

## Some Population Parameters of Mirror Carp (*Cyprinus carpio* L., 1758) Living in Keban Dam Lake, Elazığ, TURKEY

Metin ÇALTA\*, Mustafa DÜŞÜKCAN, Burcu SAYIN  
Firat University, Faculty of Fisheries, 23119 Elazığ, Turkey  
\*mcalta@firat.edu.tr

(Geliş/Received: 28.12.2017; Kabul/Accepted: 20.02.2018)

### Abstract

This study was aimed to determine the age and growth of mirror carp (*Cyprinus carpio* L., 1758) population of Keban Dam Lake, Elazığ, Turkey. For this purpose, the fish samples were obtained from the area near the set of Keban Dam Lake by using 20-40 mm mesh size gill nets from November 2016 to December 2016. 120 mirror carps (54 females and 66 males) were examined in the present study. They ranged from 2 to 8 in age, from 21.50 to 37.50 cm in total length and from 172.66 to 789.17 g in body weight. A nonlinear relationship was found between the total length and weight of *C. carpio* ( $W=0.0135*TL^{3.0403}$ ;  $r^2=0.9724$ ). The growth parameters were estimated as 43.09 cm for  $L_{\infty}$ , 0.176 years<sup>-1</sup> for  $k$ , -2.423 years for  $t_0$ , 17 years for  $t_{max}$ , 2.51 for the growth performance index ( $\Phi$ ) and 1.62 for condition factor ( $C_f$ ). The age-at-length data fitted to the Von Bertalanffy Growth Function was determined as  $L_t=43.09*[1-e^{-0.176(t+2.423)}]$ . The absolute, relative and instantaneous growth values of mirror carp from Keban Dam Lake were the highest in the age range of 2-3, followed by the age range of 3-4. However, the values started to decrease after age 4.

**Key Words:** Mirror carp, *Cyprinus carpio*, growth, age, Keban Dam Lake

## Keban Baraj Gölünde Yaşayan Aynalı Sazan (*Cyprinus carpio* L., 1758)'de Bazı Büyüme Parametreleri

### Özet

Bu çalışma Elazığ Keban Baraj Gölü'ndeki aynalı sazan (*Cyprinus carpio* L., 1758)'in yaş ve büyümesini belirlemek amacıyla yapıldı. Bu amaçla, balık örnekleri 20-40 mm göz açıklığındaki galsama ağlarını kullanarak Keban Baraj Gölü seti yakınındaki alanlardan Kasım 2016-Aralık 2016 döneminde yakalandı. Çalışmada, toplam 120 adet aynalı sazan (54 dişi ve 66 erkek) incelendi. İncelenen balıkların yaşları 2-8 yıl, toplam boyları 21,5-37,5 cm ve vücut ağırlıkları 172,66-789,17 g arasında değişim gösterdi. *C. carpio*'nun toplam boy-vücut ağırlığı arasında doğrusal olmayan bir ilişki bulundu ( $W=0,0135 \times TL^{3.0403}$ ;  $r^2=0.9724$ ). Büyüme parametreleri olan  $L_{\infty}$ ,  $k$ ,  $t_0$ ,  $t_{max}$ , büyüme performans indeksi ( $\Phi$ ) ve kondisyon faktörü ( $C_f$ ) sırasıyla 43,09 cm; 0,176 yıl<sup>-1</sup>; -2,423 yıl; 17 yıl, 2,51 ve 1,62 olarak hesaplandı. Von Bertalanffy Büyüme Fonksiyonu  $L_t = 43,09 * [1 - e^{-0,176(t+2,423)}]$  olarak belirlendi. Aynalı sazanın Keban Baraj Gölü'ndeki mutlak, oransal ve anlık büyüme değerleri 2-3 yaş aralığında en yüksek olup, bunu 3-4 yaş aralığı takip etmiştir. Ancak değerler 4 yaşından sonra düşmeye başladı.

