Reproduction biology in *Chondrostoma regium* (Heckel, 1843) in Gamasiab river in Kermanshah province, Iran*

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Abstract: In this study reproduction characteristics of *Chondrostoma regium*, which were caught from Gamasiab river, Kermanshah province,Iran were determined. Of 309 *C. regium* (146 males and 151 females and 9 unknown) were captured between August 2010 to July 2011 by gill nets of various mesh sizes. The observed sex ratio was 1.03:1 (females/males). Totally the age composition of the specimens ranged between 1-5 age groups. Total lengths and weights ranged from 117 to 261 mm and 12.2 to177.6 gr. The mean of GSI for all fishes and males and females were (5/476, 1/421, 8/68) .The max of GSI for males was in March and April and females was in April, March and February.The mean of relative fecundity (into fork length and weight) were (46/74,96/424). Mean absolut fecundity in femals was 9422/76(rang 1367-19016) and observed positively related to total length (r^2=0.86) and weight(r^2=0.88). Egg size varied monthly and egg diameters ranged from 0.5 mm to 2 mm in March. Egg size correlated negatively with the number of eggs in the ovaria.In according to GSI, absolut fecundity, diameters egg of *Chondrostoma regium* in Gamasiab river , reproduction season was reported March to May.
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1. Introduction

There are about 140 fish species in the inland waters of Iran, which generally belong to three families: *Cyprinidae*, *Balitoridae*, and *Cobitidae* (Wossughi and Mostagir 1976). The cyprinid species exhibit a wide range of geographical distribution, life histories, and reproductive styles (Winfield and Nelson 1991). Cypriniformes or carps are a group of freshwater fishes with 6 families, 321 genera and about 3268 species found throughout the world except Australia and South America (Nelson 2006). *Chondrostoma* is one of them.There are about 26 species of *Chondrostoma* which two are known for Iran including *Chondrostoma regium* (Heckel, 1843) and *C.cyri* (Kessler, 1877) (Coad 2010). The king nase, *Chondrostoma regium.*

River in Kermanshah province 90 km long river and its catchment area is over 12,000 square kilometers (Rahimzade et al.2010). This river during the warm months of the year (late April to early November) with increasing temperature and decreasing rainfall has the lowest water volume (Biokani 2004). Understanding the reproductive biology of exploited fish stocks is important for developing stock assessment and population-viability models used for fisheries management (Kenndy et al. 2006;Nitschke et al. 2001) and knowledge of the reproductive cycle and the factors affecting it are important issues in fish and fisheries biology (Tomkiewicz et al . 2003).

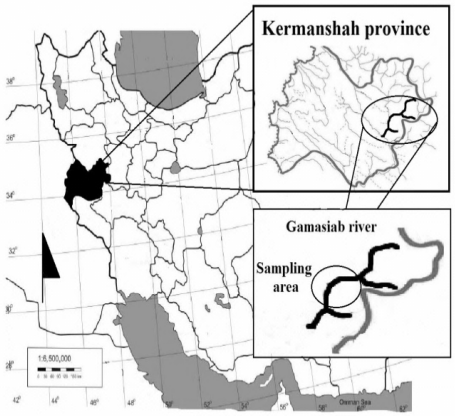

Fig 1.Situation of Gamasiab river in iran and sampling region.

Kara et al in 1998 ,Oymak in 2000 ,Zulfu in 2002 ,Ozcan in 2006 respectively in the dam lake Karasu, Ataturk, Keban and state of Hatay, Turkey, age, growth and reproduction in *C.regium* were examined. The calculation of the number of larvae from eggs and egg survival in natural environments is not possible, there by determining the fecundity rate, an estimate of future generations and the condition makes it possible (Pitcher 1996). *Chondrostoma*

regium has a wide dispersion, but there is little information on its biology in Iran. The main objective of this study is determaint of absolut fecundity, relative fecundity; gonadosomatic index, egg diameters and breeding season of *C.regium* inhabit the Gamasiab river and the fecundity relationships with other variables. We believe that information on the reproductive biology of this native fish could be important for conserving its stock.

