

ORIGINAL ARTICLE

Some Biological Properties of *Chondrostoma regium* (Heckel, 1843) in Gamasiab River in Kermanshah Province, Iran

Keyvan Ghanbary¹, Mojtaba Poria², Hossein Azari³, Mohammad Behrouz⁴, Farshad Ejraee¹

¹ Islamic Azad University, Kermanshah Province, Iran, P.O.Box: 6719968564

² Islamic Azad University, Kermanshah Fisheries Province, Iran, P.O.Box: 6714653181

³ Islamic Azad University, Boshehr Province, Iran, P.O.Box: 7515855156

⁴ Department of Marine Biology and Fisheries Sciences, Islamic Azad University, Tonekabon, Iran.

ABSTRACT

In this study, age, growth and reproduction characteristics of 297 *Chondrostoma regium* fish (146 males and 151 females) from the Gamasiab River were investigated monthly between August 2011 to July 2012. Age of captured fish ranged between 1 and 5. The age-length in females and males were estimated as; $L_t = 316[1 - e^{-0/25(t+0/577)}]$, $L_t = 306[1 - e^{-0/21(t+0/61)}]$ respectively. The length-weight relationship for male and female individuals $W = 8 \times 10^{-6} L^{3/05}$ and $W = 6 \times 10^{-5} L^{2/687}$. Mean GSI in female and male populations of Gamasiab River was 9.15 ± 4.8 , 1.5 ± 1.13 , respectively. Mean absolute fecundity in females was 9440.98 ± 5011.88 . Mean egg diameter was 1.05 ± 0.25 mm. In the analysis of fishes conditions factor the mean of it for male and female fishes were 1.042 ± 0.17 and 0.99 ± 0.14 , respectively. The maximum condition factor for male and female was in Apr and Mar respectively. In according to GSI, absolute fecundity, egg diameters of *Chondrostoma regium* in Gamasiab River reproduction season was in March to May.

Key Words: *Chondrostoma regium*, Length-weight relationship, growth, GSI, Gamasiab

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INTRODUCTION

The *Chondrostoma* genus belonging to *cyprinidae* family has a vast distribution in South west Asian countries as Turkey, Iraq and Syria that 2 species have been identified in Iran until now. Subspecies distribution *C. regium* can be found in Khuzestan, Ilam, Hamedan, Lorestan and Kermanshah province Rivers basin of Iran and it is found in the Tigris River and Kor River basins. Additional localities are Gamasiab river in Kermanshah province, the Marun river, Hour al Azim marsh [25]. The widely distribution of *Chondrostoma* species probably depending on the omnivorous regime. Gamasiab River is one of the important river in Kermanshah province in Iran. Fish growth is associated with various individual characteristics. Fish in good condition may be assumed to produce a growth in length, thus body size and condition are good growth indicators [11]. Length-weight relationship parameters plays a major role in fisheries biology and population dynamics [19]. Understanding the reproductive biology of exploited fish stocks is important for developing stock assessment and population-viability models used for fisheries management (Kennedy et al., 2006; [13]. Several studies have examined the some biological properties of *Chondrostoma regium* in Dam lakes Karasu [10], Ataturk [15], Keban [27], Almus [14]. Şevik in 1997 examined the biology of *C. regium* which lives in Euphrates between Ataturk Dam Lake and border of Syria line [21]. There was no data available on age, growth and reproduction characteristics of *C. regium* in Iran until now. therefore in reason of economical importance of this fish and widely distribution in Iran, investigations on biological characteristics of it for fisheries management and protection of wildlife species seems importance. The aim of this study determine the some biological properties of *C. regium* population that habiting in Gamasiab River downstream.

MATERIAL AND METHODS

In this study, 297 individuals (146 males and 151 females) of *Chondrostoma regium* were caught in Gamasiab River in western Iran using Cast net and Gill nets (length, 10-40m and mesh size, 1-4cm) from August 2011 to July 2012. The sampling locality in Gamasiab River was located at the geographical coordinate (latitude 34 25 39 N, longitude 47 31 02 E and Altitude, 1400m).

