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A comparative study of the chemical and integrated treatments impact against the defoliating insects on the structure and dynamics of the edaphic mesofauna in two oak forests from North-Eastern Romania

A. Călugăr

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Abstract. The author presents in this paper some aspects about the edaphic microarthropods from the organic horizon of two forest soils belonging to the Ciurea Forest District, Iaşi County: Şanta (mixed stands mainly with oak, chemically treated against defoliating insects) and Poieni - Tomeşti (*Quercus robur* and *Quercus petraea* stands with integrated treatments). The study of edaphic microarthropods was performed both from qualitative and quantitative point of view. It considered the average of the total density of the microarthropod populations and by each taxonomic group, according to stations and subhorizons, as well as the ratio between the taxonomical and trophic groups. The investigations concerning edaphic mesofauna consist in inventory and analysis of the mites belonging to *Oribatida, Gamasida, Actinedida* and *Acaridida* orders, of the *Collembola*, as well as other insects; other groups of microarthropods were taken into consideration too (pseudoscorpiones, myriapods etc). The consequences of the treatments against the defoliators on the edaphic mesofauna were performed at four different moments. Generally, lower densities were observed in the case of the chemically treated stands. The communities of the edaphic mesofauna from the integrated management treated stands are more stable during the time. In the chemically treated stands, the densities of the microartropods vary between large limits; this instability could be assigned to this kind of treatment. The vertical distribution of the mesofauna depends on the textural characteristics of the soil, being at the same time a dynamic parameter that is modifyed according to the variation of the climatic factors
Keywords: edaphic microarthropods, forests, treatments, defoliators

Author. Adina Călugăr (cadina_2004@yahoo.com) - Institute of Biological Researches, 47 Lascăr Catargi Str., 700107 - Iaşi, Romania

Introduction

The oak forests are cyclically infested with lepidopteran defoliators, and in the last 30-40 years different pest control methods were applied. Considering the remanence and the negative influence of the chemical products, nowadays the integrated pest management is applied on a larger scale. The integrated pest control is a strategy that focuses on the reduction of chemical polluting substances and on the use of the biodegradable selective insecti-

cides, without harmful effect with respect to human beings and useful entomofauna. A common criterion to evaluate long-term sustainability of ecosystems is to assess the fluctuations of soil quality (Schöenhöltz et al. 2000 cited by Parisi et al. 2005). Between soil quality indicators, the evaluation of mesofauna groups represents a modern method.

The edaphic microarthropods, in relation with the soil microflora, are actively involved in the biodegradation of the litter, in the nutrient cycling and energy fluxes of the ecosystem; the density of these living beings, the ratio and the relations between them, induce in a decisive way the rate and the effect of the decomposition processes. A greater taxonomic and trophic diversity insures in a bigger extent a dynamic equilibrium between mineralization and humification. In this way, the most favourable conditions for the functioning of the respective ecosystem are realised (Lebrun 1971, Krantz 1978, Neher&Barbercheck 1998, Coleman et al. 2004).

It is demonstrated that the pesticides, with their remanent effect at the soil level, penetrate into the food chains and can be assimilated on a harmful or even lethal concentrations into the vertebrates' organism. In some countries, many researches on the effects of biocides into the soil were performed; as a result it was evidenced the real impact against the edaphic life (Wallwork 1970, 1976, Lebrun et al. 1981, Krogh 1991, Cortet et al. 2002, Vig et al. 2006).

The results of all mentioned researches proved that the pesticides solved some problems in a short period of time, but created other problems on a long term. The researches on the edaphic fauna from soil surface, where the pesticides were used on a long term, are quite necessary, because at the soil level appears cumulative effects, insufficiently known. Nowadays, the quality of the environment is very important, both in the whole world and in our country.

Although in Romania different researches were performed concerning the mesofauna (on the whole or on groups) from the *Quercus* forests (Bulimar 1991, Huțu&Bulimar 1993, Ivan&Vasiliu 2000, Ivan 2004, Călugăr 2006, 2008), the effect of the pesticides on the edaphic microarthropods from these forests or from any kind of forests wasn't studied until now.

The present paper considering all the mentioned aspects pursued in a comparative way some qualitative and quantitative aspects of the communities of edaphic microarthropods that dwell in the organic soil horizon of two *Quercus* forests: one chemically treated and the other one treated into an integrated way against the defoliators.

Materials and methods

The two forests belonging to the Ciurea Forest District, Iaşi County were selected: Şanta (mixed stands - mainly with oak,); Poieni - Tomeşti (*Quercus robur* and *Quercus petraea* stands) (Table 1).

The researches on the edaphic mesofauna were performed at four different moments: at Tomeşti-Poieni in 2006 (February and May), 2007 (January and April); at Şanta in 2006 (March, May) and 2007 (January and April).

