Life history traits of *Capoeta trutta* (Heckel, 1843) from Seymareh River, western Iran (Teleostei: Cyprinidae)

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Abstract: In the present study, some biological aspects of *Capoeta trutta* (Heckel, 1843) have been examined for the aim of future stock assessment, exploitation and conservational managements. A total of 103 fish specimens were collected seasonally from Seymareh River, Tigris basin, Iran, in four seasons during 2011-2012. Observed maximum age was 4^+ in both sexes and sex ratio obtained as 1M:1.9F. Analyses showed a highly significant length-weight relationship of 0.98 for *C. trutta* with a *b* parameter of 3.09. Generally, females were larger than males with the maximum length of 28.0cm and minimum of 9.8cm. Mean Relative Length of Gut (RLG), weight (*W*) and total length (TL) were calculated according to size classes and ages. The most frequent size belonged to 20-24cm length group with the percentages of 52.9 and 48.6 for females and males, respectively. Based on the results of main reproductive indices; Gonado-Somatic Index (GSI), Modified Gonado-Somatic Index (MGSI) and Dobriyal Index (DI), *C. trutta* spawns once a year in spring. Condition factor (*K*) value also revealed the peak in the spring which is in accordance with the highest gonadal maturity of this species. The mean value for RLG was obtained as 4.6 and Zihler's index (ZI) was calculated as 2.11. Based on RLG and Zihler indices, *C. trutta* might be considered an herbivore species.

Keywords: Cyprinids, Longspine scraper, Biology, Reproductive indices, Zihler's index, Tigris basin.

Introduction

The genus *Capoeta* Valenciennes, 1842 has a wide distribution in south China, North India, Turkmenistan, Aral Sea, Middle East and Anatolia with 7 representative species in Iran (Coad 2016). The longspine scraper, *Capoeta trutta*, is widely distributed in Tigris-Euphrates basin, which drains into the Persian Gulf (Esmaeili et al. 2010). It is also known from west and south of Iran. The combination of small scales, transverse mouth, dorsal and anal fin branched rays, the very strong last unbranched dorsal fin ray and small, distinctive black spots on the head, body and the dorsal fin are key characteristics of this species (Coad 2016). *Capoeta trutta* is an economically important species with a good market value in the Khorramabad and Kermanshah regions (Peyghan et al. 2001; Poria et al. 2013).

Growth, reproductive and feeding parameters and indices such as sex ratio, gonado-somatic index (GSI), modified gonado-somatic index (MGSI), dobryial index (DI), relative length of gut (RLG), Zihler's index (ZI) and length-weight relationship (LWR) parameters are of main biological parameters to be studied enormously in different fish species including cyprinids (Polat 1987; Ünlü 1991; Gül et al. 1996; Kalkan 2008; Patimar & Farzi 2011). Differences are known to occur in growth and reproductive features between the populations of same species living in different regions, and these differences are fundamental for understanding the

Table 1. Sex ratio parameters of *C. trutta* from Seymareh River, Iran.

Total	Females	Males	F%	M%	Chi-square	df
103	68	35	66.01	33.98	10.57	1

species' life history patterns (Patimar & Farzi 2011). There are also differences in feeding biology among isolated populations of the same species due to ecological variations of their habitats (Matthews 2012).

Study of growth and reproductive cycle and its parameters provide us with one of the main biological issues in stock assessment as well as rational exploitation in fisheries and conservation programs (Tomkiewicz et al. 2003). Also, study of feeding biology of fish species can help us to understanding of prey/predator relationship between sympatric species in a habitat and is another biological issue required for management programs. *Capoeta trutta* is native to the Middle East, however little is known about its life-history in Iranian waters. In this study, we provided data on some biological aspects of longspine scraper, *C. trutta* including reproduction, relative gut length, and growth in Seymareh River, Tigris River drainage, Persian Gulf Basin.

