IS THE AREA ADJACENT TO THE CLIFF ECOSYSTEM CHARACTERIZED BY STABLE SOIL MITE POPULATIONS?

MANU Minodora, ONETE Marilena

Abstract. The paper presents the three years dynamics of the soil mite communities from an area adjacent to a cliff ecosystem from Brebu gorges-the Doftana Valley. 54 species were identified, with 347 individuals. In temporal dynamics, the population parameters varied every year of the study. In 2010, there were recorded the highest values of the numerical density and species diversity and in 2009, the lowest values. Seven species were common for all three years of research: *Eviphis ostrinus* (C. L. Koch 1836), *Geholaspis mandibularis* (Berlese 1904), *Hypospis aculeifer* Canestrini 1883, *Olopachys suecicus* Sellnick 1950, *Pachylaelaps furcifer* Oudemans 1903, *Prozercon traegardhi* (Halbert 1923) and *Veigaia nemorensis* (C. L. Koch 1839). The analysis of the dominance and constancy indices on the whole period of study revealed that eudominant-dominant species represent 5.45% from all identified species. Only 10.9% are euconstant-constant species and 78.18% are accessory and accidental. The same situation was presented for each year of research. The increased number of exclusive species for every year, the high number of accessory and accidental species demonstrated that the area adjacent to the cliff ecosystem is not characterized by stable soil mite populations.

Keywords: cliff, mesostigmatids, dynamics, community.

Rezumat. Este zona adiacentă a unui ecosistem de stâncărie caracterizată de populaţii stabile de acarieni? Lucrarea prezintă dinamica populaţiilor de acarieni dintr-o zonă adiacentă a unui ecosistem de stâncărie situat în Cheile Brebului de pe Valea Doftanei. Au fost identificate 54 specii, cu 347 indivizi. In dinamică temporală, parametrii populaţionali au variat in fiecare an de studiu. In 2010, s-au obţinut cele mai mari valori ale densităţii numerice şi a diversităţii specifice, iar în 2009 cele mai mici valori. Au fost identificate şapte specii comune pentru cei trei ani de studiu: *Eviphis ostrinus* (C. L. Koch 1836), *Geholaspis mandibularis* (Berlese 1904), *Hypospis aculeifer* Canestrini 1883, *Olopachys suecicus* Sellnick 1950, *Pachylaelaps furcifer* Oudemans 1903, *Prozercon traegardhi* (Halbert 1923) and *Veigaia nemorensis* (C. L. Koch 1839). Analiza indicilor de dominanţă şi constanţă, pe întreaga perioadă de studiu, a arătat că speciile eudominate-dominate reprezintă 5,45% din numărul total de specii. Numai 10,9% sunte specii euconstante-constante, iar 78,18% sunt accesorii şi accidentale. Procentul mare al speciilor exclusiviste pentru fiecare an de studiu, a speciilor accidentale şi accesorii a demonstrat că zona adiacentă a unui ecosistem de stâncărie nu este caracterizată de comunităţi de acarieni stabile.

Cuvinte cheie: stâncă, mesostigmate, dinamică, comunitate.

INTRODUCTION

Ecological studies in an untypical type of ecosystems as cliff and its adjacent area are rare. Cliffs represents primary habitats for plants and animals, being a veritable refuge for native flora and fauna. Cliff ecosystems have low potential productivity and their characteristic flora and fauna are very sensitive to any environmental disturbing factors (LARSON et al., 1989; 2000). In Romania, one of the investigated cliff ecosystem is situated on Brebu gorges from the Doftana Valley. This valley is characterized by various types of terrestrial ecosystem, as deciduous and coniferous forests, shrubs, mountain meadows and cliffs. Research–conducted in these ecosystems revealed a characteristic structure and dynamics of the plant and soil invertebrates communities, in correlation with environmental factors (PAUCĂ–COMĂNESCU et al., 2008; MANU, 2010b; 2012; ONETE et al., 2011; FIERA, 2013; FIERA et al., 2013).

Cliff ecosystems have a specific microclimate (increased temperatures, presence of wind, absence of direct precipitations, constant battles with the force of gravity), vegetation (lack of space for roots) or type of soil (lack of soil cover, presence of carbonate-based rocks) (MASER et al., 1979; LARSON et al., 2000). This microclimate influences the adjacent area as well. Due to climatic factors and to heterogeneity of cliff surface, the process of erosion is accentuated, influencing the soil structure of the adjacent area. Sometimes, even the vegetation from the adjacent area to this type of ecosystem can be similar with that from the cliff (ONETE et al., 2011).

Studies concerning the edaphic mite communities from the cliff and its adjacent area showed that these habitats are not proper for these predatory mites (MANU, 2011a, b; 2013). But these population analyses are based on data collected in one year. This study presents a complete ecological investigation on the structure and dynamics of the soil mite communities (Acari: Mesostigmata) from a period of three years. The question is: is the area adjacent to the cliff ecosystem characterized by stable a gamasid population (constant and dominant species) or their presence in this habitat is accidental?

