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ENCHYTRAEIDS (*OLIGOCHAETA*, *ENCHYTRAEIDAE*)
OF WARSAW AND MAZOVIA

ABSTRACT

The study on the species composition and abundance of the *Enchytraeidae* living in Warsaw was carried out on 24 plots in 1974—1977. In this period 22 species were recorded of eight genera, among which the genus *Fridericia* Mich. was most numerous (Tab. 1). The highest number of species occurred in the soils of parks, green areas of housing estates, and lawns in the centre of the town.

Four geographical groups of species have been distinguished: European (50.0%), Holarctic (37.5%), cosmopolitan (=geopolitan) (8.3%), and Palaearctic (4.2%) (Tab. 2).

No association of individual species with particular habitats was found. But the numbers of species and individuals were considerably higher on the plots located under or near the canopy of trees and shrubs. All the urban plots were generally characterized by considerably lower numbers of *Enchytraeidae* than other anthropogenic habitats, especially agroecosystems. As far as the origin of urban *Enchytraeidae* is concerned, local species predominate, with large ranges and high adaptability to changing environmental conditions.

INTRODUCTION

Among many groups of soil fauna, most ecological and faunistic data concern *Lumbricidae* and *Enchytraeidae* (*Oligochaeta*). However, *Enchytraeidae* have received much less attention than *Lumbricidae*. The occurrence of the latter group in different soil types as well as its effect on the structure and fertility of soils were discussed as early as in the 1850s. The biology and ecology of *Enchytraeidae* have been studied in more detail only during the last 20 years. Most of the studies on *Enchytraeidae*, mainly faunistic, were carried out in different types of natural ecosystems, and only very recently these animals have become the subject of detailed and more comprehensive ecological studies in anthropogenic environments, particularly in agrocoenoses.

Information on the *Enchytraeidae* fauna in urban habitats has been very incomplete as yet. First remarks on the occurrence of these animals in towns are reported by Nusbaum [31], who found several species in the soil of gardens in Lwów. He does not report, however, any more detailed

information on the occurrence and abundance of the recorded species. Some references to the occurrence of few *Enchytraeidae* species in urban habitats are also given by Jaworowski [5—7], who observed them in wells of Kraków and Lwów. More detailed study on the occurrence of *Enchytraeidae* in different urban habitats of Poznań and Lwów was conducted by Moszyński [26], who presented not only qualitative but also quantitative characteristics of these animals in the soil of urban parks and suburban gardens, meadows and clumps of trees. It is worth noticing that for some urban habitats this author prepared a short analysis of the effect of ecological conditions, particularly, of soil moisture and structure, humus content and plant remains, on the occurrence and numbers of *Enchytraeidae* [24—27]. Scant references to the occurrence of few species in soils of Poznań and Inowrocław are to be found also in earlier papers by Moszyński [21—23]. His studies were also concerned with the occurrence of *Enchytraeidae* in greenhouses and flower pots [26, 28]. The faunistic-ecological studies were then continued by Kasprzak [8—12], who characterized the occurrence of many *Enchytraeidae* species in different terrestrial habitats of Poznań. Particular attention was paid to the *Enchytraeidae* fauna of marshy soils of the alder (*Alnus glutinosa*) communities growing in green areas of Poznań [14].

The first information on the occurrence of *Enchytraeidae* in Warsaw we owe to Szczepański [35], who characterized the distribution of an aquatic species, *Propappus volki*, in the Vistula. The first information on the species composition, numbers, and the effect urban pressure on the *Enchytraeidae* inhabiting soils of the green areas of Warsaw, was provided by Kasprzak, Niedbała and Sterzyńska [16]. Data on the occurrence of *Enchytraeidae* in Mazovia are also very scarce. The only analysis is provided by Górny [3], who characterizes species composition and numbers of these animals in the soil of pine forests (*Vaccinio myrtilli-Pinetum typicum*) in the Kampinos National Park.

The present paper analyses the species composition of *Enchytraeidae*, their abundance, and the effect of urban pressure on the fauna of *Enchytraeidae* in Warsaw. For this purpose a part of the unpublished materials collected by Górny is used [2, 4]. A detailed presentation of zoocenotic studies on the relationships between the fauna and urban habitats carried out in Warsaw, have already been published [1, 19, 20, 36].

