

# ANCHIALINE CAVE ŠPILJA U UVALI VIDROVAČA (KRKA RIVER ESTUARY, CROATIA), PRELIMINARY BIOGEOCHEMICAL PROSPECTION

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Špilja u uvali Vidrovača anchialine cave is situated within upper Cretaceous layered limestones, in the upper part of the Krka River Estuary and has a direct connection with estuary water. The main channel of the cave is almost horizontal, 42.2 m long and 8.7 m deep. Salinity in the cave varied from 4 to 17. Total concentrations of trace metals in its water were: Cd 23.8 ng/L, Pb 62.7 ng/L, Cu 387 ng/L, Zn 6731 ng/L, Ni 374 ng/L and Co 56.0 ng/L. The cave fauna consists of very tolerant species, physiologically well adapted to strong salinity variations. In this cave invasive tubeworm *Ficopomatus enigmaticus* (Fauvel, 1923) showed a tendency to form aggregations.

**Key words:** Anchialine cave, Krka River Estuary, Dinaric Karst, trace metals, *Ficopomatus enigmaticus*

## INTRODUCTION

Anchialine cave Špilja u uvali Vidrovača is located in the middle section of the eastern Adriatic coast, in the upper part of the Krka River Estuary. This karst cave is located in upper Cretaceous layered limestones. The entrance to the cave is a little below water level and the cave has direct connection with estuary water. Only one other anchialine cave with open connections (Medova buža on Rab Island) is known in Croatia (CUKROV *et al.*, 2009). Moreover, Vidrovača cave is connected with estuary water whose major characteristic is variable salinity.

## MATERIAL AND METHODS

Following a preliminary visit to the cave during July of 2010, when water samples were taken, the research was conducted in April 2012. Speleological scuba diving techniques were used for measurement *in situ*, water sampling, photography and fauna collection. Salinity was measured by a Hach Lange HQ40D Multimeter (PSS-78). Water for trace metal analysis was sampled at a 5 m depth, 10 m from the cave entrance. Fauna in the cave was collected manually, with scraping from cave

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walls through the whole of the cave (random sampling), from surface sediments and by nets and preserved in formaldehyde for examination in the laboratory.

Total concentrations of trace metals were measured by stripping voltammetry, as described earlier (CUCULIĆ *et al.*, 2011).

## RESULTS AND DISCUSSION

As a result of underwater measurements, a topographical plan of the cave was drawn (Fig. 1). Anchialine cave Špilja u uvali Vidrovača is a horizontal cave filled with water along the entire channel. It is 42.2 m long and 8.7 m deep. In July 2010 there was a considerable flow of water from the cave (like a small spring) while in April 2012 the cave was without notable water flow. Higher measured salinity in the cave water was 17 at the depth of 5 m and 10 m from the entrance, while at the surface it was 4, the same as in the surface layer of the Krka River estuary (Fig. 2). Due to Špilja u uvali Vidrovača cave morphology a detailed salinity profile was not taken. Nevertheless, it was noted by a speleo-scuba diver that the salinity profile is more gradual and the halocline was deeper than in the estuary. The same situation was noted in the nearby anchialine cave Jama pod Orljakom (CUKROV *et al.*, 2010).

Trace metal concentration at the 5 m depth in the cave were: Cd 23.8 ng/L, Pb 62.7 ng/L, Cu 387 ng/L, Zn 6731 ng/L, Ni 374 ng/L and Co 56.0 ng/L, while in the surface layer in front of the cave concentrations were: Cd 15.8 ng/L, Pb 309 ng/L, Cu 226 ng/L and Zn 6198 ng/L.

Total concentrations of all metals except lead were higher in the cave due to slow water exchange, while elevated lead concentrations in the estuary surface water layer most probably represent intensive boat traffic from petrol additives.

Concentrations of trace metals in the Špilja u uvali Vidrovača cave are at the same levels as in the nearby anchialine cave Jama pod Orljakom (CUKROV *et al.*, 2010),

