

**REPRODUCTIVE BIOLOGY OF THE TIGRIS SCRAPER,  
CAPOETA UMBLA (HECKEL, 1843) POPULATION  
LIVING IN SOLHAN CREEK OF MURAT RIVER (BİNGÖL, TURKEY)**

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**KEYWORDS:** *Capoeta umbla*, reproductive cycle, maturity, fecundity, Solhan Creek.

**ABSTRACT**

We studied the reproductive traits in 23 of 190 individuals of *Capoeta umbla* caught monthly in the Solhan Creek of the Murat River between April 2017 and March 2018. The sex ratio (F:M) was found to be 1:1.11. The macroscopic examination of the gonads and gonado-somatic index indicated that the reproductive period lasted from May to August with peak activity in May. The fecundity ranged from 2,000 to 9,000 oocytes, and it correlated with the total length and body weight. This work represents the first attempt to investigate the reproductive traits of the *Capoeta umbla* population in the Solhan Creek. The results provide information on the reproductive biology and contribute to the conservation of the fish population and its sustainable management.

**RÉSUMÉ:** Biologie reproductive du grattoir du *Capoeta umbla* (Heckel, 1843) population vivant à Solhan bras de mer de la rivière Murat (Bingöl, Turquie).

Sur 190 individus de *Capoeta umbla* capturés chaque mois dans le ruisseau Solhan et la rivière Murat entre avril 2017 et mars 2018, les aspects reproductifs de 23 individus ont été étudiés. Le sex-ratio (F:M) était de 1:1,11. L'examen macroscopique des gonades et de l'indice gonado-somatique ont indiqué que la période de reproduction dure de mai à août avec un pic d'activité en mai. Les estimations de la fécondité variaient de 2.000 à 9.000 ovocytes, et elles ont été considérées comme corrélées avec la longueur totale et le poids corporel. Ce travail représente la première tentative d'étudier les aspects reproductifs de la population de *Capoeta umbla* à Solhan Creek. Les résultats fournissent des informations fondamentales sur la biologie de la reproduction et contribuent à la conservation de la population de poissons et à sa gestion durable.

**REZUMAT:** Biologia reproductivă a populației de *Capoeta umbla* (Heckel, 1843) care trăiește în Pârâul Solhan al Râului Murat (Bingöl, Turcia).

Din 190 de indivizi de *Capoeta umbla* capturați lunar în pârâul Solhan al râului Murat, între aprilie 2017 și martie 2018, au fost studiate aspectele reproductive la 23 dintre ei. Raportul pe sexe (F:M) a fost găsit ca fiind 1:1,11. Examinarea macroscopică a gonadelor și a indicelui gonado-somatic a indicat faptul că perioada de reproducere durează din mai până în august, cu activitate maximă în luna mai. În ceea ce privește fecunditatea, numărul ovocitelor a variat între 2.000 și 9.000, și s-a văzut că este corelat cu lungimea totală și greutatea corporală. Această lucrare reprezintă prima încercare de a investiga aspectele reproductive ale populației de *Capoeta umbla* din Pârâul Solhan. Rezultatele oferă informații fundamentale despre biologia reproducerii și contribuie la conservarea populației de pești și la gestionarea durabilă a acesteia.

## INTRODUCTION

Fish around the world are significantly impacted by direct or indirect human impact, and they have a decreasing ecological trend due to this impact (Sheridan, 2008; Trichkova et al., 2009; Jeeva et al., 2011; Khoshnood, 2014; Sosai, 2015; Gebrekiros, 2016; Kar and Khyriam, 2020; Radkhah and Eagderi, 2020; Reynaldo de la Cruz, 2020; Rios, 2021; Su et al., 2021).

Studies on the reproductive biology of fish are important to plan better conservation and management strategies of fishery resources (Grandcourt, 2009; Muchlisin et al., 2010). Reproductive biological traits play a basic role in fishery management (Miller, 1984; Komalefe and Arawomo, 2007). Knowledge of the length of the fish at first maturity and spawning season is essential for local authorities to set the suitable fish length and time for fishing (Dinh, 2018). Fecundity is among the most important aspects of fish biology, which must be understood to explain the variation in the population level as well as to make efforts to increase the fish harvest (Das et al., 1989). Determining the fecundity and the development of sexual maturity in fish is fundamental to fishery science (Brown et al., 2003). In fish biology, the analysis of life history traits related to reproduction has mainly focused on females, in part because the offspring production is limited to a greater degree by the egg production, rather than by the sperm production (Helfmann et al., 1997; Murua and Saborido-Rey, 2003).

