

## **Species diversity patterns and factors shaping the spatial distribution of cave dwelling invertebrates in Postojna Cave**

In 2019, a new eLTER Transnational and Remote Access mobility was offered by the Karst Research Institute ZRC SAZU, which hosted two Romanian researchers, Dr. Ioana Nae and Dr. Augustin Nae from the “Emil Racovita” Speleological Institute Bucharest. The 12-day research visit focused on two eLTER sites (the Postojna-Planina Cave System and the Škocjan Caves), and provided an opportunity for extensive field trips and fieldwork related to the rich subterranean biodiversity and its karst habitat in the Slovenian Classical Karst. The mobility also provided the opportunity to establish many contacts with Slovenian karstologists, speleobiologists and other experts in the field of karst research.

**Dr. Ioana Nae** - a researcher with 15 years of experience working on subterranean environments at “Emil Racovitza” Institute of Speleology in Bucharest, in the Department of Biospeleology and Soil Diversity. She is an expert in the taxonomy and systematics of oribatid mites (a group of Acari), as well as the small mammal species and arthropod communities from subterranean habitats. She received her a PhD in Biology on oribatid mite communities from mesosvoid shallow substrate (MSS) from the Piatra Craiului Mountains, Romania.

**Dr. Augustin Nae** – researcher with more than 20 years of experience in the study of caves and subterranean habitats at “Emil Racovitza” Institute of Speleology, in Bucharest, the Department of Biospeleology and Soil Diversity. He is an expert in the taxonomy and systematics of spider species and arthropod communities from subterranean environments.

### **Report of the research activities**

Ioana Nae, Augustin Nae and Magdalena Năpăruș-Aljančič

Mentor: Prof. Dr. Tanja Pipan

**1. Karstological monitoring; visit to the Postojna Karst Museum.** Together with Dr. Matej Blatnik and Dr. Cyril Mayaud (IZRK) we visited the area of a new railway construction site in the Slovenian Classical Karst. The construction site is under karstological monitoring (if new caves are discovered during the excavation work for the new railway, researchers from the Karst Research Institute will establish the scientific significance of the discovery, Photo 1).

In the afternoon we visited the Notranjska Museum Postojna (Postojna Karst Museum), a museum dedicated to karst research in Slovenia. Our guide was Dr. Slavko Polak, a biospeleologist at the museum (Photo 2).



Photo 1. Visit at the railway construction site (photo M. Aljančič).



Photo 2. Visit at the Karst Museum (photo M. Aljančič)

**2. Visit to Bela Krajina, SE-Slovenia.** We visited Bela Krajina (SE Slovenia, Karst of Dolenjska region), where we had the opportunity to explore the habitat of the very rare and endangered cave amphibian, the black proteus (*Proteus anguinus parkelj*), which is endemic to the Slovenian karst. We also visited the recent inaugurated Info Centre specialized in video-monitoring of black proteus, and we learned about non-invasive methods used to study the distribution of the proteus in the shallow and inaccessible karst of the area. We also learned about the pollution threats of the karst area and the mitigation of conservation solutions. Biologist Gregor Aljančič was our guide with whom we discussed possible joint projects on amphibian species from karst areas (the Romanian Institute recently implemented a project on adaptation of hypogean species to subterranean environments, using the fire salamander (*Salamandra salamandra*) as case study. We also discussed on site with Dr. Tanja Pipan, about the main research topics at IZRK and ISER as well as field sampling methods for cave species. Overall, the experience of the scientists involved in the field work, their multidisciplinary approach to studying the black proteus is a good example for future studies on cave species, especially endemic or cryptic ones, common in subterranean environments.



