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AGE, GROWTH RATE AND CONDITION FACTOR OF THE CHUB (*SQUALIUS ORPHEUS* KOTTELAT & ECONOMIS, 2006) IN THE STRYAMA RIVER

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Abstract

A study of the Maritsa chub in the Stryama River, a left tributary of the Maritsa River was carried out. The research was conducted in autumn in the period 2006–2011. A total of 458 specimens of Maritsa chub were caught by electrofishing. The size-age composition was simple. The population was represented by five age groups. The chub's population in the Stryama River was dominated by young and middle size groups. The relationship between the average values of *L* (standard length) and *S* (scale radius) was described by the equation: $L = 17228+2.1934 \cdot S$; correlation $r = 0.9979$. The length growth of the chub in the Stryama River is relatively fast. The relation between the fish weight (*W*) and length of the population was represented by the equation: $W = 0.000009 \cdot L^{3.1154}$; $r = 0.9996$. The condition factor of the chub in the Stryama River is one of the lowest in comparison with the other water courses in the Aegean catchment area.

Key words: length growth, size-age composition, Squalius orpheus, weight growth.

Introduction

The Maritsa chub (*Squalius orpheus* Kottelat & Economis, 2006) is an endemic species for the Balkan Peninsula. It was recently identified as a separate species by Kottelat and Economidis (2006). Apostolou and Dobrovolov (1999) assume that the chub from Aegean basin is a separate species as well. The species occurs in the water courses of the Aegean watershed from the Maritsa River to the Struma River (Kottelat and Economidis 2006, Kottelat and Freihof 2007). This is one of the most numerous fish species in the middle zone of the Maritsa River tributaries in Bulgaria and also one of the favorite sport fish in these water courses.

The first detailed study of the Maritsa chub along the whole Bulgarian water course of the Struma River was conducted by Michajlova (1964). The author published the data for the length and weight growth of the chub in the Struma River. A study of the age structure and the increase of the chub population in the Batak dam, situated in the watershed of the Maritsa River, was carried out by Zivkov (1973). He reported detailed data on the growth rate of the chub in this dam. The length and weight growth rate of the Maritsa chub in the Dzerman River, a left tributary of the Struma River, was studied by Dikov and Zivkov (1985). In his PhD

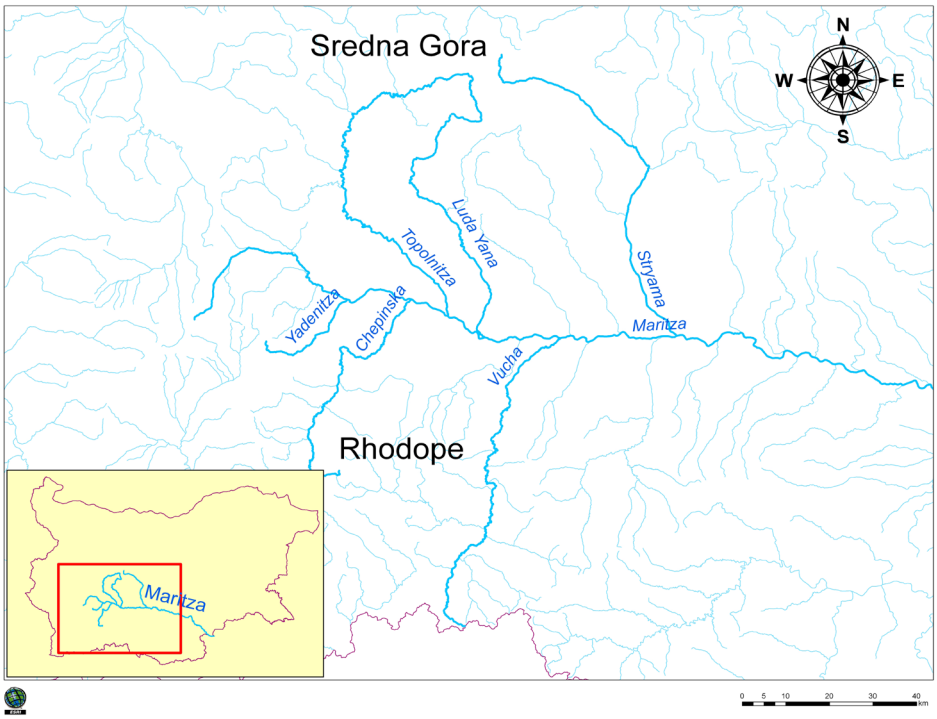

Fig. 1. Location of the Sryama River, Arc Map 10.0 (ESRI – ArcGIS 2013).

thesis Marinov (1986) reported information about the length growth of the chub in the Chepinska River, a right tributary of the Marisa River. Dikov et al. (1994) published the results of a survey of the fish stocks in the inland rivers of Bulgaria. They reported data on the length growth of the chub in the rivers Struma and Mesta and also in the Arda River, a right tributary of the lower course of the Maritsa River.

