ICHTHYOFAUNA OF SMALL RIVERS OF LUBLIN CITY

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Summary. Six control fishings were conducted in two small urban rivers (Lublin city) in order to determine their species composition, abundance structure and biomass, as well as species diversity. A total of 1994 fish was caught, representing 15 different species, 7 families, among which family Cyprinidae was the most common. The abundance of fish in the sampling sites of the examined rivers ranged from 82 to 287 fish 100 m⁻¹ 1 h⁻¹. The ichthyofauna of the studied rivers was characterised by low diversity (H' index ranged from 0.49 to 0.73), while their abundance structure was dominated by gudgeon and threespine stickleback. The study revealed the occurrence of two protected species (stone loach and weather loach) and a few individuals representing four alien species.

Key words: ichthyofauna, urban rivers, small rivers, Lublin

INTRODUCTION

The quality of natural environment and species composition of water ecosystems are strongly influenced by catchment use [Lenat and Crawford 1994, Weaver and Garman 1994, Wang *et al.* 2001].

Urban areas are characterised by worse quality of water and usually lower density, biomass and species number of fish communities [Lenat and Crawford 1994, Onorato *et al.* 1998, Walters *et al.* 2003].

So far the structure of ichthyofauna has been studied on large areas of Poland [Witkowski and Kotusz 2008], however, the south-east part of the country is not well recognized. Previous studies on fish communities focused on selected sections of Bug and Wieprz rivers [Radwan *et al.* 2000], as well on the rivers of Roztocze region [Danilkiewicz 1994], including river Tanew and its tributaries [Rechulicz *et al.* 2009]. Up to now few studies have been concerned with the ichthyofauna of urban areas of the country [Kruk *et al.* 2003, Radtke *et al.* 2007]. So, the present paper aims at determining the species composition, abundance and biomass of fish communities of small rivers situated in the city of Lublin.

MATERIAL AND METHODS

Rivers Czechówka (27 km in length) and Czerniejówka (18 km in length) constitute right and left side, partly regulated, tributaries of river Bystrzyca in the area of Lublin city [Michalczyk and Wilgat 1998, Wiśniewolski 2007]. On both rivers, within the city area, two sampling sites of 100m length were selected (on river Czechówka: Czech1 and Czech2; on river Czerniejówka: Czer1 and Czer2). Six control fishings were conducted in total: autumn 2003, spring and autumn 2005 and spring, summer and autumn 2006. Fish were caught using IUP-12, across the whole width of the river bed, and wading up the river [Penczak 1967, Hickley 1990].

Collected fish were identified to the species level, measured (to the nearest 1mm) and weighed (to the nearest 1g) and put back into the water. The obtained results of fishing were converted to CPUE (ind. 100 m⁻¹ 1 h⁻¹) in order to enable a comparison of fish abundance.

For both rivers, at each sampling site, the species composition, structure of dominance in abundance and biomass, and frequency of occurrence (C_i) were determined, and two indices of species diversity were calculated: the Shannon-Wiener index (H') and the index of species richness (S):

$$C_i = 100 \cdot Ns_i/Ns;$$

where:

 Ns_i – number of catches in which the presence of *i* species was observed, Ns – total number of catches.

$$H' = -\sum_{i=1}^{S} p_i \ln p_i ;$$

where:

S – number of species (species richness),

 n_i – number of individuals of *i* species,

N – total number of individuals of all species,

 $p_i - n_i/N$ ratio.

The obtained results were analysed statistically with the use of the SAS 9.0 software.

RESULTS

A total of 1994 fish individuals were collected. The fish represented 15 species and 7 families. In river Czechówka 10 species were noted, while in river Czerniejówka – 14 species. The highest number of species belonged to the cyprinids (8 species) (Tab. 1).

