

LENGTH GROWTH OF THE GUDGEON *Gobio gobio* (Linnaeus, 1758) IN THE VARDAR RIVER (THE REPUBLIC OF MACEDONIA)

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Summary

The river Vardar is the biggest potamian biotope in the central part of the Balkan Peninsula. Along the 300 km long cross that was studied, a total number 24 species were collected from the examined 12 profiles; from the total of 3019 specimens of widespread Euro–Asian species that were collected, *G. gobio* was among the eight most frequently found ones, and with participation of 12.5% it was placed on the third place. The research of the length growth was done on the scales taken from 150 samples, using the Rosa Lee method. Consequently, a correction of 25 mm was determined. The smallest exemplar (1) was 42 mm long, and it was aged 1+, and the longest one was 108 mm, aged 5+. The results were calculated for both the male and the female specimens. The conclusion reached was that this cyprinid species is relatively resistant to pollution; therefore, the density of its population does not seem to be in jeopardy as it was the case with some other more sensitive native species. The length growth depends on the global climate circumstances; the Vardar River gudgeon grows as fast as the other Mediterranean populations, both lotic and limnetic, but slower than the Middle European populations.

Key words: *river Vardar*, *G. gobio*, *length growth*, *fluent biotope*, *Balkan Peninsula*.

INTRODUCTION

The drainage of the river Vardar lies in the central part of the Balkan Peninsula. The surface of the flow is 28.410 km², which is about 5.6% of the total surface of the peninsula. The river is 420 km long, out of which 300 km are in the Republic of Macedonia and 120 km are in Greece (Gaševski,

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1968). Therefore, we can say that the river Vardar is an international river; the biggest part of the flow, about 4/5, or to be more precise 21.430 km², belongs to the national territory of the Republic of Macedonia (Gaševski, 1978).

The biotope is young, with a quite complex character, where five planes and five gorges interchange simultaneously. The planes represent bottoms of former lakes, filled by the desposits of the mountains surrounding the planes. The river Vardar is a relatively full-water fast-running ecosystem. The description of the morphological, hydrographical, and mineralogical, biological and hydro-biological characteristics of the Vardar river-bed is given by Georgiev (2000). The longitudinal declination is higher in the gorges (the average is 4.4‰), and it is lower in the depressions (from 0.4‰ to 2.2‰) (Gaševski, 1968). In the gorges the bottom is rocky with many speeds and pools, whereas in the depressions it is graveled and sandy.

From ecological point of view, this benthal species is equally successful in inhabiting both lotic and limnetic biotopes in Eurasia; and in the Republic of Macedonia the Vardar River watershed (Banarescu *et al.*, 1999; Vuković and Ivanović, 1971), mesotrophe ecosystem, whereas its population is very low in one extremely eutrophe stagnant ecosystems as the Dojran Lake is; here it has not been mentioned among the other four as a fish of any economic importance (Apostolski, 1991; Apostolski *et al.*, 1956). Furthermore, in the oligotrophe Ohrid Lake it has a marginal economic importance (Stanković, 1957). It is quite obvious that the ecological conditions of the fast running-stream of the Vardar river biotope are convenient for this species, so the activity of the anthropologic factor, that has in global changed the natural conditions of the ecosystem of the Vardar river (Grupče and Dimovski, 1973; Georgiev, 2000; Georgiev *et al.*, 1998, 1998a; Stanković *et al.*, 1984), has not made any harm nor damage to the population of this fish. On the contrary, perhaps the decrease of the populations of the other native species, with larger individual growth, is quite convenient for the gudgeon.

Other works related to the gudgeon of the Vardar river flow (taxonomy, distribution and place in the ichthyocenosis), are those of Dimovski and Grupče (1971, 1972, 1977); Economidis (1991); Economidis *et al.* (1981); Economidis and Banarescu (1991); Georgiev (1998); Karaman, M. (1971); Karaman, S. (1924); Kottelat (1997); Nastova-Đordioska *et al.* (1998). This fish was analyzed as member of the ichthyocenoses under natural conditions and under the influence of the anthropological factor, here are mentioned the works of Janković, (1982); Janković and Meštrov (1989); Libosvasky (1989); Lusk (1979).

MATERIAL AND METHODS

The material was assembled in the period from 1996 until 1999; a total of 12 profiles equally distributed at every 25–30 km were examined, (Fig. 1.).

