TAXONOMICAL STRUCTURE OF THE SOIL MITES FAUNA FROM A CLIFF ECOSYSTEM AND ITS ADJACENT AREA (DOFTANA VALLEY, ROMANIA)

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The present material revealed the taxonomical structure of the soil mites fauna from a cliff ecosystem and its adjacent area. The study was made in 2011, on Brebu gorges, from Doftana Valley, Romania. The taxonomical structure was represented by 10 families (Epicriidae, Parasitidae, Veigaidae, Ascidae, Rhodacaridae, Macrochelidae, Pachylaelaptidae, Laelaptidae, Eviphididae and Zerconidae) with 17 genera and 33 species. Taking account of the two geographical positions of the investigated ecosystems, on the north sides there was recorded the highest species diversity, in comparison with the south sides. 33.36 % from the identified species have a wide ecological plasticity and 9.02% are pioneer species. The Jaccard index revealed similarities between mite populations from the north side of the investigated ecosystems and those from the south sides.

Key words: Mesostigmata, soil mites, taxonomical structure, Brebu gorges, Romania.

INTRODUCTION

Mites (Acari:) are the most abundant invertebrates from soil, mostly of them being predators (Krantz & Walter, 2009; Klarner *et al*., 2013). They have a wide ecological distribution and are used as bioindicators for the soil quality. The environmental variables (as soil humidity, soil temperature, pH, organic matter, etc.) influence their taxonomical and structural structure. Based on these characteristics and on many studies from different types of ecosystems, researches assess the sensitivity of different taxonomic levels of soil mites to anthropogenic disturbances in soil ecosystems of central Europe (Ruf & Beck, 2005; Gulvik, 2007; Bedano & Ruf, 2010).

Despite this, researches on mesostigmatids from the cliff ecosystems in Europe are missing. In the last three years, in Romania, some distinct ecological researches were made concerning the mesostigmatids populations from different types of ecosystems, including the adjacent area of a cliff ecosystem (Manu, 2011a b; Manu *et al*., 2013). These studies do not provide information concerning the taxonomical structure of the mesostigmatids populations from the rocky surface of the cliff ecosystems. The present material brings new information: a comparative taxonomical analysis between soil mites (mesostigmatids) communities from a cliff ecosystem and its adjacent areas, for Romania, as well for Europe.

MATERIAL AND METHODS

This study was made in 2011, in a cliff ecosystem and its adjacent area from Brebu gorges, Doftana Valley, at 537 m altitude (N: 45°12'31.1”; E: 25°44'23.5”) (Figure 1). Vegetation was represented by species characterized by different ecological requirements (Ciocîrlan, 2009) (Table 1). 23% are pioneer species, 13.3% are xerophilous and 40% are xeromesophilous species (Onete *et al*., 2011).

Table 1
Characteristic vegetation from the investigated ecosystems

Species	**Cliff North**	**Cliff South**	**Adjacent area North**	**Adjacent area South**	**Ecological characteristics**
Achillea millefolium L.				+	M
Asperula rumelica Boiss.	+	+			Xm
Asplenium ruta-muraria L.	+				Xm; Otr
Cnidium silaifolium (Jacq.) Simonk.	+	+			Xm; M
Cornus sanguinea L.			+	+	M; Mh; Mtr
Coronilla varia L.				+	Otr; Mtr; Xm
Cytisus nigricans L.	+	+			Otr; Mtr; Xm; P
Galium mollugo L.		+			Etr; M; Xm
Hedera helix L.		+			M; Mtr
Hippophaë rhamnoides L.	+	+			Otr; X; Mz; P
Melica ciliata L.				+	Otr; X; Xm; T; St
Myosotis arvensis (L.) Hill			+	+	M; Etr
Plantago media L.				+	Xm; M
Rubus caesius L.	+	+	+	+	Etr; Mh; P
Salix purpurea L.			+	+	H; P
Salix silesiaca Willd.			+		Etr; M; H; P
Salvia glutinosa L.	+				Mh
Salvia nemorosa L.			+		X; Xm
Sambucus nigra L.			+		Etr; M; Mh
Sanguisorba minor Scop.			+		Xm; Otr; P
Saxifraga corymbosa Boiss.	+				Xm; T
Sesleria heufleriana Schur	+				Otr; Xm; M
Setaria viridis (L.) Beauv.				+	Xm; M
Stachys officinalis (L.)Trevis.		+			Xm; M
Stachys sylvatica L.					Mh
Thymus pulcherrimus Schur	+	+			Xm; T
Tussilago farfara L.				+	M; Mh; P
Valeriana montana L.	+				Mh

