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THE INFLUENCE OF LIMESTONE MINING FROM MATEIAŞU MOUNTAIN (SOUTH ROMANIAN CARPATHIANS) ON EDAPHIC MEZOFAUNA

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ABSTRACT. Our data emphasize the fact that calcareous powder on the soil, coming from Mateiaşu limestone mining, influences Collembola and Acarina fauna from the polluted soils, reducing their individual number. Thus, the differences between numerical densities of Collembola from polluted areas, by comparison with unpolluted soils, were, in all cases, significant, with a "d" value > 3.291, which justifies null hypothesis resignation, with a probability "p" = 0.001. In the case of Acarina, between beech areas (unpolluted and polluted ones), the difference was significant, with a value "d" > 2.576 and a probability "p" = 0.01. In the case of pine and meadow areas, "d" value > 3.291 and probability "p" = 0.001, which also justifies the resignation of null hypothesis. In the condition of working with the same technics for sample prelevation, in the condition of comparing these densities of pairs of arias with the same type of vegetation, the explanation of existing significant differences between the numerical densities of Collembola and Acarina remains the influence of pollution of soils with calcareous powder.

Keywords: limestone mining, cement factory, soil, invertebrate fauna

INTRODUCTION

Human living standards are directly dependent on the state of health of environment evinces, but this natural capital must be protected, because it supports life (Stoian et al., 2009; Badea et al., 2010). Limestone mining from Mateiaşu Mountain (Câmpulung Muscel) whose activity is planned for 1999 2018, and also the cement factory, located at 300 400 meters by the limestone mining, influence all life environmentals, soil, air, water, and also all plant and animal species. Invertebrate soil fauna of Collembola and Acarina from polluted area is also influenced by the deposition of calcareous powder on the soils. Generally, all mining activities at the soil surface generate powders and chemical substances which, depending by the ores which are extracted, represent a constant source of pollution. In the case of cement factory from Mateiaşu, it is equipped with special filters which retain a part of powders, in accordance with the lows in force. However, limestone mining activities represend a constant source of powders which are deposited on the vegetation and soils, in quantities which progressively diminish with the distance from the limestone mining. From known data, concentrations of Ca, Mg, Fe şi Al exceed maximum admissible concentrations in the level of 0 5 cm of the soil.

MATERIALS AND METHODES

In order to know soil types, its physical and morphological peculiarities, and also the influence of limestone mining on soil invertebrate fauna, researches have been done in six areas, three in unpolluted zone (A, C and E) and in polluted one (B, D and F). Study areas were established depending on the type of vegetation namely: A (unpolluted) and B (polluted) areas = beech forest; C (unpolluted) and D (polluted) areas = pine forest; E (unpolluted) and F (polluted) areas = meadow. A soil prophyle has been done and faunistical samples were prelevated in each of these areas. Collembola and Acarina fauna were collected using Macfadyen sonda, having an area of 7 sq cm. Four samples were collected from each area, units of sample being represented by the levels of soil as folloows: LH (litter-fermented humus); S_1 (0 10 cm soil); S_2 (10 20 cm soil). Soil pH was determined in water, Ca and K through laboratory specific methods.

RESULTS AND DISCUTIONS

The research has been oriented on three main objectives namely: 1. to obtain characteristic data (geographical coordinates) in order to identify the searched areas; 2. to know morphological and physical characteristics of the soils and also the influence of limestone mining on their chemistry; 3. to know soil Collembola and Acarina fauna.

Identification of areas has been done pointing out the following elements: geographical coordinates; absolute altitude; relief-slope; exposition; type of vegetation. Beech forest (unpolluted area A) is identified by: 45^0 18' 31" N; 25^0 09' 04" (geographical coordinates); 849 meters (absolute altitude); 35% (slope); east exposition; beech forest (type of vegetation); Beech forest (polluted are B) is identified by: 45^0 18' 25" N; 25^0 07' 51" (geographical coordinates); 923 meters (absolute altitude); 25 35% (slope); vwest (expozition); beech forest (type of vegetation); **Pine forest (unpolluted area C)** is identified by: N 45grade 17' 59"; E25 grade 08'50"

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(geographical coordinates); 830 meters (absolute altitude); 25 35% (slope); south esast (expozition); pine forest (type of vegetation); Pine forest (polluted area D) is identified by: 45^0 17' 09" N; 25^0 08' 23" (geographical coordinates); 887 meters (absolute altitude); 25 35% (slope); south (expozition); coniferae forest (type of vegetation); Meadow (unpolluted area E) is identified by: 45^0 18' 25" N; 25^0 09' 24" (geographical coordinates); 829 meters (absolute altitude); 20 30% (slope); east (expozition); meadow (type of vegetation) pajişte; Meadow (polluted area F) is identified by: 45^0 17', 20" N, 25^0 07', 57" (geographical coordinates); 887 meters (absolute altitude); 15 20% (slope); west (expozition); meadow (type of vegetation).

