MONITORING OF PRIORITY ABIOTIC FACTORS IN THE WINTER OF 2014-2015 IN THE COLLUVIAL MESOVOID SHALLOW SUBSTRATUM FROM THE SHALE IN LEAOTA MASSIVE

DOROBĂŢ Magdalin Leonard, DOBRESCU Codruţa Mihaela

Abstract. Leaota Mountains, located in the east of the Southern Carpathians, Bucegi Group, although covers a relatively small area, approx. 350 km^2, present a varied geology, crystalline metamorphic schists being present on almost three-quarters of the surface, while in their north-western part, at the contact with Piatra Craiului Massif and Bran-Rucăr Corridor, there appear organogenic limestone. If calcareous rocks show, in fact, a continuation of Piatra Craiului Mountains, with the advent of debris, as a result of crioclastic processes, it is interesting to study the crystalline schists scree, which, along with the limestone scree, are part of what is known as the superficial underground environment (MSS) or shallow underground habitat (SSH) in biospeleology. This new component of the underground domain plays a very important ecological role, hosting many species of invertebrates and small mammals, but allowing the migration of zoocoenotic components between two deep underground environments (caves); the MSS is connected through a network of cracks or being a refuge for some species living in the litter or even on the soil surface, when environmental conditions become unfavourable for them. Ecological factors with a primary importance in MSS are temperature and the relative air humidity, which is why this paper aims to present the partial results of the research in this regard, which are the result of continuous monitoring during the winter, into an ecological stationary located in the north-west of Leaota Mts. This type of research is a novelty in Romania and is part of a project that has as main objective to identify similarities but also differences between MSS with different geologic substrate (crystalline schists and limestone) from the point of view of priority abiotic factors (temperature, relative humidity) and the way in which they determine biocoenotic features in both types of environments.

Keywords: mesovoid shallow substratum (MSS), abiotic factors, temperature, relative humidity, scree, Leaota.

Rezumat. Monitorizarea factorilor prioritari abiotici în iarna 2014-2015 în mediul subteran superficial coluvial şistos în Masivul Leaota. Munţii Leaota, localizaţi în partea de est a Carpaţilor Meridionali, Grupa Munţilor Bucegi, deşi se desfăşoară pe o suprafaţă relativ mică, cca. 350 km^2, prezintă o geologie variată, cu predominanţa şisturilor cristaline metamorfice pe aproape trei sferturi din suprafaţă, iar în partea de nord-vest, la contactul cu Masivul Piatra Craiului şi Culoarul Bran-Rucăr, cu apariţia calcarelor organogene. Dacă rocile calcaroase prezintă, de fapt, o continuare a celor din Piatra Craiului, cu apariţia grohotişurilor, ca rezultat al proceselor de crioclastie, sunt interesant de studiat grohotişurile de natură şistoasă, care şi ele, alături de cele de natură calcaroasă fac parte din ceea ce este cunoscut în biospeologie sub numele de mediu subteran superficial (MSS) sau habitat subteran superficial (SSH). Această nouă componentă a domeniului subteran joacă un rol foarte important din punct de vedere ecologic, găzduind numeroase specii de nevertebrate şi micromamifere, dar permiţând şi migrarea unor componente zoocenotice între două medii subterane profunde (peşteri), de care MSS este legat prin reţeaua de fisuri sau fiind loc de refugiu pentru unele specii care trăiesc în edafon sau chiar la suprafaţă, atunci când condiţiile de mediu devin nefavorabile pentru acestea. Factorii ecologici de primă importanţă în MSS sunt temperatura şi umiditatea relativă a aerului, motiv pentru care lucrarea de faţă îşi propune să prezinte rezultatele parţiale ale unor cercetări în această privinţă, care sunt rodul unor monitorizări continue, permanente, pe perioada de iarnă, într-un staţionar ecologic amplasat în zona de nord-vest a Leaotei. Acest tip de cercetări reprezintă o noutate în România şi face parte dintr-un proiect care îşi propune ca obiectiv principal identificarea asemănărilor, dar şi a deosebirilor între MSS cu substrat geologic diferit (şisturi cristaline faţă de calcare) din punctul de vedere al factorilor abiotici cei mai importanţi (temperatură, umiditate relativă), dar şi a modalităţii prin care aceştia determină particularităţi faunistice în cele două tipuri de medii.