The aim of the study was to compare the growth rate and the condition factor of the chub in the Stryama River with the results obtained for other rivers.

Study area

The study area includes the Stryama River, a left tributary of the Maritsa River coming from the Sredna Gora Mountains. The Stryama River springs east of the peak Vezhen in the Middle Balkan Mountains and flows between the Balkan and the Sredna Gora mountains (Fig. 1). Its length is 110 km with a catchment area of 1,789 km^2. The river flows into the Maritsa River near the village of Manole. Most of the Stryama River is in the Upper Thracian Valley. The river is characterized by small slope, although its average altitude is high.

Materials and Methods

The aim of the study was to establish the age structure, the length growth and the condition factor of the chub in the Stryama River and also to compare them with these

Table 1. Sampling areas in the Stryama River.

No	Location	Geographic coordinates		Altitude, m a.s.l.	Date of sampling
		N	E		
1	Near the bridge of the road Plovdiv-Rakovski	42°15'07.29''	24°50'21.05''	174	16.11.2006
2	Near the bridge of the road Plovdiv-Banya	42°32'18.12''	24°49'22.78''	283	17.11.2006 17.04.2011
3	Near the town of Banya next to the fish farm.	42°33'39.11''	24°47'45.81''	302	17.11.2006 19.11.2006 19.10.2011 20.11.2011 16.12.2011
4	Near the village of Rozino next to the bridge on the Stryama River	42°41'29.46''	23°34'00.57''	478	26.10.2008

features of the chub in the other water courses in the Aegean catchment area.

In the period 2006–2011 458 pieces of Maritsa chub were collected from the Stryama River 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. The catch was performed according to the EN 14011:2004 instruction (Water quality – Sampling of fish with electricity).

Fish for this study were caught mainly in autumn. In order to collect the material for the study four sampling areas were used (Table 1). The standard length (*L*) of the fish with a precision of 1 mm and weight (*W*) with a precision of 1 g were measured. The age was determined by measuring the fish scales. For this purpose a microscope Olympus CX 31 at a 40× magnification was used.

The identification of the species was made according to Kottelat and Freyhof (2007).

An estimation was made of the growth rate of the Maritsa chub in different water bodies, comparing the average lengths of equal age specimens (Raikova-Petrova and Zivkov 1993, Zivkov 1999). The weight calculated for the specimens of fixed lengths (50, 100, 150, 200, 250, etc., mm) were used as condition factors of the different populations of Maritsa chub (Zivkov 1999).

Survival ($S = e^{-z}$) and annual mortality rate ($A = 1–S$) were calculated using the equation describing the relationship between the number of fish in the catch and their age (Raikova-Petrova and Zivkov 1993, Zivkov 1999).

Results and Discussion

The relation between the fish length (*L*) and the scale radius (*S*) is:

$L = 17228+2.1934 \cdot S$; $r = 0.9979$.

The decrease of mean logarithmic values of chub's abundance in the Stryama River is well described by the slope regression:

$\text{Ln } N\% = 4.9353–0.851 \cdot t$; $r = 0.8526$; $n = 458$.

Age composition

The second age group dominates in the catch (Fig. 2). The dominant size is between 121 and 130 mm (Fig. 3). The big-

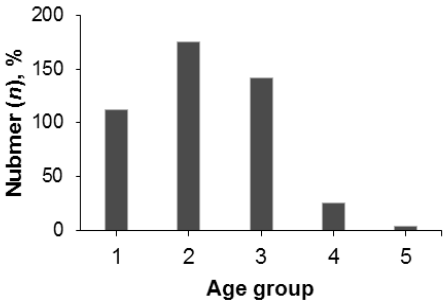

Fig. 2. Age structure of the population of Maritsa chub in the Stryama River.

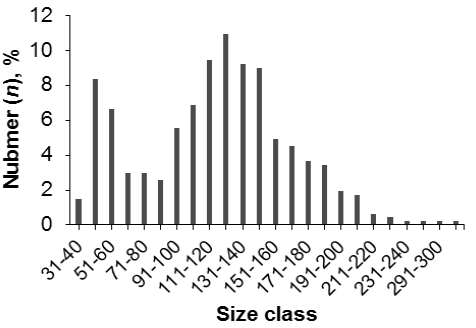

Fig. 3. Size class of the population of Maritsa chub in the Stryama River.

gest specimen is 322 mm long and weighs 607 g. The full length of the body of this specimen is 368 mm, and the total weight is 698 g. It has been caught in 2006 and it is not the oldest specimen (its age was four years) (Table 2). The oldest specimen has been caught in 2010. It is five years old and measures 295 mm and 428 g.

