

# ABSTRACT BOOK



## 4<sup>th</sup> Dinaric Symposium on Subterranean Biology

11<sup>th</sup> - 12<sup>th</sup> October 2025

Nova Kršlja, Croatia



## **4<sup>th</sup> Dinaric Symposium on Subterranean Biology – Abstract Book**

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# PREFACE

Dear friends and admirers of the unique subterranean life of the Dinaric Karst!

It is our great pleasure to welcome you to the **4<sup>th</sup> Dinaric Symposium on Subterranean Biology**, taking place at the *Speleon* Centre of Subterranean Heritage in Nova Kršlja, Croatia, on **11–12 October 2025**. The symposium is jointly organised by the Croatian Biospeleological Society (CBSS) and the Public Institution Barač Caves – Protected Areas Management in the Municipality of Rakovica.

The story of the symposium began in 2016, when, on the occasion of the 20th anniversary of CBSS, we organised the first meeting in Zagreb. With 60 participants from ten European countries and an unforgettable atmosphere, it became clear that this gathering deserves continuity. In 2019, the symposium moved to Postojna (Slovenia), the cradle of biospeleology, and in 2022 to Trebinje (Bosnia and Herzegovina), a global hotspot of subterranean biodiversity. Now, we are delighted to host the fourth edition in a region renowned for its natural wonders—spectacular caves, tufa-barred rivers, and rich subterranean life.

**The animals featured on this year's symposium logo highlight this diversity:**

*Machaerites pavleki*, a pselaphine beetle described from and endemic to Barač Caves,

*Neobisium stygium*, a highly troglomorphic pseudoscorpion widespread across the north-western Dinarides, and

*Monolistra fongi*, an isopod crustacean endemic to the local area, named in honour of our late American colleague and friend Daniel Fong.

The 4<sup>th</sup> Dinaric Symposium on Subterranean Biology is hosting 64 participants from 11 countries. Over these two days, a wide range of topics will be presented. We trust that the diversity of research and international participation will inspire stimulating discussions, foster new collaborations, and spark fresh ideas for the future.

The Organising Committee warmly wishes you an enjoyable stay in Nova Kršlja and a rewarding symposium experience.

On behalf of the Organizing Committee,  
*Jana Bedek*

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## SESSION 2 SUBTERRANEAN BIODIVERSITY

CHAIR DRAGAN ANTIĆ

- 14:00** ● Genetic and morphological diversity of *Stalagtia hercegovinensis* species complex  
**Pischiutta, Pavlek**
- 14:20** ● Genetic diversity of Istrian olms [*Proteus anguinus*]  
**Kermek, Recknagel, Trontelj, Zakšek**
- 14:40** ● Genomic insights into the evolution of two highly troglomorphic pseudoscorpions from the Dinarides  
**Hlebec, Enguídanos García, Machata, Arnedo, M**
- 15:00** ● Lithobiidae (Chilopoda: Lithobiomorpha): the most diverse centipede family in the caves of the Dinaric Karst  
**Kos, Delić, Komerički, Kos, Stojanović, Zagmajster**
- 15:20** ● Patterns of variation in the "Crown Jewel" of the Dinaric Karst: the cave beetle *Leptodirus hochenwartii*  
**Delić, Milošević, Polak, Jalžić, Trontelj, Zagmajster**
- 15:40** ● Proposal for stygozoogeographic division of the Balkan Peninsula with respect to stygobiotic gastropod diversity  
**Grego**
- 16:00** ● **POSTER SESSION AND COFFEE BREAK**
- How much do we know about threat status of cave habitats and its fauna?  
**Batista, Žeger Pleše, Katsušić, Komerički, Bedek**
- Cave biodiversity mapping of the endangered Komarnica canyon in Montenegro  
**Đokić, Kountouras, Deleva, Ivanov, Njunjić**
- Research of subterranean biodiversity in Nikšić field, Montenegro  
**Đokić, Zagmajster, Delić, Pavičević, Vittori**
- Millipedes (Myriapoda: Diplopoda) in subterranean habitats of Plitvice Lakes National Park (Croatia)  
**Dražina, Kuharić**
- Sulfur Cave as a Refuge: New Insights into Bat Ecology in the Sarantaporos Valley, Epirus  
**Ńițescu, Crețu, Bego, Loce, Sarbu, Georgiakakis**
- New book on subterranean habitats and fauna of Slovenia as the basis for education and raising public awareness on importance of subterranean biodiversity  
**Pekolj, Di Batista Borko, Delić, Fišer Ž, Kos, Premate, Rexhepi, Zagmajster, Zakšek, Fišer C**
- Diversity in the shadows: unveiling lesser-known lampenflora phototrophs in show caves worldwide  
**Popović, Jakovljević**
- The poorly known cave centipede *Cryptops illyricus* Verhoeff, 1933 (Chilopoda: Scolopendromorpha: Cryptopidae) from caves of the northern Dinarides  
**Stojanović, Kos, Delić, Zagmajster**
- Subterranean Biodiversity of Hvar Island: Insights from the SpeleoPharos Project  
**Tolić, Buljan, Mihovilić, Pavlek, Hlebec, Komerički, Lukić, Bedek, Jalžić, Dražina**
- Monitoring olm [*Proteus anguinus*] populations in karstic springs in Slovenia via infrared cameras  
**Valenčić, Fišer, Kekec, Premate, Recknagel**

17:30

- SESSION 3**  
**BAT CONSERVATION AND RESEARCH**  
CHAIR SLAVKO POLAK
- 17:30 ● Application of infrared sensor cameras for bat monitoring in the Jamina underground roost  
Maleš, Rnjak G, Grozić, Hodak, Rnjak D
- 17:50 ● Shining a light on bats: UV fluorescence in lesser and Blasius's horseshoe bats  
Zrnčić, Smith, Budinski, Hargreaves, Damant, Schofield
- 18:10 ● Revision of the internationally important underground sites for bats according to UNEP/ EUROBATS Agreement in Croatia  
Hamidović, Rnjak G, Maleš, Hodak, Grozić, Janež, Zrnčić, Rnjak D
- 18:30 ● What can we learn about the state of the Alpine-Dinaric ecosystems in Slovenia from two decades of bat monitoring in caves?  
Presetnik, Zamolo, Podgorelec
- Lovački dom  
Jelov Klanac 211c, Rakovica
- 20:00 ● DINNER AND SOCIAL EVENT

SUNDAY

12  
OCTOBER

- SPELEON - Centre of subterranean heritage,  
Nova Kršljia 47, Rakovica
- 10:00 ● COFFEE
- SESSION 4**  
**FROM PAST TO FUTURE**  
CHAIR TVRTKO DRAŽINA
- 11:00 ● Palaeospeleobiology: a new perspective  
Polak
- 11:20 ● Diversity of genus *Tritamurus* (Tomoceridae, Collembola) in the Dinaric Karst and its unusual, controlled jumping behavior  
Lukić
- 11:40 ● Life-history traits in *Niphargus balcanicus*  
Premate, Bračko, Delić, Fišer Ž, Kogej, Kos, Pekolj, Rexhepi, Zagmajster, Fišer C
- 12:00 ● Functional trait divergence and morphological heterogeneity in a common troglophile *Lepthyphantes leprosus* (Araneae: Linyphiidae) across epigean and subterranean habitats  
Elverici
- 12:20 ● Resource transfer from aquatic to terrestrial food webs in a sulfidic subterranean ecosystem  
Băncilă, Șarbu, Brad, Nițescu, Ștefan Maraun
- 12:40 ● Hidden connections: tracing subterranean biodiversity of the Reka-Timavo River through eDNA  
Tommasi, Spoto, Restaino, Bruschi, Burja, Mezgec, Morel, Rozman, Giulianini, Pallavicini, Manfrin
- 13:00 ● LUNCH
- 14:30 ● Visit to SPELEON  
Centre of subterranean heritage
- 16:30 ● Visit to Upper Barač cave  
at Nova Kršljia 47A, Rakovica



The background of the slide is a dark red upper half and a dark grey lower half, separated by a horizontal line. Both halves feature a complex, low-poly geometric pattern of thin white lines. A faint, white wireframe silhouette of a horse's head is visible in the background, facing right, spanning across the horizontal line.

