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A Study on the Age, Growth and Reproduction of *Aspius vorax* (Heckel, 1843) (Cyprinidae) in Atatürk Dam Lake (Euphrates River), Turkey

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Abstract

In this study, the age, growth and reproduction characteristics of *Aspius vorax*, which were caught from Atatürk Dam Lake (Euphrates River) between September 2007 and August 2008 were determined. The age composition of the specimens ranged between II and IX age groups. The observed sex ratio was 1:1.75 (females/males). The fork length and weight of the individuals that were examined ranged from 184 to 863 mm and from 54 g to 4,317 g, respectively. The relationship of fork length (L_F) and scale radius (S) was estimated as: L_F=-95.6669+172.254 *S*, (r^2= 0.669). L_∞ values were calculated to be 158.36 cm for females and 218.47 for males. Length - weight relationships were Log *W* =-3.4242+2.4297 Log L_F (r^2=0.8686) for females, and Log *W* =-4.7247+2.9051 Log L_F (r^2=0.9549) for males. Mean somatic condition of females and males were estimated as 1.069 and 1.062, respectively. The highest values of the somatic condition were determined in the November for females (*K*=1.23) and in the September and October (*K*=1.13) for males. Males matured during their third year of life in the studied samples, but due to lacking of young female specimens, the first maturity age for female was not determined. However, all those females examined at age 4 and over were seen to reach mature.

Keywords: *Aspius vorax*, growth parameters, condition factor, fecundity, gonadosomatik index.

Atatürk Baraj Gölü (Fırat Nehri, Türkiye)'nde Yaşayan *Aspius vorax*'ın Heckel, 1843 Yaş, Büyüme ve Üremesi Üzerine Bir Çalışma

Özet

Bu çalışmada, Eylül 2007 ile Ağustos 2008 arasında Atatürk Baraj Gölü'nden (Fırat Nehri) yakalanan *Aspius vorax* türünün yaş, büyüme ve üreme özellikleri belirlenmiştir. Örnekler II-IX yaş grupları arasında dağılım göstermiştir. Gözlenen eşey oranı 1:1,75 (dişi/erkek) olarak belirlenmiştir. İncelenen örneklerin çatal boyu 184-863 mm, ağırlıkları ise 54-4.317 g olarak ölçülmüştür. Çatal boy (L_F) ve radius çapı (S) ilişkisi: L_F=-95,67+172,254 *S*, (r^2= 0,669) şeklinde hesaplanmıştır. L_∞ değeri dişilerde 158,36 cm erkeklerde 218,47 cm, boy-ağırlık ilişkisi dişilerde Log *W* = -3,424 + 2,4297 Log L_F (r^2=0,8686), erkeklerde Log Log *W* = -4,7247 + 2,9051 Log L_F (r^2=0,9549) olarak. Ortalama somatik kondisyon dişilerde 1,069, erkeklerde ise 1.062 olarak hesaplanmıştır. En yüksek değer ise dişilerde kasım (*K*=1,23), erkeklerde ise eylül ve ekim (*K*=1,13) aylarında görülmüştür. İncelenen örneklerde erkeklerin 3. yıldan itibaren eşeysel olgunluğa ulaştıkları belirlenmiştir. Bununla birlikte daha genç yaşlara ait dişi birey elde edilmediği için dişilerde ilk eşeysel olgunluk yaşı tam olarak belirlenememiştir. Ancak incelenen 4 yaş ve üstündeki bütün dişi bireylerin eşeysel olgunluğa ulaştıkları görülmüştür.

Anahtar Kelimeler: *Aspius vorax*, büyüme parametreleri, kondisyon faktörü, yumurta sayısı, gonadosomatik indeks.

Introduction

The freshwater fish *Aspius vorax* Heckel, 1843, is a cyprinid which is found along the Euphrates and Tigris Rivers in Turkey, Syria and Iraq (Mahdi, 1967; Kuru, 1979; Coad, 1996; Bogutskaya, 1997). The biological characteristics of the *A. vorax* have been investigated in several studies at different localities in Iraq (Jasim, 1980; Shafi and Jasim, 1982; Ali *et al*., 1986; Al-Nasiri *et al*., 1975; Al-Dabical and Al-Daham, 1995; Epler *et al*., 2001; Szczerbowski *et al*., 2001 and Szypula *et al*., 2001). However, there is no available information regarding the biological characteristics of the *A. vorax* in Turkey.

