DIVERSITY OF SOIL MITE FAUNA (ACARI: MESOSTIGMATA) FROM SOME CLIFF ECOSYSTEMS - ROMANIA

MANU Minodora, ONETE Marilena

Abstract. The paper presents the diversity of soil mite fauna from some cliff ecosystems from mountain and hilly areas, from Romania. 39 species were identified, with 272 individuals. The Shanon index of diversity demonstrated that the cliffs from mountain areas are the most favourable habitats for these arthropods. The dominant species in all the studied cliff ecosystems, neighbouring forests, were: *Leptogamasus parvulus* (Berlese 1903), *Pergamasus crassipes* (Linne 1758), *Veigaia nemorensis* (C.L. Koch 1839), *Hypoaspis aculeifer* (G. Canestrini, 1884), *Prozercon traegardhi* (Halbert, 1923), *Zercon berlesei* Sellnicki, 1958 and *Trachytes aegrota* (C. L. Koch 1841). Only, two species were characteristic only for the cliffs situated in proximity of a meadow: *Hypoaspis praesternalis* Willmann 1949 and *Asca bicornis* (Canestrini & Fanzago 1887). The evenness index revealed that some mites from mountain cliff areas are numerically dominant, as: *Leptogamasus parvulus, Zercon berlesei* and *Trachytes aegrota.* In the cliffs from hilly areas, this index showed us that the numerical abundances of identified species had an equitable distribution. The Bray-Curtis similarity index between the soil mite populations from the investigated cliffs revealed an affinity between invertebrates from ecosystems, closed to the forests.

Keywords: cliff, diversity, evenness, mite, similarity.

Rezumat. **Diversitatea faunei de acarieni edafici (Acari: Mesostigmata) din câteva ecosisteme de stâncărie din România.** Lucrarea prezintă diversitatea faunei de acarieni de sol din cîteva ecosisteme de stâncărie din zone montane şi de deal din România. Au fost identificate 39 de specii, cu 272 indivizi. Indicele de diversitate Shannon a demosntrat faptul că ecosistemele de stâncărie din zonele montane oferă cele mai bune condiţii de dezvoltare pentru aceste arthropode. Speciile de acarieni dominante pentru stâncăriile învecinate cu ecosisteme forestiere, au fost: *Leptogamasus parvulus* (Berlese 1903), *Pergamasus crassipes* (Linne 1758), *Veigaia nemorensis* (C. L. Koch 1839), *Hypoaspis aculeifer* (G. Canestrini, 1884.), *Prozercon traegardhi* (Halbert, 1923), *Zercon berlesei* Sellnicki, 1958 şi *Trachytes aegrota* (C.L. Koch 1841). Numai două specii sunt caracteristice pentru stâncaria învecinată cu un ecosistem praticol: *Hypoaspis praesternalis* Willmann 1949 and *Asca bicornis* (Canestrini & Fanzago 1887). Indicele de echitabilitate a evidenţiat că ecosistemele de stâncărie din zonele montane sunt caracterizate de câteva specii dominante numeric: *Leptogamasus parvulus, Zercon berlesei* şi *Trachytes aegrota*. În zonele de deal, conform valorilor acestui indice, populaţiile de acarieni au fost distribuite în mod echitabil. Indicele de similaritate Bray-Curtis a arătat o afinitate semnificativă între acarienii din ecosistemele de stîncărie, învecinate cu păduri.

Cuvinte cheie: stâncă, acarieni, diversitate, echitabilitate, similaritate.

INTRODUCTION

It is known that soil mites (mesostigmatids) inhabit diverse ecosystems as forests, shrubs, meadows, urban areas, agroecosystems, anthropogenic ecosystems (industrial areas), being found in different microhabitats (soil, bark, litter, humus, moss, detritus, plants, in anthill, molehill, on fungus, mushrooms) (WALTER & PROCTOR, 1999; KRANTZ & WALTER, 2009; SALMANE & BRUMELIS, 2010; MADEJ et al., 2011). There are many studies concerning the species diversity and distribution in these ecosystems, all over Europe, as well as in Romania (KOEHLER, 2000; BEAULIEU et al., 2006; CĂLUGĂR, 2006; GULVIK, 2007; KACZMAREK et al., 2009; RUF & BEDANO, 2010; MARCHENKO, 2011; WISSUWA et al., 2012; MANU, 2013; KAMCZYC et al., 2014). But which is the diversity of mites in an untypical ecosystem as cliff? If we take into consideration the acarofauna, this type of ecosystems are not studied in Europe. In Romania, some researches were made only in one area (Brebu gorges - Prahova County), revealing characteristic structure and dynamics of the plant and soil invertebrates communities, in correlation with environmental factors (MANU, 2010; 2012; ONETE et al., 2011; FIERA, 2013; FIERA et al., 2013). Even, the adjacent area to cliff ecosystems was investigated, demonstrating that the soil mites are not stable communities (MANU, 2014). But this research is singular. I considered that these studies must be extended on many cliff ecosystems from Romania, from mountain and hilly areas. In this context, the main objectives of this study were to establish the diversity of soil mites from four cliff ecosystems from a temperate area.