MATERIAL AND METHODS

The present research was made in 2009-2011, in the area adjacent to a cliff ecosystem from Brebu gorges, the Doftana Valley, Romania (N: 45° 12' 31. 1''; E: 25° 44' 23. 5'') (Figs. 1 A. B. D). Altitude reached 537 m. Vegetation was represented by different types of elements: Eurasian, European, central-European, Carpathian, Mediterranean. The most abundant species are: *Rubus saxatilis*, *R. caesius*, *Hippophae rhamnoides*, *Populus tremula*, *Salix caprea*, *Salvia* *glutinosa*, *Campanula sibirica*, which have an Euro-Asian distribution. In the cliff area, some pioneer species were identified, as: *Cytisus nigricans*, *Rosa canina* and *H. rhamnoides*, which are quite abundant (20 %) (ONETE et al., 2011). In the area adjacent to the cliff, the dominant plant species were: *Hippophaë rhamnoides, Rosa canina, Salix purpurea, Alnus* sp*., Rubus caesius* and similar species with those from the cliff, resistant to dryness.

In the adjacent area of the cliff the soil is typically alluvial, sometimes having a thin humified organic matter layer (about 2-3 cm). The average values of the soil pH on the north side of the adjacent area were 7.76 in litter-fermentation layer, 7.34 in humus layer and 7.52 in soil. On the southern side, the acidity of the soil was lowest: 7.94 in the on litter-fermentation layer, 8.19 in humus and 8.23 in soil. On the cliff, the type of soil has a various distribution, correlated with slope and with erosion process: clayey till argillaceous on the moderate and strongly inclined peaks, which are seriously affected by erosion; brown eumesobasic till pseudogleyic, which have a mineral component formed at the soil surface, connected to a thin humified organic matter layer (MANU, 2011a, b; 2013). The air temperature and humidity were recorded on the meteorological station from Câmpina city, which monitors the climate from the Doftana Valley.

In total, 180 soil samples, with 54 species and 347 individuals were analysed. The total numerical density was 34 700 ind./sq.m. Twenty samples/month were collected with MacFadyen corer (5 cm diameter), 10 cm deep (Fig. 1C). The soil samples were taken in April, June and October, 2009-2011, at the base of the cliff. The extraction was performed with a modified Berlese-Tullgren extractor, in ethylic alcohol and the mite 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).

The statistical analysis was conducted with the aid of the BioDiversity Pro 2.0 software, designed and developed by Neil McAleece and provided by The Natural History Museum, London.

Using statistical information, dominance was calculated, according to Engelmann's dominance classification (ENGELMANN, 1978). The constancy was determined following the methodology of SKORUPSKI et al. (2009).

The dominance was calculated using the formula:

$D = 100*n/N$. where:

n - number of individuals of one species from one sample;

N - total number of individuals of all species from one sample.

The dominance classes for the identified mites were: eudominant = over 10% (D5); dominant = 5.1-10% (D4); subdominant = 2.1 – 5% (D3); recedent = 1.1- 2% (D2) and subrecedent ≤ 1.1% (D1).

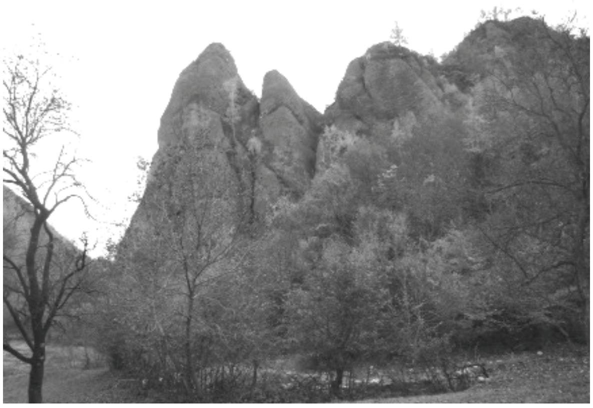
The constancy was obtained using the formula:

$C = 100*pA/P$. where:

pA - number of samples with species A.

P - total number of samples.

The mite species were classified into four constancy classes: euconstant = 75.1-100% (C4), constant = 50.1-75% (C3), accessory = 25.1-50% (C2) and accidental = 1-25% (C1).



1 A. Adjacent area of the cliff- northern side. (www.eszph.ro)

1B. Adjacent area of the cliff- southern side. (www.eszph.ro)

1C. MacFadyen soil core with sample (original). 1D. Brebu gorges -general view. (www.eszph.ro)

Figure 1. The adjacent area and cliff ecosystem from the Brebu gorges (Prahova county).

RESULTS AND DISCUSSIONS

If we take into consideration the abiotic factors, the highest average value of the temperature was recorded in 2011 and the lowest one in 2009. The humidity had the most increased value in 2009 and in 2011 this factor decreased significantly. In monthly temporal dynamics, in June the temperature had the highest values (between 18.8^{0}C and 19.03^{0}C). In October, there were obtained the highest values of humidity, with one exception: in 2011, this maximum value was recorded in June (Figs. 1A. B).

