ECOLOGICAL RESEARCH ON THE DYNAMICS OF BIOMASS AND BIOLOGICAL PRODUCTIVITY SPECIES *OCTOLASION LACTEUM* *"(OLIGOCHAETA – LUMBRICIDAE)"*

Gheorghita Brinzea*

*University of Pitesti, Targu din Vale street, No. 1, Pitesti, Romania
E-mail: georgeta_branzea@yahoo.com

Abstract
The present study analyzes Octolasion (Oligochaeta - Lumbricidae) and Octolasion lacteum species in terms of biomass dynamics and biological productivity at different soil levels (from 10cm to 40cm) in three hilly forest areas of Cândeşti Piedmont, Arges County, in the period March- October 2008. This species belongs to the group of endogeic species with an important role in mixing organic-mineral soils and is considered eudominant with the most important role in the functioning of forest ecosystems. The results showed that the monthly biomass of the soil levels in the three areas ranged from 0.57 - 3.221 mg.d.s/m2 in the deciduous forest, 0.22 - 0.492 mg.d.s/m2 in the spruce forest and 0.67 - 2,389 mg.d.s/m2 in the grassland. The deciduous (20.155 mg.su./m^2) and the grassland forests (22.643 mg.su./m^2) had the highest biological productivity.

Keywords: Octolasion lacteum, deciduous, spruce, grassland, biomass, environmental factors

1. INTRODUCTION

Earthworms play an important role as of soil "ecosystem engineers" to maintain soil fertility and in soil conservation. Through their activity they influence soil properties that determine its functional characteristics. Through their feeding, burrowing and casting habits earthworms enhance the incorporation of organic matter into soils and stimulate the formation of macroaggregates that impacts on soil structure as well as on the population of soil organisms (Guggenberger et al., 1996; Blanchart et al., 1997, Bossuyt et al., 2005; Pérès et al., 2010; Briones et al., 2011). Activity of earthworms has a such an impact on important regulatory functions like those associated with the soil water balance, regulation of biological population, nutrient cycling and soil organic carbon cycles that determine important ecosystem services like carbon sequestration and water supply and therefore the ability to sustain agricultural productivity (Derouard et al., 1997; Bronick and Lal, 2005; Ilstedt et al., 2007; Bhardwaj et al., 2011). However, these roles may depend on the type of ecological categories, namely epigeic, endogeic and anecic species (Bouché, 1977); and their functional attributes (e.g. compacting vs decompacting). Earthworms of different ecological groups prefer differenthabitats and feed on different food resources. Their effect on soil structure through the type and amounts of burrows created and type and amount of cast produced will depend on the group (Pérès et al., 2010). Epigeic earthworm species, incorporate litter material into the mineral soil thereby making it available to all kinds of soil organism to enter the soil food web, and hereby increasing soil porosity (Monroy et al., 2011). Anecic species mix plant fragments and mineral particles ingested during their burrowing through the soil and feeding on the surface and stimulates humification and the formation of stable organic-mineral compounds. Consequently, they increase soil macroporosity and enhance water infiltration. Endogeic earthworm species primarily consume soil and associated humified organic matter in the upper layer of the mineral soil. However, their effect on soil physical properties depends on the organic matter content in soils and on cast types, because of the selective feeding on organic materials, low assimilation efficiency and depending on body size, (Blanchart et al., 2004; Jiménez and Decaëns, 2004). The activity of endogeic earthworms leads to the formation of mull-type soils (Müller 1950, Bal 1982, Scheu 1987, Bernier 1998). Mull soils are characterised by a complete mixing of fragmented litter into the mineral soil layers by the soil macrofauna resulting in an accumulation of soil organic matter in mineral soil horizons (Kubiena, 1948). Mull type soils are common in mature deciduous forests with a relative high pH.

