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Age, Growth and Length-Weight Relationship of Tarek (*Alburnus tarichi* Güldenstädt, 1814) from Lake Van, Türkiye

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ABSTRACT

This study was carried out to determine the some population parameters of tarek (*Alburnus tarichi* Güldenstädt, 1814) in Lake Van between October 3, 2020 and October 13, 2020. A total of 695 specimens were caught by using European Standard (*EN* 14757) gillnets. The fish sample was consisted of 51.2% female and 48.8% male individuals, so ratio of ♀:♂ was computed as 1.05:1. The age distribution of sample was found 0-7 range. Average total length of the age classes were calculated as, 7.95, 14.37, 18.92, 21.96, 23.14, 23.97, 24.65, 25.60 cm and average weights were calculated as, 3.38, 22.37, 54.98, 89.07, 105.87, 120.42, 132.02, 154.75 g for from 0 to VII age classes respectively. The length-weight relationship (*LWR*) of population (for all individulas) was described as W=0.0033TL$^{3.3044}$. The growth type of the fish was determined as positive allometric (+). Fulton condition factor, L_∞, K_{brody}, t_0, W_∞ were estimated as; 0.790, 25.9937 cm, 0.4674 year^{-1}, -0.7713 year and 156.1708 g respectively for the all individuals. Our study contributes to updating the literature on the determination of growth characteristics and age distributions of the population of tarek in the Lake Van.

Keywords: Tarek, *Alburnus tarichi,* growth, Lake Van, population parameters

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Van Gölü İnci Kefali *(Alburnus tarichi* Güldenstädt, 1814) Populasyonunun Yaş, Büyüme Özellikleri ve Boy-Ağırlık İlişkisi

Öz: Bu çalışma, İnci Kefali popülasyon parametrelerinin belirlenmesi amacıyla 3-13 Ekim 2020 tarihleri arasında Van Gölü'nde gerçekleştirilmiştir. Çalışma kapsamında Avrupa Birliği standartı (*EN* 14747) galsama ağlarıyla toplam 695 adet inci kefali avlanmıştır. Avlanan örnekler incelendiğinde Van Gölü inci kefali popülasyonunun %51,2 dişi, %48,8 erkek bireylerden oluştuğu ve ♀:♂ oranının 1,05:1 olduğu anlaşılmıştır. Popülasyonun 0 ile 7 yaş aralığındaki bireylerden oluştuğu tespit edilmiş olup yaş sınıflarının ortalama total boyları 0 yaş gurubundan başlamak üzere sırasıyla: 7,95; 14,37; 18,92; 21,96; 23,14; 23,97; 24,65; 25,60 cm ortalama ağırlıkları ise yine sırasıyla: 3,38; 22,37; 54,98; 89,07; 105,87; 120,42; 132,02 ve 154,75 g olarak hesaplanmıştır. Total-boy ile ağırlık arasındaki ilişki tüm bireyler için W= 0,0033TL^{3,3044} şeklinde tanımlanmıştır. İnci kefallerinin pozitif allometrik (+) büyüme tipine sahip oldukları belirlenmiştir. İnci Kefali popülasyonun tamamı için kondisyon faktörü; 0,790, L_∞; 25,9937 cm, K_{brody}; 0,4674 yıl^{-1}, t_0; -0,7713 yıl, W_∞; 156,1708 g olarak hesaplanmıştır. Çalışmamız, Van Gölü inci kefali popülasyonunun büyüme özellikleri ve yaş dağılımlarının belirlenmesine yönelik bilimsel literatürün güncellenmesine katkı sağlamaktadır.

Anahtar kelimeler: İnci Kefali, *Alburnus tarichi*, büyüme, Van Gölü, populasyon parametreleri

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Introduction

In generally, two different fishing methods are applied on tarek by fishermen of the Lake Van, that shows differences according to times of the year. First one is a traditional method that based on ancient times, in which is the fish are caught when they are in streams for spawning. The second one is legal fishing which applied during fishing season from 15 July to 15 April.

Today, tarek consist of approximately 30% of the total inland fish catch in Türkiye. However, this species is endangered in a closed basin can be negatively affected by frequent human interventions. The tarek has been included in the red list since 1996

by the IUCN (International Union for Conservation of Nature) as a "Near threatened species whose population trend is in decline" (Şen et al. 2015; IUCN 2021).

There are various previous studies on the populations of tarek in different localities of the south-eastern region of Türkiye (Akgül 1980; Özdemir 1982; Sarı 1997; Elp 2002; Gündoğdu 2010; Bostancı and Polat 2011). But, there is no current study that comprehensively examines the population of Lake Van which is the largest population of tarek. The aim of the study is obtain some population parameters of the tarek inhabit the Lake Van.

Materials and Methods

Lake Van is the largest lake of Türkiye with 3602 km^2 surface area and 451 m maximum depth. The salinity of the lake is 21.7‰ and its water volume is 614 km^3. Lake Van is the world's largest soda lake with a pH value of 9.7 (Figure 1) (Degens and Kurtmann 1978). The only fish species living in the lake is the tarek (Alburnus tarichi, Güldenstädt, 1814) also as known as "Van Fish" (Figure 2) (Aydın 2017).

