FORESTRY IDEAS, 2019, vol. 25, No 2 (58): 443–450

MATURATION AND FECUNDITY OF *BARBUS CYCLOLEPIS*, HECKEL FROM THE CHEPINSKA RIVER, MARITSA RIVER BASIN, BULGARIA

Vasil Kolev[1*] and Galerida Raikova[2]

[1]University of Forestry, Faculty of Forestry, Wildlife Management Department, 10 Kliment Ohridski Blvd., 1797 Sofia, Bulgaria. *E-mail: vassilkolev@ltu.bg

[2]'St. Kl. Ohridski' Sofia University, Faculty of Biology, Department of General and Applied Hydrobiology, 8 Dragan Tzankov Str., 1164 Sofia, Bulgaria. E-mail: galerida@abv.bg

Received: 17 April 2019 Accepted: 27 November 2019

Abstract

The set of reproductive parameter estimates, determined by this study, gives the first quantitative estimates for this population. The study was conducted in the autumn during the period of years 2010–2011. A total of 97 fish specimens were caught by electrofishing. The study found that both sexes mature sexually in the second year. The females become sexually mature, once they reach a length of 122 mm and 25 g weight. The males become sexually mature once they reach a length of 90mm and 7 g weight. The fecundity of barbel population from the Chepinska River ranges from 2000 to 17,969 eggs. The average fecundity was 5246 eggs. The absolute fecundity was positively correlated with the growth of the length and mass of the fish. Consequently, the five years old Maritsa barbels had the highest fecundity rate. The average values of the relative fecundity were 115 eggs per kg.

Key words: *Barbus cyclolepis*, Chepinska River, fecundity, sex composition.

Introduction

The Maritsa barbel (*Barbus cyclolepis* Heckel, 1937) is an endemic species for the Balkan Peninsula. It is found in watercourses of the Aegean watershed as well as in some rivers of the Black Sea watershed (Chichkov 1935, Heckel 1937, Kottelat and Freyhof 2007). This is the most abundant fish species in the middle zone of the Maritsa River tributaries including the Chepinska River (Kolev 2013, 2016). The Maritsa barbel is not a commercial fish, but it is one of the most popular sports fishes in Southeastern Bulgaria. The fish is included in Council Directive 92/43/EEC/ 21.05.1992 Annex II (as *B. plebeus*).

The first study of the fish's breeding season in the Maritsa water basin of Bulgaria was conducted by Mihaylova (1965). Almost twenty years later Marinov (1986) published data about the spawning season and fecundity of the barbels in the rivers: Chepinska, Mesta, Struma and Stroumeshnitsa. Recent studies of the it's

reproductive biology, sex composition, maturity and fecundity in the Bulgarian stretch of the Maritsa River was undertaken by Rozdina (2009), Raikova-Petrova and Rozdina (2012). In Northern Greece the species has been examined by Vasiliou and Economidis (2005), the sex composition and the reproduction being described. However, the research has not yet explored the maturation and fecundity of the Maritsa barbel fish, inhabiting the Bulgarian tributaries of the Maritsa River.

The aim of this research was to study sex composition and the fecundity distribution, according to age and sex distribution of the Maritsa barbel in the Bulgaria rout of the Maritsa (or Evros) River.

Study area

The study area includes the Chepinska River, a right tributary of the Maritsa River. Chepinska River originates in the West Rhodopes Mountains; its springs are located underneath the peak Mala Siutkia (2078.7 m a.s.l.) (Fig. 1). In its upper reaches the river flows to the Northwest and is called Bistritsa. Once it reaches the town of Velingrad the river runs northwards and near the village of Vetren it enters the Upper Thracian Valley. Chepinska River flows into the Maritsa River near the village of Kovachevo (close to the town of Pazardzhik). The Chepinska River is 81.7 km long with a catchment area of 899.6 km^2.

