

Full Length Research Paper

The growth characteristics of *Liza (Mugil) abu* (Heckel, 1843) in Atatürk Dam Lake

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In this study, the population features of *Liza abu* in the Atatürk Dam Lake were examined. During the month of March 2004 and February 2005 period, 821 fish samples were collected by gillnets with mesh sizes of 18, 22, 26, 30, 34 and 38 mm. The total length differed between 11.10 and 22.20 cm. The total weights were 16.20 to 136.60 g, and the age distribution was between 1 and 5. 50.99% of the caught samples were female and 49.01% were male. The average condition values were $K = 1.18$ for males and $K = 1.15$ for females. The length-weight relationship was calculated as $\text{Log } W = -0.87 + 2.08 \cdot \text{Log } L$ for males and $\text{Log } W = -1.79 + 2.88 \cdot \text{Log } L$ for females. The Von Bertalanfy growth parameters were $L_{\infty} = 24.63 \text{ cm}$, $K = 0.28$, $L_t = 24.63(1 - e^{-0.28(t - (-1.36))})^{0.93}$, $t_0 = -1.36$ years, $W_{\infty} = 362.95 \text{ g}$, $K = 0.07$ and $Wt = 362.95 (1 - e^{-0.07t - (-1.36)})^{0.93}$.

Key words: Atatürk Dam Lake, age, growth, *Liza abu*.

INTRODUCTION

Liza is the largest genus of the *Mugilidae* family and it contains 24 species (Sepkoski, 2002; Ayo-Olalus et al., 2010). *Liza abu* (Heckel, 1843) inhabits in Turkey, Iraq, Syria, Iran, and Pakistan (Kuru, 1979; Coad, 1980). The species remains in freshwaters (Beckman, 1962; Naama et al., 1986) but it has also been recorded in Iraqi brackish water and from the Khawr-Alzubeir (North-west of the Persian Gulf) in a marine environment (Nasir and Naama, 1988).

Several studies have been done about the fish inhabiting in the Euphrates and Tigris rivers and their branches (Beckman, 1962; Bozkurt, 1994; Şevik and Bozkurt, 1997). The presence of *Liza abu* in the Euphrates and Tigris river system of Turkey was mentioned for the first time by Kuru (1979). There are many studies showing *Mugil* species except *L. abu* living

Mediterranean connected waters of Turkey (Balik et al., 1992). There are also other researches carried out in other regional countries showing *L. abu* inhabits in Euphrates and Tigris river systems (Mahdi, 1967; Değer et al., 2013). The feeding ecology of *Liza ramada* in the south-west of Portugal, Almeida (2003) and the age estimation and scales of *Liza aurata* in Greece's Ksilova (Messolonghi) lagoon were studied (Hotos, 2003). Akın et al. (2005) showed that, there were 7 species except *L. abu* belonging to the *Mugilidae* living in the Köyceğiz lagoon in Turkey. However, the first noteworthy study about *L. abu* inhabiting in other waters out of the Mediterranean was performed by Ünlü et al. (2000).

Many data exists on the growth characteristics of freshwater fishes in regarding the effects of different water conditions. After construction of Atatürk Dam in

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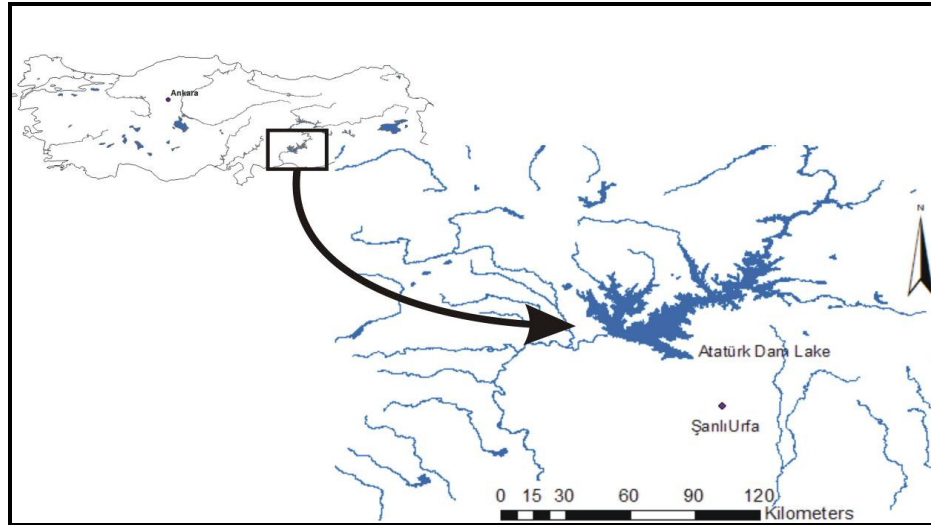


Figure 1. Atatürk Dam Lake.

