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NEW SPIDERS (ARANEAE) FROM THE MESOVOID SHALLOW SUBSTRATUM (MSS) FAUNA, LEAOTA MOUNTAINS (ROMANIA)

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INTRODUCTION

Until the beginning of our research (2014-2015), regarding the connection between the different geological substratum of the mesovoid shallow substratum, main ecologic factors (relative humidity and temperature) and the distribution of some invertebrate taxons in the north-western side of Leaota Massif, almost nothing had been known about the micro-fauna which populates this massif. In order to reach the objective we had proposed, we installed ecologic stationaries in more areas of the massif which are covered in both limestone and mezo-metamorphic crystalline schist MSS. At the same time, we also installed stationaries in litho-clastic soil, both limestone and schist soil. This paper approaches the Araneae fauna met at different depths in the MSS. The mesovoid shallow substratum (MSS) represents a type of habitat with particular features, which makes this habitat type different from the caves or from the surface (epigean) habitats. Thus, Giachino&Vailati consider that the MSS is defined by a set of environmental features, such as empty spaces in the scree, the absence of light, humidity that nearly reaches the saturation degree (Nitzu *et al*., 2014). Apart from this features, the relation with the caves is a basic feature of the MSS, as has been proved by the presence of some troglophile species within the scree (Nitzu *et al*., 2014). Pipan and his collaborators (2011), Culver&Pipan (2014) claim that, in the MSS, also called SSHs (shallow subterranean habitats), thermic amplitudes are lower compared to the epigean habitats. The ecologic significance of the MSS comes from the fact that it represents a shelter for a series of invertebrates (Nitzu, 2016) and small mammals, when the meteorological conditions become unfavorable for the edaphic components of the biocoenosis. The MSS can also function as an ecologic passing pathway ("shallow rocks", Bleahu, 2004), an ecologic relay, through which some species colonize the *deep underground habitats* (caves). The MSS is an ecotone zone between epigean and hypogean environments (Prous *et al*., 2004). The mesovoid shallow substratum eases the migration of some zoo-coenosis components from a deep underground habitat towards a similar habitat, as the MSS functions as an intermediate stage within the colonization process. Considering all of these, it results that the study of the invertebrate fauna, temporarily or permanently sheltered in the MSS, is very important. As already mentioned, this research regarding the invertebrate fauna in the Leaota represents a pioneering activity, the present results being completely new for this habitat.

MATERIALS AND METHODS

In order to collect the invertebrate elements, we have placed four ecologic stationaries, Ghimbav, Rudărița and Cheii Valley stationaries in limestone MSS and Popii Valley in schist MSS (Figs. 1a, b, c). To collect the fauna, we used the sampling method (Nitzu, 2010), using PVC tubes, perforated on the lower part for the invertebrates to enter the sample and to be captured by the Barber trap in the tube. We have used ethylene-glycol as conserving agent and we have used a weak attractant (altered cheese), with which we greased the walls of the glass. In the stationaries with limestone MSS, we have placed samples at three depths: 1m, 0.75m and 0.5m and in the Popii Valley stationary we have installed only two samples, at 1m and 0.5 m depth. We have chosen areas with exclusively natural scree, for the human influence to be zero. Due to this reason, we have not placed the samples at 0.75 m in schist MSS in the Popii Valley area, as this was the single area with colluvial scree of natural origin and its surface was small, of only several square meters; the placing of the third additional sample, alongside the two others (at 0.5 m, respectively 1m depth) would have destabilized the scree. The captured fauna had been collected on a monthly basis (30-33 days), in the below-mentioned intervals, for each stationary.

Rudarița ecological stationary was placed on the south-eastern slope of Căpățâna Mountain, in a limestone scree, located in the north-western sector of Leaota Mountain (Fig. 1.a). The slope has a southern exposure, the inclination is 50 degrees. The slope is placed on the right side of Rudărița brook.

The three samples were placed scree, as follows:

- Sample 1, at an altitude of 1089 meters, 1m depth, in nude, mobile scree, GPS coordinates N 45°24´39.8"; E 25°16´13.1".

- Sample 2, at an altitude of 1085 m, dug at a depth of 0.75 m, GPS coordinates N 45°24´39.2”; E 25°16´12.3”. The scree is mobile and we rarely met some herbs.
- Sample 3, at an altitude of 1080 m, at a depth of 0.5 meters and GPS coordinates N 45°24´31.5”; E 25°16´13.7”, placed at the end of an immoral forest, in fixed scree, covered by a layer of soil and litter, nearly 10 cm thick.