The genus *Capoeta*, Cyprinidae, is distributed in southern China, northern India, Turkmenistan, Lake Aral, the Middle East, and Anatolia (Bănărescu, 1999). Its representatives inhabit mainly fast flowing streams and rivers and are also found in lakes and springs (Turan et al., 2006). Freyhof (2014) and Esmaceli et al. (2016) reported the presence of *Capoeta umbla* in Iran (Tigris River basin), Iraq, Syria, and Turkey (Asian part) and listed it in the Least Concern (LC) category. *Capoeta umbla* is called black fish, Zeruke, sarı balık, or Siraz (Turkish) (Türkmen et al., 2002; Çiçek et al., 2016). Some investigations regarding various biological traits of *Capoeta umbla* have been carried out in Tercan Dam Lake and Tuzla River (Gül et al., 1996), Hazar Lake (Yüce and Şen, 2003), and the Ceyhan Dam Lake (Kara et al., 2010).

*Capoeta umbla* is the most commercially valued fish for the local people around the Murat River. Since the current work has been carried out on *Capoeta umbla* in the Murat River and its creeks, some general data regarding the reproduction of this species in the Solhan Creek are presented here. Accordingly, this study aims to enrich the knowledge on the reproductive traits of *Capoeta umbla*, such as the sex ratio, reproductive season, fecundity, and its relationship with total length and total weight, which may be used for fishery management.

## MATERIAL AND METHODS

The Solhan Creek is one of the important branches feeding the Murat River and is located in upper Fırat of Eastern Anatolia (Kılıç, 2015). This creek is 39 kilometers from Bingöl City.

For each fish, the total length (TL) was approximated to the nearest mm and the total weight (TW) to 0.1 g. The sex (male, female) and gonads were analysed macroscopically and the gonad weight (GW) was approximated to 0.01 g. The maturity stages of the gonads were determined with reference to the universal scale, considering five stages in accordance with Holden and Raitt (1974) (Tab. 1). Fish with gonads at stage greater than or equal to three were considered mature (Fontana, 1979).

Table 1: A five-point maturity scale for partial spawners.

Stage	State	Description
I	Immature	Ovary about 1/3 length of body cavity. Ovaries pinkish, translucent. Eggs not visible to naked eye.
II	Maturing	Ovary about 1/2 length of body cavity. Ovary pinkish, translucent. Eggs not visible to naked eye.
III	Ripening	Ovary and testis are about 2/3 length of body cavity. Ovary pinkish-yellow colour with granular appearance. No transparent or translucent eggs visible.
IV	Ripe	Ovary from 2/3 to full length of body cavity. Ovary orange-pink in colour with conspicuous superficial blood vessels. Large transparent, ripe eggs visible.
V	Spent	Ovary shrunken to about 1/2 length of body cavity. Walls loose. Ovary may contain remnants of disintegrating opaque and ripe eggs, darkened or translucent.

The sex ratio is defined as the proportion of each sex, determined by macroscopic observation of gonads in a given population (Avşar, 2016). The principal hypothesis supposes that there is equal sex ratio. This was evaluated with a chi-square test ( $\chi^2$ ) (Sümbüloğlu and Sümbüloğlu, 2019).

To quantify the changes in the gonad weight during the annual sexual cycle and to determine the spawning season, we calculated the gonad-somatic index (GSI) for 190 specimens (90 females and 100 males) by the following formula:  $GSI = (GW/SW) \times 100$ , GW: gonad weight (g), SW: somatic weight (g) (body weight minus gonad weight) (Avşar, 2016).

The gravimetric or weight method has been successfully used by Doha and Hye (1970), Bagenal and Braum (1978), Shafi et al. (1978), Dewan and Doha (1979), Sarker et al. (2002). It offers the best possibility of minimizing errors owing to its simple and easy sampling techniques. This method has been used for its greater efficacy compared to the other methods (Bitty Blanchard et al., 2003). The gravimetric method was applied as follows: before estimating the fecundity, a sample of 0.1 g was taken separately from the anterior, posterior, and middle region of the lobe of each ovary and weighted.

