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Diversification of enchytraeid communities (*Enchytraeidae, Oligochaeta*) of the South Basin of the Biebrza National Park

Abstract. Species composition and community structure was studied in enchytraeid communities in the soil of plant associations in the Biebrza River valley situated at various distances from the river trough. Thirty species of *Enchytraeidae* were registered. Considerable similarity was observed for communities inhabiting reed beds, sedge and moss fens. These types of community were different from communities occupying a mineral elevation, a meadow and a swamp alder wood. Habitat location and plant association type have a much smaller effect on the characteristics of a community than the type of soil, mowing frequency and tree cover.

Key words: *Enchytraeidae*, community structure, Biebrza NP, peatland

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1. INTRODUCTION

The Biebrza National Park includes the largest and best preserved peatland complex in Europe (117,000 sq. km.). Vegetation in the Biebrza valley still exhibits a unique zoning pattern of plant associations, which is the result of the river's seasonal overflows. The zonation is most pronounced in the South Basin of the Biebrza National Park.

The habitat occupied by enchytraeid communities in the South Basin consists of wet, fertile and non-acidified hydrogenous, mud-peat and peat soils. Given these living conditions, one might expect to find there enchytraeid communities rich in species numbers and individuals numbers, composed primarily of amphibiotic species, thriving both in the soil and in water.

However, despite the broad habitat spectrum afforded by the Biebrza National Park, faunistical knowledge of *Enchytraeidae* from this area has so far been rather scanty. The only data available to date are a list of species from 5 sites in the South Basin of the Biebrza National Park (NOWAK, PILIPIUK 1997; STERZYŃSKA, PILIPIUK 1999).

The aim of this study was to compare species richness and assess structure similarity between enchytraeid communities in the soils of plant associations in various parts of the Biebrza River valley.

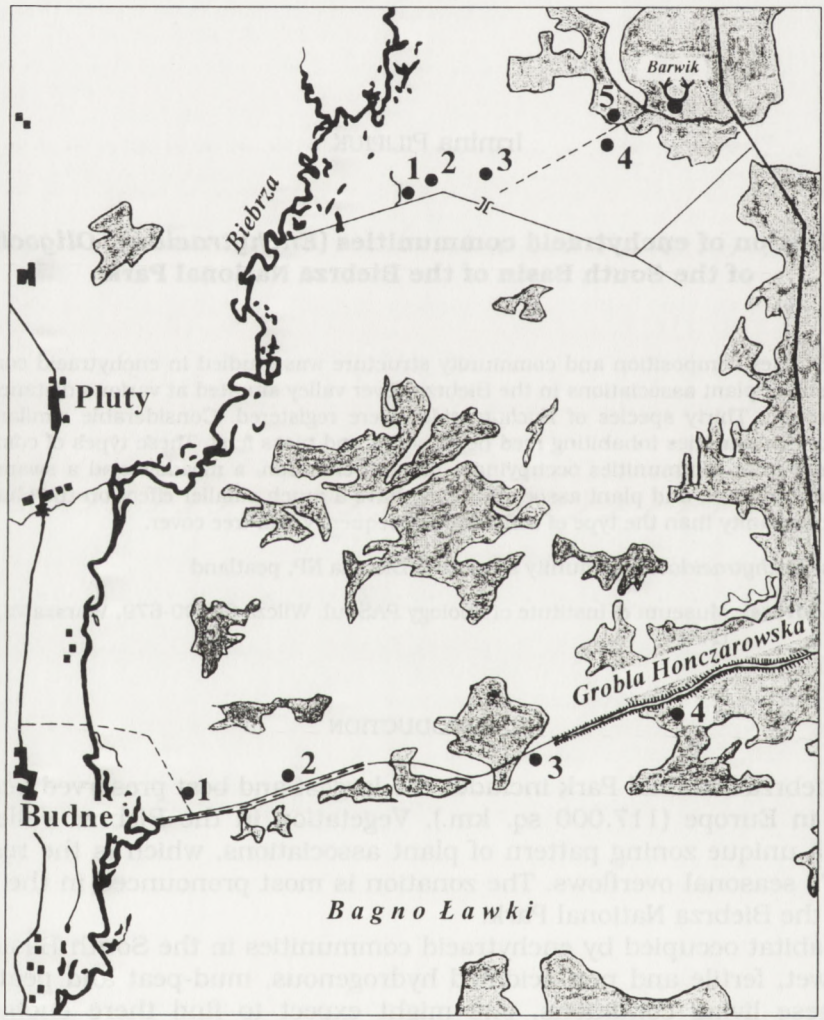

Fig. 1. Distribution of sites at transect I (Barwik) where: 1 – reed bed, 2 – sedge fen, 3 – mineral elevation, 4 – moss fen, 5 – swamp alder wood and transect II (Grobla Honczarowska) where: 1 – sedge fen, 2 – moist meadow, 3 – moss fen, 4 – reed community.

