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VARIETY OF MEIOBENTHIC ASSEMBLAGES AGAINST THE BACKGROUND OF ENVIRONMENT IN SELECTED FRESHWATER RESERVOIRS OF CENTRAL ROZTOCZE REGION (SE POLAND)

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Summary. The paper presents the results of research on meiobenthic assemblages in freshwater reservoirs of Central Roztocze, a region with high diversity of environmental conditions. The results are related to the distribution, frequency, relative abundance, density and Bray-Curtis similarity of meiobenthic fauna assemblages in different freshwater reservoirs, considered individually and by their types (rivers, ponds and bogs).

Key words: meiobenthic assemblages, Roztocze region

INTRODUCTION

Small meiobenthic invertebrates (the most common criterion 0.042–1.0 mm), as a functional group, are a sensitive indicator of changes occurring in the water environment [Warwick 1990, Särkkä 1992, Reiss and Schmid-Araya 2008]. Some species belonging to meiobenthic invertebrates are sensitive bioindicators of changes occurring in the water environment [Martins *et al*. 2007]. Meiobenthic assemblages include also pioneer taxa, resistant to variable, extreme or/and polluted hydrological conditions of water reservoirs [Stolarska and Wojtasik 2008, Wojtasik and Cieszyńska 2008]. The Roztocze region, particularly Central

Roztocze, is characterised by a great diversity of environmental conditions, including the water reservoirs [Buraczyński (ed.) 2002].

STUDY AREA

Roztocze is an elevation located between the Wieprz and Bug rivers' catchments in NE, and San and Dniester rivers' catchments in SW. It is stretched in the form of an arc from Kraśnik to Lviv, about 14–28 km wide and 180 km in length. It is built from upper Cretaceous gaizes and opokas, cut by a plain surface on 300–330 m and 320–350 m a.s.l. height in the Central Roztocze region. These rocks are exposed on the surface or they are covered by loess and sands.

In the Roztocze region there is a contrast between plenty of ground waters and poverty of surface waters. Precipitation is relatively high (650–700 mm), but water is rapidly infiltrated into fissured Cretaceous rocks: gaizes, opokas and marls. The Roztocze region is dissected by deep valleys, in which plenty of springs feed a sparse river network. Therefore, the rivers of the region have small fluctuations of discharge. The main ground water layer is established by local Quaternary aquifer in sands. In places, swamps and peat-bogs developed on the surface. The surface river network is supplemented by artificial retention and recreation reservoirs and fishing ponds [Buraczyński (ed.) 2002].

Poorly diversified bedrock lithology makes chemical composition of Roztocze rivers and springs waters relatively monotonous. All waters are composed of two ions – hydrogen carbonate and limestone. Differences in general mineralization (150–300 mg/l) and in concentration of subservient ions are connected with diversity of deposit cover, such as rock-mantle, loess and sands. It is emphasized especially in the central Roztocze region, in upper Wieprz River catchment with its tributaries and upper Szum River one. Those catchments are hydrologically and hydrochemically controlled by the Roztocze Research Station in Guciów (station of Maria Curie-Skłodowska University in Lublin) in collaboration with the Roztocze National Park. The catchments which are located in the Zwierzyniec depression: Świerszcz and Szum rivers, are characterised by low concentration of ions in waters, while high ions concentration occurs in the waters of Kryniczanka River loess catchment [Świeca (ed.) 2004].

MATERIAL AND METHODS

The material for the research on the group of meiobenthos was collected in August and the first part of September 2008. The samples were collected from 37 different sites (Fig. 1), including rivers Wieprz (W1-W6), Świerszcz (S1-S8), Szum (Sz1, Sz2), Sopot (So), Kryniczanka (Ky), Krupiec (Kr); ponds: Kościelny in Zwierzyniec (Z1), Echo (E1), Florianiecki (F1-F4), Czarny (C1, C2) and the pond in Hutki (H1), peat-bogs Wygoda (T1), Kruglik (T2, T3), near Hrabska Droga (T4-T7), Kosobudy-Bór (T8, T9). The samples were collected for quantitative and qualitative analyses of meiobenthos. Samples of the surface layer of the bottom sediment (0–10 cm) were collected using a tube of a diameter of 2.5 cm.