# ABSTRACTS **ORAL COMMUNICATIONS**

\* Presenting author

ORAL  
COMMUNICATIONS

# Towards the Red Book of terrestrial cave-dwelling arthropods in Serbia

Antić, Dragan<sup>1\*</sup>; Vesović, Nikola<sup>1</sup>; Ćurčić, Srećko<sup>1</sup>; Karaman, Ivo<sup>2</sup>; Horvatović, Mladen<sup>2</sup>; Stojanović, Dalibor<sup>1</sup>; Grujić, Nikola Z<sup>2</sup>; Makarov, Slobodan<sup>1</sup>

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The ongoing biodiversity crisis, driven by multiple human-induced pressures, is manifested in a rapid and partly irreversible decline of ecosystems. In Serbia, this process has been intensified by the exploitation of natural resources, deforestation, land-use conversion, urbanization, river alteration and pollution in general. Subterranean habitats, including caves, are among the most vulnerable ecosystems, highly sensitive to anthropogenic disturbance. In this context, Red Lists and Red Books play a crucial role in identifying threats, proposing conservation measures and raising public awareness. To date, six Red Books of Serbian fauna have been published, with three more in preparation, including the first dedicated to cave-dwelling terrestrial arthropods (troglóbionts). The cave fauna of Serbia comprises 122 troglóbiont arthropod species across seven classes, 16 orders, 23 families and 47 genera. For the Red Book, a database of 870 distribution records was compiled and integrated into the national database of potentially threatened species. The conservation status of the evaluated species was assessed using the national threat assessment application in line with the IUCN methodology. A total of 85 species were evaluated. Most belong to Insecta (33 species) and Diplopoda (27), followed by Arachnida (11) and Malacostraca (8), while Chilopoda, Collembola and Diplura are each represented by two species. All evaluated species fall into six IUCN threat categories: Critically Endangered (43 species; 51%), Endangered (18 species; 21%), Vulnerable (13 species; 15%), Near Threatened (six species; 7%), Least Concern (one species; 1%) and Data Deficient (four species; 5%). Notably, all taxa are endemic: 42 are stenoendemic, 37 are locally endemic, while six also occur in neighboring countries. Biogeographically, 48 (56 %) species belong to the Carpatho-Balkan region, while 37 (44%) are from the Dinaric region.

ORAL  
COMMUNICATIONS

# Preliminary data on lampenflora and associated organisms in Gornja Baračeva Cave (Rakovica, Croatia)

Baković, Najla<sup>1\*</sup>; Popović, Slađana<sup>2</sup>; Jakovljević, Olga<sup>2</sup>; Kušan, Ivana<sup>3,4</sup>; Matočec, Neven<sup>3,4</sup>; Samardžić, Miroslav<sup>4</sup>; Vuković, Slaven<sup>5</sup>

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Show caves are an irreplaceable channel for disseminating knowledge about caves and promoting their conservation to the broader public. At the same time, preserving subterranean habitats and the geomorphological heritage of these caves is challenging. The installation of artificial (electrical) lighting creates a particular issue: the development of lampenflora—an assemblage of phototrophic organisms whose impacts on cave ecosystems are still poorly understood. Until now, the impact of artificial lighting in Gornja Baračeva Cave had not been studied. The aim of this research was to identify the species composition and extent of lampenflora using field observations and sampling, combined with laboratory analyses (transmission light microscopy and stereomicroscopy, culturing, and molecular techniques), as well as instrumental measurements of environmental parameters and identification of habitat characteristics. Initial findings revealed that macroscopic lampenflora is present near 62.5% of the lamps. Its assemblages include phototrophic organisms such as algae, cyanobacteria, mosses, and ferns, which form characteristic green coatings. Filamentous and yeast-like fungi were also isolated from the lampenflora. Other microscopic organisms detected included heterotrophic protists, nematodes, and mites. In situ visual observations of lampenflora-covered surfaces further confirmed the presence of macroscopic invertebrates such as springtails, isopods, beetles, land snails, dipterans, and pseudoscorpions. Lampenflora in Gornja Baračeva Cave developed despite the installation of eco-friendly lamps and the seasonal closure of the cave during bat hibernation period. Preliminary analyses of the assemblages associated with lampenflora and their extent revealed no clear correlation with lamp type, illuminance, or other environmental parameters which indicates its complex genesis. Since the occurrence of lampenflora represents an anthropogenic element in cave environments, it is essential to deepen our understanding of its impact on the subterranean ecosystem, the mechanisms enabling its growth, and to identify appropriate methods for its control.



ORAL  
COMMUNICATIONS

# Resource transfer from aquatic to terrestrial food webs in a sulfidic subterranean ecosystem

Băncilă, Raluca I.<sup>1</sup>; Sarbu, Serban M.<sup>1\*</sup>; Brad, Traian<sup>1</sup>; Nițescu, Ruxandra<sup>2</sup>; Ștefan Andrei<sup>2</sup>; Maraun, Mark<sup>3</sup>

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Trophic transfer from aquatic to terrestrial biological communities has been widely studied in surface ecosystems. Numerous invertebrate species complete their larval development underwater where they feed on abundant food resources of photosynthetic origin. Once they emerge from the water as adults, they transfer the trophic resources to the terrestrial environment as they often become food for predator species. However, the complexity and high biodiversity of the surface ecosystems often obscure the tracing of organic matter across trophic levels, due to overlapping functional feeding and taxonomic groups and multiple sources of primary production. In contrast, the simplified and low-diversity subterranean ecosystems allow for a clearer delineation of trophic pathways. Yet, the flow of matter from aquatic to terrestrial habitats in caves – particularly in sulfidic hypogean karst systems, where primary production is based on chemosynthesis – remains poorly understood. The aim of this study was to investigate trophic transfers in Sulfur Cave, a sulfidic cave located on the Greece–Albania border, using stable isotope (<sup>15</sup>N, <sup>13</sup>C) analysis combined with seasonal observational data. Field trips were performed several times per year, during different seasons, and each time we performed detailed observations and collected samples for subsequent analysis. The results revealed distinct food web structures within this subterranean ecosystem. Trophic resources produced by chemosynthesis within submerged sulfur-oxidizing biofilms support dense populations of aquatic larvae of scirtids (Coleoptera) and of two species of chironomids (Diptera). Upon emerging from the aquatic environment as adults, these insects are consumed by terrestrial predators, including a huge colony of spiders exceeding 100,000 individuals, and unusually rich populations of centipedes, pseudoscorpions, and scorpions. Our data show a clear, unidirectional trophic transfer from aquatic to terrestrial environments in this underground ecosystem that functions independently of sun-driven surface photosynthesis. The simplicity of these subterranean food webs – both in terms of the number of species involved and their highly specific food preferences – makes sulfidic caves an excellent natural model for understanding trophic relationships within much more complex and species-rich surface ecosystems, offering insights into connectivity and cross-ecosystem nutrient fluxes.

ORAL  
COMMUNICATIONS

# Patterns of variation in the “Crown Jewel” of the Dinaric Karst: the cave beetle *Leptodirus hochenwartii*

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The scientific discipline of speleobiology traces its origins to 1832, when the slender-necked beetle *Leptodirus hochenwartii* Schmidt, 1832 was first described from Postojnska jama. Owing to this discovery, Slovenia is often regarded as the “cradle of speleobiology”, and *Leptodirus* has since become one of the unofficial symbols of the country. Despite its cultural importance and inclusion in the Natura 2000 framework, knowledge of the taxon has remained limited. While the species’ distribution has been relatively well documented and six morphological subspecies described, recent surveys across the Northern Dinaric Karst prompted a reassessment of both its range and taxonomic validity. Using nearly 200 specimens, we combined molecular and morphological analyses to test the existing subspecies framework. Species delimitation approaches, based on both single- and multilocus datasets, revealed six well-differentiated phylogroups, not all of which correspond to the currently recognized subspecies. Morphological variation was analyzed using both classical and geometric morphometrics, confirming the robustness of the phylogenetic results. Our results demonstrate that *L. hochenwartii* is not a single species, but a complex of six morphologically similar yet genetically distinct lineages. Of the previously described subspecies, two should be synonymized, while the remaining four, along with two newly identified phylogroups, merit recognition as independent species. These results not only reshape our understanding of a significant emblem of the Dinaric natural heritage, but also raise important questions for conservation policy at both national and European levels.