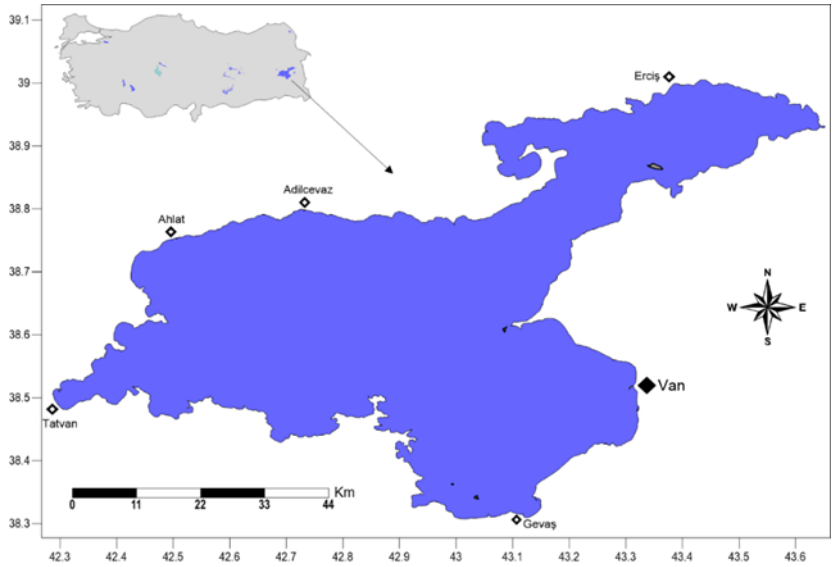

Figure 1. Study area and its location

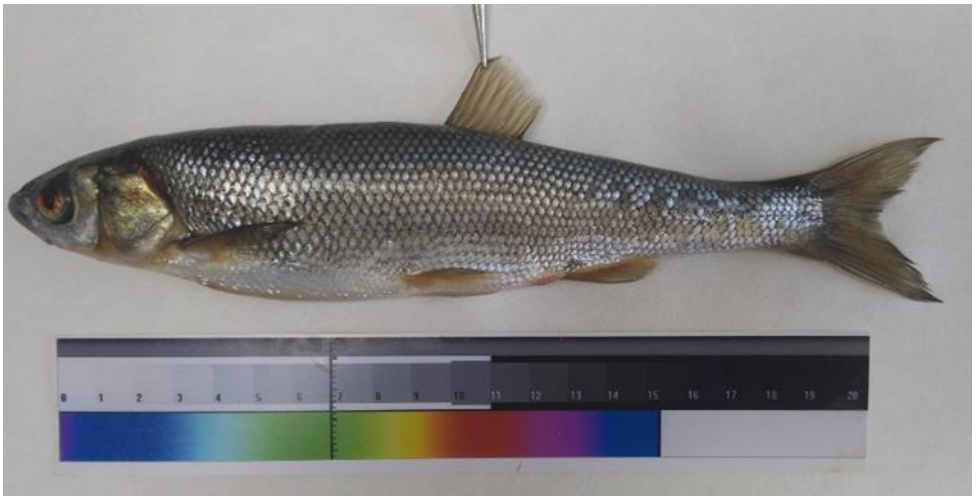

Figure 2. The tarek (*Alburnus tarichi* Güldenstädt, 1814)

Fish sampling was carried out according to *EN* 14757 (Water quality - Sampling of fish with multi-mesh gillnets) standard (*CEN* 2005). The multi-mesh gillnets have been designed for catching all species of freshwater fish species. Each gillnet is composed of 12 different mesh-sizes ranging from 5 mm to 55 mm (knot to knot). The mesh-sizes follow a geometric series, with a ratio between mesh-sizes of about 1.25. All gillnets have the same order of mesh panels.

Between October 3, 2020 and October 13, 2020, 695 tareks were caught in 7 fishing operations with four *EN* 14757 standard gill nets. All caught fish were measured by measuring board with 0.5 cm precision, and all of them weighted by 0.5 g sensitive electronic balance.

A total of 323 fish age were determined by reading the otoliths (sagitta), the tissue suggested by Ataman (2010) for tarek age studies. Fort he age readings it were followed the guidelines of Vitale et al. (2009). Gender determination of fish were made according to Lagler et al. (1977).

The length-weight relationship is determined by using parabolic equation $W=aL^b$ (Froese 2006).In this equation, *W* is the total weight (g), *L* isthe total length (cm), a and b are regression constants. The increase in length and weight is represented by von Bertalanffy equation (Sparre and Venema 1998).