MATERIAL AND METHODS

The present research was made in 2011-2012, in four cliff ecosystem from mountain and hilly areas: Buila-Cheile Cheii (BuC), Peleş Valley (PC) from the first category and Tohani cliff (TC) and Brebu gorges (BrC) from the second category. Three of the investigated ecosystems are located in Prahova County (PC, TC, BrC) and only one is located in Vâlcea County (BuC) (Fig. 1). Some of the investigated cliff ecosystems are included in Natura 2000 protected areas (Fig. 1, Table 1). The geographical characterization of the investigated cliff ecosystems is presented beneath (Table 1).

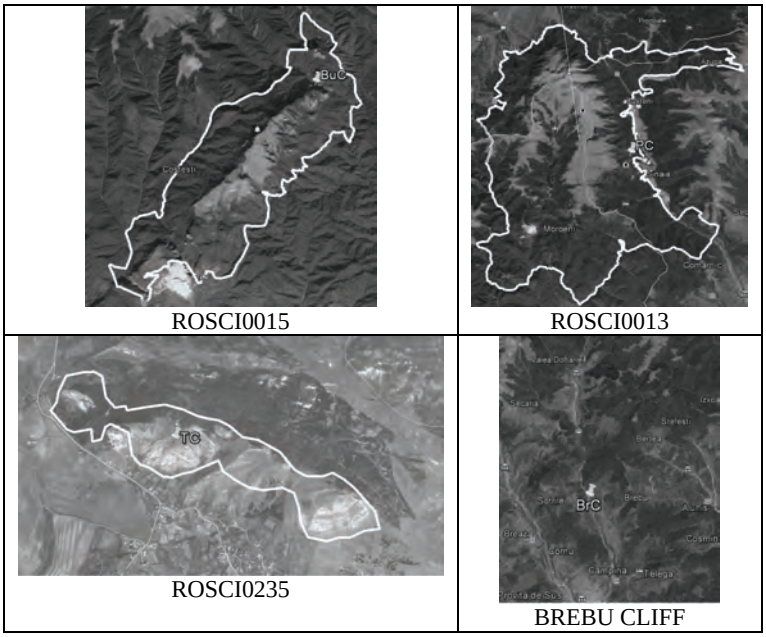

Figure 1. Geographical position of the investigated cliff ecosystems (www. earth.google.com).

In total, 112 soil samples, with 39 species and 272 individuals were analysed. Twenty eight samples per ecosystem were collected with a metal frame (20 x 20 cm), on 3 cm deep. The samples were taken in July, August, October and November, 2011-2012. Often, the sample contained moss or sandy substrate from the cliff area. The extraction was performed with a modified Berlese-Tullgren extractor, in ethylic alcohol and the mites samples were clarified in lactic acid. The identification of the mites from the Mesostigmata order was made up to the species level, using the most actual keys for determination (GHILIAROV & BREGETOVA, 1977; KARG, 1993; MASAN, 2003; MASAN & FENDA, 2004; GWIAZDOWICZ, 2007; MASAN, 2007; MASAN & HALLIDAY, 2010, 2014).

Mite diversity (Shannon index), dominance (Simpson's index), and evenness (E index) were calculated using the PAST software (HAMMER et al., 2001). The similarity of mite presence and composition was assessed using Bray-Curtis (q_{BC}) dendrogram.

Table 1. Description of the investigated cliff ecosystems.