Morphological and physical peculiarities of the soils are as follows: Beech forest (unpolluted area A) is installed on typical eutricambosoil with a weak alkaline reaction in $A_{0,}$ $B_{v1,}$ B_{v2} levels (pH = 7.28, 7.41 and irespectively 7.35), wheak alkaline reaction in BC, C+R levels (pH = 6.09, 6.04) and an Ca content of 1856.4 în A_0 level. Given the soil of unpolluted area, having a Ca content of only 28.1, soil of polluted area is 66 times higher Ca content and that is only because of calcareous powder deposition on that soil. Beec forest (polluted area B), taxonomical unit of the soil being litic cambic rendzina, moderate acid neutral reaction, with a pH value in water = 5.43, in A_m (10-20 cm) level and 6.93 in B_v + R (27-37 cm) levels. Pine forest (unpolluted area C) with a litosol eutric, wheak alkaline reaction, pH value in water = 7.55 at 3 13 level of soil, in $A_t + A_{o.}$ Pine forest (polluted area D) with a litic eutricambosoil, wheak alkaline reaction, pH value =7.49 in A_0 level and 7.71 in B_v (33 43 cm) level. Meadow (unpolluted area E) has a substrate of typical litic rendzina with a wheak alkaline reaction (pH = 7.59) at the level of 10 20 cm at the levels of A_t + A_m. Meadow (polluted area D) with a eutric regosoil, neutral reaction, pH = 6.46 in $A_t + A_0$ (5 15 cm) levels, 6.84 in C_1 (25 35 cm) levels and 7.22 in C_2 (41 51 cm) level.

Collembola fauna

Table 1, which presents numerical densities of Collembola from the unpolluted beech (A) and polluted beech (B) areas, and Figure 1, which present numerical densities and their standard deviations, show that these data were smaller în soils of polluted areas, comparing with unpolluted ones.

The differences between the means from unpolluted and polluted areas, statistical calculated, at all depth levels of soilwere significant significant and higher than 1.96, representing the value of standard deviation. In this case, with a probability p = 0.001and 95% level of significance, the null hypothesis is resigned.The resignation of null hypothesis means that in the conditions of sample prelevation using the same technique, in the conditions of comparing areas with the same type of vegetation, the differences are because of the deposition of powders coming from the limestone mining. Collembola fauna is influenced by these powders, which reduce their numerical densities, comparing with soils from unpolluted soils. Analysing parameters of central tendence (the mean), dispersion of individuals in samples (standard error, standard deviation and variance), and also the significance of difference between sample means from unpolluted area, comparing with polluted one, it has been found that these values differentiate, which justify the resignation of null hypothesis.

Table 1

Numerical densities of Collembola from soils of two beech ecosystems

Mean of individuals	Beech forest (unpolluted area A)			Beech forest (polluted area B)		
	Level of soil			Level of soil		
	LH	0 – 10 cm	10 – 20 cm	LH	0 – 10 cm	10 – 20 cm
	20	25	15	8	6	3
	15	18	13	6	4	2
	18	21	10	7	5	2
	14	17	9	10	0	1
Mean on the level of soil (sample unit)	16.75	20.25	11.75	7.75	3.75	2
Mean on the sample (all levels)	16.25			4.5		
Real difference between means "d"	11.75					
Differences between means "d" statistical calculated	3.93					
Significance of difference between means (p = 0.001; SD = 1,96)	d = 3.93 > 1.96 (SD) Null hypothesis is resignated					

LH (A=unpolluted; B=polluted); 0-10 cm (C=unpolluted; D=polluted); 1020 cm (E=unpolluted; F=polluted)
LH = lititer and fermented humus; 0 10 cm and 10 20 cm = soil levels

3.93, representing the value, statistical calculated, of the difference between the mean of individuals in the samples from unpolluted area and polluted one, is higher than 1.96, representing the value of standard deviation, which justify the resignation of null hypothesis with p = 0.001 and 95% level of confidence. There are too significant differences between numerical means of Collembola, statistical calculated, from the other areas (unpolluted, C, and polluted, D) with pine and also with meadow (unpolluted, E, and polluted, F) with p = 0.001 and 95% level of confidence. Thus, between numerical means of colembola from the areas with pine, unpolluted and polluted ones, the statistical calculated difference is 4.29 (Table 2; Figure 2), which is higher than standard deviation (1.96), with a probability p = 0.001, which justify the resignation of null hypothesis, having the same explanation as those from beech areas.

