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Structure and dynamics of the oribatid mite communities (*Acari, Oribatida*) in some *Quercus* forests, in relation with the treatments used in the control of defoliating insects

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Abstract. This study was carried out in the context of some complex researches concerning the effects of long standing use of the pesticides in the control of the defoliating insects, in forest ecosystems. These investigations showed that the structural parameters of the oribatid mites' communities are obviously influenced by the stands biotic and abiotic factors, alongside some varied anthropogenic factors, such as: treatments, industrial pollution, some management measures etc. This paper includes a comparative analysis of the research results obtained in two forest stands placed in the Moldavian Plateau (Ciurea Forest District, Iaşi county): Tomeşti-Poieni (integrated control of the defoliating insects) and Şanta (chemical control). The analysis of the faunistic material collected in these two forests has shown that, in the first stand (the control perimeter), the density, the number of species, and also the specific diversity have higher values compared to the second station. In unfavourable climatic conditions (e. g. during the winter season) it was observed a more increased decline of these parameters in the Şanta forest, related to the control station. In such conditions (low temperatures, deficit of humidity etc.) the change of the vertical distribution of the effectives was observed in both stands, and a massive migration of the oribatid mites in the deeper, humiferous layer of the soil. The results gathered during the project emphasize that the chemical treatments used against the defoliating insects enhance the negative effects of some natural factors, representing an additional stressing factor on the edaphic microarthropods' communities.
Keywords: soil microarthropods, oribatid mites, dynamics, oak forests, defoliators' control.

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Introduction

The oribatids are edaphic mites with a detrito-microphytophagous trophic regime, which hold a special importance within the decomposer subsystem; due to the large number of species and individuals, their role is determinant, beside collembolans, in the organic matter bio-degradation processes, especially in the forest ecosystems. A series of studies proved the special selectivity of these soil mites in relation with their life conditions; therefore, the oribatids are useful as bio-indicators in the monitoring of the soil quality and of the changes occurred after some human practices or interventions (Wallwork 1970, 1976, Weigmann 1991).

Regarding the effects of the pesticides on the soil fauna, including the edaphic microarthropods, a number of researches were carried out in different agro-ecosystems (Bund 1965, Călugăr et al. 1989, Wallwork 1970; 1976); in the forest ecosystems there are no similar studies. In this respect, the present study constitutes a new approach.

Materials and methods

The field research has been conducted in two forest stands (Ciurea Forest District, Iaşi county), where different methods were used to control the defoliating insects' populations: Tomeşti-Poieni - *Quercus robur* and *Quercus petraea* forest (integrated control) and Şanta - *Quercus robur* forest (chemical control).

Four series of samples from the organic layer of the soil, of 100 cm^2 each, have been taken over in each stand, at two different levels: a superficial, litter and fermentation layer (*olf*), and a deep, humiferous layer (*ah*). The extraction of fauna from the soil samples was made by the selective Tullgren-Berlese method.

Analysis of the oribatid communities structure was based on the analytical ecological indices (average abundance of each species - $\overline{a}$, frequency - *C*, relative density - *D.r.*) and synthetic indices (the index of ecological significance - *W* (Dziuba), specific diversity (Shannon-Wiener) - $H_{(s)max}$, $H_{(s)}$, $H_{.r.}$). For a global characterization of the oribatid communities were used, also, the following parameters:

- the global average abundance ($\overline{A}$), and also $\overline{a}$, has been expressed as individuals/100 cm^2;
- the number of species (*S*), expressing the richness in species;
- the percent of individuals identified - out of their whole number - in the litter and fermentation sub-horizon (olf), which reflects the vertical distribution of the effectives;
- the adults/preadults ratio (expressed as an absolute value) providing information on the demographic structure of the communities under study;
- the representation (*R*%) (Müller et al. 1978) - the percent of individuals belonging to a certain species, recorded in each stand, related to the total individuals' number identified in a series of ecosystems.

Results

The analysis of the structural global parameters of the oribatid communities shown, as a rule, higher values of the densities, number of species, and specific diversity in Poieni forest, comparatively with Şanta forest (Table 1). In both stations, similar dynamics can be observed, with decrease of the abundance, and the number of species also in the less favourable periods (e. g. during the winter season). A massive migration of the mites to the deeper, humiferous layer of the soil was to be found; therefore the percent of individuals identified in *olf* sub-horizon was extremely low (Lions 1978, Ivan 2004). In the Şanta forest, the decline of these parameters was more marked, comparatively with the control stand Poieni, indicating a reduced self-regulation capacity of this oribatid community.

