COMPARATIVE ECOLOGICAL CHARACTERIZATION OF THE SOIL MITE POPULATIONS (ACARI: MESOSTIGMATA) FROM SOME ANTHROPOGENIC ECOSYSTEMS, ROMANIA

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Abstract. The paper presents the taxonomical structure and diversity of soil mite populations (Acari: Mesostigmata) from some anthropogenic ecosystems: arable fields from Insula Mare a Brăilei; urban parks from Bucharest and spoil dump areas from Retezat Mountains. Forty three species were identified, with 197 individuals. Each investigated anthropogenic ecosystem was characterized by the specific acarological structure. The Shanon index of diversity demonstrated that the urban ecosystems were the most favourable habitats for these arthropods (invertebrates), in opposition with arable fields. The dominant species for the studied ecosystems were *Hypoaspis aculeifer* (Canestrini 1884) and *Asca bicornis* (Canestrini & Fanzago 1887). The dominance and equitability index revealed that the ecosystem with a lower diversity was characterized by a few species with a highest number of individuals (arable field with *Zea mays* L.). In urban parks and spoil dump areas, these indexes showed us that the numerical abundances of the identified species had an equitable distribution. The Bray-Curtis similarity index between soil mite populations revealed the affinity between invertebrates from the three categories from the anthropogenic ecosystems.

Keywords: agroecosystems, diversity, indexes, dominance, dump, mites, urban.

Rezumat. Caracterizarea ecologică comparativă a populațiilor de acarieni edafici (Acari: Mesostigmata) din câteva ecosisteme antropice, România. Lucrarea prezintă structura taxonomică şi diversitatea faunei de acarieni edafici (Acari-Mesostigmata) din câteva ecosisteme antropice: culturi agricole din Insula Mare a Brăilei, parcuri urbane din Bucureşti şi halde de steril din munţii Retezat. Au fost identificate 43 de specii, cu 197 indivizi. Fiecare ecosistem antropic investigat a fost caracterizat de o structură acarologică specifică. Indicele de diversitate Shannon a demonstrat faptul că ecosistemele urbane au oferit cele mai bune condiţii de dezvoltare pentru aceste nevertebrate, în opoziție cu agroecosistemele. Speciile de acarieni dominante pentru ecosistemele studiate au fost *Hypoaspis aculeifer* (Canestrini 1884) şi *Asca bicornis* (Canestrini & Fanzago 1887). Indicele de dominanţă şi de echitabilitate au evidenţiat că ecosistemele agricole sunt caracterizate de câteva specii dominante din punct de vedere numeric (în special terenul arabil cu porumb, *Zea mays* L.). În parcurile urbane şi haldele de steril, indivizii de acarieni au fost distribuiţi în mod echitabil. Indicele de similaritate Bray-Curtis a indicat o afinitate semnificativă între populațiile de acarieni din cele trei categorii de ecosisteme antropice studiate.

Cuvinte cheie: agroecosistem, diversitate, indici ecologici, dominanţa, haldă, acarian, urban.

INTRODUCTION

It is known that soil mites - Mesostigmata were used as bioindicators, due to their low tolerance to changes in soil environment, being relatively easy to collect undamaged, reaching high densities in soil and recording high trophic and taxonomic diversity. Their presence or absence in the soil horizons may be a good base for describing changes of environmental conditions and ecosystem perturbations (GULVIK, 2007; KOEHLER & MELECIS, 2010; SKORUPSKI et al., 2013). SKORUPSKI et al., (2013), declared that “even common species may be used to evaluate the effects of human influence on the environment, not only at the species level but also the zoocoenosis level”.