**Anahtar Kelimeler:** Aynalı sazan, *Cyprinus carpio*, büyüme, yaş, Keban Baraj Gölü

### 1. Introduction

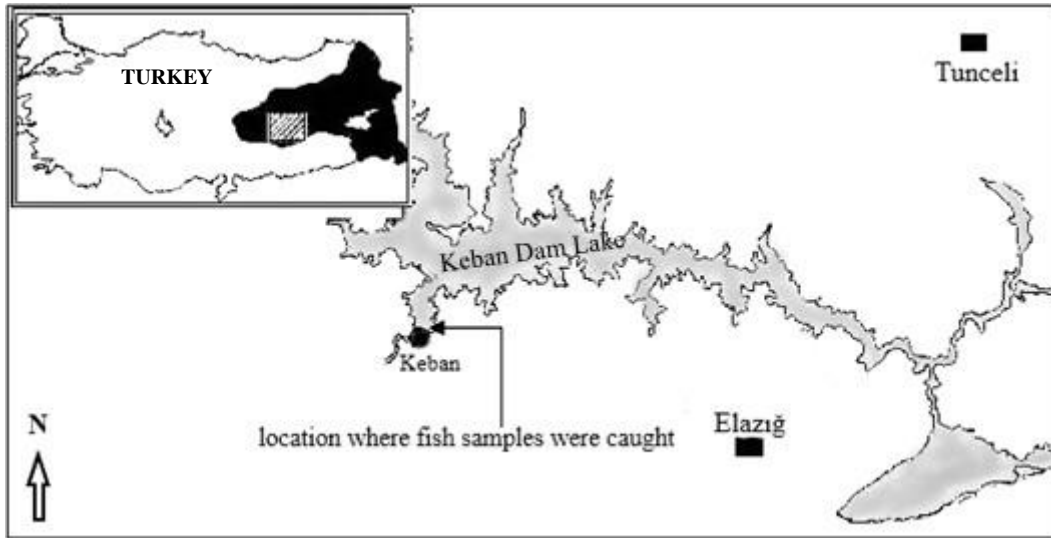
Approximately 28 fish species belong to seven families permanently inhabit in the lake [1]. *Cyprinus carpio* is one of the most dominant fish species in Keban Dam Lake. Mirror carp is a type of *C. carpio* species and differs from others with possessing the irregular and patchy scaling [2]. There are several investigations carried out on some population characteristics (i.e., growth properties, reproduction biology, spermatological parameters, age determination and population

dynamics) of the mirror carp in different water reservoirs of Turkey [3-9]. The age and growth studies are very important for fisheries biology. However, no studies have been found on the age and growth of mirror carp population of Keban Dam Lake. Therefore, the present study aimed to determine the age and growth of the mirror carp population of Keban Dam Lake.

## 2. Materials and Methods

In this study, 120 mirror carp (*C. carpio* L., 1758) were sampled from the location near to the set of Keban Dam Lake (38° 48' 23.67''K and 38° 46' 23.88''D; see Figure 1) that was constructed on the Euphrates River in the Eastern Anatolia region of Turkey in 1974. It has a large reservoir with 675 km<sup>2</sup> surface area at normal water level [10]. The mirror carp samples were caught by using 20-40 mm mesh size gill nets from November 2016

to December 2016. They were immediately transferred to the laboratory. The total lengths (TL) and body weights (W) of all individuals were measured to the nearest 1 mm and 0.1 g, respectively. Scales were extracted from each fish, kept in 3% KOH solution for nearly 1 h and stored dry in paper envelopes for further observation. The age of fishes was determined by reading of the growth rings formed on scales under a binocular stereoscopic microscope (Leica S8APO) combined to a computer.



**Figure 1.** The map of Keban Dam Lake and the location in which the mirror carps were sampled (modified from Tombul and Karadoğan [11])

The length-weight relationship (LWR) was estimated by the equation:

$$W = a * TL^b \quad [2.1.]$$

Where,  $W$  is the body weight (g),  $TL$  is the total length (cm),  $a$  is the intercept and  $b$  is the slope [12]. Log-transformation was applied prior to regression, thus the equation was transformed to:

$$\text{Log}W = \text{Log}a + b * \text{Log}TL \quad [2.2.]$$

A log-log plot of  $TL$  and  $W$  was made in order to remove outliers, and the 95% confidence limits of  $a$  and  $b$  were calculated with the statistical program (SPSS ver. 22.0, IBM Corporation) in order to confirm the distance between the  $b$  value and the isometric value of 3 [13].

