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Research Article

Age and growth of brond-snout, *Chondrostoma regium* in Beheshtabad River of Chaharmahal & Bakhtiari Province of Iran (Teleostei: Cyprinidae)

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Abstract: The age and growth parameters of the brond-snout, *Chondrostoma regium* in Beheshtabad River of Chaharmahal & Bakhtiari Province were investigated during April 2013 to April 2014. The males ranged between 8.04-22.10cm and 5.20-105.00g. The females ranged between 7.84-23.15cm and 8.70-155.00g. Males were categorized in age classes 1^+-5^+ and females in age classes 1^+-6^+. The age class 3^+ was the dominant one in the whole samples. The length-weight relationship for males, females and all individuals was as $W=0.0089L^{3.045}$ ($r^2=0.95$), $W=0.0082L^{3.109}$ ($r^2=0.85$) and $W=0.0107L^{3.000}$ ($r^2=0.92$), respectively, indicating a positive allometric growth pattern for the females and an isometric growth for the males and all fish. The age-length and age-weight relationships in males and females were estimated as $L_t=26.23[1-e^{-0.267(t+0.483)}]$, $W_t=160.77[1-e^{-0.267(t+0.483)}]^{3.045}$ and $L_t=31.89[1-e^{-0.148(t+2.067)}]$, $W_t=266.11[1-e^{-0.148(t+2.067)}]^{3.109}$, respectively. The growth performance index (Φ') value was 3.84 in males and 2.18 in females, indicating a faster growth rate in males. The mean condition factor was 1.02±0.01 for males and 1.14±0.02 for females. The relative length of gut was 1.18±0.05 for all fish, indicating a herbivorous habit for this fish. The highest mean feeding intensity of males was in July and the lowest in March and April. In the female, the highest was in January and the lowest in June. The highest mean value of Gut vacuity index of males and females was in the spring and the lowest in summer. About 55% of the studied stomachs were full. The highest number of empty stomachs was in May (80%) and the lowest in July (32%). Based on the mean Gut vacuity index (48%), this fish is considered a medium feeding fish (40<VI<60).

Keywords: Age-Length, Age-Weight, Cyprinidae, Length-Weight relationship.

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Introduction

Age determination is an important step in studying age-length keys, survival rate, growth and mortality indices, age composition and stocks reproduction rate which are the key subjects in fisheries management. Also, determination of age at first maturity, studying the population dynamics, estimating the growth and optimizing the harvesting time are very important (Polat et al. 2001). Length-weight relationships provide basic information in fisheries biology, being beneficial to determine the weight of an individual fish of known length or total weight from length–frequency distribution, and to compare specific growth among different regions. This relationship was first used to gain information on the growth condition and to determine the somatic growth

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pattern of fishes (Hasankhani et al. 2013, 2014).

The cyprinid fish *Chondrostoma regium* (Heckel, 1843) is widely distributed in Tigris-Euphrates basin and the Mediterranean basins of southeastern Turkey and the northern Levant (Suiçmez et al. 2011). In Iran, it is found in Karun River, Karkheh River, the Hoor Alazim Marsh and also in Zayandehrud River and Bushehr basin (Jouladeh-Roudbar et al. 2015; Keivany et al. 2016; Esmaeili et al. 2017). This species is not found in other basins such as the Caspian and other internal basins of Iran (Esmaeili et al. 2014). This species is extensively studied in Turkey. Length-Weight relationship and condition factor of *C. regium* in Euphrates was investigated by Özedmir (1982), age determination by Sen (1993) and Polat & Gumus (1995) in the Bafra Altınkaya Reservoire in Turkey using vertebrae, otoliths, scales, opercle and subopercle. Polat et al. (1999) studied the age range in Suat Ugurlu Reservoir, Turkey. Oymak (2000) examined growth characteristics of this species in Ataturk Reservoir on the Turkish Euphrates River. Gumus et al. (2002) studied the feeding of the species in Suat Ugurlu Reservoir, Turkey. Age, growth and reproduction properties of this species living in Sır Reservoir was reported by Kara and Solak (2004). Ünlu (2006) reported that this species prefers stone grounds and still waters in rivers and lakes in Turkey. Also, Khalaf et al. (1986) studied the age and growth of *Chondrostoma regium* in Diyala River of Iraq. It is a benthopelagic species inhabiting both lentic and lotic environments. This species is omnivorous taking insect larvae and eggs and fry of other fishes, diatoms and algae (Suiçmez et al. 2011).

However, there is little information about *C. regium* biology and habitat requirements in Iran. Mahboobi-Soofiani et al. (2014) studied the age, growth and reproduction of this species in Zayandehrud River in Isfahan basin, Kiani et al. (2016, 2017) studied the age, growth and reproduction of this species in Bibi-Sayyedan River of Semirom and Keivany et al. (2017) studied the reproduction of this species in Beheshtabad River. The aim of the present study was to investigate the age and growth parameters of *C. regium* population in Beheshtabad River of Chaharmahal & Bakhtiari Province, as a tributary of Karun River basin in Iran.