In Europe, studies concerning the structure and dynamics of Mesostigmata mites were intensively made in different anthropogenic ecosystems (arable fields, urban, industrial and post-industrial habitats) from Germany, Poland, Austria, Latvia, Ireland, Norway, Spain and Greece (NIEDBALA, 1982; 1990; RUF & BECK, 2005; SALMANE & BRUMELIS, 2010; KOEHLER & MELECIS, 2010; BADIERITAKIS et al., 2012; PÉREZ-BOTE & ROMERO, 2012; WISSUWA et al., 2012; ARROYO et al., 2013; SKORUPSKI et al., 2013; COULSON et al., 2015; TELNOV & SALMANE, 2015; MANU et al., 2015).

In Romania, the soil fauna (including the soil mites) from anthropogenic ecosystems was investigated and the results were published in few scientific papers (FIERA, 2009; VASILIU-OROMULU et al., 2009; MANU & HONCIUC, 2010; HONCIUC & MANU, 2010; MANU, 2010; FIERA et al., 2013). However, a comparative study is required, in order to highlight the importance on an extensive research program on national level, being significantly to demonstrate that soil fauna constitutes a valuable tool to characterize the anthropogenic impact on natural ecosystems, even if it will be investigated a microscopic edaphic group, as mites.

MATERIAL AND METHODS

The research was made in period 2005-2007, in three types of anthropogenic ecosystems from Romania: agroecosystems from Insula Mare a Brăilei – *Triticum aestivum* L. (TA); *Glycine max* L. (GM); *Zea mays* L. (ZM), urban parks from Bucharest city – Cişmigiu (CS); Unirea (UN); Izvor (IZ) and spoil dump areas from Retezat Mountains – Bârlii (BR); Râuşor (RS); Ciurila (CR). The geographical description of the investigated ecosystems is presented in Table 1 and Fig. 1.

Taking into account the vegetation, the agroecosystems were monocultures with *Triticum aestivum*, *Glycine max* and *Zea mays*. The urban parks are characterized by the presence of 42 species of trees, 23 species of shrubs, 9 species of lichens and 78 vascular plants. Common species for all urban parks were: *Aesculus hippocastanum* L., *Quercus rubra* L., *Parmelia saxatilis* L., *Geranium pusillum* L. and *Agrostis stolonifera* L. The natural vegetation had mainly disappeared, being replaced by planted species (especially trees brought from Europe, China, Japan, America, etc.) (MANU & HONCIUC, 2010).

Table 1. Characterization of the investigated anthropogenic ecosystems.

Ecosystems	Code	GIS coordinates	Altitude	Soil
Agroecosystems	TA	44°49’33.09” N 27°59’35.34” E	1. 5 m.	Alluvial
	GM	44°49’26.35” N 27°59’29.54” E	2 m.	Alluvial
	ZM	44°49’01.43” N 27°59’31.59” E	1. 75 m	Alluvial
Urban parks	CS	44°25’56.6” N 26°05’27.5” E	77 m.	Sandy
	UN	44°25.5’56.6”N 26°08’09.9” E	77 m.	Sandy
	IZ	44°25’56.4” N 26°05’27.8” E	78 m.	Sandy
Spoil dump areas	BR	45°23’29.13” N 22°47’58.87” E	1,090 m.	Partially covered with acidophilous rendzinic soil
	RS	45°25’13.57” N 22°50’48.80” E	1,100 m.	Partially covered with acidophilous rendzinic soil
	CR	45°25’11.06” N 22°51’33.62” E	1,155 m.	Stable acidophilous rendzinic soil stratum

In spoil dump areas, the vegetation is characterized by woody species (*Betula pendula* Roth.; *Picea abies* (L.) H. Karst.; *Rubus idaeus* L.), hemicryptophyte species, ruderals and grassy species. In Bârlii dump area (BR), there were identified ombrophilous species, as: *Myosotis sylvatica* Ehrh. ex. Hoffm.; *Chrysosplenium alternifollium* L., *Impatiens noli-tangere* L., *Laserpitium archangelica* Wulfen ex Jacq. Râuşor (RS) spoil dump area is defined by herbaceous species, characteristic for the forest cuttings, the wet weeds and for the meadows. In Ciurila dump area (CR), there were observed species with high biomass: *Deschampsia caespitosa* (L.) P.Beauv.; *Dryopteris filix-mas* (L.) Schott; *Petasites albus* (L.) Gaertn. and *Tussilago farfara* L. (MANU, 2010).

