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Enchytraeid communities (*Enchytraeidae, Oligochaeta*) of the ash-alder carr (*Circaeo-Alnetum*) in two regions of Poland

Abstract: Both species composition and community structure of enchytraeid worms were studied in the soil of alder carr forest in two parts of Poland, viz., the Mazovian Lowland and Puszcza Białowieska (Białowieża Forest). A total of 25 species were recorded. All communities under study were revealed similar in species composition and dominance structure, showing no regional differentiation in the fauna either. The communities in Puszcza Białowieska were characterised by a greater constancy of species occurrence than those in the Mazovian Lowland. The communities from Puszcza Białowieska were also characterised by a smaller mean niche width and a smaller habitat overlap, which is indicative of a greater habitat diversity and a greater specialisation of the species compared to those in the Mazovian Lowland.

Keywords: *Enchytraeidae*, fauna, community structure, ash-alder carr, Białowieża Forest, Mazovian Lowland.

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INTRODUCTION

The ash-alder carr is a common forest ecosystem in the Polish lowlands. These eutrophic woodlands, situated in valleys of slow-flowing streams on rich and moist soils, are distinguished both by high productivity and a considerable floristic richness, where spatial diversification encourages the formation of a number of microhabitats.

The above factors combined can be expected to support rich enchytraeid communities since many of the species are amphibiotic forms that thrive in fertile and moist habitats.

The location of ash-alder carrs along watercourses provides natural pathways for enchytraeid dispersal while the adjacent ecosystems provide additional possibilities for species exchange. The carrs can often be regarded as ecotone zones between adjacent ecosystems and the stream.

The important roles the *Enchytraeide* appear to play in ash-alder carrs is demonstrable by the fact that their contribution to the turnover of matter in these ecosystems is equivalent to 10% of leaf fall (MAKULEC manuscript), which is a considerable figure.

Despite the common occurrence of the ash-alder carrs in Poland, the enchytraeid fauna of this habitat has been inadequately studied to date. Quantitative studies on enchytraeids in the ash-alder carr of Puszcza Kampinoska were carried out by MAKULEC (1983) in the 1970's, followed by a study in Białołęka Dworska by KASPRZAK (1981). Earlier data on the occurrence of enchytraeids in associations of the common alder in the Wielkopolska-Kujawska Lowland can be found in papers by KASPRZAK (1972, 1977a, b).

The aim of this study was to investigate enchytraeid communities in the ash-alder carrs of the Mazovian Lowland and Puszcza Białowieska (Białowieża Forest) as well as to determine the extent of similarity so as to identify a community structure possibly typical of these ash-alder carrs by finding out whether the study communities show differences due to soil type or Poland's geographical region.

STUDY AREA

The study sites were located in two forest complexes in the Mazovian Lowland, central Poland and the other in Puszcza Białowieska, northeastern Poland. The study was carried out in 1991 at six sites. The Mazovian Lowland sites included two lying in the Młochowski Łęg Nature Reserve in the valley of the Utrata river (sites M I, M II) and one site in the Radziejowice Forest district, division 116p, in the valley of Pisia Gągolina River (site R). In Puszcza Białowieska, one site was located within the Białowieża National Park, forest division 315D (site B I) near the Orłówka River, and two sites were located in the Hajnówka Forest Inspectorate range, divisions 599B (site B II) and 600C (site B III) along the bank of a tributary of Leśna River. The sites supported different soil types: sites M I and II had a peaty-silty type of soil (ŁASZEK, SENDZIELSKA 1989), site R a brown acid soil with a mull humus (BAŃKOWSKA, GARBARCZYK 1981); site B I a peat-muck soil (MICHALCZUK 1994); site B II had a proper gley soil, and site B III a mucky black-earth type of soil.

Informations about the soils at sites B II and B III, situated in the Hajnówka Forest Inspectorate range, derived from Surface Description cards compiled by the Office for Forest Management and Forest Land Survey, Białystok 1996.