In the spring 2007, a significant increase (over 10 times) of the oribatids' abundance was to be found in the Şanta forest, subsequently to the extremely low values occurred in the winter season. The density was 3.7 times higher than in Poieni stand, but the number of species, and mostly the specific diversity, is lower. The analysis of the mites' distribution on species indicate that this peak of the global abundance is due, especially, to one species - *Hypochthoniella minutissima* - which holds almost 32% of the total adults number. This microphytophagous species was, probably, favoured by a certain soil microflora proliferation, which provided overabundant trophic resources (Lebrun 1971). The uneven distribution of the mites on species leads to low values of the real and relative specific diversity, which indicate a state of instability, tending to the structural entropy. Oppositely, in Poieni forest, the slight variations of the quantitative and, mostly, qualitative parameters that can be observed; point out the remarkable stability of

Table 1 Dynamics of the structural global parameters of the oribatid mite communities in the investigated forests (Ciurea Forest District, Iaşi county)

Station/	date/	sub-horizon	Â		Adults/ preadults	S	% individuals in olf	Specific diversity		
			global	adults				H(s)max	H(s)	H.r.
Tomeşti- Poieni (control perimeter, integrated treatments)	02.2006	olf	70.6	18.8	0.36					
		ah	68	35	1.06					
		global	**138.6**	**53.8**	**0.63**	**42**	**50.9**	**5.3923**	**4.4912**	**83.29**
	05.2006	olf	59.2	42	2.44					
		ah	59.6	51.8	6.64					
		global	**118.8**	**93.9**	**3.75**	**45**	**49.83**	**5.4918**	**4.3055**	**78.36**
	01.2007	olf	13.8	10	2.63					
		ah	82.2	54	1.91					
		global	**96**	**64**	**2**	**41**	**14.4**	**5.3575**	**4.3607**	**81.39**
	04.2007	olf	21.6	12	1.25					
		ah	105	71.6	2.14					
		global	**126.6**	**83.6**	**1.94**	**48**	**17.06**	**5.5849**	**4.6639**	**83.51**
Şanta (chemical treatments)	03.2006	olf	46.4	36.6	3.73	32				
		ah	49.4	36.2	2.74	28				
		global	**95.8**	**72.8**	**3.16**	**41**	**48.4**	**5.3575**	**4.1305**	**77.09**
	05.2006	olf	74.2	64.6	6.73					
		ah	22	19	6.33					
		global	**96.2**	**83.6**	**6.63**	**41**	**77.13**	**5.3575**	**4.2853**	**79.98**
	01.2007	olf	8.2	4.8	1.41					
		ah	33	28.6	6.5					
		global	**41.2**	**33.4**	**4.28**	**27**	**19.9**	**4.7549**	**3.7624**	**79.13**
	04.2007	olf	94.2	52.4	1.25					
		ah	375.6	278.2	2.85					
		global	**469.8**	**330.6**	**2.37**	**46**	**20.05**	**5.5235**	**3.5797**	**64.81**

Legend: $\hat{A}$ - global average abundance, individuals/100 cm^2; *S* - number of species; H(s)max- maximal specific diversity; *H(s)* - real diversity; *H. r.* - relative diversity (%); *olf*- litter and fermentation sub-horizon; *ah*- humiferous layer.

the oribatid coenosis (Table 1, 2).

The coenological analysis, carried out in each time sequence, showed that there are no considerable differences between the two forest stands, regarding the specific composition of the oribatid communities. The edifying and influential species cumulate 65-86% of the total number of individuals, at Poieni and 77-84% in Şanta forest (Table 2). From a season to another one, some changes in the structure of the edifying species groups, in both Poieni and Santa forests, there occured. Thus, there are no species which remain in the same ecological significance class in all the time sequences, in a station or another; only few species have high or relatively high values of *W*, such as: *P. capucinus, S. laevigatus, M. pulverulenta, M. pseudofusiger, A. coleoptrata*. The other species have more fluctuant abundance and frequency, and consequently, ecological significance. This fact illustrates the normal population dynamics of these species, in relation to abiotic and biotic factors (dynamics of the climatic factors, especially) (Lebrun 1971, Lebrun & Mignolet 1974).