From the Rudărița stationary, the monthly micro-fauna capture was collected for the August-November 2014 period and for April 2015 (Rudărița stationary was dissolved in May 2015, being affected by a bear twice in a row, which destroyed the samples by taking them out of the scree. Samples were replaced in a new stationary, with limestone MSS too, located in the Cheii Valley).

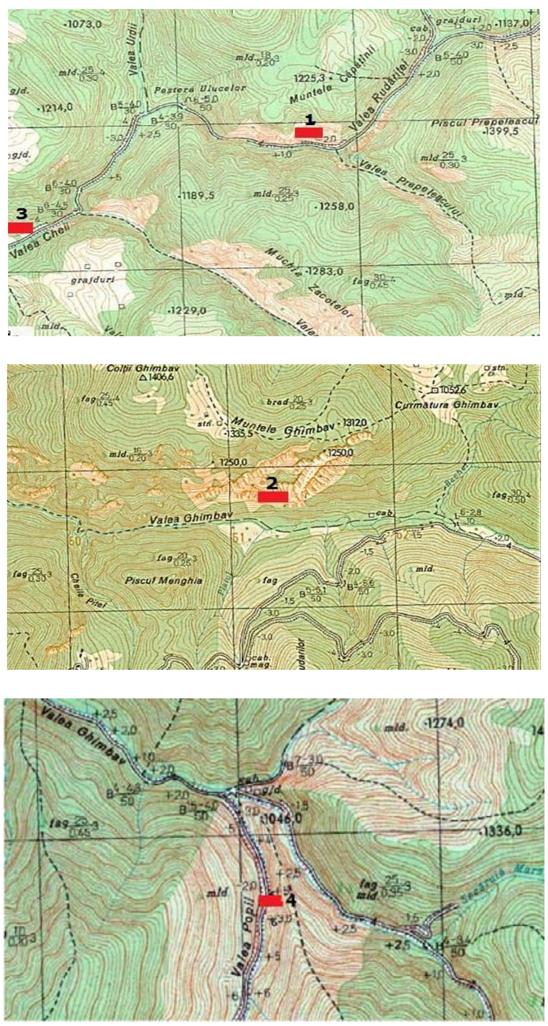

Fig. 1. a, b, c: Location of the ecological stationary: 1 – Rudărița, 2 – Ghimbav, 3 – Cheii Valley, 4 – Popii Valley (http://limite.opengov.ro/leaota)

The Ghimbav ecological stationary has functioned in a mobile MSS, developed on the southern slope of Mount Ghimbav, where we placed the 1m and the 0.75 m depth samples. At the basis of this slope, we had a fixed scree, covered in forest and herbal vegetation, scree that goes until the basis of the forest road. The slope is located on the right side of Ghimbav River (Fig. 1b). In this fixed MSS we have placed the 0.5 m sample. The positioning of the samples is:

- Sample 1, at a depth of 1m, mobile scree, no vegetation, 879 m altitude, GPS coordinates: N 45°22´43.0”; E 25°13´49.4”.
- Sample 2, 0.75 m depth, in mobile scree, nude, GPS coordinates N 45°22´43.1” and E 25° 13´ 49.2”, 883 m altitude.
- Sample 3, 0.5 m depth, located on the basis of the slope, in a forest, in fixed scree, covered by a layer of soil and litter, approximately 10 cm thick. GPS coordinates of the sample are N 45° 22´ 42.7”; E 25° 13´ 49.3”, and the altitude it was placed at is 860 m.

The inclination degree of the slope is 40°, southern exposure.

From the Ghimbav stationary, we have collected samples on a monthly basis during July and November 2014; April and August 2015.

Cheii Valley (Valea Cheii) ecological stationary (Fig. 1a), replacing the stationary in Ghimbav, also placed in limestone scree, in the “Colțul Surpat” area has the following features: the scree is mixed with rocky regions also consisting of limestone. The inclination degree of the slope is 40°, southern exposure. Samples were placed in mobile, nude scree, sample 1 at 1 m depth, sample 2 at 0.75 m and sample 3 at 0.5 m. The GPS coordinates that define the position of the stationaries and their altitude are:

- Sample 1: N45° 24´11.8"; E 25° 15´08.5", elevation 911 meters.
- Sample 2: N45° 24´12.1"; E 25° 15´ 08.3", elevation 923 meters.
- Sample 3: N45° 24´12.4"; E 25° 15´ 08.5", elevation 924 meters.