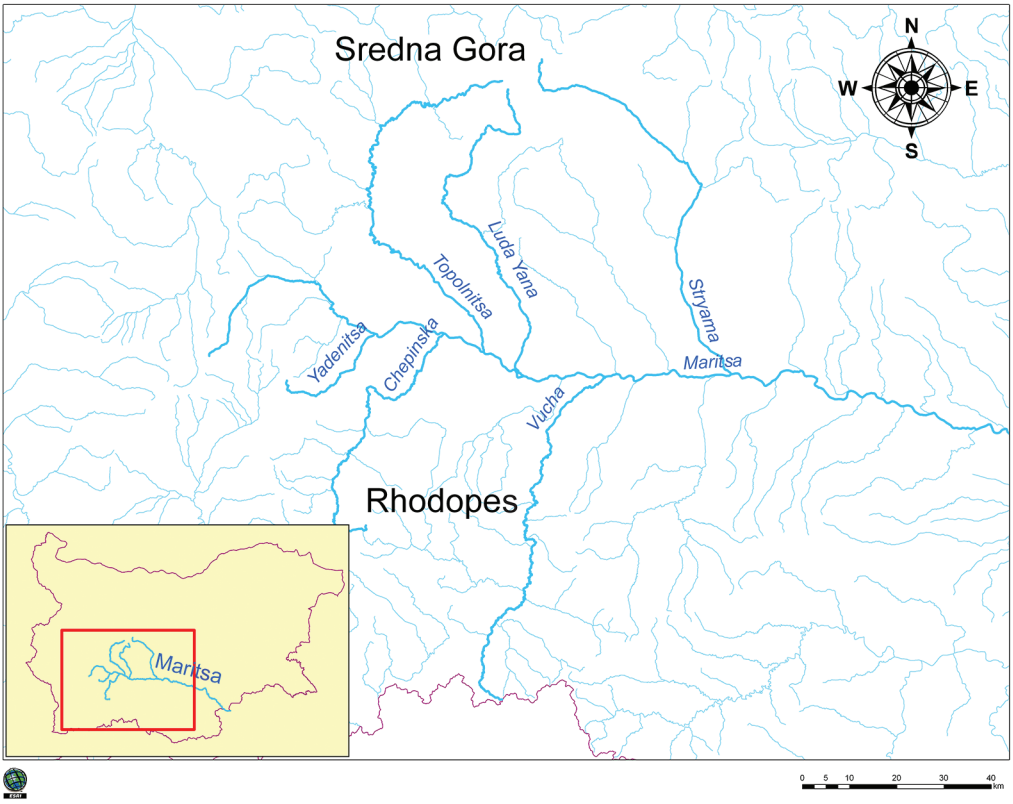

Fig. 1. Location of the Chepinska River, Arc Map 10.0 (ESRI – ArcGIS 2013).

Materials and Methods

The specimens for this study were collected from seven sampling sites (Table 1).

The specimens were collected in the 2010–2011. A total of 97 Maritsa barbel specimens were caught in the Chepinska River by using the method of electrofishing. A SAMUS 725G converter was used, providing up to 640 V direct current (DC), with a frequency of 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).

Table 1. Sampling sites.

No	Location	Geographic coordinates		Altitude, m a.s.l.	Date of sampling
		N	E		
1	In the vicinity of the mineral baths of the village of Varvara	42°07'42,02"	24°07'24,53"	401	13.06.2010
2	In the vicinity of the railway station M. Nikolov	42°06'24,78"	24°06'20,11"	465	14.06.2010
3	In the vicinity of the mineral baths of the village of Varvara	42°07'42,02"	24°07'24,53"	401	26.07.2010
4	In the vicinity of the village of Draginovo	42°05'43,81"	24°04'54,82"	523	27.07.2010
5	In the vicinity of the railway station M. Nikolov	42°06'24,78"	24°06'20,11"	465	08.04.2011
6	In the vicinity of the village of Draginovo	42°05'43,81"	24°04'54,82"	523	09.04.2011
7	In the vicinity of the village of Lozen	42°11'09,62"	24°09'45,65"	240	18.11.2011

The standard length (*SL*), to the end of the scales cover with a precision 1 mm and specimen's net weight without guts (*NW*) were measured with a precision 1 g. The sex was determined microscopically.