Ecological research on mesostigmatid mites revealed that the favourable conditions for their development are: soil temperature between 12°C and 16°C, humidity over 60%, acid pH and the presence of food (SALMANE, 2000; LINDBERG et al., 2002).

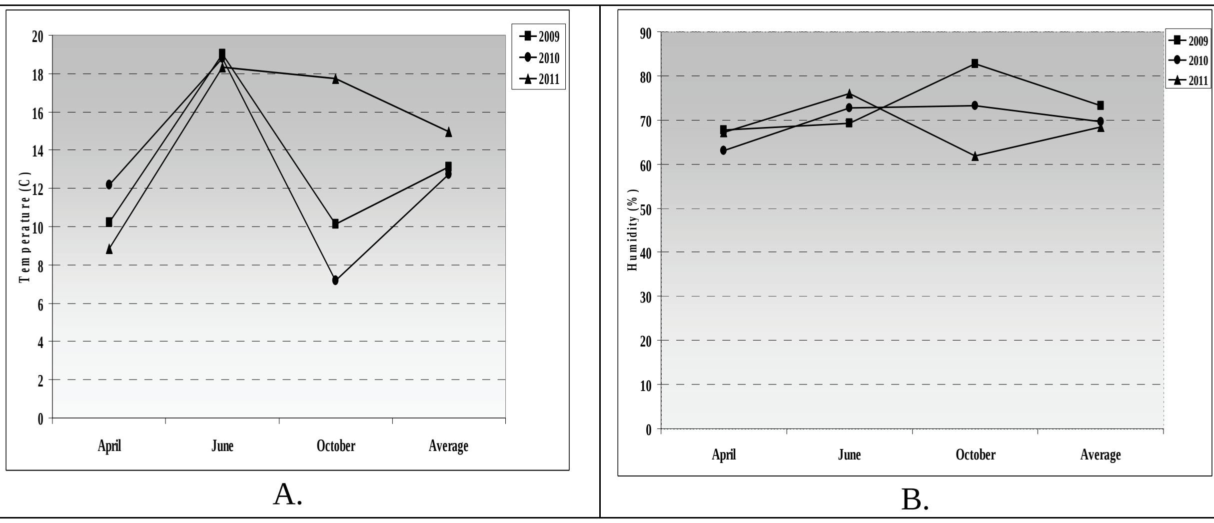


Figure 2. Temperature (C^0) A. and humidity (%). B. from the area adjacent to the cliff from Brebu gorges.

After taxonomical identification of the soil mite communities in the whole period of study, 54 species were found, with 347 individuals, grouped into 11 families: Epicriidae (2 species), Ascidae (2 species), Veigaiidae (5 species), Phytoseiidae (1 species), Eviphididae (1 species), Macrochelidae (6 species), Parasitidae (13 species), Laelapidae (6 species), Pachylaelapidae (6 species), Zerconidae (11 species) and Rhodacaridae (1 species). The majority of these soil mites are predators, one of the most important limiting factors being the availability for food. A sustainable and stable ecosystem is often characterized by the presence of edaphic (e.g. Rhodacaridae), hemiedaphic and epigeic species (Macrochelidae, Parasitidae and Veigaiidae) (KOEHLER, 1999; GLUVIK, 2007).

In temporal dynamics, the highest number of species and individuals was recorded in 2010. The lowest values of the numerical abundance and species diversity were obtained in 2009. The obtained number of species and individuals are higher, in comparison with those from different types of ecosystems from the Doftana Valley. In the deciduous forests from Lunca Mare and Șotrile localities, 21 and respectively, 12 species were identified. In the alluvial shrub ecosystem, 13 species were recorded (MANU, 2008; 2009; 2010b).

In 1982, BOTNARIUC & VĂDINEANU demonstrated that the stable-mature and complex ecosystems are characterized by a decreased number of species, but an increased number of individuals. The ecosystems that are in the first phase of the climax (maturity) stage are characterized by a higher number of species and a decreased number of individuals.

If we make a comparison with the total number of species recorded in the whole period of study (three years), in 2009, there was found only 41.81% from them, in 2010 there were identified 63.63% and in 2011, the percentage was by 54.54%. Seven species were common for all three years of research: *Eviphis ostrinus* (C. L. Koch, 1836), *Geholaspis mandibularis* (Berlese, 1904), *Hypospis aculeifer* Canestrini, 1883; *Olopachys suecicus* Sellnick 1950, *Pachylaelaps furcifer* Oudemans 1903, *Prozercon traegardhi* (Halbert, 1923) and *Veigaia nemorensis* (C. L. Koch, 1839). These species are predators, with a wide ecological plasticity and are found in different type of terrestrial temperate ecosystems, as: forests, shrubs, agricultural fields and even in urban areas (KOEHLER, 1999; SALMANE, 2000; RUF & BECK, 2005; SKORUPSKI et al., 2009; RUF & BEDANO, 2010; MANU & HONCIUC, 2010; MANU 2012, 2013).