METHODS

To estimate the species composition and numbers of *Enchytraeidae*, all the plots were sampled on the following dates: 3—10 September and 22 October 1974, 15—22 April and 20—24 June, 1975 (M. Górny), 15 October, 1976, 24 May and 23 October, 1977 (K. Kasprzak). Soil cores of 8.6 cm²

surface area, 9.5 cm deep, and 81 cm³ in volume, were taken by means of a sampler enabling us to preserve the natural soil structure. In 1974/1975 soil samples 20 cm² in surface area, 5 cm deep and 100 cm³ in volume were taken. Each time a series of 10 samples was taken on each plot. *Enchytraeidae* were extracted from the soil by means of the O'Connor method [32, 33], at 40°C for 3 hours. The material was determined *in vivo* and on the basis of slides made by the Nielsen and Christensen method [29] modified by Kasprzak [13].

SPECIES COMPOSITION

In general, 22 species belonging to 8 genera were found in soils of the green areas of Warsaw, the genus *Fridericia* Mich. being most abundant (Tab. 2). They contributed to about 25% of all *Enchytraeidae* species found in Poland so far. These data, however, should be considered as very rough since in many regions of Poland, including Mazovia, *Enchytraeidae* have not been studied at all. The largest number of 19 species was found in Warsaw in soils of parks, then in soils of housing estate greenery (12 species) and of lawns in the centre of the town (11 species). Each of the plots was inhabited by *Enchytraeidae* community with different species composition and domination structure. The most abundant and abundant species were *Fridericia bisetosa*, *F. bulboides*, *Henlea ventriculosa*, *Enchytraeus buchholzi*, *Buchholzia appendiculata* and, to a lesser degree, *Achaeta eiseni* and *Fridericia galba*. The species composition clearly shows the effect of anthropogenic factors on changes in the *Enchytraeidae* community. Soils of urban greenery are mainly inhabited by species with a large geographical range and high adaptability to new habitats. The species associated with natural habitats such as soils of deciduous forests: marshes, or peat bogs, either died or has been replaced by species with higher adaptability.

ZOOGEOGRAPHICAL ANALYSIS

Data on the geographical distribution of *Enchytraeidae* are little precise as only fragmentary studies have been carried out in the world so far. That is why it is difficult to classify particular species to zoogeographical groups, their distribution being poorly known. The studies already conducted show that most of the *Enchytraeidae* species have large geographical ranges, which is related to their small ecological specialization. In general opinion, *Enchytraeidae* are particularly abundant in the arctic zone and in northern parts of the temperate zone [33]. Probably many species occur circumpolarly, which is indicated, among other things, by a large similarity between the *Enchytraeidae* of the Palaearctic region and of eastern parts of the Nearctic region [30].

On the basis of known data on the geographical distribution of *Enchytraeidae*, the following groups of species can be distinguished:

- European species (12; 50%): *Mesenchytraeus pelicensis*, *Cognettia sphagnetorum*, *Achaeta camerani*, *A. eiseni*, *A. affinis*, *A. bulbosa*, *Buchholzia fallax*, *Fridericia bisetosa*, *F. leydigi*, *F. connata*, *F. gracilis*, *F. alata* ;
- Holarctic species (9; 37.5%): *Henlea perpusilla*, *H. similis*, *Buchholzia appendiculata*, *Bryodrilus ehlersi*, *Fridericia galba*, *F. ratzeli*, *F. bulbosa*, *F. paroniana*, *F. bulboides* ;
- cosmopolitan (= geopolitan) species (2; 8.3%): *Henlea ventriculosa*, *Enchytraeus buchholzi* ;
- Palaeartic species (1; 4.2%): *Fridericia perreri*.

The observations carried out so far show that similar zoogeographical relations among *Enchytraeidae* occur over the whole central Europe.

Tab. 1. Proportions of zoogeographical elements in enchytraeids of Warsaw and non-urban habitats of Mazovia (N — number of species)

Zoogeographical element	Mazovia		Warsaw									
			Suburbs		Urban green areas							
	Total				Parks		Housing estates		Town centre			
	N	%	N	%	N	%	N	%	N	%	N	%
European	3	50.0	3	50.0	12	54.0	9	47.0	5	42.0	3	27.0
Holarctic	3	50.0	3	50.0	7	32.0	7	37.0	5	42.0	5	46.0
Cosmopolitan	—	—	—	—	2	9.0	2	11.0	2	16.0	2	18.0
Palaeartic	—	—	—	—	1	5.0	1	5.0	—	—	1	9.0

ECOLOGICAL ANALYSIS

HABITAT

Little is known about the association of *Enchytraeidae* species with the environment in Poland. Most species are either eurytopic or polytopic, and only very few are associated with definite habitat types, e.g. with soils of forests, peat bogs, or marshes. On the study plots in Warsaw individual species were not associated with any particular habitat. Only a general tendency was observed that higher numbers of *Enchytraeidae* species and higher densities occurred in the soil of lawns located near or under the tree and shrub canopy.

