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Age structure, growth rate and condition of *Barbus petenyi* (Cyprinidae) in the middle and upper stream of the Ogosta River

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Abstract

This is a study of length and weight growth of Romanian barbel from the middle and upper stream of the Ogosta River. Population parameters estimates were based on scale annual interpretation. The estimates were compared with growth data obtained in previous periods from other Bulgarian water courses. Methodologically, 100 individuals were collected by electrofishing in 2020. Specimens' age ranged from 1 to 5 years. More than half of the sample was represented by one-year-old fish. Older fish were relatively few. The lengths of all sampled individuals ranged from 39 mm to 202 mm. A relationship between standard length (*SL*) and scale radius (*S*) was described by an equation: $SL = 2.7077 \cdot S$, $r^2 = 0.9485$, $p < 0.005$. A relationship between fish gutted weight (*W*) and *SL* was represented by an equation: $W = 0.00002 \cdot SL^{2.8936}$; $r^2 = 0.9956$, $p<0.005$.

Key words: growth of weight, linear growth, Romanian barbel, size and age composition.

Introduction

Romanian barbel (*Barbus petenyi* Heckel, 1852) is a rheophilic fish typically encountered in the middle and upper reaches (Michaylova 1960, 1970; Marinov 1986) of Danube River tributaries in Romania and Bulgaria (Kottelat and Freihof 2007). The species is also found in the Kamchia River of the Black Sea watershed in Bulgaria (Drenski 1951, Kottelat and Freihof 2007). This is one of the 'meridionalis group' barbels, which are medium sized and adapted to moderately cold water (Bianco 2012). Five-year-old specimens reach over 20 cm in length (Michaylova 1960). However, some authors indicate 28 cm (Marinov 1986) and even 30 cm as the maximum species length (Peshev et al. 2003, Karapetkova and Zhivkov 1995). The Romanian barbel is one of the most numerous species of the middle zone of the North Bulgarian Rivers (Karapetkova and Dikov 1986; Dikov et al. 1988, 1994). This species is of interest for recreational fishing.

The aim of this study was to establish the growth parameters of the Romanian barbel from the Ogosta River and fill the knowledge gap that exist for this species.

Study Area

The Ogosta River (Fig. 1) is the largest watercourse in the north western part of Bulgaria (Fig. 2). With a length of 144.1 km, the river ranks 7th in the ranking of the 'big' rivers of Bulgaria (Hristova 2012). The Ogosta River springs below the Vrazha Glava peak (1935 m) in the Balkan Mountains. After collecting waters from many tributaries, the river flows into the Danube River, not far from the town of Oryahovo. Built in 1986 near the city of Montana, the Ogosta Dam, divides the river into two parts. This study was conducted in the middle zone of the river, located above the dam (Table 1).

Ecological characteristics of the studied section of the river were established as follows: the river meanders through a hilly area and so distinct changes of the depth of its flow were observed and recorded. The river bottom was covered with larger and smaller stones, as well as gravel. The terrain was inclined, which enabled rapid water flow. The banks were overgrown with black alder and white willow; their branches covered the riverbed. Fish found refuge from the strong current in hidden holes in the roots of these sur-

