



## GROWTH OF THE RED MULLET, *MULLUS BARBATUS* (LINNAEUS, 1758) ON THE MONTENEGRIN SHELF (SOUTH ADRIATIC)

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**Abstract:** Red mullet, *Mullus barbatus* (Linnaeus, 1758), economically is very important species. Materials for analysis were collected from October 2002. till Jun 2004., with trawl net using commercial boats on the Montenegrin shelf. For the first time in this area growth parameters were analyzed, separated for males and females, and for all specimens together. Till now data about this species was only about space distribution and CPUE (catch per unit of effort). Estimated growth parameters was  $L_{\infty}= 17.811$ ,  $K= 0.282$  and  $t_0= -3.013$  for males, and  $L_{\infty}= 27.479$ ,  $K= 0.149$  and  $t_0= -2.688$  for females. Estimates for all specimens together have values  $L_{\infty}= 30.129$ ,  $K= 0.118$  i  $t_0= -3.182$ . Estimate of growth rates showed a pronounced contrast between male and female red mullet, as the males grow twice as fast as females after the first year of life.

**Key words:** *Mullus barbatus*, growth parameters, Montenegrin shelf

### Introduction

Red mullet, *Mullus barbatus* (Sparidae, Percoidae), with 23.10% in total trawl catch and 5.4 kg/h in CPUE, (Joksimović *et. al.*, 2005), is one of the economically most important species for trawl fishery at Montenegrin coast. On the other hand, data on biology and population dynamics of this species in this part of Adriatic Sea were almost absent, while it was studied in detail in other parts of Adriatic (Haïdar 1970; Jukić and Piccinesi 1981, 1988; Jukić and Arneri 1983; Vrgoč 2000, 2004). Last data on distribution and participation of certain economically important species in trawl catches of eastern south Adriatic were presented by Merker and Ninčić (1973) and Jovanović and Stjepčević (1982).

Since 1998, the beginning of continuous monitoring of demersal resources on the shelf on Montenegrin coast also marked the

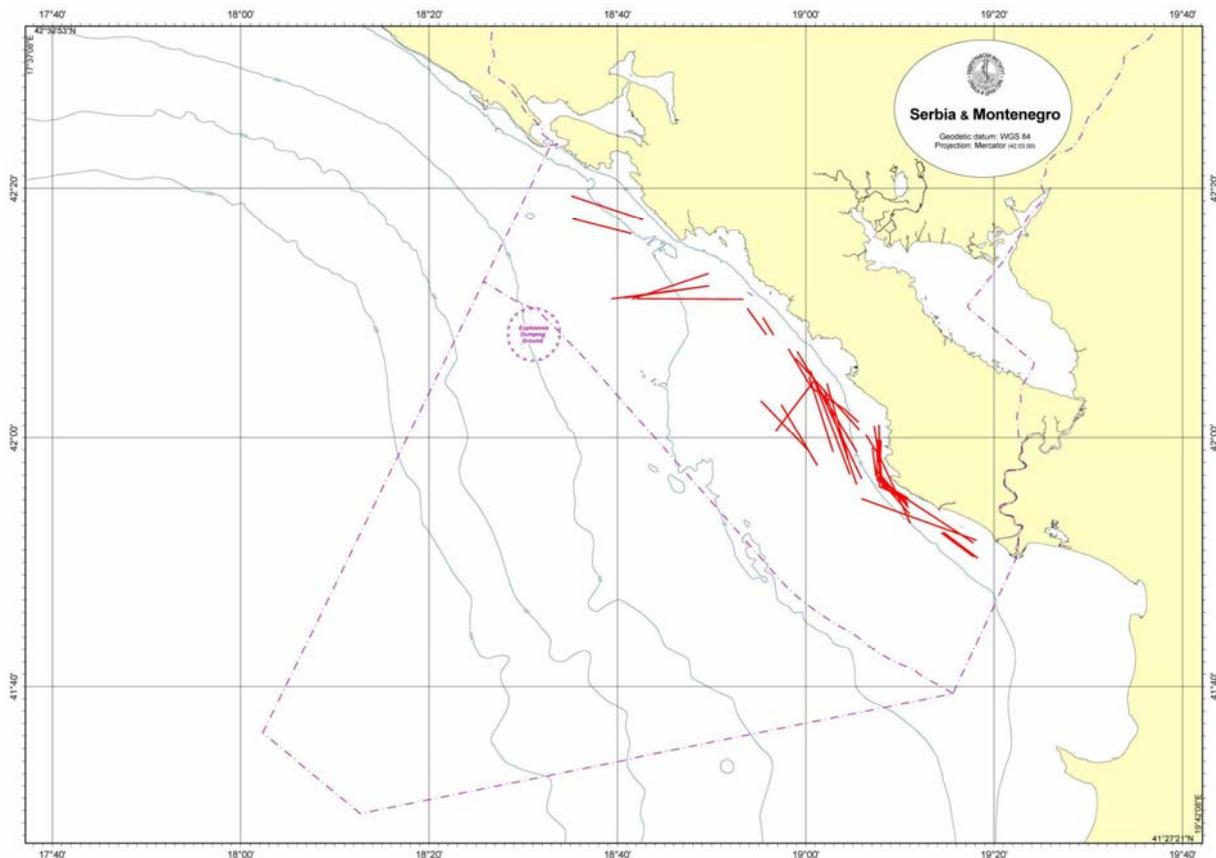
onset of first studies of population dynamics of economically important species of fishes and crustaceans in trawl fishery. Knowledge of parameters of growth, mortality, gear selectivity, biomass, period and intensity of reproduction contributes to proper estimate of resources and managing marine fishery on principles of sustainable development. This paper presents the results of growth parameters of red mullet estimated during these studies at Montenegrin coast.