The population is dominated by young and middle-sized fish respectively 40–50 mm and 100–150 mm long. The greatest is the mortality rate of the Maritsa chub in the Stryama River in the forth and the fifth age groups (Fig. 2 and Fig. 3). The population of chub in the Sryama River is characterized by relatively low survival rate (S = 42.7 %) and a higher annual mortality rate (A = 57 %). The number of specimens over 200 mm long in the sample is very small, which shows a great elimination of fish of larger sizes due to angling (Pravdin 1966). Confirmation of this hypothesis is the higher annual mortality rate and the fact that the oldest caught specimen in the sample is only five years old. Michajlova (1964) has found six age groups of the Maritsa chub in the Struma River, Dikov et al. (1994) has indicated seven age groups of the chub in the Struma River and Zivkov (1973) has established eleven age groups of the Maritsa chub in the Batak dam. Obviously in the Struma River and in the Batak dam the Maritsa chub lives many years more and reach larger size.

Growth rate

The length and the weight growth of the Maritsa chub are shown in Tables 2 and 3. The Maritsa chub has the greatest length growth in the first year of its life. This is due to the fact that in their first year fish are not yet sexually mature and use their reserves only for growth. In the subsequent year, length growth is significantly reduced. It is very likely that this growth reduction is related to sexual maturation of some of the chub at that age (Nikolsky 1965). From the third year on, the linear growth rate slightly increases and remains at a constant level until their fifth year (Table 2).

Both the length and the weight growth increase steadily but relatively slowly from the first to the fifth year (Table 3). The annual values of length and weight reached by the chub in the Stryama River are one of the smallest for the Maritsa chub in the Aegean watershed on the territory of Bulgaria (Table 4). The growth of chub in the Stryama River approximates that of chub in the Arda River. As shown

Table 2. Back calculated body length of the Maritsa chub in the Stryama River.

Generation	Age group	Body length (L, mm) at the end of each year of thelife, calculated from scales radius (S)					Number
		L_1	L_2	L_3	L_4	L_5	
2011	I	76					12
2010	II	50	94				35
2009	III	63	72	134			86
2008	IV	54	80	127	173		63
2007	IV	57	83	127	186		22
2006	V	50	81	100	125	175	86
2005	II	41	81				34
2004	III	55	74	123			86
2003	IV	61	81	124	173		31
2002	V	76	104	114	151	210	3
Average body length (L_{av}), mm		58	83	121	162	192	
Real length (L_r), mm		49	84	122	166	181	
Growth length (t'), mm		58	25	38	41	31	

in Table 4 the chub in the dams Batak and Pyasachnik has registered the fastest growth of the Maritsa chub, faster than the chub growth in all investigated rivers

Table 3. Back calculated body weight of the Maritsa chub in the Stryama River.

Generation	Age group	Back calculated body weight (W, g) of the Maritsa chub at the end of each year of the calculated life, from body length (L, mm)					Number
		W_1	W_2	W_3	W_4	W_5	
2011	I	6.6					12
2010	II	1.8	12.6				35
2009	III	3.7	5.5	37.6			86
2008	IV	2.3	7.5	32.0	84.4		63
2007	IV	2.6	8.6	32.2	106		22
2006	V	1.8	7.9	15.1	30.5	87.1	86
2005	II	0.9	7.9				34
2004	III	2.4	6.1	29.3			86
2003	IV	3.3	7.9	29.6	84.4		31
2002	V	6.6	17.5	22.9	55.3	155.1	3
Average body weight (W_{av}), g		3.2	9.1	28.4	72.1	121.1	
Real weight (W_r), g		1.8	8.6	26.9	74.3	108.2	
Weight growth – (t'), g		3.2	5.9	19.3	43.7	49.0	

Table 4. Comparison of average lengths of equal age Maritsa chub in different water bodies from its habitat.