The present paper aims to determine some biological characteristics; such as age and sex composition, growth in length and weight, age-length, age-weight and length-weight relationships, somatic condition, spawning time, age of sexual maturity and fecundity of *A. vorax* from the Atatürk Dam-Lake,

Turkey.

Study Area

Atatürk Dam Lake was built on Euphrates River in the South-Eastern Anatolia for irrigation and hydroelectric purposes, which was completed in 1990. It is the largest man-made dams in Turkey. The lake covers an area of approximately 817 km². The lake surface lies 530 m above sea level.

Due to its large size and ecological properties, it has a high importance of fisheries and fishing potential at 21 fishing areas (Şafak *et al*., 1994; Olgunoğlu *et al*., 2009). About 28 species and subspecies, belonging to 8 families live in the River Euphrates and its reservoirs in Turkey, Syria and Iraq (Kuru, 1979; Bozkurt, 1994). Some of the fish species living in the lake have a high economical value, such as *Aspius vorax*, *Capoeta trutta*, *Capoeta capoeta umbla*, *Carasobarbus luteus*, *Barbus esocinus*, *Barbus rajanorum*, *Leuciscus lepidus*, *Tor grypus*, *Mastacembellus mastacembellus* and *Silurus triostegus* (Bozkurt *et al*., 1999; Duman and Çelik, 2001; Oymak *et al*., 2001; Olgunoğlu *et al*., 2009). In 2008, the total quantity of local fish catches at the fishing areas (Adiyaman) was determined as 397.61 ton/year (Olgunoğlu *et al*., 2009)

The study was conducted from two important fishing area on the Atatürk Dam-Lake (Figure 1) near Kahta and Samsat towns, Adiyaman Turkey. More than 30 commercial fishing boats operate in these fishing areas. In the area, average monthly temperatures vary between 12°C during December and February and 25°C during August. In generally, vegetation is poor in the shore. However, the habitat which Kahta stream participates to Dam Lake is dominated by bulrush, which is among the most valued plant for fish.

Materials and Methods

Totally 201 *A. vorax* specimens were captured monthly from September 2007 to August 2008 by using gill-nets of mesh sizes 25, 32, 40, 55, 60 and 80 mm. Each net was 100 m long and 2 m deep. The distribution of fish number caught during the study period is given in Table 1.

The caught fishes were immediately transported to the laboratory to record their fork length (FL, mm) and sex. Ten to fifteen scales were removed from the right side of each fish body just between the lateral line and dorsal fine base. Scales were cleaned in the 5% sodium hydroxide solution for 2 hours. They were then rinsed and wiped clean to remove any flesh and mucilage. Non-regenerated scales were then mounted between two glass microscope slides. They were examined for age determination via a microfilm reader (Chugunova, 1963). All scales were read twice and a third reading was made if the first two readings differed. When two of the three measures did not agree, the scale was discarded.

The chi-square analysis was used to determine whether the sex composition differs between female and male and to compare overall sex ratios in studied specimens (Zar, 1996; Mendonca *et al*., 2006).

Back-calculated fish lengths were determined by Fraser-Lee formula (Francis, 1990; Morita, 2001).

$$L_{Ft}=[S_t \,.\, S_c^{-1} (L_{Fc} - a)]+a$$

where L_{Ft} is the back-calculated fork length (mm) at time t, S_t is the distance from the scale focus to the annulus (mm) at time t, S_c is the total scale radius (mm), and L_{Fc} is the fork length (cm) at the