Materials and Methods

Sampling was carried out during one year (March 2011-December 2012), seasonally in Seymareh River, Karkheh sub-basin, Tigris River basin. Totally 103 specimens were collected by electrofishing. The collected specimens were fixed in 10% formaldehyde and transported to the laboratory. Total length (TL) and gut length (GL) of the preserved specimens were measured to the nearest 0.05mm using vernier caliper. Total weight and gonad weight were weighted to the nearest 0.01g by a digital scale. Sex was determined visually or by microscopic examination of the gonads. A chi-square test was used to assess deviation from 50:50 sex ratio (Robards et al. 1999). The ovaries were examined macroscopically and microscopically to determine maturity stages and egg diameters were measured

under compound microscope by using ocular scale.

The length-weight relationship (LWR) was determined by fitting the data to a potential relationship in the form of: $W = \alpha L^b$, where W is the fish weight; L, total length; and α and b are the parameters to be estimated, with b being the coefficient of allometry based on the test given by Pauly (1980).

GSI, MGSI, DI, RLG and ZI were calculated as following:

GSI = (gonad mass/fish mass) × 100 (Nikolsky 1963)

MGSI = (gonad mass/fish mass−gonad mass)×100 (Nikolsky 1963)

DI = $\sqrt[3]{GW}$ (Dobriyal et al. 1999)

RLG = gut length/fish length (Al-Hussaini 1947)

ZI = gut length (mm)/10[body mass (g)1/3 (Zihler 1982)

Where W is total fish mass in gram, GW is gonad mass in gram, L is fish length in mm. Comparison of LWR parameters; GSI, MGSI, DI, RLG and ZI values were carried out by analysis of variance (ANOVA) between sexes. Statistical analyzes were performed using statistical analytic software SPSS version 17 with a significant level of 0.05.

Results

A total of 103 specimens were sampled among which 68 were female and 35 were male. The overall sex ratio between males and females was significantly female biased and deviated from the hypothetical distribution of 1:1 (1M:1.9F; Chi square=10.57, df=1, *P*<0.05) (Table 1). One-way analysis of variance (ANOVA, *P*<0.05) showed a high significant relationship between length and weight of *C. trutta* with the estimation of 3.09 for *b* parameter (Table 2). Moreover, females exhibited higher length than males, being 9.8 and 28cm for minimum and maximum lengths, respectively (Table 2).

Condition factor is another parameter of growth

Table 2. Descriptive statistics and estimated parameters of the length-weight relationships (LWRs) for females and males of *Capoeta trutta* from Seymareh River drainage, Iran.

Sex	Mean TL (cm)	Range of TL (cm)	r^2	*a*	*b*
Male	20.15	8.3-27.8	0.97	0.0079	3.084
Female	21.30	9.828.0	0.98	0.0079	3.089
Total	20.91	8.3-28.0	0.98	0.0078	3.091

Table 3. Descriptive statistics parameters of K, GSI, MGSI, RLG and ZI of female and male of *Capoeta trutta* from Seymareh River.

| Index	Sex	Min	Max	Mean	S.D.
K	Male	0.469	1.220	1.025	0.1
	Female	0.803	1.277	1.040	0.1
GSI	Male	0.057	9.807	1.769	3.0
	Female	0.104	10.533	2.521	3.0
MGSI	Male	0.057	10.874	1.904	3.3
	Female	0.104	11.773	2.688	3.2
DI	Male	0.22	2.22	0.91	0.5
	Female	0.34	2.21	1.15	0.5
RLG	Male	2.58	7.98	4.97	1.2
	Female	2.25	7.50	4.41	1.0
	Total			4.6	1.1
ZI	Male	1.04	3.42	0.27	0.1
	Female	1.10	3.71	2.03	0.5
	Total			2.11	0.5

Table 4. Mean TL, W and RLG in 5 length classes based on age in female and male of *Capoeta trutta* from Seymareh River, Iran. cm.