Cuvinte cheie: mediu subteran superficial (MSS), factori abiotici, temperatură, umiditate relativă, grohotişuri, Leaota.

INTRODUCTION

Leaota Mountains, geographically located in the Southern Carpathians (from the geological perspective, some authors consider the Southern Carpathians as a part of the Oriental Carpathians) (MUTIHAC & MUTIHAC, 2010) display a diversified geology, all these three large rock categories being met in outcrops in this Massive: sedimentary, metamorphic and also several magmatic intrusions. Leaota Mountains are adjacent to Piatra Craiului Mountains in the North-Western side, the latest being covered on significant areas with limestone scree (NITZU et al., 2010). In this North-Western part of Leaota, the geological composition has limestone or schist origins, both the limestone and the crystalline schist being frequently met in outcrops (***, 1968). From the geologic perspective, the limestone is similar to the limestone in Piatra Craiului Mountains. Through the interaction between the rocks that outcrop and the external agents, especially through gelivation, scree appears (detrital sedimentary uncemented rocks), which gravitationally accumulate at the basis of slopes, or, if flowing waters are located at the basis of the slopes, they can be transported. These screes emerge at the basis of the slopes (in situ).

Crystalline schists cover approximately 74% of the total surface of Leaota Mountains (MURĂTOREANU, 2009). Due to this reason, it is clear that we can talk about specific landforms developed on geologic substrate formed by crystalline schist in Leaota Massive. The cryonival processes that have succeeded the periglacial processes that influenced the crystalline schist have led to the formation of scree which, in the subalpine floor, has been most frequently fixed by the forest vegetation. We also meet outcrops that in this crystalline schist are still influenced by external modelling agents, thus leading to the development of mobile scree areas.

Subsequently to the research in biospeleology, relatively recent, there emerged an idea took, according to which, alongside caves, which represent the concept that is referred to as deep underground substratum, there is another substratum, called mesovoid shallow substratum (MSS), (JUBERTHIE, 1998) or shallow subterranean habitat (SSH) (CULVER & PIPAN, 2014) or subterranean shallow biotope (RACOVIŢĂ, 1996) that clearly represents another type of subterranean substratum compared to caves (NAE, 2010).

Thus, the existence of this substratum, which is different from the caves, has been inferred even since the beginning of the 20th century by the creator of biospeleology himself, Emil Racoviţă, who claimed, in 1907, that 'the vital space of cave animals is not limited only to caves'; the French researchers from the subterranean research laboratory in Moulis (France) are the ones who have defined, for the first time, in a very accurate manner, the mesovoid shallow substratum (RACOVITZA, 1907; RACOVIŢĂ, 1983) and have considered that this ecologic entity is different from the caves and is a part of the subterranean field (RACOVIŢĂ, 1996). The MSS mainly consists of colluvial scree slimes, which are met at the basis of slopes, scree caused by the disintegration of rocks which outcrop in the mountain–slopes, disintegration that is caused especially by the repeated gelivation processes (frost-defrost). Thus, there occurs an accumulation of various granulometry clasts, which contain various size interstitial spaces, which allow the hosting of some zoocoenotic troglobionts, edaphobionts and also of some species that can be considered specific to this particular compartment of substratum (RACOVIŢĂ, 1996; CULVER & PIPAN, 2014). The significance of this substratum type comes not only from the fact that it hosts some fauna components in various evolution stages, but, also from the fact that the MSS communicates with the subterranean deep substratum through cracks, the migration of some species from a cave to another is also allowed, using the MSS as a transitory space, some of the fauna components expanding their area through it.

Studies regarding the MSS in Romania are not numerous, and, in Leaota Massive, they have not been carried out until now. This is why this paper displays partial results (during winter) of some research regarding the ecologic factors (relative humidity and temperature) from the mesovoid shallow substratum consisting of crystalline schist, ecologic factors that condition the distribution of some biocoenosis components. The permanent monitoring of these abiotic parameters represents a premiere in Romania. They are part of a wider research plan on different types of mesovoid shallow substrates (schist and limestone) from the North-Western part of Leaota Mountains and also of studies on the micro-fauna hosted by the nude MSS or covered by litter, research for which more ecologic stationaries were installed.