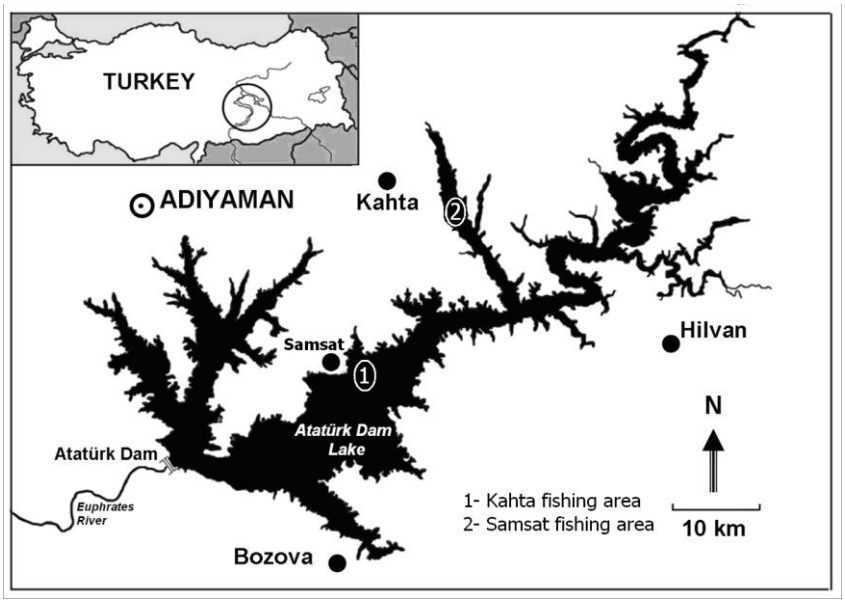

Figure 1. Map of the study area.

Table 1. Monthly fish number caught during the study period

Months	Fish Number		
	Female	Male	Total
September 2007	6	5	11
October	4	7	11
November	9	18	27
December	4	9	13
January 2008	4	15	19
February	9	16	25
March	9	5	14
April	6	8	14
May	6	4	10
June	10	14	24
July	5	12	17
August	1	15	16
	73	128	201

time of capture; *a* is the intercept from the regression of scale radius and fork length.

The von Bertalanffy (1938) growth equation was used in order to determine the relationship between age-length:

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

where L_t is the length at age *t; K* is a growth constant, determining the rate of change in the length increment; and t_0 is the hypothetical age when the length is zero.

The regression equation for the length-weight relationship was estimated by the least squares method with log-transformed data by commonly used equation:

$$W = \mathrm{a}\ L_F^{\mathrm{b}}$$

where *W* is the body weight (g) and L_F is the fork length (mm) (Le Cren, 1951; Tesch, 1968). The analysis of covariance (ANCOVA) was used to determine the effects of the sex on the weight-length relationship. The t-test was performed in order to evaluate the difference of the b slope of length-weight relationship from 3 (Arslan *et al*., 2007). Statistically significant differences were considered at P<0.05.

Somatic condition (K) was estimated for males and females, using the formula:

$$K=W.10^5/L_F^3,$$

where *W* is the body weight (g) and L_F is the fork length (mm) (Tesch, 1968). One-way ANOVA was used to evaluate the effects of age, months and sex on the somatic condition. Tukey's HSD test was used for multiple comparisons after ANOVA (Zar, 1996).

The gonads were removed and weighed with sensitiveness of 0.01g. The monthly gonado-somatic index (GSI) was used to determine the spawning period following the formula given by Pantulu (1963):

$$GSI=100(W_G/W),$$

where W_G is the gonad weight. Maturity of females and males were determined on the basis of morphological appearance of gonads (Jellyman, 1980). The age at which 50 % of fish were mature was considered to be age at first maturity for both sexes. Absolute fecundity was estimated gravimetrically (Laevastu, 1965). Intra-ovarian egg diameter was measured by using an ocular micrometer with a scale of 0.01 mm. Regression equations describing relationships between fecundity (F) and fork length (FL), fecundity and body weight (W), and fecundity and gonad weight (GW) were calculated by the following formula:

$$\mathrm{Log}\ F = \mathrm{Log\ a} + \mathrm{b\ log}L,\ \mathrm{Log}\ F = \mathrm{log\ a} + \mathrm{b\ Log}\ W,$$
$$\mathrm{Log}\ F = \mathrm{Log\ a} + \mathrm{b\ Log}\ GW$$

where *F* = number of eggs, *L* = fork length (mm), *W*= body length (g) and *GW*= gonad weight (g) (Pantulu, 1963; Ünlü *et al*., 1994).

