

Age and Growth Properties of *Acanthobrama marmid* Heckel, 1843 Population Inhabiting Uzuncayir Dam Lake (Tunceli/Turkey)

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Abstract: This study was aimed to investigate the some growth properties of *Acanthobrama marmid* Heckel, 1843 population in Uzuncayir Dam Lake (Tunceli/Turkey) between May 2011 to September 2012. A total of 604 *A. marmid* samples (340 males and 264 females) were caught from Uzuncayir Dam Lake; the age composition of the specimens ranged between 1-9 years. The overall sex ratio (females/males) was 1:0.78. Total lengths of specimens ranged from 8.80-27.80 cm and weights ranged from 6.20-182.00 g. The von Bertalanffy growth parameters were $L_{\infty} = 28.25$ cm, $K = 0.26$ year⁻¹ and $t_0 = -0.90$ year for males and $L_{\infty} = 28.49$ cm, $K = 0.23$ year⁻¹ and $t_0 = -1.24$ year for females. The length-weight relationship was found as $W = 0.009 \times TL^{3.009}$ in males and $W = 0.012 \times TL^{2.926}$ in females. The growth performance index (Φ') values of males, females and all samples were 2.317, 2.271 and 2.301, respectively. The condition factor values varied between 0.61-1.30 for entire population.

Key words: Uzuncayir Dam Lake, *Acanthobrama marmid*, age, growth parameter, condition factor

INTRODUCTION

Acanthobrama genus is represented by 9 species in the inland waters of world and all of species live in the Middle East countries (Froese and Pauly, 2013). There are three species of this genus (*Acanthobrama mirabilis* Ladiges, 1960, *Acanthobrama marmid* Heckel, 1843 and *Acanthobrama centisquama* Heckel, 1843) in the inland waters of Turkey (Ozcan and Balik, 2009).

Acanthobrama marmid distributes in the freshwaters of Turkey, Iran, Iraq and Syria (Coad, 2013). This species was reported in Euphrates, Tigris, Seyhan, Orontes, Ceyhan and Kura-Aras river systems, Berdan, Esen and melet streams and inland waters of Samsun (Colak, 1981; Unlu *et al.*, 1994; Aydin and Sen, 1995; Sasi and Balik, 2003; Onaran *et al.*, 2006; Kara *et al.*, 2010; Polat and Ugurlu, 2011).

A. marmid is typically a benthopelagic river form but it also lives in the lakes and dam lakes. Generally, this species feeds on zooplankton and phytoplankton and spawns at temperatures between 18-25°C. Although, this fish is used in human nutrition locally, it is not an important species economically (Aydin and Sen, 1995; Bozkurt, 1998; Konar and Parlak, 2009).

Uzuncayir Dam Lake was built up on the Munzur Stream which is one of the important branches of the

Euphrates River is a new reservoir and there is no studies about growth properties of *A. marmid* population inhabiting in this reservoir. Additionally, the studies about *A. marmid* populations living in Euphrates and Tigris river systems are very outdated. In this study, it was aimed to eliminate and update the missing information in this field.

MATERIALS AND METHODS

Uzuncayir Dam located in Tunceli province was built on Munzur River in order to generate energy between 1996 to 2003. The body of dam is rock fill and its volume is 551 m³. Lake volume and area are 308 hm³ and 13 km², respectively. Uzuncayir Dam is one of the most important Hydro-electric power plants of Tunceli region (Fig. 1).

This study was conducted on *Acanthobrama marmid* Heckel, 1843 individuals caught from Uzuncayir Dam Lake between May 2011 to September 2012. In this study, fish samples were collected using the 10 trammel and gill nets (each net was 100 m in length) with mesh sizes between 20 and 140 mm.

In the laboratory, total length and weight of the each fish sample were measured and then its sex was noted. Ages of fish were determined by vertebrae (Polat, 1986). Sex ratio of the fish was studied using χ^2 -test. The



Fig. 1: The map of research region

condition factor was determined from $CF = (W \times 100) / L^3$ equation (Pauly, 1984). The Length Weight Relationship (LWR) was determined from equation (Sparre and Venema, 1998):

$$W = a \times L^b$$

Where:

W = Total fish weight (g)

L = Total length (cm)

a and b = The parameters describing the length-weight relationship

Length-weight relationships of fishes and Standard Error (SE) of a and b values were estimated with SPSS 16.0 Statistical Software (SPSS Inc.).