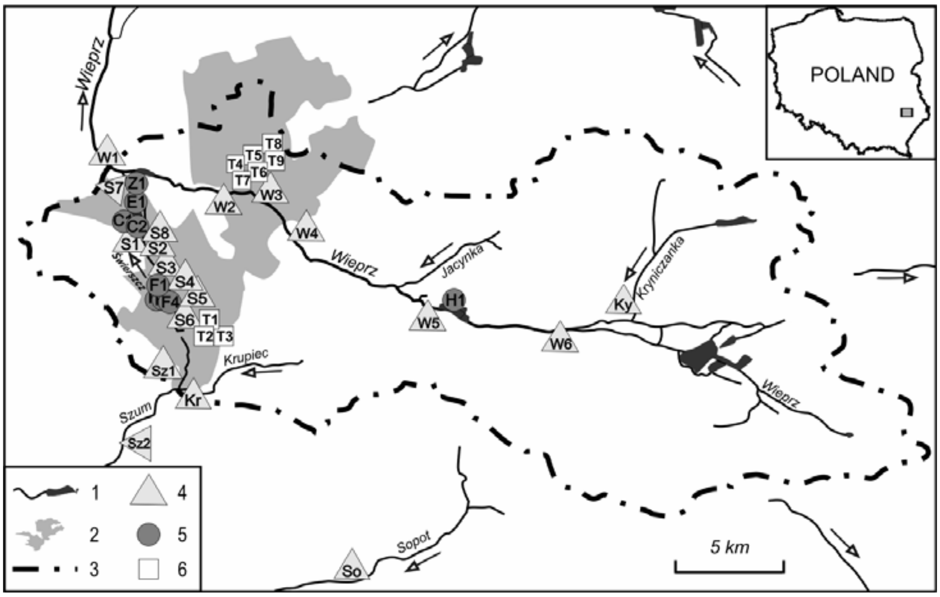

Fig. 1. Location of sampling points in Central Roztocze region against the background of hydrochemical monitoring range realized by MCSU Roztocze Research Station; 1 – rivers and reservoirs (ponds), 2 – Roztocze National Park area, 3 – range (watershed) of MCSU RRS monitoring; sampling points: 4 – in rivers, 5 – in reservoirs (ponds), 5 – in peat-bogs

From each station there were collected two or three subsamples which were then mixed [Szymelfenig *et al*. 1995]. The samples were preserved using 70% ethanol and stained with rose bengal (Rose Bengal sodium salt, SIGMA nr R3877-5G). Thus prepared material, after washing through a 0.042 mm sieve, underwent a detailed analysis with regard to the presence of meiobenthic organisms. The analysed material was not washed using a 1.0 mm framed mesh in order to separate meiobenthos from macrobenthos. The size of animals was assessed using, among others, scale pans with a grid of 1 and 2 mm sides. Animals longer than 1 mm, whose width or thickness were equal to or larger than 1 mm, were classified as macrobenthos. Organisms whose size theoretically enabled them to pass through a 1 mm mesh were classified as meiobenthos. In order to recognise the biodiversity accurately, additional samples were taken using a hand scoop of a 0.042 mm mesh (the volume of one sample was about 0.5 dm^3).

In the analysed material, systematic groups characteristic of meiobenthos, yet of various systematic positions, were determined. The calculations covered: 1) the number of specimens per 10 cm^2 of bottom sediment (N_{10}), 2) frequency

(F), commonness of occurrence expresses as $F = Nf_i/Nf$, where Nf_i – number of sites in which given species occurred, Nf – number of all sites; 3) relative number (D_m) expressed as percentage of the number of specimens of i-taxon to the number of all specimens in a given site or the material, $D_m = (Nd_i/Nd) \cdot 100\%$, where Nd_i – number of specimens of i-taxon in site/the whole material, Nd – number of all specimens in site / in the whole material; domination index, where the following division in terms of percentage proportion in the group was adopted: dominants ($D > 50\%$), subdominants ($25\% < sD \leq 50\%$), influents ($10\% < I \leq 25\%$), subinfluents ($3\% < sI \leq 10\%$), recedents ($1\% < R \leq 3\%$), subrecedents ($sR \leq 1\%$) [Wojtasik 2007]; 4) faunistic similarity coefficient of Bray-Curtis (non-transformed data) calculated using computer program PRIMER v.5 [Clarce and Gorley 2001] and presented in the form of MDS (non-metric multi-dimensional scaling) ordination arrangement, taking into consideration the type of bottom sediment occurring in a given site.

