

## **Ichthyofauna of the River Dunajec in the region of the Czorsztyn–Niedzica and Sromowce Wyzne dam reservoirs (southern Poland)**

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**Abstract** – In connection with the construction of new dam reservoirs the structure of ichthyofauna in the region of these reservoirs was investigated immediately before their filling. It seemed highly probable that they would affect to a great degree the ichthyofauna of this river sector and its tributaries. Changes in the ichthyofauna during the last 33 years were also taken into consideration. The results of the investigations given here constitute a basis for observation of future changes which may occur in the native submontane river fish community, brought about by reservoir species, especially perch and pike.

**Key words:** fish community, submontane river, dam reservoir, eutrophication.

### **1. Introduction**

Since the pioneer studies by Nowicki (1883, 1889) numerous ichthyologists have investigated fish populations in the River Dunajec and its catchment basin. The works by Dixon (1924, 1931), Żarnecki (1929, 1952), and Chrzan (1947) concerned almost exclusively the so-called "salmon campaigns", being devoted to sea trout (*Salmo trutta m. trutta* L.), its migration, spawning, and the smolt migration to the sea. The publications by Solewski (1964, 1965), Klimczyk-Janikowska (1968), and Skóra and Włodek (1969) concerned particular fish species found in the River Dunajec basin, though to a smaller degree describing the fish of the basin in general as initiated by Nowicki (1883) and Niezabitowski (1903). Their description was complemented with current data given by W. Kolder (unpubl.), Bieniarz and Epler (1972), Włodek and Skóra (1992), and Starmach (1984).

In connection with the filling of the new reservoirs at Czorsztyn–Niedzica and Sromowce Wyzne there occurred the necessity of describing the state of the ichthyofauna of the River Dunajec and its tributaries immediately before filling. It is highly probable that the reservoirs will considerably affect the ichthyofauna of this sector of the river. The percentage share of different fish species presented in this work is a basis for further studies concerning the effect on the typical rheophilous ichthyofauna of a submontane river of a dam reservoir constructed in an area where no larger water bodies previously existed.

## 2. Study area, material, and methods

The River Dunajec, one of the longest Carpathian tributaries of the Vistula (247.1 km) is characterized by abundant water resources and at the same time by the greatest flood potential in Poland (Łajczak 1989). The sources of the Dunajec lie in the western Tatra Mts at an altitude of about 1500 m. The Czorsztyn–Niedzica dam reservoir, with an area of 1226 ha and water storage capacity of  $231.9 \cdot 10^6 \text{ m}^3$ , and the Sromowce Wyżne compensation reservoir, of 88 ha and capacity of  $7.5 \cdot 10^6 \text{ m}^3$  are located on 75th km of river course, respectively. The catchment area of  $1147 \text{ km}^2$  in the cross-section of the Czorsztyn–Niedzica reservoir is characterized by a relative high water outflow owing to its altitude (415–2630 m), a high annual precipitation (an average for the whole catchment of 1072 mm), and low evaporation. At the mouth to the Czorsztyn–Niedzica reservoir the mean annual discharge of the Dunajec is  $23.8 \text{ m}^3 \text{ s}^{-1}$ .

The investigation was carried out at 7 stations on the River Dunajec above the Czorsztyn–Niedzica and Sromowce Wyżne reservoirs, in the mouth zones of their selected tributaries, and on the Dunajec below the reservoirs (Fig. 1). Fish were caught in the period 1992–1997 using a battery electric current assembly (IUP 1.2, Poland), by wading up against the water current in 200 m sectors.

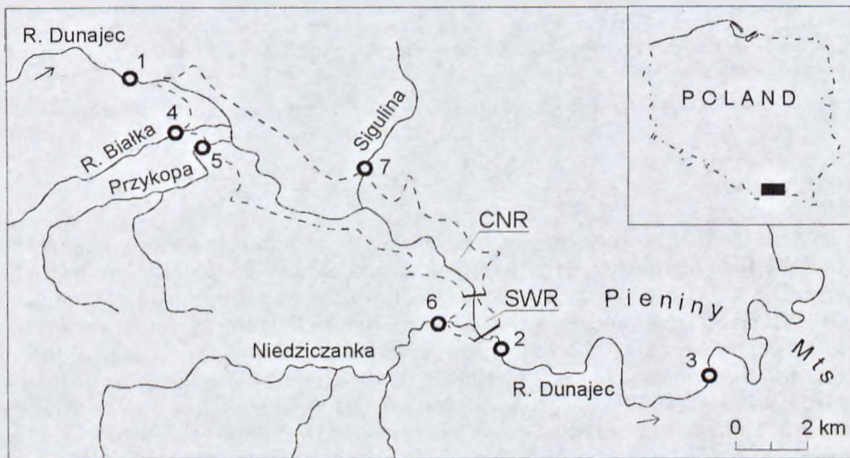


Fig. 1. Location of the sampling stations on the River Dunajec (1–3) and its tributaries (4–7): 1 – Harkłowa, 2 – Sromowce Wyżne, 3 – Sromowce Niżne, 4 – the River Białka, 5 – the Przykopa stream, 6 – the Niedziczanka stream, 7 – the Sigulina stream (CNR – Czorsztyn–Niedzica Reservoir, SWR – Sromowce Wyżne Reservoir).