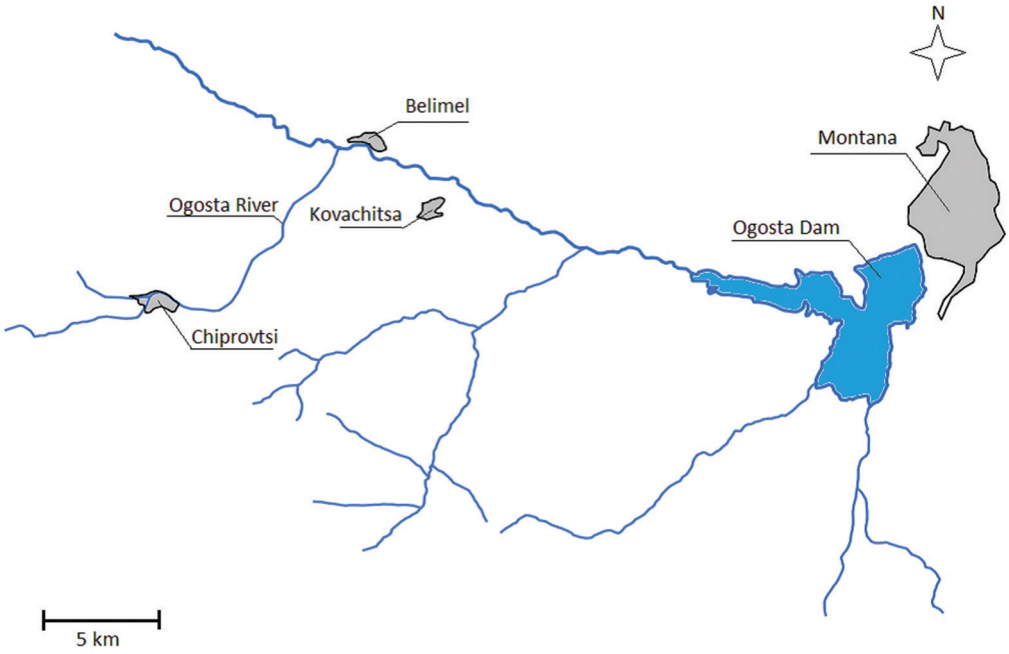

Fig. 1. Schematic map of Ogosta River middle zone, where the Romanian barbel was found.

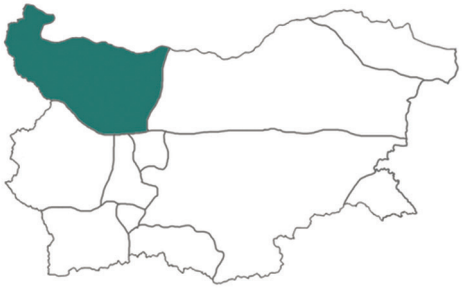

Fig. 2. Location of the studied region of Bulgaria.

rounding trees. The studied part of the riverbed lied between 190 and 380 m above the sea level. The study took place in the autumn, when the measured daily water temperature reached 8–12 °C while dissolved oxygen values were between 4.8 and 7.6 mg·m^{-3}.

Materials and Methods

The study was based on a sample of 100 individuals of Romanian barbel. Sampling took place at five sampling areas in the middle zone of the Ogosta River (Table 1). Sampling material was collected in the autumn of 2020 by electrofishing. A SAMUS 725G converter was used, providing up to 640 V direct current (DC), frequency 50 Hz and output power reaching up to 200 W. Catch was performed according to the EN 14011:2004 instruction (Water quality Sampling of fish with electricity). Measurements were conducted of total fish length (*TL*) and standard fish length (*SL*) with a precision of 1 mm and gutted weight (*W*) with a precision of 1 g. Age was determined by measuring fish scales, using an Olympus CX 31 microscope at a 40× magnification.

Table 1. Sampling areas in the Ogosta River.

No	Location	Geographic coordinates		Altitude, m a.s.l.	Date of sampling
		N	E		
1	Near the confluence of the Ogosta River and the Ogosta Dam.	43°23'49"	23°03'58"	195	23.10.2020
2	Near the strawberry farm.	43°24'20"	23°03'16"	221	22.10.2020
3	Near the village of Gorna Kovachitsa.	43°25'20"	23°00'40"	250	23.10.2020
4	Near the village of Belimel.	43°25'33"	22°57'30"	305	22.10.2020
5	Near the town of Chiprovtsi.	43°23'42"	22°55'26"	380	22.10.2020

In addition to Romanian barbel, 10 fishes from 2 families were recorded in the middle part of the Ogosta River. Species identification was made according to Kottelat and Freyhof (2007).

A fish's linear growth was determined via a back-calculation of length (*SL)* from the diagonal caudal radius of a scale (*S*) (Zhivkov 1981). This relation is described by a linear equation (1):

$$SL = a + b \cdot S, \quad (1)$$

where: *SL* – standard length of fish, mm; *S* – diagonal caudal radius of a fish scale (eyepiece micrometer scales divisions); *a*, *b* – equation coefficients.