The values of Shannon index of diversity revealed the same annual fluctuation as the previous two parameters. The species evenness (an index which quantifies how equal the community is numerically) calculated for the three years of study showed that in 2009 and 2010 had close values. In 2011, evenness index had recorded a more decreased value (Table 1).

Table 1. Diversity of soil mites in the area adjacent to the cliff in 2009, 2010, 2011 and in the whole period of study.

Index	2009	2010	2011	Three years
Total number of species	23	35	30	54
Total number of individuals	59	161	127	347
Numerical density (ind./sq.m.)	2950	8050	6350	17350
Mean number of species in a sample	1.07 ± 1.89	2.92 ± 3.92	2.37± 4.24	6.30 ± 7.94
Total number of exclusive species	5	15	11	
Total number of rare species (D<3%)	9	22	19	46
Total number of eudominant - dominant species	7	3	4	3
Total number of euconstant - constant species	0	4	3	10
Total number of accessory - accidental species	22	31	24	43
H' (Shannon index of diversity)	2.84	3.22	2.93	3.46
E (Evenness index)	0.74	0.72	0.62	0.58

Analysis of the species rank graph revealed differences in proportional abundance of the identified mite species (Fig. 3). The highest values were recorded for the species identified in 2010, the lowest for species from 2009.

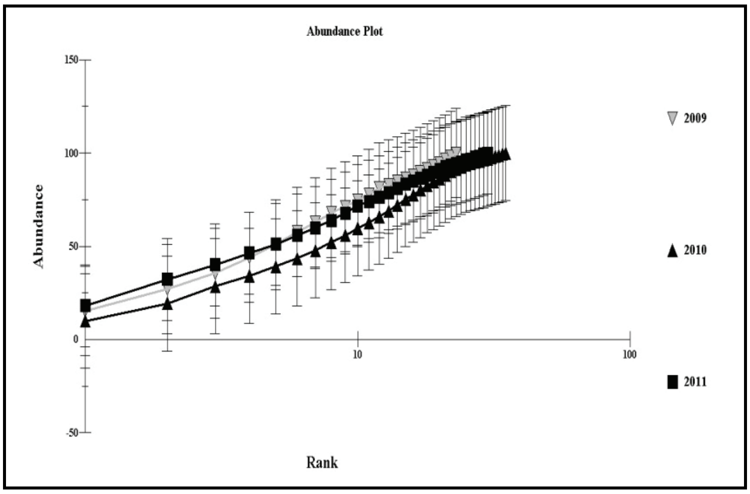


Figure 3. Species rank for mesostigmatid mites in three years of study.

In 2009, only 30.43% are eudominant-dominant species. Besides the common species mentioned above, in this category of dominance were included the species *Veigaia kochi* (Tragardh, 1901) and *Pseudolaelaps doderoi* (Berlese, 1910) as well. No euconstant-constant species were identified, but the accessory-accidental species represent 95.65% from all identified soil mites (Table 2).

In 2010, the representation of the eudominant-dominant and euconstant-constant species was lower than the precedent year (8.57% and respectively 11.42%). One of the most abundant species was *Veigaia planicola* (Berlese, 1892), which is an expansive species, found in many types of ecosystems in Romania as well in Europe, as grassy arable fallows, pine and oak forests (MORAZA, 2010; WISSUWA et al., 2001; MANU, 2011 A). Accidental and accessory mites represented 88.57% from the total number of species (Table 2)

In 2011, the eudominant-dominant species represented 10% from all identified mites. Species with a high number of individuals were *Veigaia planicola* (Berlese, 1892) and *Macrocheles montanus* Willmann, 1951. The euconstant-constant species represented 13.33% and the majority of them are accidental and accessory (80%) (Table 2).

If we take into consideration the whole period of study (2009-2011), only *Prozercon traegardhi* (Halbert, 1923), *Veigaia planicola* (Berlese, 1892) and *Veigaia nemorensis* (C. L. Koch, 1839) are eudominant-dominant species, which represent 5.45% from all identified species. Only 10.9% are euconstant-constant species and 78.18% are accessory and accidental (Table 2).