$L_t=L_\infty[1-e^{-k(t-t0)}]$

$W_t=W_\infty[1-e^{-k(t-t0)}]^b$

The growth parameters L_∞, K_{brody} and t_0 are estimated using the least square method recommended by Sparre and Venema (1998) by using *TropFishR* (v1.6) package (Mildenberger et al. 2017). Monte Carlo simulation with 1,000 repetitions was used to calculate the 95% confidence intervals of the parameters.

The following formula was used calculate the growth performance index for age and sex groups (Pauly and Munro 1984).

$Ø=logk+2logL_\infty$

The Fulton condition factor is calculated for sex and age groups by the following formula where; *W*:total weight (g), *L*: total length (cm) (Sparre and Venema 1998).

$FCF=100W/L^3$

All statistical process was computed with R (v4.0.3) based R Studio (v1.3.1093) software and "rstatix" R-package was used for all statistical evaluations (Kassambara, 2021). In addition to descriptive statistical methods (mean, standard deviation, standard error) in the evaluation of data, independent samples "*t-test*" and "one-way analysis of variance (*ANOVA*)" were used to compare parametric data, while "Pearson Chi-Square (X^2)" test was used to compare nonparametric data. $TUKEY^{HSD}$ was preferred as a multiple comparison test. The results were evaluated at the 95% confidence interval, at the $p<0.05$ significance level.

Results

Age and Sex Composition

The sexes of 254 fish out of a total 323 fish whose ages determined, were identified. 130 of them are female (51.2%) and 124 of them are male (48.8%). The ♀:♂ ratios were 0.8:1 for I and II age groups; 1.1:1 for III age group; 1.7:1 for IV and V age groups; 2.0:1 for VI age group; 1:1 for VII age group; It was calculated as 1.05:1 for the sum of all age groups. (Table 1). Although the ratios of female-male are differ according to age groups, this difference was not found to be statistically significant (X^2:8.076; $p>0.05$).

Table 1. Sex ratios of tarek by age classes

Age	♀		♂		♀♂	♀:♂
	N	*N%*	*N*	*N%*	*N*	
0	0	-	0	-	17	-
I	23	43.40	30	56.60	101	0.8:1
II	34	43.59	44	56.41	83	0.8:1
III	20	51.28	19	48.72	39	1.1:1
IV	22	62.86	13	37.14	35	1.7:1
V	20	62.50	12	37.50	31	1.7:1
VI	10	66.67	5	33.33	15	2.0:1
VII	1	50.00	1	50.00	2	1.0:1
Σ	130	51.20	124	48.80	323	1.05:1

Pearson chi-square (X^2): 8.076; $p>0.05$

Length Distribution

Average total length, standard deviation, minimum and maximum length values according to age and sex groups are shown in Table 2. At all ages, the difference of the mean total length between the female and male sex groups was found to be statistically insignificant by the independent samples *t-test* ($p>0.05$). The differences between the mean total lengths of the age groups in each sex group were calculated with the one-way *ANOVA* with $Tukey^{HSD}$ test, and the results are shown in Table 2 by coding with letters.

Table 2. Total length distribution of samples by age and sex groups

Age	♀			♂			♀♂			*P*
	N	$\overline{TL}$±*SD*	Min-Max.	*N*	$\overline{TL}$±*SD*	Min-Max.	*N*	$\overline{TL}$±*SD*	Min-Max.	
0	0	-	-	0	-	-	17	7.95±0.92^{a}	5.70-9.70	-
I	23	14.38±1.52^{a}	11.60-16.80	30	14.62±1.28^{a}	12.30-16.90	101	14.37±1.58^{b}	9.50-16.90	0.540
II	34	19.01±1.37^{b}	16.90-21.50	44	18.94±1.32^{b}	16.50-21.80	83	18.92±1.31^{c}	16.50-21.80	0.833
III	20	22.23±1.02^{c}	20.60-23.80	19	21.68±0.84^{c}	20.50-23.40	39	21.96±0.97^{d}	20.50-23.80	0.750
IV	22	23.20±0.72^{cd}	22.00-24.60	13	23.03±0.60^{d}	22.00-23.90	35	23.14±0.67^{de}	22.00-24.60	0.481
V	20	24.13±0.74^{de}	22.50-25.30	12	23.83±0.34^{de}	23.30-24.40	31	23.97±0.60^{e}	22.50-25.10	0.125
VI	10	24.75±0.57^{e}	24.00-25.70	5	24.44±0.36^{e}	24.00-25.00	15	24.65±0.52^{ef}	24.00-25.70	0.295
VII	1	26.0	26.00-26.00	1	25.2	25.20-25.20	2	25.60±0.14^{f}	25.20-26.00	-
∑	130	20.68±3.72	11.60-26.00	124	19.49±3.50	12.30-25.80	323	18.54±4.64	5.70-26.00	-

P: represented of *t-test* result for $\overline{TL}$ comparing of female and male sex groups in the same age class. There are statistical differences of means marked with different letter in same column.