The areas under study show the following characteristics: the *deciduous forest* is located on a slope with a sunny southeast exhibition, average inclination, holm-beechwood forest type, the type of station is hilly (holm), *Asarum stellaria* flora, soil type: dystric regosols, medium sandy clay/ medium clay; pH between 4.70-5.51; the *spruce forest* is located in the middle third of a corrugated slope with a medium inclination of 20^0, shady northeast exhibition; the stand is a monoculture, 100% spruce, having artificial origin by plantation, *Asarum stellaria* flora, soil type: dystric regosols, medium clay; pH between 4.60-5.28; *the grassland* is located in the lower third of the slope between the spruce forest side and a river stream with an average inclination of 10^0, northeast exhibition. It is a natural grassland where grass vegetation has settled spontaneously. The herbaceous vegetation in the grassland comprises *gramineous plants*, *legumes, Cyperaceae, Juncaceae* and other plants belonging to species and different families, the type of soil: aluvisol coluvic, medium sandy clay/medium clay, pH between 5.14-5.56. The aim of this study was to observe the monthly dynamics of biomass and biological productivity of the species *Octolasion lacteum* assuming that an increase in the biomass and hence higher productivity may be associated with plant species diversity and composition as weel as microclimate conditions existing in these forest ecosystems.

2. MATERIAL AND METHOD

The *Lumbricidae* samples were taken randomly, from March to October 2008, by making ten holes in the station, using a metal frame with sides of 25/25 cm. The sample units were built on depth levels, namely: L = litter; S_1 = 10 cm; S_2 = 20 cm; S_3 = 30 cm; S_4 = 40 cm. The earthworms were manually extracted from the samples, immediately after making the holes and put in tightly closed containers of 90^0 alcohol. The containers had labels containing: sampling place, date (day, month, year), depth of the soil, sample number.

The faunistic material was taken to the laboratory in order to test each species, using a determinator (Easton, 1983; Pop, 1949).

The biomass of *Lumbricidae* species was calculated by the ratio between individual weight and dry weight of each individual (mg.d.s./m^2). Individual live weight and individual weight after drying was determined by weighing on analytical balance. To remove water from the body, the faunistic material was dried in a drying cabinet, at a temperature of 105^0C. By successive weighings, after 48 hours, the weight of the individuals remained constant and drying was complete. Estimation of gravimetric abundance in the form of dry weight, per square meter, facilitated calculation of biological productivity of *Lumbricidae* during one year, expressed as gravimetric increases on a time unit. Data on biological productivity were obtained by adding gravimetric differences between collection time, within a month.

3. RESULTS AND DISCUSSIONS

The monthly biomass of the soil levels in the three ecosystems (fig.1), ranged between 0.57 – 3.221 mg.d.s./m^2 in the deciduous forest 0.22 – 0.492 mg.d.s./m^2, in the spruce forest and 0.67 – 2.389 mg.d.s./m^2 in the grassland. The species recorded the highest biomass at level S1 (10cm) in March (3.221 mg.d.s./m2), standing for 15.98% of the total biomass in the deciduous forest.

The biomass of the spruce forest is underrepresented at the soil levels under study. At level S1 (10cm) the biomass value was 0.492 mg.d.s../m^2, standing for 13.52%, whereas the highest biomass of the grassland was in the stand, in May, 2.389 mg.d.s./m^2, resulting in 10.55% of the species total biomass in the analyzed period (fig.1).

