THE NUMERICAL STRUCTURE OF LUMBRICIDAE POPULATIONS IN SOME TERRESTRIAL ECOSYSTEMS OF CÂNDEŞTI PIEDMONT (SOUTH ROMANIA, ARGEŞ COUNTY)

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Abstract. The present work establishes the species composition, numerical density and relative abundance of lumbricide populations in the soils of some of the forest ecosystems. The three ecosystems are: the mixture of beech and oak, spruce and grassland. These ecosystems are located into the high and middle hills of the Southern Carpathians, namely in the Candeşti Piedmont. Among the three types of studied ecosystems, differences have been reported, considering the parameters described above. Specific relief unit is the slope, plateau also being present. The dominant exposure of the slopes is partly sunny, with a bending curve that does not exceed 25-30 degrees and an altitude ranging between 340-700 m. Representative geological formations consist of alternating clay, coarse sand, gravel and boulders. The relative abundance revealed *Aporrectodea rosea rosea* and *Octolasion lacteum* species with the highest percentages in all stations. *Aporrectodea rosea rosea* species had the highest percentage of relative abundance in the spruce ecosystem in March. However, *Octolasion lacteum* species was best represented in the specific outline, in all months. Relative and numerical abundance and density of lumbricidae are influenced by several factors of biotope, among which pH and humidity are the most important.

Keywords: lumbricidae, numerical density, relative abundance, forest ecosystem.

INTRODUCTION

Soil organisms are known to affect plant growth by enhancing mineralization of soil organic matter and modifying physical and chemical properties of soil [2, 10]. Within soil organisms, earthworms are in term of biomass and activity among the most important detritivores in terrestrial ecosystems [5]. Earthworms are major driving forces for belowground processes [16].

The ecosystems under study are located in Dobreşti village, Argeş County (Romania). From a geographical point of view, these ecosystems are located in the forest of the fourth production unit of Cârcinov, which is administered by Topoloveni Forestry. Forests in this area are located in hilly floor vegetation of oak and beech. Characteristic of this floor is that the distribution of vegetation is strongly influenced by relief. Alternation spread of oak on the sunny slopes and beech in the shady area highlights the existence of different topoclimates. Depending on the particular soil, flora and vegetation existing in each studied area, lumbricidae can differentiate in terms of specific structure and numerical dynamics, which have an important role in decomposition and mineralization of organic matter [4]. The present study highlights the species composition, numerical density and relative abundance of species in the three terrestrial ecosystems of Dobreşti village – Cândeşti Piedmont.

Research on lumbricidae from some types of forest ecosystem in the Getic Plateau is noted for novelty both in terms of abstract faunal group and of some numerical parameters (density, space, distribution, diversity) and functional parameters (breathing of some eudominante species), in an area of the country in which such investigation were not performed. Also, the research stands as a contribution to better understand the influence of the soil abiotic factors on the structural organization of lumbricidae, that are a major group in the decomposition and mineralization processes of organic substance.

MATERIALS AND METHODS

Research has been conducted by environmental station method, near Dobreşti village, Argeş County (Central – Southern in Romania). There were established three stations each of 2500 square meters (50/50 feet), as follows: beech and oak ecosystem, spruce ecosystem and grassland ecosystem.

1. Beech and Oak Ecosystem is located on the right side of the valley Ruginoasa in the upper third of the slope, with an average slope angle of 20°; the altitude ranges between 380 – 400 m and the exhibition is S-E sunny. The litter is continuous, thin, due to rapid decomposition of the layer of leaves, branches fruit, etc. in humus. The flora is *Assarum stellaria* type. The forest is a mixture of oak and beech. The soil is clay-iluvial typically defined by A_0-B_t-C horizons. A_0 is the thick horizon of 20 to 30cm with moderate humus content and grainy structure, slightly skeletal with medium edaphic volume. B_t horizon is 80 – 100cm thick with a harder texture than A_0 and prismatic structure. The station is hilly type of medium brown oak productivity, low - medium - podzolic.