Materials and Methods

A total of 335 specimens (145 females, 185 males and 5 undetermined sexes) were sampled monthly from Beheshtabad River of Chaharmahal & Bakhtiari Province, Iran, from April 2013 to April 2014. The sampling was performed using seine and gill-nets of various mesh sizes. After being caught, fish samples were transported to the laboratory and their total length (L) (in mm) and weight (W) (in g) were measured to the nearest 0.01 mm and 0.01 g, respectively. Scale preparation for ageing was based on Biswas (1993). The length-weight relationship (LWR) was calculated by the formula:

$$W=aL^{b}$$

Where W is the weight of fish (g), L is the total length (cm), *a* Intercept and *b* the slope of the regression line. The strength of LWR was evaluated by means of regression coefficient (r^2). The value of *b* can determine the growth pattern (Pauly 1984).

$$T=(sdLnLT/sdLnW)\times(lb\text{-}3l/\sqrt{1-r^2})\times\sqrt{n-2}$$

Where sdLnLT is the standard deviation of the log length of fish, sdLnW is standard deviation of the log weight, b, is the slope of LWR and r^2 is the regression coefficient. This value is the square of the correlation coefficient of n samples.

Age was determined by scales. Some 11-15 scales from the left side of the body between the lateral line and dorsal fin were removed and cleaned using 3% KOH and 96% ethanol and were read under a binocular microscope for age determination by three people to verify the correctness of the readings. The Von Bertalanffy (1938) growth function was used to determine age-length relationship as:

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

Where Lt is the total length at age t; L∞ is the asymptotic length (cm), k is the body growth coefficient ($year^{-1}$) and t_0 is the theoretical age at zero length ($year^{-1}$). The growth performance index was

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used to compare growth of fish (Pauly & Munro 1984):

$$\Phi'=\log k+2\log L_\infty$$

Sex was determined by visual examination of gonads. For sex ratio calculation, the Chi square test was used:

$$X^2=\sum(Oi-Ei)^2/Ei$$

Where X^2 is K-square, Oi is the observed sex ratio and Ei is the expected sex ratio. The condition factor was calculated by Hile (1936) formulae:

$$CF=(W/L3)\times100$$

Where CF=condition factor, W=total body weight (g) and L=Total length (cm). The relative length of gut was calculated following Al-Hussaini (1949) as:

$$RLG=Li/TL$$

Where RLG= Relative length of gut, Li=gut length (cm) and TL=Total length (cm). The feeding intensity was calculated following Desai (1970) as:

$$FI=Wi/W$$

Where FI= feeding intensity, Wi=gut weight (g) and W=Total body weight (g). The vacuity index was calculated following Euzen (1987) as:

$$VI=(Es/Ts)\times100$$

Where VI= vacuity index, Es= number of empty guts and Ts=number of total examined guts. To compare mean length, weight and age of the different months, one way analysis of variance (ANOVA) followed by Duncan multiple range test at 95% confidence level, in SPSS 19 and Excel 2010 computer software, were used.

Results

The length, weight, age and sex of 335 specimens (185 males, 145 females and 5 unidentified) of *C. regium* in Beheshtabad River of Chaharmahal & Bakhtiari Province were determined during a full year (Tables 1 and 2). The total length for males ranged 8.04-22.10cm (15.69±0.24), for females 7.84-23.15cm (17.50±0.20) and for unidentified between 5.95-7.08cm (6.46±0.23). The total weight for males ranged 5.20-105.00gr (44.75±1.81), for females between 8.70-155.00gr (65.39±2.45) and for unidentified 4.69-1.90gr (2.99±1.10). The length

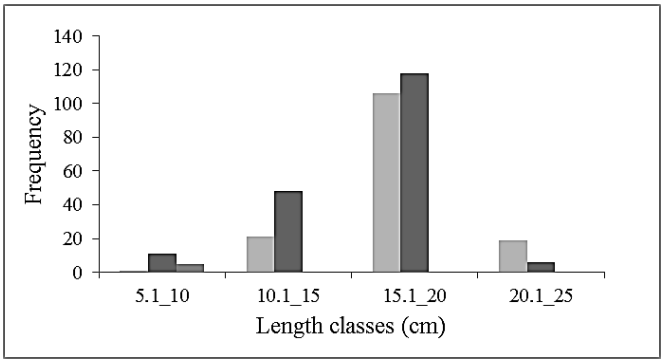

Fig.1. The frequency of males (dark), females (medium) and immature (very light bar) at different length classes of *Chondrostoma regium* from Beheshtabad River.

class 15.1-20 was the dominant in both sexes (Fig. 1).

Age ranged between 1^+-5^+ years in males and 1^+-6^+ years in females. Undetermined specimens belonged to 0^+ age group. The 3^+ year class was dominant in both males and females (Table 2). Some 145 specimens (68%) were females, 85 (29%) males, and 5 (3%) were undetermined sexes, because they had very thin and transparent gonads (Fig. 1). The sex ratio was 1M:1.3F, which is significantly different from 1:1 ratio (P<0.05) (Table 1). Females were dominant in all age groups.

The length-weight relationship for males, females and all individuals was as $W = 0.0089L^{3.045}$ (r^2= 0.95), $W=0.0082L^{3.109}$ (r^2=0.85) and $W= 0.0107L^{3.000}$ (r^2=0.92), respectively, indicating a positive allometric growth pattern for the females and an isometric growth for the males and all fish (Fig. 2). Correlation coefficient value (b), which determines the growth pattern, was very close in males and females and more than 3, based on Pauly (1934) test, a positive allometric growth pattern for the females and an isometric growth for the males and all fish (P<0.05).