MATERIAL AND METHODS

Two series of samples were obtained, one each in May and September, the periods of a spring and autumn peaks in enchytraeid abundance. Each series consisted of 20 samples 20 sq. cm in area and 16 cm in depth each. O'CONNOR's method (1955) was used for extracting a total of 4601 individuals. Samples collected at site M I yielded 587 individuals, followed by M II - 495, R - 351, B I - 744, B II - 684 and B III - 1200 individuals. Species identification was carried out using live material.

The values of the species richness index were used as a measure of community diversification in terms of species composition. Community characteristics included the indices of constancy, frequency (GÓRNY, GRÜM 1994), dominance, MORISITA's index of dominance structure similarity modified by HORN (1966) and SHANNON-WIENER's index of general species diversity (SHANNON, WEAVER 1949). Cluster analysis based on MORISITA's index was performed according to the method described by MOUNFORD 1962. Community diversification was described in terms of mean habitat overlap and mean niche width (PIELOU 1972).

RESULTS

Species composition

A total of 25 species of enchytraeids were identified in the communities under study (Table I). The number of species at individual sites ranged from 16 to 19. The following eight species were found at all sites: *Buchholzia appendiculata* (BUCHH.), *Cognettia sphagnetorum* (VEJD.), *Fridericia bisetosa* (LEV.), *Fridericia bulboides* NIEL. & CHRIST., *Fridericia connata* BRET., *Fridericia galba* (HOFFM.), *Henlea nasuta* (EIS.) and *Henlea perpusilla* FRIEND. There were no species recorded either in the Mazovian Lowland or Puszcza Białowieska only. While 4 species (*Marionina argentea* (MICH.), *Fridericia regularis* NIEL. & CHRIST., *Achaeta camerani* (COG.), *Achaeta eiseni* (VEJD.)) were only reported from the soil of ash-alder carrs of the Mazovian Lowland but not in Puszcza Białowieska, they were actually revealed in other studies in some other forest habitats of Puszcza Białowieska. Similarly, *Cernosvitoviella atrata* (BRET.) found in the ash-alder carrs of Puszcza Białowieska was absent from the study habitat in the Mazovian Lowland, yet occurring in the latter region elsewhere.

The index of species richness attained the highest values in the Młochowski Łęg Nature Reserve community (site M I), being the lowest at site B I in Puszcza Białowieska (Table I). Similarity in species composition was high inr all study communities, reaching its highest value (0.91) for the communities in forest divisions 315 and 600 in Puszcza Białowieska; the lowest value (0.69) was recorded at site M II and forest division 315 in Puszcza Białowieska (Fig. 1).

Abundance

The mean density of enchytraeid community was the lowest at the Radziejowice site, the highest at the site in forest division 600 in Puszcza Białowieska. A comparison of data referring to the sites in the Mazovian Lowland and Puszcza Białowieska shows clearly that the average enchytraeids densities was higher in the latter place (Table I).

Dominance structure

C. sphagnetorum was a species dominant at all study sites. This species is characterised by a wide ecological valence and has been recorded as dominant from many different forest habitats. In the ash-alder carr communities, its proportion varied from 16 to 54%, followed by *H. nasuta, H. perpusilla* and *Henlea ventriculosa* D'UDEK, found in

peaty soils, and *Mesenchytraeus armatus* (LEV.) associated with moist forest soils. Five species of the genus *Fridericia* also had considerable shares in the communities while *B. appendiculata* was quite abundant at one site (Fig. 2).

Table I. Species composition and average density (indiv./m²) of enchytraeid communities at the study sites.

