AACL BIOFLUX
Aquaculture, Aquarium, Conservation & Legislation
International Journal of the Bioflux Society

Growth rate of the chub (*Squalius cephalus*) and the nase (*Chondrostoma nasus*) from Raba, Dunajec, and Poprad River

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Abstract. In presented study growth rate of the chub *Squalius cephalus* and nase *Chondrostoma nasus* from Raba, Dunajec, and Poprad River were investigated using a back-scaling method. A total number of 167 chubs and 186 nases were analysed. Age of these fishes varied from 2 to 12 years. Growth rate of fish analysed was high and similar to other results from upper Vistula River drainage. We consider that artificial fry gained from these rivers may contribute declining populations of these two species in other rivers of upper Vistula drainage.
Key Words: growth rate, chub, nase, Raba, Dunajec, Poprad.

Strzeszczenie. Celem badań było określenie tempa wzrostu klenia *Squalius cephalus* oraz świnki *Chondrostoma nasus* z Raby, Dunajca i Popradu metodą odczytów wstecznych. Przebadano łącznie 167 kleni i 186 świnek w wieku od 2 do 12 lat. Tempo wzrostu obu gatunków w badanych rzekach było wysokie i porównywalne z danymi uzyskanymi podczas badań na innych rzekach w rejonie Górnej Wisły. Można przypuszczać, że materiał zarybieniowy wyprodukowany na bazie klenia i świnki z Raby, Dunajca i Popradu z powodzeniem mógłby zostać użyty do wzmocnienia zagrożonych populacji tych ryb w rejonie Górnej Wisły.
Słowa kluczowe: tempo wzrostu, kleń, świnka, Raba, Dunajec, Poprad.

Rezumat. În prezenta lucrare s-a investigat prin metoda «back scaling» rata de creştere la clean (*Squalius cephalus*) şi scobar (*Chondrostoma nasus*). Un număr total de 167 cleni şi 186 scobari au fost luaţi în studiu, vârsta acestora variind de la 2 la 12 ani. Rezultatele obţinute arată o rată de creştere mare şi similară altor rezultate din bazinul superior al Vistulei. Considerăm că puietul produs artificial din populaţiile acestor râuri ar putea contribui la înlocuirea populaţiilor acestor două specii din alte râuri ale bazinului superior al Vistulei.
Cuvinte cheie: rată de creştere, clean, scobar, Raba, Dunajec, Poprad.

Introduction. The chub *Squalius cephalus* (Linnaeus, 1758) and the nase *Chondrostoma nasus* (Linnaeus, 1758) are both rheophilic cyprinids that had dominated in ichthyofuana of southern Poland during former decades (Prawocheński 1964; Żelepień 1997). In Vistula River near Kraków their relative abundance amounted, respectively, 9.8% and 29.2% (Starmach 1948). In the same region in the period 1963-1969 *S. cephalus* the numbers were 63.82% for *S. cephalus* and 1.5% for *Ch. nasus*, and in 1997 and 2001 they declined to 1.0% and 0.2%, respectively (Epler et al 2003e). In Skawinka River in 1967-1968 relative abundance of the chub amounted 45.8% and of the nase – 17.6%. Investigations conducted in 1997 and 2003 showed that abundance of *S. cephalus* did not decrease significantly (44.2%), whereas sharp decline of the nase was observed (to 3.0%) (Epler et al 2003d). Also in Łososina River *S. cephalus* (75%) still dominates, and abundance of *Ch. nasus* is also decreasing (2.0%) (Augustyn et al 2003a). In the Fisheries Region No. 3 on Raba River both species are much rarer, their abundance amounted in the beginning of 20th century 6.9% and 0.2%, respectively (Mikołajczyk et al 2003).

Visible decrease of these two species is most probably due to, beside of water pollution, increase in number of dams built. In Ropa River, after building the Klimkówka

Dam Reservoir, abundance of *S. cephalus* decreased from 28.4% (above the reservoir) to 6.5% (below of the dam); *Ch. nasus* has completely extinct below of the dam, whereas its relative abundance above the reservoir was 17.6% (Augustyn et al 2003b).

