future trends suggest that ongoing human disturbance of natural landscapes and economic activities will continue to facilitate the dispersal and establishment of these species. To combat this, a multi-faceted approach is necessary. Proposed protective measures include the restoration of natural water retention areas and the removal of obstacles to enhance fish migration, which can help increase the resilience of the river ecosystem. Ultimately, the long-term ecological impacts of these invasions necessitate urgent and sustained conservation efforts to protect the native biodiversity of the Odra River basin.

Conservation of the weather loach (*Misgurnus fossilis*) in near-natural habitat pools

Lukas Fuxjäger[1], Hans Rund[1], Josef Wanzenböck[1]

1) Research Department for Limnology Mondsee, University of Innsbruck, Mondseestraße 9, 5310 Mondsee, Austria

The weather loach (*Misgurnus fossilis*) is highly specialized in its habitat choice and adaptation to standing or slow flowing water bodies with soft sediment and macrophytes, sometimes bearing low oxygen levels, but tends to be a weak interspecific competitor. The widespread loss of those special habitats, ongoing climate change and arriving Neozooans are main factors that drive the dramatic decline of *M. fossilis* populations. The arrival of Asian weather loaches *Misgurnus bipartitus* and *M. anguillicaudatus* and moreover *Perccottus glenii* to habitats within Europe as a direct competitor for the same food and habitat sources, tremendously increases the pressure on the last populations. Furthermore, hybridization between Misgurnus species is possible and produced viable offspring. Not only the populations and their habitats themselves are at risk, also the genetic integrity and the whole genetic variability of this species is facing the threat of being obliterated. *M. fossilis* from different populations are used to maintain reproductive stocks for an ex-situ program to conserve *M. fossilis* in Austria. There are two main ways to keep weather loaches in different setups for controlled reproduction and long-term husbandry. One is to keep them in larger fish ponds and on the other hand to keep them in aquaria. Each strategy has its benefits and downsides The larger outdoor version in fish ponds suits the natural habitat use of *M. fossilis* and reduces density problems like disease spread, follows a natural rhythm and requires lower maintenance efforts. Nevertheless, it comes with some downsides. The waterbody area and water quantities needed quickly limits the local possibility to keep several different populations aside, and is quite costly. The lack of control and the broad range of habitat factors (different primary- and secondary production, uncontrolled predation and competitors, water chemistry and other abiotic factors…) is challenging. Husbandry in aquariums is easier to control but has some severe downsides like the high costs for larger aquariums, the technical infrastructure and their permanent costs and need for maintenance, as well as energy costs and low secondary production, as well as density problems and fast disease spread, especially in connected systems. We came up with an alternative solution, to combine the two systems. We installed four large, round semi natural habitat pools, with about 15m³ (400cm x 120cm, round shaped) of water volume each, and several movable planters to provide adequate habitat conditions. The substrate consists of a 5-10cm thick layer of leaf litter and several oak branches. Each habitat pool was seeded with daphnia, isopods and other invertebrates to start a natural food chain. These setups show high zooplankton production, guarantee easy access to the fish, widely controllable conditions, and low maintenance requirements. The semi natural conditions in those habitat pools benefit an overall good health status, growth and body condition of the brood stock for the upcoming reproductive seasons.

Limnophilic Fish Species in Slovakia: the Red List Status and Threats

Fedorčák, Jakub[1]; Križek, Peter[2], Koščo, Ján[1]

1) Department of Ecology, Faculty of Humanities and Natural Sciences, University of Presov, Ul. 17. Novembra 1, 080 16 Prešov, Slovakia,

2) Department of Ichthyology and Ecology of Fishing Grounds, Slovak Angling Association–The Board, Andreja Kmeťa 20, 010 55 Žilina, Slovakia,