### Material and Methods

Material was collected on the Montenegrin shelf area, (Fig. 1.) during the period from October 2002. to June 2004. with commercial trawlers. Thirty eight trawl hauls were analyzed in total and covered total surface about 900 km<sup>2</sup>. Weight and length were determined for 671 specimens and reading age from 375 otoliths of red mullet. Duration of hauls was from 0.6 to 4

hours For every haul data on characteristics of the boat (LOA, beam, engine power) and of the net (length of the net and of codend, mesh sizes of the net and codend) were taken. The local times, as well as the coordinates of the beginning and of end of

hauls were noted. Collected material was almost entirely rocessed on board Total length (TL), from the peak of the mandible to the stretched ends of the caudal fin was measured with the one mm precision. Weight of fishes was measured with precision of one gram.



**Figure 1. Map of investigated area with hauls**

The estimate of the growth parameters was performed through the method of least squares of non-linear functions (SSE), as well as the method of modal decomposition of length frequencies (Bhattacharya 1967). The programs used were FISAT (Gayanilo *et al.* 1995) and TRAWLAN (Regner 1999). As male and female mullet have different growth rates, calculations were done for both sexes separately and for all individuals together. Also calculated was ratio  $L_{max}/L_{\infty}$ ,

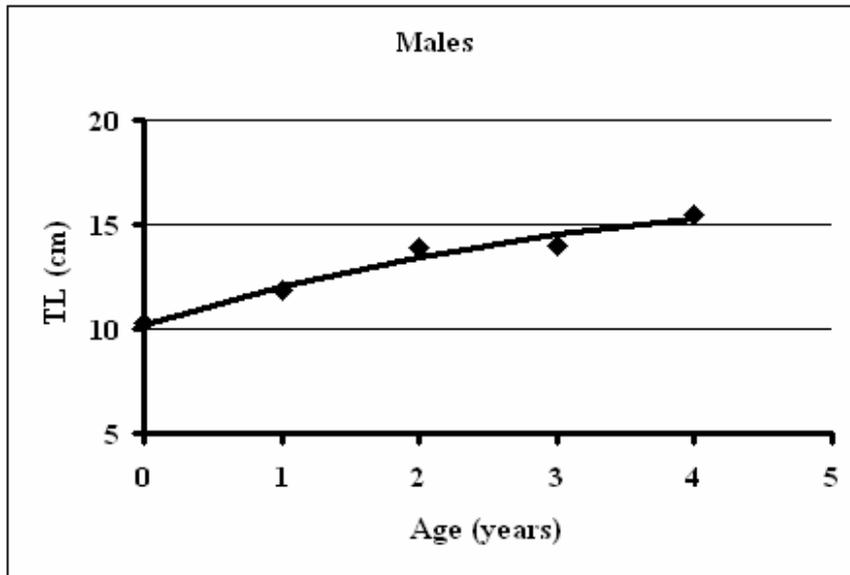
Hohendorf's index (Hohendorf 1966). After the estimate of parameters of length/weight ratio and growth functions, the weight growth in function of time was also calculated according to von Bertalanffy (1934, 1938).