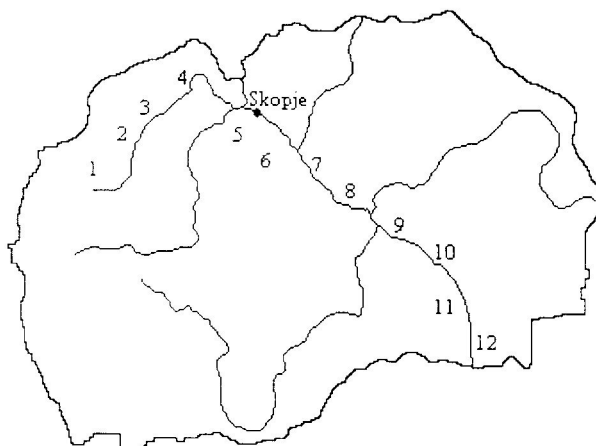


Figure 1. Disposition of the profiles of the river Vardar where the material was collected

Slika 1. Raspored profila na rijeci Vardaru gdje je sakupljen materijal

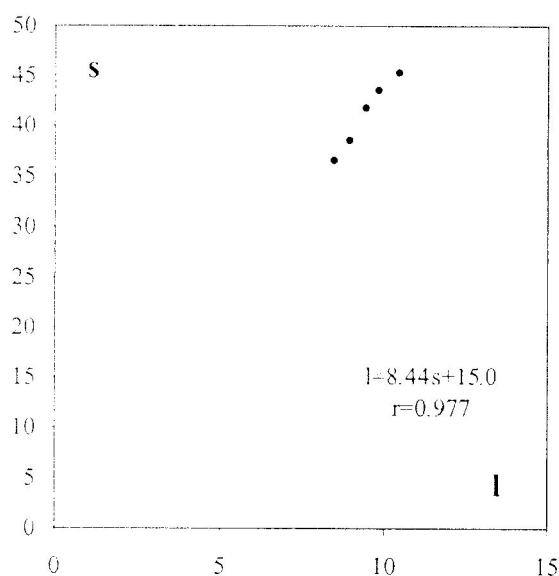
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|--------------|------------|---------------|---------------|
| 1. Vrutok | 4. Radusha | 7. Taor 2 | 10. Klisura |
| 2. Volkovija | 5. Skopje | 8. Nogaevci | 11. Miravci |
| 3. Sirichino | 6. Taor 1 | 9. Pepelishte | 12. Gevgelija |

The gathering of the material in the different seasons, was not always done at the same place; on the contrary, it was done with deviations of some hundred meters upstream or downstream, depending on the possibility to reach the profile when there is a different water level in the river bed. Different fishing techniques have been used: horizontal and vertical nets, hooks, and partly the sport fisherman have given away some of the samples. After the fishing of the specimen was completed, the fish were conserved in a 4% solution of formaldehyde and studied at the laboratory. The length of the fish was measured starting from the top of the mouth to the end of the scale cover (l=body length). In the three-year period 1996–1999, 376 specimens of gudgeon were collected. Out from the total catch of 3019 specimens, *G. gobio* is on the third place, in fact it has arrived at a 12.5% presence. For this purpose the scales of 150 samples were examined; the scales came from seven different profiles, in the upper and middle cross. However, some unsettled inter-human relations at the Institute for animal science were a great obstacle for the author, and therefore not all of the scales from the gathered fish could be studied. In order to conduct the length growth study, some scales were taken from the left side of the body under the dorsal fin; the next step was to clean them in distilled water and read through the Reichert binocular at an enlarged scale of 5X4.0:1. The average values for the diagonal scale radius in number of divisions on the ocular-micrometer (s) and

the average values of the body length (l) in mm, were distributed in length classes of 0.5 cm, and after that were placed on the abscise and ordinate, in order to empirically discover the value for the correction of the length of the body when the scales appear. The length growth was studied according the method of Rosa Lee, Chugunova (1957).