Scales were used to determine the age. It was reported by counting the annual rings of the scales. The number of fish eggs was counted by using the weighting method. In 1 g of gonads, the eggs were counted by using a counting chamber. Both operations were performed with a microscope Olympus CX 31, at a 40× magnification.

The maturity was determined by the coefficient *b* from the equation: $g = a+b \times W$, recommended by Morozov (1964) and Zhivkov (1985) which describes the relationship between the gonads' mass (g) and the mass of a fish without its entrails (*NW*).

The relative fecundity (*RF*) was explained directly by the ratio of fishless gut (*F*/*NW*) (Spanovskaya and Grigorash 1976). Another method to determine the *RF*, proposed by Zotin (1961) and Zhivkov (1999), was also used. According to this method the coefficients *a* and *b* were calculated from the equation: $F = a + b \times NW$ (the equation reveals the dependence between absolute fecundity – *F* and *NW*).

Results

Table 2 presents the age and sexual composition of the Maritza barbel population in the Chepinska River. The sample included five age groups. Three and four years old barbels were the most abundant.

The average sex ratio was ♂:♀ 1.5:1. This difference was not statistically significant, d = 1, calculated χ^2 = 2.48, χ^2critical = 3.83 – the value over which the null hypothesis H_0 (i.e. ♂:♀ 1:1) must be rejected; $P < 0.005$, thus, the sex ratio did not differ from the normal ♂:♀ 1:1. Figure 2 shows the relationship between fecundity and length of the body to the end of the scales cover.

Table 2. Sex composition.

Size class *SL*, mm	Age, years													*n*	%
	1			2			3			4		5			
Sex	juv.	♂	♀	juv.	♂	♀	juv.	♂	♀	♂	♀	♂	♀		
61–70	1													1	1
71–80				9	2		5	1						17	18
81–90					3		8	4						15	16
91–100							15	8		6				29	30
101–110							1	4		4				9	9
111–120								2						2	2
121–130										1			2	3	3
131–140											1		1	2	2
141–150											1		10	11	11
151–160													5	5	5
161–170													2	2	2
171–180													1	1	1
Sum	1	0	0	9	5	0	29	19	0	11	2	0	21	97	100
% of the total number of fish	100	0	0	69.2	38.5	0	60.4	39.6		85	15	0	100		
♂:♀		0	0		100	0		100	0	85	15	0	100		

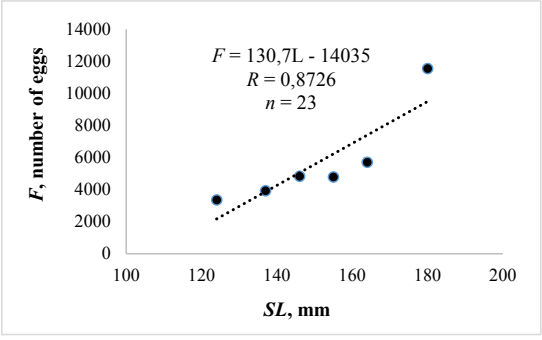

Fig. 2. Relationship between the absolute fecundity (*F*) and the standart length (*SL*).

This relationship is described by a linear equation with a high degree of reliability. As the length was increasing, absolute fecundity was also increasing. The individual fecundity of the Maritsa barbel was between 2000 and 17,969 eggs. The average individual fecundity rate was 5246 eggs. These results have been obtained from 23 specimens with a length between 122 mm and 183 mm. The most fertile female barbel, found in the sample, was a five years old fish,

183 mm in length and weighing 88 g. Its fecundity was 17,969 eggs. In the sample, the specimen with the lowest fecundity of 2000 eggs was a three-year-old female, 147 mm long and weighing 40 g.

The average absolute fecundity of the Maritsa barbel in different length classes is shown in Table 3.

Table 3. Change of absolute fecundity by length classes.

Length class (*L*), mm	Average length, mm	Range, number of eggs	Average (*F*), number of eggs	*n*
121–140	132	3350 – 4896	3711	5
141–160	148	2000 – 7560	4826	14
161–180	168	2652 – 8784	5522	3
181–190	183	17 969	17 969	1

The average *F* increases naturally with increasing of the body length. In the weight class 181–190 mm it is very high.