## Results

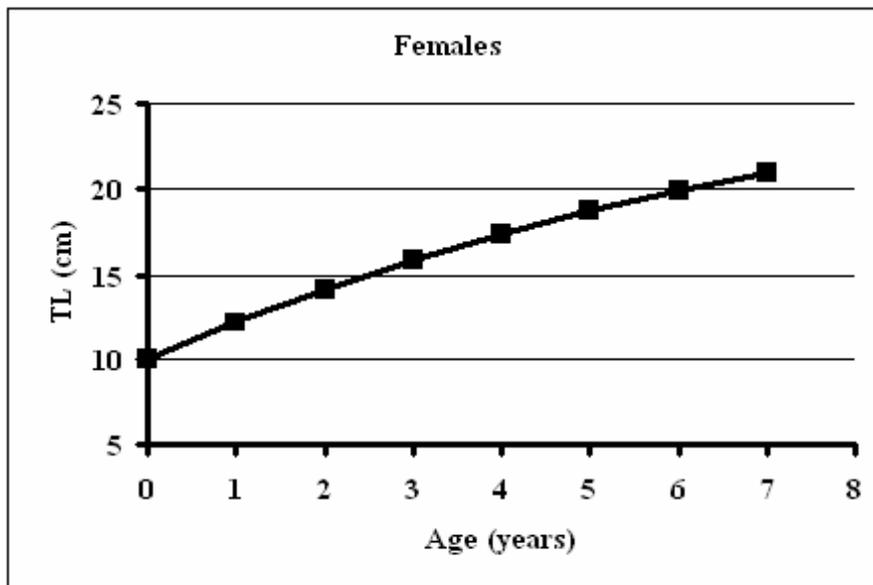
The calculated values of growth parameters are presented in Table 1 as well as graphically at Figures. 2, 3 and 4.

**Table 1. Growth parameters of red mullet by SSE methods**

Sex	$L_{\infty}$ (cm)	s.e.	K	s.e.	$t_0$	s.e.	SD	Ef	r	$r^2$
Males	17.811	0.0003	0.282	0.0004	-3.013	0.0001	0.325	0.2295	0.969	0.985
Females	29.131	0.0001	0.122	0.0006	-3.013	0.0002	0.325	0.1433	0.992	0.996
M+F	30.118	0.0001	0.118	0.0003	-3.181	0.0002	0.271	0.1210	0.995	0.998



**Figure 2. Graphical explanation of growth parameters of males specimens red mullet**



**Figure 3. Graphical explanation of growth parameters of females specimens red mullet**

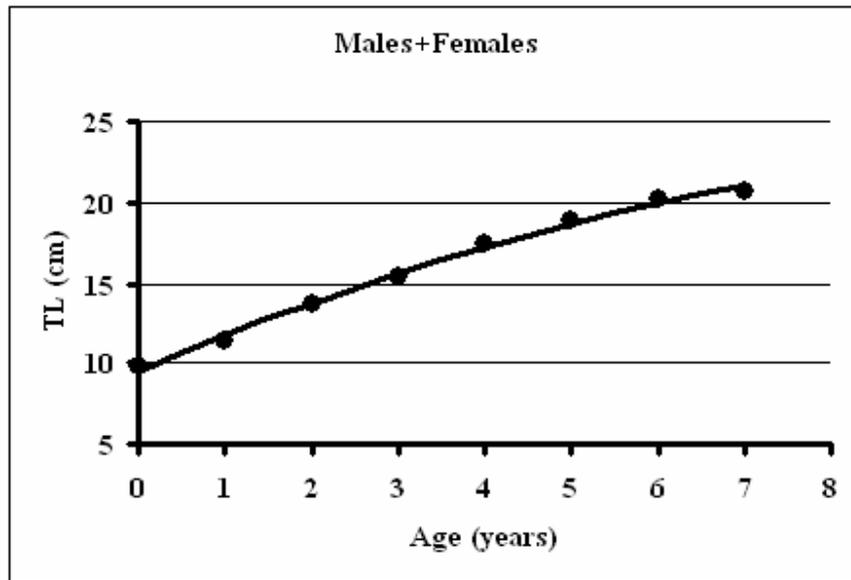


Figure 4. Graphical explanation of growth parameters of males + females specimens red mullet

Table 2. Growth parameters of red mullet by Bhattacharya methods

Sex	$L_{\infty}$ (cm)	s.e.	K	s.e.	$t_0$	s.e.	SD	Ef	r	$r^2$
Males	17.811	0.0003	0.282	0.0004	-3.013	0.0001	0.325	0.2295	0.992	0.994
Females	27.479	0.0001	0.149	0.0451	-2.688	0.0052	0.325	0.1433	0.992	0.996
M+F	30.129	0.0001	0.118	0.0003	-3.182	0.0002	0.325	0.1210	0.969	0.985

Values of growth parameters estimated through the program FISAT (Gayaniilo *et al.* 1995) are presented in Table 2.