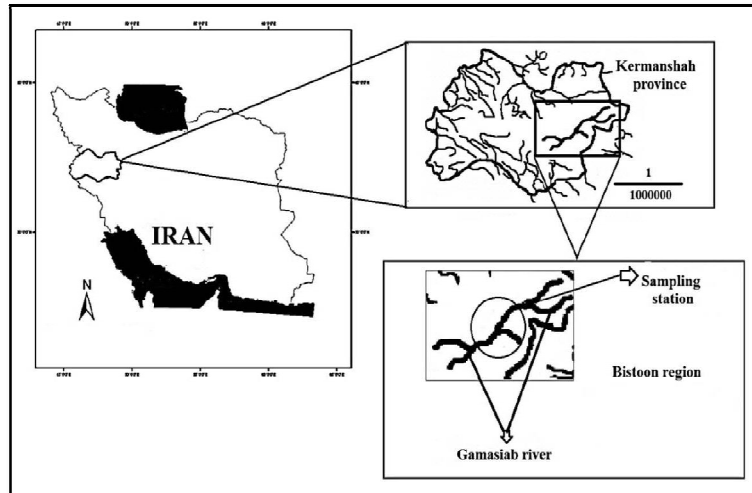


Fig 1. Collection site of *C. regium*, Gamasiab River, Bistoon region, Kermanshah Province, Iran.

The samples were brought to the laboratory, identified and counted. Age determination was carried out using scale reading method of Lagler [12]. The fish were dissected laterally and sex was determined visually. The gonads were removed and weighed ($\text{mg} \pm 0.01$). Ovaries were fixed in Gilson's fluid [3]. Fecundity was estimated by the gravimetric method [27]. For this purpose, three 0.1 gr subsamples (front, middle and caudal sections) from each ovary were taken and the number of eggs was counted in each subsample and then the total fecundity (F) was estimated using the equation [26]:

$$F = \frac{\text{Gonad weight (g)} \times \text{Egg number in the subsample}}{\text{Subsample weight (g)}}$$

To determine the mean egg size, diameter of 10 oocytes from each subsample were measured using a micrometer lamella under a microscope. Gonadosomatic index (GSI) was determined by the equation [26]:

$$\text{GSI} = \frac{\text{Weight of gonad (g)} \times 100}{\text{Total weight of fish (g)}}$$

Specimens of *C. regium* were measured ($\text{TL} \pm 1\text{mm}$) and weighted ($0.01 \pm \text{g}$). The length-weight relationship of *C. regium* was determined using the equation [17]: $W = aL^b$ and logarithmically transformed into $\log W = \log a + b \log L$ where "W" is the weight of the fish in grams and "L" is the length of the fish measured in centimeters. The parameters "a" (proportionality constant) and "b" (regression coefficient) of the length-weight relationship. For determining the pattern of growth used of Pauly formula's [7]:

$$T = \frac{\text{SdlnL}}{\text{SdlnW}} * \frac{|b-3|}{\sqrt{1-r^2}} * \sqrt{n} - 2$$

Von Bertalanffy (1957) growth equations were calculated according to:

$$L_t = L_{\infty} [1 - e^{-k(t+t_0)}]$$

Where "L_t" is the length of fish in cm, letter "e" is the base of natural log (2.71828), "t" the fish age (as year), to the hypothetical time at which the length of the fish is zero, "K" is the rate at which growth curve approaches the asymptote [4]. The moment growth coefficient calculated by for male and female was determined by the equation [14]:

$$G = \frac{(\text{Ln}(W(t+1)) - \text{Ln}(W(t)))}{\Delta t}$$

"Ln" = natural logarithm, "W" = weight (gr), "t" = age. Condition coefficients were calculated for both sexes using the equation [2]:

$$K = \frac{W \times 100}{L^3}$$

"K" = condition factor, "W" = weight of fish (gr), "L" = length of fish (cm). Statistically significant differences between sexes were tested with Student t-test ($P > 0.05$ and 0.01) and for Length-weight relationships used of linear regression in Microsoft Excel 2010.