In the investigation of the growth of the *A. marmid* population, the von Bertalanffy growth equations were used (Sparre and Venema, 1998):

$$L_t = L_{\infty} \times \left[1 - e^{(-K \times (t - t_0))} \right],$$

$$W_t = W_{\infty} \times \left[1 - e^{(-K \times (t - t_0))} \right]^b,$$

$$W_{\infty} = a \times L_{\infty}^b$$

Where:

L_t = Length of the fish at age t

L_{∞} = Asymptotic length

K = Brody growth coefficient

t_0 = Age of the fish at 0 cm length

W_{∞} = Asymptotic weight

VBGF parameters (L_{∞} , K, t_0) and their SE were calculated from the age-length data using the non-linear regression (Marquard's algorithm) implemented in the FAO-ICLARM FiSAT II package (Gayaniilo *et al.*, 2005). Growth performance index, $\Phi = \log k + 2 \log L_{\infty}$ was used to compare growth of fish (Munro and Pauly, 1983).

The natural mortality rate of *A. marmid* was estimated using the equations of Ursin (1967) ($M = W^{-(1/b)}$), Pauly

(1980) ($\ln M = -0.0152 - 0.279 \times \ln L_{\infty} + 0.6543 \times \ln K + 0.463 \times \ln T$) and Djabali *et al.* (1993) ($\log_{10} M = 0.736 - 0.114 \times \log_{10} L_{\infty} + 0.522 \times \log_{10} K + 0.583 \times \log_{10} T$). The average of these values was regarded as real natural mortality rate.

The growth type of fishes, the differences between total lengths, fish weights and condition factors of males and females were identified by Student's t-test using SPSS 16.0 Computer Program.

RESULTS AND DISCUSSION

Age and sex distribution: In this study, a total of 604 *Acanthobrama marmid* (Heckel, 1843) (340 male and 264 female) caught from Uzuncayir Dam Lake were investigated. Of the total fish examined, 340 (56.29%) were males and 264 (43.71%) females. The ages of the fish were ranged between 1 and 9 years and high numbers of individuals were determined in 3 years with 87 for male and 77 for female. The overall sex ratio was 0.78:1.00 (females/males), differing significantly from the theoretical 1:1 value ($\chi^2 = 4.78 > \chi^2_{(1, 0.05)} = 3.84$) (Table 1).

Length, weight and condition: The total lengths of the specimens were ranged from 8.80-27.80 cm for males and from 9.20-26.80 cm for females. The differences of length values in ages 2, 3, 4, 5 and 6 for males and females were statistically significant ($p < 0.05$) (Table 2). The maximum individuals were caught between 19.10-20.50 cm total length ranges with 17.05% (103 individuals) for males and 14.73% (89 individuals) for females (Fig. 2).

The total weights of the fishes were changed between 6.20-182.00 g for males and from 8.20-172.00 g for females. The differences of weight values in ages 2, 3, 5 and 6 for males and females were statistically significant ($p < 0.05$) (Table 2).

Condition factor values of *A. marmid* living in Uzuncayir Dam Lake ranged from 0.61-1.22 for males and

from 0.66-1.30 for males. A regular increase or decrease between condition factor values was not determined for both sexes. According to t-test, the differences of condition factor values of 2, 4 and 7 years old for males and females were statistically significant ($p < 0.05$) (Table 2).

Length-weight relationships The equations of the length-weight relationships were as follows:

Male : $W = 0.009 \times TL^{3.009}$ ($R^2 = 0.95$; $SH_a = 0.001$; $SH_b = 0.036$)

Female : $W = 0.012 \times TL^{2.926}$ ($R^2 = 0.93$; $SH_a = 0.002$; $SH_b = 0.048$)

Male+Female : $W = 0.010 \times TL^{2.973}$ ($R^2 = 0.94$; $SH_a = 0.001$; $SH_b = 0.029$)

Isometric growth was observed for male because the b value was not statistically different from 3 ($p > 0.05$). Negative allometric growth was observed for female and all samples due to the b values were significantly lower than 3 ($p < 0.05$) (Fig. 3).

Age-length and age-weight relations: According to sexes, von Bertalanffy growth parameters and equations were given in Table 3, age-length and age-weight graphs were given in Fig. 4. The differences between observed and calculated lengths and weights were not statistically significance ($p > 0.05$).