The analysis of the edifying species distribution by their representation (*R*%) in the stations under study, showed 3 groups of species: the first one, with high values of *R* at Poieni, the second, with higher *R* at Şanta, and the third - only 3 species - which have a balanced distribution of the populations in the two forests (Table 3). This fact illustrates the selectivity of the oribatid mites in relation with the bioedaphic conditions.

Based on quantitative and qualitative data, it can be considered that the chemical treatments used against the defoliating insects (the used concentrations and frequency of treatments) have not a marked effect on the oribatid mites, a group of special importance within the edaphic mesofauna; the effect is tenuous, consisting in decrease of the specific diversity, and also of the coenosis stability, which emphasizes the action of some natural limiting factors (excessive temperatures, deficit of humidity etc.).

Table 2 Dynamics of the edifying and influential species groups in the investigated forest ecosystems

Species	Tomeşti-Poieni – integrated treatments								Şanta – chemical treatments							
	02.2006		05.2006		01.2007		04.2007		03.2006		05.2006		01.2007		04.2007	
	â	W	â	W	â	W	â	W	â	W	â	W	â	W	â	W
Scheloribates (S.) laevigatus (Koch, 1836)	5.6	IV	9	IV	1	II	2.8	III	0.4	II	4.4	III	0.6	II	0.2	I
Heminothrus (P.) peltifer (Koch, 1839)	9.8	IV	-	-	-	-	-	-	-	-	-	-	0.2	II	0.2	I
Lauroppia similifallax Subias et Minguez, 1986	5.4	IV	0.2	I	2.8	III	7.2	IV	-	-	-	-	-	-	-	-
Metabelba (M.) pulverulenta (Koch, 1840)	3.4	III	4.6	III	2.4	III	4.4	IV	5	IV	2	III	0.4	II	9.4	III
Damaeolus ornatissimus Csiszár, 1962	-	-	5.6	IV	2.2	III	6.4	IV	6.8	IV	4.4	III	-	-	3	II
Medioppia sp.	-	-	19.8	V	3.4	III	8	IV	4.6	IV	4.4	III	-	-	26.6	III
Minunthozetes pseudofusiger (Schweizer, 1922)	1	II	0.4	I	-	-	0.2	I	19.8	V	5	IV	1.4	III	39.6	IV
Hypochthoniella minutissima (Berlese, 1904)	-	-	0.6	II	0.2	I	0.4	I	5.6	IV	2.8	III	-	-	106.4	V
Protoribates capucinus Berlese, 1908	0.4	II	12	IV	15.4	V	5.4	IV	1.6	III	2	III	8.2	V	7.8	II
Achipteria (A.) coleoptrata (Linné, 1758)	1	II	4.4	III	4.2	IV	7.4	IV	0.2	I	0.2	I	-	-	0.8	II
Ceratozetes (C.) gracilis (Michael, 1884)	1.2	II	2.2	III	1.8	III	6	IV	-	-	-	-	-	-	2.2	II
Phthiracarus (A.) globosus (Koch, 1841)	-	-	0.6	II	-	-	-	-	-	-	8	IV	-	-	-	-
Sellnickochthonius immaculatus (Forsslund, 1942)	-	-	0.6	II	-	-	-	-	-	-	-	-	4.8	IV	0.2	I
Medioppia obsoleta (Paoli, 1908)	0.6	II	-	-	-	-	-	-	-	-	-	-	4.4	V	-	-
Oppiella (O.) nova (Oudemans, 1902)	0.2	I	1.4	II	3.4	II	-	-	2.2	III	0.2	I	1.6	III	45.4	IV