Cliff ecosystem	**Tohani cliff**	**Brebu gorges**	**Buila- Cheile Cheii**	**Peleş Valley**
GIS coordinates	N: $45^0$04'19,34" E: $26^0$25'35,21"	N: $45^0$12'31,10" E: $25^0$44'23,50"	N: $45^0$16'04,52" E: $24^0$07'34,91"	N: $45^0$21'50,75" E: $25^0$31'29,76"
Altitude	388 meters	537 meters	966 meters	1110 meters
Adjacent ecosystems	Meadow	Deciduous Forest Shrub Grassland	Mixed forest	Mixed forest
Affiliation to Natura 2000 Protected Areas	ROSCI0235 Stânca Tohani	-	ROSCI0015 Buila National Park	ROSCI0013 Bucegi National Park

RESULTS AND DISCUSSIONS

After taxonomical identification of the soil mite communities, in the whole period of study 39 species were found, with 272 individuals (Table 3). The species are included in the following families: *Parasitidae* (28.20%), *Zerconidae* (20.51%), *Ascidae* (10.25%), *Macrochelidae* (10.25%), *Pachylaelapidae* (10.25%), *Veigaiidae* (10.25%), *Laelapidae* (7.69%), *Digamasellidae* (2.56%), *Eviphididae* (2.56%) and *Trachytidae* (2.56%).

The dominant species are mobile predators, finding their prey by chemical or tactile stimuli. Species belonging to the families: *Ascidae*, *Parasitidae* or *Veigaiidae* feed with small arthropods, especially springtails. Others, as those from *Macrochelidae* family feed on eggs of insects and their first instar larvae. In general, even if the body size on Mesostigmata is big, their trophic position was not related with this feature. Their hunting success may depend on the availability i.e., on the density of prey in the investigated microhabitat. The species from *Ascidae*, *Veigaiidae*, *Macrochelidae* and *Pachylaelapidae* families are hemiedaphic surface dwellers, found not in greater soil depths (KOEHLER, 1999; GULVIK, 2007; WISSUWA et al., 2012; KLARNER et al., 2013).

Pursuing the species diversity, as well as the highest abundance of the mite fauna, in the analysed ecosystems, it has been pointed out that the best conditions for their development are in mountain cliffs (Peleş Valley, Buila- Cheile Cheii), as well as one in the hilly area (Brebu gorges).

Shannon index of diversity, as well as the alpha diversity had recorded the highest values in these ecosystems (Table 2, Fig. 2A). The proximity of the forest ecosystem to the cliff areas and the characteristic environment could be the main explanation of the most abundant mite fauna in mountain cliff ecosystems. Many researches revealed that in the soil of the forest ecosystems the humidity is more increased, the temperature is lower, the acidity is higher and the organic layer is more developed, in comparison with the sandy soils from grassy areas, as those from Tohani (PONGE, 2003; LAL & BRONICK, 2005).

If we make a comparison with other types of ecosystems from Romania, adjacent to cliff area, the recorded number of species from Buila - Cheile Cheii and Peleş Valley is low, compared with the mountain forest (97 species) and mountain grassland (46 species). If we take into consideration the hilly cliff ecosystem, the species diversity is comparable with that obtained in the deciduous forest (12-22 species) and in shrub ecosystems (12-15 species) (Table 3) (MANU, 2012; 2013).

The species evenness calculated for the four investigated areas had recorded similar values in Tohani cliff – Brebu gorges and in Buila - Cheile Cheii – Peleş Valley. The numerical abundances of identified species from the Tohani cliff and Brebu gorges had an equitable distribution. In Buila- Cheile Cheii and Peleş Valley, identified species are characterized by different (more increased) numerical abundances, revealing that the cliffs from mountain area are more favourable habitats for some dominant mesostigmatids, as: *Leptogamasus parvulus* (Berlese 1903), *Zercon berlesei* Sellnicki 1958 and *Trachytes aegrota* (C. L. Koch 1841). The probability that two individuals randomly selected from a sample will belong to the same species, measured through Simpson index, is higher in Buila- Cheile Cheii, Peleş Valley and Brebu gorges, being strongly related with numerical abundances (Table 2).

Table 2. Diversity of soil mites in investigated cliff ecosystems.