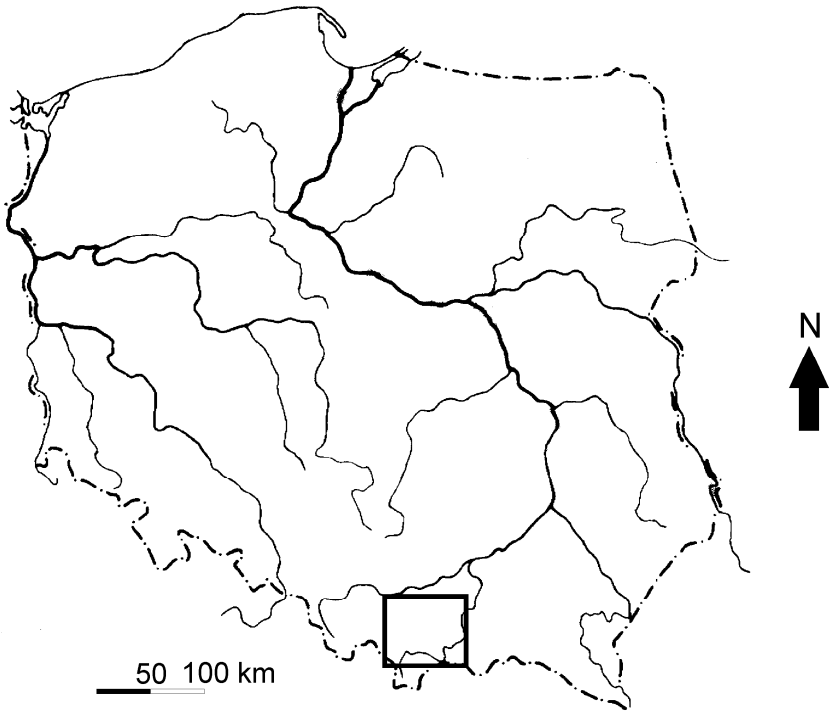

Figure 1. Map of Poland with marked study area (outlined box).

A significant decline of these two and also other rheophilic species was stressed in the monograph of the ichthyofauna of Dunajec River (Augustyn & Epler 2006). That phenomenon induced a need of artificial hatching and rearing of these fishes (Penczak et al 1998; Kamler & Keckeis 2000). Such efforts has already been conducted with partial or full success (e.g. Augustyn & Janik 2000; Cieśla & Konieczny 2000; Mizeliński et al 2000; Wojda et al 2000; Wolnicki 2000; Wolnicki et al 2000).

Knowledge about age and growth rate of a fish species, especially one which should be protected and contributed, is necessary for proper fishery management. For that reason we conducted this study in which we investigated age composition and growth rate of the European chub and the nase from three rivers in the upper Vistula River drainage, i.e. Raba, Dunajec, and Poprad River.

Material and Method. Chubs and nases investigated were harvested from Raba, Dunajec, and Poprad Rivers within upper Vistula River drainage (Figure 1). They were collected by electrofishing using IUP-12 portable electroshocker in the period 1999-2001 (Table 1). In Raba River fish were harvested from six sampling sites, each of 1000 m long, within the area of Fisheries Region No. 3. In Dunajec River samples were collected from three 1000 m long sites within Orawsko-Nowotarska Cirque (14 km long part of the river), and from three 1000 m long sites within Beskid Sądecki (19.3 km long part). In Poprad River fish were sampled from six 1000 m long sites within Sądecka Cirque (31.8 km long part of the river).

After electroshocking, fish were anaesthetised with Propiscin (Etomidate, 0.2 $mL \cdot L^{-1}$), and their body length (L, taken from the tip of the anteriormost point of the head to the end of the last scale on caudal peduncle) was recorded to the nearest 1 mm using a standard measuring board. Then they were weighed (W) with an accuracy of 1 g. From each specimen a few scales were taken in order to provide further age

determination. Scales were collected from left side of the body, below of the first dorsal-fin ray and above of the lateral line.

In the laboratory age of each fish was determined using a back-scaling method according to Lea (1910), taking into account remarks of Heese (1992). That methodology was applied in order to make possible a comparison with older data from literature. Moreover, Fulton's coefficient of condition (K) was calculated, according to equation: $K = 100 \cdot W \cdot L^{-3}$.