| Sex	Age	Mean TL	Mean W	Sex	Length classes (cm)	Mean RLG
Female	0	11.26	13.81	Female	8-12	0.32
Male	0	8.30	6.23	Male	8-12	0.30
Female	1	16.43	49.33	Female	12-16	0.52
Male	1	16.87	51.88	Male	12-16	0.34
Female	2	19.60	79.02	Female	16-20	0.43
Male	2	18.62	67.72	Male	16-20	0.55
Female	3	23.02	133.49	Female	20-24	0.46
Male	3	22.73	126.86	Male	20-24	0.46
Female	4	25.51	162.00	Female	24-28	0.42
Male	4	24.43	148.76	Male	24-28	0.56

assessment due to the relationship between fish length and weight, therefore, it is a tool to evaluate fish status in terms of obesity or skinny. Seasonal distribution of mean K for both sexes is given in Figure 1. As it is clear, the highest value of mean *K* is seen in spring with a decrease in summer. Maximum and minimum of *K* was 1.28 and 0.47, respectively (Table 3).

To assess the states of sexual maturation, three reproductive indices were calculated. Seasonal variations in the gonado-somatic index (GSI),

modified gonado-somatic index (MGSI) and Dobriyal index (DI) of both sexes are presented in Figure 2. One-way ANOVA analysis did not show significant differences in means of GSI, MGSI, DI and *K* between the two genders, however, the differences among seasons for each gender were significant ($P<0.05$). The peaks of the three indices for both sexes were in summer. In general, all indices represented almost higher measurements in females than males. To evaluate feeding habit of *C. trutta*, relative length of gut (RLG) and Zihler's index (ZI)
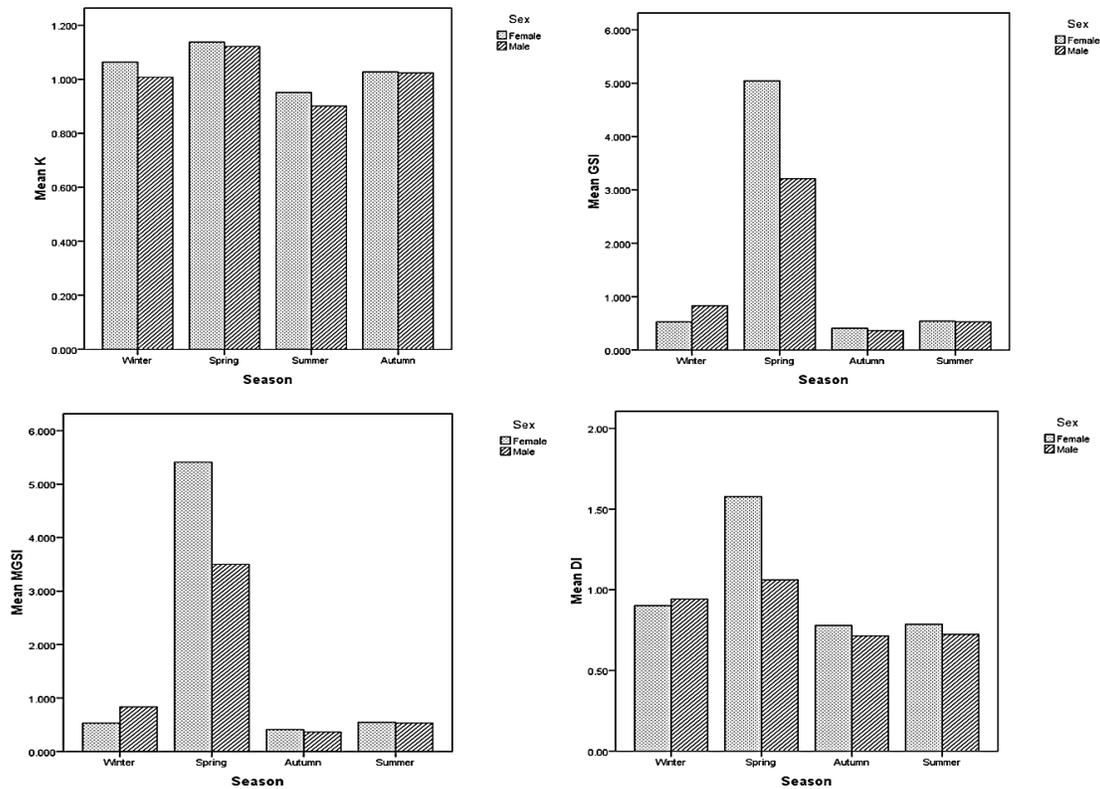
Fig.1. Seasonal distribution patterns of mean K, GSI, MGSI and DI in *Capoeta trutta* from Seymareh River.
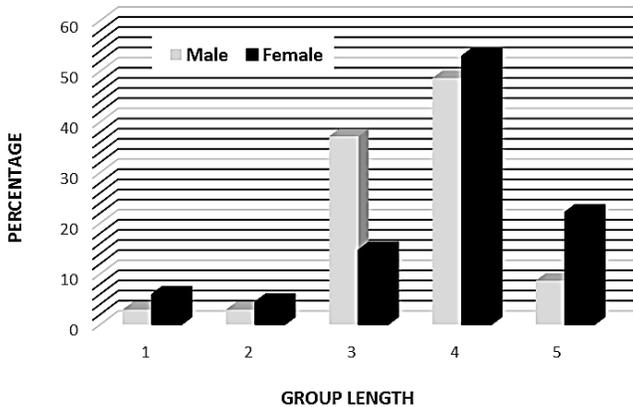
Fig.2. Distribution pattern of size classes in both sexes of *Capoeta trutta* from Seymareh River.