Absolute annual linear incensement was accepted as a characteristic of the growth (Zhivkov 1972), calculated by formula (2):

$$t = S \cdot L_n - S \cdot L_{n-1}, \quad (2)$$

where: *t* – absolute annual linear incensement, mm; *Ln*; L_{n-1} – average standard length of fish for two consecutive years, mm.

Gutted weight (*BW*) values were estimated by equation (3) Ricker (1979), used by many authors (Zhivkov 1981, 1999; Prodanov 1982; Raikova-Petrova and Zhivkov 1993; Kukushkin 1997; Belomacheva et al. 2005):

$$BW = a \cdot SL^b, \text{ g} \quad (3)$$

where: S*L* – standard length of fish, mm; *a, b* – equation coefficients.

A comparison of the length growth of different populations of Romanian barbels is made by ranking them according to their average length at the same age (Zhivkov 1972).

Condition of a population is studied in three ways:

1) By calculating a classical coefficient (K_f) of the Fulton equation (4):

$$K_f = (BW \cdot SL^{-3}) \cdot 10^2 \quad (4)$$

where: *SL* – weighted average standard body length, cm; *BW* – weighted average gutted body weight, g.

2) By calculating a coefficient K_b, using the Fulton equation, but instead of exponent 3, exponent *b* from the population weight-length relationship from equation (3) is used.

3) By comparison of weight growth (*TW*) of fish from different populations, a method proposed by many authors (Goldspind 1979; Zhivkov 1981, 1999; Basami and Grove 1985; De Silva 1985; Raikova-Petrova 1992). A relationship is expressed by the equation (5):

$$TW_L = a \cdot SL^b, \text{ g}, \quad (5)$$

where: *L* – length of fish, mm; *TW* – total weight of fish g; *a*, *b* – equation coefficients.

In order to obtain comparable values of *W* in equation (3), pre-selected rounded values of *L* (50, 100, 150, 200 and 250 mm) are successively substituted in place of *L* (*L* = 50, *L* = 100, *L* = 150, …). Using equation (5) with the listed values of *L* (mm), allows obtaining the corresponding values of mass *TW*: $TW_{L=50}$, $TW_{L=100}$, $TW_{L=150}$, $TW_{L=200}$, $TW_{L=250}$. The so-obtained mass values ($TW_{L=50}$, $TW_{L=100}$, $TW_{L=150}$, $TW_{L=200}$, $TW_{L=250}$) for each of the studied populations are then compared (Zhivkov 1981, 1999; Raikova-Petrova and Zhivkov 1993).

Results and Discussion

Age and size composition

The age of Romanian barbel from the Ogosta River ranges from 1 to 5 years. The first age group is the most abundant and accounts for more than half of the catch (56 %) (Fig. 3). The number of fish of other age groups decreases progressively with age. Only one specimen was found in the fifth age group.

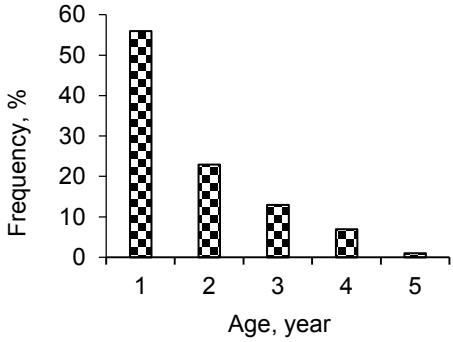

Fig. 3. Age structure of Romanian barbel from the Ogosta River.

Similar age structure reported Michaylova (1960) for the Vedena River, where first and second age groups represented 85 % from the sample. In this river, however, the most numerous were two-year-old fish (49 %). The available data show that only two five-year-old individuals (1 %) were caught in the Vedena River. A lack older groups' specimen from both studied rivers, Vedena and Ogosta, is likely a result of increased natural mortality or fishing elimination (Pravdin 1966).

In the sample from the Ogosta River, the largest fish is a five-year-old individual with body length 172 mm (*TL* 202 mm) and body weight 71 mm (*TW* 80.6 g). Mean length is 83 ±26 mm and mean weight 10

±12 g. The following size groups are the most numerous: 51–60 mm; 61–70 mm. Specimens longer than 100 mm are relatively few (Fig. 4).