RESULTS AND DISCUSSION

The first thing that was determined was the correction of the body length of the gudgeon when the scales start to appear. The correction was stated to be 25 mm (Fig. 2.). However, attention should be placed on reading of the scales. Unlike the other cyprinid species studied by the author (Georgiev, 2000a; Georgiev *et al.*, 1998) where the scales are rounded or ellipsoid, the scales of the gudgeon are a bit irregular and hexagonal, as it is shown in the work of Lelek (1965). The center of the scale is located near the anterior edge, somewhere 1/4 of the horizontal diameter. Therefore, it was impossible to read and to measure the distance among the annual rings at the anterior or posterior side, which is a procedure so normal and usual for the other cyprinid



S scale radius in divisions of ocular-micrometer

l body length in cm

Figure 2. Body length–diagonal scale radius relationship of the *G. gobio* from the river Vardar

Slika 2. Suodnos dužina tijela — dijagonalni radius ljuske za *G. gobio* iz rijeke Vardara

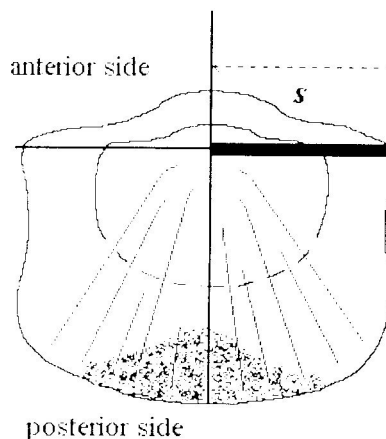


Figure 3. The gudgeon scale and the place of the reading of the annual rings

Slika 3. Ljuska krkuš e i mjesto čitanja godišnjih prstenova

fish, but it had to be done diagonally (Fig. 3.). L e l e k (1965), has also studied the development, the morphology and the characteristics of the gudgeon scales difference according the sex. He has discovered differences in the scale structures in different localities, and furthermore, that the male exemplars need a longer growth period than the female ones. L o h n i s k y (1961) has determined a correction of 7 mm. Here we should also mention that the smallest sample he had on his disposition was 29 mm. The formula for the body length/the diagonal radius of the scales of the species from the river Vardar is $l=8.44s+15$, regression $r=0.977$.

The results are shown for both the male and female samples together (Tab. 1.), according the profiles and the averages for the entire stream and they have been shown both numerically (Tab. 1) and graphically (Fig. 4.).

As it can be seen, the fish reach the most intensive length growth in the first year of their life, and as they get older the growth decreases. In general, the growth is regular and adequate to the theoretically known experience for all the fish population growth. For the oldest fish, only two on the highest profile, the salmonid zone of the Vardar river stream, were assessed to be at the age of 5+. If we ignore the extremely fast growth of one sample of 3+ on the profile Taor 1 (l mm 118), and the extremely slow growth of one sample of 4+ age on the Radusha profile, we can see that the gudgeon length growth in the river Vardar at the examined part of the cross, does not differ. This is quite easy to explain. The profile Taor 1 is just where the influence of the polluted water from Skopje is the strongest, the fish populations are devastated and the rare individuals grow fast, on the other hand, although the polluted water of JUGOCHROM (black metallurgy complex) in the Radusha profile causes destruction of the fish assemble, the cross in the gorge with highest declination of 6.6%, makes the fish spend a lot of energy in order to oppose the water current.

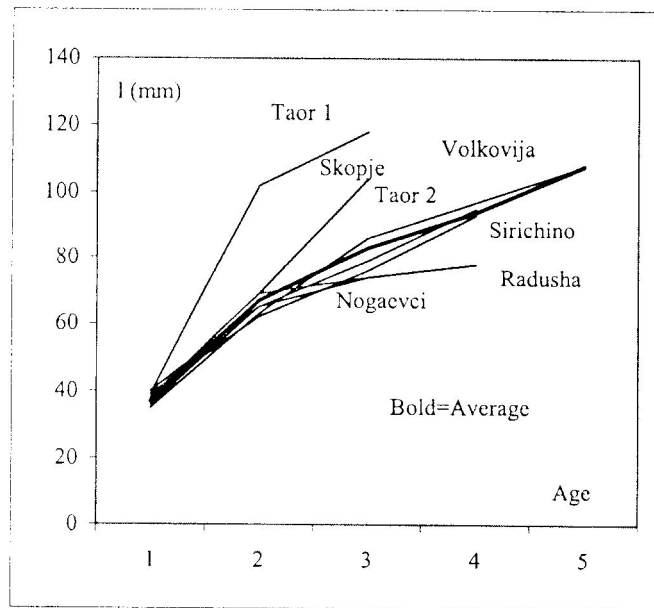
age	n	l_1	l_2	l_3	l_4	l_5
2+	9	40	74			Volkovija
3+	16	32	59	87		
4+	3	35	62	81	96	
5+	2	31	52	80	97	108
	30	35	63	86	97	108
Absolute increase mm			28	23	11	11
Relative increase (%)			80	36	13	11
1+	3	40				Sirichino
2+	12	38	75			
3+	12	34	57	80		
4+	2	30	55	79	95	
	29	36	65	79	95	
Absolute increase mm			29	14	16	
Relative increase (%)			81	21	20	
1+	12	41				Radusha
2+	7	40	67			
3+	3	41	62	83		
4+	1	30	44	57	78	
	23	40	65	74	78	
Absolute increase mm			25	9	4	
Relative increase (%)			62	14	5	
1+	28	39				Skopje
2+	13	36	67			
3+	1	40	92	104		
	42	38	69	104		
Absolute increase mm			31	35		
Relative increase (%)			82	51		
1+	4	38				Taor 1
3+	1	41	102	118		
	5	39	102	118		
Apsolutni prirast mm			63	16		
Relativni prirast (%)			161	16		
1+	7	41				Taor 2
2+	2	42	67			
3+	2	33	71	74		
4+	2	31	49	78	93	
	13	39	62	76	93	
Absolute increase mm			23	14	17	
Relative increase (%)			59	23	22	
1+	4	40				Nogaevci
2+	3	35	75			
3+	1	38	54	74		
	8	38	69	74		
Absolute increase mm			31	5		
Relative increase (%)			82	7		
Average for all the stream						
1+	58	36				
2+	46	39	71			
3+	36	35	62	84		
4+	8	32	55	77	93	
5+	2	31	52	80	97	108
	150	37	67	83	94	108
Absolute increase mm			30	16	11	14
Relative increase (%)			81	24	13	15