From the Cheii Valley stationary, we have collected the micro-fauna on a monthly basis between May and August 2015.

Popii Valley (Valea Popii) ecological stationary was installed on the banks of Popii brook, left tributary water of Ghimbav (Fig. 1c).

Samples 1 and 2 were installed in a colluvial schist scree, of mezo-metamorphic crystalline schist, recently formed, completely nude, mobile.

This schist MSS resulted from the gravitational accumulation at the basis of the western slope of Cumpărata Mare Mountain, of the clasts broken from the slope subsequently to the gelivation processes. The scree is placed on the right bank of Popii brook. This scree is recently formed. This can be deducted from the fact that the chemical alteration processes of the crystalline schist are missing or are in an incipient stage. Samples 1 and 2 were placed at a distance of 1.5 meters each.

- Sample 1 has a depth of one meter and sample 2 has a depth of 0.5 meters. The position of these two samples is defined by the GPS coordinates: N 45° 21´41.6"; E 25°16´38.8", their altitude being is 107 meters.
- The position of sample 3 is defined by the GPS coordinates: N 45°21°42.4"; E 25°16´36.9", 1081 meters altitude, and sample 4 has the GPS coordinates: N 45°21°45.5"; E 25°16´36.1", at an altitude of 1070 meters.

Samples 3 and 4 are also placed at a depth of 0.5 meters, like sample 2, but they were placed in litho-clastic soil, where, at a depth of more than 60-70 cm, there are little free spaces between the clasts, due to the fact that these ones were filled with residual clay, resulted from the chemical and bio-chemical alteration of the parenting rocks (mezo-metamorphic crystalline schist).

We used an infrared thermometer (type IAN 271160) to measure the temperatures.

RESULTS AND DISCUSSIONS

Subsequently to the sorting of the fauna collecting, we have discovered 12 species from the Araneae order, belonging to 6 families (Table 1).

From the analysis of the data presented in the table 1, we can observe some interesting facts:

Four species: *Diplostyla concolor* (Wider, 1834), *Micrargus herbigradus* (Blackwall, 1854), *Taranucnus bihari* Fage, 1931 and *Cybaeus angustiarum* L. Koch, 1868 were identified only in the schist MSS.

Other three species: *Nesticus balacescui* Dumitrescu, 1979, *Coelotes terrestris* (Wider, 1834) and *Inermocoelotes inermis* (L. Koch, 1855) were discovered in the both types of the MSS, the schist and the limestone MSS.

The other five species were discovered only in the limestone MSS: *Centromerus serratus* (O.P.-Cambridge, 1875), *Lepthyphantes notabilis* Kulczynski, 1887, *Histopona torpida* (C. L. Koch, 1834), *Cicurina cicur* (Fabricius, 1793), *Drassodes lapidosus* (Walckenaer, 1802).

No other species were met in the four stationaries.

Only the *Lepthyphantes notabilis* (Kulczynski, 1887) was met in three stationaries, all of them with limestone MSS and, also, only the individuals of this species were collected from all the three different depths, of 0.5 m, 0.75 m and 1 m. Moreover, even in the same stationary, Ghimbav (limestone MSS), the individuals of the same species were captured at two different depths, 0.75 and 0.5 m depth.

At 1m depth, we identified spiders belonging to two species, *Drassodes lapidosus* (Walckenaer, 1802) si *Lepthyphantes notabilis* Kulczynski, 1887.

At the depth of 1m, in the Popii Valley stationary with crystalline schist and the Cheia stationary we have not found any species of Araneae.

