ON THE PATTERN OF CORRELATION BETWEEN THE FECUNDITY, LENGTH, WEIGHT AND AGE OF *MUGIL CEPHALUS* LINNAEUS, 1978 (MUGILIDAE) FROM THE BULGARIAN BLACK SEA COAST

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Abstract: The purpose of this article is to show the correlation between the fecundity, length, weight and age of *Mugil cephalus* Linnaeus from the areas of Bulgarian Black Sea coast. Absolute fecundity varied from a minimum of 423 267 for age 2 (L - 16.9 cm, EW - 51g) to a maximum of 6 002 345 oocytes for age 8 (L - 43.5 cm, EW - 1101 g). The mean fecundity was 305 972 eggs.

Relationship between absolute fecundity and weight and fecundity and length was best described by the following equations: F=492043+4216.6W, r=0.9675 and F =-5000000 + 2359954L, r=0.9614. Fecundity-age relationship was best described by the exponential equation: $F = 77053e^{1.8797}t$, r = 0.90.

The average weighted relative fecundity was 501. A more accurate indicator to describe the relative fecundity is the coefficient **b** from the equation witch F = a+**b***W. For flathead grey mullet the coefficient **b** is 4216.6.

INTRODUCTION

Over the past 50 years, in different periods, studies have been conducted on the biology and monitoring of stock of up to 8-10 Black Sea fish species. Fishing pressure constantly reinforces, the stock is falling down, but officially published data based on research are almost absent.

Mullets are herd fishes. Representatives of this family are distributed in various coastal aquatic habitats of the world's tropical, subtropical and temperate regions (Thomson 1997; Harrison 2003).

MATERIALS AND METHODS

M. cephalus specimens were collected during the period May 2010 – June 2013 from the areas of Bulgarian Black Sea coast (Figure 1). The samples were collected by cast nets fishing - size of the eye 22-38 mm, length 50 m and height of the nets between 1.5 and 2 m.

Fish fecundity was studied on 71 specimens.

Standard length (SL ± 1mm), total Weight (TW ± 1g), gutted (somatic) weight (W ± 1g) and gonad weight (g ± 0.1 g) were measured.

The age was determined by the scales at magnification of 17.5x with Projector Dokumator, Lasergeret (Carl Zeiss, Jena).

As input parameters for the analysis of fecundity the individual total fecundity (the number of mature eggs, ready to be spawned from one individual during one spawning season) and the total fecundity (the average number of eggs of the individuals from one eggs, size or weight group) are used (Anohina 1969, Brilinska, Brilinski 1974, Spanovskaya, Grigorash 1976).

The relative fecundity is measured in two ways:

1. As a relation between the total fecundity and the gutted weight of the fish (Spanovskaya, Grigorash 1976) **RF = F/W**;

2. By the coefficient **b** from the equation **F = a+b*W** (Zotin 1961, Zhivkov 1983).

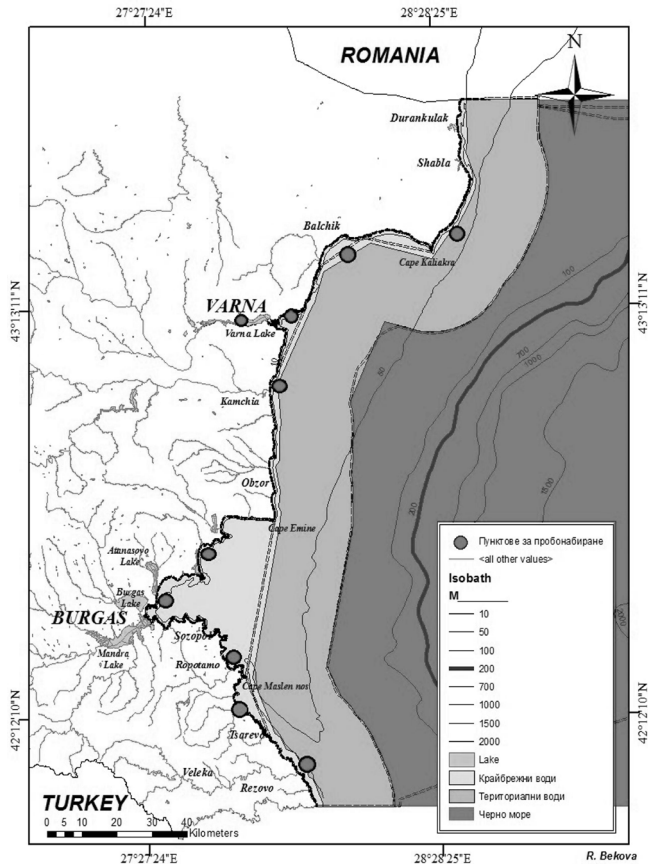Data was statistically processed with MS Excel.

