



THE IMPORTANCE OF CAVE MANAGEMENT FOR THEIR NATURE VALUES CONSERVATION

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SYNOPSIS

In this paper, the part that is related to the most valuable and the most sensitive parts of cave systems is discussed, and these parts are the nature made values: stalactites, stalagmites, cave pillars, rimstone pool, cave pearls and the live world. The cave management has great significance in purpose of mentioned nature values protection and there are numerous examples of good and bad experience for that. And also local people can help significantly in preserving, spreading ideas and in realization of carrying out the cave management by conscience raising and ecologic educations.

SINOPSIS

ZNAČAJ MENADŽMENTA PEĆINAMA ZA OČUVANJE NJIHOVIH PRIRODNIH VREDNOSTI

U ovom radu se razmatra segment koji se odnosi na najvrednije i najosetljivije delove pećinskih sistema a to su prirodom stvorene vrednosti: stalaktiti, stalagmiti, pećinski stubovi, bigrene kade, pećinski biseri i drugi živi svet. Menadžment pećinama u cilju očuvanja pomenutih prirodnih vrednosti ima veliki značaj o čemu govore brojni primeri dobre i loše prakse. Uz to lokalno stanovništvo podizanjem nivoa svesti i ekološkim edukacijama može značajno pomoći u očuvanju, širenju ideja i na realizaciji sprovođenja menadžmenta u pećinama.

INTRODUCTION

The cave represents underground voids in Earth's crust made by natural processes and they are large enough that adult man can enter in it. In Serbia, the greatest number of caves originated in karst relief, i.e., in carbonate rocks, by

chemical and mechanical influence of water. There are caves in other types of rocks on the world, so caves can be formed in gypsum, igneous rocks, conglomerates, and in the ice, but in less number.

Until now, it is recorded between 1200 and 1500 speleological objects in Serbia. According to data from Institute for nature conservation of Serbia (2006), 50 caves are partially explored and officially recorded. From that number, there are 26 protected caves, and only 9 are arranged for turistic purpose. Considering that the beginnings of geo heritage protection in Serbia are dated from 1888. when, for first time, one cave is arranged for visitors (Prekonoska cave near Svrljig), this is small number for that long period. Otherwise, this cave is not in touristic offer of Serbia today, because it is disheveled. In that view, there is the need to take concrete measures and steps for caves protection, which, according to their structure, represent one of most sensitive continental ecosystems.

This problem is differently threaten in the world, that in the most of developed countries, these ecosystems have significant attention, i.e., the protection of geologic and biologic diversity in both inner and outer environment of these goods. Among other things, the numerous publications and management plans are made, with a view of that the values of caves have been valuated in the best way, and they have been protected as well. In that view, in this paper it will be given the basic postulates of this system in Serbia, according to examples of good and bad practice from other countries.

THE CLIMATE PARAMETERS OF CAVES

The basic climate parameters in caves: temperature, blast of air and humidity are constant, or with minimum oscillations depending of seasons. Otherwise, these parameters depend first of altitude and the amount of precipitation.

The air temperature. The air temperature in the caves (J. Petrović, 2002) has the values around the average annual temperatures on the surface of locality of cave. In the cave, temperature is constant in some parts (hall, gallery...) or it is less changeable, and it depends of seasons and climate conditions (around 5 °C). Except this, the temperature in caves depends of depth where are some its parts.

In some our caves, during the winter time, temperature is below 0°C.

The blasts of air. The blasts of air are characteristically for any cave and they primary depend of cave canals construction and size of underground areas. They are especially great in river caves, during the winter time when big masses of warmer air come from the interior of cave, and near the entrance of cave, they become condensed water vapor, because the temperature of outer air is far lower as temperature in cave.

The air humidity. The air humidity is not constant in the cave, it is the highest in spring and fall, when the percolated waters are the most frequent, and it is the lowest toward the end of summer and the winter, when there is no percolated waters. The maximum value of air humidity can be even 100%, and minimum value is not lower

than 41%. The air humidity in the caves of Serbia takes the value from 60 to 90% (often from 70 to 80%, and during the maximum water level, it takes the value of almost 100%).

THE NATURE VALUES OF CAVES

In the caves, because of influence of constant conditions and some processes, there are the particular number of different forms which can be made by chemical and mechanical erosion of carbonate and some other types of rocks also. Otherwise, it is need 1000 years for 1 cm³ material forming. With respect to number and presence of some forms, on this occasion we will cite just some nature forms. The most numerous and the most frequent representative forms in the caves are: stalactites, stalagmites, stalactons, helictites, draperies, cave pearls, rimstone pool etc.