	Column A	Column B	Column C	Column D	Column E	Column F
Mean	16,750	7,750	20,250	3,750	11,750	2,000
Std Error	1,377	0,854	1,797	1,315	1,377	0,408
Std Dev.	2,754	1,708	3,594	2,630	2,754	0,816
Variance	7,583	2,917	12,917	6,917	7,583	0,667
Lower 95%CL	12,368	5,032	14,531	-0,435	7,368	0,701
Upper 95%CL	21,132	10,468	25,969	7,935	16,132	3,299
Count	4,000	4,000	4,000	4,000	4,000	4,000

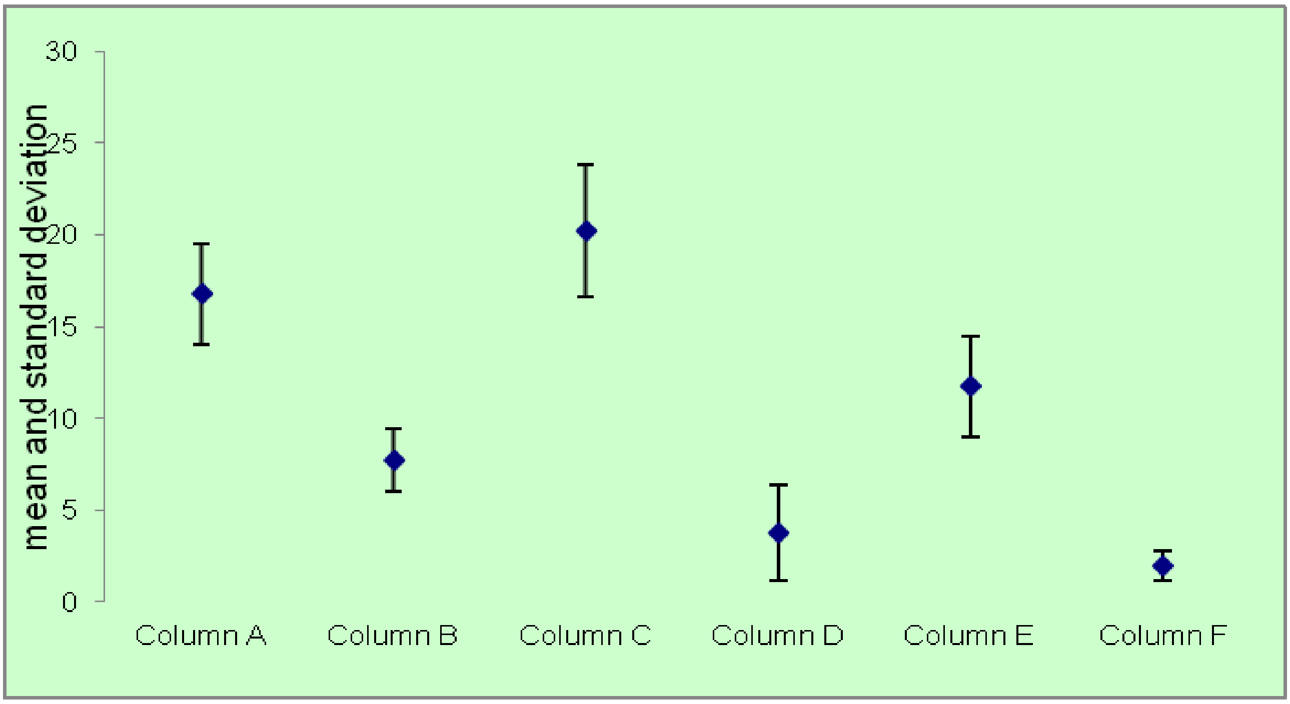

Fig. 1 Central tendency parameters (mean) and individual dispersion (standard error, standard deviation and variance) of Collembola in beech forests

Table 2

Numerical densities of Collembola from soils of two pine ecosystems

Mean of individuals	Pine forest (unpolluted area C)			Pine forest (polluted area D)		
	Level of soil			Level of soil		
	LH	0 – 10 cm	10 – 20 cm	LH	0 – 10 cm	10 – 20 cm
	17	23	13	5	3	0
	11	19	10	7	1	2
	15	18	8	2	3	1
	13	15	9	4	2	2
Mean on the level of soil (sample unit)	14.00	18.75	10.00	4.5	2.25	1.25
Mean on the sample (all levels)	14.25			2.66		
Real difference between means “d”	11.59					
Differences between means “d” statistical calculated	4.29					
Significance of difference between means (p = 0.001; SD = 1,96)	d = 4.29 > 1.96 (SD) Null hypothesis is resignated					

