Vestnik zoologii, **51**(4): 349–352, 2017
DOI 10.1515/vzoo-2017-0040

Short communications

DE GRUYTER
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UDC 595.142:574(477.41/.42)

ECOLOGICAL SPECTRA OF THE MOST ABUNDANT LUMBRICID (OLIGOCHAETA, LUMBRICIDAE) SPECIES OF THE CENTRAL UKRAINIAN (POLISSIA)

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Ecological Spectra of the Most Abundant Lumbricid (Oligochaeta, Lumbricidae) Species of the Central Ukrainian (Polissia). Khomyak, I. V., Onischuk, I. P., Kotsyuba, Y. Yu. — Distribution of species in earthworm communities under the influence of basic environmental factors was established using phytoindication methods. We described the environmental spectrum for lumbricid certain species. *A. rosea* and *A. caliginosa* are identified as everytopic species, *E. tetraedra*is is rather everytopic than stenotopic. *D. octaedra* and *De. rubidus* are stenotopic.
Key words: synphytoindication, ecotope, biocenosis, earthworms, ecological spectrum.

Introduction

Pedofauna is an important element of natural ecosystems. Similarly to other groups of organisms, it is now under the impact of various environmental changes. The global anthropogenic transformation of the biosphere is a threat to this group of organisms, which subsequently can lead to the disruption of energy and matter cycling in ecosystems and lead to their degradation (Gyliarov, 1953; Viktorov, 1987).

Today among the most actual approaches there are attempts to model the impact of anthropogenic and natural changes on individual cenopopulations and species of earthworms. This requires determining the fundamental environmental factors that make up the ecological spectrum of the species and will form the species' ecological niche.

The use of instrumental methods has several disadvantages (labor-intensiveness, high research costs, the need for complex instrumentation and equipment). The good solution for this is the synphytoindication approach, which has a rather small measurement error compared to instrumental studies, provides a summarized description of the factors and does not require expensive instruments and materials (Didukh, Pliuta 1994; Didukh, 2012).

We have selected materials concerning the most abundant typical lumbricid representatives commonly found in the studied types of plant communities. In Polissia region these communities belong to the following types: moderately moistened deciduous forests (alliance *Alno-Ulmion Br.-Bl.* R. Tx 1943), sedge bogs (alliance *Caricion lasiocarpae Venden Bergh.* Ap. Lebrun et al. 1949), hygrophytic meadows (alliance *Calthion palustris* R. Tx 1937), ruderal communities (alliance *Dauco-Melilotenion* Görs 1966), nemoral deciduous forests (alliance *Carpinion betuli* Oberd 1953).

The most common and abundant earthworm species in Eurasia are *Eiseniella tetraedra* (Savigny, 1826), *Dendrobaena octaedra* (Savigny, 1826) and *Dendridrilus rubidus* (Savigny, 1826). Among them *D. octaedra* is one of the most dominant forest lumbricid species of Northern Eurasia. It is a motile moisture-loving worm species, with well-studied anatomical, morphological, ecological features and geographical range, information on these peculiarities can be found in a number of scientific papers (Perel, 1979; Khomiak, Garbar, 2005; Popov, 2008). *De. rubidus* is a cosmopolitan species, which can be found in the forest litter and decaying wood (Perel, 1979). *E. tetraedra* inhabits riparian areas of water bodies, heavily waterlogged soils and forest floor (Perel, 1979; Popov, 2008). The numerous representatives of *Aporrectodea* (Öerley, 1885) genus, including *Aporrectodea rosea* (Savigny, 1826) and *Aporrectodea caliginosa* (Savigny, 1826) have a definitive importance in soil formation processes. Mentioned taxa are synanthropic species commonly occurring in the soils of pastures, orchards and forests.

Material and methods

Materials were collected in April–August 2016 from the territory of Central Polissia during the mass vegetation season. The collection, transportation and management of earthworms, was carried out using common techniques (Giliarov, 1953; Byzova et al., 1987) and for species identification we used the relevant identification keys (Perel, 1979; Vsevolodova-Perel, 1988).

Phytosociological relevés were carried out according to the standard method (Lavrenko, Korchagin, 1959;

Mirkin, 2001), on 10 by 10 m plots for herbaceous vegetation and 25 by 25 m plots for shrub and forest vegetation, also considering the visible boundaries of natural plant communities. Vegetation communities organized in long bands were processed as linear plots of 10–15 m. During the laboratory processing of the data and materials, we performed classification of the present plant communities according to the principles of floristic vegetation classification using Braun-Blanquet approaches (Westhoff, Maarel, 1973).

For each identified phytocoenosis we have investigated the lumbricid species composition, calculated Simpson and Berger-Parker dominance indices and assessed the Sypmpson species diversity index (table 1). In order to identify the similarities between the studied phytocoenoses, Chekanovski- Sørensen faunistic similarity indices were calculated (table 2).