The total length (*TL*) distribution in all age and sex groups is shown in Figure 3. Colored dots in the figure represent data points for age and sex groups, rectangle is interquartile range (25% - 75%), horizontal line that is inside the rectangle is median, red dot is mean total length, the up and down lines on both sides of the rectangle indicate the minimum distance (25% - 1.5 x interquartile range) and the maximum distance (75% + 1.5 x interquartile range). Colored dots which are outside these lines represent outlier data.

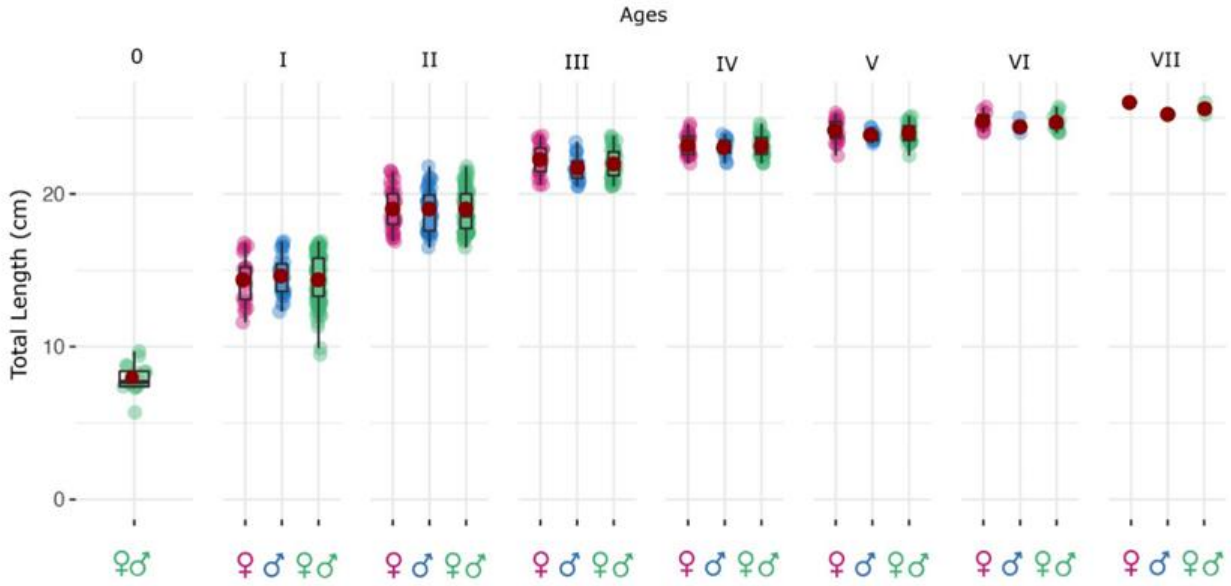

Figure 3. Total legth distributions at age and sex groups

Weight Distribution

Average weight (*W*), standard deviation, minimum and maximum weight values according to age and sex groups are shown in Table 3. Statistical differences was not found in mean total weight (p>0.05) of tarek between different sex groups for all age classes except IV age class (p<0.05). The differences between the mean weight of the age classes in each sex group were tested with the one-way *ANOVA* with *Tukey*^{HSD} test, and the results are shown in Table 3 by coding with letters.

Table 3. Total weight distribution of samples by age and sex groups

Age	♀			♂			♀♂			*P*
	N	$\overline{W}\pm SD$	Min-Max.	N	$W\pm SD$	Min-Max.	N	$\overline{W}\pm SD$	Min-Max.	
0	0	-	-	0	-	-	17	3.38±0.99^{a}	1.50-5.50	-
I	23	22.93±8.68^{a}	12.91-44.65	30	23.08±6.30^{a}	12.50-37.00	101	22.37±7.49^{b}	5.50-44.65	0.942
II	34	54.31±15.76^{b}	34.00-88.00	44	56.86±15.13^{b}	34.00-89.50	83	54.98±15.27^{c}	34.00-89.50	0.470
III	20	92.23±11.66^{c}	72.00-11.50	19	85.76±9.95^{c}	68.50-106.07	39	89.07±11.21^{d}	68.50-111.50	0.071
IV	22	108.75±12.69^{cd}	84.00-130.31	13	101.00±5.86^{d}	88.69-108.63	35	105.87±11.22^{de}	84.00-130.31	**0.020**
V	20	122.71±16.26^{de}	96.50-152.84	12	117.83±6.86^{de}	108.50-131.83	31	120.42±13.56^{e}	96.50-152.84	0.333
VI	10	135.52±13.51^{e}	116.50-163.50	5	127.02±8.93^{e}	114.89-139.00	15	132.02±13.23^{ef}	114.89-163.50	0.229
VII	1	163.5	163.50-163.50	1	146.0	146.00-146.00	2	154.75±12.37^{f}	146.00-163.50	-
∑	130	81.41±40.83	12.91-163.50	124	67.19±35.31	12.50-146.00	323	62.17±41.54	1.50-163.50	-

P: represented of *t-test* result for $\overline{W}$ comparing of female and male sex groups in the same age class. There are statistical differences of means marked with different letter in same column.