ORAL  
COMMUNICATIONS

# Functional trait divergence and morphological heterogeneity in a common troglophile *Lepthyphantes leprosus* (Araneae: Linyphiidae) across epigean and subterranean habitats

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Spiders in Anatolia exhibit striking patterns of diversity in caves, yet the scale and structure of functional trait diversity remain unknown at both interspecific and intraspecific levels within closely related lineages. *Lepthyphantes leprosus* (Ohlert, 1865) exhibits a broad geographic distribution with a marked preference for subterranean habitats from Europe to Asia. Its troglophilic nature allows it to exploit both cave and epigean environments. Focusing on *L. leprosus* and closely related lineages with similar niches, multivariate trait differences among epigean, and shallow and deep hypogean habitats were quantified using PCA, PERMANOVA, and tests of multivariate dispersion on standardized morphometrics. Habitat type explained a significant portion of trait variance, and this signal persisted after accounting for spatial structure. Deep-cave populations displayed greater within-group spread in the trait space, indicating elevated morphological heterogeneity relative to epigean and shallow-cave groups. Trait-wise comparisons highlighted habitat effects on troglomorphic traits—coloration, leg length or elongation, ocular metrics, and fang length. Together, these results reveal habitat-linked shifts in multivariate phenotype consistent with adaptive shifts in subterranean environments, even within a narrow lineage.



ORAL  
COMMUNICATIONS

# Proposal for stygozoogeographic division of the Balkan Peninsula with respect to stygobiotic gastropod diversity

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During the studies of stygobiotic animals including the gastropods we are still face a lack of sufficient division of the Balkan Peninsula into stygozoogeographic regions. The distribution according to Freshwater Ecoregions of the World (FEOW) does not match the stygogfauna distribution patterns, as the Balkan stygofauna have much older origin than the actual river basin setup of the Balkan Peninsula presented by FEOW. Historical division of ecoregions by countries was driven by creating the national lists for purpose of conservation, but as such it does not reflect the natural history and geology driven clustering of the Balkan stygofauna. Herein we are proposing a model based on the diverse geology of the Peninsula with naturally clustering of karst and alluvia as suitable habitats for the stygofauna. The division is supported by the available molecular data of stygobiotic gastropods, although molecular data for the vast majority of the known stygogastropoda are still missing, and future new data can further define the proposed division and its borders. The ecoregions hitherto presented for epigean plants and animals had been also considered in the presented proposal. The proposed stygioecoregions also reflect the natural history of the particular areas with repeated hypogean colonization events from different primary aquatic sources as Adriatic Sea, Pannonian Lake, Slavonic Lake, Apennine Foredeep Lake, Dacic Lake, but also terrestrial migrations through alluvia and other hypogean habitats from Apennine, Alps and likely also from Anatolia. The complicated natural history of the region together with the favorable karst-based geology is the main prerequisite for high diversity of the stygogastropoda in the Balkans currently containing 301 species in 81 genera, which represent 40% of the recognized global diversity of stygogastropoda. The Dinaric stygoecoregion itself contributes with 227 stygogastropod representing 30 % of the global fauna.

ORAL  
COMMUNICATIONS

# Revision of the internationally important underground sites for bats according to UNEP/EUROBATS Agreement in Croatia

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Caves, mines, fortifications, and tunnels play a vital role in the life cycles of many European bat species. Bats can use them year-round, during hibernation, reproduction, spring and autumn migration or during autumnal swarming. UNEP/EUROBATS Agreement recognized importance of such bat roosts in 1998, and Resolution 2.4 was adopted at the Meeting of Parties in Bonn, Germany, in which internationally important underground sites should be listed. Guidelines “Protecting and managing underground sites for bats” were issued in 2007. First list of such sites was prepared in 2010, and second was revised in 2014, which was adopted at the Meeting of Parties in Brussels, Belgium, in the same year. The latter is published on the web site of the UNEP/EUROBATS Agreement and contains 1895 sites. The list submitted by Croatia contains 55 sites: caves, pits, railway tunnels and waterway tunnels. For each site, the submitted data include coordinates, site name, type, primary usage (nursery, hibernation, migration, year-round), name and code of the Natura site, biogeographical region, bat species and their maximum recorded numbers since 1994, and the level of site protection. Overall, 25 out of 35 bat species in Croatia was recorded in such sites. Most of the listed hibernacula are in the continental region, while most nurseries are from the mediterranean region. All the sites are in the Natura 2000 network. During 2022 and 2023 within the project framework of “Development of monitoring system for the conservation status of species and habitat types”, existing sites were revisited and reevaluated in terms of providing maximum numbers per species and primary usage of the site to revise existing list, along with newly discovered important underground sites according to the EUROBATS and national criteria. New list will be sent to the EUROBATS upon approval of the Ministry of Environmental Protection and Green Transition.

ORAL  
COMMUNICATIONS

# Genomic insights into the evolution of two highly troglomorphic pseudoscorpions from the Dinarides

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Subterranean biodiversity, including variation within and between species, remains poorly explored compared to that of surface ecosystems. *Neobisium spelaeum* (Schiödt, 1847), the first scientifically described cave-dwelling pseudoscorpion, inhabits the Dinaric Karst, a global hotspot of subterranean biodiversity. Despite a long-standing tradition of biospeleological research in the region, its genetic structure and evolutionary history remain unknown. This study investigates the taxonomy and evolutionary relationships of two endemic pseudoscorpion species from the Dinarides: *N. spelaeum* and its morphologically similar species, *Neobisium stygium* Beier, 1931. Large-scale mtDNA sequence data (304 specimens), and ddRADseq genomic data (91 specimens) were used to investigate the genetic diversity, evolutionary history, and biogeography of both species across their entire known distribution. Additionally, phenotypic data based on 22 characters from 102 fresh specimens, including those from type localities, as well as 22 type specimens, were used to explore phenotypic differentiation through geometric morphometrics. Species delimitation analyses were performed independently using both mtDNA data and nuclear genome-wide SNP data, while three complementary approaches were used to explore spatial patterns of genetic structure. The final dataset included 12,568 unlinked SNPs, with 32.81% missing data. No admixture was detected between lineages. All analyses consistently revealed seven deeply divergent, reciprocally monophyletic lineages, and molecular and phenotypic variation within lineages was low. The identified genetic clusters generally corresponded to the two nominal species and their respective subspecies. These results underscore the importance of conserving karst regions and their narrowly endemic subterranean fauna.

ORAL  
COMMUNICATIONS

# Genetic diversity of Istrian olms (*Proteus anguinus*)

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The olm (*Proteus anguinus* Laurenti, 1768) is a remarkable inhabitant of the Dinaric Karst and serves as a flagship species for subterranean biodiversity conservation. Recent genomic studies have revealed that there are nine highly diverged evolutionary lineages of olms distributed along the Dinaric Karst. Among these, the Istra lineage is the most divergent, forming the sister group to all other lineages, with its separation that occurred around 17–15 Ma. Although known from the Istrian Peninsula for 140 years, nearly all genetic data on this lineage have been derived predominantly from single cave population: Pincinova jama. The population in this cave is relatively large but genetically homogeneous. However, historical and recent sporadic observations indicate that the distribution of Istrian olms is not limited to Pincinova jama. Sampling of a few additional individuals on distant localities across the Istrian karst regions enabled a more detailed insight into the genetic structure of Istrian olms. New samples revealed previously unknown COI haplotypes in southern and eastern Istria, while amplification with a set of 20 polymorphic microsatellite markers increased detected genetic diversity and allelic richness of Istrian olms. Although based on a limited sample size, the results indicate that geographically isolated populations are also genetically distinct. However, these differences are minor and do not exceed the variation observed within populations. This pattern points to a relatively recent expansion of the Istrian olm across all known sites. It further suggests that these localities were hydrologically interconnected during the late Pleistocene. Despite some populations being extremely difficult to access, all Istrian olm populations warrant full and immediate conservation attention due to their small size and pronounced fragmentation.

ORAL  
COMMUNICATIONS

# Subterranean fauna and habitats managed by Barač caves Protected Landscape

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The Public Institution Barač Caves manages the Barač Caves Protected Landscape and the Natura 2000 sites within the municipality of Rakovica. In 2020, the institution initiated a collaboration with Croatian Biospeleological Society (CBSS) to conduct systematic research of the managed area, including the development of a cave fauna inventory for the municipality and monitoring of the only show cave in the landscape, the Upper Barač Cave. Between 2020 to 2024, CBSS sampled 17 caves and 2 springs, recording a total of 100 invertebrate taxa inhabiting subterranean habitats. We identified specimens from 14 taxonomic groups (Amphipoda, Araneae, Chilopoda, Coleoptera, Collembola, Diplopoda, Diplura, Gastropoda, Isopoda, Opiliones, Orthoptera, Palpigradi, Pseudoscorpiones and Trichoptera), while material from other groups is still under examination. Of the 100 identified taxa, 31 are troglobites (including 3 stygobites), 37 troglaphiles, 22 troglloxenes, and 10 remain without ecological classification. Upon completion of cave inventory in 2024, all collected results were consolidated, leading to the identification of five keystone and five indicator invertebrate species for long-term monitoring of caves across the entire area managed by the Public Institution. Based on these findings, we developed a monitoring protocol encompassing six caves, which are to be regularly surveyed for the presence and abundance of the selected keystone and indicator species. For each cave, the protocol specifies the monitoring methodology, along with detailed instructions for implementation and data analysis. A monitoring protocol for the Upper Barač cave was established in 2020 and has been conducted annually since, with minor adjustments over the five-years. To date, 47 invertebrate taxa have been recorded, with springtails (Collembola) representing the most abundant group. The overall condition of the cave remains favorable, as we have not recorded a negative impact on fauna composition or abundance, nor new threats associated with tourism activities. Recommendations for future monitoring and cave management were also provided.