RESULT

During the 12 months of sampling period in the Gamasiab River, a number of physico-chemical properties of water were recorded. The water temperature ranges from 8 °C to 32 °C throughout the year. Both figure 2 and table 1 show the physico-chemical profile of water during the studied period (2011-2012) in Gamasiab River.

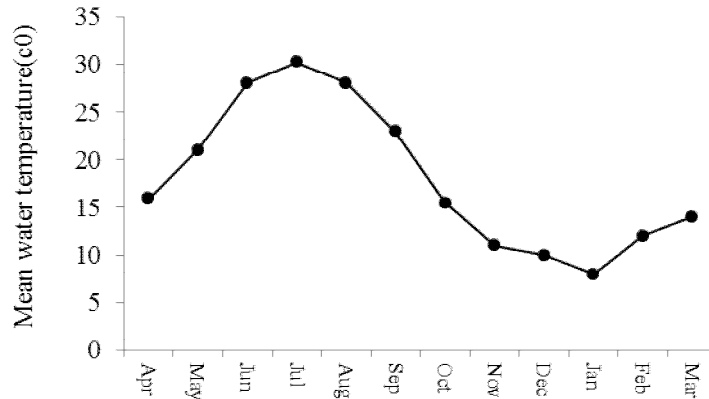


Fig 2. The monthly temperature(c°) values of Gamasiab River in 2011-2012

Table 1. The mean, min, max and range for five physico-chemical properties of water in Gamasiab River during 2011-2012.

	Mean±SD	Min	Max
Temperature(c°)	18.63± 8.05	7.5	30.1
pH	6.5±0.29	6.2	7
Hardness(mg/lit)	183.2±24.4	153	232.2
EC(μ²/cm)	1260.06±363.03	824	1864
O ₂ (ppm)	9.4±0.19	9.3	10

In this study, 297 fish were studied. 146 specimens were males and 151 specimens were females. The ages of captured fish ranged between 1 and 5 and the 3 was dominant in the population. The sex ratio (M:F) was 1:1.03 and was not significantly different from 1:1. Comparison of mean GSI for male and female using Duncan's test showed that GSI peak levels for male fish were held in March and April and for female in April, March and February. Figure 3 shows the monthly variation of the GSI in male and female fish during 2011-2012. The mean absolute fecundity in *C.regium* in Gamasiab River was 9422.98±5011.88 and the minimum and maximum values were 1367 and 19016 respectively. Egg diameter and age were significantly correlated ($p < 0.01$). The age and sex distribution of specimens caught during this study are summarized in table 2.

Table 2: The age and sex distribution of *Chondrostoma regium* in Gamasiab River.

Age	Total		Male		Female	
	N	%N	N	%N	N	%N
1	9	2.9	4	2.7	5	3.3
2	53	17.2	34	23.3	16	10.6
3	107	34.6	66	45.2	34	22.5
4	77	24.9	21	14.4	55	36.4
5	58	18.8	21	14.4	37	24.5

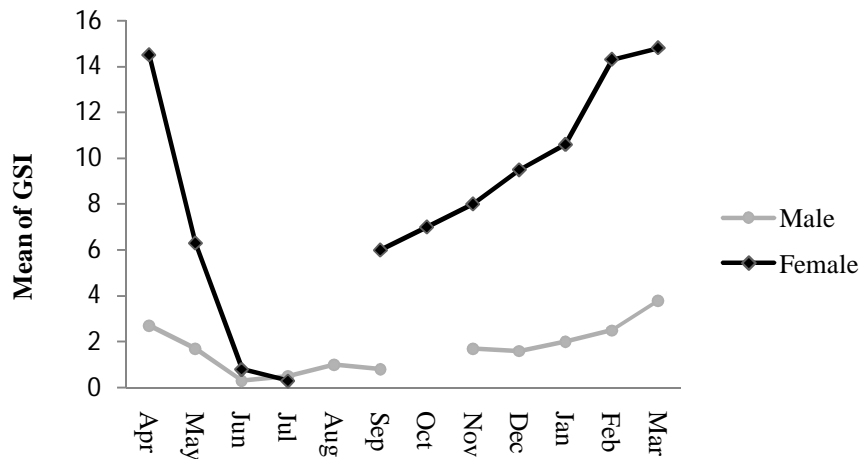


Figure 3. The monthly GSI values for female and male *C. regium* from Gamasiab River in 2011-2012. No data were available for female in Aug and male in Oct.