The Von Bertalanffy growth function (VBGF) was fitted to individual length and age data for the mirror carp population and expressed with the equation given by Von Bertalanffy [14];

$$L_t = L_\infty * [1 - e^{-k(t-t_0)}] \quad [2.3.]$$

Where,  $L_t$  is the length (cm) at age  $t$ ,  $L_\infty$  is the asymptotic length (cm),  $k$  is the rate at which the growth curve approaches the asymptotic length ( $\text{year}^{-1}$ ),  $t_0$  is the hypothetical age of the fish at zero length.

The growth performance index ( $\Phi$ ) was estimated in each case according to the formula of Munro and Pauly [15]:

$$\Phi = \text{Log} k + 2 * \text{Log}TL_\infty \quad [2.4.]$$

The longevity was calculated by using equation stated by Taylor [16]:

$$t_{max} = 3/k \quad [2.5.]$$

Where,  $L_\infty$  is the asymptotic length (cm),  $k$  is the rate at which the growth curve approaches the asymptotic length ( $\text{year}^{-1}$ ),  $t_{max}$  is the longevity (maximum age reached by the species).

Fulton's Condition Factor (CF) was calculated using the equation:

$$CF = \frac{\bar{W}}{TL^3} * 100 \quad [2.6.]$$

Where,  $\bar{W}$  is mean total weight in g and  $\bar{TL}$  is mean total length in cm.

Absolute, relative and instantaneous growth rates were calculated using the formulas given by Ricker [17]:

$$\text{Absolute growth rate} = \frac{TL_2 - TL_1}{t_2 - t_1} \quad [2.7.]$$

$$\text{Relative growth rate} = \frac{TL_2 - TL_1}{TL_1(t_2 - t_1)} * 100 \quad [2.8.]$$

$$\text{Instantaneous growth rate} = \frac{\ln TL_2 - \ln TL_1}{t_2 - t_1} \quad [2.9.]$$

Where  $TL_1$  and  $TL_2$  are the respective total lengths of fish at the age  $t_1$  and  $t_2$ .

### 3. Results

The results showed that the age composition of the mirror carp varied from 2 to 8 (Table 1). According to the percentage occurrence, the age groups 3 and 4 constituted more than a half of all ages (66.3%). Overall, the sex ratio (females to male) was 1:1.2, which is not significantly different from 1:1 ( $\chi^2=0.27$  at  $p>0.05$ ). The number of samples, the total length and body weight of the mirror carps of the different age groups are presented in Table 1. The differences in the mean values of total lengths and body weight between the age groups were statistically significant (ANOVA,  $p<0.001$ ).

**Table 1.** Age groups, total length (cm) and body weight (g) of the mirror carp caught from Keban Dam Lake (N = sample size; min = minimum; max = maximum; SE = standard error)

Age group	N	Total length (cm)			Body weight (g)		
		min-max	mean ± SE	95% CI	min-max	mean ± SE	95% CI
2	14	21.50-24.00	23.08±0.22	22.59-23.56	172.66-221.46	190.48±3.67	182.55-198.42
3	40	23.35-28.23	26.26±0.22	25.82-26.69	200.90-351.10	276.25±5.90	264.33-288.18
4	36	27.74-31.53	29.30±0.16	28.98-29.62	270.54-483.18	388.28±8.12	371.80-404.76
5	10	30.53-31.92	31.25±0.16	30.89-31.61	450.12-544.76	481.33±10.26	458.13-504.53
6	12	32.02-33.92	32.90±0.20	32.46-33.33	544.09-601.40	569.32±4.85	558.65-580.00
7	4	34.23-34.76	34.54±0.13	34.12-34.95	609.37-691.69	658.03±18.51	599.12-716.93
8	4	35.32-37.50	36.15±0.48	34.61-37.69	699.26-789.17	740.13±18.67	680.71-799.55
Total	120	21.50-37.50	28.48±0.32	27.85-29.11	172.66-789.17	374.44±13.11	348.48-400.39