## 3. Results

In the River Dunajec between Nowy Targ and the Pieniny Mts and in its tributaries Białka, Niedziczanka, Przykopa, and Sigulina, i.e. above and below the Czorsztyn–Niedzica and Sromowce Wyżne dam reservoirs, there occurred 17 fish species from 6 families (Salmonidae, Thymallidae, Cyprinidae, Cobitidae, Percidae, and Cottidae).

In the Dunajec above the reservoirs in the locality of Harkłowa eleven fish species were recorded (Fig. 2). In this river sector the dominant species was brook

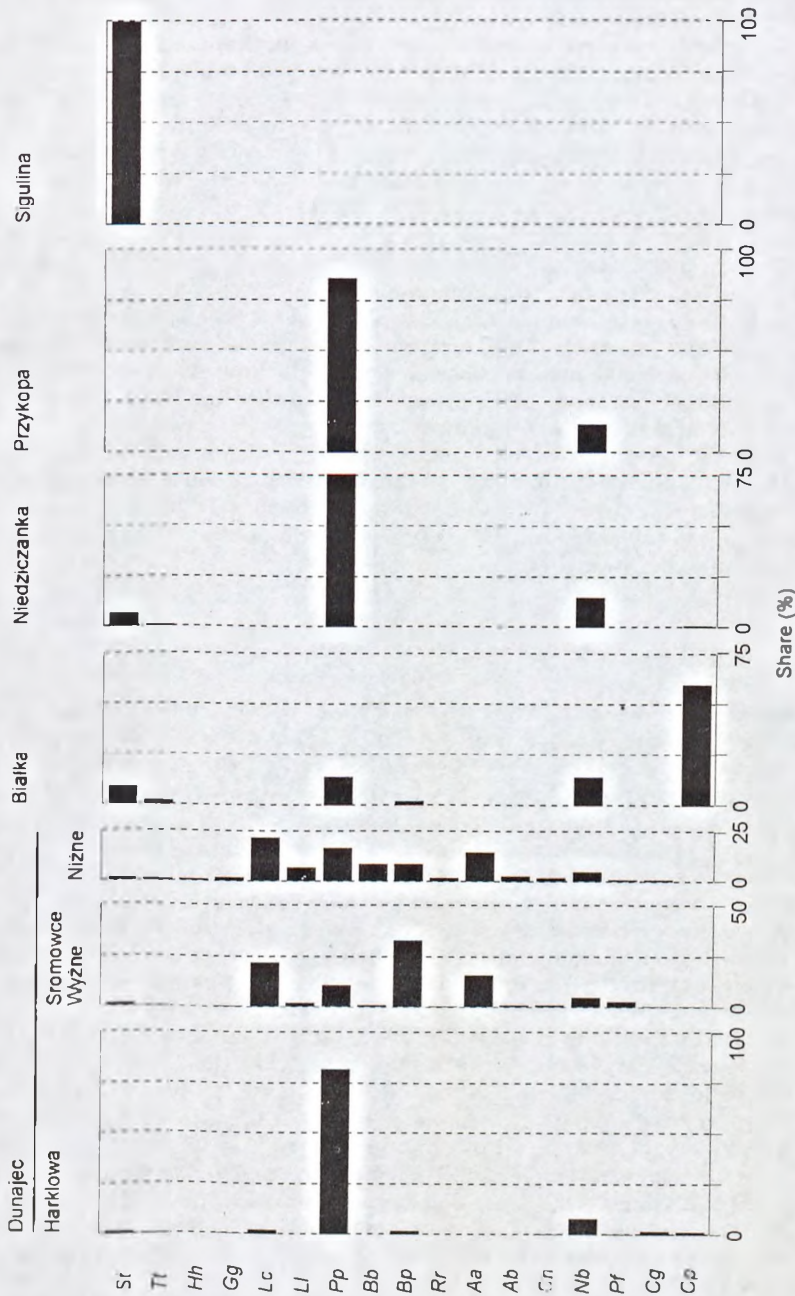


Fig. 2. The structure of ichthyofauna in the River Dunajec and its tributaries in 1997: Sr - *Salmo trutta* m. fario L., Tt - *Thymallus thymallus* (L.), Hh - *Hucho hucho* (L.), Gg - *Gobio gobio* (L.), Lc - *Leuciscus cephalus* (L.), Ll - *L. leuciscus* (L.), Pp - *Phoxinus phoxinus* (L.), Bb - *Barbus barbus* (L.), Bp - *B. pterygi* Heck., Rr - *Rutilus rutilus* (L.), Aa - *Alburnus alburnus* (L.), Ab - *Alburnoides bipunctatus* (Bloch), Cn - *Chondrostoma nasus* (L.), Nb - *Noemacheilus barbatulus* (L.), Pf - *Percu fluviatilis* L., Cg - *Cottus gobio* L., Cp - *C. poeciliopus* Heck.