Natural mortality rate: The natural mortality rate (using by $L_\infty = 28.29$, $K = 0.25$, $T = 13.6^\circ C$ and $W = 77.99$)

Table 1: Age composition and sex distribution of *A. marmid* population inhabiting Uzuncayir Dam Lake

Ages	♂		♀		♂+♀		% / ♂ ratio	χ ²
	N	%	N	%	N	%		
1	5	0.83	4	0.66	9	1.49	0.80	0.055
2	44	7.28	26	4.30	70	11.59	0.59	2.314
3	87	14.40	77	12.75	164	27.15	0.89	0.304
4	76	12.58	62	10.26	138	22.85	0.82	0.710
5	66	10.93	51	8.44	117	19.37	0.77	0.961
6	37	6.13	31	5.13	68	11.26	0.84	0.264
7	15	2.48	10	1.66	25	4.14	0.67	0.500
8	8	1.32	2	0.33	10	1.66	0.25	1.800
9	2	0.33	1	0.17	3	0.50	0.50	0.166
Totally	340	56.29	264	43.71	604	100.00	0.78	4.781

Table 2: Length, weight and condition factor distributions of *A. marmid* population inhabiting Uzuncayir Dam Lake according to ages and sexes

Ages	♂			♀			♂+♀					
	N	TL	W	CF	N	TL	W	CF	N	TL	W	CF
1	5	11.10±0.64 (8.80-12.40)	10.22±1.36 (6.20-14.30)	0.74±0.05 (0.61-0.91)	4	10.68±0.58 (9.20-12.00)	9.93±0.73 (8.20-11.50)	0.83±0.08 (0.66-1.05)	9	10.91±0.42 (8.80-12.40)	10.08±0.78 (6.20-14.30)	0.78±0.04 (0.61-1.05)
2	44	14.14±0.13 ^x (12.40-16.50)	25.65±1.02 ^y (14.85-46.00)	0.89±0.20 ^z (0.70-1.22)	26	15.42±0.32 ^x (12.80-18.50)	38.46±3.13 ^y (19.20-74.00)	0.99±0.02 ^z (0.74-1.17)	70	14.61±0.16 (12.40-18.50)	30.40±1.51 (14.85-74.00)	0.93±0.02 (0.70-1.22)
3	87	19.05±0.12 ^x (13.80-20.20)	69.41±1.42 ^y (21.80-94.00)	0.99±0.11 (0.70-1.18)	77	18.30±0.17 ^x (14.60-19.70)	63.72±1.73 ^y (24.19-98.00)	1.02±0.01 (0.74-1.29)	164	18.70±0.11 (13.80-20.20)	66.74±1.13 (21.80-98.00)	1.00±0.01 (0.70-1.28)
4	76	20.41±0.10 ^x (15.50-21.60)	81.57±1.25 (34.91-106.00)	0.95±0.01 ^z (0.77-1.17)	62	20.07±0.09 ^x (16.20-21.00)	81.13±1.32 (48.00-98.00)	1.00±0.01 ^z (0.78-1.21)	138	20.26±0.07 (15.50-21.60)	81.37±0.91 (34.91-106.00)	0.98±0.01 (0.77-1.21)
5	66	21.73±0.90 ^x (16.70-23.00)	94.69±1.79 ^y (48.00-132.00)	0.92±0.01 (0.66-1.12)	51	21.06±0.10 ^x (18.40-22.20)	88.75±1.55 ^y (52.00-115.00)	0.95±0.02 (0.76-1.30)	117	21.44±0.08 (16.70-23.00)	92.10±1.24 (48.00-132.00)	0.93±0.01 (0.66-1.30)
6	37	22.96±0.24 ^x (18.10-24.90)	109.19±2.70 ^y (62.00-138.00)	0.90±0.02 (0.70-1.16)	31	22.13±0.19 ^x (19.80-24.50)	99.39±2.92 ^y (66.00-125.00)	0.91±0.01 (0.78-1.22)	68	22.58±0.16 (18.10-24.90)	104.72±2.05 (62.00-138.00)	0.91±0.01 (0.70-1.22)
7	15	24.52±0.40 (20.00-26.30)	120.33±4.11 (70.00-142.00)	0.81±0.02 ^z (0.69-0.99)	10	23.57±0.38 (21.10-25.30)	115.20±5.69 (82.00-138.00)	0.87±0.01 ^z (0.81-0.95)	25	24.14±0.29 (20.00-26.30)	118.28±3.32 (70.00-142.00)	0.84±0.02 (0.69-0.99)
8	8	25.15±0.63 (22.20-27.60)	135.62±9.09 (92.00-173.00)	0.85±0.03 (0.67-0.98)	2	24.60±1.10 (23.50-25.70)	141.50±11.50 (130.00-153.00)	0.95±0.05 (0.90-1.00)	10	25.04±0.53 (22.20-27.60)	136.80±7.41 (92.00-173.00)	0.87±0.03 (0.67-1.00)
9	2	26.75±1.05 (25.70-27.80)	160.00±22.00 (138.00-182.00)	0.81±0.01 (0.80-0.81)	1	26.80 -	172.00 -	0.89 -	3	26.76±0.60 (25.70-27.80)	164.00±13.32 (138.00-182.00)	0.84±0.03 (0.80-0.89)