Weight and the absolute fecundity showed a significant correlation ($r^2 = 0.842$), ($p < 0.05$) and fork length and the absolute fecundity showed significant correlation ($r^2=0.782$), ($p<0.05$). Mean of egg diameter was 1.05 ± 1.13 mm and the minimum and maximum values of 0.54 and 2 mm were observed. Figure 4 shows the changes in egg diameter during the study period. Average diameter of eggs in different months in 2011-2012 showed that the mean of egg diameter had started to increase in December and reached to its peak in April. It was also observed that with the increase of the age and the absolute fecundity, the egg diameter decreases. Also significant differences were observed between age and egg diameter ($p<0/01$).

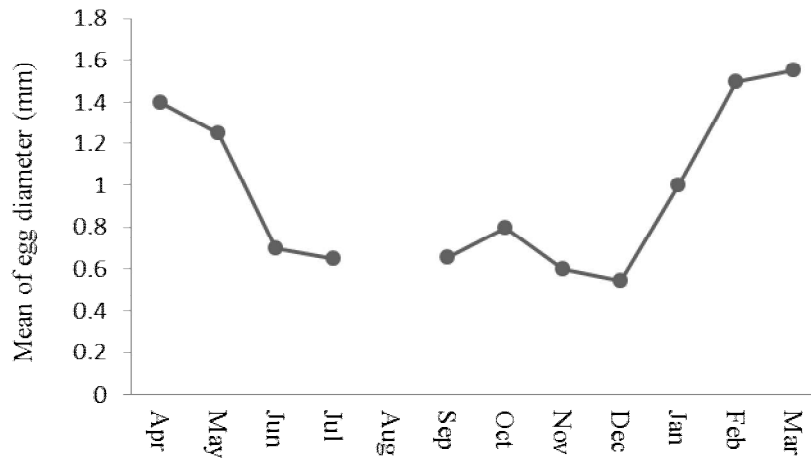


Figure 4. The monthly egg diameter values for *C. regium* in Gamasiab River in 2011-2012. No data were available for female in Aug.

The total length of females in the Gamasiab River ranged from 132 mm to 261 mm and mean was 207.76mm. The range was smaller for males, from 117 mm to 240 mm and means was 189.41mm. The total weight of females ranged from 26gr to 177gr and mean was 96.69 gr. The range for males was from 12gr to 142gr and mean was 73.63gr the difference weight and length between the sexes was statistically significant ($p<0.01$). The length-weight relationships were separately evaluated for females and males, and are presented in (Figure 5a,5b).

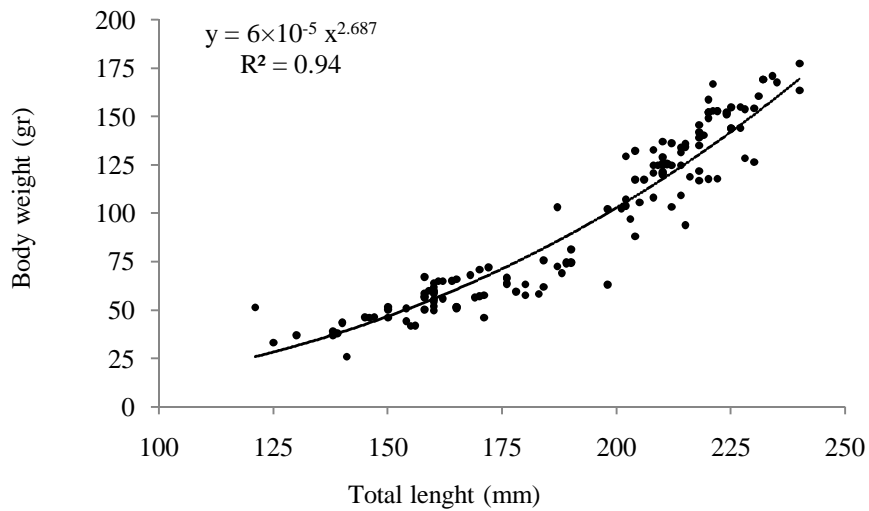


Fig 5a. Length-weight relationship for 151 specimen female *C.regium* in Gamasiab river in 2011-2012.

