MESOSTIGMATID MITES AS A PIECE OF THE BIOINDICATORS PUZZLE

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Abstract

Mites belonging to the order Mesostigmata have different types of life, those which populate soil habitats and litter being generally free living predators. Predatory mites play a leading role in biological control, but they are considered useful in bioindication, also. This study explored in a comparative way the edaphic gamasid communities from a series of forest ecosystems, meadows and agroecosystems in order to evaluate the impact of natural and anthropic factors and to highlight the bioindicator value of these mites. Both a quantitative and a qualitative analysis were performed. The degree of anthropization could be evidenced at the level of all analyzed ecosystems. A reduction of the number of species and individuals in the ecosystems marked by human interventions was observed. Generally, the phenomenon was more pronounced in forest ecosystems than in the praticolous ones. From the point of view of the ecological peculiarities of the species, a differentiation was noticed that in natural forests the silvicolous species are dominating while in plantations, meadows and agroecosystems the praticolous ones are the majority. In the case of natural forests the best represented family is *Zerconidae* with 2 genera and 8 species. In the rest of the studied ecosystems on the first place is *Hypoaspididae* with 1, 2 or 3 genera and 5 species or even more.

Key words: Acari, Mesostigmata, ecosystems, bioindication

Paradoxically, with the progress of civilization, the effects of human activity on ecosystems became increasingly dangerous nowadays, if we consider soil degradation, the loss of biodiversity, climate change etc. As these effects emerged, there was a constant concern to monitorize them, first only instrumentally, then with the help of indicators "provided" by nature itself, i.e., bioindicators. Bioindicators are species, populations or sets of species that, due to their variability (biochemical, physiological, ethological or ecological), allow the characterization of the state of an ecosystem and highlight, as soon as possible, its natural or anthropogenic changes (Măciucă A., 2003). Thus, during the time, finding and using the correct bioindicators have become a major concern for scientists.

Since the second half of the twentieth century, researchers have sought to find new bioindicators and methods to obtain information about air, soil or water pollution. With the observation of several types of ecosystem degradation, the identification of bioindicators was sought in order to provide information related to the maintenance of biodiversity, the stability of ecosystems and their sustainable management. Soils are a major reservoir of biodiversity and are also subjected to many threats, so it is urgent to preserve them. Among the soil mesofauna, mites are very diverse, taxonomically and ecologically being frequently used as bioindicators, especially in Europe (Breure A. M. *et al*, 2005 after Meehan M. L. *et al*, 2019). The two mite taxa that are used most frequently as soil bioindicators are *Mesostigmata* and especially *Oribatida*. Mesostigmatid mites are not as numerous as oribatids, but are universally present in soils occupying a variety of niches and may be important predators. Some researchers considered that the response of predators to environmental influences in soil ecosystems is more accurate over shorter periods of time than of other soil arthropods (Karg W., Freier B. 1995; Koehler H. H., 1999). As Mesostigmata includes the main predators among the soil mesofauna, by shaping communities of decomposers they are important regulators of decomposition processes and occupy a high trophic level in the soil decomposition food web (Schneider K., Maraun M., 2009). Furthermore, they are highly susceptible to anthropogenic and natural disturbances and perturbations, which makes them good indicators of ecosystem processes (Gulvik M. E., 2007). This study is a briefly, synthetic part of a wider investigation dedicated to the edaphic mesofauna on the whole, in order to evaluate the functional

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state and the intensity of human pressure, exerted on various types of ecosystems (forests, meadows, agroecosystems) from Central Moldavian Plateau.

MATERIAL AND METHOD

The paper summarized the results of researches focused on mesostigatid mites fauna from the main types of ecosystems located in Central Moldavian Plateau. Thus, this sinthesis is focused on representative stands from 9 forest ecosystems (natural forests and plantations), 6 meadows (natural and anthropized), 4 crops (perennial alfalfa and annual: wheat, sunflower, maize) and one uncultivated field. From all these, two oak forests and two meadows are included in Natura 2000 network (Special Areas of Conservation/SCI)http://cbde.ro/localization/?lang=en).