Stalactites are pointed pendants hanging from the cave ceiling, from which they grow. The water saturated by calcium-bicarbonate solution filtrates through narrow capillary rifts in ceiling of underground area, whereby calcium-carbonate is exuded at the exit of rift like thinner or thicker small tube. Further filtering of water continues through the small tubes and again there is calcium-carbonate exuding in the end. In that way, stalactite „grows“, hanging from the cave ceiling to the floor of underground area. The water spreads out on the outer wall of tube, so stalactite „grows“, increasing its width. The diameter of tube is 5 mm which through water is filtering. The dust can be held on the edge of stalactites so the sphere look layers of calcium-carbonate are deposited, that gives the shape of stalactites that only nature can give.

Stalagmites are made in that way the water filtering through stalactite exudes one part of calcium-carbonate solution through stalactite exit. The rest of solution drips on the floor of underground area like water drops. With dripping, the carbon dioxide and water are released, and the remains of calcium carbonate are deposited as little column which grows from the floor to the ceiling of underground area. Contrary to stalactite, the stalagmite is completely full. The size, the shape and the colors of stalagmites variate, subject to amount of water dripping from the ceiling, to heights from water drips and to width of water drops splashing, to water saturation with calcium-carbonate and to colored components additives. The stalagmite height is from few centimeters to few meters.

Stalactons, or cave columns, are made by stalactites and stalagmites, joining in the most different shapes and colors, their size take the values from meters to decameters. These columns have a role in underground areas building up and in prevention of further ceiling downcome.

The cave ecosystems are habitats to many unique and specialized life forms, which are sensitive on live conditions changes. For usual visitor, the bats are the most typical life form in the caves. All bat species are under protection of Law. Otherwise, it is very important to not disturb these animals, especially during the winter sleep, from October to March. Namely, that can cause even their dying. Other beings which live in the caves, on the floors and in the water, are invertebrates (mostly these are endemic species of spiders, freshwater crabs and insects) and fishes (for example, human

fish). These animals are part of cave ecosystems and their chances for survival are greater in as much as human do not disturb their living conditions, i.e. the balance.

In regard to mentioned ecological factors, the living beings which exist in the caves are separated to: *trogloxenes*, *troglophylles* and *troglobites*. Otherwise, Paven (1958) separated all cavern organisms in seven categories according to their way of infiltration in underground.

Trogloxenes are animals that casually go into the caves and they take up their life span on the surface of ground.

Troglophylles are animals which have some part of development cycles carrying on in the caves. They are located in the entrance part of caves where they spend their time. Namely, they warps there (cicads), so their grubs can be found in caves during the summer time.

Troglobites (*troglos-cave* and *bios-life*) are animals bounded to the caves during their entire living cycle. During their evolution, these organisms developed entire range of morph anatomic and eco physiologic adaptations for survival in underground habitats. These adaptations are: the loss of seasonal limitedness of reproduction, modification sense apparatus presence, the elongated extremities, the body depigmentation, the eyes loss etc. Troglobites can not survive without caves.

In scientific circuits, two classifications of habitats and ecological niches in speleological objects are accepted and they are: CORINE and EUNIS (*European University Information Systems*).

The endems of fauna caves are bounded mostly for karst habitats, which are not explored enough.

According to its nature characteristics (region, hydrogeology, geomorphology, vegetation, flora and fauna), the karst area joins the greatest number of uniqueness and singularities. Regarding to total uniqueness, the richness of endemic species and living associations, and high level of preservation, this area represents extraordinary quality not only in European, so but in world proportions also.

THE ACTIVITIES THAT ENDANGER CAVES

The great number of activities that human prefers for its existence nearby the caves, i.e. on ground surface (for example, the quarries, the road construction etc.), can seriously endanger the caves, even degrade it completely, because, for example, any change of surface waters flow mode can have dramatic effects on underground waters flow, because of drying, or overflowing. Besides, the activities taken during cave arrangement for touristic visits like closing entrance, the opening of new ones or extending the existing entrances, reacts on microclimate changes in the caves. In that way, the cave ecosystem is disturbed even causing interruption of creating ornament processes.

With space deficit for waste disposal, many caves are used for communal and industrial waste disposal. In that way, the worst cave destruction happens, even the pollution of water-flows, which plunge into caves or well from it, occurs.

Making the artificial lakes for water supply or for other purpose, can endanger the caves by sinking, which causes the underground water level disturbance and relative air humidity increasing in the caves also.

The using of chemical substances in agriculture and acid rains also can cause the balance disturbance in the caves because of filtering water comes in through cave ceiling or underground waters plunge into the cave.