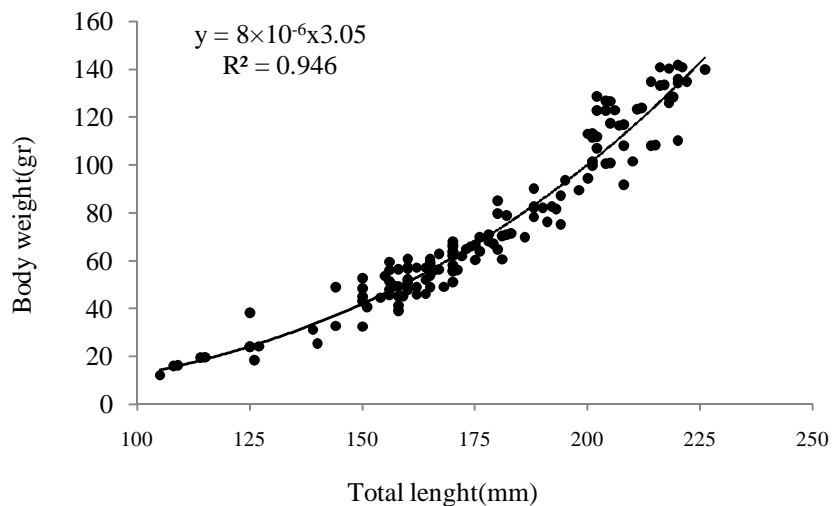


Fig 5b. Length-weight relationship for 146 specimen males *C.regium* in Gamasiab river in 2011-2012.

The exponent for both sex demonstrated an allometric growth. Comparing the length-weight relationships of the sexes using covariance analysis, was statistically significant ($p < 0.01$). The equation for the relationship was $W = 6 \times 10^{-5} L^{2.687}$ ($r^2 = 0.94$) for females, and $W = 8 \times 10^{-6} L^{3.05}$ ($r^2 = 0.94$) for males.

The estimated von Bertalanffy growth parameters for the *C.regium* in female and male were as follows:
 $L_t = 316 [1 - e^{-0.25(t+0.577)}]$
 $L_t = 306 [1 - e^{-0.21(t+0.61)}]$

Table 2 show that the maximum yearly increase in length for male and female occurs at 1-5 years.

Table 3. The moment growth coefficient in females and males *C.regium* in Gamasiab River in 2011-2012.

Age	Moment growth coefficient	
	Female	Male
1-2	0.2	0.088
2-3	0.13	0.12
3-4	0.13	0.23
4-5	0.06	0.033

Condition factor

The mean condition factor for females was higher than that for males, but were not sexes were not significant ($P>0.05$). The mean condition factor was calculated as 1.04 ± 0.77 and 0.99 ± 0.14 for females and males, respectively. Additionally, monthly variations in the condition coefficients were determined for two sex. (Figur 6)