The age-length and age-weight relationships in males and females were estimated as $L_t= 26.23[1-e^{-0.267\,(t+0.483)}]$, $W_t= 160.77[1-e^{-0.267(t+0.483)}]^{3.045}$ and $L_t= 31.89[1-e^{-0.148(t+2.067)}]$, $W_t= 266.11[1-e^{-0.148(t+2.067)}]^{3.109}$, respectively (Figs. 3-5). The Von Bertalanffy growth parameters for males, females, and all fish are displayed in Figure 3. Based on the growth performance index (Φ'), males showed a

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Table 1. The frequency of males (dark), females (medium) and immature (very light bar) at different length classes of *Chondrostoma regium* from Beheshtabad River.

Months	Sex	Counts	Sex ratio	Weight Mean±SD	Total Length Mean±SD
April 2013	Male	16	1:0.25	64.69±3.38	18.61±0.35
	Female	4		84.07±4.99	19.37±0.42
May	Male	6	1:1.25	52.35±4.52	16.57±0.89
	Female	8		54.64±7.33	16.13±0.74
June	Male	12	1:0.45	35.70±4.40	14.88±0.44
	Female	5		57.88±9.53	16.29±0.68
July	Male	17	1:0.5	70.33±3.49	18.08±0.21
	Female	9		87.00±5.73	18.83±0.65
August	Male	22	1:0.70	34.81±2.25	15.13±0.35
	Female	15		52.06±3.16	16.89±0.33
September	Male	8	1:0.75	51.12±4.83	16.99±0.54
	Female	6		59.88±5.31	17.58±0.53
October	Male	7	1:2	81.30±6.60	19.08±0.56
	Female	14		71.42±6.62	18.16±0.55
November	Male	7	1:2	30.38±6.17	14.07±1.04
	Female	14		73.32±9.23	17.64±0.64
December	Male	31	1:3.3	17.52±2.86	11.17±0.43
	Female	9		31.37±7.57	13.99±0.87
January	Male	16	1:1.1	39.08±4.15	15.81±0.83
	Female	15		47.29±3.98	16.66±0.75
February	Male	31	1.0.8	45.11±3.84	16.55±0.47
	Female	24		58.13±4.33	17.73±0.28
March	Male	9	1:2.1	73.24±7.70	18.20±0.68
	Female	12		95.71±6.05	19.40±0.47
April 2014	Male	5	1:1.2	33.90±13.90	13.79±0.87
	Female	6		106.73±17.18	19.37±0.24
	Total	335	1:1.3	53.11±1.59	16.35±0.17

Table 2. Age groups of *Chondrostoma regium* in Beheshtabad River and their sex ratios.

Age	Males	Females	M:F
0^+	0	0	-
1^+	8	3	1:2.7
2^+	44	17	1:2.6
3^+	77	72	1:1.1
4^+	45	28	1:1.6
5^+	10	19	1:2.0
6^+	0	2	-
Total	184	141	1:1.3

higher (3.84) growth rate than females (2.18). Mean total length and weight for different ages of males and females were estimated (Fig. 4). Age-Length and Age-Weight relationships of males and females are plotted in Figures 5 and 6.

The mean condition factor was significantly different in some months. The highest value was in spring and the lowest in fall (Fig. 6). The mean RLG

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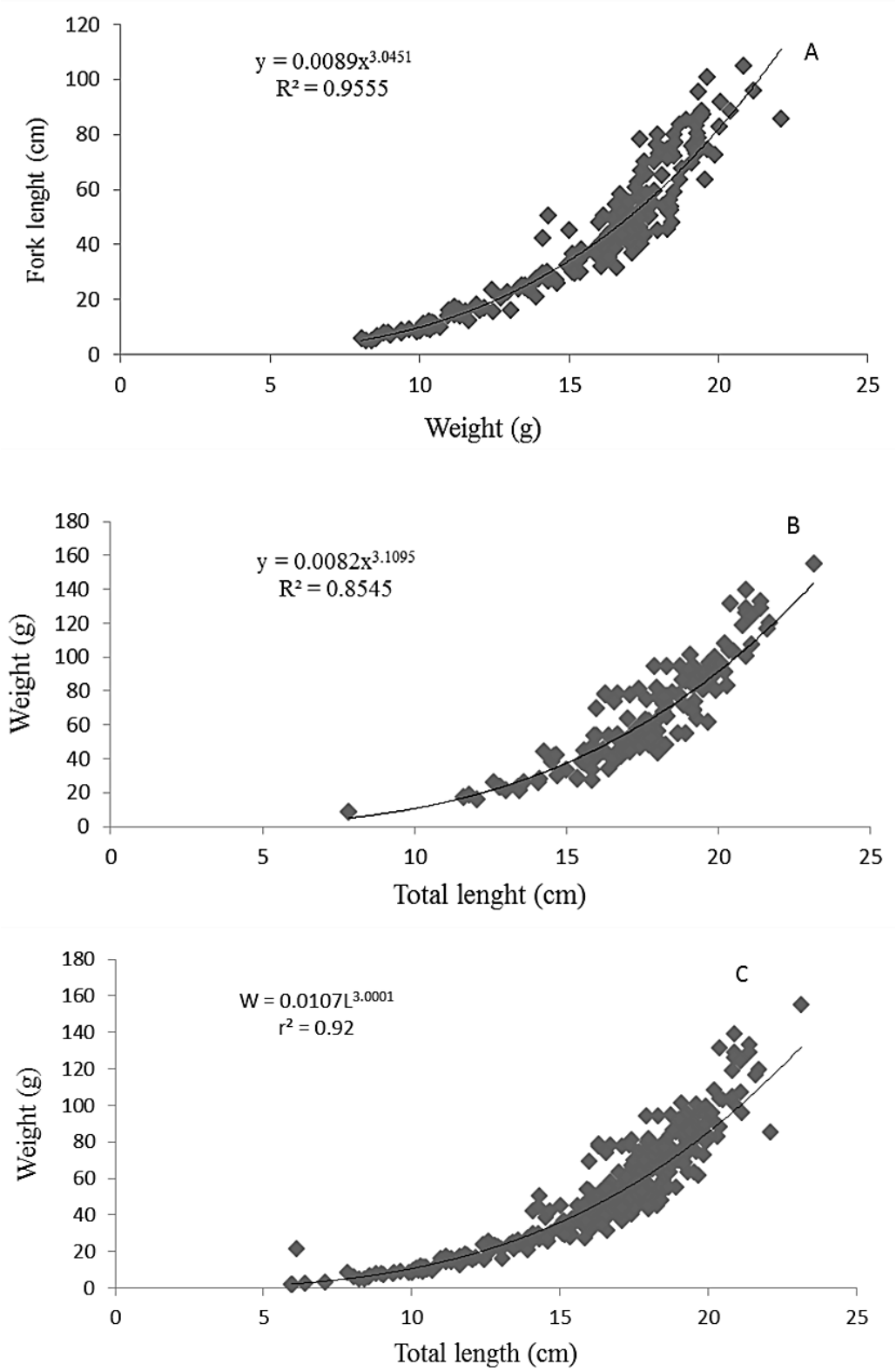

