Abundance, species richness and diversity of earthworms (lumbricidae) in several habitats of the northern part of Jastrebac Mountain

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Abstract: The aim of this study was to investigate the diversity of earthworms in different habitats (meadow, humid meadow, oak and beech forest). A total of nine earthworm species belonging to six genera were found in the studied habitats. In the studied habitats, the earthworm fauna was found to be different: the beech forest was richer in earthworms (6 taxa), while the oak forest was poorest in earthworms (3 taxa). The earthworm abundance was higher in the humid meadow (34 individuals), while was lower in the beech forest (17 individuals). A combination of the alpha diversity index (Shannon-Weaver, Evenness, and Berger-Parker) and beta diversity (Jaccard's coefficient of similarity) were used to determine the impact of studied habitats on the earthworm fauna. Shannon's diversity and Shannon's evenness indices had higher values in the beech forest/humid meadow, while the Berger-Parker index of dominance had higher values in oak forests. Jaccard's index of similarity showed the earthworm fauna was clearly separated between the oak forest, meadow, humid meadow and beech forest. The results of these indices confirmed that vegetation cover strongly influences the diversity of earthworm fauna.

Keywords: earthworm, diversity, habitats, indices, Jastrebac Mountain

1. Introduction

Jastrebac Mountain is located in the central part of Serbia and belongs to the Rhodopes Mountain range. It has a total length of about 45 km and is composed of two mountain massifs. The first of them is Veliki Jastrebac (in the west) and Mali Jastrebac (in the east). In a geological sense, the enigmatic area of Jastrebac Mt. in central Serbia is characterized by a complex geological structure with its wider environment, which is related to its position within the transit zone— the Vardar zone, between the units of the Adriatic and European plates, as well as to multiphase tectonic activity from the Mesozoic to the present day [1]. On the other hand, earthworms can act as useful

biodiversity indicators, as their abundance and richness may reflect the diversity of other arthropods [2]. Species diversity has two parts. In contrast to abundance, which refers to the overall number of individuals of each species present in a community, richness refers to the number of species present. During the last years, earthworm studies in Serbia gained new momentum and several papers added new data on the earthworm diversity of regions such as the Kopaonik Mountain [3, 4].

In this paper, we compare the earthworm fauna of different habitats in the Jastrebac Mt. Our objectives were: a) to determine species richness and abundance of earthworm fauna in studied habitats b) calculate alpha and beta diversity indices as well as to examine the impact of vegetation cover on the species richness and abundance of earthworm fauna in the studied habitats.

2. Material and Methods

The earthworm fauna was sampled on the northern part of Jastrebac Mt. (43° 23′ 31″N; 21° 26′ 57″E) during the course of two months in 2021 (from May and June, which coincided with the rainy season), in secondary oak forest (OF) (village Naupare 380 a.s.l.), primary beech forest (BF) (village Buci 450 a.s.l.), meadow (M) (village Naupare 380 a.s.l.) and humid meadow (HM) (near Lomnička River 300 a.s.l.). We sampled eight samples of 50 x 50 cm from each of the sampling units (plots). Earthworms were collected by the diluted formaldehyde method, complemented by digging and hand-sorting. The specimens were killed and fixed in 75% ethanol or 4% formaldehyde. The specimen identification was carried out based on the works of Stojanović et al. [5] using a stereo microscope. The material is deposited in the Earthworm Collection of the University of Kragujevac, Serbia (CEKUS).

Species richness (S) was represented by the number of species in the habitats, and total abundance (Ab) by the total number of individuals of each species in the habitats. We used alpha diversity (Shannon-Weaver (H'), Evenness (J'), and Berger-Parker (D_{BP}) indices) to describe the diversity of communities within habitats, while for diversity between habitats, we used cluster analysis (UPGMA) based on Jaccard's coefficient of similarity. Paleontological statistics software (PAST) was utilized for calculating the alpha and beta diversity indices in the studied habitats [6].

3. Results and Discussion

The present study resulted in reporting altogether nine earthworm species (*Aporrectodea caliginosa (*Savigny 1826), *Aporectodea rosea* (Savigny 1826), *Cernosvitovia dofeini* (Ude, 1922), *Lumbricus polyphemus* (Fitzinger, 1833), *Lumbricus rubellus* Hoffmeister, 1843, *Lumbricus terrestris* Linnaeus, 1758, *Octolasion lacteum* (Örley, 1881), *Panoniona leoni* (Michaelsen, 1891) and *Proctodirlus antipai* (Michaelsen, 1891)) belonging to six genera of the family Lumbricidae. The most abundant taxon in the BF and HM was *L. rubellus* (N = 10;58.8%/N = 23;67.6% of all observed individuals in mentioned habitats), while in OF and M (N = 17; 68%/N = 19; 70.3% of all observed individuals in

mentioned habitats) as well in the overall study *Ap. rosea* (N = 36; 34.9% of all observed individuals) was most abundant. It is not surprising that *Ap. rosea* is the species that dominates the investigated habitats. According to Stojanović et al. [7], one of the most represented earthworm species in Serbia is the peregrine species *Ap. rosea*. According to Lee [8], earthworm communities typically contain two to five taxa. Nevertheless, some studies indicated earthworm communities are reported to be able to have from one to 11 taxa [3, 9]. Our results showed BF and M were richer in earthworm species, while OF and HM were poorer in earthworm species. The xerothermic character of oak forests is caused by a small depth of useful soil layer, the skeleton presence on the surface and in profile and by water permeability, which is very unfavorable for earthworm species. The H' and J' indicated that the BF/HM had a higher species diversity/uniformity than the other habitats. In contrast, the D_{BP} index showed higher dominance species in OF (Table 1).

Table 1. Alpha diversity index of earthworm fauna in the studied habitats.

Alpha diversity	OF	M	HM	BF
S	3	5	4	6
Ab	25	27	34	17
H'	0.65	1.25	1.1	1.28
J'	0.64	0.7	0.75	0.6
D_{BP}	0.76	0.48	0.44	0.64

The cluster analysis showed a clear separation of earthworm fauna in studied habitats (Figure 1). Essentially, rankings in the cluster analysis of the select habitats confirm the obvious vegetation and earthworm relationship at the ecosystem level [2, 10].

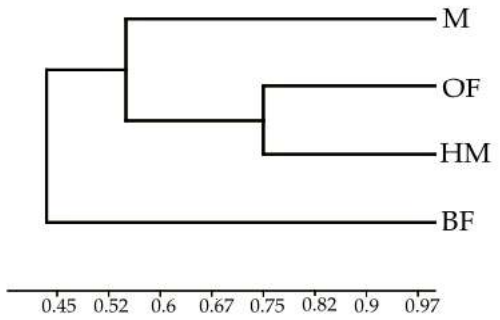

Figure 1. Cluster analysis (UPGMA) using Jaccard's index of similarity among the studied habitats.

3. Conclusions

This study indicates that species richness and abundance in studied habitats are different. The spatial distribution of earthworm fauna depends on a variety of factors, including the amount of food available and the characteristics of the soil (i.e., moisture, pH concentration, temperature, and organic matter). Actually, Lavelle & Spain [11]

established that earthworm diversity depends on the relative significance of different ecological categories of a region, climatic factors, phylogenetic and biogeographic history, and regional parameters such as vegetation type or soil characteristics. *Aporrectodea caliginosa*, *Ap. rosea* and *L. rubellus* were recorded in the studied habitats. These species have a wide ecological valence (peregrine species) and high tolerance when it comes to fluctuations in environmental factors. Overall, earthworms have important roles in the functioning of a variety of ecosystems and have high potential as model organisms for this type of study.

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