Results

Age and Growth

A total of 201 *A. vorax* individuals (73 females and 128 males) were examined throughout the sampling period. The caught specimens composed of six age groups (from IV to IX) for females and seven age-groups (II to VIII*)* for males. Age group V was dominant age group for both sexes (Figure 2). Males were abundant until age group V, while beginning from age group VI female were more abundant than males. In general, there were statistically significant differences in the age groups of IV (χ^2= 8.53, P<0.05) and V (χ^2= 15.21, P<0.05) with predominance of males and in the age groups of VI (χ^2= 5.45, P<0.05) and VII (χ^2= 0.11, P>0.05) with predominance of females. The overall sex ratio was 1:1.75 (females/males), differing significantly from the theoretical 1:1 value (χ^2=15.05, P<0.05).

The distribution of the length ranged from 184 to 863 mm. The weight of the samples ranged from 54 g to 4.317 g and the majorities of individuals were 1001-2000 g for females and weighed between 501 and 1.500 g for males. The weight and length frequency distributions were different for males and females. The majority of individuals of both sexes individuals were in a range of 401-600 mm.

The relationship of the fork length (L_F) vs scale radius (S) was proportional and showed moderately significant association. The equation was determined as: L_F=-95.6669+172.254 *S*, r^2= 0.669, P<0.05.

The lengths for each age group observed and calculated by back calculation in *A. vorax* are given in

Table 2.

The maximum fork length observed for females was 863 mm (age 9+*)*, while that of males was 801 mm (age 8+*)*.

The fork length, as estimated by back-calculated method, showed a very close agreement to the observed mean length at each age group.

The differences between observed and estimated length, derived from back-calculation method, for the same age groups of females were not statistically different (P>0.05), whereas in the males the observed length was significantly higher than estimated length for the ages groups II, III and IV (P<0.05).

The linear growth parameters of von Bertalanffy's equation were L_t= 158.36 [1-e$^{-0.0904\ (t-0.75087)}$] for females and L_t= 218.47 [1-e$^{-0.011(t-0.6605)}$] for

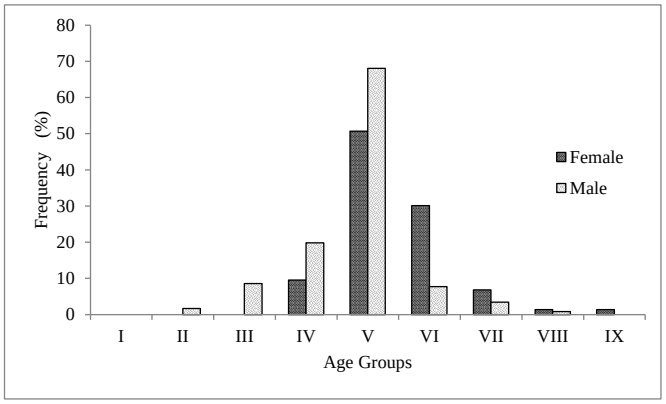

Figure 2. Age distribution of *A. vorax* from Atatürk Dam Lake, Euphrates basin, Turkey, from September 2007 to August 2008.

Table 2. The observed and estimated lengths at corresponding age groups of *A. vorax* in Atatürk Dam Lake, Euphrates basin, Turkey, collected between September 2007 and August 2008. [mean±SD (min.-max.)]