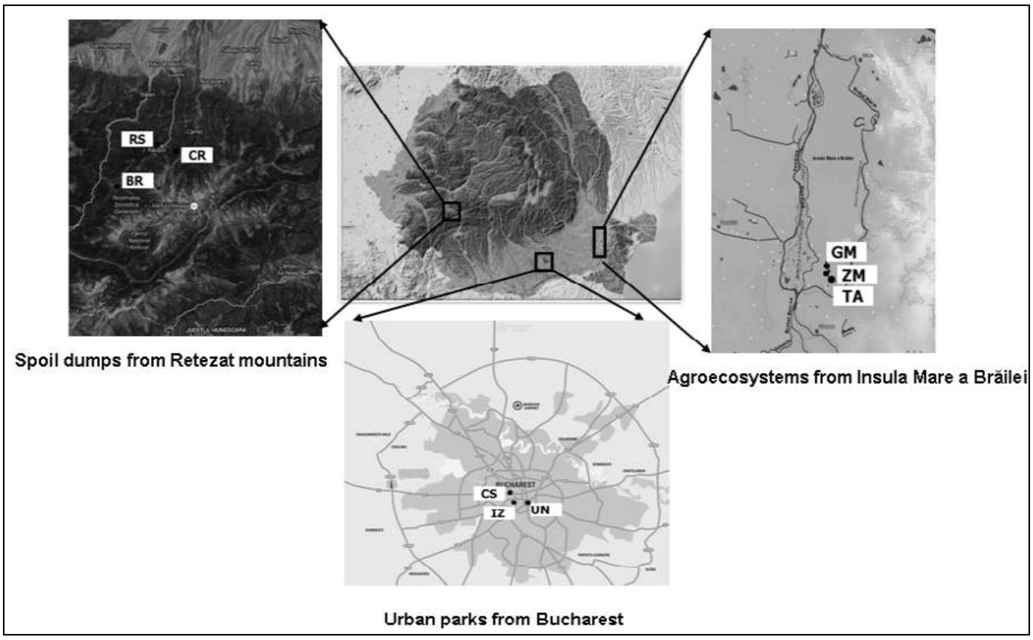

Figure 1. The geographical position of the anthropogenic investigated ecosystems from Romania (www.google earth.com).

The soil samplings were collected randomly, with MacFadyen soil core, by 5 cm diameter. The sampling was made till 10 cm depth. The extraction of the mites was made in 10-14 days by the Berlese-Tullgren method, modified by BALOGH (1972). The samples were kept in a refrigerator till the next extraction. In total, 270 samples (5 samples, 3 times/year, 2 years, 9 ecosystems), 43 species with 197 individuals were analysed. Data were collected during the vegetation period – June, August and September, for two years. Counting and identification of the mites were made under a Zeiss binocular and microscope, using the systematic keys (GHILIAROV & BREGETOVA, 1977; KARG,

1993; MAŠAN, 2003, 2007; MAŠAN & FENĎA, 2004; MAŠAN et al., 2008; MAŠAN & HALLIDAY, 2010). Preservation of the soil mites was made in an alcohol and glycerine mixture. All identified specimens are deposited in the mite collection of the Institute of Biology – Ecological Stationary from Posada.

Mite diversity (Shannon index), dominance (D), and equitability (J) were calculated using the PAST software (HAMMER et al., 2001). The similarity of mite presence was assessed using Bray-Curtis dendrogram.