LH (A=unpolluted; B=polluted); 0-10 cm (C=unpolluted; D=polluted); 1020 cm (E=unpolluted; F=polluted)
LH = lititer and fermented humus; 0 10 cm and 10 20 cm = soil level

	Column A	Column B	Column C	Column D	Column E	Column F
Mean	10,500	5,250	11,000	4,250	8,250	2,750
Std Error	0,645	1,031	0,913	0,750	0,479	0,479
Std Dev.	1,291	2,062	1,826	1,500	0,957	0,957
Variance	1,667	4,250	3,333	2,250	0,917	0,917
Lower 95%CL	8,446	1,970	8,095	1,863	6,727	1,227
Upper 95%CL	12,554	8,530	13,905	6,637	9,773	4,273
Count	4,000	4,000	4,000	4,000	4,000	4,000

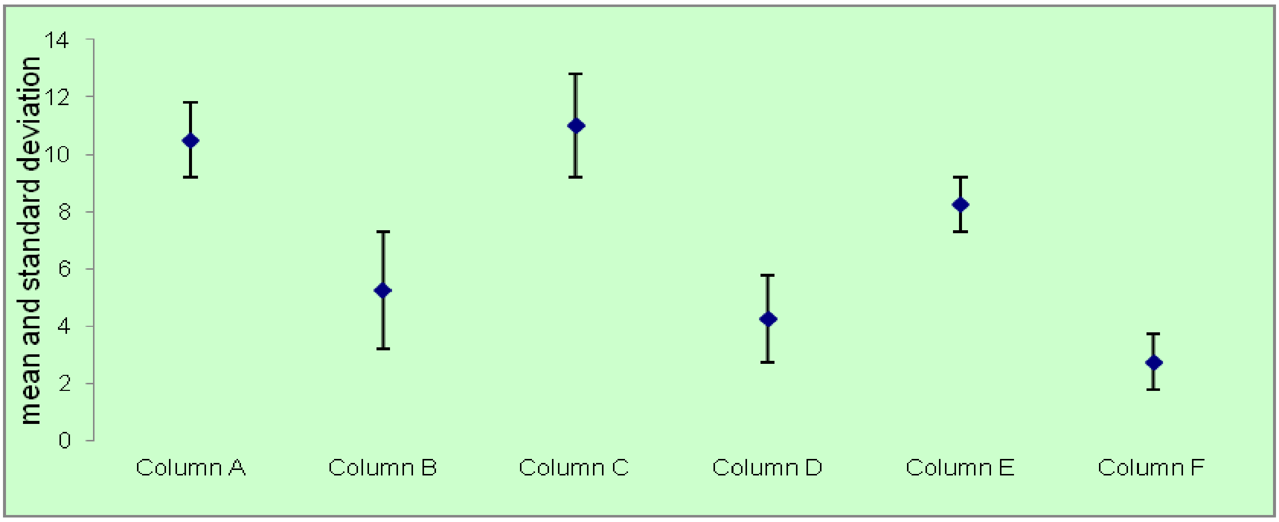

Fig. 2 Central tendency parameters (mean) and dispersion (standard error, standard deviation, variance) of Collembola in meadow ecosystems

Table 3

Numerical densities of Collembola from soils of two meadow ecosystems

Mean of individuals	Meadow (unpolluted area E)			Meadow (polluted area F)		
	Soil level			Soil level		
	LH	0 – 10 cm	10 – 20 cm	LH	0 – 10 cm	10 – 20 cm
	12	10	9	8	6	2
	10	9	9	5	3	3
	9	13	7	3	5	4
	11	12	8	5	3	2
Mean on the level of soil (sample unit)	10.5	11.00	8.25	5.25	4.25	2,75
Mean on the sample (all levels)	9.92			4.08		
Real difference between means "d"	5.84					
Differences between means "d" statistical calculated	3.58 > 1.96 (SD) Null hypothesis is resignated					
Significance of difference between means (α = 0.001; SD = 1,96)						

LH (A=unpolluted; B=polluted); 0-10 cm (C=unpolluted; D=polluted); 1020 cm (E=unpolluted; F=polluted)
LH = litter and fermented humus humus; 0 10 cm şi 10 20 cm = level of soils

In the case of meadow areas, the differences between numerical means of Collembola, statistical calculated, are also significant, with p = 0.001 and 95% level of conficdence. Thus, the difference between numerical means of Collembola from unpolluted and polluted meadow areas, statistical calculated, is 3.58 (Table 3; Figure 3) which is higher than standard deviation (1.96). The resignation of null hypothesis is also justified, having the same explanation as those from beech and pine areas