The cave ornaments, unfortunately, are damaged mostly because of explorations or irresponsible behavior of tourists.

The disturbances of ecological niche can be caused by troglonexes and troglophylles organisms. Namely, some species of insects, the fanerobiontes, inserts the heavy metals from the air and from food, the bats eat them and through guans insert these pollutants in guanophylles criptobiontes.

THE MANAGEMENT OF NATURE VALUES OF CAVES

First organized activities in order to stop the cave degradation are taken in IV International Speleological conference in Ljubljana in 1965. In the same year, the Commission for organizing and cave protection is founded, in national unions. Next, in 1975, at VI International Speleological conference (Olomouc, ČSSR), it is decided, that year will be pronounced for cave protection international year. In the same year, the definition of "touristic cave" is accepted. After that, in 1992, the Council of Europe brought Directive No. 36, about "underground habitats protection". By this recommendation, 10 criteria for caves selection was cited according to their biological values and the procedure of protection and cave habitats management were suggested (P. Jakšić, 2004).

For preserving the unrenovable nature values of caves, the microclimate elements (the air temperature, the blasts of air and air humidity) are the most significant for origination of geomorphologic forms like stalactites, stalagmites, rimstone pool, cave pearls and the other karst forms. The hydrologic conditions are also important and the chemism of water what cross-pores of rock and sediments which influence on the color of cave ornaments. All previously mentioned elements are significant for preservation of living forms in caves which have endems characteristic mostly, because some living forms the most frequently are characteristic for particular cave or karst area. The outer factors have significant influence on geo and biodiversity, like climate factors, and especially the amount of downfalls that influences on air humidity in the cave. Based on condition in the caves, we can say that, by ecological meaning, the main attributes of cavern habitats are low and constant temperature and high humidity and permanent darkness, the low oxygen content and the food deficiency.

It is important to mention that some caves are in the same time and only habitats for many living organisms like human fish or some bats species, insects, etc., and because of that it is necessary to implement management of these nature goods.

The management needs to provide such regime of touristic visits of caves, that the disturbance of nature balance of these ecosystems could be minor. For the case of big visits, the groups need to be smaller, and, before entering into the cave, they must get the knowing of behavior within the caves (the way of moving or behaving). Otherwise, during the cave arrangement, it is necessary that they have been illuminated according to recommendations of world and international organizations for cave preserving and conservation.

THE EXAMPLES FROM PRACTICE

It is showed that the lighting in caves has negative consequences to living organisms and to cave ornaments also. The Resavska cave near Despotovac is good example for that. Namely, this cave passed through some parameters changing because of inadequate lighting which caused the decrease of autochthonal habitants in cave and appearance of some other alochthonal organisms like green and blue-green algae. The algae appearance makes opportunity for new groups of bacteria appearance. The algae secrete the acids, so in that way, it comes to biological erosion of cave forms, the layer over ornaments is made and it changes its color and loses its decorative role and the cave loses its valorized value. For that reason, in 2007, the reconstruction of installations and illumination started in this cave. This project was financed by Ministry of Economy and Regional Development. The cost of these works is 12 million RSD. The works were controlled by Institute for nature conservation of Serbia This project is over at these days, and now that cave is only cave in Serbia arranged according to international rules, because it have installed video watch in all halls.

More frequently, in the world, the acoustic installations are built into caves (the example from Greece and the cave Alistrati) and adequate melodies can be listen by visitors there, providing them greater comfort. This cave is obvious example of good practice for many reasons, for example: the lighting and preserving the influence of outer climate conditions (temperature from 15 to 17°C). During the summer time, the schools for youth education are organized there from domain of protection, conservation and management of this protected nature object.

CONCLUSION

The importance of cave management in order to nature values conservation is reposed to a few elements. The first and the most significant element is continuous monitoring which brings the data for database about watched cave and these factors give us the picture about cave resources and its underground and above ground preservation, including the history, geology and biology.

It is very important to replace the cave lighting because in many caves there is still heat lighting which raises the temperature, and it is forbidden a few years ago, it

must be replaced with cold lighting because of prevention of cave ornament melting and green algae creation on stalactites and stalagmites. There is significant data that replacement of existing lighting installation starts in Serbia, and two of our the most visited caves, Revaska and Zlotska, are example for that. There is need to point out that at present, Zlotska cave is the longest arranged cave for visitors with 7 km long arranged paths.

There is still no the particular law dealing with this problem in Serbia. At present, the Environment protection Law deals with these problems ("Official Gazette of Republic Serbia", No. 66/91, 30/92, 24/94, 17/96, 135/04.) and the Geologic researches Law also („Official Gazette of RS“, No. 44/95).

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