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PLANKTONIC ROTIFERS DIVERSITY IN SELECTED RIVERS OF THE VISTULA, WIEPRZ AND SAN DRAINAGE-BASINS

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Summary. Planktonic rotifers were investigated during the years 1991-1993 in the rivers Bystra, Minina and Ciemięga belonging to drainage-basin of the Vistula and Wieprz Rivers and during the years 1995-1996 in rivers belonging to the San River drainage-basin – Bukowa, Branew and Czartosowa. Totally, in all studied rivers 49 rotifers species were noted. The higher number of species – 45 – was observed in drainage-basin of the Vistula and Wieprz Rivers, where arable lands dominated in the structure of land use. The much lower number of rotifers species – 19 – was noted in the San River drainage-basin, where forest areas dominated. Shannon-Wiener biodiversity index reached higher values in the streams of the Vistula and Wieprz drainage-basin and it ranged from 3.08 to 3.97. In small streams of the San drainage-basin Shannon index reached lower values: 2.30-3.21. Among planktonic rotifers species in the Vistula and Wieprz drainage-basin the highest occurrence was shown by *Keratella cochlearis*, *Keratella cochlearis tecta*, *Polyarthra vulgaris*, *Elosa spinifera*, *Filinia longiseta*, *Notholca squamulla*, *Lecane closterocerca*, *Lepadella ovalis and Brachionus angularis*, and in streams of San drainage-basin: *Polyarthra vulgaris*, *Brachionus diversicornis*, *Anuraeopsis fissa*, *Keratella cochlearis*, *Brachionus angularis* and *Keratella quadrata*. Densities of planktonic rotifers were higher in the drainage-basin of the Vistula and Wieprz Rivers, and they ranged from 21 ind. · dm^{-3} in the Minina River to 76 ind. · dm^{-3} in the Bystra River. In the San drainage-basin observed rotifers densities were very low: from 9 ind. · dm^{-3} (Branew River) to 20 ind. · dm^{-3} (Bukowa River).

Key words: rivers, planktonic rotifers, species diversity

INTRODUCTION

Rotifers inhabiting running waters are considered to be the most important group of potamoplankton. They are consumers of microorganisms such as: bacteria, algae, protozoan; some species are detritivorous. That is why these microorganisms play an important role in rivers trophic structure [Radwan 1973]. Selected rotifers species are used as indicators of organic pollution or trophy of running waters [Radwan 1973, Karabin 1985, Paleolog *et al.* 1997, Radwan *et al.* 1998].

The present studies concerned the qualitative and quantitative structure of planktonic rotifers in selected rivers of Vistula, Wieprz and San drainage-basins. Up to now in these rivers the biology and ecology of zooplankton have not been investigated very carefully [Paleolog *et al.* 1997, Radwan and Paleolog 1999, Paleolog 2000].

STUDY AREA, MATERIAL AND METHODS

On the area of Lublin Province (eastern Poland) in the region of the Rivers Vistula and Wieprz two geomorphologically different areas are present: the first – part the of Vistula and Wieprz Rivers drainage-basin (situated near Lublin City on Nałęczowski Plateau and Lubartów High Plain) with visible domination of areable lands and meadows; the other – small part of the San River drainage-basin (situated near Janów Lubelski on the area of Biłgoraj Plain) with domination of forests in land use structure.

Studies were carried out in six small streams running through the Vistula and Wieprz Rivers drainage-basins (Bystra, Minina, Ciemięga) and the San River drainage-basin (Bukowa, Branew, Czartosowa) – Tab. 1.

Table 1. Selected hydrological and morphometric parameters of rivers in the Vistula and Wieprz drainage-basin [Rzążowska 1980, Michalczyk and Wilgat 1998]

Tabela 1. Wybrane hydrologiczne i morfometryczne parametry rzek dorzecza Wisły i Wieprza

