5th Central European Symposium for Aquatic Macroinvertebrate Research

Abstracts

Druskininkai, LITHUANIA

28 June – 3 July 2026

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18:00–19:00	Welcome Reception					
19:00–.....		BBQ Evening			Conference Dinner	

Word from organizers

After finally admiring the breathtaking mountainous landscapes in Stará Lesná, SLOVAKIA during the 4th CESAMIR in 2024, we are eager to welcome participants to the 5th CESAMIR, a little off the usual range and a smidge more toward the North. Between 28 June and 3 July 2026, CESAMIR will be hosted in the Baltic lands, and the organizers cordially invite all participants to the charming spa town of Druskininkai, LITHUANIA!

We warmly welcome all researchers working on freshwater macroinvertebrates across Europe. CESAMIR unites experts in taxonomy, ecology, biomonitoring, functional ecology, invasion biology, conservation, and freshwater management, offering a forum for exchanging ideas and experiences. Join us to connect with colleagues, build new collaborations, and strengthen the network of aquatic macroinvertebrate researchers in Europe.

Denis Copilaş-Ciocianu and Eglė Šidagytė-Copilas
5th CESAMIR Committee Chairs

Main organizer:

State Scientific Research Institute Nature Research Centre (https://gamtostyrimai.lt/en/)

Co-organizers:

Lithuanian Entomological Society (https://entomologai.lt/lt/)

Lithuanian Hydrobiological Society (http://hidrobiologai.lt/)

Sponsors:

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Vilnius University Life Sciences Center – *A Key Player in the Field of Life Sciences*
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Conference committees

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Carola Winkelmann (Universität Koblenz-Landau, GERMANY)

Full conference schedule

	SUNDAY June 28
15:00–17:00	**Registration**
18:00–21:00	**Welcome Reception**

	MONDAY June 29
08:00–8:40	**Registration**
08:40–9:00	**Opening**
09:00–10:00	**Plenary lecture I** **Steffen Pauls – *Biogeography and diversification of European caddisflies and montane aquatic Insects***
10:00–10:30	COFFEE BREAK
Session 1–1	**Biogeography & Phylogeny**
10:30–10:45	**Denis Copilaș-Ciocianu** – The challenge of hyperdiverse cryptic dark taxa in biodiversity hotspots: DNA barcoding as a foundational tool for understanding diversity patterns and conservation priorities
10:45–11:00	**Michał Grabowski** – DNA barcoding of macroinvertebrates in springs of the Northern Carpathians: Wrap-up of the BioSpring/SpringBio projects
11:00–11:15	**Zsolt Kovács** – Unrecognized diversity in the *Hydroporus planus* group (Coleoptera: Dytiscidae): The *H. fuscipennis* and *H. discretus* lineages
11:15–11:30	**Karolina Biniek** – Three stages of fauna radiation: Patterns of freshwater crustacean diversification in the Periadriatic region
11:30–11:45	**Wiktoria Cechowicz** – Ephemeral beings, eternal patterns: First insight into molecular diversity of Ecdyonurinae and Rhithrogeninae mayflies from the Balkan biodiversity hotspot
11:45–12:00	**Szymon Kaczmarek** – Fossil Psychodomorpha (Diptera: Nematocera) in perspective of current systematics and phylogeny
12:00–13:30	LUNCH
Session 1–2	**Biodiversity & Conservation**
13:30–13:45	**Yaron Hershkovitz** – Hidden diversity: Using macroinvertebrates to identify East-Mediterranean freshwater key biodiversity areas (KBAs)
13:45–14:00	**Michal Rendoš** – From hidden diversity to ecological patterns: Integrative insights into epikarst copepods
14:00–14:15	**Matthieu Lucchini** – Beyond composition: The role of spatial configuration in identifying refuges for macroinvertebrates in aquatic landscapes

14:15–14:30	**Cristian Andrei Murgu** – Riparian forested buffers are beneficial for carabid diversity in agriculturally modified catchments
14:30–14:45	**Arnold Móra** – Distribution and phenology of the endemic caddisfly *Chaetopteryx mecsekensis* in the Mecsek Mountains
14:45–15:00	**Austėja Černiauskaitė** – Insect diversity and ecological structure in partially submerged dead wood in Lithuanian freshwater ecosystems
15:00–15:30	COFFEE BREAK
Session 1–3	**Climate Change & Thermal Effects**
15:30–15:45	**Petr Pařil** – Does reduced temperature heterogeneity of stream microhabitats favour climate change "winners"?
15:45–16:00	**Tymoteusz Matera** – The impact of temperature changes on the morphology of Chironomidae
16:00–16:15	**Tadeusz Zając** – Global warming impacts on freshwater mussels
16:15–16:30	**Kamil Hupało** – Feeling the heat: A first insight into genetic diversity and thermal adaptation of *Gammarus fossarum* in the hot springs of Kaiserstuhl, Germany
16:30–16:45	**Zoltán Csabai** – Islands under pressure: Integrative insights into the aquatic macroinvertebrate fauna of the Ionian Archipelago
16:45–17:00	**Bálint Pernecker** – Destroying the myth: Could the Balkan Goldenring (*Cordulegaster heros*, Odonata) be a potential winner of climate change?
19:00–…	BBQ Evening (Restaurant *Armank* and Druskininkai Campsite)

	TUESDAY June 30
09:00–10:00	**Plenary lecture II** **Jonas Jourdan – *Stress along a river gradient: How species ecology and interactions shape persistence in human-dominated landscapes***
10:00–10:30	COFFEE BREAK
Session 2-1	**Pollution & Anthropogenic Stressors**
10:30–10:45	**Bella Japoshvili** – Evaluating water quality of the Zhinvali Reservoir, Georgia (South Caucasus): Insights from macroinvertebrate communities
10:45–11:00	**Ivna Azinović** – Kayaking: Think twice… What would tufa say?
11:00–11:15	**Selma de Donnová** – Microplastics in running waters: Assessment of surface water and macroinvertebrates along longitudinal river gradients
11:15–11:30	**Adéla Černá** – Downstream distribution of microplastics along the river continuum with a focus on potential pollution sources: A study on *Gammarus* spp.
11:30–11:45	**Csaba Békési** – Effects of diffuse pollution on aquatic macroinvertebrate communities in oxbow lakes
11:45–12:00	**Ioana Enache** – Taxonomic and trait-based shifts in macroinvertebrate communities upstream and downstream of small hydropower plant intake points
12:00–13:30	LUNCH

Session 2-2	Restoration, Management & Applied Ecology
13:30–13:45	**Violeta Berlajolli** – Pristine mountainous vs. rural upland landscapes: Springs as habitats for mime midge communities
13:45–14:00	**Emese Gyökeres** – The role of species replacement in the reassembly of aquatic macroinvertebrate communities after dredging
14:00–14:15	**Carola Winkelmann** – Stream restoration effects on benthic invertebrates: Habitat quality over habitat diversity?
14:15–14:30	**Jan Sychra** – Does the creation of new artificial ponds help support aquatic invertebrates in lowland agricultural landscapes?
14:30–14:45	**Bart Achterkamp** – Macroinvertebrates in Dutch softwater lakes impacted by birds
14:45–15:00	**Jan Marcin Węsławski** – The decline of sandhoppers (*Talitrus saltator*) on sandy beaches in Poland – 60 years of observations
15:00–15:30	COFFEE BREAK
15:30–19:00	**Poster Session**

	WEDNESDAY July 1 – Conference Trip to Trakai
07:40–08:00	Meeting point in from of *SPA VILNIUS Druskininkai*
08:00–10:00	Bus trip to Trakai
10:00–12:00	Trip option: Castle Museum, Boat Cruise, or Nature Trail
12:00–14:00	Lunch (Restaurant *Senoji kibininė*)
14:00–17:00	Free time for independent exploration
17:00–19:00	Return trip to Druskininkai

	THURSDAY July 2
	Plenary lecture III
09:00–10:00	**Maja Zagmajster – *Groundwater biodiversity in Europe: Exploring patterns and processes***
10:00–10:30	COFFEE BREAK
Session 3–1	**Monitoring & Assessment Tools**
10:30–10:45	**Vid Švara** – Fostering cross-border river monitoring of macroinvertebrates using (e)DNA metabarcoding in the Drava/Drau River
10:45–11:00	**Andrea Desiderato** – Breaking the extraction bottleneck: Direct PCR and rapid isolations democratize real-time freshwater biomonitoring
11:00–11:15	**Saskia Schmidt** – Macroinvertebrate monitoring of large streams: The potential of DNA metabarcoding for ecological assessments

11:15–11:30	**Diana Osadčaja** – Does the Lithuanian river macroinvertebrate index fit EU requirements?
11:30–11:45	**Michal Straka** – Adapting the WFD ecological status assessment for intermittent streams: A Czech approach
11:45–12:00	**Anna Biró** – Effort vs. results: The efficiency of a minimum standards on aquatic subterranean habitat monitoring
12:00–13:30	LUNCH
Session 3–2	Special session: **Ecological Responses to Habitat Drying**
13:30–13:45	**Júlia Szeles** – Dry Hard: Macroinvertebrate community thresholds along drying gradients
13:45–14:00	**Barbora Loskotová** – Do small reservoirs benefit intermittent streams? Effect on aquatic macroinvertebrates, water quality and dry phase duration
14:00–14:15	**Tamás Bozóki** – More is not always better: Selective trait filtering governs assembly under emerging flow intermittency
14:15–14:30	**Gábor Várbíró** – Flow intermittency amplifies temporal instability in macroinvertebrate communities: Insights from directional β-diversity
14:30–14:45	**Gábor Várbíró** – Longer, larger, and less predictable: Tracking the effects of stream drying on aquatic macroinvertebrate communities using community trajectory analysis
14:45–15:00	**Basile Marteau** – Seasonal dynamics of aquatic macroinvertebrate communities in boreal temporary wetlands and their importance for breeding waterfowl
15:00–15:30	COFFEE BREAK
Session 3–3	**Functional & Community Ecology**
15:30–15:45	**Alejandra Correa-Bedoya** – Modelling habitat suitability of freshwater insects in the Magdalena–Cauca river basin (Colombia) using high-resolution hydrographic data
15:45–16:00	**Kamil Słomczyński** – Urban water reservoirs as breeding sites for mosquitoes: Larval phenology and habitat diversity in urban conditions – a case study from Łódź (Poland)
16:00–16:15	**Péter Borza** – Mechanisms of niche differentiation among invasive Ponto-Caspian corophiids (Crustacea, Amphipoda)
16:15–16:30	**Mariia Shrestkha** – An updated perspective on species diversity and host interactions in European branchiobdellidans (Annelida: Clitellata)
16:30–16:45	**Mindaugas Žilius** – Partitioning of benthic nitrogen cycling among macrofauna holobionts in estuarine systems
16:45–17:00	**Daniele Ricaldone** – Drivers of macroinvertebrate diversity in Alpine streams: A multiscale spatial analysis
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FRIDAY July 3

	Plenary lecture IV
09:00–10:00	**Jarosław Kobak – *When worse becomes the enemy of bad: On mechanisms and consequences of the ongoing species exchange in the invasive fouling dreissenid assemblage***
10:00–10:30	COFFEE BREAK
Session 4–1	**Long-Term Trends & Ecosystem Processes**
10:30–10:45	**Krzysztof Podwysocki** – Spatial and temporal changes in freshwater macroinvertebrate diversity across Poland
10:45–11:00	**Martin Drenovácz** – Unlocking two centuries of data: Temporal trends and historical insights into the aquatic beetle fauna of Hungary
11:00–11:15	**Armin Lorenz** – 12 sites 14 years – Long-term development of benthic invertebrate communities in an urban stream system after restoration
11:15–11:30	**Nathan Jay Baker** – Thirty-seven years of freshwater monitoring reveal undersampled dipteran diversity compared with well-resolved EPT groups
11:30–11:45	**Francesca Vallefuoco** – Seasonal melt dynamics drive long-term macroinvertebrate biodiversity in a glacier-fed Alpine stream
11:45–12:15	AWARDS & CLOSING CEREMONY
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33. **Višinskienė G, Arbačiauskas K, Ozoliņš D, Jēkabsone J, Piterāns U, Dzierkale MT.** *Atrichops crassipes* (Diptera: Athericidae) in the Baltic ecoregion: First records from Latvia and northward range expansion; **P11**
34. **Výravský D, Straka M, Polášek M, Němejcová D.** Using benthic macroinvertebrates to assess ecological status of intermittent streams; **P14**
35. **Wardziak N, Sulikowska-Drozd A.** Changes in the malacofauna of the Grabia River over the last 60 years; **P22**
36. **Wasiak A, Płóciennik M, Krzyszkowski D, Malkiewicz M, Niska M, Wieczorek D, Sławska A, Wachecka-Kotkowska L.** Chironomids of Pleistocene glacial-interglacial paleolakes (Szczerców mine, central Poland); **P12**
37. **Xerxa B, Gashi A.** Conservation status and spatial priorities of mayflies (Ephemeroptera) in Kosovo's freshwater ecosystems; **P4**
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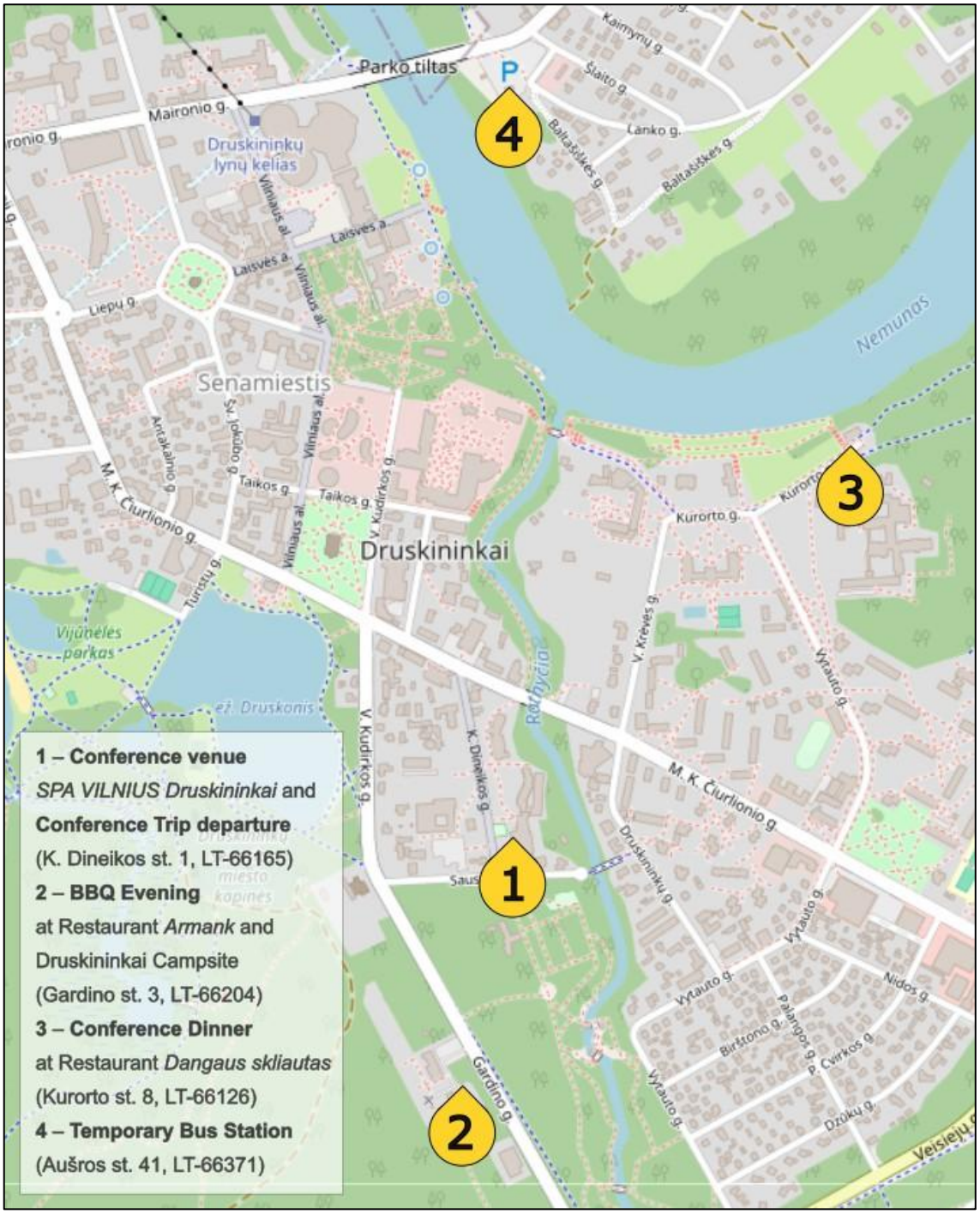
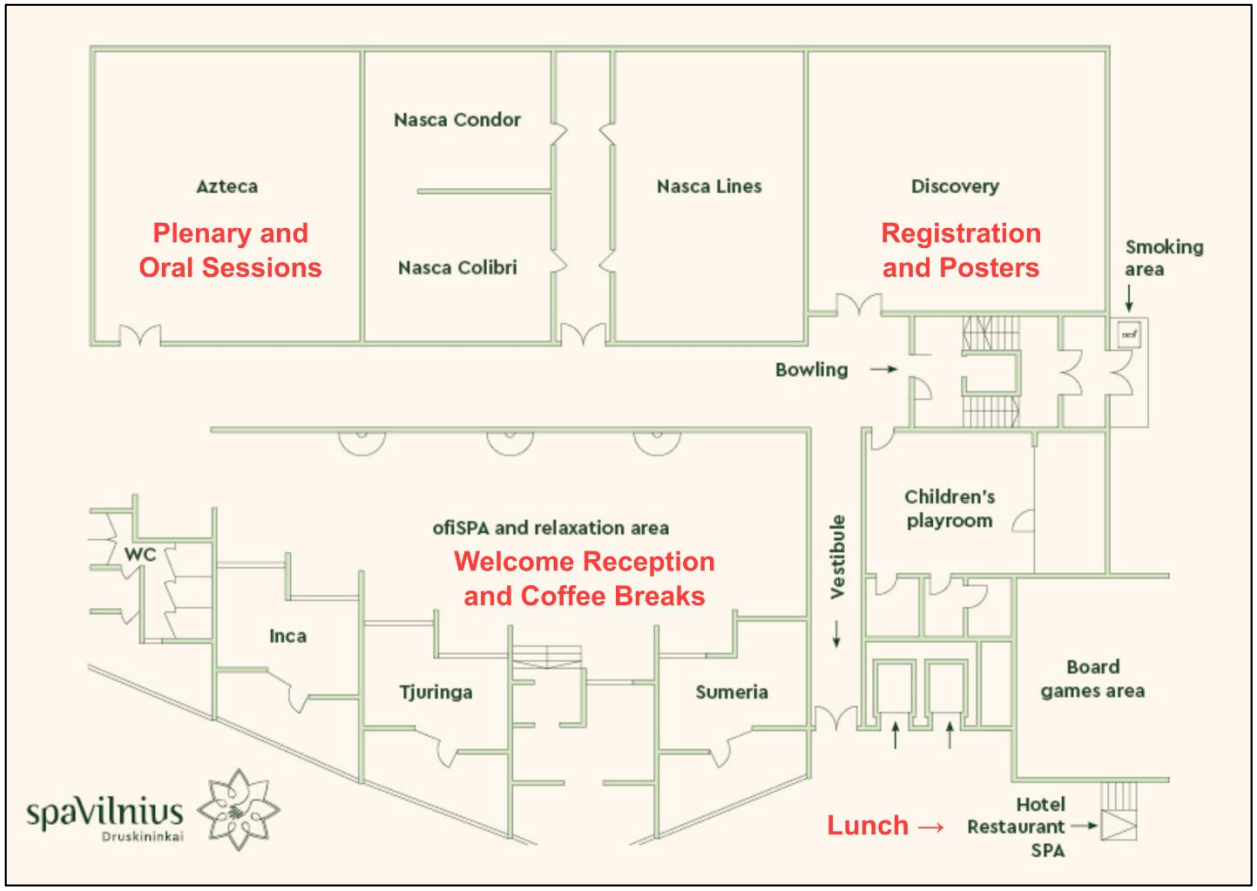
General information

Location

Welcome to Druskininkai. It is one of Lithuania's oldest and most renowned spa towns, located in the country's scenic south, on the shores of the Nemunas River. Known for its mineral water springs, health resorts, and pine forests, the town combines natural beauty with a peaceful atmosphere ideal for scientific meetings.



Conference venue. The symposium will be held at the *SPA VILNIUS Druskininkai* wellness retreat, a modern and environmentally responsible 4-star hotel and spa complex located near the city centre, surrounded by greenery and within walking distance of major local attractions. It also offers many fully equipped conference facilities including the *Azteca* and *Discovery* conference halls that we will use. The complex features the Restaurant *LABAI*, which takes pride in its seasonal cuisine, largely based on local produce, as well as bars, cafés, a bowling hall, and a mineral water spring.



Registration. Registration will begin on Sunday, June 28, from 15:00. Participants need to register at the registration desk in the *Discovery* hall where they will receive the official conference package, a certificate of attendance, an invoice, and a name badge. All attendees should always wear their conference name badge visibly to enter the sessions, meals, and social events.

Meals. The BASIC and FULL conference packages cover lunch in the hotel restaurant and coffee breaks in the relaxation area on the four symposium days, as well as Welcome Reception (Sunday) in the relaxation area, and the BBQ Evening (Monday). The FULL package additionally includes lunch during the Conference Trip (Wednesday) and the Conference Dinner (Thursday). The 1-DAY package fee covers lunch and coffee breaks on the day of attendance. The ACCOMPANYING GUEST package includes meals during all four social events: the Welcome Reception, BBQ Evening, Conference Trip, and the Conference Dinner.

Social events

The conference will have four social events.

Welcome Reception

All participants are kindly invited to have a welcome snack **from 18:00 on Sunday, June 28**, in the relaxation area of the conference venue *SPA VILNIUS Druskininkai*.

BBQ Evening

All participants are invited to attend the informal barbeque evening starting **from 19:00 on Monday, June 29**. It takes about 10 minutes to walk from the conference venue to Restaurant *Armank* and the Druskininkai Campsite where the event will take place.

Conference Trip

Participants with the FULL and ACCOMPANYING GUEST packages will attend the mid-conference trip to the historical town of Trakai. We will **meet at 07:40 on Wednesday, July 1**, in front of the conference venue *SPA VILNIUS Druskininkai* where we will take the bus for a two-hour trip. Once in Trakai, we will then split into groups based on your choice during online pre-registration and meet again to enjoy a lunch of local specialities together at Restaurant *Senoji kibininė*. After lunch and until the evening **departure back to Druskininkai at 17:00**, you will have the opportunity to explore the town's natural, historical, and cultural riches on your own, or just sit down at one of the many restaurants to discuss your collaborations and relax.