Table 2. The soil mites (Acari: Gamasina) from the area adjacent to the cliff from Brebu gorge**.**

		2009		**2010**		**2011**		**2009+2010+2011**	
No.	**Species**	**D%**	**C**	**D%**	**C**	**D%**	**C**	**D%**	**C**
1	*Amblyseius* sp.	1.69	10					0.29	10
2	*Arctoseius cetratus* (Sellnick 1940)					2.48	30	0.88	30
3	*Arctoseius resinae* Karg 1960			0.62	10			0.29	10
4	*Asca bicornis* (Canestrini & Fanzago 1887)			0.62	10			0.29	10
5	*Epicrius mollis* (Kramer 1976)					0.83	10	0.29	10
6	*Epicrius tauricus* Bregetova 1977	1.69	10	0.62	10			0.59	20
7	*Eviphis ostrinus* (C.L. Koch 1836)	1.69	10	1.86	30	1.65	20	1.76	40
8	*Geholaspis longisetosus* Balogh 1958			1.86	20			0.88	20
9	*Geholaspis longispinosus* (Kramer 1876)					1.65	20	0.59	20
10	*Geholaspis mandibularis* (Berlese 1904)	8.47	40	4.97	50	1.65	10	4.40	80
11	*Holoparasitus calcaratus* (C.L. Koch 1839)	1.69	10			0.83	10	0.59	20
12	*Hypospis aculeifer* Canestrini 1883	8.47	20	1.24	20	2.48	20	2.93	40
13	*Geolaelaps brevipilis* (Hirschmann 1969)					4.96	40	1.76	40
14	*Hypospis claviger* (Berlese 1883)					1.65	20	0.59	20
15	*Hypospis miles* Berlese 1892	1.69	10					0.29	10
16	*Leptogamasus obesus* (Holzmann 1969)	1.69	10	4.35	70			2.35	70
17	*Leptogamasus* sp.	5.08	20			1.65	10	0.59	10
18	*Leptogamasus tectegynellus* Athias-Henriot 1967	3.39	20					0.59	20
19	*Lysigamasus lapponicus* (Tragardh 1910)			0.62	10	0.83	10	0.59	20
20	*Lysigamasus neoruncatellus* Schweizer 1961			0.62	10	2.48	20	1.17	30
21	*Lysigamasus* sp.			0.62	10			1.17	30
22	*Macrocheles montanus* Willmann 1951			3.73	50	6.61	50	4.11	60
23	*Macrocheles recki* Bregetova & Koroleva 1960	3.39	10	3.11	40			2.05	50
24	*Macrocheles* sp.	1.69	10					0.29	10
25	*Olopachys suecicus* Sellnick 1950	6.78	10	1.24	20	7.44	60	4.40	70
26	*Olopachys vysotskajae* Koroleva 1976	1.69	10	1.24	20			0.88	30
27	*Pachylaelaps dubius* Hirschmann & Krauss 1965			0.62	10			0.29	10
28	*Pachylaelaps furcifer* Oudemans 1903	5.08	20	4.35	50	1.65	10	3.52	60
29	*Pachylaelaps pectinifer* (G & R Canestrini 1881)			0.62	10			0.29	10
30	*Pachyseius humeralis* Berlese 1910	1.69	10	3.11	20			1.76	30
31	*Parasitellus* sp.			0.62	10			0.29	10
32	*Pergamasus barbarus* Berlese 1904			1.86	30			0.88	30
33	*Pergamasus crassipes* Berlese 1906			2.48	30			1.17	30
34	*Pergamaus longicornis* (Berlese 1906)					2.48	30	0.88	30
35	*Poecilochirus carabi* G & R Canestrini 1882			0.62	10			0.29	10
36	*Prozercon carsticus* Halaskova 1963			3.11	40	0.83	10	1.76	40
37	*Prozercon fimbriatus* (C.L.Koch 1839)					2.48	20	0.88	20
38	*Prozercon sellnicki* Halaskova 1963	3.39	20			0.83	10	0.88	30
39	*Prozercon similis* Balan 1992					0.83	10	0.29	10
40	*Prozercon* sp.			2.48	40			1.17	40
41	*Prozercon traegardhi* (Halbert 1923)	11.86	40	9.32	80	14.88	50	11.73	100

42	*Pseudolaelaps doderoi* (Berlese 1910)	6.78	40	2.48	40			2.35	60
43	*Rhodacarellus silesiacus* Willmann 1935					1.65	10	0.59	10
44	*Veigaia exigua* (Berlese 1916)	3.39	20	3.11	40			2.05	50
45	*Veigaia kochi* (Tragardh 1901)	8.47	30					1.47	30
46	*Veigaia nemorensis* (C.L.Koch 1839)	10.17	40	11.80	100	19.01	80	14.08	100
47	*Veigaia planicola* (Berlese 1892)			11.18	90	9.09	60	8.50	90
48	*Veigaia propinqua* Willmann 1936			1.86	10			0.88	10
49	*Vulgarogamasus kraepelini* Schweizer 1922			1.86	20			0.88	20
50	*Zercon berlesei* Sellnick 1958					4.13	30	1.47	30
51	*Zercon fageticola* Halaskova 1969					0.83	10	0.29	10
52	*Zercon foveolatus* Halaskova 1969			4.35	40			2.05	50
53	*Zercon hungaricus* Sellnick 1958			3.11	10			1.47	10
54	*Zercon peltadoides* Halaskova 1970			3.73	40	4.13	30	3.23	60
	Total	100		100		100		100	

If we make a comparison with the soil mite-communities from other types of ecosystems, it is evident that the representation of the eudominant-dominant and euconstant-constant species is very low. For example, in the beech forest from the Doftana Valley the dominant species represent over 25% and in the shrubs over 17% from all identified soil mites. In *Querco petraeae-Carpinetum* forests from the southern region of Romania, the eudominant-dominant species represent between 23.53% and 30%. The same situation was recorded on euconstant-constant species (MANU 2008, 2009, 2010b; MANU & ONETE, 2013). On the opposite, a higher representation of recedent-subrecedent and accessory-accidental species was identified on the soil mites communities from anthropized ecosystems (as spoilt areas or deciduous polluted forests), recording a percentage between 80% and 90% (MANU, 2010a; CĂLUGĂR, 2013).