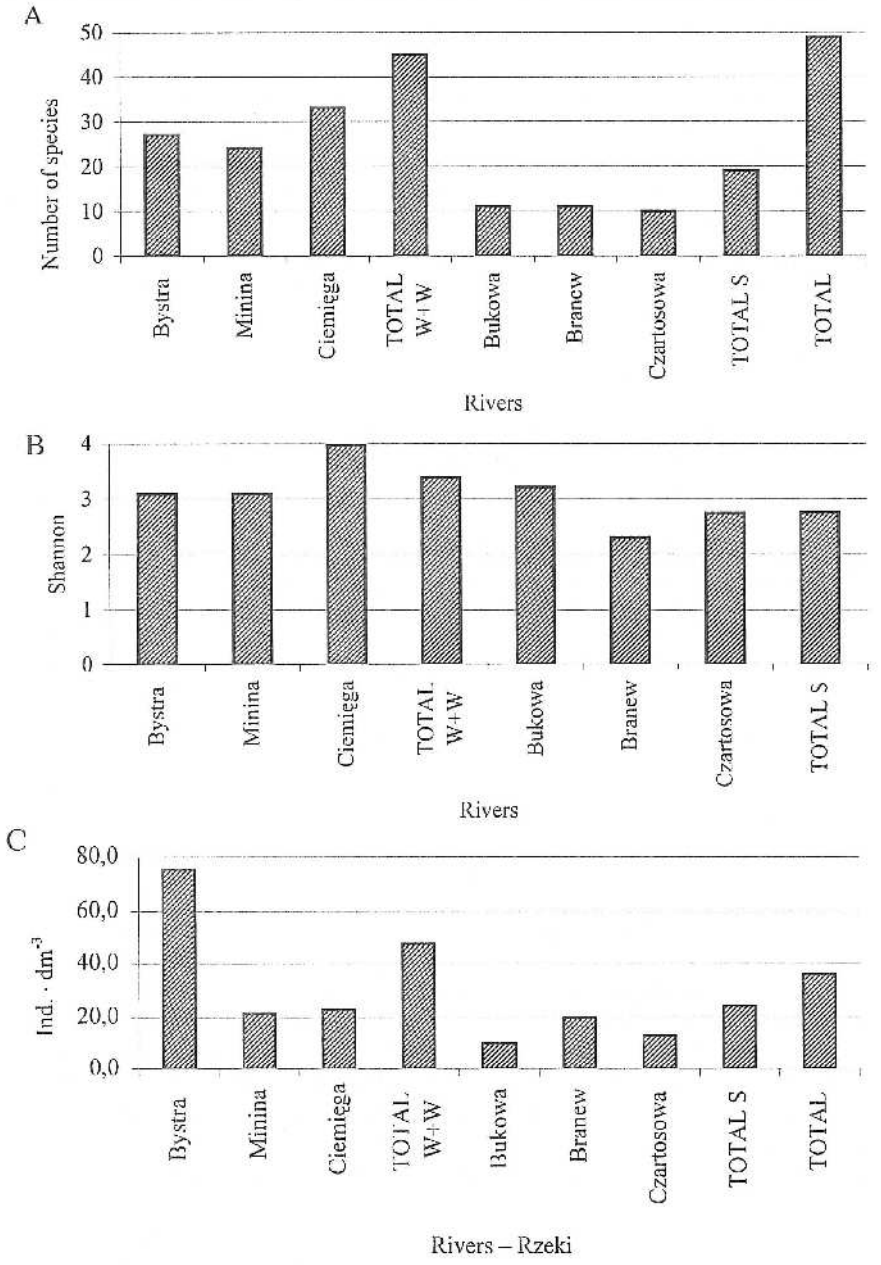
Rivers Rzeki	River development Rozwój rzeki	Order of the river Rząd rzeki	River lenght (km) Długość rzeki	Catchment area (km^2) Obszar zlewiska	Mean values Wartości średnie		Flow dimension at river mouth ($m^3 \cdot s^{-1}$) Rozmiar strumienia z ujścia rzeki
					Fall of riverbed (‰) Spadek koryta rzeki	Flow velocity ($m \cdot s^{-1}$) Szybkość strumienia	
Bystra	1.43	II	34.4	306.9	2.8	0.56	1.20
Minina	1.20	III	39	463.8	2.0	0.52	1.50
Ciemięga	1.61	IV	41	157.1	1.5	0.25	0.60
Bukowa	1.33	III	54.2	650.8	1.4	0.53	4.90
Branew	1.49	IV	27.3	73.4	2.2	0.49	0.35
Czartosowa	1.16	IV	8.9	32.57	3.8	0.60	0.34