The fecundity (F1) was estimated by using the following equation (Yeldan and Avşar, 2000):

$$\text{Fecundity (F1)} = \frac{\text{No. of eggs in sub sample} \times \text{Gonad weight}}{\text{Weight of sub sample}}$$

Then, by taking the mean number of three sub-sample fecundities (F1, F2, and F3), the individual fecundity for each female fish was calculated by the following equation:

$$\text{Fecundity (Fe)} = \frac{F1 + F2 + F3}{3}$$

The total length and body weight of fish were estimated to establish a mathematical relationship with fecundity:  $F = a.L^b$ , where  $F$  = fecundity (dependent variable),  $L$  = total fish length (cm); and the regression equation:  $F = a + b (W-GW)$ , where  $F$  = Fecundity,  $GW$  = gonad weight (g),  $W$  = total fish weight (g),  $a$  = regression constant, and  $b$  = regression coefficient (Bagenal and Braum, 1987; Avşar, 2016).

## RESULTS AND DISCUSSION

A total of 190 specimens were examined in our study. The macroscopic study of gonads showed that the sample consisted of 90 females and 100 males (Figs. 1a-b).



Figure 1a: Female gonads.



Figure 1b: Male gonads.

The gonado-somatic index indicated that the reproductive period lasted from May to August with peak activity in May. The highest average values of GSI were found in May, 11.57 and 11.74 for male and female respectively, while the lowest average values were in July (1.93), respectively (Fig. 2).

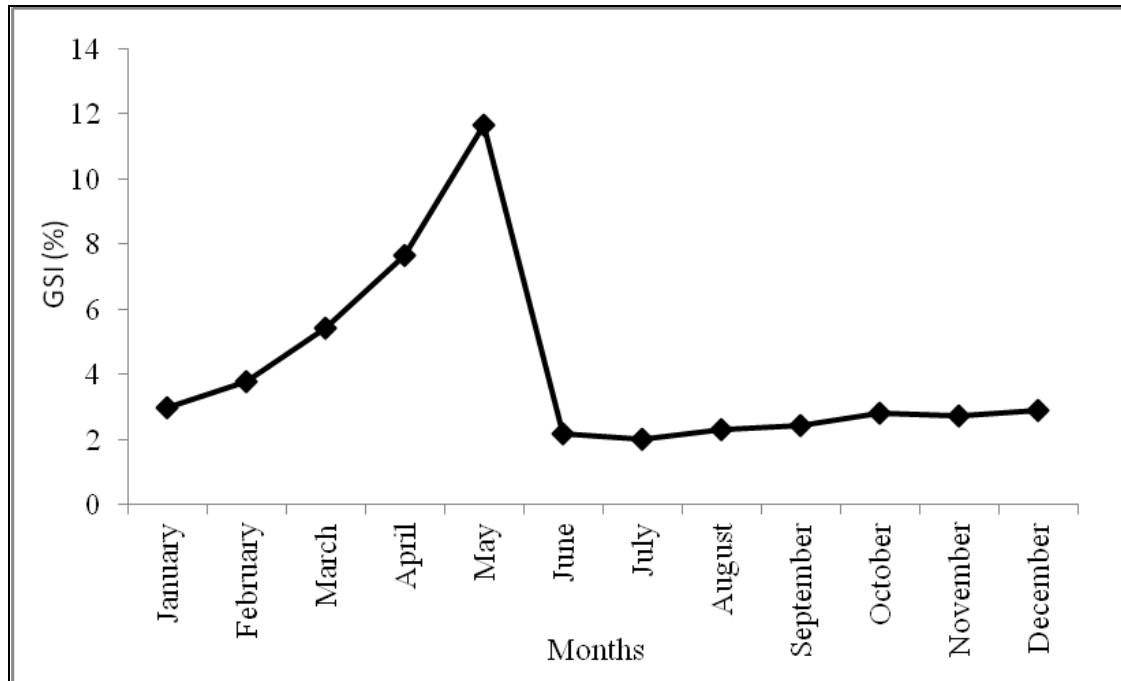


Figure 2: Gonadosomatic index of *Capoeta umbla* in the Solhan Creek in the Murat River according to months.

The fecundity of 169 mature female fish was estimated within the range from 2,000 to 9,000 oocytes for the corresponding total length and body weight of the fish: from 19.5 cm and 76.00 g to 32.2 cm and 333 g, respectively.