Length-Weight Relationship

Length-weight relationship was investigated for each sex groups separately, data set consisted of 264 female, 307 male and 695 total individuals. In all sex groups "*b*" value was found above 3 and it was understood that tareks had positive allometric growth type. It was determined that the relationship between total length and total body weight was quite strong, and it was determined that the 96.9% increase of the weight cause from increase in length (Table 4).

Table 4. Length-weight relationship parameters of tarek

Sex	Parameters						Significance test for "*b*"		
	N	*a*	*b*	95% Cl "b"	R^2	*LWR* equations	t_c	t_t	Growth type
♀	264	0.0028	3.3659	3.2537-3.4782	0.959	W=0.00287$TL^{3.3659}$	13.66	3.09	(+) Allometric
♂	307	0.0052	3.1619	3.0668-3.2570	0.951	W=0.0052$TL^{3.1619}$	5.57	3.09	(+) Allometric
♀♂	695	0.0033	3.3044	3.2471-3.3617	0.969	W=0.0033$TL^{3.3044}$	13.61	3.09	(+) Allometric

The length-weight distribution plot with 99% confidence interval of the tareks in Lake Van is shown in Figure 4. Also the number of individuals in each sex groups, the regression equation and the regression coefficient are shown on the relevant figüre.

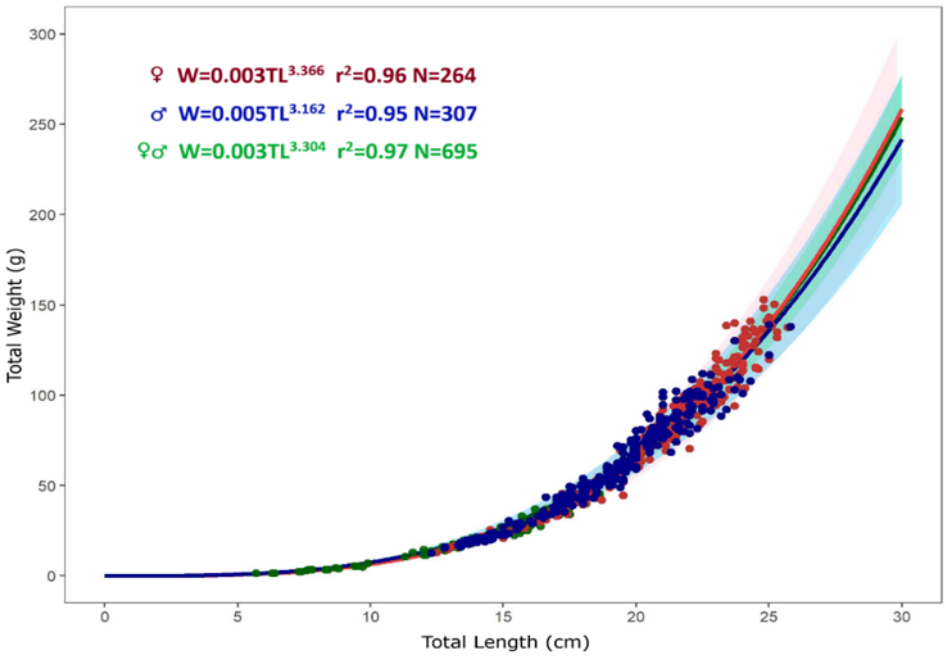

Figure 4. Length-weight distribution of tarek

Fulton Condition Factor

Conditions of 130 female, 124 male, and 69 juvenile, a total of 323 individuals were examined according to age and sex groups. In female individuals the lowest condition factor value was calculated in the "I" age group (0.744±0.026), and the highest condition factor value was calculated in the "VII" age group (0.930). In males, the lowest *FCF* was calculated in the "I" age group (0.723±0.007), and the highest *FCF* was calculated in the "VII" age group (0.912). In all individuals, the lowest *FCF* value was calculated in the "0" age group (0.661±0.018), and the highest *FCF* value was calculated in the "VII" age group (0.921±0.009). Average *FCF* value was calculated, 0.819±0.008 for females; 0.808±0.007 for males and 0.790±0.005 for all individuals. *FCF* values, standard error (*SE*) and statistical analysis results according to sex and age groups are shown in Table 5. At all ages except age II, the difference of the mean *FCF* between the female and male sex groups was found to be statistically insignificant by the independent samples-t test ($p>0.05$). The differences between the mean *FCF* of the age groups in each sex group were tested with the one-way *ANOVA* with *Tukey*^{HSD} test, and the results are shown in Table 5 by coding with letters.

Table 5. Fulton condition factor (*FCF*) at age and sex groups.