Species	Białowieża Forest			Mazovia Lowland		
	B I	B II	B III	MI	MII	R
Mesenchytraeus armatus (LEV.)	62.5	37.5	75	187.5	0	0
Cernosvitoviella atrata (BRET.)	12.5	0	25	0	0	0
Buchholzia appendiculata (BUCHH.)	25	75	37.5	75	175	12.5
B. fallax MICH.	37.5	37.5	150	25	0	37.5
Bryodrilus ehlersi UDE.	25	0	25	50	0	0
Cognettia sphagnetorum (VEJD.)	2562.5	1387.5	8225	3212.5	2400	1012.5
Marionina argentea (MICH.)	0	0	0	37.5	0	0
Enchytraeus buchholzi VEJD.	0	12.5	0	37.5	37.5	12.5
Fridericia bisetosa (LEV.)	75	237.5	62.5	137.5	112.5	375
F. bulboides NIEL.& CHRIST.	75	62.5	150	25	112.5	100
F. connata BRET.	12.5	12.5	12.5	87.5	12.5	150
F. galba (HOFFM.)	250	25	262.5	87.5	212.5	87.5
F. gracilis BULOW	12.5	0	12.5	0	0	12.5
F. leydigi (VEJD.)	0	50	50	0	62.5	0
F. maculata ISSEL	0	112.5	0	12.5	162.5	50
F. paroniana ISSEL	0	25	37.5	0	25	50
F. perrieri (VEJD.)	75	100	25	0	25	12.5
F.ratzeli EISEN	100	0	37.5	62.5	137.5	75
F. regularis NIEL.& CHRIST.	0	0	0	12.5	12.5	0
Enchytronia parva NIEL.& CHRIST.	0	12.5	12.5	25	0	0
Henlea nasuta EISEN	287.5	400	1175	275	162.5	112.5
H. perpusilla FRIEND	1162.5	1150	837.5	262.5	187.5	12.5
H. ventriculosa D'UDEK.	175	75	50	237.5	37.5	0
Achaeta camerani (COG.)	0	0	0	0	0	25
A. eiseni VEJD.	0	0	0	0	0	12.5
Mesenchytraeus sp.	225	25	875	37.5	0	0
Cernosvitoviella sp.	87.5	75	25	12.5	0	0
Buchholzia sp.	62.5	150	175	150	37.5	12.5
Marionina sp.	862.5	1275	525	675	200	150
Enchytraeus sp.	312.5	137.5	75	162.5	250	0
Fridericia sp.	2587.5	3000	1912.5	1100	1687.5	1312.5
Enchytronia sp.	0	0	0	0	25	412.5
Henlea sp.	125	75	137.5	212.5	62.5	12.5
Achaeta sp.	87.5	0	12.5	0	12.5	250
density indiv./m2	9300	8550	15000	7200	6150	4300
Number os species	16	17	19	18	16	17
Index of species richness	2.27	2.45	2.54	2.67	2.42	2.57
Index of diversity	3.08	2.98	2.48	3.07	2.92	3.22

Dissimilarity of dominance structures in the study enchytraeid communities is reflected by values of the Shannon-Wiener index. With the number of species being

quite similar, the most uniform distribution of abundance, and the highest values of the index, were observed for the community at site R, while the species diversity index assumed the lowest value for the community at the site in forest division 600 in Puszcza Białowieska.