Fig. 1. Sampling area on Bulgarian Black Sea coast (R. Bekova, ARC GIS 10)

RESULTS AND DISCUSSION

The total fecundity for the population of *M. cephalus* from the Bulgarian Black Sea coast varied from 423 267 to 6 002 345 numbers of eggs (Table 1). The average fecundity was 305 972. The individual with the lowest individual fecundity had 16.9 cm length and 51 g weight. The fish with the highest fecundity (6 002 345) had 43.5 cm length and 1101 g weight, but this is not the biggest studied specimen.

The youngest flathead grey mullets was two annual with 590,794 eggs fecundity.

The values of the fecundity increase with increasing the length of fish (Fig. 2).

Table 1. Change of absolute fecundity in different length classes of *M. cephalus* from the Bulgarian Black Sea coast

| Length class (L,cm)	Average length (L,cm)	Absolute fecundity (F, eggs)		n
		Range	Average	
19.1 - 22	20.1	423267 - 700891	679802	3
22.1 - 23	22.4	513704 - 729816	654733	5
23.1 - 24	23.6	713498 - 1324999	899014	11
24.1 - 25	24.5	768554 - 1400972	900327	12
25.1 - 26	25.6	937024 - 1342608	1178340	7
26.1 - 27	26.7	804764 - 1551428	1342587	9
27.1 - 28	27.5	1111230 - 2970468	2154309	5
28.1 - 29	28.5	2100977 - 2489721	2222091	6
32.1 - 36	34.1	2998473 - 4112721	3987596	3
36.1 - 49	43.5	3136798 - 6002345	5 563 423	3
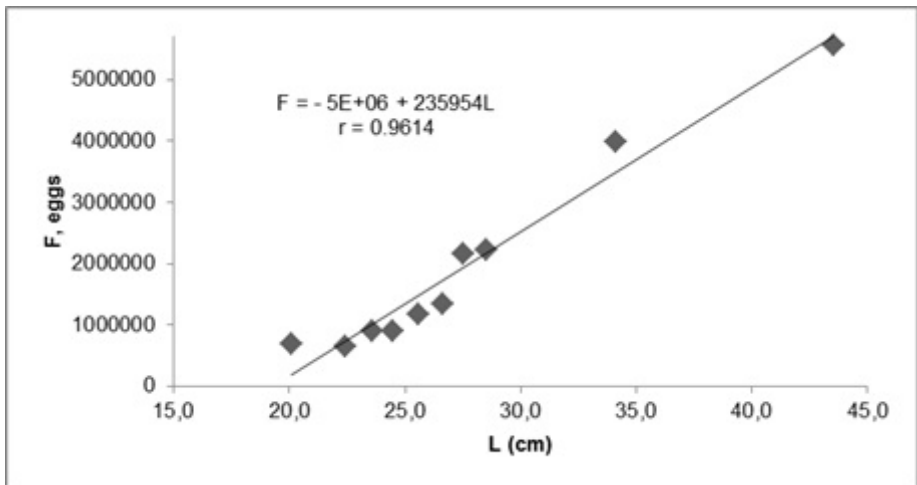
Fig. 2. Relationship between the total fecundity (F) and the average length (L) of *M. cephalus* from the Bulgarian Black Sea coast.

The regression is described by the equation F=-5 000 000 + 235 954L, r=0.9614. A linear regression was established in raising the fish fecundity with the fish weight (F= 492043 + 4216.6W, r = 0.9675), as for the F-L relationship (Fig. 3). In the last weight class are observed the highest average values of the indicator (Table 2). The values of the fecundity increase with increasing the fish age and the most suitable function to describe the relation was the exponential (Fig. 4). The equation to describe this relation is: $F= 22675e^{0.368t}$, r=0.97. The changes of absolute fecundity in different age classes are shown in Table 3.

Besides the size and age of the fish, fecundity also depends on in which path the female involved in spawning process. Usually individuals that reproduce for the first time are characterized by the lower values of the fertility. Probably this is one of the reasons for the big variability of the indicator in some of the studied size, weight and age groups.

Table 2. Change of absolute fecundity in different weight classes of *M. cephalus* from the Bulgarian Black Sea coast

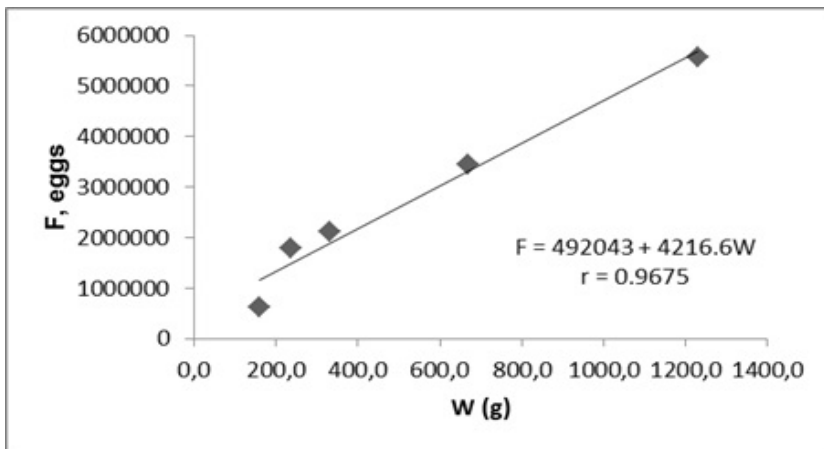| Weight class (g)	Average weight (g)	Absolute fecundity (F, eggs)		n
		Range	Average	
81 - 200	160.6	423 267 – 744 209	631 497	7
201 - 300	236.6	667 421 – 1 898 023	1 789 032	14
301 - 400	331.4	1 400 987 – 3 429 675	2 112 467	12
401 - 800	667.4	2 789 450 – 3 677 596	3 442 676	13
801 - 1500	1231.5	3 412 628 – 6 002 345	5 563 423	9