were calculated in both sexes (Table 3). The overall mean of RLG was 4.6 and the overall mean of ZI was 2.11. The age distribution of *C. trutta* was found between 0-4^{+}. Average values of total length and weight were presented in relation to age groups (Table 4). The highest mean length and weight was seen in females at age 4^{+} with the values of 25.51cm and 162g, respectively.

According to The distribution of size classes, the most frequent size class belonged to class 4 (20-24cm), with the percentages of 52.9 and 48.6 for females and males, respectively. Class 2, 12-16cm, in females and classes 1 and 2, 8-12 and 12-16, respectively, in males represented the lowest frequencies (Fig. 2).

Discussion and Conclusion

Our results showed the peak of reproductive indices (GSI, MGSI & DI) in the spring for *C. trutta*. Condition factor, *K*, as a factor of assessing the growth status of the fish also corresponded with the above results, meaning an increase in fish total body mass in spring. There was a high relationship between length and weight of *C. trutta* and the maximum age was observed 4^{+}. Zihler's index was also calculated as 2.11 in this study. Till now, a few studies have been done on different biological traits of *C. trutta*, including its reproductive strategies, feeding habits and growth parameters in Iran and

Turkey from Tigris River basin (Polat 1987; Duman 2004; Kalkan 2008; Patimar & Farzi 2011; Javaheri Baboli et al. 2012).

According to Cone (1989) the relationship between fish weight and length is used to compare the effect of biotic and abiotic factors on the health or well-being of a fish population. Length-weight relationships (LWRs) showed highly significant positive relationships for *C. trutta* as it can be seen in other reports (Patimar & Farzi 2011; Javaheri Baboli et al. 2012; Esmaeili et al. 2014). The estimation of *b* parameter is within the expected range of 2.5-4 reported by Tesch (1971). The reasons for the variation of *b* in the different regions are seasonal fluctuations in environmental parameters, physiological conditions of the fish at the time of collection, sex, gonad development, food availability and quality in habitat, diet, stomach fullness, health and the preservation techniques of the samples (Tesch 1971; Esmaeili & Ebrahimi 2006; Esmaeili et al. 2014).