FOOD

All *Enchytraeidae* species are humifying saprophages having, like *Lumbricidae*, an important part in the development of proper soil structure, and increasing soil fertility [17, 18]. The general contribution of *Enchytraeidae* to

the mineralization of organic matter is, however, considerably higher than that of *Lumbricidae* because of their generally large numbers in soil and more intensive respiration.

ABUNDANCE

The abundance of most *Enchytraeidae* species found in soils of green areas in Warsaw, is not known in Poland. Only few species such as *Cognettia sphagnetorum*, *Henlea ventriculosa*, *Buchholzia appendiculata*, *Fridericia bisetosa*, *F. paronina*, *Enchytraeus buchholzi*, and probably also *Fridericia galba* and *F. ratzeli*, occur in large numbers in Poland. All study plots in Warsaw are generally characterized by considerably lower *Enchytraeidae* numbers than other anthropogenic habitats, e.g. soils of agroecosystems. The highest number of these animals, not exceeding or being equal to about 20 000 individuals per m², was recorded in soils of green areas in Warsaw housing estates and in parks. The average numbers of *Enchytraeidae* in soils of meadows and pastures varied from 25 000 to 80 000 individuals/m² [15], and in soils under potato crops about 23 000 individuals/m² were recorded [34].

There are no data on the synanthropization, origin and expansiveness of *Enchytraeidae*.

GENESIS OF THE URBAN ENCHYTRAEIDAE FAUNA

The fauna of *Enchytraeidae* is probably dominated by local species which were originally present in the Warsaw area before the clear-cut economic effect of man on this environment. A more detailed analysis is not possible since information on the geographical distribution of *Enchytraeidae* and the way of their dispersion is insufficient. The effect of anthropogenic factors on the *Enchytraeidae* fauna in Warsaw can be seen in the species composition. The soils are inhabited mainly by the species with a large geographical distribution (European and Holarctic species predominate) and high adaptability to changing habitat conditions. There are no communities, particularly in the centre of the town, with established dominance structures.

CONCLUSIONS

1. The study on the fauna of *Enchytraeidae* in Warsaw was carried out on 24 plots in 1974—1977. During this period 22 species of 8 genera were recorded. The genus *Fridericia* Mich., was most abundantly represented. The highest number of species occurred in parks, green areas of housing estates, and in lawns located in the centre of the town.

2. Four zoogeographical groups of *Enchytraeidae* can be distinguished: European (50%), Holarctic (37.5%), cosmopolitan (= geopolitan) (8.3%), and Palaeartic (4.2%).

3. No association of individual species with particular habitats was found. Higher numbers of species and higher densities were found in the soil of lawns located near or under the tree and shrub canopy.

4. Numbers of *Enchytraeidae* on all the plots in Warsaw were considerably lower than in other anthropogenic habitats, particularly, in agroecosystems.

5. As far as their origin is concerned, the *Enchytraeidae* of Warsaw are probably dominated by local species with large geographical ranges and high adaptability to changing environmental conditions.

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Tab. 2. Check list of *Enchytraeidae* species occurring in Warsaw and Mazovia

No.	Species ○ — literature data + — unpublished data	Mazovia	Warsaw				
			suburban areas	parks	green areas in housing estates	town centre	other sampling areas
1	<i>Mesenchytraeus pelicensis</i> Issel	○	-	+	-	-	-
2	<i>Cognettia sphagnetorum</i> (Vejd.)	○	+	+	-	-	-
3	<i>Achaeta eiseni</i> Vejd.	-	+	+	+	+	-
4	<i>Achaeta camerani</i> (Cogn.)	-	-	-	+	-	-
5	<i>Achaeta affinis</i> Niels. et Christ.	-	-	+	-	-	-
6	<i>Achaeta bulbosa</i> Niels. et Christ.	-	-	+	-	-	-
7	<i>Henlea ventriculosa</i> (d'Udek.)	-	-	+	+	+	-
8	<i>Henlea perpusilla</i> Friend	+	-	+	+	+	-
9	<i>Henlea similis</i> Niels. et Christ.	-	-	-	+	-	-
10	<i>Buchholzia appendiculata</i> (Buchholz)	○	+	+	+	+	-
11	<i>Buchholzia fallax</i> Mich.	○	-	-	-	-	-
12	<i>Bryodrilus ehlersi</i> Ude	○	-	-	-	-	-
13	<i>Fridericia galba</i> (Hoffm.)	-	+	+	+	+	-
14	<i>Fridericia ratzeli</i> (Eisen)	-	-	+	-	-	-
15	<i>Fridericia bisetosa</i> (Lev.)	-	+	+	+	+	-
16	<i>Fridericia bulbosa</i> (Rosa)	-	-	+	-	+	-
17	<i>Fridericia perrieri</i> (Vejd.)	-	-	+	-	+	-
18	<i>Fridericia leydigii</i> (Vejd.)	-	-	+	-	-	-
19	<i>Fridericia connata</i> Bretscher	-	-	+	+	-	-
20	<i>Fridericia paroniana</i> Issel	-	-	+	-	-	-
21	<i>Fridericia gracilis</i> Bülow	-	-	-	+	-	-
22	<i>Fridericia bulboides</i> Niels. et Christ.	-	+	+	+	+	-
23	<i>Fridericia alata</i> Niels. et Christ.	-	-	+	-	-	-
24	<i>Enchytraeus buchholzi</i> Vejd.	-	-	+	+	+	-