Located just 28 km west of the capital Vilnius, Trakai is one of Lithuania's most charming and historically rich settlements. Its roots trace back to the 14th century, and the city received town rights in 1409. Once the medieval capital of the Grand Duchy of Lithuania, Trakai played a pivotal role in the country's history. Known for its castles (the stunning Trakai Island Castle and the Trakai Peninsula Castle), as well as its natural features (forests, hills, and over 30 interconnected lakes), the town sits at the heart of Trakai Historical National Park and has long been home to a vibrant mix of communities. It is known as the historical home of the Karaim community (people of Crimean origin brought here in the 14th century), with distinctive architecture and culinary traditions still alive today. Visitors love strolling through the quaint old town, enjoying lakeside views, and sampling local delights, especially kibinas, a savoury pastry filled with chopped mutton, a traditional Karaim speciality.

Trip options in Trakai:

Option 1: Trakai Island Castle Museum. Take a history lesson about Lithuania, Trakai town, its castles and the surrounding lands, and examine the museum and collections of furniture, smoking pipes, stamps, clocks, china, glass, hunting trophies, and liturgical art. Trakai Island Castle is one of Lithuania's most iconic landmarks, dating back to the 14th century. Built by Grand Duke Kęstutis and completed by Vytautas the Great, it was both a strategic stronghold of the Grand Duchy of Lithuania and a ducal residence. Plundered and burned during the war with Russia (1655–1661) and

reconstructed after WWII, the castle is now part of the Trakai History Museum, a living monument to the nation's medieval past and cultural heritage.

Option 2: Boat Cruise on Lake Galvė. Take a break from the conference pace and enjoy a peaceful boat cruise on Lake Galvė, an impressive glacial lake with a surface area of 3.3 square kilometres and depths up to 47 meters. It has a complex shoreline and harbours 21 islands, each wrapped in its own legend. The boat ride will feature the natural and historical landmarks surrounding the lake. This experience offers a chance to relax, continue conversations in an informal setting, and admire one of Lithuania's most iconic views – Trakai Island Castle reflected in the water.

Option 3: Varnikai Nature Trail. Take a walk along a beautiful nature trail in Varnikai botanical-zoological reserve right outside of Trakai. The 5-km circular trail is a haven for nature lovers, featuring various forest types and a distinctive raised peat bog with several residual open lakes, crossed by a 1.5-km-long wooden boardwalk. Walking along this trail, visitors can see rare plant species, peat-bog landscapes formed over thousands of years, and many different biotopes in a single hike. The trail is easy to walk, features viewing platforms and informational stands, making it suitable for a relaxed 1–2-hour educational nature-spotting hike.

Conference Dinner

The event for participants with FULL and ACCOMPANYING GUEST packages will take place **from 19:00 on Thursday, July 2**, at the legendary Restaurant *Dangaus skliautas* featuring the panoramic view of the Nemunas River. The restaurant is within a 15-minute walk of the conference venue.

Guidelines for presenters

The official language of the conference is English. There will be two types of presentations: oral and poster presentations.

Oral talks. Oral talks are scheduled for 15-minute slots, including the presentation (10–12 minutes) and discussion (3–5 minutes). The time limit will be enforced by session chairs. Speakers should provide their presentation on a USB/external drive on site as soon as possible, but not later than the morning (morning sessions) or during lunch break (afternoon sessions) of the day of the presentation. Files will be deleted after the conference. Files should be named **Session_Last name (e.g., 1-1_Smith)**. Format should be PowerPoint or PDF. After uploading the presentation, please check it to make sure that it works properly.

Posters. Recommended poster size is **A0 (841 × 1189 mm)**. Each poster will be assigned a unique number and should be mounted (pins will be provided) no later than one hour before the Poster Session on Tuesday afternoon. Posters will be exhibited for the duration of the conference, and at a minimum until the poster session is officially over. Note that there is no possibility to print posters in wide format in Druskininkai.

Student awards

Oral and poster presentations held by undergraduate and PhD students will be judged by the members of the Scientific Committee. The main criteria are preparedness of the presenter, clarity, design, and structure. Based on the proposal of the jury, two awards will be given: **Best student speaker prize** and **Best student poster prize**.

Plenary speakers

Steffen Pauls is a stream ecologist at the Senckenberg Research Institute, whose research focuses on the diversification, evolution and ecology of aquatic insects. He completed his PhD at the University of Duisburg-Essen in 2004. Following 5 years of postdoctoral fellowships in the USA and Germany, he began to establish a working group on aquatic evolutionary ecology at the Senckenberg Biodiversity and Climate Research Centre in 2010. Since 2017, he has been the head of Department at the Senckenberg Research Institute and Natural History Museum Frankfurt and was awarded a joint Professorship for General Entomology at the Justus-Liebig-University in Gießen in 2019. Steffen applies classic stream ecology methods and molecular tools to understand how populations differentiate, how distinct species evolve and how environmental conditions drive these processes. Central themes of this research are exploring the caddisfly diversity in mountain systems and tropical regions and elucidating the genomic basis of caddisflies' ecological success and evolutionary diversification. In his talk he will present examples of systematic and biogeographic research on European caddisflies and aquatic insects.

Jonas Jourdan is a Research Group Leader at Goethe University Frankfurt (https://www.uni-frankfurt.de/aee). He is a freshwater evolutionary ecologist by training, and his research is driven by the urgent need to understand how global change reshapes freshwater ecosystems and threatens global biodiversity. Jonas investigates how species respond to anthropogenic stressors across multiple biological scales—from individual phenotypic plasticity and development to broad-scale community shifts and ecosystem functionality. By identifying why some species thrive while others vanish, his work sheds light on the emergence of novel species interactions in changing environments. Bridging the gap between theory and practice,

he is a member of the RobustNature research network (https://www.robustnature.de/en/) and works with the Competence Center Water Hesse (https://www.kompetenzzentrum-wasser-hessen.de/) to translate ecological insights into effective river conservation and management strategies.

Maja Zagmajster is a research scientist at the University of Ljubljana, Biotechnical Faculty, Department of Biology, where she works in the SubBioLab research group. Her interest in bats during her studies soon led her into caves, where she became fascinated by the remarkable diversity of obligate subterranean species. She completed her PhD on the biodiversity of cave beetles in the Dinaric Karst and further expanded her expertise through research visits to American University and University of Florida. These opportunities were supported by the L'Oréal-UNESCO For Women in Science international fellowship. Her research focuses on understanding the patterns and processes that shape the biodiversity and distribution of subterranean taxa from local to continental scales. She applies GIS tools and spatial statistical modelling to visualise and analyse subterranean biodiversity patterns. Maja founded and manages the Subterranean Biodiversity Database (SubBioDB), which contains spatially explicit records of species distributions, as well as individual-level data such as DNA sequences. It has become the most comprehensive database on subterranean species distribution in the northwestern Balkans and, for certain taxa such as Niphargidae, across Europe. She currently leads the Biodiversa+ project Sub-BioMon, which aims to develop innovative methods (DNA barcoding and eDNA) for monitoring subterranean fauna in European karst regions, and coordinates SubBioLab's participation in the Biodiversa+ DarCo project. She previously coordinated SubBioLab's role in the national LIFE NarcIS project, which established Slovenia's national information system for nature, to which SubBioDB contributes. She is also leading the testing of monitoring methods for caves as habitat types within the national project IP LIFE Natura.si. Her research is closely linked with conservation efforts, both through scientific work and active advocacy for the protection of subterranean biodiversity, particularly in areas threatened by large infrastructure projects. She is a member of the network Scientists for Balkan Rivers and has participated in two Science Weeks in Bosnia and Herzegovina, contributing to both research and public awareness in the region. In addition, she led a project funded by the Critical Ecosystem Partnership Fund aimed at improving knowledge and conservation of subterranean fauna in Bosnia and Herzegovina, particularly in the southeastern Dinarides. She is currently leading efforts to open SubBioDB to broader use as part of another conservation-oriented CEPF-funded project.

Jarosław Kobak is an invertebrate zoologist and freshwater ecologist at the Nicolaus Copernicus University in Toruń, Poland (https://www.umk.pl/en/), particularly interested in the impact of global change (including biological invasions, warming, and artificial light) on aquatic communities, behavioural ecology (especially induced anti-predator defences, feeding preferences, habitat selection), and interspecific interactions. His major research areas so far have been: (1) ecology of invasive fouling dreissenid bivalves, (2) ecology of invasive freshwater Ponto-Caspian amphipods, (3) the phenomenon of Invasional Meltdown in invasive communities, and, recently, (4) ecology and behaviour of American crayfishes in Europe. Additionally, he enjoys participating in research led by his friends from the aquatic ecology group based at the NCU and from other research teams in Europe, working on invasive fishes and Asian bivalves (*Corbicula* complex, Chinese pond mussel), physiology of aquatic animals, role of parasites in aquatic communities, freshwater ecotoxicology, and many others. His research is mostly based on ecological experiments, complementing field surveys by explaining causal relationships and mechanisms underlying phenomena observed in the field.

Abstracts – Plenary lectures

Stress along a river gradient: How species ecology and interactions shape persistence in human-dominated landscapes

Jonas Jourdan

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River ecosystems are unique, highly interconnected habitats defined by their dendritic networks and unidirectional flow, which naturally dictate the spatial distribution of aquatic communities. However, widespread anthropogenic intervention has introduced a multitude of novel stressors. In densely populated regions like Central Europe, the specific geomorphological properties of river networks cause these chemical, physical, and structural stressors to accumulate continuously from headwaters to mouth, creating downstream gradients increasingly shaped by human activity. Consequently, historically resident species are displaced by generalist taxa—often neobiota—that emerge as the "winners" of global change due to their capacity for rapid adaptation. Crucially, as these downstream communities adapt to degraded environments, they engage in unexpected ecological interactions with resident or introduced parasites, which can further alter pollutant dynamics, toxicity thresholds, and bioaccumulation pathways within the food web. To observe communities less impacted by human activity, research must now shift far upstream to the network's headwaters, which serve as the final ecological refugia for sensitive, specialized taxa. Paradoxically, we currently lack a proactive understanding of the actual vulnerability of these refugial communities, typically only documenting their disappearance post-hoc. Despite acting as critical biodiversity refugia, these headwater habitats are acutely threatened by climate change—which disproportionately impacts cold-adapted species with narrow thermal tolerance ranges—yet they continue to receive insufficient scientific attention and systematic monitoring.

When worse becomes the enemy of bad: On mechanisms and consequences of the ongoing species exchange in the invasive fouling dreissenid assemblage

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Invasive Ponto-Caspian bivalves, the zebra (*Dreissena polymorpha*, ZM) and quagga (*D. bugensis*, QM) mussel, are ecosystem engineers forming freshwater fouling communities. They transform habitats by filter feeding and accumulating 3-D shell structures on the bottom, playing a pivotal role in shaping the diversity and functioning of freshwater ecosystems. An earlier invader, ZM, is currently being replaced by a more recent newcomer, QM, in Europe and North America. We have conducted multi-year field survey and experimental research to disentangle mechanisms and predict ecological consequences of this phenomenon. We examined mussel life history traits, behaviour, and physiology using European large lakes, especially Lake Balaton (Hungary) as a study area. QM turned out to be better competitors, especially under harsh environmental conditions, due to their higher starvation tolerance, more flexible metabolism, faster growth, ability to live in larger aggregations, and lower habitat selectivity (including the ability to live on soft sediment surface). Moreover, QM are capable of fouling on ZM shells and benefiting from the established presence of ZM in the environment, while exerting a negative impact on ZM. On the other hand, ZM are likely to perform better in eutrophic conditions, under high predation pressure, using living hard-shelled organisms as substratum, and at sites occasionally exposed to air. We predict that, with the ongoing species replacement, the overall environmental impact of dreissenids will increase due to the ability of QM to colonise a wider range of habitats and to form larger aggregations than ZM, as well as providing predators with food of better quality. However, the pressure on large unionid mussels is likely to decrease due to the lower fouling of living substrata by QM.

Biogeography and diversification of European caddisflies and montane aquatic insects

Steffen Pauls

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Understanding how species responded to past environmental change is fundamental for explaining present-day biodiversity patterns and predicting future responses to environmental change. This presentation explores the biogeography and diversification of European aquatic insects through a comparative framework that integrates genetic, ecological, and geographic data. The presentation is structured around the following questions: Did cold-tolerant aquatic insects of Europe survive Pleistocene glaciations in periglacial refugia, or did they recolonize from southern and eastern refugia after glacial retreat? Do co-distributed species with comparable ecologies exhibit similar phylogeographic patterns, or do species-specific traits lead to contrasting evolutionary histories? Do closely related species share common biogeographic responses as a consequence of phylogenetic constraints and niche conservatism? How has molecular biogeographic data evolved in recent years, and does it have further application potential in freshwater biodiversity research? Drawing on studies of aquatic insects from Europe (and Asian Mountains) the results reveal that montane aquatic insects often responded differently to glacial cycles than terrestrial organisms. Evidence for periglacial persistence, micro-refugia, cryptic diversification, and trait-dependent population structure highlights the importance of ecology and evolutionary history in shaping biodiversity. Together, these findings demonstrate how comparative molecular biogeography and diversity studies can illuminate both origins of freshwater diversity and its vulnerability under future environmental change.

Groundwater biodiversity in Europe: Exploring patterns and processes

Maja Zagmajster

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Groundwater is the largest reservoir of liquid freshwater, as well as an ecosystem that hosts unique biodiversity and provides numerous ecosystem services. Like other subterranean environments, groundwater is characterised by the absence of light, limited nutrient availability, thermal stability, occurring in various geological settings. Many taxa have successfully colonised these habitats, with some exhibiting greater diversity underground than at the surface. Over the past two decades, the development of large, spatially explicit datasets on groundwater species distribution has enabled mapping and analyses of biodiversity patterns. Using groundwater crustaceans as a model group, patterns of diversity have been examined from global to regional scales. Endemism is high, with many species known from only single localities. In Europe, groundwater crustacean biodiversity peaks at mid-latitudes, while species' range sizes increase towards the north. These patterns have been explained by a combination of historical and current environmental variables, as well as limited dispersal possibilities. Due to similar selection processes, the morphological convergences and cryptic diversity is high in subterranean environments. Consequently, numerous molecular operational taxonomic units have been identified, yet DNA reference libraries remain incomplete. The use of molecular data has advanced understanding of ecological and evolutionary processes across multiple spatial scales. For example, in groundwater amphipods, a rare case of adaptive radiation in Europe has been documented. In the north-western Balkans, different biodiversity facets have been studied to investigate evolutionary processes, but also to evaluate the sufficiency of nature protection schemes. Groundwater ecosystems are vulnerable to surface-driven impacts and their conservation status is not being assessed. Therefore, monitoring methods are being developed, including testing the applicability of eDNA approaches.

Abstracts – Oral presentations

Macroinvertebrates in Dutch softwater lakes impacted by birds

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Softwater lakes are known for their rich macroinvertebrate communities. These lakes have low levels of calcium and nutrients. In the Netherlands these lakes are rare and protected in Natura 2000 (habitat type H3110). The lakes “Sarsven en de Banen” are under the influence of birds. Flocks of geese now use the lakes for resting. Foraging on very fertile surrounding agricultural fields and defecating in the lakes, they transport nutrients to the water. Small colonies of fish-eating birds might add more nutrients. Both types of bird might threaten the typical softwater quality of the lakes. Is the typical macroinvertebrate fauna still in a good state? In 2025, twelve macroinvertebrate samples were taken by hand net in the three main lakes. In addition, adult dragonflies (Odonata) were monitored in May, June and August, when typical species are most active. As a reference we use data from the past decades, and data from other softwater lakes in the Netherlands. Almost 300 macroinvertebrate species and 30 species of dragonfly were found. Dozens of characteristic species are present, for example the visually hunting aquatic bug *Cymatia bonsdorffii* (Heteroptera) and the non-biting midge *Cricotopus festivellus* (Chironomidae). We even found an undescribed species close to *Glyptotendipes pallens* (Chironomidae). However, the abundance of species that prefer eutrophic conditions is also high. Their abundances are higher than in the past, and higher than in the other Dutch lakes of H3110 type. Therefore, we conclude significant eutrophication has occurred. The local distribution of *Ceriagrion tenellum* (Small red damselfly) suggests that characteristic species survive in very shallow, well vegetated zones with groundwater influence. Although oligotrophic species remain, it is clear that the lakes are now eutrophic. It will be discussed what these results mean for the future of the softwater macroinvertebrate fauna, and the representativity and natural value of the habitat.

Funding: This research was funded by Provincie Limburg, DOS-00073765.

Kayaking: Think twice... What would tufa say?

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Tufa is a biologically mediated calcium carbonate deposit in karst streams. Algae, cyanobacteria, plants, mosses and macroinvertebrates help create them, forming the tufa barriers. Moss mats, which develop on tufa barriers, represent habitats for a vast variety of organisms, including macroinvertebrates. Due to its karstic nature and numerous waterfalls formed in tufa barriers, the Mrežnica River is a popular destination among nature lovers and for outdoor activities, such as kayaking, swimming, fishing, etc. The aim was to ascertain the level of this human impact on macroinvertebrates and determine a substitute for possibly lost natural habitats. Samples were taken from one pristine site, one site heavily impacted by humans, and two sites with medium and/or no anthropogenic impact. We examined how various macroinvertebrate taxa responded to compare their resilience and the recovery of their downstream populations. Furthermore, we have offered organisms anthropogenic materials to see whether they choose to colonise them. The decrease in numbers and diversity at the highly impacted site, compared to the pristine one, was vast. The biggest decrease was in the numbers of Chironomids, but compared to Ephemeroptera, Plecoptera and Trichoptera, their resilience and recovery in downstream populations were the best. Species richness was the lowest at the heavily impacted site, but it has proportionally increased in downstream populations. When offered anthropogenic materials, organisms colonized some of them as their new habitat. Even though the anthropogenic impact is extreme and it consequently decreases areas covered by moss mats and the populations of macroinvertebrates, we can find nooks and crannies that may serve as recolonisation and revitalisation sites and use anthropogenic materials for creating substitute habitats for macroinvertebrates.

Thirty-seven years of freshwater monitoring reveal undersampled dipteran diversity compared with well-resolved EPT groups

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Long-term datasets are essential for monitoring changes in abundance and species richness, yet they may underestimate the true diversity of taxonomically challenging groups, including many insect taxa. We analysed a unique 37-year freshwater macroinvertebrate time-series (1969–2006) collected using standardized methods (stationary “greenhouse-like” emergence traps) from seven sites along the unimpacted Breitenbach stream in central Germany to examine biodiversity patterns and species accumulation over time. We compared taxonomically well-resolved insect orders (Ephemeroptera, Plecoptera, Trichoptera; EPT) with poorly resolved “dark taxa” (Diptera), predicting that only well-resolved groups would show saturating accumulation curves. Diptera exhibited much higher diversity relative to EPT and a sustained increase in both abundance and species richness over time, with accumulation curves showing no sign of reaching an asymptote, essentially indicating that the species pool has not yet sufficiently been sampled. EPT richness increased over time without corresponding changes in overall abundance, and their accumulation curves plateaued despite a substantially larger number of sampled individuals relative to Diptera. These results highlight a significant gap in biodiversity monitoring: highly diverse but taxonomically under resolved groups such as Diptera remain inadequately sampled, even across extensive, high-resolution time-series.

Funding: This research was funded by Ramon y Cajal 2021 Program, grant No. RYC2021-032144-I.

Effects of diffuse pollution on aquatic macroinvertebrate communities in oxbow lakes

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Human land use increasingly affects floodplain wetlands, including oxbow lakes, through multiple direct and indirect pressures. Diffuse pollution from agricultural landscapes is often considered a major stressor for aquatic ecosystems, yet it remains unclear whether its effects on aquatic communities are primarily driven by surrounding land use or mediated by local environmental conditions. In this study we investigated how diffuse pollution and local habitat characteristics influence aquatic macroinvertebrate communities in oxbow lakes. Quantitative macroinvertebrate sampling was conducted in summer 2020 in 22 floodplain and non-floodplain oxbow lakes along the Danube and Tisza rivers in Hungary. In addition to community data, physicochemical variables were measured and habitat complexity was assessed based on vegetation zones. Diffuse pollution was approximated using land use within a 1 km buffer derived from the CORINE Land Cover database. Community metrics and ecological status (Ecological Quality Ratio, EQR) showed limited responses along land-use gradients. Along several land-use gradients, community metrics and EQR showed contrasting responses in floodplain and non-floodplain oxbow lakes. Community composition was more strongly related to local physicochemical variables and habitat complexity. In contrast, functional characteristics of communities showed weaker and less consistent responses to environmental gradients. Floodplain oxbow lakes showed higher similarity in community structure, whereas non-floodplain systems exhibited greater variability. Although some differences occurred between oxbow lakes along the Danube and the Tisza, these regional effects appeared secondary to local environmental conditions. Taken together, these patterns suggest that diffuse pollution primarily affects oxbow lake communities indirectly, through its influence on local environmental conditions that structure habitat availability and community assembly.

Pristine mountainous vs. rural upland landscapes: Springs as habitats for mime midge communities

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The western Balkan Peninsula contains various karst landscapes where mountain springs serve as refugia for benthic invertebrates. In regions characterised by a scarcity of large rivers and lakes, springs host a high level of freshwater biodiversity. Chironomidae are dominant in the benthic communities, thanks to short life cycles and dispersal capabilities. Here we present research conducted across 37 rheocrene springs in the Bjeshkët e Nemuna (Kosovo) and 19 springs within the Cvrcka River system (Bosnia). Results indicate that species composition is primarily driven by altitudinal hydroclimatic gradients and micro-regional landscape variations. The study identified four distinct altitudinal zones in the Bjeshkët e Nemuna mountains and categorised the Cvrcka River springs into three groups based on anthropogenic influence. Interestingly, moderately utilised springs in Cvrcka River exhibit the highest midge biodiversity. This correlation exists because stable discharge and favourable substrates often coincide with locations suitable for human use. High-altitude springs (1400–1500 m a.s.l.) are characterised by their perennial nature, sustained by the humid mountain climate. However, spring fauna typically exhibits a patchy distribution; even nearby springs can host remarkably different species assemblages. The above-mentioned habitats must be prioritised for biodiversity conservation within protected areas like national parks, while in rural regions, they must be managed through sustainable utilisation to preserve their ecological integrity.