Between 2021 and 2023, the conservation status of all native fish and lamprey species in Slovakia was revised for the forthcoming edition of the National Red List (currently in press). In this paper, we focus on the status of limnophilic fish species, including *Carassius carassius*, *Leucaspius delineatus*, *Misgurnus fossilis*, *Umbra krameri* and *Tinca tinca*. The aforementioned species, were once widespread but has experienced significant decrease. The assessment is primarily based on data from permanently monitored sites maintained by the State Nature Conservancy of the Slovak Republic, as well as additional data provided by the Slovak Water Research Institute (WRI). Based on data and the documented alterations that have transpired over the past two decades, *C. carassius* (criteria A2-a,b,c,e; B1-a,b(iv)) and *U. krameri* (A4-a,c,e; B1-b(ii,iv)) have been designated as Critically Endangered. The following species - *L. delineatus* (A2-a,b,c,e; B1-b(iii,iv)); *M. fossilis* (A2-a,b,c; B1-a,b(iii,iv)) were assessed as Endangered. The species *M. fossilis* and *C. carassius* have moved up two threat categories compared to the previous Red List (2008). Species *U. krameri* has moved up one category, from Endangered (EN) to Critically Endangered (CR). The threat categories of *L. delineatus* and *T. tinca* have remained unchanged. The species *T. tinca* was categorized as Near Threatened, primarily due to its restricted current distribution in areas surrounding water reservoirs and ponds (breeding and stocking impact). The status of natural populations of *T. tinca* is not actively monitored in Slovakia. Habitat loss, reduced flooding, and the intensive breeding and stocking of commercial fish species remain common threats to all studied species. These pressures are currently being intensified by climate change and increasing demands on water resources. Specific and localized threats to limnophilic fish species include hybridization and backcrossing, the impact of invasive alien fish species, transfer of bait fish, removal of aquatic vegetation and sediments, the release of exotic aquarium species, or/and insufficient monitoring.

Establishment of regional action plan for conservation of critically endangered crucian carp in Czechia

Zuzana Šmejkalová[1], Kiran Thomas[1,2], Lukáš Kalous[3], Lukáš Choleva[4,5], Marek Šmejkal[1,2]

1) Institute of Hydrobiology, Biology Centre of the Czech Academy of Sciences, České Budějovice, Czech Republic 2) Faculty of Science, University of South Bohemia, České Budějovice, Czech Republic 3) Faculty of Agrobiology, Food and Natural Resources, Czech University of Life Sciences Prague, Prague, Czech Republic 4) Laboratory of Fish Genetics, Institute of Animal Physiology and Genetics, Czech Academy of Sciences, Liběchov, 277 21, Czech Republic 5) Department of Biology and Ecology, Faculty of Science, University of Ostrava, Chittussiho 10, 110 00 Ostrava, Czech Republic

The crucian carp (*Carassius carassius*) occurs in two highly divergent phylogenetic lineages in Europe, 1) the northern lineage, which is widespread across northern and central-eastern Europe and occurs in the Labe (Elbe) and Odra (Oder) river basins and 2) Danubian lineage, which is restricted to the Danube basin. The crucian carp is naturally present in both phylogenetic lineages in Czechia. However, due to intensive aquaculture and transfer by recreational anglers, the phylogenetic lineages have become mixed at some places or shifted into other watersheds. Therefore, the conservation of crucian carp should consider these lineages as separate conservation units. In response, the regional action plan (RAP) was created to preserve pure phylogenetic lineages of the crucian carp in the Vysočina region, where both lineages meet. A citizen science approach ("Save the crucian carp" project) was used to find the remaining populations of the crucian carp in this region. Individual populations identified through citizen tips were selected for systematic site monitoring, and samples were collected for further analyses. The lineage (northern or Danubian) of these populations was evaluated using genetic analyses and suitable populations for conservation were selected. As part of the RAP, we initiated the repatriation of genetically verified crucian carp populations. We distinguished the two lineages genetically and repatriated the populations to locations within their corresponding watershed. In total, five and seven northern and Danube populations were identified, respectively and three and five northern and Danube populations were repatriated, respectively, using source fish coming from identified populations. This study provides a comprehensive conservation approach for a declining wetland fish species. Although regionally restricted to the Bohemian-Moravian Highlands, the approach can be applied to other declining wetland species with similar ecology and genetic diversity. The findings emphasize the need for a complex, multi-approach assessment of species threats and highlights the importance of managing conservation actions based on scientific evidence.