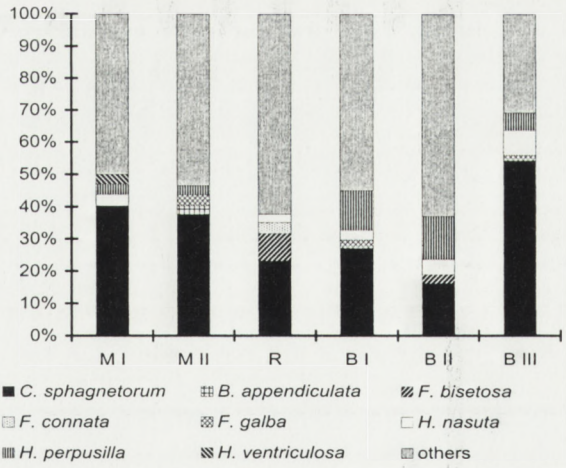
Frequency and constancy

C. sphagnetorum was found to have the highest frequency at all study sites (Fig. 3). It was a euconstant or constant species at most sites (85–75%), with the exception of the site in Radziejowice, where, despite again being the most frequent, it was included in the group of accessory species (42.5%). Of the other species, only *H. perpusilla* was constant at two sites: B I and B II in Puszcza Białowieska (55%–52.5%). At site B III in Puszcza Białowieska and site M I in Młochów, the species belonged to the class of accessory species (42.5%–32.5%), and at the other sites in the Mazovian Lowland (M II and R) it was classified as accidental (20%–2.5%). The third species ranking among the most frequent ones, *H. nasuta*, was classified as accessory at the three sites in Puszcza Białowieska (32.5%–45%) but as accidental in the Mazovian Lowland (22.5%–7.5%). Also, *F. bisetosa* and *F. galba* were classified as accessory at different individual sites.

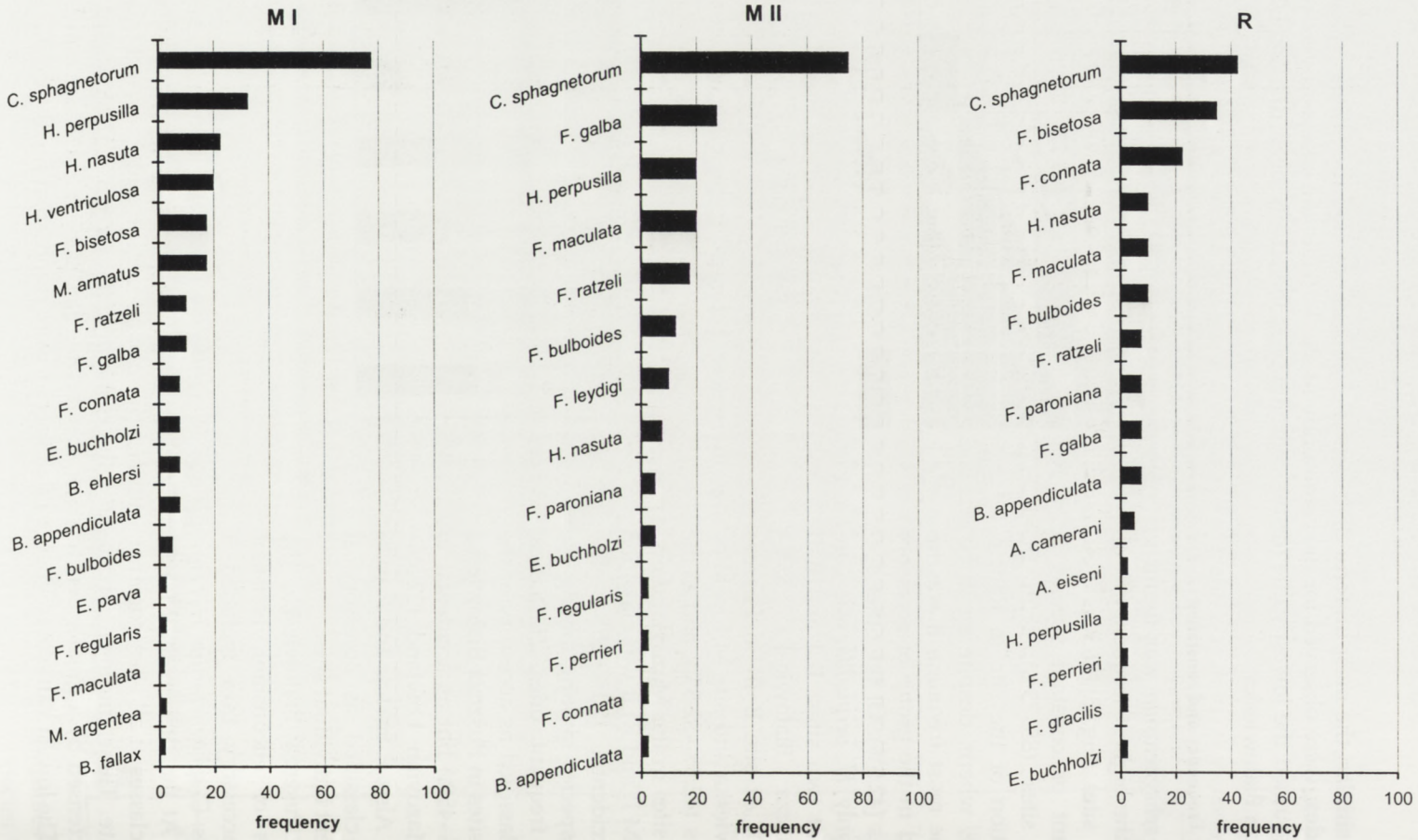
	M I	M II	R	B I	B II	B III
M I		0.76	0.71	0.76	0.81	0.76
M II			0.79	0.69	0.85	0.74
R				0.73	0.76	0.72
B I					0.73	0.91
B II						0.83
B III						