RESULTS AND DISCUSSION

The results of quantitative and qualitative analyses of meiobenthos revealed differences between the studied stations. The following systematic groups characteristic of meiobenthos were found to be present in the investigated material: Turbellaria, Rotifera, Nematoda Oligochaeta, Cladocera, Copepoda, Ostracoda, Collembola, larvae Insecta, Arachnida, Tardigrada, Gastropoda and Bivalvia. Taxonomic biodiversity was higher for the ponds and peat-bogs than for the stations on rivers. The same situation was observed for the density of meiobenthos (number individuals per 10 cm^2): the results showed a lower density of meiobenthos in river sediments compared to that of ponds and peat-bogs (Tab. 1). The highest frequency and relative abundance were calculated for Rotifera and Nematoda (Tab. 1, 2). The most interesting were the assemblages inhabiting peat-bogs of very low selected hydrological parameters: pH (about 5), conductivity and TDS, because of their rather high taxonomic biodiversity despite the specific hydrological conditions of the environment.

The number of major meiobenthic taxa in the particular sites varied considerably, from 2 to 10 taxa: in rivers from 2 to 9 (average 5.16), in ponds from 3 to 10 (average 6.65), in peat-bogs from 3 to 9 (average 6.65) (Tab. 1).

The relative abundance (D) of the analysed taxa calculated for the whole material indicates a lack of a dominant, whereas Rotifera and Nematoda constitute a group of subdominants. The remaining taxa constitute subinfluents, recedents or subrecedents. The relative number of meiobenthic taxa calculated separately for the investigated stations revealed notable differences between them (Tab. 1). The highest differences in dominance structure were observed for the peat-bogs and the Świerszcz River.

Table 1. Relative abundance D (%) and density (N_{10}) of major meiobenthic taxa (dark grey cells – dominants, light grey cells – subdominants) from sampling station in Cental Roztocze region: rivers (W1-So), ponds (H1-Z1) and peat-bogs (T1-T9) – location on Fig. 1

Station	Major meiobenthic taxa													N10
	Turbellaria	Rotifera	Nematoda	Oligochaeta	Cladocera	Copepoda	Ostracoda	Collembola	Insecta larvae	Arachnidae	Tardigrada	Gastropoda	Bivalvia	
W1		43.7	31.3	25.0										16
W2	8.6	26.7	24.1	4.3		5.4	12.8		11.2		6.4	0.5		187
W3	15.7	31.5	5.3	10.5		5.3	5.3		21.1				5.3	19
W4	2.3	18.2	**67.0**	6.8			3.4						2.3	88
W5	46.2	46.2	7.6											13
W6	3.8	3.8	**80.8**	3.8				7.8						26
S1	2.2	**55.6**	20.0						8.9		13.3			45
S2		33.3	16.7		16.7		33.3							6
S3	16.0	48.0	8.0				8.0		20.0					25
S4		17.4	26.1				17.4		4.3				34.8	23
S5		**55.6**				11.1			11.1			22.2		9
S6		**53.3**		20.0			26.7							15
S7	14.3	28.6											**57.1**	7
S8	33.3	**66.7**												3
Ky	4.6	3.8	**76.3**	3.8		7.6	1.5	0.8	0.8			0.8		131
Kr	5.4	33.8	41.9	4					4.0		1.4		9.5	74
Sz1		**75.8**							24.2					33
Sz2	1.2	37.0	**54.4**	1.2			2.5		2.5	1.2				81
So	1.7	**72.1**	21.6	3.2			0.1	0.1	0.9				0.3	694
H1	2.4	25.4	**72.2**											43
C1	3.7	34.2	39.0	1.2	2.4	2.4	1.2		14.7				1.2	82
C2	13.3	**66.7**					20.0							15
F1	1.5	45.5	39.4	1.5	3.0	1.5	6.1		1.5					66
F2	9.1	22.7	22.7			9.1	4.5		27.4				4.5	22
F3		**58.3**				20.8	16.7					4.2		24
F4		12.0	32.0	8.0	16.0	4.0	20.0		4.0				4.0	25
E1	16.9	33.7	37.1	6.7	1.4		1.4		1.4		1.4			148
Z1	3.7	42.1	22.6	1.5	14.3	3.7	0.8				11.3			133
T1	3.2	**71.0**	3.2		3.2	6.5	3.2		3.2			6.5		31
T2	19.3	10.5	0.9	18.3	1.8	1.8			0.9	0.9	45.6			114
T3	12.5	25.0	18.7	31.3			12.5							16
T4		3.2	**71.0**	9.7	3.2		3.2		9.7					31
T5	5.1	**56.4**	7.7			7.7		2.6		2.6	17.9			39
T6		50.0	16.6		12.5	4.2	8.3		4.2			4.2		24
T7		50.0				12.5	37.5							8
T8		**60.7**	16.2	1.4		12.2			8.1				1.4	74
T9		23.7	11.2	3.8		28.8	12.5		15.0			2.5	2.5	80
Total	5.0	43.7	29.0	4.2	1.5	3.2	3.5	0.2	4.2	0.1	3.8	0.4	1.2	66.8