2. Spruce Ecosystem is located on the right side of the Cetatea Valley, in the middle third of the corrugated slope with an inclination of 20 ° and an altitude ranging from 340 to 430 m. The exhibition is N-E, which is shaded. The normal continuous litter is strongly enriched by the layer of fallen needles of spruce and slowly accumulated into humus. The flora is *Assarum stellaria* type. This stand was created artificially (through afforestation) due to the introduction of softwood outside its natural area in the period 1964 -1968. The soil is brown eumesobasic and the horizon is defined by B cambic (B_v) with the sequence of horizons A_0-B_v-C. The lithologic substrate is represented by clays and other substrates rich in calcium carbonate and other basic elements. A_0 horizon is dark brown and 10-40 cm thick with grainy texture and high excess of humus. B_v horizon is yellowish-brown, rusty, 50 to 100 cm thick with high base saturation of 55% physiological thickness of 60 cm, of medium to high fertility depending on edaphic volume.

3. Grassland ecosystem is located on the right side of Cetatea Valley, in the lower third of the slope between the edge of spruce forest and Cetatea water stream. The surface of the grassland is approximately 1.0 hectare, has an average slope of 10^0, an altitude of 340m and an N-E exhibition. The forest land is for administrative needs. Humus layer is thinner than in the neighboring spruce forest, the soil is brown eumezobasic, the clay slightly skeletal with brown internal drainage and high edaphic volume, with higher moisture due to its location at the foot of the slope and near the narrow valley rich in moisture from both rain water and groundwater in the area. The herbaceous stratum is well represented by living specimens such as *Assarum stellaria* scattered with a wide suite of accompanying species of *Mull* and *Mull-moder* type, such as *Assarum europaeum*, *Asperula odorata, Dactylis glomerata, Star holostea, Geum urbanum*.

The faunal material was collected monthly from March to October 2007, by making ten holes in each of the stations, using a 25/25 cm metal frame. The sample units were built on deep levels, namely: L = litter, S_1 = 10cm, S_2 = 20cm, S_3 = 30cm, S_4 = 40cm. Worms were extracted from samples by hand, immediately after making the holes, soaked into 90^0 alcohol and species determinations were made in the laboratory.

RESULTS

Lumbricidae species composition includes the following species: *Allolobophora caliginosa caliginosa, Allolobophora dacica, Allolobophora leoni, Allolobophora sp., Aporrectodea rosea rosea, Dendrobaena alpina Dendrobaena byblica, Dendrobaena octaedra, Dendrobaena sp. Dendrodrilus rubidus rubidus, Eisenia lucens, Lumbricus castaneus, Lumbricus rubellus rubellus, Lumbricus terrestris, Octodrilus complanatus, Octodrilus lissaensis, Octolasion lacteum.* Of these, some are specific to beech forests such as: *Allolobophora caliginosa caliginosa, Allolobophora dacica, Aporrectodea rosea rosea, Octolasion lacteum, Lumbricus terrestris.* Species such as: *Dendrobaena alpina, Dendrobaena octaedra, Dendrodrilus rubidus* are found in other forests, especially in spruce stands of altitude, and others, such as *Eisenia lucens* are identified especially in mixed forests of beech and fir [12].

Lumbricus rubellus rubellus is known to also exploit resources from deeper soil layers and therefore has been classified as epi-endogeic species whereas *Dendrodrilus rubidus rubidus* and *Dendrobaena. octaedra* are strictly epigeic species [15].

The relative abundance (Fig. 1-3) revealed *Aporrectodea rosea rosea* and *Octolasion lacteum* species with the highest percentages in all stations. *Aporrectodea rosea rosea* species had the highest percentage of relative abundance in the spruce ecosystem in March. However, *Octolasion lacteum* species was best represented in the specific outline, in all months, with rates ranging from 50 - 80.55 in the oak and beech ecosystem, 10 to 86.05 in the forest of spruce and 85.19 to 27.78 in the grassland ecosystem.

Based on relative abundance, the dominance index Mc Naughton and Wolf [11] was calculated, which takes into account only the first two species with the highest percentage in terms of relative abundance (Table 1).