Three stages of fauna radiation: Patterns of freshwater crustacean diversification in the Periadriatic region

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The Periadriatic region, encompassing the landmasses surrounding the Adriatic Sea, represents one of the most significant biodiversity hotspots and a model system for studying the diversification of freshwater fauna. We investigated the diversification dynamics of several malacostracan groups - including amphipods (*Gammarus*), isopods (*Asellus*), mysids (*Diamysis*), and caridean shrimps (*Atyaephyra*, *Palaemon*) – along a geographic gradient in the Periadriatic region. By integrating molecular data from over 2000 individuals with the complex paleogeographic history of the Mediterranean, we identified three major stages of faunal diversification in the area. The first stage, initiated during the Middle and Late Miocene, was associated with the continentalization of Europe and the uplift of the Alps, Dinarides, and Hellenides. During this period, the deepest splits between Balkan and Apennine lineages occurred, particularly within the *Diamysis*, *Atyaephyra* and *Gammarus balcanicus* species complex. The second stage relates to the Messinian Salinity Crisis (6–5 Ma) and the subsequent Lago Mare episode, which promoted habitat shifts and faunal exchange among previously isolated basins. The third stage encompasses the Pleistocene glaciations (2.5–0,016 Ma), during which sea-level regressions unified hydrological networks into the Mega-Po river system, facilitating the most recent waves of colonization and lineage exchange. We show a consistent geographic pattern of significantly higher diversity in the Balkan Peninsula compared to the Apennine Peninsula across studied taxa. These findings underscore the role of the Periadriatic region as a critical evolutionary centre, where recurrent geological barriers and historical land-bridge connections have driven the accumulation of high genetic variability. The established molecular reference library provides a fundamental framework for understanding the origins and preservation of Mediterranean freshwater biodiversity.

Effort vs. results: The efficiency of a minimum standards on aquatic subterranean habitat monitoring

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Groundwater habitats harbour high diversity of fauna, yet the importance of protecting this biodiversity is generally overlooked. Although our knowledge of these systems is expanding, anthropogenic pressures are also increasing. Yet, there is almost no regular monitoring of groundwater fauna, which might assess anthropogenic impacts on groundwater habitats. As a starting point within the framework of the collaborative EU Biodiversa+ funded project Sub-BioMon, including researchers and stakeholders from six countries, we investigate the possibility of developing minimum standards for monitoring groundwater fauna. We explored the applicability and efficiency of different sampling approaches for caves and springs. Altogether, we studied 14 caves and 12 springs in Belgium, Hungary, Italy, Luxembourg, Romania and Slovenia. We collected aquatic animals using different sampling techniques and also collected water for eDNA analyses. To assess and compare the efficiency of our methods in detecting groundwater animals, we selected sites for which good faunistic knowledge was available. Our preliminary results showed that with the direct sampling methods many taxa can be detected, even the ones new to these sites. Our preliminary data on eDNA suggests that it performed well on higher taxonomic levels but failed to retrieve all the species. Here one major obstacle was the discrepancy of available DNA barcodes between taxonomic groups and the participating countries. Our preliminary results suggest that a minimum standard sampling standards for the monitoring of groundwater fauna should include different approaches, and that eDNA may represent a valuable additional sampling type. With the current state of knowledge, relying on eDNA alone cannot substitute traditional sampling.

Funding: This research was funded by Biodiversa+, the European Biodiversity Partnership, in the context of the Sub-BioMon - Developing and testing approaches to monitor subterranean biodiversity in karst project under the 2022–2023 BiodivMon joint call. It was co-funded by the European Commission (GA N°101052342) and the following funding organisations: Ministry of Higher Education, Science and Innovation (Slovenia), The Belgian Science Policy (Belgium), Ministry of Universities and Research (Italy), National Research, Development and Innovation Office (Hungary), Executive Agency for Higher Education, Research, Development and Innovation Funding (Romania) and self-financing partner National Museum of Natural History Luxembourg (Luxembourg).

Flow intermittency amplifies temporal instability in macroinvertebrate communities: Insights from directional β-diversity

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Flow intermittency increases temporal variation in riverine communities, yet conventional β-diversity metrics rarely capture the direction of community change across drying–wetting cycles. We investigated temporal dynamics of macroinvertebrate assemblages in perennial and intermittent reaches of a river network in southwestern Hungary using directional β-diversity components. Presence–absence data from 62 sites were analysed across 12 seasonal surveys between 2020 and 2023. Temporal changes in community composition were partitioned into directional components describing species gain, loss and overlap, and their contributions to turnover and nestedness. Perennial sites showed relatively stable community composition through time, characterised by high overlap and balanced turnover–nestedness structure. In contrast, intermittent sites displayed pronounced temporal instability, with alternating gain- and loss-dominated phases corresponding to drying–wetting cycles. Nestedness components were consistently lower in intermittent reaches, indicating that repeated drying events not only removed taxa but also weakened the hierarchical structure in which species-poor assemblages remain subsets of richer ones. Overall, flow intermittency was associated with larger amplitudes of temporal fluctuation and stronger directional imbalance in community dynamics, whereas perennial sites maintained comparatively stable assemblages. Directional β-diversity metrics made these contrasts explicit by identifying asymmetric signatures of species gain and loss that are not captured by conventional, non-directional measures. These results demonstrate that drying–wetting cycles impose strongly directional shifts in community composition that leave detectable signatures in temporal β-diversity patterns. Directional β-diversity therefore provides a process-oriented framework for diagnosing intermittency-driven ecological dynamics in river networks, even where direct hydrological data are limited.

Funding: The project is exclusively supported by the National Research, Development and Innovation Office – NKFIH FK 135 136 grant.

Mechanisms of niche differentiation among invasive Ponto-Caspian corophiids (Crustacea, Amphipoda)

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With the recent establishment of *Chelicorophium maeoticum* in the Netherlands, so far four Ponto-Caspian *Chelicorophium* species have expanded their ranges across Europe, coexisting locally in the colonized waters. Revealing their coexistence mechanisms of these filter-feeding, tube-dwelling crustaceans is important for understanding and predicting their population dynamics and invasion success. In this presentation, I will provide a review of my recent works on the topic and outline avenues for future research. The results have demonstrated that niche differentiation by food particle size (inferred from measurements of filter mesh sizes) is an important component of their coexistence. Filter mesh size has been demonstrated to vary dynamically within species in complex ways, showing consistent interspecific differences between certain species but occasionally high overlaps between others. Accordingly, additional factors must also be involved in the coexistence of the species. Spatial differentiation along environmental gradients has not been found among the species within a river, although salinity and substrate types are involved in the interaction of *C. curvispinum* with native oligohaline corophiids in the Baltic and North Sea. The maximal body sizes of the species are different, which might have implications on their coexistence in several ways, such as microhabitat use, generation time, or predation risks. Interspecific differences in the relative length and width of the enlarged second antennae might reveal additional aspects of the coexistence mechanisms of the species, as they might be involved in deposit feeding, interference competition for microhabitats, and the defence against predators.

More is not always better: Selective trait filtering governs assembly under emerging flow intermittency

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Flow intermittency is expanding across river networks, transforming perennial streams into newly drying habitats and exposing macroinvertebrate communities to novel selective pressures. Understanding the mechanisms governing community reorganisation under these transitional conditions is essential for predicting ecological responses to climate-driven drying. Using long-term hydrological modelling combined with trait-based analyses along a continuous intermittency gradient, we tested four mechanistic hypotheses addressing taxonomic filtering, trait-state-specific responses, the role of cumulative trait-state advantages and dimension-specific functional reorganisation between resistance and resilience dimensions. Richness declined while Simpson diversity increased with drying, indicating strong but selective environmental filtering (H1). Only specific drying-related trait states increased in representation, revealing differential responses across resistance- and resilience-related states (H2). The number of drying-related trait states did not consistently enhance taxon performance; instead, intermediate and functionally coherent combinations were favoured (H3). Functional richness and redundancy exhibited asymmetric trajectories between the two survival dimensions, highlighting differences in how resistance- and resilience-related strategies reorganise under increasing intermittency (H4). These findings demonstrate that emerging flow intermittency restructures communities through selective trait-state filtering and the dominance of optimal, rather than cumulative, survival strategies. The asymmetric functional trajectories between resistance and resilience dimensions reveal early-stage functional vulnerability in newly drying systems, providing a mechanistic foundation for intermittency-aware bioassessment tools under climate-driven drying.

Funding: This study was exclusively funded by the National Research, Development and Innovation Office – NKFIH FK 135136 Grant. TB and JS were supported by Széchenyi Plan Plus program with the support of the RRF-2.3.1-21-2022-00008 National Laboratory for Water Science and Water Security. PB was supported by the János Bolyai Research Scholarship of the Hungarian Academy of Sciences NKFIH and by the ÚNKP-23-5 New National Excellence Program of the Ministry for Innovation and Technology from the source of the National Research, Development and Innovation Fund. ZC was supported by the H2020 European Research and Innovation action grant agreement: DRYvER Project (H2020 #869226).

Ephemeral beings, eternal patterns: First insight into molecular diversity of Ecdyonurinae and Rhithrogeninae mayflies from the Balkan biodiversity hotspot

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Mayflies (Ephemeroptera) represent one of the oldest lineages of winged insects. The family Heptageniidae is the most diverse within the order, comprising three subfamilies (Rhithrogeninae, Ecdyonurinae, and Heptageniinae) with 600 species. As key bioindicators and essential components of freshwater food webs, especially fast-flowing rivers, they are vital for monitoring ecosystem health. While the Balkan biodiversity hotspot hosts numerous described species, their molecular diversity and evolutionary history remain understudied. This study aims to identify the molecular diversity and reconstruct the evolution of the genera *Ecdyonurus*, *Electrogena*, *Rhithrogena* and *Epeorus*. The methodology utilizes an integrative taxonomic approach, including extensive COI DNA barcoding, genome assembly for USCOs, phylogeographic and phylogenetic analyses. The material includes over 8,000 specimens from the Balkans, supplemented by reference material from the West Carpathians, Anatolia, and the Caucasus. Preliminary COI gene trees reveal that *Ecdyonurus* is not monophyletic, indicating significant taxonomic inconsistencies. Furthermore, standard arthropod divergence rates under a strict molecular clock model do not align with expected evolutionary timelines. Currently, the first sequenced genome is being analysed for USCOs extraction to resolve these phylogenetic discrepancies.

Downstream distribution of microplastics along the river continuum with a focus on potential pollution sources: A study on *Gammarus* spp.

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The global escalation of plastic production has led to a dramatic increase in microplastic (MP; 1 µm–5 mm) concentrations in freshwater ecosystems, posing a significant ecological threat. However, the distribution and accumulation of MPs in the environment remain understudied, partly due to the ongoing standardisation of analytical methods. Benthic invertebrates are continuously exposed to microplastics, leading to frequent ingestion. This study investigates the longitudinal distribution of MPs along a river continuum, focusing on potential point-source pollution from wastewater treatment plants (WWTPs) and quarries. Using the freshwater amphipod *Gammarus* spp. as a model taxon, we employed a paired sampling design upstream and downstream of potential pollution sources along the Bobrava River (Czech Republic), including a reference site near the headwaters. Microplastics were isolated from 20 individuals per site using oxidative and enzymatic digestion, followed by µFT-IR spectroscopy and analysis in Microplastic Finder software. We have detected MPs in all samples, with fragments predominating. The most common polymers identified were polyethylene (PE) and polypropylene (PP). Microplastic distribution was not significantly affected by the monitored pollution sources. Instead, MP concentrations exhibited a declining trend downstream, with significantly higher concentrations recorded near the headwaters. These results suggest that local point sources may play a minor role in MP accumulation within freshwater invertebrates, underscoring the necessity to consider complex environmental processes and anthropogenic inputs in microplastic research.

Funding: This research was funded by the Technology Agency of the Czech Republic, grant No. SS07010295.

Insect diversity and ecological structure in partially submerged dead wood in Lithuanian freshwater ecosystems

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Dead wood helps maintain the balance of food chains and influences the morphology, width, and flow of rivers and streams. Partially submerged dead wood creates unique microhabitats for numerous organisms, including bacteria, fungi, lichens, and insects. Many insects associated with dead wood use it as shelter or as a developmental substrate, while others feed directly on the wood. In Lithuania, insect diversity associated with partially submerged dead wood has not previously been investigated, particularly with respect to feeding guilds and habitat preferences. This study addresses this knowledge gap. The aim of this research was to determine which insect species inhabit this microhabitat and to perform an ecological analysis based on their feeding habits and typical habitats. Insects were collected from partially submerged dead wood by hand in May, June, September, and October 2024. Sampling was conducted using measuring tapes, a knife, tweezers, and small jars filled with 70% ethanol. Specimens were identified using morphological and molecular methods, supported by phylogenetic analysis. Each species was assigned to a feeding guild and typical habitat based on literature sources. The data were grouped and analysed using Microsoft Excel. A total of 300 pieces of dead wood were examined at four sites and twelve sampling points in the Varėna and Trakai districts. In total, 1719 insect specimens were collected (1684 larvae, 22 pupae, 4 puparia, and 9 adults). Morphological and molecular identification showed that the specimens represented 43 species. Most detected species (24) are not typically associated with dead wood. In terms of abundance, however, most individuals belonged to species usually associated with flowing water habitats (112 individuals). Detritivores/saprophages constitute the largest feeding guild by species richness (16 species), whereas obligate xylophages were the most abundant in terms of individual numbers (164 individuals).

Funding: This project has received funding from the Research Council of Lithuania (LMTLT), agreement No. S-SV-24-127.

The challenge of hyperdiverse cryptic dark taxa in biodiversity hotspots: DNA barcoding as a foundational tool for understanding diversity patterns and conservation priorities

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Quantifying species richness in hyperdiverse morphologically cryptic and widespread dark taxa is challenging and resource demanding. As such, this diversity remains overlooked, with unclear conservation implications, particularly in biodiversity hotspots. We employ DNA barcoding and molecular species delimitation to document and map diversity and endemism patterns of *Gammarus* amphipods in the Caucasus hotspot, helping to identify key conservation needs. While morphological examination revealed six morphotypes, molecular analyses uncovered a tenfold increase in diversity, delimiting 122 lineages grouped in six morphotype-matching major clades. Intraclade diversity varied considerably (1 to 66 lineages) with up to 35% genetic divergence. Landscape genetics indicated a geographically uniform distribution of genetic diversity and clade-specific patterns. Despite dense sampling, 74% of lineages were detected at single sites, and rarefaction-extrapolation analyses suggest substantial undiscovered diversity, with sampling coverage reaching 50%. Ecologically, 76% of lineages occurred in headwaters, predominantly at 200–400 m, though altitudinal turnover was clade-specific. Our findings reveal unprecedented endemism in Caucasian headwaters, underscoring their long-term refugial role and the potential of *Gammarus* as an umbrella taxon. Nevertheless, headwater remains vulnerable to short-term local anthropogenic threats and long-term climate change-driven groundwater depletion. By demonstrating the utility of DNA barcoding in understudied biodiversity hotspots, our study timely informs regional conservation planning while laying the foundation for subsequent formal taxonomic validation.

Funding: This study was funded by the Research Council of Lithuania (contract No. S-LL-24-13) and the National Science Centre, Poland (contract No. UMO-2024/52/L/NZ8/00117). Additional funding was provided by the German Federal Ministry of Education and Research (01DK20014A) via CaBOL (Caucasus Barcode of Life).

Modelling habitat suitability of freshwater insects in the Magdalena–Cauca River Basin (Colombia) using high-resolution hydrographic data

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Biogeographic patterns of tropical freshwater insects remain largely unexplored, and Colombia—despite its exceptional biodiversity—is markedly underrepresented in the literature due to historical sampling gaps rooted in armed conflict, limited infrastructure, and insufficient research investment. We focus on the Magdalena–Cauca Basin and model the habitat suitability of freshwater insects along the river network. We also address the river network structure and connectivity to assess how it shapes species richness, range size, rarity, and endemism. Finally, we will quantify how current and planned hydropower dams fragment taxa distributions given network connectivity. Taken together, we will identify spatially explicit conservation priorities across the river network, providing a forward-looking and ecologically robust framework for freshwater biodiversity management in one of the world's most biodiverse yet data-deficient regions. We will show preliminary results where we used species key lists for freshwater insect orders compiled across the Neotropics. Occurrence records were retrieved via GBIF, cleaned, and harmonized before spatial integration. Using the hydrographr R-package and the new Environment90m dataset, we link each occurrence record to the corresponding stream network segment and extracted stream topographic and environmental information. Based on this spatially explicit dataset, we fitted species distribution models (SDMs) at the sub-catchment scale to estimate habitat suitability for the studied orders across the Magdalena–Cauca Basin, accounting for river network structure, environmental filtering, and biotic interactions. We present occurrence data diagnostics, spatial and temporal availability patterns, and preliminary habitat suitability maps for selected orders, providing a replicable baseline for freshwater conservation assessments in data-limited tropical systems.

Funding: The German Academic Exchange Service (DAAD) funded the research and The Water Science Alliance (WSA) funded attendance to the conference.

Islands under pressure: Integrative insights into the aquatic macroinvertebrate fauna of the Ionian Archipelago

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Freshwater ecosystems on Mediterranean islands are highly sensitive to climate-driven hydrological changes, particularly increasing drought frequency and the shortening of hydroperiods. The Ionian archipelago provides an excellent natural setting to examine how such changes influence aquatic biodiversity. Here we present results from a large-scale integrative survey of freshwater macroinvertebrates conducted in April 2024 on three Ionian Islands: Zakynthos (39 sites), Kefalonia (64 sites), and Lefkada (49 sites), covering a total of 152 sampling locations. At each site, the complete macroinvertebrate assemblage was sampled using pond nets in standing waters and kick-and-sweep methods combined with hand collecting in flowing habitats. Specimens are being analysed using an integrative taxonomic approach combining morphology-based identification and DNA barcoding. To date, 121 taxa have been identified from the processed material including Annelida (1), Coleoptera (63), Crustacea (8), Ephemeroptera (8), Heteroptera (16), Odonata (14), Plecoptera (3), and Trichoptera (8). DNA barcoding largely confirmed the morphology-based identifications; however, several cases of unique Barcode Index Numbers (BINs) and large genetic distances suggest the presence of previously unrecognized cryptic diversity. The taxonomic composition of the assemblages strongly reflects ongoing climatic changes. Aquatic beetles and bugs dominate the fauna, while other macroinvertebrate groups were recorded only at a small fraction of sites, mostly in habitats that historically supported more stable water regimes. Preliminary comparisons with material collected on Corfu in April 2010, where aquatic beetles and bugs were studied in detail, allow an initial assessment of faunal overlap and possible shifts in species composition.

Longer, larger, and less predictable: Tracking the effects of stream drying on aquatic macroinvertebrate communities using community trajectory analysis

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Stream drying is an increasingly widespread phenomenon, yet its ecological consequences remain insufficiently understood, particularly in catchments where drying has only recently emerged. Most previous studies have compared perennial and intermittent reaches as static states, leaving the temporal dynamics of community change largely unexplored. Here, we applied Community Trajectory Analysis (CTA) to a five-year dataset of macroinvertebrate communities from a Central European catchment undergoing a recent transition from perennial to intermittent flow. By quantifying community trajectories in multivariate space, we assessed both the temporal divergence of sites from their initial or perennial reference states and the within-group divergence among sites sharing the same hydrological group. Our results show that temporal divergence from reference states increased markedly with drying: communities at intermittent sites followed longer, more erratic, and more directional trajectories, departing irreversibly from their initial conditions. In contrast, within-group divergence decreased with drying, as sites exposed to recurrent intermittency displayed more parallel and homogenized responses than perennial ones. These complementary findings indicate that drying simultaneously destabilizes communities by driving them away from historical baselines, while constraining their variability through environmental filtering. This dual perspective advances understanding of how drying reshapes community dynamics, highlighting that ecological change must be viewed not only in terms of departure from the past, but also in terms of the coherence of responses within stressed regimes. By integrating trajectory-based metrics into biomonitoring, our study provides a framework for detecting early warning signals, anticipating tipping points, and informing adaptive conservation in increasingly intermittent river networks.

Microplastics in running waters: Assessment of surface water and macroinvertebrates along longitudinal river gradients

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Microplastics (MPs; 1 µm–5 mm) are widespread contaminants of freshwater ecosystems, yet their distribution in running waters remains poorly understood. Rivers act as both transport pathways and potential accumulation zones, making longitudinal MPs contamination assessments essential for identifying sources, sinks, and exposure routes. However, sampling, extraction, purification, and analytical approaches vary widely among studies, limiting the comparability of results. We therefore aim to develop and validate a standardised methodology for quantifying and characterising microplastics across freshwater matrices. Here, we compare MPs in surface water and in macroinvertebrate samples collected along longitudinal river profiles. At each river, samples were taken at (i) a minimally impacted headwater reference site, (ii) sites upstream and (iii) downstream of a major wastewater treatment plant (WWTP), and (iv) sites upstream and (v) downstream of a reservoir, allowing assessment of point sources and depositional effects. Strict contamination control was applied throughout sampling and laboratory processing. Microplastics were extracted by oxidative purification using optimised reagents, and particle identification and polymer characterisation were performed by µFT-IR transmission spectroscopy. Initial results indicate spatial variability in MP abundance and polymer composition. Some of the highest particle counts occurred in upper river sections, suggesting atmospheric deposition as a potentially important source. Spatial patterns of MPs in macroinvertebrate and surface water samples were broadly comparable. However, these findings remain preliminary and highlight the value of multi-matrix monitoring and further methodological harmonisation to better understand microplastic sources and pathways in freshwater systems.

Funding: This research was funded by the Technology Agency of the Czech Republic, grant No. SS07010295.

Breaking the extraction bottleneck: Direct PCR and rapid isolations democratize real-time freshwater biomonitoring

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Environmental DNA metabarcoding is transforming freshwater biomonitoring, yet standard laboratory workflows remain tethered to costly and time-consuming DNA isolation kits. This creates a significant bottleneck for timely and large-scale applications. We performed a comprehensive comparative analysis of traditional DNA isolation (Qiagen Blood and Tissue), alternative rapid chemistries (Chelex, Diaxxo magnetic beads), and extraction-free Direct PCR (dPCR) using the Cytochrome c oxidase subunit I (COI) full barcode (658bp) across freshwater ecosystems. To evaluate the potential for field-deployable workflows, we sequenced libraries using Oxford Nanopore Technologies (ONT) platforms. Our results reveal that the extraction-free dPCR approach and rapid Diaxxo beads consistently match or exceed the performance of gold-standard kits in capturing Molecular Operational Taxonomic Unit (MOTU) richness. Specifically, Diaxxo beads with heat incubation yielded the highest total richness, while dPCR demonstrated a superior ability to detect broad eukaryotic diversity while significantly reducing processing time and contamination risk. By integrating rapid amplification protocols with portable ONT sequencing, we demonstrate a democratized, high-throughput solution for real-time aquatic conservation and biodiversity assessment.