	Column A	Column B	Column C	Column D	Column E	Column F
Mean	10,500	5,250	11,000	4,250	8,250	2,750
Std Error	0,645	1,031	0,913	0,750	0,479	0,479
Std Dev.	1,291	2,062	1,826	1,500	0,957	0,957
Variance	1,667	4,250	3,333	2,250	0,917	0,917
Lower 95%CL	8,446	1,970	8,095	1,863	6,727	1,227
Upper 95%CL	12,554	8,530	13,905	6,637	9,773	4,273
Count	4,000	4,000	4,000	4,000	4,000	4,000

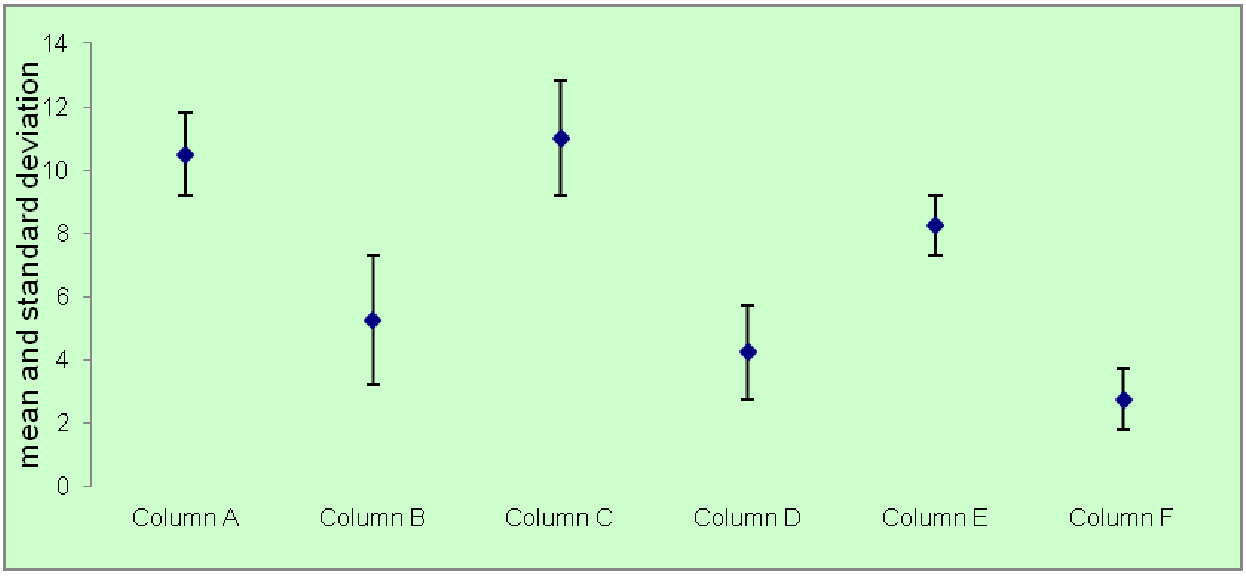

Fig. 3 Central tendency parameters (mean) and dispersion (deviation error, deviation standard and variance) of Collembola in meadow areas

Acarina fauna

Acarina fauna is also influenced by powders coming from limestone mining reducing individual numbers in all three polluted areas . Thus, in beech forest, powders deposited on the soil diminuted mean density of individuals, for all depth of soil levels, from 11.08 to 4.58 (Table 4, Figure 4), which caused the resignation of null hypothesis. In pine forest from polluted area, numerical density was reduced from 12.83, in unpolluted area, to 3.08, in polluted one (Table 5, Figure 5). That diminution also determined the resignation of null hypothesis.

Table 4

Numerical density of Acarina in the soils of two beech forests

Mean of individuals	Beech forest (unpolluted area A)			Beech forest (polluted are B)		
	Level of soil			Level of soil		
	LH	0 – 10 cm	10 – 20 cm	LH	0 – 10 cm	10 – 20 cm
	16	17	4	4	5	1
	13	15	3	6	4	1
	18	13	5	8	7	3
	11	14	4	5	9	2
Mean on the level of soil (sample unit)	14.5	14.75	4.00	5.75	6.25	1.75
Mean on the sample (all levels)	11.08			4.58		
Real difference between means “d”	6.5					
Differences between means “d” statistical calculated	2.85					
Significance of difference between means (α = 0.01; SD = 1,96)	2.85 > 1.96 (SD) Null hypothesis is resignated					

LH (A=unpolluted; B=polluted); 0-10 cm (C=unpolluted; D=polluted); 1020 cm (E=unpolluted; F=polluted)
LH = litter and fermented humus; 0 10 cm and 10 20 cm = level of soils

In meadow areas (Table 6, Figure 6), the difference between means of unpolluted and polluted ones, statistical calculated, was 5.93, which shows the diminution of individual numbers, justifying the resignation of null hypothesis, with a probability p = 0.05.