>75% >50%

Fig. 1. Similarity of species composition at the study sites (Sørensen index).



In Puszcza Białowieska, the classes of euconstant, constant and accessory taxa included 3 species: *C. sphagnetorum*, *H. perpusilla* and *H. nasuta* at all sites and, at one site, also *F. galba*. At the sites in the Mazovian Lowland only *C. sphagnetorum* was included in these classes at all sites, together with *H. perpusilla* at one site and *F. bisetosa*, also at one site. These findings indicate that the communities in Puszcza Białowieska are characterised by a greater constancy of occurrence than those in the Mazovian Lowland. The lowest value of frequency of all species were recorded at site R (Fig. 3).



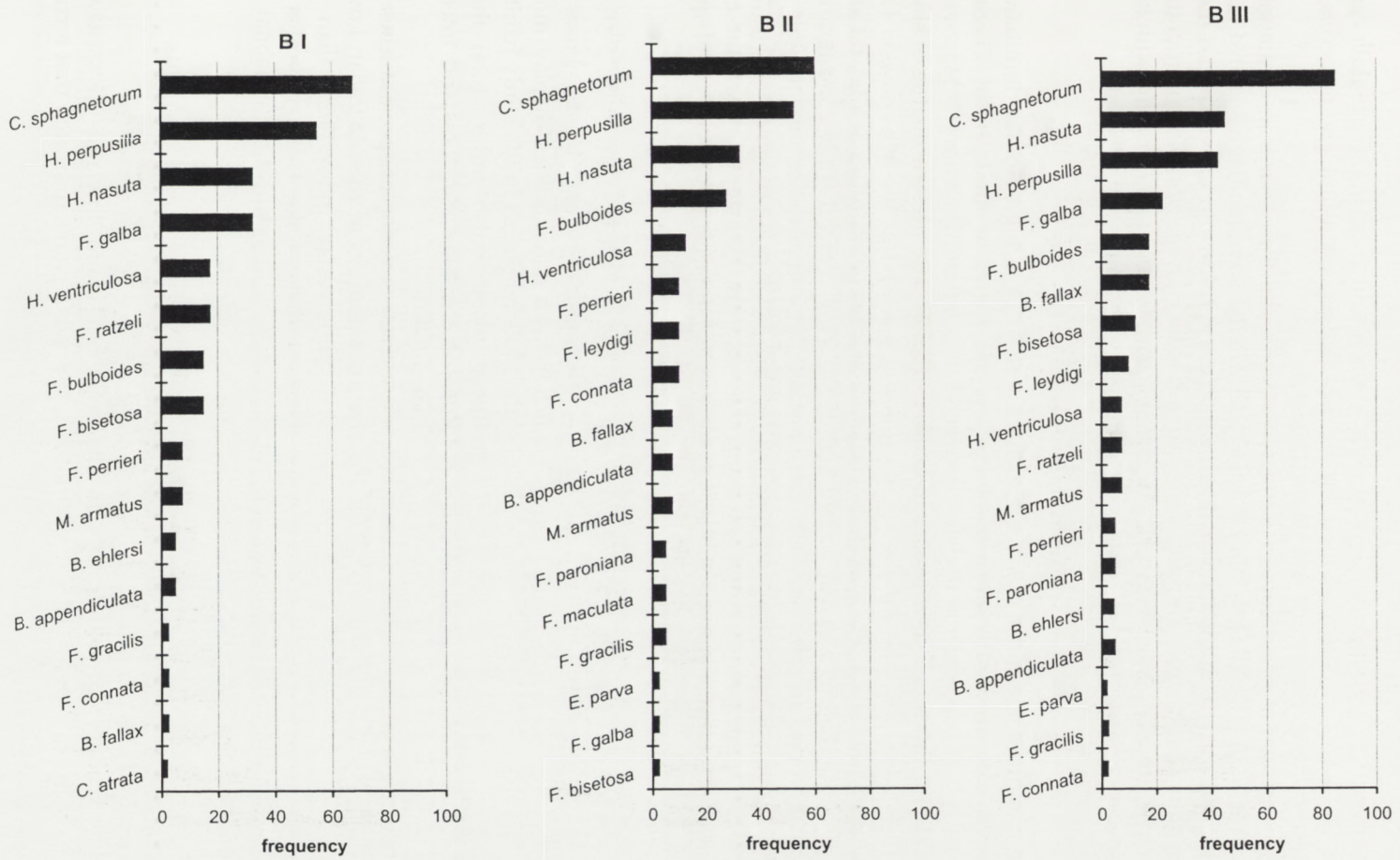


Fig. 3. Frequency of enchytraeid species at the study sites.

An analysis of the constancy of occurrence at the 6 study sites in the ash-alder carrs reveals that 9 species occurring there can be classified as euconstant, and 6 species as constant, with 5 accessory and 4 accidental species.

The constancy of occurrence of individual species and their shares in community abundance make it possible to more precisely characterise communities associated with the ash-alder carr. With the help of these two characteristics. a group of species most important for the structure, forming the core of ash-alder carr *Enchytraeidae* communities has been identified as consisting of *C. sphagnetorum, H. perpusilla* and *H. nasuta*, with two other species: *F. bisetosa* and *F. galba* occupying slightly less important positions.

Similarity of communities