2. Material and Methods

Fish samples were monthly collected in Gamasiab river was performed using by Cast net and Gillnet invarious mesh sizes of (1,2,3,4,5)cm and by 10,20,30,40 m lenght between August 2010 to July 2011. The water temperature ranges from 8 °C to 32 °C throughout the year. A total of 309 individuals (151 females, 146 males and 12 undetermined sexes) were sampled. Fish samples were preserved into formaldehyde 10% and taken to laboratory. The total lengths (±0.1 cm) and weight (±0.1 g) of fish were recorded (King 1995). Age determination was carried out from the scale by the method of Lagler et al(Lagler 1966). For this purpose, 15-20 scales were taken from a region under the dorsal fin (Lagler 1966). The scales were kept in 5% KOH and then in water cleaned and age was determined under a microscope. The fish were dissected laterally and sex was ascertained macroscopically and microscopally and their gonads were removed and weighed (mg). Ovaries were fixed in Gilsons fluid (Bagenal and Braun 1978). For fecundity was estimated by the gravimetric method (Zulfu and Sen 2002). 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:

$$F = \frac{Gw \times En(\text{in subsample})}{Sw}$$

GF=gonad weight,En=egg number in the subsample ,Sw=subsample weight (Wootton 1998). The diameters of 10 oocytes from each subsample were measured by a micrometer lamella under a microscope for determining egg size. Gonadosomatic index (GSI) was determined by the equation:

$$GSI = \frac{Gw \times 100}{Tw}$$

Gw = weight of gonad (g),Tw=total weight of fish(g) (Wossughi et.al.1978). Differences were examined by t-test and x^2 .A value of ($p < (0.05$ and $0.01)$) was considered to represent statistical significance (Kara and Solak 1998).

3. Results

During the 12 months sampling of river waters of Gamasiab river, minimum and maximum and mean range of each of physico chemical properties of water, respectively. Both figure 2 and table 1 show temperature and physico chemical properties changes in the years 2010 to 2011 in Gamasiab River. In this study, 309 fish were caught. 146 specimens were male and 151 specimens were female and 12 specimens were unlimited.

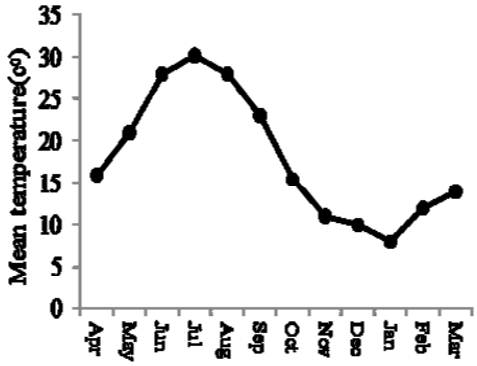

Fig2. The monthly temperature(c°) values of Gamasiab River in 2010-2011

Table 1.The mean,min,max and range for five physico chemical properties of Gamasiab river in 2010-2011

	Mean	Min	Max	Range
Tempeature(c°)	18.63	7.5	30.1	22.6
Ph	6.5	6.2	7	0.8
Hardness	183.2	153	232.2	79.2
EC	1260.06	824	1864	1040
O_2 (ppm)	9.4	9.3	10	0.8

Sex ratio of male to female fish 1: 1/03, respectively. Fish caught in five age groups (1-5) were classified. Figure 3 show numbers of specimens of *C.regium* in different age groups

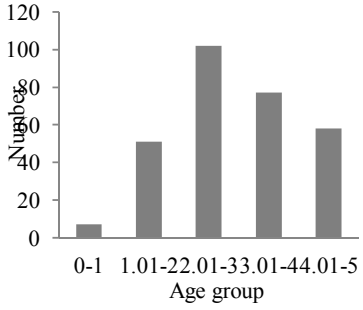

Fig3. Number of specimens of *C.regium* in different age groups in 2010-2011

Both table 2 and 3 show the profile length and weight of fish. The mean GSI for the total population was 5/476 and in male and female fishes were 1/421 and 8/68, respectively. GSI showed a significant difference between male and female fishes (p<0/01). GSI of male and female fishes separately, showed significant differences (p<0/01), (p<0/01).