Back calculated lengths (Female)										
Age at capture	n	I	II	III	IV	V	VI	VII	VIII	IX
1+	-	-								
2+	-	-	-							
3+	-	-	-	-						
4+	7	56.37	135.71	250.74	387.77					
5+	37	43.87	142.96	265.44	394.21	496.54				
6+	22	41.50	167.54	287.42	397.13	476.89	540.39			
7+	5	65.38	189.45	372.99	543.99	617.53	732.56	787.99		
8+	1	93.47	164.39	282.60	329.88	566.30	613.58	802.72	826.36	
9+	1	96.07	191.93	287.80	335.73	431.60	575.40	623.33	767.13	839.03
Mean		66.11	165.33	291.16	398.12	517.77	615.49	738.01	796.75	839.03
SD		±23.84	±23.12	±42.64	±77.40	±73.92	±83.58	±99.59	±41.88	--
Annual growth			99.22	125.83	106.96	119.65	97.71	122.53	58.73	42.28
Observed lengths (Female)										
Mean					411.6	504.3	548.5	797.4	850	863
SD					±22.41	±20.40	±41.65	±43.95		
Min-Max.					380-445	465-540	455-624	763-846		
Annual growth						92.7	44.2	248.9	52.6	
Back calculated lengths (Male)										
Age at capture	n	I	II	III	IV	V	VI	VII	VIII	IX
1+		-								
2+	2	70.67	188.10							
3+	10	46.78	147.08	302.80						
4+	23	37.46	131.98	243.22	395.32					
5+	79	38.67	135.14	240.52	371.49	468.77				
6+	9	39.08	167.63	284.18	405.22	479.31	534.41			
7+	4	81.04	164.40	257.75	384.94	522.81	643.02	731.31		
8+	1	83.67	195.75	263.00	397.50	532.00	599.25	711.33	778.58	
Mean		56.77	161.44	265.24	390.89	500.72	592.23	721.32	778.58	
SD		20.89	24.84	24.19	13.04	31.33	54.64	14.13		
Annual growth			104.67	103.80	125.65	109.83	91.50	129.10	57.26	
Observed lengths (Male)										
Mean			237.00	314.10	413.90	477.20	754.30	754.30	801	
SD			±74.95	±24.20	±30.99	±31.49	±33.69	±3.69		
Min-Max.			(184-290)	(280-350)	(340-485)	(390-558)	716-798)	(716-798)		
Annual growth				77.10	99.80	63.30	277.10	0.00	46.70	

males. An L_∞ value of female was estimated lower than given for male.

The observed weight in the different age groups of the *A. vorax* are given in Table 3. Weights of the females and males varied from 476 to 4,317 g and 54 to 4,230 g, respectively.

The weight was observed to be different for females and males at all ages. Males were heavier than females at the age groups IV, VII and VIII. However, females were only heavier than males in age groups V. Statistical differences between sexes were only determined in age groups V and VII (P<0.001).

The length-weight relationships are presented in Figure 3. The resulting equations for females and males are given below:

Female: Log W = -3.4242 + 2.4297 Log L_F (r^2=0.8686) P<0.001
Male: Log W = -4.7247 + 2.9051 Log L_F (r^2=0.9549) P<0.001

The length and weight relationship for males and females was found to be different from each other (ANCOVA, P<0.05). The results indicated that the *b* value of the females (2.4297) was less than 3 (t-test, P<0.05), meaning negative allometry in the females, whereas *b* value (2,9051) for males was not statistically different from 3, indicating an isometry in the males (t-test, P>0.05).

The mean somatic condition of females (1.069) was similar to that of males (1.062), and the differences between sexes were not statistically significant (ANOVA, F=0.0897, P>0.05) except the ages groups IV and VII (Table 4).

In the monthly variations in the somatic condition, it was noticed that the mean values were at highest level in November (1.23), and at lowest in August (0.92) in females, whereas at highest in September and October (1.13) and at lowest in March (0.85) in males (Figure 4).

Reproduction

The sexual maturity of *A. vorax* was found in their third year for males. Due to lacking of young female specimens, the first maturity age for female was not determined. However, all samples at age 4 and over were found to reach mature. The smallest mature female and male fork length were 380 and 281 cm, respectively. The determination of the spawning season for *A. vorax* population in Atatürk Dam Lake

Table 3. Weight at corresponding age groups of the *A. vorax* in Atatürk Dam Lake, Euphrates basin, Turkey, collected between September 2007 and August 2008 [Mean±SD (Min.-Max.)]