2. STUDY AREA

The study was carried out in the South Basin of the Biebrza National Park, where the vegetation zones are best developed. Closest to the river trough is a belt of reed beds while a little farther away, in the flood land, a large sedge community has developed. The next zone, with moss fens, is virtually never affected by river overflows. This zone is subject to the action of underground waters, which waterlog the sod through most of the year. Coming last in this series of habitats is a swamp alder wood growing along the valley's mineral margin (PAŁCZYŃSKI 1984, OŚWIT 1994). Superimposed on this habitat zonation are a number of factors determining a much greater diversification of the area than would be implied by the zonation itself. There are mineral islands, tufts and belts of bushes, large areas being overgrown by reed as well as hay-growing meadows and pastures. The value of this area lies in the generally intact character of its low peatlands. The swamp alder woods, too, represent mature climax ecosystems.

The study took place in the years 1998–1999 at two transects. Sites were chosen at various distances from the Biebrza River trough. Soils bearing various plant associations were inlcuded. Transect I along an artificial causeway, extending from the Barwik forestrer's lodge, included soils at 5 sites: reed bed (*Phragmitetum communis*), sedge fen [tufted sedge tussocks according to Code Corine] (*Caricetum elatae*), a moss fen [carex diandra quaking mires according to Code Corine] (*Caricetum diandrae*), mineral elevation (a dry green with some tree plantings) and a swamp alder wood (*Carici elongatae-Alnetum*). Transect II along the artificial causeway "Grobla Honczarowska" had four sites: a sedge fen (*Caricetum elatae*), moist meadow (*Calthion*) (hay growing), moss fen (*Caricetum diandrae*) and a reed community (*Phragmitetum*) formed as a result of penetration of reed into a moss fen (Fig. 1).

The hydrogenic soils of the sites examined in the study are classified as peat-mud and mineral formation at mineral islands (CHURSKI & SZUNIEWICZ 1993).

3. MATERIAL AND METHODS

Each site was sampled twice – in spring and autumn. Each sampling series consisted of ten samples 20 sq. cm in area and 16 cm deep. Specimens were extracted by O'Connor's method (modified). Species identification was done on living material consisting of 4,592 specimens (3,412 specimens from transect I and 1,180 specimens from transect II).

The following indices were used to describe the soil communities of *Enchytraeidae*: species richness (MARGALEF 1957), abundance index, Shannon and Weaver's index of diversity (SHANNON, WEAVER 1949) and Morisita's index of similarity modified by Horn (HORN 1966). The basis for grouping was the method described by MOUNTFORD (1962).

Table I. Species composition of enchytraeid communities at the study sites, where: S – sedge fen, R – reed bed, E – mineral elevation, M – moss fen, A – swamp alder wood, Me – moist meadow.

No.	species	transect I					transect II			
		S	R	E	M	A	S	Me	M	R
1	*Mesenchytraeus armatus* (LEV.)				+	+	+		+	+
2	*Cernosvitoviella atrata* (BRET.)	+	+		+	+	+		+	+
3	*Buchholzia appendiculata* (BUCHH.)							+	+	
4	*B. fallax* MICH.	+				+	+	+	+	
5	*Bryodrilus ehlersi* UDE	+						+		
6	*Cognettia glandulosa* (MICH.)	+	+	+	+	+	+			+
7	*C. sphagnetorum* (VEJD.)	+	+	+	+	+	+	+	+	
8	*Marionina argentea* (MICH.)	+	+		+	+	+	+	+	+
9	*M. riparia* BRET.		+							
10	*Enchytraeus albidus* HENLE	+	+	+	+	+	+	+	+	
11	*E. buchholzi* VEJD.	+	+	+	+	+	+	+	+	
12	*Fridericia bisetosa* (LEV.)	+	+		+	+	+	+	+	+
13	*F. bulboides* NIEL.& CHRIST.	+	+	+	+	+	+	+	+	+
14	*F. bulbosa*						+			
15	*F. galba* (HOFFM.)		+			+	+	+	+	
16	*F. gracilis* BULOW				+	+	+	+	+	
17	*F. leydigi* (VEJD.)	+	+			+		+		
18	*F. maculata* ISSEL	+				+	+			+
19	*F. ratzeli* EIS.	+		+		+		+		
20	*F. regularis* NIEL.& CHRIST.					+				
21	*F. semisetosa* DOZSA-FARKAS	+			+					
22	*F. striata* (LEV.)		+							
23	*Enchytronia parva* NIEL.& CHRIST.	+	+			+	+	+		
24	*Henlea heleotropha* STEPH.		+	+						+
25	*H. jutlandica* NIEL.& CHRIST.		+			+				
26	*H. nasuta* EIS.	+	+		+	+	+	+	+	+
27	*H. perpusilla* FRIEND	+	+	+	+	+	+	+	+	+
28	*H. similis* NIEL.& CHRIST.						+	+	+	+
29	*H. ventriculosa* d'UDEK.	+	+	+	+	+	+	+	+	+
30	*Hemifridericia parva* NIEL.& CHRIST.	+			+		+	+		
	Number of species	19	18	9	15	21	20	19	16	12
	Index of species richness	2.58	2.38	1.86	2.41	3.14	3.47	2.97	2.74	1.97
	Index of diversity	3.28	2.91	2.82	2.84	3.43	3.44	3.13	2.88	2.88