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WAZONKOWCE (*OLIGOCHAETA*, *ENCHYTRAEIDAE*) WARSZAWY I MAZOWSZA

STRESZCZENIE

Badania składu gatunkowego i liczebności fauny *Enchytraeidae* Warszawy prowadzono w latach 1974—1977 na 24 stanowiskach. W okresie tym stwierdzono występowanie 22 gatunków należących do 8 rodzajów, spośród których najliczniej reprezentowany jest rodzaj *Fridericia* Mich. (Tab. 2). Największa liczba gatunków występuje w glebach zielenców parkowych, osiedlowych terenów zielonych oraz trawników usytuowanych w centrum miasta.

Pod względem zoogeograficznym wyróżniono cztery grupy gatunków: europejskie (50%), holarktyczne (37,5%), kosmopolityczne (8,3%), palearktyczne (4,2%) (Tab. 1).

Nie stwierdzono przywiązania określonych gatunków do poszczególnych środowisk. Jednak na stanowiskach znajdujących się w pobliżu, lub pod okapem drzew i krzewów notowano wyraźnie większą liczbę gatunków i ich liczebność. Wszystkie badane stanowiska miejskie charakteryzują się na ogół znacznie mniejszą liczebnością *Enchytraeidae* niż inne środowiska antropogeniczne, zwłaszcza agroekosystemy. Pod względem pochodzenia dominują gatunki miejscowe o szerokim zasięgu występowania i dużych zdolnościach przystosowawczych do zmieniających się warunków środowiskowych.

ЭНХИТРЕИДЫ (*OLIGOCHAETA, ENCHYTRAEIDAE*) ВАРШАВЫ И МАЗОВИИ

РЕЗЮМЕ

Исследования по видовому составу и численности фауны энхитреидов Варшавы проводили в 1974—1977 г.г. в 24 станциях. Констатировали 22 вида, принадлежащих к 8 родам, среди которых наиболее многочисленно представлен род *Fridericia* Mich. Больше всего видов встречается в почве городских парков и зеленых насаждений жилых районов, а также на газонах в центре города.

С зоогеографической точки зрения выдели 4 группы видов: европейские (50,0%), голарктические (37,5%), космополитические (8,3%) и палеарктические (4,2%) (табл. 2).

Не обнаружили приуроченности определенных видов к отдельным биотопам. Однако, в станциях, лежащих под кроной деревьев и кустарников количество видов и их численность была четко выше. Все исследованные городские биотопы характеризуются в общем значительно меньшей численностью энхитреидов по сравнению с инными антропогенными биотопами, особенно агросистемами. С точки зрения происхождения — доминируют местные виды с широким географическим ареалом и большими адаптивными возможностями по отношению к изменяющимся условиям среды.

INTRODUCTION

This work was done as a part of the complex studies conducted by the Institute of Zoology PAS, and concerned with the effects of urban pressure on the fauna. This is one of the set of contributions centered upon the origin of the fauna of Warsaw. Some works have already been published, including those on essential premises [18], phytosociological characteristics of Mazovia [5], description of urban habitats and the extent of the studies on them [10], as well as the methods used [1].

The objective of the study is an analysis of the occurrence of earthworms in Warsaw, as compared with the faunistic composition of the family Lumbricidae in Mazovia. Also an attempt was made to explain why some species were successful and other failed to live in the urban habitat.

The following materials are used in the present paper: literature data on the occurrence of earthworms in Warsaw and Mazovia, museum collections of the Institute of Zoology PAS, and the author's own materials collected in 1976—77.

Faunistic studies on the family Lumbricidae in Poland have been carried out since the end of the past century. The first publication on the earthworms of Warsaw surroundings was prepared by Nussbaum in 1891 [11]. In the interwar period rather intensive study was carried out on the earthworm fauna, but not in the Mazovia region nor in Warsaw. The study