The increased number of exclusive species for each year of study, the high number of accessory and accidental species demonstrated that the soil mites are not stable communities in the area adjacent to the cliff. This phenomenon is highlighted by the decreased number of dominant and constant species recorded in the whole period of research. Even if the environmental factors are favourable for these soil invertebrates (average temperature between 12.73^0 C and 14.97^0 C; humidity over 60%), it is possible that the type of soil (alluvial-sandy), the lack of organic layer and the type of vegetation (which indirectly influenced the quantity and quality of organic matter) to determine unstable soil mite communities. Expressing ourselves in a different manner, the area adjacent to a cliff ecosystem it is not represented by stable mite populations. Due to their high mobility, the edaphic-soil mites can temporarily migrate from the close forest ecosystems, situated on 200 m distance from the adjacent area of the cliff. In dry summer periods, at the base of the northern side of the cliff, the humidity of soil is more increased, in comparison with that registered in the nearby forest ecosystem. This area could be a refuge island for these invertebrates.

Some researches revealed that physical/chemical, climatological and geomorphological factors are often those that most heavily influence plant and animal distributions, but interspecific relationships, such as competition, predation or processes related to growth and development are also important (BOCARD et al., 1992; GUTIEREZ-LOPEZ et al., 2010).

CONCLUSION

Taxonomical structure of the mite communities from an area adjacent to a cliff ecosystem, on a period of three years of study revealed the presence of 54 species, with 347 individuals, grouped into 11 families. The majority of these soil mites are predators, influenced by the availability of the food source. In 2010, there was recorded the highest number of species and individuals. The lowest values of these two population parameters were obtained in 2009. The obtained number of species and individuals are higher, in comparison with those from forests and alluvial shrubs from the Doftana Valley. Seven species were common for all three years of research: *Eviphis ostrinus*, *Geholaspis mandibularis*, *Hypospis aculeifer*, *Olopachys suecicus*, *Pachylaelaps furcifer*, *Prozercon traegardhi* and *Veigaia nemorensis*. These species with a wide ecological plasticity and wide trophic preferences have been found in different type of terrestrial temperate ecosystems from Romania and Europe, as well.

According to the dominance and constancy index, in all three years of study, recedent-subrecedent and accessory-accidental species had the highest representation. Only *Prozercon traegardhi*, *Veigaia planicola* and *V. nemorensis* are eudominant-dominant species. Euconstant-constant species represents 10% from all identified mites. The increased number of exclusive species for each year of study, the high number of accessory and accidental species demonstrated that the soil mites are not stable communities in the area adjacent to the cliff. This phenomenon is highlighted by the decreased number of dominant and constant species recorded in the whole period of research. Even if the environmental factors are favourable for these soil invertebrates, the lack of organic layer and the type of vegetation could determine an unstable soil mite communities.

ACKNOWLEDGEMENTS

This study was carried out in the framework of RO1567-IBB01/2014 project and was financed by UEFISCDI in the framework of Contract 50/2012 "Accounting for the service providing units of plants in the environmental assessment of plans and projects with biogeochemical impact at multiple scales in Rivers basins" (ASPABIR).

We thank to Simona Plumb and Rodica Iosif for their assistance in the lab and the field. The authors would like to thank for checking of Mesostigmata mites to Prof. dr. hab. Dariusz Gwiazdowicz from the Department of Forest and Environmental Protection, Agriculture University, Poznan, Poland.

REFERENCES

BOCARD D., LEGENDRE P., DRAPEAU P. 1992. Partialling out the spatial component of ecological variation. *Ecology*. **73**: 1045–1055.

BOTNARIUC N. & VÃDINEANU A. 1982. *Ecology*. Edit. Didactică şi Pedagogică. Bucureşti. 444 pp. [In Romanian].

CĂLUGĂR ADINA 2013. Effect of pollution with cement dust on the edaphic gamasid mite fauna (Acari:Gamasina) in different forest ecosystems from Romania. *Acarologia.* **53**(2): 151–161.

ENGELMANN H. D. 1978. Classification of the epigeal arthropods. *Pedobiologia.* **18**(5/6): 378–380. [In Germany]. Exploatare Sistem Zonal Prahova SA. www.eszph.ro (Accessed: March. 11. 2014).