Table 1

Number of specimens examined, age, and Fulton's condition coefficient (K) of *S. cephalus* and *Ch. nasus* from Raba, Dunajec, and Poprad River

Species	Number of specimens			Age (years)	K
	Raba R.	Dunajec R.	Poprad R.		
S. cephalus	67	51	49	2-12	1.20-1.67
Ch. nasus	100	50	36	2-12	1.32-1.54

Results and Discussion. Age of the chubs and nases analysed varied from 2 to 12 years. Fulton's condition coefficient (K) calculated for the chub amounted 1.20-1.67, and for the nase 1.32-1.54 (Table 1). Analysis of the growth rate showed that body length (L) of 1+ and 12+ *S. cephalus* was, respectively, 6.07 cm and 38.60 cm in Raba River, 5.71 cm and 43.20 cm in Dunajec River, and 4.54 cm and 36.50 cm in Poprad River. Annual growth rates of *S. cephalus* varied from 0.90 cm (7+/8+) to 4.42 cm (1+/2+) in Raba River, from 1.50 cm (11+/12+) to 4.56 cm (2+/3+) in Dunajec River, and from 1.46 cm (7+/8+) to 4.06 cm (4+/5+) in Poprad River (Table 3).

Mean body length of *Ch. nasus* in Raba River was 6.40 cm in first year and 33.80 cm in tenth. In Dunajec River it was, respectively, 6.40 cm and 33.48 cm. In Poprad River the values were, 5.30 cm in first year and 38.80 in twelfth (Table 4). Annual growth rates varied from 1.60 cm (8+/9+) to 4.60 cm (3+/4+) in Raba River, from 1.50 cm (9+/10+) to 3.80 cm (2+/3+) in Dunajec River, and from 1.60 cm (11+/12+) up to 4.60 cm (4+/5+) in Poprad River (Table 5).

Growth rates of the chub from Raba and Poprad River were very similar, and their average body lengths in the age of 12 were also very close, i.e. 38.6 cm (Raba) and 36.5 cm (Poprad) (Table 2). These values are similar to results obtained from Vistula, San and Soła (Klimczyk 1965), Tanew (Lewandowska-Jarzynowa 1969), Warta and Pilica (Jakubowski & Penczak 1970), and Dunajec River as given by Klimczyk-Janikowska (1968). Lower growth rate was indicated in Biała Tarnowska River (Klich et al 2003), whereas chubs from Symsara River presented faster growth (Szczerbowski et al 1976). Among three rivers investigated in presented study, the highest growth rate was found in Dunajec River. In comparison to the results of Klimczyk-Janikowska (1968) it may by hypothesised that since 1960s some environmental factors has changed with some benefits to the chub population. As the growth rate, also the annual growth was the highest in Dunajec River and the lowest in Poprad River (Table 3). Comparison of the average annual growth of chubs in the age of 1-7 years from certain Polish rivers reveals that the fastest annual growth was in populations from Dunajec and Symsara River (4.00 cm), then in Tanew River (3.90 cm), and in Raba and Poprad River (3.49 cm).

The chub and even more the nase are both bioindicators of well-oxygenated, not polluted montane and sub-montane rivers, with bottom consisting of rocks and gravel (Prawocheński 1964; Żelepień 1997). Populations of these two rheophilic species are currently endangered, and they need some contribution by stocking (Penczak et al 1998).

Growth rate of a fish depends on a number of factors, both biotic and abiotic, that are present within a river system, and it may varied from a one river to another (Epler et al 2003a,b,c). Knowledge about growth rate and certain other features (e.g. Fulton's condition coefficient or weight-length relationships) of a population of rheophilic fish species allows an appropriate controlling of that population by proper artificial hatching and stocking, when and where needed.