Age Groups	Female		Male		Diferrences between female and male	t-test	P=
	N	Mean±SD (Min-Max)	N	Mean±SD (Min-Max)			
II	-	-	2	148.5±133.64 (54-243)			
III	-	-	10	349.4±57.51 (271-447)			
IV	7	660.1±139.76 (476-843)	23	728.2±186.78 (356-1180)	-68.0	-0.82703	0.2077
V	37	1376.5±171.27 (1102-1804)	79	1170.5±215.51 (606-1692)	205.9	5.102299	0.0000*
VI	22	2026.4±365.45 (1603-2915)	9	1822.4±339.57 (1092-2323)	204.0	1.437887	0.0806
VII	5	3496.8±104.06 (3375-3654)	4	3883.0±122.14 (3752-4012)	-386.2	-5.13262	0.0007*
VIII	1	4093.0	1	4230.0	-137.0		
IX	1	4317.0		-			

*Statistically different

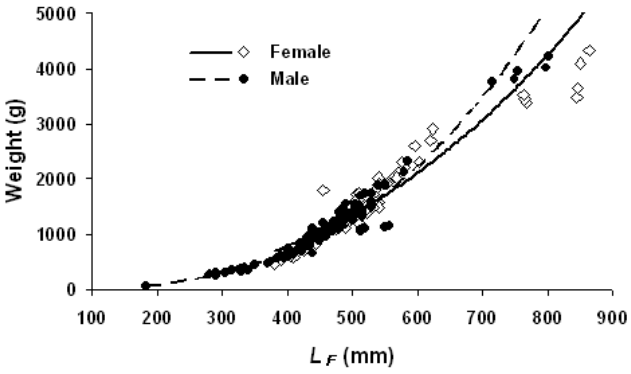

Figure 3. Observed individual fork length-at-weight of *A. vorax* sampled in Atatürk Dam Lake, Euphrates basin, Turkey, collected between September 2007 and August 2008.

Table 4. The condition factors in different age groups of the *A. vorax* in Atatürk Dam Lake, Euphrates basin, Turkey, collected between September 2007 and August 2008

Age	Female		Male		Differences between female and male	
Groups	N	Mean±SD (Min-Max)	N	Mean±SD (Min-Max)	Student's *t* test	P
I		-				
II		-	2	0.93±0.09 (0.87-1.00)		
III		-	10	1.13±0.11 (0.94-1.31)		
IV	7	0.93±0.07 (0.87-1.09)	23	1.01±0.09 (0.76-1.15)	-1.847	0.038
V	37	1.07±0.08 (0.90-1.26)	79	1.07±0.13 (0.66-1.33)	-0.113	0.455
VI	22	1.23±0.17 (1.06-1.92)	9	1.16±0.06 (1.05-1.25)	1.203	0.119
VII	5	0.70±0.10 (0.58-0.79)	4	0.91±0.10 (0.79-1.02)	-3.215	0.007
VIII	1	0.67	1	0.82		
IX	1	0.67	-			

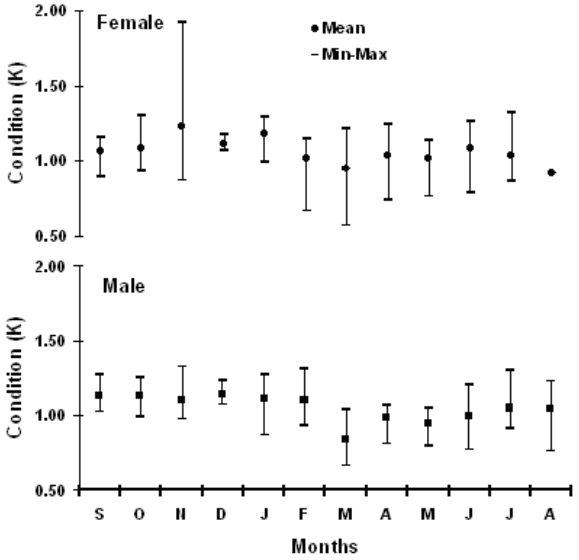

Figure 4. Monthly fluctuation in the somatic condition for male and female of *A. vorax* sampled in *Atatürk* Dam Lake, Euphrates basin, Turkey, between September 2007 and August 2008.

was based on the gonado-somatic index, analysis of monthly variation of mean egg diameter (Figure 5), and direct observation of gonads. Higher GSI values were observed in the samples of March, April and May for females and males. The mean egg diameter reached its maximum size in April as 1.98±0.04 mm, while its minimum size was measured in July as 0.32±0.13 mm. According to the GSI values, seasonal development in ovary size, and through direct observation of the gonads, it is concluded that the spawning took place in April and extended to May in the *A. vorax* population.