^xThe differences of length values of males and females in same age groups were statistically significant ($p < 0.05$) (t-test); ^yThe differences of weight values of males and females in same age groups were statistically significant ($p < 0.05$) (t-test); ^zThe differences of condition factor values of males and females in same age groups were statistically significant ($p < 0.05$) (t-test)

Table 3: VBGF parameters and equations of *A. marmid* population inhabiting Uzuncayir Dam Lake according to sexes

Parameters	♂	♀	♂+♀
L_∞	28.25±2.07	28.49±2.47	28.29±1.69
K	0.26±0.06	0.23±0.08	0.25±0.05
t_0	-0.90±0.49	-1.24±0.68	-1.00±0.43
W_∞	209.38	218.82	211.22
L_t	$28.25 \times (1 - e^{-0.26 \times (t+0.90)})$	$28.49 \times (1 - e^{-0.23 \times (t+1.24)})$	$28.29 \times (1 - e^{-0.25 \times (t+1.00)})$
W_t	$209.38 \times (1 - e^{-0.26 \times (t+0.90)})^{3.009}$	$218.82 \times (1 - e^{-0.23 \times (t+1.24)})^{2.926}$	$211.22 \times (1 - e^{-0.25 \times (t+1.00)})^{2.973}$
Φ'	2.317	2.271	2.301

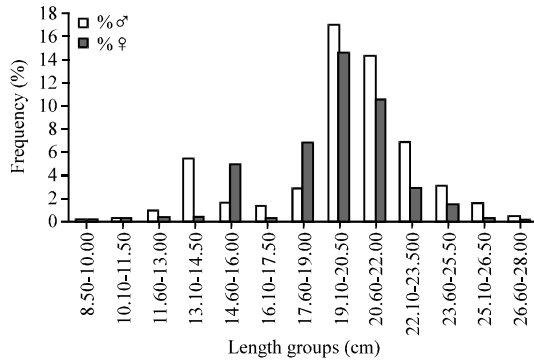


Fig. 2: The length distribution of *A. marmid* population inhabiting Uzuncayir Dam Lake

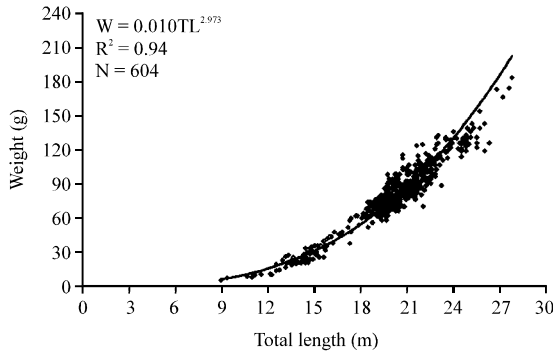


Fig. 3: Length-weight relation of *A. marmid* population inhabiting Uzuncayir Dam Lake

of *A. marmid* was estimated as 0.39, 0.54 and 0.23 according to Ursin (1967), Pauly (1980) and Djabali *et al.* (1993), respectively. Average natural mortality rate was determined as 0.38 ± 0.08 (31.51%).