The average density of meiobethos (N_{10}) for the whole material was 66.8. The N_{10} value for the Świerszcz River was smaller for all sites than the average value. The value of N_{10} calculated separately for individual samples and for different types of reservoirs also revealed differences (Tab. 1, Fig. 2a). The range of density calculated for Roztocze Region (up 3 to 691 ind. 10 cm^2) was higher than in other regions in Poland. For example, in the Wiślinka Region, near a phosphate heap in summer season, the range of density was from 18 to 126 ind. 10 cm^2 [Stolarska and Wojtasik 2008]. In the littoral zone of the lakes in the Zaborski Park (Kashubia Region), the range of density was from 14 to 384 ind. 10 cm^2 [Wojtasik, unpublished]. In the littoral zone of the Czorsztyn dam reservoir near the Niedzica dam (Pieniny Mountains), the meiobenthos density was from 4 to 22 ind. 10 cm^2 and in the littoral zone of Sromowce reservoir the range was from 40.8 to 412.2 ind. 10 cm^2 [Wojtasik and Cieszyńska 2008, Wojtasik 2009].

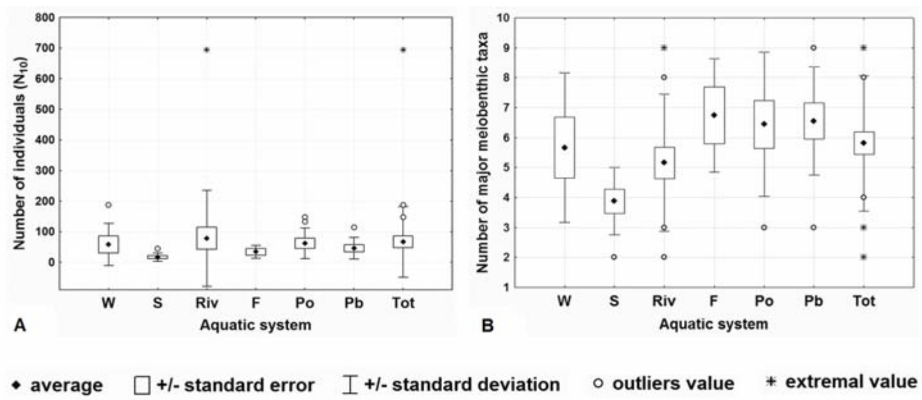

Fig. 2. Statistical features of meiobenthic assemblages in Central Roztocze region, in selected reservoirs and by the type of reservoirs (W – Wieprz river, S – Świerszcz river, Rv – all river points, F – Florianiecki pond, Pd – all pond points, Pb – all peat-bog points, Tot – total points): A – number of individuals (N10), B – number of major meiobenthic taxa

The highest frequency of occurrence was observed for Nematoda (F = 0.78) and Rotifera (F = 1.0), but also high for Turbellaria, Oligochaeta and Ostracoda. In the case of Copepoda, Collembola, Arachnida and Gastropoda, the F value depended on settlements (Tab. 2). A similar situation for Nematoda and Rotifera was observed in the littoral zone in other freshwater reservoirs in Poland (summer season). *Copepoda* was observed in higher frequency in Kashubian Lakes, Czorsztyn and Sromowce reservoirs and Gdansk region reservoirs than the average value of F in the presented results [Wojtasik 2007, Stolarska and Wojtasik 2008, Wojtasik and Cieszyńska 2008].