1990, *L. abu* population could not find an opportunity to migrate to the sea. So, these conditions might affect some characteristics of this population.

The aim of this study was to determine some growth characteristics such as total length and weights, sex, age composition and the findings may reflect the effects of the newly constructed dams on the *L. abu*.

MATERIALS AND METHODS

Working area

The Atatürk Dam Lake has a surface area of 81700 ha (Karadede et al., 2004). This feature makes it the biggest dam and the second biggest inland water of Turkey. It has been built for irrigation and energy purposes, but it is also important for the fishery points (Figure 1).

Data analysis

The total of 821 *L. abu* caught during the period of March 2004 to February 2005 constituted the fish material. The samples were caught by gill nets, and they were brought immediately to the laboratory where their lengths were measured in centimeters. Then, their total weights were weighed by using a scale with 0.01 g sensitivity.

The evaluation of data and statistical calculations were done on MS Excel program. The significance between different checked parameters was controlled by using χ^2 test. The length-weight relationship was calculated by the logarithmic explanation of the equation $W = a \cdot L^b$ (Le Cren, 1951). In this equation, the values W = total weight, L = total length, a = the weight of the unit fish length, b = relative growth index between length and weight. The condition factor was calculated with the formula $K = W/L^3 \cdot 100$. Since the age estimation from hard tissues of boned fishes is reliable (Hoşsucu, 2000), the ages estimation of *L. abu* were determined from otoliths that photos were taken with a stereo-microscope and an inverted photo-microscope (Nikon SMZ 2 T stereo). The Von Bertalanffy

equation was calculated by the regression method.

For the length $L^\infty = a/(1-b)$, for the weight $W^\infty = a/(1-b)$, for hypothetical zero age $t_0 = (Ln(L^\infty) - a_2)/b_2$ and for any t age the length $L_t = L^\infty (1 - e^{-K(t-t_0)})$ and for the weight $W_t = W^\infty (1 - e^{-K(t-t_0)})$ equation have been used (Avşar, 1998). In these equations, L^∞ and W^∞ show the infinite length and weight of the fish, K = Body growth coefficient (year^{-1}), t_0 = the hypothetical age (in years) of the fish before coming out of the egg and L_t and W_t shows the length and weight at the t age.

RESULTS

The smallest female specimen of *L. abu* population was determined as 13.70 cm, and this value also showed the lowest fishing length. Out of the 821 specimens caught, 65 of them (7.92%) were smaller than 13.70 cm in total length. As the sampling was made with nets used in commercial fishing, approximately 8% of *L. abu* were caught before the female reached the stage of sexual maturity. As this is an indicator of early fishing, this character has been found to be statistically significant by the χ^2 - test ($\chi^2 = 582.29$, $P > 0.05$).

Sex and age composition

Out of the 821 caught specimens, the sexuality determination was done on the 810 specimens, and it was found that, the male: female ratio was 1.04 (49.01:50.99%) and the χ^2 test was ($\chi^2 = 0.32$, $P < 0.05$). These results showed that, the difference between the male: female ratio is not statistically significant. The sexuality composition, length distribution and the standard deviation are given in Table 1.

The total lengths of the sexualities changed between 11.10 to 22.20 cm. Out of these specimens 306 were in

Table 1. The length groups of *L. abu* in Atatürk Dam according to the sexualities and the specimen numbers with their standard deviations.

Parameter	Result											
*L (cm)	11	12	13	14	15	16	17	18	19	20	21	22
N	5	9	88	306	258	93	27	14	6	3	0	1
M	5	4	47	160	126	46	9	0	0	0	0	0
F	0	5	41	146	132	47	18	14	6	3	0	0
S.D.	3.54	0.71	4.24	9.90	4.24	0.71	6.36	9.90	4.24	2.12	0.00	0.71

L = Total length (cm), N = specimen number, M = male, F = female, S.D. = standard deviation *Length groups are between 0.0 and 0.9.

Table 2. The average length and weight with their standard deviations and minimum and maximum limits according to the age groups.