Past and Present distribution of *Carassius carassius* in Croatia

David Dianežević[1], Zoran Marčić[1], Perica Mustafić[1], Marko Ćaleta[2], Sven Horvatić[1], Roman Karlović[1], Goran Tvrdinić[1], Ivana Buj[1], Davor Zanella[1]

1) University of Zagreb, Faculty of Science, Department of Biology, Rooseveltov trg 6, 10000 Zagreb, Croatia
2) University of Zagreb, Faculty of Teach Education, Savska 77, 10000 Zagreb, Croatia

The crucian carp (*Carassius carassius*) is the only native representative of its genus inhabiting Croatian freshwater ecosystems. This limnophilic species has become extremely rare and endangered across its entire range in recent decades. In response to reported declines of crucian carp populations across Europe, a comprehensive analysis of available data was carried out for its native and introduced range in Croatia, aiming to assess the species' spatial distribution and population trends. Relevant literature, museum collections, online databases (iNaturalist, GBIF), and unpublished records from researchers were reviewed. Our results indicate a severe decline in crucian carp populations in Croatia, with an estimated reduction of nearly 80% in its distribution. Competition with Prussian carp appears to be the main driver of disappearance from many sites in the Pannonian ecoregion, whereas relatively stable populations were recorded in ponds and other watercourses of the Dinaric ecoregion, where the species was introduced. Such sites represent important refugia for potential conservation and repopulation efforts within the species' natural range. Furthermore, this study emphasizes the need to assess the genetic status of Croatian crucian carp populations to determine their true condition and to design effective long-term conservation strategies at both national and regional scales.

Cryptic Diversity and Taxonomic Ambiguities in *Carassius carassius* from Czech Wetlands: Implications for Conservation

Kumkar, Pradeep[1]; Verma, Chandani[1]; Thomas, Kiran[2,3]; Šmejkal, Marek[2,3]; Lamatsch, Dunja K. [4]; Kalous, Lukáš[1]

1) Department of Zoology and Fisheries, Faculty of Agrobiology, Food and Natural Resources, Czech University of Life Sciences Prague, Prague, Czechia

2) Institute of Hydrobiology, Biology Centre of the Czech Academy of Sciences, České Budějovice, Czechia

3) Faculty of Science, University of South Bohemia, České Budějovice, Czechia

4) Research Department of Limnology, Mondsee, University of Innsbruck, Austria

The crucian carp (*Carassius carassius*) is a native freshwater fish and an important indicator of wetland ecosystem health across Central Europe. However, its populations are increasingly threatened by habitat degradation and hybridization with non-native congeners. In this study, we present a mitochondrial cytochrome b (cytb) dataset from *C. carassius* populations sampled across various tributaries of the Danube and Elbe River basins in Czechia to evaluate genetic diversity and taxonomic clarity within the Carassius genus complex. Our preliminary results reveal multiple distinct mitochondrial haplotypes within nominal *C. carassius*, highlighting the presence of cryptic genetic diversity. These findings underscore the urgent need for integrative taxonomic approaches to support accurate species identification and conservation management. We advocate for the use of molecular tools in conservation monitoring programs to safeguard the genetic integrity of native *C. carassius* populations in vulnerable wetland habitats.

Genetic assessment of crucian carp (*Carassius carassius*) populations in Hungary as part of a conservation initiative aimed at creating a live gene bank

István Lehoczky[5], Fatema Ali Al Fatle [2],, Quynh Nguyen Thi[3], Erika Edviné Meleg[5], Zoltán Sallai[4], Gergely Szabó[5], Eszter Várkonyi[5], Dániel Péter[1], Gábor Beliczky[1], Balázs Kovács[1], Béla Urbányi[6] ,Tamás Molnár[1,5]

1) Institute of Aquaculture and Environmental Safety, Hungarian University of Agriculture and Life Sciences, Gödöllő - Keszthely 2100, Hungary. 2) Department of Biology, College of Science, University of Baghdad, Baghdad, Iraq. 3) Jabiru Vietnam Company Limited, Van Giang, Hung Yen, Vietnam. 4) Vaskos Csabak Ltd., Szarvas 5540, Hungary. 5) Institute for Farm Animal Gene Conservation, National Centre for Biodiversity and Gene Conservation, Gödöllő 2100, Hungary. 6) University of Győr, Albert Kázmér Faculty of Mosonmagyaróvár, H-9200 Mosonmagyaróvár, Hungary,