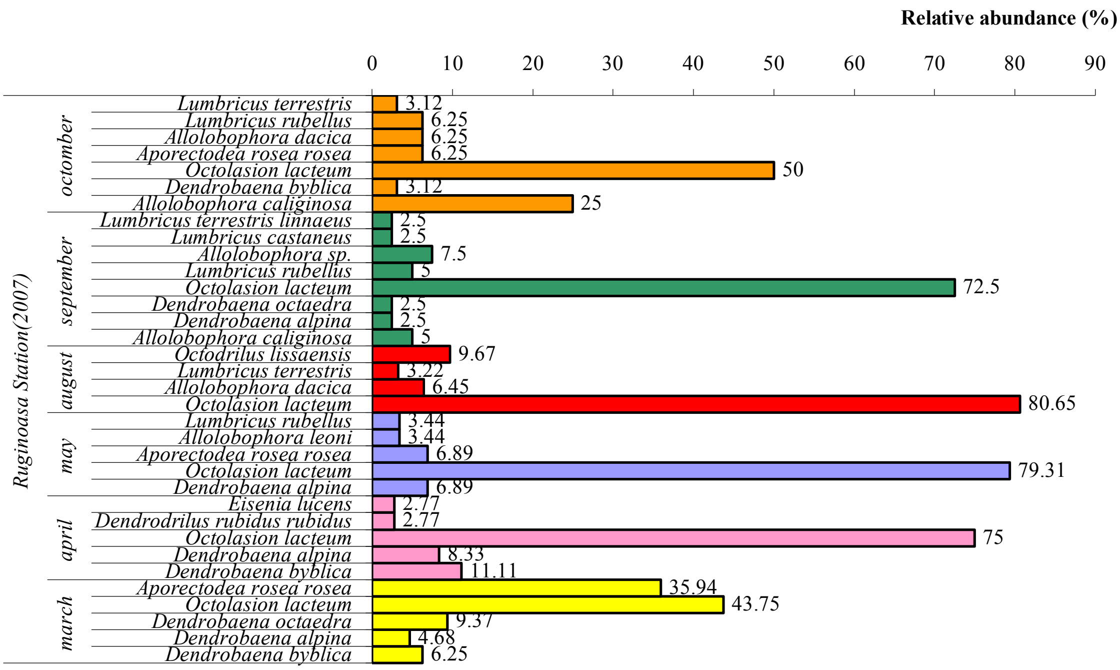

Figure 1. Relative abundance of lumbricidae species in oak and beech mixture.

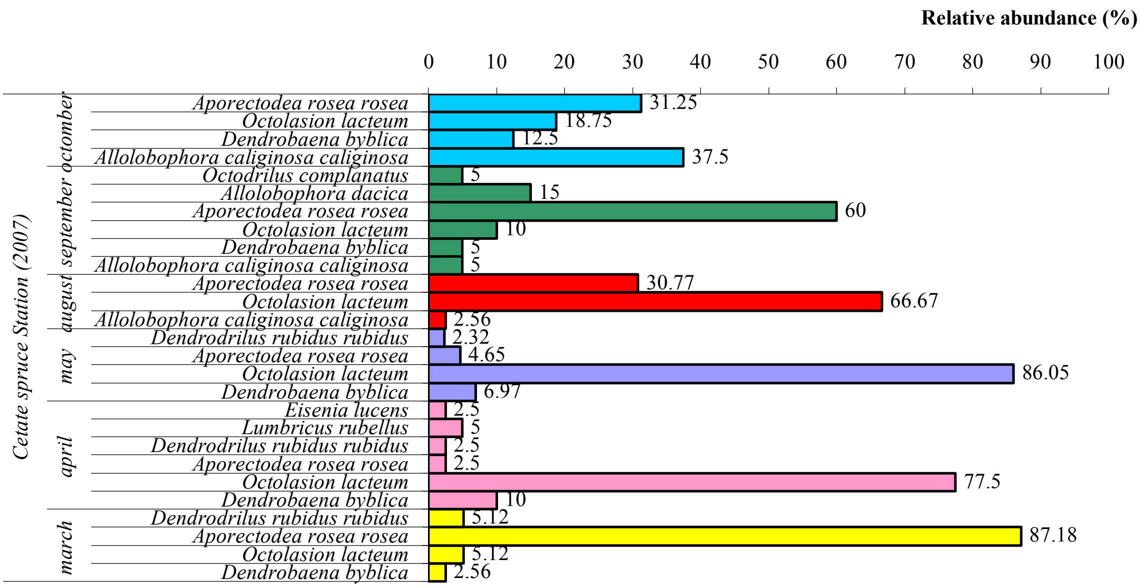

Figure 2. Relative abundance of lumbricidae species in the spruce ecosystem.