Funding: This research was funded by the National Science Centre of Poland (NCN) under the SONATA 19 call, grant No. UMO-2023/51/D/NZ8/00386.

Unlocking two centuries of data: Temporal trends and historical Insights into the aquatic beetle fauna of Hungary

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Freshwater ecosystems are under increasing environmental pressure, making long-term biodiversity baselines essential for effective conservation. While aquatic coleopterans serve as excellent bioindicators of freshwater health, vital occurrence records are often locked within unstructured historical texts and fragmented across centuries of literature. In this study, we present a comprehensive synthesis of aquatic Coleoptera in Hungary, systematically reviewing and digitizing data from more than 400 scientific publications spanning from the early 1800s to 2024. This extraction yielded a robust dataset exceeding 60 000 individual records. Crucially, this spatially and temporally explicit dataset enables the exploration of long-term trends in faunal knowledge, sampling intensity and species occurrence frequencies across two centuries. To unlock the analytical potential of these historical records for modern spatial ecology, the entire dataset has been standardized according to Darwin Core (DwC) specifications, ensuring full interoperability and open-access compatibility with the Global Biodiversity Information Facility (GBIF). In our presentation, we will highlight the first results derived from this synthesis, focusing on long-term temporal patterns in recording activity and illustrating changes in the reported frequencies of selected species across the past two centuries. These examples demonstrate how large historical datasets can reveal emerging trends in faunal knowledge and species occurrence dynamics. This synthesis provides a critical baseline for understanding the biogeography and ecology of aquatic beetles in Hungarian freshwater ecosystems, while also identifying knowledge gaps and informing future monitoring and management strategies.

DNA barcoding of macroinvertebrates in springs of the Northern Carpathians: Wrap-up of the BioSpring/SpringBio projects

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Springs are unique aquatic environments characterised by stable year-round conditions, including low water temperatures, reduced dissolved oxygen, and constant hydrochemistry. As patchy and isolated habitats—particularly in mountainous terrain—they restrict the migration of crenic (spring-dwelling) organisms. Consequently, springs are critical biodiversity hotspots, especially in the mosaic landscapes of mountain regions. Despite their importance, spring ecosystems are not classified as a distinct category of surface waters under the EU Water Framework Directive, residing in a "legal limbo" and remaining insufficiently studied, particularly in biodiverse regions such as the Carpathians. The BioSpring/SpringBio projects addressed this gap by investigating macroinvertebrate diversity and connectivity across five mountain ranges in the Northern Carpathians, establishing a dedicated DNA barcode library. In 2022–2023, samples were collected from 52 sites across the Orava and Żywiec Beskids, Inovec Mountains, Bieszczady and Bukovec Mountains, Vepor Mountains, and Island Beskids. The project generated over 2500 DNA barcodes, targeting the 658 bp 5' fragment of the cytochrome c oxidase subunit I (COI) gene, sequenced using the ONT platform. These sequences, with photographs and metadata, were deposited in the Barcode of Life Data Systems (BOLD). BOLD clustered the data into 228 Barcode Index Numbers (BINs), acting as rough proxies for species. Notably, 53 BINs were previously unknown to the database. Findings indicate that the Bieszczady/Bukovec Mountains exhibit the highest biodiversity, while the Inovec Mountains show the lowest. The study revealed substantial faunal differentiation among ranges, with a high proportion of unique BINs; only two BINs were common to all five ranges. These results provide the first barcode library for Carpathian springs, establishing a foundation for future metabarcoding and eDNA-based biomonitoring of these vulnerable waterbodies.

Funding: This research was funded by the APVV SK-PL-21-0023, NAWABPN/BSK/2021/1/00084/U/00001, UniLodz IDUB NR4/ML/2022, Eramsus+ BIP: Biodiversty of the Carpathian Springs.

The role of species replacement in the reassembly of aquatic macroinvertebrate communities after dredging

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In Hungary, dredging is a commonly used practice in water management to control sedimentation. During dredging, accumulated silt and vegetation are removed, restoring the channel's water carrying capacity. However, this intervention may have ecological consequences, as vegetation and sediment-associated organisms are eliminated and habitat conditions are strongly modified. Consequently, dredging generates a modified habitat that undergoes recolonization by macroinvertebrates. In our study, we monitored temporal changes in the macroinvertebrate community of a Hungarian lowland stream (Szévíz): before dredging (autumn 2022) and 1 and 2 years after dredging (autumn 2023 and 2024). The study did not reveal significant differences in species richness and abundance between the pre-dredging and post-dredging states. However, ordination analyses indicated clear differences in community composition among the three sampling years, with distinct assemblages before dredging and one and two years after dredging. The apparent stability in diversity metrics was driven by species replacement. Approximately one quarter of the species disappeared, and another quarter newly appeared after dredging, while about half of the species persisted. Species replacement was already pronounced one year after dredging and remained evident two years after the intervention. However, the dynamics differed among taxonomic groups. In some groups (e.g. crustaceans, dipterans) the proportion of persistent, disappearing and colonizing species remained relatively stable between the first and second years, whereas in others (e.g. coleopterans, caddisflies) these proportions changed more markedly. Overall, dredging was followed by rapid recolonization of macroinvertebrates, but the species structure of the community changed substantially. These patterns suggest that dredging acts as a disturbance initiating community reassembly in which species replacement plays a key role.

Hidden diversity: Using macroinvertebrates to identify East-Mediterranean freshwater Key Biodiversity Areas (KBAs)

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Israel serves as a pivotal biogeographical crossroads at the junction of three major regions: the Mediterranean, the steppic Irano-Turanian, and the arid Saharo-Arabian. This unique position, defined by a sharp north-south climatic gradient and the Jordan Rift Valley, supports a remarkably high diversity of freshwater systems, ranging from perennial northern streams and small calcareous foothill springs to ephemeral desert wadies and large, slow-flowing coastal rivers. Over the past century, these ecosystems have faced exceptional pressures from a fast-growing population, water abstraction, and pollution. Consequently, many streams have lost their natural functions, leading to significant biodiversity decline. Current efforts to halt species loss target the protection of sensitive sites, such as nature reserves and parks. Identifying these locations as Key Biodiversity Areas (KBAs) provides a critical, globally recognized framework for prioritizing conservation. This study utilizes existing data on aquatic macroinvertebrates collected from 130 streams nationwide, identifying 260 native species (105 families). Results indicate that the Upper Jordan is the most biodiversity-rich region, harbouring >80% of the country's macroinvertebrate taxa. Notably, this region serves as the southern distribution limit for rare endemic taxa such as *Electrogena galileae* (Heptageniidae), *Protonemura zernyi* (Nemouridae), and *Adicella syriaca* (Leptoceridae). Other critical hotspots include the Dead Sea region, home to the mayfly *Choroterpes ortali* (Leptophlebiidae), and the brackish coastal sections of the Taninim the last remaining habitat for crustaceans such as *Lekanesphaera hookeri*, *Corophium orientale*, and *Diamysis bahirensis*. By delineating these community-rich sites, this study provides a scientific framework for the formal designation and enhanced protection of freshwater KBAs in the Eastern Levant.

Feeling the heat: A first insight into genetic diversity and thermal adaptation of *Gammarus fossarum* in the hot springs of Kaiserstuhl, Germany

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Thermal springs represent rare and understudied freshwater habitats characterised by year-round elevated and stable water temperatures. Such thermally buffered environments serve as natural laboratories for studying the adaptation of aquatic organisms to conditions that deviate from the regional norm. The Kaiserstuhl region in SW Germany harbours several such springs where geothermally heated groundwater discharges at a constant temperature of 19–22°C. Historical surveys documented a diverse macroinvertebrate community in these springs, including native freshwater gammarids, yet their genetic diversity and population-level responses to this unique thermal regime have never been investigated. Here, we explore the genetic diversity, population structure and morphological differentiation of those gammarids from two thermal spring outflows and seven reference populations in surrounding non-thermal streams. COI barcoding revealed the presence of *Gammarus fossarum* and *G. roeselii* in the area, with only *G. fossarum* being present in the thermal springs. We observed high intraspecific genetic diversity with two co-occurring *G. fossarum* BINs. Population genetic analyses (F_ST and Φ_ST) showed that thermal spring populations were genetically similar to each other and to geographically close control sites, but strongly differentiated from more distant populations. Additionally, gill surface area comparison between one thermal and one reference population revealed larger gill size surface areas in thermal spring specimens, suggesting a potential physiological adaptation to the higher oxygen demands of warmer aquatic environment. Our results present the Kaiserstuhl thermal springs as a promising system for investigating thermal adaptation in a widespread, nominally cold-water gammarid species. Further experimental work is needed to disentangle the role of observed genetic diversity and to evaluate possible ecological differentiation of the thermal spring populations.

Evaluating water quality of the Zhinvali Reservoir, Georgia (South Caucasus): Insights from macroinvertebrate communities

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The Zhinvali Reservoir is a strategic multi-purpose water body in Georgia, serving as a primary source for drinking water and hydroelectric power. This study presents interim results from a three-year monitoring project (2024–2026) evaluating the reservoir's ecological health across different zones, using macroinvertebrates as biological indicators integrated with physicochemical and fish parasitological assessments. Benthic samples were collected using a combination of a grab sampler and kick nets, covering both the littoral and deeper zones. Ecological health was diagnosed using the Biological Monitoring Working Party (BMWP), Average Score Per Taxon (ASPT), Family Biotic Index (FBI), Taxa Richness (TR), and the Shannon Diversity Index (H). Preliminary results revealed significant seasonal fluctuations. While the littoral zone showed some taxonomic variety, the interior parts of the reservoir exhibited a notably sparse benthic community. During the summer, the reservoir displayed a higher taxonomic diversity, with a Taxa Richness of 8 and a BMWP score of 26, compared to the autumn values of 3 and 6, respectively. Despite this, the ASPT remained low, measuring 3.25 in summer and 2.0 in autumn, while FBI values ranged between 7.19 and 7.62, initially suggesting organic enrichment. The Shannon Index remained low but stable (1.01–1.03). However, these low biotic scores, particularly the scarcity of data from the deeper zones, may reflect sampling challenges due to the naturally low density of benthos and substrate characteristics. To ensure a more representative characterization of the entire water body, the 2026 monitoring phase will focus on refined sampling strategies. The ongoing correlation of macroinvertebrate data with physicochemical parameters and fish parasitological status remains a crucial early-warning system for the reservoir's ecological degradation and future management.

Funding: This research was funded by the Shota Rustaveli National Science Foundation of Georgia, grant No. FR-23-5951.

Fossil Psychodomorpha (Diptera: Nematocera) in perspective of current systematics and phylogeny

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Psychodomorpha is an infraorder of flies (Diptera) comprising three families: Psychodidae (moth flies), Tanyderidae (primitive crane flies), and Blephariceridae (net-winged midges). The biology of these insects, especially in the larval stages, is entirely or partially associated with aquatic environments, ranging from rheophilous to limnophilous habitats. In the extant fauna, the morphology of these families appears markedly distinct at first glance. However, analyses of Cretaceous taxa preserved in Lebanese and Burmese amber reveal specimens that exhibit a mosaic of characters typical of different lineages at the family and subfamily levels. Such taxa constitute direct and observable evidence of the close evolutionary relationships within Psychodomorpha. By applying an integrative approach that combines the morphology of both fossil and extant taxa, analysis of homologous structures, ecological preferences, and genetic data, it is possible to obtain a more comprehensive understanding of the evolutionary history of this group. This framework also allows for the formulation and testing of robust taxonomic, paleoecological, and phylogenetic hypotheses. Among the examined specimens from the collection of the Institute of Systematics and Evolution of Animals, Polish Academy of Sciences (ISEZ PAN) in Kraków, Poland, morphological “chimeras” of the currently recognized subfamilies were identified with respect to body length, wing venation pattern, and genital morphology. Such specimens are problematic from a taxonomic perspective and should be treated as representatives of the stem group or early lineages of given higher taxonomic unit. The aim of this presentation is to outline the current state of knowledge on the evolution and taxonomy of Psychodomorpha and to present a new perspective on these issues in light of new data.

Funding: This research was funded by the Polish National Science Centre (NCN), grant No. 2020/37/B/NZ8/03042.

Unrecognized diversity in the *Hydroporus planus* group (Coleoptera: Dytiscidae): The *H. fuscipennis* and *H. discretus* lineages

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The Holarctic genus *Hydroporus* Clairville, 1806 currently comprises 188 species and represents one of the most species rich genera within the family Dytiscidae. Although the genus has been divided into several species groups, reliable identification remains challenging in some lineages due to strong morphological similarity among species. One such complex is the *Hydroporus planus* group (also referred to as the *H. fuscipennis* group), which currently includes 38 species, most of them distributed across the Palearctic region. In this study we focus on the integrative revision of two problematic lineages within this group, the *H. fuscipennis* and *H. discretus* complexes and their closely related allies. Our analyses combine traditional morphological examination (male genitalia and external morphological characters) with molecular species delimitation using DNA sequence data. *Hydroporus fuscipennis* has been considered a widely distributed Palearctic species ranging from Central Europe to Japan. However, preliminary examination of male genitalia revealed consistent morphological differences suggesting that this taxon represents a complex of multiple species rather than a single widespread species. Similarly, distribution patterns within the *H. discretus* lineage raise taxonomic questions. For example, the nearest previously known records of *H. transgrediens* originated from Turkey, Cyprus, the Caucasus region, Asia Minor and Central Asia, making its occurrence in Hungary geographically isolated from the main distribution range. Our integrative analyses revealed clear and concordant morphological and genetic differentiation among several specimens, requiring the reinstatement of previously synonymised names in order to stabilise the taxonomy and nomenclature of the group. In this presentation we summarise the first results of this ongoing revision and highlight evidence for previously overlooked diversity within the *Hydroporus planus* species complex.

12 sites 14 years – Long-term development of benthic invertebrate communities in an urban stream system after restoration

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Benthic invertebrate recolonization after stream restoration is a complex process. Repeatedly low habitat diversity and missing source populations are mentioned as factors hindering or delaying recolonization processes. Particularly in urban streams colonization sources are a big problem and additionally multiple stressors often impede ecological recovery. The Boye system in Germany is a 78 km^2 catchment area which flows through the Ruhr metropolitan area, which is inhabited by more than 5 million people. Most of the system was used as open sewers in the 20th century. In the beginning of the 21st century the wastewater was redirected to underground sewers and the streams morphologically restored. Since 2012, benthic invertebrate samples were taken annually at 12 sites to monitor the recolonization. The data show clear changes in the communities and in the ecological quality. In the beginning good dispersing generalist taxa colonized the sites but with the years sensitive species became more abundant proving that recolonization sources are present and that recolonization takes time but has chances even in highly disturbed urban catchments. This talk will show details of community developments and improvements in ecological quality over more than a decade and highlight its drivers and pressures.

Funding: This research was funded by the German Research Foundation (DFG) – CRC 1439 – project number: 426547801.

Do small reservoirs benefit intermittent streams? Effect on aquatic macroinvertebrates, water quality and dry phase duration

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Intermittent low-order streams constitute a substantial proportion of river networks and play a pivotal role in maintaining the ecological integrity of downstream reaches. These systems are increasingly stressed by anthropogenic activities, including the construction of small water reservoirs (SWRs). We investigated the role of SWRs as water-retention elements and their downstream influence on aquatic macroinvertebrates in intermittent streams in the humid continental climate of the Czech Republic. Using a paired design across sixteen streams, we compared sites above and below reservoirs with analogous sections in unregulated intermittent streams. Our results demonstrate that SWRs significantly degrade water quality by increasing biochemical oxidation demand, suspended solids, and nutrient concentrations, while simultaneously prolonging the duration of dry periods downstream. While broad biodiversity metrics such as Shannon diversity and taxa richness were primarily suppressed by intermittence intensity itself, specific indices, including the saprobic index, rhithral index, and PSI index, effectively captured the ecological shifts caused by SWR presence. These shifts reflect a transition from rheophilic to limnophilic communities more tolerant of hypoxia, siltation and increased organic pollution. Furthermore, SWRs significantly increased community dissimilarity between upstream and downstream sections, acting as both environmental filters and recolonisation barriers. These findings highlight that the interaction between stream intermittency and SWRs necessitates careful management to mitigate cumulative negative impacts on lotic ecosystem functioning and biodiversity during dry periods.

Beyond composition: The role of spatial configuration in identifying refuges for macroinvertebrates in aquatic landscapes

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In the context of a study on aquatic refuges under global change, we investigated how fluvial mosaic diversity influences benthic invertebrate biodiversity. Specifically, this work tests the hypothesis that both the composition and structural organization of mesohabitats within the active channel promote the species abundance, and that mesohabitat spatial configuration also plays an important role in shaping biodiversity patterns. To test these assumptions, aquatic invertebrates were sampled along a naturally sandy river (the Lauter) located at the border between France and Germany. In parallel, detailed maps of the active channel were produced for each of the five study sites in order to characterize habitat landscapes relevant at the scale of benthic invertebrates using quantitative descriptors. Analyses were performed at the sampling-point scale, with the surrounding environment defined within a 2 m radius around each point, representing 120 distinct situations. RLQ and fourth-corner methods were used to explore how fine-scale spatial heterogeneity shapes functional community structure. Our results reveal that while substrate composition (erosion vs. sedimentation) acts as a primary environmental filter, spatial configuration—particularly edge richness and patch complexity—helps maintain community functional diversity. Even in highly sandy reaches, complex mesohabitats reflect context-dependent structural patches and ensure the local conditions required to maintain demanding functional traits, such as those of rheophilic organisms that would otherwise be absent from simpler habitat configurations. By demonstrating how landscape metrics explain fine-scale biological responses, this study offers new insights into the role of mesohabitat heterogeneity. Ultimately, shifting the focus toward these spatial dynamics provides a promising framework for identifying and preserving critical refuges for invertebrates in hydrosystems.

Funding: This research was funded by the INTERREG-RiverDiv program, launched by INTERREG in 2023 and financed by the ERDF (European regional development fund). This program is led by colleagues from the RPTU University Kaiserslautern-Landau and Eußerthal Ecosystem Research Station (EERES).

Seasonal dynamics of aquatic macroinvertebrate communities in boreal temporary wetlands and their importance for breeding waterfowl

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Temporary wetlands are increasingly recognised as important habitats for biodiversity, yet their role in supporting aquatic macroinvertebrates and breeding waterfowl remains poorly understood. In boreal regions, vernal pools and beaver-created wetlands are characterised by strong seasonal dynamics, high organic matter inputs, and often low fish presence, conditions that may favour high abundances of aquatic invertebrates. Because breeding ducks and ducklings rely heavily on protein-rich macroinvertebrates, these wetlands may represent key feeding habitats during critical reproductive stages. This study investigates temporal patterns of aquatic macroinvertebrate communities and their potential importance for breeding waterfowl in southern Finland. During the 2025 breeding season, macroinvertebrates and waterfowl were monitored at 21 sites comprising seven vernal pools, seven beaver wetlands, and seven permanent lakes. Aquatic invertebrates were sampled repeatedly throughout the season, while waterfowl presence was assessed through field observations and camera traps. Preliminary results indicate clear differences among wetland types. Vernal pools showed particularly high macroinvertebrate abundances early in the season following snowmelt, coinciding with periods when female ducks require substantial energy resources for egg production. Beaver wetlands appeared to be more stable later in the breeding season and may provide important feeding habitats for ducklings. Vernal pools also tended to support the highest macroinvertebrate abundances, whereas beaver wetlands appeared to sustain greater macroinvertebrate diversity. These findings highlight the ecological importance of temporary wetlands in boreal landscapes and suggest that small and dynamic habitats may contribute disproportionately to aquatic productivity and waterfowl breeding success.

The impact of temperature changes on the morphology of Chironomidae

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The Chironomidae (non-biting midges) are one of the most widespread and diverse families of invertebrates in freshwaters. Due to their wide distribution, noticeable responses to environmental changes and the remains, which are produced in lake sediments, they are widely studied in the context of ecology, bioindication and paleobiology. However, the poorly explored process relies on the ability of species to acclimate to novel climates through a series of changes across biological levels, including body size changes. To investigate potential changes in the morphological dimensions of Chironomidae, we conducted a two-pronged study involving both - a literature meta-analysis focused on temperature–size relationships and prior to that - an experiment. The experiment was conducted using *Chironomus riparius* larvae reared at three different temperatures (20, 22, and 24°C). Results indicate that noticeable changes in the length of head capsule occur with slight temperature variations with smaller size at higher temperature. Given the relatively short duration of the experiment, it can be concluded that Chironomidae may exhibit considerable phenotypic plasticity expressed in HC size variations, a hypothesis that may finds support in the existing literature. That is why complex meta-analysis was performed. In total 2668 individual measurements of Chironomidae were extracted from the literature (considering both larvae, and imagines), including as many as 142 species represented solely in the wing length analyses. In order to determine the effect of temperature on selected morphological traits, the same linear model was used where “mm change in wing length per 1°C increase in temperature” was represented on the x-axis. Overall, after comparing the results of the experiment and the meta-analysis of the literature, we may accept the hypothesis that chironomids exhibit phenotypic plasticity, however the topic still leaves room for further research.

Distribution and phenology of the endemic caddisfly *Chaetopteryx mecsekensis* in the Mecsek Mountains

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Chaetopteryx mecsekensis, an endemic and flightless species of the Mecsek Mountains, has an extremely restricted distribution and highly specialized habitat requirements, occurring almost exclusively in springs. Despite its considerable conservation and biogeographical importance, the last detailed occurrence data date back to the 1980s, only a few years after the species was discovered. Based on its habitat preferences and autumn activity period, the species is considered cold-adapted; however, little is known about its biology beyond these basic observations. The aim of our study was to reassess the current distribution and activity period of *C. mecsekensis* approximately four decades after the last detailed surveys. Adult individuals were surveyed during three periods in the autumns of 2023–2025. Previously known localities were revisited and additional potential habitats were also examined. At two sites (Pásztor Spring and Kánya Spring), where the largest populations were detected, detailed surveys were conducted to determine the activity period. Our results indicate that the overall distribution of *C. mecsekensis* has not changed substantially; however, population sizes have declined dramatically. The activity period has also shifted from the previously reported September–November interval to November–December. In addition, a marked phenological difference was observed between the two springs, with activity beginning about three weeks later at Kánya Spring than at Pásztor Spring. These results suggest that climate warming and associated habitat changes may strongly influence the occurrence of this species. Continued warming may lead to the loss of suitable habitats and a shortening of the reproductive period, potentially resulting in severe population decline and potentially the extinction of *C. mecsekensis*.