MATERIALS AND METHODS

The research displayed in the paper were made in an ecologic station located in an area with scree originating in quartzofeldspathic crystalline schist with biotite and chlorite, in Valea Popii area (Fig. 1). We considered that the origin of scree is not anthropogenic and either influenced by such activities, in order to not influence the results. In the ecologic station, 4 surveys were placed: a survey at 1m depth and other three at 0.5 m depth. We wanted that the placing of the sample to be made in different schist scree; sample 1 (1m depth) and sample 2 (0.5m depth) were placed in nude, recently emerged mobile scree (Fig. 2). Clasts displayed fresh breaking, where biotite was present, with rare, insignificant emergences of secondary chemical modified minerals, namely chlorite and limonite, which indicate the fact that this colluvial scree was recently formed. Samples 3 and 4 were installed in older, fixed scree, on which the surface of the clasts display oxidation and hydroxide, namely advanced chemical modification processes, the mineralization being rich in chlorite and limonite, namely secondary chemical modification minerals (Fig. 3); these two last stationaries were placed in areas covered by forest vegetation, in which surfaces of 1-2 square meters of scree rarely emerge, covered by herbs. The digging of a 1m sample was not possible in this older schist scree, as, at heights higher than 50-60 cm, there were not any interstitial spaces between the clasts that would allow the circulation of the micro-fauna, which are hindered by the residual clay formed after the chemical modification processes that influenced the schist. Each sample consists of a PVC tube, with a 1.1m length, respectively 0.6 m; in the lower part of the tube, at a height of 10 cm, on a 10 cm width, all around the tube, we made holes 0.8 cm in diameter, such as to allow the migration of the micro-fauna element towards the Barber trap that we had been installed inside. The tubes were then placed in scree, then, in each tube, we placed a glass with the same diameter as the internal diameter of the tube, namely 8 cm, the margin of the glass being glued to the internal wall of the tube. The glass was 10 cm high and was partly filled with conservation liquid (propylene-glycol), and a weak olfactory attractant was put over. Through a nylon wire, we placed a data-logger over the Barber trap, to register the temperature, the relative humidity of the air and the temperature of the dew point in the sample. The device was set to measure the abiotic parameters at every 12 hours; this data monitoring period could be considered as being too long, but the data-logger was set in this manner as to reduce the energy consumption and to extend the life of the batteries that it uses as long as possible, since we did not have access to the area during winter in order to replace them, due to the snow (Fig. 4).

The original battery was replaced with two alkaline, high capacity batteries, so that the batteries will not discharge during the cold season. Moreover, in order to reduce the exposure to low temperatures of the batteries and avoid the interruption of the data-logger and the data loss, the batteries were covered in an insulating layer of foil with air bubbles and connected to the data-logger through electrical cables. On the upper part of the PVC tube, we placed the other end of the nylon wire with adhesive tape, to which we attached the data measuring and storing device, then the tube was covered in a piece of foil and with scree.

Figure 1. The placement of the ecological stationaries in Valea Popii area, Leaota Massive ( ).
(www. google.ro/maps/place/Leaota) (modified).

Figure 2. Scree from shale, nude, mobile, recently formed.

Figure 3. Schists affected by chemical alteration.

Figure 4. Layer of snow about 40 cm, Valea Popii, April 5th 2015.
(Figures 1-4 – original).

The position of the devices is defined by the following GPS coordinates:

Samples 1 and 2: N 45° 21´41.6"; E 25°16´38.8", at 1076m high; the distance between them, 1.5m, nude, mobile schist scree.

Sample 3: N 45°21°42.4"; E 25°16´36.9", 1081m high, fixed, schist scree.

Sample 4: N 45°21°45.5"; E 25°16´36.1", 1070m high, fixed schist scree.

RESULTS AND DISCUSSIONS

Subsequently to the collected data analysis and interpretation, we noticed the following:

In sample 1, at 1m depth (Fig. 5), in mobile, nude scree, the maximum registered temperature was 1.7°C, at the beginning of the monitoring period, namely December 5th 2014, 04.06 p.m. The minimum registered temperature in the period was - 4.6°C, between February 23rd 2015, 10.06 a.m. and February 24th 2015, 02.06 p.m. Between January 6th 2015 12:06 and April 10th 2015, 12:06, the temperature of the air in the sample varied to the limit of maximum 1°C. The temperature began to quickly increase after this date to the maximum value of 0.9°C, registered at the end of the monitoring period. As for the relative humidity, this abiotic factor had a 100% value or close to it during the whole monitoring period. Only in the beginning, the relative humidity of the air reached 94%, on December 5th 2014, at 04:06 p.m., reaching 99% after 3 and a half days, maintaining almost the same until 20 days before the end of the monitoring period, namely April 16th 2015, at 08:06 a.m. After this date, until the end of the monitoring, the relative humidity is maintained at saturation, respectively 100%.