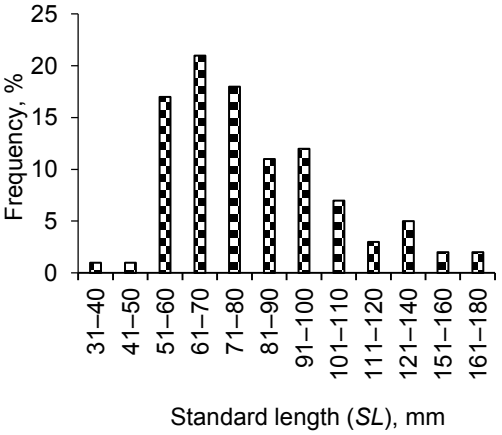

Fig. 4. Size classes of Romanian barbel from the Ogosta River.

Growth rate

A relationship between standard length and scale radius is well expressed by a linear function (Fig. 5). Length growth of different age groups is relatively constant (Table 2). Due to the onset of sexual maturity (Nikolsky 1965) two-year-old fish have a slight delay of linear growth. In subsequent years, length growth remained close to that, observed during the first year. Exceptions are five-year-old fish, which exhibit the fastest growth. Older and larger fish are likely to be more successful in finding food in this watercourse.

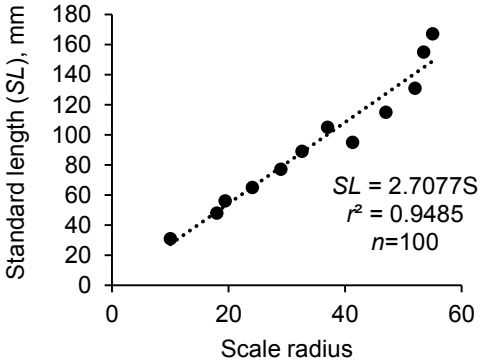

Fig. 5. Growth in length of Romanian barbel from the Ogosta River.

Table 2. Back-calculated standard body length (*SL*) of Romanian barbel of the Ogosta River.

Year	Age group	N	Mean back calculated *SL* (mm) at age				
			SL_1	SL_2	SL_3	SL_4	SL_5
2020	I	56	65				
2019	II	23	35	87			
2018	III	13	30	54	108		
2017	IV	7	30	54	79	138	
2016	V	1	32	54	84	100	149
Mean calculated *SL*, mm		100	38	62	90	119	149
Mean observed *SL*, mm		100	65	89	111	135	172
Annual increment, mm			38	30	36	38	49

A well-defined, almost functional relationship between body length and weight is characteristic of Romanian barbel (Fig. 6). Weight growth is characterized by a gradual increase up to the fifth year (Table 3). Two-year-old fish exhibit some growth retardation both in terms of length and weight. Probably, this is a result of in-

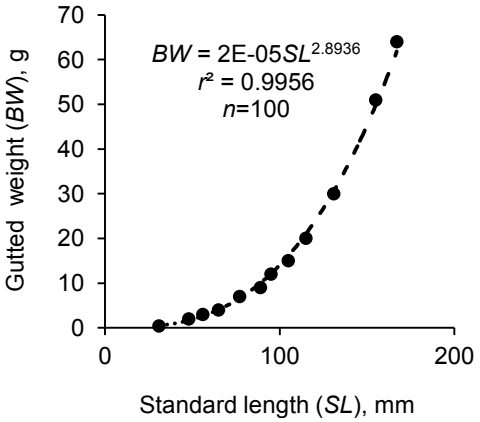

Fig. 6. Growth in weight of Romanian barbel from the Ogosta River.

creased sexual function; for this species, it takes place in their second year (Michaylova 1960). Five-year-old fish have the highest weigh growth.

Available data for this species allows a comparison of linear growth, using observed total body length (*TL*) (Table 4). The highest linear increment was associated with fish of the Rositsa River, and the lowest one – with fish of the Osam and Lom rivers (Danube watershed) (Marinov 1986). Observed total body length of Ogosta River fish is very close to that reported by Michaylova (1960) for the Vedena River. Although the Vedena River is located in southern Bulgaria and the Ogosta in northern Bulgaria, both rivers are part of the Danube basin. Growing conditions in the two rivers are obviously similar, as colder climate in Northern Bulgaria is compensated by the lower altitude of the Ogosta riverbed.