minnow, *Phoxinus phoxinus* (L.) and to a smaller degree stone loach, *Noemacheilus barbatulus* (L.). The share of the remaining species ranged from 0.5 to 2.1% of the total number of recorded individuals.

Sixteen fish species occurred below the reservoirs at Sromowce Wyzne. The dominant species were chub, *Leuciscus cephalus* (L.), spotted barbel, *Barbus petenyi* Heck., bleak, *Alburnus alburnus* (L.), and brook minnow. The remaining species occurred in numbers from 0.5 to 5.0% of the total fish number.

At Sromowce Nizne the percentage composition of fish species was different. In this sector of the Dunajec Siberian sculpin, *Cottus poecilopus* Heck. was no longer recorded, while the occurrence of Danube salmon, *Hucho hucho* (L.) was found. The most numerous species were chub, brook minnow, bleak, barbel, *Barbus barbus* (L.), spotted barbel, and dace, *Leuciscus leuciscus* (L.). The remaining fish species ranged from 1 and 5% of the total ichthyofauna.

The following fish species composition was observed in the tributaries of the River Dunajec in the area of the Czorsztyn–Niedzica and Sromowce Wyzne reservoirs: in the River Bialka stream Siberian sculpin dominated, accompanied by stone loach and brook minnow. The brown trout, *Salmo trutta* m. *fario* L. constituted only 9% of the total fish number.

In the Niedziczanka stream brook minnow decisively dominated, followed by stone loach. Brown trout constituted 7% of the total fish number and grayling, *Thymallus thymallus* (L.) only 1%. In the Przykopa stream only two species were found, i.e. brook minnow constituting 86% of the total number and stone loach. In the Sigulina stream only brown trout was found.

#### 4. Discussion

In name only is the discussed river sector of rapid current, stony bottom, and low water temperature the so-called trout zone (Fric 1872, Nowicki 1889, Starmach K. 1956) or the trout and grayling zone (Borne 1887, Staff 1950). With the present pollution of the river, however, expressed by a concentration of mineral phosphorus of about  $92 \mu\text{g L}^{-1}$  (H. Kasza unpubl.) and the occurrence of a thick layer of sessile algae characteristic of fertile waters (*Hydrurus foetidus* (Villars) Trevisan, *Cladophora glomerata* (L.) Kütz., and *Ulothrix zonata* (Weber et Moor) Kütz.; J. Sanecki unpubl.), it rather resembles the so-called barbel zone (Starmach 1984).

The eutrophication process occurring in the discussed sector of the River Dunajec and its tributaries considerably affects the species structure of the ichthyofauna which was repeatedly investigated in the period 1963–1996 by the Karol Starmach Institute of Freshwater Biology, Polish Academy of Sciences, Cracow.

In spite of intensive stocking operations carried out by the Polish Angling Union (PZW), the numbers of brown trout, the leading species of this river zone, were distinctly reduced in the investigated sectors of the Dunajec and its tributaries. At Harklowa they decreased from 17% in the total number of fish in 1963 to 1.4% in 1996, in Sromowce Wyzne from 5 to 1.6%, and in Sromowce Nizne from 4 to 2% in 1972–1996, even though between Nowy Targ and Krościenko the purest waters flow in the sector at Sromowce Nizne and downstream through the Pieniny Mts owing to the great self-purification potential of the River Dunajec. Also in the tributaries the number of brown trout fell over the years – in the River Bialka from 38 to 9% and in the Niedziczanka stream from 31 to 7% (Table 1).

Grayling, a species very sensitive to water pollution, now occurs rarely in the discussed sector of the Dunajec where until the sixties was a famous zone of trout

Table I. Percentage share of particular fish species at selected stations in the catchment basin of the River Dunajec in 1963-1996: *St* - *Salmo trutta* m. *fario* L., *Tt* - *Thymallus thymallus* (L.), *Lc* - *Leuciscus cephalus* (L.), *Bb* - *Barbus barbus* (L.), *Bp* - *Barbus petenyi* Heck., *Cn* - *Chondrostoma nasus* (L.), *Cg* - *Cottus gobio* L., *Cp* - *C. poecilopus* Heck.