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COMMUNICATIONS

# Lithobiidae (Chilopoda: Lithobiomorpha): the most diverse centipede family in the caves of the Dinaric Karst

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The family Lithobiidae is the species-richest group of centipedes in the caves of the Dinaric Karst. Since the description of the first exclusively subterranean species, *Lithobius stygius* Latzel, 1880, additional representatives of this family have been reported from caves in the region. Here we present a comprehensive overview of the Lithobiidae species inhabiting the caves of the Dinaric Karst. Furthermore, we have assembled a dataset detailing the main functional traits of these species. To prepare the overview, we compiled information from the literature and examined the material from three morphological collections. In total, we documented 47 species occurring in caves of the Dinaric Karst. Of these, 44 species from three genera have previously been reported in the literature, while three additional species were identified: *Lithobius mutabilis* L. Koch 1862, *Lithobius pygmaeus* Latzel 1880 and *Lithobius dentatus* C.L. Koch 1844. Seventeen species are exclusively restricted to cave habitats. All are endemic to the region, including five species of *Eupolybothrus* Verhoeff, 1907, one species of *Harpolithobius* Verhoeff, 1904, and 11 species of *Lithobius* Leach, 1814. Recent field sampling improved the knowledge of the distribution of many species, including the first record of *Lithobius troglomontanus* (Folkmanová, 1940) from Croatia, and the recollection of *Lithobius remyi* Jawłowski, 1933 from near its type locality. To explore the functional traits of Lithobiidae species occurring in caves, we measured 49 morphological features linked to locomotion, sensory abilities, feeding, defence, and other roles. We measured more than 100 adult individuals of 28 species. These species vary in size from 4 to 40 millimeters, have 0 to 25 ocelli and 26 to 114 antennal articles. The morphological differences may reflect different functional roles and varying degrees of dependence on cave habitats. Our study provides a basis for further research on the species richness, ecological role and functional biodiversity of centipedes in caves.

ORAL  
COMMUNICATIONS

# Overlooked biodiversity of the subterranean habitats in the Plitvice Lakes National Park

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The renowned UNESCO World Heritage Site, Plitvice Lakes National Park (Croatia), is known for its lakes formed by the sedimentation of tufa barriers. Decades of research have focused on its aquatic ecosystems and forests, while systematic speleological exploration, initiated by the Public Institution "Plitvice Lakes National Park", began only in 2020. Over the following five years, more than 350 caves were documented within the protected area. Following speleological exploration, in 2021 the Croatian Biospeleological Society started a four-year survey of cave invertebrates within the park and in the cave Baraćeve špilje, a nearby Natura 2000 site managed by the Park. This is the first systematic study of subterranean fauna in the area. We collected both terrestrial and aquatic invertebrates from 118 caves and an additional 38 surface localities (soil fauna). We recorded a total of 246 invertebrate taxa, including 47 troglobionts. The majority of troglobionts were represented by Pseudoscorpiones (13), Collembola (8), Coleoptera (7), Isopoda (5), Amphipoda (3), Diplopoda (3), Gastropoda (2), Araneae (2), and Chilopoda (2), while Palpigradi and Decapoda were each represented by a single species. Twenty-three species new to science were discovered (13 Pseudoscorpiones, 5 Collembola, 2 Isopoda, 1 Coleoptera, 1 Araneae, and 1 Diplopoda). In addition to the extensive cave invertebrate survey, threats to cave habitats were documented, and rich photographic and video material of cave species and habitats was produced. Guidelines for active conservation measures, education, and public outreach were also developed, providing a basis for the effective management and promotion of cave ecosystems.

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# Diversity of genus *Tritomurus* (Tomoceridae, Collembola) in the Dinaric Karst and its unusual, controlled jumping behavior

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The genus *Tritomurus* Frauenfeld, 1854 comprises five described species: two from France and Spain, two from the Dinaric Karst, and one with a broader European distribution. The type species, *Tritomurus scutellatus* Frauenfeld, 1854, is a troglobitic species described from cave Velika jama nad Trebnjem in Slovenia, and is distributed in caves of the northwestern Dinaric Karst. Another troglobitic species, *Tritomurus veles* Lukić, Houssin & Deharveng, 2010, is endemic to Mt. Biokovo in Croatia and is known only from several deep caves. The troglophilic *Tritomurus terrestralis* Stach, 1922, described from Virpazar in Albania, has a wider European distribution and also occurs in the Dinaric Karst. Troglobitic populations of *Tritomurus* are common and abundant in the caves of the northwestern Dinaric Karst, where they have generally been identified as *T. scutellatus*. Preliminary morphological and phylogenetic COI analyses, however, have revealed the presence of several undescribed species in this region. An ongoing revision of the genus will include a redescription of the type species and descriptions of several new species. One of these newly discovered species was observed performing unusual jumping behavior on small water pools within caves. Most Collembola possess a catapult-like organ, the furca, which enables them to jump when disturbed or threatened by predators. The speed and trajectory of such jumps are generally considered uncontrolled, although a recent study has shown that one semiaquatic collembolan species can actively control all phases of its jumps—takeoff, flight, and landing. Remarkably, the new troglobitic *Tritomurus* species was observed and filmed exhibiting similar controlled jumping, with horizontally directed trajectories. This ability enables them to cross water surfaces while maintaining their direction of movement. Control over jump direction and force, combined with landing control, is likely another collembolan adaptation to humid cave environments.

ORAL  
COMMUNICATIONS

# Application of infrared sensor cameras for bat monitoring in the Jamina underground roost

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Jamina cave, located within the protected area of Biokovo Nature Park, gained international significance for bat conservation following the discovery of a colony of approximately 3,000 *Miniopterus schreibersii* (Kuhl, 1817) individuals in spring 2004. As a result, it was designated as an underground roost of international importance for bats (UNEP/EUROBATS). Between 2004 and 2018, several surveys were conducted, revealing substantial fluctuations in colony size. These findings suggested that Jamina Cave plays an important role during migratory periods, although its overall significance and the dynamics of its use remained unclear. In cooperation with Biokovo Nature Park, starting with 2019, systematic field surveys were conducted, and for the first time, continuous monitoring was tested using an automatic infrared (IR) photo camera, applied alongside standard methodologies for monitoring bats in underground roosts. Monitoring continued in the following years using the same methodology. While seasonal field visits typically recorded up to 300 individuals, predominantly *M. schreibersii*, the IR camera revealed considerably larger aggregations. In late winter and early spring, over 1000 individuals were documented within a single day, whereas in late autumn numbers commonly reached up to 500 individuals. Owing to the effectiveness of continuous IR monitoring, this method was incorporated into standard research protocols and further enhanced through the installation of an additional high-resolution camera capable of live-streaming bat activity in real time. This lecture presents both the methodological advantages of employing infrared photo and video cameras for continuous monitoring of bat populations in underground roosts, as well as the importance of Jamina cave as a key underground roost for bats during migratory periods based on the most recent findings.

ORAL  
COMMUNICATIONS

# Genetic and morphological diversity of *Stalagtia hercegovinensis* species complex

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The Dinaric Karst is recognized as one of the world's hotspots of subterranean biodiversity. Alongside other unique and endemic cave-dwelling organisms, several spider groups in this region display typical adaptations to life underground, such as loss of pigmentation and eye reduction. One such species, described from the Vjetrenica cave, is *Stalagtia hercegovinensis* (Nosek, 1905) from subfamily Harpacteinae, family Dysderidae. Its range extends across the southern Dinarides, from Krka National Park in the north to northern Montenegro in the south. Such a wide distribution—spanning more than 250 km—is unusual for a cave-adapted species and raises the possibility that *S. hercegovinensis* actually represents a species complex. To investigate this, DNA was extracted from 94 specimens collected across the species' entire range, including topotypic specimens and five genetic markers (COI, 16S, 18S, 28S, and H3) were amplified and sequenced. Phylogenetic analyses, combined with species delimitation methods, revealed six well-supported, geographically distinct lineages corresponding to different regions of the southern Dinarides. Subsequent morphological examinations confirmed consistent differences among these groups, particularly in reproductive structures, the number and arrangement of spines on the front legs, and the degree of eye reduction. Notably, in some caves, individuals of two different genetic lineages (putative species) co-occurred—a rare phenomenon among cave spiders. This study provides a foundation for describing new species within the *S. hercegovinensis* species complex. Recognizing this hidden diversity could support conservation efforts for these spiders and their fragile habitats in southern Croatia.