Index	BuC	TC	BrC	PC
Total number of species	17	3	19	18
Total number of individuals	134	5	67	66
Simpson (D)	0.81	0.56	0.92	0.84
Shannon index of diversity (H)	2.12	0.95	2.74	2.35
Evenness index (E)	0.49	0.6	0.81	0.58

The dominant species in all studied cliff ecosystems were: *Leptogamasus parvulus*, *Pergamasus crassipes* (Linne 1758), *Veigaia nemorensis*, *Hypoaspis aculeifer*, *Prozercon traegardhi*, *Zercon berlesei* and *Trachytes aegrota*. All the species are indicator of natural ecosystems, having a wide ecological plasticity. *Zercon berlesei* and *Prozercon traegardhi* are well adapted to the xerothermophilous phytocoenosis, as those from cliffs (MASAN & FENDA, 2004). With the exception of *Trachytes aegrota*, *Veigaia nemorensis* and *Prozercon traegardhi*, all signalled species are common for Buila- Cheile Cheii, Brebu gorges and Peleş Valley. In Tohani cliff, two species are characteristic for this area: *Hypoaspis praesternalis* and *Asca bicornis* These species are most abundant in sod from grassland or meadows ecosystems, as the Tohani cliff adjacent ecosystems (CĂLUGĂR, 2006; GWIAZDOWICZ, 2007).

Table 3. Soil mite species (Acari: Mesostigmata) from investigated cliff ecosystems.

No.	Species	BuC	TC	BrC	PC	Total
1	*Asca aphidoides* (Linnaeus 1758)	2	0	0	0	2
2	*Asca bicornis* (Canestrini & Fanzago)	0	1	0	0	1
3	*Cheroseius bryophilus* Karg, 1969	0	0	1	0	1
4	Digamasellus sp.	2	0	0	0	2
5	*Eviphis ostrinus* (C. L. Koch, 1836)	0	0	2	1	3
6	*Gamasolaelaps excisus* (C. L. Koch, 1879)	0	0	0	1	1
7	*Geholaspis mandibularis* (Berlese, 1904)	0	0	2	0	2
8	*Holoparasitus calcaratus* (C.L. Koch, 1839)	0	0	0	3	3
9	*Hypoaspis aculeifer* (G. Canestrini, 1884)	9	0	1	1	11
10	*Hypospis claviger* (Berlese, 1883)	0	0	5	0	5
11	*Hypospis praesternalis* Willmann, 1949	0	3	0	0	3
12	*Leptogamasus parvulus* (Berlese, 1903)	20	0	9	5	34
13	Leptogamasus sp.	0	0	0	4	4
14	*Leptogamasus variabilis* Juvara-Bals, 1981	1	0	0	0	1
15	*Lysigamasus lapponicus* (Tragardh, 1910)	0	0	4	1	5
16	Lysigamasus sp.	7	0	0	0	7
17	*Lysigamasus neoruncatellus* (Schweizer, 1961)	0	0	5	0	5
18	*Macrocheles montanus* (Willmann, 1951)	0	0	2	0	2
19	*Macrocheles recki* Bregetova & Koroleva, 1960	0	0	4	0	4
20	*Olopachys suecicus* Sellnick, 1950	0	0	1	0	1
21	*Olopachys vysotskajae* Koroleva, 1976	0	0	2	0	2
22	*Pachylaelaps furcifer* Oudemans, 1903	3	0	0	0	3
23	*Pachylaelaps pectinifer* (G. & R. Canestrini, 1881)	0	0	2	0	2
24	*Paragamasus alpestris* (Berlese, 1904)	0	0	0	2	2
25	*Paragamasus similis* (Willmann, 1953)	0	0	0	2	2
26	*Pergamasus crassipes* (Linne, 1758)	7	0	4	2	13
27	*Pergamasus barbarus* (Berlese, 1904)	2	0	0	2	4

28	*Prozercon karsticus* Halaskova, 1963	0	0	2	0	2
29	*Prozercon sellnicki* Halaskova, 1963	1	0	0	0	1
30	*Prozercon traegardhi* (Halbert, 1923)	5	0	5	0	10
31	*Trachytes aegrota* (C. L. Koch, 1841)	12	0	0	0	12
32	*Veigaia kochi* (Tragardh, 1901)	0	0	0	2	2
33	*Veigaia nemorensis* (C. L. Koch, 1839)	9	0	3	9	21
34	*Veigaia planicola* (Berlese, 1892)	0	1	3	1	5
35	*Zercon berlesei* Sellnicki, 1958	51	0	10	23	84
36	*Zercon fageticola* Halaskova, 1969	1	0	0	2	3
37	*Zercon peltatus peltatus* C. L. Koch, 1836	1	0	0	0	1
38	Zercon sp.	1	0	0	3	4
39	*Zercon triangularis* C. L. Koch, 1836	0	0	0	2	2
	Total	134	5	67	66	272

Analysing the Bray-Curtis similarity between mesostigmatids, we observed that numerical abundances recorded have closed values in the species from Peleş Valley and Buila- Cheile Cheii areas (q_{PC-BuC} = 45.71) and in those from Brebu gorges and Peleş Valley ecosystems (q_{PC-BrC} = 43.24). On the opposite, there are species from Tohani cliff and Peleş Valley ecosystems, where the Bray-Curtis index recorded the lowest value (q_{PC-TC} = 9.52) (Fig. 2B).