The edaphic mesofauna was extracted using Tullgren-Berlese`s method, sample by sample and subhorizon with subhorizon, over duration of samples' exposure in the installations of at most 10 days.

The microarthropods were made transparent in lactic acid, for identification, and then observed under binocular microscope. Files have been elaborated for each sample, the number of individuals for each taxa being recorded by samples and by subhorizonts. In the end, it was calculated the average of individuals' abundance on each identified group, expressed as individuals/100 cm^2 ($\overline{a}$) and the global average abundance, expressed as individuals/100 cm^2 ($\overline{A}$). Standard deviation (σ), Pearson's coefficient of variation (s%) and the ratio between oribatids and collembolans - the main detritomicrophytophagous groups - have been calculated, also.

Results

As a result of our investigations concerning edaphic mesofauna, there were identified *Oribatida, Gamasida, Actinedida* and *Acaridida* mites, *Collembola* and other insects, as well as other groups of microarthropods (pseudoscor-

Table 1 Stational conditions and treatments

Features	Stations (Ciurea District)	
	Poieni	Şanta
Altitude (m.a.s.l.)	200-390	100
Annual average temperature (°C)	9,4	9,6
Rainfalls (mm)	587	450-500
Type of soil	eutricambosoil	eutricambosoil
Forest species	sessile oak (*Quercus petraea*), pedunculate oak (*Q. robur*), beech (*Fagus silvatica*)	pedunculate oak (*Q. robur*), lime tree (*Tilia cordata*),
Inclination (degree)	16-30	10
Treatments against the defoliating insects	Silvetox - 1990; integrated treatments after 1990	DDT products, Dimilin – before 1989, Rimon - 2003
Other features	-	progressive cuttings, helping natural regeneration

piones, myriapods etc).

In the stands where integrated treatments were developed, the densities of the edaphic microarthropods varied between 198.2 and 270.8 individuals/100 cm^2 and in the forest chemically treated against defoliators, varied between 78.2 and 583.4 individuals/100 cm^2 (Table 2).

The analysis of the results regarding the edaphic microarthropods densities shows that the highest values were registered in the case of the stands with integrated treatments against defoliating insects (Poieni), comparatively to the chemically treated (Şanta) stands. Thus, in most of the time sequences, were registered higher abundances; those ones recorded in January 2007 even 2.53 higher. An exception was observed in April 2007, when at Şanta the density of the edaphic mesofauna was almost 3 times higher than at Poieni (Table 2).

The repartition on taxonomic groups showed at Poieni the domination of the mites in all the time sequences, in higher proportion (up to 77%) (Table 2). At Şanta was recorded the same situation; here the mites reached in April 2007, 93.62% from the whole edaphic mesofauna.

Among the mites, the oribatids are the most numerous taxa, at Poieni, in February 2006 (66%), May 2006 (76.15%) and January 2007 (69.76%). In April 2007, the oribatid mites and the gamasids had almost the same values of the densities (about 81%). At Şanta, the oribatids were majority, with a percentage between 70.96% and 86.01%. The second place was occupied by gamasids in both forests: at Poieni (16-18%) and at Şanta (8-12%).

The exceptions were represented by two cases - that of Poieni, when in February 2006 the acaridid mites are more numerous (23%) and that of Şanta when in May the actinedids were placed on second place among mites, with 16.29%.

The ratio between oribatids and collembolans the main detritomicrophytophagous groups are in all the examined cases over unit (Table 2).

The vertical distribution of the mesofauna effectives in the case of Poieni station showed a migration in the deeper layers, both in 2006 and 2007; if in 2006 the percentage of the community from the humiferous soil subhorizon was just slightly higher (56% for the both months), in 2007 there were observed higher densities (76% in January and 83% in April). The low temperatures from January and February, but mostly the drought that characterized the year 2007 determined the presented situation (Fig. 1).

Regarding the stands from Şanta in 2006, the vertical distribution is a normal one for the respective period (in the litter and fermentation subhorizon, in March 53% and in May 73% of the effectives). In 2007 it was observed that the biggest community of the deeper subhorizon (in January and April with 74% and respectively 81% of the total effectives) could be correlated with low temperatures of winter season