In Figure 3 is present the relationship between *F/ NW* of the Maritsa barbel from the Chepinska River.

It was very well expressed by a linear equation with very hight degree of signification (R = 0.9746). The graph shows that fecundity is positively correlated with the weight of the fish. This results confirms the suggestion of several authors (Nikolsky 1965, 1974; Zhivkov 1999) that the main factor which increase fecundity according to the fish growth in weight.

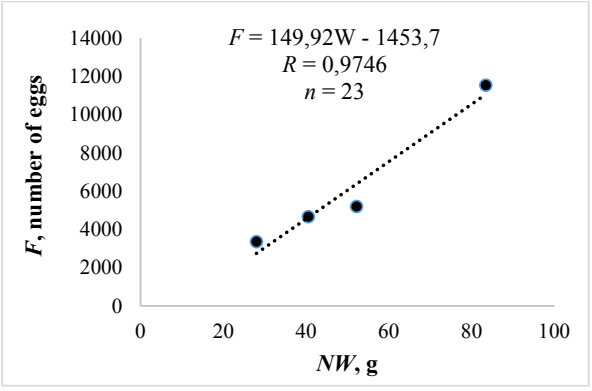

Fig. 3. Relationship between the absolute fecundity (*F*) and the averave net weight (*NW*).

In Table 4 the absolute fecundity of the Maritsa barbel from the Chepinska and Maritsa Rivers were compared according Zhivkov's (1999) method. This method is very appropriate for comparing the fecundity of fish from different watercourses.

Table 4. Absolute fecundity (*F*) of the Maritsa barbel calculated at same Weight (*NW*).

Author (year), (river)	*F*/*NW* Relationship	Net weight (*NW*), g Absolute fecundity (*F*), number of eggs				
		12	25	50	100	200
Aur data (2015–2016), (Chepinska River)	$F = 149.92NW - 1453.7$; $r = 0.9746$, $n = 23$	345	2294	6042	13 538	28 530
Rozdina (2009), (Maritsa River)	$F = 81.33NW + 2203.3$; $r = 0.99$, $n = 61$	3179	4237	6270	10 336	18 469

The result shows that the absolute fertility of the barbel in the Maritsa River is greater than in the Chepinska River in the first three weight classes. An increase in the fecundity occurs with larger specimens.

The relationship between *F* and age showed an increase in absolute fecundity according to age (Fig. 4).

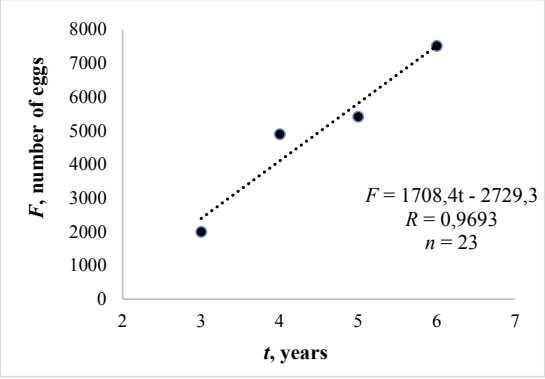

Fig. 4. Relationship between total fecundity (*F*) and age (*t*).

Table 5 shows the changes of the relative fecundity of the Maritsa barbel according to size and weight.

Table 5. Relative fecundity (*RF*) of Maritsa barbel from the Chepinska River.