4. RESULTS

4.1. Species composition

Thirty species of *Enchytraeidae* were found in the South Basin of the Biebrza NP. (Table I), accounting for about 50% of all species known from the soils of the Polish lowlands. At the majority of the sites, the dominant group was composed of a number of species with a preference for moist and wet

soils: *Cognettia glandulosa* (MICH.), *Cernosvitoviella atrata* (BRET.), *Marionina argentea* (MICH.), *Henlea perpusilla* FRIEND, *Mesenchytraeus armatus* (LEV.) and *Cognettia sphagnetorum* (VEJD.). There are also some other less abundant species displaying a preference for moist habitats, viz., *Marionina riparia* BRET., *Henlea heleotropha* STEPH. and *Henlea jutlandica* NIEL. & CHRIST. The presence of all of the above species is attributable to the considerable moisture and fertility of the habitat. These species have been reported from both in forests and in open areas. The other species are characterized by tolerance to a broad range of soil moisture changes. Life in a habitat subject to considerable differences of water level requires a number of adaptations. These include reproduction by fragmentation, seen in *C. glandulosa* and *C. sphagnetorum*. This reproduction strategy allows them to respond quickly to a reappearance of favourable conditions. The blood is colourless in the majority of soil enchytraeids, but in individuals of certain species inhabiting considerably wet habitats it is red (HEALY 1979). In this study this feature, making possible survival in anaerobic conditions (MOORE et al. 1965), was observed in individuals of *C. glandulosa* and *C. sphagnetorum*.

The number of species at individual sites ranged from 9 (mineral elevation) to 21 (swamp alder wood). The preferences of individual species, evidenced for by their greater abundance in certain habitats, are shown in Figure 2. The distribution of abundance of individual species in habitats along the transects extending from the river trough to the valley margin is exemplified by data from transect I. A small group of species confined to one habitat comprises 3 species only found in the reed bed community (*M. riparia*, *F. striata*, *H. heleotropha*), 1 species found only in the sedge fen (*B. ehlersi*) and 1 species only found in the swamp alder wood (*F. regularis*). Of the other species, 7 were most abundant in the reed bed community, 5, in the sedge fen, 1, in the moss fen, and 6, in the swamp alder wood. The three remaining species did not display any preferences for a particular habitat and had a more even abundance profile across the various habitats. The species richness index was highest for the communities inhabiting sedge fens and swamp alder woods, and lowest for the community occupying the mineral elevation (Table I).

Figure 3 shows percentage contributions of the species at individual study sites. The data are based on transect I data, with the reed bed enchytraeid community given the comparator value of 100%. This community forms the core of all enchytraeid communities studied, containing 68–89% of species found in the soil at the other sites.

4.2. Dominance structure

The dominant species group (accounting for >20% of a community) in the reed beds and fens communities examined in this study consisted of *C. glandulosa*, *M. argentea* and *H. perpusilla*. The dominance structure of the moss fen enchytraeid community in the transect II "Grobla Honczarowska" causeway transect did not fit this pattern, with *B. fallax* as the dominant species. This species had the highest relative abundance on the moist meadow in the same