Age group	L Mean \pm S.D.	L (Min.-Max.)	W Mean \pm S.D.	W (Min.-Max.)
1	11.38 \pm 0.68	11.10 - 13.20	17.42 \pm 3.38	16.20 - 26.50
2	14.90 \pm 0.80	12.90 - 16.80	37.76 \pm 5.58	21.20 - 62.10
3	17.45 \pm 0.28	16.60 - 17.90	62.82 \pm 6.34	44.80 - 76.20
4	18.91 \pm 0.57	17.00 - 19.70	83.33 \pm 5.94	69.70 - 91.20
5	20.22 \pm 0.80	19.40 - 22.20	100.40 \pm 12.83	86.10 - 136.60

the 14.00 to 14.90 cm length groups; however, there were no caught samples in the 21.00 to 21.90 cm length groups. In 22.00 to 22.90 cm length group only one fish was caught. The average length and weight with their standard deviation and the minimum and maximum values according to the age groups of the caught specimens are shown in Table 2.

The age groups of the collected specimens showed a distribution of 1 to 5 years. As there were no specimens caught in the 0+, there were also any specimens in the 6 years age group. The examples (where the age areas have been shown) of every age group of otoliths of *L. abu* are in Figure 2.

The condition, length-weight relationship and growth features

Monthly condition change values have shown similarity in the two sexualities. In both sexualities, the condition values were found to be the lowest in July (male = 1.07 and female = 0.99), however the highest values were determined in August (male = 1.37 and female = 1.30). The conditional values of male and female sexualities according to the months have been given in Figure 3.

When the length-weight relationship considered, the data belonging to the 397 male specimens have been calculated with $\log a = -0.87$ and $b = 2.08$ and the data belonging to 413 female specimens have been calculated with $\log a = -1.79$ and $b = -2.87$. The length-weight relationship for the male and female specimens can be

seen in Figure 4. Also, the regression equations were given on the graph of same figure.

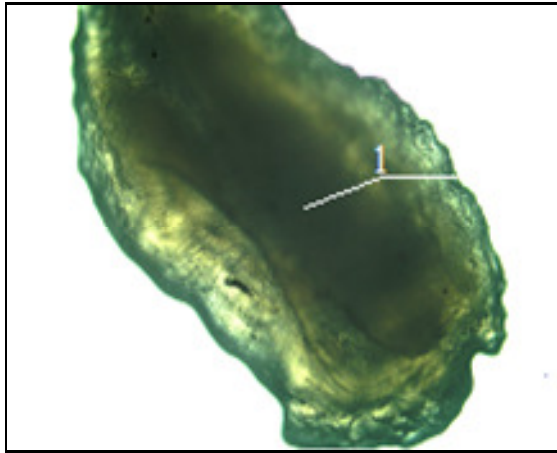
For the Von Bertalanffy, the formula of the average lengths and weights of the age groups have been given in Table 3. The values in Table 4 have been calculated from the data in Table 3.

The Von Bertalanffy growth equation parameters were estimated as $L_{\infty}=24.63$ cm, $W_{\infty}=362.95$ g, $K=0.28$, $K=0.07$, $T_0=-1.36$, $L1=24.63(1-e^{0.23(t-(1.32))})$, $Wt=362.95(1-e^{-0.07(t-(1.36))})^{0.93}$.

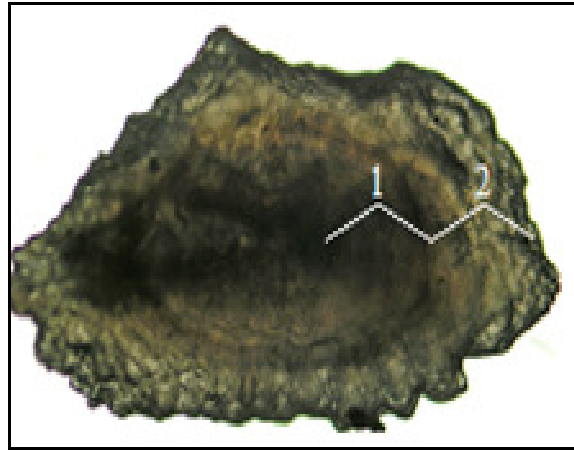
DISCUSSION

The age distribution of the total of 821 specimen of *L. abu* population caught from the Atatürk Dam Lake was varied from the ages of 1 to 5, and their total length varied from 11.10 to 22.20 cm. Age groups of *L. abu* living in the Tigris River were varied between ages of 1 and 5, and their fork lengths were determined as between 11.50 and 19.20 mm (Ünlü et al., 2000). Our findings in the Atatürk Dam were similar to Tigris River.