Age	♀			♂			♀♂			*P*
	N	$\overline{FCF}$±*SE*	Min-Max.	N	$\overline{FCF}$±*SE*	Min-Max.	*N*	$\overline{FCF}$±*SE*	Min-Max.	
0	0	-	-	0	-	-	17	0.661±0.018^{a}	0.548-0.810	-
I	23	0.744±0.026^{a}	0.622-1.271	30	0.723±0.007^{a}	0.659-0.800	101	0.726±0.007^{ab}	0.619-1.271	0.398
II	34	0.771±0.012^{ab}	0.600-0.922	44	0.818±0.012^{b}	0.686-1.054	83	0.793±0.009^{bc}	0.600-1.054	**0.009**
III	20	0.836±0.008^{bc}	0.782-0.901	19	0.841±0.015^{b}	0.709-0.915	39	0.838±0.08^{cd}	0.709-0.915	0.787
IV	22	0.870±0.017^{c}	0.743-1.011	13	0.827±0.011^{b}	0.774-0.907	35	0.854±0.012^{cd}	0.743-1.011	0.078
V	20	0.870±0.015^{c}	0.768-1.002	12	0.871±0.012^{b}	0.795-0.954	31	0.871±0.010^{cd}	0.768-1.002	0.943
VI	10	0.893±0.023^{c}	0.810-0.986	5	0.869±0.013^{b}	0.831-0.894	15	0.881±0.017^{cd}	0.782-0.986	0.371
VII	1	0.930	0.930–0.930	1	0.912	0.912-0.912	2	0.921±0.009^{d}	0.912-0.930	-
Σ	130	0.819±0.008	0.600-1.271	124	0.808±0.007	0.659-1.054	323	0.790±0.005	0.548-1.271	0.319

P: represented of *t-test* result for $\overline{FCF}$ comparing of female and male sex groups in the same age class. There are statistical differences of means marked with different letter in same column.

The correlation matrix showing the relationship between Fulton's condition factor and total weight, total length and age is given in Table 6. It was understood that the strongest relationship is between the condition factor and total weight (0.726), and the weakest relationship is between the condition factor and age (0.605). All relationships were determined to be significant at the 0.001 significance level.

Table 6. Correlation matrix between various variables

Parameters	*FCF*	Total Length	Total Weight	Age
FCF	1			
Total Length	0.644**	1		
Total Weight	0.726**	0.953**	1	
Age	0.605**	0.891**	0.940**	1

** The correlation is significant at the 0.01 level.

Growth parameters

The L_{∞} value was calculated as 26.0286 cm in the females and as 25.4674 cm in the males. The L_{∞} value for the whole population was calculated as 25.9937 cm. The K_{brody} values for female and male individuals were calculated quite similar to each other and were 0.5016 year^{-1} and 0.5038 year^{-1}, respectively. The K_{brody} value for the whole population was calculated as 0.4674 year^{-1}. W_{∞} value was calculated as 162.7431 g for female individuals, 145.1197 g for male individuals; and 156.1708 g for all individuals. The growth performance index ($\emptyset$) was calculated as 2.531 for female individuals, 2.514 for male individuals; and 2.499 for all individuals. The constants L_{∞}, K, t_0, W_{∞}, with confidence intervals at the 95% significance level are given in Table 7. In addition, the equations for growth in length and weight are also included in Table 7.

Table 7. Von Bertalanffy growth parameters of tarek in habit Lake Van

Sex	N	L_∞ CI	K CI	t_0 CI	W_∞ CI	Ø	vBGE for Length vBGE for Weight
♀	264	26.0286 24.78-28.16	0.5016 0.32-0.73	-0.6129 -1.50/-0.10	162.7431 137.90-212.07	2.531	L_t=26.0286[1-e$^{(-0.5016*(t+0.6129))}$] W_t=162.7431[1-e$^{(-0.5016*(t+0.6129))}$]$^{3.366}$
♂	307	25.4674 24.86-26.23	0.5038 0.41-0.60	-0.6989 -1.07/-0.41	145.1197 134.41-159.26	2.514	L_t=25.4674[1-e$^{(-0.5038*(t+0.6989))}$] W_t=145.1197[1-e$^{(-0.5038*(t+0.6989))}$]$^{3.162}$
♀♂	695	25.9937 25.25-26.88	0.4674 0.40-0.54	-0.7713 -0.94/-0.63	156.1708 141.95-174.55	2.499	L_t=25.9937[1-e$^{(-0.4674*(t+0.7713))}$] W_t=156.171 [1-e$^{(-0.4674*(t+0.7713))}$]$^{3.304}$

Von Bertalanffy growth curves in length and weight are plotted acording to the sex groups in Figure 5 and Figure 6. The curves drawn in red, green and blue colors represent the growth curves for length calculated by the von Bertalanffy growth equation according to the sexes, and the points in the same color represent the data points from the measurement. The red, blue and green colored ribbons show the confidence intervals of the curves at the 95% significance level.