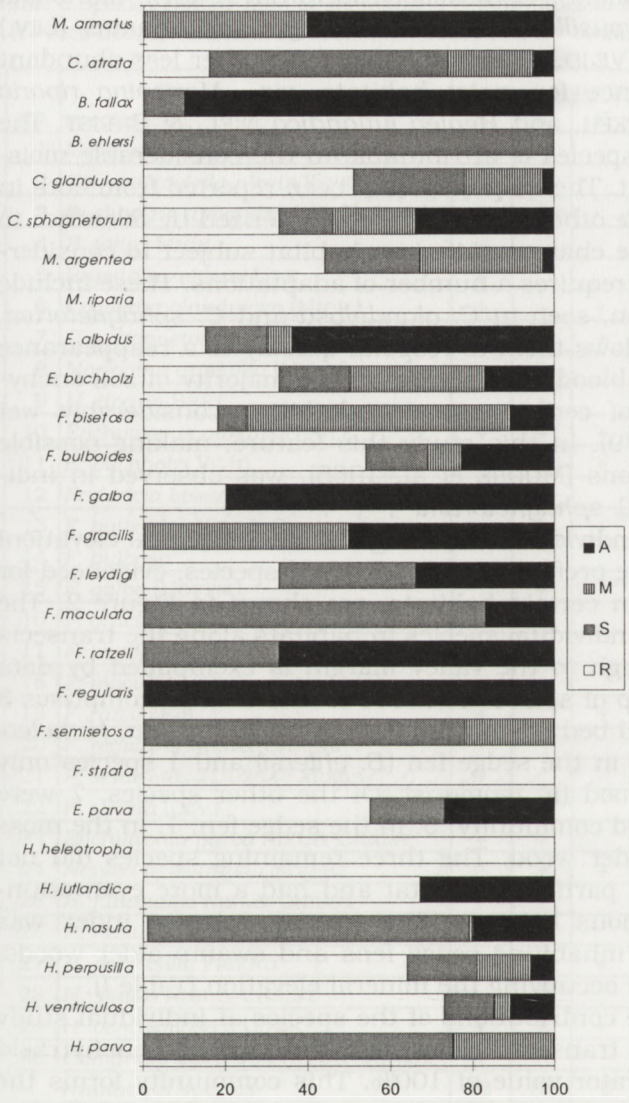

Fig. 2. Species abundance in relation to transversal zones in transect I.

transect. The community living in the soil at the mineral elevation was characterized by the dominance of *H. perpusilla* and *F. bulboides*. In the swamp alder wood enchytraeid community, *C. sphagnetorum* and *B. fallax* were the dominants (Figs 4, 5). These differences of dominance structures are reflected in the values of Shannon's and Weaver's index of general diversity (Table I), which was higher for the communities inhabiting the swamp alder wood, sedge fens and meadow and lower for the moss fen, reed bed and mineral elevation enchytraeid communities.

4.3. Abundance

A comparison of mean abundance data for the enchytraeid communities of the reed bed, sedge and moss fen sites in both study transects reveals substantial differences. Generally, mean abundance at these sites in transect I was much higher than in transect II (Table II). A comparison of the various habitats shows that the enchytraeid community occupying the reed bed habitat in transect I had the highest mean abundance, while that inhabiting the moss fen site in transect II had the lowest mean abundance. When relative abundance of enchytraeids is compared between the habitats in transect I, it can be seen that the animals were most abundant in the soil of the reed community while the mineral elevation was home to the lowest num-

ber of enchytraeids. In transect II, enchytraeids were most abundant in the soil of the meadow, and least abundant, in the moss community (Fig. 6).

4.4. Similarity of communities

An analysis of similarity data for enchytraeid communities occupying the soil at the study sites in transect I shows a considerable degree of similarity between the reed bed and sedge fen communities of enchytraeids. The community inhabiting the moss fens was less similar to the former two, while the communities occupying the mineral elevation and the swamp alder wood were quite different (Fig. 7). A similarity diagram for transect II communities represents a different picture than the one described above: the reed bed and sedge fen communities in transect II are similar again but the moss site community only shows some similarity to the community occupying the meadow site (Fig. 7).

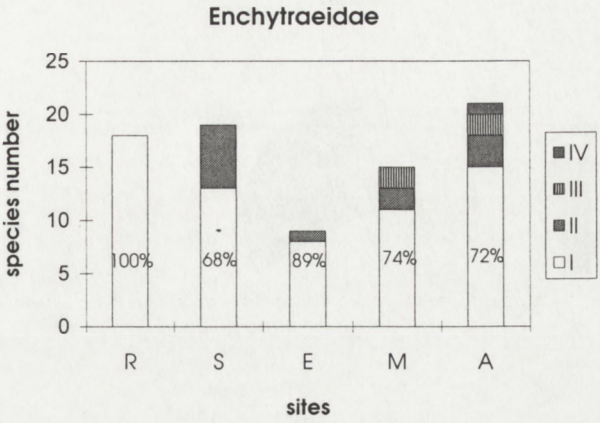

Fig. 3. The overlapping of species composition in transect: I – species recorded in reed (R), II – species recorded in sedge fen (S), III – species recorded in moss fen (M), IV – species recorded in swamp alder wood (after STERZYŃSKA, PILIPIUK 1999).

