THE SPECIFIC STRUCTURE, FUNCTIONAL ROLE AND ORGANISATION OF LUMBRICIDAE IN A SECONDARY NATURAL GRASSLAND

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Abstract
The present work analyses the indices of aggregation, dispersion, expansion, dominance and receptivity of lumbricidae fauna in a grassland located in the high hills of Piedmont Candesti in the south-east of Arges County. The higher aggregation of species in the grassland, in certain months expressed a lower number of points with optimal food and physiological conditions. It also emerges the idea that, a higher density of the population caused a higher degree of expansion, which gave the species a determining role within the biogenesis.

Keywords: Lumbricidae, specific structure

1. INTRODUCTION

The floristic and relief diversity, exhibition and inclination of the slopes form specific topoclimates with characteristic soils, differentiated vegetation which influences the presence of absence of certain lumbricidae species in the soils of these ecosystems, as well as their functional role. It is a secondary natural grassland formed in the place of the woods cleared by man, subjet to the influence of human activities and natural factors. The type of grassland is *Agrostis tenuis-Festuca rubra* (Motcă Gh., et al., 1994). The results of the indices of aggregation, dispersion, expansion and dominance of lumbricidae populations were different from species to species, thus highlighting the function of each species, with a greater or lesser role in the ecosystem. For these reasons, the ecosystem under study has a diverse fauna of this group of invertebrates with a strong tendency of aggregation.

2. MATERIAL AND METODS

The samples were taken during March-October 2007 and March-October 2008 on an area of 2500 square meters. There were taken 10 sample units, 25/25cm in size, on depth levels from 10 to 10 cm, up to a depth of 40 cm. The earthworms were captured from each soil level and put immediately in 90˚ alcohol, in air-proof labeled containers. When transported to the laboratory, the earthworms were identified at the species level (Pop V., 1949). To highlight the numerical dominance of lumbricidae and their role in the grassland ecosystem, we used the methodology laid down by H.R. Debouche (1962), which involves a series of environmental indicators. These environmental indicators are: aggregation index (λ), dispersion index (i), expansion index (E) numerical dominance index (D) and total receptivity (R) of species in this ecosystem.

The aggregation index depends on the number of existing population units and density of individuals. It will increase with the decrease of population units and increase of density of individuals within these units. When the entire population is gathers in a single group, the index reaches the highest value and will increase only with the group. The formula of this index is :

$$\lambda = \frac{s}{m}, \text{ in which:}$$

λ = aggregation index;
s = standard deviation;
m = average number of organisms in a sample.

The aggregation index can change its value depending on the habitat conditions or the ecological tolerance of the species. Aggregation of lumbricidae species is closely related to their *dispersion*.

Dispersion is calculated using the formula.

$$i = \frac{1-\lambda}{\sqrt{\sum X}}$$, in which:

λ = aggregation index value;

Σ_x = maximum possible aggregation value.

The dispersion coefficient is a value whose ecological significance is highlighted only by association with the expansion degree of the species.

The expansion index is obtained by multiplying the dispersion coefficient with density, resulting in the dispersion of the entire population at a time.

The formula of the expansion index is:

$$E = m\left(\frac{1-\lambda}{\sqrt{\sum X}}\right)$$, in which:

m = average number of organisms;

$\left(\frac{1-\lambda}{\sqrt{\sum X}}\right)$ = dispersion index.

The expansion index value is proportional to the size of a population.

Dominance is a parameter expressing the influence of one or more species on the structure and functioning of the biocenosis. This expresses the ratio between the number of individuals of a species and the total number of individuals in a sample and it was calculated using the formula.

$$D = \frac{n_A}{N} \times 100$$, in which:

n_A = A species number of individuals;

N = total number of individuals

Numerical dominance is an expression of habitat receptivity to certain species. In this respect, total receptivity (R) was calculated, representing the sum of numerical dominances of all species forming the respective biocenosis, for which we used the formula: R = ΣD

3. RESULTS AND DISCUSSION

The specific composition of the grassland in the two years highlighted the following species: *Allolobophora dacica, Allolobophora chlorotica, Allolobophora dugesi, Allolobophora caliginosa caliginosa, Allolobophora leoni, Aporrectodea rosea rosea, Dendrobaena alpina, Dendrobaena byblica, Dendrobaena octaedra, Dendrobaena sp., Dendrodrilus rubidus rubidus, Eisenia lucens, Lumbricus rubellus, Lumbricus terrestris, Lumbricus terrestris linnaeus, Octodrilus complanatus, Octodrilus lissaensis, Octolasion lacteum.*

The aggregation index values in grassland, 2007 were higher for *Octolasion lacteum* and *Aporrectodea rosea rosea* eudominant species. In *Octolasion lacteum* species, the values of this index ranged from 1.60 – 3.03, with the highest aggregation, in ascending order, in September (2.01), April (2.65), August (3.00) and May (3.03) (Figure1).