In all studied rivers 19 sampling sites were located: 4 sites on rivers Bystra, Minina and Ciemięga, 3 sites on Bukowa and two sites on Branew and Czartosowa. Rivers from the Vistula and Wieprz drainage-basin were sampled in spring and autumn during the years 1991-1993; rivers from the San drainage-basin once a month (from spring to autumn) from 1995-1996. Single sample was collected by taken 50 l of water using scooper type „Toń", then trickled through the planktonic net no. 25 and condensed to the constant volume of 100 cm^3. Collected samples were fixed with Lugol liquid, after some hours preserved by 4% formaldehyde with glycerin. Rotifers density and species structure were estimated under stereomicroscope. Numbers of individuals were counted per 1 dm^3 of water.

RESULTS AND DISCUSSION

Species diversity

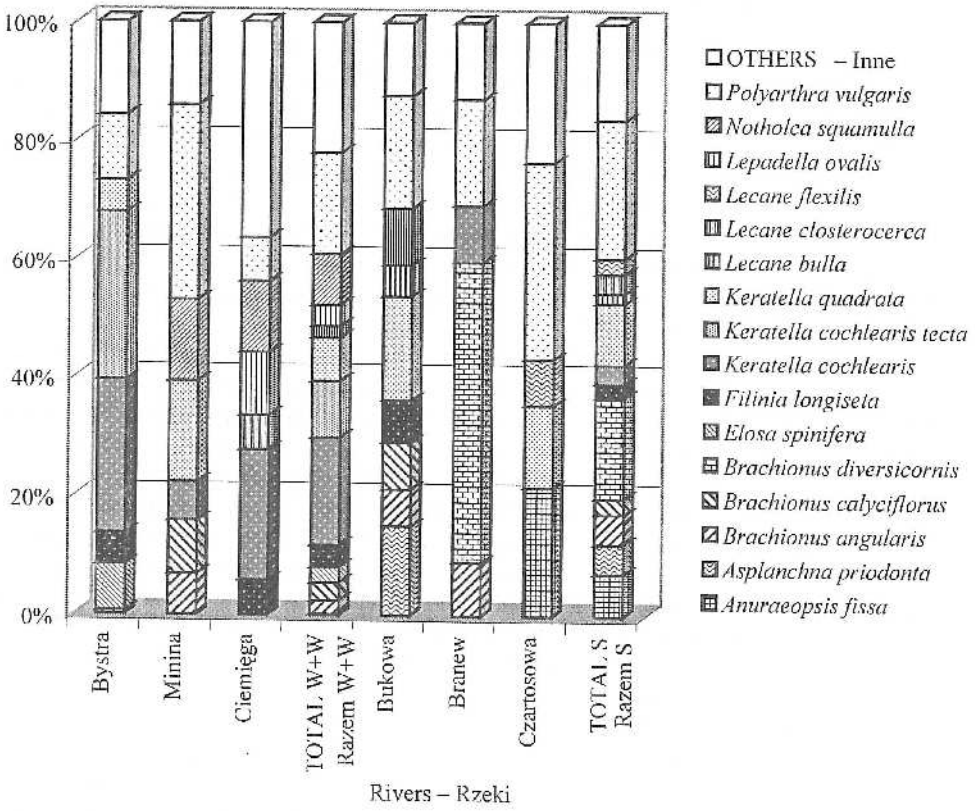
Totally, 49 planktonic rotifers species were noted in all studied streams: 45 – in rivers of the Vistula and Wieprz drainage-basin and only 19 in the San drainage-basin (Fig. 1A). The number of rotifers species was differentiated in particular rivers. In the Vistula and Wieprz drainage-basin the number of species ranged from 24 in the Minina River to 33 in the Ciemięga River (area of very low impact of human activity). In turn in



TOTAL W+W – rivers belonging to Vistula and Wieprz Rivers drainage-basin
TOTAL S – rivers belonging to San River drainage-basin
Razem W+W – rzeki należące do dorzecza Wisły i Wieprza
Razem S – rzeki należące do dorzecza Sanu