Riparian forested buffers are beneficial for carabid diversity in agriculturally modified catchments

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Riparian zones represent habitats formed between lotic and terrestrial ecosystems that possess unique biodiversity and provide a wide array of regulatory ecosystem services. Despite their benefits, such areas have been massively impacted by land use changes within most catchments of the globe. The protection and efficient management of river corridors require strategies and trade-offs best guided by scientific knowledge. Consequently, we analysed the role of riparian forested buffers in shaping the taxonomic and functional diversity and community composition of ground beetles within an moderately agriculturally modified catchment. We consider carabids to be reliable study organisms since they represent key cross-ecosystem trophic links, valuable crop pest predators and scientifically validated bioindicators of environmental change. Our results indicated that buffered riparian zones support higher carabid diversity and provide shelter for rare and specialized taxa, as opposed to unbuffered zones. Additionally, we highlight carabid compositional differences between buffered and unbuffered riparian habitats and showcase how local riparian characteristics and spatial structure influence the studied communities differently from taxonomic and functional standpoints. We conclude by raising awareness on potential threats of further land use change within our catchment and by providing recommendations for the improvement of riparian conservation and management.

Does the Lithuanian river macroinvertebrate index fit EU requirements?

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Macroinvertebrates are among the most widely used bioindicators for assessing the ecological quality of freshwater under the Water Framework Directive (WFD) and worldwide. Since the implementation of the WFD, methods for assessing the ecological status of freshwater have evolved from simple single-indicator metrics, like EPT richness, to more complex country-specific multimetric methods. The Lithuanian River Macroinvertebrate Index (LRMI) was developed in 2013, and applied equally to all its five river types, despite the WFD's type-specific requirements. This study presents a newly updated ecological quality assessment method calibrated to each of Lithuania's five river types, incorporating different taxonomic and macroinvertebrate functional metrics. Despite the widespread use of commonly applied metrics in Europe, such as EPT richness, our results demonstrate that metrics incorporating Crustacea and Diptera taxa show strong and consistent responses to organic pollution. Conversely, Trichoptera showed relatively weak and inconsistent correlations with organic enrichment, suggesting limited sensitivity or an impoverished species pool. The inclusion of functional metrics into the method, which can help provide additional insights into ecosystem functioning and community dynamics, may help bridge the gap of current ecological assessment methods used in Lithuania. This is because the ecological quality of rivers may appear similar, i.e., fall into the same ecological status class or show similar trends, but may have underlying differences in ecosystem functioning and community structure that remain undetected by EQR alone. The updated assessment method is expected to be more ecologically relevant or more comprehensive in the assessment of river ecosystems and effective in the context of the management and restoration of Lithuania's waterbodies.

Does reduced temperature heterogeneity of stream microhabitats favour climate change "winners"?

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Climate warming restructures freshwater macroinvertebrate communities by favouring tolerant winner taxa while excluding sensitive ones. Although temperature is widely recognized as a primary driver of community responses, the role of fine-scale thermal heterogeneity in mediating climate driven changes remains poorly understood. We examined whether microhabitat-scale thermal variability determines the local occurrence of climate-change winner versus non-winner taxa, while accounting for other important environmental factors. Using high-resolution data from temperature loggers and physicochemical characteristics (velocity, depth, substrate, nutrients etc.) collected across 60 microhabitat plots within short reaches in six undisturbed Central European streams, we quantified how thermal characteristics shape macroinvertebrate community richness and composition. Richness of winner taxa increased significantly with declining temporal thermal variability but showed no response to mean or maximum temperatures. In contrast, non-winner richness declined with increasing mean and maximum (i.e. 95th-percentile) temperatures and with greater water depth. Community composition of winner taxa was primarily driven by thermal variability and flow velocity, with thermal variables independently explaining ca 20% of community variation, while physicochemical factors less than 10%. It showed that winners preferred thermally stable microhabitats, while non-winners responded to broader thermal and abiotic gradients. Fine-scale thermal heterogeneity therefore acts as a contemporary environmental filter for macroinvertebrates, and understanding this role may clarify the drivers behind long-term biodiversity changes. Maintaining groundwater connectivity and geomorphic complexity may help preserve thermal microhabitat mosaics on smaller spatial scales and buffer the ecological consequences of climate warming in temperate streams.

Funding: This research was supported by the CSF grant No. GA23-05268S.

Destroying the myth: Could the Balkan Goldenring (*Cordulegaster heros*, Odonata) be a potential winner of climate change?

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Cordulegaster heros is a dragonfly endemic to Central and Southeastern Europe, protected under the EU Habitats Directive, the Bern Convention, and national legislation in Hungary and Croatia. Although previously classified as Near Threatened, it is currently listed as Least Concern by the IUCN. The preferred habitats of the species are shaded 1st and 2nd order headwater streams. The species is often referred to as 'vulnerable', and it is usually associated with clean, cold, and well oxygenated waters, and high canopy cover. The often-mentioned main threats for the species are habitat degradation and dryings. In this presentation we synthesize current knowledge on the ecology and distribution of *C. heros* based on available literature and studies from the past 15 years, including larval samplings, long-term exuviae surveys, and ecological experiments, and we discuss the following trends: the known distribution range has expanded since the early 2000s, and modelling studies also suggest future area expansion under multiple climate scenarios. The species prefers perennial flow; however, larvae could survive a 3-week-long drying in laboratory conditions, and it seems that the species has other drying-resistant/resilient mechanisms too. Although prolonged dry periods limit the distribution of the species, it can still be present at sites with even 100 consecutive dry days. Reduced dissolved oxygen concentration did not significantly affect larval survival in laboratory trials. In a stream that transitioned from perennial to intermittent flow, emergence numbers initially decreased but began to recover after six years of regular seasonal drying, indicating potential population-level adaptation. Although we still believe that the species' special conservation status is justified, based on our assessment we argue that *C. heros* may not be as vulnerable as it was considered before, and it could even be one of the rare species to benefit from the effects of climate change.

Spatial and temporal changes in freshwater macroinvertebrate diversity across Poland

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Understanding how freshwater biodiversity changes across space and time is essential for predicting ecosystem responses to environmental change, yet such analyses are surprisingly scarce for large and environmentally diverse countries like Poland in the heart of Central Europe. We compiled a nationwide dataset mandated by the WFD and provided by the General Directorate for Environmental Protection in Poland, comprising freshwater macroinvertebrate data collected between 2009 and 2023, mostly identified to the family level. This study aimed to investigate changes in the taxonomic and functional diversity of Polish freshwater macroinvertebrates across space and time. In total, we used data from 225 sampling events representing 54 sampling sites, each with at least four sampling events over an observation period of at least eight years. Additionally, we extracted environmental variables from Copernicus' CORINE land cover and TerraClimate datasets. We applied a two-step analytical framework. First, we used generalized least squares to assess temporal changes in diversity metrics at each site. Next, we used an unweighted meta-analytic Bayesian approach to synthesise trend estimates across sites. Across all sites, we observed minor increases in overall abundance, but more pronounced increases in taxonomic richness, accompanied by a decline in evenness. Functional diversity remained relatively unchanged. Increases in richness and abundance were primarily observed in non-EPT insects, molluscs, and crustaceans, while annelids generally declined. Concurrently, average increases in temperatures at the same sites over time may partly explain the observed biological patterns. Our results highlight ongoing shifts in freshwater macroinvertebrate communities in Poland and suggest a potential link to climate change. These findings provide the first glimpse of changes occurring in these key Central European freshwaters and are particularly relevant for conservation management.

Taxonomic and trait-based shifts in macroinvertebrate communities upstream and downstream of small hydropower plant intake points

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Macroinvertebrates contribute to aquatic ecosystem functioning through a wide range of ecological roles. Because they respond sensitively to multiple anthropogenic pressures, changes in their taxonomic composition, diversity, and functional traits provide valuable insights into the ecological state of freshwater systems. Small hydropower plants (SHPs), although often perceived as environmentally friendly, can alter local flow regimes, turbulence, and longitudinal connectivity, potentially affecting habitat quality and, consequently, macroinvertebrate community structure and functional composition. This study compared macroinvertebrate communities sampled up- and downstream of 24 SHP intake points distributed across streams within four Hydrographical Basins in Romania. We assessed spatial and seasonal differentiation using taxonomic abundance data, diversity metrics and community - weighted means (CWM). Hydromorphological and physico-chemical variables were also included to improve the interpretation of the observed patterns. Results revealed both taxonomic and functional shifts, particularly during summer, when community composition diverged most clearly between up- and downstream sections, in patterns consistent with local environmental conditions. Understanding these effects is essential for developing effective adaptation and mitigation measures aimed at reducing hydropower related ecological impacts, particularly in the current context of ongoing climate change.

Funding: This research was financed by the Romanian Ministry of Environment, Waters and Forests which is kindly acknowledged.

From hidden diversity to ecological patterns: Integrative insights into epikarst copepods

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Subterranean ecosystems are increasingly recognised as reservoirs of hidden biodiversity, where morphologically similar organisms may represent distinct evolutionary lineages. Groundwater copepods are a prominent example, as their simplified morphology often obscures species-level diversity. Using an integrative approach combining morphology with mitochondrial (COI) and nuclear (28S rDNA) markers, we investigated copepod diversity in epikarst seepage of the Demänová Karst (Slovakia). Molecular analyses revealed a genetically distinct lineage among specimens previously identified as *Elaphoidella phreatica*. Detailed morphological examination subsequently identified subtle but consistent diagnostic characters, leading to the description of a new species, *Elaphoidella droppai*. To place this taxonomic discovery in an ecological context, we analysed copepod occurrence and assemblage composition in relation to environmental variables across multiple caves. Both were associated with key environmental factors, particularly drip rate, pH and ceiling thickness. In particular, *E. droppai* occurred more frequently at sites with thicker ceilings and higher pH, whereas *E. phreatica* lineages showed weaker or more variable environmental associations. Together, these results illustrate how integrative taxonomy combined with ecological analyses can reveal hidden diversity and improve our understanding of biodiversity patterns in karst groundwater ecosystems.

Funding: This research was funded by the Slovak Research and Development Agency (APVV-23-0208).

Drivers of macroinvertebrate diversity in Alpine streams: A multiscale spatial analysis

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The global biodiversity crisis is affecting ecosystems worldwide, with freshwater environments among the most vulnerable to anthropogenic pressures and climate change. Despite covering only a small fraction of the Earth's surface, freshwater ecosystems support about 10% of known species, and aquatic insects represent a key component of this biodiversity. However, several species in Alpine streams are increasingly threatened by climate change, water quality degradation, and habitat alteration. In this context, improving our understanding of freshwater ecosystems is crucial for developing effective management and conservation strategies at both local and broader spatial scales. We conducted a spatial analysis of freshwater macroinvertebrate assemblages in the Autonomous Province of Bolzano (Italy), sampling 120 sites across small Alpine catchments. Using multiple biodiversity indicators, we investigated how environmental gradients at different spatial scales shape macroinvertebrate assemblages. At the microhabitat scale, substrate type emerged as the strongest driver. Substrate diversity was calculated for each site and used, together with chemical and physical parameters such as water temperature, pH, and conductivity, to assess their influence on community composition at a broader spatial scale. This multiscale approach allowed us to disentangle the relative contribution of local habitat features and larger-scale environmental conditions in determining biodiversity patterns across Alpine freshwater ecosystems. Our results contribute to a better understanding of benthic diversity and highlight the importance of integrating multiscale ecological information to guide innovative and effective strategies for freshwater biomonitoring and ecosystem conservation.

Funding: This research was funded by the Biodiversity Monitoring South Tyrol (BMS) project.

Macroinvertebrate monitoring of large streams: The potential of DNA metabarcoding for ecological assessments

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Since 1986 and 1992 respectively, the Federal Institute of Hydrology (Germany) has been monitoring benthic invertebrates in the Rhine and Elbe rivers resulting in over three decades of valuable biodiversity data from nearly 17,000 samples. This data forms the backbone for the assessment of waterway management regarding ecological aspects and the evaluation of the ecological status of German federal waterways. They also serve to record biodiversity and track invasive species. Species identification based on morphological characteristics has been best practice over decades and is used and recognised worldwide for recording biodiversity and ecological quality. However, it is costly, time-consuming and requires specialist knowledge acquired through years of experience, which is becoming increasingly rare in Germany and other European countries. The development of innovative methods for species identification, such as DNA analysis, has advanced rapidly in recent years. The first international standard has already been adopted (DIN EN 17805), and it has become apparent that DNA-based methods also have great potential for ecological monitoring. Yet, the widespread introduction of the methodology into regulatory monitoring is still pending. For the monitoring of benthic macroinvertebrates in federal waterways, we aim to supplement traditional monitoring with genetic analyses and thus enrich our long-term data set with high taxonomic resolution data. In my talk, I will present comparisons between morphological and DNA metabarcoding results from recent sampling campaigns in the Rhine (2020) and Elbe (2021). We will explore how the methods differ in species detection and ecological status evaluation and what their combination might imply for the future of large-scale aquatic monitoring of German rivers. Insights from ongoing research projects will highlight challenges, opportunities, and the next steps toward integrating DNA-based tools into long-term environmental assessment.

Funding: This research was funded by the Federal Institute of Hydrology, Germany.

An updated perspective on species diversity and host interactions in European branchiobdellidans (Annelida: Clitellata)

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Branchiobdellidans comprise a group of obligate ectosymbionts, parasites or commensals of freshwater crayfish whose diversity and host interactions in Europe have long been underestimated. We present a new multilocus phylogeny based on mitochondrial (CO1, 16S) and nuclear (28S, ITS) loci across seven described and at least two potentially new European branchiobdellidan species. Our phylogeny is based on new collections from more than 60 localities across Europe. In addition, museum specimens (collected in 1929–2018) were included in the morphological analysis, resulting in a total of 150 analysed localities. Our results expand understanding of the distribution of branchiobdellidans in Europe. Morphological analysis of fresh samples from the type locality of the sub-species *Branchiobdella balcanica sketi* led to the rejection of the taxon. Integration of morphological and molecular approaches allowed resolution of taxonomy within the *B. parasita* complex, revealing at least three distinct species. We documented how individual branchiobdellidan species demonstrate specific symbiotic interactions both with each other and with their crayfish hosts, in particular in the partitioning of microhabitats on the exoskeleton for cocoon deposition and in the expression of distinct ecological strategies. While some species remain more parasitic, feeding on host tissues, others actively use the host as a hunting platform to capture benthic prey from the surrounding environment. This reveals a triple "host–symbiont–benthic environment" interaction framework that extends beyond classical binary symbiosis models.

Funding: This research was partially supported by the Slovenian Research and Innovation Agency through Research Core Funding P1-0184; the Ministry of Education and Science of Ukraine under the project No. 0125U001468.

Urban water reservoirs as breeding sites for mosquitoes: Larval phenology and habitat diversity in urban conditions – a case study from Łódź (Poland)

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Mosquitoes (Diptera: Culicidae) comprise approximately 3500 species worldwide, more than 50 of which occur in Poland. Mosquito larvae inhabit both natural and humanised environments. In urbanized areas culicids occur across a wide range of habitats with different abiotic conditions, which highlights the importance of detailed studies on their ecology in urban ecosystems. Therefore, the aim of the present study was to investigate the phenology and habitat preferences of mosquitoes in the city of Łódź. Mosquito larvae were collected from 22 locations within Łódź between March and October, twice per month. Simultaneously, several habitat parameters (e.g. type of water body and water availability), including physicochemical variables, were recorded. Based on 5537 collected larvae belonging to 14 species, the phenology of mosquito larvae and the diversity of habitats they occupied in the studied urban area were determined. Species of the genus *Culex* and *Anopheles maculipennis* s.l. were observed for the longest period during the year. Species occurring mainly in early spring included *Culiseta morsitans* and *Aedes annulipes/cantans*, whereas larvae of *Aedes geniculatus* and *Anopheles claviger* s.s. were recorded primarily in late spring and summer. Regarding habitat characteristics, species of the genus *Culex* exhibited the broadest ecological spectrum. In contrast, *Aedes japonicus* showed preference for artificial water containers, while *Culiseta morsitans* was frequently present in natural water bodies. A strong association with temporary water bodies was found for *Aedes japonicus*, *Aedes geniculatus*, *Aedes punctor* and *Aedes communis*. No species were recorded exclusively in permanent water bodies. Summarising, in this study the occurrence of each species was linked with specific environmental and physicochemical factors. Thus, the results obtained on the ecology of mosquitoes in Łódź constitute an essential basis for developing monitoring plans and preventive strategies.

Funding: This research was funded by the University of Lodz within the Student Research Grants Programme, grant No. 758.

Adapting the WFD ecological status assessment for intermittent streams: A Czech approach

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Due to accelerating climate change, intermittent streams are becoming increasingly common across Central Europe. Current biological assessment methods under the Water Framework Directive (WFD), however, were primarily designed for perennial watercourses. When applied to drying streams, these methods often produce misleading results, interpreting the natural decline of sensitive taxa during drought as evidence of anthropogenic degradation. This incorrect assessment of ecological status poses a significant challenge for water management and the setting of realistic environmental objectives. To address this discrepancy, we developed an assessment method adapted to the specific conditions of drying streams. The research focused on identifying indicators within phytobenthos and macroinvertebrate communities that can distinguish between natural drying and human-induced pressures, such as pollution or morphological degradation. Key challenges were assignment of drying water bodies and the establishment of reference communities. Our findings indicate that assessing the ecological status of drying water bodies is feasible when using a specific approach. However, the high temporal instability of biological communities during the autumn recovery phase prevents the use of samples collected during that period for correct assessment. Consequently, a modification of current monitoring strategies is proposed to ensure more relevant results. The resulting framework provides a more objective basis for classifying water bodies and ensures that intermittent streams are not penalised for their hydrological regime. By bridging the gap between hydrological reality and regulatory requirements, this approach provides water managers with essential tools for effective river basin management under a changing climate.

Fostering cross-border river monitoring of macroinvertebrates using (e)DNA metabarcoding in the Drava/Drau River

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Global change and intensive freshwater use are reshaping river ecosystems. Yet current monitoring often lacks the resolution and frequency needed for timely management. ZDrauA, an Interreg Slovenia–Austria project, is developing a toolset that integrates molecular methods with established frameworks to support cross-border management of the Drava/Drau catchment. In the project, we are synthesizing existing guidelines, best practices, and standards and proposing regionally focused protocols that enable the detection of macroinvertebrates. To support the implementation of molecular methods, a stakeholder questionnaire addressed the use of different methods and the needs of regional agencies and laboratories. The outcome revealed that the majority of the 26 participants focus on river ecological status assessment and expressed a need for practical protocols and regulatory integration of molecular methods and interest in collaboration with research partners. Options to foster these outcomes through ZDrauA were presented in online workshops. To share know-how on the use of commercial and custom filter systems for eDNA collection and bulk sample/eDNA metabarcoding analyses, 9 sites were analysed in Austria and 12 in Slovenia. Preliminary in silico analysis on available macroinvertebrate reference sequences and primers were conducted. The analysis indicated that metabarcoding of samples from Drava/Drau samples can detect and distinguish up to 90.7% of 497 target taxa known from state assessments. On one hand, overall coverage is high; on the other hand, it highlights the need for taxa-specific refined markers or complementary methods. To further support data interpretation in both countries, resources including a ZDrauA sequence database are being established. By providing metabarcoding results for regional and national information facilities and refining analysis protocols, ZDrauA is enabling more responsive freshwater assessments and cross-border collaboration.

Funding: The “Next-generation biomonitoring of the Drava/Drau River for sustainable and healthy regional development (ZDrauA)” project is supported by Interreg Slovenia-Austria grant No. SIAT00231.

Does the creation of new artificial ponds help support aquatic invertebrates in lowland agricultural landscapes?

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Over the past 150 years, the intensification of agriculture has led to a widespread and irreversible transformation and disappearance of wetland habitats in the lowland landscapes of Central Europe. For this reason, a large number of new habitats—primarily ponds—are currently being constructed to support endangered wetland biodiversity. However, these habitats face a number of problems, including very poor water quality, lack of care leading to overgrowth, and the presence of invasive fish species. Furthermore, there is a complete lack of a comprehensive assessment of the significance of these new habitats. For this reason, we studied aquatic invertebrate communities in the habitats of small fishponds, near-natural wetlands, and newly constructed ponds. We found that the number of invertebrate species in the new ponds is comparable to that in intensively managed fishponds but significantly lower than in natural wetlands, with this situation varying among individual taxa. The new ponds supported the occurrence of dragonflies and dipterans but did not provide a suitable environment for aquatic beetles, molluscs, or annelids. For other groups, such as mayflies and caddisflies, none of the three studied habitats offers a suitable environment and their representatives have disappeared from the landscape. Aquatic bugs exhibited comparable species richness across all habitat types. Our results further show that different factors play a key role in various habitats. Overall, it is clear that new ponds fall short of expectations in supporting invertebrate biodiversity. Rare and endangered species occur less frequently in them than in natural wetlands, and the community composition is similar to that of fishponds. To support aquatic invertebrates, a shift is needed in the current approach to wetland restoration toward more comprehensive solutions that include the restoration of the water regime within the landscape context and the support of associated natural processes.

Funding: This research was funded by the Technology Agency of the Czech Republic, grant No. SS06010189.

Dry Hard: Macroinvertebrate community thresholds along drying gradients

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When environmental change is multidimensional, ecological inference depends not only on disturbance magnitude but also on how environmental gradients are represented. In river networks, the expansion of flow intermittency exemplifies this challenge: surface-water loss occurs through contrasting temporal configurations that differ in frequency, duration, and cumulative extent. Although these dimensions of drying are commonly quantified using interchangeable proxies, it remains unclear whether they capture equivalent ecological information or translate into similar community-level outcomes. We examined how multiple drying patterns structure macroinvertebrate communities within a historically perennial river network that has only recently begun to experience recurrent drying. We quantified four complementary drying proxies describing frequency, mean duration, maximum duration and cumulative duration of dry phases. We paired conventional diversity metrics with Threshold Indicator Taxa Analysis (TITAN) to quantify taxon-specific change points and emergent community-level thresholds along each drying gradient. Aggregate alpha-diversity metrics responded weakly and consistently across all drying proxies: taxonomic richness and total abundance declined with increasing drying, whereas Shannon diversity and evenness showed no significant change. In contrast, threshold-based analyses revealed proxy-dependent community reorganisation. Coordinated taxon responses emerged most clearly along proxies describing prolonged and cumulative drying, whereas responses along the frequency-based proxy were more diffuse. These transitions arose from taxon-specific responses, including both broadly responsive and configuration-sensitive taxa. Our results show that ecological thresholds are not solely properties of communities, but also of how environmental change is represented, such that strongly correlated proxies can yield non-equivalent threshold inferences.