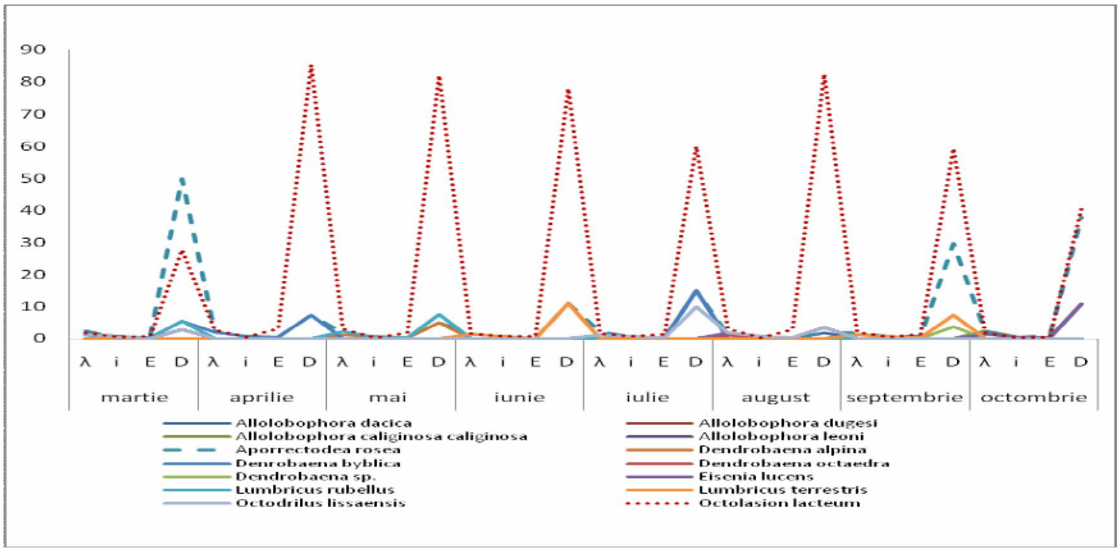

Figure 1. Indices of aggregation (λ), dispersion (i), expansion (E) and dominance (D) of lumbricidae in grassland, 2007 (Martie – March, aprilie – April, mai- may, iunie- June, iulie- July, august – August, sept – September, oct.- October)

In *Aporrectodea rosea rosea* species, the aggregation index ranged between 1.26 – 2.54, with the highest aggregations in July (2.19), October (2.20) and March (2.54). Although *Lumbricus terrestris* species was sampled in only two months, the aggregation index value was 2.19 in May, 2007. *Allolobophora caliginosa* was also present in October with an aggregation index of 2.52. The values of the other species ranged between 1.11 – 1.78.

From March to October 2008, there was a significant increase of the aggregation index values for most species in the grassland. *Octolasion lacteum* species had higher values compared to other species composing the structure of lumbricidae fauna in the grassland. In certain months of the period under study (March, May, June, August), the aggregation index values ranged from 3,03 to 3,81, while in others (April, July, September, October) these values ranged from 2,48 to 2,74. *Aporrectodea rosea rosea* species had values ranging from 1,73 to 3,25 (Figure 2).