Fig.2. Length–weight relationships of *Chondrostoma regium* samples from Beheshtabad River of Chaharmahal & Bakhtiari Province, Isfahan, Iran. A) male, B) female, C) all the specimens.

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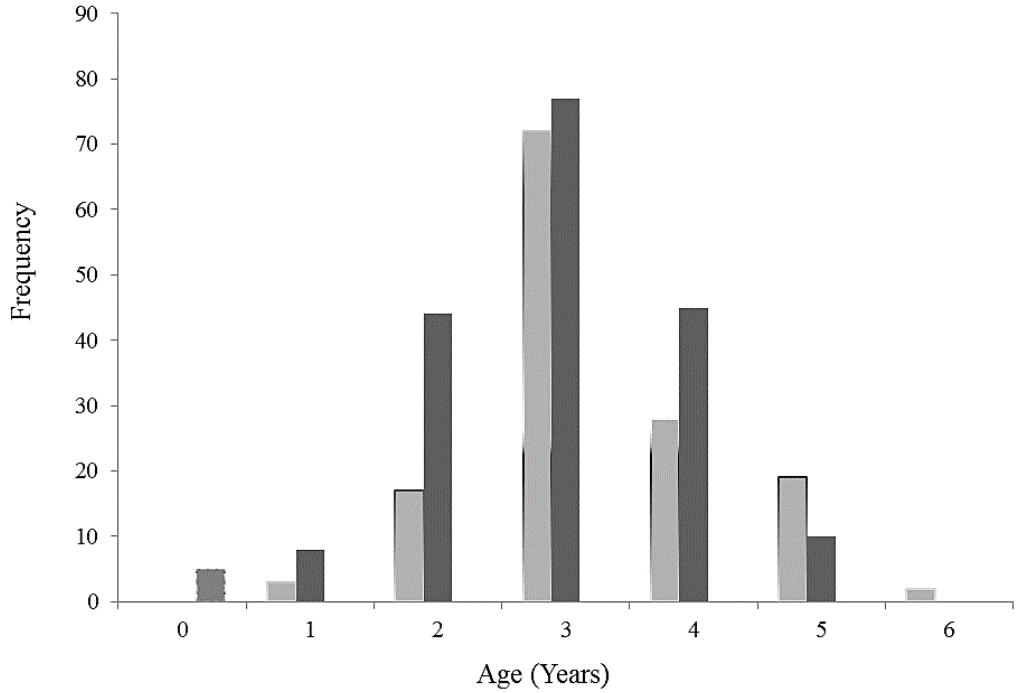

Fig.3. The frequency for each age group of *Chondrostoma regium* from Beheshtabad River. Males (dark), and females (light bar).

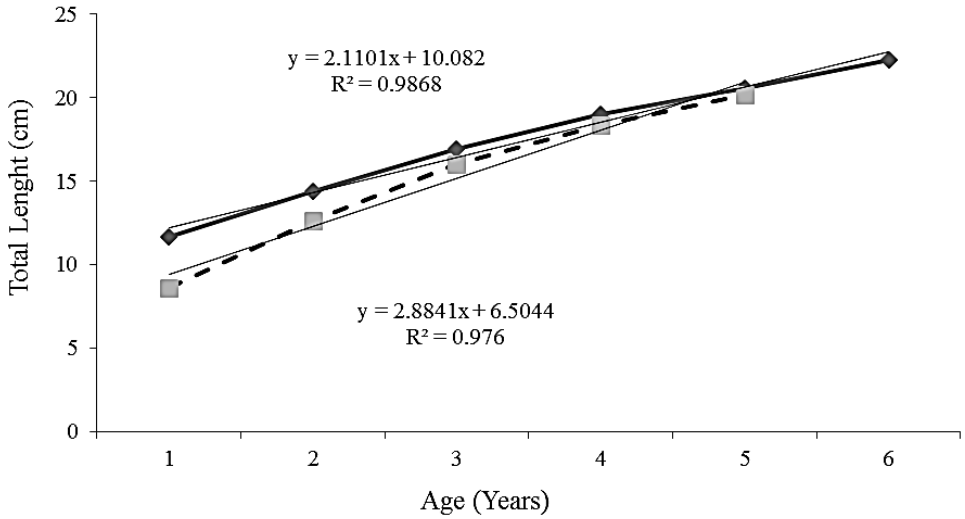

Fig.4. Age-Length relationships of males (dark dash line) and females (light continues line) of *Chondrostoma regium* in Beheshtabad River.