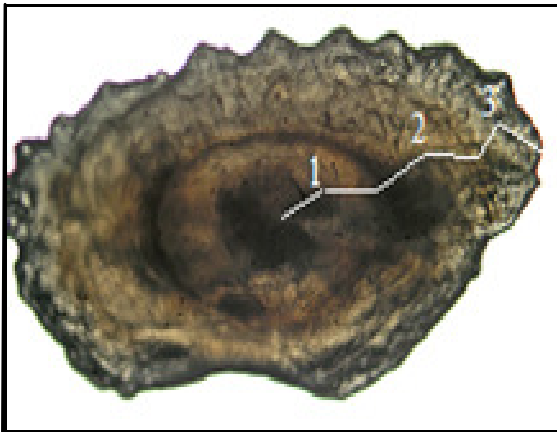
Out of the 1048 specimens of *L. aurata*, living in the Messolonghi lagoon in the west of Greece, the age groups were varied from 0+ and 8+, (only female specimens were found in 7+ and 8+ ages) and the total lengths were determined as 9.00 to 59.00 cm (Hotos, 2003). In the same article, the researcher emphasized that, the total lengths of the *L. aurata* in some other studies were varied between 20.00 and 42.00, 8.10 to 41.40, 7.30 to 30.00, 2.00 to 29.00 cm. The reason for



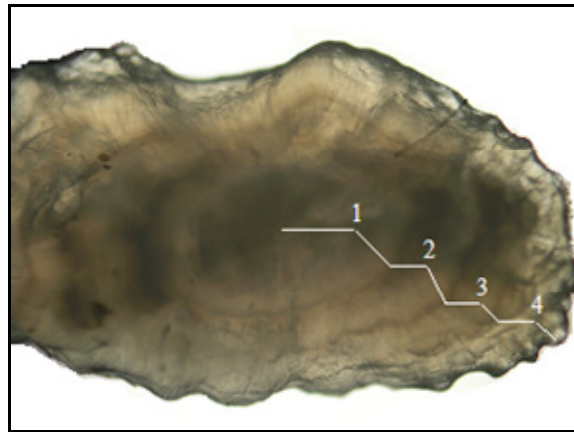
Age 1, L = 11.80 cm, W = 21.30 g,



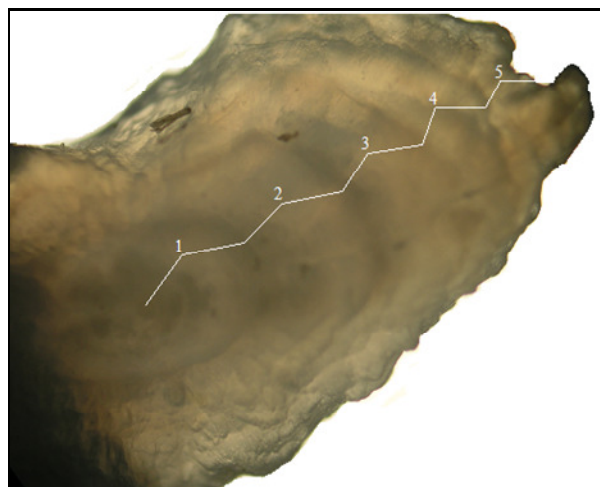
Age 2, L = 15.40 cm, W = 40.50 g



Age 3, L = 17.40 cm, W = 55.40 g,



Age 4, L = 18.20 cm, W = 75.30 g



Age 5, L = 20.20 cm, W = 113.20 g

Figure 2. Otolith photographs belonging to every age group (L = total length, W = total weight).

