

# Monitoring and segmentation of 10 caves from the Pădurea Craiului Mountains in order to ensure conservative management. Case study: Ciur Ponor Cave

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**Abstract**— The selected caves were monitored to establish management plan for speo-tourism. Several aspects were taken in consideration, among these the biology, geology, climatology, geo-morphology, paleontology and archeology of each cave. Our study is the result of several monitoring stages and it evaluates the thermic characteristics of air, carbon dioxide content, water temperature, quantity of oxygen dissolved in water, evaluation of biodiversity, evaluation of fossil bones deposits and monitoring of underground risk factors. We made propositions for sectors with integral conservation and sectors where speleo-tourist activities are allowed. The selected caves were monitored to establish their sections and finishing the management plan for speo-tourism. Several aspects were taken in consideration, among these the biology, geology, climatology, geomorphology, paleontology and archeology of each cave.

**Keywords**— *cave; monitoring; sectorization; protection class*

## I. INTRODUCTION

The karstic environments represent complex organized systems, distinguished through the endo- and exokarstic landscape and their capacity to archive information about paleoclimate, archeo-paleontology, sedimentology, morphology etc. Environmental conditions, lithological typology, drainage mode, generate a type of relief which can be valued in various ways. The underground environments represent real “data bases” for science and this is why some caves or caves sectors are destined only for conservation and systematic scientific research and are restricted to the public. On the other hand, caves with local importance, without unique elements, can be used for activities such as cave tourism or mass tourism.

## II. STUDY AREA

Pădurea Craiului Mountains have a high speleological potential, a number of 1300 caves being reported from this area. From these, we studied 10 caves (Craiului, Gruetului, Hârtopul Bonchii, Ciur Ponor – Toplița de Roșia, Doboș, Osoi, Bătrânului, Vântului, Gălășeni) using a multidisciplinary approach.

Ciur Ponor Cave lies in the karstic complex which includes Ciur Izbuca cave—Ciur Ponor Cave- Izbuca Toplița localized in Pădurea Craiului Mountains, Natura 2000 Site Defileul Pădurea Craiului, respectively.

The site is under the administration of Bihor’s Center for Protected Areas and Sustainable Development, and is included in a category of Reservations and nature Monuments under the Law No.5/2000, with modifications. The cave lies in tectonic limestones, its position is accessible and the morphological variation of the karstic system, determined by the local tectonics which generated the development in big part on diaclase. It has two levels, one active, the other, hydrogeological inactive which resembles a dendritic underground network, rich with erosion and corrosion forms.

## III. METHODS AND RESULTS

Our study is the result of several monitoring stages and it evaluates the thermic characteristics of air (Fig. 1), carbon dioxide content (2830 ppm in Vestiarul 1), water temperature, quantity of oxygen dissolved in water (Tab. 1), evaluation of biodiversity (terrestrial and aquatic), evaluation of fossil bones deposits and monitoring of underground risk factors. Also, an inventory of the bat species was made, along with determination of numerous invertebrate species, part of them endemic for the area. In Ciur Ponor Cave the pollution has low levels (the cave does not shelter a large colony of bats, only five species,

found occasionally, have a community importance and they do not form birth or hibernation colonies). We, also, evaluated the characteristics of fissile bone deposits of *Ursus spelaeus*, found on Tributary 1.