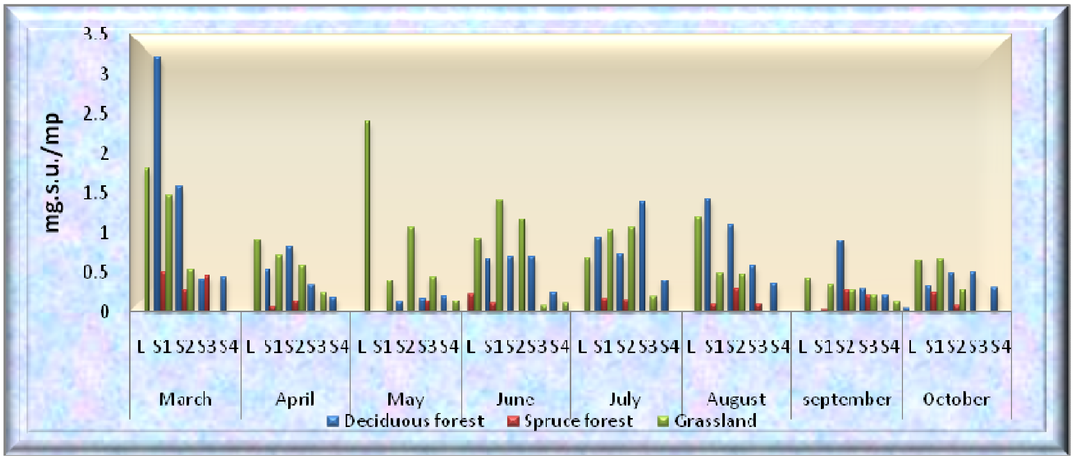

Figure 1. Monthly dynamics of the biomass in the soil levels for Octolasion lacteum species in the period March-October 2008

The total biomass of the deciduous forest ranged between 0.487 – 5.632 mg.d.s./m^2, that is 27.94%, the biomass of the spruce forest recorded values between 0.32 – 1.211 mg.d.s./m^2, that is 16.74%, whereas the biomass of the grassland ranged between 1.349 – 4.396 mg.d.s./m^2, standing for 19.41% (fig.2).

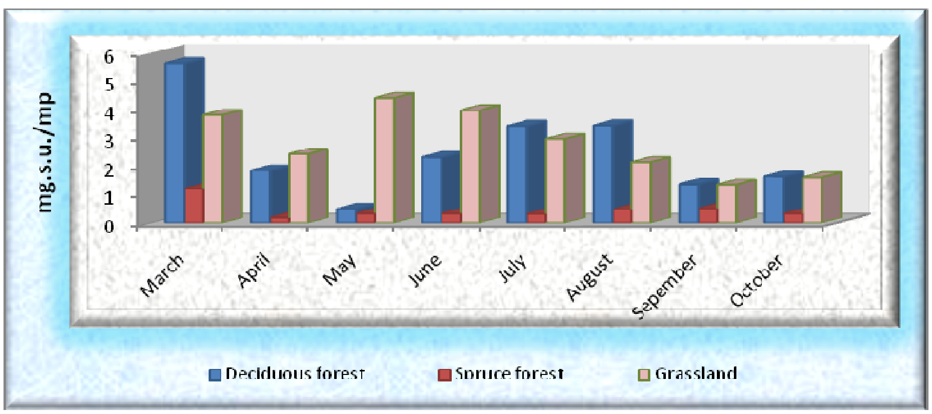

Figure 2. Monthly total biomass of Octolasion lacteum species in the period March-October 2008

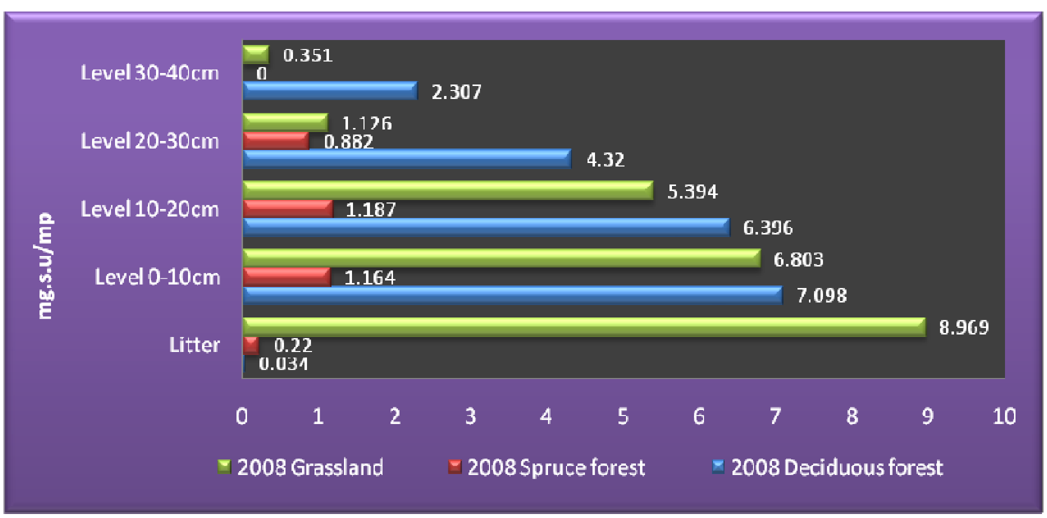

Figure 3. Biological productivity at the soil levels for Octolasion lacteum species in the period March-October 2008