The normal distribution of total lengths was determined by use of Kolmogorov-Smirnov test ( $p>0.05$ ) (Figure 2). The foremost length group was 28-29 cm (12.5%), followed by 27-28 cm (10%). The total length of fish mostly clustered between 25 and 33 cm (72.5%).

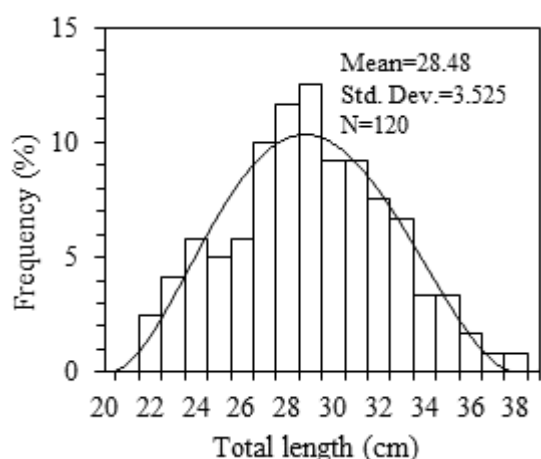
It provided a good fit to the examined age-at-length data, as the coefficient of determination was highly significant ( $r^2=0.910$ ) (Figure 3).

The age-at-length data fitted to the Von Bertalanffy Growth Function was determined as:

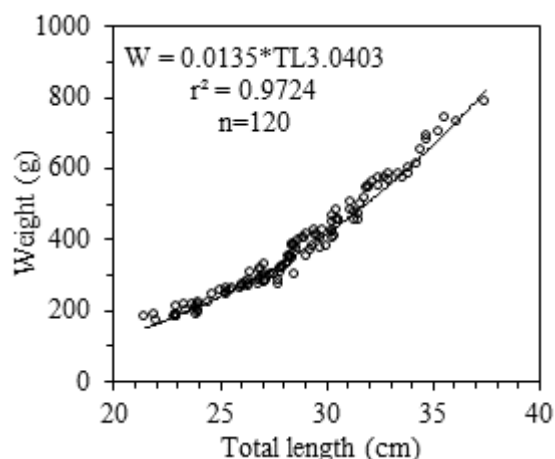
$$L_t = 43.088 * [1 - e^{-0.176(t+2.423)}]$$

Growth parameters estimated for the mirror carp caught from Keban Dam Lake between November 2016 and December 2016 were: 43.088 cm for  $L_\infty$ , 0.176 years<sup>-1</sup> for k, -2.423 years for  $t_0$ , 17 years for  $t_{max}$ , 2.51 for growth performance index ( $\Phi$ ) and 1.62 for condition factor ( $C_f$ ).

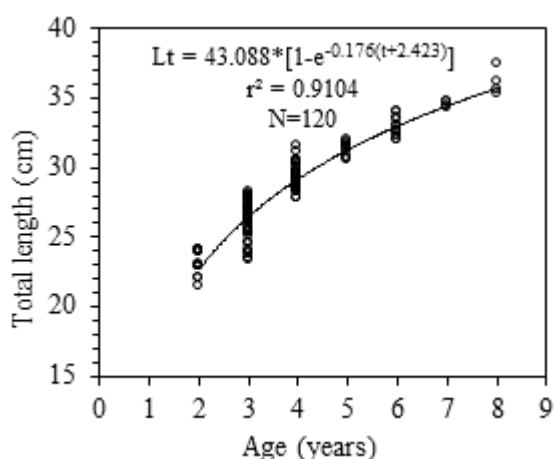
Total length-weight relationship and the logarithmic total length-weight relationship of the mirror carp caught from the lake are given in Figure 4 and Figure 5, respectively.