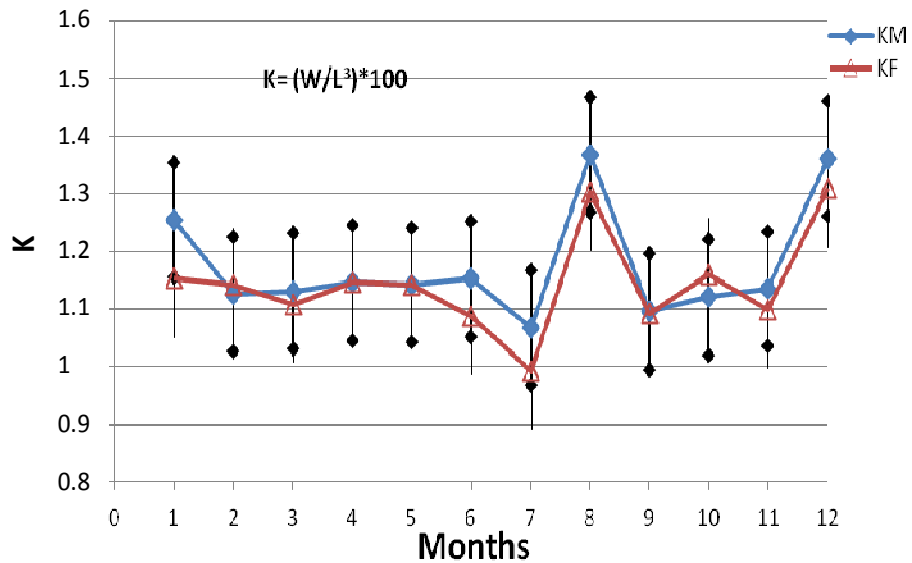


Figure 3. The conditions of male and female sexualities according to the months.

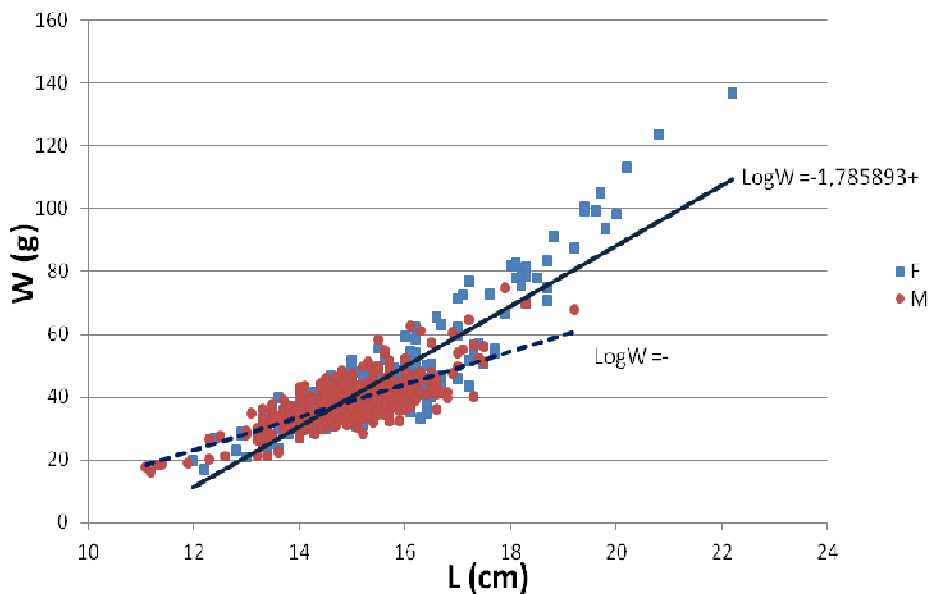


Figure 4. Length-weight relationship of male and female sexualities.

Table 3. The average length of the age groups and the Von Bertalanffy equation data.

Parameter	X(t = age)	W (g)	L (cm)	L [∞] -L	Y[Ln(L [∞] -L)]	X*Y	X ²
	1	17.42	11.38	13.25	2.58	2.58	1
	2	37.76	14.90	9.73	2.28	4.55	4
	3	62.82	17.45	7.18	1.97	5.91	9
	4	83.33	18.91	5.71	1.74	6.97	16
	5	100.40	20.22	4.41	1.48	7.41	25
Total	15				10.06	27.43	55
Average	3				2.01	5.49	11

Table 4. Von Bertalanffy growth results.

$L_{\infty}=24.63 \text{ cm}$	$W_{\infty}=362.95 \text{ g}$	$T_0 = -1.36$
$K = 0.28$	$K = 0.07$	
$L_1 = 24.63(1 - e^{-0.23(t - (-1.32))})$	$W_t = 362.95(1 - e^{-0.07(t - (-1.36))})^{0.93}$	

this could be due to the species differences.