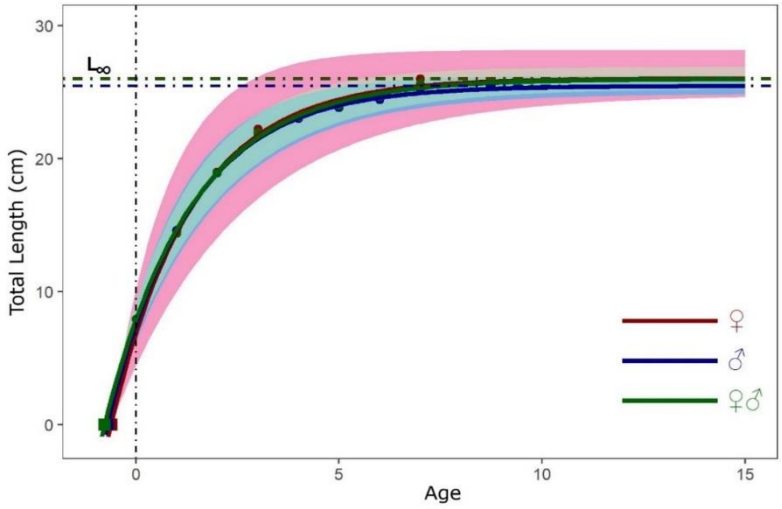

Figure 5. VBGP growth curve in age at length

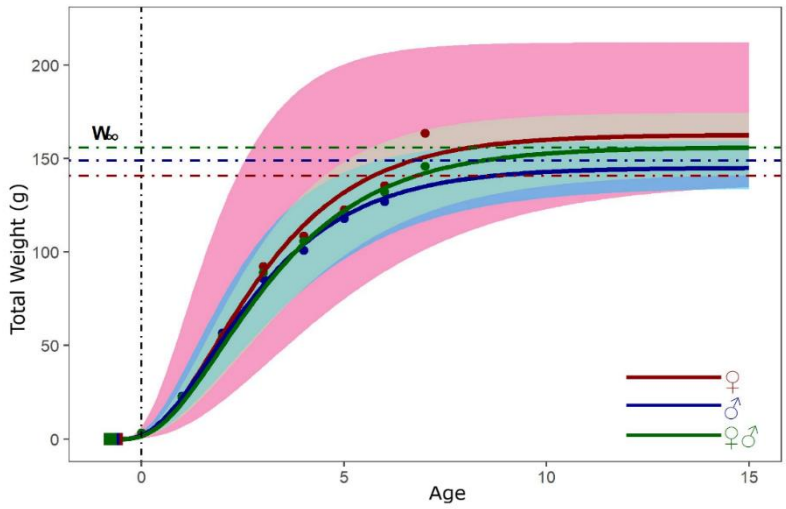

Figure 6. *VBGP* growth curve in age at weight

Discussion

Some values found in previous studies on tarek are shown in Table 8. Since the average length, weight and age range calculated from the sample may vary depending on the fishing tools or the sample collection method, these calculated values may be different. In all previous studies, it is seen that the ratio of females in the population is higher. In this respect, it can be said that our study is compatible with previous studies. Gündoğdu (2010) calculated the highest L_∞ value (39.52 cm *FL*). It is considered that this is due to the fact that the study was

conducted in Lake Erçek, where the fishing exploitation is very low. In the study of Elp (2002), the L_∞ value was found to be quite low (17.92 cm *FL*). The reason for this may be that the study was carried out in Koçköprü Dam Lake which is a totaly different envairoment and tarek competes with other species for food or environmental parameters pressure on the growth of the tarek. W_∞ values are incompatible with each other. This value is very low in Elp (2002) and very high in Gündoğdu (2010), this may be due to the difference in the study areas. t_0 values are compatible with each other in studies other than Gündoğdu (2010). A similar situation exists for K_{brody} values. The reason for this may be that the study was carried out in Erçek lake and the tarek population in the lake is at the limit of the carrying capacity of the lake. Because there is insignificant tarek fishing in Lake Erçek. There is no discrepancy in the K_{fulton} values. It is seen that the "*b*" value is below 3 in all previous studies but in this study, it was calculated over 3. Therefore, unlike other studies, it was calculated that the Lake Van tarek population had a positive allometric growth type. The reason for this may be the prevalence of samples in which the length-weight relationship is calculated. The reason why the "*b*" value determined in our study is different from other studies may be that sampling was done to cover all age groups between 0-7. Other reason; Since the body weight of the fish will increase depending on the gonad weight, the "*b*" value is expected to increase as the spawning season approaches. Therefore, whether the sampling period is before or after the spawning period may change the "*b*" value. It is possible to see the same phenomenon in the regression coefficient (R^2). The findings of length, weight, age and growth parameters obtained in some previous studies performed on tarek are presented in Table 8. It is thought that the differences between our study and each other are due to the different study region, sampling time and sampling method.