Author/s and year	River Dam	Body length (L, mm) of Maritsa chub at the end of each year of life, calculated from scales radius (S)										
		L_1	L_2	L_3	L_4	L_5	L_6	L_7	L_8	L_9	L_{10}	L_{11}
Dikov et al. 1994	Arda River	58	104	137	159							
Our data 2015	Stryama River	58	83	121	162	192						
Michajlova 1964	Struma River	83	115	148	176	202	215					
Dikov & Zivkov 1985	Dzerman River	52	101	141	183							
Marinov 1986	Chepinska River	61	115	152								
Dikov et al. 1994	Mesta River	64	114	159	195	214						
Dikov et al. 1994	Struma River	54	119	164	211	223	241	243				
Stefanova et al. 2008	Maritsa River	60	95	130	240							
Zivkov 1973	Batak Dam	96	163	215	247	272	294	318	352	379	397	406
Boyadgiev 1966	Pyasachnik Dam	89	155	218	298	316						

Legend: S – scale radius (measured in divisions of the eyepiece – micrometer); $L1$–$L11$ – fish's body length in the end of every year of life (1 to 11).

in Bulgaria. Thanks to the rich food base (Nikolsky 1965), standing water and favorable temperature conditions in both of the dams, two-year old chub has reached length that the chubin the Stryama River reach in their fourth year. The chub in the rivers Struma, Dzerman and Mesta have relatively slow lentgth growth rate (Michajlova 1964, Dikov et al. 1994). The chub in the Maritsa River has a faster lentgth growth rate thant the chub in all other rivers of the Aegean watershed, including the Stryama River (Table 4).

The condition factor

The condition factor is shown in Table 5. The chub populations are arranged according to their weight at rounded length (250 mm – W_{250}). The chub in the rivers Struma, Dzerman and Mesta have a greater condition factor than these in the Stryama River. The condition factor of the chub in these three rivers is greater even than that of the chub in the Batak dam. The watershed of the rivers Struma, Dzerman and Mesta is at lower altitude then that of the Batak dam. The Mediterranean influence there is much greater and probably the growing conditions there are much better than these in the northern rivers and dams. Moreover the Struma River, a left tributary of which is the Dzerman River, is the sixth longest and the second by water quantity river from all the internal water courses in Bulgaria (Stoyanov et al. 1981, Uzunov and Kovatchev 2002). The condition factor of the chub in the Maritsa River is lower than this of the chub in the Struma River and its tributary the Dzerman River,

Table 5. Condition factor of the Maritsa chub in different rivers.

River, Dam	Author/s and year	Equation of the whole population	Average weight (W_L, g) calculated with the same rounded lengths (L, mm)				
			W_{50}	W_{100}	W_{150}	W_{200}	W_{250}
Arda	Dikov et al. 1994	$W = 0.00005L^{2.7522}$	2.3	16.0	48.8	107.6	198.8
Stryama	Our data 2015	$W = 0.000009L^{3.1154}$	1.8	15.3	54.2	132.7	265.9
Struma	Dikov et al. 1994	$W = 0.00003L^{2.9007}$	2.5	19.0	61.6	141.8	270.9
Batak	Zivkov 1973	$W = 0.000007L^{3.1662}$	1.7	15.0	54.3	135.1	273.8
Mesta	Dikov et al. 1994	$W = 0.00006L^{2.7793}$	3.2	21.7	67.0	149.1	277.2
Maritsa	Stefanova et al. 2008	$W = 0.0148L^{3.0595}$	2.0	17.0	58.7	141.5	280.1
Struma	Michajlova 1964	$W = 0.00001L^{3.1175}$	2.0	17.2	60.8	149.1	298.9
Dzerman	Dikov & Zivkov 1985	$W = 0.0116L^{3.05}$	2.2	18.6	64.1	154.3	304.7

Legend: W_L – weight of the fish with rounded values of body length (50 to 250 mm).

regardless of its greater length growth rate (Stefanova et al. 2008) (Table 5).

The data shows that the chub condition factor in the tributaries of the Maritsa River- the rivers Arda and Stryama is the lowest (Dikov et al. 1994) (Table 5). And there is evidence that the feeding conditions there are worse than these in the other water bodies (Raikova-Petrova and Zivkov 1993, Zivkov 1999, Zivkov and Raikova-Petrova 2001).

Conclusions

Considering our data on the population of the Maritsa chub in the Stryama River we reached to the following conclusions:

1. The chub population in the Stryama River is dominated by young and middle size groups, with length of 40–50 mm and 100–150 mm due to the elimination of larger fish;

2. The length growth of the chub in the Stryama River is the greatest in the first year;

3. The chub in the Stryama River has relatively slow length growth rate in comparison with the chub in the other water courses of the Aegean catchment area;

4. The condition factor of the chub in the Stryama River is one of the lowest in comparison with the ones of the chub in the other water courses in the Aegean catchment area.

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