After the estimate of quotients a and b of length-weight ratio (Joksimović, 2005) and function parameters, we calculated the weight growth in function of time, according to von Bertalanffy (1934, 1938):

$$W_t = aL_{\infty}^b \left[ 1 - e^{-K(t-t_0)} \right]^b \quad (1),$$

Where  $W_t$  = weight in time t, while a and b are quotients of functions of length-weight ratio. If:

$$W_{\infty} = aL_{\infty}^b, \quad (2),$$

Then:

$$W_t = W_{\infty} \left[ 1 - e^{-K(t-t_0)} \right]^b \quad (3)$$

Therefore, the weight growth of mullet was:

$$W_{\infty} = 0.00773 * 17.811^{3.090} = 56.598 \text{ g, for males,}$$

$$W_{\infty} = 0.00729 * 29.131^{3.118} = 268.279 \text{ g, for females,}$$

$$W_{\infty} = 0.00767 * 30.118^{3.102} = 296.560 \text{ g, for males and females together.}$$

**DISCUSSION**

Estimate of growth rates has shown a pronounced difference in growth between male and female mullet, as males grow quicker than females after the first year of life. The estimated growth parameters  $L_{\infty} = 17.811$  and  $K = 0.282$  (for males) and  $L_{\infty} = 29.131$  and  $K = 0.122$  (for females) supported this hypothesis. The estimates for both sexes together show values  $L_{\infty} = 30.118$  and  $K = 0.118$  (Table 1). All values were estimated with a high correlation quotient.

Comparison of these values and values recorded in other authors' studies in Adriatic and Mediterranean showed certain similarities (Table 3). The values of our estimates fall within the range of values recorded by other authors. The estimated value  $L_{\infty} = 17.811$  for males is clearly the lowest estimated value within all the studies.

During our study we noticed that it was difficult to read the otoliths of the male fish, as they were quite indistinct with poorly visible rings, in contrast to the female fish. It is obvious that males are characterized by uneven, accelerated growth, indicated by the value of quotient  $K$ , which was 2.5 times larger in males than in females. The insignificant differences in the values were probably caused by differences in study areas. We must acknowledge the diverse hydrographic conditions in northern, middle and southern Adriatic, as well as in the other parts of Mediterranean. As this is a benthos species, the composition of sea bottom has a significant impact as well as the organic productivity of the area and intensity of fishing. All these factors have complex interactions and therefore influence the population dynamics of this species.

**Table 3. Literature data about growth parameters of red mullet in the Mediterranean**

Author	Sex	$L_{\infty}$ (cm)	K	$t_0$
Scaccini, 1947	M+F	27.49	0.5	-0.25
Papaconstantinou <i>et al.</i> , 1981 (Jonsko more)	M	19.23	0.191	-2.811
	F	24.4	0.135	-2.941
Jukić i Piccineti, 1988	M+F	27.0	1.8	
Toğulga i Mater, 1992, Izmirski zaliv	M+F	26.47	0.161	-2.701
Ungaro <i>et al.</i> , 1994	M+F	19.70	0.360	-1.18
Vrgoč, 1995 ('Hvar')	M+F	27.75	0.274	-0.616
Marano, 1996	M	27.0	0.184	-1.92
	F	34.5	0.156	-1.53
	M+F	31.5	0.182	-1.45
	M+F (Bhatt.)	26.3	0.45	
Vrgoč, 2000	M+F	26.86	0.295	
Akyol <i>et al.</i> , 2000, Izmirski zaliv	M	22.5	0.202	-2.299
	F	27.0	0.172	-1.844
	M+F	27	0.183	-1.506
Vrgoč <i>et al.</i> , , 2004	M+F	25.65	0.414	

According to the estimated quotients of length-weight ratio  $a$  and  $b$  (Joksimović 2005) and parameters of von Bertalanffy's growth function (Tab. 1) we calculated the weight growth in function of time. For males it is  $W_{\infty} = 56.598$  g, for females  $W_{\infty} = 268.279$  g and for all individuals together  $W_{\infty} = 296.560$  g. There is a highly visible difference in acquiring the maximal weight of males and females, as it is five times greater in females. As this growth estimate includes the value of  $L_{\infty}$ , it explains such a large difference in acquiring the maximal predicted weight of males and females.

The value of Hohendorf index for all mullet specimens was 0.77, and as its value may vary from 0 to 1, it may be concluded that this species has a relatively good growth potential in the study area. As no literature data were found on this index in mullet from other parts of Adriatic and Mediterranean, it was not possible to compare the data.

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