Table 8. Comparison of population parameters with previous studies on tarek

Studies	Study area	$\overline{FL}$	$\overline{W}$	♀/♂	*Age*	L_∞	W_∞	t_0	K_{brody}	K_{fulton}	*a* *b*	R^2
Akgül 1980	Lake Van	15-23*	30-122	1.13	1-6	-	-	-	-	0.883	0.000 3.16	-
Özdemir 1982	Lake Van	16-23	44-99	-		-	-	-	-	0.908	0.557 1.636	-
Akyurt et al. 1985	Lake Van	-	-	-	1-4	-	-	-	-	0.855	-	-
TOKB 1986	Lake Van	-	-	1.72	1-5	-	-	-	-	-	-	-
Çetinkaya et al. 1995	Karasu R.	7-21	5-80	-	1-7	-	-	-	-	-	0.012 2.94	-
Elp 1996	Lake Van Karasu R.	-	-	1.8	1-8	-	-	-	-	1.049	-	-
Sarı 1997	Lake Van	17.6	61.43	1.36	2-7	22.17	-	-1.158	0.301	-	0.08 2.309	0.79
Elp 2002	Koçköprü Dam Lake	13.63	30.2	1.3	0-7	17.92	60.07	-0.672	0.322	1.067	0.008 3.092	0.98
Gündoğdu 2010	Lake Erçek	21.99	136.7	1.11	2-7	39.52	699.3	-5.096	0.089	1.255	0.020 2.845	0.96
Ataman 2010	Lake Van	18.26	71.01	1.01	-	-	-	-	-	-	-	-
Kocabaş and Çetinkaya 2011	Lake Nazik	-	-	1.82	1-10	-	-	-	-	-	-	-
Bostancı and Polat 2011	Lake Van	16.82	68.66	1.47	2-7	22.37		-1.74	0.296	-	0.074 2.544	0.84
Present Study	Lake Van	18.12*	50.93	1.20	0-7	25.99	156.17	-0.771	0.467	0.790	0.003 3.304	0.97

(FL); mean fork length, $\overline{W}$; mean weight, L_∞; asymptotic length, W_∞; asymptotic weight, t_0; theoretical age at zero length, K_{brody}; brody growth coefficient, K_{fulton}; fulton condition factor, "a" and "b"; regression equation constants, R^2; regression coefficient, R; rive
* Total length (*TL*=1.058*FL*+0.5025 (Bostancı and Polat 2011))

Average length and weight values that are calculated according to age classes in previous studies on tarek are shown in Table 9. Calculations made on different times and on different populations have produced quite different results. In all studies except for the study by Gündoğdu (2010), the average length and average weight calculated for age classes was found to be lower than this study. This may be caused by different age readings, as well as the selectivity of the gill nets used in lake.

Table 9. Comparison of length and weight at age data with previous studies on tarek

Studies	Ages	0	I	II	III	IV	V	VI	VII
	Study area	$\overline{FL}$ ($\overline{W}$)	$\overline{FL}$ ($\overline{W}$)	$\overline{FL}$ ($\overline{W}$)	$\overline{FL}$ ($\overline{W}$)	$\overline{FL}$ ($\overline{W}$)	$\overline{FL}$ ($\overline{W}$)	$\overline{FL}$ ($\overline{W}$)	$\overline{FL}$ ($\overline{W}$)
Akgül 1980*	Lake Van	-	15.43 (33.51)	18.70 (49.30)	19.90 (66.61)	20.97 (82.85)	22.21 (101.94)	22.97 (122.68)	-
Akyurt et al. 1985	Lake Van	-	14.65 (29.5)	16.5 (40.65)	17.4 (51.98)	19.9 (84.73)	-	-	-
TOKB 1986	Lake Van	-	16.3 (60.8)	18.2 (85.1)	22.3 (102.6)	25.3 (110.2)	27.2 (120.8)	-	-
Çetinkaya et al. 1995	Karasu River	-	7.4 (4.58)	12.27 (21.71)	15.70 (40.92)	17.95 (58.91)	18.80 (68.53)	19.75 (79.52)	20.02 (80.27)
Elp 1996	Lake Van Karasu River	-	-	-	12.03 (18.51)	-	-	-	-
Sarı 1997	Lake Van	-	-	14.62 (37.37)	15.98 (48.85)	17.27 (58.05)	18.15 (65.50)	19.35 (73.91)	20.58 (82.06)
Elp 2002	Koçköprü Dam Lake	3.66 (0.6)	6.75 (3.4)	10.98 (15.0)	12.85 (23.0)	13.78 (29.1)	14.38 (34.4)	15.62 (39.8)	16.90 (44.8)
Gündoğdu 2010	Lake Erçek	-	-	18.01 (73.67)	20.08 (101.06)	21.6 (125.19)	22.86 (152.17)	24.18 (175.6)	25.78 (217.82)
Kocabaş and Çetinkaya 2011	Lake Nazik	-	-	-	12.3 (16.28)	-	-	-	-
Present study*	Lake Van	7.95 (3.38)	14.37 (22.37)	18.92 (54.98)	21.96 (89.07)	23.14 (105.87)	23.97 (120.42)	24.65 (132.02)	25.60 (154.75)

$\overline{FL}$; mean fork length, $\overline{W}$; mean weight
* Total length (TL=1.058FL+0.5025 (Bostancı and Polat 2011))

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