Table 2.The mean,min,max and range of fork length(mm) in *C.regium* in Gamasiab river in 2010-2011

	Mean	Min	Max	Range
Male	175.9	105	226	121
Female	190.6	121	240	119
Male+Female	182.66	105	240	235

Table 3.The mean,min,max and range of total weight(gr) in *C.regium* in Gamasiab river in 2010-2011

	Mean	Min	Max	Range
Male	73.63	12.2	142.12	129.92
Female	96.6	26	177.6	151.6
Male+Female	88.32	12.2	177.6	165.4

Figure 4 show the GSI changes of the male and female fish during the months of the year 2010-2011. Comparison mean of gonad weights in males and females of different ages showed that with increasing fish ages, gonad weight Increases and this difference for females (p<0/05)and males (p<0/05) was Significant. Mean absolute fecundity in *C.regium* in Gamasiab river was 9422/76 and the minimum and maximum of this were 1367, 19016 respectively. Egg number and age showed significant differences (p<0/01).

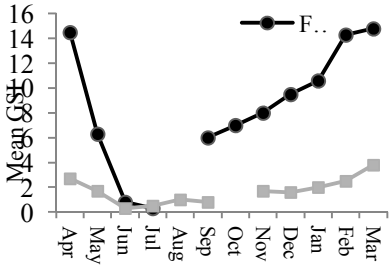

Fig 4. The monthly GSI values of females and male of *C. regium* samples from Gamasiab river in2010-2011. No data were available for female in Aug and male in Oct.

A significant correlation was observed between egg number and age (r^2=0/675),(p=0/05). Figure 5 showed a significant correlation between weight and absolute fecundity (r^2=0/842),(p=0/05). Figure 6 shows that there is significant correlation between fork length and absolute fecundity of fish(r^2=0/782) ,(p=0/05). Gonad weight and absolute fecundity also showed significant correlation (r^2=0/3922), (p=0/01). Average, minimum and maximum relative fecundity (than fork length) and relative fecundity (than weight), were obtained respectively (46/64, 7/02, 108/32) and (96/924, 10/14, 343/23).

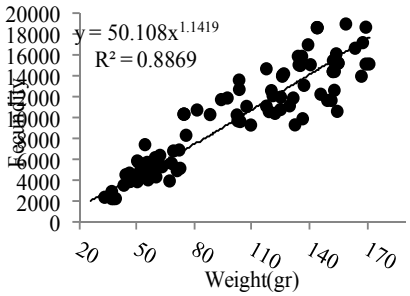

Fig 5.Relationships between fecundity and weight for 151 specimen *C. regium* from Gamasiab River in 2010-2011.

Compared mean of the relative fecundity (than fork length and total weight) of different age showed that the difference between relative fecundity (than fork length) with the age is significant (p<0/01), but the relative fecundity (than total weight) with age does not show any significant difference (p>0/05).

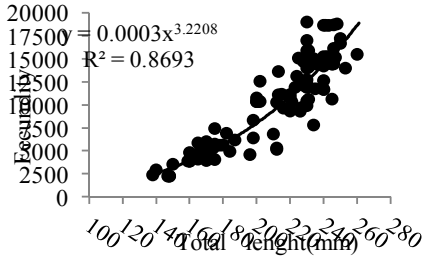

Fig 6. Relationships between fecundity and total lenght for 151 specimen *C. regium* from Gamasiab River in 2010-2011

But in general it was observed that with increasing age increases the relative fecundity. Figure 7 shows the Correlation between absolute fecundity with age

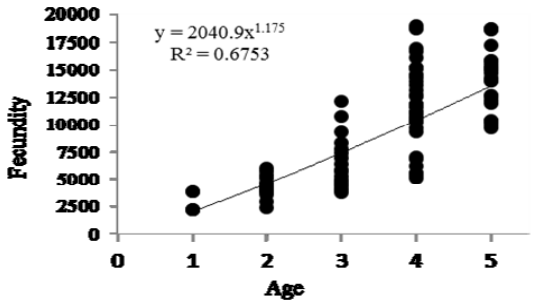

Fig 7. Relationships between fecundity and age for 151 specimen *C. regium* from Gamasiab river in 2010-2011.