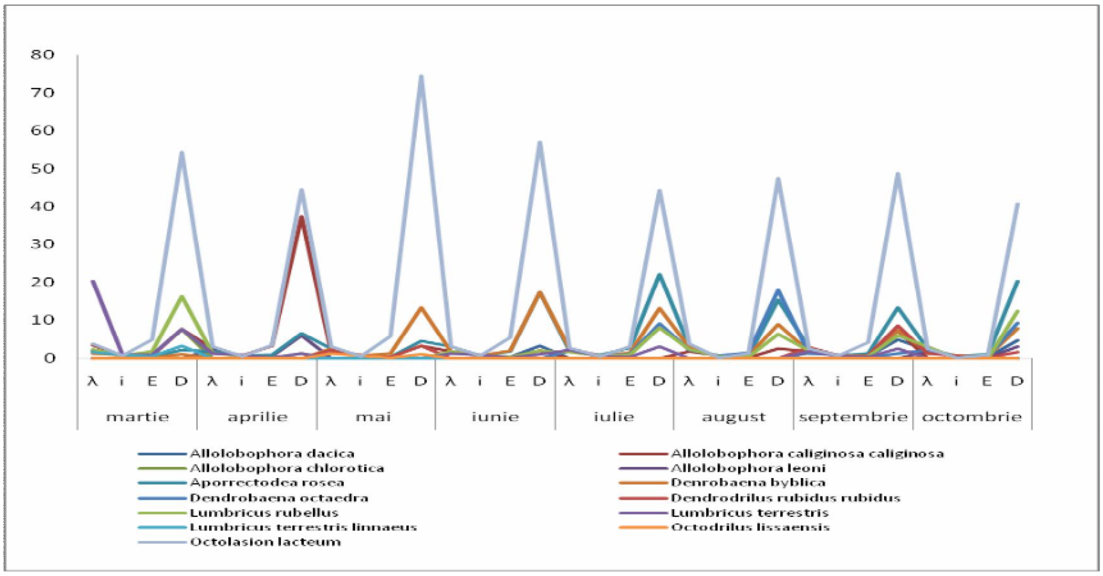

Figure 2. Indices of aggregation (λ), dispersion (i), expansion (E) and dominance (D) of lumbricidae in the grassland, 2008 (Martie – March, aprilie – April, mai- may, iunie- June, iulie- July, august – August, sept – September, oct.- October)

Considering the dispersion index values of lumbricidae in 2007 and comparing them with the values of this index in 2008, we noticed an increase especially in species with a higher aggregation index. The expansion degree of species in the grassland was higher in *Octolasion lacteum* both in 2007 and 2008. *Aporrectodea rosea rosea* species had lower values of this index in comparison with *Octolasion lacteum* species. In 2008, a higher expansion degree, in addition to the two species (*Octolasion lacteum* şi *Aporrectodea rosea rosea*) was observed in *Allolobophora caliginosa caliginosa*, *Dendrobaena byblica*, and *Dendrobaena octaedra. Octolasion lacteum* and *Aporrectodea rosea rosea* were the eudominant species in the grassland, in 2007.

In 2008, throughout the studied period, *Octolasion lacteum* and *Aporrectodea rosea rosea* were eudominant species, but, as for others indices of the grassland, there were species with higher values of this index, which placed them in certain months in the category of eudominant species. *Allolobophora caliginosa caliginosa* species was eudominant in October, *Dendrobaena byblica* – eudominant in July, dominant in April and subdominant in March, *Eisenia lucens* – eudominant in October, *Lumbricus rubellus* –dominant in March and May, *Lumbricus terrestris* – eudominant in June, dominant in September. The remaining species with lower values of the numerical dominance index were categorized as subdominant, eudominant and dominant (*Dendrobaena byblica, Lumbricus rubellus, Dendrobaena octaedra*).

Total receptivity in the grassland was high, almost 100%. In 2007 it ranged between 90 and 99.99, with the lowest value in July, while in 2008 the values ranged between 99.94 –100%.

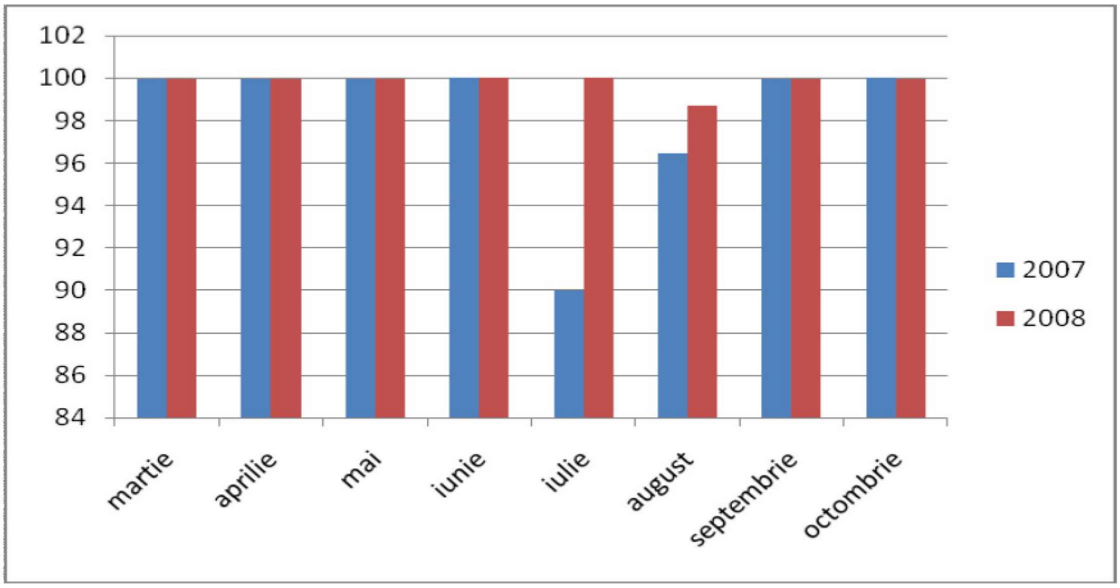

Figure 3. Total receptivity (R) of the habitat in the grassland (Martie – March, aprilie – April, mai- may, iunie- June, iulie- July, august – August, sept – September, oct.- October)