Table 2 Average density of the edaphic microarthropods from the studied biotopes

Systematic group		Tomeşti – Poieni – integrated treatments				Şanta – chemical treatments			
		2006		2007		2006		2007	
		II.	V.	I.	IV.	III.	V.	I.	IV.
Gamasida	â	*19.2*	*29.4*	*23.2*	*25.4*	*42.0*	*16.4*	*6.4*	*45.8*
	ó	18.3	11.27	20.48	11.15	18.75	6.05	6.89	55.77
	s	*95.32*	*38.34*	*88.27*	*43.88*	*44.64*	*36.89*	*107.61*	*121.78*
Oribatida	â	*138.6*	*118.8*	*96.0*	*127.6*	*95.8*	*96.2*	*41.2*	*469.8*
	ó	146.68	18.43	77.98	51.66	41.42	61.91	19.55	390.152
	s	*105.82*	*15.52*	*81.23*	*40.48*	*43.23*	*64.36*	*47.45*	*83.04*
Actinedida	â	*2.8*	*2.8*	*5.0*	*1.2*	*9.8*	*22.2*	*2.6*	*21.8*
	ó	2.32	2.64	2.45	0.74	5.53	37.11	2.42	12.93
	s	*82.68*	*94.22*	*48.99*	*62.36*	*56.41*	*167.20*	*92.95*	*57.97*
Acaridida	â	*49.0*	*5.0*	*13.4*	*2.6*	*19.8*	*1.4*	*0.2*	*8.8*
	ó	53.18	3.03	17.9	2.87	19.62	1.49	0.4	10.55
	s	*108.53*	*60.66*	*133.54*	*110.41*	*99.09*	*106.90*	*47*	*119.92*
Total Acari	â	***209.6***	***156.0***	***137.6***	***156.8***	***167.4***	***136.2***	***50.4***	***546.2***
	ó	**217.59**	**24.02**	**115.78**	**60.68**	**35.16**	**85.73**	**23.69**	**441.49**
	s	***103.82***	***15.4***	***84.14***	***38.69***	***21.0***	***62.94***	***47***	***80.83***
Collembola	â	*47.2*	*61.2*	*39.8*	*29.2*	*66.6*	*48.6*	*18.8*	*24.0*
	ó	44.57	37.15	33.11	11.79	53.11	23.07	8.45	27.63
	s	*94.42*	*60.69*	*83.20*	*40.37*	*79.75*	*47.50*	*44.93*	*115.11*
Other insects	â	*2.2*	*4.0*	*6.2*	*3.6*	*2.6*	*4.6*	*1.2*	*6.6*
	ó	1.94	1.67	8.61	3.49	1.85	4.54	1.17	7.84
	s	*88.14*	*60.69*	*138.89*	*97.18*	*71.34*	*98.76*	*97.22*	*118.76*
Total Insecta	â	***49.4***	***65.2***	***46.0***	***32.8***	***69.2***	***53.2***	***19.8***	***30.6***
	ó	**43.29**	**37.75**	**33.15**	**8.47**	**53.51**	**27.04**	**8.01**	**35.38**
	s	***87.64***	***57.89***	***72.06***	***25.83***	***77.33***	***50.82***	***40.45***	***115.62***
Other groups	â	*12.8*	*14.2*	*14.6*	*13.6*	*14.2*	*12.8*	*8.0*	*6.6*
	ó	4.79	7.76	6.71	6.53	6.73	2.86	5.18	9.56
	s	*37.44*	*54.62*	*45.97*	*48.01*	*47.43*	*22.316*	*64.71*	*144.89*
T O T A L	â	***271.8***	***235.4***	***198.2***	***203.2***	***250.8***	***203.2***	***78.2***	***583.4***
	ó	**262.0**	**31.90**	**146.88**	**56.73**	**71.87**	**111.43**	**33.61**	**479.43**
	s	***96.40***	***13.55***	***74.10***	***27.92***	***28.66***	***54.83***	***42.97***	***82.18***
O/C		**2.93**	**1.94**	**2.41**	**4.36**	**1.43**	**1.97**	**2.19**	**19.57**

Legend: â - average of the abundance in individuals/100 cm^2;ó - standard deviation; Pearson's coefficient of variation (s%)

and respectively with the absence of precipitations (Fig. 1).

Another feature of the communities taken to study is the horizontal distribution of the populations. It was analyzed the variation of the abundance on groups and on total for each series of samples by means of the standard deviation and the Pearson`s coefficient of variation (s%). One can observe that in Poieni forest the values of s% are higher in winter (over 70%), comparatively to spring (below 70%), both in 2006 and 2007, for the most of sampled soil microarthropods, such as *Gamasida, Oribatida, Collembola* and other insects. These results indicate a better aggregate distribution of the main microarthropod groups in winter - when the conditions are less favorable - and a disperse one in spring. Regarding some other