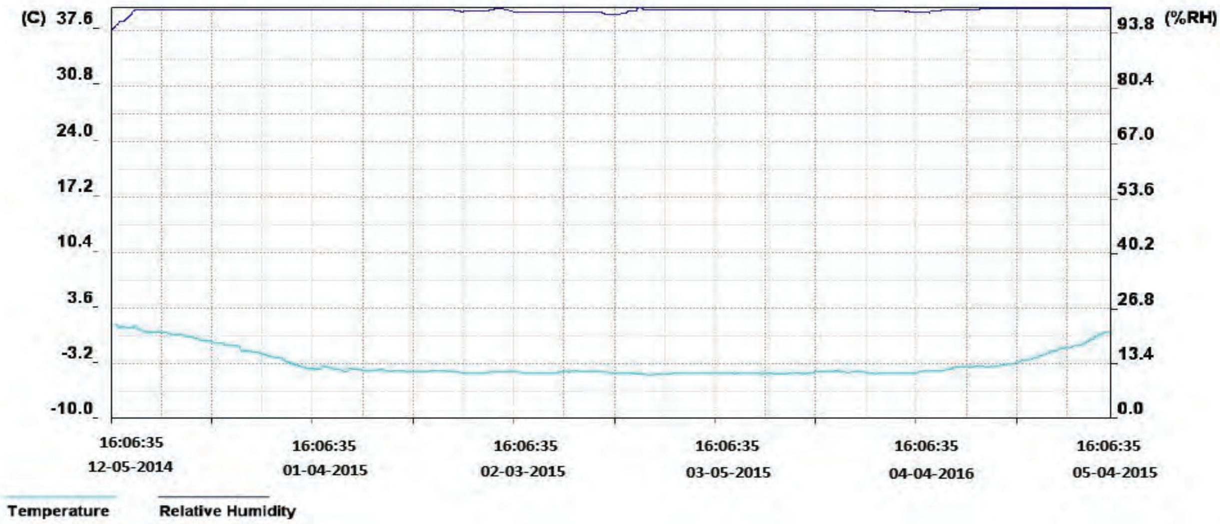

Figure 5. Variation of temperature and relative humidity, survey 1 - 1m depth.

In sample 2, at 0.5m depth, in mobile, nude scree, we noticed that the temperature of the air began decreasing quite fast, from the maximum 1.6°C temperature, registered right when we set the device, on December 5th 2014, 3:43 p.m. at the value of - 6.14°C, on January 3rd 2015, 11:43 a.m., temperature that maintained until January 4th 2015, 08:13 a.m. (Fig. 6). After a very slight increase, a period between January 6th, 07:43 a.m. and January 7th 2015, 0:43 followed, with the minimum value of - 6.29°C. This value was registered again between January 6th 2015, 11:43 p.m. and January 9th 2015, 9:43 a.m. and it represents the lowest registered value in the monitoring period. The temperature variation was lower than 1°C between January 2nd 2015, 3:43 p.m. and March 15th 2015, 12:43. From this last date, until the end of the monitoring period, the temperature increased, the maximum registered value being of 1.1°C at 04:34, on May 3rd 2015 and between May 1st 2015, 04:43 and until the end of the monitoring, the temperature was 1°C. As for the relative humidity of the air, it maintained constant, with the minimum value being registered at the beginning of the monitoring, as well as between March 3rd 2015, 04:43 p.m. and March 8th 2015, 0:43. Maximum values, 100%, were reached after March 26th 2015, 04:43 a.m. and this value was constant, with several exceptions, until the end of the period.