The exponential relationship between the fecundity and total length was expressed as  $F = 1.421 \times TL^{2.527}$  ( $R^2 = 0.463$ ) (Figs. 3a-b).

The diagram obtained from the fecundity and body weight showed a positive linear relationship that was expressed as  $F = 2107TW + 1858$  ( $R^2 = 0.390$ ).

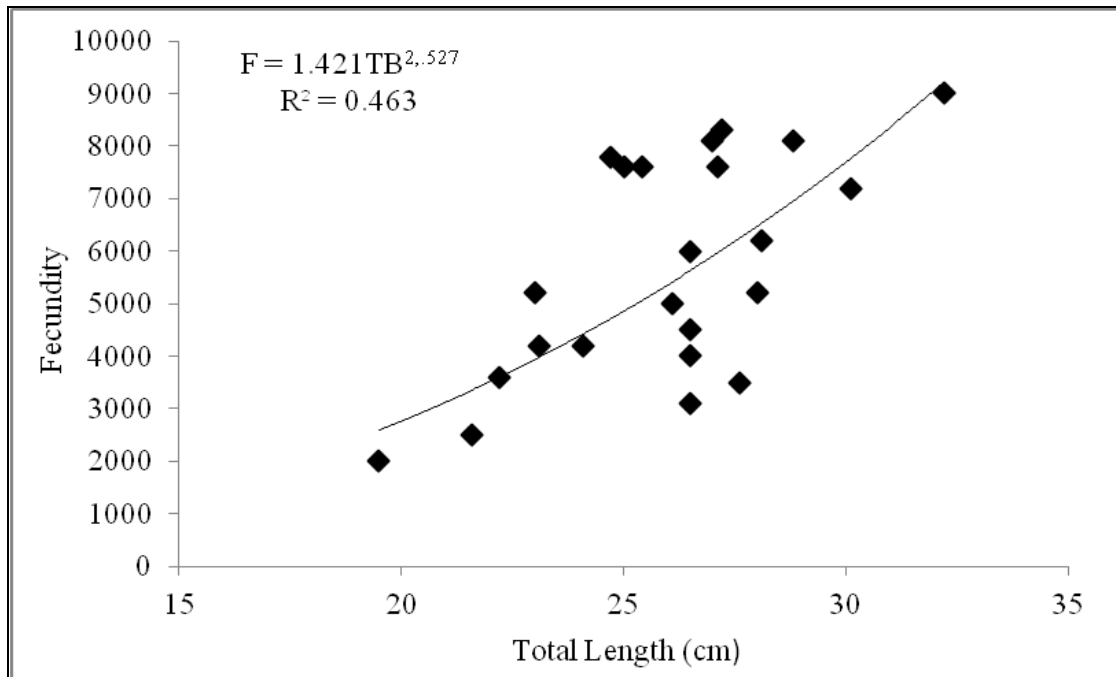


Figure 3a: Relationship between fecundity and total length of *Capoeta umbla* in the Solhan Creek of the Murat River.