In our study, the caught specimens constituted of 49.01% male and 50.99% female (1:1.0403). Similarly, in the *Mugil cephalus* population in Greece this ratio was 51: 49 (Katselis et al., 2005). As a result of the study, it was determined that, both of the sexualities belong to the *L. abu* specimen were in their lowest condition in July (male = 1.07 and female = 0.99) and were in their highest condition in August (male = 1.37 and female = 1.30). The highest *L. abu* condition for both sexuality living in the Tigris River were determined in August, however, any values could not have been recorded in July (Ünlü et al., 2000). These highest values determined in August were in harmony in both studies. The condition values being the lowest in Atatürk Dam in July showed that, reproduction activity of *L. abu* was completed before July. Graphics and equations belong to the 810 specimen for both sexualities can be seen in Figure 4. Logarithms taken for the same equation data were determined as simple linear regression form in Morocco's Zerga, Tunisia's Ichkeul, and Egypt's Edku lakes as $y = 3.15 \times -2.25$ and $R^2 = 0.97$; $y = 2.82 \times -1.74$ and $R^2 = 0.83$; $y = 3.13 \times -2.22$ and $R^2 = 0.84$, respectively (Kraïem et al., 2001). The calculations by taking the fork length as the base made on the females of *L. abu* living in the Tigris river were determined as $\log W = -5.85 + 3.44 \log FL$ ($R^2 = 0.96$) and $W = -5.37 + 3.22 \log FL$ ($R^2 = 0.95$) for males (Ünlü et al., 2000).

The L_{∞} , K and t_0 values in Table 4 were found to be higher than the values $L_{\infty} = 195.77 \text{ mm}$, $K = 0.38$ and $t_0 = -1.96$ found for the same species in the Tigris river. Once again, the value $W_{\infty} = 362.95 \text{ g}$ obtained at the Atatürk Dam was higher than that of the Tigris river and $K = 0.07$ value was lower than that of the Tigris river (Ünlü et al., 2000). The same values were found for *L. ramada* in Morocco's Zerga, Tunisia's Ichkeul and Egypt's Edku lakes to be for L_{∞} 50.70, 53.00, 54.60, for the value K 0.21, 0.22, 0.23 and for t_0 -0.31, -0.19, -0.08 (Kraïem et al., 2001). In the same study, L_{∞} for *L. ramada* in France were determined as 31.60 cm for males and 47.00 cm for females; in Greece 31.60 cm for males and 45.90 cm for females. The L_{∞} values determined for *L. abu* were smaller than the L_{∞} values established for *L. ramada*.

The smallest female specimen of *L. abu* population was determined as 13.70 cm, and this value also showed the lowest fishing length. Out of the 821 specimens caught, 65 of them (7.92%) were smaller than 13.70 cm in total length. As the sampling was made with nets used in commercial fishing, approximately 8.00% of *L. abu* were caught before the female was reached the sexual maturity.

As this is an indicator of early fishing, this character has been found to be statistically significant by the χ^2 -test ($\chi^2 = 582.29$, $P > 0.05$).

As seen in Table 1, it is excited that, there are no male specimens bigger than 17.90 cm. Our results is similarity to that of Ünlü et al. (2000) study, they determined the fork length 18.70 mm for male and 19.20 mm for female. In a research at *L. aurata* carried out in Greece, it was determined that, males live until the age of 6 and 48.80 cm length, females live until the age of 8 and 52.80 cm length (Hotos, 2003). Our results showed the similarity with male not living as much as female.

L. abu is a species of the *Mugilidae* that goes to the sea for the completion of their reproduction cycle. The research population could not migrate from the river to the sea as of 1990, since after this date the water was started to keep in Atatürk Dam. This situation could have affected some of the features of the research species. Some *Mugil* species could adapt to 100.00% fresh and 100.00% salty ($S = 39\%$) water (Chervinski, 1977). However, it can be expected that, *Mugil* species in fresh water, which had been cut off from the sea may expose the growth and reproduction problems. In normal situation, it can be expected that, there would be a strong relationship between the length and weight gain. Building of Atatürk Dam highly affected living story of the *L. abu* species. In our study, low R^2 values showed that, some characteristics such as length-weight relationship ($R^2 = 0.58$ for the male and $R^2 = 0.79$ for the female) were affected by the cut off from the sea. Some studies related to this subject stated that, the lowest R^2 value was found to be 0.83 in *Mugilidae* (Kraïem et al., 2001).

According to these results, Atatürk Dam Lake may have affected some growth characteristics of *L. abu* by changing water conditions and also feeding conditions. Further studies are needed to search the effects of Atatürk Dam on *L. abu* species in the near future.

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