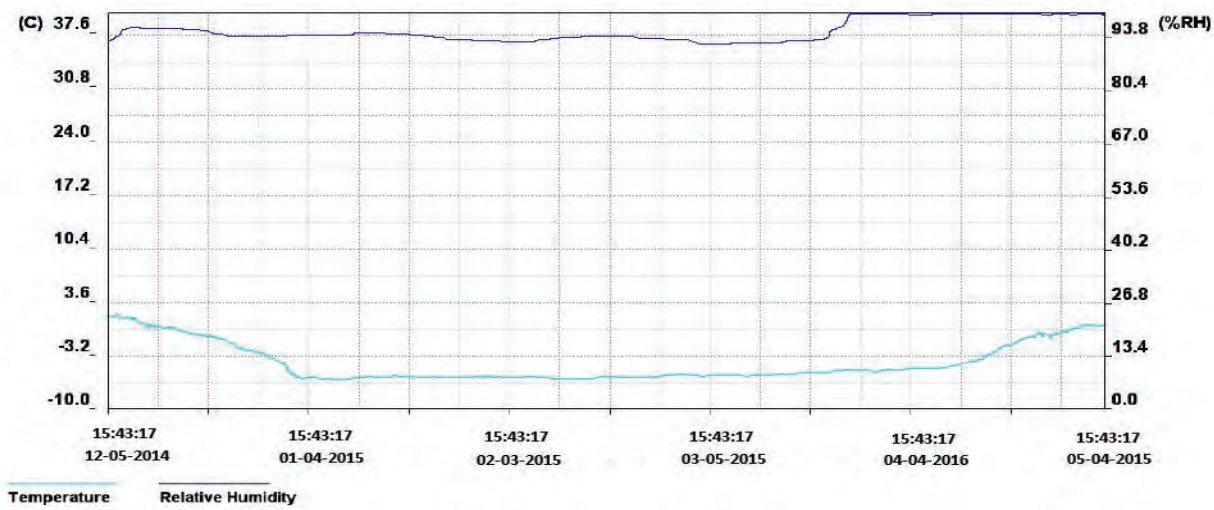

Figure 6. Variation of temperature and relative humidity, survey 2 – 0.5m depth.

In sample 3, at 0. 5 m depth, in fixed scree, a minimum temperature of – 5.4°C was reached between February 27th 2015, 08:38 p.m. and February 28th 2015, 10:38 a.m.; the maximum value was registered at the beginning of the monitoring and reached 2.5°C, on December 5th 2014 (Fig. 7). At the end of the period, the temperature reached 1.3°C, on March 30th 2015, at 08:38 p.m. and maintained until 02:38 p.m., on May 3rd 2015; during the last 24 monitoring hours, we registered values of 1.4°C. Between January 31st 2015, 06:38 p.m. and March 19th 2015, 02:38 p.m. the variation of the temperature did not exceed over 1°C. The relative humidity of the air had a minimum value of 93,8% at the beginning of the monitoring process, this value being probably influenced by the fact that we opened the device, in order to extract the Barber trap and to download the data the device had recorded during the previous period. The relative humidity increased together with temperature close to the saturation, slightly oscillating and reaching value of 100% on March 2015, at 13:38 and maintained until the end of the period.