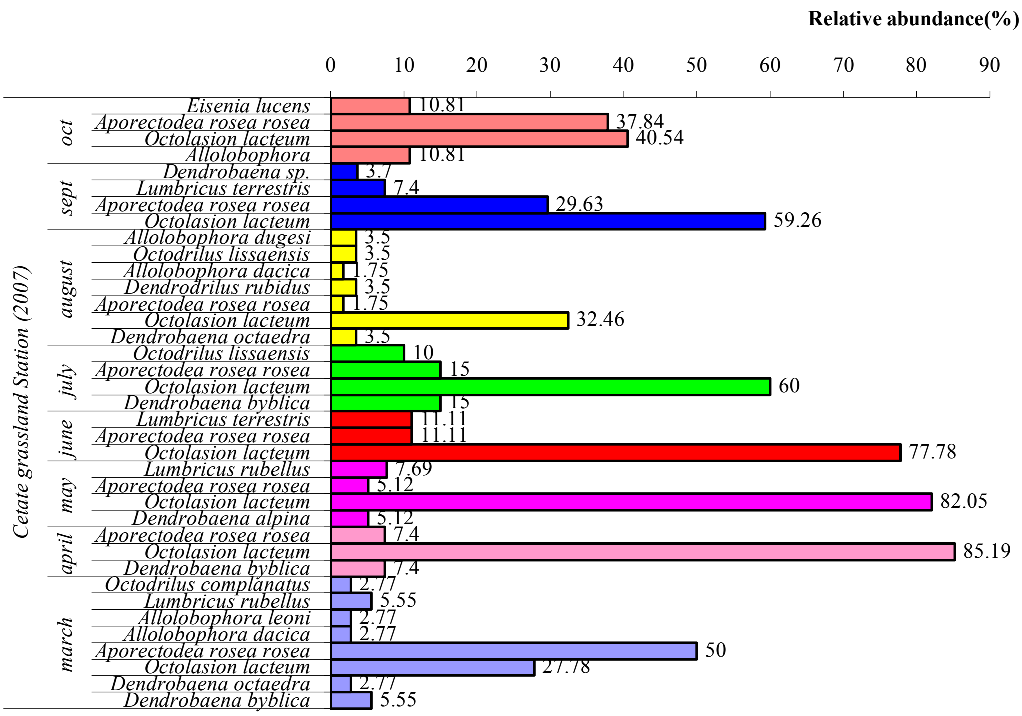

Figure 3. Relative abundance of lumbricidae species in the grassland ecosystem.

Table 1. The dominance index McNaughton and Wolf of lumbricidae species in some natural ecosystems of the Getic Plateau.

Species	Station		
	Oak and beech ecosystem	Spuce ecosystem	Grassland ecosystem
Octolasion lacteum	0.64	0.51	0.67
Aporrectodea rosea rosea	0.13	0.34	0.18

Only *Aporrectodea rosea rosea* and *Octolasion lacteum* species were numerically dominant in proportion of 77%, all the other species representing only a quarter of the proportion of the first two. Frequency and consistency of lumbricidae species showed the same two species, *Aporrectodea rosea rosea* and *Octolasion lacteum*, as constant species; the others are lateral and accidental species. Of all 17 species, 9 were common to all stations, 5 were common to spruce and the grassland stations, and one species, *Lumbricus castaneus,* was identified in the spruce and beech ecosystem soil. Numerical density, expressed as average number of individuals per square meter (Fig. 4-6) revealed the same two species *Octolasion lacteum* - mean 4.64 (1 SD: 4.3) in the mixed forest soil, 5.92 (1 SD: 7.66) in the spruce forest soil, 7.86 (1 SD: 7.2) in grassland ecosystem soil with the highest numerical densities in all stations, followed by *Aporrectodea rosea rosea* species - mean