The working methodology and the location of the investigated areas was described in the articles previously published (Călugăr A., Ivan O., 2013; Ivan O., Călugăr A., 2013)

RESULTS AND DISCUSSIONS

The faunistic material sampled from the forest ecosystems (9 stands) totalized a number of 45 species, 22 genera and 12 families. A comparison between forests and plantations indicated for forests a number of species which are 1.6 times higher and densities of almost 2 times higher. The specific spectrum of *Mesostigmata* from the two categories of ecosystems, it turned out to be quite different, only 17% of the species being common elements. From these, about half are characterized by a high ecological plasticity. A percentage of 55% are specific to natural forests, while 28% are specific to plantations. The largest number of species, but also of individuals was identified in an oak forest with hornbeam and linden tree. This forest is located at the southern limit of the continental biogeographical region, at the contact with the steppe region, constituting a barrier against the steppe advancing. The lowest number of species and individuals were observed in the case of an oak forest with hornbeam, with a small area, under a certain anthropogenic pressure, being in the neighborhood of human settlements and agricultural lands. Comparative analysis of the community structure of edaphic gamasids from the considered forests showed that only 14% of the species are common: *Arctoseius sp., Pergamasus cf. primorellus, Prozercon plumosus, Veigaia nemorensis, Zercon similifoveolatus*. Of these, *P. plumosus* and *Z. similifoveolatus* are silvicolous and *V. nemorensis* is an euribiont element.

Referring to the plantations, in that of acacia and black pine, the most numerous and diversified fauna was found, at the opposite pole being a willow plantation. Structural parameters of edaphic mites communities are closely related to the age and type of plantation; in mixed plantations with age over ten years, edaphic mites fauna is more diverse and more abundant than in very young plantations (Călugăr A., Ivan O., 2013).

Another aspect discussed is about the families with a higher number of taxa. In the case of natural forest ecosystems, the richest in species proved to be *Zerconidae* and *Ascidae* but in plantations *Hypoaspididae* is the best represented qualitatively (*table 1*). Some authors considered that sustainable and stable ecosystems, euedaphic (*Rhodacaridae*), hemiedaphic and epigaeic species (*Macrochelidae*, *Parasitidae* and *Veigaiidae*) must be present (Koehler H. H., 1999 *after* Gulvik M.E, 2007). The results of this study have shown that only *Parasitidae* and *Veigaiidae* are present in all natural forests; *Macrochelidae* is represented by one species and only in one oak forest (*Quercus robur*, *Q. pedunculiflora* and *Carpinus betulus* in composition) and *Rhodacaridae* is represented by two genera and two species in the *Querco-Carpinetum* with *Tilia tomentosa*. Some data from the PhD thesis dedicated to the study of the *Zerconidae* family showed that natural forests offer the most favorable conditions for the development of zerconid mites, while meadows and especially agroecosystems that are completely artificial have proven to be unfavorable. Thus, the human pressure revealed at quantitative level of the mesostigmatid communities seems to be present at the qualitative level, too by changing the composition of the communities.

The mesostigmatid mites fauna from the investigated meadows (6 stands) led to the identification of 31 species, 14 genera and 8 families. A comparative analysis between hay meadows and pastures led to the finding that in the first ones the number of taxa is lower, but the number of individuals is 2.5 times higher. A percentage of 29% of species was common to hay meadows and pastures; approximately 1/3 of the species are with preferences for praticolous ecosystems and have broad ecological valences. In the praticolous ecosystems, both in hay meadows and pastures, *Hypoaspididae* is the best represented with 3 genera and 8 species, the same as in plantations (*table 1*).

Generally, the species number of *Gamasina* is much lower in arable fields than in forests (Niedbała W. *et al* 1981; Koehler H. H. 1997 after Gulvic M. E., 2007). Indeed, the results of these research evidenced that in the case of the agroecosystems there were found a number of species that are 1.36 -3 times lower than in forests

(33 species belonging to 16 genera and 9 families). The biggest number of species it was observed in the case of *Ascidae* (4 genera, 6 species) and *Hypoaspididae* (2 genera and 11 species). The biggest number of species was identified in the wheat crop and the smallest in the alfalfa and corn cultures. The same trend is observed for densities: the lowest one in alfalfa, followed by that's in corn crop (*table 1*).

Among Mesostigmata, the uropodid mites are considered particularly sensitive and thus good bioindicators of environmental changes (Athias-Binche F., 1981; Gulvik 2007). In this study, uropodids were identified only in the case of natural forests (13-31%), in the rest of the ecosystems they were missing from the collected samples; this situation may be an indicator of a certain degree of anthropization for the plantations and meadows.