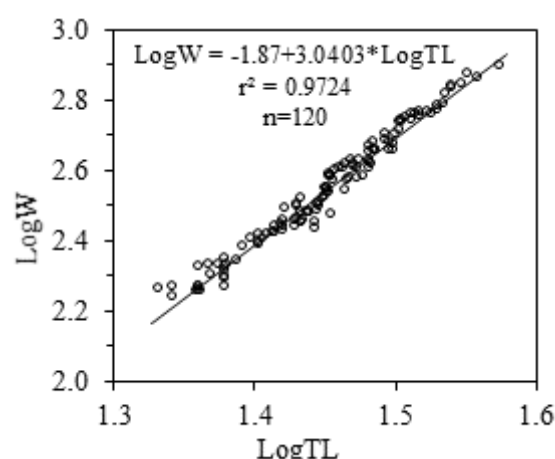
**Figure 2.** Total length-frequency (%) distribution of the mirror carp caught from Keban Dam Lake



**Figure 4.** Total length-weight relationship of the mirror carp caught from Keban Dam Lake



**Figure 3.** Age-at-total length predicted by Von Bertalanffy growth function of the mirror carp caught from Keban Dam Lake. Circles are experimental values; lines are estimated trend line



**Figure 5.** Logarithmic total length-weight relationship of the mirror carp caught from Keban Dam Lake.

Some descriptive statistics and estimated parameters of total length–weight relationships for the mirror carp caught from Keban Dam Lake are given in Table 2.

**Table 2.** Descriptive statistics and estimated parameters of total length–weight relationships for mirror carp from Keban Dam Lake

N	Total length (cm)		Length-weight relationship parameters					
	min	max	a	95% CL of a	b	SE (b)	95% CL of b	r <sup>2</sup>
120	21.50	37.50	0.014	0.011-0.018	3.040	0.047	2.947-3.135	0.972

The absolute, relative and instantaneous growth values of the mirror carp caught from Keban Dam Lake were the highest in age range 2-3, followed by age range 3-4 (Table 3). However, after age 4, the values started to decrease at a significant level.

**Table 3.** The absolute, relative and instantaneous growth values of the mirror carp caught from Keban Dam Lake.

Age range	Absolut growth (cm)	Relative growth (%)	Instantaneous growth
2-3	3.182	13.789	0.129
3-4	3.046	11.601	0.110
4-5	1.946	6.640	0.064
5-6	1.651	5.284	0.051
6-7	1.634	4.967	0.048
7-8	1.622	4.697	0.046

#### 4. Discussion

In the present study, growth parameters were found to be  $L_{\infty}$  (cm) = 43.088 cm,  $k = 0.176$ ,  $t_0 = -2.423$  and  $b = 3.04$ . The Brody Growth Coefficient ( $k$ ) was found in the present study (0.176) is higher than for the carp populations in Gölhisar Lake (0.172) [18], in Hafik Lake (0.140) [19], in Mamasın Lake (0.134) [20], in Tödürge Lake (0.110), [21], in Mogan Lake (0.087) [22]. On the other hand, the  $L_{\infty}$  value was determined in the present study (43.088) is smaller than for carp populations in the lakes mentioned above. Furthermore, "k" value alone is insufficient to determine the growth performance [15]. Because growth performance was not only related to "k" value, but also to  $L_{\infty}$  value. Thus, Munro and Pauly, [15] developed an equation that is known as the "Phi Prime Index or growth performance index ( $\Phi$ )" (equ., 2.5). In the present study, determined  $\Phi$  value (2.51) was smaller than that of other studies mentioned above.

According to the exponent  $b$  value (3.04), the mirror carp (*C. carpio*) population of Keban Dam Lake showed isometric growth ( $b \cong 3$ ). Similar  $b$  value has also been found for the common carp (*C. carpio*) population of Gelingüllü Dam Lake (3.023) [5], Kemer Reservoir (3.037) [23] and Sakarya River (2.98) [24]. However, some population of the common carp showed negative allometric growth ( $b < 3$ ) (i.e., Altinkaya Reservoir (2.825) [25], Lake İznik (2.830) [26] and Gölhisar Lake (2.874) [18]). Moreover, positive allometric growth ( $b > 3$ ) was also observed for some populations of common carp (i.e., Almus Dam Lake (3.319) [26], Ömerli Reservoir (3.140) [27]).