GUTIEREZ-LOPEZ M., BESUS J. B., TRIGO D., FERNANDEZ R., NOVO M., DIAZ-COSIN J. D. 2010. Relationships among spatial distribution of soil microarthropods earthworm species and soil properties. *Pedobiologia.* **53**: 381–389.

FIERA CRISTINA 2013. The structural dynamics of the collembolan communities (Hexapoda: Collembola) from two forest ecosystems located in Doftana Valley (Romania). *Acta Oecologica Carpatica.* **6**: 67-74.

FIERA CRISTINA, KONIKIEWICZ M., SKARŻYŃSKI D. 2013. Tetracanthella doftana sp. nov. (Collembola. Isotomidae) from Romania with a key to Carpathian Tetracanthella Schött. 1891. *Zootaxa*. **3691**(4): 467-472.

GHILIAROV M. S. & BREGETOVA N. G. 1977. *A Key to Soil-Dwelling Mites (Mesostigmata).* Russian Academy of Science. Leningrad. 717 pp. [In Russian].

GULVIK M. E. 2007. Mites (Acari) as indicators of soil biodiversity and land use monitoring: a review. Polish Journal of *Ecology*. **55**(3): 415-450.

GWIAZDOWICZ D. 2007. Ascid mites (Acari. Gamasina) from selected forest ecosystems and microhabitats in Poland. *University Augusta Cieszkowskiego*. Poznan: 1-247.

KARG W. 1993. *Acari (Acarina). Milben Parasitiformes (Anactinochaeta) Cohors Gamasina Leach*. **59**:1-513.

KOEHLER H. H. 1999. Predatory mites (Gamasina. Mesostigmata). *Agriculture. Ecosystems and Environment* **74**(1): 395–410.

LARSON D. W., SPRING S. H., MATTHES-SEARS U., BARLETT R. M. 1989. Organization of the Niagara Escarpment cliff community. *Canadian Journal of Botany*. **67**: 2731–2742.

LARSON D. W., MATTHES U., KELLY P. E. 2000. *Cliff Ecology*. Pattern and Process in Cliff Ecosystems. Cambridge Studies in Ecology series. Cambridge University Press. 340 pp.

LINDBERG N., ENGTSSON J. B., PERSSON T. 2002. Effects of experimental irrigation and drought on the composition and diversity of soil fauna in a coniferous stand. *Journal of Applied Ecology*. **39**: 924-936.

MANU MINODORA 2008. The influence of some abiotical factors on the structural dynamics ofthe predatory mite populations (Acari: Mesostigmata) from an ecosystem with Myricaria germanica from Doftana Valley (Romania). *Trav. Mus. Nat. D'Hist. Nat."Grigore Antipa"* **51**: 463-471.

MANU MINODORA. 2009. Ecological research on predatory mite populations (Acari: Mesostigmata) in some Romanian forests. *Biharean Biologist.* **3**(2):110-116.

MANU MINODORA & HONCIUC VIORICA. 2010. Ecological research on the soil mite's populations (Acari: Mesostigmata-Gamasina. Oribatida) from forest ecosystems near Bucharest city. *Roumanian Journal of Biology- Zoology*. **55**(1): 19-30.

MANU MINODORA. 2010a. Predator mites (Acari: Mesostigmata-Gamasina) from soil of some spoilt areas from Retezat and Ţarcu-Petreanu mountains. *Studia Universitatis „Vasile Goldiş" Arad. Seria Ştiinţele Vietii.* **20**(3): 9-94.

MANU MINODORA. 2010b. Structure and dynamics of the predator mite's populations (Acari-Mesostigmata) in some shrubs ecosystems from Prahova and Doftana Valley. *Studia Universitaria Babeş-Bolyai. Biologia* **55** (1): 17-30.

MANU MINODORA. 2011a. Acarofauna (Acari: Mesostigmata-Gamasina) from an adjacent area to the cliff ecosystem from Brebu gorges (Prahova district. Romania). *Roumanian Journal of Biology- Zoology.* **56**(1): 41-48.

MANU MINODORA. 2011b. Influence of the cliff microclimate on the population ecology of soil predatory mites (Acari: Mesostigmata - Gamasina) from Romania. *Proceedings of the Third International Conference "Research People and Actual Tasks on Multidisciplinary Sciences*". Bulgary. **3**. pp. 1-6. ISSN 1313-7735. Publisher: Bulgarian National Multidisciplinary Scientific Network of the Professional Society for Research Work. Lozenec.

MANU MINODORA. 2012. The similarities between predator mite populations (Acari: Gamasina) from some natural forests in Bucegi Massif. Romania. *Biologia. Section Zoolog.* **67**(2): 390-396.

MANU MINODORA & ONETE MARILENA. 2013. Structural characteristics of soil mite populations (Acari-Mesostigmata) from oak-hornbeam forests from southern-Romania. *Muzeul Olteniei Craiova. Oltenia. Studii şi comunicări. Ştiinţele Naturii*. **29**(1): 306-312.