Table 2

Growth rate of the chub from certain rivers in Poland (body length (L) in cm)

River	Age class												Reference
	1	2	3	4	5	6	7	8	9	10	11	12	
Raba	6.07	10.49	14.40	18.26	21.83	24.61	27.80	28.70	31.30	33.00	36.50	38.60	Presented study
Dunajec	5.71	9.99	14.55	18.96	22.78	26.47	29.86	33.09	36.03	39.20	41.70	43.20	Presented study
Poprad	4.54	8.00	11.74	15.74	19.80	23.10	25.50	26.96	28.70	31.30	33.00	36.50	Presented study
Biała Tarnowska	4.80	7.40	10.00	12.40	15.00	17.40	19.90	23.10	26.50	29.50	-	-	1
Wisła	5.50	9.70	13.70	17.20	20.10	22.90	25.50	-	-	-	-	-	2
San	4.60	8.80	12.60	15.70	18.30	20.60	23.30	-	-	-	-	-	2
Dunajec	-	10.50	12.80	13.80	16.60	19.50	21.70	25.80	29.00	32.60	-	-	3
Soła	4.60	8.80	12.50	15.70	18.50	21.50	23.80	-	-	-	-	-	2
Tanew	4.90	9.60	13.90	17.90	21.50	25.80	29.00	32.60	36.80	-	-	-	4
Warta	-	10.00	14.20	18.70	19.70	25.20	28.50	30.4	31.70	-	-	-	5
Pilica	-	-	16.00	20.30	20.70	27.30	30.50	33.50	35.00	-	-	-	5
Symsara	7.40	13.10	18.20	22.60	26.00	29.80	31.90	37.00	40.00	41.50	43.50	-	6

Table 3

Annual growth rates of the chub from certain rivers in Poland (in cm)

River	Years of life											Reference
	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10	10-11	11-12	
Raba	4.42	3.91	3.86	2.82	2.78	3.19	0.90	2.60	1.70	3.50	2.10	Presented study
Dunajec	4.28	4.56	4.41	3.82	3.69	3.39	3.23	2.91	3.17	2.50	1.50	Presented study
Poprad	3.46	3.74	4.00	4.06	3.30	2.40	1.46	1.74	2.60	1.70	3.50	Presented study
Biała Tarnowska	2.60	2.60	2.40	2.60	2.40	2.50	3.20	3.40	3.00	-	-	1
Wisła	4.20	4.00	3.50	2.90	2.80	2.60	-	-	-	-	-	2
San	4.20	3.80	3.10	2.60	2.30	2.70	-	-	-	-	-	2
Dunajec	-	2.30	1.00	2.80	3.90	2.20	4.10	3.20	3.60	-	-	3
Soła	4.20	3.70	3.20	2.80	3.00	2.30	-	-	-	-	-	2
Tanew	4.40	4.30	4.00	3.60	4.30	3.20	3.60	4.20	-	-	-	4
Warta	-	4.20	4.50	1.00	5.50	3.30	1.90	1.30	-	-	-	5
Pilica	-	-	4.30	0.40	6.60	3.20	3.00	1.40	-	-	-	5
Symsara	5.70	5.10	4.40	3.40	3.80	2.10	5.10	3.00	1.50	2.00	-	6

Table 4

Growth rate of the nase from certain rivers in Poland (body length (L) in cm)

River	Age (years)												Reference
	1	2	3	4	5	6	7	8	9	10	11	12	
Raba	6.40	10.50	15.10	18.60	21.40	23.80	25.70	27.50	29.10	33.80	-	-	Presented study
Dunajec	6.40	9.90	13.70	16.90	20.20	23.40	26.30	29.40	32.00	33.48	-	-	Presented study
Poprad	5.30	9.30	13.30	17.10	21.70	24.70	28.10	30.70	32.80	34.90	37.20	38.80	Presented study
Raba	5.45	8.93	12.55	15.59	18.74	21.72	24.22	26.33	27.49	29.42	-	-	7
Dunajec	6.00	11.40	14.10	16.60	21.10	23.10	26.60	29.50	31.80	-	-	-	8
San	5.50	10.20	13.10	16.20	20.10	22.60	25.60	-	-	-	-		8
Wisła	5.80	11.60	17.40	20.00	24.70	32.10	44.00	50.70	-	-	-	-	9
Dunajec	5.20	9.90	14.70	18.60	22.20	25.80	28.40	30.80	32.80	34.70	36.00	38.00	10
Raba	6.00	9.20	13.80	18.10	22.00	25.50	28.30	30.80	33.30	34.60	-	-	10

Table 5

Annual growth rates of the nase from certain rivers in Poland (in cm)