Seasonal melt dynamics drive long-term macroinvertebrate biodiversity in a glacier-fed Alpine stream

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Alpine glacier-fed rivers are among the freshwater ecosystems most exposed to climate change, as glacier retreat, rising temperatures, and increasing droughts alter hydrological regimes, sediment dynamics, and habitat stability. These changes strongly affect aquatic biodiversity, particularly cold-adapted benthic macroinvertebrate communities. We investigated long-term ecological dynamics in the Saldur/Saldura stream, a glacier-fed Alpine river located in the inner northeastern Italian Alps. The catchment is characterised by a dry climate, relatively low anthropogenic pressure, and the presence of the Matscherferner glacier, which has lost approximately 30% of its surface area over the last three decades. Since 2010, benthic macroinvertebrates have been sampled monthly during the snow-free period (April–October) at three elevations along an altitudinal gradient. The study aims to assess temporal and seasonal trends in community structure, taxonomic and functional diversity, with particular emphasis on disentangling species turnover from species loss as drivers of community change using a Bayesian framework. Community responses to hydrological and physicochemical parameters were also evaluated. Our results show that seasonal variability in discharge strongly influences the structure of macroinvertebrate assemblages. Increased runoff during peak glacial- and snow-melt periods is associated with reduced faunal density, taxonomic richness, and functional diversity. In contrast, longitudinal patterns reflect downstream decreases in environmental harshness. Preliminary compositional analyses reveal interannual variability and marked temporal turnover during the peak melt periods, highlighting the importance of species replacement processes along the altitudinal gradient in summer. Continued long-term monitoring is essential to disentangle climate-driven biodiversity change from natural seasonal and interannual variability in glacier-fed Alpine rivers.

The decline of sandhoppers (*Talitrus saltator*) on sandy beaches in Poland – 60 years of observations

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The occurrence and density of sandhoppers was observed along the entire Polish Baltic Sea coast (500 km) in the mid 60-ties of the XX century, when approach to the beach was limited by the military, and sandhoppers were common almost everywhere. The study was repeated in the early 2000s, when only half of the sites were still occupied by the species, and tourism with associated infrastructure clearly impacted its occurrence. After further 25 years we have confirmed the species ongoing decline (which is now protected by law and is endangered) and again an increase in human disturbance levels (including vehicles on the beach) is most likely to blame. New elements in the system are three relatively new non-native sandhopper species *Cryptorchestia garbinii*, *Platorchestia platensis*, *Deshayesorchestia deshayesii*. However, their ecology and distribution are different compared to *Talitrus saltator*.

Stream restoration effects on benthic invertebrates: Habitat quality over habitat diversity?

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Since the enactment of the European Water Framework Directive (WFD), huge amounts of money have been spent on stream restoration projects in Germany. They usually aim at restoring near-natural hydromorphology, while also initiating dynamic processes and allowing them to reshape hydromorphology. The idea behind this approach is to promote benthic invertebrates by providing a high variety of habitats, thereby fostering a diverse community composition, including sensitive species. Ideally, the result would be an increase in ecological status. However, the positive effect of restoration on benthic invertebrates is generally much lower than expected, although habitat heterogeneity is usually improved. In Germany, many streams suffer from eutrophication effects, specifically algae blooms, due to anthropogenically increased nutrient input. Detritus clogs the hyporheic interstices, which severely reduces oxygen supply in the hyporheic zone and thereby limits habitat quality for benthic invertebrates. Consequently, the quality of those habitats might limit the colonisation of sensitive benthic invertebrate species and not habitat heterogeneity. This would at least partly explain the lack of biological recovery following hydromorphological improvements. We analysed benthic community composition in a eutrophicated mountain river at sites with different hydromorphological quality and varying oxygen supply in the sediments and the effects of a restoration project on benthic invertebrates. Our results indicate the importance of habitat quality for the improvement of ecological quality of benthic invertebrates. Benthic invertebrates showed a clear response to the increase of oxygen supply and redox potential within the sediment, while habitat diversity did not seem to have a measurable effect. In addition, we can show how hydromorphological restoration measures, specifically planned to increase habitat quality for benthic invertebrates, can indeed improve ecological status.

Global warming impacts on freshwater mussels

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Recently, there have been numerous reports of mass mortality events among freshwater mussels. The mechanism behind such phenomena is difficult to capture, as they are generally short-lived and the factors triggering mass die-offs can change rapidly. We have conducted a detailed study of the phenology and reproductive effort of an endangered freshwater mussel species from the *Unio crassus* complex (Bivalvia: Unionidae) in relation to the impact of global warming. Furthermore, based on national monitoring data, we have demonstrated an intensifying extinction process of this mussel across Poland. An analysis of the situation across Europe indicates that populations in Southern Europe are the most vulnerable, where the quality of state-led monitoring is often insufficient. Therefore, a discussion on research priorities is essential, particularly regarding monitoring methods for this group, as well as the collection, sharing, and analysis of data gathered under the Habitats Directive.

Partitioning of benthic nitrogen cycling among macrofauna holobionts in estuarine systems

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The effects of single macrofauna taxa on benthic nitrogen (N) cycling have been extensively studied, whereas the effects of whole macrofaunal communities on N cycling remain poorly explored. The simultaneous analysis of whole benthic community functioning and the metabolic activity of individual macrofaunal taxa is needed to understand species' roles in the community and to identify interspecific interactions. In our recent studies, we began using a methodologically integrated approach that included incubations of the whole benthic community as well as individual holobionts to disentangle and reconstruct benthic N cycling in the estuarine systems. In this talk, we will highlight hidden and interactive effects among the abiotic environment, microbes, and macrofauna with different feeding modes and burrowing activities. The results show that benthic macrofauna significantly contribute to benthic metabolism through both direct (e.g., excretion) and indirect (e.g., bioturbation, stimulating microbial activity) effects. Collectively, the macrofauna community promotes the recycling and reuse of N at the benthic level, limiting net losses (e.g., denitrification) and effluxes to bottom water. The detection of multiple N transformations in dominant macrofaunal holobionts suggested a community-associated, versatile microbiome that actively contributes to biogeochemical processes. Overall, in this simplified benthic community, the marked decrease of a single functional group may eventually alter biogeochemical functions or services in surface sediments.

Funding: This research was funded by the European Social Fund according to the activity “Improvement of researchers’ qualification by implementing world-class R&D projects of Measure”, grant No. 09.3.3-LMT-K-712-01-0069; National Science Centre and the Research Council of Lithuania, grant No. 2024/52/L/ST10/00304.

Abstracts – Poster presentations

Invertebrates as bioindicators of saline deep groundwater inflow to the hyporheic zone

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The chemical composition of running waters depends on the nature of the catchment and the characteristics of the geological bedrock underlying the riverbed. Saline deep groundwater reaching the hyporheic zone may alter the chemical conditions in the stream. This situation occurs in the Moszczenica River flowing over the Rogóźno salt diapir, where the inflow of deeper groundwater to river waters has been documented. Hydrochemical analyses confirm that elevated conductivity (384–3430 µS/cm) in Moszczenica hyporheic zone' result from the leaching of the underlying salt structure. It remains uncertain whether these outflows are of natural origin or come through the exploratory drillings for mineral deposits from 1960'. The saline waters contain high concentrations of elements rarely found in inland waters, such as I, Br, Mo, Y, as well as radioactive isotopes including 228Ra/226Ra. In 2025/26 over 200 samples of invertebrates and CPOM were collected from 4 sites, at the stream section where conductivity in hyporheic zone varied from 1000 µS/cm to 2500 µS/cm, and one reference site where there was no exceptional salinity. Subsequently, the spectrophotometric (SEM-EDS) analyses of crustacean and insect exoskeletons, and mollusc shells along with CPOM were conducted to determine the bioaccumulation of rare elements originating from the salt diapir. The Br, Mo, B, Rb were recorded in insects, and I, Y, Mo, In, Zr, Sn, Pu and Ra in crustaceans and molluscs. The occurrence of rare elements that are unusual in north-European freshwater is at least partly associated with deep-groundwater leaching to the hyporheic zone and thus riverbed stream. This shows that invertebrates are potentially good bioindicators of geogenic contamination of freshwaters. The investigation is being continued on fish as top predators. This will allow to assess the scale of biomagnification across successive trophic levels. The radioactivity analysis of invertebrate and fish dry mass is underway.

Current state of glacial relict calanoid crustaceans in lakes of Lithuania

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Two species of glacial relict calanoid crustaceans, *Limnocalanus macrurus* and *Eurytemora lacustris*, continue to inhabit Lithuanian lakes of glacial origin. These organisms are of significant scientific interest, as their population status can serve as an indicator of lake ecological conditions. Moreover, they play an important role in aquatic food webs by serving as a food source for fish and contributing to overall fish production. However, their populations are increasingly threatened by eutrophication and climate change. The aim of this study was to compile existing information and examine the distribution and abundance of *L. macrurus* and *E. lacustris* in Lithuanian lakes. Samples were collected in 2022 and 2025 using plankton nets of different sizes and analysed under a stereomicroscope. Data from 2022 and 2025 showed that the status of glacial relict copepod crustaceans in Lithuanian lakes can be assessed as good. *Limnocalanus macrurus* and *E. lacustris* were found in 14 and 9 lakes, respectively. Both species were found in all previously known habitats, and additional locations were identified. *Limnocalanus macrurus* was newly recorded in Juodieji Lakajai and Žeimenys lakes, while *E. lacustris* was detected in Alaušas, Galstas and Virintai lakes. The findings suggest that Lithuanian lakes are still insufficiently explored, as new habitats of relict calanoid crustaceans continue to be identified. Therefore, more comprehensive and systematic studies are needed to accurately assess the population status of these species in Lithuania.

Refugia within refugia: Dispersal, cryptic speciation and long-term survival of water crickets throughout the Balkan biodiversity hotspot – A project overview

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The Pleistocene glaciations left a profound mark on European biogeography. During glacial cycles, biodiversity was extirpated at northern latitudes, while the southern peninsulas (i.e. Apennine, Balkan, and Iberian) acted as major refugia. Recent evidence indicates that these refugia were not homogeneous or continuous during the ice ages but instead formed heterogeneous mosaics of smaller refugia interspersed with areas of limited or no refugial function, leading to within-peninsula isolation of populations during glaciations. This pattern of small areas (also known as "microrefugia" or "cryptic refugia") sheltered from broader-scale environmental instabilities over time, in which small populations of organisms can survive outside their main distribution area ("microrefugia") has become known as "refugia within refugia". The Balkan Peninsula was arguably the most important glacial refugium in Europe and is currently a major biodiversity hotspot. Features such as lower latitude, topographic complexity, and climate heterogeneity not only favoured species survival throughout the Pleistocene but also suggest that the peninsula did not constitute a single homogeneous refugium, instead comprising fragmented areas that likely supported multiple isolated refugia. In this project we will use the water cricket genus *Velia* (Heteroptera: Gerromorpha) as a model to test three interrelated hypotheses: 1) glacial microrefugia were widespread throughout the Balkan peninsula, 2) wing polymorphism shapes phylogeographical patterns, and 3) cryptic speciation has occurred in certain taxa. To address these questions, we will employ an integrative approach combining multilocus phylogenetics, species delimitation, molecular dating, ecological niche modelling, and morphometrics. By identifying microrefugia and assessing the roles of biotic and abiotic factors, the project aims to advance our understanding of dispersal, genetic connectivity, and speciation in the Balkan biodiversity hotspot.

Funding: This project is funded by the Research Council of Lithuania (grant No. S-PD-25-16).

Morphological deformities of *Prodiamesa olivacea* (Meigein,1818) (Diptera: Chironomidae) in response to physicochemical conditions in the northern Drini i Bardhë River basin, Kosovo

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The Drini I Bardhë stream in Western Kosovo flows from Shpella e Bukuroshes së Fjetur cave, which supplies tap water to the 25 000 citizens of the city of Pejë. The quality of the drinking water at the city's intake is good, but the upper section of the river and its tributaries generally suffer from pollution. Benthic invertebrates, such as Chironomidae, are good bioindicators of water quality and its anthropogenic and natural pollution. Mouthpart abnormalities of the mime midges well reflect the ecological state of the freshwater. Morphological anomalies in 554 *Prodiamesa olivacea* larvae collected in Drini I Bardhë River during May 2024 were analysed. The most frequent were deformations of the mentum (8–30%), whereas deformations of the premandibulae and mandibulae were rare. The reason for such a high share of deformed specimens may be higher Mn and Zn and low oxygen content. The present studies have a preliminary character, but they draw attention to the water quality of the stream and its tributaries, which are one of the water sources for the local agriculture and domestic animals. An extensive water quality investigation using broad chemical and biological indicators is needed to assess the impact of the river on local settlements' health.

A diet of debris? Assessing microplastic pollution in invasive crayfish (*Faxonius limosus*) populations in urban catchments

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Microplastic pollution is a critical research area among emerging contaminants. Estimating the scale of this pollution and its trophic transfer within food webs is essential for both environmental conservation and public health. Aquatic ecosystems, particularly lotic waters, often exhibit high microplastic concentrations in water and sediment. This is further exacerbated in urban watersheds by stormwater runoff and inefficient wastewater treatment plants. The spinycheek crayfish, *Faxonius limosus*, is an omnivorous scavenger and detritivore. As a benthic organism living at the sediment-water interface, it is directly exposed to high-density microplastics that sink and accumulate in sediments. This widespread species serves as a key component of food webs, acting as prey for various birds and mammals. Despite its resilience in degraded urban environments, *F. limosus* has not been extensively studied regarding microplastic accumulation. This study aimed to characterize microplastic ingestion in this species under urban watershed conditions. The research was conducted in a small urban stream in the Łódź metropolitan area (Central Poland) during 2024–2025. Forty-six individuals (total length: 30.4–110.2 mm were collected. Following morphometric measurements, gills and digestive tracts were isolated, chemically digested using 10% KOH, and filtered through glass fibre filters. Microfibers and microfragments were the most prevalent types of microplastics, consistent with the composition of local sediments. Higher microplastic concentrations were observed in the digestive tract compared to the gills. These findings highlight the role of *F. limosus* as a potential bioindicator of plastic pollution. Further analysis is required to identify polymer types and compare these results with populations from low-contamination areas.

Responses of biochemical and cytogenetic biomarkers in *Unio pictorum* from the Nemunas River affected by contamination from the large-scale fire at the Alytus tire recycling plant

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The levels of chemical contamination and biomarker responses were assessed in *U. pictorum* from the Nemunas River after a large-scale fire at nearby located tire storage and processing plant (October 2019) and following discharge of partially cleaned firefighting water. In mussels collected in 2020, downstream of the accident and discharge point contained higher concentrations of low-molecular-weight PAHs and metals (Pb, Cu, Co, Cr, Al, Zn) than upstream. Significantly higher frequencies of genotoxic effects were assessed in the gill cells of those mussels collected downstream. Those mussels accumulated higher concentrations of naphthalene- and benzo(α)pyrene-type PAH metabolites, increased AChE activity and frequencies of cytotoxic aberrations were also observed; however, compared to the upstream station, though the differences were not significant. Despite the impact of the fire accident, data from the 2020 survey shows that the concentrations of accumulated pollutants (PAHs and metals) and the levels of cytogenetic damage in *U. pictorum* from the same stretch of the Nemunas were several times lower than the one assessed during the previous surveys in 2015 and 2016. After gradual removal of severe restrictions associated with the COVID-19 pandemic anthropogenic impact on studied stretch of the Nemunas River significantly increased. Thus in 2021 and 2022 accumulated total PAH concentrations were respectively – 0.096 mg kg^{-1} d.w. and 0.094 mg kg^{-1} d.w., which is more than five times higher than the one determined in 2020, concentrations of Ni, Cd, Cr, and Pb decreased, while concentrations of Zn have increased more than 2.7 times. The haemolymph of mussels collected in 2021 contains the highest concentration of benzo(α)pyrene type PAH metabolites, biochemical parameters indicate the significant increase of oxidative stress and neurotoxic impact as well as increase of genotoxic impact on *U. pictorum* from all stations, including uppermost reference site.

Pontogammarus robustoides as bioindicators for the assessment of environmental genotoxicity and cytotoxicity in Lithuanian lakes

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For the first time environmental genotoxicity and cytotoxicity was assessed in Lithuanian lakes (Dusia, Asveja, Lūšiai) and lagoons (Antalieptė, Kaunas) using as a bioindicator organism the freshwater crustacean *Pontogammarus robustoides*. The results revealed a clear gradient of environmental impact across the studied sites, and differences in genotoxic and cytotoxic effects among lakes were significant. The highest levels of total genotoxicity and cytotoxicity (ΣGC) were observed in *P. robustoides* collected from Dusia and the Kaunas Lagoon, with values reaching up to 4‰. The elevated ΣGC values may be attributed to increased anthropogenic impact, including agricultural runoff, industrial inputs, or urban pollution sources. ΣGC values were determined in *P. robustoides* collected from the Lake Asveja were equal to 2.7‰ and in crustaceans from the Lake Lūšiai – 1.65‰. The lowest level of summed genotoxicity and cytotoxicity aberrations was assessed in *P. robustoides* from the Antalieptė Lagoon, where such value was 1‰. These findings indicate relatively low environmental stress, suggesting that this lagoon may be less affected by anthropogenic pollution. Current study demonstrates that *P. robustoides* can be used as sensitive and informative bioindicator for assessing environmental genotoxicity and cytotoxicity in freshwater ecosystems. The application of cytogenetic biomarkers, particularly the micronucleus test, provides valuable insights into the biological effects of pollution and may enhance existing monitoring strategies. These results emphasize the need for continued monitoring of water bodies in Lithuania and beyond, as well as for the integration of biological indicators into environmental management and policy frameworks.

Funding: Research Council of Lithuania, grant No. P-SV3-25-112.

Validation of standards for physico-chemical supporting elements using benthic invertebrate-based indices to assess ecological status in rivers

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The assessment of ecological status under the WFD is based on biological quality elements (BQEs), while physico-chemical parameters act as supporting elements (SE) and are essential for interpreting and validating the status derived from BQEs. Contemporary guidance emphasises that SE thresholds should not be defined in isolation, but rather through statistically robust relationships with biological responses, aiming to minimise mismatches between physico-chemical and biological classifications and to ensure that good ecological status (GES) is effectively supported. The latest ECOSTAT recommendations therefore encourage the use of analytical toolkits to test existing boundaries against observed biological responses, including the evaluation of classification agreement using confusion matrices and the consideration of trade-offs between precautionary and non-precautionary approaches. The present study addresses this need by evaluating national boundary values for total phosphorus using a data-driven approach that links nutrient concentrations with benthic invertebrate-based indices (SIG3, SMEIH). The analysis follows the recommended workflow implemented in the ECOSTAT Toolkit, including exploration of pressure–response relationships and the application of binary logistic modelling to assess the probability of achieving GES under varying physico-chemical conditions. By systematically comparing biological classifications with those predicted from physico-chemical thresholds, the study aims to assess the adequacy and ecological relevance of existing national standards. The results will contribute to a better understanding of the alignment between SE and BQEs and provide a basis for the potential refinement of threshold values. At the same time, the study highlights broader methodological challenges associated with boundary setting under complex ecological conditions, where uncertainty, data limitations, and context-specific factors play a decisive role.

Macroinvertebrate community composition in the intermittent river Crna Reka and its main tributaries

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The Crna Reka is an intermittent river in Eastern Serbia. It often dries up, while most of its tributaries have a permanent flow, although with considerable seasonal fluctuations in the amount of water. The Crna reka, with tributaries Ogašu Krjoši, Valja Streži and Vrkaluca, together with the Tisnica River, feed the Mlava Spring in Žagubica. The study was conducted over three seasons (spring, summer, and autumn) in 2024. Samples of macroinvertebrate communities were collected with a hand net using the Kick & Sweep method from all available habitat types (EN 27828:1994), at seven sites: four along the Crna Reka and three at its main tributaries. Overall, a total of 144 macroinvertebrate taxa were identified. The most abundant and diverse group was Insecta (89% and 115 taxa recorded), followed by Oligochaeta, Crustacea and Mollusca. The highest number of taxa (74) was found in the Vrkaluca River while the lowest (26) was in the confluence of the Crna reka and Tisnica. All sites were characterised by dominance of oligo- and beta mesosaprobic organisms, with the exception of the confluence of the Crna reka and Tisnica where alfa- and beta-mesosaprobic organisms dominated. This was also confirmed by the highest value of Zelinka & Marvan's saprobic index (2.06). Shannon-Wiener Diversity index ranged from 2.23 (Ogašu Krloši) to 3.57 (Crna reka 1). As many as 26 sensitive taxa were identified. In addition to a high species diversity and a large number of invertebrates in these rivers, three species were found to be strictly protected under Serbian legislation: *Epeorus yougoslavicus* (Samal, 1935), *Cordulegaster heros* Theischinger, 1979 and *Austropotamobius torrentium* (Schrank, 1803). Such high diversity recorded in the intermittent river, along with the presence of strictly protected species, provide valuable insights for further research and the development of conservation measures for this type of habitats.

Funding: This research was funded by the Ministry of Science, Technological Development and Innovation of the Republic of Serbia (contract No. 451-03-33/2026-03/200007).

Legal “Grey zones” in freshwater invertebrate protection in Central Europe

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Freshwater invertebrates are increasingly recognized for their ecosystem services, yet legal protection in Central Europe remains fragmented and often disconnected from hydrobiological practice. This poster focuses on the practical implications of nature protection laws by compiling lists of protected species from three countries, interviews with practitioners of hydrobiology and verifications of our ability to recognize protected species in their larval stages. We compare the protected species lists for Poland, Ukraine and Slovakia. We also interviewed a number of hydrobiology practitioners (n = 10) to compile their interpretations of the law and opinions on how their fieldwork methods are influenced by it. Finally, we verify whether it’s always possible to recognize protected species in vivo, in their different life stages. We conclude that enforcement of the law is minimal and that many invertebrates placed on protected species lists are highly impractical or impossible to identify in vivo as belonging to a protected species in some of their larval stages. This creates a paradox where we are unable to verify the legality of taking a sample before we preserve it. We argue that the current regulations contribute to creating a “grey zone” of legal protection which creates barriers for research. Practical solutions include obtaining blanket exemptions for all potentially protected species and improving larval identification protocols to ensure lawful field work.