Photo 3. Visit at the Krupa spring in Bela Krajina, SE-Slovenia (photo M. Aljančič)



Photo 4. Visit at the info center Jelševnik dedicated to black proteus in situ observations in Bela Krajina, SE-Slovenia. (photo M. Aljančič; <https://crni-moceril.si/en/info-centre>)

### 3. Karst Research Institute ZRC SAZU (IZRK) and visit at Rakov Škocjan karst valley.

Dr. Magdalena Năpăruș-Aljančič introduced us to data management at the IZRK, the DEIMS platform and the Slovenian eLTER sites and together we explored the possibilities of including a similar karst site in the eLTER sites in Romania). In the afternoon we visited Rakov Škocjan (in Notranjska region), a typical karst valley within the Postojna-Planina Cave System eLTER site. Dr. Matej Blatnik and Dr. Magdalena Năpăruș-Aljančič, both geographers at IZRK, explained the particularities of this karstic environment and the difficulties involved in exploring and describing vast cave systems.



Photo 5 -6. Visit at the Rakov Škocjan karst valley

**4. Sampling of terrestrial fauna in Postojna Cave.** Together with Dr. Peter Kozel and Lara Valentić, biologists at IZRK, we set pitfall traps at several sampling points in the cave, discussed the sampling protocol used for monitoring invertebrate species in Postojna Cave and compared it with the protocol used at ISER Bucharest. Although we had proposed to test a new sampling protocol in Postojna Cave as part of our eLTER project, Slovenian legislation only allows this for authorized personnel. The collaboration with biologists involved in this monitoring program gave us the opportunity to exchange expertise in the field of efficient and ethical sampling of cave invertebrates. In addition, the biologists showed us the meteorological stations that are active in the cave, what parameters they monitor (the O<sub>2</sub> and CO<sub>2</sub> concentration, Radon levels, wind, etc.) and explained how these abiotic parameters are integrated into the long-term management of the cave.



Photo 7 - 8. Sampling cave fauna in Postojna Cave

5. **Sampling the terrestrial fauna in Postojna Cave.** We collected the traps set two days earlier and identified the large invertebrates found in Postojna Cave (the cave cricket *Troglophilus* sp.; the cave spiders *Nesticus* sp., *Meta menardi*, *Metellina merianae*; the cave moth *Triphosa dubitata*). Dr. Kozel will provide a list of the invertebrate species collected on this field trip. In the afternoon we visited the Planina Cave, the hotspot of *Proteus anguinus* in the Dinaric karst, in order to get in touch with the natural habitat of this unique cave amphibian.



Photo 9. Visiting Planinska jama, the natural habitat of *Proteus anguinus*

6. **Visit at the Tular Cave Laboratory in Kranj ([www.tular.si](http://www.tular.si)),** a unique research facility specialized in long-term studies on the ecology, behavior and conservation of *Proteus anguinus* in semi-natural conditions (with almost 60 years of research on this cave amphibian). The laboratory is a member of the eLTER Slovenian Consortium. Gregor Aljančič, the head of the laboratory, told us many details about the history of the laboratory and the current work on proteus, an endeavor they follow for several years, unique in the world, with outstanding scientific results. In the afternoon, we visited the Jovan Hadži Institute of Biology from ZRC SAZU, where Dr. Matjaž Gregorič told us details about the exotic spiders from their research station at IG near Ljubljana and the Institute collections.

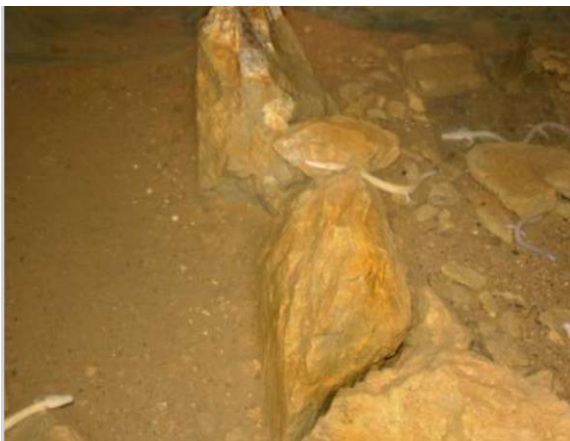


Photo 10. Visiting proteus at Tular Cave Laboratory (photo G. Aljančič)