Average diameter of eggs was 1/065 mm and minimum and maximum 0/54 and 2 mm were observed. Figure 8 show the changes in egg diameter during the months of the year 2010-2011.

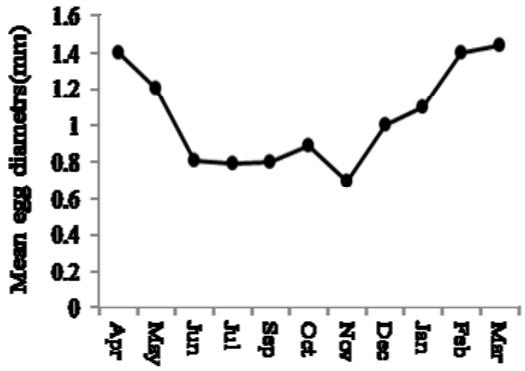

Fig8. The monthly egg size values for 151 specimen *C. regium* from Gamasiab River in 2010-2011. No data were available for Aug.

Average diameter of eggs in different monthe in 2010-2011 showed that the diameter of the egg have started to growth in December and reaches its peak in April. Egg diameter in relation to age was studied and was observed that with increases absolute fecundity and age, the egg diameter decreased. Also significant differences were observed between age and egg diameter ($p<0/01$).

4. Discussions

Gamasiab River was 5/589 and for males 1/41 and the females 8/12 .The max of GSI was observed in males in March and minimum in July and its max for female in April and in July it was at least. In Keban Dam Lake, the average GSI for *C.regium, in* male and female were 0/789, 3/47 and the max was in February and June (Zulfu and Sen 2002). In Sir Dam Lake in males and females, respectively, 1 and 4/57 was estimated and reported that the max is seen in May months (Kara and Solak 1998). Dauod in the 1999(Coad 2010), Oymak in 2000, Sevick in 1997, Balaci in 1990 , Ozcan in 2006, Oymak in 2001 reported that the max for this index of the male and female respectively in months (March - May) (April - July), (April - March), (April - March), (May- May) and (May - July). Water nitrate levels in freshwater and rainy seasons and dry years are the sequence of events that led to the creation of different effects in is reproductive in different samples (Wooton 1995). The seasonal reproductive patterns can be occur caused by weather conditions and species interactions (Gougnrad et al. 1987). Gamasiab river volume in 2008-2009 was low because rainfall was decline and a also due to pressure from the fishing industry ,Gamasiab river fishes feel threatened about their habitat and fishes increase produce sex cells and GSI. Average, minimum and maximum of absolute fecundity,in *C.regium* in Gamasiab river were respectively 9422/76, 1367 and 19 016. It was observed that the absolute fecundity increases with age but be reduced egg diameter, this could indicate that efforts to increase the quantity of fish reproduction and in contrast, it appears that reduce of quality of reproduction is of main maintain the sequence. Absolute fecundity of fish living in the Diyala River, Iraq (Coad 2010) and Tigir River (Coad 2010) were reported 6800 and 13280, the minimum and maximum absolute fecundity of fish living in Anatolia region (Ozcan 2006), Keban Dam Lake (Zulfu 2002), Saivor river (Zulfu 2002) and Ataturk dam lake (Oymak 2001) were respectively 6800,13800and 1904,16800 and1780,11340 and1074 ,15492 numbers. in comparison absolute fecundity with other regions, this is visible of fish inhabit the Gamasiab river have the more eggs with a diameter less and higher GSI, due to stress and pressure on their environment, these fish have a greater effort to reproduce and release reproductive cells, actually the sudden increase in female GSI and reach to maximum of 16/93, prove this theory. It should also be noted that the difference in fecundity in species in different regions is related to genetic profile of the different species and environmental factors such as supply and availability of food and its size, species and varieties (Zulfu 2002). The fecundity have difference for a specified size and in a population from year to other year and even different populations of a species (Nikolskii 1963). Average, minimum and maximum diameter of eggs in fish living in Gamasiab were observed 1/06, 0/54 and 2 mm. Minimum and maximum diameter of eggs in fish living Anatoly, Keban Dam Lake,Ataturk Dam Lake and Saivor river respectively, 0/75 - 1/79, 0/2 - 1/63, 0 / 66 - 1/63, 0/966- 1/939 mm have been reported. Varley in 1967 reported the egg diameter in the major freshwater fish is between 1/3-3/2 mm