Table 1. Data for the G. gobio growth from the river Vardar on the different profiles

Tablica 1. Podaci o dužinskom rastu G. gobio iz rijeke Vardara na različitim profilima

Figure 4. Graphical presentation of the length growth of *G. gobio* from the river Vardar on the different profiles and the average values.

Slika 4. Grafički prikaz dužinskog rasta *G. gobio* iz rijeke Vardara na različitim profilima i srednje vrijednosti.



The results of the length growth of *G. gobio* in the different potamian biotopes are widely compared on Tab. 2. and Fig. 5., in the European part of the areal. As we can see from the annexes, the gudgeon from the river Vardar grows slowly in comparison to the other populations. The same low length growth rate can be noticed among the infiltrated populations in the waters of the Iberian Peninsula, the Jarama river and the Pinilla reservoir (Lobon-Cervia and Torres, 1983/1984), whereas, the populations in the Middle Europe (Lohnisky, 1961; Skora and Wlodek, 1969), among which we find the neighboring Morava river, the Danube river confluent on the north

Table 2. Compared data for the growth of the *G. gobio*
 Tablica 2. Uspoređeni podaci za dužinski rast *G. gobio*

Author	Locality	1+	2+	3+	4+	5+	6+
Skora & Wlodek (1969)	Dunajec	67	88	102	113	121	142
Lobon-Cervia & Torres (1983/1984)	Jarama males	34	60	82	97	-	-
Lobon-Cervia & Torres (1983/1984)	Jarama females	34	59	84	100	-	-
Lobon-Cervia & Torres (1983/1984)	reservoir Pinilla males	37	71	91	-	-	-
Lobon-Cervia & Torres (1983/1984)	reservoir Pinilla females	37	70	94	115	-	-
Lohnisky (1961)	Vykan	57	90	106	130	142	-
Lohnisky (1961)	Olza	57	84	105	120	-	-
Lohnisky (1961)	M. Arzimova	53	84	104	-	-	-
Lohnisky (1961)	Blatna	57	81	95	-	-	-
Lohnisky (1961)	Vymola	52	72	92	115	167	-
Lohnisky (1961)	Poltruba	54	68	81	104	-	-
Šorić & Ilić (1987)	Velika Morava	42	64	96	115	134	-
Our results	Vardar	37	67	83	94	108	-