It was determined that 56.29% of the samples (604) examined was male and 43.71% was female. Age distribution ranged between 1-9 years old and 3 years old fishes dominated for all individuals with 164. Age distribution reported as between 1-5 years old by Aydin and Sen (1995) in Keban Dam Lake and Unlu *et al.* (1994) in Ataturk Dam Lake between 1-6 years old by Bozkurt (1998) in Ataturk Dam Lake and between 0-7 years old by Kalkan *et al.* (2001) in Karakaya Dam Lake. Additionally, Aydin and Sen (1995), Unlu *et al.* (1994), Bozkurt (1998) and Kalkan *et al.* (2001) reported that III age group had the most abundant (139, 233, 179 and 63 individuals, respectively). Differences between age distributions mentioned in these results are related with the different fishing tools, mesh size and ecological situations.

Total lengths and weights of *A. marmid* population inhabiting Uzuncayir Dam Lake varied 8.80-27.80 cm and 6.20-182.00 g, respectively. When these ranges were compared with those reported by Aydin and Sen (1995), Unlu *et al.* (1994), Bozkurt (1998), Basusta (Girgin) (2000),

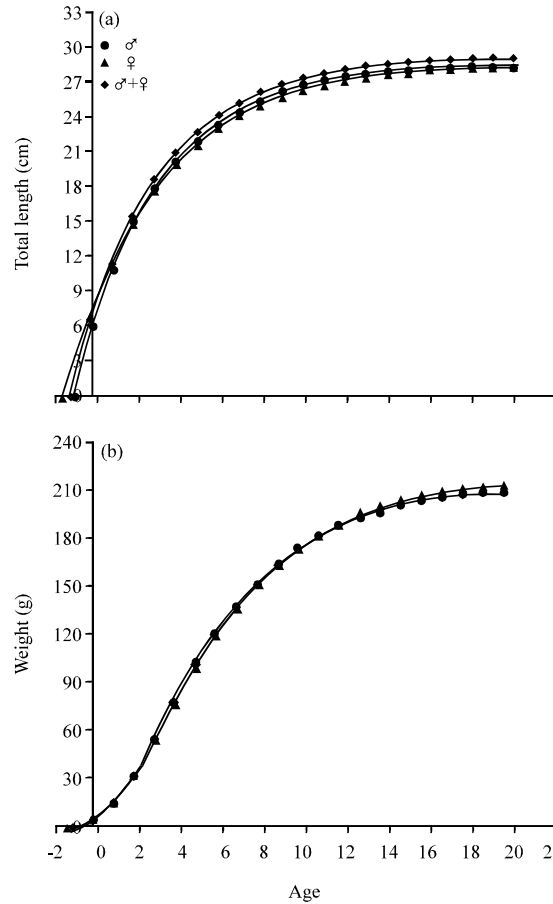


Fig. 4: a) Age-length relation and b) Age-weight relation according to sexes, for *A. marmid* population inhabiting Uzuncayir Dam Lake

Kalkan *et al.* (2001), some differences were shown between these values (Table 4). 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 (Suicmez *et al.*, 2011).

The condition factor was calculated as 0.61-1.30 for all individuals. While Aydin and Sen (1995) and Basusta (Girgin) (2000) calculated lower condition factors, Unlu *et al.* (1994), Bozkurt (1998) and Kalkan *et al.* (2001) estimated higher condition factors values than this study (Table 4). Condition factor values in fish population may vary according to age, sex, fat reserve level, species, season, locality and year (Le Cren, 1951).

The Length-Weight Relationships (LWR) of *A. marmid* from Uzuncayir Dam Lake were estimated separately for all sexes. The coefficient b of LWR was calculated as 3.009 for male, 2.926 for female and 2.973 for all individuals. The b value of males were not different

Table 4: Population characteristics of *A. marmid* presented in different studies and their comparison with the results of the present study

