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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 aclitellat and clitellat exemplars was estimated. 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.

Results and Discussion

The lumbricid density ranged between 75 – 32 exemplars/m². The earthworm abundance explored in study area revealed that a high value was measured in Pellic Vertisols (very fine soil texture) – 75 exemplars/m². Lower density was observed in Cromi-Vertic Luvisols (fine soil texture) 45 exemplars/m² and in Calcaric Fluvisols (medium soil texture) was observed - 32 exemplars/m² (Table 1).

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

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

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.

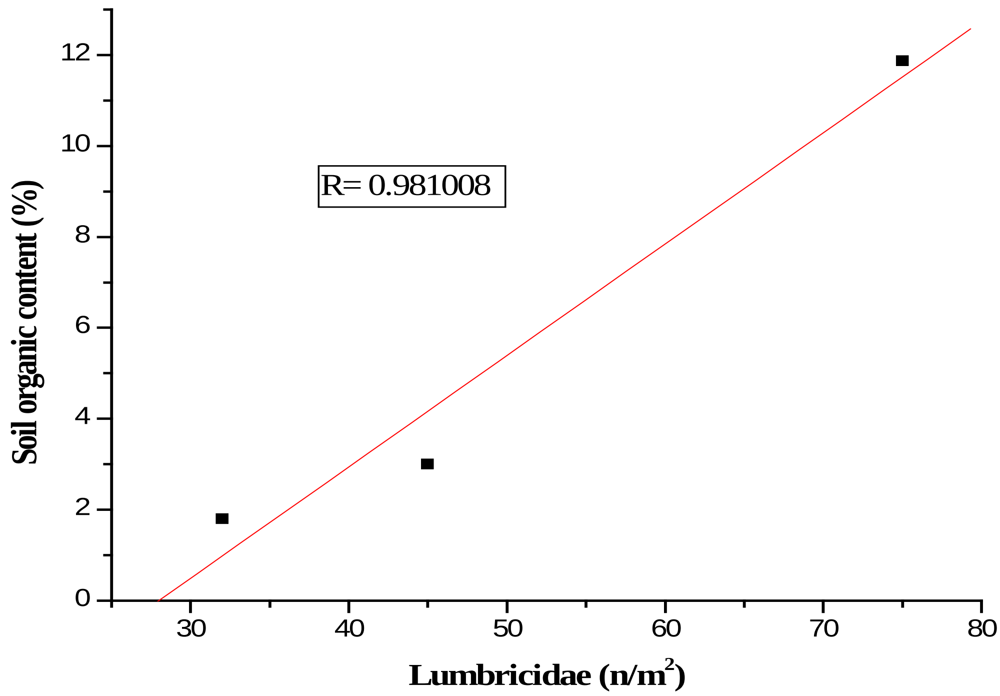

Fig. 1. Correlation analysis between the earthworm abundance and soil organic matter content.