The biological productivity of *Octolasion lacteum* species in 2008, is shown in figure 3. The stand in the grassland recorded a high productivity (8.969 mg.s.u./m^2). Not the same has been observed in the spruce forest where productivity was low at all soil levels. Also, although the biological productivity was higher in the deciduous forest and grassland, however it decreased as the soil level deepened.

The total productivity of *Octolasion lacteum* species in the three ecosystems , figure 4, was higher in the deciduous forest and the grassland, and lower in the spruce forest. The highest total productivity of the grassland was 22.643 mg.d.s./m^2. The productivity in the deciduous forest was 20.155 mg.d.s./$m^{2,}$ whereas the total productivity value in the spruce forest was 3.453 mg. d.s/m ^{2}. It can be noticed that *Octolasion lacteum* species records high productivity and biomass in the deciduous forest and the grassland which explains the species preference for certain soil types. Several studies (Wardle, 2002; Tian et al., 1993; Zou, 1993) suggest that the chemical composition of plants, especially N, lignin contents, and phenolic compounds play a crucial role in the abundance of soil and litter fauna through their effect in palatability and decomposability. Epigeic and anecic earthworms, the functional groups most affected by litter quality, are more likely to be directly influenced by the interspecific differences in plant residues; however endogeic earthworms have also shown preferences of some plant residues over others (Sarlo, 2006).

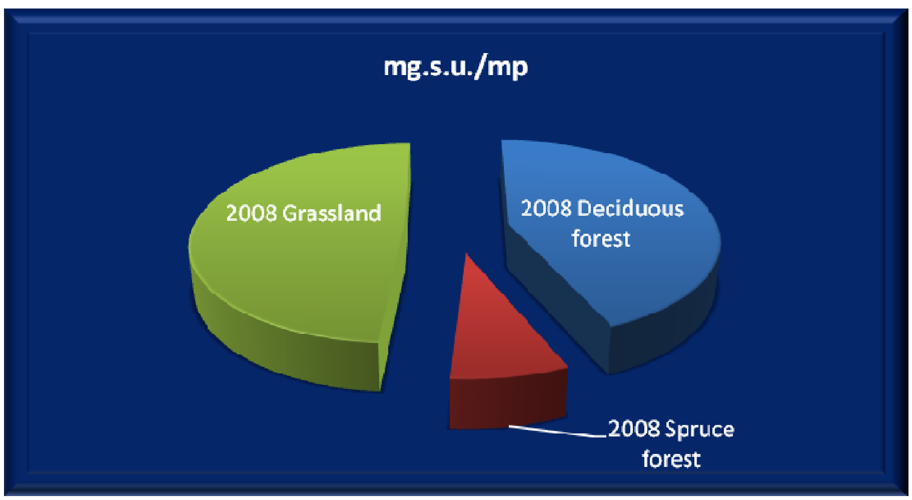

Figure 4. Total productivity of Octolasion lacteum species in the period under study

Octolasion lacteum species is usually common to all types of soil, but is most common in sandy, alluvial and clay soils in the hills, as in the case of the analyzed stations, where it prevails. Soil organic matter is an important resource of food for endogeic earthworms , but little is known about the size and origin of organic matter in which earthworms actually live.