The absolute, relative and instantaneous

growth values started to reduce after age range 3-4 (see Table 3). It is well known that the growth is faster in young fish and slow down with reaching the sexual maturity. For mirror carps inhabiting in Keban Dam Lake, sexual maturity age was found as 3 year [6]. This finding supports the our growth values.

In conclusion, the present study is the first study on the some population parameters of mirror carp living in Keban Dam Lake. The findings of this study will be an important reference for the similar studies in the future.

#### 5. References

1. Yıldırım, T., Şen, D., Eroğlu, M., Çoban, M.Z., Demiroğlu, F., Gündüz, F., Arca, S., Demir, T., Gürçay, S., Uslu, A.A. ve Canpolat, İ. (2015). Keban Baraj Gölü balık faunası, Elazığ, Türkiye. *Fırat Üniv. Fen Bil. Der.*, **27**(1), 57-69.
2. AFYD. (2017). Angling for Youth Development. Some coarse species you may encounter; [cited 2017 Oct 18]. Available from <http://www.afyd.co.uk/wp-content/uploads/2013/11/Coarse-Species-for-website.pdf> [cited 2017]
3. Göksu, M.Z.L., Çevik, F., Fındık, Ö. and Sarıhan, E. (2003). Investigation of Fe, Zn and Cd in mirror carp (*Cyprinus carpio* L., 1758) and pike perch (*Stizostedion lucioperca* L., 1758) from Seyhan Dam Lake. *Ege J. Fish. Aqua. Sci.*, **20**, 69-74.
4. Çalta, M. and Ural, M.Ş. (2004). Acute toxicity of the synthetic pyrethroid deltamethrin to young mirror carp, *Cyprinus carpio*. *Fresenius Environ. Bull.* **13**, 1179-1183.
5. Kırankaya, Ş.G., Ekmekçi, F.G. (2004). Gelingüllü Baraj Gölünde yaşayan aynalı sazan (*Cyprinus carpio* L., 1758)'ın büyüme özellikleri. *Tr. J. Vet. Anim. Sci.*, **28**, 1057-1064.
6. Güç, G. (2006). Keban Baraj Gölü (Elazığ)'nde yaşayan aynalı sazan (*Cyprinus carpio* Linnaeus,