References	Sex	N	$L_{min}-L_{max}$	$W_{min}-W_{max}$	$CF_{min}-CF_{max}$	a	b	R ²
1	♂	151	10.40-16.70	13.00-78.000	1.16-1.96	0.000003	3.289	0.97
	♀	277	8.60-17.80	11.00-99.000	1.02-1.90	0.000002	3.400	0.96
	♂+♀	454	6.10-17.80	2.40-99.000	0.96-1.96	-	-	-
2	♂	139	10.80-21.00	9.60-91.000	0.56-1.02	0.000002	3.277	1.00
	♀	175	10.00-21.10	8.50-89.800	0.62-1.27	0.000003	3.163	0.99
	♂+♀	314	-	-	-	0.000003	3.196	1.00
3	♂	289	11.73-22.45	18.30-122.40	0.72-1.54	0.01455	2.915	0.97
	♀	308	11.90-22.89	17.24-142.60	0.83-1.56	0.01009	3.002	0.98
	♂+♀	605	10.12-22.89	15.20-142.60	0.72-1.56	0.00059	2.931	0.98
4	♂	85	11.00-20.00	13.00-72.000	0.66-1.20	0.000005	3.086	-
	♀	127	11.00-21.50	12.00-115.00	0.59-1.15	0.000001	3.363	-
	♂+♀	212	-	-	-	0.000002	3.254	-
5	♂	138	10.10-25.50	16.14-212.96	1.15-1.44	0.053	3.324	-
	♀	56	11.20-22.60	17.12-166.00	1.20-1.49	0.059	3.820	-
	♂+♀	194	-	-	-	0.052	3.312	-
6	♂+♀	62	9.20-28.60	-	-	0.00563	3.168	0.96
	♂	340	8.80-27.80	6.20-182.00	0.61-1.22	0.0090	3.009	0.95
7	♀	264	9.20-26.80	8.20-172.00	0.66-1.30	0.0121	2.926	0.93
	♂+♀	604	-	-	-	0.0100	2.973	0.94

1: Aydin and Sen (1995); 2: Unlu *et al.* (1994); 3: Bozkurt (1998); 4: Basusta (Girgin) (2000); 5: Kalkan *et al.* (2001); 6: Basusta and Cicek (2006); 7: Present study

Table 5: von Bertalanffy growth parameters of different *A. marmid* populations

References	Sexes	L_{∞}	K	t_0	W_{∞}	Φ'
Colak (1982) for 1978	♂	28.50	0.31	-1.86	-	2.401
	♀	28.90	0.26	-1.34	-	2.336
Colak (1982) for 1979	♂	24.80	0.69	-0.34	-	2.627
	♀	26.70	0.51	-0.65	-	2.560
Unlu <i>et al.</i> (1994)	♂	16.50	0.74	0.58	72.78	2.304
	♀	17.20	0.65	0.36	83.86	2.283
Present study	♂	28.25	0.26	-0.90	209.38	2.317
	♀	28.49	0.23	-1.24	218.82	2.271
	♂+♀	28.29	0.25	-1.00	211.22	2.301

from 3 ($b = 3, p > 0.05$) and males have showed isometric growth. Negative allometric growth was observed for female and all samples due to the b values were significantly lower than 3 ($p < 0.05$). Table 4 demonstrates the parameters of LWR of this species reported from different periods and study areas. The findings showed an accordance with data of Bozkurt (1998) while these values were recorded lower than results of Aydin and Sen (1995), Unlu *et al.* (1994), Basusta (Girgin) (2000), Kalkan *et al.* (2001) and Basusta and Cicek (2006). 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 (Tesch, 1971; Wootton, 1998; Suicmez *et al.*, 2011).

Asymptotic Length (L_{∞}) and growth coefficient (K) values were estimated 28.25 cm and 0.26 in males, 28.49 cm and 0.23 in females and 28.29 cm and 0.25 in all individuals. L_{∞} and K values were determined as very close in all sexes. The Φ' values of present study were estimated 2.317 in males, 2.271 in females and 2.301 in all individuals. The von Bertalanffy growth parameters and growth performance index values of *A. marmid* calculated in various studies are shown in Table 5. The L_{∞} and K

findings were similarly with Colak (1982)'s findings for 1978 but his findings for 1979 and Unlu *et al.* (1994) estimated lower L_{∞} and K than present study. This situation may be linked to different habitat, sampling year and age distribution. The Φ' values of current study are not statistically different from other studies ($T = 0.022 < T_{(2, 0.05)} = 2.920$ for males and $T = 0.017 < T_{(2, 0.05)} = 2.920$ for females). This means that the growth of *A. marmid* in Uzuncayir Dam Lake is similar to population in other localities.

CONCLUSION

The study is the first investigation about *A. marmid* population inhabiting Uzuncayir Dam Lake and provides information some biological properties of this species. According to results of present study, it is suggested that the growth features of *A. marmid* in this dam lake are largely similar to those of different localities. Further studies are required for biological data such as feeding and reproduction characteristics, sustainable fishery management and conservation of *A. marmid* in Uzuncayir Dam Lake.

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