With the use of synphytoindication approach we have determined the ecological factor indicators of the following studied ecotopes: sagittal and ruderal forests, sedge bogs, hygrophytic meadows, broad-leaved deciduous forests. Among the ecological factors we used 5 edaphic factors: long-term soil humidity regime (HD), soil acidity (RC), total salt regime (SL), soil carbonate content (CA), soil nitrogen content (NT) and 3 climatic factors: climate thermal regime (TM), climate continentality (KN) and cryo-climate (CR). Synphytoindication analysis was conducted using the standard relevé data processing method using geobotanical software package Simargl 1.12. (Didukh, Khomiak 2007; Khomiak, 2012 a, b).

Results and discussion

The moderately moistened deciduous forests were shown to be dominated by *De. rubidus* species, and subdominated by *D. octaedra*. Dominance indices of Simpson and Berger-Parker comprised 0.315 and 0.48 respectively (table 1), due to the moderate species diversity. The most abundant life forms appeared to be ground litter earthworms, because of the large amounts of dead foliage in ectohumus, while earthworms confined to the soils were few in number, as the forest soils are quite tight and poor in organic matter.

Sedge bogs and hygrophytic meadows were the phytocoenoses where the dominant species was *E. tetraedra*, and *A. rosea* was subdominant. Simpson and Berger-Parker dominance indices comprised 0.712 and 0.41 respectively for the bogs, and 0.83 and 0.56 for the meadows (table 1), which can be explained by low species diversity. The reason for the low faunistic richness of these plant communities could be due to the specificity of *physio-climatic* conditions: considerable soil humidity and soil damping together with poor soil aeration.

The dominant species in ruderal plant communities was *A. rosea*, and subdominant species was *Lumbricus terrestris* Linnaeus, 1758. Simpson and Berger-Parker dominance indices comprised 0.243 and 0.32 respectively (table 1) due to moderate species diversity. Relatively low values of the indices show more leveled dominance structure in this region because of prevailing fresh black soil rich in organic matter.

The dominant species in nemoral deciduous forests was *A. rosea*, and *A. caliginosa* was subdominant. Simpson and Berger-Parker dominance indices were 0.241 and 0.3 (table 1), indicating a moderate species diversity. Relatively low Simpson dominance index suggests a small proportion of individual dominant species, due to moderate soil humidity and considerable amount of leaf litter containing organic remains.

Combining synphytoindication characteristics of plant communities with the

Table 1. Indices of domination and diversity of the studied earthworm communities within the specific plant communities

Plant communities	Simpson's Dominance Index	Berger-Parker Index	Simpson's Diversity Index
Ruderal communities (alliance *Dauco-Melilotenion* Görs 1966)	0.243	0.32	0.757
Sedge bogs (alliance *Caricion lasiocarpae* Venden Bergh. ap. Lebrun et al. 1949)	0.712	0.83	0.288
Hygrophytic meadows(alliance *Calthion palustris* R. Tx 1937)	0.41	0.56	0.59
Moderately moistened deciduous forests (alliance *Alno-Ulmion* Br.-Bl. R. Tx 1943)	0.315	0.48	0.685
Nemoral deciduous forests (alliance *Carpinion betuli* Oberd 1953)	0.241	0.3	0.759

Table 2. Czekanowski-Sørensen indices of faunistic similarity

Plant communities	Indices				
	I	II	III	IV	V
I	-	50	60	50	80
II	50	-	40	100	50
III	60	25	-	33	60
IV	50	100	25	-	50
V	80	50	60	50	-

Note. I — *Dauco-Melilotenion*; II — *Calthion palustris*; III — *Alno-Ulmion*; IV — *Caricion lasiocarpae*; V — *Carpinion betuli.*

characteristics of lumbricid species groups we can see a comprehensive picture of earthworm distribution under the parameters of the main environmental factors and ecological spectrum for each of them (table 3).

One of the most important environmental factors for the distribution of earthworm species is the soil moisture. In terms of long-term moisture regime most species occur in mesophytic and hygromesophytic ecosystems (10.56–13.99 ecological scale points). Only *A. rosea*, *A. caliginosa* and *E. tetraedra* sometimes enter hygrophytic plant communities. The least humid ecotopes is a habitat for the representatives of *Lumbricus* Linnaeus, 1758 genus. Only *Aporrectodea* genus is characterized as the most eurytopic concerning the long-term soil humidity indicator.

Regarding the soil acidity regime, studied species mainly belong to the group of subacidophiles (6.74–7.56 ecological scale points or pH 5.5–6.5). Members of the *Aporrectodea* genus and *E. tetraedra* were also found in acidophilous conditions (5.86 points).

