

## SEAZONAL FLUCTUATIONS AND SOME ASPECTS OF COLLEMBOLA DISTRIBUTION FROM THE “PLAIUL FAGULUI” NATURAL FOREST RESERVE

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**Abstract.** The influence of soil humidity and temperature on seasonal fluctuation of Collembolan density was studied in seven experimental areas of the “Plaiul Fagului” Natural Forest Reserve. The study demonstrated that the insects from the order Collembola are very active in Moldova during the whole year and their density depends mostly on the soil humidity, less on the temperature and season.

**Key words:** Collembola, Natural Forest Reserve, seasonal dynamics.

**Rezumat. Dinamica sezonieră și unele aspecte ale distribuției colembolilor din Rezervația Naturală de Stat „Plaiul Fagului”.** Dinamica sezonieră a colembolilor și influența temperaturii și umidității solului asupra densității lor a fost studiată în șapte suprafețe experimentale ale Rezervației Naturale de Stat „Plaiul Fagului”. S-a constatat, că insectele din ordinul Collembola sunt active pe parcursul întregului an calendaristic și numai umiditatea redusă a solului în sezonul estival influențează negativ asupra densității lor.

**Cuvinte cheie:** Collembola, Rezervație naturală forestică, dinamica sezonieră.

### INTRODUCTION

The important role of soil invertebrates in the decomposition of forest litter and the formation of humus profiles are an integral part of the ecological studies beginning from the first half of XXth Century (GRUIA M., ZAMFIRESCO A., 1971). Edafic microarthropods, particularly Collembola are important members of the detrital system. They participate in the fragmentation of plant detritus and stimulate the activity of fungal and bacterial colonies. Their relatively large population size and potential influence in nutrient mobilization make Collembola an important component in forest ecosystem processes. Soil microarthropods community is considered as a useful bioindicator of forest condition and change (HOLE F., 1981). The present study aimed at investigate the seasonal dynamics of Collembola communities' and some aspects of their distribution.

The first results of the study of Collembola fauna of “Plaiul Fagului” Natural State Reserve are presented in the paper BUȘMACHIU G., 2006 and include 53 species collected from the soil, litter and mosses. Among them, two species are cited as new for the Republic of Moldavia.

The objective of this experiment was to establish the influence of soil temperature and humidity on Collembola abundance in neighbouring forest sites situated in the slopes with Southern and Northern expositions. It was hypothesized that their response will be different according to the physical parameters of soil and as a result of ecological changes at temporal scales.

### MATERIALS AND METHODS

The „Plaiul Fagului” Natural State Reserve is situated in the North – West of the Central Moldavian Hills, at 70 km from the city of Kishinev - the capital of the country, at the longitude of approximately 28° 01' E and latitude 47° 17' N. This reserve is an important part of Moldavian protected areas with a surface of 5,558.7 km<sup>2</sup>. The Vegetation of the Reserve consists of several types of temperate mixed forest with dominant oak or monodominant beech trees, typical for European region. The rare species of plants and vertebrate animals are mentioned, including some Carpathian elements (URSU A., 2005).

The investigations were performed in seven selected experimental areas (EA) each of them with a surface of 50 x 50 m<sup>2</sup>. The characteristics of experimental areas are given in Table 1. Six of them are temperate mixed oak forests on grey and brown soils, and one is old beech forest on rendzina soil:

1. Mixed forest from EA № 1 with dominant *Quercus petraea*, *Tilia tomentosa*, *Carpinus betulus* with grass *Carex brevicola*.
2. Mixed forest from EA № 3 with *Fraxinus excelsior*, *Quercus petraea*, *Tilia tomentosa* with grass *Parietaria officinalis*.
3. Mixed forest from EA № 6 with *Quercus robur*, *Tilia cordata*, *Carpinus betulus* with grass *Geranium phaeum*.
4. Mixed forest from EA № 8 with *Quercus robur*, *Carpinus betulus* with grass *Rubus caesius*.
5. Mixed forest from EA № 9 with *Quercus petraea*, *Tilia tomentosa*, *Carpinus betulus* with grass *Scutellaria altissima*
6. Forest from EA № 15 with predominant *Fagus sylvatica*, *Carpinus betulus* with grass *Cephalanthera damassonium*.
7. Mixed forest from EA №16 with *Quercus robur*, *Fagus sylvatica*, *Tilia cordata* with grass *Epipactis hebeborine*.