Table 3. Back-calculated gutted body weight (*BW*) of the Romanian barbel in the Ogosta River.

Year	Age group	N	Mean back calculated *BW* (g) at age				
			BW_1	BW_2	BW_3	BW_4	BW_5
2020	I	56	3				
2019	II	23	4	8			
2018	III	13	1	2	15		
2017	IV	7	1	2	6	31	
2016	V	1	1	2	7	12	39
Mean calculated *BW*, g		100	2	4	10	22	39
Mean observed *BW*, g		100	4	10	19	36	71
Annual increment, g			2	2	8	15	27

Table 4. Comparison of mean observed total body length (*TL*) of Romanian barbel of the same age.

Source	River	Total body length (*TL*), mm					
		N	TL_1	TL_2	TL_3	TL_4	TL_5
Marinov 1986	Rositsa	20	76	142	163		
Marinov 1986	Nishava	15	77	125			
Michaylova 1960	Vedena	168	75	108	158	170	202
Our data 2020	Ogosta	100	78	108	131	160	202
Marinov 1986	Dryanovska	20	70	101	133	152	
Marinov 1986	Vit	32	71	120	127		
Marinov 1986	Archar	20	43	100	117		
Marinov 1986	Dryanovska	32	48	86	109	142	

Source	River	Total body length (*TL*), mm					
		N	TL_1	TL_2	TL_3	TL_4	TL_5
Marinov 1986	Lom	15	42	86			
Marinov 1986	Osam	25	42	86			

However, use of calculated standard body length (*SL*) for comparative analysis is recommended by many authors (Prodanov 1982; Raikova-Petrova 1992; Zhivkov 1981, 1999; Raikova-Petrova and Zhivkov 1993; Kukushkin 1997; Belomacheva et al. 2005). This method would give more accurate results. In this way, individual deviations are reduced and a general trend in length growth is better expressed. Our data show that calculated *SL* for the species is lower than observed (Table 2). Applying standard length (*SL*) instead of total length (*TL)* prevents potential errors, due to caudal fin damage.

Condition factor

Condition factor is calculated by the Fulton equation – K_f. The calculated K_f for barbel from the Ogosta River, K_f =1.4, is higher than the average reported for specimen from the Vedena River – K_f = 0.6–2.56 (Mihailova 1960). The author points out that K_f is higher only for four- and five-year-old fish from the Vedena River, which are few in the sample (about 5 %).

Many authors prefer the use of K_b to Fulton's coefficient K_f because it gives more accurate results. In this study, the coefficient K_b =1.75 is much larger than K_f.

By substituting rounded values for the body length (50 to 250 mm) into the equation expressing *BW*/*SL* ratio – BW_L=0.00002$L^{2.8396}$, the weight at a corresponding length is obtained. The results are as follow: BW_{50} = 2 g, BW_{100} = 12 g, BW_{150} = 40 g, BW_{200} = 92 g, BW_{250} = 176 g. Those data allow the comparison of the growth of the Romanian barbel from different populations.

Conclusions

The population of Romanian barbel of the Ogosta River is predominated by one-year-old fish. Adult and larger fish are very few. Replenishment dominates over residue.

Species' length growth is closer to that of fish of the Vedena River (the Iskar River watershed). The condition factor and Fulton's coefficient of Romanian barbel of the Ogosta River is higher than the highest reported for barbel of the Vedena River.

Acknowledgments

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Authors' statement

The present study was conducted in accordance with the national legislation. The electrofishing was conducted with a permit 31/26.08.2020, issued by the Minister of the Ministry of Agriculture, Food and Forestry of Bulgaria. Most of the fish caught were released back into the water. Only the quantity indicated in the electro-

fishing permit was detained.

Conflict of interest

The author declares no conflict of interest.

Data availability statement

The data that support the findings of this study are available on request from the author.

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