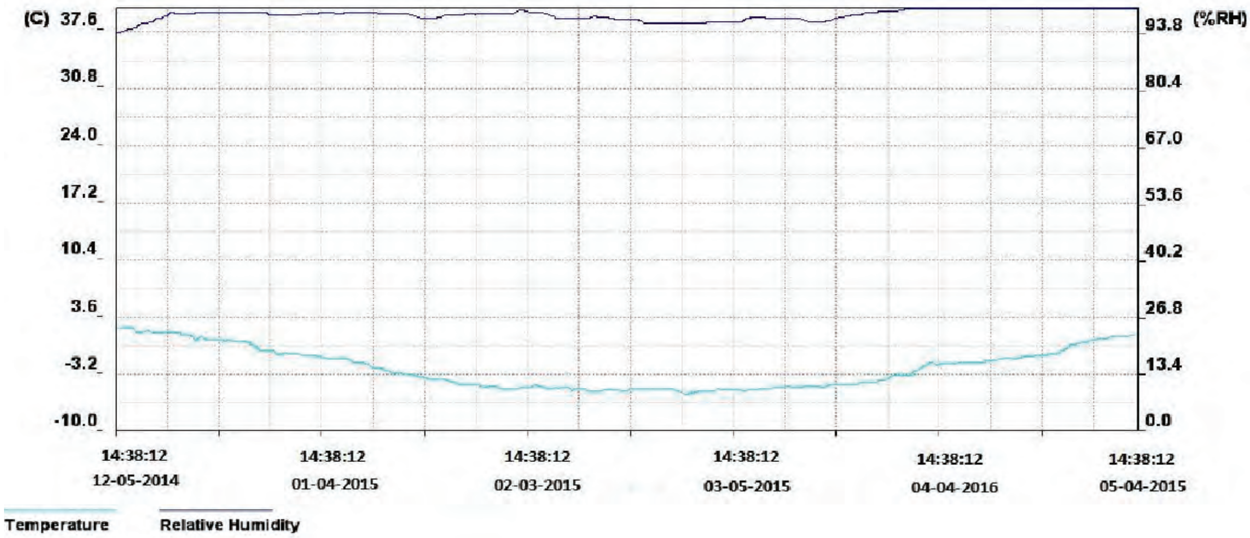

Figure 7. Variation of temperature and relative humidity, survey 3 – 0.5m depth.

In survey 4, at 0.5m deep, in fixed scree, the maximum temperature of 1.4°C was registered during the whole monitoring process, on December 5th 2014, 05:01 p.m. and probably, the removal of the devices cap to collect the Barber trap and the data in the device had somehow influenced the value of the temperature. The minimum values was registered on January 4th 2015, at 05:01 p.m. and reached -7.7°C. From January 2nd 2015, 12:31 until March 21st 2015, 09:01 a.m., the temperature of the air in the probe varied with only 1°C. At the end of the monitoring period, the temperature in the probe increased to the value of 1.2°C. As for the relative humidity, it suddenly increased, from 92,8% to 100% in the beginning of the monitoring period, similar to the previous above-described case; it is certain that the opening of the probe led to a lower initial value (we mention that, at the opening of the probe, we found condensed water on the walls of the PVC tube). As we can also notice from the graphic, the relative humidity varied between saturation (100%) and 93.7%. In the last monitoring period, after April 8th 2015, the value of the relative humidity registered values of 100% (Fig. 8).

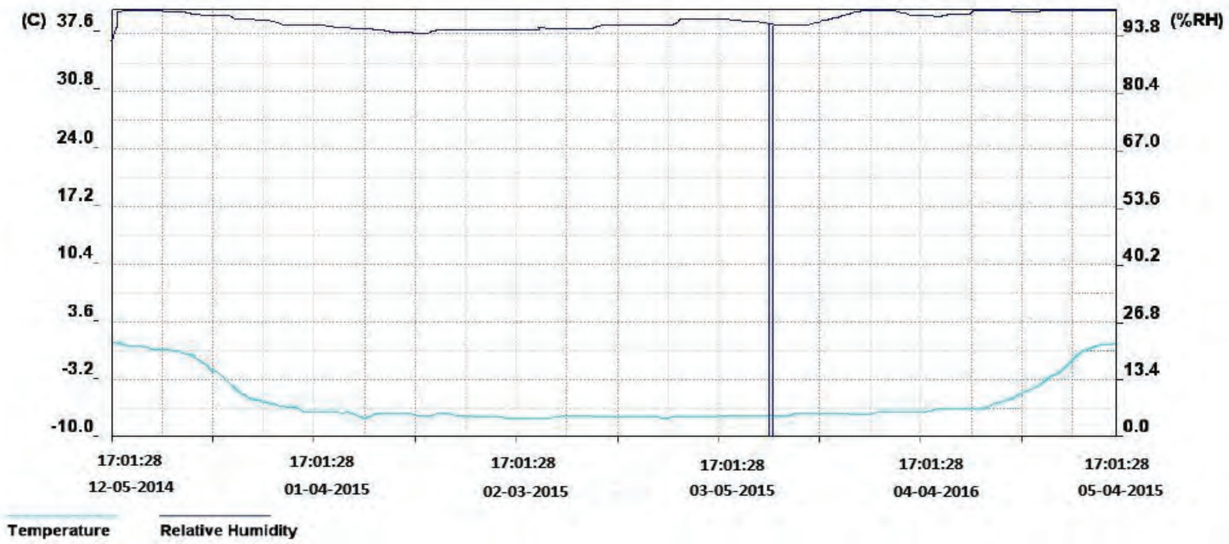

Figure 8. Variation of temperature and relative humidity, survey 4 – 0.5m depth.