Similarity data were also compared between communities inhabiting the soil of the reed bed, sedge fen and moss fen sites in both study transects in the South Basin. The transect II moss fen site enchytraeid community was the only one different from the others, while the remaining five had a relatively high degree of similarity between them (Fig. 8).

5. DISCUSSION

In view of the considerable habitat diversity in the area of the Biebrza National Park and its protection zone, the size of the area, the various forms of land usage that can be observed there and different degrees of transformation, it is likely that at least 17 new species of enchytraeids, never previously recorded but known from the soils of the Polish lowlands, may be found there. Mean abundance at sites in transect II much lower than in transect I may be the result of human impact.

The high similarity between communities at most sites of reed beds and sedge and moss fens, despite their location at various distances away from the river trough, and the fact that the mineral elevation and swamp alder

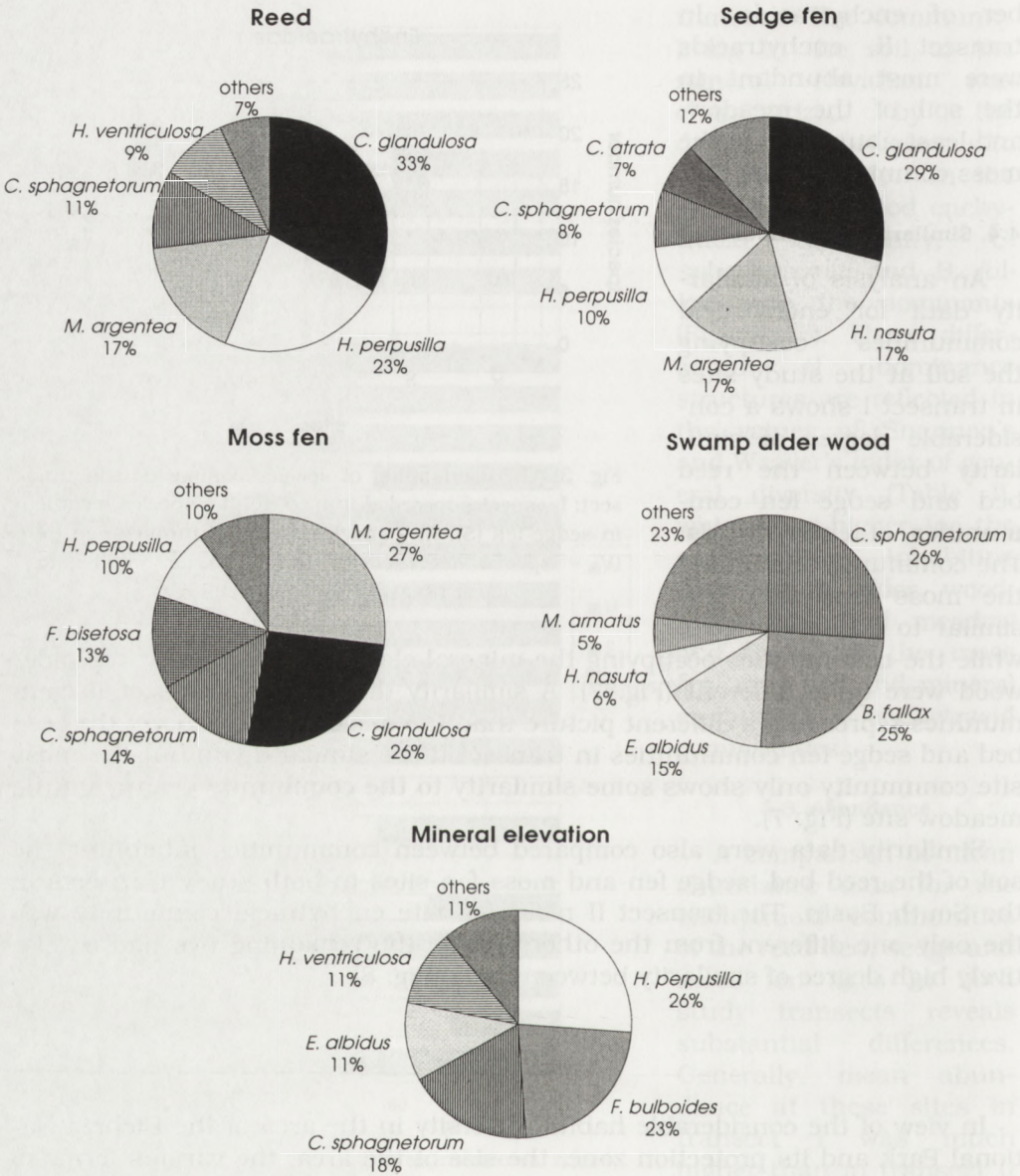

Fig. 4. Structure of dominance of enchytraeid communities at the study sites in transect I.