Table 2. Frequency F of major meiobenthic taxa in different water ecosystems in Central Roztocze region: Fr – in rivers, Fp – in ponds, Fb – in bogs, Fm – in all material

Ecvosystems	Major meiobenthic taxa												
	Turbellaria	Rotifera	Nematoda	Oligochaeta	Cladocera	Copepoda	Ostracoda	Collembola	Insecta larvae	Arachnidae	Tardigrada	Gastropoda	Bivalvia
Fr	0.68	1.0	0.74	0.53	0.05	0.21	0.53	0.16	0.58	0.05	0.16	0.16	0.32
Fp	0.78	1.0	0.78	0.56	0.56	0.67	0.89	0.0	0.56	0.0	0.22	0.11	0.33
Fb	0.44	1.0	0.89	0.56	0.44	0.78	0.67	0.11	0.67	0.22	0.22	0.33	0.22
Fm	0.65	1.0	0.78	0.54	0.27	0.46	0.65	0.11	0.59	0.08	0.19	0.19	0.30

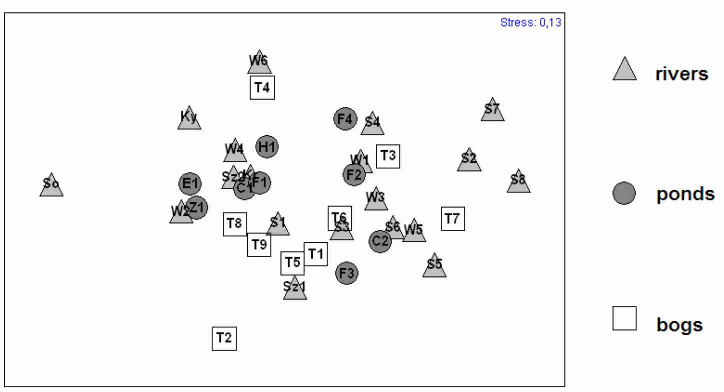

Fig. 3. MDS analysis of meiobenthic assemblages in Central Roztocze region

The number of major meiobenthic taxa was also varied, and the highest average value was observed in Florianiecki Pond (Fig. 2b). The analysis of Bray-Curtis faunistic similarity of meiobenthic assemblages (including the type of site: rivers, ponds/reservoirs, peat-bogs) revealed fortuity and a lack of distinction (Fig. 3).

CONCLUSIONS

Water reservoirs of the Central Roztocze region, because of small influence of anthropopresion, are an important example of the natural process of differentiation among meionbethic assemblages.

The results of the research have shown that there are no differences among the types of reservoirs. A higher differentiation was observed for meiobentic assemblages for the same type of reservoir (rivers, ponds, peat-bogs) but for different locations. In conclusion, the presented results suggest a stronger influence of the kind of sediment on meiobenthic assemblages than hydrological water parameters, particularly for springs and rivers.

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ZRÓŻNICOWANIE ZGRUPOWAŃ MEIOBENTOSU NA TLE ŚRODOWISKA W WYBRANYCH AKWENACH ROZTOCZA ŚRODKOWEGO

Streszczenie. W pracy przedstawiono wyniki badań fauny meiobentosowej w akwenach Roztocza Środkowego, mezoregionu o dużym zróżnicowaniu warunków środowiskowych. Porównano gęstość występowania, frekwencję, liczebność względną i współczynnik podobieństwa faunistycznego meiobentosu między poszczególnymi akwenami oraz ich typami (rzeki, mokradła i stawy).

Słowa kluczowe: zgrupowania meiobentosu, Roztocze