Abbreviations: Etr = eurotrophic; H =hygrophilous; M = mesophilous; Mx = mesoxerophilous; Mtr = mesotrophic; Mh = mesohygrophilous; Otr = oligotrophic; P = Pioneer; St = subthermic; T = thermic; X = xerophilous; Xm = xeromesophilous.

The soils from the cliff ecosystem are classified as clayey till argillaceous on the moderate and strongly inclined peaks, which are seriously affected by erosion; sometimes brown eumesobasic till pseudogleic. In the adjacent area there is a typically alluvial soil (Manu, 2011 a, b).

45 moss samples were collected from the cliff ecosystems, with a square of 20/20 cm, on 2-3 cm deep. In the adjacent area of a cliff ecosystem, 10 soil samples/month were collected with MacFadyen corer (5 cm diameter), on 10 cm deep. The soil samples were taken at the same time from cliff and its adjacent area, in May, July and October, 2011, taking account of its two geographical orientations: north and south. The studied area was by 100 m^2. The distance between the north and south sides is about 75 meters. The extraction was performed with a modified Berlese-Tullgren extractor, in ethyl 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.

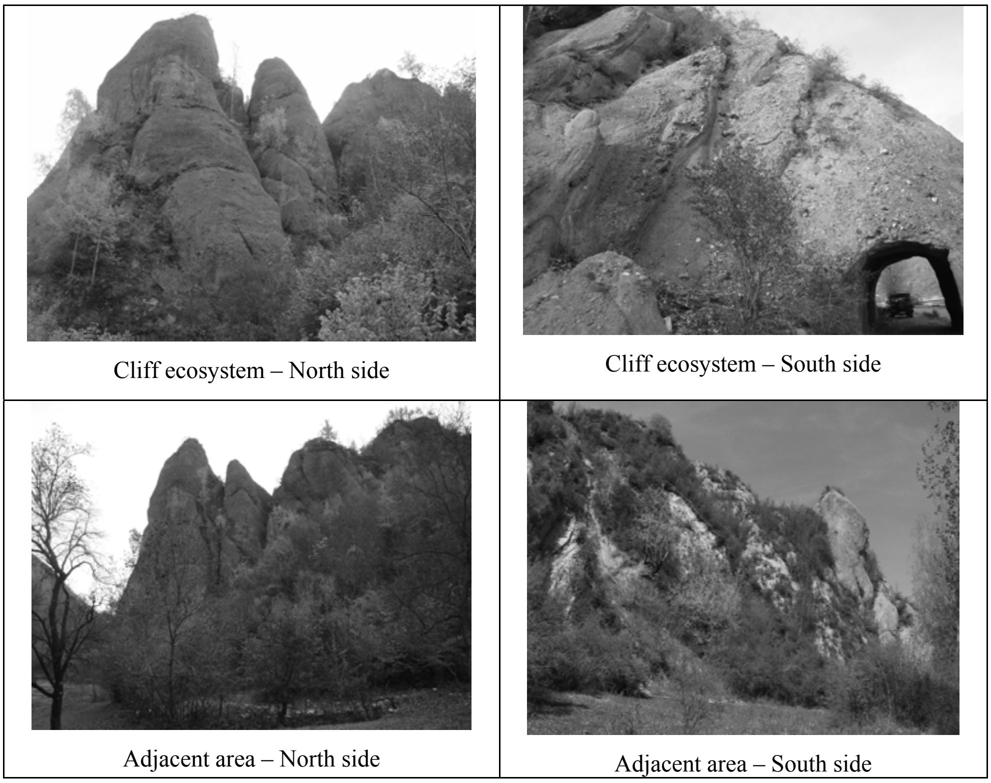

Fig. 1. Investigated ecosystems from Brebu gorges.