Size classes (*NW*), g	Weight (*NW*), g	*RF*, number of eggs	*n*
11.0–30.9	28	120	2
31.0–50.9	40.5	115	15
51.0–70.9	52.2	100	4
71.0–90.9	83.4	138	2
Average and sum	-	115	23

Discussion

Barbel population from the Chepinska River is relatively young. Six, seven and eight adult barbels were absent. The smallest sexually mature specimens found was a two-year-old male, over 90 mm in length. Female's fish in Chepinska River developed sexually at the earliest in the fourth year. The smallest sexually mature female captured was 122 mm in length. Males are more numerous in the first three age groups. Vasiliou and Economidis (2005) reported that in the Doirani River the Maritsa barbel males start mature in the second year, while the females in their third years. According to Raikova-Petrova and Rozdina (2012) in the Maritsa River both sexes start mature in their second year. The same authors also found the smallest sexually mature male in Maritsa River and it was 55 mm in length and the smallest sexually mature female was 63 mm long. In the both rivers Doirani and Maritsa, the Maritsa barbel reaches an older age than in the Chepinska River. In the Doirani River 9 age groups were found (Vasiliou and Economidis 2005), while in the Maritsa River – 8 age groups were established respectively (Raikova-Petrova and Rozdina 2012). The absence of 6, 7, 8 and 9 age groups in the population in the studied Chepinska River shows that this species is under strong pressure from the sport fishing.

The comparison of the *F*, calculated for the same weight, showed that for fish weighing up to 50 g, the fecundity of the Maritsa barbel from the Chepinska River is lower than that of a barbel from the Maritsa River (Table 4). Simular result was obtained by comparing the coefficient *a* from the equation $F = a + b \times NW$ (Zotin 1961, Zhivkov 1999), described

the fecundity-mass ratio of the barbels from both rivers. The coefficient *a*, the so-called 'initial fecundity', from the equation for the Chepinska River in absolute value is *a* = 1453.7; while this from the equation for the Maritza River is *a* = 2203.3.

The main flow of the Chepinska River and its tributaries (the Matnitsa River) passes through many villages and cities. Therefore, the industrial and domestic pollution of the waters is very high after the town of Velingrad (Tsachev et al. 1977, MOEW 2012) and it deteriorates the living conditions. In the lower stretch of the river, the steel processing plant of the village of Varvara has built water basins in order to meet its needs. A quarry for aggregates was also built right inside the river bed. These modifications of the river bed drastically reduce the water runoff in the lower stretch of the Chepinska River, before its confluence with the Maritsa River, and disturb the migration. Considering that the rate of fish growth is a reflection of the living conditions (Nikolsky 1965, 1974; Zhivkov 1999), the anthropogenic disturbance has also impacted the growth of the species in the Chepinska River.

Average fecundity of Maritsa barbel in the Chepinska River increased with an augmentation of the length (Table 3). In the last size class, the average *F* increased rapidly. At length of over 181 mm, the value of the individual fecundity was more than three times higher than that in the other size classes.

Some authors like Vasiliou and Economidis (2005), Raikova-Petrova (1992), Rozdina (2009), Raikova-Petrova and Rozdina (2012) established that older Maritsa barbels produce more eggs due to its higher weight. Our results (Figure 4) also confirm that with increasing body mass, absolute fertility increases.

RF of the barbels from the Chepinska River decreases with increasing the weight. Only in large fish, weighing over 71 g, it increases. Similar results have been obtained for this species also from other authors – Rozdina (2009), Raikova-Petrova and Rozdina (2012).

Conclusions

Male Maritsa barbels become sexually mature during the second year. The females reach sexual maturity after the second year. In October and November the barbels have already spawned. During these months, the Maritsa barbel has already formed the new caviar for the next year. The caviar in this period is much smaller than the breeding period and is greyish in color.

The absolute fecundity varies between 2000 and 17,969 eggs. The average individual fecundity rate is 5246 eggs. The sex ratio does not differ from the normal sex ratio of 1:1. The average relative fecundity is 115 eggs per kg female fish.

The set of reproductive parameters estimated, determined in this study, provides the first quantitative estimates for this population and will improve the scientific knowledge about the reproductive potential of the Maritsa barbel. The improved understanding of the population status will also hopefully lead to a more sustainable management of this endemic and protected fish.

References

ArcGIS 2019. My Map. Available at: http://www.arcgis.com/home/webmap/viewer.html

Chichkov G. 1935. About a little-known barbell. Excerpt from the Yearbook of University of Sofia, Faculty of Physics and Mathematics,

Volume XXXI, book 3 (Natural sciences), 1934/1935: 316–330 (in French).