Year	Species								
	<i>St</i>	<i>Tt</i>	<i>Lc</i>	<i>Bb</i>	<i>Bp</i>	<i>Cn</i>	<i>Cg</i>	<i>Cp</i>	Others
River Dunajec (Harklowa)									
1963*	17	9	10	12	13	9		3	27
1980**	13	5	9	5	15	7		4	42
1996***	1.4	0.7	2.1		1.8	0.4	1.8	1.4	9.1
River Dunajec (Sromowce Wyzne)									
1963*	5	9	9	11	20	24			22
1980**	10.6	6	9	6	12	12			45
1996***	1.6	0.5	2.2	1	3.3	1	0.5	0.5	3.9
River Dunajec (Sromowce Nizne)									
1972**	4	3	15	19	7	39			13
1983**	2	5	5	24	21	20			33
1996***	2	1	2.2	9	9	2	1		5.2
Niedziczanka (stream)									
1980**	31	19			16			2	32
1990**	5								9.5
1996***	7	1						1	7.6
River Bialka									
1964**	38	1						12	4.8
1980**	28	1						19	5.3
1996***	9	2						6.0	2.8

\* W. Kolder unpubl.

\*\* J. Starmach unpubl.

\*\*\* present study

and grayling. In relation to 1963 its number decreased at Harklowa and similarly at Sromowce Wyzne from 9 to 0.7% of the total fish number. At Sromowce Nizne its population was reduced from 3% in 1972 to 1% in 1996. In the Niedziczanka stream grayling constituted 19% of the fish population in 1980, currently only 1%, while its share in the River Bialka slightly increased (Table I).

Changes are also observed in the number of index species of the family Cyprinidae, i.e. of chub, spotted barbel, barbel, and undermouth, *Chondrostoma nasus* (L.). In the course of 33 years in the Dunajec at Harklowa the number of undermouth was reduced by 8.6%, of spotted barbel by 11.2%, of chub by 7.9%, while barbel disappeared altogether (Table I). At Sromowce Wyzne the undermouth and barbel occur less numerously while spotted barbel and chub increased their percentage in the total number of fish. Also at Sromowce Nizne the percentages of undermouth, spotted barbel, barbel, and chub changed in the course of 24 years. In 1972-1983 the number of barbel and spotted barbel considerably increased, while in the following 13 years their populations were reduced by more than half of that in the eighties. The number of undermouth gradually decreased in the entire period of the investigation. In 1996 this species constituted only 2% of the total fish community in this sector of the Dunajec. The pattern of changes occurring in the population of chub was different from that of barbel and spotted barbel. Its

number was reduced to 1/3 in the period 1972–1983 and then increased four times up to 1996.

The decreasing numbers of fish species sensitive to eutrophication were accompanied by an increasing abundance of eurytopic species such as stone loach, brook minnow, and gudgeon, *Gobio gobio* (L.), characterized by a pronounced potential of adaptation to different abiotic and biotic conditions of the aquatic environment (Table I).

In the Białka stream the number of Siberian sculpin, a species very sensitive to water eutrophication and hence occurring only in pure, cold, and well oxygenated montane streams with no mud hollows in the stony bottom (Starmach 1972), was considerably increased (Table I). This may be attributed to the fairly negligible water pollution in this river which, with respect to the abiotic conditions, is a typical stream of the upper brown trout zone (epirithron), presenting the optimum habitat conditions for Siberian sculpin and characterized by the absence of predators, i.e. numerous large trout.

The comparison of data concerning the state of ichthyofauna in the period before the construction of the reservoirs shows that the decisive factor in the distribution and abundance of fish species in the catchment basin was the pollution of waters with municipal sewage from the towns and villages lying along the river course, in spite of the great potential of rapid self-purification due to the pronounced oxygenation of the water in the River Dunajec and its tributaries. The community of fish species of the so-called brown trout zone, adapted to specific environmental conditions, was historically associated with oligotrophic, well oxygenated, and cold streams and rivers, rapidly flowing over a stony bottom with no algal cover or mud hollows. Therefore, it cannot conform to such drastically changed conditions, although particular species show a great adaptability potential.

The results of the present study may be used as a basis for future records of possible changes occurring in the community structure under the impact of the dam reservoirs. In an area where no larger water bodies formerly existed, the group of reservoirs with a specific ichthyofauna of stagnant waters may bring further losses, especially above the reservoirs, in the greatly impoverished fish community characteristic of the upper Dunajec catchment. As shown by preliminary studies carried out by the Nowy Sącz Branch of the Polish Angling Union there have appeared such predatory species as perch, *Perca fluviatilis* L. and pike, *Esox lucius* L. which easily adapt to life in flowing waters (L. Augustyn, unpubl.).

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