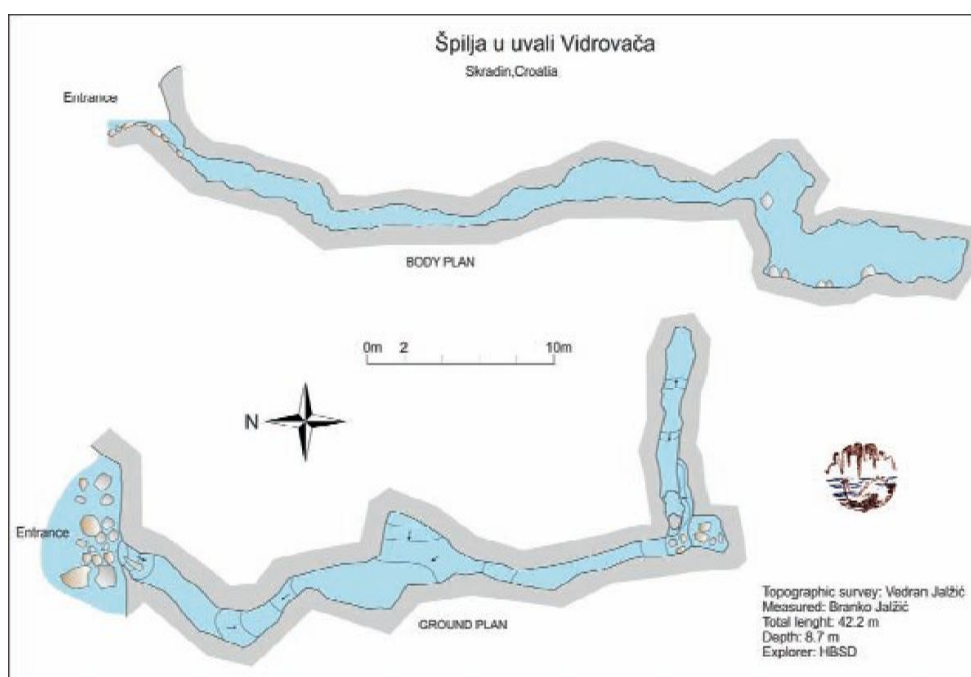


Fig. 1. Topographic plan of the anchialine cave Špilja u uvali Vidrovača.

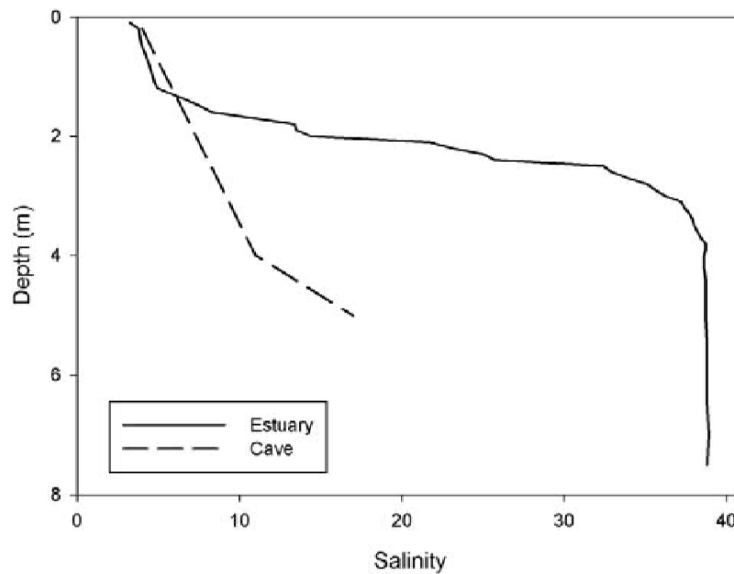


Fig. 2. Salinity profile

but significantly lower than in the anchialine caves of the Mljet island (CUCULIĆ *et al.*, 2011) for example.

The collected specimens of cave fauna are still being identified. The sedentary cave fauna is represented by Mollusca – *Mytilus galloprovincialis* (Lamarck, 1819) and *Mytilaster minimus* (Poli, 1795), Gastropoda – Hydrobiidae Troschel, 1857, Serpulidae – *Ficopomatus enigmaticus* (Fauvel, 1923), Cirripedia – *Balanus eburneus* Gould, 1841, Bryozoa – *Conopeum seurati* (Canu, 1928). As opposed to *M. galloprovincialis* and *M. minimus*, which were collected live, only empty shells of species *Parvicardium exiguum* (Gmelin, 1791) and *Telina* sp. were collected from the surface sediments. A few specimens of unidentified Amphipoda were collected upon scraping sedentary species. The cave shrimp *Troglocaris* sp. (Decapoda, Atyidae) were collected by net in the distal part of the cave.

Populations of benthic species on the cave walls were very dense at the entrance of the cave with density falling with distance from the entrance. The serpulid species *F. enigmaticus* is an invasive tubeworm previously found in only two anchialine caves (CUKROV M. *et al.*, 2010) as solitary specimens. *F. enigmaticus* in Špilja u uvali Vidrovača cave has the densest population with a tendency to form aggregations. Tubeworm and molluscs populations are denser in this cave than in the estuary just in front of the cave entrance.

In the cave were also noted but not collected a spider crab, *Maja* sp. (Decapoda, Majidae) on the cave floor and two fish species, the eel *Anguilla anguilla* (Linnaeus, 1758) and black goby *Gobius niger* Linnaeus, 1758.

## CONCLUSION

Špilja u uvali Vidrovača is a typical karst anchialine cave located in upper Cretaceous layered limestones, on the left side of the Krka River canyon. Concentrations of trace metals in this cave are similar to those in the nearby anchialine cave Jama pod Orljakom, but significantly lower than those in anchialine caves of Mljet Island. Sedentary species penetrated throughout the cave but with the densest populations

at the entrance of the cave. The serpulid *F. enigmaticus* and mollusc *M. minimus* are dominant species. In this cave, the invasive tubeworm *F. enigmaticus* showed a tendency to form aggregations.

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