River	Years of life											Reference
	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10	10-11	11-12	
Raba	4.10	4.60	3.50	2.80	2.40	1.90	1.80	1.60	3.90	-	-	Presented study
Dunajec	3.50	3.80	3.20	3.30	3.20	2.90	3.10	2.60	1.50	-	-	Presented study
Poprad	4.00	4.00	3.80	4.60	3.00	3.40	2.00	2.10	2.10	2.30	1.60	Presented study
Raba	4.80	3.62	3.04	3.15	2.98	2.50	2.11	1.16	1.93	-	-	7
Dunajec	5.40	2.70	2.50	4.50	2.00	3.50	2.90	2.30	-	-	-	8
San	4.70	2.90	3.10	3.90	2.50	3.00	-	-	-	-	-	8
Wisła	5.80	5.80	2.60	4.70	7.40	7.90	10.70	-	-	-	-	9
Dunajec	4.70	4.80	3.90	3.60	3.60	2.60	2.40	2.00	1.90	1.30	2.00	10
Raba	3.20	4.60	4.30	3.90	3.50	2.80	2.80	2.50	1.30	-	-	10

References to Table 2 and 3:

1. Klich et al 2003
2. Klimczyk 1965
3. Klimczyk-Janikowska 1968
4. Lewandowska-Jarzynowa 1969
5. Jakubowski & Penczak 1970
6. Szczerbowski et al 1976

References to Table 4 and 5:

7. Klimczyk-Janikowska 1973
8. Prawocheński 1963
9. Rychlicki 1933
10. Klich 2001

Growth rate of the nase was similar in all three rivers investigated. Fish in age of 10+ were of very close body length (Table 4). Only in Poprad River some older fish were caught, they were in age of 11+ and 12+ (Table 4). Available literature data concerning this species are not as rich as in the case of the chub. Only some previous data on the nase from Raba, Dunajec, and San River were found and analysed. 10+ Fish, according to presented investigation, were of 33.80 cm in body length, whereas according to Klimczyk-Janikowska (1973) and Klich (2001) they were of 29.40 cm and 33.30 cm, respectively. 9+ Nases from Dunajec were of 32.00 cm in body length according to presented study, 31.80 cm as revealed by Prawocheński (1963), and 31.80 cm as given Klich (2001) (Table 4). In comparison with data obtained from San River (Prawocheński 1963), where *Ch. nasus* in the age of 7+ had 25.60 cm in body length, nases from presented herein rivers were somehow longer, 25.70 cm in Raba, 26.30 cm in Dunajec, and 28.10 cm in Poprad River.

Growth rate of the nase from Vistula River (Rychlicki 1933) was sharply higher than discussed above values, however comparison is rather difficult due to lack of absolute values of body length in the study of Rychlicki (1933).

During the first 7 years of live annual increase of body length of *Ch. nasus* from Raba, Dunajec, and Poprad River were, respectively, 3.20, 3.30, and 3.80 cm (Table 5). Excluding ambiguous data from Vistula River (Rychlicki 1933), these results are similar with data from previous studies on nases from Raba (Klimczyk-Janikowska 1973; Klich 2001), Dunajec (Prawocheński 1963; Klich 2001), and San River (Prawocheński 1963). In most of the cases annual increase of growth was higher during the initial years of life, and was decreasing with time (Table 4).

Conclusions. Summarising, it may be concluded that populations of the chub *S. cephalus* and the nase *Ch. nasus* from analysed rivers, Raba, Dunajec, and Poprad, are in relatively good condition, and, if needed, they might be used as broodstocks for contribution of populations of these two rheophilic species in other rivers within the upper Vistula River drainage.

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Received: 18 January 2009. Accepted: 19 January 2009. Published: 30 January 2009.
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How to cite this article:
Epler P., Nowak M., Popek W., 2009 Growth rate of the chub (*Squalius cephalus*) and the nase (*Chondrostoma nasus*) from Raba, Dunajec, and Poprad River. AACL Bioflux 2(1):1-8.
Printed version: ISSN 1844-8143
Online version: ISSN 1844-9166 available at: http://www.bioflux.com.ro/docs/2009.2.1-8.pdf