Absolute fecundity was achieved at 66 females ranging in lengths from 380 to 860 mm. Fecundity ranged from 5247 (L_F=380 mm and W=476 g) to 237162 (L_F =850 mm and W=4093 g). Any significant correlation was not found between fish length, fish weight and gonad weight versus fecundity; the regression equations are given below:

$\log F$=-2.9751+2.8664 $\log L_F$ (r^2=0.232) P>0.05
$\log F$ =0.9030+1.2303 log W (r^2=0.290) P>0.05
$\log F$ =4.7660+1.2428 log GW (r^2=0.600) P<0.001

Discussion

The species of *Aspius* are relatively large cyprinids. However, their biological characteristics have not been well studied due to difficulties of the sampling. The overall male : female ratio was significantly different from 1:1 in favor of males for *A. vorax* from the Atatürk Dam Lake. This change in the sex ratio appears to be due to the absence of small females in our sampling, which have presumably not been caught with nets in the study area. According to Mouine *et al*. (2010) the biased sex ratio seems to depend on the fishing area, since females and males can be found to be more abundant in different places, shallow or deep waters. Moreover, differences in sex ratio, related to corresponding differences in growth and selectively in the sampling, have also been proposed for other fish species (e.g. Bartulovic *et al*., 2004).

The oldest specimens of *A. vorax* were reported

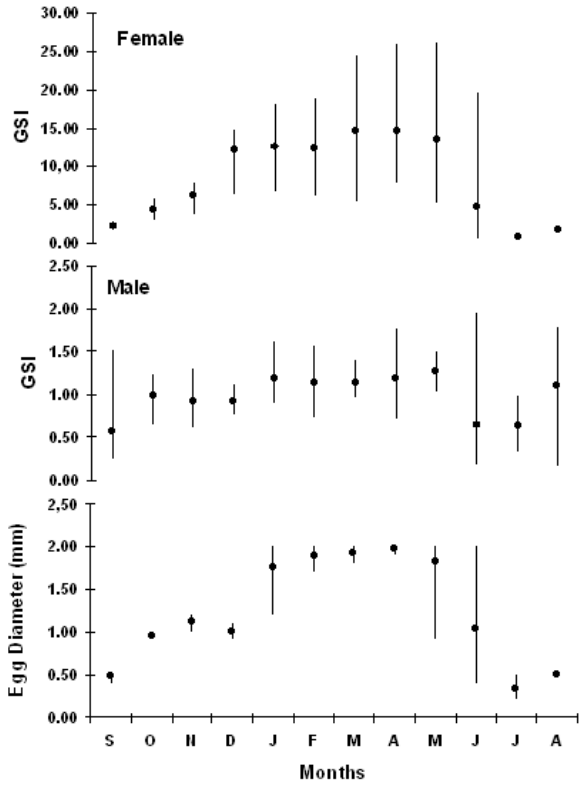

Figure 5. Monthly variation of gonado-somatic index (GSI) and eggs diameter of *A. vorax* in Atatürk Dam Lake, Euphrates basin, Turkey, from September 2007 and August 2008.

for the Habbaniyah Lake to be 7 years old (Shafi and Jasim, 1982). A shorter age was reported for the *A. vorax* to be 5, 6 and 7 in the Iraqi lakes of Razzazah, Habbaniyah and Tharthar respectively (Epler *et al*., 2001; Szypula *et al*., 2001). It was also reported that, *Aspius aspius*, attains an age of 11+ in Lake Balaton (Biro and Furesz, 1976). The longest length for this species was previously given as 636 mm at the age of 7+, 530 mm at age 5 and 585 mm at age 6+ in samples from the lakes Tharthar, Razzazah and Habbaniya, respectively (Szypula *et al.*, 2001). In this study, the oldest age was found to reach an age of 9 years as 839.03 mm fork length. This may be explained by the selectivity of the sampling nets used and low fishing press on this species in the dam lake. The mean weight of *A. vorax* was found higher than those stated by Szypula *et al.* (2001) for each age group. The reason for these differences may be factors such as water condition, food supply, population density (Nikolsky, 1963).