# Palaeospeleobiology: a new perspective

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Palaeontology is the scientific study of extinct plants and animals, or their remains, such as fossils and imprints. This study mostly involves bones, teeth and shells, since fossils or imprints of soft tissues are rarely found in geological sediments. True cave animals, or troglobionts, are mostly invertebrates and tend to be extremely small and delicate. Therefore, we do not expect to find fossilised remains of troglobionts in the geological record. However! The *Marifugia cavatica* Absolon & Hrabě, 1930 is the only known freshwater cave tubeworm endemic to the Dinaric Karst. It builds solid limestone tubes in which it lives. These tubes are strong enough to have been preserved as fossils for millions of years. The oldest known *Marifugia* fossil tubes, dating back 3.6 million years, were found attached to the walls of fossil cave in the Črnotiče quarry in Slovenia. We recently discovered and documented another such site in the nearby Črni Kal quarry, where fossilised tubes were sieved from cave sandy sediment. Similarly, during palaeontological research of the Pleistocene sediments from the Uršnja luknja cave in Slovenia, we found the well-preserved calcified fossilised exoskeletons of troglobiont or troglophile millipedes, woodlice and snails by sieving and washing the sediments with the finest sieves. Some of the remains are so well preserved that we can even identify the genera *Brachydesmus* Heller, 1858, *Polydesmus* Latreille, 1802, *Trachysphaera* Heller, 1858, *Titanethes* Schiöedte, 1849, and *Zospeum* Bourguignat, 1856. The studied sediments are estimated to be around 100,000 years old. These taxa are characterised by exoskeletons that contain high levels of calcium carbonate. Fossilisation is less likely for cave animals with chitinous exoskeletons, such as beetles and arachnids. The well-preserved fossil remains of cave invertebrates found in Uršnja Luknja are certainly not an isolated case. Further microscopic analysis of cave sediments using washing and sieving techniques will undoubtedly reveal more fossilised cave animal remains as well in many other locations.



ORAL  
COMMUNICATIONS

# Life-history traits in *Niphargus balcanicus*

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Acquiring life-history data requires long-term observations of individuals or populations in natural habitats or laboratories, both of which are particularly demanding in subterranean species. For most subterranean taxa, such data remain scarce, even in well-studied model groups. Amphipods of the genus *Niphargus* Schiødt, 1847 are no exception. Here, we systematically obtained life-history data for *N. balcanicus* (Absolon, 1927), one of the largest and functionally distinct *Niphargus* species. We monitored the offspring of two females (“A” and “B”, beginning with 109 juveniles in total) from hatching to two years of age. We checked the juveniles weekly to record their condition, feeding, and presence of the exuviae on an individual level. We also measured body length on a subset of juveniles every five weeks. We analyzed survival and growth rates, molting patterns, feeding habits, and explored relationships among these traits for each group (“A” and “B”). Overall, growth, feeding, and molting patterns in relation to age were similar in the two groups. Body length increase per molt was greater during early molts than in later ones and intermolt periods lengthened with age. In most cases, the juveniles consumed the food provided, while feeding activity varied with age and molt stage. We also inferred the approximate size at sexual maturity from the development of secondary sexual characters, which occurred after >600 days and at >1.6 cm body length. These observations provide rare data available on early growth and life-history traits in *Niphargus*, and the first of this kind for *N. balcanicus*. Given its recognition as an endangered species, getting insights into life-history traits is even more valuable. Moreover, the experience gained within our two-year observations and analyses of such data will be helpful for designing future studies in other subterranean species.

ORAL  
COMMUNICATIONS

# What can we learn about the state of the Alpine-Dinaric ecosystems in Slovenia from two decades of bat monitoring in caves?

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Slovenia's state bat monitoring comprises four basic elements: surveys of hibernacula and summer roosts, bat sound recordings, and mistnetting. A substantial proportion of the monitoring sites are caves and a few other subterranean sites (app. 80). Sites include tourist caves (15), easily accessible horizontal caves and caves with entrances or internal pits that can only be accessed by using single rope technique. Hibernacula (64) and summer roost counts (21), as well as mistnetting at the cave entrances (13), focus on 7, 8 and 9 bat species respectively, together covering 14 species — almost half of those living in the country, covering wide range of foraging habitats and roosting sites. The most statistically robust population trends are those from hibernaculum counts, followed by summer counts. However, summer results from caves have not yet been analysed separately from other sites due to the small number of caves. For the same reason and also due to sparse sampling, mistnetting provides little more than confirmation of species presence. The results are for now optimistic for most of the bat species in question (9 species), as their population trends are stable or increasing, or at least their presence is stable; for the others, the trends are uncertain. Cave surveys also occasionally led to the detection of 12 non-target species. Therefore, through our "cave" monitoring we have collected at least some faunistic observations on 80% of the present bat species in the country. Additionally, we have collected information on the conservation status of caves, mainly considering direct threats caused by humans. While no major disturbance or destruction of cave habitats was recorded, there is room for improvement in the bat conservation regime in some tourist caves. In summary, the evidence gathered from monitoring of the bats using caves suggests that the Alpine-Dinaric ecosystems are in a sufficiently good state to support the current bat populations. Only time and the monitoring programme will tell if this will be the case in future.

ORAL  
COMMUNICATIONS

# Hidden connections: tracing subterranean biodiversity of the Reka–Timavo River through eDNA

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The Reka–Timavo hydrological system, extending nearly 40 km underground, remains only partially explored, with approximately half of its course documented within the transboundary karst region of Italy and Slovenia. Environmental DNA (eDNA) has transformed biodiversity research by enabling the detection of species distributions even in habitats that are otherwise inaccessible. In this study, we examined metazoan communities of the Reka–Timavo system using eDNA from water samples collected at two subterranean sites. At the ponor zone of the Škocjan Caves Regional Park (Slovenia) and at Luftloch Cave (Italy), located 13 km downstream in a straight line and newly discovered in March 2024; this site lies approximately 20 km upstream from the river resurgences. Our results revealed both shared taxa, reflecting the hydrological connectivity within the system, and distinct assemblages, highlighting ecological differences among the sampling sites. Slovenian samples were dominated by rotifers, particularly members of the genus *Ploima*, whereas Italian was characterized by arthropods, including copepods (*Acanthocyclops*) and dipteran insects. Notably, hydrozoans – rarely recorded in subterranean environments – were detected. The DNA of the freshwater jellyfish *Craspedacusta sowerbii*, native to East Asia but now widespread in European inland waters, was detected at all sites. Its inconspicuous polyp stage often hampers direct observation, and its presence here corroborates a recent record by the Museum of Natural Sciences in the upper part of the Reka–Timavo River, where the species was found. Additionally, DNA of *Hydra vulgaris*, already known from the region, was identified in Slovenian samples. Of particular interest is the detection of *Velkovrha enigmatica*, the only known stygobiotic freshwater hydrozoan endemic to the Dinaric karst. This species has never been reported in Italy before, and its DNA detection highlights the need for further ecological and biogeographical investigations of the Reka–Timavo system.

ORAL  
COMMUNICATIONS

# Management of protected areas in the Dinaric Karst – Barač Caves

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Protected area management is sometimes simple and sometimes very complicated. Management refers to the implementation of a series of measures and activities necessary for the long-term preservation of the natural and other values of an area, within the responsibilities of the institutions of the nature conservation system according to legal regulations. Public institutions for the management of protected areas at the national, regional or local level, have a significant impact on nature protection due to the direct implementation of protection. Experience has shown that simply declaring an area protected, it is not possible to achieve the full preservation of the values for which it was protected, but it is necessary to permanently monitor changes and, if necessary, implement activities to improve the condition of the area. It is also necessary to monitor and influence human activities within protected area, limiting or adapting when they represent threat, and encouraging when they support sustainable management.