for all fish was 1.18±0.05 indicative of a herbivorous habit for this fish. In age group 5.1-10 cm showed a Signiant difference with others. No difference between the sexes (Table 3). The mean feeding intensity of males and females was different in some months (P<0.05). The highest value in the males was in July and the lowest in March and April (Fig. 7). In the female, the highest was January and the lowest in June. The highest mean value of Gut vacuity index of males and females was in the spring and the lowest in summer (Fig. 8). About 55% of the studied stomachs were full. The highest number of empty stomachs was in May (80%) and the lowest in July (32%). Based on the mean Gut vacuity index (48%), this fish is considered a medium feeding fish (40<VI<60).

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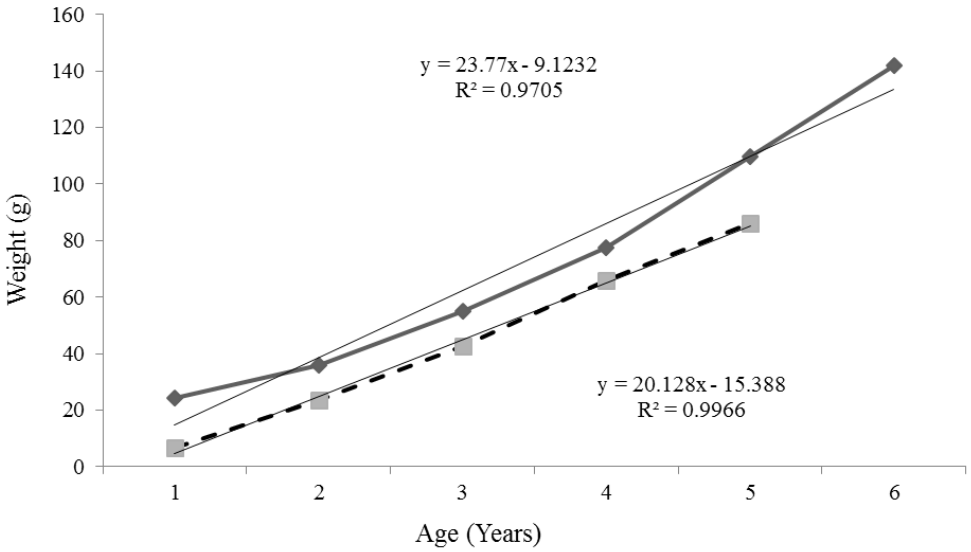

Fig.5. Age-Weight relationships in males (dark dash line) and females (light continues line)) of *Chondrostoma regium* in Beheshtabad River.

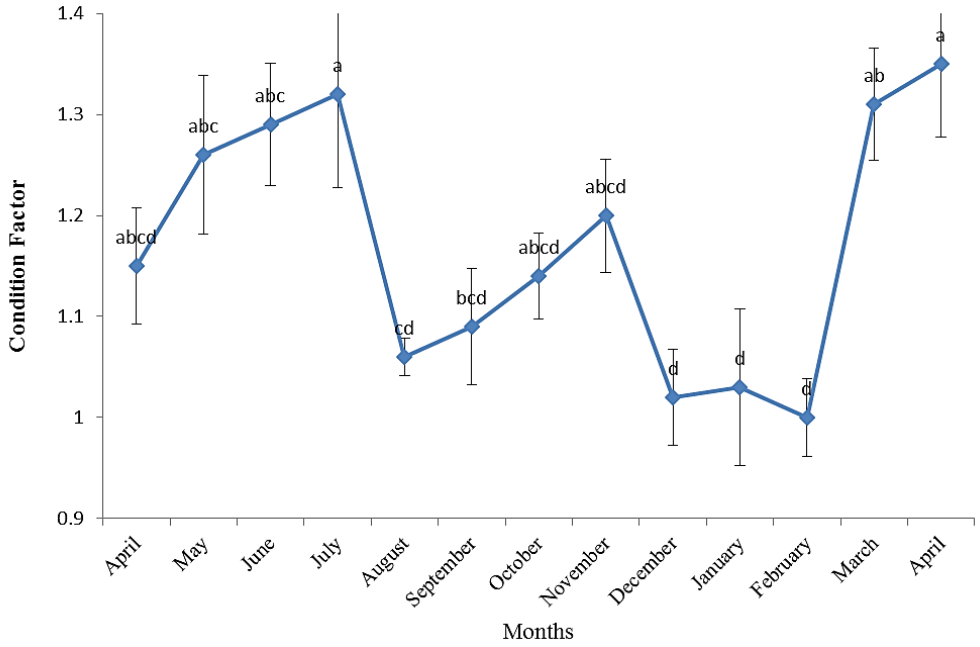

Fig.6. Condition factor of *Chondrostoma regium* in Beheshtabad River.