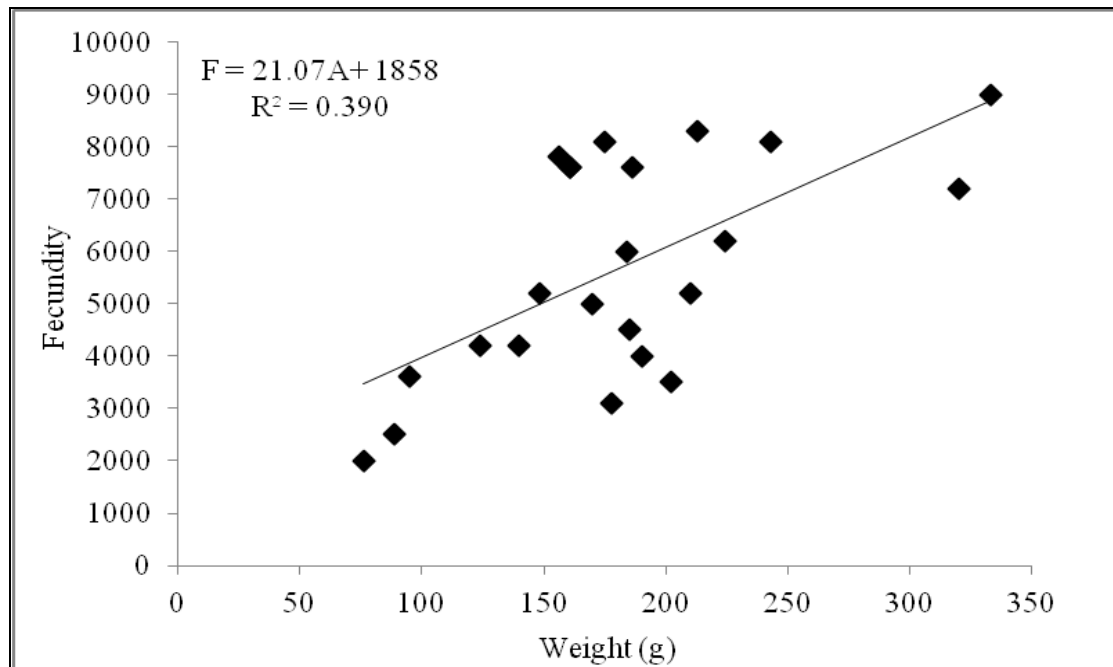


Figure 3b. Relationship between fecundity and weight of *Capoeta umbla* in the Solhan Creek of the Murat River.



The spawning season exhibited a different pattern in other areas (Tab. 3). It may be said that the starting and finishing time of reproduction might include different months because of the ecological and climatic conditions. The spawning cycle is closely related to temperature. The spawning periods of fish vary also with respect to such ecological differences as stagnant or running water, as well as altitude, temperature, and quality of food. (Nikolsky, 1980)

Data on fish fecundity are much less available than data on maturity and sex ratio (Tomkiewicz et al., 2003). Therefore, the authors use different methods to predict fecundity. The fecundity varied from 2,000 to 9,000 oocytes for fish ranging in total length and body weight from 19.5 cm and 76.00 g to 32.2 cm and 333 g in the Solhan Creek. Ünlü (1991) and Türkmen et al. (2002) reported a fecundity of 3,754 to 35,859 oocytes and 4,713 to 18,240 oocytes for females, respectively, while Ekmekçi (1996) specified it from 10,840 to 12,175 oocytes in Sariyer Dam Lake. Yıldırım and Aras (2000) reported a fecundity between 1,768 to 29,121 oocytes from the Çoruh River. Erdoğan (1998) reported similar values of fecundity 1,711 to 16,254 oocytes from the Aras River, while Türkmen et al. (2002) estimated it between 3,754 to 35,859 oocytes for females from the Karasu River. Fecundity correlates with the fish length and weight according to Bircan and Polat (1995), Erdoğan (1998), Yıldırım and Aras (2000), and Çoban et al. (2013). A basic property of fecundity is its increase during the growth of the fish. A large fish produces more eggs than a small one. The correlation between fecundity and body weight in most fishes is higher than that between fecundity and total length (Nikolsky, 1980). Çoban et al. (2013) reported fecundity values between 1,860 and 15,624 eggs in fish ranging from 11.8 to 19.5 cm in length caught in the Hazar Lake. The fecundity of *Capoeta umbla* was strongly correlated to TL and TW, due to the high value of the determination parameter ( $r^2$ ) obtained from the relationships. Our study showed that the fecundity increased as the female fish grew. Larger fish with a greater visceral space for egg development have larger ovaries, and thus more eggs than smaller fish. Although variation occurs between years in response to environmental conditions (Bagenal and Braum, 1978; Mitton and Lewis, 1989), it is also generally accepted that egg size also increases with body length (Wright and Shoesmith, 1988; Zivkov and Petrova, 1993; Moyle and Cech, 2004). However, variation in fecundity between populations of the same species and between years within a population is well known (Bowering, 1978; Pinhorn, 1984; Gundersen, 1990; Kraus et al., 2002; Bitty Blanchard et al., 2003; Power et al., 2005; Rideout and Morgan, 2007). Fecundity is influenced by age, size, fish species, feeding of fish, season, and environmental conditions (Nikolsky, 1980). Differences between this study and other studies can be explained by the above-mentioned reasons.

## CONCLUSIONS

The tigris scraper *Capoeta umbla* is an important fishery resource in the Murat River, Eastern Anatolia of Turkey, due to their high commercial value. Thus, the aim of this work was to study the reproduction to understand the population dynamics of this species for ensuring sustainable and rational exploitation of their stocks in the studied region. To achieve sustainable maximum production in the population of this species in the Murat River basin, the fishery activities should be forbidden between May and July.

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