ORAL  
COMMUNICATIONS

# Sub-BioMon project – setting the schemes to monitor subterranean biodiversity in karst

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Subterranean habitats and the associated fauna present a great challenge for research and conservation. There is no unified monitoring approach available that would enable detecting potential trends in status of subterranean biodiversity through time and space. This is not surprising, as subterranean species are highly endemic, exhibit high species richness in only a few regions, and are difficult to sample and identify. Conservation activities are often directed toward caves as habitats, having a protected status in national as well as international legislation (e.g., the EU Habitats Directive), while the life inhabiting them, including species important for individual caves, are usually overlooked. While only a few countries have ongoing biological monitoring programs for caves, most countries are lacking it. Establishing minimal standardized monitoring protocols for subterranean biodiversity in karst is one of the central goals of the three-year international project Sub-BioMon (<https://www.sub-biomon.net/>), funded by the EU Biodiversa+ partnership. The project involves partners from six European countries, differing in the proportion of karst, richness of troglobionts, and the scope of ongoing activities dedicated to monitoring of subterranean habitats. Combining both standardized and novel field sampling techniques, we plan to design a minimum subterranean fauna monitoring protocol that provides comparable results among various European karst regions. Besides different methods of sampling terrestrial and aquatic species, we are exploring a range of DNA-based molecular approaches (DNA barcoding, eDNA) to test their efficiency and usability in routine species identification and detection. An important part of this project is also the involvement of the relevant stakeholders, including decision makers, managers, cavers and the general public.

ORAL  
COMMUNICATIONS

# Shining a light on bats: UV fluorescence in lesser and Blasius's horseshoe bats

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Biofluorescence, the absorption of high-energy light (UV) and its reemission at lower energy wavelengths, is widespread across living organisms initially observed in plants. In recent years it has been reported increasingly widely in animals. Though not as ubiquitous as in the ocean, it is not a rare phenomenon on land. Fluorescence occurs in all major phyla of terrestrial animals including mammals. The function of UV fluorescence in animals has been attributed to a number of reasons including signalling around mate choice, a type of Batesian mimicry where prey species emit a similar fluorescence to predators, camouflage against vegetation or habitats that themselves fluoresce or it may simply be the by-product of biochemical processes and have no adaptive purpose. In July 2024, we incidentally discovered biofluorescence in a colony of *Rhinolophus hipposideros* (Bechstein, 1800), on Lokrum Island in southern Croatia. Under illumination with both 365 nm and 395 nm ultraviolet light, the pelage emitted a distinct light-blue fluorescence visible to the naked eye, whereas wing membranes showed no fluorescence. Our surveys of the other European rhinolophids have subsequently shown the phenomenon to also occur in *Rhinolophus blasii* Peters, 1866 but not in *Rhinolophus ferrumequinum* (Schreber, 1774), *Rhinolophus euryale* Blasius, 1853 or *Rhinolophus mehelyi* Matschie, 1901. Fluorescence was observed exclusively in adult individuals and was absent in carried pups and newly volant juveniles. We explore possible functional and non-functional explanations for this phenomenon and discuss its potential applications for monitoring and surveying *R. hipposideros* and *R. blasii* populations.



# ABSTRACTS **POSTERS**

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## POSTERS

# How much do we know about threat status of cave habitats and its fauna?

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The Dinaric karst area of Croatia represents a “hot spot” of the world’s cave biodiversity. In addition to the high presence of biodiversity, unfortunately, the threat of cave fauna is also increasing. The threat to cave fauna in Croatia is most often due to: physical devastation of cave habitats; pollution of cave habitats; inappropriate tourist development and use of caves; global climate change and the immediate threat to cave taxa. The Red Book of Cave Fauna, published in 2009, highlights human activities and processes caused by these activities as the greatest threat to cave fauna. The Ministry of Environmental Protection and Green Transition maintains the CroSpeleo system as part of the Nature Protection Information System. It provides access to a large number of data on caves, including the anthropogenic impact on caves in Croatia. According to CroSpeleo, most caves are threatened by waste pollution. In July 2025, the Ministry prepared a Report on the State of Conservation of Species and Habitat Types in Croatia for the period from 2019 to 2024. According to the report, of the 3 species analyzed; *Congerja jazici* Morton & Bilandžija, 2013 is in an unfavorable-bad state; *Congerja kusceri* Bole 1962 is in an unfavorable-inadequate state and *Leptodirus hochenwartii* Schmidt, 1832 is in a favorable state, in all three biogeographic regions. The greatest number of pressures on the listed species is related to agriculture related practices; energy production processes and related infrastructure development; development and operation of transport system; development, construction and use of residential, commercial, industrial and recreational infrastructure areas. Habitat type 8310 “Caves not open to the public” is in unfavorable-poor condition, and the greatest number of pressures is also related to development, construction and use of residential, commercial, industrial and recreational infrastructure areas. Compared to the 2019 report, the conservation status of the habitat type in the Alpine and Mediterranean regions has deteriorated, while the status of the species mentioned has remained the same. According to all of this data, the greatest threat to cave fauna is posed by human activities.

## POSTERS

# Cave biodiversity mapping of the endangered Komarnica canyon in Montenegro

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While many European countries are removing dams (like Urrutienea dam removal in France) and restoring rivers, governments in the Balkans are planning more than 3,000 new hydropower projects. Among them is the Komarnica dam, designed to flood the mid-section of the 25-km-long, up to 600-m-deep Komarnica Canyon, located just south of Durmitor National Park, a UNESCO World Heritage Site. The dam is projected to generate 213 GWh of electricity, increasing the country's energy production by only 1–2%. The Komarnica Canyon is one of Europe's most pristine canyons, featuring a cold, fast-flowing mountain river that flows through a limestone region within the Dinaric Mountain range, a global biodiversity hotspot for subterranean fauna. At the request of the Save Komarnica movement, our team began biodiversity surveys of the canyon slopes in 2023. Preliminary results highlight the exceptional conservation value of this area. Subterranean ecosystems—unmapped, unstudied, and difficult to access—harbor the highest concentration of endemic species and would be severely impacted by flooding from a 170 m deep hydropower reservoir. To date, we have located and mapped 10 caves in the canyon and the surrounding limestone area. These caves, together with degraded trees, provide key roosting habitats for bats: our surveys recorded 13 species, representing nearly half of Montenegro's 28 known species and more than one-quarter of Europe's 51 species. Moreover, cave invertebrate surveys yielded species new to Montenegro and taxa new to science. Our findings underscore the global significance of Komarnica's biodiversity and highlight the urgent need to reconsider hydropower development in this unique ecosystem.

## POSTERS

# Research of subterranean biodiversity in Nikšić field, Montenegro

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The Dinaric Karst in the western Balkans is known for its remarkable underground fauna. For many years, scientists have been discovering new species in its caves, and today this region harbors more subterranean species than almost anywhere else in the world. Because of this, it is considered the most important hotspot for underground biodiversity. Through our project, funded by CEPF, we decided to study an area that had not been examined in detail before. The Nikšić Field is the largest karst field in Montenegro, located in the west of the country. Despite the importance of its underground system, there are no available data on the biodiversity and conditions of this habitat, which was the main reason we initiated activities in this area. In total, 14 caves were selected for research in the Nikšić Field and the wider River Zeta basin. Some of the caves contain both terrestrial and aquatic habitats, including subterranean lakes, while most provide only terrestrial environments. During the research, we collected specimens from 14 different groups of arthropods. This includes the following taxa: 38 beetles (Coleoptera), 19 springtails (Collembola), 18 spiders (Araneae), 11 harvestmen (Opiliones), 10 isopods (Isopoda), 9 mites (Acariformes + Parasitiformes), 9 stone centipedes (Lithobiomorpha), 7 pseudoscorpions (Pseudoscorpiones), 5 two-pronged bristletails (Diplura), 5 snails (Gastropoda), 3 millipedes (Diplopoda), 1 true bug (Hemiptera), 1 fly (Diptera), and 1 flatworm (Turbellaria). The collected material comprises specimens from 14 different caves, with some taxa potentially represented more than once.