RESULTS AND DISCUSSIONS

In all investigated ecosystems, 43 Mesostigmata mites were identified, with 197 individuals. The highest number of species was identified in urban ecosystems (25 species), in comparison with agroecosystems (11 species) and spoil dump habitats (16 species). The same situation was recorded for numerical abundance and Shannon diversity index. The highest values were recorded in the investigated urban parks, in comparison with the other two types of ecosystems (Table 1). It is possible that the irrigation from urban parks in summer and the highest cover of soil with vegetation (even if we identified sandy soil, which is not so reach in organic matter) constituted proper environmental factors for Mesostigmata mites (Fig. 2). On the other hand, in urban habitats the import of different types of allochthonous soil could influence the structure of mite communities. In the spoil dump areas, the coverage with vegetation does not exceed 15% and the soil layer with organic matter is missing or very thin (Figs. 2a-i).

a. *Triticum aestivum* (TA) agroecosystem b. *Glycine max* (GM) agroecosystem c. *Zea mays* (ZM) agroecosystem

d. Cişmigiu (CS) urban park e. Unirea (UN) urban park f. Izvor (IZ) urban park

g. Bârlii (BR) spoil dump area h. Râuşor (RS) spoil dump area i. Ciurila (CR) spoil dump area

Figures 2(a-i). Investigated anthropogenic ecosystems (original).

If we refer to these results as preliminary ones for Romania, they are comparable with those obtained in different countries from Europe for the three types of ecosystems (Table 3). It is one exception: in Poland, intensive studies from industrial and post-industrial sites revealed the presence of 80 Mesostigmata species (SKORUPSKI et al., 2013). Seventy-five percent of the identified species from Romanian spoil dump ecosystems are similar to those described by the Polish researchers.

The dominant species were: *Hypoaspis aculeifer* (Canestrini 1883) and *Rhodacarellus kreuzi* Karg 1965 for agroecosystems; *Ameroseius fimentorum* Karg 1971, *Asca bicornis* (Canestrini & Fanzago 1887), *Hypoaspis aculeifer* (Canestrini 1883), *Rhodacarellus perspicuous* Halaskova 1959 and *Pseudolaelaps doderoi* (Berlese 1910) for urban parks; *Pachyseius humeralis* Berlese 1910, *Asca bicornis* (Canestrini & Fanzago 1887), *Hypoaspis aculeifer* (Canestrini 1883) for spoil dump areas (Table 2). It is obvious that the most abundant species for the investigated ecosystems were the last two mentioned species. *Asca bicornis* was reported in moss, rotting wood, in industrially polluted areas and derelict industrial land, being characterized as an indicator species for the first stage of ecological succession (GWIAZDOWICZ, 2007).

Table 2. The soil mites (Acari: Mesostigmata) from the investigated anthropogenic ecosystems.