In total there were analyzed 75 mite samples, with 33 species (Ghiliarov & Bregetova, 1977; Karg, 1993; Masan, 2003; Masan & Fenda, 2004; Gwiazdowicz, 2007; Masan, 2007; Masan & Halliday, 2010; Masan & Halliday, 2014). The ecological characterization of species was described after the researchers mentioned above, including Koehler (1997) and Salmane & Brumelis (2010).

In order to establish de similarities (Jaccard index – q) between investigated population of mites from the two ecosystems the PAST software was used (Hammer *et al*., 2001).

RESULTS AND DISCUSSION

Analyzing the taxonomical structure of the mite populations, 33 species were identified, belonging to the 17 genera and 10 families (Epicriidae, Parasitidae, Veigaidae, Ascidae, Rhodacaridae, Macrochelidae, Pachylaelaptidae, Laelaptidae, Eviphididae and Zerconidae). The families Parasitidae (15.15%), Laelapidae (24.24%) and Zerconidae (28.78%) are dominant, being represented by the most increased number of species, in comparison with Rhodacaridae, Ascidae, Pachylaeleapidae and Eviphididae, which include 3.03% by the total number of species (Table 2).

If we make a comparative taxonomical analysis of the investigated area, we observed that the north sides of the cliff and adjacent area are represented by the same number of families, species and by the closed values of the genera. On the opposite, on the south sides of the investigated ecosystems there was recorded the most decreased number of taxons (Table 3).

If we analyze the number of species, the north side of the studied ecosystems recorded the highest values, in comparison with the south side. These differences are possible due to the decreased humidity and higher temperature of the southern habitats of the rocky area. Researchers revealed that cliff ecosystems have specifical microclimate, characterized by increased temperatures, presence of the wind, absence of direct precipitations, constant battles with the force of gravity; vegetation, which has not space for roots; lack of soil cover and the presence of carbonate-based rocks (Maser *et al*., 1979; Larson *et al*., 2000).

The number of identified species is comparable with those obtained in other types of ecosystems from the Doftana Valley, such as: *Luzulo-Fagetum* beech forest (13 species); Medio-European limestone beech forest of the *Cephalanthero-Fagion* (15 species); Pannonic woods with *Quercus petraea* and *Carpinus betulus* (22 species); galio-carpinetum oak – hornbeam forests (17 species); alpine rivers and their ligneous vegetation with *Myricaria germanica* (14 species); alluvial shrub, characteristic for a hilly-mountain area, with *Salix purpurea* (14 species). These similarities are possible due to the specifical environmental conditions from Doftana Valley, especially to the type of soil from these ecosystems (mainly alluvial, argillaceous and with sandy-clay texture) (Manu *et al*., 2013).

On the other hand, if we take into discussion the number of mite species from other types of ecosystems from temperate region, the obtained values are similar with other natural ecosystems from Europe, such as: forest with *Populetum albae* (26 species), *Salicetum albo fragilis* (36), *Fraxino-Alnetum* (33), but much lower with other types of forests: spruce (22-29 species), beech (41-56 species), oak forest (54-64 species), oak-hornbeam (58-76 species) (Fenda & Cicekova, 2005; Moranza, 2007; Peverieri *et al*., 2008; Skorupski *et al*., 2009; Kaczmarek *et al*., 2012).

Table 2
Comparative taxonomic analysis of the investigated mite families from a cliff ecosystem and its adjacent area from the Brebu gorges

Family	**Number of species**			
	Cliff-North	Cliff-South	Adjacent area-North	Adjacent area-South
Epicriidae	1		1	
Parasitidae	5		5	
Veigaiidae	2	1	2	1
Rhodacaridae	1		1	
Ascidae		1		1
Macrochelidae	3		2	
Laelapidae	3	4	4	5
Pachylaelapidae	1		1	
Eviphididae		1		1
Zerconidae	8	1	8	2

Table 3
Comparative taxonomic analysis of the investigated mite fauna from a cliff ecosystem and its adjacent area from the Brebu gorges

Taxa	**Cliff-North**	**Cliff-South**	**Adjacent area-North**	**Adjacent area-South**
Family	8	6	8	7
Genus	14	7	13	9
Species	24	9	24	12

From all identified species, *Rhodacarellus silesiacus, Arctoseius cetratus* and *Prozercon sellnicki* are signaled as pioneer species (that represent 9.02 % from all identified species) (Table 4). It is possible that specific environmental conditions for a cliff ecosystems (the lack of organic matter, the poor vegetation layer, increase temperature and decreased humidity of the substrate) to be similar with those from the ecosystems found in an early succession stage. This phenomenon is highlighted by the presence of the pioneer plants, which represent 23% of the dominant species (Table 1).