The anomaly value recorded for the relative humidity on March 13th, around 05 a.m. can be explained by the fact that the data – logger was affected by condensation; this was also remarked on different surveys on other occasions.

CONCLUSIONS

The temperature of the air in the probes, during winter, is relatively constant on long periods, not being influenced by the variation of the external temperature. This is also due to the snow layer that covers the scree, acting like a protective layer, and also to the air in the interstitions between clasts, which, also through the low thermic conductivity, leads to low variations of the temperatures in the probes.

Like in other registering cases we made, the relative humidity of the air in the probes is close to 100% or even 100%; this sometimes led to malfunctions of the data-loggers, because of the condensed water.

The minimum temperature registered in the samples is higher at 1m depth and the variations of the temperatures are lower, the depth of the probe being a factor that influences the variation of this ecologic factor; the more the depth increases, the more the temperature maintains constant for a longer time.

When scree is covered by snow, there is registered a thermic inertia, the temperature in the probes being preserved for a longer time. Relatively rapid increases of the temperature in all probes, to the end of the monitoring period, can be explained by the disappearance of the insulating snow layer.

During a typical winter, with normal temperature, the survival of the biocoenosis components in the MSS is not possible, not even at 1m depth. Though, considering the fact that the temperatures are not very low, during an atypical winter, with higher temperatures, the conservation of some positive temperature would be possible in the probes, thus favourable to the activity of some invertebrates, especially in the case when the scree is covered in an insulating litter layer, eventually additional soil.

ACKNOWLEDGMENTS

This paper of Magdalin Leonard Dorobăţ was supported by the strategic grant POSDRU/159/1.5/S/138963 - PERFORM, co-financed by the European Social Fund – Investing in People, within the Sectorial Operational Programme Human Resources Development 2007-2013.

REFERENCES

CULVER D. C. & PIPAN T. 2014. *Shallow Subterranean Habitats: Ecology, Evolution, and Conservation.* Oxford Univeristy Press. Oxford. 258 pp.

JUBERTHIE C. 1998. *Underground habitats and their protection.* Nature and Environment. Council of Europe Publishing. Strasburg. **72**. 158 pp.

MURĂTOREANU G. 2009. *Munţii Leaota. Studiu de geomorfologie*. Edit. Transversal. Târgovişte. 182 pp.

MUTIHAC V. & MUTIHAC G. 2010. *Geologia României în contextul geostructural central-est-european*. Edit. Didactică şi Pedagogică. Bucureşti. 648 pp.

NAE A. I. 2010. *Biospeleological Research in Piatra Craiului Mountains.* Ph. D. Thesis. Speleological Institute of the Romanian Academy. Bucharest. 304 pp.

NITZU E., NAE A., GIURGINCA A., POPA I. 2010. Invertebrate communities from the mesovoid shallow substratum of the Carpatho-Euxinic area: Eco-faunistic and zoogeographic analysis. *Travaux de l'Institut de Spéologie "Emile Racovitza"*. Romanian Academy. Bucharest. **94**: 41-79.

RACOVITZA E. G. 1907. Essai sur les problèmes biospéologiques (Biospeologica I). *Archives de zoologie experiméntale et generalé.* Academic Press. Paris. **6**(4): 371-488.

RACOVIŢĂ G. 1983. Sur les relations dynamiques entre le milieu souterrain superficiel et le milieu cavernicole. *Mémories de Biospéology*. Academic Press. Bucharest. **10**: 85-89.

RACOVIŢĂ G. 1996. *Ecologia faunei cavernicole terestre*. Editat de Asociaţia Speologică ,,Sfinx" Gârda (jud. Alba). 25 pp.

***. 1968. Harta Geologică 1: 200000. *Foaia Braşov*. Notă explicativă de D. Patrulius, R. Dimitrescu, N. Gherasi. Bucureşti.

Dorobăţ Magdalin Leonard, Dobrescu Codruţa Mihaela
University of Pitești, Faculty of Sciences, Department of Natural Sciences,
Pitești, Târgu din Vale Street, No. 1, Romania.
E-mails: coltanabe@yahoo.com; codrutza_dobrescu@yahoo.com

Received: March 31, 2016
Accepted: June 10, 2016