As concerns ecological peculiarities it was observed that in natural forests are dominant silvicolous species or that with preferences for this type of environment, whereas in the plantations, as well as in hay meadows, in the pastures and agricultural crops are dominating the praticolous species or that with preferences for praticolous environment. A comparison between annual and perennial crops indicates a number of common species (32%), i.e., euryplastic elements or with a preference for the praticolous ecosystem (*table 2*).

Table 1

Structural global parameters of the mesostigmatid communities (*Acari*: *Gamasina*)

Ecosystems types (number of stands/number of samples)			Abundance (individuals/m^2)*	Taxa			Families with a higher number of taxa
				species	genera	families	
Forests	natural (4/20) (reserves - SCI)		5275	34	20	11	Zerconidae – 2 genera, 8 species Ascidae – 3 genera, 3 species
	Plantations (5/25)		2760	21	12	9	Hypoaspididae – 2 genera, 8 species
Meadows	Hay meadows (3/15)		846	19	8	4	Hypoaspididae – 2 genera, 8 species
	Pastures (3/15)		2160	23	13	8	Hypoaspididae – 2 genera, 8 species
Agricultural crops	perennial	alfalfa (2/10)	350	12	8	7	Hypoaspididae – 2 genera, 8 species
	annual	wheat (3/15)	1940	25	11	7	Ascidae – 4 genera and 5 species Hypoaspididae – 2 genera, 11 species
		sun flower (2/10)	1060	13	9	7	Hypoaspididae – 1 genus, 5 species
		corn (3/15	546	12	8	6	Hypoaspididae – 1 genus, 5 species
Uncultivated land (1/5)			1340	11	4	4	Hypoaspididae – 1 genus and 7 species

Legend: an average value of the average abundances calculated for each stand

Table 2

Ecological spectrum of the mesostigmatid mites fauna/types of ecosystems

Ecosystem types / Autecological peculiarities	forests		meadows		agroecosystems
	natural	plantations	hay meadows	pastures	
silvicolous species or with preferences for silvicolous environment	21	19	5	4	6
praticolous species or with preferences for praticolous environment	11	33	21	26	18
euriplastic species	14	19	5	9	12
mymecophilous	-	5	5	4	-
others	6	19	16	17	9

Legend: the values represent % of the total number of species

The analysis of the zoogeographical spectrum of the fauna shows that European species were present in all discussed ecosystems. As a common point for all categories of ecosystems, it is observed that the lowest values have the holarctic elements, that are also found in other geographical areas. It should also be noted that cosmopolitan species are present only in anthropized and anthropic ecosystems, with the highest percentages in the latter. In the forest ecosystems, but also in the agricultural ones, it has been identified species which are reported so far only in our country (*table 3*).

In the context of the present study there were recorded new species for Romanian fauna. Thus, from forest plantations *Hypoaspis heselhausi* Oudemans, 1912 was identified, in the hay meadows *Neojordensia levis* (Oudemans & Voigts, 1904) and *Arctoseius insularis* (Willmann, 1952) and from crops *Antennoseius bacatus* Athias Henriot 1961 and *Neoseiulus cucumeris* (Oudemans 1930), the last one with economic importance being used in pest control.

Table 3

Zoogeographical spectrum of the mesostigmatid mites fauna/types of ecosystems

Ecosystem types Chorological category	forests		meadows		agroecosystems
	naturals	plantations	Hay meadows	pastures	
European species	50 (10)	53 (17)	55 (27)	39 (15)	33 (13)
Palaearctic species	15	12 (6)	9	15 (8)	13 (7)
Holarctic species	(5)	(6)	(9)	(8)	(7)
Cosmopolitan species	-	6	-	15	20
species reported only in Romania	20	-	-	-	7

Legend: the values represent % of the total number of species with known geographical area; the values from the brackets represent the cumulative percentage of the species with an area, extended beyond the respective bio - geographical zone

CONCLUSIONS

The qualitative and quantitative aspects of the structure of mesostigmatid mites communities depends on the particular conditions of each ecosystem type and each stand (vegetation, age of the trees, type of soil, human impact etc.). The degree of anthropization has been highlighted in all the analyzed ecosystems, in the ecosystems marked by human intervention, there was a reduction in the number of species and / or individuals. In general, the phenomenon was more pronounced in forest ecosystems than in praticolous ones.

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