Zercon foveolatus is mentioned as semi-xerotolerant. According to Masan & Fenda (2004) it inhabits primarily warm and dry stands in wolds, foot-hills, and low highlands at altitude between 200-900 m, with an optimum up to 550 m. It was found in thermophilous deciduous forests with oak, but it was also quite numerous in forest steppes stands, beech forest, hornbeam forests (*Carpinion betuli*) with elm. It was also found in spruce forests with beech and in spruce monocultures at alt. 670-890 m. Another zerconids species are known that resist to the various climatic conditions from temperate area, from 400 m to 2200 m altitude, as *Zercon pelatus peltadoides*, *Zercon berlesei*, which are psychrophilous and *Zercon sellnicki*, characterized as psychrotolerant (Table 4).

The majority of the identified species (36.36%) from the cliff and its adjacent area have a wide ecological plasticity. In general they were found in various ecosystems (deciduous and coniferous forests, grasslands, moorlands, urban ecosystems, agroecosystem) and in diverse microhabitats (soil, litter, moss, humus, lichens, rotting wood, under bark, decaying vegetation; in general where habitats are rich in organic matter) (Masan, 2003; Masan & Fenda, 2004; Gwiazdowicz, 2007; Masan, 2007; Masan & Halliday, 2010, 2014; Salmane & Brumelis, 2010).

This characteristic is essential for the mesostigmatids species to survive in such unfavorable environmental conditions, as those from a cliff ecosystem.

Table 4

Soil mite species (Acari: Mesostigmata-Gamasina) from cliff ecosystem and its adjacent area (N-North; S-South) – Doftana Valley, Romania

Species	**Cliff ecosystem**		**Adjacent area**		**Ecological characteristics**
	N	**S**	**N**	**S**	
Family Epicriidae					
Epicrius mollis (Kramer 1976)	+		+		
Family Parasitidae					
Lysigamasus lapponicus (Tragardh, 1910)	+		+		
Lysigamasus neoruncatellus Schweizer, 1961	+		+		
Leptogamasus sp.	+		+		
Pergamasus longicornis (Berlese, 1906)	+		+		
Holoparasitus calcaratus (Koch, 1839)	+		+		
Family Veigaiidae					
Veigaia exigua (Berlese, 1916)			+		
Veigaia nemorensis (Koch, 1839)	+				Wep
Veigaia planicola (Berlese, 1892)	+	+	+		
Veigaia propinqua Willmann, 1936				+	
Family Rhodacaridae					
Rhodacarellus silesiacus Willmann, 1935	+		+		P
Family Ascidae					
Arctoseius cetratus (Sellnick, 1940)		+		+	P
Family Macrochelidae					
Macrocheles montanus Willmann, 1951		+		+	Wep
Macrocheles recki Bregetova & Koroleva, 1960	+				Xt
Geholaspis longispinosus (Kramer, 1876)	+		+		Wep
Geholaspis mandibularis (Berlese, 1904)	+		+		Wep
Family Laelapidae					
Hypospis aculeifer Canestrini, 1883	+	+	+	+	Wep
Hypospis brevipilis (Hirschmann, 1969)		+		+	
Hypospis claviger (Berlese, 1883)	+	+	+	+	
Olopachys suecicus Sellnick, 1950	+	+	+	+	Wep, Et, Eh
Olopachys vysotskajae Koroleva, 1976			+	+	
Family Pachylaelapidae					
Pachydellus furcifer Oudemans, 1902	+		+		Wep
Pachylaelaps pectinifer (G. & R. Canestrini, 1881)				+	H
Family Eviphididae					
Eviphis ostrinus (Koch, 1836)		+		+	Wep
Family Zerconiidae					
Zercon berlesei Sellnick, 1958	+				Wep, Xt, T, Pp
Zercon fageticola Halaskova, 1969	+		+		S
Zercon foveolatus Halaskova, 1969			+		T, Sx
Zercon peltatus peltadoides Halaskova, 1970	+		+	+	Pp
Prozercon carsticus Halaskova, 1963	+		+		Wep
Prozercon fimbriatus (Koch, 1839)	+		+		S
Prozercon sellnicki Halaskova, 1963	+		+		Wep; Pt
Prozercon similis Balan, 1992	+		+		S
Prozercon traegardhi (Halbert, 1923)	+	+	+	+	Wep.; Xt