	Column A	Column B	Column C	Column D	Column E	Column F
Mean	14,500	5,750	14,750	6,250	4,000	1,750
Std Error	1,555	0,854	0,854	1,109	0,408	0,479
Std Dev.	3,109	1,708	1,708	2,217	0,816	0,957
Variance	9,667	2,917	2,917	4,917	0,667	0,917
Lower 95%CL	9,553	3,032	12,032	2,722	2,701	0,227
Upper 95%CL	19,447	8,468	17,468	9,778	5,299	3,273
Count	4,000	4,000	4,000	4,000	4,000	4,000

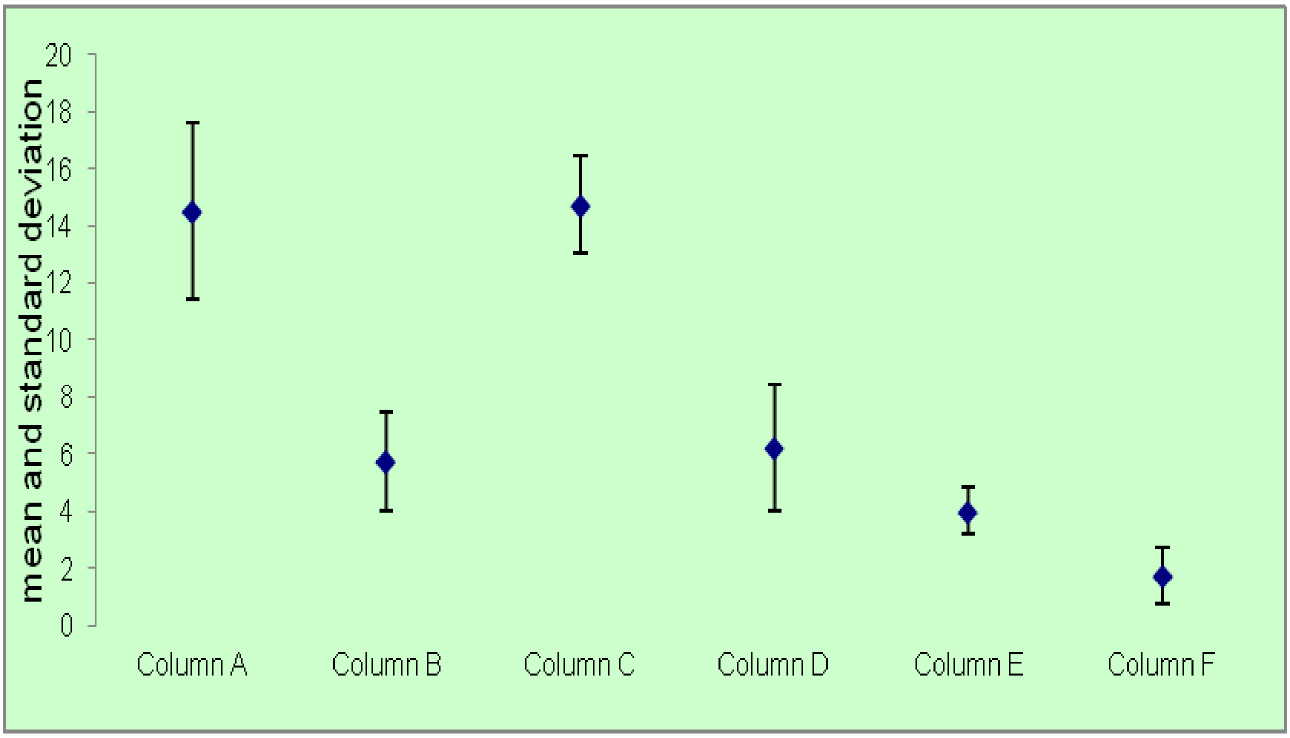

Fig. 4 Central tendencey parameters (mean) and dispersion (standard error, standard deviation, variance) of Acarina in beech forests