Damaeus (E.) kamaensis (Sellnick, 1925)	1.8	III	1.4	II	0.8	II	0.6	II	0.6	II	4.4	III	0.2	II	1.4	II
Suctobelbella (S.) subcornigera (Forsslund, 1941)	1.6	III	0.8	II	0.2	I	0.8	II	0.8	II	0.2	I	-	-	9.4	III
Liacarus (D.) splendens (Coggi, 1898)	1.4	III	3.6	III	0.4	II	1	II	0.4	II	0.4	II	-	-	1.4	II
Oribatella (O.) hungarica Balogh, 1943	0.8	II	0.8	II	-	-	-	-	3.4	III	3.8	III	-	-	5	II
Metabelba (M.) papillipes (Nicolet, 1855)	0.4	II	0.8	II	0.6	II	1	II	2.4	III	1.6	II	-	-	1.2	II
Phthiracarus (A.) bryobius (Jacot, 1930)	0.6	II	2.8	III	0.2	I	1.2	II	0.6	II	1.6	III	-	-	2.6	II
Zetorchestes micronychus (Berlese, 1883)	0.6	II	3	III	3.4	II	2.8	III	0.8	II	1.4	II	-	-	6.8	III
Chamobates (C.) cuspidatus (Michael, 1884)	0.6	II	0.2	I	1	II	1.4	III	-	-	1.4	II	0.6	II	1.4	II
Suctobelbella (S.) acutidens (Forsslund, 1941)	1.2	II	2.2	III	0.6	II	2	III	-	-	-	-	0.4	II	9	III
Hypochthonius rufulus Koch, 1836	1.2	II	0.4	I	2.2	III	4	III	-	-	-	-	0.6	II	-	-
Nothrus biciliatus Koch, 1841	0.6	II	2	III	1	II	1.8	III	1	II	1	II	-	-	-	-
Anomaloppia differens Mahunka et Topercer, 1983	1	II	-	-	-	-	5.8	III	2.8	III	3.2	III	0.2	II	-	-
Phthiracarus (A.) ligneus (Willmann, 1931)	-	-	2	III	2.8	III	2.8	III	-	-	0.6	II	-	-	1	II
Euphthiracarus (E.) monodactylus (Willmann, 1919)	-	-	-	-	2.6	III	0.4	II	-	-	1.6	II	-	-	-	-
Phthiracarus (A.) peristomaticus Willmann, 1951	-	-	-	-	1.8	III	0.2	I	-	-	-	-	-	-	1.2	I
Suctobelbella (F.) nasalis (Forsslund, 1941)	0.2	I	0.4	I	0.6	II	3.4	III	-	-	-	-	-	-	1	I
Achipteria (A.) acuta Berlese, 1908	0.2	I	2.4	III	-	-	0.2	I	-	-	-	-	-	-	-	-
Malaconothrus (M.) egregius (Berlese, 1904)	3.2	III	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Phthiracarus (P.) compressus Jacot, 1930	2.4	III	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Acrotritia (A.) ardua (Koch, 1841)	-	-	0.6	II	0.4	II	-	-	-	-	2	III	0.8	III	-	-
Xenillus (X.) tegeocranus (Hermann, 1804)	0.4	II	-	-	1.6	II	-	-	-	-	-	-	1	III	-	-
Berniniella (B.) bicarinata (Paoli, 1908)	-	-	-	-	-	-	0.8	II	2.2	III	-	-	-	-	5	II
Microppia minus (Paoli, 1908)	-	-	0.8	II	-	-	-	-	0.8	II	0.4	II	0.2	II	15	III
Machuella draconis Hammer, 1961	-	-	-	-	0.4	II	0.4	II	0.6	II	-	-	-	-	10.6	III
Semipunctoribates zachvatkini (Shaldybina, 1969)	0.6	II	-	-	-	-	-	-	-	-	-	-	0.8	III	0.2	I
Phthiracarus (P.) zicmani Balogh et Mahunka, 1983	-	-	-	-	1	II	-	-	-	-	-	-	1	III	-	-
Steganacarus (T.) carinatus (Koch, 1841)	-	-	-	-	-	-	-	-	0.6	II	2.4	III	1	II	-	-

Legend: *â* – average abundance, individuals/100 cm^2; *W* – ecological significance, classes: V, IV – edifying species, III – influential species, II, I – accompanying species