Abbreviations: E = eurytopic; Eh = euryhygrophilous; H = hygrophilous; P = pioneer species; Pp = psychrophilous; Pt = psychrotolerant; S = silvicolous; Sx= semi-xerotolerant; Xt= xerothermophilous; T= thermophilous; Wep = wide ecological plasticity.

Taking into account the presence/absence of data of the mite populations, similarities (Jaccard index) between the investigated populations from the studied ecosystems were established (Figure 2). The dendrogram revealed that the mesostigmatids were divided into two groups: mites from the north side of the studied areas (q = 0.78) and those from the south side of the two ecosystems (q = 0.62).

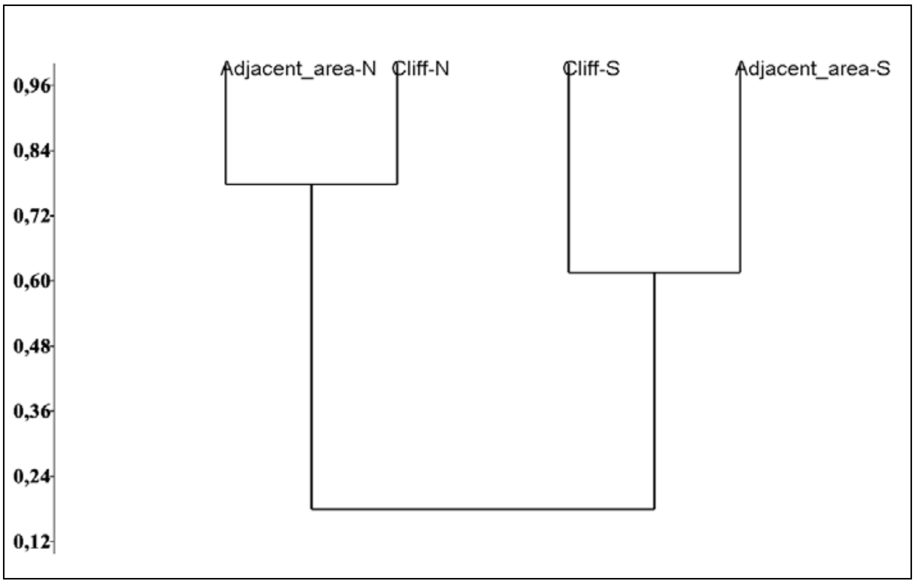

Fig. 2. Jaccard similarity dendrogram between mite species from a cliff ecosystem and its adjacent area (N-North; S-South) – Doftana Valley, Romania.

Geographical position of the investigated ecosystems determine specifical environment conditions. On the north sides, even if we take into consideration two different ecosystems (cliff and its adjacent area) it is possible that the humidity is much increased. This phenomenon could provide a proper habitat for soil mites (more developed moss layer, more accelerated decomposing process of the litter layer).

CONCLUSIONS

Mesostigmata communities have recorded a specifical taxonomical structure for the investigated ecosystems. The taxonomical structure was represented by 33 species belonging to the 17 genera and 10 families. The dominant species were included in Parasitidae, Zerconidae and Laelapidae families.

Taking account of the two geographical positions of the investigated ecosystems, on the north sides there was recorded the highest species diversity, in comparison with the south sides. The dominant species were zerconids, which had a wide ecological plasticity. On the other hand, the presence of pioneer species, plants and mites as well, indicates that the cliff and its adjacent area are not mature ecosystems, the biological process being in continuous transformation.

The similarity index divided the mite populations into two groups: mesostigmatids from the north side of the investigated ecosystems and those from the south sides.

Acknowledgements. This study was carried out in the framework of RO1567-IBB01/2014 project. We thank Simona Plumb and Rodica Iosif for their assistance in the lab and in the field. The author 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.

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Received November 28, 2014

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