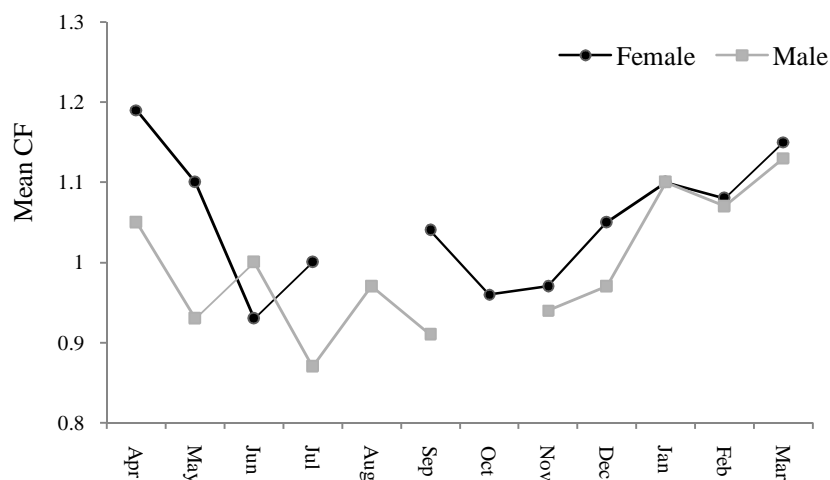


Fig 6. The monthly CF values of females and males of *C. regium* samples from Gamasiab River in 2011-2012. No data were available for female in Aug and male in Oct.

DISCUSSION

It was determined that 48.9% of the samples of *C. regium* in Gamasiab River examined was female and 47.2% was male. The ratio of males to females was 1♂:1.03♀. The sex ratios for this species from different habitats were determined 1♂:0.53♀ in the Savur Stream [4], 1♂:1.06♀ in the Euphrates [21], 1♂:0.71♀ in the Atatürk Dam Lake [14], 1♂:1.23♀ in the Karakaya Dam Lake [8], 1♂:0.82♀ in the Sır Dam Lake [10], and 1♂:0.83♀ in the Seyhan Dam Lake [6]. According to Nikolsky (1963), the sex ratio may vary from one population to another as well as from year to year within the same population, the factors affecting the sex ratio are largely unknown [23]. Regarding the available data, the ratio of males to females in Gamasiab River is nearness with data of Sevick [21]. In other investigations on this species, range was reported to be 1-6 in Euphrates [21], 1-8 in Ataturk dam lake [14], 1-6 in Keban Dam lake [27], 2-5 in Karakaya dam lake [8], 1-5 in the Sır dam lake [10], 1-6 in the Almus dam lake [20], 1-4 in the Seyhan Dam lake [6]. Differences between age distribution mentioned in these results are related with the differences in fishing tools, mesh size and ecological situations. Hence, the age range of *C. regium* in Gamasiab River is consistent with the data of Kara and Solak (1998). Total length and body weight range of the samples in Gamasiab River varied 11.7-26.1 cm and 12.2-177.6 gr, respectively. These ranges were compared with those reported by Unlu for Savur Stream in 2000 (2.8-29.0 cm and 11-296 g), Sevik for Euphrates in 1997 (11.5-29.2 cm and 17-283 g), Oymak for Atatürk Dam Lake in 2000 (13.0-30.5 cm and 23-385 g), Kalkan and Erdemli for Karakaya Dam Lake [8] (20.4-31.8 cm and 109-314 g), Kara and Solak for Sır Dam Lake in 1998 (15.5-26.0 cm and 42-243 g), Erdugan et al, for Seyhan Dam Lake in 2008 (14.3-24.5 cm and 33-128 g), Suicmez et al, for Almus Dam Lake in 2007 (13.7-28.1 cm and 19-240 g). Regarding the available data the total length and body weight range of sample in this study is nearness with data of Sevik (1997). The variations in the length and weight compositions can be attributed to differences in sampling time and method, sample size, type of length measured, and the ecological properties of studied areas [24]. The von Bertalanffy growth parameters of *C. regium* calculated in various studies are shown in table 3.

Table 4. The von Bertalanffy growth parameters values of *C. regium* reported from different studies

Locality	Sex	n	L_{∞} (cm)	t 0(year)	K(year ⁻¹)
Gamasiab river (2011-2012)	F	151	31.6	-0.577	0.25
	M	146	30.6	-0.61	0.21
Ataturk Dam Lake (Oymak,2001)	F	422	38.67	-3.074	0.136
	M	303	35.01	-2.754	0.168
Sır Dam Lake (Kara and solak,1998)	F	252	31.89	-3.445	0.178
	M	209	38.13	-4.037	0.117
Karakaya Dam Lake (Kalkan et.al,2003)	F	64	39.59	-0.325	0.21
	M	79	34.96	-0.389	0.326
Almus Dam Lake (Suicmez et.al,2007)	F	194	33.5	-2.369	0.219
	M	128	27.5	-1.455	0.397
Seyhan Dam Lake (Erdugan and Goksu,2008)	F	89	29.83	-1.984	0.262
	M	75	26.85	-1.63	0.255