Species	R	K	Т	т	Occurrence		
				п	Czechówka	Czerniejówka	
Gobio gobio							
– Gudgeon	Psammophylis	LC	Ι	В	Х	Х	
Carassius gibelio							
 Prussian carp 	Phytophils	Ι	0	В	Х	Х	
Rutilus rutilus							
– Roach	Phytophils	LC	0	WC	Х	Х	
Gasterosteus aculeatus							
 Threespine stickleback 	Phytophils	LC	Ι	WC	Х	Х	
Perca fluviatilis							
– Perch	Phytophils	LC	I/P	WC	Х	Х	
Alburnus alburnus							
– Bleak	Phytophils	LC	Ι	WC	Х	Х	
Leuciscus leuciscus							
 Common dace 	Phytophils	LC	Ι	WC	Х	Х	
Misgurnus fossilis							
– Weather loach	Phytophils	LC	Ι	В	Х	Х	
Barbatula barbatula							
– Stone loach	Psammophylis	LC	Ι	В	Х	Х	
Salmo trutta m. fario							
– Brown trout	Lithophylis	CD	I/P	WC		Х	
Tinca tinca							
– Tench	Phytophils	LC	Ι	В		Х	
Ictalurus nebulosus							
 Brown bullhead 	Phytophils	Α	0	WC/B		Х	
Perccottus glewii							
– Amur sleeper	Phytophils	Α	I/P	WC		Х	
Leuciscus idus							
– Ide	Phytophils	LC	0	WC	Х		
Pseudorasbora parva	Phytophils	Δ	Т	WC		x	
 Topmouth gudgeon 	1 nytopinis	11	1	we		11	

Table 1. List of fish species recorded in the studied river

Explonations: R – classification of reproductive guilds according to Balon [1975]; K – IUCN categories of threat according to Witkowski *et al.* [1999]: LC – species of minimal care, CD – species dependent of the protective action, I – introduced, A – alien species; T – trophy: I – bentivorous, O – omnivorous, P – predacious; H – habitat: B – groundling fish, WC – pelagial fish

The fish caught in the rivers were characterised by low total length and individual weight; only single individuals of brown trout, Prussian carp and common dace reached lengths above 20 cm (Fig. 1, Tab. 2 and 3).

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Fig. 1. Total length (cm) of fish in the studied rivers

Table 2. Number of individuals (in ind. 100 m⁻¹ h⁻¹ fishing), frequency of occurrence (C_i) and average individual mass fishes from studied sites of Czechówka River (N = 1433, SD – standard deviation)

Species	Site	Mean ±SD	Range	C_i	Average individual weigth, g
Gudgeon	Czech1	145.60 ± 129.90	33.60-398.00	100.00	4.71
	Czech2	55.20 ± 70.60	0-147.40	83.30	4.04
Prussian carp	Czech1	17.90 ± 26.70	0-67.00	66.60	84.06
Roach	Czech1	8.70 ± 10.80	0-4.00	50.00	12.73
Threespine stickleback	Czech1	41.73 ±72.40	0-188.00	83.30	0.74
	Czech2	95.60 ± 81.00	12.00-226.00	100.00	1.83
Perch	Czech1	3.70 ± 4.60	0-12.00	66.60	29.00
Bleak	Czech1	69.60 ± 123.10	0-316.00	66.60	1.58
	Czech2	2.00 ± 4.90	0-12.00	33.30	2.00
Common dace	Czech2	101.40 ± 189.20	0-481.70	50.00	5.95
Weather loach	Czech2	0.67 ± 1.60	0-4.00	16.70	62.00
Stone loach	Czech2	0.67 ±1.60	0-4.00	16.70	37.00
Ide	Czech2	0.29 ±0.70	0-1.70	16.70	8.00