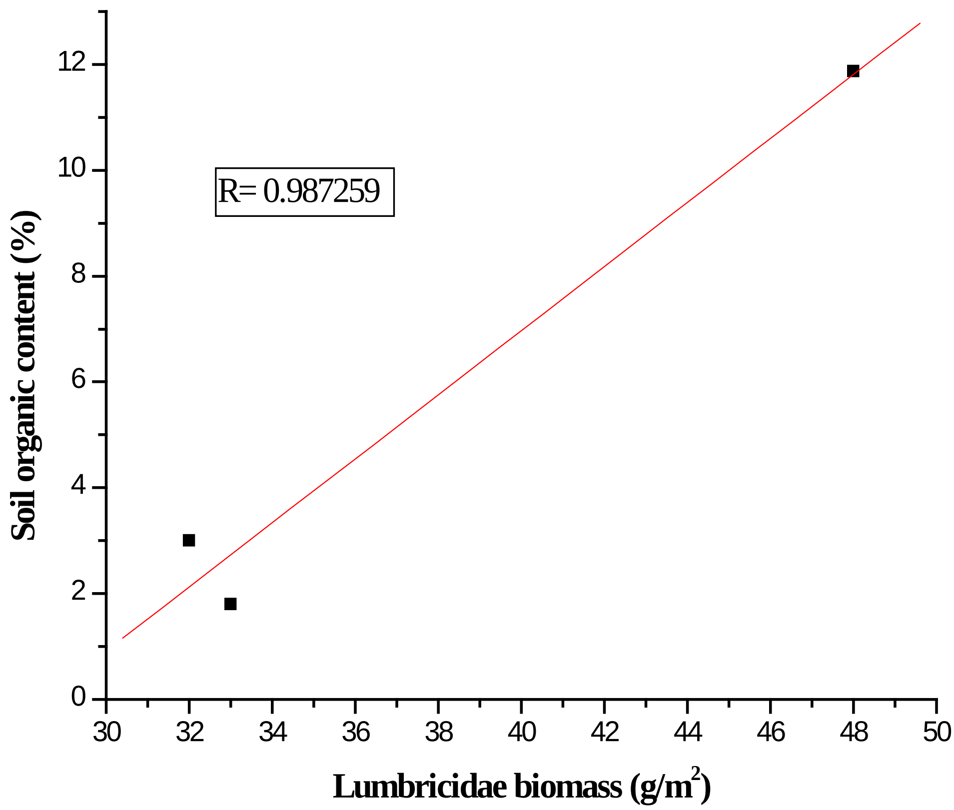

Fig 2. Correlation analysis between earthworm biomass and soil organic matter content.

References

CURRY J.P. 1998. Factors affecting earthworm abundance in soils. - In: Edwards C-A. (Ed.): *Earthworm Ecology*. Boca Raton, Florida. USA. CRC Press, pp. 37-64.

EDWARDS C.A., P.J. BOHLEN. 1996. *Biology and Ecology of Earthworms*. 3rd Ed. London, United Kingdom. Chapman and Hall.

HENDRIX P.F., B.R. MUELLER, R.R. BRUCE, G.W. LANGDALE, R.W. PARMELEE. 1992. Abundance and distribution of earthworms in relation to landscape factors in the Georgia Piedmont, USA. - *Soil Biology and Biochemistry*, 24(12): 1357-1361. [DOI]

MARTIN A. 1991. Short- and long-term effects of the endogeic earthworm *Millsonia anomala* (Omodeo) (Megascolecidae, Oligochaeta) of tropical savannas on soil organic matter. – *Biology and Fertility of Soils*, 11(3): 234-238. [DOI]

LANGMAID K.K. 1964. Some effects of earthworm invasion in virgin Podzols. – *Canadian Journal of Soil Sciense*, 44(1): 34-37. [DOI]

LAVELLE P., A. MARTIN. 1992. Small-scale and large-scale effects of endogeic earthworms on soil organic matter dynamics in soils of the humic tropics. - *Soil Biolology and Biochemistry*, 24(12): 1491-1498. [DOI]

LAVELLE P., S. BAROT, M. BLOUIN, TH. DECAËNS, J.J. JIMENEZ, P. JOUQUET. 2007. Earthworms as key factors in self-organized soil systems. - In: Cuddington K.J.E.B., W.G. Wilson, A. Hastings (Eds.): *Ecosystem Engineers: From Plants to Protists*, *Theoretical Ecology Series*, 5 chapter. The Netherlands. Elsevier, pp. 77-106. [DOI]

NIELSEN G.W., F.E. HOLE. 1964. Earthworms and the development of coprogenous A1 horizons in forest soils of Wisconsin. - *Soil Science Society America Journal*, 28(3): 426-430. [DOI]

RAW F. 1959. Estimating earthworm population by using formalin. – *Nature*, 184: 1661-1662. [DOI]

STOUT J.D. 1983. Organic matter turnover by earthworms. - In: Satchel1 J.E. (Ed.): *Earthworm Ecology from Darwin to Vermiculture*. London, United Kingdom. Chapman and Hall, pp. 35-48. [DOI]

TURBÉ A, A. TONI, P. BENITO, P. LAVELLE, N. RUIZ, W.H. VAN DER PUTTEN, E. LABOUZE, S. MUDGAL. 2010. *Soil biodiversity: functions, threats and tools for policy makers*. Bio Intelligence Service, IRD, and NIOO. Report for EC.

TURIN I.V. 1937. *Organic Substances of Soils*. Moscow, Russia. Selhozgis.

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