**Table 1.** Characteristics of experimental areas  
**Table 1.** Caracteristicile suprafețelor experimentale

	1	2	3	4	5	6	7	
EA №	1	3	6	8	9	15	16	
Altitude a.s.l.(m)	232	390	232	167	287	273	250	
Exposition	N	N	SE	S	SE	N	NW	
Slope	15 <sup>0</sup> -20 <sup>0</sup>	2 <sup>0</sup> -10 <sup>0</sup>	5-7 <sup>0</sup>	2-3 <sup>0</sup>	15 <sup>0</sup>	50 <sup>0</sup> - 60 <sup>0</sup>	15 <sup>0</sup>	
Soil type*	Greyzems	Luvisol	Greyzems	Greyzems	Luvisol	Rendzina	Greyzems	
N	47 <sup>0</sup> 17 <sup>1</sup> 55	47 <sup>0</sup> 17 <sup>1</sup> 16	47 <sup>0</sup> 18 <sup>1</sup> 17	47 <sup>0</sup> 18 <sup>1</sup> 13	47 <sup>0</sup> 18 <sup>1</sup> 43	47 <sup>0</sup> 17 <sup>1</sup> 29	47 <sup>0</sup> 17 <sup>1</sup> 41	
E	28 <sup>0</sup> 01 <sup>1</sup> 46	28 <sup>0</sup> 01 <sup>1</sup> 42	28 <sup>0</sup> 03 <sup>1</sup> 57	28 <sup>0</sup> 04 <sup>1</sup> 65	28 <sup>0</sup> 01 <sup>1</sup> 76	28 <sup>0</sup> 03 <sup>1</sup> 18	28 <sup>0</sup> 02 <sup>1</sup> 82	
Number of soil cores	24	32	16	32	32	32	24	
Soil depth (cm)	5	5	5	5	5	5	5	
Litter layer (cm)	1.5 - 2	1.5 - 2	1 - 1.5	2 - 3	3.5 - 4	5 - 6	1 - 2	
Humus content*	5.7-6.0	6.1	6.89	4.93	2.78	7.28	3.6	
pH*	6.8	6.8	6.60	5.6	6.2	7.2	6.3	
W*	<0.001 mm	-	17	19	-	21	40.79	-
	<0.01 mm	-	32	29	-	25	25.52	-

\*Type of soil, humus content, pH, W and soil moisture according to Ursu, 2005.

Samples were collected jointly from EA with S and N exposition from March 2006 to May 2007 in two horizons: soil and litter layers in eight replications. Soil samples with 25 cm<sup>2</sup> surface area and litter samples with 100 cm<sup>2</sup> and 5 cm depth were taken with squares 5 x 5 cm and 10 x 10 cm respectively. Specimens of Collembola were extracted from soil and litter samples using flotation method, then processed in 70-80 % ethanol and mounted in permanent slides.

For each sample point, soil temperature was recorded at the time of collection and soil humidity was determined in the lab. condition.

The winter season of 2006-2007 in the Republic of Moldova was the warmest for all the observation period. The registered mean of air temperature was + 0.9 - +2.8°C, being higher than usual with 4.1-4.6°C. The spring came very early with higher temperature and low precipitation. Climatic data are based on long-term observations and refer to the Meteorological Station of Kishinev.

## RESULTS AND DISCUSSION

The general mean of collembolan density from all EA during the studied period was 21, 654 ind.m<sup>-2</sup>, with minimum 10, 733 ind.m<sup>-2</sup>, maximum 34, 950 ind.m<sup>-2</sup> and SD 7 899. The maximum mean of the collembolan density was registered in the springs of 2006 and 2007.

The maximum collembolan density for one of the selected studied area was recorded in April 2006 in EA № 9 and minimum in July 2006 in EA № 8. The greatest difference in collembolan density occurred in collections taken from beech forest (EA №15) in January (min value 13, 775 ind.m<sup>-2</sup>) and in May 2006 (max value 33, 900 ind.m<sup>-2</sup>). Figure 1 shows the changes of collembolan density during the studied period including mean, maximum, minimum parameters and standard deviation for each month of collection.

The lowest annual mean of collembolan density between all the studied experimental areas only 13, 864 ind.m<sup>-2</sup> were observed in EA № 8. Also in the same EA there were registered the lowest maximum, that is 20, 750 ind.m<sup>-2</sup> and minimum value of 10, 733 ind.m<sup>-2</sup>. The highest annual mean collembolan density value between all studied areas - was 23, 025 ind.m<sup>-2</sup> and the value of the minimum density was - 16, 000 ind.m<sup>-2</sup> and the maximum density of - 33, 700 ind.m<sup>-2</sup> was observed in EA № 9.

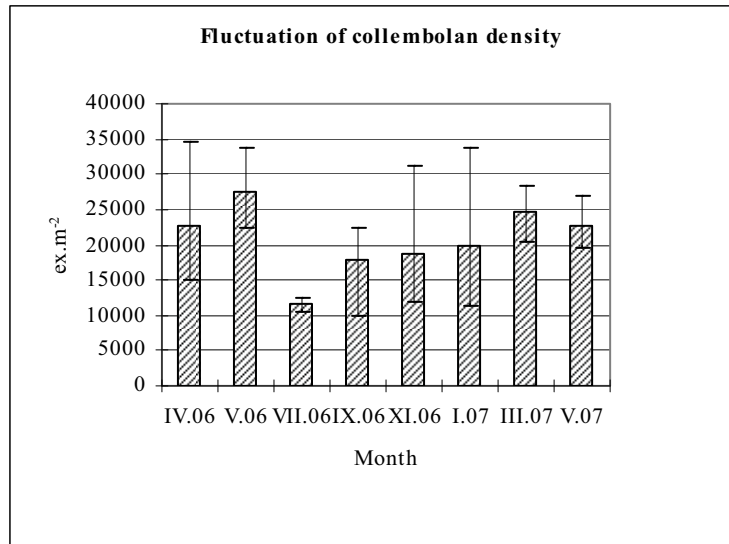
**Table 2.** Mean value (mean dens.; ind.m<sup>-2</sup>), standard deviation, minimum (min dens.; ind.m<sup>-2</sup>) and maximum (max dens.; ind. m<sup>-2</sup>) of Collembolan density for some EA