wood site communities stand out from the rest indicates that the location of a site relative to the river trough and the type of plant cover weigh less on community structure than the type of soil and whether the site is situated in an open or forested area. While soil moisture is an extremely important factor

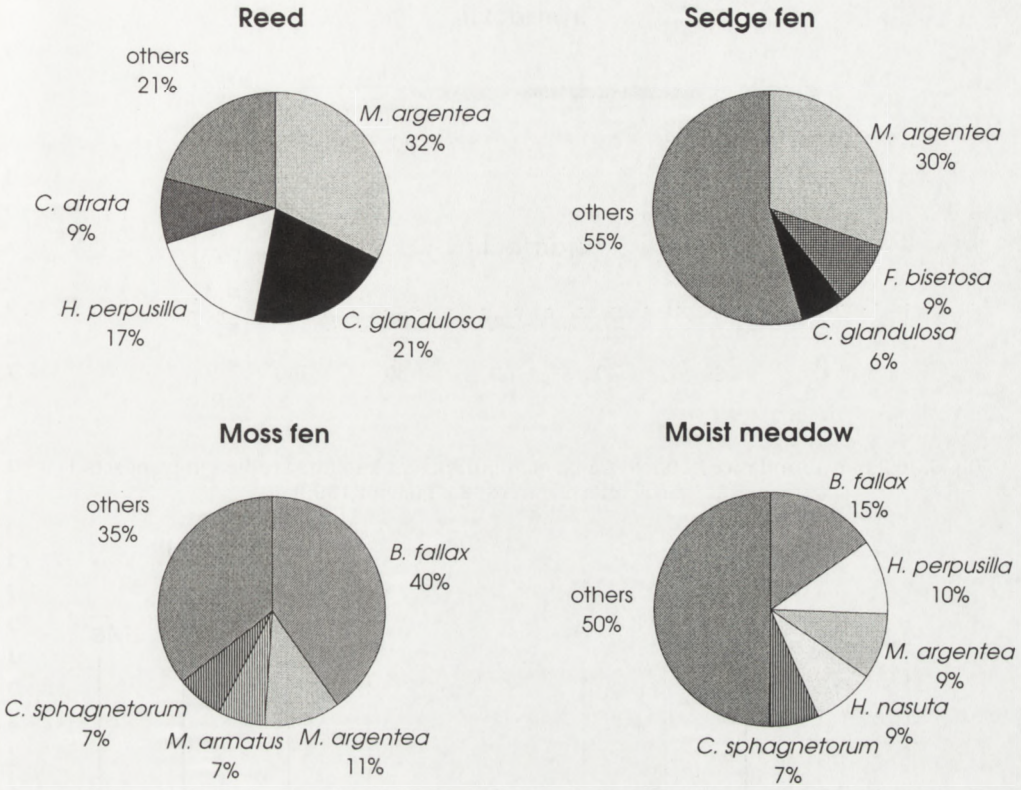

Fig. 5. Structure of dominance of enchytraeid communities at the study sites in transect II.

affecting the development of enchytraeid communities, moisture fluctuations at the study sites in the rushes and low peatlands (all considerably moist habitats) do not appear to have a truly significant effect. The dominance of *B. fallax* at the moss fen site in the Grobla Honczarowska indicates a lack of similarity between this community and those inhabiting the soil at the other natural open area sites. The transect II reed bed site, situated in an emersion zone, with the reed advancing into the moss fen, had a rather small number of enchytraeid species registered (12) while enchytraeid abundance there was comparable to that registered at the other natural sites within that transect. Despite its location and a secondary nature of this site (reed expansion), its enchytraeid community is quite similar to the communities inhabiting the reed bed and moss fen sites in transect I and the sedge fen in

Table II. Average density of enchytraeid communities at the study sites.

transect I		transect II	
site	indiv./m^2	site	indiv./m^2
S	18050	S	6025
R	31725	Me	10875
E	7400	M	6000
M	19100	R	6600
A	14575		