In present study, while asymptotic length estimated for females (L_{∞} =316 mm) is the higher than males (306mm). The similar result was reported by Unlu et al [24], Oymak [14] and Kalkan and Erdemli [8] for populations inhabiting different habitats of *C. regium*. Many factors, such as physico-chemical and biological factors, may have an effect on the growth rate in length and weight of fish directly or indirectly. In addition to food and population density, temperature is a factor that has been recognized to be a primary significant factor in this respect [18]. The parameter b values of length-weight relationship of *C. regium* in this study for female and male were within the expected range of 2.5-3.1, but they can vary between 2 and 4 [6]. The coefficient b of length-weight relationship of *C. regium* was calculated as 2.68 for female, 3.05 for male. All estimated b values were different from 3 ($b > 3$), and this result shown a positive allometric growth for male and negative allometric for female of *C. regium* in Gamasiab River. Table 4 show the parameters of LWRs of this species that reported from different study areas.

Table 5. The parameters of length-weight relationship of *C. regium* reported from different studies

Locality	Sex	n	L_{min} - L_{max} (cm)	W_{min} - W_{max} (gr)	b	r^2
Gamasiab river (2011-2012)	F	151	13.2-26.1	26-177	2.68	0.94
	M	146	11.7-24	12-142	3.05	0.94
Ataturk Dam Lake (Oymak,2001)	F	422	13-29.7	23-351	3.197	0.914
	M	303	16.8-30.5	29-358	3.278	0.944
Sır Dam Lake (Kara and solak,1998)	F	252	15.5-26	46-223	3.109	0.84
	M	209	16-24.3	42-177	2.989	0.81
Karakaya Dam Lake (Kalkan et.al,2003)	F	64	20.43-31.8	112-243	2.517	-
	M	79	20.6-31.2	109-294	1.77	-
Almus Dam Lake (Suicmez et.al,2007)	F	194	14.2-28.1	22-240	3.317	0.989
	M	128	13.7-25.8	19-168	3.269	0.984

Differences in LWRs can be referred to many factors including habitat, area, season, the number of samples, degree of stomach fullness, gonad maturity, sex, health, preservation techniques, and variations in observed length ranges of the specimen examined [22, 26]. The condition factor of *C. regium* inhabiting Gamasiab River showed that the females were in better condition than the males. This may be due to several reason such as feeding activity and gonadal development of females. Moreover, condition of fish can be varied by several factors including state of sexual maturity, feeding regime, fullness rate of the stomach, and age of fish as well as season and sex [2, 1]. The mean of GSI was 5.589 and its maximum value in Gamasiab River in March and April. In this study GSI decline from May. In other study max GSI were in Feb-Jul [27], Apr(Kara and Solak,1998),Apr-Feb [15], Apr [16] In this study the maximum GSI was observed in Apr and Mar which is in accordance with the result of other studies. Absolute fecundity range in this study varied from 1367-19016 and mean fecundity was 9422 . The absolute fecundity in this fish was correlated significantly with fish length, body weight and gonad weight. Absolute fecundity for *C. regium* in other studies were 6800-13800 [24], 1780-11340 [4], 1904 -16800 [27], 1074 – 15492 [15]. The variation in absolute fecundity between the populations may result largely from selectively different

environmental factors such as water temperature, feeding and food abundances and species differentiation [18]. Hence, the absolute fecundity range in this study is not consistent with other researchers. Egg diameter range was 0.54-2 mm and other studies reported the egg diameter to be 0.2-1.63 mm [15], 0.966-1.93 mm [4]. Regarding the available data, egg diameter range in this study is higher than of other studies. In according to GSI, absolute fecundity, egg diameter of *Chondrostoma regium* in Gamasiab River reproduction season was March to May. According to the results it can be proposed that fishing should be prohibited between March and May for maximum productivity from the *Chondrostoma regium* population in the Gamasiab River.

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