(Varley 1967).The fish that have lived at 8-34 C°, are named eurytherm who often spawning at temperatures above 15 C° (Varley 1967). Temperature range in 2010-2011 in Gamasiab river was 7/5-30 C°. Temperature in this river began to rise from February and GSI in male and female fish during the months of March and April reach to peak and be low in May and will fall rapidly in June, therefore they began the breeding season for *C.regium* in Gamasiab river can be from March and max in April and May. It should be noted that the max diameter of the eggs was recorded in April and May. Temperature range was reported 15-25 C° in May and April. The factors such as temperature, ecological conditions, flooding rivers, changes in ion concentrations, changes in water quality, changes in pH and oxygen and carbon dioxide levels and environmental factors affect on the stimulation of sexual maturation (Kamali and Valinasab 2003). (Harsh dry to mesic). Moreover, basal forms of Violaceae showed affinity to mesic and cold conditions under the oak forest. Few species are able to tolerate the entire spectrum of environment and range throughout the gradient (Brown, 2001). Our study showed that perennials gained dominance over annuals in oak forest as well as pine forest (Figure 1). Perennial have ability to conserve soil and with their extensive root systems of perennial grasses they also add more organic matter to the soil than annuals which can be more favourable for plant growth. Singh and Singh (1987) observed that annuals colonize and dominate the early stages of succession. Annuals to perennials species ratio are higher at primary successional site than climax stage. Species richness generally increases during secondary succession when environmental and edaphic conditions are favourable with low fluctuations. The above results indicate that the oak forest makes climax stage for succession. The evenness and β-diversity showed similar values in sub-sites of oak as well as pine forests. The high values of beta-diversity indicate that the species composition varied from one stand to another. Equitability/evenness varied in pine forest with respect to sub-site from 27.3 (HB) to 31.4 (HT) (Table 3). This was because of the conditional presence or absence of functional relationship of species. Comparatively higher value of equitability in pine forest with respect to oak forest indicated that the individual herb species distribution is higher. This may perhaps due to intermediate level of disturbance.

The allocation of species in the Kumaun Central Himalaya is mainly governed by moisture and temperature gradients that incorporate the effect of many physical factors. Moustafa (1990) found that the association of community types is the result of the performance of the species in response to the environmental conditions that prevail in a particular forest type. Tewari (1982) assumed that the temperature gradient is the net product of elevation and aspect; while moisture gradient is a function of slope degree, soil texture and nature of soil surface.

In addition to that, hierarchical diversity concerns taxonomic differences at other than the species level. Pielou (1975) and Magurran (1998) suggested that hierarchical (taxonomic) diversity would be higher in an area in which the species are divided amongst many genera as opposed to one in which most species belong to the same genus, and still higher as these genera are divided amongst many families as opposed to few. The families, genera and species ratio was observed maximum in the pine forest as compared to the oak forest in the present study (Table 4), indicating diverse taxonomic vegetation in the pine forest.

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