Table 3. Relative length of gut in different length classes of *Chondrostoma regium* in Beheshtabad River.

Length classes Total Length (cm)	Counts	Mean Relative gut length
5.1-10	18	0.49±0.19[a]
10.1-15	68	1.24±0.14[b]
15.1-20	224	1.22±0.06[b]
20.1-25	25	1.18±0.13[b]
Total	335	1.18±0.05

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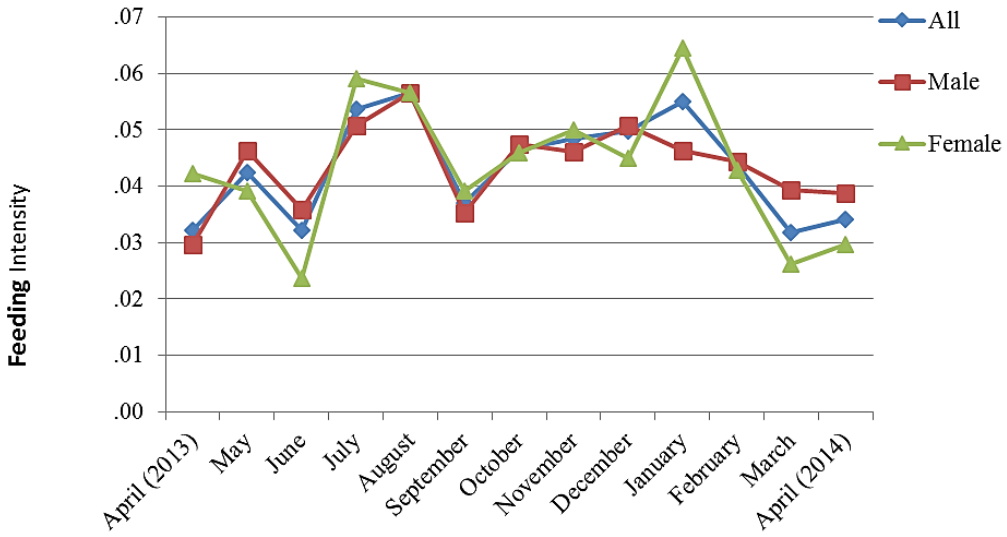

Fig.7. Feeding intensity of *Chondrostoma regium* in Beheshtabad River.

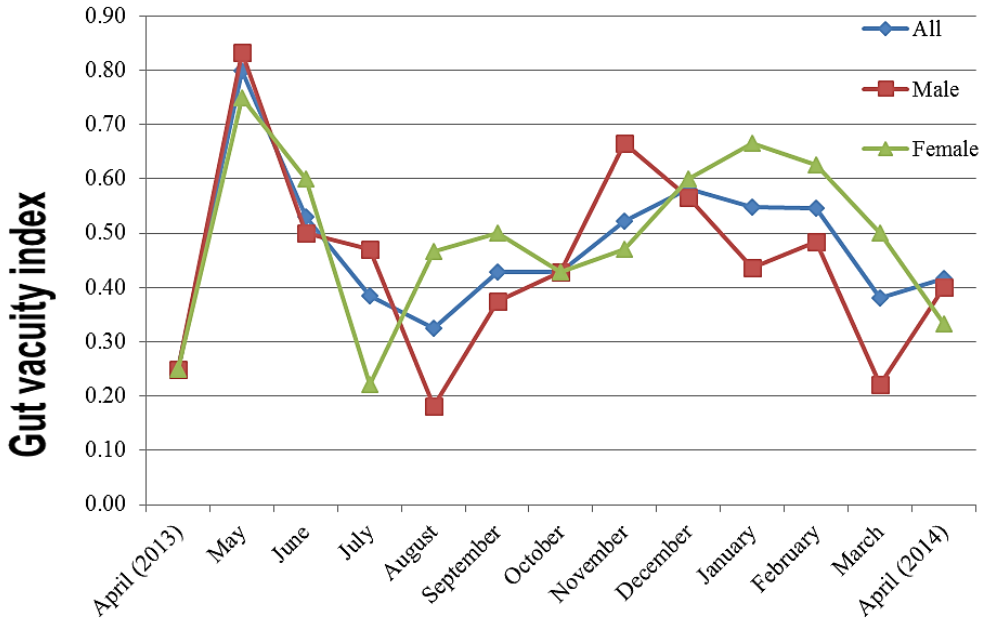

Fig.8. Gut vacuity index of *Chondrostoma regium* in Beheshtabad River.

Discussion

Age range in this study for males and females was 1^+–5^+ and 1^+–6^+ years, respectively, and age class 3^+ years was dominant in both sexes. Age ranges for this species from different habitats in Turkey were determined as 2^+–5^+ years in Koban River (Sen 1993), 1^+-8^+ years in Euphrates (Oymak 2000), 2^+-5^+ years in Karakaya Reservoir (Kalkan & Eredmil 2003), 1^+–5^+ years in Sir Reservoir (Kara & Solak 2004), 1^+-4^+ years in Seyhan Reservoir (Ergüden et al. 2010), and 1^+-6^+ years for females and 1^+-5^+ years for males in the Almus Reservoir (Suiçmez et al. 2011). Mahboobi-Soofiani et al. (2014) reported that as 1-6 for males and 1-5 for females from Zayandehrud River and Kiani et al. (2016) as 1^+-4^+ for males and 1^+-5^+ for females with the age class 3^+ being the dominant one from Bibi-Sayyedan River. The slight differences in the age distribution may be due to differences in habitat, nutrients, genetic, populations, fishing tools, mesh size and error in age determination (Kara & Solak 2004; Ghanbarzadeh et al. 2014).