Ten years of national stream biomonitoring in Israel: Macroinvertebrate-based assessment of ecological condition

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Israel's national stream biomonitoring program applies the European AQEM methodology to assess ecological status using benthic macroinvertebrates. Since its establishment in 2015, the program has generated a 10-year database comprising more than 1000 samples from approximately 500 sites across 130 streams and 15 basins. Ecological condition is evaluated using taxonomic richness, community composition, the Average Score Per Taxon (ASPT), and indicators of organic pollution. Results reveal a strong basin-scale gradient in ecological condition across Israel. Assemblages in less impaired basins include up to 58 to 60% sensitive and highly sensitive taxa, whereas in more impacted basins tolerant taxa comprise 61 to 87% of the community. Intermediate basins display mixed assemblage structures. These patterns correspond with gradients in organic pollution and habitat degradation, highlighting the strong response of benthic macroinvertebrates to anthropogenic pressure. In addition, the database provides valuable information on the occurrence of rare, endemic, and invasive taxa, thereby extending its relevance beyond ecological status assessment alone. This long-term standardized dataset provides a national baseline for freshwater bioassessment and supports ecological classification, restoration prioritization, long-term assessment of stream condition, and biodiversity-informed management.

From riffles to dredged material deposits: Ecosystem transformation in the Nemunas River

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This study examines the impact of Nemunas River riffle destruction—fast-flowing, coarse substrate sections—on macrozoobenthic communities, comparing natural habitats with dredged river stretches in the Radžiūnai–Alytus section. In natural habitats, invertebrate abundance and species diversity were significantly higher than near dredged material deposits, which formerly contained various fast-flow habitats. At the edges of dredged material deposits, macrozoobenthos abundance ranged from 54 to 286 individuals, compared to 542–1413 in riffles. Riffle communities were dominated by a few species, while dredged deposits had low, evenly distributed species. Dominant taxa in riffles were molluscs (Sphaeriidae) and dipterans (Simuliidae). Significant abundance differences between dredged deposits and riffles were observed in six taxonomic groups: Trichoptera, Diptera, Crustacea, Bivalvia, Gastropoda, and Odonata. Ephemeroptera abundance was similar, but species composition changed: slower-flow mayflies appeared near deposits, while riffles hosted rheophilic species (*Baetis rhodani*, *B. vernus*, and *B. buceratus*). The mayfly *Ephoron virgo*, a filter feeder in sandy/silty substrates, occurred in dredged areas, contrasting with riffle species preferring gravel/cobble. Average species number in dredged deposits was 16 (range 13–22), significantly lower than riffles (26, range 23–30). Substrates at deposit margins were unstable, partially mobile, and not yet colonized by phytobenthos, an important food source for invertebrates. The best conditions were in Radžiūnai (uppermost site without deposits) and Alytus (remaining riffles). This highlights cumulative dredging impacts and riffle importance. In conclusion, riffle destruction and riverbed dredging reduce biodiversity and alter communities. With only ~11% of the natural Nemunas remaining and ~40% of rifles lost, protection and restoration of coarse-substrate habitats are urgent, and further degradation should be avoided.

Uncovering chironomid diversity in the Hungarian Danube using pupal exuviae

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Non-biting midges (Diptera: Chironomidae) constitute one of the most important families of aquatic insects due to their high taxonomic and functional diversity and their key role in aquatic food webs and nutrient cycling. However, the chironomid fauna of the Hungarian section of the Danube remains poorly known, with only 55 species previously recorded. Most earlier records were based on larval material, although species-level identification at this developmental stage is often uncertain due to taxonomic limitations. In contrast, approximately 120 species have been reported from the Danube side arms, where the generally more identifiable pupal exuviae have also been collected. In the present study, chironomid pupal exuviae were collected monthly between March and October 2012 at three sites within Budapest, the capital of Hungary, and at three sites upstream of the city. A total of 128 species were identified, the majority of which had previously been recorded from the Danube or its side arms. In addition, several rare species known mainly from other large Hungarian rivers were detected, including *Cladopelma goetghebueri*, *Conchapelopia melanops*, *Glyptotendipes signatus*, and *Xenochironomus xenolabis*. The most important faunistic findings were two species, *Cladotanytarsus bicornutus* and *Pseudosmittia ruttneri*, recorded for the first time in Hungary. Our results demonstrate that in a large river system such as the Danube, the examination of larvae alone is insufficient to adequately characterize the chironomid assemblages, and the study of pupal exuviae is therefore essential.

Impact of intensive agriculture on macroinvertebrate communities: A long-term assessment (1997–2024)

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Intensive agricultural land use imposes significant pressure on freshwater ecosystems. Traditionally, monitoring the impact of pesticides in small streams has been challenging due to their low concentrations and sporadic temporal peaks driven by application cycles and rainfall. The use of bioindicators, specifically the Species at Risk (SPEAR) index for pesticides, provides a robust, integrated measure of pesticide-induced stress. This study evaluates the specificity of the SPEAR index across 79 small agricultural streams (Strahler order 3–4; with catchment areas of less than 100 km^2) in the Czech Republic. Using a dataset from 1997 to 2024, we selected sites that were representative of diffuse agricultural pollution (with a nitrate-to-total nitrogen ratio of over 0.95), while excluding municipal point sources. Our results demonstrate that SPEAR index values decrease significantly as the proportion of arable land increases and increase as forest cover increases. High agricultural intensity was found to be significantly correlated with a decline in EPT taxa, the RETI index, grazer proportions, and lithophilic species. Conversely, the saprobic index, the drought index and the mass of suspended sediments all increased significantly. To distinguish the effects of agricultural stressors from those of climate change, we analysed thermal preferences. The proportion of taxa exhibiting cold tolerance has been confirmed to decrease significantly in recent years, in line with the increasing proportion of arable land. In contrast, there has been an observable increase in the prevalence of thermophilic species alongside an increase in arable land and over the passage of time. Our study provides substantial evidence that intensive agricultural activities have a significant negative impact on the macroinvertebrate community. This effect is further accelerated by the ongoing climate change.

Funding: This study was supported by the Technology Agency of the Czech Republic, project No. SS02030027.

Life history comparison between invasive Ponto-Caspian amphipods inhabiting contrasting habitats

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Biological invasions are a major driver of biodiversity change in freshwater ecosystems, particularly in Central and Eastern Europe where several Ponto-Caspian amphipods have successfully established outside their native range. Although the life history of several species has been studied, the extent to which habitat type influences population dynamics remains unknown. In this study, we investigated the life history of two species with different ecological niches (*Pontogammarus robustoides* and *Chaetogammarus warpachowskyi*) in Lithuanian inland waters. We compared their seasonal population structure and reproductive dynamics between two contrasting habitat types: a large lake (Metelys) and a large river (Nemunas). The sampling was conducted from November 2022 to October 2023, omitting the winter months (December–February) due to ice coverage. The results show that both species exhibit a similar population structure and reproductive patterns between the two habitats, with a high proportion of juveniles in the warmer months and significantly larger body size in the overwintering generation in comparison to the warm season generations. Both species have at least two generations per year in both habitats, with a more marked seasonal population variability of in the Nemunas River. Our results reveal that the environmental plasticity of Ponto-Caspian amphipods is not accompanied by significant changes in population dynamics, highlighting that their reproductive success is not habitat dependent.

Funding: This study was partially funded by the Research Council of Lithuania, contract No. S-MIP-20-26.

Littoral macroinvertebrate communities in Greek lakes: Spatial and temporal patterns along environmental gradients

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Lakes are exposed to several anthropogenic stressors, including eutrophication and shoreline modifications, which strongly affect littoral habitats and their biological communities. In this study, we investigated littoral macroinvertebrate communities in three natural lakes (Kourna, Zazari and Pamvotis), characterized by differing trophic status and human pressures. Samplings were conducted in autumn 2018 and spring 2019. Benthic macroinvertebrates were sampled using the semi-quantitative kick and sweep method and identified to family level. Physicochemical parameters, including temperature, pH, conductivity, dissolved oxygen, chlorophyll *a* (Chl-*a*) and total phosphorus (TP) were measured. Non-metric Multidimensional Scaling (NMDS) and PERMANOVA revealed significant differences in both benthic community composition (R^2 = 0.35, p = 0.001) and physicochemical conditions (R^2 = 0.59, p = 0.001) among the three lakes, with season as a secondary driver in both cases (R^2 = 0.09, p = 0.036 and R^2 = 0.63, p = 0.001, respectively). Redundancy Analysis (RDA) showed that the first axis (RDA1; 69.1%) was positively associated with conductivity and temperature and negatively with Chl-*a* and TP. The second axis (13.4%) was influenced by pH and conductivity. Zazari autumn and spring stations showed the greatest separation as to pH and Chl-*a*, respectively. Kourna stations clustered at the positive end of RDA1, influenced mainly by conductivity and temperature. Pamvotis stations except for one station (S6 autumn) were grouped around the center of the axis. Variance partitioning demonstrated that physicochemical parameters (17.1%) and lake location (18.4%) were significant independent predictors. These findings highlight the importance of lake-specific approaches to management and restoration measures of freshwater ecosystems exposed to anthropogenic pressures.

Freshwater gastropods of Lithuania: A literature-based overview of species diversity and distribution

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Freshwater gastropods are key components of aquatic ecosystems and, with other macroinvertebrates, are widely used as indicators of environmental conditions. However, information on their diversity and distribution in Lithuania is scattered across historical and recent publications. The aim of this study was to compile and analyse available literature data on freshwater gastropod species recorded in Lithuania. Literature sources published between 1937 and 2025 were reviewed and analysed. These included faunistic surveys, regional inventories, monitoring reports and studies on non-indigenous species. The most comprehensive works were carried out by the German malacologist Peter Zettler, highlighting the need for systematic national research. In total, 51 freshwater gastropod species (30 genera, 14 families) have been recorded in Lithuania, compared with ~43 species in Latvia and 51–54 in Poland, raising questions about the presence of IUCN-listed threatened species in the region. The families Lymnaeidae and Planorbidae showed the highest species diversity. Three non-indigenous species were identified: *Physella acuta*, *Potamopyrgus antipodarum* and *Lithoglyphus naticoides*. Several species were considered doubtful due to old records or findings without confirmed observations of living individuals. These species include *Ampullaceana lagotis*, *Anisus leucostoma*, *Anisus septemgyratus*, *Anisus spirorbis*, *Ecrobia ventrosa*, *Gyraulus rossmaessleri* and *Omphiscola glabra*. Considering the rapid loss of species, studying freshwater snails is crucial for effective conservation of aquatic ecosystems. The compiled overview highlights the current knowledge of freshwater gastropod diversity in Lithuania and demonstrates that existing information is largely based on a limited number of faunistic studies. The results provide a basis for future malacological research and biodiversity monitoring in Lithuanian inland waters.

Energy reserves variability of *Gammarus varsoviensis* in the course of the Daugava River, Latvia

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Energy availability (an indicator of the overall condition of an organism) depends on feeding. Amphipods are shredders and omnivores, primarily feeding on detritus. They play a crucial role in incorporating terrestrially fixed organic material into the freshwater food web. *Gammarus varsoviensis* is the dominant amphipod found in the natural flow of the Daugava River until the Pļaviņas Reservoir. In this study, we examined the effects of resource quality on the energy reserves (glycogen, lipids) of *G. varsoviensis*. Specimens of were collected during August in 2022 and 2024 in the middle stretch of the Daugava River from the upper site at Markova/Ruģeļi to the lower site at the Veczeļķi. Simultaneously, measurements of water physico-chemical parameters were performed. We determined water biochemical oxygen demand (BOD5), total organic carbon (TOC) and nutrients, as well as fresh mass, glycogen and lipid content of gammarid specimens. The BOD5 and TOC data were used to calculate the decay coefficient k. The concentrations of TOC, BOD5, and the coefficient k displayed a similar decreasing trend from the upper to the lower site in both years studied. In 2022, the fresh mass of gammarids and phosphate concentrations decreased, while glycogen and nitrite concentrations increased from the upper to the lower site. In turn, in 2024, the observations demonstrated an opposite trend. A significant negative correlation was observed between gammarid fresh mass and energy reserves in both years. Gammarid growth was related to the phosphorus, but the effects of food quality (as indicated by the coefficient k, BOD5) on the energy reserves of *G. varsoviensis* are also dependent on biomass (or size). This reflects the allometric metabolic relationships or trade-offs. The results indicate that the quality of detritus can change over time and site in the middle stretch of the Daugava River.

Funding: This research was funded by the DU research projects No. 14-95/2022/16 “Environmental assessment of the Daugava River by analysing energy reserves of alien amphipod *Gammarus varsoviensis*” and No. 14-95/2024/4 “Spatial structural and functional variations of the zooplankton and macroinvertebrates communities in the River Daugava”.

DNA barcoding of epigean amphipods in Central Asia reveals cryptic montane diversity, cross-steppe postglacial dispersal and range expansion of invasive species

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Central Asia is a key region for understanding Eurasian freshwater biogeography, yet remains insufficiently explored, particularly regarding macroinvertebrates. Here, we present DNA barcoding data (cytochrome c oxidase subunit one – COI) from epigean gammarid amphipods (144 specimens) sampled across a vast region spanning the entire territory of Kazakhstan, ranging from lowland steppe lakes to mountain rivers, streams and reservoirs (90 sites). Our results indicate significant diversity within the *Gammarus lacustris* species complex with several putatively undescribed species occurring mainly in mountain foothills while a single widespread lineage dominated the lowland steppe lakes. The montane *G. balcanicus* species complex was less diverse, consisting of several species known from neighbouring Chinese provinces (*G. takesensis*, *G. taliensis*), however with significant local geographic structure. *Turcogammarus aralensis*, the only amphipod known from the former Aral Sea, was found to inhabit nearby lakes, raising prospects for future ecological restoration. With respect to invasive species, *Pontogammarus robustoides* was found to inhabit the brackish Balkhash Lake as well as the Kapchagay reservoir, likely introduced from the Caspian Sea, representing a 2000 km eastward range expansion. The invasive Baikalian species *Gmelinoides fasciatus* was found for the second time in Kazakhstan, in the Markakol Lake. Overall, these results fill a significant gap in our understanding of gammarid diversity in Central Asia, paving the way towards improved conservation of freshwater biodiversity in this increasingly arid region.

Funding: This research was funded by the Ministry of Agriculture of the Republic of Kazakhstan (grant No. BR23591095) and the Research Council of Lithuania (contract No. S-LL-24-13).

Building the first DNA barcode reference library for freshwater invertebrates of Cyprus

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This study presents progress toward assembling the first DNA barcode reference library for freshwater invertebrates of Cyprus. Aquatic macroinvertebrates are widely used in environmental monitoring programmes to assess water quality. However, species level identification is often limited by the need for specialized taxonomic expertise, the presence of morphologically cryptic taxa, and the difficulty of identifying immature life stages. By linking DNA sequences to validated taxonomic identifications, barcode reference libraries enable molecular identification and support the application of genomic tools in biodiversity monitoring and ecological assessment. Here we report the current status of the first DNA barcode reference library for freshwater invertebrates of Cyprus. The dataset comprises 222 COI sequences obtained from specimens collected in inland waters across Cyprus. Morphology-based identification revealed 66 morphospecies and an additional 24 higher level taxa (genus or above). Analysis of genetic diversity resulted in 98 Barcode Index Numbers (BINs), including 29 unique BINs, suggesting the presence of a significant proportion of previously undocumented diversity. Establishing such reference libraries is essential for enabling DNA-based biodiversity assessments and for integrating genomic approaches into freshwater biomonitoring, particularly in understudied regions such as the eastern Mediterranean.

Funding: This research was funded by the Cost Action DNAqua-NET CA15219.

Endemic freshwater gastropods of Greece: An IUCN Red List perspective for extinction risk and conservation priorities

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Greece is a biodiversity hotspot characterized by a high level of endemism in freshwater gastropods. Despite their ecological importance, gastropods are frequently underrepresented in conservation strategies compared with vertebrate taxa. This study presents a comprehensive assessment of the conservation status of 136 endemic Greek gastropod species using the International Union for Conservation of Nature (IUCN) Red List categories and criteria. The analysis reveals that more than 70% of the evaluated endemic species are classified within threatened categories. Specifically, 40 species are Critically Endangered (CR), 16 are Endangered (EN), and 42 are Vulnerable (VU). Additionally, 12 species are classified as Near Threatened (NT), while only 4 species meet the criteria for the Least Concern (LC) category. A further 22 species remain Data Deficient (DD), highlighting significant knowledge gaps regarding the distribution and population trends of 16.2% of the endemic fauna. The high proportion of threatened (CR, EN, VU) species is primarily attributed to restricted geographic ranges, with many species being steno-endemic and confined to single, isolated localities. These habitats are increasingly vulnerable to climate change, ongoing droughts and anthropogenic pressures, including water abstraction, pollution from agricultural runoff, habitat fragmentation and degradation. The results underscore that without targeted management actions, many of these endemic species may face a high risk of “silent extinction”. Conservation strategies should therefore shift from broad ecosystem monitoring to species-specific action plans, prioritizing the protection of microhabitats supporting CR species and targeting field surveys for DD taxa to clarify their conservation status. Integrating Red List assessments and field data into the Greek environmental policy framework will be essential for the long-term preservation of Greece's endemic freshwater gastropod fauna.

Armoured invaders: Exoskeleton traits as drivers of predation resistance and competitive dominance of non-native amphipods

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Invasive species frequently cross ecological and biogeographical barriers by gaining advantages over native taxa, particularly in competition and predator avoidance. In aquatic arthropods, the exoskeleton serves as both a protective barrier and a potential factor shaping species interactions, yet its importance in invasion success is still not fully understood. This project investigates whether exoskeleton strength and structural features contribute to the success of invasive Ponto-Caspian amphipods. Three main hypotheses will be tested: (H1) species with stronger exoskeletons are less vulnerable to predation by vertebrates; (H2) cuticular structures such as spines or projections reduce predation risk; and (H3) stronger exoskeletons are associated with increased aggression and dominance in shelter competition. The study will include three experiments using five native and five invasive amphipod species co-occurring in Lithuanian waters. First, susceptibility to predation by European perch (*Perca fluviatilis*) will be related to exoskeleton strength. Second, cuticular projections will be experimentally modified to assess their defensive role. Third, outcomes of aggressive interactions between amphipod species will be analysed in relation to exoskeleton properties. The project combines behavioural experiments with morphological and histological analyses, offering an integrated perspective on how structural traits influence ecological performance. By linking predator–prey interactions with interspecific competition, the study will provide new insights into mechanisms underlying invasion success. All data collected will be made openly available after project completion.

Funding: This research was funded by the Research Council of Lithuania, grant No. S-PD-25-39.

Chironomidae diversity along the Tisza River (Hungary–Serbia)

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The Tisza River is one of the major rivers of Central and Eastern Europe. With a total length of 977 km, it is the largest tributary of the Danube. As such, it is under constant influence of different anthropogenic pressures. Chironomidae (non-biting midges) are among the most abundant and taxonomically diverse aquatic macroinvertebrates, yet their biodiversity in the Tisza River remains scarcely documented. To analyse Chironomidae communities in the Tisza River, samples were collected from 20 sites across Hungary and Serbia in 2025. Sampling targeted all available microhabitats and employed a combination of standardized techniques: Multi-Habitat Sampling (MHS), Kick & Sweep (K&S) and Deep-Water Sampling (DWS), a method that involved dredging. This integrative approach maximized taxonomic coverage across substrate types, flow conditions and depth to provide a comprehensive assessment of Chironomidae diversity. A total of 41 chironomid taxa were identified. The most abundant and frequent taxa belong to genus *Chironomus* (344 individuals recorded at 75% of localities), followed by *Polypedilum* (322 individuals, 80% of localities). The highest number of taxa (12) was found in the Tiszabecs, Aranyosapáti, Tuzsér and Tiszacsege, while the lowest count (3) was found at Tivadar. Alfa diversity was generally high at all sites, with a lower value of its component (species richness, equitability and Shannon entropy) at sites Tuzsér, Kisköre and Tiszaug. All sites were characterised by dominance of alfa- and beta-mesosaprobic taxa, tolerant to high and moderate organic matter loading. In terms of functional diversity of chironomid communities, most of the recorded taxa preferred the potamal zone (20.07%) of the Tisza, followed by the rhithral (17.3%) and littoral (10.33%) zones. Regarding feeding types, most taxa were gatherers/collectors (48.19%). The results of this study could provide a valuable baseline for further research on the Tisza River.

Funding: This research was funded by the Ministry of Science, Technological Development and Innovation of the Republic of Serbia (contracts No. 003388783 2024 13440 003 000 016 012 and 451-03-33/2026-03/200007).

Do monkey gobies alter macroinvertebrate communities within Lithuanian freshwater ecosystems?

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Invasive species can demonstrate feeding selectivity, potentially altering ecosystem functioning and community dynamics. In Lithuania, the monkey goby, an invasive fish species widely distributed across mainland Europe, was first recorded in 2015 and by 2020 it had become abundant in the Nemunas River basin. The ecological impact of the monkey goby is uncertain, especially regarding its ability to modify macroinvertebrate communities in shared habitats. We investigated three ecosystems within the Nemunas River basin: Kaunas water reservoir (KWR, lentic system), Nemunas river (slow-flowing lotic system), and Neris river (fast-flowing lotic system). We analysed monkey goby feeding selectivity and temporal changes in macroinvertebrate communities before and after its appearance and establishment. Across all ecosystems, monkey gobies preferred amphipods and insect larvae (Trichoptera, Ephemeroptera, Diptera), and avoided molluscs, odonates, isopods, and annelids. In the KWR, temporal shifts in the relative abundance of macroinvertebrates matched the monkey gobies feeding selectivity, with decreases in amphipods and chironomids and increases in molluscs and annelids. However, no such patterns were found for the riverine ecosystems. We offer several explanations for the contrasting patterns between lotic and lentic systems. First, the KWR has lower microhabitat diversity compared to unmodified rivers and it may thus have fewer places of refuge and support more homogenous macroinvertebrate communities. Second, monkey goby populations in the KWR were more abundant compared to those within the sampled rivers, likely resulting in higher predatory pressure. Overall, monkey gobies can shift macroinvertebrate community dynamics in lentic waters when abundant. While their impact in lotic systems, with higher habitat heterogeneity, is considerably weaker and strongly dependent on habitat structure and ecosystem complexity.