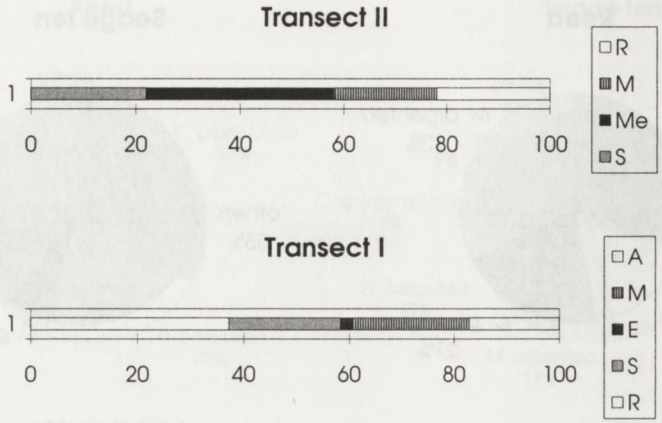

Fig. 6. Relative abundance of enchytraeid communities at habitats studied in transects I and II (partly after STERZYŃSKA, PILIPIUK 1999).

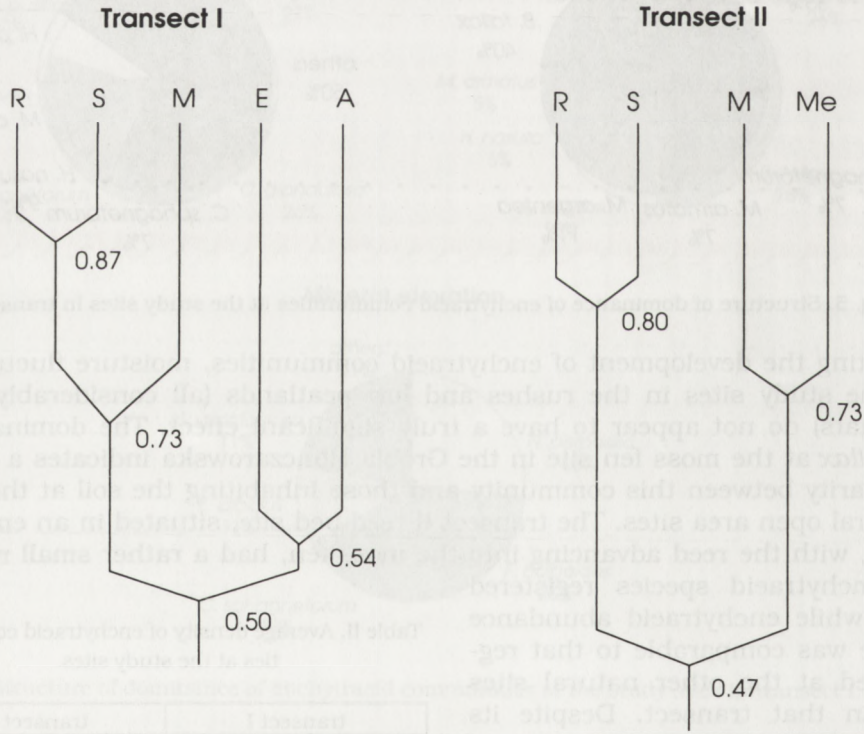

Fig. 7. Similarity of enchytraeid communities in the study habitats in transects I and II

transect II. The transect II reed bed site community shows little similarity to the communities inhabiting the moss fen sites in transects I and II, which should be interpreted in terms of the effect on the structure of this enchytraeid community of microhabitat conditions related to the advancement of reed.

The finding of structural similarity between enchytraeid communities in the moss fen site and the meadow site and their dissimilarity from the communities occupying the other natural open-area sites is indicative of a considerable degree of transformation, probably human-dependent.

The diversity index registered high values for all the communities under study. It was the highest for the sedge fen and swamp alder wood enchytraeid communities and also quite high for the community inhabiting the soil at the meadow site. High diversity in an alder swamp, a mature climax-type ecosystem, is indicative of a healthy enchytraeid community, while high diversity registered for the meadow site community can be explained in terms of a temporary increase in species diversity in habitats subject to anthropopression due to migration of expansive species of broad habitat resilience.