In their studies regarding the effect of earthworms on plants, Spehn et al., (2000) and Scheu (2003) made known the key role of earthworms in the cycle of nutrients and the improvement of the physical properties of the soil, and therefore, the growth and development of plants. Also, Wurst et al.,(2005) have showed that earthworms can increase the competitive capacity between plants, increasing the concentration of N for grasses. However, most studies have focused on the effect of plants on earthworms (Scheu, 2003, Brown et al., 2004). Kreuzer and al., (2004) have studied the activity of earthworms in the soil and concluded that it is more pronounced in graminaceae than in legumes, suggesting that their activity varies according to the groups of functional plants. Hirth et al., (1998) have found that *Aporrectodea rosea rosea* builts its galleries near the roots of perennial plants, suggesting that the roots associated with microorganisms are part of the endogeic earthworms diet. This research confirms the many and different ways of organising lumbricidae species in the grassland, as part of the present study.

4. CONCLUSIONS

Octolasion lacteum and *Aporrectodea rosea rosea* species had higher values of the indices of aggregation, dispersion and dominance in the two periods analysed (2007-2008), performing the main functions within the biocenosis. The higher aggregation of species in the grassland, in certain months expressed a lower number of points with optimal food and physiological conditions. It also emerges the idea that, a higher density of the population caused a higher degree of expansion, which gave the species a determining role within the biogenesis.

The dominance index of *Allolobophora caliginosa*, *Allolobophora dacica, Dendrobaena byblica, Dendrobaena octaedra, Lumbricus rubellus, Lumbricus terrestris* species with certain position variations in certain months, completed the general picture of the dominant species, followed by the other species, each with a lower or higher value, which occupied a precise position within the ecosystem.

In terms of total receptivity of the lumbricidae species, the high values of this index led to the conclusion that lumbricidae found optimal conditions for their activity and development in the grassland. The high percentage of the aggregation tendency for different species, even anecic ones, at the upper levels of the soil, especially between the plant roots, showed the plant influence on lumbricidae by the availability of food sources for this group of invertebrates.

5. REFERENCES

Brown G.G., Edwards C.A., Brussaard L. (2004) *How earthworms affect plant growth: burrowing into the mechanisms.* In: Edwards CA (ed) Earthworm Ecology, 2nd ed. CRC Press, Boca Raton, pp 13-49.

Debauche, H.R. (1962) *The structural analysis of animal communities of the soil.* In: Murphy PW (ed) Progress in soil zoology. Butterworths, London, pp 10–25.

Hirth J.R., McKenzie B.M., Tisdall J.M. (1998) *Roots of perennial ryegrass (Lolium perenne) influence the burrowing of the endogeic earthworm Aporrectodea rosea.* Soil Biology & Biochemistry 30: 2181-2183.

Kreuzer K., Bonkowski M., Langel R., Scheu S. (2004) *Decomposer animals (Lumbricidae, Collembola) and organic matter distribution affect the performance of Lolium perenne (Poaceae) and Trifolium repens (Fabaceae).* Soil Biology and Biochemistry 36: 2005-2011.

Motcă Gh., Oancea I., Geamănu L. (1994) *Pajiştile României (tipologie tehnologie).* Editura Tehnicã Agricolã, Bucureşti, 256 p.

Pop V. (1949) *Lumbricidele din România. Anal. Acad. Rep.Pop. Române.* 1(9): 383-505.

Scheu S. (2003) *Effects of earthworms on plant growth: patterns and perspectives.* Pedobiologia 47: 1-11.

Spehn E.M., Joshi J., Schmid B., Alphei J., Körner C. (2000) *Plant diversity effects on soil heterotrophic activity in experimental grassland ecosystems.* Plant and Soil 224: 217-230.

Wurst S., Langel R., Scheu S. (2005) *Do endogeic earthworms change plant competition?* A microcosm study. Plant and Soil 271: 123-130.