Influence of Soil Organic Matter Content on Abundance and Biomass of Earthworm (Oligochaeta: Lumbricidae) Populations

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Abstract. The current study explores the influence of soil organic matter content on abundance and biomass of earthworm communities. The observation was carried out on three type of soils: Pellic Vertisols (very fine texture), Cromi-Vertic Luvisols (fine texture) and Calcaric Fluvisols (medium texture) from the Balkan Peninsula (Bulgaria). The field experiment was provided on uncultivated plots. In the studied area earthworm fauna comprises of four species: Aporrectodea rosea, Aporrectodea caliginosa, Lumbricus terrestris and Octolasion lacteum. We found peregrine lumbricid taxa, which are widely distributed in European soils. Our study demonstrated that soil organic matter has a positive effect on lumbricid populations. It was revealed that augmentation of soil organic matter favours characteristics of earthworm communities. The soil organic matter content and earthworm abundance are in strong positive correlation (r > 0.981). The same relationship was revealed between the biomass of lumbricid fauna and amount of soil organic matter (r > 0.987). In sum, the soil organic matter could be used as an indicator for earthworm communities in uncultivated soils.

Key words: earthworms, Lumbricidae, Oligochaeta, soil organic matter, Aporrectodea rosea, Aporrectodea caliginosa, Lumbricus terrestris, Octolasion lacteum.

Introduction
Earthworms are considered as ecosystems engineers with great impact on physical, chemical and biological soils (Lavelle et al., 2007). Lumbricid abundance is considered major actors in the delivery of ecosystem services by soils. Earthworms feed and live in the soil, so their communities and their abundance are determined by soil properties and soil environmental conditions (Curry, 1998). Earthworms incorporate plant residues into the soil and decompose organic matter (Lavelle & Martin, 1992), thus affecting availability for plant and microbial growth (Edwards & Bohlen, 1996). Through their burrowing activities, they create habitats for soil mesofauna. Earthworms often form the major part of the soil fauna biomass, representing up to 50% of the soil fauna biomass in some temperate grasslands, and up to 60% in some temperate forests (Turbé et al., 2010).

Materials and Methods
The study was carried out over the 2011 - 2013 year period on uncultivated soils: Pellic Vertisols from Bozhurishte town, Cromi-Vertic Luvisols from Chelopechene village and Calcaric Fluvisols from Negovan village in Sofia Plain (Bulgaria). Earthworms were collected by the diluted formaldehyde method (Raw, 1959) complemented with digging 0.5 × 0.5 m quadrates, hand sorting and searching under stones and the bark of fallen logs. The biomass of
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The abundance of all collected earthworms was adjusted to one square meter. The specimens were killed in 70% ethanol, fixed in 4% formalin solution and 96% ethanol, then transferred into 75% ethanol. The organic matter content was estimated by the method of TURIN (1937). The statistical data were presented with correlation analyses and mean ± standard deviation.

**Table 1.** Earthworm abundance, biomass and soil organic matter content in studied soils.

<table>
<thead>
<tr>
<th>Soil</th>
<th>Abundance (n/m²)</th>
<th>Biomass (g/m²)</th>
<th>Soil organic matter (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pellic Vertisols</td>
<td>75±9</td>
<td>48±6</td>
<td>11.87</td>
</tr>
<tr>
<td>Cromi-Vertic Luvisols</td>
<td>45±4</td>
<td>32±3</td>
<td>3.0</td>
</tr>
<tr>
<td>Calcaric Fluvisols</td>
<td>32±3</td>
<td>33±2</td>
<td>1.8</td>
</tr>
</tbody>
</table>

The abundance of earthworms (Lumbricidae) increased proportionally with augmentation of soil organic matter content. The data showed a strong correlation R= 0.981008 (Fig. 1). The biomass of lumbricid communities ranged in the studied soils between 48 and 32 g/m². High biomass was estimated in Pellic Vertisols - 48 g/m². Calcaric Fluvisols and Chromi-Vertic Luvisols had earthworm populations with a similar biomass amount - 33 and 32 g/m².

Influence on earthworm biomass have not only organic matter, but and species biodiversity. In Calcaric Fluvisols, beside of lower abundance of earthworms in comparison with Chromi-Vertic Luvisols, the biomass is similar, because of high density of *Lumbricus terrestris*. This species is a large size earthworm with high biomass. Correlation analyses showed a strong relationship between the soil organic matter and earthworm biomass R= 0.987259 (Fig. 2).

Similarly, HENDRIX et al. (1992) reported a strong correlation between earthworm abundance and soil organic carbon. Earthworms play a major role for the accumulation and transformation of organic matter, while they ingest plant residues and soil enriched of organic litter. Earthworm populations could produce 1t/ha casts per year (TURBE et al., 2010) and form vermic horizon (NIELSEN & HOLE, 1964). Lumbricid species produce soil macroaggregates (casts), which can last years and are important for conservation of soil organic matter (MARTIN, 1991). Earthworms increase the turnover of soil organic carbon (STOUT, 1983), as they enhance humification in the soil and transformation of mor and moder type humus in mull humus (LANGMAID, 1964).

**Conclusions**

The field experiment revealed that the soil organic matter content favours abundance and biomass of earthworm (Lumbricidae) populations. Soil organic matter content and earthworm abundance and biomass are in a strong positive correlation in all explored types of soil. Influence of humus on lumbricid populations is very high, nevertheless of different soil texture. Overall, the soil organic matter could be used as indicator for earthworm communities in uncultivated soils.
Fig. 1. Correlation analysis between the earthworm abundance and soil organic matter content.

Fig. 2. Correlation analysis between earthworm biomass and soil organic matter content.
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References


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