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Species	Site	Mean ±SD	Range	C_i	Average individual weight, g
Gudgeon	Czer1	34.10 ±20.10	6.90-62.00	100.00	15.39
6	Czer2	65.60 ±33.20	21.00-122.60	100.00	19.13
Prussian carp	Czer1	6.00 ±4.90	0-10.00	66.60	34.99
*	Czer2	1.50 ± 1.70	0-4.00	50.00	20.25
Roach	Czer1	0.30 ± 0.80	0-2.00	16.70	14.00
Threespine stickleback	Czer1	17.30 ±25.60	0-66.00	83.30	0.90
	Czer2	39.30 ± 57.20	2.00-151.30	100.00	3.88
Perch	Czer1	0.67 ± 1.00	0-2.00	33.30	47.50
	Czer2	1.50 ± 2.30	0-4.80	33.30	55.25
Common dace	Czer1	2.30 ± 5.70	0-14.00	16.70	75.71
Bleak	Czer1	4.70 ± 5.90	0-14.00	66.60	1.79
Weather loach	Czer1	1.00 ± 1.70	0-4.00	33.30	21.67
	Czer2	1.53 ± 1.90	0-4.80	50.00	22.75
Stone loach	Czer1	14.20 ± 16.80	2.00-46.00	100.00	7.26
	Czer2	14.20 ± 12.70	2.40-36.00	100.00	10.85
Brown trout	Czer1	1.00 ± 2.40	0-6.00	16.70	198.67
	Czer2	1.20 ± 2.00	0-4.80	33.30	237.33
Tench	Czer1	0.30 ± 0.80	0-2.00	16.70	57.00
Brown bullhead	Czer1	1.30 ± 2.40	0-6.00	33.30	60.75
Amur sleeper	Czer1	1.00 ± 2.40	0-6.00	16.70	5.00
Topmouth gudgeon	Czer1	0.30 ± 0.80	0-2.00	16.70	5.00

Table 3. Number of individuals (in ind. $100m^{-1} h^{-1}$ fishing), frequency of occurrence (*C_i*) and average individual mass fishes from studied sites of Czerniejówka River (N = 561, SD – standard deviation)

The abundance of fish varied depending on the river site, and ranged from 82 to 287 ind. 100 m⁻¹ 1 h⁻¹, and was more than twice larger in river Czechówka than in river Czerniejówka. The most common species in both rivers was gudgeon, whose abundance amounted to 55-122 ind. 100 m⁻¹ 1 h⁻¹ in the Czechówka River and 34–65 individuals 100 m⁻¹ 1 h⁻¹ in the Czerniejówka River (Tab. 2 and 3).

The highest number of individuals was noted for gudgeon, constituting from 21.6 to 51.6% of all collected individuals, as well as for threespine stickleback (from 14.0 to 37.0%). Additionally, at site Czech2, bleak amounted to a considerable percentage of 24.2%, whereas at site Czech1 common dace dominated (39.6%). In the Czerniejówka River, apart from stone loach and Prussian carp (Fig. 2), a high share in the abundance structure was recorded for gudgeon and threespine stickleback.

In the biomass structure of the fish Prussian carp dominated at site Czech1 (59.3%) and at site Czech2 – common dace (56.8%). In river Czerniejówka both sites revealed the highest share of gudgeon (from 42.9 to 57.7%) and a considerable share of brown trout (13.3–16.2%) and stone loach (7–8.3%) (Fig. 3).

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Fig. 2. Abundance structure of fish from the Czechówka and the Czerniejówka Rivers



Fig. 3. Biomass structure of fish from the Czechówka and the Czerniejówka Rivers

All catches revealed the presence of gudgeon and stickleback ($C_i = 100$), and additionally in the Czerniejówka River – stone loach (Tab. 2 and 3).

At three sampling sites (Czech1, Czech2 and Czer2) the values of species richness index (S = 6-8) and Shannon-Wiener index (H' = 0.49-0.57) reached similar values. Only at site Czer1 the indices reached higher values (S = 13; H' = 0.73).

Two protected fish species (stone loach and weather loach) and four alien species (Prussian carp, brown bullhead, Amur sleeper and topmouth gudgeon) were found in the studied rivers. All of the alien species were noted in the Czerniejówka River, while in the Czechówka River only one species – Prussian carp.