By synthesizing the data regarding the distribution of the Araneae species in different depths, we can notice that at the depth of 1m we met two species, at the depth of 0.75 we met 5 species (only in the stationaries with limestone MSS, we installed surveys of 0.75 m depth), and at 0.5 m depth we identified 11 species. We clearly notice that, alongside with the growth of the depth, the number of species we met in the survey decreased. This phenomenon can also be attributed to the fact that the inter-klastic spaces in the scree are becoming more and more restrained. In the case of the schist MSS, the phenomenon is much more notable, as we have already claimed before, in the older schist MSS, the chemical alteration of the schist has generated a residual clay which had filled the empty spaces, making the circulation of the invertebrates impossible. Another explanation of the fact that less Araneae species had been found at lower depths might also be the fact that their food is also fewer, at higher depths. Somehow, at the first glance, a different thing might be the Cheii Valley, where we had not found any species at lower depths of more than 0.5 m, but we had found one of them at 0.75 and 1m depth. We explain this fact through the fact that the scree was completely nude, the southern exposure and the high temperatures, and also the low relative humidity of the air at the level of the soil were not favorable enough, the existence of the micro-fauna (for example, we had measured, at the level of the soil, 34.5°C and the relative humidity of 24% on July 5th 2015, 16:58; the same day, at 18:08, we registered 33.2°C and 27% relative humidity. A month later, on August 5th, we had observed, at 15:20, a temperature of 29.2°C, with a relative humidity of 39%, repeating the measurements, at 15:47, we reached the temperature of the soil of 29°C, and the ecologic factor of relative humidity reached the value of 40%. During the second period, this stationary had functioned for a shorter period of time and it is normal that, due to this, the number of identified species in here to be lower.

The *Nesticus balacescui* is a species considered by the speleologists as a recent troglobiont species (Nae, 2010) and endemic for the Bucegi and Leaota Mountains (Dumitrescu, 1980). Nae (2010) identified this species in the neighboring massif, Piatra Craiului and considers that its area extends not only to the Leaota and Bucegi, but also in Piatra Craiului. The *Nesticus balacescui* is the second species regarding the frequency in the MSS (Nae & Dorobăț, 2015).

Table 1. The distribution of the spiders species on families (Araneae Ord.) on stationaries and on samples

Family/Species	**Ghimbav stationary – sample in limestone scree**			**Rudărița stationary- sample in limestone scree**			**Valea Popii stationary – sample in schist scree**		**Valea Cheii stationary - sample in limestone scree**		
	1m	**0.75m**	**0.5 m**	**1m**	**0.75m**	**0.5 m**	**1m**	**0.5m**	**1m**	**0.75 m**	**0.5m**
Fam. Nesticidae											
Nesticus balacescui Dumitrescu, 1979		x						x			
Fam. Linyphiidae											
Centromerus serratus (O.P.- Cambridge, 1875)			x								
Diplostyla concolor (Wider, 1834)								x			
Lepthyphantes notabilis Kulczynski, 1887		x	x		x				x		
Micrargus herbigradus (Blackwall, 1854)								x			
Taranucnus bihari Fage, 1931								x			
Fam. Agelenidae											
Coelotes terrestris (Wider, 1834)			x					x			
Histopona torpida (C. L. Koch, 1834)										x	
Inermocoelotes inermis (L. Koch, 1855)						x		x			
Fam. Cybaeidae											
Cybaeus angustiarum L. Koch, 1868								x			
Fam. Dictynidae											
Cicurina cicur (Fabricius, 1793)		x									
Fam. Gnaphosidae											
Drassodes lapidosus (Walckenaer, 1802)	x										

CONCLUSIONS

Alongside with the deepening, the spiders are less present.

In the schist MSS, where chemical alteration processed develop, there is no inter-klastic space favorable to the existence of Araneae (and, generally, for the existence of most invertebrates). These inter-klastic gaps are blocked by residual clay.

We have identified 12 Araneae species in the placed stationaries. Beside the previously mentioned *Nesticus balacescui* species, in this areal, the other 11 have been mentioned for the first time in the Leaota Massif.

At low depths, of approximately 0.5 meters, in schits MSS, recently developed, there are free spaces that host the reach Araneae fauna.

The *Nesticus balacescui* species has been noticed, for the first time in the literature in the schist MSS.

The capturing methods of the spiders are combined and diversified, in order to identify the whole variety of species.

ABSTRACT

This paper presents the faunistic results regarding the spider fauna (Araneae Ord.) encountered in the superficial underground environment of the Leaota Mountains. The gathering of spiders was carried out during 2014-2015 in surveys located in limestone and schists colluvial scree. We captured faunistic elements at depths of 1m, 0.75m and 0.5m in limestone MSS; in shale MSS we collected fauna only from the depth of 0.5m and 1m. As a result of our research, we identified 12 spiders species, of which 11 are new for Leaota. The *Nesticus balacescui* species was first reported in shale MSS.

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***http://limite.opengov.ro/leaota

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