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Sex differentiation is one of the main indices in fish biology and also the primary stage for artificial breeding. Sex ratio can provide information about the mortality of a particular sex. In this study, the sex ratio was 1M:1.3F, which is significantly different from the expected ratio. Sex ratio in *C. regium* in Euphrates was calculated as 1M:1F (Sevik 1998) in Ataturk Reservoir as 1M:0.7F (Oymak 2000) and in Almus Reservoir as 1M:0.7F (Suiçmez et al. 2011). Mahboobi-Soofiani et al. (2014) reported that as 1M:1.8F from Zayandehrud River and Kiani et al. (2016) as 1M:2.3F from Bibi-Sayyedan River. Although the sex ratio in some populations was close to 1, for most populations the estimated values were significantly different from the expected ratio. In this research the females were more abundant than the males. Males had a short lifetime and earlier sex maturation. This difference could increase the ratio of females to males. Another reason could be the easier catch of one sex relative to another. Moreover, increasing variety of resources and availability of food supplies are other factors affecting the sex ratio. When food is abundance in the ecosystem, females outnumbers the males and vice versa. It has been reported that females take advantage of environmental conditions more than males. Effect of temperature, selective mortality through sexual variable fishing, different behavior between the sexes, stopping of one sex in spawning zone and seasonal patterns of spawning migration is among the factors affecting the sex ratio in different geographical areas. Also, the differences in sex ratio may be due to fishing tools, predation season and time-location dispersal. This index may differ from one species to another, from one population to another population of the same species, and can vary from year to year within the same population (Nikolsky 1963; Schultz 1996). Several other instances to explain this sexual occurrence include variation in spatial distribution, different response to the given net color or differences in their feeding behavior (Wirtz & Morato 2001).

The total length and weight range of males were 8.04-22.10cm and 5.20-105.00g and of females were 7.84-23.15cm and 8.70-155.00g, respectively. The range of length in males was smaller than that of females. The smaller size of the males may be due to the halting of growth at maturity and higher male mortality rates (Penaz & Zaki 1985). Length and weight ranges of *C. regium* in Euphrates River was reported as 11.5-29.2 cm and 17-283 g (Sevik 1997), in Ataturk Reservoir as 13.0-30.5cm and 23-385g (Oymak 2000), in Karakaya Reservoir as 20.4-31.8 cm and 109-314g (Kalkan & Erdemli 2003), In Savur Stream as 2.8-29.0cm and 11-296g (Ünlu et al. 2006), in Seyhan River as 14.64-21cm, 36.93-97.68g and 16-23.55 and 48.74-131.20g (Ergüden et al. 2010). Mahboobi-Soofiani et al. (2014) reported that as 10.7-19.7cm for males and 1-10.5-18.0cm for females from Zayandehrud River and Kiani et al. (2016) as 6.1-18.1 for males and 5.5-21.5 for females from Bibi-Sayyedan River. As it appears, the Beheshtabad River population reaches a smaller size relative to those in Euphrates River, Ataturk Reservoir, Karakaya Reservoir d Savur Stream and to the same size as that in Seyhan River. Differences in the length and weight compositions could be due to many factors, including habitat, ecological properties of the study areas, season, the numeral and size of samples, sampling time and method, types of length measured, degree of stomach fullness, sex, gonad maturity, wellbeing, conservation techniques and differences in observed length ranges of studied specimen (Tesch 1971; Suiçmez et al. 2011; Keivany et al. 2012; Tabatabaei et al. 2014), and environmental conditions such as temperature and photoperiod and intraspecific difference with other individuals in different geographic regions (Keivany & Soofiani 2004; Hasankhani et al. 2013). Also, the *b* value being more than 3 is indicating a positive allometric growth; the value of *b* can be variable between 2.5 and 4 and as a result of changes in fish shape, season, age, food availability, feeding, geographical location and growth (Özcan 1987). Also, it is likely that in Bibi-Sayyedan River, dietary behavior and competition for food increase the *b*

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Table 4. The Von Bertalanffy growth parameters and growth performance index values of *Chondrostoma regium* reported from different studies.

Studies	Sex	n	L∞ (cm)	t_0 (year)	K (year^{-1})	Φ'
Ünlu (1990)	F	188	28.35	-3.30	0.430	2.53
(Savur Stream)	M	101	23.76	-3.08	0.670	2.57
Oymak (2000)	F	422	38.67	-3.07	0.136	2.30
(Attaturk Reservoir)	M	303	35.01	-2.75	0.168	2.31
Kara & Solak (2004)	F	252	31.89	-3.44	0.178	2.55
(Sir Reservoir)	M	209	38.13	-4.03	0.117	2.23
Ergüden (2010)	F	89	29.83	-1.98	0.262	2.36
(Seyhan Reservoir)	M	75	26.85	-1.63	0.255	2.26
Suiçmez et al. (2011)	F	194	33.50	-2.36	0.219	2.39
(Almus Reservoir)	M	128	27.50	-1.45	0.397	2.47
Mahboobi Soofiani et al. (2014)	M	81	24.6	-0.175	0.206	2.09
(Zayandehrud River)	F	140	25.3	-0.034	0.206	2.12
Kiani et al. (2016)	M	103	18.97	-0.580	0.279	2.35
(Bibi-Sayyedan River)	F	192	23.87	-0.535	0.196	2.23
Present study	M	145	26	-0.42	0.148	3.84
(Beheshtabad River)	F	185	31	-0.24	0.266	2.18

n: number of specimens, L∞: asymptotic length, K: Growth rate, t_0: Hypothetical age at zero length, Φ': Growth performance index.

value (Suiçmez et al. 2011; Esmaeili et al. 2014).