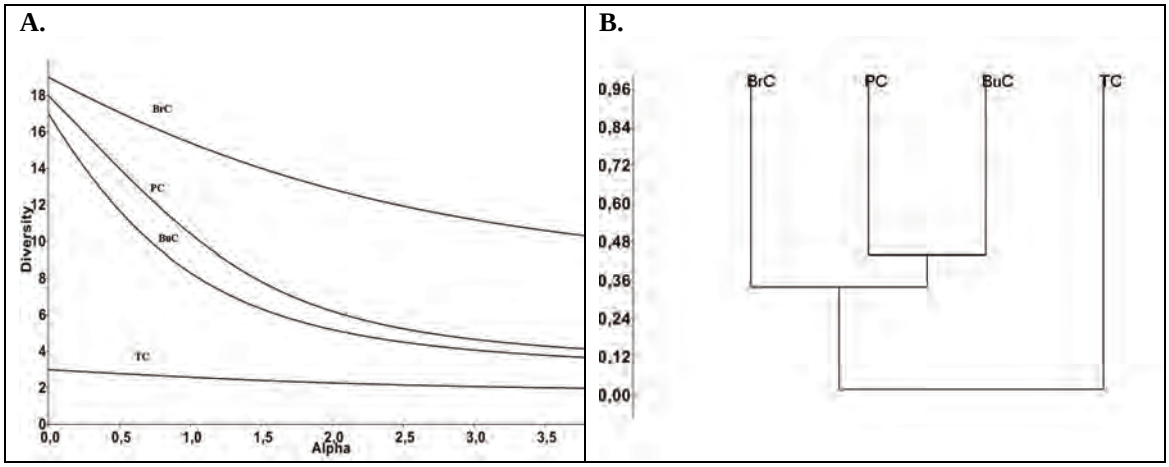

Figure 2. Population parameters of mites from investigated cliff ecosystems (A= Alpha diversity; B = Bray-Curtis Similarity dendrogram).

These differences between cliff areas are possible due to the influence of the adjacent ecosystems and to their geographical position. The cliffs from mountain areas recorded closed population structure and numerical abundances. In the same time, even if the cliff is not in mountain area, the forest ecosystems situated near it, influence the species composition (as is in Brebu gorges ecosystem). In the cliff from the hilly area, Tohani cliff, due to the specific structure of mites, the differences between it and the other three ecosystems are very high. Due to their closed vicinity with a meadow, the species composition is different, a phenomena that is highlighted by the similarity dendrogram (Fig. 2B).

CONCLUSIONS

Taxonomic structure of the mite communities from some cliff ecosystems from Romania revealed the presence of a total of 39 species, with 272 individuals, grouped into 10 families. The best conditions for their development are provided by the mountain cliffs ecosystems (Peles Valley, Buila - Cheile Cheii), as well as one from the hilly area (Brebu gorges), where there was recorded the highest species diversity. On the opposite, it is the ecosystem Tohani cliff, with the lowest species diversity. The dominant species in all studied cliff ecosystems, neighbouring forests, were: *Leptogamasus parvulus, Pergamasus crassipes, Veigaia nemorensis, Hypoaspis aculeifer, Prozercon traegardhi, Zercon berlesei* and *Trachytes aegrota*. They are mobile predators, with a high ecological plasticity. Two species were characteristic only for the Tohani cliff area: *Hypoaspis praesternalis* and *Asca bicornis*, species that are often identified in grassland or meadows ecosystems.

On one hand, the evenness index calculated for soil mites from four ecosystems revealed that the cliffs from the mountain area, Buila - Cheile Cheii and Peles Valley are more favourable habitats for some numerically dominant mesostigmatids, as *Leptogamasus parvulus, Zercon berlesei* and *Trachytes aegrota*. On the other hand, this index showed that the numerical abundances of the identified species from the Tohani cliff and Brebu gorges from the hilly areas had an equitable distribution. The similarities between the soil mite populations from the investigated cliffs revealed an affinity between invertebrates from ecosystems, closed to the forests.

In order to evaluate all biological processes from this unique type of ecosystems (as cliff), the research must be extended, on all soil fauna groups in correlations with environmental factors.

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