Taxonomic sufficiency in the isotopic niche approach of lake macroinvertebrate assemblages: The effects of taxonomic resolution

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Taxonomic sufficiency (TS) has been proposed as a method for assessing community composition and environmental impacts, aiming to balance the biological detail of the organisms present with the time and effort required for species identification. While TS has been extensively applied to lake macroinvertebrate assemblages, empirical tests of its utility within the community-wide isotope niche approach remain scarce. The ecological information derived from $\delta^{13}C$ and $\delta^{15}N$ biplots serves as a proxy for the trophic niche, reflecting the variety of primary food sources utilized by an organism and its relative trophic position within the food web. In this study, we analysed the effects of taxonomic resolution (order, family, genus, and species levels) on community-wide trophic niche metrics in lake benthic macroinvertebrate assemblages. Samples for stable isotope analysis were collected from 19 boreal lakes during the autumns of 2009–2014, and all specimens were identified to the species level. Each taxonomic group was divided into five analytical replicates, consisting of 3–15 individuals per replicate. Six community-wide isotope metrics were employed to evaluate the impact of taxonomic resolution on macroinvertebrate isotopic niche metrics. The results indicated no significant differences in any of the metrics between the family and genus levels. However, the ecological information retained at the species level was statistically richer than at the family and genus levels. Conversely, information at the order level was significantly poorer. Interestingly, the overall degree of trophic diversity remained statistically reliable up to the order level. In conclusion, these results suggest that for macroinvertebrate community-wide isotopic niche studies, taxonomic identification to the family level is optimal, as it provides a robust balance between ecological accuracy and the effort required for species-level identification.

Funding: This research was funded by Research Council of Lithuania, grant No. S-MIP-24-101.

Multimetric macroinvertebrate index for assessing the hydromorphological status of Lithuanian rivers

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Currently, the Lithuanian River Macroinvertebrate Index (LRMI) is the sole macroinvertebrate method for assessing the ecological status of Lithuanian rivers in a Water Framework Directive-compliant manner. LRMI integrates four metrics: DSFI (Danish Stream Fauna Index), ASPT (Average BMWP Score Per Taxon), #DEP (taxa richness of Diptera+Ephemeroptera+Plecoptera), and %EHP-%CrHi (difference in relative abundance of Ephemeroptera+Heteroptera+Plecoptera v. Crustacea+Hirudinea). However, it was primarily calibrated against nutrient enrichment and organic pollution and is considered to reflect general river degradation. Here, we present the first attempts to design an additional macroinvertebrate index specifically aimed at alterations in river hydromorphology (LRMI-hm). We used a macroinvertebrate sample dataset (n = 1409) covering the 2014–2023 period obtained from the Lithuanian Environmental Protection Agency and aimed to select a robust mixture of established and newly designed metrics of differing taxonomic resolution, presented in forms of scoring systems, taxa richness, and relative abundance. The hydromorphology data clearly comprised two gradients (morphology/substrate/riparian vegetation v. hydrology), the importance of which varied by river type. Thus, the resulting LRMI-hm averages five metrics with type-specific weights: LIFE (Lotic-invertebrate Index for Flow Evaluation), Lithuania-adapted MESH (Macroinvertebrates in Estonia: Score of Hydromorphology), #DP-#Cr (difference in taxa richness of Diptera+Plecoptera v. Crustacea), %morphoF (difference in relative abundance of positive v. negative families in relation to morphological channel alterations), and %hydroF (same in relation to hydrology alterations). We conclude this was a successful attempt, as the LRMI-hm showed a medium-strength correlation with the Lithuanian river hydromorphology index, substantially higher than that of the LRMI, whereas the opposite was true for nutrients.

Funding: This work was partly supported by the LIFE Strategic Integrated Project “Integrated Water Management in Lithuania” LIFE22-IPE-LT-LIFE-SIP-Vanduo/101104645.

Restoration of an urban river in the Czech Republic: The impact of construction works on river biota and the environment

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A riverside promenade was constructed along the Svratka River in the city centre of Brno between 2022 and 2025. The primary goals of the project were to provide flood protection, create a recreational space, and transform the river channel to resemble more natural conditions. To achieve this, the river channel was given a more natural form by creating riffles and pools, increasing its capacity, and adding small wetland elements to its surroundings. Our study investigated the impact of construction works, including dredging the riverbed, draining the river by pumping out the water, and modifying the banks using heavy machinery. We expected these interventions to have a significant impact on both the macroinvertebrate community and environmental conditions. We examined the impact of the construction works using the BACI (Before–After–Control–Impact) design, which means that disturbed and undisturbed sites were compared before and after the intervention. This study describes the condition of the sites before, during and shortly after the construction. Dredging caused a significant decline in the number of macroinvertebrate species and individuals, but their numbers slowly increased again due to recolonisation. Flow and substrate characteristics as well as phytobenthos density were modified by dredging and construction works in the channel. The recovery pattern differed between the sites. It may take several years for environmental conditions and the structure of the macroinvertebrate community to stabilise, however our data indicated that the species richness of macroinvertebrates recovered relatively early after the disturbance. Long-term monitoring is necessary to assess the stabilisation and restructuring of the river environment and its biota.

“So it begins…” – Integrated terrestrial and aquatic biodiversity monitoring along an urbanization gradient in Debrecen, Hungary

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Urban expansion reshapes habitats and ecological conditions unevenly across taxonomic groups and ecosystems, creating a need for integrated biodiversity monitoring. In 2024, the local government of Debrecen and the University of Debrecen established a city-wide environmental monitoring system that, uniquely in Hungary, incorporates biodiversity monitoring alongside air, soil and water assessments. The programme operates at 48 stations covering major habitat types and the full rural-suburban-urban gradient within the 451 km^2 administrative area of the city. Sampling includes terrestrial plants and animals, aquatic communities in small streams and reservoirs, targeted surveys of species of conservation concern, and automated recording methods. Within this framework, aquatic macroinvertebrates provide a particularly informative indicator group for assessing ecological condition in urban and peri-urban waters. First-year data revealed contrasting biodiversity patterns along the urbanization gradient. Plant diversity in urban and suburban habitats was similar to that in rural sites, largely because of the high contribution of weeds and invasive species. In contrast, overall animal diversity decreased from rural to urban areas, while bird diversity peaked in suburban habitats. Rural grasslands and forests supported the highest animal diversity, followed by garden-dominated suburban sites. Results based on aquatic macroinvertebrate assemblages suggested generally degraded conditions across the surveyed water bodies. These results establish a baseline for tracking biodiversity change in a rapidly transforming urban landscape and show that organism groups respond differently to urbanization. Integrated monitoring is therefore essential for linking habitat transformation, ecological condition and biodiversity responses across terrestrial and aquatic systems, while also supporting evidence-based urban planning, conservation and environmental policy.

Indicative ecological status assessment along the Serbian stretch of the Danube River based on aquatic macroinvertebrates – JDS5

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As part of the "Joint Danube Survey 5" (JDS5) research programme, the national research team of Serbia conducted the WFD–standardised Multi-Habitat Sampling method (AQEM Consortium, 2002) to assess indicative ecological status along the Serbian stretch of the Danube River, based on aquatic macroinvertebrates. Sampling was carried out in July 2025 at 12 sites: 5 on the Danube River (588 km, covering the middle and partly lower Danube) and 7 on its tributaries (Tisza, Sava, Velika Morava, and Timok rivers). All rivers are classified as large lowland rivers dominated by fine substrate, except Velika Morava in Varvarin and Timok mouth, which were classified as large rivers dominated by medium-sized substrate. Indicative Ecological Status (IES) assessment was preformed according to national legislation (Official Gazette, 74/2011). In total, 97 taxa belonging to 12 taxonomic groups were identified, 44 were found in the Danube River and 83 in the tributaries. The main taxonomic groups in the macroinvertebrate community, in terms of taxa richness, were Diptera (32.74%), Oligochaeta (25.17%), Gastropoda (16.53%), and Crustacea (16.49%). Other recorded groups each accounted for less than 5% of the total community. The most abundant taxa were *Limnodrilus hoffmeisteri* Claparede, 1862, and *Lithoglyphus naticoides* (Pfeiffer, 1828). Selected metrics for the IES, according to national legislation, were obtained using ASTERICS software (AQEM, 2002). The IES of the Serbian stretch of the Danube River indicated a moderate (class III) to bad (class V) status, while its tributaries indicated a good (class II) to bad (class V) status. Based on the aquatic macroinvertebrate community, it was concluded that the investigated sites are primarily affected by moderate organic pollution and various types of hydromorphological pressures. Monitoring water quality increases our understanding of the overall health, biodiversity, and pollution levels of the Danube River across the entire basin.

Funding: This research was funded by the Ministry of Science, Technological Development and Innovation of the Republic of Serbia (contract No. 451-03-33/2026-03/200007).

Effects of land use on riparian millipede communities in the middle basin of the Argeș River, Romania

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Riparian zones are sensitive ecosystems increasingly affected by anthropogenic pressures such as deforestation, overgrazing, and agricultural land use. This study assesses the effects of land use on millipede communities (Class Diplopoda, Subphylum Myriapoda) in riparian habitats of the middle basin of the Argeș River, Romania. We compared the structure of millipede communities between riparian sites affected by land use change and sites with forest buffers. Sampling sites were organized into six pairs, each consisting of one forest-buffered site (used as a proxy for riparian restoration) and one upstream unbuffered site dominated by agricultural land use. Generally, the site selection and sampling protocol followed the methodology applied in the Crosslink (BiodivERsA3-2015-49-CROSSLINK) project. Millipedes were sampled monthly from May to November 2018 using Barber pitfall traps placed along three transects on each riverbank (eighteen traps per site). Along each transect, traps were installed at distances of 1 m, 5 m, and 15 m from the stream. Millipedes were identified to species level based on gonopod morphology. In total, eighteen species were recorded, of which six occurred exclusively in forest-buffered sites and two only in unbuffered sites. These results indicate that several species show high sensitivity to riparian land use changes, while only a few species tolerate anthropogenic disturbance. Species richness was generally higher in forest-buffered sites across most site pairs, and millipede activity-density was consistently higher in these sites throughout the sampling period. Differences in species composition and distribution between buffered and unbuffered sites demonstrate that land use significantly influences the structure of riparian millipede communities.

Linking microplastic contamination to biological uptake in Alpine rivers along anthropogenic gradients using benthic macroinvertebrates

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Microplastics (MPs) are increasingly recognized as pervasive contaminants in freshwater ecosystems, including Alpine rivers often perceived as near pristine. The PlasticFree project addresses this issue through an integrated monitoring framework combining seasonal field campaigns at ten river sites in South Tyrol (Italy) including investigations at five wastewater treatment plants (WWTPs) testing a novel filtration system under a Before–After–Control–Impact design. MPs dynamics were assessed in water, sediments, and biota through seasonal sampling (spring and autumn) along a gradient from remote glacial streams to more anthropogenically influenced reaches, and upstream and downstream of WWTPs before, during, and after filter installation. Within this framework, this contribution focuses on benthic macroinvertebrates to assess microplastic exposure and potential trophic transfer in lotic ecosystems. Three replicates of community samples were collected per site. Environmental parameters were measured to explore their influence on MPs distribution. Invertebrates were sorted by order/feeding groups and digested in 10% KOH to remove organic matter while preserving exoskeletons and MPs. Particles were analysed under a stereomicroscope and identified by FTIR spectroscopy for polymer characterization. Preliminary results show that MPs are detectable in macroinvertebrates even at remote Alpine sites, confirming bioavailability also under low-impact conditions. Consistent with sediment patterns, ingested MPs slightly increased downstream compared to glacial sites, indicating rising exposure along a longitudinal gradient. The highest MP prevalence (38%) was observed at the most downstream site. Fibres dominated ingested particles. This overview demonstrates the potential of macroinvertebrates to link environmental MP contamination with biological uptake in Alpine rivers along anthropogenic gradients, strengthening the ecological relevance of freshwater MPs monitoring.

Funding: The project EFRE1018-PlasticFree was co-funded by the Autonomous Province of Bolzano and by the Decree of the Director of the European Integration Office No. 18465/2023, Programme ERDF 2021/2027.

Diseases of crayfish caused by certain microscopic fungi

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While conducting behavioural observations of spiny-cheek crayfish (*Faxonius limosus*) using video recording, it was observed that some of the crayfish became ill and died. An attempt was made to determine the cause of the disease and to investigate whether other crayfish species living in Lithuania carry such pathogens. Potential pathogens were identified using metagenomic methods. Based on literature data, the following species were selected for testing: *Fusarium avenaceum*, *Fusarium equiseti*, *Phoma herbarum* and *Phoma macrospora*. Experiments were conducted with four species currently living in Lithuania: the native European crayfish (*Astacus astacus*) and the long-pincered crayfish (*Pontastacus leptodactylus*). The invasive species Signal crayfish (*Pacifastacus leniusculus*) and spiny-cheek crayfish (*Faxonius limosus*) were also included. All of the microscopic fungi caused disease in crayfish of all species, but *F. equiseti* was the most aggressive. In tests conducted in aquariums with non-circulating water and an infection concentration of 106, all species became infected and died within 24–48 hours. Additional experiments were conducted with this species (*F. equiseti*). In the next stage of the experiment, the conditions were changed: the experiment was conducted in flowing water (with the entire water volume replaced every ~4 hours) and the inoculum concentration was reduced in stagnant water. In both cases, the pathogenicity of the pathogen decreased with a decrease in pathogen concentration and with water exchange. When the pathogen concentration decreased to less than 10^2, no effect on the crayfish was observed. In summary, we can conclude that infection with *F. equiseti* may contribute to the decline of both invasive and native crayfish populations in water bodies.

Atrichops crassipes (Diptera: Athericidae) in the Baltic ecoregion: First records from Latvia and northward range expansion

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The water-snipefly *Atrichops crassipes* (Meigen, 1820) is a thermophilic aquatic dipteran species historically confined to Western and Central Europe. This study reports its first confirmed occurrence in Latvia and provides additional records from Lithuanian rivers, contributing to the understanding of its distribution in the Baltic ecoregion. The data are based on larval specimens collected during freshwater macroinvertebrate monitoring and research surveys, including previously unpublished material. Larvae were recorded in the Tartaks and Dubna rivers (Latvia) and multiple medium-sized rivers in Lithuania, indicating a broader regional presence than previously documented. The Latvian findings represent the northernmost known localities of the species. The aquatic larvae prey on other aquatic invertebrates, such as chironomids and oligochaetes, and typically inhabit soft substrates in streams, rivers, and standing waters. The results support the hypothesis of a northward range expansion, likely associated with ongoing climate warming and increasing regional temperatures. In Lithuania, repeated findings suggest that *A. crassipes* is not rare but has remained overlooked due to the scarcity of adult-based records. This study highlights the importance of larval-stage identification in biodiversity assessments and provides new faunistic and ecological insights into the distribution dynamics of *A. crassipes*. Continued monitoring is necessary to track its spread and to evaluate potential implications for freshwater ecosystem structure and function.

Using benthic macroinvertebrates to assess ecological status of intermittent streams

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In the Czech Republic, the assessment of the ecological status of running waters faces significant challenges in water bodies with disrupted hydrological regimes. Current assessment methods, calibrated for perennial rivers, systematically underestimate the ecological status of intermittent streams. In these ecosystems, biological communities are shaped by natural drying stress, causing standard metrics to indicate poor quality even in the absence of anthropogenic pressure. We present a newly developed multimetric index (MMI) for benthic macroinvertebrates, specifically designed for intermittent water bodies. Based on an extensive dataset from 2012–2024, we identified biological metrics most responsive to pollution and hydromorphological degradation under drying conditions. The resulting MMI integrates five key metrics: Plecoptera proportion, Margalef's diversity index, Saprobity, Temperature preference, and Reproductive strategies. Compared to the currently used methods, the proposed MMI significantly improves the assessment of near-pristine reaches, while maintaining comparable results for degraded sites. Consequently, it captures the anthropogenic pressure gradient with twice the effectiveness. To ensure high reliability, our assessment relies on spring samples, as autumn data exhibit excessive variability tied to the timing of rewetting. This approach facilitates an objective evaluation of intermittent streams, preventing incorrect management decisions and ineffective restoration measures.

Funding: This research was funded by the Technology Agency of the Czech Republic (TACR), project No. SS06010258.

Changes in the malacofauna of the Grabia River over the last 60 years

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The Grabia is a lowland river in Central Poland that remains under constant human influence (mainly agriculture and recreation). Despite this, it has retained many features characteristic of natural rivers – it remains unregulated in middle and lower courses. For this reason, it has been studied for many years by researchers from the University of Lodz. Studies conducted in 1962–1965 by Prof. A. Piechocki on the Grabia River constitute a valuable source of information on the malacofauna of that time, both within the river and its floodplain. However, due to the passage of approximately 60 years, these data require updating. The aim of the study was to update the list of mollusc species occurring in the Grabia River and to analyse qualitative and quantitative changes in its malacofauna over the last 60 years. Sampling sites were designated for the upper, middle, and lower courses of the river. These sites were determined based on information provided in the publication *Mięczaki (Mollusca) rzeki Grabi i jej terenu zalewowego* (Piechocki 1969). The riverbed and submerged vegetation were sampled. The collected specimens were identified to the lowest possible taxonomic level. In some cases, molecular methods were used to confirm identifications. Measurements of unionid shells were also carried out and will be used for morphometric analyses to determine bivalve age and condition. All collected unionids were returned to their natural habitat after examination. The highest density and diversity were observed in lower course in sections with abundant aquatic vegetation. The results suggest that, despite local anthropogenic transformations, the Grabia River still provides a suitable habitat for molluscs including four unionid species (*U. crassus*, *U. pictorum*, *U. tumidus*, *A. anatina*). However, changes have occurred in the relative abundance of particular species, as well as the emergence of *P. antipodarum*, a small invasive snail species that was absent from earlier studies.

Chironomids of Pleistocene glacial-interglacial paleolakes (Szczerców mine, central Poland)

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In 2014, 2017, and 2019, organic sediment samples infilling palaeolake basins were collected from the Szczerców Opencast Lignite Mine in Poland (Bełchatów Lignite Mine) at the Parchliny and Kuźnica profiles. These basins most likely formed as a result of dead-ice melting. Pollen analysis revealed that the sediment sequence from a depth of 400–408 cm in the Parchliny 2014 profile corresponds to the early Eemian Interglacial (MIS 5, c. 130 000 years ago), whereas the Kuźnica 2017 profile represents the early Ferdynandovian Interglacial (MIS 15e, c. 620 000 years ago). The age of the Kuźnica 2019 profile is still unconfirmed. The organic sediments were subjected to sedimentological, palaeobotanical, and palaeozoological analyses. In the analysed section of the Parchliny 2014 profile, 121 Chironomidae head capsules were identified. The most frequently occurring morphotypes were *Dicrotendipes nervosus*-type, *Corynocera ambigua*, and *Procladius*. The Chironomidae assemblages from the Kuźnica 2017 profile (47 head capsules) indicate a relatively cool climate and mesotrophic conditions characteristic of early interglacial deep palaeolakes. The dominant morphotypes were *Microtendipes pedellus*-type, *Corynocera ambigua*, and *Chironomus plumosus*-type. The Chironomidae of Kuźnica 2019 (91 head capsules identified in 13 samples) developed in a warm climate within a shallow, eutrophic lake, with *Chironomus plumosus*-type, *Chironomus anthracinus*-type, and *Ablabesmyia* being the most numerous.

Funding: The research is financed by the IDUB project entitled “Eemian paleolake ecosystems (Szczerców field, Bełchatów Lignite Mine) in the face of rapid climatic and hydrological changes” (No. 12/IGB/2025).

Conservation status and spatial priorities of mayflies (Ephemeroptera) in Kosovo's freshwater ecosystems

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Mayflies are among the most ecologically sensitive and conservation-relevant indicators of freshwater ecosystem integrity, yet they remain poorly incorporated into biodiversity conservation frameworks in Kosovo. This study provides the first comprehensive, conservation-focused synthesis of the Ephemeroptera fauna of Kosovo, integrating faunistic records with analyses of species richness, endemicity, habitat associations, threat pressures, conservation status, and spatial prioritisation. A total of 48 mayfly species representing 20 genera and 9 families are currently known from Kosovo. Eighteen species are identified as being of national conservation concern, including taxa of European, Balkan, and national significance. The fauna comprises one rare European species (*Metreletus balcanicus*) and five Balkan endemics (*Electrogena* cf. *mazedonica*, *Rhithrogena braaschi*, *Epeorus yugoslavicus*, *Ephemera* cf. *parnassiana*, *Caenis* cf. *strugaensis*), underscoring Kosovo's importance within the Balkan freshwater biodiversity hotspot. Conservation-relevant species show predominantly restricted national distributions, with over half recorded from single localities. National assessments applying IUCN Red List Categories and Criteria, supported by the Red Book of Fauna of Kosovo and existing legal instruments, indicate that five species qualify as Endangered, while most remaining rare taxa meet the criteria for Vulnerable due to limited area of occupancy and low number of locations. Lentic and large-river specialists, particularly within *Caenis*, *Ephemera*, and *Potamanthus*, are notably underrepresented, reflecting ongoing habitat degradation and historical sampling bias. Key threats include untreated wastewater discharge, agricultural pollution, river regulation, deforestation, and climate-driven hydrological instability. Spatial prioritisation identifies the Blinaja and Slivova catchments as freshwater conservation hotspots in Kosovo.

Diversity and seasonal dynamics of ciliates (Ciliophora) in the mantle cavity of the endangered *Unio crassus* species complex (Bivalvia: Unionidae)

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Symbiotic single-celled organisms belonging to the Ciliophora group are frequently observed in various invertebrates. Freshwater mussels serve as hosts for these organisms, contributing to their biodiversity, yet our understanding of these relationships remains limited. Given the high risk of extinction for freshwater mussels, ciliate endosymbionts may potentially cause diseases and mass mortalities, particularly in restocked and commercial populations. The relationships between Ciliophora parasites and commensals in mussels are still poorly explored, and many species may disappear before being discovered. Previous studies of the mantle cavity in the endangered mussel *Unio crassus* have identified the genera *Conchophthirus* sp. and *Trichodina* sp. This study aimed to comprehensively understand species diversity, infection intensity, and the distribution of ciliates across different river types. Research was conducted in three Polish rivers: the San, Czarna Włoszczowska, and Czarna Hańcza, covering three periods of the mussel's reproductive cycle (May, July, September). The methodology relied on next-generation sequencing (NGS) of Ciliophora genetic material, targeting the V4 and V9 regions of the 18S rRNA gene, allowing for precise taxonomic identification. A total of 98 operational taxonomic units (OTUs) were identified, with 54 assigned to the genus or species level. While the majority were common cosmopolitan species, potential parasites such as *Tetrahymena* sp., suspected of killing mussel glochidia, were also detected. A strong influence of habitat and seasonality on community structure was observed; the highest diversity was found in lowland rivers, while it was significantly lower in the mountain San River. The hierarchical biocomplex formed by Ciliophora in the mantle cavity of freshwater mussels presents an intriguing subject for further investigation into host-symbiont interactions, which is essential for the effective conservation of *U. crassus* populations.

Funding: This research was funded by the National Science Centre (Poland), grant No. 2021/05/X/NZ2/01839.

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