- 1758)'in üreme biyolojisi. [Master's Thesis]. Fırat University, Graduate School of Natural and Applied Sciences, 49p.
7. Bozkurt, Y. and Seçer, S. (2006). Evaluation of spermatological parameters of mirror carp (*Cyprinus carpio*) during spawning season. *Ege J. Fish. Aqua. Sci.*, **23**, 195-198.
  8. Temizer, İ.A. ve Şen, D. (2008). Keban Baraj Gölü'nde yaşayan aynalı sazan (*Cyprinus carpio* L., 1758)' da kemiksi yapılardan karşılaştırmalı yaş tayini. *Fırat Üniv. Fen ve Müh. Bil. Der.*, **20**(1), 57-66.
  9. Çolakoğlu, S. ve Akyurt, İ. (2011). Bayramiç Baraj Gölündeki (Çanakkale) aynalı sazan balıklarının (*Cyprinus carpio* L., 1758) populasyon yapısı ve büyüme özellikleri. *İstanbul Univ. J. Fish. Aqua. Sci.*, **26**, 27-46.
  10. DSİ. (2014). Keban Baraj Gölü [cited 2017 Oct 18]. Available from <http://www.dsi.gov.tr/projeler/keban-baraj%C4%B1> [cited 2017 Oct 18]
  11. Tombul, S. ve Karadoğan, S. (1998). Harput'un kuruluş yeri ve şehrin fonksiyonunu yitirmesi üzerinde etkili olan doğal çevre faktörleri, Dünü ve Bugünüyle Harput Sempozyumu, 24-27 Eylül 1998, Elazığ, s. 303-324.
  12. Ricker, W.E. (1973). Linear regressions in fishery research. *J. Fish. Res. Board. Can.* **30**(3), 409-434.
  13. Froese, R. (2006). Cube law, condition factor and weight-length relationships: history, meta-analysis and recommendations. *J. Appl. Ichthyol.*, **22**, 241-253.
  14. Von Bertalanffy, L. (1938). A quantitative theory of organic growth (inquiries on growth laws II). *Human Biol.*, **10**(2), 181-213.
  15. Munro, J.L. and Pauly, D. (1983). A simple method for comparing the growth of fishes and invertebrates. *Fishbyte*, **1**, 5-6.
  16. Taylor, C.C. (1958). Cod growth and temperature. *J. Cons. Int. Explor. Mer.*, **23**, 366-370.
  17. Ricker, W.E. (1979). Growth rates and models. In: Hoar WS, Randall DJ, Brett JR, editors. *Fish Physiology, III, Bioenergetics and Growth*, Academic Press, New York. pp. 677-743.
  18. Alp, A. and Balık, S. (2000). Growth conditions and stock analysis of the carp (*Cyprinus carpio* Linnaeus, 1758) population in Gölhisar Lake. *Turk. J. Zool.*, **24**, 291-304.
  19. Cengizler, İ. and Erdem, Ü. (1989). Hafik Gölündeki sazan (*Cyprinus carpio* L., 1758) populasyonunun bazı yapısal özelliklerinin incelenmesi. *Doğa Tr. Zool. Der.*, **13**, 175-188.
  20. İkiz, R. (1988). Mamasın Baraj Gölü'ndeki sazan (*Cyprinus carpio* L., 1758) populasyonu'nun Gelişmesi ve en küçük av büyüklüğünün saptanması. *Doğa Tu. Zool. Der.*, **12**, 55-67.
  21. Erdem, Ü. (1988). Tötürge Gölü'ndeki sazan (*Cyprinus carpio* L., 1758) populasyonunun bazı biyolojik özelliklerinin incelenmesi. *Doğa Tr. Zool. Der.*, **12**, 32-47.
  22. Düzgüneş, E. (1985). Mogan Gölü'ndeki sazan (*Cyprinus carpio* L., 1758) stoklarının tahmini ve populasyon dinamiği üzerinde bir araştırma. [PhD Thesis]. Ankara University, Graduate School of Natural and Applied Sciences, 91p.
  23. Özcan, G. ve Balık, S. (2007). Kemer Baraj Gölü'ndeki *Cyprinus carpio* L., 1758'nun bazı biyolojik özellikleri. *Türk Sucul Yaşam Dergisi*, **5**, 170-175.
  24. Ölmez, M. (1992). Yukarı Sakarya havzası Sakaryabaşı bölgesi balıklarının populasyon dinamiği üzerinde bir araştırma. [PhD Thesis]. Ankara University, Graduate School of Natural and Applied Sciences, 239p.
  25. Yılmaz, S., Polat, N. ve Yazıcıoğlu, O. (2010). Samsun İli içsularında yaşayan sazan (*Cyprinus carpio* L., 1758)'ın boy-ağırlık ve boy-boy ilişkileri. *Karadeniz Fen Bilimleri Dergisi*, **1**, 39-47.
  26. Karataş, M., Çiçek, E., Başusta, A. and Başusta, N. (2007). Age, growth and mortality of common carp (*Cyprinus carpio* Linnaeus, 1758) population in Almus Dam Lake (Tokat-Turkey). *J. Appl. Biol. Sci.*, **1**, 81-85.
  27. Tarkan, A.S., Gaygusuz, Ö., Acıpınar, H., Gürsoy, Ç. and Özuluğ, M. (2006). Length-weight relationship of fishes from the Marmara region (NW-Turkey). *J. Appl. Ichthyol.*, **22**(4), 271-273.