## POSTERS

# Millipedes (Myriapoda: Diplopoda) in subterranean habitats of Plitvice Lakes National Park (Croatia)

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Plitvice Lakes National Park (Croatia), a UNESCO World Heritage Site, is renowned for its lakes formed through the creation of tufa barriers. This globally recognized karst phenomenon has been extensively studied, primarily with respect to geomorphology, hydrology, water chemistry, and aquatic flora and fauna. In contrast, the Park's terrestrial habitats, which cover the majority of its surface and include numerous caves and pits, have not been systematically investigated. Within the framework of a four-year biospeleological research project (2021–2025) led by Croatian Biospeleological Society, a highly diverse assemblage of invertebrates was collected. Here, we present detailed results on the millipede (Diplopoda) fauna. During this period, millipede fauna was sampled at 106 localities, including 88 speleological sites, four MSS traps, and 14 cave and pit entrances, with additional collections made across various microhabitats (soil, leaf litter, decaying wood, etc.). A total of 26 taxa were recorded, 21 identified to species level and five to genus or family level only, as they represented juveniles that cannot be reliably determined to species. Three species are troglobionts, seven taxa are troglophiles, while most of the recorded millipedes are troglloxenes of edaphic character. Six species were documented for the first time in Plitvice Lakes National Park: *Polyxenus lagurus* (Linnaeus, 1758), *Glomeridella minima* (Latzel, 1884), *Glomeris hexasticha* Brandt, 1833, *Trachysphaera schmidtii* Heller, 1858, *Brachydesmus herzegowinensis* Verhoeff, 1897, and *Brachydesmus inferus* Latzel, 1884. In addition, a new species to science belonging to the genus *Haasia* was discovered, representing one of the most significant findings of this research. Other troglobiont taxa confirmed in the study area include *Attensia likana* Strasser, 1966, and *B. inferus*. Prior to this study, 23 species had been recorded from Plitvice Lakes National Park; with these new findings, the total number of millipede species recorded in the Park has increased to 30.

## POSTERS

# Sulfur Cave as a Refuge: New Insights into Bat Ecology in the Sarantaporos Valley, Epirus

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Sulfur Cave in Sarantaporos Valley exemplifies a unique hypogean ecosystem where hot sulfidic waters continuously erode carbonate bedrock, creating vast underground networks. These chemosynthetic environments operate independently of photosynthesis, with specialized bacteria converting sulfur compounds into essential nutrients that fuel subterranean food webs. Seasonal research employing visual documentation, capture techniques, and bioacoustic analysis has unveiled a significant bat refugium along the Greek-Albanian border region. Population dynamics show seasonal fluctuations, with summer aggregations reaching several thousand individuals before declining to hundreds during cooler months. Six primary species dominate this underground community. The long-fingered bat *Myotis capaccinii* (Bonaparte, 1837) and Schreiber's bent-winged bat *Miniopterus schreibersii* (Kuhl, 1817) form substantial colonies alongside four horseshoe bat species: Blasius's *Rhinolophus blasii* (Peters, 1866), Mediterranean *Rhinolophus euryale* (Blasius, 1853), greater *Rhinolophus ferrumequinum* (Schreber, 1774), and lesser *Rhinolophus hipposideros* (Bechstein, 1800). The most significant finding involves Bechstein's bat *Myotis bechsteinii* (Kuhl, 1817), a species typically classified as arboreal. The discovery of numerous newborns on the cave floor in late June 2024, followed by the capture of juvenile individuals in nets during July 2025 within the same cave system, represents a significant finding that challenges current understanding of species-specific roosting behavior and habitat selection patterns. Predator-prey dynamics within the cave demonstrate remarkable ecological complexity. Abundant chironomid thriving in sulfur-enriched waters, provide abundant prey for hunting *M. capaccinii*. Ultrasonic recordings documented characteristic feeding buzzes in proximity to aquatic areas, providing acoustic evidence of active *M. capaccinii* foraging behavior within the cave environment. This foraging activity demonstrates the ecological



## POSTERS

complexity of the cave's predator-prey relationships, where sulfur-enriched waters sustain abundant chironomids serving as prey. Regional surveys identified three additional caves with significant bat populations. In June 2024, we recorded hundreds of individuals in Pixaria Cave (*R. ferrumequinum*, *R. hipposideros*, *R. blasii*, *R. mehelyi*, *M. emarginatus*) and Turtle Cave (*M. schreibersii*, *Myotis* spp.), with surveys of the third cave scheduled for October 2025. These findings suggest an interconnected metapopulation structure where Sulfur Cave may function as part of a broader network of regional colonies. This network architecture underscores the Sarantaporos Valley's conservation value, demanding landscape-scale protection strategies that encompass entire cave systems rather than isolated sites. Such comprehensive approaches prove essential for maintaining these extraordinary chemosynthetic ecosystems and their specialized biological communities.



## POSTERS

# New book on subterranean habitats and fauna of Slovenia as the basis for education and raising public awareness on importance of subterranean biodiversity

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Subterranean fauna and habitats represent a special case for conservation, and measures to raise awareness must consider the inaccessibility of these habitats and the “out of sight, out of mind” effect. Slovenia has the longest tradition of speleobiological research, as the first scientific descriptions of subterranean animals originated here. Despite the extensive scientific literature on subterranean fauna, there are only a few publications dedicated to educating the public and raising awareness of subterranean life. We have taken up this challenge and the result is the recently published book “Živo podzemlje Slovenije” – Subterranean Life of Slovenia, published by the University of Ljubljana Press. The book has 256 pages and contains numerous diagrams, illustrations and high-quality photos. It is divided into two parts. The first part introduces the reader to the subterranean realm and its biological explorations, including different types of subterranean habitats, overview of methods used to sample subterranean animals and identify them, and characteristics of subterranean communities. We outline Slovenia’s role as the cradle of speleobiology and present it as a hotspot of subterranean biodiversity, concluding with conservation notes of these hidden yet threatened ecosystems. The second part of the book provides an overview of the main animal groups found in Slovenia’s subterranean habitats. 50 different taxa are presented through various fascinating facts about their mysterious life. We included notes on the history of their exploration, distribution, taxonomy, biology and conservation status, complemented by photographs. The book fills a large gap in the speleobiological literature in Slovenia and presents a much-needed contribution to raising awareness about the subterranean habitats and their unique and rich biodiversity in Slovenia. Although written in popular language and aimed at wider public, it contains scientifically accurate data and descriptions so it can also be used by experts and students.

## POSTERS

# Diversity in the shadows: unveiling lesser-known lampenflora phototrophs in show caves worldwide

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Lampenflora is a community of organisms that develops near artificial lighting in tourist caves and consists primarily of cyanobacteria and algae, but also lichens, mosses, ferns and, more rarely, vascular plants. Although often overlooked, lampenflora represents a growing ecological problem in show caves around the world as it is opportunistic or even invasive, exploiting unnatural conditions created by human activity. Due to its resilience and adaptability, lampenflora is difficult to control and it tends to persist for long periods of time, even in the dark, or even re-establishes quickly after removal. This community is being studied by scientists around the world from various aspects, with the main focus on primary colonizers, microorganisms, cyanobacteria and algae. Many authors generally report a low species richness of phototrophic microorganisms in lampenflora, but when different literature is combined and summed up, the overall diversity seems to be much higher than previously thought. To summarize the knowledge on phototrophic microorganisms in this specific community, we conducted a comprehensive literature review. Herein we do not focus on the three dominant groups (Cyanobacteria, Chlorophyta, Bacillariophyta), but on some lesser-known phototrophic microorganisms belonging to other algal groups that are rarely encountered or mentioned in the literature as part of lampenflora community. These taxa belong to the Xanthophyceae, Eustigmatophyceae, Dinophyceae, Euglenophyceae, Synchronophyceae, Chrysophyceae and Florideophyceae as classified in AlgaeBase. Although these algae are rare, they are only sporadically documented and can sometimes be overlooked during identification, summarizing their occurrence contributes a valuable insight into the true diversity and ecological complexity of lampenflora.

## POSTERS

# The poorly known cave centipede *Cryptops illyricus* Verhoeff, 1933 (Chilopoda: Scolopendromorpha: Cryptopidae) from caves of the northern Dinarides

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Genus *Cryptops* Leach, 1814, with more than 180 described species, represents one of the most species-rich genera within the class Chilopoda. Representatives of this evolutionary lineage of eyeless scolopendromorphs inhabit a wide range of habitats, mostly associated with the upper soil layers. Some species have been reported from caves, primarily as troglophiles, but some are also exclusively cave-adapted (troglobiotic) species. A significant number of species are known from only a few specimens and have uncertain taxonomic status, requiring further revision. One such example is a poorly known species *Cryptops illyricus* Verhoeff, 1933 reported only from few caves. This species was originally described from the cave Zjati in vicinity of Markovščina, northern Istria (Slovenia), based on a single male specimen. To date, only two additional localities have been reported in the literature, both in Italy (Grotta del Punt near Clauzetto and Grotta Frasassi near Ancona), each represented by no more than one or two collected specimens. Here we present a new record from the cave Jama pod Krogom, near Podpeč, representing a second known locality of this species in Slovenia. A total of three females were collected under stones near the cave entrance. All morphological characters relevant for species identification, as well as the species' COI based phylogenetic position are presented. The currently known distribution of the species is unusual, as it is been reported from distant localities on opposite sides of the Adriatic Sea. Additional specimens need to be collected and subjected to both molecular and morphological analyses to clarify its taxonomic status and true distribution range.