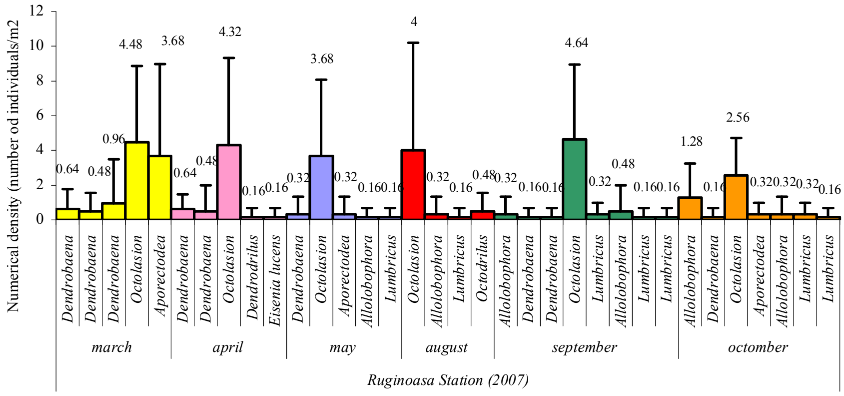

Figure 4. Numerical density of lumbricidae species in the spruce and beech ecosystem.

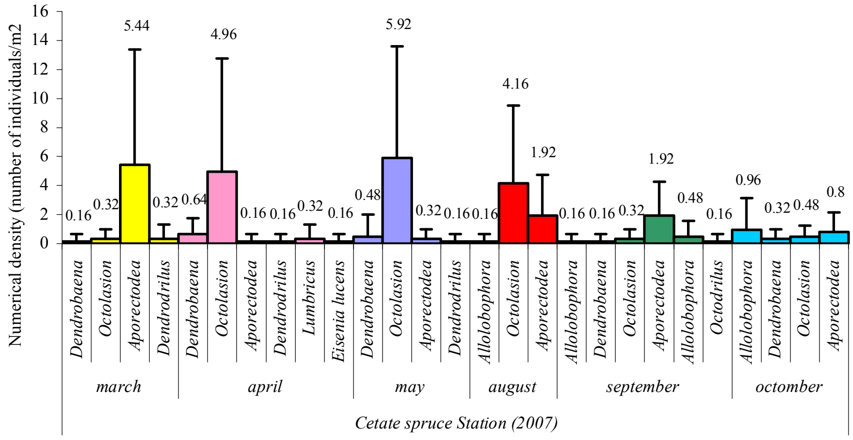

Figure 5. Numerical density of the lumbricidae species in the spruge ecosystem.

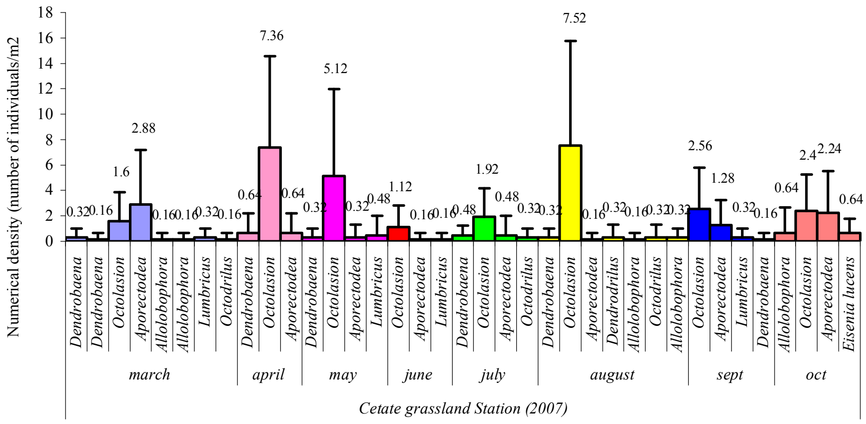

Figure 6. Numerical density of lumbricidae species in grassland ecosystem.

3.68 (1 SD: 5.28) in the mixed forest soil, 5.44 (1 SD: 7.92) in the spruce forest soil, 2.88 (1 SD: 4.32) in grassland ecosystem soil.

Both relative and numerical abundance and density of lumbricidae are influenced by several factors of biotope, among which pH (Table 2) and humidity (Tables 3 & 4) are the most important.

DISCUSSIONS

Soil pH was found to be a significant predictor of species density in the plant borders and is known to be a major factor influencing the distribution of a number of soil taxa, including the Oligochaeta, Diplopoda and Isopoda [17]. Such detritivorous groups rely on enzymes produced by microbes to aid decomposition of plant structural compounds, and these micro-organisms are strongly influenced by decreasing soil pH levels, resulting in decreased population densities of these macrofauna groups [20]. Soil pH also influences nutrient availability [17].