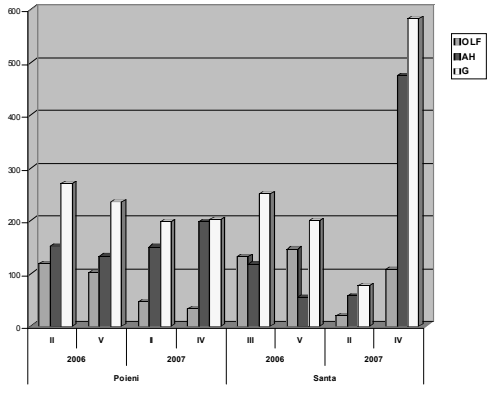

Fig. 1 Evolution of the microarthropods densities by subhorizons - OLF - litter and fermentation subhorizon; AH - humiferous suborizon; G - global

groups (*Actinedida, Acaridida*), the distribution is predominant uneven, the Pearson's coefficient of variation having big values in the most time sequences. At Şanta it was not observed an obvious relation between horizontal distribution and unfavorable conditions as we remarked at Poieni (Table 2).

Discussion

The obtained results concerning the abundance of edaphic microarthropods from both forests (Poieni and Şanta) are generally comparable to that recorded before on the occasion of some researches developed in the oak forests, situated in the North East of the country (Călugăr 2006, Huţu&Bulimar 1993). In the same time these results concerning the densities of the edaphic mesofauna that dwells in the organic horizon has been illustrated the seasonal dynamic of their coenosis.

The densities of the microarthropods vary in large limits at Şanta, the chemically treated forest, while at Poieni, the integrated treated forest, the total abundance more uniform values. These variations were observed also for the oribatids, the main detritomicrophytophagous group. The limits of the oribatid densities variations (calculated from the total mesofauna) at Şanta between 47.81-80.52% are, comparatively to Poieni 48.43-62.61%. For both forests the densities of the oribatid mites are greater in the spring months. The bigger variation from Şanta could prove the instability of the coenosis that populates the soil of this forest. This instability could be accounted to the chemical treatments and to the cuttings interventions that took place in this stand.

The differences between the two stands are mostly due to the concrete microstational biopedoclimatic conditions, especially to the litter quality. It is known from the literature data that in case of pedunculate oak the decomposition is about one year and about 6 month at linden (Huţu&Bulimar 1993). So, it could be expected that at Şanta the average of the microarthropod abundance should be bigger, the biodegradation processes being faster because of the linden leaves chemical composition. The results of our researches showed that the anthropogenic influences, represented also by the chemical treatments, play a restrictive role. With one exception, that of April 2007, the densities recorded here are lower than at Poieni - control stands.

The collembolans - less specialized concerning the food and very prolific - are dominant in young soils, in formation ones or in the first phases of the organic matter decomposition. The oribatids, with a lower ecological plasticity and a more strict trophic specialization, are dominant in mature soils, which are rich in organic substances and with a high level of decomposition, when prevails the aerobic reactions. For this reasons, it is admitted that the ratio between oribatid mites and collembolans (O/C) represent a biodegradation index of the way that processes from soil (Chifu et al. 1993). Generally, a ratio O/C (the main detritomicrophytophagous groups) over unit indicates a fast process of decomposition and a humification tendency. In the forests under anthropic pressure, the O/C ratio diminished or become under unit in zones where oribatids are usually dominant; this fact illustrated a transfer of the necromass' decomposition to an unfavourable course of the humification (Bulimar et al. 1993).

Despite of the instability recorded at Şanta stands, the processes of humification developed in a normal way. This fact is evidenced by the analysis of the ratio between the ori-

batids and collembolans, which was over unit for both forests and all the studied sequences of time. In the present study, the ratio O/C was over unit, including the case of the forest where the treatments against defoliating insects were chemical (Table 2).

Conclusions

The study of the edaphic mesofauna, in the organic horizon of the studied forests, followed both quantitative and qualitative aspects. It was observed that the densities of the microartropods vary in large limits in the case of Şanta chemical treated stands. At Poieni, the densities display more uniform values, the populations being stable in time. The differences between the two stands couldn't be explained only by the treatments, but also by the whole complex of factors, naturals and anthropogenic. The concrete site conditions have a big influence on the structural characteristics of the edaphic microarthropods communities. The influence of chemical treatments on the edaphic mesofauna is difficult to appreciate, but the instability of the microarthropod communities from Şanta could be due to this kind of treatment. To establish precisely this fact the researches must be continued.

The proportion of different taxonomic groups showed a situation usually found in the forest ecosystems, irrespective of the applied treatments; the ratio between the main detrito-microphytophagous groups (oribatids and collembolans) was over unit for both stations, in all the studied sequences of time. This fact indicates a fast process of decomposition and a humification tendency, even in the case of the chemically treated stands. Thought the Rimon product has some influence on the edaphic mesofauna, this is not very dangerous and can be used in integrated control of defoliators.

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