In this study sex ratio showed a significant deviation from the expected ratio of 1:1 which seems to be due to a number of parameters such as age, season, fishing methods, and migration (Nikolsky 1963, Tahami et al. 2015). The sex ratio of *C. trutta* is also reported to be 0.98:1 (M:F) in Karakaya Dam lake, Turkey and 1:135 (M:F) in Meymeh River, Iran (Kalkan 2008; Patimar & Farzi 2011). Significant differences between males and females represents a key factor for determination of reproductive strategies and the growth/death ratio differences between genders.

Fish condition can be extremely important to fisheries managers. Condition factor is frequently used to assess ecological and biological factors such as obesity, gonad development and availability of food resources (Mac Gregoer 1959). The average condition factor was 0.8 for females and 0.5 for males. Kalkan (2008) reported that the average of *K* is 1.30±0.06 for females and 1.28±0.05 for males. Javaheri Baboli et al. (2012) also, in their studies obtained an insignificant difference of 0.93 of *K* in

male and 0.94 in female. In all cases the *K* coefficient value is higher in females. Variation in *K* coefficient reflects sexual maturity and feeding condition. It also changes with fish age and sex in some species (Williams 2000). Both males and females of *C. trutta* showed a similar increase in *K* coefficient in spring which could be due to their gonad maturation and accumulation of fat in result of higher accessibility of food in spring.

Moreover, females exhibited significantly a higher size than males, as reported in other studies (Kalkan 2008; Patimar & Farzi 2011; Javaheri Baboli et al. 2012) and the maximum age in this population was observed as 5^+ for both sexes which is less than other reports for this species, as in Gül et al. (1996) and Patimar & Frazi (2011) the maximum observed age was 7^+ and in Ünlü (1991) as 10^+.

The spawning season of *C. trutta* was determined on the basis of the seasonal variations in the mean gonado-somatic index, modified gonado-somatic index, and Dobriyal index. GSI, MGSI and DI indices showed positive relationships with gonad and their monthly ranges in *C. trutta* showed a drastic peak in spring, indicating the spawning season of this fish. These indices are affected by fluctuations in temperature, light, good feeding, species and environmental conditions (Nikolsky 1963), that results in variation of the oocyte and gonad mass.

To assess feeding habits of *C. trutta*, the RLG and ZI were calculated. The relative intestine length only lets us to predict diet in fishes to broad dietary categories (carnivore, herbivore, and omnivore) and not to finer divisions (Kramer & Bryant 1995). The mean value for RLG was obtained as 4.6. According to Al-Hussaini (1947), the feeding guilds of Red Sea fishes based on RLG can be classified as followings: plankton feeders (0.5-0.7), carnivores (0.6-2.4), omnivores (1.3-4.2) and herbivores (3.7-6.0). Also, Kramer and Bryant (1995) categorized fishes ranged between 50-100 mm (SL) as carnivores (RGL= 0.6-0.8), omnivores (0.8-1.0) or as herbivores (2.5-16.4). Zihler's Index relates gut length to body mass rather than standard length, and offers a potentially more

powerful approach to decide to which feeding category a species belong (German & Horn 2006). Zihler's index was obtained 2.11 in this study. According to Kramer and Bryant (1995), fishes categorized by their ZI as carnivores (ZI=2.5- 3.5), omnivores (3.5-6) or as herbivores (12-55). Taking all above in to account, *C. trutta* is most probably an herbivore species.

In conclusion, sex in the population of *C. trutta* from Seymareh River, Tigris River Basin, is generally female biased (1M:1.9F), females are larger in size than males, the maximum age is 4[+] for both sexes belonging to length class 5 (24-28cm), with the most frequent size belonging to length class 4 (20-24cm) for both genders. *Capoeta trutta* is an herbivore species based on RLG and ZI indices and spawns in spring, based on the reproductive indices.

Acknowledgments

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