Table 5

Numerical densities of Acarina in soils of two pine ecosystems

Mean of individuals	Pine forest (unpolluted area C)			Pine forest (polluted area D)		
	Level of soil			Level of soil		
	LH	0 – 10 cm	10 – 20 cm	LH	0 – 10 cm	10 – 20 cm
	13	12	10	4	7	0
	11	14	8	3	3	1
	19	16	7	5	6	2
	17	15	9	2	4	1
Mean on the level of soil (sample unit)	15.75	14.25	8.5	2.75	5.5	1
Mean on the sample (all levels)	12.83			3.08		
Real difference between means "d"	9.75					
Differences between means "d" statistical calculated	4.1					
Significance of difference between means (p = 0.001; SD = 1,96)	4.1 > 1.96 (SD) Null hypothesis is resignated					

LH (A=unpolluted; B=polluted); 0-10 cm (C=unpolluted; D=polluted); 1020 cm (E=unpolluted; F=polluted)
LH = litter and fermented humus; 0 10 cm şi 10 20 cm = soil levels

	Column A	Column B	Column C	Column D	Column E	Column F
Mean	15,000	3,500	14,250	5,000	8,500	1,000
Std Error	1,826	0,645	0,854	0,913	0,645	0,408
Std Dev.	3,651	1,291	1,708	1,826	1,291	0,816
Variance	13,333	1,667	2,917	3,333	1,667	0,667
Lower 95%CL	9,190	1,446	11,532	2,095	6,446	-0,299
Upper 95%CL	20,810	5,554	16,968	7,905	10,554	2,299
Count	4,000	4,000	4,000	4,000	4,000	4,000

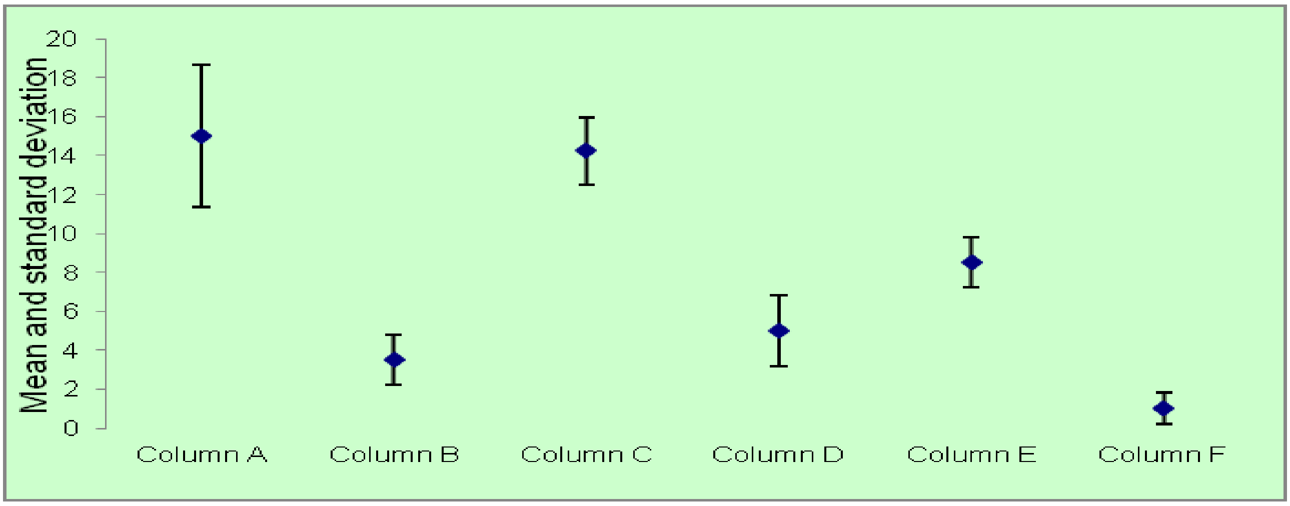

Fig. 5 Central tendency parameters (mean) and dispersion (standard error, standard deviation, variance) 0f Acarina in pine forests

LH (A=unpolluted; B=polluted); 0-10 cm (C=unpolluted; D=polluted); 1020 cm (E=unpolluted; F=polluted)
LH = litter and fermented humus; 0 10 cm şi 10 20 cm = level of soils

Table 6

Numerical densities of Acarina individuals in soils of two meadow ecosystems

Mean of individuals	Beech forest (unpolluted area A)			Beech forest (polluted are B)		
	Level of soil			Level of soil		
	LH	0 – 10 cm	10 – 20 cm	LH	0 – 10 cm	10 – 20 cm
	4	5	3	0	0	0
	6	8	6	2	2	1
	8	7	5	1	2	1
	5	6	2	1	1	2
Mean on the level of soil (sample unit)	5.75	6.5	4	1	1.25	1
Mean on the sample (all levels)	5.41			1.08		
Real difference between means “d”	4.33					
Differences between means “d” statistical calculated	5.93					
Significance of difference between means (p = 0.01; SD = 1,96)	5.93 > 1.96 (SD) Null hypothesis is resignated					