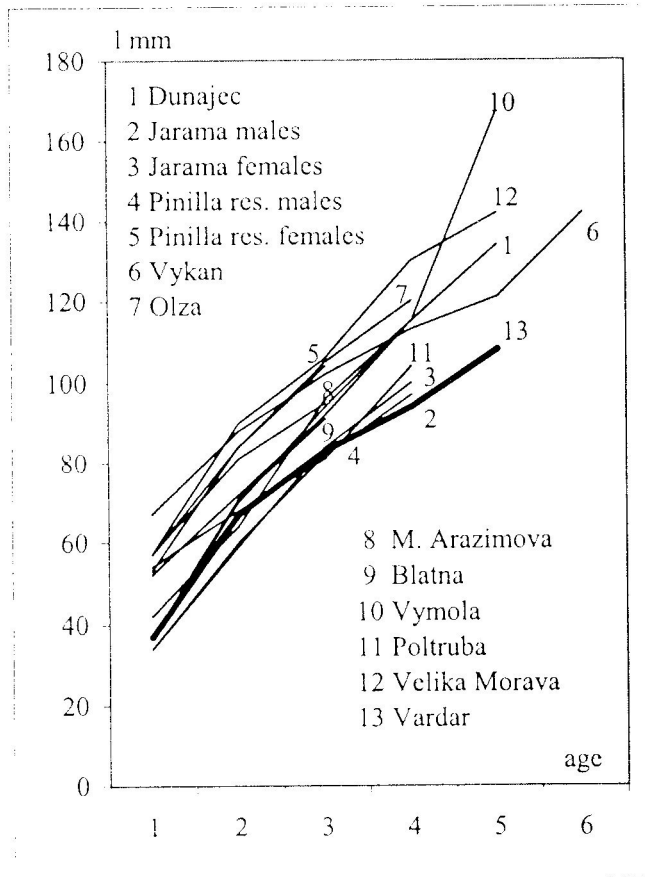


Figure 5. Compared data for the *G. gobio* growth, Graphical presentation

Slika 5. Uspoređeni podaci za dužinski rast *G. gobio*, grafički prikaz

part of the Balkan Peninsula (Šorić and Ilić, 1987), grow faster. The hypothesis that the bigger stream elevation in the Mediterranean potamian biotopes causes the slower length growth of the gudgeons in the southeast parts of gudgeon's areal, native and artificial, should be rejected, because even in the limnetic one, the Pinilla reservoir, the gudgeon grows as slowly as in the Mediterranean rivers. One thing can be concluded, the global Mediterranean climate circumstances are more inconvenient for the gudgeon length growth than in Middle Europe, where the ecological factors are much more stable, with smaller deviations of the air and water temperature.

CONCLUSION

G. gobio is a small fish with slow growth speed; after a detailed research was conducted, it was determined that in the River Vardar ecosystem this fish at the oldest age of 5+ reaches length of about 108 mm.

This fish is one of the most frequently found ones, living nearly down the entire Vardar stream, on the territory of the Republic of Macedonia, but in Greece too. In the fish assemblage of the river Vardar in the Macedonian part of the cross, it keeps the high third place, which implies that the character of the biotope is quite convenient for the gudgeon's ecological needs.

The pollution does not damage the gudgeon population in the river Vardar, in fact, the destruction of the other fish populations, which are with larger individual growth, seems to be quite convenient for the gudgeon.

The examination of the length growth of Vardar river gudgeon, *G. gobio* has shown that it grows equally fast as the Mediterranean population, both lotic or limnetic.

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Sažetak

DUŽINSKI RAST KRKUŠE *Gobio gobio* (Linnaeus, 1758) U RIJECI VARDARU (REPUBLIKA MAKEDONIJA)

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Rijeka Vardar najveći je tekući biotop na središnjem dijelu Balkanskoga poluotoka. Na istraživanome tijeku dugom 300 km među 24 vrste sakupljene na 12 profila od 3 019 primjeraka, široko rasprostranjena euroazijska vrsta *G. gobio* među osam je najčešćih, s udjelom od 12,5%, na trećem mjestu. Dužinski je rast proučavan na ljuskama 150 primjeraka, primjenom metode Rosa Lee. Utvrđeno je da popravak iznosi 25 mm. Najmanji primjerak (I) bio je 42 mm dug, 1+, najduži 108 mm, na uzrastu 5+. Rezultati su izračunani skupno za oba spola. Čini se da je ova ciprinidna vrsta relativno otporna na onečišćenje, te se tako na osnovi gustoće njezine populacije ne stječe dojam da je ugrožena kao što je bilo utvrđeno za neke druge osjetljivije domaće vrste čija je brojnost pala. Dužinski rast ovisi o cjelovitim klimatskim okolnostima; krkušica u rijeci Vardaru raste toliko brzo kao i ostale sredozemne populacije, obje tekuće te stajaće, sporije no srednjoeuropske populacije.

Ključne riječi: *rijeka Vardar, G. gobio, dužinski rast, tekući biotop, Balkanski poluotok.*

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