Fig. 1. Rotifers of selected rivers in drainage-basins of Vistula and Wieprz (years 1991-1993) and San (years 1995-1996). A – number of species, B – Shannon's diversity index, C – density
Rys. 1. Wrotki planktonowe wybranych rzek w dorzeczach Wisły i Wieprza (lata 1991-1993) oraz Sanu (lata 1995-1996). A – liczba gatunków, B – wskaźnik różnorodności Shannona, C – gęstość

the rivers of the San drainage-basin the number of rotifers species was almost equal in all streams and reached 10 species in the Czartosowa River and 11 species in the Rivers Bukowa and Branew. The numbers of rotifers species in the rivers of Vistula, Wieprz and San drainage-basins were lower or similar in comparison to those noted in other small streams in Poland [Bielańska-Grajner 1990, 1997, Żurek 2000].



TOTAL W+W – rivers belonging to Vistula and Wieprz Rivers drainage-basin
TOTAL S – rivers belonging to the San Rivers drainage-basin
Razem W+W – rzeki należące do dorzecza Wisły i Wieprza
Razem S – rzeki należące do dorzecza Sanu

Fig. 2. Percentage of planktonic rotifers of selected rivers in drainage-basins of Vistula and Wieprz (years 1991-1993) and San (years 1995-1996)
Rys. 2. Procent wrotków planktonowych wybranych rzek w dorzeczach Wisły i Wieprza (lata 1991-1993) oraz Sanu (lata 1995-1996)

Species diversity of planktonic rotifers (values of Shannon-Wiener index) just as the number of species was higher in the rivers of Vistula and Wieprz drainage-basin (H = 3.38) than in San drainage-basin (II = 2.75) (Fig. 1B). In particular streams values of Shannon index were completely different from the respective number of rotifers species. In the rivers of the Vistula and Wieprz drainage-basin H index ranged from 3.08 and 3.09 in the rivers Bystra and Minina to 3.97 in the River Ciemięga. In the San drainage-

basin Shannon index reached 2.30 in the Branew River and 3.21 in the Bukowa River (Fig. 1B). So, in the Bukowa River despite a low number of rotifers species observed values of Shannon index were quite high. In the Czartosowa River in spite of the lowest number of rotifers species the value of H index was higher than in the Branew River.

Density and domination structure

Mean density of planktonic rotifers ranged from 24 ind. · dm^{-3} in rivers of the San drainage-basin to 48 ind. · dm^{-3} in Vistula and Wieprz drainage-basin (Fig. 1C). Rotifers density showed visible differences among the studied rivers. In the streams of Vistula and Wieprz drainage-basin the number of individuals ranged from 21 to 22 ind. · dm^{-3} in the Rivers Minina and Ciemiega to 76 ind. · dm^{-3} in the Bystra River. In turn, in the rivers of San drainage-basin rotifers density reached rather low values – from 10 ind. · dm^{-3} in the Bukowa River to 20 ind. · dm^{-3} in the Branew River. The observed planktonic rotifers densities both in the San and Vistula and Wieprz drainage-basins reached lower or almost equal values to other rivers in Poland [Pawłowski 1970, Bielańska-Grajner 1990, 1997, Żurek 2000].

Domination structure of planktonic rotifers differs in the two compared drainage-basins. In the Vistula and Wieprz drainage-basin three groups of species eudominants were distinguished: *Keratella cochlearis* and *Polyarthra vulgaris*, dominants, such as: *Keratella cochlearis tecta*, *Notholca squamulla* and *Keratella quadrata* and subdominants: *Lepadella ovalis*, *Filinia longiseta*, *Brachionus calyciphlorus*, *Elosa spinifera* and *Brachionus angularis*. The remaining species reached very low percentage in total rotifers density (Fig. 2). Among three studied streams of the Vistula and Wieprz drainage-basin, the Ciemięga River seems to represent the highest ecological status. In this river subdominant and receding species reached 37% of total rotifers density Apart from this, species typical of waters of low trophy: *Notholca squamulla*, *Lepadella ovalis* and *Lecane closterocerca* reached 27% of total density (Fig. 2).