Fig. 3. Relationship between the total fecundity (F) and the average weight (W) of *M. cephalus* from the Bulgarian Black Sea coast.

Table 3. Change of absolute fecundity (F) in different age classes (t) of *M. cephalus* from the Bulgarian Black Sea coast.

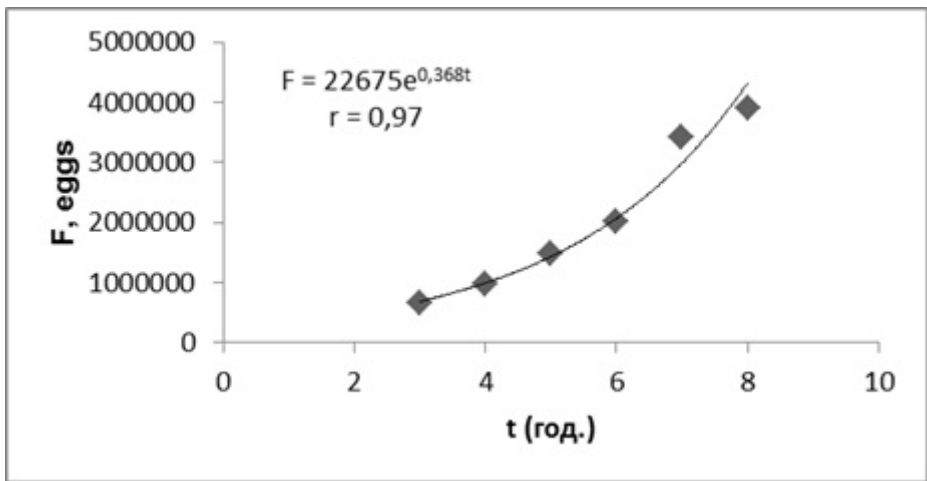| Age (t)	Absolute fecundity (F, eggs)		n
	Range	Average	
3	423 267 – 798 321	665 709	9
4	713 421 – 1 230 751	982 486	20
5	833 649 – 1 672 202	1 472 583	13
6	999 748 – 2 300 463	2 012 763	4
7	1 650 734 –3 821 449	3 412 788	4
8	2 376 741– 4 103 879	3 902 785	8

Fig. 4. Relationship between total fecundity (F) and the fish age (t) of *M. cephalus* from the Bulgarian Black Sea coast

Data about fecundity of flathead grey mullet are presented by Ibanez & Cabello (2004) for the Gulf of Mexico. The range of fecundity is from 540,706 to 1,483,056 numbers of eggs. Such as our values come close to those which are presented by Ibanez & Cabello (2004) and Stoyanov et al. (1963).

The average relative fecundity for the population of *M. cephalus* from Bulgarian Black Sea coast was 501. Its values decreased with increasing the size class (Table 4) due to F-W regression line starting above the beginning of the coordinate system (Fig. 3). Therefore Zhivkov (1999) proposed coefficient **b** (4216.6) from the equation $F = a+b*W$ (Fig. 3) to be used as an index of the relative fecundity. This coefficient shows the average speed of the total fecundity increasing in relation to fish weight and in a very accurately describes the relation between **F** and **W**.

Table 4. Changes of the relative fecundity by weight classes for *M. cephalus* from the Bulgarian Black Sea coast

Age (t)	Absolute fecundity (F, eggs)		n
	Range	Average	
3	423 267 – 798 321	665 709	9
4	713 421 – 1 230 751	982 486	20
5	833 649 – 1 672 202	1 472 583	13
6	999 748 – 2 300 463	2 012 763	4
7	1 650 734 –3 821 449	3 412 788	4
8	2 376 741– 4 103 879	3 902 785	8

The data for the relative fecundity of our study populations of flathead grey mullet cannot be compared with those of other populations of the species, because of missing data from the known to us literature.

CONCLUSIONS

The total fecundity of *M. cephalus* from the Bulgarian Black Sea coast ranged between 423 267 – 6 002 345 number of eggs. The average fecundity was 305 972. The values of the fecundity riced with increasing the fish length, weight and age. The relative fecundity was 501. Due to F-W regression line starting above the beginning of the coordinate system, the coefficient tb from the equation F=a+b*W is more precise index to describe the relative fecundity in *M. cephalus* from Bulgarian Black Sea coast.

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