Council Directive 92/43/EEC of 21 May 1992 on the conservation of natural habitats and of wild fauna and flora. Official Journal of the European Communities L 206, 22.7.1992: 7–50.

Heckel J. 1937. About the families Cottoiden, Scorpaenoiden, Gobioiden und Cyprinoiden. Ichthyologic. Contributions: 155–156.

Kottelat M., Freyhof J. 2007. Handbook of European Freshwater Fishes. Kottelat, Cornol, Switzerland and Freyhof, Berlin, Germany. 646 p.

Kolev V. 2013. Species composition of the ichthyofauna of some tributaries of the Maritsa River. Forestry ideas 19(2): 129–139.

Kolev V. 2016. Status of Maritsa barbel (*Barbus cyclolepis* Heckel, 1937) and Maritsa chub (*Squalius orpheus* Kottelat & Economidis, 2006) populations in some of the Maritsa River tributaries and possibilities for their future management. PhD thesis, University of Forestry – Sofia, Department of Wild life management. 159 p. (in Bulgarian).

Marinov B. 1986. Taxonomy, binomial and faunistics of some species of the family Cyprinidae and Cottidae (Pisces) from Bulgaria. PhD thesis, 'St. Kliment Ohridski' Sofia University, Department of General and Applied Hydrobiology: 46–76 (in Bulgarian).

Mihaylova L. 1965. On the ichthyofaunal of Trakia. Fauna of Trakia. Part II. BAS, Zoological institute with museum: 265–289 (in Bulgarian).

Ministry of Environment and Waters (MOEW) 2012. Regional Inspectorate of Environment and Water (RIEW), town of Pazardzhik. Annual report on the state of the environment. 157 p.

Morozov A. 1964. About coeficient of the maturity of fish. Voprosii Ichthyologii 4(33): 757–762 (in Russian).

Nikolsky G. 1965. Theory of fish population. Dynamics as the biological background for Rational Exploitation and Management of Fishery Resources. Nauka, Moskva: 80–115 (in Russian).

Nikolsky G. 1974. The ecology of fishes. Moskva High school. 367 p. (in Russian).

Raikova-Petrova G. 1992. Comparative population biology of the Pikeperch (*Stizostedion lucioperca* L.) in Batak and Ovcharitsa Dams. PhD thesis. Institute of zoology, Bulgarian Academy of Sciences. 181 p. (in Bulgarian).

Raikova-Petrova G., Rozdina D. 2012. Maturation and fecundity of *Barbus cyclolepis* Heckel from the middle stream of Maritsa River, Bulgaria. In: Proceeding Ecology – Interdisciplinary Science and Practice, part two: 569–575.

Rozdina D. 2009. Population biology of the Maritsa barbel (*Barbus cyclolepis* Heckel) from the middle stream of the Maritsa River. PhD thesis, 'St. Kliment Ohridski' Sofia University. 126 p. (in Bulgarian).

Spanovskaya V., Grigorash V. 1976. The methodology for determining fecundity in fish that spawns many times per year and for fish that spawn once per year. Type methods for the study the fish fertilities within their area, Vilnius. Mintis. part II: 54–62 (in Russian).

Tsachev T., Ivanov K., Peichinov D., Totev I. 1977. Pollution of rivers in Bulgaria with organic substances. Bulgarian Academy of Sciences: 88–100.

Vasiliou A., Economidis P. 2005. On the life-histoy of *Barbus peloponnesius* and *Barbus cyclolepis* in Macedonia, Greece. Folia Zoologica 54(3): 316–336

Zhivkov M. 1985. Fish sex products maturity indicators. Bulgarian Academy of Sciences. Hydrobiology 24: 3–12 (in Bulgarian).

Zhivkov M. 1999. Factors, patterns and methodological importance of the population biology variability of the freshwater fishes. DSc thesis. Institute of zoology, Bulgarian Academy of Sciences. 406 p.

Zotin A. 1961. The relative fecundity of fish and egg size. Voprosy Ichthyologii 2(19): 307–313 (in Russian).