In the San drainage-basin among eudominant species were noted *Polyarthra vulgaris*, *Brachionus diversicornis* and *Keratella quadrata*, among dominants: *Anuraeopsis fissa*, *Brachionus angularis* and *Asplanchna priodonta* and among subdominants: *Brachionus calyciphlorus*, *Keratella cochlearis*, *Filinia longiseta*, *Lecane closterocerca* and *Lecane flexilis*. The remaining species reached a very low percentage in total rotifers density (Fig. 2). Among the three studied streams of the San drainage-basin, the Bukowa River seems to represent the highest ecological status. In this river 8 species belong to eudominants and dominants (88% totally, Fig. 2). A very unusual domination structure was shown by rotifers in the Czartosowa River. There occurred 3 eudominant species: *Polyarthra vulgaris*, *Anuraeopsis fissa* and *Keratella quadrata*, all of them are common [Karabin 1985, Radwan *et al.* 1998]. Quite a high share of receding species, the occurrence of rare species – *Lecane flexilis* (8%) and a high value of Shannon-Wiener index suggest that the ecological status of the Czartosowa River is higher than the Branew River.

CONCLUSIONS

Studies of planktonic rotifers in selected streams of the Vistula, Wieprz and San Rivers drainage-basins showed that:

1. Rivers of the Vistula and Wieprz drainage-basin are characterized by higher rotifers diversity than streams of the San drainage-basin. Probably it is a result of the stream

size and lower water temperature (rivers run through forest areas) in the rivers of the San drainage-basin.

2. The highest rotifers diversity was observed in the Ciemięga River, the lowest in the Bukowa River. The remaining rivers showed lower species diversity: Bystra, Minina, Czartosowa and Branew.

3. The highest density of planktonic rotifers was noted in the Bystra River, lower in the rivers: Ciemiega, Minina, Branew, Czartosowa and Bukowa, respectively.

4. In all the studied rivers dominated *Polyarthra vulgaris,* additionally in the Vistula and Wieprz drainage-basin: *Keratella cochlearis, Keratella cochlearis tecta* and *Notholca squamulla* and in the rivers of the San drainage-basin: *Brachionus diversicornis* and *Anuraeopsis fissa.*

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RÓŻNORODNOŚĆ GATUNKOWA WROTKÓW PLANKTONOWYCH W WYBRANYCH RZEKACH DORZECZA WISŁY, WIEPRZA I SANU

Streszczenie. W latach 1991-1993 przeprowadzono badania wrotków planktonowych w rzekach: Bystrej, Mininie i Ciemiędze, należących do dorzecza Wisły i Wieprza, a w latach 1995 i 1996 dokonano analogicznych badań w Bukowej, Branewi i Czartosowej, należących do dorzecza Sanu. W zooplanktonie wszystkich rzek stwierdzono łącznie 49 gatunków wrotków. Więcej, bo aż 45, wystąpiło w dorzeczu Wisły i Wieprza, w którym przeważają użytki rolno-łąkowe, zaś mniej, gdyż zaledwie 19 gatunków, w dorzeczy Sanu, gdzie dominują tereny leśne.

Wskaźnik różnorodności gatunkowej Shannona osiągał wyższe wartości w rzekach dorzecza Wisły i Wieprza, gdyż wahał się od 3,08 do 3,97. W małych śródleśnych rzekach dorzecza Sanu wartości jego były niższe i wynosiły od 2,30 do 3,21.

Do najczęściej występujących gatunków wrotków w rzekach dorzecza Wisły i Wieprza należały: *Keratella cochlearis*, *Keratella cochlearis tecta*, *Polyarthra vulgaris*, *Elosa spinifera*, *Filinia longiseta*, *Notholca squamulla*, *Lecane closterocerca*, *Lepadella ovalis* i *Brachionus angularis*, a w rzekach dorzecza Sanu były to: *Polyarthra vulgaris*, *Brachionus diversicornis*, *Anuraeopsis fissa*, *Keratella cochlearis*, *Brachionus angularis* i *Keratella quadrata*.

Liczebności wrotków były wyższe w dorzeczu Wisły i Wieprza i wahały się od 21 ind. · dm^{-3} w rzece Mininie do 76 ind. · dm^{-3} w rzece Bystrej. W dorzeczu Sanu liczebności wrotków były niewielkie i wynosiły od 9 ind. · dm^{-3} w rzece Branwi do 20 ind. · dm^{-3} w rzece Bukowej.

Słowa kluczowe: rzeki, wrotki planktonowe, różnorodność gatunkowa