Table 3 Representation of the edifying species in the investigated forests

Species	Tomeşti-Poieni		ªanta	
	â	R	â	R
Lauroppia similifallax Subias et Minguez, 1986	3.9	100	-	-
Heminothrus (P.) peltifer (Koch, 1839)	2.45	96.08	0.1	3.92
Achipteria (A.) coleoptrata (Linné, 1758)	4.25	93.4	0.3	6.59
Ceratozetes (C.) gracilis (Michael, 1884)	2.8	83.58	0.55	16.42
Scheloribates (S.) laevigatus (Koch, 1836)	3.85	73.33	1.4	26.66
Protoribates (P.) capucinus Berlese, 1908	8.3	62.88	4.9	37.12
Hypochthoniella minutissima (Berlese, 1904)	0.3	1.03	28.7	98.96
Minunthozetes pseudofusiger (Schweizer, 1922)	0.4	2.37	16.45	97.63
Phthiracarus (A.) globosus (Koch, 1841)	0.15	6.97	2	93.02
Oppiella (O.) nova (Oudemans, 1902)	1.25	9.19	12.35	90.81
Sellnickochthonius immaculatus (Forsslund, 1942)	0.15	10.71	1.25	89.28
Medioppia obsoleta (Paoli, 1908)	0.15	12	1.1	88
Damaeolus ornatissimus Csiszar, 1962	3.55	50	3.55	50
Medioppia sp.	7.8	47.6	8.9	53.29
Metabelba (M.) pulverulenta (Koch, 1840)	3.7	46.83	4.2	53.16

Legend: $\overline{a}$ - average abundance, individuals/100 cm^2 (the mean of the 4 series of samples); *R*- representation, %.

Discussion

The previous researches have shown that in the mesophilous *Quercus* forests - because of the variety of the microhabitats and of the trophic resources - the oribatid mites constitute complex communities, with a large number of species, and a large specific diversity (Lebrun 1971, Ivan 2004).

In the investigated forest ecosystems, the global average abundance, the number of species, and the specific diversity, also, have comparable values with those recorded in other *Quercus* forests, in the eastern part of the country (Ivan 2004). The groups of edifying and influential species comprise sylvicolous or preferential sylvicolous species, which are frequent in the mesophilous *Quercus* forests, such as: *Damaeolus ornatissimus, Ceratozetes gracilis, Minunthozetes pseudofusiger, Hypochthoniella minutissima, Phthiracarus ligneus, P. globosus, P. bryobius, Zetorchestes micronychus, Damaeus (E.) kamaensis, Steganacarus carinatus, Liacarus (D.) splendens, Gustavia microcephala* etc. Beside them, there are some euryplastic elements, which are indifferent related to the vegetal layer - *Protoribates capucinus, Achipteria coleoptrata, Metabelba pulverulenta, Scheloribates laevigatus*, some *Oppiidae* and *Suctobelbidae* representatives (Rajski 1967; 1968, Vasiliu et al. 1993, Ivan 2000).

In both forests, the oribatids represent the dominant detritophagous group; within the edaphic mesofauna, these mites represent 51.2-62.6% of the total effectives at Poieni and 38.1-80.5% at Santa. The *Oribatida/Collembola* ratio varies between 1.94 and 4.33 in the first station, and 1.44 and 19.57 in the second (Călugăr, in press). It can be observed that the ample fluctuations of the oribatids density in Şanta forest reverberate in the variable numerical ratios with the other groups of edaphic microarthropods; at Poieni, the limits of variation of these ratios are much closer. These data prove the increased instability in time of the oribatid community at Şanta - where the chemical treatments were used in the control of defoliators - with consequences at the functional level of the organic matter's biodegradation within the ecosystem.

Regarding the effects of the chemical treatments, the lower frequency and the quantities used to control the forest defoliating insects do not cause the effects so marked, as in the case of their use in agriculture. Moreover, if considering the complexity of forest ecosystems, it is difficult to evidence these effects. Therefore, further researches carried on in different ecological conditions, are needed.

Conclusions

The qualitative and quantitative study of the oribatid mites has shown that, in the forests where the chemical methods were used to control the defoliators, ample fluctuations of the density, but also of the number of species and specific diversity there occur; they can affect the rate of the vegetal necromass decomposition, because of the important weight of the oribatids within the edaphic mesofauna. Therefore, the investigations results evidenced that the chemical treatments emphasize the negative effects of the natural and anthropogenic impact factors, representing an additional stressing factor on the edaphic microarthropods communities

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