**Table 2.** Valoarea medie (dens. medie, ind.m<sup>-2</sup>), deviația standard, minimă (dens. min., ind.m<sup>-2</sup>) și maximă (dens. max., ind. m<sup>-2</sup>) a densității colembolilor pentru unele SE

EA №	Mean dens.*	SD*	Maximum*	Minimum*
EA № 3	20 599	±8 189	33 650	12 499
EA № 8	13 864	±4 628	20 750	10 733
EA № 9	23 025	±7 601	33 700	16 000
EA № 15	22 477	± 9 578	33 900	13 775

The study demonstrated that Collembola are very active also in the winter season in the Republic of Moldova. The mean collembolan density value in the winter of the year 2006 – 2007 was higher than in autumn and it increases in the spring season.

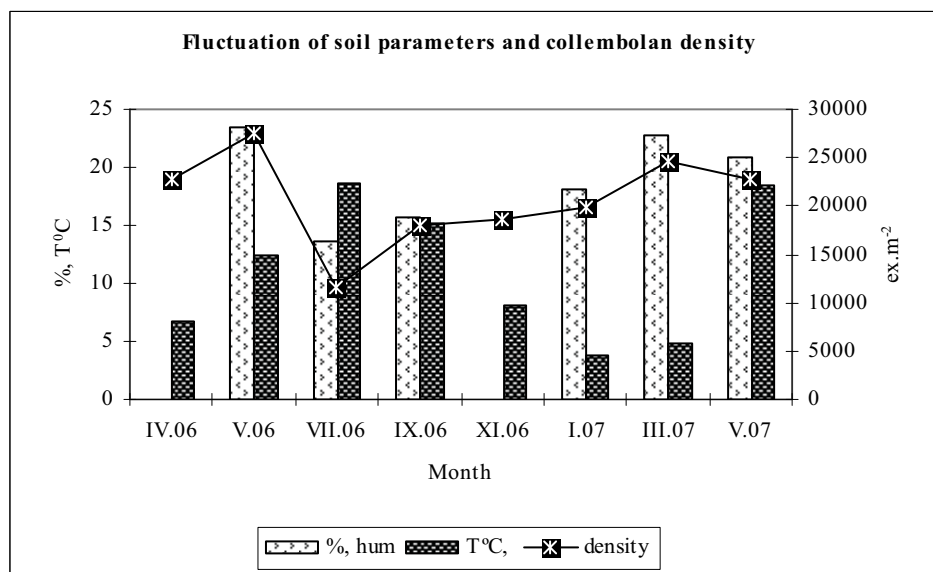
The standard deviation (Table 2) shows the great fluctuation between recorded collembolan densities collected in each EA taken in the part during the studied period. The maximum SD 9 578 was calculated for EA № 15 and minimum for EA № 8.



**Figure 1.** The fluctuation of collembolan density during the 14 studied months. Vertical bars indicate standard deviation of the mean.

**Figura 1.** Fluctuația densității colembolilor în cele 14 luni de studiu. Barele verticale indica media deviației standard.

Analyzing the 2006 – 2007 time-series data there was determined the fluctuation of annual mean density of Collembola collected from different EA of the Reserve in relation to the temperature and humidity (Fig.2). The changes of collembolans density, soil humidity and temperature during 14 studied months were considerable. The mean temperature measured monthly had value between +3.1<sup>0</sup> C in January 2006 and +19.5<sup>0</sup> C in May 2007 and it was clearly higher at EA with South exposition compared with North exposition.



**Figure 2.** The fluctuation of soil humidity, temperature and collembolan density in the studied period.

**Figura 2.** Fluctuația umidității solului, temperaturii și densității colembolilor în perioada studiată.

The mean registered value of the soil humidity during the studied months was minimum of 12.42 % in July 2006 and maximum of 26.18 % in January 2007. The registered decrease of the soil humidity in July 2006 was, of

course, the cause of the minimum collembolan density in this month. The highest value of the soil humidity of 28.48 % was registered in EA N.8 in January 2007. It was observed that the EA with South exposition was usually dryer than the EA with North exposition. The humidity decreases more quickly with the increasing of soil temperature in the EA with South exposition. The collembolan density changed in the same direction as the values of soil humidity being lower in hot summer period with insufficient precipitations. The changes of soil temperature during the year haven't big influence on the collembolan density, but lower soil humidity influenced negatively on their density.

### CONCLUSIONS

In spite of the neighbouring location of the studied experimental areas, there were big differences between the values of the collembolan densities. The maximum annual mean density values were registered in the spring during both studied years. The study demonstrated that the insects from the order Collembola are very active in Moldova during the whole year and their density depends mostly on the soil humidity, less on the temperature and season.

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