There is little data on age and growth parameters and growth performance index of this species in the literature (Froese & Pauly 2016). The growth rate for males was higher than females in the early life, but in later phases, this rate declined in males and increased in females. Asymptotic length and weight estimated for females (L∞=31.89cm and W∞=262.11g) was higher than for males (L∞=26.23cm and W∞= 160.77g and the growth coefficient for females (K= 0.148) was less than that for males (K=0.267). This may be related to the faster growth and longer lifespan of females (Ricker 1975). Mahboobi-Soofiani et al. (2014) reported that as L∞=246cm, W∞=163.29g and K=0.206 for males and L∞= 253.1cm and W∞=188.25g and K=0.206 for females from Zayandehrud River and Kiani et al. (2016) as L∞=18.97cm, W∞=61.91g and K=0.279 for males and L∞=23.85cm and W∞=124.75g and K=0.196 for females from Bibi-Sayyedan River. The Φ' values of present study are not significantly different from most other studies (Table 4) (P>0.05).

Growth differences in Ergüden et al. (2010) are probably due to animate environmental conditions, fishing period and lentic systems. Population of *C. regium* in Bibi-Seyyedan River grow relatively slower than other areas. Fish in standing waters, grow better than flooding streams because of more abundant food, higher temperatures and less activity requirements in standing waters (Ünver & Tanyolaç 1999; Noltie 1988).

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مقاله پژوهشی

سن و رشد ماهی نازک (*Chondrostoma regium*) در رودخانه بهشت‌آباد استان چهارمحال و بختیاری ایران (ماهیان استخوانی عالی: کپورماهیان)

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گروه شیلات دانشکده منابع طبیعی دانشگاه صنعتی اصفهان، اصفهان ۸۴۱۵۶۸۳۱۱۱، ایران.

چکیده: پارامترهای سن و رشد ماهی نازک (*Chondrostoma regium*) در رودخانه بهشت‌آباد چهارمحال و بختیاری در طی اردیبهشت ۱۳۹۲ تا اردیبهشت ۱۳۹۳ مورد بررسی قرار گرفت. طول نرها بین ۲۲/۱۰-۸/۰۴ سانتی‌متر و وزن آنها بین ۱۰۵/۰۰-۵/۲۰ گرم بود. طول ماده‌ها بین ۲۳/۱۵-۷/۸۴ سانتی‌متر و وزن آنها بین ۱۵۵/۰۰-۸/۷۰ گرم بود. نرها در گروه‌های سنی $^{+}$۵-$^{+}$۱ و ماده‌ها در گروه‌های سنی $^{+}$۶-$^{+}$۱ سال قرار داشتند. گروه سنی $^{+}$۳ سال گروه غالب در بین همه نمونه‌ها بود. رابطه طول و وزن برای نرها، ماده‌ها و همه افراد به ترتیب به صورت $W=0.0089L^{3.045}$ ($r^2=0.95$)، $W=0.0082L^{3.109}$ ($r^2=0.85$) و $W=0.0107L^{3.000}$ ($r^2=0.92$) بود که نشانگر رشد ناهمسان مثبت در ماده‌ها و رشد همسان برای نرها و کل افراد بود. رابطه سن و طول و سن و زن در نرها و ماده‌ها به‌ترتیب به صورت $L_t=26.23[1-e^{-0.267(t+0.483)}]$، $W_t=160.77[1-e^{-0.267(t+0.483)}]^{3.045}$ و $L_t=31.89[1-e^{-0.148(t+2.067)}]$، $W_t=266.11[1-e^{-0.148(t+2.067)}]^{3.109}$ بود. شاخص عملکرد رشد (Φ') در نرها ۳/۸۴ و در ماده‌ها ۲/۱۸ بود که نشاندهنده رشد سریع‌تر نرها است. میانگین شاخص وضعیت در نرها ۰/۰۱±۱/۰۲ و در ماده‌ها ۰/۰۲±۱/۰۱ بود. طول نسبی روده در همه ماهی‌ها ۰/۰۵±۱/۱۸ بود که نشاندهنده نوع تغذیه گیاهخواری در این گونه است. بیشینه میانگین شدت تغذیه در نرها در تیرماه و کمینه آن در اسفند و فروردین بود. در ماده‌ها بیشینه میانگین شدت تغذیه در دی‌ماه و کمینه آن در خردادماه بود. بیشینه میانگین شاخص تهی بودن معده در نرها و ماده‌ها در بهار و کمینه آن در تابستان بود. حدود ۵۵٪ معده‌های مورد بررسی پر بودند. بیشترین تعداد معده خالی در اردیبهشت‌ماه (۸۰٪) و کمترین آن در تیرماه (۳۲٪) بود. بر اساس میانگین تهی بودن معده (۴۸٪)، این ماهی با تغذیه متوسط محسوب می‌شود (40<VI<60).

کلمات‌کلیدی: رابطه سن-طول، سن-وزن، کپورماهیان، طول-وزن.

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