The crucian carp, *Carassius carassius* Linnaeus 1758, is a native cyprinid species in Europe that is experiencing a concerning decline in its population numbers. This species predominantly resides in small aquatic habitats and faces significant threats, primarily as a result of climate change, human-induced impacts, and competition from invasive relatives, particularly the Prussian carp. Despite ongoing conservation initiatives being implemented throughout Europe, comprehensive data regarding populations within the Carpathian Basin remain limited. In the present study, we undertook an analysis of nine distinct natural populations comprising a total of 257 individuals located in Hungary. This endeavor utilized thirteen microsatellite markers along with mitochondrial DNA Cytochrome Oxidase I (COI) sequencing, which involved 187 individuals from these populations. The results of the mitochondrial DNA sequencing indicated the likely introduction of a Baltic stock in addition to the indigenous Danube lineage, as well as the identification of hybrids between the crucian carp and Prussian carp in certain populations. The analysis employing microsatellite markers further verified the presence of these hybrids; however, it also revealed that some populations in the southern region of Hungary were free from any hybridization. The assessment of genetic diversity demonstrated moderate levels, with observed heterozygosity (Ho) values ranging from 0.49 to 0.61 and allelic richness (Ar) ranging from 6.01 to 7.98. According to the genetic structure analysis, two or three principal units exhibiting low to moderate differentiation were recognized, with FST values ranging from 0.054 to 0.192. Moreover, based on assessments of gene flow, it was found that the Danube-Drava region displayed clear separation from populations located in the northern areas and those situated on the eastern side of the Danube River. Conclusively, findings revealed that eight of the nine populations studied, notably those in the southern Danube region, possess substantial potential for forming the foundation of a genetically managed gene bank dedicated to preserving the remaining stocks of crucian carp that are devoid of hybrid genetic influence. This insight provides a vital opportunity for efforts aimed at conserving the genetic integrity and sustainability of this declining native species.

The Distribution of the Belica *Leucaspius delineatus* and the Crucian Carp *Carassius carassius* in Hungary over the Past Fifty Years and the Threats to the Persistence of Their Populations

Zoltán Sallai[1], Ákos Harka[2] & István Lehoczky[3]

1) VASKOS CSABAK Bt., Békésszentandrás, Hungary 2) Magyar Haltani Társaság, Tiszafüred, Hungary 3) National Centre for Biodiversity and Gene Conservation, Institute for Farm Animal Conservation, Gödöllő, Hungary

In the Carpathian Basin, large-scale water regulation projects in the 18th century – primarily the drainage of extensive marshlands – led to a substantial reduction of wetland habitats, which in turn caused significant declines in the populations of marsh-dwelling fish species. The Belica *Leucaspius delineatus* (HECKEL, 1843) is also among these rare marsh fauna elements, for which distribution data are still scarce. In Hungary, the Belica is currently classified as "protected". Its most typical habitats are marshes and wetland areas where it co-occurs with other threatened marsh fish species such as Tench *Tinca tinca* (LINNAEUS, 1758), Crucian Carp *Carassius carassius* (LINNAEUS, 1758), Weatherfish *Misgurnus fossilis* (LINNAEUS, 1758), and Mudminnow *Umbra krameri* WALBAUM, 1792. Additionally, populations have been recorded from mid-mountain streams, where it coexists with species such as Chub *Squalius cephalus* (LINNAEUS, 1758), Danube Gudgeon *Gobio obtusirostris* (VALENCIENNES, 1842), and Stone Loach *Barbatula barbatula* (LINNAEUS, 1758). In several cases, it has also been found in small lowland drainage channels, degraded habitats, and in small pits or oxbows within the floodplains of larger rivers. The Crucian Carp *Carassius carassius* (LINNAEUS, 1758), according to Bănărescu (1994), became the second most endangered fish species in Romania by the 1990s, after the *Romanichthys valsanicola*. Unfortunately, the situation in Hungary is similar. The invasive Prussian Carp *Carassius gibelio* (BLOCH, 1782) is now considered the most common fish species in Hungary, and has spread even into isolated marsh habitats where the Crucian Carp is gradually being displaced. The Crucian Carp has disappeared from many sites, especially oxbows, due to fishing exploitation and illegal introductions of the Prussian Carp. Unfortunately, the Crucian Carp does not currently enjoy legal nature conservation protection in Hungary, although its capture is prohibited year-round. Field surveys were conducted primarily using low-voltage battery-powered electrofishing gear. Data collection was often carried out under challenging field conditions, caused partly by dense submerged and emergent aquatic vegetation, and partly by deep soft sediments. At most survey sites, photographic documentation of the habitat was taken, the most common water quality parameters were measured (pH, dissolved oxygen content, conductivity, water temperature), and the number of individuals of captured species was recorded using a digital voice recorder. In this presentation, we aim to provide an overview of the distribution of these two endangered marsh fish species in Hungary over the past 50 years and to identify the main threats to the persistence of their populations.