MANU MINODORA, BĂNCILĂ RALUCA IOANA, ONETE MARILENA. 2013. Soil mite communities (Acari: Gamasina) from different ecosystem types from Romania. *Belgian Journal of Zoology.* **143**(1): 30-41.

MASAN P. & FENDA P. 2004. *Zerconid mite's of Slovakia (Acari. Mesostigmata. Zerconidae).* Institute of Zoology. Bratislava. Slovak Academy of Science. 238 pp.

MCALEECE N., GAGE J. D. G., LAMBSHEAD P. J. D. & PATERSON G. L. J. 1997. BioDiversity Pro: Free Statistics Software for Ecology. The Natural HistoryMuseum. London. http://gcmd.nasa.gov/records/NHML Biopro.html.

MASAN P. 2003. *Macrochelid mites of Slovakia (Acari. Mesostigmata. Macrochelidae).* Institute of Zoology. Slovak Academy of Science. (Bratislava). 149 pp.

MASAN P. & FENDA P. 2004. *Zerconid mites of Slovakia (Acari. Mesostigmata. Zerconidae).* Institute of Zoology. Slovakia Academy of Science (Bratislava). 238 pp.

MASAN P. 2007. *A review of the family Pachylaelapidae in Slovakia with systematics and ecology of European species (Acari: Mesostigmata: Eviphidoidea).* Institute of Zoology. Slovak Academy of Science (Bratislava). 247 pp.

MASAN P. & HALLIDAY B. 2010. Review of the European genera of Eviphididae (Acari: Mesostigmata) and the species occurring in Slovakia. *Zootaxa*. **2585**: 1–122.

MASER C., RODIK J. E., THOMAS J. W. 1979. Cliffs. talus and caves. In: Thomas J.W. (Ed) *Wildlife habitats in managed forests: The Blue Mountains of Oregon and Washington*. Agriculture Handbook USDA Forest Service. Washington. **553**: 96-103.

MORAZA MARIA L. 2010. Effects of reforestation with conifers on the communities of mesostigmatic mites in northern Spain (Acari. Mesostigmata). In: Sabelis M.W. & Bruin J. (Eds.). *Trends in Acarology: Proceedings of the 12th International Congress*. Springer Science+Business Media B. V.. Dordrecht: 129-133.

ONETE MARILENA. ION ROXANA. ION MIHAELA. MANU MARILENA. 2011. *The need of multidisciplinary research of cliffs. Case study: The vegetation from Brebu gorges (Romania)*. Proceedings of the Third International Conference "Research People and Actual Tasks on Multidisciplinary Sciences". Lozenec. Bulgary. ISSN 1313-7735. Publisher: Bulgarian National Multidisciplinary Scientific Network of the Professional Society for Research Work. **3**: 73-78.

PAUCĂ-COMĂNESCU MIHAELA, PURICE DORINA, ONETE MARILENA, DIHORU G., HONCIUC VIORICA, VASILIU-OROMULU LILIANA, MANU MINODORA, FIERA CRISTINA, FALCĂ. M., MAICAN SANDA, ION MIHAELA, MUNTEANU CRISTINA. 2008. Alluvial Salix purpurea and Hippophaë rhamnoides collinar shrublands in Prahova and Doftana zone. *Roumanian Journal of Biology- Plant Biology.* **53**: 97-122.

RUF ANDREA & BECK L. 2005. The use of predatory soil mites in ecological soil classification and assessment concepts with perspectives for oribatid mites. *Ecotoxicology and Environmental Safety.* **62**: 290–299.

RUF ANDREA & BEDANO J. C. 2010. Sensitivity of different taxonomic levels of soil Gamasina to land use and anthropogenic disturbances. *Agricultural and Forest Entomology.* **12**(2): 203-212.

SALMANE INETA 2000. Investigation of the seasonal dynamics of soil Gamasina mites (Acari: Mesostigmata) in Pinaceum myrtilosum. Latvia. *Ekologia* . **19**: 245-252.

SKORUPSKI M., BUTKIEWICZ G., WIERZBICKA A. 2009. The first reaction of soil mite fauna (Acari. Mesostigmata) caused by conversion of Norway spruce stand in the Szklarska Poręba Forest District. *Journal of Forest Science.* **55**(5): 234–243.

WISSUWA J., SALAMON J. A., FRANK T. 2011. Effects of habitat age and plant species on predatory mites (Acari. Mesostigmata) in grassy arable fallows in Eastern Austria. *Soil Biology & Biochemistry.* **50**: 96-107.

Manu Minodora, Onete Marilena
Romanian Academy. Institute of Biology. Department of Ecology. Taxonomy and Nature Conservation.
Splaiul Independenţei. no. 296. P.O. Box 56-53. code 0603100 Bucharest. Romania.
E-mail: minodora_stanescu@yahoo.com

Received: March 30, 2014
Accepted: April 10, 2014