As for the general salt regime in soil, studied species were mainly found in mesotrophic ecotopes (5–7 ecological scale points or 95–150 mg/l of carbonates, chlorides and sulfates). *A. rosea*, *A. caliginosa* and *E. tetraedra* sometimes can occur in semioligotrophic soils. Occasionally, the species can tolerate the salinity levels of 4.88 ecological scale points, or 94 mg/l of salts. *A. rosea*, *A. caliginosa, E. tetraedra, L. terrestris, Lumbricus castaneus* (Savigny, 1826) and *L. rubellus* (Hoffmeister, 1843) are able of penetrating semieutrophic ecotopes. Maximum recorded salinity levels

Table 3. Synphytoindication characteristics of the ecotypes inhabited by lumbricids

Species	The average number of species	Indicators of environmental factors in scores for the unified Diduch-Plyuta scale							
		HD	RC	SL	NT	CA	TM	KN	CR
L. terrestris	10.3	12.48	6.74	5.95	5.89	4.92	8.13	8.20	7.89
	27	10.56	7.56	8.11	6.18	7.02	8.50	8.53	7.75
	23.3	12.19	7.34	6.11	5.96	5.29	8.49	8.15	8.30
L. castaneus	6.8	12.48	6.74	5.95	5.89	4.92	8.13	8.20	7.89
	11.00	10.56	7.56	8.11	6.18	7.02	8.50	8.53	7.75
D. octaedra	20.6	12.48	6.74	5.95	5.89	4.92	8.13	8.20	7.89
	16.6	12.19	7.34	6.11	5.96	5.29	8.49	8.15	8.30
De. rubidus	48.2	12.48	6.74	5.95	5.89	4.92	8.13	8.20	7.89
A. rosea	13.6	12.48	6.74	5.95	5.89	4.92	8.13	8.20	7.89
	26.4	15.61	5.86	4.88	3.83	3.87	7.09	8.83	6.76
	12.5	13.99	7.00	7.22	5.95	5.02	7.81	8.56	7.39
	35	10.56	7.56	8.11	6.18	7.02	8.50	8.53	7.75
	30	12.19	7.34	6.11	5.96	5.29	8.49	8.15	8.30
A. caliginosa	18	15.61	5.86	4.88	3.83	3.87	7.09	8.83	6.76
	4.2	13.99	7.00	7.22	5.95	5.02	7.81	8.56	7.39
	24.3	10.56	7.56	8.11	6.18	7.02	8.50	8.53	7.75
	26.6	12.19	7.34	6.11	5.96	5.29	8.49	8.15	8.30
E. tetraedra	56	15.61	5.86	4.88	3.83	3.87	7.09	8.83	6.76
	83.3	13.99	7.00	7.22	5.95	5.02	7.81	8.56	7.39
L. rubellus	5.4	10.56	7.56	8.11	6.18	7.02	8.50	8.53	7.75
	3.3	12.19	7.34	6.11	5.96	5.29	8.49	8.15	8.30

Legend. Long-term soil humidity regime (HD); soil acidity (RC); total salt regime (SL); soil carbonate content (CA); soil nitrogen content (NT) and 3 climatic factors: climate thermal regime (TM); climate continentality (KN) and cryo-climate (CR).

for the mentioned species equaled 8.11 scale points or 180 mg/l of salts content in soil. *A. rosea*, *A. caliginosa* and *E. tetraedra* are eurytopic, while *D. octaedra* and *De. rubidus* are stenotopic species according to salinity factor.

The studied species were often found in soils relatively poor in nitrates and ammonium salts (5.0–6.18 ecological scale points or 20–26 mg per 100 g of soil). The exceptions are *A. rosea*, *A. caliginosa* and *E. tetraedra*, which are able to live in subnitrophilous conditions (up to 3.83 ecological scale points, or 12 mg per 100 g of soil).

The tolerance limits of carbonate content in soil characterize these species as mainly hemicarbonatophobes (5.32 ecological scale points on average, or about 0.5 %). These ecotopes are characteristic for podzolic and gley meadow soils. With the exception of *A. caliginosa* and *L. rubellus*, all species occur in carbonatophobic conditions (up 3.87 scale points or 0.3 %).

The pedofauna representatives are not very prone to microclimatic changes, but they all inhabit ecotopes with relatively stable indicators of this type. The influence of microclimate has an indirect effect, through the creation of specific soil-forming conditions. Thus, concerning the climate thermal regime, their ecotopes belong to submicrothermic group (1465–1780·MJ·m^2·year). As to the climate continentality factor, ecotopes belong to hemioceanistic group (8.15–8.83 ecological scale points) and as to cryoclimate they belong to subcryophytic group (critical average temperatures of January are around –8 °C).

Conclusions

Ecotopes occupied by lumbricid species are characterized primarily as mesophytic, subacidophilous, mesotrophic, heminitrophilous, hemicarbonatophilous, submicrothermic, hemioceanistic, subcryophytic ecological groups.

Such species as *A. rosea*, *A. caliginosa* and, to a lesser extent, *E. tetraedra* are eurytopic concerning most environmental factors, while *D. octaedra* and *De. rubidus* are relatively stenotopic species.

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Received 18 November 2016
Accepted 23 May 2017