Species	**Agroecosystems**			**Urban parks**			**Spoil dump areas**		
	TA	**GM**	**ZM**	**CS**	**UN**	**IZ**	**BR**	**RS**	**CR**
1. *Alliphis siculus* (Oudemans 1905)					1				
2. *Alloparasitus oblonga* (Halbert 1915).									1
3. *Amblyseius meridionalis* Berlese 1914					1	2			
4. *Amblyseius obtusus* (C. L. Koch 1839)					2	3			
5. *Ameroseius fimentorum* Karg 1971				1	3	5			
6. *Ameroseius plumigerus* (Oudemans 1930)									1
7. *Arctoseius cetratus* (Sellnick 1940)								1	1
8. *Asca bicornis* (Canestrini & Fanzago 1887)					11	6			
9. *Cheiroseius borealis* (Berlese 1904)							1	2	3
10. *Crassicheles concentricus* (Oudemans 1904)					2				
11. *Dendrolaelaps* sp.					1				
12. *Geholaspis longispinosus* (Kramer 1876)			5						
13. *Hypoaspis aculeifer* (Canestrini 1883)	7	4		2	3	6	4	1	1
14. *Hypoaspis praesternalis* Willmann 1949					3				
15. *Leioseius magnanalis* (Evans 1958)								1	1
16. *Leptogamasus* sp.				1					
17. *Lysigamasus neoruncatellus* Schweizer 1961					1				
18. *Lysigamasus truncus* Schweizer 1961				1					
19. *Macrocheles decoloratus* (C. L. Koch 1839)							1	3	
20. *Macrocheles glaber* (Muller 1860)								5	
21. *Macrocheles montanus* Willmann 1951								5	
22. *Macrocheles* sp.				1					
23. *Olopachys vysotskajae* Koroleva 1976			3		1				
24. *Pachydellus furcifer* Oudemans 1904		3		1		1			
25. *Pachyseius humeralis* Berlese 1910				4			1		8
26. *Parasitus beta* Oudemans & Voigts 1904				2		1			
27. *Parasitus loricatus* (Wankel 1861)							2		
28. *Pergamasus barbarus* Berlese 1904		2						1	
29. *Pergamasus quisquiliarum* (Canestrini 1882)	5								
30. *Pergamasus* sp.	2					1			
31. *Prozercon fimbriatus* (C. L. Koch 1839)						1			
32. *Prozercon kochi* Sellnick 1943							1		
33. *Pseudolaelaps doderoi* (Berlese 1910)					9	2			
34. *Rhodacarellus kreuzi* Karg 1965		6							
35. *Rhodacarellus perspicuus* Halascova 1959				9		3			
36. *Rhodacarellus silesiacus* Willmann 1936				4	1	2			1
37. *Rhodacarus denticulatus* Berlese 1921					1				
38. *Veigaia exigua* (Berlese 1917)						1			

39. *Veigaia nemorensis* (C. L. Koch 1939)				2		1		2	
40. *Vulgarogamasus kraepelini* (Berlese 1905)							1		
41. *Vulgarogamasus oudemansi* (Berlese 1903)	2								
42. *Zercon peltatus* C. L. Koch 1836		1							
43. *Zercon romagniolus* Sellnick 1944	5								
Total no. of species	5	5	2	11	14	14	7	9	8
	11			**25**			**16**		
Total no. of individuals	21	16	8	28	40	35	11	21	17
	45			**103**			**49**		
Shannon (H)	1.49	1.46	0.66	2.08	2.22	2.40	1.77	1.99	1.66
	2.20			**2.75**			**2.49**		
Dominance (D)	0.24	0.25	0.53	0.16	0.15	0.10	0.20	0.16	0.27
	0.13			**0.08**			**0.10**		
Equitability (J)	0.93	0.90	0.95	0.87	0.84	0.91	0.91	0.90	0.79
	0.92			**0.86**			**0.90**		

The dominance and equitability index revealed that the ecosystems with a lower diversity were characterized by a few species with the highest number of individuals. This phenomenon was observed in agroecosystems, especially in *Zea mays* field, where there were identified only two species with 8 individuals (Table 2).

Table 3. The number of Mesostigmata species recorded in anthropogenic ecosystems from Europe.

Type of ecosystem	**Country**	**No. of species**	**Reference**
Arable field	Ireland	13	ARROYO et al., 2013.
	Germany	6-23	KARG & FREIER, 1995. KOEHLER, 1999; 2000. RUF & BECK, 2005. VAN CAPELLE et al., 2012.
	Greece	1-14	BADIERITAKIS et al., 2012.
	Austria	22-36	WISSUWA et al., 2012.
	Netherlands	4-20	POSTMA-BLAAUW et al., 2012
	Latvia	28-104	SALMANE, 2001. SALMANE & BRUMELIS, 2010.
Spoil dump area	Poland	28-32 6-19 80	MADEJ & SKUBALA, 2002 MADEJ & KOZUB, 2014. SKORUPSKI et al., 2013
	Norway-Svalbard	9	COULSON et al., 2015.
	Germany	4-33	CHRISTIAN, 1995; 2002. WANNER & DUNGER, 2002 KOEHLER & MELECIS, 2010.
Urban area	Poland	1-32	NIEDBALA, 1982; 1990.
	Latvia	25	TELNOV & SALMANE, 2015.
	Germany	37	HELDT, 1995.