The communities under study were characterised by a high similar dominance structures, measured with Morisita's index. As the degree of similarity of all communities is high, no regional division between the communities from the Mazovian Lowland and Puszcza Białowieska can be seen (Fig. 4). The highest degree of similarity (0.96) was obtained for the communities at site M I in the Młochowski Łęg Reserve and site B III in Puszcza Białowieska while the communities at sites B I and B II in Puszcza Białowieska also scored high (0.94). However, all study communities are similar to one another (at 0.84). The most similar communities inhabit soils of different types, such as a peaty-silty soil and a black earth or a peat-muck soil and a gley soil. Thus, despite different soil types that support the ash-alder carr, the enchytraeid communities appear similar to one another in terms of structure and species composition.

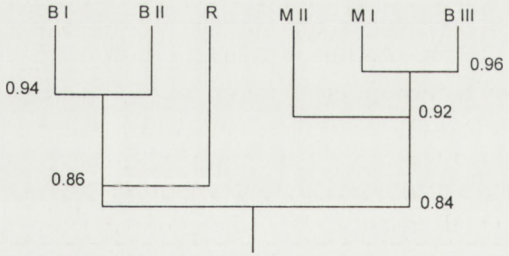


Fig. 4. Similarity of the enchytraeid communities in ash-alder carr soils (Morisita index).

Mean niche width and mean niche overlap

The species found in the Puszcza Białowieska communities display more limited niche ranges in the study habitat (mean niche width index, 1.24) than those in the Mazovian Lowland (mean index, 1.40).

A greater overlap of species niches in the communities of the Mazovian Lowland (an overlap index, 2.29) than in Puszcza Białowieska (1.95) indicates a greater specialisation of the species and greater degree of diversification of habitat in the latter place.

DISCUSSION

Earlier studies of enchytraeids in the soils of Poland lowlands (KASPRZAK 1977a, b, NOWAK, PILIPIUK 1997, PILIPIUK 1997, 1998, 2000) have indicated that fertile

and moist soils offer optimum conditions for the development of multi-species communities.