LH (A=unpolluted; B=polluted); 0-10 cm (C=unpolluted; D=polluted); 1020 cm (E=unpolluted; F=polluted)
LH = litter and fermented humus; 0 10 cm and 10 20 cm = level of soils

	Column A	Column B	Column C	Column D	Column E	Column F
Mean	5,750	1,000	6,500	1,250	4,000	1,000
Std Error	0,854	0,408	0,645	0,479	0,913	0,408
Std Dev.	1,708	0,816	1,291	0,957	1,826	0,816
Variance	2,917	0,667	1,667	0,917	3,333	0,667
Lower 95%CL	3,032	-0,299	4,446	-0,273	1,095	-0,299
Upper 95%CL	8,468	2,299	8,554	2,773	6,905	2,299
Count	4,000	4,000	4,000	4,000	4,000	4,000

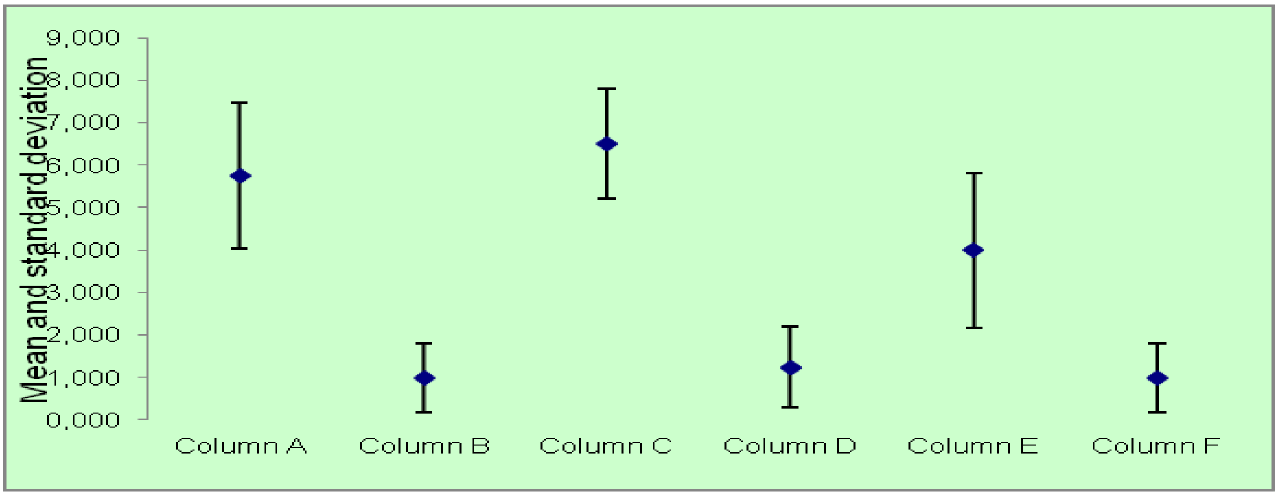

Fig. 6 Central tendency parameters (mean) and dispersion
(standard error, standard deviation, variance of Acarina in meadow ecosystems

CONCLUSIONS

The researches that have been done in 2011, in the area of limestone mining from Mateiaşu Mountain and of cement factory from its proximity, have revealed the following conclusions:

The powders generated by the limestone mining and also by the cement factory, in smaller quantities, influence the numbers of Collembola and Acarina soil mezofauna, reducing their numbers. Thus, in all three areas from polluted zone (beech, pine and meadow areas), numerical densities of Collembola were smaller than those corresponding areas, as type of vegetation is concerned located in unpolluted zone. In all three areas from polluted zone, numerical densities of Collembola were smaller than those from unpolluted zone. The differences between their numerical densities from polluted and unpolluted areas were significant , higher than 3.291 standard deviations, with a probability = 0.001, which justify the resignation of null hypothesis. In the case of Acarina, things were the same. The differences between numerical densities of pine and meadow polluted areas, comparing with the corresponding unpolluted areas, as far as type of vegetation is concert, were significant, higher than 3.291, with a probability p = 0.001. In the case of beech areas, unpolluted and polluted ones, the difference between their numerical densities was also significant, with a "d" value > 2.576 and a p = 0.01. Because the unpolluted and polluted areas had the same type of vegetation, because all the aspects reffering to sample prelevation technics were identical in all areas, the only cause which determined the reduction of individual numbers of Collembola and Acarina were the deposition of powders, comming from limestone mining and cement factory, on the soils.

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