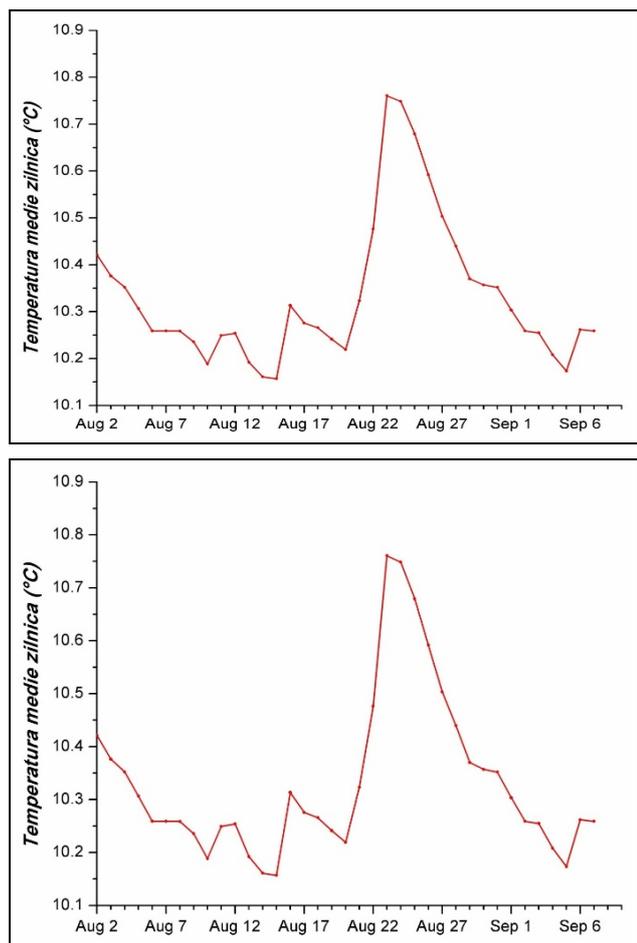


Fig. 1 The average daily temperature variation in the Ciur Ponor Cave: Station 1; in the monitoring interval between 02.08.2016 and 07.09.2016 (up) Station 2, in the monitoring interval between 02.08.2016 and 20.11.2016 (down) highlights the influence of external

TABLE I. PHYSICAL AND CHEMICAL PARAMETERS OF THE RIVER IN CIUR PONOR CAVE

Ciur Ponor Cave	T (°C)	R (kΩ/cm)	C (μS/cm)	TD S (ppm)	Salt level (SSE)	Disolved Oxigen (mg/L)	pH
Water course under the gate (A1 - uphill)	16.25	5.3	156	94	0.09	18.33	5.57
Water course before first waterfa ll (A2 - downhi ll)	11.59	5	148	99	0.09	19.9	5.55

The cave is Class A protected area, with high scientific interest and unique resources, representative for the speleological national and international heritage.

We made the following propositions for:

- sectors with integral conservation (all galleries and rooms from Tributary 1, the galleries and rooms network downhill of siphon/draintrap after Sala Paragină (Toplița of Roșia), all galleries and rooms which form the tributary upstream Cascada Mare) (Fig. 2);
- sectors where speleo-touristic activities are allowed (the cave system between the cave entrance and the first siphon after Sala Paragină of the main underground stream). This sector includes the Entry, The Waterfall -4 The Waterfall -10m with a plan of activities and permanent monitoring of the cave (checks on topoclimate, water and air quality, monitoring of underground fauna, monitoring of visits).

In this sector of the cave speleo-touristic activities are allowed, in small groups, with trained guides and suitable equipment that uses only temporary arrangements for safety reasons, in accord with the Management Plan and Regulations.

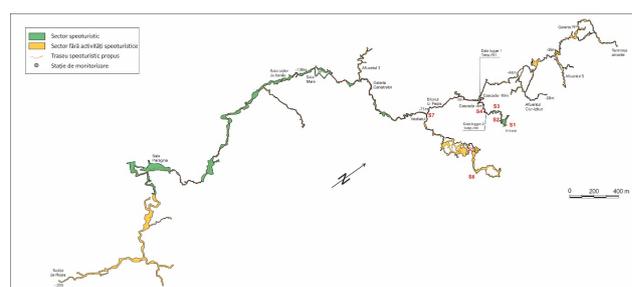


Fig. 2 Ciur Ponor cave map with proposal for tourism sectorization and positioning of stations for temperature, humidity and aeromicroflora measurements

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