As revealed in the earlier and present studies, species inhabiting ash-alder carrs account for 37% of the total number of species found to date in the soils of the Polish lowlands and nearly a half (47%) of the number of species occurring in Poland's lowland forests.

The present studies show, that enchytraeid communities of ash-alder carrs characterized by high similarities of species composition and dominant structure. This suggests that typical structure of the enchytraeid communities may prove to exist in this type of environment.

The rich soils of ash-alder carr abundantly supplied with water against the background of a profound spatial diversification of the ground cover, reflecting habitat heterogeneity (MATUSZKIEWICZ 1996), allow for survival and coexistence of species showing different habitat requirements. Indeed, *Enchytraeidae* form species-rich communities in this type of habitat. The high-degree similarity of enchytraeid communities at the study sites may be due, on the one hand, to the fact that ash-alder plant associations are azonal, thus showing little regional diversification. On the other hand, this may also point to greater importance of the water regime and the type of plant association than of soil type for the formation of enchytraeid communities.

The enchytraeid community at Radziejowice differed most markedly from the other communities investigated here in terms of species composition, structure of dominance, frequency, and community abundance. The index of general species diversity reached its highest values in that community. This is due to uniform structure of dominance, which in turn was most probably the result of certain environmental disturbances in relation to anthropogenic press. The ash-alder carr at Białołęka Dworska (KASPRZAK 1981), subjected to a great deal of anthropogenic press, hosted only one species, *Fridericia bisetosa*. Rich communities of enchytraeids in ash-alder carrs, as well as other moist habitats such as peatlands, are more prone to degradation than communities inhabiting other habitats. The findings of this study confirm that *Enchytraeidae* may be used as indicator of environmental change or the direction of change (DIDDEN *et all* 1997).

The Puszcza Białowieska enchytraeid communities, where the species are characterised by a smaller mean niche width and smaller mean niche overlap, may be regarded as better adapted to life in this habitat and more diversified than in the Mazovian Lowland, and thus capable of a better utilisation of the environment.

CONCLUSIONS

The enchytraeid communities studied in different types of soil in two regions of Poland are characterised by similar species composition and dominance structure. However, compared to the communities in Mazovian Lowland, the ash-alder carrs of Puszcza Białowieska support communities with higher values of constancy, and lower value of mean niche width and mean niche overlap.

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STRESZCZENIE

[Tytuł: Wazonkowce (*Enchytraeidae, Oligochaeta*) lasów łęgowych (*Circaeo-Alnetum*)]

Badano skład gatunkowy i strukturę zgrupowań wazonkowców na 6 stanowiskach w łęgach jesionowo-olszowych usytuowanych na Nizinie Mazowieckiej i w Puszczy Białowieskiej. Stwierdzono występowanie 25 gatunków wazonkowców. W skład grupy gatunków dominujących wchodzą: *C. sphagnetorum, H. nasuta, H. perpusilla, H. ventriculosa*. Zgrupowania Puszczy Białowieskiej odznaczają się większą stałością niż zgrupowania Niziny Mazowieckiej. Na podstawie stałości występowania po-

szczególnych gatunków i ich udziału w liczebności wyłoniono gatunki mające największe znaczenie w strukturze, stanowiące trzon zgrupowań łęgowych. Do gatunków takich należy *C. sphagnetorum, H. perpusilla, H. nasuta,* nieco niższa jest ranga gatunków *F. bisetosa* i *F. galba.*

Zgrupowania wazonkowców lasów łęgowych cechuje znaczne podobieństwo składu gatunkowego i struktury mimo różnego typu gleby i usytuowania geograficznego. Można więc uznać, że zgrupowania te są charakterystyczne dla lasów łęgowych. Przeprowadzona analiza średniej szerokości niszy i średniego pokrywania się nisz wskazuje na lepsze wykorzystanie środowiska glebowego i większą stabilność zgrupowań Puszczy Białowieskiej.