DISCUSSION

Fish as organisms participating at different trophic levels in the flow of matter and energy, being long-living and at the same time easy to catch, are often particularly useful in assessing the long-term influence of environmental factors, e.g. the effect of urban areas on water ecosystems [Karr 1987, Barbour *et al.* 1999, Wiśniewolski 2002]. Therefore, the six control fishings conducted on the selected sections of rivers of Lublin may provide a reliable picture of the structure of the ichthyofauna inhabiting them.

The structure of land use in a catchment area, particularly in urban areas, not only affects the quality of water in rivers but also their species richness, diversity and dominance structure of abundance and biomass [Wang *et al.* 2001]. In the natural river ecosystems of western Georgia (USA) [Helms and Feminella 2005], Germany [Siligato and Böhmer 2002] or even in the Lublin region [Rechulicz *et al.* 2009], the number of fish species reached 20. A decrease in the number of fish species, especially in highly transformed rivers, can be very dramatic. The fish stock may be reduced only to two species, gudgeon and threespine stickleback [Wiśniewolski 2002, 2005, Rechulicz 2008]. Control fishing in the small rivers of Lublin showed that the number of species, depending on the sampling site, ranged from 7 to 13, yet in the abundance structure there dominated the two species (60 to 82%) mentioned above. A similar relationship was recorded by Kruk *et al.* [2003] in the ichthyofauna of the city of Łódź.

The decrease in the number of fish species along the rising gradient of catchment's urbanisation of river ecosystems has led to changes in species composition. Similarly to the studies performed by Siligato and Böhmer [2002] as well as by Helms and Feminell [2005], the prevailing reproductive group of fish in the urban sections of Rivers Czechówka and Czerniejówka were phytophilous species, whereas the natural sections of the rivers are usually dominated by litophilous species.

Despite the fact that the sampling sites were situated within the urban part of the rivers, the fishing at two sites of the Czeniejówka River (Czer1 and Czer2) revealed single individuals of brown trout of quite a significant biomass. Additionally, at a site of Czechówka River (Czech2), high abundance of common dace was noted. The presence of these two species, particularly at a close distance from the river's mouth into the main river, may suggest their migration in order to find suitable breeding sites or available food. It should also be noted that the abundance of alien fish species observed in both rivers was scarce and their occurrence was limited to one sampling site on the Czerniejówka River (Czer2).

CONCLUSIONS

1. Both urban rivers revealed the presence of 15 fish species (Czechówka River – 10 species, Czerniejówka River – 14 species) representing 7 families.

2. The abundance structure showed domination of two species – gudgeon and threespine stickleback whose share in both rivers amounted to 62–72% on average. Moreover, a high share in the abundance was presented by common dace and bleak in Czechówka River, as well as stone loach in Czerniejówka River.

3. The ichthyofauna of both rivers was characterised by low diversity expressed in low values of species richness and Shannon-Wiener indices.

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ICHTIOFUNA MAŁYCH RZEK MIASTA LUBLIN

Streszczenie. W dwóch rzekach płynących przez teren miasta Lublin przeprowadzono sześciokrotne odłowy kontrolne ryb w celu ustalenia ich składu gatunkowego, struktury liczebności i biomasy, a także różnorodności gatunkowej. Ogółem odłowiono 1994 ryby należące 15 gatunków, 7 rodzin, z czego najliczniej reprezentowana była rodzina karpiowate. Liczebność ryb na stanowiskach wahała się od 82 do 287 szt. \cdot 100 m⁻¹ \cdot 1 h⁻¹. Ichtiofaunę badanych rzek charakteryzowała mała bioróżnorodność (*H*[°]), od 0,49 do 0,73, a w strukturze liczebności dominowały kiełb i ciernik. W badanych rzekach stwierdzono występowanie dwóch gatunków chronionych: śliza i piskorza, oraz pojedyncze osobniki czterech obcych gatunków.

Slowa kluczowe: ichtiofauna, rzeki miejskie, małe rzeki, Lublin