4. CONCLUSIONS

The results of the present study show that the dynamics of biomass and monthly productivity of the soil levels differ depending on the analyzed surface, soil type and level, thus observing high values of the parameters analyzed at the higher levels of the soil. This demonstrates that these species migrate upward bringing organic debris in the mineral layers which subsequently contributes to soil mineralization. The biological productivity, assessed on the basis of biomass growth, differentiates the deciduous forest and grassland from spruce forest.Due to high summer temperatures the activity and metabolism of *Octolasion lacteum* species were reduced resulting in a lower biomass.

6. REFERENCES

Bal L. (1982) Zoological ripening of soils. Centre for Agricultural Publishing and Documents, Wageningen.

Bernier N. (1998) Earthworm feeding activity and development of the humus profile. Biology and Fertility of Soils. 26: 215-223.

Bhardwaj A.K., Jasrotia P., Hamilton S.K., Roberston G.P. (2011). Ecological management of intensively cropped agro-ecosystems improves soil quality with sustained productivity. Agriculture, Ecosystems and Environment. 140: 419–429.

Blanchart E., Albrecht A., Brown G., Decaens T., Duboisset A et al. (2004). Effects of tropical endogeic earthworms on soil erosion. Agriculture: Ecosystems and Environment 104: 303–315.

Blanchart E., Lavelle P., Braudeau E., LeBissonnais Y., Valentin C. (1997). Regulation of soil structure by geophagous earthworm activities in humid savannas of Côte d'Ivoire. Soil Biology & Biochemistry. 29: 431–439.

Bossuyt H., Six J., Hendrix P.F. (2005). Protection of soil carbon by microaggregates within earthworm casts. Soil Biology & Biochemistry. 37: 251–258.

Bouché M.B. (1977). Stratégies lombricienne, in Soil Organisms as Components of Ecosystems. In: Lohm U, Persson T eds. Ecology Bulletin. Stockolm: NFR 122–132.

Briones M.J.I., Barreal M.E., Harrison A.C., Gallego P.P.(2011). Earthworms and nitrogen applications to improve soil health in an intensively cultivated kiwifruit orchard. Applied Soil Ecology 49: 158–166

Bronick C.J., Lal R. (2005). Soil structure and management: A review. Geoderma 124: 3–22 Derouard L., Tondoh J., Vilcosqui L., Lavelle P. (1997). Effects Of earthworm introduction on soil processes and plant growth. Soil Biology & Biochemistry 29: 542–545.

Guggenberger G., Thomas R.J., Zech W. (1996). Soil organic matter within earthworm casts of an anecic-endogeic tropical pasture community. Applied Soil Ecology 3: 263–274.

Ilstedt U., Malmer A., Verbeeten E., Murdiyarso D. (2007). The effect of afforestation on water infiltration in the tropics: A systematic review and meta-analysis. Forest Ecology and Management 251: 45–51.

Jiménez J.J., Decaëns T. (2004). The impact of soil organisms on soil functioning under neotropical pastures: A case study of a tropical anecic earthworm species. Agriculture, Ecosystems and Environment103: 329–342.

Kubiena W. L. (1948) Entwicklungslehre des Bodens. Springer, Wien.

Monroy F., Aira M., Dominguez J. (2011). Epigeic earthworms increase soil arthropod populations during first step of decomposition of organic matter. Pedobiologia 54: 93–99

Müller P.E. (1950). Forest soil studies, a contribution to silvicultural theory. III. On compacted ground deficient in mull, especially in beech forest. Dansk Skovforenings Tidsskrift. 1: 10-619.

Pérès G., Bellido A., Curmi P., Marmonier P., Cluzeau D. (2010). Relationships between earthworm communities and burrow number under different land-use systems. Pedobiologia 54: 37–44.

Sarlo M. (2006). Individual Tree Species Effects on Earthworm Biomass in a Tropical Plantation in Panama. Caribbean Journal of Science 42 (3), pp 419 - 427.

Scheu S. (1987). The role of substrate feeding earthworms (Lumbricidae) for bioturbation in a beechwood soil. Oecologia. 72: 192-196.

Tian G., Brussaard L., and Kang B.T. (1993). Biological effects of plant residues with contrasting chemical compositions under humid tropical conditions. Forest Ecology and Management. 31, pp 211 – 220.