## POSTERS

# Subterranean Biodiversity of Hvar Island: Insights from the SpeleoPharos Project

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The Biospeleology Section of the Biology Students' Association – BIUS conducted a biospeleological survey of subterranean habitats on the island of Hvar in March 2025. Twenty sites were explored: 17 caves and three wells. Seven sites were investigated biologically for the first time, and four were subjected to their first speleological exploration. A total of 74 invertebrate taxa were identified. The most diverse groups were spiders (19 taxa), isopods (12 taxa), and pseudoscorpions (11 taxa). Eighteen taxa were troglobionts, fully adapted to subterranean life, while 27 were classified as troglophiles. The richest sites are: cave Kraljevska jama na Gulišini, the deepest cave on the island (142 m deep), and cave Borovik, each harbouring 14 taxa. The survey revealed several species new to science. Two new troglobiont centipedes of the genus *Lithobius* Leach, 1814 were discovered, including the most troglomorphic representative of the genus recorded in the Dinarides. A new troglobiont millipede (family Trichopolydesmidae Verhoeff, 1910) was also identified. Among pseudoscorpions, four potentially new species of the genus *Chthonius* C. L. Koch, 1843 and two of the genus *Roncus* C. L. Koch, 1873 were recorded. The range of pseudoscorpion *Lasiochernes pavlekae* Hlebec & Harvey 2024 and isopods of the genus *Echinarmadillidium* Verhoeff, 1901 were expanded to Hvar, while specimens of a new species of terrestrial isopod genus *Alpioniscus* Racovitza, 1908 were collected for future description. In addition, the endemic harvester *Lola insularis* Kratochvil, 1937, previously known as single-site endemic (from the cave Špilja pod Kapelu), was found in the cave Borovik. This study significantly enriches knowledge of Hvar's subterranean fauna. The presence of several endemic and potentially new species underlines the need to preserve Hvar's subterranean habitats.

## POSTERS

# Monitoring olm (*Proteus anguinus*) populations in karstic springs in Slovenia via infrared cameras

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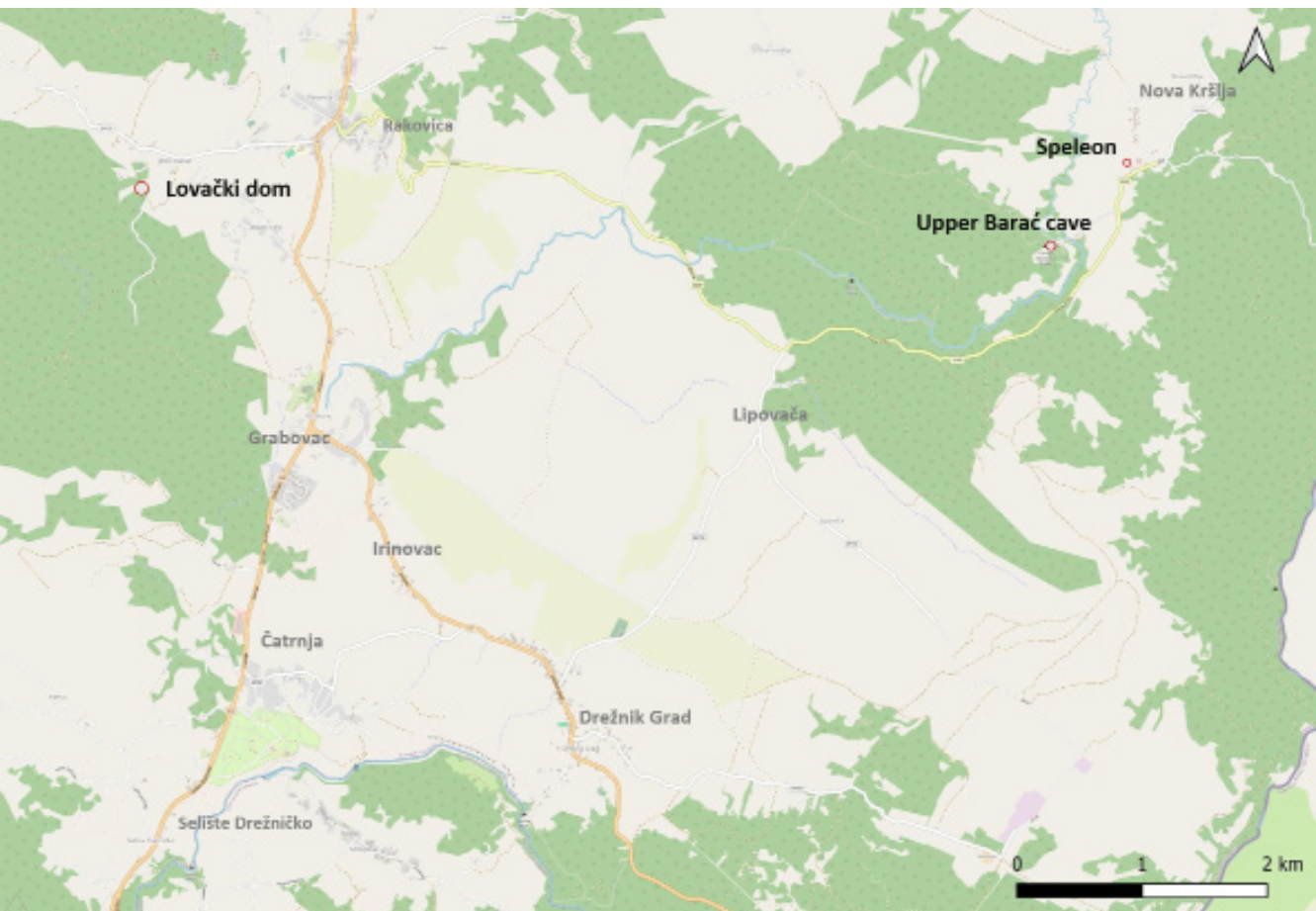
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The olm (*Proteus anguinus* Laurenti 1768) is one of the largest fully groundwater-adapted vertebrates in the world. This unique amphibian is a Dinaric Karst endemic and listed as a vulnerable species by the IUCN. Recently, nine distinct lineages of the olm have been identified. Some of them are extremely narrow endemics restricted to only a few sites, making them highly threatened by pollution and habitat destruction. Establishing a monitoring scheme for olms and their groundwater habitat is therefore vital, particularly for these lineages. However, this task is challenging due to the inaccessibility of the subterranean environment. Karstic springs, by contrast, are easy-to-access and some of the endemic olm lineages are known to occur in these ecotones. We assessed the suitability of these “windows” into the underground and tested remote sensing with infrared cameras for olm monitoring. Cameras and data loggers (temperature, light intensity) were deployed at three springs in southeastern Slovenia inhabited by two of the rarest olm lineages. Two springs were natural, while the third was an artificially covered spring. At each site, one camera was mounted above the water to directly monitor olm presence, while a second camera monitored spring visitors from nearby. First analyses revealed that olm abundance varied throughout the day and year. At the natural springs, olms were active almost exclusively during nighttime, while at the covered spring (a permanently dark environment) they appeared throughout day and night, suggesting that light deters olms from exploiting springs. The three springs also differed in olm density and occurrence probability. Long-term monitoring could establish spring-specific baseline values of olm occurrence during different seasons, with significant deviations serving as early-warning signals of population decline. Finally, our data provides a rare opportunity to uncover the otherwise hidden biology of this enigmatic species, including its behavioral ecology and interactions within the spring ecosystem.

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61. Zagmajster Maja
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63. Zrnčić Vida
64. Žalac Sanja

# LOCATIONS



**10<sup>th</sup> October, from 20:00:** The Icebreaker Meeting will be held at [Lovački dom- Jelov Klanac 211c, Rakovica](#).

**11<sup>th</sup> and 12<sup>th</sup> October:** The entire scientific program will take place at the [Speleon – Centre of Subterranean Heritage in Rakovica](#). Speleon is a modern visitor and research center that showcases the rich underground biodiversity and geology of the Dinaric karst, offering interactive exhibitions and educational programs dedicated to cave ecosystems and their conservation.

**11<sup>th</sup> October:** Dinner and social event at [Lovački dom – Jelov Klanac 211c, Rakovica](#).

Both lunches (on 11<sup>th</sup> and 12<sup>th</sup>) will be served at [Speleon](#).

**12<sup>th</sup> October, from 14:30:** Visit to [Speleon](#) and [Upper Barać Cave](#). Please bring comfortable walking shoes and a light jacket (the cave temperature is around 10°C). We also recommend bringing a bottle of water.

A link to all of these locations in **google maps**: <https://maps.app.goo.gl/5wc8gKwcupHc57BG9>



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