Photo 11. Visit at Jovan Hadži Institute of Biology from ZRC SAZU (photo M. Aljančič)

7. **Visit at the [Park Škocjanske jame](#).** The Park is a UNESCO Heritage Site since 1986, a Regional Park since 1996, Underground Wetland - Ramsar Site since 1999 and Karst Biosphere reserve since 2004. The Škocjan Caves are a unique natural phenomenon, a creation of the Reka River. The Reka River springs from below the Snežnik plateau and flows on the surface for about 55 kilometers. After reaching the Karst, the river deepens its bed not only by erosion, but also by corrosion. The exceptional volume of the underground canyon is what distinguishes the Škocjan Caves from other caves and makes them one of the most famous underground sights in the world. Lara Valentić, biologist at the IZRK and former cave guide, gave us many details about the geology and hydrology of the Reka River, the current state of research in the Škocjan Caves, local speleology and the importance of the entire karst system for the region.



Photo 12 - 13. Visit at Park Škocjanske jame

## 8. Water sampling at Rečica ob Savinji (NE Slovenia)

We travelled with Dr. Matej Blatnik to a place where we helped take water samples for a tracing experiment. The karst spring at this locality is being monitored (the O<sub>2</sub> and CO<sub>2</sub> concentrations, conductivity, pH, chemical content, water discharge) because it has been proposed as a source of drinking water for the community in the nearby village.



Photo 14-15. Water sampling at Rečica ob Savinji spring

## 9. Monitoring environmental parameters from the caves at the karst-flysch lithological border

We accompanied Dr. Mitja Prelovšek on a fieldwork in the Divača karst area near the settlements Beka and Ocizla ("Blažev spodmol-Ocizeljska jama" and "Miškotova jama v Lokah" caves) and the area near Kačiče (Mejame cave and blind doline). Here, Dr. Prelovšek monitors the karst water sources for chemical compounds such as Ca and Mg, water conductivity, the O<sub>2</sub> and CO<sub>2</sub> concentrations and also, the sulphur concentrations of the springs that flow from the karst into the flysch.



Photo 16-18. Water sampling at Miškotova jama v Lokah

## 10. Microplastic sampling at Rižana karst spring

We visited the Rižana karst spring (the water comes from flysch recharge area, and is the most important karst spring that provides drinking water for the entire Slovenian coast). Here, Lara Valentić is conducting a study on microplastic contaminations of underground waters from Slovenia. We then stop at Predjamski grad (Predjama, the only castle in Europe built in a cave).

### Overall assessment of the eLTER TA-RA mobility

As the IZRK team involved us in their daily work, we had the opportunity to participate in the sampling of the invertebrate fauna in Postojna Cave, to directly identify cave invertebrate species endemic to Slovenia, or to see the locations (*terra typica*) where these emblematic species were discovered (such as the cave salamander *Proteus anguinus*, or the cave beetle *Leptodirus hochenwarti*). The multidisciplinary approach of the IZRK in karst research and conservation is a very good example for our institute and can open new paths for the development of speleology in Romania. As biologists, we had the opportunity to meet and collaborate with other experts from our research domain (Dr. Tanja Pipan – expert on biology of caves and subterranean habitats, Dr. Peter Kozel – expert in harvestman and cave invertebrates, Dr. Slavko Polak – expert on cave beetles, Biologist Gregor Aljančič – expert on proteus, Dr. Magdalena Năpăruș-Aljančič – geographer and data manager at IZRK, Dr. Matjaž Gregorič – expert on spiders, Lara Valentić, PhD student, studying microplastic impact on karst systems). An important part in our field trips were conducted by Dr.

Matej Blatnik, Dr. Cyril Mayaud, and Dr. Mitja Prelovšek (geographers and geologists at IZRK) – having the opportunity to helping them to gather water samples from karst rivers or springs.



Photo 19-20. Dr. Ioana Nae and Dr. Augustin Nae in front of the Karst Research Institute ZRC SAZU