Analyzing the Bray-Curtis similarity between mesostigmatids, we observed that the mite populations were divided in three main clusters: spoil dump areas, with higher similarity index recorded between communities from RS and CR ($q_{CR-RS} = 0.31$) and between RS and BR ($q_{RS-BR} = 0.23$); urban parks ($q_{IZ-UN} = 0.33$ and $q_{IZ-CS} = 0.39$) and arable fields, with the highest Bray-Curtis index between TA and GM ($q_{TA-GM} = 0.11$) (Fig. 3). On the opposite, the highest differences were obtained between populations from urban parks and agroecosystems on one hand and between spoil dump area and urban ecosystems, on the other hand, where the index of similarity recorded values lower than q = 0.55 (Fig. 3).

We suppose that these differences between soil mite populations from the three types of the studied ecosystems were due to the specific environment conditions, type of vegetation and geographical position, taking into account that in the present study there were analysed ecosystems from mountain and plain areas.

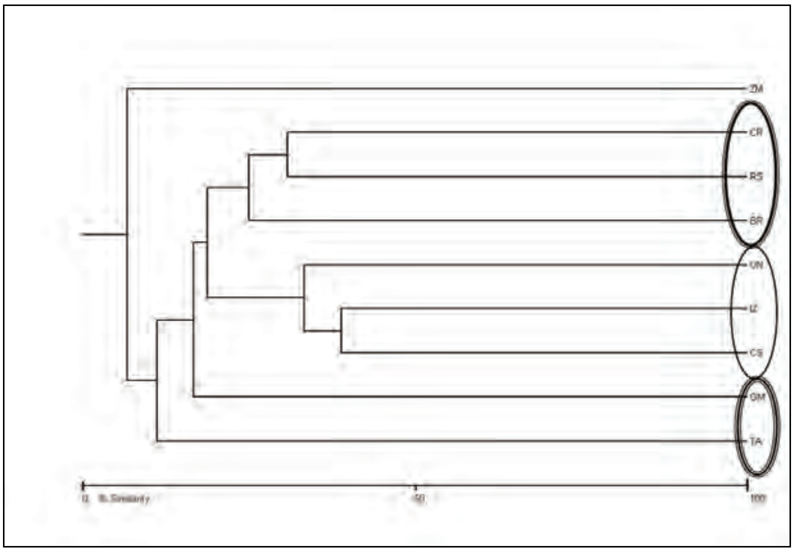

Figure 3. The similarity dendrogram (Bray-Curtis index) of the mite populations from the investigated anthropogenic ecosystems.

CONCLUSIONS

Taxonomical structure of the mite communities from anthropogenic ecosystems (arable fields, urban parks and spoil dump areas) led to the identification of 43 species, with 197 individuals. Each type of anthropogenic ecosystem was defined by a characteristic structure of the mite populations. Ecosystems with a lower diversity were characterized by a few species with the highest number of individuals. The highest species diversity was recorded in urban areas. On the opposite, there were agroecosystems, where the lowest species diversity was recorded. The dominant species in all studied ecosystems was *Hypoaspis aculeifer*. The species *Asca bicornis* was signalled in spoil dump areas and urban ecosystems. The similarities between the soil mite populations from the investigated areas revealed an affinity between invertebrates from the same type of anthropogenic ecosystems.

The present data could be considered as preliminary ones. Extensive studies concerning the soil fauna (especially mites) in correlation with environment variables, from anthropogenic ecosystems, must be developed in Romania, in order to obtain a richer database, which has to be used as an important tool for ecosystem characterization depending on the type of land use.

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