Table 2. Soil pH ecological station

Oak and beech ecosystem		Spruce ecosystem		Grassland ecosystem	
Horizon	**pH**	**Horizon**	**pH**	**Horizon**	**pH**
OF	5.28	OH	5.51	A	5.17
Ac	4.63	Ac	4.70	Ao	5.23
Cn_1	4.60	Cn_1	4.95	Cn_1	5.34
Cn_2	4.73	Cn_2	5.22	Cn_2	5.46
Cn_3	4.91	Cn_3	5.25	Cn_3	5.4

Table 3. Monthly dynamics of soil moisture (surface and depth) in the period: March-November 2007 in the spruce and beech ecosystem and the spruce ecosystem.

Level	March	April	May	June	July	August	Sept	October	Nov
0 st.	15.5	24.4	20.0	30.0	28.4	32.5	20.1	28.8	24.8
10 st.	20.3	24.8	21.0	30.7	28.0	32.4	20.9	29.5	28.5
0 for.	15.9	24.8	20.5	30.8	29.2	33.2	20.7	29.1	25.1
10 for.	20.5	25.0	21.4	31.2	28.4	32.8	21.3	29.9	28.7

Table 4. Monthly dynamics of soil moisture (surface and depth) in the period: March-November 2007 in the grassland ecosystem.

March	April	May	June	July	August	Sept	October	Nov
31.5	31.5	33.1	35.9	28.6	36.2	30.5	34.6	32.9
32.3	33.2	35.4	38.2	30.6	35.2	31.4	36.3	34.5
34.7	34.7	36.4	43.1	34.3	39.1	34.0	38.1	36.2
35.5	36.5	38.9	45.8	36.7	38.0	34.5	39.9	38.0

The soil pH is one of the most important limiting factors of lumbricidae populations. The soils of the studied stations are acidic, noting that acidity is higher in the beech and oak ecosystem, as well as the spruce ecosystem, compared with the grassland ecosystem where the pH values for all horizons, tend to be neutral. Most species prefer neutral or slightly acidic soils [8, 9].

Acidic litter of coniferous trees coupled with low evaporation rates during cold summer promote the leaching of base cautions and form generally very acidic soils with pH rarely above 5. Acidic soils under coniferous forests are unfavorable for most earthworms, except acid-tolerant species such as *Dendrobaena octaedra*, *Dendrodrilus rubidus rubidus* [18].

Dendrobaena species are generally acid, and among these, *D.octaedra* species identified with low relative abundance in all researched stations is cited as being more tolerant to acidity [6, 7]. It is known that *Dendrobaena octaedra* is highly resistant to low temperatures and for this reason the distribution of this species is related by the lower limits of temperature in its habitat [3]. The considerably higher resistance to low temperatures compared to other European species expands the ecological valence of *Dendrobaena octaedra*, thus favoring colonization of cold regions [3]. *Octolasion lacteum* species with the highest relative abundance in all three stations studied, but particularly in the grassland ecosystem, is classified as medium-tolerant slightly acidic species with pH around 5. The acid tolerant species category also comprises *Dendrodrillus rubidus rubidus* species, identified in all stations but with very small percentages. *Lumbricus rubellus* is slightly less tolerant of winter temperatures, but thrives in soils with a low pH [1].

In predominately deciduous forests the expansion of lumbricidae does not appear to be significantly affected by edaphic conditions or inhospitable habitat types even though earthworm populations or species may be limited in some localities by low soil pH and/or dry, coarse textured soils [18].

The soil relative humidity is another limiting factor of numerical abundance and density of lumbricidae species [19]. The soil moisture is lower in all horizons, in the oak and beech stations, as well as spruce stations, which are very close in space, compared to the grassland ecosystem. This difference in moisture influences the lumbricidae density which is highest in the grassland ecosystem, particularly for *Octolasion lacteum* species - mean 7.86 (1 SD: 7.2). *Lumbricus terrestris* occurs mainly in grasslands of city parks or in smaller arable areas where vegetables may be cultivated. A high density of *Octolasion lacteum* at this site showed that both invader species were involved in the replacement of the former earthworm fauna [13].

Earthworms can significantly influence grassland ecosystems through their effects on soil nutrient and carbon (C) cycling, soil aggregation and porosity, decomposition and plant productivity [14].

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