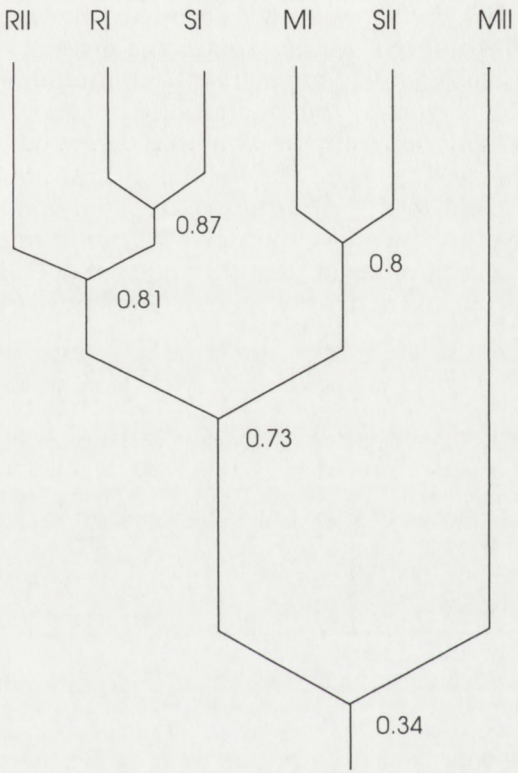

Fig.8. Similarity of enchytraeid community structure in peatland [natural open-area habitat] soils in transect I and II

On the one hand, the diversity of communities occupying the reed and fen sites may be limited by certain features of these habitats (high moisture). On the other hand, however, some of these sites can be regarded as climax-type. This, combined with their considerable fertility, may result in high diversity. Prolonged use of meadows leads to some unification of the fauna and reduces its diversification (NOWAK, PILIPUK 1997).

6. CONCLUSIONS

A comparison of the communities at sites situated along the two transects will show that the soil in transect I houses more natural communities, as indicated both by community structure and by abundance. When corresponding sites from both transects (i.e. reed bed, sedge fen and moss fen sites) are

compared, the abundance of transect II communities turns out to be three times lower than that of transect I communities.

The results indicate that direct anthropic pressure (mowing, cattle grazing) has a greater influence on the formation of the structure of enchytraeid communities than succession (expansion of reed). The evidence comes from the high similarity of communities occupying the reed bed, sedge fen and moss fen sites studied on the one hand and the distinct character of the transect II meadow and moss fen site enchytraeid communities relative to the rest. Where the type of soil is similar, the amount of tree cover becomes important hence the lack of similarity between the swamp alder wood site and the others. The structural differences between the peatland- and mineral elevation-inhabiting communities point to the effect on soil type on enchytraeids. In particular, the overlapping of the meadow and moss fen site communities and their dissimilarity from the communities of the other natural open-area sites studied provides evidence in favour of enchytraeids being a sensitive indicator of environmental change.

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STRESZCZENIE

[Tytuł: Zróżnicowanie zgrupowań wazonkowców (*Enchytraeidae, Oligochaeta*) Basenu Południowego Biebrzańskiego Parku Narodowego]

Badano skład gatunkowy i strukturę zgrupowań wazonkowców na 9 stanowiskach usytuowanych na terenie Basenu Południowego Biebrzańskiego

Parku Narodowego. Objęto nimi różne środowiska w transektach od koryta rzeki do brzegu doliny – szuwary trzcinowe, turzycowiska, mechowiska, wyspę mineralną, łąkę i ols. Stwierdzono występowanie 30 gatunków wazonkowców. Kilka z nich preferuje gleby mokre i wilgotne. Grupę gatunków dominujących w glebie badanych szuwarów i torfowisk niskich stanowią: *C. glandulosa*, *M. argentea* i *H. perpusilla*. Na łące i mechowisku transektu II dominuje *B. fallax*, w glebie wyspy mineralnej *H. perpusilla* i *F. bulboides* a w olsie *C. sphagnetorum* i *B. fallax*. Zgrupowania torfowisk niskich cechował znaczny stopień podobieństwa. Odmienną strukturą cechowały się zgrupowania z wyspy mineralnej, łąki i olsu. Różnice usytuowania stanowiska względem koryta rzeki jak również typ zbiorowiska roślinnego nie mają takiego znaczenia jak typ gleby czy pokrycie terenu drzewami. Wysokie podobieństwo zgrupowań z badanych trzcinowisk, turzycowisk i mechowiska a z drugiej strony brak podobieństwa do pozostałych zgrupowań z łąki i mechowiska tarnsektu II wskazuje na to, że większy wpływ na zgrupowania wazonkowców ma bezpośrednia działalność człowieka (koszenie, wypasanie) niż sukcesja (zarastanie trzciną). Podobieństwo tych ostatnich zgrupowań świadczy o tym, że wazonkowce mogą być czułym wskaźnikiem zmian zachodzących w środowisku.