The value of *b* was lower than 3, and negative allometry was found in the females but indicated an isometry in males; *b* is greater in males than in females. Al-Dabical and Al-Daham (1995) stated 'b' as 3.077 in samples collected in the Shatt Al Basrah Canal. Such changes in the values of 'b' may be attributed either to differences in methodology or to factors like overfishing, food competition, stomach fullness, major change in environment and stage of maturity (Tesch, 1968; Kleanthidis *et al*., 1999), all of which were not not taken into account in the present study, requiring further study.

Asymptotic length of males was calculated as higher than those given for female (L_∞ = 158.36 cm for females and 218.47 cm for males). This may be attributable to the variation in growth differences between females and males. L∞ values determined in the present study was also higher than that of the Shatt Al Basrah Canal population of the *A. vorax* (L∞ = 104.118 cm) (Al-Dabical and Al-Daham, 1995) and in Habbaniyah Reservoir (L_∞ = 91.00 cm) (Shafi and Jasim, 1982) and in Lake Tharthar (L_∞ = 145.5 cm) (Epler *et al*., 2001). It has been reported that there must be some differences between the growth characteristics from one area to another for reasons of quantity and quality of food and hydrographical and climatic conditions (Bartulovic et al., 2004)

The mean somatic condition determined in this study is compatible with those given by Shafi and Jasim (1982) from the Habbaniya Lake (Iraq) and by Ali *et al*. (1986) from the Thartar Lake. The study showed that the somatic condition of the *A. vorax* increased during summer and autumn seasons in relation to feeding activity. Low somatic condition was found in the March for both sexes. After March the somatic condition increased again due to the growth of the gonads. In general, the seasonal variation of condition factors is influenced by the gonadal development, feeding activity and several other factors (Doddamani *et al.*, 2001).

The sexual maturing age was at least 4+ for females and 3+ for males. Epler *et al*. (2001) found similar results at the *A. vorax* in Iraqi lakes. Our observations indicate that the spawning period is from April to May, when the water temperature between 14-18ºC. Shafi and Jasim (1982) determined possible spawning in January at 10°C; however, Epler *et al*. (2001) reported the spawning period at the end of February and the beginning of March when water temperature was between 13-14ºC. These differences in the spawning period vary depending on water temperature. Nikolsky (1963) pointed out that the spawning characteristic of a fish varies in respect to species and ecological characteristics of the water system in which they live.

In the present study, the observed egg diameter in spawning season varied from 1.70 to 2.00 mm. It was different from that of 1.1 mm reported by van den Eelaart (1954) in Iraqi rivers. This difference in the eggs diameter may be attributed by length and sampling period of fish examined. Many researchers have also reported that egg size increased with fish length, weight and age (Nikolsky, 1963; Jellyman, 1980; Epler *et al*., 2001; Mendonca *et al*., 2006).

There are variations in the estimated values of fecundity reported in different studies. In this study, the fecundity of *A. vorax* were found to be between 5,247 and 237,162. The fecundity of the *A. vorax* reported by other researchers (Shafi and Jasim, 1982; Epler *et al*., 2001) were between 74,509 and 92,000 eggs, respectively. Although many factors complicate the interpretation of fecundity data, fertility, the frequency of spawning, parental care, egg size, population density and environmental factors (Bagenal, 1978) higher fecundity observed in this study can be attributed to the differences in fish length and weight.

Fecundity correlates closely with size (Wootton, 1998). However, a weakly positive correlation was found between fish length and fish weight versus fecundity. The Picture is far from to explain the weakly correlation due to low sample size. Thus further investigation is required with more sample size, which makes it possible to analyse the correlations between the fecundity and length and weight.

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